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Past Trends for the UK Energy Scenarios: How close are their predictions to reality?

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Abstract

This study provides an exploration of the future energy trends in the UK by assessing existing energy scenarios studies and their predictions compared with actual data. The criteria for inclusion were to be national in scope, backcasting and comprehensive (covering the electricity sector). The importance of assessing the historic energy system projections could conduct us to improvements in future energy scenarios. The three studies considered relate to the same four factors: growth indicators, fuel prices, new installations and power stations retirement. The scenarios review revealed several common and different themes although all were developed under the same national targets.

Selection and peer-review under responsibility of KES International

Keywords :Energy Scenarios, Electricity Sector, Projections, Renewables

1. Introduction

During the last decade, based on a wider policy framework established by the European Union, aiming to combat climate change, the UK government made several efforts by imposing targets to reduce carbon emissions. Initially, the first major and official target derived from UK's Kyoto Protocol in 1997 that imposed a 12.5% reduction in GHG emissions (compared to 1990 levels) by 2008-2012 for the UK [1]. Additionally, a stricter national commitment of a 20% decline in CO_2 emissions by 2010, was proposed in the same year [2]. The UK succeeded to achieve the Kyoto target by 2000, almost 8 years earlier than the initial target [1]. The European Emissions Trading Scheme adopted by the European Union in 2002 along with other major UK policies described in Table 1 established a strong foundation towards the decarbonisation of the UK energy system. One main UK energy policy, the Renewables Obligation (RO) part of the 'Regulation Structure' was released in 2002 to support the development of major renewable electricity installations in the UK. The RO suggested that this will be attained while imposing the electricity supplier companies to generate a minimum amount of their electricity supply from renewable energy [3]. Additionally, the UK was the first EU member to force upon itself a commitment to accomplish further, ambitious targets, based on the 2008 Climate Change Act [4]. The Act intends to attain a 80% reduction in GHG emissions by 2050, compared to 1990 levels through carbon budgets, introducing emissions caps based on a five year period basis.

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Table 1:The main UK Energy Policies

Main UK Policies & Year of Establishment
Carbon Pricing
European Carbon Trading Scheme, 2002 [5]
CRC Energy Efficiency Scheme, 2007 [6]
Energy Efficiency & Consumption
Climate Change Levy, 2000 [5]
Climate Change Agreements, 2001 [7]
Carbon Trust Standard, 2008 [8]
The Green Deal, 2011 [9]
Energy Companies Obligation, 2011 [9]
Support of Renewables
The Renewables Obligation (RO), 2002 [3]
The Renewables Transport Fuel Obligation (RFTO), 2008 [10]
Renewable Heat Incentive, 2007 [11]
Renewable Energy Feed-In Tariff (FITs), 2010 [12]

Aiming to achieve these ambitious targets, the UK government proposed that the energy system had to be drastically adapted to follow new, decarbonised, future pathways. As such, the predominant fossil fuels have already started being replaced by renewables while more and more efficient technologies are being integrated into the energy market in order to achieve the objectives.

Due to the many planned targets and changes in policy, several research studies have been undertaken in the last two decades. These studies usually presented in the form of scenarios projections, present different views of the future energy system and estimate whether the national goals for energy demand and carbon emissions reductions are going to be achieved or not. The year of 2010 has been an intermediate year in the projection plan for emissions decrease by 2020, 2030 and 2050.

Nonetheless, the period between 2005 and 2010, is regarded as a milestone assessment horizon upon which can be assessed the accuracy of energy projections of various scenarios along with the feasibility of the established UK emissions targets. During these five years, several changes occurred in key factors that scenarios are based on. While, the UK population was increased by approximately 2 million people [13] the GDP decreased by almost 35.1% [14]. Two other major indicators, representing the UK energy system, the primary energy consumption and electricity generation, declined by 8.2% [15] and 4.1% [16] respectively, due to several reasons related to the drop of economic indicators alongside efforts to combat climate change. Additionally, the UK energy production declined by 27% from 2005 [17] whilst the UK import dependency increased by 16.3% consequence of the exhausted oil and gas reserves and the several maintenance issues that are related with fossil fuels drilling. This impacted the decrease of the exported energy from the UK to approximately 9% from 2005 [18]. Renewables started to replace some amounts of fossil fuels in the electricity generation and evidently have increased over these five years by 50%, managing to penetrate to the UK system by almost 25,500 TWh [19]. This increase of alternative energy forms along with the implementation of other technological improvements succeeded to reduce GHG emissions from 2005 to 2010 by 10% [1].

