



**SP ENERGY  
NETWORKS**

# Using Network Data in a Smart Grid

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Future Networks

LCNI Conference

Aberdeen

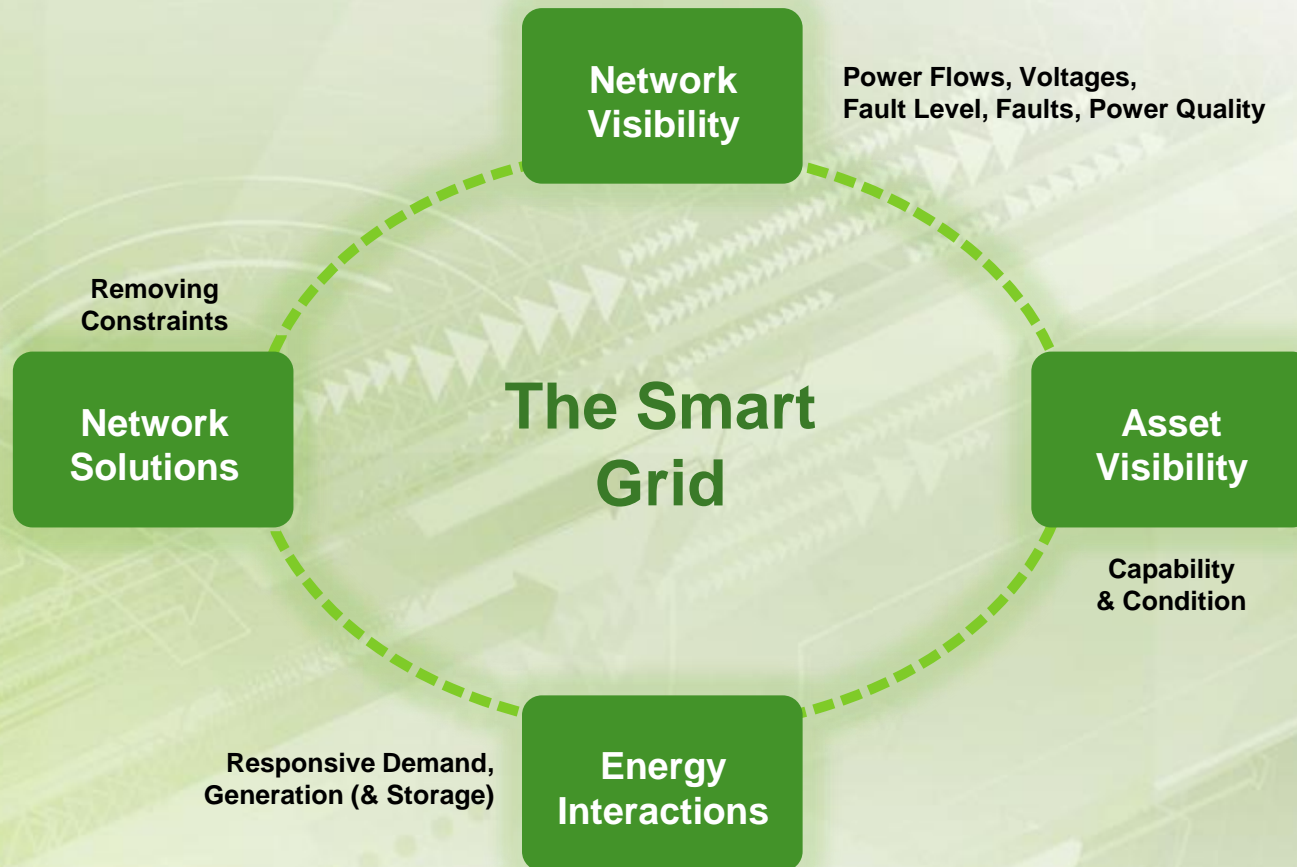
October 2014

# Presentation Overview

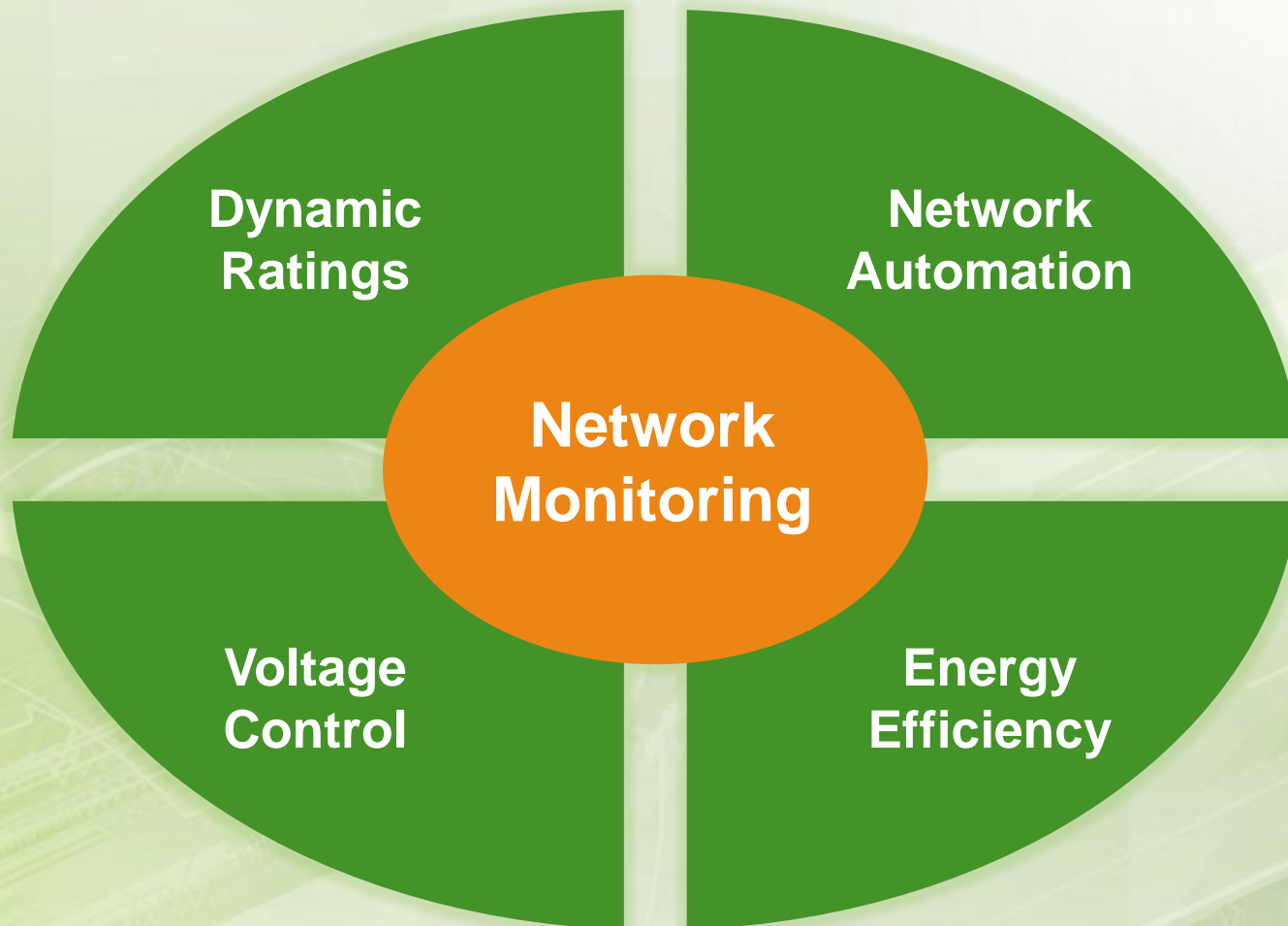
- **The Smart Grid**
- **Flexible Networks for a Low Carbon Future**
- **Use Cases**
  - Load Forecasting
  - Dynamic Transformer Rating
  - LV Load Imbalance
  - Data Analytics
- **Key Learning Outcomes**

