

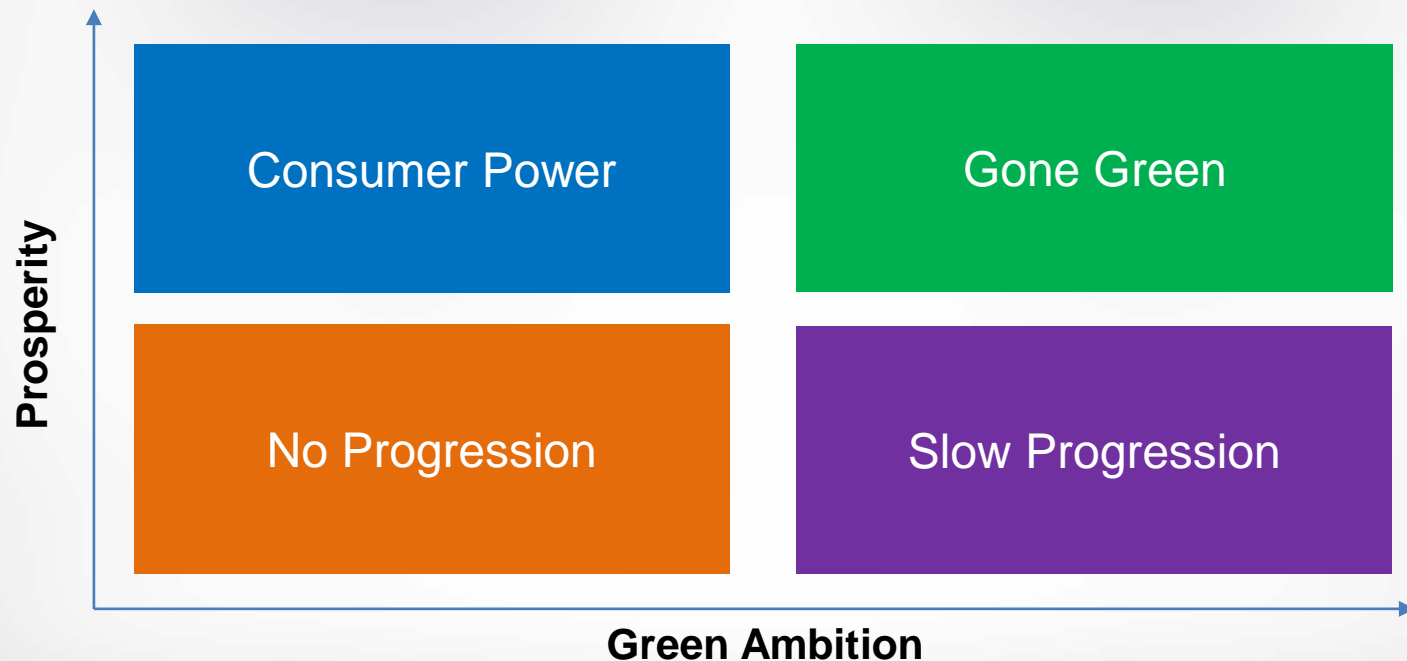
Limejump BIEE Conference



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1. Overview of Current System Changes
2. Grid Challenges and Operability Areas
3. New Strategic Services
4. Business Models
5. Conclusions

