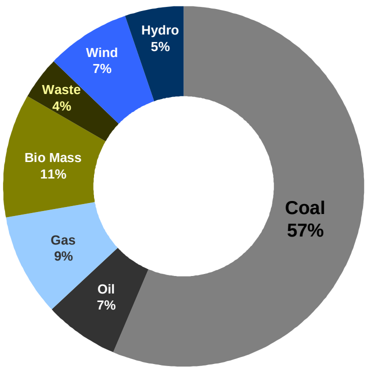
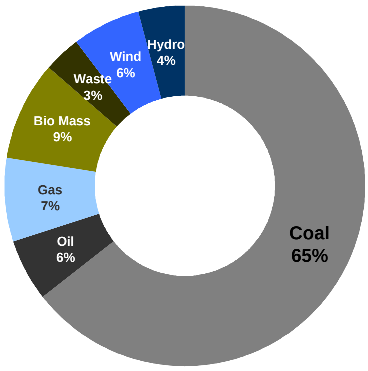
# Dong Energy:

## Risk Assessment for Shareholders of the Proposed 1500 MW Coal-fired Power Plant near Greifswald, Germany

**CURRENT FUEL MIX**




**PROPOSED FUEL MIX**




CONTINUE TO EXECUTIVE SUMMARY…

**Report prepared for WWF Denmark by:**

Innovest
STRATEGIC VALUE ADVISORS

KEY ISSUES-

- » Dong Energy is proposing a1,500 MW coal fired power plant near Greifswald, Germany which will be used to provide base-load power for northern Europe. This outlines the risks and alternatives to this and future plans for coal fired power generation, e.g. investment plans in Emden, Germany and Hunterston, Scotland
- » Dong Energy's planned expansion will occur at the same time as Phase III of the Emissions Trading Scheme gets underway, exposing the new plant to high carbon prices throughout its operating life. Current carbon price estimates of €20 to €40 per ton for Phase III imply a yearly carbon cost for Dong of between € 526 million and € 1,052 million of which Greifswald would constitute at least 25%. At the same time this project would make Dong one of Europe's most coal dependent utilities.
- » Estimates of operational costs under Phase III, including construction costs, show that alternatives such as offshore wind power are more cost competitive given expected carbon prices. Offshore wind is cost competitive with coal at a carbon price of €20.39.
- » An investment in offshore wind has an expected annual cost advantage of in average € 64.9 million or almost DKK ½ billion compared to the coal plant near Greifswald.

**This report was prepared for WWF Denmark by:** Innovest Strategic Value Advisors: Marc Brammer, Director, Product Development & Carbon Finance
St. Martin's House, 16 St. Martin's Le Grand, London, United Kingdom EC1A 4EN
Tel: +44 0207 397 8766; mbrammer@innovestgroup.com

**WWF Denmark contact person:** Jacob Fink Ferdinand, Projektleder, Klima og Virksomheder / Project Manager, Climate & Business
Ryesgade 3 F, 2200 Copenhagen N
Tel +45 3524 7840; j.ferdinand@wwf.dk

**TABLE OF CONTENTS**

## Chapters



## Figures

# Executive Summary

According to Dong Energy's 2007 Annual Report: *"DONG Energy is exploring the possibility of building a coal-fired power plant near the town of Greifswald near the German Baltic coast. With a net generating capacity of 1,500 MW, this power station would significantly strengthen DONG Energy's power activities. The project is pending approval by the German authorities and DONG Energy's Supervisory Board. If the necessary approvals are obtained, the plant could be ready after 2012. DONG Energy is also exploring other options for the establishment of thermal production facilities in Northern Europe."*

At the same time the government of Denmark is looking to sell a significant portion of its ownership in the company making it a fully private enterprise. The majority (73%) of DONG Energy is owned by the Danish Government together with Seas NVE-holding A/S (11%) and Syd Energi Net A/S (7%) as the 3 largest shareholders. Foreningen Energi Horsens, Østjysk Energi, Nyfors a.m.b.a., Galten Elværk Net A/S, Nyborg Elnet A/S and GEV Net A/S comprise the remainder 8%.

According to a political agreement, the Danish Government shall maintain majority ownership in the company until 2025. Reduction of the ownership below 50% requires political agreement of Danish parties. An IPO and listing at the Copenhagen Stock Exchange was expected in the spring of 2008, but was suspended due to the situation of the international financial markets and put on hold until such time as it was felt Dong Energy would garner the proper price level when it was sold. Given that Dong Energy currently has a sizable portfolio of coal fired generation assets already (3.67 GW) and that it is facing potential limitations of its plan to expend them in Germany, the issue of the valuation of these coal assets, current and proposed, is important to establish for potential investors before those plans reach maturity. In the current regulatory and consumer environment, alternatives to coal may positively impact Dong Energy's future potential valuation, while investments in new coal appear almost certain to become a liability.

The completion of the proposed Greifswald plant would increase the company's reliance on coal generation from 57% to 65% (including renewables) relative to current levels. Dong Energy's annual carbon emissions could subsequently increase by over 7 million tonnes annually or roughly 50% over 2007 levels. Since the plant will become operational after Phase III of the EU emissions trading scheme (ETS) begins the plant will be exposed to carbon prices during its entire operational lifetime. Depending on the future of carbon prices, the proposed expansion could result in annual carbon allowance costs of between €140 million and €280 million, assuming carbon costs of between €20 and €40/tonne.

Despite the likelihood that Dong Energy's existing and proposed coal-fired power plants will face significant carbon costs and shifts in consumer demand toward alternative forms of power generation; the company has not demonstrated how it will protect shareholder value and guarantee a return on investment for the development of over 1,500 MW of new coal capacity.

FIGURE 1 Dong Energy's Generation Assets and GHG Emissions

| | 2006 | 2007 | Projected (2013) |
|---|---|---|---|
| Total Fossil Fuel Generation Capacity (MW) | 6,510 | 6,510 | 9,418 (est.) |
| Renewable Capacity (MW) | 828 | 828 | 1,408 (est.) |
| Tons carbon equivalents | 18,186,464 | 14,010,997 | 26,310,310 (est.) |
| Total Yearly GHG ETS Value - High Cost Scenario (€40/Ton) | | | € 1,052M (est.) |
| Total Yearly GHG ETS Value - Low Cost Scenario (€20/Ton) | | | € 526M (est.) |
| Greifswald GHG Emissions – High cost Scenario | | | € 280M (est.) |
| Greifswald GHG Emissions – Low cost Scenario | | | € 140M (est.) |

Source: Estimated numbers - Innovest Strategic Value Advisors; 2006/7 numbers - Dong Energy Annual Report 2007 / Dong Energy Corporate Responsibility Report 2007; high and low carbon scenario based on "Carbon Prices in Phase III of the EU ETS", Climate Strategies, Aug. 2008; Grubb, Michael, Chief Economist at the carbon Trust, and Faculty of Economics, Cambridge University

There is also the possibility that Germany will deny the permit for the full 1,500 megawatts planned at Greifswald, reducing it to 750 MW or denying a permit entirely. While there are many viable alternative investment scenarios if such events were to occur the company has yet to outline what if any alternatives this investment capital might be utilized for.

