Assessing the localised socioeconomic impact of central government policy

Authors

Jon Stenning[1]

Mike May-Gillings[1]

Hector Pollitt[2]

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Abstract

Central government policymakers are often concerned primarily with the net socioeconomic impacts of policy at a national level. However, policies can have extremely local impacts; energy policy particularly can have major implications for a small number of large plants, and therefore have substantial implications for the local economy around each site.

This paper assesses the largest localised socioeconomic impacts of changes to the UK carbon price floor. We apply a modelling approach, based on simulation properties, that allows for a combination of bottom-up modelling of the power sector and top-down models of the economy (and the interactions between the energy system, the economy and the environment). The global E3ME macro-econometric model (www.e3me.com) is coupled to the Future Technology Transitions (FTT) modelling framework for the power and road transport sectors, and the outputs used to shape local area outcomes are captured in the Local Economy Forecasting Model (LEFM). This approach is qualitatively different from the optimisation tools that are used in other analyses and draws on theories from post-Keynesian and evolutionary economics. Instead of trying to find least-cost pathways, the model simulates the responses to policy inputs (including market-based instruments) and is parameterized on real-world time-series data.

E3ME is used to capture the national-level effects of policy, including second-order and international trade impacts, while the LEFM framework is then applied to estimate the manner in which these effects cycle through the local economy, focussing primarily upon the severe demand-side shock to the economy from the closure of gas-fired power plants and the subsequent impacts that this has on the local economy, modelled through an input-output framework with adjustments for local supply content. This presents, using the UK as an example, the potential for using similar local area models, linked to a global model such as E3ME, to estimate regional or local impacts of national or international policy in any country.

[1] Cambridge Econometrics, Cambridge, CB1 2HT, United Kingdom
[2] Cambridge Econometrics, Cambridge, UK, CB1 2HT and Cambridge Centre for Environment, Energy and Natural Resource Governance, The David Attenborough Building, Pembroke Street, Cambridge CB2 3QZ, United Kingdom

Introduction

This paper demonstrates an application of two linked Input-Output models; the E3ME model, which models on a national and global scale the links between the energy, environmental and economic systems, as well as the role of technology in the energy system through the Future Technology Transitions (FTT) modelling framework. These are linked, along with LEFM, to model the potential adverse impact of a change in national energy policy (changes in the future level of the UK carbon floor price) on a small number of local communities across the UK.

In many countries, strategically important policy is primarily determined at a national level, often informed by national-level analysis of potential impacts (either through a cost-benefit analysis or a formal modelling exercise). However, what may be a small impact on the national scale can be substantial if concentrated on a limited number of small geographical areas. This paper provides a framework for assessing the localised impact of national policy, through the macro-economic modelling of UK national energy policy, capturing the impact on the UK energy generation system, and then assessing where the 'marginal' impacts are likely to fall, through analysis of the relative efficiency of UK electricity generation plants. By identifying generation plants that are most likely to be impacted, we can map which local authorities in the UK may face a reduction in employment in the energy generation sector, and using a local area economic model, estimate the impact on both the supply chain and wider economic activity in the region that may result in the closure of the plant.

UK energy

UK energy policy has long been set by the central government in Westminster, London. It rose to prominence in UK policy circles in 1974 with the creation of the Department of Energy, in response to the 1973 oil crisis, and as North Sea oil became an increasingly important strategic asset. The privatisation and liberalisation of the energy market through the 1980s marked the start of energy policy in its current guise, with government setting regulatory and taxation regimes adhered to by private sector energy companies (including the operator of the transmission and distribution network, National Grid).

While electricity generation has long been distributed geographically across the UK, until recently the generation capacity has been dominated by large plants. Through much of the 20th century, these plants were coal-fired, although in the later parts of the century (and into the 21st), gas-fired and nuclear plants increased in number. In all of these technologies, large-scale plants typically resulted in more efficient electricity generation, leading to the concentration of generation in an increasing number (as electricity demand rose) of sizeable plants. More recently, falling technology costs and government policy has made renewables generation more favourable; and the cheapest forms of renewables generation (solar PV and onshore wind) do not benefit from the same economies of scale as fossil fuel generation; as such, the number of small-scale generation sites has rapidly increased, leading to a much wider geographical distribution of electricity generation.

This poses substantial challenges to local communities which have a high concentration of jobs in fossil fuel-powered electricity generation; jobs in these sectors which are lost as part of the transition to low-carbon electricity generation are unlikely to be filled by jobs in renewables generation (which, in addition to potentially being less labour intensive, are not as geographically concentrated, as outlined above).

UK energy policy and the Carbon Price Floor

The UK has been subject to a carbon price since 2005, with the introduction of the first phase of the EU ETS, the 'cap and trade' carbon emission system implemented by the European Union, whereby allowances (each of which entitles the holder to emit one tonne of CO_2) are issued through a mixture of free allocations and auctions, and can be subsequently traded. However, allowance prices have fallen substantially through the lifetime of the scheme, and as of May 2017 were below €5. As part of Coalition Agreement which bought to power the Coalition Government in the UK in 2010, it was announced that the UK would introduce a floor price for carbon (implicitly above the current EU ETS price, which it was believed was too low to bring about the desired transition to a low-carbon economy in the UK). The Carbon Price Floor was announced in March 2011, starting at £16 per tonne of CO_2, with the aim of reaching a target price of £30 in 2020. The UK Treasury subsequently slowed the trajectory of increases, and since 2016 the floor price has been fixed at £18 per tonne of CO_2, and current policy is for it to remain at this level until 2021 (no prices have been proposed for subsequent years). In this paper, we explore the potential impact on the energy generation system of a shift in the floor price post-2021, doubling the real price to £36 (2021 prices) from 2022 onwards, as compared to a reference case where the floor price is held constant at £18 (in 2021 prices).

