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INCENTIVES FOR DEVELOPING RENEWABLE ENERGY SUPPLIES AND IMPROVING THE ENERGY EFFICIENCY OF HOUSING

REVIEW OF THE LITERATURE

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Introduction

The purpose of this literature review is to summarise the main points to come out of the studies and reports which have been produced in recent years on two sets of issues:

- The costs of producing electricity from the main types of renewable energy sources (water, wind, solar photovoltaic and thermal, and bio fuels) in different parts of the EU and the rates of profitability that these imply as compared with the cost of electricity generated from fossil fuels
- The various obstacles – financial, regulatory and institutional – which impede the implementation of measures to increase the energy efficiency of housing.

An initial aim, however, is to review the relevant theoretical literature on the case for public intervention in the two areas concerned and, beyond this, the justification for intervention at EU level.

Reasons for government intervention

General considerations

A general framework

The main reasons for Government Intervention in the economy (GI) are discussed in every good textbook of microeconomics or public finances (for example Varian, 1992; Atkinson-Stiglitiz, 1980). According to traditional theory, intervention can be justified on three grounds:

- to correct distortion of the market (market failure) to obtain a more efficient outcome
- to redistribute income in a more socially desirable way than results from free market forces
- to pursue objectives other than the efficient distribution of resources at one moment in time (such as industrial policy to develop a competitive industry)

Market failure

According to economic theory, the market economy (operating under conditions of perfect competition) achieves a socially optimal outcome through prices, when they are free to move in response to demand and supply, bringing into balance the willingness of consumers to pay and that of producers to supply. Through such movement, the market reaches the most efficient allocation of resources (the so called Pareto optimum), where it is not possible to make any individual better off without making anyone else worse off.

The underlying assumption is that producers and consumers consider only their own interests when setting prices or agreeing to pay the prices asked and do not consider the effect of their decisions on anyone else. Prices, therefore, reflect the cost of producing the good or service concerned and the 'utility', or satisfaction, derived from it by consumers. Market failures arise when this is not the case, when prices do not accurately reflect the costs of production or consumer utility, such as when, for example, there are costs to the environment from production which the producer does not have to pay. It should be noted, moreover, that the situation of optimal efficiency reached by the free operation of market force is a static one, which takes account of the distribution of resources between potential uses only at particular point in time. Such a situation does not necessarily imply that resource are distributed in the most efficient way to achieve the optimal outcome over time, that they go, for example, into the uses which offer the best prospect of growth over the longer-term. While prices, therefore, may reflect the prevailing costs of production, they may not reflect the future costs or, indeed, the potential future gain to consumers of shifting resources in a particular direction, such as into developing a new product or process.

Four types of market failure are commonly considered:

- externalities
- public good
- information asymmetries
- Non- competitive markets

Externalities occur when a transaction between consumers and producers affects others. The externalities can be positive, resulting in larger gains than simply to the individual purchasing the good or service concerned,, or negative, resulting in larger costs than those borne by the producer alone. In the first case, the market, if left to itself, will lead to less being produced than is socially warranted (i.e. the wider gains are not taken into account);. In the second case, more will be produced than is socially desirable (given the higher costs which are left out of account). Basic research for innovation, leading to future gains to society, and pollution resulting from production are two classic examples of positive and negative externalities, respectively. Government intervention can be justified in the first case to increase innovation, such as by subsidizing investment in R&D,, and in the second to reduce the pollution caused, such as by taxing the producers concerned[1]

A public good (or service) is one that, once produced, can be consumed or enjoyed by many people as the additional cost of supplying more users is virtually zero. Its consumption by one person does not preclude its consumption by others and, moreover, it is not possible to exclude those who do not pay from enjoying it. Examples are collective services of one kind or another, such as defence or street lights. Since individuals know that they can consume the good or service without paying for it, they have no incentive to do so, and if it has no price, no-one will produce it, so necessitating collective provision.

Information asymmetries refer to cases where the possession of relevant information about a particular transaction varies significantly between customer and supplier or between different suppliers, such as when the customer can evaluate a product only after buying it or, for example, in

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[1] According to Coase, externalities occur because there is no market for the output, or effects, concerned, and accordingly no price is attached to them (Coase 1960). A solution, therefore, is to create such a market, but as has been pointed out, high levels of transaction costs might be involved in establishing a market (Williamson, 1975), so government intervention can be justified in such a situation, even though in principle it might be possible to establish a market.

the financial sector, when certain traders might have access to privileged information (such as in cases of insider trading). Governments become is involved when the information asymmetry is dangerous for those possessing relatively little information, such as in the case of children's toys or drugs. In most cases, Governments intervene through legislation or regulations obliging toy manufacturers to signal, for example, that a toy is unsuitable for children under three or drugs manufacturers to point out the hazards of taking a particular medicament.

Market failure arising from non-competitive markets occur when a firm or several firms behave in way that undermines the ability of other firms to compete which may work against the interests of consumers (such as entering into restrictive agreements or abusing their monopoly power). The usual solution is to establish a competition authority to police market behaviour and to prevent monopoly situations from arising (Hay, 1993; Motta, 2004; Neven, 2006; Röller-Stennek–Verboven, 2000; Voight, 2006). Situations of 'natural' monopoly (markets where there is room for only one supplier), however, typically require regulation by a government agency (Joskow 2005).

Market failure versus government failure

Market failure is only a necessary condition for government intervention not a sufficient condition: The costs of such intervention and possible inefficiency also need to be taken into account.

Analysis of the costs of intervention is a subject of the evaluation literature (Besley-Seabright 1999; Davies 2004; EC 1999; Martini 2006; Mohr 1995), which starts from the position that Intervention needs to be publicly justified and assessed in terms of its effects on the economy as compared with having no intervention (i.e. by undertaking a counterfactual analysis). The issue is, therefore, whether behaviour has been altered in a positive way by intervention or whether the individuals or organisations concerned would have behaved in the same way in the absence of intervention.

The wave of privatisations which has occurred over of the past 30 years across the EU has in part been motivated by the claimed inefficiency of public enterprises. Other than in situations of natural monopoly, public enterprises can be less efficient than private firms essentially only for two reasons: 1) their openness to politicians intruding and modifying the way the way the enterprise operates and/or its objectives (Shleifer-Vishny, 1994)[2]; 2) the absence of a capital market capable of monitoring the behaviour of the enterprise and penalising inefficiency (Alchian vs. Hart: Alchian 1965, Hart 1995)[3].

A more general line, emphasised by the US libertarian policy analysis of the 1970s (Niskanen 1971), focuses on the inefficiency of the production of goods and services when this is divorced from market prices, i.e. in the public sector. In terms of political philosophy, the emphasis is on the Minimal State (Nozick 1974), where the tasks performed by the public sector are largely confined to

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[2] Control over a public enterprise can benefit politicians in various ways, by, for example, giving rise to a higher level and different spatial distribution of employment than otherwise or a different pattern of production, though the 'price' to the enterprise is greater uncertainty about how to operate, not least because political priorities can change.

[3] The argument is that If a firm is not well run, its stock market price will fall opening it up to possible take-over. This, however, depends on share-owners behaving in a particular way which collectively might not be the case in practice (see Hart, 1995).

police, the judiciary and defence. The most ambitious attempt to construct a theory which highlights the causes and consequences of public sector inefficiency is by Charles Wolf (Wolf 1979). According to Wolf, the cost and quantity of goods and services supplied by the State differ from those supplied by private firms in that they are insulated from market forces and competition from other producers

While the theories outlined above may adopt extreme positions, it is broadly accepted that the mere existence of market failure in itself is not sufficient to justify government intervention: what is necessary is for the consequences of market failure to be greater than those of government failure.

Two other aspects of market failure have historically attracted the attention of economists (and policy makers). The first is the inability of competitive markets to ensure an equitable distribution of income, which gives rise to a potential need for redistributive policies, the second, the inability to ensure favourable conditions for the development of particular sectors of activity, which gives rise to a possible justification for industrial policies. The focus here is on the latter.

Industrial policy

There are many different definitions of industrial policy. According to Paul Geroski, "Any random collection of six economists is sure to produce at least a dozen different opinions on the subject, not least because many economists have trouble in reconciling their gut reaction that industrial policy should not exist with the obvious fact it does" (Geroski, 1989). The definition preferred here is that: "Industrial policy is a complex of interventions … decided and organized by a public entity, which (is aimed) at influencing the industrial system or parts of it through microeconomic tools" (Ninni-Silva, 1997).

In modern States (Bianchi-Labory, 2006), industrial policy was initiated in the 1960s to defend industries weakened by international competition or as a means of developing sectors which were regarded as "strategic", either because of the technology used or because of beneficial effects on other parts of the economy.. Mixing industrial policy with arguments for infant industry, in the Odagiri's model (Odagiri 1986) the State can fund the entry of a producer into a market even if the costs of entry are not recoverable. Though it might be possible to earn a return on investment, except in the very long-run, this might be smaller than the costs of entering the market, so that no bank would have financed the entry.

The argument is that subsidies to industries can be justified in a context of imperfect competition (Brander J. and Spencer B. 1985) since they enable producers to improve their competitiveness over time in a way which would not have been possible without them.

The decline of traditional industrial policy as means of stimulating industrial development is usually attributed in the case of the EU (Pelkmans, 2006) to the events of the early 1990s, when 'unfair' competition was banned under the Internal Market policy and when the EU signed WTO agreements (in 1995), including the Agreement on Subsidies and Countervailing Measures, which made it more difficult to subsidise a sector permanently, without reprisals from other countries. This change led to a move away from a sectoral industrial policy to a "horizontal" one under which various activities (R&D and innovation, for example) relevant for improving the competitiveness of many different sectors were subsidised.

A trade-off seems to arise between different kinds of government intervention, namely, competition policy and industrial policy, the first aimed at enhancing the competitiveness by focusing on the behaviour of firms, the latter with the same aim but through State aid (Gual and Jodar, 2006). According to many economists, competition policy is more socially efficient than industrial policy for two main reasons: 1) information on developments in the market and technology is more abundant in firms than in the State; 2) competition policy involves less frequent meetings of State officials with firms than industrial policy and therefore gives less opportunity for corruption (Laffont 1996; Ades-DiTella, 1997).

Traditional industrial policy has diminished in importance in developing countries as well, because of the effects of WTO agreements (Trade-related investment measures, Subsidies and countervailing measures, Trade related intellectual property rights, and so on) which ban industrial policies from favouring domestic firms (Bora-Lloyd-Pangestu 2000) even if in theory the case for an interventionist approach remains valid (Chang 1994).

At the beginning of the present century, however, another change occurred. Government intervention through industrial policy again became focused on sectors, though without discriminating against foreign firms. In Europe, this change was inspired by two developments: a) globalisation and b) new policy priorities, triggered by the Lisbon strategy.

New policy priorities included the common goals of sustainability and security of supply as well as the maintenance of competitiveness, linked by innovation, which was the main focus of the Lisbon strategy. The new EU industrial policy was characterised by a "return to (a focus on) sectors" (Aiginger-Sieber, 2006) as some sectors are more important for the economy than others.

The development of renewable sources of energy and improving energy efficiency were added to EU policy priorities as a way of meeting the Kyoto Protocol commitments (i.e. to reduce Greenhouse gas emissions over the period 2008-2012 by 8% in relation to 1990 levels). These policy priorities were accorded increased importance when it became clear that to recover from the 2008-2009 financial and economic crisis required a substantial package of measures to stimulate the economy at EU and national level (European Commission 2009a; European Commission 2009b) and when the benefits of "green growth" were recognised and highlighted (de Serres et alii, 2010). Fiscal stimulus measures, therefore, included significant additional government expenditure on "green growth" (see Jones, R. S. and. Yoo B., 2010).

Government intervention at EU and national level

The case for government intervention and the criteria for assessing its justification outlined above apply just as much to the development of renewable sources of energy and improving the energy efficiency of residential buildings as in other areas. The further issue, however, is whether the intervention concerned should take place at the EU level or national level. The usual way of determining the appropriate level is through recourse to the principle of 'subsidiarity', that the EU should only be involved where action at national level is likely to be insufficient or where collective action is likely to be more effective.

