UNDERSTANDING SMART GRIDS

A BRIEF OVERVIEW OF NEW ENERGY TECHNOLOGY

The flow on benefits of
microgrids for agriculture

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WHAT MAKES A GRID 'SMART'?

'energy with a brain'

1. Real time data + two way communication from consumer assets to grid operators
2. Two way + flexible energy distribution
3. Complex network control capabilities, sometimes enabled by machine learning
4. Coordination + integration of DERs or other modern grid resources

A smart grid can be thought of as 'energy with a brain', the 'internet of energy', or 'the grid as a platform'.

TRANSITIONING TO SMART GRIDS

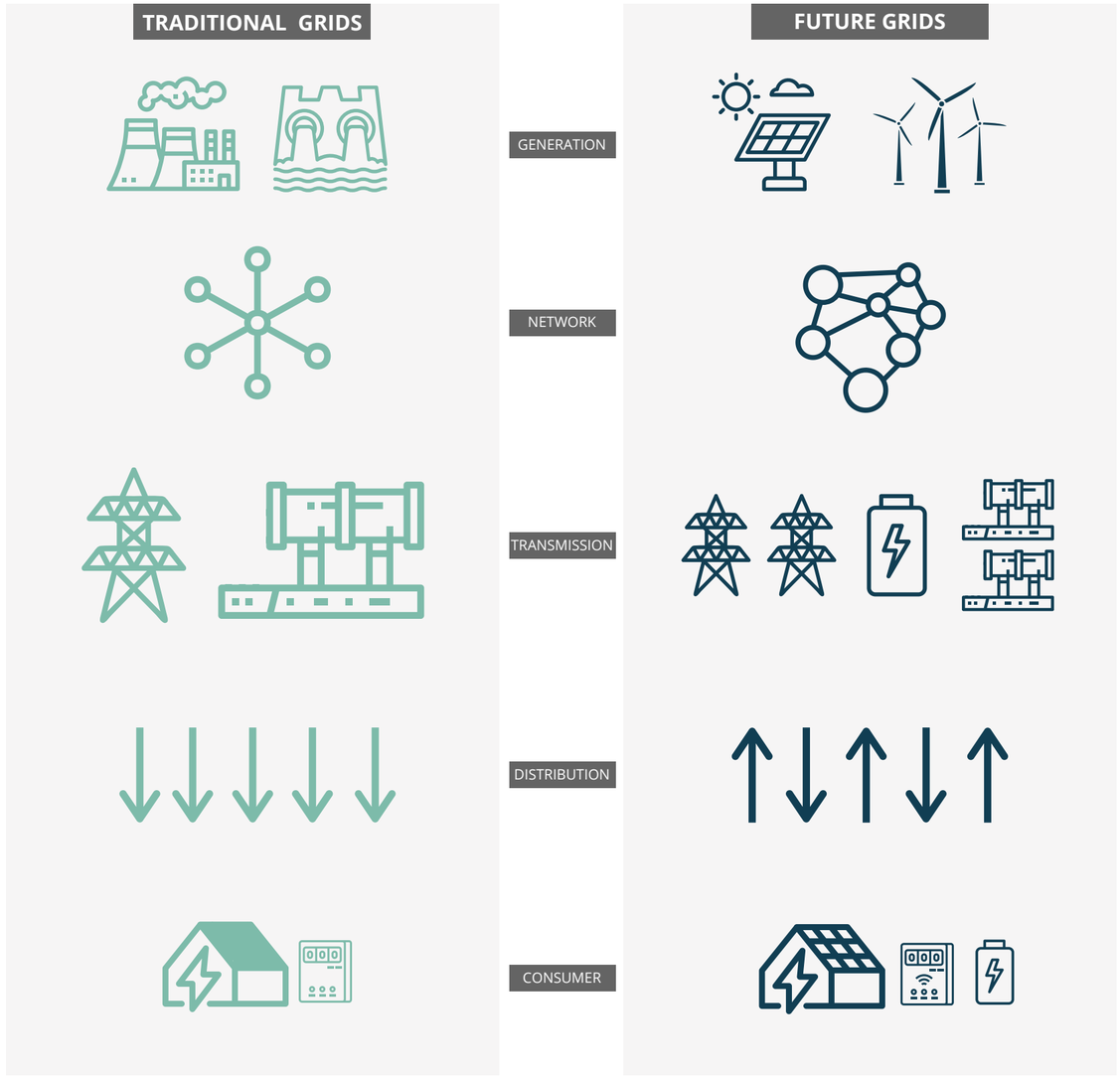
Enabled by an information technology explosion, like artificial intelligence and cloud computing, modern energy networks are transitioning to ***smart grids***.

Grids enabled by smart technology transform traditional technical and economic models for generating and delivering energy to the consumer.

Smart grids can change:

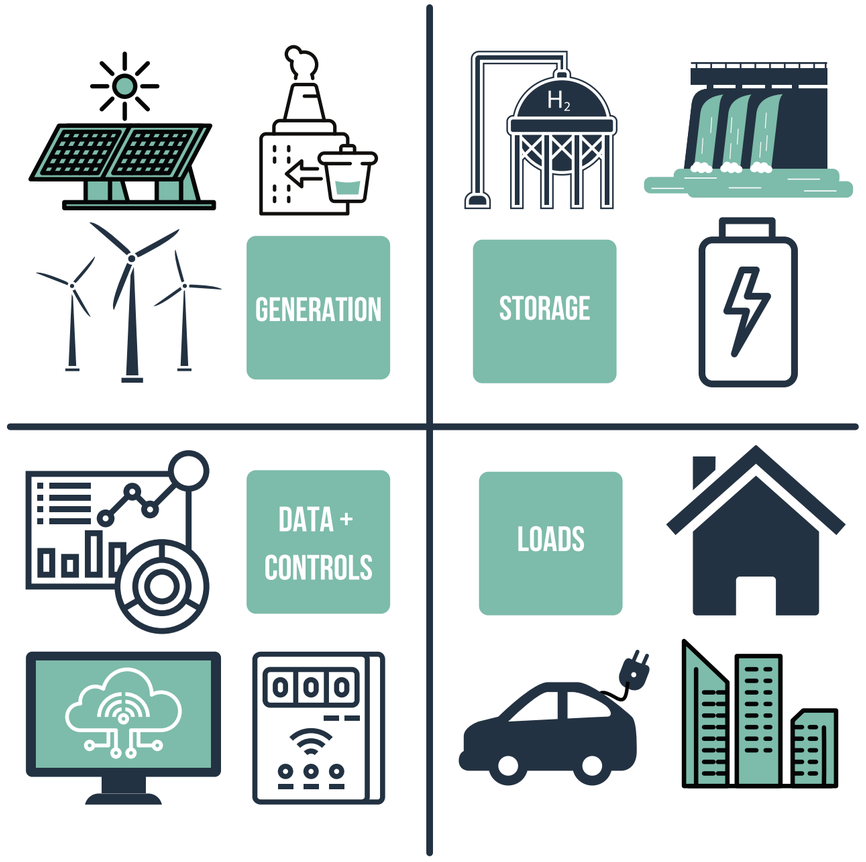
- ***generation*** from large power plants to many smaller, often renewable, power producers;
- ***networks*** from national and centralised markets to decentralised markets;
- ***transmission*** from industrial lines and pipelines to integrating small scale, localised transmission;
- one way ***distribution*** to a bidirectional flow of resources; and,
- the ***consumer*** from a passive recipient to active energy system participant.