This report will focus on the current and emerging carbon regulatory landscape, and Dong Energy's future exposure to the associated risks. This report provides an in depth cost analysis of coal, gas, and wind generation in a carbon constrained economy using Dong Energy's proposed plant in Germany. The findings of this analysis suggest that Dong Energy's current strategy is inherently risky as under nearly all predicted regulatory scenarios for Phase III of the EU ETS, alternative base-load generating capacity such as wind is more cost effective than coal.

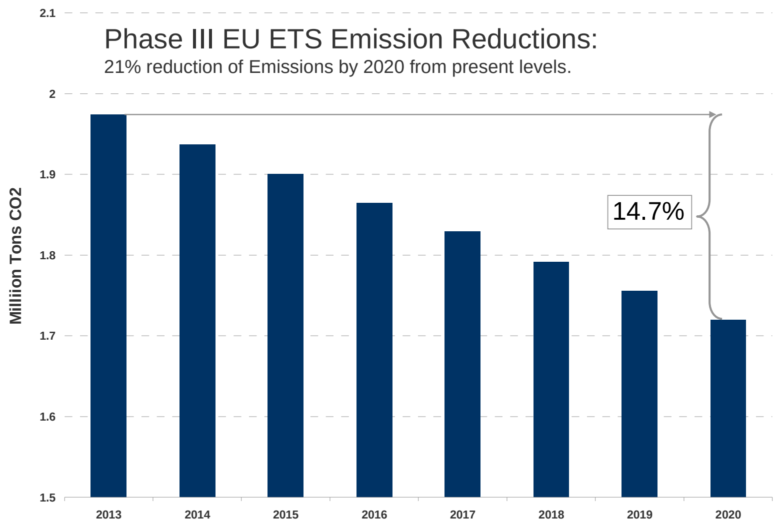
Carbon prices are expected to range between 20 and 40 €/tonne[1] all to be auctioned in Phase III, which will make offshore wind very favourable to coal. In chapter 3 it is estimated that the offshore wind production price is lower than coal above a carbon price of €20.39 €/tonne.

The first two chapters cover a policy overview of the EU Emissions Trading Scheme (ETS) and renewable energy strategies followed by an assessment of Dong Energy's current and proposed carbon profile. The final chapter is a cost comparison analysis and assessment for coal, wind and gas under Phase III of the EU ETS.

1 "Carbon Prices in Phase III of the EU ETS", Climate Strategies, Aug. 2008; Grubb, Michael, Chief Economist at the carbon Trust, and Faculty of Economics, Cambridge University

# 1 Carbon Regulation and the Power Sector

FIGURE 2 European Emissions Reductions 2013-2020

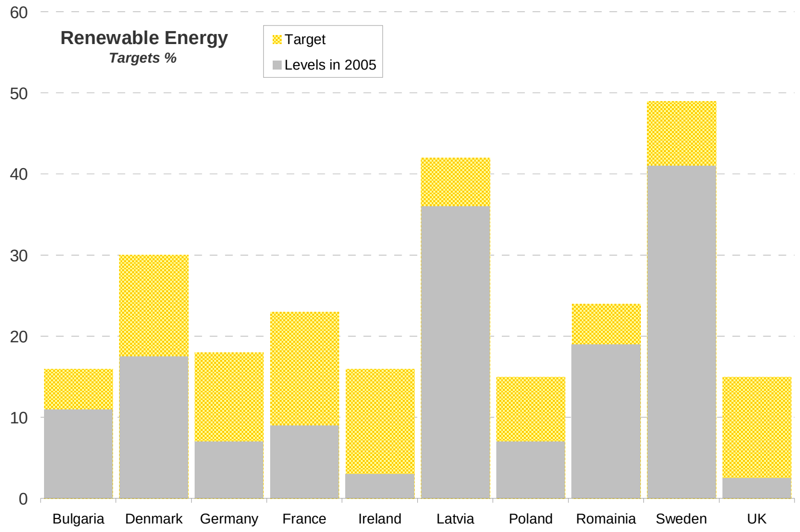



Source: European Commission

The EU is the world's foremost jurisdiction for regulation of GHGs. The cornerstone of the EU's approach to limiting GHG emissions is a cap-and-trade system known as the Emissions Trading Scheme (ETS) – a system that limits absolute emissions of carbon for certain industrial sectors and allows individual companies to sell excess emission allowances, called European Union Allowances (EUAs), in an open market. This approach provides flexibility by allowing firms to elect the optimal strategy (i.e. reduce emissions vs. purchase more rights to emit) based on factors such as investment cycles and temporary requirements for greater output. As figure 2 above shows, the emissions reduction plans under Phase III of the EU ETS are significant with a 14.7% reduction in total EU wide emission planned for the eight year period between 2013 and 2020. Given the implementation of emissions reduction plans and the expansion of renewable energy already underway in Phase II, this 14.7% reduction represents a requirement for real shifts in technology and energy use patterns to achieve the full reductions.

Combined with the EU's renewable energy growth targets (see Figure 3 below) this implies that the energy space in Europe will be facing a period of significant transformation. In light of these developments on the policy, Dong Energy's plan to expand its investment in coal appears much more risky than the standard expansion procedure that it would have seemed to be in the past.

FIGURE 3 European Renewable Energy Growth Targets




Source: European Commission

In January 2005, the ETS began operating as the first mandatory multi-jurisdictional, multi-sectoral GHG emissions cap-and-trade regime in the world set out into three phases. Phase I of the ETS covered the 2005-2007 period, while Phase II, which coincides with the Kyoto compliance deadline, covers the 2008-2012 period. Dong Energy estimates that the Greifswald plant would become operational after 2012 meaning that it would fall into Phase III of the ETS.

EUAs in the ETS are currently largely traded in over-the-counter (OTC) markets (upwards of 70% on volumes), although exchanges are active in this space and the cash market will likely be the dominant medium for carbon emissions trading in the long run. Approximately 95% and 90% of EUAs were freely allocated to regulated companies, rather than auctioned off, in Phase I and II respectively.

