Just E-volution 2030

The socio-economic impacts of energy transition in Europe

The European House
Ambrosetti

enel
Foundation

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The contents of this report refer exclusively to the analysis and research carried out by The European House – Ambrosetti and represent its opinion which may not coincide with the opinions and viewpoints of the individuals interviewed.

Preface

Francesco Starace

CHIEF EXECUTIVE
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The new President of the European Commission, Ursula von der Leyen, said in her speech to the European Parliament: "*what is good for the planet must also be good for our citizens and our regions*". The need to act quickly to combat climate change, by decarbonizing our economy, grows more urgent every day; it is a clear goal and one toward which policy-makers and businesses are focusing their efforts. However, though we all agree on the goal, we are becoming more and more aware that the starting points and speed differ from country to country. This is a fact that we have in front of us every day, and one that has to be taken into account.

Decarbonization is a great opportunity to modernize the European economy, revitalize the industrial sector and ensure sustainable, lasting growth. Technological progress has shown us that the reduction of emissions is technically feasible and economically advantageous. It is achieved through the "energy transition": the gradual replacement of fossil fuels with renewables, thanks to the sharp drop in costs of the technologies, along with digitalization of the networks. As power generation is becoming increasingly cleaner, the gradual penetration of electricity into the energy system will enable us not only to decarbonize the historically most polluting sectors, but also to create value in new ways, by offering new services to the consumers who, more than ever before, are becoming the central focus of the energy system.

What lies before us is a real opportunity: but it is fundamental that the energy transition is understood by everyone as a benefit and not a change that will be beneficial to some and detrimental for others. To achieve this, we need farsighted policies: it is increasingly obvious that only very wide-ranging measures, that combine advantages for climate, energy, industry and society can achieve this result. Europe has already shown its leadership in designing energy and climate policies that have made it a benchmark for the rest of the world. The most recent set of policies are the *Clean Energy Package,* which sets for 2030 a 40% reduction of greenhouse gas emissions, with respect to the levels of 1990; a 32% share of renewables in the EU's gross final consumption; and a 32.5% energy efficiency; and the *Mobility Package*, which is paramount for the promotion of sustainable mobility. Our country, Italy, is also doing its part: it has already reached its European targets for 2020, and is now working, like the other Member States, to define its Integrated National Energy and Climate Plan.

We need to have the same ambition and vision demonstrated in designing these energy and climate policies, to ensure that the transition to a carbon-free economy is truly sustainable and inclusive. The transition to a clean economy will bring net benefits to the Italian system, both in terms of wealth and job creation, however the sectors and regions with traditionally higher carbon emissions will need support during this transition. This study, *Just E-volution 2030*, certainly deserves credit for analyzing the changes taking place and suggesting to the policy-makers in Brussels and in the Member States a roadmap of bold measures that can facilitate the transition. As seen in the report, this transition will lead to the creation of new jobs and new professions thanks to new long-term investments. According to the study, by 2030, thanks to energy transition, the economic value of the electricity sector in the different scenarios could grow at a European level from €113 to €145 billion (with Italy growing from €14 to €23 billion), while employment could increase to a range from about 997,000 to about 1.4 million jobs (from about 98,000 to 173,000 in Italy today).

However, the road is fraught with challenges, in part due to the impact of digitalization on our economy. In a context of increasing penetration of electricity, the industrial competitiveness of the European system must be maintained, and the transformation of the value chain must be properly managed. This transition will require the labor force to undergo a process of reskilling and upskilling, shifting from sectors that are no longer competitive towards more efficient ones. Businesses and policy makers should facilitate this transition with dedicated programs. At a later stage, social redistributive measures should ensure that the benefits generated by the energy transition are available to all, without discriminating between geographical areas or segments of the population.

This is the turning point: these changes are happening across Europe and should be dealt with, no country is excluded. We will share the same challenges and should start preparing now, with courage and vision. We can do it, bearing in mind that every country will, of course, have to follow its own path. We can learn from the history of the European Union: since its foundation, it has shown us that the most ambitious common goals can be attained, even while moving toward them at different speeds.

Valerio De Molli

MANAGING PARTNER E CEO, THE EUROPEAN HOUSE — AMBROSETTI

Today’s Europe is facing major challenges. Existing political powers are crumbling, while new powers are emerging. Changes in economy, climate and technology are shaping our societies and lifestyles. This has generated a feeling of unease in many areas across Europe.
If there exists one project which has the power to develop a positive vision for Europe, it is definitely the energy transition. The message from European citizens is loud and clear: they claim a real action to fight climate change and they want Europe to lead the way towards the energy transition. European institutions have recognized energy transition as a priority: the newly elected President of the European Commission Ursula von der Leyen has stated that Europe has to become the first climate-neutral continent in the world by 2050.

In order to achieve this ambitious objective, we must take “bold steps together”: it is clear that the traditional energy paradigm, based on energy production from fossil fuels only, is no longer a viable option. In this context, the electric carrier has the potential to become the energy vector of the future, leading the energy transition currently underway.
The European House – Ambrosetti has identified seven reasons why the electric vector could guide the energy transition, offering a significant contribution to the European Union’s decarbonization goals. As shown in the study, it allows to reduce CO_2 emissions when electricity is generated through an energy mix integrating a significant share of renewables and it enables the reduction of pollutant emissions, improving air quality.

In addition, it offers several opportunities to enhance the resilience and the security of supply of the overall energy system, thanks to its versatility, flexibility and integration of renewable energy sources. It promotes higher level of energy efficiency: if compared with traditional thermal technologies, the electric ones perform better in terms of energy efficiency. It can be easily integrated with digitalization, enabling more effective management and higher efficiency of the energy system. Furthermore, it stimulates innovation and sustainability in lifestyles and industrial processes, and it can play an important role in favoring and supporting Circular Economy. It also reduces noise pollution, limiting annoyance, stress and sleep disturbance, thus reducing the consequent risks of hypertension and cardiovascular diseases.

> “Our most pressing challenge is keeping our planet healthy. This is the greatest responsibility and opportunity of our times. I believe that what is good for our planet must be good for our people, our regions and our economy. We will ensure a just transition for all.”
>
> **URSULA VON DER LEYEN**

The quantitative assessment of the socio-economic impacts of energy transition is a precondition to guide policymakers’ agendas in order to ensure a transition “just for all”. For this purpose, The European House – Ambrosetti has devised a brand-new econometric model for estimating the socio-economic impacts of energy transition. This model is unique in combining a macro and micro approach, starting from the analysis of 3,745 products/technologies that characterize European industrial production and estimating the effects of energy transition on industrial production and employment at 2030 in the European Union, Italy, Spain and Romania.

The results of the model highlight that the energy transition, enabled by electrification, represents an opportunity for boosting industrial production and employment in the EU-28 and in Italy, Spain and Romania. The final differential effects on production value, taking into account the increase in electric products/technologies, the decrease in thermal products/technologies along the overall value chains and the introduction of new digital services enabled by electrification, range between +113 billion Euros and +145 billion Euros for the whole European Union at 2030. In Italy, the net effects of energy transition on production value have been assessed to be in the range of +14 billion Euros/+23 billion Euros, while in Spain the differential impacts span from +7 billion Euros to +8 billion Euros at 2030. Finally, in Romania the final net effect is estimated to be +2 billion Euros/+3 billion Euros.

The final impact on employment shows an overall positive effect: in the European Union, the energy transition generates a net impact from +997,000 employees to +1.4 million employees at 2030. In the three selected scenarios, in Italy, the net employment gain accounts from +98,000 to +173,000 at 2030, while in Spain the effect ranges from +73,000 to +97,000 and in Romania from +30,000 to more than +52,000.

In order to effectively support the benefits associated to energy transition in the medium-long run, policy action is needed to face two major challenges. On the one hand, energy transition has to preserve European industrial competitiveness, while creating the conditions for enhancing industrial competitiveness in the global scenario. It means managing the reduction of industrial production related to thermal technologies and sustaining the conversion of existing value chains towards electric technologies, by guaranteeing adequate investment levels and facing skills mismatch. On the other hand, it has to avoid negative distributive effects across different socio-economic dimensions, preventing an unfair distribution of costs and guaranteeing equal access to the benefits generated by the transition.

The European House – Ambrosetti has identified four policy matters in order to ensure that the transition currently underway is not "just a transition" but "a just transition for all": supporting the deployment of electric technologies by promoting an effective value chains conversion toward electric technologies; managing job losses, increasing job opportunities and addressing the issue of re-skilling and up-skilling; addressing the issue of energy poverty; promoting a fair redistribution of costs associated to the energy transition. In the study, each policy matter is detailed with the specific policy actions required.

This ambitious study would not have been possible without the concerted efforts of the top management of Enel and the Fondazione Enel, starting with Francesco Starace, Carlo Papa and Simone Mori, together with the Enel and Fondazione Enel Working Group, in exploring a theme at the forefront of debate today, and without the invaluable contribution of the Scientific Committee – Adair Turner (Chairman, Energy Transitions Commission; former Chair, United Kingdom Climate Change Committee), Michal Kurtyka (State Secretary, Ministry of Energy, Ministry of the Environment of Poland; Chairman, COP24) and Enrico Giovannini (Professor of Economics and Statistics, Università di Roma «Tor Vergata»; Spokesperson, Alleanza Italiana per lo Sviluppo Sostenibile – ASviS) – and the International Energy Agency – Fatih Birol (Executive Director), Laszlo Varro (Chief Economist) and Szilvia Doczi (Energy Policy Expert) – to whom go my deepest thanks.

Lastly, heartfelt thanks go to The European House – Ambrosetti Working Group, made up of Lorenzo Tavazzi, Benedetta Brioschi, Alessandro Viviani, Francesco Galletti, Arianna Landi, Nicolò Serpella and Ines Lundra.

Contributions from the Scientific Committee

Fatih Birol

EXECUTIVE DIRECTOR, INTERNATIONAL ENERGY AGENCY

These are extraordinary times for global energy. As societies are coming to terms with the need to build a different kind of energy system than we've had in the past – one based not only on affordability and reliability, but also sustainability – a series of major trends are profoundly reshaping the energy sector. These include continued cost reductions for clean energy technologies, notably solar PV, wind and batteries, and the rapidly increasing importance of digital technologies and electricity.

In fact, electricity demand is growing at nearly twice the pace of overall energy demand. The world continues to electrify and the number of people with access to electricity grows higher each year. Electrification is also creating major opportunities through the electrification of sectors such as transport and heating which today are dominated by the consumption of traditional energy sources. This is good news, but the expanding role of electricity can only be a pathway to lower emissions if the increase in electricity demand is met with low-carbon generation.

Due to this tremendous potential, the electricity sector is experiencing its most dramatic transformation since the first lightbulbs were turned on more than a century ago. It is also the reason why the International Energy Agency included a special focus on electricity in last year's edition of the World Energy Outlook (WEO).

However, the growing role of electricity in our economies will lead to a new set of challenges that must be carefully addressed. For example, the rising share of intermittent renewables such as solar PV and wind will require power systems to make flexibility the cornerstone of future electricity markets. This will require thoughtful policies and regulation and close cooperation between the private sector and policymakers in order to develop required market reforms, stimulate renewables and grid investments, and scale up the deployment of demand-response technologies.

In this respect, the initiative undertaken by The European House – Ambrosetti, Enel and Enel Foundation – arrives at an important time, exploring a theme at the forefront of the current debate and presenting innovative keys to enable our understanding of tomorrow's energy system. The very title of the study, "Just E-volution 2030" stresses the importance of enacting a "just" transition, one that takes into account the impacts that can be expected from the shift towards energy and economic systems dominated by renewable electricity.

We need thoughtful policies to manage such impacts and this year's timely report suggests what these policies could look like. Government has a key role to play in ensuring such policies get implemented.

As emphasized in the IEA's World Energy Outlook 2018, over 70% of global energy investments over the coming decades will be government-driven. In today's power sector, more than 95% of global investment are made in jurisdictions that are fully regulated or affected by risk-mitigation mechanisms. In short, the world's energy future lies with government decisions.

Crafting the right policies will be critical to meeting our common goals of securing energy supplies, reducing carbon emissions, improving air quality in urban centers, and expanding basic access to energy. The study "Just E-volution 2030", to which we were happy to contribute, provides useful guidance towards realising this goal.

Enrico Giovannini

PROFESSOR OF ECONOMICS AND STATISTICS, UNIVERSITÀ DI ROMA «TOR VERGATA»; SPOKESPERSON, ALLEANZA ITALIANA PER LO SVILUPPO SOSTENIBILE – ASviS

The question of transitioning energy toward a carbon-neutral socio-economic system has long since left the isolated rooms where scientists, economists and technologists have debated it in the last fifty (and above all in the last twenty) years, and now also involves public opinion, the world of business, the social partners and individual citizens. Fears for the impact that human activities have on climate change, the unacceptable levels of pollution in our cities and elsewhere (which in Europe are responsible for about half a million premature deaths every year), the opportunities offered by new technologies, the tremendous investments made in the field of renewable energy, now place the world in front of the concrete possibility to enact a profound change in the systems of production and distribution of energy and consequently in the way our societies and economies work, with vast consequences also on global geo-politics.

Faced with extremely complex scenarios from every standpoint, including the technical, it is not easy to deal precisely with the issue of energy transition unless we try to segment the problem, so as to be able to then direct the results of our different analyses toward a unified solution. We have seen, on the other hand, that aside from mere mathematical calculation of the economic advantages and disadvantages of different choices, politics play a vital role in indicating, and thus determining, the future that we want to achieve. From this standpoint, the recent programmatic declarations announced by the new president of the European Commission, Ursula von der Leyen, contain an extremely ambitious message: to make Europe the first carbon-neutral continent in the world, by investing significant funds not only to achieve energy transition but also to manage the social implications, with a view as well to overcoming the strong resistance already expressed by several member countries to an accelerated process of decarbonization.

The commitment of the new president will obviously have to be tested in the field, in the dialogue with the European Council and Parliament, but just for this reason it is important that every member country accelerate its own considerations on the subject, evaluating the best options to make the right and necessary change. Among other things, by the end of this year Italy - like all the other EU countries - will have to approve its final Integrated national energy and climate plan (NECP), that will guide its actions in the coming years. The draft submitted by the Government at the beginning of the year has received numerous observations, both from national stakeholders and from the European Commission, and the coming months will be crucial for deciding the definitive text.

This interesting study, which attempts to assess the impact that energy transition can have on the Italian economic and social system, can be read in this contest, which is certainly complex but also rich in opportunities. It is an extremely detailed analysis, which necessarily adopts a number of hypothetical simplifications, as do all the studies of this type. The message that emerges is clear: not only does Italy already possess important “champions” of renewable energy, but the advantages of transition also appear greater than the costs, especially if the process were to be accompanied by adequate policies.

The very title of the study stresses the importance of enacting a “just” transition, one that takes account of the many effects (not only with regard to employment) that the adoption of an economic system dominated by the use of electrical energy from renewable sources will produce. The subject is a matter for serious reflection also by the social partners, and was one of the most intensely debated topics during the 2019 edition of the Italian Festival of Sustainable Development (from May 21 to June 6) organized by the Italian Alliance for Sustainable Development (ASviS). In particular, the “Manifesto” prepared for that occasion highlighted the most urgent needs: to accelerate the transition; to consider not only environmental and economic sustainability, but also social sustainability: to acknowledge and respect the rights of the future generations, with greater safeguards for the most exposed categories and subjects; to initiate processes of democratic participation in the planning and in the measures of implementation of the transition; to provide adequate public and private investments and enact an eco-friendly fiscal reform capable of shifting taxation from income to the use of resources, and direct the focus of the market and private investments toward sustainable productions and consumptions.

Clearly, it is a broad and complex program, but essential to achieve a project of “just transition”. The results of this study offer a number of suggestions for businesses, the social partners and the country’s policy-makers, who urgently need to find forms of dialogue and synthesis, also in view of the opportunities offered by the European policies in the framework of the 2021-2027 financial programming. At this point, it is no longer a matter of “if” transition is possible but of “how” we are going to implement it. The hope is that Italy arrives on time at one of its main appointments with human history, that is the conversion from a clearly unsustainable development to one that is fully sustainable from the economic, social and environmental standpoint.

Michal Kurtyka

STATE SECRETARY, MINISTRY OF ENVIRONMENT, POLAND; PRESIDENT, COP24

The barriers of energy transition in Europe are no longer technological. Today they are more of a socio-economical and political nature. Changes in energy sector will deeply affect regions and local communities. Hence, all decisions should be taken with consideration of its effects to regions and local communities.

Socio-economic transformation, which is becoming a dominant mindset for the following decades should be taking place on the two levels. First, includes structural reconstruction of economy and redefinition of concepts, such as growth and development. It will require close cooperation between the world leaders and the business. However, to make this system change effective, it must be accepted and adopted on the grounds.

Societies of Europe, similarly to others from the region called the Global North, highly rely on energy in every aspect of life, including heating or transportation. Starting point for the changes of lifestyle, which will support the economic transition, is common understanding that current model of development is no longer valid. Redefinition of growth, change of dietary habits, changing professions are inevitable elements of the economic evolution.

During COP24 in Katowice (December 2018) Polish Presidency launched Solidarity and Just Transition Silesia Declaration, so the idea of just transition or just E-volution became more visible onto the global agenda. One of the key aspects of the Declaration is the notion, that the challenges faced by energy sector in transition from fossil fuels and high emitting industry need not only involvement of stakeholders (relevant international organizations, observer organizations), promotion of low greenhouse gas emission and sustainable economic activities, but to support workers, cities and regions on the issue of just transition of the workforce and the creation of decent work and quality jobs.

Poland with its energy mix highly dependent on coal is still facing just E-volution challenge. We were convinced, that responsible decision-makers must not only deliver a transformation of the energy system but remain mindful on how it is being conducted.

Changing habits is always challenging, but more and more actors realize that crisis can be turned into opportunity. New technologies used in all aspects of life, from everyday smart to the high-tech can be large part of the solution. And young generations, which are natural to innovations, can be *spiritus movens* of the social transformation. It is in the best interest of the youth to embrace changes as soon as possible, but responsibility is on the side of the contemporary leaders to provide education and structural framework for actions.

One of our core goals was to create alternative or complementary business models for energy sector. From 2016 Poland promote e-mobility and alternative fuels as the potential way to move to deep and transformative change without immense socio-economic push-back in the energy sector. Investing in new technologies, such as electromobility for Poland and many other countries is a chance not only for the E-volution but for E-revolution. As just transition is a very complicated and multidimensional process, sometimes we need to move fast enough to achieve our global ambitions.

Socio-economic transformation can be seen as an opportunity, not only on the economic sense, but also in much broader manner. It is kind of a test for humanity and solidarity of humankind. Climate change and depletion of the world resources will affect countries and regions in a different time, and different ways. But it is a common cause and common responsibility.

Adair Turner

CHAIR OF THE ENERGY TRANSITIONS COMMISSION; FORMER CHAIR, UNITED KINGDOM CLIMATE CHANGE COMMITTEE

2019 has brought further evidence that global warming is occurring in line with climate scientists' predictions and that the consequences for humanity could be severe and potentially catastrophic. Record global temperatures in June and July: unprecedented heatwaves in Australia and India which saw temperatures above 50°C; and huge forest fires across much of Russia, all tell us we are running out of time to cut emissions and contain global warming to at least manageable levels. We must accelerate progress towards a low and eventually zero carbon economy; if we don't, we will do huge irreversible harm to human welfare.

The good news is that we already know how to build a zero-carbon economy, the technologies are available, and the aggregate economic cost will be very low.

The most important priority is to electrify as much of our economies as possible, and to ensure that by mid-century at the very latest, and preferably much sooner, all electricity is produced in a zero-carbon fashion. That was the message of The European House – Ambrosetti / ENEL reports on *e-Mobility Revolution* and *Electrify 2030* which were presented at the Villa d'Este conferences in 2017 and 2018. It is also the clear conclusion of the Energy Transitions Commission's recent report – *Mission Possible* – published in December 2018. (www.energy-transitions.org/mission-possible). In particular, *Mission Possible* shows how electrification and the use of zero carbon hydrogen, produced via electrolysis, will be crucially important even in the harder to abate industrial sectors such as steel, cement and chemicals, and in long-distance and heavy duty transport sectors, such as trucking, aviation and shipping.

The ETC's *Mission Possible* report also confirmed that the aggregate cost of fully decarbonising the global economy by 2050 would be only about 1% of global GDP. Or to put it another way, if the world commits to building a zero-carbon economy by 2050, it will only need to wait until 2050 to reach the standard of living otherwise achieved in the middle of that year.

But while the aggregate costs and therefore the average cost to individual citizens are bound to be small there will still be major transition challenges. Jobs will be lost in some companies whose products are based on "thermal" technologies, even while jobs are created in the industries and companies focused on electrical and digital technologies.

Particular groups of consumers may face additional cost, even while others gain significantly. So it is essential to anticipate the social and distributional consequences of the transition in order to manage them better.

This year's The European House – Ambrosetti/ENEL and Enel Foundation report, *"Just E-volution 2030"*, is therefore focused on the transitional costs, benefits and complexities of the required energy transition. The analysis is based on a robust, granular and ground-breaking analysis of how the transition will affect supply chains, companies and employment in the European Union, Spain, Italy and Romania. It sets out estimates of the impact on industrial production and employment and it provides important insights on the public policies required.

Overall the report's findings are reassuring. They show that accelerated progress towards an electrified economy will increase total industrial value-added, as activity and innovation in the new electrical and digital technologies offset the gradual shrinking of "thermal" technology focused industries. Crucially too, the analysis shows that total employment in Spain, Italy and Romania, and across the European Union could be increased by a rapid shift to an electrified economy.

But the report also highlights that old technology jobs and output must shrink and provides granular understanding of the sub sectors where that will occur. As a result, its findings can better equip companies to manage their transitions, and public policy makers to provide appropriate support.

Turning to the social benefits and costs of the transition, one of the most striking sections of the report highlights the huge benefits to air quality and health which will arise in a fully electrified economy – and most strikingly in northern Italy. The adverse impact of internal combustion engines on air quality is well familiar to most people: but the report also highlights the large contribution to particulate and other pollutants caused by any form of combustion in densely populated areas, including through the use of gas in residential heating. Decarbonising residential heating, in particular through electrification using heat pumps, is therefore a major priority and one which will create large new business opportunities.

However, it is also clear that residential heating is one area where the energy transition is likely to involve significant additional costs. In the road transport sector the inherent efficiency advantage of electric versus internal combustion engines, means that the long term costs of the transition will be negative. As battery costs decline, and EV manufacturing costs are reduced through massive scale production, consumers will eventually pay significantly less for electric mobility services then they currently pay to buy and run internal combustion engine vehicles; indeed, that point is likely to be reached by the mid-2020s. But installing heat pumps and improving insulation to decarbonise residential heating will on average add to household costs, and in some cases the additional costs will be significant. It will not be enough to say that consumers in aggregate will gain on the road transport side what they lose on residential heating; we need to recognise that for some the balance will be negative even while others gain.

We therefore need thoughtful policies to manage this distributional impact and this year's report discusses what those policies could be. One crucial issue is whether subsidies for the initial deployment of renewable electricity should be recovered via customer bills or paid for out of government budgets. Direct support for low income families to install new equipment and better insulation could be an important element within the policy mix. And as was the case in renewable electricity generation, we need to recognise the potential for ambitious targets to drive big cost reductions via economy of scale and learning curve effects.

The objective we must reach is clear- net zero carbon emissions from the global industrial and energy system by mid-century. And we know the key strategy to get there - electrification of as much of the economy as possible, combined with a major expansion of the use of hydrogen. What we now need are the specific public policies and company investments which will deliver this transformation while managing the transitional social consequences. This report on the *Just E-volution 2030* will help guide us on that path.

The study's ten key findings

1

Global, European and national institutions are in the front lines in supporting the pathway toward transformation of the global energy sector from fossil-based to zero-carbon.

The energy sector is currently in the midst of a profound change where technology is revolutionizing the way energy is produced, distributed and consumed and it is opening the door to business models which, only a few years ago, were unimaginable. Global, European and national institutions are aware of this deep change and set targets going in the direction of decarbonizing the economy, including the energy sector. At the international level, the ambitious target set by the COP21 in Paris is setting in motion policy makers worldwide, who are working on policies and measures able to "*hold the increase in the global average temperature to well below* ***2 °C*** *above pre-industrial levels*" pursuing efforts to limit the temperature increase to **1.5 °C**. At the European level, targets for decarbonization by 2030 call for a reduction of **40%** of GHG emissions compared to 1990 levels, a **32%** share of renewable energy sources in final energy consumption and a **32.5%** improvement in energy efficiency. With the EU targets in mind, each Member State is setting its own national targets in their National Energy and Climate Plans.

2

Beyond policy targets, citizens are more and more concerned about sustainability and resilience, thus creating a favorable economic and societal context for the energy transition.

Beyond policy targets set at international, European and national level, there are **seven socio-economic trends**, spurring the energy transition:

- **New lifestyles:** visible negative impacts of non-decarbonized and not-sustainable economies (climate change, pollution-related diseases, impacts of air pollution on flora and fauna, etc.) are raising concerns among citizens, bringing them to behave in a more sustainable way.
- **Green Generation:** younger generations are the most sensitive to the urgency of energy transition. They strongly believe that protecting the environment and fighting climate change should be a priority for the European Union in the years to come (**67%** of respondents to a survey made by the European Commission put this issue in the **first place** of policymakers' agenda).
- **Digitalization:** it is changing the way energy is generated, transported and consumed, making it more connected, intelligent, efficient, resilient and sustainable.
- **Reduction of technological cost:** technological progress in the energy sector can be considered the first technological enabling condition to put in place actions aimed at reaching policy targets. The decreasing cost of technologies can significantly accelerate the energy transition.
- **Increasing attention to Corporate Social Responsibility:** over the last years, also companies' approach towards sustainability has changed in order not only to meet targets set by national and international institutions and company duties but also to reap all the benefits stemming from sustainability practices (i.e. gaining competitive advantage and increasing productivity). Istat (the Italian National Institute of Statistic) recently realized a survey among Italian companies about their orientation towards sustainability. The results of the survey allowed to group companies in four categories (unsustainable, low-sustainable, medium-sustainable and high-sustainable companies), according to the number of activities undertaken to promote sustainable development. Then, the study shows that medium-sustainable companies have a productivity **7.9%** higher than unsustainable companies. The percentage increases to 10.2% when considering the cluster of high-sustainable companies.
- **Green investment:** green investment assets are steadily increasing globally, with some regions demonstrating stronger growth than others, setting a favourable context also towards a zero-carbon economy (the largest increase was in Japan, where sustainably managed assets grew more than 300 times over the period 2014-2018).
- **Circular Economy:** it entails the rethinking of energy production and supply systems by using local resources that otherwise would be wasted (e.g. use of domestic and industrial organic waste to produce heat and electricity).

3

There are seven features that make the electric carrier pivotal for energy transition.

There are **seven reasons** why the electric carrier is pivotal for the energy transition, while favouring the achievement of European and national policy targets:

- It allows to reduce **CO_2 emissions** when electricity is generated through an energy mix integrating a significant share of renewables and it enables the reduction of pollutant emissions improving **air quality**, in particular in urban areas.
- It reduces **noise pollution**, limiting annoyance, stress and sleep disturbance with their consequent risk of hypertension and cardiovascular disease, thus improving the quality of life in urban areas.
- It offers several opportunities to improve the **resilience** and **security of supply** of the energy system, thanks to its versatility, flexibility and integration of renewable energy sources.
- It provides higher level of **energy efficiency**, reducing the energy demand and the GHG emissions; if compared with traditional thermal technologies, the electric ones perform better in terms of energy efficiency.
- It can be easily integrated with **digitalization**, enabling more effective management and higher efficiency of the energy system.
- It stimulates innovation and sustainability in **lifestyles** and **industrial** processes.
- It can play an important role in favouring and supporting the **Circular Economy**, thanks to the innovation in renewable energy production, energy storage and structural changes in the system (shift from a centralized to a decentralized electricity system).

4

An innovative assessment model has been devised to evaluate the socio-economic impacts of the energy transition at 2030 in the EU28 and in Italy, Spain and Romania.

The quantitative assessment of the socio-economic impacts of the energy transition is pivotal to guide policymakers' agendas in order to ensure a transition "just for all". With this purpose in mind, an **innovative assessment model** has been devised, aimed at evaluating the socio-economic impacts of the energy transition enabled by electrification at 2030. The model focuses on the **European Union** as a whole and three countries of interest, **Italy**, **Spain and Romania**, providing outcomes in terms of **production value** and **employment**. The time-frame of reference is 2030. From a methodological point of view, the model combines a micro and macro approach, dealing with the analysis of all **3,745 products and technologies** that characterize European industrial production, combined with a deep analysis of the existing literature, desk analysis and interviews with the expert panel.

5

The net effect of the energy transition on existing technology value chains will be increasingly positive at 2030 in the European Union, Italy, Spain and Romania.

In the first part of the analytical assessment model, only the extended value chains have been considered, specifically the Research & Development, Manufacturing and Distribution, Sales and Aftermarket. The production values and employment of electric, thermal and neutral technologies at 2030 have been derived according to the evolution of final energy demand in three different scenarios (EU Reference Scenario, EUCO3232.5 Scenario and Eurelectric Scenario), implying a different growth of electrification with an *ad hoc* algorithm for some electrification bundles leading the transition (solar panels, heat pumps, electric motors, electrical storage systems – batteries, LED lamps, power electronics, wind turbines). The **production value of electric technologies will increase** at 2030 in all economies considered:

- **European Union**: from **+118 billion** (in the EU Reference Scenario) to **+199 billion Euros** (in the Eurelectric scenario) between 2017 and 2030.
- **Italy**: from **+11 billion** (in the EU Reference Scenario) to **+25 billion Euros** (in the Eurelectric Scenario) between 2017 and 2030.
- **Spain**: from **+7 billion** (in the EU Reference Scenario) to **+12 billion Euros** (in the Eurelectric Scenario) between 2017 and 2030.
- **Romania**: from **+1 billion** (in the EU Reference Scenario) to **+3 billion Euros** (in the Eurelectric Scenario) between 2017 and 2030.

These increases more than outweigh the expected **decrease in production value for thermal technologies** in all economies considered at 2030:

- **European Union**: from **-71 billion** (in the EU Reference Scenario) to **-119 billion Euros** (in the Eurelectric Scenario) between 2017 and 2030.
- **Italy**: from **-3 billion** (in the EU Reference Scenario) to **-8 billion Euros** (in the Eurelectric Scenario) between 2017 and 2030.
- **Spain**: from **-5 billion** (in the EU Reference Scenario) to **-9 billion Euros** (in the Eurelectric Scenario) between 2017 and 2030.
- **Romania**: **~1 billion Euro** in the three selected scenarios between 2017 and 2030.

The production value for neutral technologies has been estimated to experience a growth at 2030 spanning from **+207 billion Euros** to **+330 billion Euros** in the European Union, from **+25 billion Euros** to **+48 billion Euros** in Italy, from **+17 billion** to **+28 billion Euros** in Spain and from **+1 billion Euro** to **+8 billion Euros** in Romania.

6

The energy transition is enabling the creation of new digital services.

Digital services will have a crucial role in fostering the energy transition currently underway. A few services related to energy transition are progressively being deployed today and are characterized by a high potential in the upcoming years thanks to technological and digital progress. Among these, the following services have been identified:

- Power system energy storage technologies.
- Smart network management.
- Demand Response.
- Sharing platform.
- Home to Grid.
- Vehicle-Grid Integration.
- Domotics.
- Sensor systems.

The quantification of the additional value generated by the digital services activated at 2030 has moved from the estimation of the additional revenues in the **transport sector at global level**. In particular, the model considered the following digital services within the transport sector: electric batteries technologies, vehicle to grid, vehicle to vehicle, vehicle to home, mobility sharing platform and vehicle sensor systems, whose overall value is equal to **250 billion Euros** at 2030.
The hypothesized scenarios for the European Union, Italy, Spain and Romania have been derived by rescaling the global estimates, using the share of value added generated by digital services in each single country on the basis of their value added in 2017. The production value at 2030 of these additional services that could be created in the near future (marketed in the next 3 to 5 years) amounts to **65 billion Euros** in European Union, **6 billion Euros** in Italy, **4 billion Euros** in Spain and **1 billion Euros** in Romania. These values might be underestimated. The fact that some digital services are still in a preliminary phase of development and the literature on this topic is limited might lead to an overall underestimation of the value of digital services at 2030.

7

The overall net effect of the energy transition will be increasingly positive at 2030 both in terms of industrial production and employment in the European Union, Italy, Spain and Romania.

The final net effects on production value range between **+113 billion Euros** and **+145 billion Euros** for the whole European Union at 2030. In Italy, the net effects of the energy transition on production value have been assessed to be in the range of **+14 billion Euros/+23 billion Euros**, while in Spain the differential impacts span from **+7 billion Euros** to **+8 billion Euros** at 2030. Finally, in Romania the final net effects are estimated to be **+2 billion Euros/ +3 billion Euros**.

The final net impacts on **employment** show an overall positive effect for the European Union and Italy, Spain and Romania. In the European Union, energy transition generates a final net impact ranging from **+997,000 employees** to **+1.4 million employees** at 2030. In the three selected scenarios, in Italy, the net employment gain accounts from more than **+98,000 employess** to **+173,000 employees** at 2030, while in Spain the effect ranges from **+73,000** to **+97,000 employees**. Finally, in Romania the net effect spans from **+30,000** to more than **+52,000**.

8

The energy transition through electrification will improve air quality, which in turn positively affect human health and socio-economic costs.

The electric carrier enables the reduction of pollutant emissions **improving air quality**, in particular in urban areas. The impact of the energy transition on air quality has been assessed for the European Union, Italy, Spain and Romania by considering emissions from transport and residential sectors, which together account for **more than 50%** of the EU total emissions. In particular, the substitution of thermal technologies with electric ones in transport (electric vehicles) and residential sectors (heat pumps) is able to reduce premature deaths in the European Union, Italy, Spain and Romania, respectively by **5,000**, **1,000**, **500** and **170** units at 2030. Moreover, costs related to air pollution in European Union could be reduced from a minimum of **1 billion Euros** to a maximum of **2.9 billion Euros** at 2030.

9

In order to reap the benefits associated to the energy transition in the medium-long run, policymakers have to face two key challenges: preserve European industrial competitiveness and avoid negative distributive effects.

On the one hand, energy transition has to preserve **European industrial competitiveness**, while creating the condition for enhancing industrial competitiveness in the global scenario. It means managing the reduction of industrial production related to thermal technologies and sustaining the conversion of existing value chains towards electric technologies, by guaranteeing adequate investment levels and facing skills mismatch. On the other hand, it has to avoid **negative distributive effects** across different socio-economic dimensions, preventing an unfair distribution of costs and guaranteeing equal access to the benefits generated by the energy transition among different areas (e.g. cities and rural areas) and population segments.

10

Four policy matters have been identified in order to effectively tackle the challenges related to energy transition and redistribute its benefits by ensuring a transition "just for all".

1. Supporting the **deployment of electric technologies** by promoting an effective **value chains conversion towards electric technologies**. Some target actions to achieve these objectives consist in introducing energy transition investment bonds, innovative financial schemes for mature technologies along the overall electricity value chain, promoting campaigns to raise awareness of the advantages associated to electric technologies and enhancing, at country-level, National Energy Clusters with a specific focus on electrification technologies.
2. Managing **job losses** and increasing **job opportunities** and addressing the issues of **re-skilling** and **up-skilling**. This could be done through social measures for workers in sectors with higher risk of substitution, a European Energy Transition Fund, new educational programs identifying and anticipating the skills needed for energy transition, exchange programs focused on energy transition and awareness campaigns.
3. Addressing the **issue of energy poverty**, introducing an official composite index for measuring energy poverty in Member States, as a premise for national policy frameworks to address it, enhancing a target program to retrofit existing buildings to a high efficiency standard, promoting measures to inform consumers and fostering social tariffs or energy subsidies for low-income households.
4. Promoting a **fair redistribution of costs associated to the energy transition**, revising cost items within electricity bills and discharging them from unproper taxes and levies.

A final recommendation is to identify **best practices** put in place at the international level to effectively manage the transition period and transposing them at EU28 level and its Member States.

Executive Summary

The reference context of the energy transition in Europe

- The energy sector is currently in the midst of a profound change. Technological progress is revolutionizing the way energy is produced, distributed and consumed and it is opening the door to business models which, only a few years ago, were unimaginable. The traditional energy paradigm, based on energy production from fossil fuels, is no longer viable. Over the last years, international institutions and policy makers have put **decarbonization and resilience** at the heart of their political agenda. Decarbonization refers to the reduction of Greenhouse Gases (GHG) release. GHG emissions generate several negative effects on the overall ecosystem: global warming, food insecurity, natural disasters, extreme poverty and human diseases. As a result, the urgency of greater resilience, defined as the ability of an ecosystem to respond and recover from a perturbation and turmoil of any type (financial crisis, natural disasters, infrastructures breakdown, etc.), has increased, with the aim to mitigate and effectively deal with the negative effects generated by GHG emissions.

- At the international level, the ambitious target set by the COP21 in Paris is setting in motion policy makers worldwide, who are working on policies and measures able to "*hold the increase in the global average temperature to well below **2°C** above pre-industrial levels*", pursuing efforts to limit the temperature increase to **1.5°C**. With the EU targets in mind, each Member State has set its national targets in their own National Energy and Climate Plans.

- At the European level, the European Commission, in response to European Union's commitment to the Paris agreement, has launched the **European Union 2030 Climate & Energy Framework**, a milestone of the long-term low-carbon economy roadmap for 2050. This framework, adopted by the European Union's leaders in 2014 and revised upward in 2018, sets three strategic goals:
  - At least **40%** cuts in greenhouse gas emissions compared to 1990 levels.
  - At least **32%** share of renewable energy in final energy consumption.
  - At least **32.5%** improvement in energy efficiency compared to 1990 levels.

Figure 1

European Union Climate and Energy targets in different policy plans

2020 Climate & Energy Package	2030 Climate & Energy Framework	Revision of the 2030 Climate & Energy Framework according to the Political agreement among The European Commission, the European Parliament and the Council
2009	2016	2018
20% cut in greenhouse gas emissions (vs. 1990 levels) by 2020	At least **40%** cuts in greenhouse gas emissions (vs. 1990 levels) by 2030	New target for renewables at **32%** by 2030
20% of EU energy from renewables by 2020	At least **27%** share for renewable energy by 2030	New energy efficiency target for the EU for 2030 of **32.5%**, with an upward revision clause by 2023
20% improvement in energy efficiency by 2020	At least **27%** improvement in energy efficiency by 2030	

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN COMMISSION DATA, 2019.

- Beyond policy targets set at international, European and national levels, people are more and more concerned about sustainability and resilience, thus creating a **favorable economic and societal context** for the energy transition. Socio-economic trends driving the energy transition could be grouped in **seven clusters**:
  - **New lifestyles**: visible negative impacts of non-decarbonized and not-sustainable economies (climate change, pollution-related diseases, impacts of air pollution on flora and fauna, etc.) are raising concerns among citizens, bringing them to behave in a more sustainable way.
  - **Green Generation**: younger generations are the most sensitive towards the urgency of the energy transition. They strongly believe that protecting the environment and fighting climate change should be a priority for the European Union in the years to come (**67%** of respondents to a survey made by the European Commission put this issue in the **first place** of policymakers' agenda).
  - **Digitalization**: it is changing the way energy is generated, transported and consumed, making the energy system more connected, intelligent, efficient, resilient and sustainable.
  - **Reduction of technological costs**: technological progress in the energy sector can be considered the first enabling condition to put in place actions aimed at reaching policy targets. The decreasing cost of technologies can significantly accelerate the energy transition.
  - **Increasing attention to Corporate Social Responsibility**: over the last years, also companies' approach towards sustainability has changed in order not only to meet targets set by national and international institutions and company duties, but also to reap all the benefits stemming from sustainability practices (i.e. gaining competitive advantage and increasing productivity). Istat (the Italian National Institute of Statistic) recently realized a survey among Italian companies about their orientation towards sustainability. The results of the survey allowed to group companies in four categories (unsustainable, low-sustainable, medium-sustainable and high-sustainable companies), according to the number of activities undertaken to promote sustainable development. Then, the study shows that medium-sustainable companies have a productivity **7.9%** higher than unsustainable companies. The percentage increases to **10.2%** when considering the cluster of "high-sustainable companies".
  - **Green investment**: green investment assets are steadily increasing globally, with some regions demonstrating stronger growth than others, setting a favorable context also towards a zero-carbon economy (the largest increase was in Japan, where sustainably managed assets grew more than 300 times over the period 2014-2018).
  - **Circular Economy**: it entails the rethinking of energy production and supply systems by using local resources that otherwise would be wasted (e.g. use of domestic and industrial organic waste to produce heat and electricity).

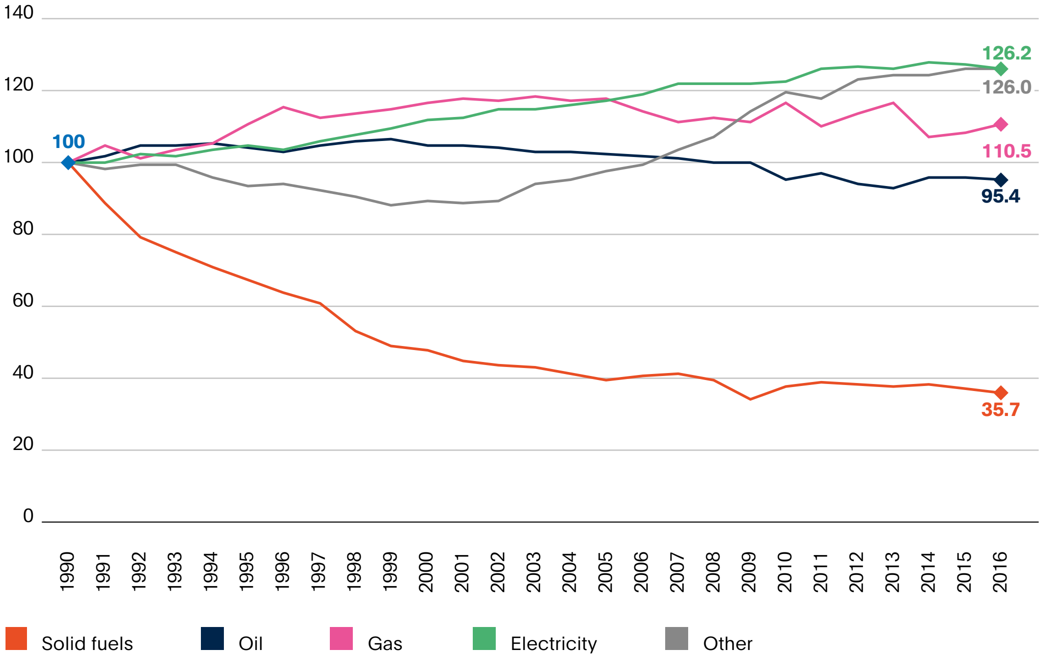
The role of electricity towards the transition

- The Total Primary Energy Demand is **constantly increasing**, accounting for a 2% average annual growth since 2000. The 2017 growth (2.1%) was mainly driven by positive global economic outlook and the rising of heating and cooling needs in some regions of the world. To date, Total Primary Energy Demand at global level is still mainly satisfied by oil, accounting for 32% of the total, followed by coal (27%). The third largest component is natural gas, totaling 22%. Biomass accounts for about 10%, while nuclear and hydropower and other renewables account both for 5% of the total. In other words, fossil fuels (oil, coal and gas) still satisfy more than 80% of the Total Primary Energy Demand.

- The electric carrier is gradually becoming the pivotal source for matching the energy needs of a society amidst a deep transformation. In ensuring a reliable and secure provision of affordable energy, while reaching environmental goals, electricity lays at the heart of the global economy. While fossil fuels maintain a predominant role in the Total Primary Energy Demand at global level, the electricity penetration in final energy consumption is rising. Indeed, electricity has been the **fastest growing energy carrier** in Europe: the electricity share in final energy consumption has increased by **26%** with respect to 1990.

Figure 2

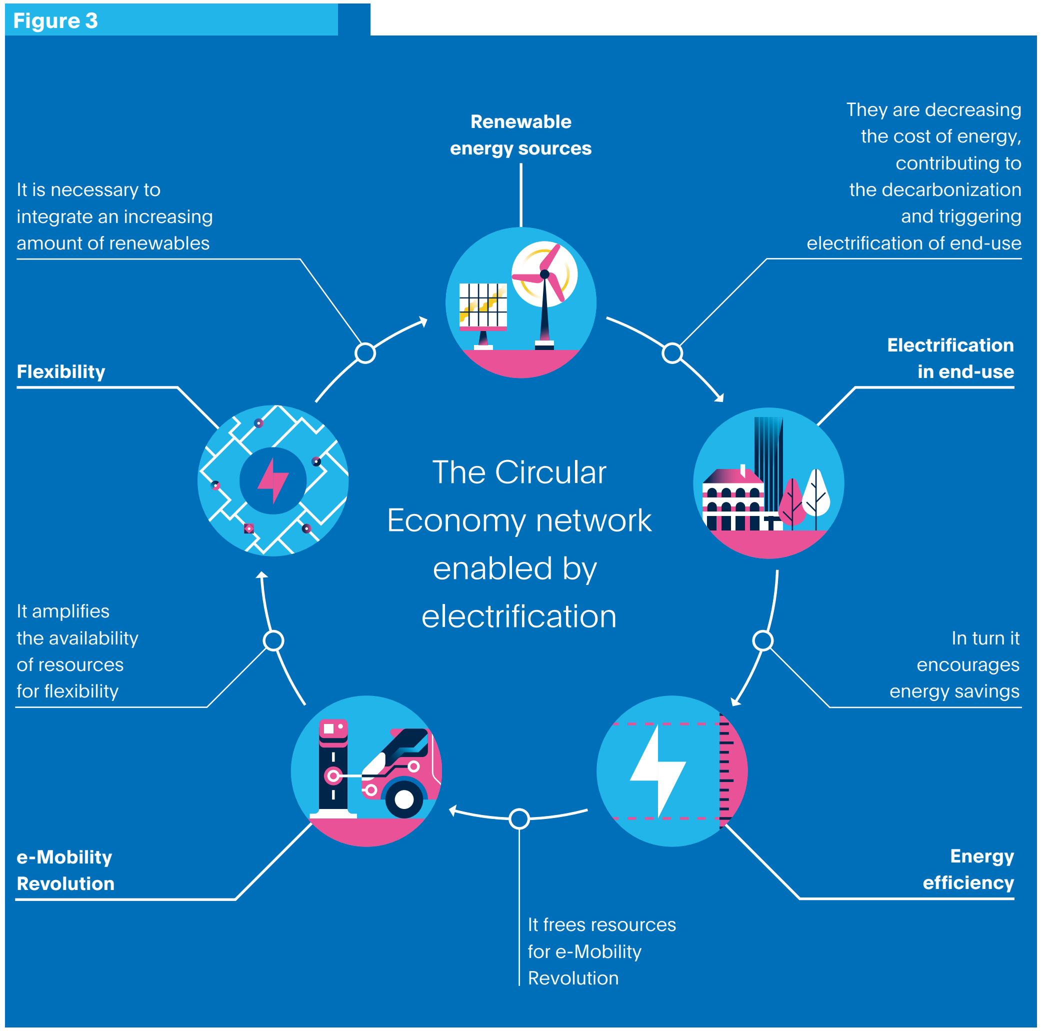
Final energy consumption by fuel in Europe, 1990–2016 (index year 1990=100)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN ENVIRONMENT AGENCY (EEA), 2019.

- There are **seven features** that make the electric carrier pivotal for the energy transition, while favouring the achievement of European and national policy targets:
  1 It allows to **reduce CO_2 emissions** when electricity is generated through an energy mix integrating a significant share of renewables and it enables the reduction of pollutant emissions **improving air quality**, in particular in urban areas.
  2 It **reduces noise pollution**, limiting annoyance, stress and sleep disturbance, reducing the consequent risks of hypertension and cardiovascular diseases, thus improving the quality of life in urban area.
  3 It offers several opportunities to **enhance the resilience** and the **security of supply** of the overall energy system, thanks to its versatility, flexibility and integration of renewable energy sources.
  4 It promotes **higher level of energy efficiency**, reducing the energy demand and the GHG emissions. When compared with traditional thermal technologies, the electric ones perform better in terms of energy efficiency. This holds for heat pumps, LED lamps, electric drives and electrochemical storage systems (batteries).
  5 It can be easily **integrated with digitalization**, enabling more effective management and higher efficiency of the energy system.
  6 It stimulates **innovation and sustainability** in lifestyles and industrial processes.
  7 It can play an important role in **favouring and supporting Circular Economy**, thanks to the innovation brought in renewable energy production, energy storage and structural changes in the system.

Figure 3



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

- Given the energy targets and the European Union full decarbonization objectives at 2050, the future of energy should be **fully renewable**. However, also short-term decarbonization goals have to be met; in this sense, other energy carriers can play an important role when combined with renewable electricity in the transition phase. Indeed, the exploitation of renewable and low-carbon gas[1] can potentially **accelerate the decarbonization effort in the short-run**. In this sense, natural gas, biomethane, biofuels and hydrogen can be used to increase sustainability and green production of energy and electricity as well.

- The world is gradually building a different kind of energy system based on three pillars: affordability, reliability and sustainability. The three pillars are closely interconnected: each of them and the trade-offs between them, require a **comprehensive approach to energy policy**, taking into account the contribution of renewable energy sources towards the affordability and sustainability of the system while considering their requirements in terms of reliability.

An innovative assessment model for socio-economic impacts of the energy transition in Europe, with a focus on Italy, Spain and Romania

- In light of the relevance of the electric carrier, the energy transition enabled by electrification presents significant opportunities for society as a whole. In this sense, the quantitative assessment of the socio-economic impacts of the energy transition is pivotal to guide policymakers' agendas in order to ensure a transition "just for all". With this purpose in mind, an **innovative analytical model** has been devised, aimed at assessing the socio-economic impacts of the energy transition enabled by electrification at 2030. The model focuses on the **European Union** as a whole and on **Italy**, **Spain** and **Romania**, estimating outcomes in terms of **production value** and **employment**. The time-frame of reference is **2030**. From a methodological point of view, the model combines a micro and macro approach, dealing with the analysis of all **3,745 products and technologies** that characterize European industrial production, combined with a deep analysis of the existing literature, desk analysis and interviews with the expert panel.

