reactive technologies

Inertia measurement:
Supercapacitor application

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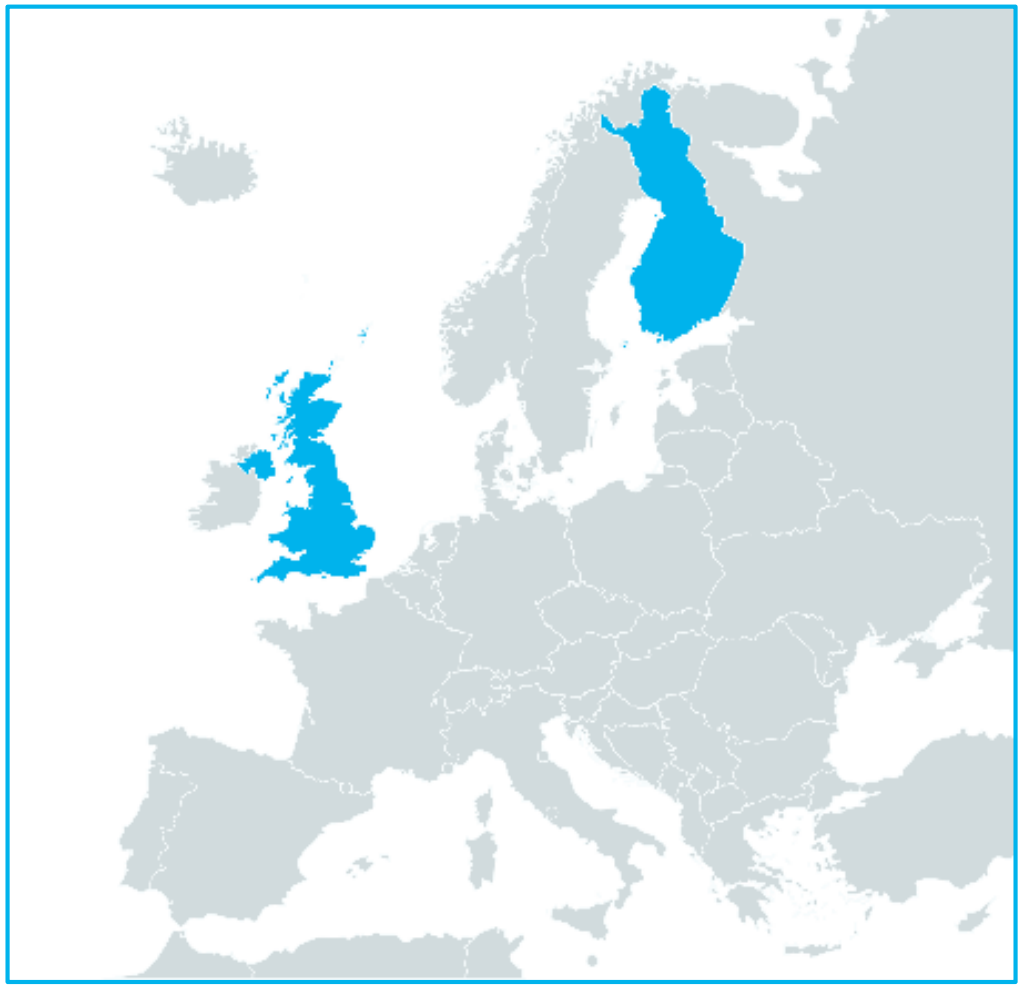
Overview of Reactive



About Reactive

- Energy tech company
- Aim to lead the transition to a lower carbon energy future
- Locations in UK and Finland
- Over 170 patents granted,

- Key Technology offerings:
  - Next Generation Grid Management Services - GridMetrix
  - PPA, Flexibility and Optimisation Services

- Investors:

What is Inertia and why is it important?