Admittedly, Phase I was a trial period and most electrical utilities with some or all of their generation assets located in the EU did not incur any substantial hardship. EU governments, for the most part, purposely over-allocated EUAs to shield their domestic industries from any significant impact.

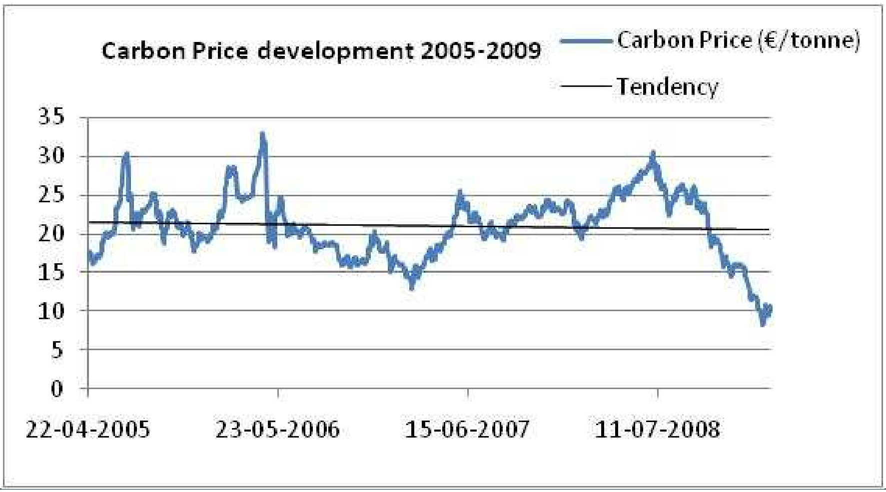
When the numbers were made public in mid-2006 and it was discovered that, as a result of over-allocation by EU governments, the ETS was net long EUAs, the markets reacted immediately and the price for a ton of carbon fell dramatically on European carbon exchanges. Although prices recovered somewhat in the following months and found support at around EUR 15, they begun declining steadily in the latter part of 2006 and into the first quarter of 2007, as the market was now aware that there would be no shortage of allowances for the remainder of Phase I.

Figure 4 below illustrates that the traded price has been fairly stable since the initiation of the ETS in 2005 with an almost 21 €/tonne average for the whole period.

The exception is the price drop to about 10 €/tonne in Feb. 2009 since Oct. 2008, parallel to the breakdown of the financial markets.

This has not been the case with Phase II of the ETS as the allocations process has been better designed. In Phase III the utility industry in Western Europe will not receive any allocations and will have to buy full credits for all emissions.

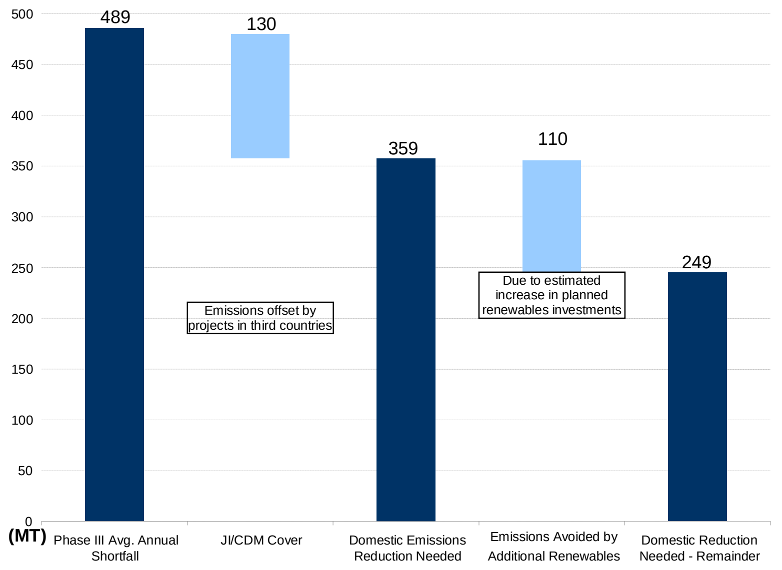
FIGURE 4 EU Carbon Price Development 2005-2009




Source: European Climate Exchange, ECX EUA Futures Dec.05-09.

As figure 5 shows below, the reductions in total EU-wide emissions will require significant adjustments in power generation. These reductions will leave at least 249 MT of yearly emissions (equivalent to 482 TW of coal switched to gas) outstanding even with current estimated expansions in wind power and CDM project offsets.

FIGURE 5 Required Annual Emissions Reductions Under Phase III EU ETS




Source: EU's Climate & Energy package figures from EU Commission. Estimate on planned renewable, from P. Lekander, S. Comper, A. Gandolfi; **UBS Investment Research – European Utilities**, "Half of Coal Generation Shut By 2015"; Feb. 22, 2008

As a result of these shifts in energy generation patterns it appears that climate change, and the regulatory and policy responses to it, present the single most significant long term risk for sector constituents based in the EU.

This study's conclusions are based on the following developments:

» As Figure 5 above indicates there are significant reductions of carbon emissions that will be required for EU countries to meet their requirements under Phase III of the ETS. UBS Investment research estimates that around 110 megatons of reductions can be achieved through existing planned renewables investments but a significant amount of reductions will have to come from closures of coal-fired generation – the reduction needed is equivalent to closing 36 coal plants annually of the size and type of the proposed near Greifswald. While the 2008-2012 period is still expected to be utility-friendly overall, it is expected to impact EU-based sector constituents to a larger extent than Phase I did and Phase III to eliminate protections almost. Dong Energy states the following about its GHG emissions in the current ETS environment: *"DONG Energy has 26 plants that have been allocated emission quotas. These plants accounted for more than 99% of DONG Energy's total emissions in 2007. The emissions from the plants that are subject to quotas are verified separately by an independent certification body. In 2007, emissions largely corresponded to the allocated $CO_2$ certificates."*

» The energy prices for fossil fuels are increasingly tightening as a number of factors come into play globally. Growth in India and China has put pressure on coal prices while Russia has become increasingly dominating the European Energy landscape as the world's largest exporter of oil and gas. The desire for European governments to become less dependent upon expensive and/or politically compromising energy supplies as well as the desire to meet climate goals will mean that public policy will favour renewable energy going forward.

The latest assessment by the Danish Energy Agency[2] on future energy prices for making socio economic analyses uses IEA's World Energy Outlook 2008 figures as a reference. The Danish Energy Agency estimates that the decrease in fossil fuel prices due to the breakdown of the financial market since 4th quarter of 2008 is only a short term fluctuation. The Danish state therefore fully adapts the long term estimates by IEA from 2013 (keeping in mind the natural high level of volatility of most long term predictions). In 2013 the coal price is expected to rise to 120 $/tonne steam coal with a slight decrease from 2020 towards 110 $/tonne in 2030. These are also the assumptions on the coal price used in the cost comparison in this report.

