Power Potential Industry Event

30 October 2018

Sli.do app: **#PP2018**

UK Power Networks
Delivering your electricity

nationalgridESO

Housekeeping

- Fire alarms and exits
- Please put your phone on silent
- Sli.do – Download the free app to vote and ask questions **#PP2018**
- Visit the exhibition stands

Agenda

1	Introductions and welcome	10:00 – 10:10
2	Keynote speaker – Dame Fiona Woolf	10:10 – 10:30
3	Why the Power Potential Project? Duncan Burt and Suleman Alli	10:30 – 10:40
4	The technical solution – a DNO/DSO enabling DER to address transmission challenges - Rita Shaw	10:40 – 10:50
5	As a distributed energy resource, why would I participate in the Power Potential project? Amy Boast	10:50 – 11:00
6	Project team Q+A	11:00 – 11:30
7	BREAK	11:30 – 11:55
8	The power of diversity - Keynote speaker Louise Kingham	11:55 – 12:10

Agenda

9	What needs to be put in place technically to facilitate the DSO transition? Enda Mimnagh	12:10 – 12:35
10	Lunch and networking	12:35 – 13:45
11	How does Power Potential fit into the wider DSO transition? Randolph Brazier	13:45 – 14:10
12	How can Power Potential help future market design and reduce costs for consumers? Goran Strbac and Michael Pollitt	14:10 – 14:50
13	Reactive power market; what are the respective benefits of market solutions verses network investment?	14:50 – 15:50
14	Closing summary	15:50 – 16:00
15	Networking drinks and exhibition stands	16:00 – 17:00

Your World First

Power Potential – a transformational project in a changing world

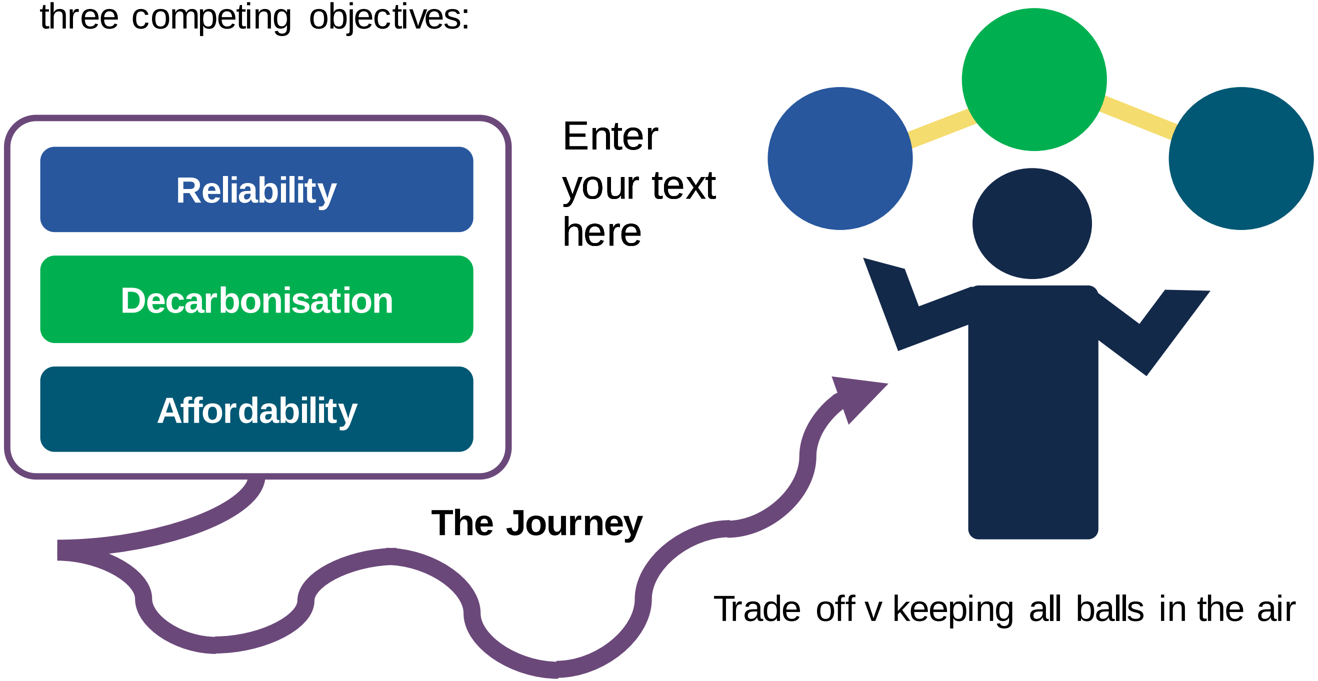
Fiona Woolf, CMS, London

October 2018 |

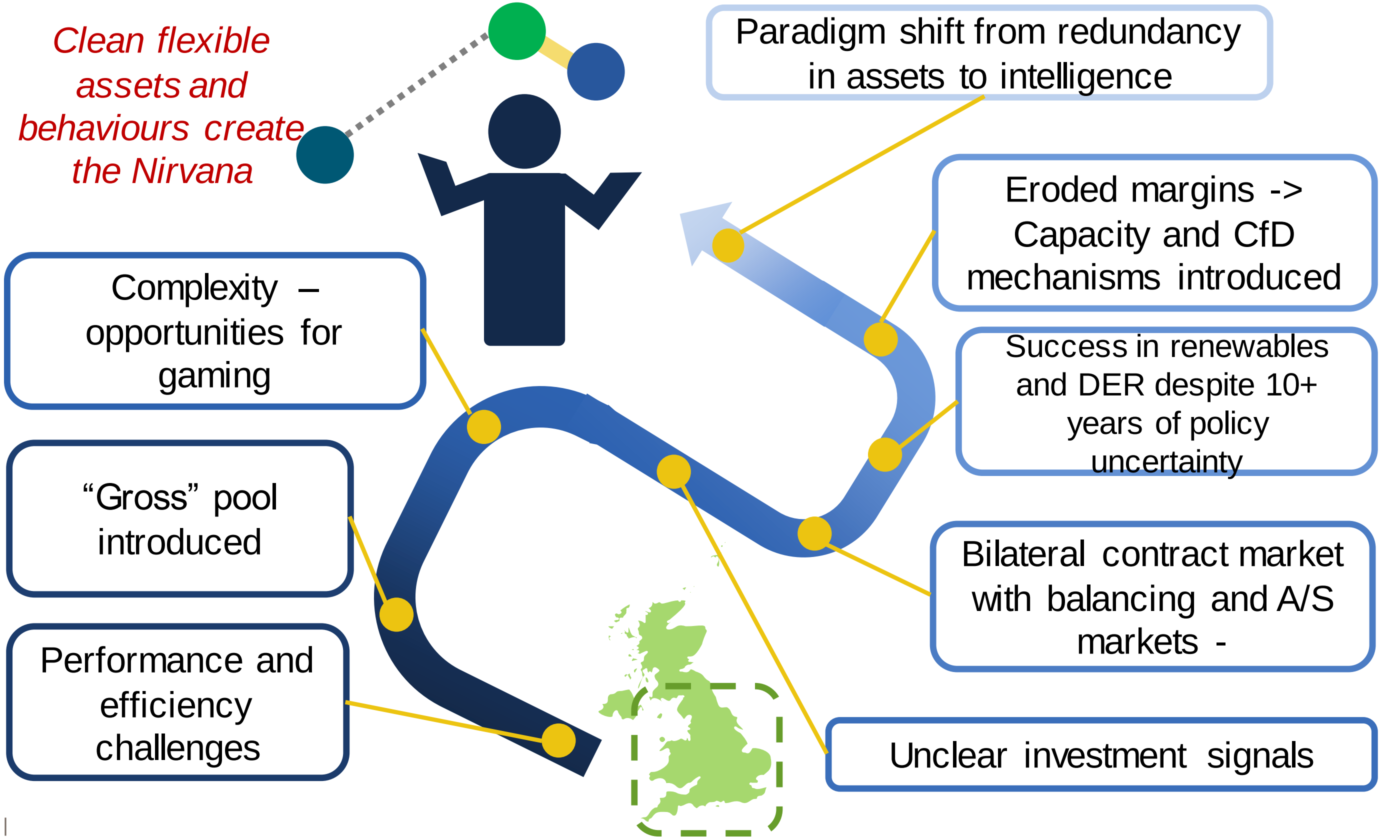
The Trilemma of electricity market design

The "Trilemma"
Simultaneously juggling
three competing objectives:

Achieving the "Nirvana"
of market objectives



The long and winding road to Nirvana in England & Wales



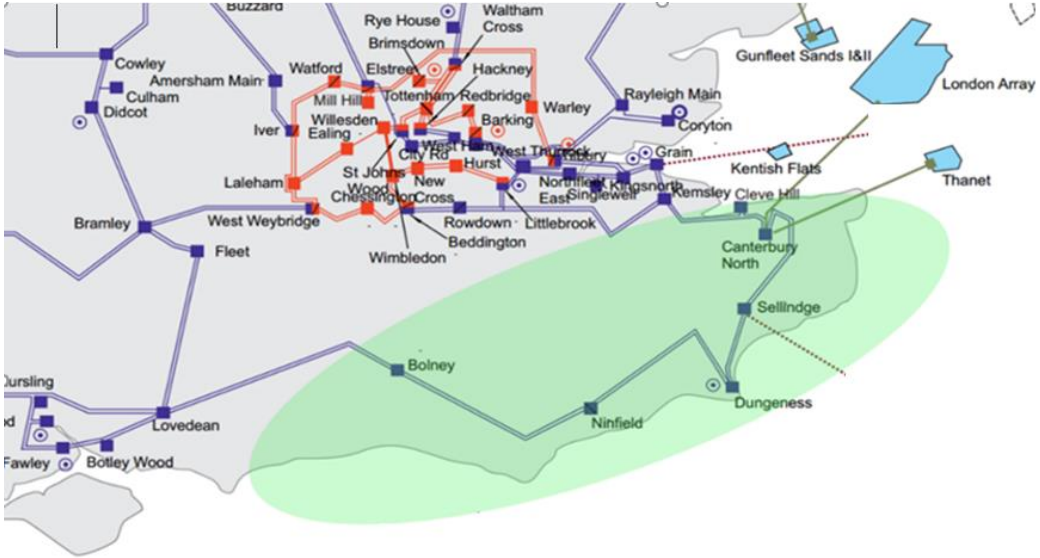
Global Transmission Expansion – Recipes for Success (2002)

- Deregulation of the power supply system called into question the best use scarce transmission capacity and how to create incentives for transmission expansion – successful use of the recipes was limited
- In 2002, distribution systems still regarded as infrastructure for one-way flows to consumers – distributed energy resources (DERs) were not regarded as an ingredient
- Chapter 3 looked into the store cupboard and regulatory incentive schemes to get more out of the system to minimise investment. The National Grid's response to the transmission services scheme (TSS) was the most successful in reducing the cost of congestion, balancing and certain ancillary services at that time – network, not market solution
- Some ancillary services were supplied through consumer response, but little thought has been given to searching further in the store cupboard for smaller scale resources
- Over a decade later, the academics began to write about it

Power Potential Unwrapped

- The Power Potential project is a world first trial in using distributed energy resources in distribution networks to provide dynamic voltage control to the transmission system – a combined technical, commercial and business solution
- Technical – it provides active power support for constraint management and system balancing
- Commercial – it creates a new regional reactive power market from DERs
- Business – involves the transition from a DNO to DSO business model
- A whole-system approach can be beneficial for everyone from network operators to generators to end consumers – proof of concept trial
- On the path to cleaner, smarter flexibility

Area of focus



- 275 kV
- 400 kV

Using what is in the store cupboard

The Pantry of Design *Ingredients*

versus

The Bookshelf of Design *Cookbooks*

Each market should judiciously form design ingredients into a recipe based on their unique circumstances…

…rather than mix incompatible design ingredients from different recipes

Demonstrating approach & establishing its commercial viability

The principles are:

1. Market efficiency
   i. Level of stimulus to DER – promote participation
   ii. Efficient allocation of budget & in line with project budget

   Examples:
   - Reward the DER that is most effective
   - Pay a fair price that reflects the need for investment to provide the service
   - Avoid placing participants in an unfairly beneficial position going forwards
2. Operational
   i. Maintain system security by not utilising trial volume to secure system
   ii. Trials to follow operational profile requirements (natural system behaviour) for reactive power
3. Continuous review of applicability to business as usual – to provide projections for future use
4. Market testing, fairness and accessibility are key to establishing viability

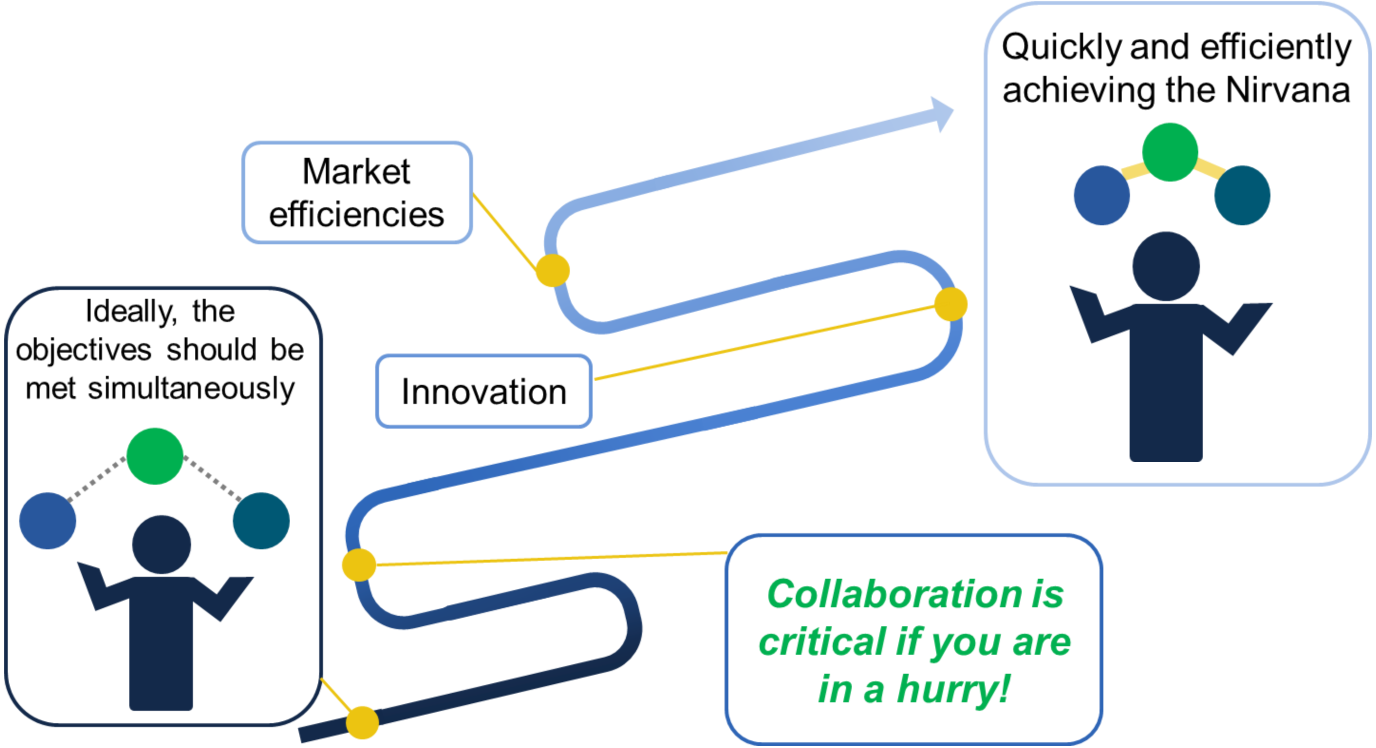
Lessons learned so far & observations

- Collaboration between two network companies with different functions and backgrounds requires effort
- Each network is different
- Innovation has to be tempered with keeping the lights on
- Exploring the individual needs of potential participants is key
- Issues such as cyber security, confidentiality and access to data are hidden complexity
- Network reinforcement may be deferred rather than avoided , but options are kept open
- Financial viability coupled with market transparency are key to feasibility and sustainability
- Trialling the market based solution does not automatically guarantee success or its application to other aspects of the electricity supply chain **but it is worth doing for the learning**

The Potential is Powerful

- Change is a constant in all aspects of electricity markets
- The learning will be useful for a wide range of purposes
- The concept could have application to many aspects of the supply chain
- It will create market opportunities for renewables (stacking) as well as DERs and consumers
- It should help to incentivise the smarter investment
- A new paradigm for flexibility (and focus) is likely to emerge which will be more sustainable
- The T and D network operators could develop their roles and achieve more efficiencies towards an improved “whole system outcome”
- We can learn more about aggregators – key to unlocking small DER and customer flexibility
- Consumers could become more responsive without a massive behaviour change through smart meters and appliances
- Everyone gets the benefit of the learning – the key to effective collaboration

The road ahead



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Duncan Burt

Director of Operations,
National Grid

Suleman Alli

Director of Safety, Strategy
and Support Services

UKPN

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Rita Shaw

Project Lead

UK Power Networks

The technical solution

DSO enabling DER contribution to transmission services

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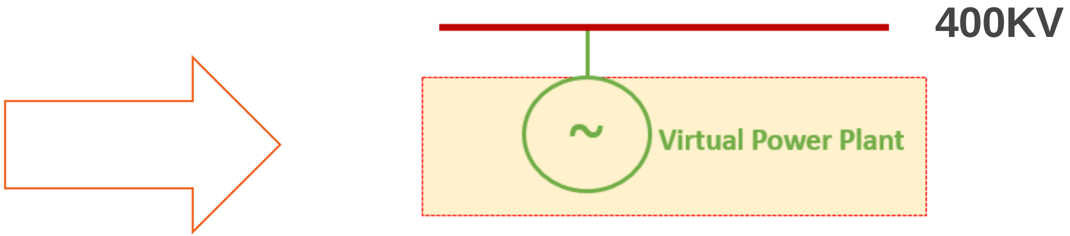
Unlocking DER's potential to deliver to transmission

Coordination and control of Distributed Energy Resources (DERs)



Why seek reactive power from DERs?

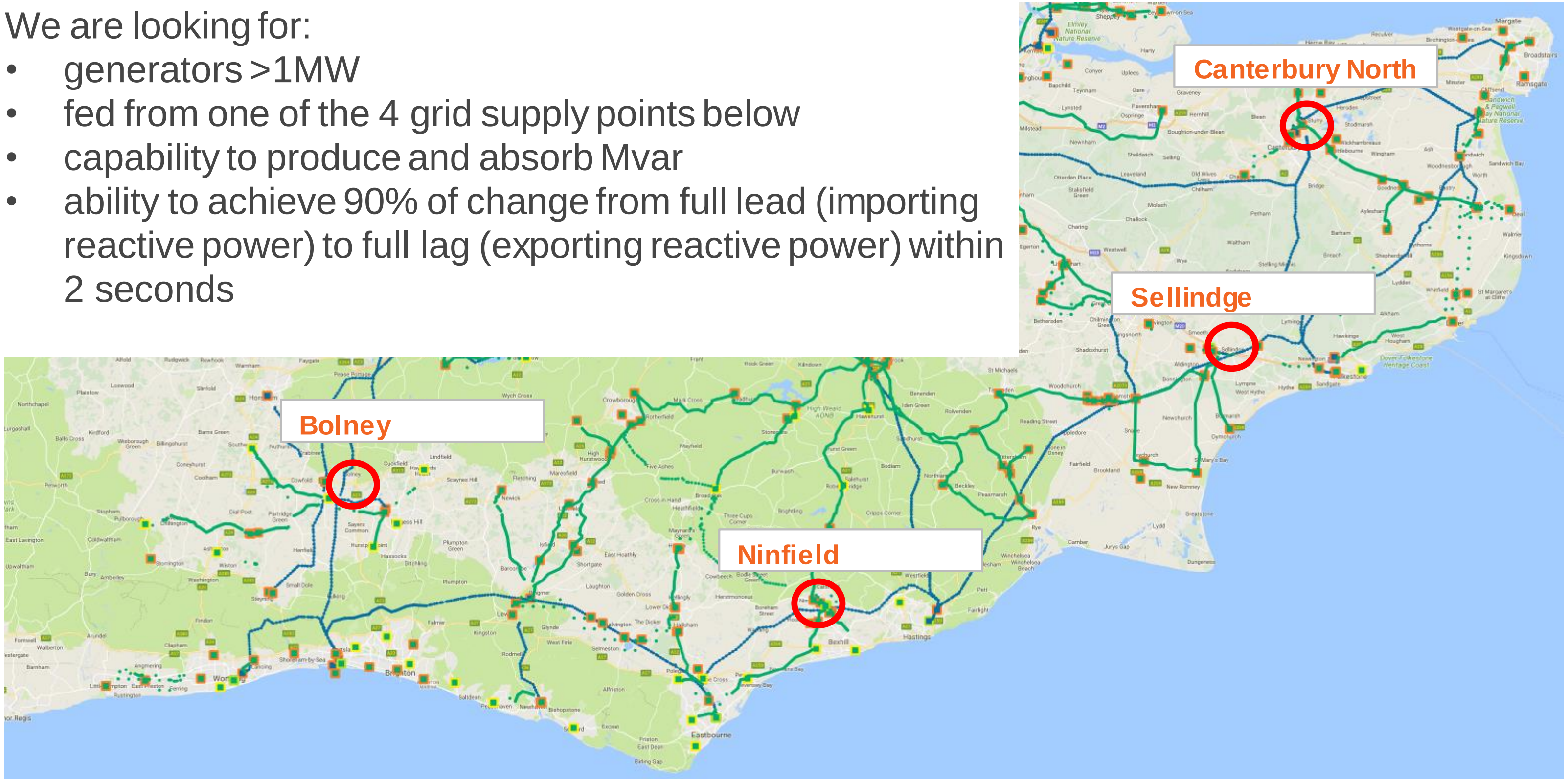
How the solution works

How we are turning this into reality?

The trial region and criteria for participation

We are looking for:

- generators >1MW
- fed from one of the 4 grid supply points below
- capability to produce and absorb Mvar
- ability to achieve 90% of change from full lead (importing reactive power) to full lag (exporting reactive power) within 2 seconds



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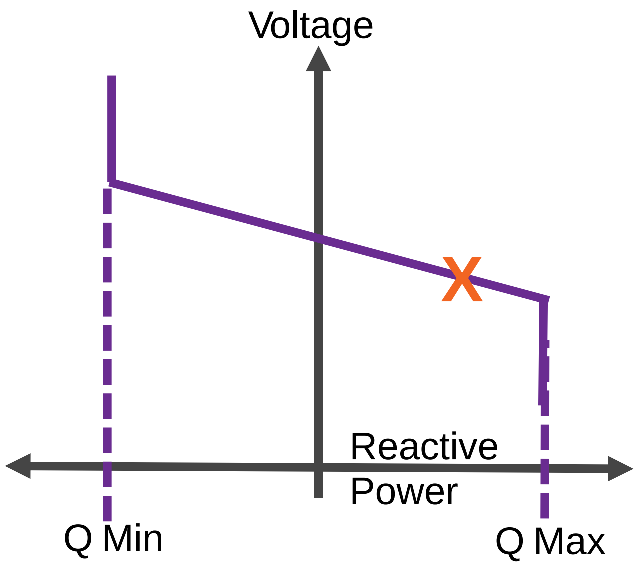
Dynamic voltage control

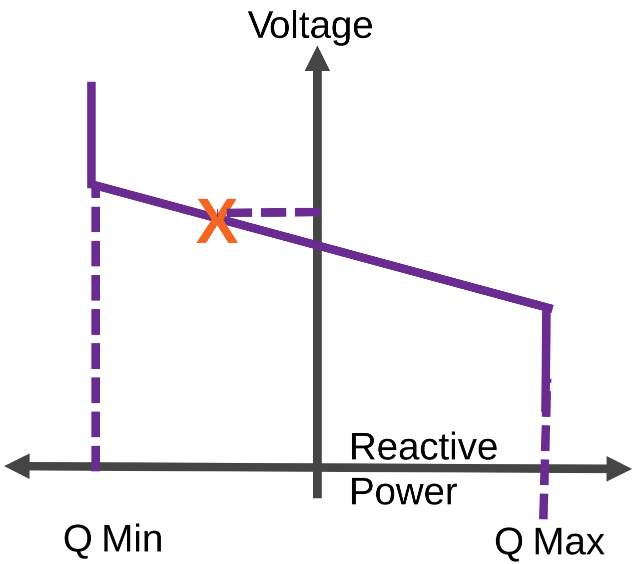
Self-dispatch:

- eg in a fault, local voltage decreased.
- Reactive power output increases.

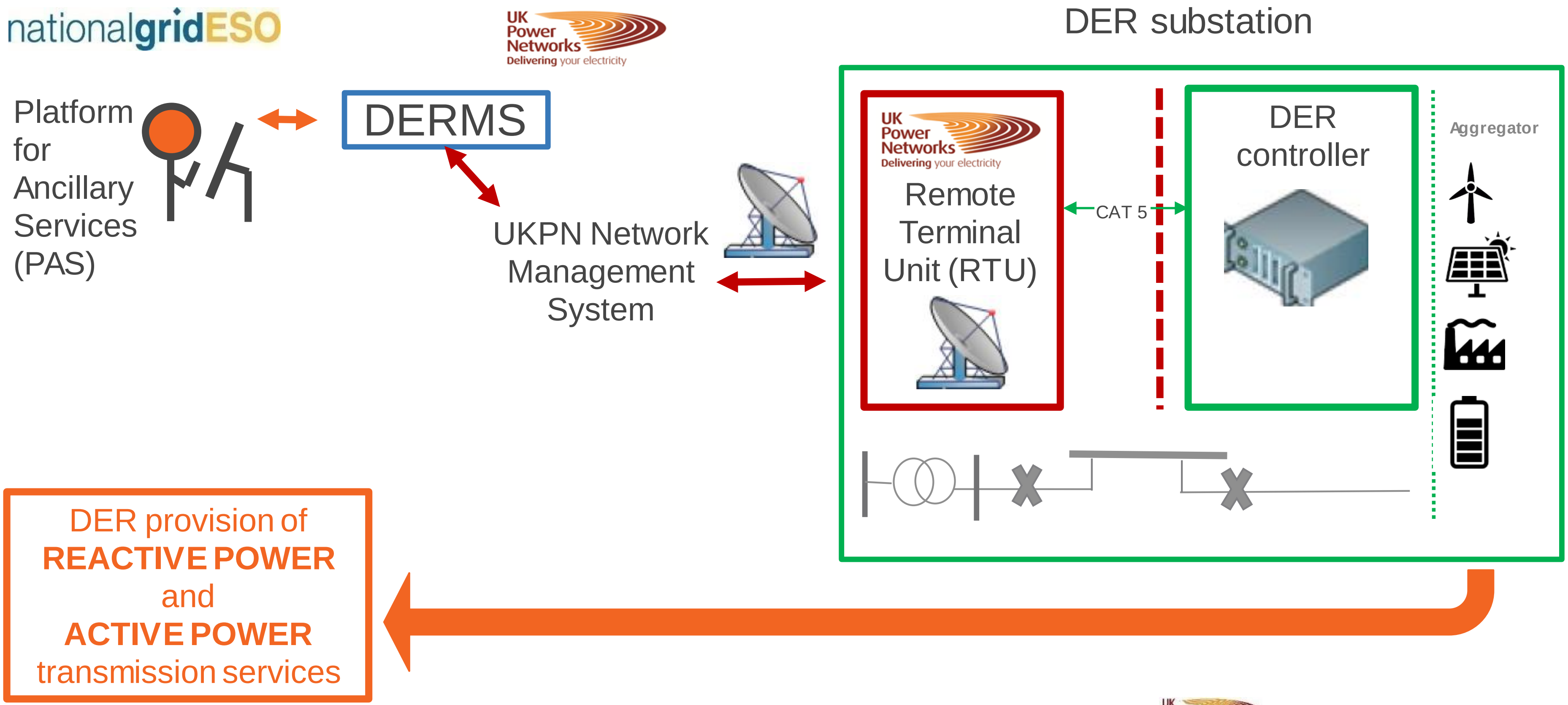


Enhanced control :

- New voltage set point.
- Reactive power output changes to adjust to localised voltage.



Whole-system process and communications



Participation information

Visit our project website: nationalgrid.com/powerpotential
And contact the team: box.powerpotential1@nationalgrid.com

And now also…
the DER Commissioning Test Specification

Optional laboratory test Jan 2019

DER commissioning Feb-April ahead of May trial start

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Power Potential: DSO enabling DER services to ESO

1. Show co-ordination / co-operation between ESO and DSO

2. Develop DERMS as an enabler of the service
   → significant data volumes to process

3. Integrate DERMS with UKPN's network management system
   → Not just an isolated proof of concept for an innovation trial
   → Preparation for UKPN to support DERMS beyond the Trial

Amy Boast

Commercial Workstream Lead

National Grid

As a distributed energy resource, why would I participate in Power Potential?

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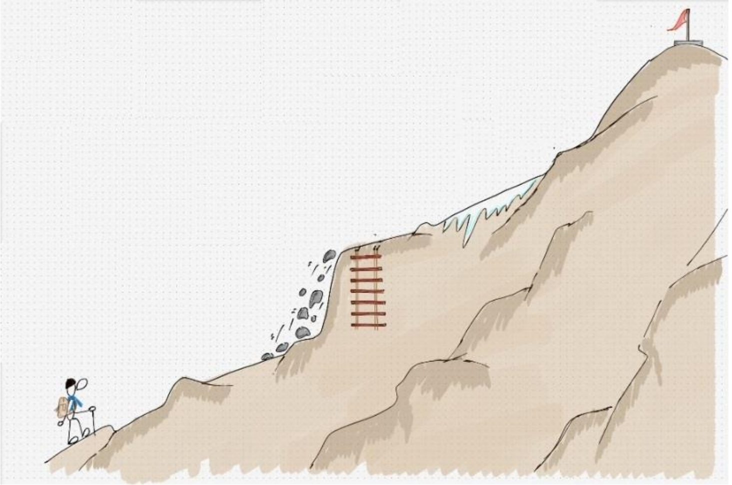
Why participate in Power Potential?



Overview of reactive power trials for 2019

Wave 1: technical trials → **Wave 2: price discovery** → **Wave 3: Transition to Business As Usual**

Objective: Demonstrate proof of concept .

DER will receive a *fixed participation payment*, in line with the number of hours they are available for during wave 1.

Objective: Establish the commercial viability of this approach

DER will compete with each other in day ahead auctions.

Objective: Prepare DER for a transition to current business as usual operations

DER will compete with each other and the mandatory market in day ahead auctions.

