



Microgrid Automation on an IOT Backbone

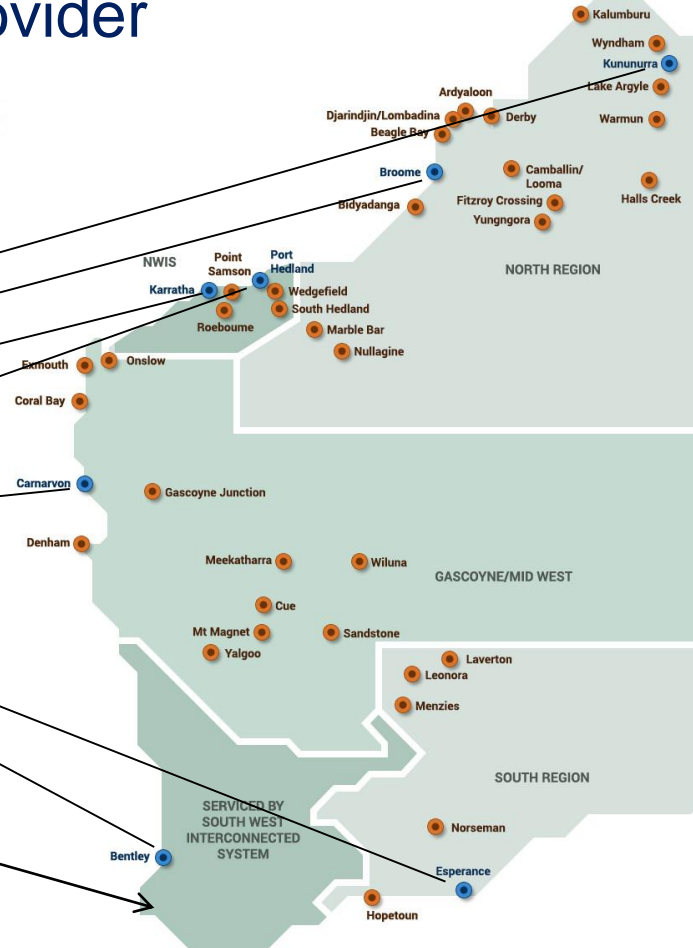
CSIRO - Microgrids 2017 – November 2017

David Edwards

Regional Service Provider

- Supply Area 2.3M km²
- 48,436 customers
- 38 Microgrids
- 114.2 GWh sent out in 2016
- **Depots in:**
- Kununurra
- Broome
- Karratha
- Port Hedland
- Carnarvon
- Esperance
- Bentley – Perth

- Southwest Interconnected System
- WEM- Wholesale Electricity Market
- Western Power – Transmission
- Synergy – Retail & Generation

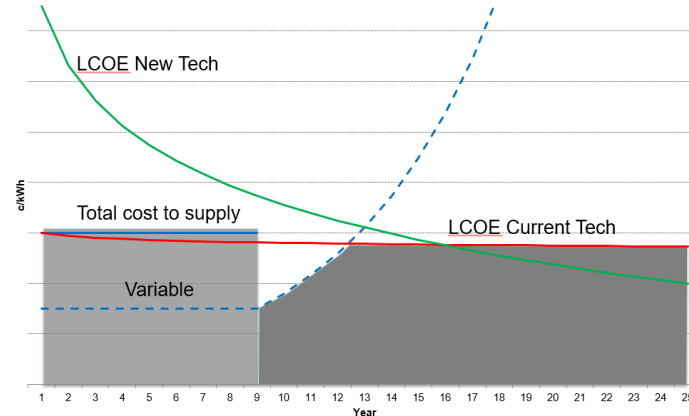
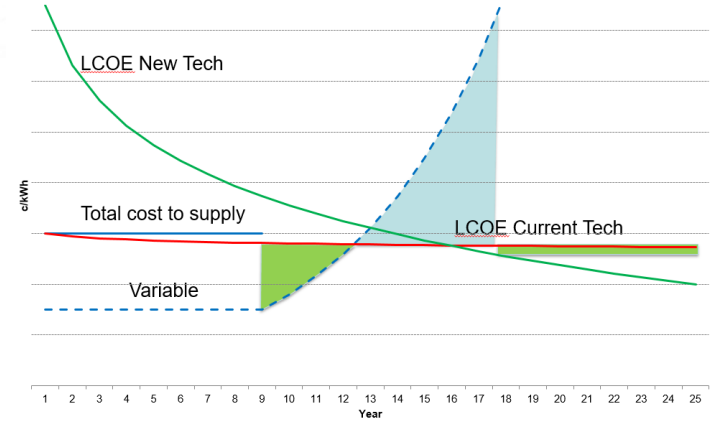


WA is five times
the size of
California with the
population of
Boulder, Colorado

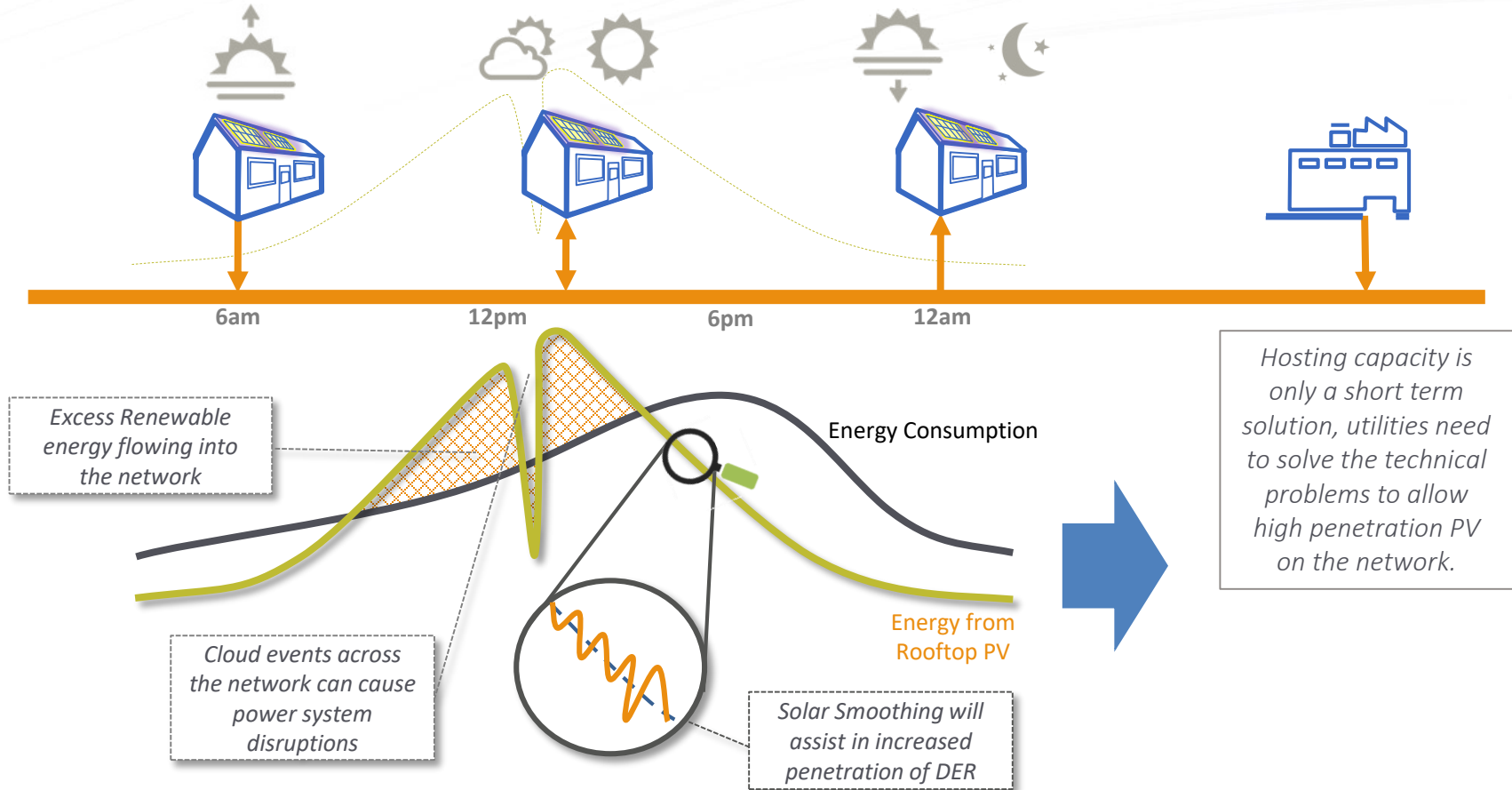
– it's microgrid
heaven.

