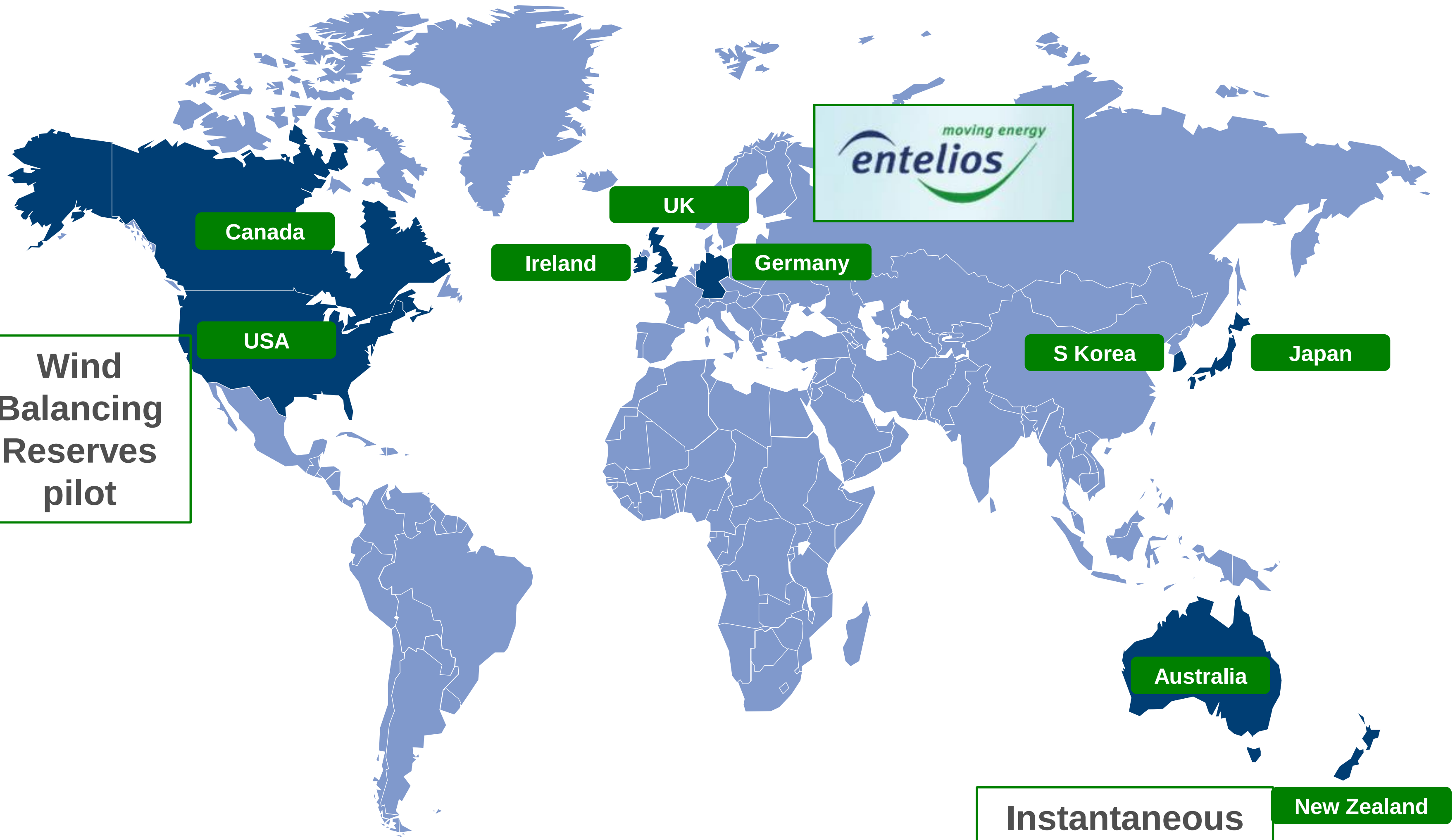
Adding Value to Wind

14 April 2014

What we will cover

- Our international world at EnerNOC
- A Systems Engineering approach is seen at last
- Energy Storage is clearly the way ahead – but who is going to take up this challenge

