Renewable Power for All

A CALL FOR AN ENVIRONMENTALLY BENEFICIAL ELECTRIFICATION AND MULTI-SECTORAL INTEGRATION

SEPTEMBER 2017

windeurope.org

Summary table

KEY MESSAGES

Fighting climate change, air pollution and delivering the Paris Agreement commitments requires replacing fossil fuels by renewables within the power sector and beyond. As large amounts of competitive renewable electricity are today available, a rapid electrification[1] of the most carbon intensive energy uses is the best and most efficient way to decarbonise and grow Europe’s economy.

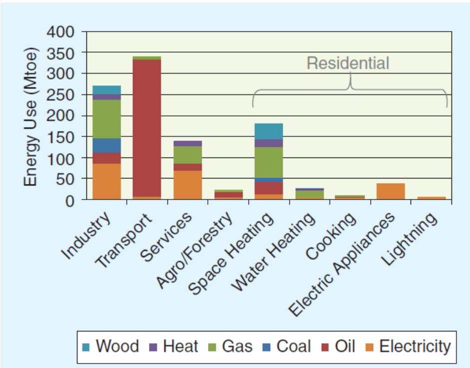

Figure 1 The final EU-28 energy uses, Kiviluoma & al. in IEEE based on Eurostat data (2017)

Decarbonising with cleaner electricity. Renewables now meet 28.8% of electricity demand[2] in the European Union (EU), 10.4% for wind energy alone. By 2030, this could be respectively 50% and 28%. Renewables contribute largely to reducing the greenhouse gas emissions from the electricity generation. The substitution of high carbon power generation with renewables has already abated an estimated average of 350 Mt carbon dioxide (CO_2) emissions per year between 2005 and 2014, more than the annual CO_2 emissions from Spain[3].

Reaping the benefits of competitive renewables. Thanks to significant reductions in technology and operating costs, wind is today the most affordable source of new power generation. In 2017, wind energy tenders, onshore and offshore, hit record low levels and this trend should continue if Member States provide a stable calendar for its deployment. By switching to electrical appliances, households and industries would benefit from an ever cleaner and cheaper power supply.

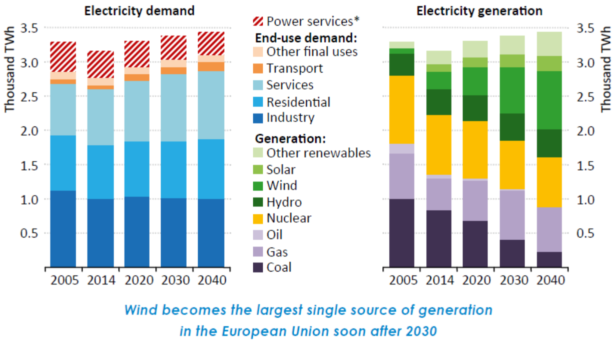

Figure 2 Power demand and generation in the European Union in the New Policies Scenario, IEA WEO 2016

[1] Electricity meets today 22% of Europe’s energy needs
[2] Eurostat (reference year is 2015). Fossil fuels (≈ 44%) and nuclear (≈ 27%) make up the rest.

[3] WindEurope, Making the transition work, 2016

Bringing flexibility beyond the power system. Electrification can help to integrate larger shares of variable generation by better matching supply with demand, and reducing the dependence on carbon-intensive back-up generation. In parallel, incentives for demand response, storage and smart grids will be needed to address inflexible loads.

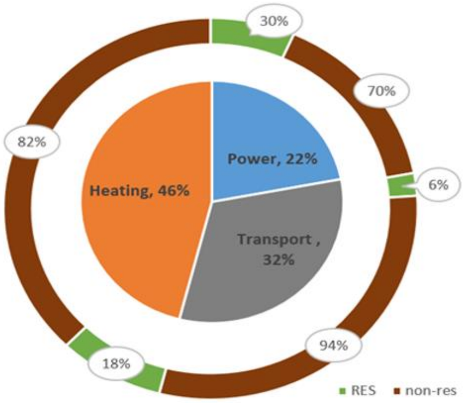

Figure 3 Renewables penetration for the main energy uses, WindEurope based on PRIMES (reference 2014)[4]

Electrifying transport and heating is a priority. These two sectors have the most important potential of fossil fuel displacement because they make up most of EU final energy demand and GHG emissions, and required technologies are widely available. Electrifying these uses would also strengthen Europe's energy security as 54% of its energy demand was imported in 2015 for a total cost of €261 billion according to the European Commission.

Revising efficiency metrics and policies. Electrification can reduce final energy demand. The efficiency of electric end-use appliances today such as heat pumps or electric vehicles (EVs) busts the myth that on-site' fossil fuels appliances are more efficient than 'off-site' electricity supply. Policies should evaluate technologies on their real environmental benefits rather than outdated rules of thumb.

Considering different technology paths to maintain Europe's industrial leadership. Beyond electrification *per se*[5], other sector coupling solutions exist in which electricity is transformed to another energy carrier. Some can be substantially and commercially used in the short-term such as EVs or Power-to-Heat. Others would likely play a bigger role after 2030 such as Power-to-Gas or -Hdyrogen. Developing alternative technologies for a variety of processes will ensure the EU keeps up with decarbonising its industry and maintaining its global leadership in low-carbon technologies.

> ***"The next frontier for the renewable story is to expand their use in the industrial, building and transportation sectors where enormous potential for growth exists"***
>
> **Dr. Fatih Birol,** IEA Executive Director

[4] Final energy demand is usually divided by sectors. We refer to energy end use.

[5] Replacing fossil fuels-based by electrical appliances

POLICY RECOMMENDATION SUMMARY

The following measures would help drive the decarbonisation and energy efficiency of the Transport, Heating and Colling sectors thanks to the uptake of wind energy and should be prioritised as part of current and forthcoming discussion on EU legislation.

Electrification in general

- Reinforcing the ETS to encourage switching to electricity in industrial sectors covered by EU ETS
- Proposing an EU framework for energy taxation to avoid favouring fossil fuels where electricity could also be used (Energy Taxation Directive)
- Developing a Digital Energy Strategy to tap into the optimisation potential of smart technologies

Electrification of transport

- The fuels suppliers' obligation should be increased to 10% to allow renewable electricity to make a larger contribution (RED, art. 25). The cap on first generation biofuels should be maintained (RED, art. 7), and renewable electricity supplied for road transport should be given a multiplication factor that reflects the higher efficiency of EVs compared to ICE (RED, art. 25)
- Requiring the installation of smart charging points for electric vehicles as well as conduits dimensioned to enable the later installation of such recharging points in newly built and refurbished residential and commercial buildings (EPBD, art. 8), and proposing higher requirements for the roll-out of public charging points (AFI Directive)
- Setting national targets for the procurement of 'clean vehicles' by public authorities with the final goal of 100% 'clean vehicles' procurement by 2030 (Clean Vehicles Directive)
- Stricter post-2020 CO_2 standards for new vehicles in line with the Paris Agreement

Electrification of heating and cooling

- Revising the EU methodology for EED and EPBD so non-combustible renewables have a Primary Energy Factor below 1 (EED, annex 2). Member States should remain free to use a European or national PEF, whichever is the lowest, but eco-design and energy labelling regulations should apply the European one.
- Introducing a label for the installed stock of boilers (EPBD, art. 14)
- Allowing clients served by District Heating and Cooling to disconnect and switch from DHC and move to heat pumps (RED, art. 24)

1. SOCIETAL BENEFITS

1.1. DECARBONISING AND IMPROVING AIR QUALITY

According to the European Environmental Agency, GHG emissions have reduced significantly since 1990 in most sectors of EU economy, with the noticeable exceptions of transport, refrigeration and air conditioning where they actually increased. The continuous uptake of renewable energies in the last two decades significantly contributed to decreasing these emissions. According to the European Environmental Agency (2016), wind and solar PV have helped to reduce the carbon footprint of electricity generation by 35%: from 431 g CO_2/kWh in 1990 to 275 g CO_2/kWh in 2014 on average for the entire EU.

