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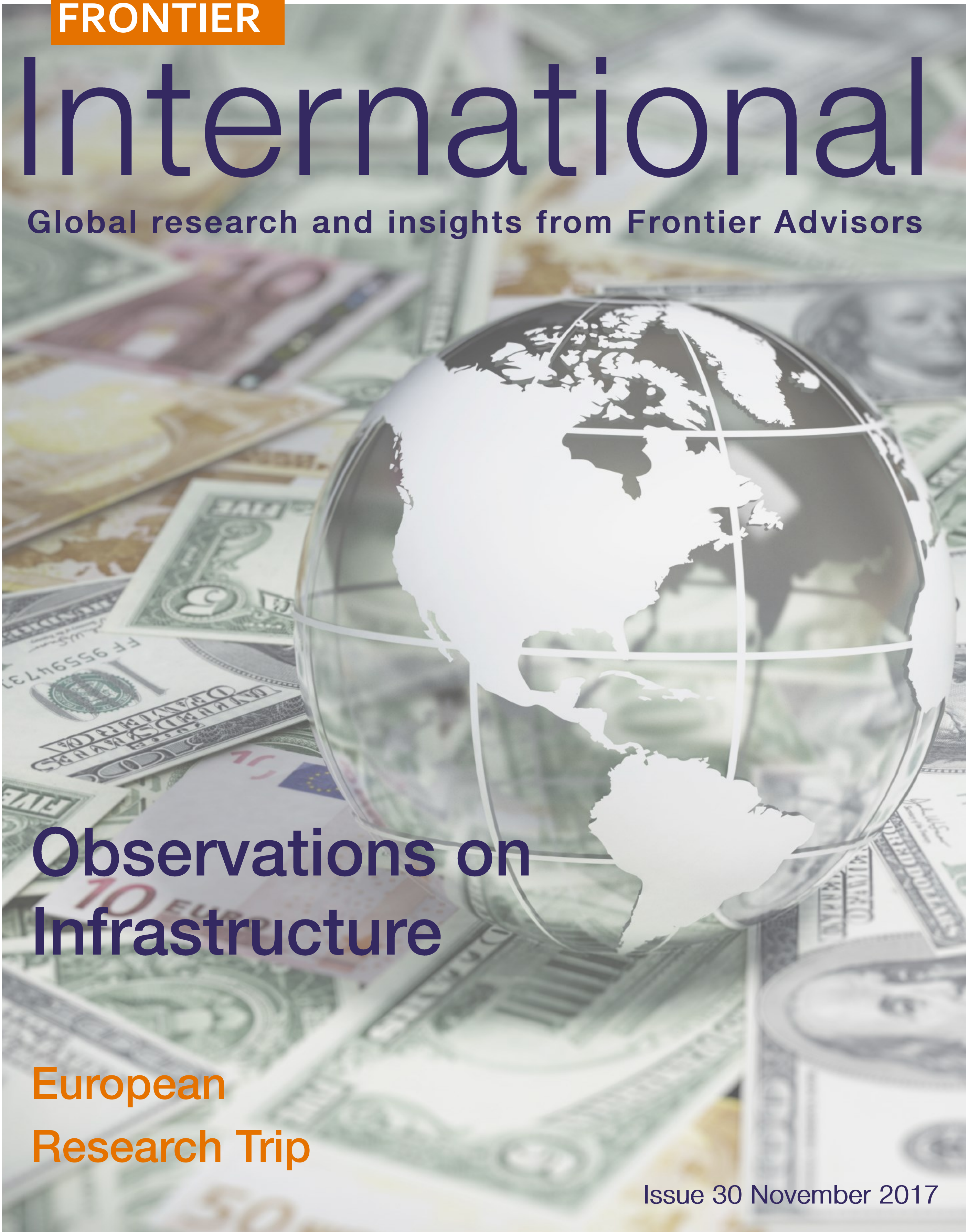

Observations on Infrastructure

European Research Trip

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Frontier regularly conducts international research trips to observe and understand more about international trends and to meet and evaluate, first hand, a range of fund managers and products.

In conjunction with insights we share with our Global Investment Research Alliance partners, these observations feed into our extensive international research library.

This report provides a high-level assessment on the key areas and observations unearthed during this recent Real Assets' trip. We would be pleased to meet with you in person to provide further detail on these observations.

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Peter is well known in institutional investment circles, and particularly within the infrastructure space, as a former Senior Executive at Hastings Funds Management, where he was CEO and Portfolio Manager of The Infrastructure Fund (TIF) and Hastings Hancock International Timberland Fund and more recently headed up Hastings' mandates business platform. With twenty years of industry experience, Peter has a varied and extensive background having worked as a fund manager, investor and asset consultant. Prior to joining Hastings in 2008, he had an eight year stint managing UniSuper's infrastructure investment portfolio and five years with William M Mercer across its actuarial consulting and asset consulting practice groups.

