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Necessities and Resources of Industrials
United Kingdom Case

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Abstract

Electricity in industrial businesses represent an important fraction of energy costs, the necessity of it use and, in the majority of the companies, the increasing of their demand plus the variable rising prices of electricity lead the industrials to look for different ways to secure their supply necessities at the minor possible cost. The aim of this paper is to present an overview of the UK electricity market and the options for industrials supply in the framework of liberalization, concluding with a proposal of which could be the better selection as a result of the analysis.

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1. INTRODUCTION

Since liberalization was introduced for the energy market in the European Union, and developed in United Kingdom, the competitiveness has growth and let the prices of electricity obey the market laws of supply and demand. Liberalization brings important benefits for consumers by offering them choice and a greater responsiveness to consumer needs (Ilie et al., 2007). Now the consumers have more responsibility in the selection of prices, depending of the way of supplying they chose, and is not an entirely concern of the government, even they establish some regulations for incentivize competitiveness, investments and service quality. Focusing on industrial consumers, they have to be carefully in taking the decision for the way of energy supply, because of the electricity in industrial businesses represent an important fraction of energy costs, it is essential and usually the demand is in constant increasing.

The variable rising prices of electricity is also a concerning of industrials, which are looking for different ways to secure their supply necessities. They try to avoid or diminish the impact of the variability in their costs, which mainly due to behavior of fossil fuels prices in response to the declining of UK's reserves.

In order to serve as a support to take such an important decision, this paper shows first an overview of the UK electricity market functioning; second, a description of the options for industrial supply including their approximately costs, for close in a third part with the comparison between them, the proposal for the better choice and a guide for the initial considerations of selecting that option.

2. GREAT BRITAIN'S ELECTRICITY MARKET

2.1 Regulation and structure of Energy Market

Government responsibilities lay down on the reaching of UK energy policy goals[1]. This is made through a set of regulations they establish, which main pieces are The Electricity Act 1989, the Gas Act 1986 and the Utilities Act 2000. On them, some of the Government functions are specified, such as: consents for power stations, defining the extent of the regulated industry by deciding on exemptions from the requirement of licenses, appointing the members of the Gas and Electricity Markets Authority, and having the power to veto any proposal by the Regulator to modify licenses. Government is also in charge of social and environmental policy in relation to Energy, and in themes related to EU liberalization and imports of oil and gas. [6]

[1] UK energy policy goals are the following ones: to put ourselves on a path to cutting the UK's carbon dioxide emissions - the main contributor to global warming- by some 60% by about 2050, with real progress by 2020; to maintain the reliability of energy supplies; to promote competitive markets in the UK and beyond, helping to raise the rate of sustainable economic growth and to improve our productivity; and to ensure that every home is adequately and affordably heated.

In the Utilities Act 2000 was established the independent economic regulator of Great Britain's electricity market, the Office of Gas and Electricity Markets (OFGEM), which main responsibilities are ensuring competition, enforcing regulations and achieving a sustainable development; these are a key contribution to achieve the energy goals. As an independent office, Ofgem ensures the freedom of regulatory process from political interference and avoids markets uncertainty, protecting in that way the interests of consumers. The key functions of the regulator are related to the managing of licenses: the issuing, modifying, enforcing and revoking; and also the setting of price controls.

The participants of the market are involved in five activities that are: generation, supply, distribution, transmission and operation of interconnectors, and Fig. 1 shows the relation between them. New businesses are required to have a license from Ofgem to participate in any sector. Nowadays, Generation and Supply are fully competitive; Distribution and Transmission are monopoly networks and Interconnectors are in process of obtaining license. The operator of the national transmission system is National Grid which is regulated by Ofgem through license conditions that oblige it to secure the system balance.

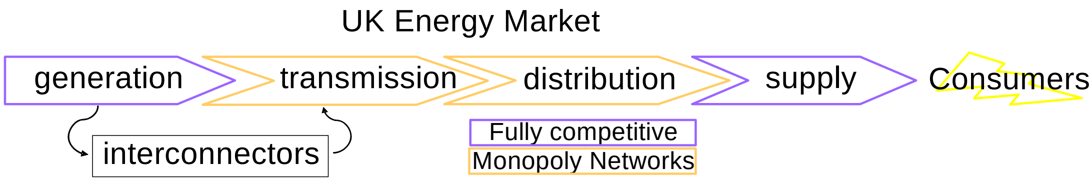

Figure 1. Participants of the market.

The trading of electricity is made under BETTA, The British Electricity Trading and Transmission Arrangements, that came into operation in April 2005 and cover Great Britain electricity grid. Bilateral contracts are the way in which electricity is traded between generators, electricity suppliers and customers, through a series of markets that operates on a rolling half hourly basis.

There have been several changes of importance in the market, as that is not allowed to the same person to own a distribution and supply business; these reforms look for a better functioning and more quality in the service, also guarantee the competition in supply. Currently, there are over 18 energy companies in charge on UK supply. Furthermore, some companies have participated in the improving of vertical integration, which has contributed to market consolidation [24].

2.2 Installed capacity and generation mix

The currently installed capacity of UK has approximately 76 GW for meet an annual consumption of about 350 TWh and a winter peak demand of 63 GW, 20% of capacity more than the expected level of peak demand. This mainly due to the period known as the 'dash for gas' in the second half of 1990s when a lot of gas fired power stations were built and continuing until mid-2000s, increasing the installed capacity. The overcapacity for generation and the competition allowed lower electricity prices for consumers beyond that period.

By the other hand, taking the gas fired power stations lifetime as approximately 30 years, it will be necessary increase investments in new generation capacity in the next two decades in order to cover around 30-35 GW to meet the rising electricity demand and replace some power stations retirements. The investments will act as a way to ensure the electricity supply for the following decades. Another strategy to secure the supply and to avoid strong dependency on a single fuel or technology type is the diverse electricity generation mix.