EnerNOC – our international footprint is growing



Wind Balancing Reserves pilot

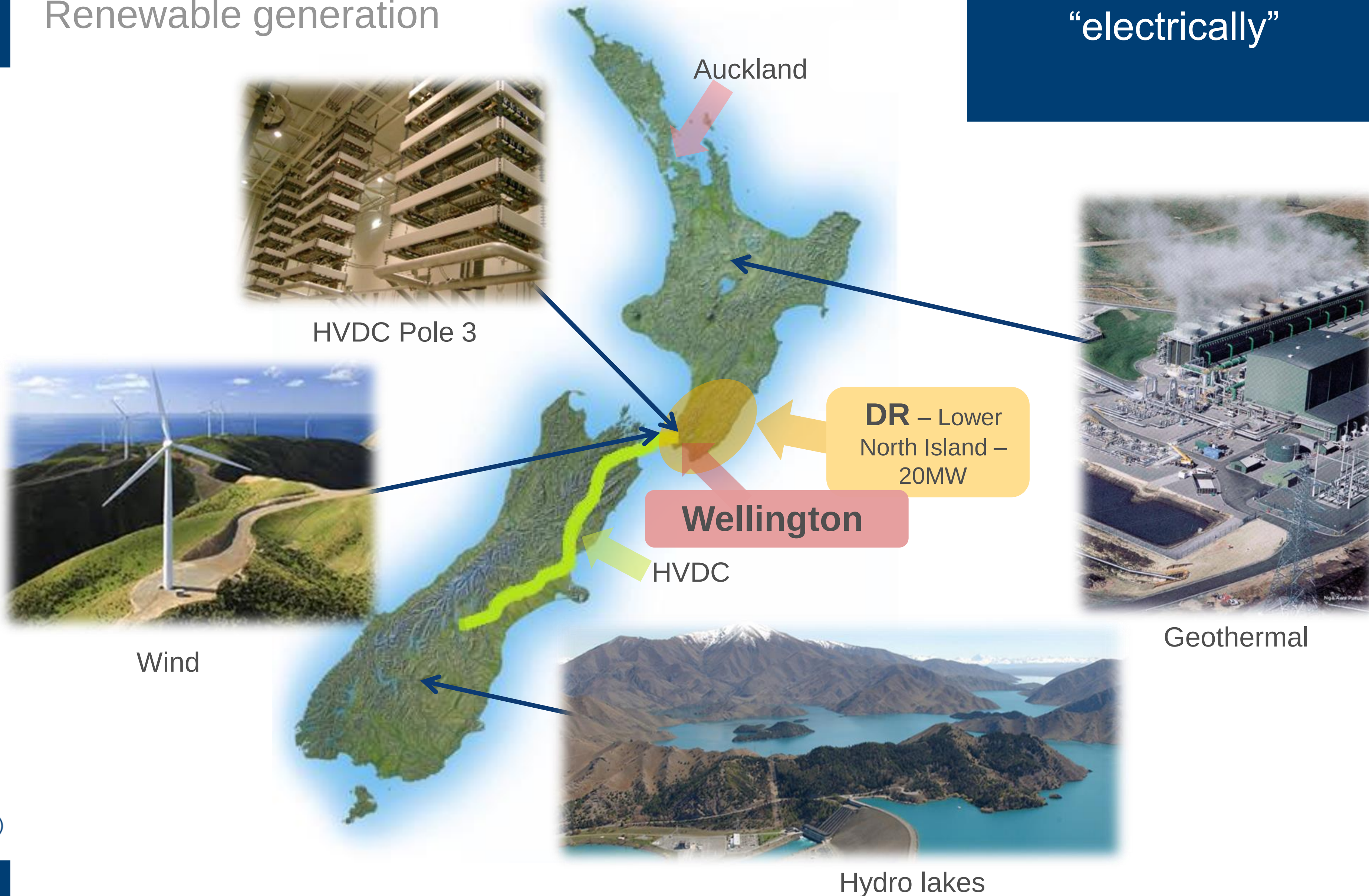
Instantaneous Reserves

■ EnerNOC Presence

Middle of Middle Earth

Renewable generation

We are top of the South Island "electrically"



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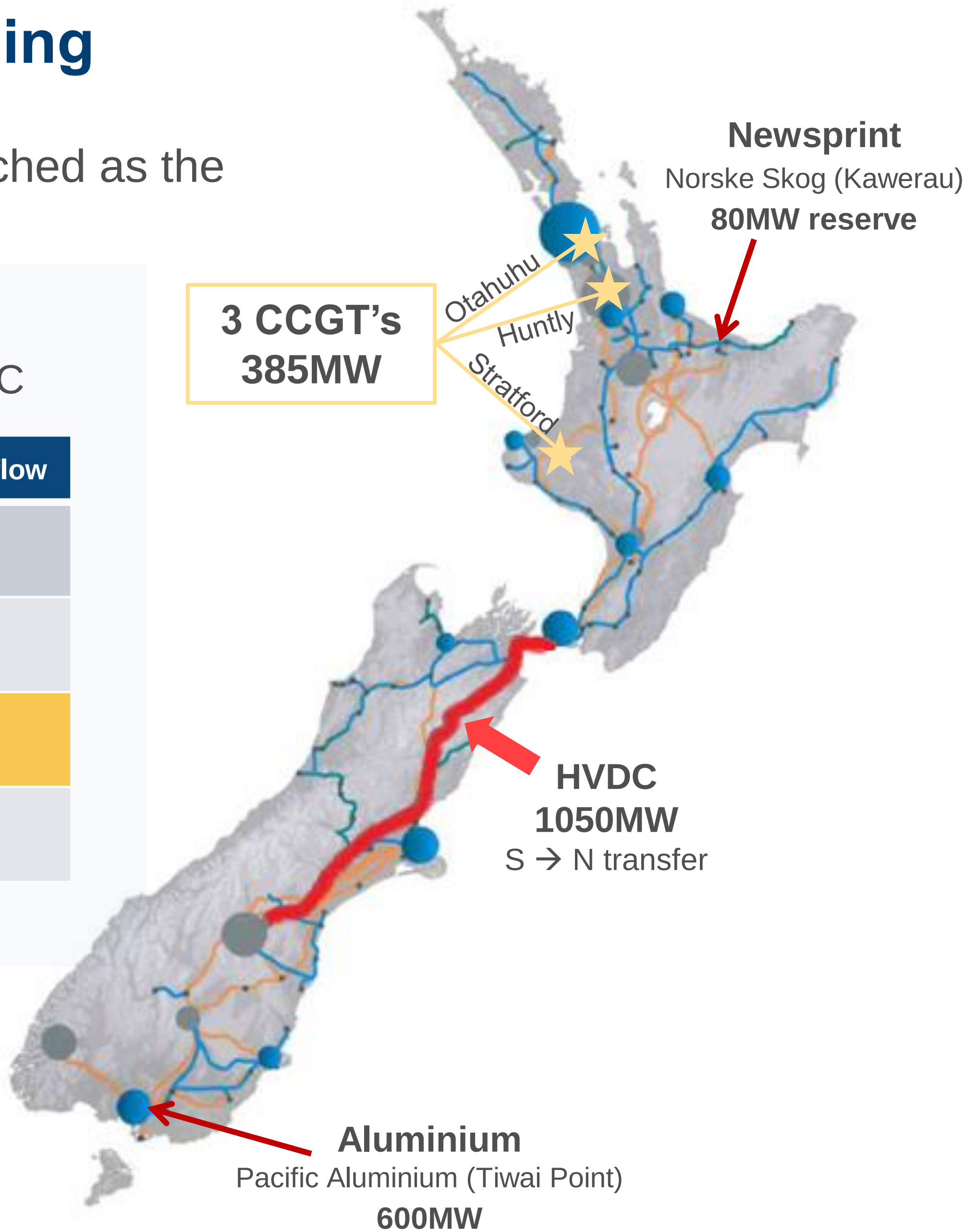
Our grid's inertia is changing

More reserves will need to be dispatched as the power flows increase on the HVDC

Poles #2 and #3 operating on the HVDC

	Normal flow	Maximum flow
Power flow (MW)	850	1050
Bi-pole cover (MW)	500	500
HVDC Reserve risk	350	**550**
CCGT Reserve risk	**385**	385

= Contingent Event which sets the reserve risk



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Our reserves story started in 2007

Pilot at Wellington Port Coldstore (300kW in SIR)

Wellington Port Coldstore

Then in 2009

Technology commercialised as our Smart Grid Terminals

100MW target set to break even

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Where we are in 2014

We have a diversified portfolio (large industry, commercial and residential hot water)

