Green Jobs and the Clean Energy Economy

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Thought Leadership Series #4

Green is the new blue... blue collar, that is

The clean energy industry has been targeted as a key area for investment for three primary reasons: greater energy independence, improved environmental benefits from reduced greenhouse gas emissions and significant, positive economic impacts. Job creation is an especially pressing issue as we confront both our climate responsibilities and the opportunity to build a low-carbon economic base. The development of indigenous sources of clean energy will spur the creation of more jobs locally than 'business as usual' fossil-fuel economies of the last century, while investments in energy efficiency measures will redirect money otherwise spent on energy costs, reduce emissions, and create a large number of jobs. Sensible investment in renewable energy will build a foundation for economic stability, sustainability, and growth.

Understanding potential job creation is a vital component of any effort to invest in the clean energy economy. The main findings of the study shared herein are based on quantitative analysis of job creation data for the major renewable energy technologies and qualitative analysis of a few key industries. They indicate that the renewable energy sector generates more jobs per unit of energy delivered than the fossil fuel-based sector, and that many sectors can contribute to both very low CO2 emissions and significant job creation. The discussion of the wind energy industry also draws upon the example of the world's largest wind energy company, Vestas.

The clean energy imperative

The findings of the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) suggest that an 80-95% reduction in industrialized countries' greenhouse gas (GHG) emissions from 1990 levels by the year 2050 is required in order to reduce the risk of dangerous and potentially catastrophic climate change[1]. To make this goal achievable and to minimize the cost of later and inevitable action, we believe emissions should be reduced by 25-40% by industrialized countries over the coming decade while rapidly industrializing countries must learn from the experiences of those more developed nations and engage on less carbon-intensive

paths to development. As a whole, global emissions need to peak and begin to decline in the next decade.

Reducing emissions as early as possible has many advantages. The Stern Review details the benefits of strong, early action to address climate change and underscores how the costs associated with progressive climate policy in the short term will impact GDP to a far lesser degree than delaying action into the future.[2] Stern and colleagues go on to say that now is the right time to invest in measures that promote low-carbon technologies, both on account of climate change and the current economic situation. This would effectively create jobs in the near term and avoid 'locking in' high GHG-emitting facilities for decades to come.[3]

Policy conditions to enable renewable energy

The electricity sector is responsible for 40% of worldwide carbon dioxide emissions, and these emissions are projected to continue rising.[4] As such, finding reliable sources of low-carbon energy will be imperative if nations are to have any hope of decoupling economic growth from emissions growth.[5] Renewable energy can be a driver for economic development and employment as the achievement of a low-carbon and more sustainable economy will likely increase demand for labor and result in the net creation of jobs.[6] Enabling this outcome, however, requires the implementation of certain policies and measures. These include:

- Long term government commitment to specified and ambitious renewable energy targets;
- Financial support in order to ensure that targets are reached;
- Access to transmission infrastructure and strategic expansion of this infrastructure;
- Streamlined planning and permitting procedures.

These policy signals deliver the message that governments are serious about addressing climate change and enable the robust capital expenditure investment required to meet the scale of the challenge. This policy certainty attracts progressive companies who believe they can profit from the coming green energy revolution and encourage the development of manufacturing and research facilities. Where progressive en-

ergy and environmental policies are implemented, so-called 'green-collar' jobs will follow.

Focus on renewable energy: Wind energy, emission reduction and job creation

The European Union's renewable energy policies are among the most progressive in the world, leading to both higher levels of investment and commensurately higher employment in the renewable energy sector. EU estimates indicate that there are currently 150,000 direct jobs in wind energy in the EU alone, half of the entire renewable energy industry. Germany, Denmark and Spain account for 70% of installed capacity and more than 90% of the EU's wind industry employees (see Figure 1)[7]. The European Wind Energy Association further states that over 60,000 jobs have been created in the last five years, an average of "33 new people every day, seven days a week". They go on and explain that "entire local communities have been revitalized as a consequence of wind turbine manufacturing and related activities," citing examples from Nakskov and Esbjerg in Denmark, Schleswig-Holstein in Germany and the region of Navarre in Spain, where the wind industry "continues to have a dramatic impact on the local economies and overall employment."[8]