NATIONAL GRID FUTURE ENERGY SCENARIOS



Gone Green is the only scenario to achieve all renewable and targets on time

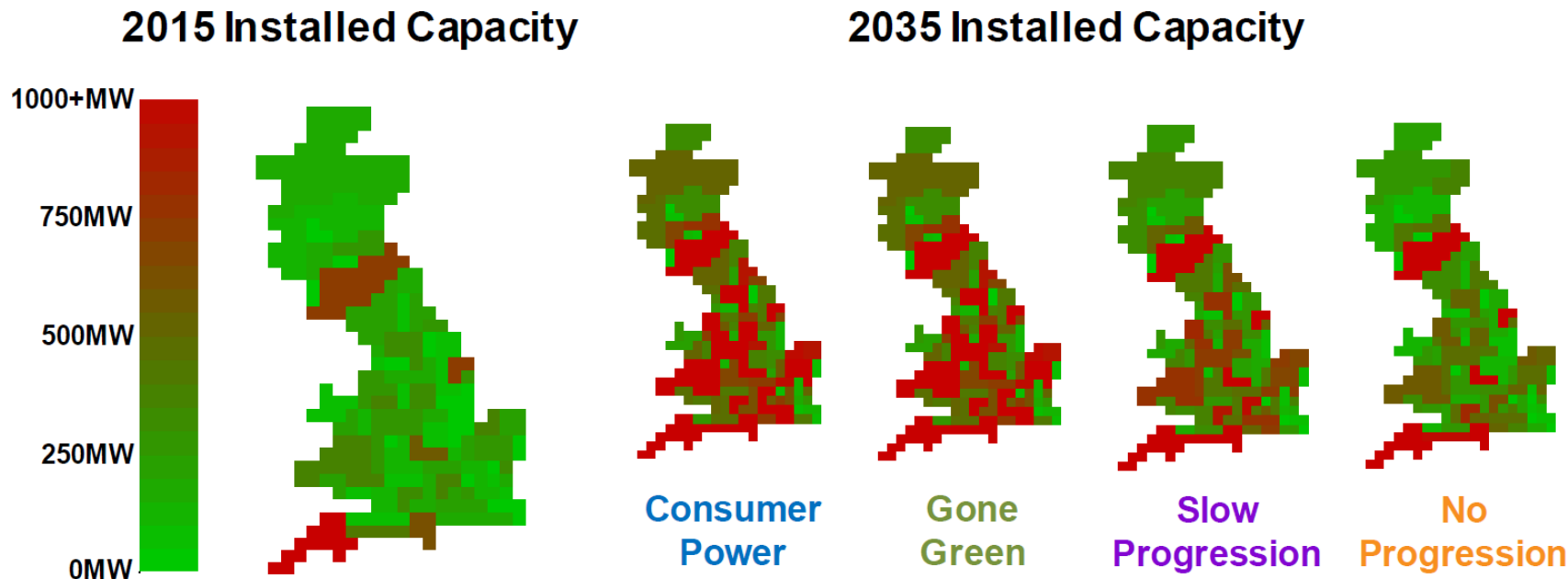


Closure of Coal Power Stations

- The government's energy strategy (Nov-15) stated the closure of all Coal power stations by 2025.
- This will lead to a reactive to active power shift on the grid.
- Coal plants have large rotating shafts, where the closure of these will impact system inertia and therefore frequency.
- Coal plants supply a large fraction of the energy system flexibility for the UK.

Increase in Distributed and Renewable Generation

Solar generation expected to be installed in the South of England is identified to be the biggest challenge to National Grid.



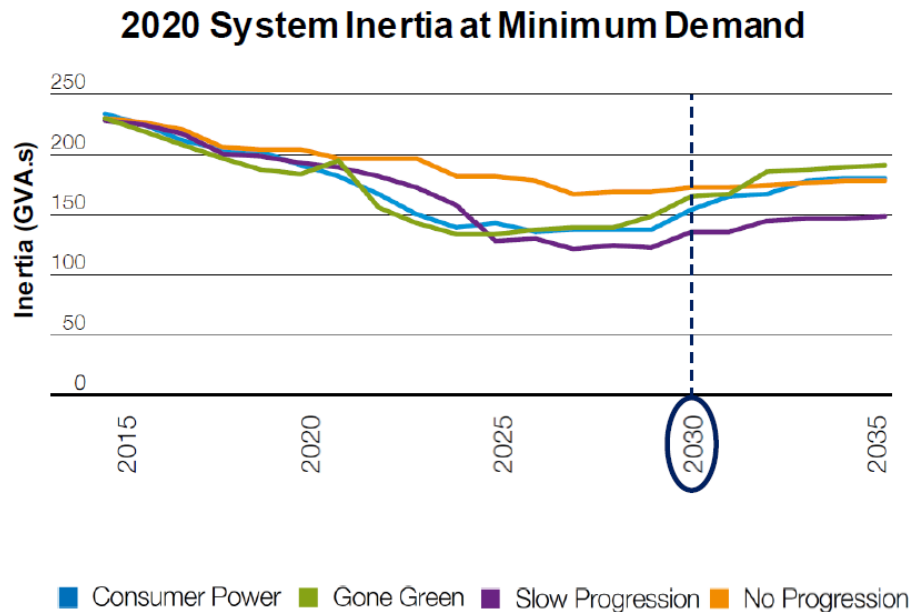
Evolving Roles of Energy Market Players

Transition from Distribution Network Operators to Distribution System Operators will become a necessity with far more

- ✓ DSO will take localised balancing actions
- ✓ DSOs will need to work closely with the National Grid

GRID CHALLENGES AND OPERABILITY AREAS

Frequency Management: Frequency response requirement will increase by 30 - 40% in the next 5 years, and 300 - 400% by 2030.