Smart tech optimises grids, improving the efficiency of energy networks and resilience of consumers and the communities they live in.



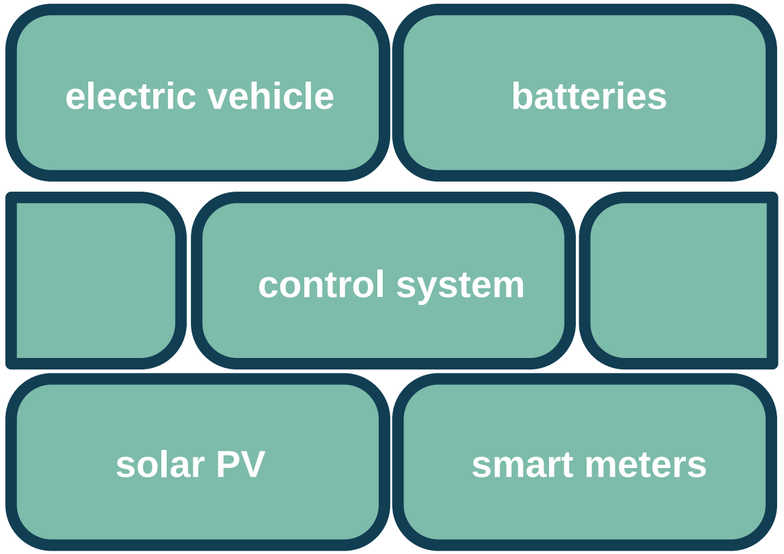
This infographic is an adaptation of *Energy Atlas: Facts and figures about renewables in Europe, 2018*; page 33, https://www.boell.de/sites/default/files/energyatlas2018_facts-and-figures-renewables-europe.pdf.pdf?dimension1=ds_energieatlas

THE BUILDING BLOCKS OF A SMART GRID: DISTRIBUTED ENERGY RESOURCES (DERS)



DERs are energy resources that orient around the consumer, often enhancing their autonomy in the energy market. Characteristically they're enabled by real time data, adaptive controls, cost-effective innovation, and other market mechanisms.

BUILDING SMART ENERGY SYSTEMS



By using DERs as building blocks, a consumer, developer, or utility can configure their desired blend of technologies to create a system suited to their energy needs.

A grid taking advantage of the best modern energy technology has to offer is capable of integrating and harmonising multiple energy system types.

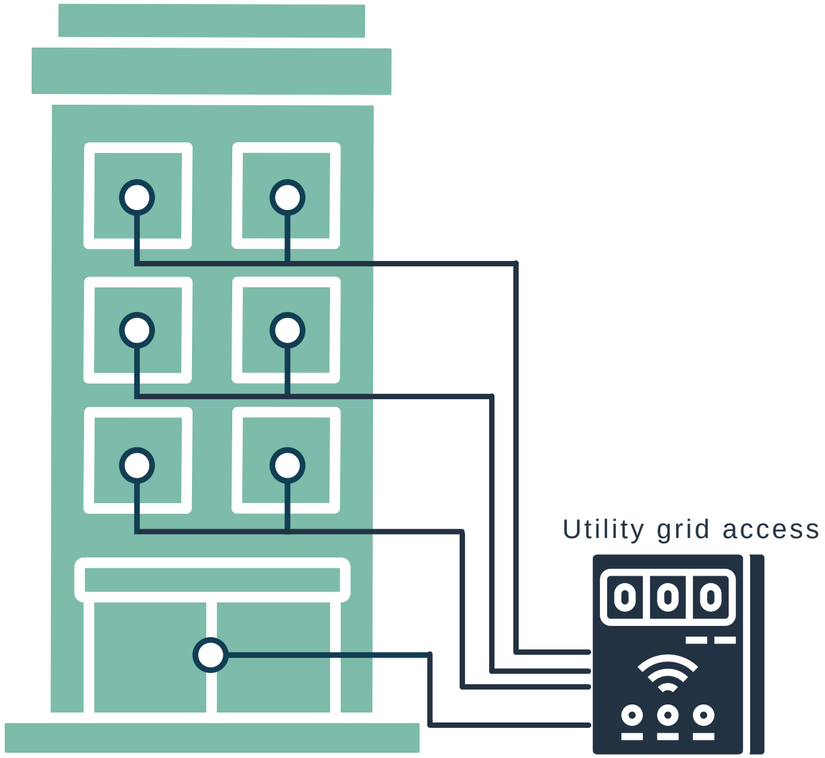
Consequently many utilities or Distribution Network Operators (DNOs) are transitioning to Distribution System Operators (DSOs).

Some of the systems DSOs are considering integrating include:

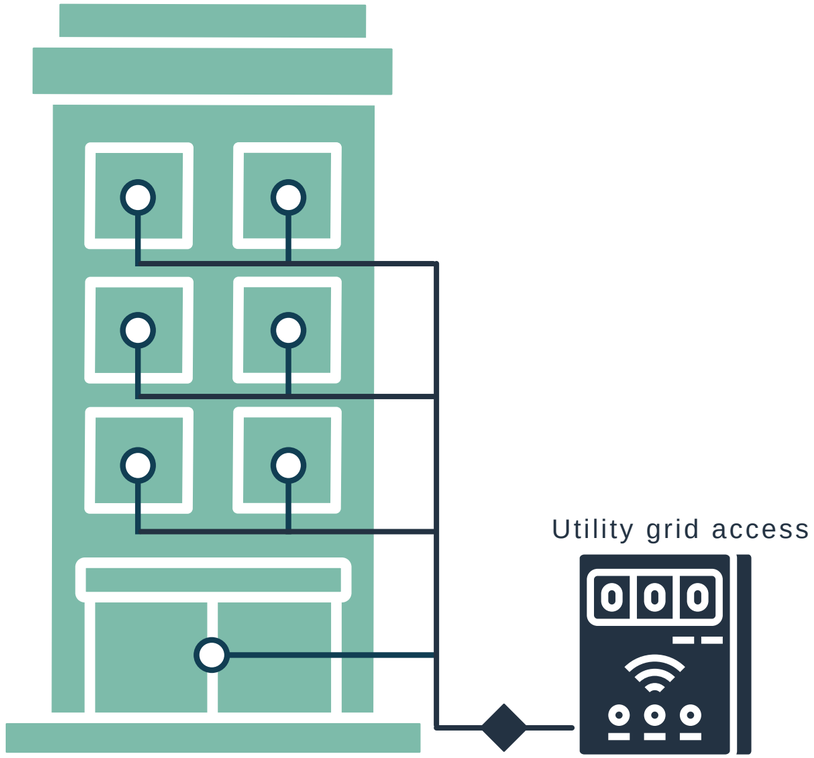
1. Embedded networks
2. Community batteries
3. Virtual Power Plants (VPPs)
4. Microgrids
5. Local Energy Markets (LEMs)