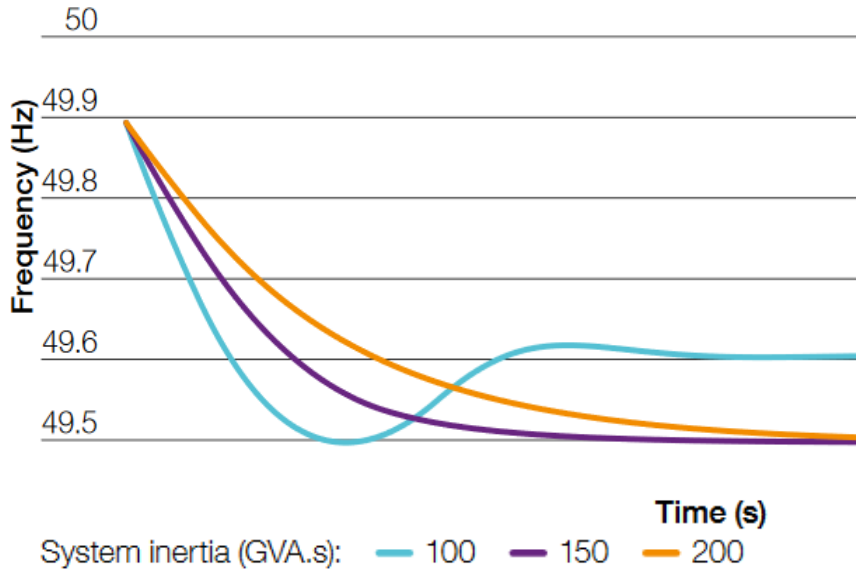
Inertia: Ability for a power system to resit a change in frequency

Source: Kinetic energy in rotating “synchronous” generators

Risk: Large frequency deviations causes disconnection of generators and a cascading effect

Impact: Low inertia systems are venerable to instability and blackouts

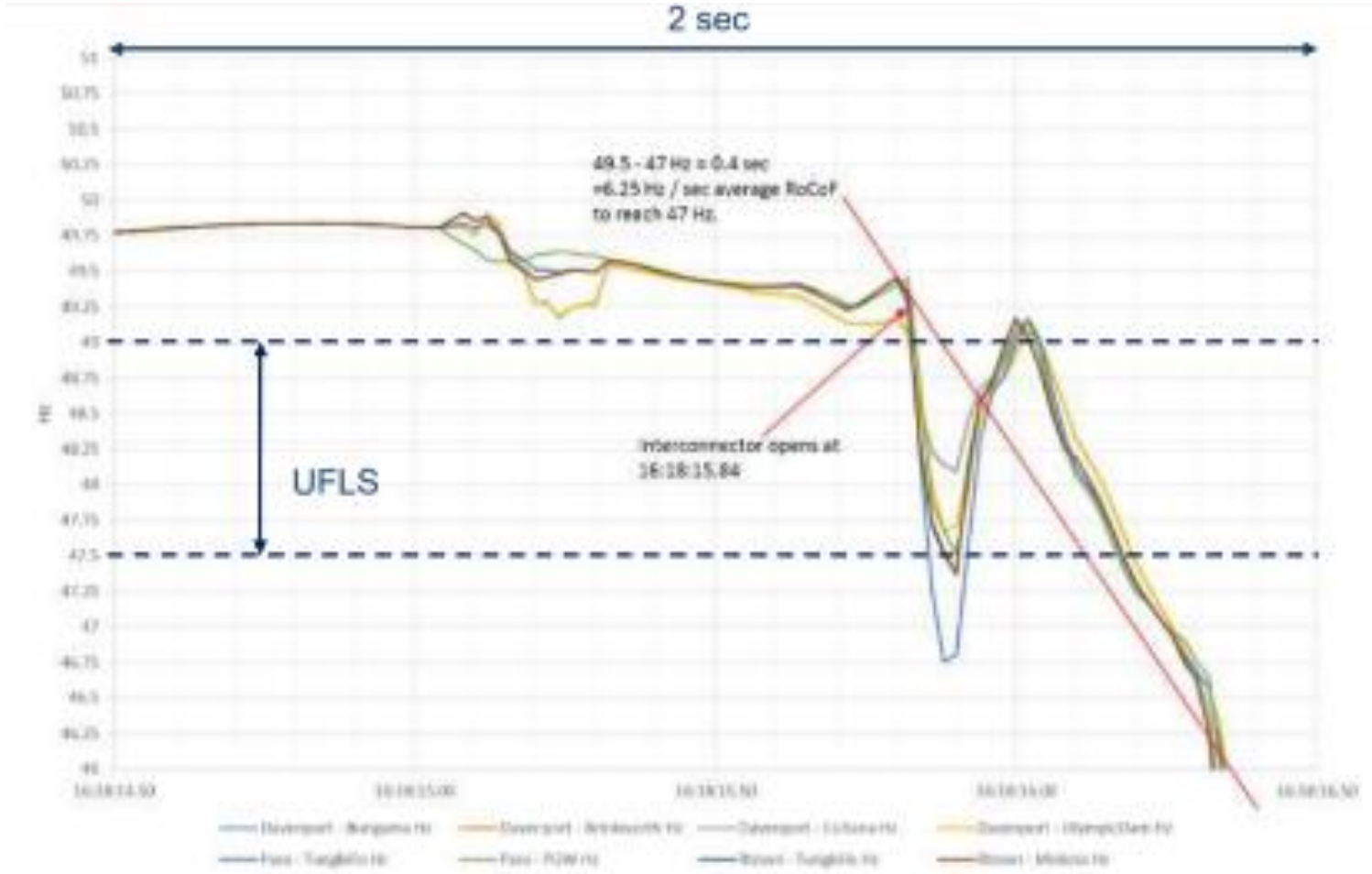
Frequency containment of a 500MW loss, NG SOF 2016



