UNIVERSITY of STRATHCLYDE
CENTRE FOR ENERGY POLICY

Policy Briefing

Decarbonising domestic heating: the need for policy to help consumers respond to the benefits of technological progress change in electricity supply?

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Summary

The UK Government's acceptance of the Committee on Climate Change (CCC) advice on moving to a **net zero carbon economy by 2050** makes the need to **decarbonise how we heat our homes** of even more pressing and strategic importance. Whatever the mix of solutions that is ultimately adopted, **increased electrification of our energy system and economy is inevitable**.

In response, electricity network operators are already developing ambitious plans for upgrading different elements of the UK network. A crucial opportunity may emerge from this process that could **help enable consumer responses to the need for increased electrification**. The process of upgrading electricity networks – and adding to generation capacity – is likely to involve efficiency gains in the production, transmission and/or distribution of electricity. This may translate to the type of **technological change** that not only allows economies to grow, but could **improve the competitiveness of low carbon electricity relative to gas in heating our homes and businesses**.

Our research (published in The Energy Journal) focuses on technological change leading to efficiency gains in the UK electricity industry. We take an example where current output levels can be delivered with a 5% reduction in input requirements. We investigate how this could both **allow the economy to grow, reduce the consumer price of electricity and encourage households to switch from gas to electricity**. We estimate that a **sustained boost in UK GDP of around 0.3% could be delivered along with a 0.2% increase in employment (just over 58,400 new jobs)**, fuelled by a general boost in competitiveness across the UK economy as energy costs fall.

Just what happens to energy use depends on **consumer responses to absolute and relative changes in the prices of electricity and gas**. In our scenario, more efficient electricity supply ultimately **lowers the consumer price of electricity by 3.7%**. With **household real incomes and purchasing power rising (by around 0.3%)**, one challenge is to ensure that the consumption of *both* electricity and gas does not rise. Addressing this requires that **consumers are able to respond to this reduction in electricity prices when making decisions as to how to heat their homes and premises**. Depending on the extent to which household consumers are able to do so, we found that they may shift away from gas to reduce their use by up to 4.4%.

A key conclusion of our research is that, where policy can act to enable consumers to switch to electric heating systems as the relative price of electricity falls, **a shift in the composition of energy use between electricity and gas can contribute to the decarbonisation of heat without sacrificing the wider economy gains of technological progress**. This could involve a range of measures. But it requires policy action to exploit any reduction in consumer prices of more efficiently delivered low carbon options to ease consumer responses in favour of their use. Moreover, **influencing and promoting the relative price of lower carbon options might be an effective way of encouraging domestic uptake of energy efficiency initiatives and reducing carbon emissions**.

Introduction: the role of technological progress in decarbonising the economy

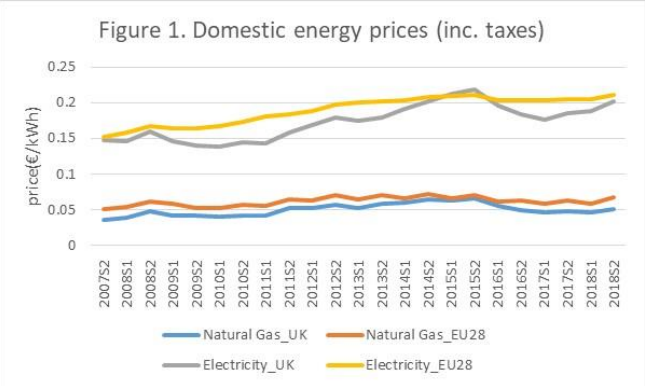
Technological change is necessary for economies to grow and develop. Our newly published research investigates how this technological change could be directed in order to **simultaneously reduce carbon-intensive energy use and deliver a range of economic benefits**. Using both market and economy-wide modelling approaches, we consider improvements in the efficiency in the delivery of electricity as a means to reduce carbon emissions in the household sector in the UK. We demonstrate how linking this to policy action to assist and encourage households to substitute away from more carbon-intensive gas- to electricity-powered heating systems may **change the composition of energy use, and implied emissions intensity, but not the level of the resulting economic expansion**.

The problem of relatively high electricity prices

The UK Government's acceptance of the **Committee on Climate Change (CCC) advice on moving to a net zero carbon economy by 2050** makes the need to decarbonise how we heat our homes of even more pressing and strategic importance. Whatever the mix of solutions that is ultimately adopted, increased electrification of our energy system and economy is inevitable. Our analysis here focuses on **how technological change in the production of electricity in the UK may drive the choice between electricity and gas for domestic space heating**.

This is a useful focus for the UK for several reasons. First, the analysis is timely given that the type of technological change we consider could emerge from the **current process of electricity network operators making plans for extensive network upgrades** (through Ofgem's RIIO2 price control process). Second, not least where the rate of the uptake of domestic energy efficiency initiatives has been slow, **improving the relative price of lower carbon options might be an effective way of reducing carbon emissions**. Third, given that electricity in the UK, and Europe more generally, tends to be highly priced per kWh relative to gas (see Figure 1), there is a **real need to improve its competitiveness as a low carbon option.**

Figure 1. Domestic energy prices (inc. taxes)



Source: https://ec.europa.eu/eurostat/data/database

Our research questions

We set out to address two inter-related research questions.

First, **can energy/climate policy outcomes benefit from more effectively directed energy efficiency improvements?** Here, we consider whether the policy focus of an efficiency improvement in one type of energy (e.g. electricity) has a wider reach than just how that energy type is used. Specifically, we investigate whether the focus should extend to how a technological change in its production may impact its competitiveness relative to other more carbon-intensive substitutes. For example, if electricity can be produced with greater efficiency, this will impact its competitiveness relative to gas in the delivery of domestic heating services.