# The Smart Grid

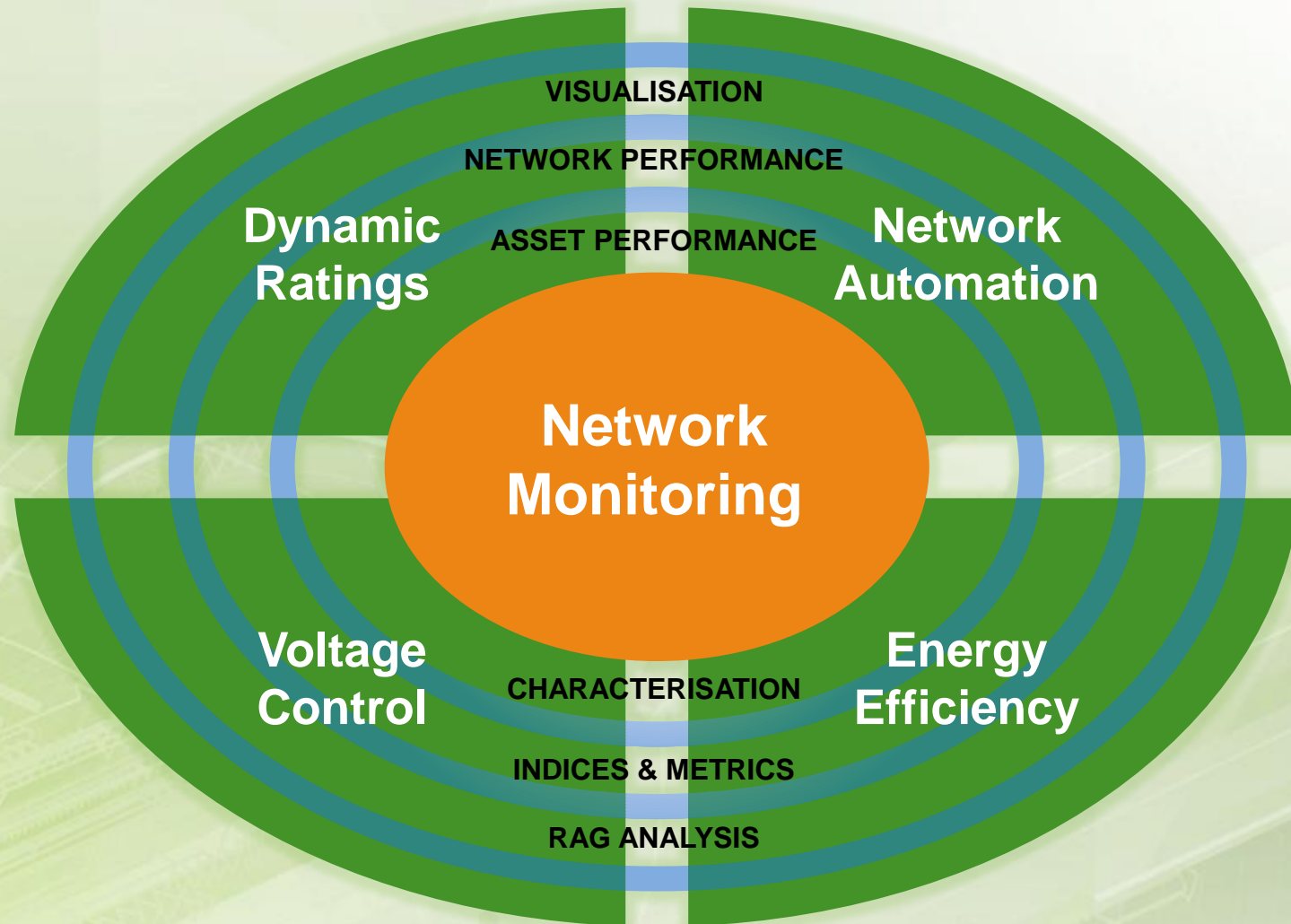
**Definition:** A smart grid is an electricity network that can intelligently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to efficiently ensure a sustainable, economic and secure electricity supply. Eurelectric (May 2009).



