Energy Cooperation Platform
中国 - 欧盟能源合作平台

Supporting the construction of renewable generation in the EU and China

Policy Considerations

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EU-China Energy Cooperation Platform was launched on 15 May 2019, to support the implementation of activities announced in the "Joint Statement on the Implementation of EU-China Energy Cooperation". The overall objective of ECECP is to enhance EU-China cooperation on energy. In line with the EU's Green Deal, Energy Union, the Clean Energy for All European initiative, the Paris Agreement on Climate Change and the EU's Global Strategy, this enhanced cooperation will help increase mutual trust and understanding between EU and China and contribute to a global transition towards clean energy on the basis of a common vision of a sustainable, reliable and secure energy system. ECECP is implemented by a consortium led by ICF, jointly with Energy Research Institute of National Development and Reform Commission and China Energy Conservation and Environment Protection Consulting; policy steering is by the EU (DG ENER) and the China National Energy Administration.

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FOREWORDS

In China, the installation and utilisation of hydropower and more recently PV and wind power have been increasing year on year. Although renewable energy sources (mainly PV and wind) have achieved double digit growth, their share in overall consumption, apart from hydropower, is still negligible. China's energy system is still dominated by coal (accounting for 57% of energy use in 2019). China is now the world's largest market for wind and solar power, yet non-electric renewables, mainly from biomass fuels, are still at the very early stage, with no clear pattern of development.

China and Europe are together struggling to manage the transition to green energy. The European Green Deal, recently issued by the EU Commission, sets Europe on an unprecedented and irreversible path within a very diversified political and technological environment represented by 27 different member states. Nevertheless, EU energy policies, a well-integrated grid and regulation of production, together with a transparent and open market, allow Europe to exploit renewable sources to their utmost and foster their growth.

The development of renewable sources is a key priority for both China and Europe; they each firmly support the move towards decarbonisation of their economies and at present they are the most credible and leading political and economic systems pressing for full decarbonisation of industry, society, transport and the overall economy.

Although Europe and China have very different political, economic, geographical and historical systems, a mutual exchange of their experiences over the past decades could result in an enhanced range of political and technical choices for the benefit of global energy transition trends. Europe has an historical timing advantage over China in terms of technology and policy models, with different results across member states and a political and geographical complexity at least on a par with that of China, if not greater. Hence, China may be able to take this opportunity to learn from Europe's choices, mistakes and successes and as well as from the consequences of its political and technological strategies.

Recent history demonstrates that Europe has been successful not only in integrating renewables, but also in planning an energy system that will support sustained economic growth. Evidence of that success is that the average EU-27 primary energy intensity – i.e. the ratio of energy consumption to GDP - is the lowest in the world and half that of China.

In spite of the significant differences between Europe and China, as very effectively outlined in this report and in its conclusions and recommendations, a comparison of the two energy systems offers clear conclusions. Europe's experience shines a light on the areas that China will need to consider when planning its energy transition over the coming years.

The first area relates to the need to tackle renewable energy development within a comprehensive, holistic and visionary energy system, taking into account technologies, security, sustainability, and energy intensity reduction across the whole energy value chain and energy sectors (electricity, heating, fuel).

The second lesson from Europe – which has been able to harmonise the complexity of 27 different countries with a variety of policies, a multitude of energy systems and a range of dominant fuels (France with nuclear, Poland with coal, Italy with gas, Scandinavia with renewable, etc.) - is the value of flexibility and distributed energy production, with approaches aimed at optimising the whole system rather than single technological segments. In this aspect the role of grid regulation and flexibility, cogeneration and prioritising renewables over fossil

fuels are key success factors that China may wish to take into account, carefully adopting UHV solutions that are fully integrated into a distributed power production system.

The third key aspect is market transparency. The focus should be on the end-user who should be able to make a direct contribution to the decarbonisation trend with 'green' choices, while bearing higher energy costs for electricity, heating and fuels. Private, commercial and industrial end-users should be given an active role and be offered a choice of energy sources, with appropriate education and awareness of their options. Empowering the consumer will lead to more rapid decarbonisation.

The fourth area of European experience relates to bioenergy and hydrogen. These new technologies, already piloted and adopted in Europe, would mitigate the intermittency of renewable sources, strengthen China's energy security, contribute to a circular economy, and enhance efforts to reduce emissions through the exploitation of biomasses for producing biogas, biomethane, second generation biofuels, etc.. Biogas and hydrogen are the ultimate solutions for decarbonisation of transport, increasing flexibility in the energy system and accelerating the move away from coal while contributing to, and even anticipating, fulfilment of the commitments taken in Paris in 2015.

The fifth, final, and perhaps most pressing point for discussion is the advisability of a genuine opening of China's market to European companies allowing them to operate in China on a level playing field, as well as through innovative pilot schemes and joint collaborations. This approach could prove the best way to harmonise European and Chinese experience on the ground and on joint projects where European companies can transfer knowledge while developing their business operations in China. This would boost China's energy transition effort by involving European technologies, processes and regulations and drawing on European companies' readiness to adapt proven solutions to the Chinese market.

This study provides an excellent basis for understanding the key differences between the power markets in China and Europe and offers a clear depiction of the lessons learned from European and Chinese experiences. It achieves this through a very careful comparative approach that advocates solutions only after considering whether local differences might render them unworkable.

I am absolutely convinced that this report will consolidate and further strengthen cooperation between China and Europe in the context of the EU-China Energy Cooperation Platform. The European Union Chamber of Commerce in China and its energy related members are fully and proactively supportive of the ECECP, in the hope and expectation that it will strengthen mutual cooperation between China and the EU and open up mutually beneficial business opportunities.

Guido D. Giacconi

National Chair of EUCCC Energy Working Group
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CONTENTS

1. INTRODUCTION

The EU-China Energy Cooperation Platform (ECECP) was launched on 15 May 2019 to support the implementation of activities announced in the 'Joint Statement on the Implementation of EU-China Energy Cooperation' issued at the 21st China-EU Summit in April 2019. The overall goal of the ECECP is to enhance EU-China cooperation on energy. This enhanced cooperation will help increase mutual trust and understanding between the EU and China and contribute to a global transition towards clean energy on the basis of a common vision of a sustainable, reliable and secure energy system.

ECECP is an official project funded by the EU and led by the government of China and the European Commission. The European Commission's Directorate-General for Energy, China's National Energy Administration (NEA) and the EU's Delegation in China form the steering committee, with ICF, Energy Research Institute of National Development and Reform Commission (NDRC-ERI) and China Energy Conservation and Environmental Protection Consulting (CECEP) as the implementing agencies. The project will last three years and will cooperate on policy exchanges and business model design in key areas including energy systems (electricity and liquefied natural gas), renewable energy, energy efficiency, and innovative initiatives.

This report is the result of research undertaken by ECECP in the first quarter of 2020. Data provided in this report is correct as of April 2020. It focuses on the policy framework and the evolution of policies to promote renewable energy development in China and the EU. The report starts with an introduction to policy decision-making, followed by a comparative analysis on the effects of policy implementation and corresponding insights. Both China and the EU have set targets for an ambitious further growth in the use of renewable sources for energy production by the year 2030. A number of decisions need to be made in order for these targets to be met: whether the targets should be broken down into smaller objectives, what kind of policies could support the renewable industry, and how to balance the growth in renewable energy with energy security and affordability. A more detailed analysis relating to the integration of renewable energy is included in a separate report issued in the framework of the ECECP.

Based on its analysis of these challenges, this report proposes suggestions for China's 14th five-year renewable energy development and policy plan, for the implementation of the EU's renewable energy targets, and for potential areas of policy cooperation between China and the EU in the future.

2. TARGET SETTING AND REGULATORY FRAMEWORK IN EU

This chapter describes the legislative / regulatory policy framework and decision making process in the EU, including an overview of the main directives and the resulting growth of renewables in the energy market. It should be noted that the information in this and the following chapters is provided for EU-27 unless otherwise indicated. Some data relates to EU-28 as it originates from the time before the UK's withdrawal from the EU on 31 January 2020.

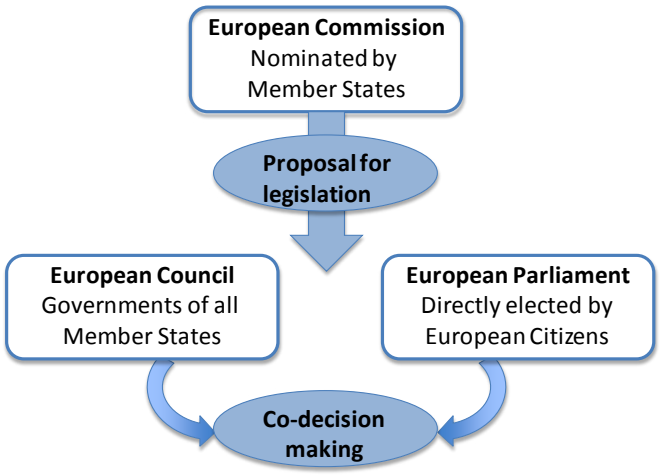
2.1 The legislative process

In the EU the responsibilities for energy are a shared competence between the EU member states and the European Union, as laid down in the EU Treaty[1].The main aims of EU energy policy include:

- To ensure the functioning of the energy market;
- To ensure security of energy supply;
- To promote energy efficiency, energy saving and the development of new and renewable forms of energy; and
- To promote the interconnection of energy networks.

According to the EU Treaty, each EU member state has the right to 'determine the conditions for exploiting its energy resources, its choice between different energy sources and the general structure of its energy supply'. Within the EU, energy follows the 'normal legislative procedure', meaning that the European Commission develops proposals for new legislation and the European Parliament and the Council jointly adopt (i.e. co-decide) legislation.[2] In this the Council represents the governments of the EU member states while the European Parliament directly represents European citizens. This process is illustrated in Figure 1.

Figure 1 Illustration of the legislative process and the co-decision procedure in the EU



1 Article 194 of the Treaty on the Functioning of the European Union (1957).

2 Article 294 of the Treaty on the Functioning of the European Union.

Within the overall legislative framework, each EU country has the right to choose its own preferred set of policy instruments, provided these instruments meet the requirements adopted by the EU. For example, for renewable energy this means that the EU has set overall targets on the share of renewable energy to be achieved, while its member states decide on the type of support instrument, the level of financial support and other specific design choices, as long as these are compatible with EU law. To ensure the choices made at country level fit within the overall EU framework, the Commission has defined guidance and set boundaries to the specific support policies.[3] Further details on this guidance and on the boundaries are provided in Chapter 4.

2.2 Policy context and target setting

The EU has a strong commitment to reducing greenhouse gas (GHG) emissions. Transitioning its energy system to one based on low carbon is an integral part of this commitment. In December 1997 the Kyoto Protocol and its corresponding targets were adopted and it was agreed that in Europe a joint strategy was required to implement these targets. The first directive published in response set a binding renewable energy target for EU member states. Many directives have followed since to address the ambitious GHG emission reduction targets. Table 1 offers an overview of the renewable energy directives issued so far. Other related directives and overall strategies are included in subsequent tables.

Table 1 Overview of EU renewable energy directives

Directive	Date	Details
2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market	Adopted 27 September 2001; entry into force 27 October 2001 (valid until 31 December 2011)	Includes an indicative share of 22.1% of renewables in electricity consumption (RES-E) in 2010 and national indicative targets for each EU member state.
Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport	Adoption 8 May 2003; entry into force 17 May 2003 (valid until 31 December 2011)	Includes a targeted share of 5.75% biofuels in transport fuels for each EU member state by 2010.
Directive 2009/28/EC on the promotion of the use of energy from renewable sources	Adoption 23 April 2009; entry into force 25 June 2009.	Update to Directives 2001/77 and 2003/30. Setting legally binding target of at least 20% renewable energy (RES) by 2020. Also sets targets at member state level: a binding target for RES-E and obligatory targets for biofuels.
Revised renewable energy directive 2018/2001/EU ('the Renewable Energy Directive II').	Adoption 11 December 2018: entry into force 24 December 2018	Establishes a new binding renewable energy target for the EU for 2030 of at least 32%, with a clause for a possible upwards revision by 2023. Each EU country has to publish national energy and climate action plans to show its contribution to meeting the target and its policies implemented.

3 Guidance is defined in the European Commission guidance for the design of renewables support schemes. Commission staff working document SWD (2013) 439 final. One of the main aspects included is that support policies have to comply with State aid rules. For energy, these rules are defined in the Guidelines on State aid for environmental protection and energy 2014-2020, (2014/C 200/01).

The directives to support growth in the share of renewable energy in overall energy consumption were issued within the overall EU energy and climate strategy agreements. Table 2 provides an overview of these agreements and the targets set in these documents.

Table 2 EU energy and climate strategy

Strategy document	Date	Details
2020 climate & energy package	Approved by the Energy Council in March 2007 and agreed by the European Parliament in December 2008	EU-wide targets for 2030 and policy framework from 2021. Key targets for 2030: • 20% reduction in GHG emissions (from 1990 levels). • A 20% share for renewable energy. • 20% improvement in energy efficiency (compared to BAU developments). • 10% electricity interconnection.
2030 climate and energy framework	Adopted in October 2014	EU-wide targets for 2030 and policy framework from 2021. Key targets for 2030: • At least 40% reduction in GHG emissions (from 1990 levels). • At least 32% share for renewable energy. • At least 32.5% improvement in energy efficiency (compared to BAU developments). • 15% electricity interconnection.
2050 long term strategy	Adopted on 28 November 2018 as part of the strategic vision 'A clean planet for all'	Aiming for GHG emissions neutrality by 2050. With targets set for 2050 including: • 80 to 95% GHG reduction (from 1990 levels). • Increased share of renewable energy and energy efficiency improvement.
The European Green deal	Presented on 11 December 2019	Confirmation of the Commission's ambition to become climate-neutral by 2050. Includes a plan for decarbonisation of the energy sector.

Other related legislation includes Directive 2018/410/EC on the EU Emissions Trading System ('EU ETS': the first version of this Directive was adopted in 2003), Directive 2018/844/EU on the energy performance of buildings ('EPBD': earlier version adopted in 2010) and the Energy Efficiency Directive 2018/2002/EC (updated legislation: the first version of this directive was published in 2012).

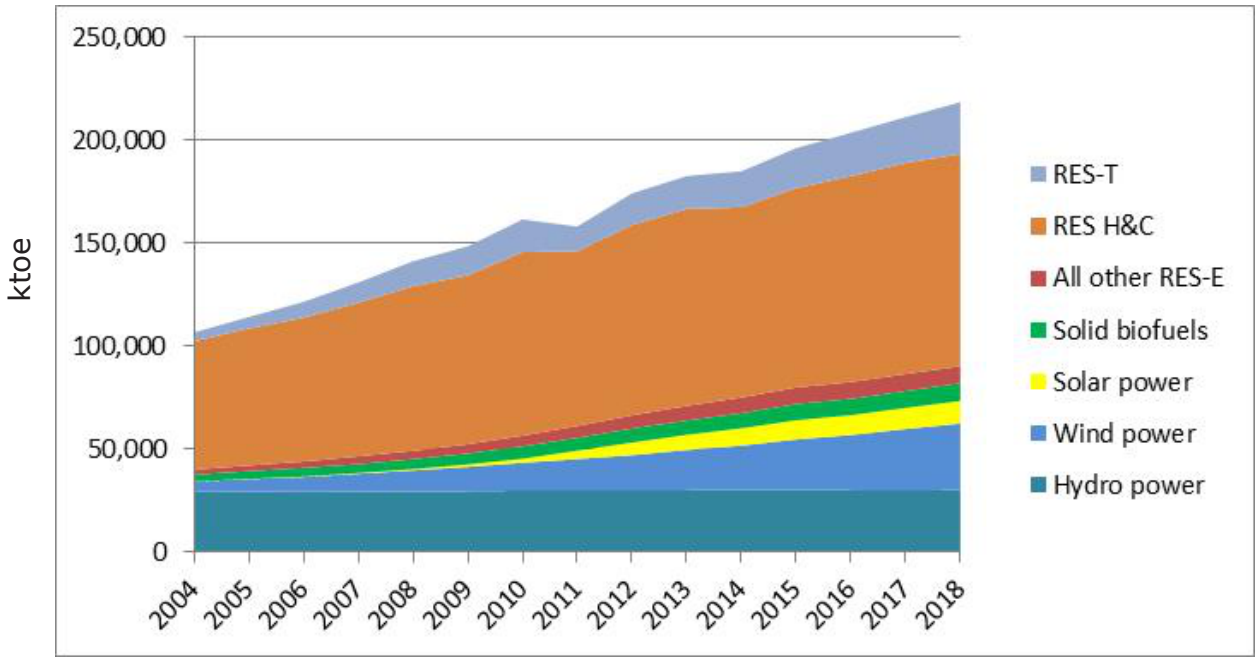
The way the legislative process is organised in the EU influences the legal basis for target setting and how strictly they are enforced. For those dossiers where there is full alignment between European Council and European Parliament it is easier to introduce strict target setting and declare the targets to be legally binding. However, if opinions differ compromises need to be achieved. This is for example illustrated in the development of target setting for renewable energy and the flanking measures defined. Whereas the 2009 renewable energy directive includes legally binding targets for each individual EU member state, there was insufficient support to include such

individual binding targets when the 2030 policy was formulated. A compromise was then reached that the overall target at EU level is binding and that EU member states should determine their national contributions to that target and provide updates on their progress. The corresponding legislation provides a suggested formula to calculate the national target, sets a minimum target for individual member states and includes a procedure that will be followed in case individual contributions are deemed insufficient for the collective achievement of the binding target at EU level. These procedures include the right for the European Commission to issue recommendations on country-specific targets as well as on defining country-specific policies and measures[4]. The legislation also includes an option to review and raise the EU target in the light of substantial cost reductions in the production of renewable energy, the EU's international commitments for decarbonisation, or in the case of a significant decrease in energy consumption.