There are three other possible reasons for EU intervention which can be added: a) where there is lack of coordination between the actions of Member States which may result in no action being taken (which might arise if Member States can behave as 'free riders', enjoying the benefits of action taken by others without acting themselves); b) where action taken by one Member State might harm another, so that EU intervention is necessary to avoid tensions between countries (the same grounds on which EU competition policy was founded); c) where economies of scale can be realised, so that, for example, if the goal is to strengthen the industry producing equipment for wind power, the effectiveness of a policy of setting a minimum percentage of electricity that has to be generated using wind power is greater if it is imposed at the EU level rather than at the national level.

The following table lists the current division of responsibility between the EU and Member States as regards the promotion of renewable energies and environmental protection.

	EU	Member State
Directives	*	
Command and control measures: norms		*
Economic support measures: feed-in tariffs, premium tariffs, quota systems, fiscal incentives, investment grants, tax exemptions		*
Labelling and other environmental signalling devices	*	
Green public procurement: to apply the directive		*
Voluntary agreements between Member States		*
Direct production by public enterprises		*

The directives are the legal measures imposed by the EU, while the ways of applying them to achieve their goals are left to Member States to decide. In the table both “command and control” measures and “economic support” measures are listed. The former include the legal imposition of thresholds on emissions, bans and sanctions. The economic support measures include all those used to promote the generation of electricity by renewables. Information asymmetry is tackled through labelling and other means which signal, for example, that a smaller volume of emissions of greenhouse gases are released per unit produced. These operate at the EU level, though there are cases where they are a result of inter-government agreements or the outcome of voluntary agreements made by trade associations. It is preferable that support measures remain the responsibility of Member States rather than the EU for two reasons: 1) because national, or regional, authorities are closer to those receiving support; 2) because the extent of support needs to vary in line with the differences in the average cost of producing electricity from fossil fuels due to the differing mixes of technologies used to generate electricity.

The Directive (2009/28) on the use of renewables emphasises the role of joint projects between Member States and, more generally, the possibility of Member States achieving their required share of consumption of energy from renewables from imports rather than from own production. This is an important novelty, which could become increasingly relevant as energy prices increase. According to the forecasts published in Member States’ National Renewable Energy Action Plans, due to be delivered to the Commission by the end of June 2011, only two EU countries report that they expect to use the Cooperation mechanism with other Member States to become net importers of renewable energy: Italy and Luxembourg. On the other hand, five countries expect to become net exporters of renewable energy during the periods up to 2020: Bulgaria, Denmark, Ireland, Greece and Slovakia. All the other Member States report that they expect to remain self-sufficient (Berskens and Hekkenberg, 2011).

No Member States envisage using public enterprises or other public bodies to produce renewable energy directly and all are relying on incentives to stimulate an increase in production.

Government intervention in energy

Government intervention in energy tends to be necessary because of the existence of negative externalities which affect prices. Intervention as regards the energy efficiency of buildings can be justified by the existence of information asymmetries in the market.

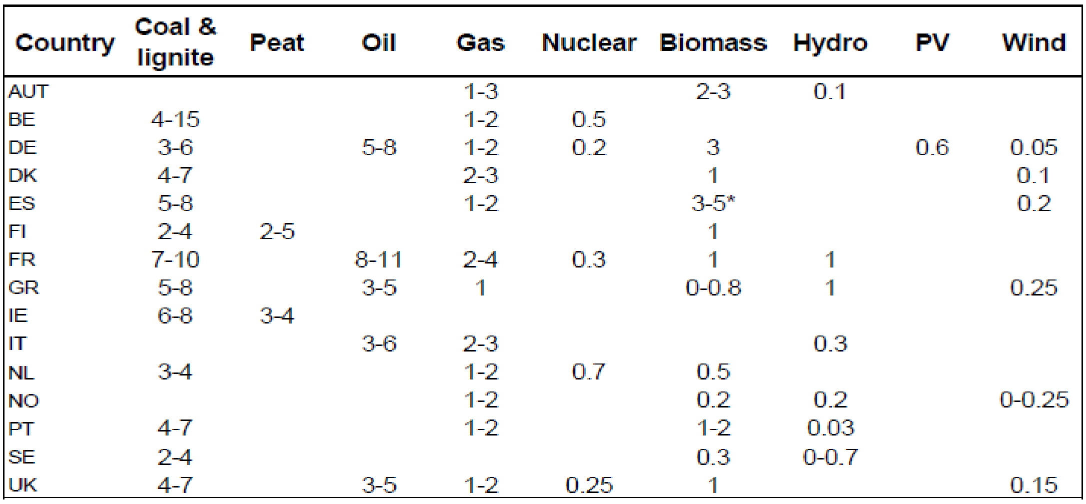
Prices of fossil fuels do not reflect damages to society (pollution and emissions of CO2)

Energy prices of fossil fuels can be argued to be “too low” in that they do not fully reflect the damage to human health and the environment and the threat to national security. Prices could in principle be adjusted to take account of such effects by the imposition of taxes which would reflect the cost of the externalities associated with each energy source[4].

The problem is that it is usually difficult to quantify the damages involved, though the EU has made a recent attempt to estimate those associated with electricity generation through the ExternE (External Costs of Energy) project. The main finding is that if negative externalities affecting the environment and human health were incorporated in the price of electricity generated from natural gas, it would be 30% higher and, in the case of electricity generated from coal, 50%: higher. The cost of externalities, therefore, is estimated to amount to 1-2% of EU GDP.

The main findings are set out in Table A (see also the site: http://www.externe.info/), which relates to estimates made in the early 1990s for countries participating in the research, for different sources of energy and for the technologies existing at the time (National Implementation Reports):

Table A – External costs for electricity production in the EU (in EUR-cent per kWh**)



Country	Coal & lignite	Peat	Oil	Gas	Nuclear	Biomass	Hydro	PV	Wind
AUT				1-3		2-3	0.1		
BE	4-15			1-2	0.5				
DE	3-6		5-8	1-2	0.2	3		0.6	0.05
DK	4-7			2-3		1			0.1
ES	5-8			1-2		3-5*			0.2
FI	2-4	2-5				1			
FR	7-10		8-11	2-4	0.3	1	1		
GR	5-8		3-5	1		0-0.8	1		0.25
IE	6-8	3-4							
IT			3-6	2-3			0.3		
NL	3-4			1-2	0.7	0.5			
NO				1-2		0.2	0.2		0-0.25
PT	4-7			1-2		1-2	0.03		
SE	2-4					0.3	0-0.7		
UK	4-7		3-5	1-2	0.25	1			0.15

Notes: * biomass co-fired with lignite ** subtotal of quantifiable externalities (such as global warming, effects on public health, occupational health, and material damage).

ExternE uses the LCA (Life Cycle Assessment) approach to make these estimates. It begins by quantifying the physical emissions of the different sources of energy and their geographical dispersion in air, water and soil. It then assesses the probable physical impact on humans and estimates damages in monetary terms according to 7 impact categories (human health, building

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[4] The objective of energy taxes is to approximate the price that would prevail if polluters had to compensate those harmed by the pollution they cause (Taylor-van Donen, 2007).

materials, crops, global warming, amenity losses, ecosystems and land use change). Where possible market prices are used to estimate monetary values (for crops and building materials); where it is not possible, willingness-to-pay is used (in the case of human health) or avoidance costs where the economic value of the damages caused are especially difficult to measure (the other categories).

As might be expected, once externalities are quantified and allowed for, oil and coal turn out to have be the largest harmful effects, while hydro and wind power have among the smallest. Nuclear power, which has little effect on climate change, also involves relatively small externalities, though the risk of accidents is not fully allowed for. The current increase in the consumption of natural gas is in line with the relatively small scale of externalities, since it is the cleanest source of energy among fossil fuels.

All the renewable sources of energy (excluding biomass) show low levels of damage to society, the cost of emissions during the construction of the plant being more than offset by the absence of emissions during the operation of the plant to generate electricity.

Another social cost that seems not to be wholly reflected in the market prices of energy is that which arises from the EU being largely dependent on imports of energy, i.e. the costs of security of supply. In some studies, the cost of this dependence is quantified by taking account of the political instability of exporting countries (Neumann 2007). This, however, can be regarded as a particular form of transaction cost and the existence of a high degree of competition among suppliers is sufficient to minimise the risks of excess dependence on politically unstable suppliers. This does not prevent many countries from expanding domestic production as much as possible (as in the case of the US as regards ethanol production), since energy is deemed to be a highly “strategic” good, for which minimising dependence on foreign producers is a must. In EU as well, the domestic development of renewable sources of energy has been driven in part by security of supply objectives.

Prices of fossil fuels do not reflect their scarcity (damage to future generations)

Fossil fuels are a non-renewable resource. The interests of future generations are not reflected in the decisions currently made by producers and consumers in energy markets. Accordingly, prices do not reflect their scarcity and the potential harm to the generations to come.

It can be argued that prices of fossil fuels do not reflect their scarcity, even if it is difficult to prove and to identify “the right price” for them. For most years, the price of natural gas, as stated in contracts, has moved in line with that of oil in the spot market, if with some delay, so that the price of oil and its determinants can be used as a proxy for the price of energy (leaving aside coal for the sake of simplicity).

According to the literature (Fattouh 2007, in particular), the oil market can be depicted in three different ways, which emphasize three different features: a) oil is a mineral and, therefore, exhaustible b) OPEC controls a large part of world supply which makes the matching of supply with demand more complicated, c) the oil market is a nervous one where political and incidental factors, plus expectations, play a significant role, so that there is need to resort to other, more informal approaches to account for market behaviour.

According to the theory of exhaustible resources (Krautkraemer 2005), the oil prices must exhibit an upward trend. At any point in time, a positive premium, called ‘a scarcity rent’, is the reward that holders of the resource obtain for having maintained their stocks up until now; price is higher than marginal cost (even including the costs of extraction) because of the existence of this rent.

In the Hotelling approach (Hotelling 1931) the optimal extraction trajectory is one where the oil price increases in line with interest rates, the owner of the resource being assumed to maximise the discounted flow of reserves over time.

According to Adelman (Adelman 1990), however, oil reserves should be considered in a similar way to stocks (or inventories), which are continuously depleted through extraction but continuously augmented through exploration and development. What matter therefore is investment in accumulating stocks and the costs involved in finding new reserves; in this case, there is no scarcity rent.

According to Mabro (1991), the availability of oil and the oil price also depend on the cycle of perceptions. An increase in oil prices will stimulate exploration and development, which will shift perceptions of future availability upwards. This will cause prices to fall, stimulating demand and leading to a shift in perceptions towards scarcity.

In the usual supply–demand framework, the demand side is relatively easy to model and is determined by the price and income elasticities of demand for crude oil (or for oil products more generally). Price elasticity is relatively stable (varying from 0 to -0.64 in the estimates made by Fattouh 2007), with the elasticity increasing in the long-run. The price elasticity of demand is higher in the long-rum than the short run because of substitution and energy conservation, though the elasticity remains relatively low.

Gately and Huntington (2002) emphasise the asymmetry of the price elasticity. An increase in the oil price tends to reduce the demand for oil but it is not necessarily true that a reduction in oil demand would be reversed by a fall in the oil price, since the increase in price may spur investment and a shift towards more efficient plant and equipment which would tend to reduce the demand for oil: a fall in price would not necessarily reverse these responses.

According to Fattouh 2007, the income elasticity of demand is relatively low (varying from 0.2 to just under 1), higher in the long run than in the short run and declining over time in OECD countries. What is important to note is that oil demand seems more responsive to income than prices, so the usual operation of demand and supply forces seems less effective in this case.

The supply side is far more complex. A distinction can be made between OPEC and the non OPEC part of production, the latter being expected to behave competitively. For the non-OPEC part, the most interesting approach is by Hubbert (1956) who emphasised the role of geophysical factors in the formation of price. According to his approach, present production is determined by cumulative production over the past and by the size of ultimately recoverable reserves. Since reserves lead oil production, the depletion of reserves would cause a decline in oil production. More specifically, it is possible to fit symmetrical bell-shaped curves for the annual rate of production to define the time path of cumulative production. To construct such curves requires only an estimate of the ultimate cumulative amount of oil production and the quantity that has to be produced in relation to cumulative production.

