100% RES-based electrification

The Electrification Action Plan Civil Society Wants to See

December 2024

Contents

Ackowledgements

Author: Tom Lewis, CAN Europe

The following members and partners of CAN Europe contributed to the development of the report:

Joni Karjalainen (CAN Europe)
Chris Rosslowe, Tomos Harrison (Ember)
Marion Revest, Rheanna Johnston, Flaminia Bonanni and Chiara Celesia (E3G)
Chris Vrettos (Electra Energy Cooperative)
Bastien Cuq (Réseau Action Climat)
Reviewed and Edited: Cornelia Maarfield (CAN Europe)

Introduction

The European Commission has announced its intention to publish an Electrification Action Plan, under the lead of the EU's new Commissioner for Energy and Housing, Dan Jørgensen. Electrification is vital to allow renewable energy, such as wind and solar, to more easily decarbonise demand. However, by limiting the focus to industry, and not coupling the action with ambitious targets for renewables, energy demand reduction, and fossil fuel phase-out, the plan risks restricting its impact on emissions reduction and lowering energy prices.

Key take-aways:

Electrification alone will not drive renewables, energy savings, and fossil fuel phase out

Ignoring ambitious frameworks for renewables, energy savings, and fossil fuel phase out risks slowing down electrification, limiting its impact on emissions reduction and lowering energy prices. Europe must implement and overshoot 2030 energy targets and set ambitious targets for 100% renewable energy, halving energy demand by 2040, and phasing out coal by 2030, gas by 2035, and oil by 2040.

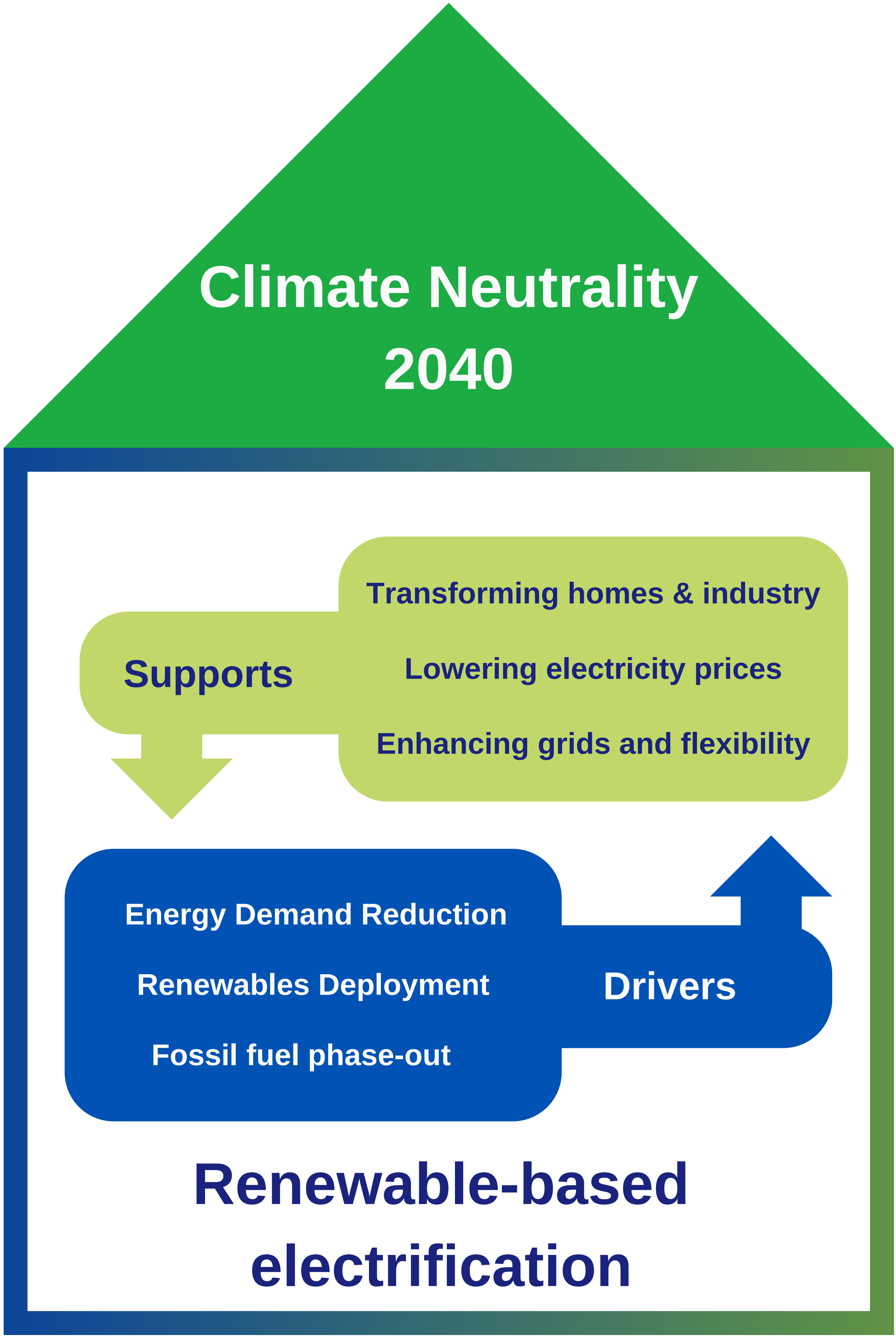
Electrification must benefit households, and ensure industry contributes its fair share

Electrification Action Plan should include households, alongside a Heating and Cooling Strategy, and the long-awaited Heat Pump Strategy. Lower-income households should not be subsidising industry through rising energy bills, but rather benefiting from cheap renewable power. Public subsidies to industry should have conditions to ensure the polluters pay principle, based on legally-binding transformation plans with clear targets.

Power electrification through cheap renewable energy for all

New electricity should be driven by the roll out of renewable energy, such as wind and solar, which can lower prices and incentivise further electrification. Long-term contracts, community-ownership, fair energy taxation, and system flexibility should be utilised.

2035 Renewable-based power system ready for 100% renewable electricity by 2040	**69%** Direct electrification rateby 2040.	**4.7** times more GW of installed RES capacityin 2040 compared to 2023. Annual deployment of 102-118 GW
Halving Energy Demand by 2040 [1]	**1.58** times more TWh of electricity in 2040 than 2020	**2040** Climate neutrality Fossil and nuclear phase out


Climate Neutrality
2040
Supports
Transforming homes & industry
Lowering electricity prices
Enhancing grids and flexibility
Energy Demand Reduction
Renewables Deployment
Fossil fuel phase-out
Drivers
Renewable-based
electrification

1. Electrification as a means to reach a 100% renewable energy system

CAN Europe urges for an accelerated electrification as an essential enabler of a 100% renewables-based energy system and achieving an accelerated path towards achieving net zero in 2040.

The Paris Agreement Compatible (PAC) scenario shows us that an energy transition that leads to climate neutrality by 2040 is both feasible and highly desirable from a climate and economic perspective, saving an additional 16.5Gt CO2e of emissions compared to a 2050 scenario, a -37.5% difference, while providing co-benefits of 1 trillion euros. This chapter briefly outlines the main findings of our PAC scenario regarding electrification.

Meeting electricity needs with renewable power

Meeting climate neutrality by 2040 entails the transition to 100% renewable electricity, which can be illustrated in Figure 1. The PAC scenario sees the expansion of renewable electricity production[1] meeting higher electricity needs while simultaneously gradually phasing out non-renewable electricity, including electricity produced by coal, gas and nuclear power. Currently, the share of renewables in the energy mix is advancing, as per EEA (2024). However, it has to be expedited to meet and exceed the EU renewable energy target of 42.5% (aiming at 45%) of final energy consumption in the EU27 by 2030, and more so to reach 50% in 2030 according to the PAC scenario. This transition should be guided by clear EU-level phase-out dates for fossil fuels, while ambitious levels of energy demand reduction assist in the renewable take over of the power sector, preventing unnecessary extensions of fossil fuel usage.

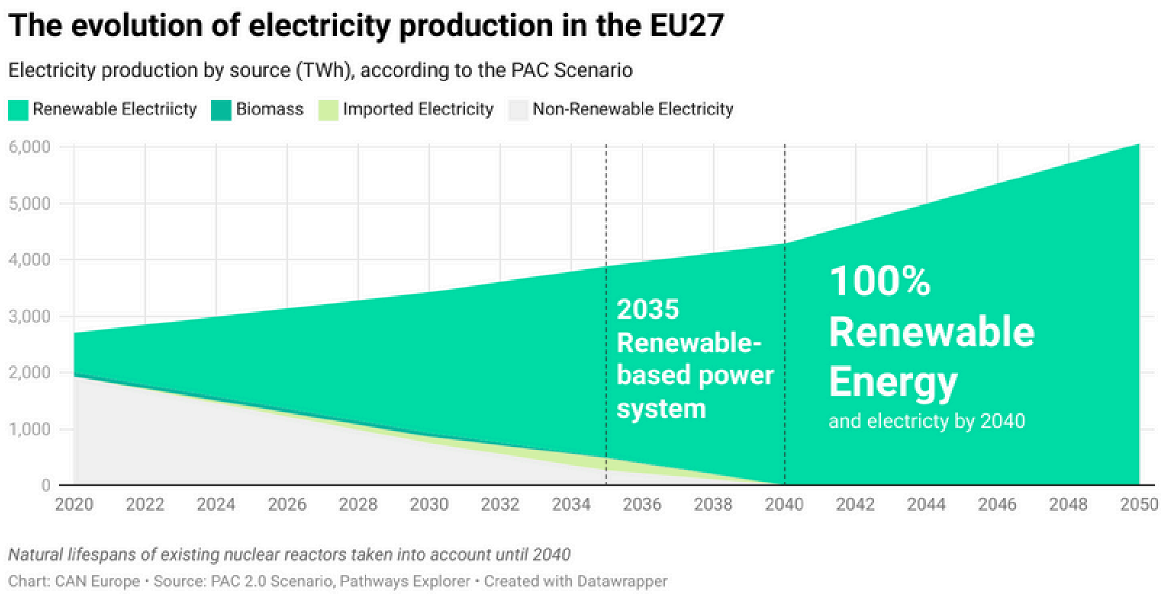


Figure 1. Evolution of electricity production in EU25: renewable vs. non-renewable electricity by 2040.