Blueprints

- Long range forecasting for all 38 networks
- Analysis of ongoing CAPEX, OPEX
- Overlaid with learning curves on PV, Energy Storage and cost of data
- Economics improved with high penetration DER
- Identification of challenges to:
 - Power system engineering
 - Operational practices
 - Commercial model
- Established a development pathway to a high penetration DER future
- Business model transition from predominantly centralised to predominantly de-centralised model
- Retention of customer choice
- Open up Hosting Capacity targets

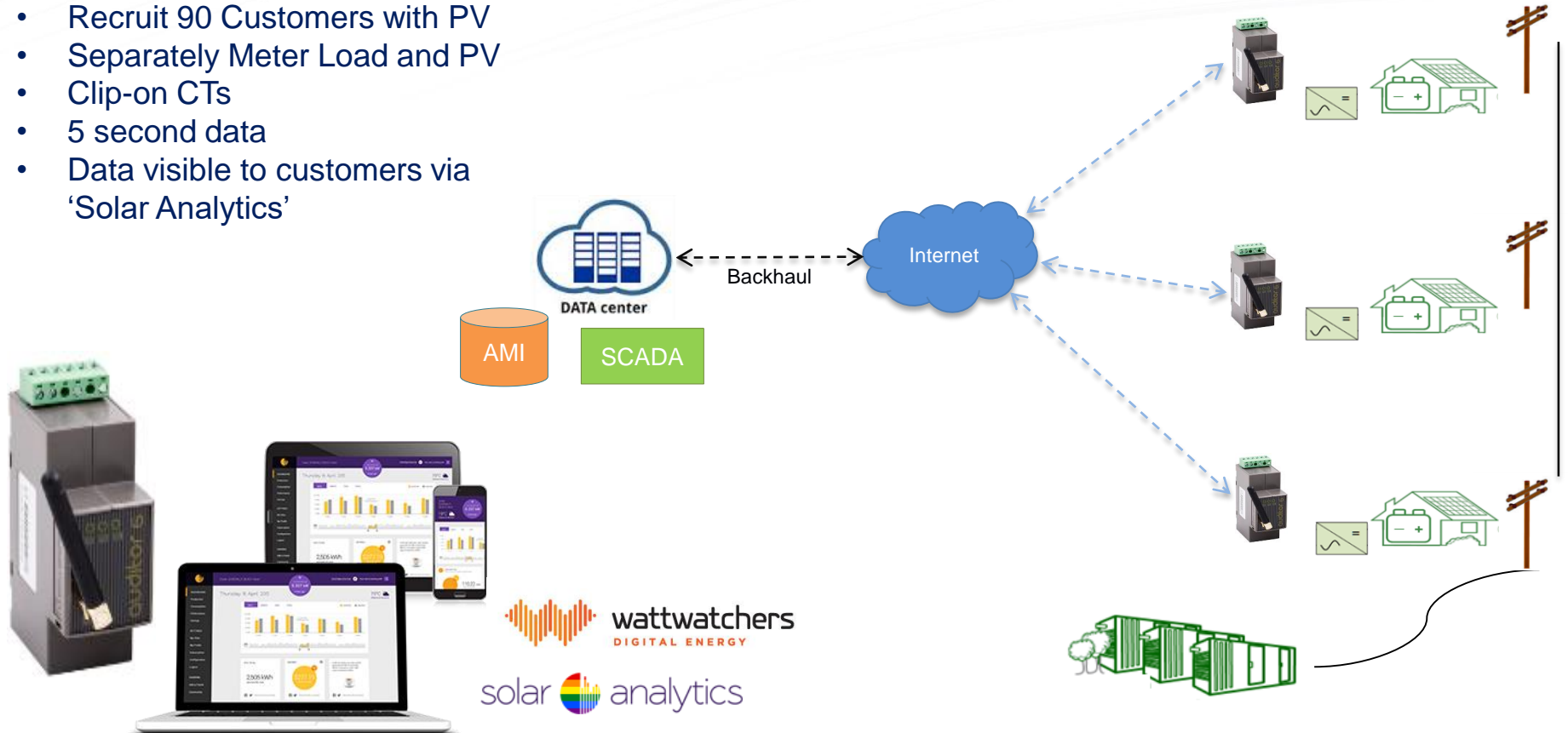


Visibility & Control



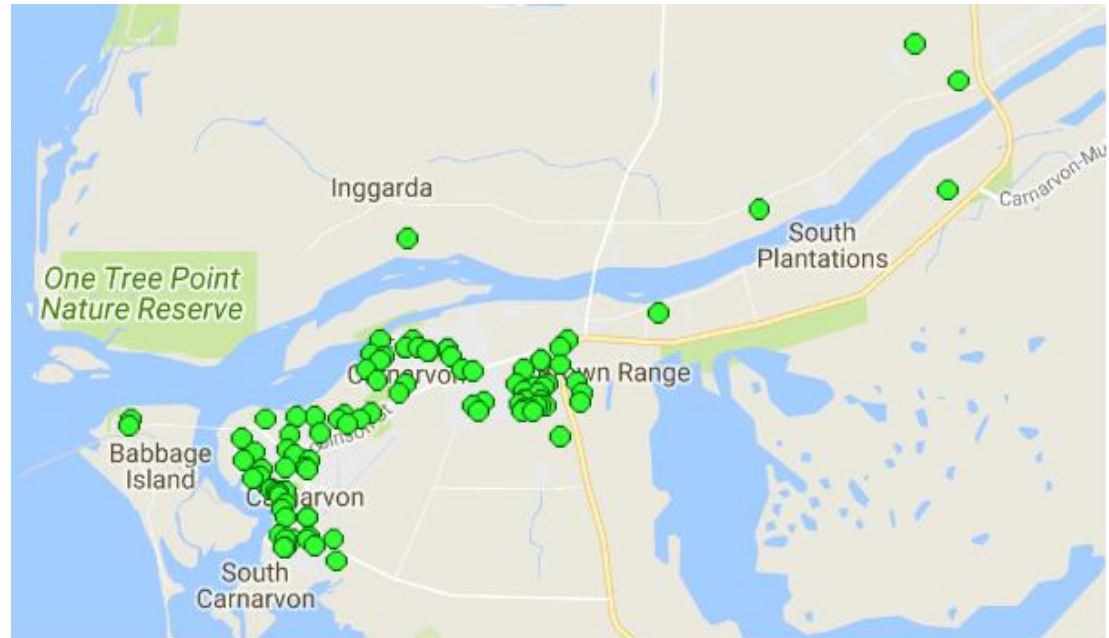
Carnarvon DER

