ENERGY-INTENSIVE INDUSTRIES
Climate policy casualties

John Constable

The Global Warming Policy Foundation
GWPF Report 21

GWPF REPORTS

Views expressed in the publications of the Global Warming Policy Foundation are those of the authors, not those of the GWPF, its Academic Advisory Council members or its directors

CREDITS

Cover image	Redcar Steelworks Night By Robert Cook, CC licence. http://bit.ly/247l4D1.

ENERGY-INTENSIVE INDUSTRIES
Climate policy casualties

John Constable

ISBN 978-0-9931189-2-0

Contents

About the author

Dr John Constable is the director of the Renewable Energy Foundation. He is also a member of GWPF's Academic Advisory Council and the energy editor of the Global Warming Policy Forum.

Summary and conclusions

Improvements in economic competitiveness are even more important now that the UK has decided to withdraw from the European Union. The recent difficulties experienced by Tata Steel suggest that this will not be straightforward, and that conditions in the UK are currently extremely difficult for manufacturers, particularly energy-intensive ones.

This paper argues that energy and climate policies are, contrary to the government's analysis, a significant part of the problem, and will need extensive revision in order to make the UK an attractive place in which to invest industrial capital. This point, which should be obvious, has been obscured because much analysis of policy effects on energy-intensive industries (EIIs) has been marred by several failings. The errors are:

1. Mistaken comparison of energy and climate policy costs against total costs, rather than approximate gross value added (aGVA) and gross operating surplus (GOS). Data from the *Annual Business Survey* conducted by the Office of National Statistics (ONS), shows that while companies engaged in the manufacture of iron, steel and ferro-alloys had a GOS of approximately £1.3 billion in 2008, their energy costs of £0.57 billion were equal to 44% of that sum. In 2014 the sector had an operating surplus of £169 million, and energy costs were 330% of GOS.

2. Mistaken concentration on present policy impacts, ignoring much larger effects in the near future. Even EIIs entitled to compensation are presently paying energy prices as much as 18% higher than they would be without energy and climate policies, and for an EII without compensation they are 26% higher. However, by 2020 the figures will be 22% higher for a compensated business, and 76% higher for an uncompensated business.

3. Failure to make reference to electricity network costs brought about by renewable policies but not modelled in government price-impact studies. This cost is likely to be in the region of £5 billion a year in 2020 (almost as much again as the renewables subsidies of £7.6 billion a year). Even if there are capital cost reductions in renewables, UK system costs will still make the energy generated much more costly than that from conventional sources.

4. Failure to recognise that the price impacts on all electricity consumers will be passed through in the cost of other inputs, including wages. DECC estimates that in 2020 and in the *Low Fossil Fuel* scenario a medium-sized business will see electricity prices 76% higher than they would be without policies, and 114% higher in 2030. Prices to households will be some 42% higher due to policies. Consequently all input costs, not just energy costs, will rise in the near and medium term because of energy and climate policies. As an energy-intensive

manufacturer of internationally traded commodities, the steel sector is particularly sensitive to energy costs. It is the first to feel the pain of the UK's climate policies, but it will not be the last. Tata Steel and the energy-intensive sector more broadly can be regarded as a miner's canary, giving early warning of general economic damage as the costs of climate policies are passed through from energy to all other costs in the economy.

1 Introduction

The causes underlying the troubled commercial circumstances of Tata Steel have been controversial, and there is disagreement as to the relative weight that should be given, on the one hand, to international over-supply, largely from China, causing steel prices to fall, and, on the other hand, energy cost increases resulting from UK energy and climate policies. Some commentators believe that energy costs, particularly those of electricity, are a significant factor,[1] whilst others suggest that policy-induced costs are less than 1 or 2% of the production costs of steel and therefore a negligible or at least a minor causal factor in the failure of Tata Steel.[2] A representative example of this latter position can be found in a letter from the Rt Hon Amber Rudd MP, Secretary of State for Energy and Climate Change to Angus McNeil MP, Chairman of the House of Commons Energy and Climate Committee:

> Electricity costs account for around 3% of total costs for the steel sector, so the 7% policy contribution implies that policies are adding less than 0.5% to total costs for that sector.[3]

Such remarks brings into focus a general misunderstanding about the scale and the total impact of energy costs to any business, and not just those classed as energy-intensive users. In the case of Tata Steel it is obvious that international market conditions, and indeed the state of its own pension fund, are an important part of pressure on the company, but the analysis below leads to the view that both current and future policy-induced energy costs should be given considerable weight in any account, and in fact provide a substantial part of the explanation of why Tata Steel's UK operations are currently uncompetitive, as well as explaining why Tata's board sees little reason to think that the situation will improve. Indeed, because of renewables targets and the Fifth Carbon Budget, the situation seems likely to become very much worse by 2020 and critically so beyond that date.

These conclusions apply in a general sense to all other businesses, and for reasons discussed below, EIIs can be regarded as a miner's canary, giving advance warning of problems that will steadily manifest themselves across manufacturing industry and other businesses in the near future. Indeed, the problems facing iron and steel should themselves come as no surprise, since they were preceded by the closures in the still-more-sensitive aluminium smelting sector, with Anglesey closing in 2009, and the larger Lynemouth plant ceasing operations in 2011. Furthermore, the sole remaining smelter of importance, at Lochaber, a small-scale plant by international standards, is currently said to be under review by its owners, Rio Tinto.[4] However, Amber Rudd's letter suggests that government persists in believing that its policies are only a minor contributory factor to such closures, a view that seems to be grounded in what this paper will argue is a superficial and incomplete assessment of the current impacts and future prospects confronting the owners and operators of such industries. In reaching this view, the approach employed recognises a much more complicated set of economic impacts than is normal in statements issued on any side of this discussion:

- Present, direct effects on energy (mostly electricity) prices to a business, consisting of:
  - manifest costs, such as renewable energy subsidies and carbon taxes
  - obscured costs, such as system expansion and system management costs.
- Present, indirect effects transmitted via the costs of all other inputs to that business, including labour.
- Future, direct effects on energy (mostly electricity) prices to a business, consisting of:
  - manifest costs, such as renewable energy subsidies and carbon taxes
  - obscured costs, such as system expansion and system management costs.
- Future, indirect effects transmitted via the costs of all other inputs to that business, including labour.

