Congo

Preliminary business case and implementation plan

Battery Storage and Grid Integration Program
An initiative of The Australian National University

SμRF

Acknowledgements

We acknowledge, respect and celebrate Aboriginal people of Yuin country as well as the Ngunnawal and Ngambri people (ACT), on whose land this research was conducted and pay our respects to Elders, past, present and emerging.

There were many contributors to this report. Firstly, we would like to thank the Eurobodalla households and businesses who participated in small group discussions, shared what's important to them about electricity systems and created mud maps of how they thought the microgrid types offered during the project might fit into their community context.

We would also like to acknowledge the work of Zepben in developing the distribution network vulnerability tool and ITP Renewables in preparing the microgrid designs and costings.

Finally, we extend our thanks to our other SµRF partners, Essential Energy and the Southcoast Health and Sustainability Alliance (SHASA) for their support and input throughout the development of this work, and to our funder, the Department of Climate Change, Energy, the Environment and Water (formerly the Department of Industry, Sciences and Resources).

This report is authored by:
- Warwick Crowfoot, Manager – Non Network Solutions Manager, Essential Energy
- Matt O'Neill, Senior Engineering Officer – Non Network Solutions, Essential Energy
- Phil Shorten Community Engagement, SHASA

A partnership between

Australian National University

essential energy

SHASA

zepben

Please note that this is a research project, the level of involvement from the community was limited to those who attended the public forums. It would be a requirement to progress a more detailed and extensive community engagement process to be able to articulate the preferred solution that the community requires for their needs.

Front cover image: Eurobodalla Coast Tourism ©

Contents

Image: chelsea-Wvus on Unsplash

Executive summary

This preliminary business case and implementation plan is for the Congo community, one of eight communities the SμRF Project has been studying to investigate the feasibility of developing an islandable electricity microgrid to service the local community.

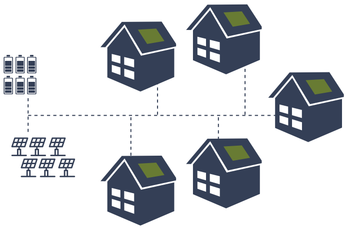
The SμRF Project considered three types of microgrid. For details refer SμRF Report: *Exploring design challenges and opportunities for microgrids to improve resilience in the Eurobodalla.*

Of the three types of microgrids the large solar microgrid option is considered feasible.

Snapshot of a feasible microgrid for Congo for further investigation

Of the three types of microgrids the large solar microgrid option is considered feasible.

The large microgrid option



This option consists of privately owned solar systems installed on roofs across the community, a few fridge sized batteries owned by the microgrid owner, potentially installed within the streetscape of the community, and a solar farm.

550 kW rooftop solar
+ 1,000 kW solar farm (PEG)*
+ 7,500 kW/1,500 kWh battery.

Solar farm security fence area: 2.28 ha.

Existing rooftop solar: 87 kW.

A large microgrid will deliver 391% CO_2e emissions savings for Congo.

NB Any solar farm larger than 5,000 kWs in NSW is considered utility scale and subject to higher levels of regulatory scrutiny and therefore is considered less feasible for a microgrid in this context.

High level cost estimate

$5,903,000

---

* https://bsgip.com/wp-content/uploads/2024/01/ITP-Concept_Design_Report.pdf
https://www.jurchen-technology.com/products/solar-mounting/peg/

Potential revenues

Rooftop solar generators could expect to be paid for charging the battery when required. The battery owner would expect to generate revenue from the purchase and sale of energy into the spot market by storing energy in low demand periods and discharging into the grid during peak demand periods (arbitrage) plus ancillary services (for example frequency control to support the transmission of electricity from generation sites to customer loads).

Solar farm owners can expect to receive revenues for providing electricity to the wholesale market via the following mechanisms:

- Power Purchase Agreements (PPAs) – A contractual arrangement between two parties, typically a power producer (solar owner) agrees to generate and sell renewable energy to a buyer (utility, corporation of government entity) at predetermined prices or rates.
- Generating revenue by selling electricity to utilities or end-users through long-term contracts at agreed-upon rates.
- Generating and selling Renewable Energy Certificates (RECs) based on the amount of renewable energy produced, providing an additional revenue source.
- Spot market sales – Possibly selling excess electricity directly into the National Electricity Market (NEM) wholesale electricity market during high-demand or high-price periods.

Potential cost savings

By investing in locally shared generation and storage assets, the community can expect to benefit from economies of scale, ie save money, compared to the higher cost of community members investing in behind the meter systems. In addition, potential savings for the local Distributed Network Service Provider (DNSP) due to the battery contributing to balancing the grid.

Values illuminated during community discussions held in the Congo community

- Access to power during an outage for heating, cooling, lighting and servicing a village sprinkler system.
- Stability for the network to facilitate more renewables in Congo.
- Sharing electricity adds resilience to the sense of community. eg maintaining power for a shared cool room for the businesses in Congo (for a battery only or a small microgrid). The large microgrid would provide sufficient power for all users. Refer SμRF Report: *Exploring design challenges and opportunities for microgrids to improve resilience in the Eurobodalla.*

Electricity market regulations requiring further consideration

Microgrids are not defined or dealt with in Australia's National Energy laws or rules, creating many uncertainties in how they ought to be governed. For a discussion of some of these issues, refer *Challenges and opportunities for delivering microgrids that benefit people.*

Community benefit

The large microgrid solar farm will provide unrestricted use of electricity when in islanded mode, exceeding the eight hours in total or four hours a day for seven days that was identified during initial discussions with community groups. When connected to the grid, sufficient kWh might be accessible, with the appropriate governance and controls in place, to reduce peak load prices from main grid for local consumers.

By way of comparison, a small microgrid for Congo would provide power in islanded mode during outages for approximately 12 hours at normal demand or up to approximately 28 hours if electricity usage were reduced by 50%.

The community also has increased access to renewable generation of electricity, especially for those who cannot afford to buy their own rooftop solar and battery assets.

If the community were to own or partly own the solar farm there may also be revenues in the form of shared profits arising from selling electricity to the market that could be used for community projects.

The high-level design is consistent with community values. The operating model would be subject to further refinement of ownership and retailer arrangements governance and controls, to reflect the communities values, financial capacity and desired benefits of a large microgrid.

Grid benefit

The electricity grid will benefit from more decentralised storage and generation assets located in communities which balances loads, enables more connections and renewable energy to be connected with a reduced capital cost.

Local, state and national interest/emissions targets

- Congo 's main grid delivered electricity emissions are 1,011 kg CO_2 per day.
- The large microgrid's emissions would be -2,948 kg's CO_2e per day. A 391% reduction.
- The small microgrid's emissions would be -393 kg's CO_2e per day. A 139% reduction
- The diesel back up emissions would be 1,178 kg's CO_2e per day.

To estimate the emissions reductions impact of the small and large solar microgrids, we calculated the amount of zero-carbon electricity that they would produce each year and the amount of carbon emissions that this energy would displace based on the average emissions intensity of the NSW grid in 2022–23 (0.73 kg CO_2-e/kWh)*.

The large microgrid option emissions

-2,948 kg's CO_2e per day (391% reduction)

The small microgrid option emissions

393 kg 's CO_2e per day (139% reduction)

The diesel back up option emissions

1,178 kg's CO_2e per day

CO_2

Key hurdles to be managed

- Initial discussions with the Congo community indicates that a third party ownership model should be explored. Sourcing capital investment of approximately $5.9m will be a major hurdle.
- Community acceptance and agreement of the type and size of a microgrid and the location of assets is also a challenge. Land around Congo has high value for both agriculture and lifestyle uses. The land required for the solar farm is 2.28 ha.

Therefore a small microgrid or community battery might be a more feasible first step as generation is not dependant on a solar farm.

---

* www.cleanenergyregulator.gov.au/OSR/EERS/eers-current-release

Key partnership/players to be consulted

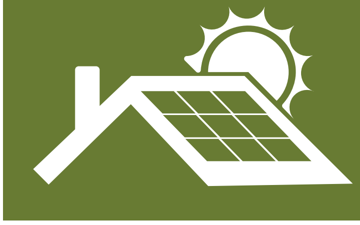
- A DNSP will be responsible for the connections process and approval of battery and solar connections with the main grid.
- A retailer will be required to access market revenues such as arbitrage and Frequency Control Ancillary Services (FCAS) and to develop the appropriate business model for revenue sharing.
- Land owners – Cleared land to the west of Congo might offer space for a solar farm.
- Government agencies such as the Australian Renewable Energy Agency (ARENA) often provide grants for research, design and construction of renewable energy projects.
- A community organisation to assist the local Progress Association to advance the necessary social licence to own and operate a large microgrid.

The preliminary business case is for a large microgrid

This business case and implementation plan is considering a large microgrid for the whole community. A community owned battery or a small microgrid might also be considered as a first step given the size of the investment and the challenge with land acquisition for the large microgrid.

