Europe Economics

Evaluation of Fiscal Measures in the National Policies and Methodologies to Implement Article 7 of the Energy Efficiency Directive

Final report

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1 Introduction

The energy efficiency target is one of three energy and climate objectives for 2020 agreed by the EU Heads of State and Government in 2007. The Energy Efficiency Directive (EED) establishes a common framework of measures for the promotion of energy efficiency within the EU, and it brings forward legally binding measures to increase Member States' efforts to use energy more efficiently. The EED required Member States to notify the Commission of their detailed planned, proposed or legally defined design and methodology for the operation of their energy efficiency obligation scheme and/or the policies they plan as alternative measures (as specified in Article 7 of the EED).

Having studied Member States' National Energy Efficiency Action Plans (NEEAPs), as well as the communications from the Member States in connection with Article 7, the Commission has identified a knowledge gap with regard to Member States' application of fiscal measures to support energy savings in end-use sectors. There is therefore a need to better understand the impact of Member States' use of government spending and taxation on the energy savings being claimed under Article 7.

1.1 Scope and objectives of the study

The focus of this study is fiscal measures that have been notified under Article 7(9) of the EED as alternative measures to the energy efficiency obligation scheme. In principle, this could encompass a broad range of measures. Here, we focus on energy and CO_2 taxation measures and other fiscal measures which involve a direct subsidy, e.g. in the form of grants or investment subsidies.

The objective of the study is to produce a conceptual framework for assessing energy savings that stem from fiscal measures notified under Article 7 that can be implemented in practice. Specifically, the study provides a framework for the evaluation of these impacts, and a more detailed focus on the complex area of price elasticity of demand estimates that can be used to assess changes in final energy consumption associated with taxation measures. To illustrate how these frameworks can be used in practice, the study reviews the savings and underlying calculations put forward by four Member States, and demonstrates where particular approaches represent good practice or where particular approaches fail to take into account relevant factors that can affect the overall level of savings that can be claimed.

1.2 Structure of the report

This report is structured as follows:

- Section 2 provides an overview of the types of fiscal measures that can be used and factors affecting the effectiveness of these measures.
- Section 3 provides a framework for evaluating the energy savings associated with fiscal measures notified under Article 7 of the EED.
- Section 4 provides an illustration of the framework by comparing the approaches taken in four Member States to the conceptual framework provided in Section 3.
- Section 5 provides a framework for the use of price elasticities and the factors that need to be taken into account when applying them.
- Section 6 illustrates this framework by comparing approaches taken in four Member States to the framework in Section 5.
- Finally, Section 7 provides recommendations for DG Energy to consider when revising the EED and associated guidance documents.

2 Effectiveness of Fiscal Measures

In this section we provide a theoretical consideration of the effectiveness of taxes and subsidies to achieve energy savings among final customers as part of energy efficiency policies. The section first looks at the operating framework of policy measures (theoretical justification, approach, and analysis of the main determinants of their effectiveness). The effectiveness of the measures is then assessed in practice by looking at some of the evidence provided in the literature and in different policy reports. The section concludes by showing the issues that may be encountered in some situations where measures are undertaken jointly. The last subsection concludes.

2.1 Theoretical framework and market failures

As with any policy measure, energy efficiency policies seek to address a specific market failure, this is, situations where the market left alone would fail to allocate resources efficiently or fail to achieve an optimum situation from a societal point of view.

The relevant market failures have been properly documented in the field of energy and climate change. The main failures (and arguments for public intervention) have been identified as problems with: externalities, imperfect information, split incentives or behavioural failures.

- Externalities may occur in situations where users do not bear the full social cost of their actions. In an energy context, externalities have been mostly associated with greenhouse gas (particularly carbon dioxide) emissions created from the use of fossil fuels. The externality arises because the emissions generated by any one user have a negative effect on the rest of society.
- Imperfect information is the presence of insufficient, inaccurate or costly information on the costs and benefits of some technologies which could create sub-optimal choices when carrying out a transaction. In the context of energy, difficulties faced in obtaining accurate information on energy-efficiency measures, and the costs of implementing them, may lead to consumers failing to take up such investments.
- Split incentives may arise in instances where the party in a position to improve energy efficiency does not reap the rewards directly. For example, this could be a situation in which a building owner does not pay for energy efficiency upgrades because it is the tenant, not him, who would recover savings from reduced energy use.
- Behavioural failures relate to consumers who make non-optimal choices in the market, usually due to an inability to impose short-term costs in order to receive long term gains. In the context of energy consumption, some consumers decline to choose energy efficient models, such as a fuel-efficient cars, despite the future savings they would make.

2.2 How do fiscal measures work in theory?

Fiscal measures have traditionally been one of the most common instruments in the field of energy and climate-change policies to control energy consumption. The most common measure typically involves a tax or levy on energy products aimed at increasing the price of the energy. It is expected that this would in turn decrease consumption with a consequent reduction in carbon emissions. In some cases, fiscal measures involve reducing taxes for energy sources which policy makers wish to promote (e.g. so called "clean" fuels). Other measures include subsidies aimed at incentivising the substitution of one type of goods (typically energy-polluting or energy-intensive) for another (with cleaner or less energy use). In many instances policy makers opt for a combination of these different types of fiscal measures, where the tax revenues from tax measures are earmarked and redirected to the provision of subsidies for more energy efficiency measures and technologies.[1]

Although both taxation measures and subsidies often aim at the same objective (reduction of energy consumption) and operate in related ways, they are more (or less) effective in achieving this aim depending on the context in which they are encountered. This implies that they have different characteristics.

Taxation measures

Taxation is principally aimed at addressing the negative externalities associated with pollution caused by energy consumption (the first of the market failures identified). As seen, it does so by charging a special tax or levy on certain type of energy sources, changing the relative price of these energy sources (either by increasing the price of "dirty" fuels or decreasing the price of "clean" fuels). The objective of the measure is to make consumers and producers pay the full social cost of the good (including the cost that pollution poses to society in the form of carbon emissions and green house effects).

Because imposing a tax on the emission of pollutants might be difficult to implement, in practice direct and indirect measures are typically used:

- Direct measures include charges related directly to the externality. This type of measures implicitly assumes that the market failure is observable and quantifiable. An example would be taxes on carbon emissions.
- Indirect measures are taxes related to the consumable generating the externality (for example, the fuels generating carbon emissions) or consumables related to it (e.g. the cars which use such fuels).

Subsidies

Subsidies are measures often used by governments to address any of the market failures described earlier. The nature of the subsidy is often targeted to ensure that a particular market failure is addressed (e.g. by focussing on a particular energy efficient technology or limiting the subsidy to particular target groups). The purpose of such measures is to *divert* consumption to alternative consumables which use less energy or pollute less. This could be alternative sources of cleaner energy (green energy or from renewable sources) or energy-efficient products (efficient cars or efficient appliances). The different types of subsidies typically used include:

- guaranteed payments (e.g. a guaranteed minimum price offered for renewable energy);
- input cost or investment subsidies (e.g. a subsidy for wall insulation);
- grants to cover losses (e.g. money provided by the government to loss-making companies producing energy efficiency products);
- favourable terms for loans to cover costs (e.g. a reduced rate of interest on loans for companies producing energy efficiency products).

2.3 What factors determine the effectiveness of fiscal policy measures?

The impacts of taxes and subsidies, and therefore their effectiveness, depend upon the extent to which suppliers and consumers react to the changes stemming from the policies and the energy-efficiency of any of the new consumables being used.

[1] It should be noted that the scope for this to be done effectively may depend on the tax collection systems in place. In some situations (especially in developing countries) provision of subsidies may be limited to the tax collection systems and their effectiveness in raising revenue. In such cases, taxation measures may be easier to implement.

Where a policy changes the price of a good, the effects have been typically modelled as the combined impact of a pass-through effect and a lost sales effect (this is the typical found in the area of energy or carbon taxation).

Pass-through: The pass-through effect measures the extent to which suppliers can pass on to consumers any increases in their costs (including changes as a result of tax increases). The pass-through rate depends on the elasticity of supply, or the sensitivity of a firm's marginal costs to changes in output (if supply is very inelastic, tax pass-through will be small, whereas pass-through will be larger in cases of elastic supply). The pass-through rate also depends on the price elasticity of demand (in cases where consumers are less price sensitive firms tend to pass on a larger part of the price change). Finally, the pass-through rate depends on the market structure, since the higher the degree of competition between suppliers the higher the pass-through rate would be (this is the case because if competition is fierce, suppliers have relatively thin profit margins and therefore their ability to absorb a tax changes is also limited).[2]

Sales effects: The sales effect measures the extent to which consumption would change as a result of increases or decreases in prices. The reaction of demand to price changes (the elasticity of demand) is used to quantify this effect. The key aspect to consider when assessing sale-side effects is the extent to which consumers are sensitive to price changes (changes in price that might result from an increase or decrease in the tax rate), and the extent to which consumers consider alternative product substitutable or not (in some cases there may be additional effects of consumers using alternative energy products that may be less energy-efficient than the product being taxed). The key metric for assessing consumers' price sensitivity and product substitutability is based on the concept of elasticity. The own-price elasticity of an arbitrary product is defined as the percentage change in the demand of that product that results from a percentage change in the price of that same product. Similarly the cross-price elasticity between two products (A and B) is defined as the percentage change in the demand of product B that results from a percentage change in the price of product A (this is further explained in Section 5).

Because the policies on subsidies are typically related to the substitution of energy use via alternative consumables, the analysis of impacts typically deals with the degree of take-up of measures, the efficiency in substituting the energy and the energy savings achieved for each of the measures. Other aspects to take into account are related to the "misuse" of funds, energy efficiency potential, rebound effects or discounting.

Take up: relates to the amount of beneficiaries that subscribe to the new policy initiative. This can relate to households benefiting from an insulation measure or companies benefiting from subsidies to invest in low and zero carbon technologies.[3]

Substitution: It is important to establish the extent to which subsidies are actually replacing previous energy inefficient products. Because many subsidies are conditional on scrapping an old product (such as measures to improve energy efficiency in cars, heating or cooling) substitution is normally assumed to be total. However, when this is not that case this is something that should be considered (this can happen with

[2] In general, the more competitive the market, the higher is the degree of pass through of industry-wide cost changes that can be expected (and the lesser the extent of firm-specific cost changes). This result arises because the lower margins earned by firms in more competitive markets reduce the impact of reduced sales volumes. However, these results are based on simplified models with simplifying assumptions. In reality, in addition to the nature and extent of competition, the degree of pass through which will have actually occurred in response to implementation of an energy or carbon tax could depend on a range of market characteristics, such as: cost structure; vertical integration; the nature of demand; proportion of total costs made up by the taxed product(s); degree of asymmetric information between firms and consumers; and pricing structure.

[3] In principle, the take-up of these substitute products would be determined by the pass-through and sales effects discussed above, as well as the responsiveness of demand to changes in the prices of other products (what is known as a cross-price elasticity). However, in practice policy analysis of subsidies would assume some level of take-up of subsidised products, rather than analysing changes in supply and demand as is more commonly the case when appraising the effect of taxes.

subsidies for energy efficient white goods; in such cases consumers may end up purchasing additional products without replacing old ones and increasing energy consumption as a result).

Energy savings: the effects of the different subsidies (in terms of energy savings) will depend on the energy efficiency of different measures. Hence, the impact of policies will depend on the savings envisaged for each of the new installations (related to this is the way such savings are calculated to assess the impact of different policies).

"Misuse" of funds: it is possible that some of the savings achieved would have happened anyway, even in the absence of the policy measure being implemented. In some instances this has been referred to as a "free-rider" effect to reflect the fact that some of the impacts include consumers which would have undertaken the investment even in the absence of funds.[4]

Energy efficiency potential: the level of technological development or existing deployment of energy-saving measures can have an impact on the new measures. Sectors that have already achieved high levels of energy efficiency can find it difficult to implement further energy efficiency measures. This would reduce the effectiveness of fiscal measures used to incentivise certain types of behaviour.

Rebound effects: The provision of a subsidy may directly reduce the overall amount of energy used. But if this is translated into a reduction in energy bills (and an increase in consumers' disposable income), these consumers may opt to spend some of their income on *more* energy. This is known as a "rebound effect". A common example that has been observed is consumers improving the insulation of their homes, but then opting to heat their homes to a warmer temperature using the financial savings resulting from the greater energy efficiency of the thermal envelope.

Discounting: a key determinant of the effectiveness of any policy is the discount rate used in the appraisal.[5] The appropriate discount rate to be used in environmental appraisal has long been a contentious point in the academic literature. For pragmatic purposes and to allow comparative assessment across policies, many Member States have opted for a social discount rate that reflects the value society attaches to present, as opposed to future, consumption. However, environmentalists often argue that this discount rate is too high and does not place enough weight on the benefit to future generations of avoiding the impacts of climate change. Whatever the merits and drawbacks of using different discount rates, it is clear that the choice of discount rate has an impact on the present value of future benefits (and costs), and this affects the extent to which it can be said that the benefits of a subsidy outweigh the costs.

One final consideration that applies to both taxation and subsidies is the problem encountered when there are several overlapping policies. In such situations the effect of one type of measure could reduce the effectiveness of other measures, e.g. a subsidy for more energy efficient products might reduce consumers' responsiveness to price increases as a result of an energy tax. But this may not always be the case: in some other situations, taxation measures may strengthen price signals to adopt energy efficiency measures, increasing the energy efficiency potential which could in turn increase the effectiveness of all energy measures.

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[4] The term should be used with caution because although it does reflect the effect of reducing the effectiveness of the subsidy (as cost is incurred in providing the subsidy to generate benefits that would have occurred anyway in the absence of the subsidy) it cannot be identified with fraudulent or lack of proper contribution to the provision of a public good, which is the idea behind the "free rider" problem.

[5] This is especially true of climate change mitigation policies as, depending on the type of measure introduced, the benefits may be long lasting while the bulk of the incremental costs may only be incurred upfront: installing more energy efficient insulation entails an upfront installation cost and typically has low maintenance costs, while the benefits of reduced energy consumption will accrue over the life of the insulation measure which could be as long as 60 years.

2.4 Effectiveness of fiscal measures in practice

Generally, the main advantage of fiscal measures (including both taxation measures as well as subsidies) compared with other regulatory instruments (such as minimum standards, quotas, restrictions, etc.) is that these instruments are efficient in theory, as set out above. Further, energy users faced with consumption subject to fiscal measures have greater flexibility to choose the level to which they wish to reduce consumption and the method by which to do so (which can also create powerful incentives for innovation). The use of fiscal measures also generally requires less detailed information than specific regulatory measures, resulting in lower administrative costs.

In this section we set out some results of the effectiveness of fiscal measures in practice with regard to the policy objective of reducing final energy consumption.

2.4.1 Effectiveness of taxation measures

The use of environmental taxes for the achievement of environmental objectives has been extensively researched in recent years. The Green Fiscal Commission (GFC) in the UK recently synthesised a number of evaluations of environmental taxes and concluded that they constituted an effective instrument for the achievement of the environmental objectives for which they have been designed.[6] However, as the study notes, the design of the instrument and a clear link to the purpose for which it is being used is crucial for ensuring the effectiveness of the policy measure. In particular, it has been established that the tax must be set at the right level, and must be directed at the source of the environmental burden which it is sought to reduce. The GFC utilised data provided by the 2006 Competitiveness Effects of Environmental Tax Reforms (COMETR) report to evaluate the general effect of environmental tax reforms implemented by several EU countries.

The COMETR report was submitted to the European Commission in 2007 with the main focus of assessing how environmental tax reforms affect competiveness for various countries. Using data provided on tax rates for several commodities and energy consumption during the period of 1990 to 2005 the report concluded that tax measures, mostly placed on energy or CO_2 consumption, are likely to have brought about a decrease in greenhouse gas emissions in all EU countries which implemented them.[7] The most relevant and important of the findings include the following:

- In Finland, the very modest carbon dioxide tax rate introduced in 1990 was reformed in 1997 with substantial increases.[8] While tax rates increased, energy consumption per unit of output decreased across almost all sectors of the economy.[9] As a result, a seven percent reduction in carbon dioxide emissions was seen from 1990 to 2005. However, the results should be treated with caution because the impacts occurred at the same time as a shift from a carbon tax to an output tax on electricity took place (in 1997) and this may have compromised the total effect of these measures.
- In Denmark, both energy and carbon dioxide taxes began to be implemented in 1992 with the aim of decreasing energy input in relation to output.[10] The actual effect of the taxes between 1992 and 1997 is

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6 The Green Fiscal Commission (2009), The Case for Green Fiscal Reform, Final Report of the UK Green Fiscal Commission.

7 'COMETR – Competitiveness effects of environmental tax reforms', (2004-2006), FP6 Proposal 501993 funded by DG Research of the European Commission.

8 The petrol tax increased from 260 EUR/1000litres in 1990 to 581.3 EUR/1000l in 2005. Natural gas tax increased from 0.002 EUR/m3 to 0.018, and coal tax increased from 2.7 EUR/ton to 43.5 EUR/ton, over the same period.

9 Only the meat products sector and the cement, lime and plaster sector did not experience a predominantly downward trend.

10 Denmark implemented both energy and CO2 taxes; petrol energy tax increased from 2250 DKK/1000l in 1990 to 3850 DKK/1000l in 2005. Coal energy tax increased from 765 DKK/ton in 1990 to1445 DKK/ton in 2005, while the CO2 tax rate decreased from 242 DKK/ton to 222 DKK/ton in 2005.

difficult to discern as it was found that subsidies for renewables may have accounted for a greater proportion of emissions reductions than tax. Between sectors of the Danish economy, the tax rate varied by a factor of more than 10, therefore indicating significant differences in incentives facing companies in those industries.

