responsible energy
for european regions

Efficient Energy

Lessons from Europe's Regions

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Preface

by Michèle Sabban

President of AER

European Regions Confront Energy Threats

Secure energy supplies, secure energy resources, diversification of the energy mix, whatever side you chose, the debate about the future of energy in Europe is surely not without its worries. Energy accounts for 80% of all greenhouse gas (GHG) emission in the EU; it is at the root of climate change and most air pollution. The EU is committed to addressing this - by reducing EU and worldwide greenhouse gas emissions at a global level to a level that would limit the global temperature increase to 2°C compared to pre-industrial levels. In spite of its importance, the European perspective on the question of energy is relatively new. In the past few years, this question has been combined with another: the fight against climate change. Europe finds itself facing both challenges and is having a hard time creating a form of governance to adequately tackle these issues. As is often the case, a change of perspective gives a new appreciation of changes underway, and a break from the pervasive pessimism. It is indeed beneficial and reassuring to look closer at initiatives at the regional level. The regions – our new survey on "Regional Investment in Energy" shows – deny the uncertainties and risks, and they are blazing a trail toward the future through innovation. However, they will only be able to give the full extent of their dynamism if they have the competencies and the means. From this point of view, much still needs to be done and the goals of the European Union for 2020 will only be achieved by revising current strategies.

Paradoxically, the budget constraints surrounding regional energy policies have become new stimulus for innovation at the regional level. In the context of the economic recovery, the regions are linking their employment strategies with their new climate and energy strategies. They do this through innovative financing and non-financing programmes like contracts for energy performance, public markets and green certificates as well as field agreements in order to aid the local industry to conform to a European trading scheme for greenhouse gas emissions. They are also establishing new partnerships and optimizing resources available through the European Union. In that vein, a growing number of regions have created specialized regional agencies for energy conversion that distribute information and ensure the support of stakeholders working in the field of energy. One example of this is the Swedish agency "Invest in Norrbotten" co-financed by the regional council, 12 municipalities and the European Regional Development Fund. The European Commission receives about 60 applications a year from public authorities seeking to create regional energy agencies. They play an important role in taking into account territorial characteristics in translating energy policies of the European Union. They also foster cooperation and dialogue between different territorial partners, both pubic and private, seeking concrete green projects for the sustainable development of our territories. In the context of uncertainty concerning the capacity of self-financing of these agencies, the European Union should consider extending financing through the program "European Intelligent Energy" or help them create partnerships through which agencies could put in place profitable activities.

Increasingly, the regions are leaders for local stakeholders involved in energy conversion. It is indeed the regions that, through the subsidiarity principle, look to involve their residents in public policies in an increasingly complex economic and technological environment. For example, in the region of Steiermark, the project DaWindSchi was aimed at convincing residents of the benefits of wind energy by using the existing ski infrastructure for a non-intrusive integration of wind farms in the countryside. Similarly, a well-crafted land management policy allowed the province of Flevoland to shoot down public opposition to the installation of wind farms. It is also the regions that, with the towns, are trying to realize energy efficiency gains or sharing energy resources. There are many examples, and an estimate 15% savings in $C0_2$ emissions by 2020 could be achieved by using information campaigns around transport, logistics, buildings and the energy production and delivery sectors. This innovative cooperation with the municipalities is also at its peak in our regions. Examples include the support of the state of Baden Württemberg for the development of bio-energy villages, the development of sustainable communities and their energy certification in the Austrian regions, or the creation of "energy managers" in the province of Voïvodine.

Our survey also underlined the need for better support for the regions in the process of shaping project financing through the structural funds. These funds are still vital for the greening of our territories: the development of clean energy sources and increasing energy efficiency. That is especially true for the new members and candidate countries in the European Union for which the structural funds offer opportunities previously nonexistent. Lack of clarity about conditions of eligibility and lack of information on the weight of different criteria in the selection process create a disproportionate burden on the regional administrations. Our study also shows insufficient communication about new financial instruments of the European Commission and the European Investment Bank, i.e. Jessica, Jaspers and Elena. These instruments are still largely unknown.

