# Using Network Data in a Smart Grid

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Future Networks

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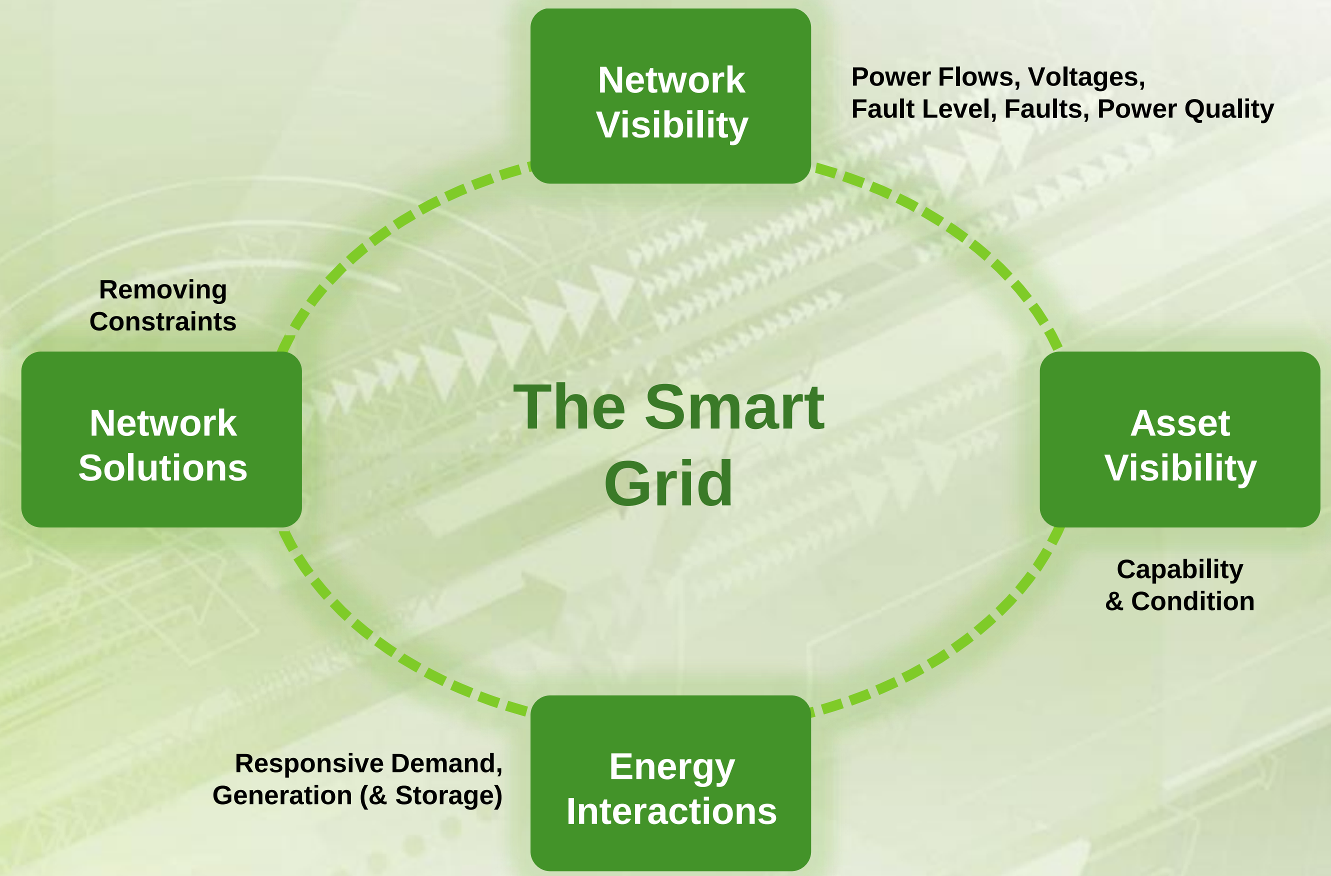
# Presentation Overview

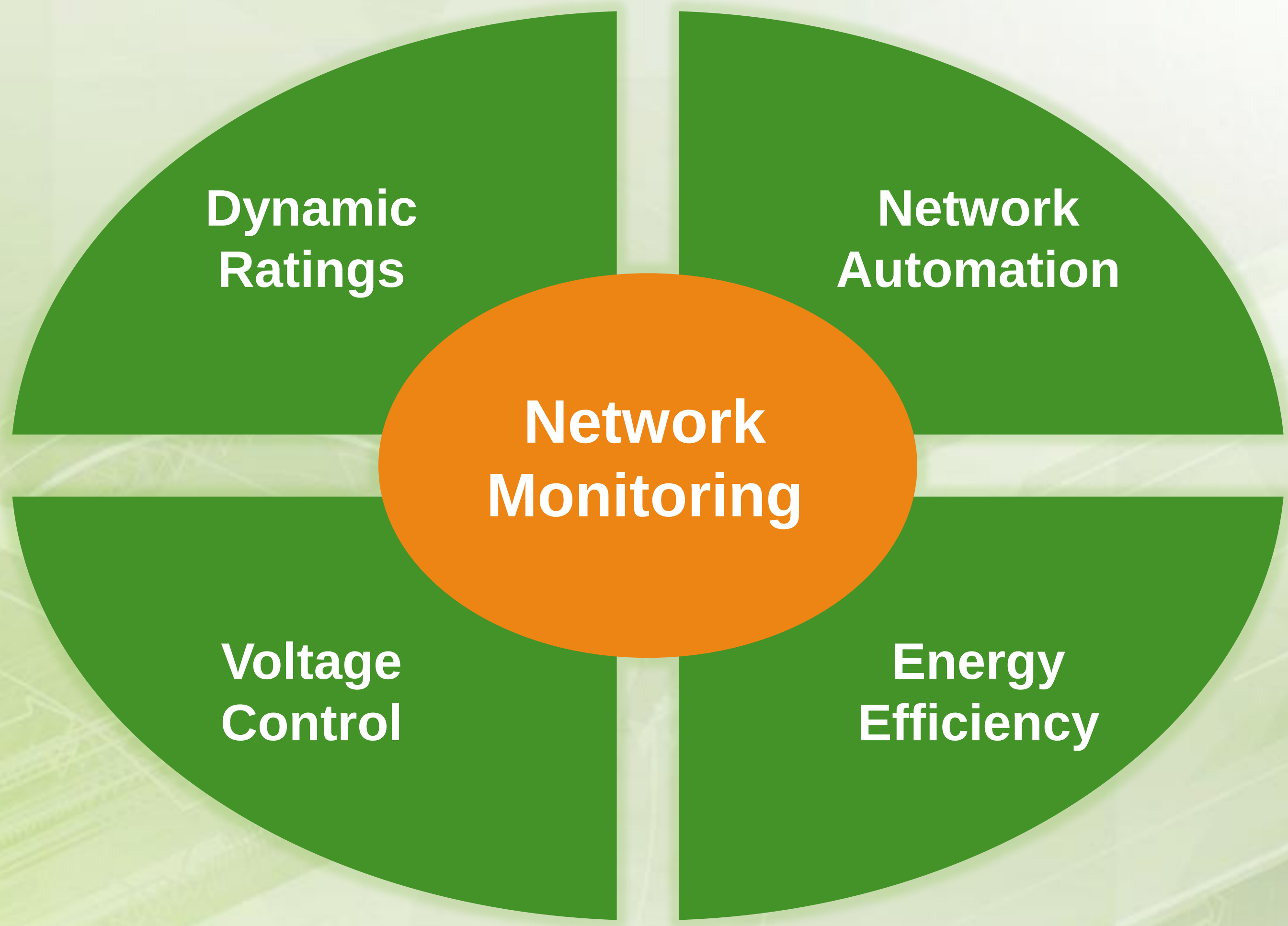
- **The Smart Grid**
- **Flexible Networks for a Low Carbon Future**
- **Use Cases**
  - Load Forecasting
  - Dynamic Transformer Rating
  - LV Load Imbalance
  - Data Analytics
- **Key Learning Outcomes**