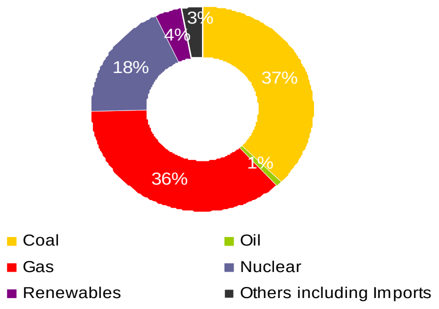

Figure 2. UK Electricity Generation Mix 2006.

As showed in Fig. 2, in 2006, 36% of electricity was generated by gas-fired power stations, 37% from coal, 18% from nuclear, and 4% from renewables. The resting comes from other sources such as oil-fired power stations and electricity imports from the continent. Mix generation also gives flexibility to the system, allowing it to adapt to the variations in demand depending on times of the day or year.

2.3 Electricity prices

In spite of the benefits from the dash of gas period in electricity prices, in last years these have been suffering increases. In the manufacturing sector the variation depends of the size of user, affecting more to larger users, and it is consequence of: the timing of the introduction of competition and previous pricing arrangements; length of contracts; and the relative to size impact of crude prices on fuel oil prices. The charts below (Fig. 3 and 4) show such electricity behavior.

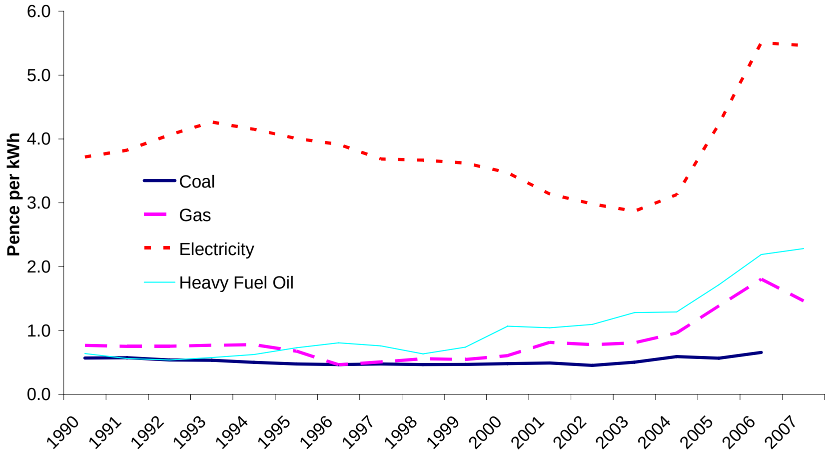

Figure 3. Fuel prices for Manufacturing Industry, in cash terms, 1990 – 2007.

Chart 3 is the annual progression of fuel prices since 1990, where after a period of falling between 1993 and 2003, the electricity price increase considerably in last four years. Chart 4 is like a zoom of chart 3 and give a more detailed view of this variations in the consumers regarding its size, it covers the period from 2004 – 2007 by quarters.

For the last quarter of 2007, the prices were 6.84 and 7.09 pence per kWh, excluding and including the Climate Change Levy, respectively. This environmental tax, which increases the prices in 2-4% approximately, was established in April 2001 as one of the measures for reducing greenhouse gas emissions, through encouraging business to reduce their energy demand.

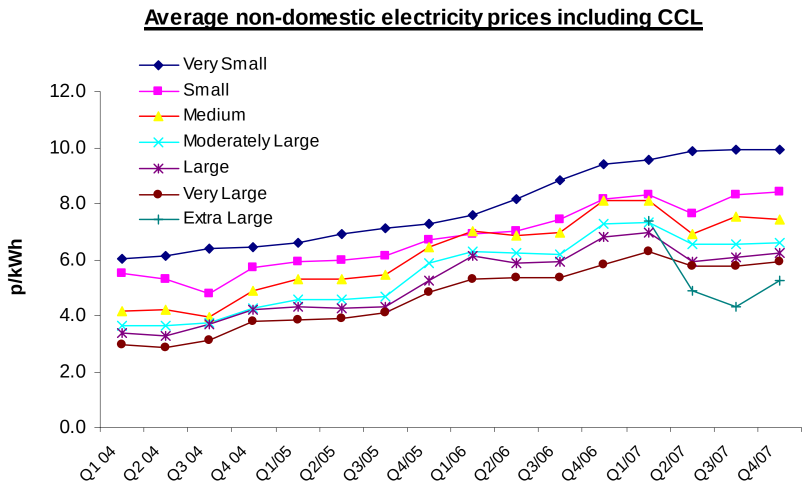

Figure 4. Quarterly average electricity prices 2004 – 2007.

2.4 Opportunity for Renewables

Other of the measures from the government to reduce greenhouse emissions was the introduction of the Renewables Obligation (RO) in April 2002, which covers England and Wales. This measure intends to support the use of renewable sources in the electricity generation, requiring to electricity suppliers to obtain part of their electricity from renewable sources. The target for 2010/11 is set at 10.4%, increasing to 15.4% for 2015/16; the options for electricity supply companies to meet their obligation are: present the Renewables Obligation Certificates (ROCs); to pay a buy-out fund contribution equals to £35.76 MWh in 2008/09, that increases each year as the Retail Prices Index; or a combination of these two options.

The RO is in place until 2027, with this long term goal the investors and developers can see the commitment of government for support the transition to renewables into the mainstream of the UK's competitive electricity market. The main advantage of this market, created by the RO, is that this kind of trading replace or makes unnecessary a Government subsidy, because the cost is passed on to the consumer rather than the taxpayer (Swider et al., 2008). To encourage the incentive generated by the RO, it has been proposed a banded RO formed by five bands (Table 1), where generators receive a ROC, more or less for each 1MWh, depending on the technology from which they generate. This measure, by the other hand, will mainly promote the commercially advanced renewables technologies, such as wind, biomass and methane recovery, due to the lower risk that they represent to investors.