# Flexible Networks for a Low Carbon Future



# Flexible Networks for a Low Carbon Future



# 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

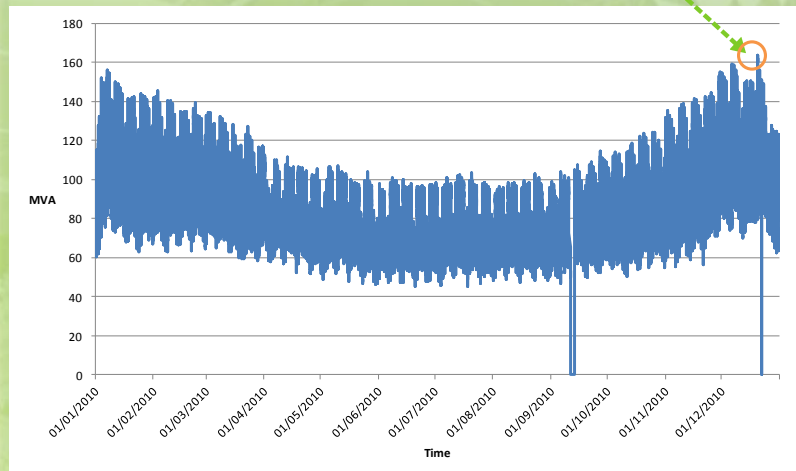
no of transformers      half-hours in a day      number of years

$$\text{Number of data points} = 2 * 2 * 48 * 365 * 10 = 700,800$$

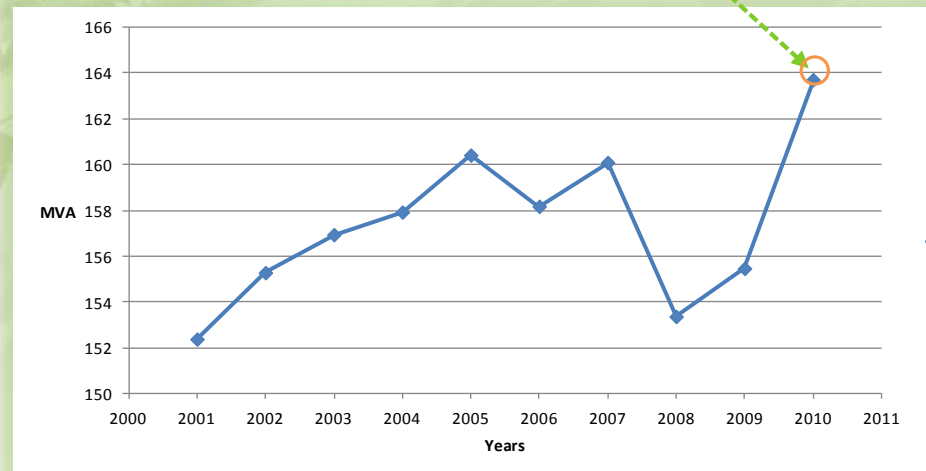
   MW, MVAr      days in a year

Annual maximum demand = 163.8 MVA

Maximum demand = 163.8 MVA for year 2010



Time series data for year 2010



Load growth from year 2001 - 2010

# Load Forecasting Tool

## Load Growth LCNF

version 1.3 beta, updated: 16th September 2014



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	
2012	
2011	
2010	
2009	
2008	
2007	
2006	
2005	
2004	

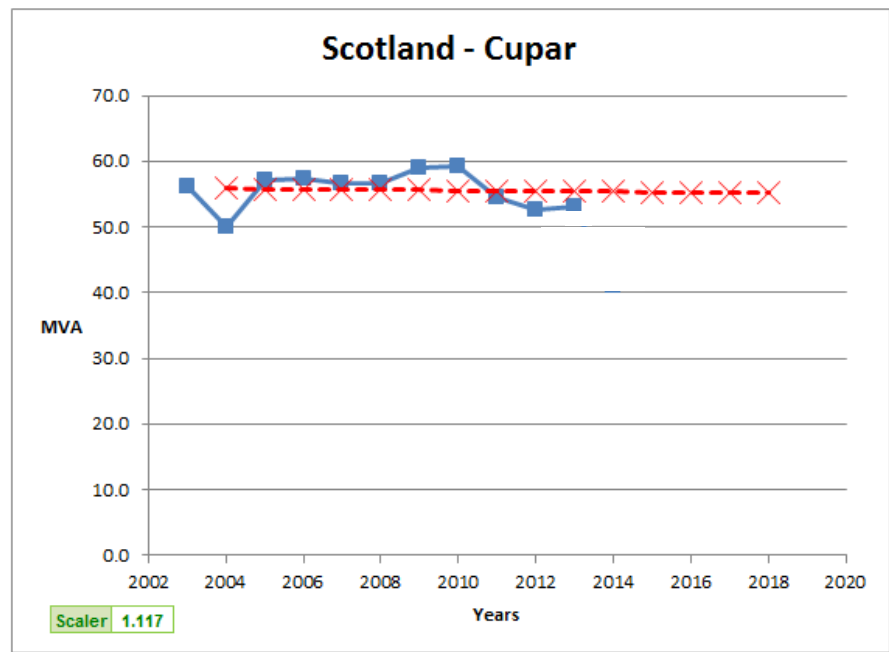
Load Growth Results	
Years	Max Demand (MVA)
2003	56.18
2004	49.95
2005	57.09
2006	57.39
2007	56.74
2008	56.77
2009	58.99
2010	59.18
2011	54.54
2012	52.67
2013	53.01
2014	41.07

Exceedance	
Years	2014
Consecutive hours (hrs)	1
Demand Limits (MVA)	18
Exceedance Results	
Occurrences	
Longest Period (hrs)	
Mean Period (hrs)	