It is evident that estimates of global reserves are crucial not only for the Hubbert model but also for every model of exhaustible resources. However, there is wide disagreement on the size of global reserves. According to official estimates (BP Statistical review of World Energy 2010), world proven reserves (i.e. "those quantities that geological and engineering information indicates with reasonable certainty can be recovered in the future from known reservoirs under existing economic and operating conditions", BP) of oil have increased in 10 years (i.e. from 1999 to 2009) by 18%, while world oil production increased in the same period by only 10.5%, so that the ratio of reserves to production ("if the reserves remaining at the end of any year are divided by the production in that year, the result is the length of time that those remaining reserves would last if production were to continue at that rate", BP) has increased (at end 2009, to 45.7). However many OPEC countries and many companies are said to overstate (or to have overstated) their estimates of reserves. According to Ali Husseini, former vice-president of Aramco, around 40% of proven world oil reserves are in fact speculative.

The OPEC supply case is even more difficult to analyse. While it is certain that OPEC does restrict output as compared with what it would produce in a competitive context, the issue is why it restricts supply. One explanation is that OPEC cannot, in fact, increase supply much because its reserves are small, or smaller than thought. Another explanation is that its goal is to maximize revenue, since many OPEC countries have only a small need for internal absorption. Smith (2005) rejects various traditional explanations of OPEC behaviour, "except the hypothesis that OPEC acts as a bureaucratic cartel; i.e., a cooperative enterprise weighed down by the cost of forging consensus among members, and therefore, partially impaired in pursuit of the common good."

A large part of the analysis on the oil market leads to the conclusion that the future movement of energy prices is upward in the long-run. This is likely to be so because oil is an exhaustible resource. It is also likely that investment in the research and development of new fields, and in the technological exploitation of existing fields, will be able to defer the depletion of reserves for some time and it is equally likely that investment in the exploitation of alternative sources of energy will replace the use of oil to a significant extent (which is already happening in transport). Nevertheless, to bring about such changes in the consumption of oil requires a very high level of prices, in real terms far higher than the existing price, even leaving aside the cost of the damage caused by emissions and the costs to society more generally.

The only way of avoiding these extra costs, which would be paid for by future generations, is to minimise dependence on fossil fuels.

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Developing renewable energy

Introduction

Renewable energy is energy produced from natural resources, which are continuously, or at least regularly (biofuels), replenished. It consists of wind power, solar power (thermal, photovoltaic and concentrated), hydro-electric power (excluding pumped storage), tidal power, geothermal energy, and biomass. For the EU as a whole the benefit of their expansion is fourfold:

1. Reducing greenhouse gas emissions
2. Diversifying geographical energy supply
3. Reducing demand for fossil fuels which will eventually run out, so prolonging their availability and increasing the sustainability of development
4. Decreasing dependence on volatile oil and gas markets and reducing pressure on prices, so making growth more secure.

Their importance in terms of employment is equally important. According to the 10th EurObserv'ER Report (2010), in 2009 the direct and indirect jobs dependent on renewable sources of energy were estimated at over 900 thousand, with Solid Biomass and Wind Power accounting respectively for 31% and 26% of the total.

According to the EU Directive 2009/28 of 23 April 2009 (EU 2009), 20% of gross final energy consumption should be supplied by renewables by 2020 in the EU as a whole, though with widely differing shares across countries, ranging from 49% in Sweden to 10% in Malta (Table 1). No targets for 2020 have been specified for the three sectors of final consumption, electricity, heating and transport, but Member State intentions have been deduced by ECN (2011) from the National Renewable Energy Action Plans. Taking the intentions of all Member States together, wind power should become by 2020 the most important source of renewable energy for the generation of electricity, accounting for more than 40% of the total, and for the largest increase in production in absolute terms (by around 425 GWh) (Table 2).

An overall picture of the installed generating capacity in 2009 by country and by source is presented in Table 3. A comparison of the proportion of electricity generated from renewables in 2009 with that required in 2010 by the Directive 2001/77 (EU 2001) indicates that by this year the EU as a whole achieved 87% of the 2010 target, though a number of countries (Hungary, Germany, the Netherlands, Ireland and Slovenia) has developed renewables at a faster rate than was expected by the Directive.

In 2009, wind power was the most important source of renewable energy for electricity generation and Germany the Member State where the increase in installed capacity from renewables was largest, which was the case for most of the different sources. Germany has 40% of the installed thermal solar power in the EU, produces around 20% of the electricity from solid biomass and already accounts for a quarter of the total consumption of biofuels (for transport purposes). The ranking of other Member States in terms of the growth of renewables varies according to the source. The countries where a relatively large amount of capacity as regards renewables has been installed in recent years are Spain, France, Italy and the UK for wind power (though the largest proportionate increase was in Denmark), Spain and Italy for photovoltaics, and Italy and France (more than Germany) for small hydro plants (usually, plants generating less than10 MW).

Table 1 – Renewable energy as a share of gross final energy consumption, 2005-2008 and target for 2020

	Renewables as % total energy consumption				
	2005	2006	2007	2008	2020
Belgium	2.2	2.7	3.0	3.0	13.0
Bulgaria	9.4	9.3	9.1	9.4	16.0
Czech Republic	6.1	6.4	7.3	7.0	13.0
Denmark	17.0	16.8	18.1	18.8	30.0
Germany	5.8	7.0	9.1	9.1	18.0
Estonia	18.0	16.1	17.1	19.1	25.0
Ireland	3.1	3.0	3.4	3.8	16.0
Greece	6.9	7.2	8.1	8.0	18.0
Spain	8.7	9.1	9.6	10.7	20.0
France	10.3	9.6	10.2	11.0	23.0
Italy	5.2	5.3	5.2	6.8	17.0
Cyprus	2.9	2.5	3.1	4.1	13.0
Latvia	32.6	31.3	29.7	29.9	40.0
Lithuania	15.0	14.7	14.2	15.3	23.0
Luxembourg	0.9	0.9	2.0	2.1	11.0
Hungary	4.3	5.1	6.0	6.6	13.0
Malta	0.0	0.1	0.2	0.2	10.0
Netherlands	2.4	2.5	3.0	3.2	14.0
Austria	23.3	24.8	26.6	28.5	34.0
Poland	7.2	7.4	7.4	7.9	15.0
Portugal	20.5	20.5	22.2	23.2	31.0
Romania	17.8	17.5	18.7	20.4	24.0
Slovenia	16.0	15.5	15.6	15.0	25.0
Slovakia	6.7	6.2	7.4	8.4	14.0
Finland	28.5	29.2	28.9	30.0	38.0
Sweden	39.8	42.7	44.2	44.4	49.0
UK	1.3	1.5	1.7	2.2	15.0
EU 27	8.5	8.9	9.7	10.3	20.0

Source: Eurostat

Table 2 – Expected generation of electricity from renewable sources, 2020 compared with 2005

	Total renewables (GWh)		% electricity consumption		% total renewables: Hydropower		Solar power		Solar PV		Wind		Total biomass	
	2005	2020	2005	2020	2005	2020	2005	2020	2005	2020	2005	2020	2005	2020
Belgium	2462	23121	2.7	4.8	14.2	1.9	na	na	0.0	4.9	13.0	45.3	72.7	47.7
Bulgaria	4341	7536	11.9	20.6	99.9	52.4	0.0	0.0	0.0	6.0	0.1	30.0	0.0	11.6
Czech Republic	3122	11679	4.5	13.9	76.2	19.5	na	na	0.0	14.8	0.7	12.8	23.1	52.8
Denmark	9882	20594	26.8	54.5	0.2	0.2	0.0	0.0	0.0	0.0	66.9	56.9	32.8	43.0
Germany	61652	216935	10.2	38.6	31.9	9.2	0.0	0.0	2.1	19.1	43.1	48.1	22.7	22.8
Estonia	107	1913	1.2	17.5	18.7	1.6	na	na	na	na	50.5	80.3	30.8	18.1
Ireland	2464	13907	9.1	42.5	30.8	5.0	na	0.0	na	0.0	64.4	86.1	4.7	7.9
Greece	1362	22397	2.1	32.7	0.0	0.0	na	3.2	0.1	12.9	93.0	75.0	6.9	5.6
Spain	58926	158053	20.2	42.1	60.3	25.1	0.0	9.7	0.1	9.1	35.2	49.5	4.5	6.3
France	75839	155284	14.4	28.5	92.6	46.2	0.0	0.6	0.0	4.4	1.5	37.3	5.0	11.1
Italy	56357	98885	16.3	26.4	77.7	42.5	0.0	1.7	0.1	9.8	4.5	20.2	8.3	19.0
Cyprus	0	1175	0.0	16.0	0.0	0.0	0.0	19.1	0.0	26.3	0.0	42.5	0.0	12.2
Latvia	3030	5191	44.8	59.8	97.1	58.8	na	na	0.0	0.1	1.6	17.5	1.4	23.6
Lithuania	460	2958	4.0	21.3	98.0	15.9	0.0	0.0	0.0	0.5	0.4	42.3	1.5	41.3
Luxembourg	214	781	3.2	11.8	45.8	15.9	0.0	0.0	8.4	10.8	24.3	30.6	21.5	42.8
Hungary	0	5598	0.0	10.9	0.0	4.3	na	0.0	0.0	1.4	0.0	27.6	0.0	59.4
Malta	0	433	0.0	13.8	0.0	0.0	0.0	0.0	0.0	9.9	0.0	58.9	0.0	31.2
Netherlands	7237	50331	6.0	37.0	1.2	1.4	0.0	0.0	0.6	1.1	28.6	64.4	69.7	33.1
Austria	41134	52378	62.1	70.6	90.3	80.4	0.0	0.0	0.1	0.6	3.3	7.3	6.9	9.8
Poland	3788	32400	0.0	19.1	58.1	9.2	0.0	0.0	0.0	0.0	3.6	46.9	38.3	43.9
Portugal	8925	35586	16.8	55.2	57.3	39.5	0.0	2.8	0.0	7.0	19.9	41.0	22.1	9.9
Romania	16091	31388	30.1	42.6	100.0	63.0	0.0	0.0	0.0	1.0	0.0	26.8	0.0	9.2
Slovenia	4213	6127	28.5	39.3	97.3	83.6	0.0	0.0	0.0	2.3	0.0	3.1	2.7	11.0
Slovakia	4677	8000	16.7	24.0	99.2	67.5	0.0	0.0	0.0	3.8	0.1	7.0	0.7	21.4
Finland	23720	33410	27.1	32.9	58.6	43.2	0.0	0.0	0.0	0.0	0.6	18.2	40.7	38.6
Sweden	81319	97193	53.8	62.9	89.6	70.0	0.0	0.0	0.0	0.0	1.2	12.9	9.2	17.2
UK	12021	116980	3.2	31.0	0.0	5.4	0.0	0.0	0.1	1.9	24.2	66.9	75.8	22.4
EU 27 (TWh)	492	1217	15.8	34.5	70.5	30.4	0.0	1.6	0.2	6.8	14.2	40.7	13.6	19.1

Note: some figures on solar power and solar PV are unknown but these are likely to be very small.

Source: ECN 2011, based on the National Renewable Energy Action Plans of the Member States

Table 3 – Installed capacity for generating electricity from renewables, 2009 and 2010

	Renewables (% total)			Estimated capacity (MW) in 2009				Elect. produced
	2009	2010*	Difference	Wind	PV	Small hydro	Solar	Biomas (TWh)**
Belgium	5.9	6.0	0.1	606	363	59	235	2659
Bulgaria	8.3	11.0	2.7	177	6	230	26	
Czech Republic	6.8	8.0	1.2	193	466	284	360	1396
Denmark	27.5	29.0	1.5	3482	5	9	339	1963
Germany	16.1	12.5	-3.6	25777	9830	1590	9030	11356
Estonia	2.7	5.1	2.4	149	0.1	7	2	
Ireland	14.4	13.2	-1.2	1260	0.4	43	85	65
Greece	9.2	20.1	10.9	1087	55	158	2853	
Spain	26.0	29.4	3.4	19149	3520	1909	1306	2139
France	13.5	21.0	7.5	4626	331	2082	1396	1279
Italy	20.3	25.0	4.7	4850	1182	2588	1410	2828
Cyprus	0.3	6.0	5.7	0	3		491	
Latvia	49.2	49.3	0.1	28	0		6	4
Lithuania	5.5	7.0	1.5	98	0.1	26	3	87
Luxembourg	3.6	5.7	2.1	43.3	26	34	14	
Hungary	7.3	3.6	-3.7	201	0.7	14	47	2238
Malta	0.1	5.0	4.9	0	2		31	
Netherlands	9.3	9.0	-0.3	2222	68		542	3550
Austria	65.3	78.1	12.8	995	53	842	3031	3321
Poland	5.9	7.5	1.6	705	1	261	357	4907
Portugal	33.5	39.0	5.5	3326	102	386	312	1713
Romania	31.6	33.0	1.4	14	0.6	450	80	60
Slovenia	36.8	33.6	-3.2	0	8	159	111	120
Slovakia	18.3	31.0	12.7	5	0.2	89	73	493
Finland	25.9	31.5	5.6	147	8	316	20	8402
Sweden	56.1	60.0	3.9	1560	9	923	295	10057
UK	6.7	10.0	3.3	4424	33	259	333	3585
EU 27	18.2	21.0	2.8	75125	16071	12743	22786	62222

* According to Directive 2001/77

** Electricity produced from biomass, including co-generation

Source: EurObserver 2010

Prices and costs of renewable sources of energy

The main problem of renewable sources of energy is that they are currently not competitive in terms of cost with fossil fuels, if costs are measured without taking account of the negative externalities – or social costs – from the emissions of carbon dioxide and other greenhouse gases: damaging effects which need to be assessed and measured in monetary terms, as the ExternE (EU 2005 for the final Report) project attempted to do. However, only in some of the Nordic countries (Denmark, Sweden and Norway) have eco-taxes continued to be imposed, after the initial euphoria of the 1990s. In practice, energy prices in all EU Member States reflect the operation of international market forces, including of cap-and-trade carbon markets (the EU Emission Trading Scheme, introduced in 2005).

