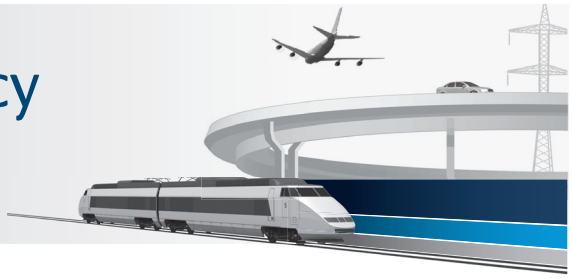
First State Investments

Research paper

Global Listed Infrastructure

Decarbonisation, energy efficiency and energy storage



Rebecca Sherlock, Senior Investment Analyst | **October 2016**

Key points

- Renewables are becoming cost competitive due to economies of scales, technological innovation and optimised processes.
- Decarbonisation targets, cost competitiveness and the social implications of burning fossil fuels are driving capacity additions in renewables.
- We look at battery storage – cost curves, regulatory changes and solving for intermittency.
- Energy efficient homes and appliances are having undeniable impacts on electricity consumption.
- These themes have significant implications for a number of companies in our global opportunity set, and are already reflected in our portfolio holdings. We favour companies leading the renewables roll-out, and regulated businesses whose revenues are being decoupled from volumes.

This paper discusses some significant themes in the electric utility sector, specifically in the fields of decarbonisation, energy efficiency and energy storage.

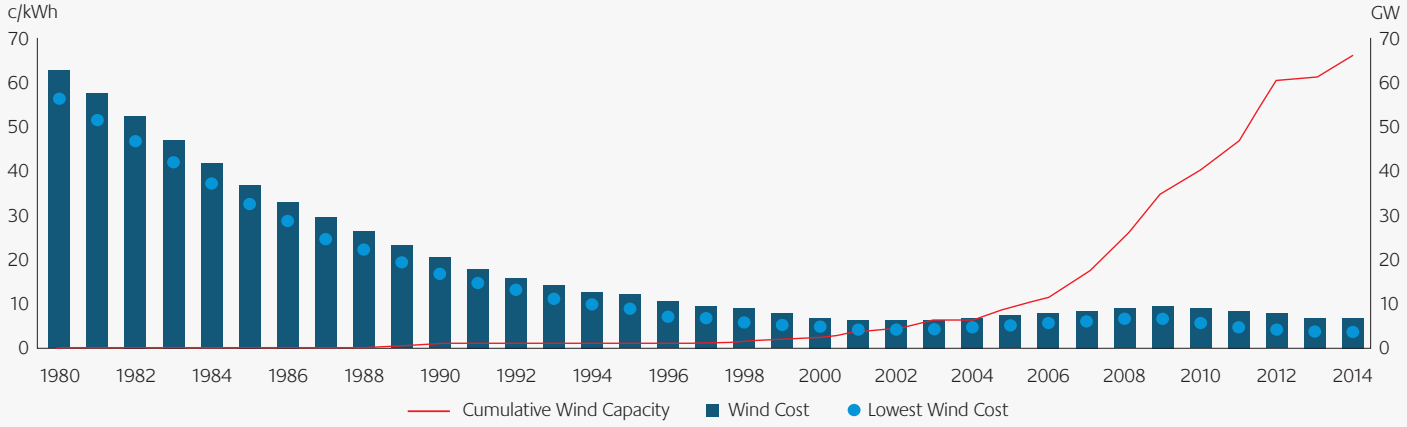
Are renewables actually cost competitive?

The cost of onshore wind energy declined by 65% between 1988 and 2014[1] due to economies of scale, technology innovations and operational and maintenance improvements. Onshore wind now generates energy at a price where it can compete with fossil fuels – the levelised cost of onshore wind is estimated to be below €0.05/KWh versus coal at €0.049/KWh and gas at €0.041/KWh[2].

We have seen similar trends in the US and China. Our expectation is that this trend will only continue due to technological improvements and productivity gains.