Source: National Grid System Operability Framework, NG SOF 2016

What if inertia measurement is not addressed?

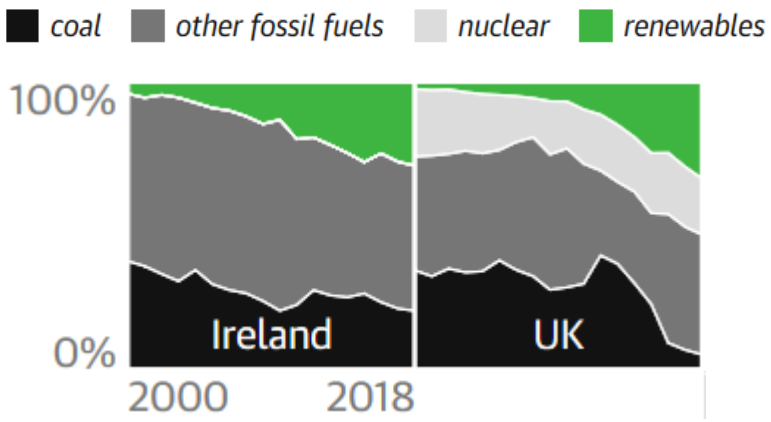
South Australia islanding in 2016

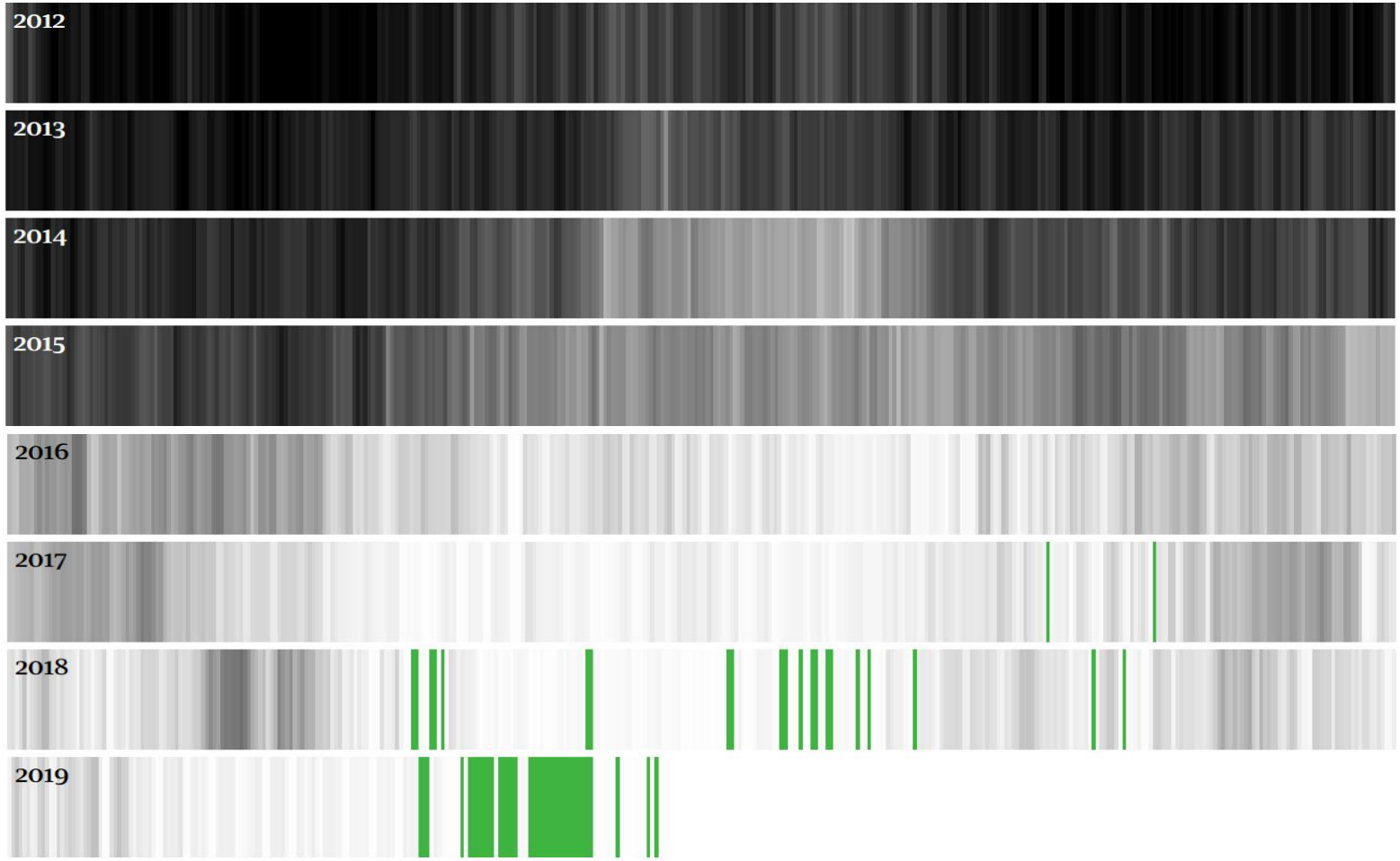


Declining trend of Power System Inertia

