SCOTTISH ENERGY READY RECKONER

Activities and opportunities in energy markets measured in terms of their contribution to gross value added and employment in the Scottish economy

October 2010

This is the fourth edition of a report first produced, tested and revised in late 2009 through early 2010 by John Higgins and Hervey Gibson of Cogent Strategies International Ltd (cogentsi) at the request of Scottish Enterprise. The assumptions used in calculation are the result of discussion and desk research with a wide range of experts in the various energy industries and in their representative bodies, public servants concerned with energy and the economy, the work of other consultants, and cogentsi's own experience, models and calculations. Opinions expressed and errors are the responsibility of cogentsi and not of Scottish Enterprise. While best efforts have been applied to achieve accuracy and reasonableness of the estimates herein, no warranty is issued and no liability can be accepted for any actions taken in consequence of these estimates or conclusions drawn from them.

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Scottish Enterprise and cogentsi acknowledge the help of many officials of the UK and Scottish Governments, of industry organisations and international and intergovernmental bodies, and of academics and research teams from many institutions in many countries in the preparation of this Ready Reckoner.

Scottish Energy Ready Reckoner

In relation to the enormous value and potential represented by the world energy markets and by the global policy environment associated with them, the resource that Scottish Enterprise can bring to bear is tiny. However, there are opportunities to make the markets work to Scotland's advantage. There is a fairly large number of different opportunities, which draw on similar resources so that choices have to be made between them. Energy markets are not only vast, but can change very quickly and very dramatically. The Scottish Enterprise Energy Team therefore needs to be fleet of foot, and able to spot and discriminate between market opportunities. In this, their task is parallel to the challenges faced by firms in the energy business.

The ready reckoner seeks to address this issue: the idea is that it can be applied to *any* energy market, although it has been set up to reflect current best guesses of the main avenues that Scottish businesses are pursuing and prospecting.

The markets are intrinsically uncertain, and so while *strategic* appraisal is mandatory, over-precise appraisal calculations will often be fruitless. The ready reckoner approach is well suited to this. This document therefore introduces a simple model which addresses five questions:

1. How big is the market in question today?
2. How is it changing in volume terms?
3. How is its price changing in real (ie relative) terms?
4. What share of the market can Scotland hope and expect to achieve?
5. How does this add up to sales, value added and employment right through the supply chain (and also induced incomes)?

This provides a common and transparent base from which the Energy Team and Scottish Enterprise's managers can approach the crunch question:

What can we, Scottish Enterprise, do to improve that?

The ready reckoner is a simple spreadsheet setting out tables to make these calculations, with some graphics to help with strategic choice and project design.

This is a report ***to*** Scottish Enterprise, not a report ***by*** Scottish Enterprise, and the policy and other views expressed are those of the authors, not SE.

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General Approach

The use for which the reckoner is designed is to help to direct *economic development resources,* typically skilled people and funding assistance provided by government to address market failure. The aim with this reckoner has been to create a tool which is easy to use and which will show up significant differences between opportunities and markets. It has been simplified to a significant degree, and if the differences between options or markets are subtle or very complicated then much closer analysis will be required.

The rationale for government to be involved *as a government* in the markets within its jurisdiction is that for structural reasons those markets fail to produce the perfectly efficient and fair results that kindergarten-level economic theory might suggest. Usually the failures in the case of energy markets arise in terms of inadequate information, difficult risk issues, the interaction of costs and technologies ('increasing returns'), the concentration (sometimes for non-economic reasons) of market power, and impacts on others ('externalities'). These last appear most prominently in terms of potentially cataclysmic environmental effects such as global warming, acid rain or nuclear fallout, or because energy resources are so fundamental and valuable that they are the causes of wars and conflicts with countless innocent victims.

Energy markets are, to a substantial extent, global, and so Scotland's Government adopts this role as a part of the nation's social responsibilities in the global community. However, our Government also has a role not only as overseer of our own markets, but as representative or tribune for Scottish people and Scottish organisations. In pursuing the interests of Scotland, it can quite legitimately seek to maximise the Scottish share of energy markets and Scottish returns from them. A degree of balance between national representation and global responsibility is expressed in the overriding aim of the Government to maximise sustainable economic growth.

Energy investments are long term, but policy horizons are often shorter, people are impatient, and action on some energy issues is very urgent. The ready reckoner has adopted a time frame of ten years, effectively covering the period 2011-2020, and has taken as its key metrics the net additional gross value added in the Scottish economy, as an annual average over this period, and the number of jobs created/supported, again as a period average. The distinction between 'supported' and 'created' reflects the fact that opportunities broadly fall into two classes: those that already exist, and have to be protected or managed or extended over the next ten years, and those that hardly exist, so that a capacity has to be built up almost from scratch.

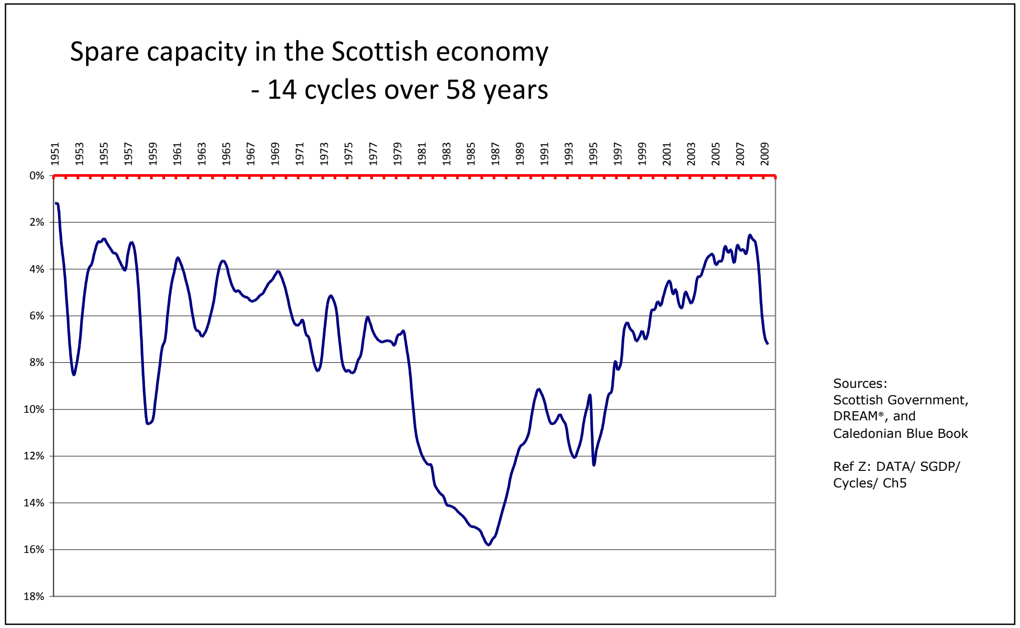
The spreadsheet in October 2010

READY RECKONER	*Envisioned capacity*	*of which* New capacity 2010-2020 MW	Development Cost /MW (£2010)	Current Annual Market Size (£mn)	Volume Growth rate	Real' Price Growth rate	Average spend over next 10 years	Scottish market share	Scottish sales	GVA ratio	Direct GVA	GVA Multipliers	Annual GVA Benefit	GVA/ job	Direct jobs	Employment muktiplier	Annual jobs
RENEWABLES																	
Scottish Hydro large, pumped		1000	3.000				300	40%	120	40%	48	1.80	86	50	960	2.10	2016
Scottish Hydro small		500	1.300				65	70%	46	42%	19	1.90	36	48	398	2.10	836
Scottish onshore wind		5600	1.200				502	28%	140	43%	60	1.92	116	51	1190	1.86	2215
Offshore wind - Scottish waters	6400	3733	2.278				1165	25%	293	44%	128	1.94	248	52	2462	1.90	4675
UK offshore wind a	33600	19600	2.278				5691	9%	506	43%	217	1.92	417	51	4291	1.86	7968
UK offshore wind b	33600	19600	2.278				5691	17%	986	43%	426	1.93	821	51	8332	1.87	15610
UK offshore wind b	33600	19600	2.278				5691	26%	1469	43%	631	1.92	1213	51	12453	1.86	23140
Wave and tidal c		1000	8.000				800	70%	560	40%	224	1.80	403	55	4073	1.90	7738
Wave and tidal d		3000	5.000				1500	85%	1275	40%	510	1.80	918	55	9273	1.90	17618
Wave and tidal e		6000	3.500				2100	55%	1155	45%	520	1.80	936	60	8663	1.90	16459
Wave and tidal c		1000	8.000				800	30%	240	40%	96	1.80	173	55	1745	1.90	3316
Wave and tidal d		3000	5.000				1500	30%	450	40%	180	1.80	324	55	3273	1.90	6218
Wave and tidal e		6000	3.500				2100	30%	630	45%	284	1.80	510	60	4725	1.90	8978
Biomass -wood	1400	1000	2.500				250	60%	150	40%	60	1.80	108	35	1714	2.60	4457
Biomass -waste		4000	2.500				1000	25%	250	40%	100	1.80	180	35	2857	2.60	7429
CONVENTIONAL/ non-renewable																	
UKCS Oil and Gas Opex				7101	-6.7%	3.7%	6259	45%	2816	47%	1324	1.70	2250	60	20745	1.87	38879
UKCS Oil and Gas E&A				1274	-15%	0%	343	20%	69	55%	38	1.55	59	105	360	1.70	610
UKCS Oil and Gas Development				4780	-10%	0%	2415	35%	845	40%	338	1.83	617	60	5299	1.87	9931
UKCS decommissioning							750	40%	300	40%	120	0.80	96	100	1200	3.00	3600
Nuclear UK	20000+	8000	2.000				1055	11%	118	45%	53	1.59	85	53	1015	1.63	1658
Nuclear decommissioning							500	20%	100	40%	40	1.80	72	100	400	3.00	1200
Clean coal																	
Capture		8000	1.500				1200	20%	240	40%	96	1.80	173	60	1600	2.80	4480
Transport		8000	0.200				160	50%	80	50%	40	1.80	72	100	400	3.80	1520
Storage		8000	0.300				240	60%	144	80%	115	1.80	207	1000	115	4.80	553

The strategic situation

The world economy comes home to Scotland

Following the collapse of financial assets and institutions spilling out from the United States, the world economy went into free fall. The hastily-designed policy parachutes for the monetary and banking system, and the built-in automatic stabilisers for taxation and government spending, have successfully slowed that fall and stopped it in many places. But here, at least in the latest available official GVA figures for Scotland, it is still a fall. Thanks to the surprising resilience of the Chinese and other Asian economies, the European economy began to turn up again last summer, and the US is growing now. Globally and nationally there remains the possibility of a 'double dip'.



In the US it was a longer recession than the post-war average of 10 months, but shorter than the average 17-month recession since they started counting, in 1871. On British GVA (GDP) the recession was perhaps three months longer, and the Scottish figure will perhaps be two or three months more than that.

With hindsight we can now see that Scotland's recession started around the same time as the US, around November 2007, and the figures available up to Easter 2010 confirmed the provisional view above – so far the worst recession since 1979. We cannot predict when it will end: in our view, no one has yet developed a model of the Scottish economy that can identify or convincingly predict GVA turning points within a few months. However, so far this recession has had only about half the effect on Scotland that the monetary and fiscal policies of the 1980s generated. In a generally more buoyant environment, the only thing likely to make this recession as bad for Scotland as the 1980s would be a substantial programme of government spending cuts. Unfortunately, such a programme is a very real part of the policy debate at UK level.

Policies for energy investment and economic development would not normally need to pay too much heed to the ups and downs of business cycles, but the 2008-2010 one is so deep, so profound and so all-enveloping that it will affect the situation for decades to come.

The present state of energy within the world economy

The world energy economy is certainly disturbed by the recession, but not necessarily in ways one might expect. For example, world oil prices, which normally reflect the pressure of economic demand, reached their all-time peak in real terms in July 2008, eight months after the economic freefall started.

A political world that was forced into collaboration over the credit crunch, made at least some attempt to get together over ecological affairs. The need to include Asia within the Western circle of economic attention highlighted the dire consequences for fuel consumption and carbon release of rising Asian prosperity and production. An estimated 95 per cent of carbon emission growth will come from Asia, but levels in the West are much higher and the global nature of the problem behoves us to reduce emissions. Kyoto's target dates are soon upon us, and the United States no longer has a Government in denial, so there remains some hope for progress following the disappointment over the UN Climate Change Conference in Copenhagen.

The climate change alarm bell that was rung by the United Nations is now echoing cavernously around all the inter-governmental chambers of the world. The introduction to the 2008 forecast from the International Energy Agency made this abundantly clear (see box) and was seen by some commentators as a shift in position, particularly as far as limits to oil resources are concerned. The global summit in November 2009 in Copenhagen (the fifteenth 'Conference of the Parties' to the United Nations Framework Convention on Climate Change) looked ahead beyond 2012, when the first commitment period of the Kyoto Protocol ends. The failure to reach agreement merely underlined the importance of all parties understanding the ramifications of the global energy system, and their own part in it, for their own wellbeing

> The world's energy system is at a crossroads. Current global trends in energy supply and consumption are patently unsustainable – environmentally, economically, socially. But that can – and must – be altered; there's *still time to change the road we're on.* It's not an exaggeration to claim that the future of human prosperity depends on how successfully we tackle the two central energy challenges facing us today: securing the supply of reliable and affordable energy; and effecting a rapid transformation to a low-carbon, efficient and environmentally benign system of energy supply. What is needed is nothing short of an energy revolution.
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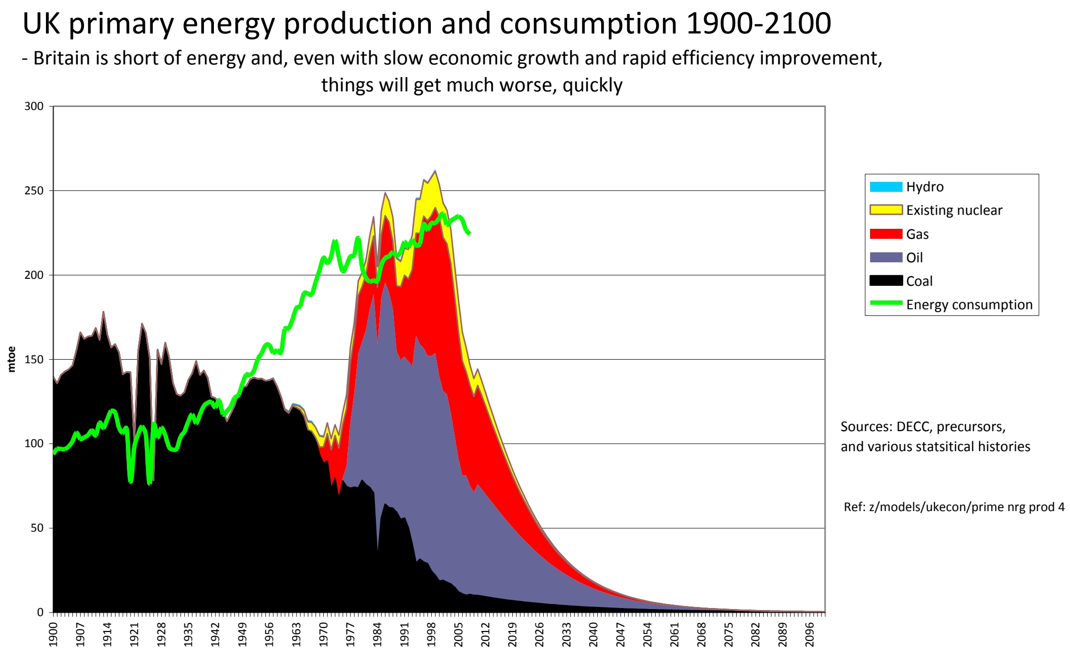
> OECD/ IEA November 2008

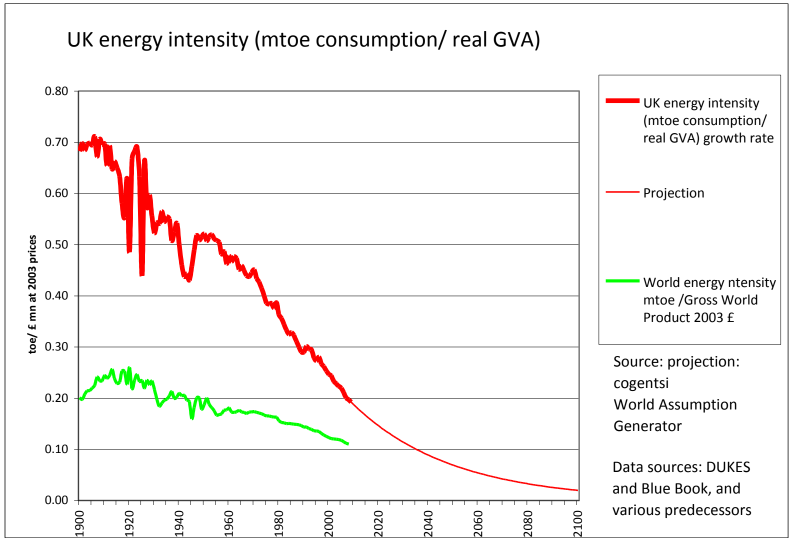
The UK energy gap

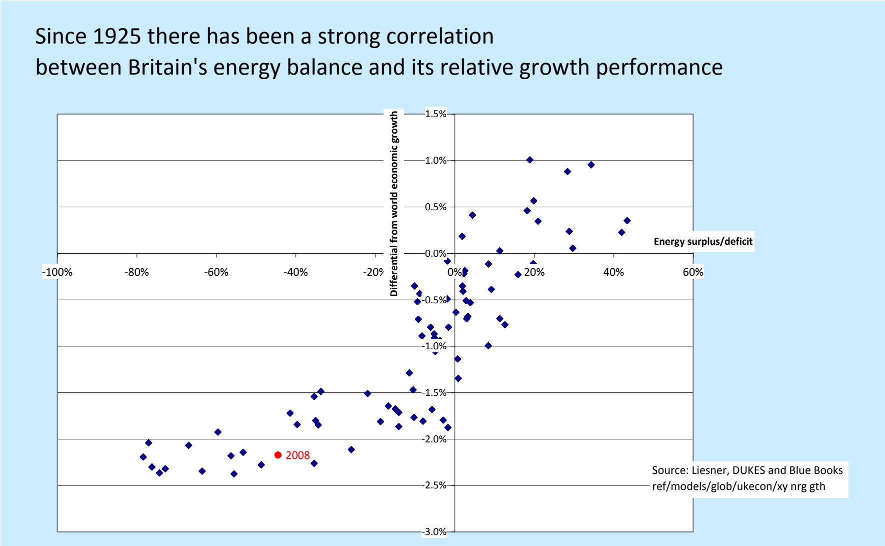


The abundance of energy resources, primarily coal, was one of the reasons Britain managed to gain and retain its leadership of the industrial revolution. Until the start of the Second World War the UK had a surplus of energy, but after 1950 the consumption of energy (the green line) began to outstrip the supply. The widening gap was due in equal measure to the growth of car ownership and other transport, and the decline of coal production.

The gap was not too serious an issue until 1973, because energy could be cheaply imported and some new domestic sources were being developed. Nuclear power had been developed for a mixture of energy and defence-related reasons from the mid 1950s, and North Sea gas had been brought ashore, and fed into a pre-existing distribution system, from the mid 1960s. North Sea oil began to flow only two years after the first OPEC-initiated oil price increase, and was well established by the time of the second one, in 1979. Britain moved into energy surplus the following year, and just about stayed in surplus until 2004. By 2008/9, Britain's energy consumption exceeded its energy production by more 50 per cent.

Today Britain's energy needs are met by four fuels, for all of which availability is declining, plus renewables, which are still too small to be identifiable on the graph with the naked eye. The decline in oil and gas is documented following page 18. With the nuclear programme now 60 years old, power stations are coming to the end of their life and are retiring on grounds of safety and expense. Conventional underground coal mining is all but finished and coal reserves suitable for surface recovery are limited. The overall rate of decline for these four resources shown on the chart is more than 5 per cent per year. This means that Britain's energy gap is now about 60 mn tonnes growing at about 7 mn tonnes of oil equivalent per year. At current oil prices and exchange rates the gap would be valued at £20 bn per year, growing at £2.4 bn per year.