A combination of better siting, longer blades and taller towers is leading to better productivity. Taking the UK as an example, load factors have increased from around the 34% level in 2003 to c45% in 2014[3]. This is set to increase due to the level of research and development that is now being spent in an industry that has gone from nothing to having key global turbine manufacturers such as Siemens, General Electric and Vestas.

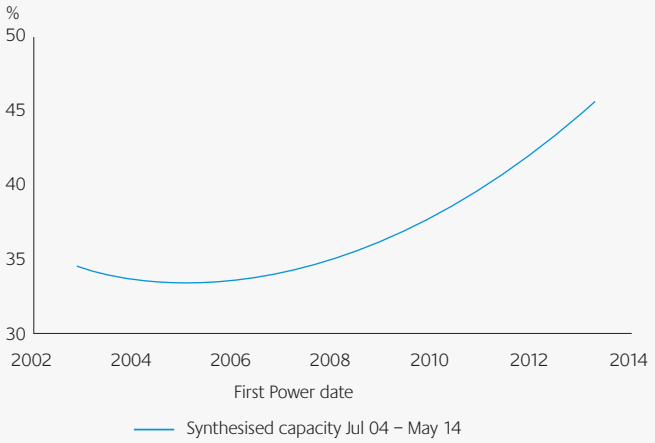
Wind – shrinking costs, growing capacity



Source: International Renewable Energy Agency.

1 International Renewable Energy Agency
2 phys.org
3 The Crown Estate

Long term load factor vs wind farm first power date

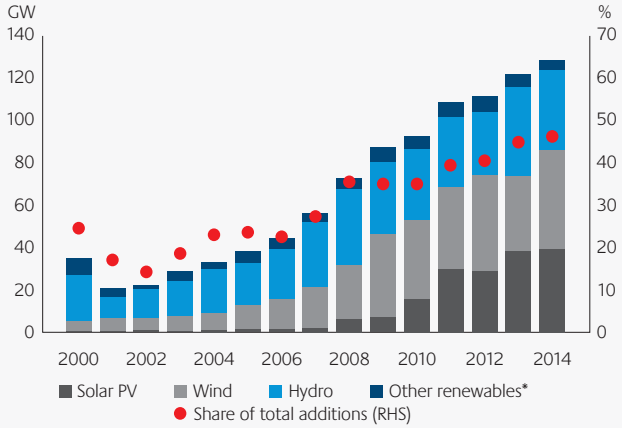


Source: The Crown Estate.

Are renewables growing as part of the energy mix?

Renewable capacity additions represented about half of all capacity additions globally in 2014 due to (1) country/state decarbonisation targets eg US RPS targets, EU carbon targets (2) carbon taxes / UK carbon floor (3) tax incentives helping the cost competitiveness outlined above eg US production tax credits/investment tax credits (4) the social implications of burning fossil fuels such as smog and (5) reduced fossil fuel subsidies – India/ Indonesia/Spain etc. We expect this trend to continue due to the points outlined above and the lack of economically viable clean coal plants in the countries we invest in. Southern Company in the US is still in the process of completing its clean coal plant in Mississippi. This plant has already reached twice the cost of original estimates and continues to see delays. The majority of the cost overrun and cost implication of delays will be borne by shareholders.

Global renewables-based power capacity additions by type and shape of total capacity additions

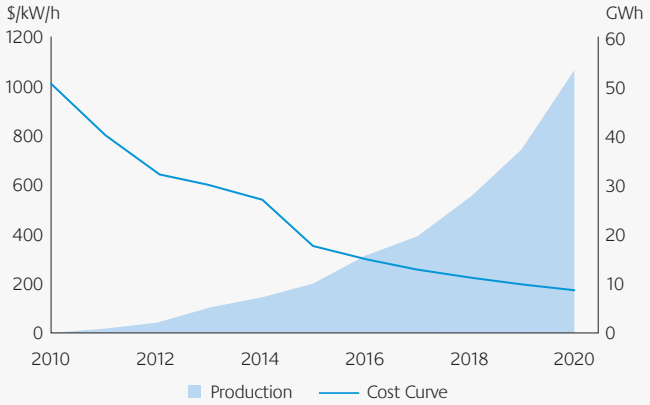


* Includes geothermal, marine, bioenergy and concentrating solar power.
Source: IEA.