Summary of final payment models for trial

Reactive Service

Wave	Participation payment	Availability payment policy	Utilisation payment policy
1	Up to £45,000 per site, linked to availability	N/A	N/A
2	N/A	Driven by market bids	Driven by market bids
3	N/A	Assessed in line with other options available to the ESO	

Active Service

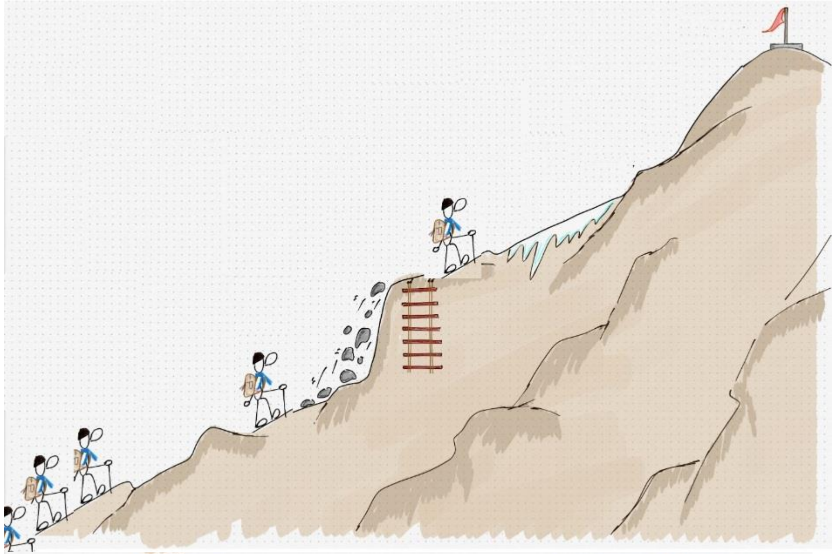
Wave	Participation payment	Availability payment policy	Utilisation payment policy
Competitive bidding	N/A	N/A	Driven by market bids

Provision of multiple services

Other service	Reactive Power (MVArs)	Active Power (MWs)
National Grid's Balancing Services (MWs)	●	▲
	Can I Participate?	
Firm Frequency Response	●	▲
Short Term Operating Reserve	●	▲
Demand Turn Up	●	▲
Capacity Market Contract	●	▲
Flexibility services to UKPN	▲	▲
Non-Firm Connections	●	

● Yes ▲ Conditional

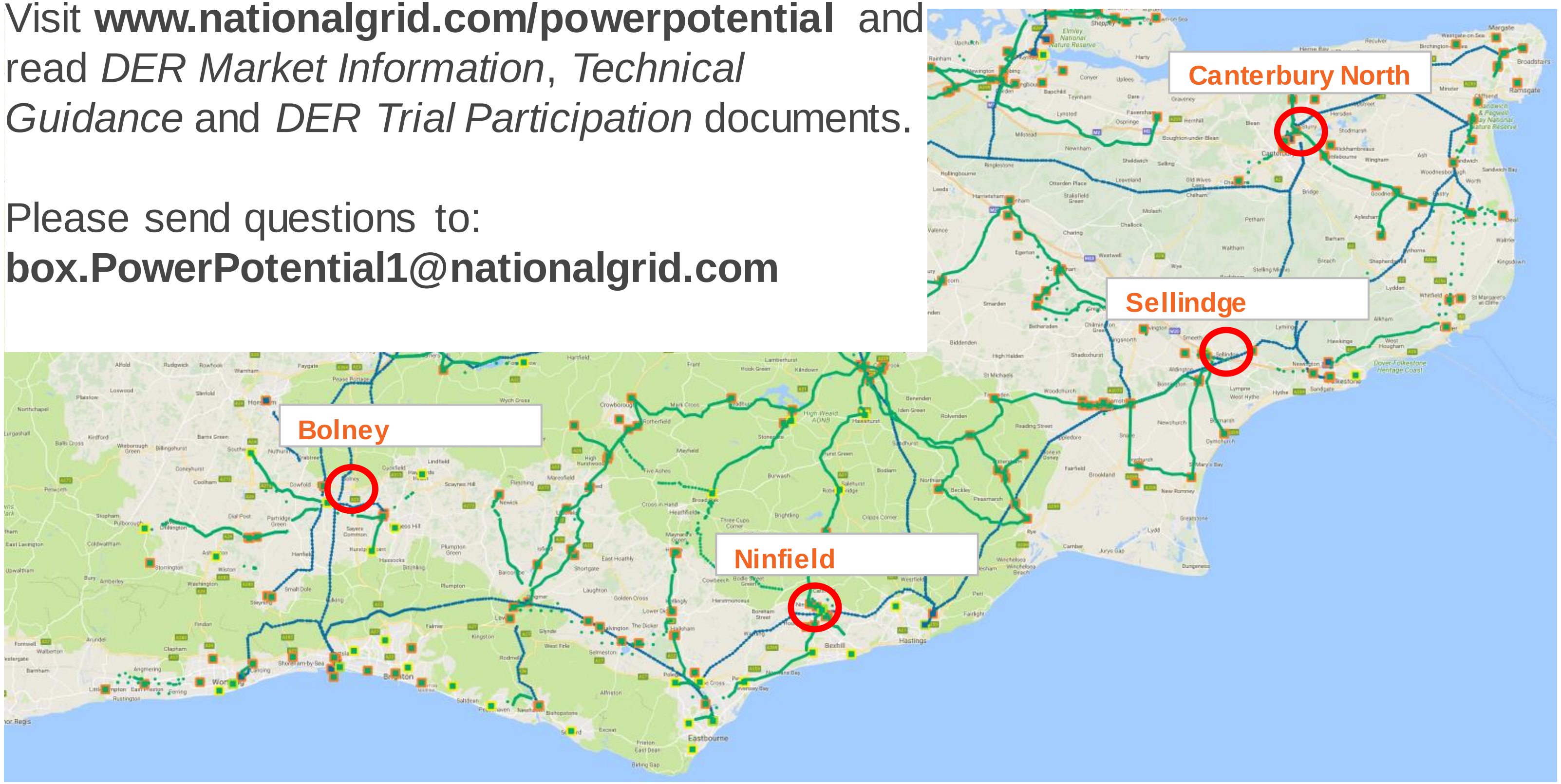
Why participate in Power Potential?



How to participate in the 2019 Power Potential trial

Visit **www.nationalgrid.com/powerpotential** and read *DER Market Information*, *Technical Guidance* and *DER Trial Participation* documents.

Please send questions to: **box.PowerPotential1@nationalgrid.com**



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Q+A

Chair:

Ian Cameron, Head of Innovation, UK Power Networks

Team members:

Rita Shaw, Project Lead

Biljana Stojkovska, Project Lead

Amy Boast, Commercial Workstream Lead

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BREAK

11:30 – 11:55

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POWERful WOMEN

THE POWER OF DIVERSITY

Louise Kingham OBE FEI

Chief Executive, the Energy Institute

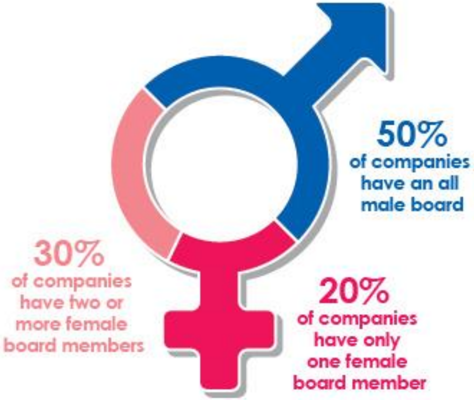
Power Potential Conference 30 October 2018

CURRENT STATE OF PLAY

2018 BOARD STATISTICS

POWERful WOMEN

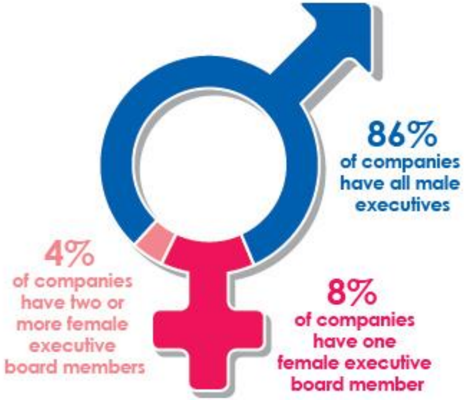
ALL BOARD SEATS
in the top 80 UK energy companies



50% of the top UK energy companies have all-male boards

13% of board seats are occupied by women

EXECUTIVE BOARD SEATS
in the top 80 UK energy companies

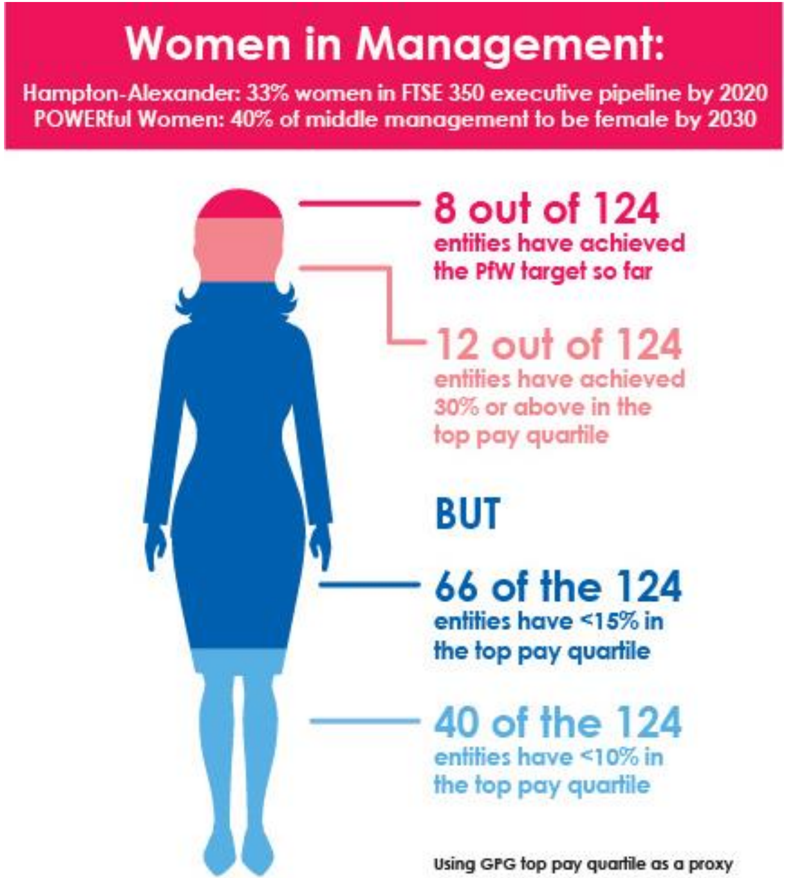


86% of the top UK energy companies have no female executive directors

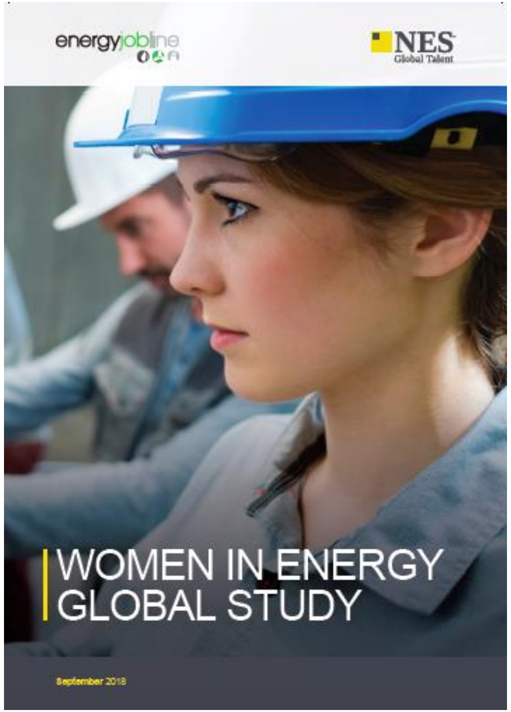
Only **6%** of executive board seats are occupied by women

2018 MIDDLE MANAGEMENT STATISTICS

POWERful WOMEN



POWERful WOMEN



New research on career trends & challenges

- Engineering is most common job type, with only 1/5 ‘pink’ jobs
- Majority say their company is only “slightly” inclusive (but power sector leads on inclusiveness)
- Biggest challenges: lack of suitable roles, lack of mentoring, lack of flexible working
- Working in energy does not deter women from having children and nearly 2/3 are bread-winners
- Vast majority would still recommend a career in energy

WHY DIVERSITY MATTERS

BUSINESS BENEFITS OF GENDER DIVERSITY

POWERful WOMEN

Better Decision Making

Equal gender diversity ratios correlate to **higher innovation**[4]

Different view points and perspective prevent "group think" and brings **new thinking**[5]

Improving performance

Increase at companies that have one woman on board[1]

26%

Share price

For companies ranking in top quartile diversity **VS** those in the bottom quartile[2]

35%

More likely to outperform

For companies with the most women on a board compared to the least[3]

66%

Higher return on capital

Achieving better corporate governance and ethics

Just one female on the board cuts the risk of going bust by

20%

WHAT DO WOMEN BRING?

POWERful WOMEN

RESEARCH

- LEADERSHIP COMPETENCIES
- COLLABORATION AND COMMUNICATION
- PLANNING AND MULTI-TASKING
- ENVIRONMENTAL PRIORITIES
- THE CONSUMER PERSPECTIVE

Greater diversity can rebalance and therefore strengthen a team, tapping women's skills to meet the energy challenges ahead.

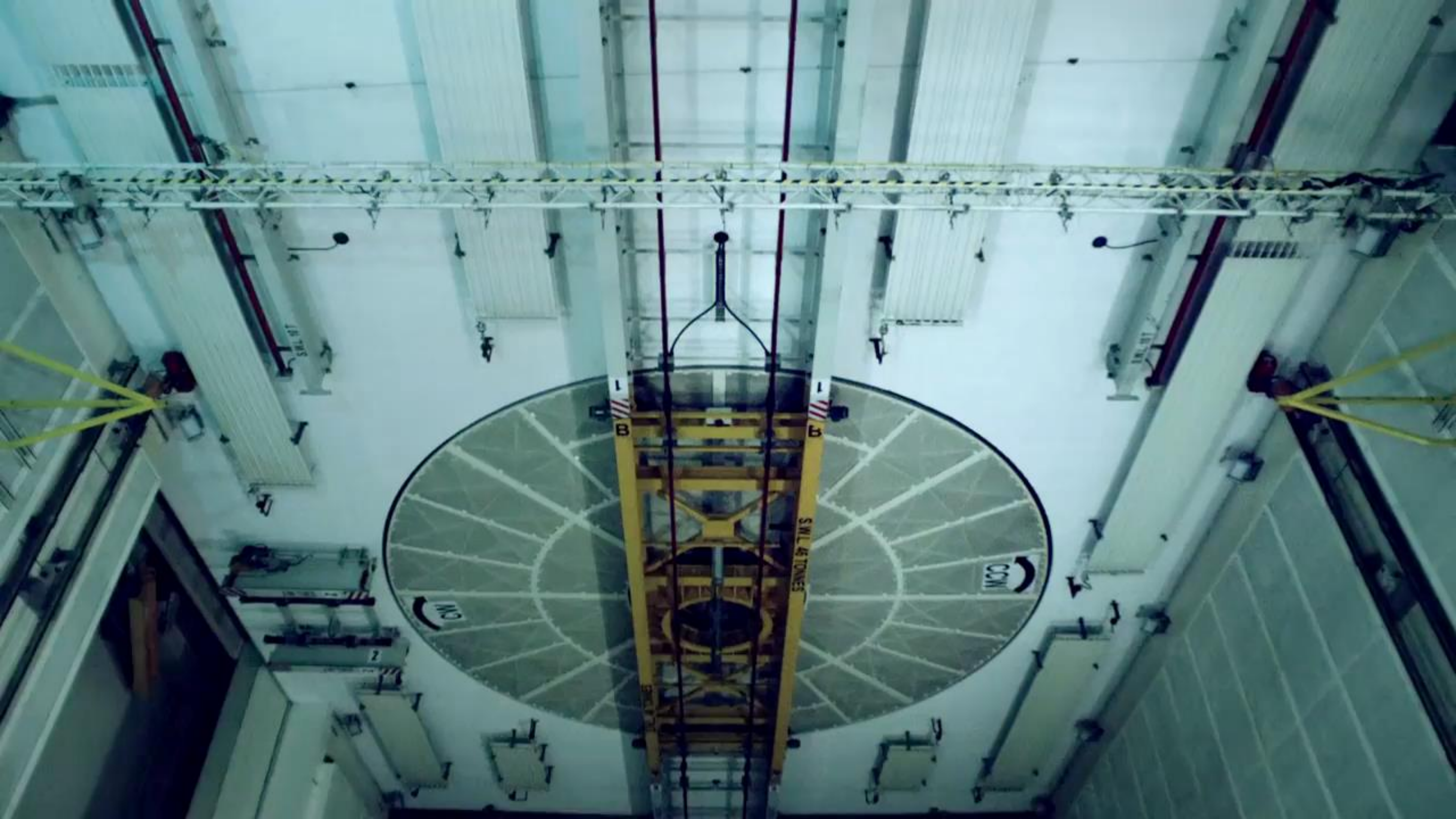
DIVERSITY CREATES OPPORTUNITIES

POWERful WOMEN

THIS IS ENGINEERING

2018. THE YEAR OF ENGINEERING

WISE
women into science, engineering and construction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CCW
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WHAT NEEDS TO HAPPEN

TARGETS ON GENDER DIVERSITY

POWERful WOMEN

- Davies/Hampton-Alexander: **33%** women on FTSE 350 boards by 2020
- PfW: **30%** of energy executive board positions to be held by women by 2030
- PfW: **40%** of energy middle management roles to be held by women by 2030

What gets measured gets managed!

POWERful Women encourages progress through:

- reporting: celebrating success and showing room for improvement
- practical advice and mentoring for aspiring women
- corporate leadership (sponsors and pledges)
- working with government (BEIS leadership)

Join in! @_PfWomen

It's time to shift it up a gear!

WHY DOES ALL THIS MATTER?

NEW SKILLS FOR A TIME OF UNPRECEDENTED TRANSFORMATION

- Decarbonisation and new sources of energy
- Emerging markets: eg flexibility
- New structure of the industry
- Changing customer expectations and affordability
- The role of technology and new innovation

- **National Grid and UK Power Networks - and the Power Potential Project - and the smart new energy future.**

AND FINALLY …

“At National Grid we understand that increasing the diversity of the workplace is crucial to ensuring we have the best and most talented people to do our vital work.”

John Pettigrew FEI, CEO of National Grid

Enda Mimnagh

Strategic Market
Development Manager

ZIV Automation

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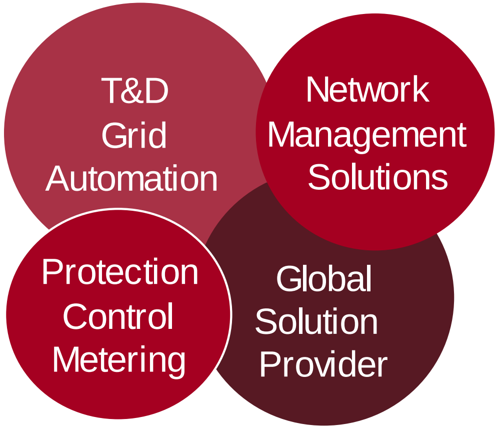
UKPN PowerPotential Presentation

Making the Smart Grid Real



- **ZIV** is a provider of innovative products solutions to the power industry for more than **30** Years
- A team of more than **500** professionals
- With presence in **85** countries
- **7** manufacturing facilities
- **15** client support centers
- **Complete automation solutions**

Making the Smart Grid Real

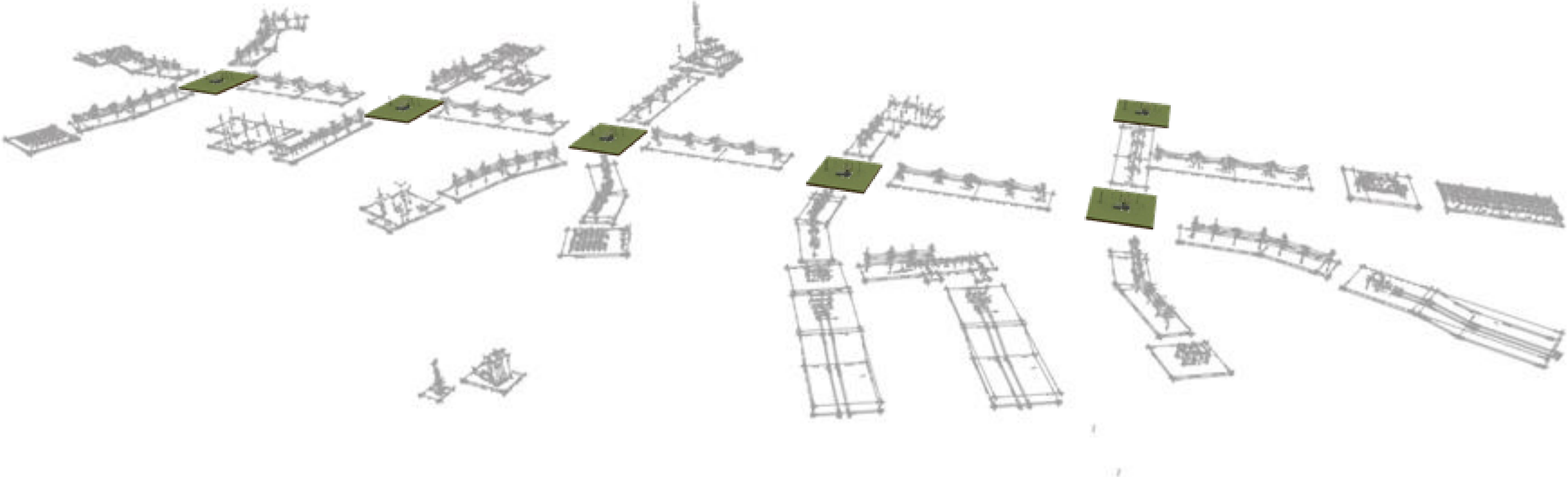
Global references

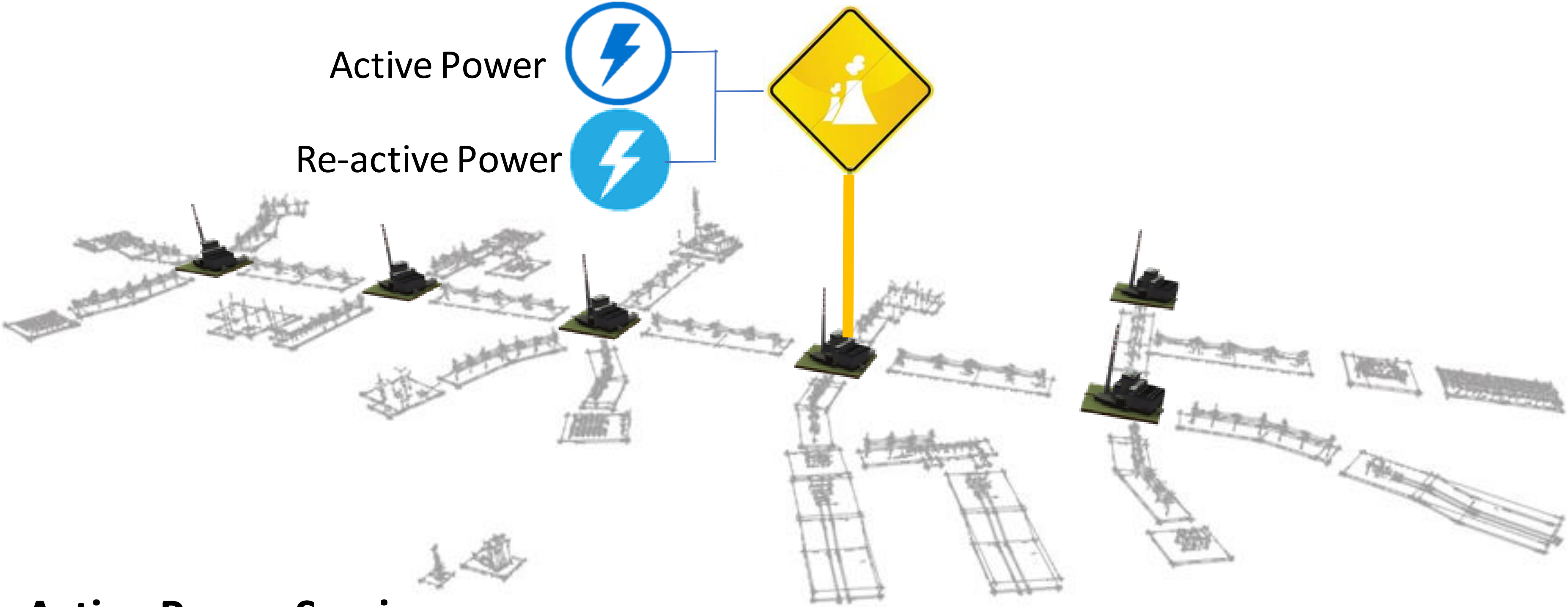
85 countries

7 Manufacturing facilities & 15 client support centers

Zamudio (ESP)	Dublin (IRL)	Singapore (SGP)
Barcelona (ESP)	New castle (GB)	Dubai (UAE)
Madrid (ESP)	Chicago (USA)	Bangalore (IND)
Grenoble (FRA)	Niteroi (BRA)	KSA
Paris (FRA)	Mexico (MEX)	Indonesia

