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PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL
COMMITTEE AND THE COMMITTEE OF THE REGIONS**

Powering a climate-neutral economy: An EU Strategy for Energy System Integration

1. AN INTEGRATED ENERGY SYSTEM FOR A CLIMATE-NEUTRAL EUROPE

The European Green Deal¹ puts the EU on a path to climate neutrality by 2050, through the deep decarbonisation of all sectors of the economy, and higher greenhouse gas emission reductions for 2030.

The energy system is crucial to deliver on these goals. The recent decline in the cost of renewable energy technologies, the digitalisation of our economy and emerging technologies in batteries, heat pumps, electric vehicles or hydrogen offer an opportunity to accelerate, over the next two decades, a profound transformation of our energy system and its structure. Europe's energy future must rely on an ever growing share of geographically distributed renewable energies, integrate different energy carriers flexibly, while remaining resource-efficient and avoiding pollution and biodiversity loss.

Today's energy system is still built on several parallel, vertical energy value chains, which rigidly link specific energy resources with specific end-use sectors. For instance, petroleum products are predominant in the transport sector and as feedstock for industry. Coal and natural gas are mainly used to produce electricity and heating. Electricity and gas networks are planned and managed independently from each other. Market rules are also largely specific to different sectors. This model of separate silos cannot deliver a climate neutral economy. It is technically and economically inefficient, and leads to substantial losses in the form of waste heat and low energy efficiency.

Energy system integration – the coordinated planning and operation of the energy system ‘as a whole’, across multiple energy carriers, infrastructures, and consumption sectors – is the pathway towards an effective, affordable and deep decarbonisation of the European economy in line with the Paris Agreement and the UN's 2030 Agenda for Sustainable Development.

Declining costs for renewable energy technologies, market developments, rapid innovation regarding storage systems, electric vehicles, as well as digitalisation are all factors leading naturally towards greater energy system integration in Europe. However, we have to go one step further and connect the missing links in the energy system in order to achieve higher decarbonisation objectives for 2030 and climate neutrality by 2050 – and do it in manner that is both cost effective and consistent with the European Green Deal's green oath to “do no harm”. Relying on greater use of clean and innovative processes and tools, the path towards system integration will also trigger new investments, jobs and growth, and strengthen EU industrial leadership at a global level. It can also be a building block of the economic recovery in the aftermath of COVID-19 crisis. The Commission's recovery plan² presented on 27 May 2020 highlights the need to better integrate the energy system, as part of its efforts to unlock investment in key clean technologies and value chains and increase economy-wide resilience. In addition, the EU sustainable finance taxonomy will guide investment in these activities to ensure they are in line with our long-term ambitions³. An integrated energy system will minimise the costs of transition towards climate neutrality for consumers and open new opportunities for reducing their energy bills and active participation in the market.

¹ COM(2019) 640 final.

² ‘Europe's moment: Repair and Prepare for the Next Generation’, COM(2020) 456 final.

³ Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088

The Clean Energy Package⁴, adopted in 2018, provides a basis for better integration across infrastructure, energy carriers and sectors; however, regulatory and practical barriers remain. Without robust policy action, the energy system of 2030 will be more akin to that of 2020 than a reflection of what is needed to achieve climate neutrality by 2050.

This Strategy sets out a **vision on how to accelerate the transition towards a more integrated energy system**, one that supports a climate neutral economy at the least cost across sectors – while strengthening energy security, protecting health and the environment, and promoting growth, innovation and global industrial leadership.

Turning this vision into a reality requires resolute action, now. Investments in energy infrastructure typically have an economic life of 20 to 60 years. The steps taken in the next five-to-ten years will be crucial for building an energy system that drives Europe towards climate neutrality in 2050.

Thus, this **Strategy proposes concrete policy and legislative measures at EU level to gradually shape a new integrated energy system**, while respecting the differing starting points of Member States. It contributes to the work of the Commission on a comprehensive plan to increase the EU 2030 climate target to at least 50% and towards 55% in a responsible way and identifies follow-up proposals that will be prepared as part of the legislative reviews of June 2021, announced in the European Green Deal.

The parallel Communication ‘*A hydrogen strategy for a climate-neutral Europe*’⁵ complements this Strategy to elaborate in more detail on the opportunities and necessary measures to scale up the uptake of hydrogen in the context of an integrated energy system.

2. ENERGY SYSTEM INTEGRATION AND ITS BENEFITS TO COST-EFFECTIVE DECARBONISATION

2.1. What is energy system integration?

Energy system integration refers to the planning and operating of the energy system “as a whole”, across multiple energy carriers, infrastructures, and consumption sectors, by creating stronger links between them with the objective of delivering low-carbon, reliable and resource-efficient energy services, at the least possible cost for society. It encompasses three complementary and mutually reinforcing concepts.

First, a more ‘circular’ energy system, with energy efficiency at its core, in which the least energy intensive choices are prioritised, unavoidable waste streams are reused for energy purposes, and synergies are exploited across sectors. This is happening already in combined heat and power plants or through the use of certain waste and residues. There is however further potential, for example, in reusing waste heat from industrial processes, data centres, or energy produced from bio-waste or in wastewater treatment plants.

Second, a greater direct electrification of end-use sectors. The rapid growth and cost competitiveness of renewable electricity production can service a growing share of energy

⁴ https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en.

⁵ COM(2020) 301 final.

demand – for instance using heat pumps for space heating or low-temperature industrial processes, electric vehicles for transport, or electric furnaces in certain industries.

Third, the use of renewable and low-carbon fuels, including hydrogen, for end-use applications where direct heating or electrification are not feasible, not efficient or have higher costs. Renewable gases and liquids produced from biomass, or renewable and low-carbon hydrogen can offer solutions allowing to store the energy produced from variable renewable sources, exploiting synergies between the electricity sector, gas sector and end-use sectors. Examples include using renewable hydrogen in industrial processes and heavy-duty road and rail transport, synthetic fuels produced from renewable electricity in aviation and maritime transport, or biomass in the sectors where it has the biggest added value.

A more integrated system will also be a ‘multi-directional’ system in which consumers play an active role in energy supply. ‘Vertically’, decentralised production units and customers contribute actively to the overall balance and flexibility of the system – for instance, biomethane produced from organic waste injected in gas networks at a local level, or “vehicle-to-grid” services. ‘Horizontally’, exchanges of energy increasingly take place between consuming sectors – for instance, energy customers exchanging heat in smart district heating and cooling systems, or feeding in the electricity that they produce individually or as part of energy communities.

2.2. What are the benefits of energy system integration?

Energy system integration helps to **reduce greenhouse gas emissions in sectors that are more difficult to decarbonise**, for instance by using renewable electricity in buildings and road transport, or renewable and low carbon fuels in maritime, aviation, or certain industrial processes.

