Integrating microgrids into communities: socioeconomic and technical considerations

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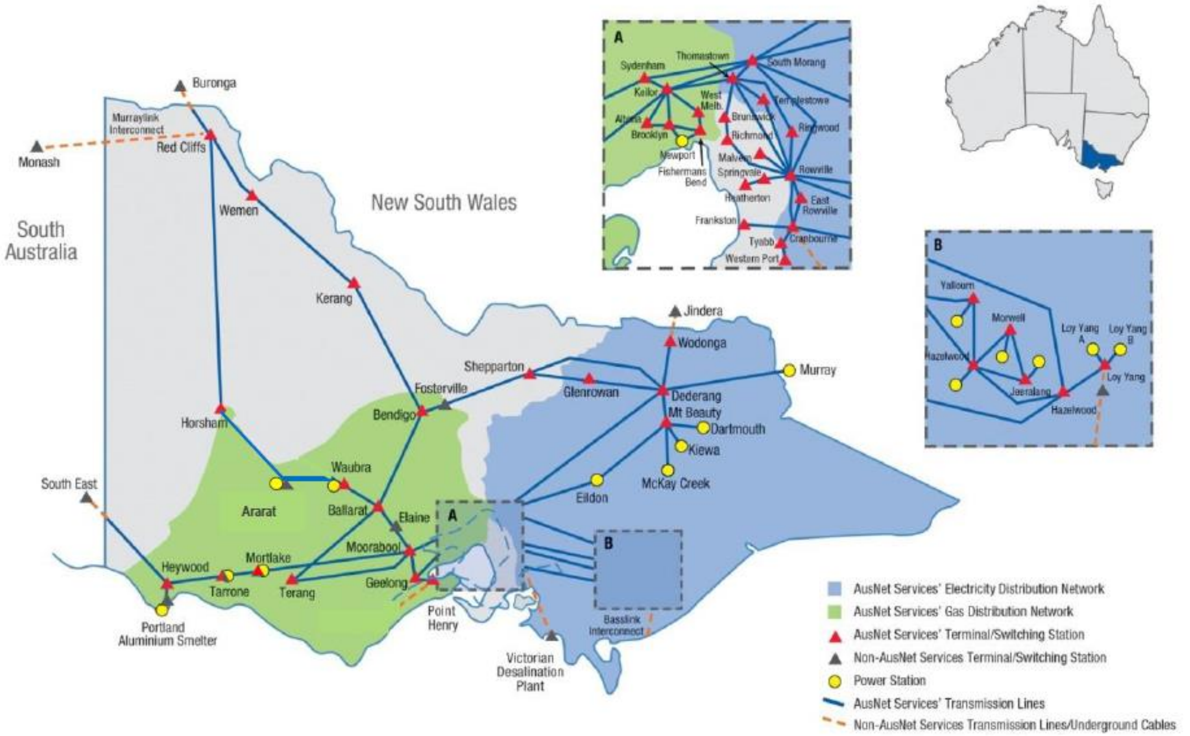
Who we are



Electricity Transmission
- 6,571km of transmission lines
- 13,000 towers

Electricity distribution
- 51,746km of electricity distribution network
- 698,648 customers

Gas distribution
- 10,993km of gas distribution network
- 668,899 customers

Transformation trends behind microgrids

- **Electricity sector undergoing exciting and unprecedented change**
- **Uncertainty is high but trends are evident and are inter-related**

Shift to decentralised energy

Shift to low carbon energy sources

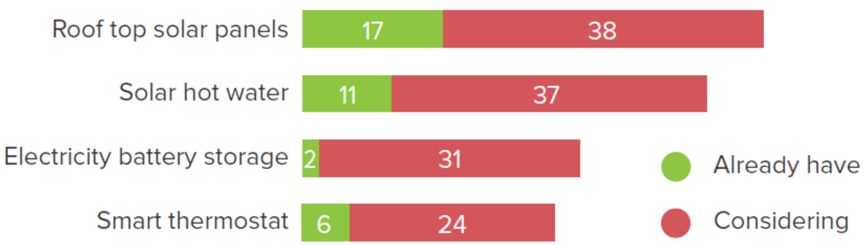
Customers moving from literacy to empowerment

Digital platforms & big data analytics

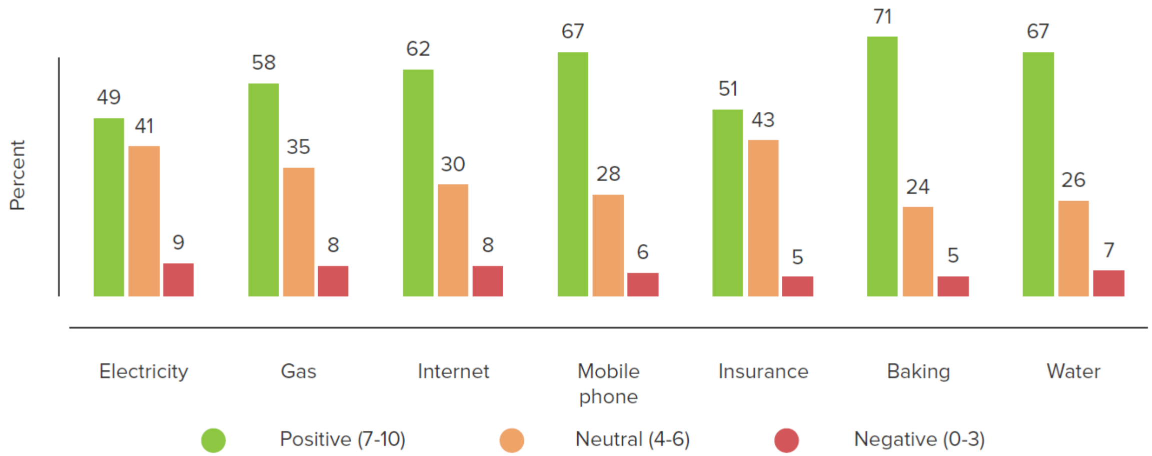
Driver 1: Customers

- **More customers are wanting to take charge of their energy needs, and expect AusNet Services to assist.**

  - Strong interest in new technology



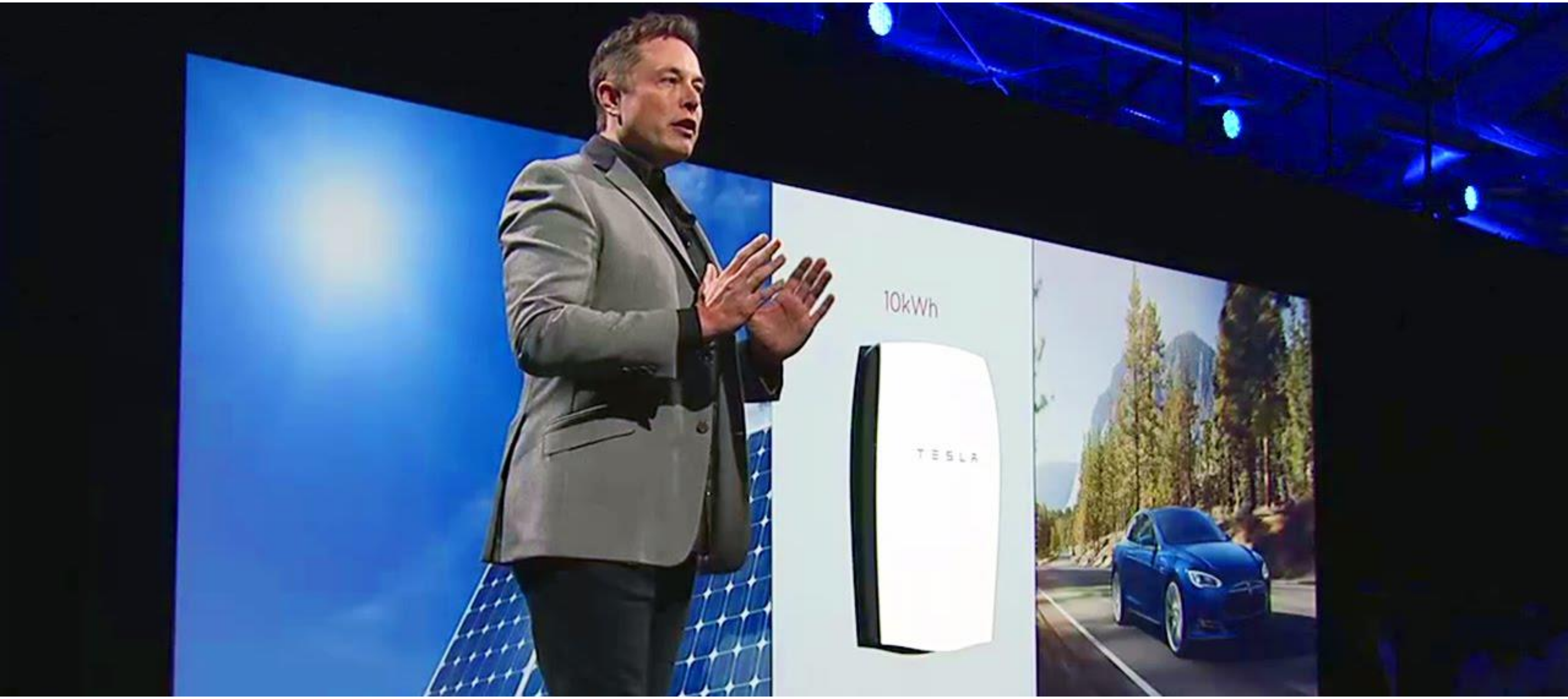
  - Low value perception of retail electricity:



Reference: *Energy Consumers Australia, Energy Consumer Sentiment Survey, July 2016 - Victoria*

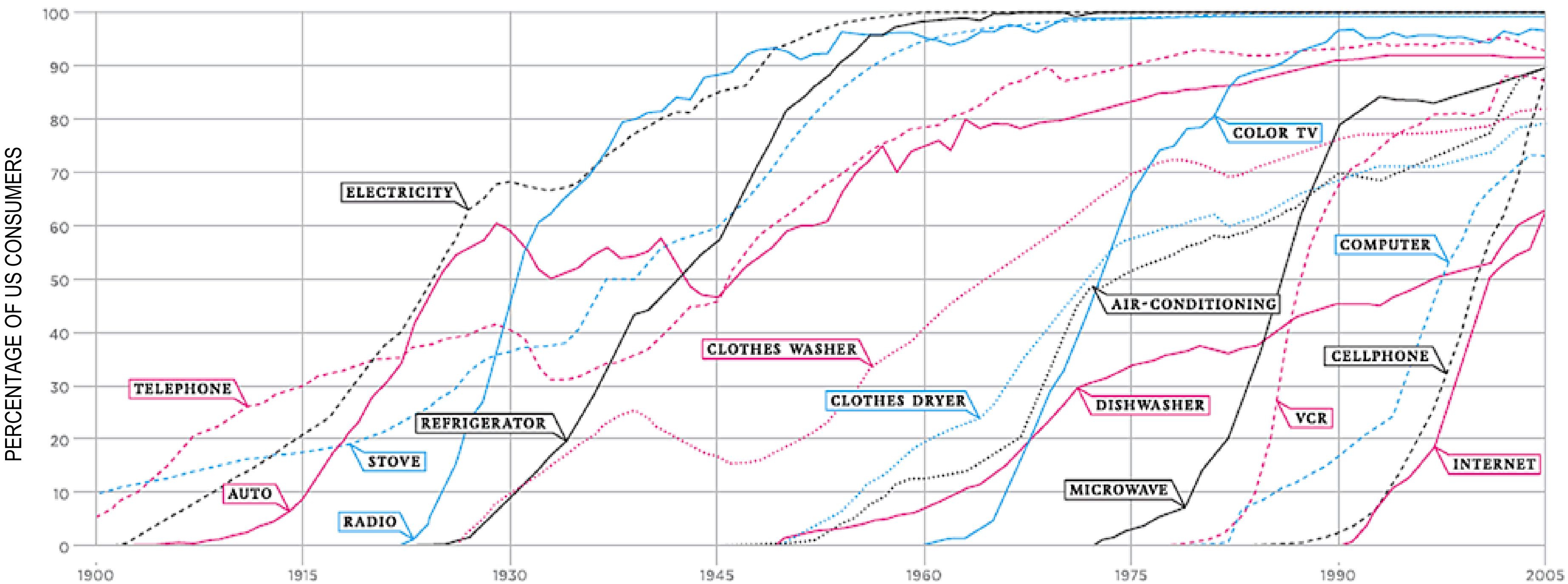
Driver 1: Customers

- **Energy technologies are becoming real consumer products**



Driver 1: Customers

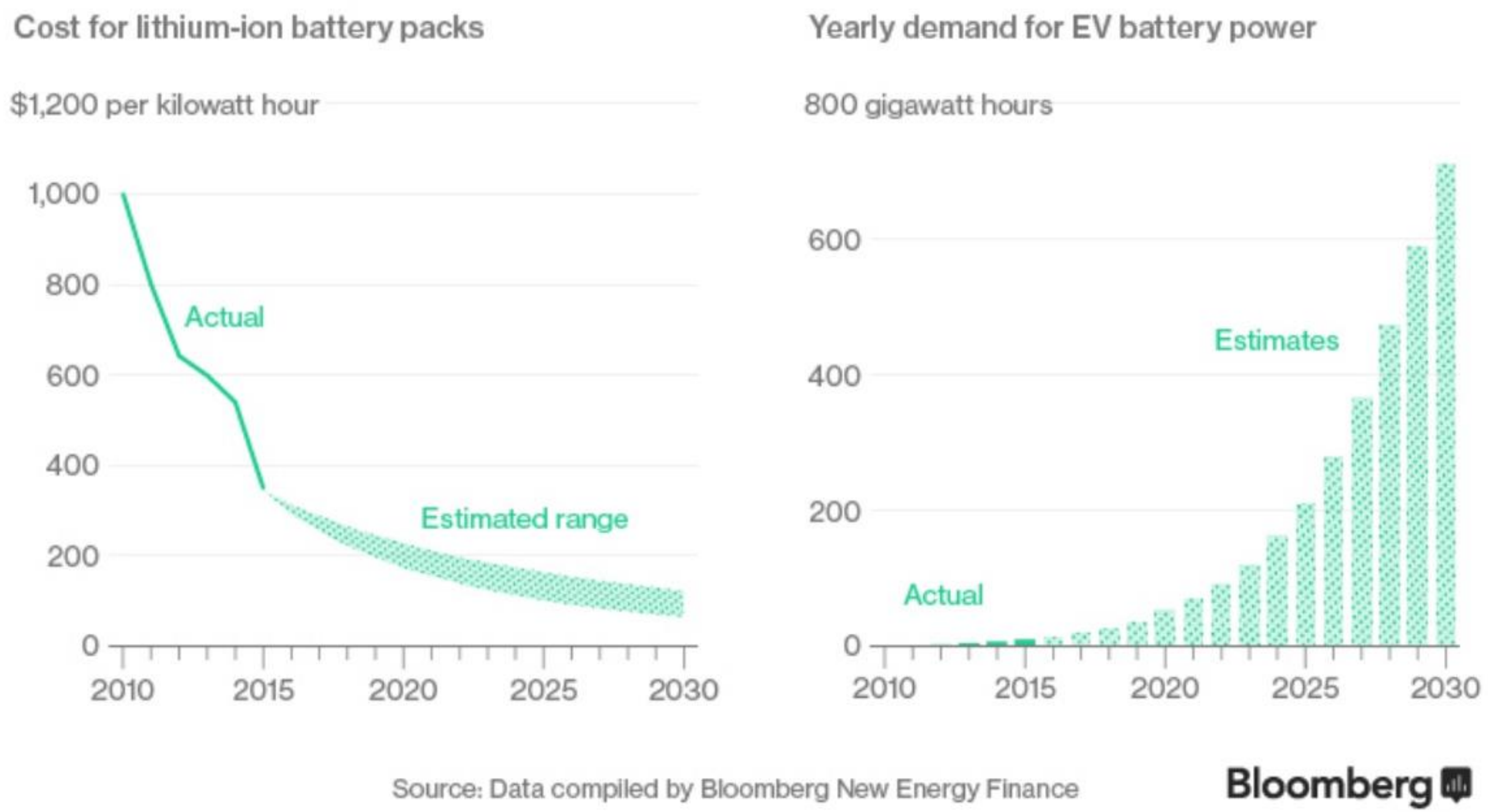
- **Customer uptake of technology uptake can be fast and unanimous**



Reference: *New York Times, http://www.nytimes.com/imagepages/2008/02/10/opinion/10op.graphic.ready.html*

