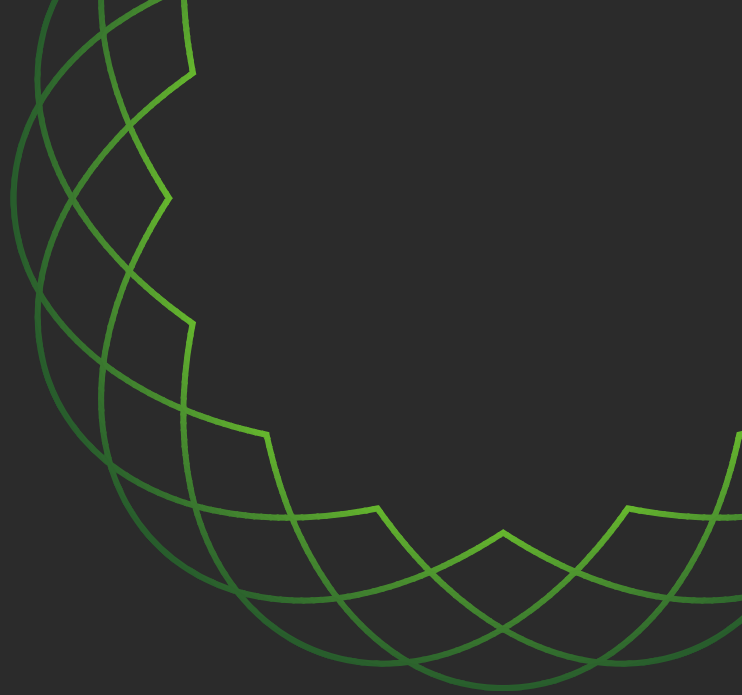

SSE
Seth Muthuraman PhD.

Build your digital industry

September, 2015

#IndustrialInternet

powered by

Who we are ?

SSE

30th largest company in the FTSE 100*

£14.95bn market capitalisation*

Around 20,000 employees

UK's broadest-based energy company

- Electricity generation, transmission, distribution, supply and services
- Gas production, storage, distribution, supply and services

Ireland's fastest-growing energy company

- Electricity generation
- Electricity and gas supply
- Street lighting maintenance

Delivered a real dividend increase every year since 1999

*As at 22 July 2014

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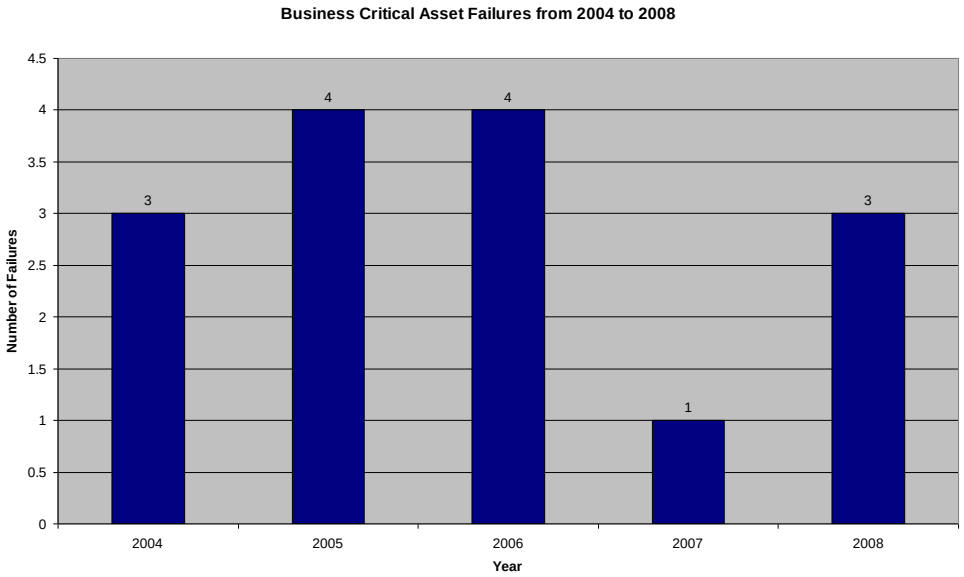
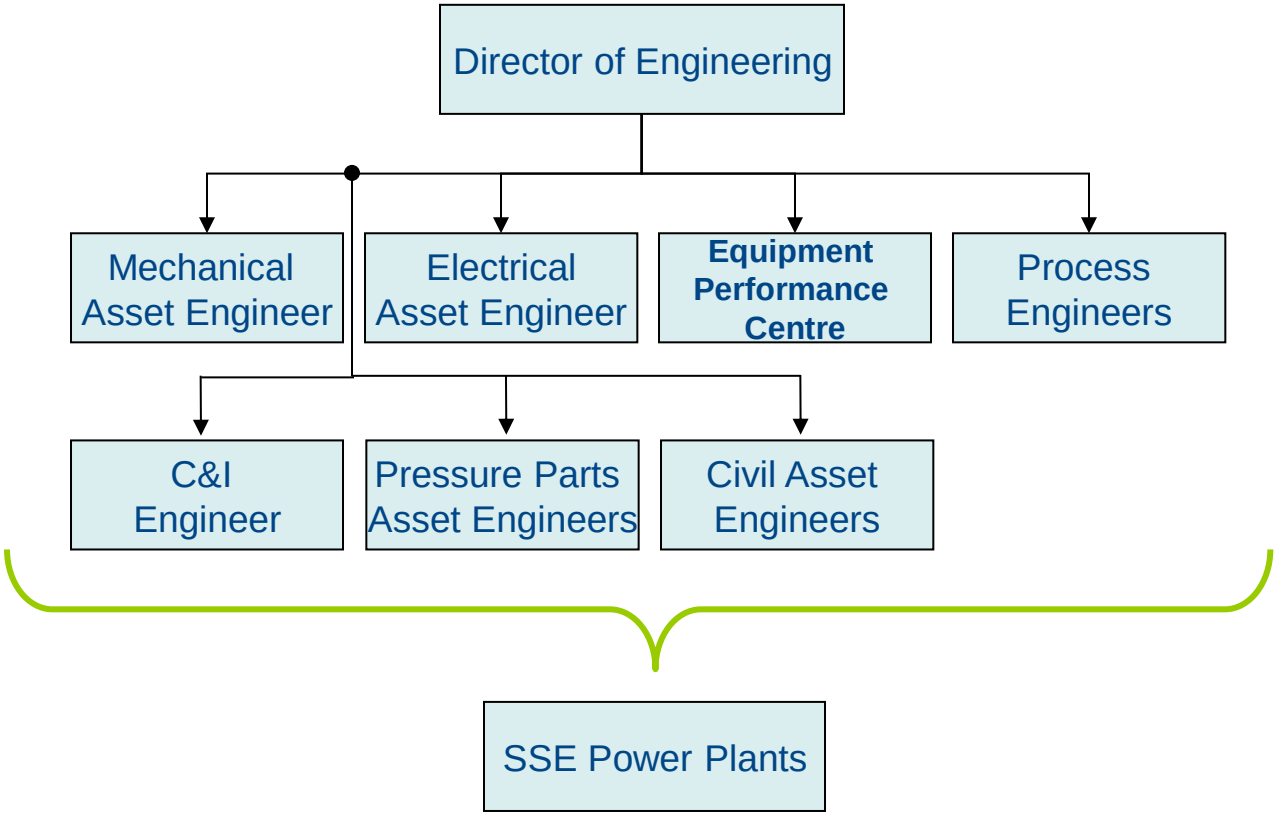
Why SSE required an Engineering Centre of Excellence ?

