Distribution waterfall : hydroelectric offers significant opportunities for investors in renewables

Hydro's role in Europe's energy transition

Aquila Capital's Dr Tor Syverud explains how one of the continent's oldest technologies can play a vital role in a clean-energy mix

Solar power, both photovoltaic and solar thermal, and wind farms, both onshore or offshore, are mainstays in the discussion of renewable energies. Both are profiting hugely from recent advances in technology that have made them more efficient as well as cheaper. However, investors need to look beyond the headlines and remember that there are much older renewable technologies that will play at least as great a role in the energy transition.

Hydroelectric power has been used for more than a century in Europe – since 1878, in fact, when William Armstrong used it to power a single arc lamp. Larger-scale hydroelectricity started 100 years ago in Norway, which still derives more than 95 percent of its energy from this source. This technology is not only tried and tested, but will play a pivotal role in the future of power generation.

For many people, the term hydroelectricity still conjures images of huge reservoirs and large-scale projects, as epitomised by China's Three Gorges Dam. However, besides such stored or single-reservoir plants, there are two other forms of hydropower generation: pumped-storage and run-of-river. The latter allows the construction of many smaller-scale, decentralised plants. Although this type of power depends on a river's flow and is thus susceptible to seasonal changes, it minimises the impact on both the environment and nearby communities. Run-of-river generation is also much less volatile than solar or wind power. Seasons and even average amounts of rainfall are more predictable in the long run than the local weather. And there is very little correlation between, on the one hand, the seasons and rainfall levels and, on the other, the output from run-of-river power plants.

Pumped-storage hydroelectricity uses

two reservoirs to profit from price fluctuations on the electricity market. In times of low demand or high production, when power is cheap, water is pumped into the higher reservoir. During times of peak demand the water flows back down through the turbines, generating power that is then sold at peak prices.

COMPLEMENTARY REMEDY

All three types of hydroelectricity have attractive risk-return profiles. Although large-scale projects demand a relatively high initial expenditure, their low operating costs and longevity make them competitive sources of renewable energy, especially over the long term.

However, storage and pumped-storage hydroelectric plants will play an even more crucial role in the transition than just as additional sources of energy. They are the perfect complement for intermittent renewable sources such as solar or wind power. A simple look at an average day in a first-world, service-driven economy makes this obvious. Although wind may blow, or not blow, at any time and the sun delivers most of its energy around midday, demand for electricity surges in the morning, when people get up, switch on their lights, and use transport to get to school or work. Demand then peaks in the evenings, when commuters use transport to return home, electric lights replace daylight, dinners are cooked, and televisions and other electrical devices are switched on.

This means there will be times when demand far exceeds the availability of solar and wind power, as well as times when these volatile sources of energy generate more electricity than is needed. This discrepancy needs to be urgently addressed. Excess energy during peak production has to be stored, and excess demand during calm nights and windless, cloudy days somehow has to be met.

For Aquila Capital, this is where stored hydro comes into the picture. It still is the most cost-efficient method of storing large amounts of energy. Conventional and pumped-storage hydro plants are thus poised to become the central balancing element in a renewable energy mix, because they provide one huge advantage: control.

Hydroelectric power is also one of the most flexible sources of energy. The output of both storage and pumped hydroelectric plants can be varied rapidly to meet changing demands. As long as there is enough water in the reservoir, power generation can be turned up within minutes if necessary. Pumped-storage plants can absorb large amounts of excess electricity, thereby reducing the stress on electricity grids and preventing energy from being wasted. They are therefore the ideal complement not only to high-output, high-volatility renewables such as wind and solar, but also to short-term storage methods such as batteries. These are faster – with reaction times in the milliseconds – and thus perfect for balancing sudden peaks in consumption or production.

Notwithstanding the fall over recent years in the cost of producing batteries, their material cost and shorter lifespans will make them more expensive than amortised hydro plants. This means it will not be viable to store large amounts of power in batteries. The ideal solution will again comprise a combination of technologies: batteries to balance short-term surges and hydro to store energy for long stretches.