We can now offer more than **200MW** to the reserves market

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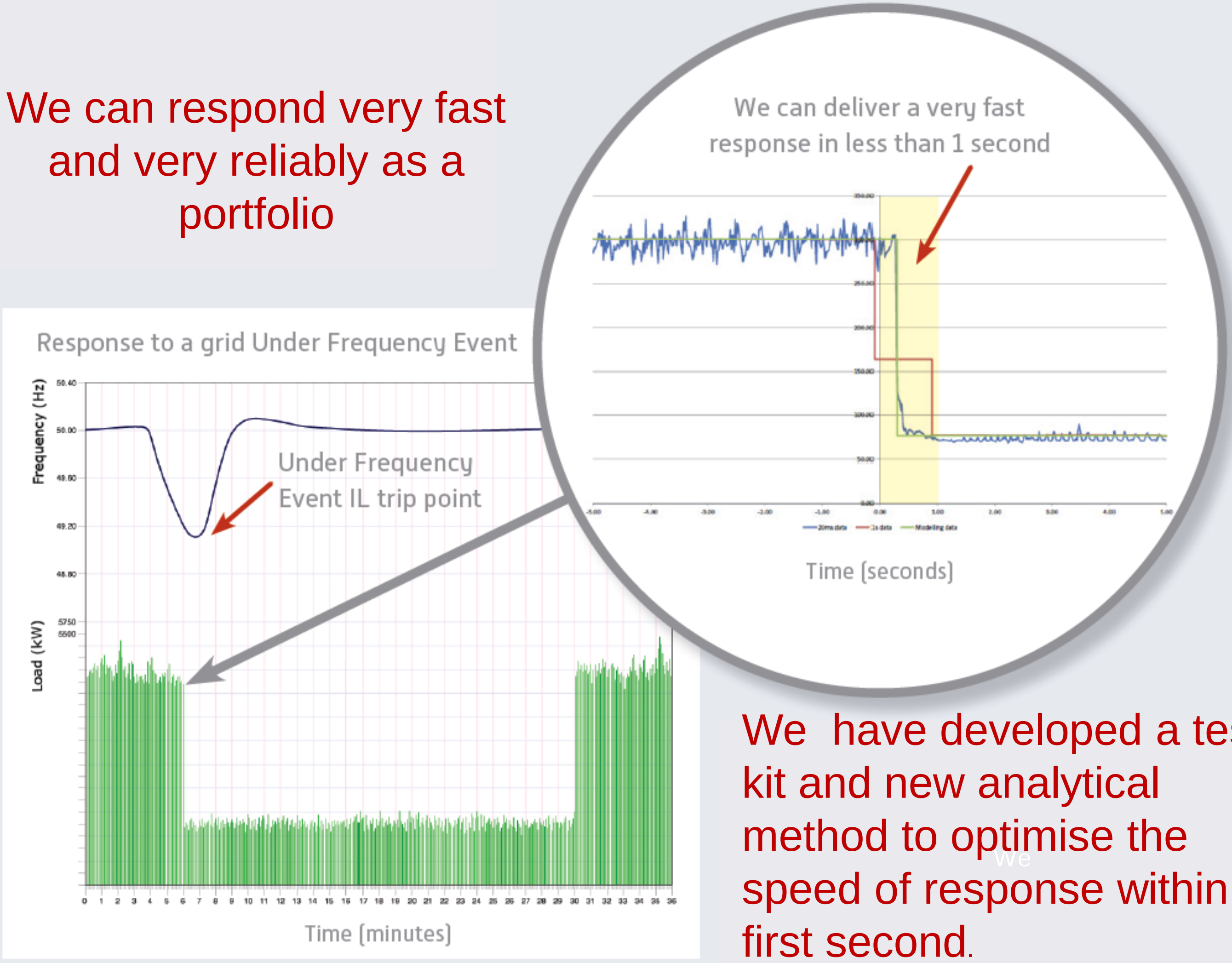
Our Interruptible Load is fast, in fact very fast

We can respond very fast and very reliably as a portfolio



We have developed a test kit and new analytical method to optimise the speed of response within the first second.