Thanks to the ongoing decarbonisation of its power sector, the EU's economic growth is decoupling from greenhouse gas (GHG) emissions. But, as Europe still relies largely on fossil fuels to satisfy its energy need, it risks falling short of the GHG emission reduction trajectory it has committed to at the Paris Climate Conference in 2015. Considering that the share of renewables in the power mix is set to grow further, the EU should mainstream the use of ever-cleaner electricity in energy intensive sectors[6]. It is the best and most efficient to accelerate such decoupling. The increase in electricity demand projected would nonetheless be lower than the assumed GDP growth due to the implementation of energy efficiency policies (see figure 4).

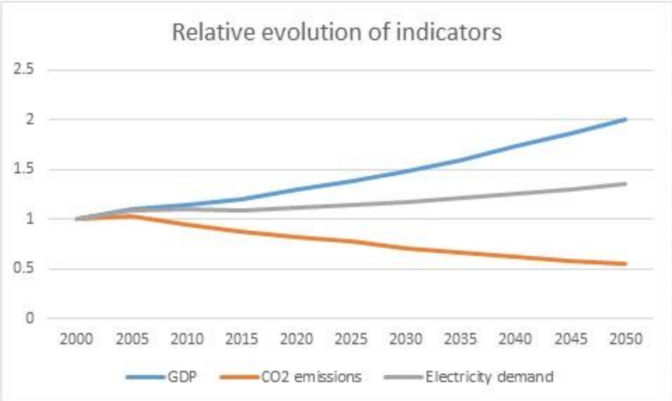

Figure 4 Decoupling of GDP & electricity demand with CO_2 emissions, WindEurope based on Eurostat and PRIMES (2016)

[6] According to the Energy Transitions Commission, electrification of transport and Heating and Cooling (H&C) globally has the potential to reduce fossil fuel use by 10-20% in these sectors. As a result, CO_2 emissions would be cut by 2 to 4 Gt per year by 2040. http://www.energy-transitions.org/sites/default/files/A-new-electricity-era.pdf

Such fossil fuel displacement would also reduce other pollutants emissions (SO_2, NOx, etc.) to which a large portion of European populations is exposed daily. The European Commission has estimated the consequent health-related economic costs of air pollution at €330 - €940 billion for the EU annually, which is equivalent to 3 - 9% of its GDP. In 2017, 130 cities in 23 Member States have infringed European air quality rules and 9 Member States have requested the European Commission exemptions for surpassing their emissions caps[7].

However, several countries would maintain a high level of carbon intensity in their power mix if policies[8] are not implemented to phase-out their most polluting power plants and better connect with their neighbours where renewables production is abundant.

1.2. INCREASING ENERGY EFFICIENCY

Moving toward an 'electrified' economy can help to reduce final energy demand. The degree of efficiency will depend on the power transformation process. Historically, there is a misperception that fossil fuels appliances are more efficient than electrical ones for end-use space and water heating. This idea is based on the relatively inefficient conversion of fossil fuel to electricity in traditional electric generation facilities and delivery to load. This view is obsolete mainly for two reasons.

Firstly, the production of renewable electricity assumes no conversion losses at all and avoids emissions associated with burning fossil fuels. It can deliver an equivalent energy service with less energy input and carbon emissions. As the European power system continues to increase its reliance on non-combustion renewable energy sources (wind, solar, hydro), the use of electricity becomes even more favourable as regard other transformation routes.

Secondly, electrical devices are becoming overall more efficient than fuel-based combustion are, even when accounting power transformation losses. For instance, battery electric vehicles have a conversion efficiency of 80-90% (from tank to wheel) as compared to internal combustion engines (20-30% on average). This allows them to drive two to three times the distance with the same amount of energy. Considering residential heating, common heat pump technology can heat space and water with efficiencies of 200-300%. And it has further potential for efficiency gains as the technology advances, whereas a traditional gas boiler would have an efficiency rate of 40-80%[9].

[7] http://eeb.org/national-governments-must-not-use-legal-loopholes-to-hide-failure-on-air-quality/. National Emission Ceilings Directive sets absolute caps for the amount of pollution allowed by any one country within a year
[8] i.e. tougher emissions standards for air pollutants and restrictions to capacity-related payments such as a carbon criterion.
[9]European Commission, an EU strategy on heating and cooling (2016)

Powertrain	Vehicle Efficiency (km/kWh)	Well-to-Wheel Efficiency (km/kWh)
Fuel Cell Electric Vehicle (FCEV)	2,05	1,26[1]
Diesel (ICE)	1,91	1,73
Gasoline (ICE)	2,27	1,84
Hybrid Electric Vehicle (HEV)	2,81	2,30
Battery Electric Vehicle (BEV)	4,75	4,54[2]

Note: [1]Assuming that hydrogen is produced by reforming natural gas; [2]Assuming that electricity is produced with a combined cycle natural gas-fired electric generator

Figure 5 Vehicle and well-to-wheel efficiency by powertrain, IEA & TESLA & CREARA 2016

Moreover, the environmental performance of electric equipment will improve over the products' lifetime because the emissions from the power mix will decrease. In contrast, end-use appliance that burns fossil fuels will lock in emissions for future decades. A coherent decarbonisation strategy would require efficiency metrics and policies to evolve now as most cars or boilers purchased today would remain in operation by 2030.

1.3. REDUCING ENERGY BILLS

As mature technical solutions emerge for the electrification of transport, residential heating and industrial processes, the European Commission expects an increase of EU electricity demand from 2,742 TWh in 2015 to 3,000 TWh in 2030[10]. The market uptake of heat pumps and electric vehicles will be key drivers. WindEurope estimates that electrification and multi-sectorial integration could revive demand for renewable electricity[11], provided the power sector decarbonisation goes on and carbon-intensive power plants are retired due to environmental requirements, age or economic conditions.

Thanks to its competitive price, wind energy can meet a large share of this future demand, up to 840 TWh (28%), against 314 TWh in 2015 (10.4%). Industrial scale deployment, driven by supporting policies and technological improvements, have made onshore wind the most affordable source for

[10] Reference scenario of the European Commission, 2016

[11] The European Commission estimates electricity demand will rise by about 230 TWh. This could be higher if the market for electric cars (4% of electricity use by 2040 according to BNEF and McKinsey, i.e. 100+ TWh) and heat pumps develop faster than expected. There could be a substantial additional demand from fuel cells (40+ TWh, according to Certifhy project).

electricity generation in many parts of Europe. These cost reductions will accelerate[12] thanks to economies of scale, more competitive supply chains and a variety of technology improvements, e.g. bigger turbines that will increase capacity factors.