Most commentators, particularly those defending policies against the charge that they are harming industry, pay attention only to the present, direct, manifest costs; in other words to the superficially obvious impacts. Surprisingly, this is also true of the Committee on Climate Change's public statements on the matter. Writing in a paper published in November of 2015, specifically addressing problems in the steel sector, the Committee on Climate Change observed that:

> Before allowing for compensation, low-carbon policy costs, for integrated producers, such as Redcar and Scunthorpe, amount to around 2% of overall costs:
>
> - Around 6% of blast furnace costs reflect electricity costs;
> - Allowing for one-third of that electricity cost to reflect low-carbon policy, this equates to around 2% of overall costs.
>
> After compensation already in place, the impact is much reduced, and this cost will decline further assuming state aid clearance for RO/FITs costs comes through. Of course, when margins are tight even an impact of the order of 1% might be said to be material, but this is clearly a different order to the impacts deriving from the reduced international price of steel and sterling appreciation.[5]

This is clearly an incomplete consideration and cannot be regarded as an adequate registration of the pressures that energy and climate policies are bringing to bear on decision-makers in businesses as they deal not only with the day-to-day running of their concerns but also fulfil what, after all, are their fiduciary duties under the Companies Act 2006 to plan the commitment of capital for the medium and longer term.

Nevertheless, it is precisely this narrow view that underlies popular restatements such as that of Lord Deben, the Chairman of the Committee on Climate Change, for *City AM* in November 2015:

> All in all, the consequences of the various measures to protect UK steel from the costs of UK climate change policies ensure that those policies probably only add around one per cent to the costs of domestically produced steel. That is relevant – and a lot of work is underway to help the industry adjust – but it is not significant compared to the 50 per cent drop in price, 15 per cent appreciation in the currency or the ongoing supply of steel into an over-supplied world market.[6]

Lord Deben repeated this point in specific in the *Guardian* on the 5 April 2016, when returning to the matter in the context of the threatened closure of Tata Steel:

> Gummer, chair of the CCC, cited research[7] and said that more broadly: 'There's no evidence at all that there's been offshoring of industry from Britain because of our green policies. For most industries, the energy element is extremely small and the amount of extra cost from the green levies is so small as not to be in any way crucial.'[8]

And they appear again in a piece co-authored with Lord Stern and published a few days later, on 14 April 2016:

> Energy costs are an important, but lesser, factor in the equation. The proportion of the cost of steel attributable to energy costs varies depending on the type of steel and the efficiency of the plant. But according to analysis[9] by the Committee on Climate Change, around 6 per cent of production costs for UK blast furnace operation are due to electricity costs. After exemptions and compensation granted to the steel industry are taken into account, then perhaps up to 2 per cent of the total costs of steel production at Port Talbot are due to low-carbon policies. Clearly, this is still relevant, but it is of a different order of magnitude to the impacts of falling steel prices and sterling appreciation.[10]

These views are now consistently and uncritically echoed, even in academic papers, where a more thorough economic examination might be expected. For example, Bassi and Duffy's recent policy brief from the Grantham Research Institute, *UK climate change policy: how does it affect competitiveness?* refers to the Deben and Stern paper and to the Committee on Climate Change papers behind it without any apparent concern that this work might not adequately reflect the policy impacts or the perspectives affecting decisions by Tata Steel's main board:

> Some commentators…have suggested that UK climate policies were primarily responsible for the financial difficulties of the UK steel industry. Such claims do not stand up to scrutiny. Stuart Wilkie, Director of Tata Steel's operation in South Wales, told the House of Commons Select Committee on Welsh Affairs in February 2016 that he expected to spend £100 million on energy in 2016, compared with an annual turnover of £1 billion (House of Commons Welsh Affairs Committee, 2016). Most of these energy costs are accounted for by the wholesale price, transmission and distribution. Calculations by the Committee on Climate Change reveal that perhaps two per cent of the costs of the loss-making steel plant production at Port Talbot were due to climate policies (Stern and Gummer, 2016).[11]

Yet, Mr Wilkie's comment here, that energy accounted for 10% of turnover, should have alerted the authors to the probability that energy costs would be large relative to the profit margins of a company engaged in the manufacture of an internationally traded commodity. Indeed, in addition to the overly narrow focus on present, direct, manifest costs, to the exclusion of future, indirect and obscured costs, all four texts referred to above suffer from the further defect that they diminish the apparent importance of policy costs by expressing them as a fraction of *total input* costs.

A more instructive parameter is calculated by expressing energy and energy policy costs in relation to the business's approximate gross value added (aGVA),[12] and to gross operating surplus (GOS) or profit. Government in fact recognises this point implicitly, since it uses the GVA metric as part of its method for determining eligibility for compensation, and in point of fact the Committee on Climate Change has referred the matter in earlier work, for example the 2013 study *Reducing the UK's carbon footprint and managing competitiveness risks*, which notes that:

> There is a higher risk of competitiveness impacts for energy-intensive firms, defined as spending more than 10% of their Gross Value Added (GVA) on energy. The risk is that these energy-intensive industries that are also subject to international competition facing higher relative energy costs will see a squeeze on profits which could potentially drive output and jobs overseas. [13]

Indeed, GVA is discussed in several other locations in the 2013 paper, with a particular interest in those companies where electricity with energy or electricity costs equivalent to more than 10% of their GVA, and though the study does not go on to discuss GOS, an unfortunate omission, the paper is, overall, more sophisticated than the later summary statements of the Committee on Climate Change that refer to it as an authority.

This paper attempts to remedy these defects by considering present, future, direct, indirect, manifest, and obscured impacts of policies, and to put them into the context of aGVA and GOS for the purposes of scale comparison.

2 Present, direct effects

Manifest costs

Most of the present, direct effects of policy measures on energy prices are felt in the electricity price, most obviously through energy subsidies and carbon taxes. The principal source for estimates of the impacts of renewable energy subsidies and other climate policies on electricity prices to industry is the November 2014 issue of the *Estimated Impacts of Energy and Climate Change Policies on Energy Prices and Bills*, published by the Department of Energy and Climate Change (DECC) and in particular the associated spreadsheet giving details of price and bill impacts for various types of consumers in three fossil fuel price scenarios – *Low*, *Central*, and *High* – and for three different years – 2014, 2020, and in some cases 2030.[14] Of these, the *Low* fossil fuel price scenario now seems very much the most probable, and it is reasonable to concentrate on those figures, except, of course, where citing effects as estimated by DECC in 2014, which year forms the basis for the central scenario.