Power Potential : Flexible Services





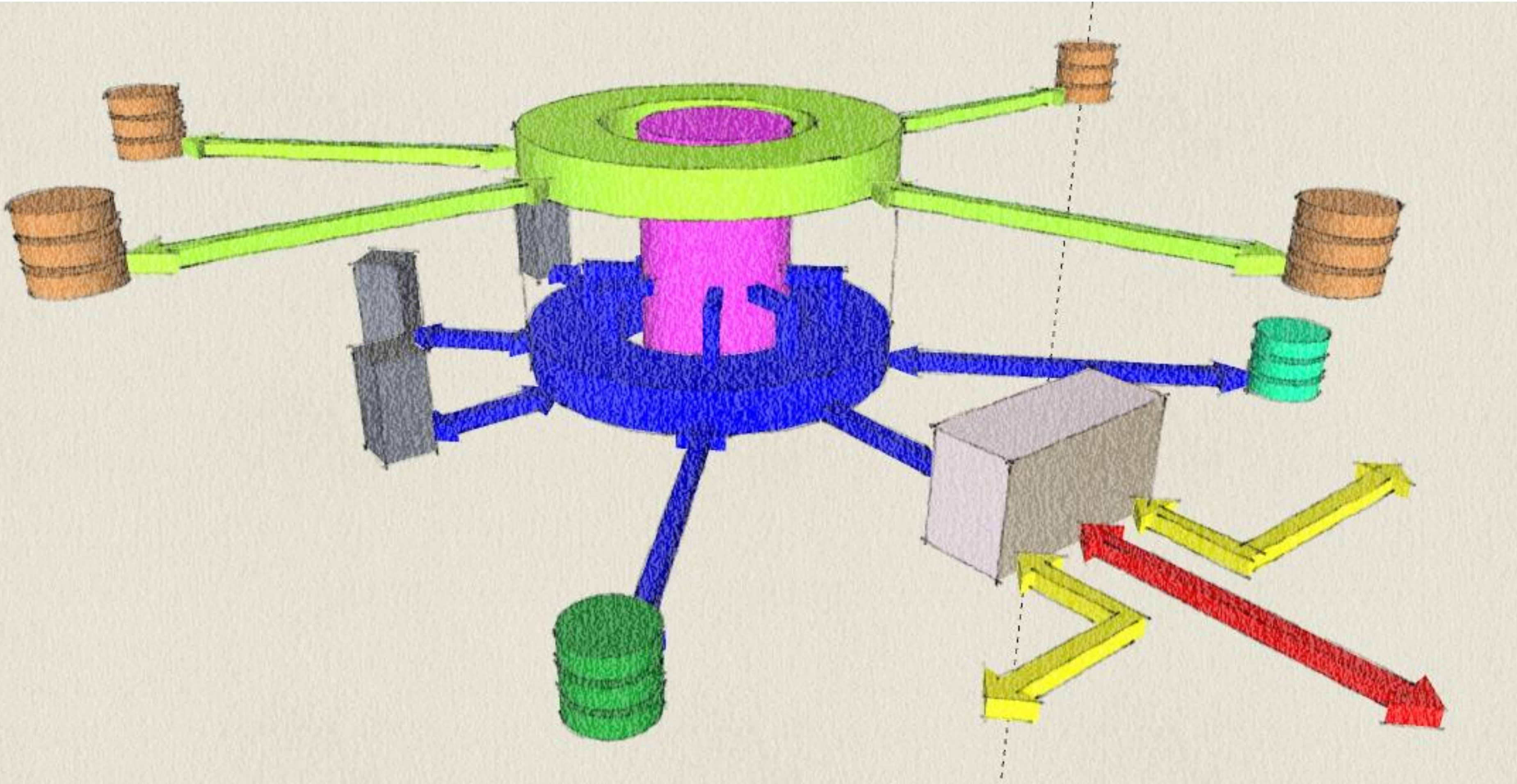
Active Power Services

Power Potential P Service

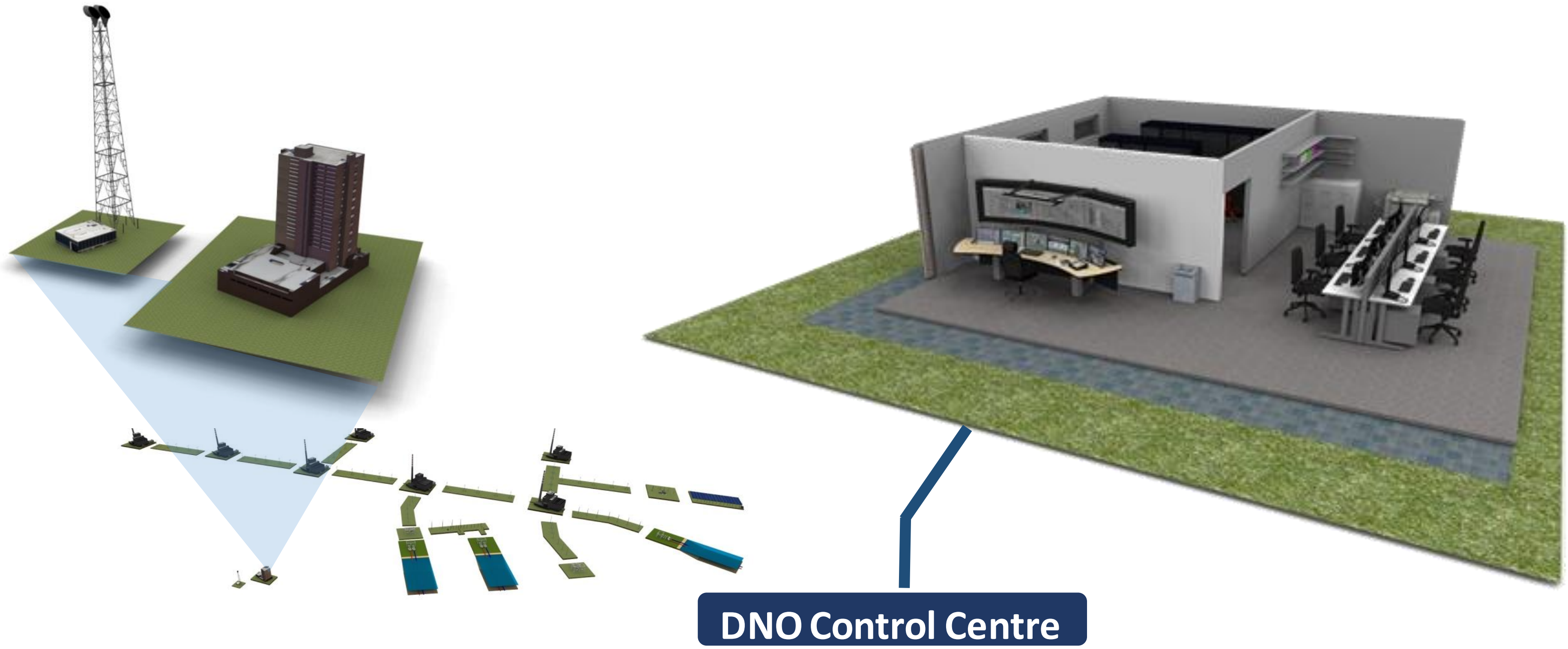
Reactive Power Services

Power Potential Q Service

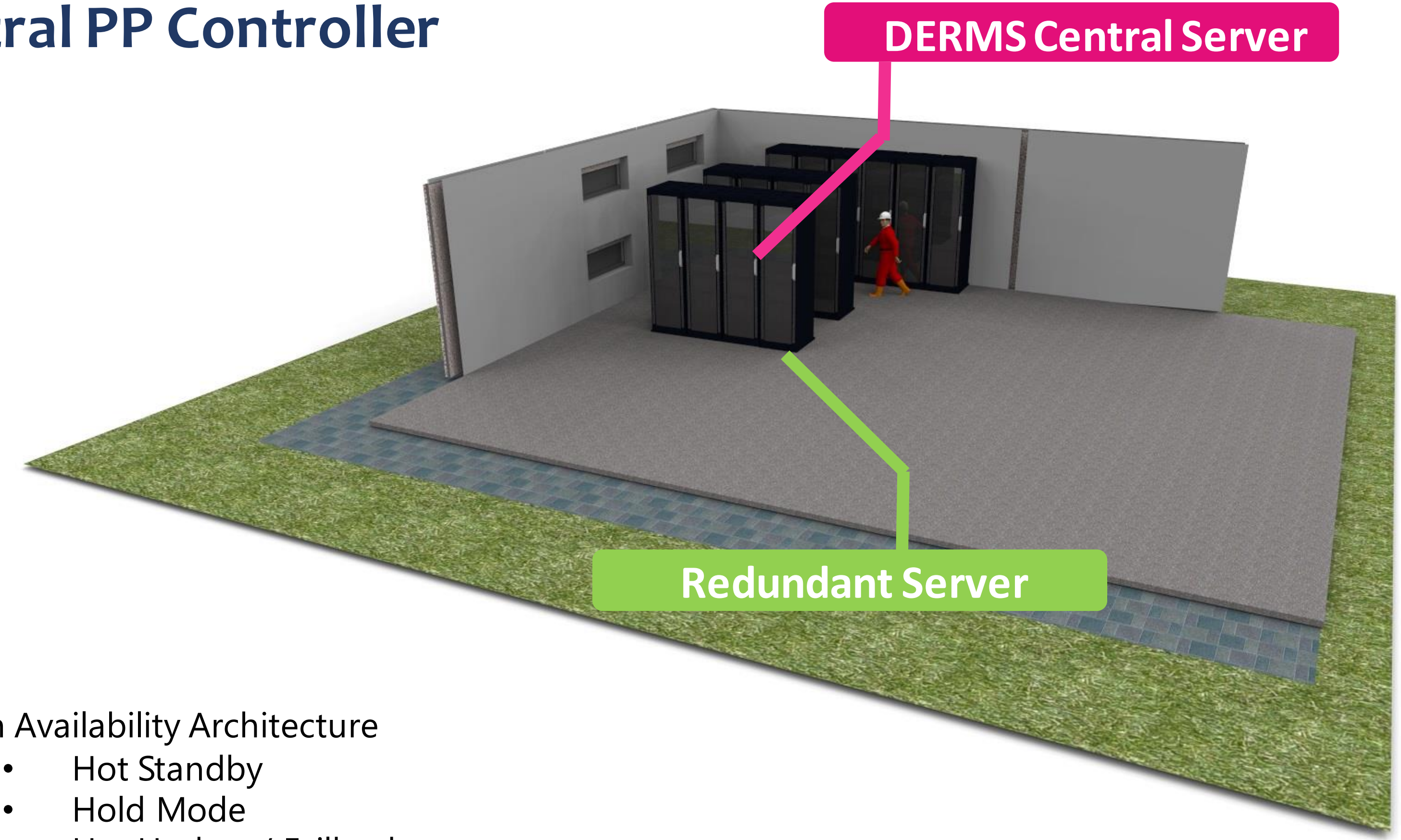
System Architecture



Potential Central Controller

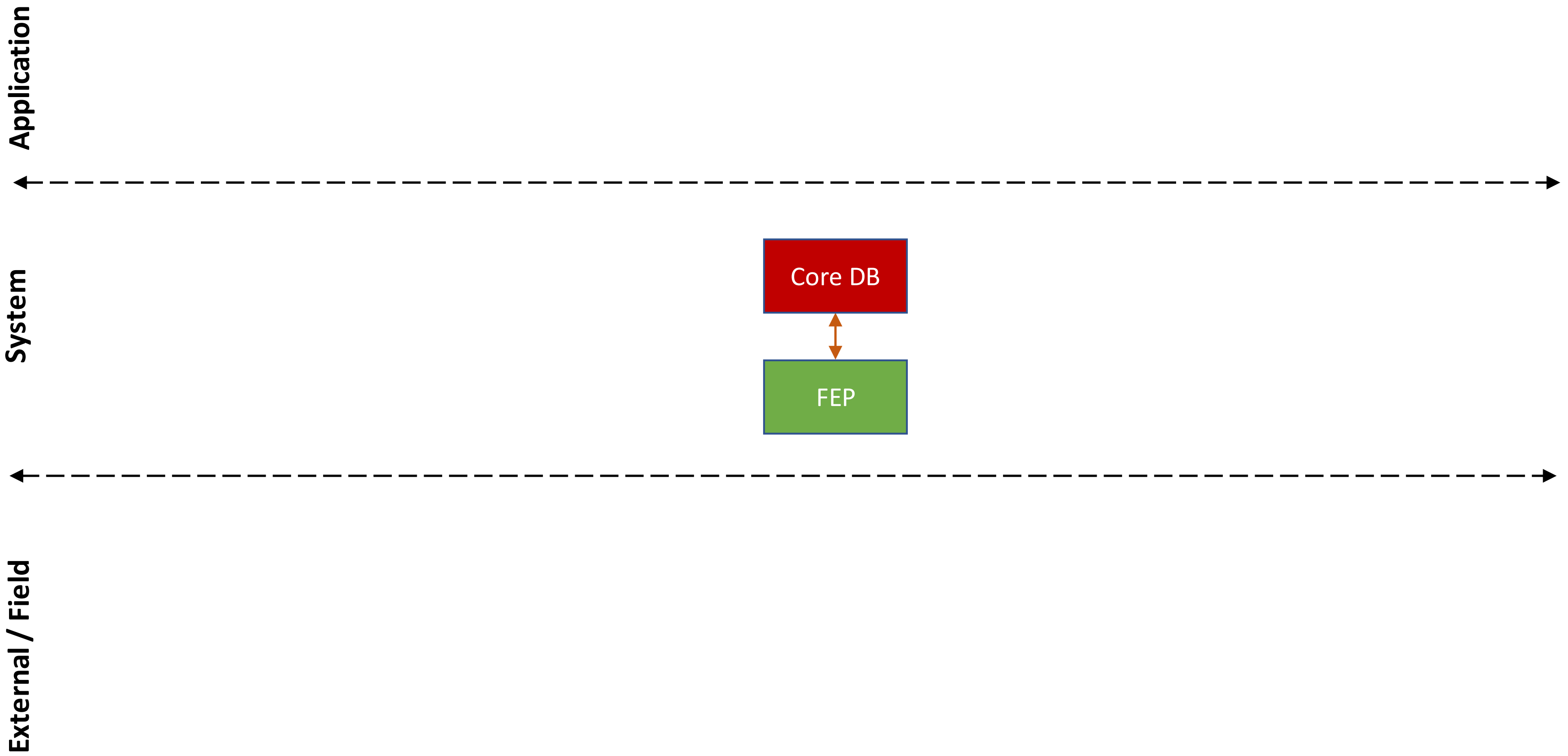


Central PP Controller

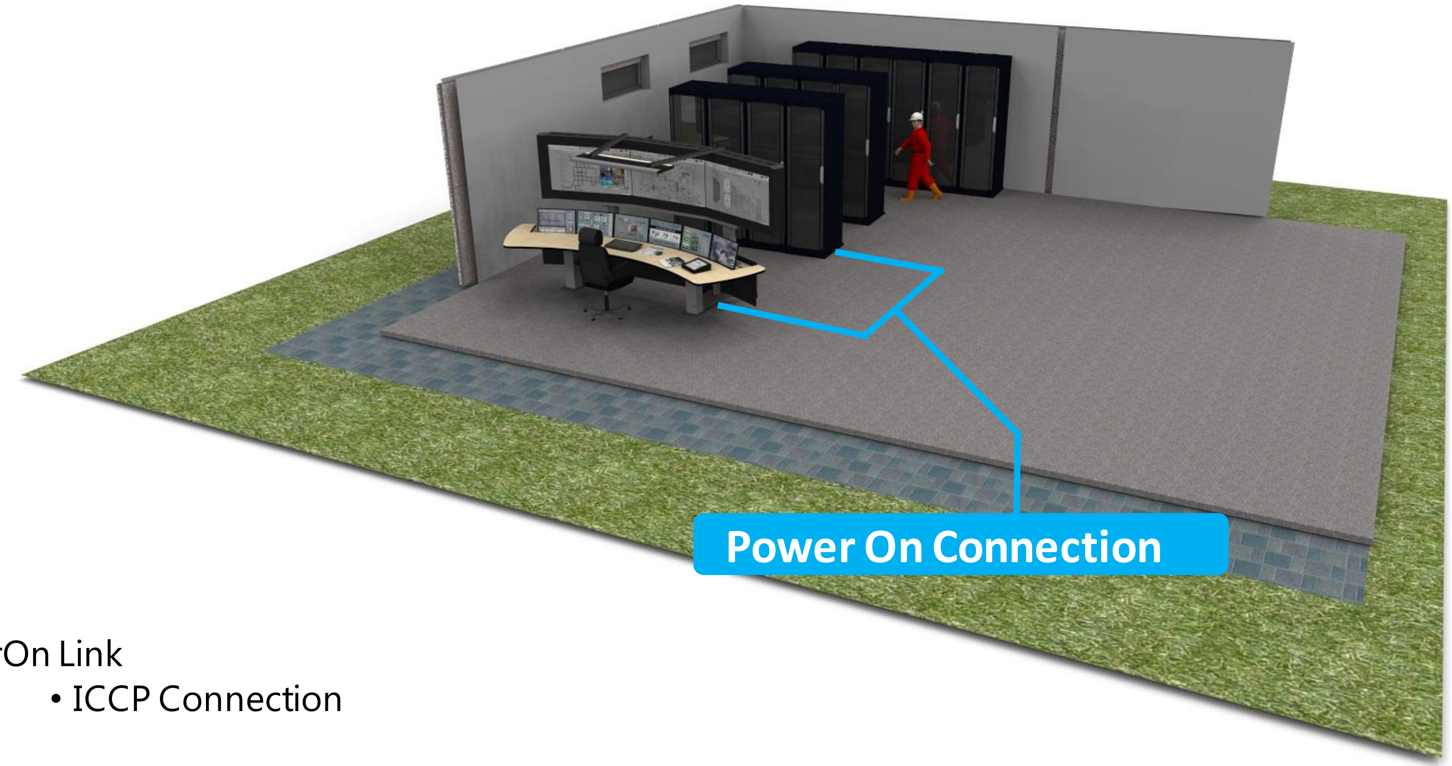


High Availability Architecture

- Hot Standby
- Hold Mode
- Hot Update / Failback
- Multi-site Deployment

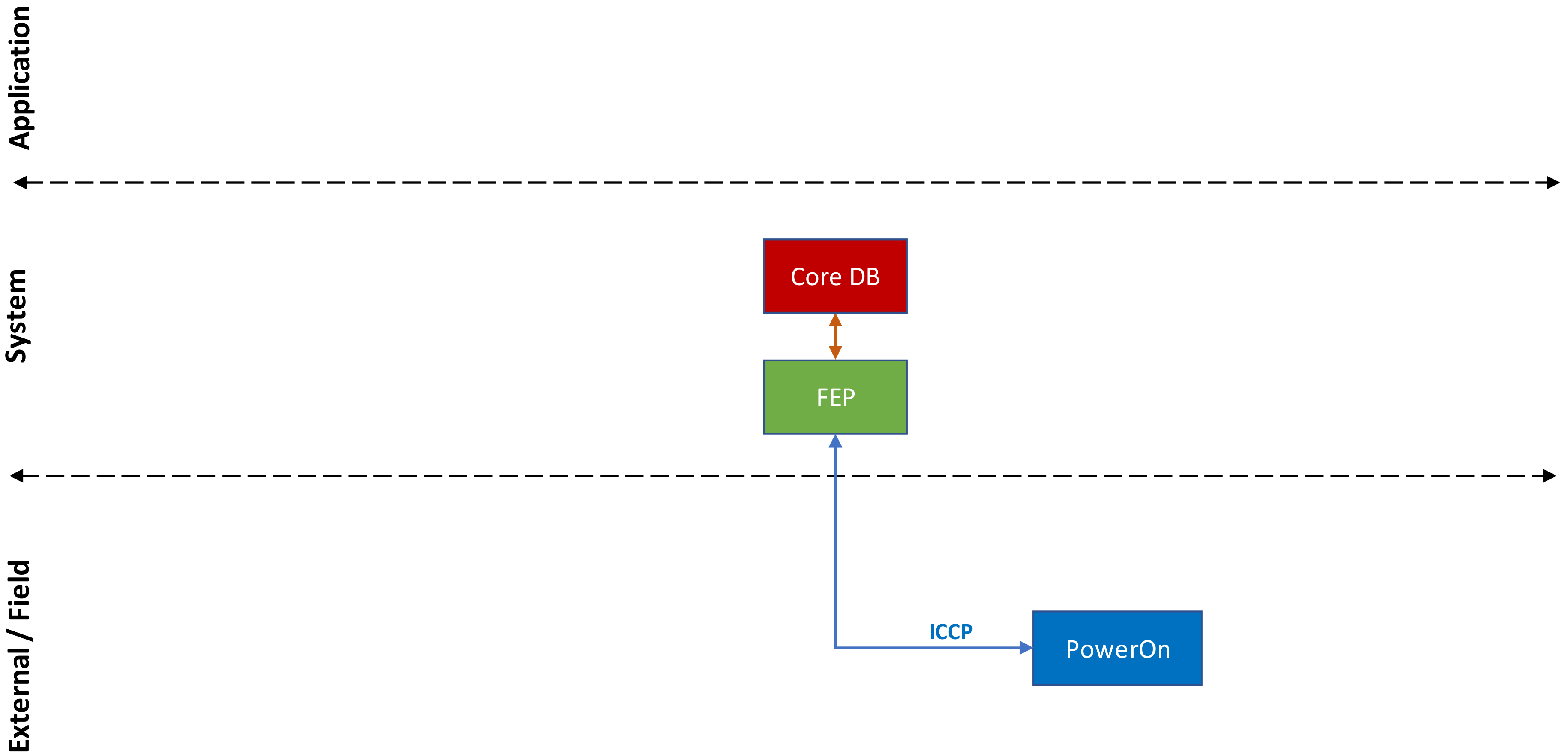

Application
System
Core DB
FEP
External / Field

Power Potential – SCADA Communications



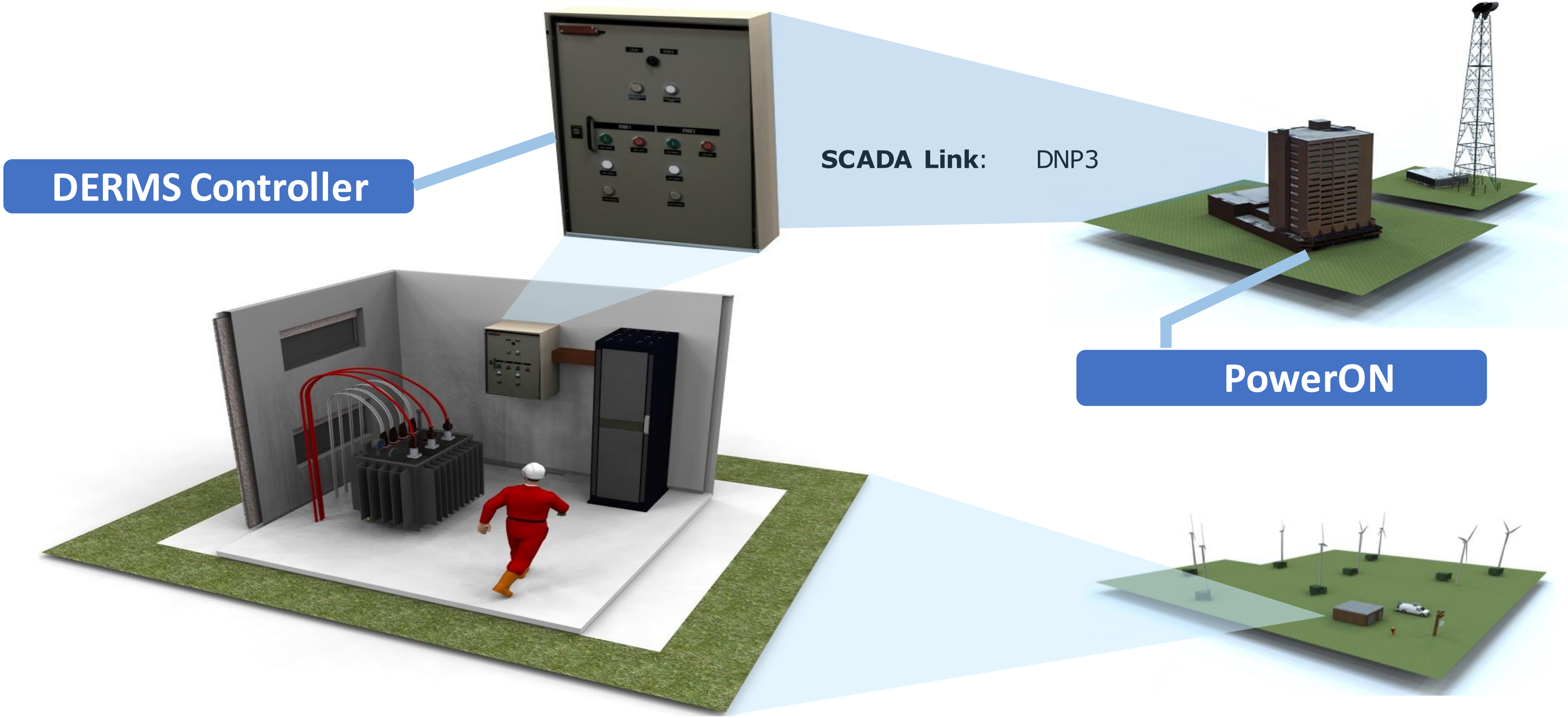
PowerOn Link

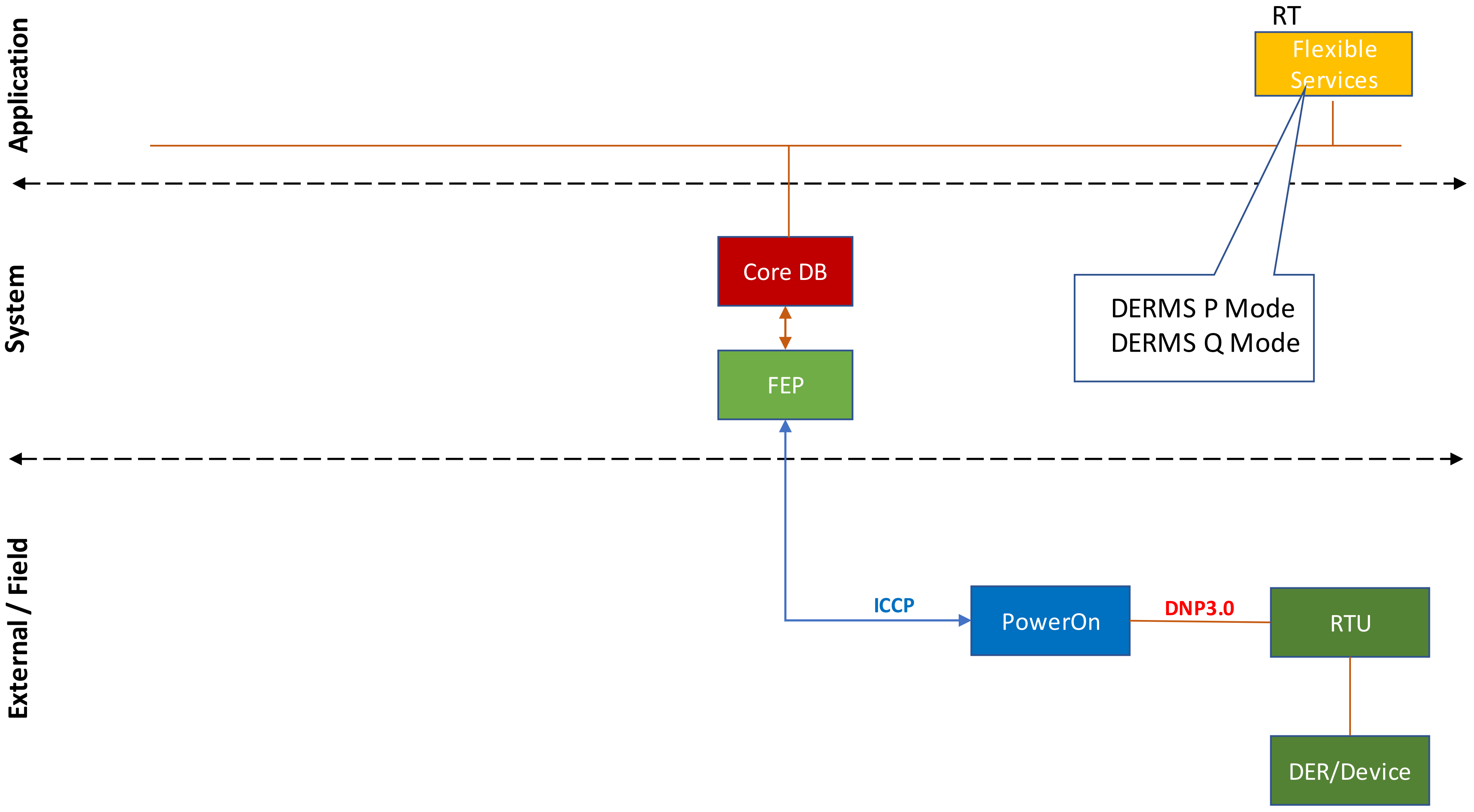
- ICCP Connection

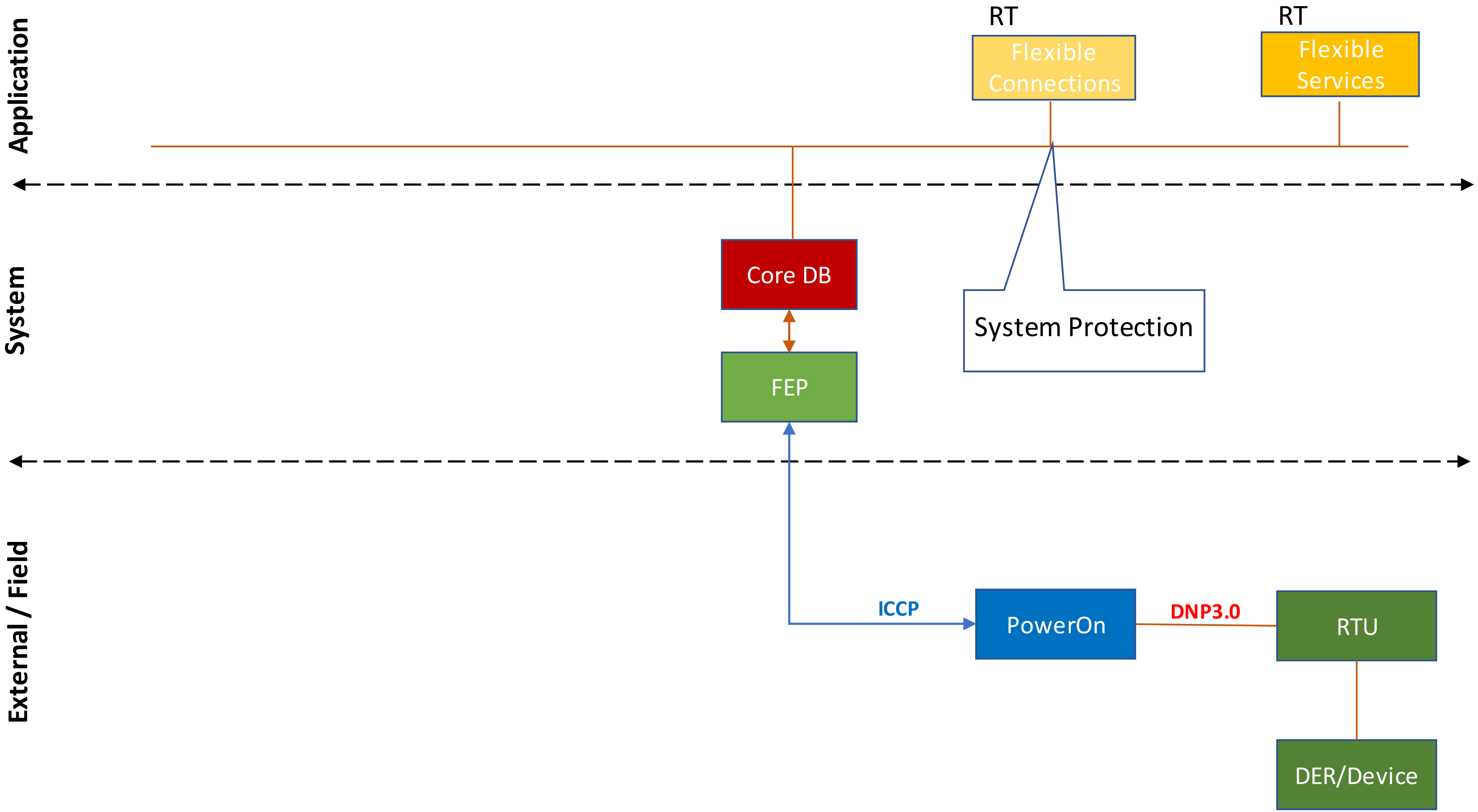


Application
System
External / Field
Core DB
FEP
ICCP
PowerOn

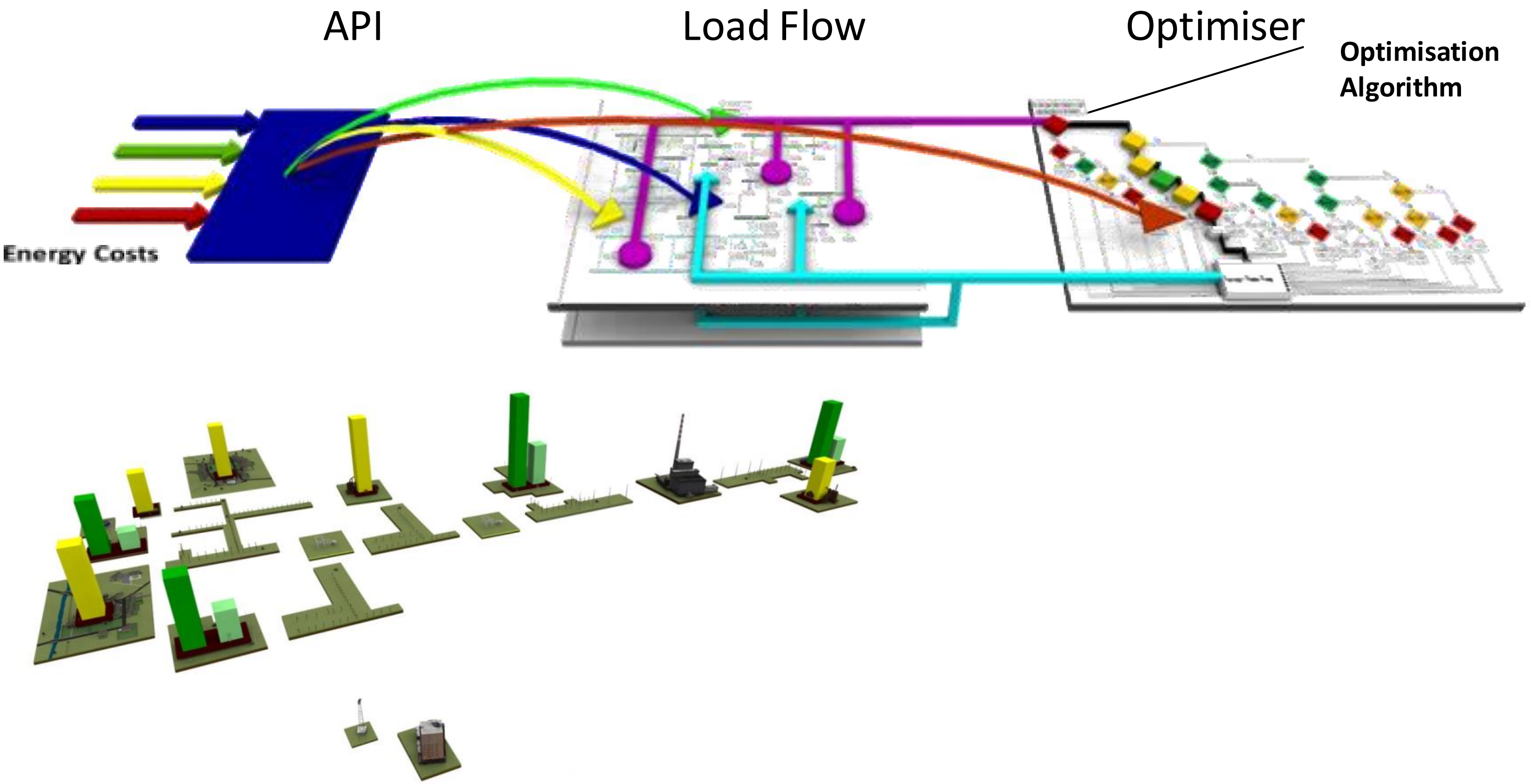
SCADA Control of DERS



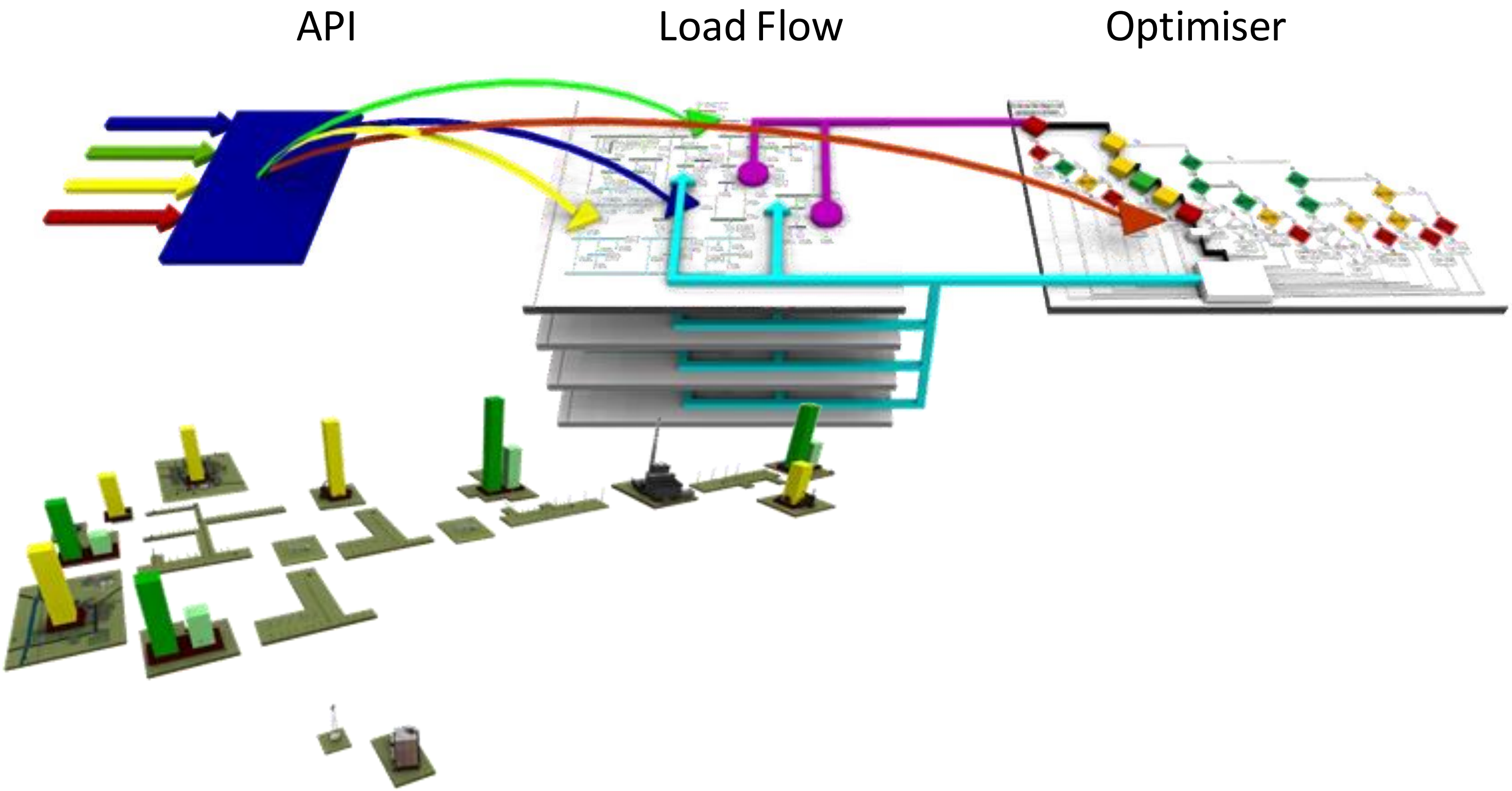

Application
System
External / Field
RT
Flexible Services
Core DB
FEP
DERMS P Mode
DERMS Q Mode
ICCP
PowerOn
DNP3.0
RTU
DER/Device


Application
System
External / Field
RT
Flexible Connections
RT
Flexible Services
Core DB
FEP
System Protection
ICCP
PowerOn
DNP3.0
RTU
DER/Device

