PREPARATORY STUDY FOR THE REVIEW OF COMMISSION REGULATION 548/2014 ON ECODESIGN REQUIREMENTS FOR SMALL, MEDIUM AND LARGE POWER TRANSFORMERS

Final Report-Annexes

Multiple FWC with reopening of competition in the field of Sustainable Industrial Policy and Construction – Lot 2: Sustainable product policy, ecodesign and beyond (No 409/PP/2014/FC Lot 2)

Client: European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

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1. ANNEX A COMPARISON OF END-OF-LIFE IN MEEUP (LOT 2) VERSUS MEERP (REVIEW) RESULTS

Results from MEEuP Ecoreport tool (2005) for BC1 - Distribution transformer A0+Ak

Life cycle Impact per product:	Date	Author
BC1 - Distribution transformer A0+Ak	0	BIO

Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
Materials	**unit**									
Bulk Plastics	g			**557967**			557967	0	**557967**	**0**
TecPlastics	g			**0**			0	0	**0**	**0**
Ferro	g			**1421195**			14212	1406983	**1421195**	**0**
Non-ferro	g			**548028**			5480	542548	**548028**	**0**
Coating	g			**12067**			121	11947	**12067**	**0**
Electronics	g			**0**			0	0	**0**	**0**
Misc.	g			**62679**			627	62052	**62679**	**0**
Total weight	g			**2601937**			578407	2023530	**2601937**	**0**
								see note!		
Other Resources & Waste							debet	credit		
Total Energy (GER)	MJ	179077	39733	**218810**	**4917**	**1200258**	39326	30550	**8776**	**1432760**
of which, electricity (in primary MJ)	MJ	5697	23796	**29493**	**12**	**1197161**	0	0	**0**	**1226666**
Water (process)	ltr	5899	354	**6253**	**0**	**79854**	0	0	**0**	**86107**
Water (cooling)	ltr	8581	11100	**19681**	**0**	**3191839**	0	0	**0**	**3211520**
Waste, non-haz./ landfill	g	9893055	132181	**10025236**	**2039**	**1487951**	31898	0	**31898**	**11547124**
Waste, hazardous/ incinerated	g	553	3	**556**	**41**	**27585**	557967	0	**557967**	**586149**
Emissions (Air)										
Greenhouse Gases in GWP100	kg CO2 eq.	7711	2212	**9923**	**290**	**52423**	2932	2280	**652**	**63289**
Ozone Depletion, emissions	mg R-11 eq.				negligible					
Acidification, emissions	g SO2 eq.	128579	9544	**138123**	**888**	**309667**	5840	2856	**2984**	**451662**
Volatile Organic Compounds (VOC)	g	867	7	**875**	**90**	**479**	86	39	**46**	**1490**
Persistent Organic Pollutants (POP)	ng i-Teq	32101	580	**32681**	**12**	**8172**	236	0	**236**	**41100**
Heavy Metals	mg Ni eq.	27558	1358	**28917**	**103**	**21083**	10564	0	**10564**	**60667**
PAHs	mg Ni eq.	23068	7	**23076**	**195**	**2849**	0	1	**-1**	**26119**
Particulate Matter (PM, dust)	g	6563	1470	**8033**	**14975**	**11073**	49587	48	**49538**	**83619**
Emissions (Water)										
Heavy Metals	mg Hg/20	13784	1	**13784**	**3**	**7855**	3316	0	**3316**	**24958**
Eutrophication	g PO4	431	20	**451**	**0**	**41**	190	0	**190**	**682**
Persistent Organic Pollutants (POP)	ng i-Teq				negligible					

Results from MEErP Ecoreport tool (2014) for BC1 - Distribution transformer A0+Ak

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL	RBR
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock		
	Materials	**unit**										
1	Bulk Plastics	g			**4 267**		**43**	2 371	1 940	0	**0**	
2	TecPlastics	g			**0**		**0**	0	0	0	**0**	
3	Ferro	g			**1 421 195**		**14 212**	71 770	1 363 636	0	**0**	
4	Non-ferro	g			**548 028**		**5 480**	27 675	525 833	0	**0**	
5	Coating	g			**0**		**0**	0	0	0	**0**	
6	Electronics	g			**0**		**0**	0	0	0	**0**	
7	Misc.	g			**40 981**		**410**	14 073	27 318	0	**0**	
8	Extra	g			**575 398**		**0**	226 649	354 503	0	**-5 754**	
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**	
10	Refrigerant	g			**0**		**0**	0	0	0	**0**	
	Total weight	g			**2 589 870**		**20 145**	342 539	2 273 230	0	**-5 754**	
									see note!			
	Other Resources & Waste							debet	credit			
11	Total Energy (GER)	MJ	146 513	17 114	**163 627**	**4 485**	**1 027 350**	1 237	-51 818		**1 144 881**	**0**
12	of which, electricity (in primary MJ)	MJ	4 971	10 179	**15 151**	**12**	**1 025 935**	0	-1 842		**1 039 256**	**0**
13	Water (process)	ltr	3 076	149	**3 225**	**0**	**31**	0	-759		**2 497**	**0**
14	Water (cooling)	ltr	3 947	4 677	**8 624**	**0**	**45 634**	0	-955		**53 304**	**0**
15	Waste, non-haz./ landfill	g	2 017 086	61 308	**2 078 394**	**2 039**	**548 844**	24 069	-770 364		**1 882 981**	**0**
16	Waste, hazardous/ incinerated	g	306	3	**309**	**41**	**16 189**	0	-109		**16 430**	**0**
	Emissions (Air)											
17	Greenhouse Gases in GWP100	kg CO2 eq.	7 497	957	**8 454**	**290**	**43 866**	2	-2 834		**49 779**	**0**
18	Acidification, emissions	g SO2 eq.	127 819	4 133	**131 953**	**887**	**195 056**	73	-48 552		**279 418**	**0**
19	Volatile Organic Compounds (VOC)	g	867	6	**873**	**90**	**22 920**	0	-242		**23 641**	**0**
20	Persistent Organic Pollutants (POP)	ng i-Teq	32 097	580	**32 677**	**12**	**2 715**	14	-12 300		**23 117**	**0**
21	Heavy Metals	mg Ni eq.	27 543	1 346	**28 890**	**103**	**10 648**	32	-10 474		**29 199**	**0**
22	PAHs	mg Ni eq.	23 065	5	**23 071**	**195**	**2 624**	0	-7 651		**18 239**	**0**
23	Particulate Matter (PM, dust)	g	6 377	635	**7 013**	**14 971**	**4 167**	36	-2 412		**23 775**	**0**
	Emissions (Water)											
24	Heavy Metals	mg Hg/20	13 620	44	**13 664**	**3**	**4 552**	4	-5 223		**13 000**	**0**
25	Eutrophication	g PO4	629	7	**636**	**0**	**200**	62	-178		**720**	**0**

2. ANNEX B MEERP TOOL (2014) INPUTS

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
1	Core steel	865000,0	3-Ferro	22 - St sheet galv.	
2	Aluminum wire	123000,0	4-Non-ferro	27 - Al sheet/extrusion	
3	Copper wire	336000,0	4-Non-ferro	29 - Cu winding wire	
4	Copper sheet	89028,4	4-Non-ferro	31 - Cu tube/sheet	
5	Steel tank	556194,7	3-Ferro	23 - St tube/profile	
6	Paper	33360,8	7-Misc.	58 - Office paper	
7	Resin	0,0	2-TecPlastics	15 - Epoxy	
8	Ceramic	12553,4	8-Extra	104-ceramics	
9	Oil	553700,0	8-Extra	102-Mineral oil	
10	Cardboard	7620,4	7-Misc.	57 - Cardboard	
11	Nomex	0,0	2-TecPlastics	20 - Aramid fibre	
12	other plastic parts	4267,4	1-BlkPlastics	2 - HDPE	
13	Wood	9144,5	8-Extra	103-Wood	

Pos nr	MANUFACTURING Description	Weight in g	Percentage Adjust	Category index (fixed)
201	**OEM Plastics Manufacturing** (fixed)	4267		21
202	**Foundries Fe/Cu/Zn** (fixed)	0		35
203	**Foundries Al/Mg** (fixed)	0		36
204	**Sheetmetal Manufacturing** (fixed)	1077028		37
205	**PWB Manufacturing** (fixed)	0		54
206	**Other materials** (Manufacturing already included)	1508574		
207	**Sheetmetal Scrap** **(Please adjust percentage only)**	53851	5%	38

Pos nr	DISTRIBUTION (incl. Final Assembly) Description		Answer	Category index (fixed)
208	**Is it an ICT or Consumer Electronics product <15 kg ?**		NO	60
209	**Is it an installed appliance (e.g. boiler)?**		YES	61
				63
210	**Volume of packaged final product in m³**	**in m3**	4,38	64
				65

Pos nr	USE PHASE direct ErP impact Description		unit	Subtotals
226	ErP Product (service) Life in years	40	years	
	Electricity			
227	On-mode: Consumption per hour, cycle, setting, etc.	2849,680948	kWh	2849,680948
228	On-mode: No. of hours, cycles, settings, etc. / year	1	#	
229	Standby-mode: Consumption per hour	0	kWh	0
230	Standby-mode: No. of hours / year	0	#	
231	Off-mode: Consumption per hour	0	kWh	0
232	Off-mode: No. of hours / year	0	#	
	TOTAL over ErP Product Life	113,99	MWh (=000 kWh)	66
	Heat			
233	Avg. Heat Power Output	0	kW	
234	No. of hours / year	0	hrs.	
235	Type and efficiency (Click & select)			86-not applicable
	TOTAL over ErP Product Life	0,00	GJ	
	Consumables (excl, spare parts)			material
236	Water	0	m^3/year	84-Water per m3
237	Auxilliary material 1 (Click & select)	0	kg/ year	86 -None
238	Auxilliary material 2 (Click & select)	0	kg/ year	86 -None
239	Auxilliary material 3 (Click & select)	0	kg/ year	86 -None
240	Refrigerant refill (Click & select type, even if there is no re	0	kg/ year	3-R404a; HFC blend; 3920
	Maintenance, Repairs, Service			
241	No. of km over Product-Life	500	km / Product Life	87
242	Spare parts (fixed, 1% of product materials & manuf.)	25899	g	1%

Pos nr	DISPOSAL & RECYCLING Description				
253	product (stock) life L, in years	40	Please edit values with red font		
		current	L years ago	period growth PG in %	CAGR in %/a
254	unit sales in million units/year	0,140	0,000	0,0%	0,0%
255	product & aux. mass over service life, in g/unit	2615768	2615768	0,0%	0,0%
256	total mass sold, in t (1000 kg)	367,2538811	0	0,0%	0,0%

Pos nr	Per fraction (post-consumer)	1	2	3	4	5	6	7a	7b	7c	8	9		
		Bulk Plastics	TecPlastics	Ferro	Non-ferro	Coating	Electronics	Misc. , excluding refrigant & Hg	refrigerant	Hg (mercury), in mg/unit	Extra	Auxiliaries	*TOTAL (CARG avg.)*	
257	current fraction, in % of total mass (or mg/unit Hg	0,2%	0,0%	54,9%	21,2%	0,0%	0,0%	1,6%	0,0%	0,0	22,2%	0,0%	*100,0%*	
258	fraction x years ago, in % of total mass	0,2%	0,0%	54,9%	21,2%	0,0%	0,0%	1,6%	0,0%	0,0	22,2%	0,0%	*100,0%*	
259	CAGR per fraction r, in %	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%		
	current product mass in g	*4310*	*0*	*1435407*	*553509*	*0*	*0*	*41391*	*0*	*0*	*581152*	*0*	*2615768*	
260	stock-effect, total mass in g/unit	0	0	0	0	0	0	0	0	0,0	0	0	*0*	0%
261	EoL available, total mass ('arisings') in g/unit	4310	0	########	553509	0	0	41391	0	0,0	581152	0	########	100%
262	EoL available, subtotals in g		4310		1988915		0	41391	0	0,0	581152	0	########	
													AVG	
263	EoL mass fraction to re-use, in %						1%			1%		5%	*1,0%*	
264	EoL mass fraction to (materials) recycling, in %	29%	29%		94%		50%	64%	30%	39%	60%	30%	*85,9%*	
265	EoL mass fraction to (heat) recovery, in %	15%	15%		0%		0%	1%	0%	0%	0%	10%	*0,0%*	
266	EoL mass fraction to non-recov. incineration, in %	22%	22%		0%		30%	5%	5%	5%	10%	10%	*2,3%*	
267	EoL mass fraction to landfill/missing/fugitive, in %	33%	33%		5%		19%	29%	64%	55%	29%	45%	*10,8%*	
268	TOTAL	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100,0%*	
269	EoL recyclability****, (click& select: 'best', '>avg', 'avg' (basecase); '<avg'.; 'worst')	**avg**	**avg**	**avg**	**avg**	**avg**	**avg**	**avg**	**avg**	**avg**	**avg**	**avg**	***avg***	
		0%	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*		

L is product (stock) life = period between product purchased and product discarded

PG=growth rate over period of L years= (value current - value L years ago)/(value L years ago)

CAGR=Compound Annual Growth Rate = (1+ PG)^(1/L) - 1 (^= to the power)

EoL available mass' or 'arisings' = Total mass available for End-of-Life (EoL) management = recycmax * current fraction * product mass, with recycmax=1/(1+CAGR)^L,

'stock' = the surplus (or deficit) of mass in stock (in use or stored with consumer) due to growth (or decline) of the unit sales or the share of the materials fraction over a period that equals the product life. stock= stock-effect arisings - product mass*current fraction ; '

're-use'= fraction of EoL available mass in components that can be re-used in new products. The generic credit relative to the re-used mass is 75% on all impacts and for all fractions, taking into account the impact of collection, sorting, cleaning, etc. (as opposed to MEEuP 2005, where the collection effort was calculated separately). In case the specific re-use credit found for a specific product deviates from the default it is recommended to adapt the mass fraction

recycling'= fraction of EoL available mass that is recycled for its materials. For metals this is already included in the production impact, based roughly on the fraction mentioned (values cannot be edited). For plastics, electronics, miscellaneous materials, refrigerants, mercury and the extra materials these values need to be edited (overwrite default values). The credit relates to the recyled mass and depends on the main virgin material that will be displaced by the recycled mass, the remaining value at final disposal (e.g. heat recovery) and/or avoidance of operations for disposal of hazardous substances (pyrolysis). E.g. for plastics the most popular displaced material is wood (e.g. 27 MJ/kg is < 50% of bulkplastics value) and remaining value at final disposal is 50% of the

For electronics (PWBs, ICs, controllers, displays, etc.) main credits come from recovery of metals (Cu, Fe, tin, traces of Au, Pt, Pd), glass (from displays, cullet displaces virgin material mainly in fiberglass insulation) and avoidance of treatment of hazardous substances (e.g. Pb, Cd, etc.). Note that the WEEE recast impact assessment report found official electronics recycling rates to be low (in 2005: 20% for tools, 27% for ITC equipment, 35-40% for TVs/monitors) but suspects actual, unreported (possibly incorrect) recycling activities to be substantially higher. For miscellaneous materials recycling fractions fully depend on the materials involved and a weighted average needs to be determined beforehand. For 'Misc.', including refrigerants and Hg, credit comes from re-use after purification, avoiding treatment as hazardous waste, etc. . For all materials, except metals (where it is assumed to be higher), a credit of 40% on all impacts is assumed related to the recycled mass. See MEErP Methodology Report Part 2 for more guidance.

'(heat) recovery' = fraction of EoL available mass where the combustion heat is used, e.g. for district heating. In the context of ErP it is assumed to apply only to plastics and all other materials for which a feedstock energy value is given. The credit is 75% of feedstock energy (net combustion value) and GWP.

'non-recov. Incineration' = fraction of EoL available mass that is incinerated without heat recovery, either because there is no effective contribution to the combustion (non-combustibles), the incineration plant has no clients for waste heat, etc.. Impacts of 'incineration' as given in the Unit Indicator table (see MEErP Methodology Report Part 2, Table 13, row 92) apply.

'landfill/fugitive/missing' = fraction of EoL available mass that goes to landfill, that escapes during use (for substances that are gaseous or evaporate at atmospheric conditions like most refrigerants and mercury) and that are unaccounted for (illegal dumping etc.). Impacts of 'landfill' as given in the Unit Indicator table (see MEErP Methodology Report Part 2, Table 13, row 89) apply.

'recyclability' relates to the potential of the new products to change the course of the materials flows , e.g. due to faster pre-disassembly or other ways to bring about less contamination of the mass to be recycled (see MEErP Methodology Report Part 2) . Therefore it is economically likely that the recycled mass at EoL will displace more virgin material in other applications . The recyclability does not influence the mass balance but it does give a reduction or increase up to 10% on all impacts of the recycled mass. It is forward looking, e.g. values different from 'avg' (=base case) should only be filled in for design options.

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit
A	Product Life	**40**	years
B	Annual sales	0,1404	mln. Units/year
C	EU Stock	2,25	mln. Units
D	Product price	€ 8 977,51	Euro/unit
E	Installation/acquisition costs (if any)	€ 0,00	Euro/ unit
F	Fuel rate (gas, oil, wood)		Euro/GJ
G	Electricity rate	€ 0,085	Euro/kWh
H	Water rate		Euro/m3
I	Aux. 1: None		Euro/kg
J	Aux. 2 :None		Euro/kg
K	Aux. 3: None		Euro/kg
L	Repair & maintenance costs	€ 0,00	Euro/ unit
M	Discount rate (interest minus inflation)	4%	%
N	Escalation rate (project annual growth of running costs)	2%	%
O	Present Worth Factor (PWF) (calculated automatically)	27,54	(years)
P	Ratio efficiency STOCK: efficiency NEW, in Use Phase	1,00	

3. ANNEX C QUESTIONNAIRE FOR INSTALLERS ON TRANSFORMERS CONSTRAINTS AND LIMITATIONS

Multiple FWC with reopening of competition in the field of Sustainable Industrial Policy and Construction – Lot 2: Sustainable product policy, ecodesign and beyond
(No 409/PP/2014/FC Lot 2)
Client: European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs

PREPARATORY STUDY FOR THE REVIEW OF COMMISSION REGULATION 548/2014 ON ECODESIGN REQUIREMENTS FOR SMALL, MEDIUM AND LARGE POWER TRANSFORMERs

Questionnaire for Installers on Transformers constraints and limitations

Dear Madams and Sirs,

This enquiry is designed to gather data to determine the effect that Tier 2 efficiency requirements would have on transformer constraints. More information on the scope of work can be found on the project website: https://transformers.vito.be/. This questionnaire document is intended to structure your data input to reflect the current and future situation in the transformer market (EU) appropriately.
The enquiry is a **joint enquiry with CENELEC CLC/TC14** and hence **if you have filled in such an enquiry before you can also send it to share the work for the ongoing study.**
Note that VTIO is committed to comply with antitrust rules. As a result, the present enquiry does not require the participants to provide (i) individualized and /or raw information on the technical specifications of transformers they supply confidential to their customers nor (ii) to provide any other commercially sensitive information. Similarly, the respondents to this enquiry should not voluntarily provide such information in response to this enquiry if this does not belong to the public domain and/or cannot be disclosed within the report of supplied to the European Commission services. This questionnaire document is only intended to structure your data input to reflect the current and future situation in the transformer market (EU) appropriately. The primary objective of this enquiry it to gather sufficient information to assess if Tier 2 requirements of EU regulation 548/2014, applicable in 2021, are still technologically justified.
You are kindly invited to reply to this Enquiry indicating, if possible, what are the most typical values to be considered in your area for the different types of transformers.
This enquiry consists of two sections, where data can be provided by filling the proposed tables. Please add as many columns as necessary (one column per each transformer). In case not all requested data are available, feel free to indicate "N.A." – "Not Available" – in the cells with missing data.
The deadline to submit your answers is December 19th, 2016.

Best Regards,

Paul Van Tichelen on behalf of the project team
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Sent to: transformers@vito.be

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1st SECTION: TRANSFORMERS GENERAL DATA AND CONSTRAINTS

Transformer category(1)					
Rated power(2) of each winding [MVA / MVA / ...]					
Frequency [Hz]					
Number of phases					
Type (liquid / dry)					
Rated voltage of each winding [kV / kV / ...]					
Highest voltage for equipment of each winding Um [kV / kV / ...]					
Vector Group(3)					
Regulation type(4)					
Type of cooling(5)					
Impedance(6) [%]					
Maximum dimensions(7) (length x width x height) [mm]					
Maximum weight [kg]					
Minimum clearance between live parts and ground [mm]					
Minimum free distance required around the transformer [mm]					
Please clarify the reason for the constraints(8) and the consequence of exceeding them					

(1) Please specify the transformer application by indicating the relevant letter among the options in the following list:

A. Arc furnace transformer
B. Distribution transformer

...

3/4

C. Earthing transformer
D. Generator step-up transformer
E. Ground mounted distribution transformer
F. HVDC converter transformer
G. Medium Voltage (MV) to Medium Voltage (MV) interface transformer
H. Offshore transformer – Oil platform
I. Offshore transformer – Wind collector substation
J. Offshore transformer – Wind turbine
K. Phase-shifting transformer
L. Photovoltaic application transformer
M. Pole mounted distribution transformer
N. Rectifier transformer
O. Starting transformer
P. Subsea transformer
Q. System intertie transformer
R. Traction transformer for fixed installations
S. Traction transformer for rolling stock
T. Variable Speed Drive transformer (VSD)
U. Wind turbine onshore transformer

In case a specific application is missing, feel free to add additional letters to the list above

(2) If different values of apparent power are assigned under different cooling methods, please indicate the highest of these values, which is the rated power
(3) As defined in EN 60076-1, paragraph 7. In particular:

   a. if a transformer is specified with a reconfigurable winding connection (reconnectable windings), the alternative coupling voltage and connection shall be noted in brackets. For example: 110 / 11 (5,5) kV indicates a reconnectable LV winding
   b. if a tertiary winding is provided as stabilizing winding, the "d" symbol shall be preceded by the "+" sign and no phase displacement shall be indicated. For example: YNa0+d indicates the presence of a tertiary stabilizing winding

(4) Please specify either "None", "DETC" or "OLTC". In case voltage variation is provided on more than one winding, please indicate each winding voltage and its regulation type separately
(5) If the transformer has several assigned cooling methods, please indicate all of them
(6) Referred to the highest value of rated power and to the rated voltage (i.e. rated tap position). In case of more than two windings, please indicate between which winding pair and at which power the value refers
(7) Parameters not constrained can be left unspecified (e.g. if the length and the width are constrained, but the height is not, it can be indicated or example: 6000 x 4000 x H)
(8) For example: size of door in existing substation, width limitation on transport, limits on pole weight, etc...

2nd SECTION: TRANSPORTATION DIMENSIONAL AND WEIGHT CONSTRAINTS

Please indicate in the following table what are the transportation constraints to be considered in your country (maximum values). In case more than one type of constraint exists (e.g. constraints may be different depending on the installation site), feel free to add rows to the table below and use the column "Comments" to clarify the rationale.

	Length [mm]	Width [mm]	Height [mm]	Weight [kg]	Comments
Railway transportation					
Road transportation					

4. ANNEX D PROCESSED INSTALLER REQUIREMENT DATA FROM ENQUIRY ON A SELECTION OF TRANSFORMERS

Received data for 250 kVA liquid transformers:

		brownfied country specifications							
country		BE	D	NL	F	PL	ES	N	N
sample (s) or representative (r)		r	s REWAG2015	r spec 11/2016	r with protect.	s	r Iberdrola2014	s	s Hafslund
Transformer category(1)		DT	DT	DT	DT-Enedis	DT	DT	DT	DT
Rated power of each winding (kVA)		250/250/250	250	250	250	250	250	200	200
Number of phases		3	3	3	3	3	3	3	3
Type (liquid / dry)		liquid	liquid	liquid	liquid	liquid	liquid	liquid	liquid
Rated voltage of each winding (kV)	high side (kV)	15,4	20,8	23	20	21	20	22	22
	Low Side (kV)	0,42	0,4	0,4	0,4	0,42	0,42	0,42	0,42
	Low Side (kV) 2 LV windings	0,242							
Highest voltage for equipment of each winding Um (kV)	high side (kV)	17,5	24	24	20	24	24	24	24
	low side (kV)	3,6	DIN EN 50386	EN 50386 (1kV		1	1,1	1,1	1,1
Vector Group(3)		DYN11a11	DYN5	DYN5 or DYN1	DYN11	DYN5	DYN11	Yyn0 or DYN11	Yyn0
Regulation type		DETC		DETC		DETC	DETC	DETC	DETC
Tapping				±2x2.5%			±2x2.5%		
Type of cooling		onan	onan	onan	-	onan	onan	onan	onan
Impedance(6) [%]		4	4	4	4	4	4	4	4,45
max. length (mm)		1200	1200	1200	1200	1350	1300	1200	1120
max. width (mm)		700	800	800	800	900	910	750	750
max. heigth (mm)		1245	1600	1600	1300	1700	1680	1500	1130
max. weight (kg)		1200	1500	1360	1200	1200	1400	NA	1105
Tier 1 (CkA0) or Tier 2(AkA0-10%)									
LV winding material									
HV winding material									
low loss steel (<0,9 W/kg@1,7T/50Hz)									
oil type									
insulation type									
operating temperature(Pk)									
stimated price increase in % of Tier 1 desig									
Sound power level			<47	<47					
Minimum clearance between live parts and ground [mm]		EC60076-3	55	100					IEC 60076-3
Minimum free distance required around the transformer [mm]					150				
Please clarify the reason for the constraints(8) and the consequence of exceeding them		existing substations	=+10 % allowed on dimensions	100 mm clearance for fork lift note: AMDT are not allowed	is include in compact substation Max floor : 1200kg DSO need to manage faults on transformers and replace in existing substation (	Size of door in existing substation, limits on pole weight			

		brownfied country specifications (received after manufacturer enquiry launch)		
country		SI	IT	IT
sample (s) or representative (r)		r	r areti	r e-distributzione
Transformer category(1)		DT	DT	DT
Rated power of each winding (kVA)		250	250/187	250
Number of phases		3	3	3
Type (liquid / dry)		liquid	liquid	liquid
Rated voltage of each winding (kV)	high side (kV)	21(10,5)	20,8(8,4)	20 or 15 or 10
	Low Side (kV)	0,42	0,42(0,242)	0,42
	Low Side (kV) 2 LV windings			
Highest voltage for equipment of each winding Um (kV)	high side (kV)	24	24	24
	low side (kV)	1,1	1,1	1,1
Vector Group(3)		Dyn5	Dyn11	Dyn11
Regulation type		DETC	DETC	DETC
Tapping				
Type of cooling		onan	onan	onan
Impedance(6) [%]		4	4(0,42)/2,8(0,242)	4 (or 6)
max. length (mm)		1400	1400	1400
max. width (mm)		750	850	800
max. heigth (mm)		NA	NA	1750
max. weight (kg)		1500	NA	2000
Tier 1 (CkA0) or Tier 2(AkA0-10%)				
LV winding material				
HV winding material				
low loss steel (<0,9 W/kg@1,7T/50Hz)				
oil type				
insulation type				
operating temperature(Pk)				
stimated price increase in % of Tier 1 desig				
Sound power level				
Minimum clearance between live parts and ground [mm]		130(230)	NA	NA
Minimum free distance required around the transformer [mm]		100	200	NA
Please clarify the reason for the constraints(8) and the consequence of exceeding them		restrictions on the size (width) of the transformer space in the existing compact TP	size of door in existing substation	

Received data for 400 kVA liquid transformers:

		brownfied country specifications					
country		BE	D	NL	PL	ES	N
sample (s) or representative (r)		r	s REWAG2015	r spec 11/2016	s	r Iberdrola2014	r
Transformer category(1)		DT	DT	DT	DT	DT	DT
Rated power of each winding (kVA)		400/400/400	400	400	400	400	500
Number of phases		3	3	3	3	3	3
Type (liquid / dry)		liquid	liquid	liquid	liquid	liquid	liquid
Rated voltage of each winding (kV)	high side (kV)	15,4	20,8	23	21	20	22
	Low Side (kV)	0,42	0,4	0,4	0,42	0,42	0,42
	Low Side (kV) 2 LV windings	0,242					
Highest voltage for equipment of each	high side (kV)	17,5	24	24	24	24	24
	low side (kV)	3,6	DIN EN 50386	EN 50386 (1kV)	1	1,1	1,1
Vector Group(3)		DYN11a11	DYN5	DYN5 or DYN11	DYN5	DYN11	Yyn0 or DYN11
Regulation type		DETC		DETC	DETC	DETC	DETC
Tapping				±2x2.5%		±2x2.5%	
Type of cooling		onan	onan	onan	onan	onan	onan
Impedance(6) [%]		4	4	4	4 and 4.5	4	4
max. length (mm)		1250	1300	1320	1400	1620	1500
max. width (mm)		850	900	800	900	1020	900
max. heigth (mm)		1300	1700	1600	1700	1750	2100
max. weight (kg)		1800	1800	1850	1500	1750	NA
Tier 1 (CkA0) or Tier 2(AkA0-10%)							
LV winding material							
HV winding material							
low loss steel (<0,9 W/kg@1,7T/50Hz)							
oil type							
insulation type							
operating temperature(Pk)							
imated price increase in % of Tier 1 des							
Sound power level			<50	<50			
Minimum clearance between live parts and ground [mm]		EC60076-3	55	100			IEC 60076-3
Minimum free distance required around the transformer [mm]							
Please clarify the reason for the constraints(8) and the consequence of exceeding them		existing substations	=+10 % allowed on dimensions	100 mm clearance for fork lift note: AMDT are not allowed	Size of door in existing substation, limits on pole weight		

		brownfied country specifications (received after manufacturer enquiry launch)				
country		SI	IT	IT	SK	SK
sample (s) or representative (r)		r	r areti-1	r e-distributzione	r	r
Transformer category(1)		DT	DT	DT	DT	DT
Rated power of each winding (kVA)		400	400/300	400	400	400
Number of phases		3	3	3	3	3
Type (liquid / dry)		liquid	liquid	liquid	liquid	liquid
Rated voltage of each winding (kV)	high side (kV)	21(10,5)	20,8(8,4)	20 or 15 or 10	33	22
	Low Side (kV)	0,42	0,42(0,242)	0,42	0,42	0,42
	Low Side (kV) 2 LV windings					
Highest voltage for equipment of each	high side (kV)	24	24	24	NA	NA
	low side (kV)	1,1	1,1	1,1	NA	NA
Vector Group(3)		Dyn5	Dyn11	Dyn11	Dyn1	Dyn1
Regulation type		DETC	DETC	DETC	OLTC (13step)	OLTC (6step)
Tapping						
Type of cooling		onan	onan	onan	onan	onan
Impedance(6) [%]		4	4,3(0,42)/3,2(0,242)	4 (or 6)	NA	NA
max. length (mm)		1400	1600	1600	NA	NA
max. width (mm)		750	880	1030	NA	NA
max. heigth (mm)		NA	NA	1850	NA	NA
max. weight (kg)		1500	2500	2000	4260	1300
Tier 1 (CkA0) or Tier 2(AkA0-10%)						
LV winding material						
HV winding material						
low loss steel (<0,9 W/kg@1,7T/50Hz)						
oil type						
insulation type						
operating temperature(Pk)						
imated price increase in % of Tier 1 des						
Sound power level						
Minimum clearance between live parts and ground [mm]		130(230)	NA	NA	NA	NA
Minimum free distance required around the transformer [mm]		100	200	NA	NA	NA
Please clarify the reason for the constraints(8) and the consequence of exceeding them		restrictions on the size (width) of the transformer space in the existing compact TP	size of door in existing substation			

Received data for 630 kVA liquid transformers:

		brownfied country specifications							
country		BE	D	NL	F	PL	ES	N	S
sample (s) or representative (r)		r	s REWAG2015	r spec 11/2016	r classical	s	r Iberdrola2014	r	r
Transformer category(1)		DT	DT	DT	DT-Enedis	DT	DT	DT	DT
Rated power of each winding (kVA)		630/630/630	630	630	630	630	630	630	800
Number of phases		3	3	3	3	3	3	3	3
Type (liquid / dry)		liquid	liquid	liquid	liquid	liquid	liquid	liquid	liquid
Rated voltage of each winding (kV)	high side (kV)	15,4	20,8	23	20	21	20	22	22
	Low Side (kV)	0,42	0,4	0,4	0,4	0,42	0,42	0,42	0,42
	Low Side (kV) 2 LV windings	0,242							
Highest voltage for equipment of each	high side (kV)	17,5	24	24	20	24	24	24	24
	low side (kV)	3,6	DIN EN 50386	EN 50386 (1kV)		1	1,1	1,1	1,1
Vector Group(3)		DYN11a11	DYN5	DYN5 or DYN11	DYN11	DYN5	DYN11	Yyn0	Yyn0 or DYN
Regulation type		DETC		DETC		DETC	DETC	DETC	
Tapping				±2x2.5%			±2x2.5%		
Type of cooling		onan	onan	onan		onan	onan	onan	onan
Impedance(6) [%]		4	4	4	4	4 and 4.5	4	4 or 6	5,8
max. length (mm)		1500	1500	1500	1700	1400	1650	1550	1500
max. width (mm)		850	900	820	920	900	1140	900	900
max. heigth (mm)		1360	1800	1680	1650	1700	1870	2100	1400
max. weight (kg)		2400	2500	2650	2500	2000	2400	NA	2300
Tier 1 (CkA0) or Tier 2(AkA0-10%)									
LV winding material									
HV winding material									
low loss steel (<0,9 W/kg@1,7T/50Hz)									
oil type									
insulation type									
operating temperature(Pk)									
Estimated price increase in % of Tier 1 design									
Sound power level			<50	<52					
Minimum clearance between live parts and ground [mm]		EC60076-3	55	100				IEC 60076-3	
Minimum free distance required around the transformer [mm]					200				
Please clarify the reason for the constraints(8) and the consequence of exceeding them		existing substations	=+10 % allowed on dimensions	100 mm clearance for fork lift note: AMDT are not allowed	In urban areas, it would be impossible to address faults on transformers rated 630 to 1000 kVA in existing secondary substations, since the space would not be big enough and the pad would not be designed for higher weight. Max floor 2500	Size of door in existing substation, limits on pole weight			

		brownfied country specifications (received after manufacturer enquiry launch)		
country		SI	IT	IT
sample (s) or representative (r)		r	r areti-1	r e-distributzione
Transformer category(1)		DT	DT	DT
Rated power of each winding (kVA)		630	630/472	630
Number of phases		3	3	3
Type (liquid / dry)		liquid	liquid	liquid
Rated voltage of each winding (kV)	high side (kV)	21(10,5)	20,8(8,4)	20 or 15 or 10
	Low Side (kV)	0,42	0,42(0,242)	0,42
	Low Side (kV) 2 LV windings			
Highest voltage for equipment of each	high side (kV)	24	24	24
	low side (kV)	1,1	1,1	1,1
Vector Group(3)		Dyn5	Dyn11	Dyn11
Regulation type		DETC	DETC	DETC
Tapping				
Type of cooling		onan	onan	onan
Impedance(6) [%]		4	6,7(0,42)/5,1(0,242)	4 (or 6)
max. length (mm)		1500	1600	1800
max. width (mm)		800	930	1030
max. heigth (mm)		NA	NA	1850
max. weight (kg)		2000	2500	2000
Tier 1 (CkA0) or Tier 2(AkA0-10%)				
LV winding material				
HV winding material				
low loss steel (<0,9 W/kg@1,7T/50Hz)				
oil type				
insulation type				
operating temperature(Pk)				
Estimated price increase in % of Tier 1 design				
Sound power level				
Minimum clearance between live parts and ground [mm]		130(230)	NA	NA
Minimum free distance required around the transformer [mm]		100	200	NA
Please clarify the reason for the constraints(8) and the consequence of exceeding them		restrictions on the size (width) of the transformer space in the existing compact TP	size of door in existing substation	

5. ANNEX E QUESTIONNAIRE FOR DISTRIBUTION TRANFORMER MANUFACTURERS (MV/LV) FOR BROWN FIELD AND GREEN FIELD APPLICATIONS

Questionnaire for 250 kVA liquid, 400 kVA liquid, 630 kVA liquid, 100 kVA pole mounted, 160 kVA pole mounted transformers
Example for 400 kVA:

		brownfield average	brownfield borderline	brownfield reference designs						Tier 1 greenfield reference design		Tier 2 greenfield reference design	
country				type									
sample (s) or representative (r)													
Transformer category(1)		DT	DT										
Rated power of each winding (kVA)		400	400										
Number of phases		3	3										
Type (liquid / dry)		liquid	liquid										
Rated voltage of each winding (kV)	high side (kV)	high side (kV)	15,4										
	Low Side (kV)	Low Side (kV)	0,4										
	Low Side (kV) 2 LV windings												
Highest voltage for equipment of each	high side (kV)	24	24										
	low side (kV)	1,1	3,6										
Vector Group(3)		Dyn11	Dyn11										
Regulation type		DETC	DETC										
Tapping			±2x2.5%										
Type of cooling		onan	onan										
Impedance(6) [%]		4	4		?	?	?	?	?	?	?	?	?
max. length (mm)		1398	1250		?	?	?	?	?	?	?	?	?
max. width (mm)		895	800		?	?	?	?	?	?	?	?	?
max. heigth (mm)		1692	1300		?	?	?	?	?	?	?	?	?
max. weight (kg)		1740	1500		?	?	?	?	?	?	?	?	?
Tier 1 (CkA0) or Tier 2(AkA0-10%)					Tier 1	Tier 2	Tier 1	Tier 2	Tier 2				
LV winding material					Alu	Alu	Alu	Alu	Alu	Alu	Alu	Alu	Alu
HV winding material					Alu	Alu	Alu	Alu	Alu	Alu	Alu	Alu	Alu
low loss steel (<0,9 W/kg@1,7T/50Hz)					≤0,9W/kg	≤0,9W/kg	≤0,9W/kg	≤0,9W/kg	≤0,9W/kg	≤0,9W/kg	≤0,9W/kg	≤0,9W/kg	≤0,9W/kg
oil type					mineral	mineral	mineral	mineral	mineral	mineral	mineral	mineral	mineral
insulation type					cellulose	cellulose	cellulose	cellulose	cellulose	cellulose	cellulose	cellulose	cellulose
operating temperature(Pk)					75°C	75°C	75°C	75°C	75°C				
imated price increase in % of Tier 1 des													
Sound power level													
Minimum clearance between live parts and ground [mm]													
Minimum free distance required around the transformer [mm]													
Please clarify the reason for the constraints(8) and the consequence of exceeding them													

6. Annex F Minutes Stakeholder KickoffMeeting for Preparatory study for the review of Commission Regulation 548/2014 on transformers

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Date : 9/03/2016
From : Paul Van Tichelen

Ref. VITO/1610352/PVT
Annex(es): Powerpoint presentations of the meeting (see project website)

To : Cesar Santos; Stakeholders

Copy (CC) : Paul Van Tichelen, Paul Waide, Berend Evenblij, Peter Heskes

Minutes of informative stakeholder kick-off meeting for Preparatory study for the review of Commission Regulation 548/2014 on transformers

EC Breydel building (Ayral room), avenue d'Auderghem 45, Brussels, 16th September 2016

Participants

European Commission

DG GROWTH — Cesar Santos (CS)

Project Team

VITO — Paul Van Tichelen (PVT)

Paul Waide Consulting — Paul Waide (PW)

TNO — Berend Evenblij (BE)

TNO — Peter Heskes (PH)

Stakeholders

Sacotte	Michel	TD EUROPE	SM
Sigrid	Jacobs	ArcelorMittal	SJ
Pierre	Lucas	T&D Europe	PL
Reiner	Korthauer	ZVEI	RK
Ray	Thomson	Noratel AS	RTO
Roman	Targosz	ECI	RTA
Hans-Paul	Siderius	Netherlands Enterprise Agency	HPS
Christophe	ELLEAU	EDF / Electricite de France	CE
Nico	Wurzel	SBA-Trafobau Jena GmbH	NW
KONSTANTINOS	PSOMOPOULOS	PIRAEUS UNIVERSITY OF APPLIED SCIENCE	KP
Jesper	Holmberg	Brussels Direct	JH
Peter	Schafeld	thyssenkrupp Electrical Steel	PS

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		GmbH	
Régis	Lemaître	thyssenkrupp Electrical Steel GmbH	RL
Bram	Cloet	CG Power Systems Belgium NV	BC
Patrick	LAUZEVIS	ENEDIS	PLA
Anthony	Walsh	Esb	AW
David	Crawley	Energy Networks Association	DC
Thomas	Hammermüller	trafomodern Transformatoren Ges.m.b.H.	TH
Angelo	Baggini	CENELC - University of Bergamo	AB
Manuel	Sojer	Maschinenfabrik Reinhausen, Germany	MS
Wim	De Maesschalck	Eandis	WDM
Robby	De Smedt	Laborelec	RDS
Carsten	Tonn-Petersen	Viegand Maagøe A/S	CT
John Bjarne	Sund	ABB/Norsk Elektroteknisk Komite	JS
Herman	NOLLET	EREA Energy Engineering	HN
Thong	Vu Van	ENTSO-E	TV

Objective of the meeting

The intention of the meeting was to serve as a first stakeholder kick-off meeting 'for the preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for small, medium and large power transformers'. The study commenced in September 2016 and is expected to conclude in May 2017 (9 months). Due to the short time available to organise this meeting direct invitations were sent to the previous Lot 2 (2011) registered stakeholders who had agreed that their names could be disclosed and after direct e-mails to the stakeholder organisations (T&D Europe, Orgalime, Eurelectric, ENTSOE). This invitation was distributed to these parties directly and anyone who registered was welcome to attend.
The purpose of the meeting was to enable the stakeholders to meet the team, discuss how they can provide input and to report their experience thus far with the current Regulation.

Note: complementary to this minutes of the meeting the meeting powerpoint presentation can be consulted

Prior to the meeting a Memo was sent by Norwegian Water Resources and Energy Directorate (NVE) (see Annex) and also JS sent in an extensive analysis evaluating the PEI index (see Annex).

Agenda

- 10h00-10h20 Coffee in meeting room Ayral
- 10h20-10h30: Presentation of the study team and tour de table
- 10h30-11h40: Scope of the assignment (Paul Van Tichelen, VITO)

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- 11h40-11h50: Regulation 548/2014 (Paul Waide, Waide Strategic)
- 11h50-12h: Discussion on data sourcing
- 12h-12h20State of art in CENELEC TC 14 standardization (Angelo Baggini, CENELEC TC14, University Bergamo)
- 12h20-13h20: lunch
- 13h20-14h40 Stakeholders view in the review of Commission Regulation 548/2014.
- 13h20-13h40 The present time situation viewed by the manufacturers (Michel Sacotte, Orgalime, Schneider-Electric)
- 13h40-14h10 The view of a DSO: Anthony Walsh (ESB Networks) & Wim De Maesschalck (Synergrid)
- 14h40-15h: Closing, participants expectations and priorities with respect to the review of Regulation

Minutes

Short presentation of participants (all)

After all participants presented themselves, Cesar Santos welcomed the participants and gave a short overview of what the study is aiming to do.

CS mentioned that there has not been enough time since the regulation measures were adopted to really know what impact it has had. The purpose of the meeting is to: ask questions, understand how the market has changed, consider which assumptions can be improved and what is being overlooked. Within this study there is a need to define priorities because the study has a modest budget and short frame. We will touch upon standardisation but discussions on this really belong in other fora.

PVT introduced the assignment (see powerpoint in annex)
See stakeholder meeting presentation slides 5 till 9

abbr.	Comment/answer
CS	asked if there were any comments on the review issues mentioned in Art 7?
MS and AB	Said that they have in in there slides that will be presented later today.
AW	said that 95% of losses from main designs and 5% from those exempted ones thus we need to focus on the main product groups
RTa	Mentioned that the study need to ensure that the end of life value of materials is considered
CS	No one mentioned the changing landscape in generation – does anyone have any concerns re the impact of the introduction of Renewable Energy (RE)?
KP	said they are doing work in this area and have experienced high harmonic distortion caused by power electronic converters, under a process of studying this within the context of distributed generation and smart grids. The first measurements show that a lot of losses are due to this and they are not included in the regulations.
AW	mentioned that future price of electricity is often driven by the capital costs of RE and this needs to be taken into account in the review of Tier 2
HPS	said the new landscape of electricity generation/consumption – distributed generation – needs to be taken into account in the regulation. However he's not happy if this is an exercise about reopening the discussion on Tier 2 because this will create uncertainty for manufacturers. NL not very happy to go in that direction.
CS	in absence of Commission making a counter proposal, Tier 2 will still apply; however, we should ask ourselves whether the assumptions behind the Tier 2 levels are still valid? It should be assessed without preconceptions.
RL	GOES producers have fulfilled the aim of Tier1 and that we have to discuss about the impact

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	of Tier 2
SJ	said that with technical solutions that might satisfy higher EE level it might have impacts on noise (due to steel type choices and the flux density) Asked if noise information should be added to the regulation?
CS	said we could consider product information requirements – minimum requirements for noise might be far-fetched at this point.
MS	said he can't see why noise should be part of Ecodesign regulations. Have to review basis for noise regarding the manufacturer of magnetic steel – to his knowledge there is no recognized standard on noise measurement for raw material (magnetos striction) because and therefore we cannot specify the component – CENELEC has undertaken some work to try and specify the component (note: noise on the transformers is specified in IEC60076-10))
SJ	in working group IEC TC 68 there is a technical document that specifies how to measure noise but this is not yet a standard
PLA	said we need a global approach of what we want for Tier 2
CS	the question was whether Ecodesign could treat noise, to which the answer is yes, but that it is not the main priority of the transformer
AW and RL	said it was best not to focus on this – it was a side topic
AB	said all of us are thinking about transformers as they are now (electromagnetic transformers), but in the future we will have the same function with electronic transformers; however, we need to take these into account as otherwise we will have lower efficiency transformers outside of the regulations
PK	silicon carbide technologies will come and replace the typical electro-magnetic transformers as we have them now (they can deal with failures very quickly and easily compared to electromagnetic transformers - these will be installed in Italian transmission network (5MW system – via ENEL) from 2018. ENEL. Mentioned risk of large power outages are reason why these are being introduced
CS	asked consultants to liaise with the stakeholders on this.
AW	said that this was covered very well in original VITO report. Discussed solutions ESB is applying (tap transformers) to address the issues PK mentioned

See stakeholder meeting presentation slides 9-14 on Task 2-6.

abbr.	Comment/answer
AW	It was confirmed that single—phase transformers were overhead and are used in the UK. Converting would require building a new line. Used since 1930s. Used to have 5 kVA and xKVA transformers but now use 15kVA. Used in rural lines to small loads.
MS	raised the case in the US that had similar cases in terms of population density etc. as found in Ireland.
AW	said that the analysis applied to Ireland based on the US case significantly overestimated the load factor for small single phase transformers.
MS	said T&D Europe would like to consider the findings from the US case for Ireland
AW	said he had gone through the US analysis and he could share the results. AW said CENELEC TC 41 said the details were sent to the Commission on this. Said in the Irish case the impedance dictated the capital costs due to the long lines (achieving sufficient short circuit power is the reason, therefore Kp is no issue because we mostly need to dimension on short circuit power, leading to a lower Kp then demanded for high eff).
PVT	requested that he share his information with the study team.

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AW	said that the total MVA used in these transformers in IE and UK was insignificant (75+120MVA of transformer capacity replaced/added per annum) and hence was not a priority
PLA	mentioned there was no goal about market surveillance. Very surprised as non EU competitors can price based on performance and gain competitive advantage if there is inadequate market surveillance. There is a problem in the tolerance and incertitude
HPS	mentioned it would be good to remind MS of their Market Surveillance obligations. He also mentioned the INTAS H2020 project that is examining market surveillance for large products (transformers and large industrial fans
PLA	asked if it was possible to create an EU level team that could address this issue – he has seen there is a problem in competition on this
JH	A cooperative market surveillance project has been recently launched by Nordsyn (http://www.norden.org) to collaborate on market surveillance in the Nordic countries
WdM	mentioned the need to ensure different MS market surveillance authorities should measure PEI in the same way
PW	extended an invitation to participants to reach out (via him) to the INTAS H2020 project if they wish to raise issues about market surveillance for transformers that can be looked at by this project (www.intas-testing.eu)

See stakeholder meeting presentation slides 15-16 with project plan.

abbr.	Comment/answer
CE	was glad to hear about the focus on costs assessment in Tier 2 assessment but said that capitalization cost should be given more emphasis. Mentioned cost of electricity is currently low and although it is expected to rise market actors adjust their behavior when that happens. Pertinent when considering relative importance of load and no load losses.
PVT	mentioned how in BE the situation changed rapidly in response to changes in the relative penetration of central versus distributed generation. Complementary to the introduction of renewables there will be a new need and cost for storage or flexibility. For example, the production of renewables do not necessarily fit with the no load losses of transformers
BE	Asked, for example, what should also be the requirement for a transformer connected to a wind farm?
WdM	mentioned there were many questions about how DSO treat upgrades for RE and electric vehicles etc. and that it's very important that we consider where the EE of the transformer fits within this investment framework.

Regulation 548/2014 (Paul Waide, Waide Strategic)

Skipped to save time in the meeting: - PW invited participants to read the PPT giving an overview of the regulation.

Data needs and data sourcing (Berend Evenblij, TNO)

BE discussed the data needs for the study and it is proposed to discuss it after the stakeholder presentations because they already contain a lot of information sources as could be concluded from the input received just before the meeting.

Distribution: General

12h00-12h20: State of art in CENELEC TC 14 standardization (Angelo Baginni, CENELEC TC14, University Bergamo) see powerpoint presentation in annex.

Note: VRDT = Voltage Regulation Distribution Transformers from WG30 has now been moved into an IEC process.
Followed by a short discussion about how utilities take into account the regulatory requirements in their procurement process.

abbr.	Comment/answer
PL	mentioned if there is a subsequent change it is a problem for utilities as it takes about 4 years to develop prototypes, test, test in situ and install.
PLA	The benefit of the regulation is that the clear timeline simplifies negotiations with the supply chain
PVT	asked if front runner utilities have already procured Tier2 transformers?
PLA	answered that in the case of ENEDIS they still procure Tier 1.
PLU	pointed out that the Ecodesign Directive is based on not increasing the amount of money customers should pay without pushing European industries to extinction

12h20-13h20: lunch provided by the EC in the building

13h20-14h40 Stakeholders view in the review of Commission Regulation 548/2014

Stakeholders could present their views and feedback.

13h20-13h40 The present time situation viewed by the manufacturers (Michel Sacotte, Orgalime, Schneider-Electric)

See powerpoint presentation in annex, some notes:

- The global view of manufacturers is that they don't want to have the PEI at thresholds below 3150kVA because they want to retain a standardised production platform.
- 75% of the products are already capable to meet Tier 2 (some issues for 1000Kva, pole mounted and 36kv dry type wind turbine), but it is not an issues for large power transformers.
- AMT are still a small fraction of products supplied and magnetic steel has improved since the previous regulation so Tier 3 could be studied.
- T&D Europe is ready to launch a study to support this study to see what is possible in future magnetic steel performance.

abbr.	Comment/answer
PL, AB	query about what the impact of attaining Tier 2 is on the weight of transformers and the implications this has for DSOs to replace existing Tier 1 products (impact on increasing T&D costs on substation floor)..
RL	said the magnetic steel product will be better tomorrow than today

MS continued, see powerpoint, some notes:

- It is important that the efficiency of the transformer has to be measured at the terminals (otherwise opens opportunity to claim high performance associated with dropping functions that will have to be added afterwards).
- In case of repairs most manufacturers are preparing blue guides. Clarification is needed to avoid legal issues. It is more complex for large transformers (blue guide or white).

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Distribution: General

abbr.	Comment/answer
AB	this is a simple economic issue on the marginal costs of repairing an existing transformer versus installing a new one
MS	said T&D E don't know well the survival rate curve of transformers – utilities may know this better.

MS presented list of T&D E wishes (last slides), some notes:

- Uniform market surveillance is highest priority.
- Need to clarify what is meant by an emergency transformer. Clarify rectifier application. Need to clarify the documentation – nobody is following this on web sales currently for B2B sales. Clarify the concession case for large power transformers.

abbr.	Comment/answer
CS	asked the stakeholders if the future limits of transformer EE are related to weight and retrofitting rather than other issues – is this true? i.e. could we end up with transformers that are so efficient that they can't be installed in substations?
PLA	raised the issue that if we want to make progress we need to consider the issue dependent on the type of final application because the retrofitting constraints are very different between DSO/TSO substations and other applications. Could take 100 years to replace all existing substations.
WdM	agreed that~60% of transformers they install are retrofits in existing buildings. Space and not touching the substation is much more important than the cost of the transformer – if the former have to be changed as a result of the transformer change the cost is 5-10 times higher
HPS	said the substation issue isn't new so the challenge is to make the Tier 2 transformers that meet the same form factor
MS	first they have to check if it is possible (in some cases it is and in some it isn't). Also, if we move form Al to CU in most cases we can meet the Tier 2 but the cost difference for conductor is a factor of 3.
PLA	raised issue of extra weight when using CU that lead to an accident with an operator

13h40-14h40 The view of a DSO: Wim De Maesschalck (Synergrid) & Anthony Walsh (ESB Networks)

See powerpoint presentations in annex.

AW (or WdM) made the following remarks during his presentation:

- Proposes to use the long run marginal cost (LRMC) and appropriate discount rate.
- For a large transformer 50% of the costs could be for transportation. Other costs are associated with site costs.
- Asked whether for Tier 1 the impact of in line with our expectations? (Reported anecdotally a 20% increase in weight and price for a range of Tier 1 transformers
- WdM mentioned utilities are limited by budget and have large asset bases – need to make assessment of what yields best result (upgrade many transformers with marginal EE gain but low incremental cost or a lower number of optimal transformers).
- AW also mentioned investment trade off choice between reducing losses by upgrading line capacity or putting in higher EE transformer.
- ESB capitalise the losses with LRMC and assess them over the life time of the transformer.

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Distribution: General

- AW said there was only 1 single phase DT manufacturer in EU

abbr.	Comment/answer
TV	said if view total losses from generation system operator range is 2-2.5% (TSO) and for distribution is round 4% - transformers can save maximum of 0.5%.
RTA	clarified typical T&D and transformer losses in the EU.
PVT	asked if we could have the price of the transformers assumed in the presentation– AB said no but can generally assume the price is proportional to the weight
AW	said no but can generally assume the price is proportional to the weight
PK	said we need to consider Ecodesign of transformers and not just the EE. Need to consider total cost on whole life time of transformer including end of life and not just operational life (which is what utilities focus on).

WdM continued part of the DSO presentation, some notes:

- Eandis (DSO) use TCO procurement in accordance with CENELEC guide and follows the Regulation in that way that tenderers can offer Tier 1 but can get a bonus for Tier 2.
- They are looking for asset performance including network reliability, customer connectivity, open market therefore open technologies, national policies/regulations on safety, RE etc. Interchangeability of transformers is critical (typically 2-3% asset stock replacement figures).
- They have focused on TCO for many years and have lower losses as a result.
- They discussed in detail problems with weight and dimensions.
- Reaching Tier 1 had been ok for size impacts but Tier 2 may be problematic.
- See conclusion slide ad general message of beware unintended consequences – i.e. shift to dry type to keep within space constraints.

abbr.	Comment/answer
PL	said for ERDF just reaching Tier 1 resulted in 20% increase in size
TV	Confirms this and recommended to put more efforts on consideration of exemptions
CE	said on behalf of the EDF Nuclear Generation: they also have these limits on weight, dimensions and clearances regards the HV parts for the transformers on site and in buildings

14h40-15h30: Closing discussion on participants expectations and priorities with respect to the review of Regulation 548/2014, AOB

abbr.	Comment/answer
CS	asked MS of T&D E if there were ingenious technical options to keep within weight and size?
MS	said that there were some options to keep within weight size but required best materials, increase cost and impact on noise. Manufacturers have to solve the three issues of weight, size and noise
RL	queried how it was possible that the size of the core had increased by 20% given that steel producers had shipped a lot more high quality magnetic steel.
MS	said that the improvement in magnetic steel had not been enough to reach the requirements and therefore size increases had also been needed
HN	mentioned the case of the Low Voltage transformers his company EREA produces. Installed base of 50 MVA per year for EREA's products
CS	said that a significant rationale would need to be elucidated for why there should be any exceptions for these products

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Distribution: General

PVT said the next step will be to send out a request for data. He will contact stakeholders and especially to request that those who have indicated in this meeting that they have conducted similar data acquisition exercises (T&D E and CENELEC (MS), Eandis (WDM), Norway,(ESB single phase(AW)) that they should share their data. Suppliers of data can indicate whether their data (in whole or in part) is confidential and the study team will discuss with them how they can manage/use confidential data. After this extra enquiries can be launched to fill the gaps identified.