The UK Government has already announced its intention to end coal-fired electricity generation by 2025 (although the formal regulation is not yet in place), and there are indications that, even without further intervention, the last coal-fired plants in the UK may close by 2022. As such, shifts in the carbon price floor are unlikely to have substantial impacts upon coal-fired generation (and such effects would be very short term) – instead, we expect an increase in the carbon floor price to affect gas-fired generation, as the next most carbon-intensive (large-scale) electricity generation method in the UK. However, because of the lower carbon intensity of gas, the increase in the carbon tax is likely to have to be substantial to have a notable impact upon gas-fired generation.

Method

Macroeconomic modelling

The E3ME Model

E3ME is an econometric model which links economic activity, based on the system of national accounts and social accounting matrices, to energy demand and environmental emissions. It was originally developed through the European Commission's research framework programs and is now widely used in Europe and beyond for policy assessment, forecasting, and research purposes. The global version of E3ME splits the world into 59 regions, including explicit representation of all G20 countries and all EU Member States.

The E3ME model is demand led, with levels of output and employment determined by levels of demand. Intermediate demand is determined by the input-output relationships in the model. When one sector increases production, it requires more inputs to do so. The sectors in its supply chain thus see an increase in demand for their products. Figure 1 shows how E3ME's economic module is solved for each region. Most of the economic variables are solved at the sectoral level. The whole system is solved simultaneously for all industries and all regions.

Figure 1 E3ME's basic economic structure

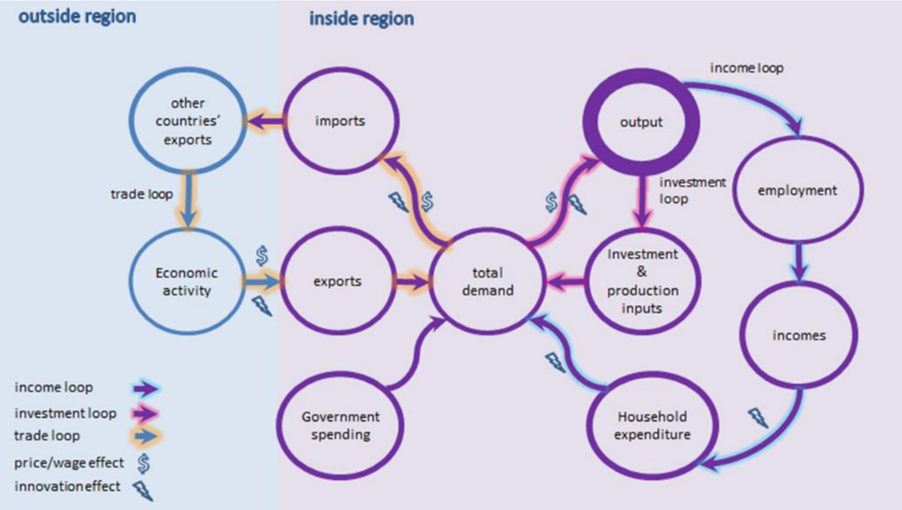
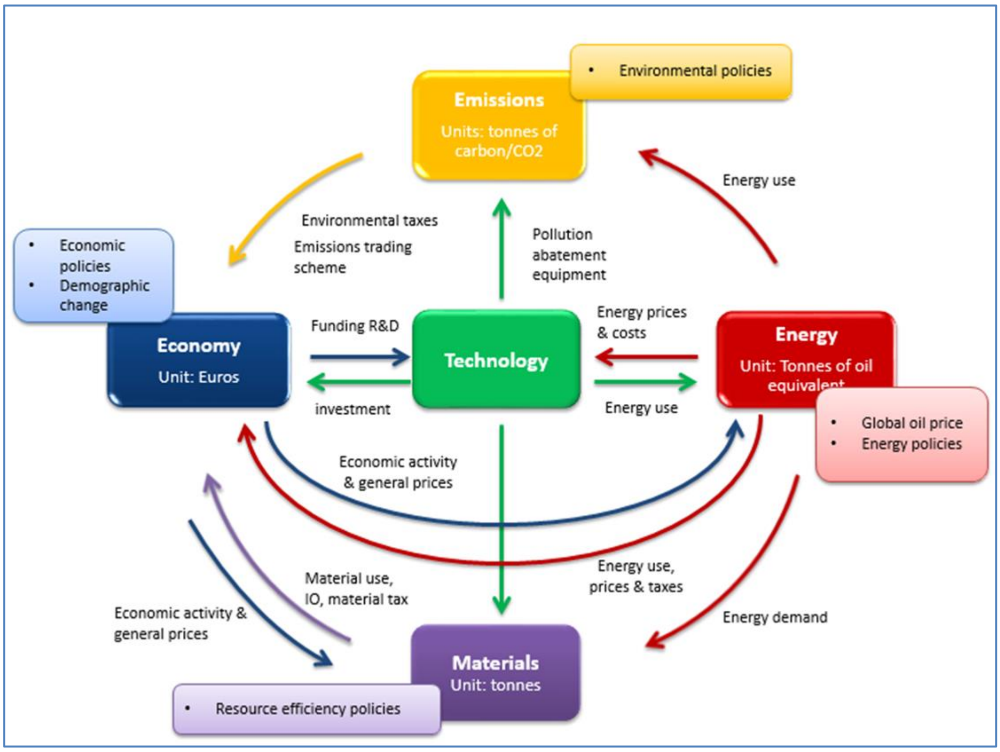