# The Smart Grid

**Definition**: *A smart grid is an electricity network that can intelligently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to efficiently ensure a sustainable, economic and secure electricity supply*. Eurelectric (May 2009).



# Flexible Networks for a Low Carbon Future



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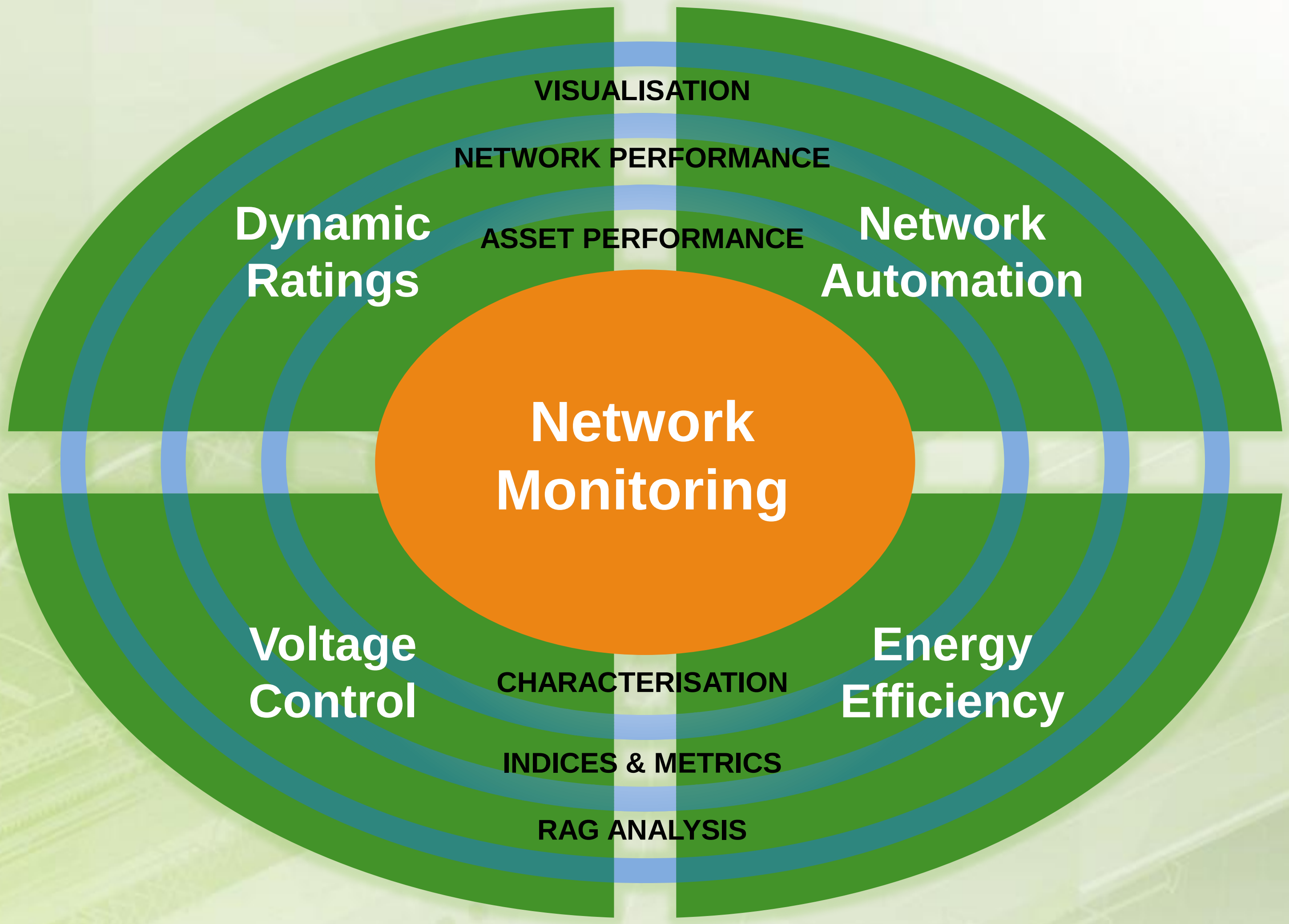


# Use Cases

- Load Forecasting
- Transformer Dynamic Ratings
- LV Load Imbalance
- Data Analytics