- In the Netherlands, between 1990 and 2002, most sectors of the economy were able to decrease their relative energy expenditure following the introduction of energy taxation.[11] This decrease was seen despite large differences in tax rates and energy use. A mechanism introduced as part of an environmental tax reform in 1998 lessened the economic burden of the taxation scheme by returning tax revenues to relevant industries.[12] Additional taxes from 1999 to 2007 are thought to have had a diminished impact over this period because of the small magnitude of such increases.
- In Germany, industries had been subject to various forms of energy taxation for a couple of years before a fully-fledged environmental tax reform was introduced in 1999. COMETR analysis of these tax rates concluded that some sub-sectors of the German economy faced a tax burden set too low to create a real impact therefore mitigating the total effect of the tax measures. A similar mechanism to that implemented by the Netherlands to recycle tax revenues was used resulting in a reduction of the tax reform's negative economic effect.
- In the UK, a climate change levy introduced in 2001 significantly increased the carbon-energy tax burden on industry. According to the study, the UK is unique in that only a couple of industries experienced a positive economic offset induced by environmental policy instruments (though this is likely due to its relatively short term exposure to tax measures as compared to the countries above).

The studies show a wide-range of measures and activities. However, it should be noted that it is difficult to compare the effectiveness of different instruments on an equivalent (like-for-like) basis, because of the different performance metrics being used to measure effectiveness, and the different national circumstances. Therefore, the comparison of the effectiveness of taxation policies across Member States is difficult to establish.

Another lesson to be extracted from this review is that whilst the objective of Article 7 of the Energy Efficiency Directive is to reduce end-use energy consumption, many energy and CO_2 taxes may also be implemented to deliver other climate policy objectives. These can include reduction of greenhouse gas emissions or improvements in air quality. Depending upon how the different policy objectives are prioritised, this may lead to differences in the design of individual instruments, which in turn means that the taxes are less effective at reducing end-use energy consumption specifically.

2.4.2 Effectiveness of other fiscal measures

The use of other fiscal measures, such as direct fiscal incentives, to achieve energy efficiency have been used in a number of Member States. Generally, these types of measures have taken the form of a subsidy or rebate provided after purchase or paid directly upon purchase. However, there are also examples of the use of tax credits for the purchase of energy-efficient products (in the US, for example, tax incentives are often given in the form of corporate tax credits to the manufacturers of energy-efficient appliances, or the owners of commercial buildings for the installation of energy-efficient equipment).

A 2009 study for DG TAXUD assessed the costs and benefits of such direct fiscal incentives for refrigerators, washing machines, boilers and compact fluorescent lamps in France, Denmark, Italy and

[11] The energy tax on petrol increased from 348.9 EUR/1000l in 1990 to 668.10 EUR/1000l in 2005. A similar tax on coal increased from 5.5 EUR/ton in 1990 to 12.45 EUR/ton in 2005.

[12] Tax revenues have been recycled back to industries facing environmental taxation in the form of a percentage reduction in the corporate tax and a percentage reduction in the employers' contributions to the national healthcare system.

Poland.[13] In particular, the study examined subsidies for consumers, and tax credits for manufacturers and consumers. The study found the following:

- Subsidies have considerable potential for generating energy savings, exceeding that of energy taxation substantially, particularly for compact fluorescent lamps in Poland, and refrigerators in France and Denmark.
- Tax credits for consumers purchasing condensing boilers also have a high energy saving potential, though this potential was more limited in Denmark (where condensing boilers already constituted 80 per cent of the market) compared to Italy (12 per cent market share). In this respect, the effectiveness of tax credit policy depends on the prevailing market conditions of the country.
- Tax credits to manufacturers for washing-machines in Italy and Poland were found to be costly policies. The net welfare costs of the policy were relatively high and the energy saving potential relatively low compared with other instruments. However, there is no additional cost to the consumer in this case because the manufacturer's savings from energy consumption are generally equivalent to the increased costs of purchasing energy-efficient equipment.

In a different study, Boonekamp (2007) carried out analysis of developments in household energy consumption in response to policy measures standards (e.g. standards for insulation in new dwellings), subsidies (e.g. for more energy-efficient appliances) and energy taxes.[14] The results showed that subsidies for more energy-efficient appliances had differing effects: during the initial period when take up is relatively low, subsidies enlarge the effect of price increases on consumption levels; much later in the policy period when take up is close to being exhausted, subsidies decrease the effect of price increases on consumption; between these two periods, subsidies were found not to influence the effect of price increases.

It is worth noting that the rebound effect (described earlier), which has been found to undermine the effectiveness of energy-efficiency polices, is not taken into account in some of these studies. Therefore, the energy saving potential of the various fiscal measures may be overestimated.

It is clear from the results above that the effectiveness of these other types of fiscal measures depends on the product / behaviour being incentivised and the relevant market conditions. One of the findings from the studies is that there is no standard way of assessing the effectiveness of different fiscal measures, as this will depend on the specific nature of the measure and the context in which it was implemented. Therefore, it is not possible to say in general terms that a particular type of fiscal measure is more effective than another fiscal or non-fiscal measure.

2.4.3 Effectiveness of combinations of measures

There have been a number of studies that have looked at the impact of combination of taxes and subsidies. The results are again not conclusive but there is evidence that shows that in some cases the combination of measures amplifies the effects of the policy measures. It has also been noted the difficulties of disentangling the effects of both type of measures when these are shown jointly.

Amstalden et al (2006) analysed the effect of different energy policy instruments on the net present value (NPV) of different retrofit energy efficiency measures for dwellings.[15] The study looked at the effects of subsidies, income tax deductions and carbon taxes, and found that combination of policy instruments have a significant effect on the NPV, although no policy instrument alone can push the measures into "profitability"

[13] Kosonen and Nicodème (2009): The role of fiscal instruments in environmental policy. Taxation Paper No 19.

[14] Boonekamp (2007) "Price elasticities, policy measures and actual developments in household energy consumption – A bottom up analysis for the Netherlands".

[15] Amstalden, Kost, Nathani and Imboden (2006) "Economic Potential of Energy-efficient Retrofitting in the Swiss Residential Building Sector: The Effects of Policy Instruments and Energy Price Expectations".

(i.e. NPV greater than zero). However, the study found that the combination of all policy instruments makes even the most advanced retrofit package (which is the most costly) profitable.

Joelsson and Gustavsson (2007) analysed energy-efficiency measures in existing electrically heated houses in Sweden.[16] The authors undertake modelling and also consider house owners' perceptions of different heating supply alternatives based on the results of two comprehensive questionnaires. They find that an investment subsidy could be useful to break the perception that house owners are locked in to a particular heating system by lowering the investment cost. The authors also find that an electricity tax makes energy efficiency measures to the house envelope more profitable. However, overall the authors find that the price differences between energy suppliers has a larger impact on the house owners' economic conditions than both subsidies and tax rate changes.

Kosonen and Nicodème (2009) conclude that fiscal instruments can play an important role in reaching EU targets for energy savings and reductions of greenhouse gas emissions, alone or in complement to other market-based instruments and regulatory measures implemented in the EU.[17] However, they find that tax instruments might sometimes be insufficient and need to be complemented by other fiscal instruments. This complementarity may be achieved by differentiated commodity taxes or by direct subsidies, depending on the necessity to target specific consumers or product characteristics. However, the authors find that the use of such complementary instruments has tended to be limited in practice.

A study by Markandya et al (2009) found that, in selected European countries, the cost per ton of abated CO_2 emissions associated with an increase in energy taxes was outweighed by welfare gains (in the case of energy savings from refrigerators, water heaters and light bulbs).[18] The analysis included the traditional welfare cost to consumers as well as administrative costs of implementing the tax, and welfare gains accruing to producers of more expensive equipment. The authors conclude that a tax option therefore looks like an attractive option for increasing energy efficiency.

A later study (Markandya et al., 2014) found that subsidies do have a positive effect on the choice of more efficient appliances. In general, rebates at purchase are more effective per euro compared to subsidised loans (however, the authors note that the problems of free-ridership and rebound effects should be considered when analysing the effectiveness of such policies).[19] Tax credits are also relatively cost-effective when measured in terms of the cost per ton of CO_2 removed.

2.5 Complementing taxations measures with other fiscal measures

The previous sections mainly consider the effectiveness of different types of fiscal measures in isolation. However, as alluded to in the last subsection, combinations of measures are often used, and in practice many Member States have notified a range of fiscal measures under Article 7. It is therefore useful to consider the justification for using taxation measures in conjunction with other fiscal measures in order to identify when different combinations of measures may be appropriate. A few examples follow.

The presence of information imperfections and asymmetries are likely to mean that taxes which ensure the optimal outcome in theory are difficult to implement in practice. To alleviate the sub-optimal outcomes that may result, multi-part instruments could be used, i.e. the combination of indirect taxes with subsidies which are better able to target emissions or other externalities than a single tax instrument.

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16 Joelsson and Gustavsson (2007) "Perspectives on Implementing Energy Efficiency in Existing Swedish Detached Houses".

17 Kosonen and Nicodème (2009) "The Role of Fiscal Instruments in Environmental Policy".

18 Markandya. A., Ortiz, R., Mudgal, S, and B. Tinetti (2009). Analysis of Tax Incentives for Energy Efficient Durables in the EU. Energy Policy 37: 5662-5674.

19 Markandya, Labandeira and Ramos (2014) "Policy Instruments to Foster Energy Efficiency".

The presence of market imperfections or market failures other than the environmental externality may cause a single tax instrument to be ineffective in reducing final energy consumption. Specifically, consumers may not fully understand the scope for particular products to reduce energy consumption. In such cases, information tools, such as labelling schemes, can usefully complement tax instruments. Subsidy schemes may also serve to raise awareness and provide more information on product qualities, but are likely to be less cost-effective.

Credit market constraints may make it difficult for certain consumers (which may constitute a large proportion of the population) to finance relatively expensive energy efficiency projects, such as the purchase of more energy-efficient products. In this case, direct subsidies or tax credits could serve to alleviate this affordability problem and usefully complement tax instruments.

Split incentives could weaken the incentives provided by taxes to invest in energy-efficient building materials and equipment. For example, the owner of a building may not (fully) benefit from costly energy efficiency measures in the form of energy efficiency savings which will accrue to tenants. The use of tax credits or other subsidies to the owner may alleviate this incentive problem whilst taxes can still encourage more efficient consumption levels by tenants.

Consumers may have limited foresight causing them to underestimate the value of energy savings that accrue beyond the near term, and focus more on the up-front costs associated with the purchase of energy efficiency measures. The use of fiscal instruments may be an effective way to reduce this cost, whilst higher taxes which affect the energy bill over the product life time could complement the savings achieved through the purchase of the more energy-efficient product. The undervaluation of future benefits could also stem from a lack of information, in which case information tools could be used to complement taxation.

The points raised earlier about other fiscal measures would be true when being used in conjunction with taxation measures too. In particular, the effectiveness of these other types of fiscal measures depends on the specific nature of the measure and the context in which it has been implemented (this is, the product / behaviour being incentivised and the relevant market conditions). Therefore, the use of complementary fiscal instruments would need to be carefully designed to ensure effective outcomes: perhaps more so than if just some fiscal incentive was used in isolation, as there may be a need to take into account interactions between the different policies.

2.6 Conclusions

Overall, it is clear that there are a number of factors that may limit the effectiveness of fiscal measures. With regard to the implementation of energy or CO_2 taxes, in principle a tax based on the effect of the carbon emissions associated with energy consumption would be the most efficient policy instrument. However, as demonstrated by the findings in the many evaluations, a carbon-based tax may be less effective in driving reductions in energy consumption, as it is designed to incentivise reductions in emissions.

Whether an energy tax, a carbon tax, or some other tax on goods that use energy is implemented, there are a number of issues that may render these taxes less effective than is desired. Practical issues are likely to include difficulties in being able to set the tax at the “right” level. Other considerations might relate to the extent to which a tax on producers is passed on to the end consumers, and whether the final price paid by consumers with a tax in place is likely to lead to significant reductions in energy consumption.

With this in mind, other fiscal measures, such as subsidies, which are more easily targeted at specific groups of consumers may be more effective. Indeed, as mentioned above, in Denmark in the 1990s subsidies for renewables were thought to have accounted for a greater proportion of emissions reductions (and implicitly energy consumption) than taxes. However, it is not possible to say concretely that subsidies are more effective than energy or CO_2 taxes, or that a particular type of subsidy is more effective than another. The evaluation of effectiveness of these types of measures is very context-specific.

3 Framework for Evaluation of Impacts

When analysing any policy intervention, it is important to capture the impacts that can be directly attributed to the policy and are not the result of other factors. In particular it is important that proper consideration is given to any other factors that may reduce the incremental impacts to be attributed to the policy in question and that a robust "counterfactual" is developed to ensure that only the *incremental* impacts of the fiscal measure are captured (hence excluding those impacts that would have occurred irrespective of the fiscal intervention).

In this section, we set out a framework for evaluating the impact of fiscal measures that are notified under Article 7 to ensure that the energy savings that are claimed by Member States are robust.[20] Here, we focus on the stages pertinent to a robust assessment of incremental energy savings. Specifically, we describe:

- Policy options.
- Calculation of energy savings.
- Construction of the counterfactual.
- Factors to consider when constructing the counterfactual.
- Assessment of incremental impacts.
- Additional factors.

It is important to recognise that elements of this framework are already contained within the Directive. In this section, we provide a structure for these various elements, looking at each point above in turn.

3.1 Policy options

This first step would seek to identify all the various policies being used for achieving the objective of reducing final energy demand.

Annex V(4)(e) requires Member States to notify the eligible measures categories. A clear definition of what is meant by eligible is not provided in the Directive[21]; however, eligibility can be thought of as being concerned with the purpose of the policy measure, i.e. the issue of whether the measure is mainly targeting end-use energy savings (as required by Article 7), other objectives such as CO_2 emission reduction or large scale renewables deployment.

In this step, it is important to also include any other policy which results in reductions in final energy use. This is relevant because it is important that the savings claimed under Article 7 can be directly attributed to the notified measures and that there is no double counting between notified measures or indeed measures that have not been notified.

[20] The framework presented follows the approach typically used in *ex ante* evaluation of policies. However, given that the policies that are notified under Article 7 will have already been developed and implemented, some stages are not relevant for the purpose of assessing energy savings associated with notified measures. It is understood that Member States should have carried out impact assessments as part of the policy making process, and this would already include preliminary stages of an impact assessment to define the problem and set out the objectives to be achieved.

[21] Article 2(18) and Article 2(19) refer indirectly to eligibility when providing a definition for "policy measure" and "individual action", but there is no direct reference to the term "eligible measure".

3.2 Calculation of energy savings

This stage should estimate the impacts on final energy consumption of the policies that have been notified under Article 7.[22] It is important that both positive and negative impacts are recognised, as well as those that are direct and indirect. In some cases, impacts may materialise after some time or may be affected by different variables that are likely to change over time and these should also be accounted for. Finally, the calculation of the savings should also allow for any potential obstacles encountered for an effective implementation of the option. We discuss below some key factors that need to be considered when assessing the magnitude of total energy savings associated with notified measures.

3.2.1 Take-up

Take-up measures the extent to which the activities envisaged in the policy are being used (this is, how many of the targeted units are engaged in the policy and start using the alternative products that have become available to them). Take-up may be a matter of *decision* (e.g. whether or not to buy a subsidised energy-efficient appliance) or *degree* (e.g. to what extent a consumer or business respond to an increased tax on a certain type of fuel). In the case of decision, measurement of take-up requires the proportion of stakeholders that would make a given change (e.g. 10 per cent of homeowners would purchase subsidised wall insulation). In the case of degree, the more pertinent question relates to the average response of the affected stakeholder (e.g. home owners with gas heating reduced their consumption of natural gas by 10 per cent in response to an increase in energy taxation of 5 per cent).

There are several factors which may affect the degree of take-up. Take-up may, for example, be driven by consumers' expectations that other more energy efficient products are on the horizon, such that they delay investing in the fixed costs of the current product that is the subject of a notified measure. Take-up may also be negatively affected by a lack of knowledge about the product in question, or a lack of clarity in terms of what the product's greater energy efficiency could translate into in terms of lower energy costs.[23]

3.2.2 Compliance

Compliance reflects the fact that the estimated energy savings as a result of a policy may not be realised in practice. Generally, this refers to compliance with the laws or regulations associated with a particular measure. There may also be a problem with "technical compliance" of a specific energy efficiency product if, for example, the potential energy savings of a new type of energy efficient light bulb are estimated to be 30 per cent relative to existing light bulbs, whereas in practice the new light bulbs may only be 20 per cent more efficient.

3.2.3 Time horizon

It is important to take into account how quickly the intervention in question will affect energy savings and the time period over which savings will occur. Only savings that accrue up to 2020 are relevant to Member States' assessments, therefore any time lags (reflecting, for example, investment cycles) should be factored in. It is also important to take into account any "phasing-in" of new policy which means that benefits are more limited to begin with but then increase as the policy is introduced more widely.

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[22] Standard practice for *ex ante* impact assessment would include an assessment of all economic, social and environmental costs and benefits, including the impact on competition and small firms. However, here we are concerned only with the assessment of changes in final energy use, so we do not consider all these other impacts.

[23] The field of behavioural economics also suggests other deterrents of take-up, such as the *status quo bias* (the concept that individuals tend to stick with their existing situation beyond the objective benefits of doing so), *information overload* (whereby the excess of information on different ways of saving energy may paralyse decision-making) and also the tendency to copy what those close to you are doing.

3.2.4 The 5 estimation methods

The rules on what quantity of energy savings can be attributed to each individual action are to be established by Member States in accordance with the framework set in Article 7 and Annex V.

