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

T&D Europe[1] position paper on "Working documents on a possible Commission Regulation implementing Directive 2009/125/EC with regard to small, distribution and power transformers"(versions of 20.03.2012 and 11.10.2012)

Brussels, 6th November 2012

Part 1: Large Power Transformers

Executive Summary

The manufacturing industry represented by T&D Europe has been constantly active in improving the energy efficiency performance of its products.

This has been shown with 4 positions papers[2] and 2 surveys from T&D Europe, one on Loss Evaluations in the EU and one on Measured Losses, Po and Pk from the latest 3 years for different categories of LPTs (Large power transformers). Both surveys have been documented.

T&D Europe has strongly supported CENELEC activities by leading EN standard for medium voltage transformers and by an active participation of many experts in the sub group for large power transformers.

The VITO report "LOT 2: Distribution and power transformers "suggests that the efficiency improvements required for power transformers can be achieved by using fixed Minimum energy performance standards (MEPS).

[1] T&D Europe (www.tdeurope.eu) is the European Association of the Electricity Transmission & Distribution Equipment and Services Industry, which members are the European National Associations representing the interests of the electricity transmission and distribution equipments manufacturing and derived solutions. The companies represented by T&D Europe account for a production worth over € 25 billion EUR, and employ over 200,000 people in Europe.

[2] T&D Europe position paper on the EU Eco-design directive (Revision January 2009); T&D Europe position on Implementing Measures for transformers in the framework of the EU Eco-design Directive (23 September 2011) - unpublished; T&D Europe Position Paper on Power Transformers (10 April 2012), T&D Europe position on Power Transformers ffollowing the meeting of the Consultation Forum on Power, distribution and small transformers (16 May 2012).

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In an earlier position paper, T&D Europe showed that the MEPS approach cannot effectively be used for Power Transformers due to **their large variability in specification requirements**. T&D Europe therefore proposed to continue to use the Total Cost of Ownership (TCO) method to reach the goal for increased power transformer energy efficiency. EC ENTR stated that this method cannot be applied in an Eco Design directive. Eco design directives can give requirements on products only.

In its Working Document of 20.03.2102, the European Commission DG ENTR proposes **Option 1: Maximum Losses,** which is not possible for LPT. **Option2: Minimum Efficiency,** one expected to use equations/formulas to provide a percentage minimum efficiency that must be met or exceeded at that particular loading point for a particular rating of transformer.

T&D Europe has now analysed such a population of many hundreds of transformers in the lower range of LPT , 5 – 100 MVA) and have found a number of difficulties and also risks in an implementation where the result can be status quo on loss reductions and also increases of losses.

Analysis of OPTION 2: Minimum Efficiency and Peak Energy Efficiency (PEE)

T&D Europe has presented to the European Commission examples from surveys on how PEE (Peak Energy Efficiency) can look like for a population of power transformers.

Because of the large variability in specification requirements, we have only looked deeper on power transformers >36 kV in the range from 4 – 100 MVA, which represents the largest share of LPT.

At this stage we have excluded from closer analysis:

- Larger transformers 100 MVA and above[3]
- Larger Generator Transformers 100 MVA and above
- Shunt Reactors
- Industrial Transformers
- HVDC transformers
- Phase Shifting Transformers

The above have been excluded because of specific technicalities very different from the bulk of transformers installed.

We analyzed a group of 60 MVA full, 2 winding transformers and saw a spread in PEE from about 99.58% up to 99.85%. In this example, between the minimum and maximum value of efficiency the value of losses are multiplied by 2.

It is not known from those examples what loss evaluations they were designed for, what impedances, what BIL or other possible parameters which determine the losses.

[3] Reason for not now analyze larger units are that they are very often used in meshed transmission networks where the short-circuit impedance are to guide the power which gives limitations

T&D Europe made a calculation for one BIL, one impedance-value but varied loss evaluations from 4000 EUR/kW up to 12000 EUR/kW for no load losses at Load Factor about 50% and got his result.