# Load Forecasting – Current Practice

Use annual peak demand over a number of historical years to predict load growth

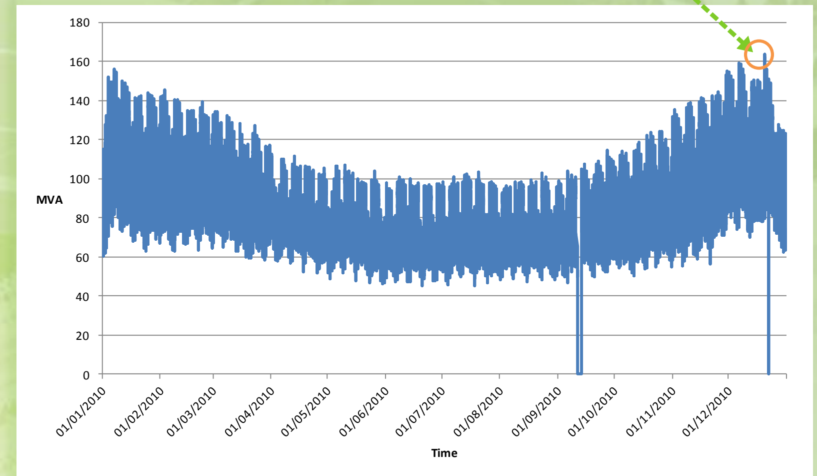
Data is manipulated in Excel spreadsheets

no of transformers — half-hours in a day — number of years

Number of data points = 2 * 2 * 48 * 365 * 10 = 700,800

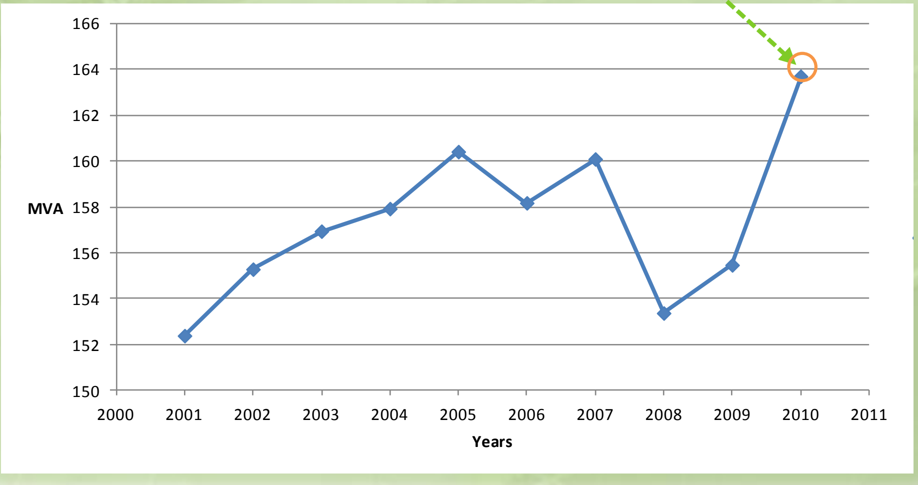
MW, MVAr — days in a year

Annual maximum demand = 163.8 MVA




Time series data for year 2010

Maximum demand = 163.8 MVA for year 2010




Load growth from year 2001 - 2010

# Load Forecasting Tool

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## Load Growth LCNF

version 1.3 beta, updated: 16th September 2014

IBERDROLA SCOTTISHPOWER

Pi Server SPRODA

| Load Growth Parameters | |
|---|---|
| Start Year | 2003 |
| Number of Years | 12 |
| Scaler | -1 |

| Demand Forecast Parameters | |
|---|---|
| Current Year | 2013 |
| Forecasted Year | 2018 |
| Number of Historical Years | 10 |
| Method | Linear Regression |

| Year | Weight |
|---|---|
| 2013 | [redacted] |
| 2012 | [redacted] |
| 2011 | [redacted] |
| 2010 | [redacted] |
| 2009 | [redacted] |
| 2008 | [redacted] |
| 2007 | [redacted] |
| 2006 | [redacted] |
| 2005 | [redacted] |
| 2004 | [redacted] |
| [redacted] | [redacted] |

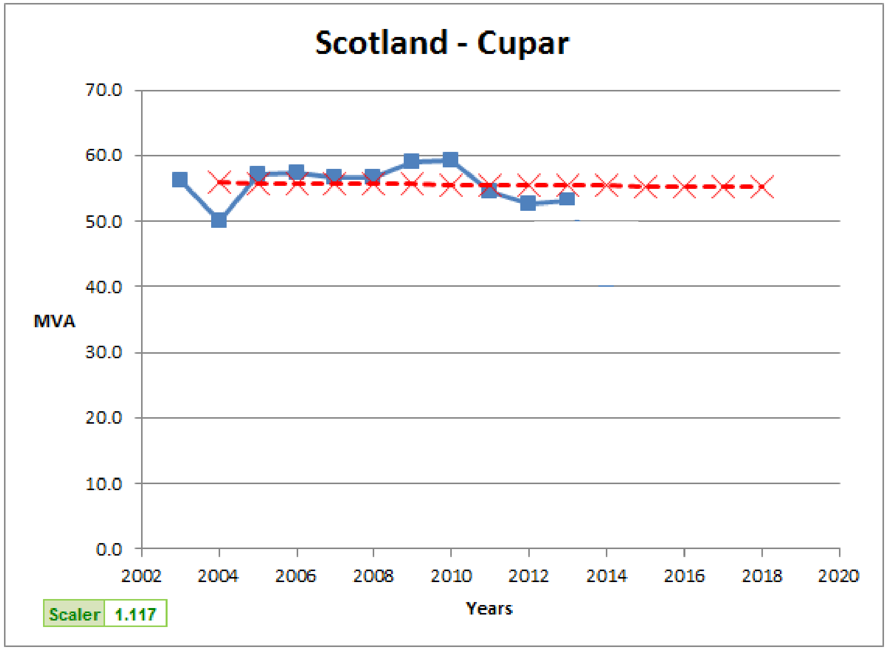
| Simulation Information | |
|---|---|
| Start time | 18/09/2014 15:34 |
| Duration taken | 00:17:20 |
| Status | Completed |

| Load Growth Results | |
|---|---|
| Years | Max Demand (MVA) |
| 2003 | 56.18 |
| 2004 | 49.95 |
| 2005 | 57.09 |
| 2006 | 57.39 |
| 2007 | 56.74 |
| 2008 | 56.77 |
| 2009 | 58.99 |
| 2010 | 59.18 |
| 2011 | 54.54 |
| 2012 | 52.67 |
| 2013 | 53.01 |
| 2014 | 41.07 |

| Exceedance | |
|---|---|
| Years | 2014 |
| Consecutive hours (hrs) | 1 |
| Demand Limits (MVA) | 18 |

| Exceedance Results | |
|---|---|
| Occurances | |
| Longest Period (hrs) | |
| Mean Period (hrs) | |