For obvious reasons the *Low* fossil fuel price scenario makes the relative impacts of the climate policies greater, but it should be noted at the outset that even in the *High* fossil fuel price scenario the effect is to increase prices to consumers by a significant margin, thus raising doubts over the degree to which the renewables policies offer any protective price insulation. For example, even in the *High* scenario an energy-intensive user without a compensation package would see prices 41% higher than they would be without policies, and a medium-sized business would see prices some 45% higher. It should be obvious that these are highly significant effects.

DECC also provides estimates of average bill impacts, which allow it to introduce assumptions about the effects of energy-efficiency policies, which are expected to reduce demand and thus offset the price impacts. This method assumes that efficiency measures will result in energy conservation, an assumption that is highly questionable and has been so since 1865 when Jevons, pointing to increases in coal consumption as steam engines improved in thermal efficiency, called it 'wholly a confusion of ideas'.[15] Furthermore, there is now ample evidence to suggest that expectations for the effectiveness of efficiency measures have been optimistic, both domestically and industrially, a result that is better known to the market than to DECC, and thus is inhibiting the further uptake of such measures.

It can also be observed that such bill estimates omit the consumer response to rising prices, and can only with extreme uncertainty make allowance for it. For example, aggregate consumption might actually fall due to price rationing, business migration, and general economic contraction, rather than the uptake of energy efficiency measures. This would mean that the electricity industry's fixed costs would have to be spread over a smaller consumer base, with a consequent effect on bills (and prices) that is not accounted for in DECC's assessment.

For all these reasons the estimated bill impacts are of little use in presenting the future effects of policies to consumers. A focus on the estimation of impacts on prices – pence per unit of electricity purchased – on the other hand, allows contemporary consumers to estimate future effects in their own particular case, and to foresee their own necessary responses, and thus to form a view on the desirability or otherwise of the policies.

Estimated impacts on energy intensive users

The following table has been redrawn from DECC's *Estimated Impacts* and reports the estimated current effects on two types of EII: one that receives compensation to offset

Table 1: Impact of energy and climate change policies on energy prices paid in 2014 by large EIIs that benefit from the full package of support measures or from none.*

		£/MWh for EEIs receiving: Full package	**No package**
Price before policies	£	64	64
Price impact of policies	£	12	16
Estimated impact of policies		18%	26%
Price after policies	£	76	80
Of which:			
Wholesale energy costs	£	42 (55%)	42 (52%)
Network costs	£	20 (27%)	20 (25%)
Supplier costs and margins	£	2 (3%)	2 (2%)
Energy and climate change policies	£	12 (15%)	16 (20%)
Of which:			
Climate Change Levy	£	—	1
Small-scale feed-in-tariffs	£	2	2
Renewables Obligation	£	10	10
Contracts-for-Difference	£	—	0
Capacity Market gross auction cost	£	—	0
EU ETS carbon cost	£	1	2
Carbon Price Floor carbon cost	£	2	4
Other wholesale price effects of policies	£	−3	−3

*Other than the CCA discount on the Climate Change Levy. Real 2014 prices. Source: Redrawn from DECC, *Estimated Impacts*, 2014.

the impacts of policies and one that does not.

Therefore, even with a compensation package, the current price after policies is £76/MWh, which is 18% (£12/MWh) higher than it would be in the absence of policies, and those companies without a compensation package are paying 26% or £16/MWh more than they otherwise would. The absolute scale of this impact will vary greatly from company to company, but as a rough indication we can take DECC's assumed figure of electricity consumption of 98,000 MWh per year, after efficiency measures, and multiply this by the policy costs, to calculate that policies would be costing such a consumer £1.2 million a year in extra electricity costs if they were receiving a compensation package, and about £1.6 million a year if they were uncompensated.

The subsequent rows in the table break down the price into its components: the wholesale energy costs, the network costs (National Grid's costs in maintaining, running, and particularly balancing the system), the supplier costs, and the policy component, which is then further subdivided into individual policy price effects.

The Climate Change Levy (CCL) is a tax paid by some industrial and commercial consumers, and is remitted to the Treasury. The Feed-in Tariff, and Renewables Obligation are income-support subsidies to renewable generators, and are currently costing UK consumers approximately £4 billion per year. By 2020 this cost must rise significantly to support the generators required to provide the electricity sector's share of the target set by the European Union Renewables Directive (2009). This target, which specifies that 15% of the UK's final energy consumption in 2020 must be from renewable sources, implies that some 35% of electricity supplied, about 110 TWh, must be renewable. The annual cost of subsidies to the renewable electricity sector is capped by the Treasury at £7.6 billion, though in fact there are sufficient planning consents already granted for renewable generators to overshoot the target quantity by some 38 TWh of capacity, which will add several billion pounds in additional cost if no preventative action is taken.

The Contracts for Difference (CfD) element describes the successor mechanism to the Renewables Obligation, which closes to new entrants in 2017. CfDs are in effect a guaranteed price, and are available not only to renewables but also to new nuclear generation. This scheme has yet to come into effect.

The European Union Emissions Trading Scheme (ETS) is a quota-based system at the European level, though it is supported by the UK's unilaterally introduced Carbon Price Floor, the effects of which are described in the penultimate row of the table. It is important to recognise that due to its design the EU ETS not only guarantees the carbon saving that it specifies, but also caps that saving. Thus, the other low-carbon policies described in this table add no additional physical emissions saving, but instead reduce the market's freedom of choice with regard to the means adopted under the ETS. In effect, the market is forced to adopt a higher-cost savings route than it would otherwise choose. That is to say, the Renewables Obligation and the Feed-in Tariff, and the CfD add no further physical savings of emissions, and simply add to the cost of the emissions saving that is guaranteed by the EU ETS. This important point has yet to receive the publicity that it deserves.

The final row of the table records a negative value, −£3, because of the wholesale price effects of policies. This results from the fact that generators such as wind and solar power have a zero marginal cost, and thus exert a downward pressure on the wholesale prices of other generators. While it is correct to include the value in this calculation, it is worth remembering that this effect is one of several weakening price signals to investors in conventional generation and so accounts for the need to introduce the Capacity Mechanism, with the net effect to the consumer not necessarily being beneficial. Future developments will doubtless decide this question.

