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

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Overview

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

Principals:

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.

Principals:

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?

Principals (contd.)

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

Approach:

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

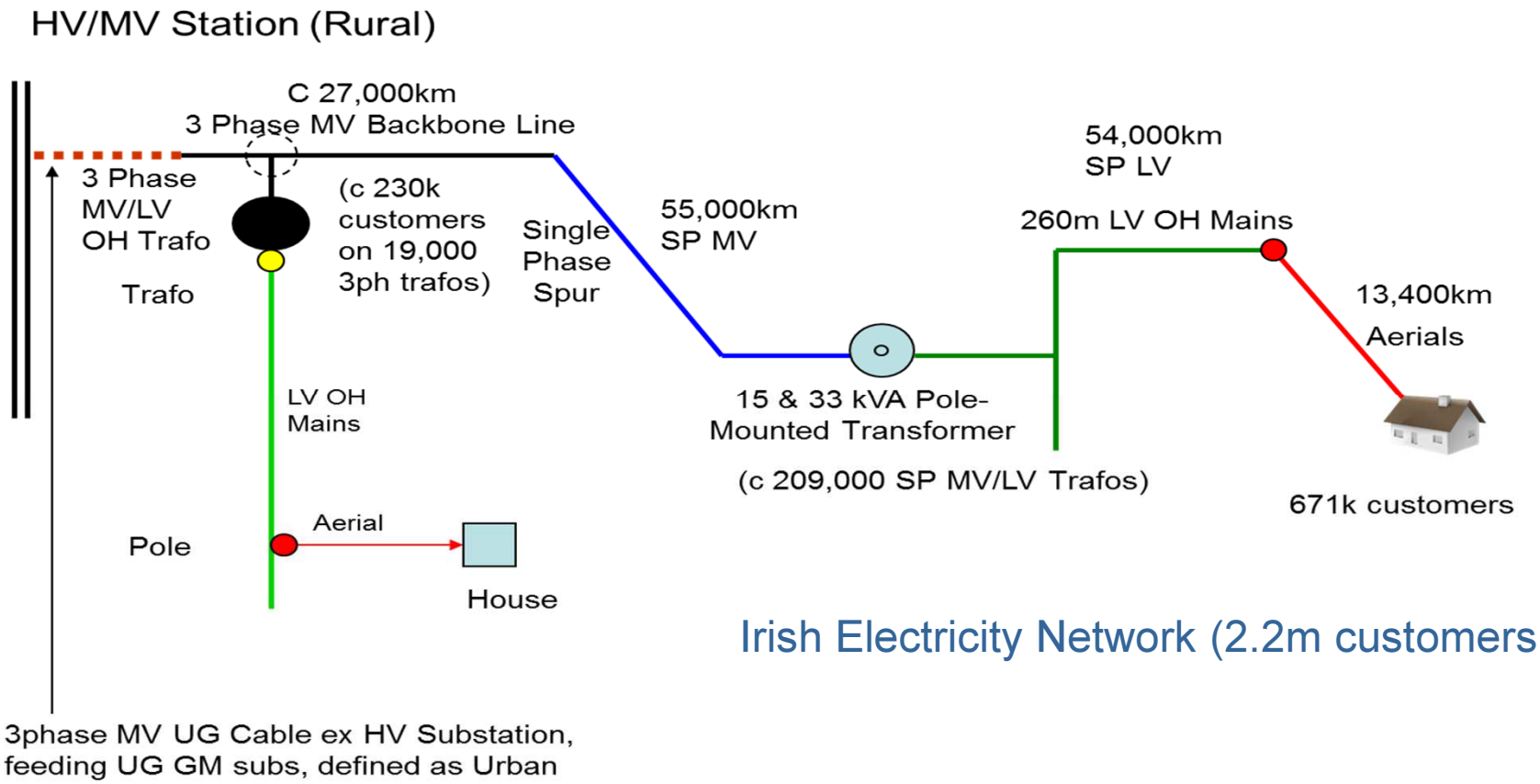
- Utilities/Eurelectric whose customers pay for any changes
- Cenelec representing Transformer Manufacturers and Users

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!

Single Phase Transformers

Single Phase Transformers



Irish Electricity Network (2.2m customers)

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.

Single Phase MV/LV Pole Mounted Transformers

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.

Single Phase Transformers

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.

Transformer Losses proposed by Cenelec to EU

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.

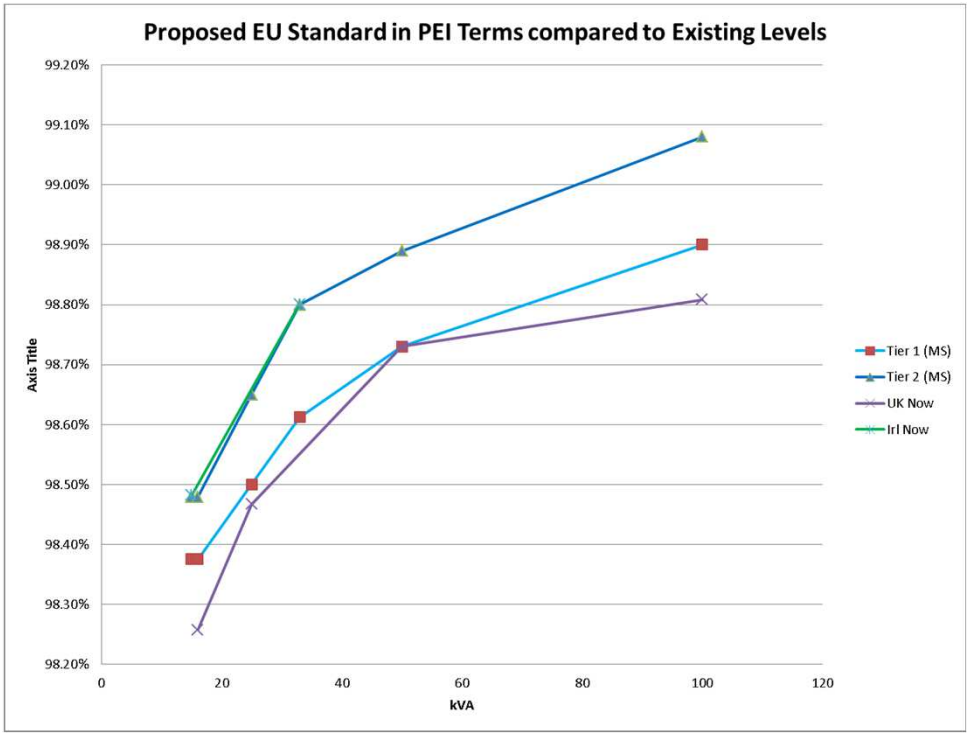
kVA	PEI Level 1 %	PEI Level 2 %
15	98.38	98.48
16	98.38	98.48
25	98.50	98.65
33	98.61	98.80
50	98.73	98.89
100	98.90	99.08

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%

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

Graphical understanding



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.

Sensitivity Analysis (Background):

	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.