- The outturn availability of the thermal generation fleet has been poor due to a number of specific technical failures.
- Evaluate the underlying capabilities and processes which support the overall engineering strategies and consider a number of specific asset strategies across the fleet in order to validate their appropriateness against best industry practices.



What’s required ?

SSE Engineering Centre



Engineering capabilities to perform…

- Asset Integrity Management (AIM)

  Asset Life Assessment, Relative Risk Ranking, High Consequence Asset Register, Action and Investment Planning

- **Early detection of potential failure**
- **Prevent past failures from reoccurring**
- **Increase availability of plant**
- Reduce dependencies on 3rd party services
- Manage and control CAPEX
- **Reduce insurance cost**
- **Condition-based maintenance**

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How to achieve the engineering capabilities ?

Meet the team

Staff based in Ferrybridge

Dr. John Twiddle

Dr. Seth Muthuraman

Manjit Singh

Staff based in Glasgow

Deborah Caffrey

Sandya Abrar

Sarah North

Brett Staneff

Turning data into information …

Turbine vibration analysis and diagnostics

LD66 blade management

Combustion dynamics analysis

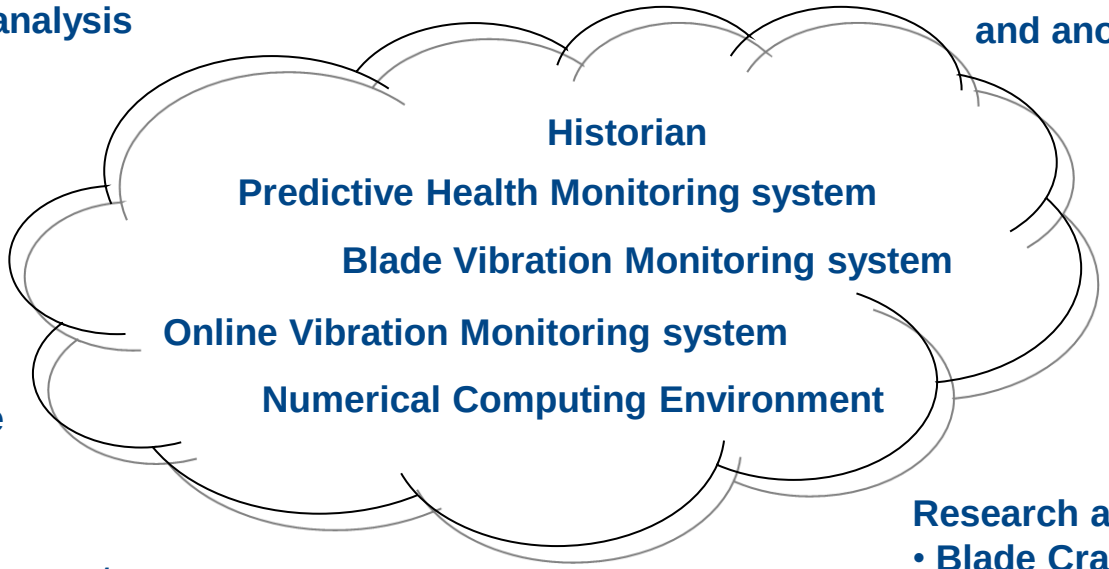
Boiler temperature monitoring,

creep analysis

safety case management

Hammer Impact Testing

Model-based CM and anomaly detection



Wind Turbine Condition Monitoring

Asset life assessment

Research and Development
- Blade Crack Detection
- Torsional Vibration
- Wind Forecasting

Electrical Testing

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… And information into value

- Displace 3rd parties
- Increase availability of plant
  Safety cases, Issue management
- Contribute to reduce insurance premiums
- Early detection of potential failures Estimate value of ‘catches’

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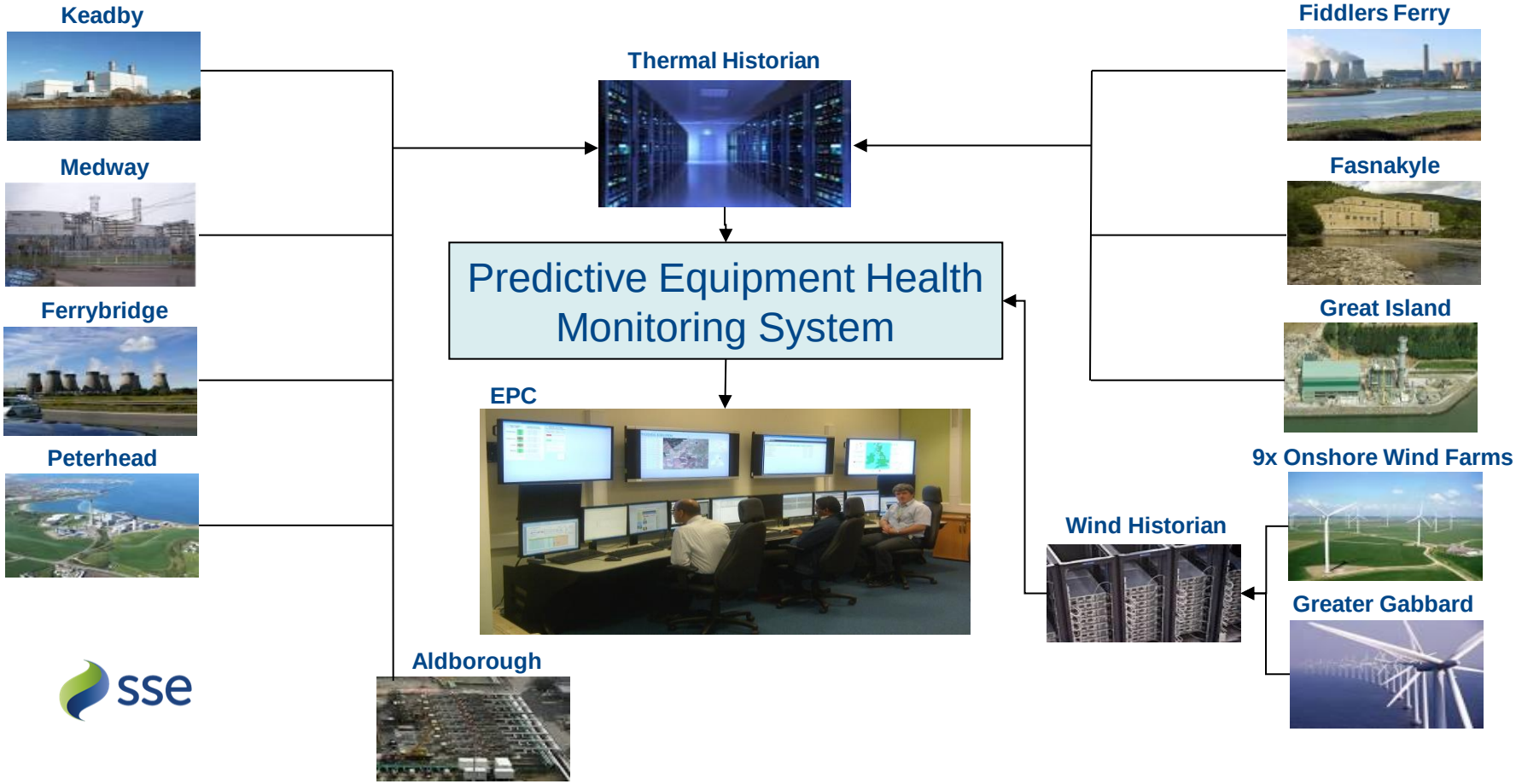
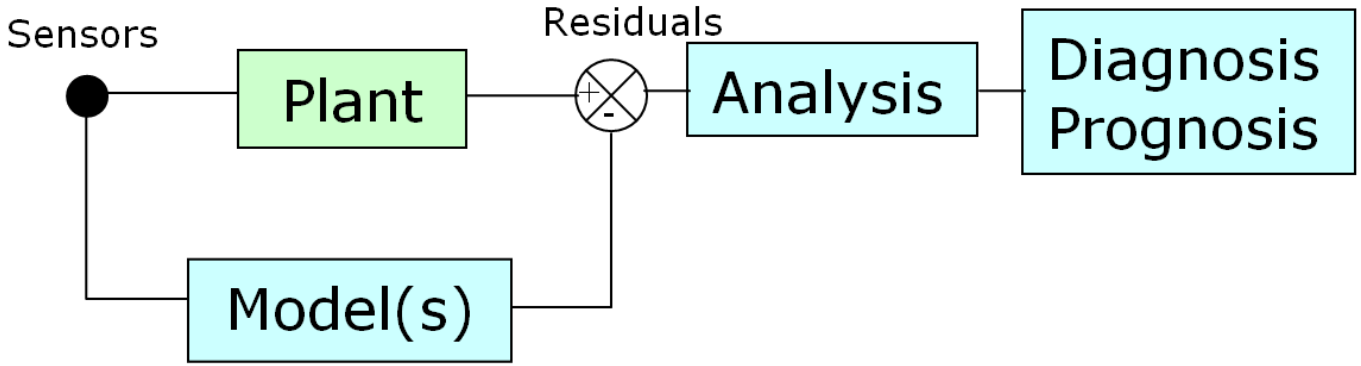
SSE Equipment Performance Centre

