Management of Intermittent Generation

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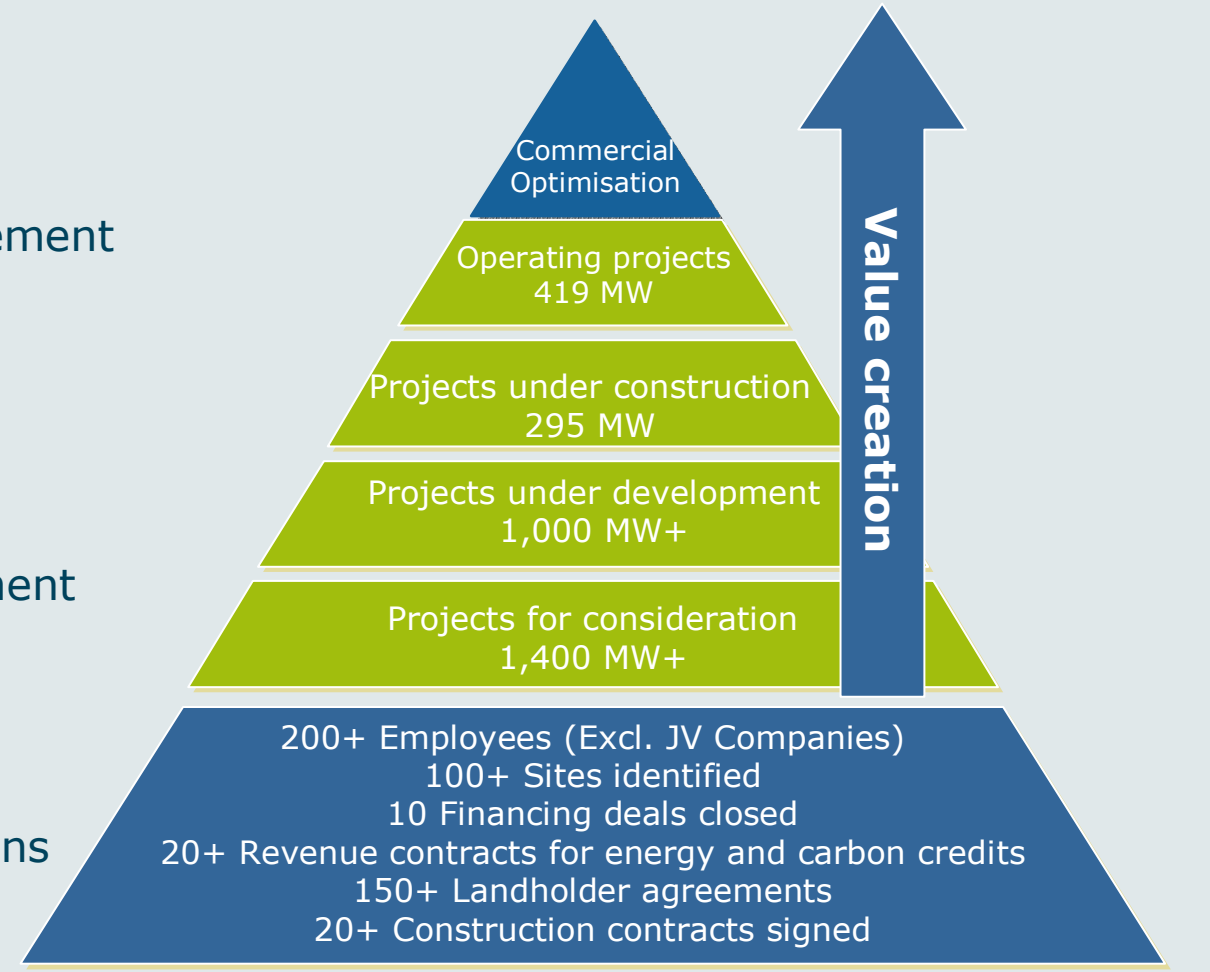
Overview

1. Pacific Hydro today
2. Clements Gap Wind Farm
3. Semi Schedule Rules under the National Electricity Rules
4. Control Systems
5. Communications
6. Operations - Constraints
7. Forecasting Systems
8. Compliance
9. Conclusion


1. Pacific Hydro today

The Pacific Hydro Clean Energy Value Chain

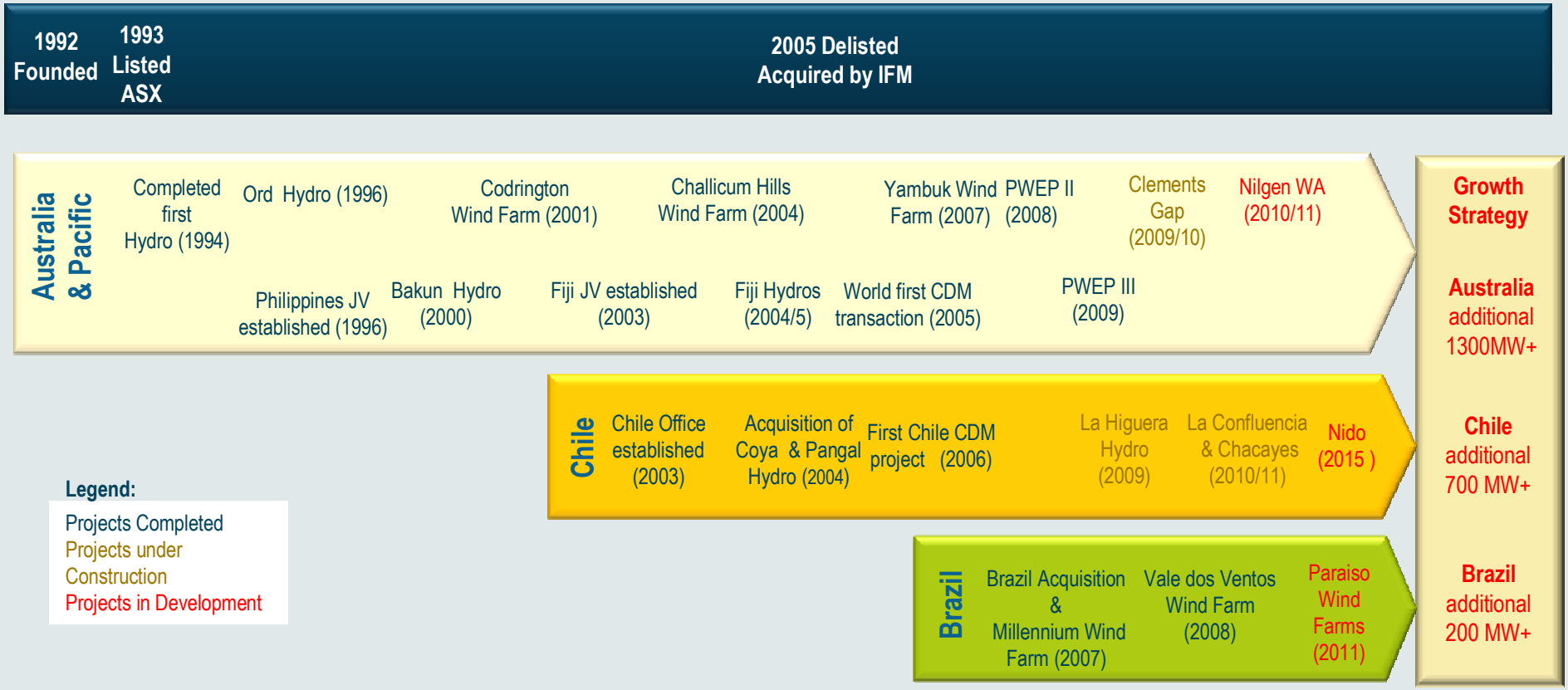
- Sales
- Marketing
- Carbon Asset Management
- Operations
- Acquisitions
- Commissioning
- Installation management
- Turbine procurement
- Permitting
- Landowner negotiations
- Hydrological studies
- Wind studies
- Site identification