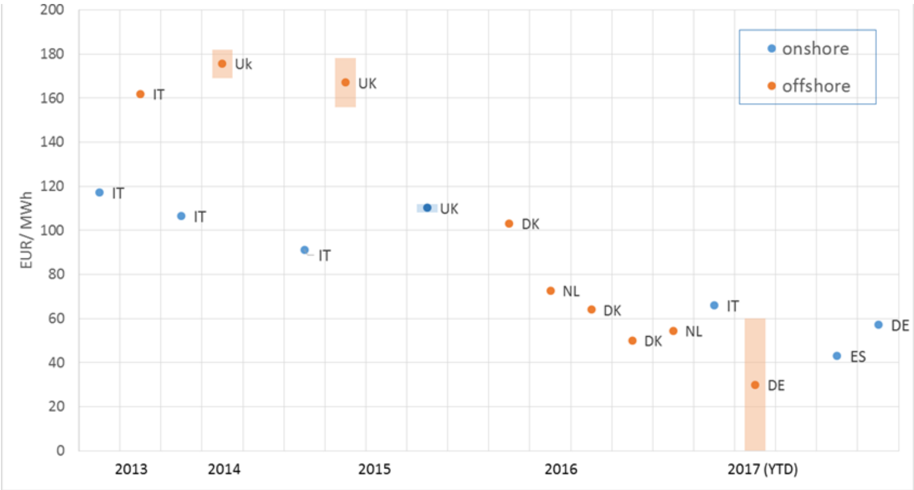

Figure 6 Wind energy tenders in Europe with strike prices[13], WindEurope 2017

Increasing shares of renewable energy sources tend to lower wholesale power prices[14]. Such decreases in prices already leads a growing number of corporates to enter into Power Purchase Agreements (PPAs) with renewables producers to hedge themselves against the volatility of fossil fuel prices. Even energy intensive industries such as the chemical sector are emerging as an actor in this market[15].

However, renewables costs reduction have not translated yet into lower electricity prices for most end-consumers. To do so, electrification should go hand in hand with a reformed energy taxation that enables a better linkage between wholesale and retail electricity markets.

[12] Onshore wind costs could fall 26% by 2025. And recent offshore tenders indicate that costs will go much lower and faster than the price figures used by the European Commission in its impact assessment for the EU's Clean Energy Package.
[13] Tenders' rules and design vary significantly from a country to another. In many cases, no final price or price floor is guaranteed to winners, and the government can sometimes change the contract awarded ex-post.
[14] In its report on energy costs and prices (2016), the European Commission suggests that a 1% increase in the share of fossil fuels (coal, gas, oil) in the power generation mix can result in an increase of up to €1.3/MWh in the wholesale electricity price, while a 1% increase in renewables share would reduce it by €0.4/MWh. These effects have different magnitudes in different regions in the EU and depending on the fuel source that is being replaced in the power generation mix.
[15] In 2017, AkzoNobel led a consortium to procure power from the Bouwdokken Wind Park in the Netherlands.

1.4. FACILITATING RENEWABLES INTEGRATION

Today's electricity demand is not as flexible as a renewables-based electricity system may require. Electrification and sector coupling can enhance demand responsiveness and ensure demand is better aligned with renewables production periods. The resulting benefits would be:

- reducing the volumes of renewable energy curtailed[16] (and associated costs);
- reducing the need for conventional power plants or back-up generators providing system-stabilising services and system-wide fuel use;
- reducing the need for grid infrastructure reinforcement;
- empowering consumers and creating potential revenue streams for them as system operators or aggregators will procure their flexibility;
- restoring the market value of renewables by shifting loads when their production peak[17].

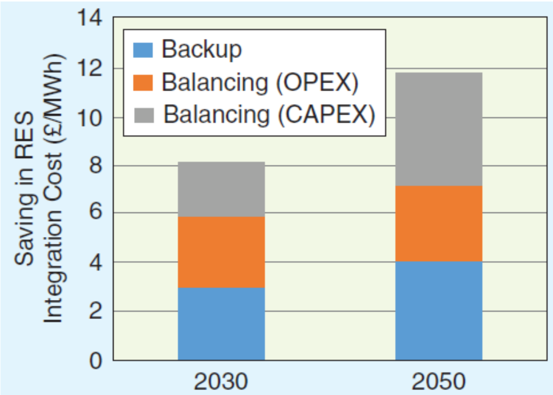

Figure 7 Reduction in integration costs of renewables (electricity sector only) enabled by the integrated operation of heat and electricity sectors, IEEE 2017

However, the parallel development of demand side response programmes, storages, smart grids and digital technologies will be essential to address inflexible loads. For instance, traditional electric resistance heaters may require additional flexibility to meet daily, seasonal, and annual variation for which the investment case might be very limited[18]. Nonetheless, the increasing use of information and communications technologies in these devices will also provide more options to shift demand loads according to power system conditions while also meeting the building occupants' comfort requirements. Overall, the International Energy Agency estimates the potential of demand side response at 20% of the annual electricity demand in the European Union[19].

Much flexibility also lies in Heating and Cooling for residential building where demand can be shifted to different periods within the same day depending on the thermal inertia of the building – the better the insulation, the longer the period of shift. Considering flexibility of the heat sector in Northern

---

[16] This amounted to 4.281 TWh for wind energy in Germany in 2015, WindEurope.
[17] Renewables tend to operate during periods of lower market prices at high penetration levels partly because of insufficient demand.
[18] In France, where they are largely used, the thermo-sensitivity of power demand is high (+/- 2,3 GW/°C) and caused a record high peak demand of 102 GW in 2012. However, it is expected to decrease as heat pumps are replacing such devices.
[19] World Energy outlook 2016.

Europe for instance, a study has ranked the benefits of adding heat pumps and electric heat boilers or integrating heat storages to a district heating system close second behind building new transmission lines[20].

1.5. REDUCING FUELS IMPORTS DEPENDENCY

According to the European Commission, the EU imports 54% of all the energy it consumes, at a cost of more than €1 billion per day. Energy also makes up more than 20% of total EU imports. Specifically, the EU imports: 90% of its crude oil, 66% of its natural gas, 42% of its coal and other solid fuels, and 40% of its uranium and other nuclear fuels.

The Heating and Cooling sector in the EU is supplied for 80% by fossil fuels, mostly natural gas[21] 90% of which is imported[22]. In countries where heat production largely relies on conventional fuels heat boilers or combined heat and power plants using various fuels, electrification based on domestic renewable energy sources would enhance security of supply and bring significant fuel import costs savings. Similarly, 94% of EU final energy demand in transport is dependent on crude oil whose import bill is estimated by the European Commission at around €187 billion a year[23].