Obscured costs

The list of policy-induced price components in Table 1 is not exhaustive, since elements in the network costs line are in fact caused by policies mandating the introduction of renewable generators. Some part of the £20/MWh is the result of grid reinforcements, such as the Beauly–Denny line, and system-management practices required to accommodate and integrate renewable electricity generators, such as wind turbines. For example there are constraint payments to wind-power generators for reducing output on one side of a grid bottleneck, and simultaneously there are payments to conventional generation on the other side of the constraint to increase output to replace the curtailed wind output. At present the scale of this cost is not overwhelmingly large – constraint payments to wind totalled £50 million in 2014 – but these costs are nevertheless real and rising. Furthermore, grid reinforcements to reduce constraint payments will not necessarily reduce the cost to consumers, since these reinforcements are in themselves very expensive, a cost that must be recovered from consumer bills.

An idea of the scale of the renewables integration costs at present can be gauged by the increase in Balancing Services Use of System (BSUoS) costs,[16] which compensate the UK System Operator, National Grid, as they correct for errors in the demand and generation forecast, and make adjustments to deal with congestion in the transmission network. These include purchasing additional generation at short notice, constraint payments, and several other ancillary services. The cost of these services, and National Grid's own administration costs and profit, are initially charged to generators and to electricity suppliers, though, obviously, ultimately recovered from electricity consumers. Figure 1 tracks Balancing Services Use of System (BSUoS) charges since 2001/2.

BSUoS costs have increased by a factor of three in the decade 2001–2012, a point that is all the more remarkable against the backdrop of falling electricity demand, now down to levels last seen in the 1990s, meaning that the BSUoS cost per unit of electricity carried through the system to consumers has increased by a factor well in excess of three, and has now reached levels of about £3.50/MWh.

Not all these costs are attributable to renewable generators, and thus to energy and climate policies, but a significant fraction must be so. It is known, for example, that in 2015 payments to wind power to cease generation amounted to about £90 million and thus comprised about 10% of BSUoS costs. As noted above, when wind is constrained off in Scotland, the GB market is consequently out of balance, and conventional generation must be constrained on the southern side of the bottleneck to rectify this situation. This cost is extremely difficult for those outside National Grid to estimate, but since these conventional generators are being asked to respond at short notice the cost cannot be low, and will constitute a significant fraction of the now £1 billion a year total BSUoS cost.

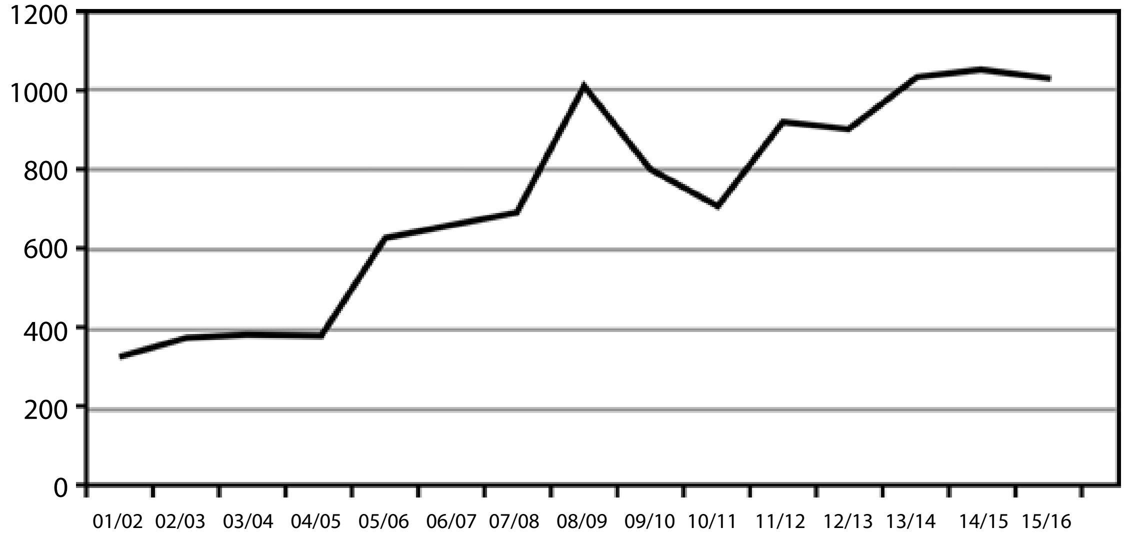

Figure 1: Balancing Services Use of System costs (£m), 2001/2–2015/16

Data sources: 2001/2–2014/15, current and historic datasets available at: http://www2.nationalgrid.com/bsuos/; 2015/16 from National Grid *Monthly Balancing Services Summary*.

It is not possible for us to offer a precise estimate of the fraction of the £20/MWh network costs attributable to climate policy, though it is unlikely to be more than the £3.50/MWh that BSUoS are currently costing in total, but it will be substantial, and in future is all but certain to become very much larger (see below).

3 Present, indirect effects

The direct energy and climate-policy price impacts on one sector of the economy are felt indirectly by other sectors as an increase in the cost of goods and services, and as upward pressure on wages and salaries. The overall scale of these impacts can be gauged from the fact that subsidies to renewable electricity generators alone are now in excess of £4 billion a year, and rising steadily. Measures such as the Emissions Trading Scheme and the Carbon Price Floor add very substantially to this cost. Table 2 summarises the electricity price impacts estimated by government in 2014 for a medium-sized sized business with a Carbon Reduction Commitment.

The Carbon Reduction Commitment (CRC) is a scheme mandatory for some larger industrial, commercial and public-sector consumers and is intended to reduce emissions of greenhouse gases and encourage certain processes or activities to become less energy intensive, in other words that less energy is used per unit of output.[17] A further element, in addition to the price elements already discussed above in relation

Table 2: Estimated 2014 electricity price impacts of policies on medium-sized businesses with a Carbon Reduction Commitment (CRC).

Category	**Price* (£/MWh)** £	%
Price before policies	74	
Price impact of policies	29	
Estimated impact of policies, %		39
Price after policies	103	
Of which:		
Wholesale energy costs	41	40
Network costs	25	24
Supplier costs and margins	8	7
Energy and climate change policies	29	28
Of which:		
CRC Energy Efficiency Scheme	8	
Climate Change Levy	5	
Small-scale Feed-in-Tariffs	2	
Renewables Obligation	10	
Contracts-for-Difference	—	
Capacity Market gross auction cost	—	
EU Emissions Trading System carbon cost	2	
Carbon Price Floor carbon cost	4	
Other wholesale price effects of policies	−3	

*At 2014 prices. Source: Redrawn from DECC, *Estimated Impacts*, 2014.

to Table 1, is the Capacity Market cost. This policy creation recognises that, due to other market-distorting policies, investment signals to conventional generation have been weakened, and that it has thus become necessary to introduce a subsidy specifically to reward generators for the provision of available capacity in order to guarantee security of supply at a particular time (usually peak load). In 2014 the Capacity Market had not begun to impose costs, but the scale of future effects is well known, with the Office for Budget Responsibility estimating annual costs of £600 million in 2018/19, rising to £1.1 billion in 2019/20, and then £1.3 billion a year in 2020/21.[18]

Taken together, the price impact of policies is £29/MWh, giving a total price of £103/MWh, some 39% higher than it would otherwise have been. Translating such an effect into a typical bill impact is particularly difficult in the case of medium-sized businesses since they vary greatly in scale, so it would be misleading to give an estimate as anything more than a very rough indication, but DECC themselves grant, in their bill impact studies, that it might be as much as £500,000 a year, even assuming considerable consumption reductions through energy-efficiency measures.

