Aquila Capital

FINANCING THE EUROPEAN ENERGY TRANSITION

Executive summary

- The share of renewable energy in the European electricity generation mix has heavily increased in recent years with no signs that this trend is going to stop anytime soon. One of the main reasons for this development is the introduction and implementation of new policies by the European governments that aim to make its member states independent from fossil fuels by 2050.
- In addition to new policies, the levelised cost of energy decreased substantially thereby bringing renewable generation towards grid parity and further accelerating its build-out.
- But the energy transition also imposes new challenges to the existing electricity infrastructure which consequently needs to become more flexible and smarter. Decentralised renewable generation as well as other trends such as increasing number of electric vehicles (EVs) or electrification in general change the load profile of grids dramatically. The energy transition is therefore heavily dependent on improving energy infrastructure and the overall implementation of smart grids. The latter will also have a significant positive influence on energy efficiency across industries and sectors.
- Due to its intermittent nature, renewable energy generation benefits significantly from energy storage, which plays a huge role in the European energy transition. Especially in the form of battery storage systems, energy storage growth for both utility-scale and end users is expected to remain as high as 40% p.a.
- Investing in the entire value chain of the European energy transition can yield synergies for investors e.g. by building co-location batteries that thereby reduce costs or by combining generation and transmission assets.

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1. Introduction

The rapid fall in cost for wind and solar PV enabled their growth over the past decade and their ever more important role in the European energy mix. It is widely anticipated that the growth of renewable energy generation will continue. The historic cost learning curves for onshore wind and solar PV have remained at 18% per year demonstrating the significant cost reduction for those generation assets.[1] Learning curves describe the concept of decreasing production cost by a fixed amount every time the production output doubles. The use of coal and oil will consequently continue, meaning the overall fossil fuel consumption will follow suit.[2] The decommissioning of fossil fuel energy generation capacities will allow for further growth of renewable energy generation.

Even if increasing renewable energy generation has an overwhelmingly positive effect on Europe's future, especially in terms of lower carbon emissions, this growth also represents a serious challenge to the European energy and electricity system. The growth in renewable energy is causing a fundamental need for change in the European energy system. Since renewable electricity is variable by nature, it requires a more flexible grid system that can handle periods of massive supply during peak hours with lots of wind and sunshine as well as calmer periods. At this point in time, renewable energy generation facilities, such as onshore wind parks, face the problem of increasing intermittency during peak hours and negative prices. During such peak periods, those parks might be forced to stop production.

Considering the continuing build-out of renewable energy capacity, the grid needs to adapt to the more variable generation profile. The grid needs to be able to store energy during peak hours and release it back into the system during calmer periods. An alternative solution could be to sell excess domestic electricity to other European markets. This would be possible with the increasing interconnection of the European electricity market. But it is not only the increasing renewable generation capacity that poses challenges to the grid. Developments such as electric vehicles (EVs) and a change in consumer behaviour also require the current grid to adapt. These challenges also represent a huge opportunity for investors and other market participants.

Policymakers on a national and European level are aware of the European energy transition (EET) and its challenges. The European Union leads the effort in aligning domestic interests with European interests and policies. It issued a number of directives and policies to support a stable energy transition. The European Energy Directive enforces the build-out of renewable energy capacity and the Investment Plan for Europe supports the financing of the build-out.[3] The latter is also known as the Juncker Plan.

Other initiatives as well as a more detailed view and the challenges and opportunities that arise from the energy transition are discussed later in this paper.

[1] *Bloomberg New Energy Finance, 2015.*
[2] *Energy Transition Outlook 2050 – DNV GL, 2017.*
[3] *European Commission, 2017.*

2. Energy Transition

The European energy market is going through an energy transition. The transition is driven by a combination of different trends and developments that are either already happening or need to happen in the future. The transition ensures that the European energy market will function well and is able to cope with a changing and more demanding energy infrastructure.

The following sections highlight and explain some of the most important trends:

Decarbonisation

The reduction of CO2 emissions across the globe is of paramount importance. Due to this the European Union has set targets to push the decrease in CO2 emissions in the right direction. The EU policies target a minimum allocation for renewable energy production which accordingly lowers carbon emissions.

Decarbonisation in the power sector refers to the increased installed capacity of renewable energy sources and the decommissioning of traditional energy generation capacities. Statnett estimates that for some European countries such as Germany or the United Kingdom, the share of renewables in the energy mix will increase from 27% in 2016 to 64% in 2040.[4] DNV GL forecasts for Europe underline this development in renewable energy generation as well (Figure 1).[5]

This continuing build-out of renewable energy generation is heavily driven by EU policies and initiatives. The European Energy Directive established a target whereby renewable energy should account for at least 20% of the energy generation mix by 2020 and at least 27% by 2030. Variable, renewable energy generation will inevitably dominate the energy generation mix in Europe.