Jobs stemming from investments in renewable energy don't just contribute towards the stabilization of an uncertain economy but towards the reduction of GHG emissions as well. On an annual basis:

- The European Wind Energy Association estimates that the 57GW of wind capacity installed in Europe at the end of 2007 avoids the emission of about 90 million tons of CO2[9];
- The Global Wind Energy Council adds that cumulative global wind power capacity could reach more than 1000 GW by the end of 2020, saving as much as 1.5 billion tons of CO2[10];
- Vestas Wind Systems monitors approximately 23,500 turbines on a real-time basis and estimates that they avoid over 40 million tons of CO2 emissions each year.

The Vestas V90 3.0-MW turbine alone is carbon neutral after only seven months of energy production; during its lifetime it saves the atmosphere from 220,000 tons of CO2.

Green Jobs: Three success stories in renewable energy

By encouraging renewable energy technologies in a sustained manner over the last twenty-five years, several countries have successfully built strong domestic industries and positioned themselves to capitalize on the rapid growth in global demand for renewable energy sources in the coming years.

Germany subsidized individual rooftop photovoltaic (PV) installation beginning in 1991 and has provided a 20-year "feed-in" tariff since 1990. To encourage adoption, from 1995-2004 the government provided loans for PV installation; the combined result of these policies has been to make Germany the top market for solar installations in the world.

During the 1973-74 OPEC crisis Japan and Denmark were 99% dependent on imported energy. Today, solar-powered electricity in Japan is cost-competitive with electricity produced from coal. The solar industry is now subsidy-free, and Japanese manufacturers currently represent 26% of the global solar PV market. Japan aims to have 30% of houses with solar panels by 2030 and has made great strides to achieve a more independent and secure energy supply.

Perhaps the most remarkable example is provided by Denmark. Since 1980, via policies promoting energy efficiency and renewable energy, Denmark's GDP has grown by 56% while its energy consumption remains unchanged. Wind energy now provides 20% of domestic electricity and Danish firms currently produce one-third of the world's wind.

The Danish government covered 30% of wind investment costs from 1979 to 1989, with loan guarantees later being provided for large turbine export projects. It also established utility purchase mandates at above market prices and funded research support for wind turbine design and manufacturing improvements. Moreover, financial incentives such as tax free income for wind generated by cooperatives has led to a high degree of citizen participation in the wind industry, with 80% of Denmark's turbines owned by over 150,000 Danish families.

The Danish wind industry is profiled in greater detail with a case study of wind energy giant Vestas

Denmark is a pioneer country in wind energy, having developed the industry over the course of the past several decades and currently boasting up to 20% wind energy in its electricity mix. Denmark is today home to some of the world's largest wind energy companies, including manufacturing, R&D and specialized service companies, and Danish manufacturers produce almost 40% of annual global installed capacity. [11] The Schleswig-Holstein government in northern Germany succeeded in creating an attractive environment for investment, including labor force and the necessary public infrastructure, to promote wind energy in the region. As a result, "each MW installed produces more than €100,000 of tax revenue during its 20 years of operation", and fiscal income from wind energy related activities was €5.8 million in 2004, with this amount expected to double in 2009. [12]

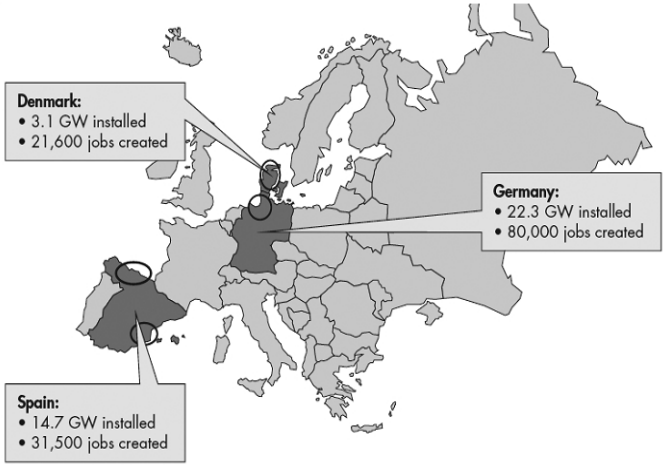

Figure 1. Map showing installed capacity of wind energy and jobs created in Germany, Spain and Denmark. Source: Boettcher et al.