300% – 400% increase
in frequency response
needed for all scenarios and
new providers required



Service opportunities
for enhanced frequency
response



Plant flexibility
has clear value for
system inertia provision

NEW STRATEGIC SERVICES

Operability Areas	New Operability Services								
	Demand Side Services	Energy Storage	Flexible Synchronous Generation	Flexible Non-Synchronous Generation	Interconnector Services	Synchronous Compensator	Support from Embedded Generation	Distribution System Operator Services	New Services from Non-Synchronous Generation
	RoCoF Management								
	Frequency Management								
	Voltage Management								

NEW BUSINESS MODELS

Operability Areas	Business Models		
	Flexible Renewable Connections	Reactive Power Support	Virtual Power Plant
RoCoF Management			
Frequency Management			
Voltage Management			

Flexible Renewable Connections

- Distribution Network / System Operators is able to curtail renewable generation through local automated control to assist with local constraint issues.
- Core benefit is mainly voltage management
- No centralised dispatch capability
- Not scalable

Reactive Power Support

- This uses the adjustment of distributed generation or even demand side assets to adjust their reactive power output in response to local voltage signals
- No centralised control required
- Solution not scalable
- Requires careful consideration between actions taken by DNO and National Grid

Able to aggregate and connect all forms of flexibility and therefore deliver all range of services at both transmission level and local distribution levels

Requires centralised cloud based control and dispatch capabilities



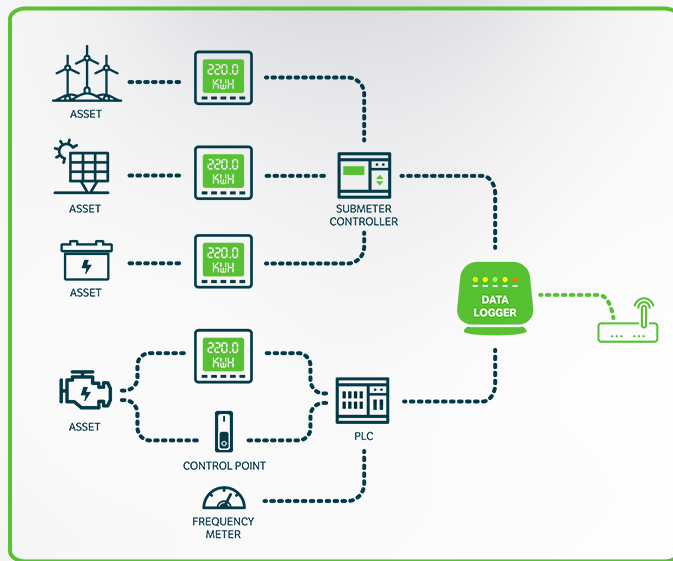
Highly scalable and cost effective

Ensures full value of flexibility can be extracted

NEW BUSINESS MODELS

Accuracy:

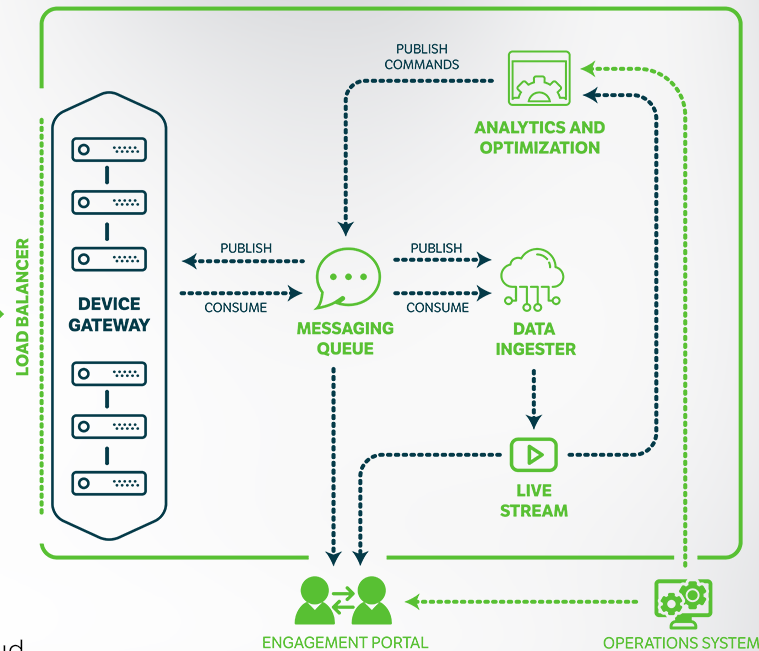
- 0.5%
- 0.001 on frequency



Localised Optimisation:

- Remotely shift dispatch templates for different product
- React 0.001 frequency every 0.1 second

CLOUD INTELLIGENCE



Data Latencies:

- 250ms within cloud computation
- Average 500ms between the device and cloud

VPP Optimization:

- Single asset behavior
- Low Latency - close loop less than 2 seconds

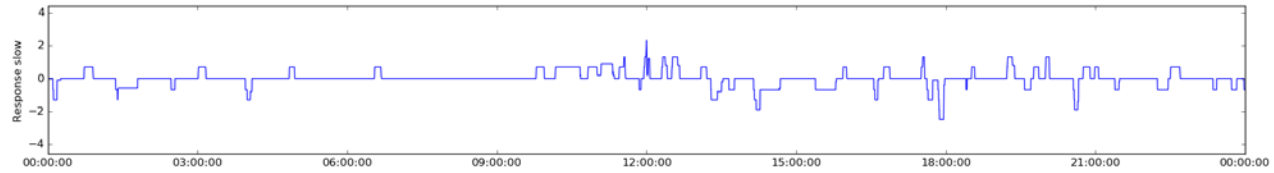
Customer Engagement:

- Automated billings
- Outage management

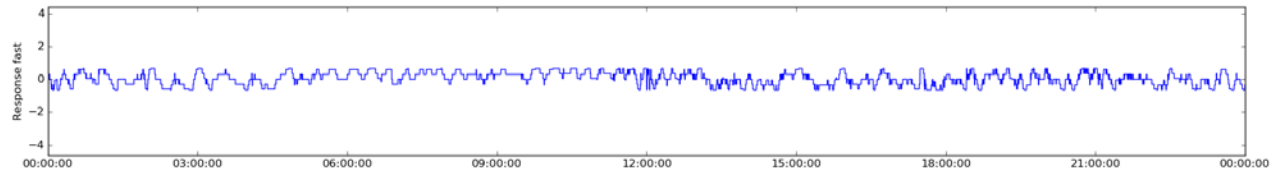
VIRTUAL POWER DISPATCH ALGORITHMS

Example of aggregated dynamic frequency response in a Virtual Power Plant

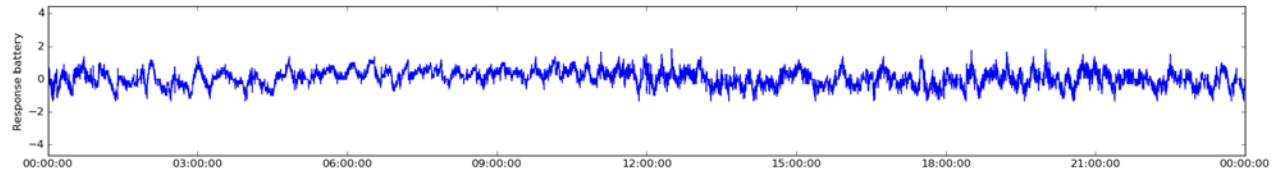
Slow Assets



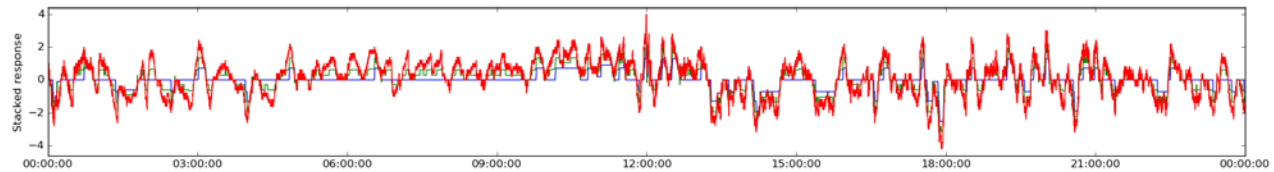
Fast Assets



Batteries

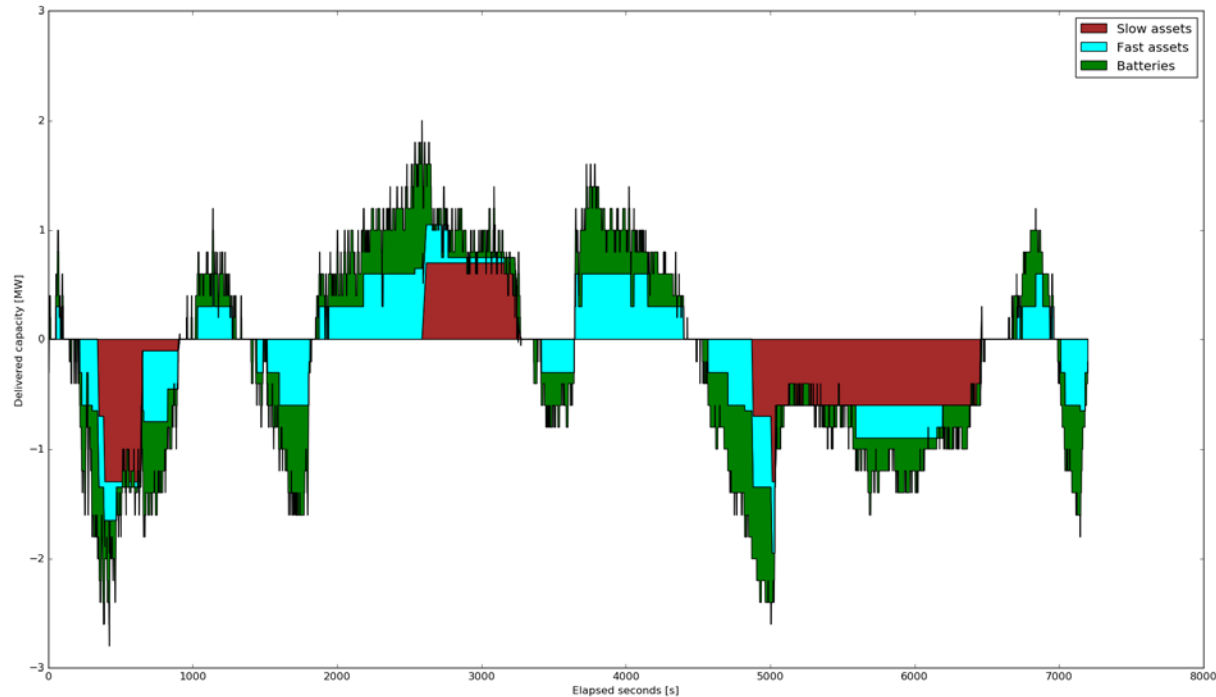


Aggregated Portfolio