EPC Data Connectivity



How does it work?



Data from historian are used to build models of the plant.

Difference between the model estimate and the measured variable is the ‘Residual.’

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What does it do?

Provides an early indication of developing faults.

These are observed as trends in the residuals.

Can quickly detect faulty transducers.

And what does it not do …

Is not a replacement for any control room activities, cannot detect ‘lightning strike’ events!

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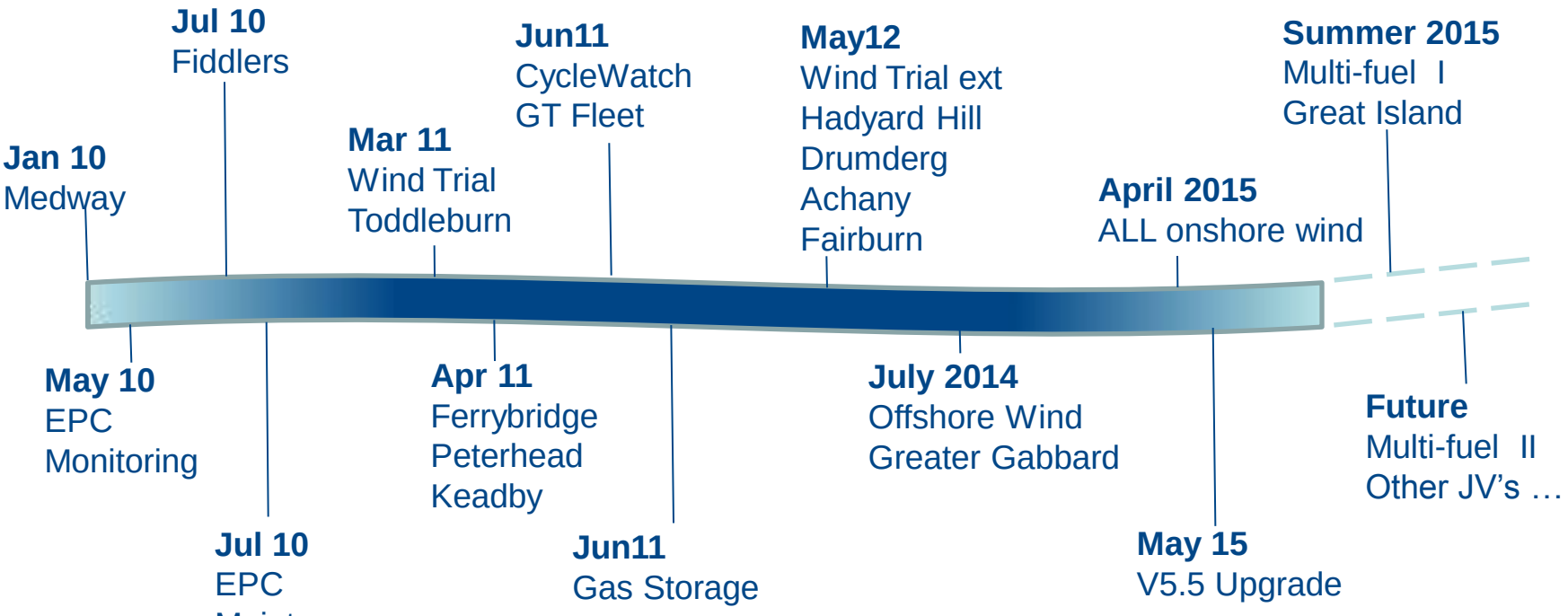
Predictive Analytics for Model-Based Condition Monitoring

- Data quality, data policy and data governance

Implementation timeline…

SmartSignal Timeline



Total 1026 Monitored assets

Where’s the Catch ?