Demand Forecast (2018) = 55.17 MVA

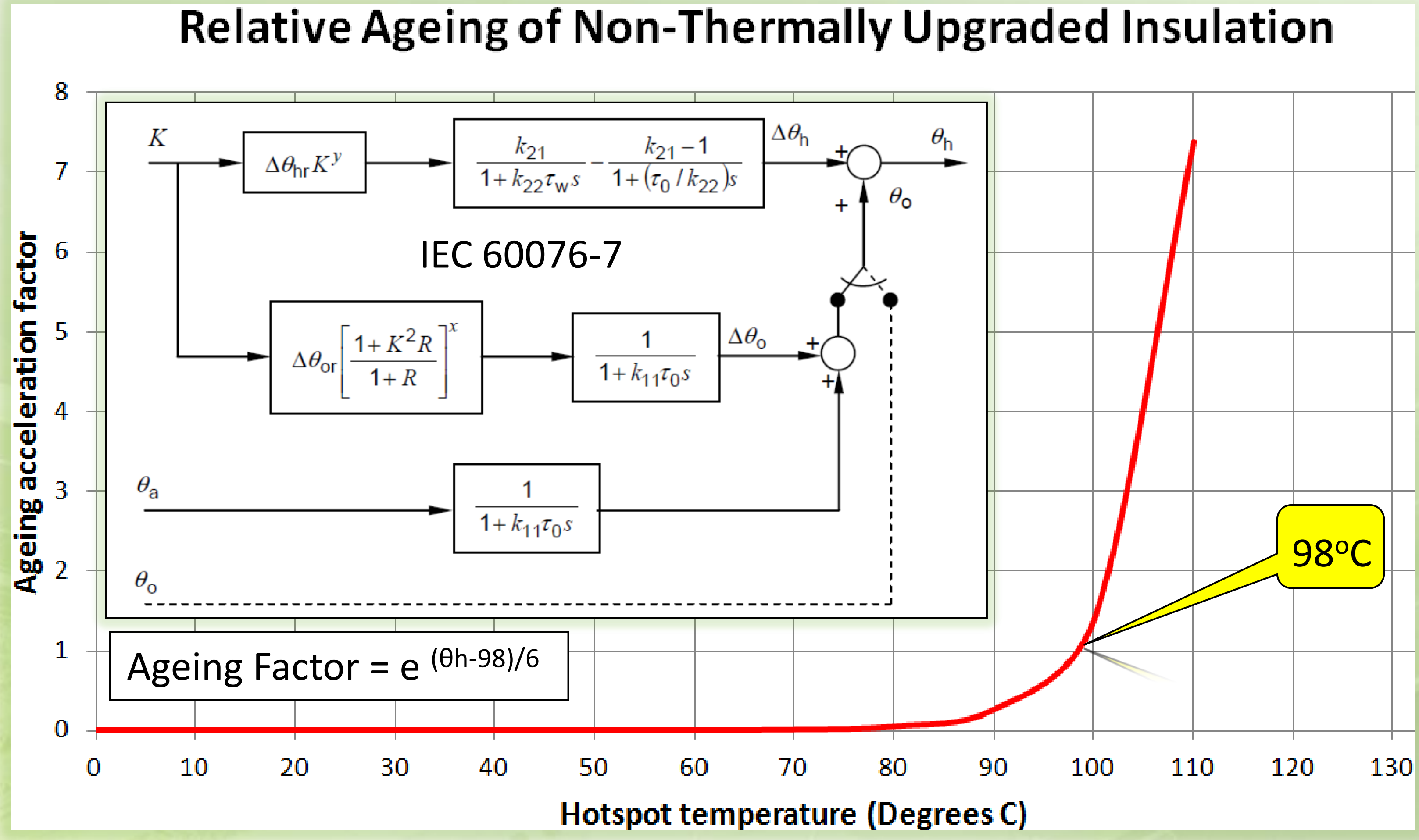



Display Unscaled Maximum Demand

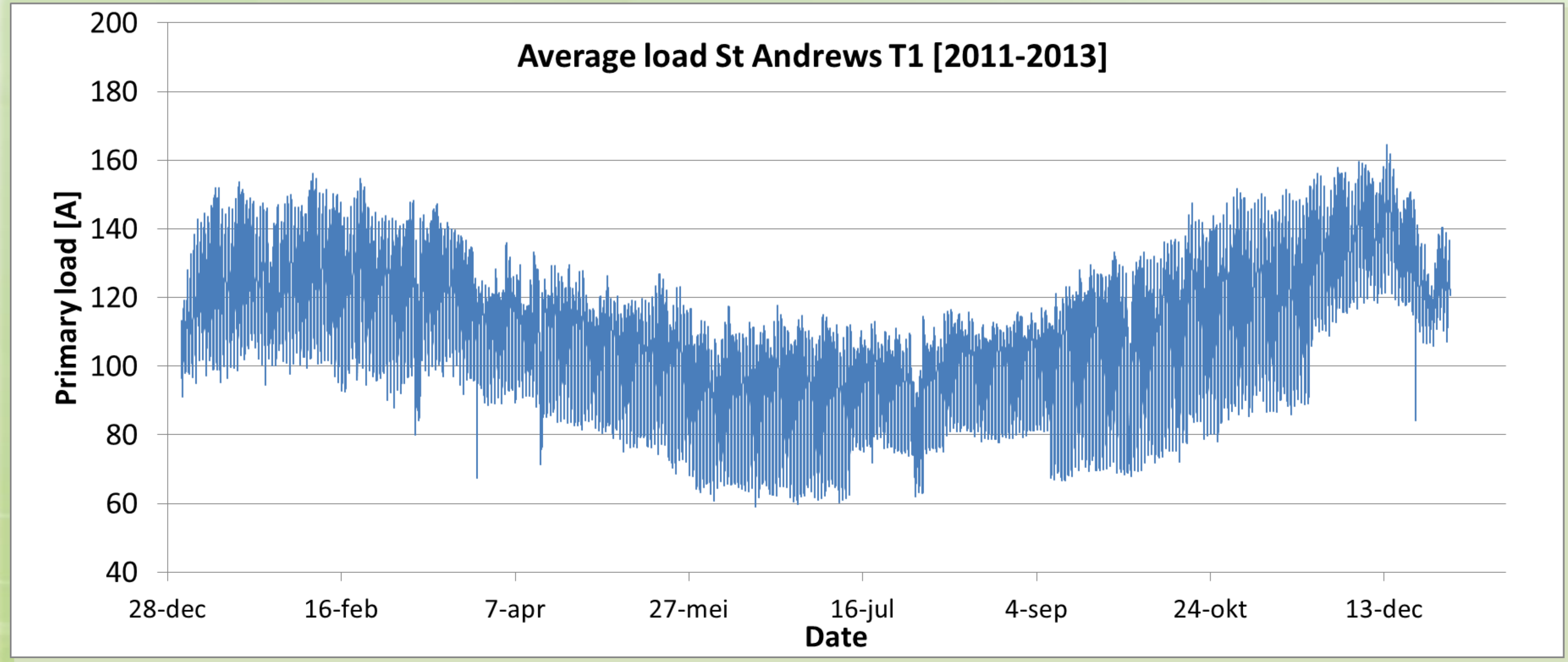
Run | Run All Groups | Forecast | Exceedance