Driver 2: Technology

- **Technology costs can plummet**



Driver 2: Technology

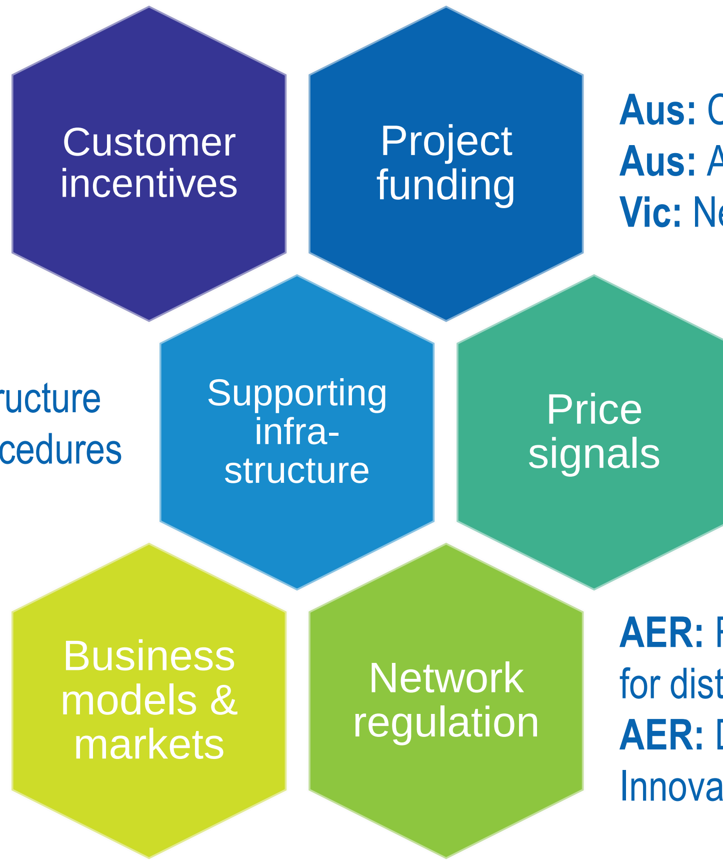
- Digital platforms can facilitate and leverage decentralised energy

Driver (or handbrake) 3: Regulation & policy

- **No shortage of DER policy reforms, but fundamental issues exist**

Aus: Renewable Energy Target
Vic ESC: Feed-in tariffs
Vic: Energy Efficiency Target

Aus: Clean Energy Finance Corp
Aus: Australian Renewable Energy Agency
Vic: New Energy Jobs Fund



Vic: Advanced Metering Infrastructure
AER: Meter Data Provision Procedures

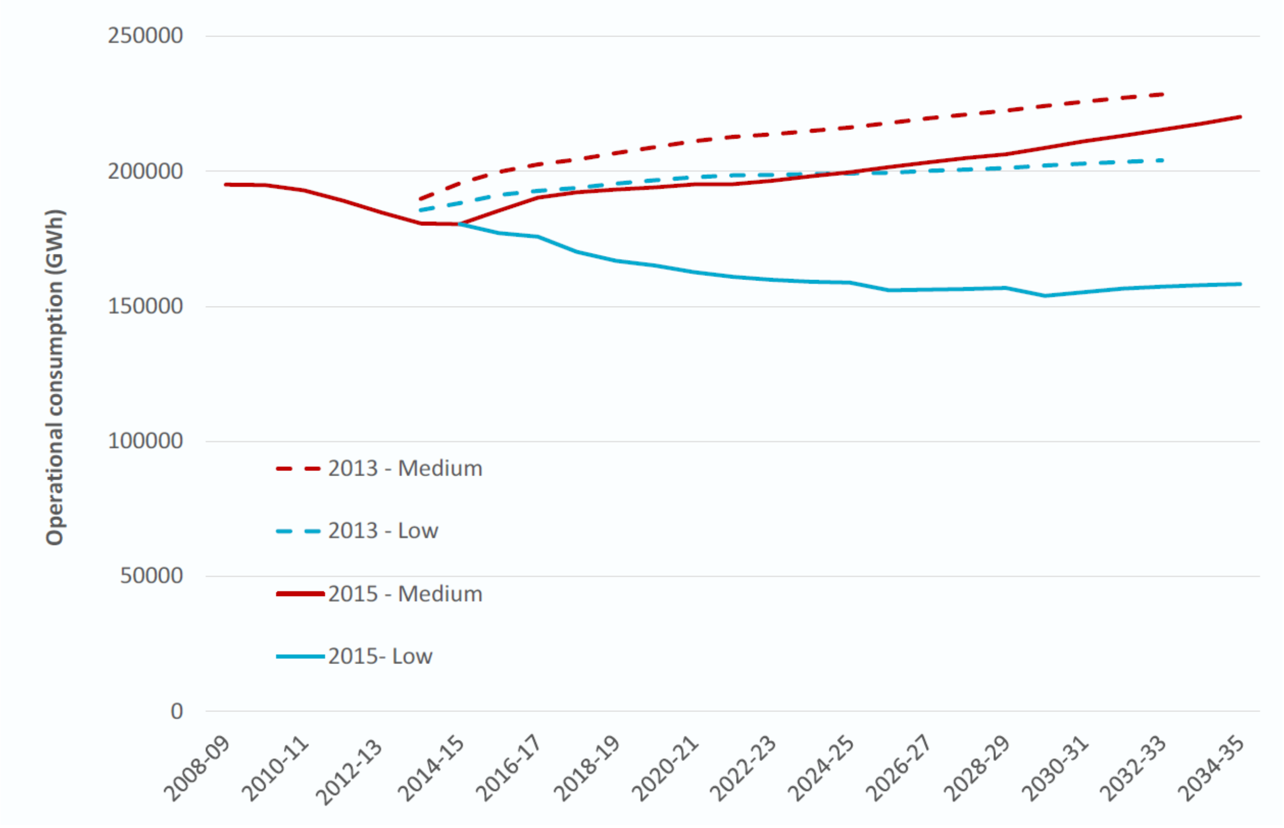
AER: Cost reflective network pricing
Vic: Flexible pricing

AER: Exempt seller framework
AEMC: Demand Response Mechanism

AER: Regulatory Investment Test for distribution
AER: Demand Management Innovation Scheme

Where will this take us?

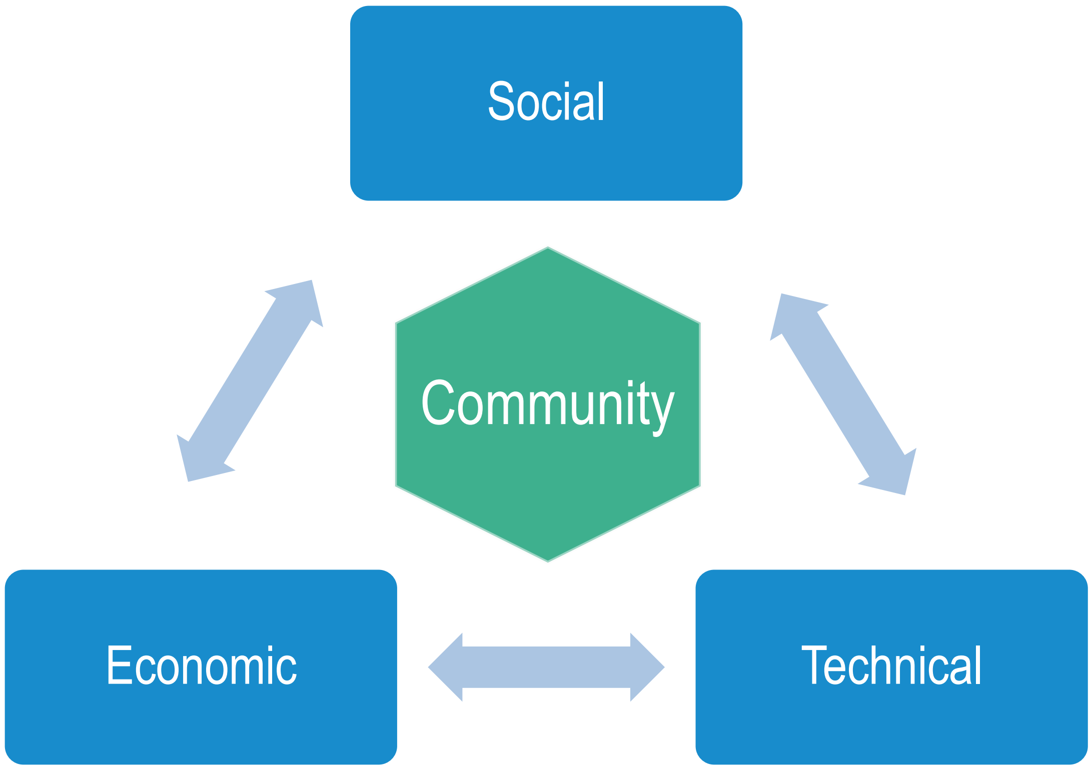
- **Energy forecasts are uncertain – but microgrids and community energy projects are a growing force**



