

# THE BENEFITS OF ELECTRIFICATION

ELECTRICITY'S CONTRIBUTION TO  
SUSTAINABLE ENERGY USE



***EURELECTRIC is the voice of the electricity industry in Europe.***

*We speak for more than 3,500 companies in power generation, distribution, and supply.*

***We Stand For:***

***Carbon-neutral electricity by 2050***

We have committed to making Europe's electricity cleaner. To deliver, we need to make use of **all low-carbon technologies**: more renewables, but also clean coal and gas, and nuclear. Efficient electric technologies in **transport and buildings**, combined with the development of smart grids and a major push in **energy efficiency** play a key role in reducing fossil fuel consumption and making our electricity more sustainable.

***Competitive electricity for our customers***

We support well-functioning, distortion-free **energy and carbon markets as** the best way to produce electricity and reduce emissions cost-efficiently. Integrated EU-wide electricity and gas markets are also crucial to offer our customers the **full benefits of liberalisation**: they ensure the best use of generation resources, improve **security of supply**, allow full EU-wide competition, and increase **customer choice**.

***Continent-wide electricity through a coherent European approach***

Europe's energy and climate challenges can only be solved by **European – or even global – policies**, not incoherent national measures. Such policies should complement, not contradict each other: coherent and integrated approaches reduce costs. This will encourage **effective investment to** ensure a sustainable and reliable electricity supply for Europe's businesses and consumers.

***EURELECTRIC. Electricity for Europe.***

*Electricity will play a central role in the low carbon economy. It can almost totally eliminate CO2 emissions by 2050, and offers the prospect of partially replacing fossil fuels in transport and heating.*

*Although electricity will increasingly be used in these 2 sectors, electricity consumption overall would only have to continue to increase at historic growth rates, thanks to continuous improvements in efficiency.*

– European Commission Communication on a Roadmap for moving to a low carbon economy in 2050 (2011)



# The benefits of electrification

## Electricity's contribution to sustainable energy use

A EURELECTRIC report

September 2015

### KEY MESSAGES

Decarbonising electricity generation will make a major contribution to help Europe meet its climate change targets. Electricity is on track to becoming a carbon neutral energy carrier and, if used more widely, will open the door for many more positive changes, spill-overs in sectors which currently have no prospect of becoming fully sustainable. These future prospective benefits of electrification include:

- **Meeting the world's energy needs with less carbon.** Major reduction of CO2 emissions from local heating in buildings, specifically in urban areas, which traditionally run mostly on fossil fuels. Switching the energy carrier in these sectors to electricity also caps emissions by effectively bringing them into the ETS;
- **More electricity can mean more energy efficiency.** Technological developments have completely reshaped the comparative efficiency of electricity use versus the use of other energy vectors. Changing an oil burner with a heat pump can save, on average, almost 50% of annual primary energy consumption. In road and rail transport the numbers can be just as impressive;
- **Improving ambient air quality,** especially in our cities. Electricity produces no emissions at the point of use and produces ever less emissions when generated. It also results in notable reductions in noise pollution;
- **Strengthening security of supply through diversification and storage.** By switching to electricity in sectors such as heating/cooling and transport, electrification helps reduce dependency on fossil fuels as electricity can be produced from a large variety of sources. The use of electric vehicle batteries or electric appliances (e.g. water heaters) as flexible demand and decentralised energy storage opens up the energy system to very high renewable penetration;
- **Empowering the European customer through choice.** Demand response options for consumers makes electric solutions more valuable compared to fossil fuelled alternatives. Such electric solutions increase the customer's ability to influence their bill with demand response, effectively giving more power and value to the final consumer.

Our current task is to ensure that the enabling technologies live up to their potential and play their part in transforming the system. A key enabler to making this transition happen is of course a strong EU Emissions Trading Scheme (EU ETS) with a CO2 price that drives investment in sustainable technologies. However, electrification is being hampered by a number of other obstacles, which include:

- The additional energy policy costs added disproportionately to power bills (compared to gas or oil bills) making electricity more expensive to customers than fossil fuel alternatives.
- Financial barriers, which slow the penetration of new technologies replacing old ones. Innovative financing models need more recognition.
- The way we compare different energy carriers and (currently) maintain a policy favouring fossil solutions for our energy using appliances, our heating and our transport systems.
- Other factors which enable electrification, such as innovation and smart grids, can significantly increase the speed and benefits brought about by electrification. The current policy obstacles in these fields must therefore be addressed and removed.

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## I. Executive summary & policy recommendations

European policy makers are gearing up to take the next steps in setting European energy policy on track towards a nearly carbon neutral economy in 2050. EURELECTRIC, the European electricity sector association, is in full support of taking this path. Already six years ago, the power sector made a pledge to achieve carbon neutral electricity supply by 2050, and we have also shown how to do it in the most cost effective manner<sup>1</sup>.

Decarbonising electricity as an energy carrier will make a major contribution to help Europe meet its climate change targets – but it will also open the door for many more positive changes – spill-overs in energy consuming sectors, which currently have no other perspective of becoming fully sustainable. While some of these opportunities are well known, such as electric vehicles (EVs) for example, much more is possible.

This report shows that electrification using carbon-neutral electricity will be able to bring benefits in form of:

- Removing emissions from local heating in our buildings and cities which traditionally run mostly on fossil fuels.
- Strongly reducing emissions from road and rail transport. Road transport is the second biggest source of greenhouse gas emissions in the EU<sup>2</sup>.
- The consequential improvement in air quality, especially in our cities. Electricity produces no emissions when we use it and produces ever less emissions when we generate it. It also results in notable reductions in noise pollution.
- Increased electrification will mean being able to use electric vehicle batteries or electric appliances (e.g. water heaters) as a source of flexible demand and as decentralised energy storage. This is a key feature to open the energy system of the future to very high renewable penetration and further empowerment of European consumers.

The electrification of transport and heating is therefore a very promising pathway. The key to unlocking its potential depends on our ability to deliver the enabling technologies as soon as possible. The good news is that these technologies are no longer dreams of the future – many of them either already exist on the market or are being prepared for mass deployment. With the support of proper innovation policies these technologies can become cheaper, more flexible and bring more benefits to consumers faster.

Our current task is therefore to ensure that these technologies can live up to their true potential and contribute their part in transforming the energy system. While there have been some positive policy signals, much more and much faster progress is possible given the right policy landscape. This report therefore also highlights the barriers which will prevent electrification from achieving its potential. Such concerns relate to:

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<sup>1</sup> EURELECTRIC report: Power Choices 2013 – A lost decade.

<sup>2</sup> European Commission – DG Mobility and Transport.



- The additional energy policy costs added disproportionately to power bills (compared to gas or oil bills) making electricity more expensive to customers than fossil fuel alternatives.
- Financial barriers, which slow the penetration of new technologies replacing old ones. Innovative financing models need more recognition.
- The way we compare different energy carriers and (currently) maintain a policy favouring fossil solutions for our energy using appliances, our heating and our transport systems.
- Other factors which enable electrification, such as innovation and smart grids, can significantly increase the speed and benefits brought about by electrification. The current policy obstacles in these fields must therefore be addressed and removed.