Although the trend of energy consumption for the past 110 years (and, indeed, before that) has been strongly upwards, this is not expected to continue. The economy has also been growing over this period, and UK energy intensity (energy consumed per £ of real GVA) has fallen very dramatically, by more than 70 per cent. Nevertheless, in common with other industrialised countries, it is around double the world average, as was highlighted at the Copenhagen Climate Change meeting. In the future we would expect the improvement in British energy intensity to continue, and even to accelerate, especially given the real and the political pressures that result from global warming, and the high price of energy today compared to the levels that prevailed a generation ago.

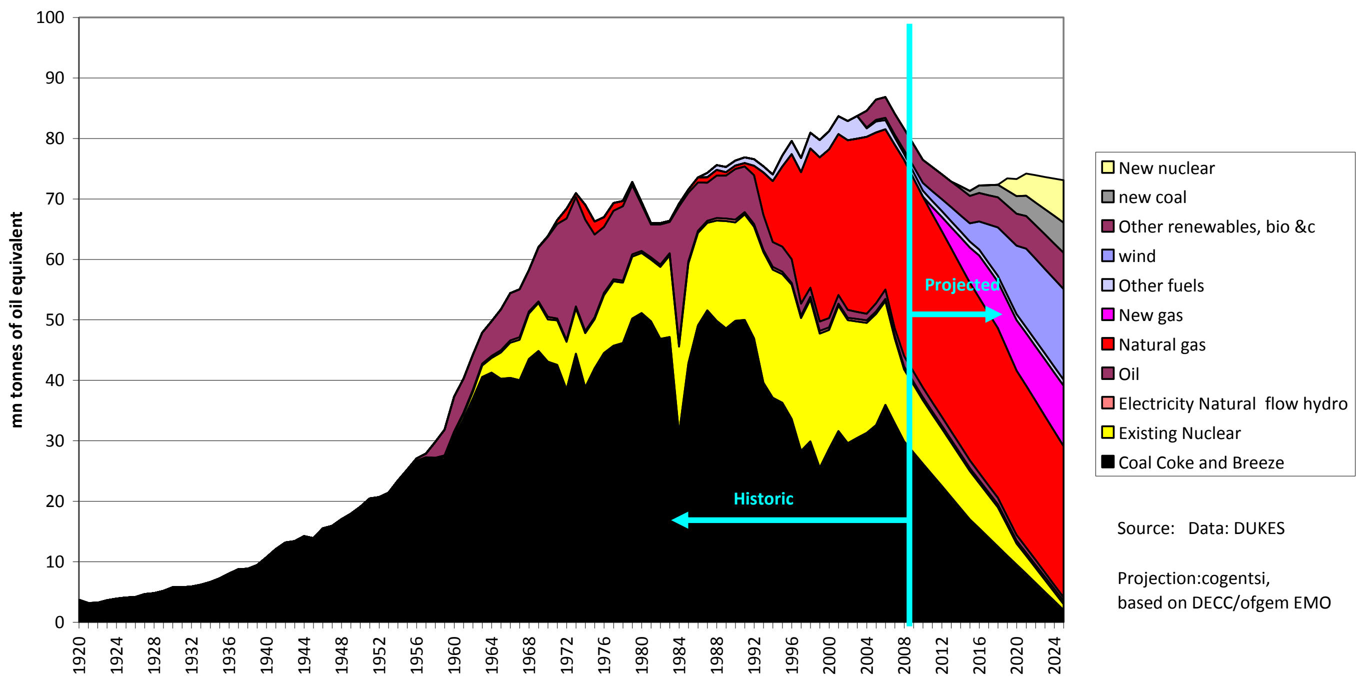
It also may be the case that energy factors will cause the economic growth rate to slow from historical levels. The second chart on this page is a scatter diagram, showing on the horizontal (X-) axis the relative balance of the UK energy economy, from deficit on the left to surplus on the right. The scale on the vertical (Y-) axis measures the *difference* between the growth rate of the entire UK economy and that of the world economy. Not only is there an evident upward slope over 85 years, but the chart can be divided into three zones. The right hand third of scatter points cover mainly the pre-war years, when Britain had an energy surplus greater than 20 per cent, and grew on average slightly faster than the world economy. For the middle third, energy is closer to balance, and across individual years there is a broad correlation between the exact balance and the growth rate, but no simple direct link. This is mainly the post-war period when the UK fell behind the world economy at a rate of 0.7 per cent per year. The left hand third consists of the troubled years 1958-1977, when economic difficulties accumulated, and of the years from 2005 to date. Here there is a significant energy deficit of more than 20 per cent, and economic growth is almost 2 per cent below the global norm.

Drivers of the UK electricity system

In addition to the progressive exhaustion of our native fossil fuel resource, documented below, the two crucial forces driving UK electricity are the obsolescence of power stations and the fact that, one way or another, the carbon footprints of electricity generation technologies must be factored into their fuel costs. In so far as carbon use or generation impacts upon the current ready reckoner it does so through the policy environment. What is crucial to the valuation of the economic opportunities available is the retiral of existing power stations.

The UK generating mix was virtually 100 per cent solid fuel until the mid 1950s, when first oil and then nuclear were introduced. From the early 1990s came the 'dash for gas' and small increases in wind and other renewables. Gas now represents about half the fuel used – and in future it must increasingly be imported – but of greater significance is that almost all coal and nuclear power stations must be shut down over the next 15 years.

Fuel input for UK electricity generation with projection



Peak generating capacity and power output, capital costs and fuel costs

The key supply parameters of an electricity system are the peak demand it can provide, in megawatts (MW), and the total amount of power supplied over the year, in Gigawatt hours. Different generating options contribute in different ways to these, according to their cost structure and operational characteristics. Broadly, where capital costs are large relative to fuel costs, for a particular generating technology, that technology will be used to provide power. The higher the importance of fuel costs, and the lower the level of capita l cost, the more the technology will be confined to generating at peak times.

Oil and gas fired stations have relatively low capital costs, but when they produce only high grade heat to drive generating sets they have high fuel costs and carbon footprint. They are primarily used, therefore, to contribute to peak capacity but are not preferred for power production. Where it is possible to use any lower grade heat, as in combined cycle gas turbines, this lowers their running costs, making them more favourable.

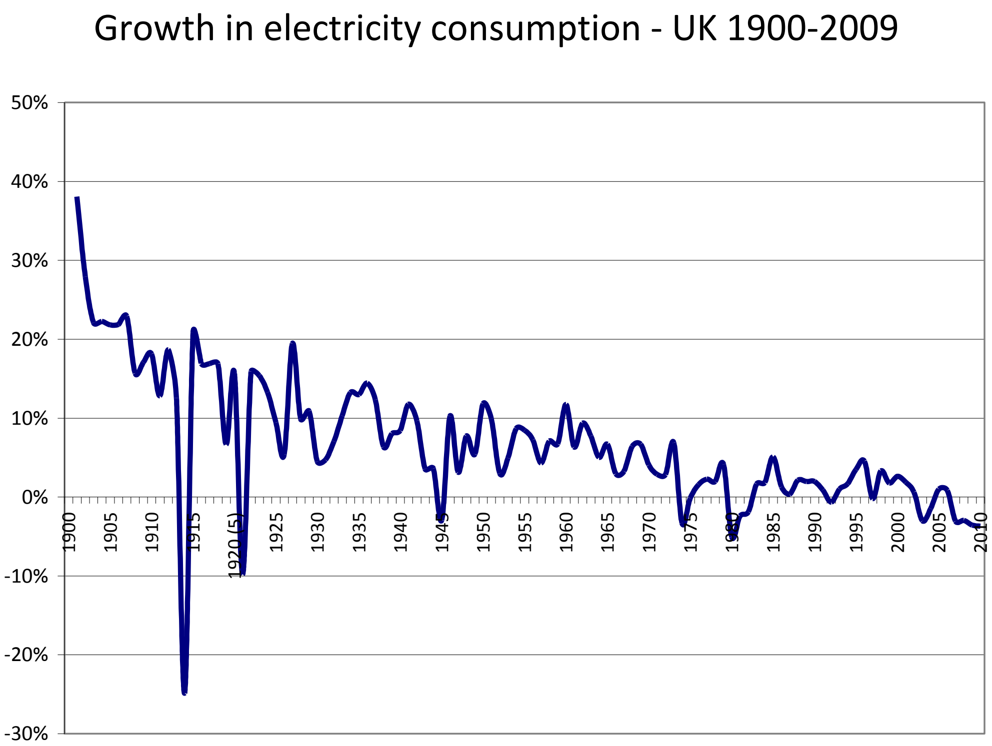
Coal stations have similar capital costs (depending on scale) so they contribute to capacity, but lower fuel costs, so when there has been little regard for carbon footprints they have been preferred for power production over gas and oil. However, the use of coal is set to change radically as a result of plant closures and carbon capture technology. On an equivalent scale, biomass stations (wood or waste) have parallel capital costs, but are considered to have a negligible carbon footprint. However, materials handling considerations usually mean they are very small, so do not achieve economies of scale.

Almost all the costs of hydroelectric, marine and wind power is capital cost, and what operating costs there are do not depend much upon output.. These technologies will provide base load power when they can, but all (except tidal) suffer to some extent from the fact that their contribution to capacity is uncertain. This may be hour-to-hour uncertainty in the case of wind, or year to year uncertainty for large hydro schemes.

Nuclear power is highly capital intensive. Variable operating costs are low, although the cost of fuel can be expected to increase in future as demand grows. Thus nuclear plants primarily provide base load power.

Storage systems, like Cruachan pumped hydroelectric storage on Loch Awe or the Rough pumped gas storage, provide capacity but no net power – in fact they are net consumers rather than producers of power, albeit on a relatively small scale.

Capital costs are intrinsic to the technology: in all technologies there are substantial economies of scale. However the cheapness of a large generation facility usually has to be traded off against either the cost of transporting fuel, or of distributing the electricity, or both. Costs have demonstrated a learning curve, which may be continuous in the case of capital costs per megawatt but which usually approaches a theoretical limit in the case of operating efficiency.



In real or relative terms the price of electricity fell until the early 1970s, and this helped to fuel substantial growth in demand. Since then real prices have risen and growth rates have slowed. After 1973 even peak years for electricity demand growth did not reach the average levels that ruled before 1973. , and since about 2005 growth rates have been generally negative.

Capital costs of generating capacity

The estimation of capital costs is a key area of uncertainty in any investment appraisal, and nowhere more so than when a technology is new, or still developing rapidly. The US Department of Energy has recently highlighted the fact that construction costs for new power plant, even of conventional design, have increased at an extraordinary rate over the past several years. It attributed a doubling in real dollar terms to:

- High worldwide demand for generating equipment
- Rising labour costs
- Sharp increases in the cost of key materials: cement, iron, steel and copper

Plant type	Cost (£/kW)	Source of estimate	Comment
Combined Cycle Gas Turbines	600	Ofgem	
Clean Coal (ASC + CCS)	2200	Ofgem	Scenarios shown in reckoner analysis
Nuclear (new)	2000	Ofgem	
Onshore wind	1200	Ofgem	
Large scale hydro	3000	Scottish Enterprise	
Small scale hydro	1300	Scottish Enterprise	
Offshore wind	2800	Ofgem	Lower scenarios shown in reckoner analysis
Biomass regular	2500	Ofgem	
Biomass energy crop	2500	Ofgem	
Biomass CHP	3000	Ofgem	
Wave	4000	Ofgem	Scenarios shown in reckoner analysis
Tidal Stream	4000	Ofgem	
Tidal Range	3800	Ofgem	
Biowaste	3600	Ofgem	
Biogas	6600	Ofgem	
Open Cycle Gas Turbines	350	Ofgem	
All capital costs as assumed constant in £2008			Source: Ofgem, Project Discovery, Energy Market Scenarios October 2009

Some of these factors were ameliorated over the recession, but on a global scale they are now operative again. The decline in sterling means they bear particularly hard on the UK.

Except where we have ourselves researched a figure, there is value in adopting a consensus view. The table is primarily taken from Ofgem's exploration of market possibilities carried out in Summer/ Autumn 2009.

These costs are based on rated capacity, so in assessing the ability to meet peak demands there is a need to take account of variability. The capacity credit considered appropriate for onshore wind is considered to be 25-30 per cent, and for offshore 35 per cent or more. For most other source 80-90 per cent is usually taken. They do not take account of subsidies and grants where available.

How this Reckoner works: general methodology

The energy debate is inundated with a flood of crazy innumerate codswallop … …we need numbers, not adjectives … … we need simple numbers, and we need the numbers to be comprehensible, comparable and memorable.

Professor David Mackay, 2009

The purpose of the Scottish Energy Ready Reckoner is to calculate simple, comprehensible and comparable numbers to inform one aspect of the energy debate: the benefits that the Scottish economy can derive from different energy markets and opportunities.

The need to be comprehensible and comparable means that in weighing up each individual market, opportunity or scenario we are not as sophisticated as it is possible to be. We have simplified both the calculations, and the method of presentation. We have prepared a calculation sheet for each case, and extract from that key variables to go into the reckoner proper, which can display up to 20 cases on a single sheet. We signal the degree of precision we think appropriate by rounding these main inputs to the reckoner to two significant figures. Where two scenarios or opportunities yield similar results at this level of precision then, if a choice must be made between them (and that 'if' is important) the debate should properly rest on the uncertainties, assumptions and valuations, and on other issues which it is not possible to capture in numbers.

Total market 2010-2020

The focus of the Reckoner is the next ten years. In some cases – for example most oil-and gas-related activity –the spending or benefit over this period is amenable to forecasting methodologies and so the annual value is shown. In most cases, however, there is a need to build capacity, and so the reckoner shows the phasing of this capacity – sometimes as part of a programme that continues past 2020. The benefits to Scotland often arise as a consequence of creating the capacity, and so they arise before the capacity is available. In these cases a ‘phasing’ schedule has been applied, for example 20/40/40 meaning that 40 per cent of the benefit occurs in the year of the capacity increment, 40 per cent in the previous year and 20 per cent in the year before that.

Quite often there is a physical element to the market calculation, and a cost per unit – eg an operating cost per tonne of oil produced or a capital cost per Gigawatt of rated generating capacity. These may be expected to change due to ‘real price effects’ arising from market situations, such as the reducing supply of oil or a scramble to buy turbines in a world that cannot make enough, or from learning or technological progress. It may also be affected by the real exchange rate, and this might change substantially if an energy deficit comes to dominate the UK economy. Projections have been made as necessary, and are intended to represent a consensus of economic opinion.

Scottish market share

Having established the size of the market, there is the question of how much of it can Scottish firms supply? This will often boil down to questions of technical ability, capacity to produce, location and cost, all of which interact. In established markets there is direct evidence, but in new markets the share available to Scotland must be a matter of judgement. This judgement needs to be made in the light of the contributing activities for an investment – for example construction services, such as the laying of foundation and the actual erection, are likely to be locally supplied, and so Scotland will have a high market share when the investment is in Scotland, and a very low one when it is not. Equipment can be shipped round the world, and so Scotland's market share will depend on Scottish companies having the technology and expertise, as well as the logistical and capacity issues of supply. The real exchange rate will be a consideration here, as well. The product of the total market and the Scottish market share is a projection of Scottish sales.

Gross Value Added

The direct value added derived from these sales is estimated using estimates of the Scottish Gross Output/GVA ratio. These have been based on the Scottish Input Output Tables as published by the Scottish Government, but updated by trends in the equivalent UK ratio, shown by the UK Input Output Tables.

Employment

Employment/GVA ratios implicit in the Scottish Input Output tables are updated by trends in GVA from the UK regional accounts and by trends in employee numbers from the Annual Business Inquiry.

Multipliers

The multipliers used are taken from the DREAM® Detailed Regional Economic Accounting Model. These differ from those calculated for the Scottish Government Input Output Tables (2004) in three important respects:

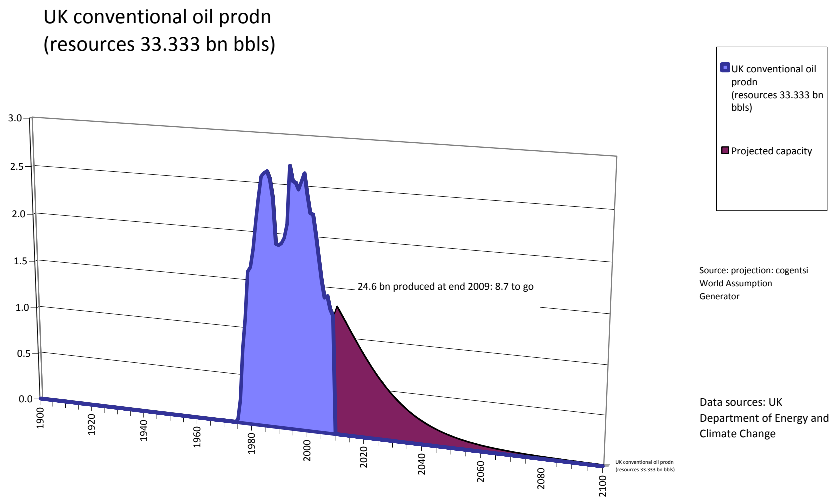
1. They are updated – to 2007 – using methods such as those outlined above.
2. They take account of self-employment in the multiplier process, and thus tend to be somewhat higher than the government multipliers, which do not. The significant proportion of self employment in the construction industry is especially relevant in the reckoner.
3. They vary geographically: a project in North East Scotland will have different multipliers to one in South West Scotland, because of different degrees of 'import' penetration and the different structure of the regional economy. As a national guideline this has not affected the basic reckoner, but it could be used to tailor its application to particular projects.

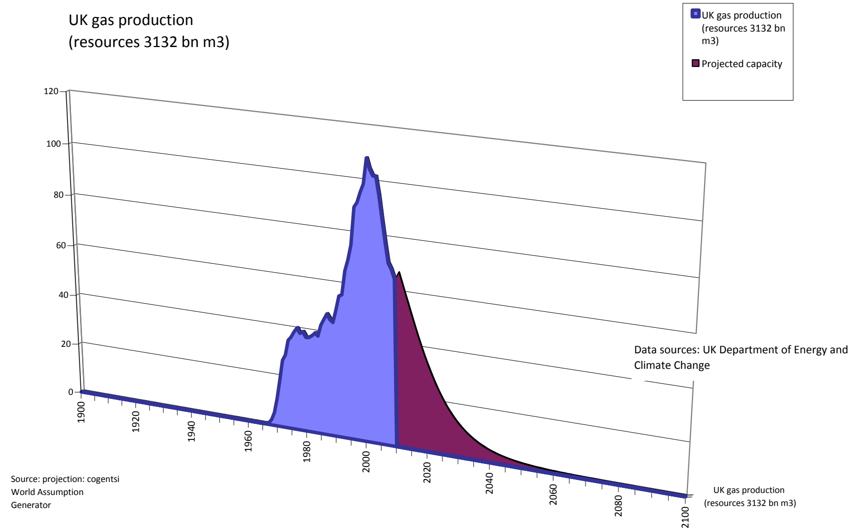
Current industries and the development of their markets and technology

North Sea hydrocarbons

For forty years gas and oil from the United Kingdom Continental Shelf have coursed through the Scottish and British economy. The main way in which the Scottish economy benefits from North Sea oil is the provision of goods and services to help extract it. Over the past forty years we have seen exploration programmes for oil and gas, appraisals of the discoveries made, development of facilities to access the fields, and operation of those facilities. We are beginning to see decommissioning, as resources are exhausted and attempts are made to return the seabed to its original state.