It could also ensure a more efficient use of energy sources, **reducing the amount of energy needed and related climate and environmental impacts**. In certain end-uses, new fuels will likely be required that use significant amounts of energy to be produced, such as hydrogen or synthetic fuels. At the same time, the electrification of a large share of our consumption can cut primary energy demand by a third⁶ thanks to the efficiency of electrical end-use technologies. Also, 29% of industrial energy demand dissipates as waste heat, which can be reduced or reused. Small- and medium size enterprises can create synergies by both improving energy efficiency and increasing the use of renewable resources and waste heat. Overall, the transition to a more integrated energy system is projected to reduce gross inland consumption by a third by 2050⁷, whilst supporting an increase in GDP of two thirds⁸.

⁶ For example, electric vehicles have an efficiency of around 60% compared to 20% for combustion engines on a tank-to-wheel basis, and heat pumps can deliver heat with three times less energy input than boilers.

⁷ See COM(2018) 773 final, A Clean Planet for all. A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy. In-depth analysis in support of the Commission communication (LTS), figure 18: -21% in the 1.5TECH and -32% in the 1.5LIFE.

⁸ See LTS, figure 92: 2050 GDP between 166% and 174% of 2015 or between GDP 154% and 161% of 2020 GDP.

Beyond energy and greenhouse gases emissions savings, it would also reduce air pollution and the energy water footprint⁹, which is essential for climate adaptation, for health and to preserve natural resources.

Energy system integration will also **strengthen the competitiveness of the European economy** by promoting more sustainable and efficient technologies and solutions across industrial ecosystems related to the energy transition, their standardisation and market uptake. Specialised companies will provide services locally and create more regional economic benefits. This creates an opportunity for the Union to maintain and leverage its leadership in clean technologies such as smart grid technologies and district heating system, and lead on new, more efficient and complex technologies and processes that are expected to play a growing role in the energy systems worldwide, such as batteries or hydrogen technologies. Territories, regions and Member States facing the biggest transition challenges will be supported by the Just Transition Mechanism and, as part of it, the Just Transition Fund.

Moreover, better integration will **provide additional flexibility** for the overall management of the energy system and thus help to integrate increased shares of variable renewable energy production. It will also boost **storage technologies**: pumped hydropower, grid-scale batteries and electrolyzers provide flexibility in the electricity sector. Home batteries and electric vehicles ('behind-the-meter') in buildings can help manage better the distribution grids. By 2050, electric vehicles could provide up to 20% of the flexibility required on a daily basis¹⁰. Thermal storage at factory-level can provide flexibility in the industrial sector. Through the closer integration of the power and heat sector, electric heat appliances could already make use of real time electricity prices to smarten demand response. Hybrid heat pumps¹¹ and smart district heating also provide opportunities for arbitrage between electricity and gas markets. Moreover, electrolyzers can transform renewable electricity into renewable hydrogen, providing long-term storage and buffering capability, and further integrating the electricity and gases markets.

Finally, by linking up the different energy carriers and through localised production, self-production and smart use of distributed energy supply, system integration can also contribute to **greater consumer empowerment, improved resilience and security of supply**. Some of the technologies needed in an integrated energy system will require large amounts of raw materials, including some listed on the EU list of critical raw materials. But replacing imported natural gas and petroleum products with locally produced renewable electricity, gases and liquids, combined with the greater implementation of circular models, will first and foremost reduce the import bill and lessen dependency on external fossil fuel supplies, creating a more resilient European economy.

3. MAKING IT HAPPEN - AN ACTION PLAN TO ACCELERATE THE CLEAN ENERGY TRANSITION THROUGH ENERGY SYSTEM INTEGRATION

This strategy identifies six pillars where coordinated measures are outlined to address existing barriers for energy system integration.

⁹ The water footprint of EU energy production was in 2015 198 km³ or 1068 litres per person and per day, or 242 km³ or 1301 litres per person and per day including energy imports. Source: JRC, Water – Energy Nexus in Europe, 2019.

¹⁰ According to METIS-2 S6 Study, baseline scenario (186TWh of 951TWh of total daily flexibility needs) would be provided by e-vehicles. Study to be published.

¹¹ Heat pumps coupled with a boiler.

3.1. A more circular energy system, with ‘energy-efficiency-first’ at its core

Applying the energy-efficiency-first principle across sectoral policies is at the core of system integration. Energy efficiency reduces the overall investments needs and costs associated with energy production, infrastructure and use. It also reduces the related land and material resources use, and associated pollution and biodiversity losses. At the same time, system integration can help the EU achieve greater energy efficiency, through a more circular use of available resources and by switching to more efficient energy technologies. For instance, electric vehicles show much higher energy efficiency than combustion engines; and replacing a fossil-fuel based boiler with a heat pump using renewable electricity saves two thirds of primary energy¹².

The first challenge is to **apply the energy-efficiency-first principle consistently across the whole energy system**. This includes giving priority to demand-side solutions whenever they are more cost effective than investments in energy supply infrastructure in meeting policy objectives, but also properly factoring in energy efficiency in generation adequacy assessments. The Energy Efficiency Directive¹³ and Energy Performance of Buildings Directive¹⁴ already provide incentives for customers, but not enough for the full supply chain. Further measures are needed to ensure that customers’ decisions to save, switch or share energy **properly reflect the life cycle energy use and footprint** of the different energy carriers, including extraction, production and reuse or recycling of raw materials, conversion, transformation, transportation and storage of energy, and the growing share of renewables in electricity supply. In certain industries for which the shift from fossil fuels towards electricity will result in more consumption, trade-offs will have to be carefully considered.

In this context, the **Primary Energy Factor (PEF)**¹⁵ is an important tool to facilitate comparisons of savings across energy carriers. Most renewables are 100% efficient and have a low PEF. The PEF should reflect the real savings brought about by renewable electricity and heat. The Commission will review the level of the PEF and assess whether current provisions in EU legislation ensure an adequate application of the PEF by Member States.

The upcoming ‘**Renovation Wave**’ initiative, announced in the European Green Deal, will also propose concrete actions to accelerate the uptake of energy and resource efficiency measures and of renewables in buildings across the EU in the next few years.

The second challenge is that **local energy sources are insufficiently or not effectively used in our buildings and communities**. Applying the principle of circularity in line with the new Circular Economy Action Plan¹⁶, a big, yet largely unused potential is the reuse of **waste heat** from industrial sites, data centres, or other sources. Energy reuse can take place on-site (for example through the re-integration of process heat within manufacturing plants) or via a district heating and cooling network. The Energy Efficiency and Renewable Energy

¹² Kavvadias, K., Jimenez Navarro, J. and Thomassen, G., Decarbonising the EU heating sector: Integration of the power and heating sector, 2019.

¹³ Directive (EU) 2018/ 2002.

¹⁴ Directive (EU) 2018/844.