Figure 2 shows how the three components (modules) of the model – economy, energy, and environment - fit together. Each data set has been constructed by statistical offices to conform with accounting conventions. For each region's economy, exogenous factors which are set outside the model are economic policies (including tax rates, growth in government expenditures, interest rates and exchange rates). For the energy system, the world oil prices and energy policy (including regulation of the energy industries) are exogenous. For the environment component, exogenous factors include policies such as reduction in SO2 emissions by means of end-of-pipe filters from large combustion plants. Endogenous variables then link the components. The economy module provides measures of economic activity and general price levels to the energy module; the energy module provides measures of emissions of the main air pollutants to the environment module, which in turn can give measures of damage to health and buildings. The energy module provides detailed price levels for energy carriers distinguished in the economy module and the overall price of energy as well as energy use in the economy.

Figure 2 E3 linkages and interactions with the technology and materials submodules



The energy, economy and environment interactions are further affected by the materials and technology sub-modules. The materials module utilises input output tables and data on materials use and tax to estimate changes in materials cost or demand. For example, increases in materials use, to build new power generating capacity in response to government programs to phase out a power technology, might increase the price of a material input (due to increased demand for a material that is supply-limited). This would have effects throughout the economy as industries that use this material as an intermediate input would see costs increase (although substitution of materials and resource efficiency would also be part of the modelled response to such a price change).

The technology submodule for the power sector (FTT: Power) utilises a dynamic framework for the selection and diffusion of technological innovation. FTT determines a technology mix for a region given a set of assumptions about carbon prices, subsidies, feed-in tariffs and regulations, by generation technology. Changes in the technology mix result in changes in the production cost, which is reflected in the price of electricity. The model takes electricity demand from E3ME and feeds back a price, fuel use, and investment costs for replacements and additional power generation into FTT.

E3ME model results are typically compared against a baseline scenario. Currently the E3ME baseline is calibrated to the PRIMES 2016 reference scenario. The effects of policy measures or changes to the energy generation profile are compared to this baseline.

Scenario Design

A series of scenarios were constructed to estimate the effects of changes to the UK Carbon Floor Price and the UK government's commitment to phase out coal power generation by 2025. A single scenario was chosen to estimate the effects of the change in the Carbon Floor Price on the UK economy, and ultimately the local impacts of the change that could lead to particular power stations going offline. A series of scenarios were constructed given the UK's announced INDC following the Paris Agreement and considering uncertainty around the UK's role in the EU ETS following Brexit negotiations. Ultimately, the price change modelled for this exercise had the largest estimated impacts on CCGT power generating capacity for the purposes of a local-level analysis.

The current announced UK Government policy for the UK carbon floor price is that it will remain at £18 per tonne of CO2 (in nominal terms) until 2021; and this price is included in both our baseline and central scenario. However, there is currently no certainty as to the future value of the price floor beyond this. In our baseline, we assume a continued commitment to the use of a carbon price floor (not least because the UK's future role in the EU ETS post-Brexit has not yet been agreed), but assume that it will remain constant in real terms (at £18 per tonne in 2021 prices), rather than ratcheting up as was envisaged in the original policy. Our central scenario for this analysis models a doubling in the UK carbon floor price in real terms from 2022 onwards.In addition, to model the effects of coal power generation being gradually phased out (legislation for which is currently being consulted on) in both the baseline and the central scenario, coal power generation was gradually decreased, by an additional 17% each year from 2020 to 2025. By 2025, UK coal power generation (which was already estimated to be very low in the PRIMES 2016 reference case) reaches zero. It was assumed that investment in coal power generation would decrease by a similar magnitude, to ensure that existing coal power generation was maintained but that no additional capacity was installed ahead of the phase-out; this intervention was required as FTT does not have regulated phase-out available amongst the policies that it can model.

Establishing impacts on the UK energy system

The UK electricity market operates primarily through a merit order system. There are regular auctions, where generators are invited to bid their lowest price for the electricity that they are generating to be sold onto the UK grid. The grid purchases electricity up to the level it needs, and the per-unit price paid to the marginal generator (i.e. the last one that is needed to meet demand) is paid to *all* operators. As a result of this auctioning mechanism, firms bid to provide the electricity from individual plants at a level very close to their marginal cost of generation. A higher carbon tax would increase marginal generation costs for those technologies which generate carbon dioxide as a by-product (primarily fossil-fuel burning plants), and encourage the provision of zero-carbon alternatives (i.e. renewables) to replace the more expensive coal- and gas-fired generation.

In order to determine which specific power plant might be affected by a decrease in demand for gas in our scenario, we developed a way of 'ranking' CCGT plants, based upon age and desk research on the qualitative technology level, in order to gauge their relative productivity. We used this as a proxy for marginal costs of production, which determines, through the merit order effect, which plants are likely to be impacted by a shift away from gas-fired electricity generation.

The Digest of United Kingdom Energy Statistics (DUKES) available from the Office of National Statistics and the Department for Business, Energy, and Industrial Strategy was utilised to determine which CCGT power stations in the UK might be particularly vulnerable to an increase in the carbon floor price. This data-set includes information on the ownership of, and type of energy generating technology utilised, by various power stations in the United Kingdom. Also included is the total capacity installed at the power station, location, and year the station was commissioned or power generation began. From this database, all the power stations that utilised CCGT technology were identified, and a series of simplifying assumption were made to determine which CCGT plant might be pushed offline due to changes in the UK Carbon Floor Price.