x 12.35 in

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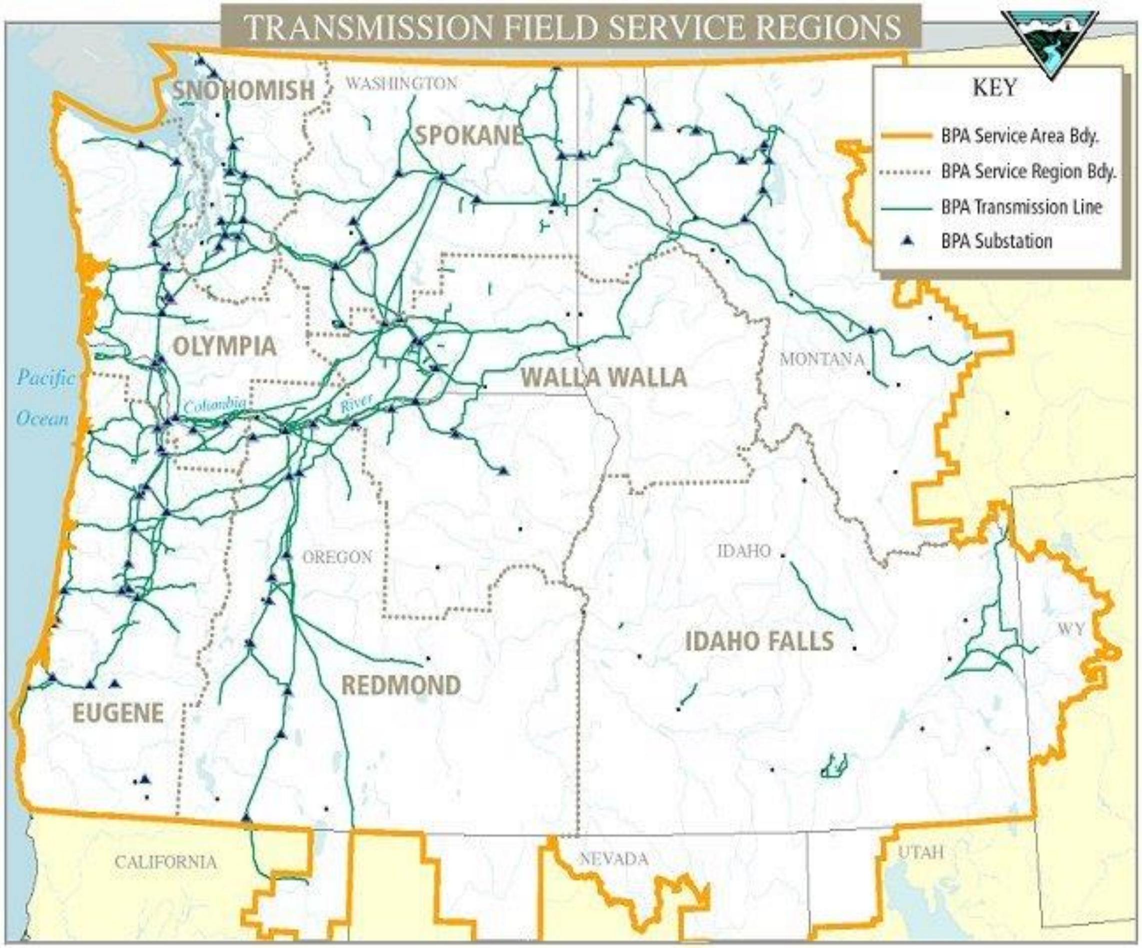
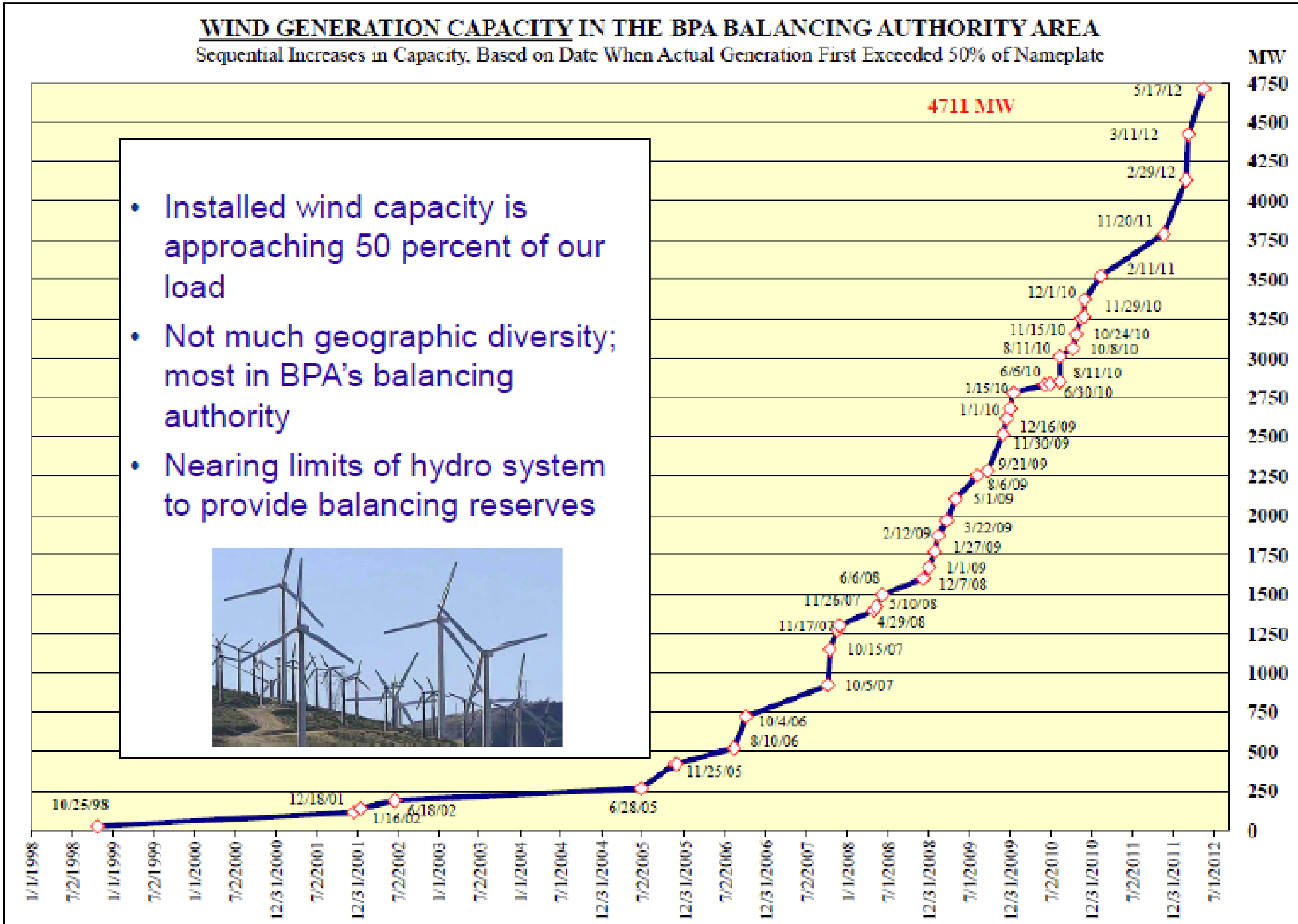
Bonneville Power Administration



- 13,500 MW of capacity, principally 12,000 MW of federal hydro projects
- 147 utilities, most of which are munis, coops, and public power
- Pace of wind power development in the Pacific Northwest is dramatically exceeding BPA's expectations

BPA's Challenge: Significant Growth in Wind Capacity



Source: BPA presentation to Pacific Northwest Demand Response Project meeting February 14, 2013 by Lee Hall, BPA Smart Grid Program Manager

BPA Pilots: Exploring the Use of DR to Balance Wind

1. Smart End-Use Energy Storage and Integration of Renewable Energy Pilot (Ecofys and EnerNOC)

Evaluate the load-following characteristics of five cold storage warehouses across four utility territories by controlling compressor and evaporator loads up and down

