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ANALYSIS

Household Energy Security in 2030

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Executive Summary

A typical household with a gas boiler and typical demand for electricity and gas, and that drives typical annual mileage in a petrol car, will rely upon 17MWh of imported energy in 2024. This is 67% (two-thirds) of the total primary energy needed to meet this household's needs for heating, power and fuel. The other third will be met by UK sources of energy, including oil, gas, biomass and renewable electricity.

For these households that predominantly use fossil fuels, energy imports are set to rise further by 2030, and beyond, as UK production of oil and gas declines, irrespective of new licences.

Without any more UK renewables or any net zero upgrades for the household, and even if new licences for oil and gas resulted in increased production, a typical household in 2030 would use as much energy as today and would rely on over 20MWh of imported energy, an increase of 3MWh (20%).

The only way that households can become less reliant on imported energy and boost their use of UK energy is to adopt technologies that cut oil and gas demand – primarily energy efficiency, electric heat pumps and electric vehicles. And the electricity to power these technologies will become more secure as more UK renewables are built.

In 2030 with faster trends in renewables and even without new oil and gas licences, a household with energy efficiency at EPC C, an electric heat pump and an electric vehicle will require only 3.4MWh of primary energy imports. That is, if a typical household can make these upgrades, with support where necessary, and if the UK makes good progress with renewables to power electrical technologies, then this household could reduce its annual energy imports of 17MWh in 2024 by almost 14MWh by 2030, a cut of 80%.

Comparing the scenarios for 2030, the 3.4MWh/yr of imported energy used by the net zero household supported by more UK renewables would be almost 85% lower than the more than 20MWh/yr of imported energy used by the home without upgrades if there were no new UK renewables and the UK continues licencing new oil and gas exploration.

Current Household Import Dependence

Previous analysis has examined the energy use and import dependence of different households in 2024. The results are illustrated in Figure 1 and discussed below.

A typical household currently has an end-use energy demand just over 22MWh per year: 8MWh of petrol for a car; 11.5MWh of gas directly in the home; and 2.7MWh of electricity.[1]

Looking at the UK's current grid mix[2] and its imports of gas, oil and various fuels, we find that 15.4MWh of this end-use energy consumption is derived from imported fuels, i.e. 69% (over two-thirds) of the energy used by the household can be linked back to imported fuels. This is one way of considering import dependence; another definition is discussed below.