- For all policy measures four methods for calculating the savings for different types of action are envisaged:[24] deemed savings (standard values for each measure), metered savings (before-and-after measurement), scaled savings (based on engineering estimates) and surveyed savings (based on consumer response).
- For taxation measures (i.e. energy and CO_2 taxes), energy savings are quantified on the basis of price elasticities, which represent the responsiveness of energy demand to price changes.[25]

The estimation of savings associated with taxation measures are typically undertaken using price-elasticity impacts.[26] The first four methods are more relevant for other fiscal measures, such as subsidies for investment and grants. We provide further detail on each of these estimation methods below.

Deemed savings

Deemed savings uses pre-determined and validated estimates of the energy savings taken for similar types of applications and/or similar installations.

These estimates are, by nature, *ex ante* assessments of expected savings, but can encompass a range of different approaches: top-down or bottom-up.[27] A top-down oriented approach could, for example, make use of estimated energy savings of an intervention introduced in a similar Member State to predict the estimated energy savings domestically. A bottom-up oriented approach could make use of pre-existing estimates of the energy savings per one household for the installation of a particular appliance to then estimate the potential savings across the entire Member State based on the number of households.

Metered savings

This is an *ex post* approach where energy savings of a particular intervention are measured by recording the actual reduction in energy use. This could, for example, include the use of smart meter readings to estimate the impact of improved insulation on domestic energy use, or the use of sales data from petrol stations to estimate the impact of a higher tax on diesel fuel.

Scaled savings

This refers to engineering estimates that are used to estimate potential energy savings. This could include, for example, the use of a 'scientific model' to understand the extent to which improved insulation would reduce the energy required to keep an average home at a specified temperature.

Annex V of the EED stipulates that such an approach can only be used where attaining robust measured data of the particular installation is too difficult or unduly expensive, or where the approach is completed in line with nationally developed methodologies by independent and accredited experts.

Surveyed savings

This is the use of surveys of consumers and/or businesses (i.e. conducting market research), strictly for the purpose of understanding the energy savings that may result from changes in consumer behaviour (as opposed to energy savings resulting from physical installation, as specified in Annex V of the EED).

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[24] The principles are provided in Annex V, parts 1 and 2.

[25] The principles are provided in Annex V, part 3, point (a).

[26] This can also be used for estimating the impact of lower taxes for certain types of energy to encourage substitution away from other types of energy.

[27] Although in both cases the 'building blocks' are based on pre-existing estimates of energy savings for similar applications.

Reductions in end-use energy consumption (elasticity estimates)

Taxation on the energy and/or CO_2 content of fuels aims to influence the market price of these fuels. Since demand (and associated consumption) for energy is related to its price, a change in price (resulting from the tax) will lead to a change in demand. Energy taxation measures are not easily estimated with bottom-up methods and are instead quantified on the basis of price elasticities (these represent the responsiveness of energy demand to price changes). Elasticities are typically estimated using official data sources.

3.3 Construction of the counterfactual

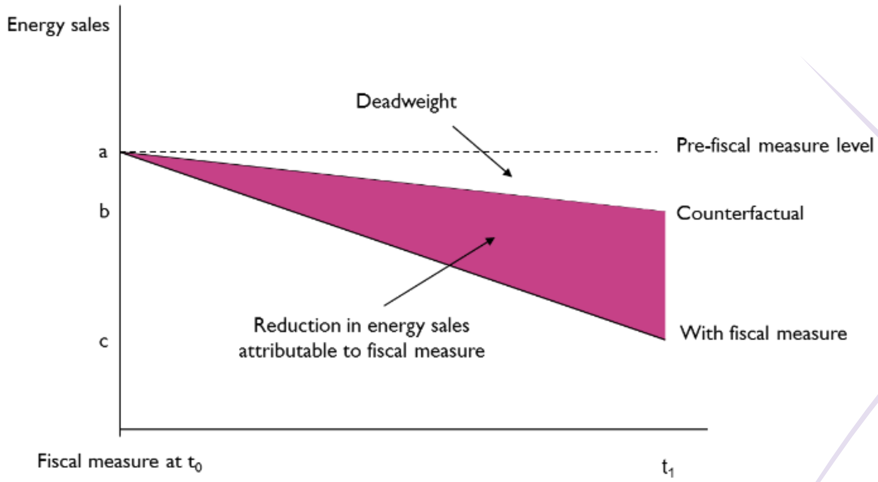
The counterfactual is defined as the baseline scenario that captures how outcomes and impacts would have evolved in the absence of the policy. The evaluation of policy, regulation or any other form of intervention needs to be conducted against the counterfactual in order to minimise the potential for under- or over-estimating the impacts of the policy in question.

When evaluating the impact of the policy in question, the outcomes and impacts of other interventions, trends and market developments may be realised at the same time in a way that interfere with the effects of the policy being evaluated (not all of the changes observed since the introduction of the policy can be solely attributed to that policy).

The key issue in developing a robust counterfactual is that this cannot be observed, as it is what would *hypothetically* have occurred had the fiscal measure not been introduced. Therefore, while the counterfactual has a clear mandate, the challenge is in establishing how energy sales would have evolved in the absence of the intervention (i.e. the fiscal measure being evaluated). Clearly, the more precisely the counterfactual can be defined, the more precisely the incremental impacts can be estimated.

To illustrate, Figure 3.1 below shows how the counterfactual operates in the case of evaluating the impact of fiscal measures on energy sales. With the fiscal measure, energy sales can be estimated at **c**, but it would be wrong to compare the reductions of the measure with the "Pre-fiscal measure level" at **a**. This is because there may have been reductions in energy sales that would have occurred "anyway". The counterfactual, estimated at **b**, accounts for the reductions in energy sales (between t_0 and t_1) that would have occurred if the fiscal measure had not been introduced. Therefore, the reduction in energy sales directly attributable to the fiscal measure is the difference between the observed level of reductions, **c**, and the counterfactual, **b** (this is represented by the shaded area in Figure 3.1). The total area between the counterfactual and pre-intervention level (the difference between **b** and **c**) of energy sales is typically defined in evaluation terms as the "deadweight", as it represents the total reduction in energy sales that would have occurred anyway (i.e. regardless of the intervention).

Figure 3.1: The role of the counterfactual



We have noted previously that the impacts of fiscal policies are modelled differently for different types of actions. In taxation measures that involve a change in the price of a good, the effects are typically modelled as change in sales (see 2.3). Such effect is normally estimated using price elasticities (and measures of tax pass-through). In the case of policies involving subsidies, impacts are typically modelled by looking at take-up of measures and estimates of energy savings achieved (and accounting for aspects related to the "misuse" of funds, energy efficiency potential, and rebound effects).

It is important to note that this second case (subsidies) calculates an estimated "absolute" energy change as a result of the measure. It is therefore important to compare such estimate with a situation "without" intervention; hence the importance of the counterfactual (to be able to obtain estimates of incremental impacts). In the first case (taxation measures) this is typically less of a problem. This is because the elasticities are already providing the "net" effect of the change in prices. Hence, if properly estimated, elasticities are excluding any other effects that may have happened in the absence of the intervention.[28] The results of the calculations therefore exclude any underlying trends, changes in consumer's income or cross-price effects from substitute products.[29] However, having an idea of a counterfactual may be helpful in any case to assess any biases or omissions in the elasticities used (in particular, to assess or quantify effects which may not be included in the elasticities being used[30]).

3.3.1 Estimation methods

There are well-established methods for estimating the counterfactual, each with their own pros and cons. We outline below three approaches that we consider to be most relevant to the assessment of fiscal measures to reduce final energy consumption.[31] These are:

1. Use of a bottom-up approach to estimate the counterfactual. This approach would use granular estimates of energy use or energy savings, e.g. the energy used by an electric vehicle or the change in energy use once better insulation is installed in a building, and multiply these granular estimates up to the total level of the affected population. The advantage of this approach is that the individual components that make up the counterfactual are being individually specified and estimated. The disadvantage is that some of the individual components may be difficult to estimate practically and thus limit the robustness of the counterfactual.
2. Extrapolation of trends in energy savings observed pre-intervention. A key advantage of this approach is that it does not require finding a suitable comparator unit that has not been influenced by the policy measure (which may be particular important where such a comparator is hard to identify). However, a simple extrapolation of the past trend can fail to account for changes in trend over time, e.g. due to a new policy or technology.
3. Comparison with similar (regional or national) markets where the intervention is not introduced. The main advantage of this approach is that it can control for other developments that occur post-intervention, providing these development are common to both the market of interest and the

[28] Elasticities are defined to represent the changes *ceteris paribus*, which means that they ignore any other factors that may also influence the relationship between price and quantity demanded.

[29] The elasticities are also referred to as being a partial derivative. If estimated through regression the equations should contain multiple variables (rather than just one) in order to isolate the individual effect of other variables such as income, the prices of substitute products and other factors affecting the market.

[30] This could be especially relevant if elasticities from previous studies are used or there have been recent changes in the market (such as the presence of new complement or substitute products in the market).

[31] There is a wide range of techniques that can be used to implement these approaches (including engineering estimation of impacts, econometric extrapolation of time series using pre-intervention data, difference-in-differences using a comparable country or region). However, the evaluation should be mindful in choosing the approach that is right for the context and type of measure being analysed. While the evaluation framework is constant and applies to all measures, it is important that each assessment is carried out in the most appropriate way (e.g. given the other policies in place, the data available, etc.).

comparator market (market specific developments would not be accounted for). The difficultly is finding a suitable comparator, i.e. one which is likely to experience similar to developments to the market in question, as any significant differences in market developments would severely impact on the robustness of this approach.

3.4 Factors to consider when constructing the counterfactual

Calculation of the counterfactual, and hence the deadweight, should ensure that the energy savings that are estimated are directly attributable to the policy measure in question and not any other policies that are in place, i.e. energy savings that result from some other policy measure should not be double counted, and therefore, any policy overlaps need to be properly accounted for in the counterfactual.

This issue of policy overlaps with EU legislation is addressed in part by the Directive in terms of "additionality" for minimum EU standards. Specifically, the Directive specifies that only savings that go beyond the minimum requirements originating from EU legislation should be included in the calculation of impacts.[32] This is relevant for energy efficiency obligation schemes, alternative policy measures and a national energy efficiency fund related to the following EU laws:

- Requirements established by implementing measures under the Ecodesign Directive (for products).
- Emission performance standards established by Regulations 443/2009 and 510/2011 (for new passenger cars and light commercial vehicles).
- Minimum levels of taxation applicable to fuels as required in Council Directive 2003/96/EC on restructuring the Community framework for the taxation of energy products and electricity or in Council Directive 2006/112/EC on the common system of value added tax (for the taxes).

Calculation of the incremental impacts must be done taking into account minimum standards as specified above to ensure that only savings that result from actions that go beyond these measures are captured.[33]

The Directive also specifies that the impact of policy measures or individual actions should not overlap with other policy measures that reduce energy consumption. That is, the effects should not be counted twice (no double counting of energy savings) when evaluating multiple options.[34] In principle, given that minimum EU standards are specified above, this relates to other policies that might be in place in a Member State that also reduce final energy consumption — whether these measures are notified or not.

3.5 Other influencing factors when constructing the counterfactual

In addition to accounting for policy overlaps in the counterfactual to ensure that no savings are double counted, the counterfactual and calculation of the level of deadweight should also take into account factors which are likely to influence the level of energy sales over time (in the absence of the intervention). Generally, it would be disproportionately time and resource intensive to develop detailed forecasts of every potentially relevant factor that could affect energy sales in the current environment absent intervention. The focus should therefore be on identifying the most significant changes that are expected to take place, so that a robust estimate of the incremental impact can be made. At a high level, for fiscal measures to achieve energy savings, this should include the following.

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32 Annex V(2)(a) and (3)(a).

33 Incremental impacts are the impact occurring over and above what would have happened anyway in the absence of the policy (i.e. in the counterfactual scenario).

34 Article 7(12) states that *"Member States shall ensure that when the impact of policy measures or individual actions overlaps, no double counting of energy savings is made"* and Annex V(2)(d) states that *"savings from an individual action may not be claimed by more than one party"*.

Trends/changes in consumer behaviour: the counterfactual needs to take into account changes in consumer behaviour that are expected to take place over the period in question even without the fiscal measure in place. This would be in terms of trends in energy use, and whether there are factors which may cause an acceleration or slowdown in this trend. This may, for example, include a gradual reduction in household energy consumption overtime through the growing awareness of the need for energy efficiency.

Technological progress: the counterfactual would need to take into account expected changes in technological capabilities that are likely to be implemented in the absence of the fiscal measure in question, and therefore what this would mean in terms of energy efficiency and, ultimately, energy usage. This may be done by extrapolating the general trend in technological progress over time, but this may need to be adjusted to account for specific technological developments that will have an impact on energy sales in the period of interest (which could include both technological developments that have already occurred and those that are expected to occur in the evaluation period).

Changes in policy environment: during the relevant policy period, there may be changes in the policy environment that are unrelated to the policy in question (for example, environmental campaigns or responses to natural disasters which make consumers more aware of energy concerns; or government initiatives to boost demand in certain sectors, such as fairs or international events) or other similar policies designed to reduce energy consumption (see section above). Such changes in policy environment could nonetheless affect the degree of energy consumption, and therefore need to be taken into account where these changes would have material impacts on the extent to which the policy in question actually reduces energy consumption.

It is worth noting that while presented separately, these issues are in fact closely related — changes in the policy environment will typically affect consumer behaviour and the development and take-up of new technology, while technological progress will also affect consumer behaviour. Therefore, it is important to consider these issues collectively and not as three disparate strands of the counterfactual.

3.6 Assessment of incremental impacts

In order to arrive at an assessment of the incremental energy savings that can be claimed by Member States for each of the measures notified under Article 7, it would be necessary to estimate energy usage “before” and “after” the fiscal measure in place in comparison with the situation (again “before” and “after”) in the counterfactual scenario without the fiscal measure in place. Below, we set out some more practical guidelines on how this should be done for each of the methods used for estimating the savings.

3.6.1 Deemed savings

In order to ensure that the calculation of savings is appropriate, Member States need to ensure that a suitable comparator is identified. Suitable comparators may include the same intervention being introduced in a similar geographic market, or a similar intervention in the same geographic market (for example an earlier version of a certain application). When using the deemed savings approach, the analysis would need to understand the qualitative differences between the comparator and the intervention in question so that relevant adjustments can be made in the calculation of deemed savings.

A second issue is understanding exactly what the pre-existing estimates represent. In particular, one would need to know to what extent do estimates represent the post-intervention impacts (and how much these are affected by counterfactual situations or the other additionality factors), and whether estimates represent incremental impacts (calculated including a counterfactual situation). This will determine whether the estimates need to be adjusted to take account of the counterfactual.

3.6.2 Metered savings

The metered savings approach could be used in a number of ways to correct for consumption levels likely to have materialised without the fiscal measure in place:

- One option would be to use the trend in metered savings of affected stakeholders pre-intervention and extrapolate this trend forwards, and then compare this to the actual metered energy savings observed post-intervention.
- Another option would be to observe the metered savings of a group of similar stakeholders who are not exposed to the intervention, i.e. the control group, and compare this to the metered savings of those who are exposed to the intervention.[35]
- A third option would be to observe the metered savings of the same control group, but to do so both pre- and post-intervention. This can then be compared with the change in metered savings of the treatment group pre- and post-intervention. The difference in the changes in metered savings across the control and treatment groups (i.e. the difference-in-difference) is then attributed as the impact of the intervention.[36]

3.6.3 Scaled savings

Under the scaled savings approach, Member States would need to ensure that any engineering estimates of energy consumption properly reflect the effects of the fiscal measure that has been introduced, e.g. the effect on gas consumption with subsidised wall insulation in place that reflects the improved u-value of the insulation. These estimates would then need to be used in a bottom-up analysis that reflects the take-up, compliance and relevant time-horizon associated with the fiscal measure.

This approach is conducive to estimating directly what energy consumption would have been without the fiscal measure in place. Taking the example above, engineering estimates would need to be generated for gas consumption without the subsidised wall insulation in place. The counterfactual should also be constructed on a bottom-up basis, and there would be scope to reflect the distribution of energy consumption among different consumers — e.g. extending our insulation example, it may be appropriate to reflect the existing levels of wall insulation in the building stock when constructing the counterfactual.

3.6.4 Surveyed savings

Depending on the design of the survey, this approach may be able to capture the likely changes in behaviour of affected stakeholders, thus allowing estimation of what levels of energy consumption would have resulted in the absence of the fiscal measure. Where it has not been possible to ask consumers what their behaviour and/or energy consumption would have been like in the absence of the fiscal measure (or the results of such an exercise are not considered to be robust), Member States may wish to consider combining the results from survey analysis with other approaches. In particular, consumer surveys could be used to support estimates under the metered savings approach when developing the counterfactual under that approach, or scaled savings whereby engineering estimates are used to derive the hypothetical energy savings that can be achieved by an intervention, and a survey is used to understand to what extent these hypothetical savings could be realised in practice.

35 An appropriate control group would be one which exhibits very similar characteristics as the treatment group, such that differences in the observed in the metered savings can be attributed to the intervention in question and not to underlying differences in characteristics across the two groups.

36 This may not be so easy in practice, as there may such underlying differences that which may make individuals or firms more, or less, likely to adopt the intervention in the first place. The choice of treatment and control groups must avoid such selection bias, as it would otherwise bias the estimates of the counterfactual and, ultimately, the incremental impacts.