Pacific Hydro is able to create significant shareholder value by owning all aspects of the value chain and pipeline of opportunities.

Note: MW capacity are Pacific Hydro share

Pacific Hydro Operating and Development Pipeline

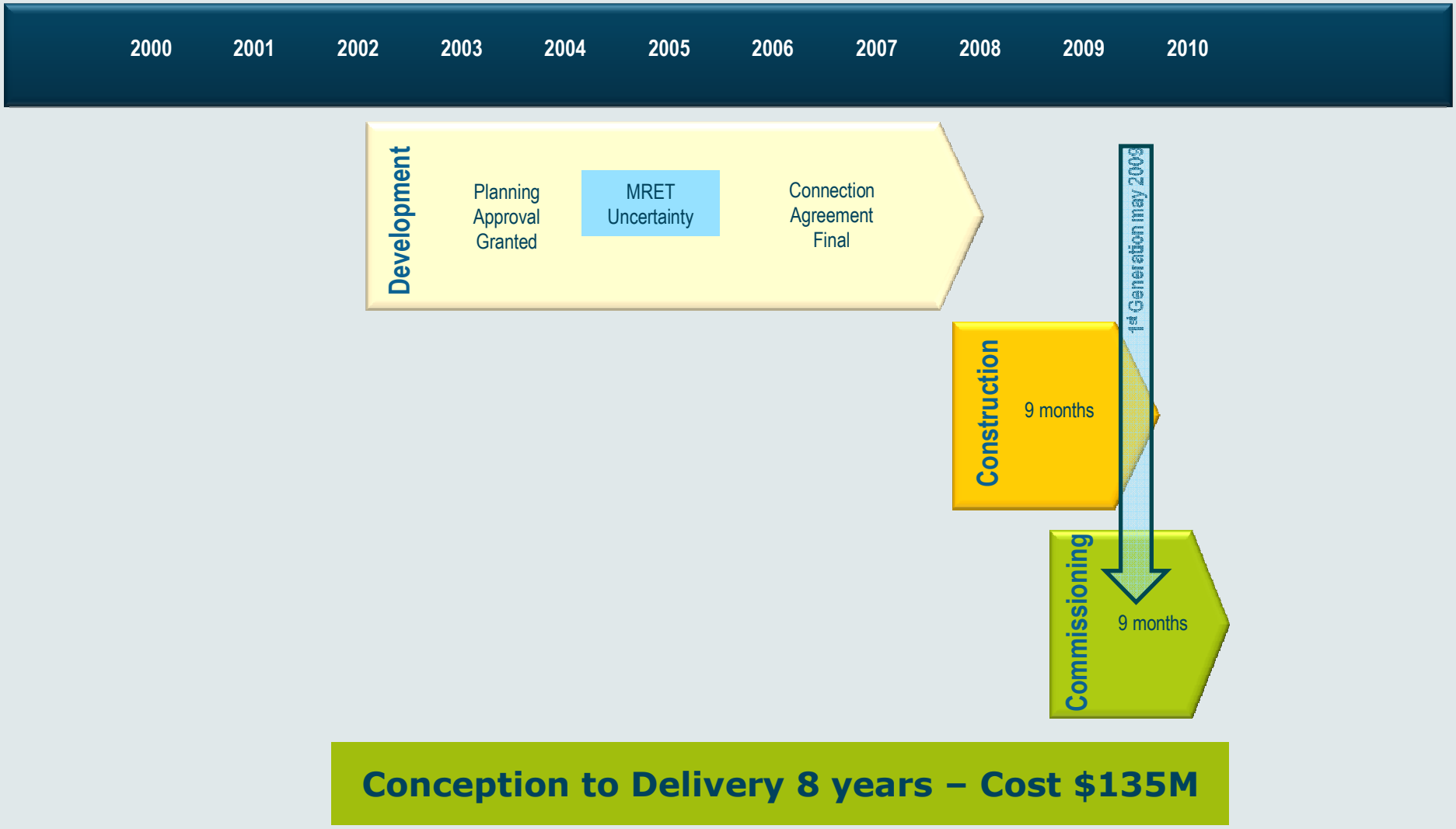


Pacific Hydro has a proven track record in delivery, operation and commercialisation of clean energy projects globally – with a defined development pipeline and the advantage of being an early entrant to each of the clean energy markets.

2. Clements Gap Wind Farm

Clements Gap Wind Farm – Where is it?

Clements Gap Project – Identification to Project Completion



Clements Gap Wind Farm – Quick Facts

- 27 Suzlon S88 2.1MW (56.7MW)
- Asynchronous 4 poles with slip ring turbines
- Pitch regulated blade, 3 stage gearbox (1 planetary and 2 helical)
- Hub height 80M, 88M rotor diameter
- Aerodynamic and Mechanical brakes
- 199 GWh per annum (40% Capacity Factor)
- 14 MVAr Reactive Plant (6 MVAr D-Var, 8 MVAr Cap Banks)
- 132kV transmission connection to ElectraNet

S88 2.1MW	Wind Speed (m/s)
Cut-in	4
Rated	14
Cut Out	25
50 year gust	59.5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3. Rules

Rules – Semi Schedule

Rules – What is Semi-Schedule?