Reference: *Australian Energy Market Operator, 2015*

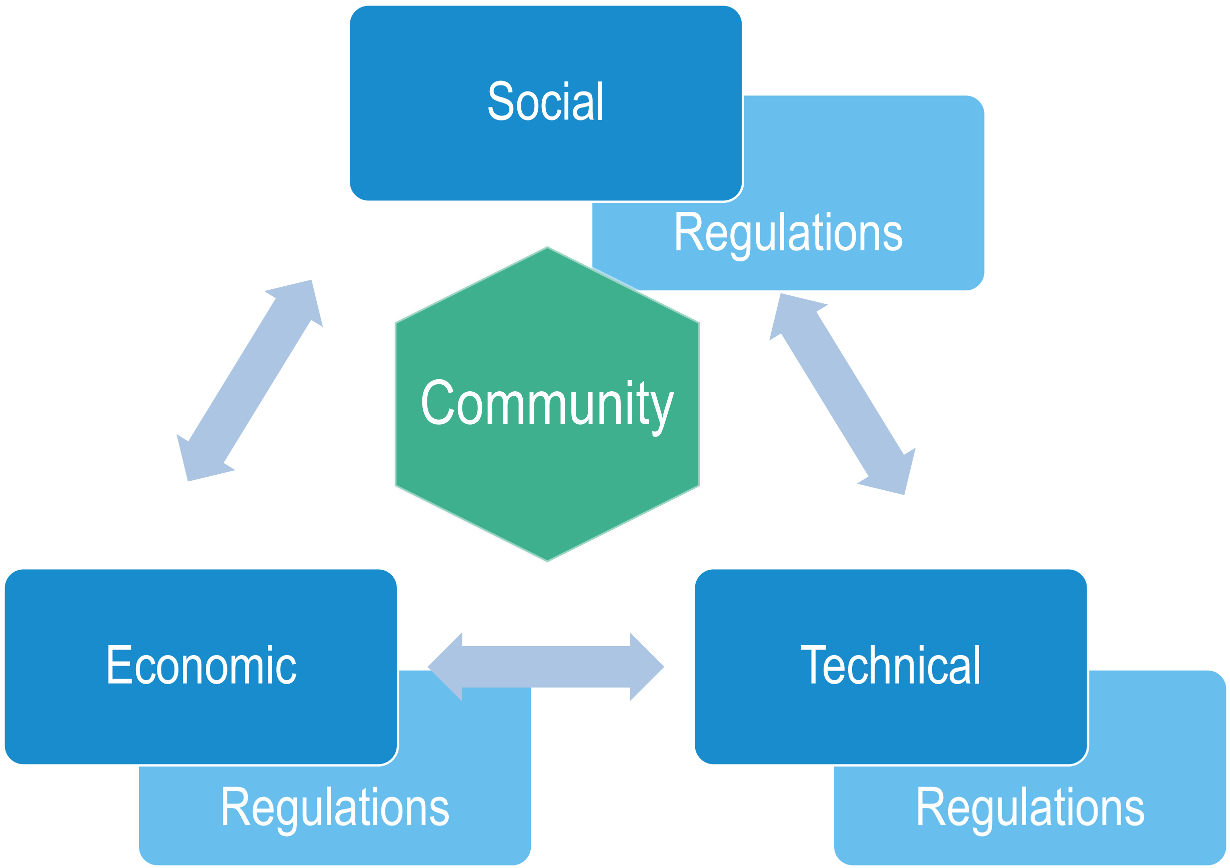
The microgrid integration challenge

- **For success, a microgrid has to integrate on three inter-related levels**



The microgrid integration challenge

- **Regulations play a major role in each integration level**



AusNet Services' perspective

AusNet Services

Regulated Energy Services

Efficient network asset management under an incentives based regulatory framework

- Adapt to customer needs
- Preparing for the network of the future
- Demand management
- Integration of RE
- Improved reliability
- Improved power quality

Commercial Energy Services

Unregulated investment in returns and growth opportunities in energy sector

- Deliver customer microgrid needs
- Microgrid solution design
- Financial structures
- Asset ownership
- Acquisitions

Regulated Network Strategy: the Distribution System Operator

- **Base assumption:** We will have a high DER future

Uncoordinated customer investment and operation of DER is inefficient

>

An integration platform that improves the reliability, efficiency and value of energy

>

An intelligent, instrumented LV network that facilitates customer choice and control

>

Transform networks to effectively integrate customer DER and optimise network asset utilisation

PROBLEM

VALUE PROPOSITION

MECHANISM

BUSINESS CHALLENGE

Customer value

- **Direct value:** Reduced costs, increased choice, access value streams
  - **Network value:** Efficient asset investment, increased network flexibility & adaptability
  - **Energy market value:** Increased market diversity, resilience and competition

The emerging DSO opportunity

- Manages the network under high DER penetration
- Harnesses the value in dispersed DER through optimisation and control
- The Mooroolbark Mini Grid project is a glimpse into the future

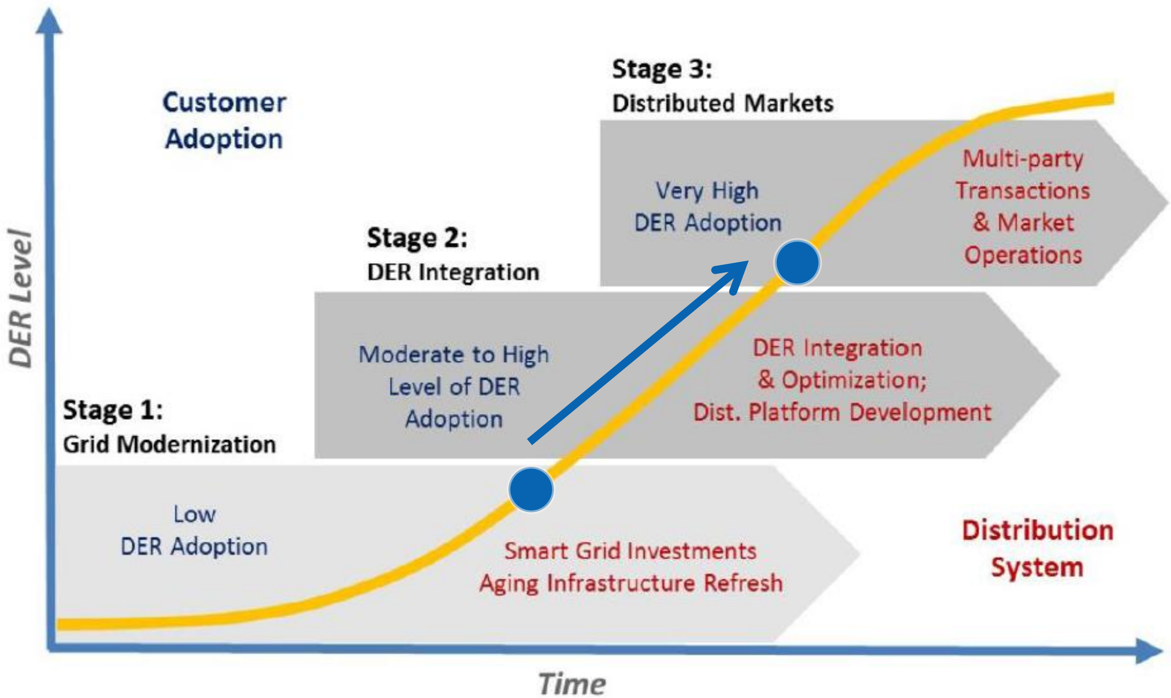


FIGURE: Distribution system evolution

Ref: De Martini, P. & Kristov, L., Distribution Systems in a High Distributed Energy Resources Future: Planning, Market Design, Operation and Oversight, LBNL, 2015.