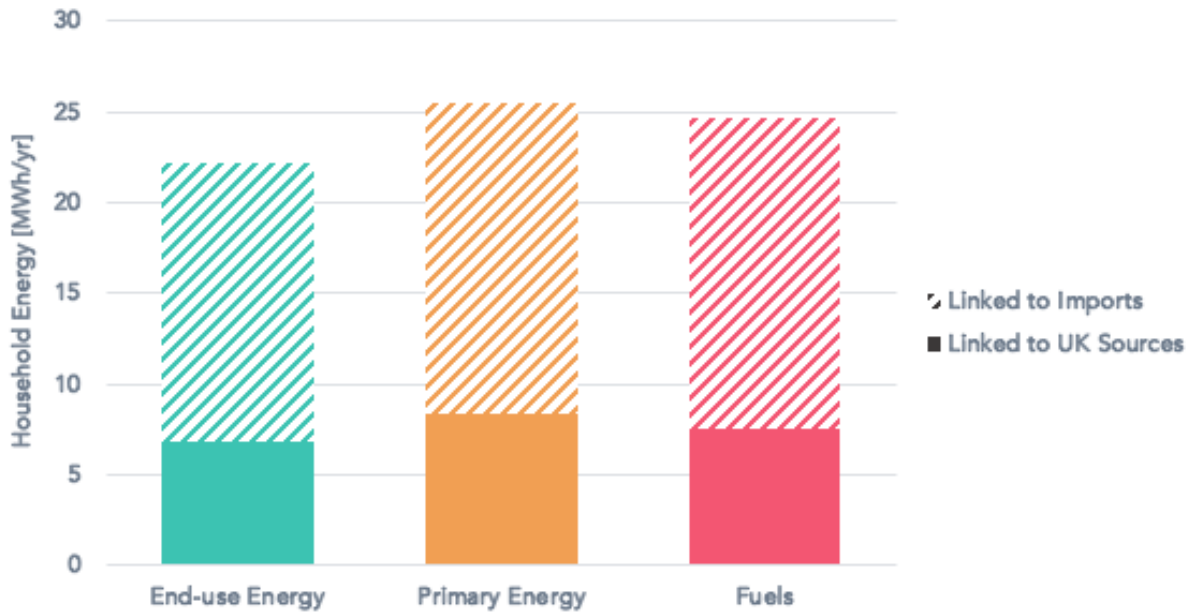

Figure 1: Energy requirements of a typical UK home in 2024, in terms of end-use energy, primary energy, and fuels, with each one split by UK sources and imports.

[1] The analysis assumes one car per home, which is lower than the average of 1.2, and hence the results slightly underestimate typical household energy demand and energy imports.

[2] The UK's grid mix for 2024 was estimated using recent data and trends from *Electricity Trends UK 5.1 and 5.2* (DESNZ, 2024). It was approximated as: 35% gas; 30% biomass and nuclear; 30% renewables that don't use fuels e.g. wind and solar; and 5% net imports of electricity (the balance between importing when Continental generators offer cheaper prices than UK marginal gas plants, and exporting when there is a market for UK electricity). Losses on the electricity system in recent years mean that power station output is 9% higher than the level used by the household – see *Energy Trends UK 5.2* (DESNZ, 2024).

The primary energy that is needed to supply the household with electricity is higher than the end-use demand, partly due to losses and mostly due to the inherent inefficiency of thermal power stations (i.e. those that use fuels).

Under the current grid mix, a typical household needs about 6MWh of primary energy for electricity, of which about 5MWh comes from fuels such as gas, biomass and nuclear fuel, and 1MWh is provided by renewables such as wind and solar that use no fuels.[3]

So, the typical household requires about 25.5MWh of primary energy in 2024. Of this, 24.5MWh are fuels: 8MWh of petrol; 13.5MWh of gas in the home and at power stations; and up to 3MWh of biomass and nuclear fuel at power stations. The other 1MWh of primary energy is renewables that use no fuels, such as wind and solar.

The import percentages for each type of energy[4] show that, of the household's 25.5MWh primary energy demand, 17MWh (67% i.e. two-thirds) is imported: 60% of the gas (8.1MWh); over 90% of the petrol (7.4MWh); and roughly half of the other fuels (1.5MWh).[5] None of the renewable electricity generated without fuels contributes to energy imports.

This definition is subtlety different to the previous one, due to the role of electricity. But the current domination of household energy by gas and oil-based fuels mean that the two metrics give very similar results for 2024.[6] By either measure, a typical household is currently highly dependent upon imported fuels, to the tune of almost 70% in 2024.[7]

[3] Average efficiency of thermal power plants was based on recent averages, giving values of gas 50%, and nuclear and biomass c.30%, based on DUKES 5 (DESNZ, 2024). For power plants that use no fuels, the primary energy is simply the same as the power station output. We can use two metrics: primary energy that includes all fuels, renewable electricity and net imports of electricity (about 0.1MWh/yr); and fuels, which is most of the primary energy but excludes renewable electricity.

[4] Proportion of fuels that are likely to be imported in 2024 are based on recent data from DUKES (DESNZ, 2023), giving approximate values of: gas 60%; biomass 50%; nuclear 100% (on the basis that the UK has no commercial uranium mines). Note that, whilst UK gas production in 2024 will likely equate to about 50% of demand, about 20% of UK gas production will likely be exported, if trade reverts to patterns from before the gas crisis, and hence, the UK will have to import about 60% of the gas that we use in 2024. For petrol, the value is based on the fact that over 90% of oil-based fuels have been imported at some stage of their supply chain, whether as crude oil or refined fuels.

[5] Obviously, 100% of the 0.1MWh of electricity net imports is imported, but this is a tiny consideration.

[6] Note that in the earlier report, the statement that 69% of the energy was imported was on the basis of fuels only, whereas the value of 67% in this new report takes into account the total primary energy including renewables that use no fuels.