- In order to manage expected increase in intermittent generation (wind generation) AEMC, with industry consultation (from 2004), developed National Electricity Amendment (Central Dispatch and Integration of Wind and Other Intermittent Generation) Rule 2008 No. 2 (Semi-scheduled Rules)
- Semi-Scheduled Rules – Legislated effective May 2008 and March 2009
- All wind farms > 30MW must register as Semi-Scheduled
- Wind Farms are "free" to generate without following dispatch instructions most of the time.
- Only during a "semi-dispatch" interval will conformance to a maximum dispatch level be required
- A Wind Farm will be in semi-schedule interval when a constraint that includes the generator is binding or violating in the market dispatch
- Majority of AEMO control of wind farms will be to manage network limits – this assessment of energy at risk is factored into investment decision.

Rules – Semi Schedule

Rules – What impact on Wind Farm Developers?

- Provide real time meteorology data (wind speed, wind direction, temperature, MW output, turbine availability)
- Provide inputs for Energy Conversion Model that translates meteorology data into energy forecasts (managed by AEMO) (eg. Wind turbine Power curve)
- Provide Turbine Availability schedule (planned/unplanned maintenance)
- Submit market bid for farm capacity (default bid)
- Develop 24/7 systems to respond to AEMO 5 minute dispatch instructions
- Brings Pacific Hydro into the NEM market