We have already had the opportunity to advocate for more localized energy policies. The success of our partnership with GE, and our common event "Regional Energy Days", during which we presented our study results, are steps toward an energy transition in Europe. This transition is based on new approaches, new strategies, more local and more mutual. Our study shows it: Europe can rise to the challenge of a European Community of energy, but to achieve this goal we must vow to pursue more localized initiatives.

Preface

by Ricardo Cordoba

President of GE Energy
for Western Europe and North Africa


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Energy efficiency begins with 'Efficient Energy'

Energy is possibly one of the greatest challenges facing the modern world and providing a secure, reliable and sustainable energy supply has become a top priority. With the most recent international energy projections showing a long-term rise in global energy demand, the necessity for the deployment of sustainable and viable energy sources has reached a greater level of earnestness than ever before. Yet the challenge remains as to how to maximise the potential of our energy generation capacities and how better to control our energy consumption.

Of the three pillars of the EU Energy 2020 strategy, 'Energy efficiency' has emerged as the most talked about. The fact that the target was never a binding target might be one of the reasons for this discussion. The European efforts to increase energy efficiency up to this point have been very focused on measures to improve end-use efficiency, and largely ignore the potential to reduce huge losses that occur in the production and delivery of power. Examples of such end-use initiatives include building insulation and energy efficient lighting and high efficiency.

While these issues are equally as important, what is often missing is the equivalent attention to another type of energy efficiency: resource efficiency, also known as supply-side efficiency. Through a new commissioned study by Delta Energy & Environment, GE Energy is seeking to highlight not only the fundamental importance of supply-side efficiency but also the opportunities that can be gained from implementing such initiatives and technologies.

Many of the technical, supply-side options are proven, cost-effective and reliable technologies that are already commercially deployed. However their potential has yet to be fully realised. The study identifies the economic potential for, and quantifies the benefits of such solutions in three European countries – France, Poland and the UK. These three countries are representing the diversity of European energy use (France is heavily reliant on nuclear, Poland is dependent on coal, while the UK has a more mixed fuel energy economy). It looks at technologies such as fuel switching in the power sector – specifically from coal to natural gas, power plant optimisation and other measures to improve the efficiency of existing CCGT power plants, and combined heat and power (CHP), from micro-scale residential projects to large-scale industrial ones. The report also covers the emergence of smart grid technologies and waste heat capture.

Today's global energy system is incredibly wasteful, from a total primary energy input for electricity production of 49,555 TWh, only 15,623 TWh of electricity was actually delivered to customers. That said, all forecasts point to rising European demand for electricity in the coming decades, net of expected demand-side efficiency and conservation gains. It is in this scenario that a reinvigoration of supply-side opportunities or more resource-efficient electric power generation and delivery can be seen for what it is – a strategic imperative for Europe.

At the heart of the development of efficient energy will be the European regions because it will be at regional level, especially in the local economies, that the benefits of operating, deciding and implementing policies will be accrued.

Regions can take their future into their own hands In fact, according to a previous study by the Assembly of European Regions (AER), 77% of the 67 regions surveyed are already employing their own energy and environmental strategies. They can support the development of the low carbon economy by growing thousands of new jobs, skills and economic clusters that will be vital to ensure the investment in infrastructure needed. So, not only are they environmentally friendly but, in the long run, they are economically friendly, factors which are important to a post-recession EU.

Regions are perfectly placed to implement such initiatives; they offer unique resources that can drive the diverse energy mix required to support low carbon energy. They have great experience with energy investments and infrastructure, they are key to planning and consent, and they are actively engaged and exercise an increasing influence over energy strategy in their territories.

The Delta Study, which is part of the REFER report, has been presented during the European Regions Energy Day between April 11th and 12th, 2011, an event which is co-organised by the GE Energy–AER partnership. It shows that with greater uptake of supply-side efficiency, significant contributions can be made to not only the achievement of the EU climate change and energy efficiency targets, but also how we can make this happen, what barriers need to be removed and what incentives we need to introduce to turn this potential into a reality.

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Efficient Energy
Lessons from Europe's Regions

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Introduction

We may look back on 2011 as a fulcrum point in the history of energy policy in Europe: revolutionary unrest in key oil-producing nations or their neighbours, an earthquake in Japan shaking confidence in nuclear power, and a series of new policies from the European Union. Not since the oil shocks of the early 1970s has there been so much focus and political will behind energy policies.