But the decarbonisation does not only include the increasing supply of renewable energy. Decarbonisation also illustrates the decreasing demand of fossil fuels mainly driven by the replacement of vehicles with combustion engines through EVs.

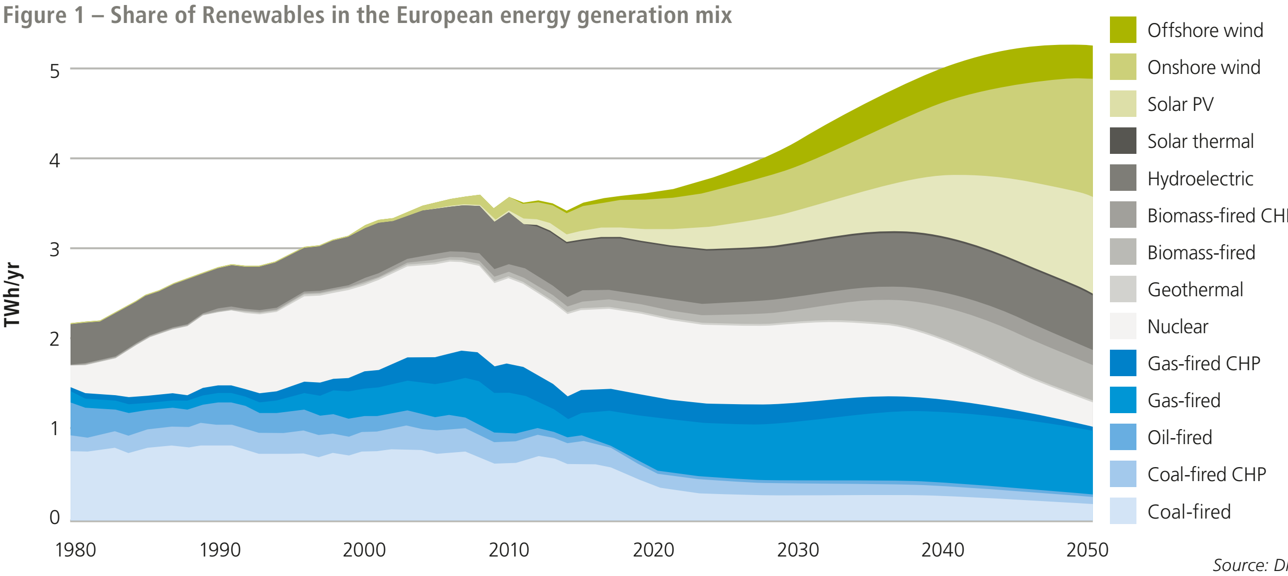
Decarbonisation is additionally expected to have a significant positive impact on the global economy. The International Renewable Energy Agency (IRENA) estimates that the decarbonisation of the energy sector could lead to a global GDP increase of 1.1% by 2030 and by 0.8% by 2050.[6]

Electrification

The electrification of large sectors of the economy is one of the most transformative and important trends of the energy transition.[7] Transportation and heating are two sectors where the electrification is especially important and pronounced. The number of EVs will play a large role in this development (Figure 2). EVs will reduce the use of fossil fuels immensely going forward.

The overall breakthrough and success of EVs is bound to two drivers: their cost-performance and the access to related infrastructure.[8] The cost-performance of EVs goes hand-in-hand with the cost of the