- Moving from a wide socio-economic analysis of all the European Union countries, the study has been focused on Italy, Spain and Romania. Indeed, combining economic, societal and energy features, it emerges that Italy, Spain and Romania are **representative of three different clusters of countries at the EU level** with respect to the energy transition. Focusing only on GDP *per capita* and the share of energy from renewable sources, it is possible to define different samples of countries within the European context. Italy belongs to the set of countries with the income and a share of renewable energy sources slightly above the European Union averages. Spain, instead, is aligned with the European Union average with respect to share of renewable energy sources, but its income is slightly below the European Union average. Finally, Romania presents a share of renewable energy sources above the European Union level, but with a GDP *per capita* of 9,600 Euros it is below the European Union average.

- The first part of the analysis focuses on the **extended value chains** (Research & Development, Manufacturing and Distribution, Sales and Aftermarket) **of all the products and technologies** involved in the energy transition process, enabled by electrification, that are already produced and marketed. The second part deals with the identification and the quantitative assessment of the **digital services** related to the energy transition that will be further developed in the future and that will be marketed in the next years (3 to 5 years). The rationale underpinning the analytical model is a **differential approach**: the final results related to the first part are expressed as the net balance between the overall production value and employment respectively gained and lost by the overall system due to the electrification deployment and thermal technologies' downsizing between 2017 and 2030. Then, the production value and employment generated at 2030 by additional digital services are estimated and added on top, since these are directly connected to the future electrification deployment.

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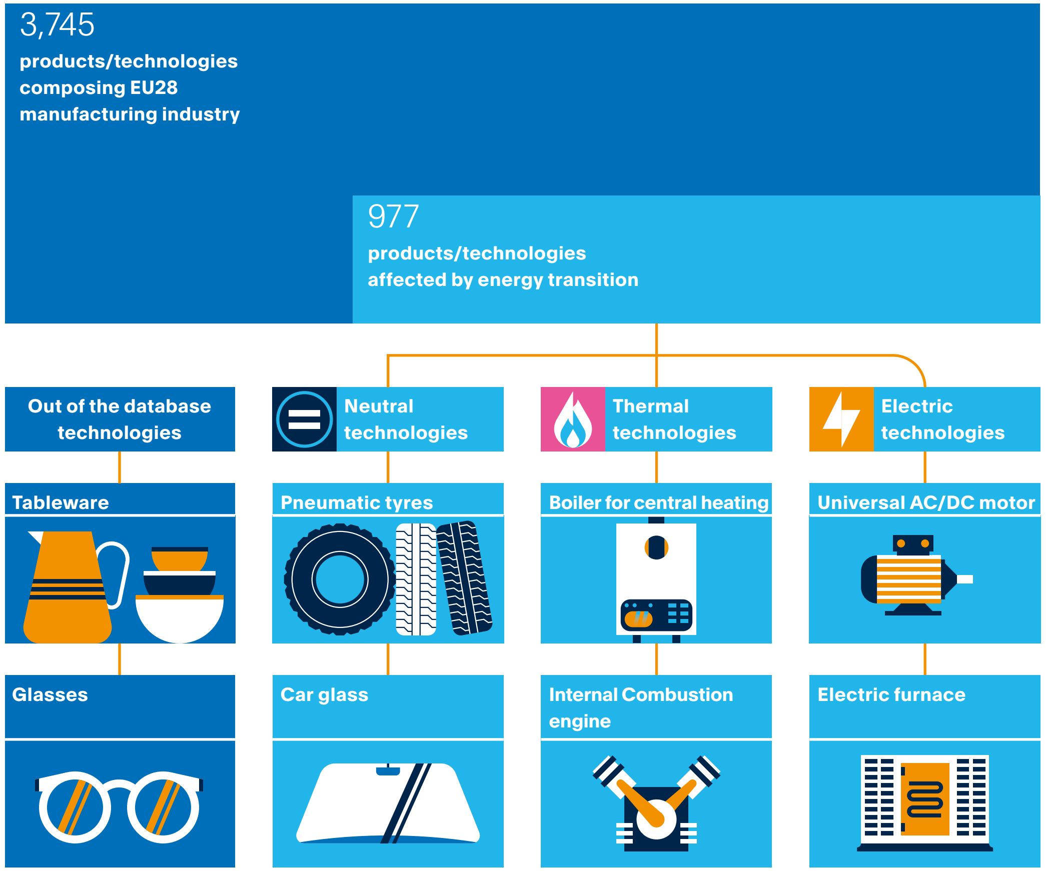
[1] Renewable gas refers to all gas produced from renewable sources. This includes biomethane, green hydrogen, produced from renewable electricity (power-to-gas), and power to methane, in which biogenic CO_2 and green hydrogen are methanised. Low-carbon gas is gas that, during production, has small volumes of CO_2 remaining uncaptured. Low-carbon gas includes also blue hydrogen.

- Starting from the first part of the model, the **3,745 products and technologies** representing the overall European manufacturing industry at 2017 have been considered. Then, the products and technologies involved in and potentially impacted by the energy transition enabled by electrification have been identified, resulting in **977 products and technologies**. Then, their prevailing nature with regard to the energy transition has been identified, namely **neutral** (the ones which should not be affected by the electrification process), **electric** (the ones more closely related to the electric technologies and expected to be potentially positively affected by the energy transition) and **thermal** (the ones more closely related to traditional fuel or other thermal technologies and expected to be potentially negatively affected by the energy transition) technologies.

Figure 4

Examples of the selected technologies by their prevailing nature, 2019



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

- The production value at 2030 of the 977 products and technologies considered is estimated for both thermal and electric products and technologies by correlating the specific (thermal and electric) production value at 2017 with the corresponding **energy demand in the period 2017–2030**, for the European Union, Italy, Spain and Romania. As a result of this correlation, **technology and country specific coefficients** have been derived. They have been applied to the production value at 2017 in order to estimate the corresponding value at 2030.

- Moreover, in order to differentiate the final results according to different policy frameworks, **three scenarios have been taken into account**, characterized by a different electrification rate: the EU Reference Scenario, the EUCO3232.5 Scenario and the Eurelectric Scenario.

- In the first part of the analytical assessment model, only the extended value chains have been considered, specifically the Research & Development, Manufacturing and Distribution, Sales and Aftermarket. The production value of electric technologies will increase in the period 2017–2030 in all the countries considered:
  - **European Union**: from **+118 billion** (in the EU Reference Scenario) to **+199 billion Euros** (in the Eurelectric scenario) between 2017 and 2030.
  - **Italy**: from **+11 billion** (in the EU Reference Scenario) to **+25 billion Euros** (in the Eurelectric Scenario) between 2017 and 2030.
  - **Spain**: from **+7 billion** (in the EU Reference Scenario) to **+12 billion Euros** (in the Eurelectric Scenario) between 2017 and 2030.
  - **Romania**: from **+1 billion** (in the EU Reference Scenario) to **+3 billion Euros** (in the Eurelectric Scenario) between 2017 and 2030.

- These increases more than outweigh the expected decrease in production value for thermal technologies in all economies considered at 2030:
  - **European Union**: from **-71 billion** (in the EU Reference Scenario) to **-119 billion Euros** (in the Eurelectric Scenario) between 2017 and 2030.
  - **Italy**: from **-3 billion** (in the EU Reference Scenario) to **-8 billion Euros** (in the Eurelectric Scenario) between 2017 and 2030.
  - **Spain**: from **-5 billion** (in the EU Reference Scenario) to **-9 billion Euros** (in the Eurelectric Scenario) between 2017 and 2030.
  - **Romania**: **~1 billion Euro** in the three selected scenarios between 2017 and 2030.

- The production value for neutral technologies has been estimated to experience a growth at 2030 spanning from **+207** to **+330 billion Euros** in the European Union, from **+25** to **+48 billion Euros** in Italy, from **+17** to **+28 billion Euros** in Spain and from **+1** to **+8 billion Euros** in Romania.

- **Digital services will have a crucial role in fostering the energy transition** currently uderway. A few services related to energy transition are progressively being deployed today and are characterized by a high potential in the upcoming years thanks to technological and digital progress. Among these, the following services have been identified:
  - Power system energy storage technologies.
  - Smart Network Management.
  - Demand Response.
  - Sharing platform.
  - Home to Grid.
  - Vehicle-Grid Integration.
  - Domotics.
  - Sensor systems.

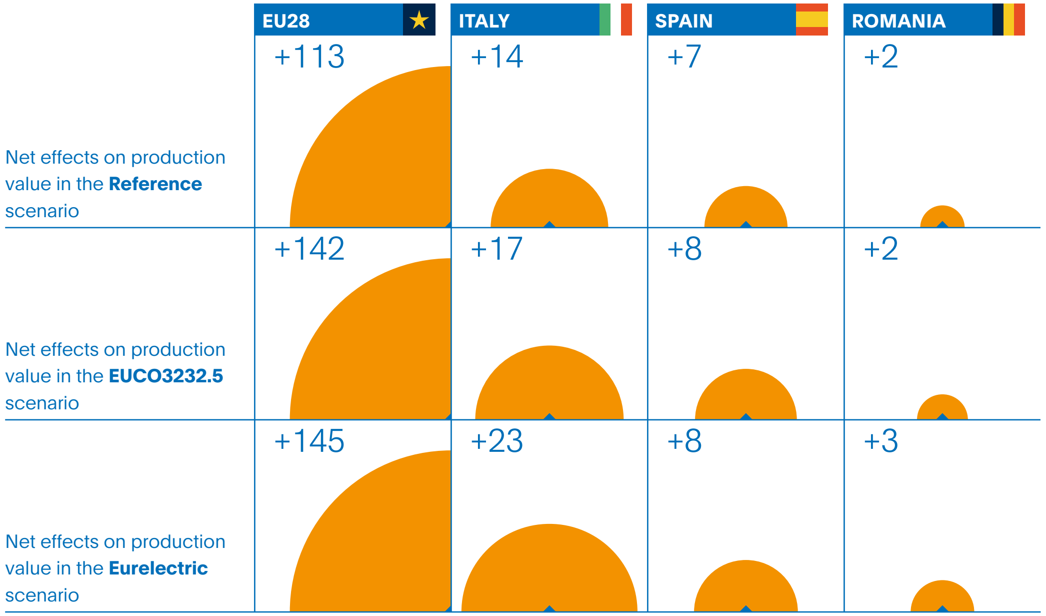
- In order to quantify the additional value generated by the digital services activated at 2030, the first step was to estimate the additional revenues in the transport sector at global level, the only one available in the existing literature. Indeed, the existing literature (see Part 3 for a detailed list of studies) provides only an estimate of the additional value of digital services activated at 2030 within the transport sector (electric batteries technologies, vehicle to grid, vehicle to vehicle, vehicle to home, mobility sharing platform and vehicle sensor systems) and is equal to **250 billion Euros**. This value (and the corresponding values for the EU28, Italy, Spain and Romania) could be underestimated due to the following reasons:
  - On the one hand, the early stage of these services to date implies that it is difficult to foresee their future value.
  - On the other hand, the fact that the ICT services include only the ones closely related to the transport sector could lead to a further underestimation of the final effect of digital services associated to the energy transition as a whole.

- As a second step, the hypothesized scenarios for the European Union, Italy, Spain and Romania have been derived by rescaling the global estimates, using the share of value added generated by digital services in each single country on the basis of their value added in 2017. The assumption beneath this reparametrization is that the share of each single country on the global value added will not vary between 2017 and 2030. The production value at 2030 of these additional services that could be created in the near future (marketed in the next 3 to 5 years) amounts to **65 billion Euros** in European Union, **6 billion Euros** in Italy, **4 billion Euros** in Spain and **1 billion Euro** in Romania.[2]

- The final net effects on production value range between **+113 billion Euros** and **+145 billion Euros** for the whole European Union at 2030. In Italy, the net effects of energy transition on production value have been assessed to be in the range of **+14 billion Euros/+23 billion Euros**, while in Spain the differential impacts span from **+7 billion Euros** to **+8 billion Euros** at 2030. Finally, in Romania the final net effects is estimated to be **+2 billion Euros/+3 billion Euros**.

Figure 5

Final net impacts of energy transition at 2030 on production value in the three analysed scenarios for EU28, Italy, Spain and Romania (billion Euros)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

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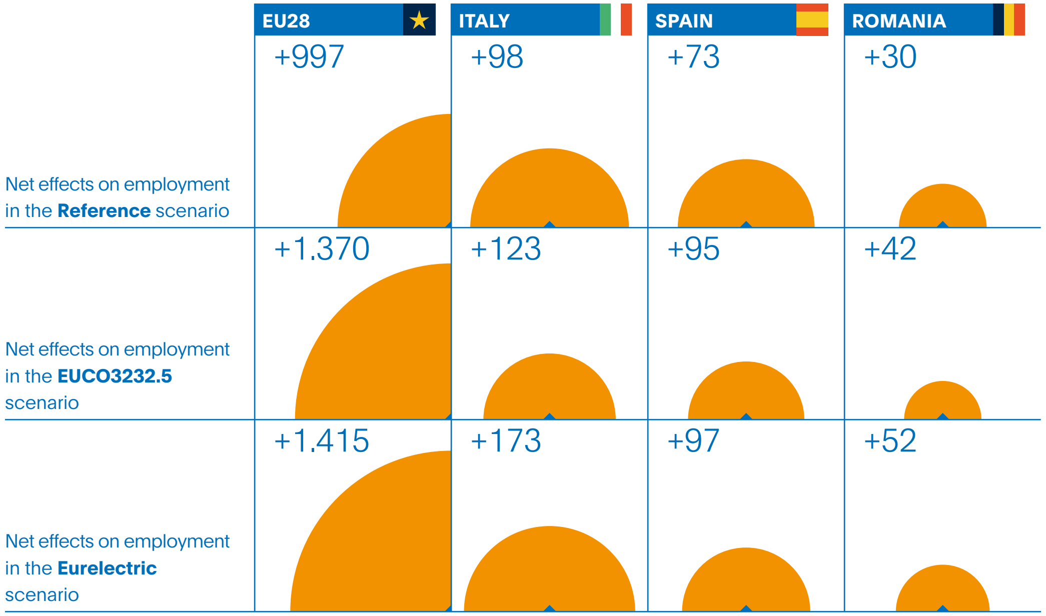
[2] New digital services directly and indirectly enabled by electrification will be fully introduced in the market in the next years and they are only at an early stage of development today. The presence of few information in the existing literature about these services could lead to an underestimation of the value generated by digital services at 2030.

- The final net impacts on **employment** show an overall positive effects for the European Union and all the countries on which the analysis is focused. In the European Union, energy transition generates a final net impact from **+997,000 employees** to **+1.4 million employees** at 2030. In the three selected scenarios, in Italy, the net employment gain accounts from **+98,000** to **+173,000** at 2030, while in Spain the effect ranges from **+73,000** to **+97,000** and in Romania from **+30,000** to more than **+52,000**.

Figure 6

Final net impacts of energy transition at 2030 on employment in the three analysed scenarios for EU28, Italy, Spain and Romania (thousands)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

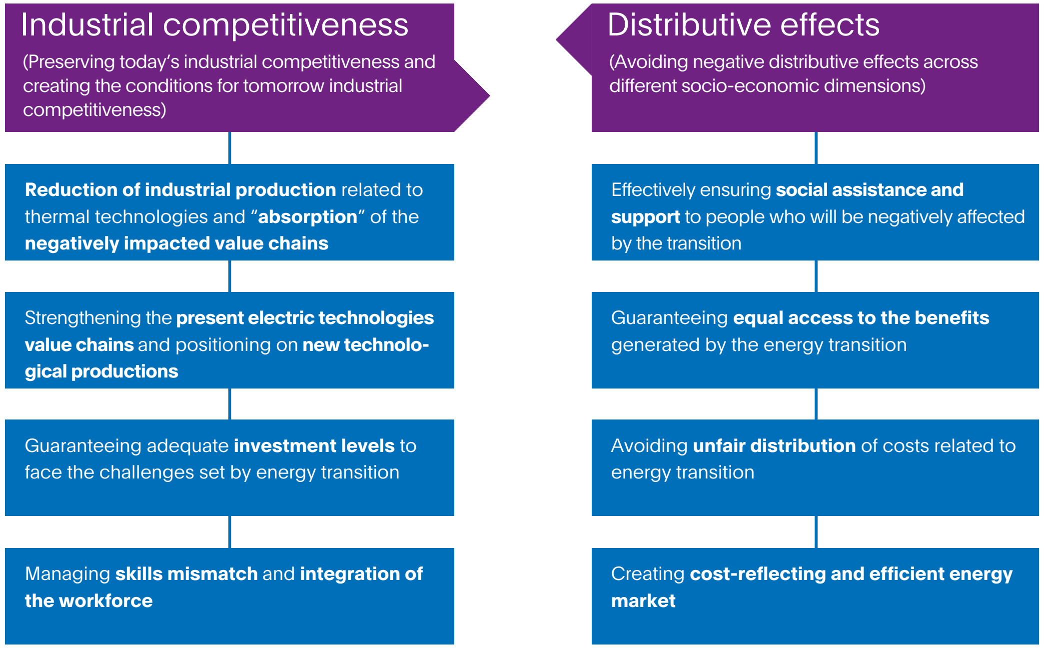
- The electric carrier enables the reduction of pollutant emissions improving **air quality**, in particular in urban areas. The impact of the energy transition on air quality has been assessed for the European Union, Italy, Spain and Romania by considering emissions from transport and residential sectors, which together account for more than **50%** of EU total emissions. In particular, the substitution of thermal technologies with electric ones in transport (e.g. electric vehicles) and residential sectors (e.g. heat pumps) is able to reduce premature deaths in the European Union, Italy, Spain and Romania, respectively by **5,000**, **1,000**, **500** and **170** units at 2030. Moreover, costs related to air pollution in the European Union could be reduced from a minimum of **1 billion Euro** to a maximum of **2.9 billion Euros** at 2030.

Policy proposals and recommendations to make the energy transition "just for all"

- In order to reap the benefits associated to the energy transition in the medium-long run, policymakers have to face **two key challenges**. On the one hand, energy transition has to **preserve European industrial competitiveness**, while creating the conditions for enhancing industrial competitiveness in the global scenario. It means managing the reduction of industrial production related to thermal technologies and sustaining the conversion of existing value chains towards electric technologies, by guaranteeing adequate investment levels and facing skills mismatch. On the other hand, it has to **avoid negative distributive effects** across different socio-economic dimensions, preventing an unfair distribution of costs and guaranteeing equal access to the benefits generated by the energy transition among different areas (e.g. cities and rural areas) and population segments.

Figure 7

Challenges associated to energy transition



Industrial competitiveness

(Preserving today's industrial competitiveness and creating the conditions for tomorrow industrial competitiveness)

Reduction of industrial production related to thermal technologies and "**absorption**" of the **negatively impacted value chains**

Strengthening the **present electric technologies value chains** and positioning on **new technological productions**

Guaranteeing adequate **investment levels** to face the challenges set by energy transition

Managing **skills mismatch** and **integration of the workforce**

Distributive effects

(Avoiding negative distributive effects across different socio-economic dimensions)

Effectively ensuring **social assistance and support** to people who will be negatively affected by the transition

Guaranteeing **equal access to the benefits** generated by the energy transition

Avoiding **unfair distribution** of costs related to energy transition

Creating **cost-reflecting and efficient energy market**

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

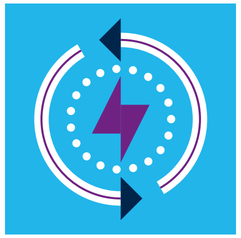
- What is good for the planet must also be good for the economy and society as a whole. In this sense, **policy actions** should be undertaken in order to effectively support the benefits that the transition can generate and address the challenges related to the transition, ensuring that the energy transition is not "just a transition" but a "**transition just for all**".

- **Four policy matters**, entailing specific policy actions, have been identified in order to tackle the challenges related to the energy transition and effectively redistribute its benefits:
  1. Supporting the **deployment of electric technologies** by promoting an effective **value chains conversion toward electric technologies**.
  2. Managing **job losses**, increasing **job opportunities** and addressing the issue of **re-skilling** and **up-skilling**.
  3. Addressing the **issue of energy poverty**.
  4. Promoting a **fair redistribution of costs associated to the energy transition**.

A final recommendation is to identify **best practices** put in place at the international level to effectively manage the transition period and transposing them at EU28 level and in Member States.

Figure 8

Policy matters and proposals in order to make the energy transition "just for all"



Policy matter 1

Supporting the deployment of electric technologies by promoting an effective value chains conversion toward electric technologies along the overall value chain

- Launching "**Energy Transition Investment Bonds**" to sustain investment with a social impact and economic return
- Setting up **National Energy Clusters** with a specific focus on electrification technologies and, in this context, creating a national **Tech Transfer Lab** focused on electrification technologies
- Introducing **innovative financial schemes for mature technologies** able to deliver high energy efficiency gains with mid-long-term payback period
- Promoting **campaigns to raise awareness of the advantages associated to electric technologies**

Policy matter 2

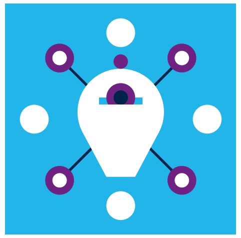
Managing job losses, increasing job opportunities and addressing the issue of re-skilling and up-skilling

- Envisaging **social measures for workers**, setting up early retirement schemes or providing allowances
- Establishing a "**European Energy Transition Fund**" helping Member States to support workers who have lost their jobs
- Introducing **new educational programs** explicitly targeting the needs emerging from energy transition
- Introducing **Circular Economy Chairs in top-notch EU universities**
- Implementing a "**Green Apprenticeship Erasmus Program**", aimed at increasing the mobility of apprentices and trainees in sectors that are relevant for energy transition
- Launching a **communication campaign** on the importance of the acquisition of an adequate set of skills

Policy matter 3

Addressing the issue of energy poverty

- Agreeing on a common definition of energy poverty, introducing an **official composite index for measuring energy poverty in Member States**
- Promoting a target program for **improving the energy efficiency of existing housing stocks**
- Developing a **communication campaign** characterized by measures to support and inform consumers
- Fostering **social tariffs** or **energy subsidies for low-income households**, maintaining cost-reflective tariffs



Policy matter 4

Promoting a fair redistribution of costs associated to energy transition

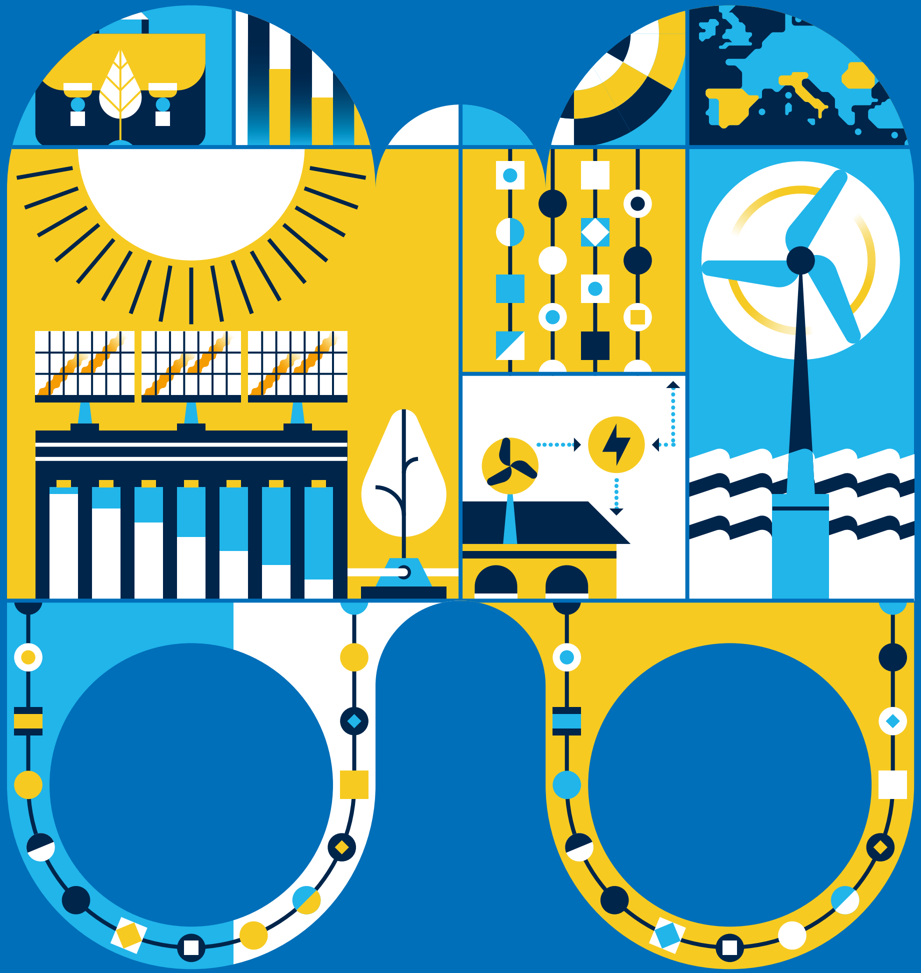
- **Revising cost items within the electricity bill** by transferring the policy costs from electricity bills to public finance
- Discharging the electricity bills from **unproper taxes and levies**

A final recommendation: identifying best practices put in place at international level and transposing them in the European Union and in Member States

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

Part 1

The reference context of energy transition in Europe



Key messages

The energy sector is currently **in the midst of a profound change**. Technological progress is revolutionizing the way energy is produced, distributed and consumed and it is opening the door to business models which, only a few years ago, were unimaginable. The traditional energy paradigm, based on energy production from fossil fuels only, is no longer viable.

Global, European and national institutions are in front lines in supporting the development of sustainable energy policies, favouring a policy framework that empowers the pathway toward transformation of the global energy sector **from fossil-based to zero-carbon**.

At international level, the ambitious target set by the COP21 in Paris is setting in motion policy makers worlwide, who are working on policies and measures aimed at "*holding the increase in the global average temperature to well below **2°C** above pre-industrial levels*" pursuing "*efforts to limit the temperature increase to **1.5°C***".

At the European level, targets for decarbonization by 2030 call for a reduction of **40%** of GHG emissions compared to 1990 levels, a **32%** share of renewable energy sources in final energy consumption and a **32.5%** improvement in energy efficiency.

With the EU targets in mind, each Member State has set its own national **targets** in their National Energy and Climate Plans. In particular, analysing the plans of the focus countries of this study (Italy, Spain and Romania), it can be observed that:

ITALY

Italy has planned to cut at least **40%** of greenhouse gas (GHG) emissions by 2030 from 1990 levels, reach a **30%** share of renewables in final energy consumption by 2030 and improve energy efficiency by reducing final energy consumption by **43%**.

SPAIN

Spain has set a **21%** reduction in greenhouse gas (GHG) emissions compared to 1990 levels, a **42%** share of renewables in final energy consumption and a **39.6%** improvement in energy efficiency.

ROMANIA

Romania is expected to register a reduction of **43.9%** for ETS sectors and **2%** for non-ETS sectors in greenhouse gas (GHG) emissions compared to 2005, reach a **27.9%** share of renewables on final energy consumption and improve energy efficiency by **37.5%**.

On June 18, 2019, the European Commission published its recommendations to all European National Plans. The results of the assessment show a common need for countries to boost renewables on final energy consumption and to plan more decarbonization policies in order to effectively meet the targets set at 2030. Furthermore, the European Commission strongly recommended to all its Member States to foresee effective measures aimed at managing the transition period from a carbon-intensive economy to zero-carbon one, guaranteeing that the transition is not "just a transition" but a "**just transition**" for everyone.

Beyond policy targets set at international, European and national level, people are more and more concerned about sustainability and resilience, thus creating a favourable economic and societal context for energy transition. There are several **socio-economic trends** driving energy transition, that could be grouped in seven clusters: new lifestyles, Green Generation, digitalization, decreasing cost of technologies, increasing attention to Corporate Social Responsibility, green investment and Circular Economy.

1.1 The policy framework empowering energy transition

1. The transformations seen in the energy sector in the past have never moved so rapidly and so explosively as the energy transition currently underway. The traditional energy paradigm, based on energy production from fossil fuels only, is no longer viable. Global, European and national institutions are in front lines in supporting the development of sustainable energy policies, favouring a policy framework that empowers the pathway toward **transformation of the global energy sector from fossil-based to zero-carbon**.

1.1.1 The international and European policy targets

2. Over the last years, international institutions and policy makers have put **decarbonization and resilience** at the heart of their political agenda. Decarbonization refers to the reduction of Greenhouse Gases (GHG) release, that is the emissions into the earth's atmosphere of any of various gases that contribute to the greenhouse effect.[1] GHG emissions generate several negative effects on the overall ecosystem: global warming, food insecurity, natural disasters, extreme poverty and human diseases. As a result, the urgency of greater resilience, defined as the ability of an ecosystem to respond and recover to a perturbation and turmoil of any type (financial crisis, natural disasters, infrastructures breakdown, etc.), has increased, with the aim to mitigate and effectively deal with the negative effects generated by GHG emissions.

3. Decarbonization and resilience are pivotal for achieving the 17 Sustainable Development Goals (SDGs), the blueprint to achieve a better and more sustainable future for all introduced in the United Nations 2030 Agenda for Sustainable Development. Through them, the United Nations recognize that ending poverty must go together with strategies that build economic growth and address a range of social needs, including education, health, social protection, and job opportunities, while tackling climate change and favouring environmental protection. Although United Nations policy targets are not binding, countries are expected to take action to meet these goals and to regularly present a progress report of their initiatives.

4. The energy and power sector can largely contribute to the achievement of sustainable development: **6 out of the 17 Sustainable Development Goals** are directly or indirectly related to energy and power sector.

Figure 1

17 United Nations Sustainable Development Goals (SDGs) and 6 Sustainable Development Goals directly or indirectly related to energy and power sector

Goal 7

Ensure access to affordable, reliable, **sustainable and modern energy** for all

Goal 9

Build **resilient infrastructure**, promote inclusive and sustainable industrialization and foster innovation

Goal 11

Make cities inclusive, safe, **resilient** and sustainable

Goal 13

Take urgent action to **combat climate change** and its impacts

Goal 14

Conserve and sustainably use the oceans, seas and marine resources for **sustainable development**

Goal 15

Protect, restore and promote **sustainable use of terrestrial ecosystems**, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON UNITED NATIONS DATA, 2019.

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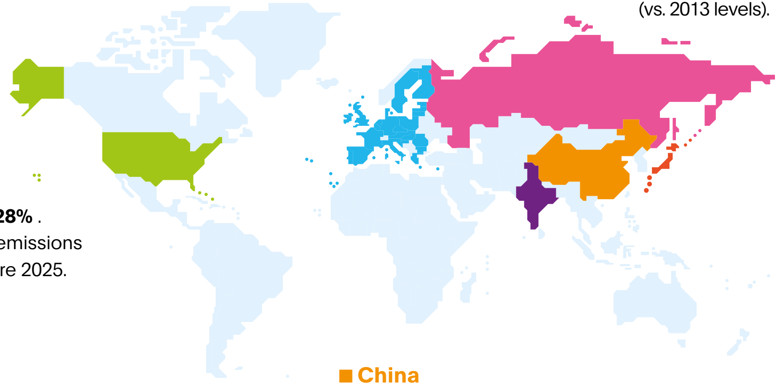
[1] The greenhouse effect is the problem caused by increased quantities of gases such as carbon dioxide in the air. These gases trap the heat from the sun and cause a gradual rise in the temperature of the Earth's atmosphere.

5. With regard to climate change, a significant step forward has been made with the **Paris agreement**, signed in December 2015 by 195 countries. The agreement aims at *"holding the increase in the global average temperature to well below **2°C** above pre-industrial levels"* pursung *"efforts to limit the temperature increase to **1.5°C**"*. The agreement has come into force in 2016 and requires all parties to put forward their best efforts through "nationally determined contributions" (NDCs). It also includes the provision that countries need to update their NDCs every 5 years pursuing the highest possible ambition, and report to each other and to the public their progress towards the achievement of commitments.

Figure 2

Transposition of COP21 goal by main countries worldwide

The 2016 Paris agreement commits the 177 signatories to keep the uprising of the temperatures **below 2˚C** and, if possible, **below 1.5˚C** as to pre-industrial levels



■ **EU and UK**

▮ Reducing by at least 40% greenhouse gases emissions levels before 2030 (vs.1990).

■ **Russia**

▮ Reducing by **25%–30%** the greenhouse gas emissions before 2030 (vs. 1990 levels).

■ **Japan**

▮ Reducing by **26%** the greenhouse gas emissions before 2030 (vs. 2013 levels).

■ **United States**

▮ Reducing by **26%–28%** . greenhouse gases emissions vs. 2005 levels before 2025.

■ **India**

▮ Reducing the carbon intensity by **33%–35%** compared to 2005 levels before 2030.

▮ Reaching **40%** of non-fossil electric capacity before 2030.

■ **China**

▮ Reducing carbon intensity by **60%–65%** compared to the 2005 levels before 2030.

▮ Increasing the intensity of non-fossil fuels in the primary energy consumption by **20%**.

How to read:

■ **Signatory country** ▮ Main NDC* target

(*) The ratification of the COP21 implied that the climate target presented to the UN evolved from Intended Nationally Determined Contribution (INDC) a Nationally Determined Contributions (NDC). Those are the objectives that any country has decided to fix in order to contribute to keeping global warming under below the 2°Celsius.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC) DATA, 2019.

6. As established in the Decision 1/COP21 taken in Paris, the **Intergovernmental Panel on Climate Change (IPCC)**, the leading international body for climate change, has performed a specific analysis on the difference in terms of scenarios and impacts of a 2°C target versus a 1.5°C target. The results of the analysis show that global CO_2 emissions should decline by about **45%** from 2010 levels by 2030, reaching net zero around 2050, in order to keep the uprising of temperatures below of 1.5°C with no or limited overshoot. For limiting global warming below 2°C, CO_2 emissions need to decline by about **20%** by 2030 and reach net zero around 2075. The report shows that at the current pathway of CO_2 emissions, world's economies will not be able to reach the target. The IPCC describes some measures that should be taken into consideration by policy makers worldwide to effectively reduce global warming. All of them project the use of carbon dioxide removal (CDR)[2] on the order of 100–1000 $GtCO_2$ over the 21st century by exploiting existing measures like afforestation and reforestation, land restoration and soil carbon sequestration, bioenergy with carbon capture and storage (BECCS), direct air carbon capture and storage (DACCS) and enhanced weathering and ocean alkalization.

7. Signatory countries of the Paris Agreement met again in Katowice in December 2018 for the 24th Conference of the Parties (**COP24**) to the United Nations Framework Convention on Climate Change (UNFCCC). The meeting ended positively approving the expected implementation rules of the Paris Agreement ("Paris Rulebook"), thus confirming the willingness of Governments to move forward despite economic uncertainty and geopolitical tensions. However, each of the three final outcomes of the meeting has been pursued more or less effectively:

- **Transparency.** Starting from 2024, each country has to release standardized reports with the aim of "clear understanding of climate action" and "tracking of progress". Moreover, detailed rules have been set for all countries, while developing economies could envisage more tailored rules based on their level of flexibility.

- **Ambition.** During the meeting, parties decided not to "welcome" the IPCC report and they only suggested countries to take into account its results. At the same time, the new rules are supposed to ease the comparison of national objectives, by setting 2031 as a common time frame. Morover, the rulebook puts in place a "technical dialogue" process aimed to monitor progresses toward the Paris goal.

- **Finance.** The rulebook foresees ministerial dialogues to take place every two years after 2020, in order to speed the energy transition in each country. The $100 billion annual target for investment remains unvaried and no decisions have been taken on carbon markets since parties did not reach consensus.

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[2] Carbon Dioxide Removal exploits technologies emissions (e.g. bioenergy with carbon capture and storage, coastal blue carbon etc.) allowing to reduce the CO_2 already in the atmosphere and creating negative emissions. Large scale deployment (and costs) of these technologies is still unproven.

On the topics of ambition and finance, negotiations will continue in the run-up to the New York UN Climate Summit in September 2019 and COP25 to be held in Santiago de Chile in December 2019.

Why Katowice for the 24th Conference of the Parties (COP24)

Katowice has been an iconic and emblematic venue for the 24th Conference of the Parties (COP24). The city has experienced a process of revitalization of the former coal mining area, which has become a "Cultural Zone" with museums and international congress centres, making the city a symbol for the proper management of energy transition.

Furthermore, the country, which is traditionally recognized as the centre of coal mining and heavy industry, is undergoing a process of transformation towards innovation and new technologies development. In addition, the city is making efforts to improve the quality of air and the condition of the surrounding environment, as well as the standard of inhabitants' life.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (UNFCCC), 2019.

8. At the European level, the European Commission has launched the **European Union 2030 Climate & Energy Framework**, as a milestone policy of the long term low-carbon economy roadmap for 2050[3] and in response to European Union's commitment to the Paris agreement. The policy, adopted by EU leaders in 2014 and revised upward in 2018, sets three strategic goals:

- At least **40%** cuts in greenhouse gas emissions compared to 1990 levels.
- At least **32%** share of renewable energy in final energy consumption.
- At least **32.5%** improvement in energy efficiency compared to 1990 levels.

Figure 3

European Union Climate and Energy targets in different policy plans

2020 Climate & Energy Package	2030 Climate & Energy Framework	Revision of the 2030 Climate & Energy Framework according to the Political agreement among the European Commission, the European Parliament and the Council
2009	2016	2018
20% cut in greenhouse gas emissions (vs. 1990 levels) by 2020	At least **40%** cuts in greenhouse gas emissions (vs. 1990 levels) by 2030	New target for renewables at **32%** by 2030
20% of EU energy from renewables by 2020	At least **27%** share for renewable energy by 2030	New energy efficiency target for the EU for 2030 of **32.5%**, with an upwards revision clause by 2023
20% improvement in energy efficiency by 2020	At least **27%** improvement in energy efficiency by 2030	

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN COMMISSION DATA, 2019.

9. To achieve the **40%** target, the European Commission has set specific goals for different types of sectors. Emissions Trading Systems (ETS)[4] sectors should cut emissions by 43% by 2030 compared to 2005 levels, while non-ETS sectors should reduce emissions by 30% compared to 2005 levels. For the latter case, each Member State has to transpose this directive in national binding targets.

1.1.2. The transposition into Italian, Spanish and Romanian Climate and Energy plans

10. Following targets set at the European level, each Member State is required to develop integrated National Energy and Climate Plans that cover **five dimensions** characterizing the European Union's Energy Union strategy for the period 2021–2030:

- **Security, solidarity and trust**, by diversifying sources of energy and ensuring energy security.
- **A fully integrated internal energy market**, by guaranteeing a freely flow of energy across the European Union, without technical or regulatory barriers in order to enable energy providers to compete freely and promote renewable energy, while providing the best energy prices.
- **Energy efficiency** to reduce the European Union's dependence on energy imports, cut emissions and drive jobs and growth.
- **Climate action and decarbonising the economy**, by putting in place policies and legislation, fulfilling the European Union's commitments to the Paris Agreement on climate change.
- **Research, innovation and competitiveness** in low-carbon and clean energy technologies, in order to boost the European Union's competitiveness.

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[3] The low-carbon economy roadmap suggests that, by 2050, the European Union should cut GHG emissions by at least 80% compared to 1990 levels. Milestones to achieve this target are 40% emissions cut by 2030 and 60% by 2040.

[4] This system works on the 'cap and trade' principle that applies to all power stations, industrial plants and airlines operating in 31 European countries, whose emissions account for 45% of the total. A cap is set on the total amount of GHG that companies are allowed to emit every year. Within the cap, companies receive or buy emission allowances which they can trade with one other as needed. After each year, a company must have the right amount of allowances that cover all its emissions, otherwise heavy fines are imposed.

11. In the following part of the report, the transposition of European policy targets in the three focus countries of the study (**Italy**, **Spain** and **Romania**) will be analysed, together with an assessment of the readiness of these three different countries to effectively reach the targets at 2030.

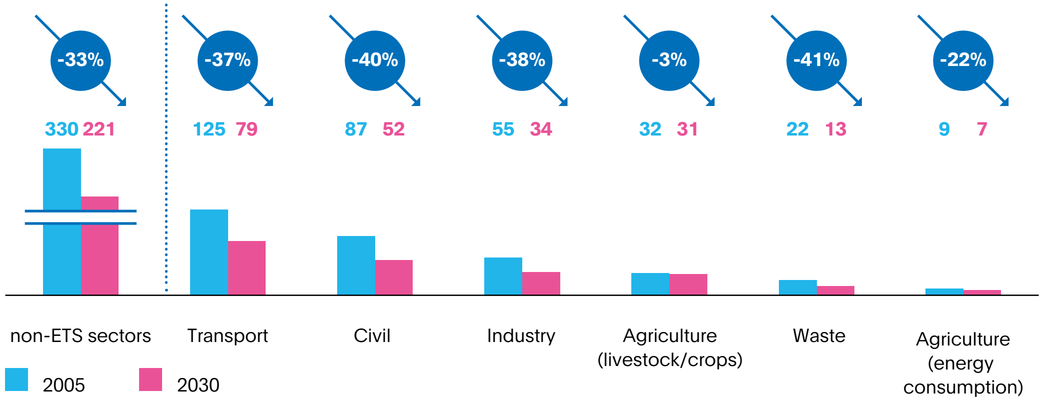
12. By following Governance of the Energy Union and Climate Action, **Italy** has launched the National Energy and Climate Plan (PNEC) in December 2018, in which has set primary objectives for Italy on energy and climate to be reached by 2030:

- Cutting at least **40%** of greenhouse gas (GHG) emissions by 2030 from 1990 levels (transposition of the EU Directive).
- **30%** share of renewables in final energy consumption by 2030.
- Improving energy efficiency, by reducing final energy consumption by **43%**.

13. With regard to decarbonization measures, Italy has set a reduction target of **-33%** compared to 2005 levels for non-ETS sectors, higher than the European Union (-30%). Looking in detail in non-ETS sectors, the most significant contribution to GHG emission reduction is expected to come from the transport and civil sectors (residential and tertiary), with a percentage change respectively of **-37%** and **-40%**. Expected emissions' reduction in transport can be attributed to the deployment of new mobility schemes (sharing mobility and public transport) and the gradual roll-out of most polluted vehicles due both to vehicle substitution in favour of alternative fuel ones and to the natural renewal of the vehicle fleet. Concerning the expected contribution of civil sector, it reflects instead the expected increase of energy efficiency in pre-existing buildings, enhanced by the increase in complete renovation measures and the application of particularly high-performing technologies.

Figure 4

GHG emissions in non-ETS sectors in Italy according to National Energy and Climate Plan, 2005–2030 (Metric tons of carbon dioxide equivalent - MTCO$_2$ Eq.)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON ITALIAN NATIONAL ENERGY AND CLIMATE PLAN DATA, 2019.

14. When it comes to renewable energy sources, Italy has set the target of **30%** share in final energy consumption, which is expected to have the following distribution among different sectors:

- **55.4%** renewables share in the electricity sector.
- **33%** renewables share in the thermal sector (heating and cooling).
- **21.6%** renewables share in the transport sector.

The main contribution to the overall renewable target will come from the electricity sector, which will have also to face the **phasing out of coal-fired generation** by 2025. In this sense, renewables will play a pivotal role in electricity generation achieving 55.4% share at 2030, compared to 34.1% in 2017. The main renewable technologies in electricity generation will be photovoltaics and wind power, whose installed capacity is expected to grow respectively by **158.5%** and **88.4%**. With regards to the heating sector, the employment of renewable sources is primarily linked to the increase in renewable energy provided by heat pumps. Finally, similar to the target on GHG emissions, the Italian National Climate and Energy Plan gives a strategic role to the transport sector also in the achievement of renewable target at 2030, by setting a target of **21.6%** renewables share for transport (+15.1 percentage points compared to the current levels of 6.5%). Moreover, it can be noted that the RES target in transport set by Italy is higher than both the minimum threshold required by the European Commission in the "Renewable Energy Directive II" (14%) and the RES share set by several other major European countries, like France (15%), United Kingdom (12.4%) and Germany that has not envisaged any RES target in transport.

Figure 5

Installed generation capacity from renewables by source in Italy, 2017–2030 (MW)

	2017	2030	2030 vs 2017 (%)
Hydropower	18,863	19,200	+1.8%
Geothermal	813	950	+16.8%
Wind	9,766	18,400	+88.4%
of which off-shore	0	900	
Bioenergy	4,135	3,764	-9.0%
Solar	19,682	50,880	+158.5%
of which concentrated solar power (CSP)	0	880	

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON ITALIAN NATIONAL ENERGY AND CLIMATE PLAN DATA, 2019.

Renewables share in the Italian transport sector

In order to reach the RES target in the transport sector by 2030, the Italian National Energy and Climate Plan details the expected role of each fuel type. The plan envisages **6 million** electric vehicles (both Battery Electric Vehicles – BEV and Plug-in Hybrid Electric Vehicles – PHEV) circulating at 2030.

Biofuels are expected to give a significant contribution to energy transition in the transport sector; in particular, a decrease of first generation biofuels is projected, in order to reach a contribution of 3% to renewables by 2030, while the target for advanced biofuels is expected to surpass the one set by the European Directive (3.5% by 2030), being equal to **8%** by 2030. Among advanced biofuels, biomethane will contribute for **75%** to the achievement of the target, since it is expected a steady increase of its production (up to 1,1 billion of cubic meters) from organic fraction of municipal solid waste.

Finally, the National Plan predicts a greater use of used cooked oil (UCO) as a vehicle fuel, contributing for **4%** to RES target in transport by 2030.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON ITALIAN NATIONAL ENERGY AND CLIMATE PLAN DATA, 2019.

15. With regards to energy efficiency, Italy intends to pursue a reduction target of **43%** for primary energy consumption and of **39.7%** for final energy consumption by 2030, with respect to 2007 European Union reference scenario. The annual energy savings targets to be attained between 1 January 2021 and 31 December 2030 are equivalent to a minimum of 0.8% per year of the average final energy consumption in the years 2016, 2017 and 2018.

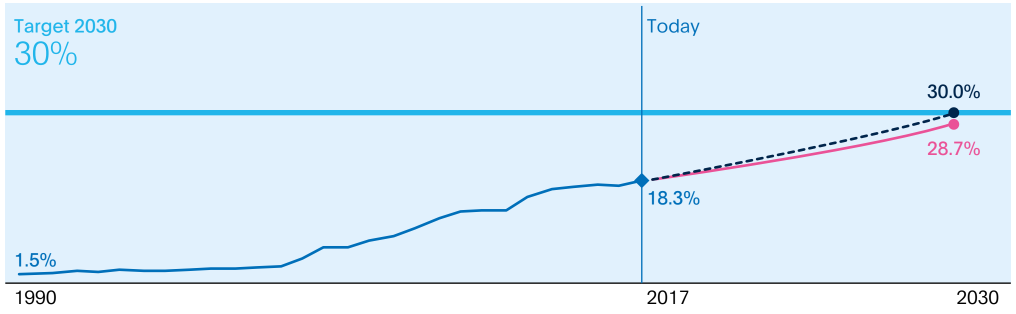
16. Once Italian targets have been identified, an assessment of the "readiness" of the country to effectively reach them has been realized. The analysis aims at evaluating if the current performance of Italy in increasing the share of renewables on final energy consumption, reducing GHG emissions and improving energy efficiency is in line with the targets set at 2030. In order to do so, the methodology starts from the calculation of tendential trends by projecting CAGR (Compound Annual Growth Rate) of different time spans according to the indicator considered:

- From 2012 to 2017 in the renewable analysis, in order to take into account the market maturity of renewable products.
- From 2005 to 2017 in the GHG emissions analysis, in order to consider the industrial evolution of each country.
- From 1990 to 2017 in the energy efficiency analysis, to take into account the time frame of policy targets.

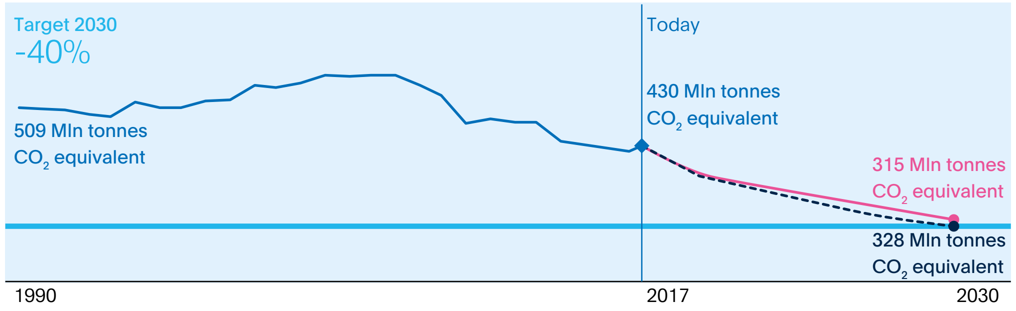
The results of the analysis show that Italy is on track with regards to the share of renewables on final energy consumption: if the country follows the current path in the next years, it will reach a share close to the national target (**28.7%** compared to 30%). The same is true also for GHG emissions reduction (**315** compared to 328 million tonnes of CO_2 equivalent). More actions are instead needed for improvements in energy efficiency, since energy consumption is projected to increase by 2030 at the current path, contrarily to policy target.