¹⁵ The primary energy factor indicates the amount of primary energy used to generate a unit of final energy (electrical or thermal), allowing a comparison of the primary energy consumption of products with the same functionality using different energy carriers. It shall be revised periodically according to Annex IV of the Energy Efficiency Directive.

¹⁶ COM(2020) 98 final.

Directives already contain provisions targeting this potential, but there is a need to further strengthen the regulatory framework to lift barriers hampering the wider application of these solutions. These barriers include insufficient awareness and knowledge about these solutions, the reluctance of companies to enter into a new business that is not their core activity, a lack of regulatory and contractual frameworks to share the costs and benefits of new investments, and barriers related to planning, transaction costs, and pricing signals. As regards data centres specifically, the Digital Strategy¹⁷ has announced the ambition to make them climate-neutral and highly energy-efficient by no later than 2030; a greater re-use of their waste heat will significantly contribute to that objective.

A third challenge is linked to the untapped use of **wastewater¹⁸ and biological waste and residues for bioenergy production**, including biogas. Biogas can be exploited on-site to reduce fossil fuel consumption, or upgraded to biomethane to allow injection into the natural gas grid or use in transport. Also, some farm infrastructures are suitable for an integrated production of solar-origin electricity and heat, creating the potential for renewable energy self-consumption and injection into the grid. The implementation of the new Circular Economy Action Plan and waste legislation and sustainable agriculture and forestry management systems could result in increased sustainable production of bioenergy from wastewater, waste and residues¹⁹. More efforts are needed to take advantage of the full potential for energy system integration, exploiting synergies and avoiding trade-offs. In agriculture, through the Common Agriculture Policy, farmers could be incentivised to contribute to a greater mobilisation of sustainable biomass for energy. Renewable energy communities can provide a sound framework for the use of such energy in a local context.

Key actions

To better apply the energy-efficiency-first principle:

- Issue **guidance** to Member States on how to **make the energy-efficiency-first principle operational** across the energy system when implementing EU and national legislation (by 2021).
- **Further promote** the energy-efficiency-first principle in all upcoming relevant methodologies (e.g. in the context of the European resource adequacy assessment) and legislative revisions (e.g. of the TEN-E Regulation²⁰).
- Review the **Primary Energy Factor**, in order to fully recognise energy efficiency savings via renewable electricity and heat, as part of the review of the Energy Efficiency Directive (June 2021).

To build a more circular energy system:

- Facilitate the **reuse of waste heat from industrial sites and data centres**, through strengthened requirements for connection to district heating networks, energy

¹⁷ C(2018) 7118 final.

¹⁸ Wastewater treatment plants represent almost 1% of electricity consumption in Europe. This consumption can be reduced with more efficient technologies, and energy can be better recovered from those plants.

¹⁹ The overall potential for increased biogas production from waste and residues remains high and, if fully exploited, could lead to biogas and biomethane production levels in 2030 of 2.7–3.7% of the EU's energy consumption in 2030. See CE Delft, Eclareon, Wageningen Research, Optimal use of biogas from waste streams. An assessment of the potential of biogas from digestion in the EU beyond 2020, 2017.

²⁰ Regulation on Trans-European Networks in Energy, Regulation (EU) 347/2013.

performance accounting and contractual frameworks, as part of the revision of the Renewable Energy Directive and of the Energy Efficiency Directive (June 2021).

- Incentivise the **mobilisation of biological waste and residues from agriculture, food and forestry** sectors and support capacity-building for **rural circular energy communities** through the new Common Agriculture Policy, Structural Funds and the new LIFE programme (from 2021 onwards).

3.2. Accelerating the electrification of energy demand, building on a largely renewables-based power system

Electricity demand is projected to increase significantly on a pathway towards climate neutrality, with the share of electricity in final energy consumption growing from 23% today to around 30% in 2030, and towards 50% by 2050²¹. In comparison, that share has only increased by 5 percentage points over the last thirty years.

This growing electricity demand will have to be largely based on renewable energy. By 2030, the share of renewable energy in the electricity mix should double to 55-60%, and projections show a share of around 84% by 2050. The remaining gap should be covered by other low-carbon options²².

Significant cost reductions in renewable power generation technologies have occurred in the last decades and are expected to continue – providing prospects that market forces will increasingly deliver investments. However, given the scale of the investments needed, it is urgent to tackle the barriers that still prevent a massive roll-out of renewable electricity, across all technologies. These include underdeveloped supply chains, the need for more and smarter grid infrastructure at national and cross-border level, the lack of public acceptance, administrative barriers and lengthy permitting (including for repowering), financing, the need for public or private long-term hedging options, or high costs for some less mature technologies.

The need for increased electricity supply can, alongside other relevant onshore renewable power technologies such as solar or wind energy, partly be met by offshore renewable energy production. The potential of offshore wind energy in the EU is between 300-450 GW by 2050²³, against today's capacity of some 12 GW²⁴. This represents a huge opportunity for the EU industry to become the global leader in offshore technology, but will require considerable efforts to increase the European industrial capacity and build new value chains. Offshore electricity production also creates an opportunity for the nearby localisation of electrolyzers for hydrogen production, including the possible reuse of the existing infrastructure of depleted natural gas fields. In addition, the development of solar energy will be further facilitated.

In the short term, the Commission will use the new recovery instrument Next Generation EU to support the continued deployment of renewable energy. It will assess opportunities to

²¹ LTS, figure 20, looking at the 1.5LIFE and 1.5TECH scenarios for 2050.

²² LTS, figure 23, looking at the 1.5LIFE and 1.5TECH scenarios for 2050.

²³ LTS, figure 24, including the UK.

²⁴ 20 GW including the UK.

channel EU funds through, or in combination with, the new **EU renewable energy financing mechanism**²⁵.

On the demand side, certain incentives to electrification are provided for instance through the sectoral targets set out in the Renewable Energy Directive, and in transport through CO₂ standards for vehicles, in the Alternative Fuel Infrastructure Directive and the Clean Vehicles Directive²⁶. But challenges for **increased electrification remain** and differ per sector and across Member States **and more needs to be done**.

In **buildings**, electrification is expected to play a central role, in particular through the roll-out of heat pumps for space heating and cooling. In the residential sector, the share of electricity in heating demand should grow to 40% by 2030 and to 50-70% by 2050; in the services sector, these shares are expected to be around 65% by 2030 and 80% by 2050²⁷. Large-scale heat pumps will play a relevant role in district heating and cooling. The most important barrier is the relatively higher level of taxes and levies applied to the electricity, and the lower levels of taxation for fossil fuels (oil, gas and coal) used in the heating sector, leading to lack of level playing field. Progress is also hampered by a number of other barriers, including unfit infrastructure planning, building codes and products standards, lack of skilled workforce for installation and maintenance, lack of public and private financing instruments, and lack of internalisation of CO₂ costs in heating fuels. This translates into low replacement rates of the EU fossil heating stocks, low development and modernisation of district heating/cooling networks, and low building refurbishment rates. With the Renovation Wave initiative, the Commission will ensure a higher penetration of renewables in buildings. It will also support training programmes under the Updated Skills Agenda.

