Briefing paper – Mini Grids

Overview

The rise of increasingly cost competitive clean distributed energy resources, from local renewables generation technologies to demand management tools, means that in many places it now makes economic sense to meet most, if not all of a community's energy needs locally. Mini-grids (also known as 'micro-grids') are one way to go about this.

The Renewables for All project is proactively supportive of the development of renewable powered mini-grids in appropriate locations in Australia, as they:

- Can reduce grid costs for all Australians
- Leverage community engagement and to permit more people to participate in renewable energy deployment,
- Are sites of innovation in new clean energy technologies, business models, ownership structures and benefit sharing approaches,
- Can reduce remote community's reliance on diesel generators, which is particularly pertinent as remote communities have a disproportionate number of low-income households.

Policy measure needed to support the uptake of mini-grids in Australia include:

- Funding for pilot projects
- Feasibility studies and technical assessments for interested communities
- Improve and upgrade mini-grids in remote locations to ensure they are powered by renewable energy not diesel
- Investigating the benefits of ownership transfer of centralised network assets where there is an interested community, particularly in edge-of grid locations.
- Assessing grid upgrades more stringently in areas where mini-grid solutions are possible
- Supporting a cultural shift in network operators and energy retailers

The briefing paper has been developed as part of the Renewables for All project.

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Description

The term mini-grids refers to a combination of energy generation and distribution that typically operate as isolated systems in a range of 10 kW to 10 MW, serving tens to several hundred customers. Mini-grids mostly exist in remote areas that are separated from the national grid or on islands. However, there is also a growing interest in grid-connected or embedded mini-grids because it allows for greater control of the electricity generation e.g. from renewables and reduce network costs.

Since the 1980s mini-grids have internationally been seen as a way of improving access to energy services in rural and remote areas and are considered a great opportunity for community participation and ownership. Although many countries continue to pursue large-scale and centralised grid programs, the interest in decentralized generation and distribution through mini-grids is growing. This applies in particular to developing country contexts' where constraints such as an isolated population, low purchasing power and limited potential for load growth hinders larger scale ambitions. But mini-grids also play an important role in developed countries for remote communities or edge of grid locations and increasingly as embedded systems.

There are a number of different approaches to the development of mini-grids which comprise technological, institutional and financial elements. Mini-grids can operate with single generation technologies such as diesel, solar PV, wind, hydropower or biomass or with a hybrid system that combines one or more of those technologies. Hybrid models are of particular interest due to their ability to mix non-interruptible (e.g. diesel, biomass) and intermittent and variable power sources (e.g. solar) to increase reliability and load matching.

The flexibility of a system can be also secured through the application of thermal and battery storage technologies. The institutional and financial arrangements to set up a mini-grid are more diverse. Private or public actors can own and operate the system or parts of it such as generation, distribution and demand management. They may also incentivise additional actors such as community members to engage and invest into the system.

The World Bank and US Aid have identified four main types of mini-grids:

- ***Community based model***. Here, the community becomes the owner and operator of the system and provides maintenance, tariff collection, and management services. For example a community group sets up a cooperative or trust that invests in and operates renewable resources of hydro, wind or solar energy systems, and makes the electricity available to all households in the community via a local distribution grid. For example, the Isle of Eigg, Scotland.

- ***Private sector operator:*** In this case, a private actor establishes and owns the mini-grid system. These initiatives can be driven by local entrepreneurs that take ownership e.g. of existing systems by setting up contracts with the utility or end users to run the system.

- ***Utility-based approach***: In this case the existing electricity utility owns and operates a mini-grid in a location that does not make sense to service centrally through the national grid (or at least service to the same degree. Typically, utilities already have the capacity, knowledge and staff to run a mini-grid system.