3.6.5 Reductions in end-use energy consumption (elasticity estimates)

The use of price elasticity estimates is separate and different to the four approaches outlined above. As explained earlier it is only appropriate for taxation measures. The change in energy usage that would result from the implementation of an energy or CO_2 tax would be calculated on the basis of a pre-taxation level of energy consumption and the pre- and post-taxation energy prices. The principal concern for Member States under this approach would be the derivation of appropriate price elasticity estimates. This is discussed in depth in Section 5 of this report.

When using this approach to estimate the energy savings resulting from energy or carbon taxation measures, it would not be necessary to explicitly make adjustments for the counterfactual, as the consumption that would have prevailed in the absence of the taxation measure is reflected in the baseline level of pre-tax consumption, and consumer behaviour represented by responsiveness to changes in price would implicitly be captured by the elasticity estimate.

3.7 Additional factors

The assessment of the incremental impact needs to take into account a number of factors for a proper assessment of fiscal measures. This subsection provides a list of relevant issues to be considered. We first consider the extent to which the incremental savings are material[37]. Second, the assessments of incremental energy savings should also capture secondary impacts that arise as a result of the intervention in question. These factors do not form part of the counterfactual as they would not have occurred in absence of the intervention, but they nevertheless form a crucial part of assessing the extent to which impacts can be considered to be additional and are related to “displacement”, “leakage”, “rebound effect” and “substitution”. We discuss each of these in turn below, demonstrating what each factor should take into account.

Materiality

Materiality relates to the need to ensure that the policy in question has had a demonstrably material impact on the take-up of the measures.[38] The term “material” is clarified in the Commission’s Guidance note[39] as contribution by the participating or entrusted parties to the realisation of the specific individual action in question. The term “demonstrably” means that the Member State must be able to show that this is so.

When assessing materiality it is important to bear in mind the counterfactual and the type of impacts that would have happened anyway[40]. It is also important to quantify the magnitude of the individual action (neglecting those that do not imply a significant contribution).

Displacement

Displacement is defined as the proportion of intervention benefits which are reduced elsewhere in the target area.[41] It accounts for the fact that the fiscal measure in question may promote its intended activities at the expense of other related activities which would otherwise have taken place. There are two key types

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37 We mean material in the context of materiality as per Article 7 (see section 3.7).

38 Annex V(2)(c) states that *“the activities of the obligated, participating or entrusted party must be demonstrably material to the achievement of the claimed savings”.*

39 Guidance note on Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EC, and repealing Directives 2004/8/EC and 2006/32/EC. SWD(2013) 451 final.

40 This should apply to all fiscal measures.

41 The European Commission’s Better Regulation Toolbox alludes to some of these concepts, but does not define any of them in a precise and structured way. In this section, all definitions of other additionality factors are taken from: Scottish Enterprise Appraisal & Evaluation Team (2008) “Additionality & Economic Impact Assessment Guidance Note: A Summary Guide to Assessing the Additional Benefit, or Additionality, of an Economic Development Project or Programme”.

of displacement: product (the intervention leads to the promotion of one product at the expense of the other) and factor displacement (intervention leads to labour, capital or land resources being diverted from one use to another).

An example of product market displacement, would be a tax break (reduced VAT rates, for certain energy-saving products) which diverts expenditure away from other products which also produce energy-savings but on a smaller scale. In this case, the net benefits in terms of energy savings should be adjusted for the energy savings that have been lost as a result of decreased expenditure on other products which did not receive the favourable tax treatment. Factor market displacement effects are more unlikely but could, for example, be caused by R&D subsidies attracting labour and capital in some areas more than others, thus encouraging technological progress in some areas at the expense of others.

Leakage

Leakage is defined as the proportion of outputs that benefit those outside of the intervention target area or group. It captures the fact that not all the impacts that accrue in relation to a given policy are necessarily accrued by the intended target group of individuals and/or firms.

In the context of national fiscal measures, the likely relevance of leakage is limited, as the fiscal measures can precisely target the intended group. Leakage is likely to play a more significant role in the assessment of regional initiatives where benefits may accrue in part to other bordering regions, and/or in the assessment of initiatives that are not (or cannot) be limited to those they are intended for. Furthermore, there may be cases where a domestic policy benefits user groups outside the Member State. An example of this would be if differential fiscal treatment of fuel led to individuals and businesses travelling across borders to purchase fuels at more preferential rates.[42]

Although the likely relevance is small, an assessment of energy savings should nevertheless consider whether leakage issues may be present.

Rebound effect

When an intervention leads to more efficient energy use the immediate impact is a reduction in energy spending by the affected parties. However, this decrease in energy spending increases the wealth of the affected parties, some of which may be spent on energy such that the energy consumption subsequently increases. This is known as the rebound effect. The expected size of the rebound effect would depend on the sensitivity (elasticities) of consumers to changes in relative prices and real income.[43] (As such, any rebound effects occurring in response to tax changes would in principle be captured implicitly if appropriate price elasticity estimates are used.)

Substitution

Substitution occurs when a unit (firm or consumer) substitutes one activity for a similar one to take advantage of policy measures. When this happens, there is likely to be a change in the consumption of the affected products. However, in many situations, a consumption shift may also take place towards other

[42] Indeed, Banfi et al. (2005) found 'fuel tourism' to be a significant factor, with a 10 per cent decrease in Swiss gasoline prices increasing demand in the border areas by 17.5 per cent. See: Banfi, S., Filippini, M. and L. C. Hunt (2005), "Fuel tourism in border regions: The case of Switzerland". *Energy Economics*, vol. 27(5), pp. 689-707.

[43] A rebound effect could, for example, come about as a result of a subsidy on energy efficient boilers which are estimated to be 5 per cent more energy efficient than standard boilers. As a result of this, consumer behaviour may adapt such that consumers heat their homes for longer, such that rather than the expected 5 per cent reduction in energy sales, energy sales in fact only decrease by 3 per cent. In this numeric example, the rebound rate would be 40 per cent. Another example would be tax incentives for lower fuel consumption, or electric, cars increasing car usage at the expense of public transport do the detriment of energy usage. Such effects appear quite plausible and imply that the energy savings realised by a given initiative would fall short of the hypothetical energy savings that the initiative is supposed to generate. Overall, therefore, this is a significant factor to take into account when assessing the additionality of energy savings.

substitute products and these effects should also be taken into account in the impact assessment. For example, when taxing carbon-intensive fuels this would directly reduce the emissions of such fuels, but would also produce a substitution from carbon-intensive fuels to other type of fuels. The energy consumption impact derived from this substitution effect should be added when assessing net benefits of the tax impact.

4 Illustration of Framework in Practice

In this section, we provide an overview of the approaches taken by the four selected Member States to estimating claimed savings for fiscal measures in the context of the framework for evaluation of impacts set out earlier in the previous chapter. As stated in the previous section, while the various issues related to estimating incremental impacts has been considered separately in the framework, this is for presentational purposes. All of the relevant concepts to ensure that claimed savings are incremental are in fact closely related. It is therefore important to consider these issues collectively and not as disparate strands of the estimation process.

A summary of the approaches for fiscal measures taken by Member States is shown in the table below:

Table 4.1: Summary of approaches used by Member States

Sweden	
Policy options:	Energy tax for electricity suppliers and generators
Energy savings:	Short-run and long-run price elasticities of demand
Counterfactual:	Captured through use of price elasticities
Overlaps with EU policy:	Overlaps with existing EU policies taken into account
Other influencing factors:	Likely to be captured within price elasticity of demand estimates
Evaluation of net impacts:	All policies assessed together to avoid double counting from policy overlaps
Additional factors:	Unlikely to be material
France	
Policy options:	Domestic carbon tax; eco-tax for heavy vehicles; sustainable development tax credit
Energy savings:	Assessment not yet undertaken
Counterfactual:	Consideration of changes in international fuel prices
Overlaps with EU policy:	Assessment not yet undertaken
Other influencing factors:	Assessment not yet undertaken
Evaluation of net impacts:	Assessment not yet undertaken
Additional factors:	Assessment not yet undertaken
Germany	
Policy options:	Energy and transport taxes plus a range of investment subsidies
Energy savings:	Price elasticities for taxation, and deemed and scaled savings approaches for subsidies
Counterfactual:	Captured through use of price elasticities for taxes; limited information for subsidies
Overlaps with EU policy:	Overlaps with existing EU policies taken into account
Other influencing factors:	Trend in energy prices considered for taxation; not clear for subsidies
Evaluation of net impacts:	Reduction factor applied for investment subsidies to account for overlaps between subsidies
Additional factors:	No specific reference to any additional factors, such as leakage or rebound effects
Spain	
Policy options:	Energy generation taxes plus subsidies for transport and buildings sectors
Energy savings:	Price elasticities for taxation, and deemed and scaled savings approaches for subsidies
Counterfactual:	Captured through use of price elasticities for taxes; limited information for subsidies
Overlaps with EU policy:	Overlaps with existing EU policies for energy taxes taken into account
Other influencing factors:	Not clear that other factors influencing the counterfactual have been considered
Evaluation of net impacts:	Not clear if overlaps between notified measures have been considered
Additional factors:	No specific reference to any additional factors, such as leakage or rebound effects

4.1 Policy options

Sweden

In Sweden, only taxation measures are envisaged (there are no Energy Efficiency Obligation schemes in place).[44] The energy tax is a tax on fuels (i.e. a good which generates the externality) levied on those who generate or supply taxable electric power commercially.

France

The fiscal measures established in France are:

- A domestic consumption duty based on CO_2 content — this is a tax on energy products, based proportionately on the CO_2 content of those different energy products.
- An eco-tax for heavy vehicles — this is a tax per kilometre on HGVs weighing in excess of 3.5 tonnes and is applicable on all national roads and on local roads that may be used as alternative routes.
- A sustainable development tax credit — this is a tax credit for individuals who purchase material or equipment which meets the current highest energy efficiency performance, or who purchase energy from renewable sources in their primary residence. More recently its structure has been altered somewhat, so that the tax credit is granted for all major renovations, i.e. those which include at least two separate components that qualify under the above, while a means-tested tax credit is in place for renovations with only a single component.

Germany

Three tax measures have been established in Germany:

- Energy taxes for a range of key energy sources (including petrol, diesel, natural gas, oil and electricity) applicable across all sectors.
- HGV tolls on trucks weighing in excess of 12 tonnes for journeys on motorway and other major roads (tolls are charged at per kilometre rates and are dependent on the number of axels).
- Air traffic tax levied on transactions which enable a passenger to fly out of a German airport (taxation is dependent on the destination airport and distance travelled).

In addition to the above taxation measures, Germany have notified a number of non-tax fiscal measures to support energy savings, namely:

- KfW support programmes for energy-efficient construction and renovation. This provides financial support in the form of grants and loans for new builds and renovations that exceed minimum standards set out in the building codes. New buildings can only qualify for soft loans, which we consider to be outside the scope of fiscal measures (for the purpose of this study where we are focussing on direct subsidy without repayment), but renovation of existing buildings that exceed minimum standards can qualify for grants. The size of the grant is dependent on the building standard achieved up to a maximum of €18,750, and up to a maximum of €5,000 per individual measure.
- Investment support in companies. The BMWi Energy Efficiency Fund is financing a programme on 'Promotion of high efficiency cross-cutting technologies in SMEs', which is providing investment grants to SMEs for investments in, for example, energy-efficient pumps and compressed air systems.
- National Climate Protection Initiative. This includes the market incentive programme to promote the use of renewable energies in the heating market, by providing grants for investment in renewable energy technologies. It also covers further funding policies to promote energy efficiency in refrigeration systems and micro-CHP installations, though it is unclear what form this funding takes and thus whether it can be classed as a fiscal measure.

[44] Sweden has not notified any other fiscal measures in order to meet its energy saving obligations.

- Other investment programmes to promote energy efficiency which have now expired but will continue to provide energy savings. The two policies of interest in the context of fiscal measures are: first, the 2008 Investment Pact between the national government and state governments and municipalities which provided investment grants for improving the energy efficiency of social infrastructure buildings; and, second, an environmental premium in the form of a one-off grant of €2,500 provided to those who scrapped cars at least nine years old in exchange for new, or nearly new, cars.
- Promotion of energy management systems (EMS) under the Energy Efficiency Fund. This is also financed through the BMWi Energy Efficiency Fund and provides grants of up to €20,000 per company for certification of energy management or monitoring systems, and for purchasing measurement technology and energy management system software.
- Promotion of municipal concepts and networks. This includes grants for integrated district concepts to improve building energy efficiency and grants to finance the work of renovation managers who will develop and oversee the implementation of energy-related renovation measures.

Spain

Spain has notified a law which regulates the following energy taxes:

- Tax on spent nuclear fuel.
- Duty on hydroelectricity generation.
- Tax on fossil fuels (Natural gas, Coal for electricity generation, Fuel oil for electricity generation, Diesel for electricity generation).
- Tax on electricity generation, from all generation sources, both ordinary and special regime generation.

In addition to the energy taxes, Spain has also implemented a range of other fiscal measures focused on the transport and buildings sectors. In particular, it has introduced:

- three fiscal measures that target take up of electric vehicles (MOVELLE, PICE and PIMA Aire),
- two fiscal measures targeting energy efficiency improvements in buildings (PAREER and PIMA SOL), and
- the JESSICA-FIDAE fund which targets (amongst other things) both type of measures.

4.2 Energy savings

Sweden

The impact of taxes is assessed on the basis of the short-term behavioural impacts (in reducing vehicle use), but also on the basis of longer term structural changes (investment in more energy-efficient vehicles). The energy savings generated by these effects are calculated through the use of short-run and long-run elasticities, respectively, of the relationship between prices and consumption.

France

According to the updated notification, an assessment of the incremental savings of the French fiscal measures has not yet been undertaken. In the case of the consumption duty, the notification says that a study will be undertaken to assess the impact of price increases on consumption, while in the case of the eco-tax for heavy vehicles the notification says that an impact study will be undertaken once the details of the scheme have been finalised.

Germany

For each of the three taxation measures in place in Germany, the methodological approach used to assess energy savings was the price elasticity approach. The energy savings generated by the other fiscal measures are primarily estimated through a combination of pre-existing estimates of savings per unit and assumptions on the likely level of take-up, i.e. a combination of deemed and scaled savings approaches.

Spain

Energy savings associated with the various energy taxes in place in Spain have been calculated using the price elasticity of demand approach.

For the other fiscal measures that have been notified, Spain has used:

- scaled savings (i.e. the use of engineering estimates on a bottom-up basis) to assess claimed savings for all policies, except for the JESSICA-FIDAE fund
- savings stemming from distribution of the JESSICA fund have been calculated using the deemed savings approach. The updated notification states that this has been done by reference to the results of previous independently monitored energy improvements in similar installations. This description appears to allude to the use of deemed savings for particular installations though this is not clear. In any case, no details are provided on the comparators so it is not possible to identify whether the counterfactual and other additionality issues (discussed below) have been accounted for.

4.3 Counterfactual

Sweden

The counterfactual would be captured implicitly through the use of price elasticities of demand to estimate savings associated with the taxation measures in place, as these capture consumers' responsiveness to changes in prices based on their starting level of consumption before the taxes were introduced. If the elasticities have been appropriately measured, this would also take into account other measures which overlap with the goals of the taxation, whether they are notified or not, as these other policies would affect the demand from which the price elasticity estimates are derived.

France

France's NEEAP recognises the need for caution in estimating the potential energy savings from their domestic consumption duty, as "the evolution of barrel prices as well as the dollars/euros exchange rate, that are in fact fundamental determinants of the pump price, are subject to great variability". This is an important point, as these key international price movements will have significant implications for the relative role played by the tax in the overall price of different energy products and thus, ultimately, on the incremental energy savings the tax can generate.[45] For example, if the pre-tax price of fuel was 10 and there is an additional tax of 10 per cent, the price would then be 11 (an increase of 1 unit). However, if a change in the underlying oil price meant that the pre-tax price fell to 8, the post-tax price would be 8.8. So the impact of the policy would result in a 0.8 units increase. This would affect the savings that can be achieved.

Germany

With regard to claimed savings for the three taxation measures in place, the use of price elasticity of demand estimates would implicitly capture the counterfactual, provided that all of the components of the calculation are well estimated — namely, the price elasticity of demand, the baseline level of consumption, the original price without the tax in place, and the new price with the tax in place.

With regard to the other fiscal measures, in general there is a lack of detail on the assessment of claimed savings. It is therefore difficult to judge the suitability of the pre-existing estimates and assumptions used and, therefore, it is difficult to assess, purely on the information provided in the NEEAP and the updated notification, to what extent the energy savings calculated are incremental in nature.

[45] Typically, where there is a high degree of uncertainty related to certain aspects or variables within the analysis, sensitivity analysis is carried out to assess the impacts of this uncertainty, e.g. with ranges that reflect the extent of uncertainty.

Spain

The use of the price elasticity of demand approach to estimating savings associated with the energy taxes in place in Spain would ensure that the counterfactual has been implicitly taken into account. However, with regard to the other fiscal measures in place, based on the information provided in the Spanish updated notification it is very difficult to assess whether the savings associated with these other fiscal measures have been properly estimated on an incremental basis, as very little detail is provided on the estimation methods.

4.4 Additional factors when calculating the counterfactual

Sweden

With regard to overlaps with existing EU policies, the estimate of incremental savings only include savings that are in excess of those generated by the EU policies. In addition, because impacts are estimated using elasticity estimates based on the period 1976 to 2012 and the large majority of EU policies were not in place this means that the impact of other policies is not captured in the elasticity estimates and, therefore, the savings reflect well those generated policy impacts and not these existing EU policies.

France

There are two important policy overlaps that will need to be considered as part of the counterfactual in relation to these policies.