It was assumed that older plants, that had not recently been refurbished (within the past 12 years) would be more likely to be taken off-line than plants that had been recently built or recently refurbished. There were two reasons for this assumption; in the first instance, older (non-refurbished) plants are likely (on average) to be less efficient than newer ones;

secondly, plants which have more recently been constructed or updated will not yet have had the opportunity to make sufficient revenues to compensate investors for their construction costs, meaning they are more likely to remain operational, even if their profitability is reduced.

Local area modelling

LEFM is a demand-led input-output model that models the relationships between firms, households, government and the rest of the world in a highly-disaggregated framework (e.g. across 45 industries), which enables the analysis of the impact on the economy (employment and value added) of demand-side factors (such as an increase in demand due to stronger world growth) to be analysed.

LEFM has been designed to project economic indicators for a local area by explaining the output of local industries through an explicit representation of expenditure flows in the area and their links with the world outside the local area. In this it differs from other methods of local economy modelling which typically link local output or employment (by sector) directly to national or regional output or employment. Such methods include shift-share or econometrically estimated equations. While these methods allow a user to derive projections for local output or employment growth from national or regional projections, they offer little scope for introducing an explanation of local performance relative to these higher levels, and they are typically not suitable for analysing the indirect effects on the local economy arising from the opening of a new enterprise or the closure of an existing one.

LEFM is also distinguished from other approaches by its sectoral detail. It identifies 45 sectors (defined on SIC07), allowing (for example) electronics to be distinguished from electrical equipment, and IT services from other business support services. Detailed disaggregation by sector is usually valuable because different sectors have different prospects (eg technological change is driving much faster growth in electronics and computing than in the other sectors with which they are commonly combined), because they have different employment characteristics, and also because it allows local knowledge about specific firms to be more easily incorporated in the forecast.

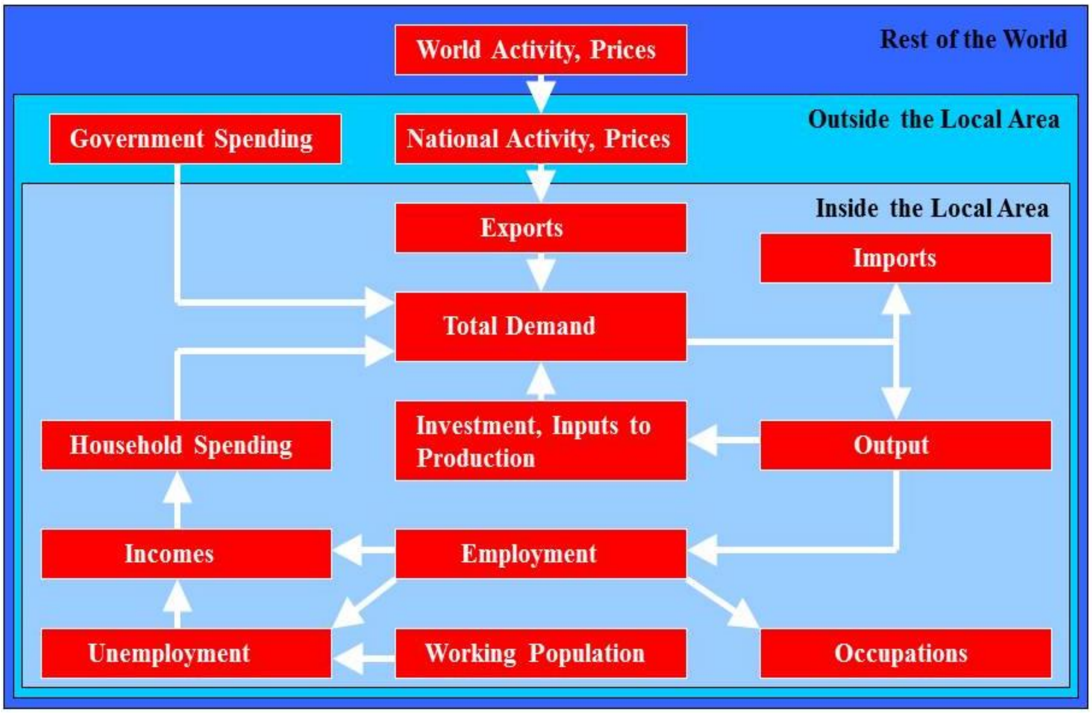
LEFM's structure draws heavily on that of MDM, Cambridge Econometrics' multi-sectoral model of the UK economy and its regions.

LEFM's Main Relationships

Accounting structure

Figure 3 summarises the model's accounting structure, which follows the social accounting matrix approach adopted in MDM. In most cases, the variables shown in the diagram are disaggregated (e.g. by sector for output and employment).

Figure 3 The structure of LEFM



Each industry's gross output is determined as the difference between commodity demand (the sum of demand coming from the final expenditure components together with intermediate demand coming from production in the local economy) and imports to the local area. Each industry's value-added is assumed to be in the same proportion to its gross output as is the case for the region as a whole.

How the main variables are determined

Employment in the local area generates incomes. Assumptions are made for net commuting, which determines the extent to which incomes from local employment accrue to non-residents. Similarly, some incomes in the local area are derived from employment outside the area, or from non-employment sources (eg unemployment benefit). Aggregate household expenditure by residents in the local area is determined by real household disposable incomes (deflated by the national household expenditure deflator) and projections for the household saving ratio (derived from changes in the regional household saving ratio). Household expenditure is then disaggregated into spending by function according to the proportions forecast for the region.

