Demand response in enhanced frequency control

EFCC March 2018

Demand Response.
Delivered.

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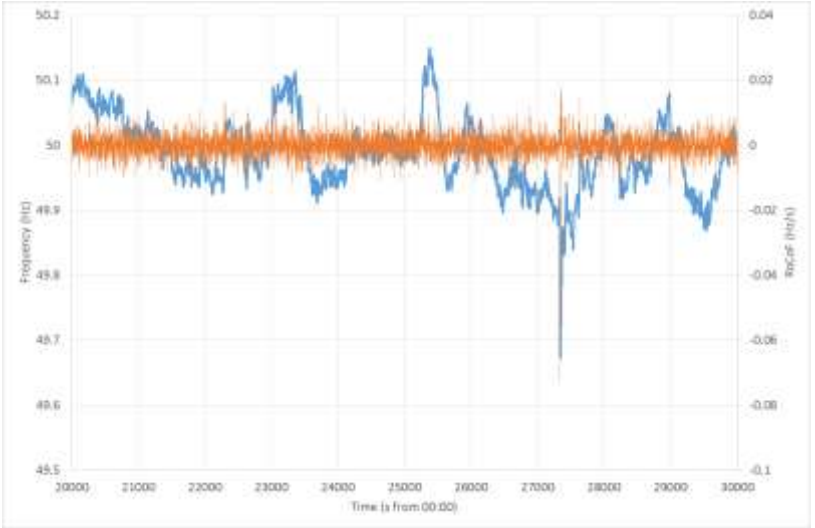
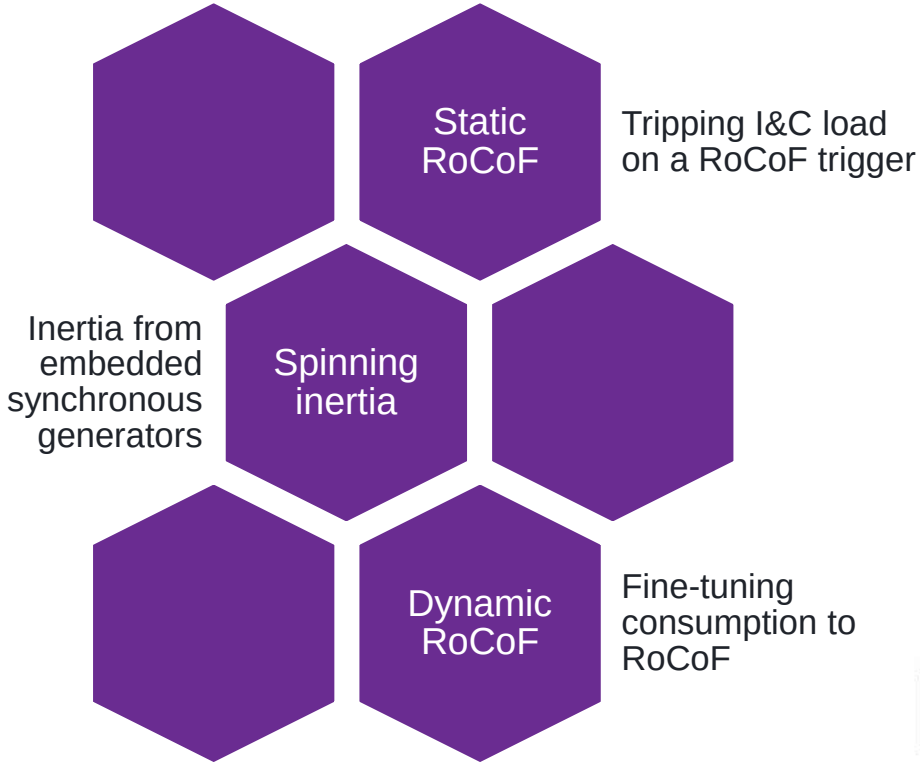
Drama, diversity and demand response

Drama

- Record-breaking year for frequency disturbances?
  - At least 20 major events
  - Normally 8-10 annually
- France
  - Usually 1GW (single bipole)
- Large power stations
  - Marchwood CCGT
  - Staythorpe CCGT
  - Hartlepool AGR
  - Drax Coal/Biomass
  - Torness AGR
  - Heysham AGR



Diversity


Static RoCoF
Tripping I&C load on a RoCoF trigger
Inertia from embedded synchronous generators
Spinning inertia
Dynamic RoCoF
Fine-tuning consumption to RoCoF

Diversity (2)

No active control

- What will it do all by itself?
- Embedded synchronous generators

Setpoint control

- Read a value, send a value
- Low impact
- Easy for site engineers

Direct control

- Get inside the loop
- Requires OEM support

Demand response

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Detection

- Big sites
  - Phasor Measurement Unit
  - Local Controller
  - Expensive!