In this context it should also be recalled that policies increase the cost of electricity to domestic households, and thus have an indirect effect, exerting an upward pressure on wages. Government estimated that in 2014 a domestic household was paying about £164/MWh for electricity, some £24 more than it would pay in the absence of policies, a premium of 17%. Assuming a household consumption of about 3 MWh a year, policies are adding approximately £70 annually to the average household bill. The full cost-of-living effect of policies is rather higher, perhaps twice as much again, since providers of goods and services to those households must recover their costs from sales.

4 Future, direct effects

Manifest costs

Table 3 is drawn from DECC's work and reports the anticipated impacts on two types of EII in 2020: one that receives compensation to offset the impacts of policies and one that does not.

Thus, even with a compensation package, the 2020 price after policies is 22% or £13/MWh higher than it would have been in the absence of policies. Those companies without a compensation package face a price increase of 76% or £45/MWh. The absolute scale of this impact will vary greatly from company to company, but as a rough indication we can take DECC's assumed figure of electricity consumption of 90,000 MWh per year, after efficiency measures, and multiply this by the policy costs, to calculate that policies would be costing such a consumer £1.2 million a year in extra electricity costs if they were receiving a compensation package, and about £4 million a year if they were uncompensated.

Obscured costs

There is considerable uncertainty about the scale of system cost increases that will be required to integrate the volumes of renewable electricity required by the European Union Renewables Directive target for 2020. All that can be said with confidence is that it will be very significant. Colin Gibson, a former main board Power Network Director (PND) at National Grid, in work for the Institution of Engineers and Shipbuilders in Scotland (IESIS), in 2011, gives a comprehensive estimate of the system impacts of renewables, including:

Table 3: 2020 policy price impacts for EIIs in the *Low* fossil fuel price scenario

	With compensation package				Without compensation*			
	Gas		Electricity		Gas		Electricity	
	£/MWh	%	£/MWh	%	£/MWh	%	£/MWh	%
Price before policies	19		59		19		59	
Price impact of policies	—		13		1		45	
Estimated impact of policies (%)		—		22		4		76
Price after policies	**19**		**71**		**19**		**103**	
Of which:								
Wholesale energy costs	12	67	35	49	12	65	35	34
Network costs	6	31	22	30	6	30	22	21
Supplier costs and margins	0.5	2	2	3	0.5	2	2	2 1)
Energy and climate change policies	—	13	18	1	3	45	43	
Of which:								
Climate Change Levy	—		—		1		1	
Small-scale Feed-in-Tariffs	—		1		—		4	
Renewables Obligation	—		2		—		15	
Contracts-for-Difference	—		1		—		10	
Capacity Market gross auction cost	—		6		—		6	
EU ETS carbon cost	—		1		—		2	
Carbon Price Floor carbon cost	—		3		—		8	
Other wholesale price effects of policies	—		–2		—		–2	

Valued at price before policies. 2) Multiplied by consumption after policies. 3) Although an estimated gross auction cost of the Capacity Market is presented for 2020 and 2030, the cost in any particular year is uncertain, and therefore an average cost represents a more useful estimate. The gross auction cost is just one impact of the Capacity Market – the overall impact is reflected in the net cost, which takes account of the reduction in the wholesale price due to the Capacity Market. *Other than the CCA discount on the CCL Values in 2014 prices. Source: DECC, *Estimated Impacts,* 2014.

- grid expansion and reinforcement
- generation plant capable of rapid ramping up and down in tandem with short-term fluctuations in renewable output, which is often neglected
- the cost of running at low load factor (i.e. under-utilising), sufficient conventional plant to guarantee security of supply at the moment of peak demand, on a dark, cold, windless winter's afternoon when the contribution from renewables will be low.[19]

These combined costs vary from technology to technology, with biomass having no additional system costs over and above those which apply to coal- or gas-fuelled generation. By contrast, offshore and onshore wind would impose a cost of about £60–67 per MWh of wind energy, more than the subsidy for onshore wind (around £45/MWh) and only somewhat less than that for offshore wind (around £90/MWh).

The total aggregate system management cost to consumers will depend on the plant mix in 2020, and this is still unclear. However, assuming the quantities of wind in the National Renewable Energy Action Plan, this would come to approximately £5 billion a year, not much less than the total subsidy bill, which is capped by the Treasury at £7.6 billion. Combining the management and subsidy costs gives a total cost estimate of about £14 billion a year.

A more recent estimate of balancing costs by Gordon Hughes suggests BSUoS costs alone, discussed above, would rise to about £1.7–2.2 billion in 2020, assuming about 24–30 GW of wind power, comprising a mixture of on- and offshore generation, with a unit cost of about £17–21/MWh.[20] It is important to emphasise, as Hughes does, that even if the grid bottlenecks are removed, the costs to consumers may not fall. Indeed, it is conceivable, if not probable, that removing bottlenecks to reduce constraint payments to wind power may actually be the more expensive option.

Overall, it is reasonable to conclude from the studies of both Gibson and Hughes that the system management costs imposed by wind power are no less significant than the current subsidy costs. Consequently, even dramatic progress towards capital cost reduction for wind turbines may not bring consumer costs down below current levels. Indeed, on Gibson's estimates of system costs, cited above, even if the capital cost of wind power were £0/MW installed, the cost of transmitting the generated electricity to consumers would still be higher than that of energy from combined-cycle gas turbines at current gas prices.