Table 1. Bands of the Renewables Obligation [4].

Band	Technologies	Level of support ROC's/MWh
Established 1	Landfill gas	0.25
Established 2	Sewage gas, co-firing on non-energy crop (regular) biomass	0.5
Reference	Onshore wind; hydro-electric; co-firing of energy crops; EfW with combined heat and power; other not specified	1.0
Post-demonstration	Offshore wind; dedicated regular biomass	1.5
Emerging technologies	Wave; tidal stream; fuels created using an advanced conversion technologies (anaerobic digestion; gasification and pyrolysis); dedicated biomass burning energy crops (with or without CHP); dedicated regular biomass with CHP; solar photovoltaic; geothermal, tidal Impoundment (e.g. tidal lagoons and tidal barrages (<1GW)); Microgeneration	2.0

3. OPTIONS OF INDUSTRIALS FOR ELECTRICITY SUPPLY

After this overview of the UK's electricity market it is possible to point the options for industrials to supply their electricity needs. They have three main options: buy from market suppliers, self-generate from renewables or be agents of market by going directly to the wholesale market. The options are described in the following sections, with the advantages and barriers that each choice presents. For the section of self-generation is also included a part for generation costs, using wind energy as renewable source.

3.1 Buy from market suppliers

The liberalization in UK electricity market has not had the expected effect in the prices, which instead of decrease, have been increasing in last years, with a little recovery of 7.8% for last quarter of 2007, as analyzed in section 2.3. However, the market offer has diversified from six dominant companies to around eighteen electricity suppliers nowadays. Then, the benefits of competitiveness are more related to service quality than cheaper prices, although they can be forced by the possibility of consumers to change of supplier if they found a better option. This capability is just stopped depending on the type of contract signed, as all companies count with a variety of contracts and tariffs with the propose of adjust to consumers needs and resources.

Buying from market suppliers, industrials have to consider also the costs of Climate Change Levy, because of greenhouse emissions of fossil fuel electricity production, which is the main type of generation of supply companies. Nevertheless, the companies are taken measures on this topic by offering, inside their variety of tariffs, a green tariff. This one vary from company to company, specially in the percentage of electricity supply from renewable generation, but the important thing here is that this tariff permits consumers to make a balance in the tax costs taken advantage from Climate Change Levy exemption for energy produced from combined heat power plants and renewable sources. Green tariffs are a little more expensive that standard ones, but it is a good deal, considering the advantages.

Table 2. Advantages and Disadvantages of buy electricity from market suppliers.

Advantages	**Disadvantages**
Quality in the service – reliability	Possible interruptions in the service when change
Option for renewables with CCL exemption for an extra cost	CCL charges
Reduction in costs by changing supplier	Unfixed supplier for change it – process requirements

3.2 Self-generate from renewables

There are several renewable energy sources that can be and had been developed in the UK, as showed in the Annex A, they are Biomass, Geothermal, Hydro, Solar photovoltaics (PV), Solar thermal, Tidal, Wave and Wind. Nevertheless, the major part of them presents a variety of barriers that diminish their feasibility, i.e. technological cost, the permits, costs of grid connections, the access to the sites, etc. The scope to construct new hydroelectric plants in the UK is very limited owing to: the majority of viable sites having already been exploited; and the construction of dams for the impoundment of large water resources being no longer acceptable for environmental reasons. PV technology is advancing considerably. It is still, however, relatively expensive compared to other generation technologies. It is unlikely to be a significant contributor to the UK energy balance within the study horizon owing to: the immaturity of the technology; and the relatively low extent of solar irradiation present in the UK. (Royal Academy of Engineering, 2004)

The UK in particular benefits from the best wind resource in Europe; an indigenous and free fuel supply which is not dependent on imports (BWEA, 2006). Onshore wind power is already one of the cheapest forms of renewable energy per kWh, with the potential for even further cost reductions as the technology develops. Due to its low cost, current predictions are that electricity supply companies will meet most of their Renewables Obligation to 2010 from wind power; and it is also a good opportunity for industrials to generate their own electricity taking advantage of this good panorama.

3.2.1 Generation costs analysis

In order to give the costs related to self-generation from renewables, it will be analyzed the case of onshore wind energy, which fits on the purpose of this paper being the most economically and technically advanced of all renewables, able to compete in cost with other conventional generation and deliver on a large scale. Generation from onshore wind plants is a well established renewable energy industry, it offers important benefits through the reduction of carbon dioxide emissions, meeting renewable energy targets, securing electricity supply and delivering investment to UK public limited companies.

The main advantage of using renewables is that the fuel is free and almost unlimited; in the case of UK there is more than enough wind energy resource to meet the target of 10% of electricity from renewables for 2010. This is supported by a variety of studies that commonly conclude that UK counts with a top-level 'theoretical' resource which is reduced by including various constraints such as conservation areas, urban conurbations, low wind speed areas and unsuitable terrain, just for mention some of them. This leads to the so-called 'technical' resource which is then further constrained by consideration of planning, environmental and social issues leading to an estimation of the 'practical' resource [12]. The table 3 gives the prediction from the Department of Trade and Industry, on the theoretical and practical onshore resource available in the UK. Only about 34,000 GWh is needed to reach the 10% target for 2010 from all renewables, so fuel is not a major problem to achieve that.

Table 3. Estimate of UK onshore wind energy resources.

Theoretical (GWh)	**Practical (GWh)**
1,000,000	50,000

Ernst and Young Estimation: DTI [13]

The levelised costs per MWh estimated by *Ernst and Young* for DTI are given in the tables below. These have been calculated by considering the underlying project assumptions including the predicted capital, operating and fuel costs, other non-electricity income, the operational life of the assets and the cost of capital. A high, medium and low levelised cost was estimated to reflect the current range of project costs that developers are generally experiencing.