Gas Turbine Exhaust Thermocouple

SmartSignal indicated GT exhaust temperature thermocouple 27 was reading low values. The EPC informed site.

Site found that the weld securing thermocouple 27 pocket (radiation) shield to the casing cracked, allowing the thermocouple and pocket to become detached and fall into the gas path.

During inspection, the majority of the pocket securing welds were found to be damaged on both units. Weld defects were repaired during an outage.

Similar weld defects also were found at a sister station and repair work was carried out.

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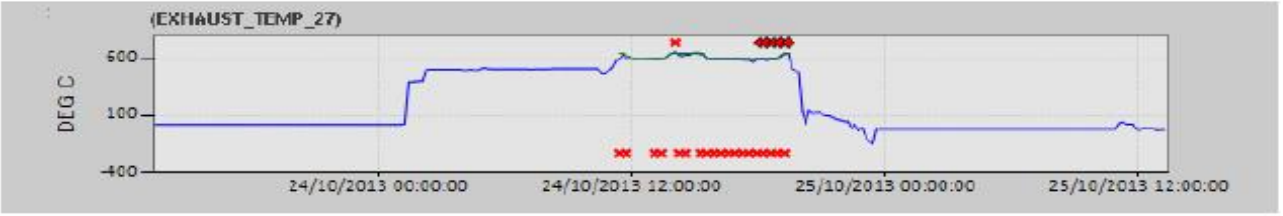
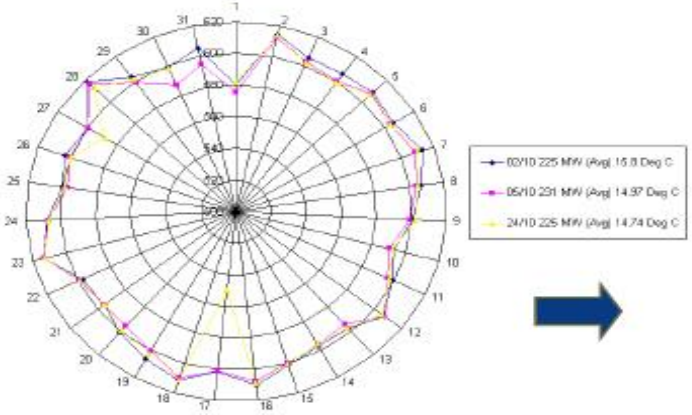
SmartSignal chart for thermocouple 27, indicating alert on 24th October





Swirl analysis to isolate a thermocouple fault

Results of site investigation; Thermocouple retrieved from gas path and welds inspected

Generator collector outlet air temp indicating high

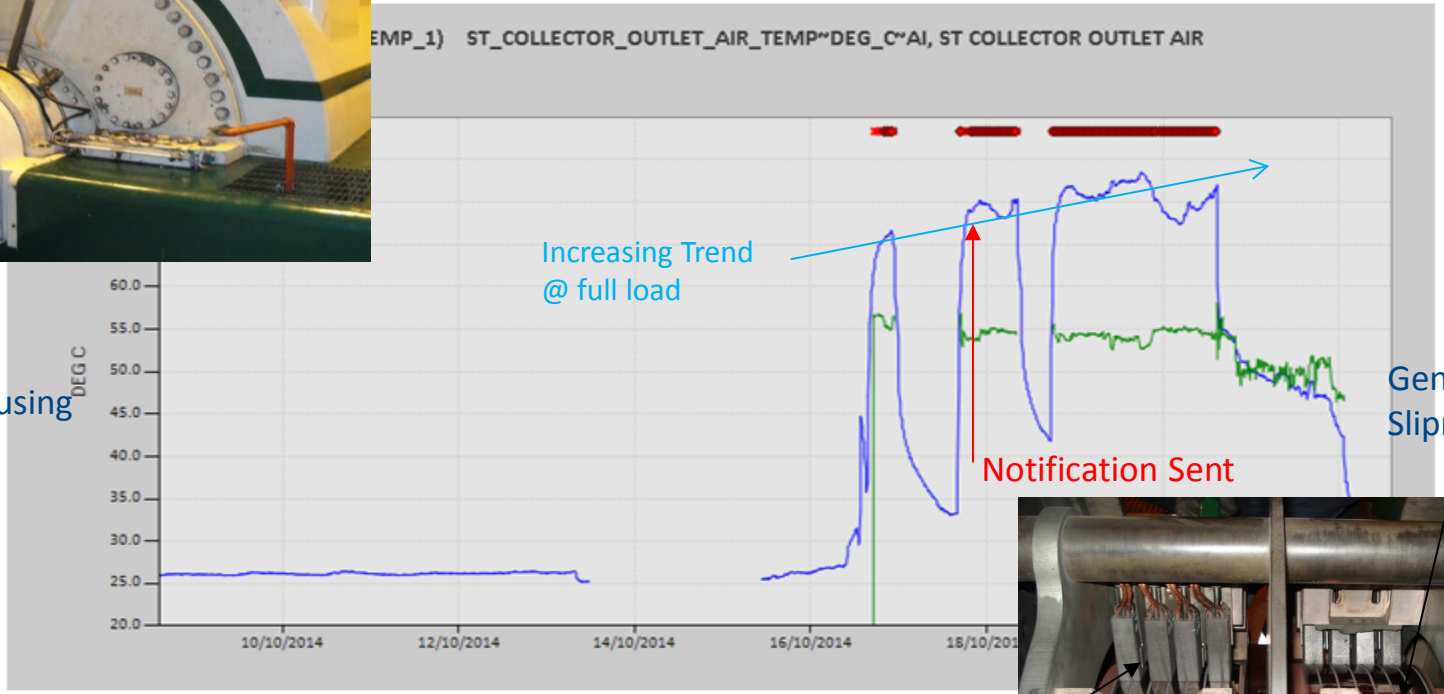
The EPC team notified site engineers that the collector outlet air temperature on the ST generator was higher than expected following return to service of the unit.