2.3 Growth in renewable energy

Support for the growth of renewable energy in the EU has led to a steep increase in the RES share in overall energy consumption, as is illustrated in Figure 2. The share of renewable energy in total energy consumption reached 18% in 2018, which is on track to reach the 2020 target of 20% and has more than doubled the 8.5% share seen in 2004. The share of renewable electricity grew from 14.2% to 32% in the period 2004-2018, the share of renewable heat rose from 10.4% to 19.7% and the share of renewable energy in transport developed from 1.4% to 8%.[5]

Figure 2 Primary production of energy from renewable sources in the EU, 1990-2018



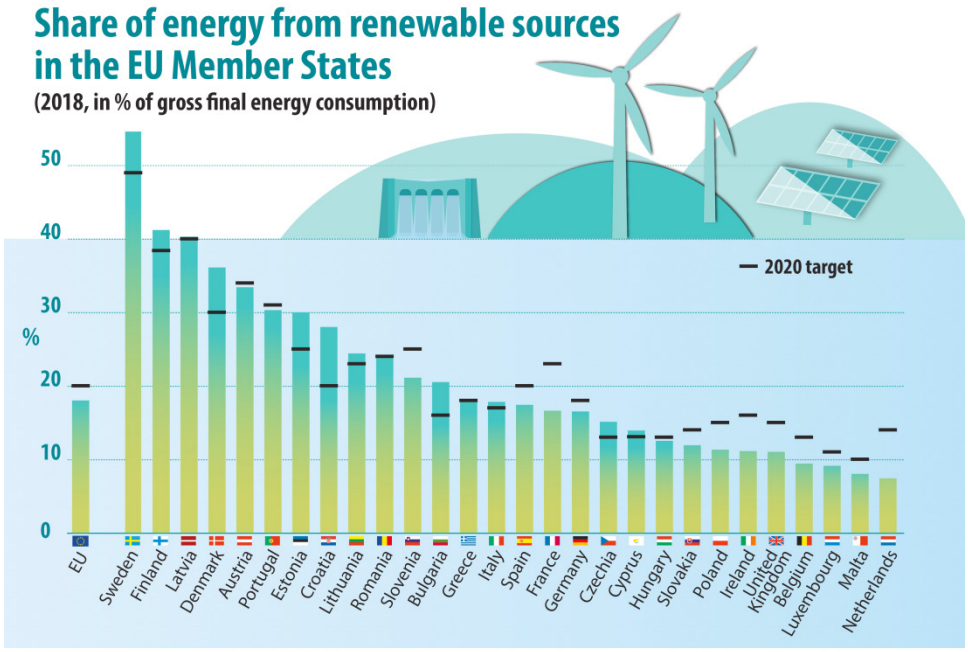
Source: Eurostat SHARES 2018 tool

4 Article 9 of Regulation (EU) 2018/1999 of the European Parliament on the Governance of the Energy Union and Climate Action.

5 Eurostat Shares tool, https://ec.europa.eu/eurostat/web/energy/data/shares, accessed 22 January 2020.

Figure 2 illustrates that the steepest growth is in wind power, followed by solar power and renewable energy in transport. There has also been a sharp increase in renewable heating and cooling. This is mostly heating sourced from biomass. Variation between the EU member states is high, influenced by differences in resource potential as well as political ambition and performance. Figure 3 shows the percentage of renewable energy in 2018 compared to the national target for 2020 for each of the EU member states. This illustrates that several countries are on target or ahead of their target while other countries have some way to go. The EU Renewable Energy Directive allows countries to use statistical transfers to reach their target, which means that countries overshooting their target can sell part of their achievements to countries falling short in 2020. Such a transfer has already taken place between Luxembourg (buyer) and Lithuania (seller) and between Luxembourg (buyer) and Estonia (seller). Others are likely to follow suit.

Figure 3 Share of renewable energy in individual EU member states in 2018 compared to their national targeted share for the year 2020



Source: Eurostat nrg_ind_ren

ec.europa.eu/eurostat

2.4 Key challenges and opportunities

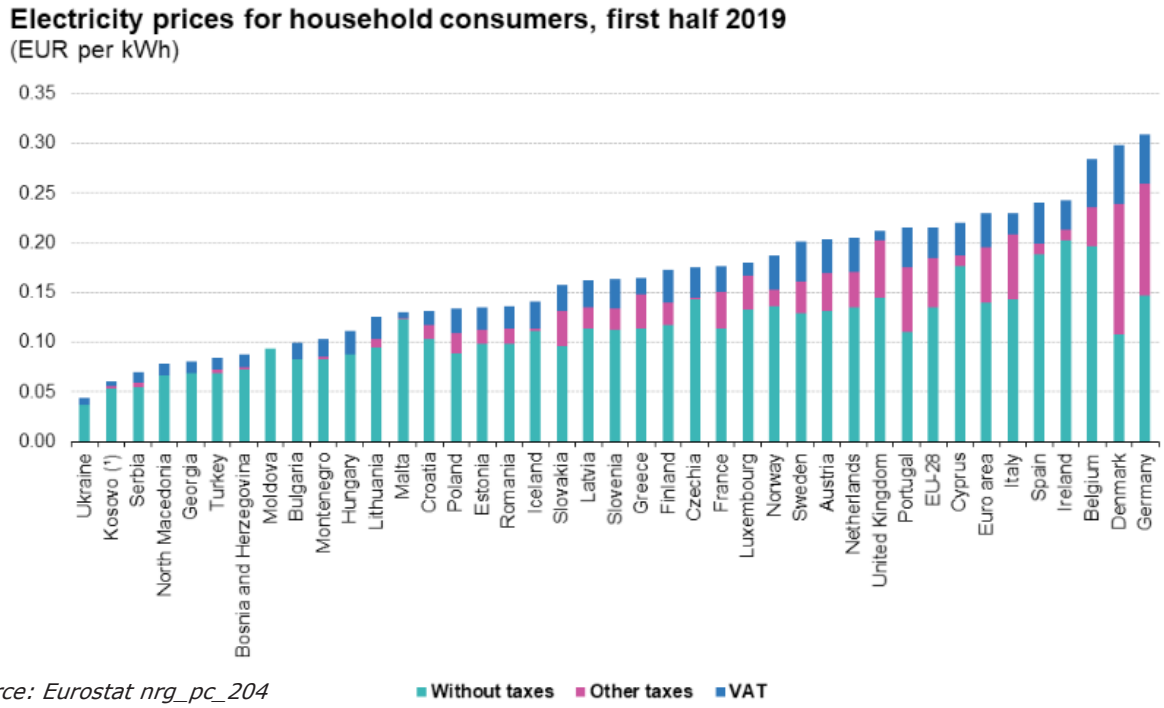
The strong growth in renewables and the expected further transition of the energy sector towards nearly 100% renewables brings about significant opportunities but also some key challenges.

European support for renewable energy is based on an anticipated set of benefits ranging from cleaner air, water and soil to improved living conditions. At the same time, the associated innovation in industry is linked with job growth. Statistics show that renewable energy currently accounts for 1.4 million jobs (in full-time-equivalent)

with an estimated related turnover of 154.7 billion euros.[6] Statistics also show that the growth in renewable energy, in combination with improved interconnections and a more integrated internal electricity market, have resulted in lower wholesale energy prices.[7] Prices in the EU however remain much higher than in most other countries and regions in the world. Relatively high consumer taxes and non-recoverable taxes for industry are the main reason for the higher prices, with charges for renewable electricity incentives being a significant portion of consumer electricity tax levels overall.[8] It is important to note that many of the higher costs incurred are legacy costs of the countries which first adopted renewable energy, such as Germany and Denmark. These countries invested in significant amounts of renewables when the costs of the associated technologies were still relatively high. Since these higher-cost projects are paid for over a longer period of time, these costs are still included in today's tariffs. More recent projects are deployed at significantly lower costs and therefore result in a reduced impact on tariffs. In addition, more and more projects are being introduced without subsidies (illustrated in section 4.4).

Figure 4 illustrates that there is a large variation in prices among the EU member states and surrounding countries; on average prices are lower in newer member states in Central and Eastern Europe and higher in countries with higher shares of renewable energy (such as Denmark and Germany) or where problems with interconnection and security of energy supply represent a greater challenge (such as Spain, Ireland and Belgium).

Figure 4 Electricity prices for household consumers in EU member states in the first half of 2019



Source: Eurostat nrg_pc_204

6 Eurobserv'ER (2019) 2018 barometer. https://www.eurobserv-er.org/18th-annual-overviewbarometer/

7 Data on energy price developments and comparison of price levels, taken from: European Commission – DG Energy, 'Study on Energy Prices, Costs and Subsidies and their Impact on Industry

8 Data on electricity prices for household consumers and non-household consumers, with indication of tax levels, taken from Eurostat (nrg_pc_204) and Eurostat (nrg_pc_205).

One of the main challenges to the strong growth of renewable energy is balancing this growth with other key objectives such as security of energy supply and affordability. In the EU this is addressed by a combination of actions, including:

- **Removing fossil fuel subsidies.** By removing subsidies for non-renewable energy the market distortions are removed, reducing the price difference with renewable energy. This in turn reduces the need for financial support for renewable energy, resulting in lower indirect taxes on energy consumers;

- **Improving cost-effectiveness of financial support to renewables.** While member states can choose what support to give renewables and which support instruments to use, support mechanisms have to be cost-effective and meet EC requirements. This has led to several changes in the design of policy instruments (as is elaborated in Chapter 5);

- **Integration of markets.** Integration of wholesale electricity and gas markets in the EU has brought about efficiency gains: markets that are coupled use generation capacity more efficiently, reducing the need for payments to reserve capacity. The EU supports the integration of electricity and gas markets through the Agency for the Cooperation of Energy Regulators (ACER) and the Council of European Energy Regulators (CEER). ACER is a legal EU body that ensures that market integration and the harmonisation of regulatory frameworks are achieved, for example by preparing guidelines for network codes or taking binding decisions on access and operational security for cross border infrastructure. CEER provides a forum where national regulators cooperate and exchange best practice to foster energy markets and empower energy buyers;

- **Grid strengthening and increase of interconnectivity.** Reliable grid capacity and interconnections make it easier to manage variable renewable electricity, because surplus production can be used elsewhere in the system and shortages can be overcome by importing from other regions. In addition, effective (inter-) connections lower the risk of shortages and blackouts and reduce the need for reserve capacity or new capacity. The EU is actively facilitating cooperation between national gas and electricity transmission system operators respectively via the European networks ENTSOG (for gas) and ENTSO-E (for electricity). Both networks develop network codes for market and system operation, draw up ten-year network development plans, provide regular information on supply and demand balancing, and deliver common operational tools to support security and reliability of the networks;

- **Supporting energy efficiency.** Improvements in energy efficiency reduce overall energy demand, and thereby lower the absolute deployment levels targeted for renewable energy. In addition, savings from energy efficiency improvements can be ring-fenced for investment in renewable energy projects. Jointly implementing energy efficiency and renewable energy policies may also provide synergy, for example in the electrification of processes that currently rely on fossil fuels. For example, the International Renewable Energy Agency (IRENA) has established that electric heating and cooling in buildings is four times more efficient than heating and cooling using a conventional gas boiler. In a further example, electric motors are significantly more efficient than internal combustion motors. When the electricity used for these processes is generated from renewable energy sources a synergy is achieved. The EU facilitates such developments by providing support for

the uptake of energy efficiency, by continuous improvement of energy efficiency standards for various product groups and by supporting electrification.

Countries that have actively implemented a range of measures to promote energy saving initiatives have seen their share of renewables grow rapidly. In other countries further action is still needed. For example, Poland and Spain still have a low share of electricity interconnection which is hampering the development of renewable electricity integration.

3. TARGET SETTING AND REGULATORY FRAMEWORK IN CHINA

3.1 Overall framework and target setting

The overall framework

The formulation and implementation of China's renewable energy development and related policy mechanisms are mainly provided under two frameworks. The first is the national energy strategy, which projects that renewable energy and other clean energy will be the leading players in the country's future energy structure, and which forms the basis of the strategy relating to renewable energy development. The second relates to the introduction of structural mechanisms and policies that favour renewable energy. China's Renewable Energy Law, passed in 2005 and amended in 2009, was established to formulate and implement various policies and mechanisms that provide direct support for renewable energy development.

The National Energy Strategy

China's renewable energy development is inseparable from its deepening and strengthening energy transformation strategy. In 2009, China first set targets for the share of non-fossil fuel energy in primary energy consumption, 11.4% by 2015 and 15% by 2020. In 2014, in the US-China Joint Statement on Climate Change, China proposed a plan for CO2 emissions to peak around the year 2030 or earlier, if possible. China stated its intentions for the share of non-fossil fuel in primary energy consumption to increase to about 20% by 2030. In the same year, China put forward its Four Revolutions and One Cooperation strategy, which aims to promote a revolution in energy production and consumption, namely:

- a revolution in energy consumption, reducing excess energy consumption;
- ensure energy supply, establishing a diversified supply system;
- improve energy efficiency using cutting edge technology;
- promote energy-related institutional reforms;
- strengthen international cooperation on all fronts.

For the implementation of above principles, NDRC and NEA issued a long-term Strategy of Energy Production and Consumption Revolution (2016-2030) in 2016. It set out China's aims to promote an energy revolution as a national policy of energy development, enhance energy security, introduce an energy supply revolution, establishing a clean and low-carbon energy system, promote energy welfare, enhance science and technology innovation, deepen reform of management, and strengthen cooperation, in order to achieve a fundamental transformation of energy production and consumption patterns. In this strategy, qualitative and quantitative objectives were also proposed, as shown in Table 3.

Table 3 Some of the targets for the Strategy of Energy Production and Consumption Revolution (2016-2030)

Targets	2020	2030	2050
Energy consumption	≤5 billion tce	≤6 billion tce	Stable
Clean energy	Main part of incremental energy (i.e. larger part of annual consumption growth)	Incremental energy	
Share of non-fossil-fuel in energy consumption	15%	20%	Over 50%
Share of non-fossil-fuel power in power production		50%	
CO_2 emissions per unit of GDP	Reduce 18%, based on 2015	Reduce 60-65%, based on 2015; peak CO_2 emissions	
Energy consumption per unit of GDP	Reduce 15%, based on 2015	Global average level in 2016	
Local energy supply ratio(*)	Over 80%	Keep a high ratio	
Energy management mechanism	Establishment of basic mechanisms and systems, including electric power mechanism, energy pricing mechanism, green financing and tax incentives	Modern energy market mechanism	Form a 21st century electricity market that is open to everyone

(*): The share of consumption that is supplied from local production

The Renewable Energy Law

The Renewable Energy Law came into force in 2006 and was revised in 2009. The Law established five core mechanisms to support the development of renewable energy:

- Total volume target mechanism, namely: setting a total volume target for different periods, defining the scale of development and utilisation of RES, and guiding industrial and technological development. The total may be implemented through the five year plans of the central and local governments at different levels;

- Mandatory grid-integrated mechanism / guarantee purchase mechanism: mainly for grid integration and consumption of renewable power. Additionally, access for renewable fuels and heating supplies to the vehicular fuel network and municipal heating systems, to ensure the development of various types of renewable energy. Energy sales will remain a monopoly industry;

- Feed in Tariff (FiT) mechanism for renewable power: By setting the electricity prices for various types of renewable energy generation offering cost-based compensation

to renewable energy producers, this type of policy mechanism could play a role in encouraging investment, reducing risks and expanding the market;

- Cost-sharing / cost-compensation mechanism: By clarifying the additional costs generated by renewable energy, the burden between different regions and enterprises could be evenly distributed;

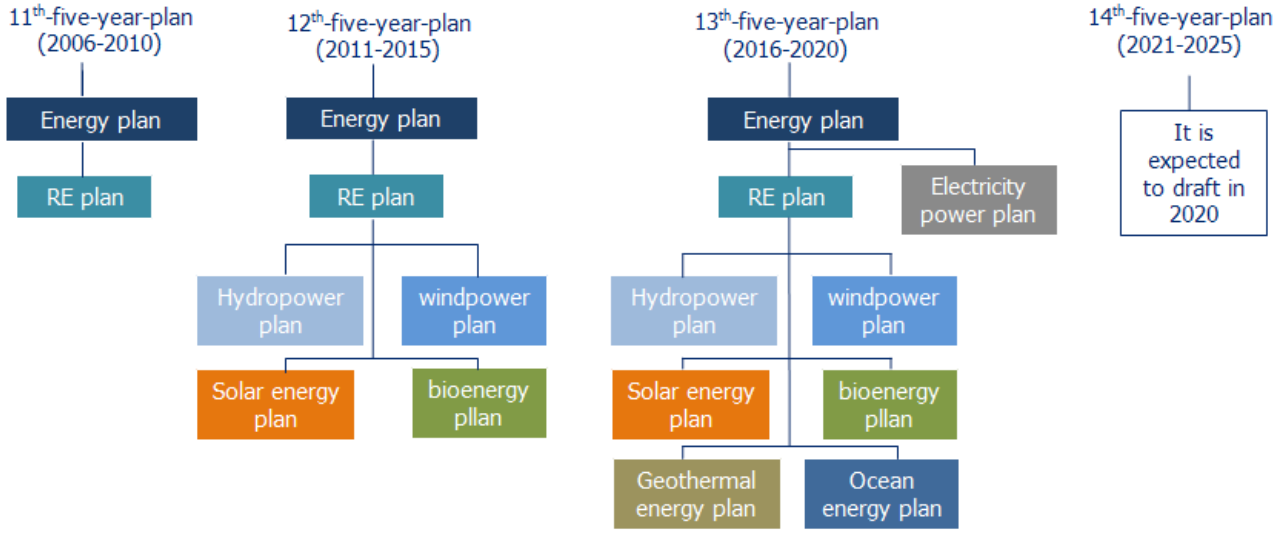
- Special fund mechanism: A special fund for renewable energy has been established for compensation, subsidies and other forms of financial support for renewable energy projects.