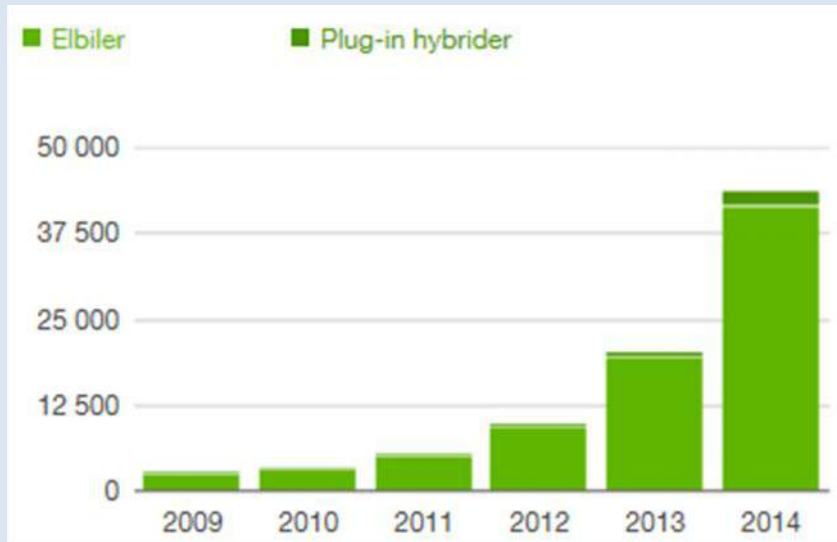
In addition to these obstacles, there are other factors which are required to enable electrification that still need to be addressed. Whilst many of the technologies are mature (e.g. electric vehicles, heat pumps, smart technologies controlling energy consuming appliances, and direct heating based on low carbon generation) market penetration remains low. This market penetration could be accelerated if greater innovation support for new and next generation technologies (e.g. in the field of electric vehicles and smart grids) was provided in these earlier stages. This would also allow technologies to become cheaper and more efficient.

The choices we make today will determine whether we reap the potential benefits from electrification in 10 years, or whether we continue to consume large quantities of fossil fuels for another generation. If we are serious about decarbonisation, and the European power sector is, unlocking electrification's potential in parallel will multiply its benefits for society and the environment.

In order to provide further information on specific technologies, this report also contains a number of case studies, which are explained in more detail in the respective text boxes.

## Case study - Electric Vehicles in Norway

Norway is Europe's clear leader in electro mobility. In total, in March 2015 there were close to 50,000 battery electric vehicles (BEV) and 3500 Plug-in Hybrid Electric Vehicles (PHEV) on Norwegian roads. BEVs and PHEVs amounted to approximately 16 % of the total sales of new passenger cars in Norway in 2014. This success story is a result of sustained political will to convert the transport sector by providing great incentives to early movers in order to kick-start a market and to enable the necessary infrastructure to be established.



*Total registered BEV and PHEV in Norway 2009-2014*

### Key incentives make EVs attractive

The current political incentive scheme was introduced in order to bring BEVs up to or beyond par with similar conventional (ICE) vehicles in Norway, both from an economic and a functional perspective. BEVs and fuel cell electric vehicles (FCEV) are completely exempt from import tax and VAT. In addition, operating costs for EVs are significantly lower than for a similar ICE vehicle, thus making total cost of ownership of BEVs smaller than ICE cars, even more so with increased yearly driving distance.

Another incentive has been the decision to allow BEVs and FCEVs to utilise excess capacity in bus lanes and to exempt them from paying the road toll on Norwegian roads. The use of bus lanes is particularly convenient, especially during rush hours, along main roads outside main cities. The exemption from paying road toll before entering the biggest cities in Norway is also beneficial. While beneficial for the EV drivers this incentive also has no direct economic cost for the municipality.

The incentives for BEVs and FCEVs are not restricted to the main cities as they also have free admission on national road ferries (for the car, not the driver). Another important usage-related incentive is the access to free parking in all publicly owned parking spaces, as well as a significant number of reserved EV-parking spaces (some equipped with charging facilities). Furthermore, the government granted around €6.5 million to accelerate the construction of charging points.

Infrastructure for charging is also crucial: by March 2015 there were nearly 9000 charging points installed in Norway, and the number is increasing steadily. Most of these are free of charge and are located on public property. However, a commercial market is also growing as a result of the emerging BEV market.

## II. Setting the scene: The energy policy agenda & the changing power sector

### a) The challenge: A cost-efficient energy policy for decarbonisation & efficiency

2014 marked the year in which the EU's climate and energy framework for the period after 2020 was defined. Striking the right balance between affordability, sustainability and security of supply will be key to its success. At the same time, completing the EU internal energy market remains critical. Our policy choices must ensure that this is achieved in the most cost-effective way possible. EURELECTRIC continues to argue for a strong EU Emissions Trading Scheme (EU ETS) to act as the key driver for the decarbonisation of the economy as it is market based and technology neutral. This will ensure that decarbonisation is driven in a cost-efficient way.

The potential gains for Europe resulting from a robust and cost-effective energy efficiency policy are undisputed. Efficient use of energy contributes to all three sides of the energy challenge triangle: affordability, sustainability and security of supply. If Europe can be more efficient in the way it produces, transforms and consumes energy, this will lead to lower bills, reduced impact on the environment and lower fossil fuel imports – a win/win/win situation.

Energy efficiency involves all the players along the energy supply and demand chain. For the power sector, 'supply side' efficiency in electricity generation, transmission and distribution are directly linked to our economic performance and success. This has made energy efficiency part of our daily business and provides a continued incentive to look for investment opportunities to stay competitive and innovative. More efficient power plants are only one part of this process.

**“The benefits of good energy policy can spread far beyond the energy supply side into the demand sectors and individuals households”**

EURELECTRIC remains a strong supporter of energy efficiency, but has also consistently advocated for a balanced cost-benefit analysis when it comes to target setting for energy policy goals. This must incorporate a genuine consideration of the socio-economic cost of energy efficiency (which becomes less cost-effective beyond a certain point) versus the cost of new supply.

### EU energy efficiency policy in 2015 & beyond

Energy efficiency has received increasing attention in recent years, which must be seen in parallel with an increasing amount of complex legislation aimed at maximising its potential. This is also linked with the diversity of energy efficiency measures, ranging from power generation to building insulation, household heating systems, or even individual energy using products and appliances. Beyond this, energy efficiency is as much about policy as it is about providing information and the behaviour and awareness of consumers, citizens, businesses, public authorities, and the many other stakeholders involved. EU legislation has tried to mobilise on most of these issues and the review of the legal tools is scheduled to continue throughout 2015 and 2016.

In addition, the increase in and ambition for energy efficiency at the EU level has been further fuelled by geopolitical issues and an energy price dimension. Geopolitically, the fuel import dependence of the EU has become an increasing concern since the disruptions of gas supplies which hit EU citizens strongly in the winters of 2006 and 2009. Initial action has aimed at diversifying energy supplies and making infrastructure more resilient. However, the crisis in Ukraine has pushed security of supply (specifically for gas) to the top of the political agenda. In May 2014, the European Commission published a 'European Energy Security Strategy'<sup>3</sup> which lists increasing energy efficiency and lowering energy consumption as the main medium to long term challenges, an initiative echoed by the current Commission in its Energy Union strategy.