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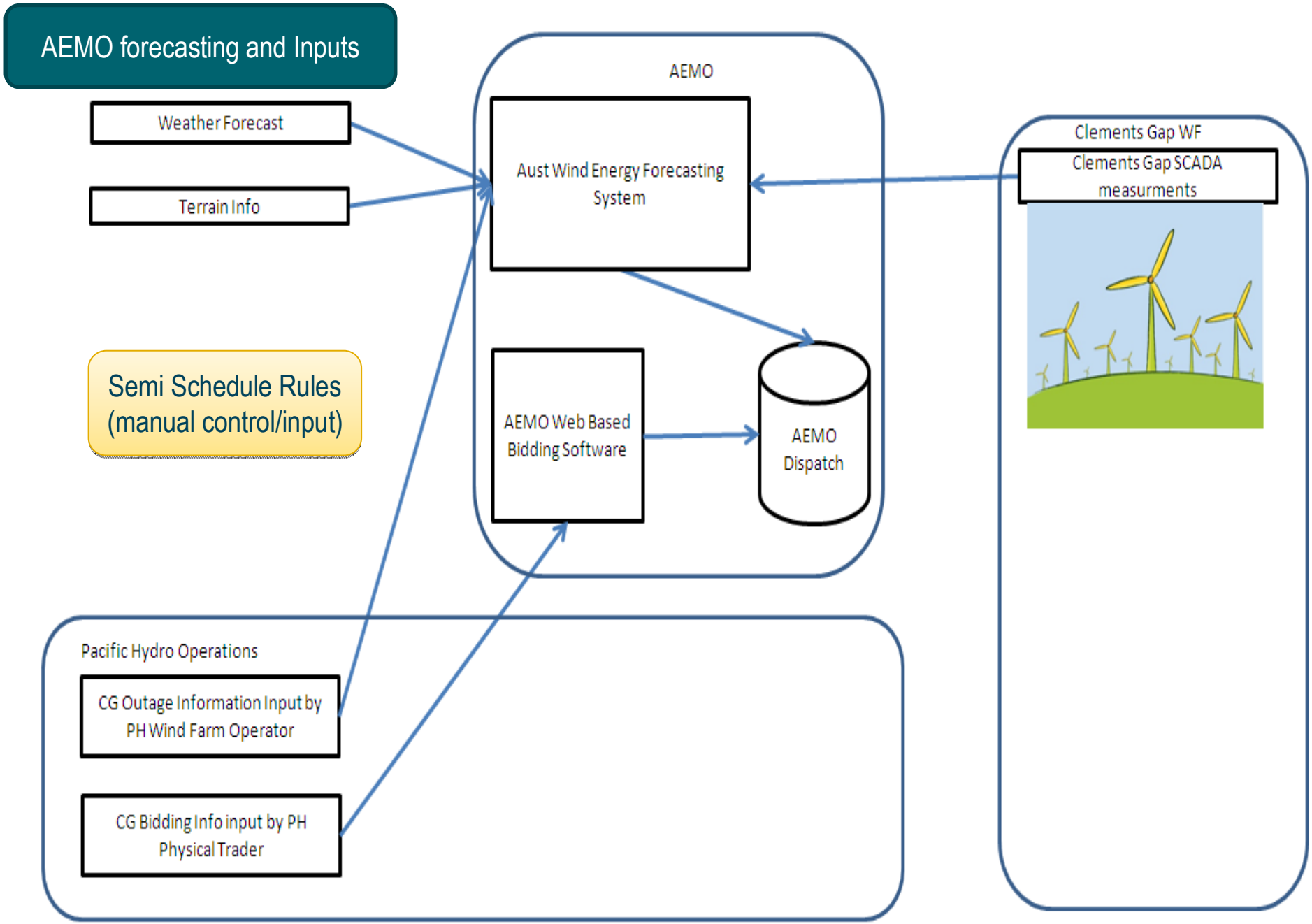
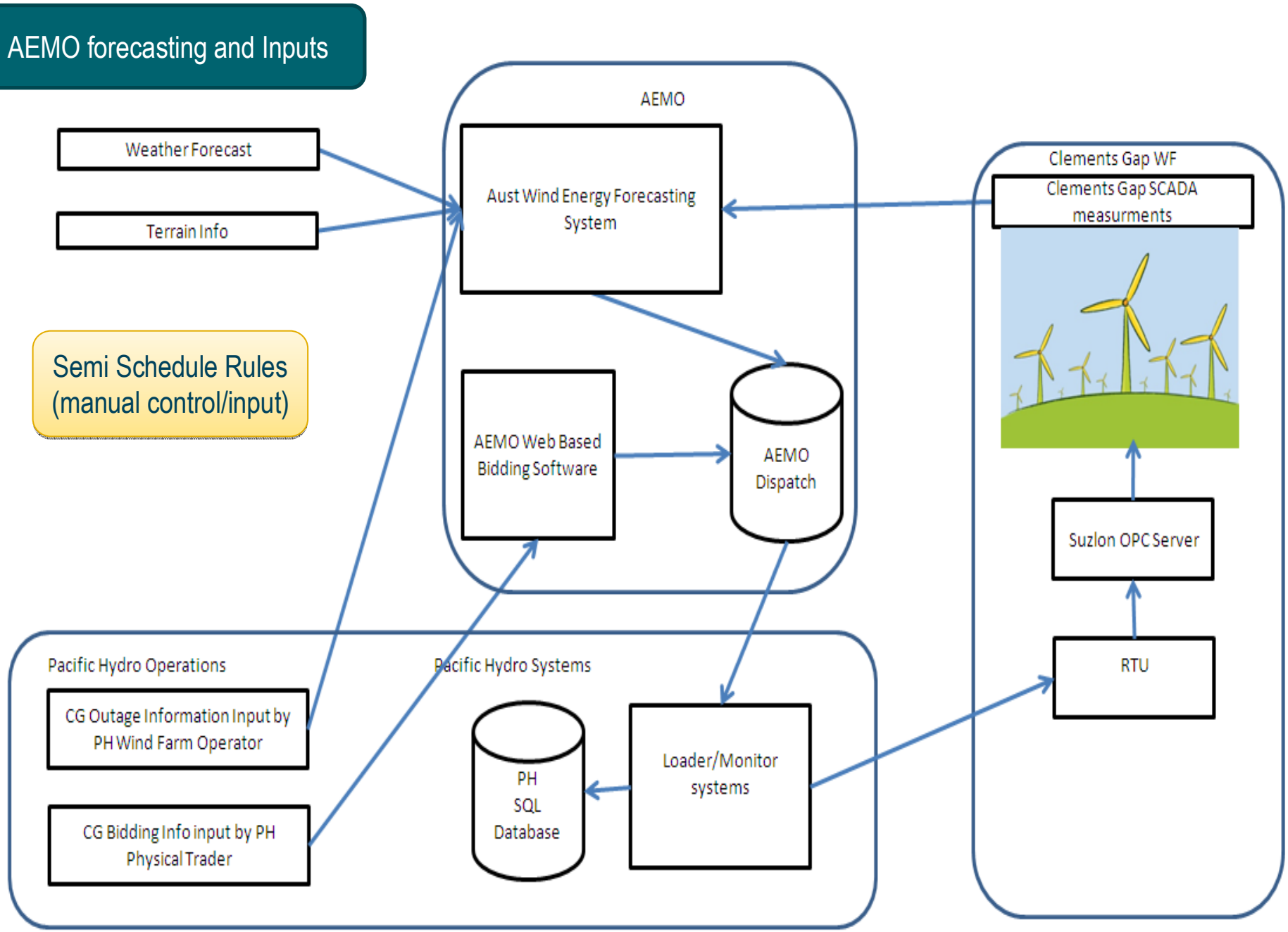
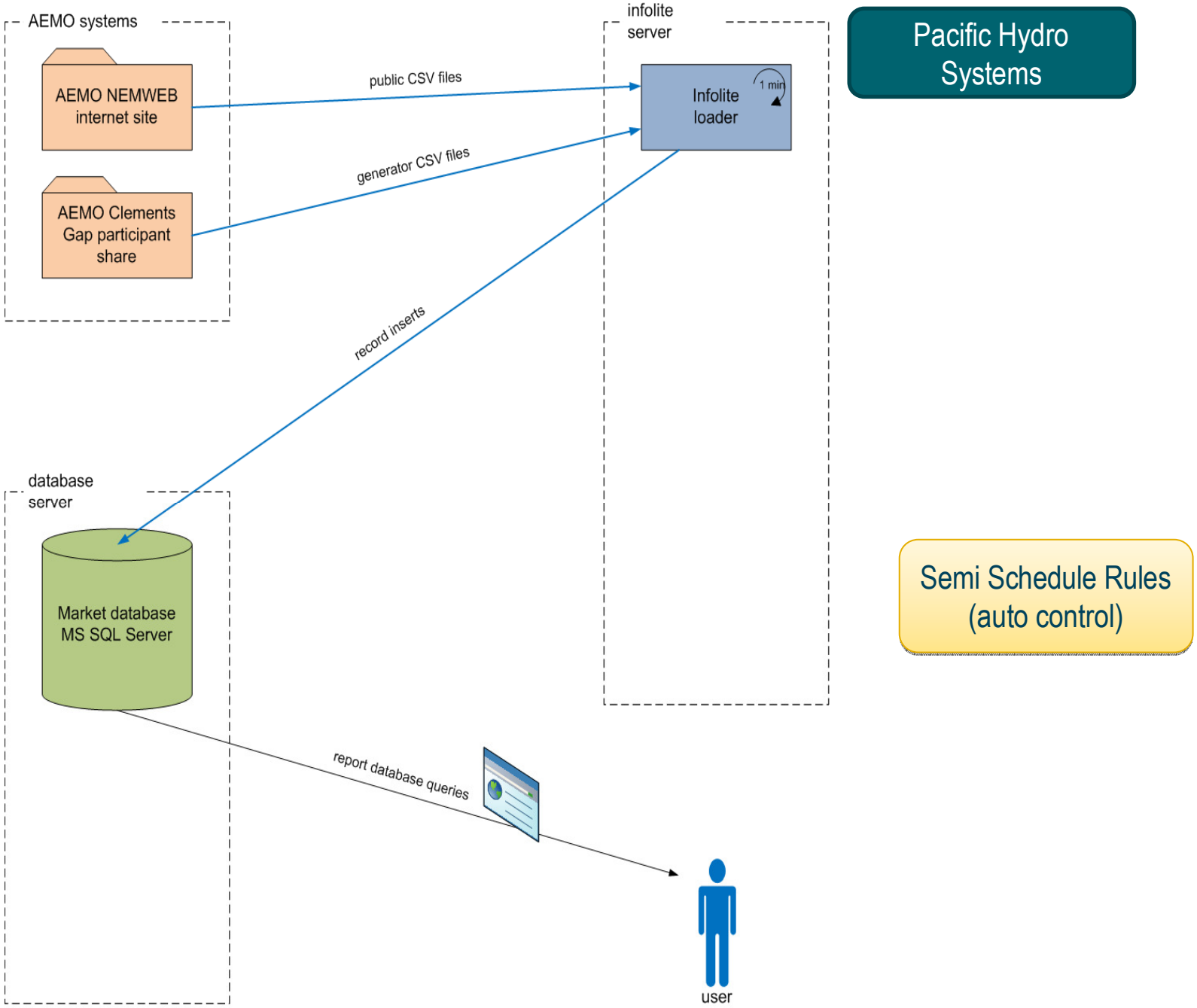
4. Control Systems