In addition, in terms of tax and financial policies, the Renewable Energy Law makes corresponding provisions, requiring the introduction of appropriate preferential policies to support the development of renewable energy.

3.2 Renewable energy planning system

Renewable energy first featured in the 11th five-year plan in 2009. This has been followed by the 12th five-year plan and the 13th five-year plan for renewable energy development, as well as the five-year plan for hydropower, wind power, solar power, biomass and geothermal energy. Fifteen provinces have implemented the 13th five-year plan for renewable energy (or new energy) development, while 16 provinces have set targets for renewable energy development in response to the 13th five-year plan for energy development or the 13th five-year plan for electric power development. Xinjiang and other provinces have also formulated separate development plans for some types of renewable energy. In addition, some local governments have formulated special plans for renewable energy demonstration zones and renewable energy construction bases. In general, local planning needs to be incorporated into the general principles and targets of national planning.

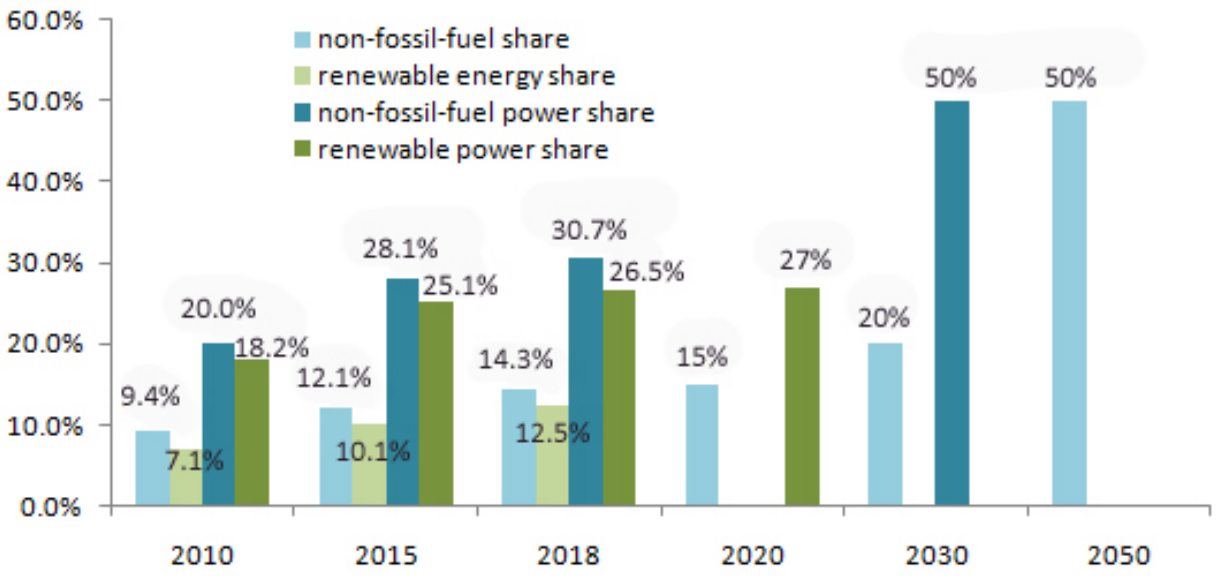
Figure 5 China's renewable energy planning system



3.3 Growth in renewable energy

Since the RE Law came into effect in 2006, China's renewable energy has entered a period of rapid development. The accumulated installed capacity of hydropower, wind power, PV as well as solar thermal utilisation is now ranked first in the world. The proportion of renewable energy in the energy network has risen, and the energy structure is becoming cleaner and more efficient. In 2018, the total utilisation of commercial renewable energy amounted to 580 million tce, accounting for 12.5% of China's total primary energy consumption, an increase of 5.4% over 2010. The absolute amount of commercial renewable energy in 2018 has already reached the target set by the 13th five-year-plan. The proportion of non-fossil fuel energy reached 14.3% in 2018, only 0.7 percentage points short of the target of 15% in 2020.

Figure 6 The proportion of non-fossil-fuel and renewable energy sources in China: status and goals



The development of renewable power generation capacity has been particularly effective. By the end of 2019, the total installed capacity of renewable power was 794 GW. This accounts for 39.5% of total installed capacity in 2019, up from 26.4% in 2010. The share of non-hydro renewable power capacity increased from 4.0% to 21.7%. In 2019, the total amount of renewable generation reached 1.867 TWh, accounting for 27.6% of total power generation in 2019, up from 18.0% in 2010. Renewable power has become the most important force in China's clean power transformation. Solar and wind power are the fastest growing sources of electricity in China.

Figure 7 Share of capacity of non-fossil fuel power sources in China

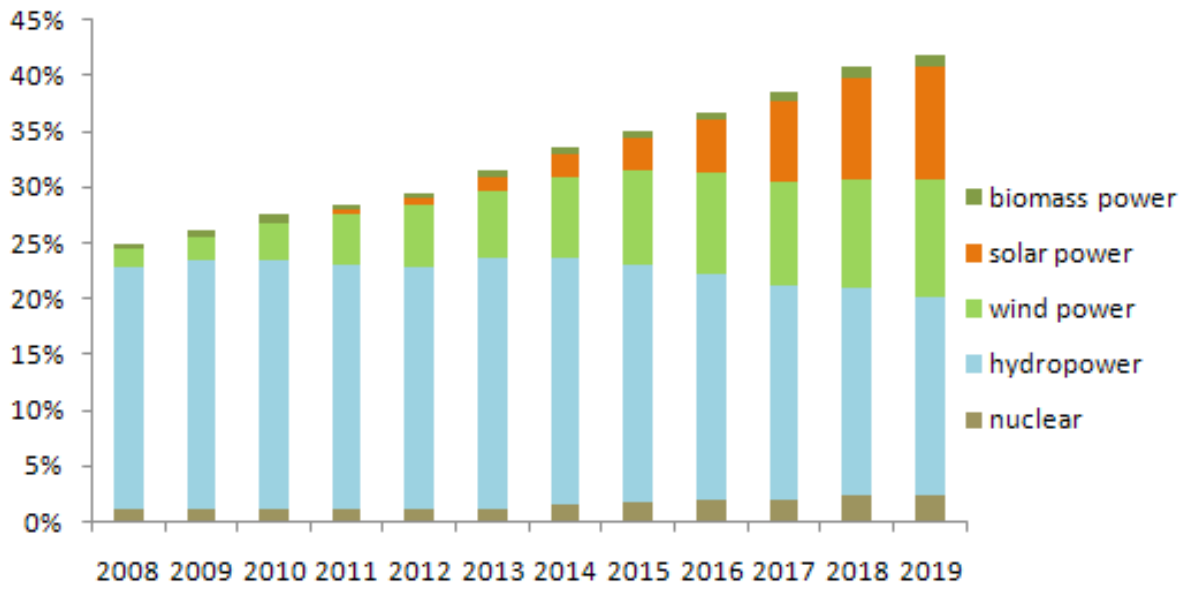
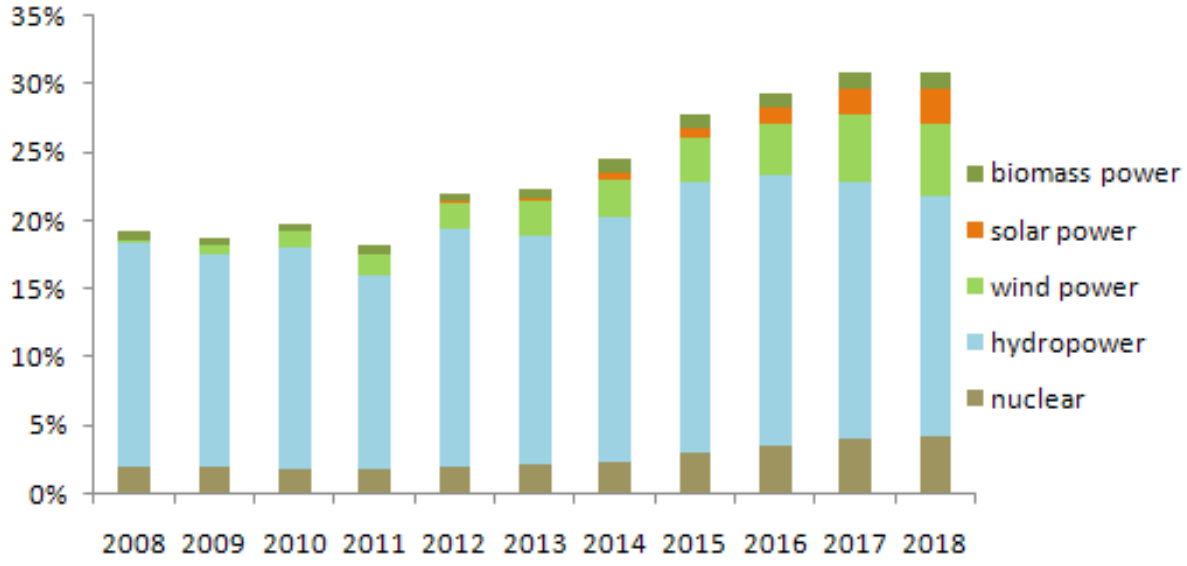


Figure 8 Share of power generation of non-fossil-fuel power sources in China



At present, non-commercial renewable energy (such as renewable energy heating, gas supply, solid fuel etc.) has not been included in the statistics for China's energy consumption. China's non-commercial renewable energy has also achieved sustained growth, from 44 million tce in 2010 to 84 million tce in 2018, with an average annual growth rate of 8.4%, but the growth rate of non-hydro renewable power is slower compared to the rest of the renewable power sector.

3.4 Key challenges and opportunities

China's renewable energy has developed rapidly. Prior to 2010, renewable energy was only seen as supplementary, but since 2016, it has become one of the main sources of incremental energy supply, especially in the field of power generation. In some provinces, renewable power has become the main source of electricity. However, renewable energy has also faced many challenges in the course of its development. China has adopted a series of policies and measures to solve these problems.

- Economic policies such as effective FiT and Feed in Premium schemes (FIP) overcome the high cost barriers in the initial stages of renewable energy development. China has implemented FiT and FIP policies for the various renewable power technologies, and has gradually reduced subsidies as the cost of renewable power generation has declined. The cost difference between renewable power and conventional power (mainly generated from coal) was offset by imposing a renewable energy surcharge. However, due to the rapid growth of renewable energy power and the failure to make timely adjustments to the renewable energy price surcharge, the renewable power subsidy increasingly fails to reflect the capital cost, which has had a negative impact on the renewable energy industry, especially for renewable energy enterprises. China has also adopted phased investment subsidies or product subsidies for renewable energy heating, liquid natural gas and solid fuel, as well as some favourable policies on taxation. The details will be listed and analysed in Chapter 4.

- An effective power grid infrastructure ensures integration and consumption of renewable power. China's power grids have developed rapidly in the past 30 years, and the demand for power in industrial facilities has played an important role in absorbing the power generated from renewable sources during the sector's dramatic growth. However, around 2015, some provinces and regions, such as Xinjiang, Gansu and northeast China, experienced a very high incidence of wind power curtailment, mainly caused by institutional issues. In 2016, China began a new round of power system reform, promoting the exposure of the power industry to market forces (marketisation). Trade in electricity accounted for 40% of total power generation sales in 2016. The market for auxiliary power services has expanded. China has initiated and scaled up measures to promote the flexible operation of existing coal power units, the construction of ultra-high voltage (UHV) power transmission projects, and the upgrading, transformation and construction of distribution networks.

China has also introduced comprehensive policy measures to reduce the curtailment rate of renewable power and improve the quality of development. In 2016, China introduced, which mandates a guarantee that grid companies purchase output from renewable generators. In 2019 introduced a requirement for all newly-installed renewable power projects to have power grid access as a precondition. Warning mechanisms for wind power construction and monitoring and evaluation mechanisms for solar power have been implemented since 2017 and 2018 respectively. These policies and measures have led to a year on year reduction in the curtailment rate for the 60GW of annual installed capacity of wind and solar power since 2017. The curtailment rates of wind and solar power fell to 4.0% and 2.0% in 2019 respectively.

As the pace of renewable energy development continues to accelerate, the challenges

and opportunities facing renewable energy are also expanding. In 2020,China is developing and drafting its 14th five-year plan for energy, electric power and renewable energy. In the next five years, China needs to maintain the stable expansion of the renewable energy market, support the renewable energy industry, and lay the foundations for the transformation of the energy market in order to its 2030 goals. The near-term challenges will be analysed in section 5.1.

4. SUPPORT FOR RENEWABLE ENERGY

Ever since the first directives to support renewable energy on the European market were adopted, the development of support mechanisms to further boost renewable investments have taken off across the EU. In some member states this was further encouraged by proactive national policies and measures. The choice of policy instruments in Europe on a range of elements is left to the member states, but the European Commission is actively monitoring them to ensure that choices made do not distort trade and competition on the European internal energy markets. To do so the European Commission has issued guidelines to clarify what it sees fit in terms of the types and levels of support provided. In China, the five-year plans and the renewable RE Law played a similar role in boosting the market. This section describes the types of support mechanisms used and the developments in the choices made both in China and the EU. In addition, it describes the developments in the use of corporate power purchase agreements (PPAs) to support renewable energy development. Details about the key drivers and impact of renewable energy support will be discussed in the following chapter.

4.1 Types of support mechanisms in Europe

Designing a policy mechanism to support renewable energy requires a careful balance between on the one hand ensuring that the developer of the project receives sufficient support to recover their costs with a reasonable return on investment and on the other hand verifying that the funds available for support are used in the most cost-effective manner. Since the risks vary significantly among the different types of renewable energy technology, it is often challenging for each type of investor in each specific situation to find the balance.[9] A wide range of support mechanisms and specific design choices have been used over the years, with governments actively sharing their experiences and learning from each other.

The following five types of renewable energy support mechanisms are widely used in Europe:

- Feed-in tariffs (FiTs);
- Feed-in premiums (FIPs);
- Contracts for Differences (CfD) or sliding FIPs;
- Green Certificates (GCs) with a quota obligation; and
- Investment grants.

In addition to these, other support instruments such as loan guarantees, soft loans, tax incentives, and net metering are also used, sometimes in combination with one

9 For example, the investment costs for hydro power and geothermal energy are substantially larger than for solar power. Network costs in mountainous areas are much higher than elsewhere and the costs of capital for private utilities are significantly greater than for pension funds.

of the main types of support instruments. Additional small-scale support is provided by means of so-called soft instruments, such as information campaigns. Since 2005 renewable electricity has also received indirect support from the EU Emissions Trading System (EU ETS) that increases the costs of electricity production from fossil fuels, thereby reducing the gap between fossil fuelled electricity production and production from renewables.

For each type of support scheme, the level of support may be set either through administrative procedures or a tender process. In the case of green certificate schemes the quota obligation sets the target, the (tradable) green certificates are used to monitor compliance and facilitate trade, if any, and a tendering procedure or administrative procedure is used to organise public support. The type of support affects the behaviour of RES developers, both in the planning and operation phase of the plant as well as during the tendering process. Table 4 provides an overview and comparison of these types of support schemes, indicating how a renewable electricity supplier receives its income, the level of market interaction for each support scheme as well as the risk level from the perspective of the supplier and society. In Europe, the use of tendering procedures has become the rule for many types of technologies and projects of a certain size.

Table 4 Overview and comparison of renewable electricity support schemes in the EU

Type	Income RES supplier	Market interaction	Risk level supplier	Risk level society	
				Risk of overspending*	Risk of overcompensation*
FiT	Fixed payment per kWh	None	Low – as income is guaranteed for entire contract period	None as payment levels are fixed	High as there is no relation between market and level of payments
FIP	Market price electricity per kWh plus fixed premium per kWh for renewable value	Yes	Higher – as supplier is fully exposed to market price developments	None as payment levels are fixed	Yes - if market prices increase (and risk of under-compensation when market prices decrease)
CfD/ sliding FIP	As FIP but premium variable, based on difference between awarded price and reference market price. Pay back of income when reference electricity price exceeds the award price.	Yes	Depending on calculation method price difference either: -Low as for FiT in case of short averaging period -High as for FIP in case of long averaging period	Higher risk of overspending in case of decreasing market prices	None as total level of compensation is capped
TGC/ obligation	Market price electricity plus kWh sales value of certificate	Yes	High – as supplier is fully exposed to market price developments	Low but prices may rise in case of shortness	Low but may exist in case of shortness of certificates
Grant	Payment for investment; no payment for supply	Yes	High – as supplier is fully exposed to market price developments	Higher as investors have incentive to overestimate capacity	Somewhat higher (see risk overspending) but lower than for FiT and FIP

** Risk of overspending refers to the risk of society paying more to achieve the targeted amount of renewable energy. Risk of overcompensation refers to the risk that the total compensation to the renewable project developer exceeds its investment cost, allowing for a reasonable profit on investment.*

In addition to the risks identified in the table it is also important to consider the risk of various types of policy instruments on the system adequacy, which refers to the ability to meet the load at all times. These risks are closely related to the level of market interaction for each type of support system: a low level of market interaction induces a high potential risk for system adequacy. With a low level of market interaction the supplier can optimise their production entirely based on their own needs and objectives and is not incentivised by any price developments on the market that may reflect potential imbalance. The more a supplier is exposed to market price developments, the more they will respond to potential imbalance and contribute to system adequacy.