The second issue which is pushing energy efficiency up the European political agenda is the sensitive debate concerning energy prices and costs across the EU. While a number of factors have led to increasing energy costs, in its recent report "[What really drives your bill up](#)", EURELECTRIC has pointed out that taxes and levies are the major drivers of such increases in the power sector. The higher prices for consumers have sparked debates about policy choices, business competitiveness and customer vulnerability across the EU. In this context, energy efficiency, especially on the demand side, is seen as an important tool to lower consumption and mitigate cost increases, as stated in the 2014 Commission Communication on energy efficiency.<sup>4</sup>

### **Energy Efficiency drivers for suppliers and customers**

For power producers (the supply side), increasing the efficiency at which they produce electricity has been a core business priority from the start as energy is the main cost factor for the business. It has been a driving force for major advancements in technology and resource use in the sector. In the EU, the ETS has also contributed to this process as it directly rewards efficiency and punishes inefficiency by internalising the external environmental cost. The EU ETS has thus become a key efficiency driver for the participating sectors, and the stronger the carbon price signal the bigger the incentive to invest in efficiency measures. Distributed renewable generation as well as combined heat and power (CHP) also have a role to play in creating a more efficient power production.<sup>5</sup> Finally, the market share of fossil generation is declining as Europe moves towards low carbon generation.

For energy consumers (the demand side) a price signal alone, even if realistic and not blurred by charges as is currently the case, will not always deliver the most cost-effective measure for increased energy efficiency due to the complexity of the levers and the heterogeneity of the stakeholders involved. The existence of market failures sometimes requires more top down approaches in order to make the most of the vast potential to be reaped on the demand side. This includes the electrification of heating/cooling and transport. The chapter on the benefits of electrification provides more information on this point.

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<sup>3</sup> Communication from the Commission to the European Parliament and the Council: "European Energy Security Strategy", European Commission, 2014.

<sup>4</sup> Communication from the Commission to the European Parliament and the Council: "Energy Efficiency and its contribution to energy security and the 2030 Framework for climate and energy policies", European Commission, 2014.

<sup>5</sup> [See EURELECTRIC's position paper on the role of CHP.](#)

## b) The power sector in transformation

The power sector is in transformation. Internal and external factors have initiated rapid and profound change in a traditionally largely asset-based industry. This implies a tremendous challenge, but the opportunities to redefine the power sector's role and create positive spill-over effects to other sectors are arguably just as significant, with electrification at the centre of this transformation. So what is changing? Practically everything: self-concept, business models, generation mix, grid infrastructure and the arising smartness at the distribution level:

**A pledge for carbon neutrality:** In March 2009, sixty-one Chief Executives of electricity companies representing well over 70% of total power generation in the EU signed a declaration committing to action to achieve carbon-neutrality by 2050. Achieving this commitment in the most cost-effective manner has since been a core interest of the power sector. However, there is currently considerable uncertainty in the energy policy framework, which is a concern for investors and is causing important projects to be delayed. Major investment is needed in new generation assets, new storage and business models, smart technologies and modernised grids, with research and innovation acting as a catalyst<sup>6</sup>.

**Growing decentralisation of the power system & utilities as service providers:** The electricity value chain is shifting from a linear supply-demand model to a new system paradigm in which consumers have become producers, information and electricity flows in both directions and the system is rapidly becoming more complex. The power sector is taking on this challenge, developing a new 'downstream' business model based around energy efficiency, growing decentralised generation, and new products and services. Much of the development is closely related to the increasing penetration of smarter networks, more active customer engagement and new technologies.

**Smarter grids and networks:** An electricity grid which can integrate decentralised generators intelligently and reward customers for intelligent use is a major enabler for the transformation of the energy system as well as the successful implementation of the new business models. The smart grid and smart meters can integrate behaviours and actions of all its users and can encourage consumers, or their agents, to actively manage their energy demand, such as enabling them to shift their power consumption to times of lower prices<sup>7</sup>. And while informed customers gain the ability to react to price signals, system managers use this flexibility to increase the system efficiency by 'shaving' demand peaks, thereby reducing the need for more generation during phases of high energy demand. Currently, the majority of EU Member States are in the process of rolling out smart meters and most will complete this process before 2020. Consumers are therefore likely to become more active in terms of their electricity consumption. This will affect the entire system operation.

The developments above illustrate how roles are being redefined. In particular the power sector's commitment to carbon neutrality opens the door for electrification and energy efficiency. This is explained in more detail in Section III.

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<sup>6</sup> EURELECTRIC report: [Power Choices 2013 – A lost decade.](#)

<sup>7</sup> EURELECTRIC report: [The retail \(r\)evolution – Power to the customer.](#)

### III. Electrification as a catalyst for a sustainable energy system

#### Case Study - Heat pumps in Sweden

One of the most important technologies to unlock the benefits of electrification are heat pumps. These use an electric compressor that “pumps” heat from one place to another. By pumping heat from outdoor air, soil or groundwater into the house, a heat pump can produce up to six times more heat per kWh than an electric radiator (‘heat factors’ - the relation between produced heat and used electricity).

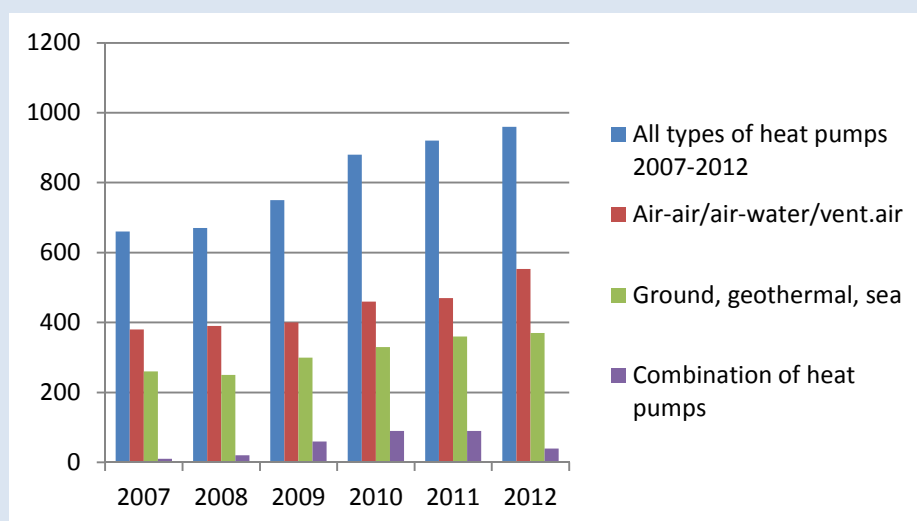
##### Outstanding efficiency

Beginning already towards the end of the 1970s, Sweden endorsed the technical and market development of heat pumps, pushing the technology to become increasingly cheap and more efficient. The substantially increased heat factors have made heat pumps very attractive and widely used in this relatively cold country. Due to their outstanding efficiency, electric heat pumps outperform other heating technologies despite severe policy obstacles (see section IV on PEF).

In 2012, almost half of the almost 2 million single family houses in Sweden had some sort of heat pump installed (see illustration below). The total use of “pumped” energy (the total amount of energy that is produced in the heat pumps minus the electricity used for driving the pumps) in Sweden can roughly be estimated at 15 TWh/year in single family homes. About the same amount is pumped via big heat pumps in district heating systems. In total approximately 40 TWh heat are produced with heat pumps every year (including the electricity for driving the pumps), which is nearly the same as the total delivered via district heating (43 TWh/year).

##### Enormous market potential

This means that approximately one third to half of all energy used for heating in the Swedish building sector is produced with heat pumps. This represents around 10% of total final energy use (industry, transport, building sector). As can be seen in the graph below, the market share of heat pumps in Sweden is still increasing, and there is potential for further growth. The potential in less developed European markets is even significantly greater.