Levelised costs reflect the amount of electricity revenue per MWh, net of PPA (Power Purchase Agreement) discounts, which is needed throughout the life of the technology to make the respective technology commercially viable. The study was made for different renewable technologies. For technologies utilizing a variable natural resource an assumption has been made related to the relevant capacity factor for that resource. Wind results were taken for this paper, which is a variable resource, and then some assumptions were taken, i.e. large wind farms will account for 95% of potential total onshore wind energy generation per annum, high and low capacity factor of 31% and 26 %, and high and low wind speeds of 7.5m/s and 6.5m/s, respectively.

Costs per MWh were also estimated for 2010, 2015 and 2020. These future costs were based on the costs in 2006 and then escalated or deflated based on major drivers such as the estimated future capacity. It should be noted that the expected capacities are based on the technologies receiving enough income to enable market entry and not the maximum capacity that is physically possible if technologies received infinite revenue support.

Onshore wind farm costs

Large wind farm >10MW installed capacity

Capital cost breakdown	
Planning	3%
Infrastructure - grid	14%
Infrastructure - other	17%
Plant	66%

Capital and operating life - **Levelised Costs**

High wind (31% capacity factor)

£/MWh	2006	2010	2015	2020
High	73	76	73	71
Medium	62	65	62	61
Low	52	54	52	50

Operating costs

Low and high wind

£/MW/yr	2006	2010	2015	2020
High	44 - 54	41 - 51	39 - 48	37 - 45
Medium	41	39	36	34
Low	38	36	34	32

Low wind (26% capacity factor)

£/MWh	2006	2010	2015	2020
High	83	87	83	81
Medium	74	77	74	72
Low	62	65	62	60

The Cost of Generating Electricity Report: Royal Academic of Engineering [15]

The *Royal Academic of Engineering* in their Report "The Cost of Generating Electricity", carried on 2006, estimates a cost of onshore wind farm generation of 5.35p/kWh, giving a forecast of a reduction to 4.78p/kWh in 10-15 years. The table 4 and the graph below (Fig. 5) show the different cost components of generating electricity.

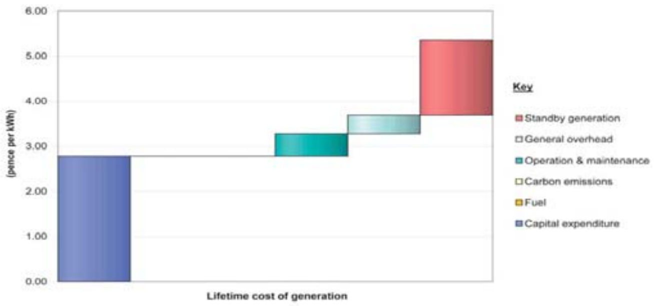

Figure 5. Components of electricity generation.

Table 4. Costs of onshore wind farm generation.

Cost Elements	2006	2020
Capital expenditure	2.78	2.36
Fuel	0.00	0.00
Carbon emissions	0.00	0.00
Operation & maintenance	0.49	0.42
General overhead	0.41	0.41
Standby generation	1.67	1.58
Total Cost (pence/kWh)	**5.35**	**4.78**

The cost of generating electricity is expressed in terms of a unit cost (pence per kWh) delivered at the boundary of the power station site. This cost value, therefore, includes the capital cost of the generating plant and equipment; the cost of fuel burned (if applicable); and the cost of operating and maintaining the plant in keeping with UK best practices. Within the study, however, the 'cost of generating electricity' is deemed to refer to that of providing a dependable or 'firm' supply. For intermittent sources of generation, such as wind, an additional amount has been included for the provision of adequate standby generation.

In a mature electricity system, with surplus generation capacity like that found in the UK, the cheapest way to provide standby generating capacity will likely be from existing thermal and hydro plants with sunk costs. Given the new entrant cost context of this study, however, it is more appropriate to employ a proxy for standby generation based on the costs of an open-cycle gas turbine (OCGT): the cheapest new plant option. The cost of standby generation capacity has been calculated on the basis of the annuitized investment cost and costs of operating and maintaining a suitable OCGT in the UK.

The generation costs for 2006, and also the estimations for the next 15-20 years, obtained from the *Ernst and Young* study and The *Royal Academic of Engineering* report presents a little difference, mainly due to the elements they used for the calculations. However those approximated costs are enough to know how much would cost to generate electricity from the onshore wind farms, that is around 6p/kWh. This compared with the majority of fossil fuel based generators is a competitive price because is near the cost of non-renewable based generation plus the cost of carbon emissions[2].

3.3 Be agent of the market

The third option corresponds to the trading of electricity by going directly to the market; it means avoiding the supplier companies and buying from generators. The trading, made under BETTA, is based mainly on bilateral contracts between generators, electricity suppliers and customers, through a series of markets that operates on a rolling half hourly basis. To secure the continuity of the service the system operator, National Grid, operates a balancing mechanism. The unbalance can be created by

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[2] See the comparison in Annex 2.

generators, being unable to provide the electricity contracted or providing in excess; or by suppliers and customers, demanding more or less than what they had arranged. The importance of the system balance lay down in their impact in the volatility of the prices and in the penalties that can be imposed for that reason [12].

The main advantage of bilateral contracts is that the price and conditions are negotiated by the parties, and then both participants agreed in what they signed. By the other hand, as the prices considered are based in the spot market, it becomes a disadvantage, when the market prices are lower than the ones used for the agreement. The graph below shows an example of the behavior of wholesale electricity prices in this market, where it is clear the increasing tendency (Fig. 6).

The key fact for be an agent of market lay down in the measuring and forecasting, in electricity demand as in prices prediction. It is necessary consider the reliability of the forecast that the company is capable of make about the electricity demand, in order to avoid the penalties for disturb the system balance; and it is also important that the company count with confident tools that approximate the real future cost, with the purpose of get always good deals.