Renewable heating and cooling has typically been supported mostly by fiscal incentives such as grants and investment subsidies, although some countries have also used FiT and FIP to support the more market mature renewable heating options such as biomass or geothermal heating.

4.2 Types of support mechanisms in China

As mentioned above, China's renewable energy support policies are mainly under the framework of the RE Law, and involve various renewable energy technology categories. As the development of the various sources of renewable energy is at different stages, the policy mechanism has been adjusted accordingly. The main direct policies are shown in the table below.

The mechanism of policy making in China is a vertical management mechanism. The National Development and Reform Commission (NDRC) and the National Energy Agency (NEA) are the national energy governance departments. The provincial Development and Reform Commissions are responsible for energy management in their regions. Most provinces have established their own provincial energy bureaus. In addition, there are six regional energy monitoring bureaus and 12 provincial energy monitoring offices. In the field of renewable energy, important policies and mechanisms are formulated by national energy governance departments, including strategy and planning, various management measures, and economic policies. Some policies are issued by national energy governance departments, and local governments may set their own detailed policies under corresponding principles. A typical example is solar price subsidies: NDRC is in charge of regulating the level of FiT (benchmark price before 2019). NDRC encourages local governments to set the local pricing subsidy or investment subsidy based on the FiT, which is financed from local budgets. For example, the Zhejiang province implemented a provincial solar FIP, and more than 10 cities in Zhejiang province at the same time introduced a municipal solar FIP. Renewable energy heating pricing policies are mostly regulated by local government.

Table 5 Main support policies of renewable energy in China since 2006

Type of policies		Detailed policies	RE technologies affected: year of formulation or implementation
Strategy		Middle & Long Term RE Development	All: 2007
		Mechanism of Target Guideline of RE Development & Utilisation	All: 2016-
Planning		11th five-year plan, 12th five-year plan, 13th five-year planfor RE as well as special RE technologies	All: 2007, 2012, 2016
Economic polices	Pricing	FiT Reduce tariff levels for wind and PV	Onshore wind: 2009-2020 Offshore wind: 2014- PV: 2011- Concentrated solar power (CSP): 2016- Biomass power: 2006-
		FIP Reduce FIP levels	Distributed PV:2013-
		Tender	PV (non-household): 2016- Wind:2018-
		Local (provincial and municipal) FIP	Mainly in PV: 2013-
		Product price subsidy	Biomass methane: 2006-
	Cost sharing/ compensation	Collect RE power surcharge	All renewable power: 2006-
	Raw material subsidy	Raw material subsidy	Biomass solid fuel: 2011-2013
	Investment subsidy	Investment subsidy	Household biogas or projects: 2006- BIPV (Golden Sun project): 2009-2013 Renewable building:2009-2012 Wind turbine special capital: 2008-2009 Green energy country pilot: 2011-2015 Rural hydropower (increasing efficiency and capacity): 2011- Ocean renewable special capital: 2011-
	Subsidy	Initial investment subsidy or product subsidy	Clean heat supply in north areas (geothermal, biomass, solar): 2017-2021
	Tax	Favourable VAT (implemented as a VAT refund)	Wind: 2001 PV: 2013-2018 Biomass: 2010-
		Favourable income tax	All
	Green power	RE green power certificate and trade	Wind & large PV: 2017-
Consumption of renewable power		Renewable power consumption guarantee mechanism	Renewable power: 2019-
		Renewable power guarantee purchase mechanism	Renewable power: 2016-
		Warning mechanism for wind power development	Wind: 2017-
		Monitoring and evaluation mechanism for PV market	PV: 2018-
National key actions		Concession bidding	Onshore wind: 2003-2009 Offshore wind: 2010 PV: 2009-2010 CSP: 2016
		PV poverty alleviation	PV: 2014-
		PV leading projects	PV: 2015-
		National Clean Energy Pilot provinces /cities/ districts	All: 2016-
		New Energy Cities	All: 2012-
		New Energy Micro power-grid pilot projects	All: 2015-
		Multiple energy complementary pilot projects	All: 2017

4.3 Development of support mechanisms

The actual choice of support mechanism varies depending on the technology, type of investors targeted and the project's risk profile, as well as specific local circumstances. Initially, support for renewable energy was driven by the need to find alternative or improved means of production, for example in response to the oil price shocks of the 1970s. The preferred choice for renewable energy support has typically been to provide subsidised research and development for specific technologies. In later years operational support mechanisms came in place.

Development in China

China's renewable energy support policies are not only diversified, but also adapted to the situation and requirements at the different developmental stages of the various renewable energy technologies. In particular, renewable energy pricing subsidies and subsidy policies are typical examples of the support provided by the government. An example follows of the wind power pricing policies that have been introduced.

(1) Direct feed-in stage: In the initial stage of development, the price for wind power was similar to that of coal power, and wind power was integrated directly into the power grid. In this period, (early 1990s - 1998), only a handful of wind power projects were installed per year. Since wind turbines were mostly imported with international aid, FiTs were low, and were designed only to cover the operational cost of wind farms. For example, the Dayancheng Wind Farm in Xinjiang province, which was built in the early 1990s, has been using tariffs that are basically the same as that of coal-fired power plants (less than 0.3 yuan/kWh).

(2) Price approval stage: In the wind power price approval stage (1998 - 2003), which is also the 'Warring States Period' of wind power pricing, the annual installed wind power capacity rose to over 100MW. Tariffs were approved by local pricing authorities and were reported to the central government. Wind power prices at this stage varied widely, with the lowest being comparable to those for coal-fired power plants. In 2001, the national pricing department issued a policy requiring that the tariffs for power generation projects should reflect the costs of the whole operating period.

(3) Bidding and price approval coexisting stage: This is the stage when wind power prices were set using a 'twin-track' process. During the period 2003-2005, annual installed capacity of wind power reached hundreds of MW. A step change towards the use of market based mechanisms is seen in the first cases of concession tendering for wind projects. Investors and developers of wind power projects were selected through a competitive bidding process. Central government organised the bidding for large wind power projects, and by the end of 2005, three rounds of bidding were completed. Tariffs were either determined under these concessions or through government-approved tariffs, depending on the size of the project. Government approved tariffs were applied to projects of less than 50 MW. The government used the tariffs approved for the concession projects as a guide for tariffs at similar sites.

(4) Bidding + price approval stage: In this stage, from 2006 to 2009, annual installations of wind generation reached several thousand MW. The first Renewable Energy Law significantly accelerated the growth of renewable energy in January 2006 with the introduction of related policies such as national renewable power pricing

and cost-sharing. Tariffs for onshore wind power projects were established by a tendering process, then standardised by provincial governments based on the bids submitted. China's first commercial offshore wind farm (Donghai Bridge Wind Farm – commissioned in 2010) also used a tendering process to establish its pricing. From 2009, concession bidding was used for offshore wind power projects.

(5) Benchmark FiT stage: From 2009, the annual installed capacity of wind power exceeded 10GW. In August 2009, NDRC introduced a feed in tariff for wind power generation, setting four different tariff categories depending on the region's wind resources. The benchmark FiT levels were 0.51, 0.54, 0.58 and 0.61 yuan/kWh. These sent a message of long term price stability to investors. At the end of 2015 and again in 2016, benchmark FiT levels were reduced for onshore wind power. In June 2014, NDRC formulated a benchmark pricing policy for offshore wind power.

(6) Benchmark FiT + trade power price + auction price + parity project stage: Since 2016, with the continuous promotion of a new round of power sector reform, wind power pricing has entered an era of multiple policy combinations, with the average annual installed capacity of wind power exceeding 20GW. Benchmark FiT has remained the core policy, and the onshore and offshore wind power benchmark FiT has continued to decrease gradually. Since 2016, in some regions a few wind power projects and on-grid wind power installations have entered the power trading market in order to establish a market price; wind power has also begun to participate in the auxiliary markets. Typical examples are the participation of wind power in the auxiliary market in northeast China, the direct trade between wind farms and large power end-users in Gansu province, and wind farms in north Hebei provinces providing otherwise curtailed power for heating supplies in winter. In 2019, China introduced new regulations that required the tariff for onshore and offshore wind power projects, apart from wind power grid-parity projects and distributed wind power projects, to be determined by auction. China began to implement non-subsidised wind power grid-parity projects in 2017, with 700MW of grid-parity projects arranged. In March 2018, NEA approved a wind power grid-parity project located at Wulanchabu in the province of Inner Mongolia, with a capacity of 6GW. In 2019, NEA released the first batch of approved grid-parity pilot projects for wind power and solar , approving 56 wind power grid-parity projects with a total capacity of 4.51GW, and nearly 15GW of solar.

(7) Subsidy-free stage. In 2019, NDRC issued a policy stating that from 2021 new onshore wind power will be completely subsidy-free. At that point, new funding mechanisms could be adopted. For example, the tradable green certificate may be introduced, which in conjunction with the renewable power consumption guarantee mechanism may play a role in improving the profitability of renewable power projects. However, the actual effect will depend on the fine details of the consumption guarantee mechanism and the green certificate mechanism. A FiT determined by auction is also a potential option for pricing, which may result in a tariff lower than that of coal-fired generation. Wind power could also be given direct access to the power market. None of these options are mutually exclusive.

The price evolution process of solar power is basically similar to that of wind power, except that investment subsidy policies were adopted in the early stage of market development (i.e. 2009-2012). In order to promote the manufacture and use of advanced solar technologies and products with high efficiency and relatively high cost, the PV Leader Program was implemented in 2015, and has been revised twice since then. At present, it is not clear when the subsidy for solar power will be completely withdrawn, but in 2019 the average subsidy for solar auction projects was only 0.065

yuan/kWh. Taking into account near-term predictions for technological improvements and industry upgrades, it is expected that solar power will become subsidy-free after the launch of the 14th five-year plan.

Figure 9 Benchmark FiT (before 2019) and guide FiT (2019 and 2020) of wind power in China

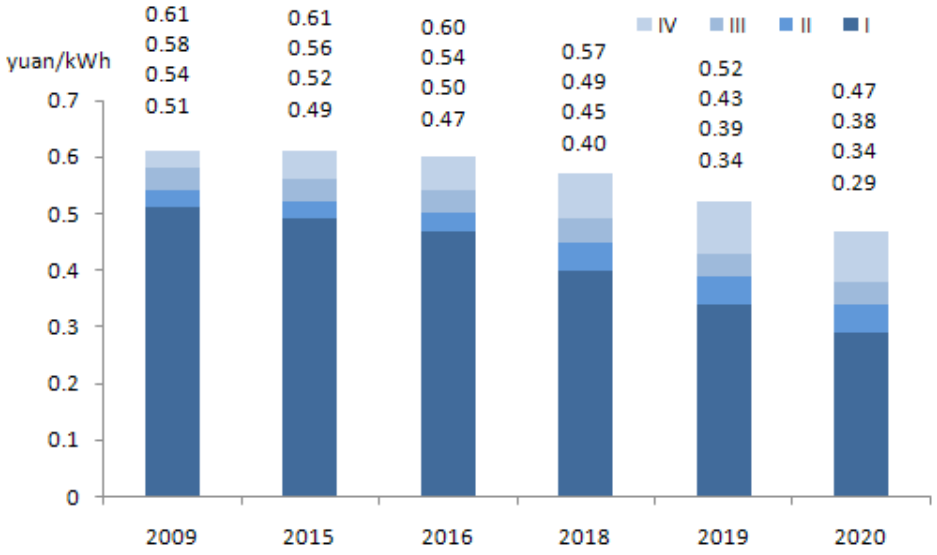
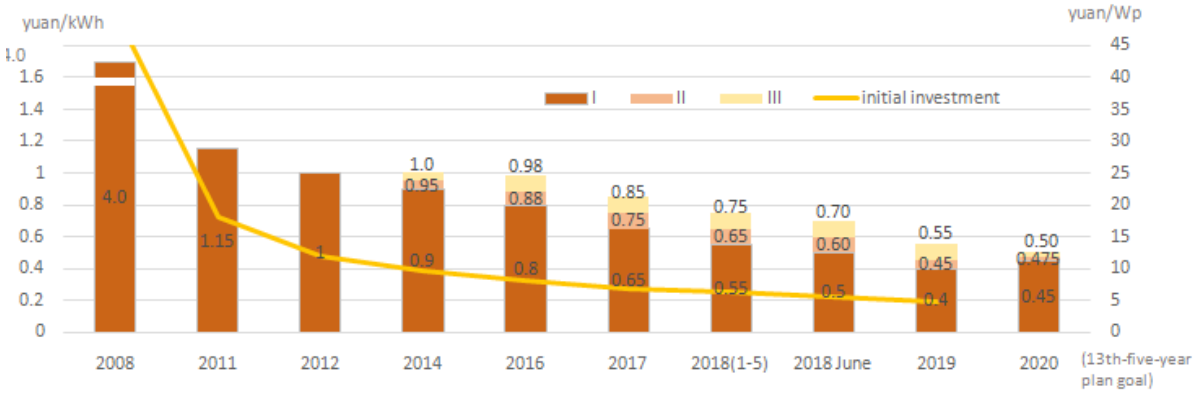


Figure 10 Benchmark FiT (before 2019), guide FiT (2019 and later) and target price in 2020 of PV in China



In summary, after 2020 China's support policies for renewable power will change from tariff and subsidy policy to three complementary mechanisms focused on the demand side, namely the guideline mechanism of renewable energy targets, a renewable power consumption guarantee mechanism, and the green certificate trading mechanism. New renewable power generation projects will have more direct access to the power market.

Evolution in Europe

In Europe, the Rio Earth summit (1992) marked a milestone in winning political support for renewable energy, with RES identified as a key element in the race to

address climate change. However, indicative targets, promotion programmes and soft coordination did not result in any significant uptake of renewable energy. Several European countries then decided to provide operational support in the form of state subsidies. The preferred instrument at the time was the Feed in Tariff (FiT) to incentivise the uptake of renewable electricity.

Support for renewables gathered pace after the adoption of the RES Directive (2001) and the Transport Biofuels Directive (2003). Both Directives required EU member states to define policies to achieve their targets. Most countries were still quite unfamiliar with support for renewable energy other than hydro power, but they then moved to introduce FiTs for a selected number of technologies. Usually the support was provided to those technologies that had the best potential on the market and that were closest to actual market introduction. The advantage of using FiTs in relatively immature markets is that they have a very low risk profile for the investor. FiT provides up-front certainty on the entire revenue stream and does not expose the investor to the market. Such certainty however can come at a cost for society as there is a significant risk of overcompensation (also called windfall profits) as the costs of the technology that is subsidised may come down and market prices may be lower than expected. In both cases the gap between the costs of renewable production and regular market prices means the fixed tariff is higher than necessary.

After a short time, the share of renewable electricity in the power market started to increase. At the same time market prices fluctuated more than expected and voices protesting overcompensation started to grow in volume. Governments responded by adapting the FiT levels to changing market circumstances. In 2003 the European Court of Justice ruled that 'services of general economic interest' did not constitute state aid, as long as the recipient had a public service obligation, the amount of financial support was not too high and the process was transparent. Renewable energy was considered to be one such service of general economic interest. In 2008 the European Commission adopted guidelines on state aid for environmental protection that allowed a higher subsidy for projects that achieved greater levels of environmental protection than required by European standards, or that achieved improvements where no European standards had been set. Renewable energy projects were included within the guidelines and therewith the guidelines encouraged member states to support renewable energy. This provided a further boost to the growth of renewable energy on the European market, which peaked around 2006 / 2007. In 2008 the global economic crisis started to hit Europe. While energy wholesale prices decreased due to reduced energy demand, several renewable energy technologies were considered to have become market mature and no longer in need of public financial support, at least not in all circumstances. When the 2009 Renewable Energy Directive came into force, it included national binding targets for the share of renewable energy to be achieved by 2020. This reinforced the need to implement renewable energy policies yet spend the available budgets wisely at a time of market uncertainty.

Two important documents from the European Commission were issued in response to such market developments: Guidance for the design of renewables support schemes, published in 2013[10]and Guidelines for environmental protection and energy, published in April 2014[11]. The guidance on support schemes detailed best practice

10 European Commission guidance for the design of renewables support schemes, Commission staff working document SWD(2013) 439 final, Brussels, 5.11.2013.

11 Guidelines on State aid for environmental protection and energy 2014-2020 Communication from the Commission 2014/C 200/01, OJ C 200, 28.6.2014.

when designing support mechanisms, with a focus on increasing the effectiveness of renewable energy support and integrating renewables support into the market. Its recommendations included phasing out FiTs and focusing on instruments that exposed renewable energy producers to market price signals (such as FIPs). The 2014 guidelines took this a step further by attaching more stringent conditions to renewable energy support mechanisms. For example, the 2014 guidelines required new support to be provided for a maximum of ten years in the form of a Feed in Premium on top of the market price, or through a system of tradable green certificates. The 2014 Guidelines also required that from 2017, technology-neutral competitive bidding processes should be the leading support mechanism to support renewable energy support. The 2014 guidelines banned investment aid for food-based biofuels (except for conversion into advanced biofuel plants) from 28 April 2014 and prohibits operating aid for food-based biofuels after 2020.