Several attempts have been made to estimate the cost of renewables (for a recent survey see Canton-Linden 2010). Before considering them, however, it is useful to summarise some of the key features of the costs of electricity generation from renewables (Mott Mac Donald, 2010).

First, most renewable energies are highly capital intensive and have low variable costs, as in many cases there is no cost of fuel as such. Nevertheless, being capital intensive creates a financial hurdle which needs to be overcome in order for producers to enter the market.

Secondly, location has a major effect on the cost of most renewable technologies. It is especially important for wind farms, where location affects the power produced by wind and the cost of construction as well as of repair and maintenance. Offshore wind farms enable the size of the plant to be increased relative to onshore locations, but capital and operating costs are increased substantially. Hydro is, of course, dependent on site conditions and the local situation as regards water supply, while the costs of biomass are equally dependent on location.

Thirdly, the success of some renewables, wind power in particular, has led to a big increase in capital equipment costs, due to bottlenecks in the supplying industries.

Fourthly, economies of scale are less important for renewables than for fossil fuels: adding more generators gives rise to only modest savings in shared infrastructure. Economies of scale at the plant level are potentially important for biomass, but transport costs are so large high they more than offset any cost savings from increasing the size of plant.

Fifthly, for a number of types of renewables, the industry is a mature one and only for photovoltaics and offshore wind power are major reductions in costs expected from technological breakthroughs in the near future.

Turning to the recent literature, the Ecofys study (2011) uses the cost assumptions applied in the Green-X database (EEG, 2004), which are shown in Table 4 below for the energy sources which are of interest here. The range of cost options is strongly dependent on the technology used, but in none of the cases is competitive with fossil fuels (at the level of market prices considered in the analysis, under USD 50 at 2009 prices). The study notes that the differences in costs for any particular technology cannot really be attributed to any large extent to differences in the cost of investment. The country in which the plant is constructed and the specific conditions at the site seem to be more important.

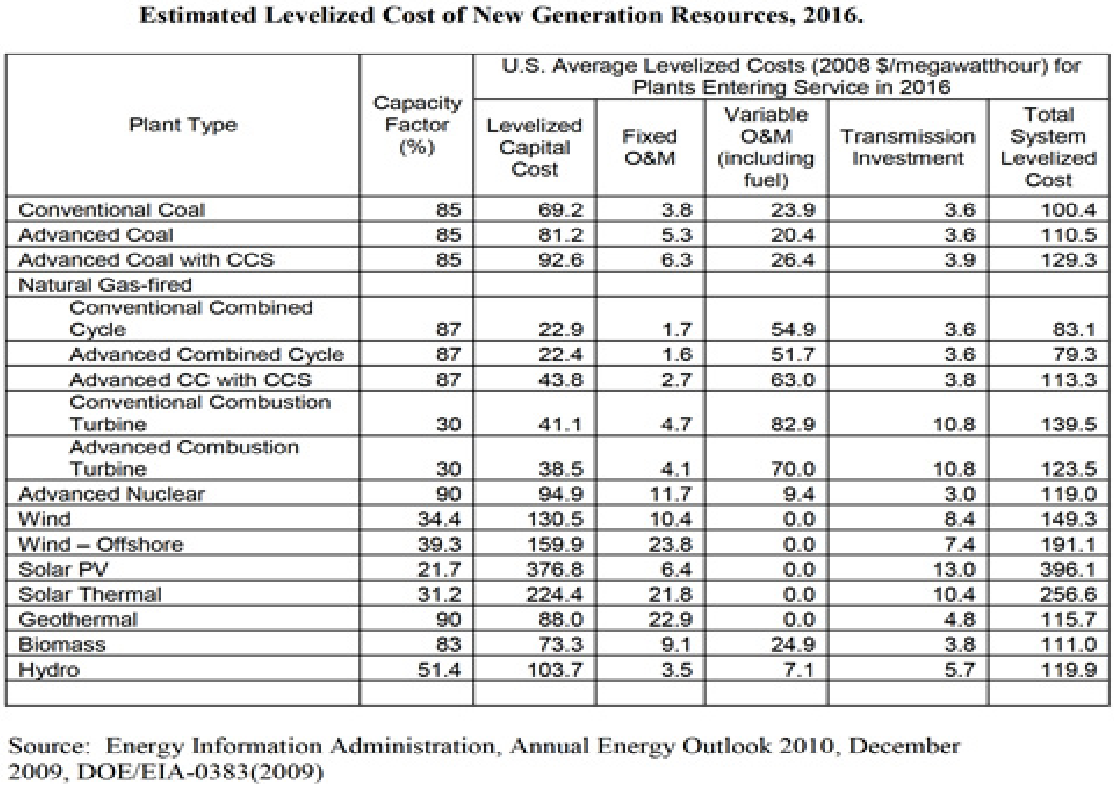
Table 4 Overview of costs and technical specifications of new electricity generating plants using renewables

	Capital cost	Operating/ maintenance cost	Average life	Typical plant size
	(EUR per kW year)		(No. of years)	(MW)
Biomass plant	2,225-2,995	84-146	30	1–25
Small-scale hydro	1,275-5,025	40	50	2
Photovoltaics	2,950-4,750	30-42	25	0.005-0.05
Solar thermal power	3,600-5,025	150-200	30	2-50
Wind onshore	1,125-1,525	35-45	25	2
Wind offshore, 30-50 km	3,100-3,350	110	25	5

Source: Ecofys, 2011

A 2010 report by the US Department of Energy assessed different technologies in terms of the dollar cost per megawatt-hour that needs to be charged in order to cover total costs over time, i.e. the Total System Levelised Costs (Table B).

Table B – Estimates of the Cost of Generating Electricity from Different Technologies



Estimated Levelized Cost of New Generation Resources, 2016.

Plant Type	Capacity Factor (%)	U.S. Average Levelized Costs (2008 $/megawatthour) for Plants Entering Service in 2016				
		Levelized Capital Cost	Fixed O&M	Variable O&M (including fuel)	Transmission Investment	Total System Levelized Cost
Conventional Coal	85	69.2	3.8	23.9	3.6	100.4
Advanced Coal	85	81.2	5.3	20.4	3.6	110.5
Advanced Coal with CCS	85	92.6	6.3	26.4	3.9	129.3
Natural Gas-fired						
Conventional Combined Cycle	87	22.9	1.7	54.9	3.6	83.1
Advanced Combined Cycle	87	22.4	1.6	51.7	3.6	79.3
Advanced CC with CCS	87	43.8	2.7	63.0	3.8	113.3
Conventional Combustion Turbine	30	41.1	4.7	82.9	10.8	139.5
Advanced Combustion Turbine	30	38.5	4.1	70.0	10.8	123.5
Advanced Nuclear	90	94.9	11.7	9.4	3.0	119.0
Wind	34.4	130.5	10.4	0.0	8.4	149.3
Wind – Offshore	39.3	159.9	23.8	0.0	7.4	191.1
Solar PV	21.7	376.8	6.4	0.0	13.0	396.1
Solar Thermal	31.2	224.4	21.8	0.0	10.4	256.6
Geothermal	90	88.0	22.9	0.0	4.8	115.7
Biomass	83	73.3	9.1	24.9	3.8	111.0
Hydro	51.4	103.7	3.5	7.1	5.7	119.9

Source: Energy Information Administration, Annual Energy Outlook 2010, December 2009, DOE/EIA-0383(2009)

The figures in Table B indicate that advanced combined cycle using natural gas is currently the cheapest technology for generating electricity and the cost is only around 70% of the least expensive technology among renewables, which is biomass. In addition, Table B highlights an important feature of some renewables, like solar and wind power, which is their 'non- interruptibility', which results in relatively heavy costs of transmission, since they have to be connected to the grid continuously.

The most interesting figures are arguably those published by the IEA (International Energy Agency) in 2010 which differ from other sources in that they show in some detail the cost differences between countries for renewables using the same technology. In 2008, the figures indicate that for none of the renewable source was the levelised (or standardised) cost of energy (LCE) generated lower than the pre-tax price of electricity for households or industry in the EU (as given by Eurostat for a yearly consumption of electricity in the case of households of between 2500 and 5000 kWh and in the case of industry of between 500 and 2000 MWh).

The most important factor giving rise to a cost difference between technologies is the choice of discount rate – i.e. the assumed cost of borrowing – (here 5% or10%, a higher rate, penalising the more capital intensive technologies. Taking account of this, the cheapest technologies according to the IEA seem to be the following (all at a discount rate of 5%):

- The biomass plant (80 MW), on data provided by the US (LCE: EUR 36.6 per MWh)
- The small hydro plant (2 MW), on data provided by Austria (LCE: EUR 33.1 per MWh)
- The large hydro plant (1000 MW), on data provided by Eurelectric (LCE: EUR 23.6 per MWh), which relates to power generated from a river
- The onshore wind plant (150 MW), on data provided by the US (LCE: EUR| 32.9 per MWh)
- The small onshore wind plant (3 MW), on data provided by the Netherlands (LCE: EUR 58.2 per MWh).

Even the cost levels for the same technology differ markedly between countries:

- For a biomass plant, the costs range from the US example (80 MW, LCE EUR 36.6 per MWh) to the Dutch example (20 MW, LCE EUR 88.3 per MWh), a difference of almost 2½ times
- For a solar power plant, costs range from the Eurelectric example (1 MW, LCE EUR 116.5 per MWh) to the US example (100 MW, LCE EUR 143.6 per MWh), a much smaller difference of 25%
- For a photovoltaic plant, costs range from the US example (5 MW, LCE EUR 146.5 per MWh) to the Italian example (6 MW, LCE EUR 279 per MWh), a difference of almost two times (the Dutch case relates to the residential sector, where costs are always higher, because roofs are involved)
- For a small hydro plant, the costs range from the Austrian example (2 MW, LCE EUR 33.1 per MWh) to the Czech example (5 MW, LCE EUR 106 per MWh), a difference of over three times
- For a large hydro plant, leaving aside the Eurelectric case, costs range from the Swedish example (70 MW, LCE EUR 74.1 per MWh) to the Czech example (10 MW, LCE EUR 158 per MWh), a difference of around two times
- For a wind onshore plant, costs range from the US example (150 MW, LCE EUR 32.9 per MWh) to the Czech example (15 MW, LCE EUR 99 per mWh), a difference of three times
- For a wind offshore plant, the costs range from the US example (300 MW, LCE EUR 68.7 per MWh) to the Belgian example (3.6 MW, LCE EUR 128 per MWh), a difference of almost two times.

Nevertheless, even the least cost example of renewable technology (the large hydro plant on data provided by Eurelectric) is more expensive (nearly 30% more) than the price of electricity for consumers in Italy, which is notable for being the highest in the EU (which in the table is the only tariff which also includes taxes, though not VAT).