The story is a similar one in Navarre, Spain: the region had strong support by the regional government to develop its wind industry base, and now boasts four wind turbine assembly factories, four blade factories, two component factories and one of the largest wind turbine testing laboratories in the world.[13]

The U.S. Department of Energy's recent report on 20% wind by 2030 in the U.S. estimates that almost 260,000 jobs will be generated per year to meet the 20% wind goal. That adds up to more than 6 million jobs from 2007 to 2030 only in the construction phase[14]. Operating 300GW of wind will require more than 76,000 direct jobs in 2030, with a total of more than 3 million jobs for operation from 2007-2030. The U.S. currently employs about 50,000 people in wind energy.[15]

In the United States, the Pacific Northwest region is one of the key clusters for the wind industry. The region expects that wind power can be a key sector for job growth and economic vitality for a number of reasons: a 75% target for clean electricity by 2025; the growing wind development community; policy incentives that have created an appropriate enabling environment; significant investment in infrastructure, and workforce development.[16]

The Renewable Northwest Project concludes the following about wind farms in Washington State: "wind power development in Washington represents a major economic windfall for the region. The four large, recently completed Washington wind farms are generating millions of dollars in new property tax revenue for counties, millions more in annual royalty payments for landowners and creating hundreds of new jobs."[17]

The consultancy McKinsey & Company has performed several studies on the wind industry that include evaluations of employment impact. In Wind, oil and Gas: the Potential of Wind, it concludes that the wind industry generates more jobs than the coal, gas and nuclear power industries per megawatt hour generated . Research institutions such as Berkeley's RAEL have reached similar conclusions. McKinsey continues and states that, for the U.S. to fulfill the 20% wind energy by 2030 target, many manufacturing jobs for the wind industry would be created and located in areas hardest hit with unemployment (see Figure 2)[18].

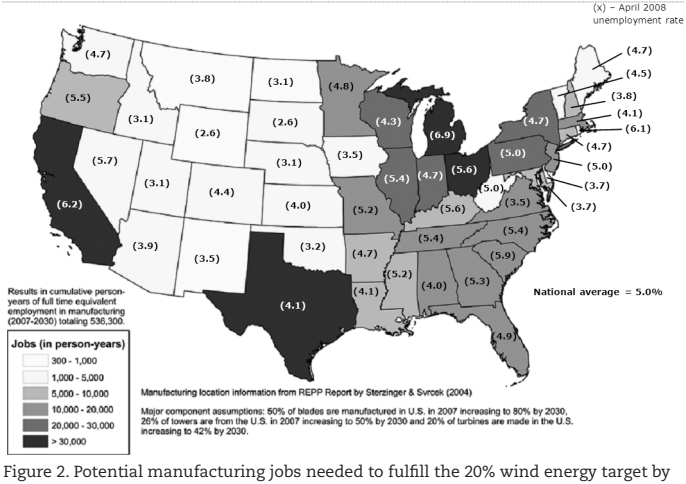

Figure 2. Potential manufacturing jobs needed to fulfill the 20% wind energy target by 2030 per state (colors on the map, the darker the color, the more jobs), compared to the U.S. rate of unemployment per state (numbers on each state). Source: McKinsey 2008

Rural clean energy and jobs: Solar in Kenya

Solar electrification has emerged as the primary alternative to grid-based rural electrification in a number of developing countries, including Kenya, one of the largest and most dynamic per capita adopters. Cumulative solar sales in Kenya since the mid-1980s are estimated to be in excess of 200,000 systems, and annual sales growth has regularly topped 15% over the past decade.[19] Much of this activity is related to the sale of household solar electric systems, which account for an estimated 75% of solar equipment sales in the country[20].