The price impacts in DECC's estimates, cited above, do not take into account these probable future system costs, and a proportional increase over and above the DECC price impacts is very likely. Thus, in addition to £19/MWh to support renewables through the Renewables Obligation and Feed-in Tariff, an EII without a compensation package would also expect to be paying approximately £10/MWh for system costs in 2020, giving a total policy impact on price of £55/MWh rather than £45/MWh.[21]

5 Future, indirect effects

As noted above, the direct energy and climate policy price impacts on one sector of the economy are felt indirectly by other sectors as an increase in the cost of goods and services purchased as inputs, as well as an upward pressure on wages and salaries. The scale of this potential pass-through effect can be appreciated from the following table, which summarises the electricity price impacts expected by government in 2020 and 2030 in the *Low* fossil fuel price scenario for a medium-sized business under the Carbon Reduction Commitment.

Table 4: Electricity price impacts of policies on medium-sized businesses with a Carbon Reduction Commitment, in the *Low* fossil fuel price scenario.

	2020		**2030**	
	£/MWh	**%**	**£/MWh**	**%**
Price before policies	69		69	
Price impact of policies	53		78	
Estimated impact of policies,		77		114
Price after policies	**122**		**147**	
Of which:				
Wholesale energy costs	34	28	34	23
Network costs	27	22	27	18
Supplier costs and margins	8	6	8	5
Energy and climate change policies	53	43	78	53
Of which:				
CRC Energy Efficiency Scheme	4		2	
Climate Change Levy	5		5	
Small-scale Feed-in-Tariffs	4		4	
Renewables Obligation	15		9	
Contracts-for-Difference	10		39	
Capacity Market gross auction cost	6		5	
EU Emissions Trading System carbon cost	2		22*	
Carbon Price Floor carbon cost	8			
Other wholesale price effects of policies	−2		−7	

Values in 2014 prices. *Due to uncertainties around EU ETS prices post 2020, the impact of the EU ETS and CPF has been combined. Source: DECC, *Estimated Impacts*, 2014.

The price impacts are obviously very significant, amounting to an extra £53/MWh or 77% in 2020 and £78/MWh or 114% in 2030. These increases must be recovered either by passing them through to customers, or by effecting reductions in wages and salaries. That distribution is hard to estimate, but it is worth observing that the Committee on Climate Change's view of these effects has a very large degree of variation. In their 2013 study of the effects on high energy-consuming industries, they report that the potential pass-through rate for the iron and steel industry varies from 25% to 75%, with other industries showing similarly large variation.[22] However, as might be expected intuitively, the CCC itself observes that 'for some sectors pass-through is likely to be towards the higher end of the range'. This seems entirely plausible, since exerting a downward pressure on wages will not be a realistic option for most companies.

Furthermore, the need to remain internationally competitive would mean that industries with both domestic and export markets, particularly commodity companies with consequently slender margins, would probably aim to recover these costs from domestic customers.

There is no compensation package available for medium-sized users, and it is very unlikely that there could be any such package, since this would entail unacceptable transfers of costs to households, which already face very significant price increases. DECC's *Estimated Impacts* predicted that in 2020 in the *Low* fossil fuel scenario, a household would see prices 42% higher (£186/MWh rather than £131/MWh) than they would without policies. In 2030 DECC's estimate suggests that prices would be about £206/MWh rather than £129/MWh, a premium of £77/MWh. Such unit price increases are likely to result in bill impacts of about £150 per year in 2020 and about £200 per year in 2030 (both assuming household consumption of 3 MWh per year). These are in themselves insignificant, but will, of course be combined with a general increase in cost of living as businesses pass on their own increased energy costs in the costs of goods and services supplied to households. If the supermarket has to pay more to refrigerate milk, it must recover this cost at the checkout. This general effect on household costs will result in an upward pressure on wages at a time when, as the previous table shows, employers will be under considerable pressure to reduce them.

6 Compensation packages

The government has recognised that EIIs are vulnerable to policy-induced energy costs, particularly if they are in competition with companies in jurisdictions where there is no comparable policy cost, such as China, or where industries are shielded from those costs, such as Germany. Inevitably, since the policy costs cannot be reduced in total, this entails transferring the cost burden to other consumers; in other words to other industrial and commercial consumers, and to households. The policy is therefore potentially controversial, and government is increasingly sensitive to the fact that the policy burden on these other consumers is already high. As a result, the compensation is only available to EIIs whose energy costs exceed 20% of their aGVA. Furthermore, EU state-aid rules limit compensation to 85% of the impact on industrial electricity prices. Similarly, these state-aid rules limit compensation related to carbon taxation and pricing to a maximum 85% of the impact on industrial electricity prices, falling to 75% by 2019/20, and this is payable only up to an energy-efficiency benchmark, so as to avoid paying more compensation to less efficient installations.

Thus, not all companies will be entitled to compensation, and even those that do qualify will not receive full compensation. This is not well understood, and even Lord Deben, Chairman of the Committee on Climate Change has issued a public statement, on Twitter on the 4 April 2016, in which he claimed that 'We more than compensate heavy energy users', which is clearly a misleading description of the actual state of affairs. Table 5, supplied by the Intensive Energy Users Group, a trade body representing these companies, summarises their expectations of entitlement.

Industries in the yellow cells are compensated for neither renewables (and nuclear) subsidy costs or for the ETS or Carbon Price Floor, though some are exempt from the Climate Change Levy. Industries in the orange cells are compensated only for the ETS and Carbon Price Floor; those in the green cells only for the renewables (and nuclear subsidies), though some are CCL exempt. Those in the blue cells are compensated for both, with some being additionally exempt from the CCL. The steel sector, as the matrix indicates, has the most comprehensive exemption of any industry, an implicit admission by government that the sector is hyper-sensitive, but this broad shielding has not proved to be sufficient to prevent that sector finding insupportable the additional burdens of policy, particularly the prospective additional burdens. This may seem surprising if one takes at face value the fact that policy burdens comprise 1 or 2% of total costs. In fact, this is a high proportion for a commodities business exposed to international markets, a fact that can be understood only by examining policy costs in the context of GVA and profit, a subject discussed in the following section.

7 Energy costs as a fraction of expenditure

The Annual Business Survey of the Office of National Statistics (ONS) contains cost breakdowns for a wide variety of industrial and commercial categories. This data, which is available on request from the ONS, unfortunately aggregates expenditure on energy and water, but for most businesses water will be a minor fraction of this total, and particularly so for those engaged in metallurgy. In what follows, we report this figure unmodified. The energy purchases even of an energy-intensive user do not account for more than 10% of turnover, sales, all purchases, or of purchases of goods and materials. However, energy costs are equivalent to between 43% and

Table 5: Energy-intensive industries compensation matrix.