Messages

# Transformer Dynamic Rating – Ageing Curve



# Transformer Dynamic Rating

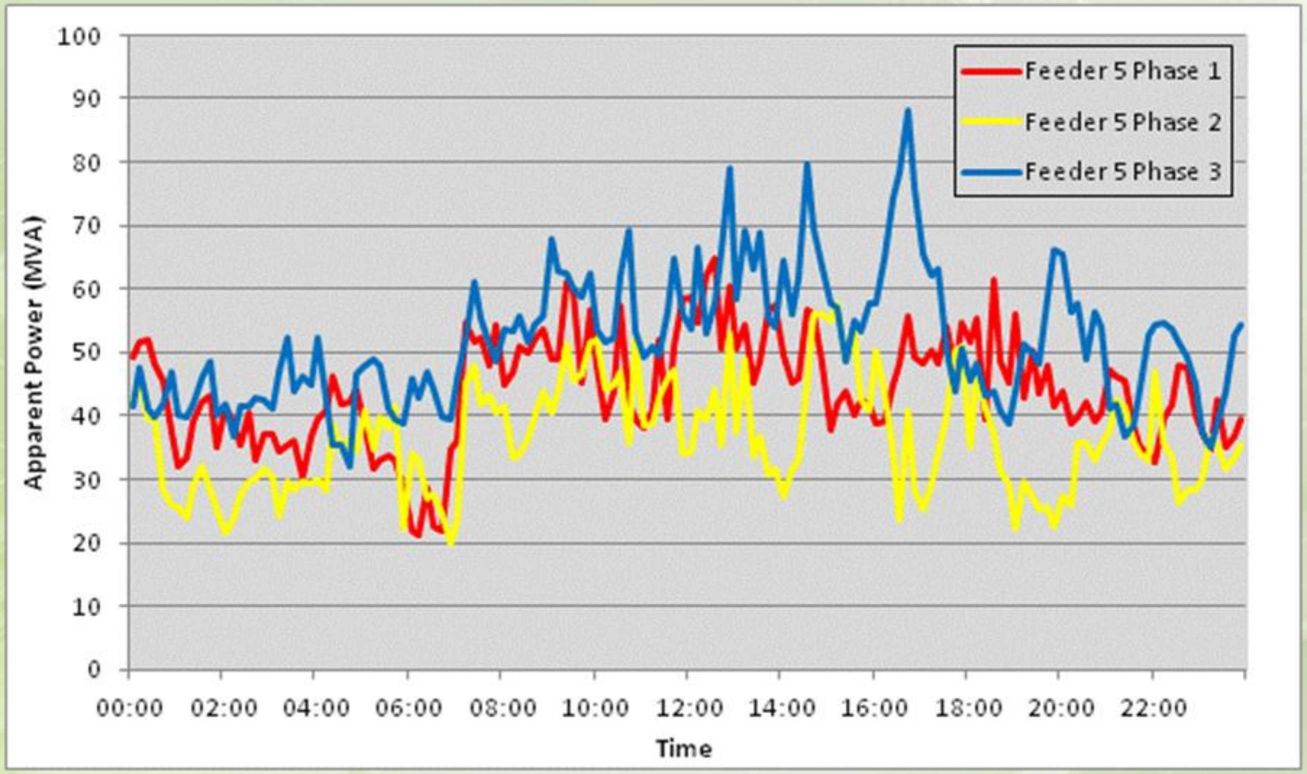



| | MVA | Amps | Ageing (days/year) | Hot Spot Temp (degrees C) |
|---|---|---|---|---|
| System Normal | 9.4 | 164 | 0.05 | 43 |
| Scaled to 21MVA | 21 | 367 | 4.27 | 82 |
| Scaled to 24MVA | 24 | 420 | 4.65 | 96 |

Key learning point –
It is the **hot spot temperature** that matters, not the **ageing**

# LV Load Imbalance

- **Increase network capacity by improving load balance between the phases**
- **Don't want to look at all the raw data. Want the 'analytics' to find it for me**
- **Find heavily loaded feeders that have significant imbalance**



# LV Load Imbalance Assessment – Capacity Release

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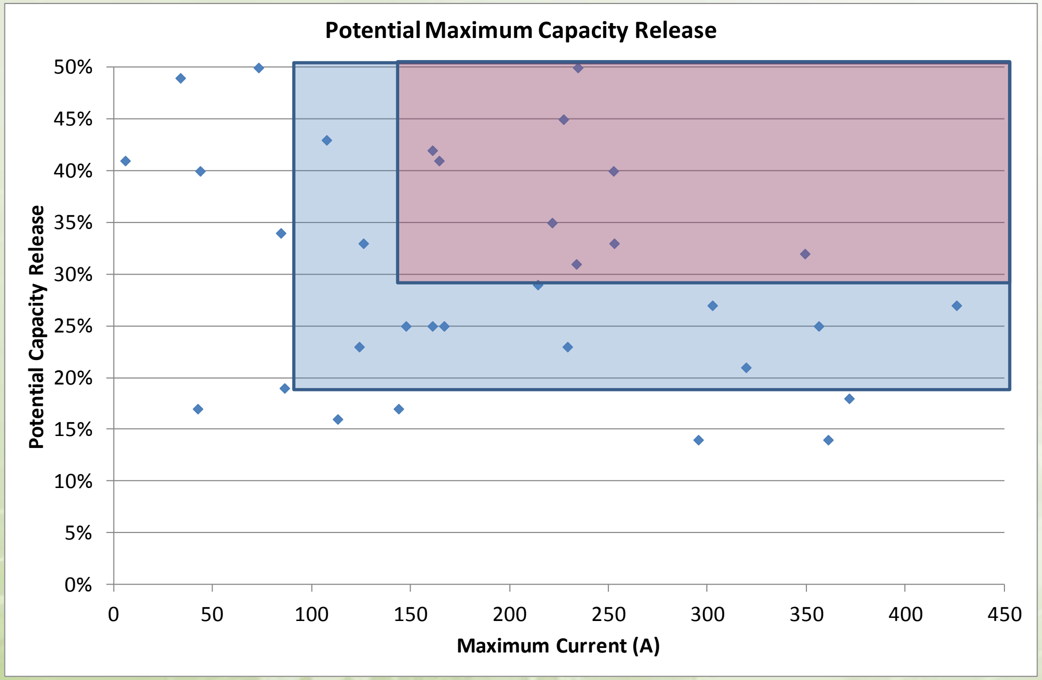

