

Citizen utilities: The emerging power paradigm



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ABSTRACT

The emergence of citizen-based power systems in an integrated grid has been anticipated for decades. We can reveal how this is emerging in practice due to the significant uptake of solar photovoltaics (solar PV) and now battery storage in Perth, Australia. The high cost of electricity, high radiant energy levels and easy access to cheap Chinese technology, has led to dramatic buying during Perth's recent boomtown years. The traditional uni-directional power system is rapidly disrupting and this paper assesses where this may lead and what it means for the grid. Results of detailed monitoring in a solar powered house along with the impact of a battery storage system show the impact on the traditional grid is substantial but it will still be needed and must therefore adapt to the new distributed, bi-directional energy system. Surveys and price trajectories reveal how the trends to solar power storage will continue and how a citizen utility paradigm will emerge as the future grid building block using new blockchain support systems. Responses from utilities are then seen to be fight, flight or innovate.

1. Introduction

The idea of distributed generation for power has been well known for many decades (Lovins, 1979, 2002; Alanne and Saari, 2006). Lesser understood are the downstream impacts on centralised electricity grids from becoming more decentralised (Sioshansi, 2014) and the social acceptance of the transition processes that flow from widespread adoption of small-scale technologies like rooftop installations of solar PV (The Economist, 2013; Nadel and Herndon, 2014). Now an emerging demonstration city, Perth, the capital of Western Australia, enables us to see some of the first signs of this new economic and social phenomenon.

Perth became one of the wealthiest cities in the world in the past decade as its population passed 2 million people with the last 400,000 people moving to the city in the previous 7 years (Australian Bureau of Statistics, 2015). The city's growth spurt was based on a boomtown flow-on from new iron ore mining and natural gas developments created to feed the growing Chinese and broader Asian markets to the near north (Committee for Perth, 2012). Part of the new wealth has been used to purchase solar PV on suburban rooftops at remarkable growth rates (The Clean Energy Regulator, 2015), with them being present on more than 23 per cent of homes in Perth resulting in no new large-scale energy installations being required for the next several decades (AEMO, 2016). Perth's largest power station is now rooftop solar PV, transforming the electricity system. The majority of this happened without a major government support program.

The paper will outline how this dramatic growth in solar PV has occurred, largely due to market forces, how it is expected to continue along with the emerging deployment of battery storage, and thus how the city is becoming a test case for the new distributed solar city, with its associated disruption of the traditional grid system and in particular the creation of citizen utilities.

2. Global solar

2.1. Solar uptake

In the last 25 years, the amount of renewable energy installed around the world has increased by 81 per cent and in the past decade by almost 40 per cent (IEA, 2015). Renewable energies in off-grid or mini-grid systems are being presented as a solution to improve the welfare of people in developing countries, and these systems have already provided many remote communities with energy independence, allowing them to bypass the need for a transmission network and therefore remove the associated costs of installing and maintaining a network (Nature Editorial, 2004; Neves et al., 2014).

Many islands have already reached grid parity for solar power and battery storage on a commercial level due to the high cost of importing fuel (Bronski et al., 2014). Strategies for small-scale decentralised projects are now being implemented around the world (Ozgur, 2015; Araújo, 2014). In 2015, Deutsche Bank modelled electricity pricing from rooftop solar PV in 60 countries and found that 30 had regions in

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which rooftop solar PV installed was at grid parity (Shah and Booream-Phelps, 2015). Germany reached grid parity at the end of 2012 and had the strongest solar PV take-up in the world with 24.8 GW of installations by 2011 (Zhang, 2013). Based on Germany's pioneering feed-in tariffs (FiT), Hungary has subsequently taken this system a step further by altering the tariff based on the time of day delivery of the electricity to the grid, a system that has also been implemented in other parts of the world (Klein et al., 2008). For jurisdictions that are reforming electricity tariffs towards time-of-day cost-reflective pricing, if protectionist policies of incumbent generators are not being pursued, it is expected also that time-of-day feed-in tariffs would be put in place to incentivise batteries providing electricity during peak periods and averting the need for expensive peak generation capacity. Thus distributed solar PV is well underway but has not yet been mainstreamed into a major urban grid as the dominant supplier of power.

2.2. Investments and cost reductions

Solar PV installations were, until recent years, prohibitive due to manufacturing costs, therefore deployment was limited to where government provided a subsidy. In 2004, investment in renewable energy technology for electricity generation became greater than fossil fuels, and has continued to outstrip them ever since (World Bank, 2013; US EPA, 2014). By 2040 investment in solar power worldwide is predicted to reach US\$3.7 trillion, accounting for 35 per cent of capacity additions and resulting in a total of US\$8 trillion spent on all forms of renewable energy (Henbest and Giannakopoulou, 2015). It is now virtually impossible to obtain commercial financing for coal energy projects across the EU, the US or when using World Bank finances (World Bank, 2013). Since 2008, renewable energy uptake in Europe has wiped off more than half a trillion USD from the value of traditional energy companies with the largest utility in Germany, E.ON, having a three-quarter share price drop since 2010, and the second largest utility, RWE, seeing its recurrent net income fall by a third since 2010 (The Economist, 2013; Gottfredson et al., 2012).