In **industry**, heat represents more than 60% of energy use. Industrial heat pumps can help decarbonise the low temperature heat supply within industries, and can be coupled with waste heat recovery. Other technologies are being developed for higher temperature heating (such as microwave or ultrasound) and for electrifying processes by electrochemistry. Barriers to deployment include lack of information and long pay-back, due to the high price of electricity relative to gas and the high abatement cost associated with these technologies, relative to current CO₂ prices. Changes in the production process leading to higher costs could also affect the competitiveness of sectors exposed to international competition. EU support could help develop a number of flagship projects and demonstrate innovative electricity-based processes. Furthermore, the industrial supply chain for these technologies is not sufficiently mature and the integration of these electrification technologies into industrial processes requires training and new skills. The Commission will explore, together with industry, ways to address these issues.

In **transport**²⁸, the Sustainable and Smart Mobility Strategy is foreseen for later this year, and will set out how our transport system needs to decarbonise and modernise to reduce its emissions by 90% in 2050²⁹. Electric mobility is key, and will accelerate decarbonisation and reduce pollution, especially in our cities, and new mobility services will increase the efficiency of the transport system and reduce congestion. The rapidly falling cost of electric

²⁵ <https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12369-Union-renewable-Financing-mechanism>

²⁶ Directive (EU) 2019/1161 on the promotion of clean and energy-efficient road transport vehicles.

²⁷ LTS, figure 42.

²⁸ Including mobile machinery.

²⁹ LTS

vehicles means that they could be competitive with combustion engine vehicles around 2025, on a total cost of ownership basis³⁰. The European Green Deal points to the need of stepping up the roll out of recharging infrastructure, starting with the ambitious objective of having at least one million publicly accessible recharging and refuelling points by 2025, as well as the use of on-shore power supply in ports. To that end the Commission will mobilise InvestEU – which will be reinforced and include a new Strategic Investment Facility – and the Connecting Europe Facility funding to broaden the coverage of the charging infrastructure network. Support through the Recovery and Resilience Facility and through Cohesion Policy to clean vehicles and alternative fuels infrastructure will be a priority as part of the strengthened focus on delivering the European Green Deal in our regions and cities, including in public buildings, offices, depots and private dwellings. The Renovation Wave initiative also offers opportunities to promote electric chargers and electric vehicle charging stations. The Commission will also propose to revise the Alternative Fuels Infrastructure Directive and the TEN-T Regulation – also assessing how to further strengthen synergies between the TEN-T and TEN-E policies. The Commission will accompany the continued support under the Connecting Europe Facility with a further mapping of funding opportunities and regulatory initiatives for the roll-out of recharging infrastructure. The Commission will also tackle challenges to make electro-mobility more attractive to the user such as the non-transparent pricing at public charging stations and the persistent lack of cross-border interoperability of charging services. Measures are also needed to boost the use of renewable electricity at ports, to facilitate the electrification of road freight transport. Further electrification of railways could be explored taking into account its economic viability³¹.

Overall, **a growing use of electricity in end-use sectors will mean a need to keep under review the adequacy of renewable electricity supply**, to ensure that it can match the scale required to support the decarbonisation of the abovementioned sectors.

Electrification can present challenges for the management of the electricity system. Regional and cross-border coordination between Member States will become increasingly important. This will be addressed by the development of Regional Coordination Centres³² in 2022, allowing for more robust security analysis, emergency and outage coordination and common infrastructure planning, and the deployment of storage and other flexibility options. The Commission will support the **uptake of energy storage** through full implementation of the Clean Energy Package and in the upcoming legislative reviews, including the review of the TEN-E Regulation.

Challenges are also expected at a more local level. For instance, the full electrification of passenger road transport will require in parts of the Union upgrades to the local grid infrastructure. At the same time, it can create **opportunities for providing storage and flexibility** to the system³³. In particular, **smart charging** and so-called **Vehicle-to-Grid (V2G)** services will be essential to manage grid congestion and limit costly investments in grid capacity. The Electricity Directive contains a number of provisions that lay the basis for enabling smart charging and the development of V2G services, but challenges still remain, for instance regarding the deployment of smart recharging points, common standards and communication protocols, grid charges, taxation and access to the in-vehicle data. The

³⁰ See for instance BNEF, Electric Vehicle Outlook, 2020.

³¹ Over 50% of the rail network and around 80% of the rail traffic is already electrified.

³² Regulation (EU) 2019/943.

³³ See Trinomics, Energy storage – Contribution to the security of the electricity supply in Europe, 2020.

development of a new Network Code on Demand Side Flexibility as well as the review of the Alternative Fuels Infrastructure Directive both present opportunities to create a robust framework for the successful integration of demand-side flexibility in general, and electric vehicles in particular.

Electrification efforts of areas not connected to the continental grid, such as the Outermost Regions, some islands, or remote or sparsely populated areas present specific challenges. Technical and financial support for energy system integration is particularly relevant for a cost-effective transition in these regions.

Key actions

To ensure continued growth in the supply of renewable electricity:

- Through the Offshore Renewable Strategy and follow-up regulatory and financing actions, ensure the cost-effective planning and deployment of **offshore renewable electricity**, taking into account the potential for on-site or nearby hydrogen production, **and strengthen EU's industrial leadership in offshore technologies** (2020).
- Explore establishing minimum **mandatory green public procurement** (GPP) criteria and targets in relation to **renewable electricity**, possibly as part of the revision of the Renewable Energy Directive (June 2021), supported by **capacity building** financing under the LIFE programme.
- Tackle remaining barriers to a **high level of renewable electricity supply** that matches the expected growth in demand in end-use sectors, including through the review of the Renewable Energy Directive (June 2021).

To further accelerate the electrification of energy consumption:

- As part of the **Renovation Wave** initiative, promote the further electrification of buildings' heating (in particular through heat pumps), the deployment of on-buildings renewable energy, and the roll-out of electric vehicle charging points (from 2020 onwards), using all available EU funding, including the Cohesion Fund and InvestEU.
- Develop more specific measures for the use of **renewable electricity in transport**, as well as for **heating and cooling** in buildings and industry, in particular through the revision of the Renewable Energy Directive, and building on its sectoral targets (June 2021).
- Finance pilot projects for the **electrification of low-temperature process heat in industrial sectors** through Horizon Europe and the Innovation Fund (by 2021).
- Assess options to support the further decarbonisation of industrial processes, including through electrification and energy efficiency, in the revision of the **Industrial Emissions Directive** (2021)³⁴.
- Propose to revise **CO₂ emission standards for cars and vans** to ensure a clear pathway from 2025 onwards towards zero-emission mobility (June 2021).