Some of the necessary debates that will help shape Europe's energy future took place during the European Regions Energy Day in Brussels, 11-12 April. But it shouldn't stop there. That is why the Assembly of European Regions and GE Energy have created a network called "Responsible Energy for European Regions" (REFER) to continue the dialogue.

This network of energy professionals on the ground and in the institutional sphere will actively contribute to an exchange of good practices, information and questions. These discussions are taking place through events all over Europe and through a dedicated online social network.

This report is part of this initiative and aims at engaging dialogue. It profiles a handful of regional programmes on the leading edge of energy policy. There are many more examples in the annual report from the Assembly of European Regions. They show what bold, long-term thinking and best practices can generate for consumers, businesses, the economy and the environment.

For policymakers and leaders in the energy field, this report also includes exclusive and important research by Delta Energy & Environment on trends in technology areas that are behind some of these success stories. When it comes to technology, there is not one answer, and there are many still to be discovered -- and each tailored to the topography and geology of the regions.

We invite you to join these debates and to log on to www.refer.eu.com, share your region's success stories and brainstorm with other professionals to help find the technical, financial and political solutions to ensure Europe achieves its energy targets for 2020 and beyond.

Executive Summary

The European Commission released figures in March showing that at the current rate of progress energy efficiency will only increase by about 10% by 2020 -- half the European Union's official target.

In its Energy Efficiency Plan of March 2011, the Commission called on member states to extend their energy efficiency policies to cover not just the demand side but also the supply side – production and delivery sectors – of the energy chain. In other words, member-state policies should not only address how energy can be efficiently consumed, but also how it can be efficiently produced. In many of Europe's regions, cleaner energy production may be the fastest way forward.

The "Responsible Energy for European Regions" (REFER) report is structured to present some of the best regional cases in Europe and highlight the significant role that existing supply side technologies can play in those regions.

The high importance of cost-effective, demand-side efficiency measures has been well recognised by EU institutions and many member states and regions - most recently in the European Commission's Energy Efficiency Plan published in March 2011.

Analysis by Delta Energy & Environment compared the primary energy saving benefits of the supply side efficiency measures with demand-side measures that France, the UK, and Poland have identified over a similar time-frame in their 2007/08 National Energy Efficiency Plans (of the three, only the UK also stated its associated CO_2 savings).

Using European Commission energy data from 2009, Delta stripped out transport measures to enable a fairer comparison, and converted the demand-side efficiency potential into equivalent primary energy savings.

Taking into account that the Delta study did not assess a comprehensive range of supply-side measures, the benefits of supply side measures were still comparable in scale for demand-side measure in Poland and the UK. The UK comparison is an interesting one: its demand-side efficiency potential is particularly high in part because its building stock is notoriously energy inefficient.

In fact, through Delta's analysis of France, Poland and the UK, we have concluded that supply-side energy efficiency measures have the potential to make a significant contribution to the achievement of the EU's carbon emissions and primary energy savings targets. In these three major member states, Delta estimates that supply-side options can contribute up to 35% of an overall goal of a 20% carbon emissions reduction and up to 30% of an overall goal to reduce primary energy consumption by 20%.

In some countries, notably in Eastern Europe, there is a significant potential for increasing energy efficiency and reducing carbon emissions by replacing aging coal generation with new combined-cycle gas turbine generation.

This report will look also look at a great example of a technology that delivers cleaner, more efficient energy is the FlexEfficiency 50 Combined Cycle Power Plant. GE's latest innovation in combined cycle technology engineered from the ground up. Combining GE's unique aviation technology and power generation expertise, the FlexEfficiency 50 plant is engineered to provide an unprecedented combination of efficiency and flexibility. This means it can quickly and efficiently ramp up when the wind is not blowing or the sun is not shining and can ramp down when they are available. Ecomagination-certified, this advanced power plant was developed by GE engineers and technologists to create a clean energy future. It will enable utilities to take advantage of the benefits of abundant natural gas, the cleanest-burning fossil fuel, and avoid 12,700 metric tons of carbon emissions per year relative to GE's existing technology. This power plant will save money for consumers and is better for the environment.