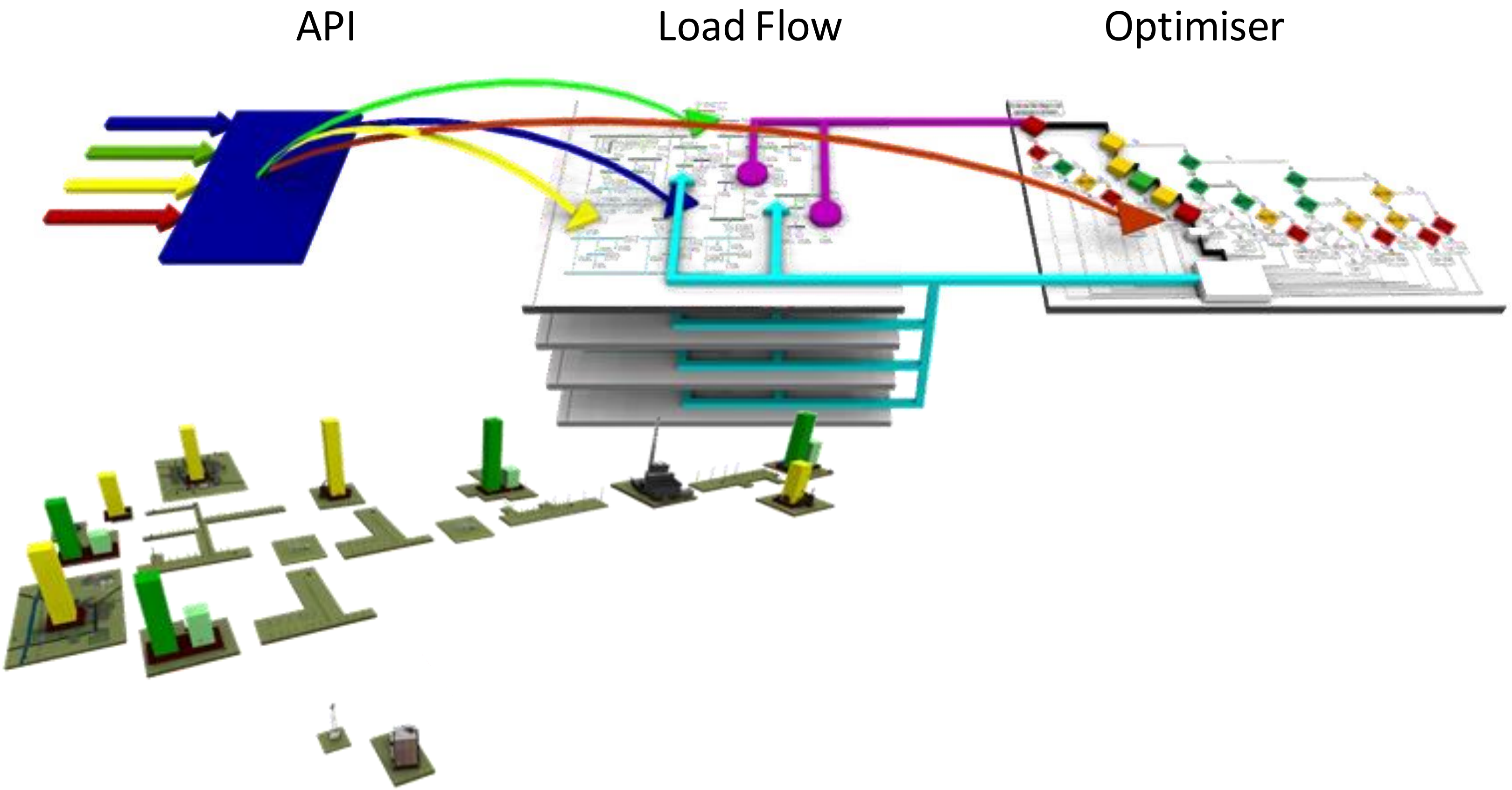
Network Analysis Engine



Network Analysis Engine



Network Analysis Engine

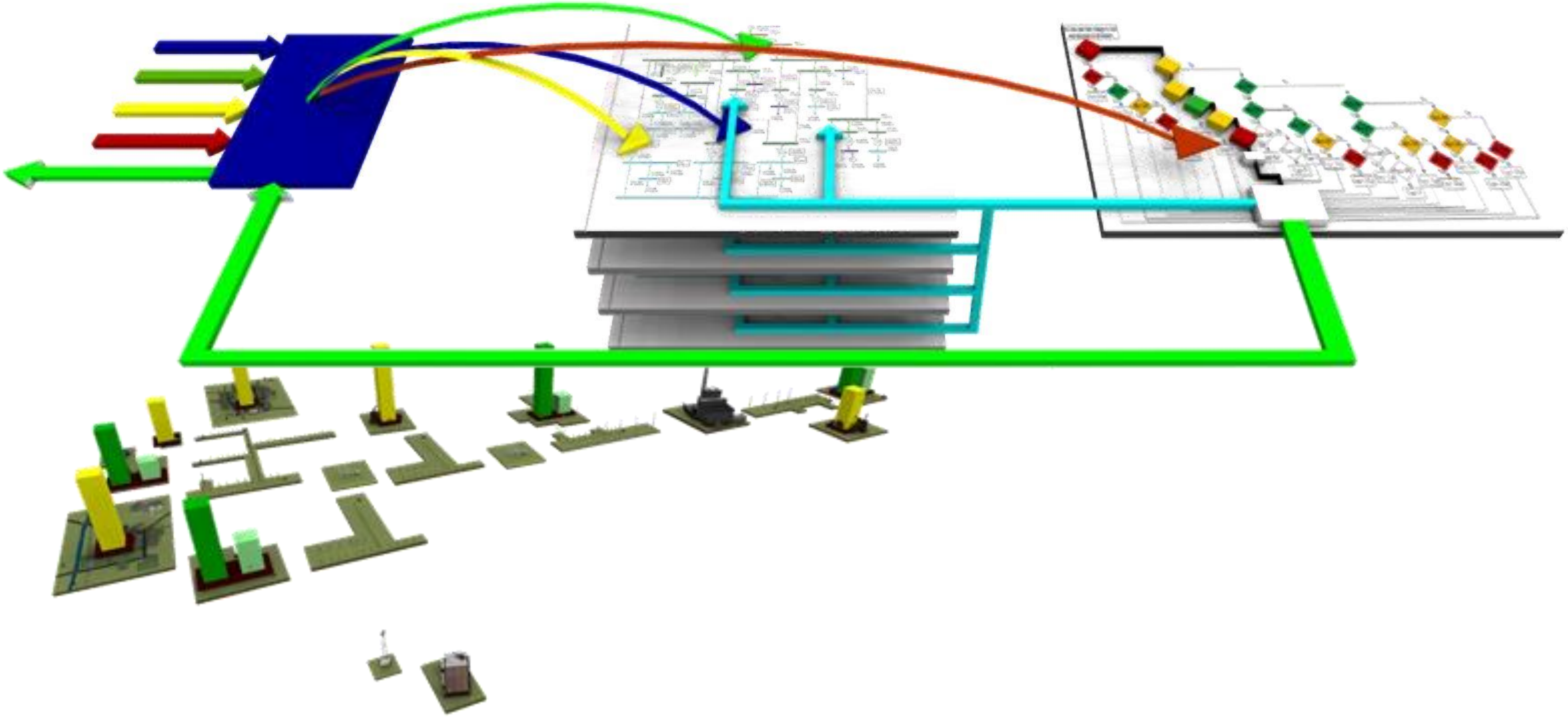


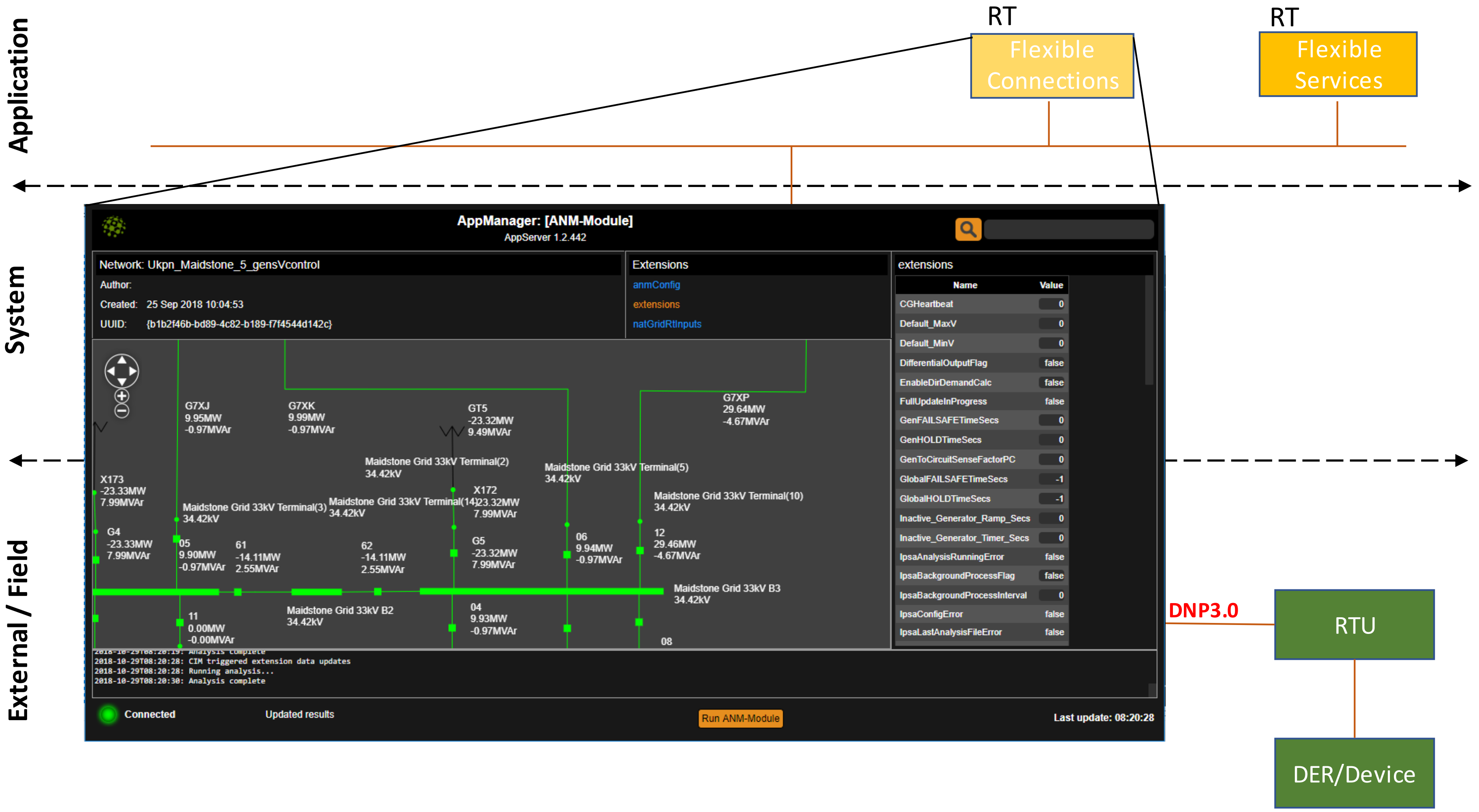
Network Analysis Engine

API

Load Flow

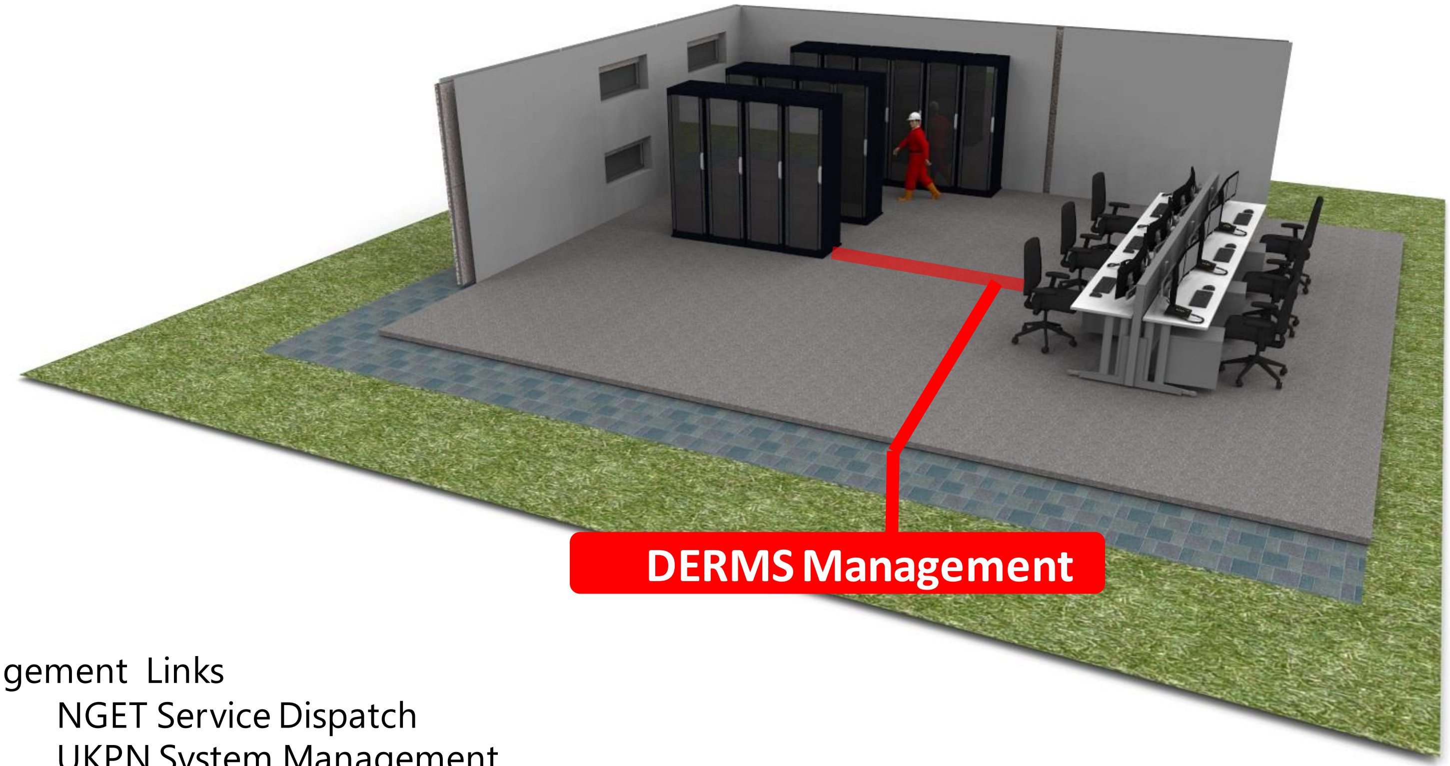
Optimiser





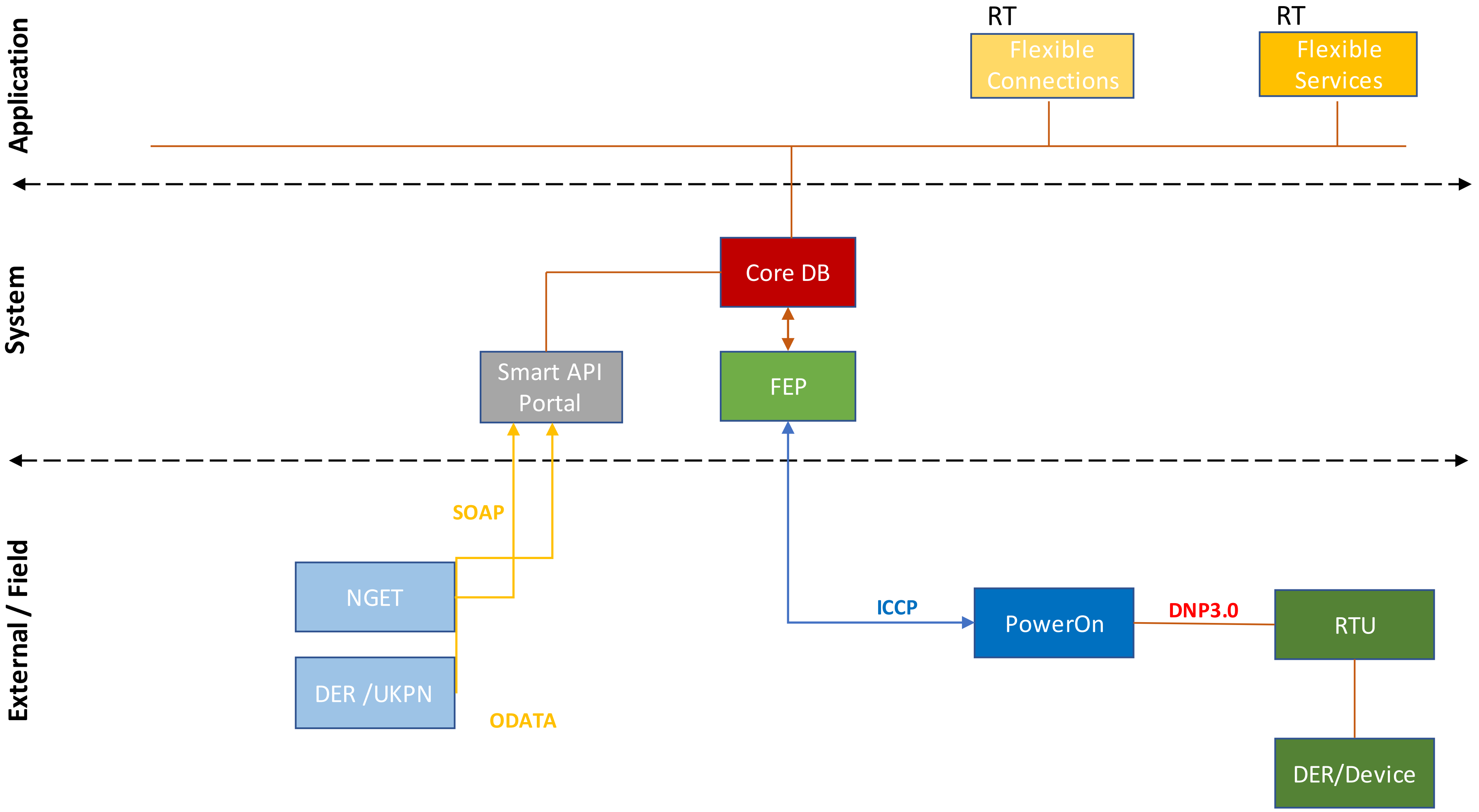
Application
System
External / Field
RT
Flexible Connections
RT
Flexible Services
AppManager: [ANM-Module]
AppServer 1.2.442
Network: Ukpn_Maidstone_5_gensVcontrol
Author:
Created: 25 Sep 2018 10:04:53
UUID: {b1b2f46b-bd89-4c82-b189-f7f4544d142c}
Extensions
anmConfig
extensions
natGridRtInputs
extensions
Name
Value
CGHeartbeat 0
Default_MaxV 0
Default_MinV 0
DifferentialOutputFlag false
EnableDirDemandCalc false
FullUpdateInProgress false
GenFAILSAFETimeSecs 0
GenHOLDTimeSecs 0
GenToCircuitSenseFactorPC 0
GlobalFAILSAFETimeSecs -1
GlobalHOLDTimeSecs -1
Inactive_Generator_Ramp_Secs 0
Inactive_Generator_Timer_Secs 0
IpsaAnalysisRunningError false
IpsaBackgroundProcessFlag false
IpsaBackgroundProcessInterval 0
IpsaConfigError false
IpsaLastAnalysisFileError false
G7XJ 9.95MW -0.97MVAr
G7XK 9.99MW -0.97MVAr
GT5 -23.32MW 9.49MVAr
G7XP 29.64MW -4.67MVAr
Maidstone Grid 33kV Terminal(2) 34.42kV
Maidstone Grid 33kV Terminal(5) 34.42kV
X173 -23.33MW 7.99MVAr
X172 -23.32MW 7.99MVAr
Maidstone Grid 33kV Terminal(3) 34.42kV
Maidstone Grid 33kV Terminal(14) 34.42kV
Maidstone Grid 33kV Terminal(10) 34.42kV
G4 -23.33MW 7.99MVAr
05 9.90MW -0.97MVAr
61 -14.11MW 2.55MVAr
62 -14.11MW 2.55MVAr
G5 -23.32MW 7.99MVAr
06 9.94MW -0.97MVAr
12 29.46MW -4.67MVAr
Maidstone Grid 33kV B3 34.42kV
Maidstone Grid 33kV B2 34.42kV
11 0.00MW -0.00MVAr
04 9.93MW -0.97MVAr
08
2018-10-29T08:20:28: CIM triggered extension data updates
2018-10-29T08:20:28: Running analysis...
2018-10-29T08:20:30: Analysis complete
Connected
Updated results
Run ANM-Module
Last update: 08:20:28
DNP3.0
RTU
DER/Device

DERMS User Interfaces

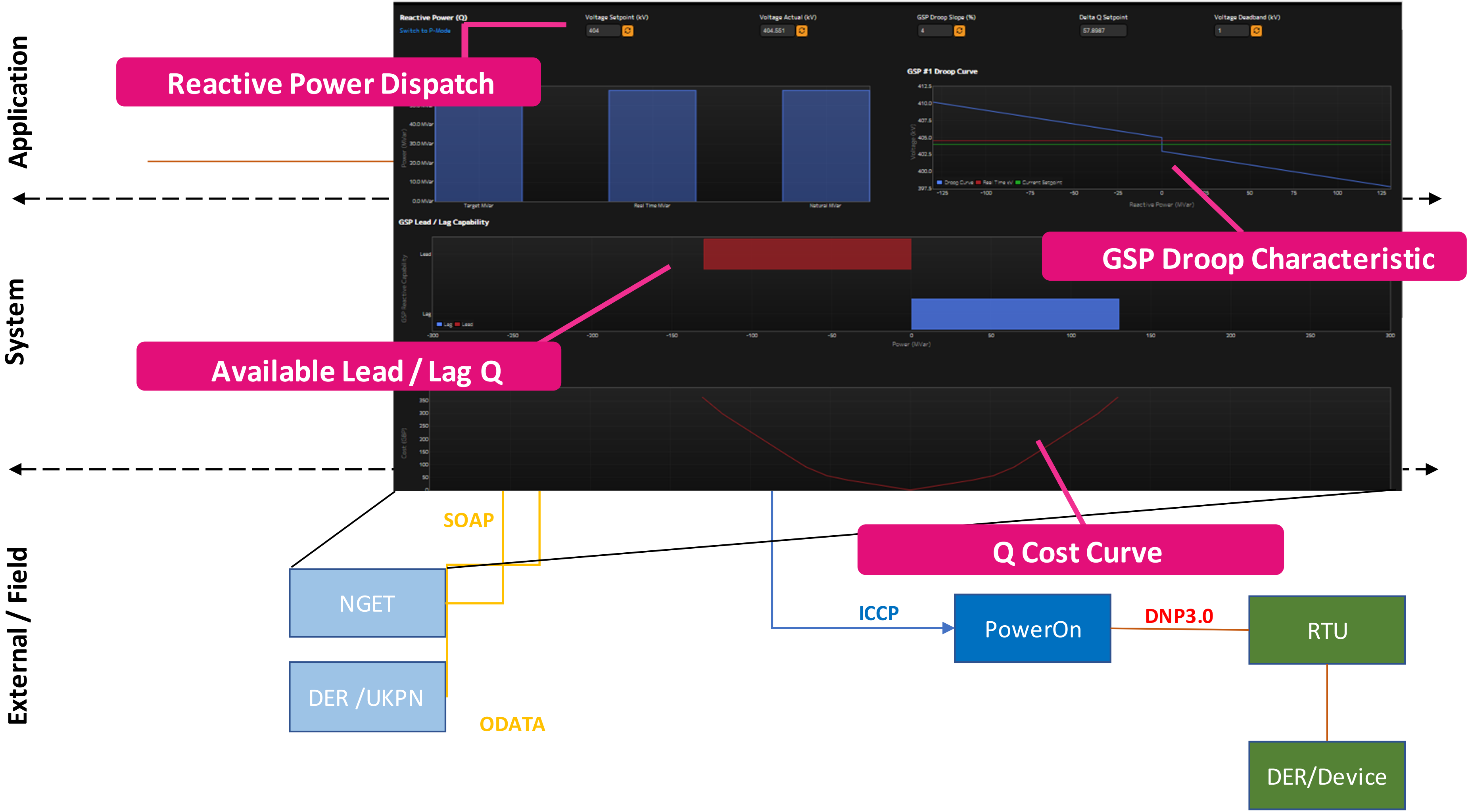


Management Links

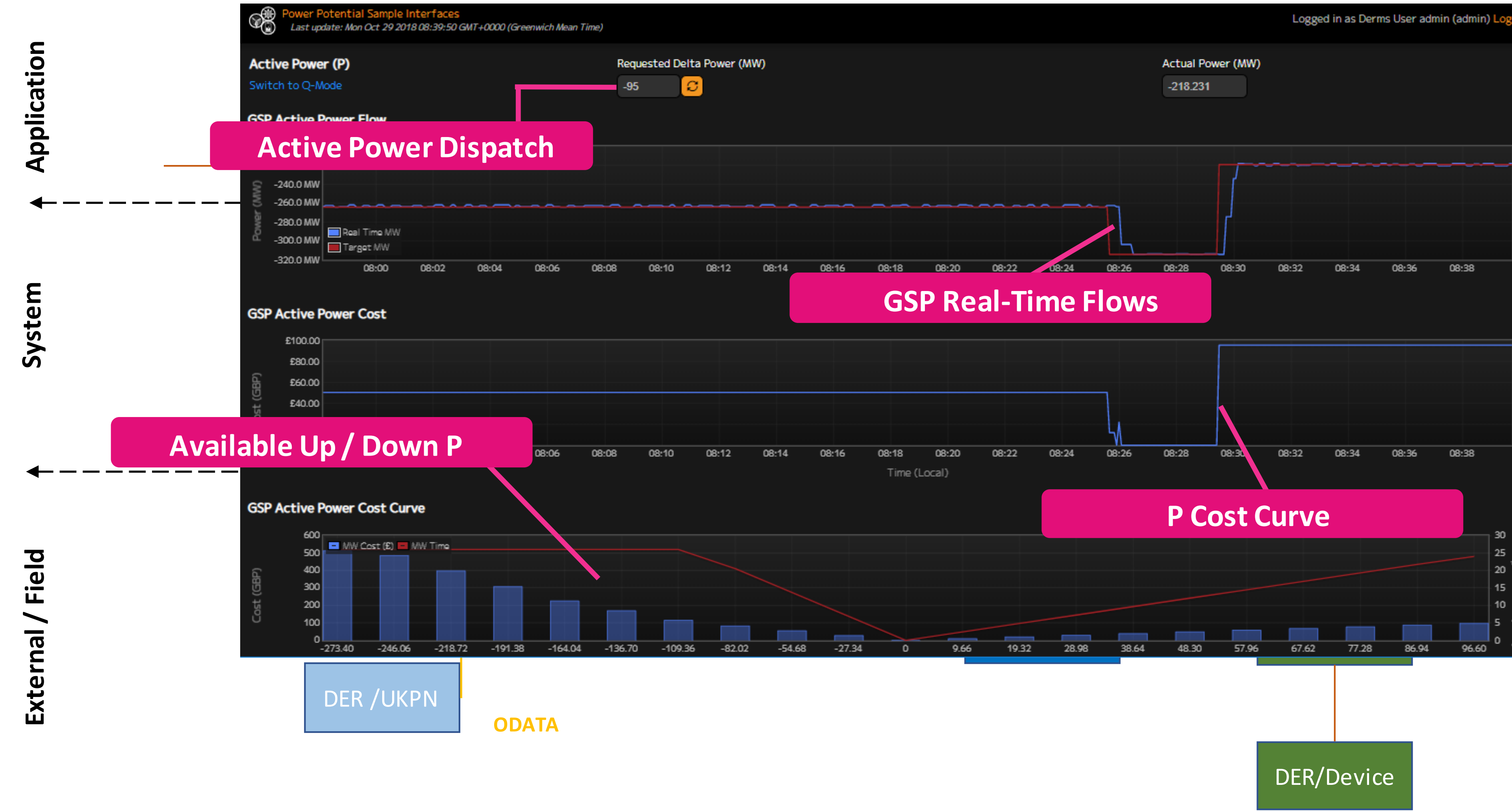
- NGET Service Dispatch
- UKPN System Management

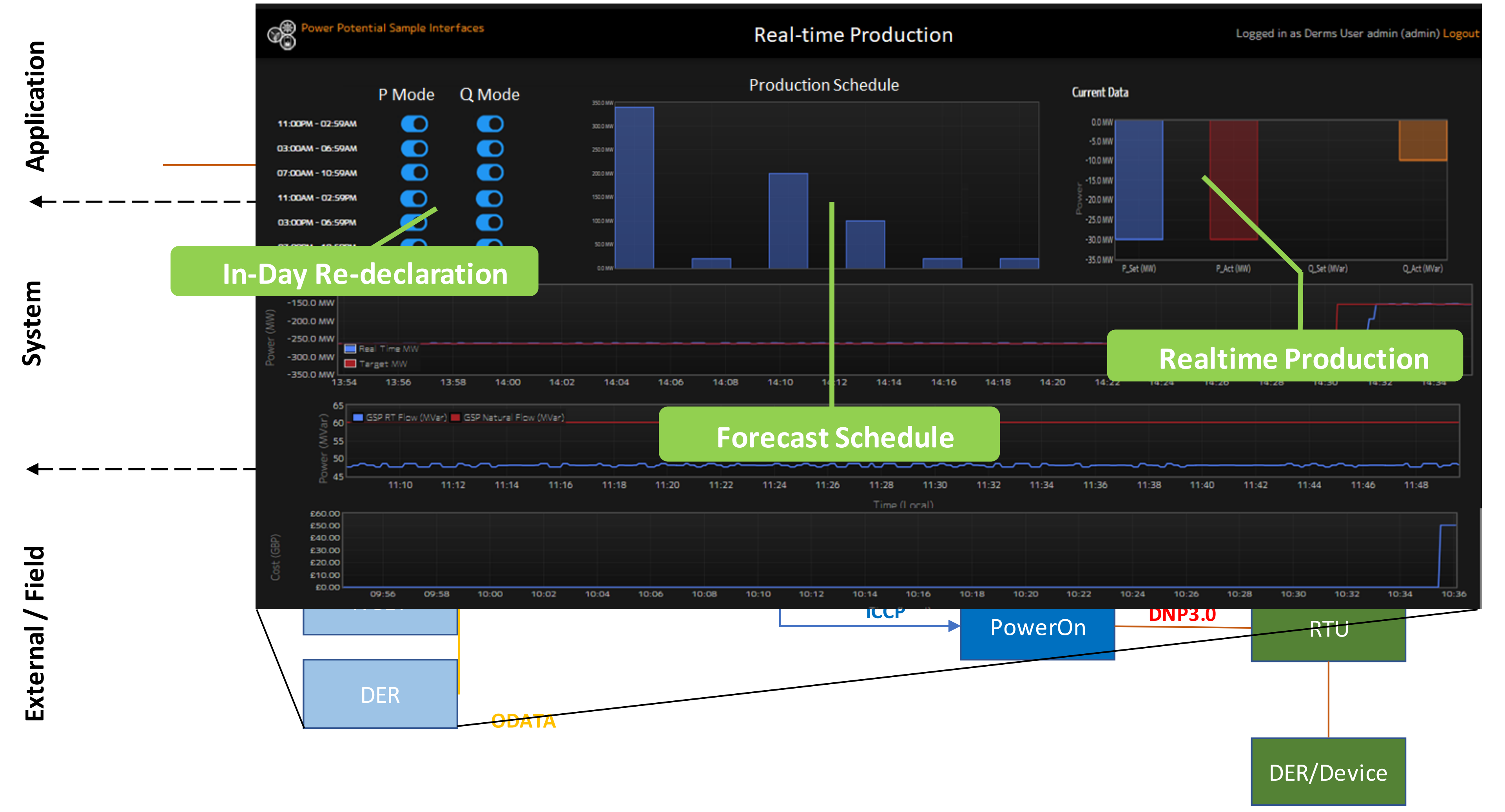


Application
System
External / Field
RT
Flexible Connections
RT
Flexible Services
Core DB
Smart API Portal
FEP
SOAP
NGET
DER /UKPN
ODATA
ICCP
PowerOn
DNP3.0
RTU
DER/Device