To accelerate the roll-out of electric vehicle infrastructure and ensure the integration of new loads:

- Support the roll-out of **1 million charging points by 2025**, using available EU funding,

including the Cohesion Fund, InvestEU and Connecting Europe Facility funding, and communicate regularly on the funding opportunities and regulatory environment to roll out a charging infrastructure network (from 2020 onwards).

- Use the upcoming **revision of the Alternative Fuels Infrastructure Directive** to accelerate the roll-out of the alternative fuels infrastructure, including for electric vehicles, strengthen interoperability requirements, ensure adequate customer information, cross-border usability of charging infrastructure, and the efficient integration of electric vehicles in the electricity system (by 2021).
- Take up corresponding requirements for charging and refuelling infrastructure in the **revision of the Regulation for the Trans-European Transport network (TEN-T)** (by 2021) and explore greater synergies through the revision of the **TEN-E Regulation** in view of possible energy network related support for cross border high capacity recharging as well as possibly hydrogen refuelling infrastructure (by 2020).
- Develop a **Network Code on Demand Side Flexibility**³⁵ to unlock the potential of electric vehicles, heat pumps and other electricity consumption to contribute to the flexibility of the energy system (starting end-2021).

3.3. Promote renewable and low-carbon fuels, including hydrogen, for hard-to-decarbonise sectors

While direct electrification and renewable heat present the most cost-effective and energy-efficient decarbonisation options in many cases, there are a number of end-use applications where they might not be feasible or have higher costs. In such cases, a number of renewable or low-carbon fuels could be used, such as sustainable biogas, biomethane and biofuels, renewable and low-carbon hydrogen or synthetic fuels. These cases include a number of industrial processes, but also transport modes such as aviation and maritime, where sustainable alternative fuels such as advanced liquid biofuels and synthetic fuels will have an essential role to play. Rapid action is necessary: for example, in aviation, only around 0.05% of total jet fuel consumption comes from liquid biofuels.

Unlocking the potential of renewable fuels produced from sustainable biomass

Today, **biofuels**³⁶, **biogas and biomethane**³⁷ account for only 3.5% of all gases and fuels consumption³⁸ and are largely based on food and feed crops. Their full potential should be achieved in a sustainable manner, which mitigates climate, pollution and biodiversity risks³⁹.

Biofuels will have an important role to play, notably in hard-to-decarbonise transport modes, such as aviation or maritime – including through hybridisation projects linking biofuels and renewable hydrogen production. The Commission will in particular explore how to support to

³⁵ Under Regulation (EU) 2019/943.

³⁶ Biofuels are liquid fuels produced from biomass, through a variety of processes and using a variety of feedstock, such as biodiesel, bioethanol and Hydrotreated Vegetable Oils (HVO).

³⁷ Biogas is a gaseous mixture (primarily methane and carbon dioxide) produced from biomass, through the decomposition of organic matter in the absence of oxygen (anaerobically). Biogas can be used directly as a fuel, or be purified or “upgraded” into biomethane, which can thus be used for the same applications as natural gas and injected into the gas grid.

³⁸ Source: Eurostat.

³⁹ Directive 2018/2001 establishes a cap to first generation biofuels and limitations to high Indirect Land Use Change (ILUC) risk food and feedstocks, while reinforcing and extending sustainability criteria.

the quick development of innovative low-carbon fuels such as advanced biofuels, alongside synthetic fuels, across the whole value chain of the industry in Europe, leading to better coordination of the market actors and rapid increase of production capacity. Biomethane can contribute to the decarbonisation of the gas supply. However, the deployment of biofuels and biogases has so far been hampered by regulatory uncertainty. The revised Renewable Energy Directive has taken a first step to address these issues by introducing a target of 3.5% for the consumption of advanced biofuels and biogas in transport⁴⁰. The 6% greenhouse gas emission target of the Fuel Quality Directive also supports the deployment of biofuels. In addition, the Communication *'The role of Waste to Energy in the circular economy'*⁴¹ clarifies which waste-to-energy approaches are more sustainable, including for the production of biomethane, while the Biodiversity Strategy underlines that the use of whole trees and food and feed crops for energy production should be minimised.

The revision of the Renewable Energy Directive, as well as the Commission initiatives to boost the supply and uptake of sustainable aviation and maritime fuels announced in the European Green Deal, will present opportunities for further targeted support to accelerate the development of the market for biofuels and biogases.

Promoting the use of renewable hydrogen in hard-to-decarbonise sectors

Today, hydrogen contributes less than 2% of Europe's energy consumption⁴², and is almost exclusively produced from unabated fossil fuels. Hydrogen has an important role to play in reducing emissions in hard-to-decarbonise sectors, in particular as a fuel in certain transport applications (heavy-duty road transport, captive fleets of buses, or non-electrified rail transport, maritime transport and inland waterways) and as a fuel or feedstock in certain industrial processes (steel, refining or chemical industries – including to produce 'green fertilisers' for agriculture). Carbon dioxide in reaction with hydrogen can also be further processed into synthetic fuels, such as synthetic kerosene in aviation. In addition, hydrogen brings other environmental co-benefits, such as the lack of air pollutant emissions.

Hydrogen produced through electrolysis using renewable electricity can play a particularly important "nodal" role in an integrated energy system, where it can help integrate large shares of variable renewable generation, by offloading grids in times of abundant supply, and providing long term storage to the energy system. It can also allow local renewable electricity production to be used in a range of additional end-use applications.

The Hydrogen Strategy, adopted today, presents measures to create the conditions for hydrogen to contribute to decarbonising the economy in a cost-effective way, addressing the whole hydrogen value chain to support economic growth and recovery. The priority for the EU is to develop hydrogen production from renewable electricity which is the cleanest solution. In a transitional phase however, other forms of low-carbon hydrogen are needed to replace existing hydrogen and kick-start an economy of scale. In addition to providing financial support in certain end-use applications, the Commission will consider establishing

⁴⁰ The use of "advanced" biofuels and biogas (gained from certain residues and by-products from agriculture and forestry activities, industrial and municipal waste in full respect of the waste hierarchy, and other ligno-cellulosic material) is encouraged under the Directive 2018/2001. Biofuels and biogas need to meet sustainability requirements to be statistically accounted as renewable under that Directive.

⁴¹ COM(2017) 034 final.

⁴² Calculated on the basis of production data provided by Fuel Cells and Hydrogen Joint Undertaking, includes the use of hydrogen as a feedstock; FCHJI, Hydrogen roadmap, 2019.

minimum shares or quotas of renewable hydrogen in specific end-use sectors. Renewable and low-carbon fuels (including hydrogen) can be promoted most effectively if they can be easily distinguished from more polluting energy sources. Therefore, the Commission will work to introduce a comprehensive terminology and a European certification system covering all renewable and low carbon fuels⁴³. Such a system, based notably on full life cycle greenhouse gas emissions savings, will allow for more informed choices when deciding on policy options at the EU or national level.

