Micro Grids for Macro (Benefits)

Deakin University along with network operator AusNet service today announced a 7.25 MW microgrid construction at Deakin's Waurn Ponds Campus. Prospective smart microgrid will be part of the Deakin's research and visualisation facility and will constitute 7.25 MW solar farm, a 1 MW/1 MWh lithium ion battery storage along with other smart technologies. Prospective microgrid will provide a platform for developing new technologies and solutions which could be evaluated, qualified and tested. I would like to take this opportunity to briefly introduce and highlight the importance of the microgrids.

What is a Microgrid?

A microgrid is a localized confined group of distributed electricity generation sources, loads, and storage mechanisms which can operate both as part of the centralized main grid or independently as an island.

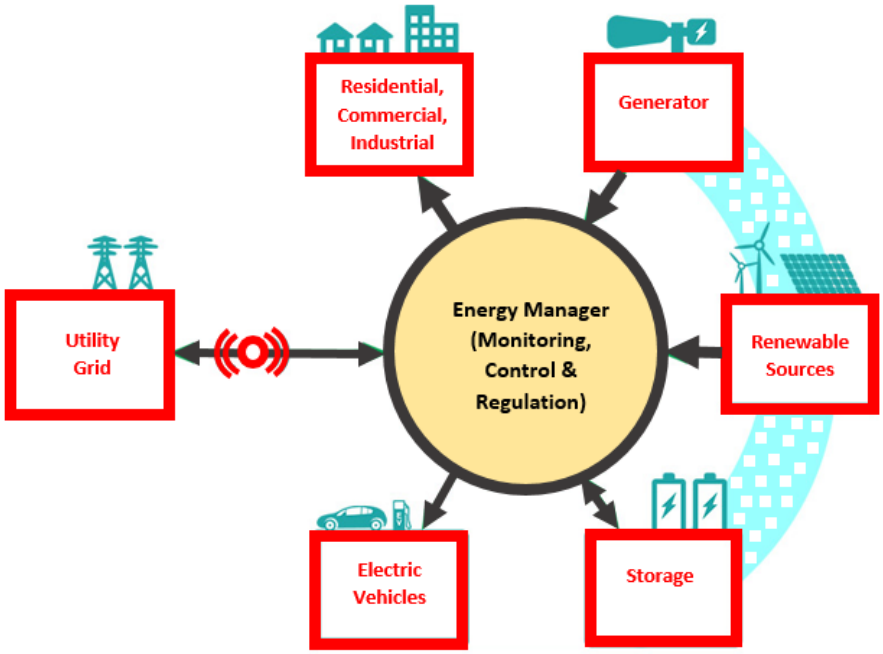

Figure 1: Generalized Schematics of Microgrid

How Does a Microgrid Work?

Microgrids can be considered the building blocks for modernisation of the grid as Smart Grid or an alternative path to the "super grid." A microgrid usually operates while connected to the grid, but prominently one of its distinctive features is the ability to disconnect from the utility grid (known as "islanding" in electrical term). Microgrids deliver autonomous power in response to load demand or in case of other events like power outages or emergencies due to the extreme weather. Microgrid optimize the utilization of generation resources, manage charging and discharging energy storage units, and manage consumption. When microgrid is operating in grid-connected mode, the microgrid

operator can economically participate in energy market depending upon on-site generation capability and the energy market prices. When in islanded mode operation, local generation sources will continue to supply power to loads within the microgrid. Figure 2 presents a common electrical configuration of microgrid which consists of combination of various renewable and non-renewable generation sources and loads. Combined Heat and Power unit (CHP), diesel engine generator, micro turbine, fuel cell, wind turbine, and solar Photovoltaic (PV), storage devices (battery, flywheel, super-capacitor) along with the different types of loads such as; critical (sensitive) and non-critical (controllable) loads constitute the main components. Energy manager is the other key component which monitor, control and regulates various electrical parameters of the microgrid. Garden Island microgrid project in Western Australia is incorporating wave energy generation technology along with 2 MW of photovoltaic solar capacity, a 2 MW/0.5 MWh battery storage system and a control system. Microgrid configuration under different topology can be utilized at different market segments as shown in Figure 3. Institutional/Campus and industrial microgrids are comparatively simpler with moderate energy reliability while utility microgrids providing power to urban or rural communities includes distribution substation and has the option of selecting from wide variety of distributed energy resources. Island microgrids are like utility microgrids with the difference that there is no connection to the utility grid.