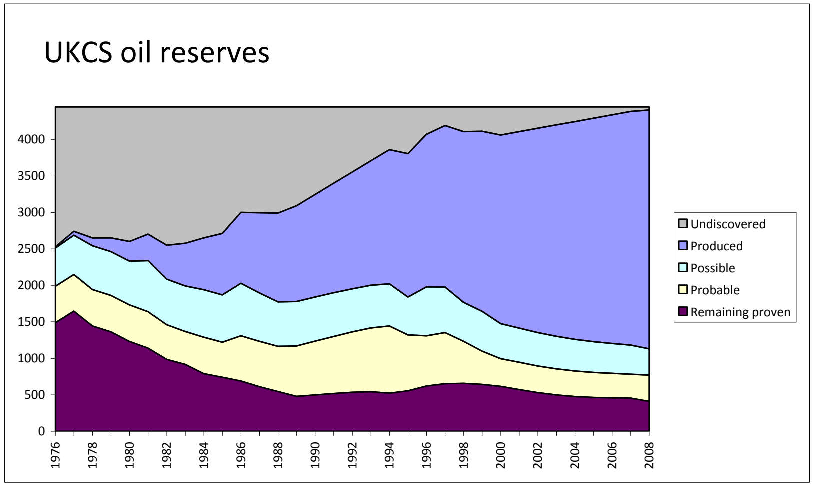
For many years there was huge uncertainty about the reserves available: about how much oil and gas could technically and economically be recovered. Now there has been so much exploration and other activity that we have a fairly good idea of how much was originally in place. This amounts to 4.4 bn tonnes of oil (33 bn barrels) and 3.1 trillion cubic metres of gas (2.7 bn tonnes of oil equivalent)

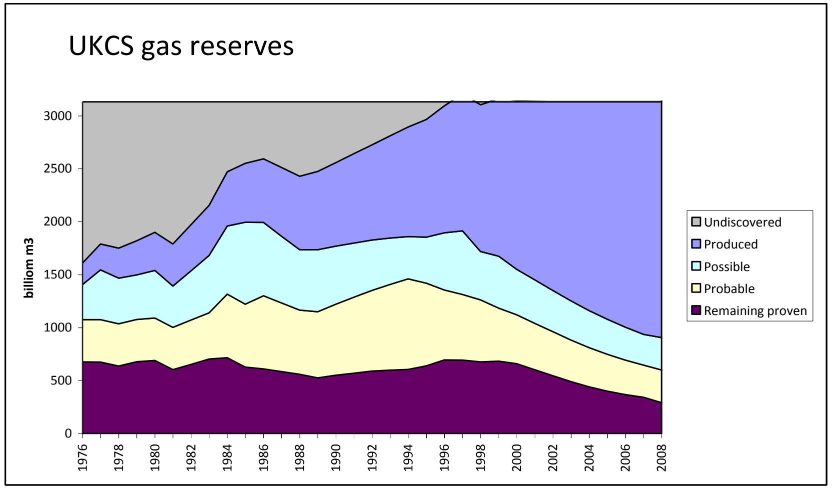


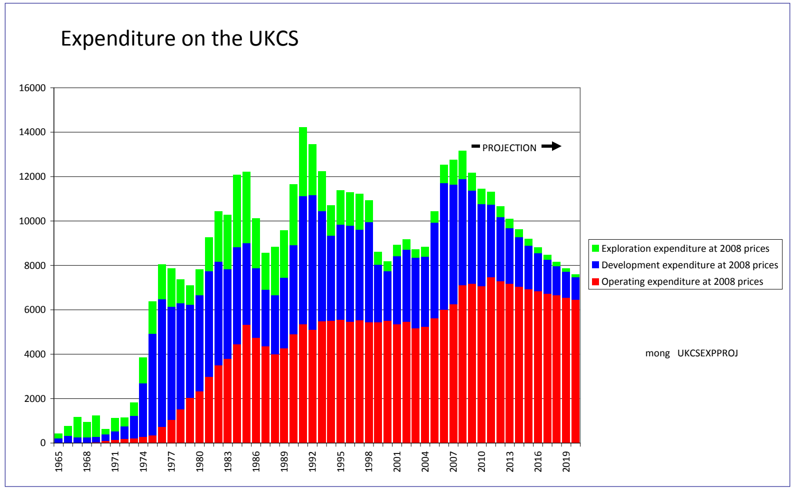


Based on ‘peak oil’ and ‘peak gas’ calculations, 5bn tonnes of oil equivalent have been produced from the UKCS and 2.2 bn are still to be produced. The resource will be significant for another twenty years, but production peaked around the millennium, and has already dropped to around half that level.

There is still some uncertainty, of course.   Remaining oil reserves can be divided more-or-less equally into those that are proven, those that are probable, and those that are possible. Many of the latter are not yet accessible to current installations.

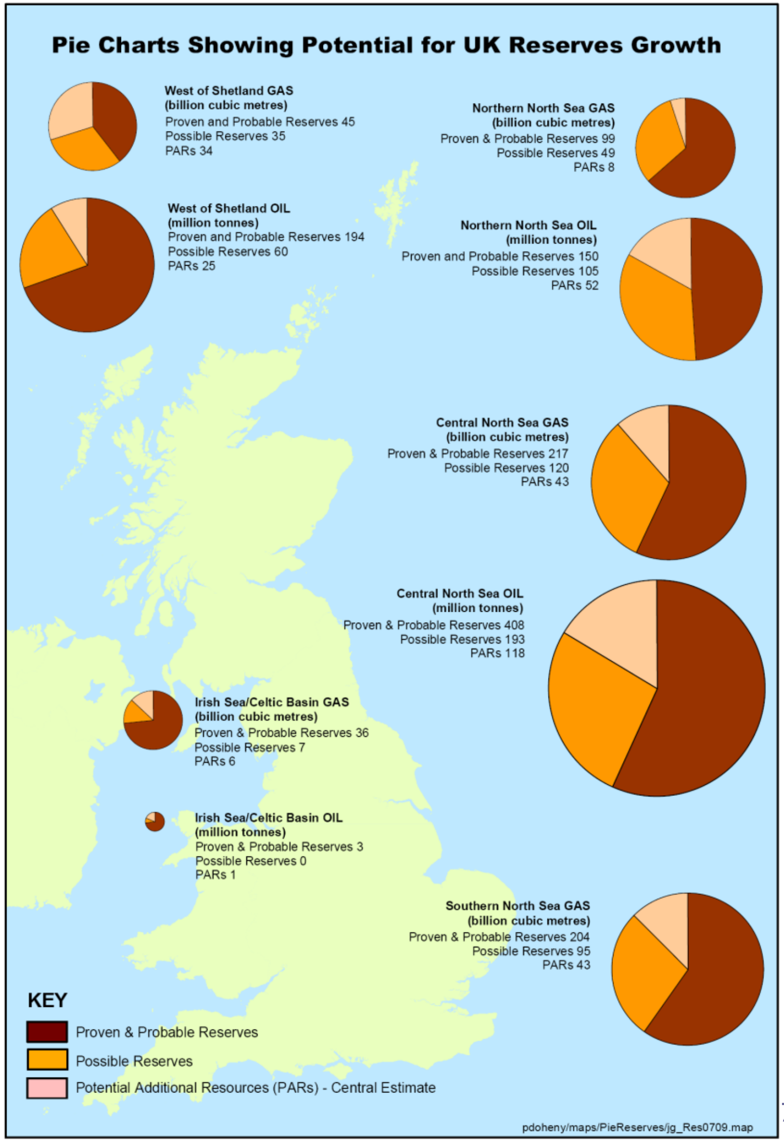




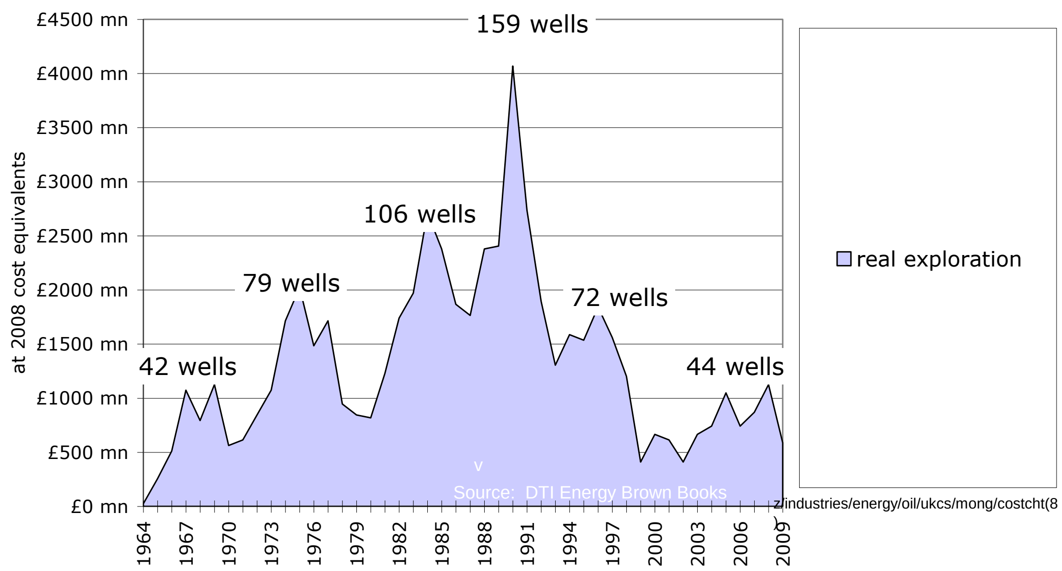


The value added from the North Sea and other offshore reserves have has so far totalled about £660 bn. Because of the way that UK national accounts are constructed, this is not considered part of the Scottish economy. Rather, Scotland benefits from some of the £370 bn that has been spent to access the value added available from the Continental Shelf. Thus the potential *benefits* to Scotland are in fact the *costs* of the activities to explore, develop and operate the North Sea resource. In real terms, expenditure on costs has only briefly been higher than it is today, and since operating expenditure (the most remunerative for Scotland) is at a peak, benefit to the Scottish economy has probably never been higher than it is now.

UKCS exploration – annual GVA benefit £71 mn



Exploration expenditure of UK oil and gas industry



The amount of exploration undertaken in the North Sea depends on what the (UK) Government has chosen to license, the value expected for oil and gas, the cost of the exploration programmes, but most of all on expectations of success. The pie charts show DECC's expectations of reserves some 18 months ago, and by now the expectation of undiscovered oil has diminished significantly. A 15 per cent annual decline in real exploration expenditure has been assumed.

Scenario: OGExp

Oil and Gas Exploration

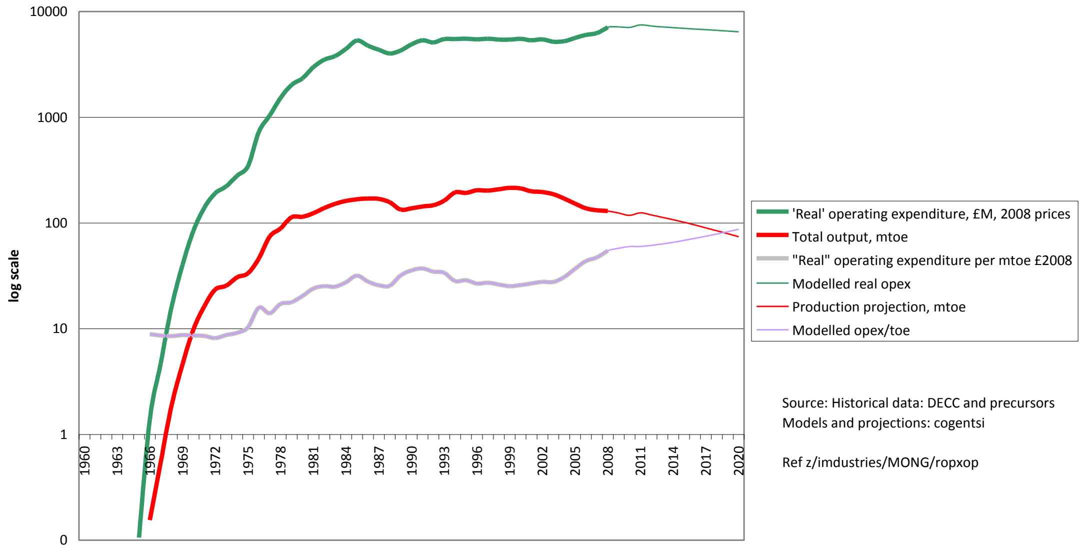
0.0 GW in 2010 — 4.0 GW in 2020

Profile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Expenditure at 2009 prices £mn	£680	£578	£491	£418	£355	£302	£256	£218	£185	£157	£134	£343
No of wells	20	17	14	12	10	9	7	6	5	5	4	10
Scottish market share	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Scottish sales	£136	£116	£98	£84	£71	£60	£51	£44	£37	£31	£27	£69
Sales:GVA ratio	1.81	1.81	1.81	1.81	1.81	1.81	1.81	1.81	1.81	1.81	1.81	1.81
Direct GVA	£75	£64	£54	£46	£39	£33	£28	£24	£20	£17	£15	£38
GVA multiuplier	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55	1.55
Annual GVA Benefit	£116	£99	£84	£71	£61	£52	£44	£37	£32	£27	£23	£59
GVA/job	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105	£105
Direct jobs	713	606	515	438	372	316	269	229	194	165	140	360
Employment multiplier	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
Annual jobs	1209	1028	874	743	631	536	456	388	329	280	238	610

UKCS operating costs – annual GVA benefit £2.4 bn

From an Operator's point of view these form part of UKCS operating expenditure ('Opex'). An important determinant of operating costs is the level of production of oil and gas, although a substantial proportion of costs can be considered fixed. Over the past five years operating costs per tonne of oil equivalent have doubled, from £28 to £56, as production has fallen from more than 200 mn tonnes per year to 125 mn.

Real opex and output



Source: Historical data: DECC and precursors
Models and projections: cogentsi

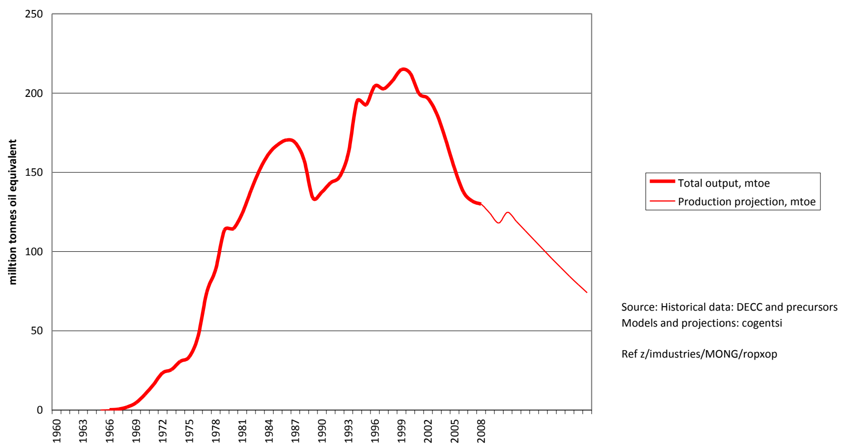
Ref z/imdustries/MONG/ropxop

Over the next ten years or so production is expected to fall further, to about 75 million tonnes of oil equivalent (mtoe), but rising costs per tonne will largely offset this fall. Over the history of the North Sea, the lower cost fields were developed first, so each successive barrel of oil costs a little more to produce. In the longer run, to some extent costs move up and down with energy prices. This is likely to be partly a 'rational' effect - some costs are not worth incurring unless the oil is valuable – and partly a result of control and budgeting systems, which are likely to bite harder when prices and margins are low, and less hard when prices are high. Therefore the long term effect of rising oil prices will also offer some long-term mitigation to the downtrend in Scotland's harvest from oil.

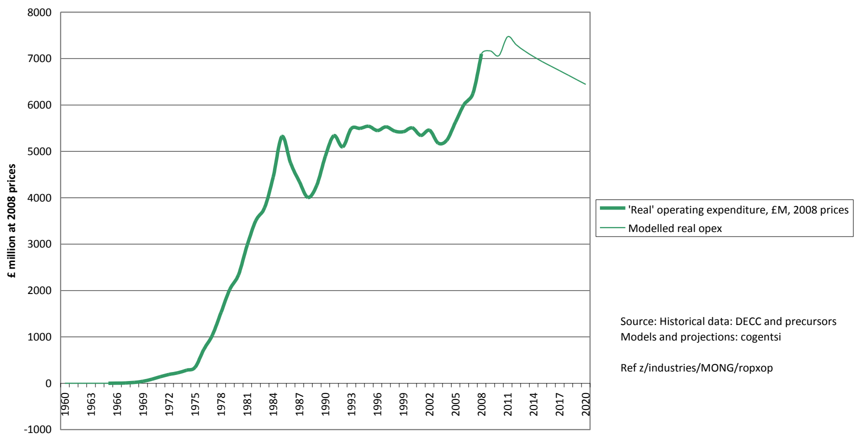
Care should be taken in interpreting the chart above, because it is based on a very compressed log scale. On a linear scale the trends in total costs, production, and costs per tonne (or per barrel) are much more dramatic, as shown on the following page.

The charts on this page illustrate the links between operating costs, and their structure as indicated in the UK national accounts.

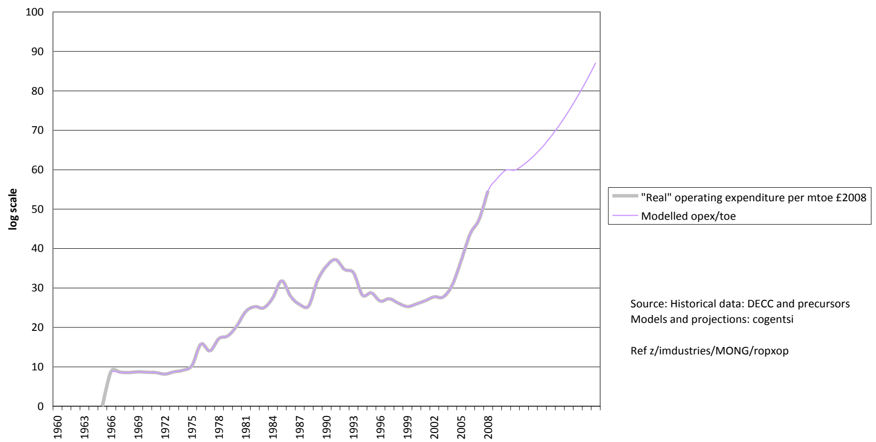
UKCS output



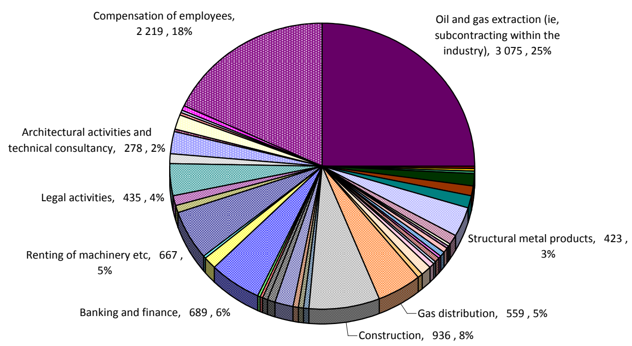
Real opex



Real opex per ton of oil equivalent



Structure of oil and gas company costs 2007



z/industries/energy/oil/ukcs/ukcsopex/pie2007

UKCS opex in 2008 was just over £7 bn per annum, compared to an average of £5.7 bn over the past ten years. The volume of UKCS production is falling at around 5 per cent per year. However the 'diminishing returns' effect, which only really set in in 2004 or so, is now quite important, and pushes up future costs to significantly mitigate the production decline: each year's production currently costs about 3 per cent more in real terms per barrel (or per cubic metre) than the previous year's.

Thus total Opex is expected to stay around £7bn for the next few years, and then to begin to trend slowly downwards, at 1-2 per cent per year. Apart from the salary bill and trading with specialised contractors in the industry, many of the costs are related to services including banking and finance, leasing, and legal services.

There has not been any serious investigation of the Scottish supply share of operating resources for about a decade, when the estimate made was about 40 per cent.[1] This is expected to have risen slightly, as operations have concentrated around Aberdeen. Further investigation and modelling would be worthwhile.

Because of the high proportion of services, it can be assumed that a relatively high proportion of the payments to suppliers directly are translated into GVA. A figure of 47 per cent was assumed for operating costs.

For this and the multiplier analysis, calculations were based on the average ratios for the main supplying industries.