These factors although they are interdependent, they have different degrees of uncertainty related to their possible future development. Scenario modelling is the key of creating images of the future energy sector able to integrate to some extent such ambiguities. Therefore, this paper focuses on an effective approach to compare three selected studies, developed in 2006 by ILEX [20], DTI [21] and Friends of Earth [22] with projections covering the five year period 2005-2010. The aim of the review is to present and further examine these three studies and their proposed scenarios with diversified views in order to compare them with actual data for 2010. The evaluation of their accuracy will be based on a wide range of assumptions used as inputs in the energy models alongside results generated by them.

2. Review of the UK energy scenarios studies

The selection of the studies was based on the common value of being released by authors and institutions coming from academic, governmental and highly respected positions. The three studies produced by ILEX, DTI and FOE were all published in 2006 holding 2005 as the base year. The main focus of them is the electricity system in the UK and not the whole of the energy sector since the power sector is the major contributor in the emissions production [23]. The reports share both commonalities and differences. A major common feature of them is that they presented backcasting and normative scenarios that examine all the prerequisites and strategies and take values and interests into account that could lead to the achievement of specific targets controlled by European and domestic policies such as the 20% reduction in CO_2 emissions by 2010.

2.1. Main features of the studies

Each study was developed based on different assumptions and methods. WWF contracted ILEX consultancy to prepare a report for evaluating the possibility of achieving significant CO_2 emissions reduction in the UK electricity sector for four milestone years (2010, 2016, 2020 and 2025) in the absence of new nuclear capacity. For this purpose, ILEX developed three scenarios: a Business as Usual scenario, and two PowerSwitch scenarios (PS1 and PS2). On the other hand, DTI from which ILEX took some of its data information, in combination with its own database considering only 2010 and 2020, while presenting forecasts for four different cases: two central fuel price scenarios, along with a high and a low fuel price scenario. Under each scenario, strict policies and measures are in place to support the growth of a low carbon energy system. It should also be noted that DTI baseline forecasts include only the current policies and do not consider future regulations. The Digest of UK Energy Statistics (DUKES) is the main source of data for the DTI study, and indicates the foundation for the sectoral classification that is adopted.

Finally, FOE presented a large number of scenarios (six) while projecting for a long term horizon of 2030. This study, apart from assessing the possibility for CO_2 emissions reduction, emphasizes also on maintaining a secure energy supply and market in the UK. Moreover, it does not include a 'business as usual' scenario, as it was judged that there are plenty other published reports which supported this perspective. In each scenario, electricity demand is met and CO_2 emissions are reduced. In the majority of the cases, natural gas consumption faces small initial growth; but eventually decreases in its overall contribution in the UK. The Data used in this report are sourced from, the Digest of UK Energy Statistics DUKES (2005), Environment Agency's Pollution Inventory, British Wind Energy Association, Carbon Trust and other sources (particularly industry-produced data). Some of the key points of this study indicate that these projections are achievable while concurrently natural gas will face only a slight increase and there will be no need to invest in new nuclear power plants. The main objective of this study is to prove that the projected electricity demand can be met while reducing CO_2 emissions by 48-71% until 2030, without the need for new nuclear capacity.

