Energy Networks Australia- DER Consultation Paper

About the author

Samuel Steinberg is an Engineering Entrepreneur, Inventor and innovator.

Experienced in Power, Efficiencies, Power Electronics and Engineering Managment.

Contact details:

samuel_steinberg@bigpond.com; mobile phone: 0415 694 852

Table of Contents

Executive summary

Climate Change is a good driver to change electricity production from traditional fuel to renew nature's natural kinetic energy, and harness it into controlled power production.

Electricity Networks were designed by philosophy, and then practically to transmit and distribute energy via electrical means from a source to a downstream destination at optimal cost and minimum loss. To overcome voltage attenuation and protect the system, there are regulating and protection systems that were put in a unidirectional configuration. Exporting energy upstream introduces challenges that requires vast investment to rectify, while these challenges can be prevented in the first place.

Residential export should not be allowed, in fact any residential systems' capacity should be less than the calculated After diversity Maximum Demand. Electricity production systems should be combined with storage systems to allow continuous production to address demand.

Distributed Generation planning should be managed by the distribution utilities' system planners to allow/ not allow the installation of distributed generation means along the LV networks.

Background

What is changing?

Climate is changing, not necessarily to the best.

Why is climate changing?

Published Scientific information is suggesting that emissions by humankind are affecting the climate in a negative manner.

What can we do about it?

One aspect that we can do is reduce the emissions by moving from emissions generating technologies to non (or reduced) emissions technologies.

Electricity Production

Current traditional electricity generation is by means of placing an energy converter (a power plant) near a fuel source (coal mine), and then control the amount of fuel (the Potential Energy stored in the fuel) converted to electricity, based on demand forecast plus contingency for sudden changes (the Inertia). Whether the generated electrical energy is consumed or not, the fuel is being consumed, hence *Use It or Lose It*.

In this method, the energy flow (**Kinetic Energy**) in the conductors, that is Responding to Demand, is dependant on the **Continuous Production** of electricity; i.e.:

- Fuel, Conversion, Transmission, Distribution and Consumption.
- This is **Continuous Production**.

Alternative electricity generation is by renewal of the existing **Kinetic Energy** in nature, i.e wind and solar radiation into the electricity form of Kinetic Energy. In this method there are different converters. Unlike traditional converters (power plants) these converters are **Real Time** converters, converting one form of Kinetic Energy (wind, solar) into Electricity flow form of **Kinetic Energy**.

However, as Nature's Kinetic Energy is not given to control by humankind, the electricity flow form of kinetic energy is solely dependent on the uncontrolled weather.

These alternative sources conversion could be now defined as **Batch Production**.

If there is excess wind energy, or excessive solar radiation, both available for electricity flow, but there is not enough load to consume it, it is like the Use It or Lose It. This excess energy is "gone with the wind", no problem here; However, if load is now present, and is demanding more than the sources can supply, we now have a problem. This problem could be relatively easy to be resolved by adding Excess Energy Storage facility (to be discussed in the Proposal section herewith).

Conclusions re Production:

The change in power generation could be concluded as the following:

Continuous Production: Potential Energy Storage (fuel), Conversion (Kinetic Energy flow), Transmission, Distribution and then Consumption;

Batch Production: Conversion (harnessing nature's kinetic energy from wind or solar), storage (batteries, hydro), Transmission, Distribution and then consumption.

The change is therefore from **Continuous Production** to **Batch Production.**

Electricity Networks

There are few major properties to the electricity networks, from the point of generation to the point of consumption:

- Like water equilibrium, where water flows naturally from high point to a lower point. Same with electricity, energy flows from high pressure point (high potential generator) to lower pressure point (low potential load).
- The downstream distribution has always bigger capacity than the source can produce due to consumption diversity considerations; for a numerical example: a power plant with 1GW generation capacity will feed a 4GW distribution bus bar; each exit feeder (say four off 1GW) from this bus bar will feed a downstream distribution bus bar of another 4GW capacity, and so on and so forth, until this network is feeding a total 100GW multiple loads. This philosophy assumes that not ALL loads will consume at one time, hence a significant element of diversity is implemented.
- Protection schemes are generally unidirectional, every protection element is protecting its upstream system from downstream events (but also the downstream chain). There are several protection schemes that are monitoring forward zones, but also back zones; by operating in this method, the protection elements can determine location of fault/ event and isolate the problematic location.
- Distribution Networks must comply with Power Quality Standards, in particular voltage levels. The networks are designed and constructed to provide compliant voltage level via Tap Changers and regulators, these work very well downstream; for these voltage regulating systems to operate in reverse might pose a technical challenge (expensive challenge).