- Wee sites
  - Can’t afford PMU every time
  - Can’t afford high-grade comms
  - Needs a different approach

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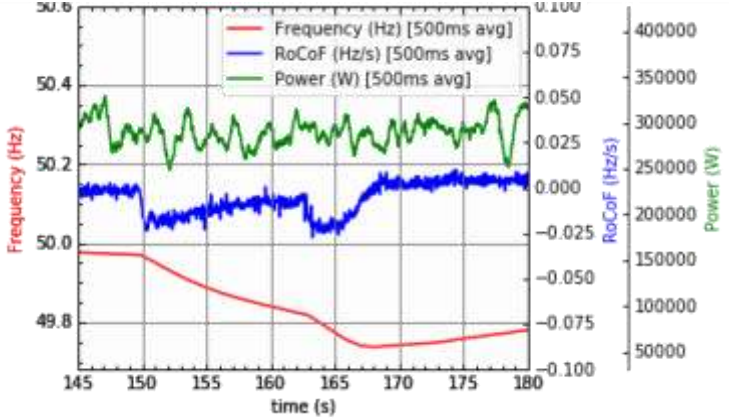
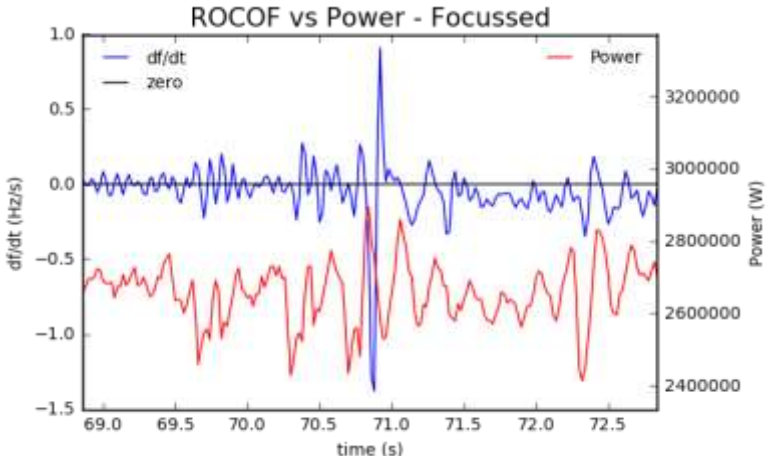
Spinning inertia – site 1

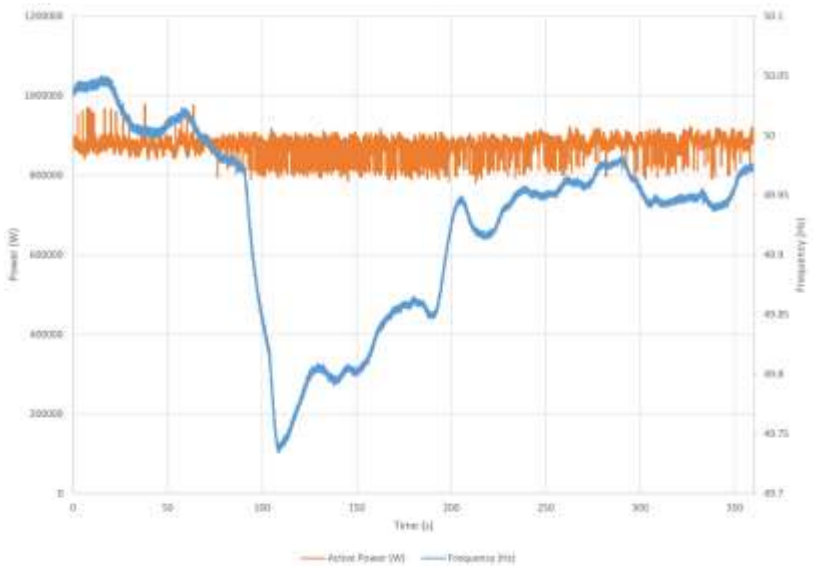




- Combined heat and power (CHP)
  - Greenhouse
- Governor action
  - Too imprecise?
  - Dominated by site mechanicals?
  - Oscillatory behaviour on large events
- Suggests direct control needed