Enabling carbon capture, storage and use to support deep decarbonisation, including synthetic fuels

Even a fully integrated energy system cannot completely eliminate CO₂ emissions from all parts of the economy. Together with alternative process technologies, **carbon capture and storage (CCS)** is likely to play a role in a climate-neutral energy system. In particular CCS can address hard-to-abate emissions **in certain industrial processes**, thus enabling these industries to have a place in a climate neutral economy and maintaining industrial jobs in Europe. In addition, if the stored CO₂ was captured from biogenic sources or directly from the atmosphere, CCS could even compensate residual emissions in other sectors.

An alternative to the permanent storage of CO₂ is to combine it with renewable hydrogen to produce synthetic gases, fuels and feedstock (Carbon Capture and Use, or CCU). Synthetic fuels can be associated with very different levels of greenhouse gas emissions depending on the origin of CO₂ (fossil, biogenic, or captured from the air), and the process used. Fully carbon-neutral synthetic fuels require sourcing the CO₂ from biomass or the atmosphere. Synthetic fuels are currently inefficient in terms of energy required for production and are confronted with high production costs. Support to progress the development of this conversion technology, including demonstration and upscaling of the full production process, is relevant with a view to having substitutes for fossil fuels in particular in the most difficult to decarbonise sectors, which may continue to rely on high energy density liquid fuels, such as aviation. As their production requires large amounts of renewable energy, their uptake would have to be matched by a corresponding increase in renewable energy supply.

It is of key importance to properly monitor, report and account the emissions and removals of CO₂ associated with the production of synthetic fuels to reflect correctly their actual carbon footprint. Complementing the current greenhouse gas emission monitoring and reporting system, a robust carbon removal certification mechanism will ensure the traceability of the CO₂ along its emission, capture, use and potential reemission throughout our economic system. The Development of a carbon removal certification system, as announced in the Circular Economy Action Plan⁴⁴, can provide regulatory incentives for market take-up of synthetic fuels.

The uptake of CO₂ capture and usage in Europe is slow, with investment and operational costs still high. There are also barriers that prevent the transport of CO₂ to those places where it will be stored or used. In some parts of the EU, there are also concerns among citizens and political decision-makers regarding the storage of CO₂. An annual European CCUS Forum could be convened as part of the Clean Energy Industrial Forum to further study options to foster CCUS projects.

⁴³ See also Hydrogen Strategy, COM(2020) 301 final.

⁴⁴ COM(2020) 98 final.

Key actions

- Propose a **comprehensive terminology for all renewable and low-carbon fuels** and a **European system of certification** of such fuels, based notably on full life cycle greenhouse gas emission savings and sustainability criteria, building on existing provisions including in the Renewable Energy Directive (June 2021).
- Consider **additional measures to support renewable and low-carbon fuels**, possibly through minimum shares or quotas in specific end-use sectors (including aviation and maritime), through the revision of the Renewable Energy Directive and building on its sectoral targets (June 2021), complemented, where appropriate, by additional measures assessed under the REFUEL Aviation and FUEL Maritime initiatives (2020). The support regime for hydrogen will be more targeted, allowing shares or quota only for renewable hydrogen.
- Promote the financing of **flagship projects of integrated, carbon-neutral industrial clusters** producing and consuming renewable and low-carbon fuels, through Horizon Europe, InvestEU and LIFE programmes and the European Regional Development Fund (from 2021).
- Stimulate first-of-a-kind production of **fertilisers from renewable hydrogen** through Horizon Europe (from 2021).
- Demonstrate and scale-up the **capture of carbon** for its use in the production of **synthetic fuels**, possibly through the Innovation Fund (from 2021).
- Develop a regulatory framework for the **certification of carbon removals** based on robust and transparent carbon accounting to monitor and verify the authenticity of carbon removals (by 2023).

3.4. Making energy markets fit for decarbonisation and distributed resources

In an integrated energy system, trustworthy and efficient markets should guide customers towards the most energy-efficient and cheapest decarbonisation option, on the basis of prices that properly reflect all the costs of the energy carrier used.

Ensuring non-energy price components contribute to decarbonisation across energy carriers

In many EU Member States, **taxes and levies on electricity are higher than for coal, gas or heating oil**, both in absolute value and as a share of total price⁴⁵. Over the past years, charges and levies on electricity, such as those financing renewable support schemes, have continued to increase. At the same time, the *energy component* of the final (retail) electricity price has reduced both in absolute and relative terms. This has widened the asymmetry in non-energy costs between electricity and gas: for retail household electricity prices, for instance, taxes and levies now add up to 40% of the final price, compared to 26% of gas or 32% for heating oil⁴⁶. Some other energy- or carbon-intensive sectors such as international aviation and maritime transport, as well as agriculture, can be subject to low or no VAT, and, under the current Energy Taxation Directive, to low energy excise duties.

Also, carbon costs are only partially internalised, or not internalised at all, in some sectors (e.g. road and maritime transport or space heating) or in some Member States, or may not be

⁴⁵ DG Energy, Energy Prices and Costs Report, 2019.

⁴⁶ DG Energy, Energy Prices and Costs Report, 2019.

sufficient to incentivise decarbonisation in some sectors covered by the ETS (e.g. aviation). Finally, fossil fuel subsidies also persist in the EU.

Overall, applicable taxes and levies, including carbon pricing, are not applied homogeneously across energy carriers and sectors, and create distortions towards the use of specific carriers.

Finally, the specificities of electricity used for energy storage or for hydrogen production should also be considered, avoiding double taxation (so that energy is only taxed once when delivered for final consumption), and avoiding unjustified double grid charges.

Placing consumers at the centre

Clear and easily accessible information is essential to enable citizens to change energy consumption patterns and switch to solutions that support an integrated energy system. Customers – citizens and businesses alike – should be informed on their rights, on the technology options available to them and their associated carbon and environmental footprint, so they can make informed choices and truly drive decarbonisation. It is important that vulnerable households are not left behind and energy poverty is addressed⁴⁷. In the context of the Climate Pact, the Commission will launch a **consumer information campaign** on their rights related to the energy market.

Customer information rights for electricity customers have been enhanced with the Clean Energy Package – further work remains to be done for **gas and district heating customers** to align those with the electricity sector.

Furthermore, **markets for sustainable products and services** are still missing, for instance for products such as steel, cement and chemicals produced from renewable or low-carbon fuels. As part of the broader efforts announced in the Circular Economy Action Plan to improve sustainability of such intermediary products, consumers should receive relevant information that may encourage them to pay a price premium.

*Making electricity and gas markets fit for decarbonisation*⁴⁸

The Clean Energy Package already laid the foundation to make **electricity markets** fit to integrate large amounts of variable electricity and the integration of flexibility from demand response and storage, while improving the market signals to stimulate investments and empowering electricity customers. The challenge now lies in implementing the measures properly, in particular the completion of market coupling through day-ahead and intraday trading.