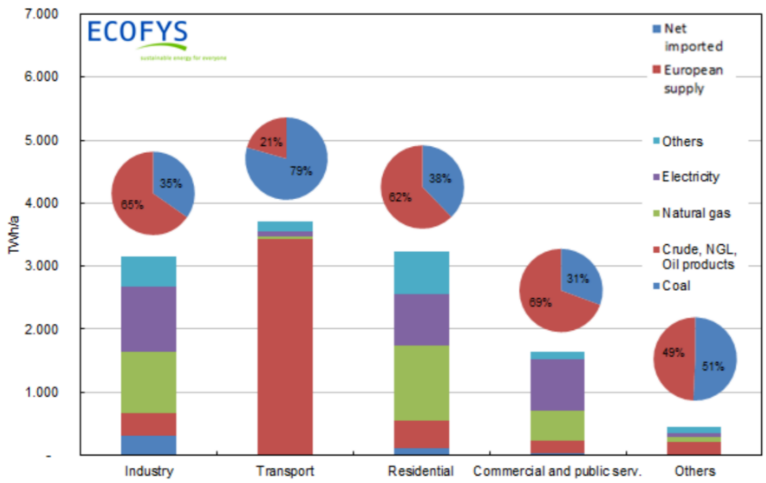

Figure 8 Final energy consumption per sector and energy carrier with energy import dependency, Ecofys 2014

---

[20] Kiviluoma & al, IEEE magazine (2017)
[21] Up to 80% for residential space and water heating in the United-Kingdom. See *ibid*
[22] See *ibid*
[23] EU dependence on oil imports has grown from 76% in 2000 to 88% in 2014, Transport & Environment (2016)

Even though the price of fossil fuels has fallen recently[24], replacing fossil fuels by domestic renewable electricity in these aforementioned sectors will significantly improve EU security of energy supply and energy imports bill for consumers. The benefits would vary depending on the underlying structure of the final energy consumption per sector and energy carrier, but they would become even greater as the efficiency of the power system and of electrical end-use appliances increase.

2. POTENTIAL IN RELEVANT SECTORS

2.1. HEATING & COOLING OF BUILDINGS

Electrification of heating and cooling is indispensable as it is the largest energy use in the EU and fossil energies account for almost 75% of its primary energy supply. It would also create the flexibilities to integrate large amounts of variable renewable electricity. The following sections focus on space and water heating in residential and service sector buildings, which represents 45% of final energy use for heating in the EU[25], while section 2.3.1 addresses heat for industry.

2.1.1. RESIDENTIAL HEAT PUMPS

In the residential and tertiary sectors, electricity has a marginal role as it accounts for 13% of H&C consumption on average[26], with a few national exceptions (e.g. France, Bulgaria). Domestic electric heating systems involve either direct-resistance electric heaters or heat pumps. The latter are much more efficient: air-source heat pumps typically produce 2 to 4 units of heat for each unit of electricity consumed, and ground-source heat pumps can even reach performance coefficient of 5. In 2016, they saved 135 TWh of final energy compared to a conventional heating systems.

Electric heat pumps represent only 2% of the final energy demand for H&C today as upfront investment costs are high. But they are quickly spreading. According to the European Heat Pump Association (2017), the heat pumps stock at the end of 2016 exceeded 9.5 million units. If all Member States had the same market penetration as Sweden, the total stock of heat pumps could be 85.9 million units in 2030. This would mean a useful 'renewable' energy production of 670 TWh, therefore an increase of power demand of 223 TWh (with an average performance coefficient of 3). This demand would represent the annual production of 111 GW of wind energy or 37,216 wind turbines.

---

[24] Most notably the crude oil price which fell by 60% since 2014. European Commission (2016)

[25] In contrast, cooling demand is considerably lower although it is growing quickly with increasing space-cooling requirements and also due to the heavy urban development in warmer climates. New uses are also emerging in services/industries, such as cooling large data centers.

[26] A European strategy for heating and cooling, European Commission, 2016. Renewables accounts for 18%.

Besides efficiency, heat pumps can help to integrate large share of wind energy, especially if they are complemented by use of an electrical resistance heater or a gas boiler at home, or other heat supply technologies at local level. Such hybrid systems allow to switch from one device to another when the power system is under stress or depending on price variations (see figure below).

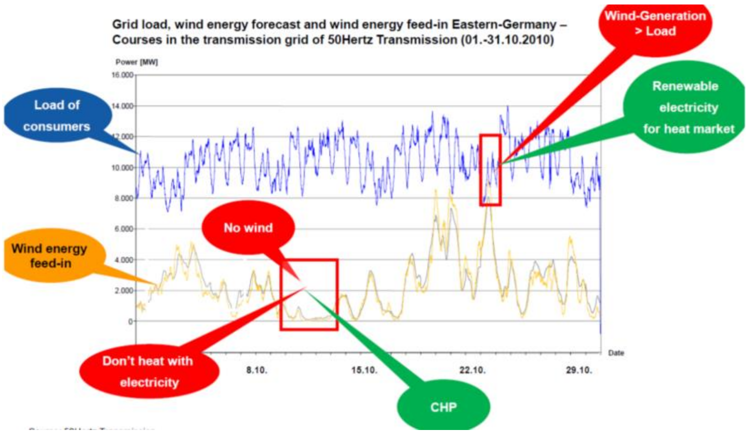

Figure 9 Example of synergies between power and heat systems, European Commission (2016)

2.1.2. DISTRICT HEATING & COOLING NETWORKS

Compared to building-level solutions, district heating and cooling (DHC) networks can decrease the relative cost of heating and cooling generation and offer considerable economies of scale for heat storage.

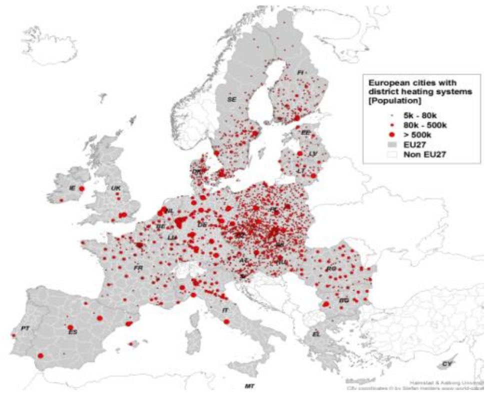

Figure 10 European cities with district heating systems, Halmstad & Aalborg Universities 2013

According to the European Commission (2016), DHC supplies 9% of EU heating demand. Its utilisation in buildings is still low on average but Denmark, Sweden, Finland, Estonia, Latvia, Lithuania, Poland as well as in densely populated areas in Germany, Central, and Eastern European countries have rates of around 50% or above. In total, the EU counts 6,000 systems which usually rely on combined heat and power (CHP) plants burning coal or natural gas.

A growing number of countries are opening up their DHC systems to alternative H&C technologies. This would allow to bring in large shares of wind energy via power-to-heat in various forms to the building stock, and to scale up the market for these technologies such as heat pumps that are technically and economically ready[27].

Denmark, where DHC meets 63% of heat demand has adopted this strategy for example. According to Euroheat&Power (2015), renewable energy sources (mainly biomass and wind power) account today for 46.6% of DHC supply and the government aims to bring this share to 100% by 2035. Key drivers of this transformation are high taxes on fossil fuels-based heating system and the availability of low power market prices in time of high wind energy generation.

2.2. TRANSPORT

Transport today accounts for 26% of EU's GHG emissions, and is the only major sector of the EU economy where they keep increasing. Renewable energy only accounts for 6% of the EU energy consumption in this sector, and renewable electricity less than 0.1%.

