Written evidence commissioned by the Committee from Dr William Blyth, Oxford Energy Associates

Acknowledgements

This report has benefited from inputs and suggestions from a number of colleagues, and the author would like to thank in particular Antony Froggatt, Doug Koplow, Richard Tol, Morgan Bazilian, and Ulrik Stridbaek. Any outstanding errors and omissions remain the author's.

CONTENTS

Energy Subsidies in the UK

1 Background

This report provides an overview of energy subsidies in the UK, starting with an overview of the basic economics, then identifying the scale of subsidies in the UK, and finally comparing the UK position with other countries.

The scope of the report is limited to a review of published sources, and it is not possible to say that such an approach captures all subsidies. Although a considerable amount of information has been published, such efforts nevertheless feel somewhat piecemeal. Some subsidies are hidden and hard to quantify, so the figures identified here probably represent a lower limit. For example, cross-subsidies relating to payments for electricity system balancing and maintaining security of supply in the face of risks of unexpected outages for different plant would ideally be included, but they are notoriously difficult to quantify and allocate, and are beyond the scope of this report. In other cases, the definition of subsidies is very dependent on the particulars of a country's tax base, making international comparisons difficult.

Ideally, a thorough study on energy subsidies would track, for each branch of the energy system, total income arising through energy taxes, and net off all public payments made for infrastructure, services (including regulatory functions, system balancing etc.) as well as the direct subsidies provided through price support mechanisms.

At an economy-wide level, simple generic comparisons can be made on this basis. Tax revenues from energy in the UK amount to around £28bn annually, the vast majority (97%) of which comes from road fuel taxes. Tax income for transport of around £27bn considerably outweighs the total government transport budget of around £20bn[1]. Road transport fuel has long been used to provide net revenues to treasury.

Outside of the transport sector, the other energy sectors on the other hand are much more lightly taxed (as shown in Figure 5). The consumer tax base for energy products in the UK generates revenues (excluding VAT and carbon taxes) of around £1bn (Figure 5). This compares with subsidies identified in this report totalling around £10bn, which is around 0.8% of the market value of energy (~£120bn excluding road transport fuel). Even considering that this is a lower bound estimate, in aggregate, energy subsidies and taxes are therefore rather low compared to market value. Nevertheless, they form an important part of the revenue stream for many different types of energy investment, and for this reason, subsidies have an important strategic influence on the development and choice of energy technology used in the UK.

1.1 Subsidies from first principles

Subsidies have become synonymous with bad economic practice because of the distortionary effects they have on producer and consumer behaviour. This leads to a

[1] http://www.ukpublicspending.co.uk

working assumption in policy-making that subsidies generally reduce economic efficiency, and that removal of subsidies should therefore lead to an overall welfare gain, albeit with winners and losers along the way. The creation of winners and losers means that there are often strong interests on all sides about the appropriateness and scale of different types of subsidy.

This section attempts to take out some of the heat and inject some light into the debate by exploring the underpinnings of these basic assumptions in more detail in order to clarify the theoretical basis from which different points of view are argued. It will be shown that there are indeed unresolved theoretical issues over which reasonable people might reasonably disagree. Energy subsidies are part of a country's adaptation to uncertain and dynamic futures, and decisions will need to be based as much on political judgment as on 'hard' economic evidence.

1.1.1 Perfect markets as a benchmark for assessing subsidies

Subsidies are usually measured in terms of the deviation they create in terms of the prices and quantities of goods exchanged from the 'ideal' equilibrium market price. In order to understand why, it is worth revisiting some basic economic principles.

Arguments in favour of free markets usually proceeds along two different routes (Sander 2009). The first is the libertarian defence of the principle of free markets which argues that letting people engage in voluntary exchanges respects their freedom. As Amartya Sen compellingly points out in his review of the role of markets in economic development, "To be *generically against* markets would be almost as odd as being generically against conversations between people…"(Sen 2001). Sen's argument is that free exchange between people is part of the natural order of the human experience, and therefore in general is a desirable mechanism to promote, although he recognises that there are many instances where the power balance between people is such that exchange is not truly free, and protections need to be put in place.

The second main defence of free markets is made in terms of economic efficiency. In 1906, Vilfredo Pareto showed that social welfare is maximised by an allocation of resources that meets with unanimous approval. A Pareto efficient allocation means that it is impossible to reassign resources so as to make any individual better off without making at least one other individual worse off. (Arrow and Debreu 1954) then showed that a competitive market economy would lead to an equilibrium position which would satisfy this condition of optimal social welfare (the so-called first fundamental theorem of welfare economics). The Arrow-Debreu proof requires perfect and complete markets in all transactions in order for the optimal equilibrium position to be reached.

Pareto efficiency does not however guarantee political desirability. There are many different possible equilibrium positions in which individuals are allocated a different level of initial wealth, but which could still be considered overall welfare maximising. This leads to the second fundamental theorem of welfare economics, which states that any of these efficient equilibrium solutions can be achieved by a perfect market as long as it is accompanied by a (politically decided) lump-sum redistribution of resources.

This is the basis of the rather convenient general claim of economics to be able to separate issues of efficiency (i.e. maximising overall social welfare, the typical domain of economists) from issues of equity (i.e. the distribution of wealth, the typical domain of politicians).

Based on the idea that perfect markets achieve maximum social welfare, it then follows simply that any distortion of these markets (including taxes, subsidies etc.) must therefore reduce social welfare, incurring an overall cost to society. This viewpoint reaches its peak in the Chicago school and the economic outlook of Milton Friedman. The rationale for these beliefs rests on the assertion that the real world comes sufficiently close to the idealised world enshrined in the first fundamental theorem that its tenets can be applied to real-world policy making. Whilst most economists would recognise that although the markets may not be optimally efficient, government interventions are not either, and politicised interventions will often have unintended consequences, making unambiguous social welfare improvements difficult to achieve. However, as we will see in the next section, there are opponents of this school who question the applicability of the two fundamental theorems to the real world.

1.1.2 Critique of perfect market assumptions

The history of the two fundamental theorems of welfare economics is not as solid as one might suppose (Blaug 2007). The assumption of perfect market conditions is a severe constraint on the applicability of the first theorem. Meanwhile the applicability of the second theorem is severely limited by the fact that it is practically impossible to achieve perfect lump-sum transfers that do not influence marginal behaviour of producers and consumers (calling into question the ability to separate issues of efficiency and equity).

In quantitative terms, the most significant challenge to the perfect market view is given by the general theory of second best (Lipsey and Lancaster 1956). This shows that although social welfare is maximised under perfect market conditions, if there are some market imperfections already in the system that cannot be addressed, there is no guarantee that 'correcting' other market imperfections will necessarily improve efficiency or welfare. Lipsey demonstrates with a simple example of a market with three commodities. It is assumed that one commodity has a tax imposed that cannot be removed, and a second commodity has no tax imposed. The socially optimal tax on the third commodity ranges from positive (tax), zero, or negative (subsidy) depending on the degree to which the commodities act as substitutes or complements[2] for each other.

The general theory of second best does not contradict the first fundamental theorem of welfare economics, but it does potentially limit the latter's applicability to real-world policy decisions, depending on one's view of the degree to which market imperfections in the real world prevail. Many economic theorists and practitioners still work on the assumption that the perfect market assumption is *good enough* that the first fundamental theorem still applies to real-world situations.

However, there are also many reasons to suppose that market imperfections are ubiquitous in the real world, and that assumptions of general equilibrium may be a poor guide to policy

[2] Substitutes can be used in place of each other, whereas complements require the other commodity to be in place before it can be consumed.

decisions. As Lipsey noted in a later paper (Lipsey 2007), many real-world sources of economic imperfection prevail which are not created by policy:

1. Markets are rarely competitive enough to make prices equal to marginal costs. Pricing is often influenced by other factors such as economies of scale, barriers to entry of new firms, and product differentiation (e.g. brand value).

2. When products are differentiated, fixed costs such as establishing distribution networks, product development costs and marketing costs create non-convexities that break the requirement of general equilibrium.

3. There are many cases of missing markets, where commodity exchanges required to achieve general equilibrium are not available, and many markets (e.g. labour markets) often deviate from perfect market assumptions due to incomplete and asymmetric information.

4. Externalities (both positive and negative) are associated with many economic activities, and it is often hard to create compensating market mechanisms to internalise these costs or benefits.

In addition to these 'static' market imperfections, there is also the question of how economies should respond to dynamically changing and uncertain future conditions. Equilibrium economics assumes that conditions can be optimised in terms of economic efficiency given knowledge of all current and future states of the input variables. In practice, the future is uncertain, and firms undertake innovation activities in order to adapt to these uncertain changes.

It has been argued (Blaug 2007) that even if one were to take the first fundamental theorem as a valid guideline for achieving static efficiency, there is no theoretical basis to suppose that achieving static efficiency will guarantee achievement of dynamic efficiency. Whilst competitive pressures can no-doubt help to channel such innovation in socially useful ways, the conditions for innovation to respond to dynamic and uncertain futures are generally far from those usually considered under static equilibrium. Indeed, Schumpeter's conception of 'creative destruction' (Schumpeter 1942) is a determinedly non-equilibrium view of how competition leads to dynamic progress. Indeed, a branch of operations research (Abernathy 1979, Adler, Benner et al. 2009) has grown up around a micro-economics view of how this might play out at the firm level. This suggests that firms may experience a tension between aiming for static efficiency (optimising processes based on historical learning about what has worked in the past), vs. a focus on learning and innovation to respond to new challenges in the future.

1.1.3 Consequences for policy decision-making on subsidies

The upshot of the theoretical literature is not that markets are an inappropriate model. On the contrary, in Lipsey's (2007) words there is a "long line of appreciative theorising running from Adam Smith to Milton Friedman and Thomas Schelling and many others…" behind the key propositions that:

> *"1) the market system coordinates economic activity better than any known alternative – not optimally, just better, and 2) markets do this* relatively *efficiently by*

producing prices that are influenced (but not solely determined) by relative scarcities"

In other words, the market model still provides a very important benchmark, but this should not be used as the basis for a dogmatic rejection of interventions that seek either to redress some of the more obvious failings, or to help build in robustness to dynamic pressures. Lipsey recommends basing "advice on a combination of formal models, appreciative theorising, empirical knowledge, and a large dose of judgement".

In the case of energy subsidies, arguments in favour of some intervention include:

1. **Infant industries**. In cases where new technologies are being introduced which are not yet competitive with mainstream technologies, but could be expected to be so in the future, there is a dynamic efficiency argument for creating protected niche markets to allow these to develop appropriate economies of scale and learning by doing cost reductions in the supply chains for these industries. These arguments are typically used in connection with subsidies for renewable energy, and to some extent are again being invoked in the case of third generation nuclear energy. In practice, infant industry arguments are often used inappropriately as a lobbying tool by industry players who wish to carve out a specific subsidy that will benefit them. In general, the infant industry argument can only be justified for a certain length of time before those industries should be expected to stand on their own feet. In the long run, subsidy-dependence is likely to breed inefficiency and lack of competitiveness.

2. **Pro-poor policies.** Some sections of society may simply be too poor to access the supposedly 'free' market, or they may not be able to afford sufficient fuel to maintain a basic level of energy services. In these circumstances, subsidies are often introduced to reduce prices for reasons of equity and to promote overall economic development or standards of living across the whole population. Such subsidies are perhaps the most prevalent stated reason for subsidies on fossil fuels at the global level. On the other hand, there is evidence that many of these subsidies are not well targeted towards poorer consumers, but actually create proportionally higher benefits for richer sections of society.

3. **Protection from foreign competition.** Subsidies to protect domestic industry from foreign competition have been rife throughout the history of economic development, but are coming increasingly under control as a result of free trade agreements such as WTO and the EU single market. Nevertheless, protection of jobs is still an important political driver for subsidies in contexts where there is a perception that foreign competitors in some way have an unfair advantage. This is particularly relevant in dynamic contexts (such as emerging economies are experiencing) or where such subsidies are taken as a precaution against explicit anti-competitive behaviour by external trade partners. However, in a long-run equilibrium context, such domestic subsidies will tend to lead to higher domestic prices for the protected goods, leading to inefficiencies that leave the country worse of in terms of jobs and the economy.

The common factor behind all these arguments for subsidies is that they are very context-specific, and they usually relate to a situation that is temporary or dynamic by nature. Whilst the general theory of second best suggests that it is difficult, or perhaps even impossible to judge what exact conditions are required to achieve a social optimum in terms of static efficiency across the whole economy, there are grounds for considering positive interventions based on more parochial considerations of costs and benefits in relation to potential 'corrections' of dynamic effects in the particular sector being considered.

In general, subsidies introduced to address these temporary conditions should therefore be designed with a sunset clause. This allows them to be phased out in line with the timescale over which the dynamic effects are expected to be addressed in order to avoid fostering inefficient subsidy-dependence. though there are many examples of provisions with sunsets being continually extended, and legacy subsidies that do not get debated. Super-majorities for overturning sunset clauses is one way around this. If the factors that the subsidies are intended to correct for are not expected to be temporary by nature, then subsidies are unlikely to be a suitable response. For example, if a foreign supply of cheap energy becomes available (and is expected to remain available over a long period of time), then it is likely to be more efficient for a country to adapt to this new situation rather than trying to protect domestic sources for long periods of time. Clearly however, adaptation also raises its own set of costs that need to be factored into this consideration.

1.1.4 Source of economic inefficiencies of subsidies

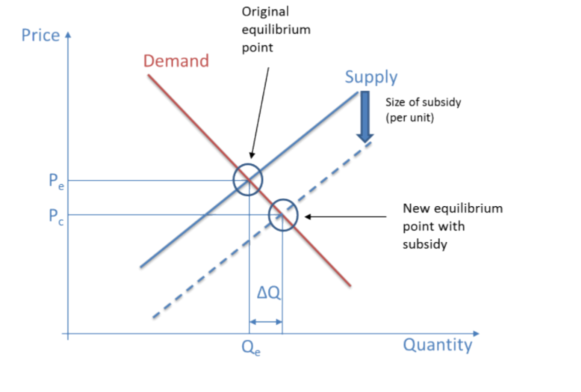
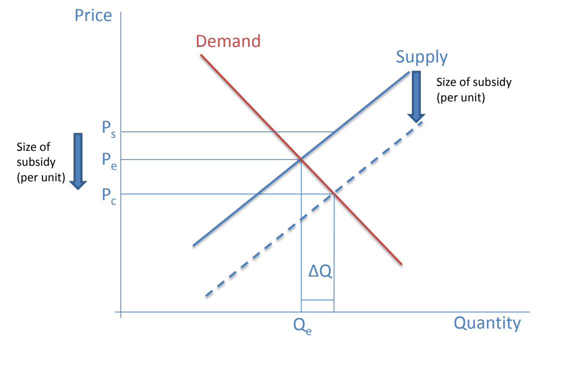
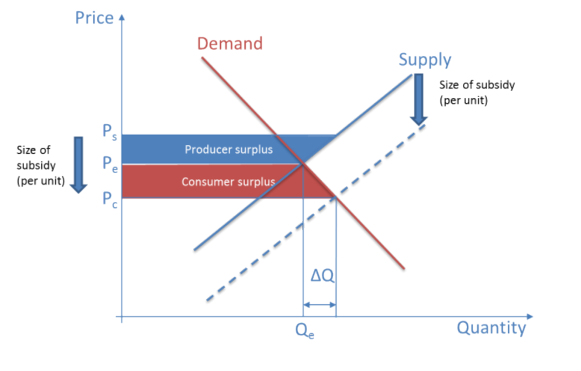
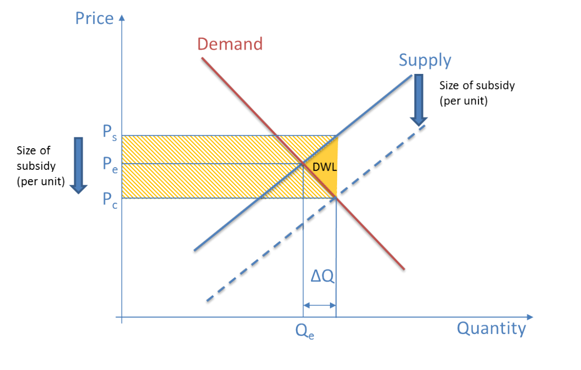
Putting aside for the moment concerns raised by the general theory of second best, it is useful to review the theoretical basis for how subsidies introduce economic inefficiency and loss compared to a perfect market context, because this often provides the basis for most major studies of energy subsidies.

In order to calculate the total economic cost of a subsidy, the cost to government of paying the subsidy needs to be weighed against the economic benefits that accrue to producers and consumers. This is illustrated in **Figure 1**. The effect of a subsidy is not only to change prices, but also the quantity of goods exchanged. This is because of the elasticity of demand, whereby consumers will tend to increase demand if prices reduce. Subsidies paid to a producer will in general alter market prices leading to benefits to both consumers and producers, although the total costs of the subsidy outweigh these total economic benefits. Based on the area of the triangle DWL in the final diagram, the total economic loss (or deadweight loss DWL) is approximately ½ΔQS where S is the size of the per unit subsidy. The size of the overall economic loss is therefore strongly dependent on the slope (elasticity) of the demand curve.

It should be noted that very similar considerations apply to taxes (since subsidies are effectively just a negative tax). Taxes also result in a deadweight loss to the economy (although an exception is where fees termed as "taxes" are really user fees to recover the government cost of goods or services linked to a specific fuel: the absence of such fees would actually constitute a subsidy). In principle, subsidies are no more inefficient than taxes, except insofar as they need to be funded, and may therefore have budget implications for overall tax burden.

This simple graphical representation needs to be treated with care, as it assumes that the initial equilibrium point is somehow optimal. In practice, there may be various externalities that are not included in such a representation. For example, in considering the quantity of fuel purchased in the context of fuel poverty, the free market equilibrium point may well represent a sub-optimal consumption level, leading for example to health problems for elderly consumers not able to heat their houses sufficiently in winter. In such cases, the optimal level of consumption may indeed be higher than the simple crossing point of supply and demand curves would indicate. This is not to say that subsidising energy (especially for all consumers) is necessarily the most appropriate measure to take, only to point out that simple analyses of equilibrium points in the market need to be considered carefully to see what may be missing.