The state aid guidelines had a significant impact on the choice of renewable energy support on the European markets. Firstly, there was a major shift from FiT to FIP. This limited the risk of overcompensation while maintaining a lower price risk for renewable energy project developers. However, the revenue risk for a renewable energy project was higher as the project developer was exposed to market risks. In addition to the trend towards FIP, some member states implemented a system of green certificates in conjunction with a renewable obligation (RO) mechanism, in most cases targeting electricity suppliers and occasionally electricity distribution companies. Subsequently, there has been a clear trend toward competitive bidding systems, usually implemented in the form of an auctioning system. The advantage of an auctioning system for governments is that it reduces the costs of renewables support while maintaining control over the budget spent or the volume of renewable energy on the market, depending on the specific design choice made. By the year 2018 15 out of 28 member states had implemented competitive bidding schemes while eight further member states were planning or considering implementing such system.

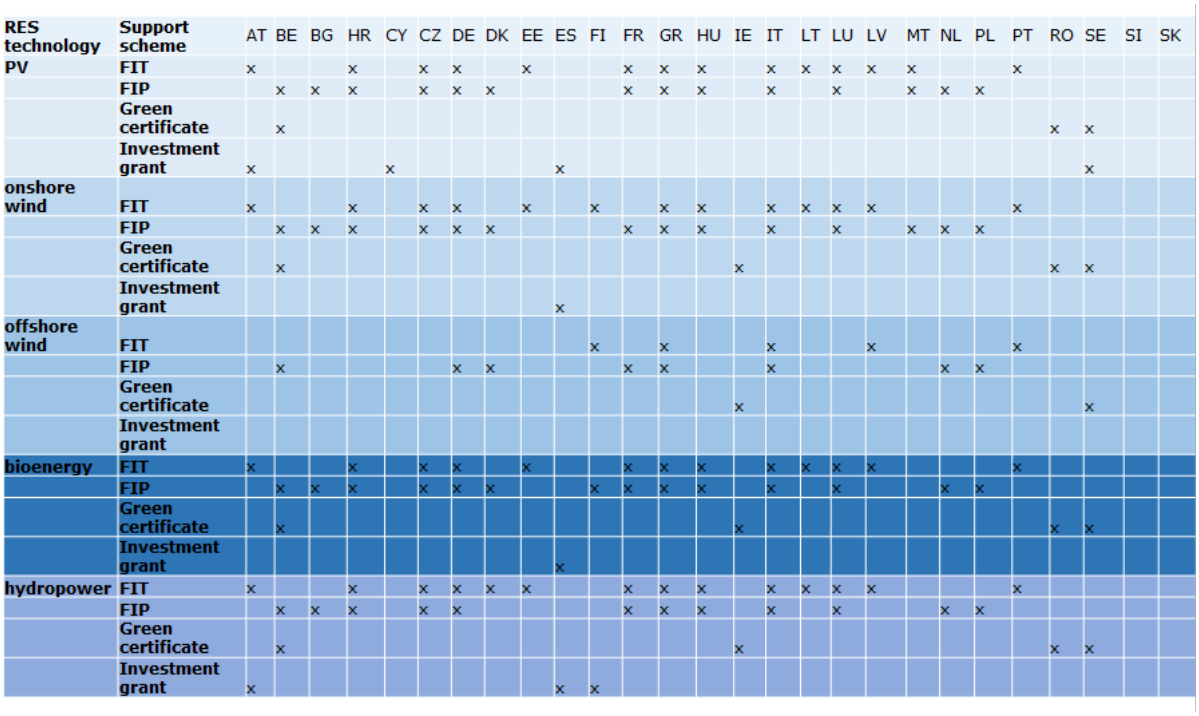
4.4 Evolution at EU country level

Within the EU each country can select its own set of policy support instruments provided it complies with the set of requirements formulated by the European Commission. Just as the countries differ in terms of their climate and geography, so the size and strength of renewable industries vary among countries according to social and political conditions. Therefore each country has made its own choice on the set of policy instruments implemented. Figure 11 provides an overview of the main choices made in the EU-27 which illustrates that most countries have a preference for FiTs or FIPs over green certificates and investment grants. It should be noted that more and more countries use auction systems to implement their FiTs or (primarily) their FIPs. Figure 11 also illustrates that countries have in some cases implemented specific instruments for individual technologies.

This overview illustrates that the selection of policy instruments differs in each member state, and that the selection may differ per technology within national borders. It furthermore illustrates that in the review period 2016-2017 16 countries used FiT schemes and 15 used FIP schemes. The FiT schemes are mostly used for smaller-sized installations. Tradable Green Certificate (TGC) systems and investment grants are much less popular. Further research (CEER, 2018) shows that the duration of support schemes varies significantly, between five and 30 years, as is illustrated in

Table 6 below. The duration within a country may vary according to the mechanism and the technology involved.

Figure 11 Overview of policy instruments for renewable energy support in the EU-27



RES technology	Support scheme	AT	BE	BG	HR	CY	CZ	DE	DK	EE	ES	FI	FR	GR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK
PV	FIT	x			x		x	x		x			x	x	x		x	x	x	x	x			x				
	FIP		x	x	x		x	x	x				x	x	x		x		x		x	x	x					
	Green certificate		x																						x	x		
	Investment grant	x				x					x															x		
onshore wind	FIT	x			x		x	x		x		x		x	x		x	x	x	x				x				
	FIP		x	x	x		x	x	x				x	x	x		x		x		x	x	x					
	Green certificate		x													x									x	x		
	Investment grant										x																	
offshore wind	FIT											x		x			x			x				x				
	FIP		x					x	x				x	x			x					x	x					
	Green certificate															x										x		
	Investment grant																											
bioenergy	FIT	x			x		x	x		x			x	x	x		x	x	x	x				x				
	FIP		x	x	x		x	x	x			x	x	x	x		x		x			x	x					
	Green certificate		x													x									x	x		
	Investment grant										x																	
hydropower	FIT	x			x		x	x	x	x			x	x	x		x	x	x	x				x				
	FIP		x	x	x		x	x					x	x	x		x		x			x	x					
	Green certificate		x													x									x	x		
	Investment grant	x									x	x																

Source: EC, 2019 with data on years 2016-2017 from CEER, 2018

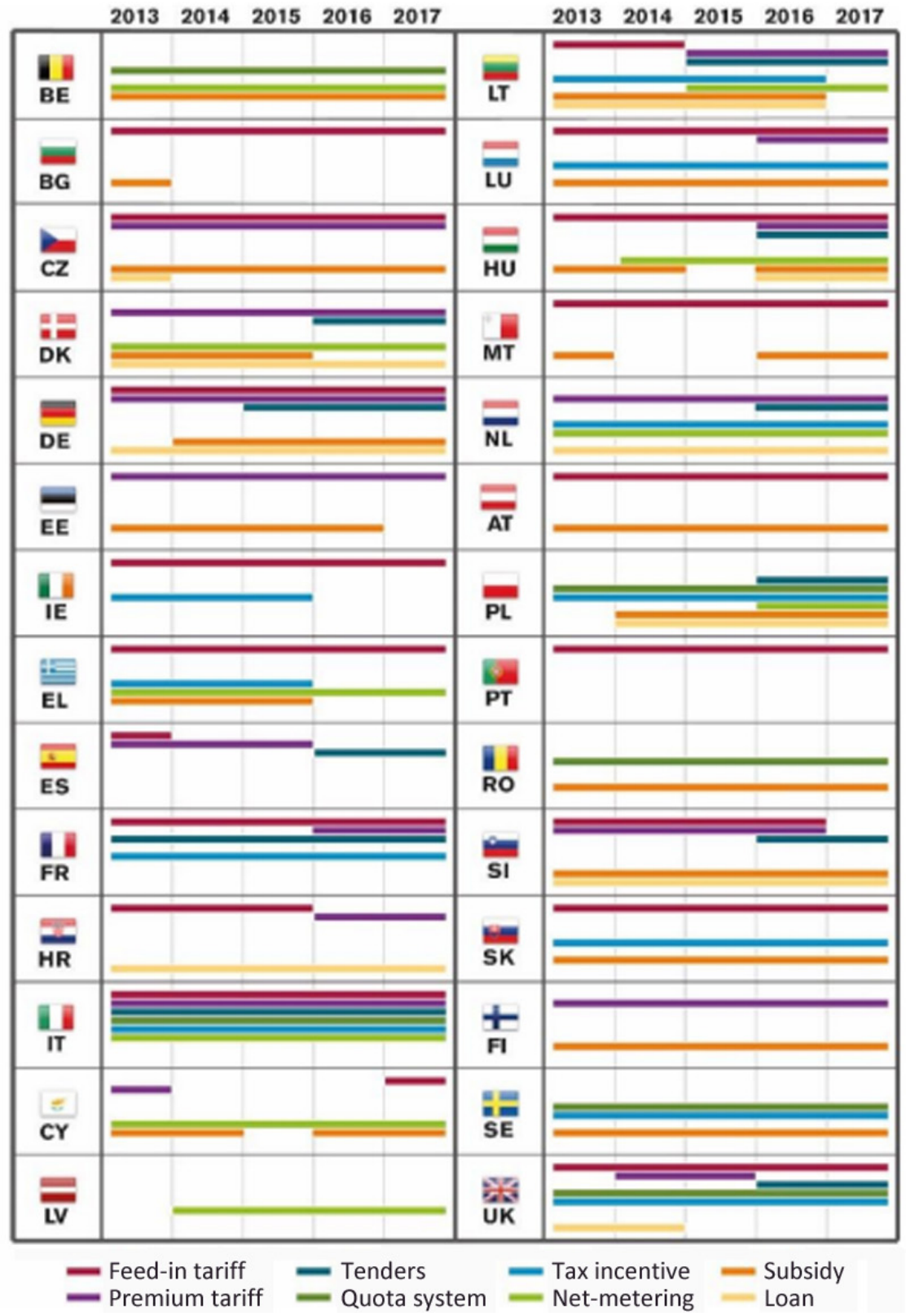
Table 6 Duration of renewable electricity support schemes in selected EU countries

Country/ type of scheme	Duration (years)	Country/ type of scheme	Duration (years)	Country/ type of scheme	Duration (years)
Austria (FIP)	13-15	Germany (FiT/FIP)	20	Malta (FiT/FIP)	6-20
Belgium (TGC/FIP)	10-20	Greece (FiT/FIP)	20-25	Netherlands (FIP)	8-15
Bulgaria (FIP)	12-20	Hungary (FiT/FIP)	5-25	Poland (FIP)	15
Croatia (FiT/FIP)	14	Ireland (TGC)	15	Portugal (FiT)	15-25
Czech Republic (FiT/FIP)	20-30	Italy (FiT/FIP)	5-25	Romania (TGC)	15
Estonia (FiT)	12	Latvia (FiT)	20	Spain (grant)	20-30
Finland (FiT/FIP/grant)	12	Lithuania (FiT)	12	Sweden (TGC/grant)	15
France (FiT/FIP)	20	Luxembourg (FiT/FIP)	15		

Source: CEER, 2018

Figure 12 illustrates some of the developments within countries over time as well as the use of several support instruments within a country.

Figure 12 Trend in use of support schemes for renewable electricity in EU-27 countries, 2013-2017



Source: Ecofys, 2019

Whereas Europe has already gained long-term experience in applying various types of support instruments to grow the share of renewable electricity in its power market, support for renewable heating and cooling has lagged behind, despite the fact that it represents around half of energy consumption in the EU. The 2018 Renewable Energy Directive recognises that the absence of a harmonised strategy at EU level, the lack of internalisation of external costs and the fragmentation of heating and cooling markets have been the main causes of the slow progress. Support for renewable heating and cooling has so far mainly focused on research and innovation in European funds. In addition, European support is provided for demonstration of innovative approaches and for the integration of sustainable heating and cooling infrastructure in EU cities. Non-technological support concentrates on overcoming barriers to the uptake of renewable heating and cooling solutions and on technical assistance to support the development of bankable investment projects, usually in the form of finance facilities. At country level a patchwork of support activities has been initiated, with choices heavily dependent on the availability of district heating (DH) systems, as illustrated in Annex 1. The table in this annex also lists the share of renewable heating and cooling in 2017 and the targeted share (if available) or projection for the year 2030.

The many developments in the design and implementation of renewable energy policy support in Europe are clearly illustrated in Germany. Germany is regarded as the leader in Europe with a long-term and consistent policy to support renewable energy. Its FiT system was introduced in 1991 and was the leading support instrument until 2016. Despite this stable framework, Germany has seen many changes in the specific design choices of the FiT and has used a combination of instruments to support its renewable industry. The main elements of the German's support system over time have been:

- 1991: introduction of the Electricity Feed-in Law which was the first FiT scheme world-wide. The tariff levels were defined as a fixed premium on top of the market price for electricity. The FiT was paid until renewable electricity achieved a 5% share of the German market. This provided the basis for a domestic market for the renewable energy industry.

- 2000: introduction of the Renewable Energy Sources Act or in German 'Erneuerbare-Energien-Gesetz' (EEG2000). The EEG2000 changed the tariff structure to fixed total tariffs for a period of 20 years, providing more certainty on total revenues for renewable producers. The fixed tariff levels were substantially higher than those of previous years, but were designed to reduce at regular intervals to keep pressure on the industry to seek cost reductions in technology development and implementation of renewable energy projects. The tariffs also differentiated between scale (lower FiT for larger plants) and electricity yield (higher FiT in low-wind areas). The EEG2000 also introduced priority dispatch and increased the potential share of renewable electricity to 15% in order to provide a longer-term horizon to the domestic industry.

- 2004: update of tariff levels to adapt to market developments. This included defining very favourable tariffs for bioenergy that resulted in a surge of bioenergy projects on the German market as well as exports to other markets.

- 2009: further update of tariff levels and introduction of the first elements to adapt the FiT to an FIP.

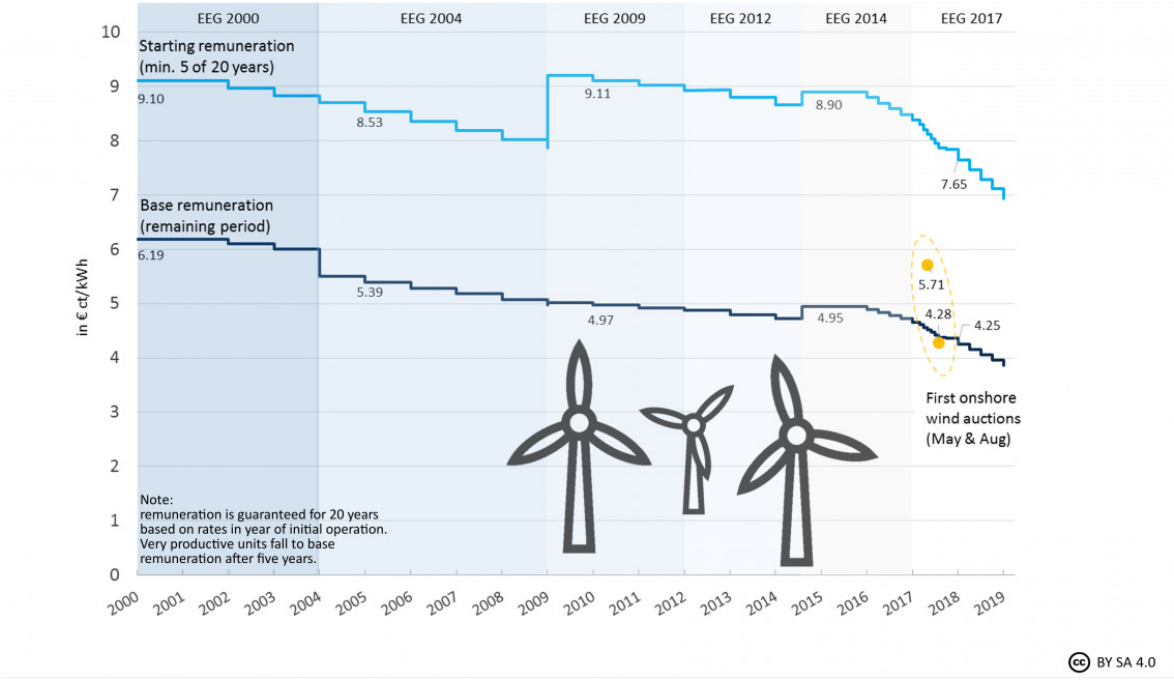
- 2012: significant tariff reductions for solar photo voltaic projects, onshore wind and bioenergy in response to large cost reductions on the market. In addition, the EEG2012 introduced special provisions for geothermal electricity and offshore wind.

- 2014: introduction of pilot auctions for solar energy and announcement of the phasing out of FiTs

- 2016: introduction of the auction system as the leading instrument for all technologies.

Figure 13 illustrates the tariff level changes for onshore wind energy in the various versions of the EEG. The figure also clearly illustrates that although the German FiT provides guaranteed support for a period of 20 years it does make a distinction between the starting level that is provided for the first period of plant operation (at least five years) and the remaining period of operation.

Figure 13 FIT tariff levels in Germany for onshore wind as defined under the various versions of the Renewable Energy Sources Act (EEG) in the period 2000-2018



Source: Clean Energy Wire using data from BNetzA 2017 and Windmonitor Fraunhofer IWES

As illustrated, the various versions of the EEG aimed to adjust remuneration levels to ensure cost reductions were adequately taken into account and thus reduce the risk of overcompensation. Upward changes were made in case the tariff levels were insufficient to trigger new investments. Alongside these developments, other mechanisms and regulations were implemented within the leading instrument of the FiT. For example, when FiTs were too low for the solar PV market to take off, additional support was provided in the form of soft loans in the period 2000-2003. When this program ended, and tariffs were still insufficient for further growth an interim PV Act was issued to increase FiT tariffs. When this additional support led to a boost in PV

beyond expectations, changes were made again in the form of interim Acts in 2010, 2011 and 2013 that reduced FiTs for solar PV.