Spinning inertia – site 2

- Combined heat and power (CHP)
- Governor action
  - Quantised?
  - Underdamped?
  - Too fast? (400 sparks/second)
- Suggests direct control needed



Static RoCoF, static frequency

- Industrial load
- PMU + local controller
- Trip tested, functioning
  - 100% record on frequency trips
  - Each site shows consistent trip times
  - Sub-second response on most sites
  - No RoCoF trips yet
- Trial ongoing
  - RoCoF settings reviewed

Dynamic RoCoF

- Three sites, four loads
  - Waste water (pumps, aeration)
  - Refrigeration (compressors)
- Conservative trial design
  - Responds for one minute max
  - 15 minutes between events
  - Deadband
- Off-the-shelf hardware
- Frequency transducer
  - Check calculation method
  - Check slew rate
- PLC for processing
  - Filtering and smoothing
  - Scaling and deadband

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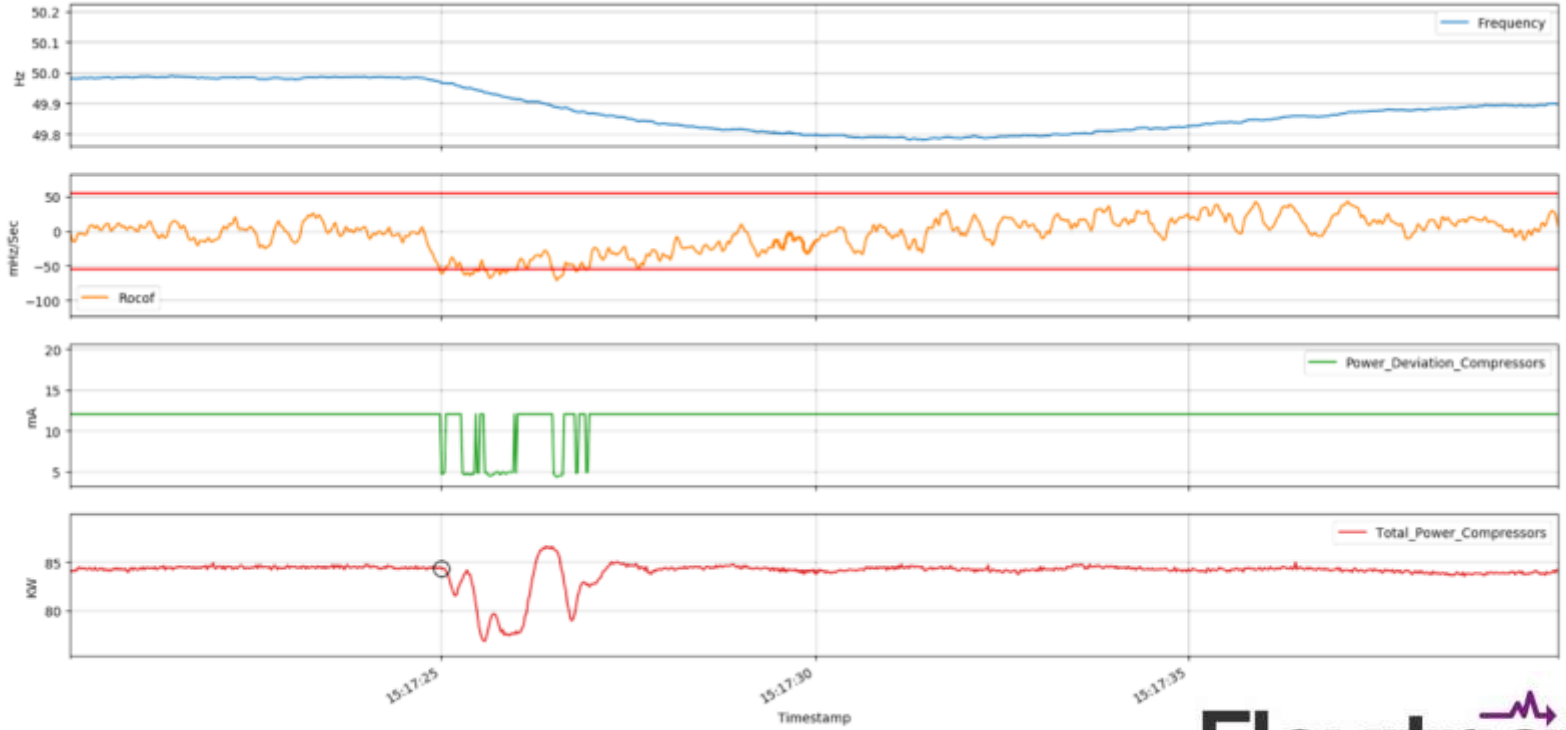
24/2/18, Kent / Hartlepool