1. EMBEDDED NETWORKS

Apartment **without** an embedded network

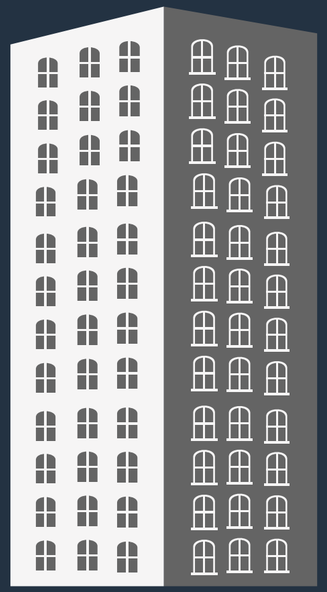


Apartment **with** an embedded network



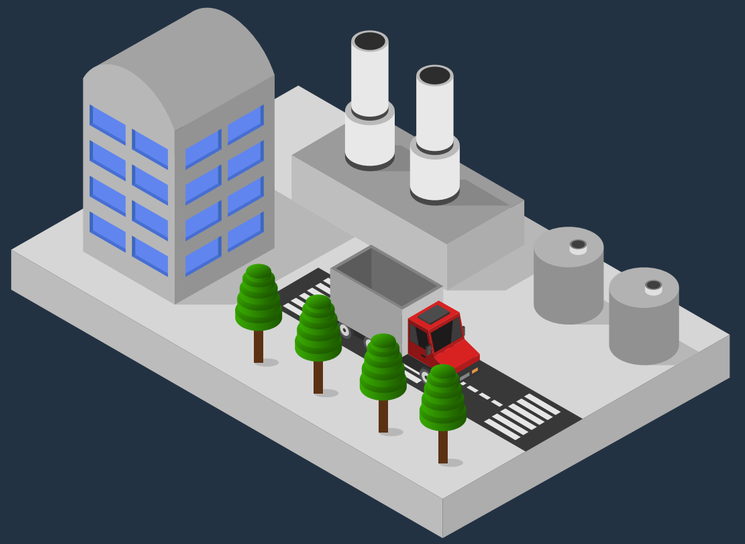
An embedded network is a small group of users whose energy is serviced via a single, parent utility meter.
The embedded network owner sets the embedded network's tariffs and pays network charges to the utility grid.

EMBEDDED NETWORKS IN PRACTISE



Apartment Blocks

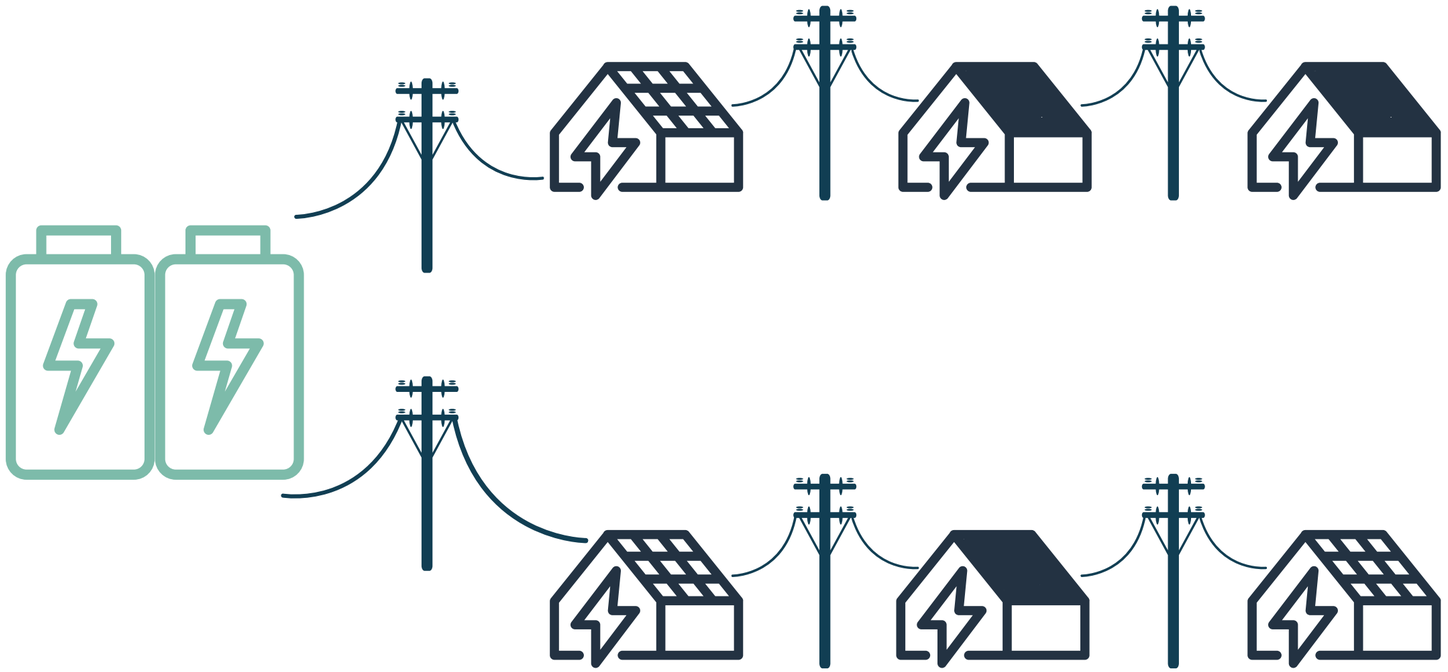
The building owner typically submeters tennants, charging for use and a share of common space consumption.
The state of Victoria has banned residential Embedded Networks due to equity concerns.



Business Parks

Large C&I loads are often consolidated within business parks and offered as a turnkey service, managed by the landholder.

2. COMMUNITY BATTERIES



A community battery is situated within and shared across a community. It is designed to optimise grid performance, locally. For example it can soak up excess solar and reduce night time peaks, stabilise voltage, or provide resilience to grid failure.