The following diagram reflects Congo's discussion groups interpretation of the SµRF projects large microgrid and how it might look in Congo's context.

This business case and implementation plan is considering a large microgrid for the whole community. A community owned battery or a small microgrid might also be considered as a first step given the size of the investment and the challenge with land acquisition for the large microgrid.



Who controls the microgrid

It is recommended that the local DNSP should control the 'Islanding' component of the system. This means that automation of faults and enabling the microgrid to be re-energised to support an outage upstream is enabled through the DNSP 24/7 operations control room.

The owner of the microgrid can control the orchestration of the systems when connected to the grid through the services of a retailer to optimise the performance of the system.

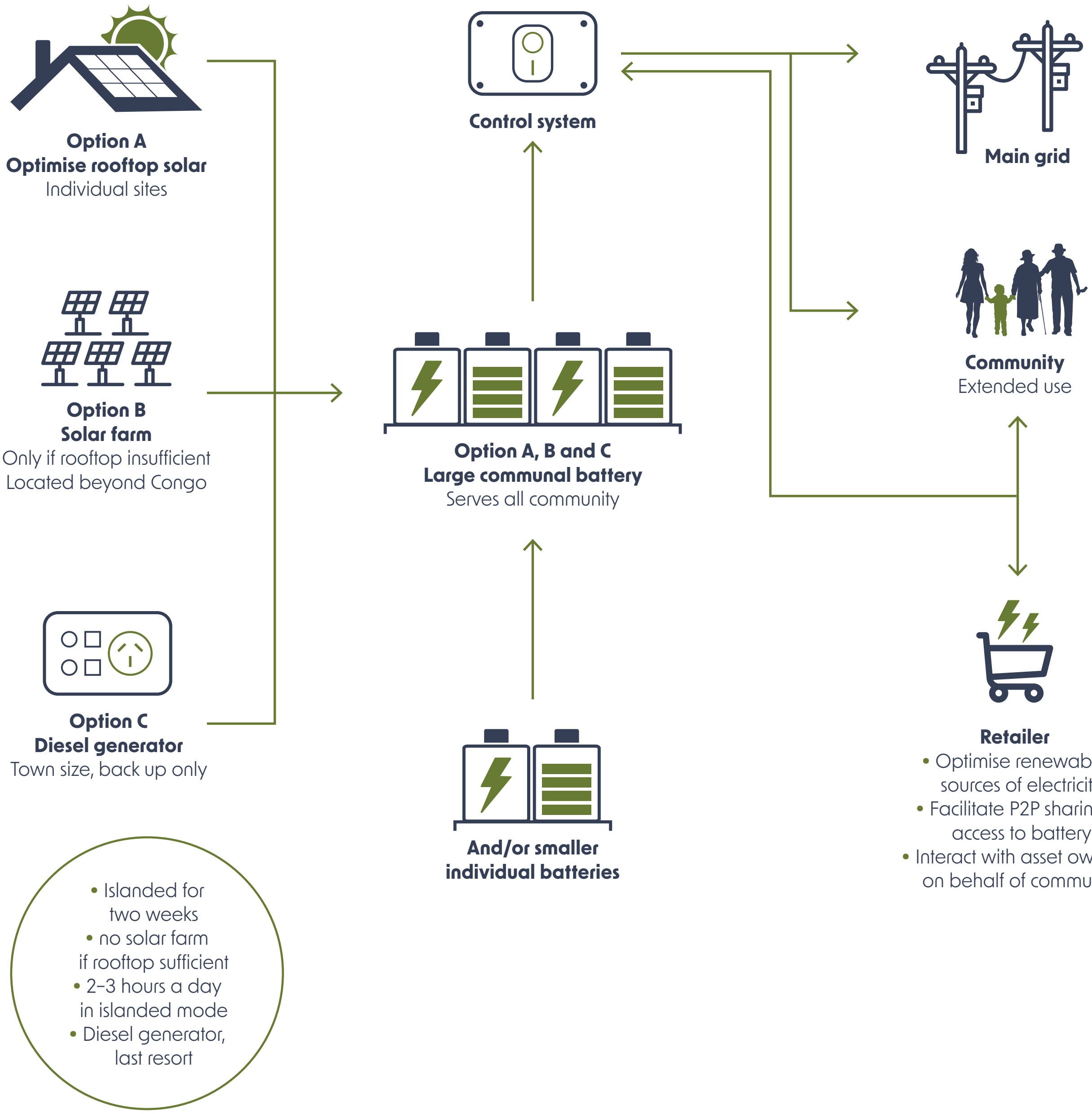
How is the microgrid controlled

The microgrid can in its simplest form use the microgrid controller capability of the onsite inverter-based system to provide the islanding of the grid through a SCADA connection with the local DNSP and a retailer providing orchestration services.

A fully optimised microgrid could include the installation of a Distributed Energy Resource Management Solution (DERMS) to optimise all generation, storage and loads within the microgrid when connected to the grid for revenue generation, and in island mode to range extend the microgrid to support longer outages.

Potential design, large microgrid, Congo

Visualised by the SμRF project team and the Congo community discussion group



Concept only: The community consultation process undertaken by the SμRF project to date is limited and should not be considered in any way as whole community acceptance of the most feasible options identified in this business case.

Image: Eurobodalla Coast Tourism ©

Introduction and context

Microgrids in context

Refer *Exploring design challenges and opportunities for microgrids to improve resilience in the Eurobodalla* – microgrid design and opportunities for Eurobodalla.

The SμRF project in context

Refer *Project overview Southcoast μ-grid Reliability Feasibility (SμRF) project.*

The SμRF project feasibility work has been undertaken within communities, with no 'one' motivated stakeholder. The context is more complex with land, the existing grid, islandable generation and storage assets, regulatory control, governments and retailers, as well as the community, all having potential ownership and a share in the risks and rewards associated with changing the electricity supply system.

Congo in context

Located approximately 300 kms south of Sydney, on the far south coast in the Eurobodalla Shire. Population of 253 (2021) comprising 121 premises, including B&B's, mainly residences.

The village is surrounded by forested areas and some limited cleared land. Approximately one third of the houses are only seasonally occupied.

This preliminary business case

There are more than 15 microgrids in Australia operating or under development with all but one or two motivated by the replacement of diesel powered generators and/or are in remote locations compromising main grid delivery. All of the microgrids that are currently operating have had a clear business case relating to the cost of diesel, poles and wires maintenance and greenhouse gas calculations favouring a solar solution. In most, if not all of these scenarios, the key stakeholders are a single owner being a DNSP or a mining company.

In contrast, the SμRF project has been undertaken within communities, with no 'one' motivated stakeholder. The context is more complex with land, the existing grid, islandable generation and storage assets, regulatory control, governments and retailers, as well as the community, all having potential ownership and a share in the risks and rewards associated with changing the electricity supply system.

Given this complexity, this preliminary business case will not meet the needs of all stakeholders, however it provides insights into:

- Microgrid configuration options most suited to each community.
- The motivations of this specific community.
- The capacity of solar generation to service the needs of this community.
- The benefits and opportunities for the DNSP and other stakeholders.
- Potential revenue streams for solar farm, battery and rooftop solar investors.
- How the retailer might interact with a microgrid given the range of ownership options.
- What is possible given current regulations and what might be possible if changes are made.

Overall this preliminary business case and complementing SμRF reports will inform a response to key questions from the following stakeholders:

1. **Local community organisations** – Is there a design that we want to investigate further on behalf of our members?
2. **Retailers** – Are there assets we might invest in? How might we support community values/goals using appropriate service agreements for the battery, solar farm, rooftop solar and consumers (generators and non generators).
3. **Community consultation organisations** – What is the current status what else do we need to do to establish a social license to progress this solution to the next phase of development?
4. **DNSPs** – what does the community want? How might we configure a solution given our regulatory constraints? What should we 'sandbox' (trial) if we want to offer more value to communities?
5. **Government funding agencies** – What benefits including resilience are there for key stakeholders? How might this assist with our sustainability targets and other development goals? What costs are involved and who are the key players?

Therefore consideration should be given to the various SμRF documents as well as this preliminary business case document when developing a response to the potential for a microgrid in these communities.

Image: Eurobodalla Coast Tourism ©

Image: Eurobodalla Coast Tourism ©

The value proposition

The problem to be resolved for Congo

According to small group discussions held within the Congo community in Spring 2022 and Autumn 2023 the microgrid solution for Congo and should address the following problems for these communities:

- Increased access to renewable energy – a diesel back up generator for limited use is considered acceptable.
- Restoration of residential and business operations including preserving commercial and private food stocks, telecommunications and water pumping for fire fighting and protection purposes during extended outages caused by emergencies (storms and fires leading to electricity outages).
- The aspiration for a minimum of 48 hours and up to seven days of back-up power to provide sufficient time to store and sell commercial quantities of foodstuffs.
- Congo's electricity supply system is considered moderately vulnerable. Refer SμRF Report: *A methodology for electrical network vulnerability analysis* for details.