[1] Cogentsi for UKOOA, DTI and Scottish Executive

Scenario: Ogopex

Oil and gas operating costs

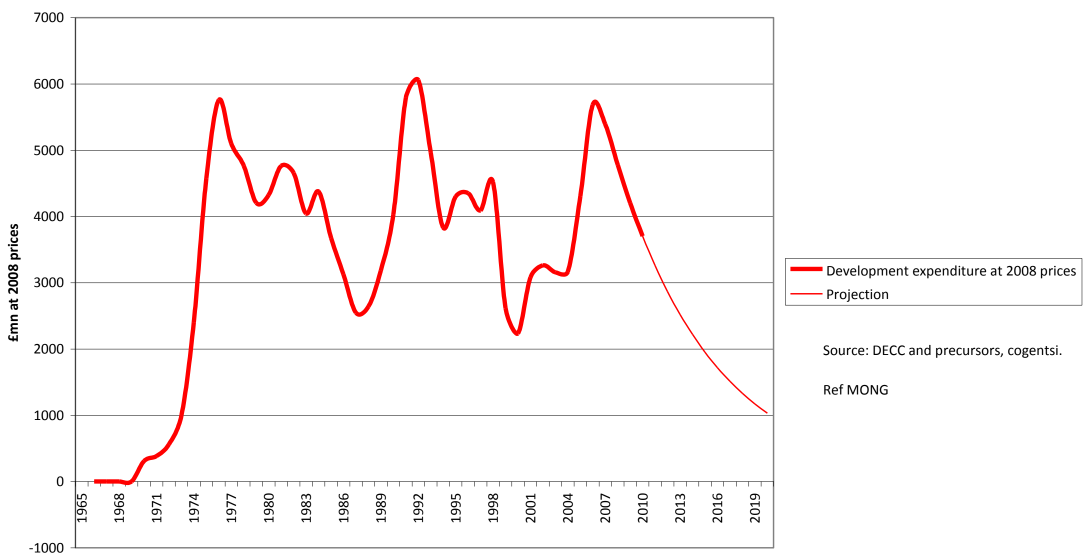
0.0 GW in 2010 4.0 GW in 2020

Profile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Production of oil	1.32	1.27	1.22	1.17	1.12	1.07	1.02	0.97	0.92	0.87	0.82	1.07
Production of gas	67.24	63.54	59.77	55.99	52.23	48.54	44.96	41.51	38.21	35.08	32.12	49.02
Oil wh	766	737	707	678	648	619	590	561	533	505	479	620
Gas wh	665	628	591	554	517	480	445	411	378	347	318	485
Total wh	1431	1365	1299	1232	1165	1099	1034	972	911	852	796	1105
Total mtoe	118	113	107	102	96	91	85	80	75	70	66	91
Opex/toe (£2008)	£ 59.89	£ 59.88	£ 61.32	£ 63.25	£ 65.63	£ 68.38	£ 71.48	£ 74.90	£ 78.64	£ 82.70	£ 87.09	£ 70.29
Total opex	£ 7 067	£ 6 742	£ 6 568	£ 6 425	£ 6 306	£ 6 199	£ 6 099	£ 6 002	£ 5 908	£ 5 813	£ 5 719	£ 6 259
Scottish market share	45%	45%	45%	45%	45%	45%	45%	45%	45%	45%	45%	45%
Total Scottish sales	£3 180	£3 034	£2 956	£2 891	£2 838	£2 789	£2 744	£2 701	£2 658	£2 616	£2 574	£2 816
Sales: GVA ratio	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13
Direct GVA	£1 495	£1 426	£1 389	£1 359	£1 334	£1 311	£1 290	£1 269	£1 249	£1 230	£1 210	£1 324
GVA Multipliers	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
Annual GVA Benefit	£2 728	£2 603	£2 535	£2 480	£2 434	£2 393	£2 354	£2 317	£2 280	£2 244	£2 208	£2 416
GVA/ job (direct)	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811
Direct jobs	42750	40785	39731	38869	38145	37498	36893	36310	35737	35167	34597	37862
Employment multiplier	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87
Annual jobs	80121	76437	74463	72846	71489	70276	69143	68050	66976	65908	64840	70959

UKCS development costs – annual GVA benefit £600 mn

Development expenditure is that part of capital spending on oil and gas which is concerned with gaining access to the oil and gas reserves, extracting the physical products, and putting it into a ship, a pipeline or a plant for distribution or further processing. It is distinguished from exploration and appraisal expenditure which is concerned with discovering oil and estimating how much there is, where it is, and what its properties are.

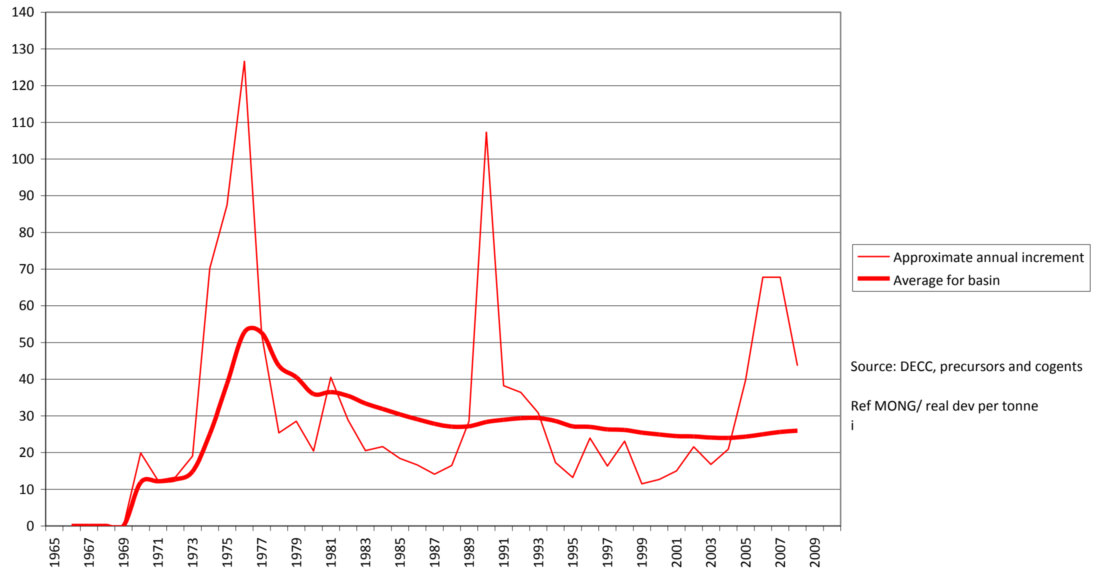
Development expenditure on UKCS



Development expenditure in the North Sea began with investments to recover gas from the Southern North Sea in 1965, initially at a rate of about £200-300 mn per year (in ‘2008 money’). With the coming of much more expensive deepwater oil developments in the Central and Northern North Sea it rose to £6bn per annum in the mid 1970s, and has cycled between that level and £2.5 bn over the past thirty years. In 2008 development expenditure had fallen back to £4.8 bn from its third, and probably final, peak at £5.7 bn.

Total development expenditure to date, at 2008 prices, has been almost £150 bn, about £100 mn on oil-related developments and £50 mn on gas-related. Over the history of the UKCS the oil expenditure has averaged out at about £25 per tonne of oil equivalent, starting at less than £20 but now running at more than £30/tonne. Gas has been significantly cheaper.

Real development costs per tonne of recoverable oil equivalent accessed



Source: DECC, precursors and cogents

Ref MONG/ real dev per tonne

i

Based on 'peak oil' and 'peak gas' calculations, 5bn tonnes of oil equivalent have been produced from the UKCS and 2.2 bn are still to be produced. About 1.5 bn tonnes are not accessible from current developments so £35-40 bn will need to be spent in order to access them: this figure may rise on the grounds that the cheaper fields have been found first. The projection in the first graph shows £25 mn being spent over the coming ten years.

Estimates indicate that about 45 per cent of the installation suppliers are Scottish-based and perhaps a quarter of the structures and equipment installed, giving an overall Scottish market share of perhaps 35 per cent. The proportion of the suppliers' sales represented by GVA varies between 30 per cent in construction and 60 per cent in structural metal products: an overall average of 40 per cent is reasonable.

There have been no significant gas finds for ten years, and none are expected.

Scenario: Ogcapex

Oil and gas capital (development) costs

0.0 GW in 2010 4.0 GW in 2020

Profile

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Production of oil mbd	1.32	1.27	1.22	1.17	1.12	1.07	1.02	0.97	0.92	0.87	0.82	1.07
Production of gas m3	67.24	63.54	59.77	55.99	52.23	48.54	44.96	41.51	38.21	35.08	32.12	49.02
Oil wh	766	737	707	678	648	619	590	561	533	505	479	620
Gas wh	665	628	591	554	517	480	445	411	378	347	318	485
Total wh	1431	1365	1299	1232	1165	1099	1034	972	911	852	796	1105
Total mtoe	118	113	107	102	96	91	85	80	75	70	66	91
Total opex	£ 3 872	£ 3 485	£ 3 136	£ 2 823	£ 2 540	£ 2 286	£ 2 058	£ 1 852	£ 1 667	£ 1 500	£ 1 350	£ 2 415
Scottish market share	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
Total Scottish sales	£1 355	£1 220	£1 098	£988	£889	£800	£720	£648	£583	£525	£473	£845
Sales: GVA ratio	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
Direct GVA	£542	£488	£439	£395	£356	£320	£288	£259	£233	£210	£189	£338
GVA Multipliers	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
Annual GVA Benefit	£989	£890	£801	£721	£649	£584	£526	£473	£426	£383	£345	£617
GVA/ job (direct)	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811
Direct jobs	15504	13953	12558	11302	10172	9155	8239	7415	6674	6007	5406	9671
Employment multiplier	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87
Annual jobs	29057	26151	23536	21182	19064	17158	15442	13898	12508	11257	10131	18126

Decommissioning

Oil and gas operators in UK territorial waters are obliged to return the sea bed to its original state. As the early field begin to be axhausted there is developing experience of decommissioning, and there are serious attempts to spread the incomes to be earned from this amongst UK and Norwegian companies.

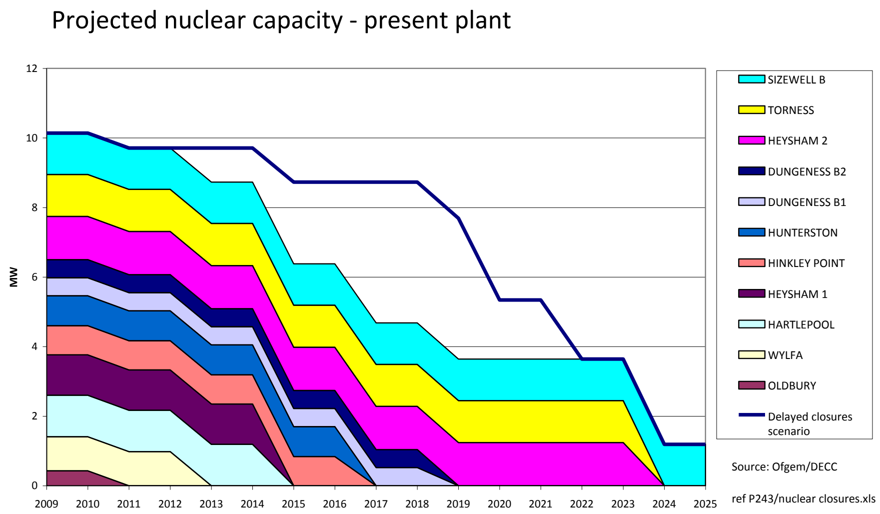
The estimated cost is of the order of £25 bn, and this is expected to be spent over the next 15 years or so. It includes not just the decommissioning of structures, but the sealing poff of oil and gas reservoirs and also the cleaning and decommissioning of pipelines, even though it is likely that most of those will be allowed to remain on the seabed.

Aberdeen is likely to be a service centre for decommissioning, and possibly Nigg a yard for the dismantlement of structures.

Decommissioning liabilities from a financial point of view lie to a significant extent with the taxman, as the earliest, kargest and most difficult to demolish structures were liable to petroleum revenue tax in the late 1970s and early 1980s. What does not lie with the taxman lies in peravctice with a relatively small number of large companies, even though the licence obligation can in principle revert to almost every company that has ever appeared as a party to the licence.

Nuclear power

Existing Nuclear Capacity Closure Dates



Current capacity for nuclear generation in the UK is 10 GW, and all except one power station are due to close between now and 2025. Life extensions are expected, but even these only put the main part of the decline back from 2015 to 2020.

The Scottish Government is opposed to the construction of nuclear power stations in Scotland. But EDF, based in Edinburgh, are among the leading contractors and Scotland has a number of engineering companies which provide equipment for nuclear power stations all over the world.

The following text is therefore based on the December 2009 Ofgem/DECC market outlook. The previous UK Government believed that new nuclear power stations should have a role to play in the country's future energy mix alongside other low carbon sources; that it would be in the public interest to allow energy companies the option of investing in new nuclear power stations; and that the Government should take active steps to facilitate this. Their White Paper described a series of facilitative actions that the Government would take to enable energy companies to invest in new nuclear power stations. The Office for Nuclear Development, which sits within DECC, had been making good progress on these facilitative actions up until the General Election.

Station	Capacity	Closure date?
Oldbury	430	2010
Wylfa	980	2012 - 2014
Hartlepool	1190	2014 - 2019
Heysham 1	1160	2014 - 2019
Hinkley Point	840	2016 - 2021
Hunterston	860	2016 - 2021
Dungeness B1	520	2018
Dungeness B2	520	2018
Heysham 2	1240	2023
Torness	1210	2023
Sizewell B	1190	2035

Source: Ofgem
Ref P243 nuklo

Under one of the facilitative actions, the previous UK Government conducted a Strategic Siting Assessment (SSA) to establish which sites in England and Wales are potentially suitable for the deployment of new nuclear power stations by the end of 2025. A list of ten potentially suitable sites was included in the draft National Policy Statement (NPS) for nuclear power, published for consultation and Parliamentary scrutiny on 9 November 2009. Within the context of the overall strategic framework set by the then Government, in principle new nuclear should be free to contribute as much as possible towards meeting the need for 25GW of new non-renewable capacity.

UK-level political considerations

The previous Government expected that under this approach a significant proportion of the 25GW would in practice be filled by nuclear power, with the first generating plant available from 2018 and the possibility of 6 reactors operating by 2020. This would amount to perhaps 60 per cent or more of the generation gap.

However nuclear power is one of the issues potentially dividing the new Coalition Partners, and to handle this difficulty the following was set down specifically in the Coalition agreement negotiated by the Conservative and Liberal Democrat parties:

> *Liberal Democrats have long opposed any new nuclear construction. Conservatives, by contrast, are committed to allowing the replacement of existing nuclear power stations provided they are subject to the normal planning process for major projects (under a new national planning statement) and provided also that they receive no public subsidy.*
>
> *We have agreed a process that will allow Liberal Democrats to maintain their opposition to nuclear power while permitting the government to bring forward the national planning statement for ratification by Parliament so that new nuclear construction becomes possible.*
>
> *This process will involve:*
>
> - *the government completing the drafting of a national planning statement and putting it before Parliament;*
> - *specific agreement that a Liberal Democrat spokesman will speak against the planning statement, but that Liberal Democrat MPs will abstain;*
> - *and clarity that this will not be regarded as an issue of confidence.*

Many commentators have remarked that even though Charles Hendry, the Conservative Energy Minister, will be directly responsible for overseeing nuclear policy, the responsible Minister in overall charge of the Department of Energy and Climate Change, Chris Huhne, is a Liberal Democrat. He has stated that he has no objection in principle to nuclear power, although in the past he has described it as 'tried, tested and failed'. He has also indicated that the Coalition has agreed 'not to subsidise nuclear power' and has been reported in interviews as indicating that this covers disaster insurance and decommissioning costs.

We would add that the likely necessary schedule for nuclear power construction, and the one envisaged by the previous Government, goes significantly beyond '*the replacement of existing nuclear power stations'* as the Conservative commitment is described in the Coalition document. Although a significant nuclear programme is very likely, there is a significant possibility of delays and political frustrations.

Scenario: RUKNUC

Nuclear Programme in rest of UK

0.0 GW in 2010 | 5.0 GW in 2020

Profile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Capacity	0.0	0.0	0.0	0.0	0.0	0.0	1.0	2.0	3.0	4.0	5.0	1.4
Annual increment		0.0	0.0	0.0	0.0	0.0	1.0	1.0	1.0	1.0	1.0	0.5
Development cost - plant mn £/GW	£1.00	£1.00	£1.00	£1.00	£1.00	£1.00	£1.00	£1.00	£1.00	£1.00	£1.00	£1.00
Development cost - plant, total	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	0.455
Development cost - construct and connect - mn £/GW					£1.00	£1.00	£1.00	£1.00	£1.00	£1.00	£1.00	£1.00
Development cost - install and connect - total					0.000	0.000	1.000	1.000	1.000	1.000	1.000	0.714
Development Cost £mn (2010)/GW					£2.00	£2.00	£2.00	£2.00	£2.00	£2.00	£2.00	£2.00
Cost of capacity increment					£0.000	£0.000	£2.000	£2.000	£2.000	£2.000	£2.000	£1.429
Phased cost: 20/40/40	£0.00	£0.000	£0.000	£0.000	£0.400	£1.200	£2.000	£2.000	£2.000	£2.000	£2.000	£1.055
Scottish market share plant	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25.0%	25%
Scottish market share installation and connection	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Scottish sales - plant			£0.000	£0.000	£0.050	£0.150	£0.250	£0.250	£0.250	£0.250	£0.250	£0.16
Scottish sales - install & connect			£0.000	£0.000	£0.008	£0.024	£0.040	£0.040	£0.040	£0.040	£0.040	£0.03
Total Scottish sales			£0.000	£0.000	£0.058	£0.174	£0.290	£0.290	£0.290	£0.290	£0.290	£0.19
Overall Scottish share of expenditure			0%	0%	14%	14%	14%	14%	14%	14%	14%	11%
Sales: GVA ratio - plant	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54
Sales: GVA ratio - construct and connect	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Direct GVA			£0.000	£0.000	£0.023	£0.070	£0.116	£0.116	£0.116	£0.116	£0.116	£0.07
GVA Multipliers - plant (Scotland)	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	
GVA Multipliers - install and connect (Scotland)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	
Annual GVA Benefit		£0.000	£0.000	£0.000	£0.042	£0.127	£0.211	£0.211	£0.211	£0.211	£0.211	0.123
GVA/ job (direct, plant)	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168
GVA/ job (direct, installation, etc)	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721
Direct jobs - plant			0	0	446	1337	2228	2228	2228	2228	2228	1436
Direct jobs - construction &c			0	0	67	200	334	334	334	334	334	215
Total direct jobs			0	0	512	1537	2562	2562	2562	2562	2562	1651
Employment multiplier - plant	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
Employment multiplier - installation	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93
Annual jobs			0	0	856	2568	4279	4279	4279	4279	4279	2758

Nuclear decommissioning

The nuclear legacy comprises a range of technical, social, political and moral obligations to future generations to clean up and recover the long-lived and potentially dangerous remains of a nuclear industry that is now 60 years old.

The symbolism of the artist's impression, right, will not be realised, because it has now been decided to demolish the sphere, but it brings to mind significant achievements of the Scottish decommissioning industry so far.

More than twenty sites are scheduled for decommissioning across the UK, and although (as we say on Page 32) the schedule may be extended, they represent a real business opportunity through and beyond 2025.

About 10 per cent of the legacy costs are site infrastructure, about 40 per cent decommissioning and site reclamation per se, and about half waste handling and storage. Scottish firms have been involved in all three activities to date, particularly at the three Scottish closures in Hunterston, Dounreay and Chapelcross. However even in Scotland the majority of the business has been taken by firms from the North West of England, often in partnerships with American companies, but also often using Scottish workers and sub-contractors. Participation in storage of non-Scottish and non-UK waste in Scotland has, as elsewhere, proved controversial. The industries involved in decommissioning and decontamination (D&D in the trade) range from more-or-less routine demolition to highly sophisticated knowledge-based companies (the 'technical consultancy sector in Caithness has grown by a factor of 5 since the decommissioning of Dounreay) and the highly engineered installations they design.

Since safety is the highest priority and there are many different designs of reactor, the total cost and timespan of decommissioning activities has proved hard to estimate and the precise figures for market size are very uncertain.

This has also led to economic development consequences in coping with the social ramifications of decommissioning: for example in Caithness and Sutherland the Dounreay establishment supported about one third of the counties' economy, but the funds available for economic reconstruction are dependent on what the Nuclear Decommissioning Agency is able to save from its technical budget.