2.2. Energy Modelling Approaches

Different methodologies were adopted by the three studies based on three energy models affecting variably the results as presented in the following chapter. ILEX used for the modelling of the three scenarios the ILEX electricity simulation 'GB model'. The GB electricity market model is built in Microsoft Excel and Visual Basic, in order to achieve transparency and a user-friendly tool. Friends of Earth study also uses a simple model based on mathematics which tests different projections. The initial aim of both models, as may be inferred, was to examine the possibility of meeting CO_2 emissions reduction targets while measuring fuel consumption and electricity demand in order to meet power requirements in all the sectors of the UK economy. However, each model focused on different indicators. As such, 'GBGen', as it is termed by ILEX, is influenced by economic values, and subsequently provides the equal of system marginal prices in order to explore the evolution of the UK power grid by 2025, (having the ability to extend results until 2050). Whilst FOE, gave emphasis on the elimination of the nuclear power by 2030 and the main model inputs were related with the new energy installations regarding the energy sources participating in the electricity generation.

On the other hand, the DTI study uses a more complex model compared to the two previous, the 'DTI UK Energy Model' that involves econometric compromises through the adoption of a top-down approach. Although the model is considered a complex tool, it does not allow a detailed exploration of further uncertainties that may occur because of the ambiguous factors related with the historical data. Due to that, a different methodology has been considered with a simplified model which assumes that energy demand is linked with price, income and future temperatures in the UK that helped to clarify uncertainties in the broader model. The uncertainty bounds associated with the projection framework of 2010-2020 is ±6% in 2010 increasing to ±6.6% in 2020. The DTI Model due to the fact that it examines the whole of the UK energy system, uses aggregate details depending on the sector that analyses e.g. for the transport sector these details can be car ownership by household, income of household, price of fuels and a wider methodology to vehicle category. All models produce results measured in TWh.

3. Modelling Assumptions and comparison with actual 2010 data

3.1. GDP growth

The projections presented in the three studies were based on some major assumptions used as inputs in the models mentioned above. The inputs were diversified between the studies, although they had several common themes. The GDP growth rate affecting directly the future energy demand was in line between ILEX (2006) and DTI (2006) in all scenarios (unless explicitly stated). In the Friends of Earth study there is no reference for a GDP input. The two studies assume an annual economic growth rate of 2.55% for the time period of 2004 to 2015. As this value includes future forecasts, it was not possible to be compared with current data. Nonetheless, specific values for 2006-2010 were also given, equal with 2.65%.The World Bank stated that the actual GDP growth for the UK between 2005 and 2010 was 0.62% [14]. The clear discrepancy between these two values and real data can be credited to the global financial crisis in 2008, which impacted the UK economy. Such unexpected 'shocks' to the system are intricate, if not impossible to be predicted and cannot be integrated in the scenario development. Therefore, they can render the outputs of scenarios largely inappropriate. Usually, this is augmented with long term distant assessment horizons.

3.2. Fuel prices

Whilst assumptions on economic growth and demographics, remain constant across all scenarios, fossil fuel prices vary. Fuel prices are a common input in both studies ILEX and DTI; nonetheless it is not explicitly examined in the Friends of Earth (2006) report, and therefore cannot be considered here. DTI, in 2006, supposed that oil prices would remain as high as they were at that time, with discrepancies trace by the gas price. Coal prices were assumed to fall slightly towards 2010 in response to investments in coal production due to high prices in 2005. These assumptions are common to 2010, with variations among scenarios with projections beyond this date. Their projections on historic analyses and estimations were based on showing a rational balance between gas and coal price differentials. ILEX used assumptions on fossil fuel prices and carbon prices based on ILEX's standard central fuel price while DTI took information from the governmental databases of 2004.

DTI presents two 'central' fuel price scenarios. 'Central 1' proposes a scenario favourable towards gas and 'Central 2' is encouraging coal, while ILEX assumptions are common to all scenarios. The ILEX study assumes much higher fuel prices than the DTI projected figures, in 2010. A possible explanation is that the ILEX study was published a few months later than the DTI study, intervening significant increase in fuel prices [23] had distorted the relative 'baselines' and trends, causing this divergence. Moreover, due to the fact that the ILEX study is exploring only the power sector, does not present a price for oil in 2010 as there is no oil-based power generation.