A key aspiration of the community is a minimum of 48 hours and up to 7 days of back-up power to provide sufficient time to store and sell commercial quantities of foodstuffs.

Generic values and benefits of a microgrid

Technical, social and economic analysis undertaken by the SμRF team has identified the following generic values and benefits that might be derived from a suitably designed microgrid.

Resilience

In this project context, microgrids can facilitate a communities ability to maintain the electricity supply during an unplanned outage caused by storms and fires by using batteries charged by local generation assets providing power for lighting, pumping, heating, cooling and telecommunications.

Reliability

Reduced incidence of outages arising from upstream failures. This is not a given as the local microgrid poles and wires are also subject to local weather extremes. A local microgrid would provide increased opportunity for reliability during planned outages of the main grid. Thereby increasing continuity of service.

Revenues

Potential revenue streams available from the National Electricity Market are summarised in operating models on pages 31–33 and is dependent on ownership or commercial revenue sharing agreements with operators of the infrastructure. It should be noted that due to the cost of islandable microgrids, users/owners are unlikely to see a reduction in electricity costs and/or provide a positive return on investment.

Renewable energy

Many existing microgrids in Australia are solely dependent on liquid (fossil fuelled) generators. ANU and consultants, ITP Renewables, have identified renewable technologies such as roof top solar, solar farms and batteries as the most feasible technologies for the microgrid options under consideration. These technologies support the general community's aspirations for increased application of renewable energy sources.

While diesel generators are by far the cheapest systems to deploy, their benefits are limited if used only during rare occurrences of grid outages and tarnished by excessive pollution emission if they are used routinely. This option is outside of the scope of this project.

Equity and sharing

The opportunity to share electricity generated from local rooftop solar with others in the community who aspire to access solar (renewables) but are limited by shade or lack of finances. This can be facilitated by a local battery and through retailer arrangements.

Self-sufficiency/autonomy

A sense of being able to influence how and when and to who electricity is supplied via sharing arrangements via microgrid controls, governance and or asset ownership.

The opportunity for Congo

There is an opportunity for Congo to improve their resilience by developing a large microgrid, while aligning with their values. This microgrid would be scaled to provide services to the community for an unlimited time in islanded mode yet also operate under normal conditions to balance the grid. Refer SμRF Report: *Exploring design challenges and opportunities for microgrids to improve resilience in the Eurobodalla.*

This could potentially provide modest revenues for rooftop generators where energy arbitrage (power bought during off-peak hours) and ancillary services (services that ensure reliability and support the transmission of electricity from generation sites to customer loads) via a battery are permissible. There are no regulations currently in place to facilitate these revenues.

The large microgrid will also:

- Increase access to renewable sources of electricity generation especially for those who cannot afford to buy their own generation and storage assets.
- Heighten a sense of community by assisting people to prepare and respond to emergencies during electricity outages, including the potential for fire firefighting and fire protection devices.
- Share electricity generated locally via the microgrid battery.

What will the microgrid need to do/provide to deliver the core values for the Congo community?

Increased access to renewable sources of electricity generation

For the Congo microgrid to be feasible it should be able to store electricity that is generated from renewable sources.

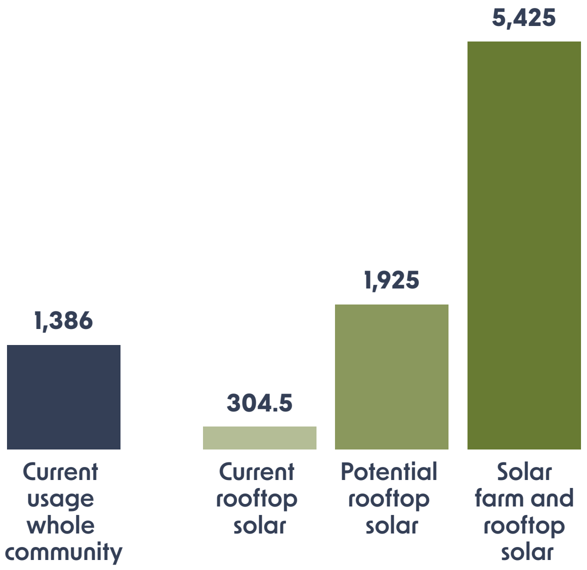
For Congo this can be achieved by optimising existing rooftop solar (refer Figure 1, solar analysis below) and providing a battery to store and make renewable electricity available to local consumers who are unable to access solar.

Congo has relatively low solar uptake, possibly due to the seasonal occupation of residences making such investments less financially attractive, or for other reasons. A solar farm is considered feasible if the cleared land nearby can be made available. If not, then a small rooftop solar scale microgrid might be a more feasible option in the short term.

Provision of back-up power during emergencies

For Congo, a battery should be included to provide power to the local community when the main grid is not operating. There is potential for this battery to be located on private land or adjacent to the solar farm west of the village. A diesel generator for back up to the battery is considered acceptable and may be located adjacent to the solar farm subject to commercial arrangements and the landowner's agreement.

Figure 1 Congo's solar and microgrid potential supply (kWh/day)



Heighten a sense of community

Congo has a track record of sharing labour resources and effort for fire fighting, food storage and fire preparation. A battery charged by rooftop solar generators, accessed by local electricity consumers will add to Congo's sense of community, their resilience and ultimately their desire to help each other during difficult events.

Autonomy

A sense of being able to influence how and when, and to who electricity is supplied via the microgrid controls governance of the microgrid and or asset ownership.

Congo community discussions have suggested a third-party ownership model should be explored, most likely with a retailer and the local DNSP.

Refer page 31 for a simple explanation of a community owned operating model. This needs to be developed further and socialised within the community for more widespread consideration.

Share electricity generated locally

The large microgrid provides an opportunity to share locally generated electricity via a 750 kW/1,500 kWh battery. This microgrid solution may not provide savings for consumers. However, there might be a potential for roof top solar generators to earn higher export revenues as well as additional annual fees for agreeing to share their electricity with locals by exporting electricity to the battery under a commercial arrangement with a retailer similar to a community battery.

Community consultation

Congo specific consultation to date has comprised two discussion forums within the community, approximately 30 residents including B&B business owners, as well as discussions with local council, an energy consultancy (ITP) and Essential Energy as the owner and operator of the main electricity distribution network along the south coast of NSW.

The community consultation to date is limited and should not be considered in any way as community acceptance of the most feasible microgrid option identified in this business case.

Opportunity to incentivise investment in Congo

There is an opportunity to incentivise further investment in solar and batteries. This can be achieved by removing any regulatory barriers that may inhibit DNSPs or other large battery owners providing revenues for rooftop generators supporting arbitrage and ancillary services that benefit the main grid.

A microgrid battery provided by the DNSP or other investors may also save consumers using their capital to purchase individual batteries.

Beneficiaries

The following benefits could be realised for the following players and participants in a large microgrid in Congo.

The community

Could have unlimited access to electricity (subject to the microgrid assets not being impacted from storms or natural disasters) during outages delivered in a manner consistent with their values and aspirations **for a resilient** renewable electricity supply system. Local consumers would also have increased access to renewable sources of electricity via a solar farm and a battery. There is also potential for revenues from community owned battery and/or solar farm as well as supporting the communities aspirations for more autonomy. Profit sharing arrangements may be configured to fund community projects.

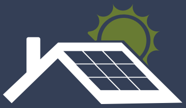
Community retailers

Could gain access to additional renewable **energy** amounting to 5,425 kWh per day via the solar farm increasing their portfolio and their attractiveness to consumers generators and investors.

Rooftop solar generators

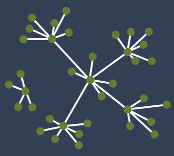
Could be able to access a modest fee for **supporting** ancillary services and energy arbitrage offered by the local battery.

This might include increasing the current export limits on roof top solar where customers systems meet current AS4777 standards.



Distribution Network Service Providers

Could have access to assets that would assist with **balancing** local generation in the grid which can increase the amount of exports from customers solar, as well as some potential for savings on network upgrades imposed on the grid as more connections are made.

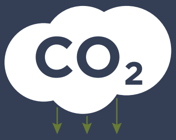


Investors

Could benefit from revenues arising from **optimised rooftop solar,** renewable electricity generation and storage made available to the wholesale electricity market as well as providing 5,425 kWh of electricity per day to the spot market.

State federal and local governments

With emissions **reduction** targets.



Government agencies

Responsible for emergencies, potential benefitting from **improved access** to power and communications during outages.

Services to be provided

A large microgrid could provide the following services for the community:

- Maintain cooling, heating, pumping and telecoms for an unlimited time, during outages in particular.
- Residents' household electricity services.

The small microgrid can provide these services but for a limited time – estimated to be 10 hours only.