COMMUNITY BATTERIES IN PRACTISE

Mallacoota Community Battery - VIC

This 1MWh community battery was developed in partnership with AusNet and Mallacoota's Sustainable Energy Group, a community organisation.

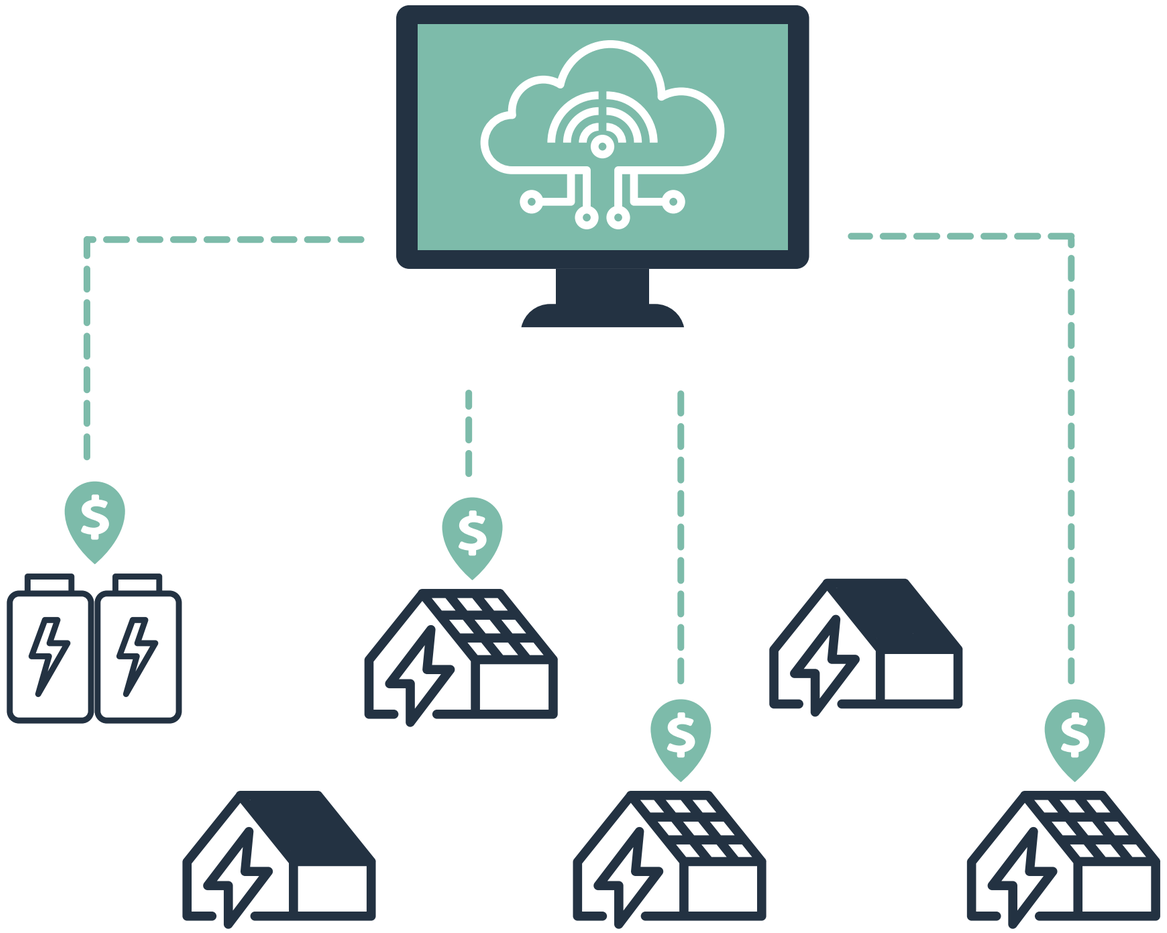
The project was developed with local resilience and decarbonisation objectives.

Energy Queensland Community Battery Fleet - QLD

EQL is rolling out a fleet of 14 network connected 8MWh batteries across major regional town centres.

The trial project is intended to improve network performance and resilience.

3. VIRTUAL POWER PLANTS (VPPS)



A VPP aggregates small scale and independent energy producers, virtually, into a single energy system that is not necessarily restricted to a single segment of the grid. VPPs can also trade excess energy locally or with the national FCAS or spot markets.

VPPS IN PRACTISE

Smart Energy Schools Pilot Project - NSW

The NSW State Government has established a VPP aggregating the benefit of rooftop solar from more than 1,500 public schools across the state.

The project will test how it can reduce school energy and upgrade costs, as well as exploring benefits to local grids.

Tesla Energy Plan - National

Tesla Powerwall customers are eligible to participate in Tesla's nation-wide VPP. Households with solar PV under 15kW per Powerwall have access to grid support credits, flexible Time of Use and feed in tariffs exclusive to the VPP.

Participation depends on your network connection.

4. MICROGRIDS

A microgrid is a *physical* energy grid that generates and distributes electricity in the same geographic footprint.

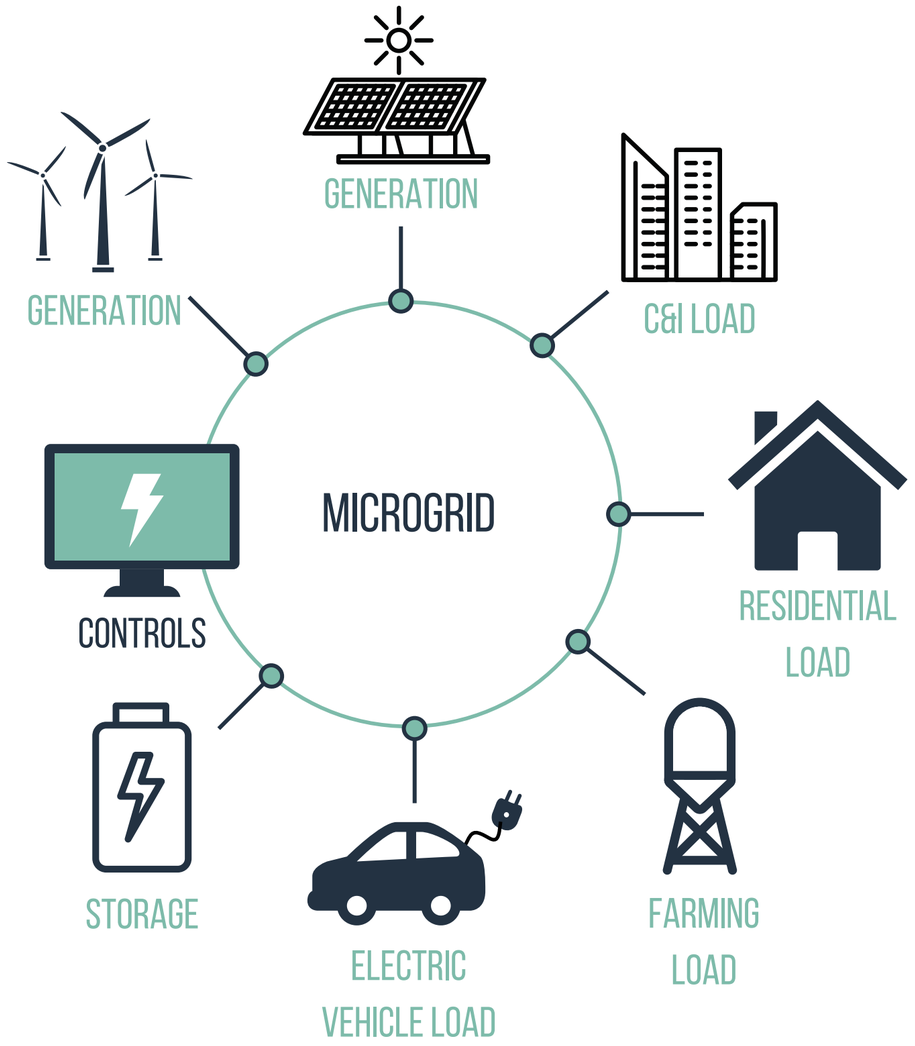
Microgrids can:

- blend generation, storage, smart meters, and other DERs to form a self-contained system;
- connect to and disconnect from the central grid on demand;
- run on renewable and non-renewable sources; and,
- enable energy sharing and trading with local and national energy markets.

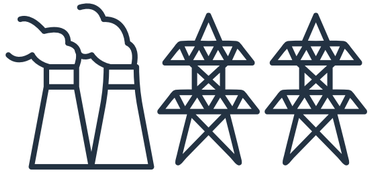
With the right technology and regulations in place, microgrids can also help modernise traditional grids to be self-healing, resilient, affordable, and sustainable energy systems.

Microgrids are design-built fit for purpose and typically fall into one of the following models:

- Stand Alone Microgrid
- Grid Connected Microgrid
- Nested Microgrids
- Grid Connected Nested Microgrids

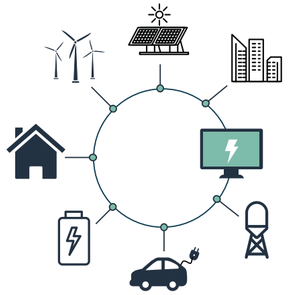


STAND ALONE MICROGRID

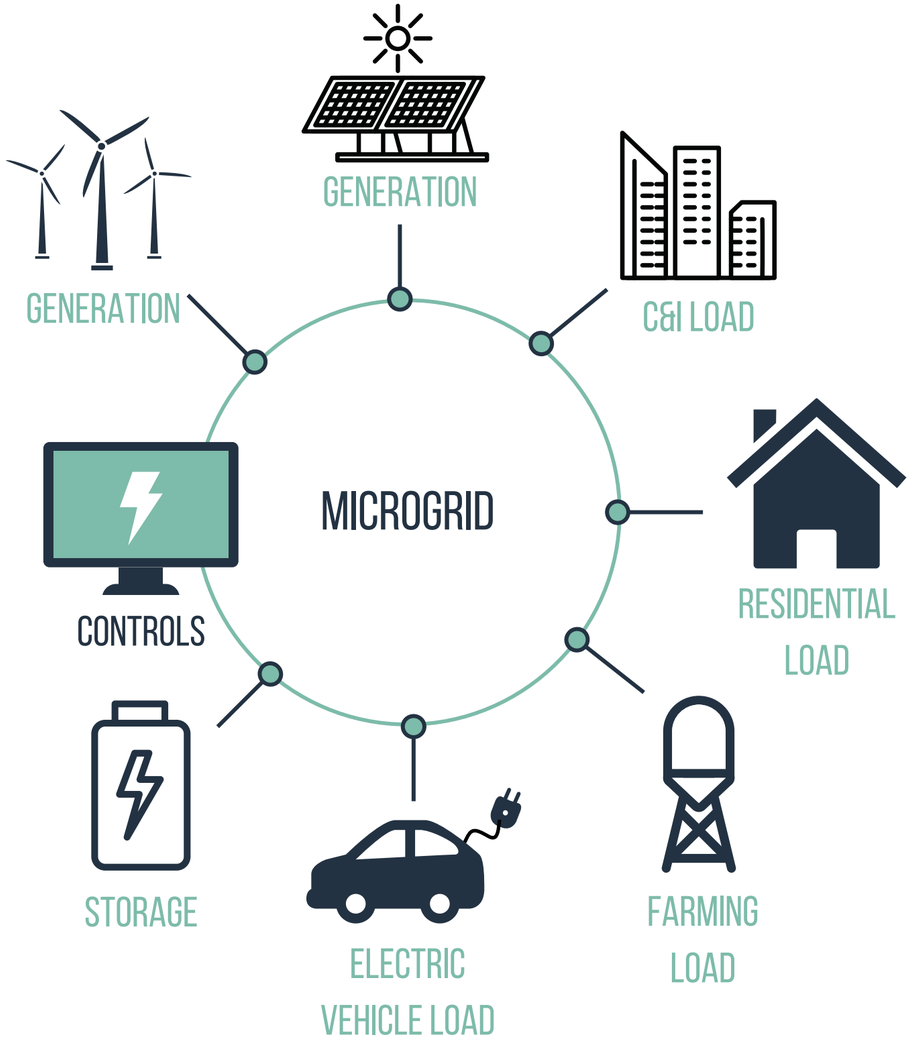


UTILITY GRID

LOCAL ENERGY MARKET/VPP

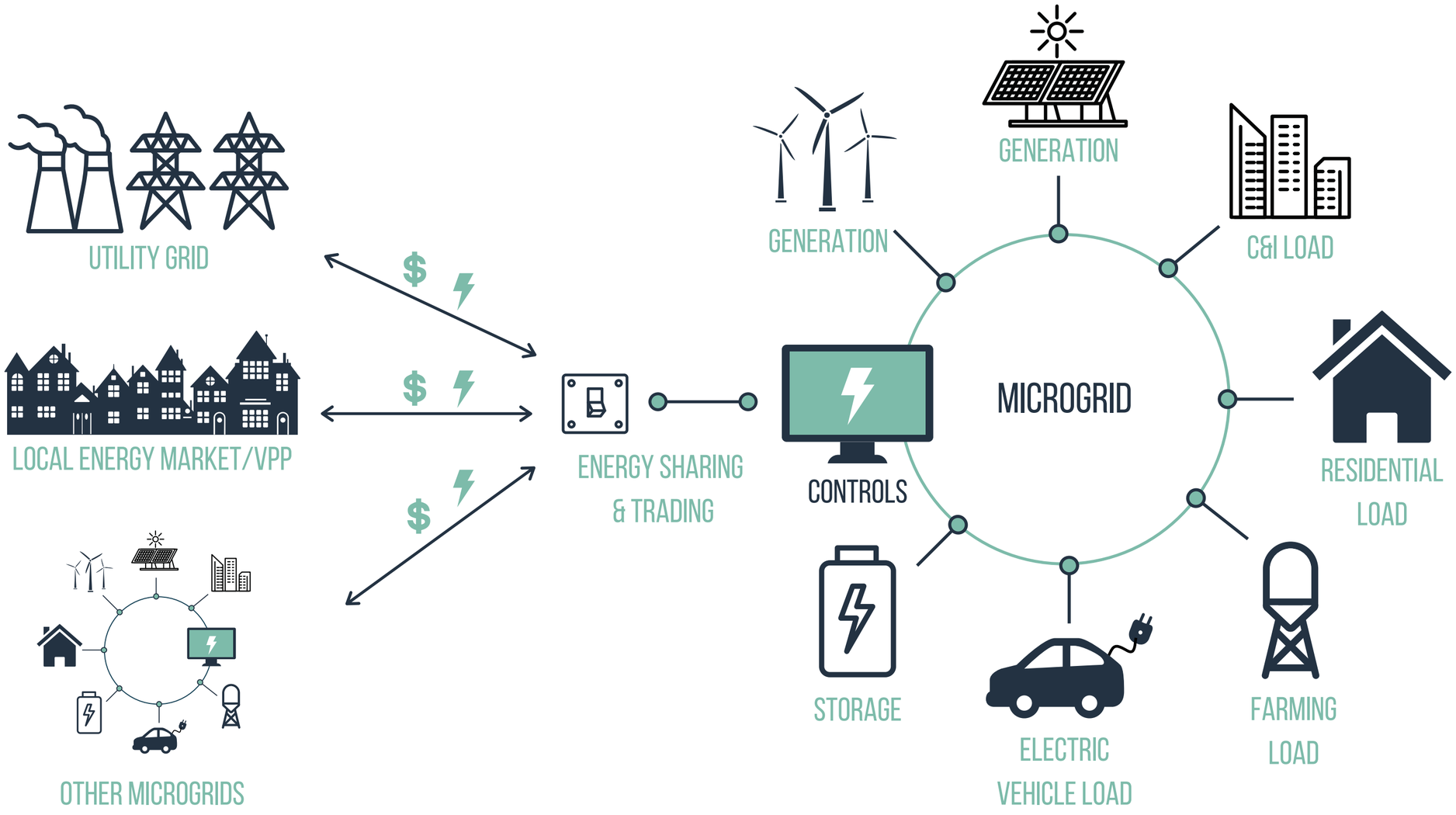


OTHER MICROGRIDS



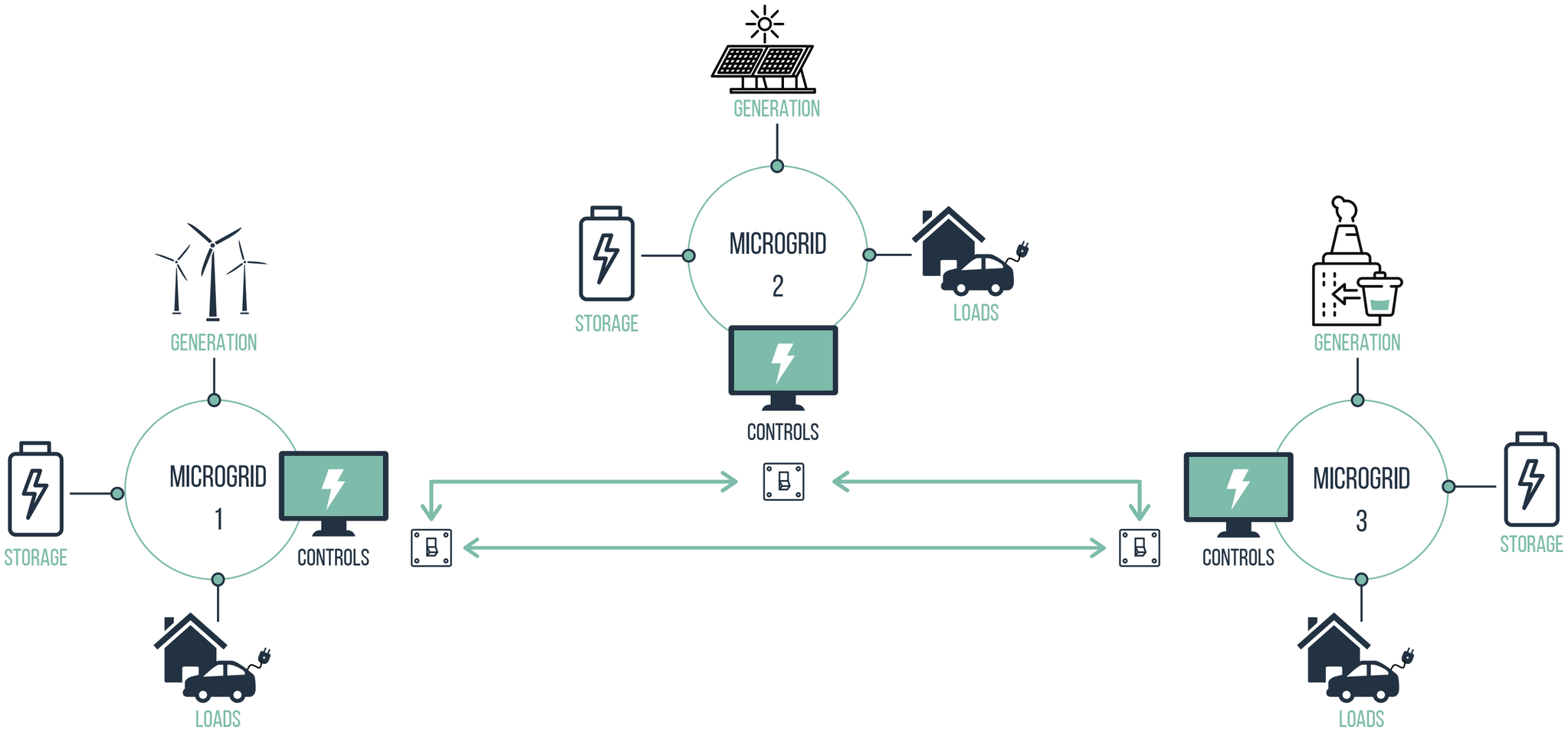
A stand alone microgrid is an off-grid, self-contained energy network that is not connected to any external energy networks.