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Some background

In October 2017, Frontier's Real Assets Team travelled to Europe as part of its annual research trip. From an infrastructure point of view, a key objective was to understand how the rise of renewable energy technology in Europe is impacting traditional forms of power generation, electricity prices, grid infrastructure and consumer power bills.

We were particularly interested in Germany, a country that is at the forefront of incorporating renewable energy generation into its energy mix. To gain deeper insight, we spoke with the CEO of 50 Hertz, one of the largest electricity transmission companies (referred to as Transmission Service Operators, TSOs) in Germany. Almost 50% of the energy generation in 50 Hertz's grid area comes from renewables - one of the highest concentrations of intermittent supply in the world.

In this article, we shine a spotlight on the German power system as a reference point for the Australian market, which is amidst its own energy transition and is grappling with many of the same issues.

Balancing the grid – Germany's high exposure to renewables

Germany is one of the largest economies in the world. It is also one of the largest supporters of renewable energy generation.

Today, around 38% of its total power supply is generated from renewable sources, mainly wind and solar (source: Fraunhofer). To compare, Australia currently generates 17% of its requirements from renewables (source: Clean Energy Council – Clean Energy Australia Report 2016).

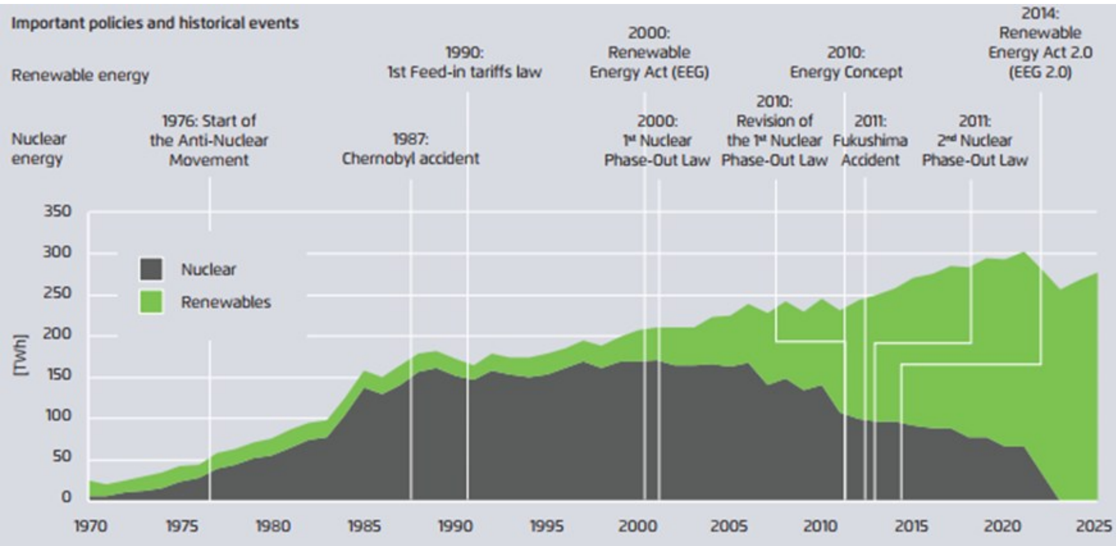
This is part of Germany's revolutionary energy transition plan termed the Energiewende (pronounced E-ner-gee-ven-de), a supportive policy and regulatory framework that has driven substantial investment not only in renewable energy generation directly, but also - and critically – in the grid to support intermittent and geographically varied supply.

For Australia, which is seeking to walk the same path, Germany's progress contains many lessons. In this article, we examine how it got to this point, how it is coping with the very real problem of intermittent supply, and who is paying for this transition.

History of energy policy

While Germany's push into renewable energy dates back to the 1980s, when opposition to nuclear power first arose, the movement only really gained traction in 2010 and 2011 when the Federal Government adopted a nation-wide, long-term strategy to phase out nuclear power. Amongst other reasons, this was in response to Japan's Fukushima Daiichi nuclear incident in March 2011. At the time, Germany received about 25% of its total power requirement from nuclear energy (source: Fraunhofer). This has dropped rapidly and today it is around 13% (source: Fraunhofer).