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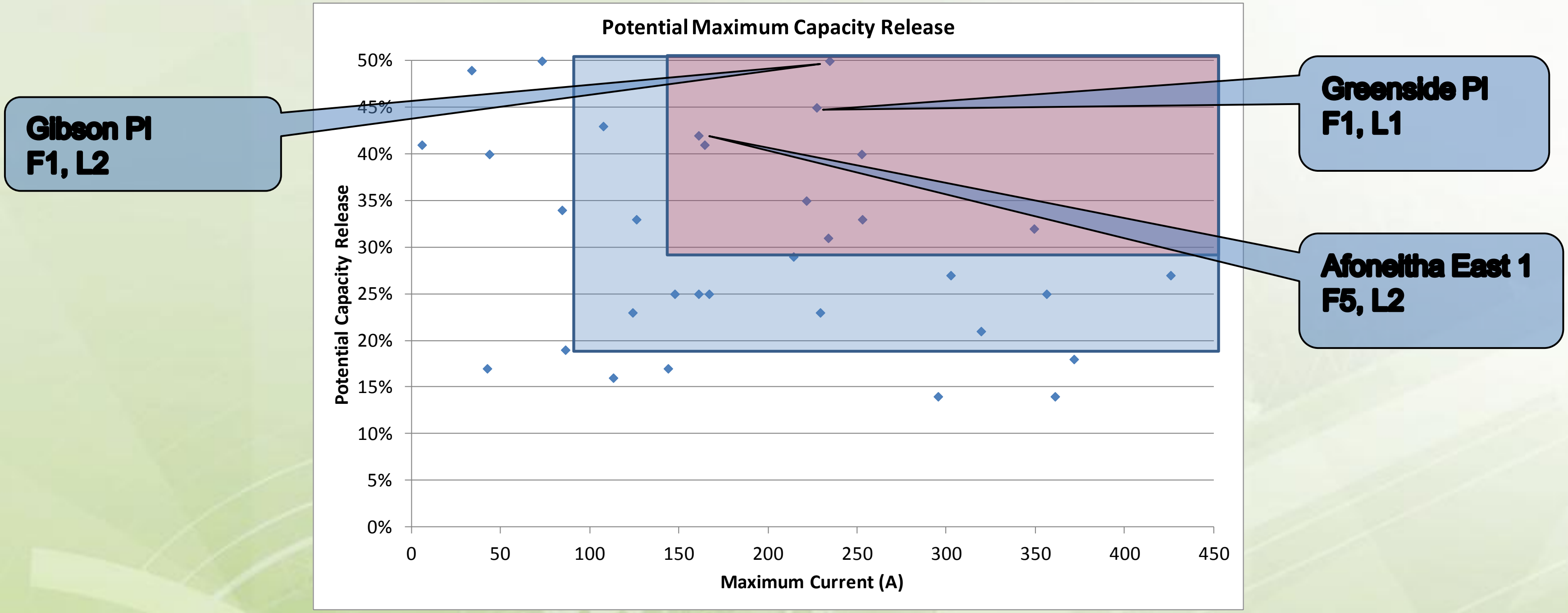
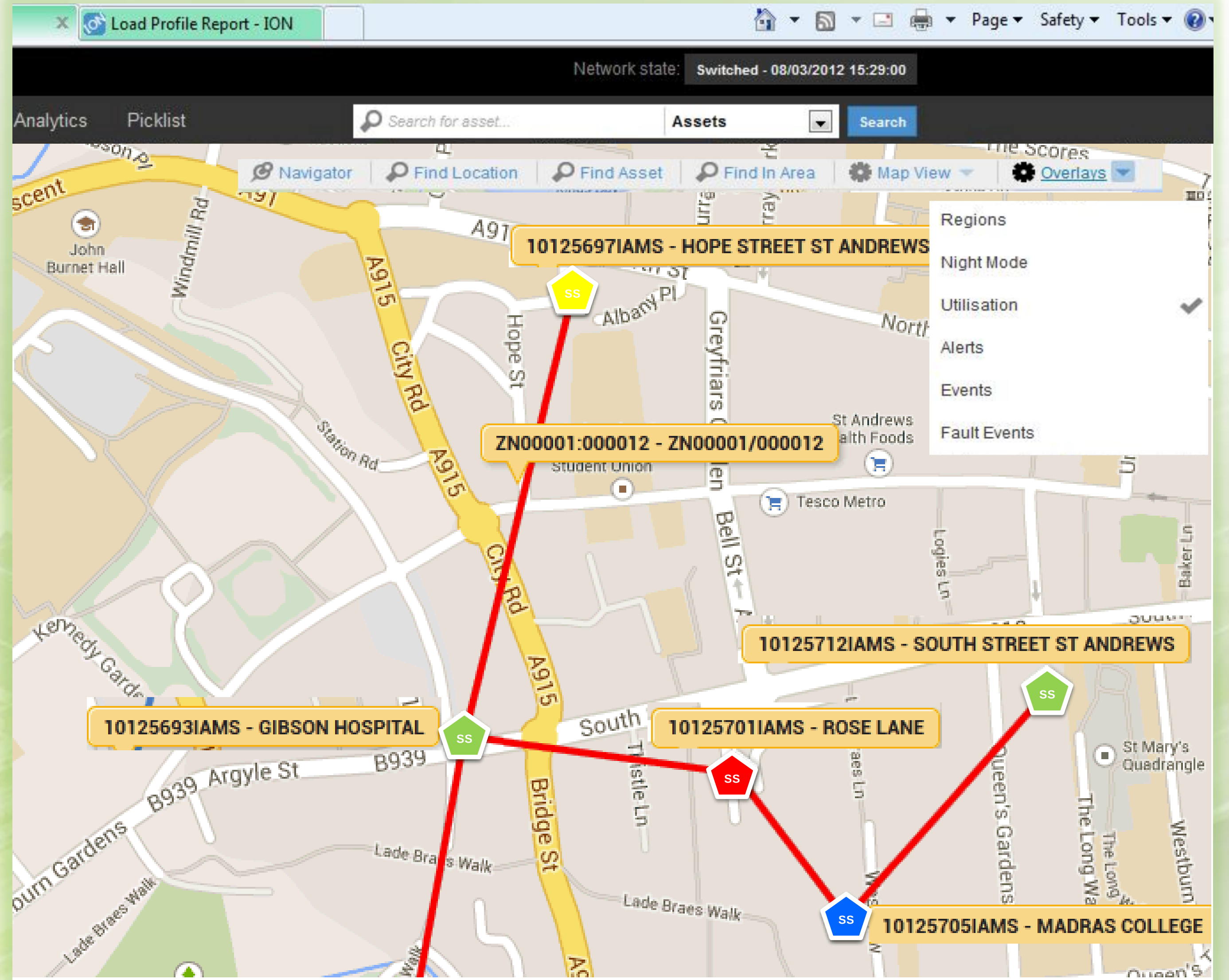



| Secondary Substation Feeder | Maximum Line Loading (A) | Potential Maximum Capacity Release |
|---|---|---|
| Gibson Place Feeder 1 L2 | 235 | 50% |
| Greenside Place Feeder 1 L1 | 227 | 45% |
| Afoneitha Est No.1 Feeder 5 L2 | 161 | 42% |
| Abbey Walk Feeder 2 L2 | 164 | 41% |
| University Library Unit B-1 Feeder 3 L1 | 253 | 40% |
| The Elms Feeder 1 L3 | 222 | 35% |
| Afoneitha Road Feeder 2 L3 | 253 | 33% |
| South Castle St Unit B Feeder 1 L3 | 349 | 32% |
| Plas Bennion Feeder 1 L3 | 234 | 31% |