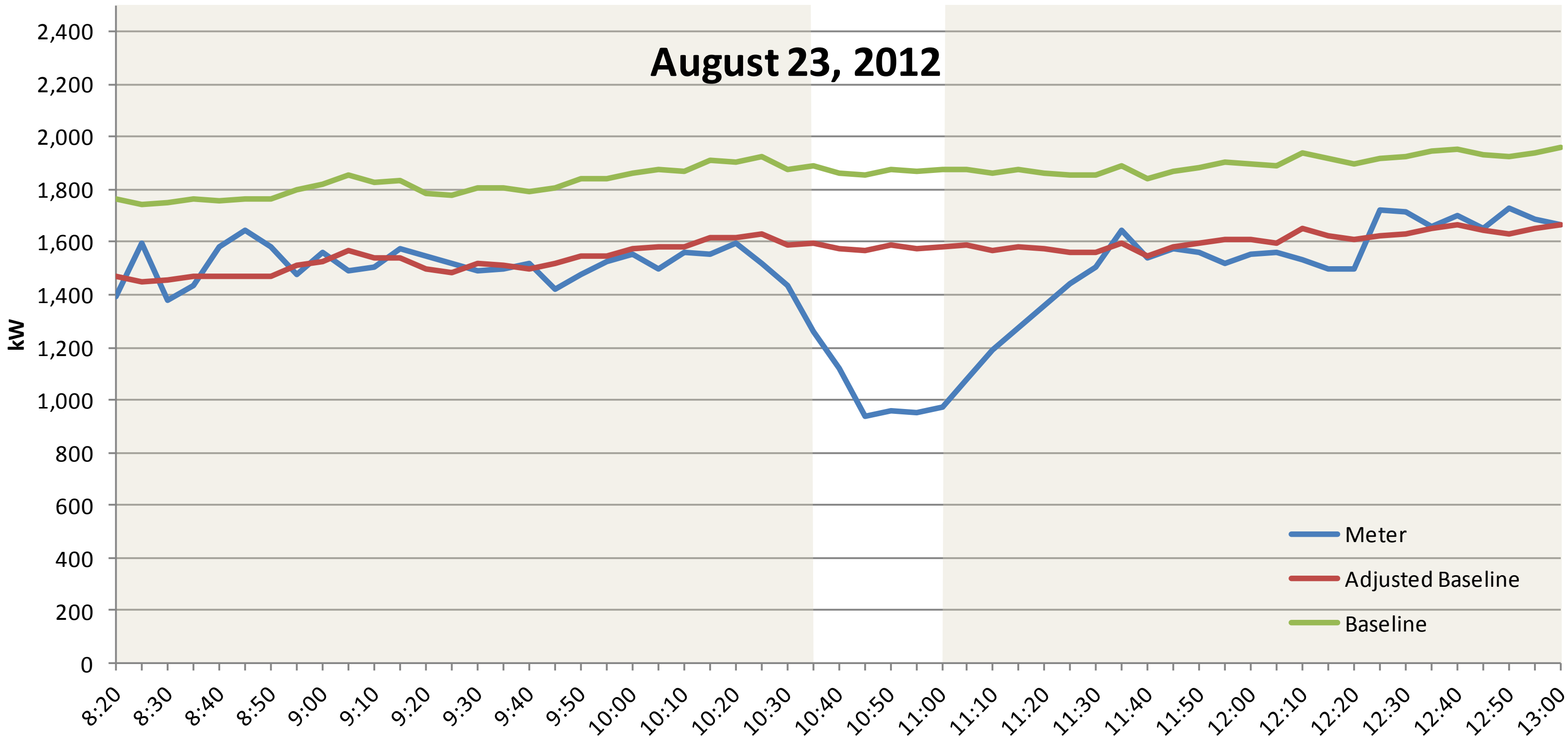
Facility Type	Equipment Enabled	Load Control Measures	DR Capability
Refrigerated warehouses	Ammonia compressors, evaporators	Raise or lower set point temperatures	10-minute, bi-directional response via remote direct load control

2. Commercial and Industrial Demand Response Pilot (City of Port Angeles)

Enable a paper mill to provide 40 MW of load following

Facility Type	Equipment Enabled	Load Control Measures	DR Capability
Paper plant	Motors	Turn on or off mechanical pulping motors	10-minute, bi-directional response via automated controls programming triggered on site

Load Decrease Dispatch (INC)



Event Details:

- Dispatch time period: 10:30 am – 11:00 am
- Portfolio information: 3 cold storage facilities, representing nominated INC capacity of 450 kW
- Event performance: 547 kW load curtailment (122% of nomination)

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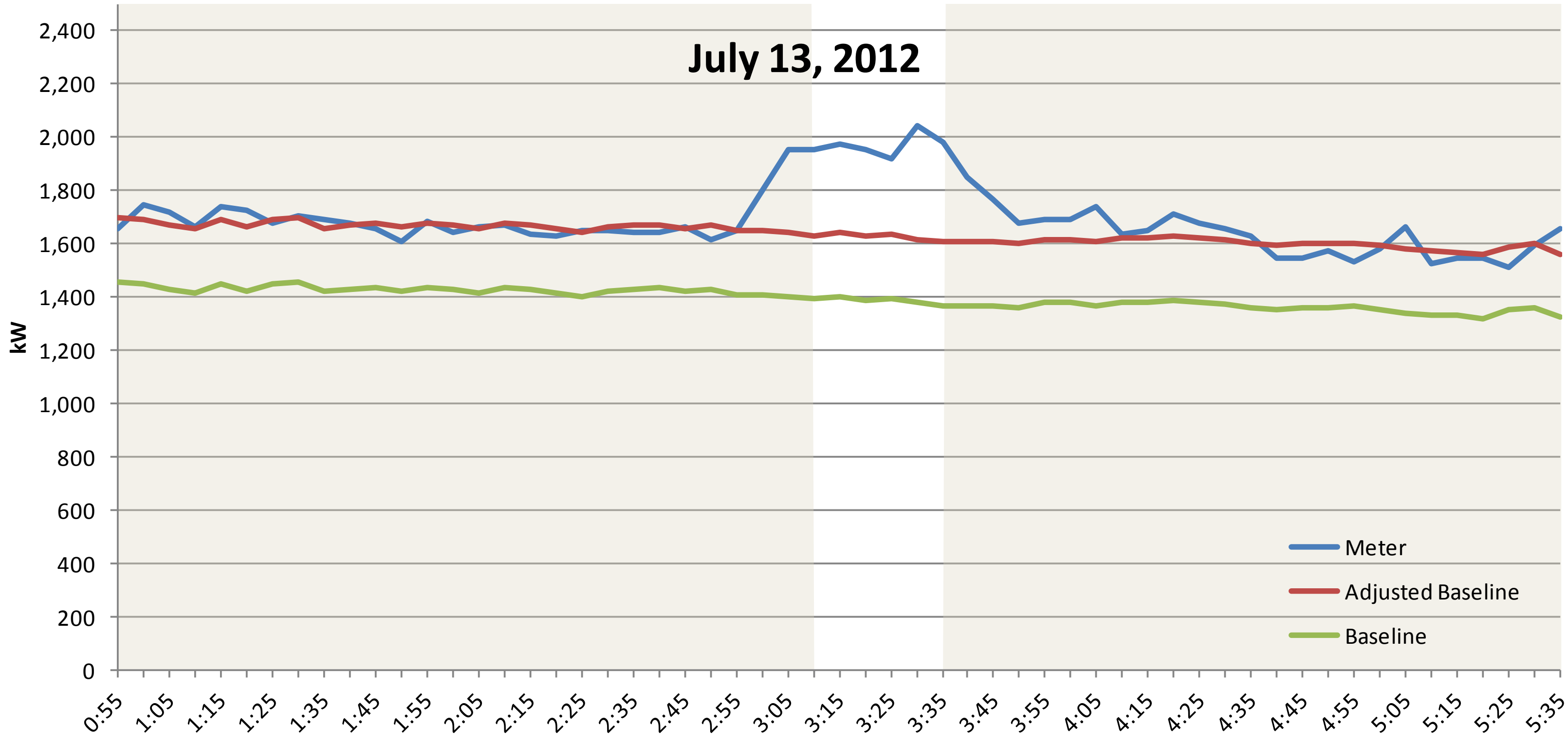
Source: EnerNOC data for August 23, 2012 DR test load following dispatch as part of Smart End-Use Energy Storage and Integration of Renewable Energy pilot project, funded by BPA and administered by Ecofys US.