		Emissions Trading Scheme/Carbon Price Floor			
		Compensated		Uncompensated	
		CCL exempt	CCL payer	CCL exempt	CCL payer
Feed-In Tariff **Renewables Obligation** **Contracts for Difference**	**Compensated**	*Steel:* 20 sites (7 primary production) 30,000 jobs 3,200 GWh pa	*Chemicals:* 9 sites 4,100 jobs 1,900 GWh pa	*Cement:* 11 sites 2,500 jobs 850 GWh pa	
			Paper: 49 sites 9,300 jobs 2,300 GWh pa	*Lime:* 7 sites (+ 6 captive), 500 jobs 152 GWh pa	*Kaolin, ball clay:* 12 sites 1,200 jobs 240 GWh pa
				Container glass: 12 sites 4,500 jobs 800 GWh pa	*Industrial gases:* 37 sites (16 primary production) 5,000 jobs
				Ceramics: 4 sites 650 jobs 90 GWh pa	
	Uncompensated		*Chemicals:* 2 sites, 540 jobs	*Ceramics:* 145 sites 15,000 jobs 700 GWh pa	*Chemicals:* 214 sites 50,000 jobs 2,900 GWh pa
				Flat, fibre, other glass: 12 sites 1,500 jobs 200 GWh pa	

Source: Energy-Intensive Users Group, EIUG, and correct at time of publication. CCL, Climate Change Levy.

Table 6: Total expenditure on energy and water for businesses engaged in the manufacture of basic iron and steel and ferro-alloys.*

Year	Expenditure on energy and water £m	% of total purchases	% of purchases of goods and materials	% of GVA
2008	587	8.7	11.8	27.4
2009	397	7.6	10.0	91.3
2010	414	6.8	8.6	35.9
2011	488	7.6	9.9	43.3
2012	479	9.0	12.1	49.8
2013	482	9.3	13.4	40.3
2014	488	8.1	12.0	56.0

*Standard Industrial Classification 24.1. Source: Standard Extracts of the Annual Business Survey, Office of National Statistics.

56% of aGVA over in the last four years, which is a great deal higher than the equivalent percentage for manufacturing businesses overall, where energy expenditures are equivalent to about 7% of aGVA.

The table shows significant fluctuations in the equivalent proportion of aGVA that was spent on energy after 2008, and it is important to note that these result from fluctuations in aGVA (see Table 7 below), not energy costs. The economic turbulence in 2008 has clearly had a major and lasting impact on the steel industry, and the details are worth rehearsing as a reminder of the severity of the impact:

- Thamesteel, an electric arc steelmaker and mill at Sheerness in Kent, closed in January 2012.
- Tata Steel's Teeside furnace, coke ovens and certain other downstream operations were mothballed in 2009, but re-started by SSI in 2011.
- The Port Talbot No 4 blast furnace was closed for a £185 million rebuild in July 2012, re-started in February 2013, but then closed in September/October 2015.

While it is perfectly true that this turbulence was not due to policy, it would be misleading to infer that because of that fact, energy and climate policies were minor causal factors in the sector's difficulties. A man up to his neck in water can be drowned by a careless splash. And even in prosperous times, EIIs are sensitive to energy costs, not only because they use a great deal of energy, but, and more importantly for the present discussion, because they rely heavily on the direct use of energy to transform input raw materials, and are thus very inflexible since capital substitution is not often an option. Indeed, though perhaps not for these reasons, the UK government itself recognises the importance of the aGVA metric, since, as noted above, it assesses eligibility for the compensation packages by determining whether energy costs exceed 20% of aGVA, rather than total expenditure.

Since we know that energy policy costs will add about one to two percentage points to the energy proportion of total purchases, we can estimate, using the 2014 ratio, that it will add about a further ten or so percentage points to the energy equivalent fraction of aGVA, meaning the energy costs would be equivalent to well over 60% of aGVA in 2020.

The impact of energy costs can be still better appreciated by presenting them in relation to GOS, or profit, which is conventionally calculated by subtracting wages and salaries from aGVA. Table 7 summarises the data for basic iron and steel and ferro-alloy manufacturers.

Table 7: Expenditure on energy and water for basic iron and steel and ferro alloy manufacturers, in relation to gross operating surplus.

Year	Expenditure on energy and water	aGVA	Wages and salaries	GOS	Energy and water as % of GOS, where positive
	£m	£m	£m	£m	%
2008	587	2,143	795	1,348	44
2009	397	435	704	−269	n/a
2010	414	1,152	664	488	85
2011	488	1,126	693	433	113
2012	479	962	690	272	176
2013	482	1,196	671	525	92
2014	488	872	703	169	289

Source: ONS, *Annual Business Survey*, calculations by the author.

Since GOS can be accepted as a reasonable approximation to profit, it can be inferred that even in periods with a good surplus, such as 2008, energy costs are equivalent to a very large proportion of profits. In other words, iron and steel manufacturers have little room for manoeuvre in relation to energy consumption. This is to be expected from the nature of the industry, in which basic commodities manufacturers produce early-stage reformation of basic terrestrial resources. For this activity, direct energy use in large quantities is all but unavoidable, and the potential for capital substitution and efficiency improvements limited. That is to say, as far as the energy required per tonne of product – in other words its energy intensity – this industry is relatively inelastic.

Other kinds of manufacturing employ a wide range of inputs that have already been prepared by others, so the energy consumption has been rendered as the complex state of those inputs, and the costs of direct energy consumption of the business are consequently equal to a much smaller fraction of GOS. In the years 2008–2014, the ONS data suggests that direct energy costs were equivalent to about 13% of GOS for the manufacturing sector. For the retail sector, excepting motor vehicles and motorcycles, energy consumption was equivalent to about 10% of GOS over the same period. Such enterprises are very much less sensitive to the direct impact of energy and climate policies than EIIs, but will feel the impact of those policies as the energy costs are passed through in the costs of other goods and services, including labour. In other words, the effect is delayed but nonetheless certain. EIIs, because they feel the effects immediately and directly, are an early warning of the hazard passing through to other businesses in the medium and longer term.

Notes

1. See: http://www.thetimes.co.uk/article/race-to-go-green-is-killing-heavy-industries-green-targets-set-to-destroy-our-industries-zq5l835gp, and http://www.spectator.co.uk/2016/04/how-is-britain-going-green-by-shutting-down-industry/.