- Recruit 90 Customers with PV
- Separately Meter Load and PV
- Clip-on CTs
- 5 second data
- Data visible to customers via 'Solar Analytics'



WattWatchers Installations

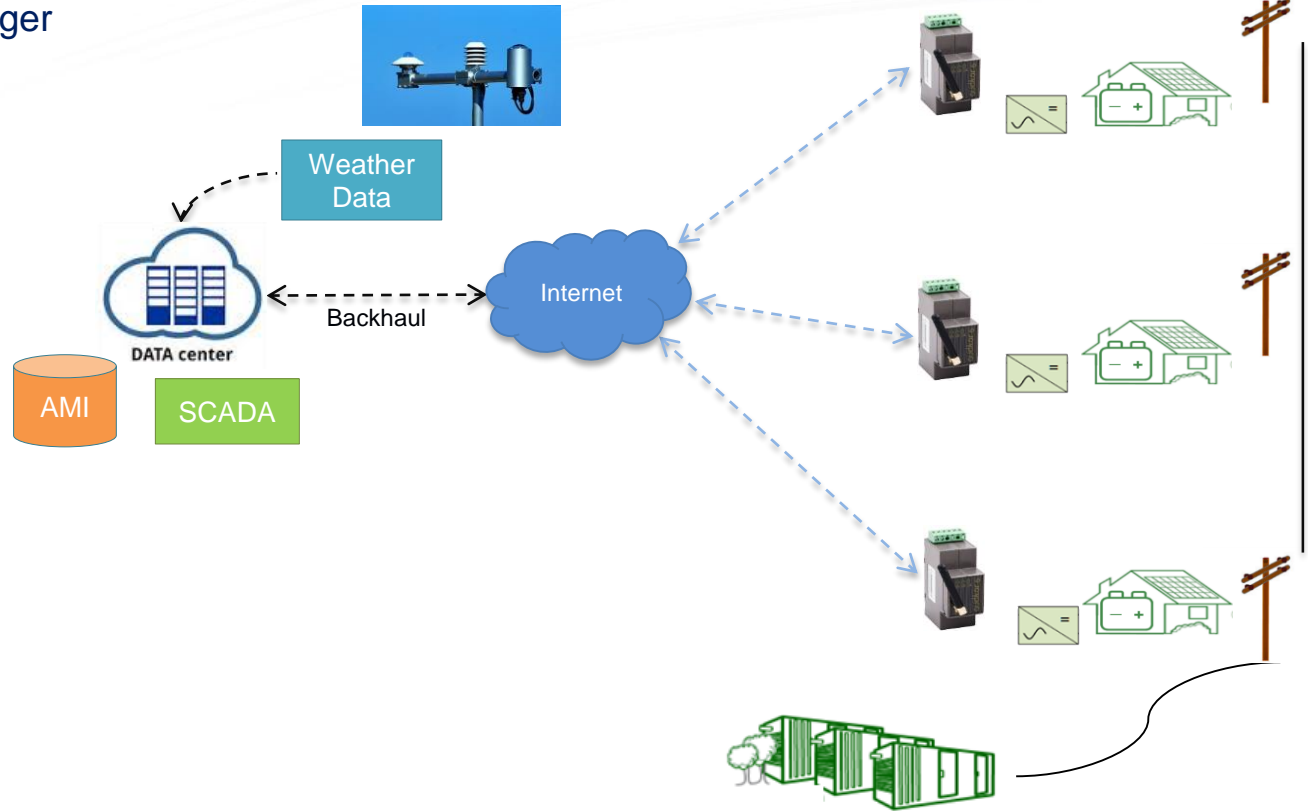
- 59 Residential and Commercial sites so far...
- Some sites with multiple PV systems
- Some sites with PV systems remote from the residence
- 108 Watt watchers installed
- Good geographic spread from East to West
- Best possible geographic spread from South to North (prevailing winds)



Skycamera & Weather Station

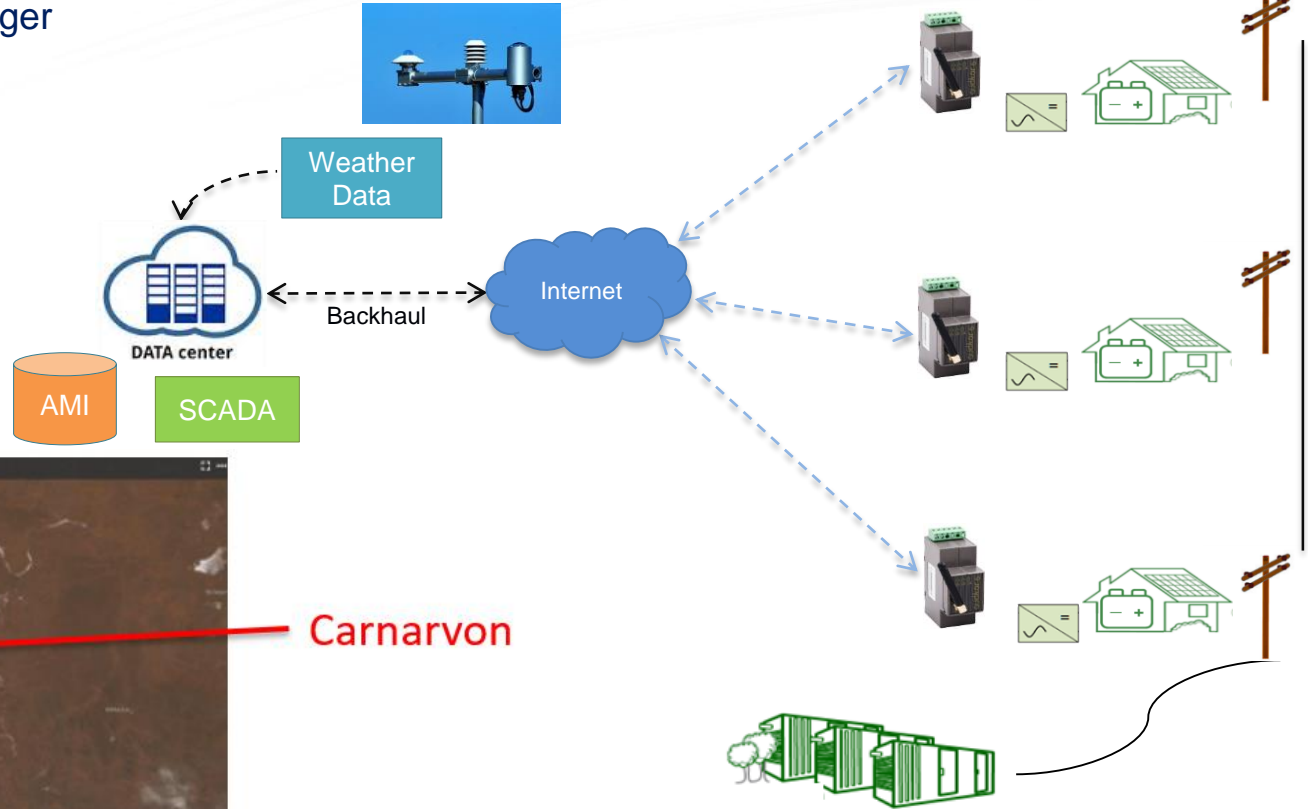
- Fulcrum 3D - 360° Sky Imager
- Temperature & Humidity
- Wind speed & Direction
- Solar Insolation