The large microgrid under the ownership model for the community would also provide revenues from trading electricity generated by the solar farm and stored in the battery that could be used for community projects, see beneficiaries on page 18 and operating models on pages 31–33.

Partners, contributors and resources

The following partners and contributors would be required if a microgrid in this community is to progress.

A retailer

To provide a business model to support the communities aspirations including tariff structures and strategies to reduce risk, generate revenue and reduce costs where feasible.

The general role of electricity retailers in a microgrid operation include:

- The aggregation of microgrid resources eg coordinate multiple sources of solar generator and battery storage.
- Provide demand response services, eg offer services to microgrid participants to generate revenue by reducing demand on the grid.
- Provide retail and energy storage services for revenue generation and tailored retail price offers for microgrid customers.
- Can provide funding for microgrid development through negotiated commercial agreements including joint ownership or power purchase agreements.

Resources required: A business model to support application for funding including a tariff structure that services the communities values and preferred operating model.

A community focussed retailer

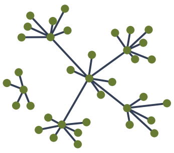
To optimise revenues for private rooftop solar investors and optimise access to solar generated electricity via arrangements with the battery the main grid and all local consumers who sign up to participate. Refer operating model pages 31–33.

Resources required: A tariff structure that services the communities values and preferred operating model.

The local DNSP

To provide connection approvals and conditions of operation, including dynamic connection agreements and dynamic operating envelopes for battery connections.

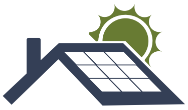
Resources required: DNSPs are restricted from owning and operating battery assets, site specific applications are required to be submitted to the Australian Energy Regulator for DNSP to be involved in commercial ownership models.



Residents and existing owners of rooftop solar

To optimise solar generated electricity to service the community battery.

Resources required: Incentives such as grants and tariffs that support investment in optimising rooftop solar. This might require the updating of inverters if systems are older and do not comply with current AS4777 rules.



State and federal government agencies

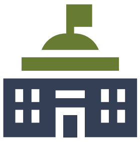
To provide funding and incentives to realise the necessary rooftop solar optimisation required for this option to operate.

Resources required: Funding applications.

Local council

To contribute via planning and development acceptance.

Resources required: Drawings and development applications.



Community

To contribute by clearly articulating their preferred operating model for this option See operating model on pages 31–33. Resources required: education and Consultation materials and expertise.

Local community

Organisation to undertake wider consultation in the community and liaise with all other players to keep community aspirations as the focus of their investigations and subsequent design and operation.

Resources required: Funding to provide suitable resources and ongoing support.

Generic challenges and risks with microgrids

The project has identified the following risks and challenges

- Complexity of operating a microgrid given regulatory restrictions and multiple stakeholders.
- Limited revenues for relatively small scale infrastructure will make it difficult to attract investors.
- Long term assurance of maintenance.
- Efficiency of microgrid versus renewables located elsewhere – are cheaper alternatives available?
- Does it resolve resilience with the limits on power available when in islanded mode.
- Control/autonomy – difficult to do for most energy businesses.
- Potential tensions in the community from unequal access to microgrid technologies – refer SμRF Report: *Community perspectives on microgrids and resilience in the Eurobodalla* for more details.

A critical challenge is establishing a 'social license' in the community to:

- **Consider the 'best' operating model and design option.**
- **Get motivated partners and players on board.**
- **Implement and operate the best option, including any agreement necessary (with consumers) to reduce electricity use during outages/emergencies (in islanded mode).**

Challenges and risks for the community given consultation outcomes

- Establishing partner relationships including a DNSP that shares the motivation to own and operate the battery.
- Establishing a partner and or investor, such as a community retailer, to invest in the solar farm and configure an operating model that meets the aspirations of the Congo community.
- Managing financial and operational risks associated with 'site' ownership, see commercial arrangements page 32.
- Establishing a 'social license' in the community to further investigate, refine the design and implement, a large microgrid.
- Financing a sufficiently large enough battery to perform arbitrage services and sell electricity to the market. Note for some services, such as Frequency Control and Ancillary Services (FCAS), a minimum of 1 MWh (1,000 kwh) must be available to trade in this service (for batteries smaller than 1 MWh participating in FCAS markets will require a retailer to aggregate small batteries together to achieve the minimum 1 MWh).
- Establishing revenue contracts for rooftop solar investors via arbitrage arrangements with battery via DNSP and retailer.
- Establishing a price reduction through the solar and battery assets for consumers with a third-party ownership model when high market prices exist during high demand periods.
- It's a challenge to deliver a cost savings where there is third party ownership. Ie the third party will take a profit on what is a small load rather than give up a modest profit to deliver savings for consumers.
- Complex priorities for DNSP to contribute to custom solutions in a regulated energy industry.
- Community acceptance of this microgrid option and the opt in participant numbers required for a retailer to be attracted to these arrangements.

- Accessing appropriate grants for solar bulk buy (as part of a funded microgrid project) to incentivise private investment in rooftop solar.
- Access to funding via microgrid programs eg ARENA, regional resilience grants and other funding from emergency service agencies.

Enablers to progress considerations

Currently in place as enablers:

- **Initial community consultation has been undertaken** and has created awareness across a small sector of the community.
- **Further community consultation is available**. The Congo progress Association has shown interest in progressing an electricity supply project and, with assistance from SHASA, to obtain a social license from the broader community to progress a community battery and/or a small or large microgrid.
- **Sufficient rooftop space for a small microgrid is available**. Technical specifications, solar capacity, high level sizing and costing of microgrid assets has been made available by ANU and ITP renewable. Refer SµRF Report: *Exploring design challenges and opportunities for microgrids to improve resilience in the Eurobodalla*.
- **Funding is available** from the Australian government (ARENA) for microgrid projects.
- **A retailer operating model is available**. The Progress Association has begun discussions with a community retailer and is in support of a electricity supply solution that increases the uptake and use of renewable electricity. The retailer has offered a revenue and operating model for a islandable large microgrid (battery and solar farm) for all participants to consider. The retailer model is not part of the SµRF project and is therefore not included in this document.
- **Preliminary site drawings are available**. Analysis by ANU and ITP has been undertaken with engineering and site drawings for consideration by government funders and private investors. Refer *Indicative battery and solar farm site drawings for the Congo.*
- **The local DNSP** is willing to 'sandbox' (subject to operating priorities) a trial project of the battery triage and ancillary grid services, regulatory changes and subsequent revenues for rooftop generators.

The following key steps will progress Congo's solution:

1. Establish a working group with appropriate partners.
2. Consider an islandable grid scaled third party owned battery at an appropriate site as a first step.
3. Obtain a financial and operating model from a community focussed retailer so that co-funding can be secured from an appropriate government agency or a private investor for next steps, building on the SµRF feasibility study.
4. Present the large microgrid operating model to Congo residences and businesses for acceptance and define the benefits for the broader community.
5. Utilise this business case and the retailer or investors financial model to obtain funding to consult the community more widely to establish a social license to progress next steps.
6. Approach land owners for potential sites for solar farm, batteries and additional roof top solar.
7. Utilise the site drawings and technical analysis undertaken in SµRF to secure suitable land for the large microgrid assets, ie solar farm, battery and control system. Consider cleared land to the west of Congo village oval for initial consideration.

Refer generic implementation plan on page 36 for a more comprehensive list of tasks to be undertaken to progress a small or a large microgrid in Congo.

Keydrivers that support consideration of islandable microgrid type solutions in the electricity grid

1. Government commitment to emissions reduction targets and the ongoing transition to renewable sources of energy.
2. The Community's aspirations for renewable sources of energy being optimised during normal operations as well as considering how they will access electricity during emergencies that result in outages.
3. The grid operators need to balance the grid during the decentralisation of electricity generation and their license to innovate hinging on meeting the needs of regional communities.
4. The size of the grid means upstream outages can have widespread impact which can be minimised with local generation and storage capability. For example, the Nowra feeder outage in the 2019–20 Summer bushfires.

Image: Eurobodalla Coast Tourism ©

Why now is a good time

- **Government has committed to emissions reduction targets and transition to renewable sources of energy.**
- **Community's aspirations for renewables and access to electricity during emergencies.**
- **Grid operators need for balancing the grid during the decentralisation of electricity generation.**
- **Local generation might offset cost of expanding centralised generation and distribution assets.**
- **The size of the grid means upstream outages can have widespread impact which can be minimised with local generation and storage capability. For example, Nowra feeder outage in the 2019–20 Summer bushfires.**

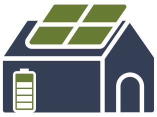
Image: istock by Getty Images Baracapix

Microgrid design options technical assessment

Generic types of microgrids*

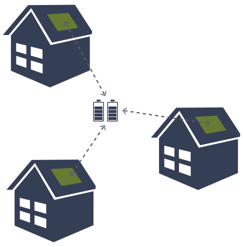
A BTM battery (not a microgrid concept within this research project)

A battery and solar installed behind the meter. This battery may be accessible during an outage or not, depending on size, technical compliance and benefits to the customer at the connection point. These types of systems are common for large load connections seeking to reduce costs and increase resilience.



