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The UK can enhance energy security through clean electrification

Electrifying the UK's energy system will strengthen energy independence, lower fossil fuel demand and help reach climate goals.

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About

This report looks at how clean electrification is helping the UK to reduce reliance on fossil fuel imports, thereby saving costs and improving energy security.

The analysis covers the growth of clean electricity generation in combination with the electrification of heat and transport, calculating the extent of efficiency savings for household power use from this process.

Executive Summary

Clean electrification is the next chapter in UK energy security

Electrifying the UK's economy with technologies like heat pumps and electric vehicles will unlock rapid reductions in fossil fuel dependence.

Clean electrification, using low-carbon electricity to power heating and transport, is the next crucial step towards a secure, clean energy system. As more electrified technologies like heat pumps and electric vehicles are used across the economy, far less energy input is needed overall, and far fewer fossil fuels – achieved both through huge gains in efficiency, and by making full use of the UK's clean power generation potential.

01 Energy wasted in generating power has fallen by 21% since 2000

Clean sources supply just under two-thirds of the UK power generation. Since wind and solar waste much less input energy than coal and gas, the share of wasted total input energy has fallen from 60% in 2000 to 47% in 2023.

02 Electrification displaced the equivalent of 14 million barrels of oil in 2023

In 2023, with UK power generation just under two-thirds clean, 1.5 million

electric vehicles and 430,000 residential heat pumps reduced oil and gas consumption by 14 million barrels of oil equivalent. This is comparable to 3.4% of the UK's annual net oil and gas imports.

03 Electric cars need three times less energy than petrol cars, limiting the grid impact of electrification.

Losses in conventional combustion engines are much higher than those across the electricity generation and transmission process, meaning electric vehicles reduce energy demand overall. Increased deployment of clean power will reduce losses even for electric vehicles even further.

04 Electrification reduces UK fossil fuel demand by four times more than the electricity demand it creates

Clean electrification is already reducing fossil fuel use in the UK, as electric vehicles and heat pumps have scaled up in recent years. With the current share of clean power, the reduction in fossil fuel consumption was four times greater than the additional power required.

Clean electrification has begun in the UK. As the power system decarbonises further, overall energy demand will reduce as more efficient, electrified technologies replace fossil-dependent machines. Despite the combined energy security benefits, the planning and policy support for different elements of clean electrification currently happen separately. A strategy that considers clean electrification holistically will be needed to achieve decarbonisation goals and secure benefits to costs and security.

“We urgently need joined-up thinking on clean electrification. Electrified alternatives like heat pumps and electric vehicles streamline the energy system, directing clean, useful power where needed. With fossil fuel savings way beyond any additional power demand, electrification opens up energy independence for whole new sections of the economy.”

Frankie Mayo

Senior Energy and Climate Analyst - UK,
Ember



The path to energy independence

Cutting fossil fuel dependence through clean power and electrification

Fossil fuels are being phased out of the power sector. Now other sectors, like transport and heating, are shifting to electricity. As a result, power consumption will increase, but total energy demand will fall, cutting reliance on fossil fuel imports.

Electrifying the economy strengthens the UK's energy security

As UK households face continued surges in energy bills, cutting reliance on imported fossil fuels is more urgent than ever. In the UK, gas and oil account for [78% of household energy costs](#), with [47% of that gas and oil relying on imports](#). Recognising the need to rapidly reduce this dependence, the new UK government has pledged a [clean power system by 2030](#), five years earlier than the target set by the previous government. This plan includes a large increase in renewable energy deployment to protect consumers from gas price spikes and ensure long-term energy stability.

The power sector is already moving towards decarbonisation. In September, the country's last [coal power plant Ratcliffe-on-Soar closed](#). This historic moment shows the enormous shift that has happened rapidly: coal power provided around 40% of UK generation in 2012, and has now been displaced by wind and solar.

The next chapter of the UK's energy transformation will be marked by electrification of the economy which, as well as clean power deployment, is a key step to cut fossil fuel imports. Building an efficient system, one that makes energy generation go further, will be critical to ensuring the lowest-cost path to decarbonisation for households. This process is already underway, but enabling the switch to electric vehicles for transport and heat pumps for heating is the next, crucial step to build in this efficiency to safeguard consumers from rising energy bills and strengthen energy security.