[7] Some analysts consider net imports rather than imports, including in government statistics. That metric is akin to 'balance of trade'. In the case of the typical household in 2024, the results would be around 40% using net imports, rather than around 70% using imports. However, using net imports in calculations is making the implicit assumption that the UK can rely upon using its full production of gas and oil, whereas in fact the volumes that are exported are essentially lost to the UK, and imports have to be made to cancel out the exports, let alone to meet demand. Therefore, using imports rather than net imports gives a better insight into UK energy security.

Future Prospects for UK Energy Imports

Another previous piece of analysis examined how UK energy imports could evolve by 2030. It considered key trends in UK energy production and consumption, including:

- the ongoing decline in North Sea oil and gas production, irrespective of whether new licences result in higher output, such that any use of gas and oil-based fuels will increasingly rely on imports[8]
- different scenarios for deployment of renewables such as wind and solar that use no fuels, and hence include no imported energy
- different scenarios for changes in energy demand, via energy efficiency (e.g. insulation) and electrification (e.g. heat pumps and EVs)

The analysis illustrated how future UK energy security will be negatively impacted by the UK's current high use of gas and oil in the context of declining North Sea production, and positively affected by reducing demand for these fuels and increasing our use of renewables, energy efficiency and electrical technologies.

No Net Zero Action

If there was no further action on renewables and other net zero technologies, and even if new licences resulted in more oil and gas production:

- If demand for gas were to stay at current levels, then the decline in gas production, even with new licences and allowing for typical exports, would mean that imports would account for around 85% of gas demand in 2030, up from 60% in 2024.
- If demand for oil were to stay at current levels, then imports would account for around 95% of fuels in 2030, even with new licences, up from just over 90% in 2024.
- It can be assumed that imports of other fuels would remain at around 50%.
- Without any more renewables to displace gas power generation, such that the UK retained today's grid mix, the electricity sector would follow the growing import dependence of gas, rising from 55% today to around 65% in 2030.[9]
- The UK would import about 1.2 units of fuels for every unit of end-use electricity used by customers, up from 1 unit of imports per unit of demand today.

[8] By 2030, UK oil production is projected to have fallen to around 60% of recent levels, if new licences yield the volumes anticipated by the NSTA, and even lower if new licences deliver less. It is likely that over 95% of fuels used in the UK in 2030 will have been imported at some stage in their supply chain, whether as crude oil or as refined fuels.

[9] It is assumed that the future grid mix would benefit from higher efficiency in new thermal power plants that replaced some of the existing fleet. This would reduce the primary energy demand and reduce energy imports, but this effect is only minimal.

Current Trajectory

Under the current trajectory for deployment of renewables and uptake of net zero technologies, alongside new oil and gas licences:[10]

- Gas imports would equate to almost 80% of gas demand in 2030.
- Oil imports would account for around 95% of demand for oil-based fuels in 2030.
- The grid mix would be roughly 60% renewables that use no fuel, 15% gas, and the rest from other fuels and imports when Continental generators are cheaper than UK marginal gas plants.
- Imports of fuels for the electricity sector would make up less than 30% of its primary energy requirements (when scaled relative to a typical home in 2024),[11] due to renewables providing primary energy without using fuels let alone fuel imports.
- The UK would import about 0.6 units of fuels for every unit of end-use electricity used by customers, down from 1 unit of imports per unit of demand today.

Faster Net Zero Trends

Under faster trends in the deployment of renewables and the uptake of net zero technologies, and without the need for new oil and gas licences:[12]

- Gas imports would account for around 75% of gas demand in 2030.
- Oil imports would account for around 95% of demand of oil-based fuels in 2030.
- The grid mix would be roughly 70% renewables that use no fuel (although this could be higher), 10% gas, and the rest from other fuels and imports when Continental generators are cheaper than UK marginal gas plants.
- Imports of energy for the electricity sector would make up just 20% of its primary energy requirements (when scaled relative to a typical home in 2024),[13] due to renewables providing primary energy without using fuels let alone fuel imports.
- The UK would import about 0.4 units of fuels for every unit of end-use electricity used by customers, lower than today and lower than in the other future scenarios.