15:50 meeting closed

7. ANNEX G KICKOFF PRESENTATION


A)Part 1 Main values 1/2
To set out minimum values of the Peak Efficiency Index for all transformers (Conversion of standard losses in PEI)
Regarding the standardization of the components (foils and cores) the manufacturers wishes to keep the level of losses and not to apply PEI
To Establish minimum performance requirements for single-phase power transformers
TD Europe is ready to participate to help in the definition
Clarification of the scope should be done (Rated power....)
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16/09/2016
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A)Part 1 Main values 2/2
To review minimum requirements set out for Tier 2 in 2021 are still appropriate(Evolution of Magnetic steel as amorphous core, Cost-effective from a lifecycle analysis perspective)
>75% of the suppliers are able to reach the Tier 2. Nevertheless some concessions on 1000kVA and Pole mounted and wind turbine on-shore 36kV Dry type.... must be done.
Large Power Transformers no issues to move to Tier 2
Case of Amorphous and other technologies for small distribution transformers shall be studied taking into account dimensions, weight and supplies
Magnetic steel has been improved since the last regulation but is seems that the minimum value are now reached. Tiers 3 then could be studied
TD Europe is ready to launch some studies accordingly
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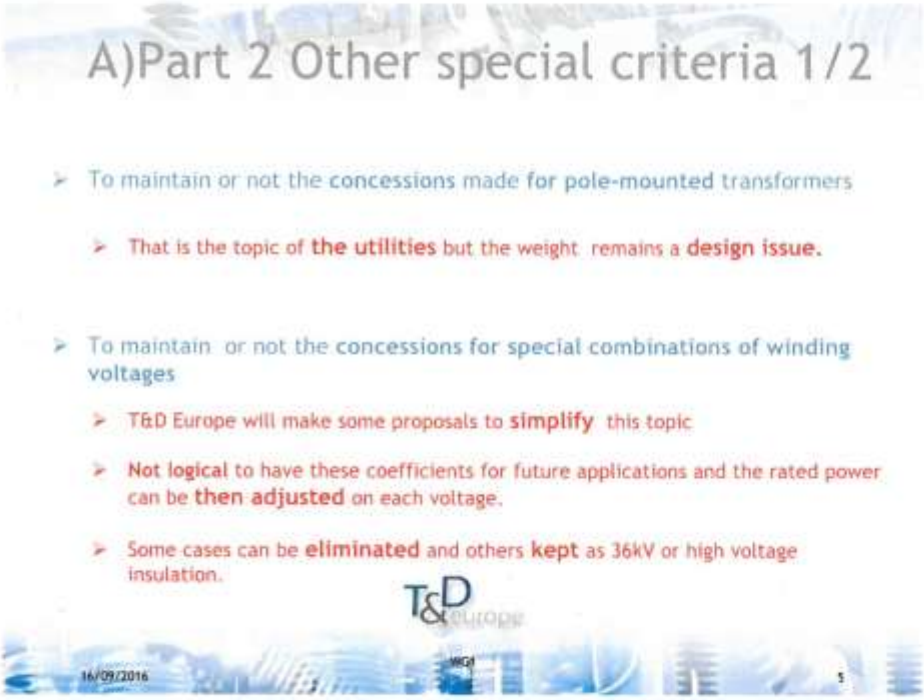
A)Part 2 Other special criteria 1/2
To maintain or not the concessions made for pole-mounted transformers
That is the topic of the utilities but the weight remains a design issue.
To maintain or not the concessions for special combinations of winding voltages
T&D Europe will make some proposals to simplify this topic
Not logical to have these coefficients for future applications and the rated power can be then adjusted on each voltage.
Some cases can be eliminated and others kept as 36kV or high voltage insulation.
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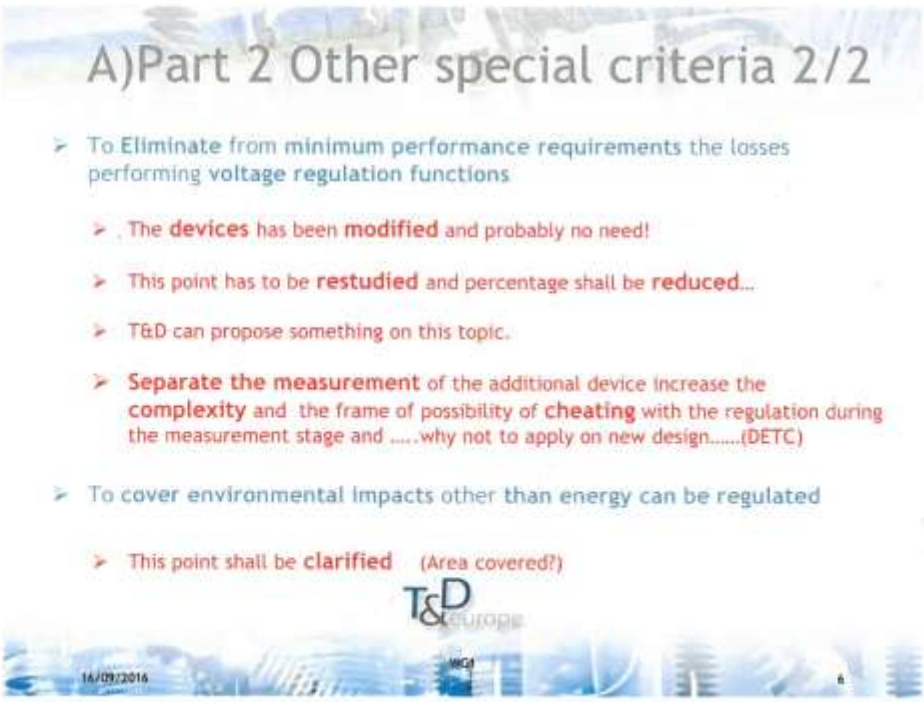
A)Part 2 Other special criteria 2/2
To Eliminate from minimum performance requirements the losses performing voltage regulation functions
The devices has been modified and probably no need!
This point has to be restudied and percentage shall be reduced...
T&D can propose something on this topic.
Separate the measurement of the additional device increase the complexity and the frame of possibility of cheating with the regulation during the measurement stage and .....why not to apply on new design......(DETC)
To cover environmental impacts other than energy can be regulated
This point shall be clarified (Area covered?)
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A)Part 3 New aspects of the regulation

- To Define accepted criteria for the **repair** of transformers
  - **Blue guide** is applied today
  - **Clarification** is needed to avoid legal issues
  - Clarification regarding the limits of **rated power** is needed to fix the repair topic
  - Other ways can be found
    - Performance
    - Life time
  - Large debate attended in T&D Europe without reaching **real consensus** today at least for Large power
  - Some works are undertaken in Cenelec on this topic

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B)T&D Europe wishes:

- To determine how **Market surveillance must be deployed** homogeneously
- To **clarify** the **scope** of the transformers **application** taking into account some part of Cenelec standard (PEI & KPEI definition....etc) as T&D Europe position paper
- To clarify **emergency** definition
- To clarify **Rectifier** application and associated efficiency requirements (Include special regulating tranformers connected to Rectifier)
- To clarify the **documentation** (Web, Plate)
- To clarify the **cooling system** in the frame in the efficiency
- To clarify the **concession case** for Large Power Transformer and add some for Medium power transformers
  - Collection of data are needed (typical Maximum weight , Maximum dimensions....)

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C)Standardization aspect
The split of the document could be changed
Standard transformers up to 3150kVA (Cast and oil) with fix losses
Other transformers above 3150kVA with PEI
Common part between EN50588-EN50629 could be done in Standardization
Technical specification with recommendations could come from WG32
TD Europe will give his opinion on this Technical Specification coming from WG32 after analysis
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BACK UP SLIDE NOT PRESENTED
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Medium Power Liquid

LIQUID	Tier 1 (from 1 July 2015)		Tier 2 (from 1 July 2021)		Pk Tiers 2/Tiers1	P0 Tiers 2/Tiers1
Rated Power (kVA)	Maximum load losses Pk (W) *	Maximum no-load losses Po (W)*	Maximum load losses Pk (W)*	Maximum no-load losses Po (W)*		
≤25	900	70	600	63	-33%	-10%
50	1100	90	750	81	-32%	-10%
100	1750	145	1250	130	-29%	-10%
160	2350	210	1750	189	-26%	-10%
250	3250	300	2350	270	-28%	-10%
315	3900	360	2800	324	-28%	-10%
400	4600	430	3250	387	-29%	-10%
500	5500	510	3900	459	-29%	-10%
630	6500	600	4600	540	-29%	-10%
800	8400	650	6000	585	-29%	-10%
1000	10500	770	7600	693	-28%	-10%
1250	11000	950	9500	855	-14%	-10%
1600	14000	1200	12000	1080	-14%	-10%
2000	18000	1450	15000	1305	-17%	-10%
2500	22000	1750	18500	1575	-16%	-10%
3150	27500	2200	23000	1980	-16%	-10%

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Medium Power Dry-Type

DRY TYPE	Tier 1 (1 July 2015)		Tier 2 (1 July 2021)		Tiers 2/Tiers1	Tiers 2/Tiers1
Rated Power (kVA)	Maximum load losses Pk (W)*	Maximum no-load losses Po (W)*	Maximum load losses Pk	Maximum no-load losses Po (		
≤50	1700	200	1500	180	-12%	-10%
100	2050	280	1800	252	-12%	-10%
160	2900	400	2600	360	-10%	-10%
250	3800	520	3400	468	-11%	-10%
400	5500	750	4500	675	-18%	-10%
630	7600	1100	7100	990	-7%	-10%
800	8000	1300	8000	1170	0%	-10%
1000	9000	1550	9000	1395	0%	-10%
1250	11000	1800	11000	1620	0%	-10%
1600	13000	2200	13000	1980	0%	-10%
2000	16000	2600	16000	2340	0%	-10%
2500	19000	3100	19000	2790	0%	-10%
3150	22000	3800	22000	3420	0%	-10%

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Medium Power PEI

	LIQUID				
		Tier 1 (01.07.2015)	Tier 2 (01.07.2021)	Pk Tiers 2/Tiers1	P0 Tiers 2/Tiers1
	Rated Power (kVA)	Minimum Peak Efficiency Index (%)			
3150 < Sr ≤ 4000	4000	99,465	99,532	-13%	-13%
	5000	99,483	99,548	-13%	-13%
	6300	99,51	99,571	-12%	-12%
	8000	99,535	99,593	-12%	-12%
	10000	99,56	99,615	-12%	-12%
	12500	99,588	99,64	-13%	-13%
	16000	99,615	99,663	-12%	-12%
	20000	99,639	99,684	-12%	-12%
	25000	99,657	99,7	-13%	-13%
	31500	99,671	99,712	-12%	-12%
	40000	99,684	99,724	-13%	-13%

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Medium Power Dry-type

	DRY TYPE				
		Tier 1 (01.07.2015)	Tier 2 (01.07.2021)	Tiers 2/Tiers1	Tiers 2/Tiers1
	Rated Power (kVA)	Minimum Peak Efficiency Index (%)			
3150 < Sr ≤ 4000	4000	99,348	99,382	-5%	-5%
	5000	99,354	99,387	-5%	-5%
	6300	99,356	99,389	-5%	-5%
	8000	99,357	99,39	-5%	-5%
	10000	99,357	99,39	-5%	-5%

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Pole Mounted

POLE MOUNTED				
	Tier 1 (1.07.2015)		Tier 2 (1.07.2021)	
Rated Power(kVA)	Maximum load losses (in W) *	Maximum no-load losses (in W)*	Maximum load losses (in W)*	Maximum no-load losses (in W)*
25	900	70	725	70
50	1100	90	875	90
100	1750	145	1475	145
160	3102	300	3102	270
200	2750	356	2333	310
250	3250	425	2750	360
315	3900	520	3250	440

Pk Tiers 2/Tiers1	P0 Tiers 2/Tiers1
-19%	0%
-20%	0%
-18%	0%
0%	-10%
-15%	-13%
-15%	-15%
-17%	-15%

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Large Power Liquid

≤4

LIQUID		
	Tier 1 (01.07.2015)	Tier 2 (01.07.2021)
Rated Power (MVA)	Minimum Peak Efficiency Index (%)	
4	99,465	99,532
5	99,483	99,548
6,3	99,51	99,571
8	99,535	99,593
10	99,56	99,615
12,5	99,588	99,64
16	99,615	99,663
20	99,639	99,684
25	99,657	99,7
31,5	99,671	99,712
40	99,684	99,724
50	99,696	99,734
63	99,709	99,745
80	99,723	99,758
100	99,737	99,77

≥100

Tiers 2/Tiers1	Tiers 2/Tiers1
-12,5%	-12,5%
-12,6%	-12,6%
-12,4%	-12,4%
-12,5%	-12,5%
-12,5%	-12,5%
-12,8%	-12,8%
-12,5%	-12,5%
-12,5%	-12,5%
-12,5%	-12,5%
-12,5%	-12,5%
-12,7%	-12,7%
-12,5%	-12,5%
-12,4%	-12,4%
-12,6%	-12,6%
-12,5%	-12,5%

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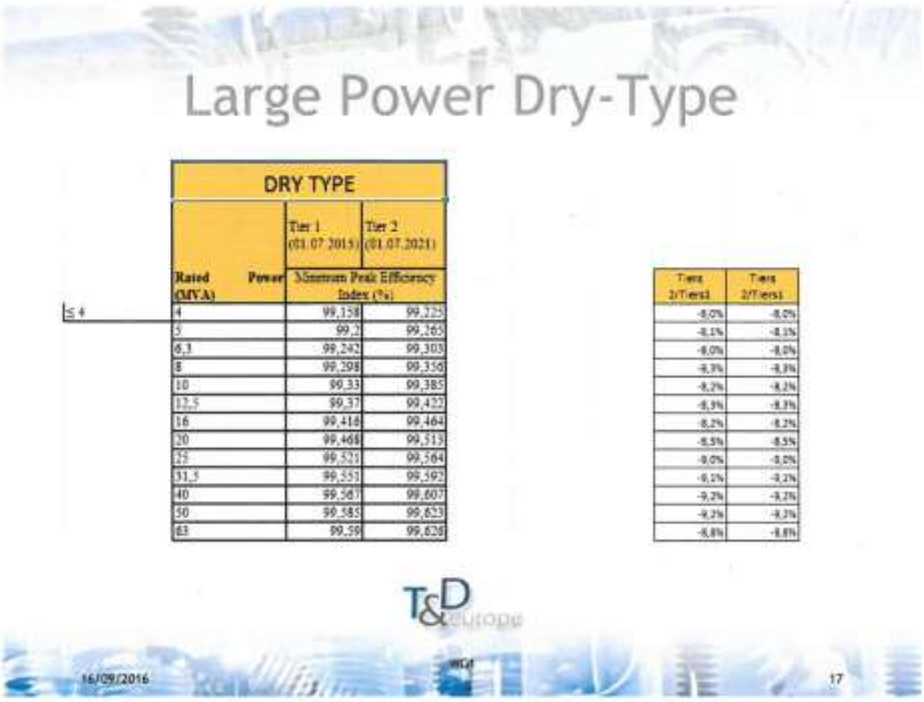

Large Power Dry-Type

DRY TYPE		
	Tier 1 (01.07.2015)	Tier 2 (01.07.2021)
Rated Power (MVA)	Minimum Peak Efficiency Index (%)	
4	99,158	99,225
5	99,2	99,265
6,3	99,242	99,303
8	99,298	99,356
10	99,33	99,385
12,5	99,37	99,422
16	99,416	99,464
20	99,468	99,513
25	99,521	99,564
31,5	99,551	99,592
40	99,567	99,607
50	99,585	99,623
63	99,59	99,628

≤ 4

Tiers 2/Tiers1	Tiers 2/Tiers1
-8,0%	-8,0%
-8,1%	-8,1%
-8,0%	-8,0%
-8,3%	-8,3%
-8,2%	-8,2%
-8,3%	-8,3%
-8,2%	-8,2%
-8,5%	-8,5%
-9,0%	-9,0%
-9,1%	-9,2%
-9,2%	-9,2%
-9,2%	-9,3%
-8,8%	-8,8%

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AGENDA

Dear Stakeholder,

Thank you for registration to the stakeholder meeting next Friday 16/9 at the EC Breydel building (Ayral room), avenue d'Audenghem 45, Brussels.

We hereby confirm your registration and please find hereafter the detailed agenda for the stakeholder kick-off meeting:
9h30: registration desk opens in EC building Breydel in Brussels **(please check that you have your ID card or passport with you)**
10h00-10h20 Coffee in meeting room Ayral
10h20-10h30: Presentation of the study team and tour de table
10h30-10h50: Scope of the assignment (Paul Van Tichelen, VITO)
10h50-11h20: Regulation 548/2014 (Paul Waide, Waide Strategic)
11h20-11h40: Data needs and data sourcing (Berend Evenblij, TNO)
11h40-12h: Comments on data sourcing
12h00-12h20: State of art in CENELEC TC 14 standardization (Angelo Baggini, CENELEC TC14, University Bergamo)
12h20-13h20: lunch (provided in the building)
13h20-14h40 Stakeholders view in the review of Commission Regulation 548/2014
Stakeholders can present their views and feedback, if you want to make a presentation sent a request and proposal.
Planned:
13h20-13h40 The present time situation viewed by the manufacturers (Michel Sacotte, Orgalime, Schneider-Electric)
13h40-14h10 The view of a DSO: Wim De Maesschalck (Synergrid) & Anthony Walsh (ESB Networks)
14h10-14h40 Any other welcome
14h40-15h: Closing, participants expectations and priorities with respect to the review of Regulation 548/2014, AOB

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CENELEC

Preparatory study for the review of
EC Regulation 548/2014 on transformers
Stakeholder kick off meeting

State of art in CENELEC TC 14 standardization

Angelo Baggini
CENELEC TC14, University Bergamo Italy

16/9/16 EC Breydel building (Ayral room)
Avenue d'Auderghem 45, Brussels

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in his personal capacity

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CENELEC

Table of content

1. What has been done?
2. What we learned?
3. What to do (work plan)?

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What has been done?

- **EN 50588-1/2015** "Medium voltage transformers 50 Hz, with highest voltage for equipmentnot exceeding 36 kV - Part 1: General requirements" + EN 50588-1 A1/2016
- **EN 50629/2015** "Energy performance of large power transformers (Um > 36 kV or Sr ≥ 40 MVA)" + EN 50629 A1/2016
- **EN 60076-19/2016** "Power transformer - Part 19: Rules for the determination of uncertainties in the measurement of losses in power transformers and reactors
- EN 60076 Series - Power transformers
- A **Secretariat Enquiry** on the use of EN 50588-1:2015 and EN 50629:2015 was circulated with deadline 2016/05/31 (TC14/Sec/0490/DC) for defining the scope of the standardization work relating to the COMMISSION REGULATION (EU) No 548/2014

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What has been done?

EN 50588-1 + A1

- Exception definitions
- Procedures and methods to measure and calculate: load losses, no load losses and PEI (+ EN 60076-1)
- Tolerances and uncertainties
- Specific criteria to be met by laboratories involved in the verification of the declared data
- Test report
- Liquid immersed Single phase <= 100 kVA (typically 15, 33kVA)
- Double/double voltage
- Um > 36 kV (CZ)

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What has been done?

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EN 50629 + A1

- ✓ Exception definitions
- ✓ Procedures and methods to measure and calculate: load losses, no load losses and PEI (+ EN 60076-1) (modified)
- ✓ Tolerances and uncertainties
- ✓ Specific criteria to be met by laboratories involved in the verification of the declared data
- ✓ Test report
- ✓ Rated power lower than 4 MVA
- ✓ Single phase
- ✓ Autotransformers and separate winding transformers having three windings
- ✓ Transformer asset data pro-forma

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What has been done?

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EN 60076-19

✓ Standard uncertainty calculation

TC14/Sec/0490/DC

✓ List with 62 items

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What has been done?

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What we learned?

- The devil is in the details*
- Synchronization with EC is hard because of respective formal procedures

(* Cesar Santos citation)

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Work plan

- WG21 – «MPT» (M. Sacotte FR)
- WG29 – «LPT» (F. Mauri IT)
- WG32 - «Umbrella» (F. Mauri IT)
- WG31 – «Uncertainty» (A. Bergman SE)
- WG30 – «VRDT» M. Heinz DE)

- Requirements
- Detailed list of specific issues will be addressed
- Expectations

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Work plan

On the **short term**:

- by the first months 2017, WG32 will produce a Technical Specification addressing Energy Performance of all power transformers in the scope of CLC/TC 14 with the goal to support the 2017 review of the Regulation also collecting the inputs coming from WG21 and WG29
- WG21 and WG29 will support WG32 for the topics in their respective revised scopes and will take care, if needed, to further amendments of actual standard EN 50629 and EN 50588-1

On the **long term** the future structure of standardization documents supporting the Commission Regulation (EU) No 548/2014 will to have a common umbrella document energy performance of all power transformers in the scope of CLC/TC 14 and specific documents addressing energy performance and other specific standardization need of specific categories of transformers according with the following table.

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Work plan

Who	Transformer categories in the scope	Doc	2017	At the publication of the revised Regulation
WG32	Medium and large power transformer	Umbrella standard	TS 50XXX-1	EN 50XXX-1
WG21	Liquid immersed power transformers with Sr ≤ 3150 kVA AND Um ≤ 36 kV Dry type power transformers	Specific standard	Draft EN 50XXX-2	EN 50XXX-2
WG29	Liquid immersed power transformers with Sr > 3150 kVA OR Um > 36 kV	Specific standard	Draft EN 50XXX-3	EN 50XXX-3
...	...	Specific standard	Not foreseen	EN 50XXX-4

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Work plan

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Requirements

- Small MPT: Separate losses
- Other T: PEI
- Timing and aligment with CLC
- NO other environmental impacts than losses

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Work plan

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Detailed lists...

- TC14/Sec/0490/DC
- Proposal for:
  - Repaired transformer definition
  - Dual voltage transformer definition
  - Cooling consumption treatement at KPEI
  - Declaration of conformity template
  - Simplification of the rating plate
  - Minimum performances
  - Exception list

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Work plan

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Expectations from the preparatory study

- **To provide**:
  - The impact of size (including safety clearences), weight and costs of TIER2
  - The impact on the structure
  - the economic impact of current and potential scenarios (T1, T2, T2')
  - A system approach
- **To support** market surveillance importance

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Work plan

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Expectations from the Regulation revision

- **To clear**
  - exemption for size and weight of transformers
  - how manage possible extemptions
  - declared value definition confirmation
  - which data shall be made public and how in the perpesctive of datacollection
  - transitional rules to manage possible TIER2 modifications
- **To support** market surveillance importance

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Synergrid

Ecodesign Transformers
Stakeholders forum – Kick-off

Feedback of the Belgian DSO's on the current EU Directive
Wim De Maesschalck - Eandis

16 september 2016
EU, Brussels

Implementation of Ecodesign

Implementation Ecodesign in **new tender**

- Tier I losses = minimum requirement
  - Impact: still to be assessed (new designs)
- Tier II losses = bonus requirement
  - TCO capitalisation of losses ~ Cenelec formula
  - Energy price + interest rate ~actual values for DSO

- Dimensions: **no increase possible**
  - Limited by available space in substations
- Weight: **no increase possible**
  - Limited by load limits of structural elements (floor/pole)

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Evaluation of Tier I

- Implementation is ongoing by DSO's
  - Not possible to draw conclusions yet (new designs)
  - Results may vary...
- ***Focus of study should be evaluation of effectiveness of Tier I***
  - Projected costs & benefits achieved?
  - Is the transformer still "fit for use"?
    - Dimensions
    - Weight
    - Special types of transformers
- Evaluation of Tier I = base for Tier II

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Evaluation of Ecodesign

Targets of DSO

- Balanced performance of assets
    - Costs >< Safety >< CML-Caidi-Saifi >< Environment
- Maintain open market with multiple vendors
- Enabler of new technologies
- Public responsibilities
  - National policies (e.g. safety, renewables, ...)
  - European policies (e.g. ecodesign, 20-20-20)

Ecodesign transformers:

- evaluation based on these targets

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DSO – specific constraints

- Regulated market:
  - Budgets for investments are regulated
    - Limited ratio of replacement: typically 2% - 3% annually
    - Specific tendering process & long term contracts
    - Focus on Total Cost of Ownership
- Very large installed base
    - e.g. Belgium:
      - 60.000+ MV substations
      - trafos: +/- 2000 annually
- Transformers are part of a larger installation
  - Interchangeability is critical
    - Upgrade / Renewal
    - New functionalities

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Impact on MV substations

- Dimensions are limited:
  - Width → limited space for access & installation
      - Typical doorway: 90 cm
      - Limited floor space in substations
      - New functionalities require more space
  - Height → limited in buildings (ceiling)
      - Typical ceiling (basement/ concrete substation): 2m20
- Weight is limited
  - structural limit of substation
    - Total weight of ALL equipment COMBINED (trafo + switch)
      - Floor / Pole
  - Impact on logistics

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Sibelga - Brussels

Underground substation in sidewalk: very little space available & limited height

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Tecteo - Liège

Underground substation: very narrow acces to substation

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Mounted on 1 pole
350 000 units
50-160 kVA
Max. 550 kg

Semi-rural substation
130 000 units
Max. 250 kVA
Max. 1500 kg

Urban substation
270 000 units
Max. 1000 kVA
Max. 2500 kg

Floor space < 2,5 m² Height < 1,5 m

Enedis (ErDF)– typical cases

Different standardised types have specific limits in weight & volume of transformer

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Liander - Amsterdam

Typical compact substation in the streets of Amsterdam. Impossible to install a larger building.

Soure: Alfen pdf-catalog: http://alfen.com/sites/alfen.com/files/downloads/Peperbus.pdf

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Impact on MV substations

- Replacing a substation is not an option
  - Not easy to obtain a "green field"
    - Available space / NIMBY
    - Permits
    - City Center?
  - Very high cost
    - Construction of new building or support
    - Cable works
- Retrofit is very important and must be possible!

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Impact on MV substations

- New functionalities requires additional space in substation
  - Smart meter equipment
  - Voltage regulator on transformers
  - Smart grid control bays

→ impact of other EU policies!

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Impact on Network

- How to improve energy efficiency?
  - Network efficiency vs. individual component
    - Investments where they yield most results
  - Optimisation of losses based on actual load profiles
    - Rated power I_n
    - Efficiency I_o & I_k
    - Actual prices & interest rates
  - Special transformers allow transformation of the network
    - Retrofit should remain possible
    - E.g. Voltage upgrade → less losses

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Impact on use in network

- Choosing the right **power rating** is key
  - Long lifetime: 30 to 50 years
  - Load profile and estimated evolution are important
    - Variations in time & season
    - Impact of new technologies
  - Global economics >< individual optimisation
    - Effect of eco-design on the transformer price
    - Price, losses, transport, stock, batch size, ...
- Optimisation of losses is required
  - DSO: specific load profile with high variation
    - Flexibility needed to have best combination of losses (I_o vs. I_k)

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Impact on use in network

- Choosing the right **type** is key
  - Different historic network lay-out
    - To change network structure → high costs
      - Modify all substation + cables
      - Limited budgets: only 2 - 3 % annually!!
  - Changes are gradual but effective
    - E.g. higher voltage for lower losses and higher capacity
      - 230 V → 400 V
      - 6000 V → 15000 V
- Special types are needed to facilitate transition

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Optimising the network vs. component

- Optimising of network requires global approach
  - Cables, substations, transformers, …
- Specific network optimisation can yield much greater results
    - Upgrade LV / MV voltage → lower losses
    - Investment in bigger cables → lower losses & higher capacity in the network
    - Voltage regulators → allow higher capacity & renewables
- Too strict policies can yield opposite results
    - Dry type transformers vs. Oil type
      - Dry transformer = higher losses but more compact – possible loophole?
    - Overloading smaller transformers (higher total losses)

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Summary

Ecodesign should

- Take into account feedback of Stakeholders
- Additional cash-out should result in benefits for users
- Allow retrofit and improvement of existing installation
- Be flexible to allow optimisation according the intended use and network system
- Encourage correct use of products

Ecodesign should not

- create products which are no longer suited for use
- Result in higher cost with little benefits
- Limit new technologies
- Encourage the wrongful use of products
- Encourage proprietary technology

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ESB NETWORKS

Eurelectric and ESBN input to EU Review of Commission regulation 548/2014 on Ecodesign requirements for small, medium and large power transformers

Anthony Walsh BE, MIE, MBA, ACCA
Manager, Materials Introduction and Innovation, ESBN

Chair, Eurelectric Network Equipment of WG Standardization

16th Sept. 2016

Overview

ESB NETWORKS

1. **Economic and Technical Approach to Tier 2**
2. **Proposals for small Single Phase MV Transformers**

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Principals:

ESB NETWORKS

The EcoDesign Directive requires the benefits from initiatives to be proportionate to the investment costs, so that the overall cost for final customers is not increased.

Balancing the energy efficiency of Distribution and Transmission networks without increasing the costs to final customers has also been the goal of Network utilities.

For society, the overall cost of the extra investment in Transformer costs is justified if matched by a similar value in increased energy savings – otherwise the same investment could be made in other projects that would give better returns in terms of energy savings.

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Principals:

ESB NETWORKS

Use appropriate Price of electricity :

- must be that of the kWh energy cost only as other components of electricity price are taxes and fixed costs which will not be affected by loss reduction
- must be a long term average to reflect changes in generation mix – move to PV, Wind with high initial cost and very low running costs

Use Appropriate Discount Rate:

- An appropriate risk adjusted discount rate must be used appropriate for the risk associated with this project as set out in EU *'Guide to Cost Benefit of Investment Projects'.*

Include Associated Costs:

- Allowance must be made in the economic analysis for Installation costs and other costs associated with larger/heavier energy efficient transformers (Transport, Civil Works, Retrofit restrictions) as these are real and significant costs. Most Transformers are used interchangeably between New and old works and must be suitable for both.

Learn from experience i.e. Review of impact of Tier 1:

- Assessment of impact of Tier 1 on weight and cost seems to have been +20% - was this in line with expectations?
- What are weight and cost implications of Tier 2?

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Principals (contd.)

ESB NETWORKS

Leave Scope in Efficiency Levels of Proposed Tiers for use of Capitalisation (i.e. not set at extreme limits):

- DNO's must optimise investments across the whole system, not just on one component.
- DNO's use the Tier to set the minimum threshold for Transformer purchases and then Capitalisation to optimise the required level of efficiency - it is not worthwhile in a transformer having very low copper losses if the load is very low. So DNO's use the same Discount Rate to ensure the same value is received from all investments.
- If Tier is set too high then Capitalisation is not effective and extra monies will be spent by utility on further reductions in transformer losses when a better reduction in losses could be achieved by spending the same money elsewhere.
- Similarly, if Tier is set too high then it may be that only a proprietary technology (e.g. amorphous) can be considered, which makes Suppliers uncompetitive.

Provide a clear Mechanism to deal with exceptions:

- The vast majority of transformers are simple components where it is straightforward to set efficiency levels that are appropriate.
- In the remaining cases it can be excessively expensive to comply with efficiency targets, the numbers of transformers are low but there is no straightforward method to deal with such cases e.g. HV/LV 100kVA trafo has to be 1000kva to be manufactured

Provide a Transition to Tier 2 for Tendering

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Approach:

ESB NETWORKS

Involve economic experts from beginning:

- Assessment of the cost –benefit of Tier 2 requires significant economic and financial expertise and such expertise should be brought into the project from the start

Consult Regularly with expert Stakeholders

- Utilities/Eurelectric whose customers pay for any changes
- Cenelec representing Transformer Manufacturers and Users

Concentrate on the 90% of Transformers where Energy Savings possible, not the 10% where special rules and cases are required!

Eurelectric and it's member utilities are willing to help in the formulation of Tier 2!

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Single Phase Transformers
NETWORKS
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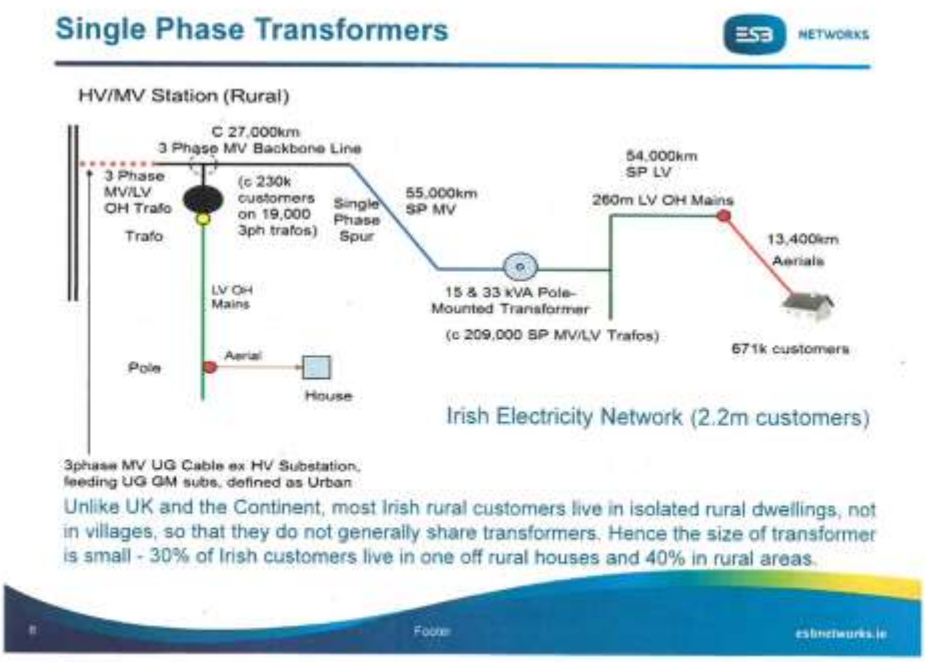
esbnetworks.ie


Single Phase Transformers
NETWORKS
HV/MV Station (Rural)
C 27,000km
3 Phase MV Backbone Line
3 Phase
MV/LV
OH Trafo
Trafo
(c 230k customers on 19,000 3ph trafos)
Single Phase Spur
55,000km
SP MV
54,000km
SP LV
260m LV OH Mains
13,400km
Aerials
15 & 33 kVA Pole-Mounted Transformer
(c 209,000 SP MV/LV Trafos)
671k customers
LV OH
Mains
Aerial
Pole
House
Irish Electricity Network (2.2m customers)
3phase MV UG Cable ex HV Substation, feeding UG GM subs, defined as Urban
Unlike UK and the Continent, most Irish rural customers live in isolated rural dwellings, not in villages, so that they do not generally share transformers. Hence the size of transformer is small - 30% of Irish customers live in one off rural houses and 40% in rural areas.
Footer
esbnetworks.ie

Single Phase MV/LV Pole Mounted Transformers

ESB NETWORKS

Single Phase MV/LV Pole Mounted Transformers are only used in Ireland and in the UK

Use is predominantly in supplying Rural load from Networks which are only Single Phase as the expense of providing three phase for such low density loads was not economic.

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Single Phase Transformers

ESB NETWORKS

About 5,500 Single Phase Pole Mounted Transformers pa used in Ireland and 5,000 pa in UK

In UK 90% of Single Phase Trafos pa are less than 50kVA each (50% - 25kVA, 20% - 15kVA, 20% - 50KVA) – approx. 130MVA

In Ireland 90% are 15kVA units increased in size from 5kVA following voltage upgrade from 10kV to 20kV which required Transformer replacement (– voltage upgrade saves 75% of losses on MV conductors).

15kVA size and low 2.2% impedance required to increase SC Level to target of 200kVA+. - this impedance was not achievable by reducing Reactance so extra Copper had to be used to reduce resistance leading to very low Copper losses for technical rather than economic reasons.

Overall capacity per annum for Ireland is hence 5,500 x 15kVA = 82MVA per annum and 130MVA pa in UK, which are tiny when compared to Transformers used in Urban areas – most Transmission Transformers will be >100MVA.

Loading on 15kVA Transformers is low as very few customers are connected to each transformer, so that simultaneous use of power which would increase Copper losses is very low. Previous Irish Capitalisation values were €6,900/kW for Iron but only €300/kW for Copper – however Copper losses are decided by impedance of 2.2% not by Capitalisation, and are 270W Copper and 48W Iron for a 15kVA unit.

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Transformer Losses proposed by Cenelec to EU

ESB NETWORKS

Cenelec WG 21 prepared submission for EU in md 2014 on proposed Single Phase Transformer losses following discussions between UK and Irish DNO's.

This took into account limits on weight and noise for the more popular sizes, and also that loss levels on most Irish transformers were determined by Impedance and Noise rather than economics i.e. Irish Trafos more efficient than economics require.

PEI (with Capitalisation) was proposed because the ratio of Copper to Iron Losses will depend on how the Trafo is loaded, which is different from Village to isolated rural house.

kVA	PEI Level 1 %	PEI Level 2 %
15	98.38	98.48
16	98.38	98.48
25	98.50	98.65
33	98.61	98.80
50	98.73	98.89
100	98.90	99.08

PEI values for single-phase pole mounted Transformers with Sr ≤100kVA

Current UK & Ireland (green), Weighted Average for UK, Actual for Ireland

kVA	NLL	LL	PEI
15	48	270	98.48%
16	48	405	98.26%
25	68	540	98.47%
33	58	675	98.80%
50	112	900	98.73%
100	228	1557	98.81%

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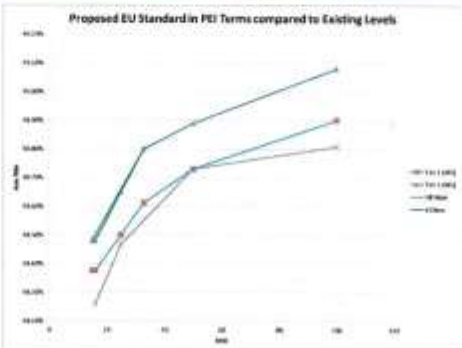
Graphical understanding

ESB NETWORKS



It can be seen from the chart that the UK efficiencies are shown in Mauve and are below the current levels in Ireland for 15kVA and 33kVA Transformers, partly because they are a weighted average of all efficiencies. However the Irish efficiency values are set predominantly by the 2.2% volt drop requirement and low noise levels rather than by economic considerations.

Accordingly as 90% of UK Single Phase Transformers are in this size range the Irish efficiencies could be used to form a Tier 2 benchmark.

The UK Mauve figures represented a weighted average of losses on UK Transformers, so that some utilities had lower losses and others higher, so in deciding on the 'sensibility' of the proposed Tier 1, this level was checked against the individual losses of each category of DNO transformer available – seven DNO's supplied data, but these were the ones with rural hinterlands which used Single Phase Transformers.

Of these categories 50% were at the proposed Tier 1 level and 50% below, so that if Tier 1 were implemented immediately 50% of UK Trafo Categories would require reduced losses. For Tier 2 the levels chosen were those currently used in Ireland on the basis that these were technically feasible and economically justified based on existing prices derived from Irish Tenders at these levels of efficiency, and this 'glide path' was then extrapolated to cover 50kVA and 100kVA units.

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Sensitivity Analysis (Background):

ESB NETWORKS

	15kVA				33kVA			
	Current design	Option A	Option B	Amorphous	Current design	Option A	Option B	Option C
Po Guaranteed	48	39	33	16	58	48	44	41
Pk Guaranteed	270	270	280	280	675	701	705	724
Tank diam.	410	420	430	520	470	490	490	490
Tank height	580	610	610	780	750	750	750	750
Total weight	180	195	202	255	270	280	285	290

A sensitivity analysis on the most efficient units (15 & 33kVA) was conducted to assess whether any further decrease in losses would produce a net saving was conducted by a manufacturer and indicated that at current prices the existing design had been optimised at both the 15kVA and 33kVA levels (as would be expected from the requirement to have 2.2% impedance).

Note 1: It should be noted that the single specification and Tender for Irish Transformers yields appreciable reductions in costs over this faced by a typical DNO, so that what is optimal in Ireland is not necessarily feasible in the UK at present.

Note 2: Amorphous has similar copper losses but much lower Iron Losses. The Core Material is made by Hitachi (Japan) or Metglas (Hitachi Metals) so restricted range of Suppliers. Costs are uncertain and will only be determined by Tender.

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Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for small, medium and large power transformer

Kick-off meeting with stakeholders

Paul Van Tichelen

Brussels, DG GROWTH
16th of September 2016

Agenda

- 9h30: registration desk opens in EC building Breydel in Brussels (please check that you have your ID card or passport with you)
- 10h00-10h20 Coffee in meeting room Ayral
- 10h20-10h30: Presentation of the study team and tour de table
- 10h30-10h50: Scope of the assignment (Paul Van Tichelen, VITO)
- 10h50-11h20: Regulation 548/2014 (Paul Waide, Waide Strategic)
- 11h20-11h40: Data needs and data sourcing (Berend Evenblij, TNO)
- 11h40-12h: Comments on data sourcing
- 13h-13h20: State of art in CENELEC TC 14 standardization (Angelo Baginni, CENELEC TC14, University Bergamo)
- 12h20-13h20: lunch

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Agenda afternoon

- 13h20-14h40 Stakeholders view in the review of Commission Regulation 548/2014.
  - 13h20-13h40 The present time situation viewed by the manufacturers (Michel Sacotte, Orgalime, Schneider-Electric)
  - 13h40-14h10 The view of a DSO: Wim De Maesschalck (Synergrid) & Anthony Walsh (ESB Networks)
  - 14h10-14h40 Any other welcome
- 14h40-15h: Closing, participants expectations and priorities with respect to the review of Regulation

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EC policy officer & Study Team

- **EC policy officer: Cesar Santos**
- **Study Team:**
  - Team leader: **Paul Van Tichelen (VITO)**
  - Koen Vanthournout (VITO), Electrical grid expert/smart grids; Dominic Ectors (VITO), website
  - **Berend Evenblij (TNO); Peter Heskes(TNO)**; Julian Croker (TNO): Electrical machines and power electronics expert, including transformers, data sourcing and processing
  - **Paul Waide (Waide Strategic),** Energy efficiency policies including transformers
- **Table round**
- **Use of voice recording**

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Introduction

- Background is the Ecodesign Directive 2009/125/EC that resulted in 'Implementing Measures' (EC Regulation ..) which is:
  COMMISSION REGULATION 548/2014 ON ECODESIGN REQUIREMENTS FOR SMALL, MEDIUM AND LARGE POWER TRANSFORMERS
- This is a preparatory study for the review
- More information on the Regulation will be in the presentation of Paul Waide
- **Further info: https://transformers.vito.be/**

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Article 7 of Commission Regulation 548/2014

- **Article 7 Review No later than three years after the entry into force(10/6/2014). Specifically, the review will assess, at least, the following issues:**
  - the **possibility** to set out minimum values **of the Peak Efficiency Index** for all medium power transformers, including those with a rated power below 3 150 kVA,
  - the possibility to **separate the losses** associated **to the core transformer from** those associated with **other components** performing voltage regulation functions, where this is the case,
  - the appropriateness of establishing minimum performance **requirements for single-phase power transformers**, as well as for **small power transformers**,
  - whether **concessions made for pole-mounted transformers** and for **special combinations of winding voltages** for medium power transformers are still appropriate,
  - the possibility of **covering environmental impacts** other than energy in the use phase
- **In addition investigate if, in the light of technological progress, minimum requirements set out for Tier 2 in 2021 are still appropriate.**

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Additional requirements of the assignement

Therefore the following tasks are specified:

- **Task 1: Verification of existing minimum requirements for Tier 2**
- **Task 2: Consideration of minimum requirements for single-phase transformers**
- **Task 3: Verification of existing exemptions and regulatory concessions, with subtasks:**
  - Task 3.1 - Verification of exemptions in Regulation 548/2014
  - Task 3.2 – Analysis of criteria for the repair of transformers in Regulation 548/2014
  - Task 3.3 – Verification of concessions for transformers with unusual combinations of winding voltages
  - Task 3.4 – Verification of concessions for pole-mounted transformers
- **Task 4: Analysis of other environmental impacts**
- **Task 5: Conclusions and recommendations**
- **Task 6: Reporting and workshop**

Objectives in a nutshell

- verify if requirements for **Tier 2** are still **cost-effective** from a lifecycle analysis perspective;
- provide **evidence** for a consideration of minimum efficiency requirements **for single-phase transformers**;
- **verify** if regulatory **concessions** made for **pole-mounted transformers** and transformers with **special combinations of winding voltages** are still appropriate;
- analyse if existing requirements for medium power transformers based on absolute levels of losses should be **converted to** relative values based on the **Peak Efficiency Index**;
- analyse if widely accepted **criteria for the repair** of transformers can be developed;
- analyse if **other, non-energy, environmental impacts of transformers** should be regulated

Task 1: Verification of existing minimum requirements for Tier 2

- **verify if the minimum energy efficiency requirements in Regulation 548/2014 for Tier 2 level, applicable in 2021 (see also presentation on the Regulation)**
  - In the light of technological progress: cost-effective, and technologically feasible?
  - estimate of the efficiency levels of the installed base of transformers in the EU, broken down according to the different categories described in Regulation 548/2014?
  - Use the Peak Efficiency Index such as for power transformers?
  - introducing a Tier 3 level with stricter requirements, indicatively sometime between 2023 and 2025?

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Task 2: TASK 2 CONSIDERATION OF MINIMUM REQUIREMENTS FOR SINGLE-PHASE TRANSFORMERS

- **Single-phase transformers** were excluded from the scope of Regulation 548/2014
- Mainly used by utilities in Ireland and the United Kingdom
- **investigate whether it is technically and economically justified to extend existing minimum energy efficiency requirements during Tier 2?**
- Follow the MEErP methodology (see previous preparatory study)

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Task 3: VERIFICATION OF EXISTING EXEMPTIONS AND REGULATORY CONCESSIONS

- TASK 3.1: **VERIFICATION OF EXEMPTIONS IN REGULATION 548/2014**
  - See later presentation on the regulation
    - Is the rationale behind it still valid? Are there unintended consequences?
- TASK 3.2: **ANALYSIS OF CRITERIA TO INCLUDE THE REPAIR OF TRANSFORMERS IN REGULATION 548/2014**
  - Should we cover them in an update? Are there market figures on this?
  - proposal for a regulatory extension

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Task 3: VERIFICATION OF EXISTING EXEMPTIONS AND REGULATORY CONCESSIONS

- TASK 3.3: **VERIFICATION OF CONCESSIONS FOR TRANSFORMERS WITH UNUSUAL COMBINATIONS OF WINDING VOLTAGES**
  - Table I.3 of Annex I in Regulation 548/2014 (see later presentation)
  - needs to be expanded for cases not yet covered?
  - Reconsidering existing regulatory concessions
- TASK 3.4: **VERIFICATION OF CONCESSIONS FOR POLE-MOUNTED TRANSFORMERS**
  - Table I.6 of Annex I in Regulation 548/2014 provides concessions
  - an assessment of whether regulatory concessions for pole-mounted transformers should be maintained or should be phased out?

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TASK 4 ON ANALYSIS OF OTHER ENVIRONMENTAL IMPACTS

- Note: The Ecodesign methodology (MEErP) used for this preparatory study has been revised in 2013 compared to those used in the existing preparatory study.
- MEErP 2013 was updated with a view to elaborating on the material efficiency aspects. (note that recycling is more elaborated)
- Will use data Task 1 (Bill of Material)
- **Purpose: investigation of significant environmental impacts, other than energy, are justified to consider additional requirements**

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TASK 5 ON CONCLUSIONS AND RECOMMENDATIONS

- collect the findings made in Tasks 1 to 4 with a view to making targeted recommendations to improve, extend or reduce the coverage of Regulation 548/2014
- An **inventory of any technical and position papers** (both solicited and unsolicited), submitted by social and economic actors in the context of Tasks 1 to 4 will be included in this task.
- The actual papers will be included as annexes.
  - **Output is draft final report**
  - **Will be discussed in a validation workshop** (all stakeholders)

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Planning chart

	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Task 1	x	x	x		x	x			
T1-market screening data collection (= also input to Task 2,3,4)	x	x							
T1- elaborate enquiry missing data			x						
T1- start working with LCC and data processing				x					
T1-final data processing& report					x				
T1-report calculate			x	x	x	x			
Task 2	x	x	x	x	x	x			
T2 collect UK missing data and/or extrapolate from IRL	x		x						
T2-calculate Ecoreports all tasks + scenario									
T2-report				x					
Task 3		x		x		x			
T3 input data from T1		x							
T3.1(exemptions), T3.3(unusual types), T3.4 (pole mounted)		x							
T3 cross check with other policyAU/US				x		x			
T3.2 Repair									
Task 4		x		x		x			
T4 input data from T1		x							
T4- process in report				x		x			
Task 5				x		x	x		
T5 Collect and process finding T1-4									
T5 Process tech & position papers									
Task 6						x	x	x	x
T6 report									
T6 workshop									
Contract coordination& project management& main author	x	x	x	x	x	x	x	x	x

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Planning important milestones

- **1 Sep 2016: Launch project & website: https://transformers.vito.be/**
- **16 Sep 2016: Project kick-off meeting with EC/Stakeholders**
- **Draft final report (within 6 months) (<March)**
- **Stakeholder workshop in March**
- **Final report (within 8 months) (<May)**

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Questions & Conclusion

- Scope: any?
- Questions, AOB?

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MEMO

Project:	Lot 2 Ecodesign Preparatory Study for small, medium and large power transformers, Kick-Off meeting
Topic:	Input from Norwegian Water Resources and Energy Directorate (NVE)
Date:	15-09-2016
To:	Paul Van Tichelen, VITO, paul.vantichelen@vito.be
Copy to:	Kirsti Hind Fagerlund, NVE, khf@nve.no
From:	Carsten Tonn-Petersen, Viegand Maagøe A/S, ctp@viegandmaagoe.dk

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The Norwegian Water Resources and Energy Directorate (NVE), in this case represented by consultants from Viegand Maagøe A/S, would like as stakeholders representatives to forward the following views and comments, with the purpose of having an impact on the now starting preparatory study for the revision of the regulation for small, medium and large power transformers, as stated in Article 7 of 548-2014.

NVE's main statutory objective is to promote social and economic development through an efficient and environmentally sound energy production, as well as efficient and reliable transmission, distribution, trade and efficient use of energy. NVE's responsibility covers the regulatory area as well as other activities defined by law, regulations and decisions from the Norwegian Parliament.

The Norwegian Parliament has taken EU Regulation 548-2014 into Norwegian law in 2015 and NVE has conducted various information activities concerning the topics covered. The following views and comments have been collected during meetings and form correspondence with Norwegian stakeholders, both manufacturers and users.

Data sourcing:

Data from Norway should be a part of the complete database used in the study. Very often we see that data from Norway are left out of similar studies, even if data are plentiful and useful. Since the regulation is supposed to be used in the entire EEA, and not only in the EU, it is important that not only the Commission but also the consultants that prepare the studies gather information and stakeholder views from all countries. We suggest that the new study will contain a more detailed description of conditions that are special for individual countries, including Norway.

Special conditions in Norway:

Norway has to deal with special problems in several ways. Because of a very high degree of electrical heating in houses, heavy industry and long distances compared to other countries in the EU, Norway has high electricity consumption per capita and a large amount of transformers in use. This makes Norwegian stakeholders important to consider, both as producers and users.

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Unfortunately at the same time these factors combined with the rocky and remote geography of Norway also presents several problems regarding keeping in compliance with 548-2014 and at the same time maintaining good economical practice, eg.:

1. Narrow roads, tunnels and bridges very often set a limit to the size and weight of transformers that can physically be transported to remote sites. Since new and more efficient transformers are often heavier and larger, older transformers will not be replaced by new ones.

2. Not only transport and handling is difficult, but very often streets and buildings are difficult to alter to accommodate larger equipment, due to the solid rock underground.

3. Norway uses many pole mounted transformers due to rocks in the ground and the difficulty of using cables; hence most distribution is carried on masts and poles. This gives Norway a special interest in how the pole mounted transformers are covered in the regulation.

4. Due to factors mentioned in 1., 2. and 3., the price of transport and installation is often unreasonably high, both when replacing and installing new transformers.

5. Norway has a need for a rather high number of special emergency transformers with several possible voltages, due to difficult repair situations in remote places.

6. Stakeholder producing transformers locally in Norway are concerned about the much higher prices on their products, due to the need of high purity copper and new types of core material in order to build transformer with correct efficiency. Increased allowed loss-tolerances (e.g.: +2 %) could make the demand for a very uniform (and therefore expensive) material quality.

7.

Questions from stakeholders:

The question (6) from the FAQ about how to interpret 548-2016 with respect to three-winding transformers (question raised from Norwegian stakeholders 10-2015) is still very unclear. Although the measurements required are described in norms, there are still problems with interpreting the results of the measurements. These types of transformers are widely used in Norway, and the definition of loss levels is urgent. We suggest that the consultants working with these questions take contact to Norwegian stakeholders who already have methods in use that could be used in the revised regulation.

Stakeholders find it difficult to be in compliance with 548-2014 when purchasing new emergency transformers. This question is only partly covered in FAQ (7) since this is only answered for replacement of existing equipment.

Stakeholders find it sometimes possible to use the PEI figures instead of the full-load and no-load losses to document compliance. Some find that this cannot be correct or feasible.

A future maximum loss of A0-10% / Ak can turn out to be very expensive. Stakeholders suggest that a maximum limit on the total loss (P0+Pk) might be more feasible.

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Regulation 548/2014 in a nutshell

Paul Waide - Waide Strategic Efficiency Ltd, UK

Transformers Ecodesign stakeholder meeting

June 16th 2016

Waide Strategic Efficiency

Overview

- This presentation gives a summary of the Regulation 548/2014

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Background

- Europe originally initiated a voluntary effort to promote energy-efficient transformers through the European norm 50464-1, which covers the same liquid-filled units that were previously included in the Harmonised Document HD 428
- For dry-type transformers, the European norm was EN 50541-1, which was based on HD 538. In these voluntary standards, maximum loss levels were associated with ratings of A, B and C, using subscripts 'o' for no-load losses and 'k' for load losses
- This approach was meant to facilitate transformer specification, such that customers could choose a combination of no-load and load losses, such as 'AoBk'

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Scope of Regulation 548/2014

- In May 2014, Ecodesign Regulation 548/2014 for 'small, medium and large power transformers' was adopted which imposed minimum energy performance and information requirements
- The regulation establishes ecodesign requirements for placing on the market or putting into service **power transformers with a minimum power rating of 1 kVA used in 50 Hz electricity transmission and distribution networks or for industrial applications**
- The Regulation is only applicable to transformers purchased after the entry into force of the Regulation

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Not in scope of Regulation 548/2014

This Regulation shall not apply to transformers specifically designed and used for the following applications:

- **instrument transformers**, specifically designed to supply measuring instruments, meters, relays and other similar apparatus
- transformers with low-voltage windings specifically **designed for use with rectifiers to provide a DC supply**
- transformers specifically designed to be **directly connected to a furnace**
- transformers specifically designed for **offshore applications** and floating offshore applications
- transformers specially designed for **emergency installations**
- transformers and auto-transformers specifically **designed for railway feeding systems**
- **earthing or grounding transformers**, this is, three-phase transformers intended to provide a neutral point for system grounding purposes,

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Not in scope of Regulation 548/2014

- **traction transformers** mounted on rolling stock, this is, transformers connected to an AC or DC contact line, directly or through a converter, used in fixed installations of railway applications
- **starting transformers**, specifically designed for starting three-phase induction motors so as to eliminate supply voltage dips
- **testing transformers**, specifically designed to be used in a circuit to produce a specific voltage or current for the purpose of testing electrical equipment
- **welding transformers**, specifically designed for use in arc welding equipment or resistance welding equipment
- transformers specifically designed for **explosion-proof and underground mining** applications (1)
- transformers specifically designed for **deep water** (submerged) applications, — medium Voltage (MV) to Medium Voltage (MV) interface transformers up to 5 MVA

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Not in scope of Regulation 548/2014

- large power transformers where it is **demonstrated that for a particular application, technically feasible alternatives are not available** to meet the minimum efficiency requirements set out by this Regulation
- large power transformers which are **like for like replacements in the same physical location/installation for existing large power transformers**, where this replacement cannot be achieved without entailing disproportionate costs associated to their transportation and/or installation

except as regards the product information requirements and technical documentation set out in Annex I, points 3 and 4.

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Requirements for three-phase liquid-immersed medium power transformers ≤ 3150kVA

with one winding with Um ≤ 24 kV and the other one with Um ≤ 1.1 kV

Rated power (kVA)	Tier 1 (from 1 July 2015)		Tier 2 (from 1 July 2021)	
	Maximum no-load losses P_o (W)*	Maximum load losses P_k (W)*	Maximum no-load losses P_o (W)*	Maximum load losses P_k (W)*
≤25	A_o (70)	C_k (900)	A_o - 10% (63)	A_k (600)
50	A_o (90)	C_k (1100)	A_o - 10% (81)	A_k (750)
100	A_o (145)	C_k (1750)	A_o - 10% (130)	A_k (1250)
160	A_o (210)	C_k (2350)	A_o - 10% (189)	A_k (1750)
250	A_o (300)	C_k (3250)	A_o - 10% (270)	A_k (2350)
315	A_o (360)	C_k (3900)	A_o - 10% (324)	A_k (2800)
400	A_o (430)	C_k (4600)	A_o - 10% (387)	A_k (3250)
500	A_o (510)	C_k (5500)	A_o - 10% (459)	A_k (3900)
630	A_o (600)	C_k (6500)	A_o - 10% (540)	A_k (4600)
800	A_o (650)	C_k (8400)	A_o - 10% (585)	A_k (6000)
1000	A_o (770)	C_k (10 500)	A_o - 10% (693)	A_k (7600)
1250	A_o (950)	B_k (11 000)	A_o - 10% (855)	A_k (9500)
1600	A_o (1200)	B_k (14 000)	A_o - 10% (1080)	A_k (12 000)
2000	A_o (1450)	B_k (18 000)	A_o - 10% (1305)	A_k (15 000)
2500	A_o (1750)	B_k (22 000)	A_o - 10% (1575)	A_k (18 500)
3150	A_o (2200)	B_k (27 500)	A_o - 10% (1980)	A_k (23 000)

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

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Requirements for three-phase dry-type medium power transformers ≤ 3150kVA

with one winding with Um ≤ 24 kV and the other one with Um ≤ 1.1 kV

Rated power (kVA)	Tier 1 (from 1 July 2015)		Tier 2 (from 1 July 2021)	
	Maximum no-load losses P_0 (W)*	Maximum load losses P_k (W)*	Maximum no-load losses P_0 (W)*	Maximum load losses P_k (W)*
≤50	A_0 (200)	B_k (1700)	A_0 - 10% (180)	A_k (1500)
100	A_0 (280)	B_k (2050)	A_0 - 10% (252)	A_k (1800)
160	A_0 (400)	B_k (2900)	A_0 - 10% (360)	A_k (2600)
250	A_0 (520)	B_k (3800)	A_0 - 10% (468)	A_k (3400)
400	A_0 (750)	B_k (5500)	A_0 - 10% (675)	A_k (4500)
630	A_0 (1100)	B_k (7600)	A_0 - 10% (990)	A_k (7100)
800	A_0 (1300)	A_k (8000)	A_0 - 10% (1170)	A_k (8000)
1000	A_0 (1550)	A_k (9 000)	A_0 - 10% (1195)	A_k (9000)
1250	A_0 (1800)	A_k (11 000)	A_0 - 10% (1620)	A_k (11 00)
1600	A_0 (2200)	A_k (13 000)	A_0 - 10% (1980)	A_k (13 000)
2000	A_0 (2600)	A_k (16 000)	A_0 - 10% (2340)	A_k (16 000)
2500	A_0 (3100)	A_k (19 000)	A_0 - 10% (2790)	A_k (19 000)
3150	A_0 (3800)	A_k (22 000)	A_0 - 10% (3420)	A_k (22 000)

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

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Correction of load and no load losses in case of other combinations of winding voltages or dual voltage in one or both windings (rated power ≤ 3 150 kVA)

One winding with $U_m \leq 24$ kV and the other with $U_m > 1,1$ kV	The maximum allowable losses in Tables I.1 and I.2 shall be increased by 10 % for no load losses and by 10 % for load losses
One winding with $U_m = 36$ kV and the other with $U_m \leq 1,1$ kV	The maximum allowable losses in Tables I.1 and I.2 shall be increased by 15 % for no load losses and by 10 % for load losses
One winding with $U_m = 36$ kV and the other with $U_m > 1,1$ kV	The maximum allowable losses indicated in Tables I.1 and I.2 shall be increased by 20 % for no load losses and by 15 % for load losses

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Correction of load and no load losses in case of other combinations of winding voltages or dual voltage in one or both windings (rated power ≤ 3 150 kVA)

Case of dual voltage on one winding	In case of transformers with one high-voltage winding and two voltages available from a tapped low-voltage winding, losses shall be calculated based on the higher voltage of the low-voltage winding and shall be in compliance with the maximum allowable losses in Tables I.1 and I.2. The maximum available power on the lower voltage of the low-voltage winding on such transformers shall be limited to 0.85 of the rated power assigned to the low-voltage winding at its higher voltage.
	In case of transformers with one low-voltage winding with two voltages available from a tapped high-voltage winding, losses shall be calculated based on the higher voltage of the high-voltage winding and shall be in compliance with the maximum allowable losses in Tables I.1 and I.2.. The maximum available power on the lower voltage of the high-voltage winding on such transformer shall be limited to 0.85 of the rated power assigned to the high-voltage winding at its higher voltage.
	If the full nominal power is available regardless of the combination of voltages, the levels of losses indicated in Tables I.1 and I.2 can be increased by 15 % for no load losses and by 10 % for load losses.
Case of dual voltage on both windings	The maximum allowable losses in Tables I.1 and I.2 can be increased by 20 % for no load losses and by 20 % for load losses for transformers with dual voltage on both windings. The level of losses is given for the highest possible rated power and on the basis that the rated power is the same regardless of the combination of voltages.

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Requirements for medium power transformers ≤ 3150kVA

with tapping connections suitable for operation while being energised or on-load for voltage adaptation purposes

- Voltage Regulation Distribution Transformers are included in this category
- The maximum allowable levels of losses set out in Tables I.1 and I.2 (the tow previous tables) shall be increased by 20 % for no load losses and 5 % for load losses in Tier 1 and by 10 % for no load losses in Tier 2.