Case Study 1: The Mooroolbark Mini Grid
Testing the DSO function in a Mini Grid construct

- **Mini Grid Trial objectives**
  - Test the technical viability & understand challenges
  - Understand the commercial value of DSO applications

- **Our Mini Grid definition:**
  - Multiple interconnected customers and supply sources (generation or storage) that have a common point of connection to the main grid, but can **coordinate** supply & demand **separately** from the main grid

1. AusNet Services main power grid. 2. Mini Grid powerlines and poles. (Existing infrastructure). 3. Solar panels . 4. Storage batteries

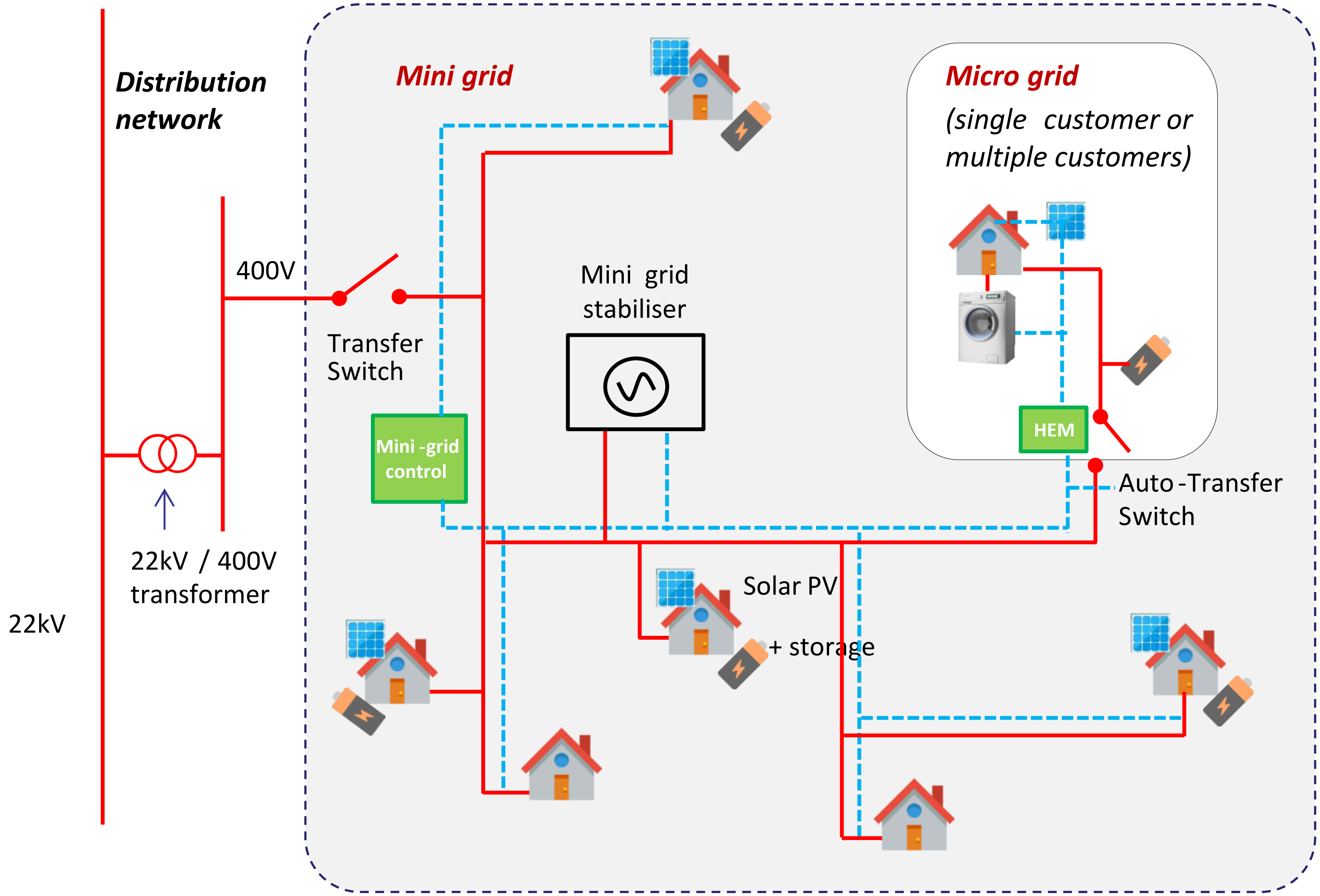
Project Site

Mooroolbark CYN31 Feeder

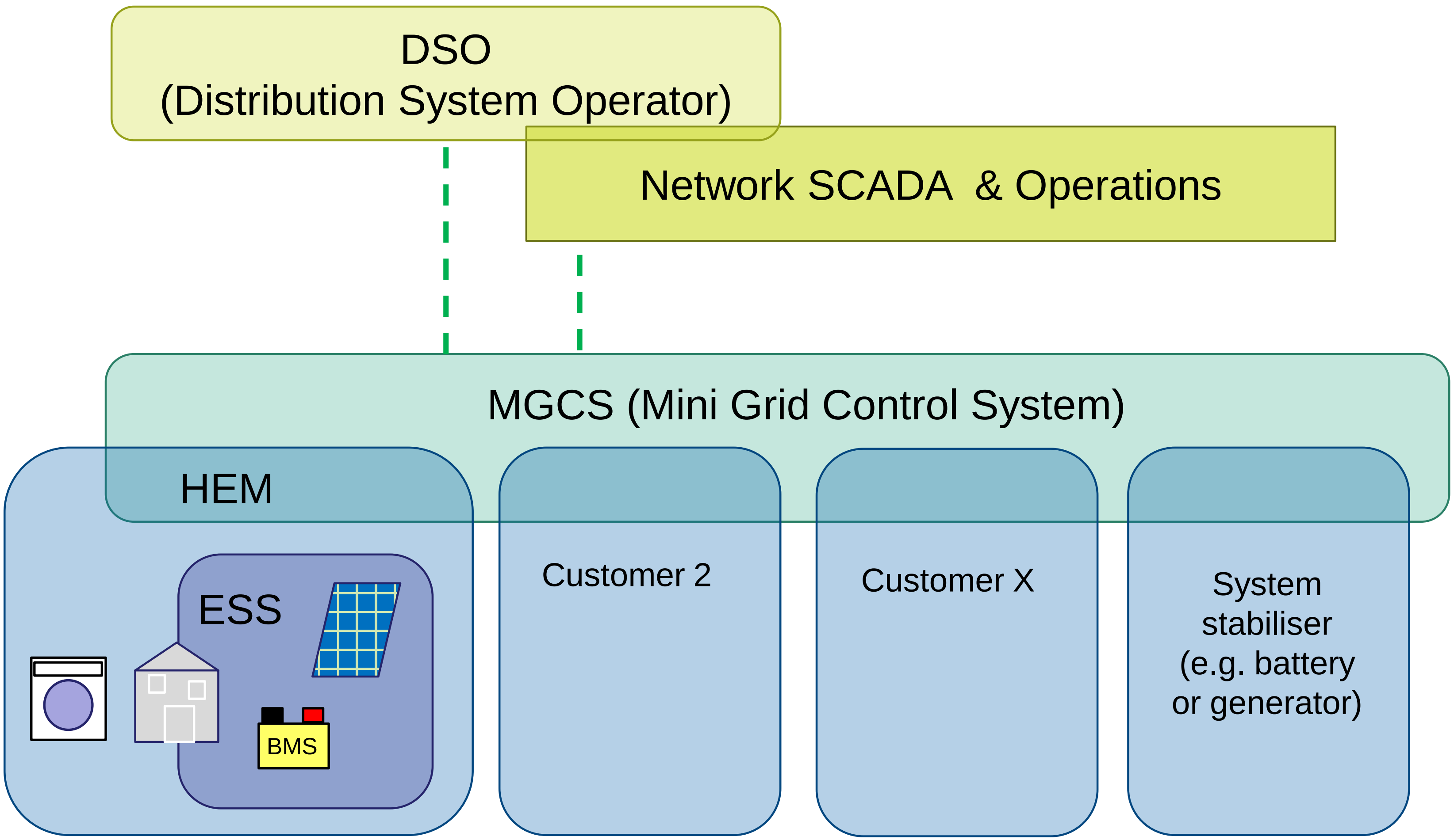
Mini Grid conceptual system design

Key attributes:

- ***Customer preference***
- ***Control***
- ***Optimisation***
- ***Services***
- ***Islanding***
- ***Exploits diversity***