Clean power and electrification cut fossil fuel consumption

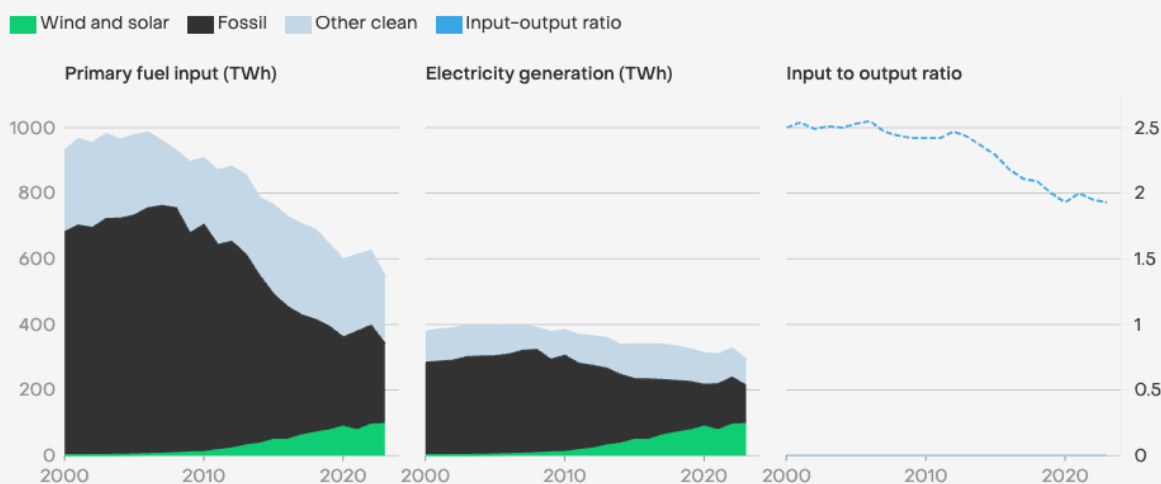
The UK's power sector is more efficient than ever

The UK's rapid move away from coal has already led to gains in efficiency, alongside the drop in power sector emissions. The emissions intensity of the UK's power sector has fallen by 20% since 2012 when coal reached its peak. This was achieved by quadrupling wind and solar generation over the same period, effectively displacing coal power, while gas only briefly spiked and then fell again to 2012 levels by last year.

This has led to a more efficient system, since wind and solar reduce energy wastage compared to fossil fuels. Wind and solar use free and replenishable energy sources to produce electricity, and therefore are considered to create no wasted energy during generation. On the other hand, due to inefficiencies inherent in the combustion process, a significant amount of primary fuel input gets lost as wasted energy when fossil fuels are burned to produce electricity. Gas and coal power plants typically only capture [50% and 34% of input energy, respectively](#).

The UK's power sector is more efficient than ever in history, as increasing wind and solar power wastes less input energy

Primary energy input and electricity output (TWh)



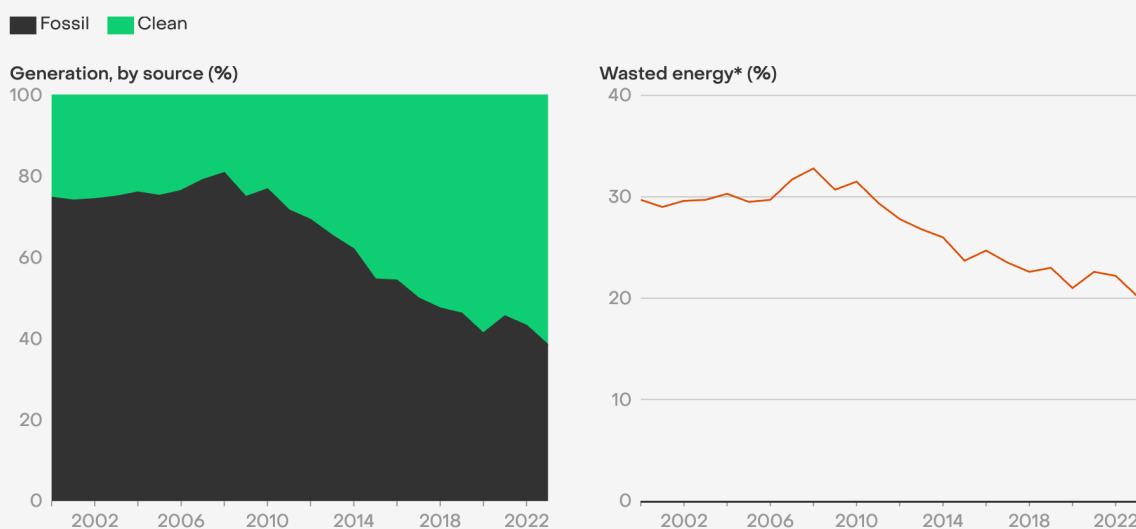
Source: Digest of UK Energy Statistics (DUKES), 2024, Ember yearly electricity data · 'Other clean' includes nuclear, bioenergy and hydro.