1 The 100% renewable energy system will primarily be based on high shares of solar and wind resources, produced in a far more decentralised and distributed manner, supported by far higher levels of flexibility, transmission, energy storage across time durations, as an affordable and secure supply of electricity.

IIn PAC, the EU's electricity production rises from 2020 to 2040. Specifically, it increases by 27% from 2020 (at 2,696 TWh) to 2030 (at 3,424 TWh) and 58% from 2020 to 2040 (at 4,270 TWh), to be fully produced through renewable energy sources.

Meeting future electricity needs while phasing out fossil fuels (coal by 2030 and fossil gas by 2035 from the power sector) will require tripling renewables between 2020 to 2030, substantially increasing the annual deployment rate of renewable energy sources, reaching around 102–118 GW in the EU27 by 2040, and much more if we fail to substantially reduce the energy demand.[2] As shown below in Figure 2, to meet the PAC 2.0 pathway, higher shares of deployed solar and wind energy would contribute to a total of installed renewable capacities of (at least) 1.2 TW by 2030, 2.0 TW by 2035, and finally, reaching more than 2.5 TW in 2040, translating to around 1.6 TW of solar, 700 GW of onshore wind and around 200 GW of offshore wind, while also halving energy demand.

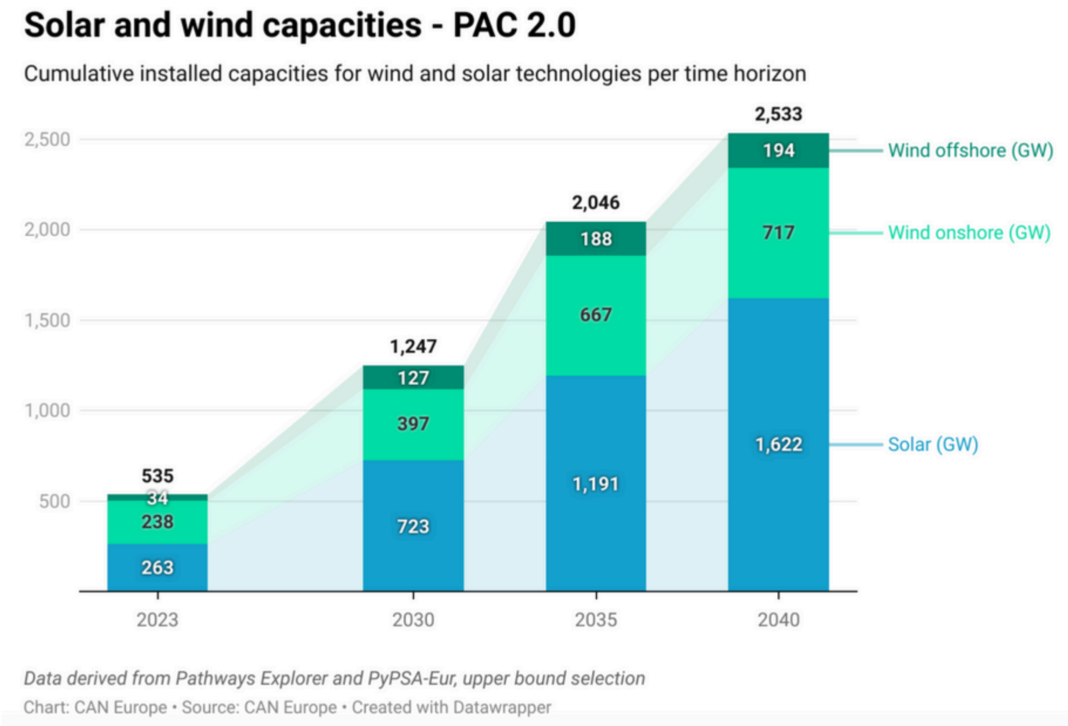


Figure 2. Total wind and solar installed capacities per technology and time horizon (EU27) [installed capacities, in gigawatts, GW]. Data: PAC 2.0 scenario, p. 20

2. As a comparison, in RES deployment, Eurelectric's Radical Action scenario is close to our estimated range, as it calls for 98 GW (2024, p. 28) of installed RES (solar PV, offshore and onshore wind) to be deployed annually. As a difference, it still keeps around 10% nuclear power in the electricity mix. Its energy demand is also higher than in PAC, with a demand of 6,775 TWh of electricity in 2040, and 7,540 TWh in 2050. Because this scenario assumes a 2050 timeline, therefore, it would fail to realise the outlined benefit of PAC 2.0 to the EU's carbon budget. Our estimated RES deployment rate at PAC 2.0 calls for more ambition than the electrification industry's scenario of "Radical Action", which although similar for RES deployment, is not as ambitious on demand reduction.

Reducing and electrifying overall energy demand

Renewables-based electrification entails electrifying energy consumption and meeting the new demand for electricity with renewable power. The PAC scenario demonstrates that the fastest way to increase the electrification rate is to tackle it from both ends - lowering the overall energy demand, making the objective easier to reach, and rapidly electrifying demand by shifting technologies and supplying cheap renewable power.

While the electricity production significantly increases, Figure 3 shows the overall decrease in energy demand until 2040, where buildings, industry and transport show significant levels of demand reduction, aided through energy savings measures, including electrification of processes, and lifestyle changes. Overall, energy demand reduction needs to happen in all sectors and in line with the Paris Agreement goals. **Without an ambitious reduction in energy demand leading to at least 20% energy savings by 2030 and to halving energy demand in 2040, the battle to electrify demand, coupled with renewable deployment needs, would be strenuous, delaying climate neutrality and fossil fuel phase-out, while increasing costs and the usage of materials, land, and water.**

The Energy Efficiency First Principle should systematically guide all energy planning, dedicated policy-making and investment decisions. However, this principle needs to be translated into reality across member states[3] which starts by adequately transposing Article 3 of the Energy Efficiency Directive into national law and ensuring that energy efficiency is put on the same level as supply-side options. alternative approaches, frameworks and cost-efficient energy efficiency measures.

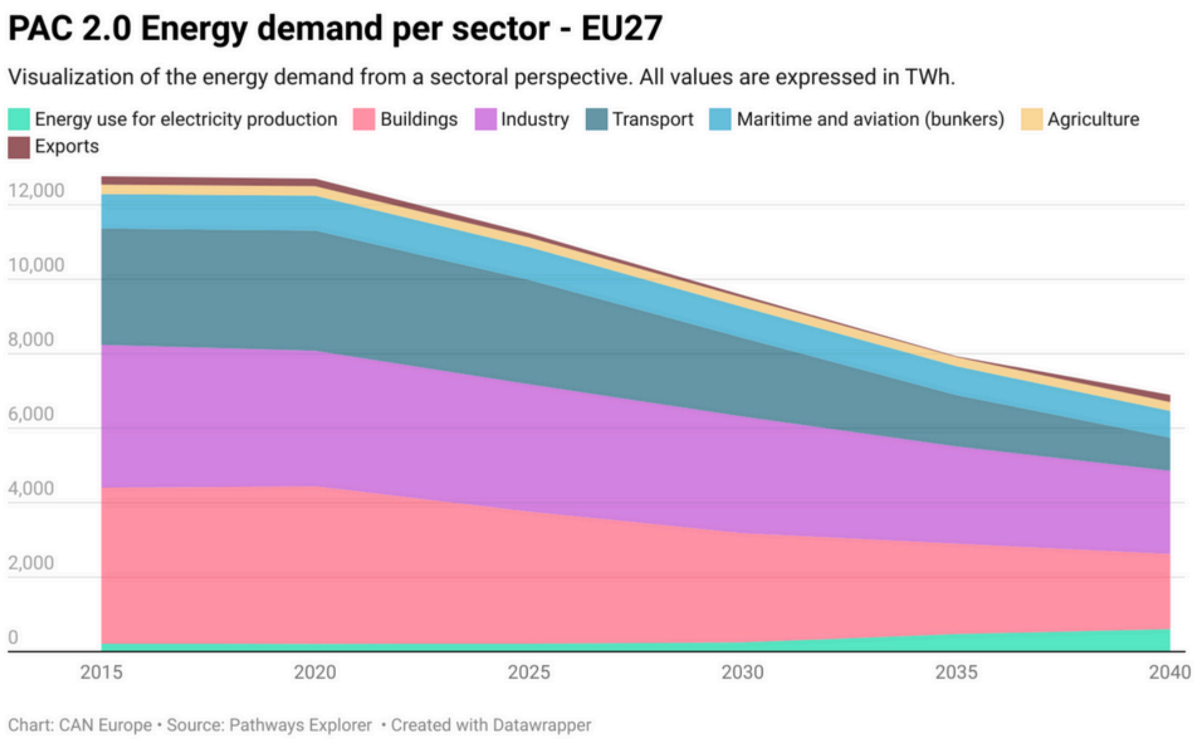


Figure 3. Sectoral demand, and their reduction potentials by 2040, Paris Agreement Compatible scenario. Technical note: Not aligned as per EED 2023 methodology.