Fulcrum 3D
precision sensing



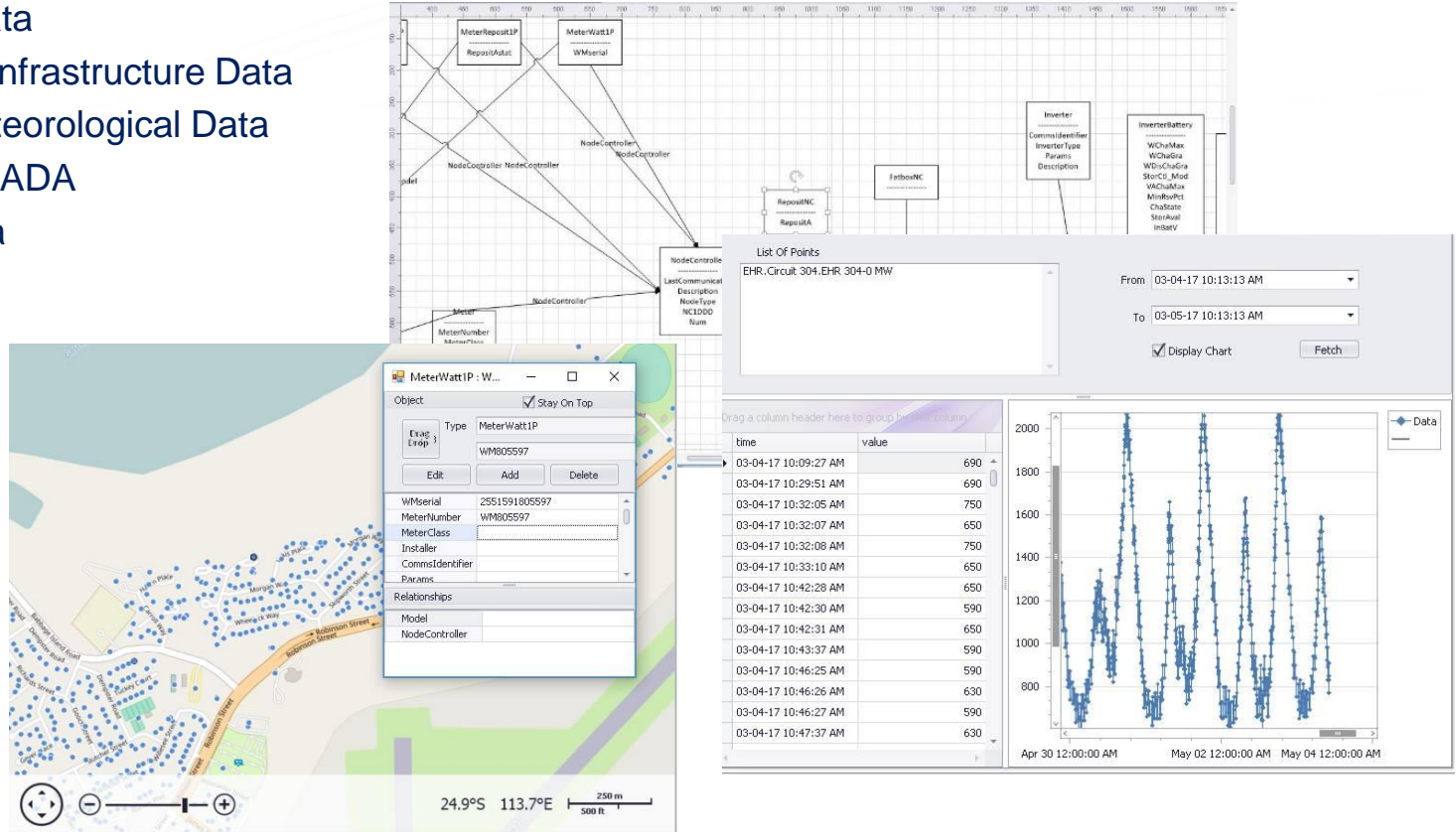
Skycamera & Weather Station

- Fulcrum 3D - 360° Sky Imager
- Temperature & Humidity
- Wind speed & Direction
- Solar Insolation
- Solcast Forecast Input



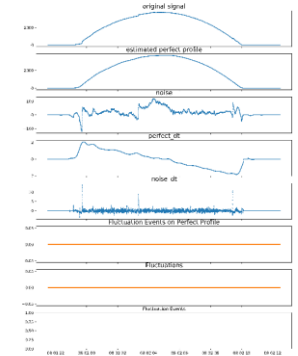
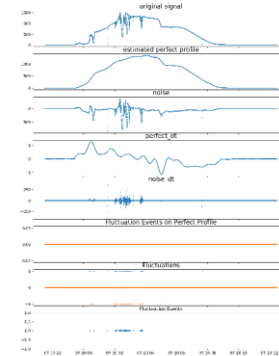
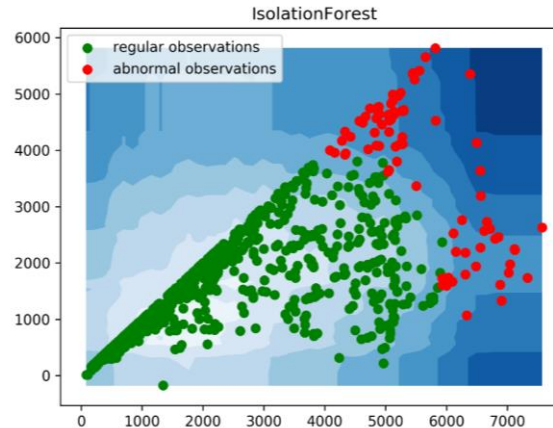
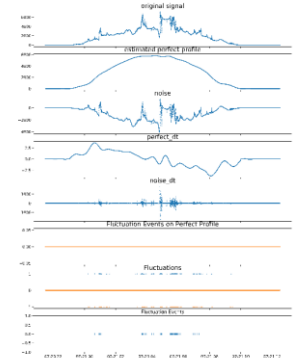
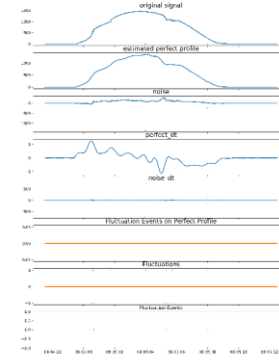
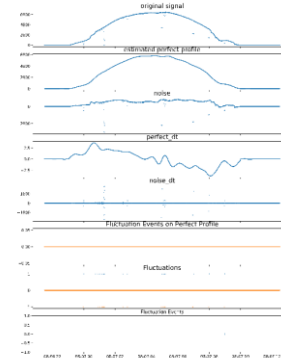
Relational Database