This has implications for costs. Input fuel prices, particularly fossil gas prices, are a dominant factor in setting overall energy bill costs. Improved efficiency in the energy system not only means lower fuel bills due to reduced consumption, but also reduced exposure to changes in the international price of gas and oil. With a more efficient system, less money is spent on wasted input fuels.

With wind and solar's rapid scale up, efficiency savings from clean power have become significant. In 2000, when fossil fuels dominated the UK's power sector, 60% of total input energy was wasted. With clean sources now supplying the majority of power generation, the share of wasted energy has fallen to 47% in 2023, a reduction of 21%. In 2000, 2.5 units of energy were needed to generate 1 unit of electricity. By 2023, this had fallen to 1.9 units.

As the UK's grid becomes cleaner, the amount of wasted primary energy consumption has reduced by more than a third



Source: Digest of UK Energy Statistics (DUKES), 2024., Ember yearly electricity data
*Share of primary energy input not converted to output



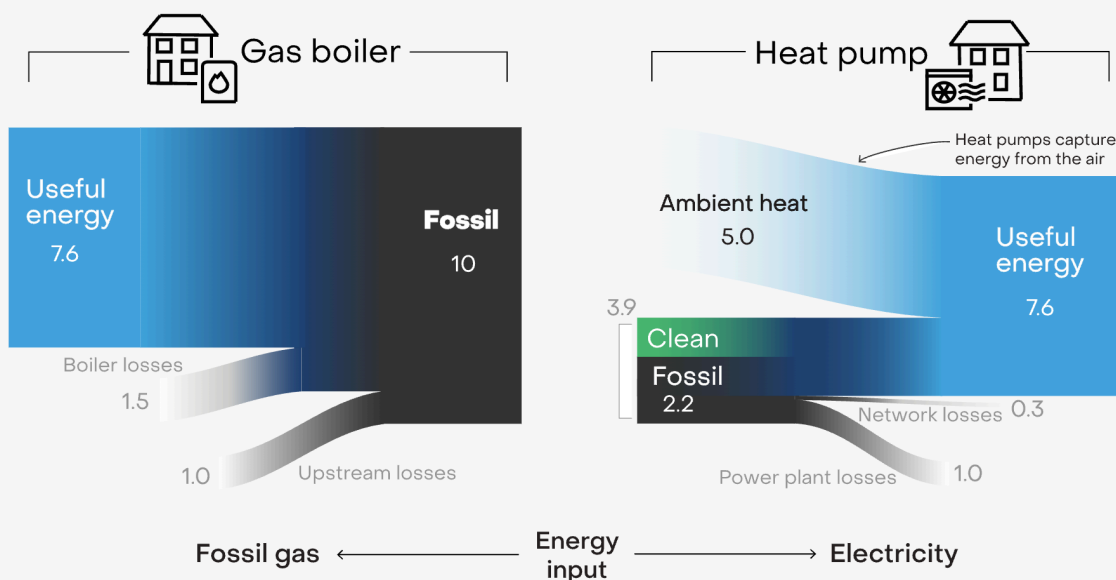
Electric vehicles and heat pumps reduce oil and gas consumption - even more so with clean power

Efficiency gains will be extended as the economy electrifies through heat pump and electric vehicle rollout, reducing the need for fossil fuels. The UK is already making progress in this. In 2023, there were 1.5 million electric vehicles and 430,000 residential heat pumps in the UK, which were powered with 60% clean electricity. These reduced oil and gas consumption by 14 million barrels of oil equivalent, amounting to 3.4% of the UK's annual net oil and gas imports.

Clean electrification reduces fossil fuel consumption at two points of the energy supply chain: when it is consumed, for example within households, and while the power is being generated. On the consumers' end, electric vehicles and heat pumps are much more efficient than fossil fuel alternatives. This means that they require much less energy to provide the same service (i.e. travel and heat) for the user compared to fossil fuel-dependent alternatives. For example, electric cars convert [89% of chargepoint electricity into useful energy](#), compared to [20% of petrol for a combustion engine equivalent](#). Heat pumps produce about three times more heat than the power input by drawing in ambient heat from the air, whereas gas boilers lose more than 10% of the fuel input while producing heat.