The report also shows that many regions are making steady progress toward their targets, and that there is a wide array of technological solutions to help them address supply-side efficiency, including smart grids and co-generating power plants, switching to cleaner fuels and energy-saving gas turbines. Hampshire County in the UK, for example, wants to form its own power generating company and become carbon neutral, while the German state of Baden-Württemberg aims to have 100 "Bio-energy Villages".

The regions profiled in this report, and those in the annual survey of the Assembly of European Regions (AER) underline the critical factors for success, including long-term policies and planning; a legal framework; a comprehensive land-use plan; consistent communication and coordination with residents, stakeholders and regulators at all levels.

Lack of financing is sometimes a deal-breaker, but other times a motivator. European countries will need to spend €270 billion over the next 40 years, another 1.5% on top of the current 19% of gross domestic product to meet 2050 energy objectives, according to the European Commission. Market incentives and price signals need to be intensified through energy and carbon taxes and through national energy-saving mandates for utilities, the Commission said. There needs to be more and better financing options, since investment costs are often major obstacles for energy efficient technologies, especially for large supply-side power projects with long paybacks.

Three out of four regions surveyed by the AER, including Lower Silesia in Poland, said they use EU funding, primarily structural funds and the Intelligent Energy Europe programme, while others, like Hampshire County, said funding mechanisms like ELENA (European Local Energy Assistance facility) are too slow and bureaucratic to be an effective option.

Whatever the funding source, energy investments will pay off for the economy as well as the environment. In just five years, the industry for renewable energy has increased its work force from 230,000 to 550,000, according to the Commission, and that is expected to grow.

Research must also play a critical role in finding new solutions to efficiency challenges in both production and consumption. The Commission is supporting research through its Strategic Energy Technology Plan and its Framework Program, which so far has financed 200 projects with contributions totaling €1 billion. And research funding is now part of many regional energy strategies, such as in the Midi-Pyrénées in France.

EU member states, with the help of its regions have until 2013 to get back on track to meet the target for a 20% gain in energy efficiency. If the Commission's progress review is still disappointing, the Commission might consider legally binding national targets for 2020.

Regional Investment in Energy

Highlights from AER 2011 Survey

This year the Assembly of European Regions survey looked at excellence in the field of energy investment. Regions will surely play a predominant role in changing the energy panorama of Europe. It will be up to the sub-national level to determine the mix of fuels – oil, gas, coal or renewable energy – which will be necessary to contribute to energy security and sustainable economic growth.

It is mainly regions that are able to turn political commitments taken at the European and national levels into concrete and vigorous action. Regions create the momentum needed for the development of clean economies in a complex and rapidly changing political environment.

The financial crisis convinced many regions that a different kind of economic development is possible to secure Europe's green and prosperous future. It became clear that Europe should start thinking out of the box if it wants both environmental protection and economic prosperity to go hand in hand.

And many regions did just that. The Swiss canton of Valais, for example, put in place an economic stimulus package directed at energy efficiency and clean energy. The Hungarian region of Békés targeted energy security, by directing additional funding to projects of strategic importance, in particular gas procurements. This decision contributed to the diversification of energy supplies and reinforcement of the regional autonomy in energy supply. Békés also made important investments in energy efficiency that brought additional employment benefits.

Many successful energy projects like these, initiated during the economic downturn, have actually shown that it is possible to combine energy technology and macro-economic dynamics and proved that energy savings can also contribute to financial savings. Even more projects of this kind are likely to come as the recovery continues.

While financial capacity can help or even hinder energy investments, there were a number of other factors that were just as important to generating investments, including political complexity, framework conditions, cooperation with stakeholders and innovation and research. Political issues, including having a stable and predictable legal and regulatory framework, play a pivotal role in energy investment, especially in terms of expensive, long-term projects like distribution networks and power plants.

Research and development policies also encouraged more energy investments, the survey found. In the Netherlands, for example, Flevoland has a scheme for funding technical and environmental innovations, while officials in Açores (Portugal) and South Denmark have created "Power Clusters" to foster brainstorming. And often educating a community can be the key to breaking public opposition, raising awareness and improving consumer behaviour, especially with regard to waste disposal and wind energy. AER found impressive educational programmes in Abruzzo, Italy as well as in the Romanian regions of Alba and Braila.