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[10] Current trajectories resemble less ambitious scenarios produced by industry experts e.g. *Falling Short* scenario in the Future Energy Scenarios (FES) (National Grid ESO, 2024)

[11] On a simple basis, primary energy imports for the electricity sector would be 38% of its primary energy, but it is important to also recognise that the overall primary energy would also be lower in the first place. So, this simple result his has been scaled down to 28% using the lower primary energy demand per unit of generation in 2030 compared to 2024 (a ratio of 0.45 to 0.6), in order to give a more meaningful comparison.

[12] Faster trends would resemble more ambitious scenarios produced by industry experts e.g. *Leading the Way* scenario in the Future Energy Scenarios (FES) (National Grid ESO, 2024)

[13] As per the previous example, the simple result of 30% has been scaled to 20% (using a ratio of 0.4 to 0.6 i.e. 2/3), in order to give a more meaningful comparison.

Future Prospects for Household Energy Imports

Applying these scenarios for UK energy imports to the mix of energy used by households allows us to estimate how household energy imports could evolve by 2030. The results are illustrated in Figure 2, and discussed below.

A typical household in 2030, with a gas boiler, typical demand for gas and electricity, and a petrol car, would have the same end-use energy demand as today i.e. about 22MWh.[14]

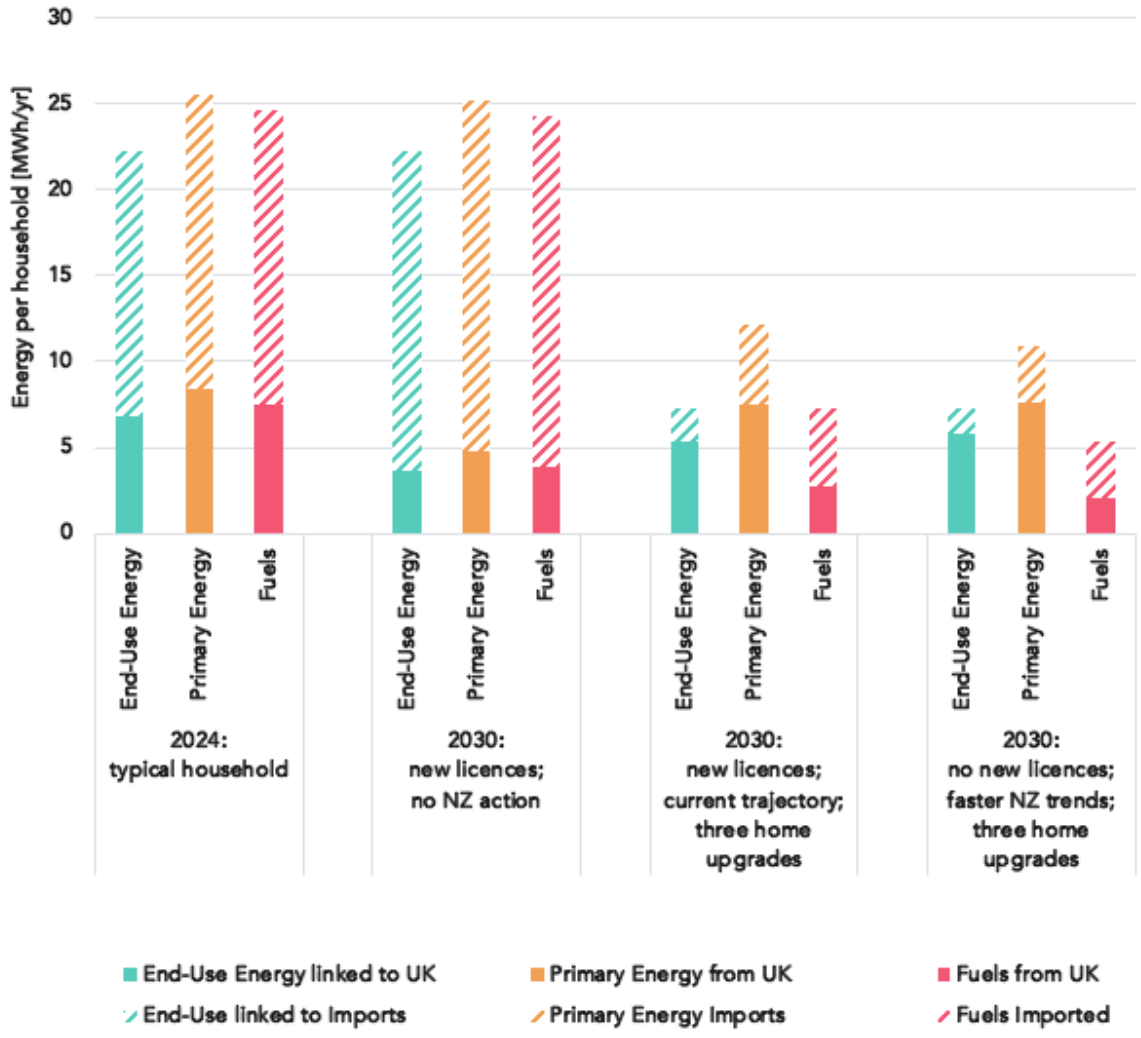

Figure 2: Energy requirements and imports in 2024 for a typical household, and in 2030 for the same household under different scenarios.

[14] As for 2024, the analysis assumes one car per home, which is lower than the average of 1.2, and hence the results slightly underestimate typical household energy demand and energy imports.

No Net Zero Action

In the scenario in which there was no further action on renewables, energy efficiency or electrical technologies such as heat pumps and EVs, but new licences resulted in more oil and gas production, then the following would apply to the typical household in 2030:

- The proportion of end-use energy consumption that is sourced from imported fuels would rise from 69% in 2024 to 83% in 2030.

- In terms of primary energy, the household would rely upon over 20MWh of imported energy, a 20% rise from 17MWh in 2024. The proportion of imported primary energy would rise from 67% in 2024 to 81% in 2030.

So, by any measure, a typical household would become more dependent upon imported energy, rising from almost 70% in 2024 to over 80% in 2030.

UK Renewables and Net Zero Households

However, this fate of rising energy imports is not the only possible future. Instead, the deployment of renewables and the adoption of energy efficiency, heat pumps and electric vehicles can help households to boost their energy security.