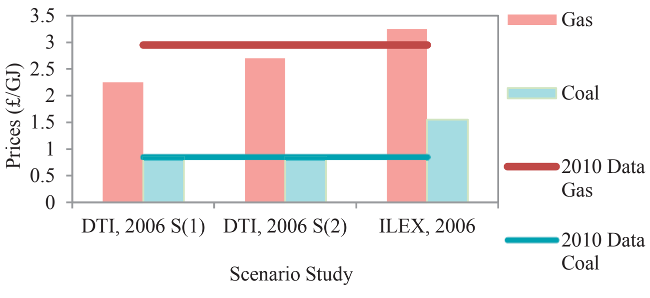

Fig.1: Projected Fuel Prices Comparison for 2010

Fig. 1 is an illustration of the data tabulated in Table 1, alongside the actual data for 2010, as published by National Grid and DECC ([24], [25]). DTI projections for coal prices proved to be highly precise, whereas ILEX projections were almost twice as much as the actual price in 2010. Regarding gas prices, ILEX projections were comparatively close, and this was the case for the Central (2) DTI scenario.

3.3. Electricity Demand Growth

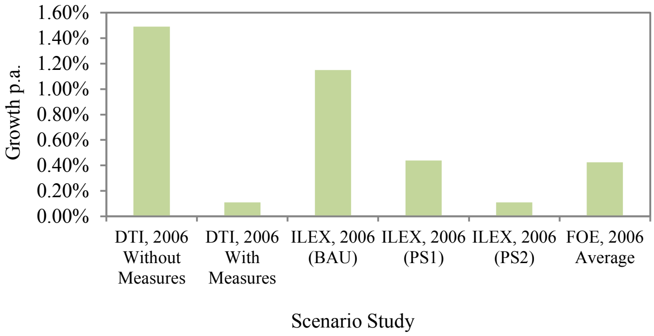

Fig.2: Electricity Demand Growth Rate Comparison

The rate of electricity demand growth is integrated in the scenario modelling either endogenously by including factors such as GDP estimations and demographic variations over the years, or it is used as an exogenous assumption. Fig. 2 illustrates the electricity demand growth rates used until 2010 in the three studies. As shown in Fig.2, the DTI study has two values: 'with measures' and 'without measures' exploring two future perspectives for the improvement of the UK energy system. The two 'central' scenarios contained in this report use the 'with measures' value (0.11%), estimated endogenously, which assumes that measures appearing in the UK's Climate Change Programme (as existed in 2006), were applied and their targets attained. The 'without measures' presumes that there are limitations regarding the progress in emissions reduction, and is applied to the 'Business as Usual' scenario. The energy demand growth rates in ILEX study were taken from the DTI 2006 study, discussed above. The 'BAU' scenario equals with 1.15% and applies the average rate used in the DTI's 'without measures' scenario, as after 2010, the DTI 'without measures' growth rate alters from 1.49% to 0.74%. In the same way, ILEX's 'PS1' scenario applies the mean DTI assumption for the 'with measures' (0.44% p.a.), whilst the 'PS2' scenario uses a rate of 0.11% over the complete assessment period of 2004 until 2025. The FOE report uses exogenous values for electricity demand included in the 'Performance and Innovation Unit's 2003 report. A number of additional assumptions were considered related to new energy efficient technologies and the degree of their implementation in the UK that affected their results to some extent. The FOE study distinguishes between its 'good progress' and 'slow progress' scenarios, however until 2010 the difference is negligible, both using a growth rate of around 0.43%.