Before examining support policies for renewable sources, it is worthwhile to mention an important critique of the use of the concept of levelised costs in the case of intermittent technologies (Joskow 2010). In particular, comparing the costs of intermittent and dispatchable electricity generating technologies by using the same assumption about the wholesale market price is misleading[5]. In practice, the value of electricity supplied varies widely over the course of a typical year, with a difference of up to four times (according to the same author). The underlying cause of this difference is the wide variation in hourly demand during the year, which, since it is usually not possible to store the electricity generated, implies a need continuously to match supply with demand. Intermittent sources of energy can produce electricity when demand is low, such as during the night; while when demand is higher, and the wholesale market price charged is also higher, such as at peak hours during the day, it is not certain that intermittent sources of energy will be available to add to supply. According to Joskow, "the intermittent technology, despite the fact that the marginal cost of generation is zero, cannot be dispatched based on traditional economic dispatch criteria and runs, in the case of wind, based on exogenous variations in wind speed and direction".

Accordingly, when electricity is produced by an intermittent technology, what matters are the level of output and the value of the electricity at the times when the output is produced. The same is the case when local factors are considered. Since electricity prices also tend to vary between locations, where the output is produced and the prices at which it can be sold should also be taken into account. The same, of course, is also true of dispatchable generating technologies.

Moreover, since both solar and wind power are intermittent technologies, the cost of the additional power needed to supplement them at times when they are not producing sufficiently - or of putting in place distributed generation and smart grids – has also to be taken into account. In essence, it means that the overall cost of the system needs to be considered and not just the cost of the plant concerned.

Policies to support electricity generation from renewables in the EU

Although renewable energies are not competitive, in terms of financial cost – i.e. before taking account of the wider costs to society – with fossil fuels as a means of generating electricity, as indicated above, EU Member States have implemented policies to support their development and overall targets have been suggested at EU level for individual Member States

A number of different measures have been implemented across the EU to support renewable energies for the generation of electricity. The main ones are listed below.

Feed-in tariffs: these give eligible producers of renewables a guaranteed price for the power they feed into the electricity grid. These prices, or tariffs, which tend to be -specific to different

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[5] 'Intermittent' in this context means that the supply of electricity is not continuous but depends on weather conditions; 'dispatchable' means that the supply can be controlled by the system operator and turned on and off according to demand conditions.

technologies, are regulated by governments and are normally guaranteed for a period of 10-20 years. The electricity produced is delivered to the grid and is then distributed by the system operator. Producers of renewables, therefore, enjoy a relatively secure and stable demand for their output. Feed-in tariffs, accordingly, reduce market risk and create a high degree of certainty for investors as regards rates of return.

Feed-in premiums: these give producers of renewables a guaranteed additional amount over and above the market price of electricity. They are again determined by governments, technology-specific and ensure a secure demand for producers. In this case, however, the prices for renewables fluctuate according to changes in the market price of electricity, so that the return on investment can vary.

Green certificates: these are normally based on quota obligations, governments obliging consumers or suppliers to obtain a certain proportion of electricity from renewables. The authorities issue certificates to producers corresponding to their production of renewable energy, which are then sold separately from electricity. The imposition of quota obligations on electricity suppliers ensures that there is a demand for certificates, since suppliers need to buy these in order to fulfil their quotas. The main advantage of this system is that it allows competition between producers of renewables, since the price of certificates depends on the demand for them relative to their supply.

An initial analysis of the cost of the support measures implemented to stimulate the development of renewable sources of energy has been carried out as part of the Intelligent Energy Europe (IEE) RE-SHAPING project (RE-SHAPING 2010), directed by Fraunhofer ISI. While other studies have also been made recently (Canton-Linden 2010, NREL 2010), the focus here is on the findings of the RE-SHAPING project (published in the D5&D6 report). The findings are based on the analysis of the support measures undertaken previously in the OPTRES (OPTRES 2007) and Ecofys Reports the people concerned being much the same as were involved in these two studies). According to the RE-SHAPING Report, the performance of the measures implemented to promote renewable energy supply and consumption in the EU Member States can be assessed on the basis of four parameters (three of which are mainly used for each of the technologies concerned in each country):

- the Policy Effectiveness Indicator, which is the “ratio of the change in the normalised final energy generated during a given period of time (2003-2009) to the additional realisable mid-term potential up to 2020 for a specific technology” (where potential is assessed by the people undertaking the project, on the basis of National Renewable Energy Action Plans);
- the Deployment Status Indicator, which “aims to quantify how advanced the market for a specific RET (Renewable Energy Technology) is in a specific Member State: the higher the value, the higher the maturity of that specific technology market in that country”. Although the Report explains the role of this indicator – differentiated according to three levels of “maturity” of the market – this indicator is not used here;
- the Economic incentives and generation costs, which reflect the amount of financial support provided, since this influences the effectiveness of the incentive and private investors’ assessment of it, as well as the budgetary cost: “the support level should be sufficient to stimulate capacity growth of renewable energy sources by offering a certain level of profitability to potential investors but should also avoid windfall profits caused by high support levels exceeding the requirements of the energy technology”. Note that the Report

takes account of the different time lengths for which incentives are given when assessing them, so that they are normalized by focusing on their net present value (using a discount rate of 6.5% and assuming a common duration of 15 years). It should be added that private investors may be more influenced by the likelihood of the incentives remaining in place and not changing markedly in form than by the precise amount involved as such;

- the profitability of investment in renewable sources and, in particular, the maximum profit available for an investor, which corresponds to the "difference between the maximum support level and minimum generation costs".

The analysis of the cost of the support set out below (Tables C) rests heavily on that of the 'RE-SHAPING study ' pp. 36-61). For each country (first column) and for each technology, the RE-SHAPING figures are used together with the data from EurObserv'ER 2010, taking account of:

- the average support level (second column of Tables C), a distinction being made between High, Intermediate and Low levels of support (in absolute terms) through comparing countries;
- the estimated cost range (third column of Tables C), which shows the extent to which the cost of generation differ within the same country, High, Intermediate and Low relating to the extent of the range of the generating costs in country concerned;
- the minimum levels of estimated cost (fourth column of Tables C), which indicates the lowest level in absolute terms among the lowest levels in each of the countries, High, Intermediate and Low relating to countries in order to highlight the one with the lowest cost for the technology concerned;
- the maximum level of costs (fifth column of Tables C), which indicates the highest level in absolute terms from among the different countries, High, Intermediate and Low relating in this case to countries, in order to highlight the one with the highest cost for the technology in question;
- the support provided minus costs (sixth column of Tables C), which shows , for each country, the difference between the (maximum) support available for the technology and the minimum level of generating costs associated with the technology and which, therefore, measures the "generosity" of support. The socially correct amount of support should, of course, be only slightly higher than the costs.
- the effectiveness of support (final column of Tables C), which measures the rate of change in electricity produced by the renewable source concerned as a percentage of it potential up to 2020. By itself, it is less significant than when coupled with the indicator of efficiency since it highlights how well from a social perspective effectiveness has been financed;
- the countries which are able to provide cheap, effective and efficient (cee) support for each technology (in the final column of Tables C), in the sense that the support provides allows an acceptable rate of profit which just covers the cost of production of electrical or which is at least within the range of costs (since costs can vary according to location, higher support may be needed to cover higher costs) and so is efficient. Since support led to a meaningful increase in electricity generated, it is also effective, and since the cost of support is relatively low in absolute terms compared with other countries, it is cheap as well;

- in some cases, the support provided is efficient and effective, even if the cost is not so low compared with the support given in other countries, perhaps because of the high level of costs in the country concerned; these can be labeled ee – expensive, efficient and effective.

The main features of the support provided to each type of technology are presented below, on the basis of the information in the RE-SHAPING 2010 report (all the results are summarized in Tables C).

Wind onshore: according to the EurObserv'ER 2010, Germany and Spain had the largest installed capacity of all Member States as regards wind power in 2009 (EurObserv'ER does not make a distinction between onshore and offshore wind power), followed by Italy, France (including the DOMs and the UK. These five countries accounted for 78% of the total in the EU-27 (Table C.1).

Table C.1 – Level of support and costs of electricity generation from on-shore wind power, 2009

	Average support level	Cost range	Cost level, min	Cost level, max	Support less cost	Effectiveness of support
Belgium	H	H	H	Int	Int	H
Bulgaria	Int	Int	Int	L	Int	Int
Czech Republic	H	L	Int	L	H	L
Denmark	L	H	L	L	equals max cost	
Germany	L	H	H	H (highest)	in range of costs	H(cee)
Estonia	L	Int	L	L	Int	H
Ireland	L	Int	L (lowest)	L	L	H
Greece	Int	H	H	Int	in range of costs	Int
Spain	L	H	L	L	in range of costs	H(cee)
France	L	H	Int	L	in range of costs	H(cee)
Italy	H (highest)	Int	Int	L	H (largest)	H
Cyprus	H	Int	Int	L	H	
Latvia	H	L	L	L	H	L
Lithuania	Int	L	Int	Int	in range of costs	Int
Luxembourg	L	L	H	Int	in range of costs	H(cee)
Hungary	Int	Int	Int	L	in range of costs	H(ee)
Malta	Int	L	Int	L	L	0
Netherlands	Int	H	L	L	L	H
Austria	L (lowest)	H	H	H	equals min cost	L
Poland	H	Int	Int	L	H	Int
Portugal	L	Int	Int	L	in range of costs	H
Romania	H	Int	Int	L	H	L
Slovenia	Int	Int	Int	Int	in range of costs	0
Slovakia	Int	Int	H	L	in range of costs	0
Finland	L	Int	H	L	in range of costs	L
Sweden	Int	L	L	L	L	H
UK	H	L	L	L	H	H

Note: H=high, or wide in case of cost range; L=low or narrow in case of cost range; Int=intermediate
The effectiveness of support is measured in terms of the increase in electricity produced relative to the 2020 target.
(cee)=cheap and efficient in terms of cost and effective in terms of outcome ; (ee)=efficient and effective
Source: Author's assessment based on RE-SHAPING 2010 and EurObserv'ER Report (2010)

In the same year, Spain, Germany, the UK, France and Portugal (instead of Italy) were the five countries producing most electricity from wind power, accounting for 76% of the total in the EU. Over the 7 years leading up to 2009, the countries in which the electricity produced by onshore wind power plants increased the most (Germany, Spain, Portugal and Ireland) all apply feed-in tariffs which, in international terms, are relatively low. The highest level of feed-in tariffs is in Italy, even though costs of production are relatively low, and the lowest level is in Austria, where it barely covers the minimum costs of production.

The range of estimated costs of production is relatively wide, however, in many countries. The minimum level overall is in Ireland, while the maximum is in Germany. In many EU countries, feed-in tariffs seem to be relatively efficient, the amount of support being within the range of costs in nearly half the countries. They seem to be least efficient in Italy for this particular technology, since the difference between the average support provided and the lowest cost is largest. The support provided appears to be effective in promoting renewable energy supply from this technology, in that, for many countries, there was a marked increase in production in 2009 in relation to potential. The use of support measures seems most successful: in respect of wind power in five countries, France, Germany, Spain, Luxembourg and Portugal, where the indications are that it is cheap, efficient and effective.

Wind offshore: Denmark has been by far the most successful country in supporting the development of off-shore wind technologies up to now. This success has been obtained by providing support which is no larger than the minimum cost of energy production in the country and not very expensive in international terms. By contrast, Italy again gives the largest amount of support, though this can be explained by the very high costs of generating electricity from this technology (Table C.2).

The range of the costs is very wide in many countries. The lowest costs are in Ireland, but despite this and despite the relatively large amount of support provided, , which means that the country is relatively inefficient in its promotion of this type of renewable energy, the amount of electricity produced in Ireland from offshore wind power in 2009 and in the 6 years before was comparatively small. In many countries, such as Belgium, Estonia, Greece, Finland, Latvia, Lithuania and Portugal, the absence of production can be explained by the fact that the support provided is lower than the costs, so that their role as incentives is minimal. However, electricity generated from offshore wind power was non-negligible in 2009 in only three countries apart from Denmark - Germany, Sweden and the UK – reflecting the immaturity of the technology.