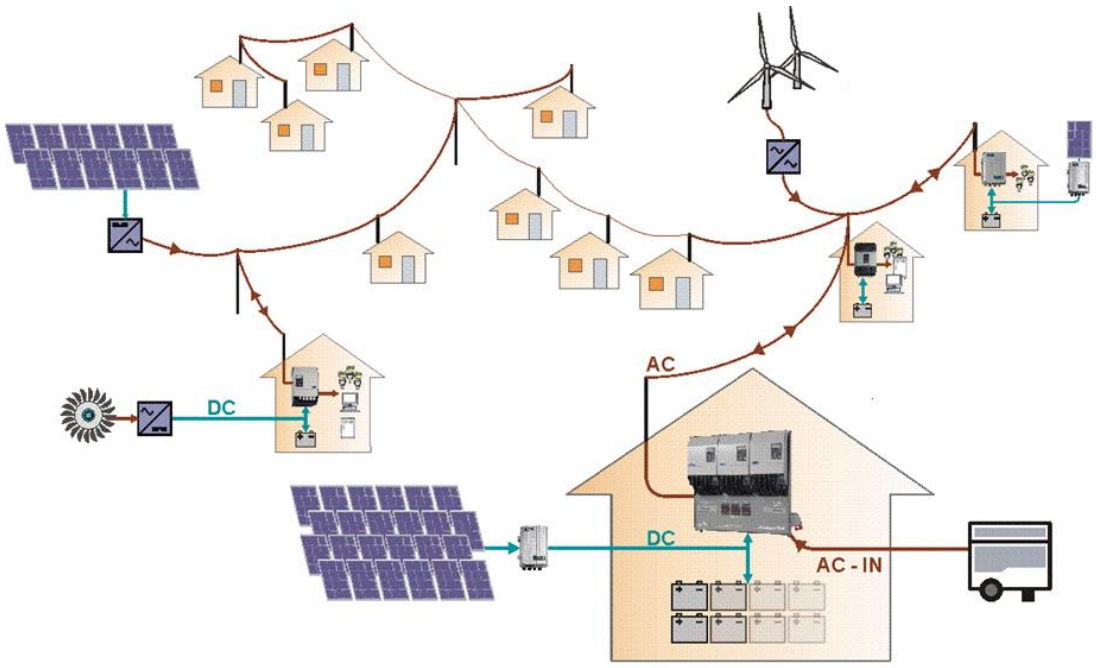
- ***Hybrid model***: This case is where a combination of the above approaches are applied. There are numerous variations of business models for hybrid mini-grid system, which can involve separate entities owning and operating different parts of the system.

To set up a mini-grid is a complex task. There are mainly two options for a mini-grid

operations: as islanded networks or connected to the main grid as back up option (if available).

In both systems households are interconnected with a local distribution network whereby the power is generated locally. Single households can also produce power for example through solar PV panels and feed their excess electricity back to system.

Figure 1: Example of an islanded mini-grid system powered by renewable energy sources - Xtender. Source Studer Innotec SA



Why Mini-grids?

In Australia there are good reasons to consider both islanded and grid-embedded mini-grid systems.

Grid-embedded mini-grids

Australia's energy system has the longest distribution network in the world and regulation sees network owners compelled to service all customers within reach. As a result there are massive cross-subsidies between urban and regional areas, for example in Queensland the Community Service Obligation is a cross-subsidy of approximate $0.5billion each year. Towns that are sometimes more than 1,000 km away from the source of generation have to be cross-subsidised by up to $600 per household (REneweconomy, Oct 2015). That is not to say that regional communities shouldn't have access to affordable electricity – they

absolutely should, but now there are smarter, cleaner and cheaper ways to do this.

In the recent years grid upgrades, maintenance and extensions have contributed to rising electricity prices across Australia. But with the reduction in costs for distributed generation technologies such as Solar PV, studies suggest that one third of the customers could be go off the grid by 2050, if not sooner (CSIRO, 2012). In this scenario renewable mini-grid solutions could help to reduce the risk of stranded assets and the Death Spiral. This has already led a number of the network operators to consider taking whole towns off the grid, or at least making their connection skinnier.