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

Messages

Demand Forecast (2018) = 55.17 MVA



Display Unscaled Maximum Demand

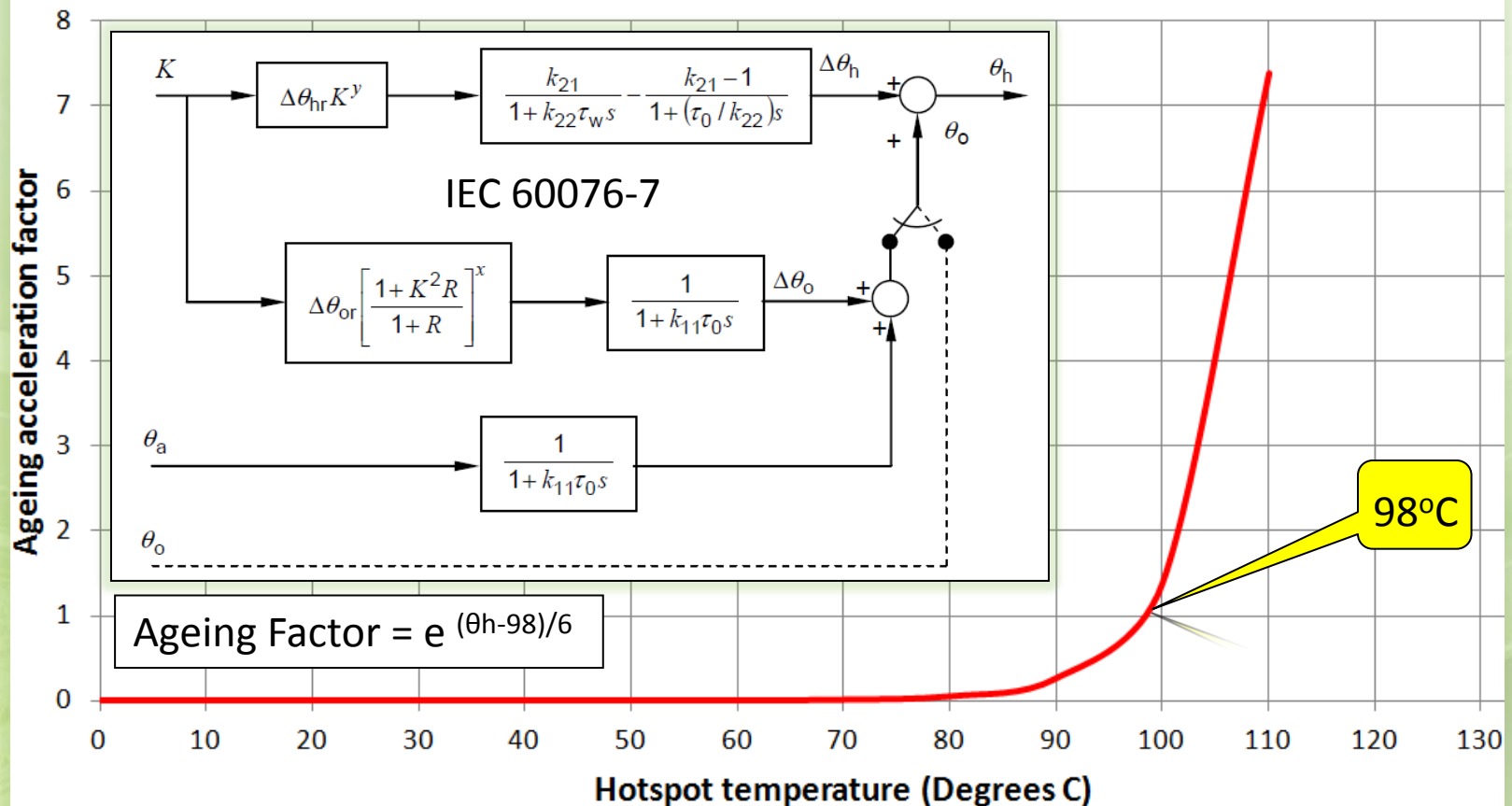
Scaler: 1.117

Run Run All Groups Forecast Exceedance

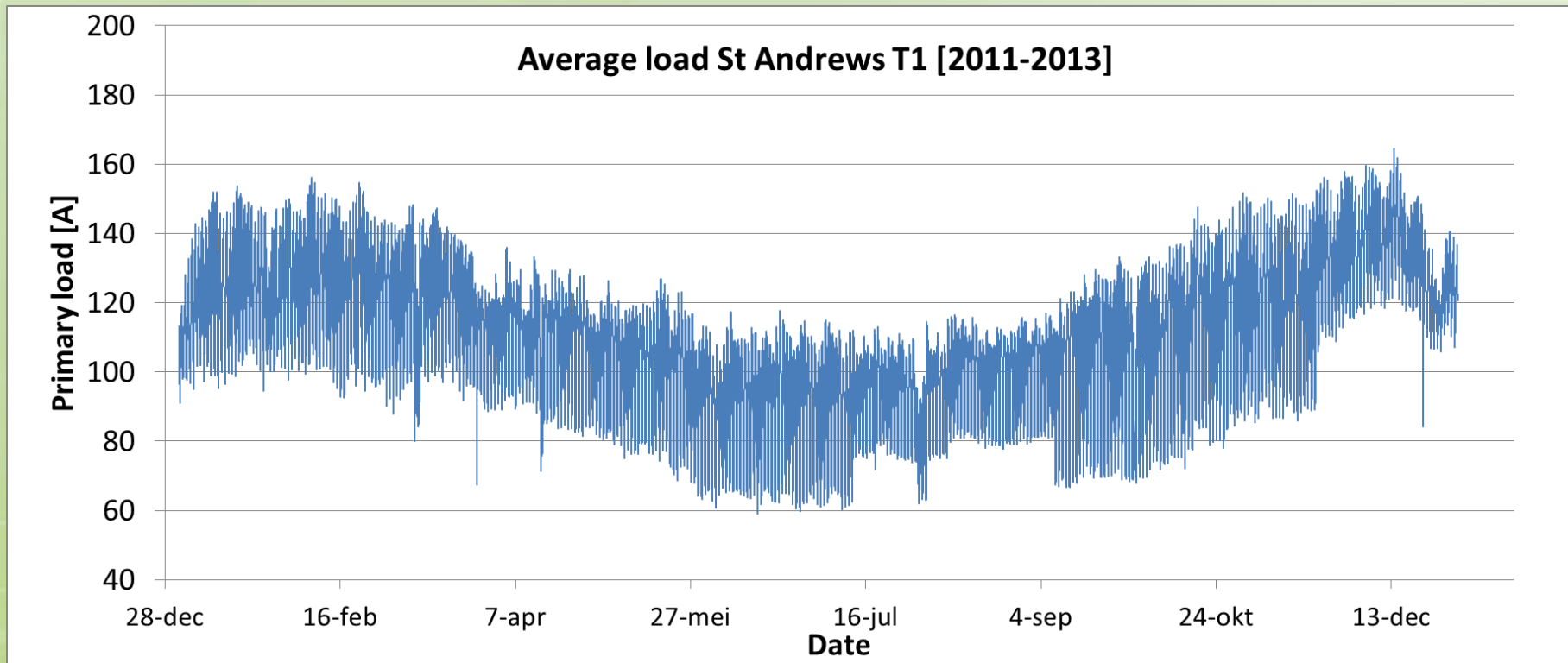


# Transformer Dynamic Rating – Ageing Curve

## Relative Ageing of Non-Thermally Upgraded