» It appears that the real risks for the electric utilities industry lay post-2012, the period when the Greifswald plant would become operational. Under the current terms of the Kyoto protocol, only industrialized countries have to limit their GHG emissions, and some key signatories, most notably the US but also Canada, have either pulled out of Kyoto altogether or will be unable to meet their obligations as a result of inaction. Despite these limitations, we believe it is increasingly likely that these industrialized country laggards, as well as the key emerging markets of India, China and Brazil will be part of a global post-2012 regime. The EU has formally committed to reducing its GHG emissions by 20% below 1990 levels by 2020, and to boost that target to 30% if other industrialized countries adopt comparable goals. The UK, acting alone, has taken on a target of reducing GHG emissions by 80% below 1990 levels by 2050.

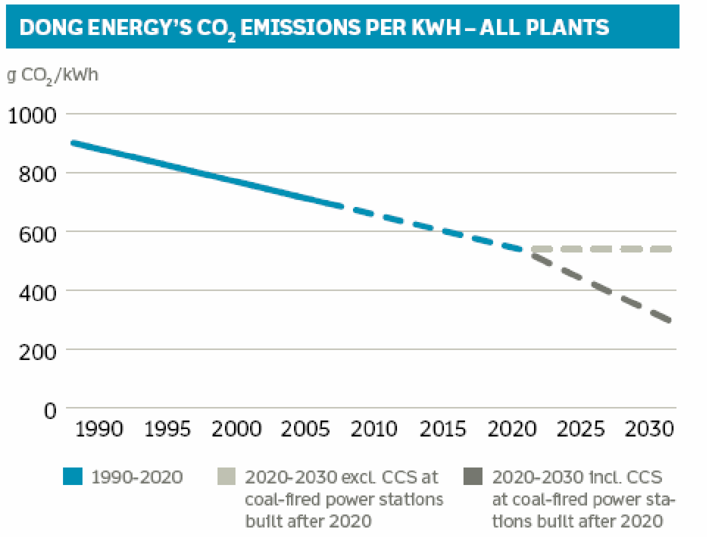
» The US, the world's second largest absolute emitter of GHG, just in 2007 surpassed by China, is currently reviewing its position in favour of federally-imposed caps on GHG emissions. Once the US moves legislatively on GHGs, necessary momentum will have been re-established for global collaboration on climate change. Under a scenario where the EU is no longer acting alone on climate change, it would be far more difficult for European governments to justify a lax approach to regulatory implementation with regards to the ETS, which would almost certainly spell hardship for industries and companies that failed to anticipate this development. Given the time-span associated with investments in the electricity generation sector, the risk posed by stranded costs associated with environmental regulation is, for electric utilities, one of the highest of any industrial sector. Given, this EC and national policy shift toward stricter mandatory greenhouse gas emissions reductions and renewable energy development, there is significant risk associated with Dong Energy's strategic decision to pursue new coal-fired power plants. This risk is intensified by the fact

[2] Energistyrelsen: "Forudsætninger for samfundsøkonomiske analyser på energiområdet", February 2009.

that Dong Energy is a provider of merchant power, and is therefore forced to compete for wholesale customers, and has greater exposure to current market trends. As carbon regulations continue to be strengthened the cost of coal generation will likely rise. The increased costs of coal generation coupled with renewable portfolio standards will likely cause utilities to seek alternative forms of generation and to limit their exposure to long-term contracts for electricity derived from traditional coal sources. Current and future regulatory constraints could severely limit Dong Energy's ability to provide shareholder returns on existing and proposed coal-fired power plants.

# 2 Dong Energy's Current and Proposed Carbon Profile

FIGURE 6 Dong Energy's Projection of Its Carbon Emissions



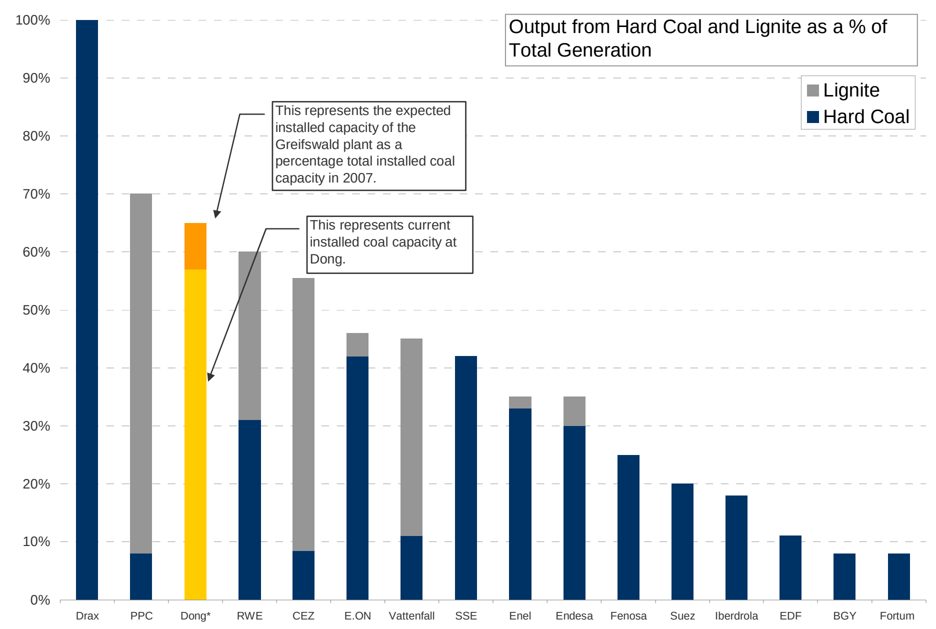

Source: Dong Energy -- Note from Dong Energy's 2007 CSR Report: "Dong Energy's carbon emissions per kWh generated from all plants, i.e. wind, hydropower, fossil, etc. from 1990 to 2007 and expected carbon emissions from 2008 to 2030. Future emissions depend on the political framework conditions and technological development."

Figure 6 above illustrates that Dong Energy's current plans for its reduction of greenhouse gas emissions are neither based on actual expansion plans the company has put forth nor on viable currently available technology. While carbon capture and storage (CCS) is technically a possibility in the time frame alluded to in the chart (1990 – 2030) there is no recognition by the company that for many years under this chart's timeframe the company will be paying for carbon emissions nor that current and foreseeable future costs for CCS are uneconomical.