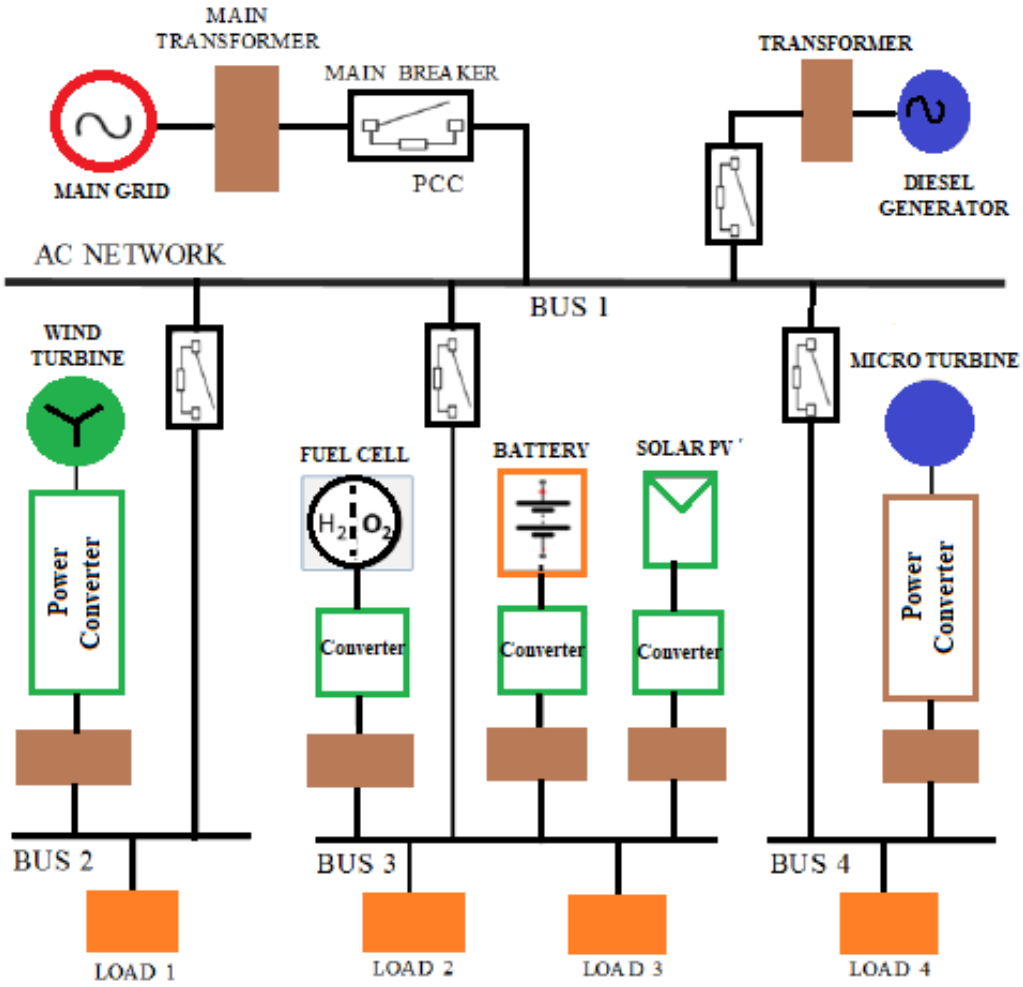

Figure 2: Electrical configuration of a microgrid

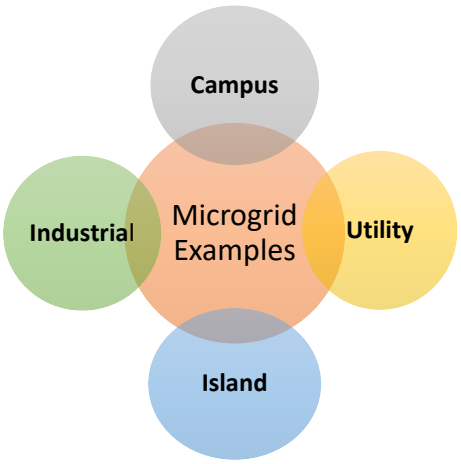

Figure 3: Microgrid utilization market segment

What macro solutions can be provided by the microgrid?

Microgrid operation are optimised for cost, reliability and sustainability. Microgrid can allow a community to become energy independent in an environmental friendly way. It can provide the necessary means to optimally utilize local but intermittent renewable energy resources in a cost-effective way. All macro solutions provided by microgrid can be categorised as:

1. **Climate change mitigation**

Increased industrialization and dependence on fuel based energy sources has brought a global challenge of climate change. Rising temperatures, increased bushfires and more storms are creating a havoc on the electrical grids. Microgrids can help us both prepare for and mitigate the realistic threat of climate change. Greenhouse gas emissions can be reduced through microgrids which provide the opportunity to deploy almost zero emission based generation sources and displace fossil fuel based generation sources. Local generating sources which are not to efficient to be grid connected, can find opportunity through microgrids. Local generating sources deployment leads to lower line losses. Power generated local to the consumer makes its economically feasible to re-utilize the produced heat energy in space and water heating.