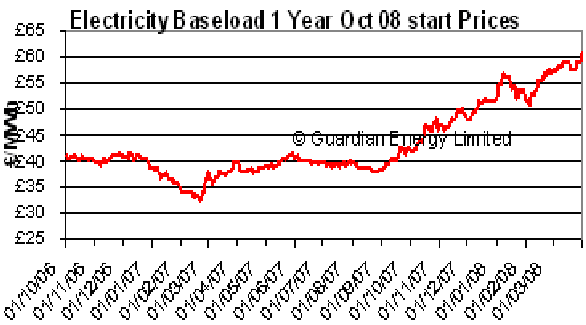

Figure 6. Electricity Market Price 2006 – 08.

4. COMPARATIVE ANALYSIS OF THE OPTIONS

The principal aspect to consider for take the better decision is related to cost, the price that suppliers offer, the generation costs that come from self-generation, and the price agreed on bilateral contracts. But in each option are also included secondary costs that increase the prices, for example, the CCL tax for the first option, the maintenance costs for the second alternative and higher prices contracted than ones of the market.

In the addition of supplier prices with CCL taxes, the result was 7.09 pence per kWh for the last quarter of 2007. For generation cost, in 2006 they were between 5.8 and 6.4 pence per kWh, this without considering the maintenance costs of around 4.1 pence/kW/yr. In the case of the third option, for around the same dates, at the end of 2007, the prices were approximately 4.5 pence per kWh, but with an important increase for the next year, reaching the 6 pence per kWh; and these costs are just an idea of the prices agreed in the contracts.

With this data comparison, it seems that in costs, be agent of market is the better option, however it implies a lot of risks because the inaccuracy of the price forecasts. With this, the selection must be then self-generation, taking out the costs of maintenance and the main investment for the installation, because, as in any project, they will be recovered in a determined period of time. The first option, buying from supply companies, is being discarded because of their predicted increasing due to the fuel reserve declining, as is based on fossil fuels, but this option can not be ignored at all. It is still a good alternative, because of the option of change suppliers and the green tariffs that diminish the impact of fossil fuels in the prices.

Now the decision can be reduced to two options, based in the importance of the fuel used. The table below shows a comparison between non-renewable and renewable fuels in the electricity generation. As can be seen, the use of fossil fuels even it is cheaper, it requires a pay of CO_2 emissions that makes the cost of generation from renewables and non renewables very similar. That is in short term, then at long term appears a disadvantage of non-renewables, as their name says, they are limited, and this will cause and increase on the generation costs as the time passes, contrary to renewables which are expected that the prices of the technology decrease and consequently their generation costs.

Table 5. Renewable vs. Non-Renewable fuels in electricity generation.

Renewable	**Non-Renewable**
Free of CO2 emissions	CO2 emissions - environmental impact (smog, acid rain)
Trading of ROCs	Costs of emission's permission
Free fuel	Cheap fuel
Decreasing in technology prices… because of their improvement	Increasing of prices… because of limited source
Small scale of the plants (PV, wind farms, except hydro)	Big scale of the plants (coal, gas and oil fired)
Climate change levy exemption for Renewables – reduction of taxes	Climate change levy

4.1 Proposal

As shown in the comparative analysis section, generation from renewables offers a very good option for industrials, mainly for those who look for less variable energy prices by doing an intelligent investment, which brings a lot of benefits. For the same reasons gave in the sections 2.2 and 2.2.1 for show the generation costs of wind farms, that ones of the very good wind resource in UK, the low cost and high advance in the technology in comparison with other renewables, and the competitive costs with conventional ways of generation, in this paper is proposed the use of wind turbines as the better technology for self-generation development.

The support scheme established by the government, the RO, offer an interesting incentive to generators who reach their targets, by receiving part of the buy out fund collected from the generators and suppliers who did not reach them. Although some studies point that this scheme has not have the expected impact in the development of renewables, it is qualified as with potential to give better support (Butler & Neuhoff, 2008), and the introduction of the banded RO is proof of that. Wind technology will be one of the mainly promote due to it is a commercially advanced technology and represent low risk to investors than other technologies.

The good wind resource which benefits UK give a big opportunity to industrials in the developing of wind farms. The BWEA has in their web page a database with the average wind speeds in UK, it is an easy and free tool that allows industrial to know if their own sites or the sites they are trying to obtain are good for wind development, giving them certainty in their inversion and also an advantage for the planning project, by considering the official values and then having more opportunities to get the planning permission from the authorities. In this way, it is possible reach the independence, or at least, less dependence of fossil fuels and their continuous increasing prices that affect the costs of industry production.

Wind farms follow three main stages for their development, they are: assessment, planning consent and implementation[3]. Despite the incentives and advantages before mentioned, they are some barriers presented on this process. One of the most important has been identified by Butler and Neuhoff, (2008), as the planning permission, getting the permission could mean considerably delays in the project, nevertheless as confirmed by BWEA data, the rate of refused planning permissions has been declining. Grid connection and extension costs are also significant delayers in the renewables development, but as concluded by Swider et al (2007) for reduce the barriers in the electricity generation from renewables, grid connection costs should be covered by the respective grid operator. Changes in energy policy are required to get out these barriers, and with the concern of the government and companies about renewables, they will not take much time.

Once the wind farm is installed and working, and in case of low generation according to demand or excess in the generation, the option is going to the market to balancing itself or sell the surplus. Wind generation is variable but also predictable, giving the option of being prepared to changes in generation and avoid shortcuts in the industry production. Furthermore with the option of going to the market is avoided the necessity of have backup which commonly will be based on some fossil fuel requiring large scale installations that had been concluded is less cost competitive.

4.2 The process of wind farm development

This section gives a brief description of the process for the development of a wind farm, with the purpose of give a clear idea to industrials of the requirements of taking this option as their choice. The process is formed by three main stages that are: Assessment, Planning Consent and Implementation, which have several activities suggested for a well carry on of the stage (Fig. 7).