UK gas boilers use 4x more fossil fuels than heat pumps

Annual household energy consumption for heating, 2023 (MWh)



Source: DUKES, Eurostat, Ember analysis

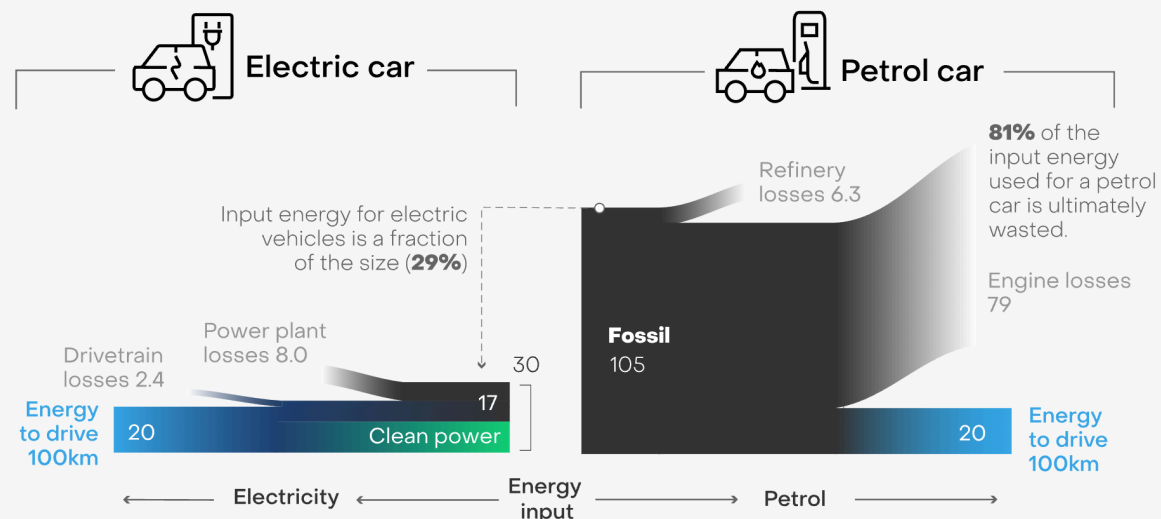
As a result, electric alternatives deliver much more than fossil counterparts with the same amount of energy. Electric cars use a third of the energy needed by petrol cars, and for the same input heat pumps can generate over three times more heat than a gas boiler. This means that consumers purchase less energy to drive the same distance or to heat their homes. In aggregate, electrification reduces consumers’ energy demand, therefore reducing the overall demand for fossil fuels.

The potential to reduce fossil fuel consumption increases by pairing electrification with the growth of clean power. Given the UK’s power mix in 2023, an average of 5.3 MWh of fossil fuels were burned to power a household with an electric car and a heat pump. Had this household used a petrol car and a gas boiler, this household would have consumed 29 MWh of oil and gas across the entire energy chain. In other words, switching to electric alternatives led to 82% reduction in fossil fuel consumption.

To summarise, clean electrification not only replaces fossil fuel consumption with electricity, but also decreases overall energy demand through efficiency improvements across the entire energy chain. As clean power grows, electric alternatives will save even more fossil fuels.

Electric cars uses a third of the input energy and 6 times less fossil fuels in the UK

Energy needed for 100km of travel, based on 2023 data (kWh)



Source: EPA, Ember calculations
 The figures shown here are national averages. Energy use and losses vary by vehicle;
 EV power plant losses include distribution loss (12%); EV drivetrain losses include battery charging losses and recovered energy from regenerative braking

Clean electrification is already reducing fossil fuel use in the UK

Clean electrification has already begun in the UK. This is contributing to large reductions in fossil fuel consumption, since clean electrification reduces fossil fuel demand by much more than the electricity demand it creates.