- PV Production Data
- Advanced Meter Infrastructure Data
- Sky Cam and Meteorological Data
- Power Station SCADA
- Web Service Data
 - BoM
 - Solcast



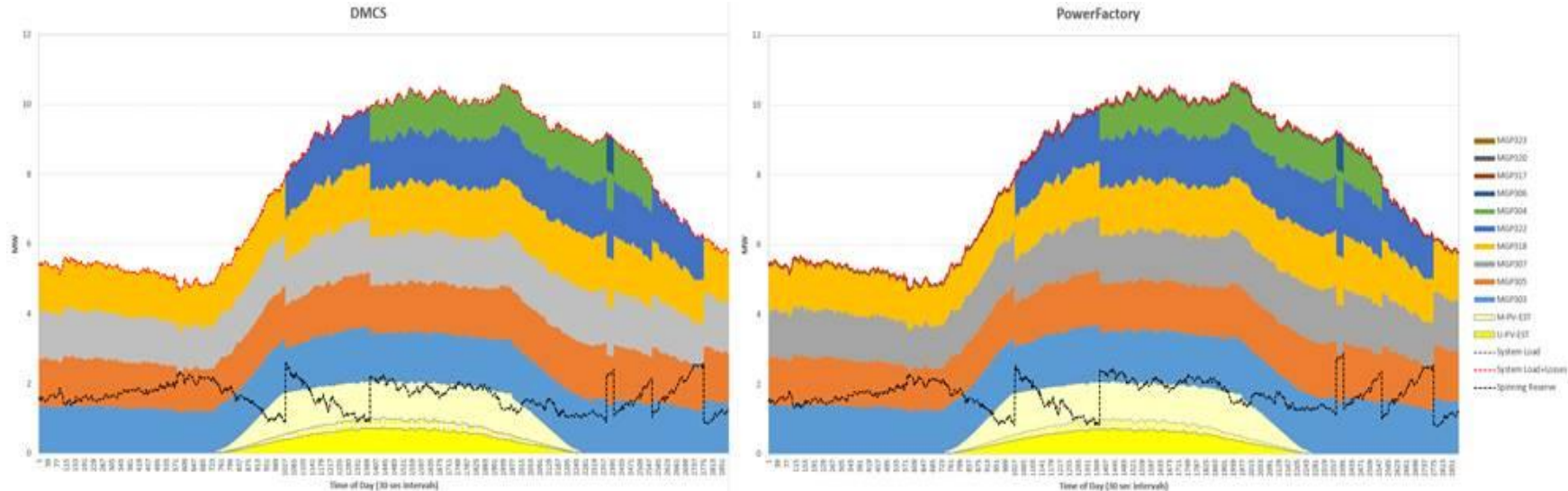
Machine Learning

- Impact of cloud events on multiple PV systems spread across the distribution system
- Unsupervised learning of the Fluctuation factor
- Unsupervised learning of the Diversity factor
- Relationship between weather, load and RE production