Government final expenditure (disaggregated by type) in the local economy is projected on the basis of changes in the local area's share of the region's population.

Investment by sector is determined by a simple relationship with output. Projections for social investment (eg education, health) and investment in social services (eg roads), which are treated as assumptions at the UK level in MDM, are allocated to the local area according to population changes.

Intermediate expenditure by sector and commodity is determined by applying the national input-output coefficients to local economy gross output by sector.

Exports by sector from the local economy are linked to national gross commodity output in each sector. In effect, local firms are treated as competing in the national pool. Export projections then depend upon UK gross commodity output in each sector, and on assumptions for trends in the local economy's share of this output. In some cases, simple methods have been tried to model these export shares (eg to represent the effects of policies to promote inward investment). Imports by sector to the local economy depend on the demand for commodities in the local economy and on assumptions for import shares.

Employment by sector is determined by gross output and trends in productivity per person employed derived from regional projections (which in turn are derived from econometric estimates). Employment by gender and type is determined by the sectoral composition of employment and local information on the representation of genders and types of employment in each industry. The default projections for trends in this representation are based on historical data for the local area, with the user given the option to change these default values. A similar procedure is followed for employment by occupation.

Projections for the resident workforce are derived from assumptions for the population for working age (by gender) and projected participation rates which vary with the unemployment rate. Unemployment is the difference between the workforce, local employment and 'net commuting'.

Method

The power plants that are most likely to be shut down as a result of an increase in the carbon price floor and the phase out of coal generation, namely the least cost-efficient ones, were identified through desk research as set out above. The impacts of these plant closures on the local economy were modelled using the Impact Analysis module in LEFM, based on the expected number of direct job losses. The direct job losses are in the Electricity & Gas industry.

The Impact Analysis module contains an input-output table, used to calculate the inputs to production (the structure of demand for intermediate inputs that the plants require) and assumptions for local supply content (the extent to which the demand for inputs to production will be met by local producers). These are used to estimate the indirect supply chain impacts of the plant closures.

The inputs to production assumptions are based on those for the industry in the UK, which assume that the majority (about 60%) of inputs for Electricity & Gas are sourced from within the Electricity & Gas sector, and from the Mining & Quarrying sector; a small proportion of inputs also come from Coke & Petroleum, Construction and Financial & Insurance Services. The sectoral breakdown of indirect employment impacts is expected to reflect this.

The local supply content assumptions are tailored to both the industry and the local area. In this instance, a relatively small proportion of the demand for inputs for the Electricity & gas industry are typically satisfied by local producers. This implies that there will be some leakage of impacts out of the local economy.

In addition, induced impacts, resulting from a reduction in spending of people employed in industries affected by the closures, are estimated using input-output multipliers for the UK. Population-dependent industries such as construction, distribution, hospitality, health and education are most likely to be affected by a reduction in consumer spending.

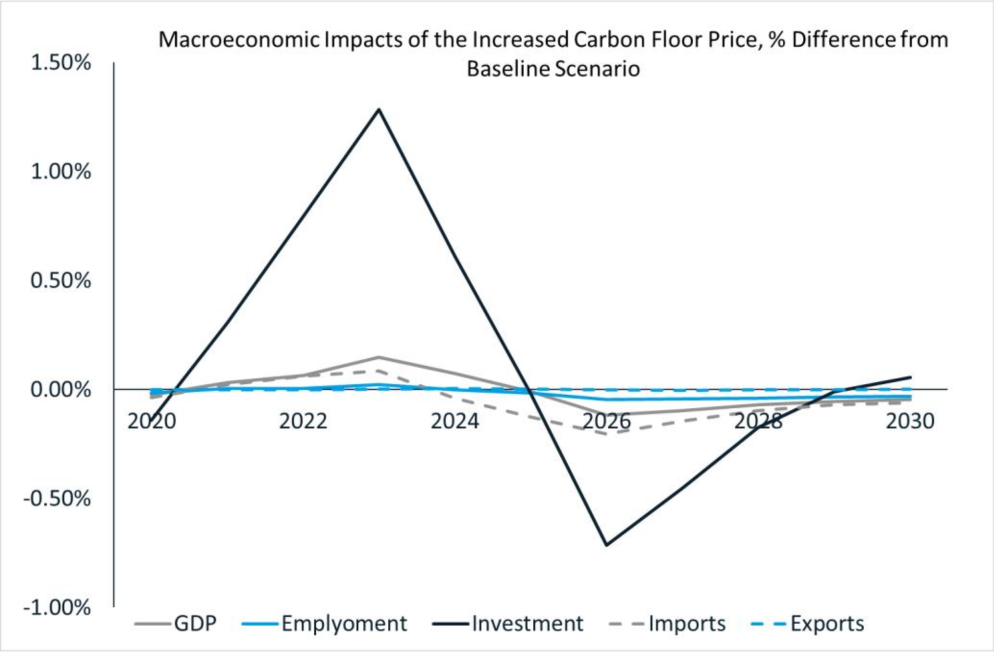
Results

Impact on the UK

Figure 4 summarises the major macroeconomic impacts of a phase-out of coal power generation and the UK carbon floor price doubling in real terms in 2022 and staying constant thereafter. The impact on GDP is estimated to be minimal, with even a slight increase in overall GDP estimated for the initial years after the carbon floor price increase, due primarily to the additional economic activity driven by the large-scale investment in the energy system in response to the change in prices. Eventually the increased cost of energy due to the raised carbon floor price outweighs the short-term stimulus effects, leading to less investment and economic activity and as a result modestly lower GDP relative to the baseline scenario.