In the case of the domestic consumption duty based on CO_2 content, the assessment of energy savings should only take into account savings over and above those generated by the minimum taxation levels on energy products established by the EU's 2003 Energy Taxation Directive.[46]

In the case of the sustainable development tax credit, it will be necessary to take into account whether or not the upgrades actually go beyond what is specified in the EU's Energy Performance of Buildings Directive (EPBD).

Germany

Germany' updated notification notes that:

- With respect to the estimated savings generated by the energy taxes, "the minimum requirements laid down in Council Directive 2003/96/EC of 27 October 2003 [i.e. the 2003 Energy Taxation Directive] have been used as a baseline/reference".
- With regard to HGV tolls and the air traffic tax, reference is made to the Annex V(3) requirements on additionality, which suggests that the minimum taxation levels dictated by the Energy Taxation Directive (i.e. 2003/96/EC), as well as other national taxation measures, have been taking into account in estimating incremental energy savings.

In the case of HGV tolls and air traffic tax, the likelihood and extent of policy overlap should be small, as they are both measures which are specific to the transport sector for which there are no other measures directly in place.

Spain

There is no evidence presented to make it clear that the policies geared towards the take up of more environmentally friendly vehicles represent policy with requirements that go over and above what is

[46] France's NEEAP notes that, while the minimum levels required by the EU directive are €33 per hectolitre (/hl) for gas oil and €35.9/hl for petrol, the corresponding national rates in 2013 were €42.84/hl and €60.69/hl respectively. Therefore, in applying price elasticities, only the effect of taxation in excess of the EU minimum levels is applicable, which in these cases are €9.84/hl and €24.79/hl respectively.

specified in EC Regulations relating to passenger cars and commercial vehicles, or that the energy efficiency measures for buildings being supported go beyond what is specified in the EPBD.

With regard to the taxation measures, these taxes are above the applicable EU minimum levels of taxation. (though we note that this is not demonstrated explicitly by the Member State in its NEEAP or its updated Article 7 notification).

4.5 Other influencing factors

Sweden

There is no specific mention of controlling for consumer behaviour or technological progress in Sweden's NEEAP. There is also no account for changes in the economic circumstances in the calculations for the housing and services, and transport. However, it is unlikely that this is problematic as Sweden has only notified taxation measures and uses price elasticity of demand to estimate the savings. This approach would implicitly capture these other influencing factors provided that the elasticity estimates are well estimated (see next chapter for further details on the estimation of price elasticities).

France

As mentioned earlier, the French updated notification does not contain estimates of incremental savings. When France comes to assess its claimed savings for the fiscal measures it has notified, consideration of how consumer/firm behaviour and technological progress would have evolved in the absence of these measures will ensure that savings are estimated on an incremental basis. For the taxation measures in place in France, the effects associated with consumer behaviour would be implicitly captured through the use of price elasticities of demand, provided that they are well estimated.

Germany

Based on our framework for assessing incremental impacts, a key issue to consider is whether the estimated energy savings have taken into account changes in consumer behaviour and/or technical progress that would have occurred in absence of the fiscal measures and therefore reduced the extent to which the activities undertaken are demonstrably material to the achievement of the claimed savings.

There is no explicit mention of such an adjustment in the NEEAP or updated notification. That said, the updated notification discusses how, in calculating savings from energy taxes, the trend in energy prices has been taken into account based on the Government's energy scenario II B (though no further details of this are given). Therefore, while the evolution of consumer behaviour and technical progress has not been modelled directly, the impact of these factors are likely to be captured through the trend in energy prices, such that the impact of energy taxes are estimated relative to the expected changes in energy prices in their absence.

However, there is no evidence that relevant trends have been taken into account in the calculation of energy savings for the other taxation measures, nor the other fiscal measures. In some cases, including the assessments of the KfW support programmes and the National Climate Protection Initiative, savings from previous years are used to calculate the energy savings for the 2014-2020 period. In the case of the KfW Support Programme, they use the mean savings per housing unit for the period 2009-2011 and applied this to the 2014-2020. While this may in fact provide an accurate estimate, the basis for assuming no change in the mean savings per housing unit across the two periods is not made explicit.

Spain

The other fiscal policies described above are short term measures with limited pots of funding which will cease once exhausted. However, in all cases the Spanish authorities have assumed that savings would accrue over a longer period due to the long-lived assets covered by the policies, namely vehicles and building fabric. It is therefore important to consider how energy consumption would have varied over the 2014-2020 period in the absence of each policy in order to generate incremental estimates. It is not clear that this issue has been examined or given any consideration in the context of each of the notified fiscal measures.

4.6 Evaluation of net impacts

Sweden

To avoid policy overlaps from various complementary instruments, Sweden estimates the impact of all different policy instruments as a whole. This means that the individual impacts are not available but that the aggregate is net of any policy overlaps. Impacts are estimated using long-run elasticity estimates based on 1976-2012.

France

As described earlier, the French updated notification states that estimates for the fiscal measures in question are to be calculated. These assessments would need to ensure that claimed savings avoid double counting or claiming savings that are attributable to other policy measures. By taking account of policy overlaps between the guaranteed home energy renovation fund and the energy renovation passports, both of which are designed to reduce household energy consumption, the analysis would ensure that policy overlaps between fiscal measures have been accounted for.

Germany

Germany has a large number of fiscal measures in place. Given that energy taxes are not sector-specific, it is useful to consider the likelihood and extent of overlap with other notified measures for energy savings. For example, energy savings from energy taxes could overlap with energy savings generated by the energy advice programmes. Energy taxes would also overlap with various minimum energy performance standards for buildings, which collectively have the effect of reducing household energy consumption. However, with regard to estimating incremental savings stemming from the energy taxes, these overlaps would be implicitly captured through the use of appropriate price elasticity of demand estimates and baseline estimates of consumption (which is discussed in greater detail in the next chapter).

With regard to the other fiscal measures that Germany has notified under Article 7, where there are overlaps between policies notified as part of Germany's alternative measures under EED, a reduction factor has been applied to each policy in order to take account of such overlaps. Essentially, the extent of overlap between the two, or more, policies is modelled and then deducted from the sum of total savings across the policies, although details of this modelling are in a separate study by Prognos. At a high level this seems to be an appropriate approach, but without further details on the modelling approach adopted by Prognos it is difficult to make conclusions about the extent to which policy overlaps have been comprehensively and accurately accounted for.

In particular, there is no explicit mention of policy overlaps being taken into account, despite the scope for such policy overlaps. There is likely to be overlap between the KfW support programme and the Renewable Energies Heat Act, which also incentivises exceeding minimum building requirements, but there is no evidence of any process to avoid double counting in this case. The energy savings generated by the KfW support programme could also overlap with those generated by other notified schemes, namely the investment grants for improving the energy efficiency of social infrastructure buildings under the 2008 Investment Pact and the grants provided as part of the promotion of municipal concepts and networks.

There is also the potential for policy overlap between the 'Investment support in companies' and the 'Promotion of energy management systems (EMS) under the Energy Efficiency Fund', as both provide investment grants to SMEs. The implication is that if an SME has to provide funding to top up the investment grant received under one of these schemes, then this would reduce the funding the SME had available to make use of the other scheme. As a result, the effectiveness of each scheme to generate energy savings when run concurrently is likely to be below the effectiveness of each scheme in isolation. There is no suggestion from the NEEAP or the updated notification that this issue has been taken into account.

Spain

There is no way to be sure whether the Spanish estimates have accounted for the effect of policy overlaps when estimating claimed savings. This is a very important issue in the context of the Spanish policy landscape given the number of different fiscal measures that are being used to cover similar sectors and incentivise similar actions.

First, there is no explanation of how the assessment has ensured that overlaps between similar notified measures have been taken into account when generating take up assumptions for use in Spain's bottom-up assessments of total savings. For example, the PAREER measure is an aid programme to renovate existing buildings in the residential sector, including hotels, to make them more energy efficient by improving the energy performance of the thermal envelope and heating and lighting installations. Under the PIMA SOL plan, the Spanish government will purchase reductions in direct greenhouse gas emissions achieved in hotels as a result of renovation projects, including measures to improve the thermal envelope and heating and lighting installations. However, it is not clear that the bottom-up assessments of energy savings using engineering estimates take into account the fact that some hotel owners will not make use of one of the policies because they are taking advantage of another, resulting in smaller scope for take up.

Second, a similar exercise has not been undertaken to demonstrate how other relevant energy efficiency policies that have not been notified under Article 7 have been taken into account in the counterfactual for each policy (where relevant and appropriate). The Ricardo evaluation also notes that RES measures *"should not be used for meeting the energy savings target under Article 7"* (this concerns: PAREER, JESSICA Fund and PIMA Sun). Furthermore, *"only savings from measures initiated after 1 January 2014 have been taken into account"*; however, it is not clear whether the impacts of these pre-2014 policies (to the extent that they are expected to have affected consumer behaviour during the 2014-2020 period) have been accounted for in determining incremental savings of post-2014 policies.

4.7 Additional factors

Sweden

Rebound effects and leakage are unlikely to be major concerns in the context of energy taxes.

- Leakage seems unlikely in the context of nationwide energy taxes, as the target group is effectively all energy consumers.
- Rebound effects are more applicable where, for example, grants/loans encourage take-up of more energy-efficient products which subsequently lead to more energy use. While this may occur in the long-run as a result of energy taxes incentivising investment in more energy-efficient products which subsequently lead to some increase in energy consumption (through rebound effects for those products), this effect is unlikely to be material, not least because any increase in energy consumption would still be subject to the energy taxation.
- Displacement/substitution effects, however, may occur between different fuels, due to the differential tax treatment, and this is not done. Use of customer surveys or pre-existing estimates of cross-price elasticities for different energy products would ensure that the assessment of incremental savings accounts for potential substitutability between high-taxed and lower-taxed products.

France

The points below summarise the expected likelihood of other factors arising with regard to each of France's fiscal measures. We discuss the cases where these factors are likely to arise in more detail in the proceeding bullets.

- Domestic consumption duty – displacement/substitution effects may arise in this case because, although the taxes apply across all applications and all sectors, there are different rates applicable to different energy products (dependent on their CO2 emissions) which may incentivise some degree of substitution between them. The assessment of incremental savings would, therefore, need to take into account the impact of higher taxation on one energy product leading to substitution into another energy product that is taxed, which could see consumption of the latter rise in spite of the tax increase (e.g. a tax on coal could reduce consumption of coal but lead to higher consumption of natural gas). The use of cross-price elasticities for this purpose is discussed in the next chapter.
- Eco-tax on heavy vehicles – displacement/substitution effects are likely to occur, as firms look to substitute, where possible, higher cost HGV road transport with other modes of freight transport (rail, air and sea). They may also look into the possibility of lighter weight road vehicles which would be under the minimum weight requirement. Thus despite a reduction in energy consumption by HGVs (weighing over 3.5 tonnes), increases in energy consumption are likely to occur in other areas of transport which would need to be taken into account in assessing incremental savings.
- Sustainable development tax credit – as mentioned earlier, this tax credit is only available for upgrades to primary residences, and such an approach could lead to attempts by small businesses or owners of multiple residences to redefine their portfolio in such a way that the property they wish to upgrade qualifies for such tax credits. That said, this may not be a concern insofar as it still likely to result in a reduction in energy consumption. A more pressing concern in the context of tax credits for material and equipment upgrades is the potential for rebound effects, caused by more energy efficiency products generating energy savings and thus, paradoxically, incentivising more energy consumption. The size of this effect could be captured through consumer surveys (which estimate changes in the electricity finally consumed by the household) and/or pre-existing estimates (in the case of *ex post* assessment metered savings would provide estimates of the final consumption after any rebound effect).

Germany

There are no specific references made to accounting for the other potential factors that could affect the magnitude of claimed savings in Germany's estimates of incremental savings. Below, we consider how significant a role these other factors (leakage, rebound, displacement etc.) may play in the context of Germany's fiscal measures for reducing energy savings.

- The significance of leakage seems limited in the context of tax measures, as each of the tax measures has a clearly defined target group and, therefore, the likelihood of spillover to other groups that were not the intended recipients is small. However, in the context of non-tax fiscal measures, leakage may be of more concern as individuals/businesses may in some way try to adapt their circumstances, in order to qualify for certain types of investment grants – this is leakage insofar as the initiative may not solely affect the intended group, but the leakage to non-target groups may nevertheless still increase energy savings.
- The assessment of the rebound effect is more appropriate in the case of regulatory measures, such as those imposing minimum levels of energy efficiency for certain appliances, rather than for tax measures. Moreover, any rebound effect should already be taken into account by the estimation of elasticities, thus any further adjustment for this would seem unnecessary. Rebound effects are more likely with regard to non-tax fiscal measures. The KfW support programme for energy efficient renovation and construction, for example, may, by improving the energy efficiency of buildings, encourage more household energy consumption, thus causing energy savings to fall short of those predicted by the

improvements in energy efficiency alone. Again there is no evidence that this rebound effect has been taken into account. This effect could be captured in a number of ways: on an ex ante basis it may be best captured by looking at the rebound effects for other building policy measures either domestically or abroad (a deemed savings approach); or, on an ex post basis, surveyed or metered savings could be used.

- Displacement and substitution effects seem plausible in the context of Germany's fiscal measures. This is because in the case of both the HGV tolls and the air traffic tax, there are viable alternatives that firms and consumers respectively may switch into. In the case of HGV tolls, firms may reassess and look at the viability of rail or air freight transport, while in the case of air traffic tax, consumers may look into the feasibility of coach or rail travel instead of short-haul flights. In both cases, therefore, the reduction in energy spending in the targeted sector is likely to be offset to some extent by increased energy spending in other related sectors, an effect which should be accounted for in estimating incremental savings. As well as displacement effects across sectors, there may also be displacement effects across time. The environmental premium, for example, provides a one-off grant for replacement of cars which are at least nine years old which, despite incentivising greater scrapping of cars older than this, could discourage the scrapping of less energy efficient-cars which are less than nine years old with owners instead waiting until the car is old enough to qualify for the one-off grant. Thus an increase in scrapping of cars over nine years old could be offset, to some extent, by a decrease in scrapping of cars slightly less than nine years old. There is no evidence that this displacement effect has been captured. The effect is likely to be estimated through the use of a survey of motorists to understand how the policy would affect their willingness to purchase a new car.

Spain

Given that many of the other fiscal measures that have been notified by the Spanish authorities are tightly defined and focus on specific energy efficiency products for specific target groups, the key feature (other than deadweight issues discussed above) that may be of relevance is likely to be the scope for leakage to other target groups that were not the intended recipients of the benefits of the fiscal measures in place. This may not be a concern to the Spanish authorities to the extent that it still results in reductions in final energy consumption. However, this could still be a salient issue if the leakage is from one notified measure to another, as this may reduce the overall level of savings that can be claimed by Spain.

The other key issue that needs to be taken into account given the types of policy that are in place in Spain is that of potential rebound effects which might reduce the total level of savings that are claimed. It is possible that the Spanish assessment has taken such effects into account given the bottom-up nature of the calculations using engineering estimates; however, this has not been made explicit.

5 Use of Elasticities

A key factor in assessing the effectiveness of taxation measures is the responsiveness of consumers to changes in price, i.e. the price elasticity of demand. In this section we consider the appropriate use of price elasticity of demand estimates for taxation measures. The chapter is structured as follows:

- We first provide a brief overview of the legal context which underpins the usage of elasticities in the context of the Energy Efficiency Directive.
- Second, we provide a theoretical background setting out what price elasticities of demand measure, why they are important for measuring savings, and key factors that affect their use when estimating energy savings from taxation measures.
- Third, we provide an overview of empirical estimates of price elasticities of energy demand and the ways in which such estimates are derived.
- Finally, we develop steps for implementation of price elasticity estimates for the purpose of estimating savings to be claimed under Article 7.

5.1 Legal context

The Directive understates the importance of elasticities for quantifying the energy savings from energy or CO_2 taxes that have the effect of reducing end-use energy consumption,[47]

However, it is useful to note that the Directive does not specify what type of price elasticities should be used or that Member States should exclusively use price elasticities of demand. This is important because, as explained in the next section, there may be good reason to use different types of price elasticities in different contexts.

5.2 Definition of price elasticity of demand

Price elasticity of demand is a measure of how responsive demand is to changes in price. Concretely, the own-price elasticity of demand (ε) for a product is defined as the percentage change in the demand of that product ($\Delta Q/Q$) that results from a percentage change in the price of that same product ($\Delta P/P$):[48]

$$\varepsilon = \frac{\Delta Q/Q}{\Delta P/P},$$

The concept of price elasticity in relation to energy or CO_2 taxation is important for understanding the impact of the tax on energy consumption, and therefore, the energy savings resulting from the tax. To illustrate, suppose higher taxation is imposed on a final consumption of a fuel. In principle, this will increase the price paid by consumers, thus reducing the demand for that fuel. However, the extent of the reduction in consumption would depend on the price elasticity of the demand. If demand is relatively inelastic, there would be a relatively small reduction in demand in response to a price rise. Conversely, if demand is more elastic, the reduction in quantity demanded would be much larger (larger than would be the case if demand is more inelastic).

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[47] *"In determining the energy saving from policy measures … recent and representative official data on price elasticities shall be used for calculation of the impact",* Annex V(3)(b).

[48] Strictly speaking, the elasticity is defined for continuous marginal changes in prices, i.e., $\varepsilon = \lim_{p_1 \to p_0} \frac{(q_1-q_0)/q_0}{(p_1-p_0)/p_0}$. However, for obvious practical purposes, it is empirically assessed through surveys for discrete changes in prices.

5.3 Estimation of savings using price elasticities of demand

As seen, an energy tax applied to a particular type of fuel increases the fuel price, lowers the demand and generates energy savings. The exact amount of savings depends on the response of fuel demand to the price increase which, in turn, depends on the elasticity of demand. A low elasticity value means that demand would reduce by a small amount. Such demand is often called inelastic. A high elasticity value means that demand would contract by a substantial amount in response to even a small price increase. Such demand is labelled as elastic.