Kenya is served by a dynamic and highly competitive supply chain that includes more than a dozen import and manufacturing companies, and hundreds of vendors, installers, and after-sales service providers. Data from a survey in 2000 conducted by the Tegemeo Institute indicated that 4.2% of rural Kenyan households owned a solar system. The same survey found that 4.3% of rural households were connected to the national electrical grid, and numerous sources indicate that solar sales are growing faster than the rate of new rural grid connections[21]. In other words, solar electricity has emerged in Kenya as a key alternative to grid-based rural electrification.

The Kenyan solar market is also notable because it developed with minimal direct government support and only very moderate inputs from international donor aid groups. Solar sales in Kenya have historically been (and continue to be) driven largely by unsubsidized over-the-counter cash purchases of household solar systems [22]. This makes Kenya an important example of a growing international trend towards market-based approaches to rural energy service delivery. This market approach has important implications for the social significance of solar electrification, as it means that the distribution of access to the technology is strongly influenced by purchasing power.

Job creation and job improvement have been a hallmark of the best aspects of the Kenyan solar industry, with business opportunities for virtually the entire supply chain. Solar energy systems, batteries, and even small wind turbines are increasingly available either directly from designers/developers, or from the array of solar companies that aggressively advertise on TV, in local newspapers, and by radio. In addition, the Kenyan industry has 'gone viral', with versions in other African nations and beyond.

Green jobs: Addressing the critiques

Studies about green jobs have proliferated in the past few years from a wide variety of sources (non-government organizations, advocacy groups, industry groups, academics etc.), with varying estimates of job creation benefits and methodologies. As a response, these studies have also produced several critiques of green jobs studies and their conclusions.

Critics of green job studies cite allegedly incomplete accounting for the costs of green job programs, namely the jobs that are lost or shifted by such programs, and whether large capital investments by the government would be better spent elsewhere in the private sector.[23] For example, requiring renewable energy sources that are more expensive than conventional sources and/or directing large government subsidies for their production, may drive up costs and cause job loss, or it may furthermore crowd out other business investment. According to one study from King Juan Carlos University in Madrid, the Spanish government has created jobs at the rate of $775,000 per job with subsidies, more than twice the estimated amount for job creation through private industry investment ($350,000 per job).

However, neither green job studies nor their critiques typically include avoided environmental costs or other potential benefits (less imported fossil fuel, reduced health care costs, etc.) that would favor green job programs. Longer-term costs are difficult to quantify with uncertainties in their magnitude, attribution and timing but have the prospect for catastrophic irremediable damages. Furthermore, in some cases, businesses may not be equipped or organized to invest in large-scale beneficial projects such as grid modernization where the government needs to play an active planning and investment role.

At the macroeconomic level, it has been argued that global warming is one of history's greatest market failures and that to preclude the prospect of severe economic and social consequences in the future a transition to a low carbon economy is urgently needed. Policies and programs to support this transition are one way of viewing the green jobs movement, and thus the key question is not whether or not to support "green jobs", but how best to do it – which policies have the greatest benefit to cost ratio, how long-term benefits should be balanced against short-term costs, how economic dislocations should be minimized, and how best to position government policies in dynamic and competitive global markets.

How many jobs can be created by the clean energy economy?

An increasing number of studies are finding that greater use of renewable energy systems and energy efficiency provides economic benefits through job creation while at the same time providing protection from political and economic risks associated with over-reliance on a limited suite of energy technologies and fuels. This paper builds upon the results of a study that reviewed the range of recent studies on job creation potential of the renewable energy industry.[24] A cross-technology assessment of the U.S electricity sector yields the following key conclusions:

(1) **The renewable energy sector generates more jobs per unit of energy delivered than the fossil fuel-based sector.** This is true for all technologies within the renewable energy sector (Table 2). A 20% national RPS in 2020 produces more than a million additional job-years than the case where there is no renewable generation and this 20% of generation is produced by coal and natural gas (see Appendix).