Is storage a game changer?

In short, the storage of electricity is a game changer. It can help in backing up intermittent renewable power; it reduces peaks in demand allowing renewable power to be dispatched when the demand is there and it can be used to power electric vehicles. Similar to renewables, the level of investment into lithium ion storage has seen prices decline almost 65% from 2010. Tesla's Gigafactory is currently producing batteries at $190/Kwh with an expectation of 30% reduction coming from economies of scale, reduction of waste, a closer supply chain, vertical integration and optimising processes. This reduction firmly places the cost of batteries within the range of 100-150/kwh which is the level at which batteries become truly viable, according to our meeting with a professor at Oxford University.

Lithium ion battery cost curve and production



Source: NextEra Energy.

For every 500,000 electric cars on the road, 192 million gallons of gas is saved per year.

That is equivalent to

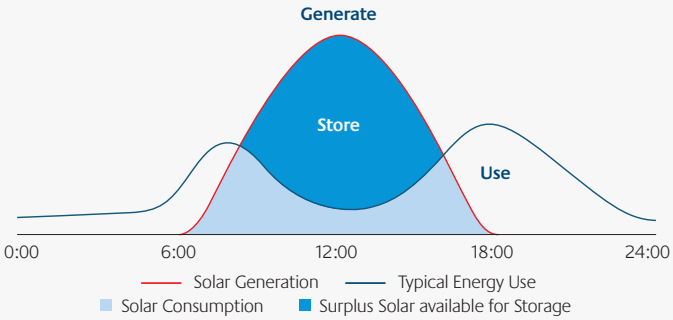
21,333 tanker trucks

Each tanker truck holds 9,000 gallons

Source: Tesla.

Much like how the renewables portfolio standards started in the US, we are starting to see some states commit to targets for battery storage. Currently only California and Oregon have set targets for the development of storage, with Massachusetts potentially the next to implement. California has stipulated that its three large investor owned utilities, including PG&E, have to commit 1,324mw of storage by 2024 which is essentially around 2% of peak load. As the chart below shows, having storage backing up the system allows for a smoother demand curve i.e. for the electricity produced to be used when it is most needed.

Demand curves with and without battery storage



Daily electricity use defines the Solar PV array size (roof permitting)
Store Surplus solar electricity & use in evening peak period

Electricity use in this period typically defines the size of the Energy Storage System

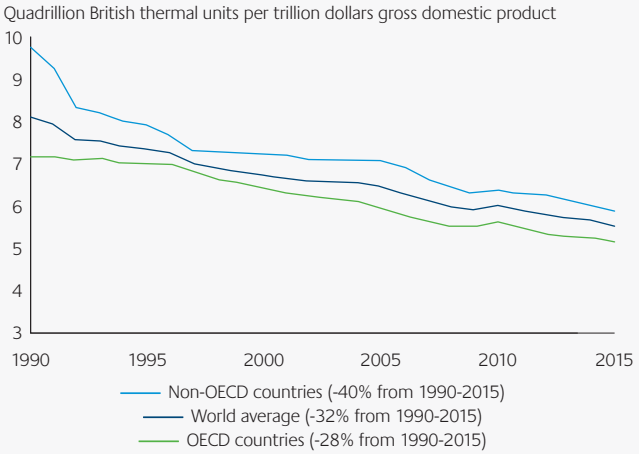
Source: smart-power.org

Is energy efficiency real?

Energy efficiency is having an undeniable impact on electricity consumption. Energy intensity, a measure of energy consumption per unit of gross domestic product, declined by nearly one third between 1990 and 2015.

Companies in the US are tending to report flat to negative load growth. Australia's Western Power said they have seen a decline of 17% in residential electricity consumption over the last 5 years. We tend to favour companies such as PG&E and National Grid where the states they operate within promote energy efficiency by decoupling revenues from volume usage.