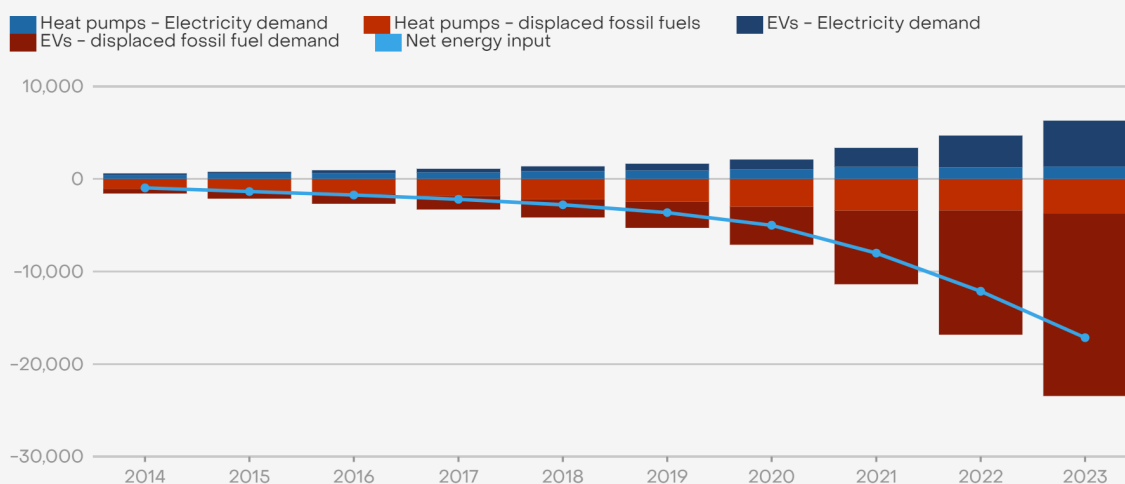
Wind and solar made up 33% of UK generation in 2023. Electric vehicles accounted for 20% of new vehicle sales in 2023, reaching 4% of total vehicles on the road. Heat pump installations are also increasing, but at a much more modest rate. In 2023, 1.5% of households in the UK had heat pumps, up from 0.5% nine years ago.

The impact of electric vehicles and heat pumps on UK power demand to date has been small, adding 6.3 TWh in 2023. This equates to only 2% of the UK's total electricity demand. Nonetheless, the increase in power demand will accelerate. In 2030, electric vehicles and heat pumps are [forecast to add 33 TWh](#) of electricity demand, equivalent to 11% of the total demand in 2023.

However, the efficiency gains from electrification and decarbonisation means that, despite this increase in electricity demand, energy use and fossil fuel consumption will continue to rapidly decline. With the current share of clean power in the UK’s power generation, electric cars require three times less energy than petrol cars to travel the same distance, limiting impact on the grid from electrification. Electrification also reduces fossil fuel demand by four times more than the electricity demand it creates.

Reduced UK fossil fuel demand through electrification far outweighs additional electricity demand created

Fossil fuels avoided by EVs and heat pumps compared to their electricity demand (GWh)



Source: Ember analysis

As the grid becomes cleaner, electrification will cut fossil fuel consumption even faster. With the combination of increased electrification and clean power, total energy demand will fall at an accelerated rate. The National Electricity System Operator ‘Holistic Transition’ pathway forecasts that demand for primary input fuels could fall by an average of 0.8% a year in the 2020s. This accelerates to 1.2% per year later in the 2030s, when electric vehicle and heat pump deployment is forecast to reach a peak.

The UK needs a clean electrification strategy

The combined increases in clean power deployment, electrification of transport and installation of heat pumps improves energy system efficiency. However, they are currently supported by separate policies and approaches. Establishing an economy-wide, comprehensive strategy for clean electrification will strengthen the UK's energy security. This will allow for focus on cutting energy imports across the energy system, looking beyond 2030 clean power to electrification opportunities out to 2040. A joined up approach can support the foundation of domestic flexible demand by ensuring households can participate in smart tariffs, and can help identify which parts of the supply chain can be feasibly delivered within the UK - including both in jobs and manufacturing.

While reducing overall energy demand, electrification is forecast to continue to increase electricity demand beyond the 2030 clean power target. Homegrown wind and solar deployment will need to be sustained to avoid reliance on imported fossil fuels for heating and transport.

Policymakers can turn the shock of the gas crisis into an opportunity to strengthen the UK's resilience against the volatility of the international energy market. A modern, electrified economy powered by clean energy will be a new engine of growth that shields consumers from future energy crises.

Methodology

Efficiency assumptions for renewable generators

The efficiency calculation does not account for capacity factors of wind and solar, since it is not 'inefficiency' from the perspective of energy balance. The input energy for renewable electricity is equal to the amount of electricity generated, in line with the Digest of UK Energy Statistics (DUKES) methodology notes:

"Indigenous production of primary electricity comprises hydro-electricity, wind, solar and nuclear energy. The energy value for hydro-electricity is taken to be the energy content of the electricity produced from the hydro power plant and not the energy available in the water driving the turbines. A similar approach is adopted for electricity from wind and solar generators where the electricity is regarded as the primary energy form because there are currently no other uses of the energy resource 'upstream' of the generation."

Estimating power demand from electric vehicles and heat pumps

See Ember's electrification data methodology.

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