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Requirements for liquid-immersed medium power transformers > 3150kVA

Minimum Peak Efficiency Index (PEI) values

Rated power (kVA)	Tier 1 (from 1 July 2015)	Tier 2 (from 1 July 2021)
	Minimum Peak Efficiency Index (%)	
3 150 < Sr ≤ 4 000	99,465	99,532
5000	99,483	99,548
6300	99,510	99,571
8000	99,535	99,593
10000	99,560	99,615
12500	99,588	99,640
16000	99,615	99,663
20000	99,639	99,684
25000	99,657	99,700
31500	99,671	99,712
40000	99,684	99,724

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

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Requirements for dry-type medium power transformers > 3150kVA

Minimum Peak Efficiency Index (PEI) values

Rated power (kVA)	Tier 1 (from 1 July 2015)	Tier 2 (from 1 July 2021)
	Minimum Peak Efficiency Index (%)	
3 150 < Sr ≤ 4 000	99,348	99,382
5000	99,354	99,387
6300	99,356	99,389
8000	99,357	99,390
>10000	99,357	99,390

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

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Requirements for liquid-immersed medium power pole transformers with 25 > kVA ≤ 315

Rated power (kVA)	Tier 1 (from 1 July 2015)		Tier 2 (from 1 July 2021)	
	Maximum no-load losses (W)*	Maximum load losses (W)*	Maximum no-load losses (P_0; W)*	Maximum load losses (W)*
25	A_0 (70)	C_k (900)	A_0 (70)	B_k (725)
50	A_0 (90)	C_k (1100)	A_0 (90)	B_k (875)
100	A_0 (145)	C_k (1750)	A_0 (145)	B_k (1475)
160	C_0 (300)	C_k + 32% (3102)	C_0 - 10% (270)	C_k + 32% (3102)
250	C_0 (356)	C_k (2750)	B_0 (310)	B_k (2333)
250	C_0 (425)	C_k (3250)	B_0 (360)	B_k (2750)
315	C_0 (520)	C_k (3900)	B_0 (440)	B_k (3250)

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

15 Waide Strategic Efficiency

Requirements for liquid immersed large power transformers

Minimum Peak Efficiency Index (PEI) values

Rated power (MVA)	Tier 1 (from 1 July 2015)	Tier 2 (from 1 July 2021)
	Minimum Peak Efficiency Index (%)	
≤ 4	99,465	99,532
5	99,483	99,548
6.3	99,510	99,571
8	99,535	99,593
10	99,560	99,615
12.5	99,588	99,640
16	99,615	99,663
20	99,639	99,684
25	99,657	99,700
31.5	99,671	99,712
40	99,684	99,724
50	99,696	99,734
63	99,709	99,745
80	99,723	99,758
≥100	99,737	99,770

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

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Requirements for dry-type large power transformers

Minimum Peak Efficiency Index (PEI) values

Rated power (MVA)	Tier 1 (from 1 July 2015)	Tier 2 (from 1 July 2021)
	Minimum Peak Efficiency Index (%)	
≤ 4	99,158	99,225
5	99,200	99,265
6.3	99,242	99,303
8	99,298	99,356
10	99,330	99,385
12.5	99,370	99,422
16	99,416	99,464
20	99,468	99,513
25	99,521	99,564
31.5	99,551	99,592
40	99,567	99,607
50	99,585	99,623
≥63	99,590	99,626

* Maximum losses for kVA ratings that fall between the ratings given in this table shall be obtained by linear interpolation

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Review

No later than three years after the entry into force, the Commission shall review this Regulation in the light of technological progress and present the results of this review to the Consultation Forum. Specifically, the review will assess, at least, the following issues:

- the **possibility to set out minimum values of the Peak Efficiency Index for all medium power transformers, including those with a rated power below 3 150 kVA**
- the possibility to **separate the losses associated to the core transformer from those associated with other components performing voltage regulation functions**, where this is the case
- the appropriateness of establishing **minimum performance requirements for single-phase power transformers**, as well as for **small power transformers**

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Review

- whether concessions made for pole-mounted transformers and for special combinations of winding voltages for medium power transformers are still appropriate
- the possibility of covering environmental impacts other than energy in the use phase.

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Question to stakeholders

- Are there any other aspects of the regulation which were not mentioned in Article 7 (review) that should be considered for review?

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Links and Contacts

Lot 2 Ecodesign study for small, medium and large power transformers

https://transformers.vito.be

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Additional slides

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Definitions

1)'Power transformer' means a static piece of apparatus with two or more windings which, by electromagnetic induction, transforms a system of alternating voltage and current into another system of alternating voltage and current usually of different values and at the same frequency for the purpose of transmitting electrical power

(2) 'Small power transformer' means a power transformer with a highest voltage for equipment not exceeding 1,1 kV

(3) 'Medium power transformer' means a power transformer with a highest voltage for equipment higher than 1,1 kV, but not exceeding 36 kV and a rated power equal to or higher than 5 kVA but lower than 40 MVA

(4) 'Large power transformer' means a power transformer with a highest voltage for equipment exceeding 36 kV and a rated power equal or higher than 5 kVA, or a rated power equal to or higher than 40 MVA regardless of the highest voltage for equipment

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Definitions

(5) 'Liquid-immersed transformer' means a power transformer in which the magnetic circuit and windings are immersed in liquid.

(6) 'Dry-type transformer' means a power transformer in which the magnetic circuit and windings are not immersed in an insulating liquid

(7) 'Medium power pole mounted transformer' means a power transformer with a rated power of up to 315 kVA suitable for outdoor service and designed to be mounted on the support structures of overhead power lines

(8) 'Voltage Regulation Distribution Transformer' means a medium power transformer equipped with additional components, inside or outside of the transformer tank, to automatically control the input or output voltage of the transformer for on-load voltage regulation purposes

(9) 'Winding' refers to the assembly of turns forming an electrical circuit associated with one of the voltages assigned to the transformer

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Definitions

(10)'Rated voltage of a winding' (Ur) is the voltage assigned to be applied, or developed at no-load, between the terminals of an untapped winding, or of a tapped winding connected on the principal tapping.

(11) 'High-voltage winding' refers to the winding having the highest rated voltage.

(12) 'Highest voltage for equipment' (Um) applicable to a transformer winding is the highest r.m.s phase-to-phase voltage in a three-phase system for which a transformer winding is designed in respect of its insulation.

(13) 'Rated power' (Sr) is a conventional value of apparent power assigned to a winding which, together with the rated voltage of the winding, determines its rated current.

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Definitions

(14) 'Load loss' (Pk) means the absorbed active power at rated frequency and reference temperature associated with a pair of windings when the rated current (tapping current) is flowing through the line terminal(s) of one of the windings and the terminals of the other windings are in short-circuit with any winding fitted with tappings connected to its principal tapping, while further windings, if existing, are open-circuited.

(15) 'No load loss' (Po) means the active power absorbed at rated frequency when the transformer is energised and the secondary circuit is open. The applied voltage is the rated voltage, and if the energized winding is fitted with a tapping, it is connected to its principal tapping

(16)'Peak Efficiency Index' (PEI) means the maximum value of the ratio of the transmitted apparent power of a transformer minus the electrical losses to the transmitted apparent power of the transformer.

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Conformity assessment

- Conformity assessment shall be carried out applying the internal design control procedure set out in Annex IV to Directive 2009/125/EC or the management system procedure set out in Annex V to that Directive.

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Verification tolerances for market surveillance purposes

- The verification tolerances set out in this Annex relate only to the verification of the measured parameters by Member States authorities and shall not be used by the manufacturer or importer as an allowed tolerance to establish the values in the technical documentation

Measured parameter	Verification tolerances
Load losses	The measured value shall not be greater than the declared value by more than 5 %.
No load losses	The measured value shall not be greater than the declared value by more than 5 %.
The electrical power required by the cooling system for no load operation	The measured value shall not be greater than the declared value by more than 5 %.

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Product information requirements

From 1 July 2015, the following product information requirements for transformers included in the scope of this Regulation shall be included in any related product documentation, including free access websites of manufacturers:

- (a) information on rated power, load loss and no-load loss and the electrical power of any cooling system required at no load;
- (b) for medium power (where applicable) and large power transformers, the value of the Peak Efficiency Index and the power at which it occurs;
- (c) for dual voltage transformers, the maximum rated power at the lower voltage, according to Table I.3;
- d) information on the weight of all the main components of a power transformer (including at least the conductor, the nature of the conductor and the core material);
- (e) For medium power pole mounted transformers, a visible display 'For pole-mounted operation only'.
- The information under a); c) and d) shall also be included on the rating plate of the power transformers.

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Technical documentation requirements

The following information shall be included in the technical documentation of power transformers:

(a) manufacturer's name and address;

(b) model identifier, the alphanumeric code to distinguish one model from other models of the same manufacturer;

(c) the information required under point 3.

If (parts of) the technical documentation is based upon (parts of) the technical documentation of another model, the model identifier of that model shall be provided and the technical documentation shall provide the details of how the information is derived from the technical documentation of the other model, e.g. on calculations or extrapolations, including the tests undertaken by the manufacturer to verify the calculations or extrapolations undertaken..

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Verification procedure for market surveillance purposes

- (1) Member States authorities shall test one single unit per model; (2) The model shall be considered to comply with the applicable requirements set out in Annex I of this Regulation if the values in the technical documentation comply with the requirements set out in Annex I, and if the measured parameters meet the requirements set out in Annex I within the verification tolerances indicated in the Table of this Annex;
- (3) If the results referred to in point 2 are not achieved, the model shall be considered not to comply with this Regulation.
- Given the weight and size limitations in the transportation of medium and large power transformers, Member States authorities may decide to undertake the verification procedure at the premises of manufacturers, before they are put into service in their final destination.

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8. Annex H Minutes of informative stakeholder Workshop for the review of Commission Regulation 548/2014 on transformers

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Date :	29/03/2017	Ref.	VITO/1610352/PVT
From :	Paul Van Tichelen	Annex(es):	**Powerpoint presentations of the meeting + stakeholder comments (see project website)**

To : Cesar Santos; Stakeholders
Copy : Paul Van Tichelen, Paul Waide

Minutes of informative stakeholder Workshop for Preparatory study for the review of Commission Regulation 548/2014 on transformers

EC Breydel building (Ayral room), avenue d'Auderghem 45, Brussels, 29th March 2017

Participants

European Commission

DG GROWTH — Cesar Santos (CS)

Project Team

VITO — Paul Van Tichelen (PVT)

Paul Waide Consulting — Paul Waide (PW)

Registered stakeholders for the meeting

First Name	Surname	Company / organisation name	acronym
Wim	De Maesschalck	Eandis / Synergrid	WDS
De Smedt	Robby	Laborelec	RDS
Angelo	Baggini	Cenelec	CENE
Michel	SACOTTE	T&D Europe	T&D
Pierre	Lucas	T&D Europe	T&D
Anthony	Walsh	Eurelectric	EUREL
Roman	Targosz	ECI	ECI
Kai	Pollari	ABB	ABB
Jean-Christophe	RIBOUD	RTE/ ENTSO-E	ENTSO
Patrick	Lauzevis	ENEDIS	ENE
Christophe	ELLEAU	EDF Production DIPNN	EDF
FREDERIC	WALTER	Cahors-Transfix / AFNOR UF14	CAHOR
John Bjarne	Sund	ABB/Norsk Elektroteknisk Komite	JBS
Armin	Vielhauer	E.ON SE	EON

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Bram	Soenen	BE Ministry of Environment - Product policy	BS
Sigrid	Jacobs	ArcelorMittal	SJ
Michael	Scholand	CLASP	CLASP
Bram	Cloet	CG Power Systems Belgium NV	CG
KONSTANTINOS	PSOMOPOULOS	PIRAEUS UNIVERSITY OF APPLIED SCIENCE	PIR
Ray	Thomson	Noratel AS	NORA
Radoslaw	Szewczyk	DuPont + Polish National Committee	POL
Mark	Allington	ICF	ICF
Jonathan	Hayward	BEIS	BEIS
Régis	Lemaitre	thyssenkrupp Electrical Steel	TK
Guillermo	AMANN	ORMAZABAL	ORMA
Theo	Meeks	Stedin B.V.	STED
Fernando	Ramalheira	EDP Distribuição	EDP
Flavio Mario	Mauri	e-distribuzione	FLAV
Carsten	Tonn-Petersen	Viegand Maagoe A/S for NVE	VIEG
Christer	Skotland	NVE	NVE
Paul	Jarman	National Grid UK / IEC TC14 chairman	UKGRI
Vincent	Hay	Energy Networks Association	ENA
Andreas	Halatsch	environment agency germany	AH
Gert	Rietveld	VSL	VSL
Hans-Paul	Siderius	Netherlands Enterprise Agency	NL
Mike	Rimmer	Dept for Business, Energy and Industrial Strategy	RIM
MAR	OLMEDO	GEDELSA	GED
Anders	Hallberg	Swedish Energy Agency	SEA
ilaria	sticchi	ANIE Federazione	ANIE
Jesper	Holmberg	Brussels Direct/Hitachi Metals	JH
Jeremy	Tait	Tait Consulting Limited (for ECOS)	ECOS
Moritz	Schlegel	BAM Federal Institute	BAM
Franziska	Schwerdtle	ZVEI	ZVEI
Herman	Nollet	EREA Energy Engineering BVBA	EREA
Senta	Marenz	CEER (Council of European Energy Regulators)	CEER

Objective of the meeting

The intention of the meeting was to serve as a stakeholder workshop for the preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for small, medium and

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large power transformers. The study commenced in September 2016 and is expected to conclude in May 2017 (9 months). The purpose of this meeting is discuss the draft report that was published on the project website (https://transformers.vito.be/) and to the hear the views of the stakeholders on the related tasks. Before the draft report was compiled two stakeholder enquiries were launched from which results are in the report and/or presented in the meeting.

Note: complementary to this minutes of the meeting the meeting powerpoint presentation can be consulted together with the input comments received from stakeholders on the project website

Agenda

9h00: Registration desk opened
9h00-9h30 Coffee in meeting room Ayral
9h30-9h40: Presentation of the study team and tour de table

TASK 1
9h40-10h20: Task 1 report on minimum requirements for Tier 2 (Paul Van Tichelen, VITO) (incl. remarks on discount rate (Eurelectric) and Tier 2 CAPEX (Hitachi Metals))
10h20-10h25: CAPEX for EE compared to CAPEX for RES(Paul Waide)
10h25-10h30: GOES development for Tier 2 (Regis Lemaitre, Thyssens Krupp)
10h30-10h50: T&D Europe on Task 1 (Michel Sacotte, T&D Europe)
10h50-11h00: Impact of using Copper for Tier 2 GOES transformers (Roman Targosz, ECI)
11h00-11h15: Eurelectric on Tier 2 Economic feasibility in green field and brown field (Antony Walsh, Eurelectric)
11h15-11h30: coffee
11h30-11h40: The view of TSOs (Jean-Christophe RIBOUD, ENTSO-E)
11h40-11h55: Discussion on the Economic feasibility of Tier 2
11h55-12h15: Discussion on how to set Tier 2 requirements for medium power transformer
12h15-12h30: AOB related to Task 1?

12h30-13h30: lunch

TASK 3
13h30-13h50: Task 3 VERIFICATION OF EXISTING EXEMPTIONS AND REGULATORY CONCESSIONS
13h50- 14h10: Summary of contributions by CENELEC TC 14 pre-standardization activity (Angelo Baginni, CENELEC TC14, University Bergamo)
14h10-14h20: T&D Europe point of view on Task 3 (Michel Sacotte, T&D Europe)
14h20-14h30: Example - existing limits in the EDF Nuclear installations (Christophe ELLEAU, EDF)
14h30-14h40: Discussion on concessions for green field large power transformers
14h40-14h50: How to deal with pole mounted transformers?
14h50-15h00: Dual voltage: is it a loophole? Review the requirements and how?
15h00-15h15: other Q&A Task 3 + How to proceed with input in Task 1&3
15h15-15h30: coffee break

TASK 4/2
15h30-15h40: Task 4 ON ANALYSIS OF OTHER ENVIRONMENTAL IMPACTS(Paul van Tichelen, VITO)
15h40-16h00: Task 2 CONSIDERATION OF MINIMUM REQUIREMENTS FOR SINGLE-PHASE TRANSFORMERS(Paul Waide)

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16h00-16h10: If and how to deal with small power transformers (Paul Waide)
16h10-16h30: Closing + AOB

Minutes

Short presentation of participants (all)
After all participants presented themselves, Cesar Santos welcomed the participants.

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9h40-10h20: Task 1 report on minimum requirements for Tier 2 (Paul Van Tichelen, VITO)
(see Powerpoint presentation available on the website)
Amongst others PvT said that Hitachi has told him Trafo costs are lower than what is assumed in the study and that the margins on sold products are low. Prices are in the reference – PVT asked for stakeholders to review this data. PvT said Eurelectric had said that the discount rate should be 4% in line with the better regulation tool #54. Seems unrealistic but even with this rdr the sensitivity analysis seems to show that Tier 2 is still more economic than Tier 1. MEErP uses a 4% escalation rate electricity prices for household products.

abbr.	Comment/answer
PVT	PVT said Eurelectric had said that the discount rate should be 4% in line with the better regulation tool #54. Seems unrealistic but even with this the sensitivity analysis seems to show that Tier 2 is still more economic than Tier 1. MEErP uses a 4% escalation rate electricity prices for household products that compensates in calculations the 4% discount rate.
EUREL	Anthony Walsh said (a) 4% is the real discount rate after inflation – inflation of 2% is NOT subtracted from the real discount Rate of 4% (b) MEErP 4% Escalation rate refers to Household electricity including taxes and fixed costs but is not appropriate to apply over full transformer lifetime (c) Rate of €0.08/kWh refers to Domestic after DUOS deducted, rate of €0.12/kWh is rate without deduction of DUOS.
PVT	said he will add a calculation with 4% rdr to the next version of the study in a kind of sensitivity analysis
CS	confirmed that a 4 % discount rate combined with 4 % escalation rate is currently used for household products
EUREL	Stressed that for households there are taxes and other factors that influences electricity prices. According to him we can't have a situation where energy prices are going up with 4 % per year. EUREL said also that long term financing costs needed to be added in.
CEER	Supported the Euroelectric view on fixed costs of electricity not being reduced i.e. that impact on energy costs should be the comparison basis.
PVT	Says that we are aware that due to the long life time of transformers these aspects have a strong impact. The study team has not a crystal ball on future development of interest rates and electricity prices but will seek advice within the EC and add various scenarios in a sensitivity analysis in an update of the report.
PVT	explored what the impact would be if the total CAPEX costs were lower & BAT (AMT), therefore reference was made to new transformer price input received from Hitachi
T&D	said that there is new data that AMT costs are now much lower for Tier 2 but it is a new data that has to be analysed
JH	Jesper from Hitachi Metals said there is a link in their comments to the price of the products
FLAV	said do not forget installation costs

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PVT	said he looked at this and found very different substation installation costs in BE and DE
ENE	Patrick Lauzevis said that there were many factors that affect these costs and there are many steps to install a substation; installation can take up to six months. You have a product price but after that you have transportation etc.. Hence he said be careful with considering the product price alone.
PVT	In summary PvT said Tier 2 is justified for green field sites but said that the main issue is for brown field sites
PVT	presented the PEI and kPEI findings
ECI	Roman Targoz said load losses should be an increasing priority. He said Eurelectric's model is not relevant to current situation – based on load data from 10 years ago and situation has changed as loads have risen.
PVT	said if the PEI approach were permitted for distribution transformers in Tier 2 we could have cases with a higher efficiency at lower load levels
T&D	For manufacturers PEI is impractical to manage for distribution transformers and will increase the price of transformers due to poorly adapted components supply and reduced concurrency, it will lead to increased CO2 production in the event that the load factor is not indicated (Often the case in diffuse market) and will also decrease the standardization of transformers in European Countries.
UKGRI	said trafo designs for high and low loads were fundamentally a choice – can't have both for a given price and therefore really critical that kPEI choice is open. Also takes issue on what is happening on the network said that for transmission networks distributed generation is increasing difference between minimum and maximum loads and that average loadings may be coming down on transmission networks. DSM could have the opposite effect on distribution networks
PVT	Said that manufacturers could check if it is technical possible to have designs optimized for either very high or very low loads
JH	Tier2 is justified for greenfield, one need to precisely define exceptions for brownfield- why not use the DoE procedure for this? Note that the DoE MEPS could also be used for tier3...
EUREL	Anthony Walsh said some utilities are in favour of Fixed Losses, but others prefer PEI because they want to be able to match the load factor of the trafo to the load they expect to get. In high loads want to minimise Cu losses in low load situations want to minimise Fe losses. So PEI should be available as an additional alternative to the values of Fixed Losses.
ENE	Patrick Lauzevis as opposed to AW said that for ENEDISF (DSO) fixed losses were very easy to manage. Having several PEI options is very complex and he is not in favour of that. If different PEI losses are allowed it's also difficult for the utility to manage the network losses. I confirm ENEDIS prefer 'fixed losses'. For information other DSO than prefer use fixed losses : EDF Nuclear plan, EON, RWE, ENBW , Laborelec, Eandis, SSE, Iberdrola and Latvia ...
ORMA	said need exception for trafos > 36kV but < 4MVa
ENTSO	said for nuclear stations safety aspects are of concern and therefore large transformers are used indoor. He is not in favour of a minimum kPEI due to physical constraints.
PVT	This will be discussed in Task 3 and is also in later presentations.
CS	Cesar Santos asked to clarify losses issue in response to JC Riboud and said that no load and losses will remain as information requirement in the regulation. Therefore he asked whether it makes sense to replace with minimum requirements with PEI and a formula versus compared to tables with no load and load losses? Please give me your views. Is there a downside for compliance?
FLAV	said he favoured PEI but other stakeholders said they were in favour of fixed losses. There is no agreement on this. A possible proper solution is to keep fixed losses as preferable and

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	PEI as alternative.
EUREL	Anthony Walsh said the additional alternative of PEI still allows using fixed losses in the tendering procedure with exactly the same values. In principle it should not make any difference for those who want fixed losses they can do that it only opens the opportunity for those who want other values to do that.
CS	Is there any downside having this choice of both fixed losses and minimum PEI?
ENE	I am in favour of fixed losses. For larger transformer PEI is right.
EDP	If the Regulation has the PEI as alternative (calculated from the Regulation table losses) each DSO can build, from this PEI and its own network Kpei, a proper fixed losses table. So, at the end, no problems for the manufactures neither for any DSO network manage, because it will work with fixe losses again. In Europe is not possible to have completely standard transformers, since there are different network voltages. If a DSO wants to follow the Regulation fixed losses table, they can make it.
T&D	Said that each country will have different set of load and no load losses for example due to differences in cost of electricity prices. This is very difficult for the manufacturers because they cannot standardise products, they want the same transformer for all countries. When they have to design different transformers for each market they will be no economic optimal transformer either. We have to remember that CO2 saving should be our target. All manufacturers around the table share the same vision.
EUREL	He points out that transformers should be designed to match the load in order to operate efficient. Utilities do not pay for the electricity used the same as other costumers, therefore for calculating the benefit to the society price they only uses the energy component which was based on their analysis on international gas prices converted to electricity taking thermal plant efficiency into account. All Utilities can do this therefore with the same factors for calculating capitalisation factors.
PVT	We noted that there are different and opposite statements but the report will contain various scenarios. He noted also that renewables are not cheap compared to converted gas prices.

John Barjne Sund presentation (see Powerpoint presentation available on the website) –

WG29 collected data on transformers which were the basis behind their PEI analysis. These data can also be analysed with respect to total losses. This is done, and the results are shown in the enclosed table. These losses are in line with the transformers having the lowest losses in the collection, which contains several hundreds of transformers. They are grouped according to their rated power and the voltage level on the high voltage side. These transformers are installed in several EU countries and have been in service for some time. This indicates that transformers with such losses are fully possible to manufacture.

John Bjarne Sund showed also a graph of total losses vs Po/Pk. The loss curves get steep below 0.2 times Po/Pk. So the conclusion is that the ratio Po/Pk should not be below 0.2 if PEI still will be chosen as the acceptance criterion. In that case the PEI figures should in addition be increased in order to obtain reduced losses.

abbr.	Comment/answer
JBS	He said that the PEI approach without additional requirements has an inherent large loophole, which enables purchasers to buy transformers with low purchase price and very high load loss *which still fulfil the PEI requirements!*
UKGRI	Paul Jarman said that this consideration for total losses was irrelevant because optimisation

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	would be for 100 % load. Network transformers should not be optimized for this load and adoption of a total losses approach would have substantial unintended consequences (in terms of a less efficient network).
JBS	John Bjarne Sund said that purchasers, who want the optimisation of a large power transformer done at a particular load current different from the rated current, can specify that in the enquiry. The manufacturers can easily meet this request. According to him, before Tier 1 came into force, the large majority of Norwegian distribution utilities simply bought distribution transformers with the lowest purchase price, disregarding the transformer losses.
CENE	We looked at this topic of total losses in CENELEC and voted negative. CENELEC believe it is better to stay on PEI.
JBS	If the purpose of the Regulation is to prevent transformers with high losses to enter the EU-market, the PEI will fail in doing so.

Roman Targoz ECI presentation – conclusion weight increase is very slight for high efficiency TIER 2 tranformers based on Copper. In many cases Cu designs shown to be lighter than Al. For 1600 kVA oil immersed weight difference is 2-3% moving to Tier 2.In all cases Cu is lighter than Al. Furthermore Cu helps to reduce oil volume.

abbr.	Comment/answer
FLAV	said that more than 90% of his existing substation sites are limited to around 2 tonnes.

Anthony Walsh Eurelectric Presentation:

Eurelectric is in favour of loss reductions, but such reductions must be in best interests of the Customer, who ultimately pays. So Savings from reduced losses must pay for any extra costs involved.
For Distribution Transformers there were large increases in the costs for the Transformers, as well as significant cost increases in accommodating new transformers of extra size and weight in existing substations. Having larger greenfield Sites would also cost extra money for both the utility and developer and was not a cost free way of accommodating more efficient transformers.
Eurelectric would like a choice of EITHER Fixed Loss or PEI for Distribution Transformers – many utilities like the simplicity of Fixed Losses but others would prefer PEI especially where their Load Factor was different.
Eurelectric illustrated that using typical capitalisation rates the savings in losses produced in moving from Tier 1 to Tier 2 were about 10% of the price of the Transformers, yet the expected price increases shown in the Laborelec report were much greater – typically 30 – 120%. This indicated that TIER 2 was excessively costly to the Customer.
Eurelectric suggested that the values propsed by CLASP for TIER 2 from a detailed engineering/financial analysis looked more economically feasible, and Eurelectric suggested that the range A0,Ak to A0 Ak+20% be considered instead for Tier 2.
In relation to exemptions for Tier 2 on the grounds of not technically possible/not reasonably practical/not economically feasible Eurelectric suggested using capitalised values as a benchmark alternative OR using a Transformer constructed to yield losses consistent with having been constructed with typical Tier 2 materials.

Regis Lemaitre presentation on GOES developments for Tier 2. There is a direct relation between performance of the material and of the transformer. GOES accounts 2.3 to 2.5 million tonnes worldwide (less than 0.2% of world steel production). 96% of trafos built with GOES – AMT ~4% (% is lower in EU). Would like EN10107:2014 and IEC60404-8-7 rel. 2017 standards terminology to be used in the final report to avoid confusion. Laser scribing technology allows performance to be even

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higher. GOES losses improvement has continued over 60 years. Thickness has also been reduced – now going down to 0.20 and 0.18. Moving from CGO to HGO reduces losses 20% at same thickness and moving to laser scribed 0.23 mm best grade reduces losses by another 25% versus HGO 0.30. Tier 1 increased demand for best HGO grades. Steel mills ready to make Tier 2 material available. EU REACH will ban Chrome VI on 21.09.17 and such Cr VI substances are used in GOES coating process. Now a Cr VI free() coating has been produced. Because it is related to the manufacturing coating process this only applies to European manufacturers. Thanks to research expenses and capital investment in coating equipment they have developed a more costly chrome VI free coating process.

abbr.	Comment/answer
PVT	Taked note of Chrome VI free coating process and will add this to Task 4 of the report.

Michel Sacotte (T&D Europe) presentation. Study needs to consider high temperature insulation trafo designs. CAPEX differences for Tier 1 and Tier 2 are appropriate for green field. Generally they are also ok for brown field sites but in some very specific cases very high prices can occur. Tier 2 is always reachable. New technology could be used to reach it but this has not happened yet. Study was based on existing technology. Risk on only specifying PEI – manufacturers oppose using PEI for < 3.15MVa even with limits on the kPEI value. Belgium distribution transformers are a special case with double winding – so does not represent the EU case for brown field sites. For Tier 3 the statements should be more technologically neutral re dry vs oil types. For single phase manufacturers can produce models with lower losses.

abbr.	Comment/answer
T&D	Michel Sacotte from Schneider said that their single phase manufacturing produce less than 100 units in Greece per year and this is not for use in Greece, hence the information supplied by Greece (see comments) on single phase transformers cannot be correct and one should be careful with it.
FLAV and ENE	New technologies available, as use of special insulating solid material and high temperature insulating liquids, are very interesting from utilities and I want to keep all options for new technology open. The regulation should not limit new technology but rather do the opposite.
ENE	Also added that therefore we should set performance requirements by function but never describe technology (copper ….)
T&D	Indeed we should not forget that in 2011 everyone thought Tier 1 is impossible and now we are there without any problem. For the future also Tier 2 will be possible with existing production technology but in some cases with new technology. The future is with new technology and we will have smaller transformers.
EUREL	They support sustainability but Tier 2 levels but it must be cost neutral and affordable to customers. Tier 2 trafo costs 30-120% greater according to their estimates. Installation cost is several times higher compared to transformer costs and therefore exemptions are needed for brown field. For large power transformers the requirements are fine but they don't support minimum kPEI. Similar issues apply for pole-mounted. More thought needs to be given to brown field vs green field. Use of Cu should not be a requirement. Suggestion is to use PEI as an additional alternative for DTs as set out in the proposals they made.
ECI	Roman Targosz – said: • Cu will not dominate the winding material of Tier 2 trafos but copper winding can better address space weight constraints (see presentation) • ECI are assisting in Copper anti-theft approaches.

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	• On interest rates ECI said that Eurelectric are using net present value calculations with very high discount rates which might potentially be explained by taking into account high risk factors, but according to the view of ECI this is not correct and discount rates should be risk free rates. There is no political risk.
EUREL	Confirmed that he used 4 % discount rates (= interest – inflation) and in his opinion this should be right.
PVT	PvT said we do not underestimate the costs and the discussion is between the future operational costs and the capital costs.

Lunch (12h30-13h30)

PvT Presentation on Task 3 on exemptions

abbr.	Comment/answer
EUREL	said the iron loss figure 0,7 W/kg proposed was very low
PVT	PVT said he agreed but this is just an indicative figure – here it was simply important to agree the principle. It should also be noted that the value is set at 1,5 Tesla while values in the standard for silicon steel are at 1,7 Tesla, the reason for proposing a value at 1,5 Tesla is to have also amorphous steel in the scope.
CS	Raised the issues again on the repair topic – a) one issue is if the current text is ok, b) if a repaired or second-hand product is imported into the EU from a third country, then it is placed on the market for the first time and it is subject to the requirements, that much we know.
EUREL and ENE	said for Euroelectric for transformers that fail they never get them repaired because the installation cost is so high that they don't take the risk and they don't see the issue, they only do it for large transformers or for small ones that were externally damaged
PVT	said its good news it's a non-issue from the utilities point of view, however we should not forget that it could be an issue for industrial clients.
PVT	said for pole-mounted trafos – concession should be limited to single pole
ENE	ENEDIS agree
T&D	said that for the time being it should be probably possible to find a solution for medium power transformer but not for large power transformers; For the time being we are applying the blue guide.
CENE	see also our analysis on the topic of repair in the next presentation

Presentation - summary of contributions by CENELEC TC 14 pre-standardization activity (Angelo Baginni, CENELEC TC14, University Bergamo). Discussed the document prTS50675 issued by CLC TC14. Conducted survey of impact on weight and dimensions. On exemptions proposal is to simplify and better qualify the exemptions – to link them practically to brownfield sites.
Requested Commission to define the economic criteria that would need to be demonstrated. Also produced a definition for single pole transformers with weight constraints. Also includes MEPS proposals in Part 2 and 3 – mostly Tier 2 with some exceptions/enhancements. Keep present definition for dual voltage transformers. For single phase transformers PEI values are listed. Designed to solve the Cz Rep issue.
Suggested to update the PEI curve to include the cooling consumption at KPEI. A new proposal on market surveillance uncertainty treatment was put forward.

abbr.	Comment/answer

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	Some stakeholder asked if this document achieved by consensus?
CENE	We did fight a lot but this really something based on a consensus.
PVT	Thanks for the presentation and this is very useful data for the review study.

Presentation: The view of TSOs (Jean-Christophe RIBOUD & Paul Jarman, ENTSO-E). Stressed that he is talking for large units. He questioned the practical recycled Cu price in the study – not as high as indicated in report because it is wrapped in paper. He raised question of Cu cost variability. For large transformer defining a minimum kPEI is against EE. He also said that the PEI approach is working effectively for large transformers. For repair felt they were not allowed to sell a 2nd hand transformer that they placed on the market – however, it is a very niche market for large transformers. For Tier 3 – potential benefits are small compared to the effort.

abbr.	Comment/answer
JBS	John Bjarne Sund said that his employer many years ago requested the purchasers to specify the loading profile of the transformers in the enquiry. Then the manufacturer should suggest the rated power of the transformer. However, the purchaser did not respond to this approach, probably because the purchasers in many cases had difficulties in predicting the future loading profile. However, in cases when the purchasers have specified loss capitalisation values, the square root of B/A gives an indication of the average loading factor during the time the transformer is intended to be in operation.

Christophe Elleau (EDF Generation) presentation - spoke about space constraints in nuclear plants. The constraints are presented in pictures with several cases in existing installations. EDF insists to keep exemptions for existing installations for power transformers, and for transportation up to the final connection in the electric room. For greenfield sites is important as well.

Michel Sacotte presentation T&D Europe point of view on Task 3. Proposed need to fix limits for medium power transformers in terms of density and magnetic flux. On repair mentioned we should not forget new technology for transformer repair.

abbr.	Comment/answer
ORMA	said that he thought the definition was clear
CS	Asked when can we consider a repaired transformer as if it were a new one? If there's is consensus on the criteria to define when a repair transformer can be considered like new, then this could be reflected in the draft Regulation ?
T&D	Said for distribution transformer we are close to having a definition. For power transformers less so.
EUREL	Said that the answer is in his paper. He wants technology neutral requirements and steel should loss requirements for Tier 2 should not be more compared to Tier 1 otherwise it would be more expensive.
T&D	Did not confirm that and said that technical progress had a positive impact on price and performance, for example compares the current situation to 2008. Therefore the market situation today does not say anything for the situation tomorrow.
T&D	Says that repair of transformers approach from CENELEC has to be shared with T&D Europe. Life time can be considered, e.g. 30 years. In the end you also have new technologies for repair to be considered.
HPS	said the citation is from the blue guide but that the blue guide said if ... then it "may" be considered a repair
ENE	said for distribution transformers that it was not worth repairing those that have failed because of the high installation cost – thus it's a non-issue

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ORMA	Said the problem was not with utilities but other users where the transformers are sold one by one.
HPS	Suggested that the consultants should look at the CENELEC definitions and combine them with the text in the blue guide.

Paul Van Tichelen presented Task 4 on other environmental impact – he note that no proposals were received. Harmonics in the line voltage justify Tier 2.

After Task 4 he requested that stakeholders should say if they wish to update their comments as we will process the final comments?

After a short discussion the conclusion was that the deadline for comments and position papers to be included in the study is the 28th April.

AOB

abbr.	Comment/answer
ECOS	Said we didn't cover small transformers – rapid growth in electric vehicles and 30% growth in market size. Can look at correlation?
PVT	It are LV/LV transformers and in all this one should also look what are the drivers to use them, safety and isolation? Could it be transformerless such as in PV converters? We can only mention in the report due to limited resources. Note there is little time foreseen in the study and it could be connected to ingle phase which is the next presentation. Note also that LV/LV transformers are often inside machines and are therefore sometimes covered by the machine energy efficiency requirements. A discussion followed but nevertheless it was concluded that for small applications that have no specific requirements it can be a good solution to set ecodesign requirements.

15h40-16h coffee break

Paul Waide presented Task 2 on single phase transformers. These transformers are used in single phase MV networks which are present in Ireland and the UK only. It is therefore not considered as a loophole and it is also not relevant for most of the European countries.

abbr.	Comment/answer
EUREL	Note that the single phase transformers as referred by in the Greece comments are in his opinion not distribution transformers
AREA	Are we talking about medium voltage single phase transformers?
EUREL	Yes
EUREL	When comparing data for small single phase transformers it is important to look at transformer impedance because it is important to achieve network short circuit levels . In Ireland this is a particular issue because the lines are very long, therefore impedance requirements are set at 2.2% for 15kVA Transformer s and 4% for others. . The consequence of these very low impedance requirements is that they have a high kPEI but this does not mean they operate at a high load factor. So the copper losses on these transformers are much lower than would be economically justified by the copper losses saved – the reduced copper loss levels arise from the requirement to achieve a low impedance by decreasing resistivity, as reactance for the size and shape of the transformer has already been minimised. The UK in contrary has 4% impedance requirements and it's copper losses are set by

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	economics, and hence higher than those in Ireland which are set by Short Circuit requirements. Reducing Iron Losses was considered and presented in papers to Vito, but as shown a decrease in Iron losses of 16W (using Amorphous, from 48W to 32W) resulted in a 75kg increase in weight. The capitalised value of this 16W saving was about €240, and it was felt that the cost of amorphous plus an extra 75kg of material would be greater than €240 and not produce any net savings.
EUREL	When looking at the price an issue is that UK transformers are split over different DSOs. Ireland has very competitive tender and includes capitalisation factors.
ENE	Was surprised with the very low PEI and said that it could be improved by amorphous and remarked that the US has also single pole. Do you use amorphous?
EUREL	No, not in Ireland. Noted that there is only one manufacturer ofSingle Phase PoLe Mounted transformers in Europe. The UK sometimes buys Amorphous Single Phase Pole Mounted Transformers in India.
PW	Raised the question if other load factors should be used for these transformers?
EUREL	Wants to use the PEI because they want the flexibility to prepare for changes in the load profile due to the use of electric vehicles and heat pumps, else it is locked into one load factor
PW	The question was discussed whether or not the IE and UK should be treated separate in the analysis according to MEErP in the study.
HPS	Warned to be careful in identify a market in a country because we do not do this in other products. He wants a technical distinction.
EUREL	Noted that this could be done because the UK has a different voltage, different transformer impedance, different tank design and has different load factor.
T&D	Also support to differentiate based on technical distinction

Paul Waide presented some slides to discuss small transformers.

abbr.	Comment/answer
PW	Paul Waide raised the question: are there loss measurement standards for small transformers? In the meeting this could not be confirmed but after the meeting we received information from Yves Boudou(IGNES) that the document prEN50645 "Ecodesign requirements for small power transformers" describing the "method of measurement for losses" is at "formal vote" step in Cenelec and this standard should be ratified within 3-4 months. It is also clearly mentioned in the prEN 50645 that according to Annex I of Regulation (UE) N°548/2014 (21 may 2014), that small transformers (above 1kVA) shall be marked with information given in clause 2 point a), c) and d). According to SR96, these requirements are sufficient to allow customers to compare easily "values and Ecodesign characteristics" of transformers from different manufacturers.
PW	Informed the stakeholders that this study does not cover small transformers, no time and budget is foreseen for this.
EREA	Noted: It is correct, *"Small power transformers"* are defined in Commission Regulation (EU) No 548/2014: Article 2 - Definitions: *(2) 'Small power transformer' means a power transformer with a highest voltage for equipment not exceeding 1,1 kV.* Also in Article 3 – Eco-design requirements it is repeated::

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Distribution: General

vito
vision on technology

	Small power transformers, medium power transformers and large power transformer shall meet the eco-design requirements set out in Annex I. But in that same document No 548/2014 where in Annex 1 - Eco Design requirements are listed, *Small power transformers* are no longer 'listed'.... See table of content at the end of this letter. This means that no table with requirements (or even no guideline) for the "*Small power transformers*"
ECOS	Should we define a new product group with the arrival of electric vehicles?
EREA	Based on the evolution of electrical vehicles (electrical charging) also a growth in LV/LV transformers can be expected. Not only today these LV/LV transformers are needed (mostly in Belgium due to local particularities with the Grid – missing Neutral), but definitively in the near future when Mode-4 DC Charging will be in place (DC charging requires an IT Grid which will require a transformer).
	A discussion followed on the classification and it was noted that CENELEC TC 96 deals with these transformers and that there are some classifications
EREA	During the meeting also the terminology "*Low Voltage Transformer*" was used. It was also said that these transformers have to follow the Low Voltage Directive (LVD) 2014/35/EU. This is true. But, basically, The LVD covers all health and safety risks of electrical equipment operating with a voltage between 50 and 1000V for alternating current (AC) and between 75 and 1500V for direct current (DC). This LVD does not cover elements as stated in the Eco-design requirements.
UKGRI	Noted that the IEC standard organisation for small transformers TC96 is mainly looking at safety
EUREL	Noted that for smaller transformers the efficiency is heavily related to the product for which they are used, and should be related to the overall efficiency requirements from the product
UKGRI	I am afraid I have to disagree with that. The use of small transformers is so diverse and this makes it complex. This is why CENELEC is talking about transmission and distribution. In summary we can define it as anything with a highest voltage below 1,1 kV is a small transformer.
EREA	Commented: - This argument is valid if these are used in a "Machine" as a building block. - This argument is not valid in a lot of other situations where a LV/LV transformer is just used as a 'single element' to change (transform) the voltage or to change the Grid (IT/TN/TT). Here multiple examples can be given: elevators, industrial laundry machines, heat pumps etc... In these cases the transformer is kept out of the 'Eco-Label' of this application since it is not considered as an integrated part. And as such escaping from the Eco-design rules?
PIR	In the Ecodesign Regulation 200.000 pieces per year is a threshold. Having requirements for small transformers will help all products that include them and therefore this is an opportunity. They are often used in various small categories of products that not have yet ecodesign requirements. Such a study will help the EC to improve efficiency in these products. This is an opportunity to harmonize and the study could do the first step.
UKGRI	I am afraid I have to disagree with that. The use of small transformers is so diverse and this makes it complex. This is why CENELEC is talking about transmission and distribution. In summary we can define it as anything with voltage below 1,1 kV for small transformers.
PIR	We should not regulate any different application but the transformer efficiency. There are hundreds of thousands sold annually. There is demand for isolation, for protection; small transformers have 1000 of applications. There will be always a market for such

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Distribution: General

	applications and a need for regulation.
EREA	*not said in the meeting but received after the meeting ans just as an indication: we supply yearly about 50.000 pieces LV/LV transformer which do represent an installed power base of 50MVA in total.*
PW	This raises the question on how you define a function. The saving is per application and this is extremely complex, we can summarize this in the report. Is there market data?
ECOS	Note that small transformers are regulated outside Europe and take care that EU does not become dumping ground. The demand is ramping up but I note that there is no technical standard looking at efficiency of these transformers and the consultant could look at that.

16h40 AOB

It was repeated that comments and position papers for inclusion in the study can be sent until 28 April

The study will be finalized by June.

CS informed the participants that the Commission will present its ideas on the revision of the Regulation to the Consultation Forum organized by the EC that will likely happen in the 2nd half of October.

There are about 60 members of the Consultation Forum but maybe half of you around the table are not part of it, although the EC can invite you ad hoc. Therefore we need an expression of interest for those who would like to be invited in the Consultation Forum and therefore you should contact Cesar Santos (Cesar.SANTOS@ec.europa.eu).

Any input ahead of the consultation forum can also be sent directly to the EC.

16h50 the meeting was closed

9. Annex I Workshoppresentation

CAPEX for EE compared to CAPEX for RES

Paul Waide - Waide Strategic Efficiency Ltd, UK

Transformers Ecodesign stakeholder meeting

March 29th 2017

Waide Strategic Efficiency

Notions behind CAPEX comparison

- Utilities are required to invest in RES in response to both EU (RED) and MS policy targets on RES
- The policy objective behind these targets is increase EU security of supply, reduce dependency on fossil fuels and reduce emissions
- However, reducing losses by increasing transformer efficiency also helps to achieve exactly the same objectives; thus, it makes sense to also compare the cost-benefits of reducing transformer losses with the equivalent cost-benefits of increasing RES so these options may be placed on an equal basis

2 Waide Strategic Efficiency

What CAPEX should be compared?

- The relevant comparator is the incremental cost of increasing RES by 1W(peak) with reducing demand by 1W (peak) via reduced transformer losses
- Comparison should be done at the point of final demand
- Needs to take into account reliability
- Therefore if considering a PV system it would include the balance of system costs (e.g. inverter and storage) as well as the cost of a panel producing 1W peak
- For wind power should include storage (e.g. pumped hydro) and grid connections costs as well as turbine costs

3 Waide Strategic Efficiency

RES CAPEX costs

- The analysis conducted assumed a blend of 50% PV and 50% wind
- Included equipment, installation and maintenance costs
- Integrated these over the typical lifetime of a transformer e.g. 25 years
- Concluded that the typical average RES cost was ~€3/Wpeak
- Compared this to the equivalent capex costs of reducing transformer losses at peak

4 Waide Strategic Efficiency

Example of findings for no load losses: 15 and 33 kVA

Base Case		Liquid Single Phase A0	Liquid Single Phase AA0	Liquid Single Phase AAA0	Liquid Single Phase A0	Liquid Single Phase AA0	Liquid Single Phase AAA0
transformer rating (S)	kVA	15	15	15	33	33	33
No load losses (P0)	W	70	63	35	76.4	68.76	38.2
no load class		Ao	AAo	AAAo	Ao	AAo	AAAo
Load losses (Pk)	W	900	900	900	964	964	964
load class		Ck	Ck	Ck	Ck	Ck	Ck
Auxiliary losses (Paux)	W	0	0	0	0	0	0
PEI	%	96.853%	98.825%	97.634%	98.365%	98.440%	98.837%
Load Factor (α) (=Pavg/S)	ratio	0.1	0.1	0.1	0.1	0.1	0.1
Load form factor (Kf)(=Prms/Pavg)	ratio	1.073	1.073	1.073	1.073	1.073	1.073
availability factor (AF)	ratio	1	1	1	1	1	1
Power factor (PF)	ratio	0.9	0.9	0.9	0.9	0.9	0.9
Equivalent load factor (αeq)	ratio	0.12	0.12	0.12	0.12	0.12	0.12
αopt (= sqrt ((Po+Paux)/Pk))	ratio	0.279	0.265	0.197	0.282	0.267	0.199
no load and aux. losses per year	kWh/y	613.2	551.9	306.6	669.3	602.3	334.6
load losses per transformer per year	kWh/y	112.1	112.1	112.1	120.0	120.0	120.0
losses per year	kWh/y	725.3	663.9	418.7	789.3	722.4	454.7
transformer life time	y	40.00	40.00	40.00	40.00	40.00	40.00
interest rate	%	4%	4%	4%	4%	4%	4%
inflation rate	%	2%	2%	2%	2%	2%	2%
kWh price no load and aux. Losses	€	0.0847	0.0847	0.0847	0.0847	0.0847	0.0847
kWh price load losses	€	0.0847	0.0847	0.0847	0.0847	0.0847	0.0847
CAPEX - transformer	€	293.40	313.49	415.93	645.49	689.68	915.04
losses per year	kWh/y	725.3	663.9	418.7	789.3	722.4	454.7
discount rate	%	2%	2%	2%	2%	2%	2%
PWF	ratio	27.36	27.36	27.36	27.36	27.36	27.36
No load loss capitalization factor (A)	€/W	20.30	20.30	20.30	20.30	20.30	20.30
Load loss capitalization factor (B)	€/W	0.29	0.29	0.29	0.29	0.29	0.29
TCO A/B ratio = α² (only if kWh price load/no load =)	ratio	0.01	0.01	0.01	0.01	0.01	0.01
TCO A/B ratio = α².(€/kWh load)/(€/kWh no load)	ratio	0.01	0.01	0.01	0.01	0.01	0.01
OPEX electricity	€/y	61.43	56.24	35.46	66.85	61.18	38.51
LCC electricity	€ /life	1,680.44	1,538.38	970.05	1,828.81	1,673.74	1,053.46
LCC total (excl. scrap@EOL)	€ /life	1,973.84	1,851.85	1,385.97	2,474.29	2,363.41	1,968.50
scrap value @ EOL	€	8.85	8.85	8.85	19.47	19.47	19.47
NPV scrap value (incl. discount rate)	€	4.01	4.01	4.01	8.82	8.82	8.82
LCC total (incl. scrap@NPV)	€	1,969.84	1,847.84	1,381.96	2,465.47	2,354.60	1,959.68

5 Waide Strategic Efficiency

CENELEC

Preparatory study for the review of EC Regulation 548/2014 on transformers Stakeholder meeting Brussels 27.3.17

Summary of contributions by CENELEC TC 14 pre-standardization activity (prTS50675)

Angelo Baggini
CENELEC TC14 chairman, University Bergamo Italy

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The document prTS50675:

- has been issued by CLC TC 14 "Power transformers" in support of the COMMISSION REGULATION (EU) No 548/2014 review
- takes into consideration the existing standards EN 50588-1:2015 and EN 50629:2015, their amendments and the feedbacks received from the National Committees as well as the aim of the European Commission
- has been circulated to NCs by SE TC14_Sec0524_DC to collect comments

Data have been collected from several European countries on dimensional and weight constraints imposed by the infrastructure as well as transport limitations

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Main addressed issues

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- Exemptions
  - List
  - Management
- Pole mounted transformers
- Power transformer classes
- Repaired transformers
- Minimum Energy performances
  - New specific requirements for PEI up to 200 MVA
  - Dual voltage transformers
  - Single phase medium power transformers
  - Solution for the inconsistency at 4 MVA and for units with Um=38,5kV from CZ
- PEI requirement improvements: cooling consumption treatement at KPEI
- Rating plate
- Market surveillance

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Exemptions

CENELEC

- Proposal to simplify and better qualify and manage the Exemptions in order to exclude less categories of transformers

EU Regulation 548/14	PRTS 50675 proposal
• large power transformers where it is demonstrated that for a particular application, technically feasible alternatives are not available to meet the minimum efficiency requirements set out by this Regulation, • large power transformers which are like for like replacements in the same physical location/installation for existing large power transformers, where this replacement cannot be achieved without entailing disproportionate costs associated to their transportation and/or installation,	• Power transformers which are like for like replacements in the same physical location/installation for existing power transformers, where this replacement cannot be achieved without entailing disproportionate costs associated to their transportation and/or installation.

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Exemption management

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- A procedure to handle exceeding dimensional or weight constraints in cases exceeding dimensional or weight constraints is proposed

Power transformers in the scope of this document for which it is not technically feasible or economically justifiable or reasonably practical to reach minimum performances requirements set out by EU REGULATION N. 548/2014, are dealt with in paragraph 5 of Part 1. This is for instance the case of particular applications or physical constraints in an existing installation. All these cases should be documented at the signature of the contract with a declaration made by the customer.

5 Transformers subject to constraints

In situations where there are physical constraints such as imposed by existing installations, or new location in existing building or transportation issues, then the following procedure shall be used:

(a) A Tier 2 transformer shall be chosen unless i specified;
(b) In the latter case a Tier 1 transformer shall b meet the constraints;
(c) Where even a Tier 1 transformer cannot be transformer is excluded from minimum ene recommended that the energy performance applicable.

CLC TC14 does not deal with economical justification but highlights the need that EC defines clear procedures to assess it

The constraints shall be specified in the transformer contract. The above is on the basis that these choices are economically justifiable from a TCO basis for the installation.

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Pole mounted transformers

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Proposal to reduce the actual quantity of units with higher losses:

- limiting definition to transformer mounted on single pole
- Extending minimum energy performance requirements also to pole mounted transformers when weight is not a constraints

3.9
Pole mounted transformer
Power transformer within the scope of EN 60076-1 that is designed for mounting on a single pole and has a maximum weight limitation.

Note 1 to entry: The definitions of power transformer and winding is given in EN 60076-1.

Note 2 to entry: for definitions of pole see IEV [466-07-01].

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Power transformer classes

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Proposal to streamline the definitions of large and medium power transformers to better suit industry practice (unification vs customization)

3.7
Medium power transformer
Power transformer within the scope of EN 60076-1 with all windings having rated power lower than or equal to 3 150 kVA and highest voltage for equipment lower than or equal to 36 kV

Note 1 to entry: The definitions of power transformer and winding is given in EN 60076-1.

3.8
Large power transformer
Power transformer within the scope of EN 60076-1 with at least one winding having either rated power greater than 3 150 kVA or highest voltage for equipment greater than 36 kV

Note 1 to entry: The definitions of power transformer and winding is given in EN 60076-1.

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Repaired transformers

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- Overhaul activitiy classification is proposed

UPGRADE
- Replacing the core (or part of it) using a material with lower specific loss
- Replacing some (but not all) windings with new ones providing lower load loss
- Replacing fans or pumps with more efficient ones

of it
- Replacing all coils on a specific leg in a three phase transformer
- Replacing one winding of a three phase transformer
- Drying and pressing the active part
- Repairing leakages, corrosion protection

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RETROFIT
- Replacement of a complete active part with a new one providing increased energy performance, replacement of the tap changer, of the bushings and of the complete insulation

pumps) to lower the relative thermal ageing rate
- Replacing insulating liquid
- Replacing all windings with new ones of the same design and material, replacing the tap changer, replacing the bushings and the complete insulation

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Minimum Energy performances

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Minimum Energy performances
have been proposed in part 2 and 3

Proposals to be highlighted are:

- To keep the present definition for **Dual voltage transformers**
- The specific PEI values to address **single phase medium power transformers**
- The **new specific requirements** for PEI **up to 200 MVA** including a solution to address the **inconsistency at 4 MVA** and also the issue of **units with Um=38,5 kV** from CZ

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Minimum Energy performances

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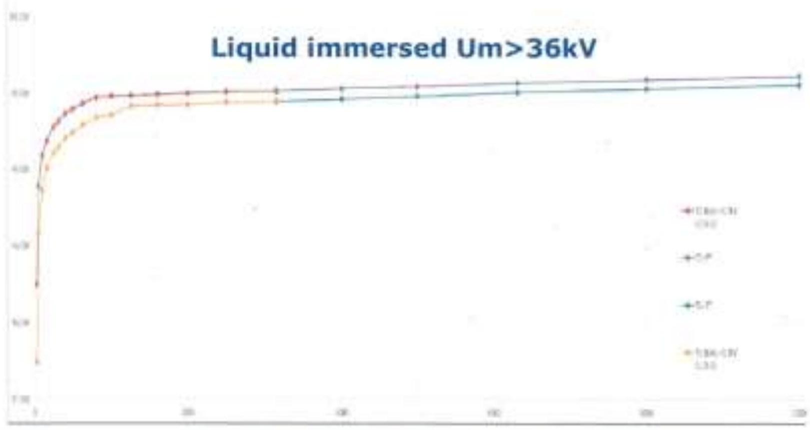
Proposed solution *,** to address the inconsistency at 4 MVA and also the issue of units with Um=38,5 kV from CZ



* by plenary CLCTC14 meeting #58 according with IT and DE comments
** NOT included in prTS50675)

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Minimum Energy performances

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Proposed solution*,** to address the inconsistency at 4 MVA and also the issue of units with Um=38,5 kV from CZ

Liquid immersed Um>36kV

Sr	PEI	
(kVA)	T1	T2
25	97,74158	98,25063
50	98,58446	98,89114
100	98,86687	99,09322
160	99,01236	99,19145
250	99,11154	99,28328
315	99,15385	99,31983
400	99,20909	99,36932
500	99,24652	99,39807
630	99,29487	99,43726
800	99,34298	99,47321
1000	99,38039	99,48376
1250	99,41827	99,48713
1600	99,42375	99,49388
2000	99,4254	99,50238
2500	99,4417	99,51431
3150	99,44455	99,5181

Dry type Um>36kV

Sr	PEI	
(MVA)	T1	T2
0,05	97,778	97,844
0,1	97,8	97,866
0,16	97,827	97,893
0,25	97,867	97,933
0,4	97,933	98
0,63	98,036	98,102
0,8	98,111	98,177
1	98,2	98,266
1,25	98,326	98,392
1,6	98,502	98,569
2	98,704	98,771
2,5	98,927	98,994
3,15	99,099	99,166

* by plenary CLCTC14 meeting #58 according with IT and DE comments
** NOT included in prTS50675)

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PEI requirement improvements

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Proposal of a new equation for PEI to take into account Cooling consumption at KPEI

$$PEI = 1 - \frac{2(P_0+P_{c0}+P_{ck}(k_{PEI}))}{S_r\sqrt{\frac{P_0+P_{c0}+P_{ck}(k_{PEI})}{P_k}}} = 1-\frac{2}{S_r}\sqrt{(P_0+P_{c0}+P_{ck}(k_{PEI}))P_k}\ (\%)$$

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Rating plate

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Proposal of harmonization between medium and large power transformers regarding weights of the main materials

In addition to EN 60076-1 and EN 60076-11 requirements, the following values shall be shown on the rating plate:

- P_0, the measured no load loss at rated voltage and rated frequency, on the rated tap;
- The name of the no load loss class for transformers with $S_r \leq$ 3 150 kVA;
- P_{c0}, the measured electrical power required by the cooling system for no load operation (if any) derived from the type test measurements of the power taken by the fan and liquid pump motors;
- P_k, the measured loss at rated current and rated frequency on the rated tap corrected to reference temperature according to Part 1 of this Technical Specification;
- The name of the load loss class for transformers with $S_r \leq$ 3 150 kVA;
- PEI based on measurements for transformers when applicable;
- k_{PEI}, the load factor at which PEI occurs for transformers when applicable;
- For dual voltage transformers, the maximum rated power at the lower voltage;
- Conductor mass and the nature of the conductor;
- Core mass and the nature of the core material;
- For medium power pole mounted transformers, a visible display "For pole-mounted operation only".

In case correction factors apply on losses because of other insulation level or dual voltage as specified in paragraphs 6.2.3 and 6.2.4, the loss class names to be written on the rating plate and in the technical documentation (e.g. A_0, AA_0, AAA_0, A_k, B_k, C_k, ...) shall remain the same, without mentioning the correction factors.

In case of dual voltage transformers for which the full rated power is available regardless of the combination of voltages, the no load and load loss to be written on the rating plate and in the technical documentation shall refer to the highest voltage of the tapped winding.

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Market surveillance

CENELEC

On the basis of the new definition of the declared values, additional requirements on uncertainty for MSAs are proposed

The measurement uncertainty applicable to the market surveillance authority shall be:

- The expanded uncertainty, as defined in EN 60076-19 and referring to a coverage factor k = 2 (i.e. to a confidence level of about 95 % assuming a normal distribution);
- The measurement uncertainty defined in this way, expressed as a relative value shall not exceed 5 %.

In case the value determined by the marked surveillance authority exceeds the declared value by more than 5 %, a second and more accurate measurement shall be taken.
For the second measurement, the measurement uncertainty applicable to the market surveillance authority shall be:

- The expanded uncertainty, as defined in EN 60076-19 and referring to a coverage factor k = 3 (i.e. to a confidence level of about 99,9 % assuming a normal distribution);
- The measurement uncertainty defined in this way, expressed, as a relative value shall not exceed 5 %.

The above requires that the standard deviation shall be less than or equal to 1,667% (5%/3) for the measurement uncertainties due to the devices and process in order that the market surveillance authority are capable making a valid measurement.
This procedure is detailed in Annex C.