Figure 6

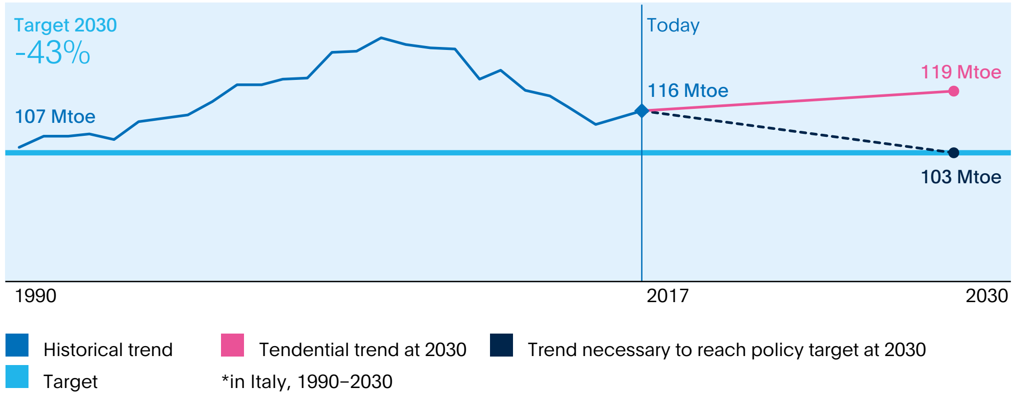
Share of renewables on final energy consumption* (% values)



GHG emissions* (% values, 1990=100)



Final energy consumption* (Mtoe)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT AND ITALIAN NATIONAL ENERGY AND CLIMATE PLAN DATA, 2019.

European Commission's assessment of the Italian National Climate and Energy Plan

On June 18, 2019, the European Commission published its recommendation on the draft of the National Energy and Climate Plan developed by Italy. The European Commission welcomes the ambitious target of 30% renewable energy share on final energy consumption but expresses its doubts about measures and policies put in place to effectively reach it by 2030. Moreover, the European Commission suggests increasing the RES target in the heating and cooling sector, while calls for more effective action in order to reach the target set for the transport sector.

As regards energy efficiency, the European Commission recommends ensuring that the key policy instruments illustrated in the draft plan would deliver adequate energy savings in the period 2021–2030. It is also suggested to exploit the untapped potential of buildings and transport in reaching the target, by addressing specific measures on these two sectors.

The European Commission asks then to clarify to what extent the expected development of the Italian gas sector can help the country to meet the decarbonization targets and to manage the envisaged phase-out of coal-fired plants for electricity generation.

According to the European Commission, Italy should set clear objectives, milestones and timelines to deliver reforms described in the plan for energy market, also in the field of research, innovation and competitiveness, in order to be able to effectively measure and monitor them. The European Commission asks Italy to include in the National Plan policies aimed at addressing the issue of air quality and to manage the transition also from a social, employment, skills and income distribution perspectives.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN COMMISSION, 2019.

17. With the EU targets in mind, **Spain** has set the following national targets at 2030 in its own National Energy and Climate Plans:

- **21%** reduction in greenhouse gas (GHG) emissions compared to 1990.
- **42%** of final energy consumption from renewables.
- **39.6%** improvement in energy efficiency.

The long-term vision of Spain by 2050 is to achieve **climate neutrality**, with the reduction of national GHG emissions by at least **90%**, in line with the European Commission commitment, as well as achieving a **100%** renewable electricity system.

18. In light of the objective to become a fully decarbonized economy by 2050, Spain foresees a decrease of the gross total emissions from 327.4 Mt of CO_2 equivalent predicted for the year 2020 to 226.7 Mt of CO_2 equivalent in 2030. Sectors that will contribute the most to this reduction over the period 2020–2030 are electricity generation (**-69.1%**), transport and mobility (**-32.7%**) and residential (**-26.8%**). The expected decarbonization in the electricity sector derives from the substantial reduction of coal use in electricity generation and the increase in the expected share of renewables in electricity generation, set at **74% at 2030** and **100% at 2050**.

19. With regard to emissions reduction in transport sector, it will be a consequence of a modal shift from the conventional combustion vehicles to new forms of mobility (i.e. public transport, sharing mobility), and of the decision of Spain to ban the circulation of traditional vehicles in central areas of cities with more than 50,000 inhabitants, starting from 2023. As a result, Spain predicts that **35%** of passenger-kilometres that are currently carried out in conventional vehicles will shift to non-emitting modalities by 2030, with e-Mobility playing a pivotal role, with a stock of **5 million vehicles**.

20. Strictly linked to decarbonization, there is the shift from traditional energy sources to renewable ones. In this framework, Spain has set the target to reach a **42%** share of renewable on final energy consumption, far above the European Union target of 32%. Transport will give a great contribution also in this case, with an expected share of renewables in the sector of **22%** (8 percentage points above the 14% required by the European Union), mostly driven by e-Mobility and biofuels. According to the National Plan, in residential sector there is still no disruptive technology able to decarbonize the system and increase the use of renewables, but a pivotal role is expected to be played by heat pumps. As already mentioned above, RES share in electricity generation is expected to reach 74% by 2030 due to an increased use of solar, biomass and wind technologies.

Figure 7

Installed generation capacity from renewables by source in Spain, 2015–2030 (MW)

	2015	2030	2030 vs 2015 (%)
Wind	22,925	50,258	+119.2%
Solar Photovoltaic	4,854	36,882	+659.8%
Solar thermoelectric	2,300	7,303	+217.5%
Hydroelectric power	14,104	14,609	+3.6%
Mixed pumping	2,687	2,687	+0.0%
Pure pumping	3,337	6,837	+104.9%
Biogas	223	235	+5.4%
Geothermal	0	30	+3,000%
Marine energy	0	50	+5,000%
Biomass	677	1,677	+147.7%

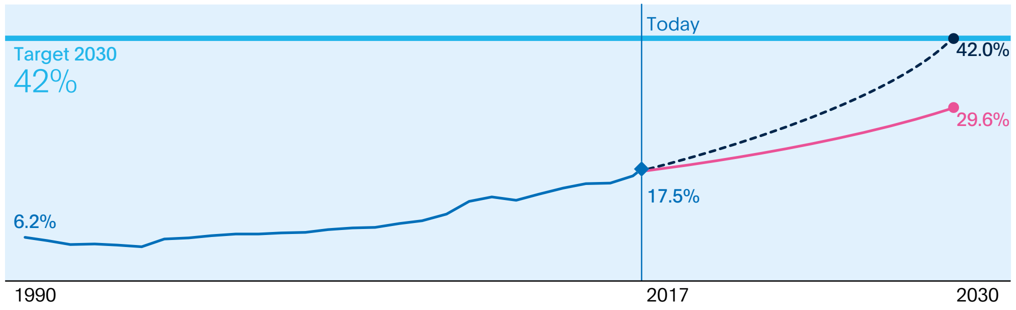
SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON SPANISH NATIONAL ENERGY AND CLIMATE PLAN DATA, 2019.

21. Finally, Spain adopted the targets set by European Union concerning energy efficiency (an improvement of 32.5% by 2030) but predicts to overcome the target thanks to a bundle of integrated policies and measures. As a result, Spain expects to obtain an improvement of **39.6%** in 2030, with a primary energy consumption of 98.2 Mtoe during that year.

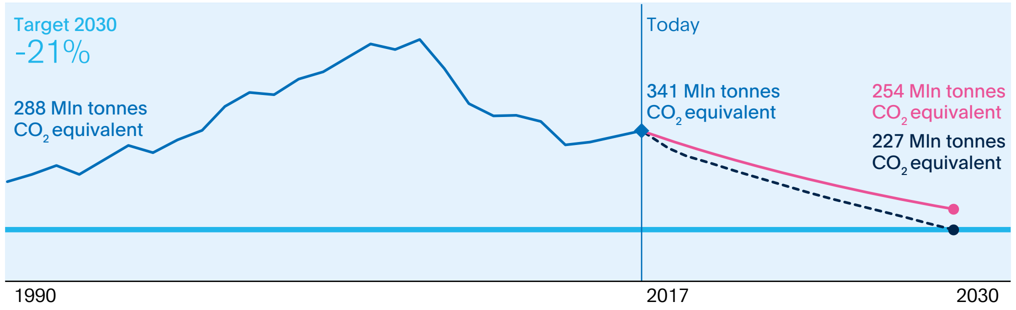
22. Similarly to what has been previously described for Italy, the performance of Spain in reaching 2030 targets (GHG emissions, RES share and energy efficiency) has been analysed. The results of the analysis show that Spain is on track with regards to the reduction of GHG emissions, given that at the current pace the country will be able to register 254 million tonnes of CO_2 equivalent by 2030 (with respect to 227 set as a target). The analysis suggests that the RES target could be challenging if actions and investment will not properly address the objective: at the current pace, Spain will be able to reach a **29.6%** share of renewable on final energy consumption instead of 42%. Similarly to the case of Italy, more efforts are required in the achievement of target on energy efficiency, since at the current speed Spain will end up with volumes of energy consumption 11% higher than expected.

Figure 8

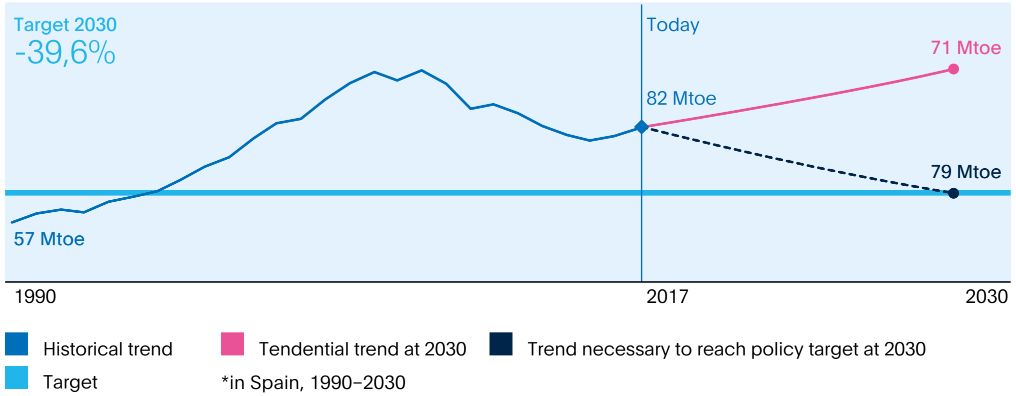
Share of renewables on final energy consumption* (% values)



GHG emissions* (% values, 1990=100)



Final energy consumption* (Mtoe)



THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT AND SPANISH NATIONAL ENERGY AND CLIMATE PLAN DATA, 2019.

European Commission's assessment of the Spanish National Climate and Energy Plan

The European Commission considers Spain's target on GHG emissions in non-ETS sectors (**-26%** compared to 2005) quite ambitious and asks the country to explain deeply how it intends to reach the target by 2030.

The planned national target of 42% share of renewables on final energy consumption, as well as the 22% share of renewables in the transport sector, seems ambitious to European Commission and thus the Commission asked Spain to develop a strategic plan that needs to be deployed to reach the target.

The European Commission suggests that Spain includes in the final plan more details on policies and measures regarding energy efficiency, whose target for 2030 (39.6%) will require considerable efforts.

On energy security, the objective to reduce energy dependency to **59%** by 2030 is very ambitious, considering that Spain has a current import dependency of 74% and the country foresees phasing out of coal and some of its nuclear capacity by 2030 for electricity generation.The European Commission recommends Spain to include specific policies into the final national plan on research, innovation and competitiveness of the energy sector.

Finally, the European Commission suggests that Spain enriches the "Just transition strategy" included in the draft plan with an assessment of the transition on employment and education, skills and social impacts, including the impact on coal and carbon-intensive regions.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN COMMISSION, 2019.

23. Following the European Union directives, also Romania has drafted its National Climate and Energy Plan, which includes the following targets:

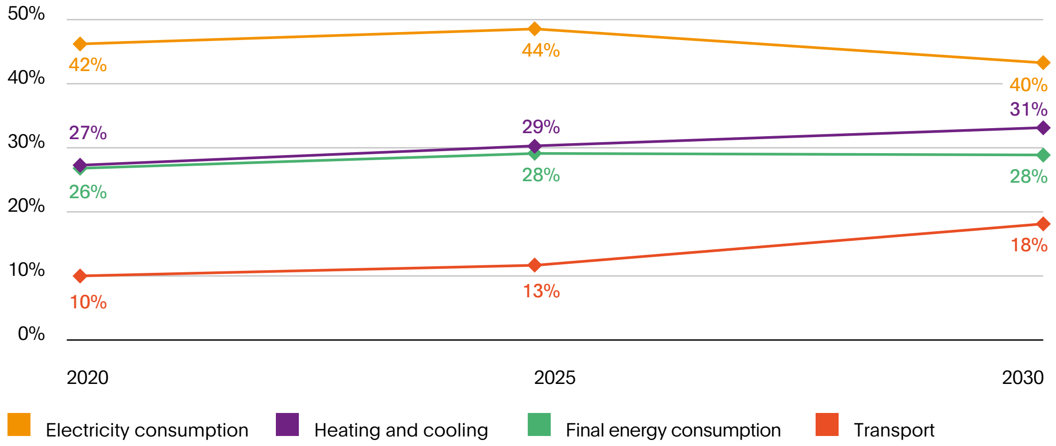
- Reduction of **43.9%** for ETS sectors and 2% for non-ETS sectors in greenhouse gas (GHG) emissions compared to 2005.
- **27.9%** share of renewables on final energy consumption.
- **37.5%** improvement in energy efficiency.

24. The Romanian targets on GHG emissions reduction might seem low compared to other European countries (**-43.9%** for ETS sectors and **-2%** for non-ETS sectors compared to **2005** levels), but it is important to analyse the reference context. In Romania, the trend of the greenhouse gas emissions is already downward, and the largest decrease have occurred in 1991 (-19% compared to 1990) due to the slowdown of the industrial activity, which dropped by 27% during the same year. In addition, Romania contributes to the total GHG emissions at European Union level by only 2.5% of the total emissions. Thus, the targets set by Romania for 2030 refers to 2005 levels, the period in which the country has experienced an increase in GHG emissions after the downturn.

25. Romania has already exceeded the renewable target of 24% set for 2020, since the country registered a RES share on final energy consumption equal to **25%** already in 2016. Moreover, Romania predicts to significantly decrease energy consumption (including electricity) thanks to energy efficiency improvement, hence RES shares seem to decline although absolute value in terms of RES consumption increases. Due to this overperformance, renewable target at 2030 seems to be modest compared to current levels: the share is expected to increase to **27.9%** by 2030, from 26.2% in 2020. The same is true also for RES targets in electricity consumption and heating and cooling, which are expected to change the share of renewable respectively by -2.2 and +4.8 percentage points by 2030. Romania wants instead to foster the adoption of renewable energy sources in the transport sector, whose share on final energy consumption is expected to increase from 10% in 2020 to 17.6% by 2030.

Figure 9

RES targets set by Romania on electricity consumption, heating and cooling, final energy consumption and transport, 2020–2030 (% values)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON ROMANIAN NATIONAL ENERGY AND CLIMATE PLAN DATA, 2019.

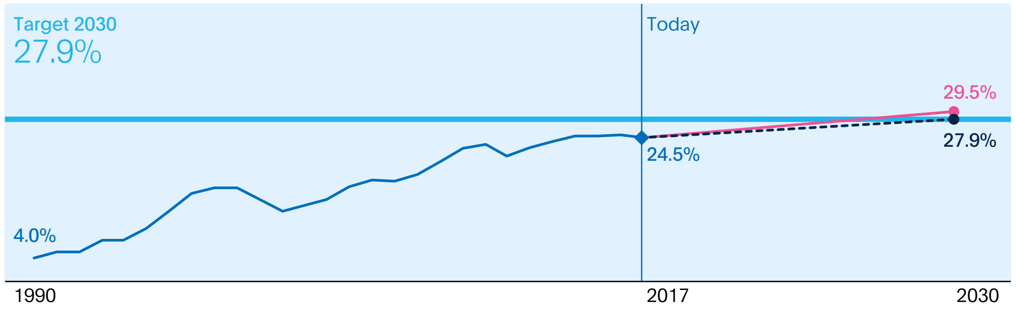
26. The energy efficiency dimension plays a significant role in the National Plan of Romania, since the country is committed to contribute in reaching the target of the European Union related to energy efficiency (at least 32.5% by 2030). Although the country predicts an increase in primary energy consumption in the next years due to an increase of the industrial production and living standards, the National Plan estimates a **37.5%** decrease in 2030 thanks to energy efficiency measures. This target is going to be pursued by an annual energy savings rate of at least **0.8%** between 2021 and 2030.

27. Finally, the performance of Romania in reaching the targets set by its National Climate and Energy Plan has been assessed following the same methodology as for Italy and Spain. Contrarily to Italy and Spain, Romania seems to be on track with regards to all the targets for renewables on final energy consumption, GHG emissions and energy consumption.

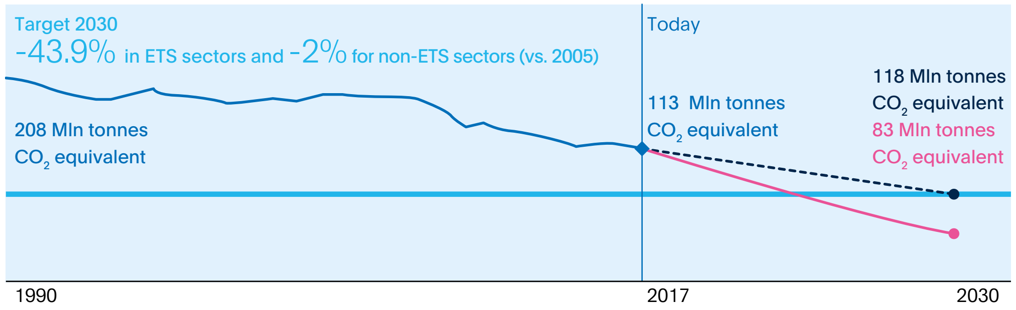
In addition, the country is expected to overperform in terms of renewable on final energy consumption that, according to these projections, will end up with a share of **29.5%**, 1.6 percentage points higher than the target.

Figure 10

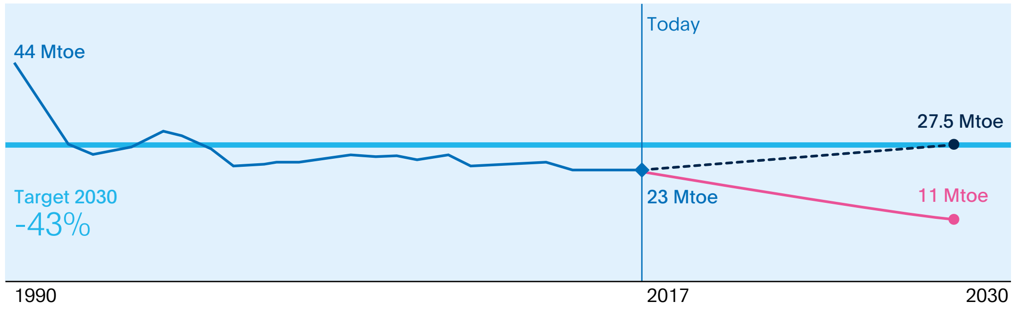
Share of renewables on final energy consumption* (% values)



GHG emissions* (% values, 1990=100)



Final energy consumption* (Mtoe)



■ Historical trend ■ Tendential trend at 2030 ■ Trend necessary to reach policy target at 2030
■ Target *in Romania, 1990–2030

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT AND ROMANIAN NATIONAL ENERGY AND CLIMATE PLAN DATA, 2019.

European Commission assessment of the Romanian National Climate and Energy Plan

The European Commission assessment on Romanian National Plan starts from the consideration that the expected share of renewables on final energy consumption is significantly below the renewable share of at least 34% in 2030 that results from the projection of the Government's econometric model. A similar comment has been made on energy efficiency target, whose contribution is considered low to reach the European Union target on energy efficiency by 2030.

The European Commission asks Romania to insert measures on the security of energy supply and nuclear generation capacity, as well as policies on research and innovation to drive the energy transition to 2030. The European Commission says that the drafted plan contains a partial assessment of the investment needs, expenditures and funding sources, and thus it does not fully take advantage of the role the plan can play in providing clarity to investors and attracting additional investments in the clean energy transition. Romania should also include in the final plan an analysis of the impacts of its policies on air quality and air emissions and elements on how to manage the just energy transition, in terms of social and employment impacts, i.e. conversion in sectors/industries affected by the transition and impacts on skills and competences, as well as distributional effects and revenue recycling.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN COMMISSION, 2019.

1.2

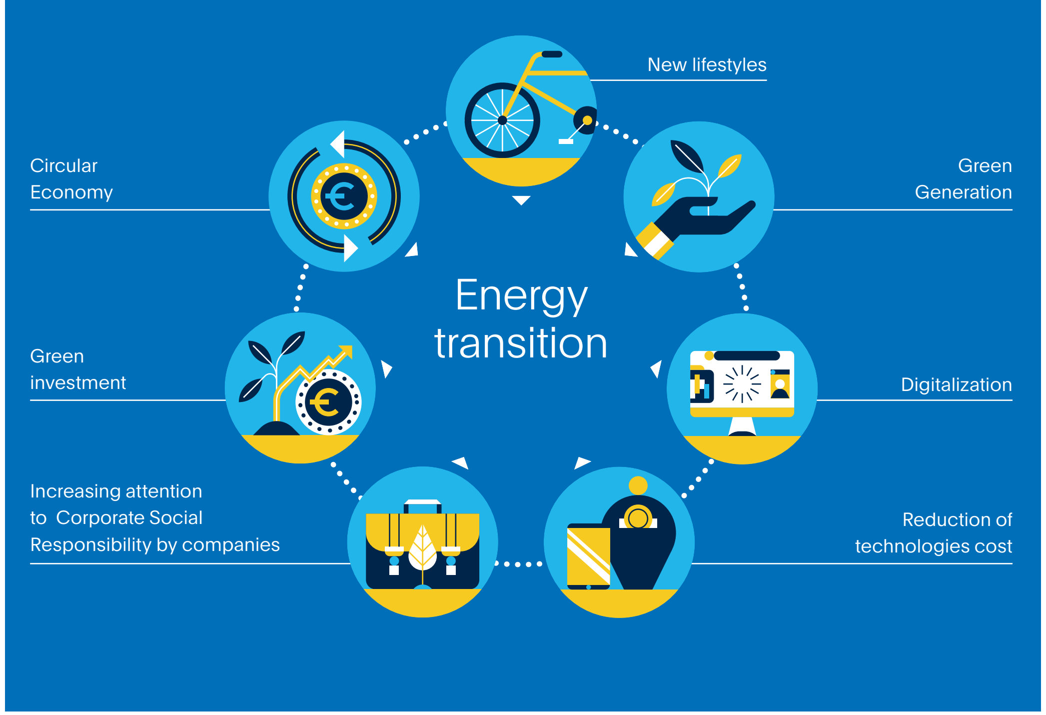
The socio-economic context favouring energy transition

28. Beyond policy targets set at international, European and national level, people are more and more concerned about sustainability and resilience, thus creating a **favourable economic and societal context for energy transition**. Socio-economic trends driving energy transition could be grouped in seven clusters:

- New lifestyles.
- Green Generation.
- Digitalization.
- Reduction of technologies cost.
- Increasing attention to Corporate Social Responsibility.
- Green investment.
- Circular Economy.

Figure 11

Socio-economic trends driving energy transition



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

29. The evolution of consumers' preferences and the raise of **new lifestyles** impacting energy transition can be attributed to visible negative impacts of non-decarbonized and not-sustainable economies. Citizens are increasingly concerned about climate change, being the most commonly cited threat in many countries around the world. Focusing on European countries, climate change is perceived as the **2nd** threat after ISIS, except for Spain, where it is the first one[5]. This is mainly because the impacts of climate change are felt everywhere in Europe, where countries have suffered recurrent flooding and have been hit by unprecedented heat-waves over the last years. Overall, in Europe climate-related extreme events caused a loss of **€452.6 billion** and **90,325** fatalities over the period 1980–2017[6]. Along with this, other concerns like poor air quality, soil pollution and increasing traffic noise in urban centres have brought citizens across Europe to be more and more careful towards the sustainability of their choices. As a result, people across Europe have started to behave in a more sustainable way by providing their homes with in-house renewable energy sources, smart meters, energy efficiency technologies and by preferring more sustainable products, starting from the purchase of their cars. Alternative fuel vehicles market has steadily increased over the last 10 years: the number of traditional fuel vehicles circulating in European roads has grown by **92%** over the period 2008–2019.

Air conditioning is the world's next big threat

With temperatures in Europe and everywhere else soaring, demand for air conditioning is booming. The extra power demand may cause a vicious circle on warming, unless electricity is decarbonized.

Because of the combination of population growth, rising incomes, falling equipment prices and urbanization, the number of air-conditioning units installed globally is set to jump from about 1.6 billion today to 5.6 billion by the middle of the century.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON INTERNATIONAL ENERGY AGENCY DATA, 2019.

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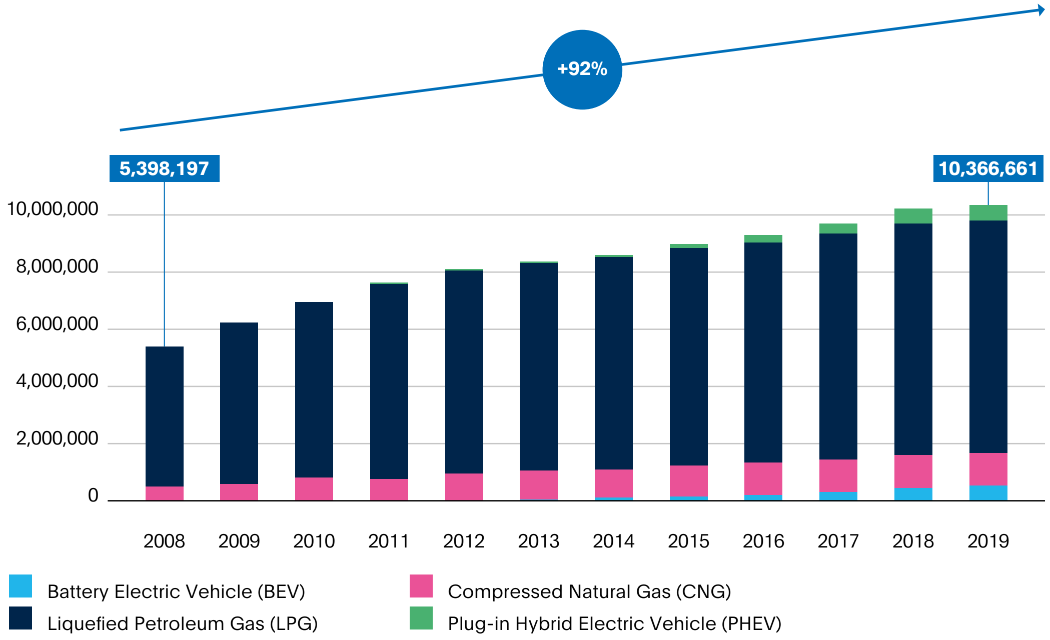
[5] Source: Pew Research Centre, 2019.

[6] Source: European Environment Agency, 2019.

Figure 12

Number of alternative fuel vehicles in European Union, 2008–2019 (absolute values)

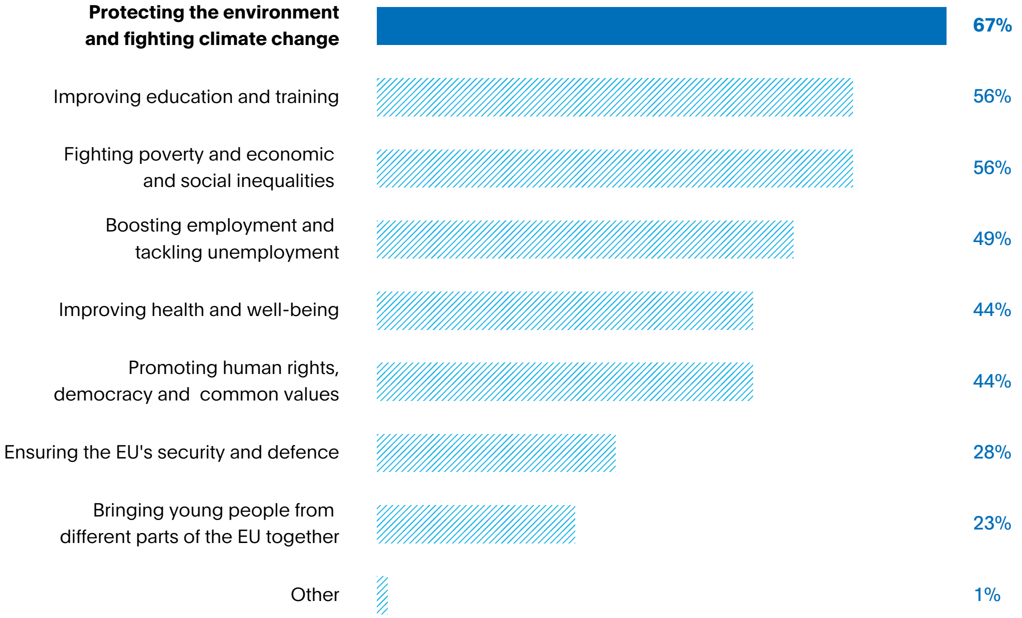


SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN ALTERNATIVE FUELS OBSERVATORY (EAFO) DATA, 2019.

30. In this context, young people are the most sensitive to the urgency of energy transition. A survey made by the European Commission shows that young generations believe that protecting the environment and fighting climate change should be a priority for the European Union in the upcoming years (**67%** of respondents put the issue in the first place). Sustainability is a priority also in youths' everyday life, affecting consumption and investment decisions: **73%** of European millennials are indeed willing to pay more for sustainable goods. At the same time, younger generations pay attention to the sustainability of their working environment, taking into account companies' commitment towards sustainability when they are looking for a job. For all these reasons, post-millennials have been called the "**Green Generation**" and they are able to drive companies and institutions towards a more accelerated process of sustainable energy transition by their everyday life choices.

Figure 13

Post-millennials responses to the question "Which of the following topics should be a priority for the EU in the years to come?", 2019 (% values)



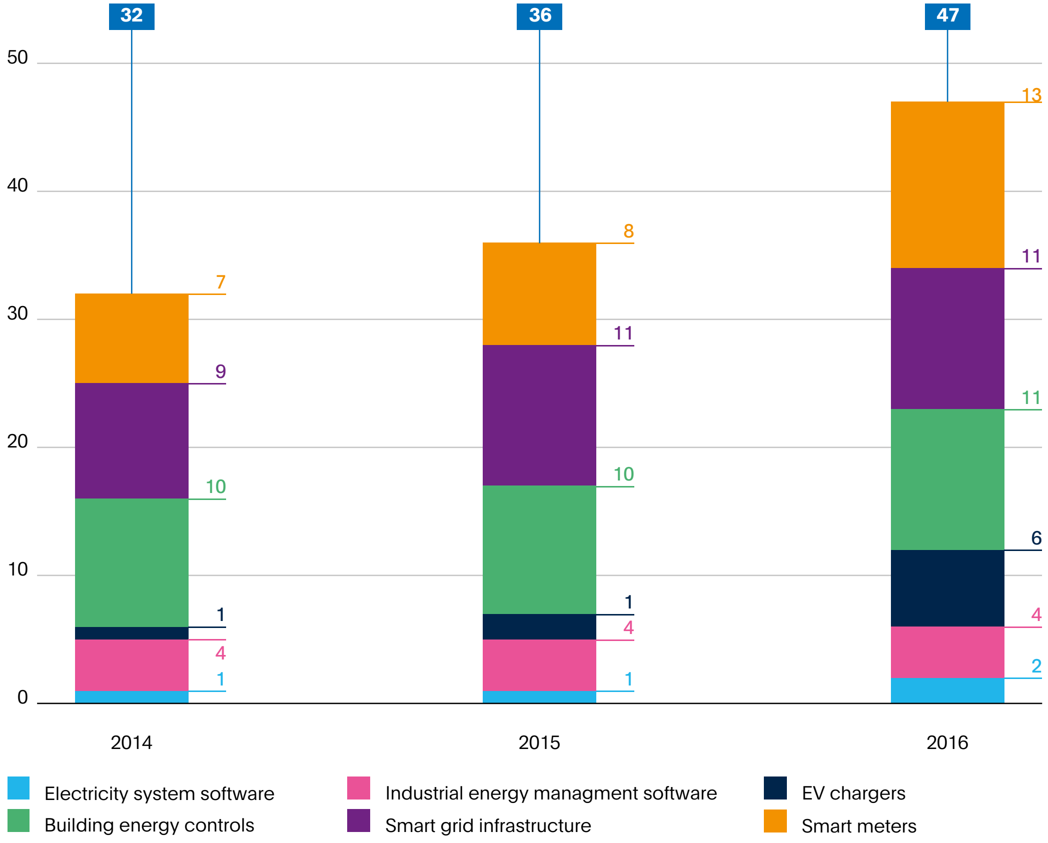
SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN UNION DATA, 2019.

31. Digitalization is changing the way energy is generated, transported and consumed, making it more connected, intelligent, efficient, resilient and sustainable. In the mobility sector, digital technologies have a crucial role in improving energy efficiency and reducing fuel use, thus contributing to the decarbonization of the overall system. Buildings account for 27% of final energy consumption and 30% of electricity consumption in Europe[7], thus the sector could reap substantial benefits from digital technologies and boost the energy transition process. Indeed, digitalization, including smart thermostats and smart lighting, could cut total energy use in residential and commercial buildings between 2017 and 2040 for a total energy saving of **9.89 PWh**[8], three times higher than the actual energy use in residential sector, contributing to the achievement of European Union targets on energy efficiency. The role of digitalization in improving energy efficiency in industrial sectors is pivotal if it is considered that industry is responsible for around 25% of final energy consumption and 22% of total CO_2 emissions in Europe. At global level, business leaders and citizens well evaluate the contribution of digitalization to the sustainability and efficiency of their activities and investment in digital technologies rose sharply over the last few years, reaching **US$47 billion** in 2016 (+46.9% compared to 2014).

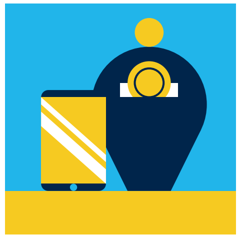
[7] Source: European Environmental Agency (EEA), 2019.
[8] 1 Petawatt hour (PWh) = 1015 watt hours (Wh).

Figure 14

Global investment in digital energy technologies, 2014–2016 (billion US Dollars)



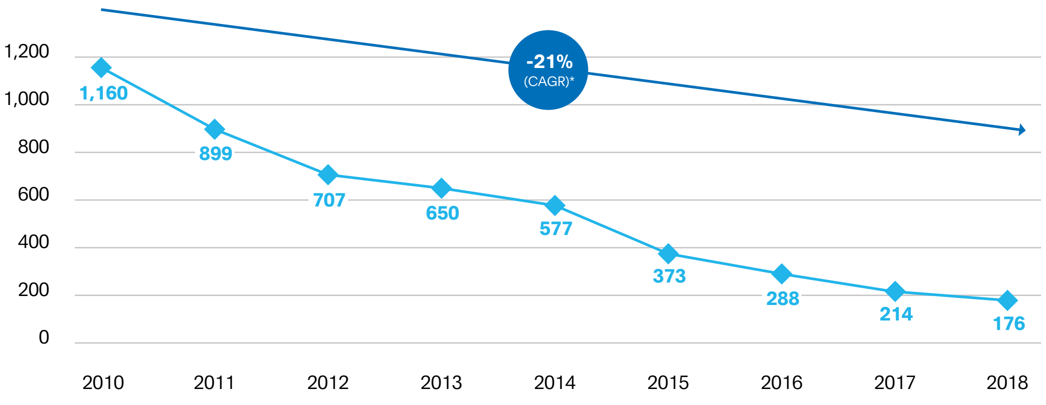
SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON INTERNATIONAL ENERGY AGENCY (IEA) DATA, 2019.



32. Technology is an essential part of energy transition, since it can be considered the first enabling condition to put in place actions aimed at reaching policy targets. Renewable energy sources, energy efficiency tools, energy storages, alternative fuel vehicles are all enabled and made affordable by the technological evolution. **The decreasing cost of technologies** can significantly accelerate energy transition. Just to make an example, recent technological progress for battery storage has been boosted by high demand for batteries in consumer electronics. Moreover, not only continued cost reductions are likely in the future, but it is strongly linked to technology progresses and rise in demand in the end-use sectors like automotive and manufacturing plants. According to the US Department of Energy, increasing production volumes from 25,000 units to 100,000 units for a Battery Electric Vehicle (100 kWh) battery pack allows a cut in battery pack production costs per kWh by **13%**. This is what happened in the last years, where the battery pack cost has fallen by **21%** yearly from 2010 to 2018.

Figure 15

Lithium-ion battery pack price, 2010–2018 (US Dollar/kWh)



(*) CAGR = Compound Annual Growth Rate

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON BLOOMBERG NEW ENERGY FINANCE (BNEF) DATA, 2019.

33. Over the last years, also companies approach towards sustainability has changed in order not only to meet targets set by national and international institutions and company duties but also to reap all benefits stemming from sustainability practices. Nowadays, companies are becoming aware that **sustainability is fundamental for having success in the market**, since it is associated with tangible economic benefits.

- *Gaining competitive advantage through stakeholder engagement.* Sustainable businesses pursue an approach based on creating value for all stakeholders and not only shareholders, including employees, players along the extended supply chains, civil society. This approach implies a regular dialogue with stakeholders which could be valuable for companies, being better positioned to anticipate and react to economic, social, environmental and regulatory changes as they arise.
- *Improving risk management.* Sustainability practices help companies to better deal with natural disasters and civil conflict, which could significantly impact operations, revenues or expenditures. Being prepared to such events makes companies more resilient and less vulnerable, by decreasing their costs.
- *Fostering innovation.* Investing in sustainability can also drive innovation by redesigning products to meet environmental standard and social needs, such as changes in consumers' preferences in favour of more sustainable products and services.

- *Improving financial performance*. In addition to financial benefits related to innovation, better risk management and competitive advantage, companies can realize significant cost savings through the deployment of energy saving technologies and facilities. Moreover, investors are even more attracted by sustainable assets, since they have assessed that better financial performance is correlated with better ESG (Environmental, Social and Governance factors) performance. As a result, **39%**[9] of companies consider revenue growth as the first motivation to take action on sustainability.
- *Increasing productivity*. It has been demonstrated that companies having sustainable activities are 7.9% more productive than non-sustainable companies. The differential increases to 10.2% when companies are highly inclined to sustainability. Furthermore, it has been assessed that companies operating in the energy sector are the ones paying more attention to the social dimension of sustainability.[10]
- *Building customer loyalty*. To date, consumers expect more sustainability in goods and are more attracted by companies' brand who declare to pay more attention on sustainability: **66%** of global consumers are willing to pay more for sustainable goods and the percentage rises to 73% if considering only millennials.[11] As consumers ask for more sustainability, companies start to take action towards this direction. 77.6% of companies believes that improving corporate image is the first reason for developing a sustainable attitude.[12]
- *Attracting and engaging employees*. Companies engaged in sustainability practices are able to create a more comprehensive and inclusive work environment, where employees are critical stakeholders. This translates into reduced absenteeism and improved productivity. Firms that adopted environmental and sustainability standards see a **16%** increase in productivity and a **25–50%** reduction of employees turnover compared to firms that do not adopt sustainability practices.[13]

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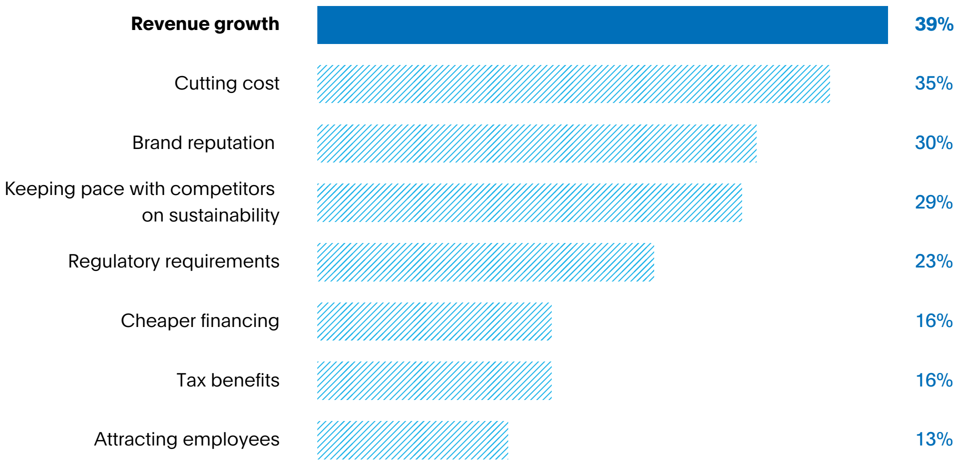
[9] Source: ING data, 2019.
[10] Source: Istat, 2019.
[11] Source: Nielsen, 2016.
[12] Source: Istat, 2019.
[13] Source: Harvard Business Review, 2019.

Figure 16

Percentage of responses to the question "Which of the following factors have been most important in driving your company to take action on sustainability?" (survey to finance executives worldwide), 2018 (% values)



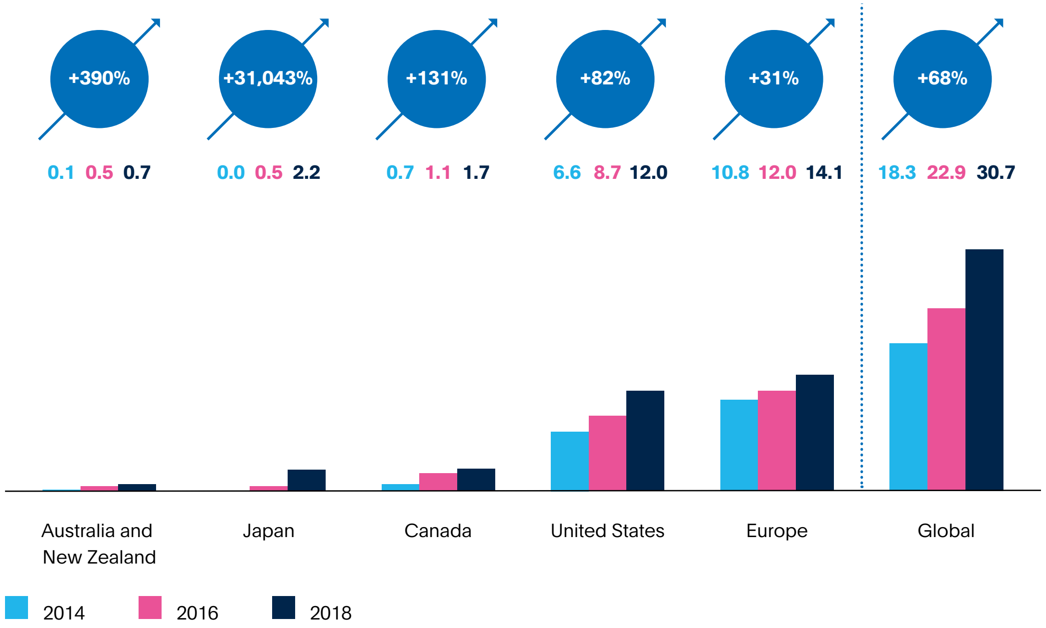
SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON GLOBAL SUSTAINABLE INVESTING ALLIANCE DATA, 2019.

34. Also, financial investors are increasingly conscious of the social and environmental consequences of human activities in business and politics. They are able to exclude from their portfolio companies that do not respect societal and environmental sustainability, while including the ones that follow practices in line with the **Environmental, Social and Governance (ESG)** criteria. As a result, sustainable investment assets are steadily increasing globally, with some regions demonstrating stronger growth than others, setting a favourable context also towards a zero-carbon economy. The largest increase was in Japan, where sustainably managed assets grew **more than 300 times** over the period 2014–2018.

Figure 17

Investments in sustainable assets by region of the world, 2014–2018

(trillion US Dollars and % change 2014 vs. 2018)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON GLOBAL SUSTAINABLE INVESTING ALLIANCE DATA, 2019.

35. Climate and energy objectives at the basis of energy transition can be pursued by following **Circular Economy** fundamentals. This means to rethink the organization of the energy production and supply system by using local resources. Some solutions can be already put in place, like using domestic and industrial organic waste to produce heat and electricity. This process avoids the release of emission in the atmosphere and allows for the return of elements to the soil. Moreover, energy losses can be limited by providing the unavoidable energy dispersion from industrial processes or flows to other energy intensive bodies. Another solution can be found in local sources of surface water that can be used for heating or cooling buildings close to them. These local solutions can not only reduce GHG emissions, but they can also meet the challenge of making regions energy self-sufficient and show multiple benefits: the reduction of air pollution, the creation of local jobs, the improvement in energy safety and the reduction of energy poverty.

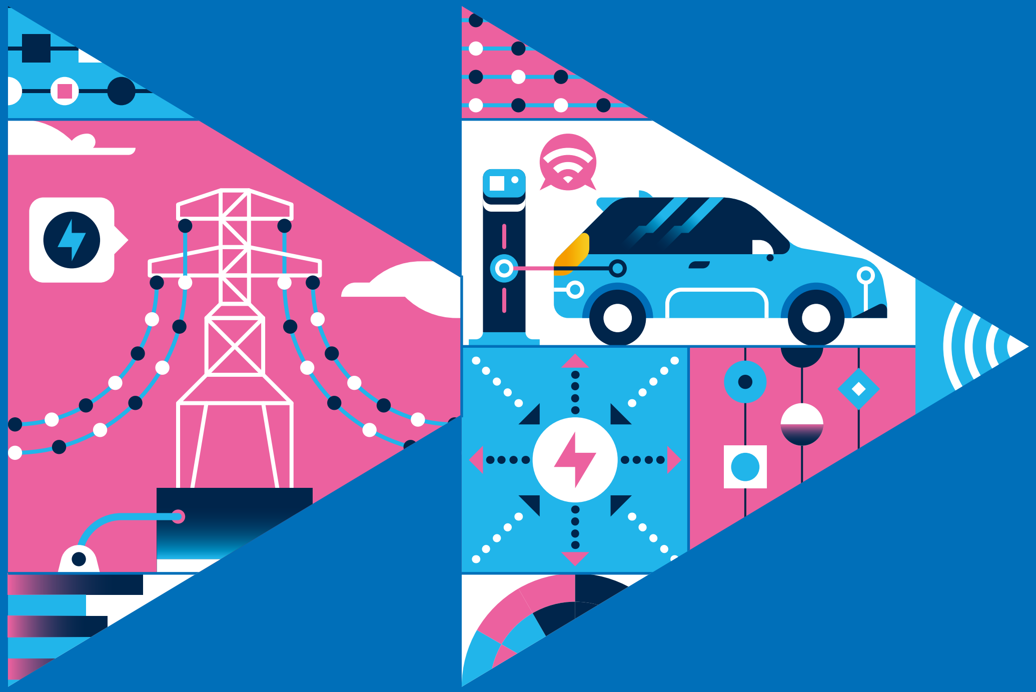
Circular Economy making the best out of waste: the case of Sydeme in France

Sydeme, a mixed transport and household waste processing association in East Moselle, in Forbach (France), has been managing the sorting and reclamation of household waste among 14 intermunicipal organizations for the last 10 years. It currently recovers biomass, packaging, glass, wood, green waste, biomedical waste and textile waste in adapted fields. Sydeme collects 45,000 tonnes of biowaste from biogas per year and produces electricity, heat and biomethane from waste collected. As a result, the use of fossil fuel is limited and Sydeme became a supplier of biomethane fuel, with the 1st BioGNV station open to the public.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON "CIRCULAR ECONOMY FOR THE PRESERVATION OF RESOURCES AND THE CLIMATE", 2019.

Part 2

The role of electricity towards the transition



Key messages

The Total Primary Energy Demand is constantly increasing, accounting for a 2.0% annual growth since 2000. In this context, the **electric carrier** is gradually becoming the pivotal source for meeting the energy needs of a society amidst a deep transformation. In ensuring a reliable and secure provision of affordable energy, while reaching environmental goals, electricity lays at the heart of the global economy and it is emerging as a central pillar of energy policy making.

There are seven features that make the electric carrier **pivotal for energy transition**, while favouring the achievement of European and national policy targets:

1 It allows to **reduce CO_2 emissions** when electricity is generated through a balanced energy mix, integrating a significant share of renewables, and it enables the **reduction of pollutant emissions improving air quality**, in particular in urban areas.

2 It reduces **noise pollution**, limiting annoyance, stress and sleep disturbance with their consequent risk of hypertension and cardiovascular disease, thus improving the quality of life in urban areas.

3 It offers several opportunities to enhance the performance and the **resilience of the energy system**, thanks to its versatility, flexibilty and integration of renewable energy sources.

4 It provides higher level of **energy efficiency**, reducing the energy demand and the GHG emissions; if compared with traditional thermal technologies, the electric ones perform better in terms of energy efficiency. This holds for heat pumps, LED lamps, electric drives and electrochemical storage systems (batteries).

5 It can be **easily integrated with digitalization**, enabling more effective consumption management and higher efficiency.

6 It stimulates **innovation** and **sustainability** in **lifestyles** and **industrial processes**.

7 It can play an important role in **favouring and supporting Circular Economy**, thanks to the innovation brought in renewable energy production, energy storage and structural changes in the system (shift from a centralized to a decentralized electricity system).

The world is gradually building a different kind of energy system based on three pillars: **affordability, reliability and sustainability**. The three pillars are closely interconnected: each of them and the trade-offs between them, require a **comprehensive approach to energy policy**, taking into account the contribution of renewable energy sources towards the affordability and sustainability of the system while considering their requirements in terms of reliability.

2.1 The contribution of the electric carrier for energy transition

1. The energy transition pathway is closely interlinked with global societal megatrends. Global population will be increasingly urban in the future: it is expected that 68% of the population will live in urban areas in 2050, posing serious challenges to the reliability and sustainability of the energy system. Furthermore, the decarbonization objective at 2050 is paving the way to a major role for renewable energy sources in the energy generation. At 2050, electricity will play a pivotal role in the global energy demand and 79% of the generating capacity will be from renewables[1], so that an increase of electricity penetration in the final energy consumption implies a more green and decarbonized economy. These radical changes imply a high level of flexibility in the system: at 2050 the share of flexibility out of the total power mix will be 20%. A powerful enabling factor in supporting the transformation is digitalization, whose investments are expected to increase by 40% by 2025.