Second, **can energy and carbon savings be augmented, without jeopardising the multiple economic benefits of energy efficiency improvements, through encouraging the substitution effects towards more efficiently delivered low carbon options?**

Scenario simulation using a multi-sector economy-wide model

We use our UKENVI computable general equilibrium (CGE) model, which models the response and adjustment process of all sectors and markets in the economy to a given disturbance and reports outcomes relative to the base year data (what the economy looks like in real terms with no other change).

It is important to examine the question of delivering efficiency gains in electricity supply with such as economy-wide model, in order to take the wider impacts of lower electricity prices into account. All uses of electricity, including industrial, household and export demand are affected, and this will have ripple effects across different markets and sectors of the economy. Lower prices can trigger gains in competitiveness and this can have positive effects on aggregate measures such as GDP or employment. The net impact on different sectors of the economy will depend on things like the employment and wage intensity of industries as demand for and price of labour rises, as well export intensities. An increase in competitiveness can have an expansionary impact on the economy in that it boosts exports and reduces import intensity. Generally, the outcome will be changes in incomes earned, with will further impact demand, household incomes and activity levels in all sectors.

In the analysis we use the CGE model to examine a simple example of technological progress in the form of total factor productivity in the electricity industry. We simulate a case where the industry can produce its current level of electricity output with a 5% reduction in all input requirements. Model specifications and assumptions are detailed in our research paper.

Scenario outcomes: economic expansion and a reduction in the price of electricity relative to gas

Table 1 reports some key macroeconomic impacts of the efficiency gains, all of which are sustained over time. These results demonstrate that a 5% increase in total factor productivity in the UK electricity supply industry may deliver sustained (long-run) **GDP gains of up to 0.3%** over and above what they would otherwise be. This is accompanied by a 0.2% boost in employment across the economy **just over 58,400 jobs**, over time. The expansion is driven by a 0.2% **reduction in the CPI** (underpinned by reductions in capital and labour costs), which triggers increased export, investment and UK household demand.

Table 1. Long run macroeconomic impacts (percentage changes)

GDP	0.32
CPI	-0.22
Investment	0.36
Exports	0.34
Household consumption	0.34
Replacement cost of capital	-0.24
Nominal wage	0.14
Real wage	0.35
Employment	0.22
Unemployment rate	-3.48
Energy (consumer) price	-1.80
Electricity (consumer) price	-3.65
Gas (consumer) price	-0.01

The **economic expansion does trigger a net increase in energy use**, driven both by a reduced consumer price of electricity increased real income and consumption. The net impacts on electricity and gas use depend on consumer responses to absolute and relative changes in the prices these fuel sources. Table 1 shows that, in our scenario, the more efficient supply of electricity ultimately lowers the consumer price of electricity by 3.7%.

With **household real incomes and purchasing power rising (by around 0.3%)**, a key challenge from a decarbonisation perspective is to **ensure that the consumption of *both* electricity and gas does not rise**. Reducing reliance on more carbon-intensive natural gas requires that consumers are **able to respond to the improved competitiveness of electricity when making decisions as to how to heat their homes and premises**.

In our research paper we focus on household consumers. We repeated the scenario simulation above, but varied the assumptions governing the extent to which they respond to the change in the relative prices of gas and electricity, i.e. the elasticities of substitution between (i) gas and electricity, and (ii) between residential energy use and all other consumption options. We find that, if the extent to which UK households will shift to electricity as its relative price falls, their natural gas use could reduce by up to 4.4%. But if is low, *and* consumers choose to spend increased real in come on energy use, then the consumption of both gas and electricity may increase.

The insight that emerges is in terms of the role of policy action aimed at increasing the **ease with which UK households can substitute away from more carbon-intensive gas use towards electricity in running heating systems**. The more they are enabled and incentivised to do so, the net impact on both domestic and total gas use across the economy can become negative. Such an outcome would require actions such as **initiatives to support switching to electric heating systems and/or the promotion of wider energy conservation in the household sector**.

Conclusion

Thus, the broader conclusion of our paper is that the outcomes of increased efficiency in the delivery of low carbon energy supply **can be effective in delivering on both decarbonisation and economic objectives**. But this requires policy action that **focuses on exploiting the reduction in consumer prices of the electricity option over more carbon-intensive options**. In tandem, policies are needed to encourage households to spend any real income gains on non-energy uses.

The main objective of our work is to direct attention to how efficiency gains in energy supply may the impact on the level and composition of household spending and overall GDP. We focus on the impacts if consumers become more responsive to improved competitiveness of low carbon options. The key lesson learned in our UK example is that **improving the price responsiveness of households to more efficiently supplied electricity permits reduced domestic reliance on more carbon-intensive gas.** This can be achieved without affecting the sustained wider economy benefits resulting from technological change.

The project

The research paper underpinning this policy brief is published in the Energy Journal, Issue 40(4), titled 'Can the Composition of Energy Use in an Expanding Economy be Altered by Consumers' Responses to Technological Change?', by Karen Turner, Gioele Figus, Kim Swales, Lisa Ryan, Patrizio Lecca and Peter McGregor. The work is an output of a wider project funded by the UK Engineering and Physical Sciences Research Council (EPSRC grant ref. EP/M00760X/1).

Contact

For more information on the research reported here, and ongoing/future research at CEP, please contact Professor Karen Turner, Director of the Centre for Energy Policy at the University of Strathclyde, or other members of the CEP project team at cep@strath.ac.uk.