Number(x1000) of Swedish single family homes with some sort of heat pump (2007-2012)\_

## a) What is electrification?

Electrification means increasing the use of electricity in satisfying consumers' energy demands and needs. Concretely this implies replacing fossil fuels with low-carbon electricity in meeting daily energy needs in transport, appliances and heating and cooling. This fuel switch can also help increase energy efficiency by reducing primary energy needs. The benefits are therefore multiple: greenhouse gas mitigation and energy security, besides potential efficiency improvements. Switching from a fossil fuelled boiler for space heating to an electric heat pump can substantially reduce energy needs per unit of heat produced.<sup>8</sup>

In the residential sector such technologies include induction cooking, heat pumps, smart technologies controlling energy consuming appliances, and direct heating based on electricity from renewable or low-carbon sources. In the industrial sector greater energy efficiency through electricity intensive technologies can be delivered by resistance and infrared heating, induction heating, high frequency heating, microwave heating, arc furnaces, or heat pumps. In the transport sector, the potential for greater energy efficiency exists in electric transport by road (especially in urban areas) and rail.

**Electrification means increasing the use of electricity in satisfying final energy demand. Concretely: Replacing fossil fuels with low-carbon electricity in meeting daily energy needs.**

Most of the technologies mentioned above are established technologies. Their use has often already been tested by the markets and their technological evolution is ongoing, driven also by the digitalisation of modern societies and economies. The potential for more development and market penetration, however, is still quite significant as well as accessible. Accelerating electrification should therefore be one of the main focuses of European energy and environmental policies, which should also be adequately addressed by innovation policies. Technology fields such as electric vehicles or smart grids include a range of different tools and equipment which often need help in crossing the bridge from basic R&D, as well as demonstration and commercialisation.

## b) Why should we electrify?

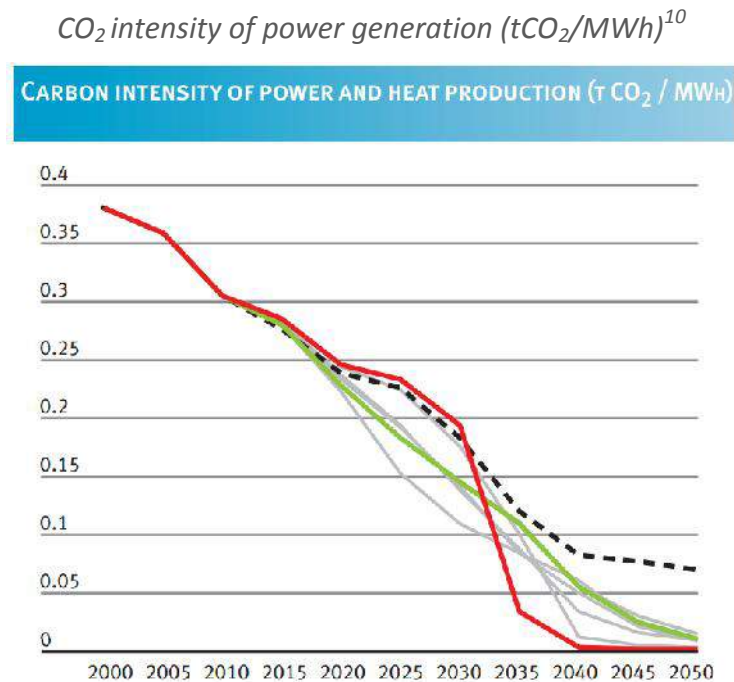
The benefits of electrification (in combination with decarbonising electricity) are multiple and these span across economic sectors. They include: greenhouse gas emission reduction, increasing energy efficiency, improving local air quality, improving security of supply, increasing safety by reducing explosive hazards. There are also significant synergies to be reaped with the rapid digitalisation of our economies and societies.

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<sup>8</sup> See case study on heat pumps in Sweden, p. 13.

## Meeting the world's energy needs with less carbon

Due to the electricity generation's ability to become carbon-neutral, electrification becomes a core part of the solution to the challenge of decarbonisation. In such respect, the EURELECTRIC Power Choices Roadmap<sup>9</sup> foresees power generation carbon intensity dropping to 0.025tCO<sub>2</sub>/MWh by 2050.



As stated above, decarbonising our power supply will generate the potential for spill overs in other sectors, specifically on the demand side. These sectors are currently based on fossil fuel technologies: gas or oil for our heating, combustion engines for our vehicles. Electric solutions will help decarbonise consumer's energy use. Therefore the answer to the 'why' question is simple: no other current energy carrier can decarbonise to the same extent and scale as electricity. This entails tremendous benefits.<sup>11</sup>

This has also been concluded by the European Commission in its Energy Roadmap 2050<sup>12</sup>. All scenarios undertaken in this key study show that electricity must play a much greater role (almost doubling its share in final energy demand to 36-39% in 2050) and will contribute significantly to the decarbonisation of transport as well as heating and cooling. Moreover, low-carbon electricity could provide around 65% of energy demand from passenger cars and light duty vehicles.

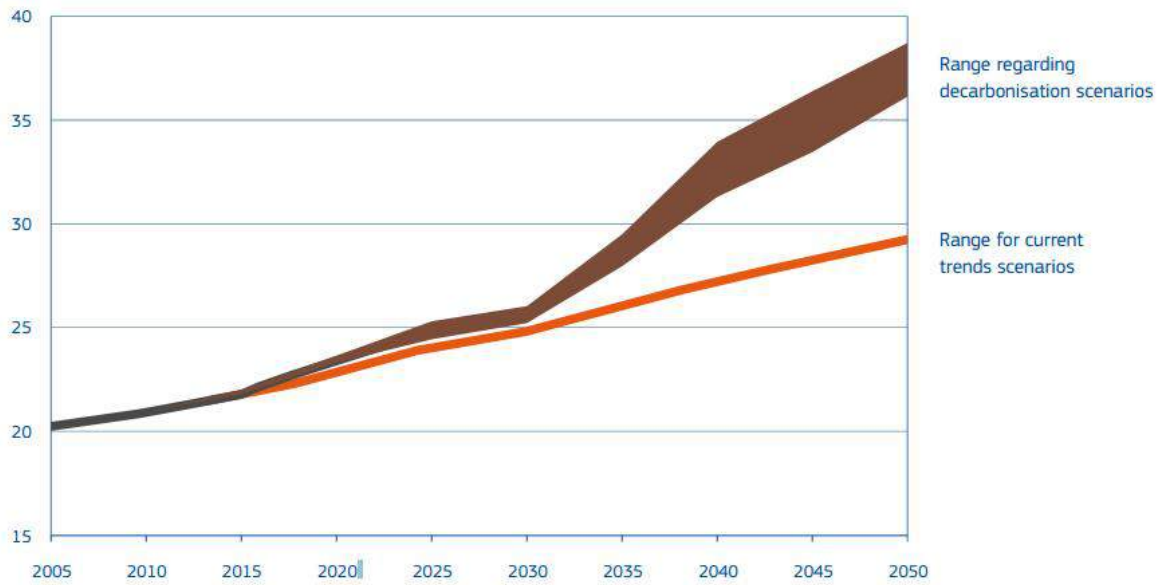
<sup>9</sup> Source: [Power Choices Reloaded](#) 2013, The Lost Decade, EURELECTRIC

<sup>10</sup> Source: [Power Choices Reloaded](#) 2013, The Lost Decade, EURELECTRIC.

<sup>11</sup> Hydrogen as an energy carrier can be carbon-neutral. However, for several reasons such as the infrastructure it requires and the costs it entails, hydrogen lacks the universal potential that carbon-neutral electricity has.

<sup>12</sup> European Commission: "Energy Roadmap 2050", European Commission, 2011.