Conceptual control design



Trial operating configurations

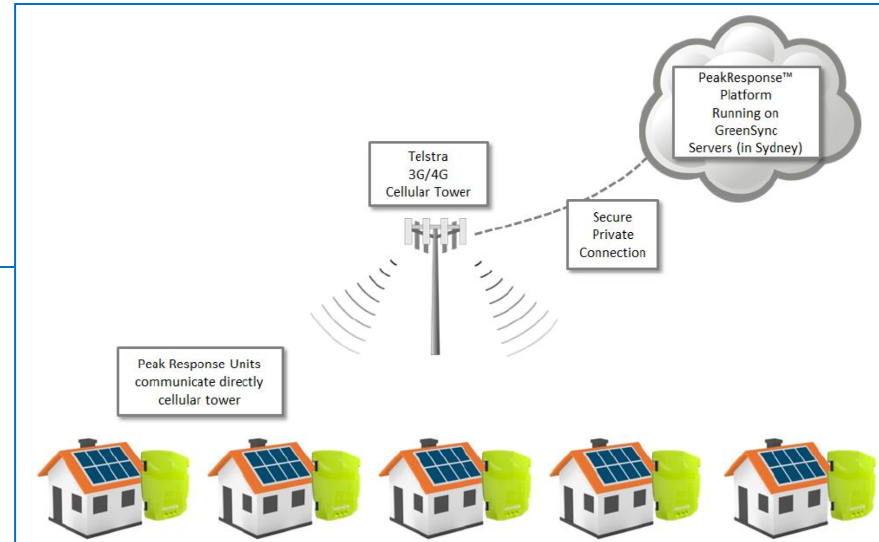
- **Test case 1: Grid connected (Normal mode)**
  - Most time spent in this configuration
  - Mini Grid is grid connected but can co-ordinate resources to:
    - Provide network support to grid
    - Optimise power within minigrid
    - Manage solar PV exports
    - Share power between customers, etc
    - Participate in energy markets

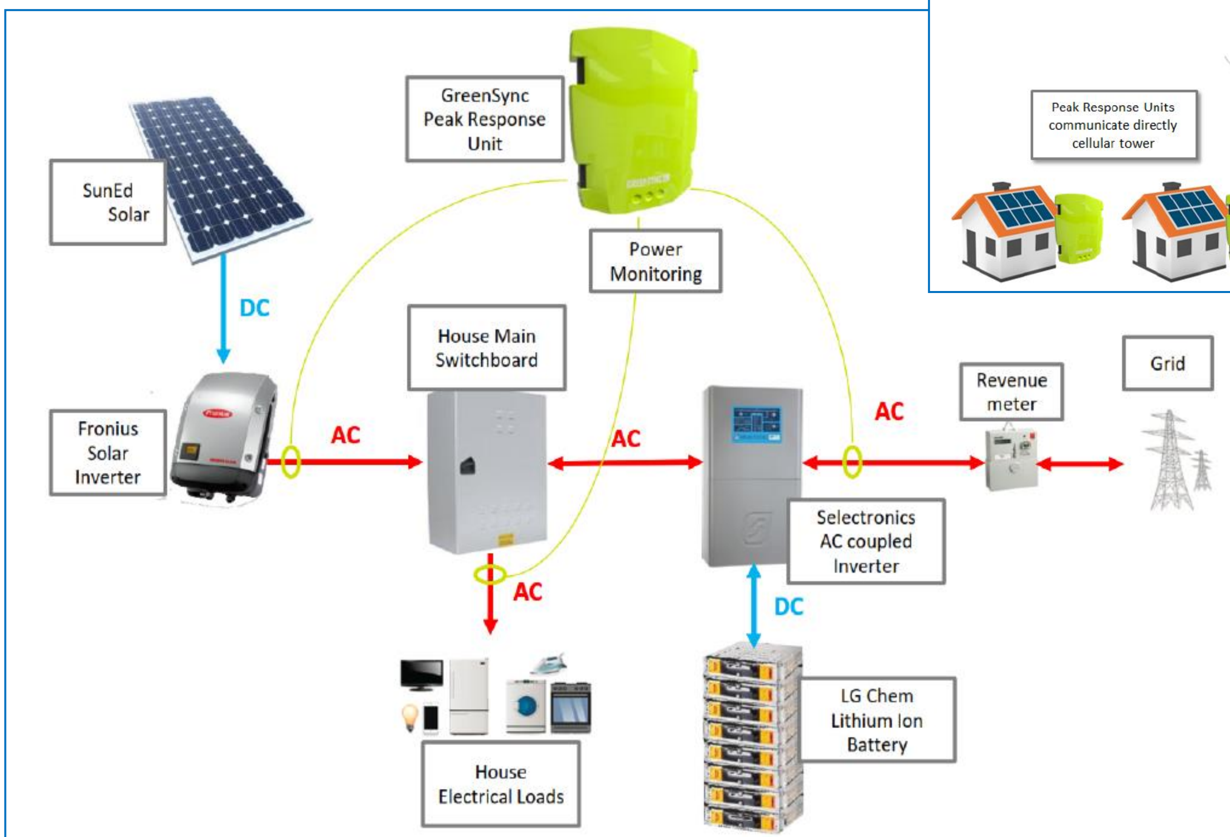
- **Test case 2: Home is islanded (UPS mode)**
  - Battery & PV provide backup supply to home

- **Test case 3: Minigrid is islanded (network of 16 customers)**
  - Mini Grid disconnected from main grid, but minigrid LV remains energised

Distributed energy equipment

Distributed energy specs:
- *3kW+ PV: SunEdison & Fronius*
- *5kW Selectronic battery inverter*
- *10kWh LG Chem Li-ion batteries*





Control specs:
- *GreenSync 'Peak Response Unit' (RTU)*
- *4G comms*
- *GreenSync cloud based control platform 'MicroEM'*

Centralised energy equipment

- **Switching cabinet** **(EIV)**
  - Motorised circuit breaker
  - Power quality meter
  - Current transformers
  - UPS

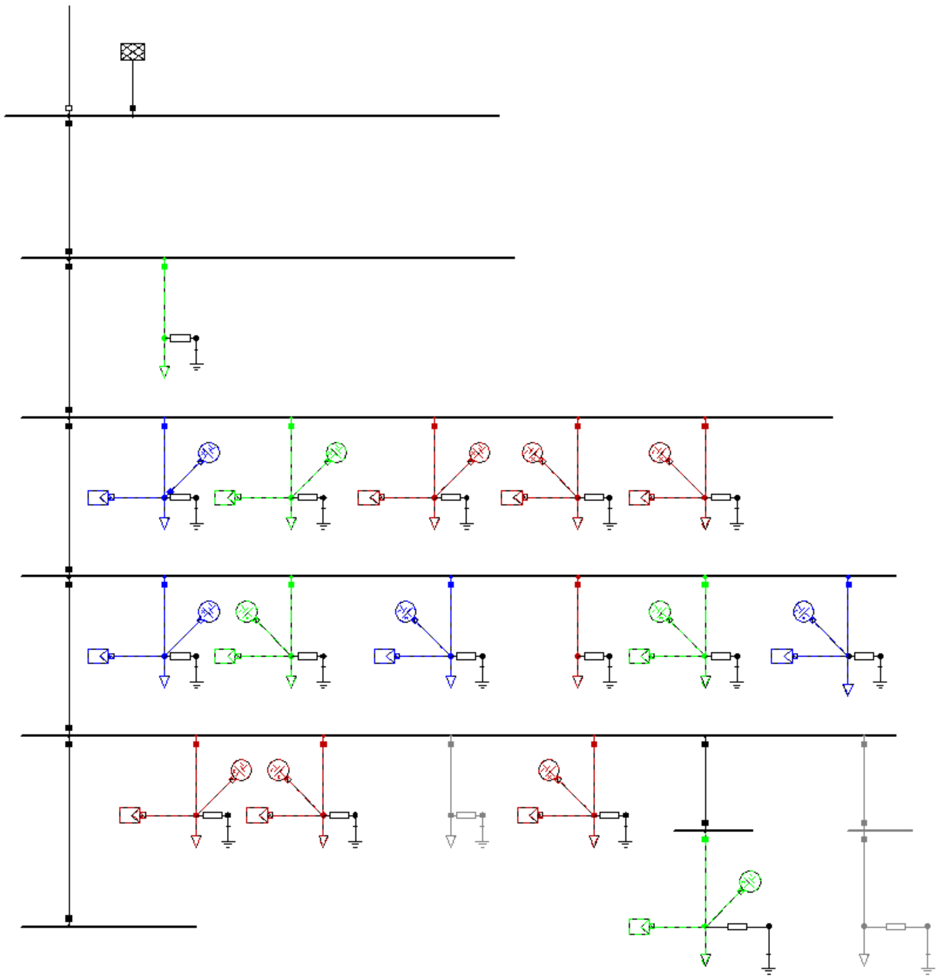
- **Stabiliser unit** **(Power Technology)**
  - 15kVA 3-phase inverter
  - 10kWh battery (high C-rating)
  - Protection relay
  - Initially only active when mini grid islanded

Stability & protection studies

- **DIgSILENT engaged to undertake studies into:**
  - Steady state power flow
  - Dynamic stability
  - Protection

- **Assessment of protection performance**
  - 3 test cases
  - Multiple fault locations
  - Low fault current environment

- **Stabiliser picks up transient power surplus / deficit**



Social integration

- Aim to achieve customer acceptance
- Build excitement and interest
- Role of informal community leaders
- Role of local Government
- Sense of empowerment
- Noise issues
- Safety review

Economic integration

- **Trial project: Attractive offers to customers, not a commercial offer**
- **Simplicity: Customers stay on standard retail**
- **Simple customer-side economics:**
  - $5k for solar – good investement
  - $15k for battery storage - poor investment

- **Trial will run a series of economic use cases under a DSO framework**
- **Economic viability relies on value stacking**
- **Facilitate customer access to different markets (network, wholesale..)**
- **Community retail model**
- **Local trading model**

The DER Integration Proposition

What is it, and what makes it work?