	1980s	Now
Gianluca Vialli		
Power System Generation		

Renewables transition will bring a low inertia future power grid





April 2017: Fist UK coal free day

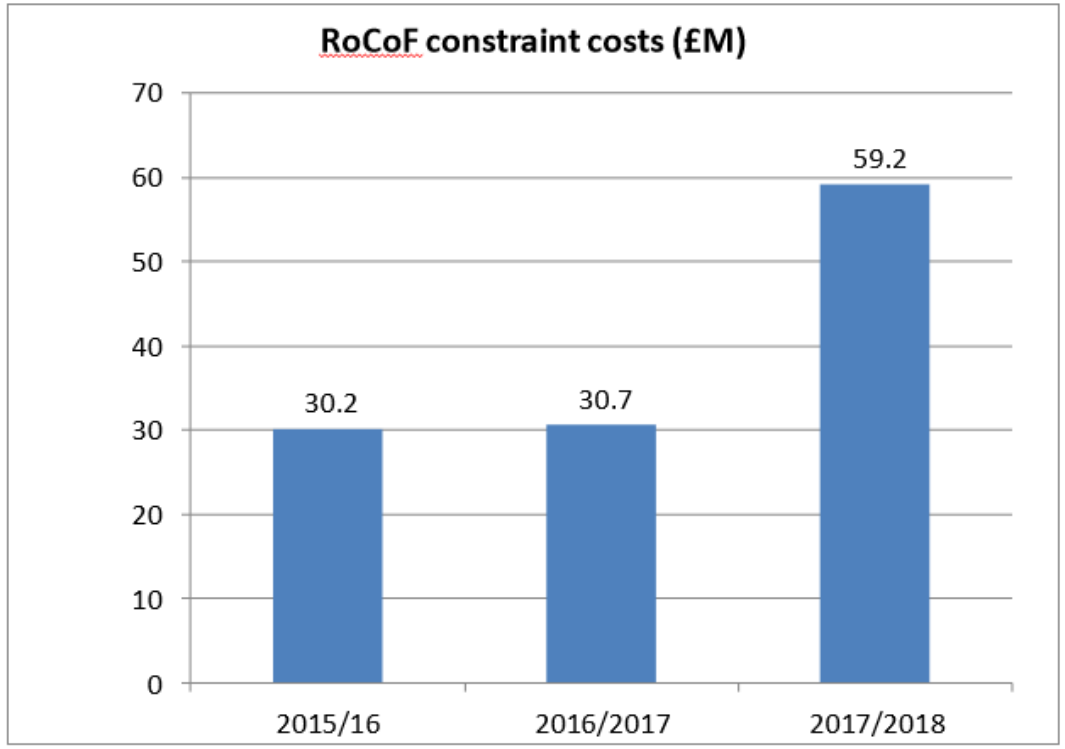
May 2019: Fist UK coal free fortnight

Source: Gridwatch