Figure 1 Subsidies alter both prices and quantities leading to deadweight loss

1. In a 'free' market, supply and demand balance at an equilibrium price P_e and quantity Q_e the crossing point of the supply and demand curves. 2. If a subsidy is given to suppliers, they are willing to supply any given quantity at a lower price, since they will recoup the production costs via the subsidy. This leads to a downward shift in the supply curve indicated by the dashed line. 3. Supply and demand now reach a new equilibrium at a lower price to the consumer P_c who as a result will tend to consume a greater amount of the good increasing the quantity by ΔQ.	
4. The supplier receives price P_s which is the price the consumer pays (P_c) plus the size of the subsidy. 5. Both consumers and suppliers therefore benefit from the subsidy, since the consumers pay a lower price, whilst the suppliers receive an increased price.	
6. The total benefit (£) to consumers of the lower price is the change in price (£/unit) multiplied by the quantity (number of units). This is the consumer surplus shaded in red. Likewise, the benefit to producers is the producer surplus shaded in blue. 7. In theory, the benefit of the subsidy is always shared between producers and consumers, irrespective of who the subsidy is paid to.	
8. The total cost of the subsidy to government is the size of the subsidy multiplied by the total quantity of the good supplied (yellow rectangle). 9. The yellow rectangle is larger than the producer and consumer surpluses. This means that the cost to government is higher than the overall economic benefits. The difference is the triangle marked DWL known as deadweight loss. This measures the overall efficiency losses arising from subsidies in comparison with the 'free' market equilibrium.	

1.1.5 Types of subsidy

Subsidies can come in many different forms. Direct subsidies are the easiest to measure as they usually provide some form of direct payment either to the producer or consumer of a particular good in order to influence the price and / or quantity of goods exchanged.

Examples of direct energy subsidies include feed-in tariffs for renewable energy, where additional payments are made to suppliers over-and-above the payments they receive from consumers for the electricity provided. Another example is where governments set energy prices for consumers below the cost of supply, usually implying the need to compensate producers for associated losses through some other budgetary mechanism. This is the source of the majority of energy subsidies measured in non-OECD countries.

However, the net can be cast much more widely than these direct subsidies. What constitutes an economic approach to defining a subsidy is itself the subject of much debate among economists and those responsible for measuring subsidies. As noted by (Donohue 2008),

> *"Broadly speaking, subsidies can be seen in one of two ways: subsidies are given by governments or subsidies are given by society. Almost all subsidy definitions available in the literature could be seen as generally conforming to one of these perspectives on subsidies. … An economic approach might be to define subsidies as transfers that distort the allocation of economic resources which would be a society-wide approach to defining subsidies. A more government-oriented approach might be to define subsidies simply as financial payments from governments to firms or consumers. … The distinction between subsidies derived from government action, versus social subsidies, is profound, and includes many possibilities for refinement."*

Because of its remit, the definition of subsidies used in the WTO is fairly focused on the more direct government-oriented approach. Article 1 of the WTO's Agreement on Subsidies and Countervailing Measures defines a subsidy as involving a financial contribution by a government or any public body within the territory of a Member … or price support in the sense of Article XVI of GATT 1994 that confers a benefit. Among the financial contributions covered by the definition are:

i. direct transfers of funds (e.g. grants, loans, and equity infusion), potential direct transfers of funds or liabilities (e.g. loan guarantees);
ii. the foregoing or non-collection of government revenue that would otherwise be due (e.g. fiscal incentives such as tax credits); and
iii. goods or services (other than general infrastructure) provided by a government in kind, or goods purchased from companies in a way that confers a benefit to that company (e.g., by paying a price that is higher than the market price).

The definition also covers situations in which a government makes payments to a funding mechanism, or entrusts or directs a private body to carry out one or more of the type of functions illustrated in (i) to (iii) above which would normally be vested in the government and the practice, in no real sense, differs from practices normally followed by governments.

However, energy economists concerned about the wider set of economic distortions in the energy sector often cast the net wider than this and would also include other types of regulation that influence market prices and quantities. For example, the OECD's definition used in its 'producer support estimate' (PSE) indicator also includes all forms of market price support involving transfers between consumers and producers created as a result of policy such as government interventions on tariffs. The OECD's 'consumer support estimate' (CSE) includes any additional policy-induced transfers that affect consumption. The OECD's framework is discussed in more detail in the following section.

Another issue to consider is the treatment of externalities (i.e. costs which are incurred in other parts of the economy that are not directly party to the transaction between producers and consumers). In the energy sector, the most obvious example includes environmental impacts of energy use. Most local pollutants are coming under a regime of increasingly stringent controls, so that it is reasonable to say that these external costs have largely been internalised.

One of the problems of internalising the climate change externality is the difficulty of estimating the scale of the damage, and therefore identifying a suitable level for the carbon price. Carbon emissions in principle are internalised through the EU-ETS for the sectors covered, although there are concerns that the carbon price is inadequate. The UK government has taken the position that carbon prices ought to follow a trajectory in line with the costs of meeting a long-term carbon reduction trajectory appropriate to staying within a 2 degree warming limit. This has led to a long-term carbon price forecast which was used to inform its carbon price floor which applies to UK emitters covered by the EU-ETS. This guarantees that carbon prices for UK power generators will not fall below a level that the UK deems is a reasonable approximation of the external costs of carbon emissions.

The imposition of carbon prices acts to correct a market failure, so carbon prices should be considered as a correction to suboptimal prevailing market price signal. In that sense, the absence of a carbon price in energy markets constitutes a subsidy since in a market without carbon prices, polluters are not paying their full production costs. Whilst this is the most intellectually robust way to consider externalities, it is clearly politically sensitive, as the attempt by the EU to impose EU-ETS carbon prices on external airlines has shown (despite the rock-bottom carbon prices). Political constraints are largest for commodity producers competing with parties outside of the jurisdiction of the policy. However, potential solutions (e.g., pooling airline carbon fees to finance upgrades within the industry rather than disbursing to national treasuries) may be one way around the conflicts. Multi-lateral agreements would also work in principle, but are struggling to make progress in practice.

A class of subsidy which is alluded to in the WTO definition, but which are difficult to measure is the provision of various forms of guarantee by government on behalf of private companies making investments in the energy sector. These guarantees can take a number of forms, loan guarantees for upfront capital investment, or guarantees associated with long-term liabilities such as nuclear waste or long-term CO_2 storage. In cases where there is partial or full government ownership of the energy companies, such guarantees are implicit, and even harder to measure. Rates of return on capital may be much lower than commercial rates, and difficult to identify in financial reports. Such guarantees transfer risk from private companies to public tax-payers. These risks may or may not materialise as real costs to the economy, but nevertheless, the transfer of risk to the public domain allows companies to borrow at lower costs of capital than would be the case if the risks were fully costed within the boundaries of the loan decision, and should therefore strictly be counted as a subsidy. Methods for quantifying the financial magnitude of such risk transfers are discussed in (Lucas 2010)).

1.2 Methodologies used in major international studies of subsidies

This section reviews some of the different methodologies used to measure subsidies in major international studies.

1.2.1 Price-Gap Approach

The most widely used method to measure subsidies is the 'price-gap' approach, developed in detail by the (IEA 1999) in their landmark publication on energy subsidies. This approach follows the same logic as that portrayed in Figure 1. The first step is to measure the price gap based on the difference between end-use prices to consumers, and a reference price that is taken to be the 'efficient' price that would prevail in the absence of subsidies. The second step is to calculate the impact of the price gap on consumption, based on estimates of the elasticity of demand. This quantity effect is then used (as described previously) to estimate the scale of welfare losses associated with the subsidy.

Conceptually, the price gap approach is straight-forward, but a number of complexities arise in calculating both the consumer and reference prices. As noted in (IEA 1999), methodological issues arising in the calculation of consumer prices include:

- Appropriate currency units (local, international at market rates, international at purchasing power parity)
- Inclusion of energy-specific taxes, fees, levies and surcharges, as well as all rebates and reductions requires detailed data
- Appropriate treatment of general taxes such as VAT
- Accounting for situations where there is a physical constraint to the supply of energy, so that consumption levels are only partially influenced by price

The reference price indicates the opportunity cost of consumption of one unit of energy, its true economic value. It corresponds either to the border price for internationally traded energy products or to the costs of production for non-traded ones, both adjusted for transport and distribution costs. For some energy goods, especially those that are internationally traded, the reference price is fairly easy to identify. Even where these markets vary regionally, there are relatively well-established traded prices in most parts of the world for oil, gas and coal, and the border prices (for both energy exporters and importers) is the relevant reference point against which the prices of domestic energy consumption can be compared. Nevertheless, care is required to take account of all internal transportation costs and to ensure that adjustments are made to account for differences for example in fuel quality between domestic sources and international markets.

Treatment of VAT needs careful handling, since it is often a general part of a country's tax structure, so could be considered a 'normal' cost which should be included in the reference price. This would allow tax exemptions to show up as subsidies in the price gap calculation. On the other hand, the electricity sector often bears no general taxation, since it is an intermediate energy transformation process rather than a final consumer, so the IEA methodology treats zero VAT rates as the normal reference point.

To date, the IEA methodology has also excluded environmental externalities from their calculations of subsidies on the basis that carbon pricing is not (yet) 'normal' practice within its member countries, although they recognise that in principle carbon prices etc. should at least theoretically be part of the reference price.

The limitations of the price gap approach are summed up by the IEA as follows:

> *"The price-gap approach captures the effects of subsidies on economic efficiency to the extent that they lower the end-use price of the good in question. Other forms of subsidies, especially those, like import tariffs, which are designed to support domestic production, would raise final consumption prices.*
>
> *When more than one subsidy applies to the same good, a frequent occurrence, the price gap measures only the net price effect of all the different subsidies together. In reality, however, the effects on economic efficiency of coincident subsidies are not netted out, but add up. For instance, the combined application of a subsidy to capital costs and an import tariff might well leave end-use prices close to the reference price. In this case, the price-gap approach would yield little or no insight, but double efficiency losses do occur. So work based on price differentials cannot measure all efficiency losses associated with government policies.*
>
> *Trade effects, the reduction of imports or the additional availability of exportable fuels, are particularly affected by this analytical limitation. Depending on the specific forms of the subsidies, their removal might have much greater impacts than simply closing or narrowing the price-gap. Removing a capital subsidy and an import tariff might change prices little, but it would have very strong trade implications.*
>
> *Depending on the form in which the subsidies are administered, taxes can also offset their impact on prices, at least to some degree. For example, if subsidies lead to lower capital costs for power generation, a tax on electricity would offset the increased consumption due to lower prices. Energy taxes, however, would not offset the efficiency losses induced by an inefficient factor mix, such as a bias towards capital-intensive forms of energy production bolstered by a capital cost subsidy."*

1.2.2 OECD 'Effective Rate of Assistance' Approach

One of the key limitations of the price gap approach is that it does not adequately address support to energy producers (Koplow 2009). The OECD calculates subsidies using a more bottom-up assessment of the scale of government budget transfers involved to energy consumers and producers arising from the major subsidies identified. This requires in-depth analysis of the policy framework for each individual energy sector. Table 1.1 shows the potential range of different types of subsidy that need to be considered under such an approach, using the coal industry as an example (IEA, OPEC et al. 2010).

Table 1.1 OECD categorisation of subsidies with examples (OECD 2012)

	To whom transfer is first given

Transfer Mechanism		Consumer Support		Producer Support			
		Unit cost of consumption	Household or enterprise income	Output returns	Enterprise income	Cost of intermediate inputs	Costs of production factors
	Direct transfer of funds	Unit subsidy	Government subsidized lifeline electricity rate	Output bounty or deficiency payment	Operating grant	Input-price subsidy	Capital grant linked to acquisition of land
	Transfer of risk to government	Price-triggered subsidy	Means-tested cold-weather grant	Government buffer stock	Third-party liability limit for producers	Provision of security (e.g. military protection of supply lines)	Assumption of occupational health and accident liabilities
	Tax revenue foregone	VAT or excise tax concession on fuel	Tax deduction related to energy purchases that exceed given share of income	Production tax credit	Reduced rate of income tax	Reduction in excise tax on input	Investment tax credit
	Other government revenue foregone	Under-pricing of access to a natural resource harvested by final consumer				Under-pricing of a government good or service	Under-pricing of access to government land or natural resources
	Induced transfers	Regulated price; cross subsidy	Mandated lifeline electricity rate	Import tariff or export subsidy	Monopoly concession	Monopsony concession; export restriction	Land-use control

The OECD method involves making a producer support estimate (PSE), a consumer support estimate (CSE), and general services support estimate (GSSE) that support both consumers and producers.

Producer support estimate (PSE). Support provided to producers by governments may be delivered through a wide range of mechanisms: increasing the output price (Market Price Support); providing cash directly (a cheque from the government); reducing the riskiness of investing in fixed capital (e.g., loan guarantee; investment insurance); foregoing a payment that would otherwise be due to the government (e.g., a tax concession) or reimbursing a tax or charge (e.g., as for fuel taxes in some countries); reducing the price of an input (e.g., electricity for mining) or of a value-adding factor (e.g., a wage subsidy); providing a service in kind (e.g., police protection of a pipeline) for free or at a price less than the producer would pay on the open market; investing in knowledge-creating activities (e.g., research and development; education and training of specialists).

Consumer support estimate (CSE) includes price transfers to or from consumers. The normal case, especially in countries that are net exporters of fossil fuels, is that transfers are made to consumers through administered pricing. These transfers may exist alongside other subsidies in cash or in kind (including vouchers) linked to the consumption of a particular energy product. When consumers pay more than the reference price for a fuel, such as because of an import tariff, market transfers can be considered the inverse of transfers associated with market price support for the production of commodities that are consumed domestically; these are called price transfers from consumers. Sometimes, when domestic prices are above international prices, budgetary transfers may be provided to first consumers of energy products where these are provided specifically to offset the higher prices resulting from market price support.

General services support estimate (GSSE). Unlike the PSE and CSE, GSSE transfers do not directly affect producer revenue or expenditure by consumers, although they may affect production or consumption of energy products in the longer term. This includes for example, research and development, inspection services, infrastructure specific to the energy sector being considered, and marketing & promotion.

The OECD method then involves quantifying the budget transfers associated with each source of subsidy in each of these three categories, and then summing them up together. Care is needed to avoid double counting, so that any transfers made from producers to consumers as a result of producer support measures passed through to consumers is netted off the calculation. See (OECD 2010) for a detailed review of the methodology.

1.2.3 World Bank

The World Bank recently undertook a review of energy subsidies globally (WorldBank 2010), with a focus on consumer subsidies for fossil fuels in developing countries. The study is not aimed so much at quantifying subsidies as understanding their role in different country contexts, and identifying conditions under which subsidy reform might be possible and effective. The Bank notes that such subsidies are often regressive, with the benefits flowing mostly to richer sections of society. Key findings of the review are:

- Gasoline, diesel, and LPG subsidies are weakly targeted to the poor, particularly in low-income countries.
- Kerosene subsidies may be targeted to the poor through their direct effects, but the leakage to better-off households, commercial establishments, and the transport sector arising from the ease of adulterating diesel fuel with kerosene means that the subsidies' pro-poor benefits may be limited.
- Electricity subsidies resulting from excessive losses or failure to collect bills do not have economic justification and should be actively reduced.
- Electricity subsidies through generalized under-pricing are likely to be regressive, and much better targeting may be achieved through a careful design of the tariff structure. Volume differentiated tariffs appear to perform much better in this respect than increasing block tariffs.
- Subsidies to connection charges for electricity can be designed to be strongly progressive, but their substantial cost per household requires an investigation into the lowest cost method of supply as well as comparative assessment of other options to help the poor.
- Cross-subsidies for tariffs and for connection charges between different classes of users can be an important instrument, but are of limited use where overall connection rates are very low.
- Social safety nets can provide a more effective way of reaching the poor while controlling public expenditure. However, they require a strong administration.
- Because energy subsidies can result in a large fiscal burden, all subsidy schemes should consider the inclusion of natural phase-out provisions. This can help to

reduce the expectation of a permanent subsidy that can be very difficult to combat at the time a government feels the need to reduce the fiscal burden. However, some subsidy schemes may be designed to be permanent, such as cross-subsidies between different groups of consumers (such as urban households cross-subsidizing rural households for whom costs of electricity supply can be markedly higher).

- Transparency is important. Proper accounting and public awareness of which groups benefit from subsidies, by how much, and the cost is essential to evaluate government policies.
- Subsidies to support a switch from fossil fuels to renewable energy need to be carefully planned and to consider the inclusion of natural phase-out provisions.

1.2.4 IMF

The IMF has also recently completed a major study of energy subsidies (IMF 2013) across both advanced economies and developing countries. Whilst the study recognises the importance of both consumer and producer subsidies, the evaluation of subsidies focusses mainly on consumer subsidies for fossil fuels. However, unlike the World Bank study, the IMF study considers post-tax subsidies – e.g. tax breaks such as reduced VAT – consistent with the definitions used by the OECD. Whilst pre-tax subsidies are mostly focussed in developing countries (especially oil-producing states in the Middle-East and North Africa), post-tax subsidies are more widespread in advanced economies.

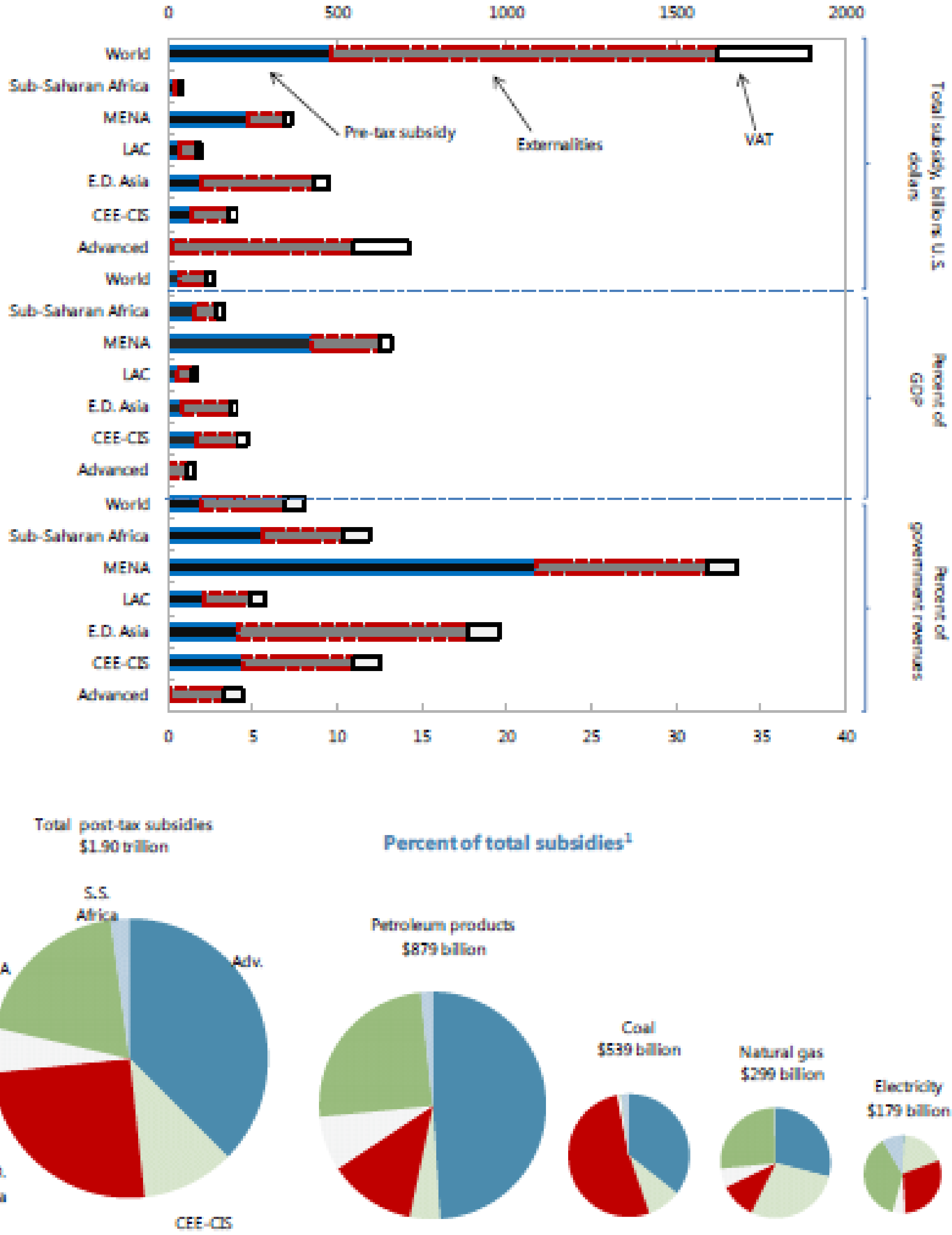
Remarkably, the IMF also introduces another strand to their analysis by including in their definition of subsidies the lack of taxes to address the externalities. They include environmental damages, as well as estimates of transport externalities, but probably the most significant element is the inclusion of a \$25/tCO_2 benchmark for CO_2 emissions from fossil fuels to cover climate change damages.