(2) **Many sectors can contribute to both very low CO2 emissions and significant job creation.** Each of the following different scenarios can produce half a million job-years by 2020: (a) reducing energy growth by fifty percent over reference levels through greater energy efficiency (0.5% per year annual growth vs. 1% reference); or (b) increasing RPS to 25% from the reference case of 7%; or (c) increasing nuclear power generation capacity to 30% of overall generation from the reference baseline of about 20% (see Appendix).

(3) **Among the common RPS technologies, solar PV creates the most jobs per unit of electricity output.** For a 20% RPS target in 2020, doubling the amount of solar PV from 1% to 2% of overall generation increases the number of jobs from 399,000 to 732,000 job-years (see Appendix).

(4) **By targeting national RPS and electricity growth rates, as well as increasing low carbon sources, the job creation potential is in the millions.** A national RPS of 25% in 2025 coupled with 0.5% annual electricity growth rate (vs. 1% reference) can generate over two million jobs, and further increasing low carbon sources by about 50%

generates over three million jobs. This additive approach results in 90% of electricity supply from renewable or low carbon sources.

(5) **Carbon capture and storage does not yet appear to be a significant driver for expanding net employment. CCS has a lower job multiplier compared to the average multiplier for renewable technologies (Table 2). Currently CCS has a lack of viable demonstration plants and large uncertainties in commercial viability, technology, and regulatory environment. Unless there are major national initiatives and expansion coupled with rapid technological progress, we do not expect a high penetration rate of the technology by 2020 and hence project relatively smaller employment impacts**

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Study results

Technology	Total Job-Years per GWh
Biomass	0.22
Geothermal	0.25
Solar PV	0.91
Solar Thermal	0.27
Wind	0.17
Carbon Capture & Storage	0.18
Nuclear	0.15
Coal	0.11
Natural Gas	0.11
Energy Efficency	0.38

Table 2: Average employment for different energy technologies normalized to the amount of energy produced (or saved in the case of energy efficiency). All renewable energy sources produce more jobs than coal and natural gas.

Jobs in the wind industry: The Vestas example

Vestas is the largest pure-play wind turbine manufacturer on the market: a global company with local expertise, represented in 24 countries and with multiple production facilities in Denmark, Norway, Sweden, Germany, China, India, Italy, Spain, England, and the USA. Vestas has installed more than 38000 turbines in 62 countries and on 5 continents. Vestas installs a new turbine on average every 3 hours somewhere on the planet. Vestas also has the largest R&D facility in the industry that employs more than 500 top engineers from around the world.

In the last five years, Vestas' revenue has more than quadrupled (from 1400 m€ in 2002 to 6035 m€ in 2008), and Vestas has more than doubled the yearly amount of MWs installed (from 2670 MW in 2002 to 5,580MW in 2007). To keep up with this rapid growth Vestas has continuously been ramping up its human resources: Vestas currently employs around 21,000 people representing 56 different nationalities.

Illustrative case: Vestas in the U.S.

Vestas Americas is the business unit that covers the U.S. and Canadian markets. Vestas Americas has been present in the U.S. since the wind boom of the 1980s, and is currently based in Portland, Oregon. Vestas Americas has a cumulative installed capacity of almost 6500MW, and it installed 1630MW in 2008. (see Appendix)

In addition to the headquarters in Portland, Vestas operates a number of facilities in the U.S. Vestas currently employs over 1700 in the U.S., and expects to directly employ 4000 people in the U.S. by the end of 2010. The employment forecasts can be seen by facility in Table 3.

The approximately 7000-8000 components of the nacelles at the new assembly line will be sourced by the already functioning purchasing office in Chicago, creating great job growth for possible sub-suppliers in the U.S.

Table 3. New Vestas facilities in the U.S., with opening dates and expected employment.