Load Increase Dispatch (DEC)



Event Details:

- Dispatch time period: 3:05 am – 3:35 am
- Portfolio information: 3 cold storage facilities, representing nominated DEC capacity of 330 kW
- Event performance: 343 kW load increase (104% of nomination)

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Source: EnerNOC data for July 13, 2012 DR test load following dispatch as part of Smart End-Use Energy Storage and Integration of Renewable Energy pilot project, funded by BPA and administered by Ecofys US.

BPA Pilot Projects: Results

51 load control events across five refrigerated warehouse sites

- 23 dispatches for load decreases (INCs); 28 for load increases (DECs)
- Average 269 kW of INC capability; 165 kW of DEC capability per site (Aug 2011 – May 2012, 4 sites)
- Average 144 kW of INC capability; 59 kW of DEC capability (Jun 2012 – Aug 2012, 3 sites)

11 load control events for large paper mill

- 4 dispatches for INCs, 7 for DECs
- Average 21.5 MW of INC capability; 17.6 MW of DEC capability
- In several cases, mill was unable to respond to requests for load control due to operational conflicts

BPA Load Following Pilot: Lessons Learned

DR can effectively act as a load following resource

Portfolio management is key

Customer incentives must align with resource objectives

More customer engagement is required than you think

New thinking and technology in Europe

entelios moving energy

For Business
For Energy Retailers
For Grid Operators

Demand Response Principle
Our Solutions
About Entelios

ENTELIOS NEWS

2014/02/13
EnerNOC Acquires Leading European Demand Response Company Entelios AG

For Energy Retailers

- Benefits
- Services
- Implementation
- Contact

The increase volumes of renewable energy sources and an increasingly decentralized energy supply have created a variety of opportunities and challenges. Integration of the demand side ("Prosumer") will become increasingly important for the energy companies of the future. A reliable and economic power supply that maximizes the use of renewables and supports CO2-reduction targets can only be achieved with Demand Response.

Demand Response is a process to manage customer consumption (demand) or generation of electricity in real-time in response to dynamic signals from the situation in the grid or from market prices. Demand Response combines decentralized energy resources (electrical loads, storage and generation units) intelligently in a Virtual Power System. By integrating their individual consumption and generation flexibility in a Demand Response program, energy customers can receive attractive financial benefits while enhancing the stability of the energy system.

Utilities benefit in multiple ways from Demand Response

See also:

The Demand Response Snapshot, SEDC 12/2012 (The Smart Energy Demand Coalition is a representative industry group dedicated to promoting the requirements of demand side programs in the European electricity markets.)

Downloads:

Demand Response Management Solutions for Utilities, Grid Operators, and Industry. Munich: Entelios AG, 7/2013 (Flyer, PDF)

Systems Engineering

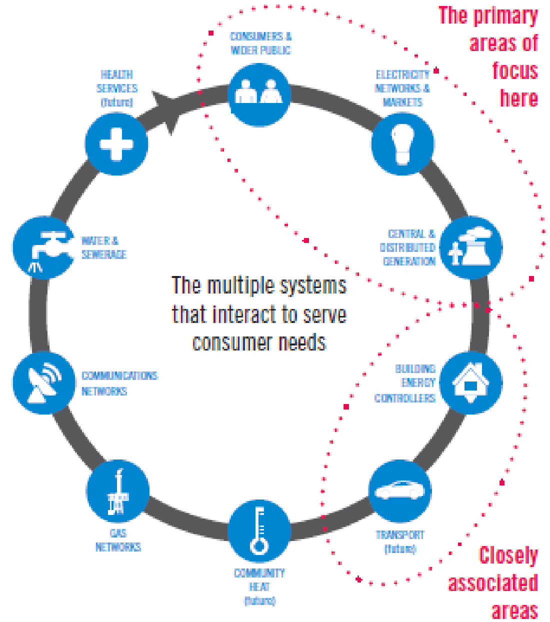
The Institution of Engineering and Technology

Electricity **Networks**

Handling a Shock to the System

IET position statement on the **whole system challenges** facing Britain's electricity network

www.theiet.org/pnjv

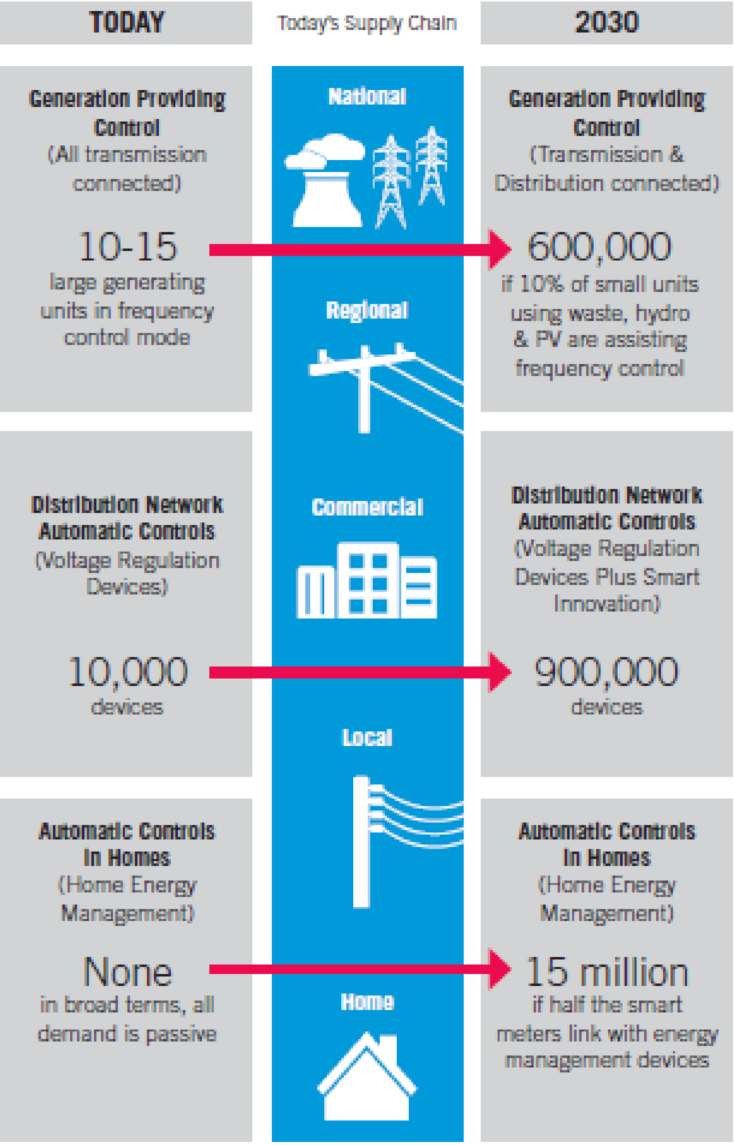


Systems Engineering is an interdisciplinary field of engineering that focuses on how to design and operate complex engineering systems.