Share of electricity in final energy demand (%)<sup>13</sup>

### More electricity can mean more energy efficiency

There is a widespread perception that energy efficiency implies reducing electricity consumption. Such views are often based on the emphasis which has historically been placed on the efficiency of electricity generation and its use in appliances. Recent technological developments have completely reshaped the comparative efficiency of electricity use versus the use of other energy vectors (e.g. gasoline, natural gas, oil).

Today, equipping a new single family house with a heat pump instead of an oil burner can save, on average, almost 50% of annual primary energy consumption. The potential contribution to the EU Energy Strategy is impressive: more than 70 million heat pumps could be installed by 2020, leading to a reduction in final energy consumption of more than 900 TWh<sup>14</sup>, thereby contributing almost 20% to the EU 2020 energy efficiency target.

In rail transport, a very mature technology, the numbers can be just as impressive. when considering freight transport, rail is the most energy efficient option: its specific energy consumption per transport unit, around 13 gep/ton-km, is about a quarter of the consumption of road transport. In the passenger segment, the rail industry presents a specific consumption equal to about 19 gep/pass-km, while the value of road transport is of about 41 gep/pass-km.<sup>15</sup>

Staying in transport but taking a longer term approach, technological progress is predicted to drastically improve the current energy performance advantage of electric vehicles. An electric vehicle can be three times more energy efficient than a standard internal combustion engine. To illustrate, already today, assuming a hypothetical scenario of 100% car electrification, the potential energy efficiency of cars could achieve a net reduction of 137 Mtoe (million tons of oil equivalent) per year in the EU.<sup>16</sup>

<sup>13</sup> Source: Energy Roadmap 2050, European Commission.

<sup>14</sup> European Heat Pump: Action Plan.

<sup>15</sup> Audizione ENEA nell'ambito dell'Indagine conoscitiva sul settore del trasporto ferroviario di passeggeri e merci, ENEA 2011.

<sup>16</sup> See EURELECTRIC paper: Smart charging: steering the charge, driving the change.

## **Improving ambient air quality**

In urban areas in particular, electrification delivers environmental benefits that go beyond the fights against climate change and to increase resource efficiency. Local air pollution in our cities can be reduced by using electricity in transport and heating, thereby reducing the emissions of pollutants such as particulates, NO<sub>x</sub>, SO<sub>x</sub>, VOCs and ozone. Moving the emissions from multiple small scale points to one more central, controllable source can help improve air quality. Traffic congestion and noise pollution in cities can be reduced by using electric mass transport (buses, trains, light trains). Beyond cities, the use of electricity instead of fossil fuels by small and medium enterprises (SMEs) allows concentrating energy related emissions to those remaining electricity producing plants with more efficient pollution abatement systems that will primarily be used as back-up for carbon-neutral generation. Similarly, in most situations, switching from direct use of fossil fuels to electricity enables energy users to meet energy needs through zero emission energy (solar, wind, hydro, geothermal, nuclear etc.). The switch will bring drastic improvements in terms of reduction of local pollutants such as particulate matter, NO<sub>x</sub>, SO<sub>x</sub> and VOC.

**No emissions from buildings  
or cars will bring huge  
benefits to air quality –  
especially in our cities.**

## **Strengthening security of supply through diversification and storage**

Beyond the environmental benefits, electricity's contribution to energy efficiency would increase security of supply while creating affordable and sustainable systems. Firstly, by switching to electricity in sectors such as transport and by using energy more efficiently, electrification could reduce the dependency on fossil fuels. In this way security of supply could be increased, especially for those end-use sectors that depend on a high share of fossil fuel imports. Electrification would also allow greater flexibility in selecting the energy source of choice, thereby further strengthening security of supply: the source of primary energy to produce electricity depending on geopolitical circumstances could be switched among different sources.

At the same time, electrifying final energy consumption could increase penetration opportunities for storage. This should, in turn, further strengthen the flexibility with which final energy needs are met, increasing the reliability of electricity supply.

## **Empowering the European customer through choice**

Being able to use electric vehicle batteries or electric appliances (e.g. water heaters) as flexible demand and as decentralised energy storage also brings additional benefits to customers of such products. On the one hand they are no longer relying on fossil fuels and their volatile prices. The parallel development of demand response options for consumers makes electric solutions more valuable over fossil fuelled alternatives. Electric solutions increase the potential to influence the bill with demand response, effectively giving more power to the final consumer.

This argument is shared by the European Commission: “As in the transport sector, shifting energy consumption towards low carbon electricity (including heat pumps and storage heaters) and renewable energy (e.g. solar heating, biogas, biomass), also provided through district heating systems, would help to protect consumers against rising fossil fuel prices and bring significant health benefits.”<sup>17</sup>

## Case Study – Smart heating switch from oil to power in Finland

### Smart technology & flexible pricing increase sustainability

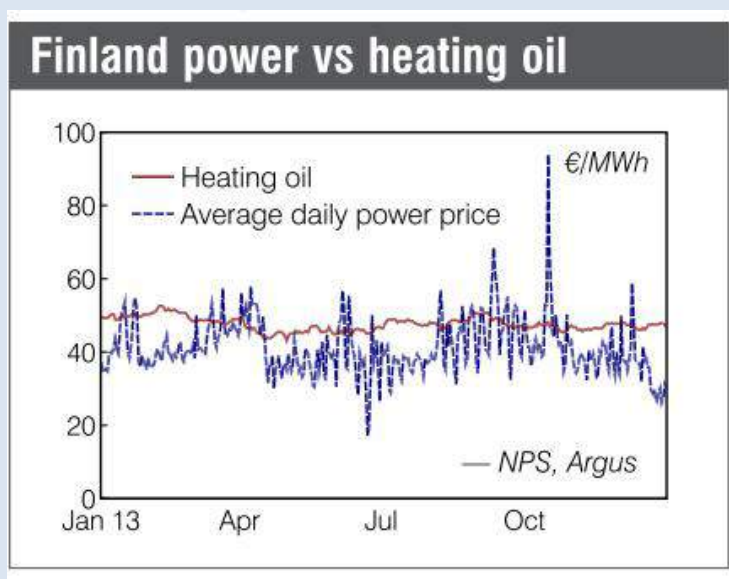
A good showcase on how electrification of heating can increase sustainability and lead to higher renewables penetration can be seen in Finland. Currently, almost 10% of Finland’s 59 TWh/year household heating demand is covered by oil burners. With the right technology & smartness elements, a move towards more sustainable solutions is possible. Since the completion of the smart meter rollout, Finnish customers have had the option for hourly pricing in their electricity.

A newly deployed automated system linked to Nord Pool Spot (the largest market for electrical energy in Europe) selects the cheapest day-ahead hour in order to switch on electric heating instead of oil heaters. This automatic switch from oil to cheap power effectively substitutes oil by hydropower to a great extent.

### Up to 75% oil consumption saved

Although the programme is currently still a pilot project, savings of up to 75% of oil consumption have been reported. Should this be implemented in other countries, savings in fossil fuel consumption and greenhouse gas emissions might be even greater, especially in populations with a stronger dependence on oil for domestic heating, such as Germany. Unfortunately the project is currently not economically viable due to extra policy costs that are added to the power bill, in this case a green levy of about 60 €/MWh.

Below is an illustration showing the price difference between daily power prices and the heating oil price.



Source: Argus Power Europe, 15 February 2014.

<sup>17</sup> European Commission: Roadmap for moving to a competitive low carbon economy in 2050, p. 8.