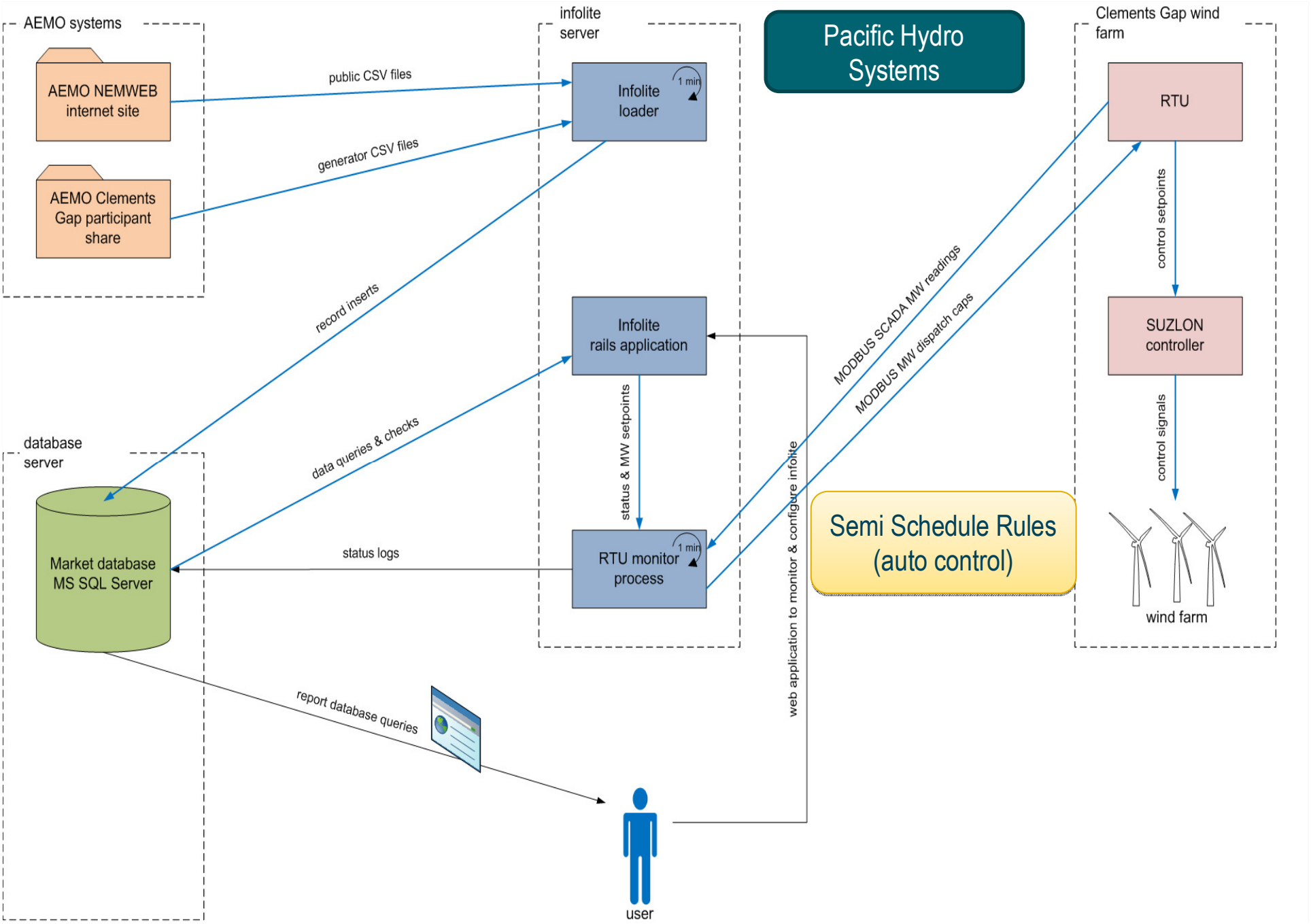
AEMO forecasting and Inputs



AEMO forecasting and Inputs




AEMO systems
AEMO NEMWEB internet site
AEMO Clements Gap participant share
public CSV files
generator CSV files
record inserts
infolite server
Infolite loader
1 min
database server
Market database MS SQL Server
report database queries
user
Pacific Hydro Systems
Semi Schedule Rules (auto control)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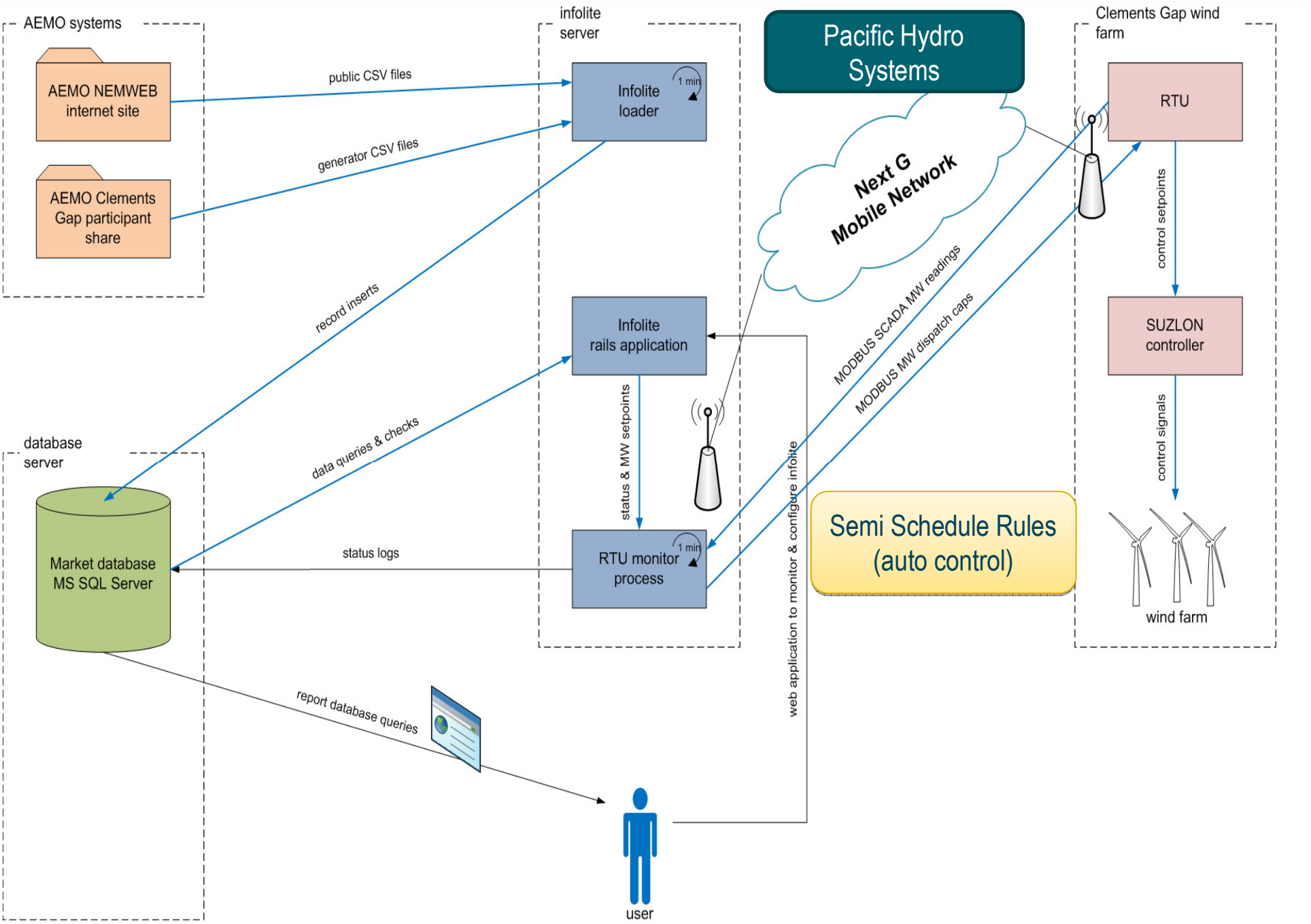
Pacific Hydro Systems
Clements Gap wind farm
RTU
control setpoints
SUZLON controller
control signals
wind farm