# Data analytics – Hybrid GIS/Schematic



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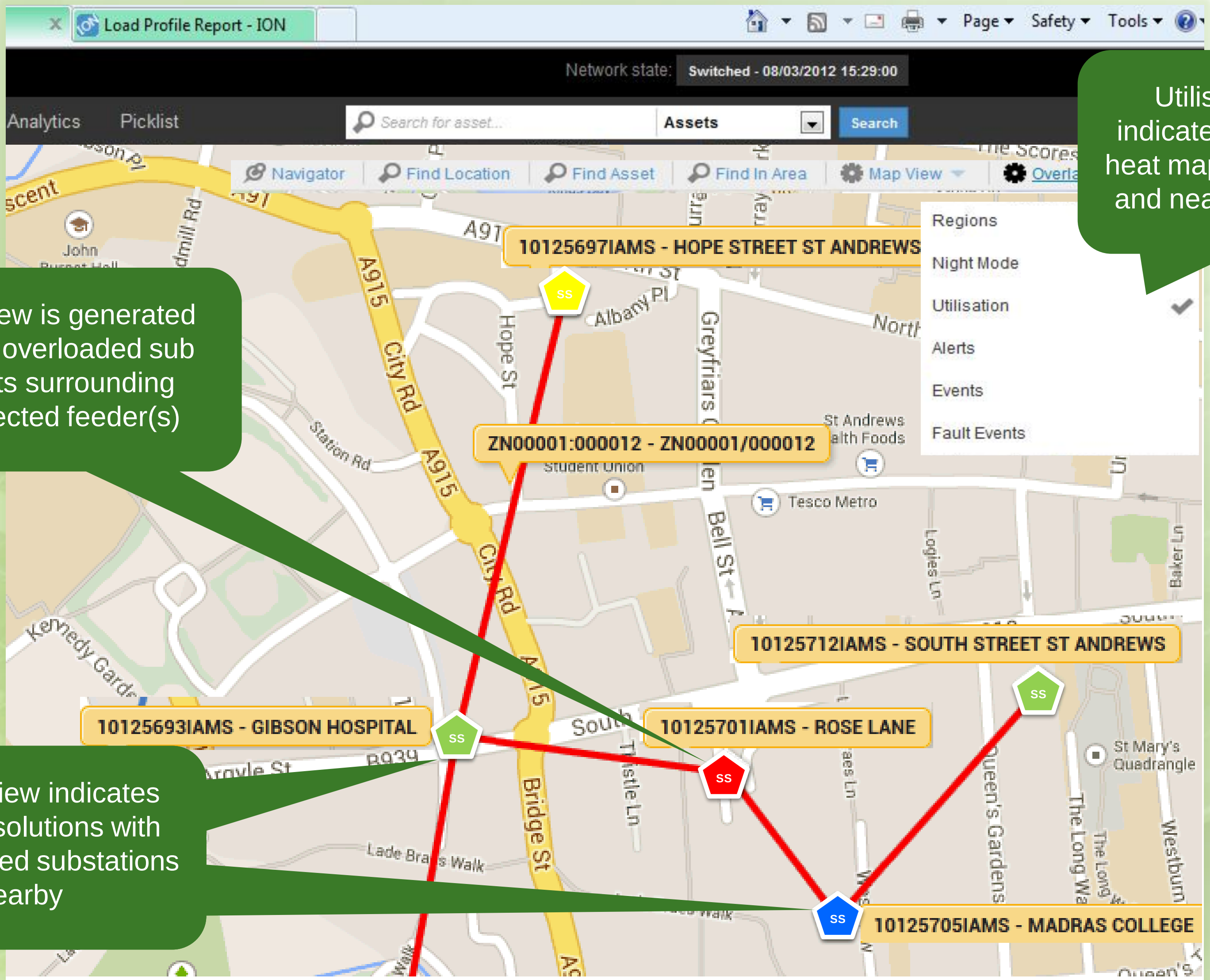


Utilisation overlay indicates the substation heat map for the selected and nearby substations.

Map view is generated for the overloaded sub and its surrounding connected feeder(s)

Overlay view indicates potential solutions with under-utilised substations nearby