In the simplest form, a fuel is taxed at the point of consumption and this changes the price of the fuel and the demand for such fuel. The reality is much more complex. On the one hand there could be shifts in demand for other fuels (which may or may not be taxed at some rate) and this could take place in the short term or in the longer term. In addition, taxes could be implemented in a variety of ways (e.g. at different stages of the value chain, for different sectors or customer groups, etc.), each creating different issues that need to be taken into account.[49] In the next section, we set out the theoretical background underpinning key factors that need to be addressed when using price elasticity estimates to estimate energy savings resulting from energy or CO_2 taxes.

5.4 Factors that can affect estimation of savings

The impact of energy or CO_2 taxes on final energy consumption depends on a number of factors that affect the relationship between supply and demand and the resultant price dynamics over time. If these factors are not taken into account in some way the savings claimed by Member States (for energy or CO_2 taxes notified under Article 7) may not represent the savings that are likely to accrue in practice.

In particular, it would be important to take into account the following factors in every estimation of energy savings as a result of taxation measures:

- Pass through by the supply side — the extent to which consumers respond to demand will depend on the extent to which producers and suppliers pass the tax on to consumers.
- Regional and sectoral variation of demand response — demand for final energy consumption may correspond to very specific characteristics of a product, and therefore, it may vary from regionally and sectorally.
- Short-run versus long-run impact of taxes — the demand response to a change in price as a result of an energy or CO2 tax could vary over time.
- Substitution effects — a relative increase in the price of one product could lead to an increase in demand for another product.

Pass through rate

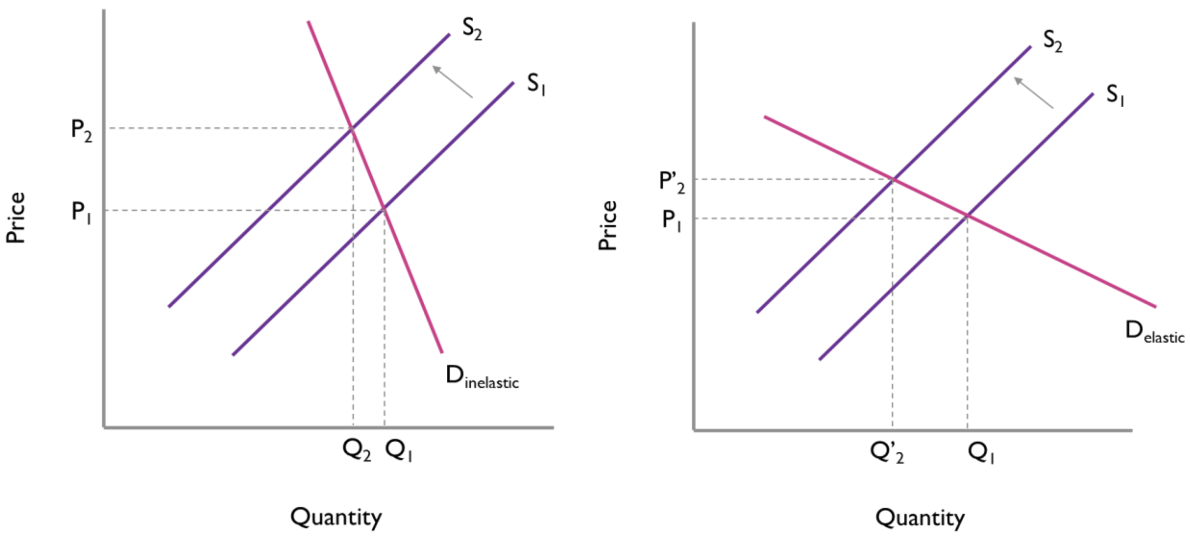
The pass through effect measures the extent to which suppliers can pass on to consumers any increases (or decreases) in their costs, including changes as a result of tax increases or decreases. This effect may apply differently at different stages of the value chain. A tax imposed at an earlier stage on raw input or intermediary product will be passed several times along the value chain before being passed onto the final output. Consequently, the increase in the output price will not immediately reflect the impact of energy tax because the impact will be distorted by the pass through effects along the value chain. The degree of pass through depends on a number of factors related to the structure of the relevant market and the competitiveness of that market. In particular, the pass through rate depends on:

[49] Price elasticities can differ according to consumer's level of income. This is something that needs to be taken into account where relevant. In such situations, different price elasticities estimates should be used for different consumer groups (e.g. consumers with very low levels of income are usually more price-inelastic for necessity goods, such as energy).

- The elasticity of supply, or the sensitivity of a firm's marginal costs to changes in output. If supply is very inelastic, the extent to which the tax is pass on will be small, whereas pass through will be larger in cases of more elastic supply.
- The price elasticity of demand. In cases where consumers are less price sensitive firms tend to pass on a larger part of the price change, while the converse is true for more price elastic demand.
- Market structure. The higher the degree of competition between suppliers the higher the rate of cost pass through would be because if competition is fierce suppliers have relatively thin profit margins and therefore their ability to absorb tax changes, rather than passing them on to consumers, is also limited.

Figure 5.1 below illustrates the importance of cost pass through to measuring the impact of taxation measures on reducing energy consumption. In the absence of the taxes, we have supply curve S_1. The intersection of demand and supply yields equilibrium quantity, Q_1, and equilibrium price, P_1. However, as the higher tax is imposed, the supply curve shifts upwards to S_2. The equilibrium that results depends on the elasticity of the demand curve. With relatively inelastic demand (left pane), we see that the market clears at a high price (P_2) with just a small reduction in quantity consumed (Q_2). However, with more elastic demand (right pane), we see that the reduction in demand is much larger (Q'_2), and the corresponding market clearing price increase is smaller (P'_2).

Figure 5.1: Illustrative elasticity of demand scenario (inelastic demand – left, elastic demand – right)



Regional and sectoral variation

Price elasticity of demand reflects the value of a good to consumers and the availability of substitutes. An important point that may need to be considered by a Member State is whether the availability and cost of substitutes varies throughout the country. For example, there may be limited capacity for a certain type of fuel in a particular region, making that fuel a more costly substitute. Further, the use of lower tax rates for certain types of energy sources may also distort the cost of substitutes across different regions within a Member State. Similarly, where the fiscal measures are targeted at industrial/commercial energy consumption rather than residential energy consumption, there may be important differences in the price elasticities of demand between sectors that need to be taken into account. While Annex V refers to the use of *representative official data on price elasticities*, it would be important to ensure that any significant variations in price elasticity of demand estimates between regions or sectors are appropriately reflected in the analysis.

Short-run versus long-run impact

Energy users' reduction in the quantity demanded in response to price increases stemming from the introduction of energy or carbon taxes could differ over time. In particular, one effect might be seen in the short run when capital is fixed (e.g. a household's gas central heating system) and another effect might be seen in the long run when capital can be varied (e.g. a household is able to replace its gas central heating system with an electric one). The precise timeframe depends on the product and industry in question. Short-run impact might imply a period of several week or months while long-run impact might cover a period of several years or perhaps a decade. For this reason, generally in the short run demand is likely to be more inelastic.

For the purpose of measuring energy savings as a result of taxation measures, this concept translates into a question of whether and when to use short-run or long-run price elasticities of demand. In principle, short-run elasticities (that reflect the relevant sector and/or region as appropriate) should be used to measure immediate impacts of the price increase (taking into account the extent of pass through to final consumers). Depending on the end users for which the change in demand is being measured, long-run elasticities should then be used at the point in time following the introduction of the tax (and therefore the resultant price increase) at which the energy user might consider changing its capital base to use an alternative energy source.

Under Article 7, Member States are to count energy savings up to and including the year 2020. Given this relatively short time frame, the use of long run elasticities would only be appropriate where evidence is available to suggest that energy users would be willing to switch to alternative technologies to allow the use of alternative energy sources within that time period.

Substitution effects

The impacts of the tax on final energy consumption may also be affected by changes in the consumption of other types of energy (especially energy substitutes).

This effect is measured by the cross-price elasticity of demand which is the responsiveness of the quantity demanded for a good to a change in the price of another good. In the short run, when energy users cannot easily change technologies to use alternative, cheaper energy sources, the extent of substitution is likely to be limited; nonetheless, it is possible that the relative increase in the price of one energy source as a result of an energy or carbon tax could lead to a reduction in demand for that energy source but an increase in demand for another energy source that is relatively cheaper.

In the long run substitution will be likely, resulting in an increase in consumption of some other energy source. Therefore, the long-run effects should also consider substitution effects, and this should be reflected in the overall reduction in energy savings claimed.

5.5 Estimation techniques

Price elasticities of demand are typically estimated using complex statistical techniques. Empirical research on price elasticities of energy demand has developed a number of standard models that differ according to the type of model used (time series, cross-sectional, panel data), time horizon (short-run versus long-run) and data frequency (the number and type of industries and/or fuel under study). There is also variation in the use of variables other than the price to explain the quantity demanded (so-called "explanatory variables").

The model type

Econometric modelling represents the most typical approach to estimating price elasticities of demand. At a very high level, the regression represents a demand function that relates demand quantity (also known as dependent or left-hand side variable) to the product price (also known as independent or right-hand side variable). The demand quantity and price are typically taken in logarithms rather than absolute values to ensure that the coefficient of price variable represents directly the price elasticity of demand.[50]

The most frequent econometric method is time series analysis that describes development of a single unit over a given period of time (for example, the world oil price only). As time dimension is the key model characteristics, special estimation methods have been developed to account for a time trend (known in the terminology as seasonality). In the context of estimating price elasticities of demand, a time series model would be suitable if the research deals with the whole economy or only one industry.

Another common but more complex econometric method is panel data analysis. A panel data model describes co-development of several units over a given period, hence a different set of methods is required to account for the inter-dependencies between units, time-invariant individual unit characteristics as well as time dimension. The panel data model would be best if the research deals simultaneously with multiple industries, e.g. manufacturing, transport and residential sector, or multiple types of fuel, e.g. gas, electricity, oil, etc., over 15-20 years,

Simulation techniques and computable general equilibrium (CGE) models represent another strand of approach. A CGE model describes in detail the input-output relationship between industries, labour, capital, intermediary products, final consumption, prices and economic growth. The elasticities are modelled as external parameters rather than estimated but the researcher has to adjust them (as well as other parameters) until the model outcome mimics real data.

Time horizon and data frequency

Short-run elasticity is typically estimated using high-frequency data such as hourly or half-hourly electricity prices. A high-frequency dataset would cover a period of one year, and up to two years at most.

Long-run elasticity is estimated using quarterly or annual data as this is the publication frequency of most statistical series on industry or economy's performance.[51] A dataset would cover a period of at least 10 years, but ideally 20-25 years.

The industries and type of fuel

The empirical research might study the economy as a whole or specific industries which most commonly include manufacturing, transport and residential sector (households). The industry classification might be more detailed, especially, if a CGE model is employed. If the residential sector is studied on its own, the model might include separate demand functions for heating, home electronic appliances and lighting.

The model might consider the overall demand for energy or demand for specific types of fuel, such as gas, electricity, gasoline (or petrol), oil and others. A model for a particular type of fuel might include prices of other energy sources, along the fuel own price, to measure cross-price elasticities of demand and the substitution effects between different types of fuel.

For the purpose of estimation, the amount of energy demand is usually converted to one common unit of measurement such as millions of tonnes of oil equivalent (Mtoe) or petajoules (PJ).[52] Demand for particular fuel, if examined on its own, might still be expressed in fuel-specific units, e.g. MWh for electricity.

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[50] A demand function that has quantity and price in absolute values rather than logarithms can also be estimated but the coefficient of price variable has to be converted to price elasticity of demand using non-linear formulae. Applying logarithms to quantity and price in the equation avoids conversion problems and produces direct estimate of elasticity.

[51] In rare cases the data might come at 5-year frequency, e.g. 1990, 1995 and 2000 only. No research has been identified that uses monthly data.

[52] The tonne of oil equivalent (toe) is a unit of energy defined as the amount of energy released by burning one tonne of crude oil. Joule is a metric unit for energy, one petajoule is equal to one quadrillion (10^{15}) joules.

Explanatory variables

Explanatory variables are often included on the right-hand side of econometric equations to control for external factors that might affect energy demand. Good practice is to include a constant, measures of income and weather impact, and sometimes calendar effects. The constant term reflects the value of base demand quantity that could be purchased if the product price was zero.

The income measure differs according to the industry under study. The income of whole economy is the gross domestic products (GDP). The income of specific industries is estimated as industrial output or index of manufacturing. Finally, the income of residential sector is usually household's disposable income.

The impact of weather is evaluated as the number of heating and cooling degree-days during the year[53] or as the average temperature in a given area during the period.

Calendar effects are modelled as dummies (zero/one indicators) to denote year, month, season, weekends and public holidays.

The following variables are typically included in a study of residential energy demand:

- Dwelling characteristics — type, age and size of the home, type of heating, number of rooms, etc.
- Household demographics — age of the household head, composition (children, elderly), etc.
- Ownership rate of home electronic appliances, by type of appliance (fridge, washing machine, etc.).

Examples of non-standard variables are size of vehicle population, gross output in state-owned enterprises or amount of foreign direct investment.

5.6 Empirical results

This section summaries empirical estimates of price elasticities of demand in the key academic literature and the estimates used by Member States to calculate claimed savings from taxation measures. There is considerable variety in estimated values within the academic publications, within results of Member States and between academic and Member States results.

The academic papers cover selected countries within the European Union (the UK, the Netherlands) and worldwide (China, the USA, Australia) and report mostly long-run elasticities (see Table 5.1). Only two studies attempted to estimate short-run elasticities of electricity demand on the wholesale market. The first study produced the estimate of –0.0014 and the other study produced the estimate of –0.4165.

Table 5.1: Price elasticities: by industry and fuel type. Long-run estimates ranges from academic literature

Industry / Fuel	Manufacturing	Transport	Residential	Whole economy
Energy*	[–0.202, +0.323]	[–0.305, –0.127]	[–0.219, –0.048]	[–0.233, –0.161]
Gas	–0.584		[−0.693, +0.02]	
Electricity	[–0.600, –0.020]		[−0.86, +0.030]	0.427
Coal	–0.529			–1.591
Oil	–0.193	–0.269	–0.230	–0.059

Notes: * Includes all sources.

[53] One heating (cooling) degree-day is a day when the temperature falls below (exceeds) base temperature. The base value is typically set at 18 °C but might be altered according to the country's prevailing climate. The base value indicates comfortable indoor temperature, below (above) which the users start switching *en mass* domestic heating (air conditioning for cooling).

Some Member States obtained both short-run and long-run estimates of elasticities for different industries and fuel types, while others did not make a distinction between short- and long-run. Table 5.2 summarises the estimates of long- and short-run elasticities.

Table 5.2: Price elasticities: by industry and fuel type. Estimates by Member States. Short-run (parentheses), long-run [square brackets]

Industry / Fuel	Manufacturing	Transport	Residential	Services	Agriculture
Energy*	–0.47	(–0.19) [–0.26]			
Gas	(–1.43, –0.03) [–1.43, –0.10]		(–0.26, –0.05) [–0.32, –0.05]	(–0.26, –0.025) [–0.20, –0.05]	–0.23
Electricity	–1.24, –0.00		(–0.18, –0.05) [–0.50, –0.05]	(–0.18, –0.025) [–0.50, –0.025]	(–0.39, –0.05) [–0.39, –0.10]
Oil			–0.20, –0.05	–0.20, –0.025	
Petrol		(–0.49, –0.05) [–0.60, –0.25]			
Diesel		(–0.50, –0.05) [–0.40, –0.00]			
Fossil fuel					–0.21
District heating			(–0.20)	(–0.20)	

Notes: * Includes all sources. Some Member states did not differentiate between long- and short-run estimates, these estimates are entered in both long- and short-run ranges.

5.7 Practical application

Drawing on the theoretical background and techniques for implementing this theory set out in the previous sections, we now provide practical steps for implementation of price elasticity of demand estimates to estimate energy savings stemming from energy or carbon taxation measures. In particular, this section sets out what are likely to be the most appropriate approaches to estimating price elasticities of demand bearing in mind the relevant context (e.g. taking into account the availability of data or methodological constraints).

Broadly, different approaches to estimating price elasticities of demand can be divided into direct and indirect methods. Ideally, a Member State should seek to obtain purposely estimated values. However, it is understandable that due to data constraints and methodological issues or practical factors (such as required knowledge, resource or time constraints), direct estimation might be not feasible. Below we discuss both options in more details, in particular reasons for using a particular approach and methods of generating indirect estimates.

5.7.1 Direct estimation

To estimate price elasticities of demand, a Member State ideally would be expected to commission a research to obtain the up-to-date values and ensure coverage of all relevant sectors. The estimation method would use an econometric model with the following features:

- Use of time series models and relevant estimation techniques.
- A separate model for each industry and, possibly, type of fuel.
- The log-log equational form for energy demand and price.
- Sufficient time horizon: at least 20 years of annual or quarterly observations for long-run elasticity and between one and two years of high frequency data for short-run elasticity (weekly records at a minimum).
- External variables to account for income, weather and calendar effects (plus dwelling and household characteristics in case of residential energy demand).
- Other external variables justified by the economic situation, current policy or prevailing technological standards.

5.7.2 Indirect estimation

Various factors might prevent direct econometric estimation of price elasticities. For example, data might be unavailable or be of poor quality (observation gaps, short time horizon). A regression with sufficient data points might still produce unsatisfactory results from a statistical point of view. Alternatively, direct estimation may be viewed as being a disproportionate exercise given the cost of developing such models (internally in terms of training and time, or externally in terms of consultancy cost).