4. Results Comparisons with actual 2010 data

4.1. Conventional Fossil Fuel Generation

Each study makes assumptions on when certain generation capacity will close, either because it reaches its end of life, or due to policy considerations. The DTI study supposes the closure of 2GW of coal and 1GW of other fossil fuel capacity (predominantly gas), from 2005 to 2010. There is no diversification among the scenarios developed by this study and the principal reasons are both their retirement year and new more robust policies that impose the energy reduction from conventional fossil fuels. The ILEX study estimates the closure of 1GW of coal-fired capacity by 2026; however it does not present any specific assumptions for 2010 in any of the scenarios. In contrast, the FOE study assumed the continued operation of existing capacity with efficiency upgrades. This has been contradicted by the UK government's declarations for closure of the half of the coal capacity by 2015 and almost the total capacity by 2023 [26]. In the 'gas' favoured FOE scenarios ('good gas' , 'slow gas'), the Drax coal-fired installation closes in 2018 (close to the actual date decided to be in 2019 [27]), but this does not impact results for the 2010 projection horizon.

Fig. 3 presents the maximum and minimum values for coal and gas-fired electricity generation projections from the studies, and they are compared with real data for 2010. It should be mentioned that among the results of the scenarios there were no major discrepancies, leading to the supposition that can be divided in two groups with maximum and minimum values. More specifically, DTI provides results for the electricity generation only for the two central scenarios (favourable to gas and favourable to coal) included in its report. ILEX has three scenarios, however 'PS1' and 'PS2' do not present any noteworthy difference, and the 'BAU' shows always the maximum outcomes. Finally, FOE although has some differentiations among the six scenarios the overall outcome of the electricity demand and the CO_2 emissions are grouped in two categories 'slow scenarios' and ' good scenarios'.

The DTI Central 'Favourable to Gas' scenario, matches very closely with what actually came to pass in 2010 [28]. Overall, DTI forecasts a reduction in coal generation by 2010 compared to 2005 as a result of the retiring of coal-fired stations, while there is slight discrepancy among the projections (probably arising from the limited variation between the scenarios in 2010). Regarding the FOE study, the modelling methodology initially sets the renewables and coal parameters and as a subsequent step gas use is increased in order to fulfil the demand requirements. As such, these scenarios assume that due to high gas prices, comparatively lower prices of coal and low levels of progress in the environmental policies implementation, the use of coal will sustain in high levels until 2020. Among ILEX projections is evident a larger discrepancy, consequential from the fact that the 'BAU' scenario projects a much higher total electricity demand. ILEX projections for coal consumption differ considerably, with the 'maximum' projection deriving from 'Business as Usual', and the 'minimum' projection resulting from a scenario ('Policy Switch' - Policy Delivered) which considers that all targets in 2010 for CO_2 emissions abatement and renewable penetration were met. In the 'BAU' scenario, relatively low coal prices incentivise its use to meet high energy demand, whilst the 'Policy Switch' scenarios assume declined electricity demand, and consequently declined demand for coal consumption.

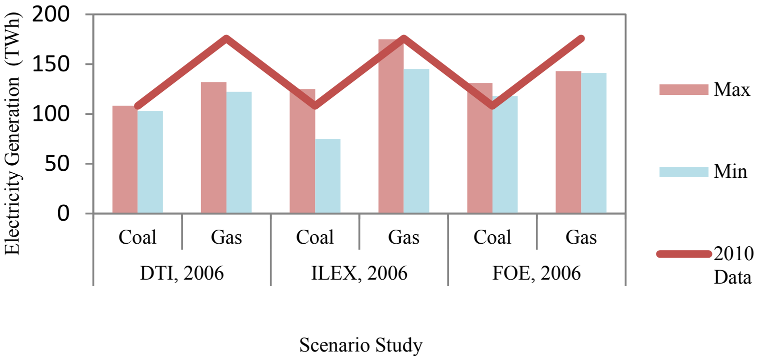

Fig.3: Projected Coal & Gas Generation Comparison for 2010

This is also the case for gas consumption variation in ILEX, displayed in the next figure, in which the 'BAU' scenario forecasts the most precise consumption profile, with 18% increase from 2005 to 2010. The DTI once more generates a small discrepancy (due to the same reasons), and is significantly below actual consumption.