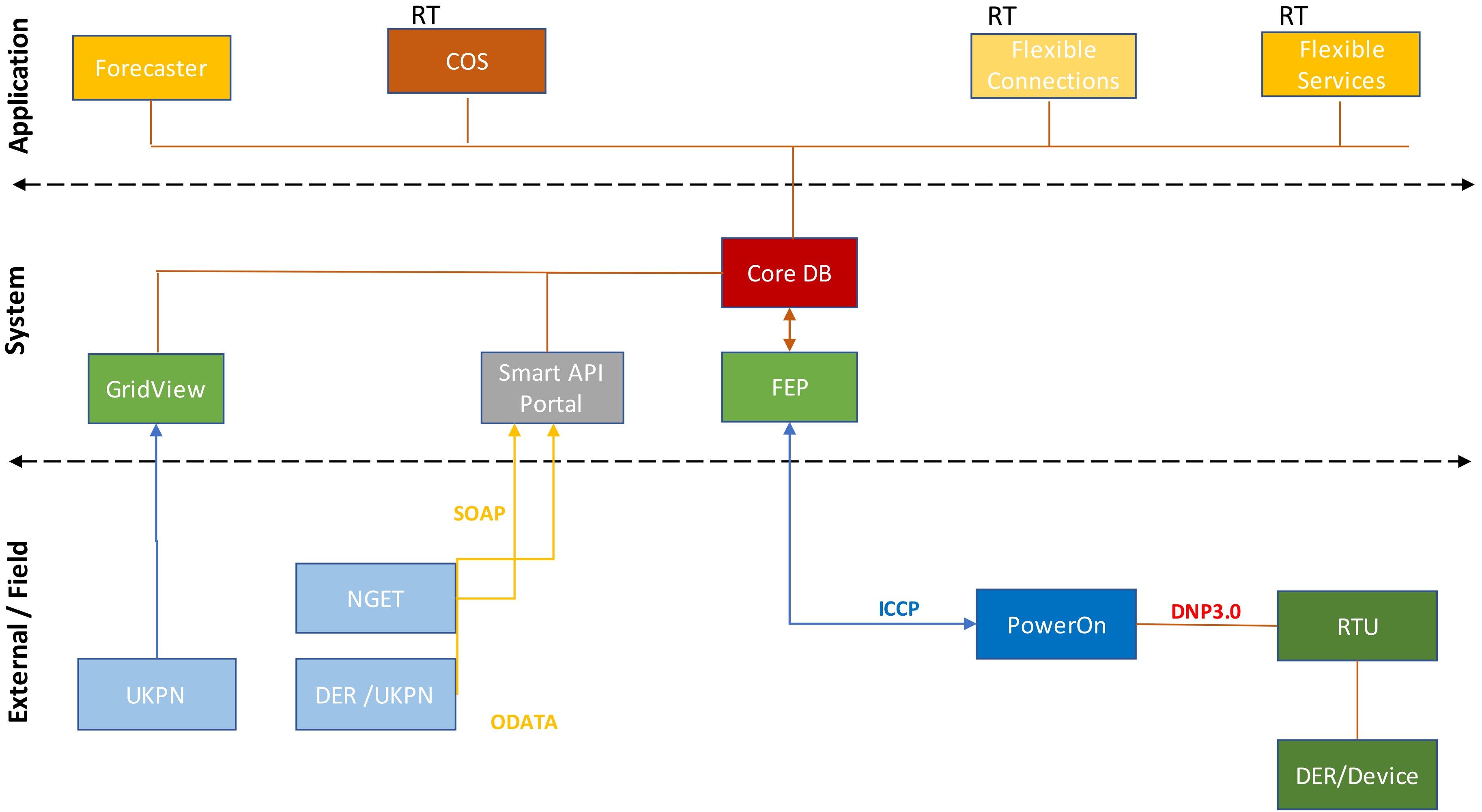
Application
System
External / Field
Reactive Power (Q)
Voltage Setpoint (kV)
Voltage Actual (kV)
GSP Droop Slope (%)
Delta Q Setpoint
Voltage Deadband (kV)
GSP #1 Droop Curve
GSP Lead / Lag Capability
Reactive Power Dispatch
GSP Droop Characteristic
Available Lead / Lag Q
Q Cost Curve
SOAP
NGET
DER /UKPN
ODATA
ICCP
PowerOn
DNP3.0
RTU
DER/Device


Application
System
External / Field
Power Potential Sample Interfaces
Last update: Mon Oct 29 2018 08:39:50 GMT+0000 (Greenwich Mean Time)
Logged in as Derms User admin (admin) Log
Active Power (P)
Switch to Q-Mode
Requested Delta Power (MW)
-95
Actual Power (MW)
-218.231
GSP Active Power Flow
Active Power Dispatch
Real Time MW
Target MW
GSP Real-Time Flows
GSP Active Power Cost
Available Up / Down P
Time (Local)
P Cost Curve
GSP Active Power Cost Curve
MW Cost (£)
MW Time
DER /UKPN
ODATA
DER/Device

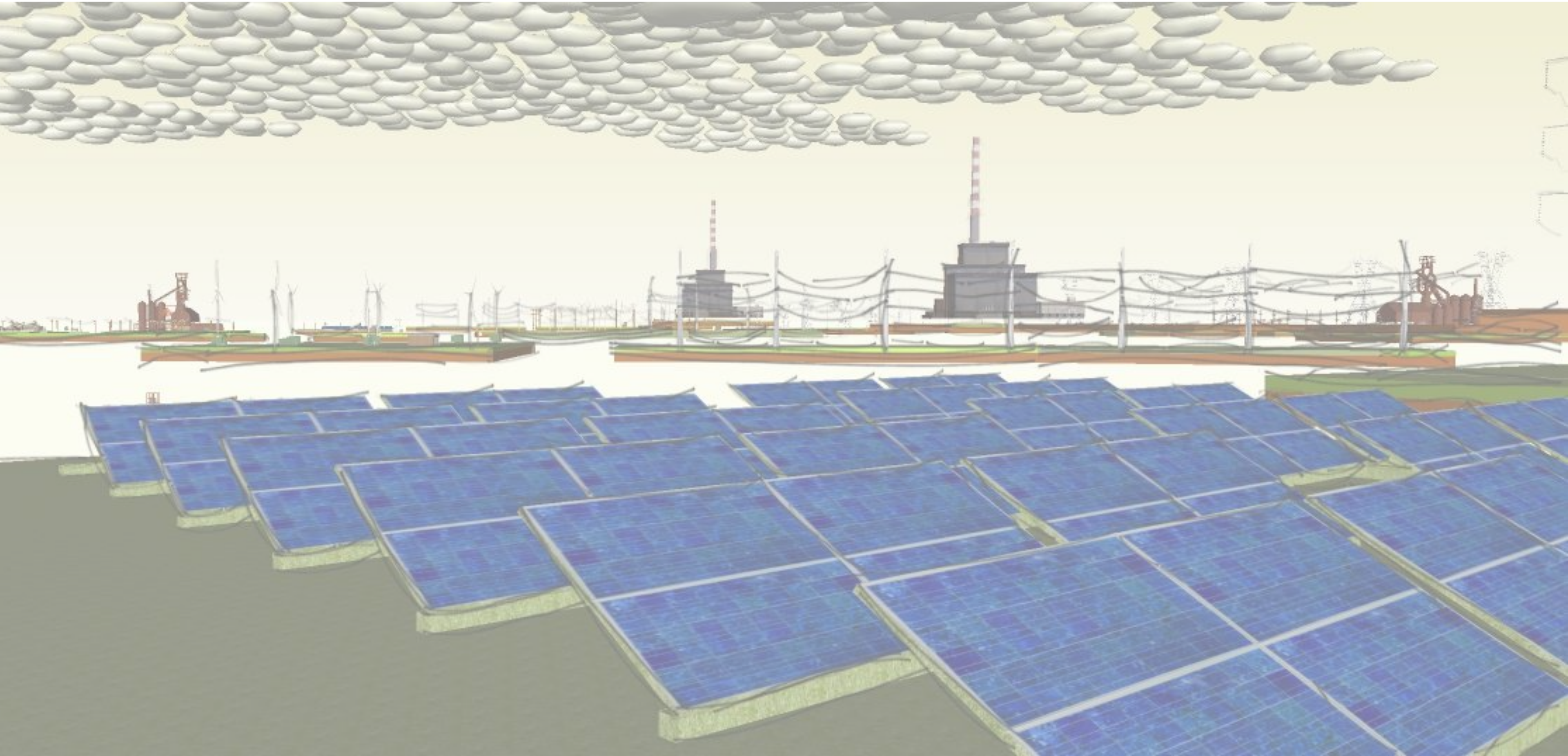


Application
System
External / Field
Power Potential Sample Interfaces
Real-time Production
Logged in as Derms User admin (admin) Logout
P Mode
Q Mode
11:00PM - 02:59AM
03:00AM - 06:59AM
07:00AM - 10:59AM
11:00AM - 02:59PM
03:00PM - 06:59PM
Production Schedule
Current Data
P_Set (MW)
P_Act (MW)
Q_Set (MVar)
Q_Act (MVar)
In-Day Re-declaration
Realtime Production
Forecast Schedule
Real Time MW
Target MW
Power (MW)
GSP RT Flow (MVar)
GSP Natural Flow (MVar)
Power (MVar)
Time (Local)
Cost (GBP)
DER
ODATA
ICCP
PowerOn
DNP3.0
RTU
DER/Device

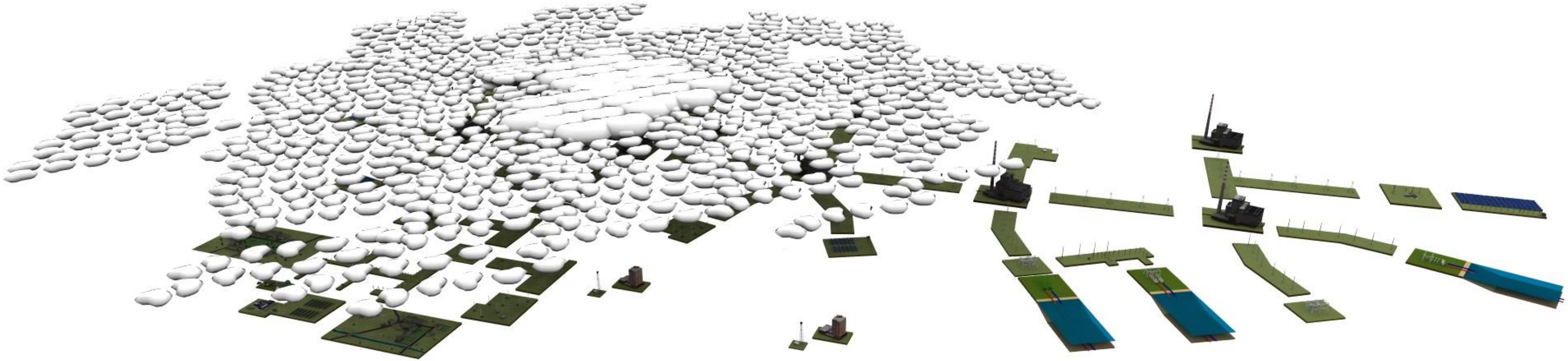

Application
System
External / Field
RT
RT
ble
ces
GridVi
UKPN
ODATA
TU
DER/Device
DER Analysis
Legend
Line Flows Normal
Line Flows Critical
Generation
Demand
Network Voltages
6.6kV
11kV
20kV
33kV
Network Summary
Generation 1277.3 MW
System Demand 1250.8 MW
DER (Current) 33.1 MW
DER (Capacity) 65.2 MW
Distributed Energy Resources
Battery 0.0 MW
Battery 4.8 MW
CHP 12.0 MW
PV 15.0 MW
Wind 10.9 MW
Power Flows
DER Controls
Generation
Gen. Capacity
Demand
Demand Capacity
Scenario Description
Run Scenarios
Screenshot saved
Grid Insight - Google Chrome


Application
System
External / Field
RT
RT
RT
Forecaster
COS
Flexible Connections
Flexible Services
Core DB
GridView
Smart API Portal
FEP
SOAP
NGET
UKPN
DER /UKPN
ODATA
ICCP
PowerOn
DNP3.0
RTU
DER/Device