Insulation



# Transformer Dynamic Rating

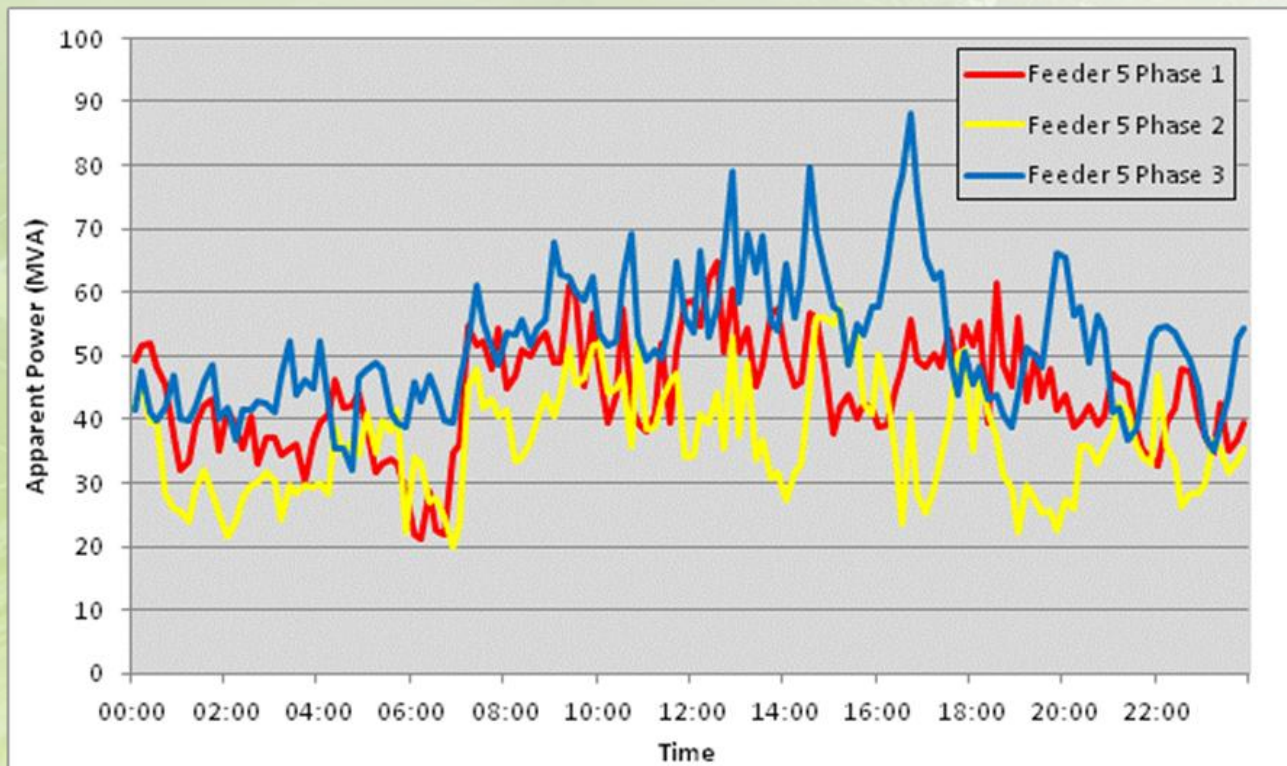


	MVA	Amps	Ageing (days/year)	Hot Spot Temp (degrees C)
System Normal	9.4	164	0.05	43
Scaled to 21MVA	21	367	4.27	82
Scaled to 24MVA	24	420	4.65	96

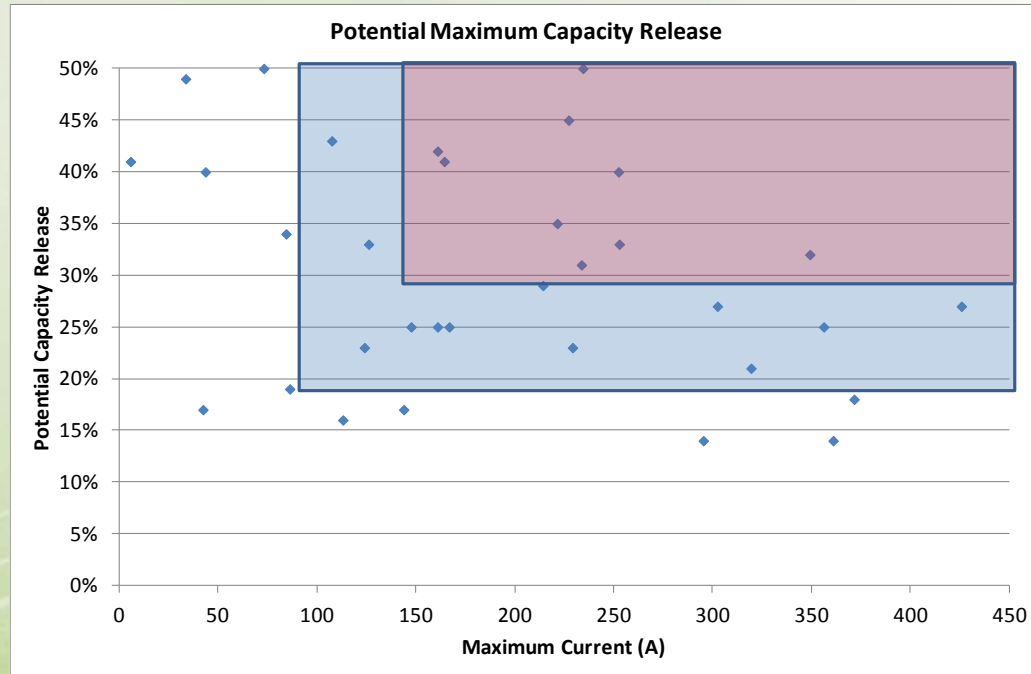
Key learning point –  
It is the **hot spot temperature** that matters, not the **ageing**