4.2. Nuclear Generation

The ILEX study assumes the closure of nuclear installations as per 2005 expectations (licence expirations, etc).These are: Dungeness A in 2006, Oldsbury in 2008, Sizewell A in 2006, Wylfa in 2010 including several closures after 2010. This equals with a closure of 1389 MW of nuclear capacity by 2010. ILEX study proves to be almost right apart from Wylfa that extended its operation until 2014. The DTI study makes similar, specific assumptions, whilst the FOE assumes a higher reduction in capacity of around 2GW, in line with the DTI's Energy Paper 68 [29]. The FOE also explicitly states that no new nuclear capacity may be built. An assumption recently disproved with the Governmental Decision of building 10GW of new nuclear capacity named as Hinkley Point C [30]. Fig. 5 illustrates the maximum projected electricity generated from nuclear in 2010, for the three studies compared with actual data from the UK government [28]. The FOE has proven the most accurate estimation at approximately 60TWh, although there is little variation among the three studies (and indeed, little if any difference between scenarios within each study). This is accepted, as decommissioning dates for existing plants have been announced and no new capacity was planned at that time, therefore extremely improbable to start operating by 2010. Additionally, fuel prices do not vary (in the same manner as fossil fuel). The little disparity presented in Fig. 5 is due to other factors such as total electricity demand, for instance.

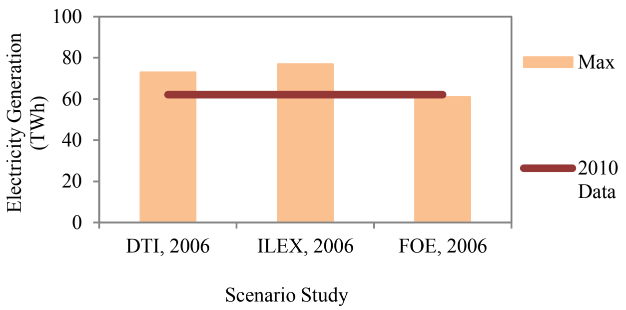

Fig.4: Projected Nuclear Generation Comparison for 2010

4.3. Renewable Generation

DTI projected that renewables will be the only energy source with fast development until 2010. According to it, the Government is dedicated to certify that the integration of renewables in the energy system will grow in the following years. This statement is justified in the other two studies as well. ILEX report refers to Renewable Obligation [3] as the key driver of the RES installation, whilst FOE mentions that: *"We believe that the growing public awareness and concern about climate change is likely to result in increasing public support for the speedy deployment of renewable schemes of all types"*.

Figure 6 presents the maximum and minimum projected electricity generated from renewables in 2010. Based on the statements from the three reports, all scenarios in the studies project an increase in the penetration of renewables into the electricity market, to different levels. ILEX and FOE have common assumptions regarding the degree of the contribution of the wind power estimating that it is the main alternative power source (firstly offshore and secondly onshore), however FOE considers much higher percentages of biomass compared to ILEX, suggesting increase in biomass with very optimistic potentialities for the next decades.

Both DTI and FOE display a slight differentiation among their own scenarios, and between each other, each projecting approximately 33 TWh of renewable generation in 2010. This is well above the actual value of just over 25 TWh [28] placing risks in the achievement of the emissions targets. Only the ILEX 'Business as Usual' projection accurately matches actual 2010 renewable generation, whilst the 'Policy Switch – Policy Evolution' scenario forecasted more that 40TWh generation, under conditions of further policy instruments.

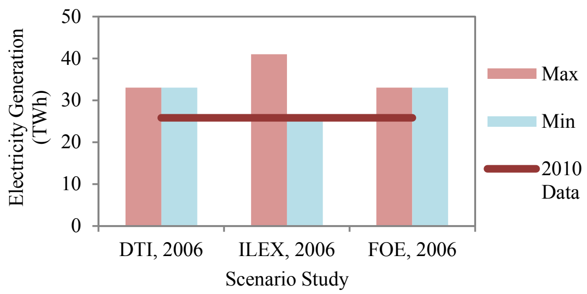

Fig.5: Projected Renewables Generation comparison among DTI, ILEX and FOE studies and 2010 results