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prTS 50675 – MAIN RECEIVED COMMENTS (*)

CENELEC

- **Germany, France and Turkey** are **against changing the border between medium and large power transformers** to 3 150 kVA (now it is 40 MVA)
- **Spain** proposing **to avoid exemptions for transformers not meeting Tier1** values, as it is in place already today
- **France** suggests **to remove** the **chart defining overhaul activities**
- **Portugal, Ireland and Italy** propose **to consider PEI as an alternative to fixed losses for medium power transformers** in order **to optimize** energy performance on the actual load **via appropriate capitalization values**
- **Italy is against loss levels requiring Cu to be met**
- **Italy proposes to work on product information** requirements (what shall be put on «free access websites»?)
- **Italy proposes to remove** the sentence stating that exemptions due to constraints shall be **justified based on TCO of the overall installation**
- **Italy proposes to keep the 2017 allowances on** losses for **Voltage Regulating Distribution Transformers also in 2021** to avoid killing promising technologies which can favor the penetration of renewables
- **Poland and Italy question** the fact that this Technical Specification contains **requirements not relating to energy performance**
- **Portugal proposes to extend to pole mounted transformers the allowances on losses** applicable to transformers having dual voltages and/or higher voltages
- **Portugal proposes to remove** the wording **«with weight limitations» in the definition of pole mounted transformer**
- **Portugal questions the different level of losses for pole mounted transformers**

(*) Comments already addressed and minor technical or editorial comments not reported here

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EcoDesign TIER2 Scope of Analysis

The following features are concerned by this analysis

- Increase of material consumption related to transition Tier2 requirements
- Change of active part material (s) related to transition Tier2 requirements

1

Calculation asumptions

When calculating the necessary increase of material consumption the following rules were implemented

- The same design
- The same materials (GOS grade, winding material)
- The same margins between maximum losses and calculated losses
- The same insulation distances

The increase factors were evaluated for the following ratings

- 160 , 630, 1600 kVA – for oil immersed transformers
  - For 160 kVA both Pole Mounted version and Ground Mounted version were considered
- 630, 1600 kVA – for cast resin transformers
- Aluminium and Copper designs were analyzed

2

General conclusions

Dry type transformers

- For dry type transformers included in this analysis the demand for loss decrease is not very significant
  - 10% reduction of NLL (generally for the whole range)
  - no reduction of LL for higher ratings (from 800 kVA)
  - 6% – 18% reduction of LL for lower ratings (up to 630 kVA); for the considered type (630 kVA) the reduction of LL was 6%
- Aluminium windings require more space between the core limbs than copper windings; hennce the material consumption increase is more remarkable in aluminium transformers (almost 2 times)
- The optimum solution is relatively flat; so the decrease of individual losses may be compensated either by more or less uniform increase of each material (core and winding), either by increase of GOS or by increase of winding material; in some cases it was observed that the decrease of losses can be met by more intensive consumption increase of one material associated by the decrease of the another one (see 1600 kVA copper version)

3

General conclusions

Dry type transformers cont.

- All TIER2 versions can be designed with the same GOS grade as the TIER1 design;
- Generally the need of material consumption increase versus the loss decrease can be described in the following way (hypothesis upon 4 samples)
  - 10% reduction of NLL can be compensated by 10% of each active material increase or 20% of one of material increase (see 1600 kVA)
  - 10% reduction of NLL and 6% reduction of LL can be compensated by 15% of GOS and almost 30% of aluminium or by 11% of GOS and 16% of copper (see 630 kVA)
  - The 6% improvement of GOS parameters reduces roughly by the same percentage material consumption increase
- No major obstacles to reach the TIER2 level with the same materials or materials slightly better; however these marerials remain in the current production scope (M090-27, M085-23, M080-23)

4

General conclusions

Oil immersed type transformers 160 kVA pole mounted (PM)

- The typical (French) requirement is to limit the weight of PM transformers up to 550 kg. The current TIER1 designs fits this limit.
- There are two ways to reach better level
  - to balance between active material part and mechanical part what very often is impossible not to affect insulation distances or cooling parameters or mechanical strength
  - to use better GOS
- All TIER2 versions have to be designed with better GOS grade than the TIER1 design; to reach the 10% improvement the grade M075-23 must be considered
- **At the moment the M075-23 grade is the best comercially available GOS material with the limited supply (only Nippon Steel). Using this grade at the moment seems to be the only way to reach the TIER2 requirement**

5

General conclusions

Oil immersed type transformers

- On the contrary to the dry type transformers for oil transformers included in this analysis the demand for loss decrease is significant
  - 10% reduction of NLL (generally for the whole range)
  - 15% reduction of LL (+/- 1%) for higher ratings (from 1250 kVA)
  - 30% reduction of LL for lower ratings (up to 1000 kVA)
- Aluminium windings require more space between the core limbs than copper windings; hennce the material consumption increase is more remarkable in aluminium transformers
- The optimum solution is relatively flat; so the decrease of individual losses may be compensated either by more or less uniform increase of each material (core and winding), either by increase of GOS or by increase of winding material; in some cases it was observed that the decrease of losses can be met by more intensive consumption increase of one material associated by lower increase of the another one (see and compare aluminium and copper versions of 630 kVA)

6

General conclusions

Oil immersed type transformers cont.

- All TIER2 versions can be designed with the same GOS grade as the TIER1 design; it concerns especially higher range which the loss reduction demand is not so deep for
- For smaller ratings when keeping the same GOS grade it causes too high need of material consumption increase, so it can be economically sound to use the better grades of GOS
- The need of material consumption increase for bigger transformers versus the loss decrease can be described in the following way
  - 10% reduction of NLL and 15% reduction of LL can be compensated by ~15% of GOS material increase and 30% (for copper) or 45% (for aluminium) of winding material increase (see 1600 kVA)
  - Improvement of GOS by 5% reduces the consumption in similar way (2% - 5%)

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General conclusions

Oil immersed type transformers cont.

- The need of material consumption increase for smaller transformers versus the loss decrease can be described in the following way
  - 10% reduction of NLL and 30% reduction of LL requires from ~25% up to ~50% of GOS material increase and 70% up to 100% more winding material (for copper)
  - For aluminium windings the need for GOS increase varies from 50% up to 65% while the need for winding material increase amounts to 40% up to 90%
  - Improvement of GOS parameters by 5% reduces the consumption by (3% - 13%)
- For bigger ratings no major obstacles to reach the TIER2 level with the same materials or materials slightly better; however these materials remain in the current production scope (M090-27, M085-23, M080-23)
- For smaller ratings it is also possible to use the same GOS material, however it requires setting the flux density on the very low level below 1.2 T what makes the GOS not to be properly utilized. In this case change for better GOS may improve the operating point of flux density. It is especially critical for the lowest range (250 kVA and below)

8

General conclusions

Oil immersed type transformers cont.

- The lower range (630 kVA and below) where the change from TIER1 to TIER2 means the decrease of LL by 30% the use of aluminium and / or the GOS grade M085 or worse lead to very low flux density andvery low current densities. In these cases it should be considered to use better GOS (<= 0.8 W/kg) together with copper winding
- The high material consumption increase may cause longer production time; this will be especially remarkable when it is connected with the change of lamination thickness from 0.27 to 0.23 (or in the future for thinner laminations)
- For this particular range it would be essential to develop GOS grades significantly better then ones being used today; the targetted level of specific loss should be 0.60 – 0.65 W/kg to reach the reasonable levels of flux and current densities and reduce the need fosuch a high consumption increase.

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APPENDICES

Dry type transformers – result on total weight

- The increase of 1600 kVA total weight is specified in the following table:

Pos	Type	GOS	Winding	Tot weight increase	
1	DT 1600/ 20 TIER1	[illegible]	Cu	reference pos.1	reference pos.4
2	DT 1600/ 20 TIER2	[illegible]	Cu	8%	8%
3	DT 1600/ 20 TIER2-2	[illegible]	Cu	7%	7%
4	DTA 1600/ 20 TIER1	[illegible]	Al	reference pos.4	reference pos.1
5	DTA 1600/ 20 TIER2	[illegible]	Al	10%	11%
6	DTA 1600/ 20 TIER2-2	[illegible]	Al	5%	5%

- Remark – the weight of TIER1 1600 kVA is almost the same for Cu and Al versions
- The increase of 630 kVA total weight is specified in the following table:

Pos	Type	GOS	Winding	Tot weight increase	
1	DT 630/ 20 TIER1	[illegible]	Cu	reference pos.1	reference pos.4
2	DT 630/ 20 TIER2	[illegible]	Cu	11%	7%
3	DT 630/ 20 TIER2-2	[illegible]	Cu	5%	2%
4	DTA 630/ 20 TIER1	[illegible]	Al	reference pos.4	reference pos.1
5	DTA 630/ 20 TIER2	[illegible]	Al	17%	21%
6	DTA 630/ 20 TIER2-2	[illegible]	Al	11%	15%

- Small or moderate weight increase (5% – 20%) for both ratings

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APPENDICES

Oil immersed type transformers – result on total weight

- The increase of of 1600 kVA total weight is specified in the following table:

Pos	Type	GOS	Winding	Tot weight increase	
1	OT 1600/ 20 TIER1	[illegible]	Cu	reference pos 1	reference pos 4
2	OT 1600/ 20 TIER2	[illegible]	Cu	13%	10%
3	OT 1600/ 20 TIER2-2	[illegible]	Cu	9%	7%
4	OTA 1600/ 20 TIER1	[illegible]	Al	reference pos 4	reference pos 1
5	OTA 1600/ 20 TIER2	[illegible]	Al	19%	22%
6	OTA 1600/ 20 TIER2-2	[illegible]	Al	18%	20%

- Remark – the weight difference between Cu and Al versions of TIER1 1600 kVA is very small (~2-3%)

- Small or moderate weight increase (5% – 20%) for 1600 kVA

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APPENDICES

Oil immersed type transformers – result on total weight

- The increase of 630 kVA total weight is specified in the following table:

Pos	Type	GOS	Winding	Tot weight increase	
1	OT 630/ 20 TIER1	[illegible]	Cu	reference pos.1	reference pos.4
2	OT 630/ 20 TIER2	[illegible]	Cu	33%	21%
3	OT 630/ 20 TIER2-2	[illegible]	Cu	30%	19%
4	OTA 630/ 20 TIER1	[illegible]	Al	reference pos.4	reference pos.1
5	OTA 630/ 20 TIER2	[illegible]	Al	51%	65%
6	OTA 630/ 20 TIER2-2	[illegible]	Al	40%	53%

- Remark – the weight difference between Cu and Al versions of TIER1 630 kVA is significant (~10%);

- Cu version is lighter
- Significant weight increase (30% – 50%) for 630 kVA

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APPENDICES

Oil immersed type transformers – result on total weight

- The increase of of 160 kVA total weight is specified in the following table:

Pos	Type	GOS	Winding	Tot weight increase	
1	OT 160/ 20 TIER1	[illegible]	Cu	reference pos.1	reference pos.4
2	OT 160/ 20 TIER2	[illegible]	Cu	42%	19%
3	OT 160/ 20 TIER2-2	[illegible]	Cu	36%	14%
4	OTA 160/ 20 TIER1	[illegible]	Al	reference pos.4	reference pos.1
5	OTA 160/ 20 TIER2	[illegible]	Al	40%	68%
6	OTA 160/ 20 TIER2-2	[illegible]	Al	38%	65%

- Remark – the weight difference between Cu and Al versions of TIER1 160 kVA is significant (~15%)

- Cu version is lighter
- Significant weight increase (approximately 40%) for 160 kVA

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APPENDICES

Oil immersed type transformers – result on oil consumption

- The increase of oil consumption is specified in the following table:

Pos	Type	GOS	Winding	Oil weight increase	
1	OT 1600/ 20 TIER1	[illegible]	Cu	reference pos.1	reference pos.4
2	OT 1600/ 20 TIER2	[illegible]	Cu	2%	-12%
3	OT 1600/ 20 TIER2-2	[illegible]	Cu	-1%	-15%
4	OTA 1600/ 20 TIER1	[illegible]	Al	reference pos.4	reference pos.1
5	OTA 1600/ 20 TIER2	[illegible]	Al	16%	35%
6	OTA 1600/ 20 TIER2-2	[illegible]	Al	17%	36%

Pos	Type	GOS	Winding	Oil weight increase	
1	OT 630/ 20 TIER1	[illegible]	Cu	reference pos.1	reference pos.4
2	OT 630/ 20 TIER2	[illegible]	Cu	21%	-10%
3	OT 630/ 20 TIER2-2	[illegible]	Cu	18%	-12%
4	OTA 630/ 20 TIER1	[illegible]	Al	reference pos.4	reference pos.1
5	OTA 630/ 20 TIER2	[illegible]	Al	39%	88%
6	OTA 630/ 20 TIER2-2	[illegible]	Al	31%	76%

Pos	Type	GOS	Winding	Oil weight increase	
1	OT 160/ 20 TIER1	[illegible]	Cu	reference pos.1	reference pos.4
2	OT 160/ 20 TIER2	[illegible]	Cu	29%	-7%
3	OT 160/ 20 TIER2-2	[illegible]	Cu	25%	-10%
4	OTA 160/ 20 TIER1	[illegible]	Al	reference pos.4	reference pos.1
5	OTA 160/ 20 TIER2	[illegible]	Al	22%	69%
6	OTA 160/ 20 TIER2-2	[illegible]	Al	21%	66%

- The oil consumption increase is smaller than relevant total weight increase
- Change from Al to Cu allows to save some oil

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APPENDICES

Oil immersed type transformers – result on oil consumption

- The oil consumption increase is smaller than relevant total weight increase
- Change from Al to Cu allows to save some amount of oil

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APPENDICES

Oil immersed type transformers – material consumption proportions

- The proportions between materials referred to the total weight are specified in the below table

Pos	Type	GOS	Winding	Core%	Wind%	Oil%
1	OT 1600/ 20 TIER1	M085	Cu	35%	26%	15%
2	OT 1600/ 20 TIER2	M085	Cu	35%	30%	14%
3	OT 1600/ 20 TIER2-2	M080	Cu	34%	30%	14%
4	OTA 1600/ 20 TIER1	M085	Al	44%	13%	17%
5	OTA 1600/ 20 TIER2	M085	Al	43%	16%	17%
6	OTA 1600/ 20 TIER2-2	M080	Al	42%	16%	17%

Pos	Type	GOS	Winding	Core%	Wind%	Oil%
1	OT 630/ 20 TIER1	M085	Cu	41%	23%	15%
2	OT 630/ 20 TIER2	M085	Cu	38%	34%	14%
3	OT 630/ 20 TIER2-2	M080	Cu	38%	34%	14%
4	OTA 630/ 20 TIER1	M085	Al	47%	14%	19%
5	OTA 630/ 20 TIER2	M085	Al	51%	17%	17%
6	OTA 630/ 20 TIER2-2	M080	Al	50%	17%	17%

Pos	Type	GOS	Winding	Core%	Wind%	Oil%
1	OT 160/ 20 TIER1	M085	Cu	41%	20%	18%
2	OT 160/ 20 TIER2	M085	Cu	44%	24%	16%
3	OT 160/ 20 TIER2-2	M080	Cu	44%	23%	16%
4	OTA 160/ 20 TIER1	M085	Al	49%	11%	21%
5	OTA 160/ 20 TIER2	M085	Al	55%	11%	18%
6	OTA 160/ 20 TIER2-2	M080	Al	54%	11%	18%

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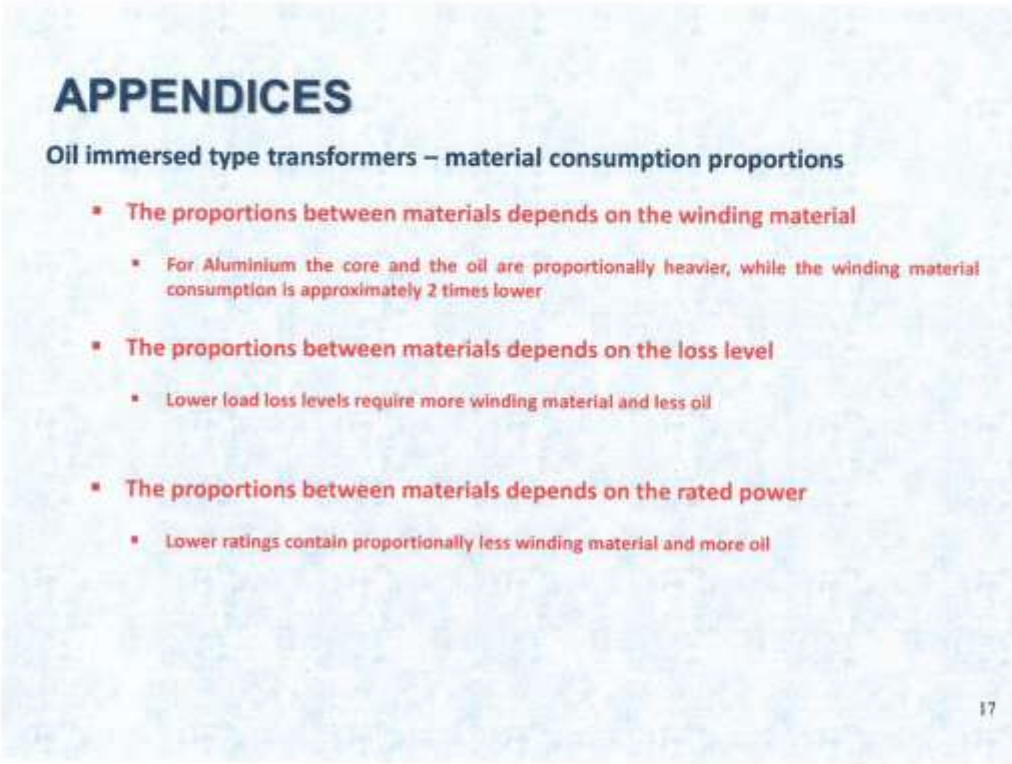
APPENDICES
Oil immersed type transformers – material consumption proportions
The proportions between materials depends on the winding material
For Aluminium the core and the oil are proportionally heavier, while the winding material consumption is approximately 2 times lower
The proportions between materials depends on the loss level
Lower load loss levels require more winding material and less oil
The proportions between materials depends on the rated power
Lower ratings contain proportionally less winding material and more oil
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EURELECTRIC input to EU Review of Commission regulation 548/2014 on Ecodesign requirements for small, medium and large power transformers

Anthony Walsh BE, MIE, MBA, ACCA

Chair, EURELECTRIC Distribution Network Assets - WG Standardization

Contact: anthony.walsh@esb.ie

29th March, 2017

Eurelectric Supports Sustainability !

- ***Eurelectric members are committed to Sustainability, and have worked for many years to minimise overall network losses in the interests of customers and society.***
- ***Eurelectric supports reductions in losses which benefit the customer.***
- ***However this requires that:***

Savings from Reduced Losses > Extra Costs!

Overview

1. Background
2. Large Power and Distribution Transformers
3. Extra Costs/Constraints with Tier 2 Installations
4. Possible Solutions?
5. Requirements for choice of Fixed Losses and PEI for Distribution Transformers.
6. Economic Justification for Tier 2 Levels – do the benefits exceed the costs?
7. Treatment of Exceptions

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Background

- Tier 1 has already added 20% to the cost of Transformers and utilities have had difficulty with increased size and weight
- Tier 2 will now increase both size and weight – but for less impact than Tier 1 - and at a substantially greater cost + 30 - 120%
- In addition accommodating larger and heavier Tier 2 Transformer in an existing Substations /on Poles will not be possible without expensive alterations.
  - Such alterations would cost more than any energy saved!
- Exemptions are required where it is not :
  - technically possible,
  - economically justifiable or
  - reasonably practical

  to meet Tier 2 levels.
- Tier 2 levels must be cost neutral – set at levels where the value of losses saved pay for all extra costs
- Tier 2 levels must be affordable to customers!

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Large Power and Distribution Transformers:

Large Power Transformers:

- Transformers use PEI and hence can accommodate a range of Load Factors
- Tenders with Capitalised Losses have had Tier 2 values offered, so Tier 2 is economic in the market
- Transportation issues due to extra weight and size can be a particular issue.
- Substation Buildings are fixed in size, so Exemption for replacements and transportation required.
- VITO Proposal to set minimum kPEI is problematic as it restricts designs and does not take into account impact of use of extra capacity in Transformer size for standby and load growth
- Large Power Transformers are already very efficient, so there are declining returns from any extra investment.

Distribution Transformers:

- **Large increase in costs for small gain in losses saved**
- **Significant Extra costs of accommodating Tier 2 transformers in/on existing Substations/Poles**

Extra Costs of Transformer Installation due to Tier 2

- **Purchase Costs of Typical Distribution Transformers (400kVA – 1000kVA) are in the range €8,000 to €15,000**
- **Tier 2 Loss savings are in the range €800 - €1,900 (Lifetime Savings)**
- **So any extra Installation costs must also be paid for from the Lifetime Savings.**
- **Installation associated Costs (where they arise) >> Cost of Transformer**
- **This means that if extra installations costs are associated with a particular Transformer design, then that design will not be economic.**

Transformer must fit into substation e.g. through hatch in floor, through entrance door, fit inside the space available, fit between existing equipment on pole.

Solutions?

- **Limit Transformer Losses such that they do not cause the Transformer to exceed the weight, and Dimension limits already set by existing Substations.**
  - So **consider basing Tier 2 in range Ao, Ak to Ao, Ak+20%,** NOT at Ao-10%, Ak – must be able to show that Extra Savings > Extra Costs!
- **Use PEI as <u>additional</u> alternative to maximise design flexibility and avoid limitations.**
- **In case of constraint, use Trafo Design which meets constraints *<u>using losses equivalent to best available materials –</u>* this approach is technologically neutral!**

***<u>DO NOT</u>* limit kVA Size to overcome size/weight constraint and fit into substation – result would be overloaded transformer with higher losses or else require an additional transformer and so double the Iron Losses**

***<u>Do NOT</u>* have different designs for 'Brownfield' And 'Greenfield' Substations as this would require two Transformer designs to be tendered and stocked for each size of Transformer, yet 90%+ of all transformers bought are for use in existing Substations. In addition, logically, utilities would simply stock <u>one</u> largest size unit for use in <u>all</u> Greenfield Substations, e.g. 1,000kVA instead of 200kVA, with much higher Iron Losses. Also Builders/Architects will object strongly to provision of large sized Substations – extra costs of Greenfield site > Losses saved.**

***<u>Avoid</u>* Loss levels that can only be met using Copper /Copper transformers as such transformers will be volatile on price. Residual Values of extra copper at end of life will be more than offset by extra costs of recycling additional oil and steel. Also tying up extra investment in Copper for 40 years not good!**

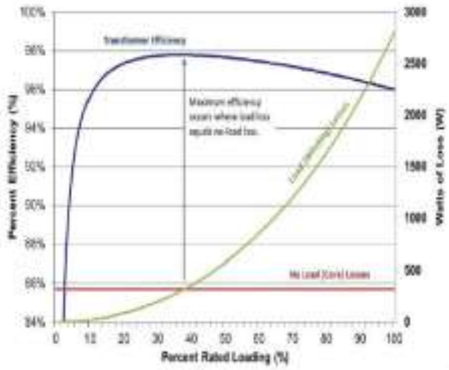
Provide choice of *<u>EITHER</u>* Fixed Losses or PEI for Distribution Transformers.

Transformer Losses are made up of constant level Iron Losses which do not vary, and Copper Losses which vary with the square of the Load.

The heavier and more constant the Load the more significant Copper Losses become, so that Transformers feeding constant heavy loads should have lower Copper Losses.

The best efficiency occurs when the Load Factor of the Load is matched to the Transformer design i.e. (Iron Losses kW / Copper Losses kW) = % Load Factor

Transformers are less efficient when they are not matched to the expected Load factor!



Requirements for choice of Fixed Losses and PEI for Distribution Transformers.

With Tier 2 and only Fixed Losses the 1,000kVA Transformer in Norway feeding Electric Heating will have the same Design and Losses as a 1000kVA in Spain feeding occasional peaky loads – all less efficient than at present!

Load Factor will also change over time as Electric Vehicles and Electrification of Heat are introduced, so that without the choice of PEI the Fixed Loss values available will be less and less appropriate.

Allowing PEI as an additional alternative for Distribution transformers would allow Transformer purchased to be matched better to the expected load e.g. Transformer feeding heavy load could be designed to have lower Copper Losses.

$PEI = 1 - 2\sqrt{(P_0 P_k)}/S$ where P_0 and P_k are the Iron and Copper Losses taken directly from the Tier 2 Fixed Loss Levels, and S is the Transformer size in kVA

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Economic Justification for Tier 2 Levels Do the benefits exceed the costs?

EU	Change in Losses (W) Tier 2 to Tier 1		Value of Losses Capitalisation factor: P0	Pk at TLF = 0.4	Value of Iron Losses	Value of Copper Losses	Total Value of Losses Saved over 40 years
kVA	P0	Pk	€7,596	€1,223	€	€	€
200	- 25	- 733	7,596	853	- 190	- 625	- **815**
400	- 43	- 1,350	7,596	910	- 327	- 1,229	- **1,555**
630	- 60	- 1,440	7,596	816	- 456	- 1,175	- **1,630**
1000	- 77	- 2,140	7,596	634	- 585	- 1,356	- **1,941**

As long as the extra costs of the transformer do not exceed the range €800 – €1,900 then the savings will outweigh the costs.
So for a €15,000 1000kVA +13% is b/even for Tier 2.
- but Laborelec Report suggests 30 – 120% Price Increase!

Capitalization calculation is very important – it must use correct Discount Rate (4%), the correct Price of ENERGY (i.e. electricity price – non energy costs of DUoS, TUoS, Levies, VAT, Supply Margin, Generation Capex) which do not vary with efficiency.

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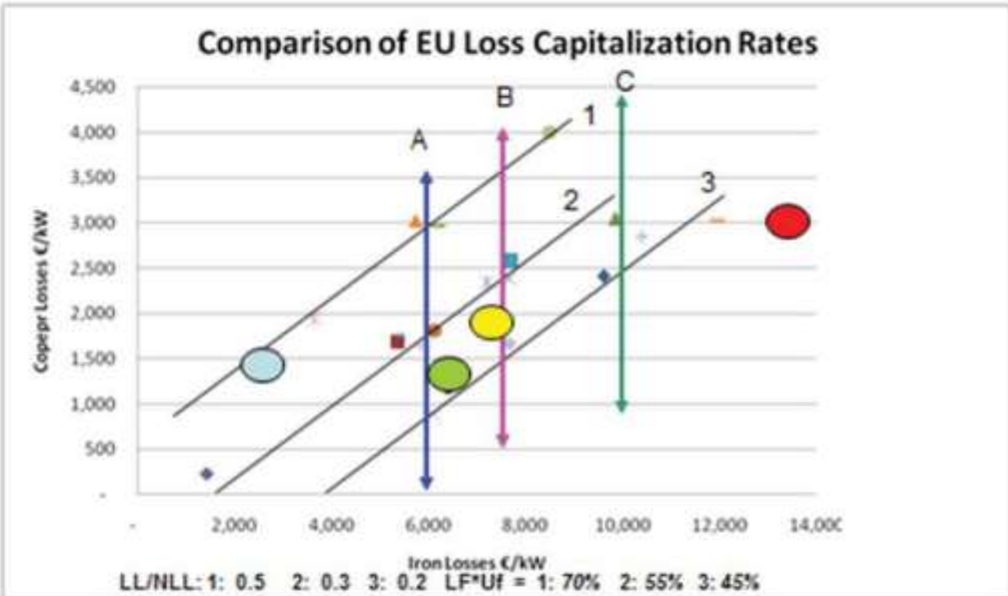
Iron Loss Capitalization based on No Years, €/MWh and Discount Rate;

Copper Loss Capitalization based on No Years, €/MWh and Discount Rate; - *And* Load Factor & Utilization Factor (Load growth also a factor)

*Differences in Copper Losses for same Iron relate to LF & UF used i.e. LL = NLL * LF²*UF²*



Consider A0, Ak as proposed by CLASP for TIER 2 - rather than A0-10%, Ak

400kVA	Existing Tier 1	CLASP	EU Tier 2
	A0, Ck	A0, Ak	Ao-10%, Ak
Fe (W)	*430*	*430*	*387*
Cu (W)	*4,600*	*3,250*	*3,250*
Extra Trafo Cost €		€1,180	??
Value of Extra Losses saved over Tier 1 €		-€1,365	€1,555
Net Saving(-)/Cost (+) €		**-€185**	??
1000kVA	Existing Tier 1	CLASP	EU Tier 2
	A0, Ck	A0, Ak	Ao-10%, Ak
Fe (W)	*770*	*770*	*693*
Cu (W)	*10,500*	*9,000*	*7,600*
Extra Trafo Cost €		€1,650	??
Value of Extra Losses saved over Tier 1 €		-€981	-€1,941
Net Saving /Cost (+) €		**€669**	??

CLASP looked at a range of Trafo Costs and loss levels prior to 2015 legislation and only found savings covering costs for the **A0, Ak** Loss Levels.

EU Tier 2 are based on **A0-10%, Ak** so are much more stringent, and were not based on actual transformer designs.

Extra costs for slightly reduced Iron loss are particularly expensive.

Suggest A0, Ak+20% to Ao, Ak as proposed by CLASP should be considered for Tier 2

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Exemption Procedures:

Reasons for being unable to meet the EcoDesign requirements may be due to :

- **Physical constraints such as imposed by Dimensional or Weight Limitations**
- **Economic Constraints where the cost of achieving EcoDesign is out of proportion to the benefits which would be realised.**

Transformer is Specified and Tendered with quotation requested and designed to meet the Specification requirements in conjunction with :

Tier 2 values	**@ Price T2**	
Tier 1 values	**@ Price T1**	
'Base level' Criteria	**@ Price 'Base'**	

Transformers can in nearly all cases be designed to meet Tier 2 values if cost is ignored but it would be unreasonable to require that windings were made of Silver and Amorphous Steel were used or that to meet the Efficiency levels a 1MVA transformer had to be designed instead of a 100kVA unit.

(e.g 'Base' based on Equivalent to Best Material/Capitalisation)

'Base Level' Criteria – use of <u>equivalent</u> losses to those obtained when using very good Magnetic Steel and Conductor – then technologically neutral

OR 'Base Level' Criteria set Transformer cost when manufactured using capitalization values within the constraints on weight and dimension set in the specification. The 'Base Level' design based on capitalised costs + losses should be used if this cost is 10% less than Tier 1 price + Capitalised Losses i.e. saving losses should not be at 'excessive cost ' (EcoDesign Directive) to customer.

Specific Exemptions as per CENELEC Proposals are also supported

Exemption Summary

In summary, the Extra Costs above Capitalisation Price /'Best Materials Equivalence Losses' Price are compared with Extra Savings (+10%) for each case and the most *efficient* transformer which has a positive net benefit is chosen.

The benefit of this approach is that it:

- is transparent and quantitative,
- is operated by the Manufacturers and
- is open to Market Surveillance.

If a transformer can be made economically within the constraints in the Specification then the most efficient design possible will be produced and bought.

However if the value of the losses saved do not justify the extra costs, then a less expensive option, which does not have such excessive costs,can be purchased.

The purpose of the EcoDesign Directive is to avoid ***'excessive costs'*** which are not justified. There is little point in spending more **customers'** money on reducing losses if the extra costs are more than the value of the losses saved!

This procedure achieves this aim of EcoDesign in a Transparent manner that is also open to Market Surveillance.

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30/03/2017

Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for small, medium and large power transformer

Stakeholder Workshop

Paul Van Tichelen

Brussels, DG GROWTH
29th of March 2017

Agenda -start

- 9h00: Registration desk opens(you need an ID card or passport)
- 9h00-9h30 Coffee in meeting room Ayral
- 9h30-9h40: Presentation of the study team and tour de table

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Agenda – Task 1

- TASK 1
- 9h40-10h15: Task 1 report on minimum requirements for Tier 2 (Paul Van Tichelen, VITO) (incl. remarks on discount rate (Eurelectric) and Tier 2 CAPEX (Hitachi Metals))
- 10h15-10h20: PEI alternatives (JB Sund, Norway)
- 10h20-10h25: CAPEX for EE compared to CAPEX for RES(Paul Waide)
- 10h25-10h30: GOES development for Tier 2 (Regis Lemaitre, Thyssens Krupp)
- 10h30-10h50: T&D Europe on Task 1 (Michel Sacotte, T&D Europe)
- 10h50-11h00: Impact of using Copper for Tier 2 GOES transformers (Roman Targosz, ECI)
- 11h00-11h15: Eurelectric on Tier 2 Economic feasibility in green field and brown field (Antony Walsh, Eurelectric)
- 11h15-11h30: coffee

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Agenda – Task 1

- TASK 1
- 11h30-11h40: The view of TSOs (Jean-Christophe RIBOUD, ENTSO-E)
- 11h40-11h55: Discussion on the Economic feasibility of Tier 2: When? Do we need to lower or postpone ambitions or a more ambitious Tier 3?
- 11h55-12h15: Discussion on how to set Tier 2 requirements for medium power transformer (if needed)? Keep as is, PEI, PEI + minimum P0/Pk, PEI + other limits(W/kg@1,5T), series that mimic PEI (A0-16%/Bk (low load transformer) + A0-10%/Ak (medium load) + A0/Ak-10% (high load) ..??
- 12h15-12h30: AOB related to Task 1?

- 12h30-13h30: lunch

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Agenda - TASK 3

- 13h30-13h50: Task 3 VERIFICATION OF EXISTING EXEMPTIONS AND REGULATORY CONCESSIONS
- 13h50- 14h10: Summary of contributions by CENELEC TC 14 pre-standardization activity (Angelo Baginni, CENELEC TC14, University Bergamo)
- 14h10-14h20: T&D Europe point of view on Task 3 (Michel Sacotte, T&D Europe)
- 14h20-14h30: Example - existing limits in the EDF Nuclear installations (Christophe ELLEAU, EDF)
- 14h30-14h40: Discussion on concessions for green field large power transformers 'rating + physical limits' vs 'spefic loss limit (<0,70 W/kg@1,5T' vs 'combination' ..?
- 14h40-14h50: How to deal with pole mounted transformers? rating + physical limits' vs 'spefic loss limit (<0,70 W/kg@1,5T' vs 'combination' ..?
- 14h50-15h00: Dual voltage: is it a loophole? Review the requirements and how?
- 15h00-15h15: other Q&A Task 3 + How to proceed with input in Task 1&3
- 15h15-15h30: coffee break

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Agenda TASK 4/2

- 15h30-15h40: Task 4 ON ANALYSIS OF OTHER ENVIRONMENTAL IMPACTS(Paul van Tichelen, VITO)
- 15h40-16h00: Task 2 CONSIDERATION OF MINIMUM REQUIREMENTS FOR SINGLE-PHASE TRANSFORMERS(Paul Waide)
- 16h00-16h10: If and how to deal with small power transformers (Paul Waide)
- 16h10-16h30: Closing + AOB

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EC policy officer & Study Team

- **EC policy officer: Cesar Santos**
- **Study Team:**
  - Team leader: **Paul Van Tichelen (VITO)**
  - Koen Vanthournout (VITO), Electrical grid expert/smart grids; Dominic Ectors (VITO), website
  - **Paul Waide (Waide Strategic),** Energy efficiency policies including transformers
  - Berend Evenblij (TNO)
- **Table round**
- **Use of voice recording**

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Introduction

- **Info: https://transformers.vito.be/**
- **We are discussing today the report available at: https://transformers.vito.be/sites/transformers.vito.be/files/attachments/ec_dg_growth_lot2_Transformer_V23.pdf**
- **The focus is on selected items based on the feedback received ahead of the meeting!**
- **The kick off meeting identified space/weight constraints as an important topic = brownfield applications!**

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Article 7 of Commission Regulation 548/2014

- **Article 7 Review No later than three years after the entry into force(10/6/2014). Specifically, the review will assess, at least, the following issues:**
  - the **possibility** to set out minimum values **of the Peak Efficiency Index** for all medium power transformers, including those with a rated power below 3 150 kVA,
  - the possibility to **separate the losses** associated **to the core transformer from** those associated with **other components** performing voltage regulation functions, where this is the case,
  - the appropriateness of establishing minimum performance **requirements for single-phase power transformers**, as well as for **small power transformers**,
  - whether **concessions made for pole-mounted transformers** and for **special combinations of winding voltages** for medium power transformers are still appropriate,
  - the possibility of **covering environmental impacts** other than energy in the use phase
- **In addition investigate if, in the light of technological progress, minimum requirements set out for Tier 2 in 2021 are still appropriate.**

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Objectives in a nutshell

- verify if requirements for **Tier 2** are still **cost-effective** from a lifecycle analysis perspective;
- provide **evidence** for a consideration of minimum efficiency requirements **for single-phase transformers**;
- **verify** if regulatory **concessions** made for **pole-mounted transformers** and transformers with **special combinations of winding voltages** are still appropriate;
- analyse if existing requirements for medium power transformers based on absolute levels of losses should be **converted to** relative values based on the **Peak Efficiency Index**;
- analyse if widely accepted **criteria for the repair** of transformers can be developed;
- analyse if **other, non-energy, environmental impacts of transformers** should be regulated

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Task 1: Verification of existing minimum requirements for Tier 2

- **verify if the minimum energy efficiency requirements in Regulation 548/2014 for Tier 2 level, applicable in 2021 (see also presentation on the Regulation)**
  - **In the light of technological progress: cost-effective, and technologically feasible?**
  - **Use the Peak Efficiency Index such as for power transformers?**

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Task 1: Verification of existing minimum requirements for Tier 2

- Analysis is **done based on Base Cases(BC)** from previous Lot 2:
  - **• BC 1: Distribution Transformer (400kVA)**
  - • BC 2: Industry Transformer: Oil-immersed (1MV)
  - • BC 3: Industry Transformer: Dry-type (1.25MVA)
  - • BC 4: Power Transformer (100MVA, primary voltage 132kV, secondary voltage 33kV)
  - • BC 5: DER Transformer : Oil-immersed (2MVA)
  - • BC 6: DER transformer : Dry-type (2MVA)
  - • BC 7: Separation/Isolation Transformer (16kVA).

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Task 1: Verification of existing minimum requirements for Tier 2

» Tier 1&2 related outcomes from the Impact Assessment and Lot 2 were note (Tier 2 =LLCC (Least Life Cycle Cost) (**note: BC1 k=0,18**) :

Base Case		BC1 DT liquid Tier1	BC1 DT liquid Tier2	BC2 Ind liquid Tier1	BC2 Ind liquid Tier2	BC5 DER liquid Tier1	BC5 liquid Tier2
transformer rating (Sr)	kVA	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
No load losses (P0)	W	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
no load class		A0	A0-10%	A0	A0-10%	A0	A0-10%
Load losses (Pk)	W	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
load class		Ck	Ak	Ck	Ak	[illegible]	Ak
Auxiliary losses (Paux)	W	0	0	0	0	0	0
PEI	%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Load Factor (k) (=Pavg/S)	value	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Load form factor (Kf)=Prms/Pavg	value	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
availability factor (AF)	value	1	1	1	1	1	1
Power factor (PF)	value	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Equivalent load factor (keq)	value	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	value	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
no load and aux. losses per year	kWh/y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
load losses per transformer per year	kWh/y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
losses per year	kWh/y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
transformer life time	y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
interest rate	%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
inflation rate	%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
kWh price no load and aux. Losses	€	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
kWh price load losses	€	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
CAPEX - transformer	€	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
losses per year	kWh/y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
discount rate	%	2%	2%	2%	2%	2%	2%
electricity escalation rate	%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PWF	value	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
No load loss capitalisation factor (A)	€/W	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Load loss capitalisation factor (B)	€/W	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
TCO A/B ratio	value	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OPEX electricity	€/y	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LCC electricity	€	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
LCC total (excl. scrap)	€	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

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Task 1: LLC review: Impact of current transformer commodity prices on Tier 2

» Current transformer commodity prices
» Conductor material prices
» Magnetic core and tank steel material prices
» Other important transformer material prices
» **Scrap value (= official value used by scrap merchants)**
» Green Field and Brown Field transformer design
» Analysis was based on:
  » available BOM data
  » value of active parts = 30 %
  » greenfield = Alu design
  » brownfield = Copper design

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Task 1: LLC review: Impact of current transformer commodity prices on Tier 2

- The conclusion was that for Green Field the price increase still seems to be valid, important comments:
  - **Scrap value not confirmed by Eurelectric ?** <> Copper thiefs? **Any other opinion?**
  - **Hitachi Metals: absolute prices are too high (30 % .. 65 %): 630 kVA Tier 1 = 6300 euro? 6300x400/630 = 4000 vs 2600 euro active parts? .. Use 50 % markup instead of 30 %?**

Base Case		BC1 DT liquid Tier1	BC1 DT liquid Tier2	BC1 DT Tier2 brown F
transformer rating (S)	kVA	400	400	400
no load class		Ao	Ao-10%	Ao-10%
load class		Ck	Ak	Ak
CAPEX - transformer	€	7 824,09	8 977,51	10 403,00
losses per year	kWh/y	5056,5	4300,6	4300,6
discount rate	%	2%	2%	2%
LCC electricity	€/life	11 713,69	9 964,60	9 964,60
LCC total (excl. scrap@EOL)	€/life	19 537,78	18 962,11	20 367,60
scrap value @ EOL	€	236,00	206,00	2 150,00
NPV scrap value (incl. discount rate)	€	106,88	93,30	973,71
LCC total (incl. scrap@NPV)	€	19 430,90	18 868,81	19 393,88
marginal CAPEX for saving	€/Wp		0,83	1,86
RES value of CAPEX	€/Wp		3,00	3,00
CAPEX increase Tier 1/Tier 2	%		116%	133%

Task 1- impact from interest, inflation, discount rates: Better Regulation "Toolbox"-2015

- **Comment from Eurelectric: DSOs think 4 % discount rate is more realistic? (e.g. inflation 2 % + 6 % interest loans), they refer to:**
- TOOL #54: THE USE OF DISCOUNT RATES:
  - The **recommended** social discount rate is 4%
  - This **4% rate is in real** applied to costs and benefits expressed in **constant prices**
  - It **can be** easily adjusted for inflation: if instead you are dealing with nominal prices, and **inflation is**, say, **3%** per annum then a **7 % nominal social discount rate** (4% rate plus 3% to account for inflation)
- MEErP uses
  - **discount rates = 4 % (real for anything apart from electricity)**
  - **Has 'escalation rate ' for electricity = 4** %, meaning that for electricity
  - **Today common practice:**
    - **4 % discount rate + 4 % escalation rate + 0,117 euro/kWh (average industrial electricity price 2016 Eurostat)**

Task 1- impact interest, inflation, discount rates: 2 %/0%/0,0847€/kWh .. 4%/4%/0,117€/kWh

Base Case		BC1 DT liquid Tier1	BC1 DT liquid Tier2	BC1 DT Tier2 brown F	BC1 DT liquid Tier1	BC1 DT liquid Tier2	BC1 DT liquid Tier1	BC1 DT liquid Tier2	BC1 DT liquid Tier1	BC1 DT liquid Tier2
transformer rating (Sr)	kVA	400	400	400	400	400	400	400	400	400
no load class		Ao	Ao-10%	Ao-10%	Ao	Ao-10%	Ao	Ao-10%	Ao	Ao-10%
load class		Ck	Ak	Ak	Ck	Ak	Ck	Ak	Ck	Ak
PEI	%	99,297%	99,439%	99,439%	99,297%	99,439%	99,297%	99,439%	99,297%	99,439%
Equivalent load factor (keq)	ratio	0,18	0,18	0,18	0,18	0,18	0,18	0,18	0,18	0,18
load factor@PEI (kPEI)	ratio	0,308	0,345	0,345	0,308	0,345	0,308	0,345	0,308	0,345
no load and aux. losses per year	kWh/y	3788,8	3390,1	3390,1	3788,8	3390,1	3788,8	3390,1	3788,8	3390,1
load losses per transformer per year	kWh/y	1288,7	910,5	910,5	1288,7	910,5	1288,7	910,5	1288,7	910,5
losses per year	kWh/y	5055,5	4300,6	4300,6	5055,5	4300,6	5055,5	4300,6	5055,5	4300,6
transformer life time	y	40,00	40,00	40,00	40,00	40,00	40,00	40,00	40,00	40,00
kWh price no load and aux. Losses	€	0,0847	0,0847	0,0847	0,0847	0,0847	0,117	0,117	0,117	0,117
kWh price load losses	€	0,0847	0,0847	0,0847	0,0847	0,0847	0,117	0,117	0,117	0,117
CAPEX - transformer	€	7 824,09	8 977,51	10 403,00	7 824,09	8 977,51	7 824,09	8 977,51	7 824,09	8 977,51
losses per year	kWh/y	5055,5	4300,6	4300,6	5055,5	4300,6	5055,5	4300,6	5055,5	4300,6
discount rate	%	2%	2%	2%	4,00%	4,00%	4,00%	4,00%	4,00%	4,00%
electricity escalation rate	%	0%	0%	0%	0%	0%	0%	0%	4%	4%
PWF	ratio	27,36	27,36	27,36	19,79	19,79	19,79	19,79	40,00	40,00
No load loss capitalization factor (A)	€/W	20,30	20,30	20,30	14,69	14,69	20,29	20,29	41,08	41,00
Load loss capitalization factor (B)	€/W	0,65	0,65	0,65	0,47	0,47	0,65	0,65	1,31	1,31
TCO A/B ratio	ratio	31,27	0,03	0,03	31,27	0,03	31,27	0,03	31,27	0,03
OPEX electricity	€/y	428,20	364,26	364,26	428,20	364,26	591,50	503,17	591,50	503,17
LCC electricity	€ /life	11 713,69	9 984,80	9 984,80	8 475,32	7 209,78	11 707,26	9 959,20	23 659,84	20 126,95
LCC total (excl. scrap@EOL)	€ /life	**19 537,78**	**18 942,11**	**20 367,80**	**16 299,41**	**16 187,29**	**19 531,44**	**18 936,71**	**31 483,93**	**29 104,45**

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Task 1- impact of lower CAPEX & BAT?

- **New reported CAPEX** 2016 **of Tier 1 vs transformer** (A0-50%, Ak). Note: prices reported were for 630 kVA but for the analysis used as 400 kVA **(Hitachi comment)**
- **.. We should not forgort BAT = (A0-50%, AK)!**
- **Add comparison (Eurelectric report): value of losses saved T2 vs T1 <> extra CAPEX**

Base Case		BC1 DT liquid Tier1	BC1 DT liquid Tier2	BC1 DT Tier2 brown F	BC1 DT liquid Tier1	BC1 DT liquid Tier2	BC1 DT liquid Tier1	BC1 DT liquid BAT
transformer rating (Sr)	kVA	400	400	400	400	400	400	[illegible]
no load class		Ao	Ao-10%	Ao-10%	Ao	Ao-10%	Ao	Ao-50%
load class		Ck	Ak	Ak	Ck	Ak	Ck	Ak
PEI	%	99,297%	99,439%	99,439%	99,297%	99,439%	99,297%	[illegible]
Equivalent load factor (keq)	ratio	0,18	0,18	0,18	0,18	0,18	0,18	0,18
load factor@PEI (kPEI)	ratio	0,308	0,345	0,345	0,308	0,345	0,308	0,345
no load and aux. losses per year	kWh/y	3788,8	3390,1	3390,1	3788,8	3390,1	3788,8	3390,1
load losses per transformer per year	kWh/y	1288,7	910,5	910,5	1288,7	910,5	1288,7	910,5
losses per year	kWh/y	5055,5	4300,6	4300,6	5055,5	4300,6	5055,5	4300,6
transformer life time	y	40,00	40,00	40,00	40,00	40,00	40,00	40,00
kWh price no load and aux. Losses	€	0,0847	0,0847	0,0847	0,117	0,117	0,117	0,117
kWh price load losses	€	0,0847	0,0847	0,0847	0,117	0,117	0,117	0,117
CAPEX - transformer	€	7 824,09	8 977,51	10 403,00	7 824,09	8 977,51	[illegible]	[illegible]
losses per year	kWh/y	5055,5	4300,6	4300,6	5055,5	4300,6	5055,5	4300,6
discount rate	%	2%	2%	2%	4,00%	4,00%	4,00%	4,00%
electricity escalation rate	%	0%	0%	0%	4%	4%	4%	4%
PWF	ratio	27,36	27,36	27,36	40,00	40,00	40,00	40,00
No load loss capitalization factor (A)	€/W	20,30	20,30	20,30	41,00	41,00	41,00	41,00
Load loss capitalization factor (B)	€/W	0,65	0,65	0,65	1,31	1,31	1,31	1,31
TCO A/B ratio	ratio	31,27	0,03	0,03	31,27	0,03	31,27	0,03
OPEX electricity	€/y	428,20	364,26	364,26	591,50	503,17	591,50	503,17
LCC electricity	€ /life	11 713,69	9 964,80	9 964,80	23 659,84	20 126,95	23 659,84	20 126,95
LCC total (excl. scrap@EOL)	€ /life	**19 537,78**	**18 942,11**	**20 367,80**	**31 483,93**	**29 104,45**	[illegible]	**28 316,95**
scrap value @ EOL	€	238,00	206,00	2 150,00				
NPV scrap value (incl. discount rate)	€	108,00	93,30	973,71				
LCC total (incl. scrap@NPV)	€	[illegible]	18 848,81	[illegible]				
extra transformer cost T1/T2	€		**1 153,42**	**2 578,91**				**1 898,80**
value of losses saved vs T1	€ /life		**1 749,09**	**1 749,09**				**3 632,85**
CAPEX increase Tier 1/Tier 2	%		**115%**	**133%**				**130%**

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Task 1-Cost effective Tier 2?

» **Our analysis still show that Tier 2 is economic justified disregarding some special brown field applications for which a dedicated design might be too expensive**

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PEI and KPEI versus P0 and Pk versus loading (k) (note BC1 k = 0,18)

» **Note: the load factor at peak load is: kPEI = sqrt(P0/Pk)**

» **.. What does it mean for 400 kVA**

ref. design	S	kPEI	P0	Pk
	kVA		kW	kW
T1 kPEI=0,1	400	0,100	0,141	14,064
T1 kPEI= 0,2	400	0,200	0,281	7,032
Tier 1 kPEI=0,306	400	0,306	0,430	4,596
PEI 1 kPEI=0,9	400	0,9	1,266	1,563
T2 kPEI=0,1	400	0,100	0,112	11,215
T2 kPEI=0,2	400	0,200	0,224	5,607
Tier 2 kPEI=0,345	400	0,345	0,387	3,251
T2 kPEI=0,9	400	0,9	1,009	1,246
BAT-AMT A0-50%&Ak	400	0,244	0,215	4,596

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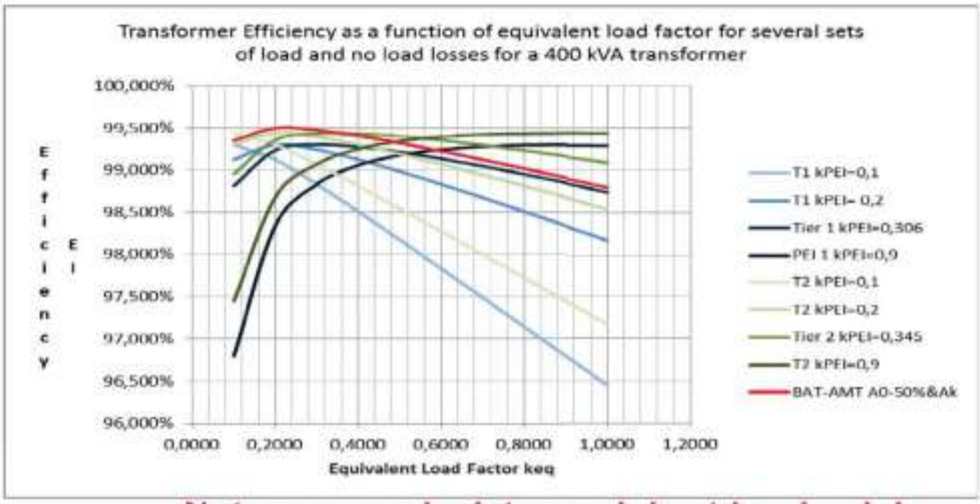
PEI and KPEI versus P0 and Pk versus loading (k) (note BC1 k = 0,18)



Note: curves deviates mainly at low loads!

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PEI and KPEI versus P0 and Pk versus loading (k) (note BC1 k = 0,18), some benefit

» **Note: A0-15%Bk is a Tier 1 compliant but not Tier 2 but has for BC 1 lower losses**

With a TIER 2 PEI approach it Could survive!

(Note:
no CAPEX data available:
assumed 10 K)

Base Case		BC1 DT liquid Tier1	BC1 DT liquid Tier2	BC1 DT Tier2 brown F	BC1 DT Tier2PEI A0-15%Bk
transformer rating (Sr)	kVA	400	400	400	400
no load class		Ao	Ao-10%	Ao-10%	Ao-15%
load class		Ck	Ak	Ak	Bk
PEI	%	99,297%	99,439%	99,439%	99,437%
Equivalent load factor (keq)	ratio	0,18	0,18	0,18	0,18
load factor@PEI (kpei)	ratio	0,306	0,345	0,345	0,292
no load and aux. losses per year	kWh/y	3796,8	3390,1	3390,1	2881,6
load losses per transformer per year	kWh/y	1298,7	910,5	910,5	1078,6
losses per year	kWh/y	5095,5	4300,6	4300,6	3960,2
transformer life time	a	40,00	40,00	40,00	40,00
kWh price no load and aux. Losses	€	0,0847	0,0847	0,0847	0,0847
kWh price load losses	€	0,0847	0,0847	0,0847	0,0847
CAPEX - transformer	€	7 824,89	8 977,51	10 403,00	10 000,00
losses per year	kWh/y	5095,5	4300,6	4300,6	3960,2
discount rate	%	2%	2%	2%	2%
electricity escalation rate	%	0%	0%	0%	0%
PWF	ratio	27,36	27,36	27,36	27,36
No load loss capitalization factor (A)	€/W	20,30	20,30	20,30	20,30
Load loss capitalization factor (B)	€/W	0,65	0,65	0,65	0,65
TCO A/B ratio	ratio	31,27	0,03	0,03	0,03
OPEX electricity	€/y	428,20	364,28	364,28	335,43
LCC electricity	€/life	11 713,89	9 964,60	9 964,60	9 175,83
LCC total (excl. scrap@EOL)	€/life	**19 537,78**	**18 942,11**	**20 367,60**	**19 175,83**

The rationale is that for Tier 2 the optimum load factor (kPEI) is 0,345 while the preparatory study had identified 0,18 (k) for BC 1 in real conditions(distribution transformer). As a consequence they do not operate at their optimum and a design A0-15% Bk (TIER2PEI) which is Tier2 incompliant is more beneficial compared to Tier2 A0-10%Ak (TIER2).

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PEI: benefits and risks

- PEI could be beneficial in some cases for distribution transformers (..but with a minimum kPEI > 0,15)
- **Benefit**: more **flexibility** to adapt to different load factors (see previous slide)
- **Risk**: A loophole which would emerge from only requiring a minimum PEI to be specified is that the **lowest CAPEX design could be specified**, e.g. simply by choosing a very low load factor at PEI(kPEI) > **add a minimum kPEI or other criteria (Norway)?**
- added: for medium power transformers discrete loss limits might be more easy to understand on the market + very difficult to analyze all potential options in the scope of
- Compromise between PEI and P0Pk limits might be simply A0-20%(?) Bk as an exception to A0-10%Ak for 'compact low loaded distribution transformers'?

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Brown Field requirements

- **with conventional production technology Tier 2 can increase size and weight**
- **brown field transformer applications**, i.e. **transformers destined for a replacement project that has specific limitations of size/weight** resulting from the need to install the transformer in an existing enclosure.
- Enquiry was done and sent to T&D Europe to assess the feasibility
- See also T&D Europe presentation

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Brown Field requirements – technology roadmap

- Low loss GOES (comment CG Power but noise increase) (see also TK presentation)
- Copper instead of Aluminium conductors (see also ECI presentation)
- High temperature inorganic insulation and esters instead of cellulose paper insulation and mineral oil cooling liquid
- Forced cooling
- Non-conductive clamps and bolds
- Hexagonal or 3D core form transformers
- On site assembly

= a large tool box to solve Tier 2 brown field applications but often not yet in production (& fear on costs from some DSOs)

= T&D exercise shows the feasibility for medium power transformers (see later presentation)

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Brown Field requirements & Tier 3

- **Feed back so far seems to suggest that:**
  - **For medium power it can be solved with technology available however there is some fear for cost increase! (see T&D Europe and Eurelectric presentation)**
  - **For large power limits might persist and a green field exemption could be considered (See Task 3 and ENTSO-E presentation**
  - **How to define exemptions will be in Task 3, e.g. require low loss steel (<0,9 W/kg @ 1,5 T) as alternative requirement**
- **TIER 3 .. Given the difficulties raised for Tier 2 considering Tier 3 is not a focus of the study and the meeting**
- **.. See stakeholder presentations**

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Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for small, medium and large power transformer

Stakeholder Workshop

Paul Van Tichelen

Brussels, DG GROWTH
29th of March 2017

Agenda -start

- 9h00: Registration desk opens(you need an ID card or passport)
- 9h00-9h30 Coffee in meeting room Ayral
- 9h30-9h40: Presentation of the study team and tour de table

Agenda - TASK 3

- 13h30-13h50: Task 3 VERIFICATION OF EXISTING EXEMPTIONS AND REGULATORY CONCESSIONS
- 13h50- 14h10: Summary of contributions by CENELEC TC 14 pre-standardization activity (Angelo Baginni, CENELEC TC14, University Bergamo)
- 14h10-14h20: T&D Europe point of view on Task 3 (Michel Sacotte, T&D Europe)
- 14h20-14h30: Example - existing limits in the EDF Nuclear installations (Christophe ELLEAU, EDF)
- 14h30-14h40: Discussion on concessions for green field large power transformers 'rating + physical limits' vs 'specific loss limit (<0,70 W/kg@1,5T' vs 'combination' ..?
- 14h40-14h50: How to deal with pole mounted transformers? rating + physical limits' vs 'spefic loss limit (<0,70 W/kg@1,5T' vs 'combination' ..?
- 14h50-15h00: Dual voltage: is it a loophole? Review the requirements and how?
- 15h00-15h15: other Q&A Task 3 + How to proceed with input in Task 1&3
- 15h15-15h30: coffee break

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Agenda TASK 4/2

- 15h30-15h40: Task 4 ON ANALYSIS OF OTHER ENVIRONMENTAL IMPACTS(Paul van Tichelen, VITO)
- 15h40-16h00: Task 2 CONSIDERATION OF MINIMUM REQUIREMENTS FOR SINGLE-PHASE TRANSFORMERS(Paul Waide)
- 16h00-16h10: If and how to deal with small power transformers (Paul Waide)
- 16h10-16h30: Closing + AOB

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Task 3: VERIFICATION OF EXISTING EXEMPTIONS AND REGULATORY CONCESSIONS

- TASK 3.1: **VERIFICATION OF EXEMPTIONS IN REGULATION 548/2014**
  - **Medium power transformers for brown field applications** with space/weight constraints relative to Tier 2
    - 'rating + physical limits' vs 'specific loss limit (<0,70 W/kg@1,5T' vs 'combination'?
    - Can this be solved with PEI or A0-15%/Bk??
  - **Large power transformers for green field applications** with transportation constraints relative to Tier 2
    - 'specific loss limit (<0,70 W/kg@1,5T'? **Add this also to current exemption for brown field?**
  - **Scope: Something to add for substations to avoid lock in into brownfield applications?**

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Task 3: VERIFICATION OF EXISTING EXEMPTIONS AND REGULATORY CONCESSIONS

- TASK 3.2: **ANALYSIS OF CRITERIA TO INCLUDE THE REPAIR OF TRANSFORMERS IN REGULATION 548/2014**
  - See report
  - CE legislation already limits the possibilities of repaired transformers that have a CE label, especially when they change characteristics
  - the study team conclude that **change of ownership, can constitute a loophole** because these products only have to comply with the requirements when they entered the market for the first time **<> some stakeholders view**
  - **Can we have requirements for second hand transformers?**

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Task 3: VERIFICATION OF EXISTING EXEMPTIONS AND REGULATORY CONCESSIONS

- TASK 3.3: **VERIFICATION OF CONCESSIONS FOR TRANSFORMERS WITH UNUSUAL COMBINATIONS OF WINDING VOLTAGES**
  - See CENELEC
- TASK 3.4: **VERIFICATION OF CONCESSIONS FOR POLE-MOUNTED TRANSFORMERS**
  - **Limited to Single Pole**
  - **In principle there is no technical rationale to maintain this concession, it is rather a lock in effect into existing procedures and installations**
  - **Could have the same type of requirements as other brown field applications, e.g. specific loss limit (W/kg@1,5T)**

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TASK 4 ON ANALYSIS OF OTHER ENVIRONMENTAL IMPACTS

- Note: The Ecodesign methodology (MEErP) used for this preparatory study has been revised in 2013 compared to those used in the existing preparatory study.
- MEErP 2013 was updated with a view to elaborating on the material efficiency aspects. (note that recycling is more elaborated)
- Will use data Task 1 (Bill of Material)
- **Purpose: investigation of significant environmental impacts, other than energy, are justified to consider additional requirements**

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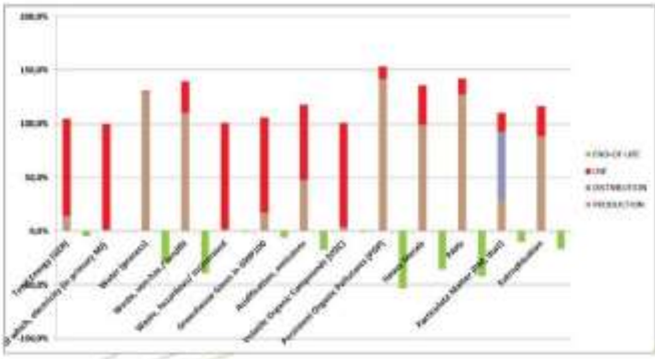
TASK 4 ON ANALYSIS OF OTHER ENVIRONMENTAL IMPACTS

- Analysis with the new MEErP has been done (does not result in many new conclusions)
- See importance of recycling (= green) > importance of BOM data
- Harmonics >> justify Tier 2
- Nothing new is proposed neither did stakeholder had such a proposal



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TASK 5 ON CONCLUSIONS AND RECOMMENDATIONS

- collect the findings made in Tasks 1 to 4 with a view to making targeted recommendations to improve, extend or reduce the coverage of Regulation 548/2014
- An **inventory of any technical and position papers** (both solicited and unsolicited), submitted by social and economic actors in the context of Tasks 1 to 4 will be included in this task.
- **Timing – to discuss –no later input as end of April as we want to conclude the Study in May**

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Questions & Conclusion

- **Scope: any?**
- **Questions, AOB?**

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CONSTRAINTS ON EDF TRANSFORMERS

VITO MEETING

CNEPE
Centre National d'Equipement
de Production d'Electricité

Christophe Elleau

March 29, 2017

SOMMAIRE

1. INDUSTRY CONSTRAINTS REMINDER
2. CONSTRAINTS IN PICTURES
3. CONCLUSIONS

EDF TRANSFORMERS CONSTRAINTS REMINDER

- In December 2016, EDF transformers constraints have been forwarded to CENELEC as reply to VITO enquiry. Replies have been collected from nuclear, hydro, thermal, renewable fields of EDF Generation.