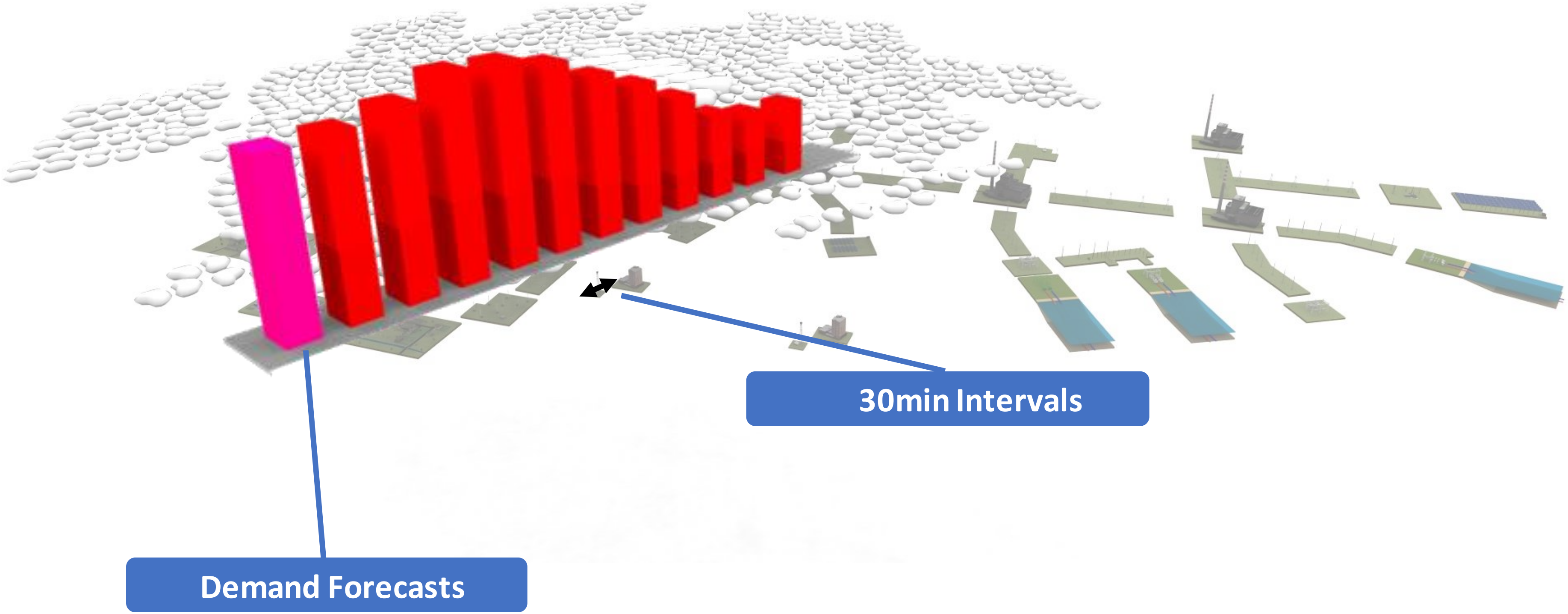
Forecasting



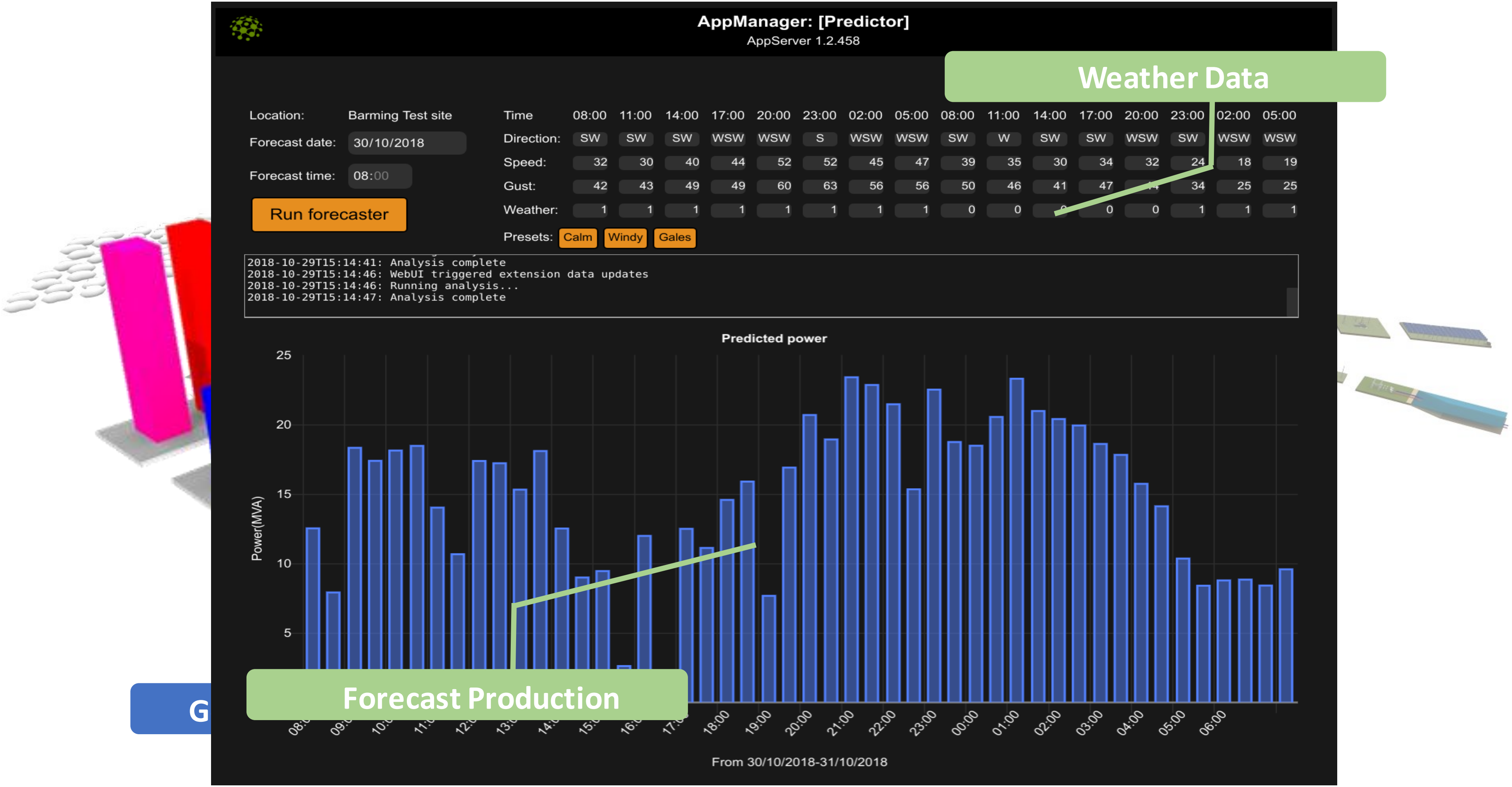
Grid_Forecaster

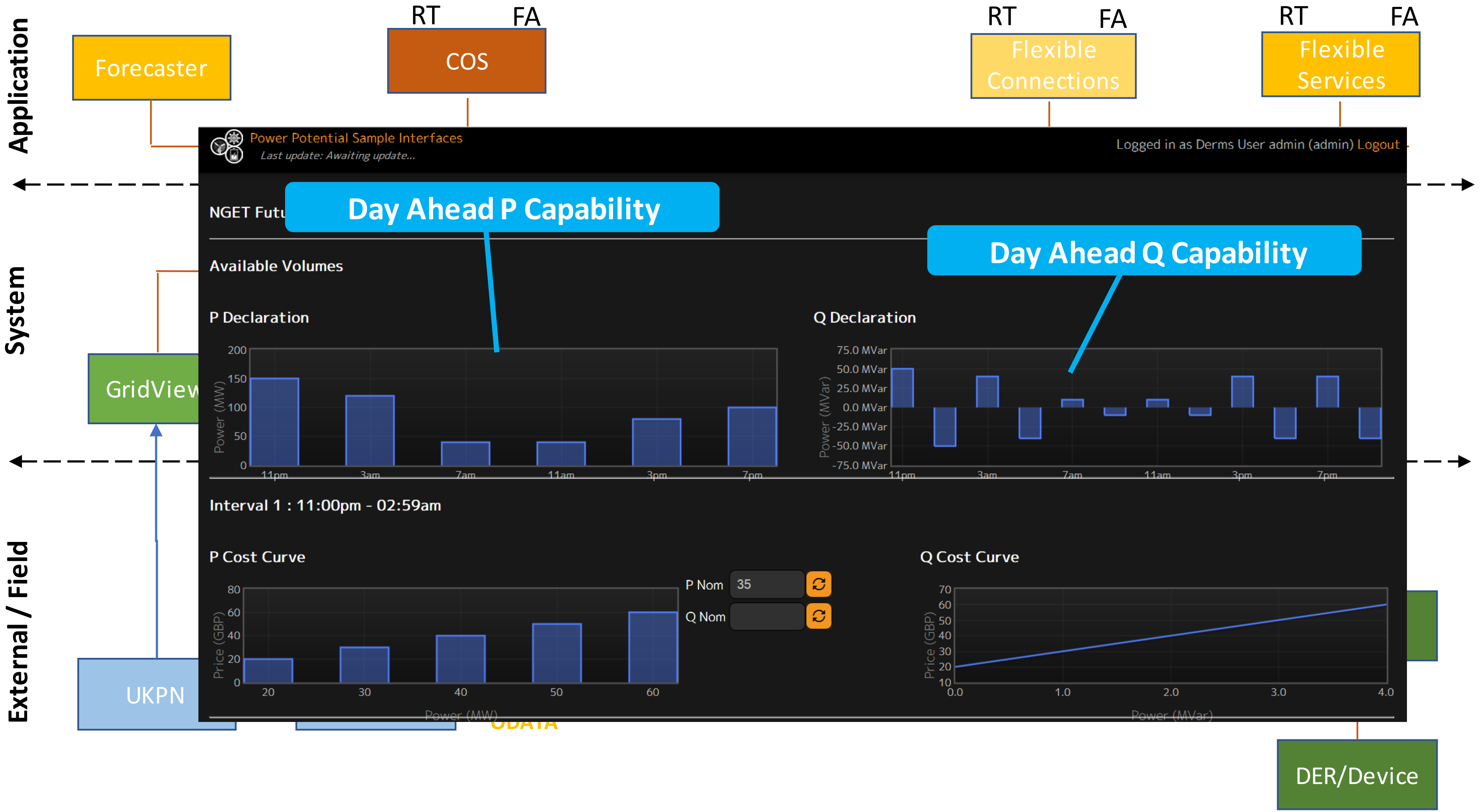


Forecasting Demand

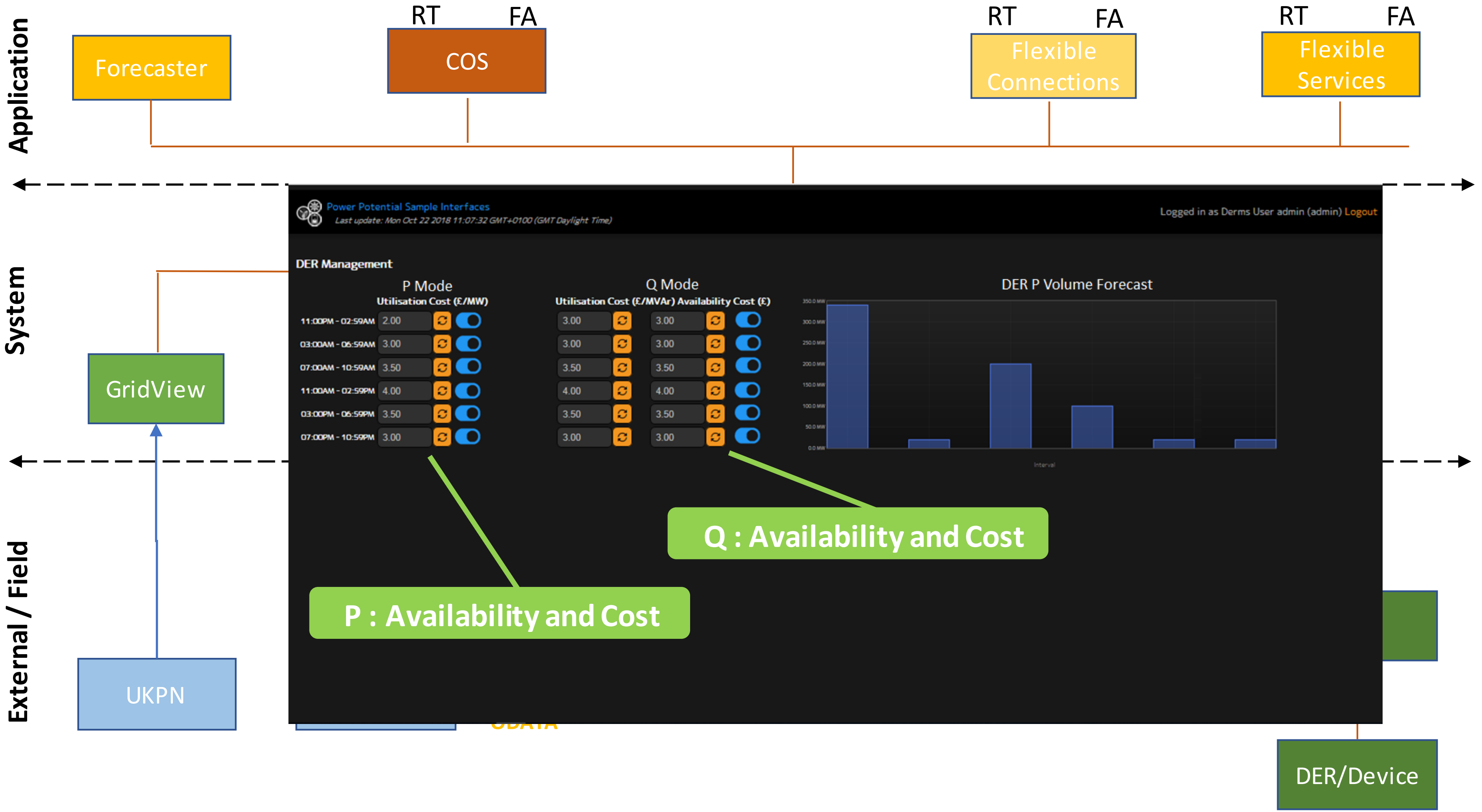


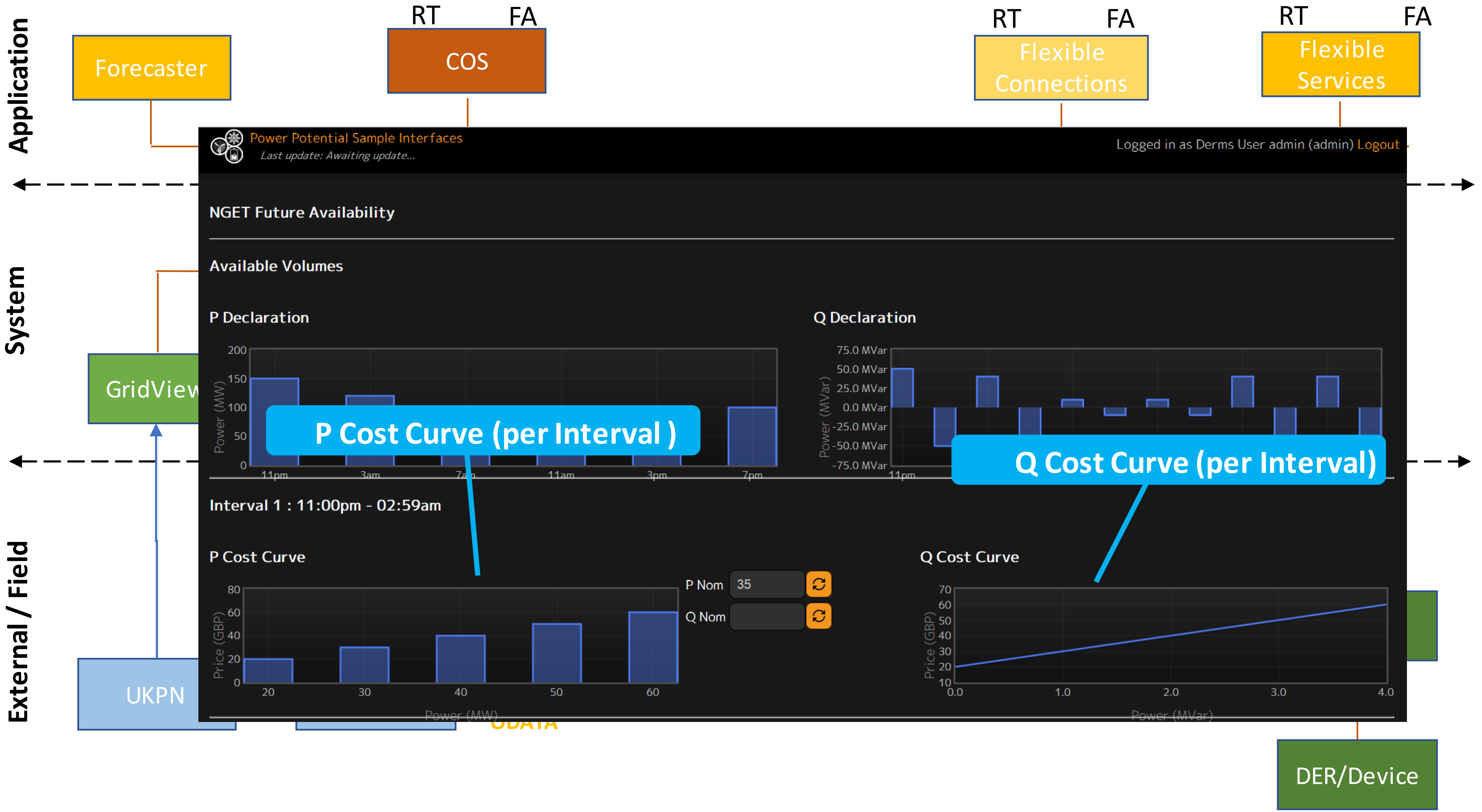
Forecasting Generation



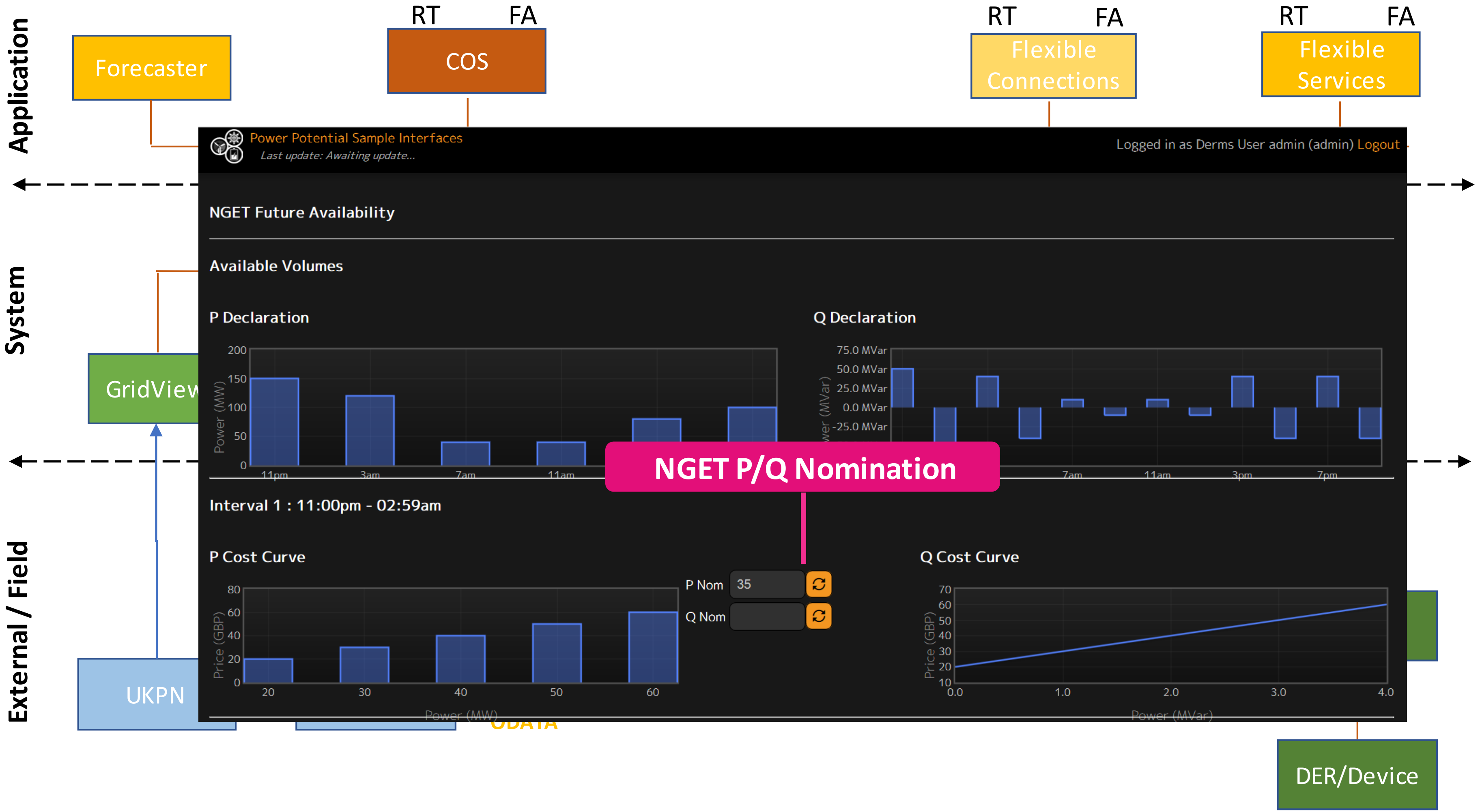


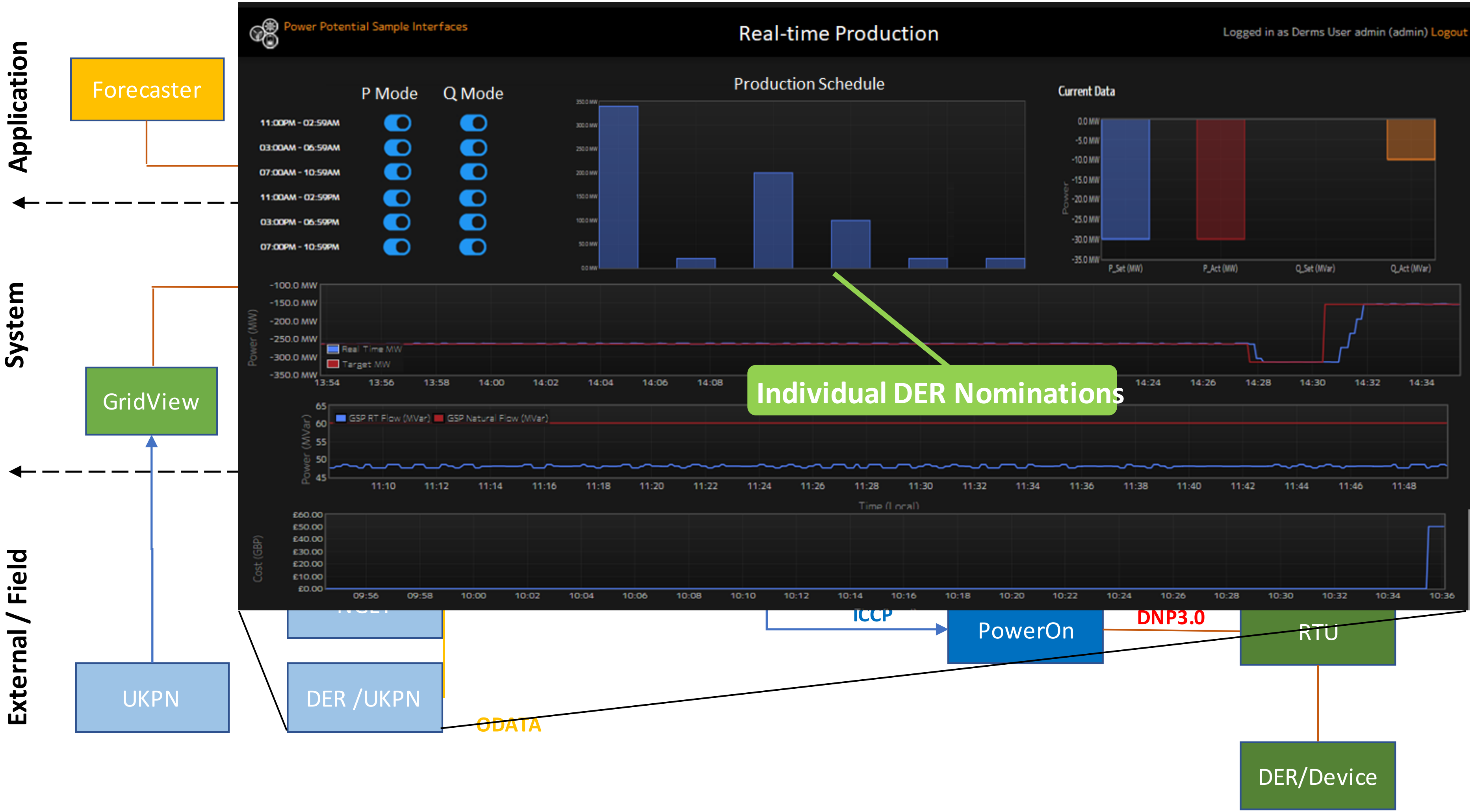
Application
System
External / Field
Forecaster
RT
FA
COS
Flexible Connections
Flexible Services
GridView
UKPN
DER/Device
Power Potential Sample Interfaces
Last update: Awaiting update...
Logged in as Derms User admin (admin) Logout
Day Ahead P Capability
Day Ahead Q Capability
Available Volumes
P Declaration
Q Declaration
Interval 1 : 11:00pm - 02:59am
P Cost Curve
Q Cost Curve
P Nom 35
Q Nom
Power (MW)
Power (MVar)
Price (GBP)


Application
System
External / Field
Forecaster
RT
FA
COS
RT
FA
Flexible Connections
RT
FA
Flexible Services
GridView
UKPN
DER/Device
Power Potential Sample Interfaces
Last update: Mon Oct 22 2018 11:07:32 GMT+0100 (GMT Daylight Time)
Logged in as Derms User admin (admin) Logout
DER Management
P Mode
Utilisation Cost (£/MW)
Q Mode
Utilisation Cost (£/MVAr) Availability Cost (£)
DER P Volume Forecast
11:00PM - 02:59AM 2.00 3.00 3.00
03:00AM - 06:59AM 3.00 3.00 3.00
07:00AM - 10:59AM 3.50 3.50 3.50
11:00AM - 02:59PM 4.00 4.00 4.00
03:00PM - 06:59PM 3.50 3.50 3.50
07:00PM - 10:59PM 3.00 3.00 3.00
Q : Availability and Cost
P : Availability and Cost



Application
System
External / Field
Forecaster
RT
FA
COS
RT
FA
Flexible Connections
RT
FA
Flexible Services
GridView
UKPN
DER/Device
Power Potential Sample Interfaces
Last update: Awaiting update...
Logged in as Derms User admin (admin) Logout
NGET Future Availability
Available Volumes
P Declaration
Q Declaration
Power (MW)
Power (MVar)
200
150
100
50
0
75.0 MVar
50.0 MVar
25.0 MVar
0.0 MVar
-25.0 MVar
-50.0 MVar
-75.0 MVar
11pm
3am
7am
11am
3pm
7pm
P Cost Curve (per Interval)
Q Cost Curve (per Interval)
Interval 1 : 11:00pm - 02:59am
P Cost Curve
Q Cost Curve
P Nom
35
Q Nom
Price (GBP)
80
60
40
20
0
20
30
40
50
60
Power (MW)
70
60
50
40
30
20
10
0.0
1.0
2.0
3.0
4.0
Power (MVar)


Application
System
External / Field
Forecaster
RT
FA
COS
RT
FA
Flexible Connections
RT
FA
Flexible Services
GridView
UKPN
DER/Device
Power Potential Sample Interfaces
Last update: Awaiting update...
Logged in as Derms User admin (admin) Logout
NGET Future Availability
Available Volumes
P Declaration
Power (MW)
200
150
100
50
0
11pm
3am
7am
11am
Q Declaration
75.0 MVar
50.0 MVar
25.0 MVar
0.0 MVar
-25.0 MVar
7am
11am
3pm
7pm
NGET P/Q Nomination
Interval 1 : 11:00pm - 02:59am
P Cost Curve
Price (GBP)
80
60
40
20
0
20
30
40
50
60
Power (MW)
P Nom
35
Q Nom
Q Cost Curve
Price (GBP)
70
60
50
40
30
20
10
0.0
1.0
2.0
3.0
4.0
Power (MVar)



Application
System
External / Field
Forecaster
GridView
UKPN
DER /UKPN
ODATA
ICCP
PowerOn
DNP3.0
RTU
DER/Device
Power Potential Sample Interfaces
Real-time Production
Logged in as Derms User admin (admin) Logout
P Mode
Q Mode
11:00PM - 02:59AM
03:00AM - 06:59AM
07:00AM - 10:59AM
11:00AM - 02:59PM
03:00PM - 06:59PM
07:00PM - 10:59PM
Production Schedule
Current Data
P_Set (MW)
P_Act (MW)
Q_Set (MVar)
Q_Act (MVar)
Real Time MW
Target MW
GSP RT Flow (MVar)
GSP Natural Flow (MVar)
Time (Local)
Individual DER Nominations

Questions ..?

LUNCH

12:35 – 13:45

UK Power Networks
Delivering your electricity

nationalgridESO

The Voice of the Networks

Energy Networks Association

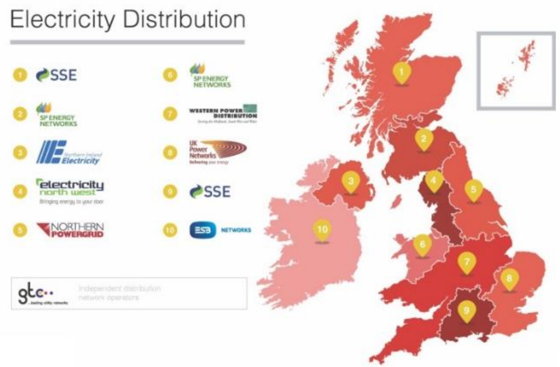
Open Networks Project

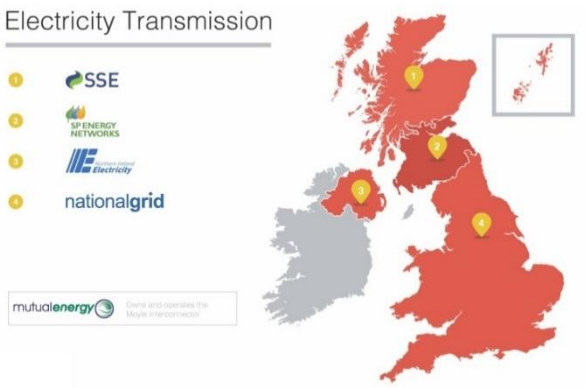
Power Potential Event

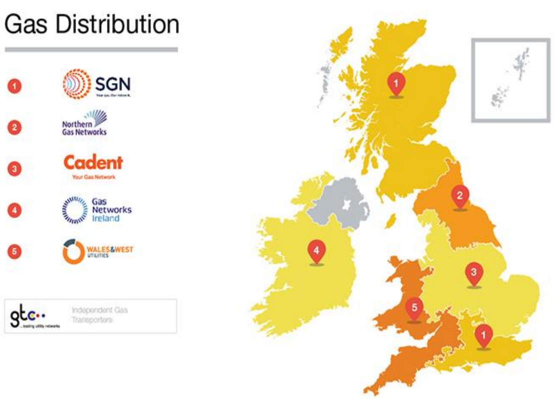
Randolph Brazier – Head of Innovation, ENA
30th October 2018

Introduction to ENA

- 29 million electricity customers
- 21.5 million gas customers







- 180,000 miles of gas network
- 519,304 miles of electricity network

Open Networks – Delivering a Smart Grid

ENA's Open Networks Project is a major energy industry initiative that will transform the way that both local Distribution Networks and national Transmission Networks will operate and work for customers. This is being driven by the 3D's; digitisation, decentralisation and decarbonisation

The Open Networks Project will help customers connect and realise value; as well as reducing cost for consumers through more cost effective planning

The Open Networks Project is a key initiative to deliver Government policy set out in the Ofgem and BEIS Smart Systems and Flexibility Plan, the Government's Industrial Strategy and the Clean Growth Plan

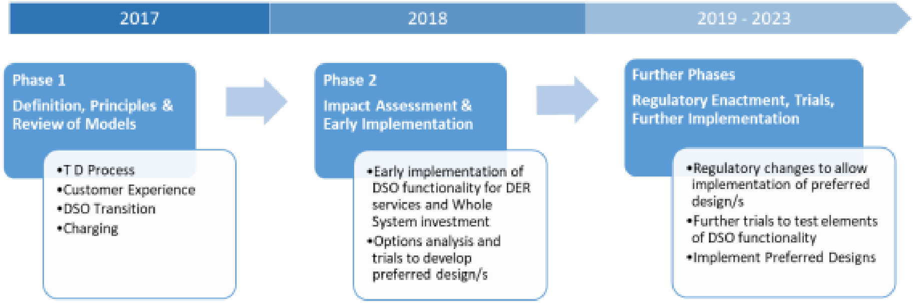
We are taking a 'learn-by-doing' approach; we are using innovation funding to trial and test aspects of the various future electricity system options

Short Animation that can be found at: https://www.youtube.com/watch?v=8GxeWsppmBI

Project Scope & Evolution

The objectives of the Open Networks Project are to:

1. Develop improved **T-D processes** around connections, planning, shared ESO/DSO services and operation
2. Assess the gaps between the **experience our customers** currently receive and what they would like and identify any further changes to close the gaps within the context of 'level playing field' and common T & D approach
3. Develop a more detailed view of the required **transition from DNO to DSO** including the impacts on existing organisation capability
4. Consider the **charging** requirements of enduring electricity transmission/distribution systems



Five 'Future Worlds'

World A
DSO Coordinates – a World where the DSO acts as the neutral market facilitator for all DER and provides services on a locational basis to National Grid in its role as the Electricity System Operator (ESO).

World B
Coordinated DSO-ESO procurement and dispatch – a World where the DSO and ESO work together to efficiently manage networks through coordinated procurement and dispatch of flexibility resource.

World C
Price-Driven Flexibility – a World where changes developed through Ofgem's reform of electricity network access and forward-looking charges have improved access arrangements and forward-looking signals for Customers.

World D
ESO Coordinate(s) – a World where the ESO is the counterparty for DER with DSO's informing the ESO of their requirements.

World E
Flexibility Coordinator(s) – a World where a new national (or potentially regional) third-party acts as the neutral market facilitator for DER providing efficient services to the ESO and/or DSO as required.

Next Steps - 2018

2017 work programme

- DSO definition & functions
- DSO functions
- Commercial Principles paper

Development phase

- SGAM modelling
- Key Enablers
- Future Worlds consultation

Review phase

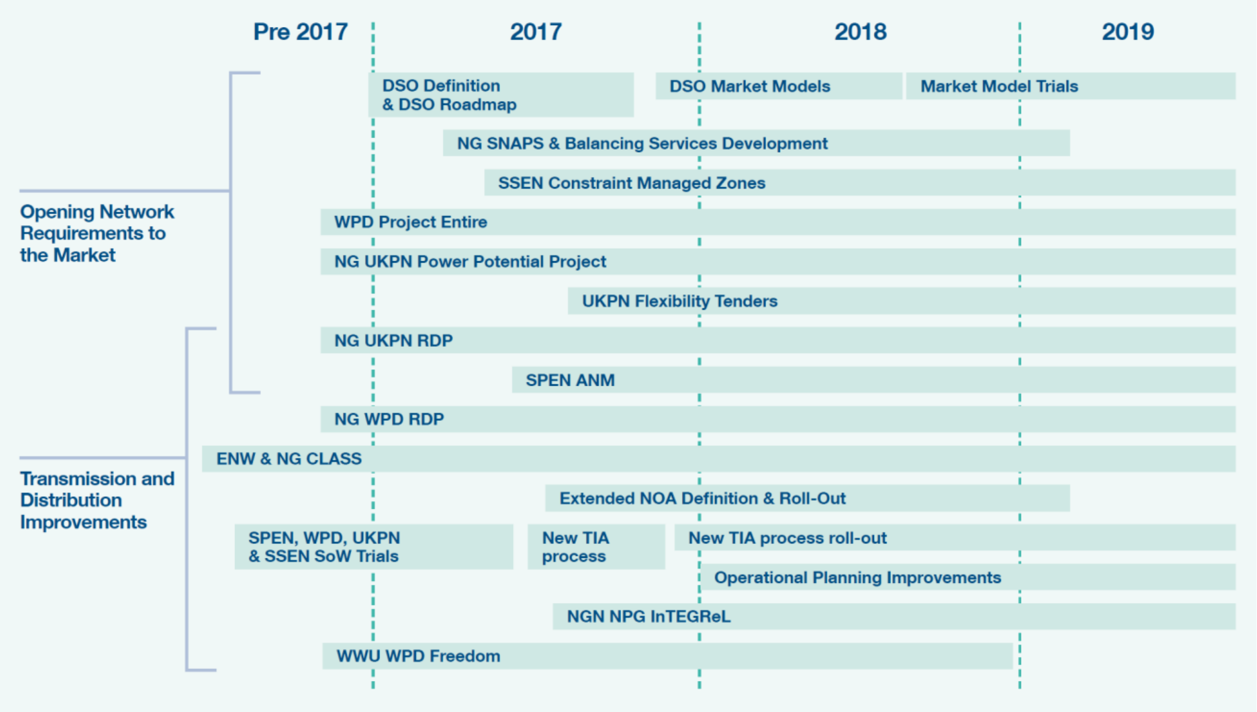
- Refining SGAM & key enablers
- Impact assessment
- Least regrets analysis

Final conclusions

- Evidence pack for BEIS and Ofgem
- Impact assessment consultation

Innovation Project Input

- The Open Networks project is taking a learn-by-doing approach
- We are using the output of various innovation trials to shape the project going forward
  - Reports
  - Individual Dissemination events
  - ENA Events
  - Project Teams
- We need to understand what works and what doesn't, and the best way to do this is by testing things in real life



What about Power Potential?

- You've heard about the immediate benefits of Power Potential, but it is also helping us shape the future of the UK electricity networks

- The project is helping us determine best practice across all of our workstreams:
  - WS1: How National Grid and DNOs can interact and solve network issues in a more collaborative way
  - WS2: How to engage better with customers and stimulate markets for providing network services
  - WS3: How a DNO can transition towards becoming a DSO
    What new markets for network services look like and how they function

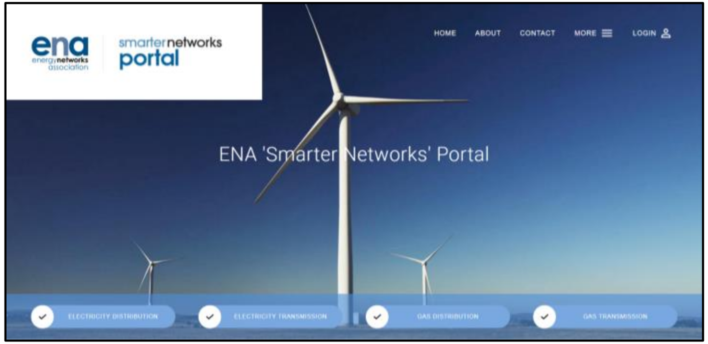
- We are bringing Project Team Members directly into the Open Networks Workstreams

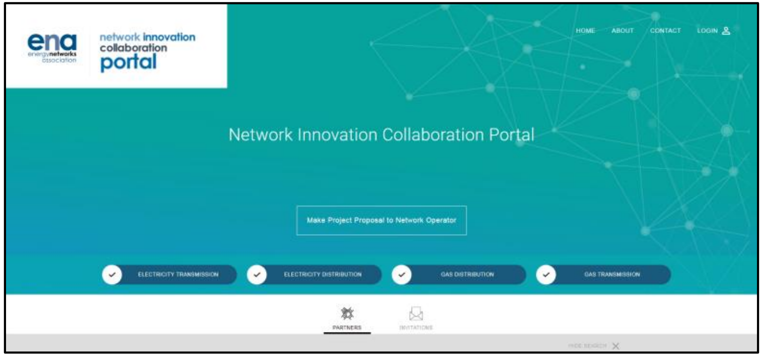
- But there is still more to do…….

How can you get involved?

- Join our mailing list: opennetworks@energynetworks.org
- Provide feedback via your Open Networks Advisory Group representative

- Smarter Networks Portal
  - Database of previous network innovation projects
  - Over 1400 projects to date
  - www.smarternetworks.org





- Network Innovation Collaboration Portal
  - Pitch your innovation project to the networks
  - Receive notifications when the networks are looking for ideas
  - http://www.nicollaborationportal.org/

Energy Networks Association

Any Questions?

randolph.brazier@energynetworks.org

Imperial College London

Power Potential Conference

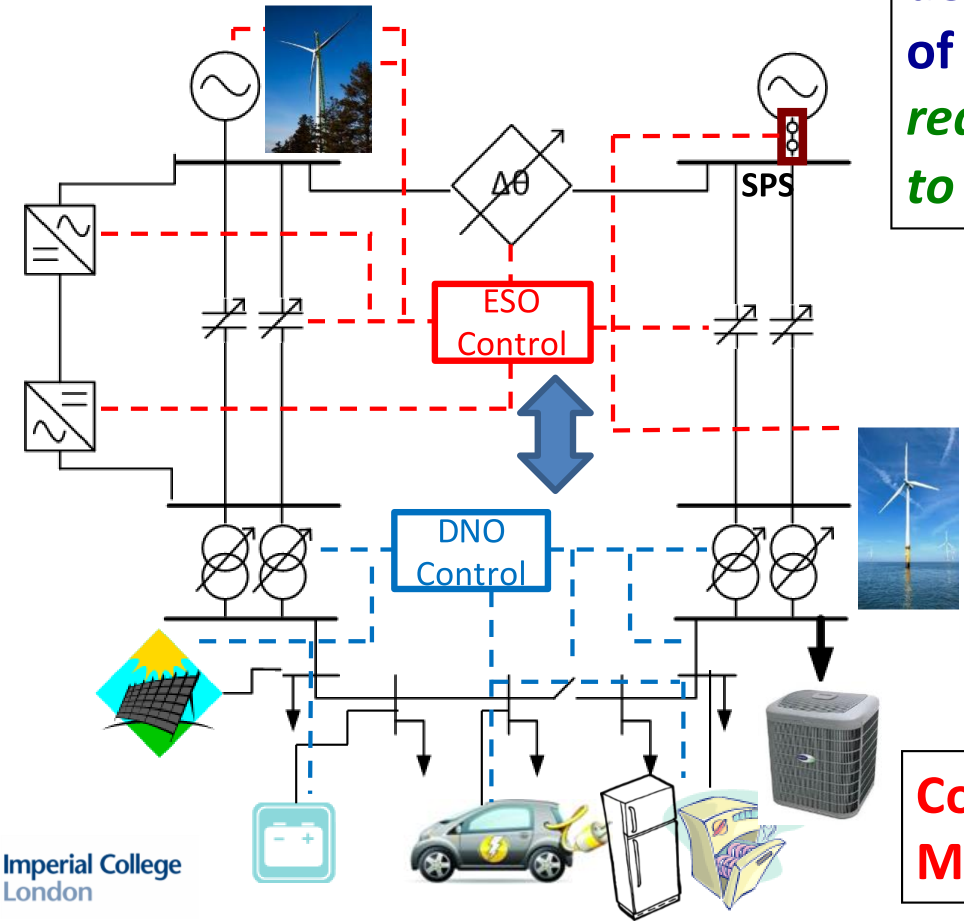
Modelling evidence to inform development of commercial framework for Power Potential

G. Strbac, D.Pudjianto, P. Djapic

Imperial College

30 October 2018

Operational challenge: *towards smart grids*



Paradigm shift in delivering security of supply: *from redundancy in assets to intelligence*

Source of control: *from Transmission to Distribution: business case for DNO/ESO*

Complexity, Risk, Market, Regulation

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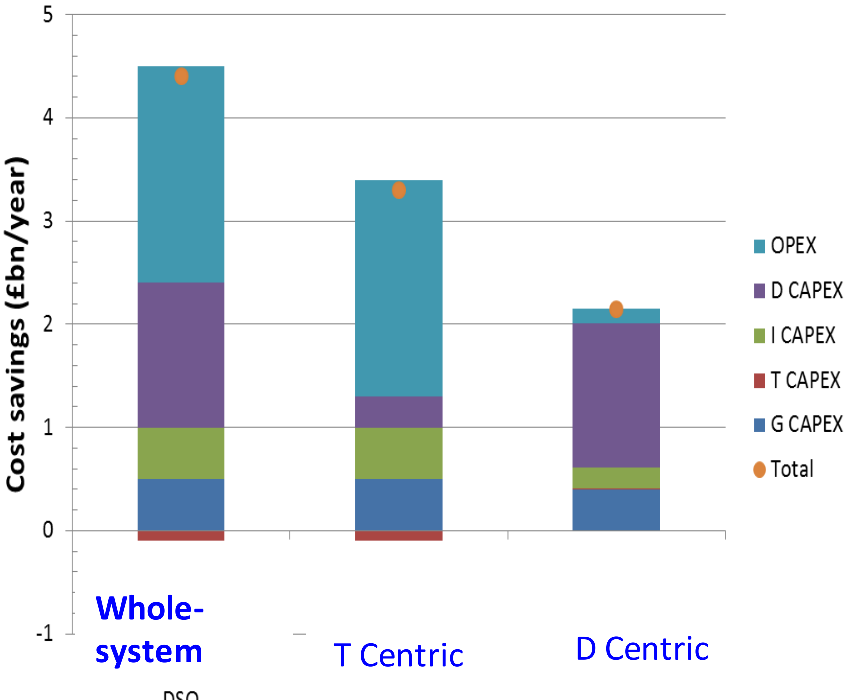
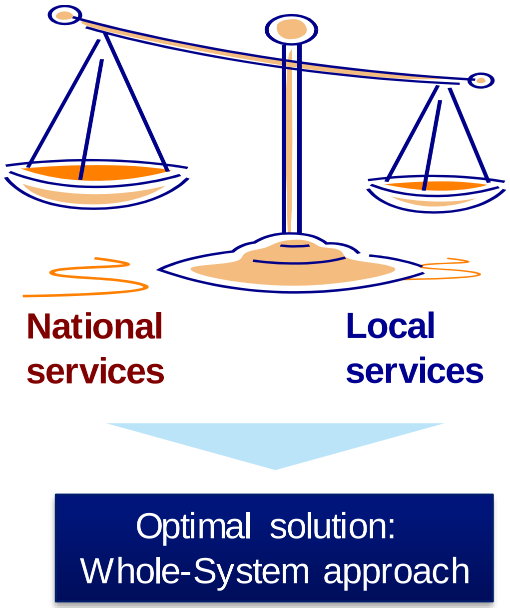
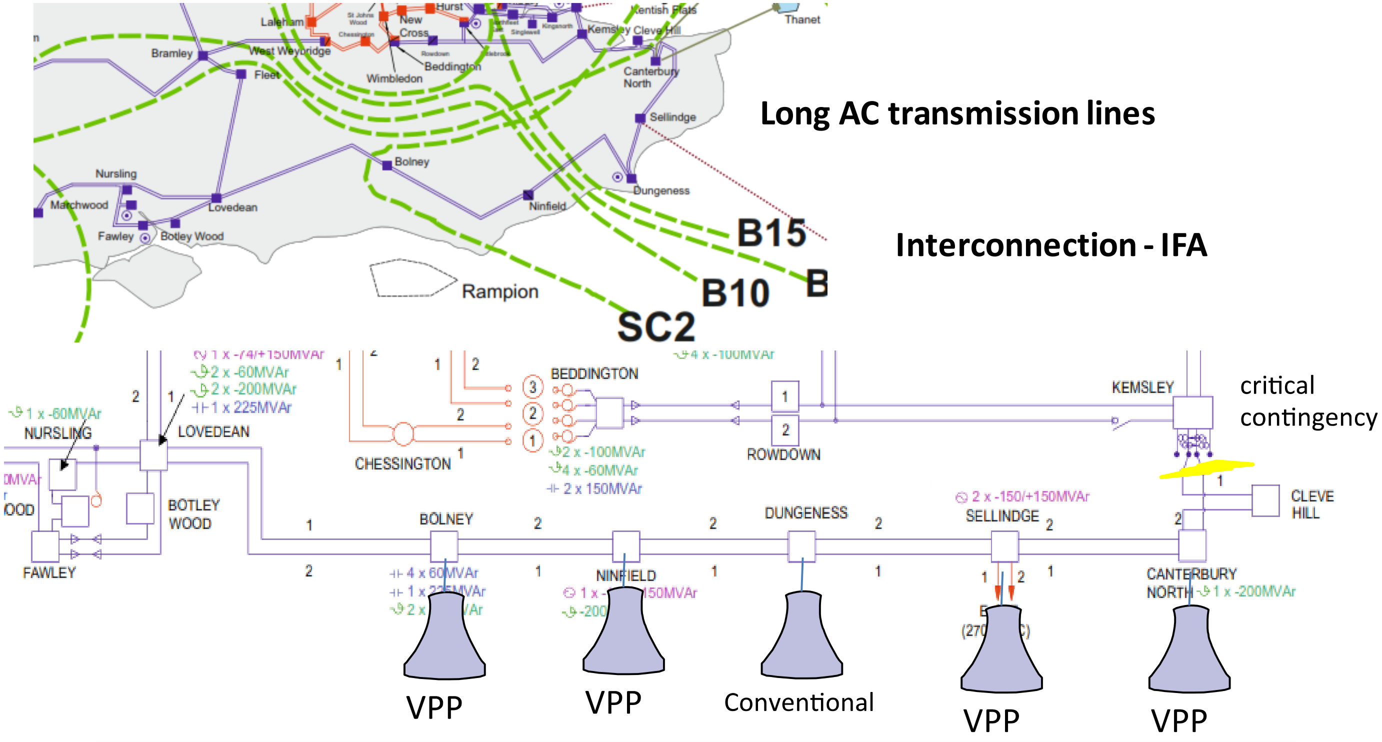
Flexibility: focus on local or national level operation and infrastructure management ?

Coordination between national and local infrastructure management objectives i.e. a whole-system approach is required, to manage the synergies and conflicts across





Reactive power market to support security in South-East region



Enable access of VPPs to support reactive power management SE transmission

Key research questions addressed/informed by modelling

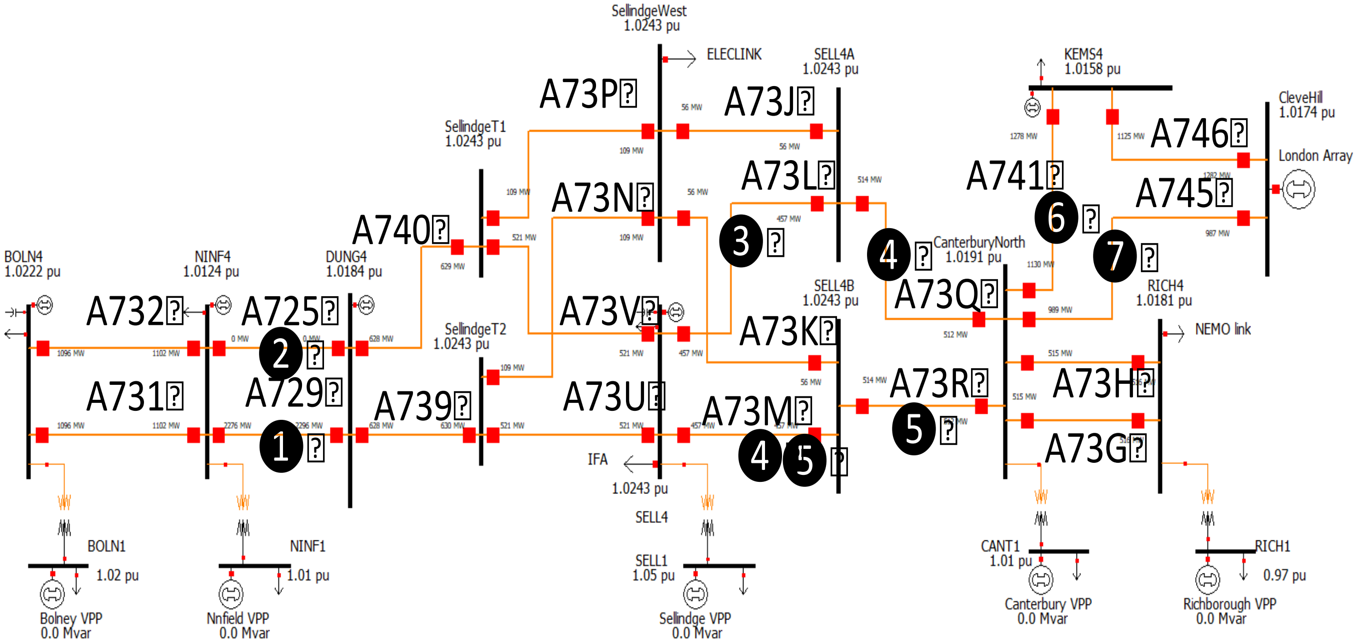
- How to facilitate access to DER for both national energy and ancillary service markets?
- How to determine the optimal portfolio of resources needed to meet system requirements within the market time scale?
- How to coordinate the commercial arrangements between SO, DNO, and DER considering that DER services can be provided to SO and DNO simultaneously?
- As distribution network can also provide services to transmission, does it compete with services from DER?
- How to optimise access to DER by SO by applying distribution network control?