2.2.1. THE ERA OF ELECTRIC VEHICLES

Road transport, which accounts for 80% of EU energy demand in this sector and a fifth of EU GHG emissions, is the node of the problem due to its extreme reliance on oil whose prices are still very low. The parallel deployment of EVs and renewables could significantly cut road transport emissions.

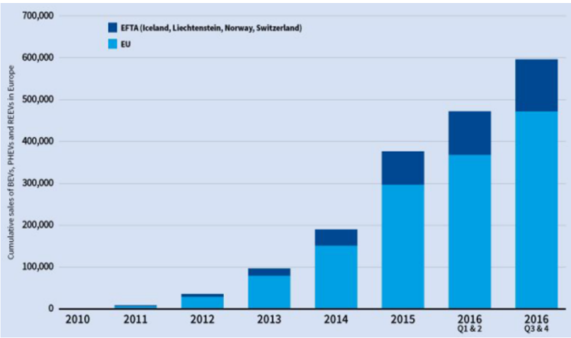

Figure 11 Cumulative sales of electric vehicles in Europe 2010-2016, Transport & Environment 2016

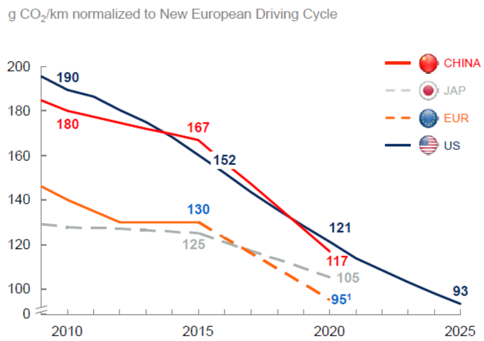

Figure 12 Planned emission standards in select regions, McKinsey & Amsterdam Roundtables Foundation

Although EVs still represent less than 1% of total vehicles sold in most markets, sales have risen quickly over the past five years. With more than half a million electric vehicles running in 2016 (EVs) Europe is the world's second largest market, after China, . The key drivers for this uptake are sales quotas for

[27] It should nonetheless respect temperature and pressure constraints to avoid destabilising the DHC networks, and allow for the current different regulatory models in Europe to coexist (e.g. heat auction or negotiated access).

zero emission vehicles, tax reduction incentives, stricter emissions and fuel efficiency standards (both at the vehicle but also from local administrations), as well as recharging infrastructure deployment. This puts pressure on countries to develop the underlying infrastructure. Today, the EU counts 100,000 charging points. The geographical coverage, interoperability and smartness of EVs charging will be key to avoiding expensive reinforcement of electricity networks, in particular at distribution level.

According to Bloomberg New Energy Finance (BNEF, 2017), this uptake will accelerate as electric vehicles are expected to reach price parity with Internal Combustion Engine (ICE) vehicles by 2025 thanks to a 65% decrease in battery costs[28] between 2010 and 2015. They could bring another 100 TWh to EU's overall power demand. 30 to 35 million EVs will be sold in the EU by 2030, representing over a 30% of the new cars market and over 10% of all the cars stock[29].

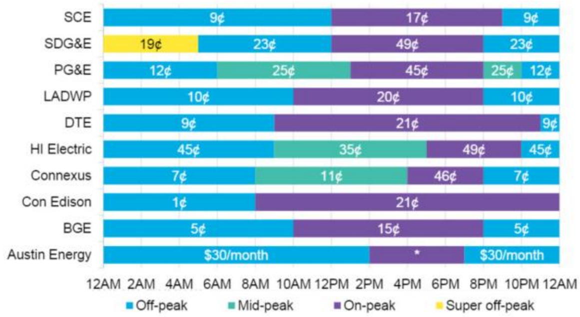

Figure 13 Tariff hours and rates offered by US charging operators (in c$/kWh), BNEF 2017. (*) indicates charging is discouraged.

Besides emissions reduction, EVs can be a cost-effective source of flexibility for the power system provided that market rules support and allow smart charging and Vehicles-to-Grid services, incentivising EVs charging when power demand is low and renewables production is high or providing power back to the grid at time of low renewable production or high electricity prices. According to BNEF (2017), over 25 US utilities now offer special tariffs for electric cars, with charging rates up to 95% lower at night.

2.2.2. A GLOBAL TREND TOWARDS E-MOBILITY

EVs are only a part of a much wider electro-mobility revolution. Electric public transportation (e.g. trains, buses and trams) provides the opportunity for cleaner, greener mobility to replace today's mainstream commuting and freight modes which essentially run on diesel. Electrifying these transport modes is key, the European Commission (2017) estimates that passenger transport will grow by about 42%, and freight transport by 60% from 2010 to 2050. Several of Europe's biggest cities

[28] From $1,000 to $350/kWh. And it continues to drop, driven by scale, improvements in battery chemistry and better management systems. They are forecasted to reach less than $100/kWh in the next decade. BNEF & McKinsey, 2016.
[29] European Commission, Impact assessment on the Renewable Energy Directive, 2016

such as Paris and Munich have started to roll out EV infrastructure and are considering to have phased out ICE buses in a few years.

Even if marginal today, maritime transport is evolving too. Ship-to-grid solutions for marine terminals are being developed, such as the Port of Amsterdam which has placed shore power stations allowing ships to connect to nearby wind power resources instead of on board diesel generators for their electricity supply. Electric ferries for short-sea shipping are also entering into commercial operation.

2.3. INDUSTRY

2.3.1. DIRECT ELECTRIFICATION OF INDUSTRY PROCESSES

Industrial heat demand accounts for 37% of H&C demand in the EU. It is made up of 85% for heat-consuming process and 15% for space heating. A large fraction of industrial heat loads is currently dominated by natural gas burners because they can deliver higher temperatures, typically over 500°C, with lower conversion losses.

Today, electric heating technologies such as resistance heating, electric arc heating, induction heating, and dielectric (radio-frequency) heating that can achieve that range and/or provide enhanced controllability in order to react to market price signals. Used in combination with a heat storage, they could provide great flexibility to the system. For instance, steel production involves blast furnaces which require a continuous supply of coke as a reducing agent that takes part in the chemical reaction. Electric arc furnaces are in contrast much more efficient because the temperature within the system is easier to control.