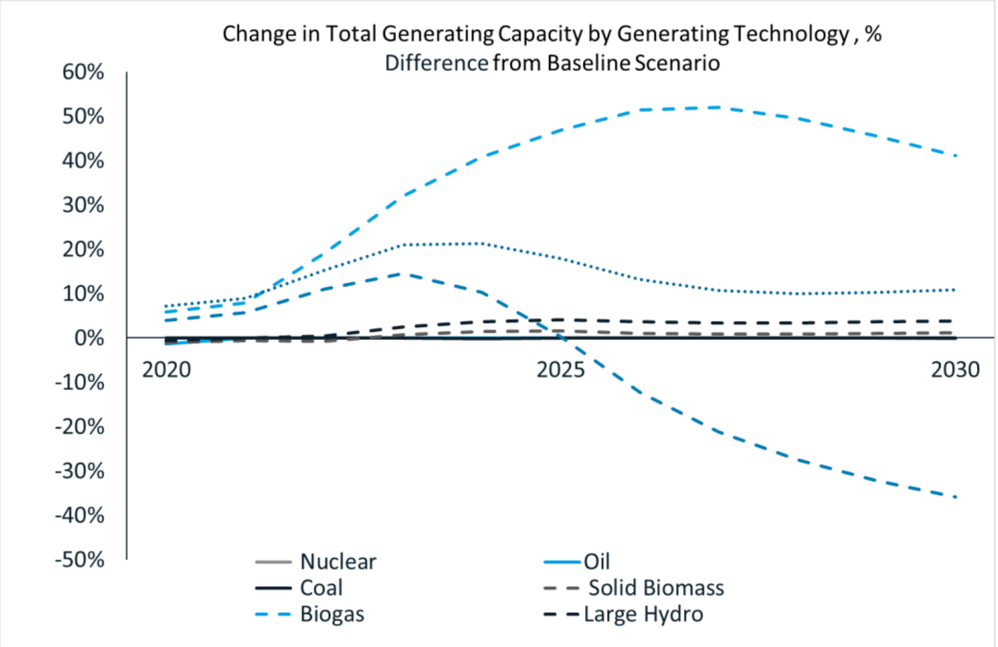
The higher carbon floor price is estimated to have a small negative impact on employment in the long-term. Investment increases in the short term after the shift in the carbon floor price, as the energy sector responds to the higher price associated with fossil-fuel electricity generation by investing in alternative low-carbon generation methods. Over time, the generating capacity of emissions-intensive technologies are reduced, and replaced by the new generation capacity as it comes on-line. After 2025, when the carbon floor price remains constant, investment drops slightly relative to the baseline scenario; reflecting partly a decrease in investment in the energy sector, as the accelerated deployment of new generation capacity over 2020-25 makes subsequent new capacity less necessary. In addition, electricity prices are estimated to rise approximately 16% relative to the baseline by 2025. The higher price of electricity reduces the amount of household income that could be spent on consumer goods and services, leading to reduced demand and slight drops in employment, imports and GDP in the long-term.

Figure 4 Macroeconomic Impacts of the Increased Carbon Floor Price, % Difference from Baseline Scenario



In response to the increased carbon floor price, CCGT power generation was taken offline, but there was also a great deal of investment in other generating technologies, leading to an increase in the share of power generation from renewable and less carbon intensive technologies that would not be subject to the higher UK carbon floor price (see Figure 5).

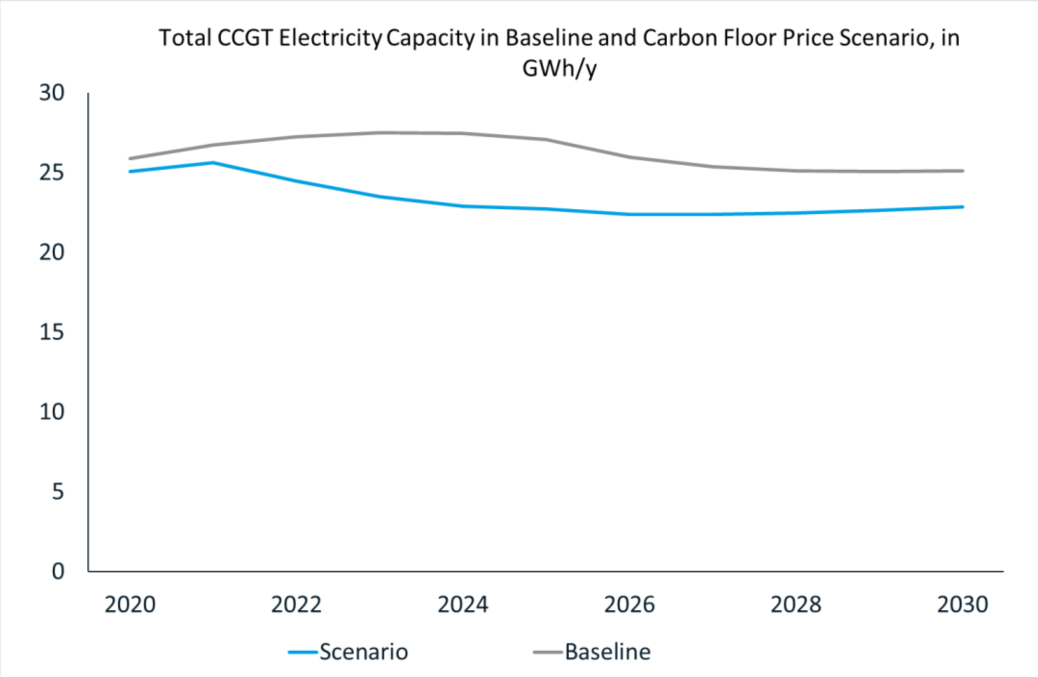
Figure 5 Change in Total Generating Capacity by Generating Technology, % Difference from Baseline Scenario