## IV. The policy path to electrification

As noted in Chapters II and III, decarbonising power production and at the same time electrifying energy use is key for creating a carbon-neutral and energy efficient economy in the EU as it removes the need to burn fossil fuels in our buildings and cars. This also helps decrease the amount of oil and gas we need to import to the EU, thereby increasing security of supply. The technologies to trigger this are already on the market, or very close to being on the market. The challenge at hand is therefore to create a policy landscape which unlocks the potential of electrification (and decarbonisation) and ensures the uptake of the technologies enabling it. On the other hand, electrification will bring more electric demand from sectors currently based on fossil fuels. This makes electrification also a strong pull-factor for the decarbonisation of the power sector.

EU energy policy has become more comprehensive and ambitious. However, despite this development, electrification and its direct and indirect benefits continue to suffer from a general lack of recognition or even a straight blockade of technologies involved. But the obstacles are more complex. This report addresses three key barriers for electrification which need addressing as soon as possible and provides an insight into further factors which will speed up the process and unlock further benefits.

### Major policy barriers:

- 1. The additional, policy related costs we add to our power bills, making electricity much more expensive to customers than fossil alternatives.**
- 2. Financial barriers, which slow the progress of new technologies replacing old ones.**
- 3. The way we compare different energy carriers and (currently) maintain a policy favouring fossil solutions for our energy using appliances, our heating and our transport (Primary Energy Factors).**

### **Challenge 1:**

#### **Cost vs price of electricity**

Electrification means the switching of one energy carrier (fossil fuel based) to another carrier (electricity). Independent of technology or generation mix, investors who 'electrify' their means of heating and transport will experience a shift in consumption from solid fuels, oil and gas toward electricity. Making sure that our electricity is affordable is therefore a key concern to incentivise electrification. But electricity bills are becoming increasingly burdened with policy related costs.

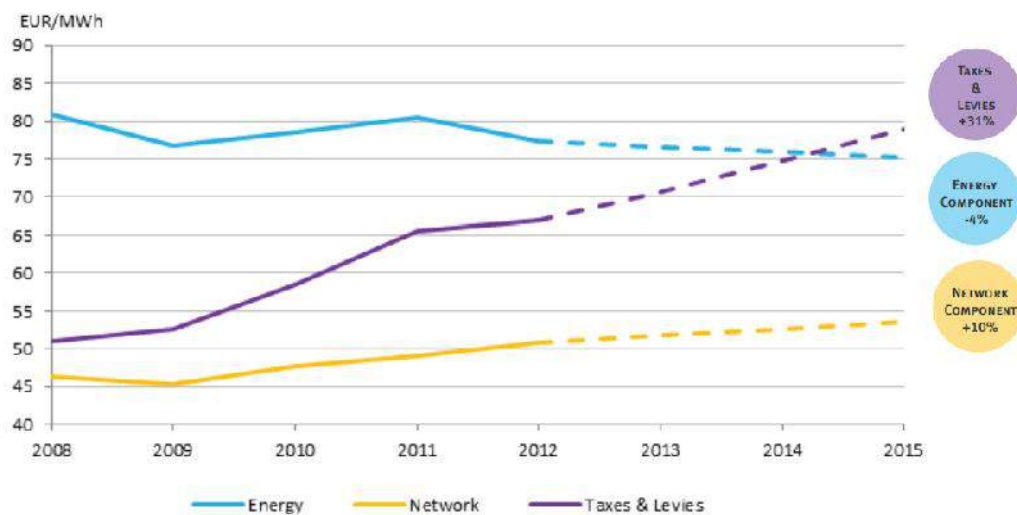
EU Member State governments are using electricity bills as a means to fund energy policy costs, including RES subsidies and energy efficiency policy. Electricity bills are therefore no longer driven primarily by the cost to generate and transport the electricity, but instead by the taxes and levies which are added on top (see below). The policy barrier lies therefore in the fact that these extra policy costs are applied disproportionately to electricity bills and not to gas or oil bills. This means that policy makers put extra cost for renewables and energy efficiency on electricity bills instead

of bills for fossil fuels. As long as we deliberately increase the price of one energy carrier over another, electrification will inevitably remain an uneconomic option for investors.

### Policy Recommendation: Stop financing energy policy primarily through electricity bills

Currently, the costs of different components of the electricity bill are not transparent due, for example, to non-standardised reporting. In order to unblock the positive spill-over effects of electrification via carbon-neutral electricity, we must stop adding policy costs to the electricity bill, especially when other energy carriers include only a fraction of such costs. All forms of energy must bear the cost of the required energy transformation. Smart meter rollouts for example, allow for an improved pricing structure for energy and network charges.

This is also true regarding the carbon price. As stated above, the power sector is committed to achieving a carbon-neutral power supply by 2050, with the EU ETS as the key driver to decarbonisation. A strong EU ETS is therefore a key enabler for electrification. However, electrification as a means of decarbonising the economy will be quicker and more efficient if a level playing field is applied to all types of energy, especially if the fossil fuel share of the final energy consumption is also subject to a carbon price.



Evolution of Household Components

source: EURELECTRIC

## Challenge 2:

### Financial barriers stalling investments

Electrifying heating and transport means the gradual replacement of fossil fuel solutions with new technology, which will require investments made by the customers. There are several barriers related to the financing sector, especially in electrification, including

- limited access to finance
- high upfront costs
- relatively long payback periods
- higher perceived credit risk associated with sustainable energy investments
- competing priorities for property owners
- tenant/landlord dilemma.

Currently, different programs are in place to finance investments in energy efficiency. Such investments include the replacement of boilers and heating systems or the installation of new appliances which therefore opens the door to electrification. Investments in new technologies are falling short however, as the processes related to such programs are often not sufficiently clear or transparent, and many tools are targeted to large scale investments and less at homeowners.

However, investments which reduce energy consumption and emissions must also be unlocked at the residential level. The transport and building sectors offer the most promising potential in terms of such investments. Accounting for around 70% of the EU final energy consumption, building and transport are the high potential sectors which decision makers should focus on. Much can be achieved here through investments in electric appliances, heat pumps and building renovation. Even though the transport sector could also deliver significant potential savings, the deployment of electric vehicles is only expected in the medium to long term.

### **Policy Recommendation: Improve existing financing models & support financing innovation**

The level of investment in the energy efficiency area is insufficient compared to the challenge at hand. This also slows the rate of installation of electric solutions to replace old fossil based products. On the one hand, new financing mechanisms need to be developed. On the other hand existing financing models need to be improved in a variety of ways:

- **Process standardisation in public financing** - Public finance institutions are typically active in sectors where market failures have substantially limited private sector investment. In these areas they often hold mandates to provide long-term financing independent of market cycles and in line with policy objectives (e.g. KfW in Germany). Processes should be improved through a standardisation approach and by increasing the relations between the public and private sectors.
- **Transparency, scalability and standardisation in private sector financing** – This will help create a secondary market for energy efficiency financial products and to unlock the potential for the refinancing of energy efficiency investments via capital market products and structures. It is generally assumed that for each Euro of public funds invested in energy efficiency, significant multiples are invested by the private sector. In this context indicative targets for private sector finance involvement could be useful in driving the involvement of financial institutions.
- **Improved use of risk sharing activities by public banks and Multilateral Development Banks (MDB)** – Risk sharing represents one of the most promising ways to ensure adequate levels of return on utility investments targeting the final consumers. Such initiatives should therefore be promoted and improved by increasing the involvement of financial institutions in the energy efficiency sector. Through their multilateral shareholder structure, MDBs are a unique mechanism for allocating finance. They seek to penetrate markets segments not yet reached by private finance because of high risks and limited institutional mechanisms.