MODBUS SCADA MW readings
MODBUS MW dispatch caps
Infolite rails application
status & MW setpoints
data queries & checks
database server
Market database MS SQL Server
status logs
RTU monitor process
1 min
Semi Schedule Rules (auto control)
web application to monitor & configure infolite
report database queries
user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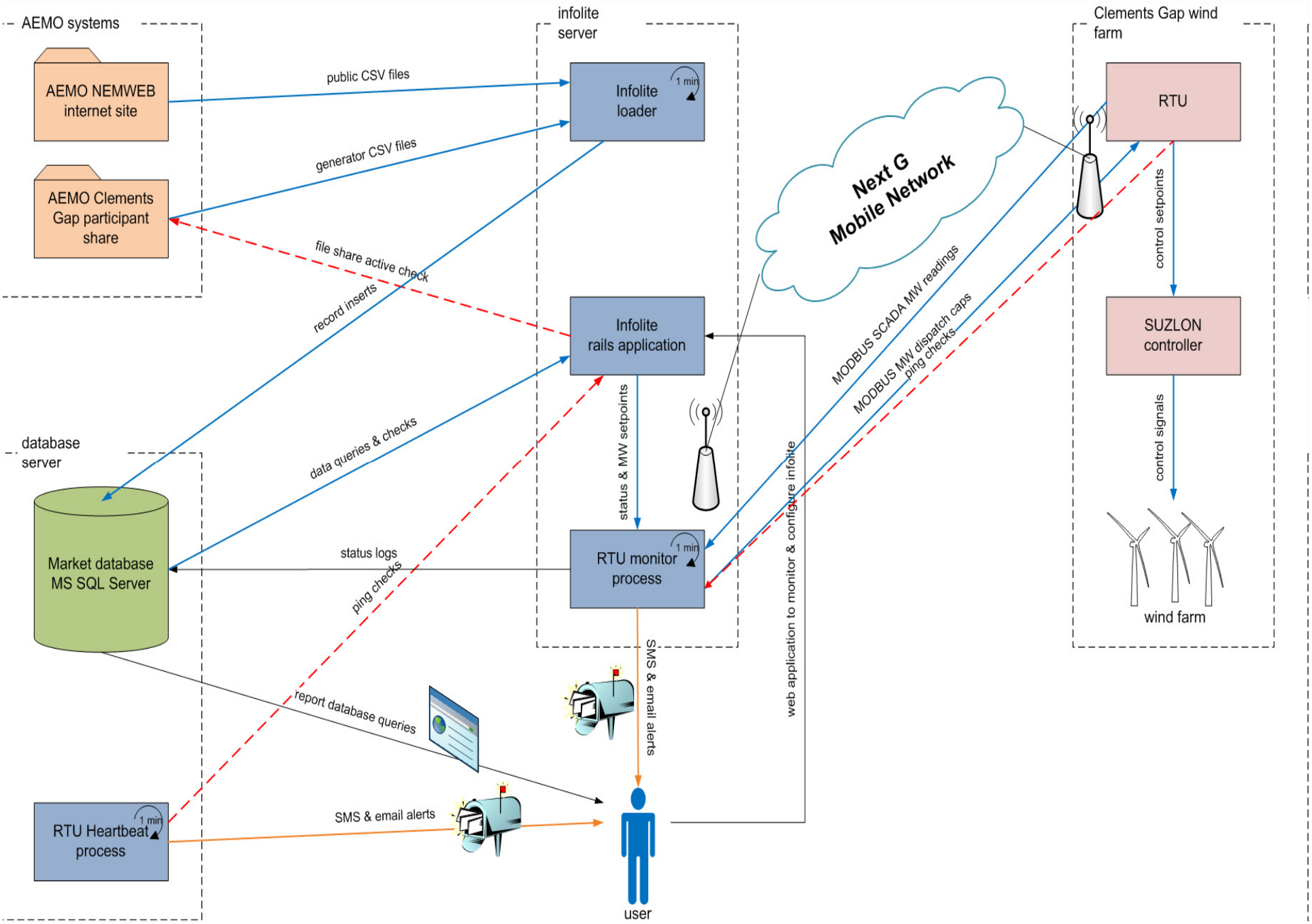
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report database queries
RTU Heartbeat process
1 min
SMS & email alerts
user

5. Communication Systems

Communication – Remote locations?