# LV Load Imbalance

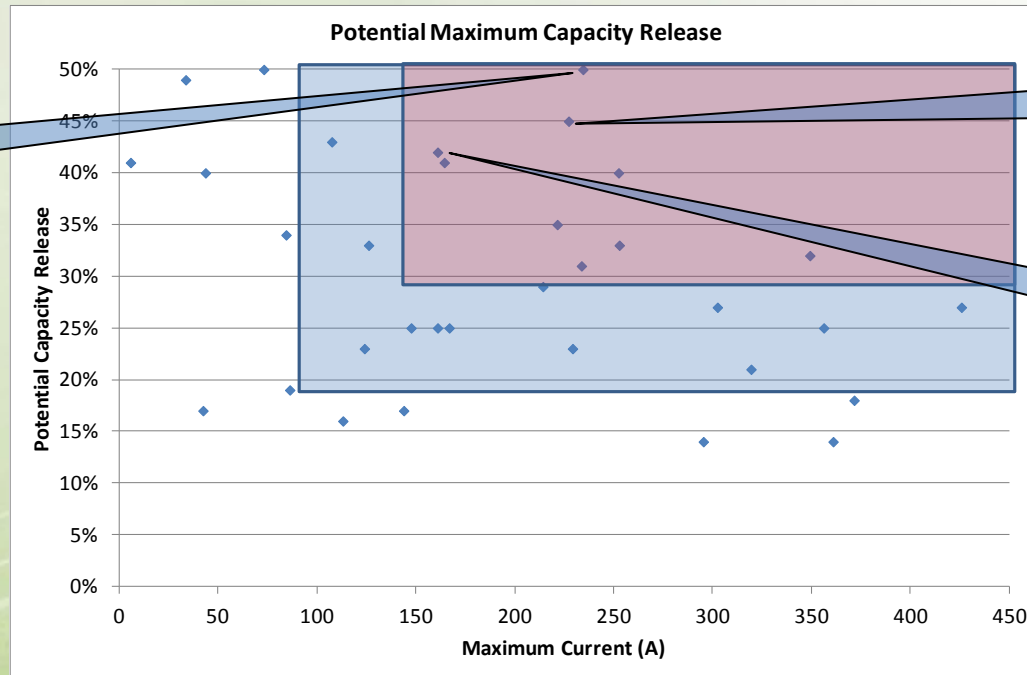
- Increase network capacity by improving load balance between the phases
- Don't want to look at all the raw data. Want the 'analytics' to find it for me
- Find heavily loaded feeders that have significant imbalance