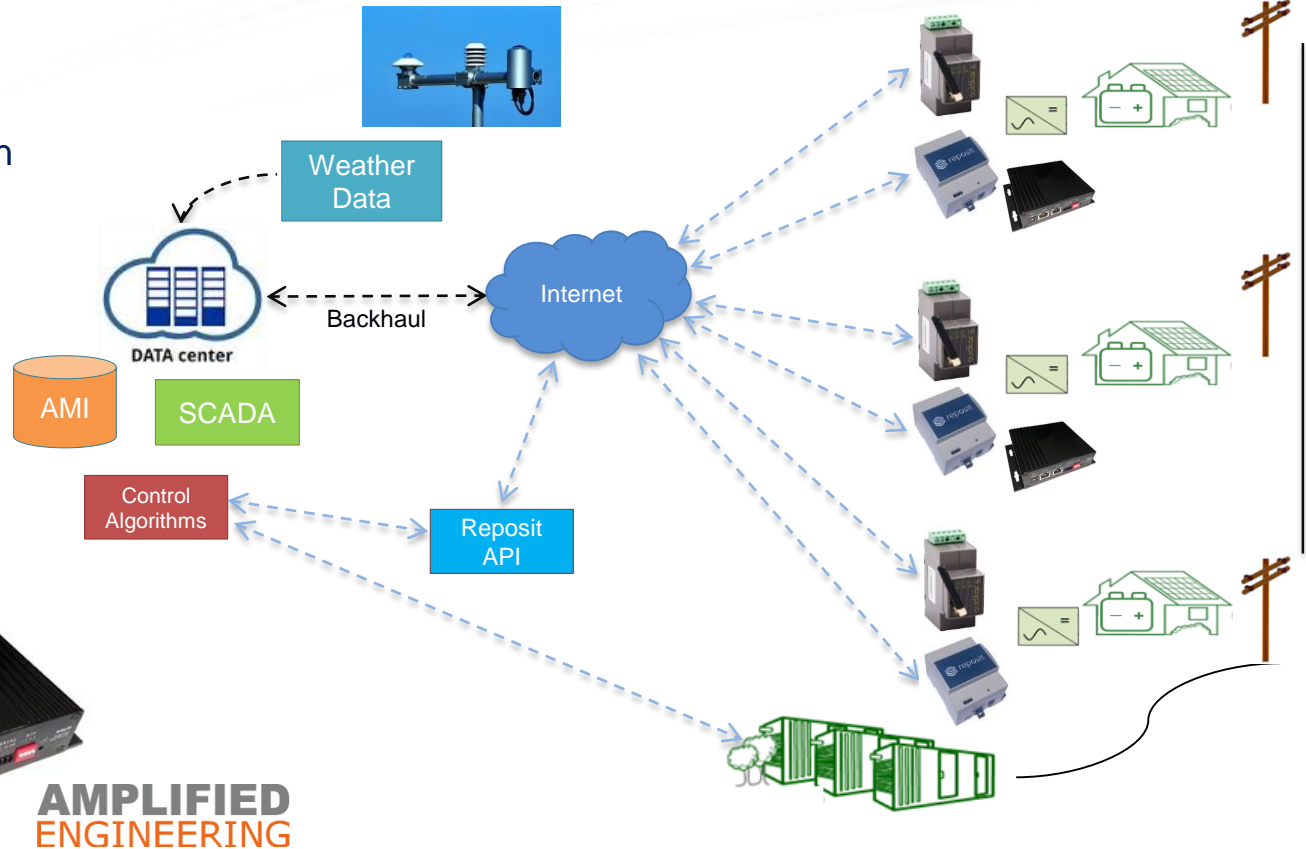


DER Monitor & Control System

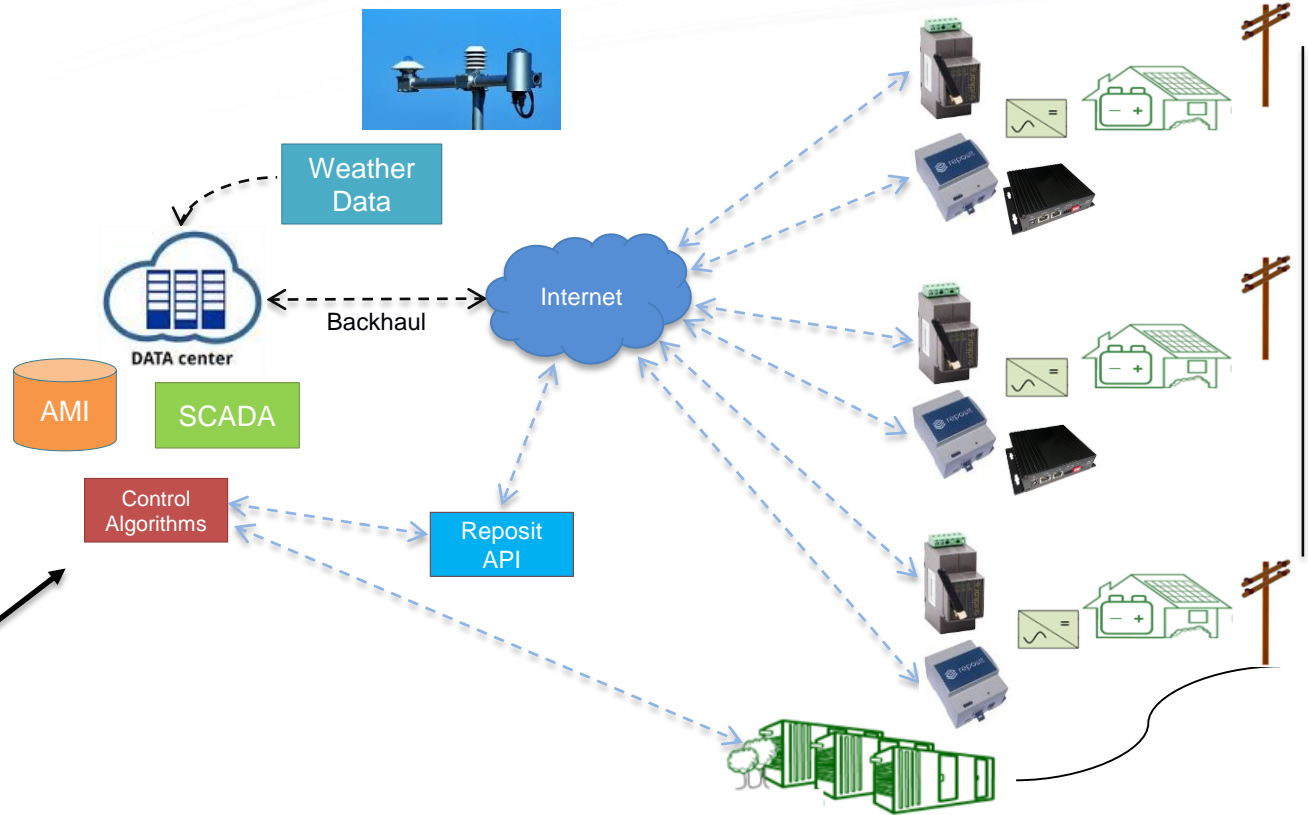
- DER Monitor & Control Simulation
- Network Risk Simulation
- Financial Outcome Simulation
- Scenario Simulation
- Predictive Simulation
- Visualisation and Analytics



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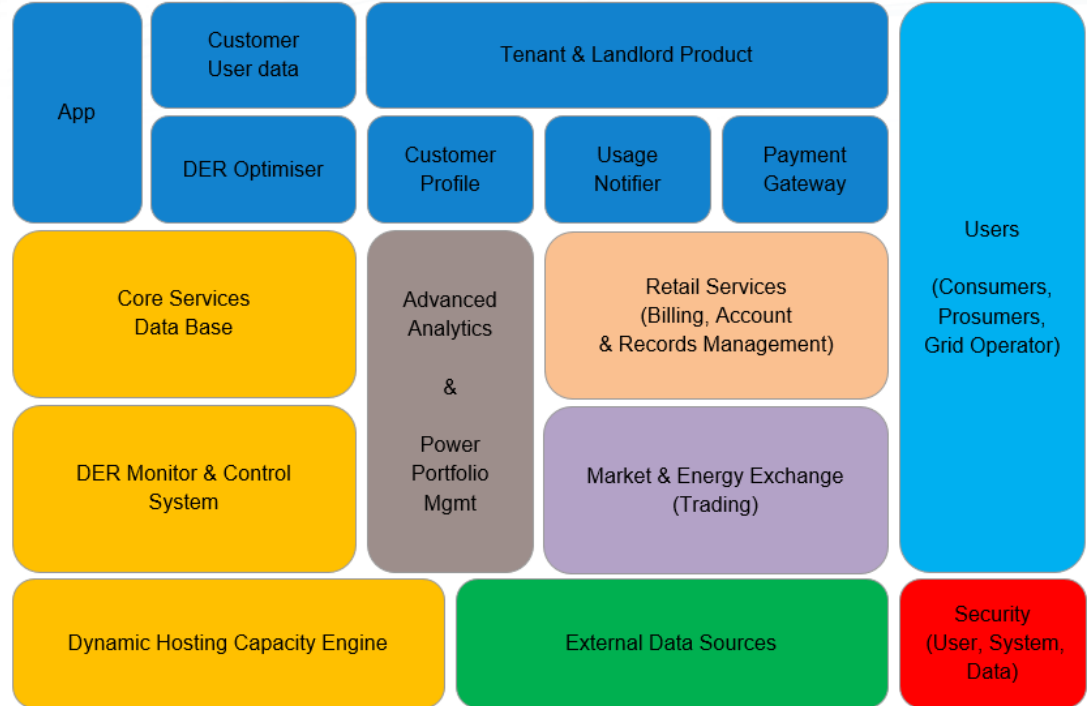


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- The diagram illustrates the components of a DERMS system, organized into a grid of colored boxes. The components are as follows:
- App** (Blue box)
 - Customer User data** (Blue box)
 - Tenant & Landlord Product** (Blue box)
 - Users** (Light blue box, appearing on the right side of the diagram)
 - DER Optimiser** (Blue box)
 - Customer Profile** (Blue box)
 - Usage Notifier** (Blue box)
 - Payment Gateway** (Blue box)
 - Core Services Data Base** (Yellow box)
 - Advanced Analytics** (Grey box)
 - Retail Services (Billing, Account & Records Management)** (Orange box)
 - DER Monitor & Control System** (Yellow box)
 - & Power Portfolio Mgmt** (Grey box)
 - Market & Energy Exchange (Trading)** (Purple box)
 - Dynamic Hosting Capacity Engine** (Yellow box)
 - External Data Sources** (Green box)
 - Security (User, System, Data)** (Red box)