GRID CONNECTED MICROGRID



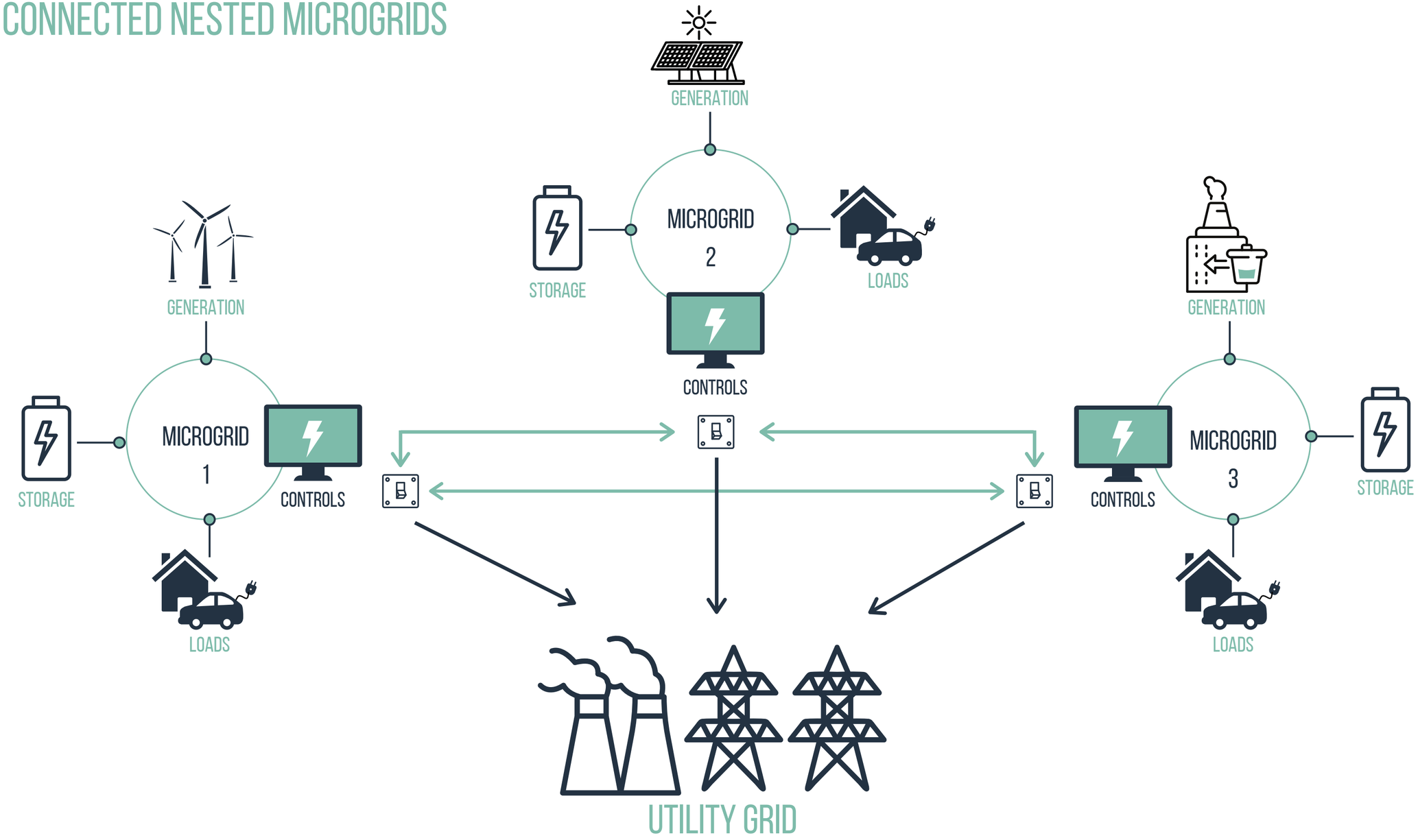
A grid connected microgrid can connect to and disconnected from external energy networks, including the utility grid, on demand.

NESTED MICROGRIDS



Nested microgrids is a network of stand alone microgrids that form a single large microgrid, and can disconnect from eachother as needed.

GRID CONNECTED NESTED MICROGRIDS



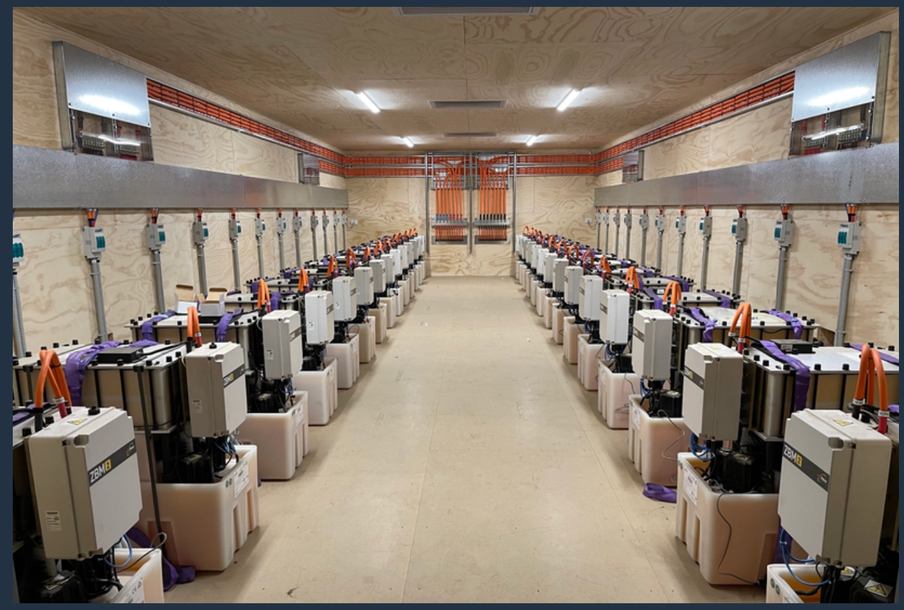
Grid connected nested microgrids is a network of stand alone microgrids that can interconnect with eachother and the central grid, on demand.

MICROGRIDS IN PRACTISE

Kalbarri Community Microgrid - WA

The grid connected town microgrid is comprised of 1.6MW of wind, 1MW of rooftop solar, and 4.5MWh of battery.

The community is at the end of a long rural feeder line and received the utility owned microgrid as a grid resilience investment.