When direct estimation is not possible, it is acceptable to use results of similar regressions as proxies for the relevant price elasticity in question. The choice of comparable regression estimates should be well justified to avoid costly policy errors. Below is a brief overview of suitable comparator regressions.

Results from academic literature for that country

Academic literature on price elasticities of demand in a given Member State might provide general guidance on the value range or specific estimates. The use of academic resources would be justified if, for example, the research involved complex estimation methods or collection of specialised data that cannot be easily replicated within the direct regression framework. Ideally, the academic research should:

- be published in a well-respected journal;
- make use of recent data and models that reflect the current policy landscape;
- cover the sectoral dimension relevant to the tax in question (unless an economy-wide estimation is appropriate);
- cover each fuel relevant to the tax in question as well as substitutes; and
- measure both short-run and long-run price elasticities.

Where such criteria are not met, the Member State would need to provide strong justification to explain why that particular academic research has been relied upon and why the results remain valid.

Results from another similar country

If academic literature on a given country, industry and fuel is not available, the Member State might resort to using regression results for a particular industry in another country similar to the Member State in some respect. If this is done, this should be properly justified. The following criteria can be used to assess proximity of two economies:

- Level of economic development: GDP per capita, economic growth rates.
- Economy's structure: share of key industries in GDP, absolute amount of output in a given industry.
- Existing energy policy: current energy taxes and prevailing tax rates, energy-related subsidies to industry/households.
- Climate: temperature, seasonality.

Using estimates for the same industry in another country would generally be preferred over using estimates for another industry in the same country. The same industries in two countries are more likely to have similar technological process, market structure, demand patterns (e.g. seasonality) and the pass through effects than two different industries in the same country. The proximity of industries is expected to be especially strong between two countries of similar economic development.

Results from one sector to apply to all sectors

An estimate of price elasticity of energy demand in one industry can be used as an elasticity estimate for another industry within the same country if there is no suitable comparator industry or type of fuel in other countries. In a situation where separate industry-by-industry analysis is not possible, one regression for the whole economy might be used to estimate generic price elasticity of energy demand.

6 Illustration of Use of Price Elasticities

In this section, we provide an overview of the approaches taken by the four selected Member States to estimating claimed savings for energy/carbon taxation measures in the context of the theoretical framework (and its practical application) set out in the previous chapter. Here, we focus on analysing specific aspects of the approaches taken by these Member States to ensuring that appropriate elasticities have been used to derive savings from taxation.

The summary of the approaches taken by Member States is shown in the table below.

Table 6.1: Summary of methods used by Member States

Sweden	
Approach taken to estimate savings:	Econometric modelling
Source of price elasticity estimates:	Reports commissioned to an academic researcher
Calculation of price increase due to taxation:	Exact formulae not presented
Granularity of estimates:	No estimates for elasticity of energy demand in industry
Time horizon:	40 years of annual observations
Substitution:	Reasonable consideration of substitution effect
France	
Approach taken to estimate savings:	Computable general equilibrium model
Source of price elasticity estimates:	n/a
Calculation of price increase due to taxation:	n/a
Granularity of estimates:	n/a
Time horizon:	n/a
Substitution:	n/a
Germany	
Approach taken to estimate savings:	Computable general equilibrium model
Source of price elasticity estimates:	n/a
Calculation of price increase due to taxation:	Exact formulae given
Granularity of estimates:	Major sectors and types of fuel covered
Time horizon:	n/a
Substitution:	n/a
Spain	
Approach taken to estimate savings:	A report by academic researchers
Source of price elasticity estimates:	Academic literature
Calculation of price increase due to taxation:	n/a
Granularity of estimates:	Major sectors and types of fuel covered
Time horizon:	n/a
Substitution:	n/a

Note: “n/a” means “not available”.

The remainder of this section provides details of the approaches taken by Member States. Each sub-section is structured as follows:

- Legal background.
- Approach taken to estimate savings.
- Source of price elasticity estimates.
- Calculation of price increase due to taxation.
- Granularity of estimates.
- Time horizon.
- Substitution.

6.1 Sweden

Legal background

Sweden employs energy and carbon (CO_2) taxes only, i.e. no other policy instruments or programmes, to stimulate energy saving. The energy and carbon taxes are regulated by the Swedish Energy Tax Act (1994). The rates depend on the fuel type, and sometimes on fuel environmental class. Table 6.2 summarises the energy and carbon taxes by type of fuel and, if applicable, fuel class.

Table 6.2: Summary of energy and carbon taxes, by type of fuel, in Sweden

Type of fuel	Energy tax	Carbon tax
Petrol	Differentiated rates by fuel class: • Environmental class 1; • Alkylate petrol; • Environmental class 2; • Other.	Yes
Diesel fuel	Differentiated rates by fuel class: • Environmental class 1; • Environmental class 2; • Environmental class 3.	Yes
Fuel oil	Yes	Yes
Natural gas, fuel	Yes	Yes
Natural gas, heating	Yes	Yes
LPG, fuel	Yes	Yes
LPG, heating	Yes	Yes
Coal and coke	Yes	Yes
Electricity	Differentiated rates: • Manufacturing industry, agriculture, forestry and aquaculture. • Certain municipalities in northern Sweden. • Municipalities elsewhere in Sweden.	No

Approach taken to estimate savings

The calculation of energy saving relies heavily on the econometric models (details below) and the forecast of GDP and energy demand growth rates to calculate price elasticities of demand, changes in energy prices and demand and the associated saving of energy due to the tax application.

Source of price elasticity estimates

To estimate price elasticities of demand, Sweden commissioned two related reports from Professor Runar Brännlund, an established academic researcher from the Centre for Environmental and Resource Economics (CERE), Umeå University. Both reports appeared in 2013 as academic working papers. The first report deals with the residential sector and services (jointly) and the second report deals with the transport sector.

The first report produced by Professor Brännlund covered housing and services and used time series methods to estimate the price elasticities of demand. The report examined electricity consumption only. The study used an error correction model that allows simultaneous estimation of long-run dynamics and short-run fluctuations. The model used logarithms of output and price to obtain direct estimates of elasticities. The explanatory variables included GDP per capita, temperature and a time trend to account for weather, income and general economic growth respectively. The sample data covered a sufficiently long time horizon between 1970 and 2010, i.e. 40 annual observations. The estimated values are –0.07 for short-run price elasticity and –0.5 for long-run elasticity. Both estimates are statistically significant and the model has good overall statistical properties as well.

The second report produced by the same author covered transport and also used an error correction model to estimate the price elasticities. In the case of transport, the key energy sources of interest were gasoline and diesel. The regression included prices and consumption of gasoline and diesel as the main variables. Both types of fuel were included in the same regression model which permitted estimation of own and cross-price elasticities of demand. The explanatory variables used were real GDP per capita to account for income and consumer price index (CPI) to account for prices of other goods. The sample data covered the period between 1974 and 2012, i.e. 38 annual observations, and were sourced from the Swedish Petroleum and Biofuel Institute and Statistics Sweden. The regression had good statistical properties and produced statistically significant estimates for most elasticities. Table 6.3 summarises the estimates of price elasticities of demand for gasoline and diesel.

Table 6.3: Price elasticities of demand for gasoline and diesel, Sweden

Time aspect	Output	Price	
		Gasoline	Diesel
Long-run	Gasoline	–1.09	0.45
	Diesel	0.40	–0.40
Short-run	Gasoline	–0.58	0.18
	Diesel	*0.12*	–0.17

Notes: Numerical value indicates that 1 per cent change in price would result in X per cent change in output (final consumption).
Italic indicates statistically insignificant estimate at 10% significance level.

Both reports were purposely commissioned to calculate the savings and, in particular, to estimate the price elasticities. The author used a robust methodology and obtained the elasticity estimates with good statistical properties. The reports were not published in a peer reviewed journal but, in our view, it can be considered to be robust for the purpose of estimating energy savings stemming from the taxation measures notified by Sweden. Indeed, in our view, the Swedish case study represents an example of good practice with regard to the use of price elasticity of demand estimates to estimate savings.

Calculation of price increase due to taxation

The Swedish Notification does not provide the exact formulae used to calculate the price increase, only the final percentage change of the energy price. The studies do not consider pass-through effects when calculating the impact of taxes, which is potentially a shortcoming of the Swedish approach, as it could lead to overestimates of the energy savings. However, given that the final energy prices are unregulated, it might be reasonable to assume that the markets are competitive, and therefore, changes in taxation are fully passed through. Nonetheless, the reporting of the calculation should give this some consideration. Further, the Notification does not provide the no-tax base price to which the tax rate is applied for the purpose of calculating a price increase; this should also be documented.

The NEEAP quantifies the energy savings by comparing energy consumption under the base and alternative scenarios, without and with the taxes respectively. Both scenarios make assumptions about GDP and price development but the source of growth rates or forecast is not clarified.

Granularity of estimates

The two studies cover key sectors that are affected by the taxes (i.e. residential, services and transport) and important types of energy (i.e. electricity, gasoline and diesel). However, the NEEAP does not explain what elasticities, if any, were used for calculating energy saving in industry.

The studies do not account for regional variation in electricity demand which is incorporated in the tax rates on electricity consumption. If the absence of regional factor in the studies is due to the lack of regional data, the Notification should articulate it (an open question is then use of differentiated tax rates on regional electricity demand against the assumed uniform price increase resulting from the tax).

The Notification also covers the industry sector, in addition to housing and transport. The document lists the amount of energy savings in each sector. However, it does not present the calculation method to the fullest extent which, together with the two previous studies, means that the relevant calculation details are still missing for industry.

Time horizon

As mentioned above, the econometric model used in the academic studies explicitly accounts for short-run and long-run estimates of price elasticities. The estimates have been applied jointly, in combination with the GDP and no-tax price forecast, to estimate the changes in output and prices due to taxation and the resulting energy saving. By the virtue of the error correction model, the long-run elasticity is used to estimate the output adjustment to the long-run price trend that reflects fundamental economic factors such as the available stock of energy (e.g. proved oil reserves) or the maximum potential production (e.g. total installed capacity of power plants). Similarly, the short-run elasticity is used to estimate the output change after an unexpected but transient demand or price shock, e.g. an unusually hot week in the otherwise normal summer weather.

Substitution

The econometric model considers the substitution effect in the specific context of the transport sector and the use of gasoline and diesel fuel. As the study excludes many other types of fuel, there is not explicit consideration of the cross-price elasticities between gasoline, diesel fuel and other types of fuel, and therefore, the substitution effect between them is unknown. Taking these additional cross-price elasticities into account could affect the calculation of energy savings to the extent that different types of fuels can be considered to be substitutes (in the short- and/or long-run) in the transport sector. If the absence of other type of fuels in the studies is due to the lack of appropriate data, Sweden's reporting of energy savings should articulate this.

6.2 France

Legal background

France has introduced two taxes: one is an energy tax on trucks ("eco-tax for heavy vehicles") that is based on the distance in kilometres travelled by trucks over the national network of publicly managed roads (but excluding regional road networks and a number of other exemptions not specified in the NEEAP); the other is domestic consumption duty based on CO2 content.

Approach taken to estimate savings

With regard to the eco-tax for heavy vehicles, the French notification states the following: *"a study will be carried out to determine the impact of the scheme on consumption in the sectors examined once the details of the scheme are finalised."* In terms of the domestic consumption duty, the French notification simply states that econometric studies will be used from 2014 onwards to calculate energy savings. No further details are provided in either case.

However, the NEEAP stated that a tool called SceGES was developed to quantify the reduction of greenhouse gas emissions, and therefore, allow evaluation of each individual policy. This tool also calculates the final energy savings resulting from the different measures, and the NEEAP states that the SceGES model has been used to estimate the impact in terms of final energy savings of the key measures within the scope of the action plan, including the eco-tax on heavy vehicles and the domestic tax on the consumption of energy products. With regard to the eco-tax on heavy vehicles, Annex 3 of the NEEAP goes on to explain that the analysis drew on the results of two studies[54] to generate certain inputs to the modelling used to derive energy savings. No details are provided on the use of the SceGES model to estimate savings associated with the domestic consumption tax.

Investigation of the SceGES model documentation indicates that this is a CGE model. However, the model documentation (in French) does not appear to report elasticities that feature in the model (either as an input or derived through the calculations). It is not clear from the NEEAP and Notification whether or how price elasticities of energy demand were used to calculate the saving, and if yes, what the source of the elasticities estimates is. Hence, it is not possible to review the use of price elasticities of demand by France in the present report. Any further notification by the French authorities should seek to provide details on the estimation of savings associated with taxation measures, giving due consideration to the different concepts presented in this chapter.

6.3 Germany

Legal background

The German NEEAP and updated notification present the calculation of energy savings due to various policy programmes and the specific energy taxes in particular. Germany introduced or modified three relevant taxes via a number of legislative acts. The taxes are as follows:

- Energy and electricity tax.
- Heavy goods vehicle (HGV) toll.
- Air traffic toll.

Approach taken to estimate savings

The energy savings resulting from taxes are calculated on the basis of a computable general equilibrium (CGE) model for the Germany economy. The CGE model is proprietary, it was developed in the 1950s and is maintained and updated by an independent consultancy company, Prognos. The CGE model includes various assumptions about the growth of the economy and trends in energy prices to compare energy consumption with and without policy instruments and the resulting energy saving. A number of targeted models for the transport sector were used to complement the main CGE model.

Source of price elasticity estimates

The updated notification presents the estimates of price elasticities of demand but does not specify the methodology or the source of estimates.[55] Table 6.4 summaries elasticities estimates for different sectors and fuel types. Statistical significance of estimates, if available, is not reported.

[54] The first is a 2009 study on the national and regional impact of the eco-tax on trucks. It assesses the impact of the eco-tax on the shift to railway and river transport. The second is a study that carries out an assessment of the different traffic forecast models and estimates the reduction in motor fuel consumption of trucks following the implementation of the measure.

[55] We investigated the Prognos model documentation, but we were unable to garner the methodology used to develop the price elasticity estimates presented in the updated notification.

Table 6.4: Estimates of price elasticities of demand, by sector and type of fuel

Type of fuel	Residential		Commerce, trade and services			Industry	Transport
	Space heating	Water heating	Space heating	Production process	Other use		
Heating oil heavy	n/a	n/a	n/a	n/a	n/a	–0.1	n/a
Heating oil light	–0.2	–0.05	–0.2	–0.025	n/a	–0.1	n/a
Natural gas	–0.2	–0.05	–0.2	–0.025	n/a	–0.1	n/a
Electricity	–0.2	–0.05	–0.2	–0.025	–0.025	–0.025	n/a
Electrical appliance	–0.025		n/a	n/a	n/a	n/a	n/a
Petrol	n/a	n/a	n/a	n/a	n/a	n/a	–0.25
Diesel	n/a	n/a	n/a	n/a	n/a	n/a	–0.25

Note: "n/a" means "not available" or absence of elasticity estimate for a given sector and type of fuel.

Separate estimates of price elasticities of demand are used in the case of HGV and air traffic tolls. For both tolls, the demand function and the corresponding price elasticity relates the distance travelled to the tax rate. In the case of the HGV toll, the distance liable for the toll is measured in kilometres. In the case of the air traffic toll, the travel distance is measured as the mileage flown. The calculation of energy saving due to the HGV toll employs a single estimate of price elasticity. However, with regard to the air traffic toll the price elasticities are differentiated by the flight type, domestic or international, the latter being further subdivided into short, medium and long distance international flight. Table 6.5 summarises the elasticities estimates in the case of the two tolls.

Table 6.5: Price elasticities of demand – the case of HGV and air traffic tolls

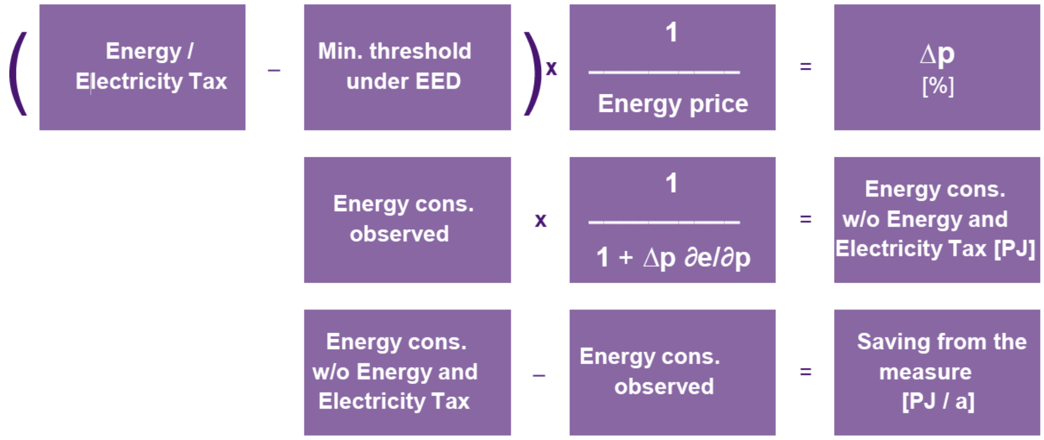
Tax	Type of travel	Price elasticity of demand
HGV toll	Distance in kilometres	–0.05
Air traffic toll	Domestic flights	–0.92
	Short distance international flight	–0.92
	Medium distance international flight	–0.76
	Long distance international flight	–0.76

Calculation of price increase due to taxation

The updated notification provides the exact formulae for calculating the price increase, output change and the resulting energy saving due to taxation. Figure 6.1 provides an example of the formula for the case of energy and electricity tax. Similar formulae are available for the HGV and air traffic tolls. Broadly, the process follows three steps:

- The first step calculates the change in prices as a result of the introduction of the tax. The energy price in the first step of calculation is the forecast of end-customer price that would prevail absent the tax measure.
- The second step calculates the expected energy consumption that would have prevailed in the absence of the tax. The elasticity estimate enters the second step of calculation and is denoted as $\partial \mathbf{e} / \partial \mathbf{p}$.
- The final step subtracts observed energy consumption from the expected energy consumption calculated in the second step to derive the savings from the measure.