Since the year 2000 the German FiT has been funded by a surcharge on electricity consumers, with high levels for household consumers and significantly lower levels for industry in order to protect their competitive position. The surcharge level for household consumers has increased over the years from a very low rate in 2000 – 0.05 €/kWh – to 6.88 €/kWh in May 2020 (which is 23% of total consumer prices).

Abstracting lessons learned from high-level overview and selected examples

Both in the EU and in China renewable energy support is a patchwork of a wide range of support schemes that may be specific to each type of technology, to each country or province, to a specific timeframe, and may include further variation such as for capacity size, type of investor and specific local circumstances. Analysing all the different choices made would provide an overload of information and would not help in identifying lessons learned. In this report we therefore provide a higher level overview of general developments over time and detailed insights into selected instruments at specific moments in time and for specific technologies. This approach aims to provide sufficient insights into how policy design can respond to varying circumstances and how improved insight into the functioning of policy instruments has helped tailor their design. The lessons learned are used to formulate recommendations on future policy design. Once the first choices on future policy design have been made, further detailed analysis can be initiated to focus on more specific design choices.

4.5 Policy at provincial and municipal levels in China

As mentioned in section 4.1, important policies and trading mechanisms in the field of renewable energy are formulated and implemented by national government energy departments. Some policies are issued by the national government energy departments to regulate the basic principles, and local governments may set and issue corresponding policies according to their local situations and requirements. Although guiding policies are issued at a national level, there is often a diversity of policy tools, a variation in supported technologies, and different approaches to support intensity among local governments. Moreover, policy adjustments are frequent as different technologies and industries develop, making this area difficult to track and summarise.

For example, after the state council issued Opinions on Promoting the Healthy Development of PV industry in 2013 (Guo Fa [2013] no. 24), provincial governments and dozens of municipal governments introduced subsidy policies to support the solar market. These local policies have been introduced successively since 2014, lasting for two, three or five years in different regions, and some have been extended after their

official expiry date. Some offered an initial investment subsidy, and some offered a power price subsidy. Nevertheless, in line with the reduction in solar costs, most of the local subsidy policies ended by 2019.

In January 2020, the Ministry of Finance (MoF), NDRC, NEA issued the 'Opinions on Promoting Healthy Development of Non-hydro Renewable Power' (Cai Jian [2020] no. 4), alongside an official explanatory document. It states that installed offshore wind power and solar projects in and after 2020 will not be given a price subsidy from the renewable energy fund, but that local governments should formulate their own support policy. The development of concentrated solar power (CSP) is mainly centred on the 'Three North' region of China. The industry anticipates that the provinces in this area will find it hard to implement economic support policies, which can only be explored from policies such as multi-energy complementarity and feasible power supply, and need to be combined with the construction of demonstration zones. Offshore wind power will be installed in the eastern coastal provinces, where there is a relatively developed economy and high electricity load. These 11 provinces have varying attitudes to the development of offshore wind power. As a result, potential means of support and intensity will also vary.

In 2017, in a key measure to solve problems of air pollution, China launched a pilot program of clean heating in winter in northern China. Renewable energy heating is one technology that is being looked at. In 2019, central government provided 15.2 billion yuan in subsidies to 43 cities in six provinces, accounting for about one third of the total sum required, with the rest coming from local governments. Taking Xiongan Zone in Hebei province as an example, for every 100 square meters of household heating that is converted from coal heating to electricity heating, the government gives a subsidy of 7,400 yuan, enterprises contribute 3,300 yuan, and farmers/residents pay 1,450 yuan. For annual heating fees, during first three years, government gives subsidies of 2000 yuan, and farmers/residents pay about 1000 yuan. After that period, all annual heating fees will be covered by the farmers/residents. The model of multi-level government subsidies and joint capital contribution by enterprises and individuals has rapidly promoted the transformation from coal heating to electricity heating, and from coal heating to natural gas heating, which has reached national targets. However, the subsidy for annual heating costs is set to be withdrawn. It is hoped, however, that having experienced clean heating in the first three years of the project, farmers and residents will have discovered the advantages and benefits of clean heating. The utilisation ratio and effects of subsidy withdrawal need to be monitored carefully.

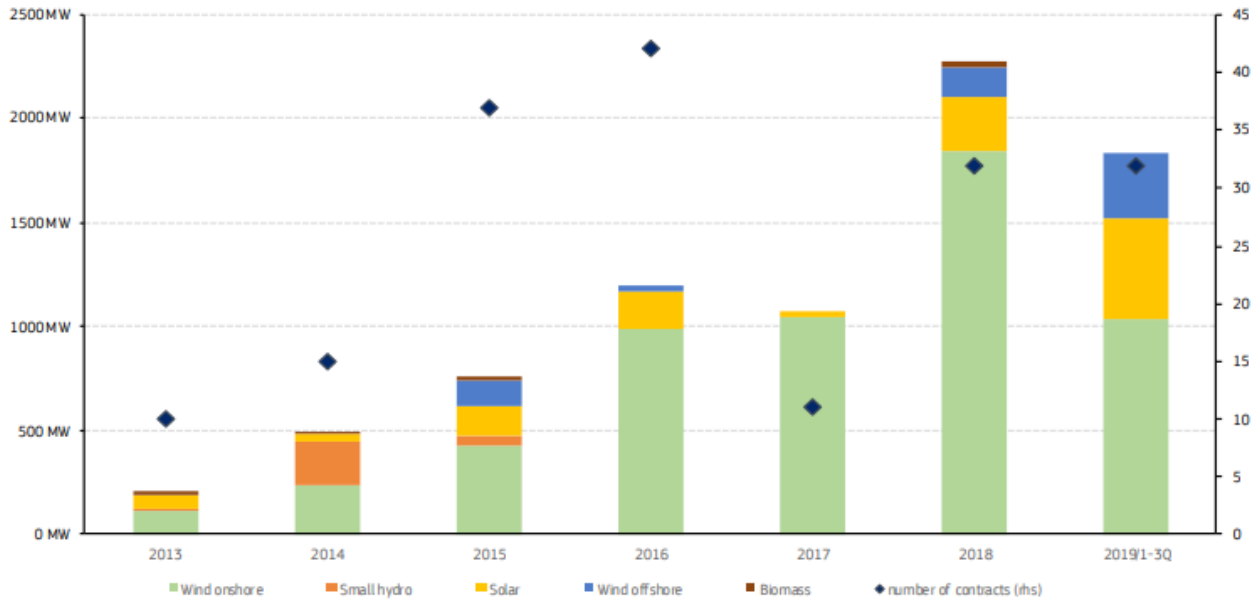
4.6 Corporate PPAs

A relatively new development is the use of corporate power purchase agreements (PPAs) for renewable energy. A PPA is a contractual agreement that is regularly used in several European energy markets to define the terms of the sale of electricity between a generator and a buyer. PPAs are typically long-term agreements at a fixed price. They provide both the buyer and the seller certainty regarding the amount and price of electricity sold. For renewable project developers, PPAs are an important mechanism to obtain competitive long-term project financing. Traditionally PPAs were agreed between a renewable generator and a utility for the sales of the electricity generated. Additional funding for the renewable value was then sought from public subsidies. In the case of a corporate PPA for renewable energy, both the electricity and the green value is sold to a corporate buyer. This buyer is motivated to improve

its environmental footprint by greening its electricity purchase. The corporate PPA offers the buyer certainty on the origin of its purchase and avoids contracting via a utility. The seller is motivated by the predictable revenue agreed in the PPA as well as by the insurance against market price swings. A corporate PPA for renewable energy is agreed without any public subsidy.

Figure 14 shows the evolution of corporate PPAs for renewable capacity in the EU, illustrating the annual amounts for 2013-2018 and the amount contracted in the period January-September 2019. The total amounts are still small, but the growth is promising. Apart from the year 2017, the table shows a continuous increase in the total volume contracted via corporate PPAs, reaching a total of 2.3 GW in 2018. Not surprisingly, PPAs are mostly used for wind projects that require a high amount of upfront financing and therefore require the certainty of revenue streams provided through PPAs. In addition, corporate PPAs are increasingly used to finance large-scale solar parks.

Figure 14 Evolution of the numbers and capacity of signed corporate PPAs in Europe

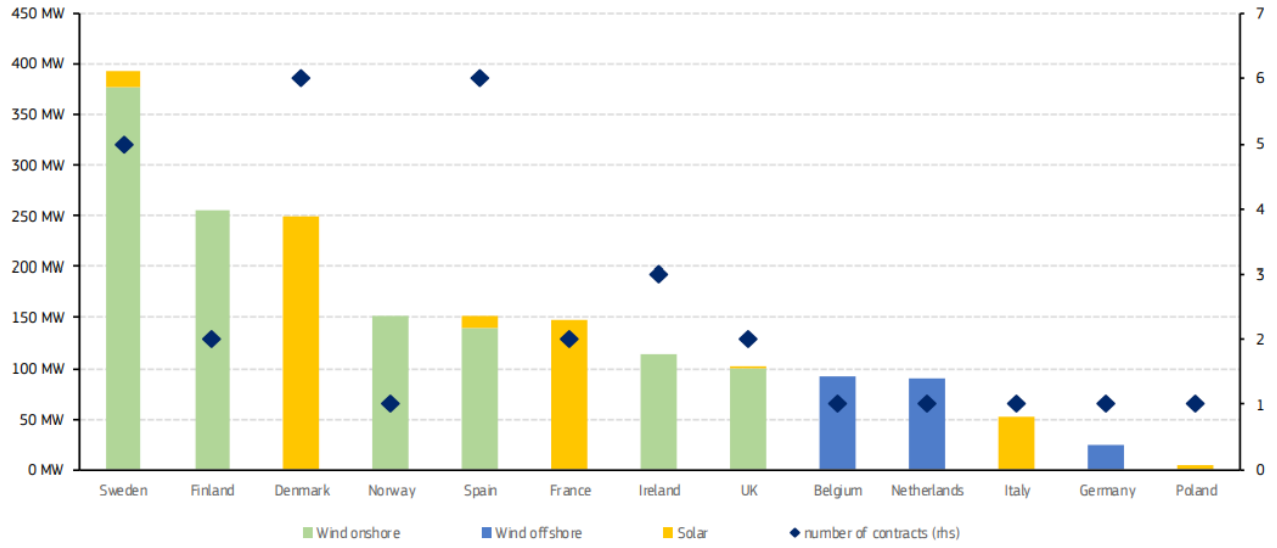


Source: EC, 2019 using data from BloombergNEF

Analysis by the European Commission shows that corporate PPAs for renewable energy are being signed in a growing number of countries, from three countries in 2013 to 13 countries in the first nine months of 2019. Figure 15 demonstrates that currently the market is still highly concentrated in a few countries, with 56% of the contracts signed in just four of the 28 EU member states. However, both the volume and spread are expected to rise strongly in the coming years, as grid parity is reached for more projects and public support schemes are announced that reduce state subsidies. Furthermore, more and more companies are shouldering sustainability commitments

or are being legally required to publish statistics showing their renewable energy or electricity consumption. Both these factors are expected to provide a further push towards the use of corporate PPAs for renewable energy (EC, 2019).

Figure 15 Country-by-country overview of corporate PPAs signed in January-September 2019



Source: EC 2019, using data from BloombergNEF

5. RENEWABLE ENERGY SUPPORT: LESSONS, DRIVERS AND IMPACT

All around the globe renewable energy is seen as the main factor that will help achieve GHG emission reduction targets. The signatories to the 2016 Paris Agreement agreed upon ambitious greenhouse gas emission reduction targets which will require a further steep growth in the use of renewable energy. This poses challenges that need to be addressed. This section discusses these challenges as well as the key drivers behind them and the lessons learned to date.

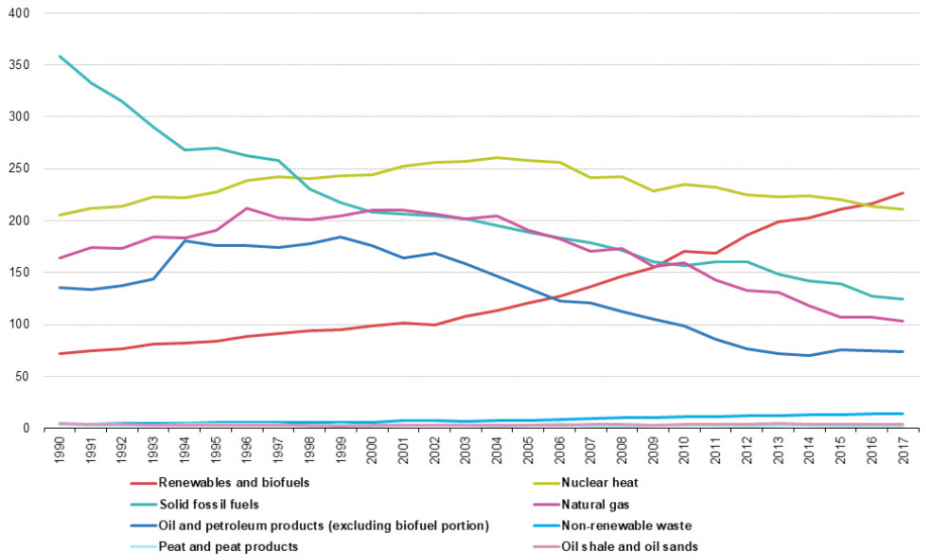
5.1 Political and societal perspective

Societal needs and preferences strongly influence the need for renewable energy support and the specific design choices. Section 3.3 discussed how the sector developed from one that was looking for alternative or improved means of energy production in the 1970s, to one that has, since the 1990s, become a key player in the global search for ways to address climate change. In addition, there are various local forces leading to the adoption of renewable energy, such as the need to reduce import dependency, stimulating local economies, increasing competitiveness (and thereby lowering energy prices for consumers), and reducing local external effects such as air pollution. The preferred choice of renewable energy support has developed alongside societal preferences.

In Europe, ambitious target setting and an overall legal framework have provided a strong impetus for growth in renewable energy, as was illustrated in the previous sections. Differences in national ambition and local acceptance - often influenced by differences in the existing energy system and national renewable energy potential – have strongly influenced variations in the pace of uptake of challenging targets and the strength of stimulating policies among EU member states. For example, countries with a domestic coal industry such as Poland have been more reluctant to adopt renewables than countries that were mainly dependent on fossil fuel imports, such as Denmark. Countries with a high potential for renewable energy or which have seen popular support for green policies, such as Austria, Germany and Sweden, have been more proactive in implementing effective policies than other countries.

The ambition to promote fuel diversification in Europe’s energy supply has certainly delivered results, as is illustrated in Figure 16. However, Europe still has a high energy import dependency of around 55%, reflecting its reliance on imports of crude oil and natural gas. Further growth in renewable energy supply is expected to have a significant impact on Europe’s import dependency, with the share of renewable energy targeted to increase from 18% in 2020 to at least 32% in 2030 and 75% in 2050. The transformation of the power generation sector is the key element in this, with a targeted increase to 97% in 2050.

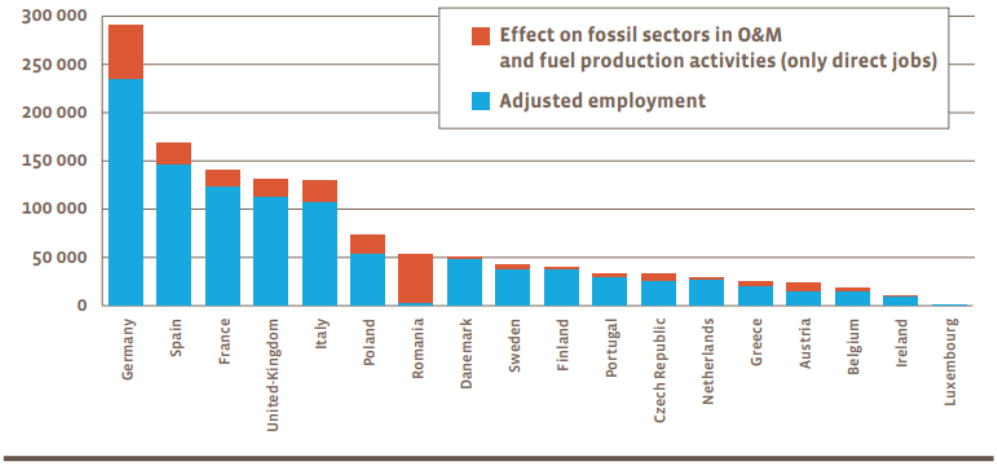
Figure 16 Primary energy production by fuel in EU-28, 1990-2017



Source: Eurostat nrg_bal_c

In terms of employment, the promotion of renewables is delivering positive results in Europe. The number of jobs within the renewable industry is steadily developing over time and increasing in nearly all EU member states. Given that the growth in renewable jobs is partially displacing employment in the fossil fuel industry the net employment effects are lower, especially in countries that produce fossil fuels (mostly coal). Figure 17 shows the gross employment within the renewable industry in the year 2017 in 18 European countries as well as the net or adjusted employment effect, taking into account displaced employment.

Figure 17 RES employment and displaced employment in fossil sectors for 18 European countries



Source : EurObserv'ER 2018. Note: The effect of renewables on operation, maintenance and fuel production activities in fossil fuel sectors. The impact of renewables on investment-related employment and indirect employment is not considered.

Evidence shows that EU target setting to support renewable energy has been an important driver and has paid off in terms of diversification and bringing new employment opportunities. In this, the combination of formulating national targets, the obligation to formulate supporting policies at a national level and to report on

progress to targets and further planned support have provided a significant boost to the growth in renewables and the development of a European renewable industry.