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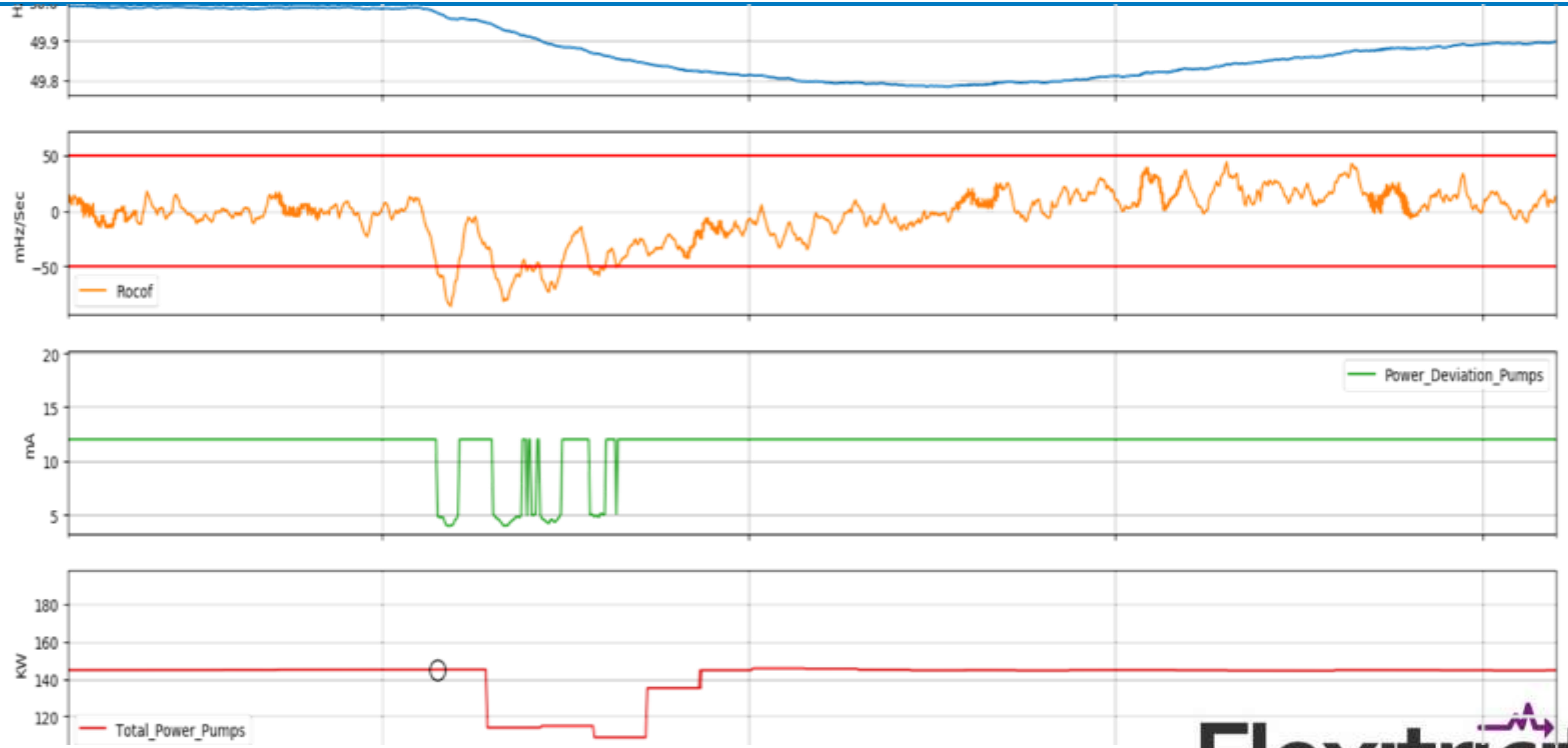
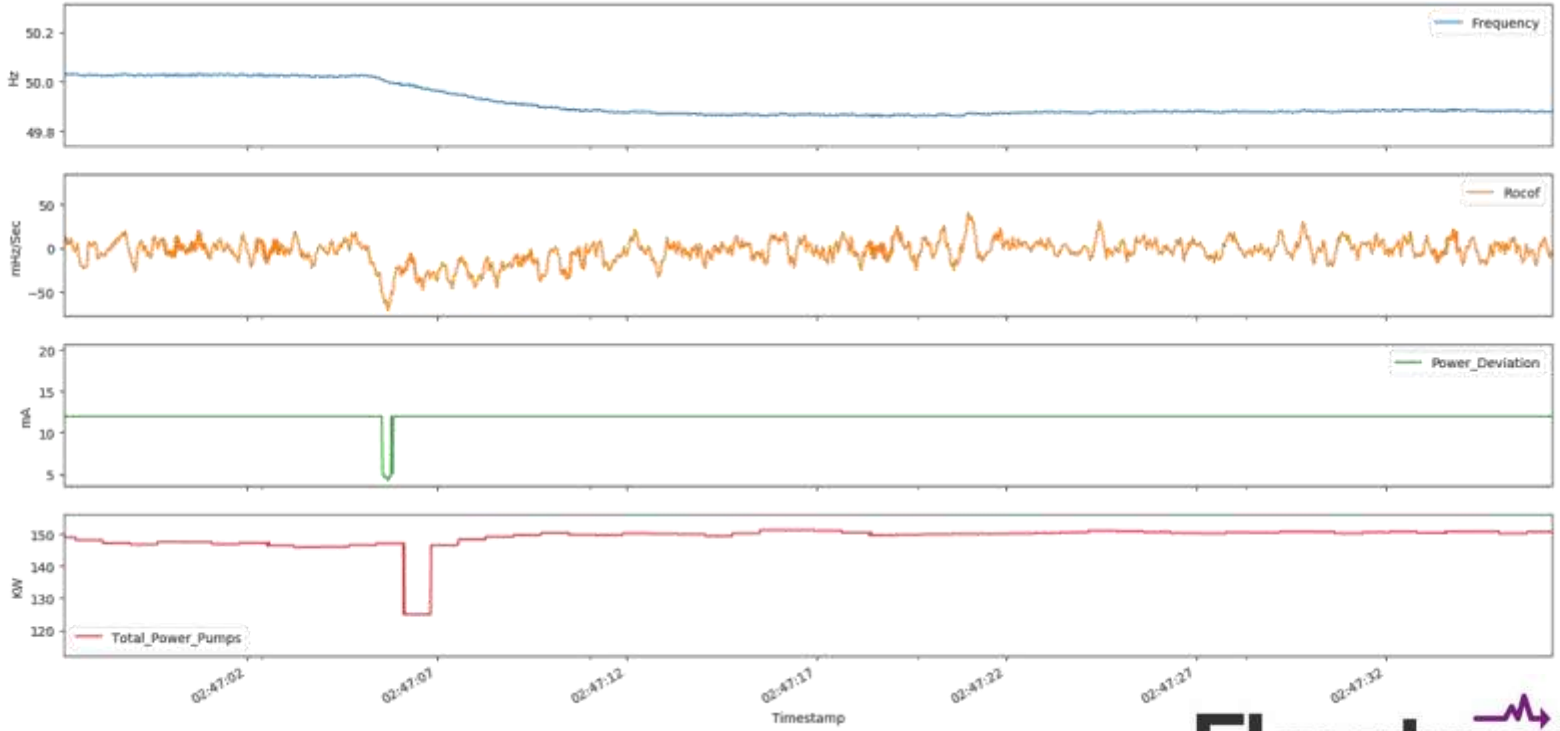
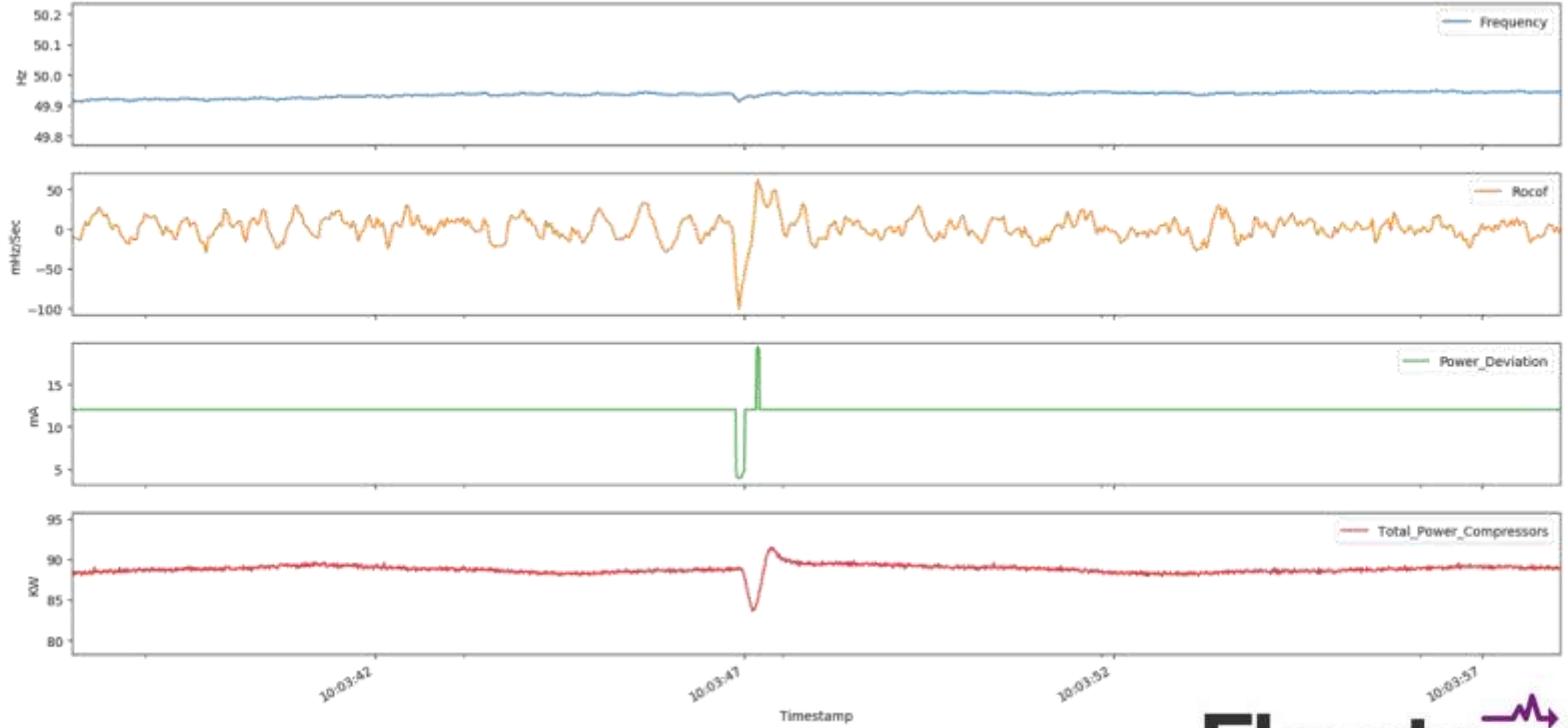
24/2/18, Dundee / Hartlepool



28/2/18, Dundee / EWIC



2/2/18, Kent / switching?



Dynamic RoCoF lessons

- Dynamic RoCoF is feasible and effective
  - Most could do more than we've demonstrated
- Site control philosophy
  - Some control systems are fast enough already
  - Some require alteration
- RoCoF measurement
  - Variable background noise
  - Discrimination
  - Tuning parameters to site
- Alternatives
  - Heavier reliance on WAM
  - Go back to raw frequency

Conclusions

- Dynamic RoCoF
  - Works; needs technical enhancement
- Static RoCoF
  - Will work; need more events
- Spinning inertia
  - Move to dynamic RoCoF control
- Large sites
  - PMU + local controller suitable
  - Refine sensitivity choices
- Small sites: swarm tactics
  - Swarm availability
  - Swarm accuracy
  - Swarm co-ordination
  - Should allow low-cost deployment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