For example, there was a large increase in biogas generating capacity relative to the baseline scenario. The sharp increase in the carbon floor price leads to a change in the energy generating mix which occurs much faster than in the baseline case. Renewable energy sources like solar PV and onshore and offshore wind generation require a great deal of permitting and planning in order to execute and the time frames involved in investment, installation, and generation utilising these technologies are relatively long. This is modelled within E3ME by 'lead times', effectively the number of years that are required to construct and bring on-line a new electricity generation plant, and they vary by technology. A sharp increase in the carbon floor price such as that modelled in this scenario will require a rapid shift in energy generating technologies that can occur within a short time-scale, and it is this which leads to the substantial increase in demand for biogas (at the expense of solar PV, in addition to carbon-intensive technologies, due to solar's longer lead time). Biogas can be installed and begin generating electricity relatively quickly in response to a large increase in the carbon floor price, with a lead time within the modelling of only one year. The mix of technologies are also influenced by the levelised costs associated with them; the FTT model includes cost-supply curves, meaning that some technologies have more capacity for rapid scaling up than others. There is an increase in other renewable generating technologies such as onshore wind and hydro-power but biogas generating capacity increases much more relative to the baseline case than these other technologies, suggesting that there is substantial excess capacity for biogas generation in the UK.

Gas power generation is estimated to decrease about 10% relative to the baseline case in 2030. This amounts to about a reduction of approximately 2GW in CCGT generation capacity (see Figure 6).

Figure 6 Total CCGT Electricity Capacity in Baseline and Carbon Floor Price Scenario, in GWh/y

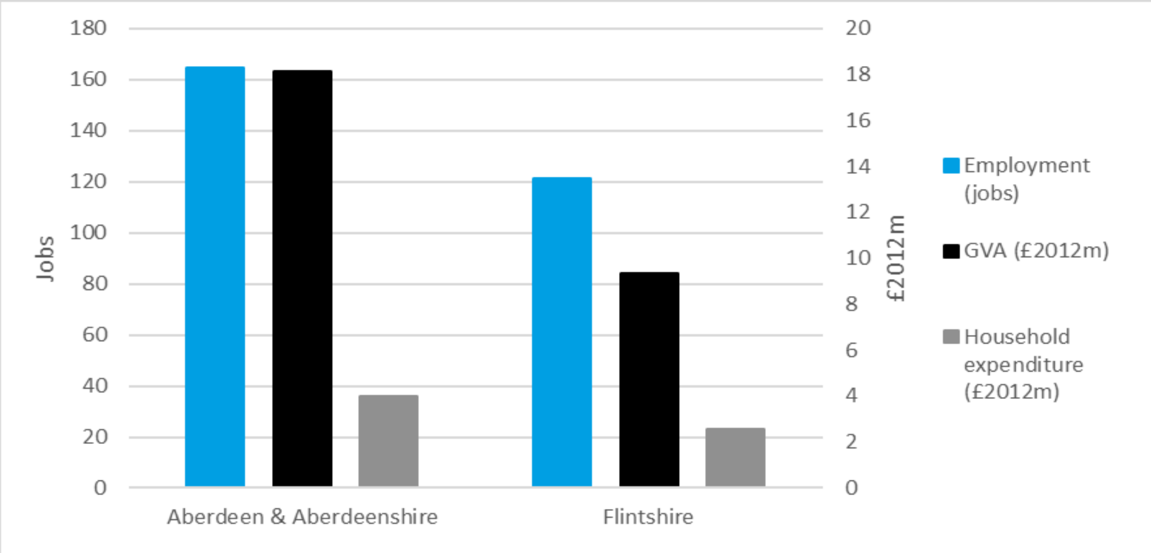


In our assessments on the impact on the generation system, we assume that older, larger plants will be most affected, as a result of being less efficient (and therefore have higher marginal costs) than more recently constructed (or upgraded) plants. Through this analysis, we have identified that the CCGT plants at Peterhead and Connah's Quay would be candidates for closure in response to a decline in the cost-competitiveness of CCGT leading to a 2 GW reduction in generation capacity. Our local area modelling in the next section therefore focuses on these, as example areas where a substantial number of electricity generation jobs (based around a single plant and supply chain) would not be easily replaced by renewables generation which has a tendency to be much more widely distributed geographically.

Impacts at a local level

This analysis focuses on the direct and indirect impacts of the closure of the power plants on local area employment, gross value added (GVA) and household expenditure. Figure 7 shows the impacts on these indicators in the modelled areas in 2025, in terms of absolute losses relative to the baseline.