As we progress towards climate-neutrality, the volume of natural gas consumed in Europe will progressively reduce. While **gaseous fuels** are expected to continue to play an important role in our energy mix⁴⁹, the mix of gaseous fuels will highly depend on the chosen decarbonisation pathway. By 2050, the share of natural gas in gaseous fuels is projected to

⁴⁷ In line with the European Pillar of Social Rights (principle 20) that guarantees the access to essential services, including energy.

⁴⁸ Issues connected to the creation of open and competitive markets for hydrogen are covered in the dedicated Hydrogen Strategy.

⁴⁹ LTS, figure 33: the 1.5TECH and LTS 1.5LIFE scenarios project a share of 18-22% for gaseous fuels in the EU energy mix by 2050, compared to 25% today.

reduce to 20%, and most of the remaining 80% gaseous fuels should be of renewable origin⁵⁰. But the future mix of these gaseous energy carriers – biogas, biomethane, hydrogen or synthetic gases – is hard to project.

The gas market regulatory framework should be re-examined so as to facilitate the uptake of renewable gases and customer empowerment, whilst ensuring an integrated, liquid and interoperable EU internal gas market.

In this context, issues to consider include the connection to infrastructure and the market access for distributed production of renewable gases, including at the distribution level, which would complement the use of renewable gases in a more local, circular context (such as biogas used on farm). In addition, with renewable gases injected into the gas network, and supply sources further diversified, the quality parameters of gas consumed and transported in the EU would change. To avoid this leading to market segmentation and trade restrictions, there is a need to look at how to ensure the interoperability across gas systems and the unhindered flow of gases across Member States' borders.

Updating the State aid framework

The current review of the State aid framework, and notably its guidelines on energy and environmental protection, will contribute to energy system integration by providing a fully updated and fit-for-purpose enabling framework for a cost-effective deployment of clean energy and the well-functioning of energy markets⁵¹.

Key actions

To promote a level-playing field across all energy carriers:

- **Issue guidance to Member States** to address the high charges and levies borne by electricity and to ensure the **consistency of non-energy price components across energy carriers** (by 2021).
- Align the taxation of energy products and electricity with EU environment and climate policies, and ensure a harmonised taxation of both storage and hydrogen production, avoiding double taxation, through the **revision of the Energy Taxation Directive**⁵².
- Provide more consistent carbon price signals across energy sectors and Member States, including through a **possible proposal for the extension of the ETS to new sectors** (by June 2021).
- Further work towards the **phasing out of direct fossil fuel subsidies**, including in the context of review of the State aid framework and the revision of the Energy Taxation Directive (from 2021 onwards).
- Ensure that the revision of the **State aid framework** supports cost-effective decarbonisation of the economy where public support remains necessary (by 2021).

⁵⁰ LTS, figures 28 to 32.

⁵¹ Beyond those provisions, the Research, Development and Innovation Framework and the Communication setting out criteria for the analysis of the compatibility with the internal market of State aid to promote the execution of important projects of common European interest are also relevant.

⁵² Initial Impact Assessment for the revision of the Energy Taxation Directive:
<https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12227>

To adapt the gas regulatory framework:

- **Review the legislative framework to design a competitive decarbonised gas market**, fit for renewable gases, **including to empower gas customers** with enhanced information and rights (by 2021).

To improve customer information:

- In the context of the Climate Pact, launch a **consumer information campaign** on energy customer rights (by 2021).
- **Improve information to customers on the sustainability of industrial products** (in particular steel, cement and chemicals) as part of the sustainable product policy initiative, and, as appropriate, through complementary legislative proposals (by 2022).

3.5. A more integrated energy infrastructure

Energy system integration will translate into more physical links *between* energy carriers. This calls for a **new, holistic approach for both large-scale and local infrastructure planning**, including the protection and resilience of critical infrastructures. The objective should be to make the most of the existing infrastructure while avoiding both lock-in effects and stranded assets. Infrastructure planning should facilitate the integration of various energy carriers and arbitrate between the development of new infrastructure or re-purposing of existing ones. It should consider alternatives to network-based options, especially demand-side solutions and storage.

The various components of the energy network will all need to evolve. Modern low-temperature **district heating systems** should be promoted, as they can connect local demand with renewable and waste energy sources, as well as the wider electric and gas grid – contributing to the optimisation of supply and demand across energy carriers. However, district heating networks account for 12% of the total final heating and cooling energy consumption, are highly concentrated in a few Member States, and only a limited share of them are highly efficient and based on renewables.

Implementing the Clean Energy Package will contribute to a more efficient use of **electricity grids**. Nevertheless, accelerated electrification of new end-uses will require to reinforce the grid, mainly at distribution but also at transmission level⁵³, and to make it smarter. Electrolysers will link up to the electricity grids, and possibly to existing gas grids. In the context of the assessment of Member States' National Energy and Climate Plans, the Commission will also analyse the progress towards the 15% electricity interconnection target and consider appropriate action, including in the context of the revision of the TEN-E Regulation.

The existing **gas network** provides ample capacities across the EU to integrate renewable and low-carbon gases and repurposing gas network for hydrogen applications may provide in some cases a cost-efficient solution, including to transport renewable hydrogen from offshore renewable electricity parks. Ports could transform into centres receiving electricity produced offshore, as well as liquid hydrogen, and thereby contribute to enable the global trade of renewable hydrogen or synthetic fuels.

⁵³ In line also with the EU electricity interconnection target included under Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action

While gas networks may be used⁵⁴ to enable blending of hydrogen to a limited extent during a transitional phase, **dedicated infrastructures for large-scale storage and transportation of pure hydrogen**, going beyond point-to-point pipelines within industrial clusters, may be needed. The expansion of hydrogen refuelling stations will also be assessed as part of the revision of the Alternative Fuels Infrastructure Directive and the Regulation on the TEN-T guidelines.

Similarly, further reflection is needed on the role of **CO₂-dedicated infrastructure**, transporting CO₂ across industrial sites for further use, or to large scale storage facilities.

The Regulation on Trans-European Networks in Energy (TEN-E) provides a framework for the selection of infrastructure projects of common interest in electricity, gas and CO₂ networks. In this context, currently, **10-Year Network Development Plans (TYNDPs)** at national and EU level are developed in parallel for gas and electricity by Transmission System Operators. Future network planning will require a more integrated and cross-sectoral approach, notably of the electricity and gas sectors. It will also require full consistency with climate and energy targets, including alignment with National Energy and Climate Plans, an adequate consideration of all relevant actors, and should be informed by local conditions.

The Commission will ensure that the ongoing revision of the **TEN-E Regulation** makes it fully consistent with climate neutrality and enables the cost-effective integration of the energy system, as well as its integration with the digital and transport systems. The ongoing revision of the Regulation on the Trans-European Transport network (TEN-T) will also seek synergies with the TEN-E Regulation, aiming to generate additional opportunities for the decarbonisation of transport from the new vision of energy infrastructure planning.