3. According to ACER, EE 1st Principle is also not adequately reflected when European cross-border energy infrastructure is developed.

Under PAC 2.0, achieving climate neutrality relies heavily on the massive electrification of the key demand sectors: buildings, transport and industry. Overall, PAC 2.0 presents a high direct electrification rate, reaching 43% by 2030 and 69% by 2040, where direct electrification entails renewable electricity consumed directly by key sectors. In addition to this, there is indirect electrification, where renewable electricity is used to first produce hydrogen or ammonia, and then later used in industry, aviation or shipping. Direct electrification must be first prioritised, before allowing for a limited and strategic use of indirect RES-based electrification[4]. Figure 4 showcases direct electrification rates of these sectors, increased through technology changes and demand reduction[5].

The **power sector** will be nearly 100% renewables-based by 2035, as the first one to decarbonise, and can assist other sectors through renewables-based electrification[6]. Coal will be phased out in 2030 and there will be no more fossil gas in the power sector after 2035. Electrifying with renewables realises energy efficiency gains, as a lot of energy is lost when fossil energy sources are burnt to produce electricity. Operating as a 100% renewables-based system by 2040, existing power grids must be rapidly improved and considerably more transmission grids will be necessary to accelerate RES deployment and their integration, complemented by energy storage.

In **buildings**, as compared to around 35% electrification levels in 2020, 60% of the sector will be electrified by 2040, as per PAC. Due to current low annual renovation rates, deep renovation rates must begin to increase to achieve a 3% rate by 2030, and when coupled with the installation of renewable heating solutions as heat pumps, they would lead to an average saving of 78%. After 2030, these renovation rate levels must be maintained. Fossil gas boilers must be phased out. As an upshot, heating energy demand can reduce by 32% in 2030 and by 57% in 2040 compared to 2020 levels. As a result, in the building sector, it could be possible to reduce energy consumption in total by almost 50% by 2040.

In **industry**, the sector is 2.5 times more electrified and sees electrification rates reach 57% by 2040. In PAC, EU competitiveness results from higher circularity, resource efficiency and improved eco-design of products, requiring lower levels of different materials, and primary raw materials used. To achieve this, direct electrification should be prioritised for low-temperature industrial heat, limited indirect electrification, with some renewable hydrogen saved for heavy industries[7]. As concerns steel transformation, alongside higher secondary use rates with scrap steel, ironmaking production to produce primary steel can use direct reduction of iron ores (DRI) instead of blast-furnaces, shifting towards fully renewables-based hydrogen (H2) to power DRI plants, already from the 2020s onwards, and to be accelerated in 2030s.

4. Indirect electrification should be left to priority sectors, such as heavy industry, with a limited amount of synthetic fuels, as e-fuels, to be used to produce green ammonia for marine, and e-kerosene for aviation fuels. Therefore, hydrogen, as renewable hydrogen that can be produced from surplus renewable electricity, is mainly used for heavy transport and hard to abate industries.

5. Agriculture and other sectors were more simply modelled, so their electrification rates are not reported here.

6. Currently, although Sweden, Finland and Bulgaria are EU forerunners in direct electrification, as per EEA, this is not necessarily renewables-based electrification. Bulgaria also has higher carbon intensity in electricity generation than the two others.

7. As also suggested by other studies, low-temperature processes (200-400°C) can be directly electrified… with heat pumps and electric boilers, shaping chemical processes... Low-temperature process heat demand like food or pulp and paper can be largely electrified with today’s technologies. Medium-temperature processes (400-600°C), also with steam can be… High-temperature heat (600°C+) is more difficult, but can benefit from technological developments.

(Electric boilers, engines and industrial heat pumps also can replace fossil fuels in industrial processes.)

In **transport**, efficiencies are brought thanks to electrification, a smaller car fleet, modal shift and improved public transport. For system efficiency, electric engines are far more efficient than internal combustion engines (ICE). Electrified transport provides a valuable flexibility service for the future energy system. As concerns phase-outs of cars with internal combustion engines, unless we can rapidly begin to transition the existing car fleet, there is a considerable risk of prolonging the circulation of 'old' cars (ICE) on Europe's roads in 2040. In addition to this, aviation will demand e-kerosene and marine sector green ammonia.

PAC 2.0 - Electrification rate

Sectoral electrification rate %, according to PAC 2.0

Sector	2020	2030	2035	2040
Buildings	35	47	54	60
Industry	24	39	48	57
Transport	2	19	44	79

Table: CAN Europe analysis • Source: PAC 2.0 Executive Summary, p. 37-38 • Created with Datawrapper

Figure 4. PAC 2.0 - Electrification rate, as the system moves towards 100% RES supply.

2. 6 barriers holding back RES-based electrification

Europe's grids are curtailing renewables, and without huge investment, renewable integration will be significantly delayed

Europe is currently facing high levels of grid congestion, which is curtailing renewable energy and rising overall system costs. According to ACER, the cost of managing grid congestion in 2023 in the EU was 4.2 billion euros, where grid congestion in the EU curtailed over 12 TWh of renewable electricity in 2023, causing additional 4.2 million tons of CO_2 emissions.[8] Looking at the future, the Joint Research Centre (JRC) foresees high levels of redispatch in 2040, a situation where the output of renewable and fossil plants is adjusted to solve grid congestion, often resulting in higher emissions, even in a scenario which foresees the total grid length in Europe increasing by more than a third, where 310 TWh of renewable energy could be curtailed because of grid congestion, which equals half the electricity production from wind and solar in the EU in 2022. These costs come from the need to pay renewable generators to curtail their energy in one part of the grid and to pay fossil plants to increase their outputs in another. This could increase the cost of grid management from 26 billion euro in 2030 to a staggering 103 billion euro in 2040 if business-as-usual continues, though the more ambitious scenario from the JRC which increased high levels of grid expansion would see costs rise from from 11 billion euro in 2030 to 34 billion euro in 2040.[9]

8. 2024 Market Monitoring Report (2024)

9. Redispatch and Congestion Management

According to ENTSO-E, annual investments of €6 billion in cross-border infrastructure through 2040 can yield €9 billion per year in generation cost savings, while avoiding 42 TWh of renewable energy curtailment each year, optimising renewable energy usage, to cut CO_2 emissions by 31 million tons annually.

To facilitate renewable energy capacities, rates of transmission capacity and interconnection are increased in the EU25 (Malta and Cyprus not included) + 8 TYNDP countries, according to the PAC 2.0 results (Figure 5). Transmission capacity would need to grow by at least 47% by 2030, reaching 404 GW, consisting of both AC and DC cables, compared to 2021. Furthermore, reaching a 634 GW total grid capacity by 2035 translates into an increase of 131%. A substantial increase in DC cables by 2035 transfers renewable energy around an increasingly electrified Europe. Finally, grids would need to reach 668 GW of total capacity by 2040, indicating an increase of 144% in their capacity over time, compared to current levels, as frontloaded investment, costing 31-42 billion euros annually. As a note, distribution networks were not modelled.

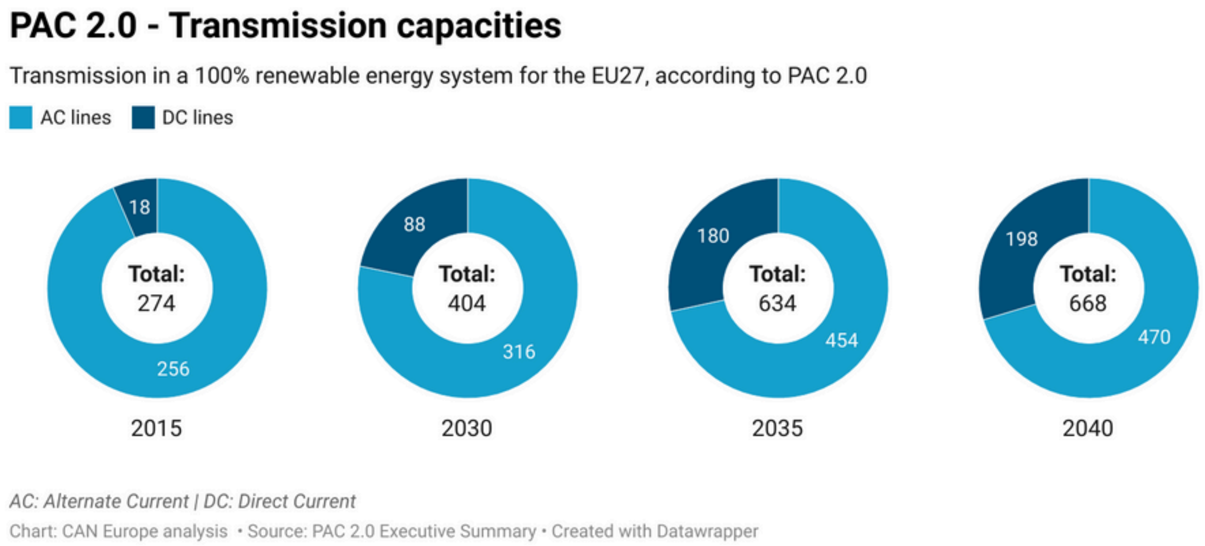


Figure 5. Power transmission capacities for EU27

The EU Commission foresee a 584 billion euro investment need in grids this decade,[10] while Eurelectric foresees the need for 375-425 billion euro of investment in distribution alone by 2030.[11] **Without tackling grid congestion, Europe is in no position to embark on a strategy of electrification as cheap renewable electricity will fail to be integrated into power networks.** On top of this, it will be important to decrease the base load demand of the energy system and tackle peak loads through demand-side flexibility options.