2. See for example, http://www.carbonbrief.org/factcheck-the-steel-crisis-and-uk-electricity-prices, and http://www.theguardian.com/environment/2016/apr/05/green-policies-are-not-responsible-for-the-tata-steel-crisis, and CCC studies https://documents.theccc.org.uk/wp-content/uploads/2013/04/CF-C-Summary-Rep-web1.pdf and https://documents.theccc.org.uk/wp-content/uploads/2016/03/Technical-note-low-carbon-policy-costs-and-the-competitiveness-of-UK-steel-production.pdf.

3. Amber Rudd to Angus McNeil, 22 April 2016: http://www.parliament.uk/documents/commons-committees/energy-and-climate-change/Energy-policy-impacts-on-EIIs-SOS-to-CHAIR.pdf.

4. See http://www.bbc.co.uk/news/uk-scotland-highlands-islands-35387426 and https://www.pressandjournal.co.uk/fp/business/north-of-scotland/885487/fears-grow-for-future-of-rio-tinto-jobs-in-lochaber/.

5. Climate Change Committee, *Technical note: low-carbon policy costs and the competitiveness of UK steel production* (Nov. 2015), available at https://documents.theccc.org.uk/wp-content/uploads/2016/03/Technical-note-low-carbon-policy-costs-and-the-competitiveness-of-UK-steel-production.pdf.

6. See: http://www.cityam.com/228211/-this-is-why-we-cant-blame-the-decline-of-the-uks-steel-industry-on-climate-change.

7. Article note: https://documents.theccc.org.uk/wp-content/uploads/2013/04/CF-C-Summary-Rep-web1.pdf.

8. See: http://www.theguardian.com/environment/2016/apr/05/green-policies-are-not-responsible-for-the-tata-steel-crisis.

9. Author's note:https://documents.theccc.org.uk/wp-content/uploads/2016/03/Technical-note-low-carbon-policy-costs-and-the-competitiveness-of-UK-steel-production.pdf.

10. See: http://www.independent.co.uk/voices/critics-blame-efforts-to-tackle-climate-change-for-the-decline-of-british-steel-theyre-wrong-a6984206.html.

11. Samuela Bassi and Chris Duffy, *UK climate change policy: how does it affect competitiveness?* (Centre for Climate Change Economics and Policy, Grantham Research Institute on Climate Change and the Environment: London, May 2016), 13. See: http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2016/05/Bassi-and-Duffy-policy-brief-May-2016.pdf.

12. aGVA differs in certain respects from the whole economy measure of GVA, but is the preferred measure for examining the internal state of a business. See: ONS, *A Comparison between Annual Business Survey and National Accounts Measures of Value Added* (24 April 2014). Available at: http://www.ons.gov.uk/ons/guide-method/method-quality/specific/business-and-energy/annual-business-survey/quality-and-methods/a-comparison-between-abs-and-national-accounts-measures-of-value-added.pdf.

13. Committee on Climate Change, *Reducing the UK's carbon footprint and managing competitiveness risks* (April 2013), 37. See:https://documents.theccc.org.uk/wp-content/uploads/2013/04/CF-C-Summary-Rep-web1.pdf.

14. DECC, *Estimated Impacts of Energy and Climate Change Policies on Energy Prices and Bills* (November 2014).

15. W. S. Jevons, *The Coal Question* (Macmillan: London, 1865), 103.

16. For further information on the Balancing System see: http://www2.nationalgrid.com/bsuos/.

17. See: https://www.gov.uk/guidance/crc-energy-efficiency-scheme-qualification-and-registration#overview.

18. See Office for Budget Responsibility, http://budgetresponsibility.org.uk/economic-fiscal-outlook-july-2015/. Data from Fiscal Supplementary Tables.

19. See: http://www.iesisenergy.org/lcost/.

20. Gordon Hughes, *The economic geography of electricity networks*, SGPE Presentation Crieff Hydro, 6 January 2016.

21. For further discussion, particularly in relation to the cost of emissions reductions achieved by adding windpower in an already congested network, see G. Hughes, Constable, J., and Moroney, L., *When is adding generating capacity to a congested network justified?* Paper presented at the workshop of the Centre for Competition and Regulatory (Barcelona, July 2014).

22. For further discussion of these effects, see Gordon Hughes, *Renewables policy and prospects for energy costs*, talk at Stirling University, 24 November 2013.

GWPF REPORTS

1	Montford	The Climategate Inquiries
2	Ridley	The Shale Gas Shock
3	Hughes	The Myth of Green Jobs
4	McKitrick	What Is Wrong With the IPCC?
5	Booker	The BBC and Climate Change
6	Montford	Nullius in Verba: The Royal Society and Climate Change
7	Goklany	Global Warming Policies Might Be Bad for Your Health
8	Hughes	Why Is Wind Power So Expensive?
9	Lilley	What Is Wrong With Stern?
10	Whitehouse	The Global Warming Standstill
11	Khandekar	The Global Warming-Extreme Weather Link
12	Lewis and Crok	Oversensitive
13	Lewis and Crok	A Sensitive Matter
14	Montford and Shade	Climate Control: Brainwashing in Schools
15	De Lange and Carter	Sea-level Change: Living with Uncertainty
16	Montford	Unintended Consequences of Climate Change Policy
17	Lewin	Hubert Lamb and the Transformation of Climate Science
18	Goklany	Carbon Dioxide: The Good News
19	Adams	The Truth About China
20	Laframboise	Peer Review: Why Scepticism is Essential
21	Constable	Energy Intensive Users: Climate Policy Casualties
22	Lilley	The Climate Change Act: The Cost to the Country

The Global Warming Policy Foundation is an all-party and non-party think tank and a registered educational charity which, while openminded on the contested science of global warming, is deeply concerned about the costs and other implications of many of the policies currently being advocated.

Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice. Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

The key to the success of the GWPF is the trust and credibility that we have earned in the eyes of a growing number of policy makers, journalists and the interested public. The GWPF is funded overwhelmingly by voluntary donations from a number of private individuals and charitable trusts. In order to make clear its complete independence, it does not accept gifts from either energy companies or anyone with a significant interest in an energy company.

Views expressed in the publications of the Global Warming Policy Foundation are those of the authors, not those of the GWPF, its trustees, its Academic Advisory Council members or its directors.

Published by the Global Warming Policy Foundation

For further information about GWPF or a print copy of this report, please contact:

The Global Warming Policy Foundation
55 Tufton Street, London, SW1P 3QL
T 0207 3406038 M 07553 361717
www.thegwpf.org

Registered in England, No 6962749
Registered with the Charity Commission, No 1131448