New facility	Start date	Employees
Blade factory in Windsor, CO	2008	650 by mid-2009
Blade factory in Brighton, CO	2010	650 by mid-2010
Tower factory in Pueblo, CO	2009	500 by mid-2010
Nacelle assembly in Brighton, CO	2010	700 by 2010
Total, new facilities		2500
Total, with current facilities		4000

Energy efficiency: An investment in economic growth

In the current global economic situation, where governments are scrambling to avoid economic and technological stagnation, it is easy to see how investment in energy efficiency may play a vital role in the return to normal, business-as-usual conditions. In the 2009 US Stimulus bill, 5% of the $787 billion allocation was targeted to the renewable energy industry; the two largest portions of that $41.4 billion were put into energy efficiency and smart grid technology. The investment in energy efficiency, especially, has immense positive and immediate economic implications.

According to the Apollo Alliance's research it is projected that about 13 FTE jobs are created per million dollars invested into EE from direct installation and production of relevant materials alone. Arguably, if efforts are made in expanding the range of energy efficiency improvements then there may be greater job creation potential as well as more energy savings for the property owner. Beyond job creation potential, construction spending on EE is projected to pay for itself over time. The California Sustainable Building Task Force estimated that for an initial investment of $100,000 for energy

efficiency in a $5 million construction project, there would be savings of $1 million over the life of the building.

The most remarkable implications lie in Dr. David Roland-Holst's 2008 study of job creation in California, which suggests that increase in disposable income due to the energy savings for a household can be responsible for the creation of many jobs. These findings show that about 1.5 million induced FTE jobs with a total payroll of $45 billion were created due to the energy efficiency savings of $56 billion in the 34-year period from 1972-2006.

Smart grids: Adding jobs and cutting energy usage

The Smart Grid, a term for a modernized transmission and distribution infrastructure for electricity, is intended to transform the electricity service sector by allowing electricity consumers and producers to communicate pricing, supply, and demand information in real time and thus purchase, sell and use power more efficiently.

A smart grid is another promising vehicle for job growth and could create many permanent new jobs not only from direct utility jobs but from enhanced investment in infrastructure equipment manufacturing as well. The in-home devices that are needed to broker between power suppliers and consumers are another potential new market for manufacturers. Much like energy efficiency, Smart Grid technology would be a long term investment in the efficient use of power and reducing overall energy usage, and could generate considerable job growth in the process.

Final remarks

Renewable energy and energy efficiency investment can be strong drivers for economic development and employment while insulating the economy from the volatility that stems from overreliance on only a few energy technologies. Studies suggest that countries and companies that take strong early action towards improving their energy use stand to benefit the most, notably due to the increasing certainty of a market price on carbon and tightening of emission limits over time.

However, to ensure the best chance for success, government policy needs to have continuity, predictability and reliability in encouraging cleaner sources of energy as well as conservation and energy efficiency. Scaled investment in renewable energy requires a long term commitment to production targets as well as sustained research support, transmission infrastructure investment, and streamlined planning and permitting procedures; energy efficiency requires aggressive policies of building codes and equipment standards, which can further spur innovation. These investments do not materialize overnight and require long-term policy certainty to be fully realized. Wind-turbine manufacturer Vestas is an excellent example of a company that has benefitted from the reliability and consistency of European renewable energy policy, with a four-fold increase in revenues since 2002 and major expansion plans in the United States.

The jobs study undertaken by UC Berkeley provides a clear indication that the renewable energy sector generates more jobs per unit of energy delivered than the fossil fuel sector. A portfolio of technologies and policies are needed to reach GHG reduction goals in a timely and cost effective manner: energy efficiency, renewable energy mandates (such as a Renewable Portfolio Standard), and nuclear power all have an important role to play in reducing CO2 emissions while generating large numbers of jobs at the same time.

The quantitative analysis that has been undertaken to date is not without its weaknesses. Current studies stem largely from developed nations and are focused on wind, solar, and energy efficiency. More study is needed on emerging technologies such as ocean energy and CCS as well as a modernized electricity grid and storage. More study is also needed in developing nations where renewable energy may play a large role in economic development and traditional power systems may be less deployed.

That said, there is mounting evidence that our climate is perched at a tipping point and that it is only through strong investment on a massive scale in renewable energy systems that there is a chance of avoiding the more dangerous predictions suggested by climate models. Politicians and industry leaders must set a resolute example by committing to long-term low-carbon solutions that will at once place the economy back on track while decoupling economic growth from emissions growth once and for all.