A household that has been able to take the three key steps of energy efficiency upgrades to EPC C, an electric heat pump, and an electric vehicle would have an end-use energy demand of just 7.3MWh/yr, which is 67% (two-thirds) lower than the typical home. This cut in end-use energy demand is irrespective of the UK's energy mix, and so applies in any year.

This net zero household would benefit most from the roll-out of UK renewables that use no fuel. Benefits would be seen under both of the net zero scenarios, but would be larger with faster trends in deployment of wind and solar than with slower renewables roll-out and new oil and gas licences. In the case of faster renewables deployment, only 7% of this net zero's household's end-use energy would be linked back to imports (when scaled to be comparable with the value of 69% for the typical home in 2024).

With the faster roll-out of UK renewables, this net zero household would require only 11MWh of primary energy (55% less than the typical home in 2024), of which half would be renewable electricity generated without fuels. A net zero household in 2030 could require just 3.4MWh of imported energy, which is 80% (four-fifths) less than the 17MWh for a typical household in 2024, even without new UK oil and gas licences.

This 80% cut in energy imports would come from three net zero upgrades:

- Energy efficiency upgrades including insulation to meet the target of EPC band C and installing a heat pump in place of a gas boiler would cut the household's energy imports by over 7MWh/yr (over 40%).

- Using an electric vehicle in place of a petrol car would cut the household's energy imports by almost 7MWh/yr (almost 40%).

Overall, this net zero household in 2030 could have an import dependency of just 13% compared to the 67% of the typical household in 2024 (when the net zero homes' value is scaled to take account of lower energy requirements).[15] Put another way, progress towards net zero would have improved the household's import dependency by a factor of five.[16]

Finally, we can compare the two scenarios in 2030. The 3.4MWh/yr of imported energy used by a net zero home in a future with faster renewables deployment would be almost 85% lower than the more than 20MWh/yr of imported energy used by a typical home in a future where the UK has increased oil and gas production but has deployed no new renewables.

[15] Note that import dependence values are calculated by dividing imported energy by primary energy demand, and then scaling by the ratio of the primary demands for the home in question in the year in question and a typical home in 2024. For example, before the scaling this net zero home in 2030 has an import dependence of 31%. This takes into account the lower energy requirements, allowing a fair comparison against the baseline of the typical household in 2024.