Chart 1: Germany's nuclear energy phase out

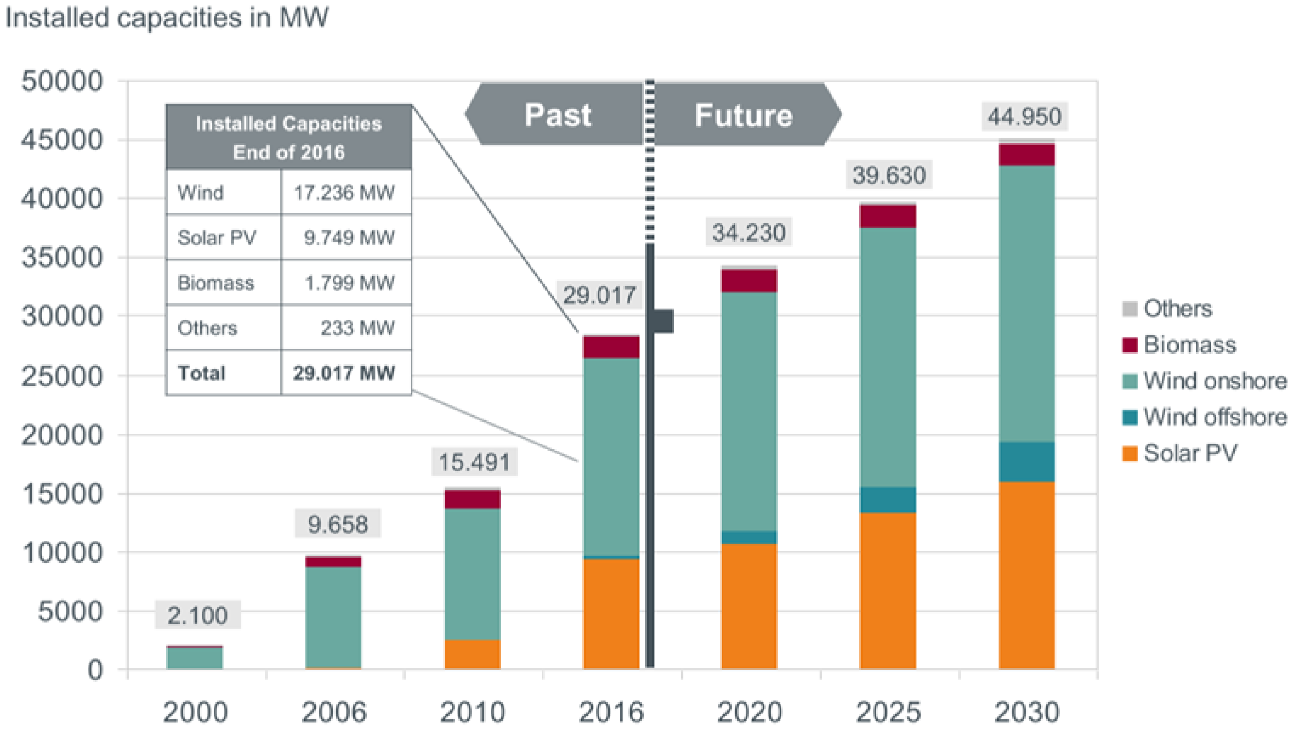


Source: Agora Energiewende. Chart only shows nuclear and renewable gross energy generation. Excludes lignite, hard coal, natural gas and other sources.

But Germany still has much further to go. The Energiewende stipulates that almost 50% of total power consumption should be from renewable sources by 2030, and at least 80% by 2050 (source: Clean Energy Wire). To date, this has required large investment across the spectrum of the energy production and consumption lifecycle.

For production, the Government has provided attractive feed-in-tariffs (FiTs) to renewable energy generators, offering 20-year contracts at set prices with guaranteed dispatch. In speaking with Boris Schucht, CEO of 50 Hertz, he commented that at the end of 2016, the 50 Hertz grid area contained approximately 29 GW of renewable installed capacity. This is forecast to increase to 45 GW by 2030. To put that in context, as at May 2017, Australia's National Electricity Market (NEM) had around 12.9 GW of renewable installed capacity (source: AEMO).

Chart 2: 50 Hertz's substantial ramp-up of installed renewable energy capacity



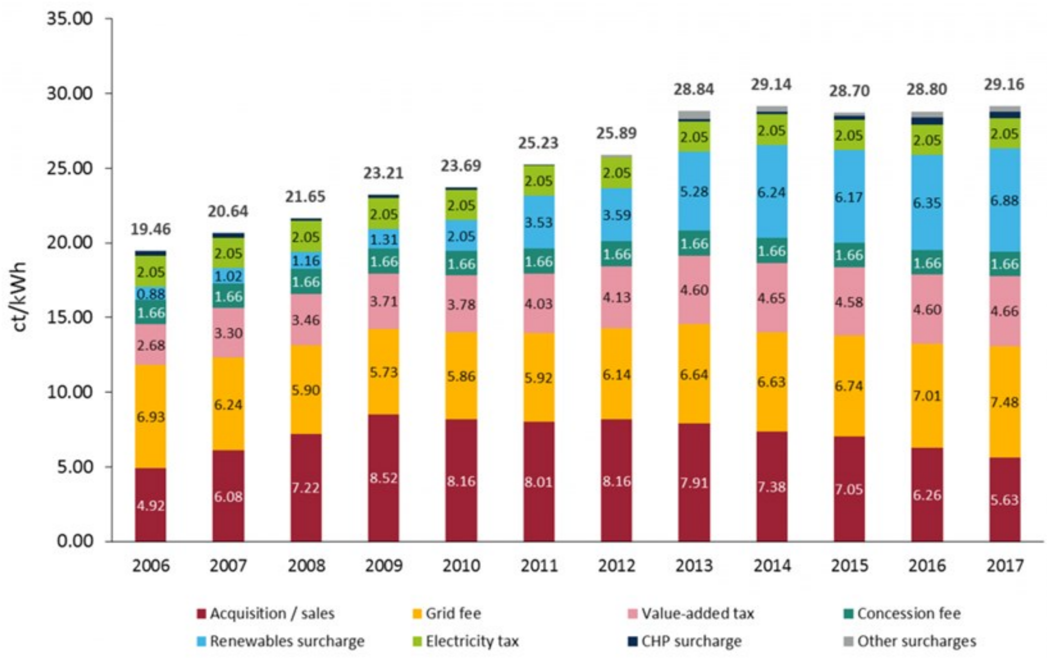
Source: 50 Hertz. As at 31 December 2016.