Glossary of terms

BAU: Business-as-usual trend without any further policy or interventions. In this paper, it refers to projections of electricity generation and sources of electricity supply to 2030 in the United States by the Energy Information Agency of the United States Department of Energy.

Feed-in Tariff: an incentive structure to promote greater production of renewable power whereby regional or national electricity utilities are obligated to buy renewable electricity (solar photovoltaics, wind power, biomass, hydropower and geothermal power) at above-market rates set by the government.

Job-Year (or "FTE"): One FTE (full-time equivalent) job is equivalent to one job-year, meaning a person employed full-time for one year. Note then that "50 FTE jobs" could mean either five full time jobs over 10 years or 25 jobs over two years or other such combinations.

RPS: Renewable Portfolio Standards are renewable energy mandates in the United States requiring that a certain percentage of overall electric power be sourced from renewable sources in advance of certain specified dates.

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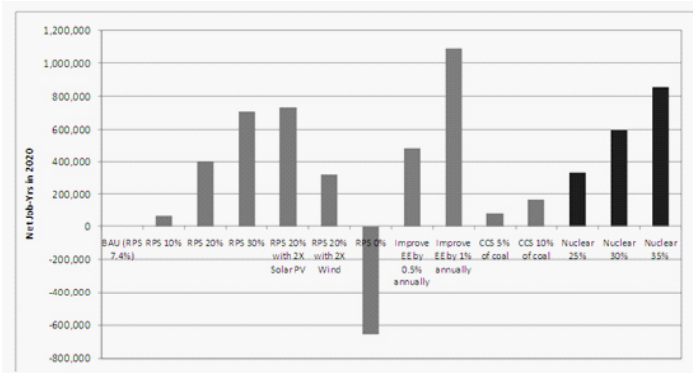
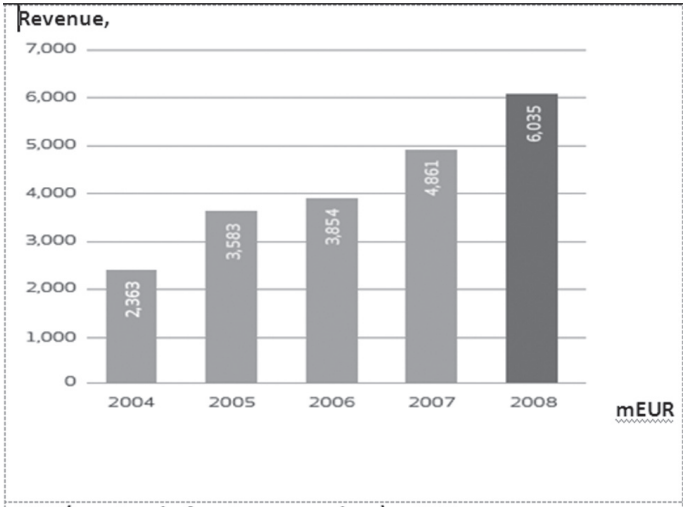
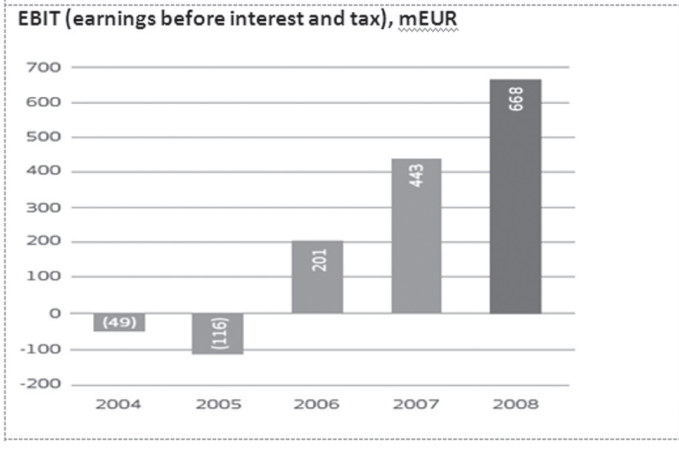
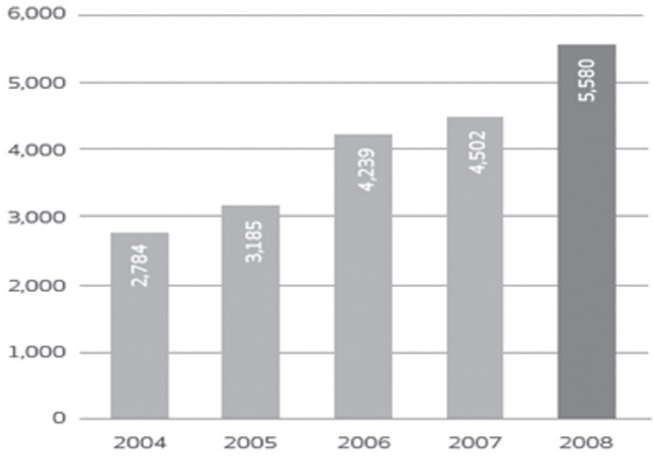
Appendix