2. The Total Primary Energy Demand is constantly increasing, accounting for a **2.0%** annual growth since 2000. The 2017 growth (2.1%) was mainly driven by positive global economic outlook and the rising of heating and cooling needs in some regions of the world. China is the world's largest energy consumer due to heavy industrial demand and increasing fuel consumption in transport. It increased in the United States as well, partially driven by extreme weather conditions (warmer summers and colder winters). To date, Total Primary Energy Demand is still mainly satisfied by oil, accounting for **32%** of the world total, followed by coal (27%). The third largest component is natural gas, totalling 22%. Biomass accounts for 10% while nuclear and hydropower and other renewables account both for 5% of the total. Considering the wider fossil fuels category[2], it still amounts for **81%** of Total Primary Energy Demand.

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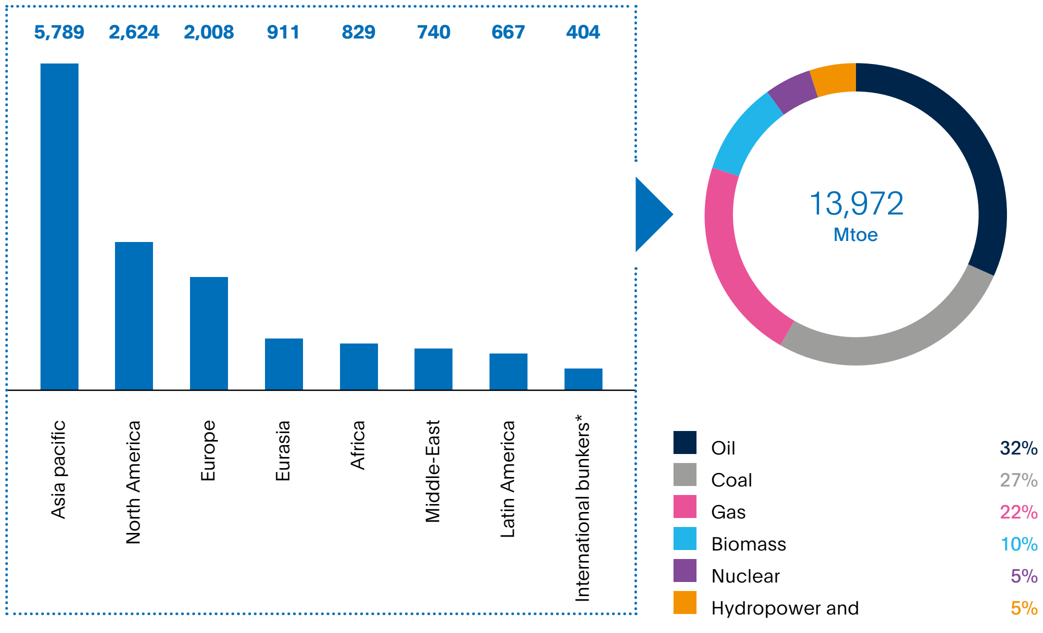
[1] Source: Bloomberg New Energy Finance, New Energy Outlook 2019.

[2] The fossil fuels category comprises oil, coal and natural gas.

Figure 1

Global Total Primary Energy Demand by region and by fuel, 2017 (Mtoe and % values)



(*) According to the International Energy Agency, the international bunkers include both marine and aviation bunkers and indicate the energy demand of ships and aircraft.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON INTERNATIONAL ENERGY AGENCY (IEA) DATA, 2019.

3. The electric carrier is gradually becoming the pivotal source for matching the energy needs of a society amidst a deep transformation. In ensuring a reliable and secure provision of affordable energy, while reaching environmental goals, electricity lays at the heart of the global economy. The global electricity demand reached **22,200 terawatt-hours** (TWh) in 2017, meaning a growth of 3% with respect to 2016, the highest growth rate registered by all energy carriers[3]. Its share in final energy consumption reached 18% in 2016 globally (+5 percentage points with respect to 1990).

4. There are several factors underpinning the steady development of electrification. First of all, its growth went in parallel with the growth of renewables, whose cost has gradually decreased over the last decade. In addition, for the second consecutive year, investments in the power sector reached $750 billion, 48% higher than the ones in oil and gas sector (totalling $716 billion).

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[3] Electricity demand is a wider concept than electricity consumption; indeed, the former includes also the electricity consumed by power plants, refineries, blast furnaces, coke ovens, oil and gas extraction, and heat and boiler transformation, in addition to the electricity consumed by end-use sectors (Source: IEA, World Energy Outlook).

5. Electrification has different features when comparing developing and developed countries. In the former, electrification is mainly focused on providing adequate and fair access to electricity to population and industries. As a consequence, electrification in these countries primarily means significant investments in infrastructures. In developed countries, instead, electrification mainly implies shifting from fossil fuels in final uses, the technological modernization in different industrial sector in order to increase energy efficiency and the digitalization in infrastructures and networks.

Access to electricity in developing countries

Universal access to electricity remains a major issue at global level.

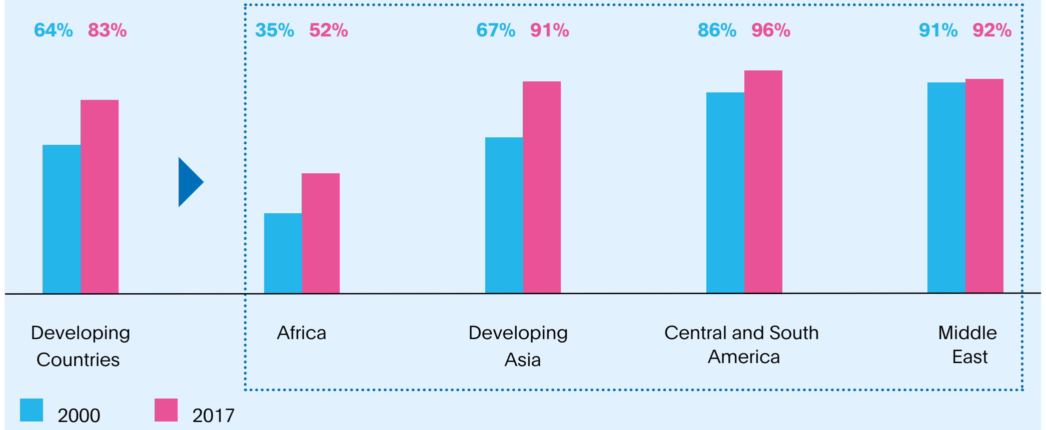
In the world, **nearly a billion people** remain without access to electricity, in particular in sub-Saharan Africa and in developing Asia.

From 2010 to 2017, almost 50 million people acquired access to electricity annually, +42% with respect to the previous decade. In the period 2000–2017, developing Asia has registered the highest increase, with 24 percentage points gained (Africa follows with an increase of 17 percentage points). Among developing Asian countries, India is making unprecedented progress in extending access to electricity, with nearly 550 million people gaining electricity access since 2000.

Sub-Saharan Africa is a particularly interesting case for electrification. According to the World Bank estimates, more than 600 million people in Africa live without electricity, including more than 80 percent of those residing in rural areas. Yet, household electricity access is 75 percent or higher in only six nations (Cabo Verde, Ghana, Gabon, Mauritius, Seychelles and South Africa). Further, it has to be specified that the demographic variable also has a role in determining the percentage of people having access to electricity. In Africa, indeed, the percentage of people having access to electricity could remain steady – or even decrease - over the next years simply because of population growing faster than electricity penetration.

Figure 2

Share of population with access to electricity, 2000 vs. 2017 (% values)



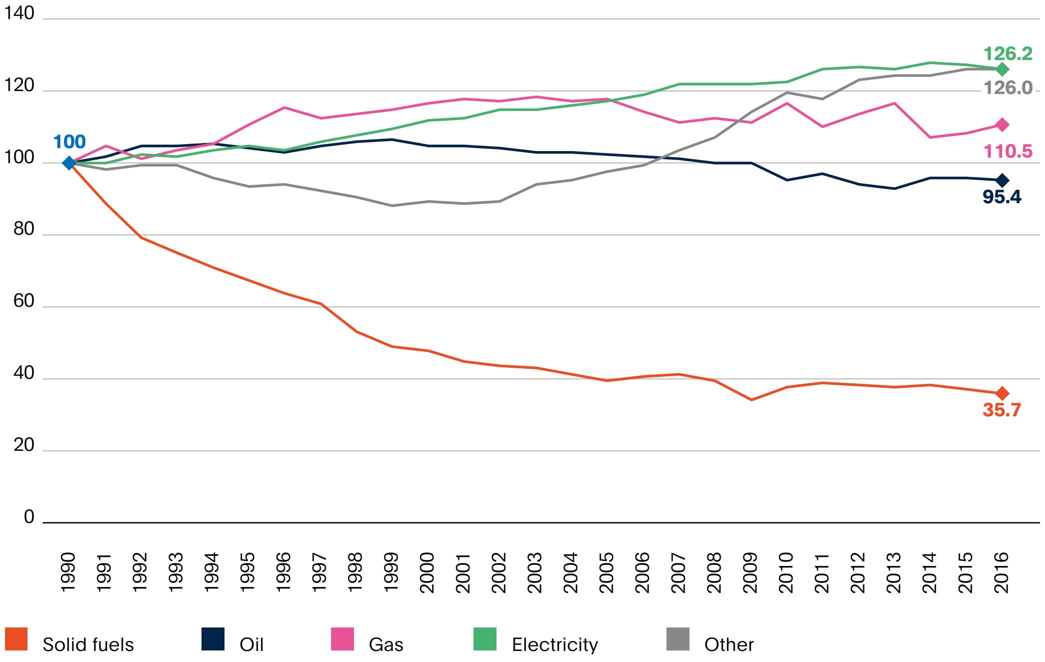
SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON INTERNATIONAL ENERGY AGENCY DATA, 2019.

6. In opposition to the developing ones, in advanced economies electricity demand has started to flatten or even decline in recent years. Correlating Gross Domestic Product (GDP) growth with the electricity demand, it can be observed that the correlation is positive for Less Developed Countries (LDCs), while it weakened significantly in the last ten years for developed countries. Several factors have affected the growth in electricity demand in advanced economies, but the main reason lies in an increase in **energy efficiency**: growth of electricity demand (enabled by digitalization and electrification of heat and mobility) has been outpaced by savings deriving from energy efficiency in advanced economies. According to the International Energy Agency, about **40%** of the slowdown in electricity demand is attributable to energy efficiency in industry that was enabled by the progressive shift from heavy and more energy intensive industry toward a service leaning economy.

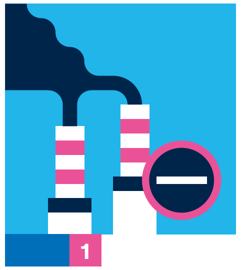
7. While fossil fuels maintain a predominant role in the Total Primary Energy Demand at global level, the electricity penetration in final energy consumption is rising. Electricity has been the **fastest growing energy carrier** in Europe: within final energy consumption, electricity consumption has increased by 26% with respect to 1990 levels.

Figure 3

Final energy consumption by fuel in Europe, 1990–2016 (index year 1990=100)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN ENVIRONMENT AGENCY (EEA), 2019.



2.1.1 The role of electrification in decarbonizing the economy and improving air quality

8. Electricity generation is a source of GHG emissions. Indeed, the energy mix in the electricity generation has been stable for decades in several important aspects. Fossil fuels held the major share in the global energy mix, accounting for about two-thirds of yearly electricity generation. In terms of facilities, the majority of the electricity supply was provided by large centralised power plants. However, emissions intensive sources, like coal and oil, are going to be gradually replaced with renewable ones. This trend has two benefits: the shift towards an energy mix balanced towards renewables leads to a reduction in emissions in power generation and, consequently, a low-emission generation mix for electricity production enables emissions reduction also in end-use sectors.

9. The advantage of increasing the share of electricity in final energy consumption has been evaluated. In order to do so, academic and scientific literature on the importance of a low-emission energy mix in electricity generation for future sustainability has been reviewed and all the analysis have been validated by the electric engineers affiliated to Department of Engineering, ICT and Technologies for Energy and Transport of the National Research Council – CNR and published in previous studies[4]. The results of the analyses show that the threshold for environmentally sustainable electricity generation, based on experimental research on technology substitution, is equal **to 600 t/GWh** CO_2 emissions meaning that:

- Countries below this threshold can fully exploit the environmental benefits of electrification by increasing their electricity production.
- Countries above the threshold need to preliminary rebalance their electricity generation mixes and then increase their electricity production in order to have a sustainable electrification.

Analysing CO_2 emissions from electricity production in EU28, it emerges that electrification is a pivotal opportunity to decarbonize the economy for European Union and Italy, Spain and Romania due to their virtuous electricity generation mix. Indeed, it has to be emphasised that the threshold of 600 t/GWh CO_2 emissions is recognized as a standard at the global level but it does not fully apply to the European case, in which almost all the countries already have a generation mix below this threshold and ambitious targets to further decarbonize the economy have been set. **A further reduction of CO_2 emissions from electricity production is therefore required in order to fully support policy targets at 2030 and beyond**.

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[4] See the study "Electrify 2030: electrification industrial value chains and opportunities for a sustainable future in Europe and Italy" realized by The European House – Ambrosetti for Enel Foundation and Enel X.

10. In this sense, the national and European renewable energy support policies, together with a relevant costs reduction gained by certain renewable energy technologies (like the solar photovoltaic systems), paved the way for a further growth of renewables: the electricity produced by renewables has more than doubled between 2005 and 2016 (**+106%** during the last 11 years).

11. The CO_2 emissions intensity, which is the ratio of CO_2 emissions from electricity production (as a share of CO_2 emissions from public electricity and heat production related to electricity production) and gross electricity production, is consistently declining in the three focus countries of the study, Italy, Spain and Romania. Among the three countries of interest, Romania has experienced the strongest decrease (**-3.4%** each year in the period 1990–2016), followed by Italy (**-2.9%** each year in the same period) and Spain (**-2.0%** each year in the same period). Considering all the EU28 countries the average is -2.2%, instead.

12. An additional factor affecting policy decisions concern the air quality infringements procedures. **Many Member States, indeed, continue to be under infringement procedure due to continuously exceeding air quality limits**. 19 Member States out of 28 are currently subject to infringement procedures for exceeding the air quality limits set by Directive 2008/50/EC, with 16 open cases for particulate matter and 12 cases for NO_2. These infringement cases have been open for years, but only recently the European Commission has escalated some of them to the European Court level. In May 2018, the European Commission decided to refer 6 Member States to the EU Court of Justice for failing to meet limits set out under EU legislation on ambient air quality and for failing to take appropriate measures to keep exceedance periods 'as short as possible'[5].

13. The introduction of electric technologies could have an impact on air quality, in particular in urban areas. As an example, battery electric vehicles (BEV) are designed to have **zero tailpipe emissions** of air pollutants. Especially in urban centres, emissions of NO_x, PM, hydrocarbons and other pollutants from Internal Combustion Engine Vehicles (ICEVs) lead to very high levels of pollutant concentrations in areas where people live and work, causing significant impact on human health (see also Part 3.4 of the study). Moreover, emissions from power generation tend to occur away from densely populated areas, since power stations are generally located outside urban centres.

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[5] In Germany the procedure refers to 26 air quality zones, among them Berlin, Munich, Hamburg, Köln and Stuttgart (peak at 40 μg/m³). In France the procedure refers to 12 air quality zones, among them Paris, Marseille and Lyon (peak at 96 μg/m³). In the United Kingdom the procedure refers to 16 air quality zones, among them Birmingham, Leeds, Glasgow and London (peak at 102 μg/m³). In Italy the procedure refers to in 28 air quality zones, including in the regions of Lombardy, Piedmont, Lazio and Veneto, where the daily limit values have been persistently exceeded, in 2016 on up to 89 days. In Romania the procedure refers to the agglomeration of Bucharest, where the daily limit values have been persistently exceeded, ever since the EU law became applicable to Romania, and in 2016 on 38 days.

The potential impact of electrifying the vehicle fleet on air quality: the case of Madrid and Barcelona

Air pollution is one of the major environmental risk for health. A significant proportion of Europe's population live in cities, where exceedances of air quality standards occur constantly.

As of today, the largest contribution of atmospheric pollutant emissions in urban areas comes from on-road transport, confirming the importance of regulating and reducing the emissions of the sector.

A modelling study in Barcelona and Madrid found that, compared with the current vehicle fleet, electrifying 40% of vehicles would reduce peak hourly NO_2 concentrations by **up to 16%** (30 and 35 µg/m^3 in Barcelona and Madrid, respectively).

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON SORET ET AL., (2014) DATA, 2019.

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2.1.2 The positive impact of electrification on noise pollution

14. Noise pollution is one of the major environmental health issues in Europe. Several studies have confirmed that human exposure to noise pollution from transport and industry can lead to annoyance, stress, sleep disturbance with consequent risk of hypertension and cardiovascular disease. The European Environment Agency estimates that environmental noise is responsible for at least **16,600 premature deaths** each year in Europe, with almost **32 million** adults affected and nearly **13 million** suffering from sleep disturbance. Moreover, it is estimated that around 13,000 school children suffer learning impairment due to the effects of noise generated by airports. Behind air pollution, the World Health Organization ranked the noise pollution due to road traffic as the **second cause of environmental stress** in Europe.

15. The Environmental Noise Directive is the main mechanism through which the European Union monitors and fights noise pollution. The Directive requires two main indicators to be applied in assessing and managing the noise pollution level:

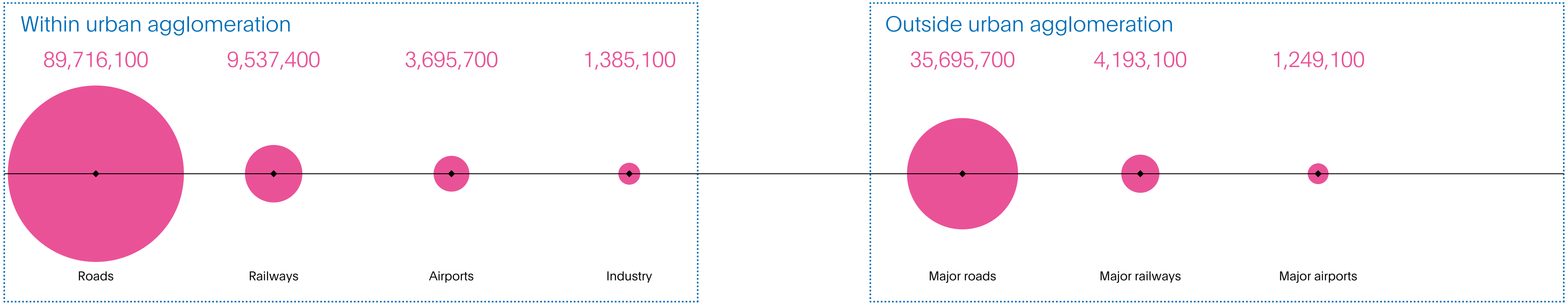
- The decibel level for day, evening and night period (Lden), designed to measure the level of "annoyance".
- The decibel level for nights period (Lnight), designed to measure the sleep disturbance level.

For the former, the Directive set a threshold of **55 decibel**, while for the latter of **50 decibel**.

16. Given this context, the electric carrier, especially if applied to the mobility sector, could have important impacts on reducing noise pollution. The electric engine on electric vehicles is quieter than an internal combustion engine. The lack of mechanical noise is expected to lower noise levels in urban areas, having a positive effect on the whole noise maps. Simulations[6] on the impact of replacing traditional vehicles with electric vehicles in Elche's[7] urban areas, demonstrate that a light-duty vehicle fleet comprising only Battery Electric Vehicles (BEVs) would be able to reduce by **10 percentage points** the share of people exposed to road noise above the maximum allowed compared with a wholly Internal Combustion Engine Vehicles (ICEVs) fleet.

Figure 4

People exposed to environmental noise in Europe within and outside urban agglomeration according to the decibel level for day, evening and night period – Lden, 2015 (absolute values)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN ENVIRONMENT AGENCY (EEA) DATA, 2019.

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[6] Campello-Vicente, "The effect of electric vehicles on urban noise maps", (2017).

[7] Elche is a Spanish town located in the region of Baix Vinalopó.

2.1.3 The opportunity to improve resilience of the energy system through the electric carrier

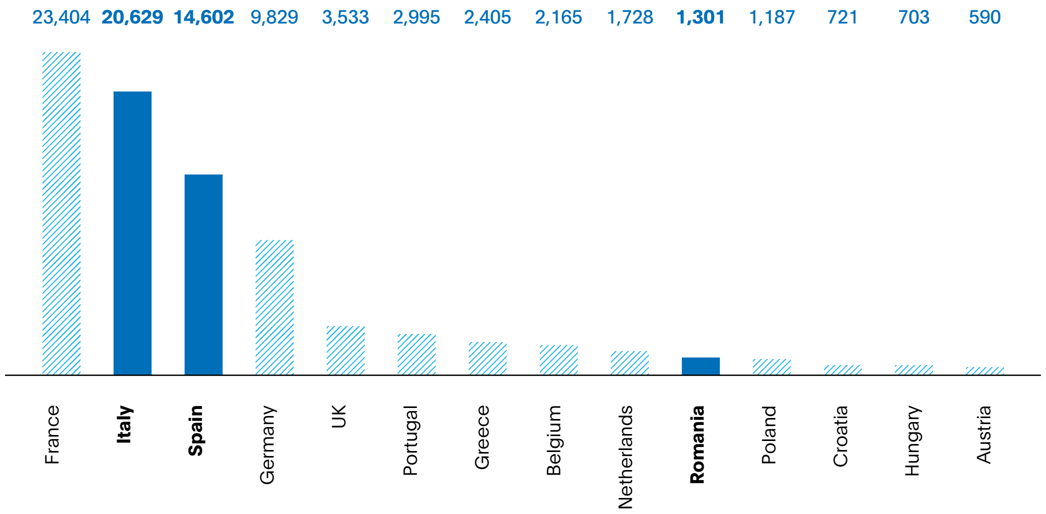
17. Resilience is the ability of a system to adapt to the main changes and to recover from any shock. In this perspective, the concept encompasses several dimensions, interconnected and closely related:

- Urban environment.
- Ecological ecosystem.
- Mobility and water infrastructures.
- Economic system.
- IT infrastructure.
- Energy system.

Energy represents a vital commodity for societies and economy and any disturbance in the energy system has the potential to severely affect economic and societal development. To date, **climate change** is one of the main sources of threats, given the extreme weather events that it might generate and the increasing pressure on energy resources, starting from water availability. The ability to be resilient to climate change impacts will be essential to the technical viability of the energy sector and its ability to cost-effectively meet the rising energy demands driven by global economic and population growth. Indeed, the interconnection between energy and water can exacerbate the issues: water is an essential element for all phases of energy generation, implying a necessity to increasingly put the attention on the proper management of energy-water linkage. In this regards, renewable energy sources can generally reduce water demand compared to thermal ones and the distributed generation usually associated with them implies a greater ability to localize and buffer possible disruptions.[8] Then, the electric carrier can strongly contribute to the energy system resilience.

Figure 5

Number of natural disasters due to extreme climate events in selected European countries, 1980–2017 (absolute number of events)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN ENVIRONMENT AGENCY (EEA) DATA, 2019.

18. When electricity is resulting from a balanced energy mix embedding a high share of renewable energy sources whose production is distributed along the grid, it can reduce the pressure on the grid and **increase the overall resilience of the system**. On the contrary, traditional forms of energy, such as fossil fuels, require an input that needs to be transported through a pipeline, making the system more vulnerable to natural disasters. Given the growing share of renewables, electricity storage systems represent a pivotal element in both providing flexibility and supporting the renewable energy sources integration: electricity storage can fully support decarbonization.

Enhancing grid resilience through Vehicle to Grid

Electric vehicles can be used in order to avoid overloading on the grid at peak hours and to take advantage of off-peak charging benefits.
In this sense, the strength of the demand-side management can be enhanced by the "Vehicle-to-Grid", a bidirectional connection between the vehicle and the grid itself that allows the electricity to flow from the vehicle to the grid, and vice versa.
This application can be regarded as one of the main features of the smart grids, collaborating with the system and increasing its stability.
Currently, Vehicle-to-Grid technology is being experimented through pilot projects and small-scale commercial initiatives.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON INTERNATIONAL ENERGY AGENCY (IEA) DATA, 2019.

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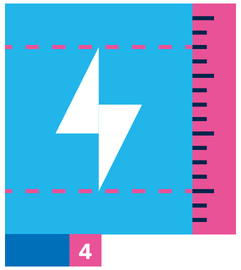
[8] Source: International Energy Agency, "Making the energy sector more resilient to climate change", 2015.

19. Massive exploitation of renewable sources in electricity generation – to guarantee a sustainable generation - and battery storage, together with network digitalization and smart management systems, are essential elements for supporting demand response, smart grids and distributed generation. Allowing a high level of interconnections between market operators, an electrified system would be able to **limit the peaks**, **enable real-time interventions** thanks to big data collection and analysis and ensure a **better management of power flows**.

20. In 2018, the global energy storage almost doubled, reaching more than 3 GW, with significant growth in Korea, Australia, Japan, Germany and the United States. Since 2013 the trend has been always positive, with a compound annual growth rate of **+70.7%**. In Europe, investments in this field are led by Germany and the United Kingdom. German behind-the-meter storage reached over 100,000 installed systems and the flow batteries emerged as an alternative to the general predominance of lithium-ion ones. Yet, globally, the technological mix remains basically unchanged, with lithium-ion battery storage accounting for nearly **85%** of the new capacity installed. Further, an important component of this growth is the steady decrease of battery price: the battery pack cost has fallen by 21% yearly from 2010 to 2018 (see Part 1.2).

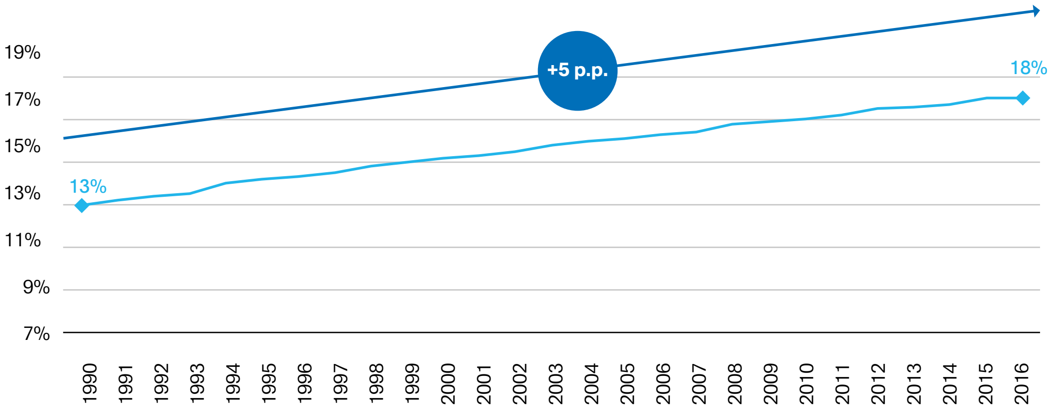


2.1.4 The efficiency gains enabled by the electric carrier

21. Global energy demand is increasing all around the world, and it would be even higher if it were not for the progress in energy efficiency. Looking at the industrial production for the year 2017, data indicate that activities in some of the most energy-intensive sectors of the economy worldwide have increased. As an example, global steel production, which accounts for 5% of the global energy use, has risen by 4% compared to the previous year. Considering the time span ranging from 2000 to 2017, around **one-third** of the total increase in energy use brought by the rise in economic activities of some of the most energy-intensive industries was offset by the enhancement in energy efficiency. At world level, energy efficiency allowed to save **12%** of additional energy use. Most of the savings have been obtained in industrial and buildings sectors.
The increase in energy efficiency ran parallel with the increase in the share of electricity in final energy consumption. Indeed, a growing set of energy efficiency opportunities rises by switching from traditional thermal technologies to more-efficient electric ones, providing simultaneously economic, environmental and health benefits.

Figure 6

Electricity in final energy consumption in the world and change, 1990–2016
(% values and % points)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON INTERNATIONAL ENERGY AGENCY (IEA) DATA, 2019.

22. The electric carrier is characterized by **higher energy efficiency**, reducing both energy demand and GHG emissions. Electric technologies perform better than their thermal counterpart[9] in terms of energy efficiency. Starting from this premise, the most relevant electric technologies leading the transition have been mapped (see Part 3 of the study for more details). These are the ones expected to develop the most and with the highest potential of penetration in the near future (3 to 5 years):

- **Heat pumps** have a great potential for energy savings. They are mainly used for heating and cooling in buildings, as well as in many industrial processes. If compared with conventional boilers, heat pumps employ about **50%** less fuel and about **50–60%** energy savings. In particular, these energy savings can be even higher depending on the climatic areas where heat pumps are installed – and enabling COP (Coefficient of Performance) even higher than 4 – or on the specific heat pump typology (i.e. the ground source heat pump).
- **LED lamps** are expected to gain significant market share in the near future. Energy consumption by lighting systems is relevant, spanning from 5% to 15% of total electricity use in industrialized countries, while in developing countries the share is even higher, equal to 86%. LED lamps result to be more efficient than standard filament lamps (about **52%** and **80–85%** efficiency gains for public and residential lighting, respectively) and fluorescent lamps (efficiency gain between **5%** and **10%**).

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[9] Thermal technologies include the ones fuelled by solid fuels, oil and gas.

- **Electric motors** are characterized by high energy intensity, thus enabling remarkable gains through small efficiency improvements. An electric drive for e-vehicles is about **40%** more efficient than an internal combustion engine, while an electric drive can bring to an energy saving of about 25% when applied in the industrial sector.
- **Lithium ion batteries** have an energy efficiency 12% higher than alternative electrochemical storage systems.[10]

2.1.5 The virtuous relationship between the electric carrier and digitalization

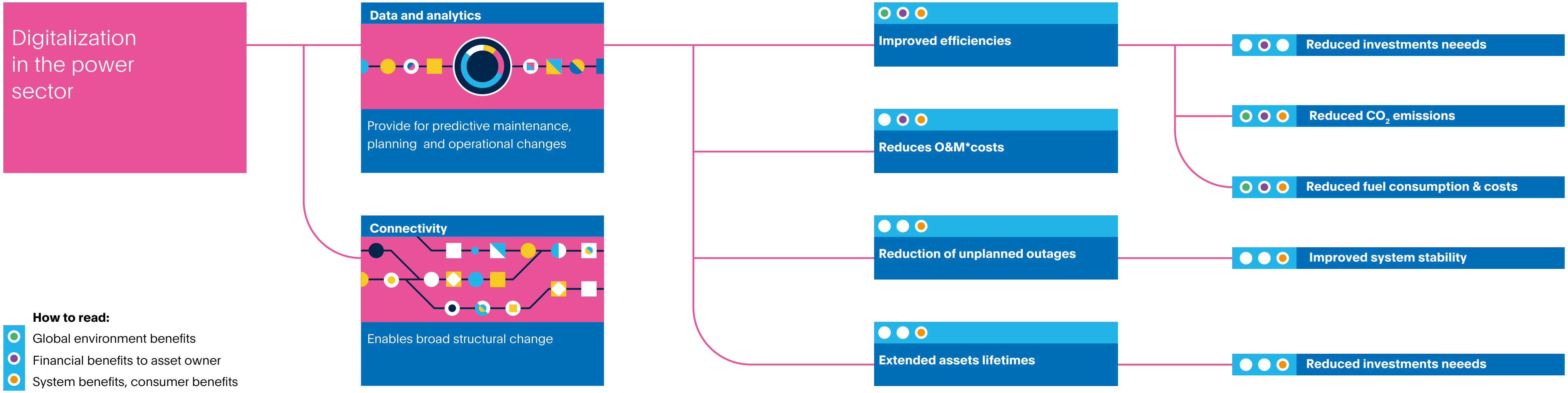
23. To date, digitalization expansion is pervasive in society. When digitalization combines with the electric carrier, the result can provide a huge variety of benefits to the system, further reducing CO_2 emissions and enhancing the overall efficiency and resilience of the energy sector. The digitalization in the power sector can create benefits enabling better data management, providing predictive maintenance and better planning and operational changes, while boosting the connectivity in the overall energy system.

24. Indeed, digital technologies can ensure constant flows of data, affecting the real-time activities of every actor in the system and ensuring a stress reduction on the network. Specifically, the predictive maintenance, allowed by the information gathered, can lower the O&M costs, with positive effects in the final electricity costs for the end-users. Data and analytics can also improve the overall efficiency of the system, achieving a higher level of planning, reducing both the loss along the network and limiting CO_2 emissions. As a consequence, higher monitoring and maintenance are associated with lower risk of unplanned outages.

25. Cost reductions and energy savings are not the only benefits generated in the power sector by a higher degree of digitalization. Traditionally, electricity is generated in large plants and then transmitted and distributed through network to final consumers. Yet, the system is in the midst of a profound transformation. The integration of renewable energy sources in electricity generation is requiring a higher level of flexibility and connectivity. With this respect, digitalization is able to support the shift towards a decentralized electricity production system, connecting and monitoring a large number of players, including prosumers.[11] As a consequence, a highly interconnected system can emerge, shading the distinction between traditional suppliers and consumers, with increasing opportunities for more local trade of energy and grid services.

Figure 7

The positive effects of digitalization in the power sector



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON INTERNATIONAL ENERGY AGENCY (IEA) AND VARIOUS SOURCES DATA, 2019.

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[10] Efficiency gain is referred to Sodium Nickel Chloride; considering lead-acid, sodium sulphur, redox flow the efficiency gain is also higher.

[11] Prosumers are active energy consumers, often called prosumers because they both consume and produce electricity. Various types of prosumers do exist residential prosumers who produce electricity at home – mainly through solar photovoltaic panels on their rooftops, citizen-led energy cooperatives or housing associations, commercial prosumers whose main business activity is not electricity production, and public institutions, like schools or hospitals.

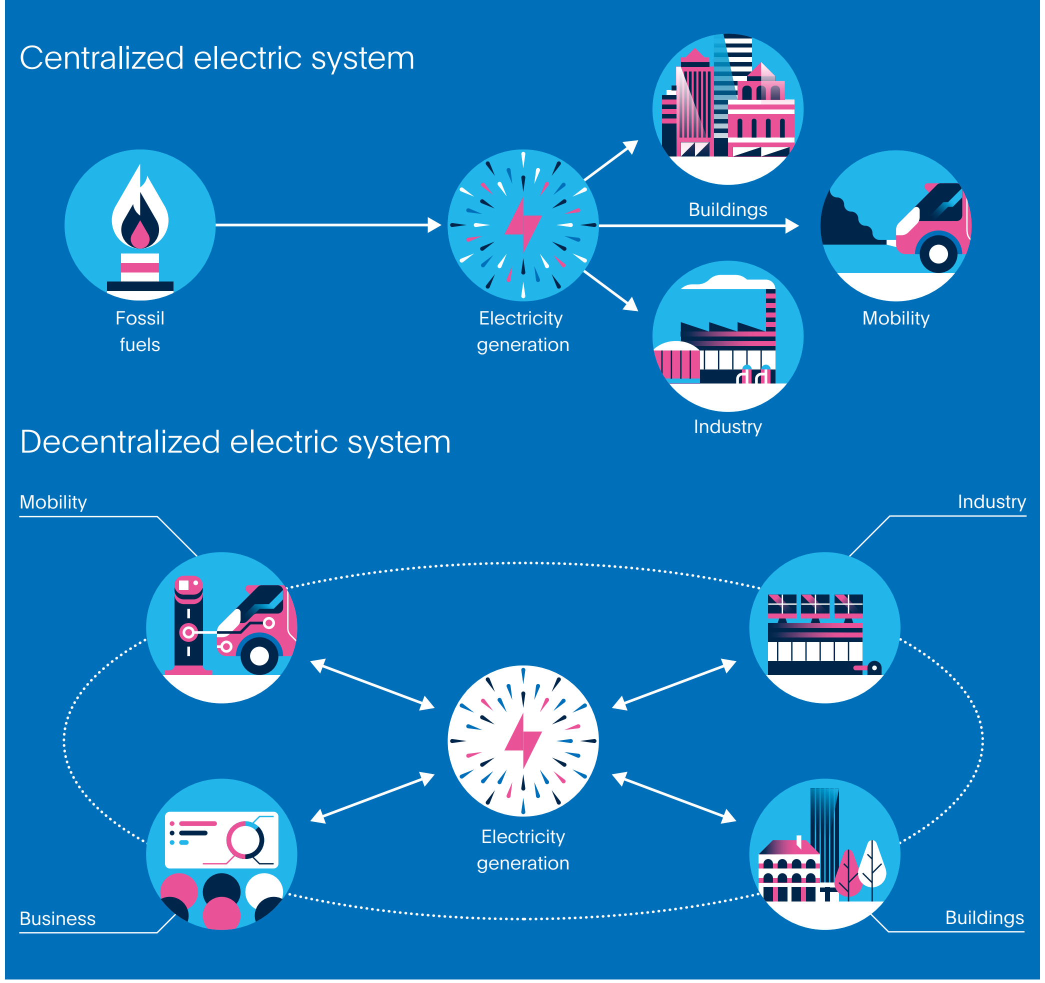
Blockchain technology: an enabling factor for network connectivity

Blockchain is a decentralised data structure in which a digital record of events is collected and linked by cryptography into a "block" together with other events. This block is then stored collectively as a "chain" on distributed computers. Any participant to a blockchain can read it or add new data. Since blockchains are transparent and trustworthy, these can facilitate peer-to-peer transactions, avoiding a third-party intermediation. There are several opportunities for the energy sector, the main being the integration and coordination among multiple heterogeneous actors and devices in smart grids and the management of decentralized transactions, guaranteeing high level of flexibility and security.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON INTERNATIONAL ENERGY AGENCY (IEA) DATA, 2019.

Figure 8

Centralized vs. Decentralized structure of electricity system



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON INTERNATIONAL ENERGY AGENCY (IEA) AND VARIOUS SOURCES DATA, 2019.

2.1.6 Innovation in lifestyles and industrial processes unleashed by electrification

26. All the aforementioned characteristics of the electric carrier allow for **innovation in lifestyle and industrial processes**. Concerning the former, indeed, there are a few societal megatrends among which the electric carrier actively contributes to fostering innovation and boosting changes in consumer habits. In turn, innovation in industrial processes enabled by the electric carrier primarily concerns the adoption of electricity-driven technologies in the energy intensive industries. In both fields, innovation brought about by the electric carrier has a positive impact on the overall sustainability.

27. Europe's population is increasingly ageing as a result of falling birth rates and a higher life expectancy. In 2015, the European Commission estimated that the so-called Silver Economy[12] valued €3.7 trillion. Its definition comprises individuals who are increasingly wealthier than the same age-range in the past, with a higher disposable income with respect to the other cohorts. In this sense, older people constitute an important share of the total demand, especially in housing, household goods and services, food and transport. In this context, electrification can promote further development in different sectors. By enabling more connected and safer electric vehicles, it can smooth also the fruition for oldest people. Mixing the electric carrier with digitalization can also be useful to enhance health management, thanks to digital health-monitoring systems. Moreover, robotics assistance and home automation allow for a better and more integrated home-care.

28. Today, over half of the world's population lives in urban areas and the European Commission's projections expect it to reach **60%** by 2030 and **70%** by 2050. Urbanization engenders issues like soil consumption, urban logistics and mobility complexity. Maintaining and upgrading the electric infrastructure is essential to enable smarter, more sustainable and more inclusive cities. In particular, favouring the penetration of electricity in the transport sector through policies such as dedicated lanes and restricted access to specific urban areas can improve traffic management and reduce pollutant emissions, improving air quality with positive impacts on human health. Moreover, better interconnection between urban devices and sensors is able to enhance security in all areas.

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[12] In 2015, the European Commission estimated that 199 million individuals were aged 50 years old and over, meaning 39% of the total population in the European Union. Further projections suggest the values can increase at 2025, with 222 million individuals (43% of the total population).

Europe is at the forefront for the development of smart cities

Europe is the top-performing geographical area in terms of smartness of its cities, with 12 cities ranking among the top 25 smart cities according to the IESE Cities in Motion Index 2018. Indeed, European cities received high scores for their quality of life and sustainability provisions, with London (1), Amsterdam (3), Paris (4), Reykjavík (5), Copenhagen (8), Berlin (9) and Vienna (10) ranking in the top 10. Furthermore, extending the analysis to the top 50 cities, the European's dominance remains evident, with more than half of the cities (28) belonging to the continent. The first Italian city is Milan, ranked 45th, while Madrid and Barcelona performed better, positioning as 25th and 26th respectively, while no Romanian cities appear in the ranking.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON IESE CITIES IN MOTION INDEX DATA, 2019.

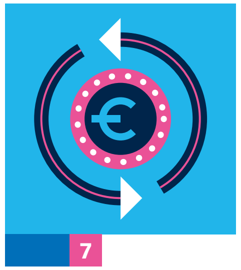
29. The mobility sector holds a significant electrification potential, with an expected growth of the electric carrier ranging between **3 to 5 percentage points** (in the Reference and Eurelectric scenarios respectively) in the share of final energy consumption. People are embracing significant changes in lifestyle in relation to the transport sector. Younger cohorts (e.g. generations Y, Z and Alpha) are increasingly shifting their consumer patterns towards more sustainable choices: they are the so-called "Green Generation" and they are able to drive companies and institutions towards a more accelerated process of sustainable energy transition by their everyday life choices (see Part 1.2). Transport is no exception and it implies a preferences' shift to public modes, shared and electric transport that guarantee to be more sustainable. The sector is evolving towards increased inter-modality, implying a better combination of transport modes both on the public (bus, metro, trolley buses, etc.) and private side (cars, mopeds, etc.). A few cities have already reached a combination in which sustainable modes cover more than a half of urban travels. For instance, in Paris almost 70% of the urban trips are made via public transport or walking and cycling. In the urban mobility evolution, the electric carrier deploys its effect to the electrically powered public transport, in which e-buses are steadily growing and both metro and trolley buses are a constant feature.

30. The other field in which the electric carrier is a powerful driver of innovation concerns the industrial sector among which the most promising field for electrification are industrial processes, meaning the adoption of electricity-driven technologies having the potential to improve product quality, reduce energy costs, and increase sustainability. In other words, innovation in industrial processes is spurred by these three drivers in which electricity plays a remarkable role and that can be summarized as follows:

- **Improved product quality.** Electricity is an energy carrier extremely precise allowing to minimize energy waste and reaching the most efficient energy use. In other terms, an electricity-driven process allows to instantly adjust energy inputs according to varying conditions and therefore obtain a high-quality product, while reducing energy waste.

- **Cost reduction.** Costs savings in industry are not limited to the reduced energy waste stemming from more precise processes but additional ones are related to the technologies supporting indirect electrification (i.e. power to hydrogen, power to fuel, etc.) that potentially allow to exploit extra-generation obtained by renewables, then maximizing the efficiency of the overall process. Furthermore, cost reduction is obtained also via an increased productivity originating from electric technologies. For instance, allowing to reach higher temperature in a shorter time span, electric technologies enable an increase in hourly production of furnaces.
- **Sustainability.** Technologies supporting electrification – when substituting gas or fossil fuels ones – contribute to reduce the emissions, making easier to reach the Emissions Trading System (ETS) targets set at the EU level for the different industrial sectors. Moreover, by reducing material losses and energy waste, electricity improves the economic footprint of the industries.

31. The transformation brought by electrification in the industrial sector has a highly deployable potential especially for the industries characterized by a high energy intensity, accounting for 67.9% of the industrial final energy consumption in Europe: chemical and petrochemical (27.3%), iron and steel (26.1%), paper, pulp and print (18%), non-metallic minerals (17.7%), non-ferrous metals (5.4%), construction (3.7%) and mining and quarrying (1.8%).



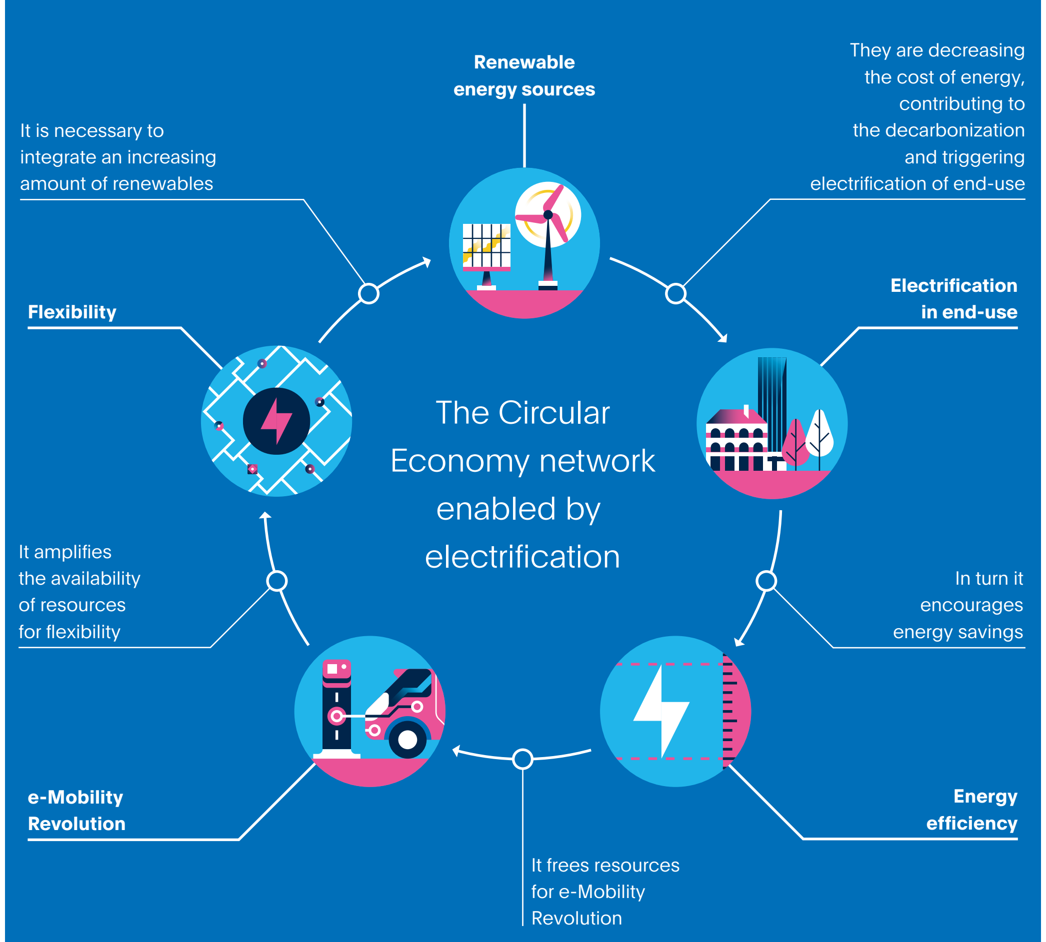
2.1.7 The electric carrier's support towards the Circular Economy

32. In a Circular Economy, the value of products and materials are maintained for as long as possible. Waste and resource use are minimized, and when a product reaches the end of its life, it is used again to create further value. This can bring major economic benefits, contributing to innovation, growth and job creation. The electric carrier can play an important role in favouring Circular Economy. Indeed, there exists a **virtuous circle between sustainability**, the objective which the circular economy tends to, and **decarbonization**, bringing to less costs, fewer CO_2 emissions, efficient energy use and affordability of the supply chain.

33. Electrification can boost **the circularity in the economy**. Renewables can decrease the cost of energy, contributing to the decarbonization and triggering electrification in end-use sectors. This turns into energy savings that further enable energy efficiency, freeing resources for the electrification of transport. e-Mobility amplifies the availability of resources for flexibility, which is needed to integrate an increasing amount of renewables, thus rebooting the circular network enabled by electrification.

Figure 9

The Circular Economy network enabled by electrification



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

34. Batteries and electricity storage can offer a valuable asset for consumers since, on the one hand, they could ensure a cleaner and affordable mobility for all, and, on the other hand, take action in favor of Circular Economy in society. As market rapidly expands for key types of batteries such as lithium-ion used in electric vehicles, correspondingly large volumes of end-of-life batteries will be generated downstream in Europe and worldwide. With this aim, The Batteries Directive of European Commission has established specific targets for collecting waste portable batteries and for defining a minimum level of efficiency for their recycling.

The second life of EVs' batteries: the example of 4R Energy Corporation

In March 2018, Nissan opened a small facility in Namie (Japan), where used Lithium-Ion batteries are retrofitted and used as replacement packs for first-generation Nissan LEAF vehicles. The plant created a joint venture between Nissan and Sumitomo Corporation, called the 4R Energy Corporation.

Used battery packs are disassembled and any module that has lost more than 20% of their capacity is replaced from other batteries. The discarded modules are repurposed for cascaded reuse. The renewed batteries will be sold at about half the price of a new replacement battery.

The facility is capable of processing 2,250 battery packs per year.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON REUTERS DATA, 2019.

The European Batteries Directive

Not all the batteries are properly collected and recycled at the end of their life cycle; the European Commission estimated that **56.7%** of all wasted batteries are not collected, annually. This, in turn, raises the risk of releasing hazardous substances, as well as a waste of resources.

The European Union legislation on waste batteries is embodied in the Batteries Directive. It aims at providing protection, preservation and improvement of the environmental quality through the minimization of the negative impact of batteries and accumulators and their waste.

The Batteries Directive was adopted in 2006 (Directive 2006/66/EC) and it has been subject to a number of revisions. In particular, the Directive prohibits the placing on the market of certain batteries and accumulators with a mercury or cadmium content above a fixed threshold, 0,0005% by weight of mercury and 0,002% by weight for cadmium.

In addition, in order to ensure that a high proportion of batteries and accumulators are recycled at the end of their life cycle, the Directive obliged the Member States to take actions in reaching a collection rates of at least 25% by 26 September 2012 and 45% by 26 September 2016 respectively.

In April 2019, the European Commission published the results concerning the evaluation assessment on the Batteries Directive. The evaluation concludes that the Directive has delivered positive results in terms of a better environment, recycling and functioning of the internal market. However, limitations in some legal provisions or their implementation prevent the Directive from fully delivering on its objectives, in particular for the collection of waste batteries or the efficiency in the recovery of materials.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN COMMISSION, 2019.