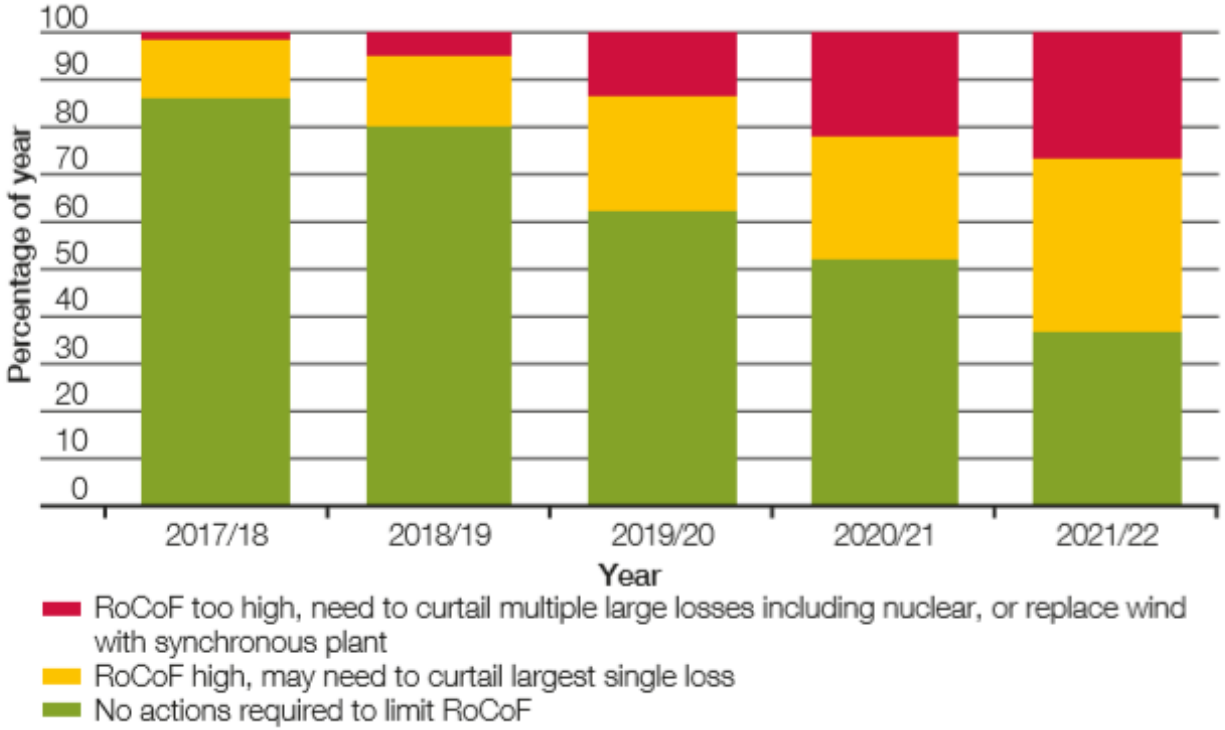
Inertia is becoming a major cost item for National Grid

National Grid's frequency stabilising costs have increased significantly since 2017 and are expected to rise further in the coming years as more renewables are absorbed onto the system.