Assessment stage includes site selection, feasibility study and detailed assessment. The site selection is the evaluation of the potential of the available sites for wind farm development, considering technical,

3 Briefly described in section 3.2.

commercial and environmental constraints. Next step is carried out a feasibility study, which includes an economically assessment, on site measurements and assessments on planning constraints. The detailed assessment could require an Environmental Impact Assessment (EIA) if the project is over 50 MW, which will analyze concerns about landscape, noise and wild life effects. In this last part of the stage they are also consultation in the community and the exact design of the farm with the economic assessment.

For the Planning Consent stage is necessary to classify the projects, under and above of 50MW, because who take the decision depends on the impact the project would have. The developers of projects that are under the 50MW ask for the permission to the Local Planning Authority (LPA), while the rest require a National Consent from the Department of Trade and Industry according with the Electricity Act 1989 and based on the Planning Policy Statement 22 (PPS22), which covers national policies for installing wind farms. If the permission is negated the developer must reconsider the proposal and can make an appeal. If the project is approved, then they can continue with the next stage.

The last stage is the Implementation, where the wind farm is constructed and switching on, process that usually takes between 6-12 months, depending of the size of the project. In this step are considered the activities of maintenance to ensure their good performance and the repowering or decommissioning at the end of the working lives (around 20 years).

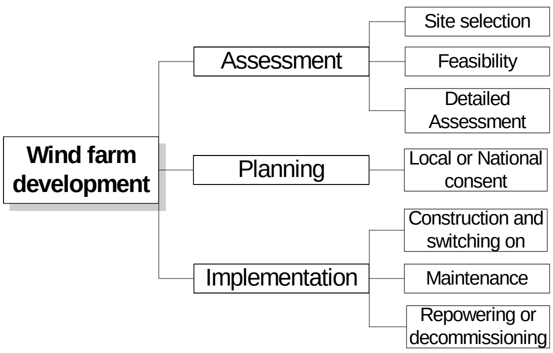

Figure 7. Stages of a wind farm development.

4.2.1 Study Case

In the following paragraphs is shown an example of how carry the assessment stage of the wind farm development, with the intention of clarify the facts that must be considered before apply for the planning permission.

Site selection

The Department of Trade and Industry wind speed database contains estimates of the annual mean wind speed throughout the UK. This may give an indication of average wind speed in different parts of the country. The data is the result of an air flow model that estimates the effect of topography on wind speed. The model was applied with 1km square resolution and takes no account of topography on a small scale or local surface roughness (such as tall crops, stone walls, or trees), both of which may have a considerable effect on the wind speed. Each value stored in the database is the estimated average for a 1km square at 10 m, 25 m or 45 m above ground level (agl). The database uses the Ordnance Survey grid system for Great Britain and the Northern Irish Ordnance Survey grid system for Northern Ireland.

If the industrial own or is considering several sites for purchase, then the database will give him a good idea of which could be the best place to install a wind farm. Wind speeds above 7.5m/s are very good and speeds equal or above 6.5 m/s are considered good enough for wind generation. Then the sites with speeds that are above this quantities must be seriously considered, the sites with speeds under 6.5 m/s but near it, can also be considered, because the wind speed increases at higher altitudes and the data is until 45 m while some turbines are in masts of 100 m. For this case will be taken the Site A which counts with an average wind speed of 8 m/s at 25 m agl.

Site A is located in an open place, with herb fields and some dispersed rows of trees, with rolling hills, gentle transversal and longitudinal slopes, there are higher mountains 10 km away. Then there are not important wind speed disturbances. There is housing within 500 m but there are areas of the site where housing is more than 500 m away, there are no airports or military bases near the site and there is a communication tower 50 m far from the site. This facts joined to the boundaries of the property owned will mean a limited number of turbines in the project design.

Feasibility study

One of the issues that must be studied is the environmental impact of the wind farm. The Joint Nature Conservation Committee (JNCC) has in their web site a list of the Protected Sites in UK [26], known as special areas of conservation (SAC). The database is useful for identify nearby protected areas that may be a barrier for turbine installation due to the impact in the wild life in those areas. By the other hand, the wind data obtained in the first approach can only be used as a guide and should be followed by on-site measurements for a proper assessment.

There are three SACs near the Site A, a National Park and a place of cultural heritage. These facts could represent important arguments for the project rejection, due to environmental impact. However it could still be in consideration.

Detailed assessment

Once identified the viability of the project, is necessary complete a detailed assessment and the documentation of the project, including the Environmental Impact Assessment, if required, and the exact design of the location of the turbines. It is important also make a community consultation to avoid complains about the wind farm installation.

For the project on Site A is not required an EIA, but is it suggested as there are areas of special interest nearby. The site is far from populated areas, community complaints are less probable, nevertheless the consultation must be carried on to use it as support for the planning consent joined to the design of the wind farm, it means the number and location of turbines, that in this case could be 2 or 3 turbines of around 2MW each one located strategically as far as possible of constraints, and the respective economic study.

Planning consent and Implementation stages

The next two stages depend on the approval or rejection of the project. The project for the Site A is around 10MW, under the 50MW, and then the planning permission has to be required to the Local Planning Authority (LPA). Once approved, it is possible proceed with the implementation.

With the characteristics of the Site A, it seems that it will be a very good option, it has good wind resource and is an open place, the area is small but for a demand of about 10MW with 2 or 3 turbines is more than enough; environmental impact could be the only barrier of importance.

5. CONCLUSIONS

Considering the situation of industrials and their concerns in the reduction and a stable behavior of their energy costs, which is the reason why they are looking for the better option of electricity supply, this paper has presented an analysis of the alternatives that the market offers, concluding that self generation is a cost competitive choice, in comparison with market prices, that satisfy the desired characteristics of a supply way. The main reasons for the fluctuation in prices is the dependence on fossil fuels and then the self generation can not be based on them, in their place are the renewables sources, being the wind the one that match with the necessities of industrials. The advanced of wind technology, the low generation costs over other renewables and the competitive generation costs in comparison with conventional ways of generation, are the arguments that allow conclude that the opportunity for an improved industrials supply is the self-generation from wind farms.