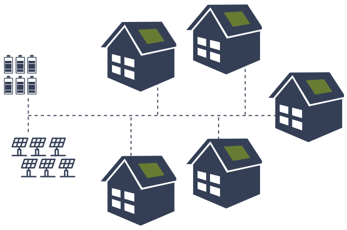
A small solar microgrid for neighbourhood

Is serviced by electricity generated by existing or optimised rooftop solar. A small battery is included and is accessible to local consumers during islanded operation. If the battery is large enough it may provide a modest revenue stream for rooftop solar generators as well as the battery owner in partnership with a retailer.



A large solar microgrid for township

Is serviced by electricity generated by a local solar farm as well as optimised rooftop solar and a grid scaled battery. This microgrid is scaled to provide a full electricity service to consumers for an indefinite time during islanded mode. It also provides commercial opportunities for selling electricity to the market.



A diesel microgrid**

The fourth and final microgrid model uses diesel generators to power communities. These generators would be able to provide all of the communities' electricity demand for as long as they have fuel.

The use of diesel generators will emit substantial carbon emissions (and other pollution) whenever they run. This may not be a major issue if they are only used during infrequent natural disasters but would become of greater concern if they are used more frequently. From a resilience perspective, large reserves of diesel present a major hazard to be managed during fires or other natural disasters.

---

* Refer SμRF Report: [Exploring design challenges and opportunities for microgrids to improve resilience in the Eurobodalla]

** Included for cost comparison only

Microgrids considered feasible for Congo

Considering typology, grid feasibility, outcomes from local discussion groups and regional social research.

Table Projected cost for microgrids in Congo[^]

Cost component	A large microgrid $	A small microgrid $	A diesel generator[+] $
	550kW rooftop solar + 1,000kW solar farm (PEG) + 1,250kW/2,500kWh battery	**550kW rooftop solar + 350kW/ 350kWh battery**	**350kVA**
Development works	278,000	75,000	278,000
EPC procurement	80,000	80,000	80,000
Design and construction principal	681,000	81,000	81,000
Design and construction EPC	4,247,000	1,264,000	376,000
EPC margin and contingency	617,000	241,000	23,000
Total projected cost	5,903,000	1,741,000	838,000

^ Sourced from *Conceptual designs and costings for microgrids in the Eurobodalla*

\+ Cost comparison only

A large microgrid for Congo

This option should provide adequate generation and storage for consumers without solar to access local solar generated electricity for a significant proportion of their demand thereby meeting some of the communities' aspirations for increased access to renewables. This will be subject to retailer arrangements. This option has the potential to reduce emissions by 391%. The small microgrid option is also attractive with an emissions reduction of 139%. Refer emissions calculations and assumptions – ANU.

Large microgrids are considered large enough in generation and storage to attract a suitable price from the energy market to offset high tariff prices during high demand. This option meets some of the financial aspirations of the community. If land becomes available, the large solar microgrid option might support these aspirations. If land does not become available, the small microgrid is the next option for consideration, albeit without the potential revenues provided by the large microgrid.

Solar and storage capacities specified in the conceptual solar microgrid designs

Peak demand: 1.3 MW

Large solar microgrid:
Rooftop solar: 550 kW
Solar farm: 1000 kW (PEG)
Storage: A 750 kW/1500 kWh battery

Small solar microgrid:
Rooftop solar: 550 kW
Storage: 350 kW/350 kWh battery

The large microgrid option provides indefinite electricity during an outage and under normal operating conditions.

The small microgrid option with an appropriately sized battery also exceeds the minimum back up power, ie eight hours suggested at the community discussions. Sixty hours may be available from this option if the community can manage to reduce their electricity consumption by 50%. This might be achieved via community agreements on suitable demand management behaviours or via central controls that limit access to certain circuits.

Average time microgrid can run independently

Small microgrid

0.5 days

normal energy usage

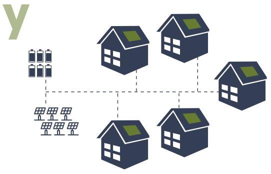
2.5 days

half energy usage

Large microgrid

indefinitely

normal and half energy usage



The optimised solar potential supports the idea that a small microgrid is feasible.

Power during these periods may be accessed from the battery by providing increments of power over a number of days eg four hours a day over three days. This might, if weather permits, enable top up charging of the battery, further extending the access to power again for limited hours as agreed to by the community consumers.

Further investigation is needed as to whether the EV's batteries might be able to support storage within the microgrid in emergency/islanded mode or become an obstacle due to the significant demand on the microgrid battery when charging the EV.

In the future, Vehicle-to-Grid capabilities will likely enable EV batteries to support the microgrid in emergency/islanded mode.*

Further consideration/investigation is needed on the benefits or challenges around avoiding export controls such as community battery locations and DNSP controls on inverters? Refer operating models pages 31–33.

Large microgrid

This option should provide adequate generation and storage for consumers without solar to access local solar generated electricity for a significant proportion of their demand thereby meeting some of the communities' aspirations for increased access to renewables. This will be subject to retailer arrangements. This option has the potential to reduce emissions by 391% per day.

* https://bsgip.com/research/realising-electric-vehicles-to-grid-services/

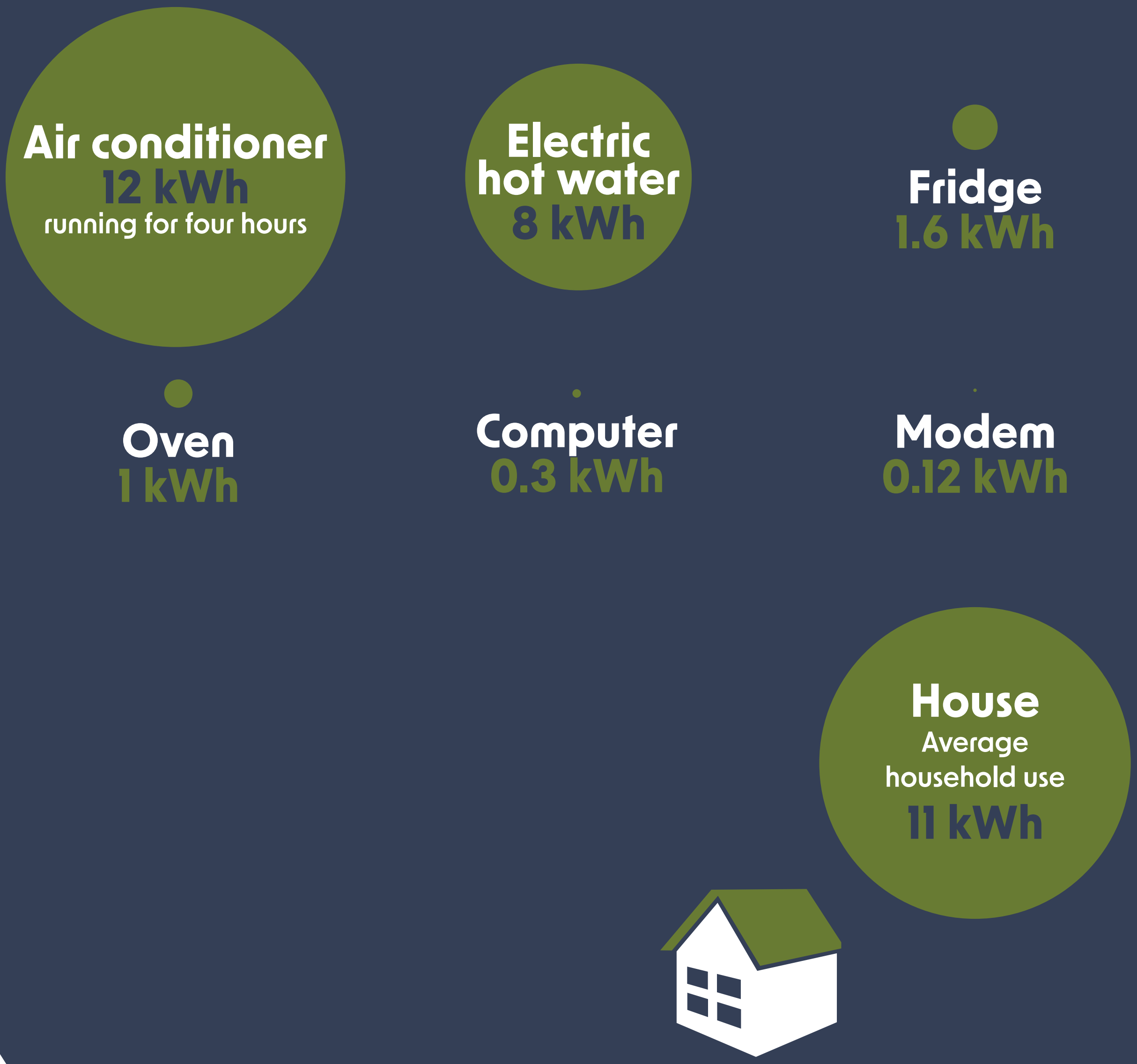
Energy consumption of appliances

The following shows the energy consumption in Broulee of an average household and for various appliances.