10 Grids, the missing link - An EU Action Plan for Grids (2023)

11. Connecting the Dots (2021)

Case study: Grid congestion holding back renewables in the Netherlands

The Netherlands has seen some of the highest grid congestion issues in Europe, limiting the connection of new wind and solar and the electrification of industrial processes. Analysis by RAP[12] highlights how the Dutch government and TSO have had to embark on a series of quick fix measures to ease congestion, including tightening mandatory participation in congestion management for grid users, capacity limitation contracts, non-firm connection contracts, connection sharing, priority lanes for certain projects, releasing unused contracts capacity (industry often applies for higher capacity than required, and must "use it or lose it"), and compensation for local communities near the development of infrastructure.

While these fixes help connect new renewable capacity and demand to the grid, some of these measures rely on continued curtailing of renewables (though with an aim for higher overall renewable penetration), and further grid development and modernisation is required to meet electrification and decarbonisation needs.

High electricity prices make it less attractive to shift away from fossil gas

Following Russia's unjustified full-scaled invasion of Ukraine in February 2022, and combined with the economic effects of the COVID-19 pandemic, Europe has faced an unprecedented energy crisis, with record-high energy prices due to the EU's dependency on Russian fossil fuels. While prices have reduced from their historic levels reached in 2022, they have not returned to pre-crisis levels and will remain high as long as the EU only diversifies its suppliers instead of putting structural measures[13] for a fossil gas phase out in place. Due to the prevalence and role fossil gas has in the electricity mix, the price of electricity remains high. As illustrated in the Draghi report on competitiveness[14] figure X shows the amplified role fossil gas has in setting the price of electricity in the EU, setting the price in 63% of hours, though only contributing to 20% of the electricity mix.

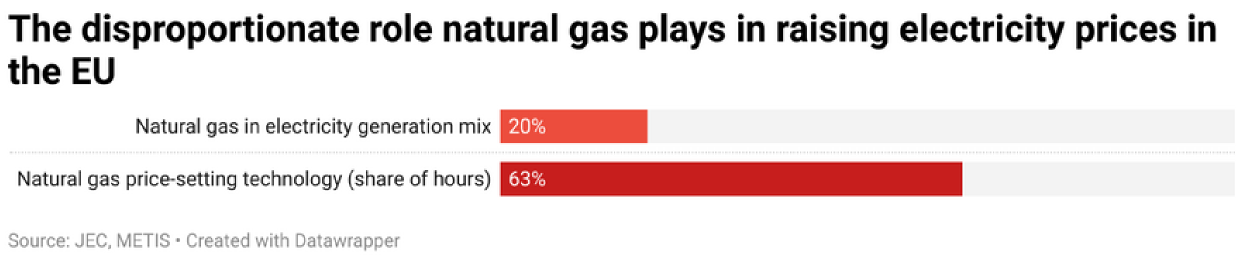


Figure 6. Fossil gas in EU electricity mix against how many hours electricity prices were set by gas

The Draghi report's main focus on electricity and energy prices is to promote European competitiveness, and recommends using tools introduced in the revised Electricity Market Design to reduce the role fossil gas plays in setting energy prices, through the introduction of Contracts for Difference (CfD), Power Purchasing Agreements (PPA) and flexibility.

12. RAP (2024), Gridlock in the Netherlands
13. See Civil Society's 10 Point Plan for a Fossil Gas Phase Out (2023).
14. The future of European competitiveness (2024)

What the report neglects to investigate is how much gas and electricity prices need to differ to incentivise the switch to electrified demand, and how this switch can be managed in a way that is equitable and socially just. This is especially evident when the report recommends measures for lowering the price of fossil gas, rather than trying to make the price better reflect environmental costs, and additionally recommends the lowering taxes, levies and charges on electricity, particularly to benefit industry without a mention on who would have to shoulder the costs.

Most heat pumps run on electricity, but electricity is about three times more expensive than fossil gas in most European countries. This means that the significantly greater efficiency of heat pumps does not translate into equally higher economic benefits for the user. This situation steers consumers towards less sustainable solutions, and increases overall costs for society. Figure 7 gives an overview of households electricity to gas price ratios, where a ratio of 2 is seen as a tipping point to incentivising the use of electricity-based heat pumps.

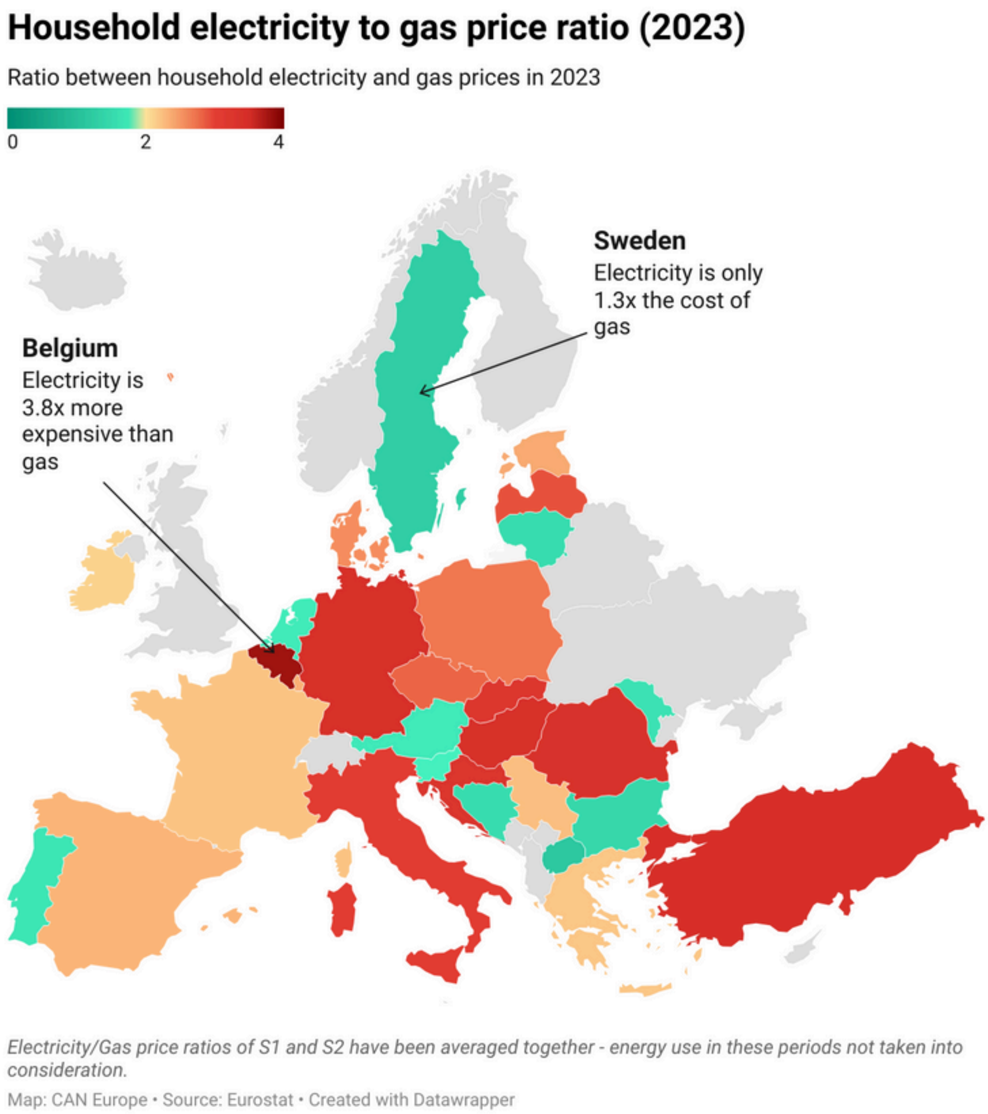


Figure 7. Average electricity/gas price ratios in Europe in 2023

13. See Civil Society's 10 Point Plan for a Fossil Gas Phase Out (2023).
14. The future of European competitiveness (2024)

On average in Europe, energy prices do not accurately reflect environmental costs, and this can be seen in the levels of levies and taxes put on electricity and significant under taxation of gas. Governments should reverse this distorted pricing by readjusting taxation levels, based on the climate impact of the different fuels and energy carriers. That would mean a reduction of environmental taxes, and other taxes and levies applied to electricity, and shifting to fossil gas and oil. This would ensure that customers are guided towards renewable heating solutions and incentivise electrification.[15] Any shift would have to be done in a manner that protects the most vulnerable in society, for example, through the use of direct payments to cover rising energy bills as was done in France during the energy price crisis in the form of an "energy cheque", or via targeted investment in renovating households on lower incomes.

When it comes to cooking, the residential electricity to gas price ratio is more favourable, where in the majority of EU member states it is more economic to cook with electricity than gas.[16] However in 2021, less than 50% of energy used for cooking in households was sourced by electricity, highlighting that initial costs for consumers to electrify may still be too high, that gas units are too cheap and do not reflect their environmental and health costs, and Member States require further action.

Upfront costs are expensive for households

Renewable heat will be brought to residential buildings to a large extent through individual heating systems: heat pumps and solar thermal collectors, among others. The upfront costs of some heat pumps are higher than those of gas boilers. This is true for ground-source and water-source heat pumps, but also for air to-water heat pumps. On the other hand, air-to-air heat pumps, which are suitable for the mild weather of most southern Europe regions and can be used for cooling, are competitive with gas boilers. If one looks only at initial costs, replacing a gas boiler with a heat pump might therefore look like an expensive undertaking, but heat pumps consume several times less energy than gas boilers, and therefore their operating costs are typically smaller. If the user decides to also insulate the building, and/or to replace old radiators with low-temperature ones, or with underfloor heating, or become a flexible consumer able to change their time-of-use vis-a-vis hourly electricity prices, the operation costs (and upfront) costs of a heat pump will be even lower. But that requires additional upfront investments.