The current support in the development of renewables is giving the signals for taking it in consideration. The banding of the Renewables Obligation encourages the trading market of ROCs which also incentivize generators and suppliers to meet their targets including awards if they exceed their generation and also penalties if the opposite happens. The possibility of export the excess of electricity back to the grid means faster recovery of the investment but also revenues when the investment is totally recouped. Furthermore, as showed in the study case, a small wind farm of around 10 MW is more viable that a big one and depending on the demand of each business it could be enough, giving also the advantage of a plant at small scale. With all these factors that diminish the risks in the investment, and with the capability of make use of a mixture of the options for any unbalance, the decision is clearer and industrials should opt for invest in generate their own electricity.

REFERENCES

[1] THE RENEWABLES OBLIGATION ORDER 2002. Electricity, England and Wales

[2] RENEWABLES OBLIGATION ORDER 2007: Consultation Responses

[3] REFORM OF THE RENEWABLES OBLIGATION May 2007

[4] RENEWABLES OBLIGATION CONSULTATION – Government Response. January 2008.

[5] ENERGY ACT 2004

[6] ENERGY WHITE PAPER 2007: Meeting the energy challenge.

[7] ENERGY WHITE PAPER 2003: Our energy future - Creating a low carbon economy.

[8] The Electricity (Guarantees of Origin of Electricity Produced from Renewable Energy Sources) Regulations 2003

[9] DIRECTIVE 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market.

[10] ENERGY MARKETS OUTLOOK. Chapter 9 – Renewable and Low Carbon Energy. October 2007

[11] Department for Business Enterprise and Regulatory Reform. http://www.berr.gov.uk

[12] Wind Power in the UK. A guide to the key issues surrounding onshore wind power development in the UK. Sustainable development commission. May 2005

[13] Impact of banding the Renewables Obligation – Cost of electricity production. April 2007. DTI. Ernst and Young's report.

[14] Onshore Wind: Powering Ahead. A Report Prepared by BWEA. March 2006

[15] The Cost of Generating Electricity. A study carried out by PB Power for Royal Academy of Engineering. March 2004

[16] Renewable Electricity Generation. Renewables Advisory Board. 2006

[17] Barriers to Commissioning Renewable Energy Projects Report. Renewables Advisory Board and DTI. November 2005

[18] Ilie, Livia; Horobet, Alexandra; Popescu, Corina. Liberalization and regulation in the EU energy market. Munich Personal RePEc Archive (MPRA) Paper No. 6419, posted 21 December 2007. http://mpra.ub.uni-muenchen.de/6419/1/ MPRA_paper_6419.pdf

[19] SWIDER, Derk J.; BEURSKENS, Luuk; DAVIDSON, Sarah; TWIDELL, John; PYRKO, Jurek; PRÜGGLER, Wolfgang; AUER, Hans; VERTIN, Katarina; SKEMA, Romualdas, 2008. Conditions and costs for renewables electricity grid connection: Examples in Europe. *Renewable Energy*, 33, 1832-1842.

[20] Butler, Lucy and Neuhoff Karsten. Comparison of feed-in tariff, quota and auction mechanisms to support wind power development. Faculty of Economics, Cambridge University, Cambridge CB3 9DE, UK. Renewable energy 33 (2008). Pages 1854 – 1867. Elsevier

[21] WARD, Graham, 2003. British energy policy and markets. *First*, Winter 2003.

[22] ALDER, Martin, 2001. Renewable energy and liberalized electricity markets. Renewable Energy 24 (2001). Pages 409-413. Elsevier.

[23] Quarterly energy prices March 2008. BERR. National statistics publication

[24] Department for Business Enterprise and Regulatory Reform. http://www.berr.gov.uk/

[25] Wind speed Database. BWEA. http://www.bwea.com/noabl/index.html

[26] Joint Nature Conservation Committee (JNCC). http://www.jncc.gov.uk/

[27] Quarterly Review of European Electricity and Gas Prices. DG Energy and Transport. January 2005.

[28] Online ROC Auction Service. Non-Fossil Purchasing Agency Limited. http://www.e-roc.co.uk/trackrecord.htm