Systems Engineering deals with processes, automation, controls, optimisation methods, and risk management. It overlaps technical and human-centered disciplines such as control engineering, industrial engineering, organisational studies, and project management.

Systems Engineering ensures that all likely aspects of a project or system are considered, and integrated into a fully functional whole. This is regardless of boundaries of geography or commercial ownership within the system.

The scale of the changes ahead of us



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Taking a Systems approach to add value to Wind

So, where should we start?

Thermal Storage Systems have been used for decades

Night Store Heater

Thermal mass heat storage

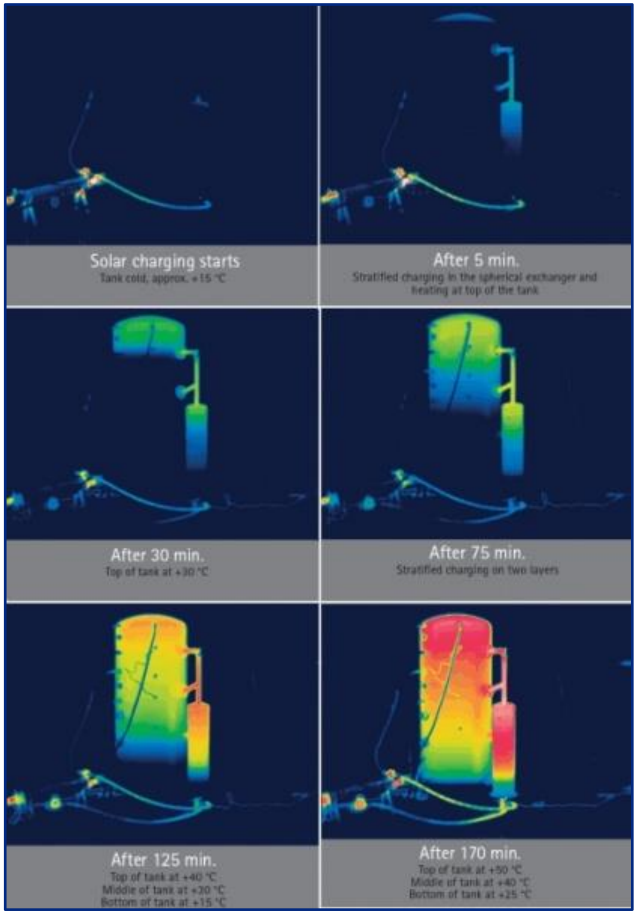
Hot Water Cylinder

Small scale stratified tank

Yet, technical support from our industry stopped in 1996, almost 20 years ago, along with the retail price signals

Understanding Stratified Tanks

Charging a water cylinder



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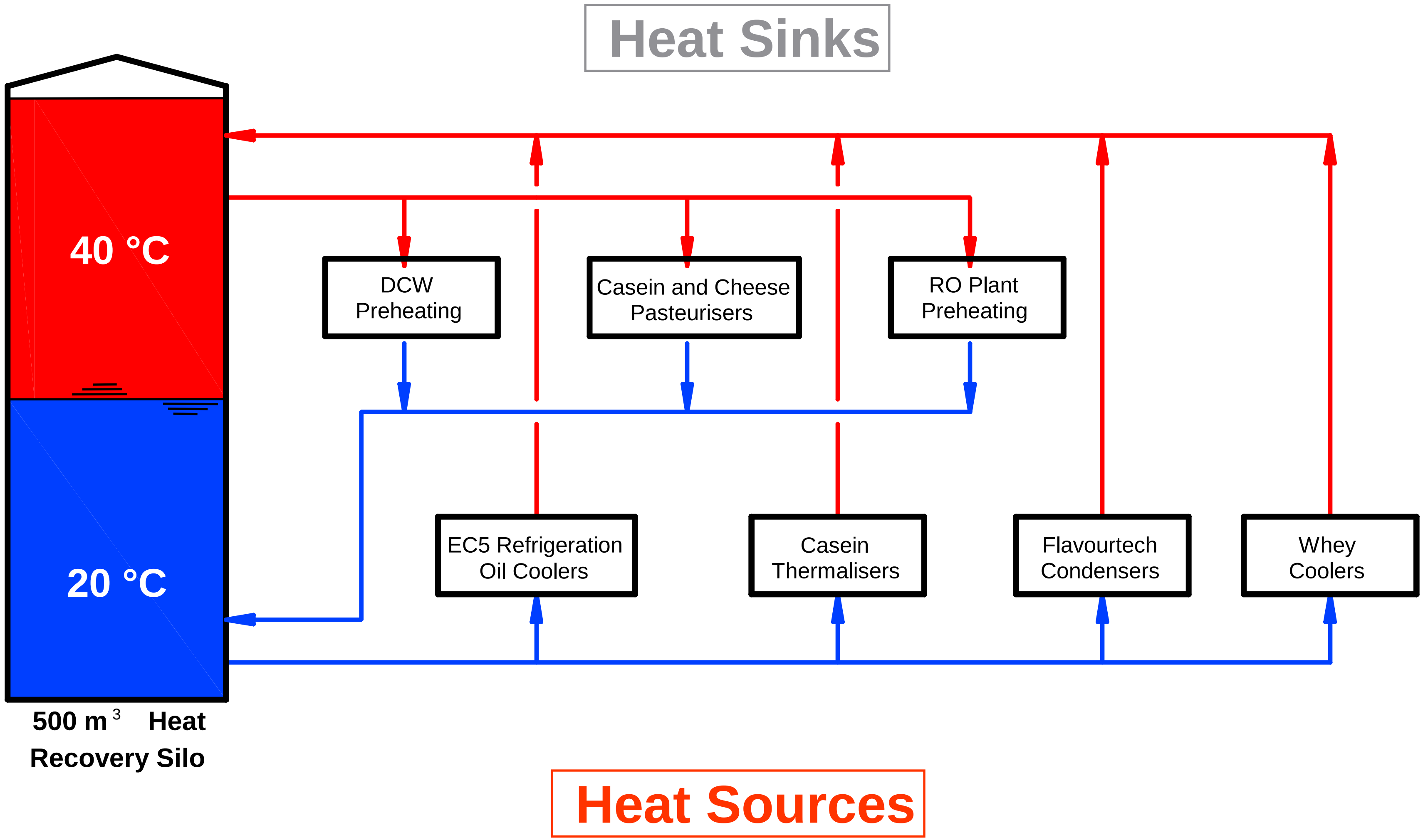
Understanding Stratified Tanks