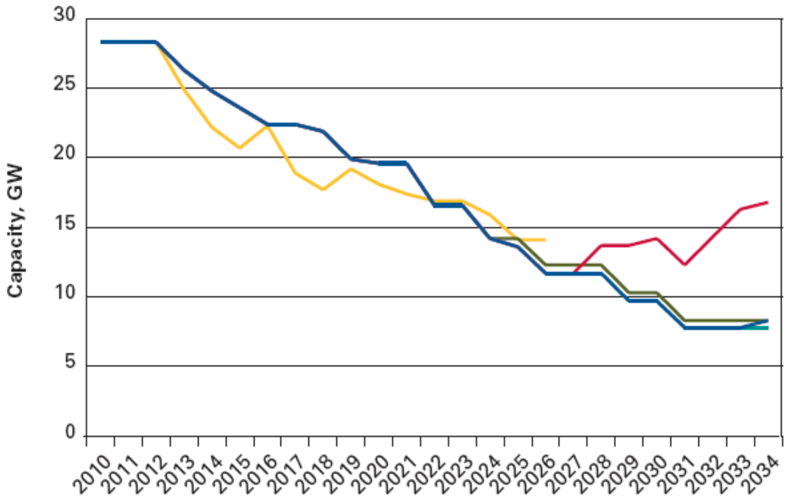
Cleaning up coal

Coal power station retiral

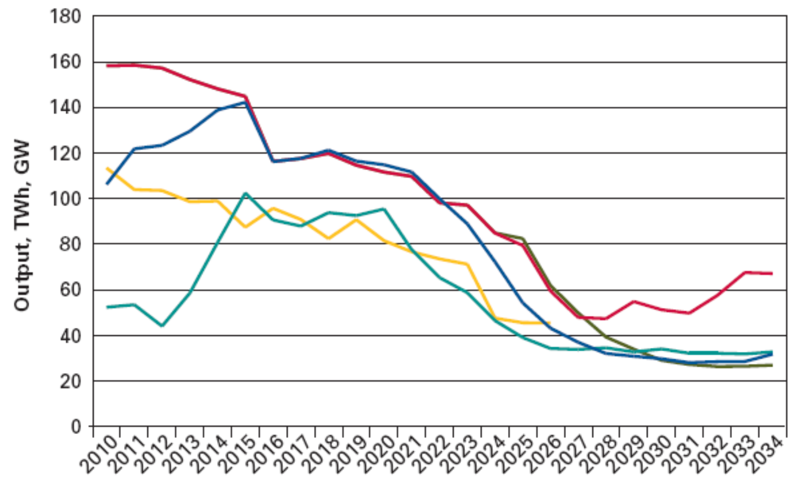
Current capacity for coal generation in the UK is about 28 GW. Quite apart from issues of economics and engineering life, closure of part of this capacity is now scheduled over the next 5 years as a result of the Large Combustion Plant Directive (LCPD), which restricts sulphur emission. Closure of the remainder will proceed over the subsequent 5-10 years as a result of the politically agreed Industrial Emissions Directive (IED). Thus a need for 2GW per year of replacement capacity is being driven by EU-level commitment on environmental and climate change measures. In Scotland, Cockenzie (1.2GW) must close by 2016. Fitting flue gas desulphurisation to three of Longannet power station's four turbine chains (2.3 GW) has shifted it from the early closure schedule to late closure.

UK Government scenarios show an almost linear decline in coal capacity, as the initial closure programme (orange) is offset by various clean coal demonstration projects. However, based on low coal prices, they suggest that the capacity will be intensively used as long as is permitted. These charts are from the DECC/Ofgem Energy Markets Outlook December 2009.

– Coal Power station capacity (GW)

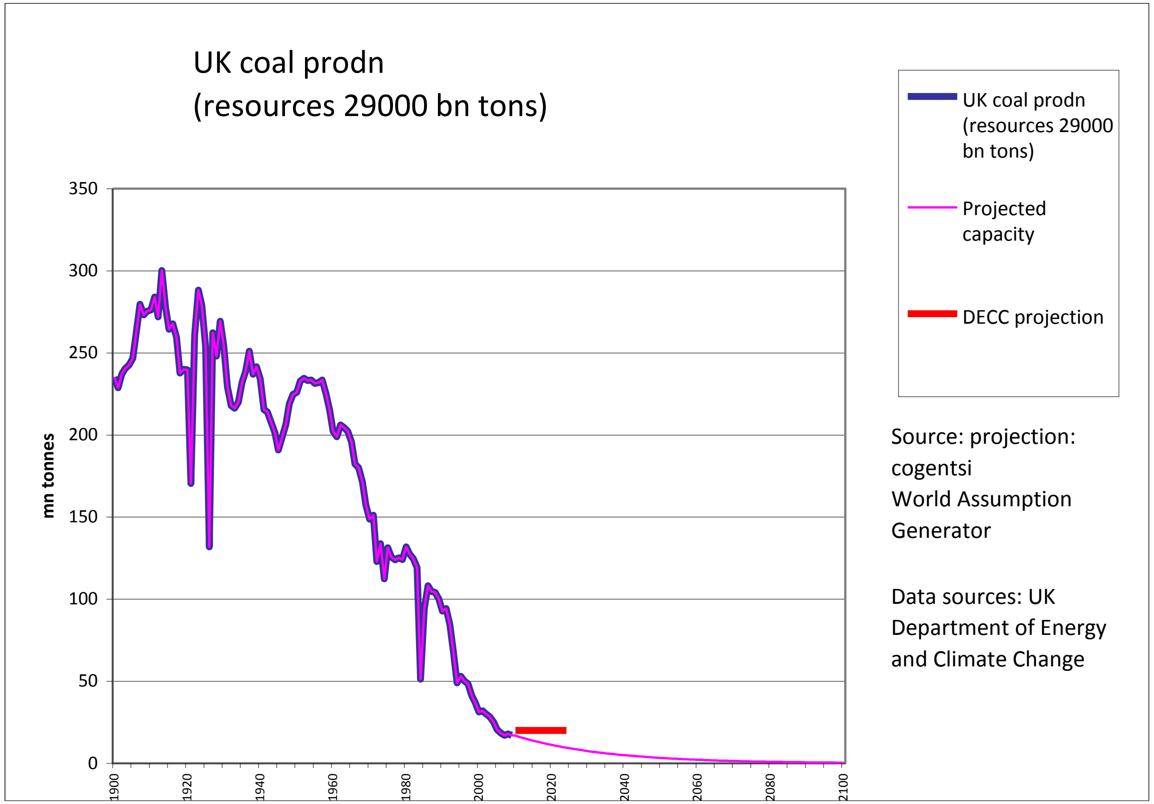


– Generation Output (TWh)



Coal sourcing

From a global total of 6.4 bn tonnes, China is by far the largest producer of coal in the world, 2.5 bn tonnes/year. It is followed by the USA, India, Australia, and Russia at 1.0, 0.5, 0.4 and 0.3 bn. All countries serve primarily their domestic markets, except for Australia which nowadays exports mainly to China. Most imported UK coal comes from Russia, with Australia, the USA, South Africa and Columbia each supplying about 10 per cent.



Imports from Russia alone are thus approximately the same as UK production. A significant proportion of imported UK coal is handled through the Hunterston deepwater facility on the Clyde, which took almost 12 mn tonnes in 2006 and is one of only four UK ports large enough to handle the most modern coal vessels.

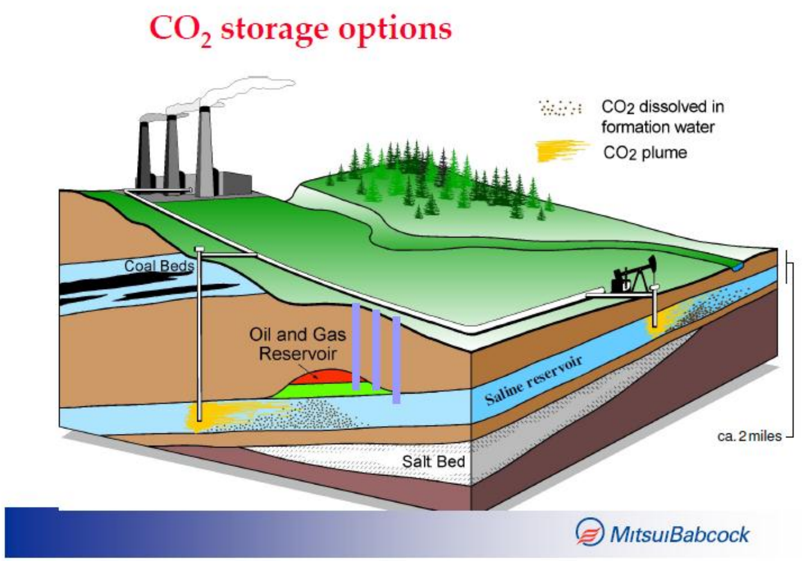
The UK's own coal output peaked at 300 mn tonnes/year in 1913 and has now fallen to 17 mn, slightly less than a third of consumption.

DECC's planning assumption (Market Outlook December 2009) is for 20 mn tonnes output. Based on the deliberations of DECC's 'UK Coal Forum' in 2007, this seems high in the light of remaining reserves in current workings and recent production declines.

Carbon capture and storage investment programme

The UK Coalition Government has announced it will continue the previous Government's proposals for public sector investment in carbon capture and storage technology (CCS) for four coal-fired power stations. It has also made a specific commitment to establish an emissions performance standard that will prevent coal-fired power stations being built unless they are equipped with sufficient CCS to meet the standard. Coupled with the generation gap this provides enormous incentive for companies to design, test and implement carbon capture and storage. This is innovative technology and the Scottish Centre for Carbon Storage represents the largest concentration of researchers in the UK.

Although no fully operation CCS power plant has been built anywhere in the world, more than 20 experiments and pilots are operating (Haszledine 2009). A report to the Chief Scientific Advisor for Scotland has concluded that Scotland's CO2 storage resource, primarily in saline aquifers in offshore waters, exceeds that of the Netherlands, Denmark and Germany combined and will meet domestic demand for 200 years. Thus, subject to pipeline availability it can be opened for other users. Even though transport is a significant element of cost, the catchment area could include most of England and significant swathes of continental Europe.



The volume and the cost estimates used in the scenario are at the upper end of the range put forward. Significant technical progress is expected, so costs in real terms are expected to be lower in the 2020s, when the technology will be deployed on a larger scale. The assumption of 2 GW new CCS-coal capacity comes just above the upper (1.9) case of the previous UK Government's white paper and the 6. Modellers indicate that this is only likely to happen if the cost of emitting a tonne of CO2 is set by cap-and-tax or emission trading schemes at around or above €50/tonne, around €200/tonne of coal.

Scenario: CCS

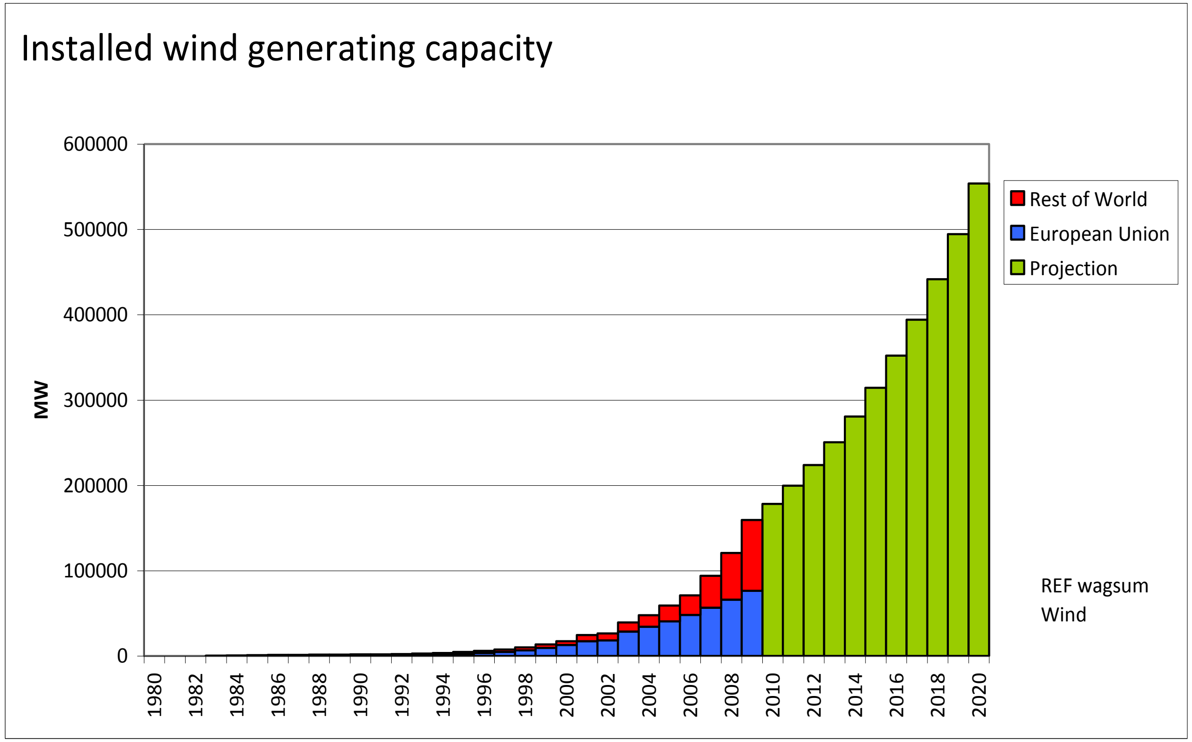
Carbon capture, transport and storage

0.0 GW in 2010 — 4.0 GW in 2020

Profile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Capacity of new and retrofit CCS coal power statio	0.00	0.00	0.00	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	3.27
TWh output at 100% load factor	0.0	0.0	0.0	8.7	17.5	26.2	34.9	43.7	52.4	61.2	69.9	
Load factor	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	70%	
TWh output	0.00	0.00	0.00	6.12	12.23	18.35	24.46	30.58	36.69	42.81	48.92	
Efficiency	38.0%	38.5%	39.0%	39.5%	40.0%	40.5%	41.0%	41.5%	42.0%	42.5%	43.0%	
TWh input (fuel used)	0.00	0.00	0.00	15.48	30.58	45.30	59.66	73.68	87.36	100.72	113.77	
Calorific value TWh/tonne	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	7.24	
Estimated annual coal consumption mn tonnes	0	0	0	2	4	6	8	10	12	14	16	6.61
CO2 generation (mtpa of CO2)	0	0	0	8	15	23	30	37	44	51	58	24
Value of one tonne CO2 (£)	0	40	40	40	40	40	40	40	40	40	40	36
Value of CO2	0	0	0	313	619	917	1208	1492	1769	2039	2304	969
Annual CO2 value per GW				313	310	306	302	298	295	291	288	300
				1281.6	1265.5	1249.9	1234.7	1219.8	1205.3	1191.1	1177.3	
Opex/toe (£2008)	£ 59.89	£ 59.88	£ 61.32	£ 63.25	£ 65.63	£ 68.38	£ 71.48	£ 74.90	£ 78.64	£ 82.70	£ 87.09	£ 70.29
Total opex	£ -	£ -	£ -	£ 19 828	£ 20 316	£ 20 907	£ 21 587	£ 22 348	£ 23 185	£ 24 095	£ 25 079	£ 16 122
Scottish market share	45%	45%	45%	45%	45%	45%	45%	45%	45%	45%	45%	45%
Total Scottish sales	£0	£0	£0	£8 923	£9 142	£9 408	£9 714	£10 057	£10 433	£10 843	£11 286	£7 255
Sales: GVA ratio	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13	2.13
Direct GVA	£0	£0	£0	£4 194	£4 297	£4 422	£4 566	£4 727	£4 904	£5 096	£5 304	£3 410
GVA Multipliers	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
Annual GVA Benefit	£0	£0	£0	£7 654	£7 842	£8 070	£8 333	£8 627	£8 950	£9 301	£9 681	£6 223
GVA/ job (direct)	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811	£ 63.811
Direct jobs	0	0	0	119948	122897	126473	130588	135191	140253	145762	151715	97530
Employment multiplier	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87	1.87
Annual jobs	0	0	0	224800	230328	237029	244741	253368	262855	273179	284336	182785

Renewables

Wind power



Wind power generation using technology recognisably like today's began thirty years ago in 1980, and the early large scale growth was in America, where Glasgow-based Howden's was a notable supplier. Under more conservative governments fiscal incentives in the USA were reduced and the US market almost vanished under President Reagan and the Bushes. Denmark, Germany and the Netherlands began to lead world markets, followed by the UK. Up until 1995 global installed capacity grew at a rate around 40 per cent per year, and since then it has grown at around 25 per cent. The projected figures shown in the chart, rising to 550 000 MW in 2020 are based on a 12 per cent annual growth rate in installed capacity, which is very conservative by historical standards. BTM Consult, one of the longest-established industry consultants, project 16 per cent to 2015. Continuation of recent growth rates would lead to a much higher figure of 1 900 000 MW in 2020, a figure which the World Wind Energy Association has said is possible.

In 2009 China continued its role as the locomotive of the international wind industry and added 13 800 MW of capacity within one year, more than doubling the installations for the fourth year in a row. This meant that in 2009 China became number two in total capacity, slightly ahead of Germany, both of them with around 26 000 Megawatt of wind capacity installed. The USA maintained its number one position in terms of total installed capacity, fiscal incentives have now returned at federal level and are supplemented in some states, so the driving market is onshore wind, for example in Texas and in Colorado where Vestas, the world's largest turbine maker, is establishing factories. Such investments remain a gamble on US incentives, mainly federal ones, being renewed or replaced as they expire. There is some US interest in offshore wind.

In Europe compulsory renewables targets effectively guarantee that incentive taxes and tariffs will continue in some form, but land for windfarms is coming under pressure, and much future growth is expected to be offshore, in the Baltic and the North Sea. Britain already has more offshore wind capacity than any other country, and has more suitable waters, so offshore wind can be seen as a very large, and distinctively British, renewable energy opportunity. Round 1 (1200 MW) and Round 2 (7600 MW) of offshore-England licensing were completed in 2001 and 2003. Developments in Scottish territorial waters are expected in due course to total up to 6 400 MW and the leasing for these is arranged. Recent announcements by the Crown Estates (12 Jan 2010) put the capacity likely to be achieved in deeper water offshore the UK as a whole over the next 15 years or so at 32 000 MW. Britain is, and will remain for some time, the largest offshore wind market in the world, and although daunting today, this total increase in capacity of 40 000-50 000 MW (including inshore English waters) must be set in the context of a European increase which plausibly may exceed 250 000 MW.

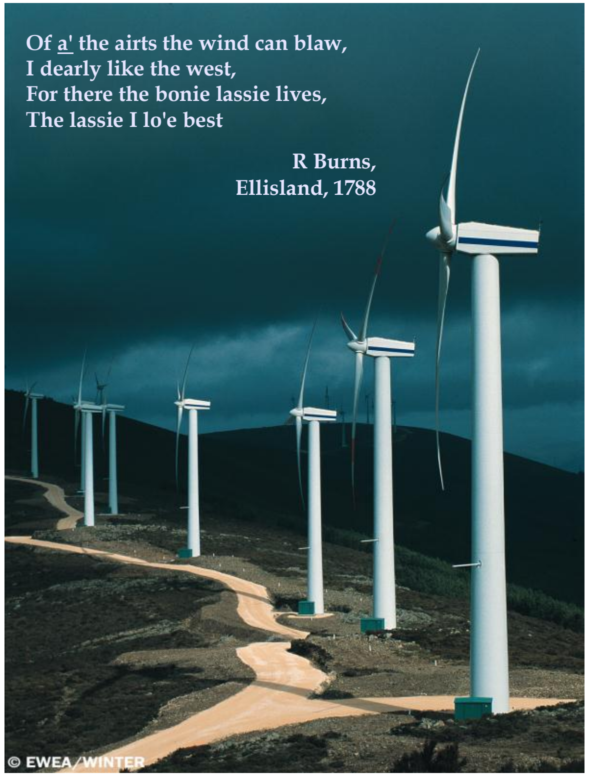
The question is: who will supply and install the equipment? German and Danish suppliers are in the lead, with Chinese, Japanese and US companies interested. The Carbon Trust, the British Wind Energy Association and others have held out the prospect of significant economic benefit if some or all of the manufacturing process can be located in the UK. However, while historically there have been various manufacturing adventures in Scotland and elsewhere in Britain, studies for Scottish Enterprise have discounted the prospects for UK manufacture of wind energy turbines (OTM and Douglas-Westwood, 2006 and 2003).