Consumer awareness of the energy consumption is important for microgrids as these appliances lead to higher electricity bills, but more importantly, these appliances when used in a microgrid that is disconnected from the main grid in an emergency situation will draw down the storage and generation capacity faster leading to a shorter duration of electricity supply.

Alternatively, the conservation of energy by not using these appliances during island mode will extend the duration of energy supplys.

Energy consumption of appliances (kWh/day)



Microgrid operating model economic assessment

Revenue streams – an overview

After reviewing the cost of options considered from ITP, the economic assessment of developing microgrids for reliability and resilience benefits is challenging when different value streams are directed to different stakeholders. When islandable microgrids are proposed in areas of network need and at locations where construction costs can be minimised; it is expected that these systems will form a positive value business case.

There is no indication that islandable microgrids can form a solution that enables a lower cost of energy to customers to reduce power bills at this stage. If the community driver is to deliver an energy project for the purpose of delivering cheaper electricity costs, other solutions such as solar and community battery projects will present a better opportunity to realise such drivers. Potential revenue streams available from the National Electricity Market can be summarised as follows, however it is dependent on ownership or commercial revenue sharing agreements with retailers.

There is no indication that islandable microgrids can form a solution that enables a lower cost of energy to customers to reduce power bills at this stage. If the community driver is to deliver an energy project for the purpose of delivering cheaper electricity costs, other solutions such as solar and community battery projects will present a better opportunity to realise such drivers.

Solar farm

Feed-in tariffs and Power Purchase Agreements (PPAs)

Generating revenue by selling electricity to utilities or end-users through long-term contracts at agreed-upon rates.

Renewable Energy Certificates (RECs)

Generating and selling RECs based on the amount of renewable energy produced, providing an additional revenue source.

Spot market sales

Selling excess electricity directly into the NEMs wholesale electricity market during high-demand or high-price periods.

Grid-scale battery

Ancillary services

Providing ancillary services to the grid, such as frequency regulation, spinning reserves, and voltage support, and earning payments for ensuring grid stability and reliability.

Energy arbitrage

Storing excess electricity during low-demand or low-price periods and selling it during peak-demand or high-price periods, maximising revenue.

Future revenue streams subject to regulatory reform

There has been and will continue to be expansion of the ancillary services that are provided into the National Electricity Market that provide new revenue streams. Over time it is expected that new markets will develop that enable new revenue opportunities from generation and storage assets that will increase the viability of a microgrid business case.

Combined solar farm with battery

Integrated dispatch

Optimising revenue by combining solar generation with energy storage, allowing for better control and dispatch of electricity to align with market conditions and demand.

Enhanced grid service

Offering a combination of solar generation and energy storage to provide enhanced grid services, including smoothing intermittent solar output and improving grid stability.

These revenue streams can help develop the business case and economic viability of microgrids or any energy project which contains these asset types.

Community owned revenue/commercial arrangements for Congo

The ownership revenue and risk models on the following pages 31–33 are offered to support further investigation into the preferred microgrid solution for Congo and to help inform the community on how to approach a suitable retailer.

It illustrates some of the ownership options and the financial and operational risks and rewards associated with ownership of microgrid assets.

Ownership as a concept only was discussed during the community consultation phase of the project. Congo is considering a third party owned battery and solar farm with some options for co-contribution.

Operating models – generic

Microgrid operating model

Community owned revenue/commercial model

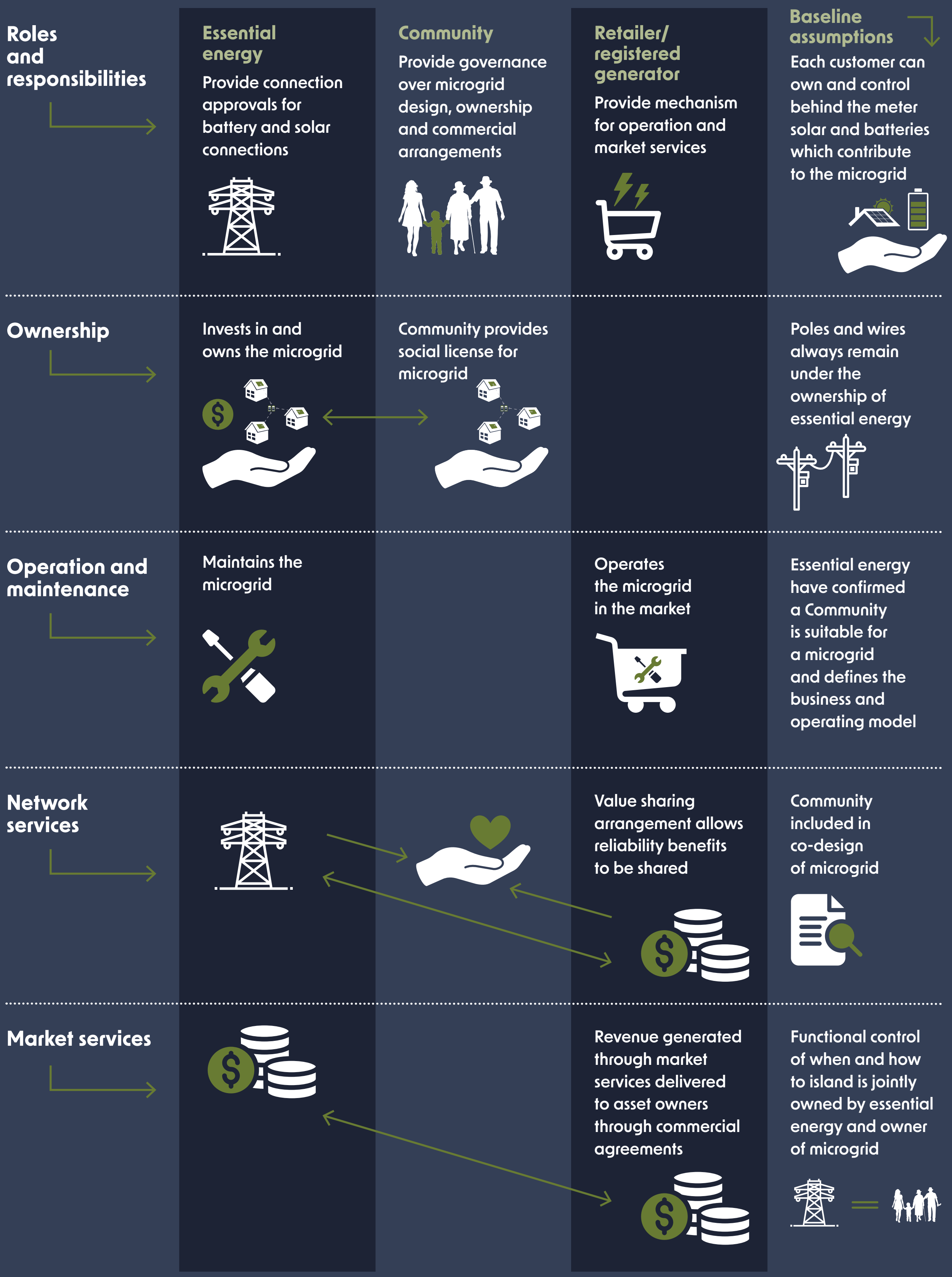
	Essential energy	Community	Retailer/ registered generator	Baseline assumptions
Roles and responsibilities	Provide connection approvals for battery and solar connections	Provide governance over microgrid design, ownership and commercial arrangements	Provide mechanism for operation and market services	Each customer can own and control behind the meter solar and batteries which contribute to the microgrid
Ownership		Community invests in and owns the microgrid		Poles and wires always remain under the ownership of essential energy
Operation and maintenance		Contracts the maintenance if microgrid	Operates the microgrid in the market	Community can choose to allow third parties to own shared assets such as solar farms and batteries
Network services		Value sharing arrangement allows reliability benefits to be shared		Community needs to define governance and decision making
Market services			Revenue generated through market services delivered to asset owners through commercial agreements	Functional control of when and how to island is jointly owned by essential energy and owner of microgrid