Figure 1 – Share of Renewables in the European energy generation mix



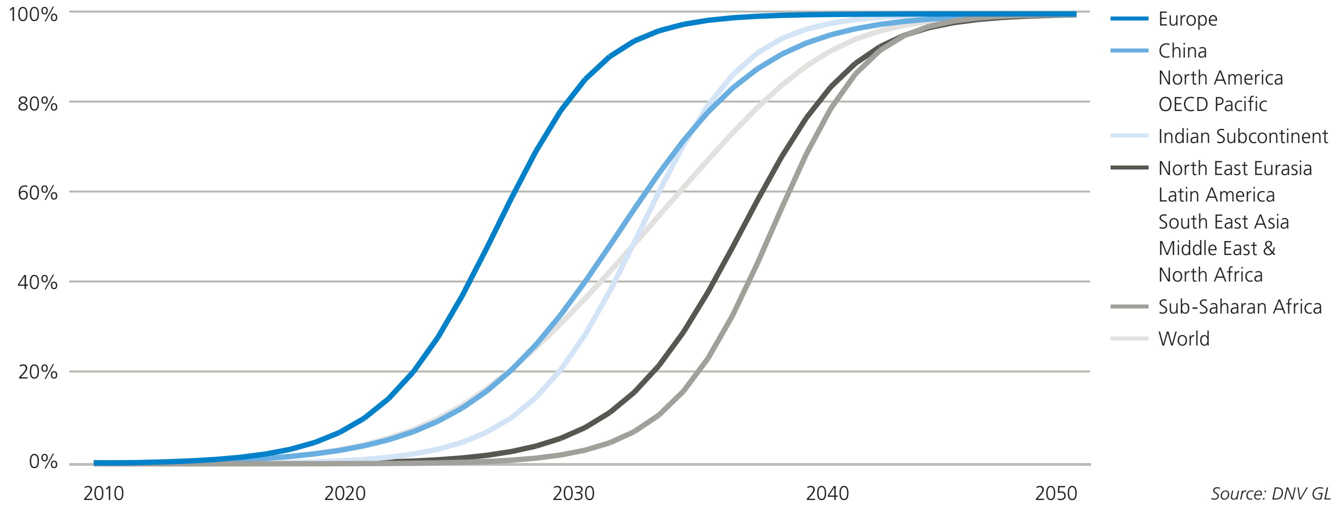
Source: DNV GL

[4] *Long-Term Market Analysis of the Nordic Region and Europe 2016 to 2040 – Statnett, 2016.*
[5] *Energy Transition Outlook 2050 – DNV GL, 2018.*
[6] *Perspectives for the Energy Transition – IRENA, 2017.*
[7] *Harnessing the value of Grid-Edge Technologies – Bain & Company, 2017.*
[8] *Energy Transition Outlook 2050 – DNV GL, 2017.*

lithium-ion batteries, which are used for electricity storage. According to Bloomberg New Energy Finance, lithium-ion batteries experienced a cost decline of 19% p.a. for the years between 2010 and 2017 (Figure 3). Bloomberg New Energy Finance also expects the learning rate to maintain at this level for the foreseeable future due to rapid technological advancement. The average lithium-ion battery price in 2025 is expected to be around $109/kWh, down from almost $1000/kWh in 2010.

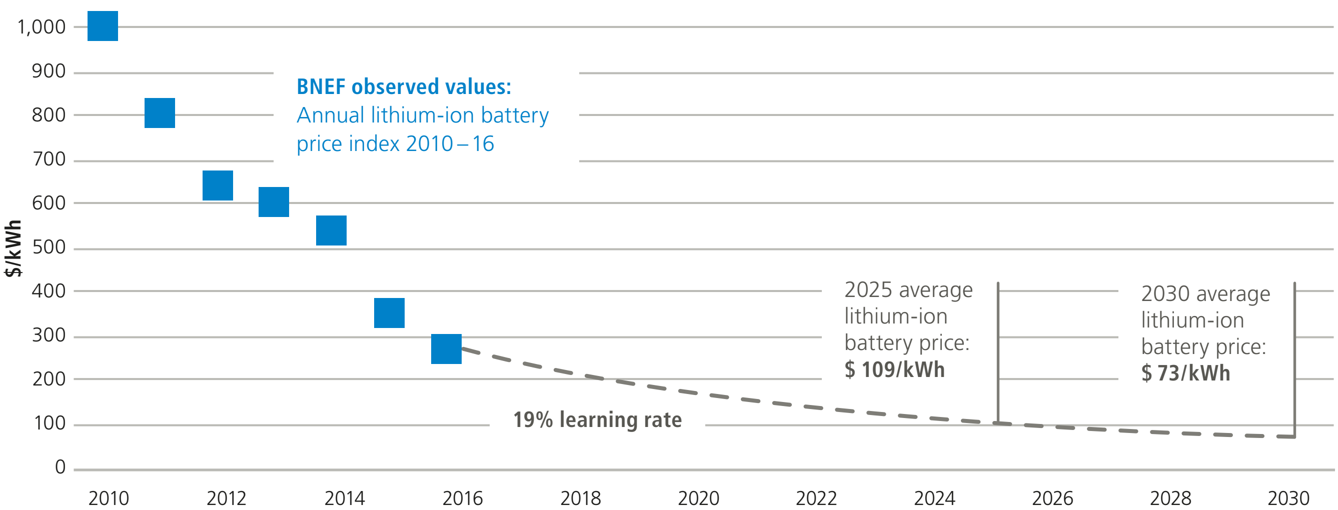
In addition to the reducing cost of lithium-ion batteries and, therefore, EVs, the larger volume of EVs requires significant charging infrastructure. A large network of fast charging stations is needed. Those stations typically use high-voltage electricity to lower charging times. Moreover, the network will also have to cope with a significant number of high-voltage charging stations located on the residential properties of the EV owners. All the new high-voltage stations represent a huge challenge to the existing electricity grid

Figure 2 – Market Share of EVs in the new light of vehicle sales



Source: DNV GL

Figure 3 – Price Trajectory of lithium-ion batteries



Source: Bloomberg New Energy Finance

since they will change the overall demand profile from electricity consumers. An efficient electricity grid needs to be able to cope with a large number of EVs possibly charging at the same time, for example during the night.