Figure 7 Absolute losses from modelled plant closures, 2025

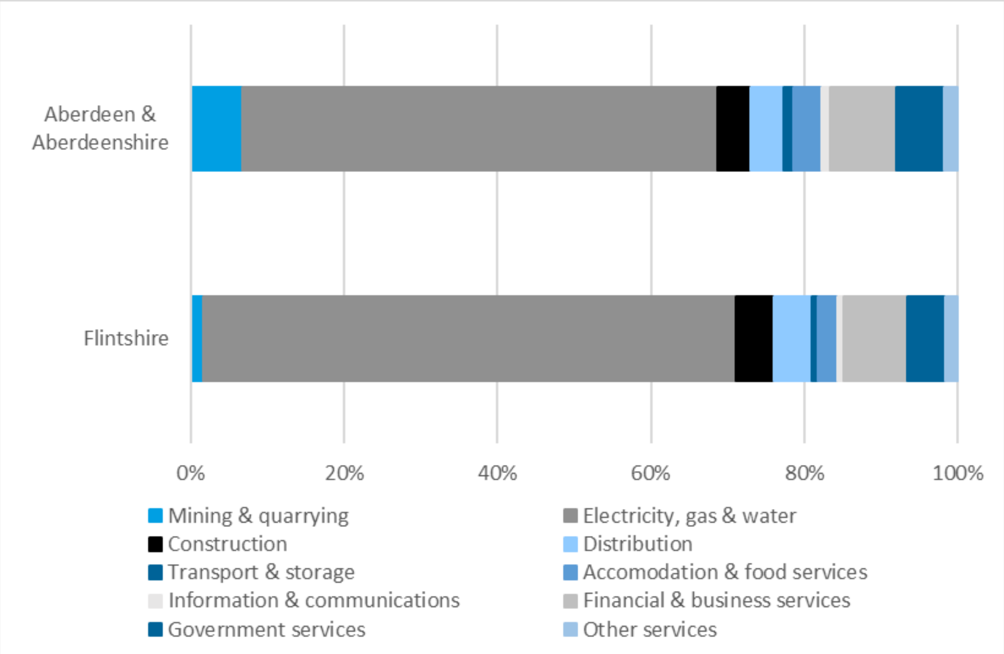


Overall, the closure of the Peterhead plant in 2025 (at a loss of 100 direct jobs within the plant) is estimated to cause a loss of 165 jobs across Aberdeen & Aberdeenshire, as well as reduce GVA by £18m and household expenditure by £4m. The closure of the Connah's Quay plant (80 direct jobs) is estimated to result in 120 job losses in Flintshire, plus a £9.3m fall in GVA and a £2.6m fall in household expenditure. These impacts fade over time as the local economy adjusts.

As well as the loss of jobs linked directly to the closure of the plants, there are also strong indirect impacts on the rest of the local economy. For example, in 2025, for every three jobs lost at the Peterhead plant, two jobs are lost elsewhere in Aberdeen & Aberdeenshire, and for every two jobs lost at the Connah's Quay plant, one job is lost elsewhere in Flintshire.

The sectoral breakdown of these employment impacts (by broad sector) is shown in Figure 8. The large loss of jobs in Electricity, gas & water is likely to include the workforce of the closing plants and indirectly affected jobs further down the supply chain within the Electricity & Gas industry. Losses in Construction, Financial & Business Services and Mining & Quarrying are most likely to include additional supply chain impacts (according to the relationships specified in the input-output table), and losses in Distribution, Accommodation & Food Services and Government Services are likely to result from lower household spending.

Figure 8 Sectoral breakdown of employment impacts of the power plant closures, 2025



Note: Agriculture and Manufacturing are not shown because no employment impact is forecasted in these sectors.

The trends associated with the decline in GVA will be similar, as productivity was assumed to be unchanged from the baseline projections (i.e. all reductions in employment are mirrored in GVA, although the precise make-up of the reduction in GVA will be slightly different, reflecting different levels of productivity between sectors).

Some of the indirect impacts may leak out of the local economy (as assumed in the local supply content assumptions), and though impacts may net out at the UK level, there is likely to be a negative net impact in the local area where the plant has closed.

No adjustment is made in the local modelling to account for an increase in employment in renewable electricity generation. There is conflicting evidence on the labour-intensiveness of renewables generation as compared to fossil-fuel generation; but more significantly, such generation is highly dispersed geographically. Assuming a similar labour intensity from renewables generation (i.e. no net change in direct jobs at a UK level), such activity is likely to be split into small numbers across the UK, and any increase in renewables employment in the specific regions of Aberdeen & Aberdeenshire and Flintshire are likely to be very small (of the order of 5-10 jobs), at least one order of magnitude smaller than the number of jobs lost.

Concluding remarks

The analysis in this paper assesses the potential impact of a national policy shift on local areas. Although the impact of a shift in the carbon floor price is not huge in macroeconomic terms (even within Aberdeen & Aberdeenshire and Flintshire the decrease in employment is around 0.1% of total jobs), within highly localised areas the direct job losses can lead to substantial impacts within both the supply chain and induced effects due to reduced consumer expenditure – our modelling suggests that in the case of jobs in energy generation, the local multiplier is around 1.5 (with additional jobs lost in the wider UK economy). This suggests an important role for local authorities, in providing opportunities for retraining and encouraging investment to provide employment opportunities for workers that lose their jobs as part of the decarbonisation of electricity.

More broadly, this paper demonstrates the benefits of combining a detailed national- or regional-level econometric simulation model with a detailed local model for localised policy modelling. There is a tendency in impact assessments to concentrate on the net macroeconomic effects of policy, without considering the uneven geographical (and/or sectoral) impacts within that net effect. By using both a detailed macro model (based upon input-output tables and national accounting frameworks) and a local input-output model we are able to capture both the detailed national level responses and how those map to the local area, including estimates of local supply content and complete local multipliers.

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