AusNet services

Investors

Customers

Energy Networks Businesses

Retailers

Market Actors
(>energy)

Others?

Resources

Generation

Energy Storage

Active Load Management

+/- Real Power (P)

+/- Reactive Power (Q)

Reducing CO_2 Emissions

Time Duration

Economic Value

- Energy Arbitrage
- NEM Participation
- Demand Management
- Supply Continuity
- Renewable Energy Certificates
- Flexibility Services
- Quality of Supply
- Peer-to-Peer Trading
- Reduced Network Losses
- Social/Environmental
- Alternative Supply

- Scale of resources ?
- Whom should invest ?

- Access
- Leverage
- Monetise

- **Market Framework**
- **Technology Platform/s**
- **Business Models**

Technical integration

- **Standards: fast moving, gaps, international vs Australian**
  - › Industry standards
  - › Internal policies
- **Safety: Protection system performance**
  - › Low fault currents
  - › Legacy equipment
- **Interoperability: 3 x suppliers**
  - › integration challenge bw protocols and devices
- **Design & performance**
  - › Models vs reality
  - › Spec sheet vs reality

Case study 2: Yackandandah

AusNet services

AusNet services

Regulated Energy Services

Commercial Energy Services

mondo™

Totally Renewable Yackandandah

AQUAREVO LYNDHURST

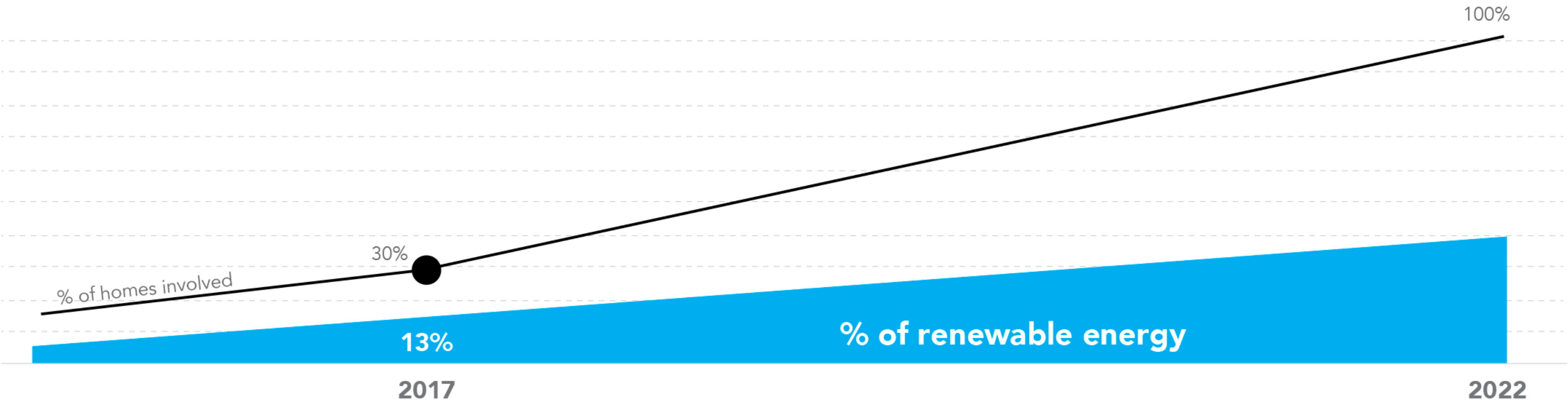
Challenges & lessons

- **Socio-economic**
  - Strong will in community to attain social and environmental benefits, but want it at the same or better price
  - Social aims tend to over-ride environmental aims
  - Business model only works under a common retailer
  - Customer offer needs to be simple
  - Aesthetics and interface important for integration
- **Technical**
  - Lack of interoperability and standardisation
  - Proprietary control systems
  - Network limitations
  - Lack of depth in supply market
  - Technical challenges from aesthetic design

Social integration:
The renewable energy journey

Solar power

Solar power at the home



Social integration:
“Ubi” Smart home energy system

Helpful hints like:

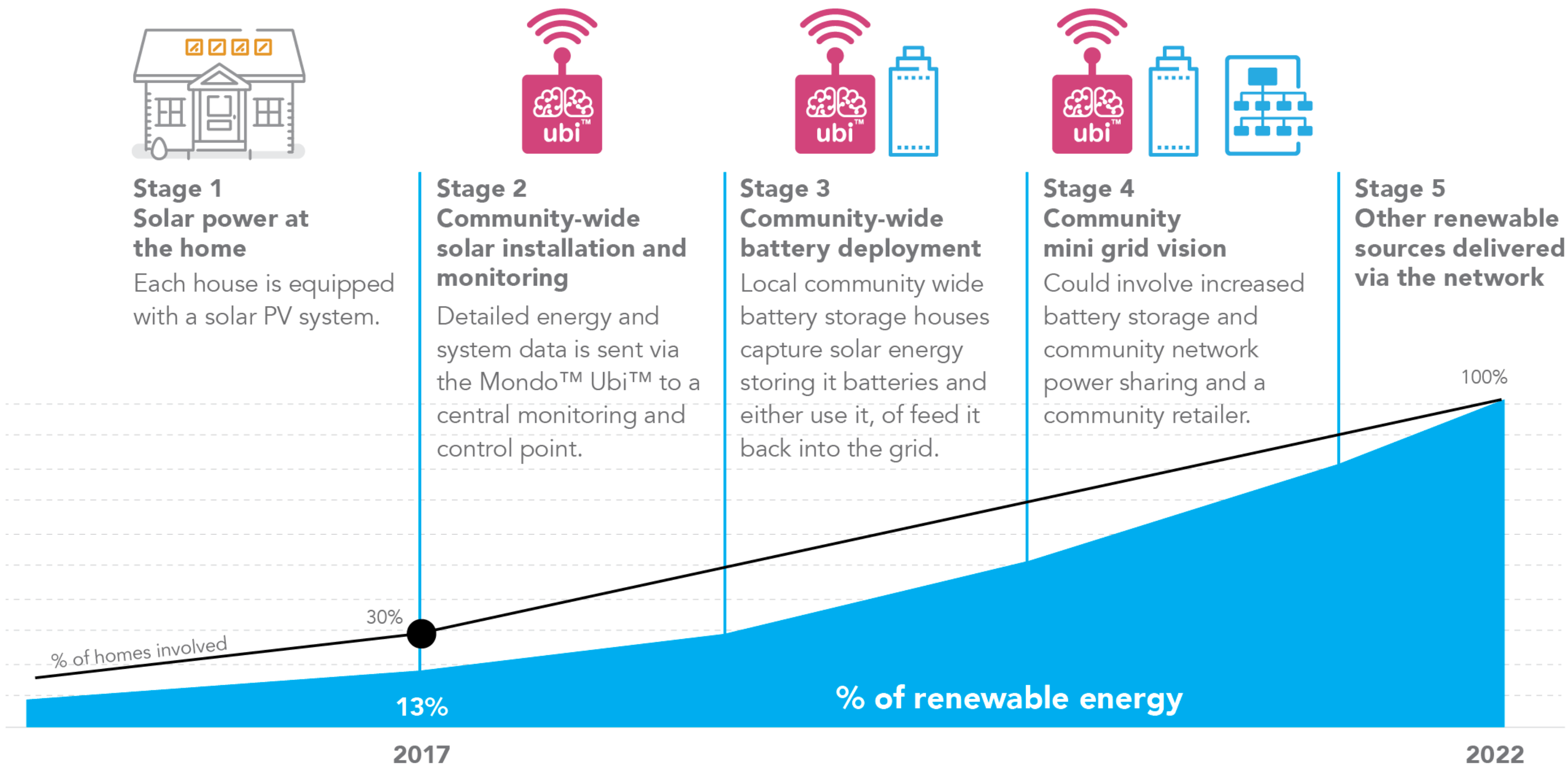
You're using a lot more power this week.

It's time to think about adding a battery to your system.