Figure 6.1: Calculation formula for energy saving fur to energy and electricity tax



Source: Germany's updated notification.

As is evident from the diagram above, the calculations do not explicitly account for the extent of pass-through, i.e. the extent to which the tax is passed on by suppliers to consumers. This may well be appropriate given the structure of the energy market in Germany; however, to the extent that 100 per cent cost pass through is a valid assumption, it should be justified.

Granularity of estimates

As shown in Table 6.4, the elasticities estimates cover the major affected sectors, namely residential, commerce (also includes trade and services), industry and transport, and a variety of fuel types relevant for each sector. However each sector has the same elasticity estimate for all or almost all energy sources. For example, the residential sector have the same elasticity value of –0.2 for three types of fuel out of four. Germany's reporting should justify the use of same values for different types of fuel or seek to obtain differentiated estimates by sector and fuel type.

The price elasticities do not account for regional variation which might be significant in Germany, given that the country consists of federal lands with potentially different energy legislation. The CGE model might take the regional factor into account. The regional aspect of the calculations should therefore be clarified in further notifications — even if it is to confirm that regional variations are not expected to be material and are therefore not considered explicitly (perhaps on grounds of proportionality).

Time horizon

The price elasticities of demand are estimated irrespective of time aspect (short- versus long-run). It is not clear if the CGE model takes into account the time aspect, and if yes, how the single estimates of elasticities are adjusted in the model.

Ideally, the estimation of energy savings stemming from the German taxation measures should give consideration to whether long-run substitution effects are possible within the time period of the policy, i.e. up to 2020. If such long-run effects are indeed possible *and* probable within the time period, the analysis should take this into account by using estimates of long-run price elasticities as appropriate. If such long-run effects are not possible *or* probable, the analysis should make clear why this is and explain that it was therefore not necessary to use estimates of long-run price elasticities.

Substitution

The estimates of price elasticities exclude substitution factor. As with other aspects (time, region), the CGE model might already incorporate the substitution effect. If yes, further clarification is needed to explain the interaction of demands for different types of fuel.

6.4 Spain

Legal background

As set out in the previous chapter, Spain has notified a law (Law 15/2012) which regulates the following energy taxes:

- Tax on spent nuclear fuel.
- Duty on hydroelectricity generation.
- Tax on fossil fuels:
  - Natural gas.
  - Coal for electricity generation.
  - Fuel oil for electricity generation.
  - Diesel for electricity generation.
- Tax on electricity generation, from all generation sources, both ordinary and special regime generation.

Approach taken to estimate savings

To calculate the energy saved as a result of taxes under Law No 15/2012, the effect of the reform on electricity and natural gas prices to final consumers was determined and the energy savings were quantified on the basis of the new prices, taking into account the coefficients for elasticity in an academic study used as a reference. In particular, the Spanish authorities drew on the results of on the report *Uso de elasticidades precio para el cálculo de los efectos de instrumentos de política energético-ambiental en España*' [Use of price elasticities to calculate the effects of energy and environmental policy instruments in Spain] by Xavier Labandeira and José María Labeaga.

The specific elasticities used are shown in the table below:

Figure 6.2: Price elasticity of demand estimates

Year	Residential electricity	Services electricity	Industrial electricity	Residential gas	Services gas	Industrial gas
2013	-0.186	-0.031	-0.052	-0.192	-0.184	-0.184
2014	-0.236	*-0.055*	*-0.073*	-0.200	*-0.203*	*-0.203*
2015	-0.287	*-0.083*	*-0.094*	-0.216	*-0.223*	*-0.223*
2016	-0.338	*-0.111*	*-0.115*	-0.232	*-0.242*	*-0.242*
2017	-0.388	*-0.140*	*-0.137*	-0.256	*-0.262*	*-0.262*
2018	-0.439	*-0.168*	*-0.158*	-0.280	*-0.281*	*-0.281*
2019	-0.489	*-0.196*	*-0.179*	-0.320	*-0.301*	*-0.301*
2020	-0.530	-0.200	-0.200	-0.360	-0.320	-0.320

Source: Report on energy saving and efficiency policy measures in compliance with Article 7, 5 June 2014.

The coefficients for elasticity shown in italics in the table above indicate the values calculated by interpolating the short and long-term coefficients indicated in the academic report.

The price increase as a result of the taxation measures was calculated on the basis of the average prices in 2013 and the forecast demand figure for 2014, broken down into each of the three sectors analysed (residential, services and industry), and the coefficients for price elasticity of demand above were then applied to the price increases for each year in the period during which the Directive applies, i.e. 2014-2020.

Source of price elasticity estimates

The Spanish authorities opt to draw on the results of academic literature rather than estimate price elasticities directly. The updated notification notes that the authors are professors of economics and public finance respectively and distinguished academics in the field who have published many international reference works on energy demand analysis. The report reviews the existing literature on Spain and places it in the international context of energy product price elasticities, and proposes applicable elasticity values for the demand for electricity, gas and liquid fuels, differentiating between short and long term estimates and between the residential, industrial and services sectors. This suggests that the source is likely to be credible and that it is appropriate to place weight on the results of the analysis.

Spain's updated notification also notes that the price elasticities which the literature gives for Spain are in many cases based on relatively old data, and do not incorporate the structural changes in energy demand which have occurred in recent years stemming from changes in the economic climate, technological progress, changes in certain patterns of behaviour, etc. Spain also considers that it is important to note that the literature review shows that the results for Spain are as a general rule lower than those given for neighbouring countries. That fact, together with the strengthening of energy and environmental policies in recent years and indeed convergence with other developed economies, amongst other phenomena, suggests that the elasticity values used to estimate the externalities are conservative, and place those externalities in the bracket below where they really are.

Further, the academic reference covers the different sectors that are likely to be affected by the taxation, and the study estimates both short-run and long-run price elasticities. Overall, therefore, it seems reasonable to assert that the price elasticity of demand estimates are representative of the national circumstances and sectors concerned, and Spain shows intention to revise the notified estimates should new revised price elasticity estimates become available. However, having said this there are potentially issues that have not been addressed in the Spanish estimation (though this cannot be said for certain given that the information provided by Spain is relatively limited).

Calculation of price increase due to taxation

Spain's updated notification states the following: "To calculate the energy saved as a result of this fiscal measure, the effect of the reform on electricity and natural gas prices to final consumers was determined". No further details on the methodology to calculate the price increase are provided, making it difficult to ascertain whether all the relevant factors that might affect the extent of price increase have been taken into account.

First, there is the issue of how the broad range of taxation measures has been translated to the fuel types considered in the quantification exercise, i.e. electricity and natural gas. While it might be assumed that the change in natural gas price is directly related to the tax on natural gas, the case for electricity is much more complicated, as there are a number of taxes on different types of electricity generation, and it is not clear how this relates to the final retail price for electricity.

Second, there is no mention of whether pass-through issues have been taken into account. This is relevant for the natural gas price, as the extent to which natural gas suppliers pass the tax on natural gas on to final energy consumers will depend on the range of factors discussed earlier in this chapter. Again, the issue is more complex for electricity, as the extent to which the tax on generation is passed on to final electricity consumers will depend on the extent of pass-through at each stage of the electricity value chain.

Granularity of estimates

As mentioned above, the price elasticity of demand covers three broad sectors which might reasonably be expected to have similar demand within each sector (i.e. residential, services and industrial). Given the nature of the taxes, any type of consumer of electricity or natural gas would be affected. Therefore, the three sectors seem an appropriate level of coverage, given that all sectors of the economy would fall within one of these three broad sectors.

It is possible that there is regional variation in demand within each of these sectors if particular sub-sectors are located in particular regions, though this only seems potentially relevant for the industrial sector. However, given the reliance on an academic publication, it is understandable that such regional variation has not been explored.

Time horizon

As mentioned earlier, the coefficients for elasticity shown in italics in the table above indicate the values calculated by interpolating the short and long-term coefficients indicated in the academic report. However, the Spanish updated notification provides no explanation as to why this has been done. It is therefore not possible to discern whether this is because short-run elasticities were not considered appropriate in those particular cases, or whether this was an attempt to derive "medium-run" elasticities, perhaps because substitution effects would have started to become embedded by 2020, but full possibility for substitution to alternative fuel types (by changing underlying technologies) was not thought to be possible in this timeframe.

Without explanation it is not possible to critically assess whether such an interpolation is appropriate. However, we would expect that use of short-run price elasticities would have been appropriate at least for the first year (or initial years) for the full population, as it seems unlikely in principle that energy consumers in each of the three sectors would be in a position to readily switch their energy consumption to alternatives with a relatively lower price in such a short timeframe. Long-run elasticities could then be applied to estimates of proportions of the population based on evidence of propensity to undertake investments to switch technology.

Substitution

To the extent that substitution has occurred, there does not appear to be any offsetting increases in consumption of the alternative energy sources as a result of the tax. Without a full consideration of why short-run and interpolated elasticities (between short- and long-run estimates) have been used, it is not possible to say what types of substitution effects should have been considered. It would be important to take this into account where appropriate, as the current savings may represent an overestimate if substitution effects have been material.

7 Recommendations

The evidence reviewed demonstrates some inconsistent reporting of claimed energy savings across Member States. As a result it is not clear the extent to which the savings being reported for measures notified under Article 7 are fully contributing to the EU-wide energy reduction targets. Therefore, a revision of the EED, and in particular Article 7 and the associated Annex V, is fully justified.

7.1 Finding 1: type of measures

Finding 1: The impacts and methodology needed for estimating energy savings can be very different for the four type of envisaged measures: energy efficiency obligation schemes; financial schemes and fiscal incentives; energy or CO_2 taxes and regulations or voluntary agreements.

Recommendation 1: It may be worth explaining the differences and the different requirements of each of these four types of measures. This could be described in different articles or specific sections. This could help to identify the need to treat the different types of measures in a specific way that is appropriate to each type.

7.2 Finding 2: methodological issues

Finding 2: There is not enough detail on how the calculations should be undertaken for the different measures. Although there is a common evaluation framework provided as the basis of the assessment of energy savings for all measures notified under Article 7, there are a number of different conceptual factors which need to be taken into account in different ways depending on the type of measure being evaluated.

Recommendation 2: we recommend that Annex V provides description for the following:

- A common framework for all measures (to ensure that savings are calculated on an incremental basis with reference to an appropriately defined counterfactual).
- A detailed section for calculating savings for all measures, except for taxation measures.
- A detailed section for taxation measures.

The common framework and detailed sections could include the elements described in Recommendation 2a, 2b and 2c indicated below.

Recommendation 2a: the common framework could include the following concepts:

- Construction of the baseline: this concept should specify that savings for each notified measure should be calculated in relation to a baseline scenario (counterfactual) that captures how outcomes and impacts would have evolved in the absence of the policy.
- Factors to consider: this concept should clarify that when constructing the counterfactual the calculation should account for:
  a) Deduction of any policy overlaps, this is ensuring there is not double counting with any other policies that in place (the different methods are suggested as part of recommendation 2b and 2c).
  b) Inclusion of relevant impacts only, this is including only savings that go beyond the minimum requirements originating from EU legislation.

- Other influencing factors: it should be established that, when constructing the counterfactual, additional factors which are likely to influence the level of energy sales over time (in the absence of the intervention) should be included. These should account for:

  a) Trends/changes in consumer behaviour.
  b) Technological progress.
  c) Changes in policy environment:

- Incremental impacts should be clarified as being calculated as the net impacts of the baseline scenario (the counterfactual constructed earlier).
- Additional factors: The assessment of the incremental impacts would need to consider the applicability of the following:

  a) Materiality: the policy in question needs to have a demonstrably material impact on the take-up of the measures. This is a contribution to the realisation of the specific individual action in question in a way that it is "demonstrably evident" (Member State must be able to show that this is so).
  b) Displacement: any intervention benefits which are reduced elsewhere in the target area should be accounted for.
  c) Leakage: although leakage may be limited, Member States may subtract any benefits that may accrue to groups or regions outside the scope of the policy.
  d) Rebound effect: authorities may assess whether any decrease in energy spending results in unintended increases of energy elsewhere (as a result of an increases the income or wealth of the affected parties).
  e) Substitution: consumer diversion to other energy resources should be accounted for in situations where subsidies or tax breaks incentivise consumer switching.

The framework is similar for all measures but its application may be different depending on the context. Users should apply each individual tool selectively depending on their relevance for the impact being measured.

Recommendation 2b: the detailed section for calculating savings for all measures, except for taxation measures should refer to the *existing* four methods for calculating the savings for different types of action:

- Deemed savings (standard values for each measure).
- Metered savings (before-and-after measurement).
- Scaled savings (based on engineering estimates).
- Surveyed savings (based on consumer response).

Recommendation 2c: the detailed section for taxation measures (i.e. energy and CO_2 taxes) should clarify that for such measures:

- Energy savings need to be quantified on the basis of price elasticities, which represent the responsiveness of energy demand to price changes (in the case where estimates are used from a similar industry or Member State, proper justification should be given in terms of similarities in the level economic development, economy's structure, existing energy policy and factors related to the climate).
- Savings should reflect the extent to which the tax is passed on to end customers, and price elasticities (including cross-price elasticities for any substitution effects) should be estimated on the basis of recent and representative official data sources.
- The construction of a counterfactual may be less of a requirement (if properly constructed, elasticities should account for "net" effect of the change in prices, excluding other effects that may have happened in the absence of intervention). However, it should be noted that having an idea of a counterfactual may be helpful in any case to assess biases or omissions in the elasticities used (in particular, to assess or quantify effects which may not have been included in the elasticity estimates being used or any changes in the markets being analysed).

7.3 Finding 3: additional concepts and guidance

Finding 3: the concepts for the calculation of energy savings may require some additional explanation. The level of detail may be extensive and would need to explain the factors that are likely to be relevant in different scenarios, and the different approaches to estimating savings that are likely to be most applicable in different settings.

Recommendation 3: the Commission could issue an updated guidance document on the approach for the calculation of all measures eligible for the purposes Article 7, including on the use of elasticity estimates for taxation measures. Such guidelines could follow Chapters 3 and 5 of this report and could make reference to impact assessment manuals (for example, the EC's better regulation guidelines and toolbox, which contain guidance on how to carry out impact assessments and evaluations).[56]

7.4 Finding 4: current structure of Article 7

Finding 4: The current structure of Article 7 is not always clear as regards the application of the requirements for the fiscal measures.

Recommendation 4: To facilitate the implementation of Article 7 and Annex V, we would suggest that Article 7 is structured in a slightly different way. The structure could show clearly the obligations, measures to be included and how energy savings should be taken into account in the calculations. We would suggest drafting the article along the lines of the previous directive but grouping the themes into some common headings. We present below an illustration of the possible themes that the Commission may choose to cover:

- The obligation on Member States to achieve cumulative end-use energy savings.
- The relevant timeframe for savings.
- The phasing of measures: the possibility that measures can be phased during the periods could also be included (subject to meeting targets).
- The sectoral coverage of the savings, i.e. type of savings that can and cannot be counted.
- The method for calculation of energy savings (at a high level and with reference to Annex V).
- The types of measures that can be notified.
- The eligibility of the measures.

[56] See EC's better regulation agenda (http://ec.europa.eu/info/strategy/better-regulation-why-and-how_en).

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9 Appendix 2: Glossary

Counterfactual: This refers to the baseline scenario that captures how outcomes and impacts would have evolved in the absence of the policy being evaluated.

Cross-price elasticity of demand: This is a measure of the percentage change in the quantity demanded for a good to a change in the price of another good.

Deadweight: This is a measure of the impact that would have occurred anyway in the absence of the policy (i.e. in the counterfactual scenario). The measurement of the impacts of any policy should exclude any deadweight.

Displacement: This is occurs when an intervention targeted at a particular group and intended to have positive consequences for them, has an offsetting negative impact on units outside of the treatment group. The overall result is that any positive impact from the intervention is reduced by these negative effects. This can be the case when an intervention places treated firms at a competitive advantage, whilst weakening the trading position of their competitors.

Eligibility: This can be thought of as being concerned with the purpose of the policy measure, i.e. the issue of whether the measure is mainly targeting end-use energy savings or other objectives.

Incremental impact: This refers to the impact that occurs over and above what would have happened anyway in the absence of the policy (i.e. in the counterfactual scenario).

Leakage: This is defined as the proportion of outputs that benefit those outside of the intervention target area or group.

Materiality: This relates to the need to ensure that the policy in question has had a demonstrably material impact on the take-up of the measures.

Own price elasticity of demand: This is a measure of the percentage change in the quantity demanded as a result of a percentage change in price. It is often referred to as price elasticity of demand.

Rebound effect: This is the increase in energy consumption that results from the increase in wealth of parties benefitting from reduced energy spending as a result of energy efficiency measures. This effect reduces the level of energy saving.

Substitution occurs when a unit (firm or consumer) substitutes one activity for a similar one to take advantage of policy measures. Changes in the consumption of substitute products should be taken into account in the impact assessment.

Suitable comparator: A comparator refers to an alternative unit (e.g. market, consumer, firm, household) that serves as a point of comparison. A suitable comparator is one which is likely to experience similar to developments to the unit being evaluated.

Take up: This measures the extent to which the activities envisaged by the policy are being used (by the targeted population).