Table C.2 – Level of support and costs of electricity generation from off-shore wind power, 2009

	Average support level	Cost range	Cost level, min	Cost level, max	Support less cost	Effectiveness of support
Belgium	Int	H	Int	Int	less than cost	
Bulgaria	H	0				
Czech Republic	Int					
Denmark	Int	H	L	L	equals min cost	H (cee)
Germany	H	H	Int	Int	L	L
Estonia	Int	Int	Int	Int	less than cost	
Ireland	H	L	L (lowest)	L (lowest)	H	
Greece	Int	H	H	H	less than cost	
Spain	Int	H	Int	Int	in range of costs	
France	Int	H	Int	Int	in range of costs	
Italy	H (highest)	H	H (highest)	H (highest)	L	
Cyprus	Int	0				
Latvia	L	L	Int	Int	less than cost	
Lithuania	L	Int	Int	Int	less than cost	
Luxembourg	Int					
Hungary						
Malta	L	0				
Netherlands	Int	H	L	Int	equals min cost	
Austria						
Poland	H	H	Int	Int	L	
Portugal	L	H	H	H	less than cost	
Romania	Int	0				
Slovenia	Int	0				
Slovakia	Int					
Finland	L	H	Int	Int	less than cost	
Sweden	Int	H	H	H	less than cost	Int
UK	H	Int	L	L	Int	L

Note: H=high, or wide in case of cost range; L=low or narrow in case of cost range; Int=intermediate
The effectiveness of support is measured in terms of the increase in electricity produced relative to the 2020 target.
(cee)=cheap and efficient in terms of cost and effective in terms of outcome
Source: Author's assessment based on RE-SHAPING 2010 and EurObserv'ER Report (2010)

Solar photovoltaics: Germany, Spain, Italy, the Czech Republic and Belgium together accounted for 96% of installed PV capacity in the EU at the end of 2009, all of these, except Germany which alone accounted for 60% of capacity, providing a high level of support (Table C.3).

In the case of Italy a high level of support goes together with relatively low costs, so that the extent of stimulus is substantial. Two other Mediterranean countries, Greece and Cyprus, are similar in this respect, giving investors a fiscal incentive net of costs that is even more generous than in Italy. Five countries – Cyprus, Spain, Italy, Malta and Portugal – have the lowest costs, while the highest costs are, as would be expected, in Finland and Sweden. The majority of countries have a relatively efficient support policy, providing an incentive which is within the range of costs, though in many countries, it is less than costs (Denmark, Estonia, Finland, Hungary, Ireland, Malta, Poland, Romania, Sweden, Slovakia and the UK). In the latter cases, the production of electricity using PV source is very limited. In Spain and Portugal, the support provided is equal to the maximum level of costs and both countries produce electricity from this source. Only two countries, Belgium and Germany, have both an efficient and effective support policy, while in none of the countries can policy be regarded as cheap.

Table C.3 – Level of support and costs of electricity generation from solar photovoltaic systems, 2009

	Average support level	Cost range	Cost level, min	Cost level, max	Support less cost	Effectiveness of support
Belgium	H	H	H	H	in range of costs	H (ee)
Bulgaria	H	H	Int	Int	L	
Czech Republic	H	H	Int	Int	in range of costs	Int
Denmark	L	H	H	Int	less than cost	
Germany	Int	H	Int	Int	in range of costs	H (ee)
Estonia	L	H	H	Int	less than cost	
Ireland	L	H	H	Int	less than cost	
Greece	H	H	L	Int	H	L
Spain	Int	Int	L	L	equals max cost	L
France	H	H	L	Int	L	L
Italy	H	H	L	Int	H	L
Cyprus	H	Int	L	L	H	L
Latvia	Int	H	H	Int	in range of costs	
Lithuania	Int	H	H	Int	in range of costs	
Luxembourg	Int	H	Int	Int	in range of costs	L
Hungary	L	H	Int	Int	less than cost	
Malta	Int	Int	L	L	less than cost	
Netherlands	H	H	Int	H	in range of costs	
Austria	Int	H	Int	Int	in range of costs	
Poland	Int	H	H	Int	less than cost	
Portugal	Int	Int	L	L	equals max cost	L
Romania	Int	Int	Int	Int	less than cost	
Slovenia	Int	H	Int	Int	in range of costs	L
Slovakia	Int	H	Int	Int	less than cost	
Finland	L	H	H	H	less than cost	
Sweden	L	H	H	H	less than cost	
UK	Int	H	H	H	less than cost	

Note: H=high, or wide in case of cost range; L=low or narrow in case of cost range; Int=intermediate
The effectiveness of support is measured in terms of the increase in electricity produced relative to the 2020 target.
(ee)=efficient in terms of cost and effective in terms of outcome
Source: Author's assessment based on RE-SHAPING 2010 and EurObserv'ER Report (2010)

Biogas: Germany, the UK, France excluding the DOMs), Italy and the Netherlands were the top five countries producing energy from this source in 2009, accounting for 86% of the EU total The highest growth in relation to potential was in Austria, Germany, and Luxemburg, which apply feed-in tariffs. In these countries, biogas is produced from agricultural materials, while in the UK, it comes from landfill gas and sewage sludge. As compared with other countries, the amount of support provided is relatively large in Germany and Italy, which is not really justifiable in terms of their costs, the difference between support and costs being larger than in most other countries (Table C.4).

Table C.4 – Level of support and costs of electricity generation from biogas, 2009

	Average support level	Cost range	Cost level, min	Cost level, max	Support less cost	Effectiveness of support
Belgium	Int	L		Int	Int	Int
Bulgaria	L	Int		Int	in range of costs	0
Czech Republic	Int	Int		Int	H	Int
Denmark	Int	L		Int	Int	L
Germany	H	Int		Int	H	H
Estonia	L	Int		Int	in range of costs	L
Ireland	L	Int		Int	in range of costs	L
Greece	Int	Int		H	in range of costs	L
Spain	Int	Int		Int	Int	L
France	Int	Int		Int	L	L
Italy	H	Int		Int	H	Int
Cyprus	L	H		H	in range of costs	H (cee)
Latvia	Int	Int		Int	Int	L
Lithuania	L	Int		Int	in range of costs	L
Luxembourg	Int	Int		Int	Int	H
Hungary	L	Int		Int	L	Int
Malta	L	H highest)		H (highest)	in range of costs	0
Netherlands	Int	L		L	H	H
Austria	Int	H		H	L	H
Poland	Int	Int		Int	Int	L
Portugal	Int	H		H	L	L
Romania	Int	Int		Int	H	L
Slovenia	Int	Int		Int	Int	Int
Slovakia	Int	Int		Int	Int	L
Finland	L	Int		Int	in range of costs	H (cee)
Sweden	L	Int		Int	in range of costs	L
UK	Int	Int		Int	Int	H

Note: H=high, or wide in case of cost range; L=low or narrow in case of cost range; Int=intermediate
The effectiveness of support is measured in terms of the increase in electricity produced relative to the 2020 target.
(cee)=cheap and efficient in terms of cost and effective in terms of outcome
Source: Author's assessment based on RE-SHAPING 2010 and EurObserv'ER Report (2010)

By contrast, the amount of support is relatively small in Bulgaria, Cyprus, Estonia, Finland, Hungary, Ireland, Lithuania, Malta and Sweden, though in most cases within the range of costs. Due to the high degree of heterogeneity of biogas sources, the range of costs is relatively wide, especially mainly in small countries like Austria, Cyprus, Malta and Portugal, where the costs are highest. As noted above, the support provided is within the range of costs in all the countries providing a low level of support, though all of these produced only a small quantity of electricity from biogas in 2008, with the notable exceptions of Bulgaria and Malta, which (according to RE-SHAPING) did not produce any at all, and Finland, where the increase in production in 2008 was substantial. Finland, accordingly, is the only country which can be considered as both efficient and effective in its support policy, as well as the policy being relatively cheap (Cyprus is similar to Finland in thee regards, but the amount of electricity produced from biogas in 2008 was very limited). On the other hand, other countries, especially the Czech Republic, Germany, Italy, Netherlands and Romania, seem "generous" in the support provided in the sense that the incentives and much higher than the costs.

Small hydro: According to the EurObserv'ER 2010, Italy, France, Spain, Germany and Sweden are the top five EU 27 countries in terms of the capacity for generating electricity from small hydro (plants with capacity of less than 10 MW), accounting in 2009 for over 72% of the EU total. The average support level is particularly high in Italy (the highest in the EU), Belgium, the Czech Republic, Latvia, Poland, Romania and the UK, while it is relatively low in Austria and Portugal, as well as in Denmark (for which there are no cost estimates) and Lithuania (where both the level and growth of electricity generation from this source are very low) (Table C.5).

Table C.5 – Level of support and costs of electricity generation from small hydro power, 2009

	Average support level	Cost range	Cost level, minimum	Cost level, maximum	Support less cost	Effectiveness of support
Belgium	H	L	H	H (highest)	in range of costs	L
Bulgaria	Int	L	Int	Int	Int	Int
Czech Republic	H	H	Int	Int	H	Int
Denmark	L (lowest)	No cost estimates				
Germany	Int	Int	H	H	equals max cost	H
Estonia	Int	L	L (lowest)	L (lowest)	Int	
Ireland	Int	H	Int	H	in range of costs	Int (ee)
Greece	Int	Int	Int	Int	Int	
Spain	Int	Int	Int	L	Int	L
France	Int	Int	Int	Int	Int	H
Italy	H (highest)	Int	Int	Int	H	H
Cyprus	Int	H	Int	Int	L	
Latvia	H	L	Int	Int	H	
Lithuania	L	Int	Int	Int	L	
Luxembourg	Int	No cost estimates				
Hungary	Int	H	Int	Int	equals max cost	Int
Malta	Int	No cost estimates				
Netherlands	Int	No cost estimates				
Austria	L	H	Int	Int	in range of costs	Int
Poland	H	L	L	L	H (highest)	L
Portugal	L	H	H	H	in range of costs	L
Romania	H	Int	Int	Int	H	L
Slovenia	Int	Int	Int	L	Int	L
Slovakia	Int	L	L	L	H	H
Finland	Int	L	Int	Int	L	
Sweden	Int	L	Int	L	Int	
UK	H	H	H	H	equals max cost	Int

Note: H=high, or wide in case of cost range; L=low or narrow in case of cost range; Int=intermediate
The effectiveness of support is measured in terms of the increase in electricity produced relative to the 2020 target.
(ee)=efficient in terms of costs and effective in terms of outcome
Source: RE-SHAPING 2010 and EurObserv'ER Report (2010)

The range of costs varies greatly between countries: in some (Estonia, Poland and Slovakia), it is very narrow, in others (Hungary, Ireland and the UK) it is very wide. The lowest costs of generating electricity from this source are in Estonia, while the highest are in Belgium. The support provided is relatively efficient (in the sense that it is within the range of costs) in Germany (where, nevertheless, support is equal to the maximum cost), Hungary (where the same is the case), Ireland, Portugal, and the UK (which is similar to Germany and Hungary in this regard). In none of the countries is the amount of support less than the estimated cost, while the most generous support in relation to costs is in Poland. Only in Ireland can support policy be considered to be efficient and effective, though not cheap.

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Financial, regulatory and institutional hurdles to improving the energy efficiency of residential buildings

Institutional hurdles

The landlord/tenant paradox

The landlord/tenant trade-off is a classic case of a principal-agent relationship. In many cases, the owner (the landlord) and the occupier (the tenant) of a house or of an apartment are two different people. Usually tenants are responsible for paying energy bills, while the landlord is responsible for dealing with (possible) energy investment. The landlord's interest is to minimise the capital cost of the appliance (with little regard to energy efficiency), while the tenant's interest is to maximise the energy efficiency of the appliance to save on energy costs. Even if obliged to invest in energy refurbishment, the landlord will tend to provide it through low-cost equipment, probably with relatively low energy efficiency. Similarly, tenants will not be willing to pay for energy efficient equipment if it remains in the dwelling when they leave No one will invest in the energy upgrading of the building: a situation termed "split incentive" (Golove-Eto 1996; de T'Serclaes, 2007; IEA, 2007; JRC 2009).

Four cases are possible from the perspective of the tenant as end user of the technology (see Table 5, IEA 2007). Only in the first case, where the buyer and the end user of the energy efficient technology are the same person, is the most efficient technology likely to be chosen. The second case is the case for split incentives: the landlord has no incentive to make energy efficiency investments because only the tenant benefits from the reduced costs of energy. In the third case the tenant does not pay the energy bills, but can choose the technology. This can occur, for example, in the case of some companies which allow their employees to select their cars; then the companies pay for fuel consumed on both business related and personal trips. In such cases, employees have no incentives to select the least expensive cars and to use them in the most fuel efficient way. This case, however, is not common in practice. In the fourth case, the tenant does not pay the energy bills and use the technology (the appliances) bought by the owner: the tenant has no incentive to behave in an energy efficient way, and the owner has no incentive to adopt the most energy efficient technology.