Using this basis of accounting transforms the focus of the energy subsidy debate. Since most countries do not tax carbon at this level (if at all), the combination of counting tax breaks as well as under-pricing of externalities swings the total level of energy subsidies from being dominated by developing country producers (as suggested by IEA price-gap approach) to being dominated by the major energy users.

On the IMF's accounting basis, of the global total, pre-tax subsidies account for about one-quarter, and tax subsidies account for about three-quarters (see Figure 2). The advanced economies account for about 40 percent of the global total. The top three subsidizers across the world, in absolute terms, are the United States (\$502 billion), China (\$279 billion), and Russia (\$116 billion).

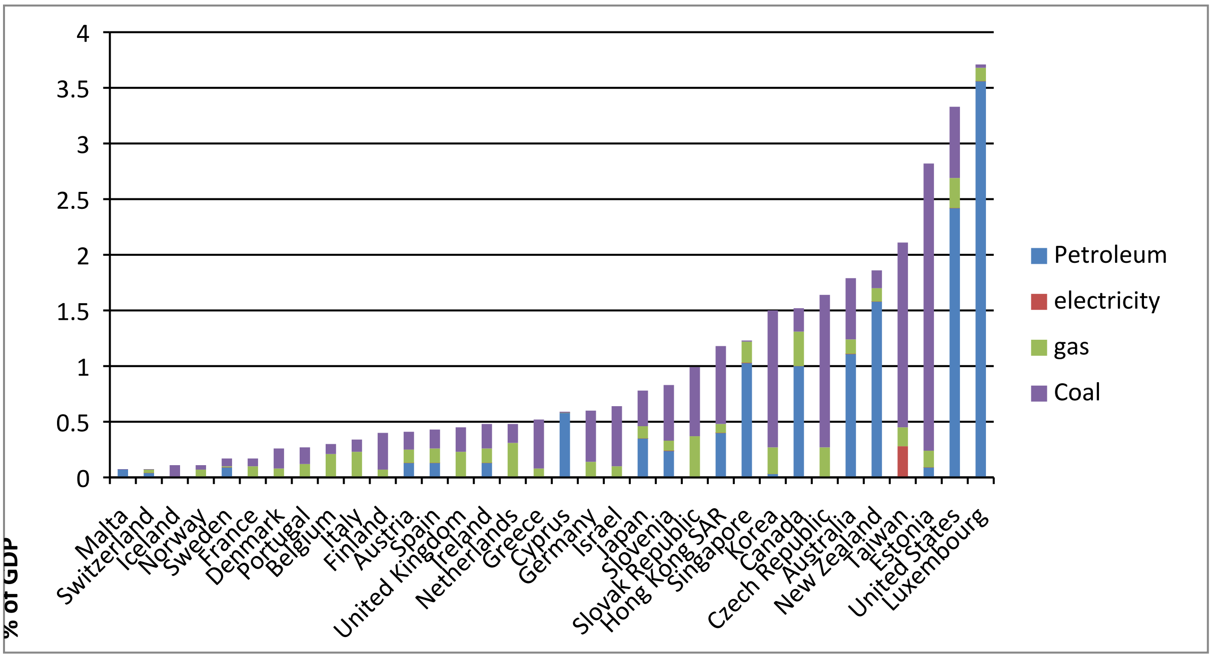
The study also undertook 22 case studies to assess experiences of energy subsidy reform (IMF 2013). The case studies show that subsidy reform requires careful handling. The case studies show examples of both successful and unsuccessful episodes of subsidy reform over the past two decades in a wide range of country contexts, but focussing mainly on developing and emerging economies.

Figure 2 IMF estimates of global energy subsidies including tax adjustments and under-pricing of externalities



The IMF study also gives a country-level breakdown of these subsidies, and the countries classified as 'advanced' in the IMF analysis is shown in Figure 3. According to the IMF definition, the UK falls into the lower half of the distribution, with energy subsidies totalling around 0.45% of GDP.

Figure 3 Subsidy levels in 'advanced' economies as defined in IMF study



However, it should be noted that these figures focus mainly on consumer subsidies, and underestimate producer subsidies. In particular, subsidies for nuclear energy and renewable energy are not included explicitly in these figures. These are addressed further in Sections 2 and 3.

1.2.5 Global Subsidies Initiative

The Global Subsidies Initiative of the International Institute for Sustainable Development has been working for a number of years towards increasing the level of transparency over the definition and measurement of subsidies, and has produced a manual aimed at promoting best practice in this regard (GSI 2010). The study goes beyond energy subsidies, looking at the environmental impact of all subsidies including the natural resources, minerals and agricultural sectors.

One issue the GSI has focussed on quite strongly is the underestimates that occur when only consumer support measures and price-gap approaches are used. As noted above, these approaches tends to suggest that subsidies are a developing country issue, whereas including producer support measures tends to show a much greater spread globally, but they require considerably more in-depth analysis in order to evaluate the extent of subsidies. To date, the GSI has produced the following quantitative studies in the area of producer subsides focussing particularly on upstream oil and gas sectors:

- Government support for upstream oil and gas in Norway (GSI 2012). The study identified nine subsidies that are offered to the oil and gas sector, totalling around $4bn per year in 2009, although these are expected to be declining over time. By far the largest component of subsidy is provided via a faster rate of capital depreciation for tax purposes compared to other industries in Norway.
- Tax and Royalty-related subsidies to oil extraction in high cost fields: Brazil, Canada, Mexico, UK and US (GSI 2010). Given the importance of high-cost fields in setting global oil prices, the role of subsidies here has considerable international importance. The report indicates that all five countries considered provide some

preferential treatment to smaller marginal fields, though quantification of these was not possible.

- Government support for upstream oil in three Canadian provinces (GSI 2010). This report identifies annual subsidies in the region of $2.8bn, approximately $2bn of which were allocated to Alberta, and evenly split between Federal and State sources. Most of the subsidies identified seek to increase exploration and development activity, (59 per cent of total subsidies $1.68 billion). These subsidies typically reduce capital expenditures through accelerated write-offs, tax credits, royalty reductions or allowances. Subsidies to support exploration, drilling, operations and research and technology comprised the remaining share of subsidies in about equal proportion.
- Government support for upstream oil and gas in Indonesia (GSI 2010). For the areas that could be quantified, subsidies totalled around $1.8bn annually, the largest component (86%) of which arises from the Domestic Market Obligation which obliges producers to sell a certain share of their production to the government-owned oil company Pertamina at below market rates. Given the involvement of the state at various levels in the industry, the total level of subsidies is likely to be significantly higher. The report identifies several areas where subsidies potentially exist, but could not be quantified without further research.

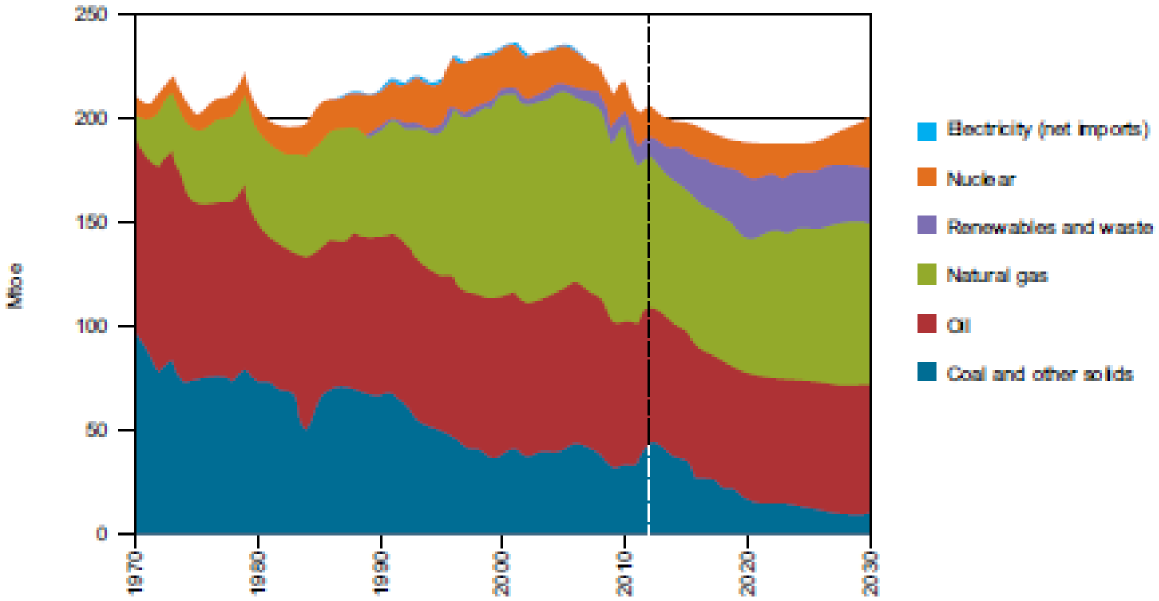
2 Extent of energy subsidies in the UK

2.1 Energy Mix in the UK –Historical and Future Trends

The energy mix in the UK and beyond is in a state of transition due to multiple drivers including technological developments in oil & gas sector, environmental constraints on carbon and other emissions, energy security concerns including international reactions to the Fukushima disaster.

The UK mix has shifted dramatically since the early 1970s from being dominated by coal and oil, to having a much larger share of gas. There are many different projections of the fuel mix going forward, but all of them show that further change in the UK is inevitable. Figure 4 shows DECC's projections with a continued decline in coal use, and expanded contribution from renewable sources. The share of a fuel in the energy mix is an important element in determining the overall size of subsidies paid to each energy source.

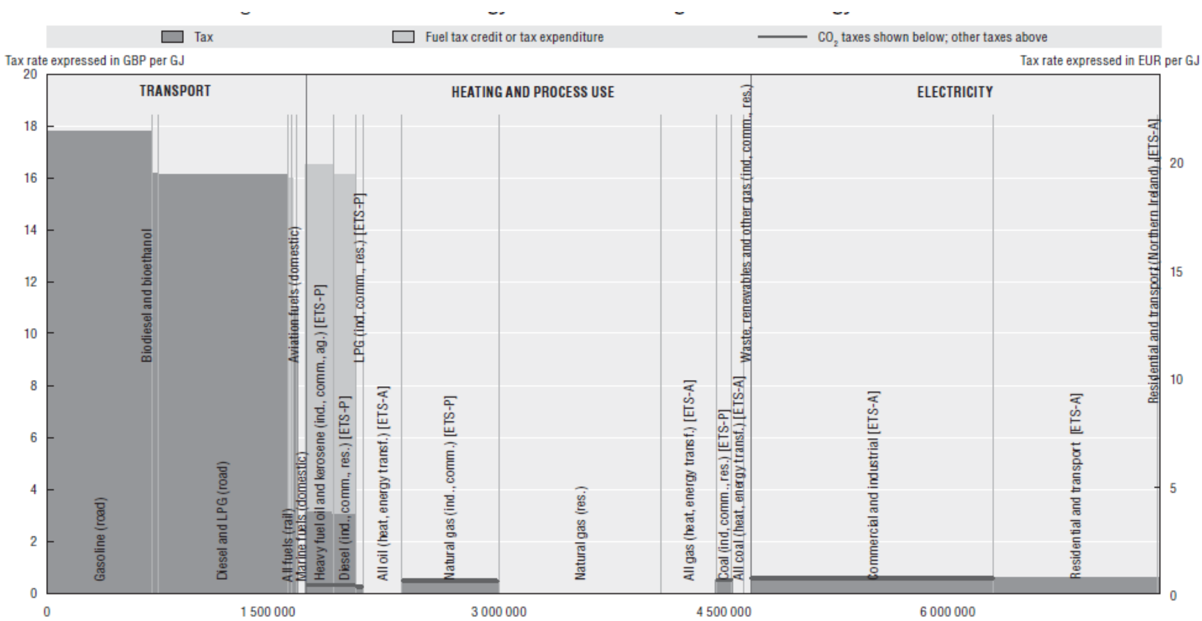
Figure 4 Primary Energy Mix in the UK



Source: DECC, Digest of UK Energy Statistics and Updated Energy Projections, October 2012

In terms of downstream energy consumption, analysis of the tax base shows that like many countries, the UK raises the great majority of its energy taxes from transport fuels (OECD 2013) as shown in **Error! Reference source not found.**. The shaded bars in the figure correspond to total tax revenue, excluding *ad valorum* taxes such as VAT. The most intellectually robust way to assess whether or not such taxes represent net revenues or net subsidies would be to take gross revenues, and subtract the degree of government expenditure for example on infrastructure or other services required to support that energy service. Such detailed assessments are beyond the scope of this study, and tend also to be excluded from assessments such as those carried out by the OECD, which takes each country's tax code as a 'norm' from which to assess subsidies.

Figure 5 The consumer tax base for energy products in the UK (excludes VAT)



[ETS-A] = all subject to the ETS.
[ETS-P] = partially subject to the ETS.

Tax base – energy use – expressed in TJ

Abbreviations: Res. = residential; comm. = commercial; ind. = industrial; ag. = agricultural; fish. = fishery; energy transf. = energy transformation; heat = merchant heat.
Source: OECD calculations based on IEA data and country-specific tax information (detailed in Annex A). Tax rates are as of 1 April 2012; energy use is based on IEA data for 2009.

2.2 Fossil Fuel Subsidies

The UK has progressively reduced subsidies to fossil fuels over the past 30 years in line with EU and OECD guidelines. There are no end-user price controls, with all prices being set by the market. The following analysis is based on the recent OECD calculations of energy subsidies for its member countries (OECD 2012).

<u>Producer support</u>

The main type of producer subsidy remaining in the UK is in the oil and gas sector and relates to tax allowances to partially offset the petroleum revenue tax (PRT). The PRT is the main tax levied at 50% of gross profits on oil and gas production in the UK. All oil and gas producing countries levy some kind of tax or royalties on production which is how they gain value from the resources being extracted. There is no common international standard for the rate of such taxes and levies, the level is set by each country. The standard PRT therefore defines the 'normal' baseline tax rate for oil production in the UK.

Various allowances which partially offset the PRT are available to companies which act as subsidies. These include a new-field allowance that was introduced in 2009 for small, ultrahigh-pressure and high-temperature oil fields, and ultra-heavy oil fields. As noted in Section 1.2.5, such subsidies for high-cost fields are not uncommon (GSI 2010). This allowance was subsequently extended by the government to cover remote deep-water gas fields (March 2010), very deep fields with sizeable reserves (March 2012), and certain large shallow-water gas fields (July 2012). Other measures to support certain types of production include Promote licences, which allow small and start-up companies to obtain a production license first and secure the necessary operating capacity and financial resources later through reduced rent for the first two years. These PRT allowances added up to £159m in 2011 for oil, and £121m for gas.

The OECD considers that in the context of the UK tax system design, the ability of oil and gas companies to write off exploration and production expenditures immediately does not constitute a subsidy.

Producer support for coal-mining sector has been removed since 2006, with only inherited liabilities relating to previous public ownership estimated by the OECD at a level of £4m in 2011. This includes management of abandoned mines and treatment of mine-water discharges.

Looking ahead, shale gas is a potentially important new area of energy resource development in the UK. HM Treasury is currently consulting with industry on a fair tax regime for this new development (DECC 2012). The definition of a 'fair' tax in this context will have to take into account whether special tax treatment is required for the sector given its different pattern of capital investment and other differences compared to conventional oil and gas fields. Given the normative nature of subsidies in the energy sector, a decision on whether or not any special treatment given to shale gas vis-à-vis conventional sources would have to take into account similar considerations. In the US which has the greatest experience of shale gas development, emerging subsidy issues include the adequacy of bonds used by oil and gas producing states to assure funding for reclamation of drilling sites, cover regulatory costs and offset public infrastructure costs. Road damage from use of heavy trucks on secondary roads, and payments for cleanup of fracking water are also emerging as costs which will need to be accounted for.

Consumer support

By far the largest subsidy for fossil fuels in the UK relates to the lower VAT rate of 5% for domestic energy supplies (compared to 20% for the economy as a whole). Since VAT is a general economy-wide tax, any reduction from the general national rate is considered by the OECD to be a subsidy. Domestic energy supplies have always been taxed at a lower rate in the UK, since being raised from zero to 5% in 1994, but this practice is unusual, as most countries tax energy at the prevailing rate of VAT (see Section 3.1).

In 2011, this tax was worth £81m for coal, £380m for oil and £3,510m for gas.

There are very few measures other than tax exemptions or reductions that support energy consumption in the United Kingdom. Schemes such as winter fuel payments for the elderly or cold-weather payments do not depend on the price of fuels and are provided in-cash to eligible households. Most of the remaining measures target consumption technologies such as low-carbon vehicles and hydrogen refuelling equipment rather than energy use *per se*.

Discounts to the climate change levy CCL (an end-user energy tax) are offered for eligible energy intensive users in return for committing to a climate change agreement to reduce energy consumption (see Section 2.6.2).