2.2 Complementary paths to energy transition

35. Given the energy targets and the European Union full decarbonization objective at 2050, the future of energy should be fully renewable. However, also short-term decarbonization goals have to be met; in this sense, **other energy carriers** can play an important role when combined with renewable electricity in **the transition phase**. Indeed, the exploitation of renewable and low-carbon gas[13] can potentially accelerate the decarbonization effort in the short-run. The rationale underpinning the interpretation is that natural gas, biomethane, biofuels and hydrogen can be used to increase sustainability and green production of energy and electricity as well. The importance of alternative energy sources can be observed looking at National Energy Plans developed by European countries. As an example, in addition to the 6 million of electric vehicles expected at 2030, the Italian Energy and Climate Plan (PNEC) attributes to the biofuels a significant role in reaching renewables goals at 2030 in the transport sector.

36. Within the category of advanced biofuels, biomethane is an important actor. Biomethane can be obtained through the "upgrade" of the biogas, that is from the raw biogas production and the subsequent removal of non-compatible components (CO_2). As of 2017, there were **17,783 biogas plants** in Europe, after a decade of steady growth. Germany has been the driving force for biogas development for many years and is still the foremost country in terms of the number of operational plants. In the same way, the biomethane production has registered a continuous growth since 2011, passing from 752 GWh in the same year to **19,352** GWh in 2017, with a compound annual growth rate of **71.8%**. Therefore, thanks to the existing gas network and plants, biomethane can contribute to the emissions reductions.

37. Hydrogen can play a role in the transformation of European energy system. It only exists as a chemically bound form, therefore it needs to be produced by specific processes. However, the hydrogen produced from fossil fuels (the so-called "grey hydrogen") entails high GHG emissions, unless CO_2 is captured. Yet, if hydrogen is produced from fossil feedstocks coupled with carbon capture and storage[14] (the so-called "blue hydrogen"), it can reduce to zero or even less the GHG footprint. When the hydrogen comes from renewable sources such as solar PV, wind or hydropower, it is called "green hydrogen". It can be stored and used to balance the fluctuating demand and to allow for high shares of intermittent renewable electricity sources. In the mobility sector, the hydrogen is used for the Fuel Cell Electric Vehicles (FCEVs), a typology of electric vehicle which uses a fuel cell, instead of a battery, to power its on-board electric motor. At the same time, hydrogen can exploit the overproduction of energy from renewables, and, through the process of electrolysis, guarantee both the stability of the network of electricity distribution and the availability of fuel (the "green hydrogen") to transports. Finally, a share of hydrogen equivalent to 10% can be feed into the actual grids without structural changes in the network, contributing to the gas network decarbonization even if, in this case, additional costs considering the infrastructural upgrade should be considered. However, there are concerns related to the large-scale hydrogen deployment. Indeed, as of today, 98% of hydrogen is produced from steam reforming and gasification, implying a high level of CO_2 emissions, while only 2% is produced with electrolysis. Moreover, at the current technological status, electrolysis presents limitations due to its high energy intensity and cost. The conversion of hydrogen back to electricity holds a low round-trip efficiency (around 30%–40%), limiting its performance as a long duration storage solution. Finally, when it comes to the hydrogen penetration in mobility sector, the FCEV's adoption faces significant challenges with respect to the BEV's one, due to the cost of transporting and storing hydrogen and the use of expensive catalysts and other materials in the fuel cell stack.

An example of technology supporting indirect electrification: Power-to-Hydrogen

The Power-to-Hydrogen (P2H) is a technology that converts electrical power to a gas through water splitting (or electrolysis) process to obtain hydrogen. The energy required for water splitting is obtained from variable renewable sources. The obtained gas can be, then, stored or transferred through, for example, pipeline in gas or liquid forms. The hydrogen may be used directly for fuelling, for example, hydrogen vehicles or it may be used indirectly for electric energy production via, fuel cell or gas turbines. Hydrogen produced via electrolysis can result in zero GHG emissions, depending on the source of the electricity used. The Power-to-Hydrogen can offer opportunities for synergy with variable power generation; given the intermittent nature of renewable energy sources, hydrogen and electric power generation could be integrated, allowing flexibility to shift production to best match resource availability with system operational needs and market factors. Also, in times of excess electricity production, instead of curtailing the electricity, it is possible to employ this excess electricity in producing hydrogen through electrolysis.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON HYDROGEN EUROPE DATA, 2019.

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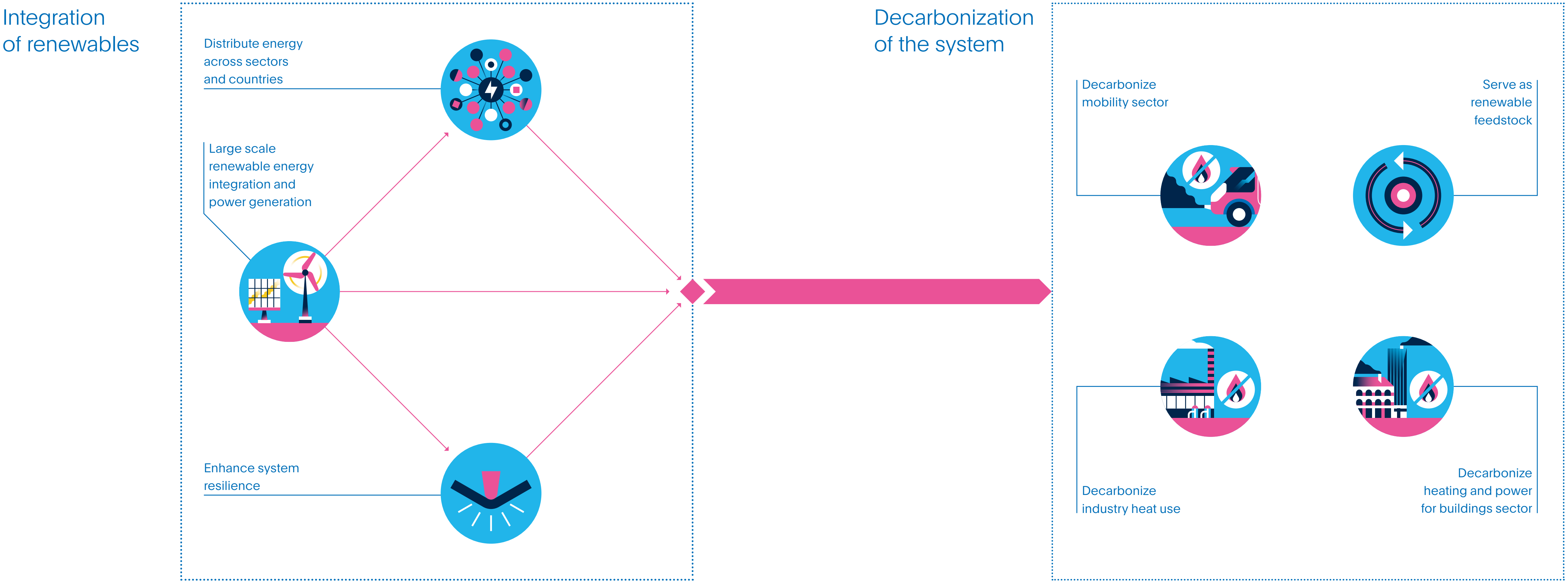
[13] Renewable gas refers to all gas produced from renewable sources. This includes biomethane, green hydrogen, produced from renewable electricity (power-to-gas), and power to methane, in which biogenic CO_2 and green hydrogen are methanised. Low-carbon gas is gas that, during production, has small volumes of CO_2 remaining uncaptured. Low-carbon gas includes also blue hydrogen.

[14] Carbon Capture and Storage (CCS) allows to capture up to 90% of the carbon dioxide (CO_2) emissions produced from the use of fossil fuels in electricity generation and industrial processes, preventing the carbon dioxide from entering the atmosphere. Furthermore, the use of CCS with renewable biomass is one of the few carbon abatement technologies that can be used in a "carbon-negative" mode taking carbon dioxide out of the atmosphere. The CCS technologies were included in the International Energy Agency's Blue Map Scenario 2050 as a powerful tool in the mitigation strategies of the pollutant emissions both in energy generation and industrial processes.

Figure 10

Hydrogen as an enabling source for supporting the energy transition in Europe



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON HYDROGEN EUROPE DATA, 2019.

38. The society is gradually facing the need of building a different energy system, based on **affordability**, **reliability** and **sustainability**. These three pillars are closely interconnected and their management requires a **comprehensive approach to the energy transition**. Indeed, their links are gradually evolving and the trade-offs among them as well; on the one hand, the renewable energy sources are contributing to the affordability of the system, generating low-emissions electricity; on the other hand, reliability needs to be addressed. Managing the complexity of the energy transition implies to imagine policies and actions with a wide scope, taking into account all the possible pathways to guide the energy transition in different time spans and meet all the policy targets, in the medium term and in the long term as well.

Part 3

An innovative assessment model for socio-economic impacts of energy transition in Europe, with a focus on Italy, Spain and Romania

Key messages

- In light of the relevance of the electric carrier, the energy transition enabled by electrification presents significant opportunities for society as a whole. In this sense, the quantitative assessment of the **socio-economic impacts of energy transition** is pivotal to guide policymakers' agendas in order to ensure a transition "**just for all**".

- An innovative assessment model has been devised. It combines a macro and micro approach, starting from the analysis of 3,745 products/technologies that characterize European industrial production, and it assesses the effect of energy transition on industrial production and employment at **2030** in the **European Union, Italy, Spain** and **Romania**.

- The first part of the analysis involves the extended value chains (**Research & Development, Manufacturing and Distribution, Sales and Aftermarket**) of all the products and technologies involved in the electrification process, that are already produced and marketed. The second part of the analysis deals with the definition and the quantitative assessment of the **digital services** associated to energy transition that can be further developed in the future and that will be marketed in the next years (3 to 5 years).

- The final differential effects on production value range between **+113 billion Euros** and **+145 billion Euros** for the European Union overall at 2030. In Italy, the net effects of energy transition on production value have been assesed to be from **+14 billion Euros** to more than **+23 billion Euros**, while in Spain the differential impacts span from **+7 billion Euros** to **+8 billion Euros** at 2030. Finally, in Romania the final net effects moves from **+2 billion Euros** to **+3 billion Euros**.

- The final impacts on **employment** show an overall positive effect for the European Union and Italy, Spain and Romania. In the European Union, energy transition generates a final net impact from **+997,000 employees** to +**1.4 million employees** at 2030. In Italy, the net employment gain accounts from more than **+98,000** employess to **+173,000** employees at 2030, while in Spain the effect ranges from **+73,000** to **+97,000** employees and in Romania it spans from **+30,000** to more than **+52,000**.

- The use of electric technologies in end-use sectors enables the reduction of pollutant emissions improving air quality in particular in urban areas. The impact of energy transition on air quality has been assessed for the European Union, Italy, Spain and Romania by considering emissions from transport and residential sectors, which together account for **more than 50%** of total emissions in the European Union. The results on emissions reduction have then been translated into impacts on human health and cost reduction. In particular, the substitution of thermal technologies with electric ones in transport (electric vehicles) and residential sectors (heat pumps) is able to reduce premature deaths in the European Union, Italy, Spain and Romania, respectively by **5,000**, **1,000**, **500** and **170** units at 2030. Moreover, costs related to air pollution in the European Union could be reduced from a minimum of **1 billion Euros** to a maximum of **2.9 billion Euros** at 2030.

3.1

The methodology for the assessment of socio-economic impacts of energy transition

1. In light of the relevance of the electric carrier, the energy transition enabled by electrification presents significant opportunities for society as a whole. In this sense, the quantitative assessment of the socio-economic impacts of energy transition is pivotal to guide policymakers' agendas in order to ensure a transition "just for all".

2. With this purpose, an **innovative analytical model** has been devised, aimed at assessing the socio-economic impacts of the energy transition enabled by electrification at 2030. The model focuses on the **European Union** as a whole and three countries of interest, **Italy**, **Spain and Romania**, estimating outcomes in terms of **production value** and **employment**. The timeframe of reference is **2030**. From a methodological point of view, the model combines a micro and macro approach, dealing with the analysis of all **3,745 products and technologies** that characterize European industrial production, combined with a deep analysis of the existing literature, desk analysis and interviews with the expert panel.[1]

3. The first part of the analysis focuses on the **extended value chains** (R&D, Manufacturing and Distribution, Sales and Aftermarket) of all the products and technologies involved in the energy transition process, enabled by electrification, that are already produced and marketed. The second part deals with the identification and the quantitative assessment of the **digital services related to energy transition** that will be further developed in the future and that will be marketed in the next years (3 to 5 years). The rationale underpinning the analytical model is a **differential approach**: the final results related to the first part are expressed as the net balance between the overall production value and employment gained and lost by the overall system due to the electrification deployment and thermal technologies' downsizing between 2017 and 2030 respectively. Then, the additional production value and employment generated at 2030 by digital services are added on top, since these are directly connected to the future electrification deployment.

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[1] See the introduction of the study for further information on the expert panel involved.

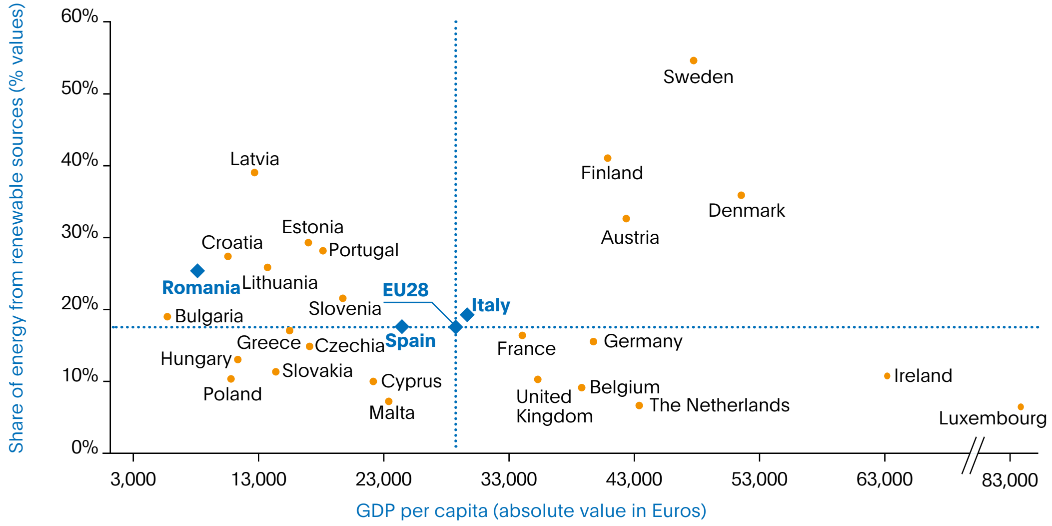
4. The focus on Italy, Spain and Romania has been extracted from a wide socio-economic analysis of all the EU28 countries along several dimensions:

- Economic and industrial context.[2]
- Societal megatrends.[3]
- Energy system development and its readiness towards the transition.[4]

5. Combining economic, societal and energy features, it emerges that Italy, Spain and Romania are representative of **three different contexts and level of development** with respect to the energy transition. Indeed, focusing only on GDP *per capita* and the share of energy from renewable sources, it is possible to define four different samples of countries within the European context. Italy belongs to the set of countries with the income and a share of renewable energy sources above the European Union averages. Spain, instead, is aligned with the European Union average with respect to share of renewable energy sources, but its income is slightly below the European Union average. Finally, Romania presents a share of renewable energy sources above the European Union level, but with a GDP *per capita* of €9,600 below the European Union average.

Figure 1

Share of energy from renewable sources and GDP per capita, 2017 (% and absolute values)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT DATA, 2019.

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[2] It includes the shares of manufacturing and services sectors on GDP, GDP *per capita*, individual consumption, GDP growth rate and share of Small-Medium Enterprises on total turnover by enterprise size.

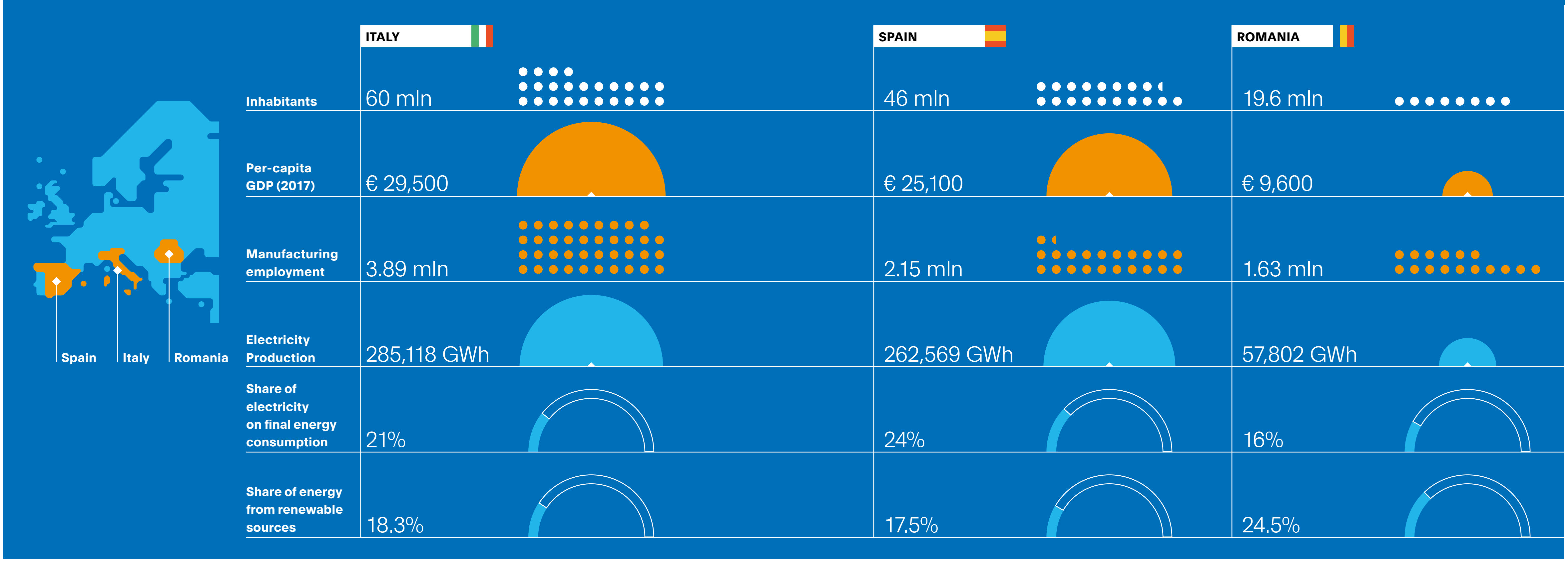
[3] It includes unemployment rate, share of graduates in Science, Technology, Engineering and Mathematics disciplines, ranking in the Digital Economy and Society Index and level of urbanization.

[4] It includes the energy mix composition, share of energy from renewable sources, renewables' energy targets at 2020 and 2030 and the current gap with respect to those, the final energy consumption by sector, the presence of domestic nuclear power production, the energy efficiency, the gross inland consumption, the energy dependency and the level of GHG emissions.

6. When it comes to the industrial structure, Spain relies more on a service-oriented economy, Italy has a strong manufacturing tradition, characterized by an intense presence of small and medium enterprises and also Romania has a strong manufacturing component. The industrial production of thermal technologies represents a relevant share in the manufacturing sector for Spain and Romania, while Italy, also due to its technical and scientific competences, has a strong industrial production of electric products and technologies to date. Moreover, Romania holds a relevant share of employment in sectors with high level of GHG emissions. Spain has a strong commitment to renewable energy sources, with the aim of achieving 100% share of renewable energy in electricity generation at 2050 (34% in 2030). Finally, the countries present a different level of digitalization, which is a crucial enabling factor for energy transition: high level for Romania (the country ranks fourth in Europe for the ICT sector share of total value added), medium-low for Spain and low for Italy.

Figure 2

Key fact&figures on the societal, economic and energy context for Italy, Spain and Romania, 2017



	ITALY	SPAIN	ROMANIA
Inhabitants	60 mln	46 mln	19.6 mln
Per-capita GDP (2017)	€ 29,500	€ 25,100	€ 9,600
Manufacturing employment	3.89 mln	2.15 mln	1.63 mln
Electricity Production	285,118 GWh	262,569 GWh	57,802 GWh
Share of electricity on final energy consumption	21%	24%	16%
Share of energy from renewable sources	18.3%	17.5%	24.5%

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT DATA, 2019.

7. The analytical model for the assessment of socio-economic impacts of energy transition at 2030 entails eight methodological steps:

1) The reconstruction of the complete database of all the electrification products, technologies and services, starting from the **manufacturing of all the products and technologies** composing the European industrial production to date.
2) The in-depth analysis of all the **3,745 products and technologies** in Prodcom database (representing the whole European manufacturing industry) and the assessment of their overall production value.
3) The identification, within the **3,745 products and technologies**, of the **977 ones** involved in the electrification process, assessing their prevailing nature with regard to the electrification process (electric, thermal or neutral).
4) The estimation of the **production values of electric, thermal and neutral technologies at 2030**, according to the evolution of final energy demand in **three different scenarios** (EU Reference Scenario, EUCO3232.5 Scenario and Eurelectric Scenario), implying a different growth of electrification with an ad hoc algorithm for some electrification bundles leading the transition (solar panels, heat pumps, electric motors, electrical storage systems – batteries, LED lamps, power electronics, wind turbines).
5) The **reconciliation of the production values** of the selected 977 products and technologies with the **corresponding number of employees**.
6) The identification of the **prevailing nature** (electric, thermal or neutral) of the other components of the electrification technologies value chains: Research & Development and Distribution, sales and aftermarket.
7) The estimation, in terms of production value and employment, of the **additional services** than can be activated by electrification at 2030 and that are not fully grasped by the existing extended value chains.
8) The **sum up of the final results** on industrial production and employment along the overall value chains, with the inclusion of additional services enabled by electrification.

8. The assessment of socio-economic impacts of energy transition moves from the **mapping of all products and technologies** potentially involved in and affected by the electrification. Leveraging on the analysis undertaken for the study "*Electrify 2030. Electrification, industrial value chains and opportunities for a sustainable future in Europe and Italy*" realized by The European House – Ambrosetti for Enel Foundation and Enel X (2018), more than 60 existing categories of electrification technologies have been analyzed, by grouping them according to both their application in buildings, industry and transport and their final use (electricity generation on site, storage and utilization).

9. Relying upon the map of electrification technologies, an extended map of the industrial value chains for the electric technologies has been defined. The value chains map is structured in a matrix form, matching the value chains macro-sectors with the different technologies. In particular, the macro-sectors taken into account are:

- **Research & Development**, which considers both the competences and skills that are necessary in the development of the given technologies and the research areas that are involved in the research related to the technology.
- **Manufacturing**, which includes the manufacture of the constitutive parts of the different technologies. Given the substantial differences in the manufacturing of the technologies, the specific distinction has been kept into account. For instance, the electric drive is divided in the components for Direct Current (DC) Motor and Alternative Current (AC) Motor, batteries are distinguished between battery types and accessories that are common to all of them, and the energy management systems are subdivided between the hardware components and the software ones.
- **Distribution sales and aftermarket**, which implies all the distribution, logistics and maintenance parts of the value chains. This category comprises also the **Recycle and second life**, which includes the recycle and reuse of materials and items as well as the possible usage for exhausted technologies as the battery regeneration for residential and industrial use.

Figure 3 Mapping of all categories of electrification technologies involved in the electrification process, 2019

	Electricity generation on site	Storage	Utilization	
Buildings & household consumption	🟩 ■ Cogeneration systems ▍High power (only for buildings with a power >100 kW) ▍Gas turbine CHP plants ▍Gas engine CHP plants ▍Biofuel engine CHP plants ▍Combined cycle power plant ▍Molten-carbonate fuel cells and Solid oxide fuel cells or Steam turbine CHP plants ▍Nuclear power plants ▍Small power: ▍Reciprocating engine or Stirling engine ▍Biomass ▍Municipal solid waste ■ Photovoltaic systems ■ Micro-wind systems 🟥 Fuel cells*	🟩 🟧 Electrochemical storage systems (batteries) ■ Electrostatic devices (supercapacitors)* ■ Electro-mechanical devices (flywheels*, CAES=compressed air energy storage) ■ Electromagnetic devices (SMES-Superconducting Magnetic Energy Storage systems) ■ Thermal storage system ■ Solar fuels* 🟥 Power to fuel 🟥 Power to gas	🟩 🟧 Heat pumps ▍Air source Heat pumps ▍Ground Source Heat Pumps ▍Hybrid Heat Pumps ▍Ductless Mini Split Heat Pumps ▍Absorption Heat Pumps 🟧 LED lamps 🟧 Electric drives ▍1–10 kW (elevator and freight elevators for residential use, washing, machine, dishwasher, water pumps - single dwelling) ▍10–100 kW (elevator and freight elevators for commercial use, water pumps for residential buildings)	🟩 ■ OLED lamps (Organic LED)* ■ Efficient refrigerators** ■ Efficient dishwashers** ■ Efficient washing machines** ■ Induction burners**
Industry	🟩 ■ **Cogeneration systems** ▍High power ▍Gas turbine CHP plants ▍Gas engine CHP plants ▍Biofuel engine CHP plants ▍Combined cycle power plant ▍Molten-carbonate fuel cells and Solid oxide fuel cells plants ▍Steam turbine CHP plants ▍Nuclear power plants ▍Small power: ▍Reciprocating engine ▍Stirling engine ▍Biomass ▍Municipal solid waste ■ Photovoltaic systems ■ Micro-wind systems 🟥 Fuel cells*	🟩 🟧 Electrochemical storage systems (batteries) ■ Electrostatic devices (supercapacitors)* ■ Electro-mechanical devices (flywheels* CAES=compressed air energy storage) ■ Electromagnetic devices (SMES-Superconducting Magnetic Energy Storage systems) ■ Thermal storage system ■ Solar fuels* 🟥 Power to fuel 🟥 Power to gas	🟩 🟧 Heat pumps ▍Air source Heat Pumps ▍Ground Source Heat Pumps ▍Hybrid Heat Pumps ▍Ductless Mini Split Heat Pumps ▍Absorption Heat Pumps 🟧 LED lamps 🟧 Electric drives ▍1–10 kW (HVAC - Heating, Ventilation Air Conditioning) ▍10–100 kW (Washing machine, Plastic, HVAC-Heating, Ventilation and Air Conditioning) ▍100 kW–1 MW (Oil-gas, cement, chemical, pulppapers, metals) ▍1 MW–100 MW (Oil-gas, cement, chemical, pulppapers, metals)	■ OLED lamps (Organic LED)* ■ Induction oven (steel industry) ■ Electrode oven (glass industry) ■ Microwave oven (ceramics industry) ■ Arc electric oven (steel industry) ■ Pulse dryer (paper) ■ Radio frequency and infrared dryer (textile) ■ Microwave dryer (paper industry) ■ Electrolysis (chemical industry) ■ High pressure processing (food) ■ Ultrasound dye (textile industry)
Transport	■ Photovoltaic systems 🟥 Fuel cells*	🟩 🟧 Electrochemical storage systems (batteries) ■ Electrostatic devices (supercapacitors)* ■ Electromagnetic devices (SMES-Superconducting Magnetic Energy Storage systems) ■ Thermal storage system ■ Solar fuels* 🟥 Power to fuel 🟥 Power to gas	🟩 🟧 Heat pumps ▍Air Source Heat Pumps ▍Water Source Heat Pumps 🟧 LED lamps 🟧 Electric drives ▍1–10 kW (Electric vehicle actuators) ▍10–100 kW (Light duty electric car propulsion) ▍100 kW–1 MW (Ship propulsion) ▍1 MW–100 MW (Ship propulsion)	🟩 ■ OLED lamps (Organic LED)* ■ Conductive and inductive recharging system

Power electronics: electric-electronic appliance that modifies features of out-coming electricity from those of in-coming electricity

Energy Management System (EMS): integrated technology used by electricity operators to monitor and optimize generation, distribution and utilization performances

Energy Management System (EMS): integrated technology used by electricity operators to monitor and optimize generation, distribution and utilization performances

Power electronics: electric-electronic appliance that modifies features of out-coming electricity from those of in-coming electricity

How to read:

🟩 Technologies enabling energy efficiency

🟥 Indirect electrification

🟧 Technologies with the highest enabling potential for electrification

🟦 Cross-cutting technologies

(*) Investigational technologies are all the technologies that are currently under investigation and have the potential to be marketed in the near future (3 to 5 years)

(**) Only energy-intensive household appliances have been considered

N.B. We have considered only technologies strictly linked to the electrification process and energy efficiency enabled by electrification

N.B. This document is a proprietary model elaborated by The European House – Ambrosetti in order to map all the electrification technologies. The model has been validated by engineers affiliated to the «Engineering, ICT and Technologies for Energy and Transportation» department at Consiglio Nazionale delle Ricerche (CNR)

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

Figure 4/a Mapping of the industrial value chains of the electrification technologies, 2019

	Research & Development		Manufacturing	Distribution, sale and aftermarket	Recycle and second life
	Competences	Research areas			
Heat pumps	■ Electronic engineering ■ Electric engineering ■ Chemical engineering ■ Environmental engineering ■ Computer science ■ Mechanical engineering ■ Physics ■ Mathematics	■ Thermodynamics ■ Materials ■ Energy efficiency ■ Environmental impacts ■ Electric and electronic systems ■ Digital system ■ Mechanical systems ■ Sensors ■ Control systems	■ Coolant ■ Evaporator ■ Compressor including electric motor ■ Condenser ■ Expansion valves ■ Throttling valves ■ Probe ■ Fan coil units ■ Coils ■ Duct connections	■ Logistics ■ Deposit ■ Sale ■ Installation ■ Post-sale assistance ■ Maintenance ■ System integrators	Recyclable materials and items: ■ Iron ■ Steel ■ Aluminium ■ Nickel ■ Molybdenum ■ Magnesium ■ Copper ■ Bronze ■ Lithium ■ Cobalt ■ Nickel ■ Graphite ■ Glass ■ Plastic ■ Silicon ■ Battery regeneration for residential and industrial use ■ Permanent magnet materials
LED lamps	■ Electronic engineering ■ Electric engineering ■ Chemical engineering ■ Physics ■ Mathematics	■ Chemical compounds ■ Materials ■ Lighting ■ Optoelectronics ■ Energy efficiency	■ Semiconductor devices (Silicon, Carbon, Germanium, Gallium Arsenide) ■ Chip ■ Electrical connections ■ Optical lenses ■ Protective cap ■ Light paths ■ Cooling plate (only in Power LED)	■ Packaging ■ Transport ■ Sale ■ Installation	
Electric drives	■ Electronic engineering ■ Electric engineering ■ Mechanical engineering ■ Control system engineering ■ Computer science ■ Physics ■ Mathematics	■ Energy efficiency ■ Power electronics ■ Electrical machines ■ Control systems ■ Embedded systems	**Electric motor** **Direct Current (DC) Motor** **Brush DC** 🟥 Shunt wound 🟥 Separately excited 🟥 Series wound 🟥 Compound wound 🟥 Permanent magnet 🟥 Servomotor **Brushless DC** 🟥 Universal **Alternating Current (AC) Motor** **Induction Motor** **Squirrel Cage** 🟥 Design A* 🟥 Design B* 🟥 Design C* 🟥 Design D* 🟥 Shaded Pole 🟥 Split phase 🟥 Capacitor start 🟥 Capacitor run 🟥 Resistance start **Wound Rotor** 🟥 Repulsion start 🟥 Repulsion induction **Synchronous Motor** ■ Permanent magnet ■ Synchronous reluctance ■ Hysteresis ■ Synchronous induction ■ Reluctance ■ Sub-synchronous reluctance ■ Variable reluctance ■ Stepper ■ Hybrid **Linear** ■ Induction ■ Synchronous **High Power Converters** **Direct Conversion** ■ Matrix converter ■ Cycloconverter **Indirect Conversion** **Voltage source** 🟥 High power 2 VSI 🟥 Neutral point clamped 🟥 Flying capacitor 🟥 Cascade H bridge 🟥 Hybrid topologies **Current source** 🟥 PWM current source inverter 🟥 Load commutated inverter	■ Transportation ■ Distribution ■ Sale ■ Installation ■ Maintenance services ■ Substitution	

How to read:

🟥 Detailed components of a single part

(*) There are different standard types of squirrel cage.
Design A: normal starting torque, normal starting current, normal slip;
Design B: normal starting torque, low starting current, normal slip;
Design C: high starting torque, low starting current, normal slip;
Design D: high starting torque, low starting current, high slip.

N.B. This document is a proprietary model elaborated by The European House – Ambrosetti in order to map the industrial value chains of the six cross-cutting technologies that can play a key role for electrification. The model has been validated by engineers affiliated to the «Engineering, ICT and Technologies for Energy and Transportation» department at CNR

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

Figure 4/b Mapping of the industrial value chains of the electrification technologies, 2019

	Research & Development		Manufacturing	Distribution, sale and aftermarket	Recycle and second life
	Competences	Research areas			
Electrochemical storage systems (battery)	■ Electronic engineering ■ Electric engineering ■ Chemical engineering ■ Chemistry ■ Physics ■ Mathematics	■ Battery Management System ■ Hybrid batteries (supercapacitors + storage system) ■ Big Data analytics ■ Smart-grid ■ Power electronic converters	**Battery types** ■ NiCdcell ■ NiMH cell ■ Lithium-ion cell ■ Lead-acid battery **Accessories** ■ Inverter ■ DC/DC converter ■ Charger	■ Transportation ■ Distribution ■ Sale ■ Installation ■ Substitution and maintenance services ■ System integrators	Recyclable materials and items: ■ Iron ■ Steel ■ Aluminium ■ Nickel ■ Molybdenum ■ Magnesium ■ Copper ■ Bronze ■ Lithium ■ Cobalt ■ Nickel ■ Graphite ■ Glass ■ Plastic ■ Silicon ■ Battery regeneration for residential and industrial use ■ Permanent magnet materials
Power electronics	■ Electronic engineering ■ Electric engineering ■ Physics ■ Mathematics	■ Materials ■ Electrical circuit ■ Nano-technology ■ Control systems ■ Semiconductor devices ■ Thermal management ■ Electromagnetic compatibility ■ Energy efficiency	■ Semiconductor power devices (power diode, power transistor, wide bandgap device, etc.) ■ PCBs (printed circuit boards) ■ High frequency transformers ■ EMI filters ■ Embedded control boards (DSP, microcontroller, FPGA, etc.) ■ Capacitor ■ Inductor A Power Electronics is an electric-electronic appliance that modifies features of out-coming electricity from those of in-coming electricity	■ Transportation ■ Distribution ■ Sale ■ Installation ■ Maintenance	
Energy Management Systems (EMS)	■ Electronic engineering ■ Information technology ■ Computer science ■ Energy engineering ■ Physics ■ Mathematics	■ Computer software ■ Embedded programming ■ ICT ■ Operations research ■ Artificial intelligence ■ Sensor networks ■ Energy efficiency	**Hardware** ■ Smart meter ■ Sensors ■ Wearable device/ IoT ■ Portable devices (PC, tablet, smartphone) ■ Embedded boards (DSP, microcontroller, FPGA, etc.) **Software** ■ Mobile app ■ Diagnostic system ■ Monitoring system ■ Automation systems ■ Big Data analytics ■ Energy management algorithms ■ Cloud and Edge computing An Energy Management System is an integrated hardware/software technology used by electricity operators to monitor, control and optimize generation, distribution and utilization performances	■ Transportation ■ Distribution ■ Sale ■ Installation ■ Consulting services ■ Maintenance ■ System integrators	

How to read:

🟥 Detailed components of a single part

(*) There are different standard types of squirrel cage.
Design A: normal starting torque, normal starting current, normal slip;
Design B: normal starting torque, low starting current, normal slip;
Design C: high starting torque, low starting current, normal slip;
Design D: high starting torque, low starting current, high slip.

N.B. This document is a proprietary model elaborated by The European House – Ambrosetti in order to map the industrial value chains of the six cross-cutting technologies that can play a key role for electrification. The model has been validated by engineers affiliated to the «Engineering, ICT and Technologies for Energy and Transportation» department at CNR

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

10. The analysis on socio-economic impacts of energy transition covers the entire value chain of the electrification technologies previously identified along the three different phases relevant for electrification deployment: **power generation, power transmission and distribution** and **end-use sectors**.

11. In order to develop the analytical assessment model, a **newly detailed database of all products and technologies** composing the European manufacturing industry – including all 28 Member States – has been reconstructed, starting from Prodcom data. The resulting database comprises the statistics on the production value of 3,745 products and technologies in the EU Member States for 11 years (from 2007 to 2017), totaling more than **6.2 million observations**. As a result, the final database aims to represent a **complete overview of the industrial production** in the EU countries, for a 11 years period range, with the highest degree of detail on every technology produced.

The overview on the European industrial production: Prodcom database

Prodcom provides detailed statistics on the production of manufactured goods. The term comes from the French "PRODuction COMmunautaire" (Community Production) for mining, quarrying and manufacturing. Prodcom database uses the product codes specified on the Prodcom List, which contains about 3,800 different types of manufactured products.

Each product is identified by an 8-digit code:

- The first 4 digits are the classification of the producing enterprise given by the Statistical Classification of Economic Activities in the European Community (NACE).
- The first 6 digits correspond to the Classification of Products by Activity (CPA).
- The following 2 digits specify the product in more details.

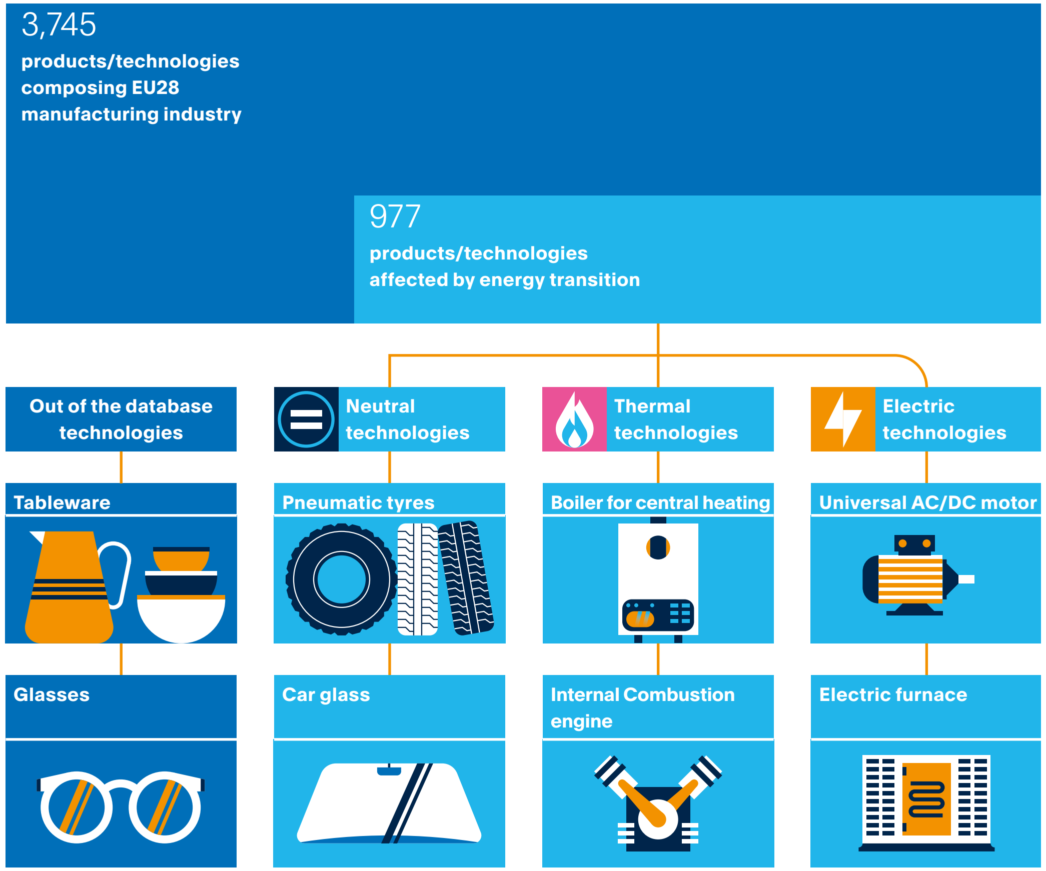
SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT DATA, 2019.

12. Building on the 3,745 products and technologies representing the overall EU28 **manufacturing industry** at 2017, the technological mapping illustrated in Figure 3 has been exploited in order to select the products and technologies involved in and potentially impacted by the energy transition enabled by electrification, accounting for **977 products and technologies**. As a further step, their prevailing nature with regard to the energy transition has been identified. As a result:

- **147 products and technologies** have been considered as **thermal**, specifically the ones more closely related to traditional fuel or other thermal technologies and expected to be potentially negatively affected by the energy transition enabled by electrification.
- **254 products and technologies** have been considered as **electric**, specifically the ones more closely related to the electric technologies and expected to be potentially positively affected by the energy transition enabled by electrification.
- **576 products and technologies** were considered as **neutral**,[5] specifically the ones which should not be neutrally affected by the electrification process.

Figure 5

Examples of the selected technologies by their prevailing nature, 2019



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

13. The production value at 2030 of the 977 products and technologies considered is estimated for both thermal and electric products and technologies by correlating the specific (thermal and electric) production value at 2017 with the

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[5] The assessment of technological neutrality is performed at the current technological status; some of these technologies could convert into electric ones in the future thanks to technological development. With this respect, an example is provided by the Israeli start-up REE, that has designed a revolutionary electric vehicle in which the motor, the steering system, the brakes and the suspension are moved from under the hood into the wheels. This enables the conversion of a traditional chassis into an electric one.

corresponding trend in **energy demand in the period 2017–2030**, for the European Union, Italy, Spain and Romania. As confirmed by the literature, the trend in energy demand can be regarded as a sound proxy for the overall economic performance.[6] As a result of the correlation, **technology and country specific coefficients** have been derived and they have been applied to the production value at 2017 in order to estimate the corresponding value at 2030. Moreover, in order to differentiate the final results according to different policy frameworks, **three scenarios** have been taken into account: the **EU Reference Scenario**, the **EUCO3232.5 Scenario** and the **Eurelectric Scenario**. The varying results of the analytical assessment model for the different scenarios relies on the different level of energy demand at 2030 underlying the different policy targets that characterize them. The development of the neutral technologies at 2030 is assumed to be linked to the electric and thermal one: on the one hand, it is the result of the increase in the production value of the electric technologies and, on the other hand, of the downsizing in production value of thermal technologies. For this reason, the average of the growth rates of electric and thermal technologies in the period 2017–2030 has been considered and applied to the neutral technologies' production value at 2017 in the three different scenarios.

Three different scenarios embedded in the analytical assessment model: Reference Scenario, EUCO3232.5 and Eurelectric

Three scenarios have been taken into account in order to estimate the socio-economic impact of energy transition in 2030: the Reference Scenario, the EUCO3232.5 Scenario and the Eurelectric Scenario.
The **Reference Scenario** is in line with the EU 2030 Climate & Energy Framework targets, meaning at least **40%** cuts in GHG emissions (vs. 1990 level), at least a **27%** share from renewable energy sources, and at least a **27%** improvement in energy efficiency (vs. 1990 level).
As part of a group of EUCO scenarios that have been derived from the EU Reference Scenario, the legislation introduced, under the European Commission's Clean Energy for all Europeans package, the **EUCO3232.5 Scenario** for 2030, including a share of at least **32%** renewable energy in the EU energy mix and an improvement in energy efficiency of at least **32.5%** at EU level. Finally, the 2030 GHG target of a reduction of domestic emissions is set at least **40%**.
The **Eurelectric Scenario** is based on the evolution curve elaborated by Eurelectric in the 2018 study "*Decarbonization pathways*" and originally it is referred to 2050. In the study "Electrify 2030" realized by The European House – Ambrosetti for Enel X and Enel Foundation, the 2030 values have been obtained through a re-elaboration of the intermediate scenario (Eurelectric-2) included in the Eurelectric's study. The re-elaboration implied computing the annual growth rate* up to 2050 and, subsequently, identifying the corresponding electrification share at 2030. Moreover, while the estimation for Italy was feasible, for Spain and Romania, the data for Iberia and EU28 a s whole have been applied respectively.

(*) COMPOUND ANNUAL GROWTH RATE (CAGR)
SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN COMMISSION, 2019.

14. Among the 254 electric products and technologies, **7 electric bundles leading the energy transition** have been considered. These bundles include the key electric products and technologies for electrification, which are expected to develop the most in the future with respect to the other electric products and technologies. In this sense, the 7 technological clusters consist in **72 products and technologies**, accounting for the **18.7%** of the total European Union electric production value and they correspond to:

- Solar panels.
- Heat pumps.
- Electric motors.
- Electrical storage systems (batteries).
- LED lamps.
- Power electronics.
- Wind turbines.

For each of the 7 clusters, a **specific multiplier[7] at 2030** has been computed, at European Union level and for each country of interest (Italy, Spain and Romania), in order to take into account the accelerated expected development to which they are expected to be undergone in the near future.

15. The Prodcom database provides detailed data only on industrial production. In order to widen the analysis of the socio-economic impacts of the energy transition also on employment, it has been necessary to **reconcile the Prodcom categories** (8 digits) **to the corresponding NACE ones** (4 digits), which correspond to the maximum level of details for which the data on employees are provided. In this way, the 977 products and technologies previously identified in the Prodcom database have been associated with **52 Eurostat categories**, allowing for a complete overview in terms of production value and employment for the manufacturing sector.

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[6] Source: "The relationship between energy demand and real GDP growth rate", Energy Economics (2017); "Relationships between energy consumption and economic growth investigated", European Commission (2013); "Has there been absolute decoupling of economic growth from energy consumption in Europe?", European Environment Agency (2018); "The relationship between energy consumption and economic growth: Evidence from non-Granger causality test" (2017).

[7] Differently from the development coefficients computed for all the 977 products and technologies, the multipliers do not vary according to the three scenarios identified since they have been reconstructed taking into account the level of development of green and brown field solar capacity for solar panels, the share of electricity in final energy consumption in residential sector for heat pumps, the share of electricity in final energy consumption in transport sector for electric motors and batteries, the estimated level of development for LED lamps, yearly investment in power generation for power electronics and green and brown field wind capacity installed for wind turbines.

Figure 6

Some examples of the 977 Prodcom products and technologies, Prodcom-NACE reconciliation and some examples of the 52 Eurostat NACE database, 2019

977 ProdCom products/technologies

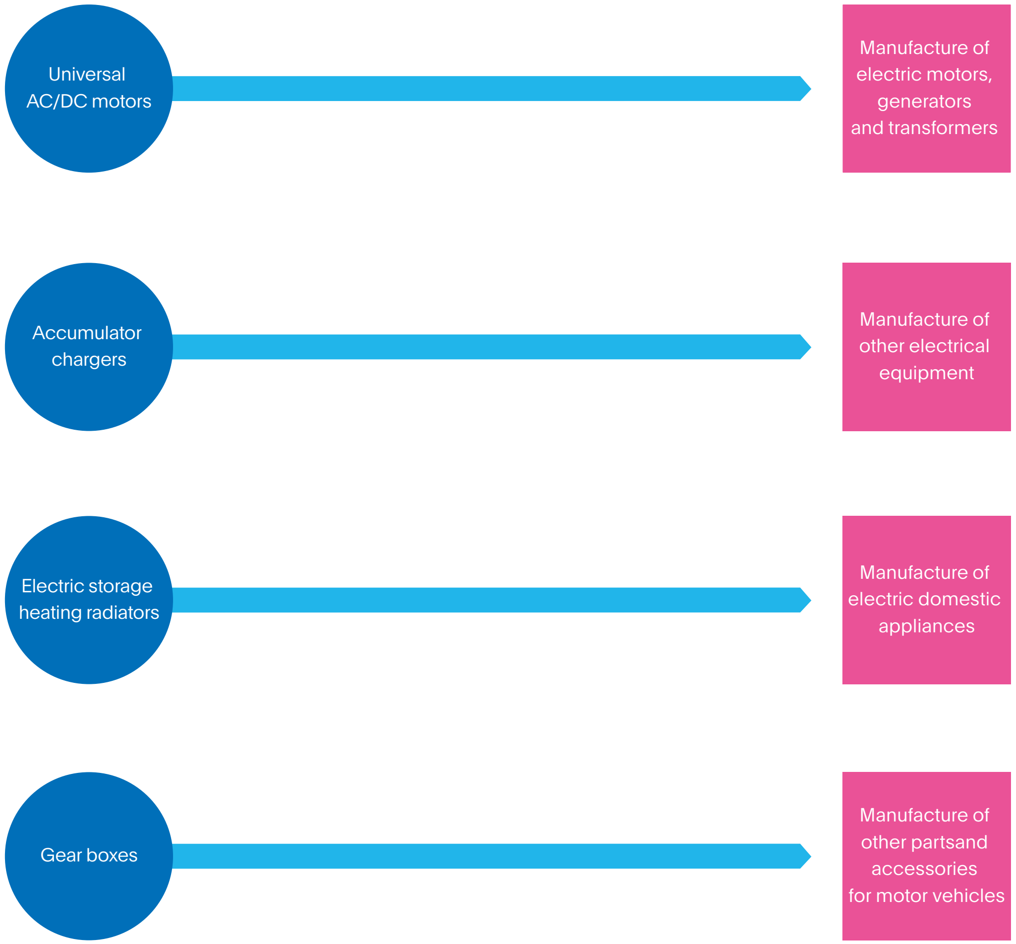
Some examples of Prodcom-Nace reconciliation

52 Eurostat categories

ProdCom database

ProdCom products/technologies affected

- Boilers for central heating
- Electronic instruments for measuring/checking the level of liquids
- Alternators of an output ≤ 75 kVA
- Gas turbines
- Furnace burners for liquid fuel
- Motor vehicles with only petrol engine > 1 500 cm³
- Electronic thermostats
- Universal AC/DC motors of an output
- Multi-phase AC traction motors of an output > 75 kW
- Rotary converters
- Plugs and sockets for coaxial cables for a voltage ≤ 1 kV
- Electric blankets
- Electric storage heating radiators
- Domestic microwave ovens
- Central heating radiator thermostatic valves
- Butterfly valves
- Electrical induction industrial or laboratory furnaces and ovens
- Heat pumps other than air conditioning machines
- Disc harrows
- Gravure printing machinery
- Horizontal machining centres for working metal
- Heat exchange units
- Gear boxes for stationary equipment, spur and helical gear boxes
- Accumulator chargers
- Valves for pneumatic tyres and inner-tubes



ProdCom	Eurostat NACE database
Universal AC/DC motors	Manufacture of electric motors, generators and transformers
Accumulator chargers	Manufacture of other electrical equipment
Electric storage heating radiators	Manufacture of electric domestic appliances
Gear boxes	Manufacture of other partsand accessories for motor vehicles

Eurostat NACE database

NACE categories affected

- Manufacture of electronic components
- Manufacture of electric motors, generators and transformers
- Manufacture of batteries and accumulators
- Manufacture of other electronic and electric wires and cables
- Manufacture of electric lighting equipment
- Manufacture of ovens, furnaces and furnace burners
- Manufacture of machinery for metallurgy
- Manufacture of motorcycles
- Manufacture of wiring devices
- Casting of steel
- Manufacture of steam generators
- Manufacture of central heating radiators and boilers
- Manufacture of power-driven hand tools
- Manufacture of electrical and electronic equipment for motor vehicles
- Installation of industrial machinery and equipment
- Manufacture of bicycles and invalid carriages
- Casting of other non-ferrous metals
- Forging, pressing, stamping and roll-forming of metal; powder metallurgy
- Manufacture of non-electric domestic appliances
- Gravure printing machinery
- Manufacture of other taps and valves
- Manufacture of other parts and accessories for motor vehicles
- Manufacture of other tanks, reservoirs and containers of metal

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

16. Exploiting the reconciliation of the Prodcom categories to the NACE ones, also the additional phases of the **extended value chains**, namely Research & Development and Distribution, Sales and Aftermarket, have been included in the analysis. Following the same procedure used for the manufacturing sector, the prevailing nature of the 213 categories identified have been assessed, resulting in **42 products and technologies** distributed among neutral, thermal or electric.