For transmission, the Government encourages TSOs to undertake major structural improvement to the electricity grid to make it "green". This includes expanding their networks to connect wind and solar plants but also investing in the technology to manage electricity flow around the country. Schucht highlighted the scale of the project. In the seven years to the end of 2016, 50 Hertz has grown its network by over 10% to 10,215 km plus materially upgraded existing infrastructure within the grid (e.g. substations and phase shifters).

All of this is paid for by the consumer. In Germany, the primary instrument for funding the Energiewende is the Renewable Energy Act (EEG) surcharge. It is an additional fee added to the consumer's power bill, and in 2017 it represented 24% of the total charge (source: Clean Energy Wire). Moreover, this has been rising. First, because installed renewable capacity has significantly increased meaning there are more power generators claiming under the tariff. Second, "power-intensive" industries are exempt from the full EEG and the number so classified has been increasing. Finally, the EEG covers the difference between FiT prices and merchant prices. With all the new supply, merchant prices have dropped and so the EEG has increased.

To go even further, the EEG is only the direct cost levied on the consumer. It doesn't even include the additional charges from the TSOs and all the other industry players for enhancing their infrastructure to support the Energiewende. This all adds up to a high-priced energy revolution.

Chart 3: Average power price decomposition



Source: . BDEW, German Association of Energy and Water Industries.

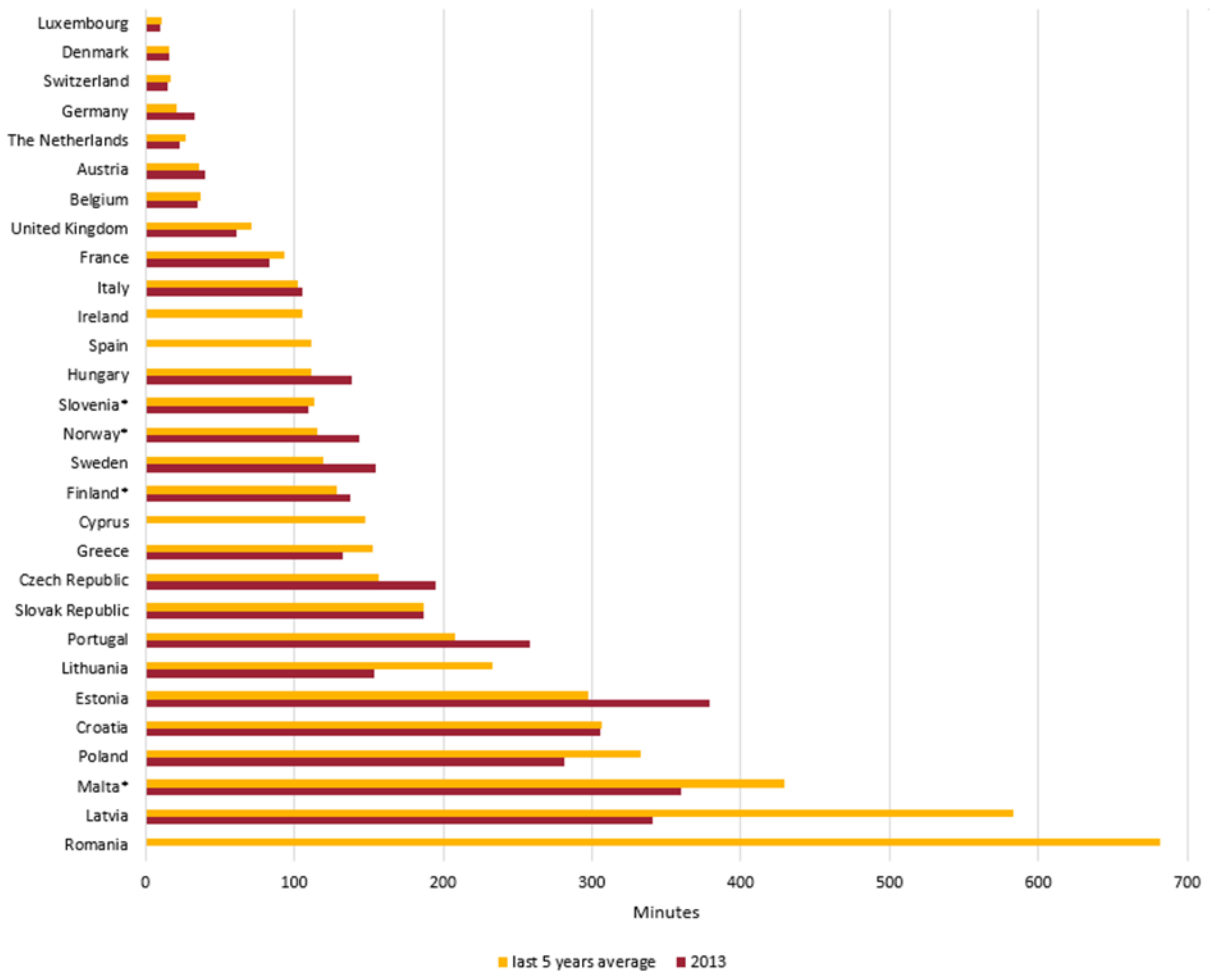
While undoubtedly a noble cause, why has there not been more resistance to higher power bills? Interestingly, surveys of the German population show an overwhelming support for the Energiewende. In fact, polls have consistently shown that more than 90% of Germans support it (source: Agora Energiewende). However, the same polls also show that the same proportion agree that prices for the private consumer are too high (source: Clean Energy Wire).