Missing Data

The OECD study points to a number of areas where data was not available to calculate subsidy levels for fossil fuels. These include:

Ring-Fence Expenditure Supplement	The Ring-Fence Expenditure Supplement (RFES) was introduced in January 2006 to replace the former Exploration Expenditure Supplement (EES). In its current version, it provides oil and natural-gas companies with a yearly 10% increase in the value of unclaimed deductions for expenses related to exploration and appraisal for a period of up to six years.
Field Allowance	This new allowance was first introduced in 2009 and later extended to encourage the development of small or technically-challenging fields. Before 2012, qualifying fields had to be small in size, feature ultra-high pressure or temperature, possess ultra-heavy oil reserves, or be remote deep-water gas fields. In 2012, it was then announced that new field allowances would also be extended to very deep fields with sizeable reserves, and large shallow-water gas fields. This extension is expected to generate revenue losses of about GBP 20 million per year (HM Treasury, 2012). The field allowance provides companies with a partial exemption from the Supplementary Charge. Relief is calculated at the level of the field but is provided at the company-level. Unclaimed allowances can be carried forward.
Mineral Extraction Allowance	The Mineral Extraction Allowance (MEA) was introduced in 1986 to provide mining companies (including coal, oil, and natural-gas producers) with faster rates of depreciation for qualifying capitalised expenditures. The latter include the acquisition of mineral rights or deposits and expenditures connected to access to the reserves. Prescribed rates vary with the type of expenditure to which the provision applies. Analysis of this provision is, however, complicated by the interaction of the MEA with the general tax regime that applies to oil and gas extraction. These caveats do not apply to coal though. Although this provision applies to the mining sector as a whole, data from the OECD's STAN database indicate that mining of fossil fuels accounts for nearly 90% of total gross output for the mining and quarrying sector (as defined in the standard ISIC Rev.3 sector classification).
Abandonment Costs	This provision allows capital expenditures connected to the abandonment of fields and mines to be deducted in full in the year in which they are incurred. Deductions are coupled with a carry-back provision which makes it possible for companies to use losses arising from decommissioning costs against profits earned in earlier years. This may therefore result in tax refunds. Although this provision applies to the mining sector as a whole, data from the OECD's STAN database indicate that mining of fossil fuels accounts for nearly 90% of total gross output for the mining and quarrying sector (as defined in the standard ISIC Rev.3 sector classification).

2.3 Nuclear Subsidies

Nuclear plants provided 62.7 TWh or 17.8% of the UK's electricity in 2011 (down from a maximum of 26.9% in 1997), coming from ten nuclear power stations with a combined capacity of 11 gigawatts (GW). The largest nuclear operator is EDF Energy, a wholly owned subsidiary of Electricité de France (EDF), which purchased British Energy Group plc in January 2009. It runs eight nuclear power stations, seven of which are advanced gas-cooled reactors (AGRs) and the remaining one is a pressurised water reactor (PWR) at Sizewell B. Two plants operated by Magnox Ltd. run Magnox gas-cooled reactors. The Nuclear Decommissioning Authority (NDA) owns several closed Magnox stations.

The UK reactor fleet is comparatively old. Up to 7.4 GW of existing nuclear capacity were scheduled for closure by 2019. However, the AGR reactors are being awarded life extensions, which is likely to delay closure, currently for around 7 years. The other reactor is the 1200 MW PWR at Sizewell B whose scheduled lifetime is to 2035 (IEA 2012).

2.3.1 Historical liabilities

The NDA has responsibility for radioactive waste management and decommissioning, and for nuclear legacy sites. It is a non-departmental public body created in 2005 that employs about 200 people. NDA owns former nuclear sites and the associated civil nuclear liabilities and assets of the public sector, including all the former sites and reactors of British Nuclear Fuels Limited (BNFL) and the UK Atomic Energy Authority (UKAEA). Its responsibilities include decommissioning and clean-up of these installations and sites, as well as the implementation of the UK nuclear waste policy. It is currently working on an annual budget of around £3 billion, of which £2.3 bn comes from the UK government, and the remainder from commercial operations. Total public liabilities for NDA's sites on a total discounted lifetime cost basis are around £50bn. As shown in the breakdown in Table 2.1, by far the largest of these is £32bn for Sellafield (net of remaining operating revenues).

However, as pointed out by the National Audit Office (NAO 2012), these cost estimates, although improving, are still quite uncertain. They note

> *"The [NDA's] undiscounted provision for the lifetime cost of the clean-up of Sellafield up to 2120 increased from £46.6 billion as at March 2009 (in 2011-12 prices) to £67.5 billion as at March 2012. The [NDA] expects that the lifetime cost will continue to rise, as uncertainties in the lifetime plan are addressed, then plateau, and finally decline as Sellafield Limited manages the decommissioning process better."*

Some of the financing of the NDA comes from the Nuclear Liabilities Investment Portfolio (NLIP), a fund of about £4bn that was separately identified in BNFL's accounts before privatisation, but which stayed in public hands. Arguably therefore, some of NDA's budget comes from the industry rather than from government, but in the bigger scheme of things, this is only sufficient to pay for two years or less of NDA's expenditure, so for the large part NDA can be considered to be publicly funded (Thomas 2004).

Table 2.1 Public liabilities for retired nuclear plant[3]

		2011/12 Estimated Discounted Lifetime Plan (£m)				
Site Licence Company	Site	Decomm & Clean-up Costs* A	Total Operations Costs** Running Cost B	Commercial Revenue C	Net Running Cost D = (B-C)	Government Funding E = (A+D)
Magnox Limited	Magnox Support	690			0	690
	Berkeley	659			0	659
	Bradwell	506			0	506
	Chapelcross	749			0	749
	Dungeness A	647			0	647
	Hinkley Point A	699			0	699
	Hunterston A	667			0	667
	Oldbury	1,008			0	1,008

[3] Source: NDA available at http://www.nda.gov.uk/sites/financials/index.cfm accessed March 2013

	Sizewell A	778			0	778
	Trawsfynydd	611			0	611
	Wylfa	1,045	80		80	1,125
Research Sites Restoration Limited	Harwell and Winfrith	1,122			0	1,122
Dounreay Site Restoration Limited	Dounreay	1,904			0	1,904
Sellafield Limited	Sellafield (including Calder Hall and Windscale)	36,601	3,571	8,040	-4,469	32,132
	Capenhurst	647			0	647
LLWR Limited	LLWR	253	533	598	-65	188
Springfields Fuels Limited	Springfields	384			0	384
Sub-Total		**48,970**	**4,184**	**8,638**	**-4,454**	**44,516**
	Electricity Sales		90	246	-156	-156
	Geological Disposal Facility	3,840				3,840
	NDA Central Liabilities & Group	83	1,447	1,550	-103	-20
Total		**59,893**	**5,721**	**10,434**	**-4,713**	**48,180**

2.3.2 Waste and decommissioning for future plant

Waste liabilities for future plant are even more uncertain than historical liabilities. The government's position is that any new nuclear plant must cover the costs of future waste and decommissioning out of their current operating costs without any public subsidy. This requires companies to put aside funds each year which can accumulate over the operating lifetime of the plant to pay for these back-end costs. However, long term disposal options will not start to become operational until after 2050, and until then, costs remain speculative.

The problem with costs being so uncertain is that it creates a barrier to investment because of the potential for liabilities to be higher than originally expected. In order to help companies manage this risk, the government therefore has proposed to introduce a fixed payment mechanism, the so-called 'waste transfer price' (DECC 2011):

> *"In order to provide Operators with certainty over the maximum amount they will be expected to pay for waste disposal the Government will, at the outset, set a Cap on the level of the Waste Transfer Price. The Cap will be set at a level where the Government has a very high level of confidence that the actual cost will not exceed the Cap. However the Government accepts that, in setting a Cap, the residual risk that the actual cost might exceed the Cap is being borne by the Government. Therefore the Government will charge an appropriate Risk Fee for this risk transfer. Hence for clarity, the Waste Transfer Price will include two separate risk allowances:*
>
> *• The Risk Premium is the premium over and above expected costs that will be included in the Waste Transfer Price to reflect the risk being assumed by the Government, when the Waste Transfer Price is set at the end of the Deferral Period, that actual costs might be higher than the Waste Transfer Price.*

• The Risk Fee is an additional element included in the Waste Transfer Price to reflect the small residual risk being assumed by the Government, when the Cap is set at the outset, that actual costs might be higher than the Cap."

The offer by government of a cap on liabilities could be considered a subsidy because it acts like an insurance policy. On the other hand, the government is aiming to charge for this transfer of risk via the risk fee, which in principle cancels out the subsidy. It is very hard to determine an appropriate 'market price' for this risk, since it would be almost impossible to obtain an insurance against such open-ended risks.

As an illustration of the potential scale of subsidy, DECC have published an indicative waste disposal liability based on cost estimates for the disposal of intermediate level waste of £14.5k/m^3. Based on this estimate, the illustrative cap would be £48.4k/m^3. However, estimates of the NDA's true marginal cost for waste disposal is put at £67/m^3 which suggests a significant risk that future liabilities may end up being transferred to the public purse. Estimates of the potential total value (undiscounted) of this subsidy have been estimated at between £400m to £1500m depending on the lifetime of the nuclear plant between 40-60 years (Greenpeace 2011). The Birmingham Policy Commission (Birmingham 2012) puts the waste transfer fee price cap into context, estimating that it is worth at most 1.5-2% of the revenue from sales of electricity, and quotes DECC estimates that the likelihood of the cap being exceeded is less than 1%.

The true scale of these risks come down to an assessment of how realistic these estimates of these liabilities are. In principle, the government could try to sell a portion of the ultimate liability on the secondary market to reality test pricing assumptions against market value, although the liquidity of such markets is likely to be questionable.

2.3.3 General operating conditions for new nuclear

Despite Ministerial announcements as recently as October 2010 that there would be no public subsidies for new nuclear plant, it is apparent that several subsidies will in fact be in place, some explicit, some implicit, driven in large part by the rapid escalation in the estimates of capital costs for building new nuclear plant (for estimates of how costs have changed over the past 10 years, see (Schneider, Froggatt et al. 2012).

The most transparent will be the price support for producers under the feed-in tariff to be introduced as part of recent electricity market reforms. The tariff is still being negotiated between the government and EdF, for planned new build at Hinkley Point in Somerset. The price that the company receives for its electricity will be fixed by a contract for difference, which requires consumers to top up payments over and above the market price up to the agreed level. Once the strike price has been announced for Hinkley Point, the extent of the subsidy will become more apparent.

These arrangements constitute a subsidy not only because of the raised price compared to market levels, but also because long-term fixed price contracts with reliable counterparties allow companies to borrow money at lower interest rates – a particularly important factor for capital intensive projects like nuclear plant. The duration of the contracts is therefore very important element of the subsidy, and is also still under negotiation, but there has been some speculation that contract periods of up to 40 years are being discussed[4].

It is likely that in the early years of operation, this market price support will constitute a substantial subsidy compared to the cost of the cheapest alternative (i.e. gas-fired plant), but in the long run, the subsidy element is not so clear. Given a 40 year time horizon, gas prices are extremely uncertain, and nuclear may turn out to be cheaper, especially taking into account the costs of removing CO_2 from gas-fired generation. On the other hand, nuclear will be competing with renewable energy sources, for which costs have been coming down rapidly over recent years. From a strategic energy security perspective, governments may consider that these macro-economic uncertainties are beyond the scope of private companies to cope with via normal market mechanisms.

Other types of subsidy are less transparent. The nuclear industry operates in a somewhat protected commercial environment because of the fact that each plant is too big to fail. This means that it is necessary for national governments to underwrite most of the commercial risks of nuclear power, as evidenced by the way the UK government had to bail out British Energy in 2005 at a cost of about £5 billion. This demonstrates the general point that, ultimately, national governments have no choice but to underwrite the commercial risks of nuclear power. The state aid for the rescue and restructuring of British Energy and BNFL were allowed by the EC in 2004 and 2006 respectively[5]. In November 2009, British Energy was sold to EDF Energy for £12bn, the proceeds of which were put into the nuclear liabilities fund. An issue for the government to manage is how to accrue sufficient interest on these funds to cover future liabilities given the current low return on secure investments such as treasury bonds. A related issue is how government funds should be accounted for when considering the cost of capital for infrastructure projects such as waste disposal. One line of argument suggests that government cost of capital is an inappropriate measure of the real costs, since it tends to mask the effects of risk (Lucas 2012).

The same goes for limits to company liabilities associated with major incidents such as nuclear accidents, terrorist threats and so on. Despite the low probabilities of such events occurring (at least on a plant-by-plant basis), the excessively high level of the maximum liability incurred means that companies are unable to obtain private insurance against such risks[6]. The value of such implicit subsidies are very difficult to assess. Estimates depend crucially on assessments of the likelihood of such events occurring. This tends to be a very subjective issue, and difficult to obtain impartial analysis. Despite the difficulty of quantifying these implicit subsidies, it is clear that without them, private investment in new nuclear power plant would not go ahead.

The UK government intends to increase the cap on liabilities to €1.2 billion from its present level of £140 million as part of its implementation of an international treaty on nuclear third party liability - the Paris and Brussels Conventions, to which the UK and most of the other EU countries are signatories (DECC 2012). This increases substantially the range of low-level incidents that companies will have to cover themselves. It is clearly substantially short of a full-scale disaster of the order of magnitude of Fukushima, for which the clean-up costs

[4] http://www.guardian.co.uk/environment/2013/feb/18/nuclear-power-ministers-reactor

[5] The case reference documents are in the state aid register: http://ec.europa.eu/competition/state_aid/register/

[6] See discussion in Der Spiegel http://www.spiegel.de/wirtschaft/soziales/0,1518,761826,00.html#ref=nldt or here for an English translation: http://tinyurl.com/d7yz48k

alone have been estimated at €175bn, not including the wider economic damages incurred (EnergyFair 2012). Significantly higher liabilities in the private sector are not unprecedented (e.g. BP has allocated $41bn to settle claims resulting from the Gulf of Mexico disaster). Such large sums are probably beyond the ability of relatively smaller utility companies to handle, but the fact remains that there is an incentive for companies to understate their ability to secure private insurance for such risks in order to gain government protection, and ways should be sought for these risks to be internalised as far as possible within the general costs of production.

2.4 Renewables

2.4.1 Current subsidy arrangements

Renewables Obligation

The main subsidy to large-scale renewable energy sources in the UK is currently the Renewable Obligation (RO) scheme which requires suppliers to provide a certain proportion of their electricity from approved renewable sources. Generators of renewable energy are issued with a renewable obligation certificate (ROC) for each MWh of power generated. Some sources of renewable energy are credited with more than one ROC per MWh, and some less in order to balance out investment incentives with respect to technology costs[7]. For example, onshore wind receives 0.9 ROCs per MWh, whilst offshore wind receives 2 ROCs per MWh (falling to 1.5 from 2014/15 onwards). These certificates are tradable. Suppliers buy sufficient ROCs to be compliant with their obligations. This creates a market for ROCs, so that their price is a transparent observable value.

Any suppliers who do not hold enough ROCs pay a 'buy-out' price. These penalty fees are paid into a central fund, out of which is taken the administration costs of the scheme, and the remainder is redistributed back to suppliers in proportion to their degrees of compliance with the RO. This recycling of the buy-out fund effectively increases the value of holding ROCs, and adds to their market price.

The value of holding excess ROCs is zero, since they cannot be banked for use in future periods, so to stop the market price of ROCs falling to zero, the government sets the RO at a level above what is expected to be delivered, so as to achieve 'headroom', ensuring a positive payment into the buy-out fund.

The current obligation level for suppliers for April 2012 to 31 March 2013 is 0.158 ROCs for each MWh they supply to customers in England and Wales. The obligation level for April 2013 to 31 March 2014 is 0.206 ROCs for each MWh supplied. This figure is calculated by DECC[8] based on the list of potential new build expected to generate in 2013/14 sourced from the Renewable Energy Planning Database (REPD), the National Grid's Transmission Entry Capacity (TEC) Report, Ofgem's preliminary ROC Register, and, the UK Wind Energy Database.

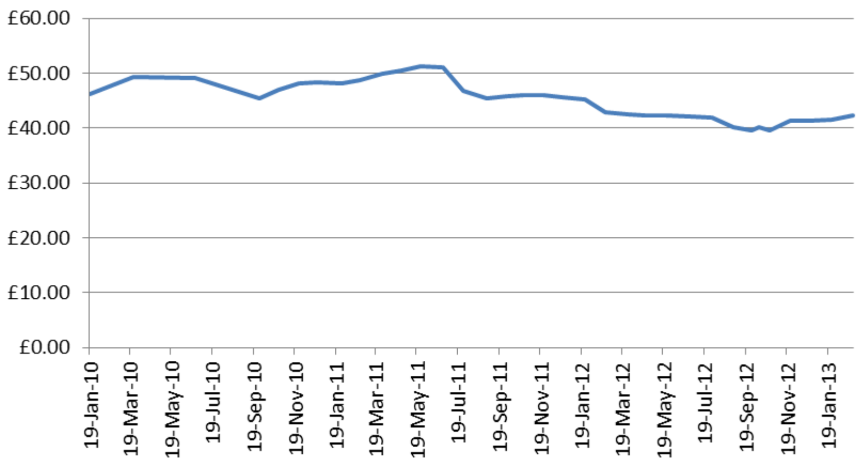
[7] https://www.gov.uk/calculating-renewable-obligation-certificates-rocs

[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65530/6527-calculating-renewables-obligation-2013-14.pdf

	ROCs (millions)
Potential ROCs from existing stations	39.7
Potential ROCs for new build	16.2
Total expected ROCs	55.9
Total (with 10% headroom)	61.5

Suppliers can pass on the costs of purchasing ROCs to their customers. The market price is currently around £42 per ROC (and has traded in a fairly narrow band between £40-50 over the duration of the market as shown in Figure 5). This puts the total value of the RO subsidy at (55.9m x £42) at around £2.4bn for 2013/14. In addition to receiving the ROC price, renewable generators also receive payments for generating levy exemption certificates (LECs). The value of a LEC is tied to the charge made on energy users under the climate change levy (CCL). Electricity is currently subject to the CCL at a rate of £5.09/MWh, which effectively sets the traded price of LECs. For the last full year for which data is available (2010/11), the number of LECs issued was 29.8m. This puts the value of this subsidy at £152m.

Figure 5 Market (auction) price for ROCs have been quite stable over the past 3 years



<u>NFFO</u>

Prior to the introduction of the renewable obligation, market support for renewables was via the non-fossil fuel obligation (NFFO). These were long term contracts priced by auction giving a fixed price per kWh for different bands of renewable technology. Based on the volumes and prevailing auction prices of the NFFO, the value of these remaining contracts are shown in Table 2.2, totalling around £400m. However, unlike ROCs, these payments are not additional to the value of the electricity, but instead they include the value of electricity generated. For NFFO 4 and NFFO 5 rounds, the fixed payments made under the long-term contracts is actually less than the wholesale price of electricity. Therefore, these contracts no longer act as a subsidy for the NFFO generators. NFFO generators are not eligible for producing LECs.