- **Standardisation of EPC/ESA programs and ESCO capacity building** – The uptake of *Energy Performance Contracts* (EPC) and *Efficiency Service Agreements* (ESA) is too slow in relation to their potential. Information and training activities need to support the market penetration of these services. Similarly, some level of standardisation of the contracts could facilitate early market uptake. Moreover, capacity building for ESCO is also necessary due to the diversity and sometime complexity of energy efficiency solutions and the need to support their penetration with simplified financial planning models.
- **Sharing lessons learnt from on-bill-repayment<sup>18</sup>** – Among the leading practices emerging at a global level to promote building investments (e.g. California) such schemes take advantage of the relationships that already exist between utilities and their clients in the residential sector. On-bill financing has been implemented with mixed results in several EU Member States. Building on these experiences and overcoming weaknesses could, in the future, provide a good basis for on-bill schemes to become safe and available financing schemes for investments in the residential sector.

### Challenge 3:

#### Primary Energy Factors (PEF)

A key factor in the slow progress towards electrification is the policy barrier reflected in current energy efficiency legislation and the methodology used to estimate how much energy is needed to produce the energy product required to satisfy final energy demand, the energy product being electricity, gas, gasoline or heat. Such estimates are centred on the primary energy conversion factor (PEF) for electricity which is effectively the principal metric by which energy efficiency is measured today. The methodology in current EU legislation compares the energy consumption of technologies using different energy carriers (e.g. electricity vs. oil or gas) according to their primary energy consumption and applies a ‘conversion factor’ to electricity to calculate how much primary energy is contained in a single unit (e.g. a unit of electricity).

EU legislation applies a PEF of 2.5 when calculating the energy efficiency of nearly all electricity using products. This means that for every single unit of electricity used by an appliance, the current methodology assumes that two and a half times as much primary energy (the fuel used to generate the electricity) has been consumed. In other words, the PEF assumes that all power generation in the EU is delivered at 40% efficiency (100% divided by 2.5 = 40%).

Why does this present a barrier for electrification?

- The 2.5 factor as used today was set at a time before we began transforming the power sector or even before the EU ETS was established. It therefore does not take into account the decreasing energy intensity of power generation which resulted from efficiency improvements or the rapid large scale penetration of renewables. It also ignores the scarcity or abundance of primary energy consumed (fossil vs non-fossil resources). Finally, it does not account for any CO<sub>2</sub> reductions in the future.

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<sup>18</sup> A mechanism used to improve the creditworthiness (or seniority) of energy efficiency investments by having them repaid in the utility or tax bill and through the existing payment collection infrastructures of utilities or public authorities.

- This means that through the current policy and methodology, even the most efficient electric heater on the market can never compete with its fossil counterpart as the application of the PEF will always translate into a less “efficient” product. A heating unit bought today should operate for around 30 years - if it is a fossil heating system, the GHG emissions will therefore be “locked in” to the energy mix until around 2045, with no chance of decarbonisation. By that time, Europe’s electricity system will be close to full decarbonisation.

### **Policy Recommendation: A future-oriented PEF / Linear reductions**

Adjusting the existing methodology for calculating the primary energy factor (PEF) in order to ensure that it is calculated on a forward looking basis would improve the signals given to investors and decision-makers enabling them to select the best technologies in terms of economic and environmental sustainability. It would ideally be defined as a single European value in order to not undermine the internal market. A forward looking PEF should be calculated according to the projected primary energy inputs to electricity in the next 10 – 15 years. This should incorporate a value of 1 (i.e. 100% conversion) for RES and other carbon neutral components in the mix. Such an approach would also imply lowering the 2.5 factor in line with the expected EU generation mix in, for example, 2020, 2030 etc. It will also provide an incentive to invest in energy using products based on carbon neutral electricity rather than continued reliance on fossil fuels.

### **Further enabling factors:**

#### **Innovation - The catalyst for transformation**

Even if many technologies enabling electrification are available already today, innovation is an imperative to unlock the potentials in the power sector’s transformation. Innovation therefore encompasses not only technology related R&D, but also the demonstration of new solutions to help them overcome bottlenecks encountered by promising new technologies. EU innovation policy, framed by Horizon 2020, provides a solid basis for innovation on electrification related projects within several ‘societal challenges’ as ‘Secure, Clean and Efficient Energy; Smart, Green and Integrated Transport’ and ‘Climate Action, Environment, Resource Efficiency and Raw Materials’.

It is essential that electrification as a sustainable concept, and with it electric technologies in heating/cooling and transport, is taken into account when innovation projects are provided with the support of EU policy. Innovation is at the heart of the power sector transformation as it lowers the costs for sustainable and flexible technologies in heating/cooling but also in the transport sector. In 2013, EURELECTRIC published its Innovation Action Plan<sup>19</sup>, delivering a comprehensive analysis of power sector innovation opportunities and policy needs.

#### **Energy savings obligations and electrification**

As has already been shown in this report, electrification is seen by policy makers (see Roadmaps 2050) and the power sector as a central part of decarbonising our economy. The Commission’s 2050 Roadmaps show that the electricity demand increases in all scenarios compared to 2005 levels. The Commission notes as follows:

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<sup>19</sup> [Innovation Action Plan](#), EURELECTRIC 2013



“The increased use of electric devices is partly compensated by the increased energy efficiency of electric appliances as well as increased thermal integrity in the residential and service sectors and more rational use of energy in all sectors, but overall the effect from emerging new electricity uses at large scale for heating and transport is decisive”.<sup>20</sup>

### Electricity - final energy demand

	2005	2050			
		Reference	Scenario 1bis	Scenario 2	
<b>Final energy demand (in TWh)</b>	2762	4130	3951	3203	
Industry	1134	1504	1426	1109	
Households	795	1343	1230	913	
Tertiary	759	1184	1041	518	
Transport	74	100	255	663	
		2050			
		Scenario 3	Scenario 4	Scenario 5	Scenario 6
<b>Final energy demand (in TWh)</b>	3618	3377	3585	3552	
Industry	1211	1169	1201	1191	
Households	1026	938	1019	1013	
Tertiary	707	605	696	677	
Transport	675	664	669	671	

Source: EU Commission Energy Roadmap 2050 (impact assessment pt2)

Given this projection, a question mark appears around the future of energy savings obligations in EU legislation. Current EU energy legislation dictates a 1.5% binding energy end-use savings target up to and including the year 2020. While EURELECTRIC acknowledges the intention of the end-use savings target, its application beyond 2020 could become a major obstacle to enable a carbon neutral energy system in effectively blocking electrification. EURELECTRIC therefore strongly urges the Commission to take this into consideration in the context of the upcoming review of the Energy Efficiency Directive in 2015/16.

### Smart Grids

As stated above, electrification increases its value with the ongoing transformation of the power sector. Smart grids provide a key element in the transition from the traditional to the new flexible power system as they allow us to benefit from decentralised generation, additional customer involvement etc. Ensuring the rollout of smart meters and setting the right policy framework for their operation is therefore crucial. They also have an important role to play for electrification. Consuming energy in times of RES surplus (associated to low or even negative electrical energy prices) not only displaces fossil consumption but also contributes towards electrical system stability (see Case Study 2 for a recent Finnish experience). Efficient investment in networks can be incentivised by setting time differentiated access charges which reflect the actual cost of electricity in real time. Smart electric appliances and new electric heaters can store energy in times of excess and reduce the demand in peak times. This helps both customers and system operators.