4.4. Electricity Generation

The main common results in the three studies are related with electricity generation and carbon emissions. Fig.6 presents the total 'maximum' and 'minimum' electricity generation projections for 2010 from the three studies, in contrast with the actual generation in 2010. FOE projections are definitely the largest at approximately 410TWh, higher than the 382TWh actually generated in 2010 [16]. There is also very small variation within the study itself, as demand growth is uniform between the scenarios. It is possible that the 2008 economic crisis and the decline in electricity demand are accountable for this divergence. The 'Power Switch – Policy Evolution' scenario in the ILEX study generates the most precise projection, around 25 TWh lower than its 'Business as Usual' projection. The 'Policy Evolution' scenario assumes the application and achievement of new (as of 2006), ambitious targets and policies, those that were already in place or

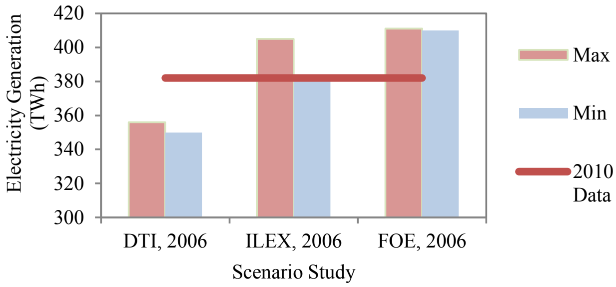

Fig.6: Projected Total Electricity Generation comparison among DTI, ILEX and FOE studies and 2010 results

announced. Although the results coincide with the actual ones, this ambitious trajectory was not accomplished, and it is probable that the financial crisis was once again the reason of this ostensibly 'successful' outcome. The DTI scenarios estimate electricity consumption in 2010 much below what came to pass. One cause of this difference among DTI and the rest of the studies is probably the amount of electricity imports and combined heat and power capacity (CHP) not included in DTI study. Additionally, DTI results are based only on the "with measures" electricity growth assumption and on the impact of Climate Change Programme which acts to reduce electricity demand.

4.5. Carbon Emissions

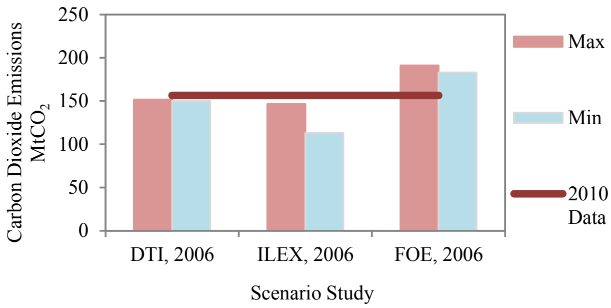

Fig.7: Project CO_2 Emissions from Electricity Generation Comparison for 2010

The three studies focused their results on the ambition of reducing the CO_2 emissions based on the policy of 20% reduction in emissions from the whole energy sector, although there was no specific target for the power sector, hindering the attempt to compare outcomes and real data with a specific target. Fig. 8 illustrates the 'best' and 'worse' case scenarios from the studies regarding carbon emissions. The FOE projected the highest emissions (only 11% decrease from 1990 levels), and well above actual emissions in 2010 taken from DECC [1], although again, with negligible variation between the maximum and minimum projections – consequential of the 'slow coal' and 'good gas' scenarios, respectively. This is principally a function of demand illustrated in Fig. 2 This does not necessarily follow for the DTI and ILEX studies, in which the latter projects lower emissions in 2010 in all cases, despite much higher electricity demand across the board. This derives from higher nuclear and renewables generation over the scenarios, along with a preference for gas over coal – especially in the 'Policy Switch – Policy Delivered' scenario in ILEX. The assumption of more efficient generation also contributes to this trend. In that sense, the ILEX study projects a highly optimistic emissions reduction of 44.5% (surpassing the actual 23%). The DTI study, constrained by CO_2 targets (Climate Change Programme), matches actual CO_2 emissions most closely compared to the rest of the studies projecting a reduction of 25%.