[16] It is useful to examine the impacts of solar panels on homes. This is on the basis of a typical 3kW solar PV array, a typical load factor of 11%, and the household making use of the entire solar output, through demand-side response and/or battery storage (e.g. in their EV). Compared to a typical home in 2024, a net zero home with the three upgrades plus solar panels could require almost 75% less primary energy in 2030, and almost 90% less imported energy. This household would have an import dependence of just 8% compared to the 67% of the typical household in 2024 (when scaled to take account of lower energy requirements). That is, progress towards net zero would have improved the household's import dependency by a factor of eight.

Conclusions

For households that predominantly use fossil fuels, energy imports are already high, and are set to rise further by 2030 and beyond, irrespective of new licences for oil and gas.

Any additional UK oil and gas production by itself would do nothing to improve the energy security of a typical household. In fact, energy import dependence would rise as demand stays static and production declines despite new licences.

Measures that reduce UK demand for fossil fuels will reduce our future energy imports and improve our future energy security. Such measures include renewables to displace gas power generation, energy efficiency, and the switch to low-carbon end-use technologies.

The way for households to reduce their energy imports and boost their use of UK energy is to adopt technologies that cut oil and gas demand, in particular insulation, heat pumps and EVs. And the electricity to power these technologies will become more secure the more UK renewables are built.

Methodology

Scenarios for future deployment of UK renewables and uptake of insulation, heat pumps and electric vehicles were as per the earlier report, *Future Energy Security* (ECIU, 2024). The first scenario has only new oil and gas production, and no new action towards net zero (i.e. no more UK renewables, insulation, heat pumps or electric vehicles). The second scenario projects the current trajectory of net zero action (broadly in line with moderate scenarios from e.g. National Grid and the CCC), and new licences. The third scenario envisages faster trends of deployment of net zero technologies (broadly in line with more ambitious scenarios from e.g. National Grid and the CCC), without new licences.

Household energy data was assessed as per the earlier report, *Household energy: buying British* (ECIU, 2024). Typical household end-use energy is based on typical values of gas and electricity demand of 11.5MWh/yr and 2.7MWh/yr, respectively (Ofgem), and typical annual mileage of 8,000miles from recent years excluding the pandemic (DfT).

Petrol and gas were treated as primary energy sources, which omits losses and energy consumption in upstream processing and hence slightly understates their contribution to primary energy. Electricity end-use was translated into primary energy by firstly applying losses, then splitting it according to the grid mix, and then applying the efficiency factor for each type of power station. Fuels were counted as being each of the primary energy types apart from renewable electricity. Net imports of electricity were counted as imported fuels, and amounted to small percentages of overall energy and overall imports.

Oil production forecasts for 2030 are from the *Production Projections* (North Sea Transition Authority, February 2024). Oil exports and import percentages for 2024 were based on data for 2018, 2019, 2021 and 2022, i.e. the four most recent years for which complete data is available, excluding the abnormally low demand in 2020 due to the pandemic, from *Production, Imports & Exports* (DESNZ, 2023). Oil demand forecasts for 2030 are based mainly on projected changes in numbers of vehicles that use petrol and diesel, but also on numbers of oil boilers and demand from other sectors, sense-checked against scenarios from the *Future Energy Scenarios* (National Grid ESO, 2023).

Gas production forecasts for 2030 are from the *Production Projections* (North Sea Transition Authority, February 2024). Gas forecasts for 2024 were based on data for the four years 2018-2021, i.e. the four most recent years for which complete data is available, excluding the abnormally low demand and abnormally high imports and exports during the gas crisis,

from *DUKES 4.1* (DESNZ, 2023). Gas demand forecasts are based mainly on projected changes in numbers of gas boilers and reduced use of gas power stations, sense-checked against scenarios from the *Future Energy Scenarios* (National Grid ESO, 2023).

Electricity grid mixes for 2030 were based on projected demand and generation mix, sense-checked against scenarios by e.g. National Grid and the CCC. Fleet-average power plant efficiencies for 2030 were modified from 2024 on the basis that new plants coming online will have different efficiencies to older plants: 40% for gas CCS, taking fleet average to 45%; and 45% for new biomass and nuclear, taking fleet average to 35-40%.