Proposed approach

- Model distribution network areas with substantial DER capacity that can support voltage management of transmission network
  - Investigate temporal PQ capability and cost function of the VPP
  - Investigate the impact of ANM, especially voltage management on the reactive power capability of the VPP
- Determine optimal VAr contract portfolio (SCOPF tool)
  - Contracted capacity of VPP
  - Investment decision to reinforce NG's reactive assets
  - Inform market design (sensitivity analysis):
    - Contract duration, cost of reactive power services

Level playing field: facilitate competition between large-scale generators, VAR compensation investment and VPP / DER

Analysis under different load/demand conditions under contingencies



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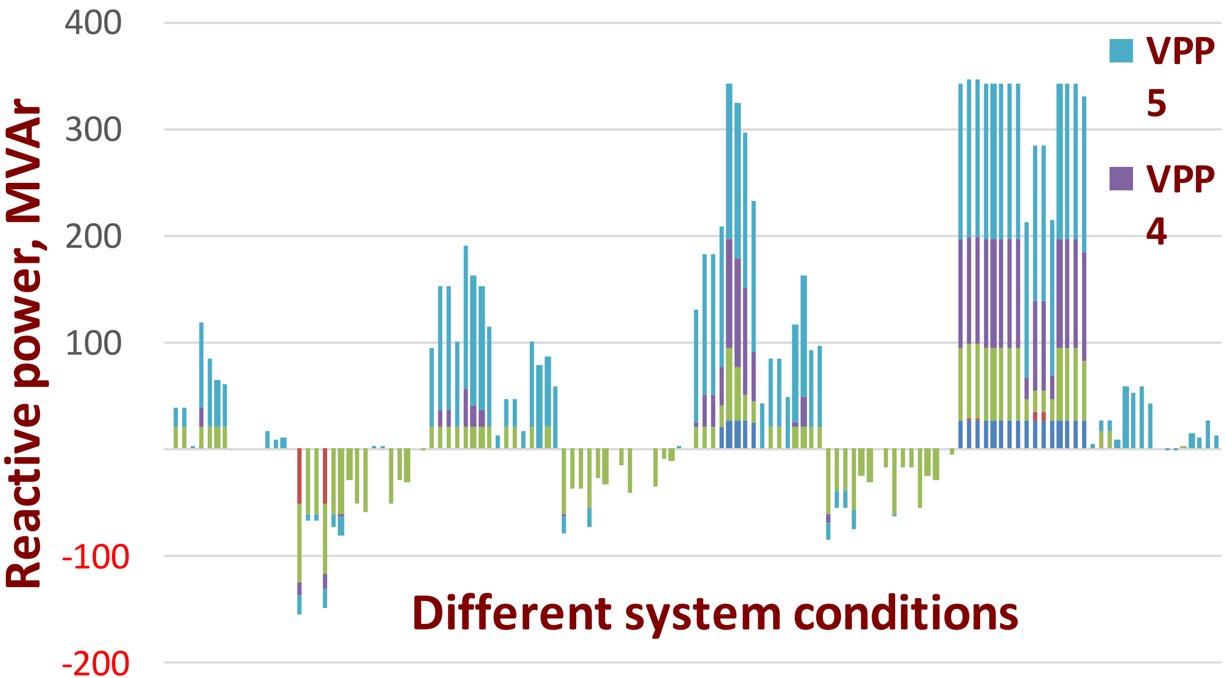
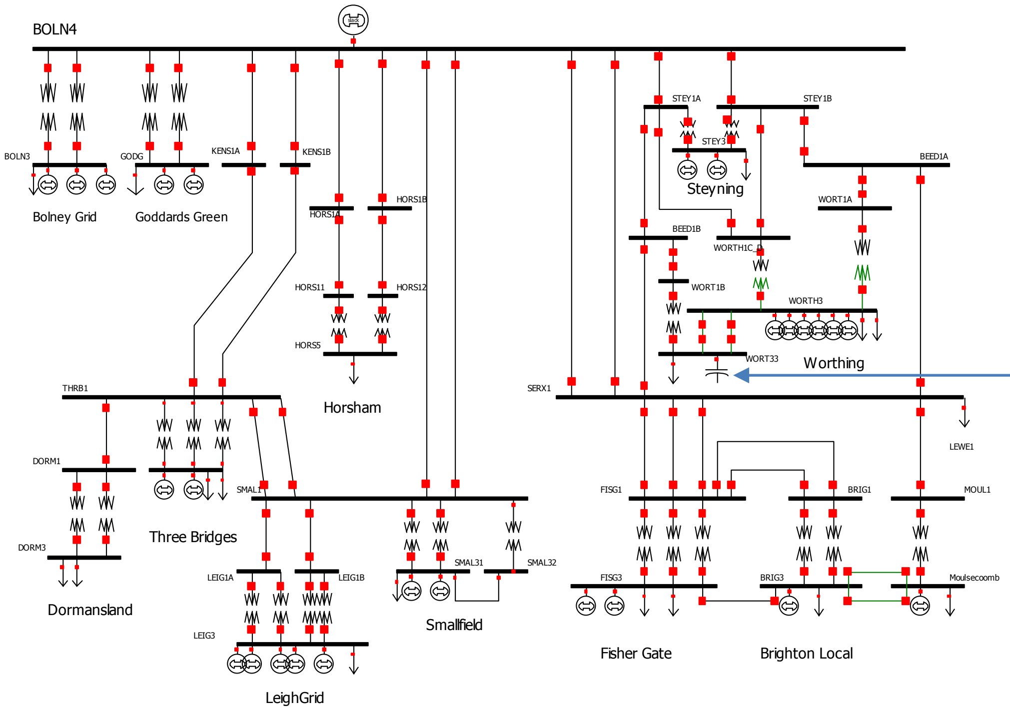
VVPs responses are very system condition specific



Requirements for delivery of VAR support change significantly with system conditions / contingencies

Example - Modelling Bolney VPP

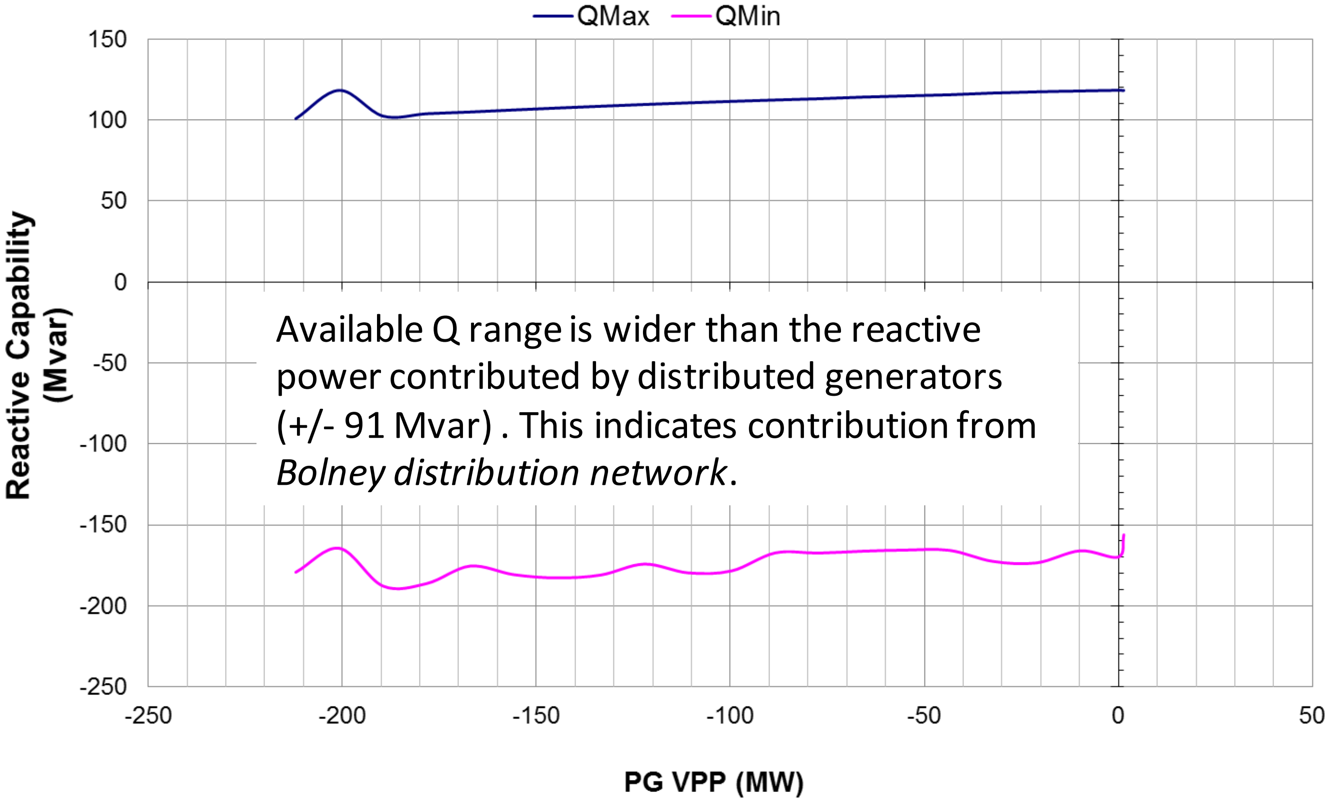


3.2 Mvar reactive compensator.

Load: 515 MW and 60 Mvar
Installed capacity of DG:

- 203 MW
- +/- 91 Mvar →

Bolney VPP: PQ curve



Available Q range is wider than the reactive power contributed by distributed generators (+/- 91 Mvar) . This indicates contribution from *Bolney distribution network*.

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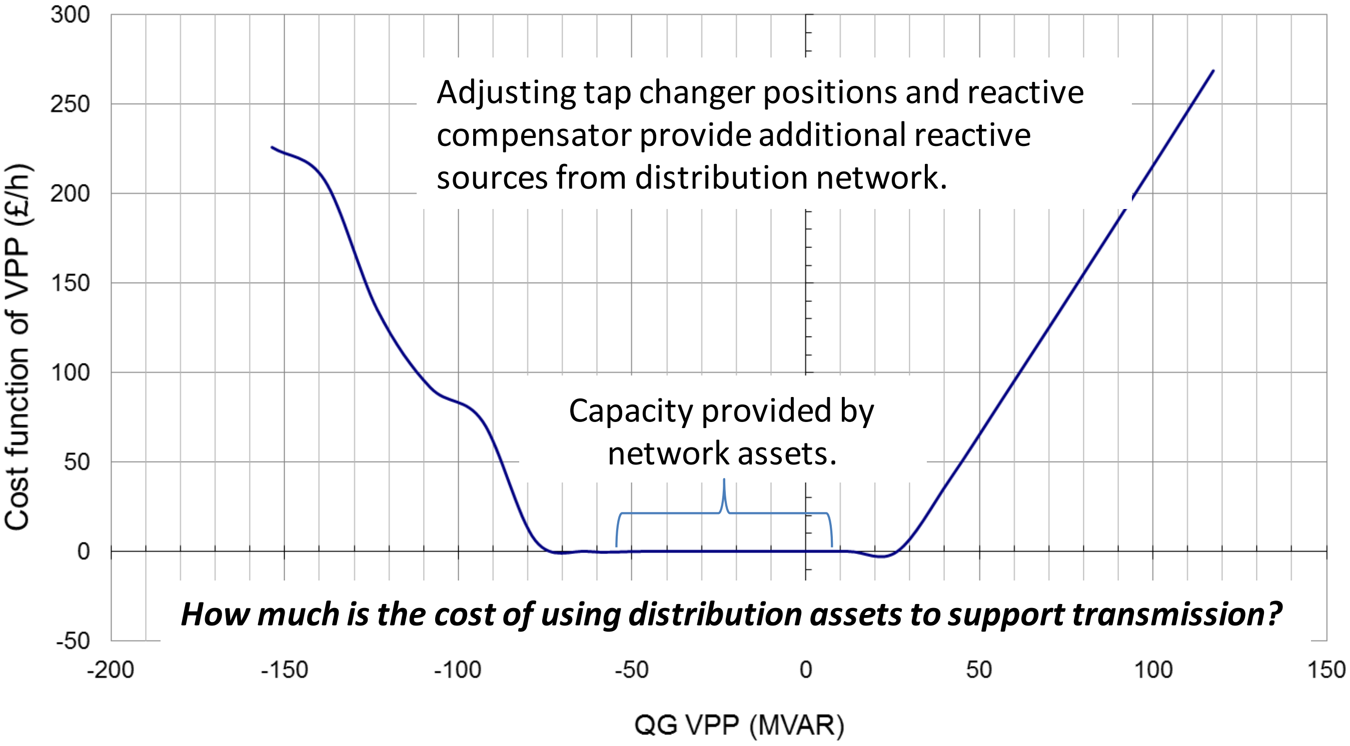
Bolney VPP: MVAr cost function



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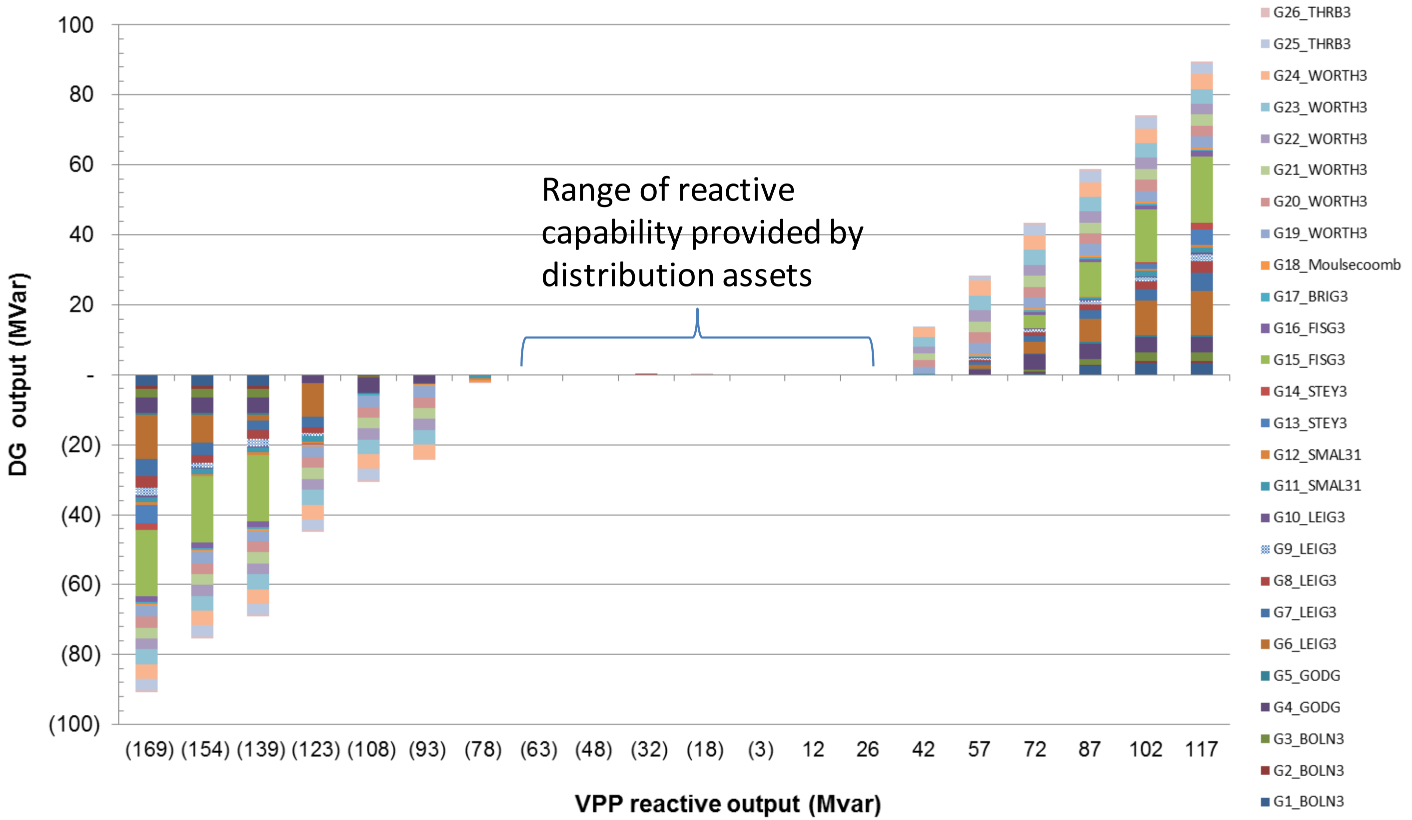
Redispatching DG's reactive power to provide reactive services to transmission

Bolney VPP



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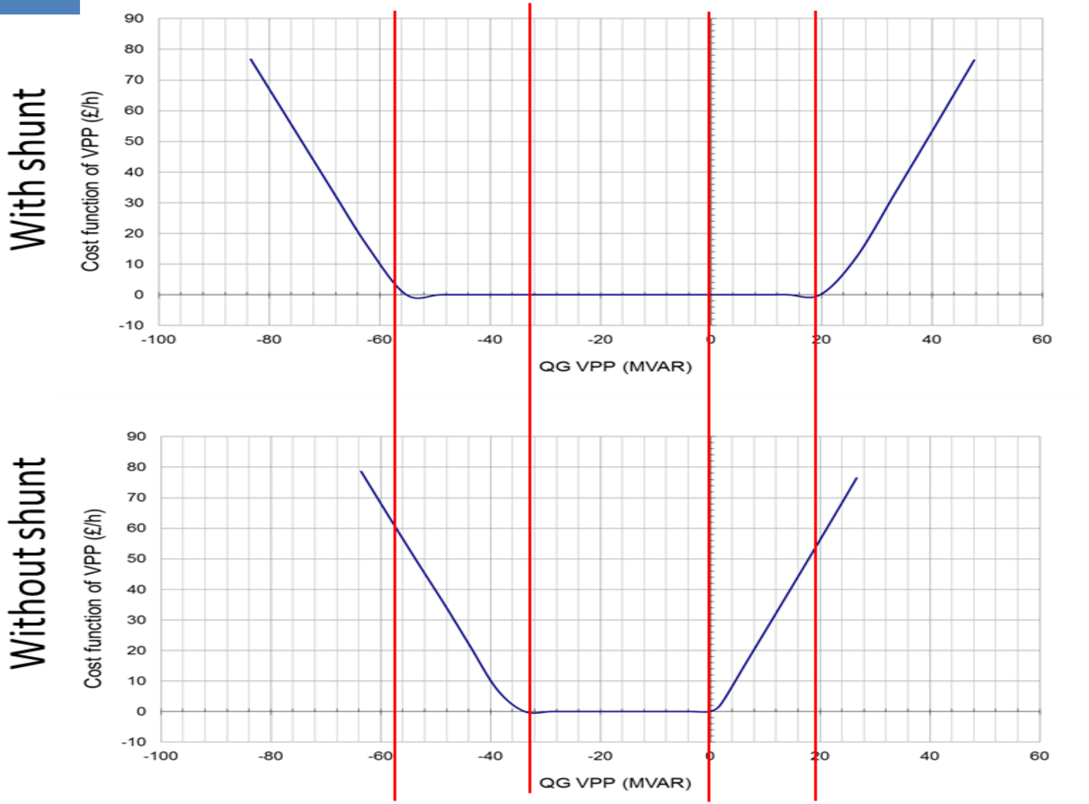
Smart operation of distribution network assets enhances reactive power services to transmission network

Sellindge VPP



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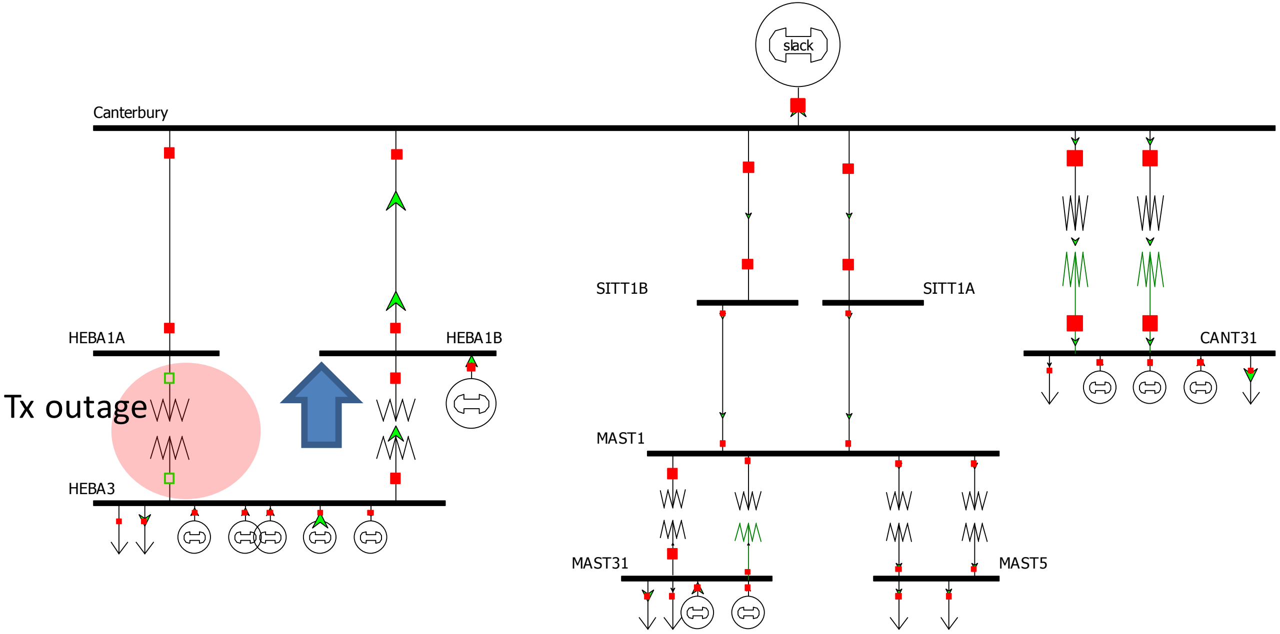
Impact of a network outage on VPP's capability/1

Canterbury VPP



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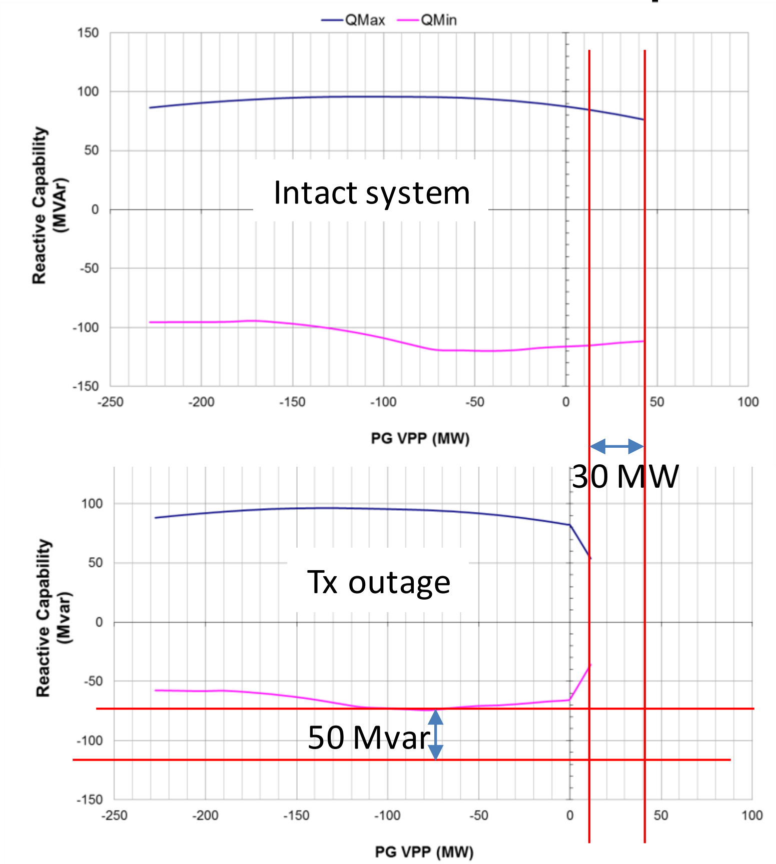
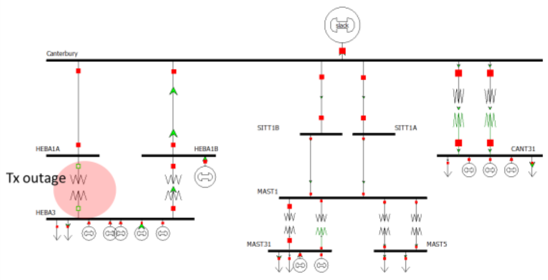
Impact of a network outage on VPP's capability/2

Canterbury VPP





This outage reduces PMax capability of VPP by 30 MW and Qmin by around 50 Mvar. Effect on Qmax and Pmin is marginal.

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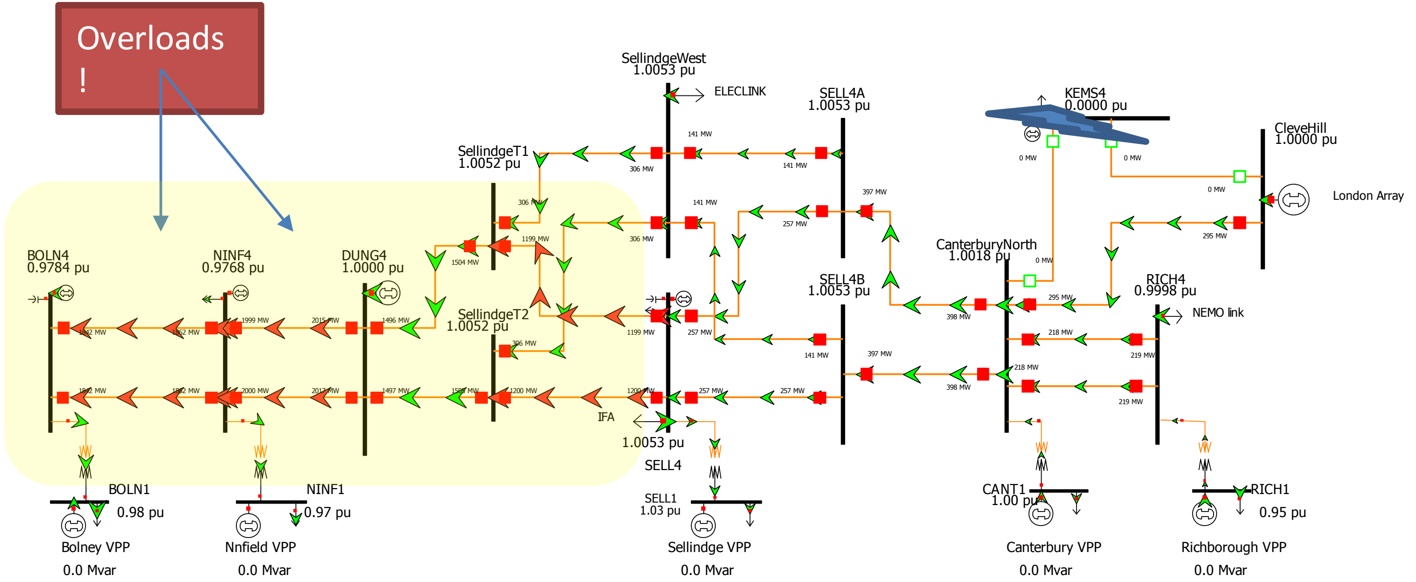
Case: double circuit outages at KEMS4/1



Role of VPPs in providing network congestion management.

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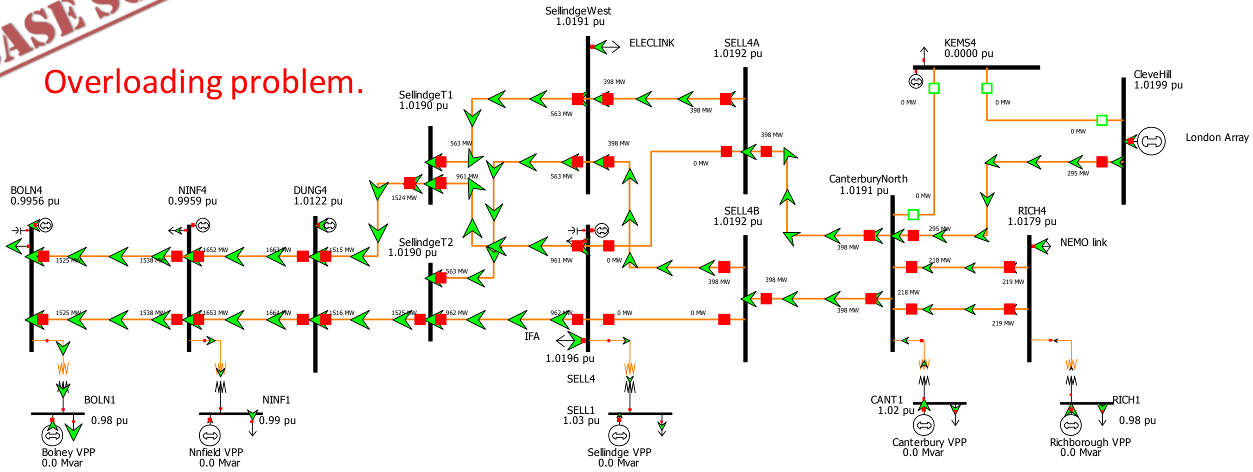
Case: double circuit outages at KEMS4/2

CASE SOLVED

Overloading problem.