5. Limitations

During the conduction of this study several limitations were identified related to the assumptions incorporated in the energy models along with the calculation approaches followed by the models that are not publically available and do not allow a deeper and more detailed exploration of the calculation methodologies affecting significantly the results. Another limitation was that the studies integrated different kinds of assumptions and not all of them were comparable. For instance, ILEX study takes into account the impact of the European Emission Trade System (EU ETS) while both DTI and FOE do not consider it as an important parameter. This is reflected in the FOE emissions results which are exceptionally higher compared to the others. DTI also mentions that although EU ETS has potential to reduce significantly UK emissions due to its high uncertainty regarding the impact on the carbon emission is excluded from that study. Nonetheless, DTI has relatively low levels of emissions as its projections from the two central scenarios are based entirely on the 'Climate Change Programme' with stronger policies, whilst FOE refers to the delay of the CCP review and does not incorporate the measures included in it in the projections until 2010. Apart from that, several other factors were diversified among the studies. The Large Combustion Plant Directive included in all the studies, is not used in the same way as FOE and ILEX assume different dates (2018 and 2015 respectively) for the phase-out of the coal plants while DTI does not specify a date. Additionally, imports seem to be extremely low in the DTI study contrasted with ILEX, while in the FOE there is no particular reference and it is embedded in each energy source (gas, coal etc). Other differences regarding imports are included in the FOE study, as it is assumed that they will be considerably reduced while renewables capacity will be growing over the years.

One more significant drawback regarding the projection of future energy scenarios is related with unexpected financial events. These trends are characterized by comparatively high forecast uncertainties, especially for long term projections. As an example, the ongoing financial crisis since 2008 has led to a noteworthy decline in energy demand and particularly electricity, surrounded by other factors, which are exceptionally complex, if not unachievable to be considered in the future scenarios projections developed before that time. This may have rendered several input assumptions and the produced outputs inaccurate. As such, concern regarding unexpected economic and political events must be taken in the scenario development as well as precise interpretation of their evaluation.

6. Conclusions

This article constitutes an attempt to present and compare three energy scenario studies, conducted at the same period of time (2006) with an exceptionally narrow projection horizon of four years. It highlights the considerable differentiation among input values (e.g. electricity growth projections), and the subsequent generation of highly varied outcomes (e.g. CO_2 emissions) that are rationally possible due to the uncertainty embedded in the calculation methodology and the assumptions considered. This is attributed to a principal disadvantage of all the projections scenarios related to the uncertainty embedded in their assumptions used as inputs which lead to a disparity in the results. Due to that, this paper emphasizes on the reduction of complexity of the factors by selecting and comparing the most relevant ones out of a large number of parameters.

Overall, through this ex-post evaluation of projections for which the assessment horizon has now passed showed that that DTI and ILEX have many commonalities. This was proved based on the appraisal of assumptions inputs, outputs and approaches as they produced similar results based on common data sources. In contrast, FOE based on less stronger policies as it negligees important EU and UK policies and focuses on the elimination of nuclear power, produced much higher results compared with actual 2010 data and the two other studies. The review of those studies proved that some of the scenarios included, do not keep up with what the authors would essentially expect to occur in the future (Business as Usual, or others with ambitious targets e.g. 'PS2' in ILEX). Nonetheless, the moderately narrow assessment horizons examined in this paper, lead to relatively precise projections with slight diversifications among the studies and scenarios, pivoting around the eventual actual result.

The actual data showed that in the power sector have been significant improvements that led to a reduction of 23% in the emissions; nonetheless the UK failed to achieve its final target of 20% emissions reduction in every sector, attaining just 15.9% reduction [31]. It is evident, that although in the electricity sector were achieved significant improvements derived mainly from the efficiencies in buildings along with renewables penetration, more efforts have to be placed in the whole UK energy system (mainly transportation) in order to achieve a more acute drop in carbon emissions. As energy scenarios are exceptionally essential for the planning of any important event and investment, further research has to be continued in the future. Particular comparisons among projections for the milestone year of 2020 upon which are based several EU and UK targets will provide a more robust evaluation of the future energy scenarios studies.

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