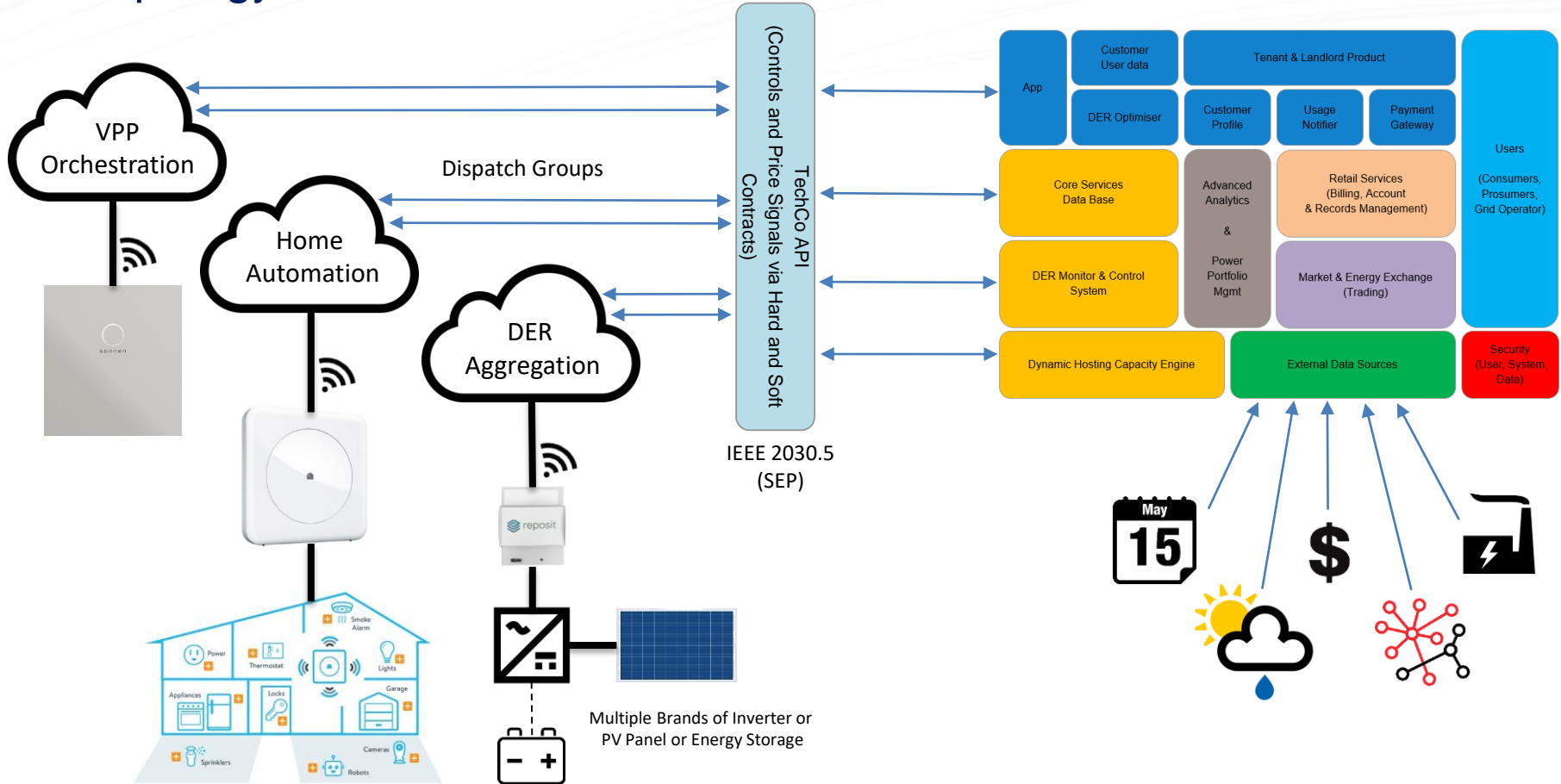


Application Stack

- Flexible and modular architecture
- DER and Grid Integration
- Ancillary & Grid Services
- Advanced Analytics & Power Portfolio Management
- Energy Exchange (Trading)
- Retail Services (Billing, Accounts & Records)
- Profiles for different platform users
- Flexible suite of Customer facing products