EDF-DIPNN

1st SECTION: TRANSFORMERS GENERAL DATA AND CONSTRAINTS

Transformer category (1)	G	G	G	D	D	D
Rated power (2) of each winding [MVA / MVA / ...]	0,630	0,800	1,6 2,0 2,5 3,15	360	570	100/50/50
Frequency [Hz]	50	50	50	50	50	50
Number of phases	3	3	3	Single	Single	3
Type (liquid / dry)	Dry	Dry	Dry	Liquid	Liquid	Liquid
Rated voltage of each winding [kV / kV / ...]	6,6kV /0,390	6,6kV /0,390	10kV / 0,720 kV	24kV/ 400/√3 kV	20kV/ 405/√3 kV	400/√3/10,5/10,5 kV
Highest voltage for equipment of each winding Um [kV / kV / ...]	7,2 kV/0,4	7,2 kV/ 0,4 kV	12 kV / 1,1 kV	36 kV /420 kV	36 kV /420 kV	420 kV/ 12kV
Vector Group (3)	Dyn11	Dyn11	Dyn 11	Dyn11	Dyn11	Dyn11

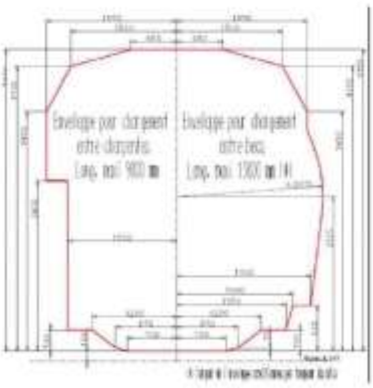
EDF TRANSFORMERS CONSTRAINTS IN PICTURES

- Transportation limits
  - By road

Caractéristiques du convoi	1 ère catégorie	2 ième catégorie	3 ième catégorie
Longueur	L ≤ 20 m	20 m < L ≤ 25 m	L > 25 m
Largeur	l ≤ 3 m	3 m < l ≤ 4 m	l > 4 m
Masse	M ≤ 48 t	48 t < M ≤ 72 t	M > 72 t

Importante data for transportation limits

  - By railways



French railway gauge :
Width : 3700 mm
Height : 4300 mm


EDF TRANSFORMERS CONSTRAINTS IN PICTURES
Examples of medium power transformers (Nuclear and Renewable fields)
2500 kVA Dry type
Margin on sides and height without ecodesign <1cm.
Nuclear substations : Constraints due to enclosures, dielectric clearances, maintenance access, interchangeability, weight limits (earthquake), nuclear design rules
630 – 800 kVA Dry type
EDF
3 | EDF | lorem ipsum | juin 2012


EDF TRANSFORMERS CONSTRAINTS IN PICTURES
Examples of constraints with large power transformers (Step up transformers)
Efficience of sprinkler Systems
Minimal gap between the tank and the wall for safety rules (people evacuation).
EDF

Conclusions on the Draft Lot 2

EDF <u>insists to keep</u> the exemptions for :

❑ **Industry technical realities**

1 - <u>Exemptions for existing installations</u> are required and justified for :

"Power transformers which are like for like replacements ...."

<u>for all power transformers</u> where it is not :

- technically possible,
- economically reasonable, affordable (not disproportionate) or
- reasonably practical

to comply with the Tier 1 and 2 levels, objectively, on existing installations.

2 - <u>Exemption for transportation</u> : from the factory up to the final service position (the transformers must also go through the existing substation door, ...)

❑ **Economic realities (Greenfield applications)**

3 - <u>Exemption for disproportionate costs</u> : Unrealistic energy savings (more GOES, more copper) induce <u>disproportionate costs</u> and <u>impact other fields not evaluated</u> in this Draft Lot 2 such as safety, civil work, mechanical withstands of slabs, nuclear design rules (Fukushima learning)), in particular for small series of transformers

4 - <u>Energy Efficiency but in a realistic and objective way without any dogmatism</u>.

eDF

Thanks

eDF

Transformer ecodesign salient points from TSO's

For large power transformers

- **Tier two is achievable**
- **Induce larger units (heavier and more bulky)**
- **Transportation costs increase**
  - May reach 50 % of the cost of a transformer
- **On site construction**
  - Is not always feasible and generate very high costs.

entsoe | Page 2

Transformer ecodesign salient points from TSO's

Economic concerns

- Scrap value of the embedded copper is not that of recycling as retrieving copper from a transformer has a cost.
- If copper demand increase price variability will increase and price revision formula may induce shortage of budget.

entsoe | Page 2

Transformer ecodesign salient points from TSO's

For large power transformers

- Transportation is a concern even for green field application
  - TSO's needs an exemption for transportation constraints
  - TSO's needs to standardize transformers including non-compliant one
  - For cost efficiency and reactivity exemption must be granted as generic and not site specific with the right not to site optimize the design

Need to have the right to purchase non-compliant standardized transformer under blanket agreement

entsoe | Page 4

Transformer ecodesign salient points from TSO's

For large power transformer

- **Defining a minimum kPEI is against efficiency**
  - As transformer needs to be tailored to their average loading
  - Example 1: 100 MVA, tier 2 PEI 99.77%
  - kPEI = 25 %, Pk = 460 kW, Po = 28 .5 kW
    if actual loading is 20 %
    Transformer actual losses will be
    $28.5+460^{*}.2^{2}=$ **46.9** kW
  - optimized transformer for 20 % kPEI Pk =475 kW Po = 23 kW
    Transformer actual losses will be:
    $23+475^{*}.2^{2}=$ **42** kW

entsoe Page 5

Transformer ecodesign salient points from TSO's

- Example 2 :100 MVA, tier 2 PEI 99.77%
  - kPEI = 25 % Pk = 460 kW Po = 28 .5 kW
    if actual loading is 40 %
    Transformer actual losses will be
    $28.5+460^{*}.4^{2}=$ **102.1** kW
  - optimized transformer for 40 % kPEI Pk =287.5kW Po = 46 kW
    Transformer actual losses will be:
    $46+287.5^{*}.4^{2}=$ **92** kW

Optimizing the transformer to the actual usage is the best option

entsoe Page 6

Transformer ecodesign salient points from TSO's

For large power transformer

- **Specifying minimum material quality:**
  - May shift the total market to a limited number of reference of material and induce shortage or cost increase
  - Reduce the freedom of design as several means exists to achieve same loss level

There shall be no special requirement on material performance

entsoe Page 7

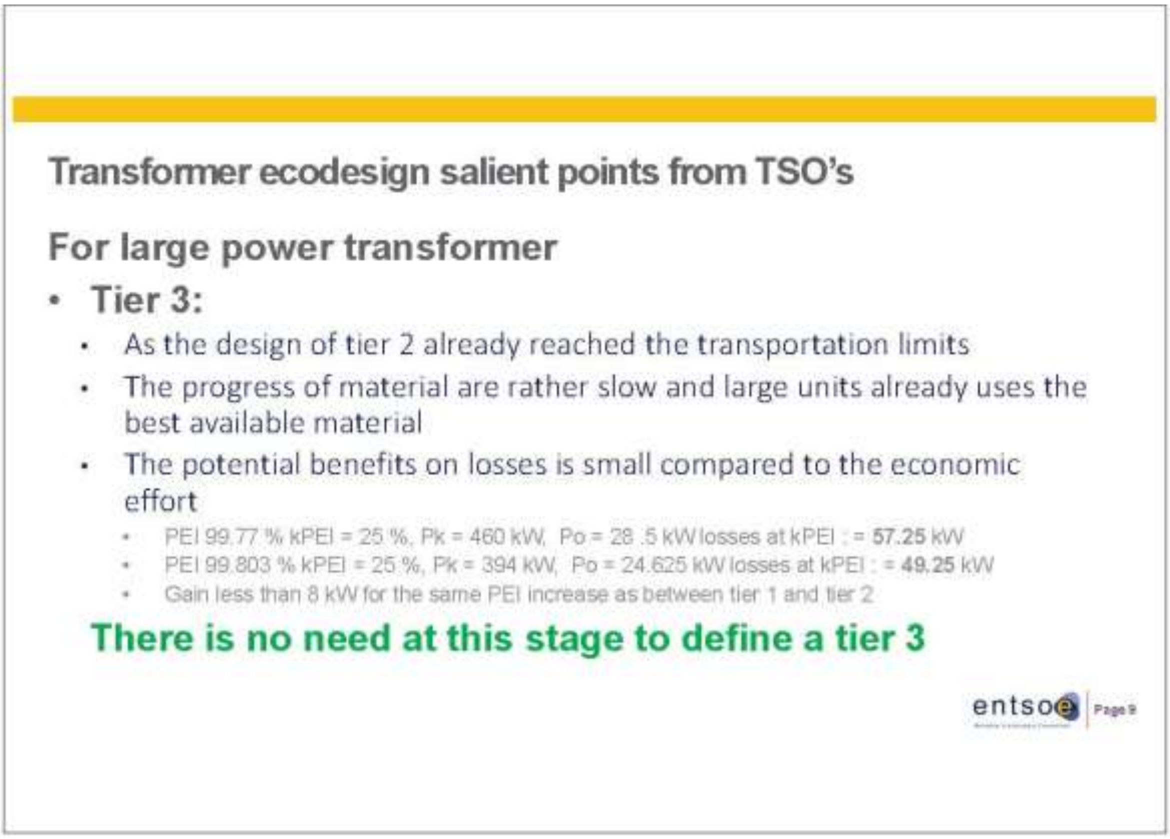
Transformer ecodesign salient points from TSO's

For large power transformer

- **Repairing is :**
  - A common practice base on TCO comparison
    - A repair is not done if there is no economic interest or other service requirement
  - Reduce the time back to service
  - Economically and environmentally justified
  - Scrapping young transformers (less than 30 years old)
    - Is puzzling the assumption of "use phase is predominant"
    - Is wasting residual values

There shall be no restriction on repair

entsoe Page 8



Transformer ecodesign salient points from TSO's
For large power transformer
• Tier 3:
• As the design of tier 2 already reached the transportation limits
• The progress of material are rather slow and large units already uses the best available material
• The potential benefits on losses is small compared to the economic effort
• PEI 99.77 % kPEI = 25 %, Pk = 460 kW, Po = 28 .5 kW losses at kPEI : = 57.25 kW
• PEI 99.803 % kPEI = 25 %, Pk = 394 kW, Po = 24.625 kW losses at kPEI : = 49.25 kW
• Gain less than 8 kW for the same PEI increase as between tier 1 and tier 2
There is no need at this stage to define a tier 3
entsoe

Small transformers

Paul Waide - Waide Strategic Efficiency Ltd, UK

Transformers Ecodesign stakeholder meeting

March 29th 2017

Waide Strategic Efficiency

Scope of the regulation 548-2014

- Some stakeholders have asked whether or not this study and regulatory process addresses small transformers?
- Note the title of Commission Regulation (EU) No 548/2014 of 21 May 2014 is *on implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to small, medium and large power transformers*
- By default the definition of such transformers could be considered to be transformers which are too small to be covered by EN 50588-1:2015

2

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Scope of the current study

- This review preparatory study is conducted on a very tight timeline and modest budget
- None of the tasks the consultants are contracted to do address such small transformers
- Task 3: Verification of existing exemptions and regulatory concessions, with subtasks:

  Task 3.1 - Verification of exemptions in Regulation 548/2014

  Task 3.2 - Analysis of criteria for the repair of transformers in Regulation 548/2014

  Task 3.3 - Verification of concessions for transformers with unusual combinations of winding voltages

  Task 3.4 - Verification of concessions for pole-mounted transformers

See next 2 slides for exemptions that could be assessed in Task 3.1 addressing small transformers

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3

Scope exemptions of the regulation

Regulation 548-2014 exempts the following products:

- instrument transformers, specifically designed to supply measuring instruments, meters, relays and other similar apparatus,
- transformers with low-voltage windings specifically designed for use with rectifiers to provide a DC supply,
- transformers specifically designed to be directly connected to a furnace,
- transformers specifically designed for offshore applications and floating offshore applications,
- transformers specially designed for emergency installations,
- transformers and auto-transformers specifically designed for railway feeding systems,

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4

Scope exemptions of the regulation

Regulation 548-2014 exempts the following products:

- earthing or grounding transformers, this is, three-phase transformers intended to provide a neutral point for system grounding purposes,
- traction transformers mounted on rolling stock, this is, transformers connected to an AC or DC contact line, directly or through a converter, used in fixed installations of railway applications,
- starting transformers, specifically designed for starting three-phase induction motors so as to eliminate supply voltage dips,
- testing transformers, specifically designed to be used in a circuit to produce a specific voltage or current for the purpose of testing electrical equipment,
- welding transformers, specifically designed for use in arc welding equipment or resistance welding equipment

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5

Implications

- Practically small transformers are not being covered by the study
- Also there are currently no applicable energy performance test standards thus no means (yet) of developing requirements
- For example IEC 61558-2-4:2009 covers safety of transformers up to 1100V but not energy performance (e.g. losses)
- Thus, should we attempt to formally define which small power transformers are not yet to be covered by the regulation?
- Given that small transformers are effectively out of scope of this study then should any efforts be made to consider the potential merits of a follow-up study?

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Task 2 - on Consideration of minimum requirements for single-phase transformers

Paul Waide - Waide Strategic Efficiency Ltd, UK

Transformers Ecodesign stakeholder meeting

March 29th 2017

Waide Strategic Efficiency

Aim and tender request

- Single-phase transformers were excluded from the scope of Regulation 548/2014 for a number of reasons, primarily due to a lack of available data. These transformers are mainly used by utilities in Ireland and the United Kingdom and their exclusion could be reconsidered, as this represents a missed opportunity for energy efficiency and a potential regulatory loophole
- Investigate whether it is technically and economically justified to extend existing minimum energy efficiency requirements during Tier 2 to also apply to single-phase transformers
- Establish whether the existing harmonised standards, CENELEC EN 50588-1:2015 and EN 50629:2015, adequately cover the measurement and calculation of the energy efficiency of single-phase transformers, or whether further standardisation work is necessary

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Issues to discuss

- Single phase transformers occupy a very small niche market in the EU's transformer market accounting for just 238 MVA of installed capacity per annum
- In practice, within the EU these products are only sold and used in EI and the UK for use within remote & isolated rural single-phase distribution networks
- There appears to be negligible risk of single phase transformers increasing their market share at the expense of 3-phase transformers due to unsymmetrical regulations concerning 3 phase transformer losses because the decisions regarding whether to apply single or 3 phase supply are governed by factors which are on a wholly different technical and economic scale to the incremental cost issues associated with 3-phase transformer loss regulations. They are also entirely of an historic legacy nature

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Issues to discuss

In practice the potential regulation of these products is an issue which only affects EI and the UK rather than the EU as a whole. In consequence, it could be argued that:

- it is only sensible to consider the issue using the load profiles, costs and economics that apply in these two economies (rather than the EU as a whole)
- as the UK has announced its intention to leave the EU, it may be justified to only consider the Irish case for the Ecodesign regulatory determination, although an analysis of the pros and cons of regulation within a UK context may also be helpful to the UK's policy making process
- however, it is not clear if the MEErP permits the use of anything other than EU average values supported by sensitivity analyses; although, the former have little meaning in this context. Even the predominant products sold and load factors vary between EI and the UK in a systematic manner

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Issues for stakeholders to consider

- We therefore invite the stakeholder process to consider these matters of principle before we finalise the analysis, as they are likely to have a significant impact on the findings
- Given the uncertainty with regard to the approach to be followed the analysis in the draft report presents provisional findings using EU average tariff data, MEErP discount rates and a range of initial assumptions regarding CAPEX costs and load factors

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Data sources and estimations

- As is clear from the discussion the majority of data on these products concerns the Irish and UK markets
- Data on market volumes, typical total load factors, load losses and no load losses was supplied in the kick-off meeting by Antony Walsh (Eurelectric, DSO) and also via a document prepared for CENELEC WG21 and supplied to the EC for use in this study
- Data on the performance of amorphous transformers is publicly available from ABB
- Data on single-phase transformer costs is missing and is interpolated from three-phase transformer costs as a function of their reactive power rating, no-load losses and load losses
- Data on typical UK single phase transformer loading factors are also missing

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Markets

- Single-phase transformers are only used in rural locations - which are especially prevalent in Ireland
- Some 154 MVA of single phase transformers are installed in the UK annually and 84 MVA in Ireland, making a total of 238 MVA of annual single phase transformer capacity installed annually in the EU as a whole

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Measurement standards

- Measurement and rating of losses from single phase transformers is covered in EN 50588-1:2015+A1:2016 (E) *Medium power transformers 50 Hz, with highest voltage for equipment not exceeding 36 kV - Part 1: General requirements*
- This is the same standard used to measure and rate losses of distribution transformers
- However, performance of products lower than 25kVA is not distinguished, nor of those between 25kVA and 50kVA
- This means that the products which are most used in Ireland (15 and 33kVA) are treated indistinguishably from those most used in the UK (25 and 50kVA) even though their losses should be less if all other aspects are equal

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Typical single-phase transformer losses in the UK (shaded white) & Ireland (shaded green)

kVA	P0(W)	Pk(W)	PEI	kPEI
15	48	270	98.48%	0.42
16	48	405	98.26%	0.34
25	68	540	98.47%	0.35
33	58	675	98.80%	0.29
50	112	900	98.73%	0.35
100	228	1557	98.81%	0.38

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Findings for load losses

- The cost effectiveness of reduced load losses is highly sensitive to the load factor - his would need to attain 0.075 for there to be an economic rationale to introduce minimum load losses for 15 and 33 kVA single phase transformers (IE) or for 25 and 50 kVA models (UK)
- While the EI average load factor is reported to be < 0.075 we have no data for the average UK load factor for single phase transformers
- A caveat in this finding is that average EU tariffs were assumed even though these products are only sold in EI or UK
- It could be argued that the average EI or UK tariff should also be applied to this analysis as these products are scarcely sold elsewhere in the EU
- The same caveats as stated previously also apply to the assumptions regarding the product price and hence CAPEX

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Findings for no load losses: 25 and 50 kVA

Base Case		Liquid Single Phase A0	Liquid Single Phase AA0	Liquid Single Phase AAA0	Liquid Single Phase A0	Liquid Single Phase AA0	Liquid Single Phase AAA0
transformer rating (S)	kVA	25	25	25	50	50	50
No load losses (P0)	W	70	63	35	90	81	45
no load class		A0	AA0	AAA0	A0	AA0	AAA0
Load losses (Pk)	W	900	900	900	1100	1100	1100
load class		Ck	Ck	Ck	Ck	Ck	Ck
Auxiliary losses (Paux)	W	0	0	0	0	0	0
PEI	%	97.892%	98.095%	98.580%	98.741%	98.806%	99.110%
Load Factor (α) (=Pavg/S)	ratio	0.1	0.1	0.1	0.1	0.1	0.1
Load form factor (Kf)(=Prms/Pavg)	ratio	1.073	1.073	1.073	1.073	1.073	1.073
availability factor (AF)	ratio	1	1	1	1	1	1
Power factor (PF)	ratio	0.9	0.9	0.9	0.9	0.9	0.9
Equivalent load factor (αeq)	ratio	0.12	0.12	0.12	0.12	0.12	0.12
αopt (= sqrt ((Po+Paux)/Pk))	ratio	0.279	0.265	0.197	0.286	0.271	0.202
no load and aux. losses per year	kWh/y	613.2	551.9	306.6	788.4	709.6	394.2
load losses per transformer per year	kWh/y	112.1	112.1	112.1	137.0	137.0	137.0
losses per year	kWh/y	725.3	663.9	418.7	925.4	846.6	531.2
transformer life time	y	40.00	40.00	40.00	40.00	40.00	40.00
interest rate	%	4%	4%	4%	4%	4%	4%
inflation rate	%	2%	2%	2%	2%	2%	2%
kWh price no load and aux. Losses	€	0.0847	0.0847	0.0847	0.0847	0.0847	0.0847
kWh price load losses	€	0.0847	0.0847	0.0847	0.0847	0.0847	0.0847
CAPEX - transformer	€	489.01	522.48	693.21	978.01	1,044.97	1,398.42
losses per year	kWh/y	725.3	663.9	418.7	925.4	846.5	531.2
discount rate	%	2%	2%	2%	2%	2%	2%
PWF	ratio	27.36	27.36	27.36	27.36	27.36	27.36
No load loss capitalization factor (A)	€/W	20.30	20.30	20.30	20.30	20.30	20.30
Load loss capitalization factor (B)	€/W	0.29	0.29	0.29	0.29	0.29	0.29
TCO A/B ratio = α² (only if kWh price load/no load =)	ratio	0.01	0.01	0.01	0.01	0.01	0.01
TCO A/B ratio = α² (€/kWh load)/(€/kWh no load)	ratio	0.01	0.01	0.01	0.01	0.01	0.01
OPEX electricity	€/y	61.43	56.24	35.46	78.38	71.70	44.99
LCC electricity	€ /life	1,680.44	1,538.36	970.05	2,144.08	1,961.41	1,230.72
LCC total (excl. scrap@EOL)	€ /life	2,169.45	2,060.85	1,663.25	3,122.09	3,006.38	2,617.13
scrap value @ EOL	€	14.75	14.75	14.75	29.50	29.50	29.50
NPV scrap value (incl. discount rate)	€	6.68	6.68	6.68	13.36	13.36	13.36
LCC total (incl. scrap@NPV)	€	2,162.77	2,054.16	1,656.57	3,108.73	2,993.01	2,603.77

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Findings for no load losses: 15 and 33 kVA

Base Case		Liquid Single Phase A0	Liquid Single Phase AA0	Liquid Single Phase AAA0	Liquid Single Phase A0	Liquid Single Phase AA0	Liquid Single Phase AAA0
transformer rating (S)	kVA	15	15	15	33	33	33
No load losses (P0)	W	70	63	35	76.4	68.76	38.2
no load class		A0	AA0	AAA0	A0	AA0	AAA0
Load losses (Pk)	W	900	900	900	964	964	964
load class		Ck	Ck	Ck	Ck	Ck	Ck
Auxiliary losses (Paux)	W	0	0	0	0	0	0
PEI	%	96.653%	96.825%	97.634%	98.355%	98.440%	98.837%
Load Factor (α) (=Pavg/S)	ratio	0.1	0.1	0.1	0.1	0.1	0.1
Load form factor (Kf)(=Prms/Pavg)	ratio	1.073	1.073	1.073	1.073	1.073	1.073
availability factor (AF)	ratio	1	1	1	1	1	1
Power factor (PF)	ratio	0.9	0.9	0.9	0.9	0.9	0.9
Equivalent load factor (αeq)	ratio	0.12	0.12	0.12	0.12	0.12	0.12
αopt (= sqrt ((Po+Paux)/Pk))	ratio	0.279	0.265	0.197	0.282	0.267	0.199
no load and aux. losses per year	kWh/y	613.2	551.9	306.6	669.3	602.3	334.6
load losses per transformer per year	kWh/y	112.1	112.1	112.1	120.0	120.0	120.0
losses per year	kWh/y	725.3	663.9	418.7	789.3	722.4	454.7
transformer life time	y	40.00	40.00	40.00	40.00	40.00	40.00
interest rate	%	4%	4%	4%	4%	4%	4%
inflation rate	%	2%	2%	2%	2%	2%	2%
kWh price no load and aux. Losses	€	0.0847	0.0847	0.0847	0.0847	0.0847	0.0847
kWh price load losses	€	0.0847	0.0847	0.0847	0.0847	0.0847	0.0847
CAPEX - transformer	€	293.40	313.49	415.93	645.49	689.68	919.04
losses per year	kWh/y	725.3	663.9	418.7	789.3	722.4	454.7
discount rate	%	2%	2%	2%	2%	2%	2%
PWF	ratio	27.36	27.36	27.36	27.36	27.36	27.36
No load loss capitalization factor (A)	€/W	20.30	20.30	20.30	20.30	20.30	20.30
Load loss capitalization factor (B)	€/W	0.29	0.29	0.29	0.29	0.29	0.29
TCO A/B ratio = α² (only if kWh price load/no load =)	ratio	0.01	0.01	0.01	0.01	0.01	0.01
TCO A/B ratio = α² (€/kWh load)/(€/kWh no load)	ratio	0.01	0.01	0.01	0.01	0.01	0.01
OPEX electricity	€/y	61.43	56.24	35.46	66.85	61.18	38.51
LCC electricity	€ /life	1,680.44	1,538.36	970.05	1,828.81	1,673.74	1,053.46
LCC total (excl. scrap@EOL)	€ /life	1,973.84	1,851.85	1,385.97	2,474.29	2,363.41	1,968.50
scrap value @ EOL	€	8.85	8.85	8.85	19.47	19.47	19.47
NPV scrap value (incl. discount rate)	€	4.01	4.01	4.01	8.82	8.82	8.82
LCC total (incl. scrap@NPV)	€	1,969.84	1,847.84	1,381.96	2,465.47	2,354.60	1,959.68

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Summary of findings

- Provisional analyses indicate that there is likely to be little or no economic justification to set Ecodesign load loss limits for single phase transformers as they are actually used in European countries (exclusively EI and UK), but that there is likely to be an economic rationale to set no load limits
- The LCC analysis for the no load cases suggest the minimum is at the AAA_0 no load class level
- The study team is awaiting new information as well as guidance on matters of principle in order to be able to complete the analysis and make final conclusions on this topic
- A related issue is whether there is any logic in setting PEI limits for such products or potentially simply no load loss limits

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Questions to stakeholders

- Is it only sensible to consider the life cycle cost issue using the load profiles, costs and economics that apply in EI and UK or those that apply to the EU as a whole?
- Are there any sources of single-phase transformer costs we can use to validate our cost assumptions?
- Are data for UK average load factors for single phase transformers available?

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Links and Contacts
Lot 2 Ecodesign study for small, medium and large power transformers
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Waide Strategic Efficiency

WG TRANSFORMERS

T&D Europe Review of Vito Draft final report

M Sacotte

T&D europe

The European Association of the Electricity Transmission and Distribution Equipment and Services Industry

2017.03.15

M Sacotte 1

T&D Europe contributions

- Gave a position paper on the revision of the regulation in January 2017
- Gave data for Green field feasibility in January 2017
- Gave data for Brown field feasibility in March 2017
- Has analyzed the VITO draft final report

T&D europe

23/03/2017 WG 2

Vito Draft final report analysis

- 1.1.1.1Other important transformer material prices
  - Conclusions on High Temperature insulation [Solid and Liquid] shall be reviewed taking also into account the global optimisation of the transformer
- 1.1.16Impact of current transformer commodity prices on Tier 2 (Table 1.9)
  - The CAPEX differences given for TIER 1 and TIER 2 Green field are reasonable
  - The CAPEX differences in average for TIER 2 brown field is reasonable too but can be higher for very specific installations

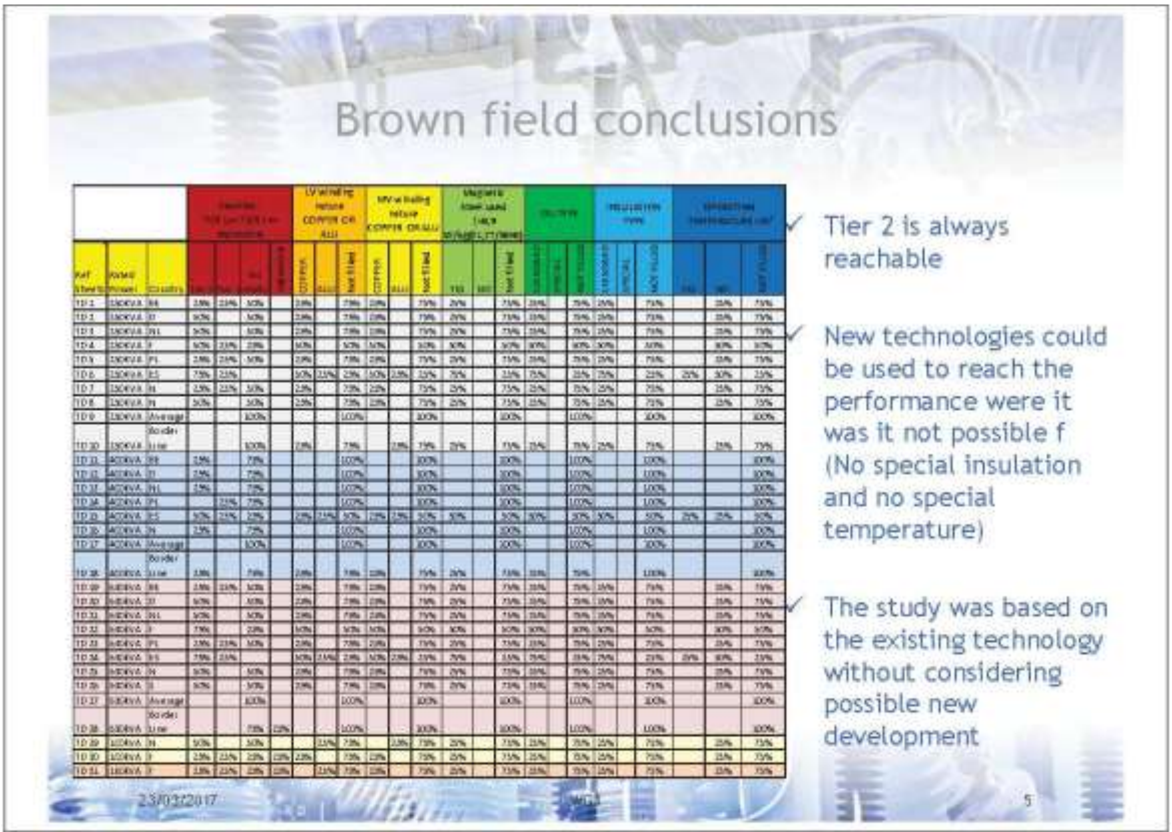
23/03/2017 WG3 3

Green Field conclusions

Base/Boundary	Application	Insulation Technology	Case Power Rating (kVA)	Case Voltage high side (kV)	Tap changer	FEASIBILITY YES	NO	Voted	RAW MATERIAL Alu	Cu	Both	Total
boundary lower	Distribution	liquid immmersed	250	20..22	DETC	100%	0%	100%	14%	29%	57%	100%
base	Distribution	liquid immmersed	400	20..22	DETC	100%	0%	100%	29%	29%	43%	100%
boundary upper	Distribution	liquid immmersed	1000	20..22	DETC	100%	0%	100%	14%	43%	43%	100%
boundary	Distribution /Industruial	liquid immmersed	3150	20..22	DETC	100%	0%	100%	14%	43%	29%	86%
base	industry transformer	dry type	1250	20	DETC	86%	0%	86%	29%	29%	29%	86%
boundary upper	industry transformer	dry type	3150	20	DETC	86%	0%	86%	29%	29%	29%	86%
boundary lower	industry transformer	dry type	400	20	DETC	86%	0%	86%	29%	29%	29%	86%
base	pole mounted	liquid immersed	100	20..22	DETC	86%	0%	86%	14%	29%	43%	86%
boundary upper	pole mounted	liquid immersed	315	20..22	DETC	71%	14%	86%	29%	14%	29%	71%
boundary lower	pole mounted	liquid immersed	25	25..33	DETC	86%	0%	86%	14%	43%	29%	86%
sample	pole mounted/single phase	liquid immersed	50	25..33	DETC	71%	0%	71%	14%	29%	29%	71%
base	medium power	liquid immersed	25 000	33	OLTC	86%	0%	86%	0%	43%	29%	71%
boundary upper	medium power	liquid immersed	31 500	33	OLTC	86%	0%	86%	0%	43%	29%	71%
boundary lower	medium power	liquid immersed	6 300	33	OLTC	86%	0%	86%	0%	43%	29%	71%
base	medium power	dry type	4 000	30	DETC	57%	14%	71%	14%	14%	29%	57%
boundary upper	medium power	dry type	16 000	30	DETC	29%	29%	57%	0%	14%	29%	43%
base	Large Power	liquid immersed	100 000	132	OLTC	71%	0%	71%	0%	43%	29%	71%
base	large Power	dry type	25 000	66	OLTC	29%	29%	57%	0%	14%	29%	43%

- TIER 2 is always reachable

23/03/2017 WG3 4


Brown field conclusions
Tier 2 is always reachable
New technologies could be used to reach the performance were it was it not possible f (No special insulation and no special temperature)
The study was based on the existing technology without considering possible new development
23/03/2017
WG3
5


Vito Draft final report analysis
• 1.3.4What is the risk of only specifying PEI requirements?
- Manufacturers are not in favour to use PEI for rated power less or equal to 3,15MVA even with limitation of K Factor for standardisation of components reasons
• 1.3.5PEI data for large power transformers
- Manufacturers has not enough data today to limits K factor(>0,25) for Large power transformers(Impact feasibility)
- Limitation of K for PEI could create issues in case of weights and dimensions limitation
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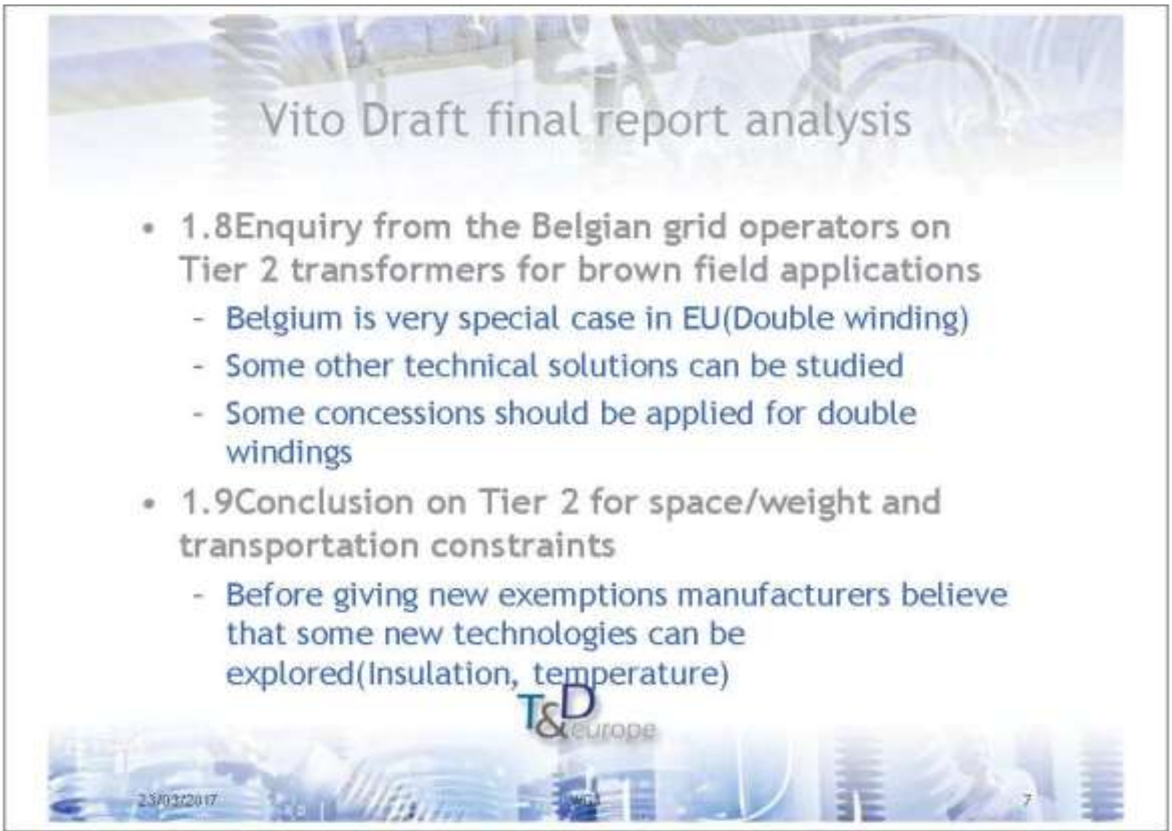
WG3
6


Vito Draft final report analysis
• 1.8Enquiry from the Belgian grid operators on Tier 2 transformers for brown field applications
- Belgium is very special case in EU(Double winding)
- Some other technical solutions can be studied
- Some concessions should be applied for double windings
• 1.9Conclusion on Tier 2 for space/weight and transportation constraints
- Before giving new exemptions manufacturers believe that some new technologies can be explored(insulation, temperature)
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Vito Draft final report analysis
• 1.10 Is Tier 3 an option?
- A study should be done to evaluate
- The information regarding dry type vs Oil should reviewed.
- Technology neutral statements are more advisable to avoid preventing development on existing technology
• 2 Task 2 on Consideration of minimum requirements for single-phase transformers
- Manufacturers are able to design single phases with reduced no load losses
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Vito Draft final report analysis

- 3.1.1.1Medium power transformers for brown field applications with space/weight constraints relative to Tier 2
  - Tier 2 shall be always the first choice.
  - Tier 1 shall be the second choice
  - If Tier 2 and Tier 1 are not possible transformers shall be manufactured with magnetic steel having less than 0,77W/kg at 1,5 T and copper

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- 3.2.1Limitations from CE marking legislation
  - The repair issue should be solved to avoid cheating situation(No loophole)
- 4 Task 4 on Analysis of other environmental impacts
  - Clear description of which material shall be considered and which designation...
  - Documentation on the web for routines tests shall be with restricted access to customers and market surveillance authorities[Antitrust law]

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Vito Draft final report analysis
• 5.6Potential amendments to concessions for transformers with unusual combinations of winding voltages
- To avoid to kill new technologies manufacturers recommend to keep TIER 1concession also for TIER2 for Voltage regulation distribution transformers
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23/03/2017
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Additional remarks
• Subject matter and scope
• improvement given in FAQ and by T&D Europe position paper(15/05/2015) and Cenelec shall be merged to clarify most of the exemptions.
• Market surveillance
- Shall be pushed to allow regulation to be efficient
• Efficiency for LPT <4MVA >36kV
- Is flat in current time regulation; More appropriate value shall be given
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GOES development for Tier 2

thyssenkrupp Electrical Steel

Stakeholder meeting – 29.03.2017 – Brussels
Dr. Régis Lemaître
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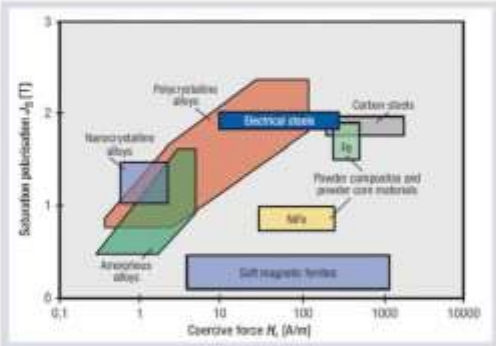
Conventional transformer at 50Hz

Grain Oriented Electrical Steel (GOES) is the core material of transformers

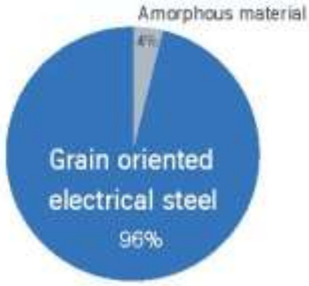
What is GOES?

A crucial steel for energy business

- A Soft Magnetic Material based on iron-silicon alloys, having high polarization & low energy loss
- A flat thin steel sheet with insulation coating
  - Nominal Thickness: 0.23 - 0.27 - 0.30 - 0.35 mm
  - Typical width: 10 to 1.000 mm



Share of worldwide available material for transformer cores



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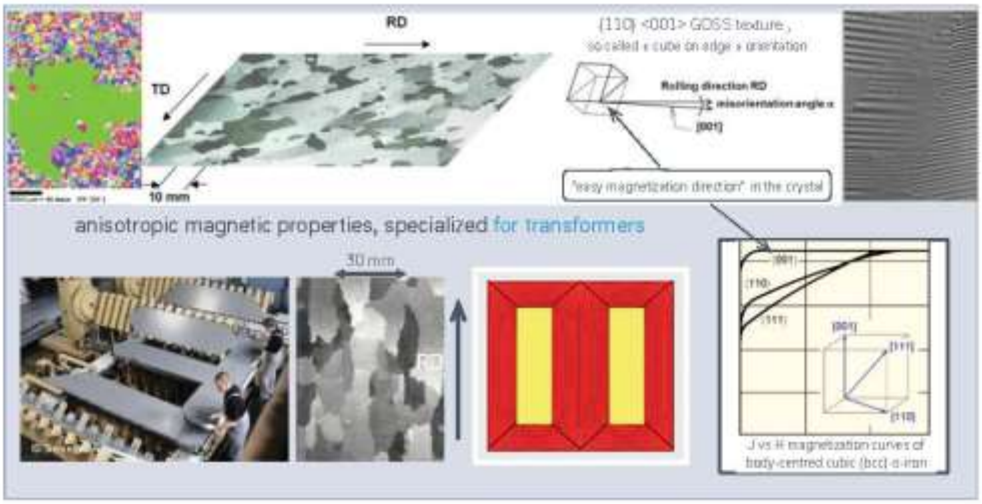
What makes GOES special?

An amazing process complexity to achieve Goss grain recrystallization

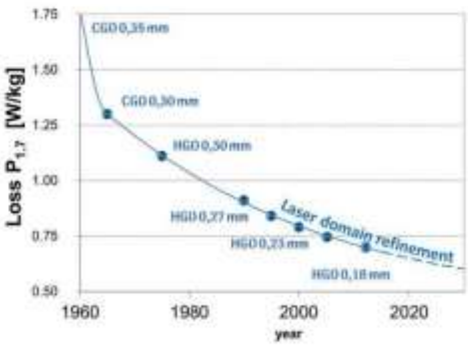


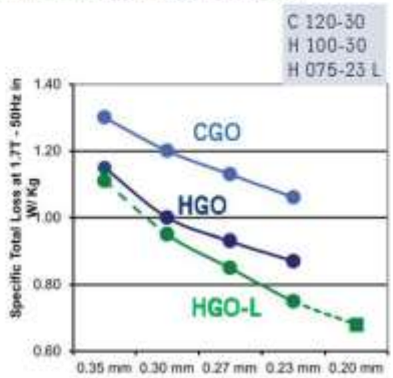
Source: thyssenkrupp Electrical Steel

thyssenkrupp | Steel | Electrical Steel

GOES development towards lower losses

A long story of energy savings … drivers for transformer improved performance





$$P_{Fe} = C_1 \cdot B^2 f + \frac{d^2 \cdot \pi^2 \cdot B_m^2}{6 \cdot \rho_{elek} \cdot \rho_{Mat}} \cdot f^2 + C_3 \cdot B_m^{1,5} \cdot f^{1,5}$$

Hysteresis Loss + Eddy current Loss + Anomalous Loss

Next breakthrough thanks to a new thinner gauge

Source: thyssenkrupp Electrical Steel

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New thin gauges of GOES

- The nominal thickness (0.35, 0.30, 0.27, 0.23 mm) is a standardized value. The next thinner gauge to be introduced in the product Standard IEC 60404-8-7 was discussed in the IEC TC68 committee meetings of Year 2016.
- It has not been yet decided if 0.20 mm or 0.18 mm or both will be introduced within the next revision of the IEC60404-8-7 Standard.
- Several GOES producers have already started to develop thinner gauge high permeability HGO 0.20 mm or HGO 0.18 mm. For the time being, the material is available on the market in small quantities compared to the thicker nominal thicknesses.

Why?

- On the one hand, steel mill manufacturing cost is higher, simply due to a lower productivity at cold rolling mills and in continuous processing lines. Development of thinner gauges will reduce the production capacity and consequently the quantity sold on the market.
- On other the hand due to permanent process optimization, the specific total loss Ps is continuously lowered. Particularly observed for the High Permeability grade HGO-L 0.23, it leads to enough available material to fulfil the demands of the transformer industry and particularly for eco-design transformer requirements.
- Besides economic optimization of the transformer industry, the new thin gauges will not be a technical issue for coil slitting, for lamination cutting with regards to distribution transformers. The technical development would take more time for the larger power transformers particularly due to lamination handling difficulties for stacking.

To conclude; according to manufacturing / handling issue the application of thin HGO-material with thickness 0.18 mm or 0.20 mm is not yet in serial transformers, even those thin gauges are in the developing phase.

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GOES grades for Eco-design transformer requirements

Status quo

- Tier 1 ("Ao class"): demand increase for the best HGO grades
  - for DT: required losses at 1,7 T in the range [0.90 W/kg - 0.80 W/kg] ie H 090-27 & H 085-23
  - for large PT and pole mounted Tr. : Tier 1 is "not very stringent"
- Tier 2 ("Ao-10%" for DT – "Mini Peak Efficiency Index" for PT):
  - for DT, at same design, a high demand of "H075-23" and for advanced transformers of H070-20
  - for PT, the "conversion time" is coming … from H100-30 steel core to H95-27 / H85-23 …
- Availability of the materials to meet such requirements is "given" by steel mills

TIER 1: 01.07.2015
H 090-27 & H 085-27
H 085-23 & H 080-23

TIER 2: 01.07.2021
H 085-27
H 080-23 & **H 075-23**

How to ensure, that transformer cores will only be built with prime GO grades defined in Tier 1 and Tier 2?

PowerCore® HGO top grades:

Suitable for EU Ecodesign requirements of power transformers

Grade	Thickness		Typical core loss at				Guaranteed core loss at		Typical polarization at	Guaranteed polarization at
			1.5 T	1.7 T	1.5 T	1.7 T	1.7 T	1.7 T		
			50 Hz	50 Hz	60 Hz	60 Hz	50 Hz	60 Hz	800 A/m	800 A/m
	mm	inch	W/kg	W/kg	W/lb	W/lb	W/kg	W/lb	typ. T	min. T
PowerCore®										
H 075-23 L	0.23	0.009	0.55	0.74	0.33	0.44	0.75	0.45	1.91	1.88
H 080-23 L	0.23	0.009	0.57	0.78	0.34	0.47	0.80	0.48	1.91	1.88
H 085-23 L	0.23	0.009	0.60	0.83	0.36	0.50	0.85	0.51	1.90	1.88
H 090-23	0.23	0.009	0.62	0.88	0.37	0.53	0.90	0.54	1.90	1.88
H 100-23	0.23	0.009	0.67	0.98	0.40	0.59	1.00	0.60	1.88	1.85
H 085-27 L	0.27	0.011	0.63	0.83	0.38	0.50	0.85	0.51	1.91	1.88
H 090-27 L	0.27	0.011	0.65	0.88	0.39	0.53	0.90	0.54	1.91	1.88
H 095-27	0.27	0.011	0.68	0.93	0.41	0.56	0.95	0.57	1.91	1.88
H 100-27	0.27	0.011	0.71	0.98	0.43	0.59	1.00	0.60	1.89	1.88
H 110-27	0.27	0.011	0.76	1.08	0.46	0.65	1.10	0.66	1.89	1.88
H 100-30	0.30	0.012	0.72	0.98	0.44	0.59	1.00	0.60	1.91	1.88
H 105-30	0.30	0.012	0.75	1.03	0.45	0.62	1.05	0.63	1.91	1.88
H 110-30	0.30	0.012	0.77	1.08	0.46	0.65	1.10	0.66	1.90	1.88

thyssenkrupp Electrical Steel has developed HGO top grade volumes for Ecodesign requirements.

Overview worldwide exports and imports

2016 exports and imports in ktons

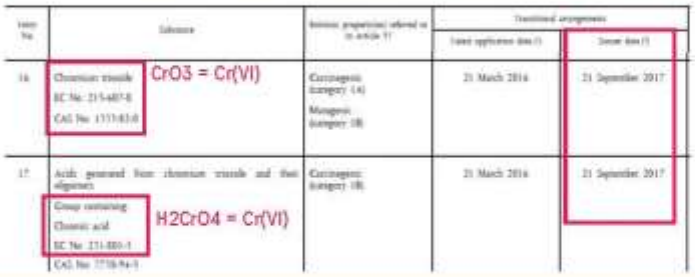
Exports in t		Imports in t	
Japan to Belgium	50.561	Belgium from Japan	0
Japan to Netherlands	13.979	Netherlands from Japan	99
Japan to EU 28	75.709t	EU 28 from Japan	20.330

Japan, Russia and South Korea are net exporters

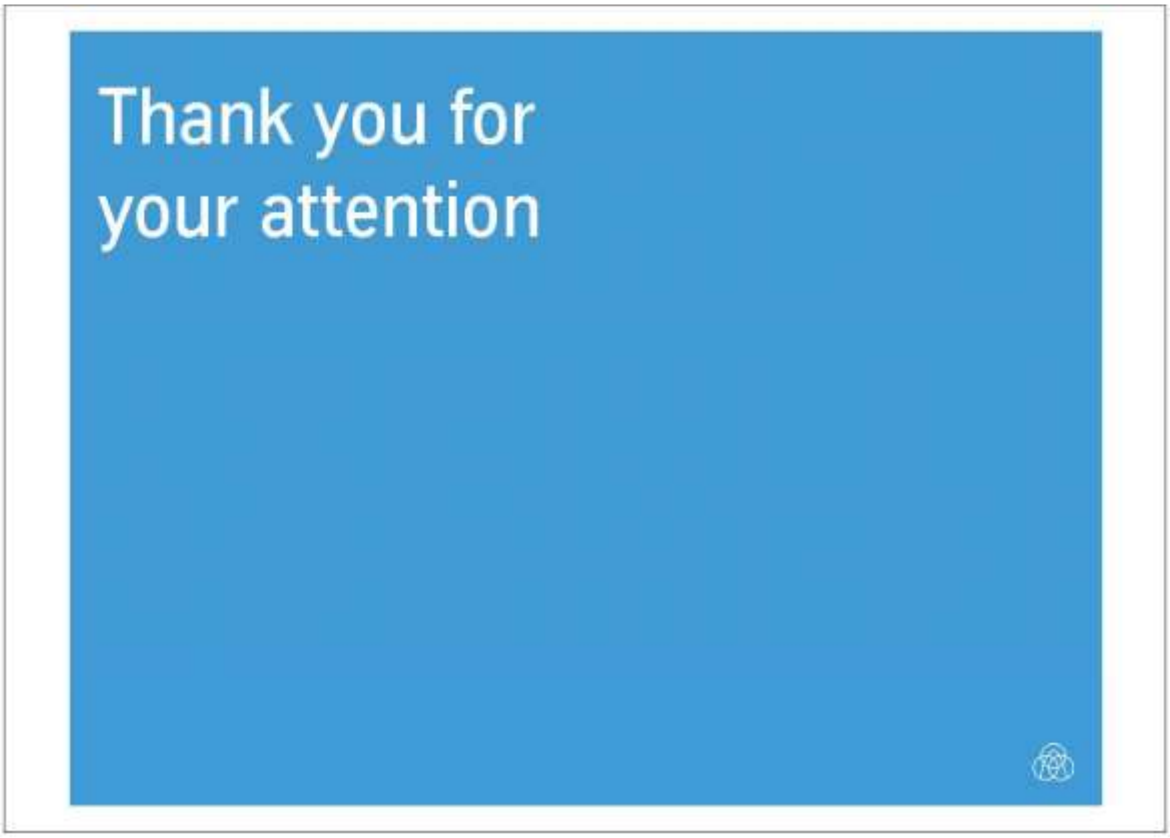
EU regulations on Chromium substances

Why developing a Cr-Free coating?

- EU RoHS Directive 2002/95 restriction on hazardous substance directive requirements:
  1 July 2006: electric & electronic devices on EU market are not allowed to contain Pb, Hg, Cd, Cr(VI)
- GOES coating process is based on a liquid solution made of chromic acid containing Cr(VI), but Cr(VI) is completely reduced during the annealing and baking process in a Cr(III) **component**.
  ➔ thyssenkrupp Electrical Steel insulation coating doesn't contain neither Cr(VI) nor harmful components
- REACH*: Ban of the harmful chromium substances **in Europe** as of **21.09.2017**



Ban of Cr(VI) substances used for the insulation coating is only applied in Europe. How to implement a coating certificate proving it has been produced without substances banned by REACH (Chromium)


Thank you for
your attention


GOES development for Tier 2
thyssenkrupp Electrical Steel
Stakeholder meeting – 29.03.2017 – Brussels
Dr. Régis Lemaître
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10. ANNEX J HITACHI METALS COMMENTS

Hitachi Metals Europe GmbH Comments on the Draft Review Study Text

Section	Page	Draft Review Study Text	HME Comment
0.	12	In addition, the study investigates if, in the light of technological progress, the minimum requirements set out for Tier 2 in 2021 are still appropriate based on a market assessment of the evolution in cost and performance ~~for conventional grain-oriented magnetic steel and equally for amorphous steel.~~ ***strike through text should be removed and replaced by:*** for the different core materials grades.	technology neutral issue under tier 2 design requirements and regardless of the core material used, the DTs physical characteristics will be very similar. reply: we do not want to hide the facts
1	14	~~In particular, the evolution and availability of amorphous steel is investigated to inform the assessment of whether these requirements for Tier 2 level are still justified, or a different level of ambition is required.~~ ***strike through text should be removed***	technology neutral issue under tier 2 design requirements and regardless of the core material used, the DTs physical characteristics will be very similar. see previous
1	14	The study also assesses the appropropriateness of introducing a Tier 3 level with stricter requirements, indicatively to be considered comig into effect	We are in favour of Tier 3 requirements. ~~reply: BAT added and Tier 3 suggested~~
1.1.2	16	~~the rationale…(GOES) transformers with efficiencies far below the Tier 1 level but which are also relatively more compact compared with amorphous distribution transformers (AMDT)(see Lot 2(2011)).~~ ***Strike through Text should be removed***	technology neutral issue under tier 2 design requirements and regardless of the core material used, the DTs physical characteristics will be very similar. ~~see previous,~~
Table 1.5	20	…various grades(M2, M3, M4, ..) which	the three product ranges out of the Official Journal of the EU L284/132 30.10.2015 point 176 should be used reply text modifed
Table 1.5	20	M3 core steel 2,04 2,04 is for <0,9W/kg losses	point 182 in the above OJ the Union industry states: 'MIPs are currently far below current market prices in the EU and third countries reply: text updated
	21	Utilities report little uptake of ~~amorphous transformers or~~ Tier 2 compliant~~, or above,~~ transformers thus far~~, however in industry there is some uptake…~~ ***Strike through Text should be removed***	technology neutral issue under tier 2 design requirements and regardless of the core material used, the DTs physical characteristics will be very similar. see previous There is no incentive for utilities to purchase tier 2 compliant equipment, before it enters into effect in 2021
1.1.5	23	**1.1.5 Green Field and Brown Field transformer design** In this study so-called green field and brown field reference designs of transformers are considered. 'Green field reference designs' are transformers designed for green field projects, i.e. a new project where the size and weight of the transformer is not a specifically constrained requirement resulting from limitations associated with the dimensions and load baring capacity of existing enclosures. Green Field designs are therefore the most cost-effective designs. Aside from green field designs brown field reference designs are also looked at, i.e. transformers for a replacement project that has specific ~~limitations of size/weight~~ resulting from the need to install the transformer in an existing enclosure.	~~limitations of size/weight.~~ ***strike through text should be removed and replaced by:*** infrastructure and/or electric limitations reply: in agreement with CENELEC only these issues were identified

March 22, 2017 1

Hitachi Metals Europe GmbH Comments on the Draft Review Study Text

1.1.6	23	The Tier 2 green field applications (Tier 2 Green F in Table 1-8) have a price in line with the Impact Assessment (2014) and hence for these applications **there is no evidence to review Tier 2 on economic grounds for green field applications.** We assume that this can only be achieved with the most efficient GOES or AMDT, hence it is important that an increase in demand for ~~this steel~~ will not cause a surge in prices relative to the price review in section 1.1.3.2.	~~this steel~~ ***strike through text should be removed and replaced by:*** these steel grades
Table 1.8	24	Prices given in this table are very high.	pricing of wound/stacked core DTs MUST be reviewed Siemens FITformer® ACT datasheet - indicates pricing to be much lower. Also check CLASP Report from 24 August 2010 on purchasing price difference thanks, updated
	36	Most Tier 2 compliant transformers on the market are Amorphous Metal Transformers (AMT). ~~As explained in Lot 2 they are larger and heavier due to the limited maximum magnetic flux density (typically 1,2 Tesla).~~ Their no load losses are well below Tier 2 requirements. ~~Due to their typical rectangular core cross section more care must be given to withstand conductor forces during short circuit. Therefore the new standard EN 50588-1:2016 also introduced an additional short-circuit test for new transformers with level of no load loss 'AAA0'. Finally AMT is more expensive due to the amount and cost of material, see section 1.1.3.2. The higher price and the volume can explain the modest uptake on the European market today.~~ ***strike through text should be removed***	technology neutral issue under tier 2 design requirements and regardless of the core material used, the DTs physical characteristics will be very similar. AMDTs respect the requirements on short circuit as exemplified by CIRED Paper from June 2009. This is a non issue and should not be mentioned in the text. text updated and reference added
1.5	38	If a transformer is too big or too heavy additional investments are required, e.g. a change of all the MV equipment and the substation, or parts of it. The cost for a complete new transformer substation can be up to 10 times greater than the transformer itself, e.g. in Belgium for example34 the approved unit cost for a fully installed greenfield transformer substation is 114094 euro.	This is a fully exagerated claim and only based on one specific refence case. In Germany SALO Elektrotechnik references a price of less than €40,000 for a substation and including a 400 kVA or 630 kVA DT in that price. thanks, price update and reference added
1.6.1	41	Using low loss ~~silicon~~ steel is one of the most obvious step to go from Tier 1 to Tier 2 to reduce no load losses, see Lot 2 (2011) for technology and section 1.1.3.2 for price and availability. **Using low loss steel will decrease the cooling needs and therefore decrease the volume and weight of cooling system and transformer**, e.g. the cooling finns for air cooled systems. Low loss GOES price and availability might be the main barrier. **Using low loss steel also allows to increase the maximum magnetic flux density and therefore the size and weight of the transformer**. In view of Tier 2 and general interest in energy savings research is ongoing to upgrade GOES production plants worldwide to lower loss grades36, hence it is reasonable to expect they will become more available at a competitive cost. ***strike through text should be removed***	technology neutral issue under tier 2 design requirements and regardless of the core material used, the DTs physical characteristics will be very similar. we do not want to hide this fact

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Hitachi Metals Europe GmbH Comments on the Draft Review Study Text

1.6.6	43	More recently in 2015 a Chinese company Haihong43 succeeded in **designing a hexagonal or so-called 3D triangle shaped** ~~amorphous~~ **transformer** and invested in innovative mass production machinery for it. This reduces the amount of ~~amorphous~~ material needed which benefits weight and also has a circular core cross section which benefits short circuit behaviour. They also claim reducing transformer noise. **It is a promising development for more compact and light weight** ~~amorphous~~ **transformers.** ***strike through text should be removed***	actually this is Hexaformer, a Swedish patent, copied by China. The advantages of a so called 3D core applies for all magnetic core materials, ie lower loss, lower noise... This is simply due to physics! see previous
1.7	44	**1.7 Current status of Tier 2 brown field solutions for medium power transformers and manufacturer enquiry** T&D Europe is committed to supply data by 9th of March; hence data will be presented and discussed in the stakeholder meeting.	Due to the importance of this information we believe that this T&D data should have been made available before the meeting to allow stakeholder to study and make comments well in advance. noted but no time was available
1.8	44	The Belgian Grid operators Synergrid46 have done a similar exercise as in section 1.7 those result will be discussed in the stakeholder meeting.. Figure 1-10 shows the results for a 400 kVA transformers with 1LV winding (242V) an excersise done with their usual suppliers. The green line in Figure 1-10 are the requirements that they did sent to a selection of manufacturers wherein Eco 2015 is Tier 1 compliant of the Regulation and Eco 2021 Tier 2. The limitations came from the construction of the existing substations, see Figure 1-6. The best Tier 2 fit (all copper windings) still did exceed the weight limit of 1800 kg by 14 %(2050 kg) Hence from these manufacturers. **It didn't result in a Tier 2 compliant transformer.**	Once again this only refences one case in one country. One Belgian case cannot be used to exemplify the situation across the EU. Please clarify last sentence noted and text more updated considering this.
1.9	45	Given the previously discussed brownfield ~~and greenfield~~ limitations some new exemptions might be considered to avoid some excessive costs for some individual cases. Stakeholders are invited to provide suggestions for this, which will be discussed in Task 3. ***strike through text should be removed***	there should be no exemptions for greenfield. For brownfield the exemption should be the exception and DT makers/utilities must document these exemptions. BAT must be used in all cases for power tranformers greenfield limits are known
1.10	45-46	**1.10 Is Tier 3 an option?** If a Tier 3 is considered for medium power transformers it should mainly be focused on further reducing no load losses, e.g. A0-10% i.e. AA0 towards AAA0. Further reducing the load losses would continue to result in a kPEI different from the Base Cases and is therefore not recommended.;	we are in favour of a Tier 3 starting in July 2025. Fixed losses vs MEEPS to be discussed. noted and the option for a Tier 3 is now added

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2.3.3	58	**Use of Amorphous Transformers:** Amorphous transformers have much lower iron losses than conventional, even those which will now use of lower loss steels. It is reported that there is no extensive use of amorphous transformers in the UK or Ireland from which to provide a reliable basis for the stimation of the costs of such transformers. ~~Equally it is reported that discussions with large suppliers of Amorphous Core Transformers provided quite contradictory information on the expected price changes from switching to amorphous ranging over a greater than +60% range. This is partly due to the actual cost depending strongly on that of the amorphous steel which is supplied from a tight market, and also on the suppliers attempting to pitch the price in relation to what the expected price from traditional manufacturers is anticipated to be.~~ ***strike through text should be removed***	VITO refers to speculative information with incorrect assumptions, where is the evidence? +60%? Vito pricing assumption were already proven to be excessive- see Siemens pricing and clasp report above (Page 2). The last sentence could be considered as a serious attempt to discredit the reputation of several world leading companies. Companies could consider legal action regarding this wording.
3.1.1	60	Note that T&D Europe has supplied a draft review of Regulation 548/2014 and CENELEC/TC14 is also working on a document, prTS 50675:2017, which contains input for the review. Those findings are not yet included in this report but during the study Stakeholder meeting on 29/3it is requested that a summary of their findings should be presented. **Thus, in the following text only some of the major findings related to the work in the draft Task 1&2 chapters are discussed.**	The T&D draft should have been made avaialble to all stakeholders well in advance to allow written comments on their findings prior to the meeting.
3.2.2	64	Because second hand transformers can constitute a loophole to the current Regulation 548/2014 it would be possible to add requirements for second hand transformers to the Regulation. In all this, the EC should check if this approach is compatible with other CE Regulation. Second hand transformers can be defined as transformers that change ownership and that are incompatible with the existing requirements for new transformers. Requirements for second hand transformers could be set in line with the Tiers for new transformers.	we agree that repaired, used and retrofit DTs must comply with ecodesign requirements.
5.	70	Position Papers & Ammendments	The documents under point 5. should have been made available to all stakeholders well in advance to allow written comments on their findings prior to the meeting.