Currently the company does not have any specific targets for reducing carbon emissions although the company's reported numbers show consistent reductions.

The completion of Dong Energy's proposed 1,500 MW of coal-fired capacity will increase the company's coal capacity by nearly 30% from 3670.6 MWs to 5170.6 MWs with the likelihood, despite company assurances to the contrary, of increasing its annual carbon emissions by about 50% relative to 2007 levels based on current installed fossil fuel-based capacity. For example the company's 2007 annual report states that while coal generation accounted for 57% of installed capacity it accounted to nearly 70% of energy generated in 2007. The addition of this new coal capacity, which would emit an estimated 6.9 million tonnes of carbon yearly, would make Dong Energy more reliant on coal as a percent of installed capacity than majority of industry players in Europe, see Figure 7 and 8 below.

FIGURE 7 Coal Fired Generation (%) of Major European Utilities



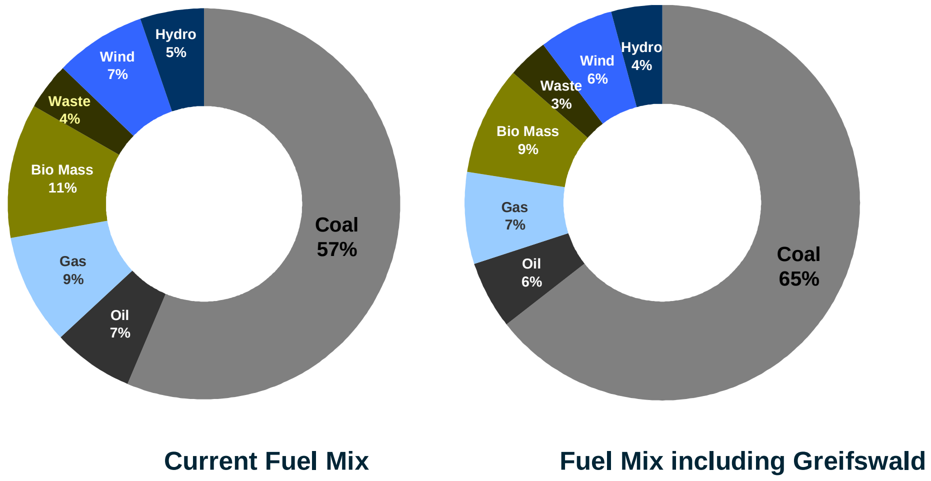

Source: UBS Estimates - P. Lekander, S. Comper, A. Gandolfi; **UBS Investment Research – European Utilities**, "Half of Coal Generation Shut By 2015"; Feb. 22, 2008; Dong Energy data comes from ISVA Estimates.

In Phase III ETS where 100% of emissions allocations are auctioned in the Western European energy utility sector, and expected carbon prices of between €20 and €40/tonne, the completion of Dong Energy's proposed power plant could result in additional annual carbon costs of between €140 million and €280 million over and above what they would already have to pay. Given Dong Energy's role as a provider of merchant power, it will likely be more difficult to pass future carbon costs to consumers, as these consumers will likely seek less costly power purchase agreements. Dong Energy recognizes that the adoption of regulatory programs that mandate a substantial reduction in carbon emissions will have a significant impact on its business.

However, the company's strategic expansion plan does not account for current regulatory trends that continue to shift the competitive balance away from coal-fired generation. In November 2008 Dong Energy proposed a £2 billion 1600 MW coal-fired power plant at Hunterston, Scotland and also in late 2008 Dong Energy announced that it has reserved a power station site in Emden in northern Germany.

This makes Dong Energy's carbon investment profile even more risky and raises uncertainties about Dong Energy's ability to provide a return on its investment and to protect shareholder value in light of impending carbon legislation.

FIGURE 8 Dong Energy's Current Fuel Mix & Proposed Fuel Mix (incl. Greifswald)



# 3 Is Greifswald a Good Investment for the Future? Carbon and Fuel Pricing Scenarios for Coal, Gas and Wind

In addition to regulatory challenges and potential shifts in demand for new coal capacity, the profitability of Dong Energy's proposed expansion may also be affected by rising coal prices. A rise in global demand for coal has lead to a sharp increase in coal prices although this has been moderated by the economic conditions recently. The outlook for the coal market in the long term is tight and economic conditions will likely have changed during the timeframe of the plant's construction. As governments worldwide try to tackle increased air pollution from power plants and other sources, different coal types will see widening cost trends based on the quality of coal. Cleaner burning coal will no doubt become more in demand. Dong Energy's strategic decision to pursue new coal capacity appears to neglect the predicted increase in coal prices. See chapter 1 and Note 1 regarding IEA and the Danish Energy Agency's estimates on the coal price.

This coupled with future carbon costs will further shift the competitive balance away from coal-fired electricity generation, and challenge the profitability of the company's proposed expansion.

Dong Energy's decision to expand its power generation using coal-fired plants occurs at a time of conflicting pressures on the electric power sector: From one side continuing increases in demand, and from the other strengthening legislation on climate change that will establish new limits on the amount of carbon emissions that power plants can emit and putting a price on these emissions.

In this context, it is critical that stakeholders of new power plant projects consider the potential costs of regulatory compliance coupled with emissions costs and a range of non-financial 'carbon risks' alongside traditional financial considerations. This analysis reviews the relative risks of three electrical power generation scenarios in a carbon -constrained operating environment:

1. **Coal-fired plant (only power)**
2. **Gas-fired Power Plant (Combined cycle gas turbine (CCGT))**
3. **Offshore Wind Farm**

## COST COMPARISON IN A POST 2012 SCENARIO

Figure 9 below shows the graphic cost comparison between the three analysed power technologies, offshore wind, gas and coal as a function of the carbon price. The methodology, background data and assumptions for this analysis is described in Note 1.