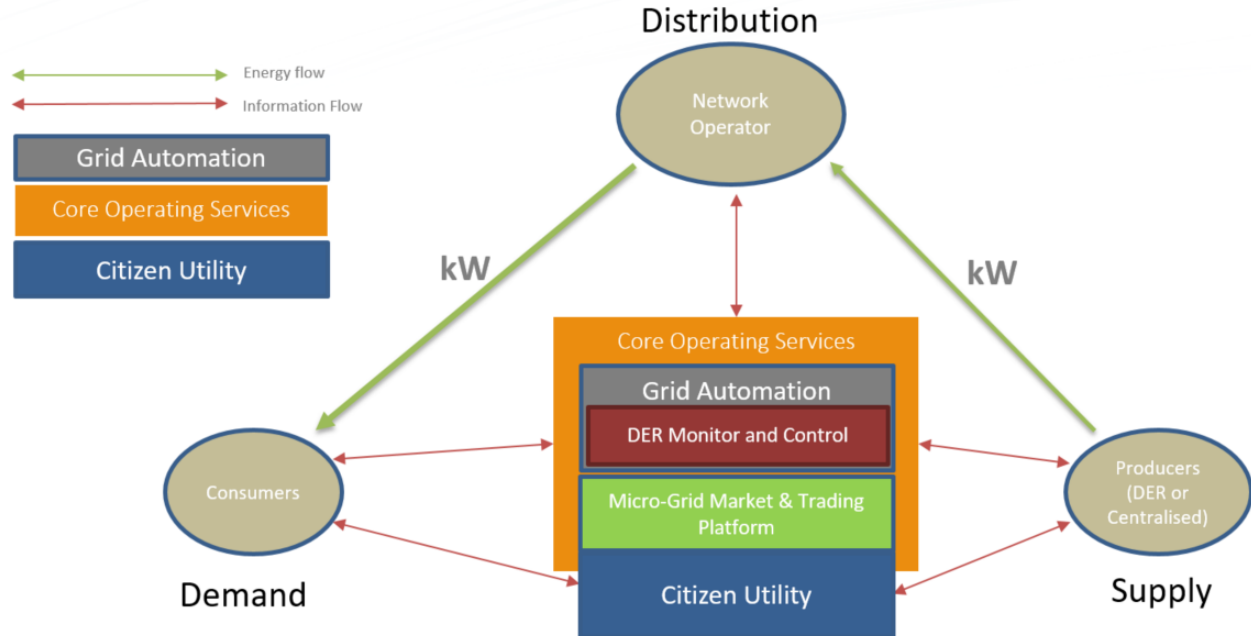


Topology



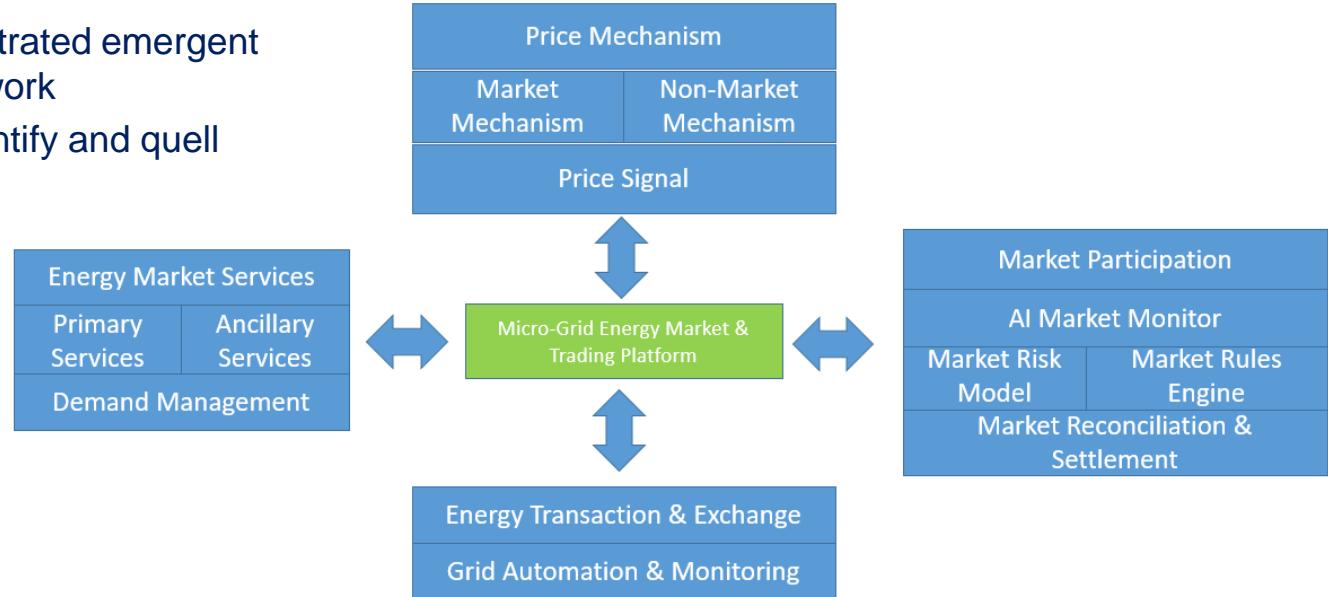
Distributed Energy Market Mechanism

- Peer 2 Pool 2 Peer trading
- Customers trade their energy into the microgrid
- Leverage DER capability to provide ancillary services
- Dynamic price for energy that reflects the abundance of renewables
- Values stored energy during the evening peak
- Drive behavioural change
- Grid aware market



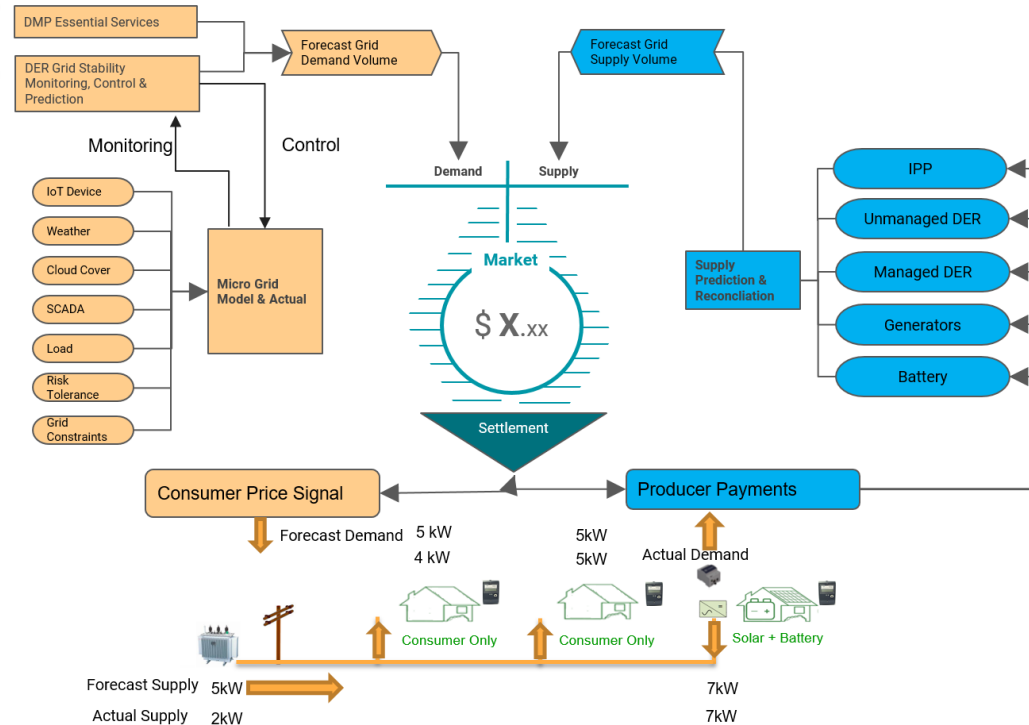
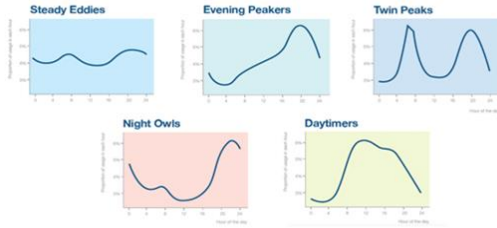
Distributed Energy Market Mechanism

- Runs an Artificial Intelligence engine
- Demonstrated a Machine 2 Machine trading mechanism on an IoT backbone
- Demonstrated a reduction in the price of energy to the customer
- Simulations have demonstrated emergent behaviour across the network
- AI monitor included to identify and quell market manipulation



Distributed Energy Market Mechanism

- Developed a demand side market that seeks the lowest price
- Reposit has a energy supply market mechanism that seeks the highest price
- Supply and demand forces find a price point in the middle



Problems or Opportunities?

Engineers

- Controlling network connected capacity via the Internet
- Handing control of that capacity to a third party
- The third party is using a cloud service....in Sydney
- Third party uses the customers internet connection

Customers

- Customer agreements – what's wrong with my existing bill?
- Boundaries of control – you want to control my PV...are you out of your mind
- Warranties and liabilities – you damaged my battery
- Data ownership – this is my data I own it
- IP ownership – you're making money out of my data
- Metering challenges – that tiny thing is not a real meter
- Broadband availability – I need to patch my what?
- Broadband congestion – you mucked up Game of Thrones...
- Cyber Security – what exactly do you mean by Malware?

Look Ahead

- Open up our API to a wider vendor list
- API integration of Home Automation Products
- Growing sophistication of Inverter Technology to include price signals response, load control and energy management systems
- Likely emergence of an App environment for Inverters
- Dropping cost of measurement and the potential for 'meter-less' devices handling transaction and reconciliation



ARENA

Australian Government

**Australian Renewable
Energy Agency**

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