All in all, regions demonstrate a great success of territorial action in the face of unprecedented energy crisis: dwindling supplies of fossil fuels, risk of energy scarcity and climate change. They offer a variety of experience in harnessing green potentials and speeding the transformation of economy. While nations fail to address these challenges, regions, acting side-by-side with the industry, take them up fruitfully. When it comes to advancing smart growth and turning promise into practice, Europe should definitely take inspiration from regions.

The Delta Study

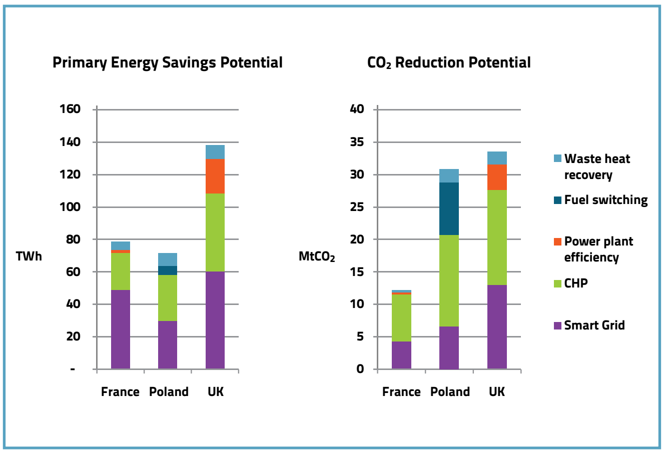
Executive Summary

GE Energy commissioned Delta to identify the economic potential for, and estimate the benefits of, supply-side efficiency options in three European countries – France, Poland and the UK. The technology areas covered by our analysis include:

- Fuel switching in the power sector – specifically from coal to natural gas.
- Power plant optimisation and other measures to improve the efficiency of existing CCGT power plants.
- CHP of all sizes and applications, from micro-scale residential to large-scale industrial.
- The Smart Grid - including continuous diagnostics of energy consumption in buildings, improved T&D operational efficiency, 'smart' demand and influencing customer behaviour.
- Waste heat recovery – capturing waste heat from gas engines and turbines, industrial processes and biomass boilers, and converting this heat to electricity.

The benefits of renewables and demand-side efficiency measures are now well understood among policymakers, and have rightfully received high priority, both at the EU and national levels. With the potential and benefits of some supply-side efficiency now becoming better understood, we believe that increased policy focus in this area, over and above the EU Emissions Trading Scheme (which in itself is unlikely to be sufficient to unlock the potential that we have identified), can enable some key EU energy and environmental objectives to be met more quickly and more cost-effectively. Figure 1 summarises our findings from the three countries.

FIGURE 1: PRIMARY ENERGY AND CO_2 SAVINGS POTENTIAL FROM SUPPLY SIDE EFFICIENCY MEASURES IN THE UK, FRANCE AND POLAND

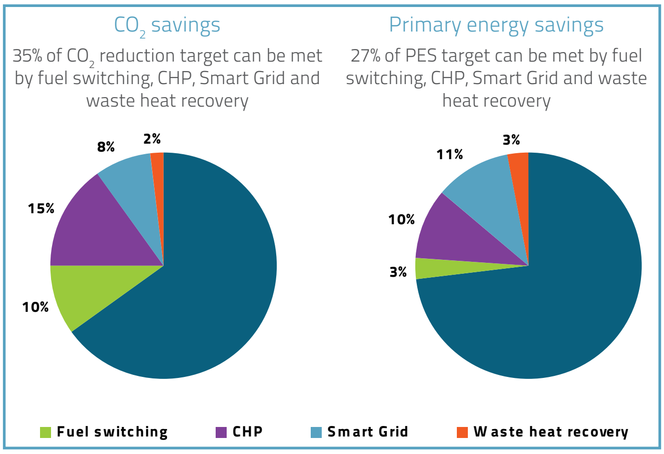


Source: Delta Energy & Environment

Poland

Poland stands out as having high potential to deploy some supply-side efficiency measures, and to great effect. By 2020, over one third of Poland's CO_2 reduction target could be met on the supply side.