The Reckoner has been used in this report to evaluate four wind scenarios:

- one onshore Scotland,
- one covering Scottish territorial waters, and
- two dealing with the UK continental shelf.

The onshore scenario is couched in terms of the Planning system, which has recently been simplified, having been a limiting factor on developments so far. The Scottish territorial waters have been estimated as permitting developments up to 6.4 GW (Crown Estate, 2009 February) and the scenario for these envisages the capacity being supplied over the period 2014 (the earliest installation date envisaged by Crown Estates) and 2025.

Of the two deepwater scenarios, one has a significant British assembly and fabrication plant, and one is without. In the first case we have assumed that Scotland will achieve a 20 per cent supplier share of the market, and in the second only 7 per cent. Until the choice of technologies is narrowed down these are highly uncertain figures: for example different methods of anchoring the turbines to the seabed could engage very different suppliers, and the location of any fabrication or assembly plant is unknown. There are concerns that some parts of the supply chain – such as installation vessels – will not materialise in time.



Costs are uncertain and some cost estimates for offshore have been as high as £3 mn per megawatt (compared with £1.2 mn and less per MW onshore). Historically, through the 1980s and 1990s, the cost per megawatt of wind capacity has declined both as a result of manufacturers learning through experience and of economies of scale as it has become possible to construct larger turbines. In addition, the timing of tariff and investment incentives, especially in the United States, has exacerbated normal market cycles so that prices and the financial viability of turbine manufacturers have fluctuated. As regards offshore installations, for example, there have been significant upward revisions of cost estimates in recent years. These have been blamed by developers and operators on unexpected technical complexities, but some commentators have ascribed them to market pressure for turbines and for installation barges. From a British point of view there has also been pressure from exchange rates as sterling has fallen against the Euro and, to an extent, against the dollar. Historically the cost per megawatt of wind turbines has fallen as a result of the learning process in manufacturing them and economies of scale.

In each of the cases the cost of the turbines and of construction/installation has been handled separately. Offshore the installation is expected to account for half or more of the capital cost, whereas onshore it is typically 30 per cent – less in more accessible sites.

The table shows the disposition of onshore wind in Scotland, with 2 000 MW operational, 7 000 under construction, a further 2 000 consented and about 4 000 in the planning process.

Location	Operational	Construction	Consented	Planning
Aberdeenshire	62		137	108
Angus			7	4
Argyll & Bute	96	80	106	156
Ayrshire				96
Caithness				20
Dumfries & Galloway	134	185	131	271
Dundee City	4			
East Ayrshire	13			460
East Lothian	48			
East Renfrewshire	324		151	
Fife	293		27	8
Highland	293	40	297	897
Midlothian				45
Moray	61		42	287
North Ayrshire	42		44	120
North Lanarkshire	30			24
Orkney	24	2	7	13
Perth & Kinross	64		220	64
Scottish Borders	140	240	79	316
Shetland Islands	4			540
South Ayrshire	130	150	90	20
South Lanarkshire	150		579	265
Stirling	75		47	73
West Lothian		14	30	69
Western Isles	5		58	267
Total	**2003**	**734**	**2052**	**4123**

Source: BWEA TO BE UPDATED BEFORE PUBLICATION
Ref P243 Scoton

Scenario: ONScot

Onshore Wind, Scotland

0.0 GW in 2010 4.0 GW in 2020

Profile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Capacity	2.0	2.4	2.7	3.4	4.0	4.7	5.2	5.6	6.1	6.6	7.1	4.5
Annual increment		0.4	0.4	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5
Development cost - plant mn €/GW	1.05	1.01	0.98	0.95	0.92	0.89	0.87	0.85	0.83	0.80	0.78	0.90
Real exchange rate €/£	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Development cost - plant mn £/GW	£0.95	£0.92	£0.89	£0.86	£0.84	£0.81	£0.79	£0.77	£0.75	£0.73	£0.71	£0.82
Development cost - plant, total	0.000	0.322	0.311	0.574	0.557	0.542	0.373	0.364	0.355	0.343	0.333	0.370
Development cost - install and connect - mn £/GW	£0.31	£0.30	£0.29	£0.27	£0.26	£0.25	£0.25	£0.24	£0.24	£0.23	£0.23	£0.26
Development cost - install and connect - total	0.000	0.104	0.101	0.182	0.175	0.169	0.117	0.115	0.112	0.111	0.109	0.118
Development Cost £mn (2010)/GW	£1.26	£1.22	£1.18	£1.13	£1.10	£1.07	£1.04	£1.01	£0.99	£0.96	£0.94	£1.08
Cost of capacity increment		£0.442	£0.426	£0.784	£0.239	£0.732	£0.503	£0.490	£0.478	£0.467	£0.454	£0.502
Phased cost: 20/40/40	£0.26	£0.504	£0.532	£0.556	£0.489	£0.592	£0.493	£0.481	£0.469	£0.457	£0.445	£0.480
Scottish market share plant	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%
Scottish market share installation and connection	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Scottish sales - plant	£0.016	£0.032	£0.033	£0.035	£0.031	£0.038	£0.031	£0.030	£0.030	£0.029	£0.028	£0.03
Scottish sales - install & connect	£0.061	£0.117	£0.124	£0.127	£0.111	£0.134	£0.112	£0.109	£0.107	£0.106	£0.104	£0.11
Total Scottish sales	£0.077	£0.149	£0.157	£0.162	£0.142	£0.171	£0.143	£0.140	£0.137	£0.135	£0.132	£0.14
Overall Scottish share of expenditure	30%	30%	30%	29%	29%	29%	29%	29%	29%	29%	30%	
Sales: GVA ratio - plant	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54
Sales: GVA ratio - install and connect	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Direct GVA	£0.03	£0.06	£0.07	£0.07	£0.06	£0.07	£0.06	£0.06	£0.06	£0.06	£0.06	£0.06
GVA Multipliers - plant (Scotland)	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	
GVA Multipliers - install and connect (Scotland)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	
Annual GVA Benefit	£0.06	£0.12	£0.13	£0.13	£0.12	£0.14	£0.12	£0.12	£0.11	£0.11	£0.11	£0.12
GVA/ job (direct, plant)	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168
GVA/ job (direct, installation, etc)	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721
Direct jobs - plant	147	283	298	313	276	335	279	272	264	257	249	270
Direct jobs - instalation &c	508	977	1033	1063	927	1116	932	914	896	883	868	920
Employment multiplier - plant	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
Employment multiplier - installation	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93
Annual jobs	1219	2346	2478	2562	2240	2700	2254	2206	2159	2122	2081	2215

Scenario: OWScot

Offshore Wind Scottish territorial waters

0.0 GW in 2010 4.0 GW in 2020

Profile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Capacity	0.0	0.0	0.0	0.0	0.5	1.1	1.6	2.1	2.7	3.2	3.7	1.4
Annual increment		0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4
Development cost - plant mn $/GW	1.09	1.04	1.00	0.96	0.93	0.89	0.86	0.83	0.80	0.77	0.74	0.90
Real exchange rate $/£	1.60	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.51
Development cost - plant mn £/GW	£0.68	£0.70	£0.67	£0.64	£0.62	£0.60	£0.57	£0.55	£0.53	£0.51	£0.49	£0.60
Development cost - plant, total	0.000	0.000	0.000	0.000	0.330	0.318	0.306	0.295	0.284	0.273	0.263	0.188
Development cost - install and connect - mn £/GW	£3.20	£2.99	£2.79	£2.60	£2.43	£2.27	£2.12	£1.97	£1.84	£1.72	£1.61	£2.32
Development cost - install and connect - total	0.000	0.000	0.000	0.000	1.295	1.209	1.128	1.053	0.983	0.917	0.856	0.676
Development Cost £mn (2010)/GW	£3.88	£3.68	£3.46	£3.24	£3.05	£2.86	£2.69	£2.53	£2.37	£2.23	£2.10	£2.92
Cost of capacity increment		£0.000	£0.000	£0.000	£0.797	£1.625	£1.526	£1.434	£1.348	£1.267	£1.191	£0.919
Phased cost: 20/40/40	£0.00	£0.000	£0.159	£0.644	£1.274	£1.547	£1.454	£1.366	£1.284	£1.207	£1.135	£0.915
Scottish market share plant	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	8%	
Scottish market share installation and connection	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	40%	
Scottish sales - plant	£0.00	£0.00	£0.00	£0.01	£0.02	£0.03	£0.03	£0.02	£0.02	£0.02	£0.02	£0.02
Scottish sales - install & connect	£0.00	£0.00	£0.05	£0.21	£0.41	£0.49	£0.46	£0.43	£0.40	£0.37	£0.35	£0.29
Total Scottish sales	£0.00	£0.00	£0.05	£0.22	£0.43	£0.52	£0.48	£0.45	£0.42	£0.40	£0.37	£0.30
Sales: GVA ratio - plant	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54
Sales: GVA ratio - install and connect	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Direct GVA	£0.00	£0.00	£0.02	£0.10	£0.19	£0.23	£0.21	£0.20	£0.18	£0.17	£0.16	£0.13
GVA Multipliers - plant (Scotland)	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	
GVA Multipliers - install and connect (Scotland)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	
Annual GVA Benefit												
GVA/ job (direct, plant)	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168
GVA/ job (direct, installation, etc)	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721
Direct jobs - plant	0	0	23	95	192	239	230	222	214	206	198	147
Direct jobs - instalation &c	0	0	429	1724	3391	4093	3820	3565	3328	3106	2899	2396
Employment multiplier - plant	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
Employment multiplier - installation	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93
Annual jobs	0	0	866	3481	6856	8286	7745	7240	6769	6328	5916	4862

Scenario: OWUKCS10

Offshore Wind UK continental shelf

0.0 GW in 2010 — 4.0 GW in 2020

Profile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Capacity	0.0	0.0	0.0	0.0	2.8	5.6	8.4	11.2	14.0	16.8	19.6	7.1
Annual increment		0.0	0.0	0.0	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.0
Development cost - plant mn €/GW	1.05	1.01	0.98	0.95	0.92	0.89	0.87	0.85	0.83	0.80	0.78	0.90
Real exchange rate €/£	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Development cost - plant mn £/GW	£0.95	£0.92	£0.89	£0.86	£0.84	£0.81	£0.79	£0.77	£0.75	£0.73	£0.71	£0.82
Development cost - plant, total	0.000	0.000	0.000	0.000	2.341	2.277	2.217	2.160	2.107	2.039	1.979	1.375
Development cost - install and connect - mn £/GW					£1.97	£1.68	£1.53	£1.43	£1.36	£1.31	£1.26	£1.51
Development cost - install and connect - total					5.519	4.706	4.287	4.012	3.812	3.655	3.528	4.217
Development Cost £mn (2010)/GW					£2.81	£2.49	£2.32	£2.20	£2.11	£2.03	£1.97	£2.28
Cost of capacity increment					£0.702	£7.860	£6.983	£6.504	£6.173	£5.918	£5.694	£5.691
Phased cost: 20/40/40	£0.00	£0.000	£0.140	£1.853	£4.822	£7.238	£6.629	£6.254	£5.975	£5.746	£5.549	£4.019
Scottish market share plant	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	7%	
Scottish market share installation and connection	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	12%	
Scottish sales - plant			£0.003	£0.039	£0.101	£0.165	£0.158	£0.153	£0.149	£0.144	£0.140	£0.12
Scottish sales - install & connect			£0.012	£0.156	£0.406	£0.585	£0.524	£0.488	£0.462	£0.443	£0.427	£0.39
Total Scottish sales			£0.015	£0.195	£0.507	£0.751	£0.683	£0.641	£0.611	£0.587	£0.566	£0.51
Overall Scottish share of expenditure			11%	11%	11%	10%	10%	10%	10%	10%	10%	
Sales: GVA ratio - plant	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54
Sales: GVA ratio - install and connect	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Direct GVA			£0.006	£0.084	£0.218	£0.323	£0.293	£0.275	£0.262	£0.252	£0.243	£0.22
GVA Multipliers - plant (Scotland)	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	
GVA Multipliers - install and connect (Scotland)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	
Annual GVA Benefit			£0.012	£0.162	£0.421	£0.620	£0.563	£0.528	£0.503	£0.483	£0.466	0.417
GVA/ job (direct, plant)	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168
GVA/ job (direct, installation, etc)	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721
Direct jobs - plant			26	344	896	1472	1410	1366	1327	1284	1244	1041
Direct jobs - instalation &c			99	1304	3393	4888	4379	4074	3856	3696	3562	3250
Total direct jobs			125	1648	4288	6360	5788	5439	5183	4980	4806	4291
Employment multiplier - plant	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
Employment multiplier - installation	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93
Annual jobs			233	3077	8006	11832	10747	10087	9604	9225	8902	7968

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Scenario: OWUKCS20

Offshore Wind UK continental shelf

0.0 GW in 2010 | 4.0 GW in 2020

	Profile 2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Capacity	0.0	0.0	0.0	0.0	2.8	5.6	8.4	11.2	14.0	16.8	19.6	7.1
Annual increment		0.0	0.0	0.0	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.0
Development cost - plant mn €/GW	1.05	1.01	0.98	0.95	0.92	0.89	0.87	0.85	0.83	0.80	0.78	0.90
Real exchange rate €/£	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Development cost - plant mn £/GW	£0.95	£0.92	£0.89	£0.86	£0.84	£0.81	£0.79	£0.77	£0.75	£0.73	£0.71	£0.82
Development cost - plant, total	0.000	0.000	0.000	0.000	2.341	2.277	2.217	2.160	2.107	2.039	1.979	1.375
Development cost - install and connect - mn £/GW					£1.97	£1.68	£1.53	£1.43	£1.36	£1.31	£1.26	£1.51
Development cost - install and connect - total					5.519	4.706	4.287	4.012	3.812	3.655	3.528	4.217
Development Cost £mn (2010)/GW					£2.81	£2.49	£2.32	£2.20	£2.11	£2.03	£1.97	£2.28
Cost of capacity increment					£0.702	£7.860	£6.983	£6.504	£6.173	£5.918	£5.694	£5.691
Phased cost: 20/40/40	£0.00	£0.000	£0.140	£1.853	£4.822	£7.238	£6.629	£6.254	£5.975	£5.746	£5.549	£4.019
Scottish market share plant	10.5%	10.5%	10.5%	10.5%	10.5%	10.5%	10.5%	10.5%	10.5%	10.5%	10.5%	11%
Scottish market share installation and connection	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%	25%
Scottish sales - plant			£0.004	£0.058	£0.151	£0.248	£0.237	£0.230	£0.223	£0.216	£0.209	£0.18
Scottish sales - install & connect			£0.025	£0.325	£0.846	£1.219	£1.092	£1.016	£0.962	£0.922	£0.889	£0.81
Total Scottish sales			£0.029	£0.383	£0.997	£1.467	£1.330	£1.246	£1.185	£1.138	£1.098	£0.99
Overall Scottish share of expenditure			21%	21%	21%	20%	20%	20%	20%	20%	20%	20%
Sales: GVA ratio - plant	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54
Sales: GVA ratio - install and connect	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Direct GVA			£0.013	£0.166	£0.432	£0.634	£0.574	£0.538	£0.511	£0.491	£0.474	£0.43
GVA Multipliers - plant (Scotland)	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	
GVA Multipliers - install and connect (Scotland)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	
Annual GVA Benefit			£0.024	£0.321	£0.835	£1.224	£1.108	£1.037	£0.986	£0.946	£0.913	0.821
GVA/ job (direct, plant)	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168
GVA/ job (direct, installation, etc)	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721
Direct jobs - plant			39	516	1344	2209	2115	2048	1990	1926	1866	1561
Direct jobs - instalation &c			206	2716	7068	10183	9122	8487	8034	7701	7421	6771
Total direct jobs			245	3233	8412	12392	11237	10535	10024	9626	9288	8332
Employment multiplier - plant	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
Employment multiplier - installation	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93
Annual jobs			461	6083	15828	23249	21048	19715	18746	17998	17362	15610

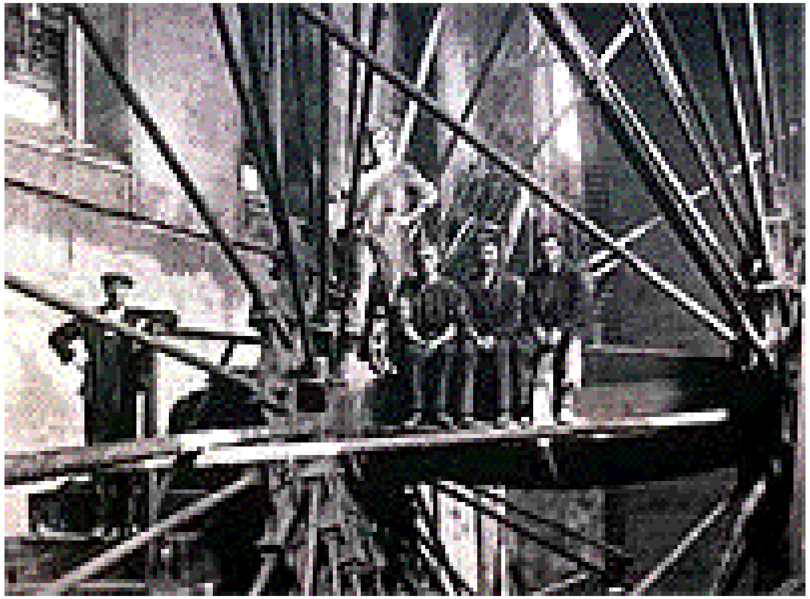
Scenario: OWUKCS30

Offshore Wind UK continental shelf

0.0 GW in 2010 — 4.0 GW in 2020

Profile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Capacity	0.0	0.0	0.0	0.0	2.8	5.6	8.4	11.2	14.0	16.8	19.6	7.1
Annual increment		0.0	0.0	0.0	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.0
Development cost - plant mn €/GW	1.05	1.01	0.98	0.95	0.92	0.89	0.87	0.85	0.83	0.80	0.78	0.90
Real exchange rate €/£	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Development cost - plant mn £/GW	£0.95	£0.92	£0.89	£0.86	£0.84	£0.81	£0.79	£0.77	£0.75	£0.73	£0.71	£0.82
Development cost - plant, total	0.000	0.000	0.000	0.000	2.341	2.277	2.217	2.160	2.107	2.039	1.979	1.375
Development cost - install and connect - mn £/GW					£1.97	£1.68	£1.53	£1.43	£1.36	£1.31	£1.26	£1.51
Development cost - install and connect - total					5.519	4.706	4.287	4.012	3.812	3.655	3.528	4.217
Development Cost £mn (2010)/GW					£2.81	£2.49	£2.32	£2.20	£2.11	£2.03	£1.97	£2.28
Cost of capacity increment					£0.702	£7.860	£6.983	£6.504	£6.173	£5.918	£5.694	£5.691
Phased cost: 20/40/40	£0.00	£0.000	£0.140	£1.853	£4.822	£7.238	£6.629	£6.254	£5.975	£5.746	£5.549	£4.019
Scottish market share plant	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20%
Scottish market share installation and connection	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%	35%
Scottish sales - plant			£0.008	£0.110	£0.287	£0.472	£0.452	£0.438	£0.425	£0.412	£0.399	£0.33
Scottish sales - install & connect			£0.035	£0.455	£1.185	£1.707	£1.529	£1.423	£1.347	£1.291	£1.244	£1.14
Total Scottish sales			£0.043	£0.566	£1.472	£2.179	£1.981	£1.861	£1.772	£1.703	£1.643	£1.47
Overall Scottish share of expenditure			31%	31%	31%	30%	30%	30%	30%	30%	30%	30%
Sales: GVA ratio - plant	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54
Sales: GVA ratio - install and connect	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Direct GVA			£0.018	£0.244	£0.635	£0.937	£0.851	£0.799	£0.760	£0.730	£0.705	£0.63
GVA Multipliers - plant (Scotland)	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	
GVA Multipliers - install and connect (Scotland)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	
Annual GVA Benefit			£0.036	£0.470	£1.223	£1.803	£1.635	£1.534	£1.460	£1.402	£1.353	1.213
GVA/ job (direct, plant)	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168
GVA/ job (direct, installation, etc)	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721
Direct jobs - plant			75	984	2560	4207	4028	3901	3791	3668	3555	2974
Direct jobs - instalation &c			288	3803	9895	14257	12771	11882	11248	10781	10390	9479
Total direct jobs			363	4786	12455	18463	16799	15784	15039	14449	13945	12453
Employment multiplier - plant	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
Employment multiplier - installation	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93
Annual jobs			678	8941	23265	34367	31209	29288	27884	26782	25844	23140

Hydro power



Wind, tidal and hydro power were the first technologies to replace animal energy. In historical times small scale power capture and use was ubiquitous (waterpower more so than wind), initially with wood and fabric construction. Come the industrial revolution, bigger machines were constructed from metals, and as global industrialisation began to take off in 1840 Shaw's waterworks at Greenock was the largest power generator in the world. It produced about 1.5MW from 30 waterwheels.