# LV Load Imbalance Assessment – Capacity Release



# LV Load Imbalance Assessment – Capacity Release



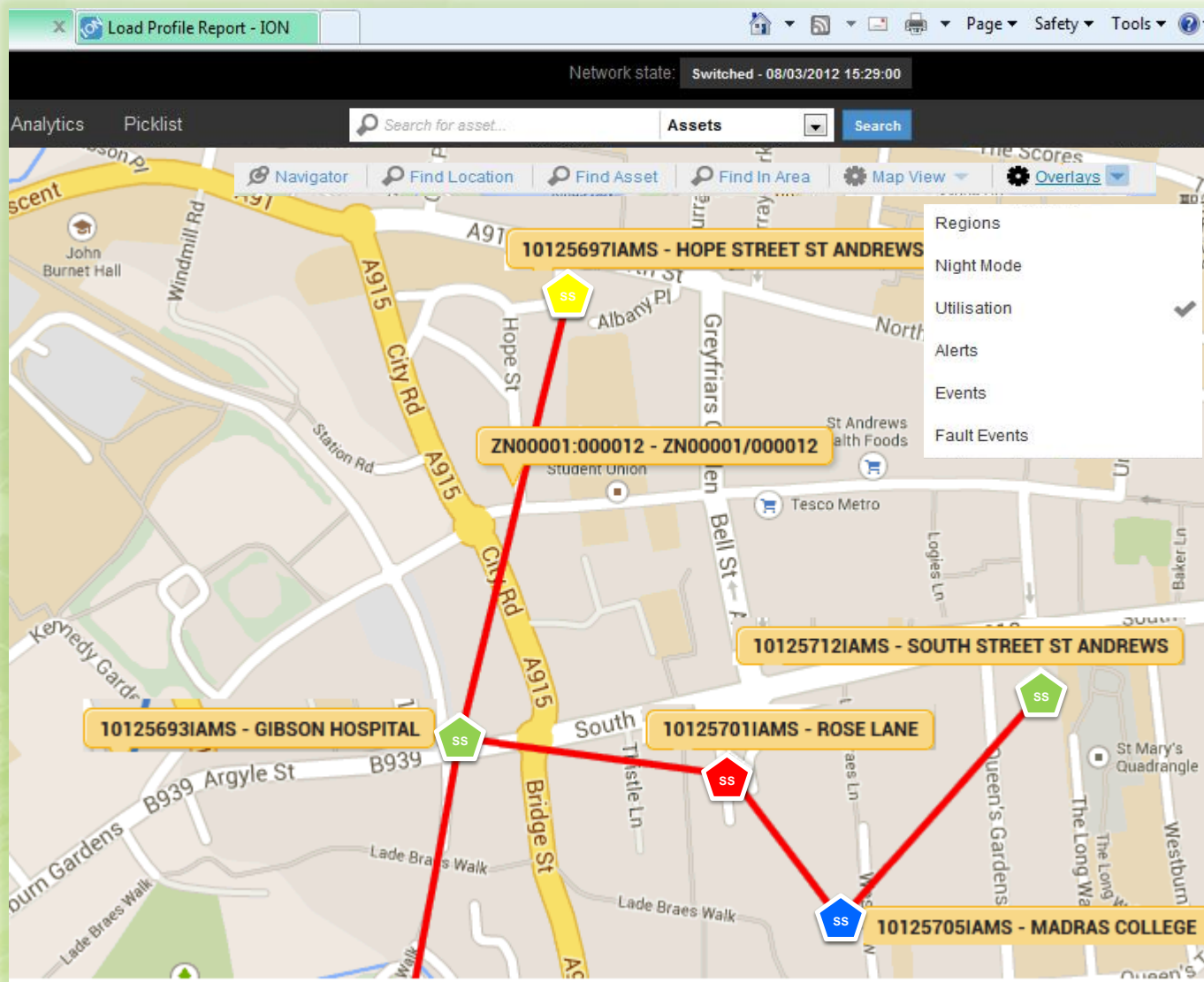
**Gibson PI  
F1, L2**

**Greenside PI  
F1, L1**

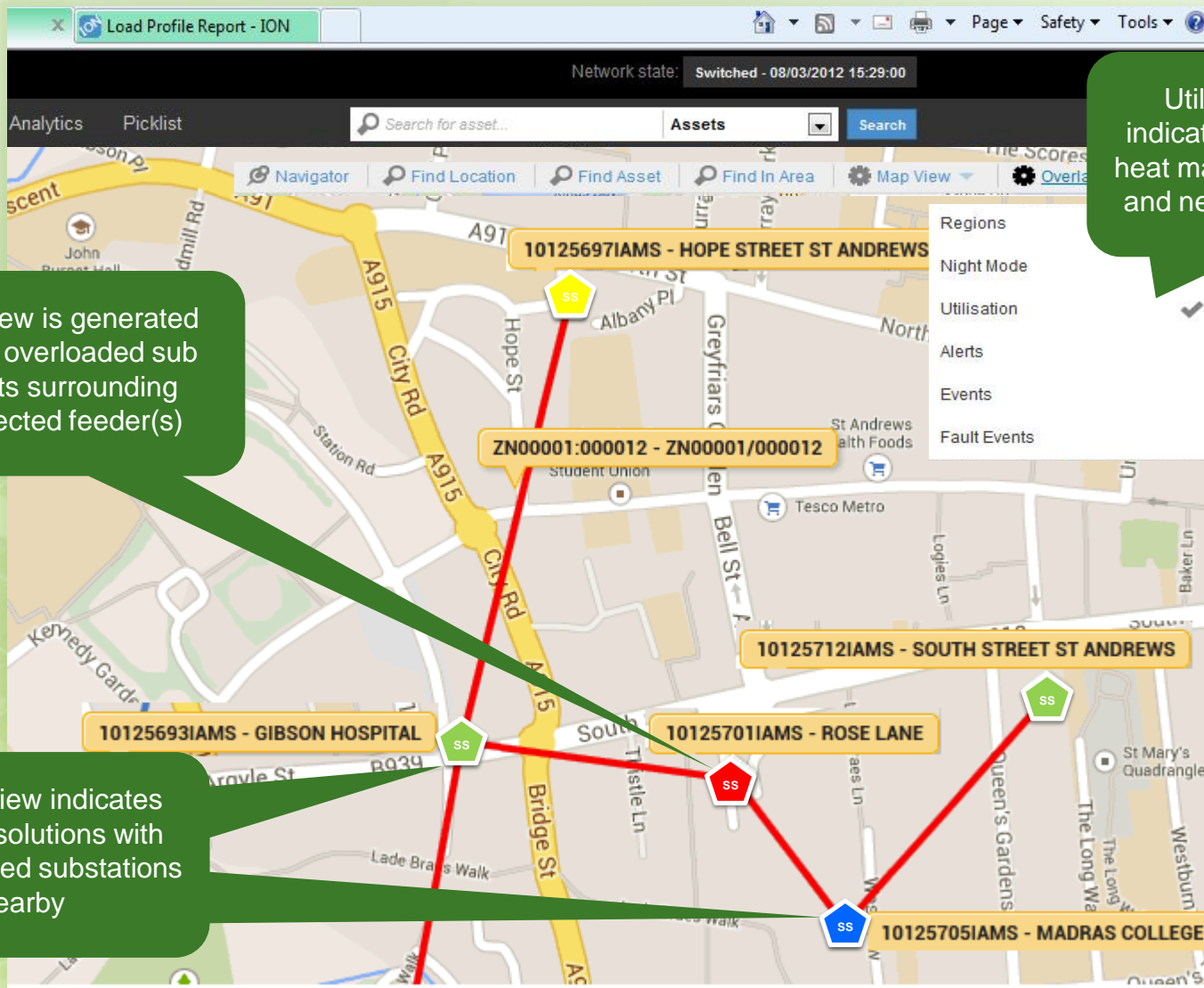
**Afoneitha East 1  
F5, L2**

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



# Data analytics – Hybrid GIS/Schematic



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

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

Overlay view indicates potential solutions with under-utilised substations nearby

# Dashboard analytics compare actual performance with design parameters

Dashboard - Mozilla Firefox

Welcome to iBAHN

file:///C:/Users/IBM\_ADMIN/Documents/Intelligent Network/DGM Solutions/LaGarde demo/Demohtml/Html/dashboard.html