Net Job-Yrs in 2020
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
-200,000
-400,000
-600,000
-800,000
BAU (RPS 7.4%)
RPS 10%
RPS 20%
RPS 30%
RPS 20% with 2X Solar PV
RPS 20% with 2X Wind
RPS 0%
Improve EE by 0.5% annually
Improve EE by 1% annually
CCS 5% of coal
CCS 10% of coal
Nuclear 25%
Nuclear 30%
Nuclear 35%

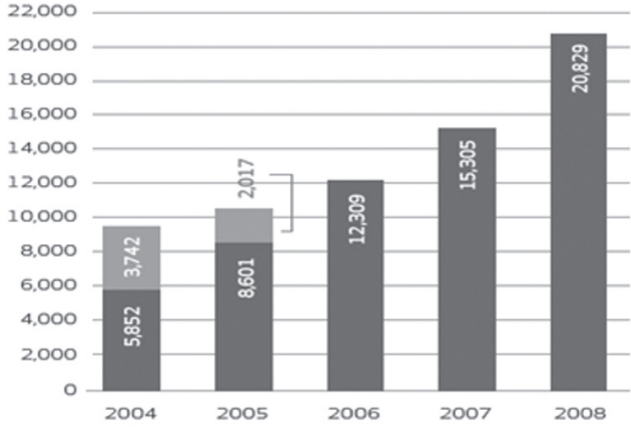

Revenue,
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
2,363
3,583
3,854
4,861
6,035
2004
2005
2006
2007
2008
mEUR


EBIT (earnings before interest and tax), mEUR
700
600
500
400
300
200
100
0
-100
-200
(49)
(116)
201
443
668
2004
2005
2006
2007
2008

MW delivered



Employees



Number of employees included in the reporting of non-financial issues.

About the Copenhagen Climate Council

The **Copenhagen Climate Council** is an international initiative that brings together leading authorities on climate change, including some of the world's most renowned scientists, business leaders and diplomats, who are dedicated to turning the challenges of climate change into new opportunities.

The goal of the **Copenhagen Climate Council** is to create a constructive and positive global dialogue based on effective solutions to climate change. The Council is the principal convenor of the World Business Summit on Climate Change, whose recommendations serve as a private sector call to action for diplomats to agree to a long-term global climate change framework at the United Nations Climate Change Conference in December 2009.

Copenhagen Climate Council Secretariat

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COPENHAGEN CLIMATE COUNCIL
Global partnership for a better climate

About the founder: Monday Morning

Monday Morning, the leading independent think tank in Scandinavia, facilitates the ongoing work of the Copenhagen Climate Council.

Monday Morning (www.mm.dk) was founded in 1989 and is based in Copenhagen. Its main objective is to enable decision-makers to successfully navigate an increasingly fragmented and competitive global society.

Transforming the most important news and trends into strategically useful knowledge, Monday Morning publishes numerous reports and papers, including weekly magazines in Denmark and in Norway, and facilitates key networks for Scandinavian decision-makers.

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