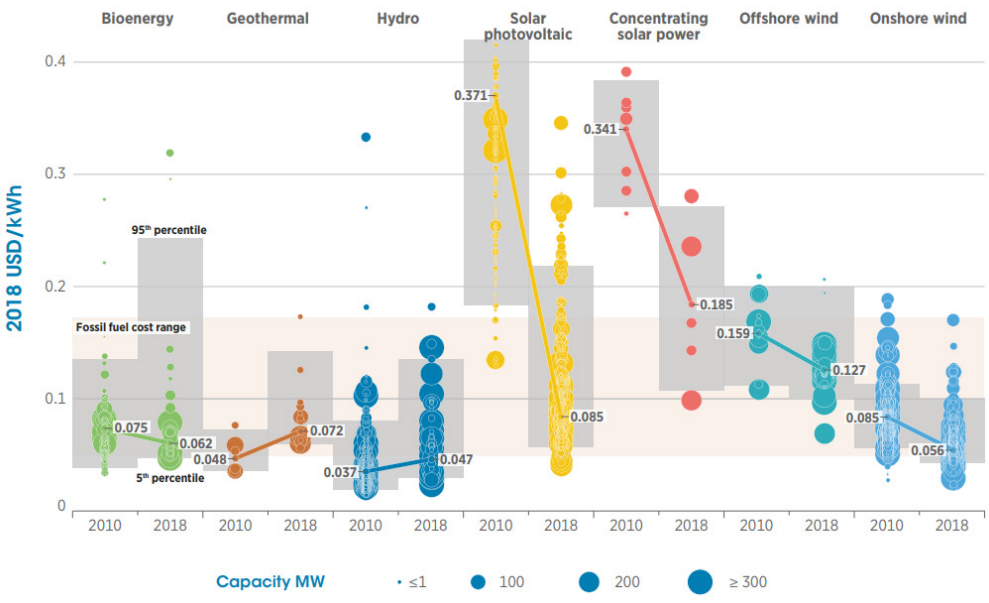
5.2 Technological perspective

From a technological perspective, the main force behind renewable energy support is the need to support technological innovation and to reduce the costs of renewable energy technologies, the ultimate aim being to be fully competitive without any public subsidy.

Data from the International Renewable Energy Agency (IRENA) (2018) illustrate that significant cost reductions have indeed been achieved for various renewable energy technologies. Figure 18 shows that the levelised cost of electricity has plunged for both solar and wind energy over the period 2010-2018. Costs of bioenergy projects also fell slightly in the same period. The Figure shows an increase in the costs of geothermal power and hydro power which could relate to more stringent environmental regulations that make new plants more expensive. It should however also be noted that the costs of these projects are very site specific, that the number of geothermal projects is small, and that for hydro power the sites with the most potential have already been exploited so new development is moving to sites with less favourable conditions. The Figure also shows that apart from concentrated solar power (CSP) the costs of these renewable electricity technologies can all compete with those of fossil fuels, and therefore depending on the circumstances new renewable plants can compete with new fossil fuel power plants. Cost developments in the EU have shown similar trends over the past few years (EurObserv'ER, 2018).

Renewable energy is understood to have positively contributed to these cost reductions, along with achieving economies of scale and innovations that have led to increased efficiency.

Figure 18 Global levelised costs at utility-scale of renewable power generation technologies, 2010–2018

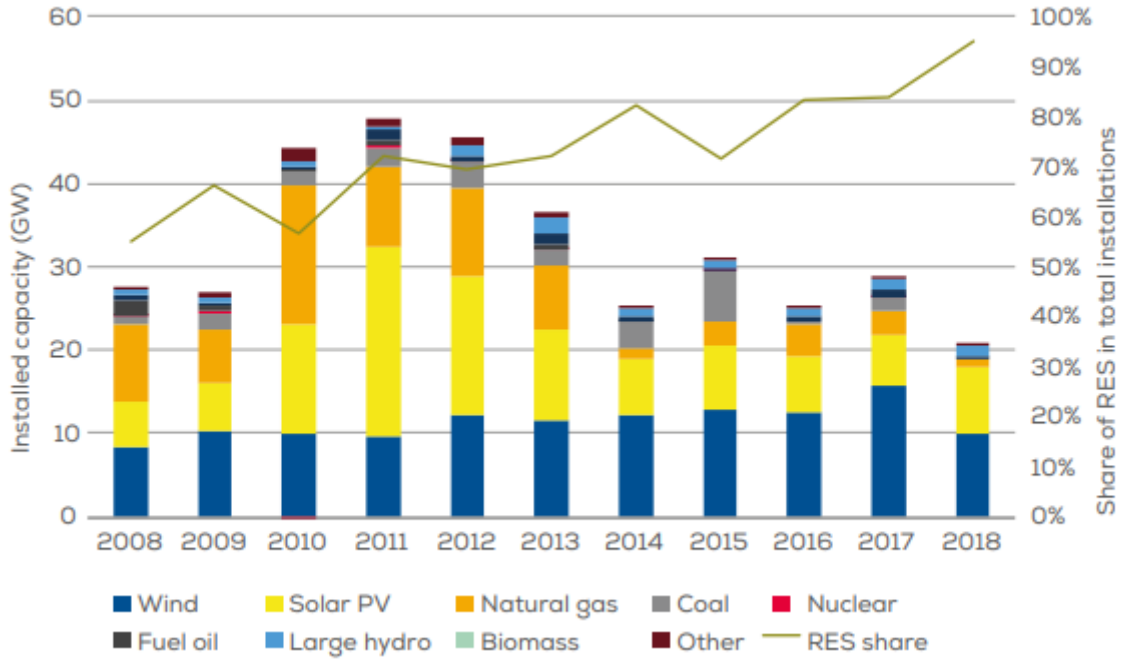


Source: IRENA, 2018

5.3 Market perspective

From a market perspective, the main drivers for renewable energy are that renewables offer the ability to strengthen the existing energy markets as well as provide new opportunities for market operators and investors. The previous sections have illustrated that the share of renewable energy in the European energy market has increased over the last years. The new investments on the European market (Figure 19) demonstrate that the share of renewables in total energy investments increased steadily from just over 30% in 2008 to nearly 100% in 2018. The vast majority of these new investments were in wind and solar energy.

Figure 19 Development in newly installed capacity in Europe and share of renewables in new capacity investments 2008-2018



Source: Platts, SolarPower Europe, WindEurope

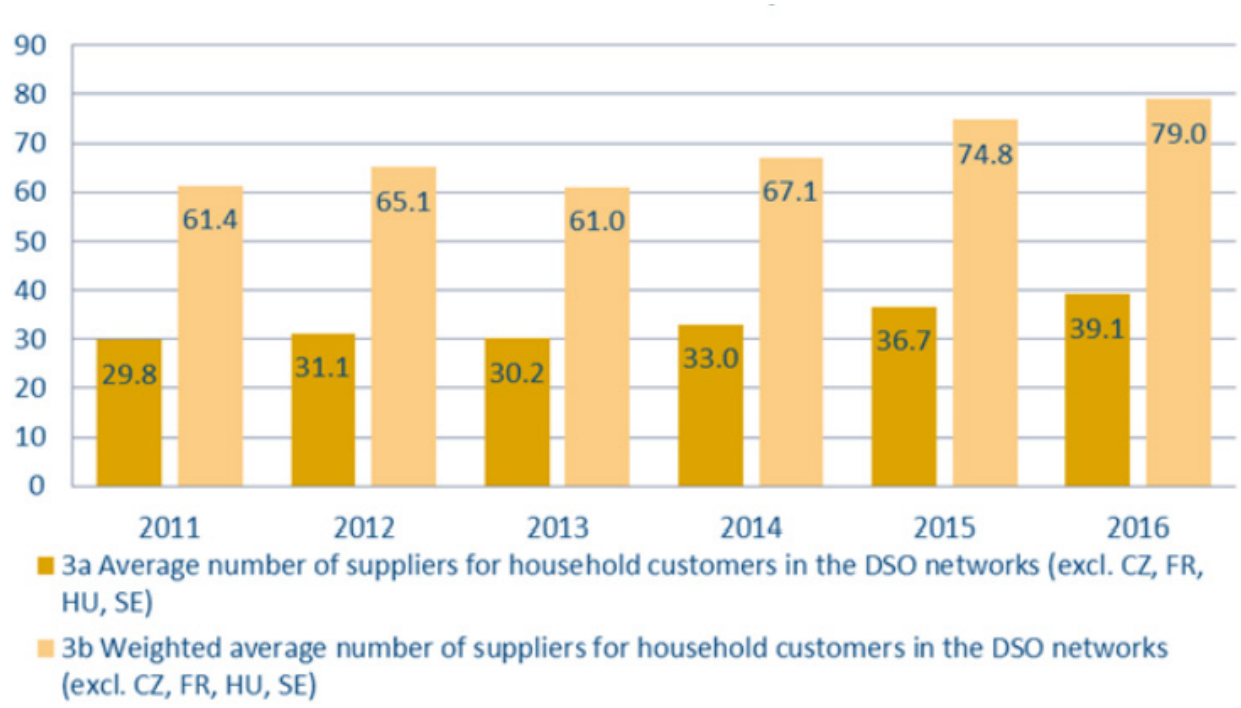
Investments in renewable energy are expected to continue increasing steadily in the coming years, given the climate and energy targets defined for the year 2030. The European Commission estimated that in the period 2021-2030 an annual investment of 260 billion euros is needed to achieve the EU's targets.[12]

The growth in renewable energy has positively contributed to increased competition on the European energy markets. Figure 20 illustrates the growth in the average number of suppliers for household consumers in the period 2011-2016. Spurred on by the liberalisation of energy markets in Europe, companies have developed new products, mostly in the area of renewable energy and – to a smaller extent – energy

12 https://ec.europa.eu/energy/en/data-analysis/energy-modelling/euco-scenarios. Figure derived from the EUCO3232.5 scenario.

efficiency. In recent years, increased competition has led to mergers and acquisitions, a development that has slowed the growth in the average number of suppliers. Yet competition on the European energy markets, especially on the electricity market, remains fierce and this continues to benefit consumers.

Figure 20 Development in average number of suppliers for household consumers in DSO networks 2011-2016



Source: CEER 2017

5.4 The consumer perspective

Renewable energy brings many additional values for consumers, including:

- Renewable energy offers a clean source of energy production with positive health benefits for society.
- It provides energy with low marginal costs, leading to lower energy bills.
- It is often more labour intensive than fossil fuel-based energy production, offering more employment opportunities,
- It provides opportunities for investors and project developers other than the existing large utilities to enter into the energy market, which means that consumers can choose between more suppliers.
- It offers consumers the opportunity to produce and potentially sell their own electricity. This may prove a valuable option for those consumers who value self-sufficiency and security of energy supply.

One of the main challenges, however, is that such benefits are not equally available to all consumers and in some cases are a distant prospect. Consequently, one of the main functions of energy policy is to bridge the time gap between today's investments in renewable energy and the future benefits to society.

Consumer empowerment is therefore one of the main pillars of EU energy policy. For example, the Clean Energy Package published in 2016 identifies consumers as the central players of the future energy markets and includes a range of measures to increase transparency and improve direct consumer involvement in the market, for example by improving the opportunities to respond to price signals and by increasing the opportunities for consumers to produce their own electricity. The package also includes a number of measures to protect the most vulnerable energy consumers. The European Green Deal, published in 2019, continues this trajectory by pushing for a transition that is just and socially fair, with an explicit objective to leave no individual or region behind in the great transformation ahead. In practical terms, this is set to be implemented by applying, among others, by the Just Transition Mechanism (JTM), launched in 2020, which aims to allocate a financial package of at least 100 billion euros to support the regions, industries and workers who will face the greatest challenges of the transition. The JTM aims to use these funds to facilitate employment opportunities in new sectors, offer re-skilling opportunities and fight energy poverty. Smaller scale examples of green energy policy that benefit consumers include the revolving funds offered by local and regional governments. Such funds offer easily accessible soft loans for renewable energy (and energy efficiency) investments at relatively low interest rates and with a long payback period, often in combination with technical support.

5.5 Future renewable energy growth and related policy support in China: the challenges ahead

China aims for non-fossil fuels to account for 20% and 50% of its primary energy consumption by 2030 and 2050 respectively, and for non-fossil fuel power to account for 50% of total power production by 2030. Renewable energy has already become the main source of incremental power, and the development trend and direction is likely inevitably to aim for RES replacing fossil fuel power completely. However, the next decade will be a period of transformation, where there will be a number of challenges including:

- Renewable energy needs to be integrated into the energy system so as to support the steady rise in the share of renewable energy in the power market and achieve the ambitious targets set for RES. Most renewable energy products, including electricity, heat and fuel, require access to the power grid networks, district heating pipework and the fuel distribution system, as well as involvement in the power, heating supply and vehicle fuel markets. A pre-condition should be that corresponding infrastructure investment will not significantly increase, or in other words, that system optimisation will ensure the efficiency of the whole energy system and effective quality costs (refer to separate report).

- According to an analysis of economic policies mentioned above, direct pricing or subsidy policies will not be the main tools to support the development of renewable energy in future. Therefore, in the absence of subsidies or

reducing subsidies, it is necessary to conduct a thorough analysis of the policy measures to promote and maintain the sustainable and healthy development of renewable energy

- How to ensure an orderly transition from fossil fuel-based energy to renewable energy, and balance renewable energy development and energy security.

A detailed analysis of recent problems and obstacles that remain to be overcome in China's renewable energy development is given below.

- The concept of priority consumption and sustainable development of renewable energy remains to be established and promoted. Local governments, energy companies, and individuals have yet to adopt clean and low-carbon energy consumption as a basic principle. They continue to be heavily dependent on coal, and remain highly receptive to inefficient and polluting heavy coal combustion. There is not yet a general consensus as to the positive effects clean energy, including renewable energy. Since 2019, concerns have been raised about the effects of renewable energy on energy security, while the coal power industry has become more vocal in defending its interests against renewable energy.

- Against these dissenting voices is the fact that renewable energy is a domestic energy resource. Renewable power and green heating supplies help to reduce coal consumption, while renewable gas and fuel are reducing China’s dependence on the international oil and gas market. Locally produced renewable energy will improve energy security, and this consideration should prompt a transformation in the development and operation of fossil fuel projects. Society as a whole needs a raised awareness of the need for the sustainable development of renewable energy.

- The energy infrastructure is not adequate to support a further increase to the share of renewable energy in the energy system. The construction of a UHVDC transmission line for southwest hydropower is behind schedule, and there is still room for further improvement in the proportion of wind and solar power in the existing UHV transmission network in the Three North Region. There is generally insufficient transmission capacity across regions. Weak links in the power distribution network and poor industry intelligence make it difficult to meet the increasing demands of DSOs and TSOs. The rural power grid in particular cannot meet the operational needs of power heating facilities. Interaction between the supply side and demand side of the power grid needs to become more flexible, to ensure that production can respond to supply needs. China’s existing gas facilities are unable to meet the demand for heating gas in northern China, and there remains the vexed issue of constructing the final leg, or ‘last kilometer’ of infrastructure to allow end-users access to the energy network.

- The energy management mechanism urgently needs to be reformed so it can adapt to allow the sustainable development of renewable energy. In some regions local governments and enterprises are unenthusiastic about using renewable energy, and local protectionism is still a regular issue. Interference in the power market by local governments has exacerbated the problems of

curtailment of hydropower, wind power and PV. It is difficult for renewable energy heating enterprises to enter the market, and renewable energy heating is often blocked by coal-fired heating enterprises. There are many obstacles confronting attempts to introduce biodiesel into the vehicle fuel market.

- Apart from subsidies or reduced subsidies, there are not enough policy instruments to enhance the economics and competitiveness of renewable energy in the energy market. Firstly, the current energy price and tax systems do not fully reflect the external cost of environmental damage caused by coal and other fossil fuels. The pricing mechanism for electric power transmission and distribution, grid network fees and pipeline fees has not been aligned, nor has the pricing mechanism for electricity transmission and distribution been layered, graded, or adjusted to reflect time of use. This has inhibited the promotion of distributed renewable energy. The renewable energy heating supply is constrained by high cost. No energy tax and / or carbon tax mechanism has been introduced to encourage the consumption of renewable energy and curb the consumption of high-carbon fossil energy. The current tax system has a limited guiding and regulatory role in encouraging renewable energy production and consumption.

- Supporting policies are not implemented uniformly, resulting in an artificially high cost for renewable energy. For example, wind power and solar technologies have made rapid progress, but the cost reductions achieved have not reached the market because of unsuitable pricing policies. Some local governments collect taxes on the use of urban land and the occupation of cultivated land, as well as taxes and compensation fees for forestland and grassland. Hydropower has assumed the comprehensive functions of flood control, water supply, irrigation and shipping, but the development costs are only borne by hydropower developers, who also bear a lot of social costs. It is common for local power grid companies to transfer the cost of renewable energy grid-integration projects to renewable power developers. Yet under the Renewable Energy Law, the cost ought to be invested by the grid company. In terms of financing, it is difficult for Chinese private enterprises to get loans, and if they manage to do so, the rates are excessively high. Some banks provide loans to renewable energy developers at a rate higher than the base rate, and sometimes twice as high as that of the international financial market.

- There is a lack of systematic and long-term policy support for renewable energy in sectors unrelated to electricity. The development of end products is not balanced between the different renewable technologies. China has seen a relatively slow development of solar thermal utilisation, geothermal utilisation and biomass fuel. There is inadequate policy support for renewable energy outside the power sector, and no systematic and long-term policy has been formulated. Renewable energy (geothermal, biomass, solar), thermal, biogas, biodiesel and other products lack specific support policies, and restricted by the franchise, it is difficult to gain fair access to the market.