Normal operational temperature of the generator collector outlet air is approximately 55 degrees Celsius.

Excursion temperature reached 70 degrees Celsius with an increasing trend.

Generator EE

Collector Housing



Generator
Sliprings

Generator
Brushes

Potential Outcome if not detected by EPC

Overheating the carbon brushes and damage to the sliprings.

Possible removal of generator rotor required.

A full station outage would be required for any remedial work as the site is a CCGT and is not capable of operating without the steam turbine.

Investigation at site

Site engineering investigated the issue and found that the door hatch to the inlet air filters had not fully sealed. This was allowing the inlet air to bypass the collector housing, resulting in a temperature rise at the collector outlet.

Outcome

The defect was corrected by site engineering and the collector outlet air temperature returned to normal.

Site engineering installed new instrumentation to the enclosure. The alarm is set at 5% above normal running temperature, ~ 58deg c.

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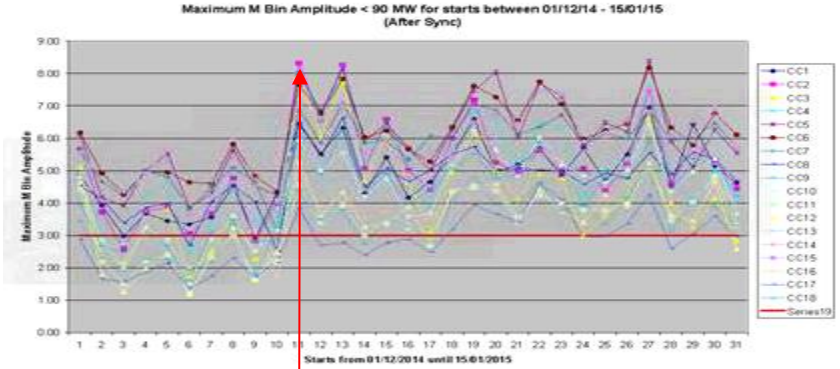
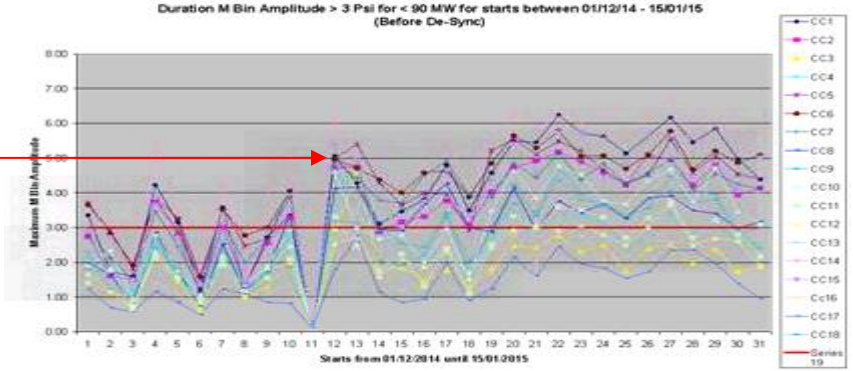
Combustion Dynamics – Low Fuel Gas Temperature