'The Vale' Ag Microgrid - TAS

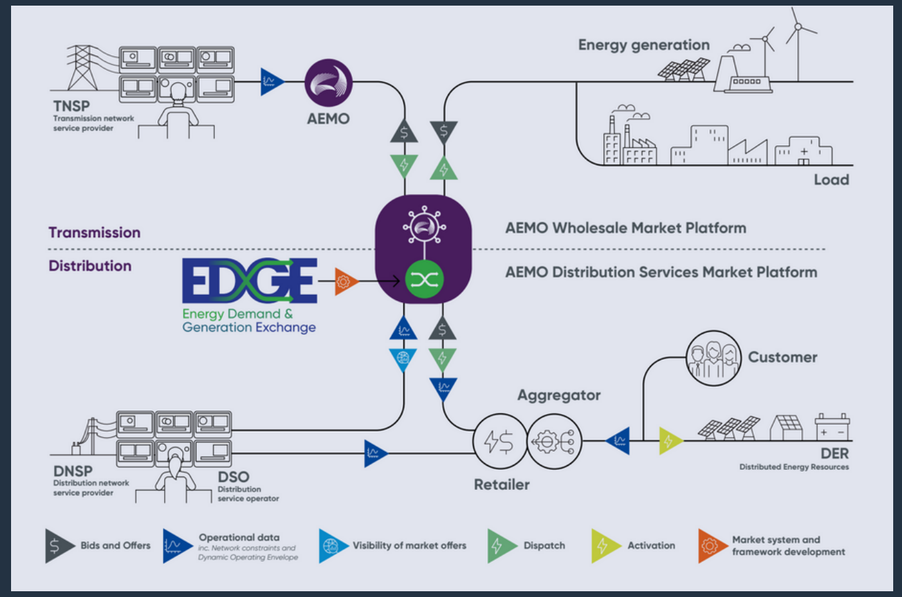
The Tasmanian sheep farm has installed 200kWp solar, 280kWh battery, controls, underground distribution and optical fibre networks, and provision for expansion.

The privately owned microgrid is islandable from the grid and was designed for self-sufficiency.

5. LOCAL ENERGY MARKETS (LEMS)

A LEM is a marketplace trading and distributing energy between local generators and consumers, improving local grid efficiency. Depending on the model, it can trade in real time via PPAs, tariffs, or a local spot price, and with the wholesale market.

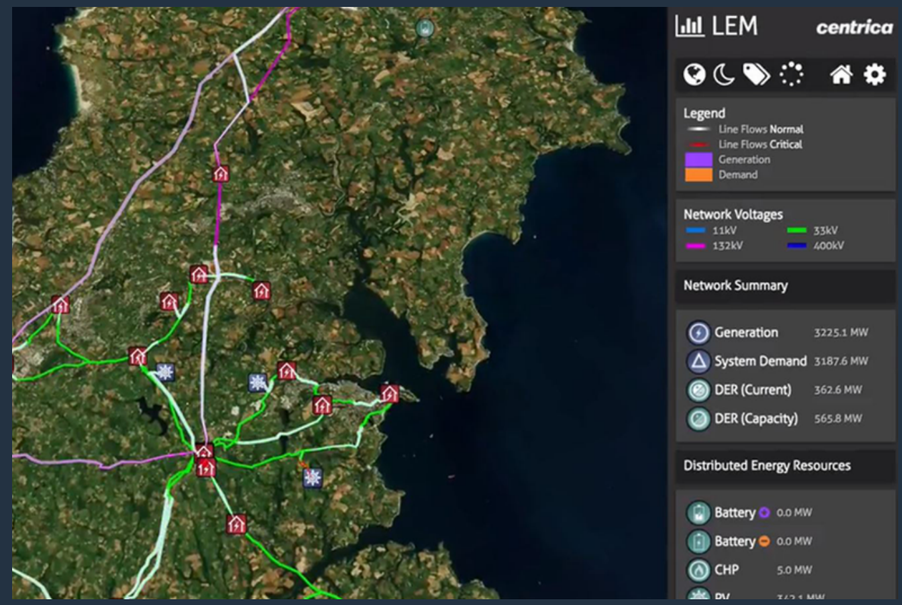
LOCAL ENERGY MARKETS IN PRACTISE



Mondo EDGE LEM Trial - VIC

EDGE is a DER marketplace in the Hume region on trial until 2023, in partnership with AEMO, ARENA, and AusNet.

The community of Yackandanda has a 100% renewable objective with a community battery, microgrid, and VPP built. The town is now considering a LEM trial via EDGE.



Centrica Cornwall LEM Trial - United Kingdom

Centrica's successful LEM trial installed and co-ordinated DERs throughout the town of Cornwall.

Residential and commercial DERs traded in real time with the local energy market which also traded with the wholesale energy market during pricing peaks.

ALTERNATIVE LOW COST ENERGY INTERVENTIONS

Smart grid tech can be cost prohibitive for many consumers to take on alone.

There are alternative products, services, and self managed interventions that help reduce energy costs and optimise energy consumption. However, not all utilities currently enable fit-for-purpose alternative solutions. Neither do all alternatives address the myriad of consumer drivers.

Efficiency

There is still considerable opportunity for on farm efficiency audits + interventions.

Meter consolidation

Consolidating meters or virtual net metering can help farmers optimise existing generation assets.

Ag/productivity tariffs

Tariffs that are geared to productivity levers offer improved utilisation for networks and more fit-for-purpose consumer products.

RESILIENT REGIONAL ENERGY NETWORKS

Smart grid technology increases the operational resilience and efficiency of energy networks, optimises local grid utilisation, and eases pressure on network costs.

It can also offer economic, energy, and environmental resilience to consumers.

Smart grids, including microgrids, can empower agricultural producers to participate in energy markets on more flexible terms that suit their needs.

They also improve the reliability of energy access, especially in regional communities. This gives farmers the ability to operate more efficiently and maximise their yield.

Finally, renewable generation microgrids, including waste to energy, can significantly decarbonise farms and build local environmental resilience.

Energy sits at the nexus of food, water, and many other fundamental inputs for agriculture. Leveraging agriculture's innovative thinking and integrating smart energy with farm design can maximise productivity and on-farm resource management.

BARRIERS & ENABLERS

Technical limitations largely relate to necessary upgrades of existing infrastructure to successfully integrate and support new technologies.

For example, improved connectivity in regions and two-way enabled transmission and distribution infrastructure are needed to support smart grid tech.

There are a variety of ownership models with willing financing. However, market rules and regulation are in flux and have not kept in step with modern energy tech and consumer needs.

This has created a non-competitive environment for many new market entrants. A derisked regulatory environment is needed to provide the market signals for innovator and investor confidence.

ARENA and the AER have established innovative funding and regulatory programs to help accelerate the derisking of integrating new energy technologies. Some state government initiatives also support these efforts.

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THIS RESOURCE WAS PREPARED BY THE 'MICROGRIDS IN AG' PROJECT' TEAM.
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