Table 5 – Choices of technology in different situations

		Choice of the technology (by the tenant)	
Payment of the energy bill (by the tenant)		Yes	No
	Yes	Y,Y: the end user of the technology will choose the best technology (depending on the budget constraint)	Y,N: the landlord will choose among the least efficient technologies (because they are cheap) : split incentive
	No	N,Y: which is not common (but split incentive and inefficient use)	N,N: the landlord can choose the best technology, but the tenant makes no effort to save on the energy bill he does not pay: bad

			use (like in the hotels)

Source: IEA 2007

Note that the "split incentive" (the second case of the example) is estimated to affect around a third of US residential energy consumption.

The IEA text also considers the case of Netherlands: where housing stock consists of three segments: 53% privately owned, 35% social rental, and 11% private rental, if all the tenants are responsible for paying the energy bill, the split incentive could affect at most 47% of the houses in the residential sector. In fact, examining the number of houses that have already implemented energy efficiency measures to reduce the energy used by space heating, the private rental segment is the one where the introduction of energy efficiency measures has been lowest.

A similar problem to the landlord/tenant paradox occurs when the payback period of the investment exceeds the expected duration of the owner inhabiting a building or a company owning it.

Split incentives also exist when the constructors of a building choose the energy appliances to install. Their aim tends to be to reduce the initial costs which means that they opt for low energy-efficient appliances while the eventual occupants of the building would prefer energy-efficient ones, which — in general — tend to have lower total costs over their lifetime (Brown, 2001).

According to Brown's survey, split incentive problems are particularly important in multifamily buildings because, in general, the majority of the residents are renting apartments. Split incentives are less important for single-family houses which are often owned by the occupants (often the owner is also involved in the selection of energy-using appliances in the building). In the EU-27, just under three-quarters of houses are owned by their occupants; while in the EU-12, the proportion in many countries is over 85%.

Little information, however, is available on the correlation between the level of energy efficient equipment in households and their ownership. According to JRC (JRC, 2009) a survey of English housing (SEH) contains some data on the endowment of households with energy efficient equipment and on the insulation level of windows according to tenure status. Generally speaking, households owning their dwelling show a higher level of energy efficient equipment and insulation level than tenants. Note that even for energy-saving equipment for which tenants are responsible, tenure status makes a difference: owned dwellings show higher levels of energy efficient equipment than households renting their accommodation.

According to the same source, the landlord–tenant problem could be resolved by contracting, in the sense that the tenant would accept to pay a higher rent if offset by reduced energy bills. An obstacle to this solution is the uncertainty arising from the fact that the tenant may move at any time: the landlord does not know if the willingness-to-pay of a future tenant will be the same, so making it uncertain whether or not their investment will pay off.

Jakob (2007) proposes contracting or a splitting of energy costs as possible solutions to overcoming the split incentive barrier in Switzerland and suggest raising the existing limits to the passing-on of costs to tenants.

In the public sector, the split incentive problem is mainly tackled by governments by allowing for third-party financing of energy efficiency projects (EuroACE, 2004) through energy service companies (ESCOs), which develop, finance and manage energy efficiency projects and provide energy at the contracted cost to the owner (WBCSD, 2007; Bertoldi and Rezessy, 2005). The profit earned by ESCOs is directly dependent on the energy savings achieved through investment.

According to Jolley (2006), awareness-raising amongst tenants on energy cost issues by information programmes would help to make tenants take account of energy consumption ‘when making decisions about which accommodation to choose. If tenants are fully informed, they should be more willing to pay higher rents for energy-efficient buildings, thereby encouraging owners to take energy considerations into account in building design and equipment.

A “premium” for energy-efficient housing?

To understand if the market recognises a “premium” for energy efficient buildings means being able to detect , within the substantial empirical literature dealing with housing issues, evidence of price differentiation in the housing market arising from the energy efficiency of buildings. The existence of this “premium” and its level are, however, difficult to find. In the literature on price determination, location, size of the plot, age, number of rooms, and living space are among the most common features emphasized when housing is sold, while external factors such the existence of services (like urban transport) and possible environmental amenities (like the presence of a lake or clean air) also seem to justify a higher price. Energy technology and related equipment, excluding air conditioning, do not seem to feature

Up very recently, analysis of the existence or not of a “premium” for energy efficient housing had been carried out only for the US (including, for example, studies by Fuerst and McAllister and Eichholz-Kok-Quingley) and Australia. Studies for Europe, however, are now beginning to be produced.

In Switzerland, Banfi-Farsi-Filippini-Jakob (2008) analyse the Willingness to pay (WTP) for energy-saving measures in residential buildings. They find that such measures are valued highly by consumers, in some cases by enough to more than compensate for the costs of implementation and operation. In new buildings, the WTP for enhanced wall insulation is about 3% while the ventilation system is valued at 4% to 12% of the reference price. House buyers and tenants have a similar WTP. In existing buildings, the WTP for wall insulation is around 6%, while the estimated WTP for aesthetic appearance is low (about 3%) and significant only for single-family houses. The WTP is particularly high for double-glazing (13 % for both tenants and house purchasers).

In the Netherlands Brounen-Kok-Menne (2009) analyse the working of the Energy Performance Certificate in the housing market. They find that when energy certification is not mandatory, adoption rates are low and clustered among young single-family dwellings, located in regions where competition among buyers is limited, but that there is a significant price premium for green energy labels. Their results provide a first indication that consumers recognise the added value of buying an energy-efficient home.

In the United Kingdom, Chegut-Eichholtz-Kok-Quigley (2010) analyse the financial implications of green building practices in the UK, the first country to introduce a formal green building rating scheme – BREEAM – in 1990. They match proprietary information on BREEAM-rated office buildings to the characteristics of geographically nearby control buildings, their selling prices and rents. Their results suggest a positive impact of a building’s green characteristics on sales and rental transaction prices of between 8% and 20%, depending on the model specification used for estimation.

In Germany, according to M. Kesternich (2010), the WTP is not determined mainly by socioeconomic attributes like household income or formal education, but instead by environmental concerns and energy awareness. Housing, however, seems not to be clearly perceived as a possibility for contributing to climate protection. The people interviewed were not asked about the total amount of money they were willing to pay but instead if they were willing to accept a higher purchase price or rent, exclusive of heating, for an energy-efficient building. More precisely, they were given a choice between three options:

(1) Yes, as long as the building is affordable • 37.2% chose this option

(2) Yes, if the rent including heating in total does not rise/ if expected future saved energy costs equal the increase in purchase price, • 33.8 % chose this

(3) No increase of purchasing prices/rent is acceptable (WTP=0) • 28.9 % chose this.

Kesternich emphasizes the rather equal distribution of replies and notes that the heterogeneity in responses cannot be fully explained by financial consideration. Accordingly, policy measures to strengthen the diffusion of energy-efficient technologies and foster retro-fit and refurbishment activities should not focus solely on subsidies and funding programmes, but :on better information as well.

Financial hurdles

Financial hurdles can be simply defined as the ratio of investment costs to improve the energy efficiency of buildings to the value of energy savings achieved through such investment.

In a rational world with perfect information, rational people would be expected to bear the costs of investment so long as they are receive pay-back in the form of sufficient energy savings over a reasonable time period. As is well known, this is not really so for energy improvements in housing because of market failure. This arises from the institutional context, exemplified by the landlord-tenant trade-off, and the existence of obstacles stemming from regulation systems in different countries.

Moreover, most owner-occupied buildings undergo multiple changes in ownership during their lifetimes and as a result each individual owner has a limited financial interest in undertaking investment to minimise the long-term energy costs of the building.

However energy improvements in residential buildings are also inhibited by financial reasons:

- the investment in energy saving may not be made because of liquidity constraints among house-owners and the financial system is not capable of providing the necessary lending;
- even if there are no liquidity constraints, the investment made by home-owners has to compete with other investment and the pay-back may be less than that from alternatives.

It should be noted that, in the absence of information about the prospective return, there is no strong incentive for owners to reduce the weight of energy bills in the expenditure of the household. The average spending of households in the EU on energy in the home is only around 4% of their total expenditure, though this ranges from over 8% in the Czech Republic to just over 2% in Greece (Table 6). The share of such expenditure has increased by around one point percentage since 2000 in the E, declining only in Latvia, though it remained unchanged in around a third of EU countries. It, therefore, r increased by more than one percentage point in many countries.

Table 6 – Household's expenditure on electricity and gas (as % total expenditure), 2000 and 2009

	2000	2009*
European Union (27 countries)	3.4	4.2
Belgium	4.8	4.7
Bulgaria		
Czech Republic	7.3	8.4
Denmark	6.0	5.8
Germany	3.5	4.7
Estonia	4.3	4.8
Ireland	2.9	3.8
Greece	2.1	2.1
Spain	2.2	2.7
France	3.5	3.7
Italy	3.4	3.8
Cyprus	2.4	2.7
Latvia	6.0	5.7
Lithuania	5.1	4.6
Luxembourg	2.4	2.5
Hungary	5.2	7.2
Malta	1.5	2.5
Netherlands	3.4	5.0
Austria	3.7	4.6
Poland	6.6	8.2
Portugal	2.7	3.3
Romania	3.1	4.2
Slovenia	5.3	5.9
Slovakia	8.9	10.5
Finland	2.4	2.8
Sweden	5.0	5.6
UK	2.4	3.8

(*) Data in italics for Ireland and Slovakia refer to 2000-2008, for Portugal to 2000-2007 and for Sweden to 2000-2005.

Source: Eurostat

This increase is to a large extent a result of a sharp rise in energy prices across the EU (excluding the price of motor fuel), of around 50% between 2000 and 2008/2009, much more than the general rate of inflation (Table 7). Over the period, therefore, energy prices increased significantly in real terms (this is the meaning of the "ratio" row in the table). Note however that this "real" increase did not occur continuously but was concentrated in particular years, when the oil price rose markedly. There are differences between EU countries, the increase being higher than average in the Netherlands, Portugal and the UK as well as in some EU12 countries.

Table 7 – % change in energy price, total consumer prices and energy relative to total (2000-2009)*

	Energy prices	Total prices	Energy rel. total
European Union (27 countries)	46.9	16.5	26.1
Belgium	39.4	19.8	16.4
Bulgaria			
Czech Republic	89.9	21.2	56.7
Denmark	28.6	16.7	10.2
Germany	56.6	12.6	39.1
Estonia	121.6	43.0	55.0
Ireland	82.9	27.4	43.6
Greece	35.4	32.1	2.5
Spain	29.2	31.1	-1.4
France	27.1	15.6	9.9
Italy	23.5	23.5	0.0
Cyprus	60.5	30.2	23.3
Latvia	64.5	45.6	13.0
Lithuania	28.1	14.0	12.4
Luxembourg	43.6	21.7	18.0
Hungary	144.6	54.8	58.0
Malta			
Netherlands	79.8	17.3	53.3
Austria	30.9	16.0	12.8
Poland	61.7	25.5	28.8
Portugal	165.6	50.9	76.0
Romania	385.6	183.2	71.5
Slovenia	63.5	45.3	12.5
Slovakia	129.0	44.2	58.8
Finland	51.2	13.2	33.6
Sweden	37.2	7.7	27.4
UK	95.3	19.6	63.3

(*) Data in italics refer for Ireland and Slovakia to 2000-2008, for Latvia, Lithuania and Portugal to 2000-2007 and for Sweden to 2000-2005.

Source: Eurostat

The low level of expenditure on energy of households, accordingly, does not give much justification for making improvements in the energy efficiency of housing, even though the continuous increase in real prices of energy might suggest it was rational for consumers to protect themselves against these by doing so

As improvements in the energy efficiency of residential building are an investment, the long-term reduction in the household savings ratio tends to make it more unlikely for this investment to be financed from savings. More generally, many users are not able to cover investment in improving energy efficiency from their own resources and they may well have difficulty in obtaining loans because of some reluctance among banks to extend credit for this purpose.

Researchers and practitioners (BPIE 2010; Jakob 2007; de T' Serclaes P., 2007; Houser 2009) agree that there are three main factors – the initial cost barrier; the nature of the financier and the lack of consensus on methods of evaluating returns - explain the existence of barriers in the financial market to improving the energy efficiency of buildings.

The initial cost barrier can be important. According to Jakob 2007, energy efficiency renovations generally call for substantial additional up-front investment as compared with repair or maintenance work. In the case of single-family houses, the costs of energy efficiency improvements in external walls, roofs and windows can reach 10% of the purchase price of houses, which is not a negligible amount for most single-family home-owners, while savings in energy costs tend to be spread over a long time period (30 to 50 years).