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11. ANNEX K COMMENT NORWAY NVE

Norwegian Water Resources and Energy Directorate

NVE

VITO NV
Boeretang 200
2400 MOL

Attn.: Paul Van Tichelen

Our date: 18.11.2016
Our ref.: 201604919-30
File no.: 652
Your date:
Your ref.:

Enquiries to:
Kirsti Hind Fagerlund, khf@nve.no

Input to the review of the Ecodesign Regulation 548/2014

The Norwegian Water Resources and Energy Directorate (NVE) appreciate this opportunity to provide input to the ongoing review study on the Ecodesign Regulation 548/2014. Our comment contains a general overview of the situation in Norway regarding the regulatory regime for electricity transmission and estimated losses from transformers. It also contains the summary of a small survey conducted by the NVE earlier in this month.

The summary of our comment is in the abstract below while the full text is in the Annex.

Abstract

Norway has a lower percentage of transformer losses (1.02% of the electricity production) than the EU. The energy efficiency gain caused by the Regulation is low, and it has a low cost efficiency in a Norwegian context. One reason for the low gain is the Norwegian regulatory regime for electricity transmission. Norwegian network operators are incentivized to choose transformers that over time have the lowest cost level.

In November 2016, the NVE conducted a small survey among six Norwegian stakeholders (of which three responded) about the impacts of the Tier 1 in Regulation 548/2014. The responding stakeholders have largely the same view of what the impacts of Regulation 548/2014 have been so far. In general, the purchasing costs for transformers have increased by 15-30%. The main reason is the need for materials of higher quality. Still, it might be a bit premature to draw conclusions for the large power transformers. The installation costs of transformers rated under 3150 kVA have not increased with the same rate as the procurement costs. This is partly due to Norwegian stakeholders having a focus on not increasing the footprint of the transformers at the site. Cooling needs might change the picture.

The total losses for transformers rated below 3150 kVA have fallen slightly, mainly due to lower no load losses. For larger transformers it is too early to conclude on the impact on the losses.

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Middelthunsgate 29	Vestre Rosten 81	Kongens gate 14 - 18	Anton Jenssensgate 7	Naustdalsvn. 1B	Vangsveien 73
P.O.Box 5091, Majorstuen	N-7075 TILLER	N-8514 NARVIK	P.O.Box 2124	P.O.Box 53	P.O.Box 4223
N-0301 OSLO			N-3103 TØNSBERG	N-6801 FØRDE	N-2307 HAMAR

NVE

Side 2

So far, there is no indication of a higher rate of repair, rather than replacing faulty transformers with more energy efficient new transformers.

Please do not hesitate to contact us if you have questions.

Yours sincerely

Mari Hegg Gundersen Head of section	Kirsti Hind Fagerlund Senior advisor

This document is sent without signature. The content is approved according to internal routines.

Annex Input to the review of the Ecodesign Regulation 548/2014 – full text

Annex

Input to the review of the Ecodesign Regulation 548/2014 – full text

Background

Norway has about 126 000 transformers in the distribution system. In addition, there are a small number of industrial and power transformers. Estimated losses in these transformers are approximately 1.4 TWh. Norway's electricity production in a normal year is approximately 137 TWh. The transformer losses are equivalent to 1.02% of the electricity production. Compared with the EU, Norway has low transformer losses. The total transformer losses were approximately 93.4 TWh in the EU27 in 2008[1], which corresponds to 2.67% of Europe's total electricity production.

Energy efficiency gains in Norway due to the requirements of the Regulation are estimated to be negligible for Tier 1, and to be about 200 GWh/year (± 20%) in 2025 for Tier 2. The gain caused by the Regulation is low, and it has a low cost efficiency in a Norwegian context. One reason for the low gain is the Norwegian regulatory regime for electricity transmission.

Since the mid-1990s, the Norwegian distribution system operators (DSOs) and the transmission system operator (TSO) have been regulated by a combination of direct regulations and incentive based economic regulation. The direct regulations set minimum standards. In the economic regulation, the aim is that the owners of the network infrastructure over time shall earn a reasonable rate of return on invested capital given efficient operation, utilization and development of the network. The results from benchmarking analyses are used in order to evaluate the performance of the network operators, and there are strong incentives in the regulatory framework to choose the most cost efficient solutions over time. More specifically for transformers, the level of network losses in different transformers is one out of several factors that the operators will consider. For example in the benchmarking model for local distribution, network losses are included as one out of several cost factors. As a consequence, Norwegian network operators are incentivized to choose transformers that over time have the lowest cost level.

Results from a small survey conducted in November 2016

In connection with the preparation of input to the current review study, NVE conducted a small survey among six Norwegian stakeholders. We received replies from three of the stakeholders (two producers and the chairman of the Norwegian Standardization Committee for transformers NK14). The questions asked and a summary of the responses follows. Stakeholders have largely the same view of what the impacts of Regulation 548/2014 have been so far.

Q1: Has the cost of procurement and installation of new transformers in Norway increased due to the requirements of Tier 1?

Answer 1: The cost of purchasing new transformers in Norway has increased because of the new requirements. The three respondents estimated an increase of total costs by 15-30%. The main reason for this increase is the need for materials of higher quality to meet Tier 1 requirements. Since there are few suppliers of these materials, both the cost and delivery time has increased significantly due to higher demand.

Regarding the large transformers (rated over 3150 kVA), it is still too early to say something about developments in acquisition costs in the period after July 2015. This is because the larger transformers

[1] Regulation 548/2014- preamble number (9)

Side 4

more often are tailor-made, and has a longer delivery time. One must let the Tier 1 requirements be present for a longer period before it is possible to say something about developments in the cost of these transformers.

The installation costs of transformers rated under 3150 kVA have not increased with the same rate as the procurement costs. This is partly due to Norwegian stakeholders having a focus on not increasing the footprint of the transformers at the site. In general, the market should prepare for greater dimensions and higher installation costs due to demands for lower losses. Installation costs will also increase if the transformer room does not already have enough cooling to eliminate the heat from the load losses in a new transformer. In many cases, it will be difficult to install cooling systems. The cheapest transformers may need cooling fans with its own energy demand.

reply: noted, is related to brownfield

Q2: Has the transformer losses increased or decreased because of Tier 1?

Answer 2: The total losses for transformers rated below 3150 kVA have fallen slightly, mainly due to lower no load losses. For larger transformers, it is too early to conclude how the new requirements have affected the losses in Norwegian transformers. Some respondents have emphasized that the PEI-requirements are ambiguous. It is possible to construct transformers that meet PEI-requirements that have higher total losses than transformers installed prior to July 2015. This is contrary to the regulation intentions.

It is possible to invest in transformers with lower total loss, but then as a voluntary choice of the buyer, not because of the PEI-requirements. Some buyers choose lower purchase costs over lower losses, especially buyers with very limited access to capital.

reply: PEI is discussed in the stakeholder meeting

Q3: Has Regulation 548/2014 resulted in a higher rate of repair, rather than replacing faulty transformers with more energy efficient new transformers

Answer 3: There has not been observed an increase in repairs. A rule of thumb has been that the repair costs has to be less than 60% of the cost of acquiring a new transformer, for a repair to be the best option. This has not changed significantly after July 2015.

reply: noted

12. ANNEX L COMMENT EDP PORTUGAL

Van Tichelen Paul

From: Fernando Ramalheira <fernando.ramalheira@edp.pt>
Sent: vrijdag 17 maart 2017 20:45
To: Van Tichelen Paul; paul@waide.co.uk; Cesar.SANTOS@ec.europa.eu

Subject: EDP Portugal concerns regarding Transformers eco Regulation - Tier2

Dear Sirs,

About this subject EDP Distribuição – Portuguese DSO agrees with the philosophy that is under the eco-design transformers regulation, and is already buying all the transformers qualified according EU Regulation 548/2014. But, for the Tier2, we have some concerns about certain application rules to our particular conditions in field all over the country that we want to share with you, in order to have a good next step Regulation without create difficulties that can have an unjustified disproportionate amount of costs to the whole Electrical Portuguese Distribution System, and we are sure is not in EU intent.

And they are:

1 - Pole Mounted Transformers Maximum Losses table I.6 and table I.3
Proposal: Regulation Table I.3 must be applied also to the pole mounted transformers losses table I.6.

Justification: the increase of maximum loss limits for transformers with Um=36 kV on primary, affects all type of transformers. So, to be coherent this rule must be applied also for Pole Mounted transformers. Without this modification is possible to have a Pole Mounted transformer with a loss limit less than loss limit of a Pad Mounted Transformer – example: 100 kVA no load loss limit 145 kW in Pole MT and 130+15%=149.5 kW in Pad MT – this seems not coherent and sure is very painful.
This is common and also recognized in prTS 50675 Cenelec document - 6.2.1 Part 2 - Note1.
EDP Network has many 36 kV pole mounted transformers in its network with many limitations on weight and dimensions and this will have impact in all that pole mounted substations.

noted: this inconsistency will be added in Task 3

2 – Pole Mounted transformers incoherent table I.6 losses values between each transformer - limitations
Proposal: consider for next step, at least the pole mounted 100 kVA transformer with load loss limits Ck instead of Bk and 250 kVA transformer with Ck Co.

Justification: EDP has 2 types of Pole Mounted Substations (AS – 50 and 100 kVA and AI – 160 and 250 kVA pole mounted transformers) and we expect problems with such loss limits, manly in the 100 kVA and 250 kVA transformers, because they are the big ones in each type of substation.
Not like EDF, where this transition to Pad Mounted Substations is made on 160 kVA where, for this reason, the regulation allows limits very very higher (Ck+32% and Co-10%) than in other transformers (Bk and Ao).

noted: alternative formulation compared to loss limits is added for space weight constraints are added material as back-up solution; note also that the focus is on single pole

3 – PEI specification on Medium Power Transformers, as alternative
Proposal: Regulation allows to have for Medium Power Transformers the limits by Maximum Losses or, in alternative, by PEI calculated from the losses tabled applied.
Justification: In each distribution network the transformers have a particular load factor so, it seems more rational that we can have also in the regulation, as alternative, the possibility to control the transformers losses by the PEI, as it is made on Large Power Transformers.

noted: discussed in the stakeholder meeting

1

The PEI table can be calculated from the losses of the tables applied for each transformer.
Then, we can balance between load losses and no load losses, in manner to have the designs near the optimum point of transformer normal service.

These are issues that we always had and communicate to the Commission during pre-publication discussions of the Tier1 Regulation 548/2014, maybe they did not get to you in time, but we consider very important to look for them, before have a final document.

noted: also discussed in the stakeholder meeting, see report.

Many thanks for your time.

Regards

edp distribuição

Fernando Ramalheira
EDP DISTRIBUIÇÃO
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13. ANNEX M INPUT ECI

Van Tichelen Paul

From:	Roman Targosz <roman.targosz@copperalliance.pl>
Sent:	donderdag 16 maart 2017 16:17
To:	Van Tichelen Paul
Cc:	paul@waide.co.uk; Cesar.SANTOS@ec.europa.eu
Subject:	Re: Announcement of 'Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for small, medium and large power transformers ': Draft report available for discussion in the stakeholder meeting

Dear Paul,

Congratulations for excellent job so far.

Some points:

1.1.2 BC2, BC3, BC5, BC6 are not very different while they are 4 out of 6 base cases. Either some more BCs should be added or opposite: BC2/BC5, BC3/BC6 are grouped? > R: was decided in Lot 2 (2011)
1.1.2.2. Big progress between T1 and T2. New classes are M085, M080, M075 (Nippon steel only) with standard thicknesses 23 or 27 but with 0,19 or 0,16 coming on the market. With these new classes mass of active materials can be reduced significantly and is not yet reflected in calculations (manufacturers are rather reluctant to show these possibilities) > R: is discussed in meeting and updated as far as possible
1.1.1.1 on page 22 should rather be 1.1.2.3. May be it should also include ester oil?>R: noted
1.5 Constraints: we are working on our own analysis for dry and oil medium power transformers. May I ask for opportunity to present it during the meeting? >R: yes, done and report updated
1.10 Tier 3 – good points. Please consider no further sub category of dry type. For example ester oil may provide similar fire resistance function as dry type. >R: noted report extended on this issue
3 Task 3: very good. Agree with 3.1.1.1. Need to secure against loopholes. 3.2. What about limit value of repair cost which imposes requirements as for new units?

>R: discussed in the meeting, it is complex to put requirements on product repair.

Best regards Roman Targosz

From: Transformers
Sent: Tuesday, March 07, 2017 5:43 PM
To: Van Tichelen Paul
Cc: paul@waide.co.uk ; Cesar.SANTOS@ec.europa.eu
Subject: Announcement of 'Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for small, medium and large power transformers ': Draft report available for discussion in the stakeholder meeting

Dear Sir or Madam,

We are contacting you with regard to a preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for transformers (https://transformers.vito.be/) to inform you that a draft report is available for commenting and discussion in the stakeholder meeting.
It can be accessed by this link: https://transformers.vito.be/sites/transformers.vito.be/files/attachments/ec_dg_growth_lot2_Transformer_V23.pdf

In order to enable to discuss the comments and input in the upcoming stakeholder meeting on 29th March please sent them before 24th March.
Of course, also written comments of those who are not able to participate in the stakeholder meeting are welcome.

1

Note: for the upcoming stakeholder meeting CENELEC/TC 14, T&D Europe and Eurelectric (Synergrid) will be contacted to present findings but others are also welcome to contact us.

Kind regards on behalf of the study team,

Paul Van Tichelen

14. ANNEX N INPUT THYSSEN KRUPP

thyssenkrupp

Grain oriented electrical steel

Steel
Electrical Steel

Prepared by: Régis Lemaître – Peter Schafeld

23.03.2017
Page 1/6

To attention of : Paul Van Tichelen - Paul Waide – Cesar Santos

Subject:
Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for transformers (https://transformers.vito.be/).
Thyssenkrupp Electrical Steel comments on the draft report available for commenting and discussion at: https://transformers.vito.be/sites/transformers.vito.be/files/attachments/ec_dg_growth_lot2_Transformer_V23.pdf

1- Preliminary words :

GOES is available in a wide variety of thicknesses (0.35, 0.30; 0.27; 0.23 mm) of various grades in Conventional Product and in High Permeability Product; see EN10107:2014 or IEC 60404-8-7. These grades are classified according to their main characteristic the specific total loss ('Ps' in W/kg).

The nominal thickness (0.35, 0.30; 0.27; 0.23 mm) is a standardized value. The next thinner gauge to be introduced in the product Standard IEC 60404-8-7 was discussed in the IEC TC68 committee meetings of Year 2016. It has not been yet decided if 0,20 mm or 0,18 mm or both will be introduced within the next revision of the IEC60404-8-7 Standard. (note: GO 18 is introduced in EN10303:2015 and IEC 60404-8-8 for medium frequency applications).

Referring to European Standard EN10107 the designation of the steel grade comprises the following in the order given:

a) capital letter M for electrical steel,

b) a number of one hundred times the specified value of maximum specific total loss at 1,7 T and 50 Hz, in watts per kilogram corresponding to the nominal product thickness,

c) one hundred times the nominal thickness of the product, in millimeters

d) the characteristic letter

– **S for conventional grain oriented products**

– **P for high permeability grain oriented products**

EXAMPLE; M150-30S, Conventional grain oriented electrical steel sheet or strip with a maximum specific total loss at 1,7 T of 1,50 W/kg at 50 Hz and a nominal thickness of 0,30 mm, supplied in the fully processed state:

thyssenkrupp

23.03.2017
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Therefore in the European Final Report of "PREPARATORY STUDY FOR THE REVIEW OF COMMISSION REGULATION 548/2014 ON ECODESIGN REQUIREMENTS", we suggest to use the correct designation for GOES grades.

For example:

- 23S for Conventional GOES 0.23mm, so called CGO 0.23

- 23P for High permeability GOES 0.23mm, so called HGO 0.23. This category will include Magnetic Domain Refined grades by laser scribed technology.

>R: thanks, report has been updated accordingly

2 – Comments of thyssenkrupp Electrical Steel (tkES) on draft final report:

Page 8 & 9 :

HiB: High-permeability steel

HiB-DR: Domain Refined High-permeability steel

tkES does not agree to use this acronym: HiB, which is a brand name of Nippon Steel Corporation. The correct designation should be: high permeability product or the acronyms: HGO and HGO-DR (for high permeability Domain Refined product).

>R: thanks, report has been updated accordingly

Page 19 & 20 :

1.1.3.2 Magnetic core and tank steel material prices

The main materials used in transformer cores are Grain Oriented Steel (GOES) and amorphous steel (AM), see Lot 2(2011). As explained in Lot 2 (2011), GOES is sold in various grades (M2, M3, M4, ...) which are classified according to their losses which is related to the sheet thickness. Obviously, low loss GOES with thinner sheets requires more processing and is more expensive. Also so-called mechanically scribed steel with lower losses is more expensive.

It should be noted that a price surge in low loss (M3) GOES, or so called GOES+, occurred in 2015 after a period of price ....

Comments of tkES:

- The main material that is used in a transformer core is GOES. Amorphous material in a transformer core represents ca. 5% worldwide and in Europe much less percent.
- Besides the product catalogue of a non-European GOES producer; M2, M3, M4 ... designations have been used long time ago for Conventional GOES, but have no relevant meanings. It is more appropriate to use the words and acronyms of the European and International Standards.
- Mechanically scribed steel is a technology used in Japan for specific applications and for a small quantity. The HGO Magnetic Domain Refined grades are produced mostly by laser scribing technology from many suppliers.
- As GOES+ is not defined here in the document, we assume it refers to HGO and HGO-DR.

thyssenkrupp

23.03.2017
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Then we propose the following text adjustment of p19-20:

"The main material used in transformer cores is Grain Oriented Electrical Steel (GOES). Amorphous material ~~steel~~ (AM) counts for a few percent, ~~see Lot 2(2011)~~. As explained in EN10107 Standard ~~in Lot 2 (2011)~~, GOES is sold in various grades (Conventional grain oriented products as 23S, 27S, 30S and 35S, and high permeability grain oriented products as 23P, 27P, 30P and 35P) which are classified according to their maximum losses which are related to the sheet thickness (0.23; 0.27; 0.30 and 0.35 mm). Obviously, low loss GOES with thinner sheets requires more processing and is more expensive. Also so-called HGO-DR laser scribed steel with lower losses is more expensive.

It should be noted that a price surge in low loss (23P & 27P) HGO and HGO-DR or so called GOES+, occurred in 2015 after a period of price...."

>R: thanks, text has been updated

Page 20: Table 1-5

Comments of tkES:

At first, we strongly recommend to use the correct acronyms and words based on the product standards.

With regards to the column *"Material"* :

- M2 core steel is referring to the thickness 0.18 mm likely Conventional GO, this material is not yet a standardized grade, it can be named 18S (or 18P if referring to high permeability grade).
- M3 core steel : 23S (or 23P) grades according to the meaning of the table author.
- M4 core steel : 27S (or 27P) grades according to the meaning of the table author
- M6 core steel : likely 35S grades , ie Conventional GO 0.35
- M3 versus M6 : 23S (or 23P) versus 35S
- mechanically scribed core steel: it is more appropriate to use HGO-DR laser scribed.

Secondly the prices mentioned here have been mismatched between HGO and HGO-DR and might be CGO as well. The confusion comes also of the addition of the column MIP !

The Regulation EU 2015/1953 introducing anti-dumping duty must be understood as following, according to the specific total losses Ps, MIP is :

1- Ps =< 0.90W/kg : MIP = 2043 €/t
2- 0.90 W/kg < Ps =< 1.05 W/kg : MIP = 1873 €/t
3- Ps > 1.05 W/kg : MIP = 1536 €/t

Category 1 is referring to HGO-DR 0.23 and HGO-DR 0.27 and partly HGO 0.23

Category 2 is referring to HGO 0.27 and HGO 0.30 and partly HGO-DR 0.27

Category 3 is referring mainly to any CGO grades and partly HGO 0.30

Furthermore what is the data origin of the column "Review study"? Our understanding is that sales prices are closed to MIP for best grades Ps =< 0.90W/kg, whereas for category 2 and 3 prices are below MIP for several months.

R: Thanks, new table is added and prices corrected accordingly

thyssenkrupp

23.03.2017
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Therefore we strongly recommend to improve this table 1-5 to avoid confusion.

Page 21:

Note however that according to our knowledge GOES M2 steel of 0.18mm thickness is currently only available in Japan[8]. In Europe one manufacturer has announced they will be producing this[9] in view of the pending Tier 2 requirements but it is not yet available in their catalogues. For Tier 1 it can be assumed that manufacturers use commonly available M3 (0.23 mm) or M4 (0.27 mm) steel. When introducing Tier 2 (in 2021) a temporary GOES+ surge price could occur again due to production capacity and market competition limits for Tier 2 compliant steel (M2, M3, M3+domain refined). Nevertheless intellectual property (IP) rights should not be a barrier because amorphous steel has already been available for a long time on the market[10] and patents expired[11] while also low loss GOES is long time available[10] and neither any patents apply. .

Comments of tkES:

- The "M2 steel" recognized as 0,18 material is produced by AK Steel in USA not in Japan. This grades corresponds to Conventional GOES for wound cores particularly developed in USA. Therefore the magnetic performance of this Conventional grade is not suitable for the demand of Tier 2.
- tkES has announced the production of HGO 0.18 which is part of our product catalogue and available on demand in limited quantity. Several GOES producers have already started to develop thinner gauge High Permeability HGO 0,20 mm and/or HGO 0,18 mm. For the time being, the material is available on the market in small quantities compared to the thicker nominal thicknesses.

Why?

On the one hand, steel mill manufacturing cost is higher, simply due to a lower productivity at cold rolling mills and in continuous processing lines. Development of thinner gauges will reduce the production capacity and consequently the quantity sold on the market ... if there is no production capacity increase by CAPEX.

On other the hand due to permanent process optimization, the specific total loss Ps is continuously lowered. Particularly observed for the High Permeability grade HGO-DR 0.23, it leads to enough available material to fulfil the demands of the transformer industry and particularly for eco-design transformer requirements.

Beside economic optimization of the transformer industry, the new thin gauges will not be a technical issue for coil slitting, for lamination cutting with regards to distribution transformers. The technical development would take more time for the larger power transformers particularly due to lamination handling difficulties for stacking.

To conclude: according to manufacturing / handling issue the application of thin GO-material with thickness 0,18 mm is not yet in serial transformers, even GO 0,20 mm is a product in the developing phase.

- Additional remark about the text: ... for Tier 2 compliant steel ~~(M2, M3, M3+domain refined)~~ ... is not enough accurate information. Only HGO-DR 0.23 having low loss Ps below 0.80 W/kg at 1.7T is compliant steel besides few other grades according to transformer designs and types.

>R: thanks, text updated

thyssenkrupp

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Page 21:

Utilities report little uptake of amorphous transformers or Tier 2 compliant, or above, transformers thus far, however in industry there is some uptake[12]. The explanation is that industry has sufficiently large technical rooms to house the higher efficiency transformers, pays a higher electricity price for their losses and sometimes has a stronger environmental commitment in comparison to utilities and hence is less sensitive to CAPEX considerations.

Comments of tkES:

This comment is uncompleted with regards to amorphous transformer cores.

Versus GOES, amorphous material is not available in mass production, having limited maximum strip width at 213mm, having a lower stacking factor, led to higher core weight, led to much noisy transformer cores, and having higher price... In addition, there are many other environmental items to be considered:

- very brittle material, causing specific work safety requirements.

- generating dust and particles mixtures with oil, which can lead to dielectric issue and might reduce life the time of the transformer or of auxiliary devices like pumps.

- handling the hazardous waste of amorphous material, and recyclability issue.

>R: noted

Page 36 & 37 :

1.4.2 Examples of Tier 2 compliant products

Most Tier 2 compliant transformers32 on the market are Amorphous Metal Transformers (AMT). As explained in Lot 2 they are larger and heavier due to the limited maximum magnetic flux density (typically 1,2 Tesla). Their no load losses are well below Tier 2 requirements. Due to their typical rectangular core cross section more care must be given to withstand conductor forces during short circuit. Therefore the new standard EN 50588-1:2016 also introduced an additional short-circuit test for new transformers with level of no load loss 'AAA0'. Finally AMT is more expensive due to the amount and cost of material, see section 1.1.3.2. The higher price and the volume can explain the modest uptake on the European market today.

Tier 2 transformers can obviously also be made from Grain Oriented Electrical Steel (GOES) but today few examples of that can be found in manufacturers catalogues. One manufacturer has a GOES distribution transformer in their catalogue[33] with no load losses +5 % and no load losses -5% compared to Tier 2.

tkES agrees with the comments

>R: noted

Page 41 :

1.6.1 Low loss GOES

Using low loss silicon steel is one of the most obvious step to go from Tier 1 to Tier 2 to reduce no load losses, see Lot 2 (2011) for technology and section 1.1.3.2 for price and availability. Using low loss steel will decrease the cooling needs and therefore decrease the volume and weight of cooling system and

thyssenkrupp

23.03.2017
Page 6/6

transformer, e.g. the cooling finns for air cooled systems. Low loss GOES price and availability might be the main barrier. Using low loss steel also allows to increase the maximum magnetic flux density and therefore the size and weight of the transformer. In view of Tier 2 and general interest in energy savings research is ongoing to upgrade GOES production plants worldwide to lower loss grades[36], hence it is reasonable to expect they will become more available at a competitive cost.

tkES agrees with the comments

>R: noted

Page 45 :

1.10 Is Tier 3 an option?

Comments of tkES:

The magnetic performance of GOES for the purpose of energy savings is a never ending story. Over the past decades, the specific total loss of GOES has been reduced thanks to various new technologies and process improvements. One way is to decrease the thickness which reduces the eddy current loss.

Tier 3 makes sense in mid/long term, exact scheduling depending on the requirement A0 - ??%, and according to manufacturing cost / handling issues for serial transformers of thin gauge GOES.

>R: noted and Tier 3 as an option is now included, but it remains difficult to convince Eurelectric of Tier 2 as feasable.

Page 68 & 69:

4- Task 4 on Analysis of other environmental impacts

4.3 Other issues

Stakeholders can bring forward topics and evidence of their significance for issues to consider in the review of Regulation 548/2014 (if any) in the stakeholder meeting on 29/3.

tkES will come up with information on REACH regulation and the requirements for EU Electrical Steel producers to be considered in the stakeholder meeting on 29/3/2017.

>R: done and text in the report updated

with best regards,

Dr.-Ing. Régis Lemaître
Head of Research & Technology
thyssenkrupp Electrical Steel

15. ANNEX O E-DESTRIBUZIONE ITALY

e-distribuzione

E-distribuzione comments on EC Ecodesign review in progress

Introduction

Although e-distribuzione is in favor to increase the transformer efficiency in the European countries for energy saving and CO_2 emissions reducing, it is essential to evidence that some aspects will lead the main stakeholders (small and medium size industries, small generation operators, electrical utilities) in unjustified large investments and increasing of costs for the customers, without reaching the intended benefits.

It has to be underlined that transformers are already very efficient components. The improving in efficiency from the design point of view is not linear and the material cost increases exponentially if the target level of efficiency is too much ambitious. Such items concern particularly the typology of Medium Voltage Transformers usually called "distribution transformers" with reference to T2 values.

Therefore a correct costs/benefits assessment is very important in order to avoid to dissipate an amount of investments that could be used in other initiatives with higher effectiveness in term of CO_2 emission reductions.

Considerations on T2 values

1) The T2 values for Medium Power Transformers were estimated mainly on the base of feasibility studies made by transformers manufacturers without detailed considerations, because of the technologies fast progressing, particularly for magnetic core material. Today it is clear that by using the same available technology, T2 values, in comparison with T1, will require weights increasing around 50 % and consequent dimensions increasing.

>R: noted: discussed in the meeting, not in line with T&D Europe

2) The transformers has not to be evaluated as stand-alone components, but their role in the network and installations dimensioning, planning and operation shall be carefully considered. In case of fault of an existing transformer, it is essential to replace it with a new one in a short time and in the same location, with its dimension constraints, otherwise it will not be possible to keep the present high level of quality of service to the customers.

>R: noted: brown field text is included in the report

3) The recent technology development permits to manufacture distribution transformers mainly with aluminum winding, giving more flexibility to the market, because manufacturers can select the material more available (or more cost effective) on the market (aluminum or copper). The T2 value requires for aluminum windings technologies a large increasing of the transformer dimensions, which would probably lead to a return to the exclusive use of copper.

It has to be considered that the price of copper is historically unstable, while the price of aluminum is quite stable. The global stock of copper is more limited compared to aluminum one, therefore when many transformer manufacturers will increase the copper demand, there will be a risk of lack of raw materials and increase of its cost.
Moreover, the possible exclusive use of copper in place of aluminum would lead to much problem suffered by the users for the risk of copper thefts with consequent related power quality problem and environmental pollution issues (this is recognized to be an important problem in several European countries).

>R: noted, the issue of copper theft is now added in the report

4) The fixed values for maximum losses prescribed for T2 require specific No Load Loss and Load Loss set up for optimization of loading profile (0,3-0,4 pu), larger than the ones usually used for losses evaluation of distribution transformers (0,2 pu).
This can lead to use an unjustified amount of material for conductor (aluminum or copper).
The use of PEI, together with proper KPEI values, would allow optimizing the transformers in accordance to the loading expected in operation (same concept of fixed losses, but with the possibility to use different ratio of load loss and no load loss).

>R: agreed, BC1 is 0,18 PU and the issue is now discussed including options to solve this

5) The very high levels of efficiency would require advanced technologies that could affect small and medium transformer manufacturers presently supplying in several European Countries.

>R: noted, this is a horizontal issue to many products and energy efficiency requirements

6) About financial/economic considerations, in investments evaluations e-distribuzione consider a WACC (Weighted Average Cost of Capital) of 5,4%, higher than the 4% interest rate used in the losses capitalization calculations.

>R: noted, WACC is now discussed in the report including an alternative scenario

In conclusion, the above mentioned items will lead to a considerable increase of costs not only for the electrical utilities, but also for all the HV and MV connected customers, including small and medium industries, that should build or renew their own electrical installations. At the same time the proposed efficiency levels will generally increase the energy costs for all consumers.

Therefore e-distribuzione wishes that all the possible efforts will be done to make the best selection of proper energy performance values.

The two following annexes are attached to show general data constraints and typical examples of installation:

Annex 1 - Transformers general data and constraints

Annex 2 - Examples of typical installations

Annex 1 - Transformers general data and constraints

The main limits and constraints in e-distribuzione, are reported here below

Transformer category[1]	B (M)	B	B	B	B
Rated power[2] of each winding [MVA / MVA / ...]	50 or 100 or 160 KVA (mainly 2 windings transformers with same power each)	160 KVA (mainly 2 windings transformers with same power each)	250 KVA (mainly 2 windings transformers with same power each)	400 KVA (mainly 2 windings transformers with same power each)	630 KVA (mainly 2 windings transformers with same power each)
Frequency [Hz]	50	50	50	50	50
Number of phases	3	3	3	3	3
Type (liquid / dry)	Liquid	Liquid	Liquid	Liquid	Liquid
Rated voltage of each winding [kV / kV / ...]	20 or 15 or 10/042	20 or 15 or 10/042	20 or 15 or 10/042	20 or 15 or 10/042	20 or 15 or 10/042
Highest voltage for equipment of each winding Um [kV / kV / ...]	e.g. 24/1,1	e.g. 24/1,1	e.g. 24/1,1	e.g. 24/1,1	e.g. 24/1,1
Vector Group[3]	Dyn11	Dyn11	Dyn11	Dyn11	Dyn11
Regulation type[4]	DETC	DETC	DETC	DETC	DETC
Type of cooling[5]	ONAN	ONAN	ONAN	ONAN	ONAN
Impedance[6] [%]	4	4 (or 6)	4 (or 6)	4 (or 6)	4 (or 6)
Maximum dimensions[7] (length x width x height) [mm]	1350x750x1600 mm	1350x750X1600 mm	1400x800x1750 mm	1600x1030x1850 mm	1800x1030x1850 mm
Maximum weight [kg]	1200 Kg for existing supports 1400 kg for	2000 Kg for existing installation 3000 kg for new	2000 Kg for existing installation 3000 kg for new	2000 Kg for existing installation 3000 kg for new	2000 Kg for existing installation 3000 kg for new

	crane using	installation	installation	installation	installation
Minimum clearance between live parts and ground [mm]	NR	NR	NR	NR	NR
Minimum free distance required around the transformer [mm]	NR	NR	NR	NR	NR
Please clarify the reason for the constraints[a] and the consequence of exceeding them	To replace transformers in existing installation places with the new ones Note 1,2, 3	To replace transformers in existing installation places with the new ones Note 2 and 3	To replace transformers in existing installation places with the new ones Note 2 and 3	To replace transformers in existing installation places with the new ones Note 2 and 3	To replace transformers in existing installation places with the new ones Note 2 and 3

Note 1:

These typologies are currently used for pole-mounted installations without the derogations given in Regulation. The same criterias shall be verified for the 2021 values.

Note 2:

It is extremely important to manufacture these transformers with aluminum windings to avoid problems related to copper thieves and consequently environmental pollution of the ground and customers interruption of energy. This possibility shall be preserve for all transformer typologies to keep the market open, not exclusive for copper.

Note 3:

Main constraints are due to door dimension, maximum weight acceptable on the floor, support of the pole etc.. It is extremely important to consider the existing installations, particularly in case of transformers fault in operation, because the replacement has to be done in the shortest time to limit the time of supply interruption to the customers.

>R: input is processed in the country overview

Annex 2 - Examples of typical installations

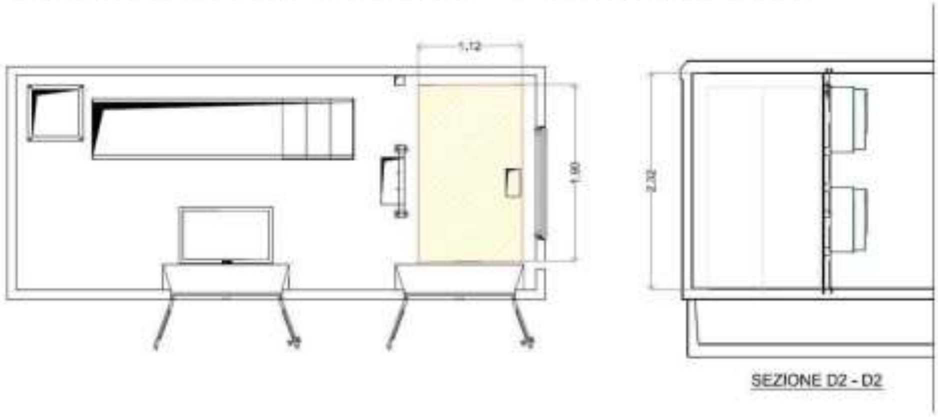
In the following some examples of typical installation sites are reported for existing installations and for the new solutions.

Typical box installation (160÷630 kVA) and pole mounted installation (50÷150 kVA)

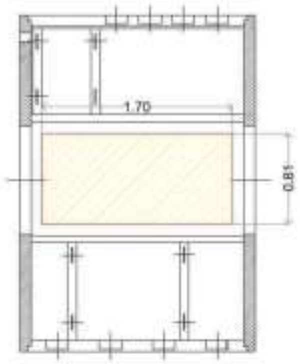
Installation in box handling

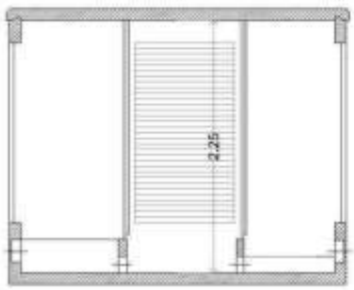
Installation on pole mounted transformers handling

STANDARD BOX DG2061 - TR max 630 kVA

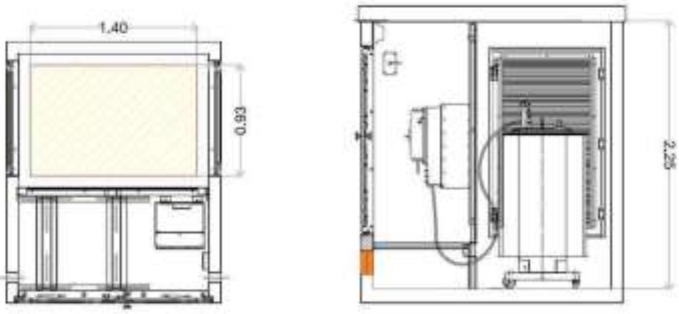


MINIBOX DG2081 - TR max 400 kVA

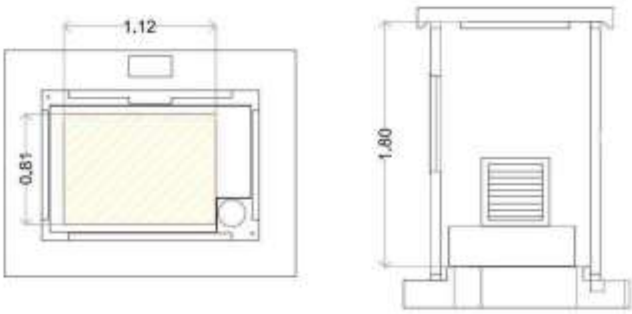




MICROBOX PLUS DG10200 - TR max 250 kVA



MICROBOX DG10197 - TR max 250 kVA



16. ANNEX P NORWAY NVE INPUT

MEMO

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energy people

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Project:	Lot 2 Ecodesign Preparatory Study for small, medium and large power transformers, Stakeholder meeting 29-03-2017
Topic:	Input from Norwegian Water Resources and Energy Directorate (NVE)
Date:	23-03-2017
To:	Paul Van Tichelen, VITO, paul.vantichelen@vito.be
Copy to:	Kirsti Hind Fagerlund, NVE, khf@nve.no Christer Heen Skotland, NVE, chsk@nve.no
From:	Carsten Tonn-Petersen, Viegand Maagøe A/S, ctp@viegandmaagoe.dk

The Norwegian Water Resources and Energy Directorate (NVE) would like as Norwegian stakeholders representatives to forward the following views and comments on the *DRAFT Final Report covering* the *Preparatory Study for the Review of Commission Regulation 548/2014:*

Data Sourcing

We are pleased to see that the study has received and used data provided by NVE and Norwegian stakeholders. Because of a very high degree of electrical heating in houses, heavy industry and long distances compared to other countries in the EU, Norway has high electricity consumption per capita and a large amount of transformers in use. NVE will continue to support the study with data and other input, in order to obtain a regulation that will ensure energy savings that are both practical and economical feasible.

>R: thanks

Space/weight and transportation constraints

We are pleased to see that the topics of space/weight and transportation constraints have been given good focus (1.5-1.7) in the draft report. As stated earlier the rocky and remote geography of Norway presents several problems regarding keeping in compliance with 548-2014 and at the same time maintaining good economical practice. Transportation is expensive in the mountains, and tunnels can be too narrow for larger transformers to pass. In addition to this, very often, due to the solid rock underground, streets and buildings are difficult and expensive to alter to accommodate more efficient and thereby often larger transformers. We therefore support the conclusions in (1.9) and the suggested extension of the scope (3.1.3) to add minimum dimensions and weight characteristics as seen in conjunction with other characteristics, e.g. core loss. The idea of minimum dimensions and weight characteristics that should match transformer manufacturer capabilities could provide a good way of managing exemption. If necessary, NVE will contact Norwegian stakeholders/manufacturers to supply such data.

>R: noted

1 of 3

PEI vs. no-load/full-load losses and possible loopholes (1.3)

Norwegian stakeholders (some) have expressed concerns about using the PEI as only measure of transformer efficiency. We do not support a wider use of this method, and support the conclusions in the draft report (1.3.4-1.3.5). Regarding the final statement in 1.3.5, we prefer that focus is put on adding *ratio of no-load to load losses* instead of *minimum load factor at PEI* as a method to avoid loopholes.

>R: noted. presentation on this is within the meeting, see also other stakeholder positions.

Single phase transformers (Task 2)

Apparently these transformers are not (widely) used in Norway, and we do not see any problems in any of the proposals for Tier 2, as they are stated in Task 2.

>R: noted

Transformers with unusual combinations of winding voltages (3.3)

Stakeholders have expressed having difficulties in determining the efficiencies of the in Norway widely used 3-winding transformers. This is apparently mostly a matter of defining measuring methods. We look forward to CENELECs and T&D Europe's presentations of their proposals on the meeting 29/3, in hope that the Norwegian issues are also covered by this.

>R: noted, see CENELEC document.

Pole mounted transformers

Norway uses many pole mounted transformers (often on double poles) due to rocks in the ground and the difficulty of using cables; hence most distribution is carried on masts and poles. This gives Norway a special interest in how the pole mounted transformers are covered in the regulation, but only for existing installations, since new local safety-regulation only permits transformers placed on the ground.

>R: noted and added to the text.

Other issues (4.3)

Although it is not proposed to consider transformer noise limits, NVE suggests that this is given a second thought. Noise limits are part of other ECO-design regulations, and transformers with higher efficiency and compact design are apparently prone to be noisier (This was discussed at the Kick-off-meeting). Norwegian environmental authorities (Miljødirektoratet) have reported that they only have limited regulatory means to set limits for especially low frequency noise from transformers.

>R: noise and potential Ecodesign regulation is discussed in Task 3

The Norwegian environmental authorities would also like to point to the topic of SF6-gas (an other greenhouse gasses), and the possible use of this gas in transformers with higher efficiency. We find that this is not at present covered by the study.

>R: SF6 gas is discussed in Task 1

At the stakeholder kick-off meeting there was a brief discussion of whether the study should cover the emerging solid-state transformers (SST). Such transformers could very possibly have higher efficiency than traditional types, but at the same time there exist a possibility that other and new

2 of 3

environmental impacts must be regulated. We propose that these issues should be briefly discussed in the study.

R> noted and more is added in Task 1 when discussing Tier 3.

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17. ANNEX Q EU_T&D EUROPE INPUT

Vito Draft final report analysis

- 1.1.1.1Other important transformer material prices
  - Conclusions on High Temperature insulation [Solid and Liquid] shall be reviewed taking also into account the global optimisation of the transformer

R> noted: text updated

- 1.1.1.16Impact of current transformer commodity prices on Tier 2 (Table 1.9)
  - The CAPEX differences given for TIER 1 and TIER 2 Green field are reasonable
  - The CAPEX differences in average for TIER 2 brown field is reasonable too but can be higher for very specific installations

T&D europe

R> noted, but discussed in the meeting and reviewed afterwards

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Green Field conclusions

Base/Boundary	Application	Insulation Technology	Case Power Rating [kVA]	Case Voltage high side [kV]	Tap changer	FEASIBILITY YES	FEASIBILITY NO	FEASIBILITY Voted	RAW MATERIAL Alu	RAW MATERIAL Cu	RAW MATERIAL Both	RAW MATERIAL Total
boundary lower	Distribution	liquid immmersed	250	20...22	DETC	100%	0%	100%	14%	29%	57%	100%
base	Distribution	liquid immmersed	400	20...22	DETC	100%	0%	100%	29%	29%	43%	100%
boundary upper	Distribution	liquid immmersed	1000	20...22	DETC	100%	0%	100%	14%	43%	43%	100%
boundary	Distribution /Industruial	liquid immmersed	3150	20...22	DETC	100%	0%	100%	14%	43%	29%	86%
base	industry transformer	dry type	1250	20	DETC	86%	0%	86%	29%	29%	29%	86%
boundary upper	industry transformer	dry type	3150	20	DETC	86%	0%	86%	29%	29%	29%	86%
boundary lower	industry transformer	dry type	400	20	DETC	86%	0%	86%	29%	29%	29%	86%
base	pole mounted	liquid immersed	100	20...22	DETC	86%	0%	86%	14%	29%	43%	86%
boundary upper	pole mounted	liquid immersed	315	20...22	DETC	71%	14%	86%	29%	14%	29%	71%
boundary lower	pole mounted	liquid immersed	25	25...33	DETC	86%	0%	86%	14%	43%	29%	86%
sample	[illegible]	liquid immersed	50	25...33	DETC	71%	0%	71%	14%	29%	29%	71%
base	medium power	liquid immersed	25 000	33	OLTC	86%	0%	86%	0%	43%	29%	71%
boundary upper	medium power	liquid immersed	31 500	33	OLTC	86%	0%	86%	0%	43%	29%	71%
boundary lower	medium power	liquid immersed	6 300	33	OLTC	86%	0%	86%	0%	43%	29%	71%
base	medium power	dry type	4 000	30	DETC	57%	14%	71%	14%	14%	29%	57%
boundary upper	medium power	dry type	16 000	30	DETC	29%	29%	57%	0%	14%	29%	43%
base	Large Power	liquid immersed	100 000	132	OLTC	71%	0%	71%	0%	43%	29%	71%
base	large Power	dry type	25 000	66	OLTC	29%	29%	57%	0%	14%	29%	43%

- TIER 2 is always reachable

>R: added to the report

T&D europe

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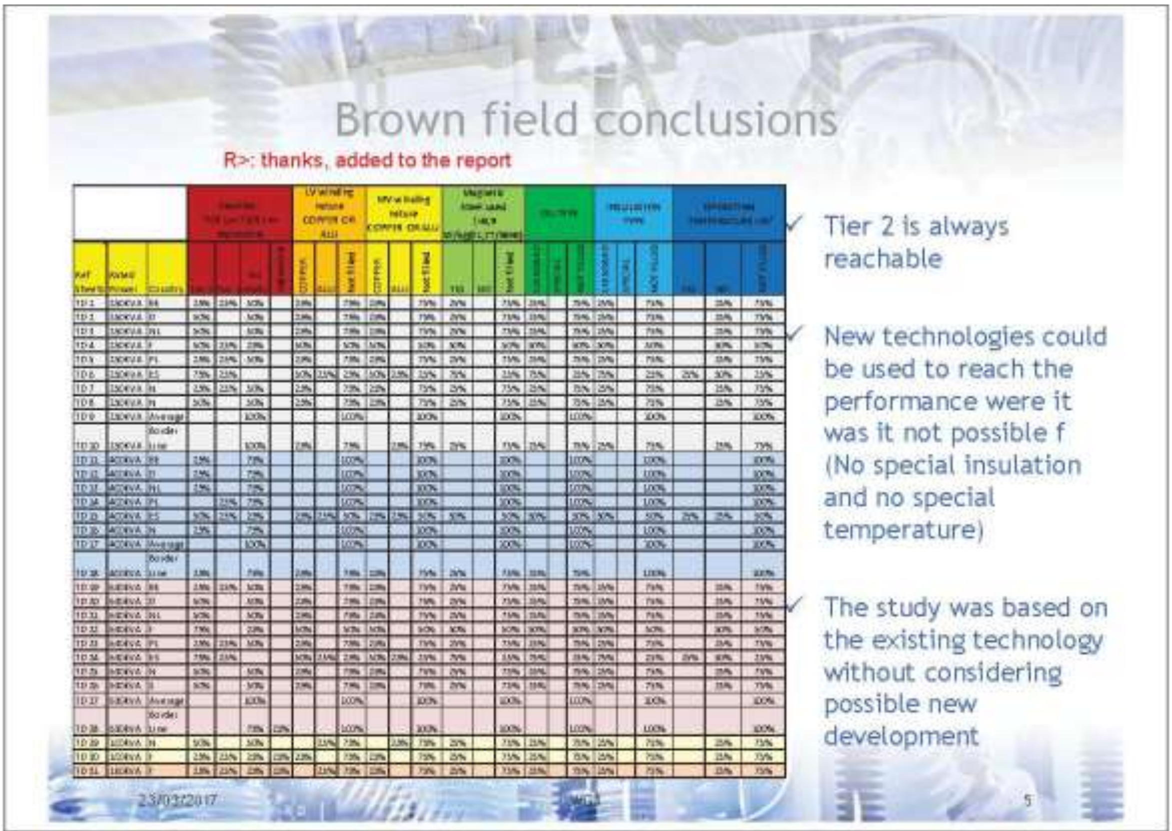
Brown field conclusions
R>: thanks, added to the report
Tier 2 is always reachable
New technologies could be used to reach the performance were it was it not possible f (No special insulation and no special temperature)
The study was based on the existing technology without considering possible new development
23/03/2017
WG3
5


Vito Draft final report analysis
• 1.3.4What is the risk of only specifying PEI requirements?
- Manufacturers are not in favour to use PEI for rated power less or equal to 3,15MVA even with limitation of K Factor for standardisation of components reasons
>R: noted and added to the report
• 1.3.5PEI data for large power transformers
- Manufacturers has not enough data today to limits K factor(>0,25) for Large power transformers(Impact feasibility)
- Limitation of K for PEI could create issues in case of weights and dimensions limitation
>R: noted
T&D Europe
23/03/2017
WG3
6

Vito Draft final report analysis

- 1.8Enquiry from the Belgian grid operators on Tier 2 transformers for brown field applications
  - Belgium is very special case in EU(Double winding)
  - Some other technical solutions can be studied
  - Some concessions should be applied for double windings
- 1.9Conclusion on Tier 2 for space/weight and transportation constraints
  - Before giving new exemptions manufacturers believe that some new technologies can be explored(insulation, temperature)

T&D europe

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Vito Draft final report analysis

- 1.10 Is Tier 3 an option?
  - A study should be done to evaluate
  - The information regarding dry type vs Oil should reviewed.
  - Technology neutral statements are more advisable to avoid preventing development on existing technology

  >R: text and recommendations for Tier 3 review are added to the report.
- 2 Task 2 on Consideration of minimum requirements for single-phase transformers
  - Manufacturers are able to design single phases with reduced no load losses

  >R: noted

T&D europe

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Vito Draft final report analysis
• 3.1.1.1Medium power transformers for brown field applications with space/weight constraints relative to Tier 2
- Tier 2 shall be always the first choice.
- Tier 1 shall be the second choice
- If Tier 2 and Tier 1 are not possible transformers shall be manufactured with magnetic steel having less than 0,77W/kg at 1,5 T and copper
>noted also the support to specific losses for exemptions
T&D europe
23/03/2017
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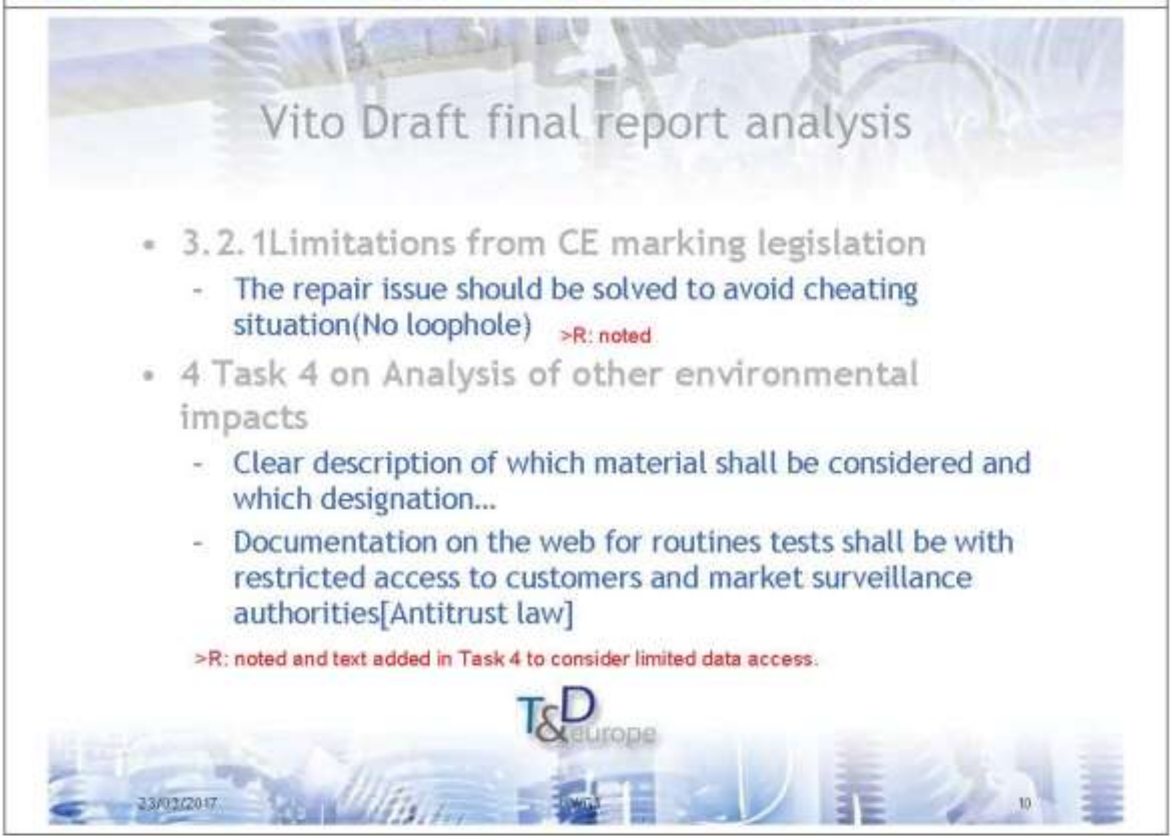
Vito Draft final report analysis
• 3.2.1Limitations from CE marking legislation
- The repair issue should be solved to avoid cheating situation(No loophole)
>R: noted
• 4 Task 4 on Analysis of other environmental impacts
- Clear description of which material shall be considered and which designation...
- Documentation on the web for routines tests shall be with restricted access to customers and market surveillance authorities[Antitrust law]
>R: noted and text added in Task 4 to consider limited data access.
T&D europe
23/03/2017
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Vito Draft final report analysis
5.6Potential amendments to concessions for transformers with unusual combinations of winding voltages
To avoid to kill new technologies manufacturers recommend to keep TIER 1concession also for TIER2 for Voltage regulation distribution transformers
>R: noted and text added
T&D europe
23/03/2017
11


Additional remarks
Subject matter and scope
improvement given in FAQ and by T&D Europe position paper(15/05/2015) and Cenelec shall be merged to clarify most of the exemptions.
Market surveillance
Shall be pushed to allow regulation to be efficient
Efficiency for LPT <4MVA >36kV
Is flat in current time regulation; More appropriate value shall be given
T&D europe
23/03/2017
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18. ANNEX R FOGELBERG INPUT (SWEDEN)

This is a comment or a position to the Stakeholder meeting March 29, 2017 from Fogelberg Consulting AB, Sweden

(I am now fully retired from ABB but has an own Company: Fogelberg Consulting AB)

Energiforsk AB, Sweden ("SE Eurelectric/Entsoe R&D") has just made my Eco Design Report on Transformers for Swedish utilities public, but in Swedish. Abstract is in English. The report is a handbook with recommendations at Project handling for procurement of transformers; to write improved specifications for transformers where Eco Design is the major part.

http://www.energiforsk.se/rapportsok/?q=Fogelberg

Summary of my position:
I support fully the suggested T2 PEI values but they should for LPT be sharper, T2 values for MPT seem to be up to date as my text and cases below will show.
It is not evident that T2 values will give problems with weights and dimensions. Low loss Distribution transformers, MPT, could be designed with higher cores and other winding conductors for a better optimization. All bigger manufacturers' R&D people know that but innovative ideas are locked in by traditional heavy winding investments. E g typical foil windings made in expensive machines are not necessary and are a limit at free optimization.
Most Utilities in EU uses loss evaluations bigger than 8000- 9000 EUR/kW for Po of LPT which give higher PEI values than T2 suggest. There are only some very few rare brown cases where 4 - 100 MVA units will get problems. And there are very few issues above 100 MVA, some very few units in underground. T2 PEI for LPT must be increased as my data below show!
So, the logic to mention dimensions so much is not there. And this must be proved by VITO studies now. All manufacturers can show this. VITO should not be alone in this critical verification phase. VITO cases are too weak.
The Eco Design of ERPs has its own EC process. I suggest that the real world with national governmental Energy Departments giving instructions to national Regulators must somewhere be reflected in the VITO report. I am elaborating this below

R> noted: to be discussed in the workshop. We can only work within the time frame and data supplied.