Weight vs. Peak Energy Efficiency

MVA	60 MVA 132+-9x1,67%/20 kV, uk=12 %							
Capitalization KEUR[4]	4/1	7,6/2	10/2,5	12/3	4/1	7,6/2	10/2,5	12/3
Core steel designation	M080-23P				M105-30P			
Po Kw	21,2	22,8	22,3	22,8	25,2	27,3	26,6	26,9
Pk kW	245,3	214,5	192,9	174,4	246,9	206,8	195,8	178,2
LF at Max. PEE	0,2940	0,3260	0,3400	0,3616	0,3195	0,3633	0,3686	0,3885
Max. PEE	99,76%	99,77%	99,78%	99,79%	99,74%	99,75%	99,76%	99,77%
Change weights in Fe	100%	115%	119%	124%	100%	115%	118%	124%
Change weight in Copper	100%	114%	135%	150%	100%	114%	131%	145%

This table shows that PEE is not a relevant method to improve energy efficiency because with one PEE value specified we can have a cluster of possible solutions.

PEE is not a relevant parameter to define energy efficiency properly and it is necessary to specify TCO (Total Cost of Ownership) as it is currently done by utilities to reach the optimum value of energy efficiency.

Consequences of setting MPEE (Minimum Peak Energy Efficiency) limits

The political goal of Eco design is to analyze how much losses can be saved in the EU electrical network, where the transformer losses are estimated to be in the range 70 -100 TWh at the current load factors.

Even if the transformers are the most efficient equipment in the value chain from source to user, they have huge absolute losses if we add all millions transformers in the network.

The industry has used capitalization of losses to find optimum at each purchase occasion. T&D Europe has shown that the average used capitalization is 7600 EUR/kW for NLL and 2200 EUR/kW for LL. The spread is from 1000EUR/kW up to some cases over 18.000 EUR/kW. These numbers show a clear tendency that the loss capitalization is steadily increasing in average. But is also shows the big variety in how different companies see the socio-economic impact of the losses in the society and utility. It deals

[4] First number is capitalization value of no load losses. The second is capitalization value of load losses
This is an example on a good working optimization process taking into account weight variations of all material especially core steel and copper.

with the risk assessment of life time, interest rates, inflation, expected energy costs and carbon-dioxide taxes.

It has now by examples been shown by T&D Europe and will be shown by the CENELEC that there are many complex parameters which are setting the PEE.

Is it possible to set a first MPEE limit? Here are the questions and some possible consequences by setting a MPEE:

- If we can do it for a group of rather complex power transformers 5 – 100 MVA, can we then do it for the rest of the variety of transformer groups as said above?
- Even if we may see some interdependencies between PEE , loss evaluations, BIL, impedances, regulation for a rather complex group as 5 -100 MVA, will it be possible to set a first limit that can be cost benefit analysed at an impact assessment ?
- It is not known how a manufacturer will design with the Po and Pk losses to match a MPEE value if a loss capitalization is not used. Loss capitalization must always be used to optimize the LPT product.
- If the future regulation sets a first limit on MPEE, how will then the market act? Will the market use it as a target value only, and loss capitalization numbers only as recommendation? Will the procurement process be changed? How will the material supply market interpret the change?
- If we set the MPEE too low, we have one scenario where companies under financial pressure will go away from normal capitalisation to buy the cheapest ones and we create more losses in the network.
- On the contrary, if we set the MPEE limits too high for any reason we might get a postponement of investments by those who use low capitalization values. By that we will keep inefficient transformers in operation for a longer time.
- The market for power transformers have never been subject to this type of legislation before. If the regulation is set incorrectly, this may create disturbance for many years.
- Normally, energy directives are set on electrical products for end consumers and not in the complex network-system itself, where the component losses are part of the whole system losses.
- The Eco-design directive deals with products with short life time (1 to 10 years), which implies a quick replacement and impact on losses. Transformers have lifetimes which now are known in EU to be more than 40 years. Any mistake in a new regulation will have huge impacts.
- It is most unrealistic to make impact assessments for the huge variability of power transformers since the base-line cannot be quantified in total as for subgroups.

The only choice of MEPS value leads to unrealistic choice of the transformers as well as uncertain investment by utilities, without reaching the EU energy efficiency targets.

What steps to be taken now?