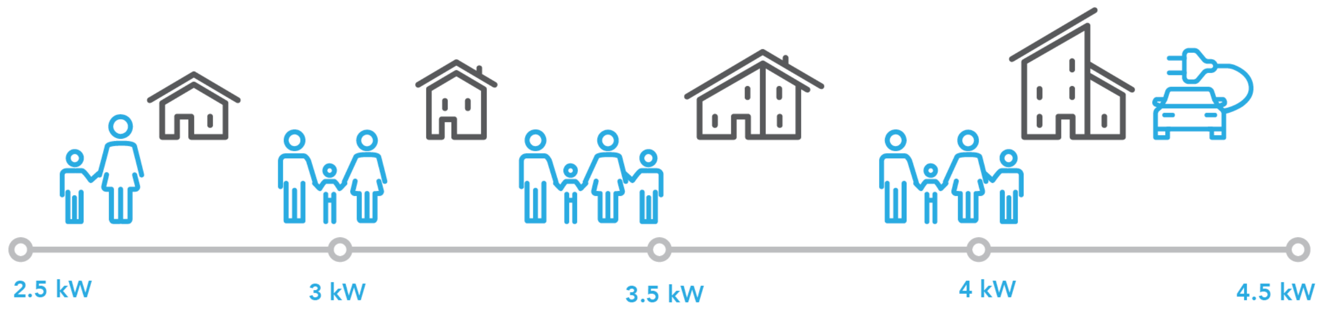
Time to clean your solar panels.

Consider changing to a different tariff.

Social & economic integration: The mini grid vision



THE YACKANDANDAH MINI GRID
UBI + SOLAR STARTER PACK



2.5 kW System	3 kW System	3.5 kW System	4 kW System	4.5 kW System
$72/mo over 5yrs	$80/mo over 5yrs	$88/mo over 5yrs	$96/mo over 5yrs	$104/mo over 5yrs
Buy outright $4320	Buy outright $4800	Buy outright $5280	Buy outright $5760	Buy outright $6240

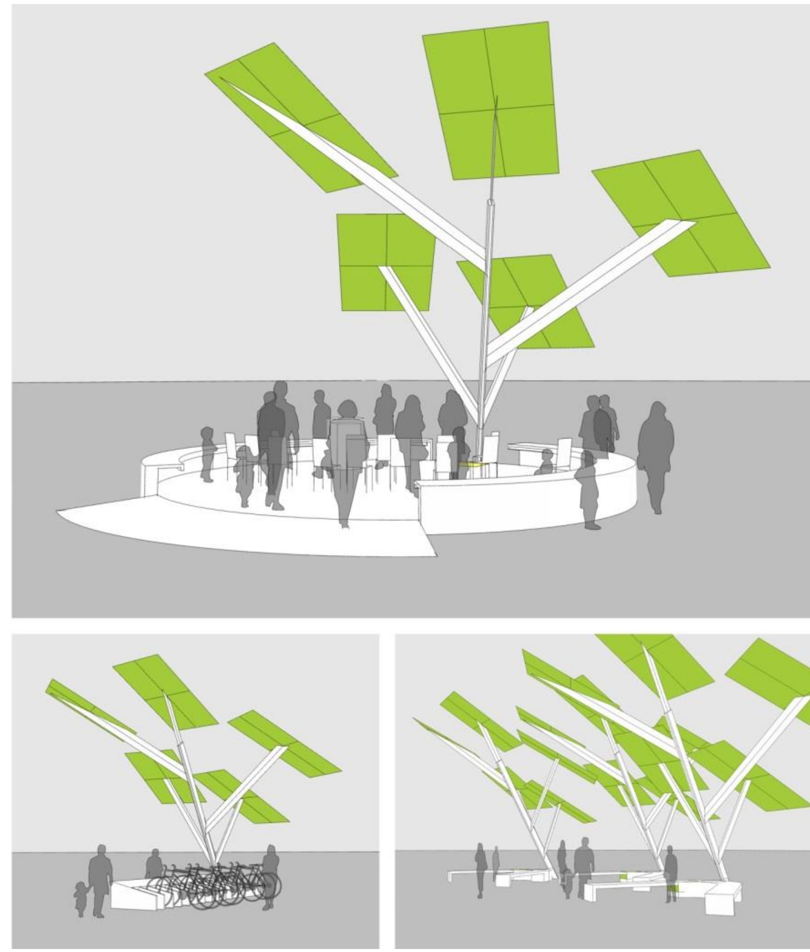
ubi™ **Each system includes the Mondo™ Ubi™ portal with 'Helpful Hints' and access to the online portal that delivers information about your energy consumption.**[3]

Stress free installation
Includes Solar Panels, Inverter, Mondo™ Ubi™ and 5 years access to the online portal and maintenance for 5 years (inspect and clean if required).

Social & technical integration: New product designs

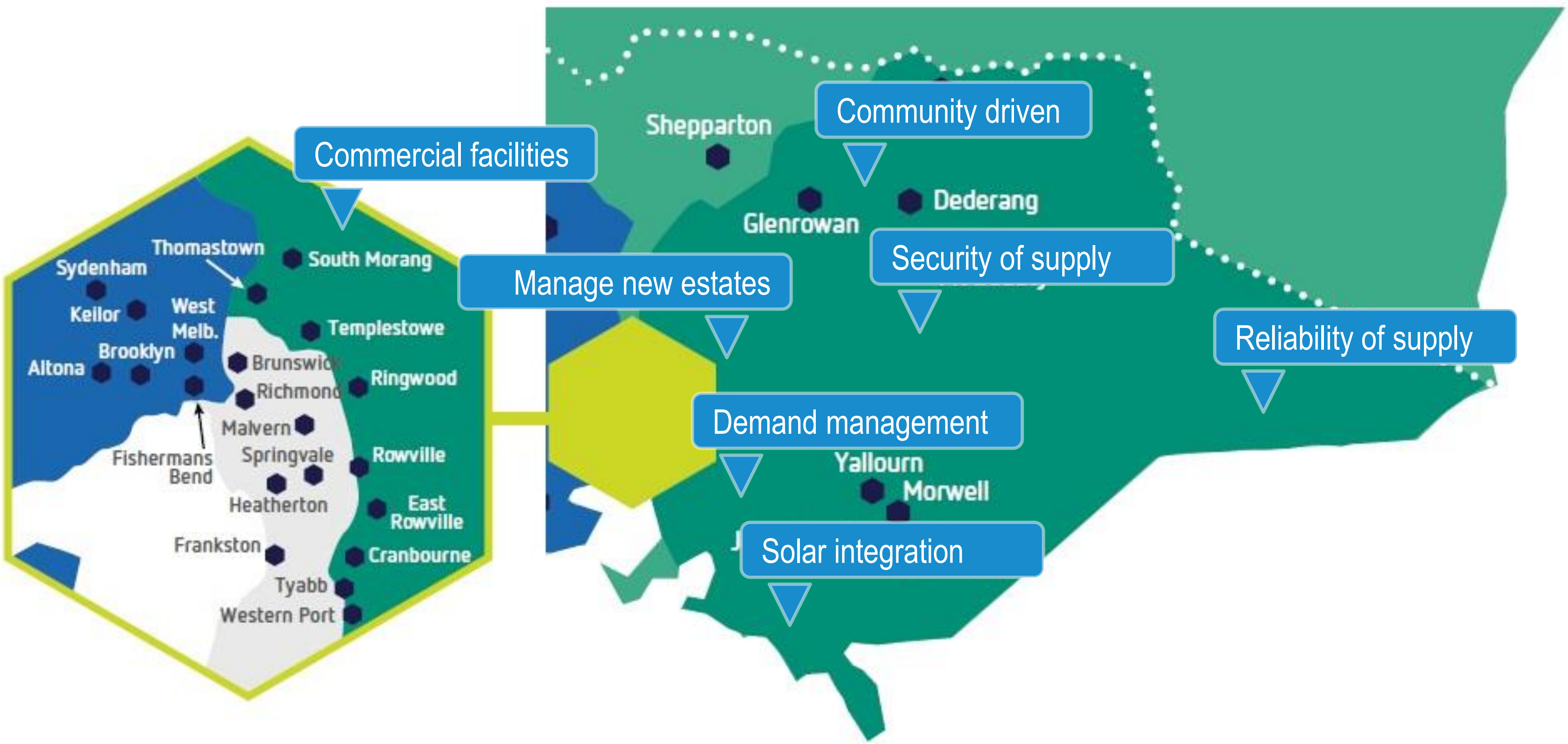
Integration of energy technology into social environment

- **Solar groves for community solar generation**
- **Underground batteries integrated into landscaping**



What could the future look like?

- **Heterogeneous network topology with diversity of microgrid projects**



Thank you

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