Stability of the grid

As mentioned, Germany's energy revolution has been accompanied by a top-to-bottom strengthening of its energy supply chain. This has paid off because today, it has one of the most stable electricity grids in the world.

A globally accepted measure of grid stability is the System Average Interruption Duration Index (SAIDI). It conveys the average power outage in a country over any given year. In Germany, in 2015, this number was 12 minutes and 42 seconds. To compare, Ausgrid, a large electricity distribution company in NSW, reported a SAIDI of 76.01 minutes in 2016 (Source: Ausgrid). This has occurred despite Germany being more renewable energy reliant than most and despite the rising proportion of power coming from renewables. It shows that the introduction of renewable energy does not necessarily translate to grid instability.

Chart 4: Germany’s low SAIDI and high proportion of renewables



Source: Clean Energy Wire. Asterisks denote countries that use alternative (but equivalent) indicators instead of SAIDI.

There are a few reasons for this. First and foremost, a huge determinant of grid stability is the quality of the grid itself. More often than not, power outages are from lines going down due to events such as storms or falling trees. To combat this, the German network operators have invested in putting cables underground. Today, around 80% of the German network is buried (source: Clean Energy Wire). To put this in context, the US has around 40% and in Australia it's less than 10% across the various states (source: Parliament of Australia, 1997[1]). As highlighted above, this investment is eventually passed on to the consumer through higher Regulated Asset Bases (RABs) for these regulated companies, which in turn allows them to charge more.

Next, Germany has a nationally connected and integrated grid. Most of its wind power is generated in the north of the country where as a resource for energy it is much more prevalent. However, all of the industrially intensive areas are in the south. Germany's national grid allows it to easily transport this power as required. Further, the German grid is also connected to its neighbouring countries, many of whom do not domestically produce sufficient power to meet domestic demand. This inter-connection allows Germany to export excess power. Finally, Germany also operates an "n-1" concept where redundancy is built into the grid such that one failed line does not cause the entire system to go down (i.e. the system remains operational with n-1 lines). The point is that any one electricity line can become overloaded if it carries too much electricity. Germany's complex grid affords it considerable flexibility in balancing the load and sending power to where it is needed. Again, this improvement of the network is passed on to consumers through service provider charges.

The final defining feature of Germany's grid stability is its investment in technology to balance its asymmetric and fluctuating power generation. This is a complex process. Particularly, because energy into the grid must equal energy out. Further, as mentioned before, renewable energy has guaranteed dispatch - the grid must take renewable power as it is produced. Germany's primary mechanism for dynamically managing this is called re-dispatch. On windy days in the north, the power can be transmitted down south (without overloading the grid) by the grid operator forcing other power stations (such as lignite power plants) to lower production. A problem is that this doesn't happen in real-time; it is based on wind and solar forecasts created the day before. To mitigate the risk of error, TSOs use multiple forecasters and rotate them based on accuracy.

Without re-dispatch, the network can become overloaded and fail (this was demonstrated in South Australia in September 2016 when the interconnector with Victoria was overloaded and tripped off to protect itself). Once more, re-dispatch is not free as network operators compensate generators for the opportunity cost of directing them to lower production. This is passed on to consumers.