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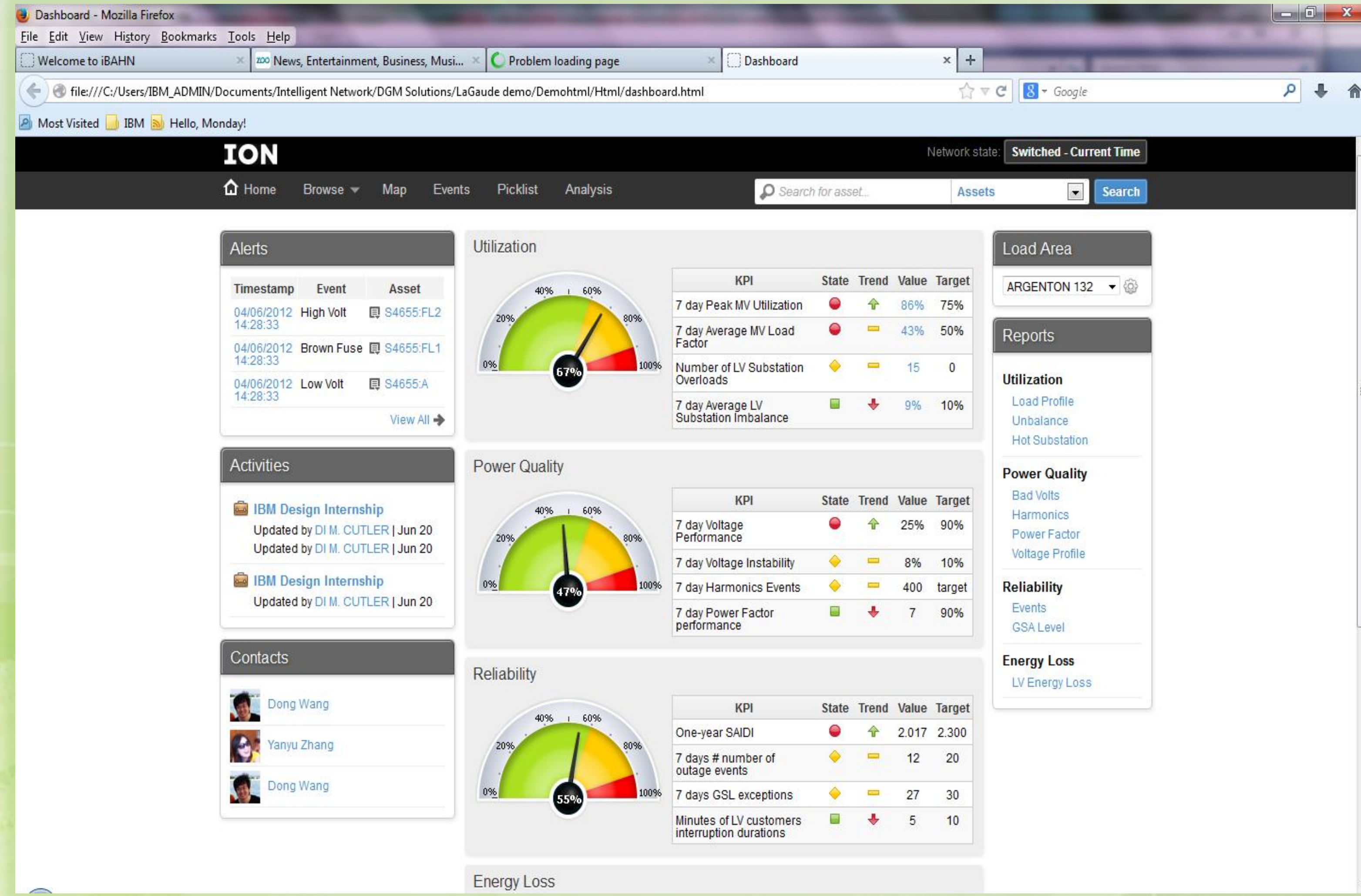
# Dashboard analytics compare actual performance with design parameters



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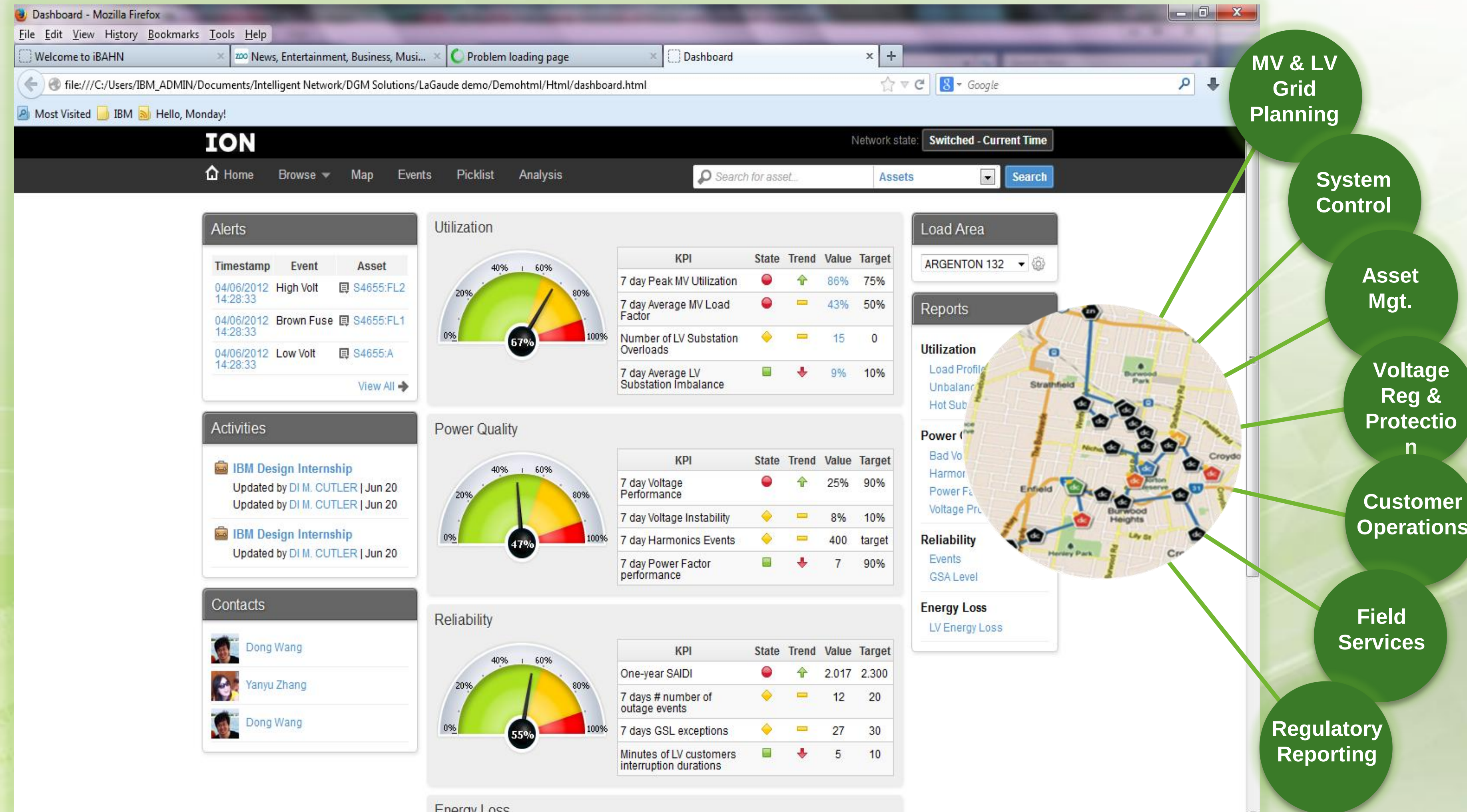

# Key Learning Outcomes

**Load Forecasting**

As well as the forecast itself, it is important to have a measure of how accurate the forecast is – a measure of the uncertainty

**Transformer Dynamic Ratings**

Transformer aging is not the limiting factor, it is the maximum temperature reached within the transformer

**LV Load Imbalance**

Not an issue in urban networks (more customers = greater diversity) . Could be of benefit to monitor in rural networks

**Data Analytics**

Critical for turning network data into information and information into knowledge