FIGURE 9 The Carbon Switching Price for Offshore Wind and Gas over Coal

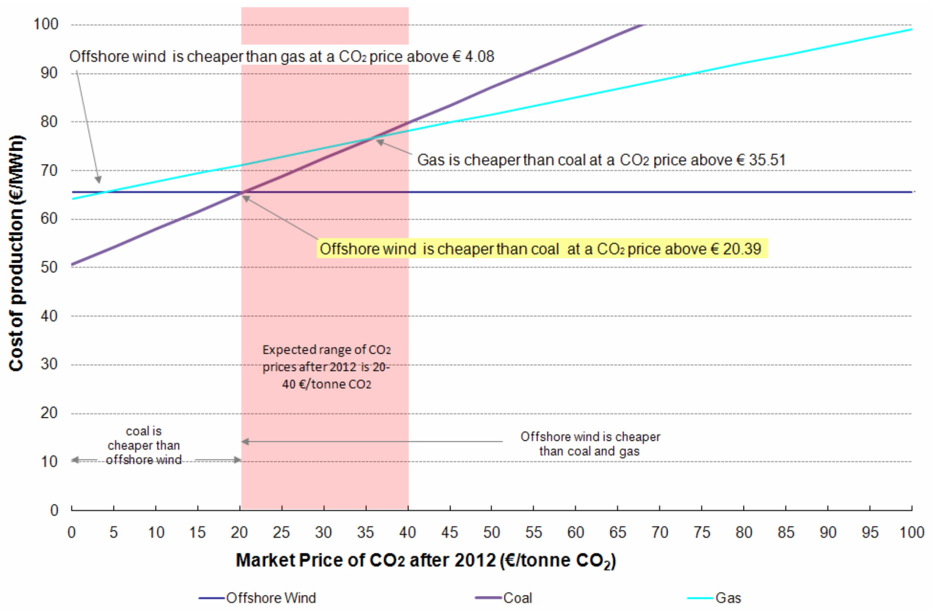



Figure 9 shows that wind is expected to be more cost effective than both coal and gas after Phase III of the EU emissions trading scheme (ETS), at carbon prices above € 20.39 and €4.08 respectively. Natural gas will be more cost effective than coal at a carbon price above €35.51.

At a mid carbon price of €30 the annual cost advantage of building Danish offshore wind with an "open door" contract as an alternative to investing in the Greifswald coal plant is €64.9 million or almost DKK ½ billion[3].

**Possible increased construction costs of the Greifswald coal power plant**

The scenario above has used the quite conservative estimate of a construction price of the power plant at Greifswald of €2 billion, because it is the most recent figure announced by Dong Energy. This is 15% lower than the price originally announced by Dong Energy, €2.3 billion, which has been used by the media in articles since autumn. A realistic cost scenario is likely in the range €2-2.3 billion €.

[3] = (72.54-65.33 €/MWh)x6000 full load hoursx1500MW

A need for water and air treatment facilities to remove dangerous heavy metals mercury, cadmium and lead, in order to get the plant approved by the German authorities, will push both the construction and O&M costs further upwards.

n increase in the coal power construction price of 15% (to €2.3 billion) will increase the competitiveness of offshore wind by almost 20%. In this scenario a carbon price above €16.71 will make offshore wind most cost effective.

**Possible state aid for coal in Germany**
As mentioned in Note 1 there is an option, though not finally decided by the EU, that EU member states can subsidize coal power plants by up to 15% of the construction costs, on the condition that the plant is "CCS ready". Taking this subsidy opportunity into account offshore wind will become more cost effective than coal at a carbon price above €24.08. The higher construction cost due to the need for compliance with the demands for "CCS readiness" are not taken into account here.

If including a 15% state subsidy for coal power and disregarding the higher construction price sustains offshore wind as the most costs effective power technology.

**Possible decreased offshore wind construction and O&M costs – economics of scale and industrialization of processes**
As a natural cause of increased experience in a maturing technology there are good reasons to believe, supported by indications from Dong Energy[4] that the construction and O&M costs of offshore wind farms will decrease in the coming years.

**Other possibly more favourable wind scenarios**
It is likely that onshore wind, other contract forms and locations in e.g. Germany and UK are even more financially attractive wind investments for Dong Energy than the off shore wind scenario used in the cost comparison. See examples below:

1. **Onshore wind in e.g. Denmark**: Using ReCABS figures and the present subsidy structure gives a total cost of about 47€/MWh, which is 28% lower than in the offshore cost comparison above.

   Onshore wind in other windy locations is also attractive. E.g. Germany subsidizes onshore wind by feed-in-tariffs. For at least 5 years (the period can be extended depending on the wind conditions) the initial tariff is 92 €/MWh and hereafter a basic tariff of 50.2 €/MWh.

   The primary hurdle for onshore wind power to grow, which must be considered, is the high competition for space on land and local opposition, particularly in Denmark.

2. **Offshore wind in Germany:** Feed-in-tariffs might make offshore wind power investment in Germany a top priority. The initial tariff for at least 12 years is 150 €/MWh, hereafter 35 €/MWh. See Note 1.

[4] E,g.from an interview with CEO Dong Energy Anders Eldrup in Dansk Energi, 16/3 2009, p.8.

# 4 Conclusions and Recommendations

## CONCLUSIONS

1. Climate change and the regulatory and policy responses to it, present the single most significant long term risk for energy sector constituents based in the EU. The carbon price is expected to range between 20 and 40 €/tonne after 2012. However, Dong Energy's strategic expansion plan does not account for current regulatory trends that continue to shift the competitive balance away from coal-fired generation. Besides the proposed coal plant near Greifswald, which is used in this risk assessment, Dong Energy has in November 2008 proposed a £2 billion 1600 MW coal-fired power plant at Hunterston, Scotland and also in late 2008 Dong Energy announced that it has reserved a power station site in Emden in Northern Germany.

   Current and future regulatory constraints could severely limit Dong Energy's ability to provide shareholder returns on existing and proposed coal-fired power plants. This makes Dong Energy's carbon investment profile even more risky and raises uncertainties about Dong Energy's ability to provide a return on its investment and to protect shareholder value in light of impending carbon legislation.

2. The cost comparison between off shore wind and coal in this study uses the most validated and conservative data from the industry and international organisations such as IEA. It is expected that off shore wind will be cost competitive at a carbon price of €16.71. This price will be even lower by using other subsidy regimes and assuming that the off shore wind construction and O&M costs will decrease due to economics of scale and industrialization of processes.

   The cost advantage of wind continues to rise unbounded for higher carbon prices. Investing in offshore wind therefore acts as a natural hedge against higher carbon prices, while investing in coal power takes on price risk equivalent to selling a 30-40 year call option on rising carbon prices. Additional annual carbon costs from Greifswald could total between €140 million and €280 million.

   At a mid carbon price of €30 the annual cost advantage of offshore wind to investing in the Greifswald coal plant is €64.9 million or almost DKK ½ billion.

3. Onshore wind in e.g. Denmark and Germany and offshore wind in e.g. Germany are possibly even more cost effective than the Danish offshore wind scenario used in the cost comparison.

4. Modern coal power plants have a few opportunities to become more competitive: The two main opportunities for plants that are prepared are fuel change and application of CCS. CCS cannot be considered a relevant

alternative because it is not expected to commercially mature before 2030 at the earliest[5]. One disadvantage of this technology is the major increase in fuel supply, today up to 40%.