These three features of the German electricity grid all contribute to a stable and well-functioning power system. Power experts from all around the world often travel to Germany to see how it is done.

[1] We acknowledge this figure is 20 years old. No more recent data was available.

The challenges

As is often the case, this fairy tale renewable energy transition is not without its fair share of problems. While they are quite easy and simple to explain, overcoming them is challenging.

Cost

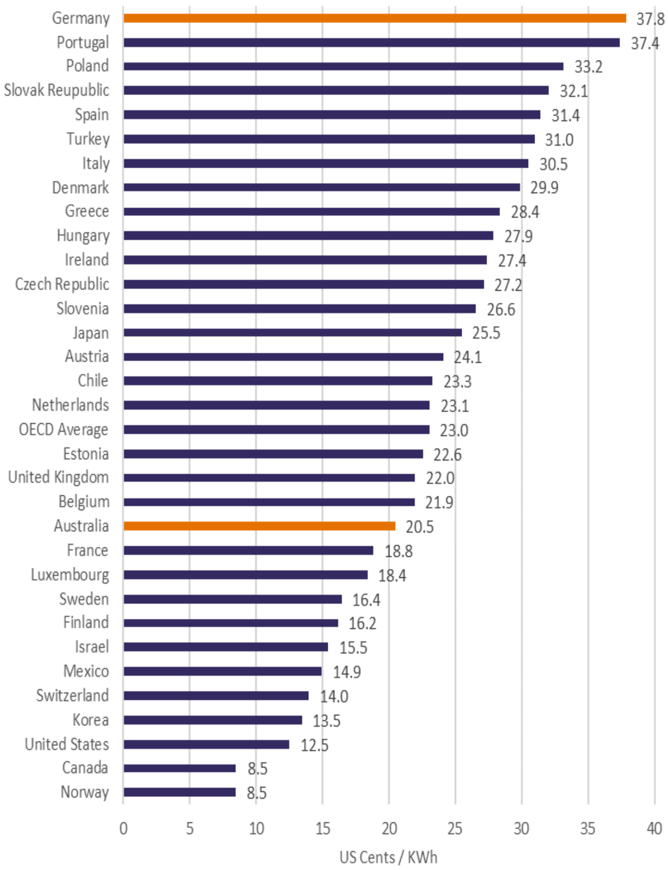
The primary issue is cost. As mentioned, all of this is eventually passed onto the consumer in the form of higher electricity bills. In fact, Germany pays some of the highest power prices in the world.

In recognition of this fact, the German government has been lowering the rates offered for FiTs and is starting to introduce power price auctions and more market exposure. These will push down the cost impost levied on consumers, especially since there has been an exponential improvement (and subsequent lowering of the cost of production) in renewable energy technology. A problem is this will take time and industry commentators also wonder if it goes far enough to address increasing prices.

At the same time, balancing the argument that renewable generation increases prices, is the fact that retail prices are likely increasing anyway. This is mainly a reflection of greater input costs (be it through subsidies for renewables or increasing fossil fuel prices) and greater network charges. In fact, proponents of renewable energy argue that retail prices will increase less than if more conventional sources of power generation continue to dominate.

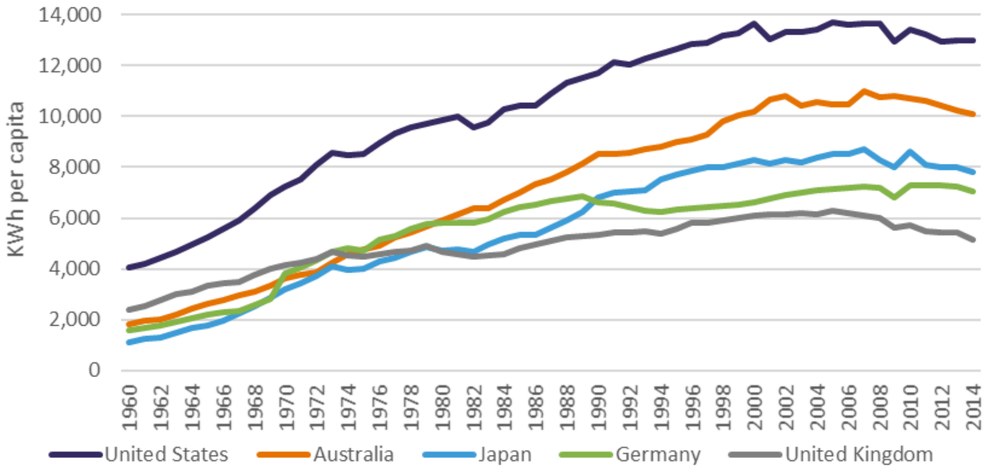
In any event, and perhaps in response, Germans are highly efficient in their energy usage, consuming less energy per capita than most other developed countries.

Chart 5: OECD Retail Electricity Prices



Source: Australian Energy Council. PPP adjusted prices as at 2014.

