Mr. NeelavSamrat De,
General Manager,
ANDRITZ HYDRO Pvt Ltd.

Energy Storage Technology and Trends

To help mitigate grid unreliability, the world's first battery storage plant was commissioned to produce 100 MW of electricity in November 2017 to the South Australian energy grid. This dispatch able renewable energy source could well set precedence for lithium-ion battery storage technology in the years to come. However battery storage could have scalability issues and could be an expensive proposition. Moreover, the issue of disposal could also pose environmental threat. How this technology is addressed keeping in mind environmental concerns would probably be visible beginning later 2019.

There is a clear shift in global trends towards capacity addition through renewable energy. Though hydro power is considered a part of renewables, the crux lies more on energy sources through solar and wind power. With COP21 commitments from countries to reduce carbon emissions to a specific level by 2021, the coal based power applications are showing a declining trend globally to reduce pollution. In fact employment in the global renewable sector has increased over 1.2% over the previous year showing a clear growth in this sphere of business.

In fact several governments implemented new renewable energy targets, especially China and India, and several cities established new commitments to 100% renewable energy. The world saw 165 GW of renewable energy coming into the grid in 2016 alone! China alone has been responsible for over 40% of global renewable capacity addition, which is largely driven by concerns about air pollution and capacity targets that were outlined in the country's 13th five-year plan to 2020.

In 2016, renewables accounted for an estimated nearly 62% of net additions to global power generating capacity. Last year, renewable power instalments (including hydro power) increased by 9% over 2015 to nearly 2,017 gigawatts. Solar photovoltaic accounted for around 47% of the total additions, followed by wind power at 34% and hydropower at 15.5%.

India's forecast is to add 9812 MW of solar PV in 2017. This is a 130% increase year over year to the 4.3 GW that India installed in 2016 and India is hence in a position to become the world's third largest solar PV market.

While there has been a slide in the module prices in China by 33% over the last 12 month period, there is similar continual drop in the solar tariffs in India which are now just 14% higher than the Chinese price modules (US$ 0.32/W).

Taking the example of South Australia where the government has achieved its 50% renewable energy targets at least 8 years ahead of schedule. The major source of electricity is through gas. Due to shortage of gas, the electricity prices have skyrocketed to a level where it has eaten into the profit margin of companies. This issue has been further coupled with the government's decision to add very ambitious renewable energy targets.

Renewable energy generators provide the variable pricing at the spot markets due to dependable energy sources thereby pulling prices down unlike conventional generators which operate at the prevailing price and without subsidy. This leads conventional generators to become unprofitable and hence the cost of electricity becomes unviable for consumers.

As per Power Purchase Agreements (PPA) in South Australia ($112/MWh), solar/wind power generators can dispatch power to the grid at prices

approaching zero - when the sun is available/wind is blowing and solar/wind power output is high; at night when demand is low, solar/wind generators will even pay the grid manager to take their power with no commercial value ($20/MWh).

Need for Storage Capacity

Renewable energy sources on the flipside prove to be an unreliable source for grid stability. Therefore, it is necessary to have a significant share of hydro in the grid as mammoth infusion of renewable energy, both from solar and wind, in future coupled with inherent nature of these sources, makes it essential to take the measures for providing quick reacting balancing power, peak energy and also for stabilized grid.

Initially, fully controllable power generation was following non-controllable load demand. With the present scenario, now with renewable energy sources coming in, power generation is no longer fully controllable.

Hence nowadays, units are operated at part load which is needed for compensation of high volatile power production from renewable energy. The peaks of generated power from renewable energy are shorter in duration.

As multifunctional power stations, pumped storage plants (PSPs) are a crucial role player of the energy transition. In contrast to other power plants, pumped-storage plants are capable of quickly absorbing and delivering several 100s of MW of electricity. They are capable of offsetting such variation not only during operation but also from an idle state, thus staving off fluctuations from wind and solar power production. Maximum electricity absorption and delivery performance can be reached within 75 to 110 seconds which is perhaps one of its most visible advantages. Most coal-fired thermal power stations take several hours to achieve the same while most nuclear power stations even take several days.

The grid voltage must remain stable at all times to maintain supply security for domestic as well as industrial usage. This can be achieved through reactive power. With pumped-storage power plants capable of switching between pumping and generator operation modes, they can provide flexible reactive power, even in partial load operation. The same can however not be said about conventional power plants like thermal, nuclear or even hydro power plants, as in partial load operation they can no longer provide reactive power for the reasons mentioned in the previous paragraph.

A very quick response time and rapid ramp up and down of power can be easily achieved through this storage facility, which perhaps suits best, the fluctuations coming from wind and solar power. The applications of pumped storage plants are seeing an increasing need globally, due to the ever increasing capacity addition coming from RE power sources.

The new trends in Energy Storage Technology:

A classic example which shows that a 100% RE source is unreliable is that of South Australia. South Australia had, in the previous couple of years, turned to a completely dependent renewable energy source through wind and solar. This led to power outages and blackouts till as recent as 2017.

To help mitigate such grid unreliability, the world's first battery storage plant was commissioned to produce 100 MW of electricity in November 2017 to the South Australian energy grid. This dispatch able renewable energy source could well set precedence for lithium-ion battery storage technology in the years to come.

However battery storage could have scalability issues and could be an expensive proposition. Moreover, the issue of disposal could also pose environmental threat. How this technology is addressed keeping in mind environmental concerns would probably be visible beginning later 2019.

There is also an existing plant in Germany that couples a pumped storage plant with a wind farm and capable to compensate for energy fluctuations. This is a first of its kind and shows a trend in hybrid storage options. Additionally, we also hear, though in concept stage, the combination of a pumped storage scheme along with a battery storage built together into a single plant. Each source would play its part as per the demand of the grid and operated under their specific conditions.

Off-set type pumped storage schemes are also in the conceptual stage. This closed loop pumped storage plant made of one or two artificial reservoirs and not linked to a river, would be a robust source of water energy and would use a tap-in from an open water source to make up for loss of water during operations.

Also, the smart grid concept has begun to take shape around the world. Smart grid utilises digital communications and control systems to monitor and control power flows, with the aim to make the power grid more resilient, efficient and cost effective. Smart grid applications have capability to accommodate all generation through solar, wind and storage options. It could address disturbances through automated prevention, containment and restoration; and operate resiliently against all hazards.

As on date, hydropower based pumped storage plants are the only commercially proven technologies available for grid-scale energy storage due to their scalability. We have started witnessing combinations and infusions of other RE sources with such PSPs, and in the long run, hydropower based storage technology could well prevail over battery storage. At the moment, the ante is on battery storage but how far it scales in terms of grid requirements is at the moment rather debatable. For the moment, it clearly is hydropower storage that has the real potential for future grid stability, reliability and scalability.