Table 2.2 Value of contracts remaining under NFFO arrangements

	period	Total contracted capacity (MW)	Average price 06/07 (p/kWh)	Total value of NFFO payments (£m)	Approx. market value of electricity (£m)	Approx. value of subsidy (£m)
NFFO 3	01 Apr 1995 - 28 Aug 2013	627	6.15	128	99	29
NFFO 4	01 May 1997 - 30 Dec 2016	843	4.51	132	138	-6
NFFO 5	01 Dec 1998 - 29 Nov 2018	1177	3.40	137	195	-58
TOTAL		2647		396	432	-36

Feed-in Tariffs

For small-scale renewables, the RO system has been deemed too complex, so to provide a simpler and more certain revenue stream, a feed-in tariff (FiT) was introduced for plant installed up to 5MW. This provides a fixed additional revenue stream over and above the value of electricity generated for each kWh of electricity generated. By far the largest beneficiary of the scheme since it was first introduced in 2010 has been rooftop solar PV, accounting for about 90% of installed capacity under the scheme (Ofgem 2012). The tariff for April 2010 – March 2011 was set to 41.3 p/kWh for systems up to 4kW retrofitted to rooftops. Tariffs are fixed in real terms for 25 years, adjusted for inflation annually at RPI. In addition, householders receive an additional tariff for any exported electricity, acting as an incentive to run the household efficiently.

The tariff was due to remain unchanged for the first two years, and then drop by 8% to 37.8p/kWh in the third year (UK 2010). In fact, demand for the tariff was so strong, that government decided to drop the tariff rate much more quickly to 21p/kWh for schemes after March 2012. The latest arrangements for setting solar PV tariffs require Ofgem to set quarterly tariff rates which can be adjusted to take account of the volume of uptake of the subsidy (UK 2012). The tariffs for other renewable technologies are set annually by Ofgem. The latest rates for small scale rooftop solar are as follows[9]:

Table 2.3 Change in tariff rates for rooftop solar PV <4kW[10]

	FIT Year 1 2010/11 (for projects up to Mar 2012)	Mar 2012 – Aug 2012	Aug 2012 – Nov 2012	Nov 2012 - Feb 2013	Feb 2013 – May 2013	May 2013 – Jul 2013
FiT p/kWh						

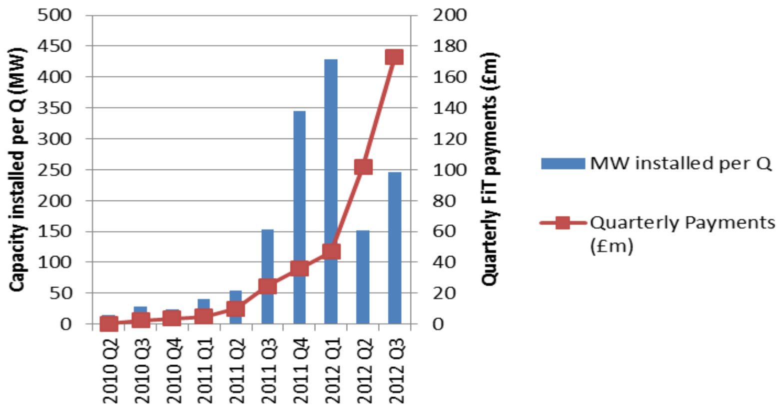
[9] From http://www.ofgem.gov.uk/Sustainability/Environment/fits/tariff-tables/Pages/index.aspx

[10] Properties with an energy performance rated D or below receive a lower tariff. Developers installing solar PV on more than 25 properties also receive a lower tariff.

	45.40	21.00	16.00	15.44	15.44	15.44
Export tariff p/kWh	3.2	3.2	4.5	4.5	4.64	4.64

Total subsidy payments made under the FiT scheme are summarised in Figure 6. The amount of installed capacity dropped significantly in 2012 Q2 compared to previous periods after the tariff was reduced, but have picked up again since then. The total payments made under the scheme are cumulative, since any new projects add to the payments made against capacity that has already been installed in previous periods. Total annual payments in 2012 will therefore amount to more than £500m for the FiT scheme.

Figure 6 Payments made under the FiT to date[11]



2.4.2 Future Investments – implications of electricity market reform

As a result of the recent energy market reforms, all support for renewables will now be moved to a feed-in tariff support mechanism. The arrangement for small (<5MW) systems remains as before. Large-scale renewable projects that would previously have been supported under the RO will instead receive a fixed price based on a contract-for-difference (CfD) payment mechanism which tops up payments to generators over and above the amount they receive for selling electricity at market rates. The tariff rates will vary according to the type of technology.

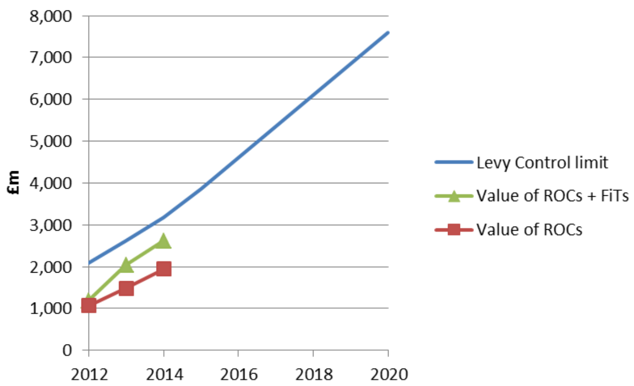
The tariffs to be received for renewables have not been yet been finalised, but it seems likely that they will be broadly comparable with the support levels received under the previous RO scheme. An indication of the total value of the subsidy is provided by the levy control framework, which sets a total limit on the value of payments that can be made via 'levy-funded' spending (i.e. increases to consumer energy bills to pay for low carbon energy sources). This is currently £2.35bn, rising to £3.56bn by FY 2014/15 (DECC 2011), and in the pre-budget report in November 2012, it was agreed to set the figure for 2020 at £7.6bn per year[12]. Figure 7 indicates that the limit on levy spending specified in the levy control

[11] Data from http://www.ofgem.gov.uk/Sustainability/Environment/fits/Newsletter/Pages/Newsletter.aspx

[12] Press release: https://www.gov.uk/government/news/government-agreement-on-energy-policy-sends-clear-durable-signal-to-investors

framework provides some headroom compared to spending to date and projected spending over the next year on FiTs and ROCs, the two main sources of levy spending. The projected rise to 2020 appears sufficient to allow for a continuation of the expansion of renewable energy at its current rate.

Figure 7. Value of current subsidies to renewables and the spending constraint under the levy control framework out to 2020



2.5 Electricity

VAT rates for electricity for domestic use is charged at a reduced rate of 5%. This acts as a subsidy compared with the general rate of VAT of 20%, leading to a higher than optimal rate of electricity usage. Because this applies to final use, it does not distort the choice of fuel used in the generation of electricity, since generators receive the ex-VAT value.

The ex-VAT value of electricity sold to the domestic sector is approximately £14.8bn per year. The value of a 15% discount on VAT is therefore of the order of £2.2bn per year.

Some of the distortions created by this subsidy are offset by a reduction in the VAT rate for energy saving equipment as listed below[13].

Table 2.4 Reduced VAT rates on energy saving goods

The installed goods	VAT rate
Air source heat pumps	5%
Boilers - wood fuelled	5%
Central heating and hot water controls	5%
Draught stripping	5%
Ground source heat pumps	5%
Insulation	5%
Micro combined heat and power units	5%
Solar panels	5%
Water and wind turbines	5%

[13] http://www.hmrc.gov.uk/vat/forms-rates/rates/goods-services.htm

Nevertheless, the lower rate of VAT for electricity and gas are a significant distortion to the tax code. Removing such subsidies is however difficult. As noted in a set of case studies on environmentally harmful subsidies in the EU (Valsecchi, ten Brink et al. 2009):

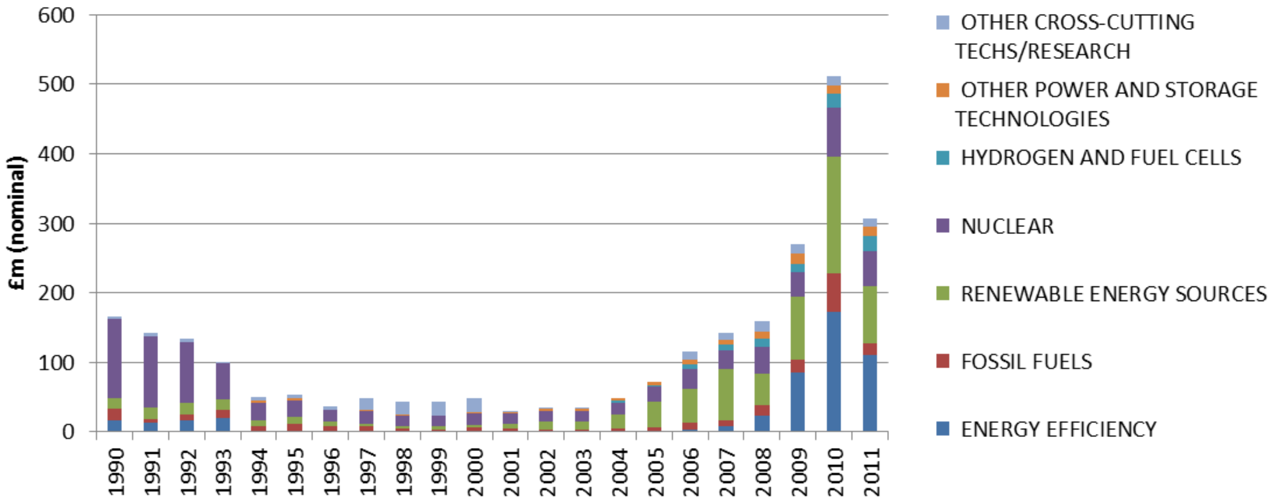
> *"The traditional argument to tax 'necessities' at a reduced VAT rate (or not to tax them at all) is that low-income households tend to spend a relatively large part of their income on these goods and services, so that taxing them at the standard rate would have a regressive distributional impact. In reality however, only a small part of the subsidy reaches the intended recipients (low-income households). High-income households receive most of the benefits, as the income elasticity of demand for energy is positive. The original social motive for the subsidy has largely disappeared, as the share of energy in household expenditure has decreased dramatically, also among low-income households. A more cost effective alternative would be to provide direct income support or tax relief for low-income households.*
>
> *There have been previous attempts to remove this subsidy including an attempt in 1995 which failed because of the expected distributional impact. In particular the fact that it would hit elderly people the hardest, led to the abandonment of the proposed increase of VAT to the standard level. A possible compensation measure that could be used to palliate the impact of removal would be to reinforce existing schemes to assist low-income households with investments in energy saving."*

2.6 General

2.6.1 Government funded energy R&D

The UK spends about £7.5 per capita per year on energy-related R&D (IEA 2012), which is approximately equal to the median amount for IEA countries. R&D expenditure has increased rapidly in recent years following a period of decline over the previous decade. Total expenditure in the UK including R&D and demonstration projects in 2010 was over £500m, representing a very significant increase (76%) increase since 2009. The figure for 2011 dropped back to around £300m, but the trend over the past 5 years is still significantly higher than over the previous decade. The breakdown of expenditure between different energy sources is shown in Figure 8.

Figure 8. UK Government energy R&D expenditures



Research on energy efficiency and renewables in particular have increased rapidly, with nuclear energy and carbon capture and storage for fossil fuels also having experienced a resurgence over recent years.

2.6.2 Climate Change Levy Exemptions and Discounts

The climate change levy is a tax applied to business energy users (including industrial, public, commercial and agricultural users). It applies to electricity, gas and solid fuels for heating, lighting and process use. The purpose of the tax is to work towards the principle that the polluter pays for the climate change externalities of the energy use, and because the tax is applied rather generically across the economy, exemptions from the CCL should therefore be considered a subsidy.

Exemptions from the climate change levy are available for:

- Small businesses (e.g. <1000 kWh per month)
- Supply from good-quality CHP schemes
- Supply of electricity from renewables
- Inputs for own-use electricity generation
- Non-fuel use (e.g. chemical feed-stocks)

In addition, a discount of 65% is available to energy-intensive users who sign up to a climate change agreement (CCA) to meet an energy reduction target. Based on the author's estimate, and assuming that CCAs cover a large proportion of industrial energy consumption, the discount is worth around £500m in avoided tax.

In some sense, this could be seen as a subsidy, since these companies face a lower tax rate than the norm for business in the UK. On the other hand, DECC estimates that the energy savings achieved under the CCAs are at least as great if not greater than the energy savings that would have occurred if the companies involved were subject to the full energy costs associated with the CCL. Therefore, tying the CCL discounts to CCAs actually reduces energy demand rather than increasing energy demand as would normally be the case for a straight subsidy. If a definition of subsidies is used which only counts situations where there is a resulting increase in energy consumption, then CCL discounts tied to CCA energy reductions would not be considered a source of subsidy.

2.6.3 Enhanced Capital Allowances

The Enhanced Capital Allowance (ECA) scheme enables businesses to claim a 100% first year capital allowance on investments in certain energy saving equipment, against the taxable profits of the period of investment. Capital allowances enable businesses to write off the capital cost of purchasing new plant or machinery (e.g. boilers, motors), against their taxable profits. The general rate of capital allowances is 18% a year on a reducing balance basis, so 100% capital allowance in one year represents a considerable benefit in terms of 1st year cash flow, and also reduces overall tax payments. It is estimated that the cost to treasury of the ECA tax breaks is round about £100m per year[14].

2.7 Summary of UK Subsidies

The values assigned to different forms of subsidy are, as described in the introduction section, dependent on a definition of what constitutes 'normal' taxation practice, which is not necessarily comparable across fuel types. Table 2.5 pulls together the various estimates made in the text should therefore be used with caution. Nevertheless, it is useful to see where the estimates of significant levels of subsidy lie, and where there are still significant gaps in the data that is readily available.

Table 2.5 Summary of UK Energy Subsidies

Energy type	Primary Energy Demand[15] (GWh)	Annual Value of Subsidy £m	Source of subsidy	Comments
Oil	975,792	159 380	• PRT • VAT	• Producer support • Consumer support
Gas	906,489	121 3510	• PRT • VAT	• Producer support • Consumer support
Oil & Gas		?	• Additional exemptions from charges and accelerated tax allowances	• Producer support
Coal	385,174	4 81	• Mining liabilities • VAT 5%	• Producer support • Consumer support
Nuclear (incl historical liabilities)	68,980	~2300 ?	• Gov't input to NDA annual budget • Possible increases in budget required to deal with legacy waste	• Producer support

[14] Personal communication with Carbon Trust.

[15] Figures for fossil fuels relate to total primary energy demand in the UK in 2011. For nuclear, renewables and electricity, the figures relate to total production in 2011.

Current Renewables	34,409	2400	• ROCs	• Producer support
		152	• LECs	•
		500	• FiTs	•
Electricity	364,897	2200	• VAT reduction	• Consumer support
Energy R&D		300	• All sectors	• General services
CCL discounts		500	• For energy intensive industry	• Consumer support (but offset by CCAs)
ECAs		100	• For en. efficiency	• Consumer support

3 International comparison

3.1 Fossil Fuels

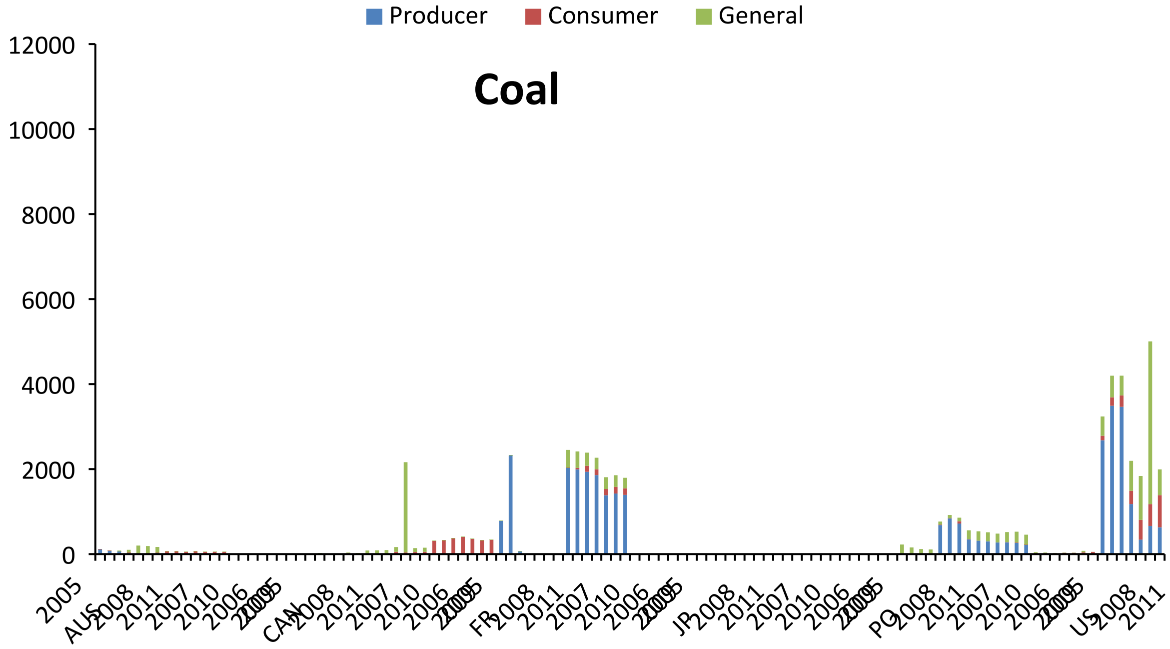
The most thorough assessment of fossil fuel subsidies in comparable countries to the UK is provided in the OECD report "Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels" (OECD 2012). The data is provided in local currency units, and has been converted here to US$ for comparison. However, a health warning is required when making these comparisons between countries. As noted in the introduction to this report, subsidies are defined in comparison to the particular tax regime, measuring deviations from whatever is deemed 'normal' in that country. Since the tax regimes vary considerably, there is no single consistent measure for subsidies in this case that ensures that they are being compared on a like-for-like basis. The OECD caveat to these figures reads:

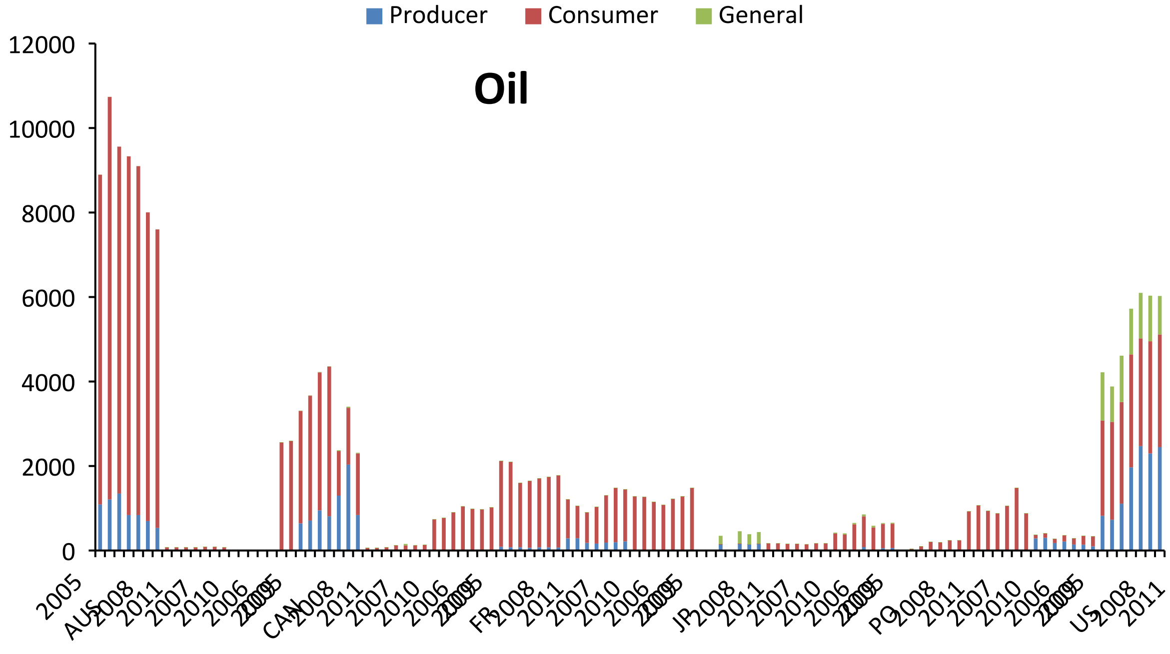
> *"Tax expenditures for any given country are measured with reference to a benchmark tax treatment that is generally specific to that country. Consequently, the estimates … are not necessarily comparable with estimates for other countries. In addition, because of the potential interaction between them, the summation of individual measures for a specific country may be problematic."*

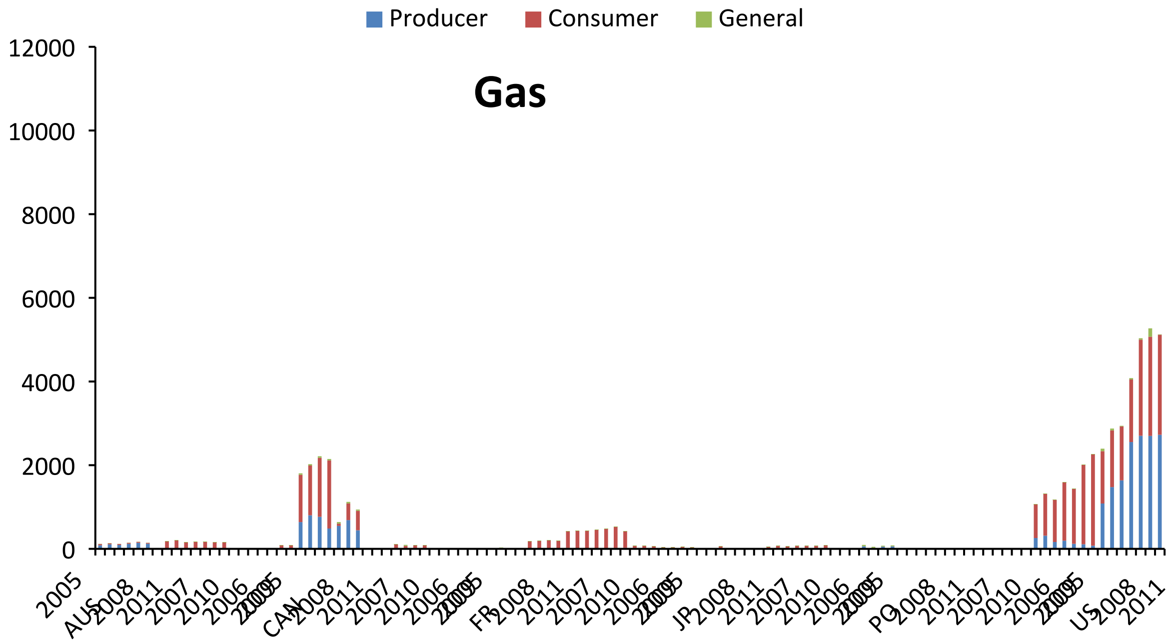
With that caveat in mind, the figures are presented here in two ways. Firstly, in total expenditure terms as presented in the OECD report but converted to a common currency unit. Secondly, the total subsidy levels are divided through by the total primary energy supply of each fuel type in that country in order to adjust for the size of the country when making the comparison. Subsidies are distinguished between Producer Support measures, Consumer Support measures and General Services.

Data is not shown here for all the countries covered in the OECD report, but the focus is on larger countries, and those that are more comparable with the UK.

Figure 9 Total Subsidy levels for fossil fuels (US$m)







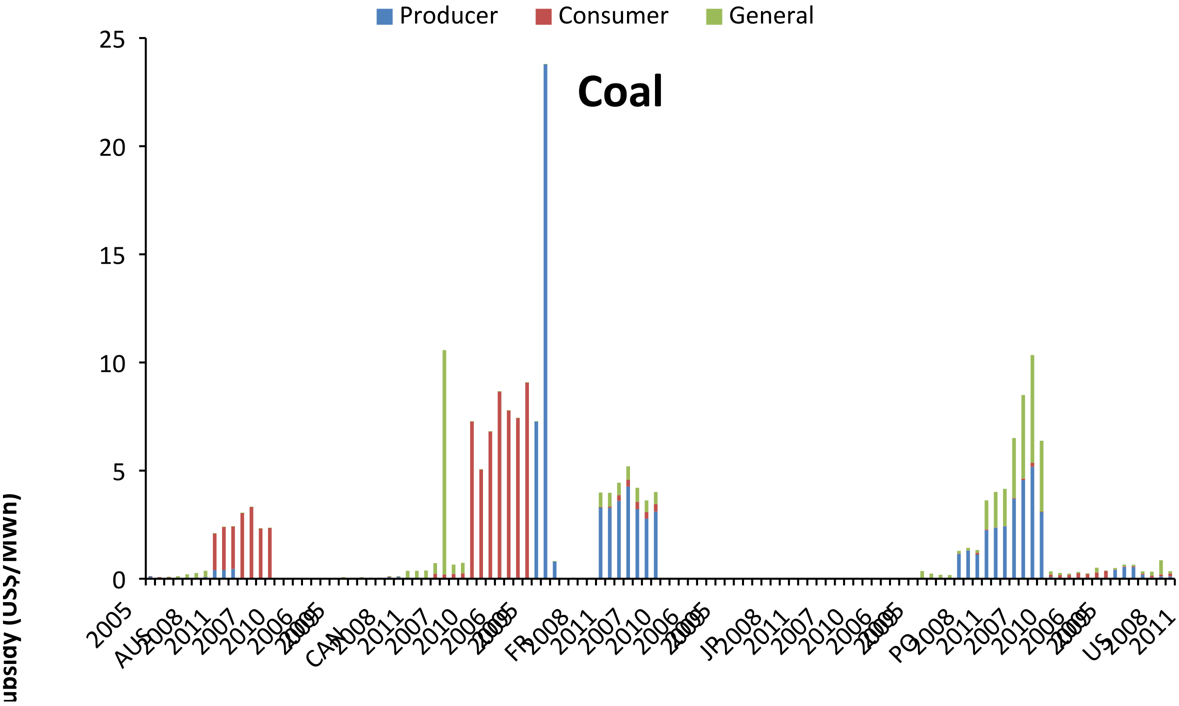
In common with many other OECD countries, UK subsidies for coal are small by international standards. Coal subsidies mostly take the form of producer support measures in countries that still have significant levels of production (Germany, Poland, Spain, US), although not all producer countries have such subsidies (e.g. Australia). In general, there is a declining profile over time for these subsidies as they are gradually phased out, and as a result of a declining share for coal in most countries.

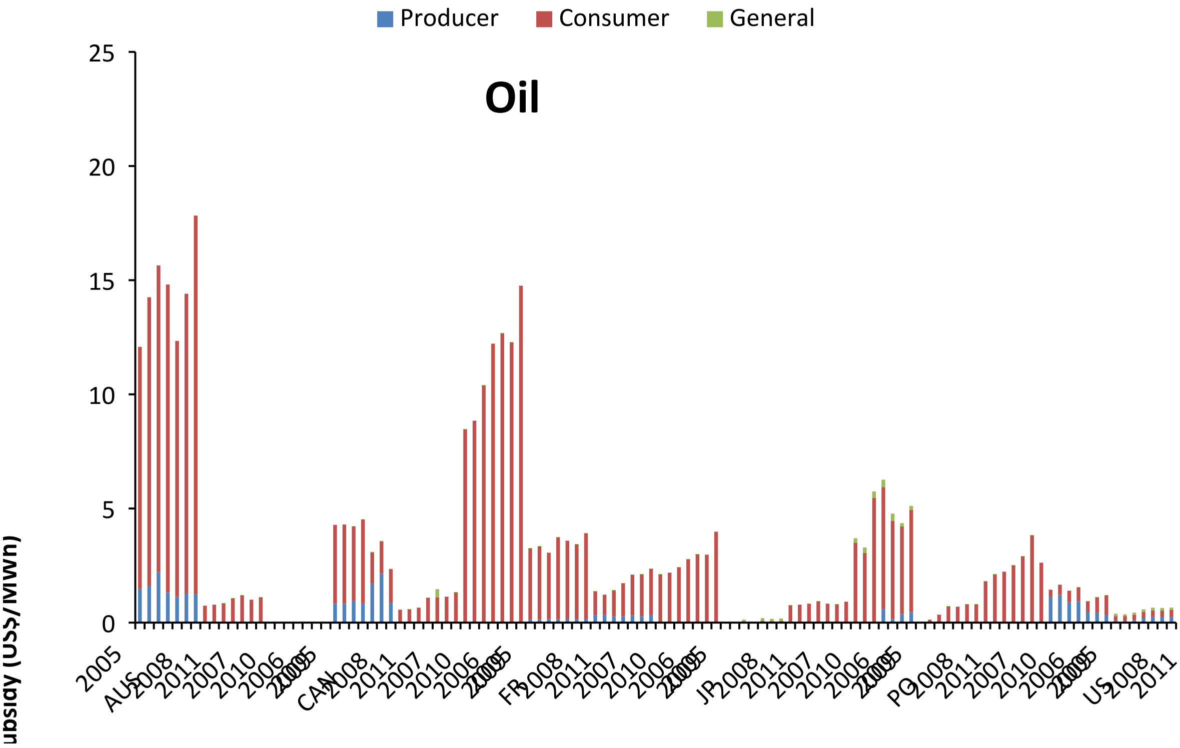
In the oil sector, producer support measures are a smaller fraction of total subsidies, and concentrated mostly in Australia, Canada and US. In most countries, oil subsidies are provided to consumers, and take the form of various tax credits, exemptions, refunds and discounts for specific end-use of oil products. These are too diverse to list in detail here, but a full explanation of the subsidies defined for each country is provided in the OECD report.

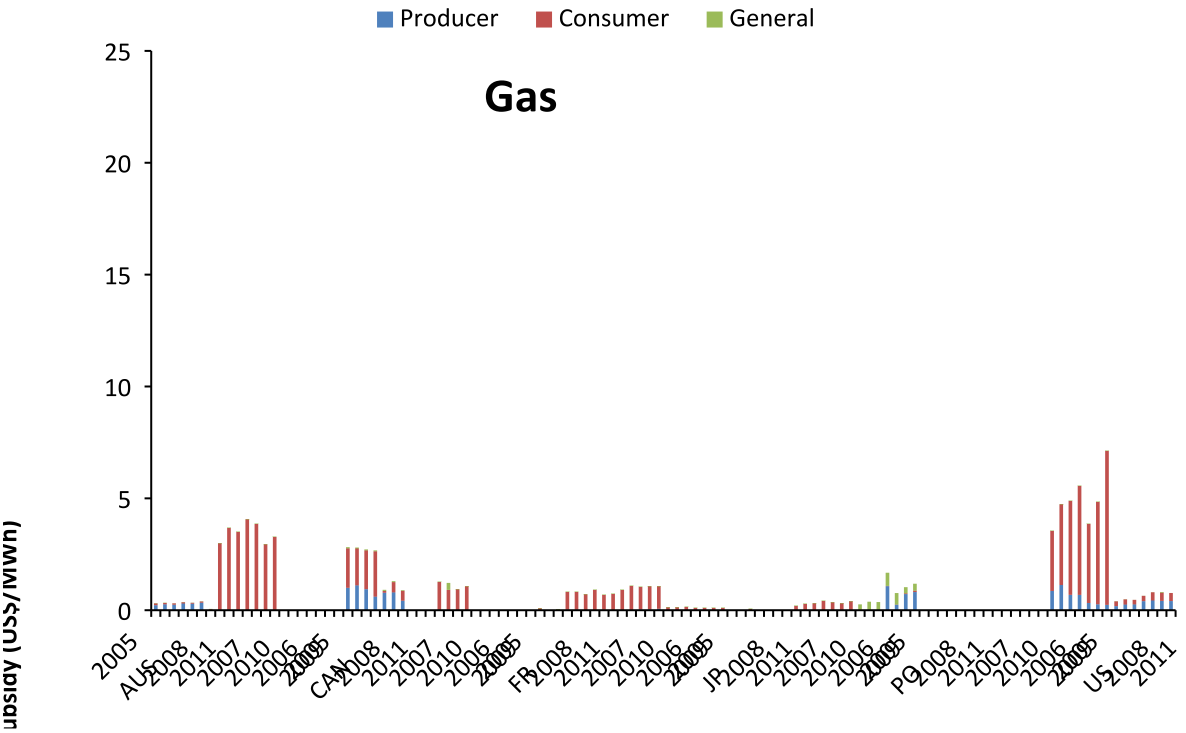
For gas, producer support is limited mainly to Canada and the US, and relatively little subsidies of any sort in most OECD countries. The UK has a relatively high level of subsidy for gas which is mostly the VAT tax break for domestic consumers. The UK is unusual in Europe in this respect in providing a sales-tax break for natural gas, although In the US, state-level exemptions of energy from sales taxes levied on other goods and services are common.

In order to adjust these subsidy comparisons for the size of the country, the figures are compared with the total primary energy consumption of each fuel in the relevant year. The charts are shown in Figure 10 in units of US$/MWh. It should be noted that under this measure, the subsidy expenditure is divided by the total fuel use for the country concerned. This will tend to underestimate the value of the producer subsidies to individual companies for the particular applications for which they apply.

Figure 10 Subsidy per unit of primary energy supply in each country







Relative to its overall consumption levels for each fuel, the UK appears to have low subsidies by international standards for coal and oil. For gas, UK subsidies are relatively high by international standards, but other countries such as Austria (tax break for energy intensive users), Czech Republic (energy tax exemptions) and Canada and Norway (producer support) also have a relatively higher degree of subsidy under this measure. Nevertheless, in general, subsidies across most OECD countries are lower for gas than they are for coal and oil.

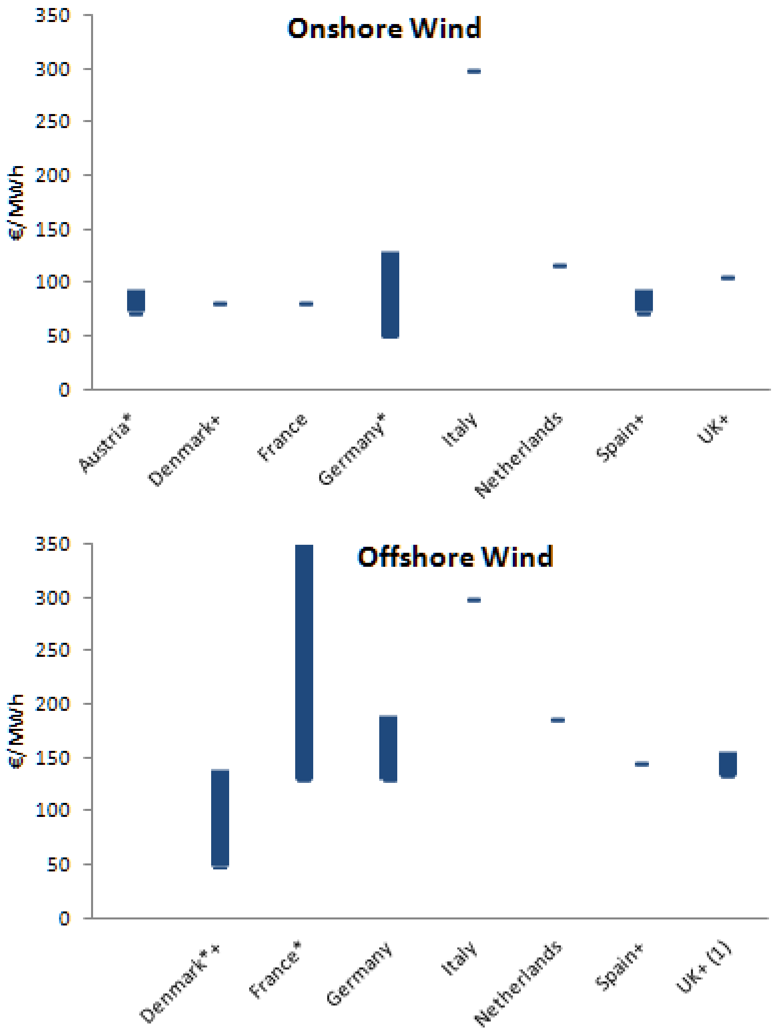
3.2 Renewables

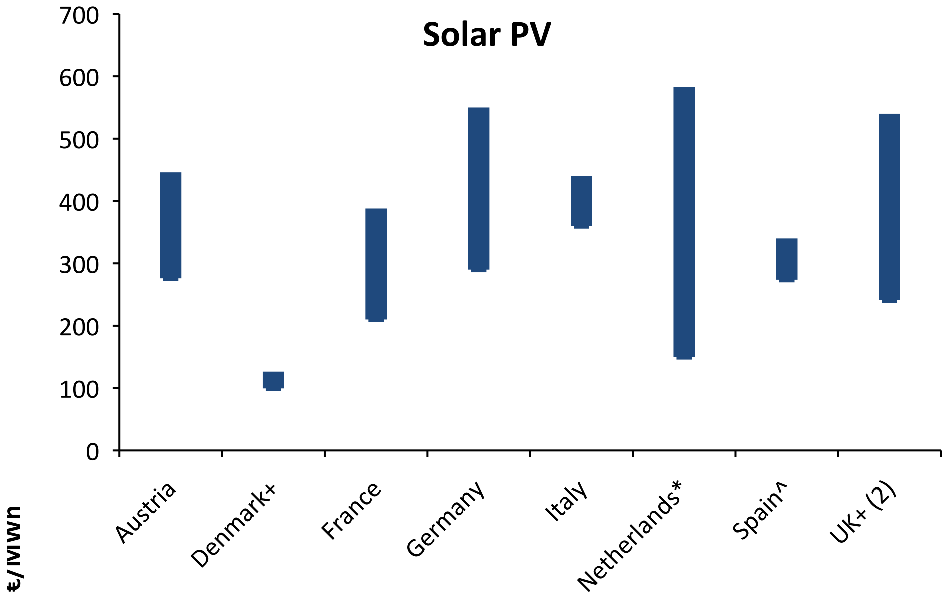
In principle, renewable energy subsidies focus on explicit price support mechanisms which should be more transparent to trace than subsidies for other fuel sources. In practice, there is quite a complex pattern of different support rates for different sizes and vintages of plant, and the legislation in each country tends to change frequently. As a result, there seems to be little literature available providing a like-for-like comparison of subsidies between countries. Two data sources have been used to construct a comparison, the EU energy portal (Portal) and a study for the European Renewable Energies Federation (Fouquet 2012).