Early in the twentieth century stations were built to power aluminium production in the Highlands, and then in the interwar years in Grampian, Clydesdale and Galloway to feed into the National Grid. But dominant in the modern development of Scotland's existing hydroelectricity resource was the 1943-65 execution of the North of Scotland Hydro-Electric Board's Development Plan.

Large scale hydro capacity is widely considered exhausted, but there are believed to be many smaller scale and run-of-river potential schemes. For illustrative purposes two scenarios have been evaluated. One is a very large pumped storage scheme, several times larger than the recent Glen Doe development, of 1000 MW. The second is a collection of small schemes totalling 500MW – this is just above what the recent Forrest report on the employment potential of Hydro considered feasible in a 2020 timescale. The *potential* for small and medium schemes that Forrest identified, using a model linking hydrotopography to accounting calculations, was 1200 MW. This is mainly in Highland, Strathclyde and Tayside, as shown in the table, and consists of almost 8000 small developments, averaging 150 Kw, the majority of smaller schemes depending for financial viability on the subsidy embedded in the 'feed-in' tariff. Forrest does not disclose its estimated costs or the details of its employment forecasting methodology, but the costs are likely to be higher than ours, and the employment generated per Kw in Forrest's report is about twice the level estimated in the Reckoner for the small-scale schemes.

Table 5: Breakdown of Hydro Potential by Scottish Region

	Region	Number	Total power (MW)
1	Strathclyde	2,090	280
2	Dumfries & Galloway	282	47
3	Borders	158	33
4	Lothian	54	4
5	Central	176	33
6	Fife	29	2
7	Tayside	893	154
8	Grampian	199	43
9	Highland	3,008	594
10	Western Isles	136	12
11	Shetland	10	1
12	Orkney	8	0.4

Scenario: BIGHYD

Large Hydro station

0.0 GW in 2010 — 1.0 GW in 2020

Profile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Capacity	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	1.0	1.0	1.0	0.4
Annual increment		0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.5	0.0	0.0	0.1
Development cost - plant mn £/GW	£0.60	£0.60	£0.60	£0.60	£0.60	£0.60	£0.60	£0.60	£0.60	£0.60	£0.60	£0.60
Development cost - plant, total	0.000	0.000	0.000	0.000	0.000	0.300	0.000	0.000	0.300	0.000	0.000	0.055
Development cost - construct and connect - mn £/GW					£2.40	£2.40	£2.40	£2.40	£2.40	£2.40	£2.40	£2.40
Development cost - install and connect - total					0.000	1.200	0.000	0.000	1.200	0.000	0.000	0.343
Development Cost £mn (2010)/GW					£3.00	£3.00	£3.00	£3.00	£3.00	£3.00	£3.00	£3.00
Cost of capacity increment					£0.000	£1.500	£0.000	£0.000	£1.500	£0.000	£0.000	£0.429
Phased cost: 20/40/40	£0.00	£0.000	£0.000	£0.300	£0.600	£0.600	£0.300	£0.600	£0.600	£0.000	£0.000	£0.273
Scottish market share plant	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20%
Scottish market share installation and connection	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%
Scottish sales - plant			£0.000	£0.012	£0.024	£0.024	£0.012	£0.024	£0.024	£0.000	£0.000	£0.01
Scottish sales - install & connect			£0.000	£0.192	£0.384	£0.384	£0.192	£0.384	£0.384	£0.000	£0.000	£0.21
Total Scottish sales			£0.000	£0.204	£0.408	£0.408	£0.204	£0.408	£0.408	£0.000	£0.000	£0.23
Overall Scottish share of expenditure			0%	66%	67%	67%	66%	67%	67%	0%	0%	44%
Sales: GVA ratio - plant	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54
Sales: GVA ratio - construct and connect	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Direct GVA			£0.000	£0.089	£0.179	£0.179	£0.089	£0.179	£0.179	£0.000	£0.000	£0.10
GVA Multipliers - plant (Scotland)	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	
GVA Multipliers - install and connect (Scotland)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	
Annual GVA Benefit		£0.000	£0.000	£0.174	£0.347	£0.347	£0.174	£0.347	£0.347	£0.000	£0.000	0.174
GVA/ job (direct, plant)	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168
GVA/ job (direct, installation, etc)	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721
Direct jobs - plant			0	107	214	214	107	214	214	0	0	119
Direct jobs - construction &c			0	1603	3207	3207	1603	3207	3207	0	0	1782
Total direct jobs			0	1710	3421	3421	1710	3421	3421	0	0	1900
Employment multiplier - plant	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
Employment multiplier - installation	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93
Annual jobs			0	3268	6535	6535	3268	6535	6535	0	0	3631

Scenario: WEEHYD

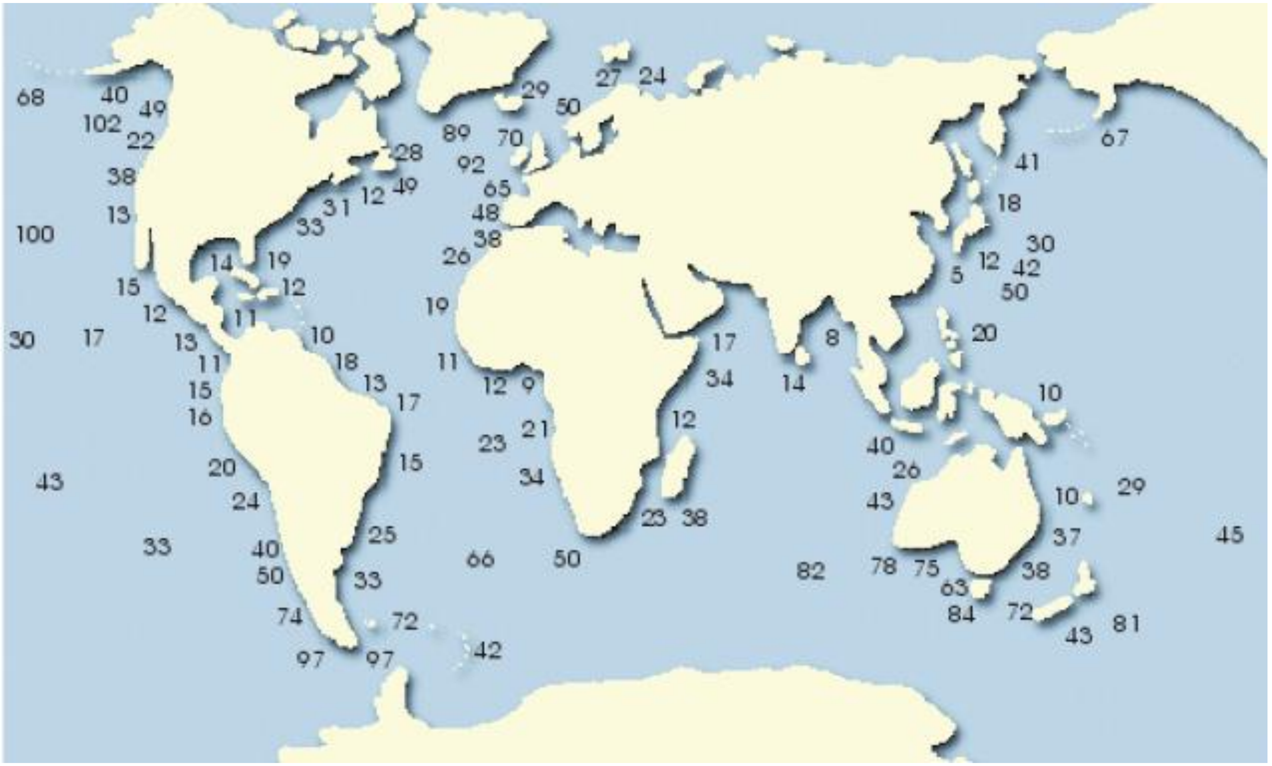
Small Hydro station

0.0 GW in 2010 — 0.5 GW in 2020

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Profile												
Capacity	0.00	0.05	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.3
Annual increment		0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1
Development cost - plant mn £/GW		£0.60	£0.60	£0.60	£0.60	£0.60	£0.60	£0.60	£0.60	£0.60	£0.60	£0.60
Development cost - plant, total	0.000	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.030	0.027
Development cost - construct and connect - mn £/GW		£0.70	£0.70	£0.70	£0.70	£0.70	£0.70	£0.70	£0.70	£0.70	£0.70	£0.70
Development cost - install and connect - total		0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035	0.035
Development Cost £mn (2010)/GW	£0.00	£1.30	£1.30	£1.30	£1.30	£1.30	£1.30	£1.30	£1.30	£1.30	£1.30	£1.18
Cost of capacity increment	£0.000	£0.000	£0.065	£0.065	£0.065	£0.065	£0.065	£0.065	£0.065	£0.065	£0.065	£0.053
Phased cost: 20/40/40	£0.013	£0.039	£0.065	£0.065	£0.065	£0.065	£0.065	£0.065	£0.065	£0.065	£0.065	£0.058
Scottish market share plant	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20.0%	20%
Scottish market share installation and connection	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Scottish sales - plant	£0.001	£0.004	£0.006	£0.006	£0.006	£0.006	£0.006	£0.006	£0.006	£0.006	£0.006	£0.01
Scottish sales - install & connect	£0.007	£0.020	£0.033	£0.033	£0.033	£0.033	£0.033	£0.033	£0.033	£0.033	£0.033	£0.03
Total Scottish sales	£0.008	£0.024	£0.039	£0.039	£0.039	£0.039	£0.039	£0.039	£0.039	£0.039	£0.039	£0.03
Overall Scottish share of expenditure	34%	48%	52%	52%	52%	52%	52%	52%	52%	52%	52%	50%
Sales: GVA ratio - plant	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54
Sales: GVA ratio - construct and connect	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Direct GVA			£0.017	£0.017	£0.017	£0.017	£0.017	£0.017	£0.017	£0.017	£0.017	£0.02
GVA Multipliers - plant (Scotland)	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	
GVA Multipliers - install and connect (Scotland)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	
Annual GVA Benefit	£0.000	£0.000	£0.000	£0.033	£0.033	£0.033	£0.033	£0.033	£0.033	£0.033	£0.033	0.024
GVA/ job (direct, plant)	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168
GVA/ job (direct, installation, etc)	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721
Direct jobs - plant	11	32	53	53	53	53	53	53	53	53	53	48
Direct jobs - construction &c	56	167	278	278	278	278	278	278	278	278	278	247
Total direct jobs	66	199	331	331	331	331	331	331	331	331	331	295
Employment multiplier - plant	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
Employment multiplier - installation	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93
Annual jobs	125	374	623	623	623	623	623	623	623	623	623	555

Marine energy –wave and tidal

The map shows wave energy potential estimated around the world. In terms of being close to a large potential and also having a significant population to use the energy, Scotland is exceptionally strongly situated. Aided by the European Marine Energy Centre in Orkney, Scottish-based inventors and manufacturers have emerged as leaders of wave developments globally.



Wave is now beginning to receive the investment it has lacked in the past, and which might have enabled technological learning-by-doing as has been found in every other energy technology.

The six scenarios that have been calculated represent ambitious deployment targets and two different market share assumptions. In the first three there is an assumption of commercial success and market dominance, and in the second three of significant competitive activity. Within each competitive case, the first two focus primarily in British waters whereas the large scale scenario would assume large export markets.

The ten agreements announced in March 2010 for 1.2 GW of capacity, with an initial target 0f 0.7 GW, are a good fit for the two smallest of the scenarios.

Presented below is a phasing scenario d for the wave and tidal developments. Costs start from current estimates and show a rapid rate of technical learning, as identified in the feasibility studies for the European Marine Energy Centre in Orkney (cogentsi, 2002). A stylised version of this is identified as Scenario D. The other five scenarios were picked relative to this.

Scenario: marine midcase (case d)

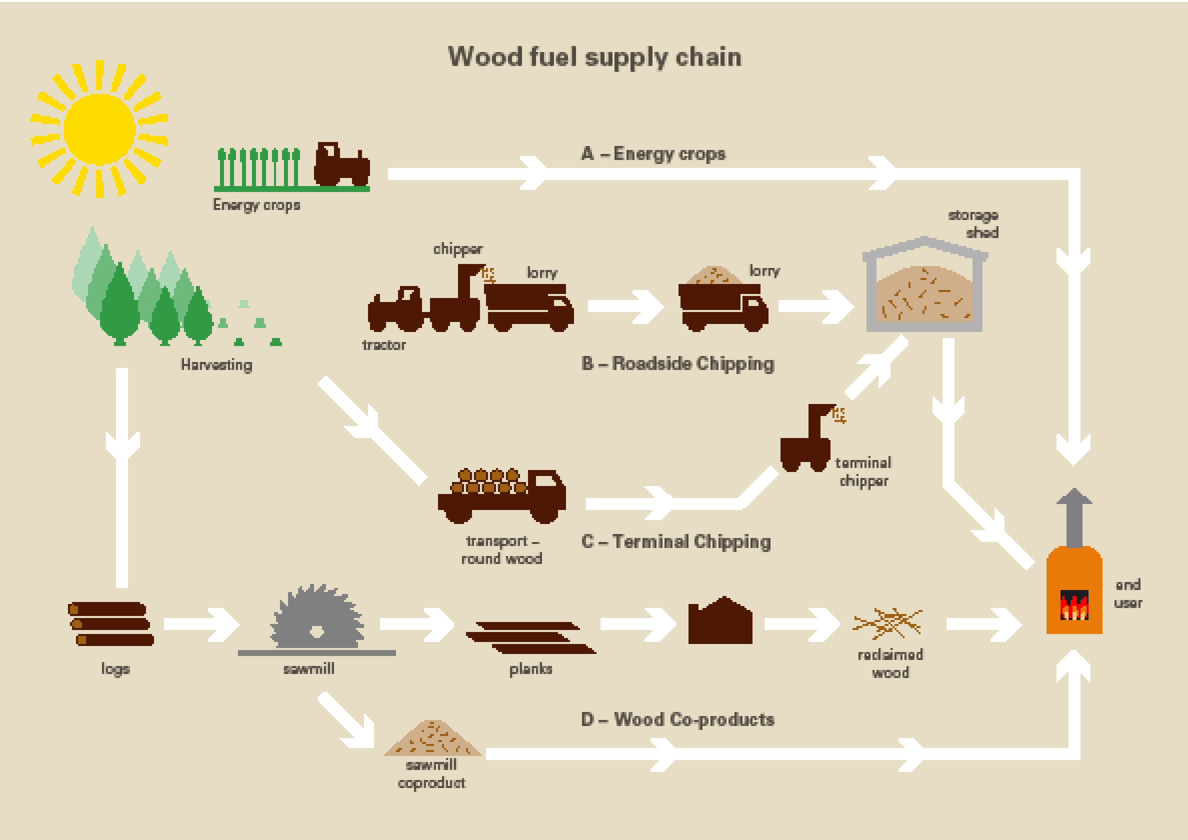
Wind/wave mid case

0.0 GW in 2010 4.0 GW in 2020

Profile	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Average 2010-2020 (where applicable)
Capacity	0.0	0.0	0.0	0.4	0.7	1.1	1.5	1.8	2.2	2.6	3.0	1.2
Annual increment		0.0	0.0	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3
Development cost - plant mn €/GW	10.00	8.50	7.23	6.14	5.22	4.44	3.77	3.21	2.72	2.32	1.97	5.05
Real exchange rate €/£	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Development cost - plant mn £/GW	£9.09	£7.73	£6.57	£5.58	£4.75	£4.03	£3.43	£2.91	£2.48	£2.11	£1.79	£4.59
Development cost - plant, total					1.752	1.489	1.266	1.076	0.915	0.777	0.661	1.250
Development cost - install and connect - mn £/GW					£2.46	£2.17	£2.01	£1.89	£1.81	£1.74	£1.68	£1.72
Development cost - install and connect - total					0.908	0.803	0.741	0.699	0.667	0.641	0.620	0.635
Development Cost £mn (2010)/GW					£7.21	£6.21	£5.44	£4.81	£4.28	£3.84	£3.47	£5.10
Cost of capacity increment					£0.341	£2.661	£2.292	£2.007	£1.775	£1.581	£1.419	£1.510
Phased cost: 20/40/40	£0.00	£0.000	£0.068	£0.669	£1.659	£2.383	£2.075	£1.829	£1.626	£1.456	£1.251	£1.183
Scottish market share plant	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%	95%
Scottish market share installation and connection	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%	75%
Scottish sales - plant			£0.043	£0.418	£1.038	£1.471	£1.243	£1.054	£0.894	£0.758	£0.613	£0.84
Scottish sales - install & connect			£0.017	£0.171	£0.425	£0.626	£0.575	£0.540	£0.514	£0.494	£0.454	£0.42
Total Scottish sales			£0.060	£0.590	£1.463	£2.097	£1.818	£1.594	£1.408	£1.252	£1.067	£1.26
Overall Scottish share of expenditure			88%	88%	88%	88%	88%	87%	87%	86%	85%	87%
Sales: GVA ratio - plant	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.54
Sales: GVA ratio - install and connect	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27	2.27
Direct GVA			£0.025	£0.240	£0.596	£0.854	£0.742	£0.652	£0.578	£0.516	£0.441	£0.52
GVA Multipliers - plant (Scotland)	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	
GVA Multipliers - install and connect (Scotland)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	
Annual GVA Benefit			£0.045	£0.443	£1.100	£1.579	£1.374	£1.210	£1.074	£0.961	£0.824	0.957
GVA/ job (direct, plant)	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168	£ 44.168
GVA/ job (direct, installation, etc)	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721	£ 52.721
Direct jobs - plant			381	3728	9251	13106	11078	9389	7963	6756	5464	7457
Direct jobs - instalation &c			146	1430	3548	5227	4799	4510	4294	4122	3793	3541
Total direct jobs			527	5158	12799	18333	15877	13899	12257	10878	9257	10998
Employment multiplier - plant	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63
Employment multiplier - installation	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93	1.93
Annual jobs			903	8841	21939	31467	27333	24019	21276	18975	16232	18998

Biomass

The economics of biomass from plants – principally wood -hinge critically on land availability and alternative uses, the distance from the crop to the generating plant, and the ability to use all the heat generated. The estimates included are based on CHP generation in a well forested moderately populated area, essentially on a Scottish translation of the 'Swedish model'. Depending on distance, and the precise details of the harvesting terrain and chipping process, the cost split for fuel is likely to be of the order 25 per cent for felling, 50 per cent for chipping and 25 per cent for transport. 'Stumpage', the legacy value of the standing tree is not included on the basis that wood for fuel will consist either of clearings, thinning etc, or that an environmentally-motivated planting policy will yield growing biomass at no net cost.



The nature of the market is thus that it consists either of biofuels seeking markets near their source, or of energy users seeking fuel sources, and having to find them further and further away. A DTI /SE/ WDA report (Department of Trade and Industry/ Scottish Enterprise/ WDA, 2003) suggested that the primary Scottish resource would be from branches or poor quality stemwood, and amounted to 1.3 mtpa, of which about a quarter was currently being exploited.

The high importance of transport in costs, and of oil in transport costs, militates towards relatively small plants local to the forests. Where there might be larger plants, they would need to be located on a coast suitable for import of timber. They also need to be near settlements of appropriate size (or, exceptionally, heat-intensive industrial processes), because the burning properties of timber militate heavily towards use of timber biomass for combined heat and power generation. It is not considered economic in either cost or carbon terms to use biomass solely for electricity: one million tonnes of wood for heating will deliver 4 TWh of heat energy but only 1.5 TWh of electricity.