Chart 6: Electricity consumption per capita



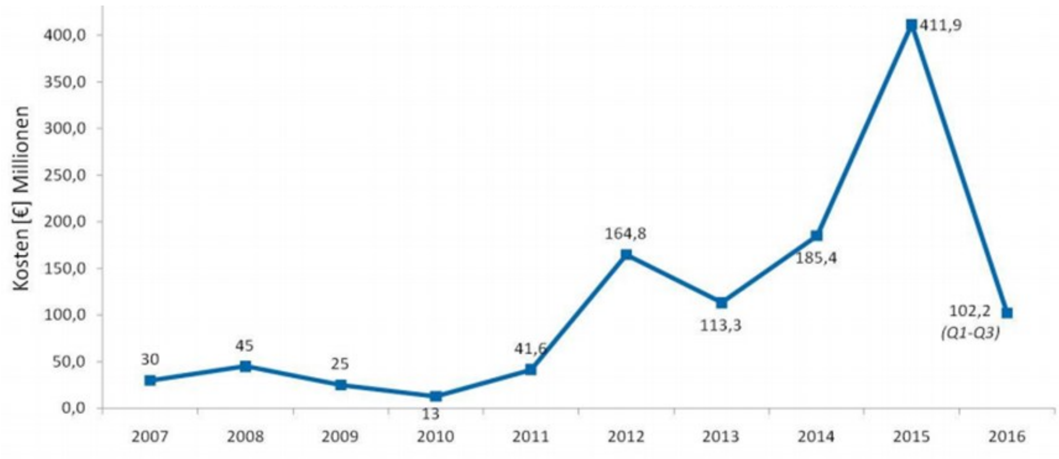
Source: World Bank.

Intermittency

A second problem is managing the intermittency. Not only is it complex, but it is expensive too. As renewable generation capacity has increased, so too have re-dispatch costs. This will become a bigger issue as the proportion of renewable power continues to increase. Further, the inflexibility of the power system can create negative electricity prices during times of high supply. As an example, this occurred in Germany on 8 May 2016 when a particularly sunny and windy day created a surge of electricity, which resulted in commercial customers being paid to consume energy. This happens because nuclear and lignite (coal fired) power plants are too difficult to shut-down quickly and it is cheaper for them to supply energy at a loss rather than bear the cost of re-start later (source: Quartz news).

A potential solution is battery storage, which will likely have a substantial role to play in supporting and stabilising the system. On a large scale, this technology is still in its infancy, but progress is rapid.