The Joint Research Centre 2023 study agreed that the high upfront costs of heat pumps were a barrier to deployment, risking the exclusion of vulnerable households from the clean energy transition. With energy poverty as high as 21% of the EU population, electrified heating and cooling will be unattainable to many, with benefits only reaching higher-income groups.[17]

15. RAP (2022), Levelling the playing field: Aligning heating energy taxes and levies in Europe with climate goals
16. The Future of Cooking in Europe (2024)
17. The Heat Pump Wave: Opportunities and Challenges (2023)

Electrifying industrial operations would require new flexible processes and significant volumes of electricity

Three quarters of the EU's industrial emissions are due to fossil-based processing heat used for the production of goods such as chemicals, steels, paper, food and beverages. It has been estimated that 90% of industrial energy demand not yet electrified can be met via direct electrification with the use of technologies expected to be available by 2035, and that today heat pumps and electric arc furnaces could meet over 60% of this demand. While low-temperature processes, such as food, pulp and paper can be largely electrified using today's technologies, higher-temperature processes, including nonmetallic minerals like cement, lime, glass or ceramics, will require the development of new technologies.[18]

A recent study by Sandbag sought to investigate the barriers faced to decarbonise aluminium and steel production, highlighting the risk of round-the-clock production cannibalising electricity produced by renewables injected into the grid for all users to benefit from. The inflexibility of these processes would incentivise the use of fossil-based forms of flexibility, namely gas turbines, to produce during periods of lower renewable energy production, as industrial demand is currently unable to shift its consumption. Electrolysers for hydrogen, necessary in many cases, to be used in the steel-making process, alongside electric arc furnaces, would put significant strains on the electricity grid, causing further congestion on an electricity system which already experiences costly bottlenecks. Whereas in the past, the use of fossil-based technologies have allowed some industrial players to operate as "energy islands", and limit direct impact on other actors, electrification would force energy-intensive industries to compete for renewable electricity, putting pressure on other industries and households.[19]

To mitigate these risks, investment is required to electrify industrial processes, while increasing renewable penetration and energy storage both onsite and on the grid, modernising the electricity network, and synchronising operating hours with the availability of renewable electricity. These alterations would need to happen simultaneously to avoid any negative spillover effects to other actors, such as the increased price in energy for households, or the continued reliance on fossil fuels, in particular new fossil gas turbines. An example of preventing these negative spillover effects would be investors committing to installing renewable and energy storage capacity which would directly meet the needs of onsite electrolysers.

The cost and attention given to industrial transition also risks distracting resources away from households and communities, and in the worst case scenario, risks making consumers, including those on lower incomes and the most vulnerable, subsidise industry to make these investments and to keep industrial electricity prices low to support competitiveness.

18. Agora Industry (2024): Direct electrification of industrial process heat

19. Sandbag: Metallurgical flexibility, enabling the aluminium and steel sectors for demand response. (2024)

Case study: Current EU State Aid for steel electrification risks fossil lock-in and conflict with consumers

Under the Temporary Crisis and Transition Framework, the EU Commission has approved three recent projects aimed at decarbonising the steel sector in Sweden, France and Germany, with a combined value of 2.415 billion euros.[20] [21] [22] In France and Germany, coal-based blast furnaces and basic oxygen furnaces will be replaced by electric arc furnaces (EAF) and direct reduction plants (DRP). However, the DRPs will initially be fueled by fossil gas transitioning to hydrogen, low-carbon or renewable. This risks locking in fossil fuels for longer than necessary.

The Swedish project on the other hand aims to build a new plant and construct a 690 MW electrolyser to produce renewable hydrogen onsite.

While investment is vital, these projects fail in many regards:

1. No commitment for industry to further advance renewables to supply higher electricity needs, which risks putting them in direct competition with households and other industries.
2. Little commitment to make processes align production with renewable electricity availability, risking grid congestion and the need for fossil-based backup power.
3. No application of the polluter pay principle, where public finance has been allocated to industries with high levels of historical greenhouse gas emissions.
4. Consumers are still footing the bill via taxation, while shareholders are paid out dividends.

Flexibility sources, such as energy storage, are being deployed too slowly

The deployment of cheap renewables to meet the needs of electrification and decarbonisation will need to be coupled with a rapid roll out of flexibility, including energy storage, demand response, and interconnection. This lack of flexibility is holding back wind and solar today, and will become an increasing issue in the future. The PAC scenario foresees in a 100% RES system the increasing importance of energy storage, which begins to be seen after 2030.

In the PAC 2.0 pathway, shown in Figure 8, home batteries reach 55 GW in 2035 and 65 GW in 2040 in the EU25 (Malta and Cyprus not included). Grid-scale batteries see a dramatic increase to 149 GW in 2030 and 225 GW in 2040. Pumped hydro storage (PHS), able to respond to demand and generation changes within minutes, is anticipated to remain at 48 GW across 2030, 2035 and 2040 for EU27.

As for the use of hydrogen for storage purposes, the role of H2 fuel cells begins to be seen from 2035 onwards, at 62 GW, and 66 GW by 2040. All in all, H2 fuel cells will reach around one fourth of battery capacities. H2 electrolysis capacities will grow from 10 GW in 2030, to 20-fold to 192 GW in 2035 and 30-fold at 299 GW in 2040. Finally, ammonia also plays a role in long-term storage. Green ammonia will reach 46 GW in 2035 and 65 GW in 2040.

20. Commission approves €265 million Swedish State aid measure (2024)
21. Commission approves €850 million French measure (2023)
22. Commission approves €1.3 billion German State aid measure (2024)

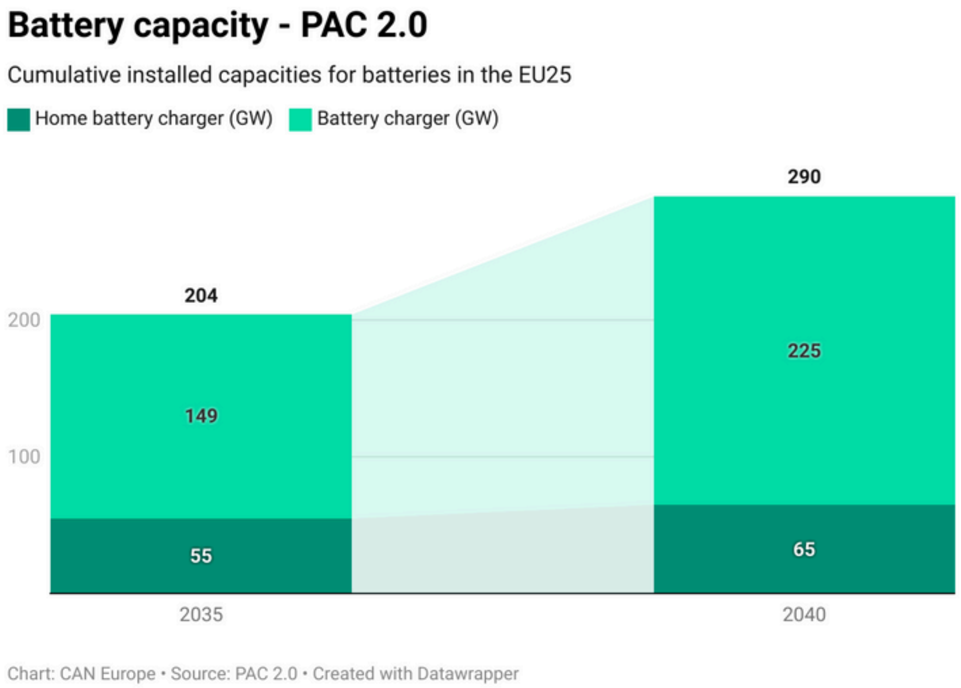


Figure 8. PAC 2.0 H2, batteries and ammonia capacities (GW) for 2030, 2035 and 2040

As reported by Ember, between August 2023 and July 2024, nine EU countries saw solar reaching more than 80% of domestic demand in some hours, where at times solar in the Netherlands and Greece exceeded 100%. Renewable integration is already hitting its limits, and without action on flexibility, this could stall electrification. Ember reports that EU countries could save 9 billions euros in gas annually by 2030 through the deployment of batteries and interconnectors and shifting this excess power and that Germany alone could have avoided 2.5 million euros in fuel costs in June 2024 with an additional 2 GW of battery storage.[23]

Case study: Only a handful of EU countries have set energy storage targets

The revised Electricity Market Design calls for EU countries to conduct flexibility needs assessments, and to set a flexibility objective in their NECPs to meet these needs, with information on the levels of energy storage and demand response required to meet this objective. Furthermore, Member States can enact flexibility support schemes to support non-fossil flexibility. There remains a risk that Member States may seek to use fossil gas turbines as a means of meeting flexibility needs.

In the most recent draft and final updated NECPs, six EU countries have set an objective for energy storage for 2030, with Spain having the highest of over 22GW, Romania setting a 1.2GW target on just batteries, Hungary with 1GW, Ireland setting a target for long-duration energy storage of 1.7GW, Portugal with 2GW for batteries and 3.9GW for pumped-hydro storage, and Lithuania with 250MW for electrical energy storage.

Europe is far behind on its interconnection objectives

Interconnection between EU countries is vital to ensure renewable electricity can be shifted during times of high production to regions in need of power, to avoid grid bottlenecks and lower overall energy costs across Europe. Interconnection can also support the phase out of coal plants and gas turbines used as back-up capacity in member states, often in the form of capacity mechanisms, by using available renewable electricity next door. Europe is better off relying on its neighbours, not fossil fuels.