Conclusions re Networks:

- The natural structure of electricity networks is for energy to flow downstream.
- Due to the nature of the system upstream flow can occur, however this now poses issues of power capacity carrying, and protection challenges.

Grid Tied Residential PV Systems

By their nature of operation, a PV inverter generally operates in a Current Mode, that is trying to maximise output energy, either for consumption, or export the excess; this is done by means increasing output voltage to allow upstream flow. Excess voltage level, not only might cause high voltage related faults, but in particular generates significant energy waste. When applying 240V to a 230V rated 1kW load, the load will now consume 1kW x $(240/230)^2$; that is increase of about 9% in the load's energy consumption. If the load is an incandescent light bulb, it might light brighter and shorten its lifespan; if the load is a refrigerator's compressor, the compressor will consume 9% more energy, however will not deliver more refrigeration. Therefore, this increase in voltage level leads mostly to wasted energy.

Conclusions re Grid Tied Residential PV Systems

Exporting energy from residential PV systems might:

- lead to assets failure;
- lead to energy waste.

Supply Reliability

The supply of solar radiation can be confidently predicted as a certain time slot during the day. The sky coverage by clouds can be predicted to a degree.

The wind blowing could be predicted to a degree, it does to however have time slots or determined durations.

Conclusions re Supply reliability

- In the traditional power generation, the conversion is in proximity to the fuel source storage.
- In the new power generation, the storage should be in proximity the converter.

Conclusions

- Climate change is a good driver for Energy Source change, from Traditional to Renewable;
- The Renewables Kinetic Energy allows to place harvesting tools near the location of consumption, saving transmission and distribution losses;
- The change from Continuous Production into Batch Production requires to increase production capacity for storage, for the stored energy to be consumed when Batch Production is at down cycle, or at time of high demand;
- Kinetic Energy harvesters needs to be placed at all levels: Transmission, Distribution and Consumption.
- Energy Storage needs to be placed at all levels: Transmission, Distribution and Consumption.
- Energy flow downstream only;
- Production and Storage assets to be owned and maintained by operators, asset owners and asset managers. Consumers may have stakes in the owners' businesses;
- Assets can be placed on private roof tops etc, by the roof top owner leasing the space, not by owning the panels and associated assets.

Other Observation

The "Smart Grid" concept, aggregators, new markets, new energy flow modelling only adds links to an already complex chain, this will result in an increased cost to customers, defeating the initial purpose of reducing energy costs.

Practical Recommendations

- Allow only down stream export;
- Allow maximum power capacity that does not exceed utilities' calculated customer's After Diversity Maximum Demand.
- The composition of base load supply and DER must not exceed certain balance (balance not necessarily means 50-50); i.e. on transmission lines, Sub transmission, MV distribution and LV distribution.
- Frequency control must be kept at the transmission level capacity.
- Grid connected inverter should be Voltage Source Mode, rather than Current Mode in order to prevent voltage fluctuations on the network.
- Implement Artificial Intelligence concepts with inverters, or at least self learning Fuzzy Logic concepts;
- Same as distribution networks are designed by System Planners, same methodology must be applied to System Plan the allowance of maximum DER capacity on networks at each level; i.e. maximum capacity per house hold not to exceed the ADMD level; the total households per LV feeder, not to exceed certain percentage of that LV feeder's capacity; the total capacity per all LV transformer's feeder not to exceed a certain percentage of transformer's capacity, etc up stream.
- Energy storage need to be as close as possible to the point of consumption;

Quotes:

About Innovation

"If you want a new idea, open an old book." (Zion Suliman)

Problem Solving

- "For every problem there is one solution which is simple, neat, and wrong."- H.L. Menken"
- "Seek simplicity, and distrust it."- Alfred North Whitehead
- "Everything should be made as simple as possible, but not simpler than that."- Albert Einstein

Thinking about the Future

From the book- "Thinking about the Future":

- "Explore the future to influence the present"
- "Evaluate whether the problem as presented is really the problem to be solved"
- "Recognise that different changes occur at different rates and will have different impacts at different times"
- "Know what to change and what not to change."

Whole System Design

From the book- "Whole System Design":

- "A Whole System Approach Is a process through which the interconnections between sub-systems and systems are actively considered, and solutions are sought that address multiple problems via one and the same solution".