Historic RoCoF Constraint Costs



Five Year RoCoF Trajectory



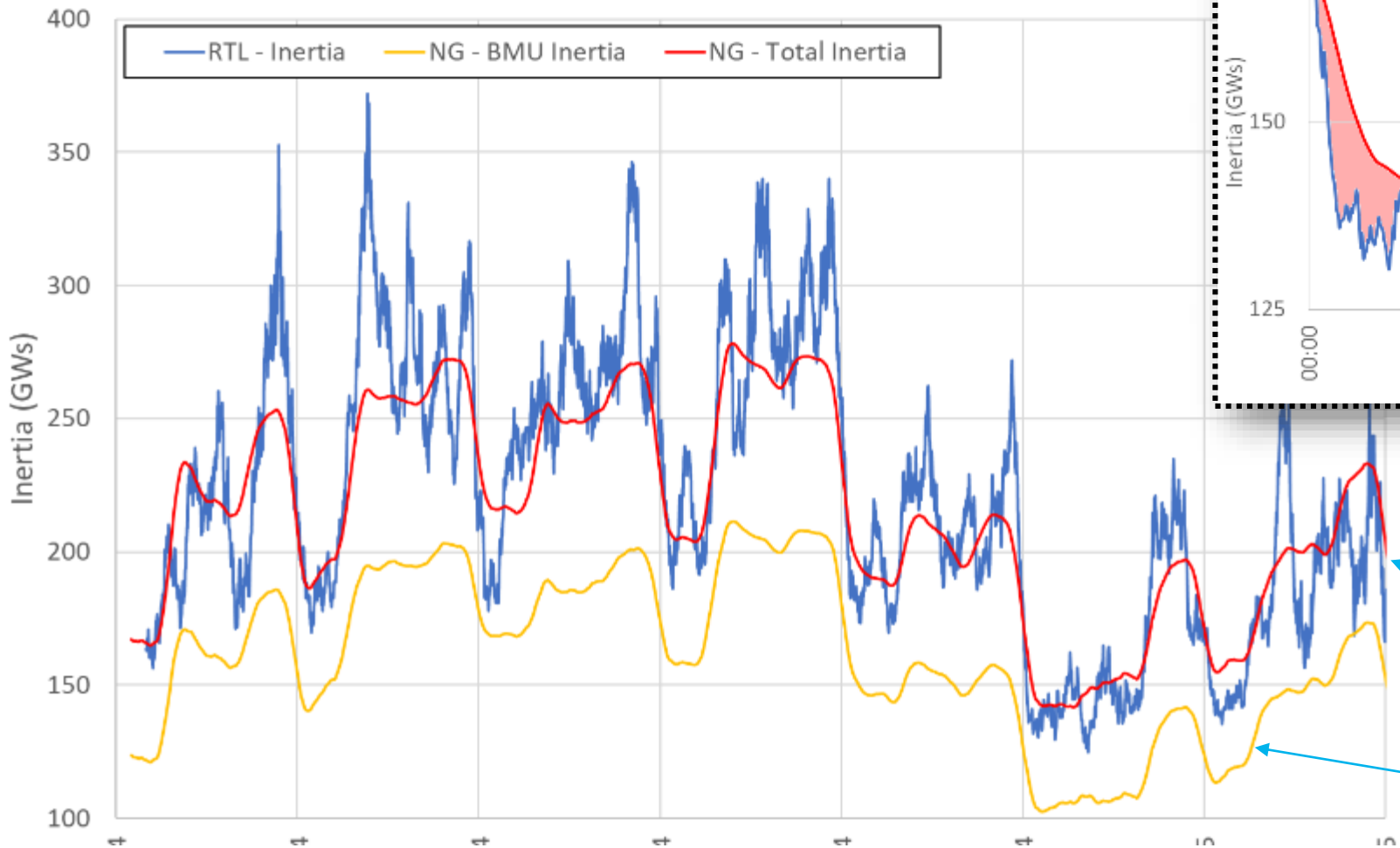
Inertia Estimates vs Measurement: Approach Overview