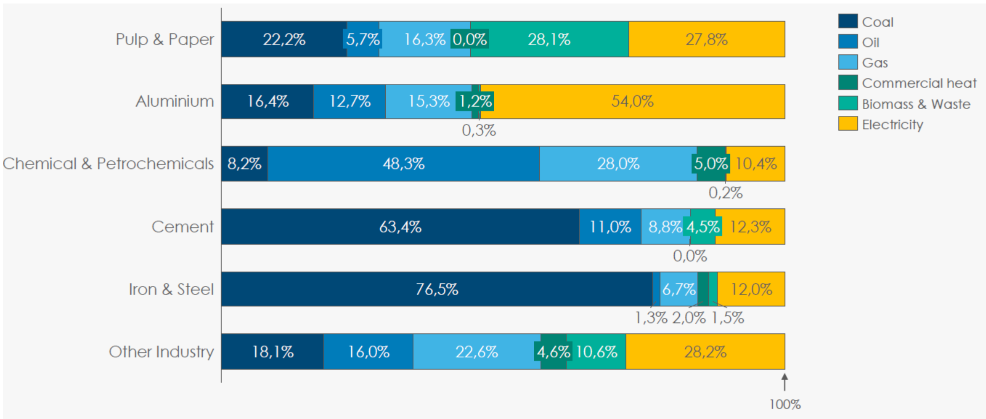

Figure 14 Share of final energy by source in 2013 for different industry processes, Climate Policy Initiative analysis based on data from IEA ETP 2016

However, the electrification potential of industrial process heat has to be analysed carefully as it would strongly differ across countries and industrial sectors. The investment costs in electrical equipment as well as grid connection costs can be high. The decreasing electricity prices on the wholesale market could make them more attractive, but would depend on the level of exposure to taxes and levies. Moreover, accounting methodology for energy savings should evolve since many industries have to comply with stringent energy efficiency requirements that might not qualify the replacement of fuel-based appliances by electrical ones with current methods.

The International Energy Agency estimates that the global use of renewable heat in industry will nearly double by 2040 because of falling costs and improved competitiveness relative to other options. However, this growth will be lower in Europe, and benefit renewables-based electricity by a modest extent (+6% between 2014 and 2040).

2.3.2. POWER-TO-GAS, POWER-TO-HYDROGEN

In addition to direct electrification, the transformation of renewable electricity into other energy carriers such as gas (e.g. synthetic gas, hydrogen) needs to be considered too. In some sectors such as cement, fertilisers or refineries, Power-to-Gas is among the few cost-effective emissions abatement options available. Hydrogen produced by electrolysis with the use of renewable electricity can be used directly or be blended with CO_2 to produce synthetic methane. The required CO_2 can be sustainably sourced from the surrounding air or biogas plants (helping to reutilise CO_2 that otherwise would be release to the atmosphere). It should not be sourced via carbon capture and utilisation from power plants and/or industrial processes that would lead respectively to the extension of redundant fossil fuel assets or a mere delay of the CO_2 emission.

As things stands, mass-market hydrogen will remain more expensive to make, transport and store by comparison to electricity. A combination of P2H for mobility/industry applications and provision of grid services would be needed to boost its profitability.[30] By 2030, 76 TWh of additional demand for renewables electricity could come from an increase use of hydrogen.

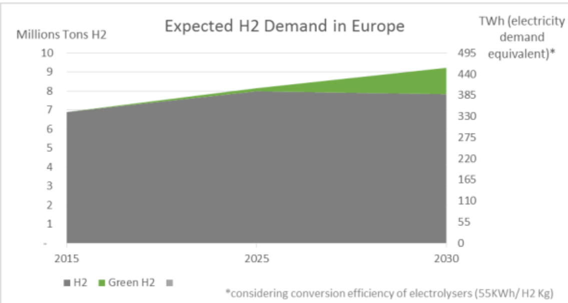

Figure 15 EU demand for hydrogen until 2030, WindEurope based on CertifHy 2017

[30] The round trip efficiency of power-to-gas-to-power is quite low (below 30%) as compared to other technologies (battery, hydro pump storage) so it will be in most case not competitive.

Today, one of the largest consumer of hydrogen in the EU is the refinery sector. According to Platts (2017), about 17% of total CO_2 emissions from the European refinery sector can be attributed to hydrogen production, mainly produced from natural gas. Refineries are expected to increase their hydrogen demand even further, as the requirements for cleaner oil increase (cf. lower sulphur content). Satisfying this growth via water electrolysis could lead to an important demand of electrolysers[31] and consequently of renewable-based electricity (see box below).

Figure 16 P2G in the Port of Rotterdam, Uniper

The Port of Rotterdam is a good example of how P2G can help to integrate renewables. 3,450 MW of offshore wind will be connected to the port in the future. P2G can help to reduce grid extension costs and balance this significant energy production. It could also be used to supply 6 neighboring refineries and other hydrogen customers with 'green hydrogen', therefore reducing CO2 emissions significantly. A 20 MW P2G installation can avoid 29.000 tCO_2/year, provided 'green hydrogen' is recognised as compliance option for reducing CO_2 emissions.

3. POLICY RECOMMENDATIONS

As things stand, the European Commission expects electricity to increase its share in EU final energy demand in the next decade to the detriment of fossil fuels. However, the pace of change would be very slow with a 3% increase only from 2020 to 2030. Many things can be done at EU level, to speed up that trend, specifically in the framework of the Clean Energy Package.

[31] This market could increase up to 3.1 GW by 2025 (Tractebel & Hinicio, 2017). Electrolysers become cost competitive with electric batteries as they aren't constrained by the same operational requirement (i.e. can bid up or down services all day vs. 2 to 4h max service duration for most batteries). Platts 2017

3.1. CLEAN ENERGY PACKAGE

The Clean Energy Package should be the cornerstone of any decarbonisation strategy based on electrification and multi-sectorial integration.

3.1.1. SETTING THE RIGHT TARGETS

New renewable energy capacities implied by the proposed target in the Renewable Energy Directive (RED) will not be sufficient to ensure additional electricity demand is met with renewable energy sources:

- The renewables target in the share of energy consumption should be at least 35**%** (RED, art. 3)

Furthermore, the proposed fuel suppliers' obligation enshrined in the same Directive should be more ambitious in order to accelerate the decarbonisation of transport, the only sector where GHG emissions are increasing, and reduce further air pollution in urban areas. Renewable electricity supplied for road transport could make a larger contribution than currently foreseen. It should be further incentivised alongside other renewable technologies.

- The fuels suppliers obligation should be increased from 6.8 to 10% (RED, art. 25)
- Waste-based fossil fuels should not be included, mainly because they entail the risk to divert waste streams from closed-loop re-use and recycling, as required by the 'EU waste management hierarchy' (RED, art. 25);
- Electricity supplied for road transport should be given a multiplication factor that reflects the higher efficiency of EVs compared to ICE (RED, art. 25);
- The contribution of first generation biofuels and bioliquids to the final consumption of renewable energy should decrease from 2021 onwards and not exceed 3.8% in 2030 (RED, art. 7);
- Fuel suppliers only supplying renewable electricity should not have to comply with the minimum share of advanced biofuels other biofuels and biogas produced from feedstock listed in Annex IX (RED, art. 25).

Consequently, the proposed way to account for renewable electricity towards the fuel suppliers obligation should also be reviewed in a way that encourages fuel suppliers to develop dedicated renewables marketing options to demonstrate the origin of the electricity to their customers, and to count towards their renewables obligation.

- In principle, Member States should use the share of renewable electricity from renewable energy sources in their country, rather than the average share in the European Union as this would lead to an overestimation of their real contribution in Member States where renewables penetration is very low (RED, art. 25);

- Fuelled electricity should be accounted as 100% renewables if suppliers can demonstrate that there is a direct connection between their charging station(s) and a renewable installation (off-grid) and/or that they purchase the electricity directly from renewable energy producers, for instance through a Power Purchase Agreement (RED, art. 25).