My view is:
1. VITO and EC should cooperate much tighter with T&D Europe and /or CENELEC who know all facts regarding interrelations between PEI, TCO- parameters and physical sizes. We are now in 2017 and not 2009 when VITO started and the market and all stakeholders were at that time completely unprepared for Eco Design for transformers.
R> noted, we are in tight contact to receive input from T&D Europe (see stakeholder meeting)
2. The Eco Design Process for transformers should from now on integrate EC, Regulators, Utilities and Manufacturers. This is not according to EC Eco Design instructions/directives. But the EC instructions don't mirror the real world when it comes to transformers in a power network with huge capital costs. When we are coming into 2021 we are entering into a new energy time in EU. I state clearly that all serious manufacturers can present data for correct decision in EC. T&D Europe and Regulators must play a much bigger role for this infrastructure product. It deals with the energy challenges in EU 2020 -2040.
R> we are aware of that and in the update the issue with capital cost barrier.
3. I am not satisfied with the review draft report. And my recommendation is a new round with saving values from less needed Power. We talk about an ERP component which in a rather easy way can save both power (MW) and energy (MWh) in an electrical network with more and more renewables. Transformers are a very odd bird in the ERP scheme.
R>noted
4. Now Regulators (ACER) should be invited to all the Stakeholder's meeting. We are not any longer talking about bulbs or washing machines. But an energy system with 220 TWh losses where transformers in a regulated system stand for 100 TWh.

R> noted and CEER was invited to the stakeholder meeting.

Some numbers to prove my bold statements:
I am just to start up a dialogue with the SE Regulator and Svenska Kraftnat (SE Grid) both responsible for the Reserve of Power in the new Swedish Energy Future without nuclear power. We have a 100% parliament decision, Energy commission 2030, for a renewable energy future.
ONLY Wind and Water and Transmission to West, South and East.

My calculation of the Swedish installed Transformer Power is 210.000 MVA. And I have estimated that from 10TWh losses in the network 4 TWh come from Transformers (I know the amount of MVA in each transformer step, e g 50.000 MVA installed distribution transformers). Such transformer population calculations can be done in all countries in one day with the right people! It could be a demand from EC only. (If Sweden have 210.000 MVA we may have very roughly 4 000 000 MVA transformer power installed in EU)

If only 3 % of this population is replaced every year with high efficient transformers I have shown that the extra costs for 20% less losses in more energy efficient transformers is marginal compared to the big benefits in energy and power savings in the future Swedish network and will have a very high impact on the Swedish society/customers. All my numbers are supported by facts around wind production costs and with likelihood for wind and not wind. SE has all statistics.

My calculations show that the best way for a country with only wind and water energy production is first to make all investments in high efficient transformers. Then more Wind. You cannot replace 210.000 transformer MVA overnight. But it is new and not taking into account by the Regulator that the high efficient transformer is a "virtual power and energy supplier"!! (Compared to the old ones)
The power savings in SE may be for high efficient transformers 3 MW per year (20% less losses than old replaced ones) under above assumptions. 3MW loss savings is about the same as the installed 9 MW rated power for a windfarm = 12.5 MEUR value. This is not in VITO's report!! The VITO review report follows a traditional way in the Eco Design process. As the VITO report is only working with energy prices, 0.08 EUR/kWh. I state that one must add another 0.04 EUR/kWh from the Power gain in the new renewable energy situation in Europe. I have now the privilege to bring it up in a new Energy situation in EU. High efficient transformers will play an important role if the laws, instructions and compensation incentives by the Regulators are changed.

R> note that the report already included a CAPEX comparison with RES but the new report will add updated reference electricity prices from the European reference scenario that includes all this (i.e. PRIMES2040+-

High efficient transformers have a much higher value than the Eurelectric/Entsoe experts are used to. Since high efficient transformers are virtual generators, less energy, less power.

I regret the stiff attitude in EC not to support more economics with TCO. But I understand your frame to work within.

I am sure that the only way to build a sustainable EU network is to bring in all Regulators to make similar and correct incentives schemes for all utilities.
The utilities must get compensation to install high efficient transformers. And these moneys are within the society as I have shown. You don't need to build so much Wind power!!! The electrical network market itself cannot regulate this. We need an EC or a Government body to understand and write the correct law-instructions.
I will bring up, as a suggestion to the Swedish Regulator, to promote a PEI like parameter in the norm-value- cost- list for 12- 15 types of transformers with the actual costs for those high efficient transformers to calculate the capital base (CAPEX base) to set the tariffs/income for the utilities.
My view is that this is the true and best way to create a key-parameter for the Regulator. The PEI concept may have a greater value for all 27 EU countries than only a loss limit parameter to control procurement.

Today the Regulator has some standard CAPEX costs in their product lists to calculate the income frame and later approve the utility's capital base (CAPEX). When one utility, with need for quick profits (there are now utility owners with high profit demands), then later shall buy a new transformer his purchaser tries to buy as cheap as possible, e g only with the lowest PEI. And the utility capital costs will be lower in the Profit and Balance sheet. And they get the high income every year from the approved tariffs. Because the yearly profit comes from too high tariffs (income) and cheap purchase which gives lower depreciations. Losses have not been given any value from the Regulator.

I would recommend that VITO takes into account the pitfalls the Eco Design Regulation may lead to if the T2 (MEPS) values be too low for LPT in a situation where the Regulator doesn't have any incentives for lower losses. We have seen that many utilities have used the TCO concept where a low or "Standard loss evaluation" is used only as a "calibration" to compare different offers where the value of loss capitalization have been the same for all manufacturers. In a case of a wrongly set T2 (MEPS) for LPT, utilities may use this new "comparison value" in their competitor evaluations. An extra condition of load factor will not change this unwished situation. The risk is huge that the expectation of lower CO2 values will fail. I said it several times to Cesar Santos when we met 2012-2014 but it was ignored. The pros and cons with PEI is not only a question of dimensions or heavy weights. It is a much more complex issue if the Regulation laws behind allow for wrong decisions. Sorry to need bring up issues from the real world.
This time the law context must bring in the responsibility by the Regulator to set up correct incentives to bring in high efficient transformers into the market. Otherwise with weak PEI we will get the contrary. I request that PEI and Regulator laws (ACER) must now be hold together from T2 and onwards. If the VITO report not includes and reviews this weakness I see this as a serious mistake.
I am free and cannot be recognized as a real stakeholder but an expert to request that this issue must be included in the VITO's Revision draft report. And then in another chapter which is not the Standard of Eco Design revisions blueprint. If not, this revision report is not handling the realities in the real world in EU today.

R> noted but for implementing TCO we are limited by the current possibilities of the Ecodesiign regulation, but nothing stops utilities and local authorities to go beyond that and apply ambitious TCO approaches

I understand EC in the Eco design context for transformers that you must follow the stated road.

But very soon some of you must try to set another playground with Governments and Regulators as I can show the huge benefits with high efficient transformers with:

0.07 EUR/ kWh (this is about the true production cost of renewable energy today in SE), taxpayer takes the depts over another channel)
4.5 % discount rates as utilities often are private and need "decent" rents on their capital, (most national economics support 3 - 4 % is enough for utilities, it is a mistake to show 2% for creditability issues)
40 years of service

R> see previous. The report is updated with more scenarios illustrating the issues, but remain limited by the current scope of the Ecodesign Regulation.

3 MW less power in the SE network per year is worth as much as 9 MW new installed Wind power or other renewables.
These 3 MW less losses may cost 6 -10 MEUR in extra material in transformers but save 26 MEUR in energy losses and 13 MEUR in power losses.
Such calculations can be done in each EU country to trigger new Regulation schemes.

Today SE has about 6000 MW wind power installed and at high peak load with small winds the authorities count on 11% from this 6000MW= about 600 MW. If SE Regulator give such strong incentives to replace 6% of all transformers per year, 6 MW gain, it will take 2034 to cover up for 600 MW.
This new thinking from my side needs now to be confirmed.

You (VITO and EC) are doing the right things according to your instructions and current responsibilities but should take up another route with governments/(Energy departments) and national Regulators. We have time to 2021 to make the right things in a comprehensive Review report.

I know there are laws guiding and managing EC but there is a future out there which needs innovative and correct ideas also from inside EC.
You need to be a "driver" from inside also. And I offer you an innovative support here.
You hardly find these innovative ideas in the stakeholder meetings.
Pls give me the mail address to the leading person in CLASP who I can talk to. I guess CLASP is a part who will participate in this type of new discussion. Because it is valid through the whole world.

All my numbers above are estimates and are not confirmed and I cannot hold responsible if some mistakes are there

R>coordinates of CLASP are available on the website and public sources

I am very interested to get your feedback as soon as possible

Best Regards

Thomas Fogelberg

Fogelberg Consulting AB , Independent, Sweden

19. ANNEX T ARMAZABAL INPUT

GUILLERMO AMANN COMMENTS FOR VITO MEETING ON MARCH 29, 2017

- **Referring to Point 1.1.3.2:** Amorphous core technology is never going to be a solution in terms of weight or volume. The reason is the fragility of any amorphous core that forces to build a very robust structure to support the coils in order them to withstand the short circuit current.
  If only one European manufacturer has expressed its intention to produce GOES M2 steel of 0.18 mm, and the quantities they will be able to produce are not clear yet, this doesn´t justify that TIER2 will be feasible in terms of magnetic steel.
  The reduction in losses between M2 and M3 will be much lower than the reduction obtained between M3 and M4 or M4 and M5. This is something known and accepted by GOES manufacturers, and will make the achievements of TIER 2 losses much more complicated for transformers manufacturers.

>R: Noted and issues discussed in the meeting

- **Referring to Point 1.1.1.1:** Trademarks, such as ABB, SLIM, ENVIROTEMP or MIDDLE, are not acceptable to be shown in the study.

> R: Noted but we do not want to hide the sources of this public information

- **Point 1.3.4 and 1.3.5, to be included as a comment at the beginning of page 46 of the document**: PEI and kPEI criterion should be applied from Tier 2 on. Many loopholes can be avoided using this.

>R: noted, thanks for supporting this proposal.

- **To be included as an exception on page 45 of the document:** For power transformers less than 4 MVA but with voltages higher than 36 kV, as PEI criterion must be applied instead of distribution losses, drives to disproportionately large dimensions for those transformers. For example, a 33/11kV, 3150KVA transformer is considered a medium power transformer and applies a loss table, while a 45kv and 50KVA transformer (i.e. for auxiliary services in a substation) is considered LPT and applies PEI. That is not logic and an exception should be considered.

>R: issue added to the report.

- Following the same rationale, it does not make sense that the PEI value for a transformer smaller than 4 MVA at a voltage value higher than 36 kV has more restrictive loss demands than a same size transformer with a voltage lower than 36 kV. What we propose is a losses table similar to the ones in Tier 1 for transformers with a size smaller than 4 MVA in voltages up to 72.5 kV, that will avoid the exceptions to be huge and uncontrollable and also will avoid loopholes. In another case we propose an adapted PEI table including several steps assigning PEI levels to determinate powers from 50 to 4000 kVA.

>R: issue added to the report.

- **Referred to Point 1.10:** We do not agree what is argued on page 63 to allow the second-hand market. We defend T&D Europe position as quoted in the last paragraph of mentioned page 63. It is also stated in section 3.2.2 on page 64.
  R>noted

- **Generally speaking, dry transformers** should meet the same loss requirements as oil ones. The origin of this misleading criteria, comes from the consideration in the standard that same denominations express different level of losses for dry transformers than for oil ones. For TIER 2 the dry ones should reduce the same percentage of losses with respect to TIER 1. It cannot be privileged a dirty technology in terms of losses, and therefore efficiency. There should be a specific paragraph within section 3 to eliminate this exception for Tier 2.
  R> thanks for the support but the issue is proposed to be shifted to Tier 3
- **Regarding point 3.3 about the concessions for dual ratio Transformers**, we know that some transformer manufacturers are using that concession to take advantage of the margin in losses (10-15%) and sell dual ratio transformers at a cheaper price than single ratio ones, even if only a single ratio is required. This is a trick to sell a tricky Eco-design transformer to customers who does not care about the losses but only the price.
  R> thanks for informing us, the issue is added to the report
- **For point 3.4.1 on page 65**, we agree not to keep exceptions for pole mounted transformers.
  R> noted
- **Referred to point 2:** Single phase transformers is a group so reduced in terms of number of units and installed power, that it seems not to be interesting to reduce very much the losses. The level of TIER1 could be enough.

- In that sense, single phase transformers don't imply an extra complication in terms of raw materials and manufacturing limitations so that they can be produced with reduced losses easily.
  R>noted

20. ANNEX 10 CG GLOBAL INPUT

Van Tichelen Paul

From:	Bram Cloet <bram.cloet@cgglobal.com>
Sent:	donderdag 23 maart 2017 13:36
To:	Van Tichelen Paul
Subject:	RE: Announcement of 'Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for small, medium and large power transformers ': Draft report available for discussion in the stakeholder meeting

Dear Paul,

I'm emailing you with some remarks on the report. It may be useful in order to prepare for the meeting of next week. The important remarks are in bold, the other are more editorial.

- Page numbers are missing
- After paragraph 1.1.3.2 the numbering restarts at 1.1.1.1, should be 1.1.3.3 I guess
- **Table 1-10: The CAPEX of "BC 1 DT liquid Tier2" is 0€ in the cases where the discount rate is 0.74%. This affects the results of "LCC total".**
- Paragraph 1.6.1: In a lot of cases there are also sound limitations imposed, which make it not possible to increase the induction to reduce the size. So **using low loss GOES does not always lead to smaller cores.**

>R: corrected and sound issue added to the text

See you next week.
Kind regards,
Bram

ir. Bram CLOET
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Smart solutions. Strong relationships. Save the environment. Please print only if essential.

From: Transformers [mailto:transformers@vito.be]
Sent: dinsdag 7 maart 2017 17:44
To: Van Tichelen Paul <paul.vantichelen@vito.be>
Cc: paul@waide.co.uk; Cesar.SANTOS@ec.europa.eu
Subject: Announcement of 'Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for small, medium and large power transformers ': Draft report available for discussion in the stakeholder meeting

Dear Sir or Madam,

We are contacting you with regard to a preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for transformers (https://transformers.vito.be/) to inform you that a draft report is available for commenting and discussion in the stakeholder meeting.
It can be accessed by this link: https://transformers.vito.be/sites/transformers.vito.be/files/attachments/ec_dg_growth_lot2_Transformer_V23.pdf

In order to enable to discuss the comments and input in the upcoming stakeholder meeting on 29th March please sent them before 24th March.
Of course, also written comments of those who are not able to participate in the stakeholder meeting are welcome.

1

Note: for the upcoming stakeholder meeting CENELEC/TC 14, T&D Europe and Eurelectric (Synergrid) will be contacted to present findings but others are also welcome to contact us.

Kind regards on behalf of the study team,

Paul Van Tichelen

2

21. ANNEX 11 EURELECTRIC COMMENT ON DRAFT

Eurelectric Commentary on VITO DRAFT Final Report on EcoDesign Tier 2

Commentary on VITO DRAFT Final Report on:

Preparatory Study for the Review of The Commission Regulation 548/2014 on EcoDesign Requirements for Small , Medium and Large Power Transformers

Anthony Walsh BE, MIE, MBA, ACCA, F.IEI

Chair, Sub-Group – Distribution Network Assets, WG Standardisation

Eurelectric

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Eurelectric Commentary on VITO DRAFT Final Report on EcoDesign Tier 2

Introduction:

This commentary is on factual details in the calculations included in the Draft Report, and should also be read in conjunction with the Eurelectric Response paper 'Consultation on Tier 2 Fixed Loss Levels on Distribution and Power Transformers implementation' March 2017.

R>noted

We have been reading your report.

Note herein:

1) we understand the concept of your comment but during noted that in the version supplied to us there was still a calculation error when we compared it to our calculations. The conceptual error in Table 1 where calculating the relative value of copper losses comparing Tier 1 tot Tier 2 because '$Bxk^2x(Pk1^2-Pk2^2) <> Bxk^2x(Pk1-Pk2)^2$'. This leads to an underestimate of the added value of Tier 2.
2) We welcome the idea of TLF =0,4, it will be taken into account in the updated text.
3) In general we have added a cost scenario in line with your proposal in the review for discussion.

Section 1.1 – 1.3:

This section carries out a Life Cycle costing to establish whether the savings in energy produced by the higher efficiency transformers actually covers their increased costs.

It does so by :

a) establishing the energy savings in kWh per annum and then capitalises these savings using a REAL 2% interest rate and a price of electricity between €0.0847 and €0.15/kWh.
b) Subtracting the NPV of the scrap value of the Copper in the transformer at end of life.
c) Applying an escalation rate to the cost of electricity in Table 1.10 of between 0 and 8% pa

Unfortunately there are very significant discrepancies between what is set out in the EU Impact assessment rules / MeeErp and what has actually been done in this Vito Draft , and these discrepancies are very material and significantly change the results of the calculations provided.

a) 'establishing the energy savings in kWh per annum and then capitalises these savings using a REAL 2% interest rate and a price of electricity between €0.0847 and €0.15/kWh.'

The EU's own Smart Regulation Guidelines[1] clearly indicate that a **<u>REAL</u>** Discount Rate of 4% is to be used in any investment analysis. If Inflation is to be incorporated in the analysis it is **ADDED** to the REAL rate to obtain the **NOMINAL** Discount Rate.

[1] http://ec.europa.eu/smart-regulation/guidelines/tool_54_en.htm and Appendix 1

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Eurelectric Commentary on VITO DRAFT Final Report on EcoDesign Tier 2

'The social discount rate is the rate most used in Impact Assessments, as these normally consider costs and benefits together from the point of view of society as a whole (rather than from the point of view of a single stakeholder group). The recommended social discount rate is 4%. This 4% rate is in real terms and is applied to costs and benefits expressed in constant prices. It can be easily adjusted for inflation: if instead you are dealing with nominal prices, and inflation is, say, 3% per annum then a 7 % nominal social discount rate (4% rate plus 3% to account for inflation) would be used.' – **Tool 54 of EU Smart Regulation Guidelines**

However in the analysis VITO have taken the 4% REAL Social Discount Rate and **SUBTRACTED 2%** Inflation to arrive at a Discount Rate of 2% which is then applied in the analysis.

This is completely incorrect and more than doubles the value of the losses saved, which is a very serious miscalculation and materially alters the results of the report.

As can be seen from the extract from the EU's own guidelines it is clearly stated that if calculations are to be done using nominal values then **inflation (2%) is ADDED to the REAL Social Discount Rate (4%)** to obtain a NOMINAL Social Discount Rate.

Note:

(a) In the earlier VITO report of January 2011, the correct 4% rate is used and it is correctly defined on p131 (Jan 2011 report)

'2.4.5 Interest and inflation rate

The services of the European Commission proposed to use a 4 % discount rate (interest minus inflation).'

It would appear there was confusion between nominal and Real rates – the Nominal Rate should have inflation subtracted to arrive at the Real 4% Discount Rate. In the current report Nominal Rates and Real rates have been confused, hence the error.

(b) In addition, in the EU Impact Assessment Report by Prof. Almeira the full real rate of 4% was used to capitalise losses.

(c) There is a possible lack of understanding of how discount rates are chosen as evidenced by statement on p26 of the Draft report that a *'0.74% interest rate is more realistic.'* The EU Social Discount Rate was chosen at 4% as it corresponded to the average real yield in longer term government debt in the EU over a long period. Using a standard rate for all EU EcoDesign decisions also means that EcoDesign Investments are all comparable – EcoDesign investments which yield less values for customers are not progressed and the EU citizens' money is spent instead on those investments which yield 4% or more. It is not possible to simply choose a lower discount rate for one EcoDesign appraisals than another – else decision making would be inconsistent.

Accordingly the Discount Rate used in this DRAFT report is inconsistent with the EU's own Guidelines and with both the original version of the report and the associated Impact Assessment Report, and the NPV calculations should be redone using the correct 4% REAL rate.

>R: discussed in the meeting, and alternative cost scenario is added that reflects your view and more guidance is given to the other cost scenarios and their rationale

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Eurelectric Commentary on VITO DRAFT Final Report on EcoDesign Tier 2

b) Subtracting the NPV of the scrap value of the Copper in the transformer at end of life.

The treatment of the residual value of the Transformer copper is fundamentally incorrect in a number of ways.

Firstly there is an assumption that there are no costs associated with the extra investment in copper as most of it's value is expected to be recovered at the end to life of the transformer i.e. (p25) €2,810 is spent initially on copper but €2,150 is recovered at the end of life. i.e. *p23 'Hence, investing in a copper based transformer might be more economic from a life cycle cost (LCC) perspective when it's EOL value is taken into account.*

The reality in fact is the exact opposite.

The Copper - Copper transformers is being used to ensure that the transformer dimensions are suitable for brownfield sites – it's losses are the SAME as those of an Aluminium transformer, so there are no extra savings made, just extra initial costs.

The extra €2,810 in cost incurred initially because Copper is used must be funded, and this funding cost accrues each year and must be paid for – effectively it is the financing costs of the interest on the money tied up until the copper is recovered (-this finance cost would normally be included in the company WACC Discount rate and would not have to be specifically included in the cash flows of a normal company investment, but is included when a Social Discount Rate is involved).

So, because a REAL Social Discount Rate is being used here (which excludes the cost of finance) the cost of funding this investment must then be included in the cash flows and discounted to an NPV Cost. If the opportunity cost of this money is say 1% per annum then this amount must be charged each year as an extra cost. i.e. 1% x €2,810 = €28 pa or an NPV at an Annuity Factor (4%, 40 Years) i.e. 19.78 X €28 = €554 extra cost.

Secondly, not all the initial value of the copper is recovered - Scrap copper is €4.2/kg vs €5.49 new, so the recovery value at end of life is €2,150, a decrease of €660.

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		Original Table 1-9 (p25)			REVISED Table 1-9 (p25)		
		BC1 DT liquid Tier 1	BC1 DT Tier 2	BC1 DT Brown F	BC1 DT liquid Tier 1	BC1 DT Tier 2	BC1 DT Brown F
Electricty Cost	€/kWh	0.0847	0.0847	0.0847	0.0847	0.0847	0.0847
Transformer Rating (S)	kVA	400	400	400	400	400	400
No Load Class		A0	A0-10%	A0-10%	A0	A0-10%	A0-10%
Load Class		Ck	Ak	Ak	Ck	Ak	Ak
Capex - Transformer	€	7,824	8,978	10,403	7,824	8,978	10,403
Losses per year	kWh/yr	5,056	4,301	4,301	5,056	4,301	4,301
discount rate	%	2%	2%	2%	4%	4%	4%
LCC electricity (capitalised)	€/life	11,714	9,965	9,965	8,475	7,210	7,210
LCC Electricty LCC total (excl.Scrap @EOL)	€	19,538	18,943	20,368	16,299	16,188	17,613
Scrap Value at EOL	€/life	236	206	2,150	236	206	2150
NPV Scrap Value (incl Discount Rate)	€	107	93	974	-49	-43	-448
LCC Total (inc Scrap at NPV)	€	19,431	18,850	19,395	16,250	16,145	17,166
Plus Finance Cost	€						556.25
LCC Total Inc Scrap plus Finance Cost	€				16,250	16,145	17,721.83
Capex Increase Tier 1/Tier 2			115%	133%		115%	133%

Fig 1 From Table 1-9

From the above it can be seen that in the original Table 1-9 the Brownfield version has the same losses as the Tier 2 Greenfield unit along with extra costs of about €1,425 due to the use of copper, yet it still appears to be better value than Tier 1 by €36.

However when using 4% interest rate instead of 2% and correctly **subtracting** the residual value of the transformer, it is seen that the Brownfield version costs 33% more than Tier 1 version and has no extra savings.

The Greenfield Tier 2 version costs 15% more initially but saves €105 over the Tier 1 version – a very small saving which is dependent on the correct pricing of the transformer and of the electricity saved.

Thirdly, when disposing of a transformer it must be treated as Hazardous Waste due to possible contaminants in the oil, and also because it requires to be disposed of in an environmentally friendly way. This is a costly process, with the costs associated with the amount of material involved

So in moving from Tier 1 to Tier 2 the weight/volume also increases leading to a proportionate cost increase in disposal which has **NOT** been taken into account in the above evaluation, but will be significant in relation to the small savings involved.

>R: the approach on scrap value has been reviewed in the final report

c) Applying an escalation rate is also applied to electricity in Table 1.10 of between 0 and 8%.

The escalation rate used is applied incorrectly, but is also not sufficiently justified.

If discounting a cost derived from electricity using a REAL interest Rate, and if the ESCALATION Rate applied to Electricity is also a REAL Rate (i.e. a rate above inflation) then it effectively subtracts directly from the discount rate e.g. 4% Real Rate with Real Escalation Rate of 2% on Cash Flows, then the net REAL Discount Rate is now 2% . (Actually $(1/(r-g))(1-((1+g)/(1+r)^n)$)

This has a very significant impact as it Doubles any savings made and can hence distort the results significantly.

So the two questions to be addressed are as follows:

(a) Is the escalation rate applied a Nominal or A REAL Rate?
(b) How is the particular value of escalation rate chosen and justified?

As these issues are critical to the analysis it would be expected that they would be covered in depth in the report – but this is not the case.

Coupling the use of an Escalation factor with a very low discount rate leads to absurdly high capitalisation factors e.g. 4% Electricity Growth rate and 0.74% Real Interest rate gives a capitalization factor of 82, and using 8% gives 225 – this compared to the figure of 27 which 2% yields – nearly 10 times higher!

With these sorts of capitalization rates anything would appear justified.

The justification for the escalation rate is one single report suggesting that for Belgium in the period between 2020 and 2030 electricity prices could rise by a factor of 2 – 3 , giving an escalation rate of 8% per annum.

However in the application the 8% was applied for 40 years along with a Real discount rate of 0.74% for the same 40 years. This is just not possible!

In fact leaving aside that this is just one report for one country, it was about the Price of electricity – of which only 30% is fuel related – the rest are capital costs, of plant , network and taxes.

The EU itself has done a report which shows that Price increase of electricity within the EU are due to non-fuel costs such as taxes, DUoS, TUOS, Levies etc, all of which are irrelevant to justifying Transformer Efficiency, as transformer efficiency only impacts on fuel/energy usage. The EU report on trends in energy prices notes that the reason for rises in electricity prices are NOT due to increases in energy costs (which could be reduced from greater transformer efficiency) but instead to increased Network costs and Taxes.

In other words it is incorrect to apply an escalation factor of 2% pa to the energy component of electricity prices.

(COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Energy prices and costs in Europe 2014 /* COM/2014/021 final */)

Finally, EU Electricity prices are quoted in nominal terms so any escalation inferred from their growth needs to be converted to real terms by removing inflation.

So this section of the report should be corrected because it is misleading, unjustified and incorrect.

>R: this section on the report has been updated and other more realistic electricity cost scenarios are added

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P 27 Section 1.1.8 Capex requirements for kWh production from EcoDesign vs RES

In this section the MARGINAL costs of Tier 2 have been compared with the AVERAGE costs of PV And Wind Power to show that using Tier 2 is more cost effective.

It is only possible to compare like with like – i.e. the MARGINAL COSTS of Tier 2 with the MARGINAL

		BC1 DT Liquid Tier 1	BC1 DT Liquid Tier 2	BC2 Ind Liquid Tier 1	BC2 Ind Liquid Tier 2	BC2 Ind Liquid Tier 1	BC2 Ind Liquid Tier 2
Transformer Rating (Sr)	kVA	400	400	1,000	1,000	1,000	1,000
No Load Losses (P0)	W	430	387	770	693	770	693
No Load Class		A0	A0-10%	A0	A0-10%	A0	A0-10%
Load Losses (Pk)	W	4,600	3,250	10,500	7,600	10,500	7,600
Load Class		Ck	Ak	Ck	Ak	Ck	Ak
Auxiliary Losses (Paux)	W	0	0	0	0	0	0
PEI		99.297%	99.439%	99.431%	99.541%	99.431%	99.541%
Load Factor (k) (=Pavg/S)	ratio	0.15	0.15	0.3	0.3	0.3	0.3
Load form factor (Kf) (=Prms/Pavg)	ratio	1.073	1.073	1.096	1.096	1.096	1.096
Availability factor (AF)		1	1	1	1	1	1
Power Factor (PF)		0.9	0.9	0.9	0.9	0.9	0.9
Equivalent Load Factor		0.18	0.18	0.37	0.37	0.29	0.29
Load factor@PEI (kPEI)		0.306	0.343	0.271	0.302	0.271	0.302
No Load and aux Losses per year (kWh)	kWh/y	3,766.8	3,390.1	6,745.2	6,070.7	6,745.2	6,070.7
Load Losses per Transformer per year	kWh/y	1,288.7	910.5	12,276.4	8,885.8	7,735.5	5,599.0
Losses Per year	kWh/y	5,055.5	4,300.6	19,021.6	14,956.5	14,480.7	11,668.7
Transformer Life time	yr	40	40	25	25	25	25
Interest Rate	%	4%	4%	4%	4%	4%	4%
Inflation Rate	%	0%	0%	0%	0%	0%	0%
kWh Price No Load an d Aux Losses	€	0.0847	0.0847	0.0847	0.0847	0.0847	0.0847
kWh price Load losses	€	0.0847	0.0847	0.0847	0.0847	0.0847	0.0847
Capex Transformer	€	7,824	8,977	13,567	17,277	13,567	17,277
Losses per year	kWh/yr	5,055.5	4,300.6	19,021.6	14,956.5	14,480.7	11,668.7
Discount Rate	%	4%	4%	4%	4%	4%	4%
Electricity Escalation Rate	%	0%	0%	0%	0%	0%	0%
PWF		19.79	19.79	15.62	15.62	15.62	15.62
No Load Loss Capitalization Factor (A)	€/W	14.69	14.69	11.59	11.59	11.59	11.59
Load Loss Capitalizatrion Factor (B)	€/kW	0.47	0.47	1.55	1.55	0.97	0.97
TCO A/B	ratio	31.27	31.27	7.49	7.49	11.89	11.89
Opex Electricty	€/yr	428	364	1,611	1,267	1,227	988
LCC Electricty	€/life	8,475	7,210	25,169	19,790	19,162	15,441
LCC Total (excl. Scrap@EOL)	€/life	16,299	16,187	38,736	37,067	32,728	32,718
Load Factor			18%		37%		29%
Extra cost of Tier 2 Trafo			1,153		3,710		3,710
Extra savings from Tier 2 Trafo			1,266		5,379		3,719
Net Savings			113		1,669		9

Revised Table 1-1

COST of PV or Wind.

But the MARGINAL Costs of PV are then very small – simply use a more efficient panel or add an additional panel on an existing system.

If such a comparison is to be done it should be done correctly.

Revised Table of Saving for Tier 2:

Fig 2 Revision of Table 1-1

In Fig 2 the Table in 1-1 is revised for the 400kVA and 1000kVA units commonly used by utilities.

An interest rate of 4% is applied.

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The price of electricity used for the 400kVA unit is € 0.0847/kWh and €0.1291/kWh for the 1000kVA unit.

This is not correct as the cost of electricity for both these transformers will be the same as the networks feeding them are identical. The reason for this discrepancy arises from ANNEX 3 of the Impact Assessment report where the 2020 price for Domestic Customers of €0.1412/kWh had DUOS of 40% deducted in an attempt to arrive at the cost of the energy contained, thus arriving at €0.0871/kWh.

Industrial Customers were then taken as having costs of €0.1291/kWh but the deduction of DUOS was forgotten. In addition the Industrial customer referred to were ones having consumption of over 500MWh per annum, which is many times the consumption of a 1000kVA transform. Most 1000 kVA transformers are used by utilities to feed mixes of small scale Domestic/Commercial loads in City Centres – larger Industrial customers (>1MVA) would use their own transformers which would be larger in size than 1000kVA.

Accordingly the kWh price for the 1000kVA unit has been corrected to €0.087/kWh

From Tier 2 the Table assumes that the following transformer cost apply:

	Tier 1	**Tier 2**	**Value of Extra losses saved**
400kVA	7,824	8,977	€113
1000kVA	13,567	17,277	€1,699 @37%LF; €9 @29% LF

The costs difference between Tier 1 and Tier 2 is 15% for the 40kVA and 27% for the 1000kVA unit.

Looking closely at the report it appears that these figures are actually just estimates from VITO and that Prices for such units were not received from Manufacturers.

However Laborelec did receive ACTUAL PRICES from Manufacturers and these showed price increases between 30% and 120%, which would make Tier 2 unaffordable.

In addition the savings are strongly dependent on the Load Factor which occurs.

>R: cost scenarios are updated. Please note that if the absolute price is lower the price increase in % can be relatively higher (e.g. due to the importance of material content) . Hence, a relative price in % does say little or nothing if the absolute price is unknown.

P33 PEI versus Absolute values of Losses:

The point is clearly made that transformers maximum efficiency is at the load factor for which it is designed. The fact that by using PEI values the associated kW losses could be different from Tier 2 is irrelevant as long as the PEI Values maximise efficiency at the load factor e.g. using Tier 2 the Load Factor at which maximum efficiency might occur at 31% Load Factor.

However if the actual Load Factor is 37% or 20% the Tier 2 loss ratios used are inappropriate and result in higher losses of kWh than should be the case.

The fact that the loss levels are different from the absolute levels set in Tier 1 or Tier 2 is irrelevant.

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>R: this issue is now more elaborated in the report and a proposal added.

P34 1.3.3 Benefit of PEI:

The lowest Life Cycle costs using PEI **are achieved** when the Capitalization values of Iron and Copper Losses are provided with PEI value.

The statement that *'PEI does not warrant the Lowest Life cycle cost'* is only correct when PEI is given with a Load Factor, not when PEI is associated with Iron and Copper Loss Capitalization values which not only indicate a Load Factor but **also** indicate the economic benefit of approaching it.

The ratio of the iron to Copper Losses indicates the ideal Load Factor for which the Transformer should be designed to give the maximum economic value of losses reduction, but the fact that the manufacturer has been given the separate capitalization values for both Iron and Copper Losses means that the manufacturer can optimised the transformer design to get close to this load factor whilst simultaneously minimising the cost of losses.

Using different prices of Load and No Load losses does not affect this optimisations and there are no issues in optimising efficiency.

>R: noted but not agreed the economic optimum is not necessarily the lowest energy consumption (otherwise the transformer price was irrelevant?)

P34 Use of PEI on Smaller Transformers:

Not allowing the use of PEI on small transformers but instead requiring use of absolute kW loss levels **will result in less efficient transformers** because they will not be matched to the Load Factor expected.

The statement that a cheaper transformer could be obtained by specifying a low Load Factor is incorrect – such a transformer would actually **be much more expensive** .

As a case in point a 1000kVA Transformer with 1,100W Iron Loss and 8,100 W Copper loss is 20% cheaper than a Tier 1 886W Iron Loss / 11,550 W Copper Loss Transformer. Moreover using the Tier 1 transformer means that Copper losses on the load are higher because the transformer has not been optimised for the high load factor of the load.

With low values of Iron and Copper loses it will not be possible to optimise the design and the same Transformer design will be used for all Load Factors in EU – mismatched to the Load Factor everywhere.

>R: issue is now elaborated more in the report but note that manufacturers do not support this view, e.g. economy of scale is lost in manufacturing .. (See T&D Europe point of view)

P35 PEI Data for Large Power Transformers:

Typically Large Power Transformers are designed so that they can provide standby during outages and have capacity to accept load growth. This means that they are much larger than the actual load they serve, so that their Transformer Load Factor will be low. At the lower end of the large Power Transformer size the transformers are expected to carry the full load of their adjoining transformer indefinitely, so that they are only loaded to about 60% of their rating.

Requiring such transformers to have low copper losses when they will be lightly loaded most of the time will be a waste of money.

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Adding in a requirement for a minimum PEI on such transformers would require a significant amount of analysis on transformer data, with such data not being available in the CENELEC tables – references to optimum load factors of 0.25 – 0.7 are incorrect as these values are derived from actual ratios of Iron and Copper losses which do not represent the actual load factor, as they are also influenced by the transformer design – they are post design values.

>R: noted but in this issue other stakeholders have a different point of view and the assembly will be reflected in the report.

P 43 Forced Cooling:

It seems to be suggested that Forced Cooling could be used to reduce transformer size for Medium Powered Transformers, but such cooling fans are themselves users of electricity and are effectively extra losses. However the power usage of such fans is not mentioned.

In addition, cooling only operates correctly when there is air circulation to the outside, which means that in a compact substation extra force is required to provide such forced circulation using even more power.

Finally, failure of the fans such as would happen in rural areas where intakes are blocked by leaves etc. means that the transformer will overheat (with greater losses) and is likely to fail catastrophically. The extra cost of such fans would also make the transformer more expensive and negate the value of the remaining losses saved.

>R: noted & proposal is added to include the losses of the fans in the case it would be needed.

P51 2.3.2 Load Losses for Single Phase Transformers

The loss values shown in Table 2-6 for 15kVA Single Phase Transformers are 48W for No Load Losses and between 900 and 600W for Load Losses.

Actual losses of 15kVA transformers purchased in Ireland by ESB are also 48W Iron Losses, but only 270W Copper losses **– less than half the lowest Load Loss in the Table**.

The reason why the Load Losses are so low is that they are set by the need to bring the Impedance of the 15kVA to just 2.2% and it is not possible to do this by reducing the reactance, leaving scope to just reduce resistance. So the Copper losses are determined by the need for a very low impedance, not by economic constraints.

Furthermore, in order that minimum Short Circuit levels are met the size of the transformer is in excess of it's load – such transformers were typically 5kVA but were replaced systematically with 15kVA units to increase Short Circuit levels.

With typically only 1-3 customers on such rural transformers the likelihood of different loads actually clashing and increasing the peak loading so as to produce I^2R loss is low, so the loading on such transformers also acts to minimise Copper Losses.

The loss values shown in Table 2-6 for 33kVA Single Phase Transformers are 58W for No Load Losses and between 750 and 1100W for Load Losses.

Actual losses of 33kVA transformers purchased in Ireland by ESB are also 58W Iron Losses, but only 675W Copper losses **– i.e. 10% lower than the lowest values of Copper Losses in the Table.**

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In relation to Capex costs for the 15kVA and 33kVA units **the Capex Costs are underestimated by a factor of over 2** i.e. they are less than half the actual purchase price.

Similar Capex ratios would also apply to the UK, although UK transformers would be more expensive again as the market is fragmented between different DNO's so that production runs for each are smaller and hence costs will be higher.

>R: noted, the CAPEX estimates have been revised to take account of the impedance factors but we do not reach the CAPEX values you are implying and cannot use these without credible data being made available.

P54 2.3.3 No Load Losses for Single Phase Transformers

Ireland has always capitalized losses in all investment decisions since before 1970, so that a consistent approach is taken across the board to losses in Transformers, lines, cables and in overall combinations of these components that for m the network.

Tenders are global with units bought from as far afield as USA and Korea, but with most now coming from a factory in Ireland. However this means that through Tenders and Capitalised losses the real economic value of Iron losses has always been achieved.

Leaving aside the fact that Table 2-10 is using a 2% discount rate and too low a Capex value for the transformer, a simpler assessment of the scope to further reduce Iron losses is available in the presentation made to the EU where a design with lower losses obtained by using amorphous was costed:

	15kVA				33kVA			
	Current design	Option A	Option B	Amorphous	Current design	Option A	Option B	Option C
Po Guaranteed	48	39	33	16	58	48	44	41
Pk Guaranteed	270	270	280	280	675	701	705	724
Tank diam.	410	420	430	520	470	490	490	490
Tank height	580	610	610	780	750	750	750	750
Total weight	180	195	202	255	270	280	285	290

Fig. 3 Impact of Lower Iron Loss on Weight and Dimensions of 15 & 33kVA Single Phase Transformers.

It can be seen from the above that a small decrease in Iron Losses requires a large increase in weight. At say €7,500/KW Iron Loss Capitalization a reduction to 16W from 48W would save 32W which would be worth €240 in saved losses.

However, the extra material in the Transformer would be 75kg and cost more than €240.

Part of the issue with Iron Losses on Rural Single Phase Transformers is that the Noise requirements are very low – rural areas are quiet at night, sound travels widely and noisy transformers would be unacceptable (- Average Sound pressure levels specified at 0.3m from transformer must not exceed 44dB).

Moreover, to reduce noise the Magnetic field must be low, which means more Iron for the same loss reduction as it cannot be operated at high levels of saturation without producing excessive noise.

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This is particularly onerous on the usage on Amorphous Core transformers where the Tesla level needs to be kept at around 1.2T, much lower than what is optimal for amorphous and much lower that the 1.8T used in pole mounted amorphous transformers in urban areas in Asia.

>R: Noted. AMT are not specifically proposed.

P 59 2.3.4 Conclusions regarding cost effective loss reduction for single phase transformers.

The suggestion that no Load Limits would be set rather than PEI would not be in the best interests of maximising efficiency. The reason for this is that the trajectory of electrification of heat and transport in Ireland is as yet unknown, although the Irish Govt is strongly in favour of it as this would have a very significant impact on CO2 reduction.

Critical to the success of this proposal is the ability to supply such increases in electric load, and transformer supplying such loads will have different load factors. Using PEI would allow the optimisation of such transformers for higher load factors whereas fixing no load losses would limit flexibility in transformers design.

Accordingly for flexibility PEI offers more scope to deal with changing load patterns in a flexible manner.

>R: Position noted.

P 60 3.1.1.1 Medium Power transformers for brown field applications with space/weight constraints relative to Tier 2

Allowing transformers to be outside Tier 2 where constraints are applicable but requiring them to use the best Iron and Copper materials looks reasonably practical, yet manufacturers will object on the basis that they would not want to be technologically constrained.

This issue comes up a lot in procurement and the problem can be completely avoided through use of the correct wording:

e.g. *Where a transformer is constrained due to issues of dimension or weight , these constraints shall be set out in the Tender Specification. Where it is not possible to meet these constraints with Tier 2 or Tier 1 PEI levels at reasonable cost, then the transformer may be constructed using whatever technology is appropriate, but such that the Iron and Copper losses are equivalent (or less) to those which would have been produced using Core loss material with a flux density of 0.xx W/kg and Conductor of conductivity >= yy.y mOhm.mm @20C.*

By allowing PEI equivalent to Tier 1 or Tier 2 there is more scope for the design to be varied and overcome the constraints, but if this is not possible then the equivalent losses which would be incurred using good magnetic steel and Copper should be used – the manufacturer might decide to use poor steel at low flux density or a greater volume of conductor of lower conductivity – no limitations imposed on the technology used.

>R: Note we are aware that manufacturers do not want to be technical constraints and that is the reason why we do not present this for the main Tier 2 requirements and we hope that manufacturers invest in meeting this requirements for all applications as they indicated in the meeting. Having this technology constraints for the exceptions or the 'backdoor' to close any loophole is not a limitation for innovation.

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P61 Consideration of the scope:

Requiring double poles for new pole mounted transformers will be inordinately expensive!

A pole is about €500 and about another €500 to install, which given that the transformer only costs €1,000 would never be paid back from any marginal increase in savings achieved.

Worse still, the acceptability of a double pole structure is low compared to a single pole structure, so that even for new build the householder will want it located further away, resulting in greater losses on the Service wire.

In many instances an existing pole already exists and providing a transformer upgrade simply involves hanging a larger transformer on the same pole. But is a second pole is required a suitable position may be unable to be found beside the existing one so that the existing pole now needs to be relocated, along with all the attachments – very expensive.

Requiring new substations/substation buildings to be larger is also not feasible – if the physical substation site already exists then only similarly sized equipment can fit on it. If it is a new substation building in an office or apartment development the extra space is provided by the developer who places a very high cost on every m^2 provided.

Imposing a requirement for a larger building simply because existing transformer technology does not accommodate transformers which could be slightly more efficient does not makes sense, as the extra costs greatly outweigh the extra savings.

It is also quite likely that technological improvements will overcome the problem over the coming years which would then strand any investment made in larger substations.

>R: noted. More text is added to explain the lock in into single poles (the price that I had was for an installed pole, the pole itself cost only half (250 euro) but it can depend on the country and the scale of the order).

P 62 Transformer Repairs:

Very Large Transformers e.g. above 5MVA are worth repairing. They are difficult to replace at short notice, they are expensive and the repairs are a small proportion of their cost. Any improvement in losses from an upgrade is completely swamped by the extra cost.

Smaller Transformers such as are used at distribution level and vary from 15 – 1000kVA are generally only worth repairing if the problem is something as simple as a broken bushing on a relatively new transformer which can be easily replaced.

Utilities will never want to buy repaired transformers from outside the utility, and would also not want to repair their existing transformers if it involved anything more than a bushing. The reason for this is that the cost of replacing and then installing a transformer is a multiple of the cost of the transformer, so that to cover these costs the transformer must work reliably in situ for at least 20 years. Any possibility of failure would result in excessive costs e.g. replacement cost of transformer, hire of generators, switching to restore supply, penalty payments for outages.

The typical response of a utility is to scrap any transformer that has any fault, and also to scrap any older transformers that are replaced on upgrade e.g. a 30 year old transformer might have 10 years service left – not worth the cost /risk of installing elsewhere.

>R: thanks for providing this input, text will be added.

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P65 Single Pole versus multiple pole constructions:

See comments re p61 on use of second poles.

Most utilities have to pay rent to the landowner when a double pole structure is used as it is considered to add restrictions to land usage. It is more visually intrusive and may attract planning permission objections, requiring it be relocated to a site further away with greater losses on the associated circuits which are now longer.

The customers who will be most affected by this requirement will be farmers who are intensely aware of the impact of electricity poles on their land and are likely to lobby strongly against such EU proposals.

The Electricity price figures used in Table 3-1 are inconsistent with other prices used at €0.15/kWh as against €0.0847/kWh elsewhere, and the discount rate at 2% is incorrect – should be 4%.

The investment analysis then carried out comparing a 270/3102W Pole mounted trafo with a lower loss 189W/1750 transformer of same size (160kVA) is fundamentally incorrect!

In making such an investment analysis it is fundamentally incorrect to compare the total costs of the options – only the incremental costs and saving should be compared.

e.g. Investment A has a cost of €1,000 and provides savings of €1,500

Investment B has a cost of €1,300 and provides savings of €1,600

Clearly Investment B provides greater savings as well as covering it's costs, but is it a good investment?

In Option A an investment of €1,000 gave a return of €1,500

In Option B the investment of an extra €300 produced an extra return of only €100, so this is not good!

In other words for €13,000 you can get 13 Investment A's done with return of €19,500

For €13,000 " " " 10 Investment B's " " " " €16,000

So Investment B is a poor investment as the marginal extra cost is not associated with worthwhile marginal benefits.

Similarly, Investing an extra €962 on a more efficient transformer (plus an extra €500+ on a second pole which is not accounted for in the analysis) i.e. a total extra of €1,462 gives a marginal saving of €92 pa (based on €0.0847/kWh)

At 4% over 25 years this is €1,437 (=15.62 x €92) i.e. a loss of €24 but with the risk of cost overruns e.g. erection of the second pole was not included.

So adding in a second pole will not be justified on losses basis.

>R: text has been updated. The cost sensitivity issue, which is horizontal, is further elaborated in the updated report taking your comments into account.

A. **Walsh**

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APPENDIX 1

EU Smart Regulation Guidelines

http://ec.europa.eu/smart-regulation/guidelines/tool_54_en.htm

TOOL #54: THE USE OF DISCOUNT RATES

2. Social discount rates and present values

A social discount rate is used to convert all costs and benefits to "present values" so that they can be compared. This discount rate is a correction factor applied to costs and benefits expressed in constant prices. Costs and benefits should be based on market prices in the year at which they occur. For example, the capital cost of an investment should be recorded as a cost when the action is undertaken, with any associated operating costs taking place in later years recorded in those years. This approach is in line with the economic principle of opportunity costs where market prices reflect the best alternative uses for goods or services.

The social discount rate is the rate most used in Impact Assessments, as these normally consider costs and benefits together from the point of view of society as a whole (rather than from the point of view of a single stakeholder group). The recommended social discount rate is 4%. This 4% rate is in real terms and is applied to costs and benefits expressed in constant prices. It can be easily adjusted for inflation: if instead you are dealing with nominal prices, and inflation is, say, 3% per annum then a 7 % nominal social discount rate (4% rate plus 3% to account for inflation) would be used.

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Concerning energy consumption in use, the level of energy efficiency or consumption must be set aiming at the life cycle cost minimum to end-users for representative product models, taking into account the consequences on other environmental aspects. The life cycle cost analysis method uses a real discount rate on the basis of data provided from the European Central Bank and a realistic lifetime for the product; it is based on the sum of the variations in purchase price (resulting from the variations in industrial costs) and in operating expenses, which result from the different levels of technical improvement options, discounted over the lifetime of the representative product models considered. The operating expenses cover primarily energy consumption and additional expenses in other resources, such as water or detergents. A sensitivity analysis covering the relevant factors, such as the price of energy or other resource, the cost of raw materials or production costs, discount rates, and, where appropriate, external environmental costs, including avoided greenhouse gas emissions, must be carried out to check if there are significant changes and if the overall conclusions are reliable. The requirement will be adapted accordingly

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http://edit.eceee.org/ecodesign/products/Ecodesign_directive_evaluation_methodology/MEErP%20Methodology%20Part%201.pdf

TASK 5/6: ECONOMICS

5 ENVIRONMENT & ECONOMICS

5.1 Product-specific inputs   Choose from the previous tasks the most appropriate information From all tasks 1 to 4:   Definition of the base case(s) (from all previous Tasks 1 to 4)   with per Base Case Task 1: The most appropriate test standard for performance and consumption data Task 2: EU-27 annual unit sales 2010   EU-27 unit stock 2010   Purchase price. the installation costs (specify end-of-life disposal costs comprised in product price)   Repair and maintenance costs   Unitary rates for energy, water and/or other consumables   Discount, inflation, interest rates to be applied Product service life Task 3 Annual resources consumption (energy, water, consumables, from Task 3.1) and direct emissions caused directly or indirectly during product life according to the real-life situation (from Task 3.2);   Product use&stock life, if appropriate (i.e. if deviates substantially from product service life)   As appropriate, multiplier(s) to transform standard test data to real-life consumption data   Average user demand/ load   Collection rate at end-of-life (per fraction if applicable) Task4 Product weight and Bill-of-Materials (BOM), preferably in EcoReport format (from Task 4)   Primary scrap production during sheet metal manufacturing (avg. EU);[12]   Volume and weight of the packaged product avg. EU;   Selected EU scenario at end-of-life of materials flow for: o   Disposal (landfill, pyrolytic incineration);   o   Thermal Recycling (non-hazardous incineration optimised for energy recovery);   o   Re-use or materials recycling scenario.   5.2 Base-Case Environmental Impact Assessment. [see Chapter 7] 5.3 Base-Case Life Cycle Costs for consumer Combining the results from tasks 2 and 3 for the Real-Life Base-Case determine the Life Cycle Costs LCC = PP + PWF * OE, where LCC is Life Cycle Costs, PP is the purchase price, OE is the operating expense and PWF (Present Worth Factor) is PWF= {1 – 1/(1+ r) N }/r , in which N is the product life and r is the discount (interestinflation) rate minus the growth rate of running cost components (e.g. energy, water rates) 5.4 Base-Case Life Cycle Costs for society Extend the calculation of the base-case Life Cycle Costs for the end-user with the societal costs for emissions indicated in Chapter 5, using the outcome of Task 5.2 (emissions in mass per product over product life) and the monetary values per emission (in €/unit of mass) in Chapter 5 5.5 EU Totals Aggregate the Real-Life Base-Case environmental impact data and the Life Cycle Cost data (subtask 5.3 and 5.4) to EU-27 level, using stock and market data from task 2, indicating 5.4.1. The life cycle environmental impact and total LCC, both for the consumer and society, of the new products designed in 2010 or most recent year for which there are reliable date (this relates to a period of 2010 up to 2010+product life); 5.4.2 The annual (2010) impact of production, use and (estimated) disposal of the product group, both in terms of the annual environmental impacts and the annual monetary costs for consumers and society.

6 DESIGN OPTIONS

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6.1 Options Identify and describe (aggregated clusters of) design options to be taken into account (from Task 4, typically 4 to 8 design options are manageable) 6.2 Impacts [see Chapter 7]

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Assess quantitatively the environmental improvement per option using the EcoReport tool. Compare the outcomes and report only on impacts that change significantly with the design options 6.3 Costs Assess/ estimate price increase due to implementation of these design options, either on the basis of prices of products on the market and/or by applying a production cost model with sector-specific margins. 6.4 Analysis LLCC and BAT 6.4.1 Rank the individual design options by LCC (e.g. option 1, option 2, option 3), both for consumer and for society; 6.4.2 Determine/ estimate possible positive or negative ('rebound') side effects of the individual design measures; 6.4.3 Estimate the accumulative improvement and cost effect of implementing the ranked options simultaneously (e.g. option 1, option 1+2, option 1+2+3, etc.), also taking into account the above sideeffects, both for consumer and for society; 6.4.4 Rank the accumulative design options; draw LCC-curves (1st Y-axis= LLCC, 2nd Y-axis= impact (e.g. energy), X-axis= options) both for consumer and for society; identify the Least Life Cycle Cost (LLCC) point and the point with the Best Available Technology (BAT), both for consumer and for society; 6.5 Long-term targets (BNAT) and systems analysis Discussion of long-term technical potential on the basis of outcomes of applied and fundamental research, but still in the context of the present product archetype; Discussion of long-term potential on the basis of changes of the total system to which the present archetype product belongs: Societal transitions, product-services substitution, dematerialisation, etc.

7.1 Life Cycle Costs

The calculation of Life Cycle Costs (LCC) is an explicit part of MEErP Tasks 5 (BaseCase) and MEErP Task 6 (Design Options).

In MEErP, based on the description on Annex II of the Ecodesign directive 2009/125/EC, the LCC analysis to end-users method 'uses a real discount rate on the basis of data provided from the European Central Bank and a realistic lifetime for the ErP; it is based on the sum of the variation in purchase price (resulting from variations in industrial costs) and in operating expenses, which result from the different levels of technical improvement options, discounted over the lifetime of the representative ErP. The operating expenses cover primarily energy consumption and additional expenses in other resources (such as water or detergent).'

7.1.1 Consumer Life Cycle Costs

The basic LCC formula is:

$LCC = PP + PWF * OE + EoL$,

where

LCC is Life Cycle Costs to end-users in €,

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PP is the purchase price (including installation costs) in €,

OE is the annual operating expense in €

PWF (Present Worth Factor) is

PWF (Present Worth Factor) is

in which

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N is the product life in years and

d is the discount rate rate in %

and in case d=0 the value of PWF=N

EoL: End-of-life costs (disposal cost, recycling charge) or benefit (resale).

During the preparatory studies it became apparent that the price increase of the operating expense plays an important role and –as argued by consultants—should be an integral part of the LCC. As a result it is proposed to use the following formula for PWF

where

e is the aggregated annual growth rate of the operating expense (a.k.a. 'escalation rate', in €) and

in case d=e (mathematically undefined) PWF= N In US federal government publications the above PWF is known as UPV, Uniform Present Value66, relating to the fact that the calculation is valid for a uniform value of growth rate e in time.

For many products the disposal-levy ('recupel') is included in the purchase price PP and the restvalue of most product at end of life is zero (0). In case the disposal costs are to be paid at the end-oflife the discounted Net Present Value (NPV) of the disposal costs should be added to PP. In case there is a rest-value of the product, then the discounted NPV of the rest-value should be deducted from PP.

In case the operating expense OE consists of several elements (e.g. energy, water, maintenance and repairs) with different annual growth rates then the parameter e is a weighted average of these elements. For example, if the annual operating expenses consist 90% of energy at a growth rate of 5%/a and 10% of maintenance costs at a growth rate of 2%/a, the aggregated annual growth rate e is 0,9*5% + 0,1*2% = 4,7%.

The data in Chapter 4 on discount rate and inflation-corrected energy rate growth rates will and the paragraph on the escalation rate of external damages has shown, that - at present - the three are very close together. The discount rate is 4% 67. The external damages escalation rate of external damages is around 4% and the inflation-corrected energy rate growth rate is - at the moment - also

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in the order of 3-4%. This means, for cases where repair and maintenance costs are insignificant, the assumption of a case where r=p and thus PWF=1 would result in a negligible error.

As a result, the LCC formula for MEErP Task 5 and 6 the LCC can be simplified to

LCC= PP + N*OE + EoL

Note that this simplified formula cannot be applied if there is a significant (>1% point) difference between discount rate r and the aggregated growth rate of the operating expense.

66 US Dept. of Commerce and National Institute of Standards and Technology (NIST), ENERGY PRICE INDICES AND DISCOUNT FACTORS FOR LIFE-CYCLE COST ANALYSIS, Annual Supplement to NIST Handbook 135 and NBS Special Publication 709. April 1, 2010 to March 31, 2011. Data for the Federal Methodology for Life-Cycle Cost Analysis, Title 10, CFR, Part 436, Subpart A; and for the Energy Conservation Mandatory Performance Standards for New Federal Residential Buildings, Title 10, CFR, Part 435, sponsored by US Dept. of Energy, Washington 2010. 67 This discount rate is the required 4% discount rate of the impact assessment guidelines of the Commission

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Table 25. ECODESIGN Scenario Analysis, INPUT sheet sample (fictitious)

INPUT data from PREP sheet, fictitious example

PARAMETER	unit	1990	1995	2000	2005	2010	2015	2020	2025	2030
Sales	1000 # /a	from PREP, aggregate from Task 2								
Stock (T2)	1000 # /a	from PREP, aggregate from Task 2								
direct ErP demand	perform/unit.a	from PREP, aggregate from Task 3 (and copy in Task 5)								
indirect ErP demand	perform/unit.a	from PREP, aggregate from Task 3 (and copy in Task 5)								
BaU (baseline)										
direct ErP efficiency	%	from PREP, aggregate from Task 4 (and copy in Task 5)								
indirect ErP efficiency	%	from PREP, aggregate from Task 4 (and copy in Task 5)								

INPUT, data from MEErP 2011 (fictitious sample)

Baseprice	500	Product price + Installation costs incl. VAT 2010 [€/unit]. Aggregate from PREP sheet (Task 5)
PriceInc	20	Price increase per efficiency %-point [€/ %]. **Aggregate from PREP sheet (design options simplified formula)**
PriceDec	2,0%	Annual product price decrease [%/ a] through product rationalisation
Rel	0,18	Electricity rate 2010 [€/ kWh electric]
Rgas	0,052	Gas rate 2010 [€/kWh GCV]
Relinc	5%	Annual price increase electricity [%/ a]
Rgasinc	5%	Annual price increase gas [%/ a]
ManuFrac	53,8%	Manufacturer Selling Price as fraction of Product Price [%]
WholeMargin	30%	Margin Wholesaler [% on msp]
RetailMargin	20%	Margin installer on product [% on wholesale price]
VAT	19%	Value Added Tax [in % on retail price]
ManuWages	0,166	Manufacturer turnover per employee [mln €/ a]
OEMfactor	1,24	OEM personell as fraction of WH manufacturer personell [-]
WholeWages	0,261	Manufacturer turnover per employee [mln €/ a]
RetailWages	0,1	Manufacturer turnover per employee [mln €/ a]
ExtraEUfrac	0,6	Fraction of OEM personell outside EU [% of OEM jobs]
Inflation	2,5%	Inflation rate [%/ a]
Interest	6,5%	Interest rate [%/a]
Discount	4%	The discount rate is expressed in real terms, taking account of inflation. This rate of 4%, used in the Commission's impact assessments[77], broadly corresponds to the average real yield on longer-term government debt in the EU over a period since the early 1980s. For impacts occurring more than 30 years in the future, the use of a declining discount rate could be used for sensitivity analysis, if this can be justified in the particular context
Power gen. & distr.	40%	Electric power generation & distribution efficiency
GWP fossil mix	0,057	kg/kWh primary

		1990		2000		2010		2020		2030
GWP electric	kg/kWh elec.	0,5		0,43		0,41		0,38		0,34

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22. ANNEX 12 PIRAEUS UNIVERSITY COMMENT

Van Tichelen Paul

From:	Psomopoulos Constantinos <cpsomop@puas.gr>
Sent:	maandag 27 maart 2017 9:57
To:	Transformers; Van Tichelen Paul
Cc:	paul@waide.co.uk
Subject:	Απ: Important notification about comments received on draft 'Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for transformers ': will be made public unless we receive an e-mail to request confidentiality

Dear Sirs,
Please accept my apologies for the delayed responce due to some health issues.
After a carrefull read in the draft report I have the following comments :
1. The TOC has included the recycling revenues from transformers as well the prices of the basic materials. This is very important but the addition of a table presenting the recycling rates of the BC used I believe that it is important as it will demonstrate better and more clear this important issue.
>thanks for supporting this, it is further elaborated taking into account other stakeholder comments
2. Single phase transformers exists also in Greece in rural areas to provide illumination in farming rural areas as well as feeding of single phase well pumps used in irrigation. I will try to collect relevant data but to my knowledge these medium voltage transformers with rated power up to 50kVA were delivered to HENDO by Schneider Electric and were mnanufactured in the facility that this company operates in Greece.
> this is discussed in the stakeholder meeting and was denied by Schneider Electric
3. ABB has recently present new distribution transformers dry type pole mounted installation. They are planning to replace the commonly used oil insulated ones. The link is
https://library.e.abb.com/public/2adb0814d3b2415abbfc18186ea64ad9/1LES100032-ZD_PoleDry%20dry-type%20transformers_EN_HQ.pdf
> thanks for this useful input
There are some speling and grammar issues that will be fixed in the final version I believe.