Generators	Accepted DEC (MW)
G1_BOLN4	-
G2_DUNG4	371.7
G2_DUNG4	371.7
G3_CleveHill	0.0
G4_BOLN1	0.0
G5_NINF1	156.0
G6_SELL1	33.5
G7_CANT1	0.0
G8_RICH1	0.0

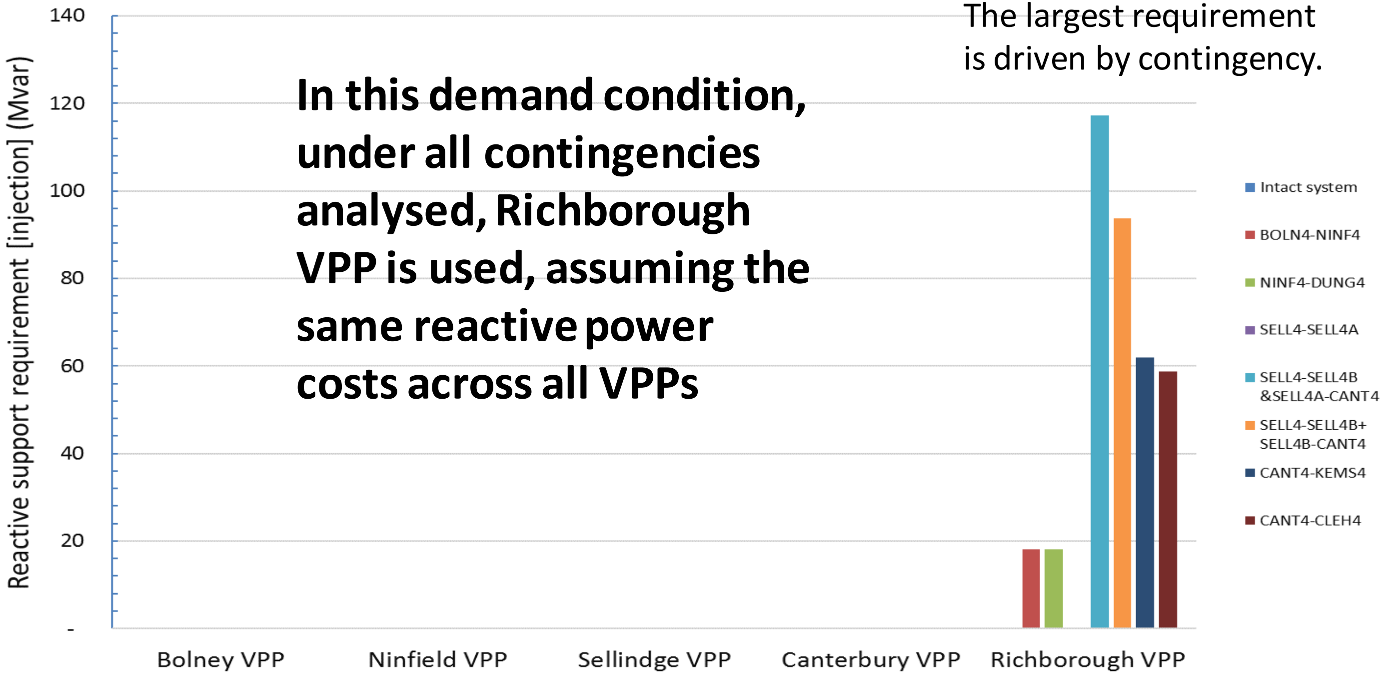
VPP (G4_BOLN1 – G8_RICH1)

VPPs provide active power services for network congestion management together with conventional generator.

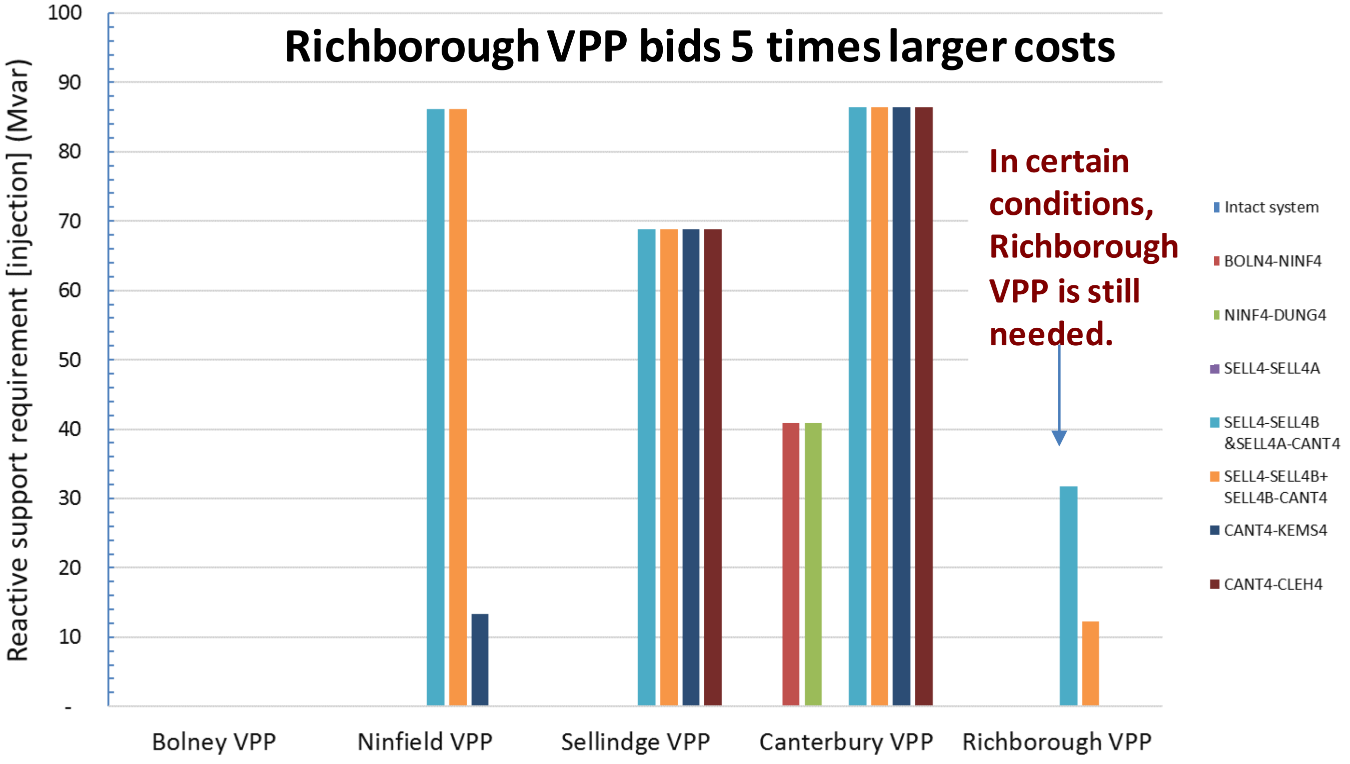
Importance of location of VPP: solution for individual contingencies/reactive capacity needed for particular demand / generation condition

The largest requirement is driven by contingency.

In this demand condition, under all contingencies analysed, Richborough VPP is used, assuming the same reactive power costs across all VPPs



Sensitivity to cost



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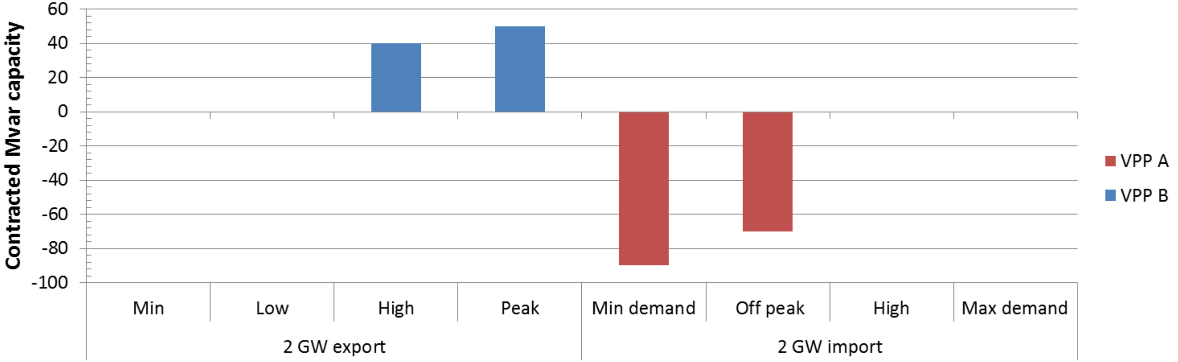
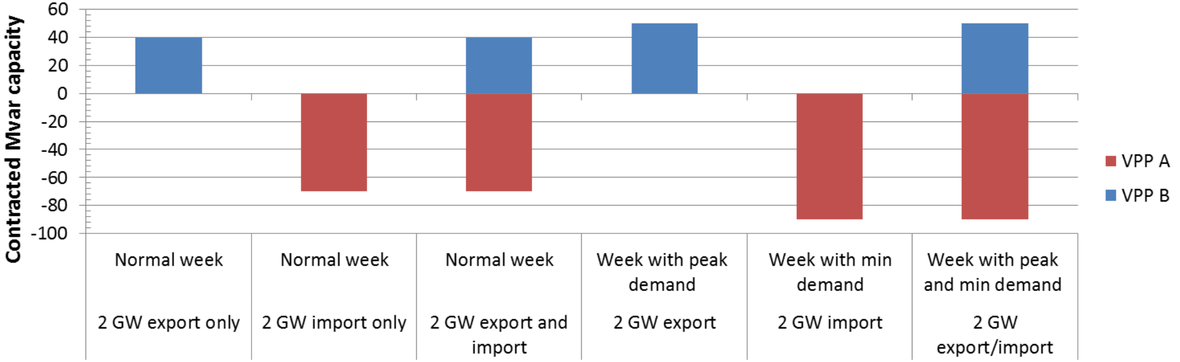
Reactive power contract for different timeframes/1

Illustrative examples

Daily contract



Weekly contract



*Normal week = the week with the typical low and high demand

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Key messages from modelling/1

- *Security Constrained Optimal Power Flow* implemented to manage local distribution network constraints and facilitate access of DER to national level market & services via the concept of *VPP*
- Using the VPP concept, the aggregated capability of resources and network within the VPP can be quantified and used without violating local distribution network constraints
  - Individual DER bids can also be accounted in the cost function
- Case studies demonstrate that the value of reactive power support varies *in time* and *with location* - depending on the system conditions
  - Reactive power market with different time scales modelled –from real time (half hourly) to day/week/month ahead

Key messages from modelling/2

- Allocation of DER services to support Distribution and Transmission networks will depend on the adopted approach
  - *Sequential* (DN first and then TN) may be different from fully *Integrated* approach (combined DN and TN)
- DER may provide services to both distribution and transmission network at the same time – *cost allocation*?
- Benefits of smart operation of distribution network assets may reduce reactive power control costs to ESO
  - Appropriate incentive mechanisms should be in place
- In the systems studied, distribution networks can facilitate full access to DER capacity - outages of distribution network assets may affect access to DER – market design implications

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Power Potential Conference

Modelling evidence to inform development of commercial framework for Power Potential

G. Strbac, D.Pudjianto, P. Djapic

Imperial College

30 October 2018

Reactive Power Management and Procurement Mechanisms: Lessons for Power Potential Project

First Report

Energy Policy Research Group (EPRG), University of Cambridge

Michael G. Pollitt, Karim L. Anaya

The Power Potential Project Industry Event
30 Oct. 2018, London

Outline

First Report

1. About the Report
2. Reactive Power Procurement: General Findings
3. Cases Studies
    1. Australia
    2. USA (California)
4. The Power Potential Project
5. Discussion and Lessons Learned

Second Report

Introduction

First Report

“Reactive Power Management and Procurement Mechanisms: Lessons for the Power Potential Project”

About the Report

Aim:

- To look at the international experience in managing and procuring reactive power (RP) in order to identify key lessons.

- To explore the auction design theory and provide key recommendations for procurement

Deliverable: Report in the context of:

1. SDRC 9.3

Commercial Tendering Process Report and Finalised Trials Approach – outline the learnings from the tendering rounds for the reactive power services and the engagement on the active power services and advise based on this process and the trials approach which customers will be utilised during each trial phase and the forecasted effectiveness

Report 1 can be found at: https://www.nationalgrid.com/sites/default/files/documents/EPRG%20Report%20SDRC%209.3.pdf
EPRG Working Paper 1829 based on Report 1 can be found at: https://www.eprg.group.cam.ac.uk/eprg-working-paper-1829/

Reactive Power Procurement: General Findings

At transmission:

- Limited or non-existent market-based mechanisms for the procurement of RP and voltage support (VS) by ISOs (with some exceptions: Australia, UK).
- Some reasons behind these findings:
  - The local nature of RP does not help (“VARs do not travel well”).
  - Limited number of potential providers, then lack of competition.
  - Technological/modelling issues (IES, 2017).
- Procurement of RP/VS closer to real time is limited:
  - A common practice for specific ancillary services (regulation, reserves).

At distribution:

- RP requirements based on connection standards (e.g. 0.95 PF (power factor)).
- Procurement of RP from DER is not yet a fact.
- Financial incentives (VAR charges) may also apply.
- Connection standards are evolving (e.g. use of smart inverters).

Can the deployment of DER help to reverse this state of affairs?

- DER can also introduce additional system complexity, then “trials” are required to “measure and evaluate” the effectiveness of DER in providing RP and voltage support *(Exelon Corporation, 2016).*
- Need for greater DER visibility by SOs and more coordination among parties.

Reactive Power Procurement: General Findings

Table 1: A Comparison of Ancillary Services in the USA and GB (selected services)

	Ancillary service markets and names	USA							GB
		CAISO	ISO-NE	MISO	PJM	SPP	NYISO	ERCOT	NG (2)
Regulation/Frequency Response	Regulation		RT	DA,RT	RT (1)		DA,RT		
	Regulation Up	DA,RT				DA,RT		DA	
	Regulation Down	DA,RT				DA,RT		DA	
	Regulation (performance)				RT			NA	
	Regulation Up Mileage	DA,RT				DA,RT			
	Regulation Down Mileage	DA,RT				DA,RT			
	Regulation Service		RT						
	Regulation movement						DA,RT		
	Regulating Mileage			DA,RT					
	Frequency response								
	Mandatory frequency response								
	Firm Frequency Response (dynamic)								monthly tenders
	Firm Frequency Response (static)								monthly tenders
Reserves	Spinning reserve	DA,RT		DA,RT		DA,RT	DA,RT		
	Ten-minute spinning reserve		RT, F						
	Synchronised reserve				RT				
	Responsive reserve							DA	
	Non-spinning reserve	DA,RT					DA,RT	DA	
	Ten-minute non-spinning reserve		RT, F						
	Quick start				RT				
	Thirty-minute operating reserve		RT, F						
	Supplemental reserve (3)			DA,RT	RT (4)	DA,RT			
	Ramp reserves (5)	RT		DA,RT					
	Reserve								
	BM startup								
	Fast reserve								monthly tenders
	Optional Reserve Services								
	Short term operating reserve (Committed)								3 tenders/y
	Short term operating reserve (Flexible)								3 tenders/y
	Short term operating reserve (Premium Flexible)								3 tenders/y
Others	Reactive power (voltage support)								
	Mandatory reactive power service								
	Enhanced reactive power service (6)								semestral tenders
	Black start					NA			

[grey] market-based mechanisms (tenders) — Markets: DA: Day Ahead, RT: Real Time, F: Forward (pre-DA), NA: No available

[green] other (cost-based, lost opportunity cost, revenue-based, mandatory)

(1): Regulation in PJM is provided by a combination of resources following 2 signals: RegA (slow response) and RegD (quick response).

(2): Simplified list of AS as of Dec. 2017, (3): Provided by online or off-line resources in MISO/PJM, (4): PJM uses a day-ahead scheduling reserve in addition to the RT for supplemental reserve (30min), (5): Ramp product: Up and Down Ramp Capability (MISO), Flexible Ramping (CAISO).

(6): Not currently active for procurement. The full list of removed products can be found at NG (2017c) and NG (2018c).

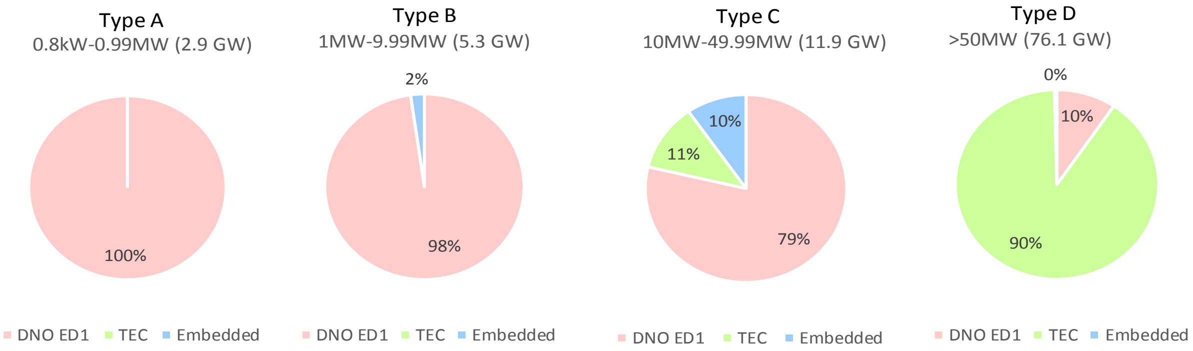
Source: Anaya and Pollitt (2017, p. 31), ISO-NE (2018a), NG (2017a), Potomac Economics (2017).

Reactive Power Procurement: General Findings

Network Code Evolution:

- Network Code on Requirements for Generators (RFG) - new generating facilities.
- Will help to support RP (technical capabilities) and harmonised solutions.
- Specific technical requirements arranged in four bands (Type A – Type D), based on capacity (MW) and connection voltage (kV).
- In GB: 88% generation on Type B&C&D (2015) but 67% on Type A&B (2021).
- RP capability from DER is expected to take a more active role.

Figure 1: Generation by band in Great Britain



DNO ED1: refers to generators connected to the distribution network. TEC: refers to generators with transmission entry connection.
Embedded: refers to generators connected to the distribution network with access rights to the transmission network.
Figures from Nov. 2015. (TEC, Embedded), week 24 2015 (DNO). Source: NG (2018a, p. 176).

Reactive Power Procurement: General Findings

Table 2: RP Procurement and Payment Methods by SOs: A Comparison

Country	SO	Procurement method		Type of payment						Periodicity
		Compulsory/ Mandatory	Tenders	Capability	Availability	Enabling	Utilisation	Opportunity costs	Others	
USA	CAISO	✓						✓		variable
	NYISO	✓		✓				✓	✓	variable
	PJM	✓		✓				✓		variable
	ISO-NE	✓		✓				✓	✓	variable
Australia	AEMO (GM)		✓		✓			✓	✓	variable
	AEMO (SCM)		✓			✓			✓	variable
GB	NG (ORPS)	✓					✓			variable
	NG(ERPS)		✓		✓		✓			every six months, with term contract minimum 1 year and then in six-month increments

GM: generation mode, SCM: synchronous condensor mode. Others include: testing charges, cost of energy used to energise equipment that provides voltage support.

Source: AEMO (2017a), CAISO (2017), NYISO (2017a, 2014), ISO-NE (2018b), PJM (2018), NG Reactive Power Service Guides.

- *ISOs from the USA apply different capability methods (NYISO: fixed rate set at: $2,747/MVAr year, others: based on FERC method: American Electric Power - AEP).*
- *In GB under the ORPS a fixed rate is applied for utilisation (£3.19/MVArh aver. Jan-Jul. 2017).*
- *Loss of opportunity costs: only when generators operate outside their mandatory range.*

Case Studies

About the Cases Studies:

- Explore different market-based initiatives that may involve the participation of DER.
- We have chosen case studies of RP and similarly procured DER services.
- Involve trials (pilot project) and Business as Usual (BAU).
- Cases:

From Australia (BAU)

- **AEMO tenders for acquiring NSCAS (network support and control ancillary services)**

From USA, CA (pilot project)

- **DRAM (Demand Response Auction Mechanism)**

Case Studies - Australia

AEMO tenders for acquiring NSCAS

Overview

- NSCAS: non-market ancillary service (AS)
- Procured by *AEMO* or Transmission Network Service Providers (TNSPs) to maintain power system security and reliability.
- TNSPs with primary responsibility to acquire NSCAS since 2012.
- AEMO will procure if the NSCAS gaps remain unmet after the TNSPs attempt to procure.

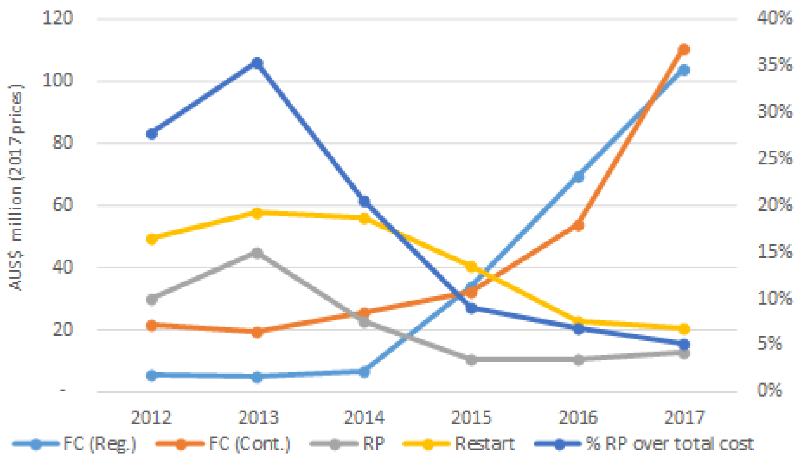
Products

- VCAS (Generation Mode , Synchronous Condensor Mode).
- Can be for short term (generating units)/long term (reactive plants) solutions or a combination.
- Provided by existing or new plants/generating units.

Evaluation criteria and offers selection

- Selection of tenders at the least cost possible.
- Assessment of the optimal combination of VCAS (locational effectiveness, others).

Figure 2: Ancillary Services Trend



Annual figures: Jan.-Dec., FC: Frequency Control, Reg: Regulation, Cont: Contingency, RP: Reactive Power.

Source: AEMO AS Payments Summary - Annual Reports (2012, 2013, 2014, 2015, 2016, 2017).

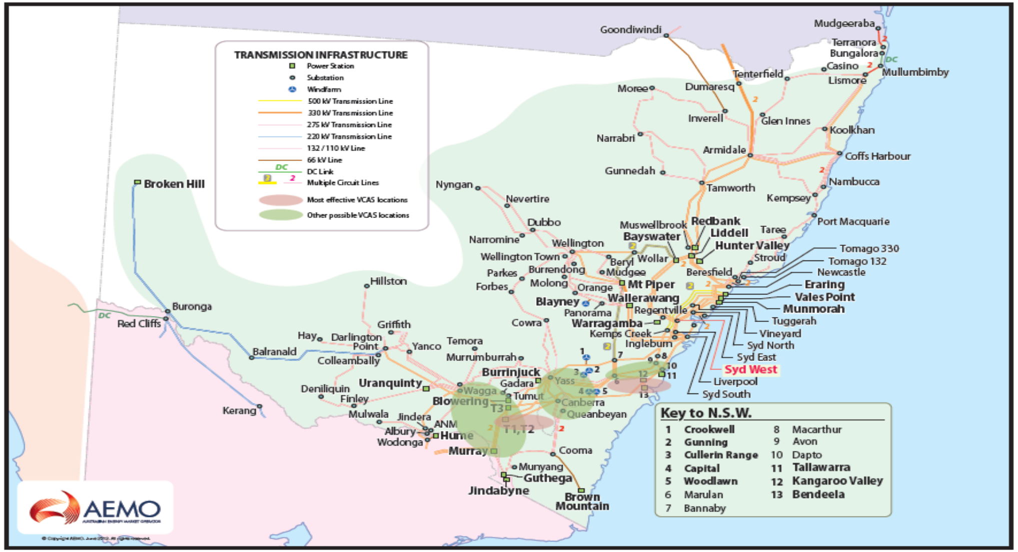
Case Studies - Australia

Table 3: Example of Effectiveness

VCAS Equipment locations (when connected at or near 330 kV substations)	Effectiveness at reducing overvoltage at both Kangaroo Valley and Upper Tumut (%)
Kangaroo Valley, Upper Tumut	100
Capital, Bendeela	97
Lower Tumut	93
Canberra, Williamsdale	90
Yass	76
Wagga	72
Jindera	59
Dapto, Marulan, Bannaby	50

Source AEMO

Figure 3: Most Effective Locations for delivery of VCAS (green areas)



Source: AEMO

Case Studies – California

DRAM (Demand Response Auction Mechanism) – State level initiative

Overview

- Mandated by California Public Utility Commission in Dec. 2014.
- Design and implementation of DRAM: through pilot programs by three IOUs.
- Allows the California SO (CAISO) to add demand response resources.
- Gradual deployment (DRAM pilot 1, 2, 3, 4) with specific budget allocated to IOUs.
- Type of auction mechanism: pay-as-bid auction.
- A more cost-effective method to secure DR capacity (by IOUs), with lower costs over time.

Products

- Different types of Resource Adequacy (RA): System, Local, Flexible
- Different types of Demand Response Products:
- Prohibition of specific resources for load reduction during DR events.

Evaluation criteria and offers selection:

- Qualitative assessment: Based on qualitative factors - QF.
- Quantitative assessment:
  - Offers ranked by Net Market Value (NMV)

$$NMV = Benefits - Costs \ (*)$$

(*) Costs lower than the long-term avoided cost of generation (US$ 113.20/kW-yr.)

Case Studies – California

DRAM (Demand Response Auction Mechanism) – State level initiative

Table 4: Summary of DRAM Pilots

Description	2016 DRAM (Pilot 1)	2017 DRAM (Pilot 2)	2018-2019 DRAM (Pilot 3)	2019 DRAM (Pilot 4)
Type of RA	System	System, local, flexible (cat. 2, 3)	System, local, flexible (cat. 1, 2, 3)	System, local, flexible (cat. 1, 2, 3)
Type of DR product	PDR	PDR, RDRR	PDR, RDRR	PDR, RDRR
Delivery Period	6 months Jun.-Dec. 2016	12 months Jan. – Dec. 2017	2 years (2018-2019) Jan. –Dec.	12 months Jan.-Dec. 2019
Budget	SCE:$6m, PG&E:$6m, SDG&E: $1.5m	SCE:$6m, PG&E:$6m, SDG&E: $1.5m	SCE:$12m, PG&E:$12m, SDG&E: $3m	SCE:$6m, PG&E:$6m, SDG&E: $1.5m
Procurement targets (minimum)	10 MW (SCE), 10 MW (PGE), 2 MW (SDG&E).	10 MW (SCE), 10 MW (PGE), 2 MW (SDG&E)	No minimum (MW).	No minimum (MW).
Procurement targets (maximum)	Based on approved budget limit or available authorised Rule 24 registrations.	Based on approved budget limit or available authorised Rule 24 registrations.	Based on approved budget limit or when there is a clear price outlier.	Based on approved budget limit or when there is a clear price outlier.
Scheduling coordinator costs	separated from the bid cost	separated from the bid cost	included in the bid cost	included in the bid cost
Capacity procured	40.5 MW	124.7 MW	over 200 MW	na (ongoing)
Regulatory framework Decision (CPUC)	D.14-12-024	D.14-12-024	D.16-06-029	D.17-10-017

RA: Resource Adequacy, DR: Demand Response, PDR: Proxy Demand Resource, RDRR: Reliability Demand Response Resource.

Source: CPUC (2017a, b), PG&E(2017), SCE (2015).

Table 5: Qualitative Evaluation Score Matrix

	Answer Yes/No	Score (a) Yes	Score (a) No	Weight (b) SDG&E	Weight (b) SCE	Weight (b) PG&E	Weigthed Score (a)*(b)
Technical requirements							
Pending requirements (interconnection agreements, environmental studies, land rights, others) prior to operation.	Yes/No	1	0	3%	0%	0%	
Ongoing/Previous Bidder Experience							
Ongoing investigation (or ocurred) within the last 5 years of any alleged violation of rule, regulation, etc., regarding the DR to be offered.	Yes/No	1	0	30%	0%	0%	
Termination/Default on past DRAM PA, offers with clear evidence of market manipulation/collusion.	Yes/No	1	0	3%	0%	15%	
DRAM PA not signed when extended a shortlisted offer or delivery less than 50% of contracted capacity.	Yes/No	1	0	3%	0%	5%	
Small Business							
Certified small business.	Yes/No	1	0	0%	0%	-1%	
Project Diversity							
Use of Enabling Technology (ET) with at least 90% of the customers comprising PDR customers.	Yes/No	0	1	3%	0%	0%	
Majority of resources/customers to emit GHG emissions.	Yes/No	1	0	3%	0%	0%	

ET: a set of communications, networking and control systems.

Source: IOUs' Offer Forms for DRAM 2019. Simplified version.

The Power Potential Initiative

POWER POTENTIAL

About the products

- RP and Active Power (AP) from DER (ideally connected at 33 kV or above).
- Total size between 10-50Mvar across the 4 GSPs, with at least 0.5MW/0.5MVAr.
- DER aggregated or directly connected.
- Exclusions may apply (AP and specific balancing services).

Participation criteria and eligibility

- DER located around 4 specific GSPs (southern region).
- Service (s) to be provided by DER in at least one of the 4 GSPs.
- Offers made only for 1 GSP at the same time.
- DER expose to different stages: Wave 1, Wave 2 (DER), Wave 3 (DER + Tran. Gen.)

Evaluation Criteria and offers selection

- Day-ahead auction wit pay-as bid method.
- Selection of offers based on a combination of lowest costs and highest effectiveness but limited to the current budget (up to £0.6m).
- An indication of low/high effectiveness is provided (heatmaps) for each GSP.
- Non-cost variables are not expected to be included in the selection of offers.

Discussion and Lessons Learned

1. Procurement of RP and the need for market-based mechanisms

- Global lack of market-based mechanisms for RP procurement (in contrast with other AS).
- RP suppliers generally subject to mandatory arrangements.
- Use of fixed methodology for RP compensation (flat rate or cost-based rate).
- Fixed methodologies should be enhanced and reflect real costs.
- Risk of over/under compensation can be mitigated by introducing more market-based solutions *(e.g. 200 Mvar, from a 200 MW plant with 0.9PF: CAISO:$0, ISONE: $225k, NYISO: $525k, PJM: $1.9m).*
- DER can help to deal with the poor locational effectiveness (Vars do not travel well).

2. A market-based approach for RP: Auction Design concept

- New initiatives in auction design for RP procurement encourage new entrants (i.e. DER) in RP market, but future participation of new entrants should depend on whether they can compete.

- The importance of enhancing competition between the RP suppliers (i.e. DERs) across the different supply sites (i.e. GSPs) via a package auction design. The sale of multiple objects encourages price discovery and induce truthful bidding.

- Consideration of pay-as-clear price determination format which works better for true price discovery and maximises economic welfare.

Discussion and Lessons Learned

- The frequency and periodicity of the auction and the cost benefit of nearer to real time procurement and co-optimisation. Adjustment of RP offers and demand closer to real time and lower costs.

- The careful specification of the counterfactual against which the auction results are to be evaluated. RP can be acquired under different methods that need to be evaluated.

- The design of the contract between the DSO and TSO to incentivise optimal risk sharing. Suitable contract agreements can help with this.

3. Power Potential initiative as an opportunity to:

- Trial the technical/commercial solutions, new roles and new interactions.

- Identify regulatory barriers that may limit the value of procuring RP competitively from DER at large scale.

- Create a regional market for RP as represented by a group of GSPs.

- Be a first mover in the procurement of RP using DER.

Second Report

"A Cost Benefit Analysis of the Power Potential Project"

About the Report

Aim:

- To conduct a Social Cost Benefit Analysis (SCBA) of the Power Potential project looking at different scenarios and counterfactuals.

Status: In progress

Final Report: 21 December 2018

Deliverable: Report in the context of:

1. **SDRC 9.5**

Cost Benefit Analysis – analysis assessing the financial case for the trial to date and for extending the approach into the future.

About the Report

About the SCBA:

- SCBA to be performed from the SO's perspective.
- Key data to be provided by NG/UK Power Networks for building counterfactuals and future capacity.
- Potential scenarios: BAU option to be compared with 2 or 3 competitive scenarios.
- BAU can be central procurement/asset building.
- Potential sources of savings in PP: cheaper sources of RP, procured closer to demand, for less hours and DSO activated network reconfigurations to support DER market.

Scope: 4 GSPs

	Conventional (current) non-competitive mechanism			**Competitive mechanism (tenders)**
Scenario	Mandatory **(generators)**	Constraint Management (voltage) **(generators)**	RP assets	DER RP compensation **(DER)**
S1 (BAU)	✓	✓	✓	
S2	✓	✓	✓	✓
S3			✓	✓

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Q&A

Thank you!

Panel

Reactive power market; what are the respective benefits of market solutions vs network investment?

Panel Chair:

Claire Spedding, National Grid

Panellists

Arthur Henriot – RTE

Lily Coles – Anesco

Colin Foote – SP Energy Networks

Louise Van Rensburg - Ofgem

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Summary and next steps for Power Potential

Power Potential – next steps for DERs

Activity	Date
Commissioning specification for DERs	This week
Signing the framework agreements and updated connection agreements with DERs (start)	21 November 2018
Optional laboratory testing with DER's controllers	January 2019
Prepare DERs for commissioning process	Until January
Testing and commissioning of DERs (start)	February 2019

Next steps for the Power Potential project

- **Complete build and test of DERMS Interim Solution**
- **Take DERs through to commissioning**

Now – 13th May 2019

- **Wave 1 Technical Trial on DERMS Interim Solution**
- *Proof of infrastructure and DER dispatch*
- **Complete build and test of DERMS Full Solution**

13th May – August 2019

- **Wave 2 Commercial Trial on DERMS Full Solution**
- *Full commercial functionality and integration with UKPN network management systems*

Sep 2019 – Jan 2020

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Thank you for coming today!

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