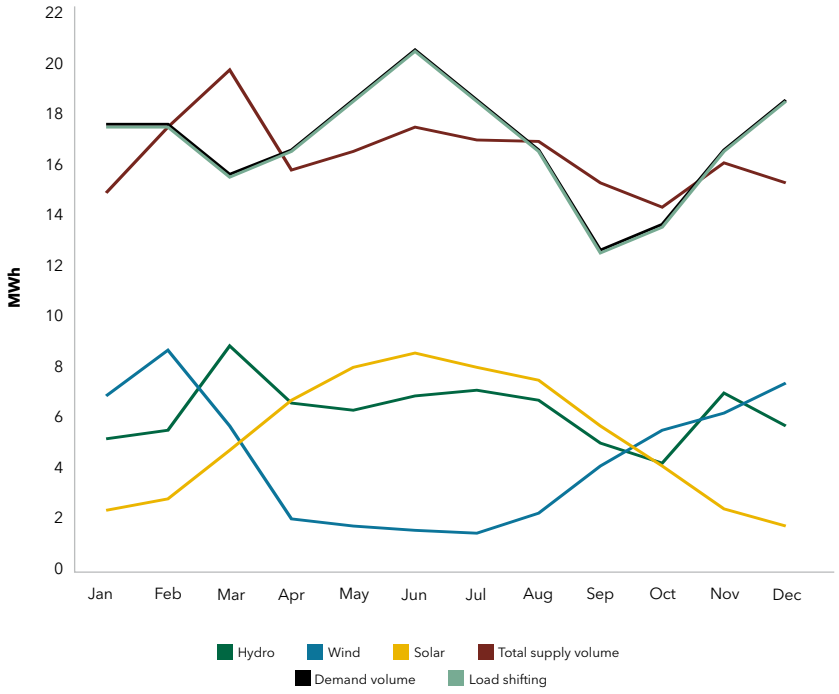
NEW REVENUE STREAMS

For investors, hydroelectric power offers new revenue models. In total, we can identify four potential revenue streams: standby services, grid balancing services, capacity revenues and energy revenues. The last of these is the most traditional: hydropower will still be fed into existing power grids at market price. The other three derive from the load-shifting capabilities of storage and pumped-storage hydro.

In modern energy markets, however, output is not the only important figure. Investors should also consider the crucial capture rate. This describes the relationship between the average market price of energy in a given timeframe and the revenue actually achieved by an energy supplier. For example, a traditional base-load supply – such as that provided by coal or nuclear plants, which feeds a constant amount of energy into the grid throughout the day – will be paid more during peak demand and less during other periods. Assuming its energy output has continually been below total demand, its capture rate will be exactly 100 percent. Run-of-river plants usually achieve a capture rate of about 95-99 percent. Solar plants currently range slightly above 100 percent, but are expected to see deteriorating capture rates as a lot more solar enters the grid. Wind power is dependent on the whims of the weather and is usually unable to achieve 100 percent. In markets where there is a large amount of wind energy capacity being built out, deteriorating capture rates are also expected. The infamous California 'duck curve' is a good example. Although solar and wind energy output are highest during the middle of the day, energy

RENEWABLE ENERGY MIX IN 2018

Hydro will provide increasing opportunities for investors as it forms a greater part of energy provision



Source: Aquila Capital; data is illustrative and does not relate to a specific geographical area

demand is usually at its lowest, making huge energy storage capacity indispensable. By contrast, storage and pumped hydro can retain energy for substantial amounts of time and release it specifically during peak price periods.

According to projections from Thema Consulting Group, hydroelectric plans will be able to achieve capture rates of up to 125 percent and therefore profit immensely from market fluctuations. Projecting a future in which societies will be largely dependent upon renewable energy, a portfolio that combined solar, wind and hydropower would be able to sustainably reach and at times exceed a 100 percent capture rate.

During times of peak production and low demand, there is also a need to balance the grid and prevent power surges. Of course, one way to prevent the grid from exceeding its capacity is to take some energy generators offline. This is the current modus operandi for many wind power stations in Germany, where grid infrastructure has not caught up with the maximum output of renewable energy during stormy days (and nights, when demand is low). This is more difficult with solar plants and, even where it works, is a waste of energy. Grid balancing will thus become an important service in the near future, and one that service pumped or storage hydro plants will be able to perform efficiently and at competitive prices.

HIGH ENERGY

Power-purchase agreements are a comparably recent revenue stream to which hydro is ideally suited. Energy-intensive companies, such as those active in the digital economy, are already willing to pay not only for the energy generated and delivered but also for capacity. These companies depend on reliable energy supplies, without surges or scarcity to deliver their services. PPAs guarantee that a certain amount of energy will be available at a moment's notice whenever needed. In the case of hydro, this means water stored in reservoirs. If cloudy and calm weather prevents solar and wind plants from producing sufficient energy, PPA customers will be able to fall back on stored hydroelectric power.

GET CONNECTED

Hydro, like any other kind of renewable, is dependent on suitable locations. Run-of-river plants need fast-flowing rivers, preferably with rapids or waterfalls. Conventional dams need large river valleys and have a significant environmental impact, while pumped-storage plants need both large geographical height and ready water supplies.

A sustainable future for European renewable energy will therefore require interconnections between local and national power grids in order to combine different sources in different locations and thereby offer reliable electricity supplies to all customers. The fewer interconnectors a country has, the greater storage capacity it will need. Governments are still struggling to meet the demand for flexible, decentralised and crossborder energy grids. Scandinavia and the Iberian peninsula are trailblazers in this regard, and are connecting more and more with the rest of the continent.

Yet this process is much slower than the transition to renewable energy production. And even if Europe were connected in one large grid, storage capacity will always be needed in a renewable energy future. Investors should aim to have a balanced energy portfolio that is diversified accordingly: with solar and wind power stations to reap peak production, in combination with batteries for short-term and hydropower for long-term balancing.

In the future, our energy supplies will be diverse and complementary. Long-term, sustainable investments in the sector should be so too. ■