Maximum M-Bin Combustion Dynamics Amplitude for each start



Duration for M-Bin Combustion Dynamics excursion for each start

Excursion Starts

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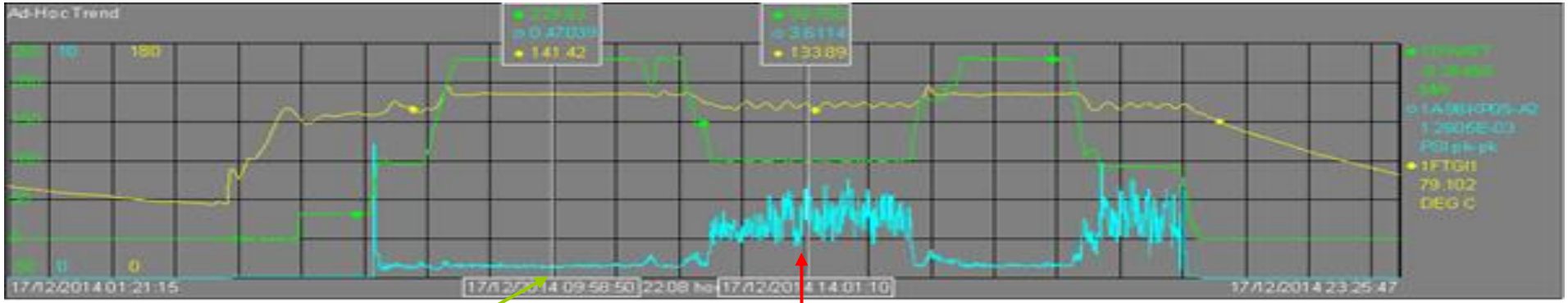
Combustion Dynamics – Low Fuel Gas Temperature

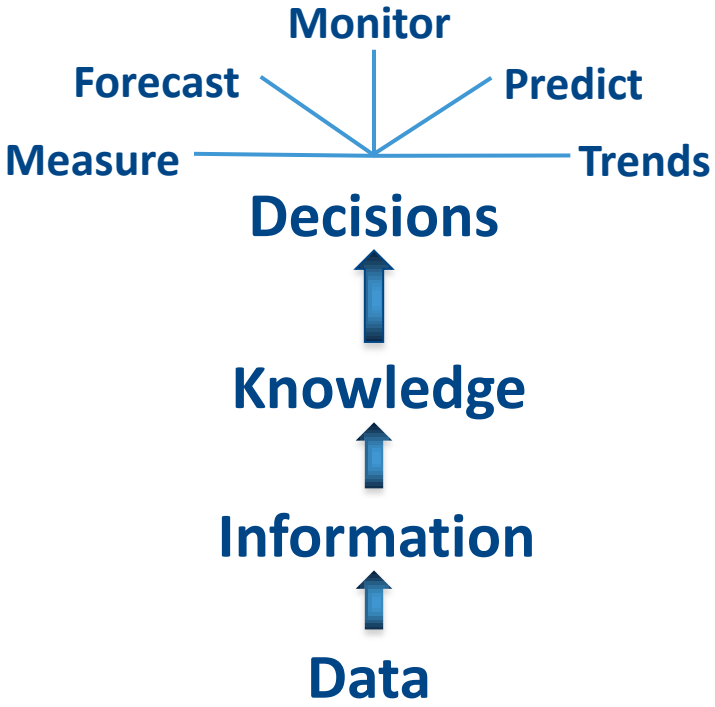
- The chart below highlights the relationship among the fuel gas temperature (Yellow), M-Band CDM (Blue) and Load (Green).
- Changes in load or fuel gas flow seem to directly affect the fuel gas temperature.
- The amplitude of the M-Band CDM becomes excited when the fuel gas temperature
- falls below 140 degree Celsius.