In China, the huge increase in demand globally for solar PV has led to a rapid growth in solar PV production in all areas of the domestic supply chain. With increasing output there has been a corresponding improvement in production technology, in the quality of the solar PV components and a subsequent decrease in the overall cost (Zhang and He, 2013). In addition to these hard costs, several countries, including Australia, are streamlining processes to reduce soft costs such as permit fees, supply chain costs and commissioning associated with solar PV production and installation as a method of further reducing overall cost. The Sunshot Initiative in the US has calculated that soft costs comprise between 52 and 64 per cent of the overall production costs of photovoltaics in the US (Fieldman et al., 2013). The strategies

outlined in their paper are forecasted to reduce solar PV production and installation soft costs by up to 79 per cent by 2020. Further improving upon the value of solar PV installations, in April 2015, founder of technology-company Tesla, Elon Musk, announced the launch of Tesla's home battery storage system, which would sell for US\$350/kWh. This set the retail price for solar power storage batteries substantially lower than forecasts had predicted. Prior to this, the Rocky Mountain Institute estimates suggested this would not be reached until beyond 2025, which is also within the predicted range of Nykvist and Nilson (2015). The rapid reduction in the price of batteries has been due to growing demand for electric vehicles, laptops and mobile devices, which all use variations on the same Li ion technology. More recently, TESLA has announced that their prices have fallen further to AU\$350/kWh (US\$260) (BNEF, 2016). Due to the costs of batteries declining faster than predicted, they are expected to reach parity with grids in Australia by 2020 and even earlier in Perth, as discussed below (The Climate Council, 2015). This situation will allow cost competitive storage of excess solar power to be used during peak electricity times when the cost of producing electricity is higher and solar electricity generation is lower.

3. Perth

3.1. Perth: solar central

The number of households in Perth with rooftop installed solar PV is now in excess of 23 per cent, with more than 200,000 systems having been installed since 2010, translating into more than 550 MW of generating capacity (AEMO, 2016). The purchase of solar PV is continuing to grow at double-digit percentages per annum (The Clean Energy Regulator, 2015). Australia in general has been growing rapidly in its adoption of solar PV with more than 1.5 million households with rooftop installed solar PV, representing around 17 per cent of households (Clean Energy Regulator, 2016) and projected to rise to over 18 million kW by 2031 (Flannery and Sahajwalla, 2013).

The reasons that Perth's rooftop solar PV has grown amongst the fastest in Australia include:

- Circa 300 days of full sunshine are enjoyed every year in the Perth region.
- Electricity prices in the regional grid have risen more than 85 per cent since 2008 and are determined by the sole retailer, Synergy, who also owns much of the generation capacity (Wood and Blowers, 2015). See below in Fig. 1.
- Perth has had an economic boom over the past decade that raised income levels to some of the highest in the world (World Bank, 2014), resulting in a doubling of the amount of solar PV installers

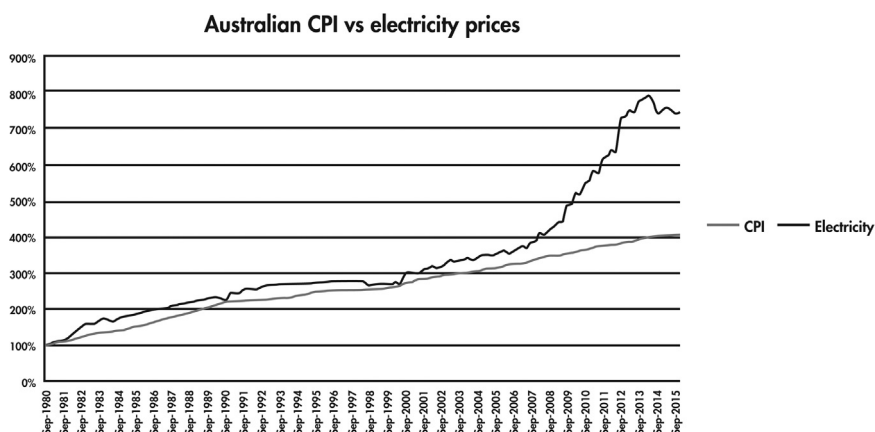


Fig. 1. Australian and Perth electricity price rises compared to CPI. Author's summary with price data and CPI data from ABS: Table 6401.0 - Consumer Price Index, Australia, Dec 2015 found at: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/6401.0Dec%202015?OpenDocument>.

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