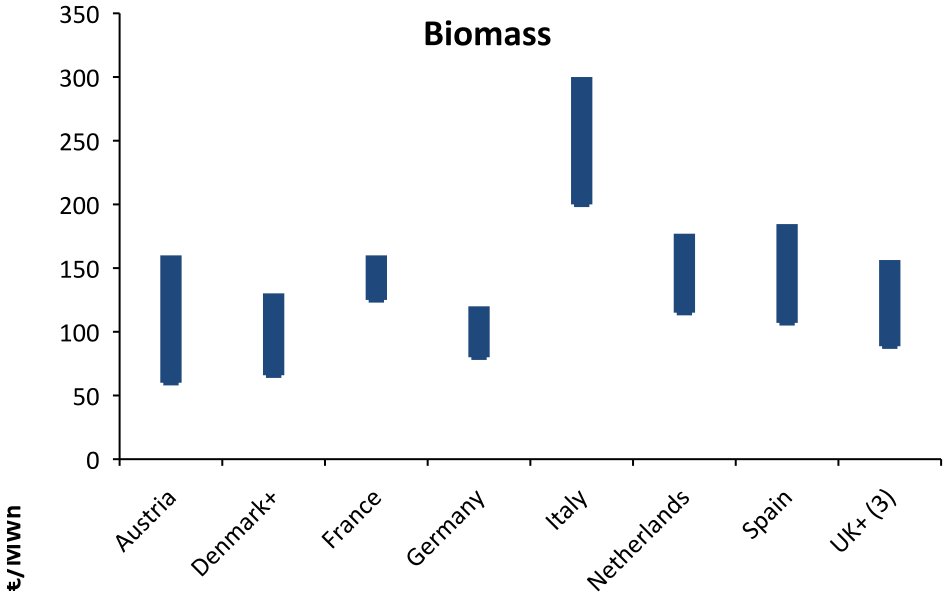
Some countries' schemes are based on a feed-in tariff that represents the total payment to renewable generators per MWh produced. Other schemes are based on a 'premium' over and above the wholesale electricity price. In these cases, an estimate has to be made of the market price for electricity in order to reach the total payment to make a like-for-like comparison. The UK situation is similar to the premium tariff in the sense that renewable generators receive income from electricity plus an additional amount for the renewable energy certificates (ROCs + LECs). Figure 11 shows values that are inclusive of electricity prices, and therefore do not represent the subsidy, but rather the subsidy + market value. Because of the difficulty of comparing across countries, a relatively smaller sample is presented here.

In some cases, there appears to be a discrepancy between the different data sources, leading to a range of estimates – these cases are noted with an asterisk. In other cases, the range relates to different tariffs applying to different sizes of plant, or for different vintages (i.e. year of installation). For example, in the UK case the ranges apply to different tariff rates applied to different dates of installation as described in the notes below the charts.

Figure 11 Ranges of subsidies for renewables in selected EU countries







NOTES:

*	Range due to differences between sources
+	Support based on a premium: these figures include an estimate of wholesale market price received
^	Tariff suspended
(1)	Lower limit is the reduced banding rate for offshore wind of 1.5 ROC per MWh. Upper limit is current rate of 2 ROC per MWh
(2)	Lower limit is the current PV tariff, upper limit is the rate that existed for projects up to Mar 2012
(3)	Lower limit is for biomass co-firing, upper limit is for dedicated energy crops or biomass with CHP

Onshore wind tariffs lie within a relatively narrow band (with the exception of Italy), reflecting the mature state of the technology. The UK lies at the upper end of this range, but is broadly comparable with other European countries. By comparison, offshore wind tariffs vary considerably. The lowest figures appear to be for Denmark, based on data from the EREF report which constitutes the lower bound of the range. On the other hand, the tariff rate arrived at by auction for the recent Anholt offshore wind farm was around €140/MWh, which is comparable with the lower end of the UK range (€134/MWh) which applies to the lower banding rate for projects built after 2014. In general, it therefore appears that under current RO banding arrangements, the price for offshore wind including subsidies and market prices is either comparable or relatively low compared to other major European countries.

Solar tariffs also vary considerably between countries, and generally have a wide range even for individual countries. This largely represents the fact that tariffs are under frequent review, and are generally coming down quite quickly. Many countries have a degression rate for subsidy levels, and these are often tied to the rate of uptake (notably in Germany). This means that different plant will receive very different rates depending on when it was installed. The range for the UK represents the difference between the current (lower) rates and the higher rates that pertained prior to March 2012. Broadly speaking, the new lower rates in the UK lie at the lower end of the range of European tariff levels, whereas the rates prior to March 2012 were at the upper end.

Support levels for Biomass in the UK are broadly comparable to those in the rest of Europe, although direct comparison is more complex than this chart would suggest because the wide range of applications of biomass and different sources of biomass tend to attract different rates, and there is no harmonisation of these categories across different countries.

3.3 Nuclear

International comparisons of national-level nuclear subsidies for new plant are difficult to obtain, partly because nuclear subsidies are more obscure, and partly because of the scarcity of new build operations. The new plant at Flamanville in France is being undertaken by EdF, a majority state-owned company, so cost overruns presumably are picked up ultimately by the state, and therefore constitute a subsidy, but independent figures are difficult to obtain. The Olkiluoto 3 plant in Finland is being built under market conditions, but it is not yet clear who will ultimately pick up the tab for cost overruns.

Estimates of funding arrangements for decommissioning and waste are available through EU comparisons of state aid, although it is not clear that such comparisons are truly on a like-for-like basis. The EU is involved in nuclear support at the national level in a number of ways, some direct, some indirect. In terms of direct support, during the accession negotiations, the Lithuanian, Slovakian and Bulgarian Governments committed themselves as part of their Accession Treaties to close their Soviet-design reactors. This was a central issue in the negotiations with all three countries, and an important part of the whole package of rights and responsibilities. To help them meet this commitment, substantial Community assistance in addition to that provided under the former PHARE programme were agreed. The overall financial support for the three programmes totals some € 2.5 bn. This covered the support for Bulgaria until 2009 and covers Lithuania and Slovakia until 2013. The EU is also involved more indirectly through its influence on state aid decisions made by Member States.

The significant liabilities for decommissioning and waste disposal built up during the lifetime of a nuclear reactor are supposed to be covered by the EU's Polluter Pays Principle. To comply with this principle, plant operators should build up a supply of finance to cover these liabilities over the productive life of the plant. This principle is only partially complied with across the EU.

The European Commission has recently (March 2013) released a staff working paper which sets out the level of support provided by Member States to fund nuclear decommissioning activities (EU 2013), from which data is summarised in Table 3.1. Member State governments are involved in these decommissioning funds in a number of different ways. Most directly, where nuclear power plants are under public ownership, the government will be directly responsible for the decommissioning and waste costs. Often these liabilities will be met out of current budgets rather than building up ring-fenced reserves. In other cases, governments have made commitments to meet some of the liabilities on behalf of the companies that own the plant. In Germany, the financial provisions for decommissioning are provided by the owners of the plant, conforming to the polluter pays principle. Nevertheless, the tax treatment of these funds does constitute a subsidy, although not a state aid, a decision arising from a test in the European courts. With €30bn of decommissioning funds set aside, the German government is forgoing income tax revenues on the order of €4.5bn[16]. This estimate is confirmed by a DIW study (Diekmann and Horn 2007) which valued this subsidy at €5.6bn.

Table 3.1 Comparison of nuclear decommissioning cost estimates across the EU

	Total estimated decommissioning costs	Provisions accumulated by end 2009	% of required funds accumulated	% of operational lifetime expired
	[€ million]	[€ million]		
Belgium	3,453	2,002	64%	63%
Bulgaria	Special case			
Czech Republic	1,280	251	20%	46%
Germany	11,672	2,529	22%	100%
Denmark	98	98	100%	100%
Finland	519	506	97%	62%
France	77,048	36,781	48%	various
Hungary	4,030	116	3%	51%
Lithuania	2,400	153	0%	100%
Netherlands	Confidential			
Romania	598	13	2%	28%
Sweden	8,548	4,459	52%	63%
Slovenia	1,155	145	13%	68%
Slovakia	1,955	931	48%	62%
UK	42,405			83%

For a review of energy subsidies to the nuclear industry (past and present) in the US, see (UCS 2011). This quantifies subsidies for investor-owned utilities (IOUs) and publicly-owned

[16] Based on an assumed application of Germany's flat rate corporate tax level of 15%.

utilities (POUs), suggesting that for existing plant, legacy subsidies amount to around 140% of market prices, whilst ongoing cost subsidies amount to between 13-100% of market prices. For new plant the study concludes that subsidies amount to between 70-200% of market price (Figure 12).

Figure 12 Estimates of subsidy levels for nuclear plant in the US ¢/kWh (Source: (UCS 2011)

A) Existing plant

	Legacy		Ongoing			
			IOU		POU	
Subsidy Type	Low	High	Low	High	Low	High
I. Output-linked support	0.00	0.00	0.00	0.00	0.00	0.00
II. Factors of production	7.20	7.20	0.06	0.06	0.96	1.94
III. Intermediate inputs	0.10	0.24	0.29	0.51	0.16	0.18
IV. Security and risk management	0.21	0.22	0.10	2.50	0.1	2.5
V. Decommissioning and waste management	NA	NA	0.29	1.09	0.31	1.15
Total	**7.50**	**7.66**	**0.74**	**4.16**	**1.53**	**5.77**
Share of market power price	139%	142%	13%	70%	26%	98%

Note: Legacy subsidies are compared to the EIA average 1960–2009 industrial power price (5.4 ¢/kWh). Subsidies to existing reactors are compared to 2009 power prices entailing comparable busbar plant generation costs (5.9 ¢/kWh).

B) New plant

	IOU		POU	
Subsidy Type	Low	High	Low	High
I. Output-linked support	1.05	1.45	0.00	0.00
II. Factors of production	3.51	6.58	3.73	5.22
III. Intermediate inputs	0.21	0.42	0.21	0.42
IV. Security and risk management	0.10	2.50	0.10	2.50
V. Decommissioning and waste management	0.13	0.48	0.16	0.54
Total	**5.01**	**11.42**	**4.20**	**8.68**
Share of high power price	84%	190%	70%	145%
Share of market power price	88%	200%	74%	152%

Note: Subsidies are compared to EIA 2009 power prices entailing comparable busbar plant generation costs (high: 6.0 ¢/kWh; reference: 5.7 ¢/kWh).

Total estimated subsidies to new reactors are much higher than those for ongoing operations at existing plants: 4.2 to 11.4 ¢/kWh—or between 70 and 200 percent of the projected value of the electricity they would produce over the next 15 years.

3.4 European-level Support for Energy

The EU's influence on energy issues has increased in recent years and culminated with the adoption of the Treaty of Lisbon and within that the inclusion of energy as an area of joint competence between the EU and Member States.

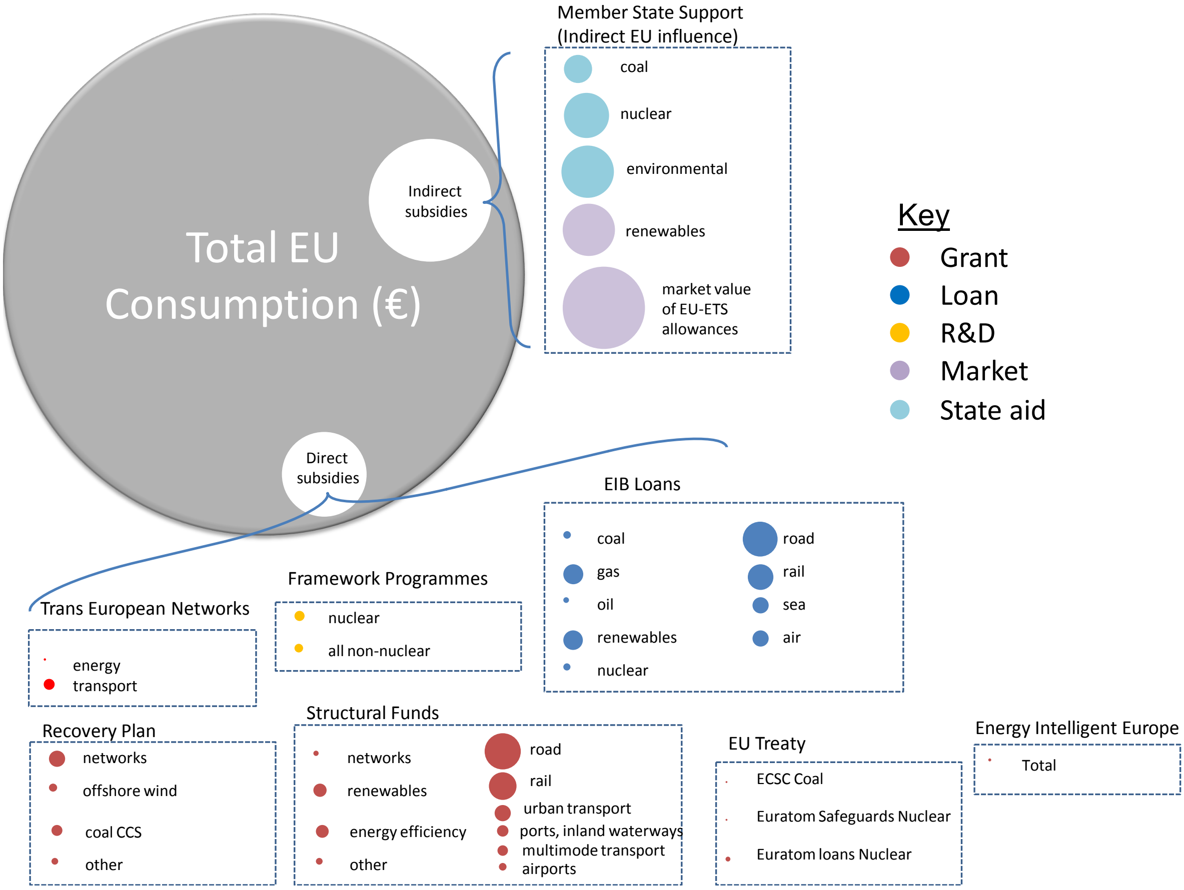
The total value of energy consumption in the EU is around €1.2 trillion per year. The EU has both a direct and indirect impact on this price through its legislation. However, the financial implications of these impacts are relatively small, compared to total energy expenditure. Of the two, the direct impacts of EU legislation is around 1% of the total expenditure, whereas the indirect affect is around 5%.

Direct Impact: The EU institutions can make available finance, either in the form of loans or grants, for the development and piloting of new energy technologies or for energy infrastructure, in particular for the gas and electricity grids, transport infrastructure and the energy efficiency of infrastructure in general. The types of projects being funded by the EU are dependent on a number of factors, for example the sector specific support mechanisms for nuclear and to a lesser extent coal exist as a direct result of the establishment of the EURATOM and Coal and Steel Treaties, over fifty years ago. However, a larger share of the finance is determined by current policies, in particular as the EU strives to meet the 20:20:20 targets.

Indirect Impact: The EU, through it legislation or rulings, also has an indirect impact on the subsidies and support schemes in Member States. This is most financially significant in the area of State Aid rulings, which determine the extent to which Member States can assist their industries, and in setting the framework for the use of market mechanisms such as feed in tariffs for renewable energy. Feed in tariffs do not require direct public financial support, but will often lead to additional financial assistance for a technology or technologies from within the market.

Figure 13 shows the degree to which the EU institutions have control and/or influence on energy subsidies and ultimately energy pricing within the borders of the European Union.

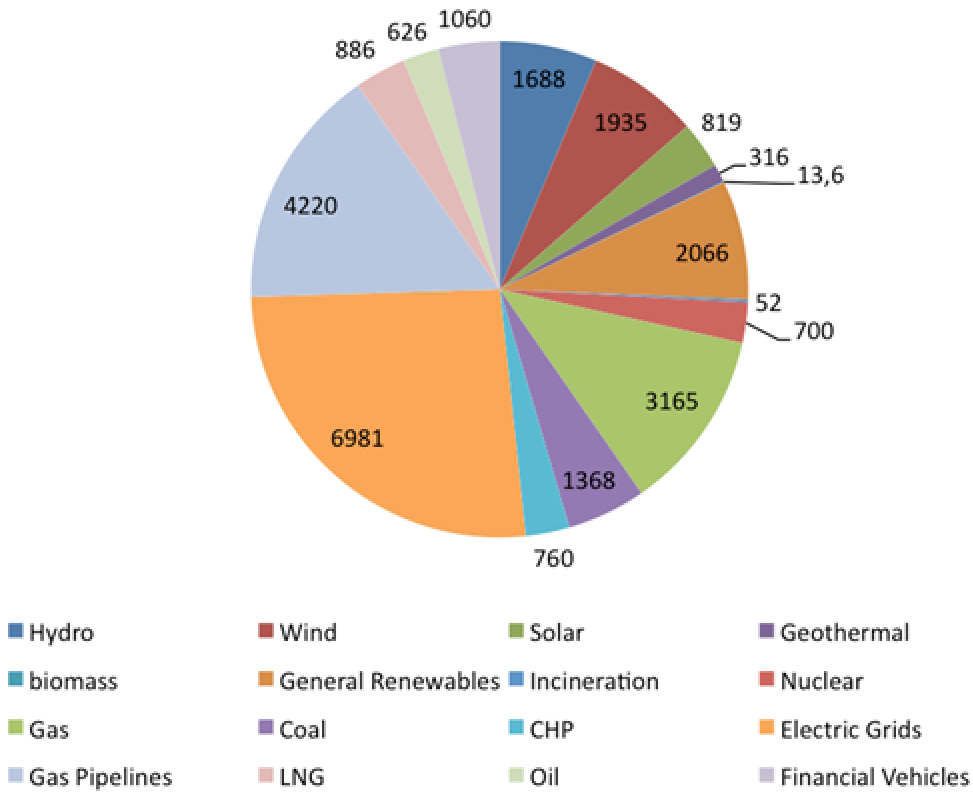
Figure 13: Influence of EU Institutions on Energy Subsidies in Europe



There are a number of mechanisms in which the EU directly funds, either through loans or grants, the development of the energy sector within and outside the EU. However, there is no single process which decides the engagement of the EU institutions. This creates both a complexity and potentially a lack of consistency in the projects and infrastructure funded.