Finally, increasing interdependencies mean that disruptions in one sector can have an immediate impact on operations in others and a new coherent security approach for both physical and digital infrastructures is necessary. The new Security Union Strategy will address both critical infrastructure and cybersecurity and needs to be accompanied by sector-specific initiatives to tackle the specific risks faced by critical infrastructures such as in an integrated energy system and infrastructure.

Key actions

- Ensure that the **revisions of the TEN-E and TEN-T regulations** (in 2020 and 2021, respectively) fully support a more integrated energy system, including through greater synergies between the energy and transport infrastructure, as well as the need to achieve the 15% electricity interconnection target for 2030.
- **Review the scope and governance of the TYNDP** to ensure full consistency with the EU's decarbonisation objectives and cross-sectoral infrastructure planning as part of the revision of the TEN-E Regulation (2020) and other relevant legislation (2021).
- Accelerate investment in **smart, highly-efficient, renewables-based district heating and cooling networks**, if appropriate by proposing stronger obligations through the revision of the Renewable Energy Directive and the Energy Efficiency Directive (June 2021), and the

⁵⁴ A blend of 5-20% by volume can be tolerated by most systems without the need for major infrastructure upgrades or end-use appliance retrofits or replacements. See for instance BNEF, Hydrogen Economy Outlook, 2020.

3.6. A digitalised energy system and a supportive innovation framework

Digitalisation supports energy system integration – it can enable dynamic and interlinked flows of energy carriers, allow for more diverse markets to be connected with another, and provide the necessary data to match supply and demand at a more disaggregated level and close to real time. A combination of novel sensors, advanced data exchange infrastructures, and data handling capabilities that make use of Big Data, Artificial Intelligence, 5G and distributed ledger technologies can enhance forecasting, allow the remote monitoring and management of distributed generation and improve asset optimisation, including the on-site use of self-generation. Digitalisation is also key to unleash the full potential of customers having a flexible energy consumption across different sectors to contribute to the efficient integration of more renewables. More generally, digitalisation provides an opportunity for economic growth and worldwide **technological leadership**.

Digitalisation represents a challenge in terms of **increased energy demand** for ICT equipment, networks and services which needs to be adequately managed in the context of an integrated energy system. Digitalisation also brings other challenges for the energy sector, in particular on **ethics, privacy and cybersecurity**, with consideration to the specificity of the energy sector.

A system-wide **Digitalisation of Energy action plan** could accelerate the implementation of digital solutions, building on the Common European energy data space⁵⁵, announced in the European Data strategy. As part of the implementation of the Clean Energy Package, it will roll-out smart metering, foster demand response, and ensure the interoperability of energy-related data. It will also use EU funding opportunities such as the Connecting Europe Facility, InvestEU, the Digital Europe Programme, and structural funds to scale-up solutions developed through Horizon Europe.

Finally, **research and innovation** will be a key enabler to create and exploit new synergies in the energy system, for instance in relation to e-mobility, to heating or to the decarbonisation of energy intensive industries. Research should focus on enabling lower maturity technologies to come into the market, while more mature and innovative technologies should be scaled up through large scale demonstrations through the proposed Horizon Europe and its partnerships and making use of complementarities among the various EU funding programmes. Technology development must go hand in hand with societal innovation.

Key actions

- Adopt a **Digitalisation of Energy Action plan** to develop a competitive market for digital energy services that ensures data privacy and sovereignty and supports investment in digital energy infrastructure (2021).
- Develop a Network Code on **cybersecurity in electricity**⁵⁶ with sector-specific rules to increase the resilience and cybersecurity aspects of cross-border electricity flows,

⁵⁵ https://ec.europa.eu/info/sites/info/files/communication-european-strategy-data-19feb2020_en.pdf

⁵⁶ Under Regulation (EU) 2019/943.

common minimum requirements, planning, monitoring, reporting and crisis management (by end 2021).

- Adopt the implementing acts on **interoperability** requirements and transparent procedures for access to data within the EU (first one in 2021)⁵⁷.
- Publish a new **impact-oriented clean energy research and innovation outlook** for the EU to ensure research and innovation supports energy system integration (by end 2020).

4. CONCLUSIONS

This communication sets out a strategy and a set of actions to ensure that energy system integration can contribute to the energy system of the future – one that is efficient, resilient, secure and driven by the twin goals of a cleaner planet and a stronger economy for all.

The transition to a more integrated energy system is of crucial importance for Europe, now more than ever. First, for recovery. The COVID-19 outbreak has weakened the European economy and undermines the future prosperity of European citizens and business. This strategy is part of the recovery plan. It proposes a path forward that is cost-effective, promotes well-targeted investments in infrastructure, avoids stranded assets and leads to lower bills for businesses and customers. In short, it is key to accelerating the EU's emergence from this crisis and for mobilising necessary EU funding, including the Cohesion Fund, as well as private investments. Second, for climate neutrality. Energy system integration is essential to reach increased 2030 climate targets and climate neutrality by 2050. It exploits energy efficiency potential, enables a larger integration of renewables, the deployment of new, decarbonised fuels, and a more circular approach to energy production and transmission.

Finally, a truly integrated energy system is vital for shaping Europe's global leadership in clean energy technologies, by leveraging Europe's existing strengths – an established leadership in renewable energy; a regional approach to system operation and infrastructure planning; liberalised energy markets; and excellence in energy innovation and digitalisation.

We are still far from where we need to be by 2050. To get there, both fundamental and far-reaching action is urgently needed. The Clean Energy Package adopted in 2018-2019 lays the foundation for system integration and should be fully implemented. In the context of the Green Deal, the new actions outlined in this communication will add the necessary scope and speed to move towards the energy system of the future, contributing to the EU's increased climate ambition and to shaping the legislative revisions to be proposed in June 2021. The time to act is now.

Obviously, system integration will not be a one-size-fits-all process: despite a common objective of EU climate neutrality by 2050, EU Member States have different starting points. As such, Member States will follow different pathways, depending on their respective circumstances, endowments and policy choices, which are already reflected in the respective National Energy and Climate Plans (NECPs). This strategy offers a compass to direct these efforts in the same direction.

Citizens have a central role in system integration. This means that they should contribute to shape the implementation of this Strategy, using the Climate Pact as well as other existing citizen fora to advance the system integration agenda.

⁵⁷ Under Article 24 of Directive (EU) 2019/944.

With this document, the Commission invites the Council, the Parliament, other EU institutions and all stakeholders to focus on how to take forward energy system integration in Europe. It intends to invite interested parties to debate in a **large dedicated public event** at the end of this year and to contribute to the **public consultations and impact assessments that will inform the preparation of the follow-up proposals envisaged for 2021 and beyond.**