Third party owned/commercial model

	Essential energy	**Community**	**Retailer/ registered generator**	**Baseline assumptions**
Roles and responsibilities	Provide connection approvals for battery and solar connections	Provide governance over microgrid design, ownership and commercial arrangements	Provide mechanism for operation and market services	Each customer can own and control behind the meter solar and batteries which contribute to the microgrid
Ownership		Community provides land and social license for microgrid	Proponent invests in and owns the microgrid	Poles and wires always remain under the ownership of essential energy
Operation and maintenance			Maintains and operates the microgrid in the market	Community **have** chosen to allow third parties to own shared assets such as solar farms and batteries
Network services			Value sharing arrangement allows reliability benefits to be shared	Community needs to define governance and decision making
Market services		Benefits (financial and nonfinancial) shared with community	Revenue generated through market services delivered to asset owners through commercial agreements	Functional control of when and how to island is jointly owned by essential energy and owner of microgrid

Congo is considering
a third party owned battery and solar farm
with some options for co-contribution

Distributed Network Service Provider model



	Essential energy	Community	Retailer/ registered generator	Baseline assumptions
Roles and responsibilities	Provide connection approvals for battery and solar connections	Provide governance over microgrid design, ownership and commercial arrangements	Provide mechanism for operation and market services	Each customer can own and control behind the meter solar and batteries which contribute to the microgrid
Ownership	Invests in and owns the microgrid	Community provides social license for microgrid		Poles and wires always remain under the ownership of essential energy
Operation and maintenance	Maintains the microgrid		Operates the microgrid in the market	Essential energy have confirmed a Community is suitable for a microgrid and defines the business and operating model
Network services			Value sharing arrangement allows reliability benefits to be shared	Community included in co-design of microgrid
Market services			Revenue generated through market services delivered to asset owners through commercial agreements	Functional control of when and how to island is jointly owned by essential energy and owner of microgrid

Implementation plan

Community energy projects – examples for comparison

The implementation of an energy project can be different depending on the type of system chosen. There are various examples within the energy industry of projects led by communities such as.

- Community solar gardens
  innerwest.nsw.gov.au/live/environment-and-sustainability/at-home/go-solar/solar-for-renters/solar-gardens
- Community solar farms
  communitysolar.org.au/
- Community batteries
  yef.org.au/ Neighbourhood Battery Knowledge Hub - Battery Storage and Grid Integration Program (bsgip.com)
- Energy efficiency projects
  energy.nsw.gov.au/nsw-plans-and-progress/regulation-and-policy/energy-security-safeguard/energy-savings-scheme
- Cobargo community microgrid
  Why a Cobargo microgrid? – Renewable Cobargo
- Cobargo case study – Microgrid regulations relating to Microgrid operating models. *Islandable Microgrids in Cobargo | AER - Regulatory Sandbox* (energyinnovationtoolkit.gov.au)

Image: Eurobodalla Coast Tourism ©

Generic Implementation plan – steps to progress SμRF options

This plan is a high level general guide as to the requirements that need to be considered for most energy projects, but will vary depending on the project, size and scale.

Stage 1
Concept development

ESTABLISH WORKING GROUP
Collaborate with partners (owners, investors and retailers) and use Business Model Canvas (BMC) and the SμRF Business Case to agree on high level models to be progressed.

Decision

☐ **YES** ☐ **NO** (no further action)

GUIDE AND DOCUMENT the conversations/agreements using the BMC: *Purpose and need, core values, services, partners and contributors, and resources*:

- Wider community consultation and engagement.
- Refine asset configuration and ownership models.
- Identify and consult on prospective land acquisition or easements.
- Define the business ownership model and seek support and in principle agreements on commercial arrangements.

OUTPUT

- Document the business case suitable for grant funding applications and/or private investment.
- Gain community engagement approval.
- Acquire funding for stage 2 – Design and approvals.

Decision

☐ **YES** ☐ **NO** (no further action)

Stage 2
Design and approvals

GUIDE AND DOCUMENT
the conversations/agreements using the BMC: *Operating model, beneficiaries, +ve and -ve impacts, costs and revenues*, includes:

- Continue community education, consultation and recruitment as per agreed ownership and commercial arrangements.
- Development applications including easements or land agreements.
- Regulatory approvals (through connections processes with DNSP).
- Detailed engineering design and connection approvals.
- Commercial Contracts.

OUTPUT

- Document engineering scope for construction tendering.
- Council approvals.
- Connections approvals.
- Acquire funding for stage 3 – Construction and operation.

☐ **YES** ☐ **NO** (no further action)

Stage 3
Construction and operation

COMPLETE THE BMC to ensure the project can achieve the required community objectives and outcomes, includes:

- Confirm and establish any commercial business partnerships for the ongoing ownership and maintenance of the system, which may also include construction of the microgrid.
- Prepare and approve tender documents and procurement approach, including the requirements from the BMC regarding *Partners and contributors and resources.*
- Award tender and establish project management and engineering capability for delivery and community engagement.
- Construction and establishment of microgrid assets.
- Commissioning and connections process.
- Inspections and auditing.
- Implement commercial models for operation and financial performance of the microgrid.
- Implement financial and settlement process to ensure the requirements of the BMC are achieved and delivered to the community, specifically *beneficiaries, operating model, costs and revenues* sections.

Refer to *Business Model Canvas – draft* page 38

Further independent research and approaches are available from industry experts in energy projects. For example, PwC Australia have published a guideline for energy projects called '*Investing in Energy Transition Projects*' which can be found *here*.

The BMC (Adapted by BSGIP from HotCubator Social Enterprise BMC) example is recommended as a tool for communities to use in the next stages of developing an islandable microgrid and associated business model. The BMC has been updated with generic information which is important to define in the next stages of community research. Utilising the BMC tool within community groups offers a structured and comprehensive approach to navigating the intricacies of establishing a new business or product.

The BMC serves as a visual tool, fostering collaboration and providing a shared understanding of the venture's key components among group members. By systematically breaking down the business into essential building blocks, community groups can efficiently identify strengths, weaknesses, and opportunities. This process encourages critical thinking, facilitates strategic discussions, and ensures that all aspects of the business are thoroughly explored. Furthermore, the collaborative nature of using the BMC within a community setting promotes diverse perspectives, harnessing collective insights to enhance decision-making and increase the likelihood of a successful business launch. Refer *bsgip.com/knowledge-hub/business-model-design/* for more information on the use of BMC tools.

Business Model Canvas – draft

Purpose and need

- **INCREASED ACCESS** to renewable sources of energy
- **STABILITY** for the network and communities to facilitate more uptake of renewables
- **COMFORT** for aged residents by increased capacity for air conditioning and cooling during outages

Partners, contributors

WHO IS NEEDED TO MAKE IT HAPPEN?

- Local community organisation to lead the project
- Community focussed retailer
- Owners of roof top solar
- Local council
- Government agencies

Resources

WHAT RESOURCES WILL YOU NEED?

- Capital finance
- Land for infrastructure
- Technical consultants
- Community leadership
- Social research and consultation specialists

Refer *Partners, contributors and resources* page 19

Services

WHAT WILL THE MICROGRID NEED TO DO/PROVIDE TO DELIVER THE CORE VALUES?

- Optimise roof top solar
- Store solar energy
- Provide sufficient backup electricity for all households
- Ensure economic viability for long term operation

Refer *Services to be provided* page 19

Core values

WHAT ARE THE VALUES AND BENEFITS THE COMMUNITY WANTS, WHICH MAY BE SOUGHT FROM A MICROGRID?

- Access to renewables
- Energy bill reductions
- Equity – sharing electricity adds resilience to the sense of community
- Reliability
- Resilience
- Self-sufficiency/ autonomy

Refer *The value proposition* page 15

Impacts

A SET OF METRICS TO MEASURE THE DELIVERY OF VALUE

- MWh renewable energy generated
- GHG reduction
- Sustainability targets
- Resilience benefits

Beneficiaries

WHO SHOULD BENEFIT FROM THE VALUE THE MICROGRID WILL DELIVER?

WHO IS THE COMMUNITY?

- The community
- Roof top solar generators
- Investors
- Emissions reductions
- Emergency response agencies

Refer *Beneficiaries* page 18

Operating model

HOW WILL THE VALUES BE DELIVERED?

- Commercial relationship created for third party ownership of the microgrid
- Community participation
- Governance

Refer *Microgrid operating model economic assessment* page 29

Costs

WHAT EXPENDITURE, CAPITAL COSTS AND OPERATING COSTS WILL BE INVOLVED IN SETTING UP AND RUNNING THE MICRO-GRID?

HOW MUCH UNCERTAINTY AND RISK IS THERE IN PROJECTED COSTS?

- Community engagement
- Land acquisition
- Grant applications
- Development applications
- Capital costs (refer ITP reports)

Refer *Microgrid design options technical assessment* page 25

Revenues

WHAT SOURCES OF REVENUE AND PROFIT WILL KEEP THE VENTURE ECONOMICALLY SUSTAINABLE FOR THE LIFE OF THE MICROGRID?

HOW MUCH UNCERTAINTY AND RISK IS THERE IN PROJECTED REVENUES?