The scale of these costs has two different effects. On the one hand, it excludes removes low-income borrowers, as "the difficulty in obtaining the initial capital is insurmountable" (de T' Serclaes P., 2007). A typical market solution here could be leasing, but leasing really fits situations where the great bulk of the expenditure financed is made up of physical assets since their use can be denied as a sanction for default. This is not the case for energy efficiency projects, where labour costs tend to represent by far the largest share.

On the other hand, it has "adverse selection" effects because of the nature of financiers. Although investment is small enough to be covered by commercial banks, these tend to lack financial expertise as regards energy efficiency and to consider the rate of return on their financing to be too low in relation to the risk. Moreover, since energy efficiency investment in housing is site specific, it is not easily replicable and so not open to standardised assessment, which means that transaction costs for banks tend to be high.

Thirdly, it is common practice for commercial banks to use the payback period as a criterion for investment. As BPIE conclude, "energy-efficient projects tend to have a longer payback period than more classical investments; hence they do not rank high on financiers' agendas. This measure is particularly inappropriate in the building sector context since a building's lifetime usually exceeds 30 years or more, therefore it does not take into consideration benefits accrued after the payback time such as an increase in overall well-being, health conditions, or job improvement in the cost/benefit analysis. Referring to payback time as the only reference point for investment validity also prevents proper consideration being given to the importance of the public good aspect of energy efficiency. Despite its inappropriateness, reference to the payback time is still common and represents an obstacle to energy efficiency projects".

To sum up the financial hurdles to energy efficiency in residential buildings:

- A large proportion of people (one third in the US) are not stimulated to invest in the energy efficiency of their houses because of the landlord-tenant trade-off.
- The remainder may not be stimulated to invest in energy efficiency because the weight of their energy bill in their budget is relatively small and the cost of the intervention relatively high

- If these people seek loans in the financial market, they are likely to be bet by a lack of expertise and be told that the payback period is too long to justify lending

Because of these forms of market failure, it has historically required major involvement of Governments through financial or fiscal measures to stimulate investment. In recent times, the existence of these obstacles in the financial market has led to the creation of specific, specialised instruments like the ESCOs (energy services companies), which are now relatively common in EU countries.

Two further issues have yet to be considered, which shed a different light on the energy efficiency issue:

- As regards the financing constraint, according to Jakob, most of the owners who put in a wall or roof insulation between 1986 and 2000 who were surveyed experienced no financing problems (over 80%) or legal restrictions (92%). This is in line with the fact that only 2.2% of single-family house-owners admitted to staggering renovation work in order to avoid having to provide an energy certificate (which is needed in the case of major conversions or renovations).
- As regards the evaluation procedures for energy efficiency projects of financing companies, according to WBCSD 2007, 1423 people were interviewed between November 2006 and February 2007 by means of a telephone questionnaire. These were chosen from among planners and developers (including architects, engineers, builders and contractors) and agents and professional landlords (including corporate building owners and corporate tenants. Among the questions asked was: “How much more do you think a certified sustainable building would cost to build relative to a normal building?” They generally overestimated the cost premium, which is likely to be under 5% in developed countries, and especially so in Germany, France and Spain.

Regulatory hurdles

Regulatory barriers refer to forms of intervention by Government which interfere with the goal of improving the energy efficiency of buildings, which is some cases no longer exist in the EU.

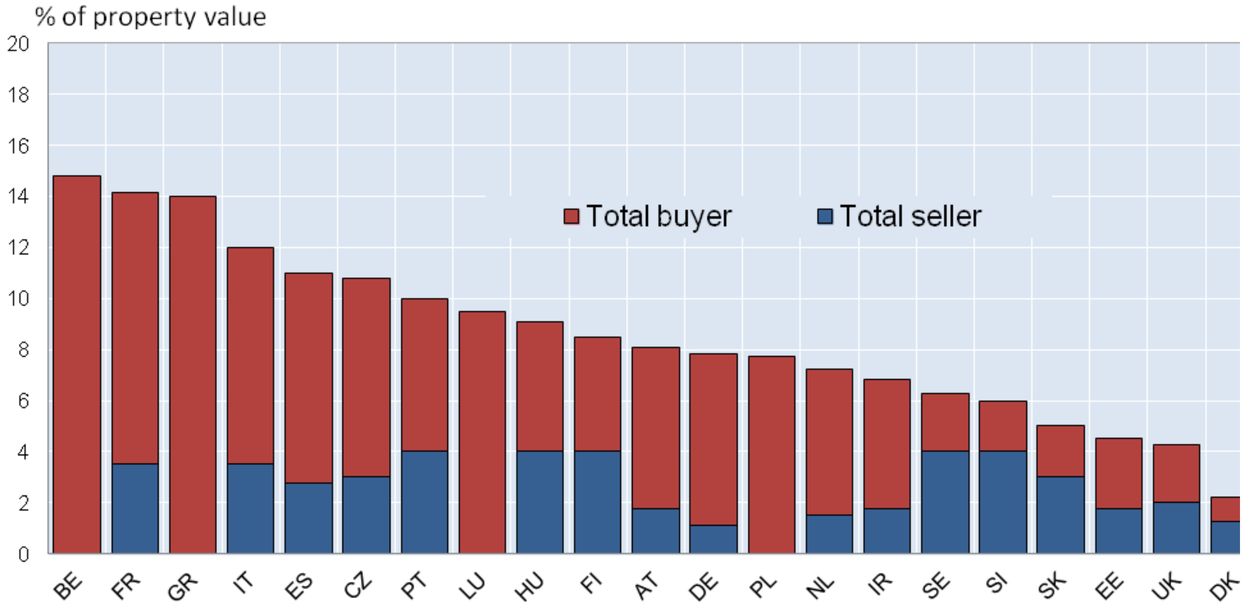
In a case of a regulatory barrier examined by Golove-Eto, 1996, namely to the mis-pricing of energy (such as electricity and natural gas) the price of which is set administratively by regulatory bodies, consumers tend to sheltered from changes in, and the instability of world energy prices. Consumers are then not typically aware of energy scarcity, so that they consume more than they should. Although regulatory bodies setting electricity and natural gas prices still exist in Europe, the liberalisation of electricity and gas markets in the EU means that such a situation is no longer common, since domestic energy prices tend now to reflect developments in the world market more closely. The question still remains, however, as to whether or not world energy prices pass on the ‘correct’ information about energy scarcity to consumers.

Other examples of government intervention which damage the pursuit of energy efficiency in buildings are quoted in the survey by Brown, 2001. “Regulatory barriers identified in this survey include prohibitions against uses of distributed energy resources … and state-to-state variations in environmental permitting requirements that result in significant burdens to project developers.” A similar list is drawn on by the IPCC survey (Levine et alii, 2007). “In many countries, these barriers include variations in environmental permitting requirements, which impose significant burdens on project developers. Similar variations in metering policies cause confusion in the marketplace and represent barriers to distributed generation. Public procurement regulations often inhibit the involvement of ESCOs or the implementation of energy performance contracts. Finally, in some countries the rental market is regulated in a way that discourages investments in general and energy-efficient investments in particular."

Recent OECD work on the housing market (Andrews et alii, 2011; OECD 2011) provide a detailed analysis of how public policies can affect the ratio of homeowners to tenants and more generally the circumstances of people as regards housing. Since investment to improve energy efficiency involves a long period payback, home-owners are reluctant to invest in energy efficiency programmes if their residential mobility is high. So public policies which have the effect of increasing residential (and labour) mobility also have the effect of reducing the propensity to invest in energy efficiency projects in housing. However, public policies can have positive effects on such projects if they are able to liberalise the housing market so much as to minimize the time and cost it takes for people to sell their existing houses and to buy new ones houses. Accordingly, there is a positive correlation between liberalisation of the housing market and investment in energy efficiency of buildings.

Part of the liberalisation concerned can be achieved through reducing housing transaction costs, which differ considerably across OECD countries (see Figure 1) and which include "a number of different types of cost and fees, such as transfer taxes (e.g. stamp duties and acquisition taxes), fees incurred when registering the property in the land registry, notary or other legal fees, and real estate agency fees. In some cases, the fees paid to intermediaries can be set directly by government regulations (or by government-backed self-regulations of the profession) or be influenced by legal barriers to entry into some markets (e.g. notarial real estate services)."

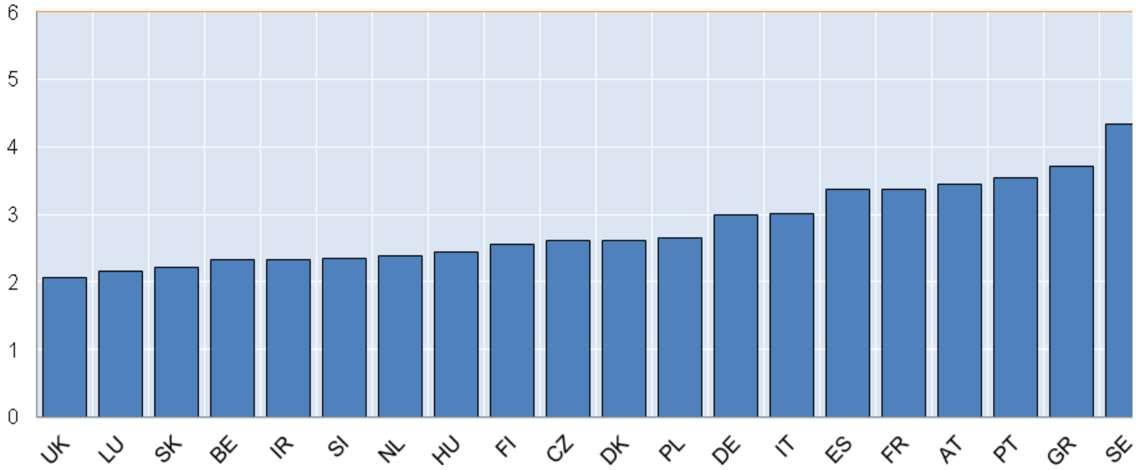
Figure 1 - Transaction costs of purchasing property



Source: Johansson, Å. (2011), "Housing Policies in OECD
OECD Economics Department Working Papers, forthcoming.

The ratio of homeowners to tenants- is affected by rental regulations as well. According to OECD, these seems particularly strict in some EU countries (see Figure 2): "Strict regulations in rental markets can reduce residential mobility as tenants in rent controlled dwellings will be reluctant to move if rents are below market levels and tenure security is greater than in the unregulated segment…. Similarly, strict tenant-landlord regulation resulting in high tenure security can lower the expected returns from residential rental supply, thereby reducing investment or encouraging hoarding or alternative uses of the existing stock by owners. Together, the negative effects of excessive rental regulation on supply and tenants' incentives to move may reduce turnover in the rental sector and lower residential mobility".

Figure 2 – Ratio of regulatory protection for tenants relative to landlords
Scale 0-6: Increasing in protection for tenants



The indicator measures the extent of tenant-landlord regulation within a tenancy. It includes the ease of evicting a tenant, degree of tenure security and deposit requirements.
Source: Johansson, Å. (2011), "Housing Policies in OECD Countries: Survey-based Data and Implications", OECD Economics Department Working Papers, forthcoming.

The ratio of landlords to tenants- can be influenced by fiscal measures, as in many countries owner-occupied housing typically enjoys more favourable tax treatment than other forms of capital investment. Furthermore in many countries mortgage interest payments can be deducted from personal income tax. However "no cross-country evidence seems to suggest that greater mortgage deductibility coincides with higher overall home ownership rates. Instead, estimates suggest that through their indirect adverse effect on prices, generous housing tax relief on debt financing costs does little to encourage home ownership by lower-income households (Andrews and Caldera Sánchez, 2011)".

More generally, government interventions in the housing market can be justified by the fact that in the case of housing, market failure is extensive. The net damage of interventions to investment in the energy efficiency of residential buildings however remains the subject of debate. Even what seem to be the most adverse consequences (on energy efficiency investment) of these regulatory obstacles, i.e. the effects of tax deductibility and rent control on the ratio between homeowners and tenants, are questionable: "across the countries covered in this chapter, there is no clear evidence that rent levels are lower in countries with stricter rent control", OECD 2011, so that differences in rent levels should not affect the ratio between homeowners and tenants.

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