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Approvals

Name	Approval
Jeff Kelliher	August 11th
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1. Introduction and Background

As part of the review of the locational signals on the island of Ireland, the RAs have requested that the SOs carry out a study to determine what a single uniform transmission loss factor (UTLF) would be on an all-island basis. This paper outlines (at a high level) the studies completed by the SOs to determine a reasonable measure of the uniform transmission losses on the all-island system. The paper describes at a high-level the methodologies used to arrive at a single figure. In arriving at a single figure, the SOs sought to maintain an accurate and technically acceptable approach using standard tools and procedures. While there are a number of different methodologies available, the SOs attempted to reduce the impact or subjectivity on the final results.

2. Overview of Methodology

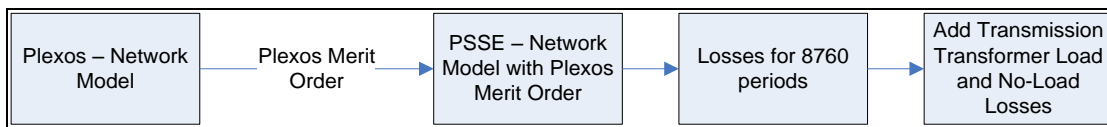| Plexos – Network Model	Plexos Merit Order →	PSSE – Network Model with Plexos Merit Order	→ Losses for 8760 periods	→ Add Transmission Transformer Load and No-Load Losses

Figure 1 High Level Overview of Methodology

In order to arrive at an acceptable figure this methodology attempts to provide a large number of cases to calculate transmission network load losses. By taking every hour in a year (8760) and by using AC Loadflow to calculate the transmission network load losses for each hour, the approach uses both an internationally acceptable tool and a large sample to identify the likely average Load Losses on an all-island system. Once the PSSE Load Losses are calculated, Transmission Transformer Load and No-Load Losses are added.

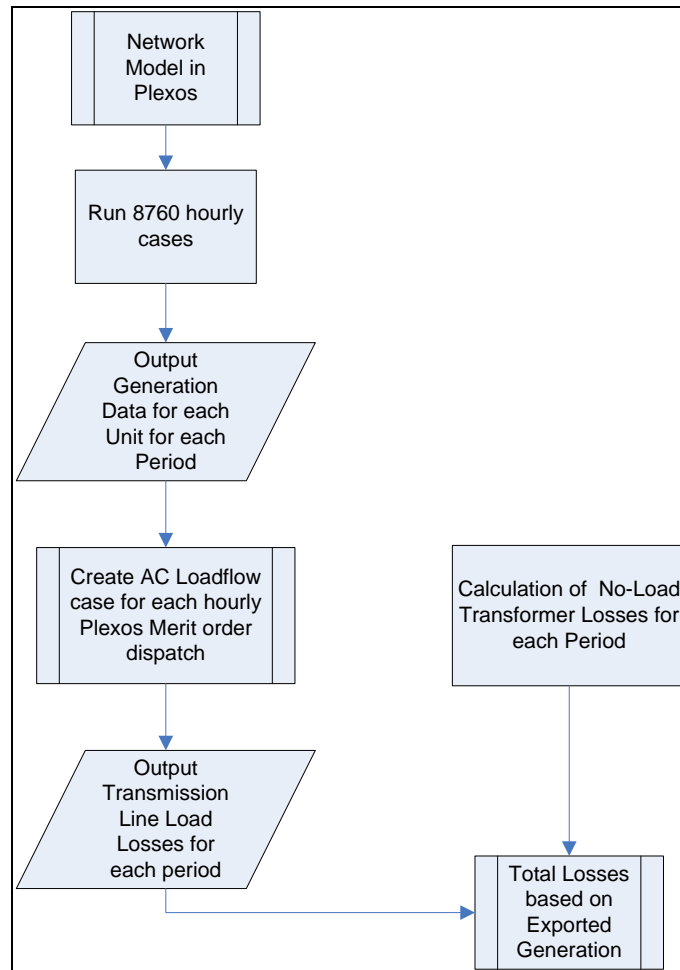The following methodology description outlines the steps taken:

Figure 2: Flow Chart of tasks involved in the study

a. A forecasted merit order generation dispatch is produced for every hour of the year 2010/2011 using the a Transmission Network Model

b. Using a Python script this is imported into PSSE

c. PSSE calculates losses for each of the hourly dispatches

d. This is summed and divided by the exported (sent out) generation to calculate the ULF

e. A Utilisation Factor is calculated for the Transmission System Transformers

f. The Transformer Load Losses are calculated using the Utilisation Factor

g. The Transformer No-Load Losses are calculated based on the Transformer Data Sheets

h. The final losses figure is reported as a function of exported generation

3. ASSUMPTIONS

The list includes those assumptions which are related to the calculation of a Uniform Transmission Loss Factor:

1. 8760h of forecasted demand and generation for the period of 2010-2011. The network and model are the same as those used for the dispatch balancing cost calculations for the same period completed by EirGrid and SONI;

2. The UTLF calculation is based on a Plexos model which was developed around a locational nodal TLAF but which is adapted accordingly;

3. An AC Load-flow case is created for each hourly Plexos dispatch.

4. The Plexos model takes appropriate transmission and generation outages and other constraint drivers into account as per the dispatch balancing costs model;

5. The modelling assumes that there are no extra losses incurred on the system as a result of an alternative losses methodology;

6. The final result is losses as a function of exported generation on the transmission network;

7. The final All-Island figure includes [1]load and no-load technical losses;

8. The final figure allows for modelling errors including those associated with voltage variance.

4. RESULTS

The overall average figure calculated for the all-island system is 2.14%. This is based on a uniform loss factor merit order dispatch. The use of an alternative approach to uniform may alter this average figure for losses.

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[1] Technical losses refer to Load and No-Load Losses incurred by the operation of the Transmission Network (Includes Transmission Lines, Substation and Transformers).

Loss Type	Losses Applied To:	Load Losses	GWh Losses	No-Load Losses	GWh Losses	Total (GWh Losses)
Technical Losses	Transmission Network (110kV Lines & Up)	PSSE	627.9	N/A	N/A	
	Transmission Substations			Using Manufacturer's Data Sheets/Test Sheets/ Assumptions	3.5	631.4
	Transmission Transformers	Using Trafo count, % Utilisation Factor, Manufacturer's Data Sheets & Trafo Test Sheets	-	Using Manufacturer's Data Sheets & Test Sheets & Assumptions	-	90.1
Total Technical Losses (GWh)						**721.4**
Losses as % of Sent Out Units						**2.14%**

Figure 3: Breakdown of Average System Losses

5. ADDITIONAL STUDIES

A number of additional independent studies were carried out using alternative methodologies in connection to this work. In each case an alternative methodology was used which had different set of assumptions and included mathematical approaches which differed to the one described in 3 above. While the methodologies and approaches were quite different the results were not substantially at variance with the results in 4. Note that in one case the study was carried out on the NI system and an extrapolation used to extend the conclusions to the ROI.

There are a number of assumptions associated with this study but the SOs will carry out a number of additional studies to confirm its results.

6. REFERENCES

LLF paper –

* http://www.topenergy.co.nz/pdf/Top%20Energy's%20Loss%20Factor%20Metodology V01.pdf

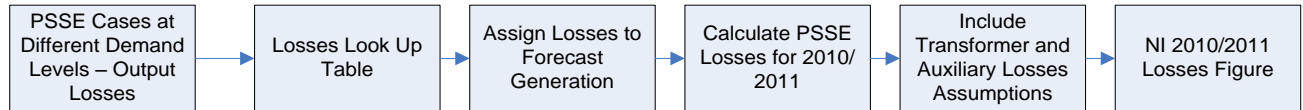- http://www.dee.feis.unesp.br/lapsee/papers/TD06_283_Oliveira_Loss_Factors.pdf