To support interconnection, the EU has set a target of at least 15% by 2030, meaning EU countries must have enough cross-border transmission capacity to facilitate the possibility of 15% of their electricity production within its territory to be transported to its neighbouring countries. In 2024, 16 member states have already met their interconnection targets well before 2030, easing the pressure off electrification. However the remaining 11 countries representent the vast majority of installed capacity of wind and solar, totaling 86.3% in 2022, as demonstrated in Figure 9, suggesting significant work is required to increase the interconnection rate in these countries, while also increasing the supply of renewable power.

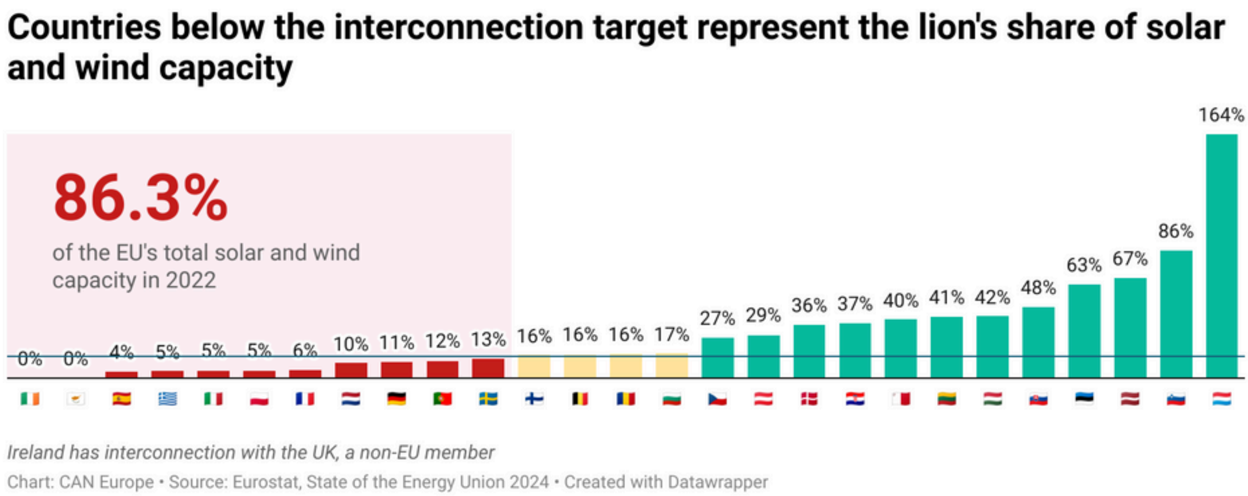


Figure 9. EU countries' contribution to meeting interconnection targets against installed capacity of wind and solar

Case Study: Poor interconnection is causing renewable curtailment

The Iberia Peninsula can largely be considered as an electricity island within the EU, due to its low interconnection ratio of only 2.8%. One key future interconnector is the Bay of Biscay project, listed as a Project of Common Interest, which aims to bring about 5,000MW of transmission capacity between Spain and France. However, the recent delay of this project, from 2030 to 2035, risks the continuation of renewable curtailment and price cannibalisation in Spain, and means the country will miss the 2030 15% interconnection target.[24]

24. Ember (2024), EU battery storage is ready for its moment in the sun

3. The risks of getting it wrong

Electrification alone will not drive renewable deployment and phase out fossil fuels

As demonstrated in the PAC Scenario, renewables are the cheapest and fastest option available to decarbonise energy and supply an increased electricity demand. The use of renewables can keep electricity prices low, which incentivises the switch from gas to renewable-based solutions in households and industry, supporting European competitiveness and the essentials for consumers. Additionally, the act of electrifying the demand-side supports the business case for new solar and wind development.

However, an electrification target alone is not enough to drive renewable deployment. Only political commitment with renewable energy and energy savings targets, proactive energy system planning, supportive frameworks, and sending the right signals will guarantee the increase in renewables, as seen by previous EU and national targets. Without targets, the electrification of the demand-side risks opening up new business opportunities for fossil fuels, such as the continued use of coal-fired power plants, and new gas turbines, which risks raising electricity prices and further coupling it to gas, causing a negative feedback, potentially stalling electrification.

The aim of an electrification strategy should be to enable renewable electricity, together with renewable heat, to decarbonise the energy system and replace fossil fuels. However, theoretically an electrification target could be met through building new fossil gas plants or increasing the operating hours of coal-fired power stations. For this reason, fossil-fuel phase out dates must be an integral part of a strategy for electrification.

Figure 10 below demonstrates how deploying more ambitious measures for 2030, reaching 20% energy savings and 50% renewable energy, and having a post-2030 framework for renewable energy with targets leading to 100% renewable energy and halving energy demand by 2040, and EU-level dates for fossil fuel phase out can create a positive feedback loop. Here, cheap renewables lower electricity prices, incentivising the switch to technologies which electrify demand, which opens further opportunities to renewables. On the other hand, continued fossil-fuel use with a less favourable framework for renewables would keep higher prices across the EU, stalling the effect of electrification, which blocks new opportunities for renewables. If electrification is to be a success, it is to be renewables-based electrification.

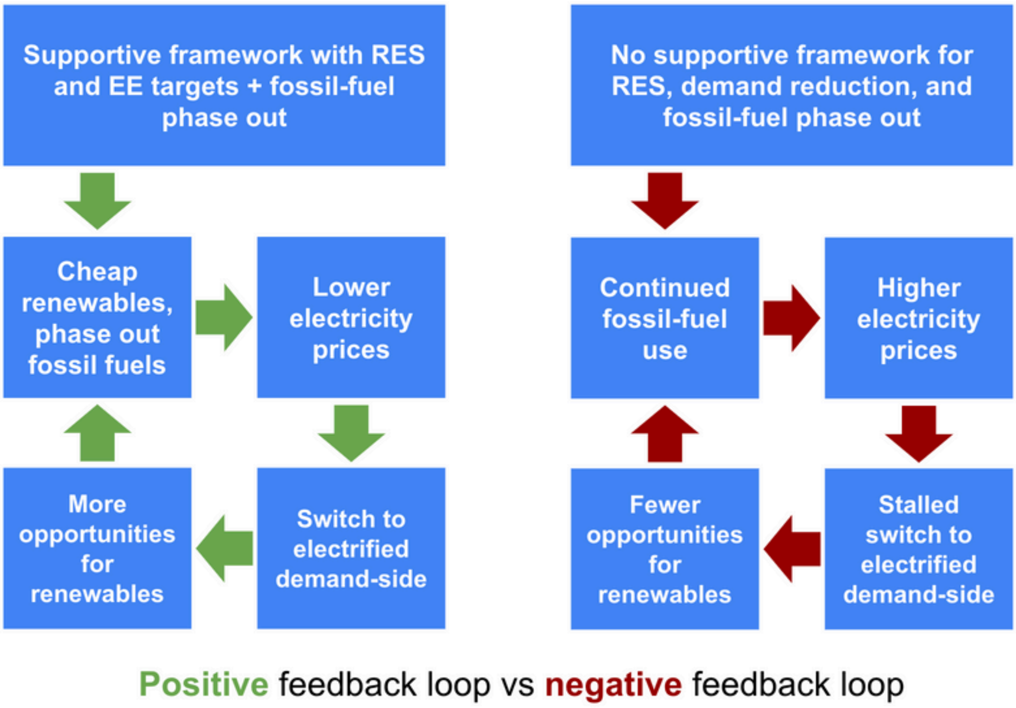


Figure 10. Demonstration of positive and negative feedback loops depending on frameworks surrounding electrification

Case Study: Poor renewables growth stalling electrification in Slovakia

In 2022, Slovakia had the lowest share of solar and wind making up the production of electricity in the EU, at only 2.4%, almost all of which was provided by solar.[25] Looking at energy as a whole, in its draft updated NECP, Slovakia has set a very low renewables target of 23% by 2030, up from only 17.4% in 2021.[26] This translates as the lowest growth in renewables capacity by 2030 per capita in the EU.

Under current conditions, renewables-based electrification in Slovakia is at a standstill. The country has 3 possible pathways:

1) bet on new nuclear, delaying decarbonisation, at high costs with the risk of new power plants not materialising,
2) fossil-based electrification with gas, increasing electricity production and flexibility, however locking the country further into fossil fuels and high prices, or
3) investments in renewables, energy storage and demand response, therefore benefiting from cheaper electricity, speedy electrification, faster decarbonisation, and energy autonomy.

25. EuroStat (2024), Shedding light on energy in Europe – 2024 edition
26. Slovakia draft updated NECP (2023)

Electrification risks distracting from overall energy savings, and not complimenting it

IIn many cases, electrification can be seen as a form of energy efficiency, ideally leading to energy savings. Take for example the replacement of gas boilers with heat pumps, where once gas was inefficiency burnt directly within the households. The energy needed to power the heat pump will in future come 100% from renewable sources, whether from renewable electricity, or from geothermal heat. However, not all energy efficiency means electrification and it is important to distinguish, as important levers for energy savings, such as building renovations or more efficient appliances or vehicles significantly reduce fossil fuel consumption, bring energy prices down and enhance competitiveness. At the same time, implementing energy savings measures can minimize the increase of electricity demand.

It is vital that energy efficiency gains lead to greenhouse gas reductions and not, paradoxically, into the growth of unnecessary electricity sinks such as data centres, AI, advertising, etc, all of which would in fact help advancing electrification, but not energy demand reduction. Therefore, the PAC scenario utilises overall energy demand reduction and electrification in tandem, to reach rapid emissions reduction, instead of an electrification-only approach.