Sector-coupling

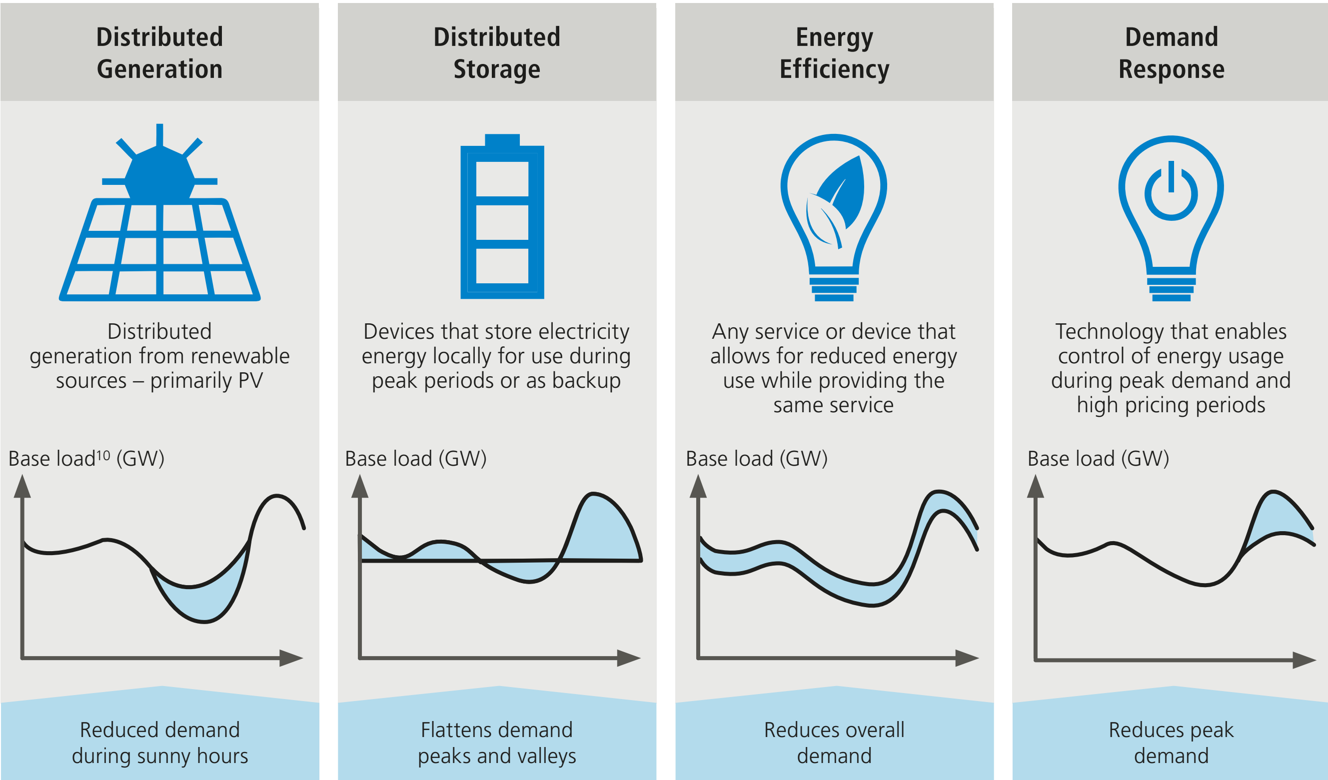
Along-side this, electrification plays a significant role in the heating sector as well, where electricity is used to generate heat instead of fossil fuels. Older, already existing buildings that rely on fossil fuels can be retrofitted with electric heat pumps. In addition, heat is produced as a by-product of energy generation plants. Those plants produce a lot of waste energy during the generation of electricity. Combined Heat and Power, or CHP, plants utilise this waste heat. The electricity is largely generated using traditional energy sources and the power plants are then retrofitted to be more efficient. Nevertheless, CHP plants can also be fuelled by renewable energy sources such as biomass for heat and electricity generation. CHP plants work particularly well with district heating (DH) systems where the waste heat can be used to provide heat such as to municipalities or hospitals. This so-called sector-coupling is not only applicable to heating and electricity generation. This trend is also observable in the power and manufacturing or building sector.