The renewable heat incentive scheme, planned by the previous UK Government for April 2011, was a self-funding levy-and-reward scheme designed to encourage use of renewable heat, and the prospective returns for small-to medium heat installations are very high. If it, or something similar, is introduced a key issue (and opportunity for potential manufacturers) is likely to be the availability of combustion equipment. (Luker, May 2010).. The effect of the proposed scheme would also be to greatly enhance the value of timber, according to some estimates to more than five times its current UK value. This would plainly have an effect on the other uses of woodfibre, known as 'mechanical' such as paper, building, and board production. It would be likely to lead to very large imports in the short term and, if maintained, to large scale planting of forests – the UK is, for its size, already the world's largest importer of wood, and the amount of energy generated *per hectare of forest* is about one third higher in Britain than in Sweden and Finland. (Data from Food and Agriculture Organisation of the United Nations web site: http://www.fao.org/forestry/site/countryinfo/en/ under Use and Ownership Statistics).

Generation of heat and power from domestic waste has the advantage that the fuel source and the heat and power demand are broadly co-located, but suffers from the disadvantage that, to the extent it burns non-bio-degradable material it does not address the issue of greenhouse gases. Broadly the economics are similar, and so the key economic question is how fast remaining opportunities for incinerators or methane collection can be taken up.

Appendix: Scottish market shares across the economy: (from Scottish Input Output Tables)

Supply of products to Scottish markets
at purchasers' prices in 2004

	a	b	c	d=a-b-c	e	f	g	h	i	j=a+e+f+h+i	j=a/g	k=e/d
↓ Industry or commodity group ↓	Scottish output of products at basic prices	Exports (includes some trade margins and taxes)		Apparent Scottish supplies to home market	Rest of UK imports	Rest of world imports	Apparent home market at 'mixed' prices	Distributors' trading margins	Taxes, less subsidies on products	Total supply at purchasers' prices	Sfottish share of Sfottish supply	RUK share of supply
	(£m)	RUK	RoW	Apparent -ve	(£m)	(£m)	Apparent -ve	(£m)	(£m)	(£m)	Apparent -ve	
1 Agriculture	2 600.8	640.0	213.6	1 747.3	559.0	472.4	2 778.6	314.3	-224.6	3 721.9	63%	14%
2.1 Forestry planting	83.4	0.9	0.0	82.5	-	-	82.5	8.8	-0.0	92.2	100%	0%
2.2 Forestry harvesting	105.0	78.4	8.9	17.7	8.5	11.0	37.3	13.4	-4.6	133.4	47%	12%
3.1 Sea fishing	294.3	142.2	179.2	-27.1	6.6	27.3	6.7	40.1	0.3	368.6	-403%	8%
3.2 Fish farming	297.7	184.0	107.1	6.6	3.9	4.2	14.7	39.3	0.0	345.1	45%	6%
4 Coal extraction etc	174.4	26.2	0.2	148.0	48.1	12.4	208.5	20.9	0.9	256.8	71%	17%
5 Oil & gas extraction	2 559.4	855.0	316.6	1 387.8	953.7	13.1	2 354.7	-	0.2	3 526.5	59%	29%
6 Metal ores extraction	0.1	0.0	0.1	-0.0	0.5	17.2	17.7	3.9	0.3	22.1	0%	1%
7 Other mining & quarrying	431.0	208.2	61.5	161.4	119.6	57.4	338.3	62.0	31.0	701.1	48%	21%
8 Meat processing	934.6	581.1	52.1	301.4	475.9	426.0	1 203.4	460.6	1.2	2 298.4	25%	19%
9 Fish & fruit processing	987.8	649.2	248.4	90.2	498.0	212.3	800.4	239.7	19.7	1 957.5	11%	28%
10 Oils & fats processing	15.8	12.3	3.4	0.1	67.1	57.5	124.7	40.8	0.4	181.6	0%	23%
11 Dairy products	563.4	322.5	43.6	197.3	340.6	127.6	665.6	315.7	10.0	1 357.3	30%	23%
12 Grain milling & starch	88.8	68.1	8.6	12.1	265.8	99.7	377.7	69.0	0.3	523.6	3%	33%
13 Animal feed stuffs	314.6	124.5	19.2	171.0	235.2	82.5	488.6	72.0	19.0	723.3	35%	27%
14 Bread, biscuits etc	751.4	637.4	119.9	-5.9	516.0	157.8	667.9	103.7	0.0	1 528.9	-1%	36%
15 Sugar	0.1	-	-	0.1	104.6	0.8	105.5	31.1	0.8	137.4	0%	43%
16 Confectionery	75.3	69.5	3.6	2.2	303.0	75.8	381.0	246.6	75.4	776.1	1%	30%
17 Other food products	241.6	212.7	35.6	-6.8	375.4	109.4	478.1	126.7	0.3	853.4	-1%	34%
18.1 Spirits & wines, etc	2 084.5	928.9	1 928.3	-772.7	194.3	306.9	-271.5	1 046.6	575.7	4 208.0	285%	15%
18.2 Beer brewing	233.7	300.0	78.6	-144.9	62.5	76.4	-6.0	233.1	301.7	907.5	2417%	17%
19 Soft drinks	337.9	172.0	1.2	164.7	130.9	54.4	350.0	121.3	62.1	706.6	47%	37%
20 Tobacco	-	-	-	-	391.5	173.8	565.3	208.1	1 214.6	1 988.0	0%	69%
21 Textile fibres	67.8	61.5	17.8	-11.5	64.5	41.9	94.8	61.5	2.1	237.8	-12%	68%
22 Textile weaving	90.5	56.2	44.8	-10.5	59.6	47.3	96.4	35.5	2.4	235.3	-11%	62%
23 Textile finishing	90.4	41.2	69.9	-20.6	22.2	8.1	9.7	27.3	1.0	149.0	-213%	229%
24 Made-up textiles	175.4	61.1	37.7	76.5	151.2	50.6	278.3	303.5	83.3	764.0	27%	54%
25 Carpets & rugs	22.8	18.5	5.2	-0.9	118.9	35.6	153.6	188.7	46.5	412.4	-1%	77%
26 Other textiles	116.7	58.9	56.3	1.5	32.4	28.4	62.3	44.0	5.3	226.7	2%	52%
27 Knitted goods	153.7	96.0	52.3	5.3	165.0	163.1	333.4	53.9	47.1	582.8	2%	49%
28 Wearing apparel & fur products	138.5	111.3	27.2	0.1	932.4	665.4	1 597.9	1 481.3	371.8	3 589.4	0%	58%
29 Leather goods	74.7	21.3	49.7	3.6	25.1	55.7	84.4	65.5	16.3	237.2	4%	30%
30 Footwear	11.5	6.0	0.2	5.3	244.4	178.5	428.2	320.6	88.7	843.6	1%	57%
31 Wood & wood products	823.9	450.1	65.3	308.5	250.5	143.4	702.5	31.9	18.7	1 268.5	44%	36%
32 Pulp, paper & paperboard	776.0	466.0	309.8	0.2	172.7	190.0	362.9	79.8	5.4	1 223.9	0%	48%
33 Paper & paperboard products	360.6	215.6	34.9	110.1	559.0	226.7	895.8	367.5	76.0	1 589.8	12%	62%
34 Printing & publishing	1 238.7	534.5	90.0	614.2	1 233.8	273.7	2 121.7	516.8	147.0	3 410.0	29%	58%
35 Coke, refined petroleum & nuclear fuel	1 964.6	608.6	305.3	1 050.7	616.3	483.2	2 150.2	176.2	2 234.2	5 474.5	49%	29%
36 Industrial gases & dyes	175.9	55.3	122.2	-1.6	79.7	41.1	119.2	44.8	2.7	344.1	-1%	67%
37 Inorganic chemicals	20.9	8.3	21.2	-8.6	122.0	30.8	144.2	58.9	1.4	234.0	-6%	85%
38 Organic chemicals	740.2	243.9	308.4	187.9	275.3	181.0	644.1	120.5	2.2	1 319.2	29%	43%
39 Fertilisers	25.7	5.5	0.3	19.9	83.8	26.1	129.8	35.1	4.0	174.6	15%	65%
40 Synthetic resins	597.6	204.7	317.0	75.9	163.8	172.8	412.5	73.4	1.6	1 009.1	18%	40%
41 Pesticides	10.7	3.8	1.7	5.2	61.9	10.4	77.4	7.6	2.3	92.8	7%	80%
42 Paints, varnishes, printing ink etc	55.5	36.5	18.4	0.6	131.6	55.9	188.1	87.4	18.5	348.9	0%	70%
43 Pharmaceuticals	533.3	249.1	234.3	49.9	396.7	184.4	631.0	282.1	36.8	1 433.2	8%	63%
44 Soap & toilet preparations	131.4	92.3	39.1	0.0	577.4	17.4	594.9	489.6	149.7	1 365.6	0%	97%
45 Other chemical products	295.6	89.1	217.3	-10.8	154.0	120.2	263.4	51.9	29.3	651.0	-4%	58%
46 Man-made fibres	14.4	3.3	10.8	0.4	13.4	5.4	19.2	2.2	0.1	35.6	2%	69%
47 Rubber products	381.1	176.0	156.7	48.5	187.4	39.0	274.9	46.2	20.7	674.5	18%	68%
48 Plastic products	678.5	308.9	232.4	137.2	659.4	311.8	1 108.5	106.4	40.4	1 796.5	12%	59%
49 Glass & glass products	237.4	114.8	38.5	84.1	169.9	87.6	341.6	91.0	15.3	601.1	25%	50%
50 Ceramic goods	85.5	23.0	53.2	9.2	68.4	58.4	136.0	56.8	18.6	287.6	7%	50%
51 Structural clay products	26.2	13.1	0.6	12.5	55.7	0.5	68.7	31.5	0.5	114.3	18%	81%
52 Cement, lime & plaster	57.2	13.3	2.2	41.7	45.3	21.0	108.0	46.8	4.7	175.0	39%	42%
53 Articles of concrete etc	318.7	49.8	26.4	242.5	127.7	39.5	409.7	30.6	7.7	524.2	59%	31%
54 Iron & steel	270.2	212.6	44.0	13.6	347.8	202.0	563.5	121.5	0.9	942.5	2%	62%
55 Non-ferrous metals	146.3	88.8	70.3	-12.8	130.4	134.1	251.7	52.4	2.1	465.2	-5%	52%
56 Metal castings	42.0	37.1	2.9	2.0	60.3	33.6	95.9	13.2	0.1	149.2	2%	63%
57 Structural metal products	617.6	284.3	133.3	199.9	202.7	82.7	485.3	56.1	5.7	964.7	41%	42%
58 Metal containers, etc	166.8	157.4	20.5	-11.0	152.0	43.0	184.0	39.0	3.3	404.1	-6%	83%
59 Metal forging, pressing etc	670.9	417.3	227.4	26.3	260.1	178.9	465.3	80.1	0.5	1 190.5	6%	56%
60 Cutlery, tools etc	37.2	7.9	1.4	27.9	215.7	69.3	313.0	106.5	24.5	453.3	9%	69%
61 Other metal products	271.0	167.1	41.5	62.4	370.4	108.3	541.1	107.7	21.0	878.3	12%	68%
62 Mech. power equipment	750.2	354.4	398.6	-2.9	294.2	185.5	476.8	55.8	13.6	1 299.2	-1%	62%
63 General purpose machinery	607.6	221.1	242.8	143.7	503.3	191.8	838.8	30.4	15.3	1 348.4	17%	60%
64 Agricultural machinery	50.3	26.4	3.3	20.5	55.8	63.0	139.3	20.4	1.5	190.9	15%	40%
65 Machine tools	31.9	11.8	10.8	9.3	104.7	7.5	121.5	13.0	3.1	160.3	8%	86%
66 Special purpose machinery	499.3	245.9	289.9	-36.5	215.6	94.7	273.9	83.6	2.7	896.0	-13%	79%
67 Weapons & ammunition	32.7	3.9	2.6	26.2	100.7	124.2	251.1	0.2	38.2	296.1	10%	40%
68 Domestic appliances nec	60.0	43.8	16.9	-0.7	336.3	157.0	492.7	324.4	107.4	985.2	0%	68%
69 Office machinery & computers	1 756.8	697.8	1 097.9	-38.9	713.8	578.3	1 253.2	249.5	133.9	3 432.3	-3%	57%
70 Electric motors & generators etc	350.1	192.7	160.6	-3.2	327.4	143.4	467.7	60.0	10.9	891.9	-1%	70%
71 Insulated wire & cable	69.9	27.7	34.8	7.4	32.8	65.5	105.8	30.7	2.3	201.2	7%	31%
72 Electrical equipment nec	186.8	86.9	124.7	-24.8	268.9	208.3	452.4	146.6	19.6	830.2	-5%	59%
73 Electronic components	691.6	174.2	489.0	28.3	261.5	517.1	807.0	294.5	8.3	1 772.9	4%	32%
74 Transmitters for TV, radio & phone	103.1	30.6	34.3	38.2	365.3	126.8	530.3	27.7	14.7	637.7	7%	69%
75 Receivers for TV & radio	359.9	127.4	255.0	-22.5	350.9	364.3	692.7	521.4	116.3	1 712.8	-3%	51%
76 Medical & precision instruments	1 158.5	691.1	495.5	-28.1	519.8	468.1	959.8	217.2	109.7	2 473.3	-3%	54%
77 Motor vehicles	311.3	292.8	51.5	-33.0	1 456.9	1 581.5	3 005.5	819.2	215.9	4 384.8	-1%	48%
78 Shipbuilding & repair	592.0	347.3	76.1	168.6	194.4	12.1	375.2	22.9	22.2	843.7	45%	52%
79 Other transport equipment	126.3	61.9	5.2	59.2	109.3	46.3	214.7	106.2	32.5	420.6	28%	51%
80 Aircraft & spacecraft	956.3	297.2	500.0	159.1	302.9	552.2	1 014.1	5.2	46.0	1 862.5	16%	30%
81 Furniture	305.7	116.2	6.3	183.1	624.4	194.9	1 002.4	312.4	145.7	1 583.0	18%	62%
82 Jewellery & related products	35.1	12.4	-	22.7	146.0	48.2	216.9	224.9	60.4	514.7	10%	67%
83 Sports goods & toys	43.7	23.8	14.7	5.2	359.8	145.6	510.6	799.6	184.8	1 533.5	1%	70%
84 Misc. manufacturing nec, recycling	262.3	181.9	90.6	-10.3	188.7	87.2	265.6	210.1	52.2	800.5	-4%	71%
85 Electricity production & distribution	5 087.0	1 657.7	35.0	3 394.2	318.4	34.4	3 747.0	-	271.3	5 711.1	91%	8%
86 Gas distribution	1 191.9	68.6	8.1	1 115.2	420.9	1.6	1 537.6	-	31.0	1 645.4	73%	27%
87 Water supply	433.3	-	-	433.3	0.5	0.7	434.4	-	-0.8	433.7	100%	0%
88 Construction	12 330.8	1 332.8	95.7	10 902.3	1 062.6	15.2	11 980.2	-	704.9	14 113.6	91%	9%
89 Motor vehicle distribution & repair, etc	2 196.1	69.3	-	2 126.7	401.6	89.8	2 618.1	-1 109.3	150.4	1 728.5	81%	15%
90 Wholesale distribution	6 561.8	1.7	0.3	6 559.8	-	-	6 559.8	-6 559.8	-	2.0	100%	0%
91 Retail distribution	6 934.2	98.3	9.4	6 826.5	30.4	29.2	6 886.0	-6 705.7	20.4	308.5	99%	0%
92 Hotels, catering & pubs etc	5 004.5	404.8	85.9	4 513.8	1 611.1	1 257.4	7 382.3	-12.1	956.6	8 817.5	61%	22%
93 Railway transport	778.2	48.0	-	730.1	150.7	85.4	966.2	-	-229.7	784.5	76%	16%
94 Other land transport	2 801.9	516.9	85.9	2 199.0	432.0	177.0	2 808.0	-	-14.5	3 396.3	78%	15%
95 Water transport	238.0	50.9	48.7	138.3	99.2	141.9	379.3	-	-2.7	476.3	36%	26%
96 Air transport	772.7	389.2	101.4	282.1	488.3	606.2	1 376.5	-	77.5	1 944.7	20%	35%
97 Ancillary transport services	4 066.1	877.3	182.7	3 006.1	692.6	130.9	3 829.6	-	46.8	4 936.4	78%	18%
98 Postal & courier services	856.9	46.2	1.6	809.1	332.6	31.4	1 173.2	-	36.7	1 257.7	69%	28%
99 Telecommunications	2 596.8	156.5	81.5	2 358.9	399.4	73.3	2 831.6	-	277.8	3 347.2	83%	14%
100 Banking & finance	7 603.0	2 490.7	836.2	4 276.1	433.6	189.6	4 899.4	-	2.0	8 228.3	87%	9%
101 Insurance & pension funds	6 115.3	2 559.0	67.0	3 489.3	944.2	123.5	4 556.9	-	350.4	7 533.3	77%	21%
102 Auxiliary financial services	1 248.9	291.3	170.8	786.9	168.1	72.7	1 027.6	-	56.1	1 545.8	77%	16%
103 Owning & dealing in real estate	3 321.1	486.4	16.3	2 818.3	282.4	4.6	3 105.3	-	83.9	3 691.9	91%	9%
104 Letting of dwellings	7 196.6	440.9	35.6	6 720.1	-	-	6 720.1	-	-16.1	7 180.5	100%	0%
105 Estate agent activities	369.1	35.9	6.2	326.9	55.2	48.6	430.8	-	9.9	482.8	76%	13%
106 Renting of machinery	1 457.8	91.5	95.4	1 270.9	572.3	139.0	1 982.3	-	52.1	2 221.3	64%	29%
107 Computing services	2 526.3	624.1	286.3	1 616.0	596.1	416.4	2 628.5	-	178.0	3 716.8	61%	23%
108 Research & development	541.9	73.8	174.9	293.2	88.6	52.8	434.6	-	19.1	702.3	67%	20%
109 Legal activities	1 232.9	86.1	39.8	1 106.9	255.2	81.1	1 443.2	-	74.9	1 644.1	77%	18%
110 Accountancy services	581.8	40.0	26.8	515.0	196.0	24.2	735.2	-	34.9	836.9	70%	27%
111 Market research	1 473.5	266.6	124.3	1 082.7	324.1	94.3	1 501.1	-	61.2	1 953.2	72%	22%
112 Architectural activities etc	3 118.5	750.9	327.0	2 040.6	335.3	132.5	2 508.3	-	63.1	3 649.4	81%	13%
113 Advertising	956.5	36.2	12.5	907.8	387.2	66.0	1 361.0	-	58.3	1 468.0	67%	28%
114 Other business services	6 873.0	2 224.1	280.5	4 368.4	1 291.5	377.3	6 037.3	-	224.0	8 765.8	72%	21%
115 Public administration	13 172.7	-	-	13 172.7	20.5	2.1	13 195.3	-	-	13 195.3	100%	0%
116 Education	7 050.6	381.8	126.8	6 542.0	91.6	57.3	6 690.9	-	37.6	7 237.0	98%	1%
117 Health & veterinary services	8 127.3	265.7	1.1	7 860.5	162.0	108.2	8 130.7	-	20.9	8 418.2	97%	2%
118 Social work activities	2 882.5	-	-	2 882.5	17.5	9.7	2 909.7	-	55.3	2 965.0	99%	1%
119 Sewage & sanitary services	1 330.4	35.9	1.2	1 293.3	37.6	21.2	1 352.0	-	108.8	1 497.9	96%	3%
120 Membership organisations nec	407.3	-	-	407.3	8.4	30.1	445.8	-	4.2	449.9	91%	2%
121 Recreational services	5 029.7	1 611.9	140.4	3 277.4	783.6	539.9	4 601.0	-	535.5	6 888.7	71%	17%
122 Other service activities	1 001.0	214.9	13.4	772.7	278.8	48.9	1 100.4	-	51.8	1 380.4	70%	25%
123 Private households with employed persons	258.8	-	-	258.8	-	-	258.8	-	-	258.8	100%	0%
				-								
Total	**170 956.6**	**35 078.2**	**14 857.7**	**121 020.7**	**37 024.8**	**18 700.7**	**176 746.2**	**-0.0**	**11 393.9**	**238 076.0**	**68%**	**21%**

Source: Scottish Input Output Tables, Scottish Government.

Highlighted negative numbers are anomalies which arise because it is not possible, from published information, to apply completely uniform price conventions to every column.

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