5. The proposed coal plant near Greifswald is not constructed with heat cogeneration (Combined Heat and Power), eventually making it very ineffective compared to Danish thermal power plants.

6. This study has merely made a cost risk comparison. However, a 1500 MW coal-fired power generation plant as proposed near Greifswald has several major environmental disadvantages: 6.9 million tonnes annual $CO_2$ emissions (about 10% of the annual Danish $CO_2$ emissions) severely contributing to climate change; 250,000 $m^3$/day cooling water, which has adverse affects to the sensitive shallow Bodden Sea water (protected by EU Natura 2000 legislation); about 1,000 kilos mercury of which a large fraction is accumulated by the already polluted ecosystem of the Baltic Sea; sea transport of coal; and occupational health issues of the coal mine employees.

7. An analysis of the current and future regulatory and carbon market environments and the associated costs of developing and operating coal-fired power plants indicates that the risks of Dong Energy's proposed expansion could prevent it from achieving a profitable return on its investment. As a result, Dong Energy's shareholders, current and future, will likely be exposed to significant risks. The expected market value of Dong Energy's generation assets will be less highly valued in the market if it includes more coal than it would if those investments were placed instead into alternative energy sources and/or alternative business strategies.

## RECOMMENDATIONS

1. Dong Energy should consider how shareholders and investors will view a large investment for which impacts are increasingly being priced back into the operating costs with diminishing improvements on the margin in increasing efficiency. In addition, coal is having increasing difficulty competing cost effectively with new and increasingly more cost effective alternatives.

2. Dong Energy should also consider what alternative opportunities the company could take to boost its profile as a clean and green power producer as this will increase the value of the company when it enters the equity markets.

3. The response to new EU policies will require a more serious long standing investment in transformational technologies and new business models.

[5] McKinsey & Company Inc. (2008): Carbon Capture and Storage: Assessing the Economics.

Dong Energy will be better placed if it redirects capital in addressing these new economic realities now.

# NOTE 1: Methodology and Data Sources for Cost Comparison of Coal, Gas, and Wind Generation

The cost calculations apply the methodology and a major part of the data sources from ReCABS[6]. This is probably the most recent, comprehensive and internationally accepted power cost comparison study, and it is implemented under the RETD Implementing Agreement of the International Energy Agency[7]. The objectives of RECaBS were to estimate the costs and benefits of electricity from renewable energy sources compared to conventional technologies in a fully documented and transparent way, to identify cost reduction possibilities for renewables and to communicate the results through an interactive website. The web based interactive REcalculator (http:/recabs.iea-retd.org) is the main output from the study, which was concluded in February 2008. Background reports and data can be found at the website.

The ReCABS aims to internalize all costs from a socio-economic point of view, e.g. air pollution and security of supply. However, in this study the focus has been the corporate economy (Dong Energy as a market actor), i.e. externalities like air pollution and infrastructure costs have been excluded. The following costs have been included in the cost comparison between coal, gas and wind generation:

- Construction costs: The construction costs or investment costs is the initial investment needed before the start of the operation phase. However, in this cost analysis certain costs are excluded, such as: Land acquisition, project management and administration, interest and insurance
- Operation and maintenance (O&M) costs
- System Integration costs: Balancing and capacity credit. Balancing are costs related to handling deviations from planned production, and extra costs for investments in reserves for handling of outages of power plants or transmission facilities. Capacity credit is the cost of some technologies, like wind power, not being able to produce power when the electricity system needs it most
- Fuel costs
- Carbon market price under Phase III (2013-2020) of the EU Emissions Trading Scheme
- Subsidies (negative costs) for certain technologies,

The risk of an unstable fuel supply could arguably be internalized, but has been excluded in this comparison for uncertainty reasons. However, it is evident that

[6] Renewable Energy – Costs and Benefits to Society.

[7] The International Energy Agency (IEA) is an intergovernmental organisation which acts as energy policy advisor to 28 member countries in their effort to ensure reliable, affordable and clean energy for their citizens. The purpose of the RETD (Renewable Energy Technology Deployment) is to significantly increase the use of renewable energy technologies in the RETD member countries. The target groups are poicy makers and private companies dealing with energy. The Implementing Agreement has been signed by ten member countries: Canada,Denmark,France,Germany, Ireland, Italy, Japan, Netherlands, Norway, and United Kingdom.

renewable energy has a fuel cost stability advantage over fossil fuel commodities. ReCABS has estimated the price stability of renewable energy fuel (100%) over fossil fuels to 2.3 €/MWh.

Hans Henrik Lindboe, EA Energy Analyses has reviewed the methodology, data and assumptions in this Note, which are used for the cost comparison scenario in chapter 3.

**Fuel Prices Data**

Fuel prices forecasts are uncertain by nature and subject to much debate, but IEA's World Energy Outlook 2008 price forecasts are at present considered the best updated and publicly accepted data.

The table below is an excerpt from IEA WEO 2008 table 1.4, modified to the unit €/GJ and 2009 prices[8]. Averages of OECD steam coal imports and natural gas European imports for 2010 and 2015 have been applied in the calculations:

FIGURE 10 IEA WEO 2008 Recalculated Fuel Price Forecasts In Real Terms (2009 prices), And Net Calorific Value.

| Fuel | Unit | 2007 | 2010 | 2015 | 2020 | 2025 | 2030 |
|---|---|---|---|---|---|---|---|
| Natural gas European imports | €/GJ | 5.66 | 8.97 | 9.25 | 10.23 | 10.82 | 11.42 |
| OECD steam coal imports | €/GJ | 2.29 | 3.78 | 3.78 | 3.68 | 3.57 | 3.47 |

The latest assessment by the Danish Energy Agency[9] on future energy prices for making socio economic analyses uses IEA's World Energy Outlook 2008 figures as a reference. The Danish Energy Agency estimates that the decrease in fossil fuel prices due to the breakdown of the financial market since 4th quarter of 2008 is only a short term fluctuation. The Danish state therefore fully adapts the long term estimates by IEA from 2013 (keeping in mind the natural high level of volatility of most long term predictions).

**Construction, O&M and System Integration Cost Data**

The figures used for construction, O&M and system integration are all retrieved from ReCABS, except the construction costs for coal and the construction and O&M costs for offshore wind.

[8] The following figures have been used: Inflation rate 2.3%, net/gross calorific value difference 10% for natural gas and 3% for coal, $/€ conversion rate 0.73 (OECD PPP 2007), 1 MBtu=1.055 GJ, 1 tonne=31.4 GJ

[9] Energistyrelsen: "Forudsætninger for samfundsøkonomiske analyser på energiområdet", February 2009.