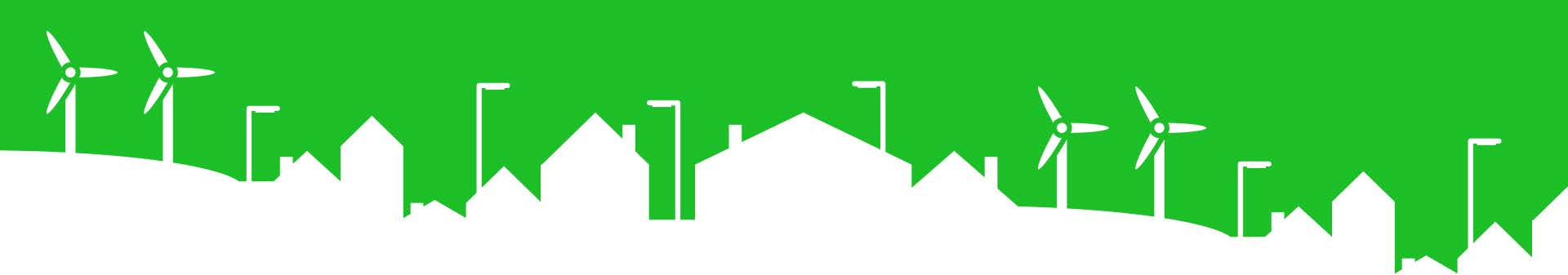
VIRTUAL POWER DISPATCH ALGORITHMS

Detailed view of dynamic response using Slow, Fast and Tracking Assets in a VPP.



CONCLUSIONS

- System losing inertia as large power plants close and voltage management is becoming more challenging due to more solar and other renewable penetration
- Greater saturation of renewable and highly intermittent generation sources
- Far greater need for flexibility and synthetic inertia
- Virtual Power Plants are a scalable solution to help mitigate short term imbalances
- Seasonal demand variations require a carefully planned mix of flexible generation types, renewables and Virtual Power Plants



Limejump
Thank you



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