17. The second part of the analytical assessment model deals with the estimation of the additional value and employment generated by **digital services that will be further developed in the next future** (3 to 5 years). Indeed, since the objective of the analytical model is to project the actual production value at 2017 to 2030, all the services, products and technologies that could be developed in the next future have not been taken into account by definition. Since there is no evidence in the literature of the expected value of all digital services that will be developed due to the energy transition, the analysis follows different detailed steps. Firstly, the identification of the set of services related to energy transition which have a limited deployment today but could be created in the coming years involves a detailed qualitative and quantitative census of the knowledge on the topic, resorting to multiple channels and sources of information:

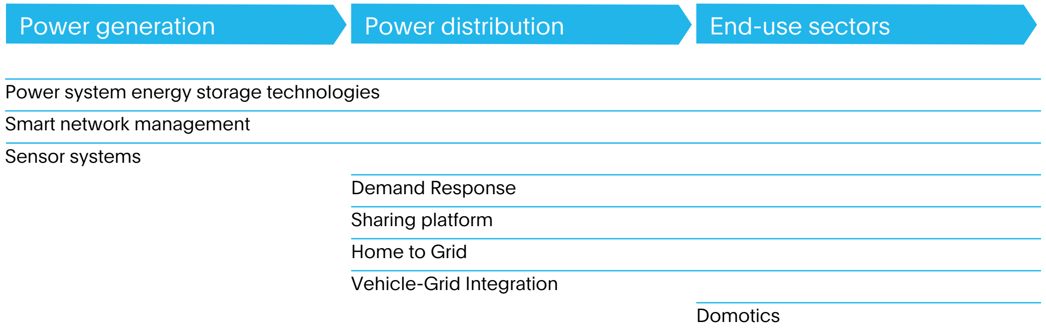
- Desk analysis of the available reports and scientific literature, leveraging also on two previous studies realized by The European House – Ambrosetti for Enel, Enel X and Enel Foundation, "*e-Mobility Revolution*" (2017) and "*Electrify 2030*" (2018).
- Interviews and confidential one-to-one meetings with industrial operators and academic experts of the energy field.

18. Digital services will have a crucial role in fostering the energy transition currently uderway. A few services related to energy transition are progressively being deployed today and are characterized by a high potential in the upcoming years thanks to technological and digital progress. Among these, the following services have been identified:

- Power system energy storage technologies.
- Smart network management.
- Demand Response.
- Sharing platform.
- Home to Grid.
- Vehicle-Grid Integration.
- Domotics.
- Sensor systems.

Figure 7

Services related to energy transition recently entered the market with high development potential in the next future



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON VARIOUS SOURCES, 2019.

19. In order to quantify the additional effect generated by digital services, the first step consisted in estimating the additional revenues of **digital services in the transport sector**, the only one available in the existing literature.[8] More specifically, the following digital services related to mobility have been considered in the model: electric batteries technologies, vehicle to grid, vehicle to vehicle, vehicle to home, mobility sharing platform, vehicle sensor systems. The hardware component has been excluded from the analysis since it has been already covered in the previous part of the model, providing a view on the entire manufacturing sector.

20. The existing literature provides only an estimate of the additional value of digital services activated at 2030 within the transport sector (electric batteries technologies, vehicle to grid, vehicle to vehicle, vehicle to home, mobility sharing platform and vehicle sensor systems) and is equal to **250 billion Euros**. This value could be underestimated due to the following reasons:

- On the one hand, the early stage of these services to date implies that it is difficult to foresee their future value.
- On the other hand, the fact that the ICT services include only the ones closely related to the transport sector could lead to a further underestimation of the final effect of digital services associated to the energy transition as a whole.

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[8] General Electric (2015), European Commission (2017), IRENA (2017), The European House – Ambrosetti "e-Mobility Revolution" (2017) and "Electrify 2030" (2018), IHS Automotive (2015), Navigant (2016), International Energy Agency (2018, 2019).

21. As a second step, the hypothesized scenarios for the EU, Italy, Spain and Romania have been derived by rescaling the global estimates, using the share of value added generated by digital services in each single country on the basis of their value added in 2017. The assumption beneath this reparameterization is that the share of each single country on the global value added will not vary between 2017 and 2030. The production value at 2030 of these additional services that could be created in the near future (marketed in the next 3 to 5 years) amounts to **65 billion Euros** in European Union, **6 billion Euros** in Italy, **4 billion Euros** in Spain and **1 billion Euros** in Romania.

Power System Energy Storage is an enabling technology for the development of renewable energy sources

Although it is still at early stages of implementation, Power System Energy Storage can offer significant benefits for the generation, distribution and use of electrical power. This is particularly important in renewable energy, which is intermittent in its supply.

The Power System Energy Storage market is projected to grow considerably, reaching around 300GW of deployment by 2030; at that time, the 53% of the energy storage capacity will be installed behind-the-meter. Globally, the investments in energy storage market will account for $1,200 billion, with $50 billion invested at 2030. Europe is expected to hold around 20% of the global market share, totalling $10 billion of investments at 2030.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON BLOOMBERG NEW ENERGY FINANCE (BNEF) DATA, 2019.

The future development of digital services: investing in Demand Response in Europe

In Europe, both the Demand Response technology is in a developing stage. Some countries have compelling opportunities for future potential development and significant competition between companies as well, while in other parts of the Continent barriers for development still exist.

The Demand Response market is expected to grow to 177GW by 2030, starting from the current 50.1GW (three times higher). This growth will be mostly concentrated in peaking applications, since energy systems are becoming more reliant on renewables, implying the need for more flexible resources. In order to support its deployment, in the period 2018–2030 the cumulative investments in the sector will account for $7 billion globally, reaching around $700 million in 2030 (in 2018 they account for about $300 million). In Europe, the Demand Response market is expected to double by 2030, reaching 24 GW of capacity and generating 960 million Euros, given an expected annual clearing price of 40,000 Euros per MW at 2030. These estimates refer only to applications such as frequency regulation, peaking capacity and reserves and do not consider other price-based (e.g., arbitrage) applications that will contribute to the growth of the Demand Reponse market. In the period 2018–2030, the forecasted cumulative investments account for $1.5 billion (with France and UK at the top), even though the amount of annual investments will decline, passing from $120 million in 2018 to $100 million, since the real cost to deploy a megawatt of demand response will be lower.

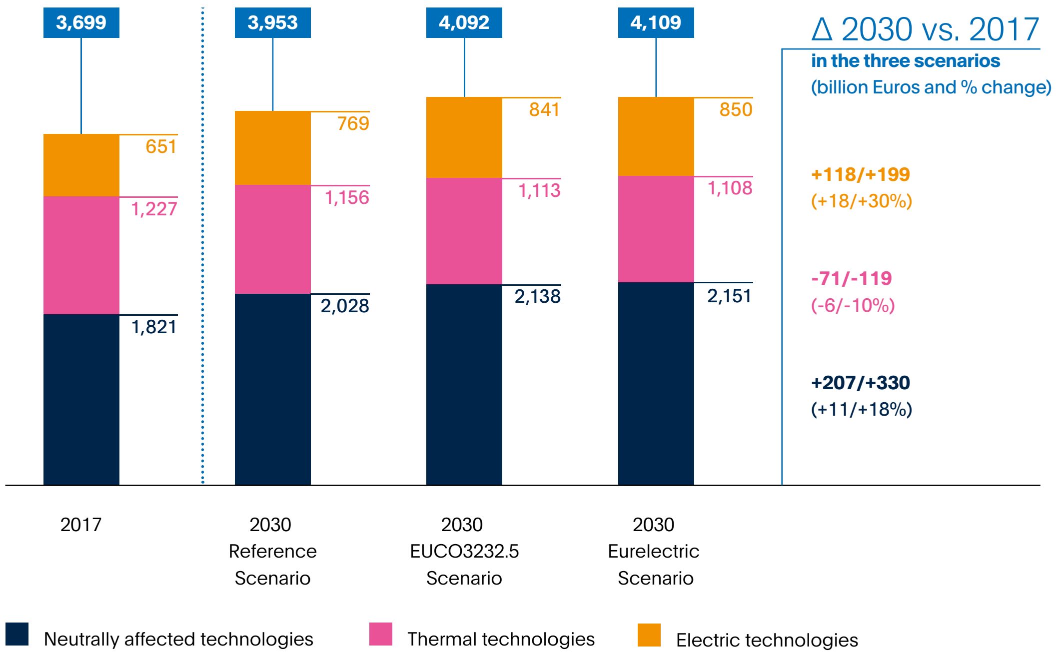
SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON BLOOMBERG NEW ENERGY FINANCE (BNEF) DATA, 2019.

3.2 The effect of energy transition on industrial production

22. In the first part of the analytical assessment model, only the extended value chains have been considered, specifically the Research & Development, Manufacturing and Distribution, Sales and Aftermarket. The production value of **electric technologies** in EU28 has been estimated to increase by 118 billion Euros in the EU Reference Scenario, 199 billion Euros in the EUCO3232.5 and 199 billion Euros in the Eurelectric Scenario at 2030. This increase outperforms the decrease in production value for thermal technologies, projected to fall from 1,227 billion Euros in 2017 to 1,156 billion Euros in the EU Reference Scenario, 1,113 billion Euros in EUCO3232.5 Scenario and 1,108 billion Euros in the Eurelectric Scenario. As a consequence, the production value for neutral technologies has been estimated to have a growth spanning from 207 billion Euros to 330 Euros billion at 2030.

Figure 8 ★

Production value of electric, thermal and neutral technologies in EU28 in the Reference, EUCO3232.5 and Eurelectric scenarios, 2017 vs. 2030 (billion Euros)

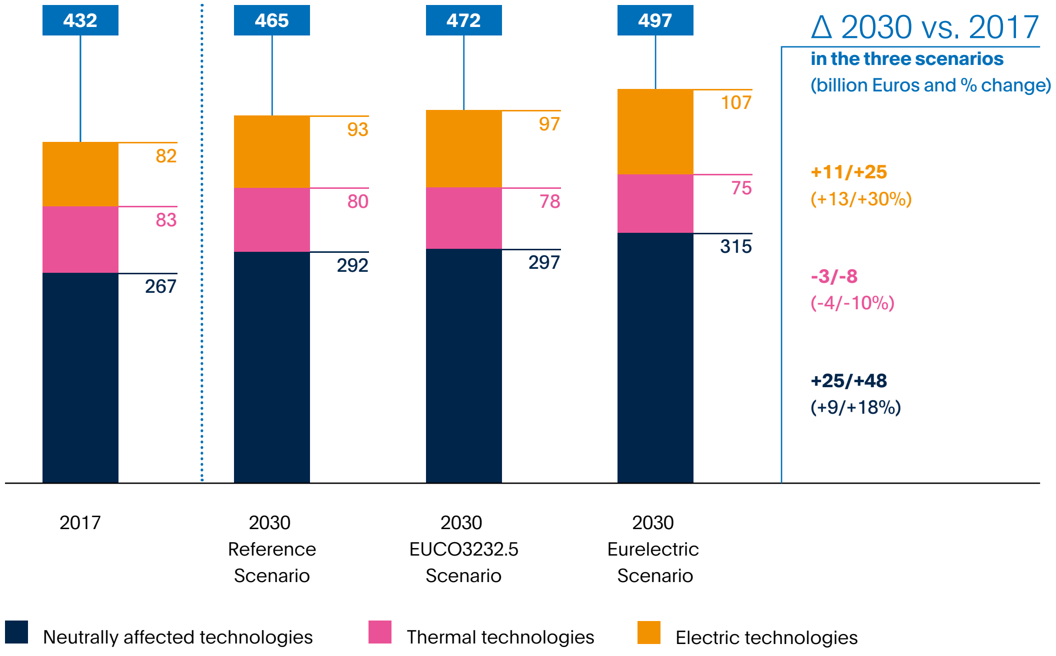


SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT AND PRODCOM DATA, 2019.

23. Italy is aligned with the European Union in terms of growth rate of production value for electric technologies, estimated to reach **+13%** in the EU Reference Scenario (**+11 billion Euros**) and **+30%** in the Eurelectric Scenario (**+25 billion Euros**). Similarly, the production value for thermal technologies has been projected to decrease by **4%** in the first scenario (**-3 billion Euros**) and **10%** in the last one (**-8 billion Euros**). As far as the neutral technologies are concerned, their production value has been estimated to increase up to 315 billion Euros (+48 billion Euros) in the Eurelectric Scenario at 2030, with respect to 2017.

Figure 9

Production value of electric, thermal and neutral technologies in Italy in the Reference, EUCO3232.5 and Eurelectric scenarios, 2017 vs. 2030 (billion Euros)

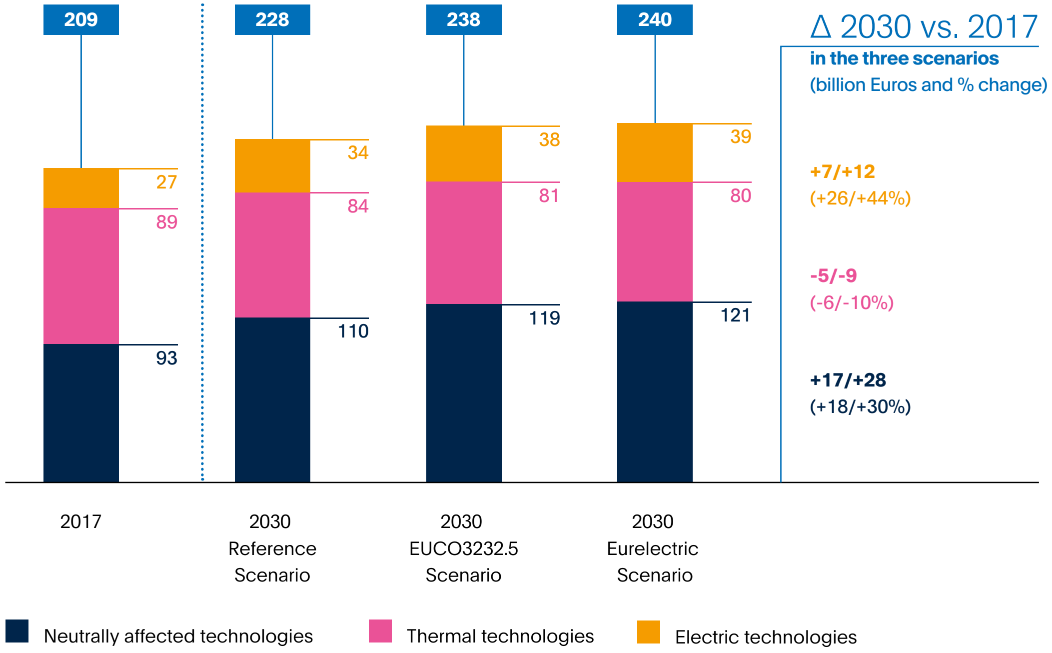


SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON PRODCOM AND EUROSTAT DATA, 2019.

24. The industrial production at 2017 in Spain is characterized by a **sound thermal component**, while the electric one is less developed. The electric technologies are expected to face a significant development, spanning from **+26%** in the EU Reference Scenario (**+26 billion Euros**) to **+44%** in the Eurelectric Scenario (**+12 billion Euros**). As a consequence, the neutral technologies are appraised to reach **121 billion Euros** in the Eurelectric Scenario, with a **30%** increase with respect to 2017.

Figure 10

Production value of electric, thermal and neutral technologies in Spain in the Reference, EUCO3232.5 and Eurelectric scenarios, 2017 vs. 2030 (billion Euros)

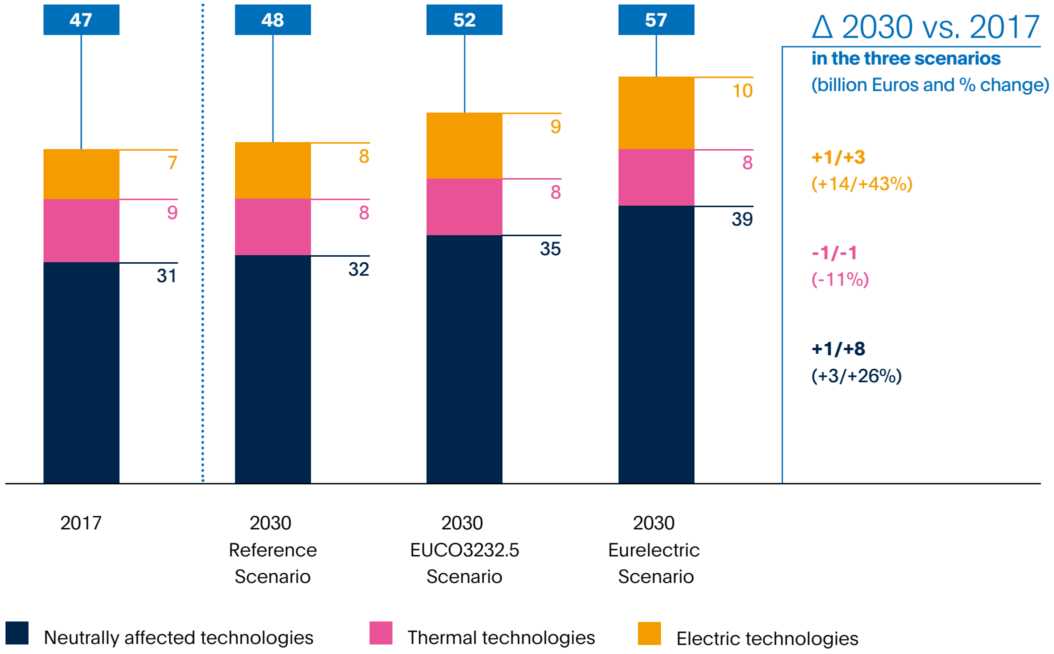


SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON PRODCOM AND EUROSTAT DATA, 2019.

25. In Romania, the electric technologies have been estimated to reach an amount between **8 billion Euros** in the EU Reference Scenario and **10 billion Euros** in the Eurelectric Scenario at 2030, an increase of **14%** and **43%** with respect to 2017 respectively, while the thermal technologies have been projected to decrease by around **11% (around -1 billion Euros)** in all the selected scenarios. The growth of neutral technologies has been estimated to range from **+3%** to **+26%** in the Reference and Eurelectric scenarios respectively.

Figure 11

Production value of electric, thermal and neutral technologies in Romania in the Reference, EUCO3232.5 and Eurelectric scenarios, 2017 vs. 2030 (billion Euros)

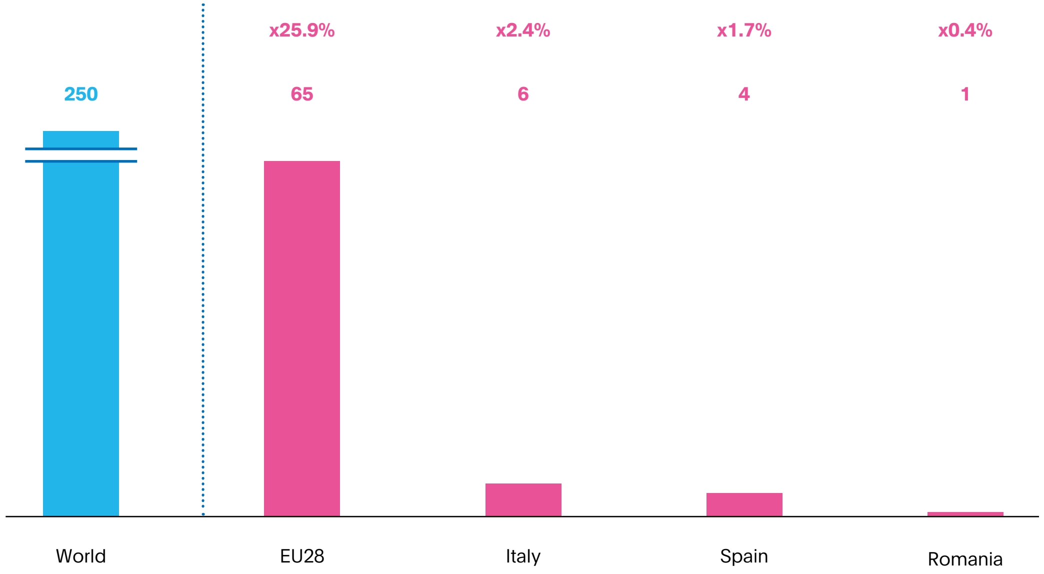


SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON PRODCOM AND EUROSTAT DATA, 2019.

26. For the second part of the analysis, the estimation of the additional value generated by **digital services** enabled by electrification at 2030 is based on parametric factors derived from international experiences, then applied to the European Union, Italy, Spain and Romania. In particular, the **existing literature** and the **academic and scientific reports** on the topic have been mapped[9], so to obtain the scenarios of digital services value generated at global level. In this case, digital services connected to the use of vehicles (with any kind of fueling) are used as a proxy, since the future penetration of the services, products and technologies identified above could have a significant deployment especially in the transport sector. The hypothesized scenarios for the European Union, Italy, Spain and Romania have been derived by rescaling the global estimates, using the share of value added generated by digital services in each single country on the basis of their value added in 2017. The assumption beneath this reparameterization is that the share of each single country on the global value added will not vary between 2017 and 2030. As previously mentioned, these values could suffer from underestimation. The fact that some digital services are still in a preliminary phase of development and the literature on this topic is limited might lead to an overall underestimation of the value of digital services at 2030

Figure 12

Additional value generated by digital services enabled by electrification at 2030 at world level, in EU28 and in Italy, Spain and Romania, 2030 (billion Euros)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON VARIOUS SOURCES, 2019.
N.B. New digital services directly and indirectly enabled by electrification will be fully introduced in the market next years and are only at an early stage of development today. The presence of few information in literature about these services could lead to an underestimation of the value generated by digital services at 2030.

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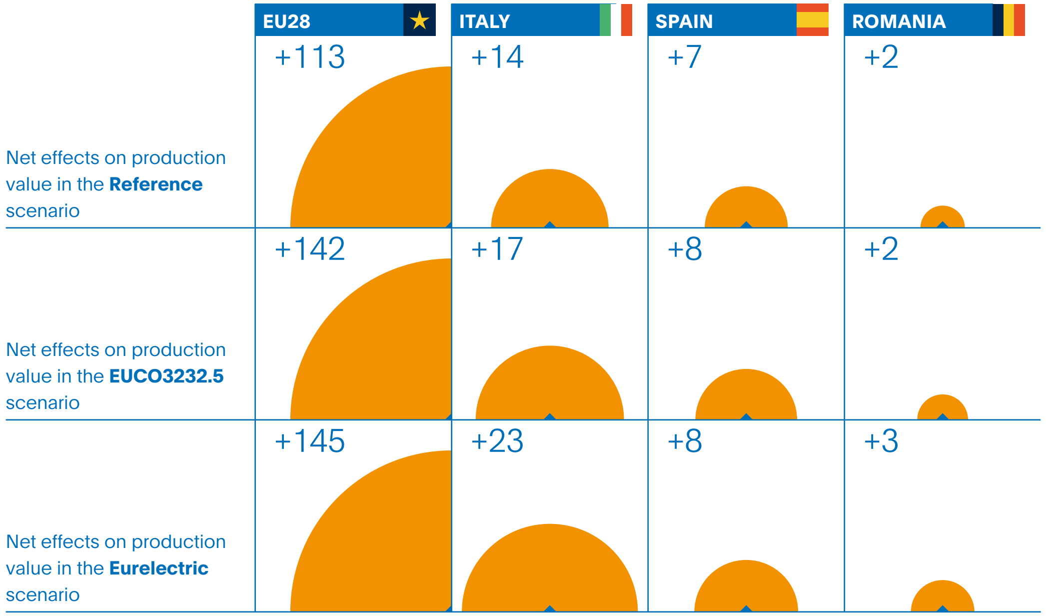
[9] General Electric (2015), European Commission (2017), IRENA (2017), The European House – Ambrosetti "e-Mobility Revolution" (2017) and "Electrify 2030" (2018), IHS Automotive (2015), Navigant (2016), International Energy Agency (2018, 2019).

27. The final results are presented in differential terms, implying that the final production value is the result of the sum of the increase in production value for the electric technologies and the decrease in the production value for the thermal ones, adding on top the additional value generated by digital services at 2030 to electric technologies' results. The final differential effects have been estimated to reach at least **+145 billion Euros** in European Union in the most accelerated scenario, namely the Eurelectric one (**+113 billion Euros** and **+142 billion Euros** in the EU Reference and EUCO3232.5 Scenarios, respectively). In Italy, the net effects on production value have been estimated to range from **+14 billion Euros** in the EU Reference Scenario to **+23 billion Euros** in the Eurelectric Scenario. Given the Spanish industrial structure, currently unbalanced towards thermal technologies, the differential impacts is more limited in this country, spanning from **+7 billion Euros** to **+8 billion Euros**. Finally, in Romania the differential effects on production value have been projected to reach almost **+2 billion Euros**, slightly more than **+2 billion Euros** and **+3 billion Euros** in the three scenarios respectively.

Figure 13

Final net impacts of energy transition at 2030 on production value in the three analysed scenarios for EU28, Italy, Spain and Romania (billion Euros)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

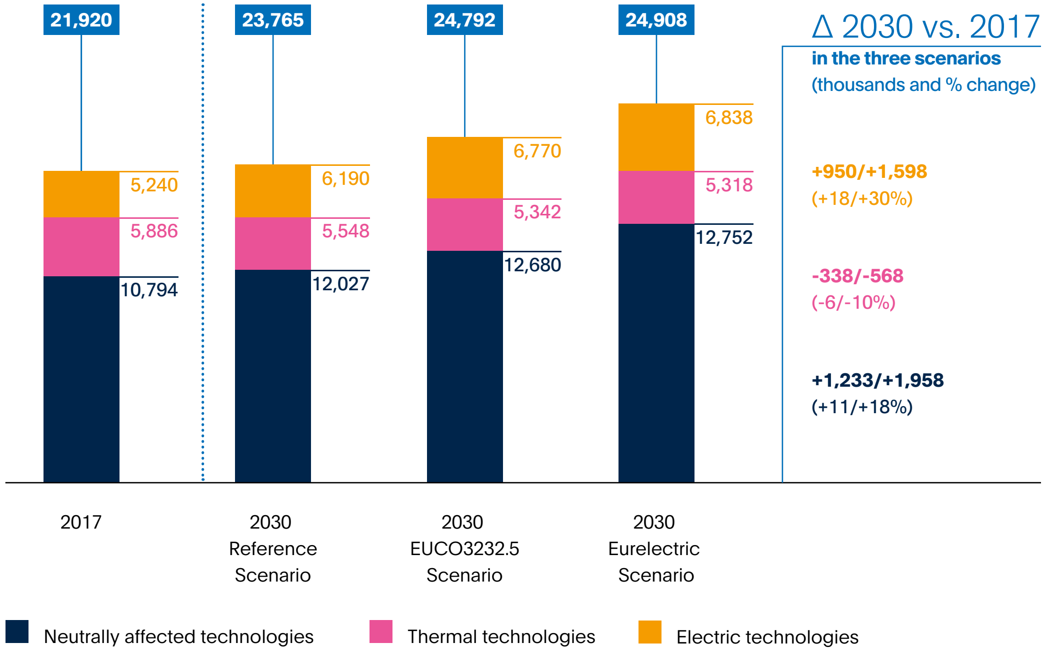
3.3 The effect of energy transition on employment

28. The final impacts of energy transition, enabled by electrification, on employment at 2030 are computed with the same methodology adopted for the production value. The employment generated by additional value of the digital services at 2030 is added on top to the employment results in the electric extended value chains.

29. The employment in the electric technologies in EU28 has been estimated to reach **6.8 million** in the Eurelectric Scenario, accounting for a **30%** increase with respect to 2017, with a net employment gain of **1.6 million**. Conversely, **568,000** is the employment that has been estimated to be lost at 2030 in the Eurelectric Scenario due to the decrease of thermal technologies (-**10%** with respect to 2017 levels).

Figure 14

Employment in electric, thermal and neutral technologies in EU28 in the Reference, EUCO3232.5 and Eurelectric scenarios, 2017 vs. 2030 (thousands)

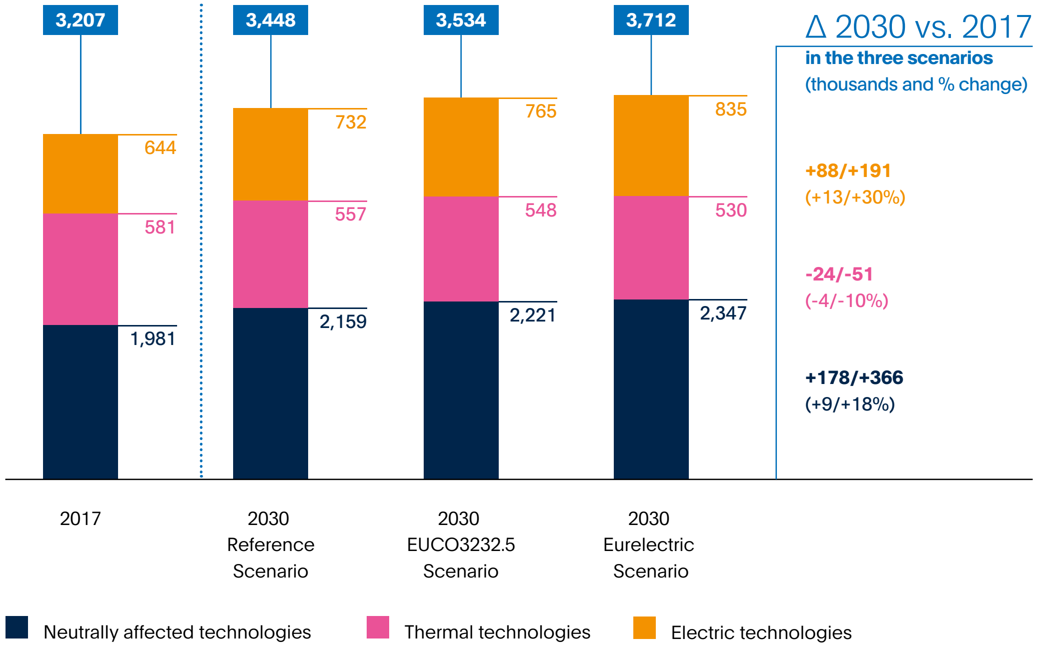


SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON PRODCOM AND EUROSTAT DATA, 2019.

30. In Italy, the net gain in employment for the electric technologies has been assessed to range from **88,000** (**+13%** with respect to 2017 levels) to **191,000** (**+30%** with respect to 2017 levels) at 2030 in the three selected scenarios. The employment in the thermal technologies is expected to decline by **24,000**, **33,000** and **51,000** people at 2030 in the three scenarios respectively, while the employment in the neutral technologies, instead, has been projected to increase up to 366,000, totaling **2.3 million** employees at 2030.

Figure 15

Employment in electric, thermal and neutral technologies in Italy in the Reference, EUCO3232.5 and Eurelectric scenarios, 2017 vs. 2030 (thousands)

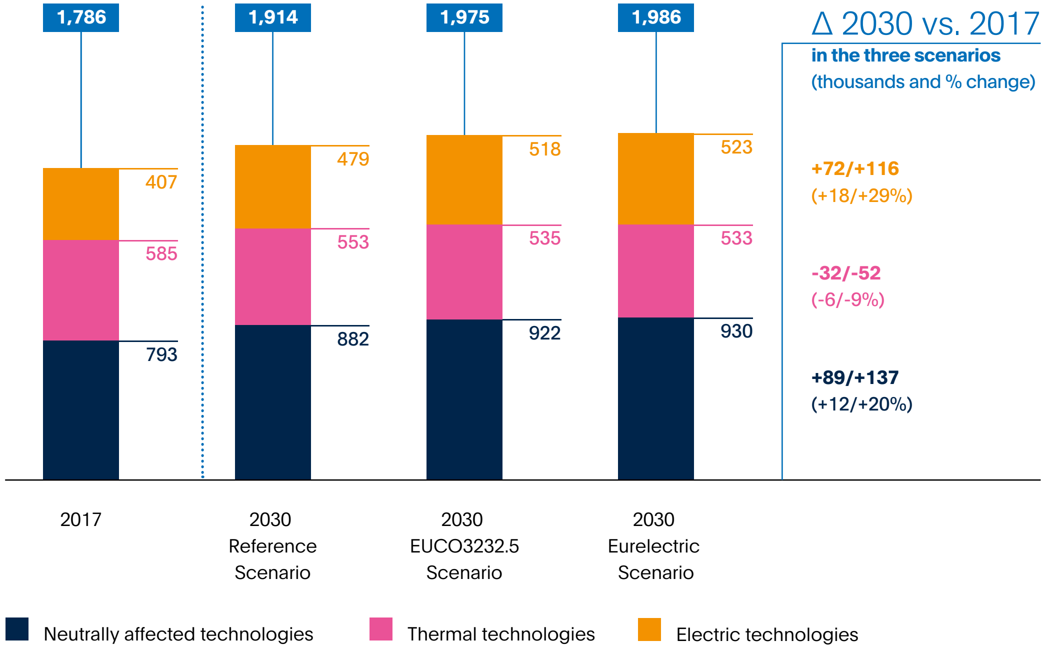


SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON PRODCOM AND EUROSTAT DATA, 2019.

31. In Spain, the net impact on employment of the electric technologies has been estimated to account for **+72,000** (**+18%** vs. 2017 levels) and **+116,000** (**+29%** vs. 2017 levels) units at 2030 in the EU Reference Scenario and Eurelectric Scenario, respectively. Instead, the employment for thermal technologies is expected to shift from 585,000 at 2017, to **553,000** (**-6%** vs. 2017), **535,000** (**-9%** vs. 2017) and **533,000** (**-9%** vs. 2017) at 2030 in the three scenarios, respectively. The employment in the neutral technologies has been projected to reach **930,000** people at 2030 in the Eurelectric Scenario, accounting for a **20%** increase with respect to 2017.

Figure 16

Employment in electric, thermal and neutral technologies in Spain in the Reference, EUCO3232.5 and Eurelectric scenarios, 2017 vs. 2030 (thousands)

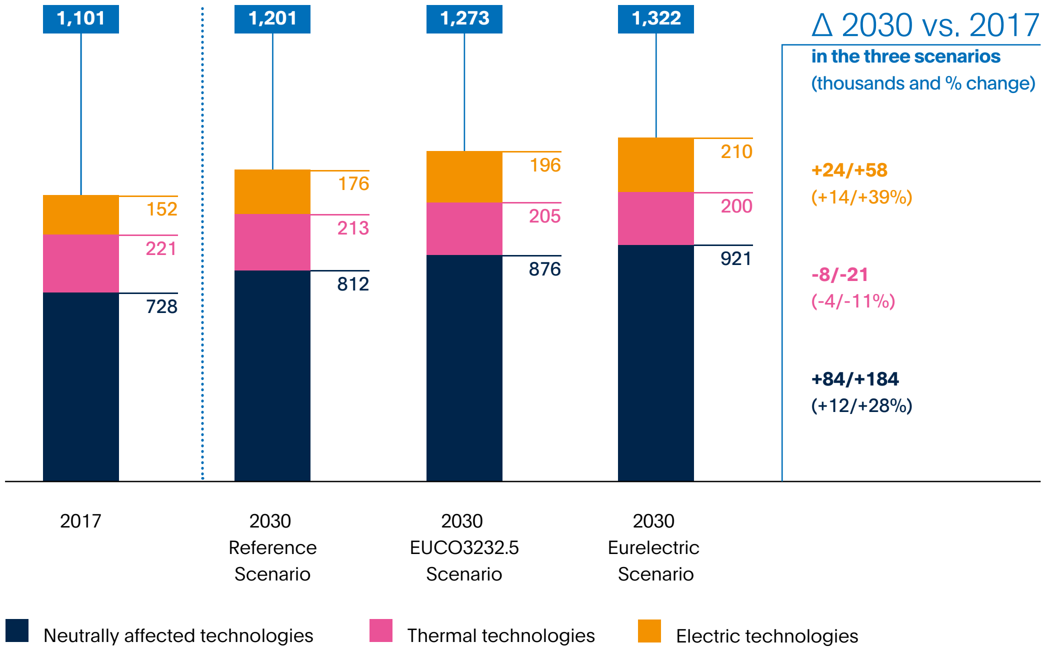


SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON PRODCOM AND EUROSTAT DATA, 2019.

32. In Romania, the number of employees in the electric technologies has been estimated to reach **210,000** at 2030 in the Eurelectric Scenario, implying a **30%** growth with respect to 2017, while the employment lost in the thermal technologies has been expected to account for **21,000** at 2030, meaning **-11%** of jobs with respect to 2017 in the same scenario. As a consequence, the employment in the neutral technologies has been appraised to rise, reaching **912,000** people at 2030 in the Eurelectric Scenario (+28% compared to 2017).

Figure 17

Employment in electric, thermal and neutral technologies in Romania in the Reference, EUCO3232.5 and Eurelectric scenarios, 2017 vs. 2030 (thousands)



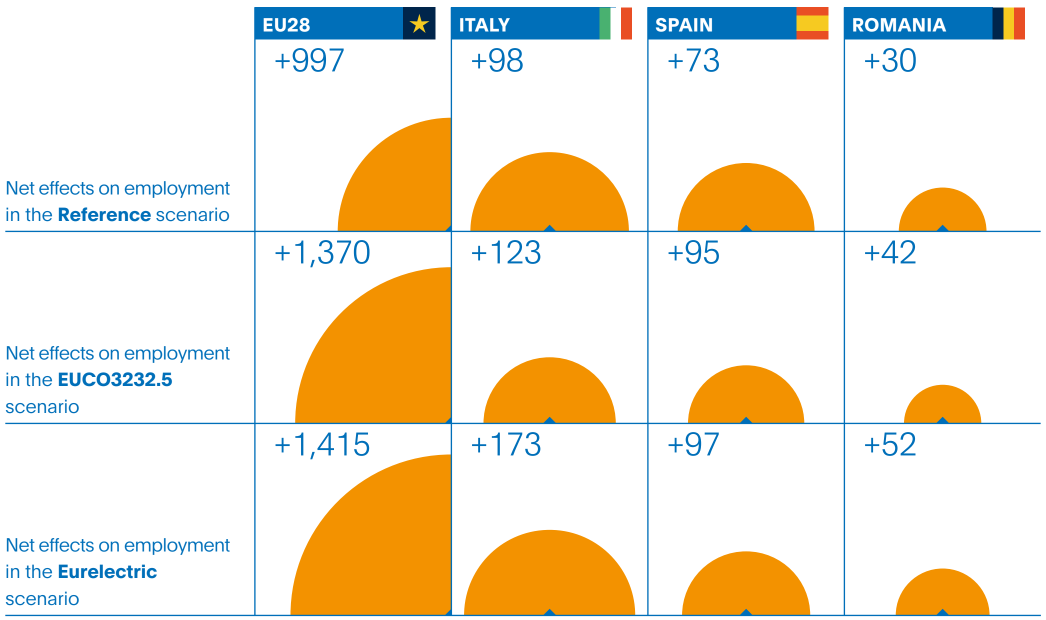
SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON PRODCOM AND EUROSTAT DATA, 2019.

33. The conversion of the production value generated by digital services at 2030 into additional employment is obtained taking into account the current labor productivity in digital services for each country considered, derived from the ratio between the digital services production value at 2017 and the persons employed in the sector. Finally, relating the additional value generated by digital services enabled by electrification at 2030 with the labor productivity, the additional employment generated by the same services at 2030 has been derived.

34. The final impacts on employment show an **overall increasingly positive effect for EU28 and all the other countries considered**. In the European Union, the differential effects on employment are expected to range from **+997,000 employees** at 2030 in the EU Reference Scenario to **1.4 million employees** in the Eurelectric Scenario. In Italy, the net employment gain has been estimated to account for **+173,000** at 2030 in the most accelered scenario, namely the Eurelectric one (+98,000 and +123,000 in EU Reference and EUCO3232.5 scenarios respectively), while in Spain **+97,000** (+73,000 and +95,000 in EU Reference and EUCO3232.5 scenarios, respectively) and in Romania **+52,000** (+30,000 and +42,000 in EU Reference and EUCO3232.5 scenarios, respectively).

Figure 18

Final net impacts of energy transition at 2030 on employment in the three analysed scenarios for EU28, Italy, Spain and Romania (thousands)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

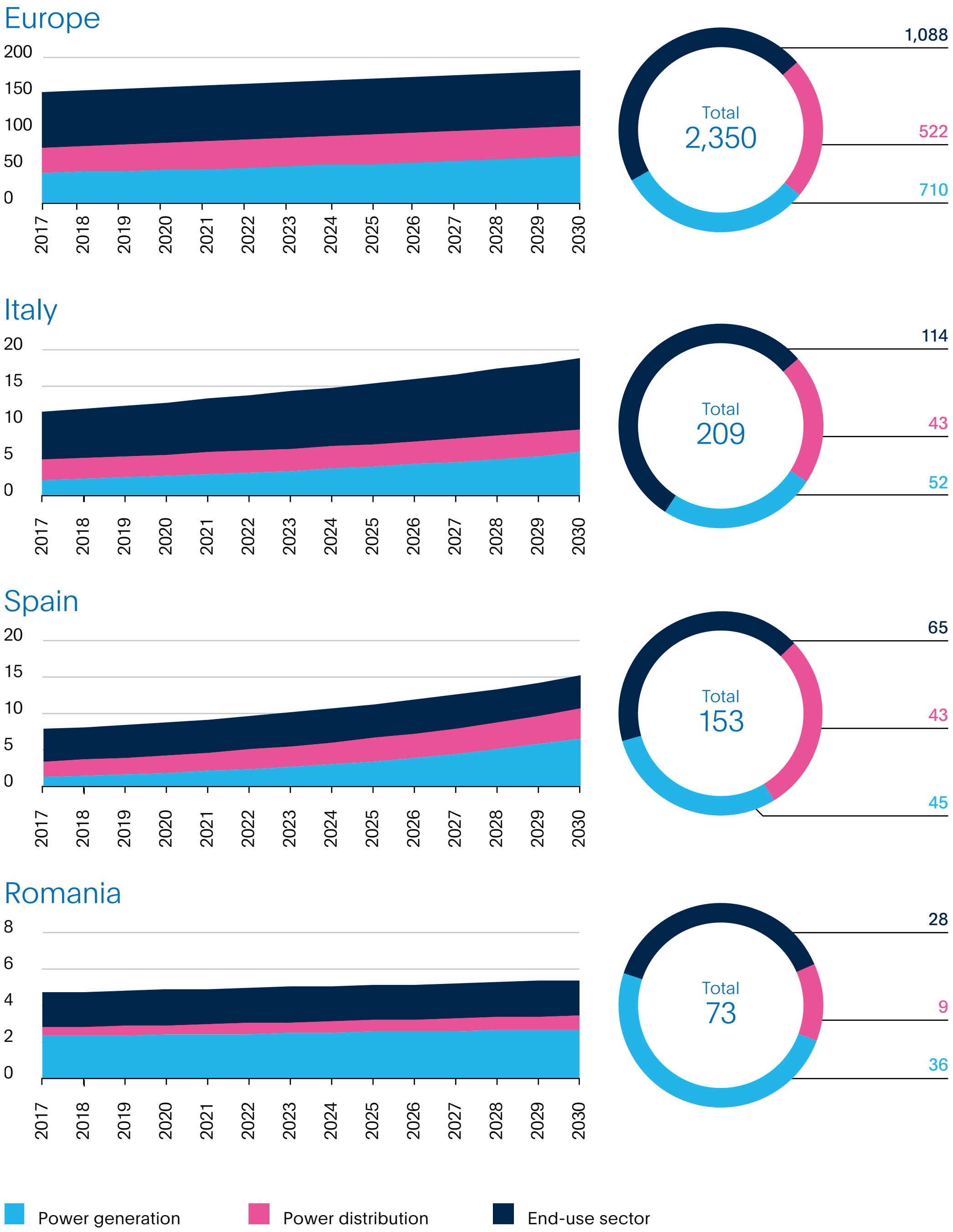
35. The analytical assessment model has estimated **positive additional benefits at 2030 in terms of production value and employment**. These results are driven by the development of the electric technologies between 2017 and 2030. However, in order to support their development and to properly grasp the benefits brought by the energy transition, an **adequate investments deployment** is required. Therefore, the investments needed at 2030 for all the phases of the electricity value chain have been assessed:

- For **power generation** and **power distribution**, the investment level at 2030 as officially reported in the national energy plans has been taken into account.
- For **end-use sectors**, the investment level necessary to support the increase in the production value of electric technologies at 2030 as foreseen by the model has been assessed. As a first methodological step, the investments in tangible goods at 2017 have been associated with the corresponding electric technologies and products. Then, the correlation between the investment level at 2017 with the production value at 2017 has been projected at 2030. The assumption beneath this methodological step is that the share between industrial production and investment will not vary between 2017 and 2030.

36. Investments are required to grow in each country along the entire value chain in order to be able to support the electric technologies development and the subsequent increase in production value and employment. Plotting the investments amount year by year, the cumulative investments required in EU28 would account for **€2.3 trillion**, with 1.1 trillion Euros in end-use sectors.[10] Looking more closely to the annual amount of investments required, it is worth noting that it represents a **feasible target** for the players in the market and for the system as a whole. Several companies have already started to plan investments in electric technologies' development in the near future. As examples, the carmaker Daimler (which holds the Mercedes Benz's brand) is planning to invest alone up to 10 billion Euros in developing electric vehicles by 2025, while Fiat Chrysler Automobiles (FCA) planned to invest 5 billion Euros for the development of the all-electric Fiat 500 by 2021 in Italy.

Figure 19

Cumulative investments required for energy transition in EU28, Italy, Spain and Romania, 2017–2030 (billion Euros)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN COMMISSION DATA, 2019.

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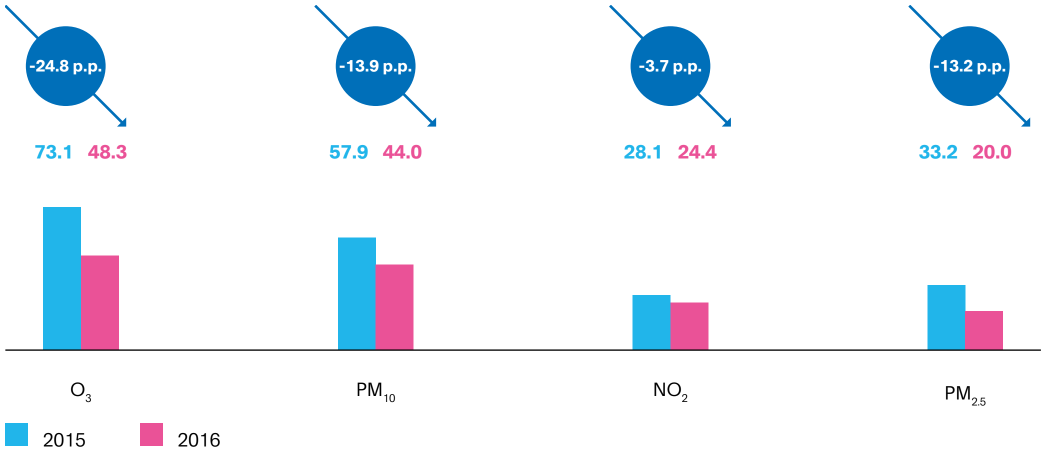
[10] The value of the investments represented in the graph is the average between the results in the three different electrification scenarios at 2030 considered in the model (Reference Scenario, EUCO3232.5 and Eurelectric).

3.4 The effect of energy transition on air quality

37. Air pollution is one of the main threats for society at the European level, being the **second biggest environmental concern** for Europeans. According to a survey undertaken by the European Commission, Europeans report that climate change is the most important environmental issue (51%), followed by air pollution (**46%**) and the growing amount of waste (40%).[11] Among the three countries analysed in this study, air pollution is a concern especially in Italy, where a percentage of population between **20%** and **48.3%** is exposed to concentrations of particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2) and ground-level ozone (O_3), above the EU standards (2016). These pollutants are the most harmful for human health. However, it is worth noting that percentages significantly decreased from 2015, when urban population exposed to O_3 concentration higher than acceptable threshold climbed to **73.1%**. The concentration of pollutants in the air is not a pressing issue for Spain and Romania, where percentages of urban population exposed to high levels of particulate matter (PM_{10} and $PM_{2.5}$), nitrogen dioxide (NO_2) and ground-level ozone (O_3) are pretty low.