[29] British Wind Energy Association BWEA. http://www.bwea.com/

ANNEX

Annex 1	Table 6: Renewable Energy Sources in the UK [12]
Biomass	Any fuel derived from organic matter, such as wood, oil crops, and agricultural & animal residues. Biomass can also be termed as biofuel, biodiesel, and biogas, and can be used for heat production, electricity generation and fuelling vehicles using a wide variety of conversion technologies. Biomass is renewable only when dedicated crops or forests are used or where replanting occurs. The carbon absorbed during growth will be equal to the emissions during combustion.
Geothermal	Traditionally, geothermal refers to thermal energy from the Earth's core. Heat and electricity can be generated by circulating water deep underground, where it is heated naturally by hot rocks. As an electricity generating option it is geographically specific, with good resources in parts of the US, and in Kenya and the Philippines. The term is increasingly used to cover near-ground energy stores, which can be exploited for low-level heat using a ground source heat pump. This latter option has good potential in the UK, although it does require an electrical input which (with the current electricity mix) will be only partially renewable.
Hydro	Makes use of the energy from moving water, usually by channelling water at high pressure from the top to the bottom of a dam or by making use of river flows to drive an electricity generator. The energy is obtained from the sun, which evaporates water from the sea and deposits it over land, giving it potential energy in the form of height. Although large-scale hydro using dams is still being developed around the world, UK developments will focus on small-scale, 'run of river' projects due to their lower environmental impact and smaller spatial requirement.
Solar photovoltaics (PV)	Solar PV uses high-tech solar cells (usually made from silicon) to produce electricity directly from sunlight. Although currently quite expensive, solar PV costs have fallen dramatically over time and further falls and technological improvements should be possible. Direct sunlight is not necessary and the cells can produce electricity even during cloudy conditions (at a reduced rate). Future applications for solar PV in the UK are likely to centre on building integrated solutions, such as cladding and roofing.
Solar thermal	Solar panels can be fitted to absorb heat from the Sun. This is usually used to heat water, primarily for domestic purposes, although industrial and commercial applications also exist. Solar thermal is exploited extensively in countries such as Cyprus and China, but so far has had limited penetration in the UK. It is now being given more encouragement. A solar thermal collector can provide around 60% of a household's hot water requirement over the year in UK conditions.
Tidal	Despite very large resources, tidal energy has not been successfully exploited on a wide scale. Tidal produced electricity is generated by making use of tidal water flows. It can be done by constructing a tidal barrage in an estuary and operating this like a conventional hydro dam – however, the environmental impacts are often prohibitive. Alternatively, turbines can be placed underwater in the tidal stream – these produce power from both in and out flows. Other variations are also possible. Tidal power is gaining increased interest in the UK, with a number of projects at demonstration and testing stage.
Wave	Waves transmit large volumes of energy from windy conditions far out to sea to the shore. Here the energy can be used to generate electricity and a variety of technologies are being developed to do this. The potential of wave energy in the UK is large due to our extensive coastline.
Wind	The subject of this report, wind energy is widely dispersed, although is greatest in high latitude locations. Wind has been used for centuries in windmills of various forms for grinding grain or pumping water. Modern wind turbines are available for both large and small scale electricity generation, and huge technological advances have been seen over the past 20 years.

Annex 2

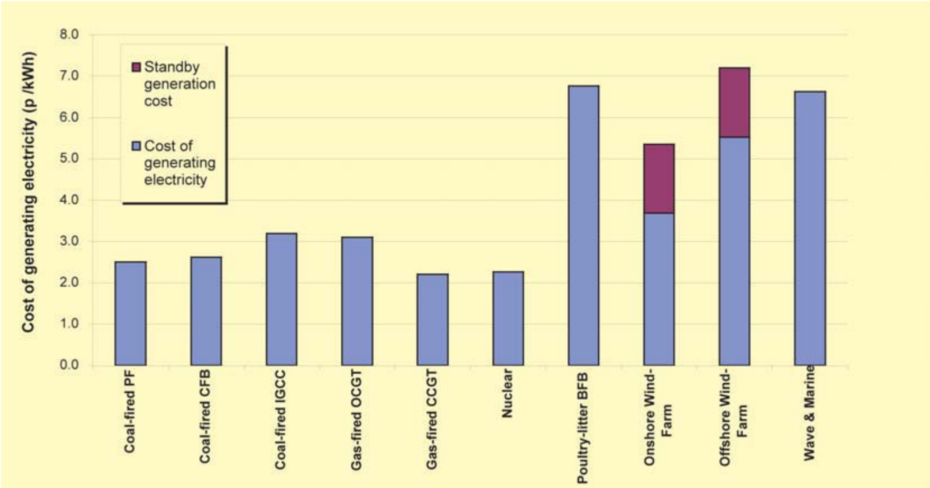

Figure 8. Cost of generating electricity (pence per kWh) with no cost of CO2 emissions included.

The standby generation costs considered for this estimation, increases the quantity in more than a unit cost. Nevertheless, as shown in the next graph, once the carbon emission costs are also considered for fossil fuel based ways of generation, the costs are very similar.

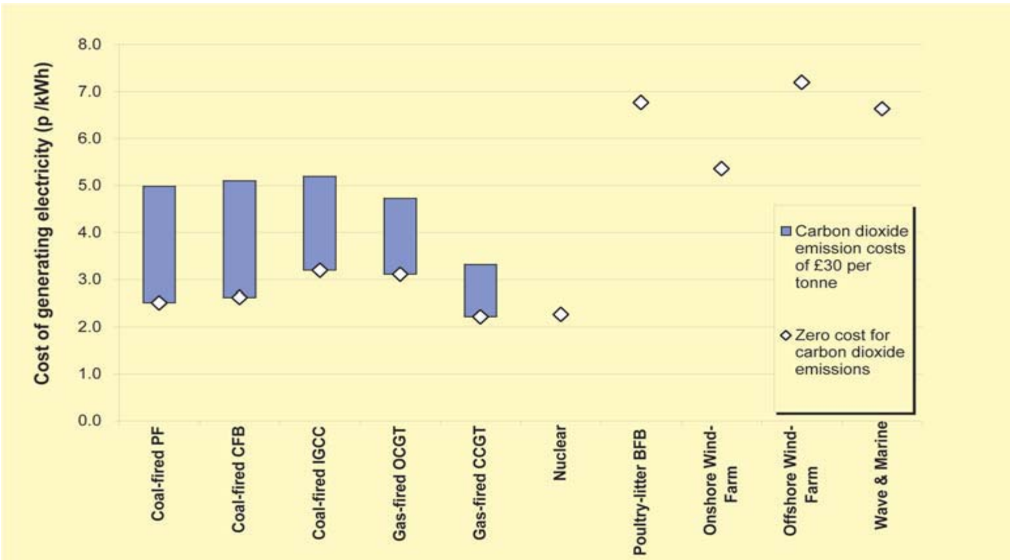

Figure 9. Cost of generating electricity with respect to carbon dioxide emission costs (Zero to £30. per tonne).

It is clear that CO2 costs will only affect those technologies burning fossil-fuels. The lower efficiency of steam plant, combined with the greater level of carbon found in coal compared with natural gas, means that the gap between CCGT plant and other coal-fired technologies will widen as the cost of CO2 increases. The cost of nuclear and other renewables (deemed to be carbon neutral) remain unchanged and, therefore, become more competitive as the specific cost of CO2 emissions increases.