Furthermore, mini-grids that employ new ownership structures which help communities to take control of their own electricity supply and to create a local energy market that captures the value of both the generation of electricity and the network savings achieved by local generation. Such mini-grids are likely to be economically efficient and effective solution at the edge-of-grid locations. This is particularly the case where communities are interested in renewable energy generation in order to reduce their members' electricity bills. At edge-of-grid locations mini-grids can increase reliability and quality of the local electricity supply and prevent power fluctuations.

Already there are a range of actors looking at mini-grids in edge of grid locations. For example, network operators in both Western Australia and Queensland are doing tender processes to take a number of edge-of-grid communities off the grid through mini-grids (REneweconomy, Oct 2015).

Other communities are also interested in a mini-grid approach for example:

- Newstead, has funding from the Victorian State Government to create an embedded mini-grid for their town in a project called Newstead Behind the Meter;
- Tyalgum, has NSW state government funding to investigate going off-grid and to be powered entirely by renewable energy. In a recently finalised feasibility study two scenarios were proposed: first option to completely become self-sufficiency with 100% renewable energy, second option still using the grid for backup with a 100% renewable energy power generation.

Islanded mini-grids

Islanded mini-grid systems already exist in a number of communities in very remote locations across Australia. Disadvantaged people are over-represented in remote communities (ABS, 2012). Yet, they depend on mini-grid systems that use diesel to generate electricity and ultimately face finite fossil sources and a steady increase in fuel prices.

The availability of cost effective renewable energy technologies provides alternatives for such communities. An upgrade of mini-grids with solar PV or wind power systems would allow for the displacement of expensive diesel-based generation to help them to become independent from fossil fuels and thereby reduce their costs of electricity. The new technologies offer the opportunity to diversify such community's energy supply and allow for the most appropriate energy sources to be deployed e.g. solar, wind, bioenergy etc.

Hence, they help to increase the community's energy security and resilience in times of diesel price volatility and when remote communities are inaccessible for a certain amount of time during severe weather events (or e.g. wet season in Queensland).

In Australia many remote communities depend on off-grid solutions particularly in the Northern Territory. A very successful program in remote locations in Australia was Bushlight that ran from 2002 to 2012 with the aim of increasing livelihood opportunities for people living in small remote indigenous communities through the provision of renewable energy services. Bushlight was a project of the Centre of Appropriate Technology (CAT) that was jointly funded by the Department of Families, Community Services and Indigenous Affairs (FaCSIA) and the Australian Greenhouse Office (AGO). Bushlight installed over 100 renewable energy systems ranging from household stand-alone systems to large scale community systems and community hybrid systems. The two latter were designed to meet the electrical needs of a small community and involved the application of mini-grid technologies. In these cases, power is generated centrally and then distributed out to individual households or buildings. Each household or building has its own Bushlight supplied switchboard that provides energy management on the household level (Rodden, 2008; CAT archive, 2012).

Further benefits of renewables powered mini-grids specifically include: emission reductions, local economic development and electricity costs savings of the broader customer base.

Policy asks

While mini-grid solutions in NSW are quite new it is necessary to better understanding some of the technical and institutional requirements for such projects and identify the barriers and challenges in the current market environment.

To support the development of mini-grid in NSW, the following measures are needed:

- Provide funding for research and implement **pilot projects** to enable accelerated learning by energy market participants and regulatory authorities;
- Support communities with funding to conduct feasibility studies and technical assessments as well as the system design processes for interested communities
- **Improve and upgrade mini-grids in remote locations** to ensure that they are powered by renewable energy not diesel
- Investigating the benefits of ownership transfer of centralised network assets where there is an interested community, particularly in edge-of grid locations.
- **Assessing grid upgrades more stringently** in areas where renewable mini-grid solutions are likely to be viable
- **Support a cultural shift** of network operators and energy retailers to conduct such projects

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