The more energy demand reduction, the less energy needs to be electrified, making the transition faster, cheaper and less material intensive. This is represented by Figure 11 below.

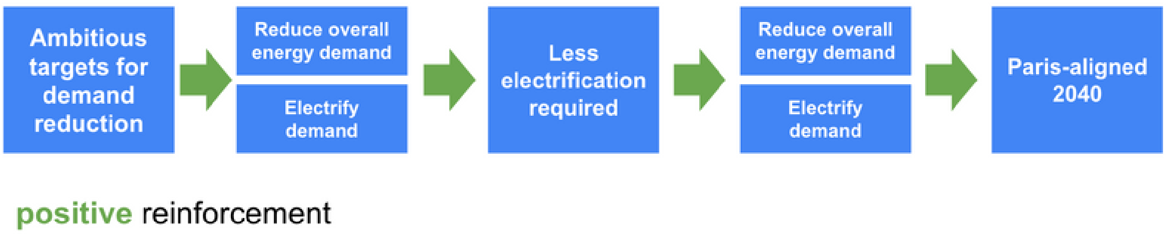


Figure 11. Energy demand reduction and electrifying demand should work together

However, without translating the Energy Efficiency First principle into strategic plans and tangible action, there is the risk that any energy savings and increased renewable electricity supply will be quickly undone by the growth of unproductive activities, and that the use of gas may be redirected toward electricity production, diminishing the effect of renewables decarbonising the energy system, and raising overall material usage.

Therefore, an electrification strategy needs to incorporate demand reduction, making sure that both go hand in hand.

Figure 12 below demonstrates this negative feedback loop.

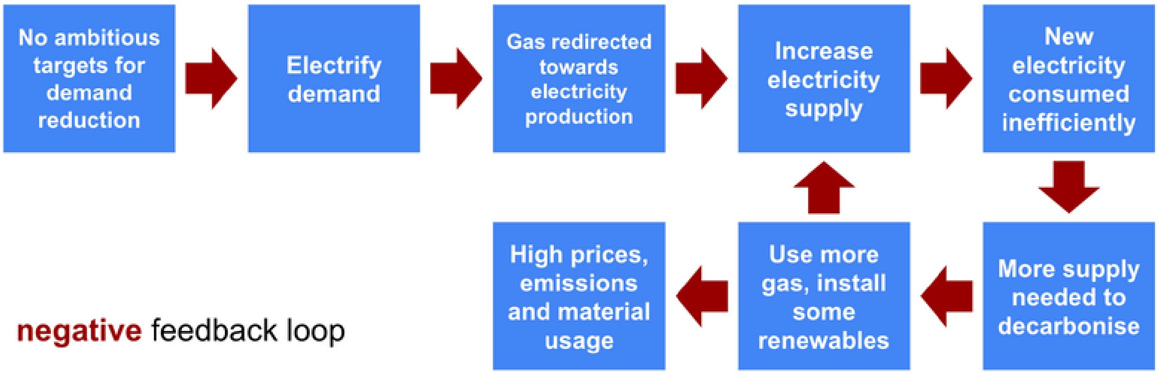
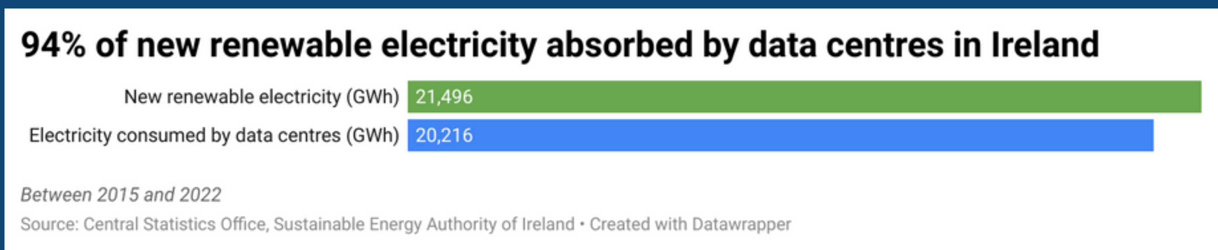


Figure 12. A negative feedback loop for electrification if energy demand reduction is not considered

Case Study: Data centres in Ireland

In Ireland, the increasing number of data centres has been a growing political debate, as significant shares of electricity are required each year to sustain the growth, causing grid congestion issues, higher electricity prices, and a stagnation in the energy transition. The share of electricity consumed by data centres in Ireland rose from 5% in 2015 to 21% in 2023,[24] higher than the consumption of urban dwellings.

When looking at new renewable electricity meeting demand in Ireland since 2015, up until 2022, and measuring it against electricity consumed by data centres in the same period, it can be seen that data centres have consumed an equivalent of 94% of all new renewable electricity.



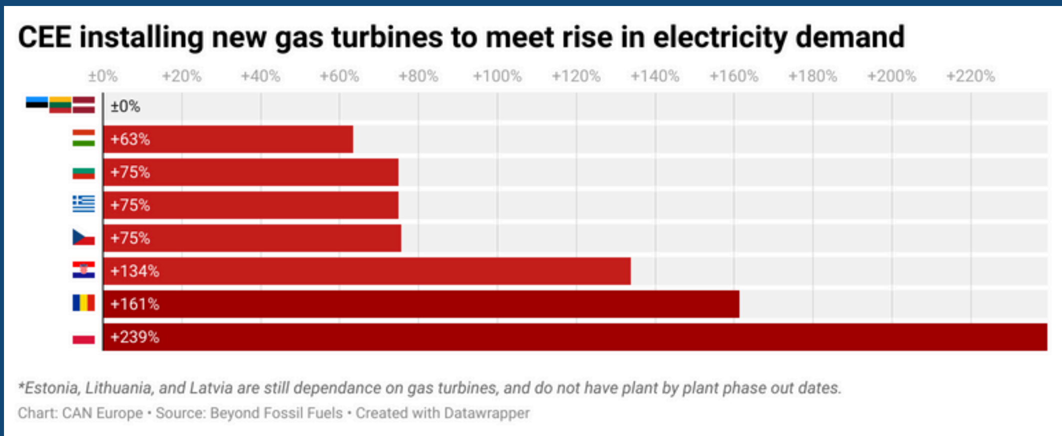
This is a clear demonstration of the need for a holistic electrification strategy which puts energy demand reduction at its core. While it can be argued that the percentage of both energy and electricity that is being met by renewables is rising in Ireland, the phasing out of fossil fuels and the electrification of essential sectors of the economy is being held back considerably.

27. Central Statistics Office - Data Centres Metered Electricity Consumption

Case study: Boom in new gas turbines to meet electrification needs in Central Eastern Europe

As a means to phase-out coal-fired power plants and meet rising electricity demands, countries in CEE have plans to expand gas-fired capacity, rather than pursuing RES-based electrification, alongside energy demand reduction measures and system flexibility. Figure 14 presents the percentage increase in gas capacity, based on projects being constructed or planned against current installed capacity, where Romania and Poland seek to double and triple their installed capacity respectively.[28]

CEE installing new gas turbines to meet rise in electricity demand



These countries are laying the groundwork for a future negative feedback loop, further delaying the energy transition. When CEE does embark on the electrification of the demand side, shifting away from gas-based heating and industrial processes, fossil gas can more easily be redirected towards electricity production with the infrastructure in place, crowding out opportunities for renewables, keeping electricity price linked to volatile fossil gas prices, slowly down the switch to further electrification, and delaying fossil-phase out and emission reductions.

Ignoring households risks delaying transition and fueling backlash

Europe has experienced significant energy prices spikes over recent years, caused by the historically high cost of fossil fuels following Russia's unjustified invasion of Ukraine in February 2022. Many households across Europe were hit with bills they were unable to pay, with national governments proposing a patchwork of protective measures to safeguard the public, though many fell through the gaps, and the root causes were left unaddressed. While prices are not what they were previously, they still remain high, during a period of cost of living difficulties for many.

The response of the far-right in Europe to these economic crises has been to fight against European environmental policies, blaming higher costs on the aspects of the energy transition. While this push by the far-right is deeply cynical and misguided given their continued support for fossil fuels - the actual drivers of the price hike -, it is a reminder that it is vital to ensure the transition is enacted in a fair and just way, and that all are able to benefit.

28. Beyond Fossil Fuels - Gas Power Plant Tracker

With this in mind, an electrification strategy aimed at appeasing industry, via subsidies and de-risking, or worse, de-regulation, and financial and environmental exemptions, which offers little in return for households is deeply unjust, and risks fueling further backlash to the transition. Additionally, a vital sector of demand that requires electrification is households, which can only be effectively electrified through investment in renovation. Ignoring this segment of demand would significantly delay the energy transition.

Case study: Far-right protests against high energy prices in favour of Russian gas in Czechia

In Czechia, public outcry over high prices during the energy crises was hijacked by far-right forces, who used the crisis for their own gain, leading people out into the streets to protest in favour of new deals to import even more fossil gas from Russia, and against the country's support for Ukraine. Rather than demanding social protections and a quick phase-out of expensive fossil fuels, the opposite message was put across - more fossil, and less social (in this case calling for limiting the number of Ukrainian refugees).

Any changes in household energy prices, both in electricity and gas, as a result of an European electrification strategy need to be viewed with cases such as this in mind. Far-right narratives need to be tackled head-on to protect green policies, benefits of electrification must be shared across society, and energy prices must be brought down by deploying more renewables to protect the most vulnerable in society.

Betting on nuclear-based electrification delays decarbonisation and raises costs

Re-orientating Europe's energy strategy towards electrification as an end goal, rather than a means of deploying renewables, reducing energy demand, and phasing out fossil fuels, risks opening the door to false solutions, such as prolonging or building new nuclear power plants.