3.1.2. REVIEWING THE PRIMARY ENERGY FACTOR

The Primary Energy Factor (PEF) indicates how much primary energy is used to generate a unit of electricity or useful thermal energy. It is used in several pieces of legislation:

Legislation	PEF function
Energy Efficiency Directive (EED)	To assess the contribution of electricity to the energy efficiency target (article 3) and energy savings obligation (article 7) which are expressed in both primary and final energy. When Member States choose to express their savings in primary energy, the PEF is applied to convert final energy savings into primary energy.
Energy Performance of Buildings Directive (EPBD)	To convert the electricity imported from the grid to primary energy as the energy performance of building is measured in primary energy.
Ecodesign and Energy Labelling Directives	To compare savings of products using different energy carriers, such as an electric heat pump with a gas boiler, and eventually labelled according to their efficiency. This impacts both the possibility for a product to retain access to European markets, and its marketing competitiveness vis-à-vis competing technologies.

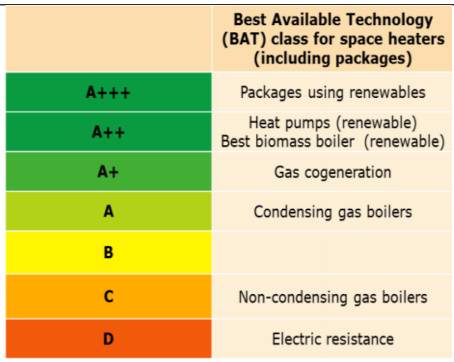

Figure 17 Efficiency rating of space heating appliances, European Commission 2016

Currently, savings in electricity are multiplied by a PEF of 2.5 in the EU methodology for EED and EPBD. It assumes that all power generation in the EU has an average 40% efficiency rate, which is approximately equal to the energy conversion efficiency of a conventional fuel fired power plant. This value incentivises electricity savings over direct fossil savings to meet the energy efficiency target, and does not reflect the transition of the EU power mix towards larger shares of renewable energy sources from which energy is harnessed without the burning or combustion of a fuel.

The PEF should not only reflect the need to reduce energy use by counting primary energy, but also recognising the role of electricity in improving 'emissions efficiency'[32]. As the EU has set a clear direction for the decarbonisation of its power sector (50% of renewables by 2030, carbon neutrality by 2050), WindEurope therefore supports a 'desired' PEF value that reflects this development:

- Revising downward the default PEF for electricity used in the EED (annex IV) and EPBD even beyond the European Commission's proposal as to reflect a PEF for non-combustible renewables which should be lower than 1.

Nonetheless, WindEurope supports a dynamic approach to the PEF ensuring it triggers the use of electricity where and when[33] it is the more efficient option.

[32] See Keith Dennis & al for a more detailed explanation of this concept (2016)
[33] If an efficiency measure reduces power consumption in hours of high demand, renewable energies and base load power plants will continue to produce and only the peak load plants (mostly gas and oil turbines) will adjust their power generation accordingly. While the average generation mix is easy to estimate, determining the marginal generation unit however requires more complex assumptions. European Commission (2016)

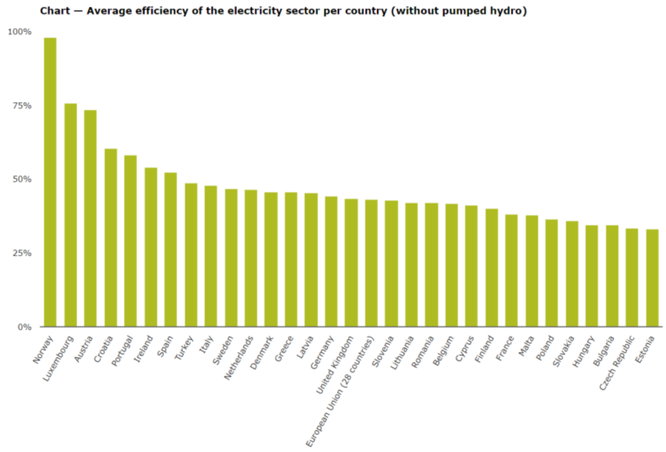

Figure 18 Average efficiency of the electricity system per country, EEA 2015

This means:

- Allowing Member States to use the European or a national PEF, whichever value is the lowest, only for EED and EPBD implementation. However, eco-design and energy labelling regulations should apply a uniform value for the entire EU market[34] based on the annex IV of EED;
- Moving away from static PEF value that are set in stone for several years to a more frequent review of these values based on annual or even seasonal average.

3.1.3. MAKING BUILDINGS ELECTRIC-READY

The construction of private recharging infrastructures remains an important pre-condition for the wide-scale deployment of electro-mobility. Daily normal power charging at the workplace or overnight at home offers the most convenient charging experience for passenger EVs, and accounts for roughly 90% of the energy charged by an EV during its lifetime. Therefore, the Energy Performance of Buildings Directive (EPBD) should remove regulatory barriers to deploying recharging points for electric vehicles in the private domain, especially as only 1% of the EU total buildings stock is renewed annually.

- By 2023, Member States shall ensure that at least one of every ten parking spaces in all non-residential buildings and new public parking lots are equipped with a smart recharging point. All

[34] It would otherwise limit the free movement of goods and services in the Single Market. The calculation of energy efficiency of products is to be specified directly in the products' regulations. For instance, the energy efficiency of electrical devices such as heat pumps is calculated as the seasonal coefficient of performance divided by the PEF, with specific corrections.

other parking spaces should be equipped with conduits dimensioned to enable the later installation of such recharging points. All new or substantially renovated residential buildings should also include conduits dimensioned (EPBD, art. 8).

Proper incentives are also needed to support the installation of heat pumps, especially in mature markets such as France and the Nordics where the renovation of old buildings should drive this increase. The implementation of the current EPBD has not resulted in an increased replacement rate of inefficient boilers. According to EHPA[35], 80 million of the 120 million space heaters installed in the EU's existing buildings are inefficient. Member States should build on eco-design and energy labelling policies to inform consumers in easy-to-understand language that their appliances are inefficient compared to the heating technologies that are currently on the market. Such labelling already exists in Germany, Austria and the UK while France and Italy are considering it.

- Introducing a provision on labelling the installed stock of boilers as a consequence of the inspection of building's heating system (EPBD, art. 14)

3.2. CLEAN MOBILITY PACKAGE

In view of a swifter transition to a sustainable European road transport, the European Commission is now assessing a large set of policy instruments as part of the Clean, Connected and Competitive Mobility Package to phase out the 35 million polluting diesel cars that are still on the EU's roads[36]. Options under review include sales quotas for zero-emission vehicles and post-2020 carbon dioxide standards for cars and vans, and possibly for heavy-duty vehicles. WindEurope calls on the European Commission to put a high level of ambition in forthcoming proposals. This includes tighter emission standards under the CO_2 standards regulation which have proven to be one of the most effective measures to bring cleaner vehicles on the road[37].