Preferred Options Paper

- SEM-09-107: Preferred Options to be considered for the Implementation of Locational Signals on the Island of Ireland
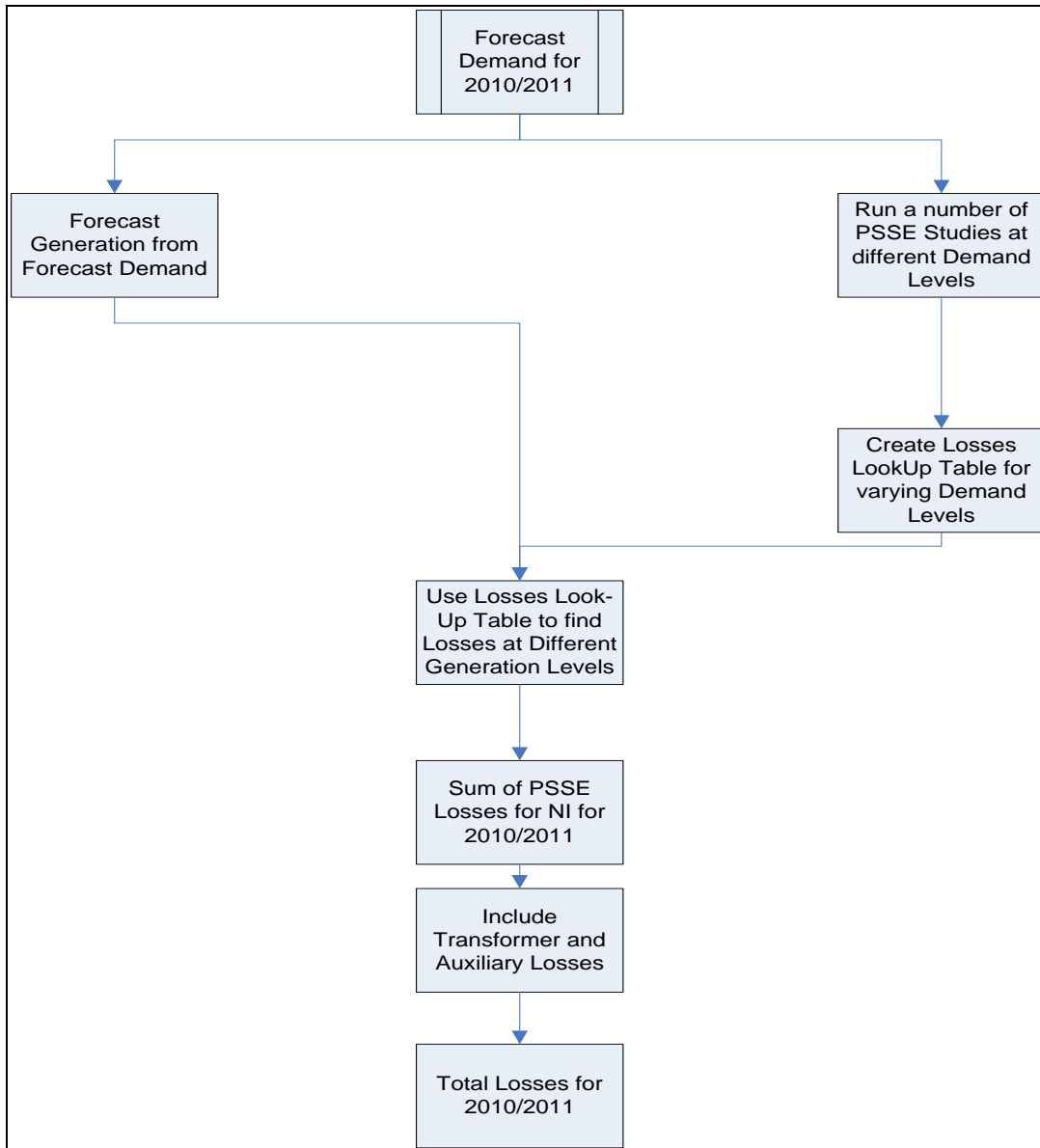
APPENDIX A

First Supplementary Losses Study Method

Block Diagram of Northern Ireland Losses Study Method:

PSSE Cases at Different Demand Levels – Output Losses → Losses Look Up Table → Assign Losses to Forecast Generation → Calculate PSSE Losses for 2010/2011 → Include Transformer and Auxiliary Losses Assumptions → NI 2010/2011 Losses Figure

Flow Diagram of First Additional Losses Study Method:

Forecast Demand for 2010/2011

Forecast Generation from Forecast Demand

Run a number of PSSE Studies at different Demand Levels

Create Losses LookUp Table for varying Demand Levels

Use Losses Look-Up Table to find Losses at Different Generation Levels

Sum of PSSE Losses for NI for 2010/2011

Include Transformer and Auxiliary Losses
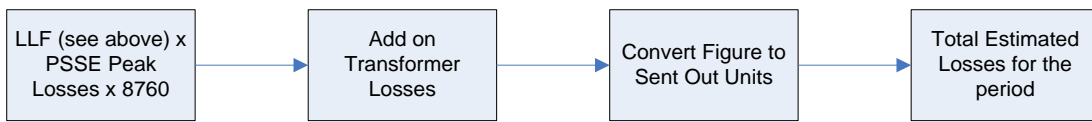
Total Losses for 2010/2011

APPENDIX B
Second Supplementary Losses Study Method

Verification Losses Study Method – Load Loss Factor (LLF)

$$LLF = \frac{\sum_{n=1}^{8760} Load^2}{\sum_{n=1}^{8760} PeakLoad^2} / 8760$$

Block Diagram of Load Loss Factor Study Method (Verification):

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┌──────────────────┐      ┌──────────────┐      ┌──────────────────┐      ┌──────────────────┐
│ LLF (see above) x│      │   Add on     │      │ Convert Figure to│      │ Total Estimated  │
│    PSSE Peak     │─────▶│  Transformer │─────▶│  Sent Out Units  │─────▶│ Losses for the   │
│  Losses x 8760   │      │   Losses     │      │                  │      │     period       │
└──────────────────┘      └──────────────┘      └──────────────────┘      └──────────────────┘
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Flow Diagram of Load Loss Factor Study Method (Verification):