Please also inform us about the final location and schedule of the meeting.

Sincerely yours

Dr. C.S. Psomopoulos, MIET
Professor Piraeus University of Applied Sciences (TEI Piraeus)

Constantinos S. Psomopoulos, Ph.D, MIET
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Skype : cpsomopoulos
Twitter : @CS_Psomopoulos

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Please consider the environment before printing this e-mail.

Από: Transformers <transformers@vito.be>
Στάλθηκε: Παρασκευή, 24 Μαρτίου 2017 6:53 μμ
Προς: Cesar.SANTOS@ec.europa.eu; paul@waide.co.uk; Van Tichelen Paul
Θέμα: Important notification about comments received on draft 'Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for transformers ': will be made public unless we receive an e-mail to request confidentiality

Dear Stakeholder,

We received several comments from stakeholders on the draft report for discussion in the meeting on next Wednesday 29/3.
Hereby we want to inform you that **they will be made public, unless you explicitly request confidentiality by a reply on this e-mail before Monday 27/3 14h CET** .
Note: if they cannot be made public it is uncertain that we can discuss them and they are only considered background information for the study.

Best regards,

Paul Van Tichelen

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23. ANNEX 13 IEC TC 96 COMMENT

Van Tichelen Paul

From:	Hoppe, Gunda <gunda.hoppe@block.eu> on behalf of Reichelt, Wolfgang <wolfgang.reichelt@block.eu>
Sent:	maandag 27 maart 2017 15:17
To:	Transformers; Van Tichelen Paul
Cc:	paul@waide.co.uk; Cesar.SANTOS@ec.europa.eu; Lühring, Andre; Kampen, Dennis; Winter, Dr. Rolf; Nollau (alexander.nollau@vde.com); Reichelt, Wolfgang
Subject:	AW: Announcement of 'Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for small, medium and large power transformers ': Draft report available for discussion in the stakeholder meeting

Dear Mr. Van Tichelen,

concerning your email from 7th March, we would like to send you our comments to the new proposal.

We have the existing IEC and European standard IEC 61558-1 (EN 61558) where we described the safety of transformers, reactors, power supply units and combinations thereof . This standard belongs to the low voltage directive and in the scope of the standard we have the following sentence:

In this standard the transformers, reactors, power supply units and combinations thereof are not forming a part of distribution networks.

That means, that the maximum input voltage of the transformers in this standard is 1.000 Volts.

These transformers are very often built into applications for machine builders, drives or other equipment. In these cases the machine builder itself has to fulfil eco-design requirements like for the drive systems i.e. the EN 50598. And the transformer is only responsible for a small part of the losses in the whole system.

For the transformer the existing volume and the costs are the most important factors for these kinds of applications. Different to the distribution transformers the low voltage transformers are often not running continuously on the grid.

Commonly for low voltage transformers non grain oriented electrical steels (NGO) or lower grades of grain oriented electrical steels are used. Sometimes we are mixing different core materials including nano crystalline materiel so we cannot say what kind of electric steel we have used in our transformers.

It would result in a large price increase if amorphous cores have to be used which the customers would not pay.

Due to size requirements, transformers are often designed for forced air-cooling and aluminum windings are used for price competition.

The conclusion is that eco-design directives for special applications for machine builders and drives and other equipment should be adjusted in limits but not the low voltage transformer itself. It is much more intelligent to look at the losses in a system level and not on part level.

For this, I suggest that the transformer from IEC 61558 / EN 61558 should not be pursued under the Eco-Design Directive and be an exception.

R> Thanks for this input on small transformers, more text added in the updated text.

Best regards

Wolfgang Reichelt
Secretary IEC TC 96

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Chair DKE K 323

Managing Director
CEO

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Telefax 04231 678-188
wolfgang.reichelt@block.eu

www.block.eu
BLOCK – Strom in Perfektion

Von: Transformers [mailto:transformers@vito.be]
Gesendet: Dienstag, 7. März 2017 17:44
An: Van Tichelen Paul
Cc: paul@waide.co.uk; Cesar.SANTOS@ec.europa.eu
Betreff: Announcement of 'Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for small, medium and large power transformers ': Draft report available for discussion in the stakeholder meeting

Dear Sir or Madam,

We are contacting you with regard to a preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for transformers (https://transformers.vito.be/) to inform you that a draft report is available for commenting and discussion in the stakeholder meeting.
It can be accessed by this link: https://transformers.vito.be/sites/transformers.vito.be/files/attachments/ec_dg_growth_lot2_Transformer_V23.pdf

In order to enable to discuss the comments and input in the upcoming stakeholder meeting on 29th March please sent them before 24th March.
Of course, also written comments of those who are not able to participate in the stakeholder meeting are welcome.
Note: for the upcoming stakeholder meeting CENELEC/TC 14, T&D Europe and Eurelectric (Synergrid) will be contacted to present findings but others are also welcome to contact us.

Kind regards on behalf of the study team,

Paul Van Tichelen

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24. ANNEX 14 JOHN_BJARNE SUND INPUT (S)

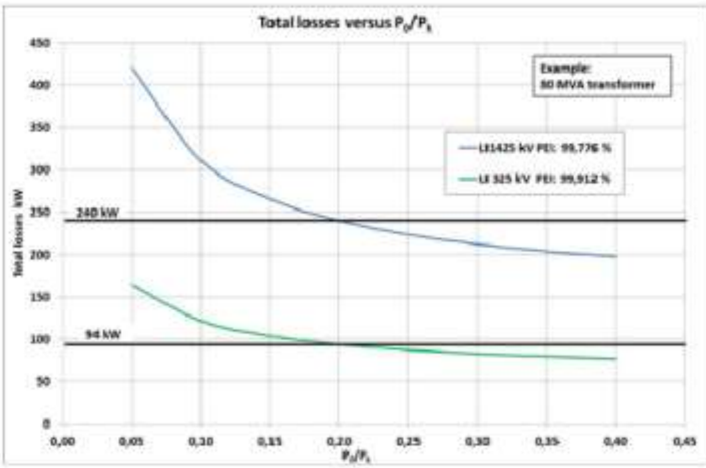
Transformers

From:	John-Bjarne Sund <john-bja@online.no>
Sent:	zondag 26 maart 2017 19:48
To:	Transformers
Subject:	Regulation review comments

Dear Paul,

I have analysed the situation regarding tightening the loophole and still keep the PEI in combination with an additional requirement. A 80 MVA transformer is taken as an example.

Instead of load factor I use the relation P_0/P_k as the additional the parameter for the requirements, with a minimum limit of 0,20. This means that the no load loss shall not be less than 20 % of the load loss.
As a consequence the no load loss shall not be less than 16,67 % of the total losses for transformers which have PEI as the approval criterion in the Regulation. Due to the properties of the PEI formula the permissible total losses increase very steeply when the P_0/P_k fraction goes far below 0,2. See the below diagram. The curves in the diagram reflect just the mathematical properties of the PEI formula.



If we now give ourselves the task that we shall use the PEI combined with $P_0/P_k = 0{,}2$ to achieve that the total loss will be equal to the losses in the table of slide 22 of my ppt presentation, what would then the corresponding PEI values be?
So far I have only calculated two values of PEI for the 80 MVA transformer. PEI =99,776 % for LI 1425 and PEI = 99,912 % for LI 325.

(LI means the lightning impulse test voltage level on the high voltage side of the transformer. A transformer with 400 kV rated voltage at the high voltage side is normally tested with an impulse voltage with 1425 kV top value at the high voltage side. A transformer with 66 kV rated voltage at the high voltage side is normally tested with an impulse voltage with 325 kV top value at the high voltage side).

The above diagram illustrates the situation. The blue curve indicates how the total losses vary with different values of the fraction P_0/P_k when PEI = 99,776 %. The green curve indicates how the total losses vary with different values of the fraction P_0/P_k when PEI = 99,912 %. In the area between the blue and the green curve four more similar curves can be inserted for the voltage levels LI450-550, LI650, LI750 and LI950.

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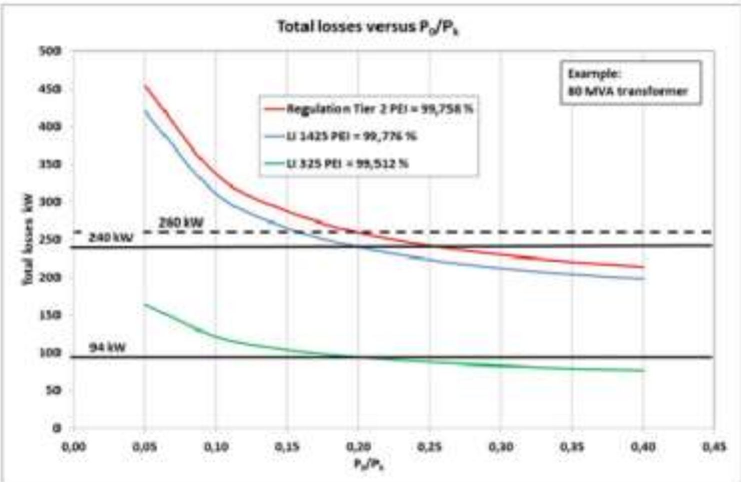
The upper black horizontal line indicates the total losses of 240 kW taken from the table in slide 22 with LI 1425. (The 240 kW maximum permissible total losses is of course independent of the fraction P_0/P_k). The lower horizontal black line indicates the total losses 94 kW, also taken from the table in slide 22, with LI 325. It can be noted that the blue curve crosses the upper black horizontal line at $P_0/P_k = 0{,}2$. The green curve crosses the lower black horizontal line also at $P_0/P_k = 0{,}2$.

The next diagram is almost the same as the foregoing diagram. The only difference is that in this second diagram, a red curve is inserted, representing PEI = 99,758 % as given in Tier 2 of the Regulation for a 80 MVA transformer.



It appears from the diagram that the PEI-value given for Tier 2 in the Regulation allows higher total losses than indicated by the blue and especially by the green curve.

If the next version of the Regulation still shall apply PEI as the approval criterion, now together with the additional requirement that the fraction P_0/P_k is not permitted to be less than 0,2, each loss in the table figure of slide 22 must be replaced by a PEI figure. The loss figures of slide 22 reflect the transformers with the lowest total losses of the pool of several hundred power transformers which are in service within the EU-region. **If this level of losses shall be kept in Tier 2, the PEI-values must be increased**. The second diagram is an example which illustrates that. There will be about 120 new minimum PEI-values to calculate. I can do that job, but I hesitate to do it before it is decided that this is the way EU wants for Tier 2.

> NOTE
> If this level of losses is considered to be too ambitious, it is easy to increase the loss values a certain agreed percentage. The most essential issue is to establish unambiguous approval criteria.

When 'translating' these new PEI-values to total losses, we get naturally exactly the same values as in slide 22. One could then ask whether this detour through the PEI has any value? Would it be better to apply the maximum total losses directly as the permissible limits?

It is important to be aware that for example a 80 MVA transformer with *400 kV* rated voltage at the high voltage side has considerably larger physical dimensions and higher weight than a transformer with the same rated power and *66 kV* rated voltage at the high voltage side. For this reason it is necessary to distinguish between the different levels of LI. The present Regulation, Table 1.7, has just one PEI-figure for each rated power, independent of the voltage level, which is a weakness.

In the last paragraph on page 34 of the draft of the Preparative Study it is mentioned that minimum of P_0 and P_k can be used. May be the fraction of P_0/P_k is what really is meant here. kPEI>0,19 and kPEI>0,25 are mentioned in two paragraphs higher up on the page. For these two values of the loading factor kPEI P_0/P_k is respectively 0,036 and

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0,063. At these low values of P_0/P_k the total losses are very high and much higher than we can allow (See the diagrams higher up in this mail). So my suggestion is that we use $P_0/P_k > 0,20$ as the additional requirement together with the increased PEI requirements. P_k at rated current and reference temperature and P_0 have for many decades been subject to guarantee in contracts between purchasers and suppliers. I don't see any good reason now to break that tradition.

So far purchasers rarely specify loading factors in their enquiries. In the former company where I was working we tried around 40 years ago to encourage our customers to specify the expected loading profile of the transformers they were asking for, but we were in that respect not successful. The reason was probably that the customers in many cases had no clear ideas about how the loading would develop in the course of its time in operation, which often can be up to 60 – 70 years. However, in cases where the purchasers specify capitalisation factors, A for no load loss and B for load loss, the squarer root of B/A can give an indication of the average loading of the transformer during its total time in operation. All purchasers do not specify capitalisation values, but buy the transformers with the lowest purchase price and disregards the losses. With clear requirements on maximum permissible total losses, the practice of buying transformers with the lowest purchase price and high losses will be brought to an end.

At the kick-off meeting I was prepared to show the mentioned ppt presentation, but we were running out of time, and I had unfortunately to leave the meeting before its ending in order to reach my return flight. I'm prepared to show this presentation at the stakeholder meeting on Wednesday. This time I will stay in Brussels one night more, so I don't need to rush from the meeting to reach my plane.

The content of this mail is primarily meant for you, Paul. But if you think that any parts of it should be made public, I have no objections.

Looking forward to seeing you in Brussels on Wednesday.

Kind regards
John-Bjarne

>R: this input was discussed in the stakeholder workshop (see minutes of meeting).

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25. ANNEX 15 ENTSOE COMMENT

European Network of Transmission System Operators for Electricity

entsoe

ENTSOE remarks on VIto's draft « Preparatory study for the review of the commission regulation 548/2014 on ecodesign requirements for transformers »

ENTSO-E AISBL • Avenue de Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 • info@entsoe.eu • www.entsoe.eu

1. Introduction

This document summarizes the position of ENTSO-e members on the draft study prepared by Vito in view of the revision of CE regulation 548/204 on ecodesign requirements for transformers. It focuses only on large power transformers used in transmission systems and does not intend to support any position on transformers of distribution size.

2. Clause to clause comments

2.1 Section 1

The CENELEC TC in charge of transformer is 14 and not 20.

2.2 Section 1.1.3.1

For large transformers, aluminium is not an efficient option and manufacturer only use copper. With regulation 548/2014 the use of copper may increase and even if the European Commission does not recognize copper as a critical raw material, a high variability of copper price is experienced. An increase in copper use may increase the copper price variability. This will force utilities to accept price revision clauses with effect out of control. This may lead to investment budget problems which should be taken into account. >R: noted and more added in importance of copper price

2.3 Section 1.1.3.2

The core steels used are not any more referred to with the M series numbers which is related to an American standard. For large power transformers, it is more and more common to use very thin (0.23 and even 0.18 mm thick) magnetic steel laser scribed, which are the highest available quality worldwide. The shift toward only top quality product may drain the market of those type of material and induce a price increase. We recommend to use the standard designations.

>R: text on steel updated

Amorphous steel is at present not envisaged for large power transformers. Its properties can't be used for large transformers.

2.4 Section 1.1.4

Scrap value of copper in transformers as experienced now is far lower than the 4.2 €/kg given here, because the copper to be scrapped is not readily available: the copper is embedded in windings and covered by paper layer. Retrieving the copper in a usable form requires efforts that deprecates the value of it. R: noted (should be confirmed by the copper manufacturer)

2.5 Section 1.1.6

Even if we agree that large transformers can be built according to Tier 2, the risk of price increase due to material cost can't be neglected in particular if the distribution market which is by far the largest consumer of magnetic steels is forced to use the highest grades which are up to now used in larger units only.

R: noted

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entsoe

2.6 Section 1.2.1

It must be noticed that due to narrow railway gauges, the use of rail transport is often impossible for large units and road transport is the only option. Which may also be difficult due limitation when crossing bridges by instance and induce extremely high transport cost which can reach up to 50% of the transformer ex work cost (500 k€ for a transformer of 1 M€) .

Waterways is also limited to a small number of countries and area at the European level.

>R: noted. The report should reflect the issue

2.7 Section 1.3.1

To avoid a loophole, the standards adopted after regulation 548/2014 have been published, have included in the PEI the losses represented by the cooler consumption at the kPEI. EN 50 629 explains this.

If those standards are not taken into account, there is a risk of designing a transformer able to cool itself at no load just by the tank evacuation but which will require a large amount of cooling power as soon as currents flow. This is due to the fact that contrary to the no load losses have their source in the core which can support quite high local temperature, load losses take place in the winding and must be efficiently evacuated to avoid damages to the paper covering. Cooling is required to limit the thermal gradient between winding and oil which is highly dependent on the current flowing and on the oil speed.

This is why the standards prescribe the use of cooling losses occurring at kPEI in the calculation of PEI.

>R: thanks for the input. The issue will be in Task 3 (3.1.3).

2.8 Section 1.3.4

Specifying a minimum kPEI of 25 % is not suitable for large transformers as the loading factor varies from nearly zero to nearly 100% depending on the application. Full freedom for optimization must be left to the user. Imposing a minimum kPEI will lead to higher no load losses for transformers designed for neglectable load only. This will create an even worst loophole. The use of a correct TCO formula takes care of this. The utilities have no interest to artificially de-optimise their transformers.

Entso-e is therefore strongly opposed to specifying a minimum kPEI.

>R: noted and position added in the text.

2.9 Section 1.3.5

Shifting artificially the kPEI to low values has no economic justification and utilities by using a correct TCO formula should not be considered as cheating. Imposing a minimum kPEI will bring on the market less efficient transformers for their particular application.

>R: see previous.

2.10 Section 1.4.2

Amorphous material have no application in the large power transformer area.

>R: we are aware of that.

2.11 Section 1.6.1

The flux density is not linked to the quality of the steel, it is the effect of the optimization realized by the transformer manufacturer between copper, steel, noise and losses. Usually using high grade steel is done for reducing losses, not to increase operating flux density in large power transformers.

>R: noted this practice (but for the future it might remain an option).

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2.12 Section 1.6.4

As required by the standard, the cooling losses are included in the PEI calculation.

>R: added in section 3.1.3

2.13 Section 1.6.5

Replacing metallic clamps with nonmetallic frames may not be applicable to large power transformers and will transfer the losses to the other metallic parts used in the core flitch plates.

2.14 Section 1.6.7

>R: noted

On site assembly as described here is the normal process for large units. On site construction is sometimes used at very high costs to overcome transportation problems.

>R: noted and added

2.15 Section 1.9

We support the creation of an exemption for large units due to transport limitation. Furthermore, due to the costs of qualification (type test including short circuit test) it must be possible to define a generic non-compliant transformer meeting the most severe transportation constraints faced by a utility and purchase it under a frame contract agreement. Those transformers will not be site dedicated and may not be the highest efficient transformers that could be brought on this specific site, but due to the number of concerned sites it will be the most economic design for a certain number of sites. This will avoid the cost of a dedicated market for each site not within reach of tier 2 compliant units.

>R: noted & is further elaborated in the report.

2.16 Section

From the economic point of view, the ENTSO-e members do not see any need for any further improvement for the energy efficiency of transformers at medium term. The progress of the raw material are slow and the financial effort may be better employed on other energy saving fields.

>R: noted. more guidance is added. Decision is up to the member states.

ENTSO-e reaffirms that defining a minimum kPEI for large units is counterproductive and will de-optimize a large batch of special purpose transformers.

2.17 Section 2

Large single phase units are dealt with in EN 50 629. Those units make the 3 phase bank usually more expensive. The choice to use single phase units is not linked to any cost reduction target but to transportation and reliability.

>R: Indeed, they also exist the focus of Task 2 is on MV/LV

2.18 Section 3.1.1

Entso-e supports the Cenelec document TS 50675 except the figure E.1 of annex E as it can lead to an unnecessary restriction of transformers' repair.

>R: noted and will be avaluated

entsoe

2.19 Section 3.1.1.1

For large power transformers low losses can be achieved either by using high performance steel or regular used in different configuration. For large power transformers, the use of a minimum core steel quality can puzzle the optimization of the manufacturer and creates transformers that will be unnecessary expensive or inappropriate for the specific purpose.

Concerning certificate of origin, this can create unnecessary bureaucracy without changing any of the environmental footprint. For large power transformers, copper is always Cu ETP pure electrolytic copper without recycled part due to the purity required to achieve low resistance copper needed to manufacture low load losses transformers.

>R: noted

2.20 Section 3.1.1.2

We do support the extension of exemption for green field applications for large power transformers. As not only for replacement but also for new installation or substation extension, transportation issues may limit the efficiency of the transformer.

We would like also to have this exemption not site specific but generic allowing for the definition of a non-compliant transformer which will fit in all transport restricted area. This will allow to keep the design and qualification cost affordable compared to a tailor made design for each substation taking into account the particular limits of this substation. Furthermore keeping the exemption "site specific" will be prone to introduce a bias in the fair competition between suppliers.

2.21 Section 3.2

>R: will be considered but might create loopholes

Repairing a transformer is in many cases the most economical and the best environmental solution. Repair shall not be restricted and even non-compliant transformers may be subject to heavy maintenance to extend their life expectance. Furthermore, the TSO transformer life is about 60 years and it will be damageable to scrap them before, as this could question the hypothesis that the use phase is the predominant one in term of environmental impact. Scrapping a relatively "new" unit is uneconomic and environmentally questionable.

2.22 Section 3.2.1

>R: text added, this is in line with Eurelectric

It is the understanding of ENTSO-E, like T&D Europe does, that non-compliant transformer can't be put on the market even as second hand as the regulation applies to the vendor.

Therefore, the CE marking can't create a loophole as non CE market transformers are usually non-compliant and will be scrapped or sold as second hand out of Europe.

2.23 Section 3.2.2

>R: according to our understanding it can be resold

TSO's have the same interpretation as T&D Europe concerning second hand transformers. Non-compliant transformers can't be sold.

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3. Conclusion

ENTSO-E considers that tier 2 is achievable for large power transformers, if exemptions because of transport constraints shall be extended to new or extended substations, with the right to define a generic transportable transformer which will not be exactly tailored to the substation it is devoted to.

ENTSO-E considers that limiting the right of repairing transformers could be damageable to the industry as a whole (more costly) and to the repair shops in particular.

>R: noted

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26. ANNEX 16 SBA COMMENT

Transformers

From:	Transformers
Sent:	maandag 3 april 2017 10:18
To:	'Nico Wurzel'
Cc:	paul@waide.co.uk; Cesar.SANTOS@ec.europa.eu; Van Tichelen Paul (paul.vantichelen@vito.be)
Subject:	RE: Important notification about comments received on draft 'Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for transformers ': will be made public unless we receive an e-mail to request confidentiality

Dear Mr. Wurzel,

This has been overlooked. Please accept our apologizes for that and I will add them to our file for processing in the final report.
I also classified them mainly relevant for LV/LV transformers (<1,1 kV), which is outside the focus of our Study and therefore the key points of the meeting.

Related to voltage levels:
In principle we refer to Lot 2 (2011) without repeating it, details of the used voltage BC1..7 levels are in the annexes and project report of 2011.
This means that all BC1-6 are MV. In our Review Study we will not consider LV/LV transformers, i.e. BC7, and thus review BC7 which is outside the scope.
But I take note that for the sake of better understanding and readability of the report I will add the voltage levels in the core text of our review report.

Rating plate information downscaling:
Noted.
Please see also ongoing work within CENELEC RC 14 (comments available).
Note that we are discussing medium and large power transformers. It is up to the EC to decide on this issue and this is also related to other products and their marking including horizontal market surveillance actions. Hence, the final word will not come from the study.
>In the study I will add a statement that 'our recommendation is for medium and large power transformers and therefore the area available does not provide an argument to reduce the amount of information. In the context of CE label requirements its market surveillance in future also other digital sources for maintaining relevant product information over its long (>40 years) life time of transformers could be considered, but therefore also an in depth technical and legal assessment will be needed which is outside the scope of this study. Nevertheless, having the information in digital form can have some benefits for preserving and accessing information. In this scenario access to product information from competitors will also be different and might involve data encryption and security. For data storage also a solution will be needed to cope with a manufacturer bankruptcy, e.g. a public database maintained by the EC could provide a solution.'

I hope this answers you main remarks ahead of our final update of the report.

Best regards,

Paul Van Tichelen

From: Nico Wurzel [mailto:Nico.Wurzel@sba.de]
Sent: vrijdag 31 maart 2017 15:05
To: Transformers

1

Subject: AW: Important notification about comments received on draft 'Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for transformers ': will be made public unless we receive an e-mail to request confidentiality

Dear Paul Van Tichelen,

I had sent them a statement by mail on 21.03.2017, why is this not published at the meeting or not with the email distributed to the stakeholder.

Our cooperation is here only useful, if our comment are also presented. I have not contradicted the publication.

Best regards

Nico Wurzel

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Web: www.sba.de

Registergericht: Handelsregister Gera, HRB 1783
Geschäftsführer: Dipl-Ing. Wolfgang Schatzler, Dipl-Ing. Matthias Leipold

Statment from 21.03.2017:

Dear Paul Van Tichelen,

from my point of view, the report contains no clear definition of the transformers (range, voltage level, ...), such as:

- BC3 and BC7 can also be low-voltage transformers according to EN 61558 (input voltage below 1000V)
- BC7 could also be an isolating transformer according to EN 61558-2-4
- to exclude misunderstandings it is helpful always to specify the voltage level in the report, especially in the tables
- the power range gives no indication of the application area; LV transformers can also lie in the MVA range
- Definition of HV, MV and LV transformers is missing
- the values are presumably based on MV-transformers or HV-transformers, this will not certainly recognise everybody and can lead to interpretation mistakes
- our values are certainly not considered in this report (see PDF, email from 12.12.2016)

Also is no information, that transformers less than 1000V input voltage are excluded from the consideration. This should be noted definitely with in the report.
With the last meeting in Brussels in the 9/16/2016 this was discussed because the LV-transformers are rather of subordinated kind and here also no real potential is too recognizable.
Besides, is to be considered that these transformers often are only operated with the machine, system or plant and normally have no-load operation.

Also the marking should reconsidered. The information specifics of the substances of transformers is impractical and not is relevant for the customers, as well as internal know-how of the manufacturer.

2

It is rather unfavourable information (Directive 548/2014 point 3. a, c and d) on the rating plate, because there are too much information. There should be sufficient in the technical documentation or in the data sheet. On the rating plate no later looking more, but on the datasheet. The data sheet is often in digital form and therefore endless durable. However, the rating plate is not often any more readably after some years. We have seen this often by exchange of a old transformers.

For example, the statics plan of an house is not written to the facade or the weights and filling amounts of a car are marked on an plate in the engine space. This information is always to be found in external documents. By cars such information is not even given, so that one is made visit a authorized dealer. Such information on the rating plate is to be found with no other electric device (plastic weight and kind by a vacuum cleaner...). However, we as a transformer manufacturer have to go all revealing. This does not function.

Best regards

Nico Wurzel

Von: Transformers [mailto:transformers@vito.be]
Gesendet: Freitag, 24. März 2017 17:53
An: Cesar.SANTOS@ec.europa.eu; paul@waide.co.uk; Van Tichelen Paul
Betreff: Important notification about comments received on draft 'Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for transformers ': will be made public unless we receive an e-mail to request confidentiality

Dear Stakeholder,

We received several comments from stakeholders on the draft report for discussion in the meeting on next Wednesday 29/3.
Hereby we want to inform you that **they will be made public, unless you explicitly request confidentiality by a reply on this e-mail before Monday 27/3 14h CET** .
Note: if they cannot be made public it is uncertain that we can discuss them and they are only considered background information for the study.

Best regards,

Paul Van Tichelen
Indien u VITO Mol bezoekt, hou aub er dan rekening mee dat de hoofdingang voortaan enkel bereikbaar is vanuit de richting Dessel-Retie, niet vanuit richting Mol, zie vito.be/route.
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27. ANNEX 17 EREA INPUT AFTER MEETING

EREA TRANSFORMERS
erea - energy - engineering

Wijnegem 2017, April 07th

To: Paul Van Tichelen, Paul Waide

Ref:
Minutes of informative stakeholder Workshop for Preparatory study for the review of Commission Regulation 548/2014 on transformers - EC Breydel building (Ayral room), avenue d'Auderghem 45, Brussels, 29th March 2017

Specific Comment was made related to LV/LV transformers.

It is correct, "***Small power transformers***" are defined in Commission Regulation (EU) No 548/2014: **Article 2 - Definitions**:

> *(2) '**Small power transformer**' means a power transformer with a highest voltage for equipment not exceeding 1,1 kV*

Also in **Article 3 – Eco-design requirements** it is repeated::

> ***Small power transformers**, medium power transformers and large power transformer shall meet the eco-design requirements set out in Annex I.*

But in that same document No 548/2014 where in **Annex 1 - Eco Design requirements** are listed, ***Small power transformers*** are no longer 'listed'.... See table of content at the end of this letter.

This means that no table with requirements (or even no guideline) for the "***Small power transformers***"

During the meeting also the terminology "***Low Voltage Transformer***" was used.
It was also said that these transformers have to follow the **Low Voltage Directive** (LVD) 2014/35/EU. This is true. But, basically, The **LVD** covers all health and safety risks of electrical equipment operating with a voltage between 50 and 1000V for alternating current (AC) and between 75 and 1500V for direct current (DC).
This **LVD** does not cover elements as stated in the **Eco-design requirements.**

Other topics addressed in the meeting related to ***LV/LV transformers***

- Based on the evolution of electrical vehicles (electrical charging) also a growth in ***LV/LV transformers*** can be expected. Not only today these ***LV/LV transformers*** are needed (mostly in Belgium due to local particularities with the Grid – missing Neutral), but definitively in the near

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future when Mode-4 DC Charging will be in place (DC charging requires an IT Grid which will require a transformer).

- *LV/LV transformers* are 'building elements' that are used in machines that should follow the "Machine Directive" and it is up to the machine manufacture to develop his 'machine' so that it meets the requirements.
    - Comment:
        - This argument is valid if these are used in a "Machine" as a building block.
        - This argument is not valid in a lot of other situations where a *LV/LV transformer* is just used as a 'single element' to change (transform) the voltage or to change the Grid (IT/TN/TT). Here multiple examples can be given: elevators, industrial laundry machines, heat pumps etc... In these cases the transformer is kept out of the 'Eco-Label' of this application since it is not considered as an integrated part. And as such escaping from the Eco-design rules?
- Also a comment was given that – referring to EUP_2009-125-EG (Eco-design requirements for energy-related products) – Article 15 - 2.:
    - The criteria referred to in paragraph 1 are as follows:
        - (a) the product shall represent a significant volume of sales and trade, indicatively more than 200 000 units a year within the Community according to the most recently available figures.

        - PS – not said in the meeting: Just as an indication: we supply yearly about 50.000 pieces *LV/LV transformer* which do represent an installed power base of 50MVA in total. If needed more figures can be deducted for this ***LV/LV market.***

Conclusion:

Regarding ***Small power transformers*** or ***LV/LV transformer:*** These are defined in the regulation and should follow the regulations but no specific figures about **Eco-design requirements** are listed.
In order to follow the EUP_2009-125-EG - Eco-design requirements for energy-related products requirements should be added.

>R: thanks for the input, it will be used for the update.

Transforming since 1933

pag

EREA TRANSFORMERS
erea - energy - engineering

Table Of Content

Conclusion:

No ***Small power transformers*** is listed

Kind regards,

Herman Nollet.

Co-Owner EREA Energy Engineering

Transforming since 1933

pag

28. ANNEX 18 ENEDIS INPUT AFTER MEETING

ENEDIS
L'ELECTRICITE EN RESEAU

N/Réf. : DT/PLZ

Objet : Minutes of stakeholder workshop
Review of Commission Regulation 548/2014

Paris La Défense, 07 april 2017

ENEDIS have been following the developments within the framework of Ecodesign Directive for many years and fully supports cost- effective measures to increase efficiency and reduce CO^2 emissions.
Since 2014, Enedis proposed approach will give a balance rise for the Commision and DSO. Enedis apply the Regulation tiers 1 and would like to continus with tiers 2 without serious problems for DSO.

>R : noted thanks for the support

Concerning the review tiers 2 of the Commission Regulation 548/2014, the main contraints for Distribution Transformers are :

1) Use the Fixed Losses proposal on the tiers 2 ;

DTs are a larger product in the factory, easy and faster for DSO to control the values of losses (goals are performance and quality), same or similar design all Europeen countries (saving CO^2, materials, cost) and reseach for the futur.
DSO need to prove the performances of the network for Autority. The composants of the network are cable (measure with losses), connecting (losses), switchgear (losses), transformers...Alot devices from network use the same unit than losses (W).
With PEI, for the same power transformer and differents manufactuers, same values PEI, you have diffrentes values of losses. It is not possible to calculate the similar losses for each transformer ;
Enedis buy 10 000 transformers/ year.
Enedis is in favour of fixed losses.

>R : noted and reflected in the final report

2) Single pole mounted ;

The main contraint is the weight with the existing network. When you have a fault inside the pole mounted transformers, it is not possible to wait a long time without electricity and no possible, to built a second pole ... It s a criteria for the Autority.

>R : noted, text added and we hope to work on an appropriate solution

3) Existing network , old building ...

Apply the liste exclusions from Ts Cenelec.
Enedis agree with Ts Cenelec.

1/2

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Enedis - Tour Enedis - 34 place des Corolles
Enedis est certifié ISO 14001 pour l'environnement

ENEDIS
L'ELECTRICITE EN RESEAU

>R : noted

Concerning the review tiers 2 of the Commission Regulation 548/2014, **for larger Transformers :**
Enedis agree with the values PEI from Tiers 2 and the Ts document from Cenelec.
Apply exclusions from Ts Cenelec (existing building and transportation)

>R : noted

Appendix - Description of secondary substations

1) The single pole-mounted substation (350 000 units)

It is designed to receive the following functions : transformer (50 to 160 kVA) with internal protections, external surge arrester, low voltage protection, low voltage and medium voltage line connections. The equipment is installed on a single pole design to carry a 550 Kg maximum load.

2) The semi-rural secondary substation (130 000 units)

The construction is optimized to be integrated in the surroundings and host transformers ranging from 50 to 250 kVA in semi-rural areas. It is designed to receive a 250 kVA maximum transformer, a simplified MV equipment and a LV network protection. Its casing is compact and is positioned on a pad supporting a 1500 Kg maximum load.

3) The urban secondary substation (270 000 units)

The size is bigger and can host a 1000 kVA maximum load, MV protection and operation equipment and LV protection. All electrical functions are positioned on a pad supporting a 2500 kg maximum load.

4) The primary substations (2200 units)

ENEDIS operates 2200 primary substations ; 450 of them are located in densely populated urban areas (Paris, Lyon, Marseille). In urban areas, primary substations are optimally designed in order to be integrated in buildings in above ground or underground locations. In any of the urban 450 existing primary substations, in case of a fault, it would be impossible to take care of it because of a lack of space in the construction.

2/2

29. ANNEX 19 THYSSEN KRUPP AFTER MEETING

thyssenkrupp

Grain oriented electrical steel

Steel
Electrical Steel

Prepared by: Régis Lemaître – Peter Schafeld

24.04.2017
Page 1/2

To attention of : Cesar Santos - Paul Van Tichelen

Subject:
Preparatory study for the review of Commission Regulation 548/2014 on Ecodesign requirements for transformers.
Comments on the draft final report of Vito page 68-69:
4- Task 4 on Analysis of other environmental impacts
4.3 Other issues

As a reminder :

- The surface of GOES sheet is electrically insulated by a coating. The insulation coating process is based on a liquid solution made of various components, usually and basically; phosphate of aluminum or of magnesium, of colloidal silica and of a chromium substance, as chromic acid or as chromium trioxide...

- About REACH an EU regulation: the regulation No 348/2013 of April 2013 amending Annex XIV of 1907/2006 Regulation has introduced the ban of the harmful chromium substances (e.g. chromic acid or chromium trioxide) in Europe as of 21.09.2017

As consequences:

the European GOES producers have to comply with REACH and therefore have developed insulation coating without Cr(VI) harmful components in their manufacturing process. This has been achieved thanks to R&D expenses and thanks to capital investment in coating equipment and with additional process costs.

The non-European GOES producers have not to comply with REACH which leads to an unfair technical competition.

thyssenkrupp

24.04.2017
Page 2/2

Therefore thyssenkrupp Electrical Steel requires to bring the "chromium" issue in the final report of Vito at the chapter 4 – § 4.3 "on Analysis of other environmental impacts".

We propose you the following text:

" GOES sheets used in transformer cores have an insulation coating which is produced by a coating manufacturing process complying with the European regulation No 348/2013 of April 2013 amending Annex XIV of 1907/2006 Regulation REACH.

In such a complying coating manufacturing process none harmful chromium substances are used, as chromium trioxide or as acids generated from chromium trioxide and their oligomers e.g. chromic acid...

A REACH complying coating manufacturing certificate has to be delivered with GOES material used within Eco-design transformer of Regulation 548/2014."

>R: thanks for the input, text updated accordingly

Thank you for your understanding.

with best regards,

Dr.-Ing. Régis Lemaître
Head of Research & Technology
thyssenkrupp Electrical Steel

30. ANNEX 20 ORMAZABAL AFTER MEETING

<u>**ORMAZABAL-ALKARGO-GEDELSA COMMON POSITION IN VIEW OF THE PREPARATORY STUDY FOR THE REVIEW OF COMMISSION REGULATION 548/2014 ON TRANSFORMERS**</u>

- **Referring to Point 1.1.3.2:** Amorphous core technology is never going to be a solution in terms of weight or volume. The reason is the fragility of any amorphous core that forces to build a very robust structure to support the coils in order them to withstand the short circuit current.
  If only one European manufacturer has expressed its intention to produce GOES M2 steel of 0.18 mm, and the quantities they will be able to produce are not clear yet, this doesn´t justify that TIER2 will be feasible in terms of magnetic steel.
  The reduction in losses between M2 and M3 will be much lower than the reduction obtained between M3 and M4 or M4 and M5. This is something known and accepted by GOES manufacturers, and will make the achievements of TIER 2 losses much more complicated for transformers manufacturers.
  >R: noted (see your previous document)
- **Point 1.3.4 and 1.3.5, to be included as a comment at the beginning of page 46 of the document**: PEI and kPEI criterion should be applied from Tier 2 on. Many loopholes can be avoided using this.
  >R: Thanks. Recommendation is kept despite critics from several stakeholders
- **To be included on page 45 of the document:** For power transformers less than 4 MVA but with voltages higher than 36 kV, as PEI criterion must be applied instead of distribution losses, drives to disproportionately large dimensions for those transformers. For example, a 33/11kV, 3150KVA transformer is considered a medium power transformer and applies a loss table, while a 45kv and 50KVA transformer (i.e. for auxiliary services in a substation) is considered LPT and applies PEI. That is not logic and a change on this should be considered.

  Following the same rationale, it does not make sense is that the PEI value for a transformer smaller than 4 MVA at a voltage value higher than 36 kV has more restrictive loss demands than a same size transformer with a voltage lower than 36 kV. What we propose is a losses table similar to the ones in Tier 1 for transformers with a size smaller than 4 MVA in voltages up to 72.5 kV, that will avoid the exceptions to be huge and uncontrollable and also will avoid loopholes. If that is not possible, as a second possibility could be an adapted PEI table including several steps assigning PEI levels to determinate powers from 50 to 4000 kVA.

Power kVA	July 2015 TIER 1	July 2021 TIER 2
25	97,742	98,251
50	98,584	98,891
100	98,867	99,093
160	99,012	99,191
250	99,112	99,283
315	99,154	99,320
400	99,209	99,369
500	99,247	99,398
630	99,295	99,437
800	99,343	99,473
1000	99,360	99,484
1250	99,418	99,487
1600	99,424	99,494
2000	99,425	99,502
2500	99,442	99,514
3150	99,445	99,518

This table has already been proposed to Cenelec as an annex for EN 50629:2015.

>R: also this table is added

- **Generally speaking, dry transformers** should meet the same loss requirements as oil ones. The origin of this misleading criteria, comes from the consideration in the standard that same denominations express different level of losses for dry transformers than for oil ones. For TIER 2 the dry ones should reduce their losses and equal the levels of the oil ones. It cannot be privileged a dirty technology in terms of losses, and therefore efficiency. There should be a specific paragraph within section 3 to eliminate this exception for Tier 2.

  Both technologies (oil type and dry type) have the same outcome, they both do the same work and they are defined exactly the same on IEC 60076.

  A transformer should be consider as a "black box" with one duty, it makes no sense to privilege one technology from another, and it should also be noted that dry type transformers:
  - Have worse noise pollution: the enclosure, the dielectric liquid insulation and a less induction, contributes to reduce noise in oil type transformers.
  - Need more installation space, a major security perimeter is required due to the active voltage components.
  - Have worse response to overloads.
  - They are more difficult to be installed outdoors: require complex enclosures with extra refrigeration systems which consume more resources.

- Their components (specially the conductors embedded in epoxy resin) are more difficult to be recycled, so the environmental impact is higher.

Also it should be noted that dry type transformer manufacturers are already using amorphous cores and achieving the oil transformer losses without any difficulty.

>R: we received several similar comments and maintain this for Tier 3.

- **Regarding point 3.3 about the concessions for dual ratio Transformers**, we know that some transformer manufacturers are using that concession to take advantage of the margin in losses (10-15%) and sell dual ratio transformers at a cheaper price than single ratio ones, even if only a single ratio is required. This is a trick to sell a tricky Eco-design transformer to customers who does not care about the losses but only the price.
The technology developed in eco-design transformers at this moment perfectly allow to manufacture dual ratio transformers without using this margin.

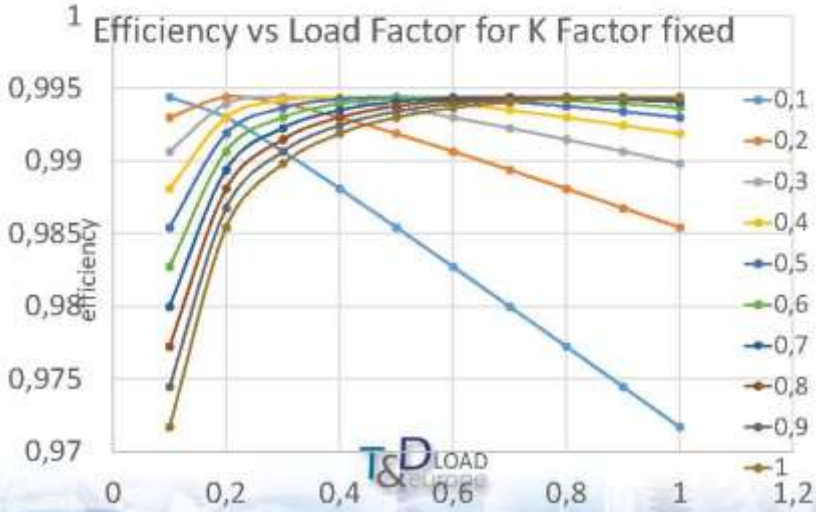
>R: added to the text

- **For point 3.4.1 on page 65**, we agree not to keep exceptions for pole mounted transformers.

>R: noted added to the text.

31. ANNEX 21 T&D EUROPE AFTER MEETING

Limits of losses for TIER 2 could be changed from A0-10%Ak to A0-15%Bk



01/06/2017

Comparison with the new level

Case of load factor 0,18				
List	Load factor	CO2	LCCT	PRICE
A0-20CK	0,273	2,0%	-	--
A0CK	0,306	15,0%	-	---
A0-15BK	0,308	0,0%	-	--
A0-10BK	0,317	5,0%	-	--
A0-10AK	0,345	REF		0

Case of load factor 0,3				
List	Load factor	CO2	LCCT	PRICE
A0-20CK	0,273	14,5%	++	--
A0CK	0,306	23,9%	++	---
A0-15BK	0,308	5,9%	+	--
A0-10BK	0,317	8,5%	+	--
A0-10AK	0,345	0		0

- **TIER 2 defines in the regulation is the best solution**
- **Two lists of losses could not gives advantages and particularly at long time**

>R: noted and vision added

01/06/2017 4


Conclusions Stakeholders Forum 29-03-17
• 5 The use of PEI for distribution transformers is not yet totally excluded despite of some requests done by some utilities but not Enedis and not clearly Enel.
• PEI or several lists of losses lead to:
- De-standardization of components and products with a non-negligible increase of costs for small series(can be>10%...)
- Reduce product competition as premises will have advantages over non-local (better-adapted products with adequate stock)
- -A poor adaptation of transformers for diffuse markets where the first price will be the priority of manufacturers and not CO2 reduction
- -An incentive to cheat because the PEI is a complex notion and more difficult to understand by the users
- -Against the construction of a Europe where the rules are the same for all
T&D europe
>R: noted and vision added
5


Conclusions Stakeholders Forum 29-03-17
• 6 Exemption can be reviewed with efficiency of material:
• In some circumstances it may be not technically feasible or economically justifiable to reach the energy performance specified in this standard, due for instance to physical constraints in an existing installation. In this case it is the responsibility of the customers to obtain the exemption before placing the order.
The customer will ask the following alternative quotations: TIER 2 compliant, TIER 1 Compliant
If TIER 2 is possible it must be chosen. If TIER 2 is not possible TIER 1 shall be chosen.
• We do not propose any other alternative. The minimum level must be TIER 1
>R: noted but it might open the door for staying at TIER 1
• 9 Excluded transformers product information requirement are not well covered in Cenelec. Web site acces should be also reviewed
>R: noted
T&D europe

32. ANNEX 22 HME AFTER MEETING

Hitachi Metals Europe GmbH Comments:
On Stakeholder Comments on the Draft Final Report
&
On the Presentations made at the Stakeholder Meeting
and on the Stakeholder Meeting Minutes

Hitachi Metals Comment - On Stakeholder Comments on the Draft Final Report

Guillermo Amann Comments on Draft Final Report – Referring to Point 1.1.3.2:
As stated in Hitachi Metals GmbH comments on the Draft Final Report, AMDTs respect the requirements on short circuit as exemplified by CIRED Paper from June 2009. This is a non-issue and should not be mentioned in the text. Reply: text will be updated.

Hitachi Metals Comments - On Stakeholder Meeting Presentations and the Stakeholder Meeting Minutes

Page 7 – Presentation of Eurelectric - The Eurelectric presentation refers to Laborelec report which presents a 30% to 120% increase in transformer prices between Tier 1 and Tier 2. Please see the T&D Europe comments on the Draft Final Report section 1.8, which clearly states that the Belgian market is not representative of the EU transformer market as a whole. Also using Best Avaialbale Technology as exemplified by the Siemens documentation (630 kVA Distribution transformer) one can see that the savings in losses exceed 42%, whereas the purchase price is only 30% higher than under Tier 1.

Reply: text is updated

Page 12 – Eurelectric remark on Paul Waide's presentation on single phase transformers (15 kVA) - We can not understand Eurelectric's claim regarding this excessive weight increase. HME would like to point out that for 16 kVA, there are many key regions in the world that are moving towards amorphous.

Reply: noted

Hitachi Metals GmbH 1 21 April 2017

33. ANNEX 23 ECOS AFTER MEETING

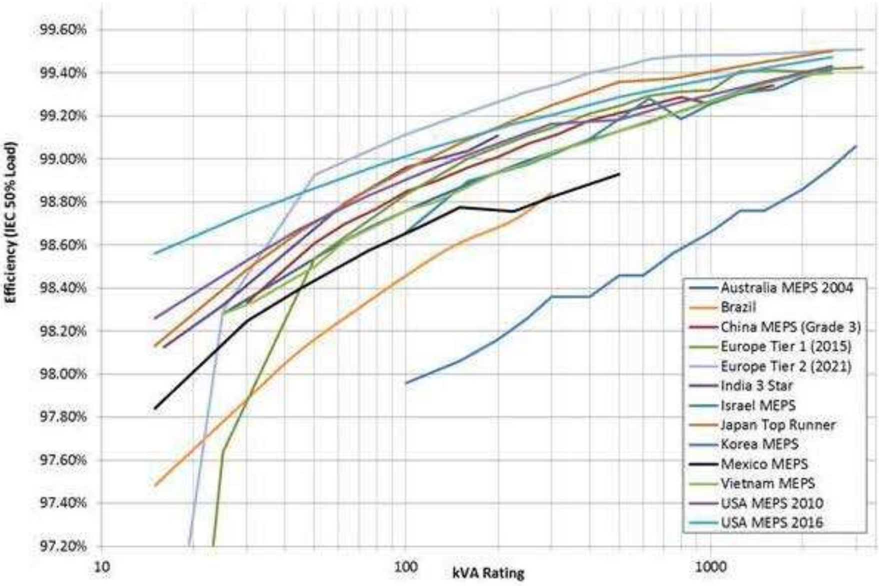
Van Tichelen Paul

From:	Transformers
Sent:	vrijdag 31 maart 2017 11:58
To:	Van Tichelen Paul
Subject:	FW: Europe low ambition for <25 kVA three-phase liquid units

Van: Michael Scholand
Verzonden: vrijdag 31 maart 2017 11:23:30 (UTC+01:00) Brussel, Kopenhagen, Madrid, Parijs
Aan: Transformers
CC: Jeremy Tait - Tait Consulting; Cesar.SANTOS@ec.europa.eu
Onderwerp: Europe low ambition for

Dear Paul -

I was just updating a graph I'm preparing for UN Environment and I realised I had stopped the European curves at 25kVA because of the table of maximum losses has ≤ 25 kVA. When I extended it down to 5 kVA holding the maximum losses as they appear in the table, I found a very strange result.....I have to admit, its worse than I thought. Look at how out of alignment Europe is with the rest of the world's MEPS on these smaller ratings.



You'll be hearing more from me on this in the future, but I think we need to address this issue.

Thanks again for posting the slides so quickly.

Kind regards,
Mike

>R: thanks for letting us this know. will be added.

1

Michael Scholand
Senior Advisor, Europe Program
CLASP
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Tel(BE): +32 2 808 7351
Skype: mscholand
mscholand@clasp.ngo
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Transparency register number: 281884219679-57

2

34. ANNEX EURELECTRIC REPORT BEFORE MEETING

A EURELECTRIC response paper (March 2017): 'Consultation on Tier 2 Fixed Loss Levels on Distribution and Power Transformers implementation',
Dépôt légal: D/2017/12.105/9 available from:
http://www.eurelectric.org/media/314743/eurelectrc_resp_ecodesign_tier2_250317_final2_public-2017-030-0205-01-e.pdf

35. ANNEX CENELEC PRTS50675

Technical specification prTS 50675 :2017 on 'Power transformers energy performance' is available from CLC/TC 14 Power transformers:

https://www.cenelec.eu/dyn/www/f?p=104:7:538425502809101::::FSP_ORG_ID,FSP_LANG_ID:1257153,25

36. PROJECT WEBSITE REGISTRATIONS

	Company / organisation name	First Name	Surname
1	Swiss Federal Office of Energy	Roland	Brueniger
2	ArcelorMittal	Sigrid	Jacobs
3	Rockwell Automation	Iain	Lindsay
4	Siemens AG	Karin	Uebelhoer
5	environment agency germany	Andreas	Halatsch
6	The Federation of Fiinish Technology Industries	Carina	Wiik
7	Energy Networks Association	Jane	May
8	ZVEI	Reiner	Korthauer
9	Noratel AS	Ray	Thomson
10	Viegand Maagøe A/S	Annette	Gydesen
11	European Copper Institute	Roman	Targosz
12	Siemens AG	Lina	Lau
13	NVE	Mari Hegg	Gundersen
14	Electricity North West Limited	Matthew	Kayes
15	EDF CNEPE Centre National Ingénierie Nucleaire	Christophe	ELLEAU
16	Piraeus University of Applied Sciences (formerly TEI Piraeus)	Constantinos	Psomopoulos
17	SBA-Trafobau Jena GmbH	Nico	Wurzel
18	T&D Europe	MICHEL	SACOTTE
19	Tramag Transformatorenfabrik GmbH	Patrick	Egerer
20	ABB	John-Bjarne	Sund
21	T&D Europe	Pierre	Lucas
22	thyssenkrupp Steel Europe AG	Said	Nekroumi
23	NVE	Kirsti Hind	Fagerlund
24	Netherlands Enterprise Agency	Hans-Paul	Siderius
25	Hafslund Nett AS	Asgeir	Mjelve
26	Møre Trafo AS	Nemanja	Grubor
27	Vacuumschmelze GmbH & CoKG	Holger	Schwenk
28	Cefic	Bernd	Kappenberg
29	trafomodern Transformatorenges. m.b.H.	Christoph	Blum
30	Trafomodern Transformatorenges.m.b.H	Thomas	Hammermueller
31	General Electric (GE) Grid Solutions	Boris	Kacmar
32	ICL-IP	Eric	Sitters
33	ABB	Kai	Pollari
34	Siemens AG	Michael	Heinz
35	J. Schneider Elektrotechnik GmbH	Thomas	Hug
36	ebm-papst GmbH & Co.KG	Uwe	Sigloch

37	GE	Elisa	Gastaldi
38	ABB	John-Bjarne	Sund
39	NEK	John-Bjarne	Sund
40	thyssenkrupp Electrical Steel GmbH	Peter	Schafeld
41	thyssenkrupp Electrical Steel GmbH	Nicole	Wiese
42	thyssenkrupp Electrical Steel	Guy	Ligi
43	thyssenkrupp Electrical Steel	Régis	Lemaître
44	Austrian Energy Agency	Thomas Maurizio	Bogner
45	Elettromeccanica Tironi srl	Gino	Tironi
46	CG Power Systems Belgium NV	Bram	Cloet
47	RTE (French TSO)	Jean-Christophe	RIBOUD
48	Norwegian Water Resurces and Energy Directorate	Helge	Ulsberg
49	ESB	Anthony	Walsh
50	Energy Networks Association	David	Crawley
51	BLOCK Transformatoren-Elektronik GmbH	Wolfgang	Reichelt
52	Maschinenfabrik Reinhausen	Manuel	Sojer
53	CENELEC	Angelo	Baggini
54	Tramag Transformatorenfabrik GmbH & Co. KG	Stefan	Plieth
55	ENTSO-E	Thong	Vu Van
56	Siemens Wind Power	Jesper	Gaard
57	Synergrid	Wim	De Maesschalck
58	Laborelec	Robby	De Smedt
59	Končar D&ST d.d.	Ivan	Sitar
60	Viegand Maagøe A/S	Carsten	Tonn-Petersen
61	thyssenkrupp Electrical Steel GmbH	Andreas	Jansen
62	National Grid UK Electricity Transmission	Paul	Jarman
63	Vattenfall Distribution Sweden	Per	Norberg
64	Ellevio AB	Eskil	Agneholm
65	Murrelektronik GmbH	Matthias	Eschle-Reinold
66	Norwegian water and energy resources directorate	Lars Andreas	Eriksson
67	Bowers Electricals	Anthony	Hall
68	NVE	Christer Heen	Skotland
69	EREA Energy Engineering	Herman	Nollet
70	Tramag Transformatorenfabrik	Matthias	Geinzer
71	thyssenkrupp Electrical Steel GmbH	Thierry	Dr. Belgrand
72	ICF International	Emmy	Feldman
73	SCHNEIDER ELECTRIC	Philippe	CARPENTIER
74	Belgian Ministry of Environment	Bram	Soenen
75	Bticino	Adriano	Fantozzi
76	TUV SUD China	Gary	Sun

77	E.ON SE	Armin	Vielhauer
78	Siemens AG	Michael	Heinz
79	EDP Distribuição	Fernando	Ramalheira
80	UK Power networks	Paul	Dyer
81	GEDELSA TRANSFORMERS	MAR	OLMEDO
82	CLASP Europe	Michael	Scholand
83	Dept for Business, Energy and Industrial Strategy	Mike	Rimmer
84	ICF	Mark	Allington
85	Miistère de l'écologie et de l'énergie	Evelyne	BISSON
86	Agoria	Tim	Hamers
87	ECOS	Chloe	Fayole
88	Isomatic Lab	Todor	Todorov
89	HVOLT Inc.	Philip	Hopkinson
90	CSRA	Ben	McConnell
91	RTE	Jean-Christophe	Riboud
92	CENELEC	Roberto	Zannol
93	DuPont	Radoslaw	Szewczyk
94	VSL	Gert	Rietveld
95	Kolektor ETRA	Istok	Jerman Kuželički
96	Bultraf Ltd	Dimitar	Petkov
97	CERB EAD	Dimitar	Beleliev
98	Umweltbundesamt	Andreas	Halatsch
99	CAHORS Transfix	Frédéric	Walter
100	BLOCK Transformatoren-Elektronik GmbH	Andre	Lühring
101	Liander	Co	den Hartog
102	German Environment Agency	Ines	Oehme
103	Končar Distribution and Special Transformers, Inc.	Ivan	Sitar
104	Mitteldeutsche Netzgesellschaft Strom mbH	Michael	Schmidt
105	ENEDIS	Patrick	LAUZEVIS
106	STEDIN B.V.	Theo	Meeks
107	SEVEn, The Energy Efficiency Center	Juraj	Krivosik
108	Enduris B.V.	Pieter	Oosterlee
109	ORMAZABAL	Guillermo	AMANN
110	JST transformateurs	Mathieu	Sauzay
111	Gimelec	Philippe	Tailhades
112	SEMI Europe	Ourania	Georgoutsakou
113	Končar Distribution and Special Transformers, Inc.	Dominik	Trstoglavec
114	Topten	Ian	Rothwell
115	Swedish Energy Agency	Anders	Hallberg
116	Anie Confindustria	Ilaria	Sticchi
117	ABB Ltd	Richard	Holliday

118	Eisenmann Thermal Solutions GmbH & Co. KG	Andreas	Möbus
119	e-distribuzione	Flavio	Mauri
120	legrand	COLANGE	Olivier
121	EDP Distribuição	Fernando	Ramalheira
122	Danish Energy Agency	Bjarke	Hansen
123	ENERCON GmbH	Sven	Heinks
124	Electricity North West Limied	Matthew	Kayes
125	ZVEI	Rolf	Winter
126	Enerrgy Networks Association	Vincent	Hay
127	Netze BW GmbH	Andreas	Hettich
128	ABB Transformers Oy	Esa	Virtanen
129	ECOS	Nerea	Ruiz Fuente
130	ZVEI e.V.	Rolf	Winter