Fonterra - Whareroa Heat Recovery Loop - 2006
Energy Innovation Award

Scaling up our creative solution

Domestic

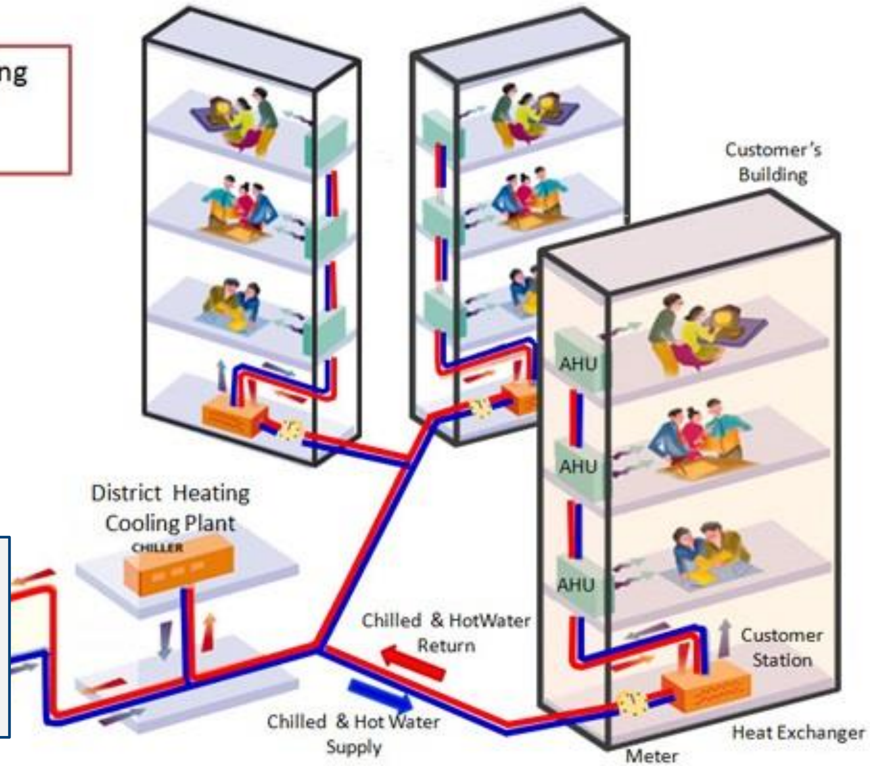
Industrial

Community / District

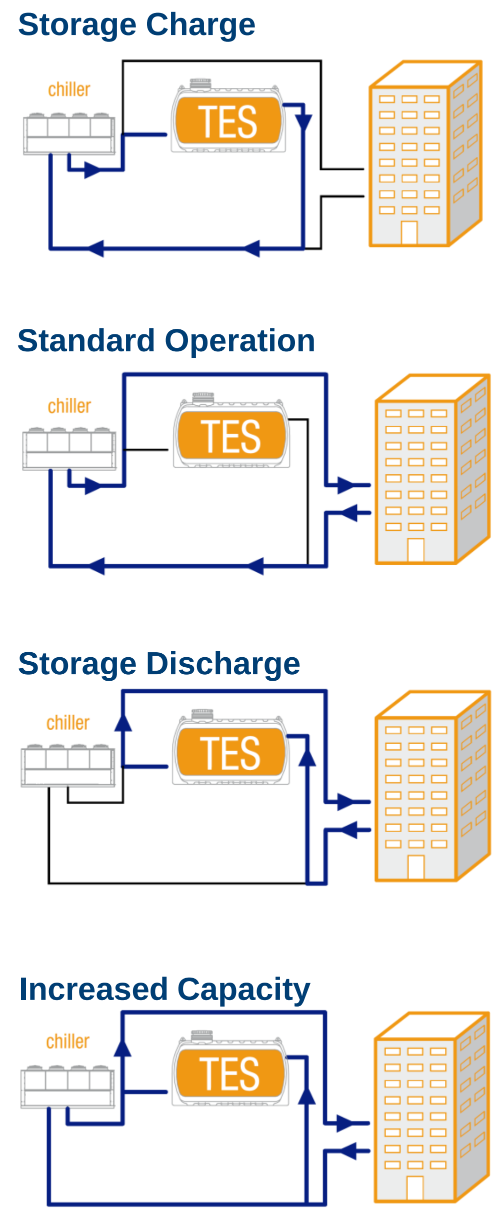
Larger scale provides greater benefits: economics, resilience and efficiency

Integrating thermal storage into a community project

District Heating Cooling System Schematic Diagram



Stratified hot and cold thermal energy storage



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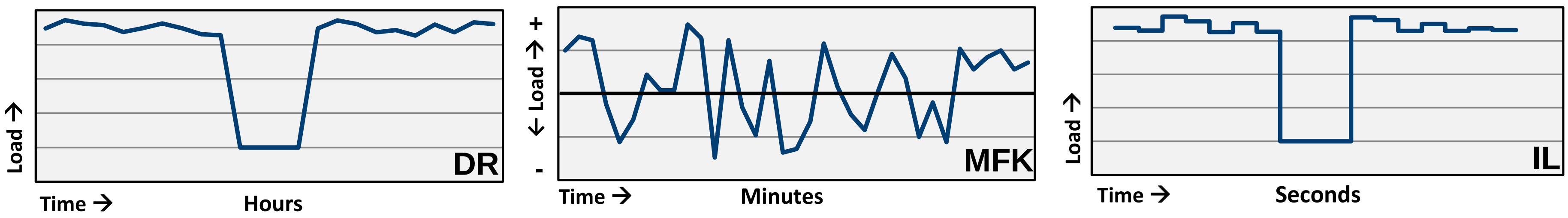
Smarter Energy Storage Systems

Grid Services

- Demand Response and Ancillary services

DR + Ancillary Services



Intelligent controls

- Balance on-peak and off-peak operations
- Self adapting control using weather forecasts
- Expected building performance
- HVAC operation

More renewable energy can be integrated

- Sustainability

Growth in Wind, like other renewables, will need a "total systems approach" on all grids.

EnerNOC will be part of these creative smart grid solutions.

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