5.6 Lessons learned for future support

Both in the EU and in China it is again a crucial moment for further development in the legislative and regulatory framework for renewable energy. In 2020, China will start to formulate the 14th five-year plan on energy, electric power, renewable energy and

the energy management system. It is expected to initial the discussion and draft of the plan in the first half of 2020. In addition, the detailed implementation rules for the renewable power consumption guarantee mechanism and the policy framework in the post-subsidy era are also under scrutiny.

In the EU, the European Green Deal was launched in December 2019. It defines a growth strategy for the year 2050 to achieve full decoupling of economic growth from the use of natural resources and net zero emissions of greenhouse gases. The Green Deal aims to cut greenhouse gas emissions by at least 50% and up to 55% by 2030 (compared with 1990 emission levels). A European Climate Law is projected for March 2020, a new plan will be formulated by 2020 to achieve the targeted emission reductions, and a review and possible update of relevant energy regulation is planned for June 2021. Given the clear impact of past target setting on renewable growth, setting achievable 2030 targets is expected to promote further development in the sector. To ensure stable market growth it is advisable to include interim targets as well as longer term targets.

With respect to the choice of policy instruments, it seems that the path towards competitive bidding is achieving good results on the European market and therefore could be maintained. As the number of renewable energy auctions spirals, so the need for coordination between member states increases. To this end the European Commission is developing an electronic platform to register all renewable energy auctions. Such a platform could provide valuable planning information to tenderers (usually national government bodies), project developers as well as financiers. In addition, further use of new business models is needed to support direct transactions between end users and suppliers as well as to facilitate the role of smaller scale suppliers on the market. Promising models that could be further developed include the use of PPAs as described in section 4.6, the role of aggregators on the market and the development of protocols and standardised contracts for distributed renewable energy projects, either stand-alone or in combination with energy efficiency projects.

As renewable energy extends its share in the power market, the EU will need more ways to integrate renewables into the European energy system. Valuable lessons can be learned from individual member states, for example in Denmark where a high level of flexibility in various elements in the system have facilitated a system with high penetration levels of volatile renewable electricity (around 45%) and a near zero curtailment ratio. This includes options such as high flexibility of thermal power plants, high integration of heat and electricity and high interconnectivity. In the near future an increased use of storage - either direct storage or increased use of power-to-heat and hydrogen – is also anticipated. More information on the integration of renewable energy can be found in a separate report (Renewable Energy Integration: Christian Romig/AVRY, June 2020).

An analysis of the implementation of the EU and China's policy on renewable energy diversification also provides some valuable lessons for China, including on which of the policies could be feasible for implementation in China after 2020. For example, in the ‘competitive bidding (auction)+long-term PPA’ mode, with the pre-condition of no increment of price subsidy demand, the bidding price can be lower than the base price of coal power or ‘base price + floating price’ of coal power. A long-term PPA offers a stable return on investment, reducing the risk to investment enterprises, reducing project costs and resulting in low bidding or auction price levels. Less established renewable power technologies can be less economically competitive in the power

market. With the pre-condition of RE fund incremental income determining the scale of newly-installed capacity of renewable power projects of less established technologies, one choice is to adopt a 'contract for difference' (CfD) policy, which not only enables those renewable power projects to participate in the power market competition, but also stabilises the return on investment and reduces the risk to investment enterprises.

6. SUGGESTIONS FOR ACTION AND COOPERATION

6.1 Policy action in the EU and China

Developments in both China and the EU have taught us that a strong policy environment is a key requirement and main facilitator for renewable energy growth. Over two decades Europe has developed a wide range of choices in the design and implementation of policy instruments, and has identified which design elements are most valuable to provide a stable investment climate and spend available funds efficiently to grow the share of renewable energy on the market. China's moves to develop the energy market have taken place more recently, but the size of the market requires China to act swiftly and set clear targets. Moreover, while renewable energy has already become an important part of the energy market in both regions, their decision makers still need to step up current efforts and facilitate full integration of renewable energy into the overall energy system.

Specific implementation choices may vary between China and the EU, but the lessons learned show many similarities. The combined set of lessons learned and related recommendations include:

- Target setting is an important element to help develop the role of renewable energy. Both China and the EU are expected to reach their 2020 renewable energy development targets. It is advisable to set quantified targets with clear strategies and specific timeframes, for both the short-term development as well as for the longer-term future. Clear targets help all stakeholders to understand the growth path and define their positions.

- Appropriate policies and measures need to be formulated and adjusted to ensure the realisation of the targets. Support should be aimed at reducing market barriers. This does not exclusively need to focus on financial support, but could also include assistance with non-financial barriers such as facilitating, permitting, technical integration and improved market operations.

- Predictability is what investors ask for before allocating their money to a project. To support the healthy and stable development of the renewable energy industry, the presence of long-term goals as well as the formulation of short and medium-term goals and policies enable renewable generators and investors to predict project returns, evaluate project risks and make the appropriate decisions. From the perspective of macro policy management, this is also a market-based approach to promote the development of renewable energy and project realisation.

- Within a stable framework, flexibility is needed to adapt policy instruments to specific market developments such as changes in technology costs.

- Monitoring of actual market developments is needed to track whether targets are likely to be met and whether policy instruments in place are adequately defined. This will also help to promote investor confidence, and encourage the healthy development of the market and industry. The European Commission issues a market report every three months and trading platforms publish daily prices. In China, information on wind power and PV has been actively monitored since 2017. It is advisable to continue this oversight, and to adjust the monitoring indicators and content according to the industry's need.

- Information on market developments should be actively shared with stakeholders to foster investor confidence and ensure the support of the wider society.

The need for renewable energy policy support will continue to vary according to region, technology and time period, and this will require a more sophisticated set of policy instruments. For China, fine-tuned policies for different needs may be needed either at the national level or at the local level. In the EU, fine-tuned policies will be mostly at the national level. The EU's careful demarcation of goals and indicators, and monitoring of national progress through effective measures, should remain the main tools.

6.2 EU-China Cooperation

A continued exchange of knowledge and experience could help tailor future policies to the specific needs of China and the EU. Cooperation between China and the EU in the field of renewable energy policy can be focused both on strategic objectives and on specific policy design. Europe's extensive practice and experience of integrating renewable energy into the electricity market can be instructive to China. For example, the Chinese auction policy for PV in 2019 draws on German experience. In addition, both regions could benefit from exchanging expertise on regional cooperation and joint operation of support mechanisms across provinces or countries.

Whereas both the EU and China have so far mostly focused their renewable energy policy on the promotion of renewable electricity, both regions also need to step up their efforts in supporting the growth of renewable heating and cooling. This report has provided some first insights in the type of support instruments currently used, but a more detailed exchange of information would be useful as well as joint research and development of advanced support instruments.

Developments for renewable electricity have so far mostly been initiated by China's central government and at a national government level in the EU, yet many future challenges lie at the regional and municipal level. To this end the central governments need to introduce macro-oriented, guiding and directional policies and to develop specific policies at the provincial level and at the municipal level. An extensive exchange of expertise and lessons learned may also be of mutual benefit.

One specific area of cooperation is the use of sustainable biogas. China has included growth in biogas supply as one of its strategic future directions and several EU countries have incorporated biogas growth into their national energy and climate plans for the year 2030.

In order to bring a high proportion of renewable energy into the energy system in future, it is necessary to consider the development of renewable energy from a system perspective. The role and positioning of the demand side, such as electric vehicles and energy storage, and the integration of power grids, heat networks and gas networks will be essential. These are potential areas for China-EU cooperation.

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ANNEX 1

Table A1: Renewable heating and cooling in Europe: status, support and potential development

Country	Share 2017	(indicative) Target/-Projection 2030*#	Legislation/policies
Austria	32%	None	• Plan for 10 large-scale projects to feed waste heat into local DH grids or to install waste heat distribution grid. • Investment subsidies to achieve CO_2 savings and increase energy efficiency, including cooling networks based on heat and cooling waste heat potential. • Investment subsidies for solar thermal, heat pumps, geothermal plants and biomass heating plants.
Belgium	8%	Projection 8%/ up to 12.7% without/with measures	• Obligation 15 kWh/m2 RE for new buildings. • Energy premiums for most efficient air-to-air heat pumps. • State guarantee for high risk /good rate of return RE technologies such as geothermal. • New planned financial support for RE heat and waste heat. • Support heat networks. • Tax deduction on investments in biomass heat plants. • Brussels-Capital region: energy subsidies and investment aid for RES-H. • Flanders region: RES-H&C promoted via overall RES obligation system and premium schemes from grid operators or municipalities. • Walloon region: RES-H subsidy system, zero-percent loan and investment incentives for companies.
Bulgaria	29%	44%	• Waiving of investment approval for RES projects up to 30 kW. • Target of minimal 15% RES H&C in buildings. • Mandatory phase-out of solid fuel stoves and boilers, with replacement by biomass stoves and boilers. • Tax incentive for building owners on use of RES in buildings.
Croatia	35.5%	35%	• General promotion of RES and specific promotion for use of biogas. • Establishment of biomass collection and logistic centres.
Cyprus	24.5%	Projection 29.3%	No specific measures.

Country	Share 2017	(indicative) Target/-Projection 2030*#	Legislation/policies
Czechia	19.7%	30%	• Operating aid for heat (biomass, including biogas, biofuels, geothermal energy). • Investment aid programme for boiler replacement in the period 2014-2020. • Subsidies for RES-H plant operators. • Exemption from real estate tax for RES-H operators.
Denmark	46.5% (and approx. 54% in 2019)	None; sub-target 90% of DH from sources other than coal, gas, oil.	Indirect support from: • Use of biomass for heat production and heat pumps exempted from energy and CO_2 taxes. • Promotion of use of waste heat. • Support schemes (FiT/FIP/investment aid) for biomass electricity production in CHP plants (most RES heat is generated in biomass CHP plants). Denmark plans to implement technology-neutral tender processes for renewable electricity and heat.
Estonia	51.6%	80%	General measures to support development of heating systems, renovation of networks and fuel switch from oil to renewable and/or local sources such as biomass and peat. Three investment support schemes include RES-H as eligible option: subsidy for renovation of apartment buildings, for use of RES-H in childcare centres and a premium tariff for RES-H CHP plants (but paid out via electricity production).
Finland	54.8%	None	• Minimum share of 10% bioliquids by 2028 for light fuel oil used in heating and machinery. • Aid for forest chips and wood-based fuels. • Exemption energy taxes for renewable sources. • Indirect support from targeted phase-out of coal in energy production by 2029 (legislation adopted), a stepwise phase-out of oil for heating by the beginning of the 2030s (planned) and a halving of the use of peat in energy production by 2030 (planned).
France	21.3%	Projection 28% in 2023, 34.30%-38.90% in 2028	• Mandatory share of RES-H in all new buildings from 2020. • Importance of biomass in buildings set higher than high-efficiency CHP, replace old wood stoves with more efficient installations, support boiler development in buildings and industry. • Support from the Heat Fund for air and geothermal for investments and resource mapping.

Country	Share 2017	(indicative) Target/-Projection 2030*#	Legislation/policies
Germany	13.4%	27%	No information on planned measures other than the plan to offset decline in biomass use by increasing heat generation from waste heat, geothermal energy and (small increase in) solar thermal generation. Ongoing support includes investment support for individual heat installations and DH systems, and low-interest loans with grant payback support for the development and expansion of heat installations/ plants from German development bank.
Greece	26.6%	32.3%	• Plan to build 30-40 MWth new DH networks for systems powered by solid biomass and geothermal. • Program 'Promotion of RES and CHP systems for own consumption of heat' includes financing of RES H&C production systems. • Mandatory coverage of 60% of hot water needs by solar thermal systems in new and newly renovated buildings. • Regulations for the promotion of biomass, geothermal and heat pumps and solar thermal through the removal of specific barriers. • Ministerial Decision to regulate the operation of combustion stoves to heat buildings and water and to adopt specifications for solid biomass fuels for non-industrial use.
Hungary	19.6%	27% (but range provided 18.2%-28.86% without/with measures)	Government indicated that the replacement of the existing gas-based district heating production by RES-H generation requires substantial additional investment aid. New support policies are planned but not specified yet. Ongoing support schemes include: • RES-H&C is eligible technology in tender program 'Improving the energy efficiency of agricultural and processing factories' • Favourable loans and grants are provided for thermal refurbishment of business buildings and residential buildings planning to use RES. • Tenders in the Territorial and Settlement Operational Programme provide investment grants for thermal refurbishment projects for public buildings (with the use of RES).
Ireland	6.9%	Projections 23.3%-34.5% without/with measures	• Support Scheme for RES-H since December 2017 for DH and for domestic heat consumers in non-ETS sectors. Comprises grant of up to 30% of installation costs for heat pumps and up to 15-years of operational support for biomass boilers and anaerobic digestion heating systems. • Additional policy to provide support for biomethane grid injection is being considered. • Budget of €300m reserved for rollout of the Support Scheme for RES-H for 2018-2027.

Country	Share 2017	(indicative) Target/-Projection 2030*#	Legislation/policies
Italy	20.1%	33%	• Planned minimum threshold of RES-H in new buildings. • Planned guarantees for the deployment of district heating and cooling networks (included in a decree that has already been adopted). • Incentive for selected small RES-H sources. • 50-75% tax deduction for refurbishment of buildings using RES-H or installation of RES-H technologies.
Latvia	54.6%	57.5%	• High role of EU funds to finance planned growth. • Considering option to reduce household taxes (real estate tax, personal income tax and value added tax) for the purchase and installation of solar collectors, heat pumps or cooling pumps. • Reduced VAT rate for companies who are supplying biomass and biogas. • Reduced excise tax rate for biogas supplied to end-users if the biogas is used for heating.
Lithuania	46.5% (excl waste)	90% in DH&C; 80% in household RES-H&C (incl waste)	• Lithuania combines plans for RES-H with plans for heat from waste. Latter provides approx. 40% of heat demand. • Priority purchase for all heat suppliers on RES-H from independent producers provided it is cheaper, does not exceed demand and meets environmental criteria. • Feed-in tariffs and purchase obligation for biogas injected into the natural gas system. • Loans and subsidies for GHG reduction projects including RES-H from Climate Change Special Programme. • Environmental Pollution Tax exemption for use of biogas, solid and liquid biomass for heating purposes.
Luxembourg	8.1%	30%	• Technology-specific trajectories have been developed, with the largest growth expected in decentralised biomass H&C, followed by grid-connected biomass and biogas H&C. • Subsidy for, among others, aerothermal and geothermal heat pumps, and RES-H plants from solar thermal energy or biomass ('PRIMe House'). • Investment grants for RES-H other than aerothermal and hydrothermal energy. • Subsidies for companies investing in RES-H or CHP. • Fund for environmental protection investments by municipalities.

Country	Share 2017	(indicative) Target/-Projection 2030*#	Legislation/policies
Netherlands	5.9%	Projection 9.68%	• RES-H is eligible for the FIP which is opened in phases and based on competitive bidding. • Enterprises may receive a tax credit (the EIA system) for investments in specific types of RES-H. • Investors in RES H&C projects (excluding biomass and biogas) are eligible for a low interest rates on the basis of a Green project declaration. Growth in DH is expected (including from RES-H sources) as a result of lower direct use of natural gas for households.
Malta	19.8%	Projection 20.9%/22.7% without/with measures	• By far the largest contribution is expected from heat pumps. Malta has no DH systems. • Since 2005 Malta has had several grant schemes for solar water heaters and aerothermal heat pumps. The current scheme providing a grant to finance 50% of the investment costs (up to €700), to private householders is set to be continued. • A new scheme is planned to encourage battery integration in PV systems where appropriate.
Poland	14.5%	25%	• Subsidy from state development bank and two subsidies from the National Fund for Environmental Protection and Water Management supporting refurbishment works that, among others, may include installation of RES-H technologies. • Subsidy from National Fund to support the purchase and installation of solar collectors. • Soft loan from National fund for purchase and installation of RES installations, including RES-H&C.
Portugal	34.4%	35%/38% without/with measures	No specific measures; general measures to support increase in RES. Until Nov 2016 specific subsidy for investments to improve energy performance of buildings, including support for solar thermal heating.
Romania	26.6%	31.3%	• Attracting investment in RES-H network infrastructure. • Promotion of efficient solutions in residential communities, such as heat pumps. • Subsidies for own consumption and for installation of smaller scale RES-H systems. • State aid support scheme for RES-E and RES-H until 2023.
Slovakia	9.8%	17.6%	Operational subsidies for RES-H plant operators.

Country	Share 2017	(indicative) Target/-Projection 2030*#	Legislation/policies
Slovenia	33.2%	31.0%	• 2030 target at least 2/3 of energy consumption in buildings from RES. • Grants for RES-H investments in one-family and multi-family houses. • Tender-based loan and subsidy scheme for RES-H from state owned energy companies.
Spain	17.5%	21.54/34.04% without/with measures	Spain has no operational support schemes for RES-H. The National Plan includes only general measures to support RES.
Sweden	69.1%	None	Indirect support from tax reductions and exemptions: • Tax deduction options for households for installation of RES and replacement of conventional heat with RES-H. • RES-H production is exempted from energy taxes, CO_2 taxes and NOx taxes.

**: None means no specific target nor projection for renewable heating and cooling. Note that all countries do have an overall target for the total share of renewable energy in 2030.*
#: Without/with measures refers to the scenarios in the (draft) NECP on the basis of existing measures and with additional measures

Source: EC 2019c, NECPs, RES-legal and Eurostat SHARES tool 2018

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