Digitalisation & Smart Grids

Digitalisation as well as other trends like electrification promise a more reliable, secure and sustainable electricity grid that would also increase asset utilisation. Additionally, digitalisation will make the grid "smarter" by implementing new technologies such as smart meters and sensors or automation and digital network technologies. Behind the meter digitalisation will transform the electricity consumer experience with more and more power-consumption, connected devices and the increasing importance of the Internet-of-Things (IoT). Those new technologies will shape a more advanced and sophisticated grid but also require a better infrastructure. Charging stations for EVs or electricity storage systems need to be built to optimise the utility of a "smart" grid.

Existing grid challenges such as intensifying electricity demand, aging infrastructure that produces losses and is unreliable, increasing share of variable renewable generation, distributed generation and EVs are addressed by smart grids that enhance the physical network, optimise grid monitoring, and enable active customer contribution.[9]

Figure 4 – Distributed technologies affect the grid and base load differently



Source: Bain & Company

[9] *Introduction to SmartGrids – AT Kearney, 2017.*
[10] *The base load represents the minimum load throughout the day. The base load is, therefore, dependent on time (the given observation day) and region.*

In summary, smart grids use digital information and communication technologies to handle the flow of data between consumers and system operators as well as the flow of power that is generated by centralised (e.g. utility-scale solar PV) and decentralised (e.g. rooftop solar panels) facilities. A smart grid should be able to accommodate all generation and storage options, optimise energy efficiency and asset utilisation as well as improve the power quality for consumers.[11]

Decentralisation

Decentralisation describes the trend away from large scale nuclear or fossil-fuelled power plants towards smaller, more distributed renewable generation facilities. It will take place largely within the energy generation and storage industry. This includes utility-scale as well as rooftop solutions for solar PV installations. End-consumer solutions like rooftop solar panels are also becoming more popular within energy storage industry as part of integrated customer solutions with battery storage becoming increasingly more affordable. Compared to traditional centralised energy storage solutions such as pumped-hydro, battery solutions are significantly smaller and can be utilised by the end-user. Large-scale battery production facilities help reduce the cost of these batteries. Companies such as Tesla are on the forefront of promoting consumer battery storage and integrated solutions of rooftop solar panels with battery packs. The increasing capacity of solar PV will lead towards lower electricity demand during sunny hours and distributed storage solutions will flatten out demand during peak and off-peak times. Both trends will, thereby, improve the grid's overall load management.

Energy Efficiency

The International Energy Agency (IEA) defines energy efficiency as key to ensuring a safe, reliable, affordable and sustainable energy system. There have been huge improvements in energy efficiency in the last two decades. The IEA estimates that the world would have used 12% more energy in the period between 2000 and 2016 if it wasn't for energy efficiency improvements. That is the equivalent of adding another European Union to the world economy.[12] A large part of the efficiency gains resulted from more energy efficient buildings. However, despite the already realised energy savings, there is still a lot of room for further savings. Previous improvements mainly focussed on the materials and the construction of buildings and not that much on the heating and cooling equipment. Realising those potential energy efficiency gains is crucial since buildings account for 40% of the primary energy consumption in Europe.[13]

Technology advancements and energy efficiency gains as whole will subsequently lead to lower energy intensity going forward. Energy intensity is measured as units of energy per unit of GDP and is often used as a measure of energy efficiency on a national level. Fast efficiency improvements will ultimately lead to flattening energy demand. The overall flattening energy demand is also perpetuated by slowing population growth and higher productivity levels.[14]

There is additionally policy support for energy efficiency improvements. The European Energy Efficiency Directive imposes a target of 30% increased efficiency until 2030. The target will achieve a 23% energy consumption cut compared to 2005 levels and will support the EU in its effort to achieve the objectives of the Paris Climate Agreement. Estimates from the European Commission show a potential GDP increase of about 0.4% or EUR 70bn. The Directive mainly addresses the building sector because it accounts for 40% of Europe's energy consumption. The Directive further empowers the energy transition by encouraging the use of innovative and smart technologies and higher renovation rates, which will improve building's energy efficiency.[15]