The TCO concept has been the successfully used methodology to combat network and transformers losses in the industry. The T&D Europe survey also showed both that values seem to have increased to

save losses only the latest 4 – 5 years, but also that we have a big scatter in handling risks and estimations of loss capitalization parameters to get correct loss capitalization numbers. They may differ from country to country but also within countries.

Regulators in countries are setting ex-ante regulations for tariffs and operational excellence performance for all utilities to protect consumers and to attract new investments.

The method of PEE and MEPS are not sufficient to fulfil the target to reduce the huge amount of large power transformers losses ranging around 55 TWh.

For large power transformers, the TCO method is a tool currently and successfully used by the utilities for the purpose of reducing the losses, but it cannot use due to the Eco-design directives rules (which apply only to products).

The results achieved so far by the European Commission Sub Group on Large Power Transformers are a very good basis, but are still not accurate to implement a regulation for Large Power Transformers.

This Subgroup with its innovative approach, involving major stakeholder like the CENELEC, UTILITIES, MANUFACTURERS, ENVIROMENTAL SPECIALISTS under the leadership of the European Commission shall provide a formal recommendation within the frame of one year.

Part 2: Small and Distribution Transformers

Modifications for planned Implementing Measures requested by T&D Europe regarding transformers with medium voltage not exceed 36Kv

For the tiers 2, as already written, we consider that 2018 is a too short period of time to make the modifications. The expenses already made in 2014 to get transformer agreements with utilities and modifications of the tools in the companies will be high. Moreover, the time to develop the new magnetic steel to reach the new level of losses is too short. We propose 2020 as date for the 2nd tiers.

To complete, we would like to be ensured that the control measures will be clearly defined, regarding the level of the losses of the delivery transformers, by some clear and periodic process, to avoid some deviation of the transformers delivered.

For the pole mounted transformers 160kVA the maximum weight is 550kg, and it is not possible to reach this weight with the level of losses given in the latest version of the planned implementing measures (Working Paper of 11.10.2012). To reach this weight, the level of losses shall be C0 (CK*1,32). It is not possible to manufacture these transformers with the level A0Ck. Without these values of losses

and no load losses, the manufacturing of pole mounted should be stopped with the consequences associated.

As it was proposed in the first Working Document for Implementing Measures (30.03.2012) we would like to inform that T&D Europe wishes to keep the level A0Ck for transformers up to 630kVA. In fact, the level of losses which is proposed in the new document will lead to considerably increased investments for the user, considering the fact that housing and infrastructure should be changed due to weight and dimensions.

Considering the level in 2020, we again recall that the minimum level that had been checked was A0-15%, whereas in the new draft of 11.10.2012 the level requested is A0-20%. This hypothesis of A0-15% was possible if the magnetic steel suppliers are able to supply magnetic steel at very low level in 2020. (0,65w/kg). We consider that this new decreasing of the minimum level will probably lead to some technical difficulties, at least for dry type transformers, where the feasibility at this level will be difficult.

After a fine-tuning of the CENELEC standard proposal, national standardisation committees have prepared the following remarks, which should be used to modify the draft Implementing Measures (Working Document of 11.10.2012, Annex 1) in order to facilitate the manufacturing of transformers:

Table 1.4 of Implementing Measures: (Working Document of 11.10.2012, Annex 1):

- One winding with Um = 36 kV and the other with 1,1 kV <Um≤24kV. It will be necessary to increase by 30% for no load losses for dry type transformers (15% for liquid immersed)

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- One winding with Um = 36 kV and the other with Um **>** 1,1 kV It shall be necessary to increase by 35% for no load losses for dry type transformers (20% for liquid immersed)

Table 1.6 of Implementing Measures (Working Document of 11.10.2012, Annex 1):

Short circuit impedance shall be extended for dry type transformers.
4 to 6,3 MVA Impedance shall be indicated between 7% and 9%
8 to 10 MVA Impedance shall be indicated between 8% and 10%

Finally, some other special transformers should be excluded from the Implementing Measures, such as:

- Transformers for high current rectifiers
- Transformers to furnace application
- Transformers for offshore platforms and floating offshore installations
- Transformers for mobile installations
- Transformers and auto-transformers for 16.7 Hz railway feeding systems
- Auto-transformers for 50 Hz railway feeding system earthing transformers.