- Communications allow electrical and wind SCADA to be sent to Pacific Hydro and Suzlon (ElectraNet required fibre optic and microwave)
- Pacific Hydro utilise NextG mobile technologies for remote locations in Chile and Brazil (NextG has been used for 5 previous projects).
- When assessing options for Clements Gap NextG was chosen due to its:
  - Reliability/bandwidth
  - Latency (delays)
  - Cost to install and run
  - Risk of failure / redundancies
- Existing copper/fibre optic was not available in the region, microwave and satellite had unacceptable costs/risks of failure and latency.
- Sites use a Yagi or Omni Directional Antenna and utilise the NextG IPWAN (corporate channel separate from public)

6. Operations / Constraints

Attitude on Constraints?

- Pacific Hydro accept that efficient and cost effective networks will at times be congested. The transparency of constraints and the assessment of the energy at risk for the investment decision is crucial
- South Australia has a number of transmission bottlenecks that result in Clements Gap being impacted, particularly at times of high wind energy generation and low SA demand
- In the 3 months of operation there have been over 1000 5 minute semi-schedule dispatch periods requiring the Clements Gap wind farm to control its generation. However the energy forgone has been immaterial.
- Pacific Hydro has now the information and the drivers to bring about augmentation to resolve material network issues with ElectraNet


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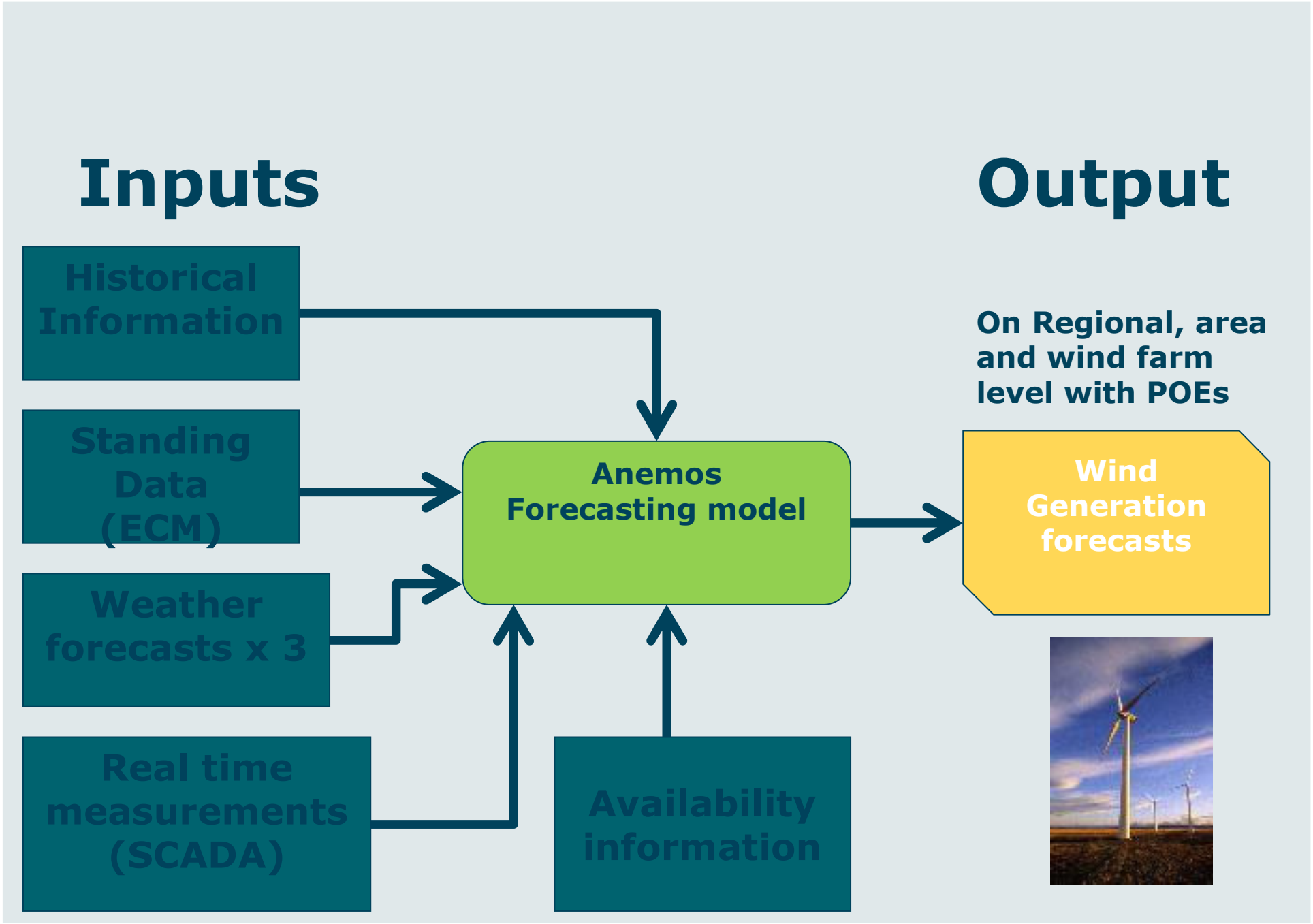
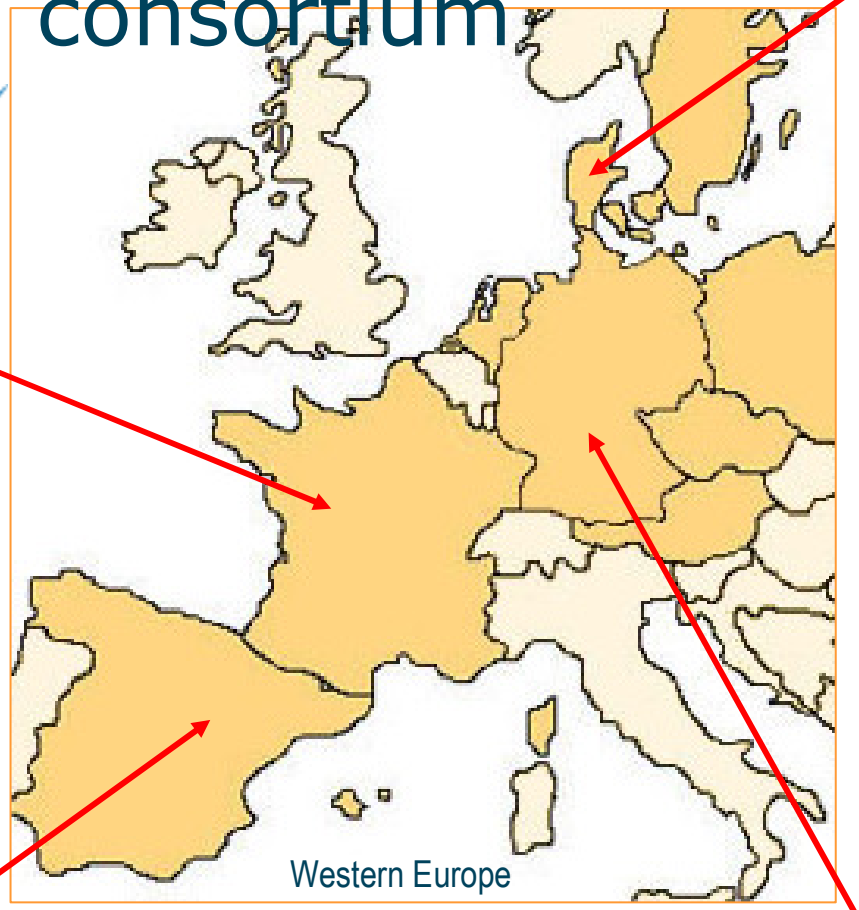
7. AEMO Forecast Systems