The specific publicly available figure for the construction costs of the coal plant near Greifswald is used, which is "more than 2 billion €"[10] or 2 billion €.

In the case of the construction and O&M costs for offshore wind the ReCABS data seem to be too conservative compared to recent experiences from the windmill industry, reflected in Havmøllehandlingsplan 2008" (Offshore windmill action plan 2008) by the Danish Energy Agency (DEA). The cost figures have been raised remarkably for the 8 prioritised Danish offshore sites compared to a 2007 study report by DEA and the ReCABS references.

Horns Rev is selected as a reasonable example, since is highly prioritized in the plan, Dong Energy already is constructing one of the sub sites (Horns Rev II), and the weighted summed construction and O&M costs are average of the 8 prioritised areas. It should be mentioned that Horns Rev is.

The discount rate used for all cost data is 7%.

FIGURE 11 Total Costs Of The 3 Power Technologies Excluding The Expected Carbon Price.

| Plant type | Unit | Construction costs | O&M costs | System integration costs | Fuel costs | Total costs exclusive carbon | Total costs inclusive subsidies[11] |
|---|---|---|---|---|---|---|---|
| Hard Coal | €/MWh | 17.91 | 5.03 | 0 | 27.77 | 50.71 | 48.02 |
| Natural gas | €/MWh | 7.43 | 3.86 | 0 | 55.88 | 64.12 | 64.12 |
| Offshore wind | €/MWh | 42.93 | 28.13 | 9 | 0 | 80.06 | 65.33 |

**Carbon price**

A critical determining factor of the fuel chosen under a carbon constrained economy is its relative green house gas intensity. A new coal-fired power plant has emissions almost 50% higher than that of a comparable gas-fired plant. To address this a model was developed to show the impact of a varying range of GHG costs from €0-100/ton carbon for each option in order to quantify a 'switching price' for the price of carbon, above which gas or wind provides cheaper electricity than coal.

The effect of the future carbon price from 2013 onwards should be compared with the expected future carbon price. The carbon price is expected to range between 20 and

[10] Dong Energy Feb. 2009 Greifswald Newsletter.
http://www.kraftwerkegreifswald.de/Presse/Neuigkeiten/Data/DONG+Energy+News+14.htm
[11] See Subsidies below.

40 €/tonne, estimated by Professor Michael Grubb at Carbon Trust[12]. This is supported by leading financial institutions with average estimates of 30-48 €/tonne[13].

The calculated carbon price in the comparison is based on an emission of 727.66 kg/MWh[14].

**Subsidies**

Offshore wind is subsidized in both Denmark and Germany.

In Denmark the subsidy[15] is different whether the wind farm is tendered or not. E.g recently tendered Rødsand II receives a tariff for the first 50.000 full load hours (about 12 years) of 84.43 €/MWh. As of Jan. 2009 this is equivalent to a subsidy of 43.3 €/MWh since the Nordpool spot price was 41 €/MWh.

For certainty reasons the "open door" subsidy for Denmark is used in this comparison. Without tender ("open door") the subsidy is the same as for onshore wind farms, 36.64 €/MWh for the first 22,000 full load hours (about 5.25 years). Recalculating this subsidy to its net present value and afterwards changing it to a cash flow similar to having the subsidy during the technical life time of the windmill gives a value of 14.73 €/MWh. The 14.73 €/MWh is subtracted from the total costs as seen in figure 11.

Since the German subsidies are higher initial tariffs than the market price, the calculated life time subsidy has to be based on an estimated market price for the whole life time. This is much too uncertain and a comparison has therefore been left on. On the other hand the subsidy system In Germany is quite attractive and it should be mentioned here.

The initial tariff for farms built before 2016 is 150 €/MWh for the first 12 years. This period can be extended according to the distance from shore the water depth: By 0.5 month for each nautical mile above 12 and by 1.7 month for each meter deeper than 20 meters. Using Horns Rev as an example with an average depth of 18 meters and 21.6 nautical miles from the nearest service harbour gives an additional 4.8 months initial tariff support. Hereafter it will be reduced to 35 €/MWh. By making a simple comparison by assuming the EEX power price in March 2009[16] to be valid during the 20 year life time gives a subsidy of 83,65 €/MWh.

In the cost comparison in chapter 3 is also included a coal scenario with a 15% construction cost subsidy to new coal plants. This is due to the fact that the European Commission, on the basis of the newly adopted (17th December 2008) text to the ETS Directive, has stated that the Member States can possibly use the revenues from the sale of carbon allowances to support CCS ready coal plants with up to 15% between 2013 and 2016. The full text is:

[12] "Carbon Prices in Phase III of the EU ETS", Climate Strategies, Aug. 2008; Grubb, Michael, Chief Economist at the Carbon Trust, and Professor at Faculty of Economics, Cambridge University
[13] McKinsey & Company Inc. (2008): Carbon Capture and Storage: Assessing the Economics, exhibit 29.
[14] CO2 emission factor for hard coal is 95 kg/GJ. I.e the emission is (95 kg/GJx3.6 GJ/MWh)/0.47 (announced efficiency by Dong Energy of the coal plant near Greifswald) = 727.66 kg/MWh
[15] The subsidies in Denmark were improved in June 2008 by a revised legislation: Lov nr. 505 af 17. juni 2008.
[16] German Baseload Month Futures, March 2009 – 37 €/MWh

**"Commission statement ad Article 10, paragraph 3 on the use of revenues generated from the auctioning of allowances**

Between 2013 and 2016, Member States may also use revenues generated from the auctioning of allowances to support the construction of highly efficient power plants, including new energy power plants that are CCS-ready. For new installations exceeding the degree of efficiency of a power plant according to Annex 1 to the Commission Decision of 21 December 2006 (2007/74/EC)[17] the Member States may support up to 15% of the total costs of the investment for a new installation that is CCS-ready."

## Technical Operational Assumptions

FIGURE 12 Technical Operational Assumptions In A 2010 Scenario For The 3 Power Generation Technologies In Comparison.

| **Plant type** | **Annual full load hours** | **Electrical efficiency** | **Technical lifetime (years)** |
|---|---|---|---|
| Coal | 6,000 | 47% | 30 |
| Natural gas | 6,000 | 60% | 25 |
| Offshore wind | 4,279[18] | N/A | 20 |

[17] Commission Decision of 21 December 2006 establishing harmonised efficiency reference values for separate production of electricity and heat in application of Directive 2004/8/EC of the European Parliament and of the Council (*notified under document number C(2006) 6817)*.

[18] Data for Horns Rev in "Havmøllehandlingsplan 2008", Danish Energy Agency.