3.2.1. PUBLIC AUTHORITIES TO LEAD BY EXAMPLE

The recast of the Clean and Energy-efficient Road Transport Vehicles Directive (CEVD) is a chance to kick-start electrification of transport through public procurement and renewal of public fleets of

[35] http://www.ehpa.org/about/news/article/joint-industry-letter-on-epbd-and-labelling-of-the-installed-stock-of-boilers/
[36] Several countries (France, UK) and big cities (Paris, Madrid, Athens) have already announced the ban of the most polluting cars and vans to tackle air pollution (see section 1.1)
[37] This policy should not only continue post 2020, but also be expanded to vans and heavy vehicles such as trucks and busses. Furthermore, ongoing attention to Real Life Driving Test is necessary to ensure listed emissions are in line with actual emissions.

vehicles, provided ‘clean vehicles’ are to be defined properly and ambitious targets set for the procurement of clean vehicles.

- A ‘clean vehicle’ should be defined by a CO_2 tailpipe emission threshold, which would be low enough to help Plug-in Hybrid EVs, EVs, and FC EVs grow (CEVD, art. 4)

As for the procurement target, it should be:

- Ambitious – 100% of the new vehicles procured by public authorities should be ‘clean’ by 2030. This would complement the European Commission’s objective of achieving CO_2-free city logistics in major urban centres by 2030[38] (CEVD, art. 5)
- Binding and predictable - in addition to 2030 targets, regular milestones should be set at National level to track progress towards the target (CEVD, art. 5 and 10)
- Reflective of Member States’ financial capacity – national trajectories should be linked to each Member State’s gross domestic product (CEVD, art. 5)
- Tailored for different categories of vehicles, as to reflect the current technological developments of low emission technology for light-duty vehicles, buses, and heavy-duty vehicles (CEVD, art. 5).

3.2.2. ROLLING OUT E-MOBILITY INFRASTRUCTURES

Public infrastructures is crucial for creating a European-wide EV market. The Alternative Fuels Infrastructures Directive (AFI) is a key instrument that should ensure their roll-out and promote convergence around common and interoperable standards. The European Commission should publish its assessment of the National Policy Frameworks required by the AFID in November 2017. To overcome the poor ambition showed by Member States policy frameworks, it should:

- Propose binding targets for the installation of EVs public recharging points and envisage regulated solutions (e.g. involving Distribution System Operators) in case of proven market failure

EU programmes such as the Connecting Europe Facility and European Fund for Strategic Investments should address the issue of investment financing.

- Such programmes should focus on deploying high power recharging points along EU major highways, where transport demand is higher, with the aim of providing full coverage of the Trans-European Networks-transport (TEN-T) corridors' core network with charging points by 2025

[38] European Commission, “Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system”

3.3. ENERGY TAXATION

Appropriate financial incentives such as a strengthened CO_2 price, proper taxation of fossil fuels and tax rebates are indispensable to support the development of electrical appliances. Tax measures are an important tool in shaping consumer demand towards low carbon breakthrough technologies. Many countries have introduced tax reductions (Germany, Austria) or bonus payments/premiums for the buyers of electric vehicles (France, UK) leading to significant rise in sales[39]. Conversely, the way energy is taxed and levied can hold up electrification of households or industries.

Firstly, the final price of electricity should reflect wholesale price variation and tax/levies should be reviewed in order to create an incentive to use more electricity. Today, taxes and levies represent on average 30% of retail electricity price in the EU. It is one reason among others why the fall in wholesale prices over the last years had not translated into a lower electricity bills for end-consumers. According to the European Commission (2016), retail electricity prices have risen about 3% a year since 2008 and gas retail prices by 2%. The ratio between electricity vs. gas and oil prices remained quite stable over time to the detriment of electric appliances, although significant differences exist between Member States. Electrification is stifled by this price differential.

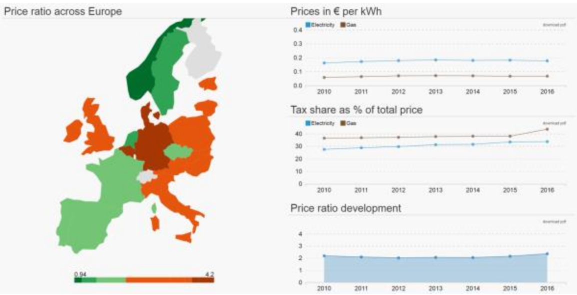

Figure 19 Electricity vs. gas prices, EHPA 2017

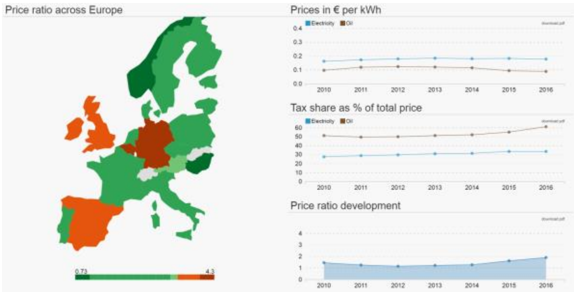

Figure 20 Electricity vs. oil prices, EHPA 2017

The main reason lies in the fact that fossil fuels still benefit from subsidies and/or tax exemptions. According to Oil Change International, Friends of the Earth, WWF and the Sierra Club (2017), the G20 nations provide four times more public financing to fossil fuels than to renewable energy[40]. Furthermore, the EU Emission Trading System (ETS) covers electricity generation ensuring that environmental externalities are factored in electricity prices. This put electricity at a competitive

[39] 100,000 registered EVs in France in 2017 following the introduction of a 'superbonus' up to €10,000 in 2015.
[40] Talk is cheap

disadvantage for energy use in sectors not covered by carbon pricing, e.g. the electricity used for shore-side electricity (SSE) is more expensive than the tax exempted fuel that is commonly used in the auxiliary engines of ships[41].

In 2011, the Commission presented a proposal to revise the Energy Tax Directive with a view to support the EU's wider environmental and energy goals. The proposal was withdrawn in 2015 following the unsuccessful negotiations in the Council of the EU. WindEurope calls now on Member States to take a fresh look at energy taxation both at national and EU level.

- Consider a new proposal of EU framework on energy taxation with the objective of removing fossil fuels subsidies by 2025 (Energy Taxation Directive)

3.4. DIGITAL TECHNOLOGIES

A cost-efficient electrification will also require from consumers and utilities to monitor and better control where, when, and how electricity is being used. In this regard, digital technologies will be essential to managing a more complex system with a higher penetration of variable renewables, and support the emergence of new business models for flexibility from distributed energy resources such as storage or Vehicles-to-Grid services.

In the wind industry itself, they will trigger important cost reduction mainly through savings in operation and maintenance, lifetime optimisation and increased yields. For network operators, smart grids and digital infrastructure will allow automated controls to improve network resiliency, safety and efficiency. For consumers, intelligent metering and new trading platform will enable them to take a more active role in managing their own energy consumption, participate in the market and overall save costs. According to the European Commission (2014), the cost of a smart metering system averages between €200 and €250 per customer, while delivering benefits of €309 (for electricity) along with, on average, 3% energy savings.

To leverage these opportunities, energy and digital policies need to be consistent in creating a stable and forward-looking regulatory framework for both sides.

- Develop a Digital Energy Strategy for the EU as suggested by the Tallin e-Energy Declaration (September 2017)

[41] Ecofys (2015), Potential for shore side electricity in Europe. Sweden asked for – and obtained – a derogation from the energy taxation directive, in order to make SSE tax-free. This would put electricity usage in ships on a level playing field with other fuels.