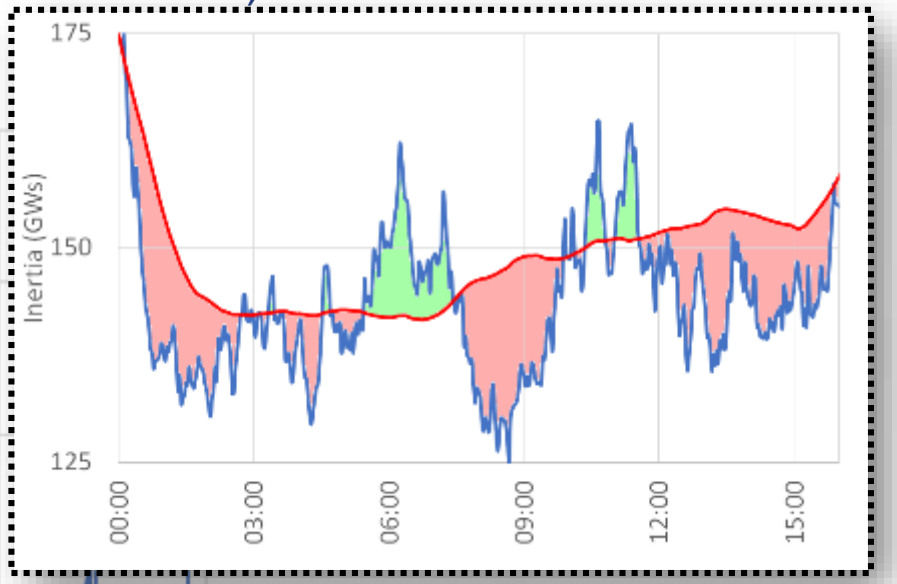
Method	Continuous results	Transmission Inertia	Distribution inertia
Summing inertia across all synchronous generators	✓	✓	✗
Calculating RoCoF during large frequency excursions	✗	✓	✓
Reactive's real-time inertia measurement	✓	✓	✓

Reactive Technologies' patented method

Inertia measurement trial: Project SIM

- Using Reactive Technologies' signalling and measurement technology in a blind test, inertia has been directly measured on the grid





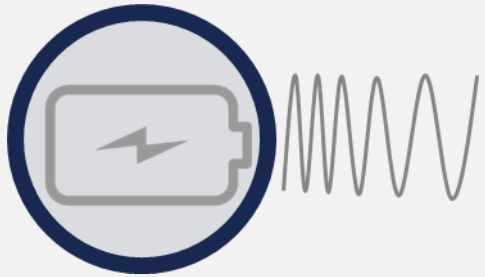
Inertia including distributed generation and 'demand side' inertia (+30%). National Grid estimate in Red, Reactive measurement in blue

Inertia from online synchronous units

National Grid ESO Discusses Working with Reactive

UK Inertia Measurement with National Grid

Reactive have created a breakthrough method to measure whole system inertia signalling and measurement technology

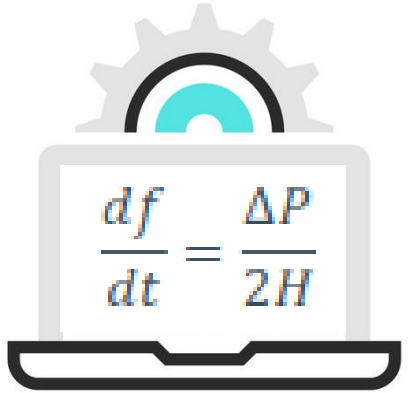


1 Modulator

A small power change in the network creates a frequency signal on mHz scale

2 Measurement

A network of measurement devises detect the signal and record high resolution power data



3 Signal processing

Reactive's patented signal processing algorithms decode the data to measure inertia

Modulator Signal for operations

Confidential

Modulator Amplitude requirement

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UK Modulator Requirement for commissioning

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Supercapacitors vs batteries

	Li-ion Battery	Supercapasitor
		
Charge Time	0.25 – 3 hours	2-10 seconds
Cycle Life	0.5 – 1 k	500 – 20,000 k
Specific Energy (Wh/Kg)	100 -250	4-10
Specific Power (W/Kg)	1,000 - 3000	5,000 – 20,000
Resistance (mΩ)	500	40-300
Cost ($/kWh)	250 – 1,000	~10,000
Cost ($/kW)	33 - 66	2 – 20
Life (years)	5-10	10-15
Self discharge	2%/month	50%/month
Overcharging	Yes	No
Thermal runaway risk	Yes	No
Explosion risk	Yes	No

UK modulator design

Confidential

National Grid ESO Discusses Working with Reactive

Click to watch video

We would love to discuss further with you

- Supercapacitor manufacturers
- System modelling
- Power grid applications for supercapacitors
- Solutions for low inertia power grids

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