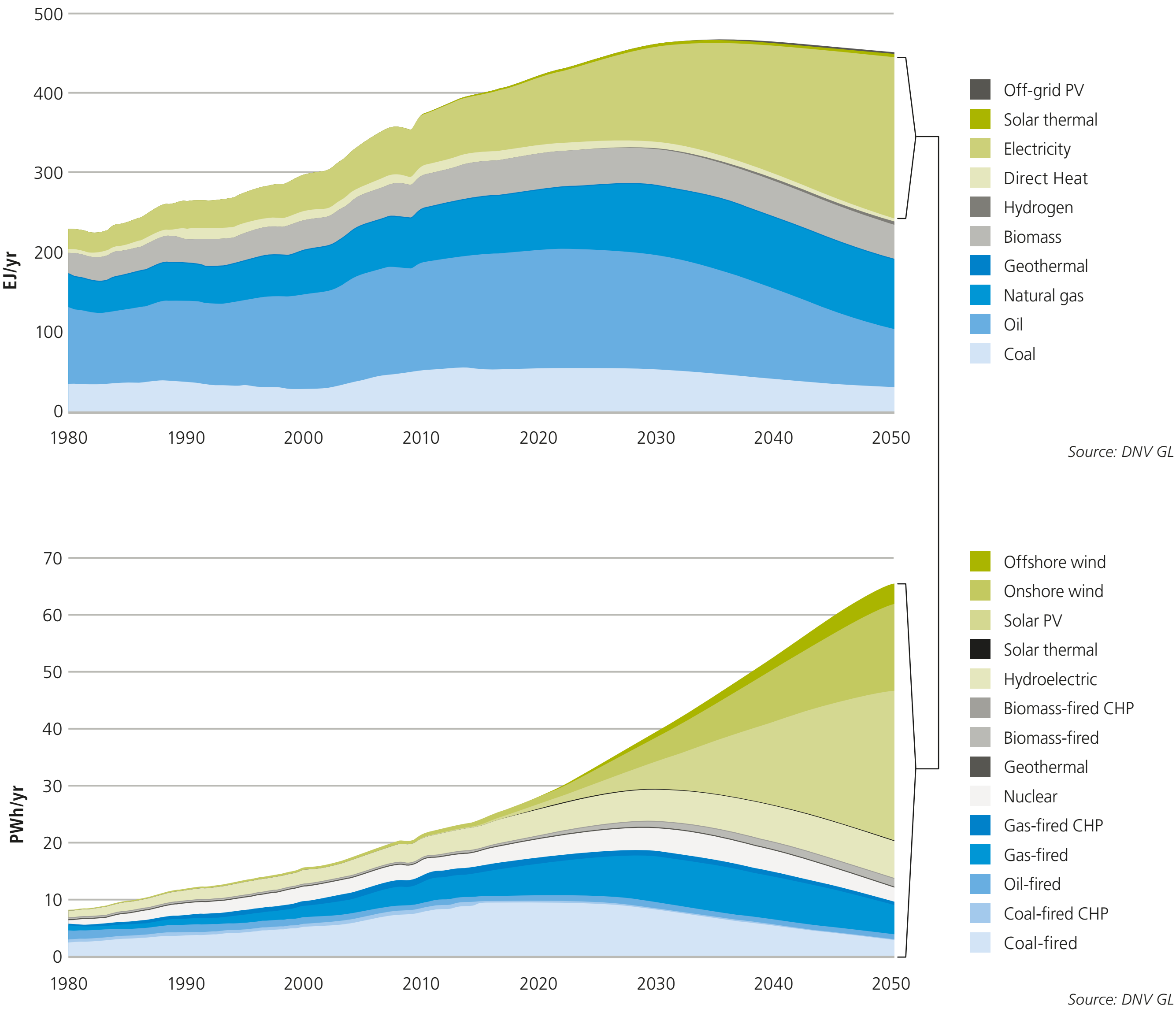
[11] *Introduction to SmartGrids – AT Kearney, 2017.*
[12] *Energy Efficiency – IEA, 2017.*
[13] *Investing in energy efficiency in Europe's buildings – The Economist, 2013.*
[14] *Energy Transition Outlook 2050 – DNV GL, 2017.*
[15] *European Commission, 2016.*

3. Putting the trends of the European Energy Transition into perspective

Through describing and segregating the different trends and investment opportunities, several interdependencies become apparent. The fundamental basis of the energy transition is the change of the energy generation mix towards renewable energy generation. Although the expansion of electricity generation through the likes of wind or solar plants is highly beneficial, the generation is more intermittent in nature compared to the constant base load that say a nuclear power plants generates.

Although the decreasing levelised cost of energy (LCoE) brings renewable generation towards grid parity and thereby decreases their dependence on subsidy schemes, the variability in the generation also imposes challenges to the existing electricity grid. The variability requires a more flexible and smarter grid with superior load management. Digitalisation plays a huge role in this providing new technologies before and behind the meter.