Revenue from:

- solar farms
- batteries
- roof top solar in partnership with retailers (refer economic assessment)

Refer *Microgrid operating model economic assessment* page 29

Impacts

DEVELOP WAYS OR PARTNERSHIPS TO MONITOR UNINTENDED CONSEQUENCES AND HARMS

- System performance
- Asset failure
- Social equity
- End of life replacement of system components

Adapted by BSGIP from HotCubator Social Enterprise BMC

Glossary

Alternating Current (AC): AC is a type of electrical current in which the flow of electric charge periodically reverses direction. This reversal occurs at a specific frequency, typically 50 hertz, depending on the region. AC is the most commonly used form of electrical power worldwide and is used in homes, businesses, and industries.

Ancillary services: Ancillary services refer to various functions necessary for the reliable operation of an electricity grid. These services include but are not limited to frequency regulation, voltage control, and reactive power support.

Arbitrage: Arbitrage is the practice of buying energy to take advantage of price differences in the Energy Market.

Australian Renewable Energy Agency (ARENA): ARENA is an Australian government agency established to support and promote renewable energy technologies and projects in Australia. It provides funding and assistance to initiatives aimed at accelerating the development and adoption of renewable energy sources.

Balance the grid: Balancing the grid involves adjusting the electricity supply and demand in real-time to ensure that the grid operates within acceptable frequency and voltage limits.

Balancing local generation in the grid: Refers to the management of electricity supply and demand within a specific geographical area or network. This process involves ensuring that the electricity generated locally matches the demand from consumers, thereby maintaining grid stability and reliability.

Behind the meter: Behind the meter refers to energy generation, storage, or consumption systems that are located on the customer's side of the utility meter.

Carbon emissions: Carbon emissions refer to the release of carbon dioxide (CO_2) and other greenhouse gases into the atmosphere as a result of human activities, such as burning fossil fuels for energy production, transportation, and industrial processes.

CO_2e: CO_2e stands for carbon dioxide equivalent, a unit used to measure the impact of different greenhouse gases on global warming.

Concentrated Solar Power (CSP) systems: CSP systems use mirrors or lenses to concentrate sunlight onto a small area, typically a receiver or heat exchanger. This concentrated sunlight is then converted into heat, which can generate electricity through steam turbines or other heat engines. CSP systems are often used in utility-scale power plants to generate electricity.

Decentralised storage: Decentralised storage refers to energy storage systems that are located close to the point of consumption, such as residential or commercial buildings.

Diesel genset: Short for diesel generator set, is a backup power generation system that uses a diesel engine to produce electricity.

Distributed Energy Resource Management Solution (DERMS): DERMS is a software platform or system designed to manage and optimise the integration of distributed energy resources (DERs) into the electricity grid. It helps utilities and grid operators monitor, control, and coordinate various DERs, such as solar PV, wind turbines, and energy storage systems.

Distributed Energy Resources (DERs): DERs refer to a variety of small-scale power generation technologies, often located close to where electricity is used. It is a term used to describe generation and storage assets located at customers connections on the electricity network.

Distribution Network Service Provider (DNSP): A DNSP is a company responsible for operating, and maintaining the distribution network infrastructure that delivers electricity from transmission lines to end-users, such as homes and businesses.

Dynamic connection agreements: Dynamic connection agreements are contracts or agreements between the DNSP and a customer that allow for flexible and dynamic adjustments to the connection parameters based on changing grid conditions and requirements.

Dynamic operating envelopes: Dynamic operating envelopes define the safe and permissible operating limits for grid-connected devices and systems, such as generators, inverters, and energy storage systems. These envelopes may vary over time based on grid conditions and regulatory requirements.

Economies of scale: Economies of scale refer to the cost advantages that result from increased production or scale of operation. In the context of energy generation, larger power plants or projects often benefit from economies of scale, leading to lower average costs per unit of output.

Emissions reductions: Emissions reductions refer to efforts aimed at decreasing the release of greenhouse gases and other pollutants into the atmosphere.

Feed-in tariffs (FITs): FITs are incentive programs that offer payments to customers for electricity they generate and feed into the grid.

Frequency control: Frequency control involves maintaining the stability of the electricity grid by ensuring that the frequency of the alternating current (AC) remains within acceptable limits.

Frequency Control Ancillary Services (FCAS): FCAS refers to ancillary services provided by generators or consumers to help regulate the frequency of the electricity grid. These services include frequency regulation, contingency response, and regulation up and down.

Generation and storage assets/ decentralised storage and generation assets: Infrastructure or equipment that both generates and stores electricity, often distributed across various locations rather than centralised in one facility.

Generation site: The physical location where electricity is generated, such as a power plant, wind farm, or solar array.

Grid outages: Periods of time when part or all of an electrical grid is not operational, usually due to equipment failure, maintenance, or extreme weather events.

Islandable microgrid: A localised electrical grid capable of operating independently from the main power grid, often utilising renewable energy sources and energy storage systems to ensure reliability.

KW (Kilowatt): A unit of measurement for electrical power, representing one thousand watts.

kWh (Kilowatt-hour): A unit of measurement for energy consumption or production, representing the amount of energy consumed or produced by a one kilowatt device over the course of one hour.

kVA (Kilovolt-ampere): A unit of measurement for electrical apparent power, representing the product of voltage and current in an AC circuit. Electrical apparent power is a measure of the total power consumed by an electrical circuit or device, considering both the real power (the power actually used to perform work) and the reactive power (the power absorbed and returned in part by inductive or capacitive elements without performing work).

Low/peak demand periods: Times when electricity consumption is relatively low or high compared to average levels, often influenced by factors such as time of day, season, and economic activity.

Microgrid: A localised group of electricity sources and loads that operates connected to the traditional centralised grid or independently as an island.

Microgrid controller: A control system that manages the operation of a microgrid, coordinating energy generation, storage, and consumption to ensure stability and efficiency.

MW (Megawatt): A unit of measurement for electrical power, representing one million watts.

MWh (Megawatt-hour): A unit of measurement for energy, equivalent to one megawatt of power consumed or produced over the course of one hour.

National Electricity Market (NEM): A wholesale electricity market operating in Australia, facilitating the buying and selling of electricity between generators, retailers, and large consumers across participating states and territories.

NFP (Not-for-profit): An organisation or entity that operates for purposes other than profit-making, often focused on providing services or benefits to the community or specific groups without the intention of financial gain.

Onsite inverter-based system: A system that converts direct current (DC) electricity generated from sources like solar panels into alternating current (AC) electricity for use onsite, often used in renewable energy installations.

Orchestration services: Services that coordinate and manage various components of a system or network to achieve a specific goal or outcome, often in the context of distributed energy resources or microgrids grids.

Peer to Peer sharing: A decentralised system where individuals or entities can directly exchange goods, services, or resources with one another without the involvement of intermediaries.

Power Purchase Agreements (PPAs): Contracts between electricity producers and consumers, typically renewable energy developers and large energy users, where the consumer agrees to purchase electricity at predetermined prices for a specified duration.

Renewable energy: Energy derived from naturally replenishing sources, such as sunlight, wind, rain, tides, and geothermal heat, which are considered environmentally sustainable alternatives to fossil fuels.

Renewable Energy Certificates (RECs): Tradable certificates that represent the environmental attributes of one megawatt-hour of electricity generated from renewable sources, often used to demonstrate compliance with renewable energy targets or goals.

Rooftop solar generators: Solar photovoltaic (PV) systems installed on the roofs of buildings or structures to generate electricity from sunlight, typically used to offset electricity consumption onsite.

Sandbox: A controlled environment or testing ground where new technologies, products, or services can be developed, evaluated, and refined before wider deployment or implementation.

Solar generation: The process of producing electricity from sunlight using solar photovoltaic (PV) panels or concentrated solar power (CSP) systems.

Solar Photovoltaic (PV) systems: PV systems use photovoltaic cells to convert sunlight directly into electricity. These systems consist of solar panels, which are made up of numerous interconnected solar cells. When sunlight hits the solar cells, it creates an electric field that generates a flow of electricity. Solar PV systems are commonly used on rooftops, in solar farms, and in other applications to generate renewable electricity.

Spinning reserves: Reserves of electricity generation capacity that can be rapidly deployed to balance supply and demand fluctuations in the power grid, typically provided by generators operating at less than full capacity.

Spot market: A financial market where commodities, including electricity, are bought and sold for immediate delivery or settlement, often based on short-term supply and demand dynamics.

Supervisory Control and Data Acquisition (SCADA) connection: SCADA systems that monitor and control industrial processes, including electrical generation and distribution, often through remote connections to sensors, equipment, and control devices.

Tariff: The schedule of rates or charges for electricity consumption or other services provided by utility companies, often regulated by government authorities.

Voltage support: Measures or devices implemented in electrical systems to maintain or regulate voltage levels within acceptable limits, ensuring the stability and reliability of the grid.

Zero-carbon electricity: Electricity generated without emitting carbon dioxide or other greenhouse gases into the atmosphere, typically from renewable energy sources or nuclear power.