Inputs
Output
Historical Information
Standing Data (ECM)
Weather forecasts x 3
Real time measurements (SCADA)
Availability information
Anemos Forecasting model
On Regional, area and wind farm level with POEs
Wind Generation forecasts

Anemos consortium

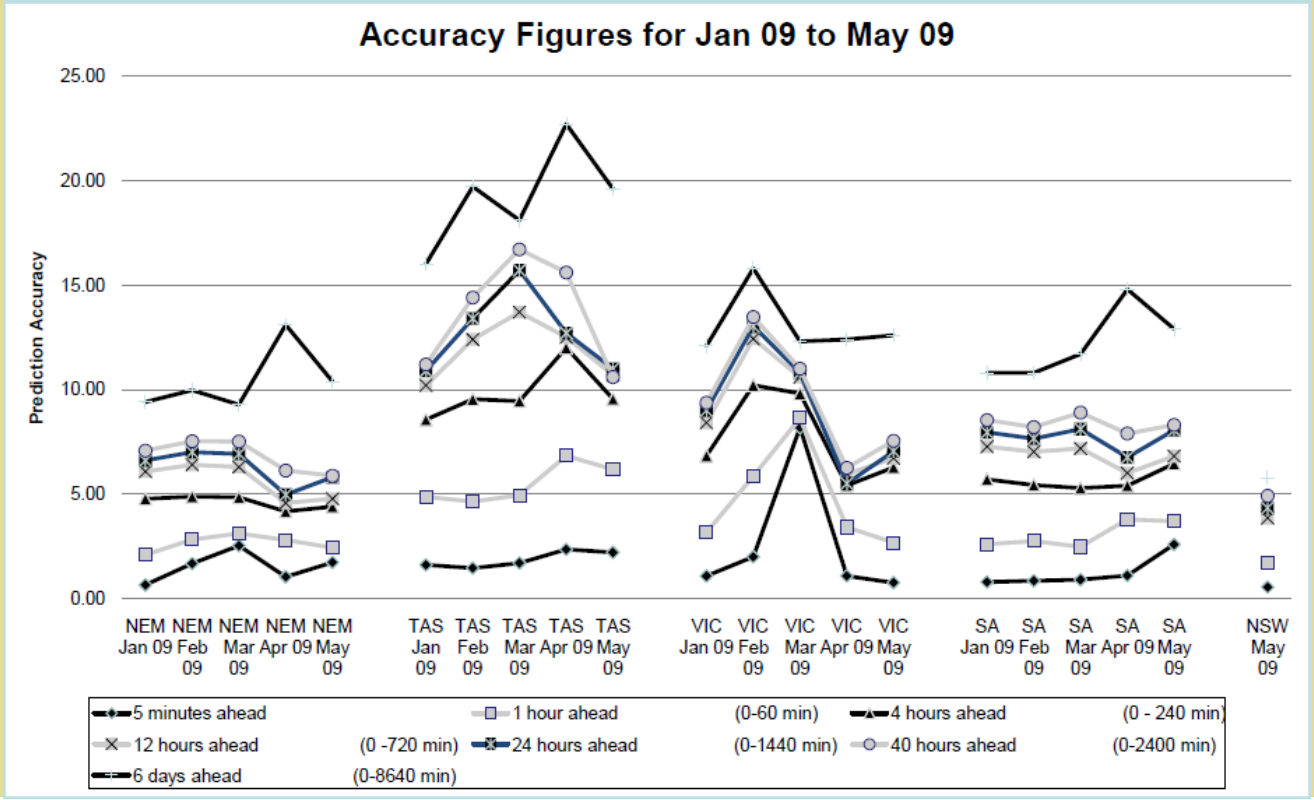


Anemos were engaged by AEMO to develop a wind generation forecasting tool for the NEM Forecast timeframes :

Forecast timeframe	Resolution	Frequency
Dispatch	5 mins (5 min interval)	5 mins
5min Pre Dispatch (wind)	2 hours (5 min interval)	5 mins
5min Pre Dispatch	1 hour (5 min interval)	5 mins
Pre Dispatch	40 hours (30 min interval)	30 mins
ST PASA (wind)	7 days (30 min interval)	30 mins
ST PASA	7 days (30 min interval)	2 hours
MT PASA (wind)	2 years (peak 30 min interval)	Daily
MT PASA	2 years (peak 30 min interval)	Weekly

AEMO have provided the following accuracy figures revealing NEM wide accuracy with less than 5% error as displayed in the following:

2. AWEFS current performance accuracy – Normalised Mean Absolute Error

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8. Compliance

Compliance Rules – What is the impact on non compliance?

- Existing AEMO Scheduled Rules apply but only during semi-scheduled dispatch intervals
- Small error – Max(6MW, 3%) over 30 minutes & Large Error – Max (6MW, 5%) over 15 minutes = 6MW error threshold for Clements Gap
- No non-compliance issues to date – all material (>6MW) dispatch instructions have been responded to within 5 minutes
- AEMO publically report non-compliance to the market and occasional non-compliance is tolerated
- AER would investigate/fine if plant non-compliance was systemic or if non-compliance resulted in material market event


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9. Conclusion

Conclusion

- Clement Gap has successfully implemented Semi schedule systems in the NEM, Pacific Hydro will leverage off this project for the future.
- Wind developers accept intermittent control as part of the evolution of the wind industry
- Key elements required for Intermittent control:
  - Real time dispatch (5 minute gate and constraint equations)
  - Real time SCADA including meteorology data
  - Accurate forecast systems
  - Compliance requirements


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