Figure 5 – World final energy demand (top) vs world electricity generation (bottom)



As Figure 4 shows, a combination of the previously described trends will transform the characteristics of the European electricity grid. Centralised generation of utility scale solar PV installations or wind parks will be supported by distributed or decentralised renewable generation. Storage solutions will play a big role in reducing demand during peak hours. Distributed storage solutions utilising lithium-ion batteries are closely linked to the increasing number of EVs and become especially useful during night hours when almost all EVs will be charging and electricity demand could be above average.

Moreover, increasing energy efficiency across all sectors and devices will support the trend of slowing energy supply growth in Europe towards its anticipated stagnation. This stagnation is part of the de-coupling of economic growth and energy supply. Although the energy supply will not continue to grow as fast as it used to, the share of renewable electricity in the energy generation mix will increase immensely as shown in Figure 5. This increasing electricity demand is also caused by the electrification of for instance the transport sector with EVs or the heating industry.

Due to the nature of renewable energy generation, some countries and locations are more suitable for particular types or renewable energy generation than others. The evolving electricity grid will help make the European grid more connected. Interconnectors are able to connect the United Kingdom or the Nordics to mainland Europe. This will help economies that generate a net electricity surplus to reduce periods of intermittency as well as countries that can import this electricity during periods of high demand and low domestic supply. The continuing build-out of renewable energy generation combined with energy efficiency or electrification efforts will contribute to the overall decarbonisation in Europe.

4. Investing in the European Energy Transition

DNV GL predicts that the electricity share of the energy mix will double from 21% today to about 44% in 2050. This will be made possible by the continuing rise of renewable generation from solar PV and wind.[16] Moreover, the challenges that this build-out impose on the energy infrastructure described in this paper as well as the build-out itself, require extensive funding that will largely be provided by the private sector.

With regards to renewable energy generation, institutional investors can benefit from a proven asset class that continues to benefit from technological advancements and offers attractive long-term, stable and risk-adjusted returns. LCoE and dependency on subsidy schemes are decreasing and thereby reducing regulatory risk. The increasing market risk exposure can be mitigated through the growing market for power purchase agreements (PPAs) with large corporates or utilities as off-takers. Those off-takers pay a fixed amount per MWh of for a period usually between 10 to 15 years for an agreed-upon volume of electricity. PPAs give institutional investors more flexibility in tailoring their merchant risk exposure. Moreover, returns from renewable generation assets are weakly correlated to those from traditional asset classes.

Installed wind farm capacity is roughly 150 GW or 17% of the total installed capacity in Europe.[17] The Nordics represent an attractive location for onshore wind since wind generation is above average during periods where wind generation in the North Sea is not. It can thereby complement the North Sea wind output and bring a natural balance to the European energy generation mix. Scandinavian countries already have a high penetration of renewable generation but Sweden aims to be completely renewable dependent by 2040 by building large-scale onshore and offshore wind farms. The Nordics in general represent a very attractive market for specialised investors considering their potential for greenfield projects.

The possibility of greenfield projects is also a huge factor regarding solar investments. The Spanish market is recovering as shown in the recent over-subscripted capacity auction where auctioned capacity increased from 3 GW to 5 GW. Portugal, and Iberia as whole, benefit immensely from their superior sunny conditions. Portugal is especially attractive and has huge growth potential. Decreasing LCoE led to the removal of the local feed-in tariff demonstrating the maturing market environment.[18]

In addition to the huge potential for greenfield wind farms, the Nordics are also an attractive region for district heating (DH) investments. DH as a centralised heat production system improves the energy efficiency compared to decentralised systems. The heat can be produced by renewable sources, such as biomass or geothermal plants, or by CHP plants. Customers have usually no incentive to install individual heating systems since the economies of scale make DH the cheapest and easiest solution for them. Additionally, it provides investors with stable profit margins. Investors typically acquire either the heat generation asset and the distribution network or just the distribution network. DH systems furthermore experience a natural monopoly since large capital requirements make it economically unattractive to have more than one DH system in a particular area.