CD excursion when fuel gas temperature ~ 140 degree Celsius

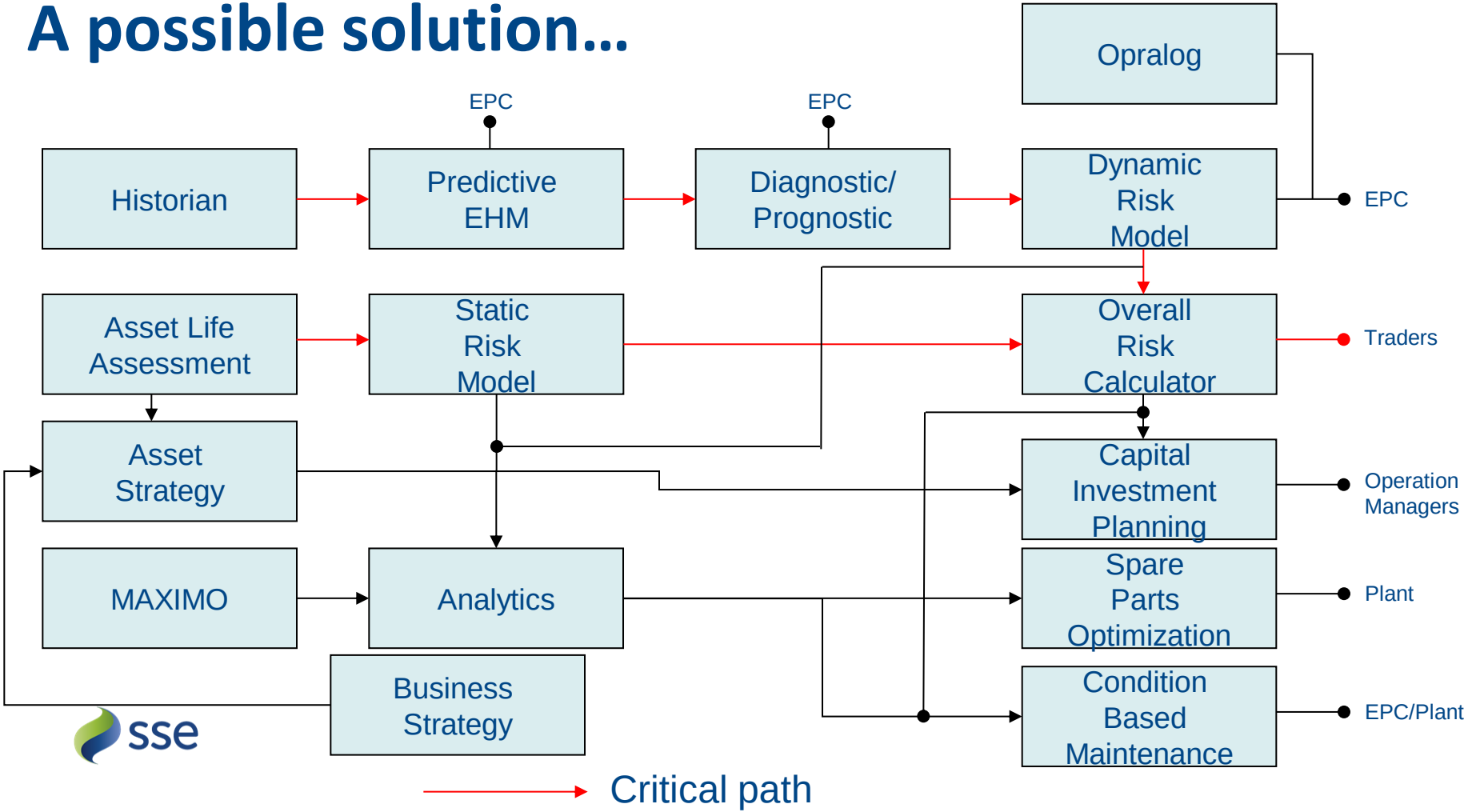
CD excursion when fuel gas temperature below 140 degree Celsius

What’s Next ?



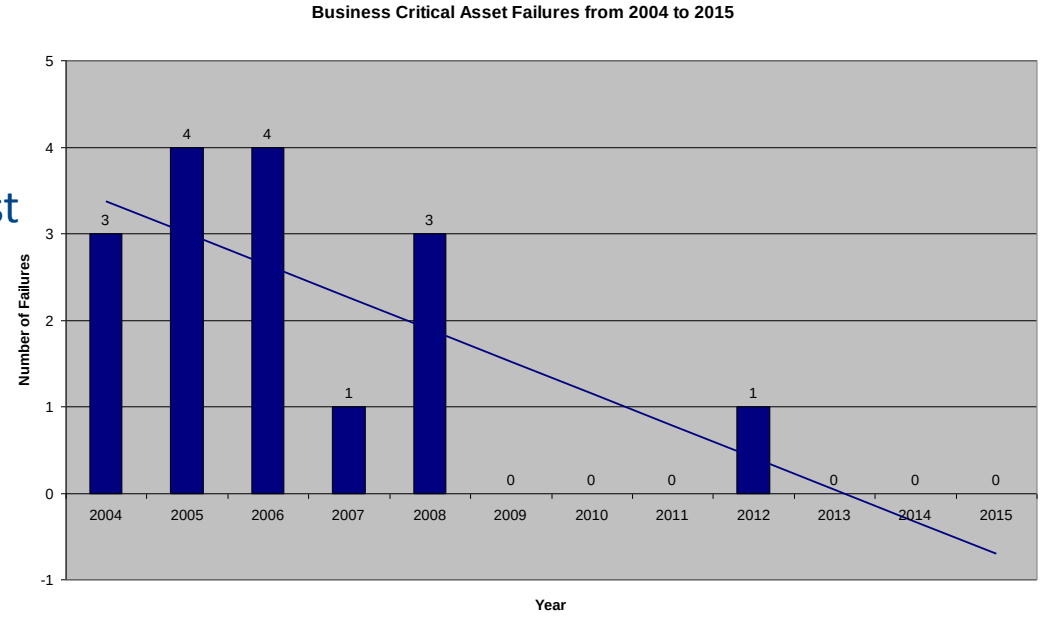
Implementing the enablers is the first step. Optimising them will ensure accurate, timely, rich information that will form the basis for sound business decisions.

A possible solution…



Conclusions

- Significant reduction in number of failures
- Significant reduction in insurance cost ~ £ 7.5 Millions per year
- Early detection failures > £ 3 Millions per year
- Prevention of past failures from reoccurring
- Increase plant availability
- Good working partnership with GE



Thank you ☺
Questions?