<sup>20</sup> EU Commission Energy Roadmap 2050 (Impact Assessment pt 2).

## Case Study - ESB's Electric Vehicles in Ireland

Irish utility ESB is in the process of installing a network of electric vehicle (EV) charge points throughout Ireland consisting of domestic, on-street and fast charge points. There are currently 1,200 publicly accessible EV charge points, providing reliable low carbon transport options for drivers. The public charging infrastructure is 'smart' with integrated communications and management capabilities that enables EV drivers to charge their vehicle anywhere on the island of Ireland. It is supported by a fully integrated Charge Point Management System, which is accessible by using a charge point access card.

### **Infrastructure is the key**

It is generally recognised that without a minimum level of infrastructure, the electric vehicle market cannot develop and this was a factor in the decision by ESB to provide a nationwide interoperable charging network. The development of the EV industry in Ireland creates the context for positive benefits on an individual, organisational and a national level. Whilst the commercial, economic and financial benefits are perhaps the most obvious, the wider societal and environmental aspects are no less significant.

### **Local wind power replacing imported oil**

Studies have demonstrated that over the average life of an electric vehicle, individual drivers can expect to save up to €17,000 when account is taken of the savings related to fuel, maintenance, insurance and motor taxation. In addition to this, each EV can be expected to avoid approximately 12 tonnes of CO<sub>2</sub> emissions over the course of its life. In the context of the Irish target of 250,000 EVs by 2020, this would equate to nearly three million tonnes of avoided CO<sub>2</sub> emissions and over €4bn savings for the pocket of the general public. In addition, powering cars from local power, rather than imported fossil fuel, can help reduce the €6 billion a year Ireland spends on imported oil.

### **Strengthening national enterprises**

At a national level, the development of the EV industry in Ireland will reduce the need for imported fuels, thereby improving the national balance of payments, and provide export and job opportunities for indigenous Irish firms to develop and sell products and expertise abroad. As part of the programme, and in conjunction with Enterprise Ireland, *ESB ecars* has already successfully assisted a number of Irish SMEs develop and bring products and services to market.

These Irish companies together now offer an end-to-end solution which can be easily transferred to other markets that are looking to develop a comprehensive network of charging points. Building on their experience with ESB, these companies have already generated significant international interest and have secured sales in overseas markets, not just in Europe, but also in the Middle East and in South Africa.

## Annex

### **Policy Question: Primary energy content to measure energy efficiency?**

The current methodology takes the primary energy content as the unit of measurement (metric) for energy efficiency policy. This way of measuring makes the reduction in primary energy consumption the only lens through which success or failure of policy is gauged. (This approach was originally established in the wake of last century's oil crises). The key question today is whether this methodology remains valid if the EU is to achieve the multiple energy and climate change policy targets that it has set for itself. The European Commission, in its Communication on Energy Efficiency (2014), states that energy efficiency policy should:

- Increase energy security
- Reduce GHG emissions
- Drive Innovation & competitiveness

Does reducing total energy demand satisfy all three objectives?

The flawed assumption here is that whenever we save any energy, we reduce our import dependence, reduce our emissions and drive innovation in the way we should. However, in the case of electricity, the power sector is clearly transforming. The share of renewables is constantly growing and will already in 2030 make up for 47% of our electricity production. In the context of developing a sustainable energy system, these renewable energy sources can be regarded as effectively infinite. Our current unit of measurement does not distinguish between saving energy from renewable sources or from carbon intensive alternatives. Shouldn't we therefore aim to reduce, first and foremost, our consumption of carbon intensive fuels through energy efficiency? In terms of import dependency, our measurement also does not differentiate between locally produced (e.g. renewables) or imported energy (fossil fuels).

**The inability of the current energy-content only metric to differentiate between the carbon content of energy sources will, in the long run, undermine the achievement of our policy goals.**

Even in the medium term, an approach to energy efficiency that promotes fossil fuel use over decarbonised electricity is neither economically nor environmentally sustainable. Consequently, a more fundamental review of the energy efficiency metric is required, taking into full consideration the fact that we exist and operate in a carbon-constrained world.

In this report a forward looking PEF is considered as a potential solution to the policy challenge of comparing final and primary energy carriers. An alternative was considered around a PEF based on final energy consumption. The energy consumer can only be concerned with the final form of energy they choose and, consequently, their actions can only affect final energy consumption. The current approach to promoting efficiency is based on primary energy. This is an historic methodology derived in part from concerns at the proportion oil used for electricity generation in Europe during the period of the oil crises in the 1970's and 80's. This approach penalises electricity as an energy choice. While this approach was rational during the oil crises of the past, it is no longer so in a world where extractable oil, gas and coal reserves continue to expand and, more fundamentally, given the urgent focus on the decarbonisation of energy use.

Consequently, as an alternative to a forward looking PEF, consideration could be given to re-basing the energy efficiency metric to final energy use. Such an approach would

- (i) place electricity on an equal footing with other forms of final energy in a carbon constrained world; and, more importantly,
- (ii) target directly the decisions of energy consumers when investing in technologies and using final energy.

In this context, EURELECTRIC considers that in the long run, moving from an energy-content to a carbon-content metric presents a solution that delivers all the outcomes of the present regime, but in addition ensures the long-term decarbonisation of the energy system.

- **Energy security in terms of fossil fuels is achieved:** Fossil fuels release their energy primarily through the oxidation of their carbon (and hydrogen) content. Consequently, there is equivalence between the energy content and carbon content of fuels. Moreover, lower carbon content (higher hydrogen content) fuels, such as gas, have higher energy content. Therefore, switching to a carbon content metric will continue to deliver the same level of energy security provided by the energy content metric and moreover favours gas, a fuel that is globally dispersed, has significant and expanding reserves and where a global distribution infrastructure is being put in place.

A carbon-content metric has a further advantage in that it will preferentially promote renewable energy (i.e. indigenous energy sources) over imported energy, thereby improving the EU's import dependency.

- **GHG emission reductions are delivered:** Given the diversity of fossil and non-fossil fuel sources and their varying carbon content, a carbon-based metric addresses directly and in the most rational manner the policy objective of GHG emissions reduction. On the contrary, an energy based metric, while delivering GHG reductions through overall energy savings, cannot deliver full decarbonisation and in practice frustrates this outcome.
- **Accelerating innovation and job creation:** Clearly both energy-content and a carbon-content metrics incentivise innovation. However, the advantage of a carbon based metric is that it will preferentially support innovation in the priority policy area of low and zero carbon sustainable energy. In doing so it enhances long-term job potentials beyond those of the energy content metric.

A summary of the implications of the above options for the stated EU policy objectives is presented below.

Metric basis	Policy Deliverable						
	Security of Supply			CO2 reduction		Innovation	Jobs
	<i>Fossil</i>	<i>RES</i>	<i>Nuclear</i>	<i>Reduced energy use</i>	<i>System decarbonisation</i>		
<b>Energy (PEF = 2.5)</b>	+	0	-	+	-	0	+
<b>Energy (PEF &lt; 2.5)</b>	+	+	-	+	0	+	+
<b>Final Energy Consumption</b>	+	0	0	+	-	+	+
<b>Carbon</b>	+	+	+	+	+	+	+

- (+) – Beneficial to the objective  
 (-) – Disadvantageous to the objective  
 (0) – no effect



EURELECTRIC pursues in all its activities the application of the following sustainable development values:

Economic Development

▶ Growth, added-value, efficiency

Environmental Leadership

▶ Commitment, innovation, pro-activeness

Social Responsibility

▶ Transparency, ethics, accountability



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