Network state: **Switched - Current Time**

Home Browse Map Events Picklist Analysis Search for asset... Assets Search

### Alerts

Timestamp	Event	Asset
04/06/2012 14:28:33	High Volt	S4655:FL2
04/06/2012 14:28:33	Brown Fuse	S4655:FL1
04/06/2012 14:28:33	Low Volt	S4655:A

[View All](#)


### Activities

- IBM Design Internship**  
Updated by DI M. CUTLER | Jun 20  
Updated by DI M. CUTLER | Jun 20
- IBM Design Internship**  
Updated by DI M. CUTLER | Jun 20

### Contacts


- Dong Wang
- Yanyu Zhang
- Dong Wang

### Utilization




KPI	State	Trend	Value	Target
7 day Peak MV Utilization	Red	Up	86%	75%
7 day Average MV Load Factor	Red	Down	43%	50%
Number of LV Substation Overloads	Yellow	Down	15	0
7 day Average LV Substation Imbalance	Green	Down	9%	10%

### Power Quality



KPI	State	Trend	Value	Target
7 day Voltage Performance	Red	Up	25%	90%
7 day Voltage Instability	Yellow	Down	8%	10%
7 day Harmonics Events	Yellow	Down	400	target
7 day Power Factor performance	Green	Down	7	90%

### Reliability



KPI	State	Trend	Value	Target
One-year SAIDI	Red	Up	2,017	2,300
7 days # number of outage events	Yellow	Down	12	20
7 days GSL exceptions	Yellow	Down	27	30
Minutes of LV customers interruption durations	Green	Down	5	10

### Load Area

ARGENTON 132

### Reports

- Utilization
  - Load Profile
  - Unbalance
  - Hot Substation

### Power Quality

- Bad Volts
- Harmonics
- Power Factor
- Voltage Profile

### Reliability

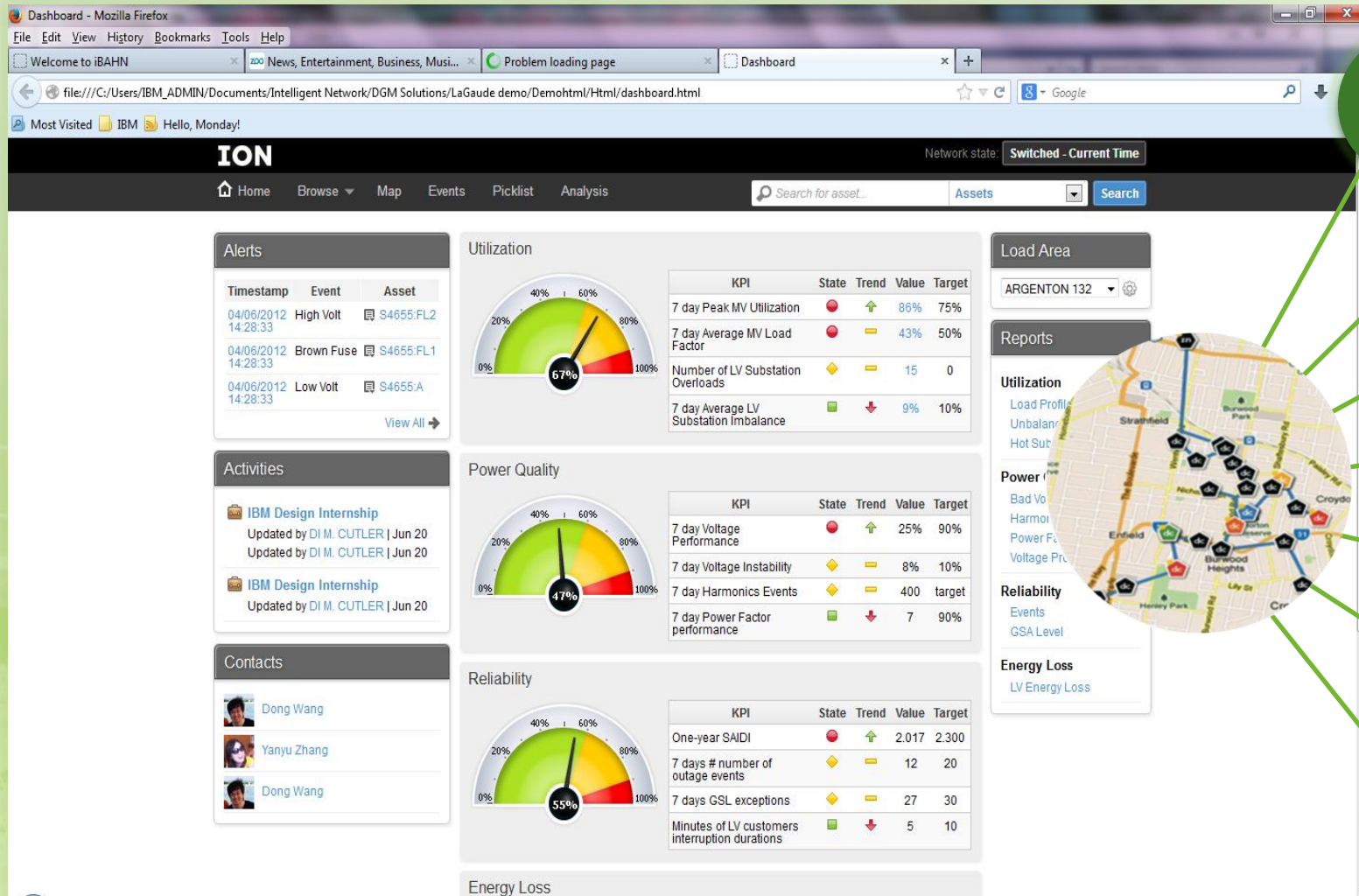
- Events
- GSA Level

### Energy Loss

- LV Energy Loss



# Dashboard analytics compare actual performance with design parameters



- MV & LV Grid Planning
- System Control
- Asset Mgt.
- Voltage Reg & Protection
- Customer Operations
- Field Services
- Regulatory Reporting

# 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