Electrification needs to be fast, and affordable to be effective and therefore nuclear is off the table when it comes to decarbonising our energy system and playing a meaningful role in electrification. New nuclear energy projects in Europe have been plagued with delays and typically take 15-20 years for construction.[30] France's six new reactors are estimated by its network operator to enter into use in 2040-2049, much too late to have any meaningful impact.[31]

When compared to renewables, analysis from World Nuclear Industry Status Report determines that the levelized cost of energy (LCOE) for new nuclear plants makes it the most expensive generator, estimated to be nearly four times more expensive than onshore wind, while unsubsidized solar and wind combined with energy storage (to ensure grid balancing) is always cheaper than new nuclear. When compared against energy savings, it is more economically efficient to invest in the renovation of households to save energy than in the construction, operation, and decommissioning of a new nuclear reactor. Expensive electricity is only going to disincentivise the switch to electrified demand.[32]

29. Guardian: Thousands gather at 'Czech Republic First' rally over energy crisis (2022)
30. Schneider et al. (2023), The World Nuclear Industry Status Report 2023
31. Contexte (2021) - Nuclear: not yet launched, future EPRs already late and more expensive
32. CAN Europe (2024), The nuclear hurdle to a renewable future and fossil fuel phase-out

Case Study: Nuclear grid congestion and connection issues in Romania and the Netherlands

In Romania, promised new nuclear reactors Cernavodă 3 and 4 have reserved grid capacity for years, blocking new renewable energy projects in the Dobrogea region, the most wind-intensive region in the country. Delayed grid investments, due to uncertainty of new nuclear units, have also meant that capacity bottlenecks exist today for renewables online.

In the Netherlands, the operator of the Borssele nuclear power station is fighting against new offshore wind turbines being connected to the grid on land, as this might hinder the possibility of new nuclear power in the area.[33] This move is in direct confrontation with the aims to develop renewable energy through the North Seas Energy Cooperation, facilitated by the EU Commission.

In these cases, the promise of new nuclear power has not increased electricity supply, but rather prevented new renewable electricity deployment, and hampers already existing renewables.

Even when operational, the inflexibility of nuclear, caused by technical limitations, safety requirements and economic factors, prevents the feed-in of renewable electricity into the grid, causing grid congestion and curtailment.

Case study: Nuclear outages prevent cheaper electricity prices in France

During a time of high energy prices across Europe following the Russian invasion of Ukraine, existing nuclear power was being brandished as a solution to keeping electricity prices low and uncoupled from gas, Russian or otherwise. However, in 2022, French reactors faced many technical difficulties leading to, on average, French reactors producing no electricity at all on 152 days, a drop in overall output of 30%.[34]

Rather than being a next exporter of electricity, France had to import electricity, with costs somewhat cushioned by cheap renewables from Spain and Portugal. It is estimated the difference in electricity trade cost an additional 16 billion euros alone.[35]

33. Volkskrant (2022)
34. World Nuclear Industry Status Report 2023, p. 105
35. Banque France: Energy Balance in 2022 (2023)

4. Policy recommendations

Robust implementation of 2030 energy targets and set targets beyond 2030 for renewables, energy savings, and fossil fuel phase-out

Strengthen the implementation of the 2023 EED to go beyond the minimum: National contributions and energy savings measures need to overshoot the current EU 2030 energy efficiency target to achieve **at least 20% energy savings by 2030.**

Deliver an ambitious implementation of the EPBD to go beyond the minimum, through leveraging the links with both EED and RED while ensuring that strong regulation (i.e. MEPS) to trigger more and deeper energy renovations, is coupled with an adequate and inclusive enabling framework.

Ensure a prompt, robust and ambitious implementation of RED III with an active support to the EU to overachieve the updated binding 2030 target up to 50% by 2030, and with adequate forward-looking grids and ambitious network plans, in line with the Paris Agreement and European Climate Law, while putting people and nature at core of the energy transition.

100% Renewable Energy Target by 2040: Only through setting adequate renewable energy targets can we ensure the rapid deployment of renewables to decarbonise the energy system and supply cheap electricity.

A binding EU 2040 energy savings target leading to halving energy demand by 2040: The more demand reduction, the less electrification is required - making the transition cheaper, faster, and less resource intensive. Gains from electrification and energy efficiency must be used to decarbonise essential activities.

Set fossil fuel-phase out dates: At the EU level, set dates to phase out coal by 2030, gas by 2035, and oil by 2040 to avoid fossil lock-in. It is essential to prevent the electrification of demand becoming a lifeline to coal power plants and gas turbines.

For more details, see our Energy Compass for the Policy Cycle 2024-29**.**

A holistic Electrification Action Plan

Fully integrate energy efficiency and energy savings into the Electrification Action Plan: The plan should ensure that energy efficiency and energy savings are at the same level as supply-side options and accelerate the rollout of energy savings measures and investments across all sectors.

Dedicate a section of the Electrification Action Plan to households: To ensure consumers are able to benefit from cheap electricity and the electrification of heating and cooling, where appropriate. Additionally measures promoting the switch away from polluting and unhealthy fossil-based cooking, and the transition towards decarbonised transport, including public transport, should be proposed.

Include a Heating and Cooling Strategy: The plan should prioritise the connection of buildings with locally available renewable heat sources such as geothermal and solar thermal, the deployment of renewables-powered heat pumps, and decarbonised district heating. Expand and consolidate the integration of the renewable heating & cooling solutions in the context of a holistic transition in the building sector and streamline it across EU and national legislation.

Release the promised Heat Pump Action Plan: This long-awaited plan should be published without further delay ensuring long term policy signals, and clarity about the shift from fossil fuels to sustainable and renewable heating & cooling solutions.

Transform industry with a new social contract

Lower-income households cannot subsidise industry: In many countries across Europe, industry benefits from lower electricity prices compared to households. Any Member State mechanism to reduce electricity prices for industry, must ensure lower-income households and the most vulnerable are not the ones paying for it.

Make polluters pay: Industrial transformation must require industries, who have profited from worsening of the climate crisis, to pay, rather than bailing out polluters with public finances and incentives. State aid must not risk artificially extending the lifespan of polluting processes.

Conditions on public subsidies for industrial electrification: Any public money for industrial transformation must have conditions for the climate, social justice, and future generations, based on a legally-binding transformation plan with clear targets. Plans must minimise any adverse effects electrification may have on other grid users, through the commitment of industry to install renewables, reinforce grids, and enhance flexibility.

Limited, strategic use of indirect RES-based electrification at a set of heavy industries, a very small amount of heavy transport, as well as for new marine and aviation fuels.

Lower electricity prices for all with cost-efficient solutions

Reduce the cost of electricity with renewables and CfDs: Renewables, such as wind and solar, are the cheapest solution to replace fossil fuels and increase the overall electricity supply. Contract for Difference (CfDs) should be designed smartly to ensure payments from the generator to the state in periods of high prices are used to lower electricity prices in an equitable manner across consumers, not just industry. This should be reflected in the Action Plan for Affordable Energy Prices.

Support community ownership of renewables and energy infrastructure: Community energy projects have the potential to lower the electricity bills as shared profits are used to keep prices low and re-invested. Municipal-ownership of energy production and networks is another potential method to use profits to reduce bills. Community ownership should be explored in the Citizens Energy Package.

Enhance flexibility to stop fossil gas setting the electricity price: The quicker Europe reduces the time gas sets electricity prices, the sooner Europe can benefit from cheap renewables. The Commission must oversee and coordinate the submission of national flexibility assessments, support schemes and objectives, and make its own assessment and objectives at the EU level. Conflicts delaying interconnectors, such as that between Spain and France, should be resolved via Commission intervention.

Shift taxation from electricity to fossil fuels and state budgets: Electricity is disproportionately taxed compared to fossil fuels in most European countries, despite being less GHG emission-intensive. Taxes and levies of energy products and electricity should be aligned to encourage investment in decarbonisation technologies in households and industry. This must be coupled with measures to protect the most vulnerable, and support energy demand reduction.

Finance transmission and distribution equitably

Increase the EU funding for electricity projects: To cover the investment needs of the transmission network, interconnectors and utility-scale storage, reduce renewable energy curtailment, and minimise the burden on consumers, a) the Connecting Europe Facility for Energy should be expanded and better targeted (including by redirecting harmful investments that are still eligible) and b) other EU funds that can finance grid and storage investments should be better harnessed by Member States. Efficient system planning is required to ensure only cost-effective solutions are financed.

Dedicated funding for distribution: Both a better leveraging of existing EU funds and new funding sources for investment in the distribution network are required at the EU level, to support the deployment of renewables, heat pumps and energy storage.

Explore progressive grid tariff design: An increase in grid tariffs to finance grid expansion and modernisation should not have negative impacts on lower-income households and the most vulnerable. Grid tariff design should share the costs more equitably, while incentivising the use of flexibility.

Don’t bet on false solutions

No public money for nuclear: Every euro invested in nuclear is a euro not invested in renewables and energy efficiency. For this reason, public finance should remain inaccessible to nuclear, as investment should be prioritised on cost-effective, sustainable solutions.

Do not promote CCS: The promise of CCS on the supply-side alongside gas turbines only prolongs the emissions of fossil fuels, whereas the promise of its use on the demand-side can be greatly inefficient and risks absorbing new renewable electricity, undoing any electrification strategy and raising electricity prices.

Contact:

Thomas Lewis, Energy Policy Coordinator at Climate Action Network Europe (CAN Europe)
E: thomas.lewis@caneurope.org T: +44 787 23 13 464