Chart 7: Rising German redispatch costs

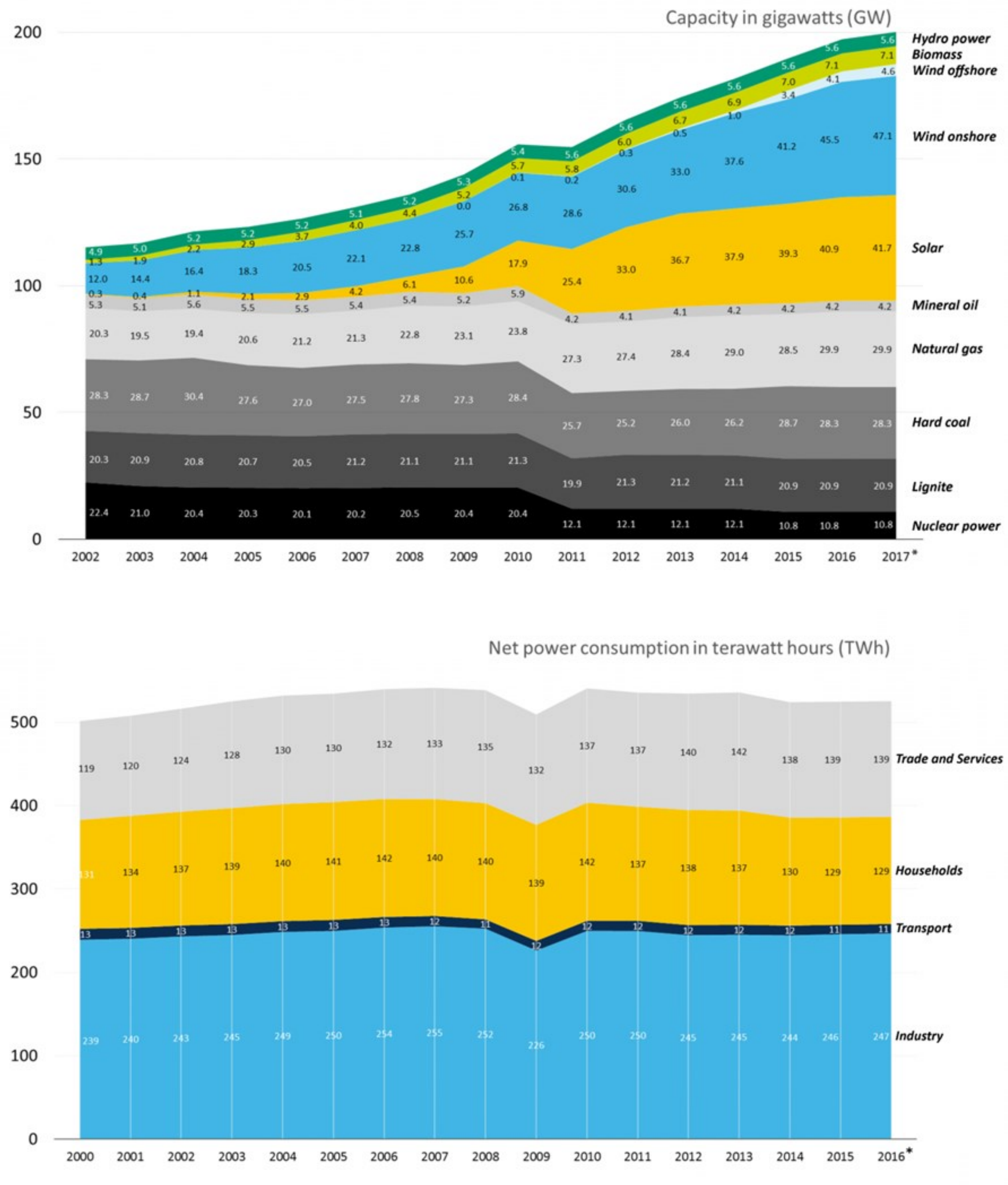


Source: BDEW, German Association of Energy and Water Industries.

Excess supply

A third problem is too much supply. Germany continues to ramp up its installed capacity, largely due to the expansion of onshore wind and solar facilities. This has not been accompanied by an increase in demand.

Chart 8: Supply exceeding demand



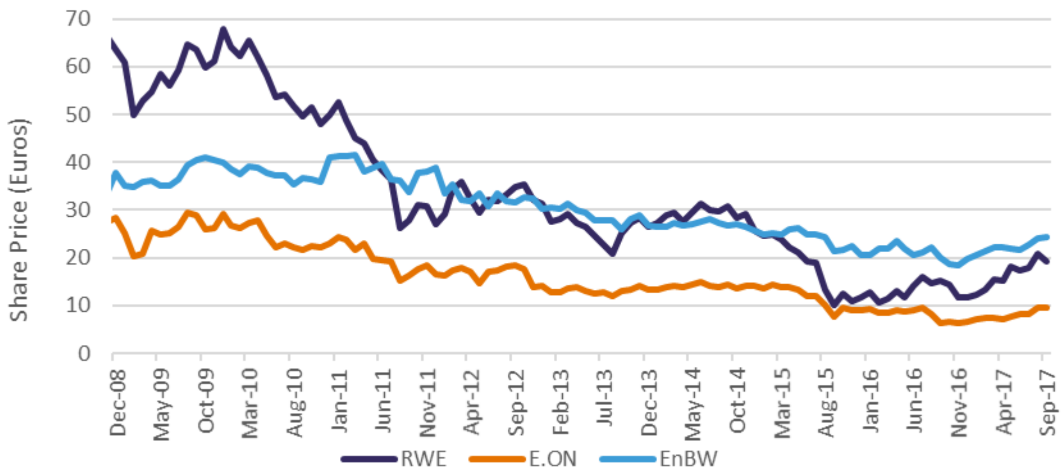
Source: Clean Energy Wire

Chart 9: Falling wholesale power prices

Source: EEX.

Lower wholesale prices, in combination with Germany's merit order effect (whereby renewable supply has guaranteed dispatch and is used before fossil fuel power generation), has resulted in the falling profitability of large utilities that continue to generate most of their power from fossil fuels and nuclear energy.

Chart 10: Poor performing major German utility companies



Source: Bloomberg

Equally, the large capital inflows into German renewables over many years now means that project returns are generally at a significant discount to those available in other European countries. This reflects the maturity of the market, the stability of the regime and the low cost of capital of domestic investors.

The last word…

Germany is leading the way in moving towards a more sustainable form of energy supply. It is a good example of how to introduce and manage a high proportion of renewable energy generation.

The country's power system sends a clear message that it is possible to deliver a stable electricity network with a high proportion of renewable energy supply. However, an equally clear message is that such an energy revolution is expensive (although arguably less expensive than doing nothing) and countries seeking to follow Germany's example will need to be prepared to invest in the quality of its infrastructure.

Germany's energy revolution, and the lessons learned to date, are relevant to Australia even if there are numerous differences (e.g. different dynamics driving pricing, no neighbouring countries, high electricity bills). However, it seems that the key for Germany was a nationally co-ordinated, consistent and continuous commitment to change.

If Australia is to follow in its footsteps, it will need the same. With the current policy uncertainty and inconsistency at the State and Federal level, this seems a way off.

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