Figure 20

Percentage of urban population exposed to concentration above EU levels for selected air pollutants - O_3, PM_{10}, NO_2, $PM_{2.5}$ – in Italy, 2015–2016 (% values and % points)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN ENVIRONMENT AGENCY (EEA) DATA, 2019.
N.B.: Data on air quality can vary a lot according to exogenous factors (i.e. weather condition and tracking stations); this may then explain the difference in values between 2016 and 2015.

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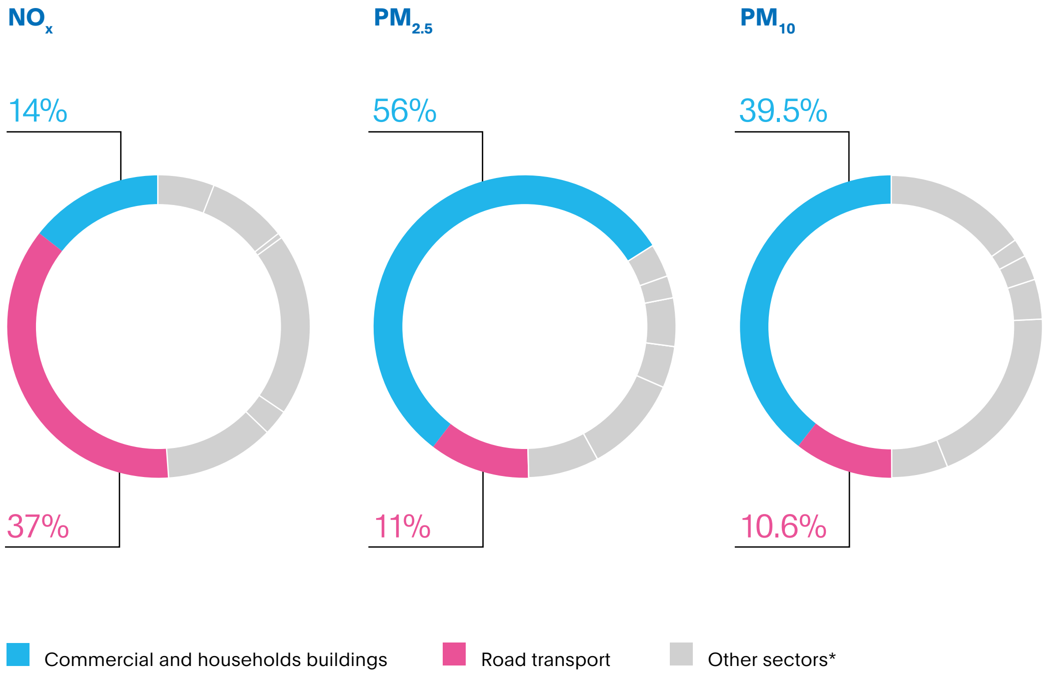
[11] Source: "Attitudes of European citizens towards the environment", European Commission, 2017.

3.4.1 The impact assessment of energy transition on air quality

38. Once the scenario of air quality in Europe has been analysed, the contribution of energy transition in reducing air pollution has been assessed. The analysis starts from the identification of the main sources of the emissions mostly effecting human health, NO_x, PM_{10} and $PM_{2.5}$.[12] As a result, in all the cases considered, **commercial and residential buildings** and **road transport** are responsible of **more than 50%** of the EU total emissions. Thus, these two sectors have been taken into account for the analysis of the impacts of energy transition on air quality and human health in the European Union, Italy, Spain and Romania.

Figure 21

Share of emissions' pollutant (NO_x, $PM_{2.5}$ and PM_{10}) by sector in the European Union , 2017 (% values)



(*) Other sectors are: energy use in industry, industrial process, energy production and distribution, waste, non-road transport, agriculture.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN ENVIRONMENT AGENCY (EEA) DATA, 2019.

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[12] Data on sources of O_3 emissions are not available.

39. With respect to the **transport sector**, the impact of energy transition on air quality in the European Union, Italy, Spain and Romania has been analysed through the following steps:

- Mapping of the current structure of vehicles' fleet for each country by year of registration (allowing to group vehicles by technology classes, i.e. <Euro 3, Euro 4, Euro 5 and Euro 6) and by vehicle type (passenger cars, light commercial vehicles and heavy duty vehicles).
- Identification of exhaust emission factors (g/km) for each fuel type of passenger cars, light commercial vehicles and heavy duty vehicles, by considering the following pollutants: CO, NMVOCs, NO_x, N_2O, NH_3, $PM_{2.5}$.
- Assessment of the average annual distance travelled by each type of vehicle per technology class.[13]
- Analysis of the evolutive curve of electric vehicles to 2030 in each country by considering the following hypothesis:
- In Italy and Spain, scenarios at 2030 for electric vehicles described in the National Policy Plans have been considered (**6 million** and **5 million** respectively).
- Estimates of the study "*e-Mobility Revolution*" realized by The Euroepan House – Ambrosetti for Enel (2017) have been taken into account for the European Union (**60 million** of EV at 2030).
- The same evolution curve as the one expected for the Italian EV stock over the period 2017–2030 has been considered for Romania, resulting in **335,800 electric vehicles** at 2030.
- Hypothesis of substitution of oldest vehicles (<Euro 3) by new electric vehicles year by year until 2030.
- Analysis of **tank-to-wheel emissions** at 2017 and their reduction thanks to electric vehicles at 2030, by considering a zero-emission factor for electric vehicles.

Electric vehicles' market in Italy, Spain and Romania

The electric vehicles' market is still underdeveloped in all the European countries involved in the study, but it grows at relevant rates. Both in Italy and in Spain, electric vehicles (passenger cars, light commercial vehicles and heavy duty vehicles) amount to 0.1% of total vehicles in circulation. In Italy there are only 28,498 electric vehicles, but the number has increased on average by 54.3% per year from 2014. The scenario is similar in Spain, where 38,415 electric vehicles circulate on roads, a number that has increased on average by 62% per year from 2014. In Romania the electric vehicles' market is smaller and it involves 1,595 vehicles (0.02% of total stock), with an average growth rate of 82.4% per year from 2014.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN AUTOMOBILE MANUFACTURERS' ASSOCIATION (ACEA) AND EUROPEAN ALTERNATIVE FUELS OBSERVATORY (EAFO) DATA, 2019.

40. The results of the analysis show that emissions **would be reduced in all European countries involved** and in the European Union. NH_3, $PM_{2.5}$ and CO are the pollutants that would be cut the most by the substitution of oldest vehicles with the electric ones, according to scenarios at 2030.

Figure 22

Emissions reduction thanks to energy transition in transport sector in European Union, Italy, Spain and Romania at 2030 (% values)

	CO	NMVOCs	NO_x	N_2O	NH_3	PM
EU28	-21.0%	-5.6%	-5.8%	-11.5%	-22.6%	-16.8%
Italy	-16.9%	-4.1%	-4.8%	-0.2%	-16.4%	-11.2%
Spain	-17.5%	-6.8%	-6.6%	-9.9%	-18.4%	-15.1%
Romania	-4.56%	-2.10%	-1.09%	-2.51%	-5.41%	-2.10%

N.B. Results in terms of emissions and impacts on human health depend on assumptions on the deployment of electric technologies, as well as on the models used to assess the effects on concentrations of pollutants and on the methods used to calculate the economic impacts. This explains the differences from other studies, such as "Fuelling Italy's Future", although all these studies point to very significant impacts.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN ENVIRONMENT AGENCY (EEA) AND EUROPEAN AUTOMOBILE MANUFACTURERS' ASSOCIATION (ACEA) DATA, 2019.

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[13] Average kilometers per year range according to vehicles' class and type:

- Passenger cars: from 4,127 (<Euro 3) to 11,641 (Euro 6).
- Light Commercial Vehicles: from 9,188 (<Euro 3) to 20,703 (Euro 6).
- Heavy Duty Vehicles: from 27,199 (<Euro 3) to 44,832 (Euro 6).

41. The benefit of energy transition in the residential sector has also been assessed by considering the emissions' reduction in the European Union, Italy, Spain and Romania. In this case, the impact has been analysed using a **"what if" approach** that considers the assumption of installing a heat pump instead of a heating system powered by gas in all houses and offices built and renovated over the period 2019–2030 in the European Union, Italy, Spain and Romania. The analysis follows the methodological steps listed below:

- Estimation of the number of new and renovated houses and offices in the European Union, Italy, Spain and Romania by projecting 2011–2014 Compounded Average Growth Rate (CAGR) at 2030.
- Estimation of the average need of heating power and running hours in an average house/office in each country, by taking into account the efficiency of gas heating systems on average.
- Estimation of the annual consumption of an average gas heating system in each country of analysis.
- Assessment of the emission levels (PM and NO_x) per kWh of primary fuel consumption of a gas heating system.
- Calculation of emissions avoided by hypothesizing the installation of heat pumps (with zero emissions in the final use) instead of gas heating systems in all new and renovated buildings.

Space heating is the first source of pollution in the residential sector

The main use of energy by households in the European Union is for heating their homes (64% of final energy consumption in the residential sector), followed by water heating (14.8%) and lighting and appliance (14.4%). As a result, heating systems are the first responsible of emissions in residential sector, with fossil fuels used as carriers in 65% of cases. In particular, 42% of heating systems in the European Union are powered by natural gas, while among all the available renewable energy sources, only biomass is used substantially (12%); solar thermal, geothermal and heat pumps are still marginal in almost all European countries.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN UNION DATA, 2019.

42. The results of the analysis show that there is a significant potential for improving air quality by utilizing renewable sources of energy, such as heat pumps, instead of fossil fuels heating and cooling systems. In particular, the installation of heat pumps in new and renovated buildings over the period 2019–2030 is able to save NO_x emission in a range from **4,760.2 tonnes** in European Union to **163.7 tonnes** in Romania. Similarly, PM emissions saved could range from **1,830.8 tonnes** in European Union to **62.9 tonnes** in Romania.

Figure 23

New and renovated buildings and avoided emissions thanks to the energy transition in residential sector in EU28, Italy, Spain and Romania, 2030 (absolute number and tonnes of emissions)

	New and renovated buildings (residential and offices)	NO_x (Tonnes)	PM (Tonnes)
EU28	22,885,428	4,760.2	1,830.8
Italy	4,217,943	877.3	337.4
Spain	3,437,129	714.9	274.9
Romania	787,202	163.7	62.9

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN ENVIRONMENT AGENCY (EEA) AND EUROPEAN COMMISSION DATA, 2019.

3.4.2 The impact assessment of energy transition on human health and cost saving

43. The emissions reduced and avoided thanks to the use of electric technologies instead of thermal ones can have benefits in terms of human health. Air pollution is indeed a major cause of deaths and diseases, causing **around 400,000** premature deaths per year in the EU28. Heart disease and stroke are the most common reasons for premature death attributable to air pollution, followed by lung diseases and lung cancer. Emission reduction could then bring to a decrease in the number of premature deaths. In order to assess this impact, **NO_x** and **PM** emissions have been considered since they are the most dangerous for human health among the pollutants considered in the analysis on transport and building sectors.

44. In order to estimate the number of avoided deaths due to emissions reduction, the analysis starts with the calculation of the number of premature deaths per gram of emissions in the European Union, Italy, Spain and Romania by taking into account:

- The current number of premature deaths due to air pollution.
- The current levels of NO_x and PM in the air in the European Union, Italy, Spain and Romania.

By matching these results with the avoided and reduced emissions thanks to the energy transition in transport and building sectors, it can be shown that in the European Union, Italy, Spain and Romania, there would be respectively **5,000**, **1,000**, **500** and **170** less premature deaths due to NO_x and PM emissions at 2030. It should also be considered that reducing air pollution is of primary benefit for human health, by preventing the outbreak of dangerous diseases (i.e. lung problems, respiratory infections and asthma).

45. Together with positive impacts on human health, emission savings and avoidance could make countries able to save costs. Economies have indeed to face costs related to negative externalities of air pollution on people and environment (premature deaths, increasing number of diseases, lost crop production, ecological risk etc.), that could be reduced thanks to emissions drop. In particular, starting the estimated cost per tonne of emission provided by the European Environment Agency, cost savings due to reduced emissions can be calculated. As a result, in the European Union costs related to air pollution (PM and NO_x emissions) could be reduced in the **range of 1–3 billion Euros** at 2030.

Figure 24

Cost savings thanks to NO_x and PM reduction in transport and building sectors in European Union, Italy, Spain and Romania, 2030 (thousand Euros)

	PM		**NO_x**	
	Min	**Max**	**Min**	**Max**
EU28	334,036	989,805	709,982	1,937,960
Italy	75,521	241,302	147,516	435,644
Spain	33,245	93,072	36,850	85,227
Romania	11,346	33,437	11,064	30,010

N.B. Results in terms of emissions and impacts on human health depend on assumptions on the deployment of electric technologies, as well as on the models used to assess the effects on concentrations of pollutants and on the methods used to calculate the economic impacts. This explains the differences from other studies, such as "Fuelling Italy's Future", although all these studies point to very significant impacts.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN ENVIRONMENT AGENCY (EEA) DATA, 2019.

46. All the results in terms of emissions and impacts on human health described in this chapter depend on several assumptions (models used to assess the effects on concentrations of pollutants and on the methods used to calculate the economic impacts) and also on the deployment of electric technologies. This explains the differences with respect to other studies, such as "*Fuelling Italy's Future. How the transition to low-carbon mobility strengthens the economy*"[14] (see the following box for further details). Notwithstanding that, all these studies point to very significant impacts and show that energy transition has a huge potential of improving Europeans' quality of life.

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[14] Jon Stenning (Director, Cambridge Econometrics), Stijn Van Hummelen (Project Leader, Cambridge Econometrics), Matteo Caspani (Consultant, Cambridge Econometrics), Jamie Pirie (Senior Consulant, Cambridge Econometrics), Shane Slater (Director, Element Energy) Michael Joos (Consultant, Element Energy), Oliviero Baccelli (Director, CERTeT, Università Bocconi), Gabriele Grea (Researcher, CERTeT, Università Bocconi) Raffaele Galdi (Researcher, CERTeT, Università Bocconi), Pete Harrison (Programme Director for Transport, European Climate Foundation), Veronica Aneris (National Expert Italy, Transport & Environment), Giuseppe Montesano, (Deputy Director, Enel Foundation), Daniela Di Rosa (Senior Researcher, Enel Foundation), "*Fuelling Italy's Future. How the transition to low-carbon mobility strengthens the economy*", 2018.

The socio-economic impact of e-Mobility in Italy according to *"Fuelling Italy's Future"*

Among the studies calculating socio-economic impacts of energy transition, it is worth mentioning "*Fuelling Italy's Future*". The study uses the econometric model E3ME to assess the impact of e-Mobility on human health and cost savings in Italy.

The study considers four evolutive scenarios for e-Mobility at 2050:

- **Reference scenario**: no changes in the mix of vehicles' type sold, but only some improvement in efficiency thanks to technological progress. This scenario is instrumental to make comparison with other scenarios.
- **Current Policy Initiatives** (CPI) **scenario**: improvements of performance of internal combustion engine and increase in sales of Hybrid Electric Vehicles (HEV), Plug in Hybrid Electric Vehicles (PHEV) and Battery Electric Vehicles (BEV) so as to reach the target of 95 gCO_2/km emissions set by the European Union at 2021 and to realize a CO_2 reduction of 15% at 2025 and 30% at 2030 compared to 2021.
- **TECH scenario**: gradual transition towards PHEV and BEV and use of energy-efficient technologies on new vehicles. After 2030, PHEVs gradually disappear and are substituted by more advanced technologies (BEV and FCEV).
- **TECH RAPID scenario**: more rapid transition towards a vehicles stock made of PHEV, BEV and FCEV compared to TECH scenario. After 2030, BEV will dominate the market, with an important share of PHEV and FCEV.

The first step of the analysis concerns the estimation of the impact of e-Mobility on air quality. In particular, the reduction of PM and NO_x emissions has been calculated by considering the local concentration of these pollutants (cities or rural areas) and exhaust components of particulate only, excluding other ways of generation related to road transport (tyre wear, brake, etc.).

The second step refers to the analysis of the impact of emissions reduction on human health in terms of less premature deaths due to air pollution, increase in productivity and reduction of the amount of pollution-related diseases.

These impacts have been estimated in monetary terms and final results of cost savings at 2050 compared to reference scenario are reported in the table below.

Figure 25

Cost savings thanks to positive effects of emissions reduction on human health in Italy, 2018-2050 (million Euros)

		CPI	Tech	Tech rapid
Total	Total savings	€367.2	€1,816.0	€1,955.0
	Average annual savings	€11.1	€55.0	€59.2
Health	Total savings	€90.3	€455.2	€485.3
	Average annual savings	€2.7	€13.8	€14.7
Productivity	Total savings	€75.0	€367.1	€397.3
	Average annual savings	€2.7	€11.1	€12.0
Life	Total savings	€201.9	€993.7	€1,072.4
	Average annual savings	€6.1	€30.1	€32.5

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON FUELLING ITALY'S FUTURE DATA, 2019.

Part 4

Policy proposals and recommendations to make the energy transition "just for all"

Key messages

The energy transition enabled by electrification can create positive effects in the mid-run (2030) along several relevant dimensions. Energy transition is associated with a **positive net effect at 2030, both on industrial production and employment**, in the European Union and in the three countries of interest (Italy, Spain and Romania). As emphasized by the model illustrated in Part 3, the shift towards renewable energy sources and electrification has also the potential to **improve air quality**, with significant benefits for **human health**.

However, the shift from fossil fuels towards renewable energy sources has to face two key challenges. On the one hand, energy transition has to preserve today's **European industrial competitiveness**, while creating the conditions for enhancing future industrial competitiveness in the global scenario. On the other hand, it has to **avoid negative distributive effects** across different socio-economic dimensions, preventing an unfair distribution of costs and guaranteeing equal access to the benefits generated by the energy transition among different areas (e.g. cities and rural areas) and population segments.

What is good for the planet must also be good for the economy and society as a whole. Thus policy action should be undertaken in order to guarantee that the energy transition is not "just a transition" but a "**transition just for all**". Four policy matters, entailing specific policy actions, have been identified in order to tackle the challenges related to energy transition and effectively support its benefits:

1. Supporting the **deployment of electric technologies** by promoting an effective value chains conversion toward electric technologies. This can be done by introducing energy transition investment bonds and innovative financial schemes for mature technologies along the overall electricity value chain, promoting campaigns to raise awareness of the advantages associated to electric technologies and enhancing, at country-level, National Energy Clusters with a specific focus on electrification technologies.

2. Managing **job losses**, increasing **job opportunities** and addressing the issues of **re-skilling** and **up-skilling of the workforce**, through social measures for workers in sectors with higher risk of substitution, a European Energy Transition Fund, new educational programs identifying and anticipating the skills needed for energy transition, apprenticeship programs focused on energy transition and awareness campaigns.

3. Addressing the issue of **energy poverty**, introducing an official composite index for measuring energy poverty in Member States, as a premise for national policy frameworks to address the issue, enhancing target programs to retrofit existing buildings to a high efficiency standard, promoting measures to inform consumers and fostering social tariffs or energy subsidies for low-income households.

4. Promoting a **fair redistribution of costs** associated with the energy transition, revising cost items within electricity bills and discharging electricity bills from unproper taxes and levies.

4.1

Unfolding benefits of energy transition along several dimensions

1. As shown by the analytical model in Part 3, the energy transition has the potential to **increase the net industrial production**. Considering the European Union as a whole, the increase in the production of electric products/technologies more than outweighs the decrease in the production of thermal products/technologies, resulting in a positive final net effect, ranging **from 113 billion Euros to 145 billion Euros** at 2030. The same holds for Italy, Spain and Romania.

2. Furthermore, energy transition plays a crucial role in preserving European Union's, and single Member States', **industrial competitiveness**. Deep decarbonization represents a historical occasion to modernize European economy, revitalise its industry and ensure long-term growth and employment. It is a premise for maintaining in Europe some strategic value chains that, otherwise, would perish in the global competitive arena, such as automotive industry. Energy transition, enabled by electrification, allows to maintain in Europe industrial value chains of neutral products and technologies that would otherwise be relocated in other countries (e.g. China or India) that are rapidly moving towards decarbonization; in addition, it allows to grasp the benefits related to the development of electric products and technologies.

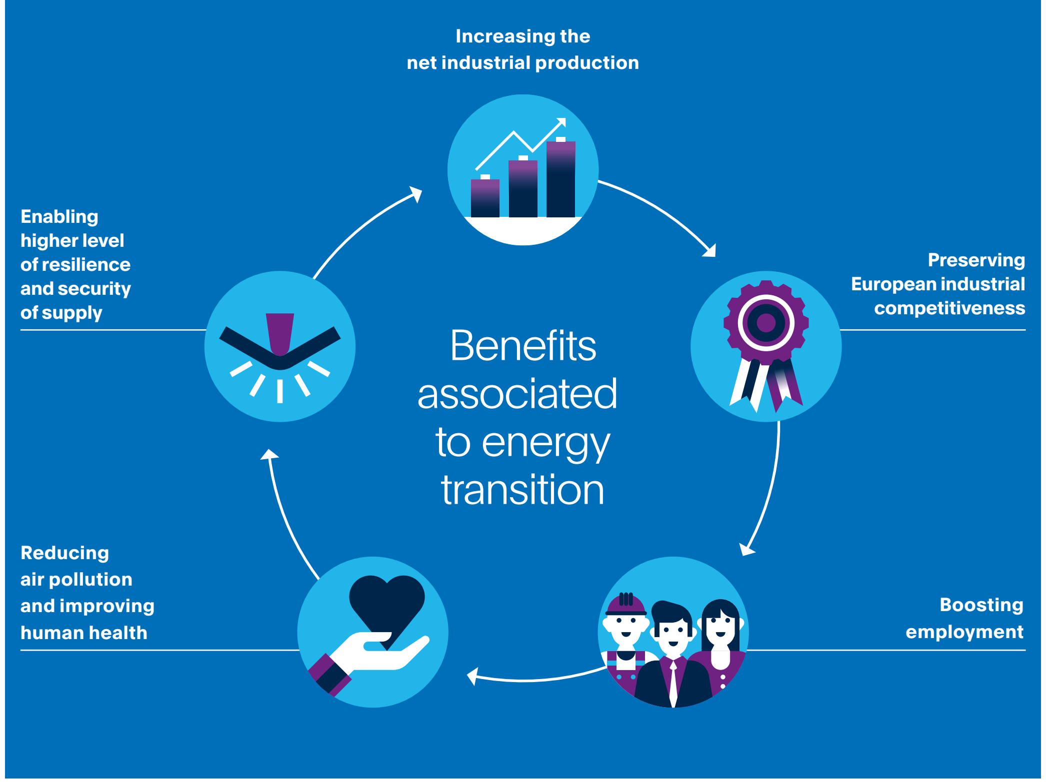
3. Energy transition represents an opportunity to **boost employment**. The innovative assessment model devised by The European House – Ambrosetti shows a net employment gain for the European Union and the countries in which the analysis is focused, i.e. Italy, Spain and Romania. In the European Union, energy transition generates a final net impact from **+997,000 employees** to **+1.4 million employees** at 2030. In Italy, the net employment gain accounts from more than +98,000 employees to +173,000 employees at 2030, while in Spain the effect ranges from +73,000 to +97,000 employees and in Romania it spans from +30,000 to more than +52,000.

4. The electric carrier enables the **reduction of pollutant emissions** improving **air quality**, in particular in urban areas. The substitution of thermal technologies with electric ones in transport (electric vehicles) and residential sectors (heat pumps) is able to **reduce premature deaths** in European Union, Italy, Spain and Romania by more than **5,000, 1,000, 500** and **170 units** at 2030, respectively. Moreover, costs related to air pollution in European Union could be reduced from a minimum of 1 billion Euros to a maximum of 2.9 billion Euros at 2030.

5. Decarbonization is also associated with **higher levels of resilience**, meaning the ability of a system to adapt to the main changes and to recover from exogenous shocks. The ability to be resilient to climate change impacts will be essential to the technical viability of the energy sector in the near future and its ability to cost-effectively meet the rising energy demands driven by global economic and population growth.

Figure 1/a

Benefits associated to energy transition



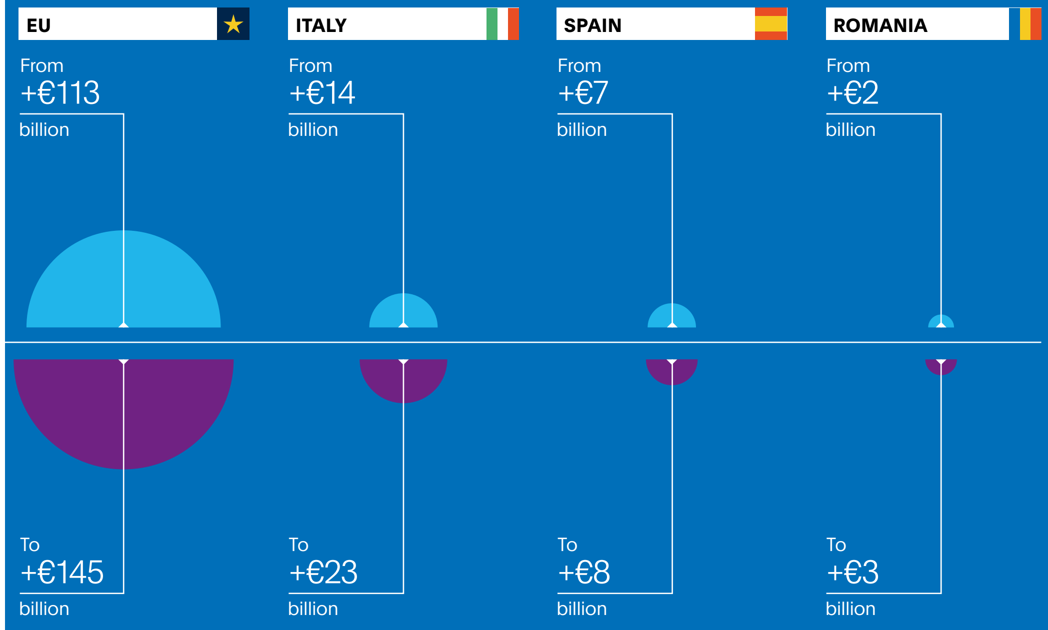
SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON VARIOUS SOURCES, 2019.

Figure 1/b

Benefits associated to energy transition

Increasing the net industrial production

Positive final net effect on industrial production at 2030



EU
From +€113 billion
To +€145 billion

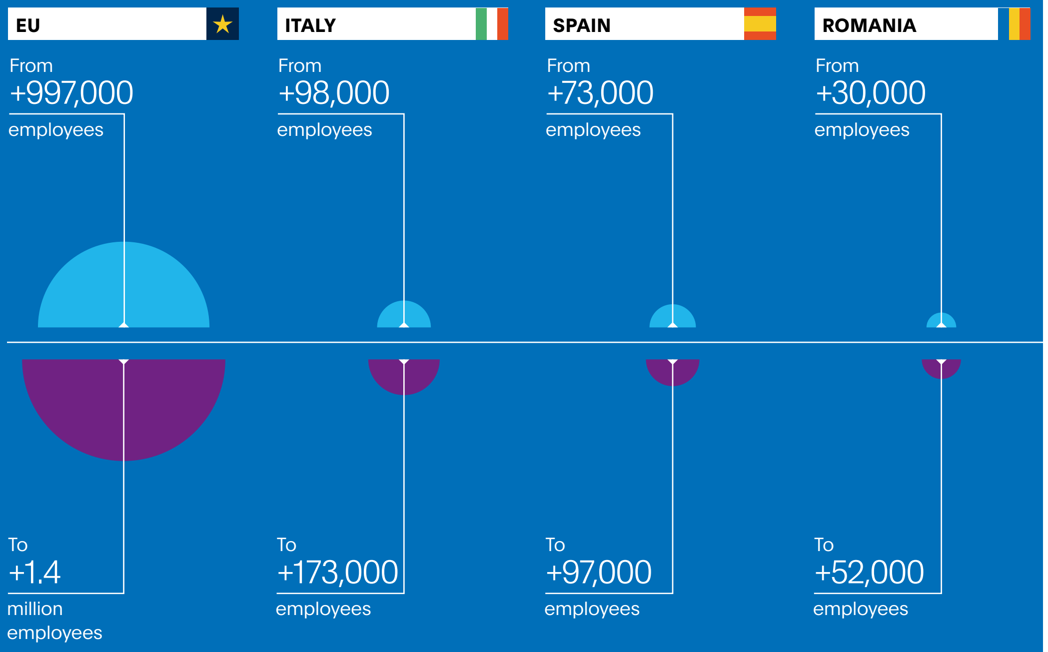
ITALY
From +€14 billion
To +€23 billion

SPAIN
From +€7 billion
To +€8 billion

ROMANIA
From +€2 billion
To +€3 billion

Boosting employment

Positive final net effect on employment at 2030



EU
From +997,000 employees
To +1,4 million employees

ITALY
From +98,000 employees
To +173,000 employees

SPAIN
From +73,000 employees
To +97,000 employees

ROMANIA
From +30,000 employees
To +52,000 employees

Preserving European industrial competitiveness

It is a premise for **maintaining in EU some strategic value chains** that, otherwise, would perish in the global competitive arena (e.g. automotive industry)

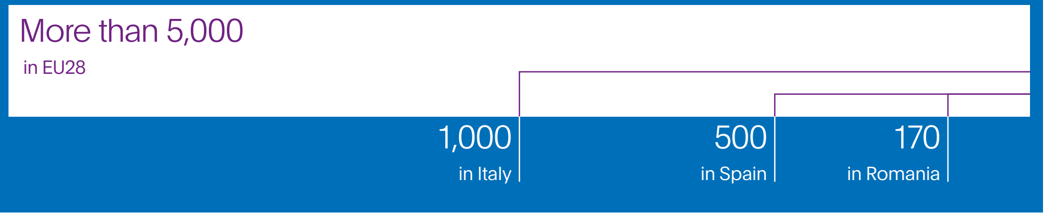
Enabling higher level of resilience

It increases the overall **resilience** of the system, improving its ability to recover from external shocks and guaranteeing the **security of supply** of the overall energy system

Reducing air pollution and improving human health

It enables the reduction of pollutant emissions improving air quality, in particular in urban areas

Avoided premature deaths thanks to NO_x and PM reduction in transport and building sectors



More than 5,000 in EU28
1,000 in Italy
500 in Spain
170 in Romania

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON VARIOUS SOURCES, 2019.

4.2

Socio-economic challenges of energy transition emerging from the assessment model

6. However, the shift from fossil fuels towards renewable energy sources has to face some challenges. On the one hand, energy transition has to preserve **European industrial competitiveness**, while creating the conditions for enhancing future industrial competitiveness in the global scenario. On the other hand, it has to avoid **negative distributive effects** across different socio-economic dimensions, preventing an unfair distribution of costs and guaranteeing equal access to the benefits generated by the energy transition among different areas (e.g. cities and rural areas) and population segments.

7. Preserving European industrial competitiveness entails several challenges:

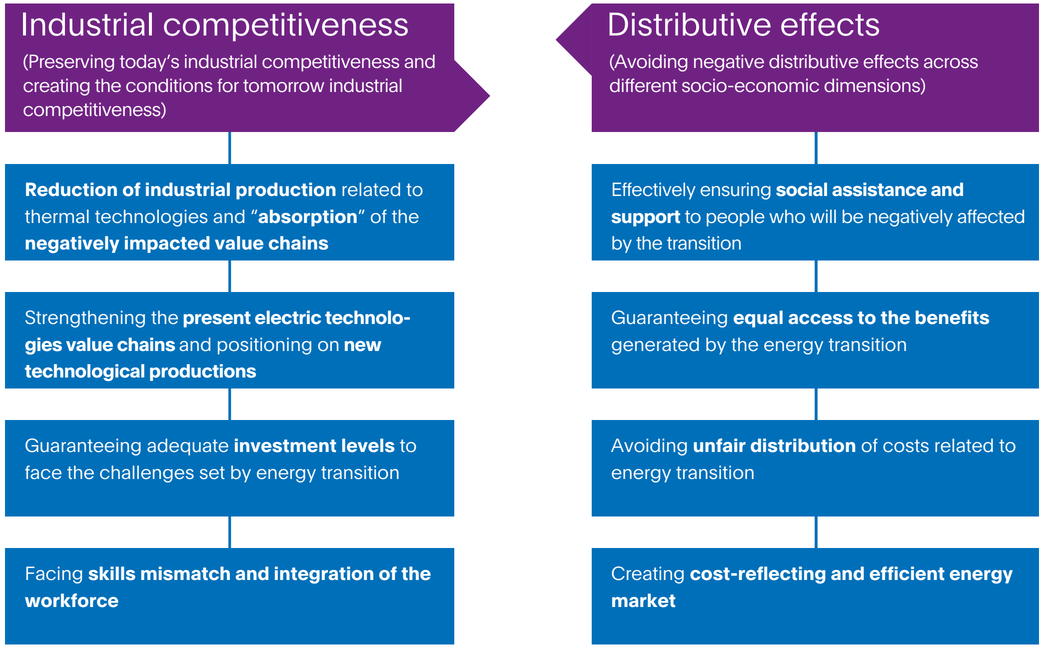
- Reduction of industrial production related to thermal technologies and "absorption" of the negatively impacted value chains.
- Strengthening of the present electric technologies value chains, starting from those headed by Europe and positioning on new technological productions.
- Guaranteeing adequate investment levels to face the challenges set by energy transition on generation, distribution and end-use sides.
- Facing skills mismatch and integration of the workforce due to the shift from thermal to electric technologies production.

8. The same holds for the risk of negative distributive effects across different socio-economic dimensions, including various aspects:

- Effectively ensuring social assistance and support to people who will be negatively affected in terms of employment.
- Guaranteeing equal access to the benefits generated by the energy transition among different areas (e.g. cities and rural areas) and population segments.
- Avoiding unfair distribution of costs related to energy transition.
- Creating cost-reflective and efficient energy market to improve transparency within the power sector and among different energy carriers.

Figure 2

Challenges associated to energy transition



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION, 2019.

4.2.1. Avoiding the loss in industrial competitiveness

Reduction of industrial production related to thermal technologies and "absorption" of the negatively impacted value chains

9. As the energy ecosystem needs to become more decarbonized, policy targets and socio-economic trends will increasingly influence intra and inter-fuel competition, posing a threat for traditional technologies related to thermal energy. As shown in the assessment model on the socio-economic impact of energy transition, companies operating in thermal sectors in the European Union, Italy, Spain and Romania are going to experience a decrease of industrial production by **0.8%** per year in the 2030 Eurelectric Scenario, the most accelerated one.

10. In this context, the challenge is to identify policy and actions boosting research and innovation, essential for European companies to face market changes. These actions would help European thermal sectors to increase their competitiveness and to generate positive spill-overs, by focusing on increasing the efficiency on their products and progressively reducing their emissions. Moreover, innovation would help European countries to diversify their export and to protect themselves from economic shocks, like global dominance of Asian countries in specific markets.

Strengthening of the present electric technologies value chains, starting from those headed by Europe and positioning on new technological productions

11. Together with the preservation of industrial competitiveness in thermal sectors, through increased emissions and energy efficiency, European companies should look at electric value chains with interest and identify new technological opportunities related to the expected evolution of the electricity sector (i.e. e-Mobility, digitalization, distributed generation, renewable sources, electrification of industrial processes). European industrial sectors have several high-quality companies that need to be sustained to meet the technology revolution challenges and reap their benefits, especially with regard to technology sectors where they traditionally boast a competitive advantage (i.e. automotive components, inverters, electric charging infrastructures, energy grid, heat pumps, led lamps, power electronics). In particular, some competences are crucial for the development of key electric technologies, starting from the ones identified as pivotal in the model of socio-economic impacts of energy transition (see Part 3):

Heat pumps. The European market development showed double digit growth for three consecutive years, leading to **1.1 million** units sold in 2017. The top 3 heat pump markets in Europe are France, Italy and Spain, which are responsible for **50%** of all units sold. Although the heat pump value chain today is global, many leading companies are located in Europe, creating not only products that are installed locally, but also an export opportunity for the Region. It has been estimated that more than **54,000** full-time jobs are involved in the value chain, of which 36% in manufacturing heat-pumps, 18% in producing components and 30% and 16% in installing and maintaining, respectively, the annual sales of heat pumps in Europe.[1]

LED lamps. The European market is still underdeveloped, with a potential for growth in the future, which is estimated to reach around **€25 billion** in 2025. Italy boasts well-established competences in this sector, leveraging on R&D top-notch centres; it is the **third exporter** of LED lamps worldwide, with annual exports of **1.8 billion Euros**. However, the leader of LED lamps market remains China, with an export value 10 times higher compared to the Italian ones. With regard to Spain and Romania, the market share of LED lamps is increasing, but the local manufacturing is underdeveloped.

Electric drives. Europe is a large market for alternating current motors, where Italy is the second largest importer, after Germany. However, production is in the hands of extra-European (above all Asian) leading car manufacturers.

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[1] Source: European Heat Pumps Association, 2019.

Electrical storage systems (batteries). The European market of electric battery is consolidated, and it is driven by the rising sales of electric vehicles, but the manufacturing needs to be sustained. Today, the European share on global cell manufacturing amounts only to **3%** (with a 77GWh capacity of lithium-ion battery cells installed), compared to **85%** of Asia. This share is expected to reach almost **16%** before 2030, with a total installed capacity of ~675GWh. Plans and actions are required in order to sustain this growth: only a few policy initiatives have been launched to support the European industry in this field (i.e. European Battery Alliance, French-German plan, European Investment Bank and Northvolt agreement to build the first European Gigafactory in Sweden).

The Franco-German alliance for battery production

France and Germany have concluded an agreement on battery cell production, that will include the construction of two factories, one in France and one in Germany. France will invest **700 million Euros** over the next five years into projects to boost the European electric car battery industry and reduce its carmakers' reliance on Asian producers. Germany set aside **1 billion Euros** to support battery cell production to reduce dependence on Asian suppliers and shore up national jobs that may be at risk from the reduction of combustion engine vehicles production.

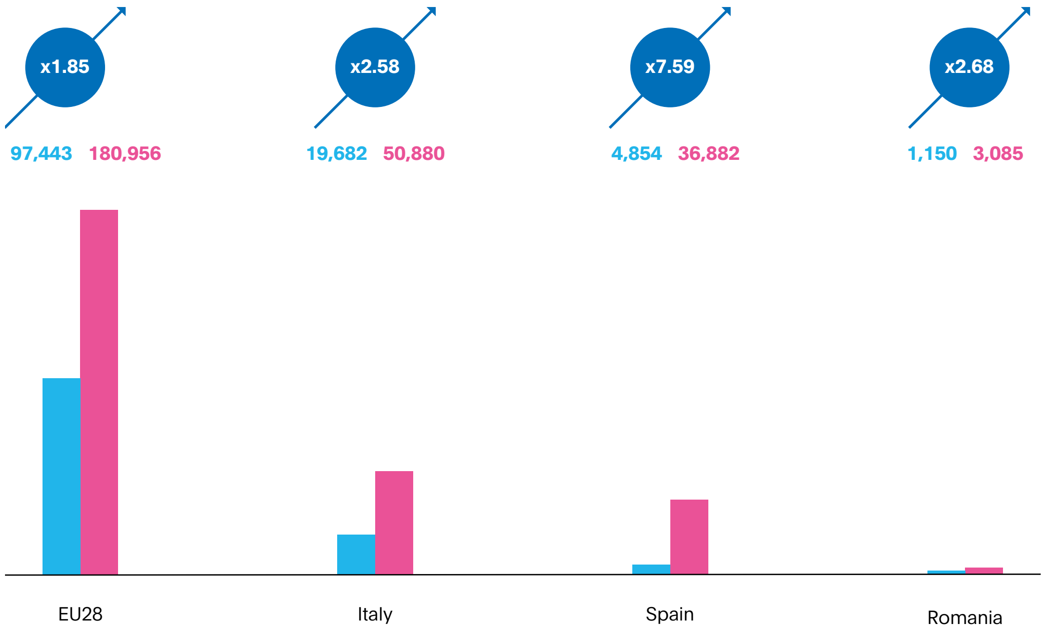
SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ON FRENCH AND GERMAN GOVERNMENTS DECLARATIONS, 2019.

Power electronics. European industry holds a strong position in the field of power semiconductors and modules and also has high quality power electronics academic research groups with well-established networks, providing platforms for discussion, cooperation and research. In 2017, the production of power electronic components amounted to **15.4 billion Euros**, with a growth of **30%** compared to 2008, highlighting the increasing opportunity stemming from this market. The industrial production of Italy, Spain and Romania is, however, underdeveloped since top performer European countries in this sector are located in the Northern part of Europe (i.e. Germany and Denmark).

Solar panels. The European solar capacity installed is expected to grow **1.85** times by 2030, playing a key role in the achievement of EU targets on renewables. Among the countries of the study, Spain is the one pushing more on solar panels since it foresees a solar capacity installed **more than seven times** higher than today. However, although Europe, led by Germany, was at the forefront of the first solar revolution, it suffers the competion of international players like the US, China and India. In the light of the expected relevant growth of solar energy, Europe may well re-emerge as a global powerhouse by exploiting its research excellences and expertises in this field.

Figure 3

Green and brown field solar capacity installed and growth factor, in EU28, Italy, Spain and Romania, 2017 and 2030 (MW, billion Euros and Compound Annual Growth Rate – CAGR)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT, EUROPEAN PARLIAMENT, PROPOSTA DI PIANO NAZIONALE INTEGRATO PER L'ENERGIA E IL CLIMA (ITALY), BORRADOR DEL PLAN NACIONAL INTEGRADO DE ENERGÍA Y CLIMA 2021–2030 (SPAIN) AND INTEGRATED NATIONAL ENERGY AND CLIMATE CHANGE PLAN FOR 2021–2030 (ROMANIA), 2019.

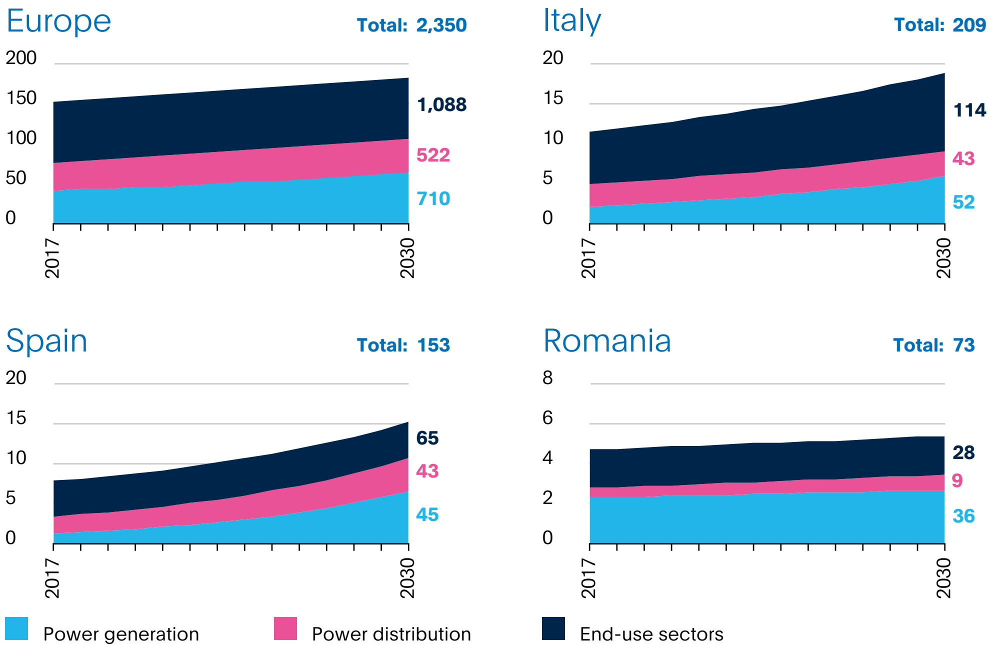
Wind turbines. With a total installed capacity of **178.8 GW**, wind energy remains the second largest source of electricity generation in the European Union in terms of installed capacity and it is likely to become the first one by the end of 2019. At that time, Spain, Italy and Romania are expected to be respectively the 5th, 10th and 23rd country for installed wind power capacity (MW). However, similarly to the case of solar panels, Europe has some gaps in the manufacturing of wind turbines, which are mainly produced abroad with the exception of Italy that boasts the presence on the territory of some leading companies in this field.

Guaranteeing adequate investment levels to face the challenges set by energy transition on generation, distribution and end-use sectors

12. The transition to a low-carbon economy will require changes in the entire economy: energy generation, distribution and consumption. Decarbonizing the energy system means building new production capacity for renewable energy sources and adapting the electricity network in order to better manage more intermittent and decentralized production. Moreover, investments are required to improve energy efficiency in end-use sectors. The European House – Ambrosetti has estimated that the cumulative investment along the entire power value chain over the period 2017–2030 amounts to **2,350 billion Euros** in European Union (209 billion Euros in Italy, 153 billion Euros in Spain and 73 billion Euros in Romania). These amounts can be affordable for all European countries considered if proper actions addressing energy transition needs are implemented. Taking into account the average annual amount of investments required in power generation, power distribution and end-use sectors it amounts to **~4–5%** of today's total investment in the European Union, Italy and Spain and to **~11%** in Romania.

Figure 4

Cumulative investment required for energy transition in EU28, Italy, Spain and Romania, 2017–2030 (billion Euros)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT, EUROPEAN PARLIAMENT, PROPOSTA DI PIANO NAZIONALE INTEGRATO PER L'ENERGIA E IL CLIMA (ITALY), BORRADOR DEL PLAN NACIONAL INTEGRADO DE ENERGÍA Y CLIMA 2021–2030 (SPAIN), INTEGRATED NATIONAL ENERGY AND CLIMATE CHANGE PLAN FOR 2021–2030 (ROMANIA) AND EUROSTAT DATA, 2019.

N.B. The value of the investments represented in the graph is the average between the results in the three different electrification scenarios at 2030 considered in the model (Reference Scenario, EUCO3232.5 and Eurelectric).

Managing skills mismatch and integration of the workforce due to the shift from thermal to electric technologies production

13. As shown in Part 3.3, the overall net effect of energy transition on employment is expected to be positive, totalling **1.4 million**, **173,000**, **98,000** and **53,000 new jobs** created at 2030 in the most accelerated scenario in the European Union, Italy, Spain and Romania, respectively.

14. However, energy transition will not impact all industries in the same way and in the same direction. Indeed, in polluting industries the extent of the impact could differ considerably:

- **Energy**: the shift from fossil-fuel-based power generation to renewable energy may entail job losses in sectors dependent on the use of fossil-fuels, such as coal mining and in supply chains of oil industry.
- **Agriculture**: the development of more environmentally friendly agriculture (which is more labor-intensive) and the deployment of new sources of energy related to agricultural waste could represent an opportunity in terms of job creation.
- **Construction**: the objective of increased energy efficiency in buildings may positively impact employment in this sector.
- **Energy-intensive industries**: the impact on employment may be negative if the sector is exposed to international competition and public policies raise production costs significantly compared to other regions in the world.
- **Transport**: the transition from internal combustion engine vehicles to electric ones may hinder the competitiveness of the automotive sector in European countries. The structure of this sector may also impact employment if autonomous vehicles and sharing mobility are used more widely, because of new skills required in the fields of automation and provision of services.

At the same time, several professional figures are expected to have opportunities in the energy transition job market and some of them still need to be developed (i.e. nanotechnology engineers, energy auditors, system inspectors, high-skilled electricians with digital competences, high-tech farmers with digital competences, etc.).

4.2.2 Avoiding negative distributive effects across different socio-economic dimensions

Effectively ensuring social assistance and support to people who will be negatively affected in terms of employment

15. The net effect on employment in thermal technology sectors is expected to be negative, with a decrease in the number of workers ranging from **21,000 in Romania** to **568,000** in the European Union in the Eurelectric Scenario by 2030. In this sense, it is necessary to address the issue related to the job loss in thermal technologies sectors.

16. Energy transition requires new talents and skills to address the social and entrepreneurial aspects of changing energy systems. These challenges are significant, especially for those employees who will need to be re-skilled or even to shift from on sector to another. In this sense, adequate policies aimed at **facing the skills mismatch** and promoting the **integration of the workforce** are pivotal in order to, on the one hand, handle the reduction in employment in thermal technologies sectors and, on the other hand, properly grasp the new job potential brought by the energy transition.

Guaranteeing an equal access to benefits associated to energy transition

17. The energy transition comes with a series of opportunities that can be leveraged to create widespread benefits. In this sense, the electrification process could potentially foster the creation of tangible benefits for the population and the economic ecosystem in general, thanks to its key unique characteristics as cleanness, safety and integrability with digital appliances (see also Part 2).

18. Anyway, following market-attractiveness principles only, the electrification process risks to be limited, or at least faster, in urban areas, where both regulated and market-free activities gather higher returns on investments. Thus specific policy actions should be developed in order to target also peripheral areas, favouring an equal distribution of benefits.