DH provides 9% of heating within the EU, and most of these networks are concentrated in the Nordics and Eastern Europe, where the climate is naturally cooler. However, many of these networks require upgrades to improve efficiency or need to be expanded.[19, 20]

Germany is one of the largest markets for district heating, however, networks are especially underdeveloped in West Germany, which only has a 9% share in the German heating market compared to East Germany's 30% share.[21] In order to reach its 14% renewables target for heat consumption, the German government put an incentive scheme in place to encourage investors to expand district heating networks, as long as the heat provided derives from clean or efficient sources (e.g. renewables, waste heat, or combined heat and power plant).[22]

In Finland, Denmark and Sweden district heating has over 50% population penetration, and is dominating the heating sector. The cold climate, high energy consumption per capita and a growing population highlight that the district heating market in these regions is relatively strong. Both Finland and Denmark are also aiming for 100% renewable energy generated district heating by 2030 and 2035 respectively.[23, 24]

The build-out of electricity storage systems such as lithium-ion batteries will represent an interesting investment opportunity going forward. Lithium-ion batteries will generate revenues by providing high frequency balancing or so-called "Enhanced Frequency Response" services to the grid and, thereby, optimise the load management of the local grid and improve the response frequency from ten seconds to just one second. Those batteries can utilise cost benefits when being located next to (renewable) generation plants since it can share its grid connection and does not require one itself.

[16] *Energy Transition Outlook 2050 – DNV GL, 2017.*
[17] *Government of Netherlands, 2016.*
[18] *Portuguese Solar Energy Market Outlook - Macedo Vitorino & Associates, 2017.*
[19] *Poland Review – IEA, 2016.*
[20] *Euroheat & Power, 2015.*
[21] *Towards 2030, Renewable Based District Heating in Europe – Policy Assessment of Selected Member States, 2015.*
[22] *Ibid.*
[23] *Nordic Energy Outlook 2017 – St1, 2017.*
[24] *Euroheat & Power, 2015.*

A number of European Transmission System Operators (ETSOs) are taking an interest in energy storage systems, particularly for the use of frequency balancing. The National Grid UK auctioned and contracted eight tenders for 200 MW worth of storage to provide frequency response services over four years and expects to make savings of GBP 200m over the term of the contracts.[25] In addition to the Enhanced Frequency Reponse tender, the UK also holds monthly tenders for firm frequency response, and offers a ten-year demand-side response tender. The possibility of stacking up to three revenue streams makes the UK the most appealing battery storage market. Additional regulatory support and demand for primary control reserves in other countries as well as decreasing capital cost is leading to a market growth forecast of over 40% p.a. Especially regarding the proven technology of pumped hydro and stored hydro supports the aspects of stable revenues.

If electricity cannot be stored, selling it to other European electricity markets is also an excellent alternative option. Cross-border electricity transmission is highly beneficial since regions such as the Nordics could sell their electricity surplus to countries such as the UK that can have electricity deficits. Connecting these particular regions requires under-sea cables or so called 'interconnectors'.

The NordPool (NASDAQ OMX) area – Denmark, Finland, Norway, Sweden and Baltics – generates the cheapest power in Europe and has exceptionally high proportion of low cost baseload power generation compared to Germany, which is still highly dependent on gas and coal. The capacity of interconnectors is expected to double until 2030. Interconnector capacity to Continental Europe will drive Nordic electricity prices higher, as the Nordic price tends to be below those in interconnected markets.

There is a number of interconnector investment projects expected to be built during the next several years. Below is an overview of the main interconnector investments:

- NordLink in operation from 2020 (1400 MW Norway-Germany)
- NSN in operation from 2021 (1400 MW Norway-Great Britain)
- NorNed2 in operation from 2030 (700 MW Norway-Netherlands)
- Danish-German upgrades from 2020 (600 MW)
- COBRA by 2019 (700 MW Denmark-Netherlands)
- Hansa PowerBridge from 2025 (600 MW Sweden-Germany)
- NorthConnect in operation from 2030 (1400 MW Norway-Great Britain)

Investing in the entire value chain of the European energy transition can yield synergies for investors. For example, battery storage facilities can be installed as co-location batteries and share a grid connection with a generation asset thereby reducing cost. But investing in energy infrastructure and the energy transition in general requires specific expertise and knowledge across all asset classes in the previously mentioned geographies.

Aquila Capital has a proven track record in renewables where it has been active since 2009 with a transaction volume of EUR 4.2 bn. It employs a team of highly experienced professional with a proven track record. Investors can benefit from Aquila Capital's active asset management that enables unique de-risking strategies throughout the investment lifecycle. It's strong network across Europe and especially in the most attractive regions of the energy transition is also unique in the industry. With local representation in 10 different countries including Norway and Spain, Aquila Capital was able to acquire a significant onshore wind portfolio in the Nordics as well as solar investments in Portugal. In order for institutional investor to increase returns it is inevitable to invest at an earlier stage in the investment lifecycle. Aquila Capital is able to provide institutional investors with access to those opportunities having already successfully completed greenfield investment in the renewable energy generation sector.

[25] *National Grid UK, 2016.*

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