2. **Macro grid support**

There is the possibility of the grid outage in case of coordinated terrorist attacks on the grid (including cyber-attacks). If one transmission node of the grid is closed or damaged due to cyber-attack or there is a loss of centralised energy sources, the rest of the grid will come under pressure to deliver the energy demand. Any further cascaded outage can be avoided through microgrids. Microgrids can provide back-up to the rest of the grid or cost-effective ancillary services. Microgrids can help in peak shaving thereby reducing energy demands from the grid during peak periods when demand variations are the highest.

How is microgrid significant to Australia?

Although all the attributes and emerging opportunities for microgrids outlined above are of relevance to Australia, there are three areas which are of significance:

1. **The tyranny of distance and variable terrain** – Australia under the banner of National Electricity Market (NEM) owns the largest geographical interconnected power system in the world. Transmission lines and associated infrastructure extending approximately 51,000 km from Port Douglas in Queensland to Port Lincoln in South Australia and across the Bass Strait to Tasmania. Australia's vast landmass and geographical distribution of communities and industries favours the economics of microgrids over centralised generation and distribution.

2. **Natural disaster** – Australia has always been vulnerable to various natural disasters which are hazards to environment and electrical network. Increasing frequency of bushfires, severe storms and flooding have been a challenge to electrical networks and their maintenance. Black Saturday bushfire in Victoria 2009, Cyclone Yasi in 2011 in Queensland and severe storm in South Australia in 2016 led to the widespread network blackout. In such situations, microgrids present a potentially cost-effective and tailor-made solution to provide security to sensitive loads and thereby promoting system resilience.

3. **Renewable energy growth and integration** – There has been substantial growth in electricity from renewables in the year 2017. There was a growth of 17.3 % electricity from renewables in 2016. Renewable power generation by fuel in year 2016-17 is shown in Figure 4. Australia's rapid uptake of renewable energy is increasing understanding and acceptance of localised energy solutions that are the basis for microgrids. Microgrids will provide individual customers the capacity to select the generation technologies of their choice and transact with grids in a manner that will improve the affordability of the energy. Microgrids are technology-neutral and able to cope with a diverse mixture of renewable and fossil-fuelled generators. Renewable energy resources for microgrid applications generally focus on solar photovoltaic (PV) and wind turbines, even if small-scale hydro and biogas-fuelled generators may also find application in predominantly rural locations. Integration of these distributed, renewable resources can provide more reliable and sustainable energy infrastructure.

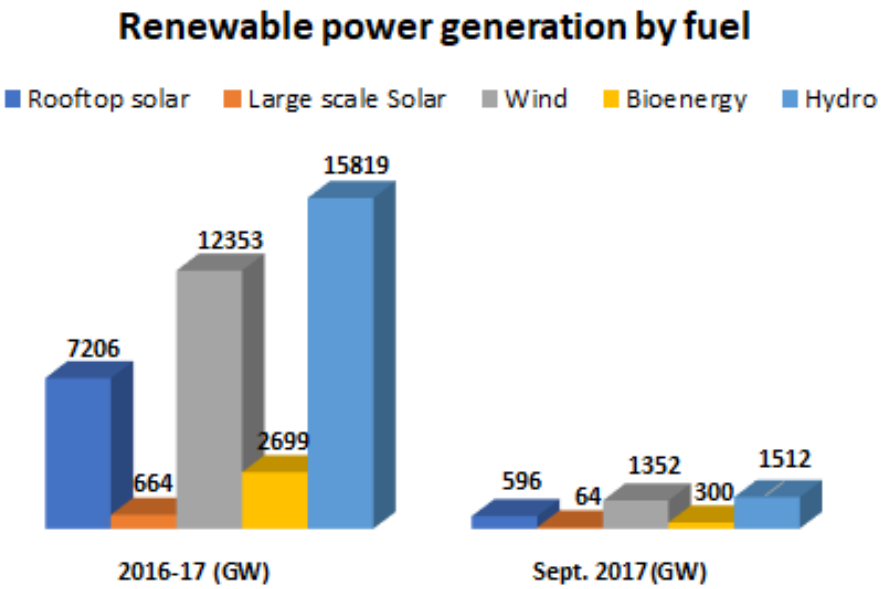

Figure 4: Renewable power generation by renewable resources in Australia for 2016 - 17. Data derived from [http://www.getup.org.au]

Conclusion

Advances in microgrids technology in Australia will provide wider options for low-emission energy usage and distribution from various renewable generation sources. Microgrids have potential to deliver benefits to the environment, the electrical grid, and consumers by ensuring an efficient and reliable system. Various economic and government policy still pose a hurdle for deployment of microgrids but their benefits will be realized by the community across the Australia in due course. A greater awareness is needed about microgrids' potential and their suitability to the future electricity grid.

Dr Asma Aziz, Deakin University, Geelong, Victoria, Australia, asma.aziz@deakin.edu.au