The main loans are granted through the European Investment Bank which, in terms of the volumes of finance that it disperses, is the largest International Financial Institution in the world (see Figure 14)

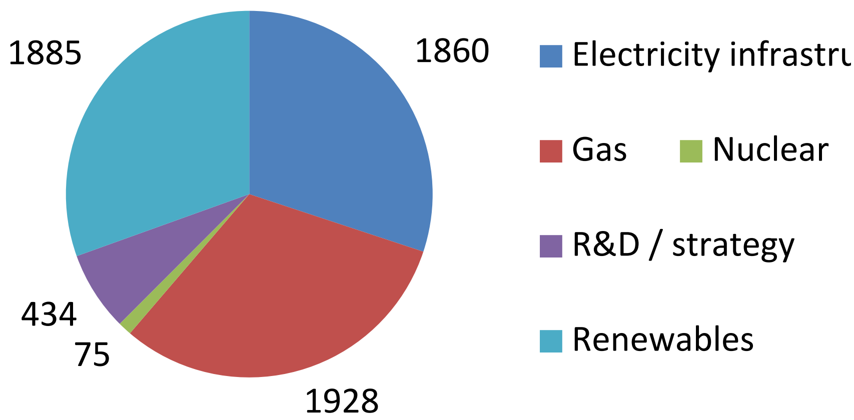
Figure 14: European Investment Bank Energy Lending 2006-2009 (€ million)



Source: EIB 2010[17]

More recently, EIB has consolidated lending around renewable energy, and gas and electricity infrastructure projects. In 2012, there were no loans to coal plant, and one loan for the expansion of uranium enrichment facilities in Almelo, Netherlands (Figure 15).

Figure 15 EIB lending in 2013[18] (€m)



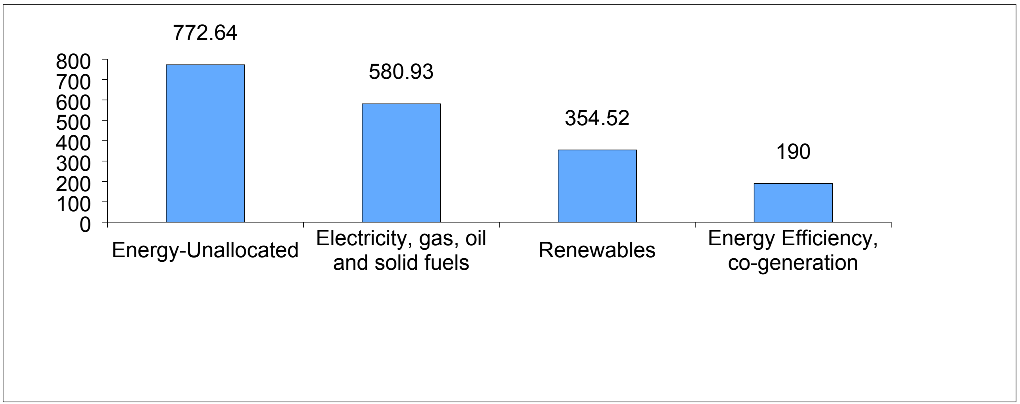
The other major direct area of influence is the EU's structural funds, which through the European Fund for Regional Development (EFRD), the European Social Fund (ESF) and the

[17] EIB (2010): Projects financed data-base, accessed June 2010 http://www.eib.org/projects/loans/index.htm

[18] EIB (2013): Projects financed data-base, accessed Mar 2013 http://www.eib.org/projects/loans/index.htm

Cohesion Fund can make available over €300 billion to promote growth and jobs leading to the convergence for the least-developed Member States and regions. In the energy sector this includes financial assistance to meet EU objectives, such as energy efficiency targets, but also the greater integration of the energy networks, though the trans European energy and transport networks programmes. The EU also seeks to directly influence the development and deployment of new technologies, through its long established research programme or through demonstration funding, such as in the European Recovery or the Energy Intelligent Europe Plans.

Figure 16: Expenditure on Energy Infrastructure 2000-6 in the European Regional Development Fund (€ million)



Source: European Commission 2002[19]

The Structural and Cohesion Funds are used widely in the EU to harmonise the economic and social conditions in different regions. Europe's poorer regions receive most of the support, but all European regions are eligible for funding under the policy's various funds and programmes. The Structural Funds are made up of the European Regional Development Fund (ERDF) and the European Social Fund (ESF). Together with the Common Agricultural Policy, the Structural Funds and the Cohesion Fund make up the great bulk of EU funding, and the majority of total EU spending. New objectives have been defined for the current programmes, which run from 1 January 2007 to 31 December 2013. The overall budget for this period is €347bn: €201bn for the European Regional Development Fund, €76bn for the European Social Fund, and €70bn for the Cohesion Fund.

In July 2004 the European Commission adopted its legislative proposals on the reform of the cohesion policy for the budgetary period, 2007-13. Within this and through the Cohesion Fund, a specific budget for investment in both energy efficiency and renewable energy was established.[20] The anticipated budgets are seen below and show how much the shift has taken place to support the development of renewable energy and energy efficiency.

[19] European Commission (2002): Staff Working Paper Inventory Of Public Aid Granted To Different Energy Sources. , December 2002, page 121. It must be noted that the figure used for renewables is less than that quoted in the same report on page 50, which estimates the renewables expenditure during this period to be €487 million.

[20] European Commission (2007): Cohesion policy: the 2007 watershed: Inforegio, Fact Sheet 2004: European Union Regional Policy.

Table 3.2 summarises the major direct expenditure by the EU for energy, including transport issues. As can be seen transport expenditure dominates the major EU sources of funding, the structural funds and the loans from the EIB. The transport sector receives eight times more funding from structural funds than energy and three times more from the EIB. The transport sector in fact receives nearly one quarter of all structural funds.

Table 3.2 Summary of Direct EU Influence on Energy Expenditure and Pricing (Source: European Commission[21])

Technology	Type of support	Programme	Dates	Total (€million)	Annual (€million)
Grants					
Energy					
Networks	Grant	Structural and Cohesion funds	2007-2013	675	112
Renewables	Grant	Structural and Cohesion funds	2007-2013	4761	793
Energy Efficiency	Grant	Structural and Cohesion funds	2007-2013	4272	712
Other	Grant	Structural and Cohesion funds	2007-2013	1101	183
Transport					
Road	Grant	Structural and Cohesion funds	2007-2013	41000	5850
Rail	Grant	Structural and Cohesion funds	2007-2013	23600	3370
Urban transport	Grant	Structural and Cohesion funds	2007-2013	8100	1160
Ports and inland waterways	Grant	Structural and Cohesion funds	2007-2013	4100	590
Multi-mode transport	Grant	Structural and Cohesion funds	2007-2013	3300	470
Airports	Grant	Structural and Cohesion funds	2007-2013	1900	270
Networks	Grant	Recovery Plan	2009-2011	2365	1182
Offshore Wind	Grant	Recovery Plan	2009-2011	565	282
Coal – CCS	Grant	Recovery Plan	2009-2011	1050	525
Coal	Grant	ECSC	1952 – 2002	13,000	260
			2003-2006	60	15
Energy Efficiency	Grant	Energy Intelligent Europe	2008	10	10
Renewables	Grant	EIE	2008	11	11
Transport	Grant	EIE	2008	13	13
Nuclear	R&D	Framework Programmes 4-7	1994-2013	8701	457
All non-nuclear energy	R&D	Framework Programmes 4-7	1994-2013	5959	313
Transport	R&D	Framework Programme 7	2007-14	4100	585
Loans					
ENERGY					
Gas	Loan	EIB	2006-2009	6981	1745
Oil	Loan	EIB	2006-2009	626	156
Renewables	Loan	EIB	2006-2009	6837	1709
Nuclear	Loan	EIB	2006-2009	886	221
Coal	Loan	EIB	2006-2009	1060	265
Nuclear	**Loan**	**Euratom loans**	**1977-2009**	**3,420**	N/A
TRANSPORT					

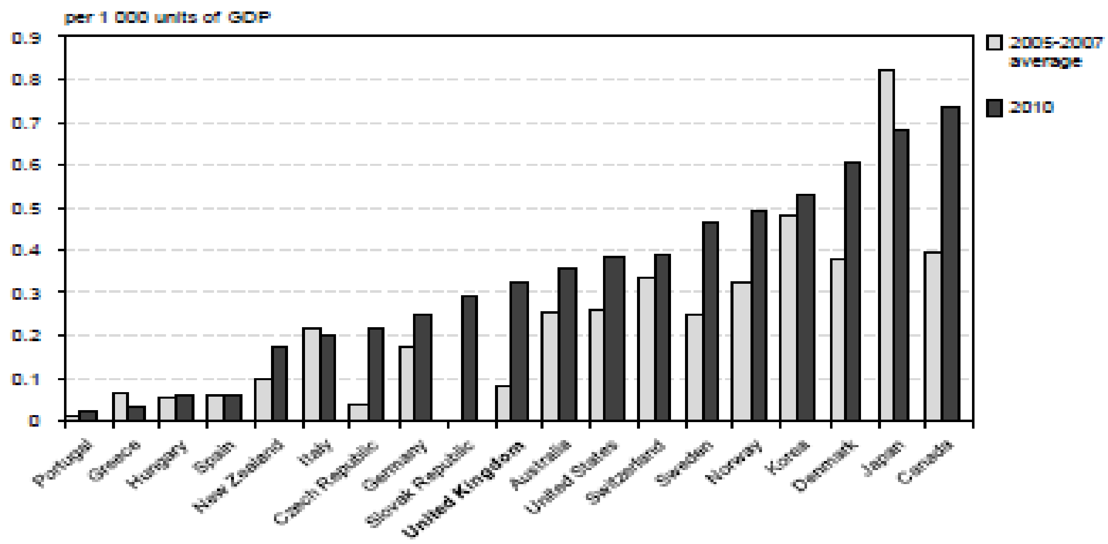
[21] European Commission (2007): Cohesion Policy 2007-13: Energy, DG Employment, Social Affairs and Equal Opportunity, DG Regional Policy. http://ec.europa.eu/regional_policy/themes/statistics/2007_energy.pdf

Technology	Type of support	Programme	Dates	Total (€million)	Annual (€million)
Road	Loan	EIB	2006-2009	21416	5354
Rail	Loan	EIB	2006-2009	11576	2894
Sea	Loan	EIB	2006-2009	4509	1127
Air	**Loan**	**EIB**	**2006-2009**	**5782**	1145

3.5 Energy R&D

A comparison of government R&D expenditure on energy is provided by (IEA 2012). As noted in Section 2.6.1, funding for energy research in the UK increased dramatically between the mid-2000's and 2010. Figure 17 indicates a similar trend (though not so extreme) in many IEA countries as interest in energy issues and concerns over energy security and the rise in energy prices rose over this period. R&D expenditure in the UK shifted from being amongst the lowest of IEA countries (measure relative to GDP), to being the median level of expenditure.

Figure 17 Government R&D budgets across IEA countries



References

Measuring and Managing Federal Financial Risk, University of Chicago Press.

Abernathy, W. J. (1979). "The productivity dilemma." Business Horizons **22**(6): 86-87.

Adler, P. S., M. Benner, D. Brunner, J. MacDuffie, E. Osono, B. Staats, H. Takeuchi, M. Tushman and S. Winter (2009). "Perspectives on the Productivity Dilemma." Journal of Operations Management **27**(2): 99-113.

Arrow, K. J. and G. Debreu (1954). "Existence of an Equilibrium for a Competitive Economy." Econometrica **22**: 265-290.

Birmingham (2012). THE FUTURE OF NUCLEAR ENERGY IN THE UK Birmingham Policy Commission, University of Birmingham.

Blaug, M. (2007). "The Fundamental Theorems of Modern Welfare Economics, Historically Contemplated." History of Political Economy **39**(2): 185-207.

DECC (2011). Control Framework for DECC Levy-Funded Spending: Questions and Answers. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48244/3290-control-fwork-decc-levyfunded-spending.pdf.

DECC (2011). Waste Transfer Pricing Methodology for the disposal of higher activity waste from new nuclear power stations, Department of Energy and Climate Change.

DECC (2012). Gas Generation Strategy, UK Department of Energy and Climate Change.

DECC (2012). Nuclear third party liabilities to be increased sevenfold.

Diekmann, J. and M. Horn (2007). Fachgespräch zur Bestandsaufnahme und methodischen Bewertung vorliegender Ansätze zur Quantifizierung der Förderung erneuerbarer Energien im Vergleich zur Förderung der Atomenergie in Deutschland Available online at: http://www.erneuerbare-energien.de/inhalt/39617 Available online at: http://www.erneuerbare-energien.de/inhalt/39617, Auftrag des BMU.

Donohue, M. (2008). Environmentally Harmful Subsidies in the Transport Sector. Paris, OECD. **OECD Document No. ENV/EPOC/WPNEP/T**.

EnergyFair (2012). Nuclear Subsidies. www.energyfair.org.uk.

EU (2013). Commission Staff Working Document: EU Decommissioning Funding Data. Brussels. **SWD(2013) 59 final**.

Fouquet, D. (2012). Prices for Renewable Energies in Europe: Report 2011-2012 European Renewable Energies Federation.

Greenpeace (2011). Subsidy Assessment of Waste Transfer Pricing for Disposal of Spent Fuel from New Nuclear Power Stations

GSI (2010). Fossil Fuels – At What Cost? Government Support for Upstream Oil Activities in Three Canadian Provinces: Alberta, Saskatchewan, and Newfoundland and Labrador. Geneva, Switzerland, International Institute of Sustainable Development.

GSI (2010). Fossil Fuels – At What Cost? Government Support for Upstream Oil and Gas Activities in Indonesia. Geneva, Switzerland, International Institute for Sustainable Development.

GSI (2010). Subsidy Estimation: A survey of current practice Geneva Switzerland, International Institute for Sustainable Development.

GSI (2010). Tax and Royalty-Related Subsidies to Oil Extraction from High-Cost Fields: A Study of Brazil, Canada, Mexico, United Kingdom and the United States. Geneva, Switzerland, International Institute for Sustainable Development.

GSI (2012). Fossil Fuels - At What Cost? Government Support for Upstream Oil and Gas Activities in Norway. Geneva, Switzerland, International Institute of Sustainable Development.

IEA (1999). World Energy Outlook: Looking at Energy Subsidies, getting the prices right. Paris, International Energy Agency.

IEA (2012). Energy Policies of IEA Countries: The United Kingdom 2012 Review. Paris, International Energy Agency.

IEA, OPEC, OECD and W. BANK (2010). ANALYSIS OF THE SCOPE OF ENERGY SUBSIDIES AND SUGGESTIONS FOR THE G-20 INITIATIVE Joint Report Prepared for submission to the G-20 Summit Meeting Toronto (Canada)

IMF (2013). Case studies on energy subsidy reform: Lessons and implications. http://www.imf.org/external/np/pp/eng/2013/012813a.pdf, International Monetary Fund.

IMF (2013). Energy Subsidy Reform: Lessons and Implications. http://www.imf.org/external/np/pp/eng/2013/012813.pdf, International Monetary Fund.

Koplow, D. (2009). Measuring energy subsidies using the price-gap approach: what does it leave out?, International Institute for Sustainable Development.

Lipsey, R. G. (2007). "Reflections on the general theory of second best at its golden jubilee." International Tax and Public Finance **14**(4): 349-349.

Lipsey, R. G. and K. Lancaster (1956). "The General Theory of Second Best." The Review of Economic Studies **24**(1): 11-32.

Lucas, D. (2010). Measuring and Managing Federal Financial Risk, University of Chicago Press.

Lucas, D. (2012). "Valuation of Government Policies and Projects." Annual Review of Financial Economics **4**: 39-58.

NAO (2012). Managing risk reduction at Sellafield: REPORT BY THE COMPTROLLER AND AUDITOR GENERAL, National Audit Office.

OECD (2010). Measuring Support to Energy.

OECD (2012). Inventory of Estimated Budgetary Support and Tax Expenditures for Fossil Fuels 2013. Paris, OECD Publishing

OECD (2013). Taxing Energy Use: A Graphical Analysis.

Ofgem (2012). Feed-in Tariff Quarterly Report. **Issue 10**.

Portal, E. "Europe's Energy Portal."   Retrieved 27 March 2013, 2013.

Sander, M., J. (2009). Justice. London, Penquin Books.

Schneider, M., A. Froggatt and J. Hazemann (2012). World Nuclear Status Report. Paris, London.

Schumpeter, J. (1942). Capitalism, Socialism and Democracy. New York, Harper & Row.

Sen, A. (2001). Development as Freedom. Oxford, Oxford University Press.

Thomas, S. (2004). **The UK Nuclear Decommissioning Authority**, **Public Services International Research Unit**

UCS (2011). NUCLEAR POWER: Still Not Viable without Subsidies Union of Concerned Scientists.

UK (2010). The Feed-in Tariffs (Specified Maximum Capacity and Functions) Order 2010 No. 678.

UK (2012). The Feed-in Tariffs (Specified Maximum Capacity and Functions) (Amendment No. 2) Order 2012 No. 1393. http://www.legislation.gov.uk/uksi/2012/1393/pdfs/uksi_20121393_en.pdf, UK Government Statutory Instruments.

Valsecchi, C., P. ten Brink, S. Bassi, S. Withana, M. Lewis, A. Best, F. Oosterhuis, C. Dias Soares, H. Rogers-Ganter and T. Kaphengst (2009). Environmentally Harmful Subsidies: Identification and Assessment Final report for the European Commission's DG Environment, November 2009

WorldBank (2010). Subsidies in the Energy Sector: An Overview Background Paper for the World Bank Group Energy Sector Strategy. Washington, World Bank.

17 April 2013