19. Apart from employment and economic growth impacts (see Part 3), there are several benefits deriving from the electrification process:

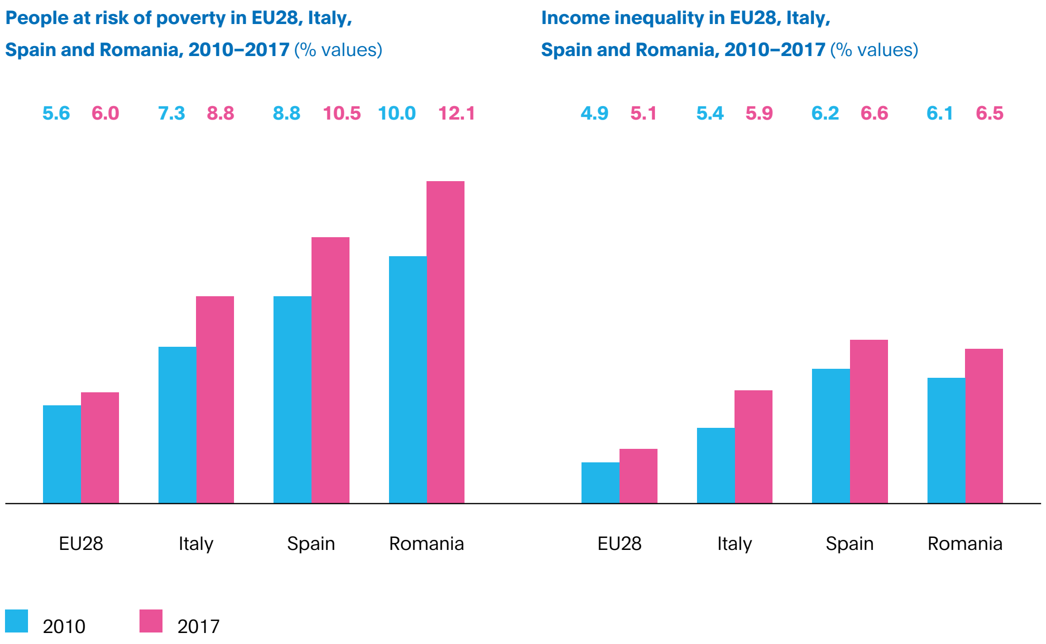
- **Better air quality and health condition**: air quality improvement is one of the most important targets sustaining energy transition. Such target shall focus both on large polluted cities and rural areas, where traditional power generation, industrial poles and major transport infrastructure insist.
- **Energy resilience and security of supply**: electrification could provide substantial improvements to energy system resilience and security of supply. This has to be prompted leveraging on a homogeneous upgrade of energy network, both in more developed areas and in market-failure zones.
- **Safety**: the electric carrier substantially solves many safety risks related to transport, handling and the usage of traditional fuels (e.g. open flames, stocks, etc.).
- **Digitalization and innovative solutions**: the electric carrier is highly interfaceable with digital ecosystems thanks to the high level of controllability and measurability. This is expected to unleash a wide range of new innovative services.

Avoiding unfair distribution of costs related to energy transition

20. Poverty and income inequality have increased in the European Union, as well as in Italy, Spain and Romania. People at risk of poverty within the European Union have risen from 5.6% in 2010 to **6%** in 2017, with a sharper increase in Romania (**2.1 percentage points**, from 10% to 12.1% in the last 7 years), Spain (**1.7 percentage points** in the period 2010–2017) and in Italy (**1.5 percentage points** in the same period).[2] Also, income inequality has risen over the last years, being Italy the most polarized country in terms of wealth distribution among the three countries of interest, with **0.5 percentage points** increase in income inequality[3] over the last years.

Figure 5

People at risk of poverty and income inequality in EU28, Italy Spain and Romania, 2010–2017 (% values)



People at risk of poverty in EU28, Italy, Spain and Romania, 2010–2017 (% values)

Income inequality in EU28, Italy, Spain and Romania, 2010–2017 (% values)

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT DATA, 2019.

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[2] The at-risk-of-poverty rate is the share of people with an equivalized disposable income (after social transfer) below the at-risk-of-poverty threshold, which is set at 60 % of the national median equivalized disposable income after social transfers.

[3] The ratio of total income received by the 20% of the population with the highest income (the top quintile) to that received by the 20% of the population with the lowest income (the bottom quintile).

21. Almost **45 million people** in the European Union are affected by **energy poverty**. Energy poverty is a condition where individuals or households are not able to adequately heat or provide other required energy services in their homes at affordable cost. This is becoming a key societal challenge that should be urgently addressed by Member States, also because it could be exacerbated by energy transition if there is an unfair distribution of costs.

22. Living in inadequately heated or cooled homes is known to have detrimental implications on respiratory, circulatory and cardiovascular systems, as well as mental health and well-being. Energy poverty has also been shown to exert wider economic and political impacts, beyond the private domain of the home.[4] This condition entails a combination of low household incomes, high energy prices, and low levels of residential energy efficiency. As such, energy poverty does not fully overlap with income poverty, although many low-income households are also energy poor.

23. Even if a common definition of energy poverty shared by all Member States does not exist to date, one of the main indicators to assess the condition of energy poor is the **inability to keep home adequately warm**.[5] In Europe, **8.7%** of households (**~45 million people**) declare that they are unable to keep their homes adequately warm. This value varies a lot across Member States, being Finland the most virtuous country in the EU28 (1.7%) and Bulgaria at the bottom of the ranking (39.2%). Also in the countries in which the analysis is focused energy poverty represents a pressing problem: in Italy **almost 9,7 million people** (**16.1%** of the total population), declare that they cannot keep their homes warm, while in Spain and in Romania this percentage amounts to **10%** and **14%**, respectively.

European Union Statistics on Income and Living Conditions (EU-SILC)

The European Union Statistics on Income and Living Conditions (EU-SILC) is an instrument aiming at collecting timely and comparable cross-sectional and longitudinal multidimensional microdata on income, poverty, social exclusion and living conditions.

This instrument is anchored in the European Statistical System (ESS).

The EU-SILC survey has run a number of ad-hoc modules on special topics, including two on housing conditions.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT DATA, 2019.

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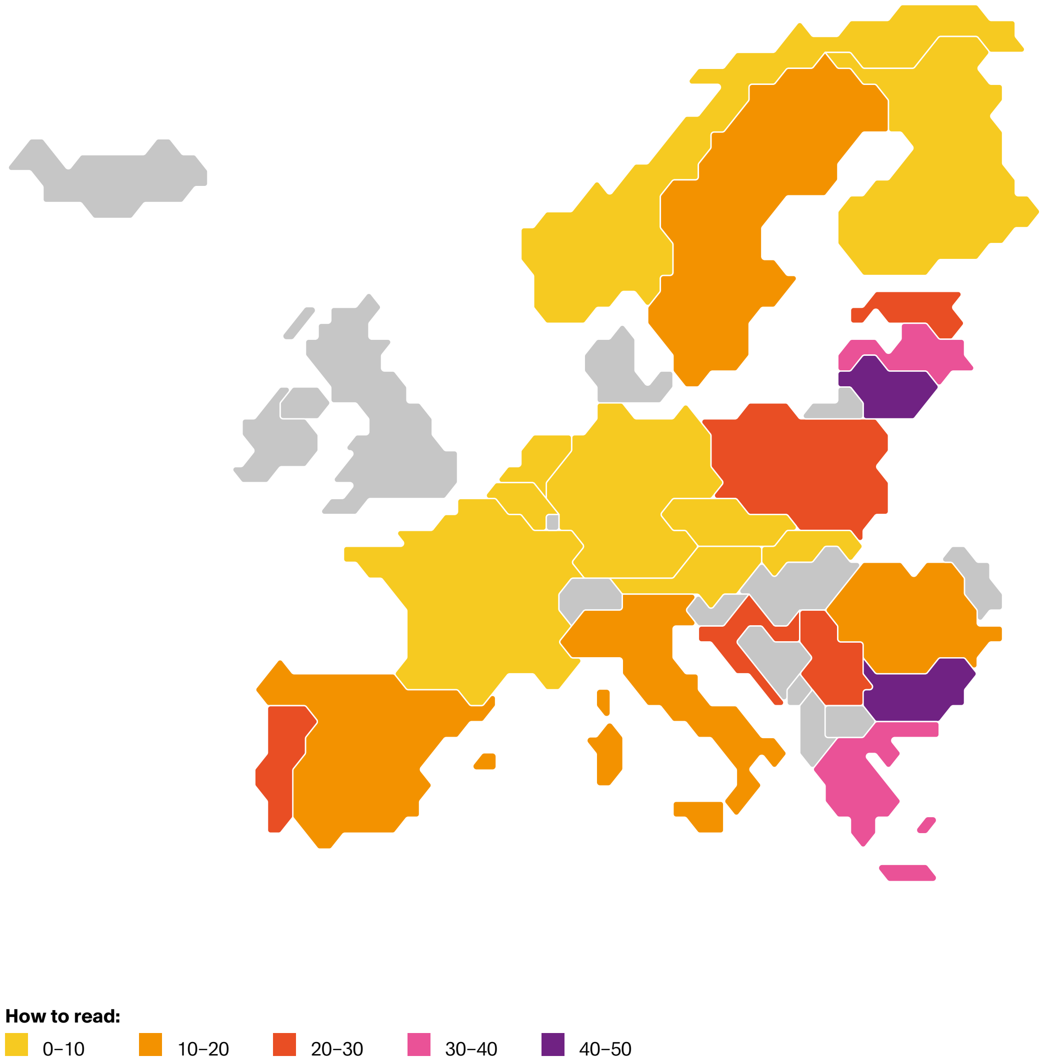
[4] Source: *"Addressing Energy Poverty in the European Union: State of Play and Action"*, EU Energy Poverty Observatory, 2018; Pye, S., Dobbins, S., Baffert, C., Brajković, J., Grgurev, I., Miglio, D. R., and Deane, P., *"Energy poverty and vulnerable consumers in the energy sector across the EU: analysis of policies and measures"*, 2015.

[5] These data are collected through the European Union Statistics on Income and Living Conditions (EU-SILC), a survey realized by Eurostat at EU level, with a number of *ad-hoc* modules on special topics, including two on housing conditions.

Figure 6

People declaring that they are unable to keep adequately warm in Europe, 2016 (% values)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EU ENERGY POVERTY OBSERVATORY, 2019.

24. Furthermore, **19.2%** of European, **26.3%** of Italian, **25.6%** of Spanish and **22.6%** of Romanian population lives in a dwelling not comfortably cooled during summer time. This represents another relevant indicator from the European Union Statistics on Income and Living Conditions (EU-SILC) that needs to be taken into account when analysing energy poverty, especially in the light of the increase in average temperatures all over Europe due to climate changes.

25. Energy poverty might entail also living in a dwelling with **low energy efficiency**, a condition that is self-declared by European households answering the EU-SILC survey. It is worth noting that, in 2015, **15%** of European, **24%** of Italian, **15%** of Spanish and **13%** of Romanian population reported to live in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor.

26. Another indicator that can be used to capture energy poverty is **having arrears in utility bills**, meaning that people are unable to pay on time for utility bills (heating, electricity, gas, water, etc.) for the main dwelling due to financial difficulties. **8.1%** of households in the EU28 (~41,5 million people), **8.9%** in Italy (~5,3 million people), **8.8%** in Spain and **17%** in Romania reported having arrears on their utility bills in 2016.

Creating cost-reflective and efficient energy market to improve transparency within the power sector and among different energy carriers

27. The realization of the energy transition implies the need to undertake a series of **investments transforming the cost structure**, both at the power system and at the final user levels. The way in which costs are allocated or redistributed is a key factor driving effectiveness and efficiency of energy transition in the upcoming years.

28. As for investments at the power system level, related **costs shall be treated based on the benefits generated**. Investments generating benefits extended to the whole society (i.e. not only to electricity final users) must be treated as such and therefore not discharged solely on electricity final users. On the other side, investments enabling the usage of electricity must affect electricity users only. The redistribution of these costs should follow levelized-cost principles, preserving from losses in competitiveness and social equality.

29. The pace of the electrification is strictly related to the **willingness of final consumers to adopt new technologies**, which in turn is related to external constraints such as: market and infrastructure readiness, regulation (bans, obligations, etc.) and, above all, total cost of ownership (TCO). In this light, the economic competitiveness of the electric carrier at the retail level should not be affected by costs not related to the electric service itself, in order to promote a fair market base competition among different energy carriers and do not penalize most efficient and cleanest ones. According to a study published by the European Commission,[6] although the EU and national energy policies are successful in securing competitive wholesale energy markets at which prices for electricity are comparable or lower than many G20 countries, yet the European Union's average retail prices for electricity are higher than in the G20, especially for households, but also for industry. The European Commission recognised that the main, but not only, driver of the observed differences is the tax regime in the EU28.

30. Most impacting costs related to the electrification process can be summarized as follow:

Costs at the power system level:

- **Support for clean generation technologies**: even in grid parity equilibrium, the use of supporting mechanisms for renewable generation could foster the energy transition pace. Green investments generate broad positive externalities, whose costs have to be socialized though **public expenditure**, avoiding potential impacts on energy-poor segments or low competitive and/or energy intense industrial sectors. Financial support to renewable energy sources has tripled over the period 2008–2016 to 75 billion Euros at European level. However, the increase in financial support has significantly slowed down since 2013, although the installed renewable energy sources capacity has continued to increase. This seems to mark a reversing trend resulting from cost reductions of renewable energy sources technologies combined with more cost-efficient policies supporting the development of renewable technologies.
- **Regulated asset base investments remuneration**: at the same time, renewables' increase and the electrification process require an upgrade in network technologies to fully exploit benefits. Those costs are tightly related to energy services and shall remain part of energy bills. Costs have to be fairly distributed among the users of the energy system without distorting **price signals**.

According to the study published by the European Commission, "*Study on energy prices, costs and subsidies and their impact on industry and households*", the average impact of cost related to the electricity delivery and to construction, maintenance and modernization of power lines on energy bill is 26%. This percentage varies significantly from country to country: 21% in Italy, 22% in Spain and 40% in Romania. This fact is even more remarkable when it is considering that in the period 2008–2016 the cost on the single unit of energy (kWh) has grown by 26% (from 4.3 to 5.4 €cents/kWh) in the European Union.

Costs at the final user level:

- **Technology switching**: the achievement of electrification targets may require a faster replacement of traditional appliances well before the end of their useful life. In this case, poorer population and low competitiveness energy intensive companies shall be supported in taking over anticipated substitution costs or in overtaking incremental costs in the case electric technologies show higher costs compared to traditional ones.
- **Cost of energy carriers**: efficient energy market shall be promoted in order to provide final customers with transparent price signals. In this light, for all energy carriers, cost-reflective tariffs shall be promoted, in order to **free bills from taxes and levies** not strictly related to energy services. Always according to the European Commission evaluation, the average impact of taxes and policy costs decided by governments on electricity bill is 38%. This percentage varies considerably from country to country: 39% in Italy, 50% in Spain and 29% in Romania. In the period 2008–2016 the cost on the single unit of energy (kWh) has grown by 71% (from 4.6 to 7.9 €cents/kWh) in the European Union.

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[6] Source: European Commission, "*Study on energy prices, costs and subsidies and their impact on industry and households*".

4.3

Policy proposals to manage the transition, making it "just for all"

31. What is good for the planet must also be good for the economy and society as a whole. Thus policy action should be undertaken in order to effectively redistribute the benefits that the transition can generate (see Part 4.1) and address the challenges related to the transition (see Part 4.2), ensuring that the energy transition is not "just a transition" but a "**transition just for all**".

32. Different types of economic and societal measures with different effects should be empowered:

- **Prevention measures**: they aim at reducing the incidence and size of shocks and, in the best case, to avert them.
- **Preparation measures**: they aim at putting in place arrangements that reinforce the resilience capacities in case a disturbance materializes.
- **Protection measures**: disturbances can still happen and protection measures are required to mitigate their impact and provide relief.
- **Promotion measures**: they serve to invoke the adaptive capacity (flexibility) necessary to cope with longer and/or more severe disturbances.
- **Transformation measures**: the role of transformation measures is to facilitate the transition, in order to avoid unnecessarily and unexpected abrupt change.

33. Four policy matters, entailing specific policy actions, have been identified in order to tackle the challenges related to energy transition and effectively support its benefits:

- Supporting the **deployment of electric technologies** by promoting an effective **value chains conversion toward electric technologies**.
- Managing **job losses**, increasing **job opportunities** and addressing the issue of **re-skilling** and **up-skilling**.
- Addressing the **issue of energy poverty**.
- Promoting a **fair redistribution of costs associated to energy transition**, revising cost items within electricity bills and discharging electricity bills from unproper taxes and levies.

Policy Matter 1

Supporting the deployment of electric technologies by promoting an effective value chains conversion towards electric technologies along the overall value chain (power generation, power distribution and end-use sectors)

Supporting the deployment of electric technologies and the value chain conversion toward electric technologies by:

- Launching "**Energy Transition Investment Bonds**" to sustain investments with a social impact and economic return and with a financing mechanism that could favor the creation of consortia involving all the players along the value chains and guaranteeing all the steps from research to implementation.
- Setting up **National Energy Clusters** with a specific focus on electrification technologies and, in this context, creating a national **Tech Transfer Lab** focused on electrification technologies, with the mission of acting as enabler of technological transfer between the research institutions and the private sector.
- Introducing **innovative financial schemes for mature technologies** able to deliver high energy efficiency gains with mid-long-term payback period.
- Promoting measures to support and inform companies and **campaigns to raise awareness of the advantages associated to electric technologies**.

34. Energy transition can lead to new technological opportunities related to the expected decarbonization of the entire energy value chain (generation, distribution and end-uses), starting from the expected increase of electric technologies (e-Mobility, digitalization, distributed generation, renewable sources, etc.). In the light of these changes, research and innovation is a strategic issue because it allows, on one hand, to develop new technologies to be used as inputs for launching new types of manufactured product and, on the other hand, to identify innovative solutions to meet sustainability goals. The European Union hosts important international industrial players, small specialized and high-quality companies and highly qualified research system that can be even more competitive in meeting technology revolution challenges.

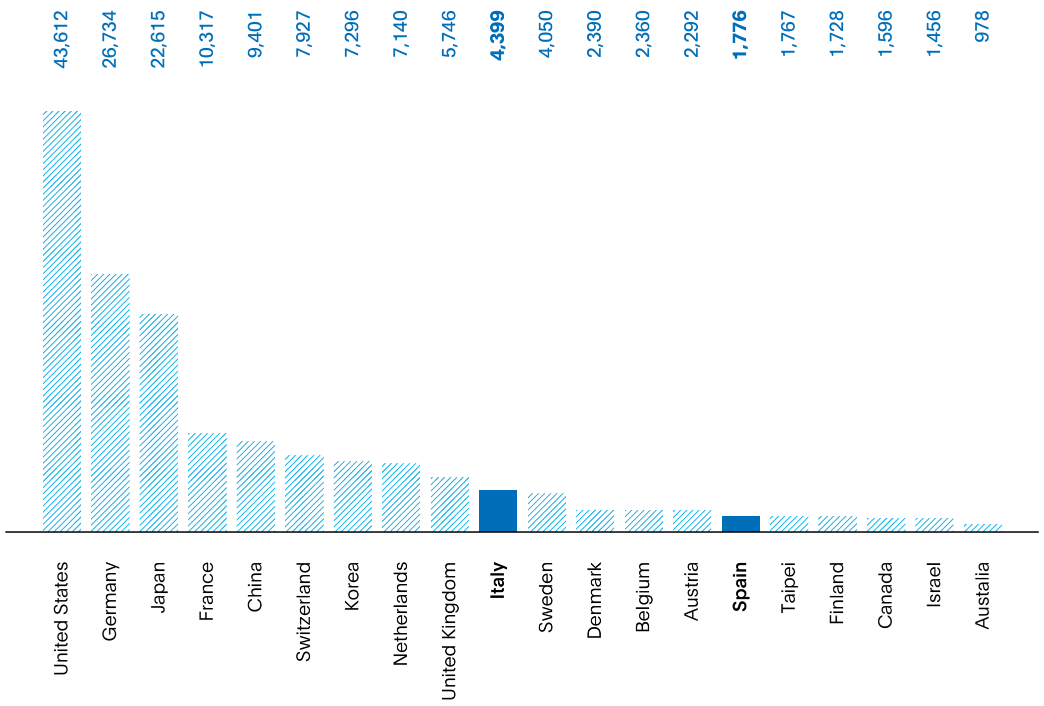
35. Thus, the European Union must aim at positioning as a leader in a number of cutting-edge technologies which represent breakthroughs for the future. In order to enhance the Research & Development activities of European companies on these types of technology, sustaining capital inflows, it is of paramount importance to create innovative ways for fundraising, that match the peculiarities of research in the electric sector (high level of initial investments, mid-long-term returns, etc.) with the expectations of private investors. With this respect, each Member State could usefully take inspiration from the Social Impact Bond (SIB) scheme to launch an **Energy Transition Investment**

Bond (ETIB) to sustain investments in projects related to R&D and innovation activities with a social impact and economic return. The recipient should be consortia that group together key players of the research network on key technologies for energy transition (i.e., universities, manufacturing companies, Energy Service Companies – ESCOs, etc.), which should guarantee coverage of all steps of the value chain from research to implementation.

36. In order to grasp all the benefits of energy transition, companies not only need to invest and attract financial contribution, but they have to work closely with research institutions and universities. In Italy, Spain and Romania there is a shortage of coordination between the research sector and the industrial one, mainly due to personnel under-sizing and scarcity of financial resources that also affect patenting activities, bringing Italy, Spain and Romania to rank respectively **10th**, **15th** and **53rd** in the world for number of European patent applications. These critical areas are at the base of the gap in terms of technological transfer, compared with international benchmarks, both in terms of company-specific initiatives and systemic coordination mechanisms that allow to new energy-related technologies to be marketed.

Figure 7

European patent applications in the first 20 countries in the world, 2018



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN PATENT OFFICE DATA, 2019.

37. Thus, the proposal is to set up **National Energy Clusters on electrification technologies**. The final goal of these clusters is to create a **national Tech Transfer Lab** aimed at empowering the already existing research centres, by stimulating them to focus on innovative electric technologies and strengthening technological transfer between research institutions (universities, research labs, etc.) and industry. In this regard, the new institute envisaged in the proposal, the Tech Transfer Lab, needs to be conceived as a facilitator of technological transfer. To provide these solutions, an effective plan could empower the already existing research institutions already working in fields closely related to the electrification technologies. Then, the Transfer Lab would not act directly in the research phase, but rather as a pivotal actor carrying out the role of reference point for academics, institutions and private players. The overall aim is to ease the transfer of knowledge from universities/research networks to companies, to provide an enriched environment, suitable for career opportunities for national and international researchers, thus contributing to reduce the outflow of talented researchers towards other countries and to sustain the "go-to-market" mechanisms of the most promising end-use electric technologies.

38. More precisely, the Lab should link universities and the private sector, undertaking a wide range of activities such as:

- Reviewing the existing technology transfer procedures and adopting consolidated best practices.
- Supporting communication between researchers and investors.
- Undertaking specific consulting activity on the most promising projects.
- Identifying opportunities, with analysis and evaluation of the entrepreneurial risk.
- Elaborating business plans and providing support in all the different phases, focusing on the most valuable technologies from the market perspective, in order to select the ones with the highest potential to be marketed hereafter.

39. Along with the issue of sustaining investment for the production of technologies employed along the entire value chain, it is important to consider **end-use sectors** as key enablers for the diffusion of actions in favour of energy transition, starting from energy efficiency. The importance of energy efficiency in buildings is supported by the fact that buildings account for **27%** of final energy consumption and **30%** of electricity consumption in Europe. Incentivizing measures for householders is then pivotal to trigger investments in energy efficiency.

Investments are a key point of the plan of the new European Commission President

During her first speech as elected President of the European Commission, Ursula von der Leyen declared that she wants Europe to become the **first climate-neutral continent** in the world by 2050. Moreover, she said that current goal of reducing emissions by 40% by 2030 is not enough and Europe needs to reduce CO_2 emissions by 2030 by 50%, if not 55%. To make this happen, she proposes to introduce a Sustainable Europe Investment Plan and to turn parts of the European Investment Bank into a Climate Bank. This will unlock **1 trillion Euro** of investment over the next decade.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ON EUROPEAN COMMISSION, 2019.

40. One measure that can be addressed in this sense is the introduction of **innovative financial schemes**. Combining traditional mortgage with an *ad hoc* loan for energy efficiency technologies, guaranteed by financial institutions under an agreement with an industrial player, can trigger mature technologies able to deliver high energy efficiency gains with medium-long-term payback period. The overall objective of this recommendation is to widen the array of financial instruments available in the residential sector by specifically targeting the necessities of those technologies, like the electrification-driven ones, that have already reached market maturity but which require an important initial investment and time to realize the full returns.

41. It is crucial to inform companies and citizens about the benefits of taking action spurring energy transition. Thus, the last policy proposal aims at promoting measures to support and inform companies and citizens **to raise awareness of the advantages associated to electric technologies** (e.g. efficiency gains, higher resilience, easier combination with digital devices, etc.). Two different measures can be put in place, according to the final target:

- Launching a **national communication campaign** for public opinion in order to inform citizens about the advantages of all electrification solutions and highlight their contribution to pollution reduction. The campaign should communicate the environmental and economic gains resulting from a higher share of electric technologies in end-uses, thus enhancing people's social responsibility towards air pollution, as well as their interest for energy efficient solutions.
- Creating a **permanent national Forum** aimed at involving business leaders, acting on two related aspects. At first, it would provide them with the opportunity to present their instances and ideas on potential development of energy related appliances, with the aim of activating all the stakeholders towards the empowerment of the national supply chain. In addition, it would constitute a context where institutions and experts can sensitize business leaders to focus on electrification technology development, envisaging their potential economic benefits.

Policy Matter 2

Managing job losses, increasing job opportunities and addressing the issues of re-skilling and up-skilling

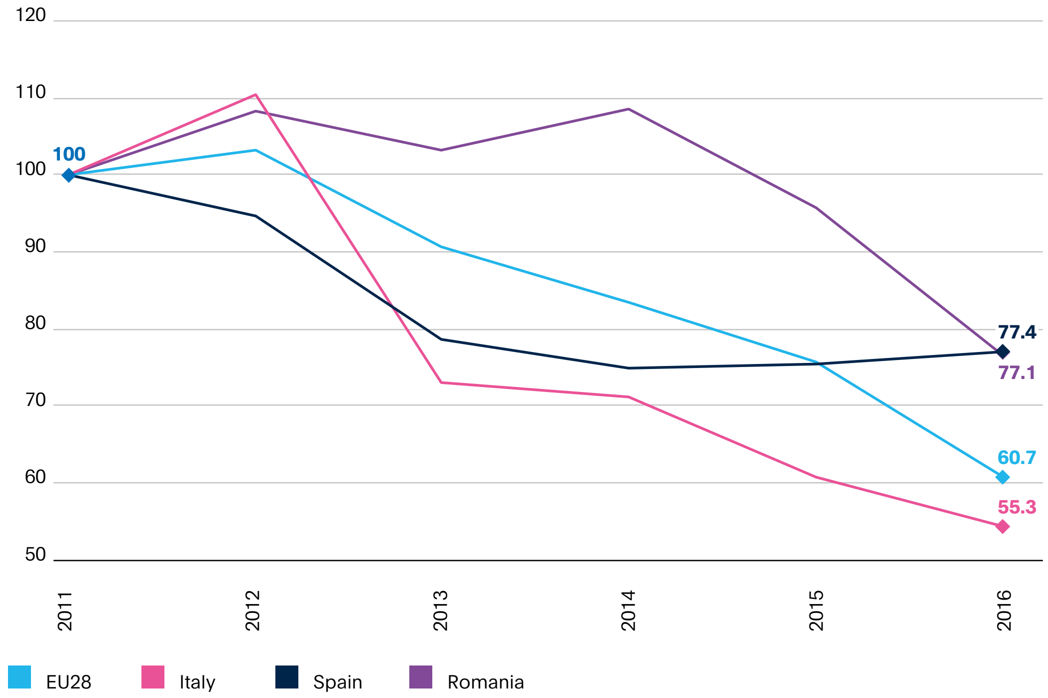
Managing job losses, increasing job opportunities and addressing the issues of reskilling and up-skilling by:

- Envisaging **social measures** for workers employed in sectors and occupations with higher difficulties to find a new job, for example setting up **early retirement schemes** for workers who have lost their jobs and who are over 50 years of age, or providing **allowances** aimed at helping younger workers to move to other sectors covering costs of training and relocation.
- Supporting workers who have lost their jobs by establishing a "**European Energy Transition Fund**", helping them to find a new job, providing career advice, furnishing education, training, re-training, mentoring and coaching and incentivizing entrepreneurship and business creation.
- Introducing **new educational programs** like university or Master degrees explicitly targeting the needs emerging from energy transition (renewables, electric technologies, etc.). These new courses could be funded by local Governments or the European Union in the first period (2–3 years) of student engagement.
- Introducing **Circular Economy Chairs in top-notch European universities**, with the aim to attract most talented students all over the world and establishing Europe as a point of reference for Circular Economy.
- Implementing a "**Green Apprenticeship Erasmus Program**", aimed at increasing the mobility of apprentices and trainees in sectors that are relevant for energy transition. This would also have the advantage of encouraging young people to prepare for the jobs of the future, which will help reduce youth unemployment in Europe.
- Raising **awareness** among workers and students on the importance of being competitive in the job market by **launching a communication campaign** on the importance of the acquisition of new skills for students and for workers to be prepared in case of job loss. This would **encourage young students** to undertake studies in science, technology, engineering and mathematics (**STEM**), which are the subjects most required for energy transition.

42. The development of electric technologies and the subsequent decline of thermal ones can undermine the socio-economic structure of several industrial sectors. As an example, to date in Europe there are still **41 regions** with active coal mining activities across 12 Member States.[7] In some countries, in particular in Eastern Europe, the coal industry has historically been a major source of economic activity and employment. However, the production value in the sector has **declined** significantly in the last 5 years, almost halving in the European Union and in Italy (**-40%** and **-45%** respectively). Therefore, if not followed by long-term regeneration plans, the coal mine closures or downsizing risk to negatively affect the regional economies.

Figure 8

Production value in mining and quarrying industry in EU28, Italy, Spain and Romania, 2011–2016 (index year 2011=100)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT DATA, 2019.

43. For this reason, the proposal aims at envisaging **social measures** for workers employed in sectors and occupations with higher difficulties to find a new job (i.e. workers in coal mining sector, technicians in oil industry, etc.), by recognizing a pivotal role to trade unions in companies' re-organization and energy transformation. In this context, the social dialogue is strategic for relations among workers and their representatives, companies and institutions and it could represent a decisive factor for workers engagement in energy transition.

International best practice: German workers in the coal mining sector

In 1950s, the coal mining sector employed more than 500,000 workers in Germany, while in 2015 there were only 10,000 jobs left.

The drastic reduction in employment in this sector was faced by a package of social measures, which ensured the continued cooperation with trade unions and attenuated structural unemployment in regions mostly reliant on coal mining:

- "Financial adjustment aid": the aid was available to workers in coal mining who have lost their jobs and who are over 50 years old. On average, the aid amounts to about €13,500 per year and it was paid for five years.
- "Adjustment allowance": the instrument was aimed at helping younger workers to relocate to other sectors of activity. This allowance covers training, travel and relocation costs.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN COMMISSION, 2019.

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[7] Source: European Commission, 2018.

44. This proposal aims at helping Member States and local authorities to finance training, retraining, and supporting enterpreneurship measures for workers who have lost their jobs as a result of major structural changes generated by the energy transition. It foresees the introduction of a "**European Energy Transition Fund**". The fund could be similar to the one established in 2006 for supporting companies hit by globalization, the so-called "European Globalization Adjustment Fund". This fund was implemented in order to support people who have lost their job as a result of major structural changes in world trade patterns due to globalization (e.g. when a multinational company shuts down or moves the production outside the European Union, or as a consequence of the global economic and finanial crisis). The fund has a maximum annual budget of **150 million Euros** for the period 2014–2020 and it was established to cover up to **60%** of the cost of specific projects designed to help redundant wokers to find another job. As a rule, the fund could be used only where at least 500 workers became redundant in a single company or if a large numbers of workers were laid off in a particular sector in one or more neighbouring regions.

The support of the "European Globalization Adjustment Fund" to the Spanish coal miners

In 2018, the Spanish government decided to implement the plan of shutting down most of its coal mines in the following years, in light of a growing attention to the environmental policy.

As a consequence, it was necessary to ask for support from the "European Globalization Adjustment Fund" following the dismissal of 339 coal workers in five coal mines in the Spanish region of Castilla y León.

The measures co-financed by the fund aimed at providing them with employment guidance and counselling; general training, re-training and vocational training; intensive job-search assistance; promotion of entrepreneurship and support for business start-up.

The total estimated cost of the package was 1.6 million Euros, of which the "European Globalization Adjustment Fund" have provided 1.0 million Euros.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN COMMISSION DATA, 2019.

45. The final purpose of the "**European Energy Transition Fund**" should be not to co-finance social protection measures (already covered by other social protection instruments), such as pensions or unemployment benefits, but mainly to co-finance projects that include measures aimed at:

- Helping workers to find a new job.
- Providing career advice.
- Providing education, training, re-training, mentoring and coaching.
- Incentivizing entrepreneurship and business creation.

46. Therefore, this proposal has the purpose to identify and anticipate the skills needed for energy transition by analyzing the industrial and labor framework of each country and addressing policies for students and workers. The introduction of **new educational programs** like university courses or Master degrees could explicitly target the needs emerging from energy transition. The objective is preparing students to fulfil growing industry demand for specialised renewable and green energy expertise, equipping students with technical skills integrated with knowledge of technological, strategic, social and economic issues. These new courses could be funded by local Governments or European Union in the first period (2–3 years) of student engagement.

Moving in the right direction: the two European Master Degrees

Since 2002, EUREC, a leading association representing research centres and university departments active in the area of renewable energy sources, has been proposing to implement new educational systems founded on the comprehension of the new energy dynamics worldwide. From this premise, EUREC has coordinated a European Master in Renewable Energy, whose objective is to train post-graduate students to become tomorrow energy specialists. The three-semester Master programme is taught in nine universities around Europe.

Moreover, it has introduced the European Master in Sustainable Energy System Management, in collaboration with four European universities, providing the economical, management skills and technical knowledge for working in the renewable energy industry.

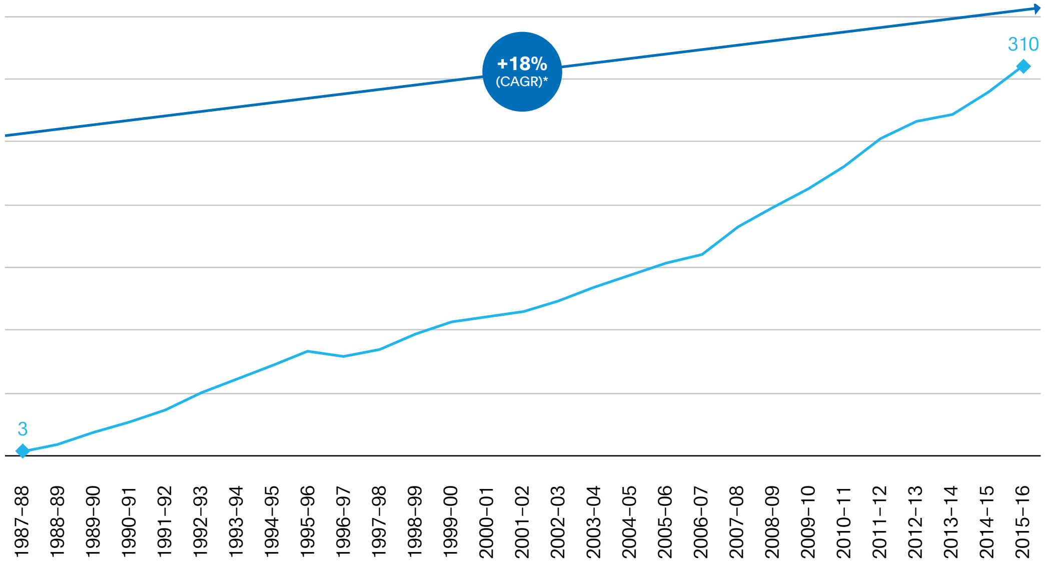
SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUREC, 2019.

47. A new paradigm closely related to energy transition is **Circular Economy**. Its fundamental is that growth no longer requires an increasing extraction and consumption of resources. It entails gradually decoupling economic activity from the consumption of finite resources, and removing waste from the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital. It is based on three principles: avoid waste and pollution, keep products and material in use, regenerate natutral systems. In this context, introducing **Circular Economy Chairs in top-notch European universities**, financed by the European Union, could attract most talented students all over the world and establish Europe as a point of reference for Circular Economy.

48. The **European Apprenticeship Erasmus Program**, with its focus on skills development for employability and active citizenship, is a central element of the European Commission's strategies. Mobility contributes to tackle youth unemployment: the unemployment rate of young people who studied or trained abroad is 23% lower than that of their non-mobile peers[8]. It also equips the new generation with social, civic and intercultural skills. Since it began in 1987-88 academic year, the Erasmus programme has provided over **3 million European students** with the opportunity to go abroad and study at a higher education institution or train in a company. With a budget of almost 2.6 billion Euros, 2017 was yet another record year, accounting for a 13% funding increase compared to 2016. This provided almost 800,000 people with an opportunity to benefit from learning, working or volunteering abroad. The Erasmus program is also an opportunity to gain experience in the job market; the number of students taking part in traineeships abroad during their studies or as recent graduates has continued to rise. Around **90,000 students** undertook training abroad in 2017 (**+18%** compared to 2014).

Figure 9

Students mobility in the context of the European Erasmus Programme by academic year, 1987–2016 (thousand students)



(*) CAGR=Compound Annual Growth Rate

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION EUROPEAN COMMISSION DATA, 2019.

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[8] Source: European Commission, 2019.

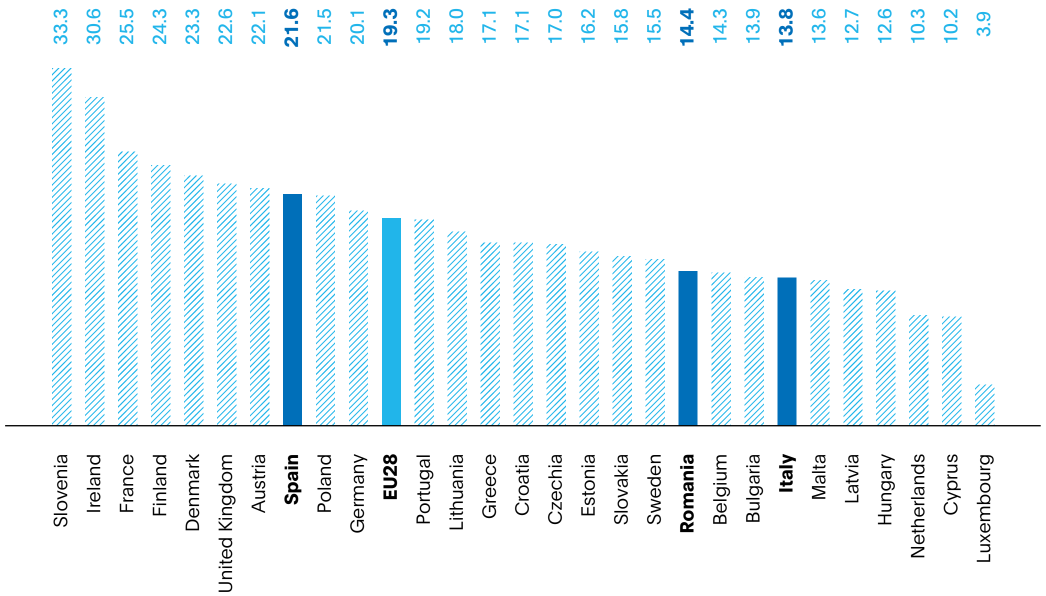
49. The European Commission could allocate part of the funds for financing the Erasmus Program for the introduction of a "**Green Apprenticeship Erasmus Program**". This would also have the advantage of encouraging young people to pursue training schemes abroad and in sectors of growing importance which, in turn, could help to reduce youth unemployment in Europe. Moreover, another important aspect is to strengthen the governmental and companies' commitment towards lifelong learning programs. For both companies and governments, supporting lifelong learning is becoming extremeley important since it can help to delay the onset of dependency among rapidly ageing populations, playing a role in overcoming inequality and exclusion, supporting inter-generational learning and creating more resilient families and communities. While the organisation and content of education remain a specific responsibility of Member States, the European Union supports lifelong learning by coordinating cooperation between them. In 2009, Education Ministers agreed on a strategy of cooperation on education and training for the next ten years, up to 2020. This strategy is commonly referred to as ET2020, and is supported by Erasmus+.

50. The highly volatile job market environment renders more difficult to forecast human resources needed in the sectors more related to energy transition. Focusing only on the renewable energy sector, the Renewable Energy Job Barometer provides an overview of the current job trends in the sector. Through an industry survey, the emerged "most wanted" profiles remain the ones with **high technical skills**: engineers in various disciplines (i.e. mechanical, process, construction, production, etc.), research engineers and field technicians. However, it is worth mentioning that the needs for technical skills should be considered on a as wide as possible dimension, including not only graduates but also technical figures (plumbers, electricians, installers, etc.).

51. Increasing the number of **Science, Technology, Engineering and Math** (STEM)[9] graduates is a pressing priority for long-term sustainable growth. Both Italy and Romania position well below the European Union average in terms of STEM graduates per thousands inhabitants (with **13.3** and **14.4**, respectively), while Spain ranks 8th in the EU, with 21.6 graduates per thousands inhabitants. In this context, this proposal aims at making students and workers aware of the importance of the acquisition of new and adequate skills to support a future career or to be properly prepared in case of job loss, through a specific and focused **communication campaign**. Moreover, in order to anticipate the competences needed and reduce the skills gap, the campaign should also address the needs to encourage students to undertake university degrees in scientific and technical disciplines.

Figure 10

STEM graduates in EU28 countries, 2016 or last year available (graduates per thousand inhabitants)



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROSTAT DATA, 2019.

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[9] The following degrees are considered as "STEM": Science, Mathematics, and Computer science, Engineering, Manufacturing and Construction.

Policy Matter 3

Addressing the issue of energy poverty

Addressing the issue of energy poverty by:

- Agreeing on a common definition of energy poverty, introducing an **official composite index for measuring energy poverty** in Member States, as a premise for national policy frameworks to address the issue, using a combination of indicators on income and living condition of households.
- Promoting a target program for **improving the energy efficiency of existing housing stocks**.
- Developing a **communication campaign** characterized by measures to support and inform consumers, protecting them against electricity cuts and campaigns to raise awareness of the topic.
- Fostering **social tariffs** or **energy subsidies for low-income households**, maintaining cost-reflective tariffs.

52. To date, there is **no common definition of energy poverty** nor is there a common rule for measuring this phenomenon. At the national level, indicators based on the level of energy expenditure as a percentage of income are often used to measure the problem for public policy purposes. There are several pan-European studies trying to gauge the extent of the problem using three indicators from EU statistics on income and living conditions (EU-SILC): the inability to keep the home adequately warm; having arrears in utility bills; and living in a dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor.

Measuring energy poverty by the level of energy expenditure as income share

The approach commonly used to quantify energy poverty at the national level explores the ratio of household income to energy expenditure.

According to this approach, an energy poor household is the one which needs to spend more than a certain share of disposable income for energy (e.g. 10% in Northern Ireland, Scotland and Wales). Similarly, in 2010, the Commission proposed that households allocating more than twice, with respect to the national average, of their total consumption expenditure to energy products should be considered energy poor. Although this expenditure approach has the advantage of being relatively straightforward, it might exclude households that restrict their energy consumption in order to limit their spending or it might include more affluent households that use an excessive amount of energy.

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EU ENERGY POVERTY OBSERVATORY, 2019.

53. Introducing an **official composite index for measuring energy poverty**, homogenous across all Member States, is a premise for national policy frameworks to address the issue. This index could entail a set of Key Perfomance Indicators, among which:

- Ability to keep home adequately warm.
- Reporting arrears in utility bills.
- Ability to keep home comfortably cooled during summer.
- Living in dwelling with a leaking roof, damp walls, floors or foundation, or rot in window frames or floor.
- Share of total consumption expenditure allocated to energy products.

54. The condition of energy poverty is closely related to the level of energy efficiency of housing stocks. Old buildings, with low levels of energy efficiency, have difficulties in retaining warmth during winter and they have higher probabilities of having leaking roof, damp walls, floors or foundation, or rot in window frames or floor. Thus introducing **target programs**, at European level, to **retrofit existing buildings to a high efficiency standard**, could significantly reduce the issue of energy poverty.

The Energiesprong programme in the Netherlands: a target program for retrofitting existing buildings to a high efficiency standard

Energiesprong is a market-based programme that is a combination of new building and whole house refurbishment standards with a funding mechanism. Developed in the Netherlands in 2012, the programme seeks to retrofit existing buildings to a high efficiency standard, which usually results in buildings with net-zero energy consumption.

Renovations are usually completed within one week, with occupants remaining in the dwelling and the energy performance is guaranteed for 30 years. The refurbishment delivers desirable homes with fully integrated solutions that are commercially financeable and scalable.

The Energiesprong financing mechanism uses an innovative approach to collect financial sources from different actors:

- Government-related grants available to all households (such as feed-in tariffs and energy company obligations).
- Access to low-interest capital (e.g. from pension funds with long-term investments).

SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON VARIOUS SOURCES, 2019.

55. There are also palliative measures to alleviate the issue of energy poverty. These measures could include actions to **support and inform consumers**, protecting them against electricity cuts in particular. In this respcet, the European Commission has proposed to strengthen these protective mechanisms by introducing new procedural safeguards which take effect before a consumer's energy supply is cut. In addition, *ad hoc* **campaigns to raise awareness of the topic** could be introduced, including tools to compare energy prices, measures to improve energy efficiency and the use of smart meters to track energy consumption.

56. Finally energy poverty can be addressed through **social tariffs** or **energy subsidies** for low-income households, maintaining cost-reflective tariffs. They can be provided in the forms of financial aid allocated to beneficiaries, under income conditions, that can be used to pay their energy bills. In order to stimulate the renovation of existing housing stock, while addressing energy poverty, these subsidies coul be conditioned to investment for improving energy efficiency of the existing buildings.

Policy Matter 4

Promoting a fair redistribution of costs associated to energy transition

Promoting a fair redistribution of costs associated to energy transition by:

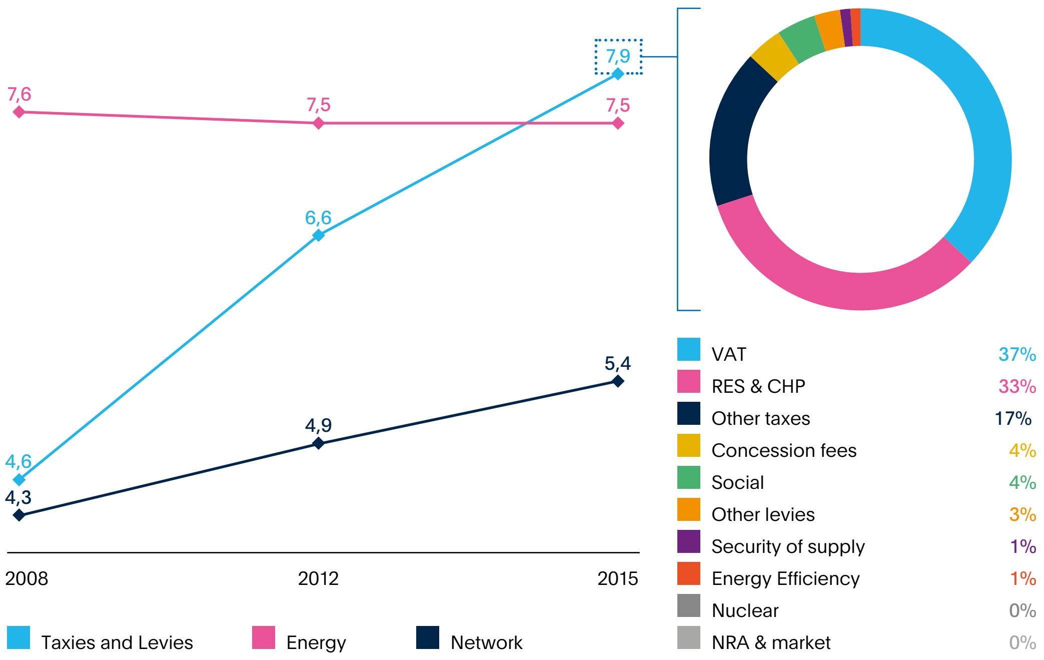
- A **revision of the cost items within electricity bills**: transferring the policy costs from electricity bills to public finance guarantees a more effective protection for energy-poor segments and low competitive industrial sectors and creates a competitive transparent market, with cost-reflective tariffs within the power sector and between energy vectors.
- **Discharging the electricity bills from unproper taxes and levies**. Clear commitment of Governments on this could also act as an incentive to the switch from traditional fuels to electricity.

57. Investments in cleaner electricity generation is a key pillar of the energy transition process, since it is the only carrier that can lead to a zero-emission energy scenario at accessible costs and without threatening security of supply.

58. Considering only the taxes, on average in Europe VAT and other taxes account for **14%** and **6.5%** of the total electricity price respectively. When it comes to the policy costs, excluding the financial support system for renewables, these account for 13% of the total taxes and policy costs and the 5% of the energy price as an average at the European level. Finally, the set of financial support mechanisms for renewable electricity generation (e.g. feed-in-tariff, feed-in-premium, green certificates, etc.) is financed though levies on the electricity bill, accounting for around the 13% of the final price.

Figure 11

Evolution of bill components and breakdown of taxes and policy costs at 2015 (€cent/kWh and %), 2008, 2012 and 2015



SOURCE: THE EUROPEAN HOUSE – AMBROSETTI ELABORATION ON EUROPEAN COMMISSION DATA, 2019.

59. While electricity generation is strictly related to the energy service, the generation of decarbonized electricity provides benefits that go beyond the power system and positively affect the whole society. In this light, even if grid-parity condition for renewable technologies is expected to lower the magnitude of subsides to clean energy generation, these should be financed by the general taxation and not just moved on to electricity consumers. This entails several positive externalities:

- Guaranteeing a **more effective protection for energy-poor segments** and low competitive industrial sectors.
- Ensuring **equal access to the benefits** generated by the energy transition thanks to lower price-barrier.
- Contributing to the creation of **cost-reflective and efficient energy market**, increasing transparency, with cost-reflective tariffs within the power sector.
- Facilitating the **switching from traditional fuels** thanks to direct comparability conditions among different energy carriers.

60. In this light, governments should **avoid to charge electricity bills with unproper taxes and levies not directly related to electricity services**. Clear commitment of governments on this could also act as an incentive to the switch from traditional fuels to electricity.

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