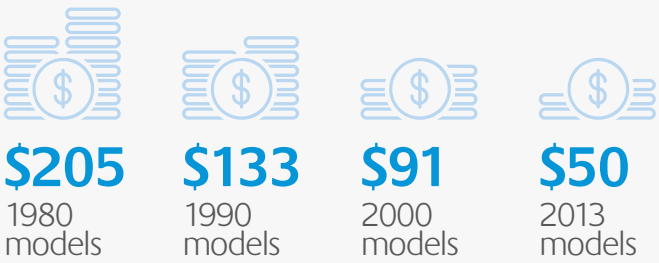
World energy intensity, 1990-2015



Source: EIA, International Energy Outlook 2016, Internationa Energy Statistics, and Oxford Economics.
Note: OECD is the Organisation for Economic Cooperation and Development. Gross domestic product calculated in purchasing power parity terms.

The two largest sources of energy use in a residential household are space heating/cooling and lighting. This accounts for around 24% of electricity consumed in a US household and around 37% in a UK household. The driving force behind energy reduction is more energy-efficient homes and appliances. More homes are being insulated, efficient condensing boilers are replacing standard boilers, houses are being double glazed and the appliances we use are getting more efficient. For example an LED lightbulb uses 85% less electricity than traditional incandescent bulbs and a new A-rated model fridge-freezer saves 73% of energy compared to its 20 year old counterpart[4]. This trend in energy consumption per household is only expected to continue as buildings and appliances get smarter and more energy efficient.

How much does it cost to run your refrigerator each year?



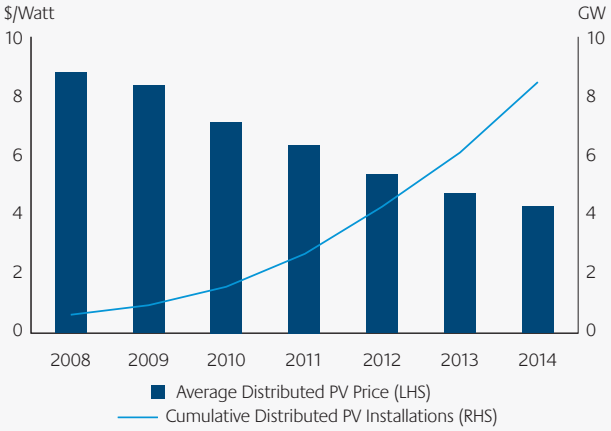
Source: US EPA ENERGY STAR Program 2013.

Make hay whilst the sun shines

Roof top solar, much like onshore wind has continued to see significant cost declines. The average photovoltaic panel price has more than halved since 2008. The subsidies that many countries have offered has encouraged many residential customers to consider installing rooftop panels on their homes. Whilst this allows consumers to generate their own electricity, a mismatch remains between when solar energy is generated and when it is used. When mismatches occur, the distribution grid is used much like storage so that energy can be used when it is needed rather than when produced.

New York has been at the forefront of developing a system that both compensates the customer for excess energy sold to the grid; and compensates the grid company that needs to be remunerated for the infrastructure it is providing to the household. This forms part of a broader regulatory aim to transform New York State utilities such as National Grid and Iberdrola into distribution system platform providers, which means that their responsibilities would change to include overseeing the interconnection of distributed resources. We believe that this puts these utilities at the forefront of changes that we could see rolled out across other states that experience a high number of sunny days.

Solar photovoltaic – lower costs, higher capacity



Source: Energy.gov.

Portfolio implications

The reduced cost of renewables, coupled with the recent extension of federal wind tax credits, means that the pipeline of project development for NextEra Energy and Iberdrola has been extended to the end of the decade and beyond. We believe both companies have first mover advantage with regard to siting and to supply-chain economies of scale.

We remain sceptical of clean coal plants in countries where renewable cost curves are declining sharply. We see risk to shareholders, as costs from delays and changes in engineering have the potential to lead to equity issuances.

In a flat-to-declining load growth environment, those companies like PG&E and National Grid that have revenues decoupled from volumes will have an advantage as appliance and homes become smarter. We do not see signs of this abating, since it benefits the consumer.

Companies that operate in states such as California and Massachusetts will be able to take part in mandated energy storage development. This should benefit companies such as Eversource Energy, PG&E and AES Corp as they seek to provide storage solutions to the states in which they operate.

4 AMDEA trade association