FIGURE 2: POLAND - CONTRIBUTION OF SUPPLY-SIDE EFFICIENCY MEASURES TO 2020 CO_2 (LEFT) AND PRIMARY ENERGY SAVING (RIGHT) TARGETS

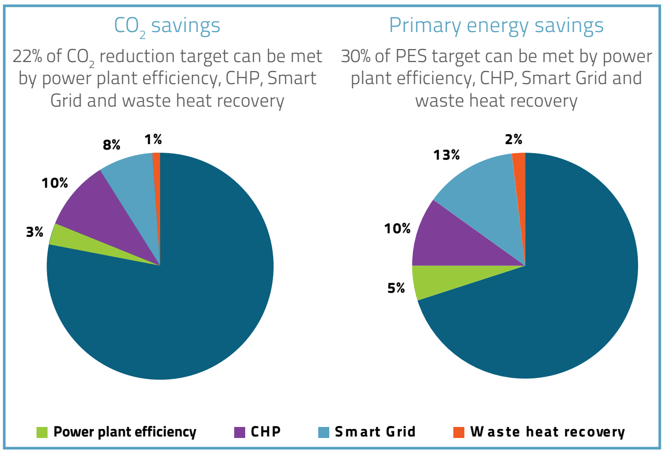


Source: Delta Energy & Environment

The UK

A policy push to achieve the potential from CHP and Smart Grid alone could see the UK meet almost one quarter of a 20% primary energy savings target and almost 20% of a CO_2 reduction target for 2020.

FIGURE 3: THE UK - CONTRIBUTION OF SUPPLY-SIDE EFFICIENCY MEASURES TO 2020 CO_2 (LEFT) AND PRIMARY ENERGY SAVING (RIGHT) TARGETS

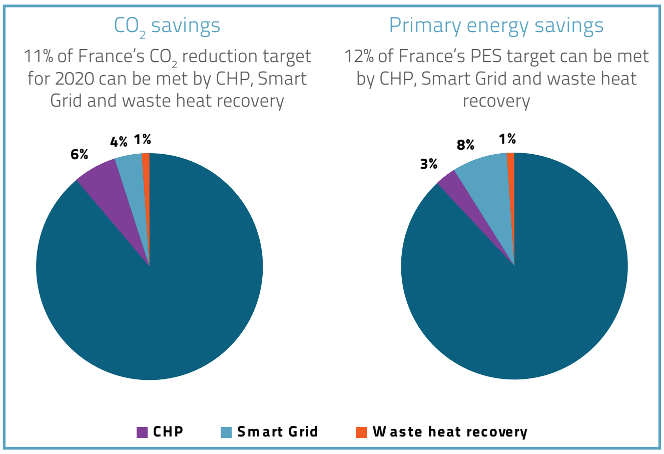


Source: Delta Energy & Environment

France

Three of the five supply-side measures that we have reviewed show significant potential – CHP, Smart Grid and waste heat recovery.

FIGURE 4: FRANCE - CONTRIBUTION OF SUPPLY-SIDE EFFICIENCY MEASURES TO 2020 CO_2 (LEFT) AND PRIMARY ENERGY SAVING (RIGHT) TARGETS

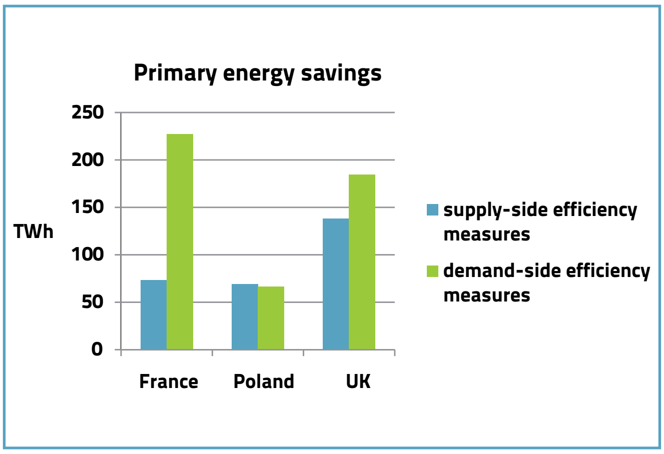


Source: Delta Energy & Environment

Benefits on a par with demand-side measures

As part of our analysis, we have also compared the primary energy saving benefits of the supply side efficiency that we have assessed (there are other options that we have not assessed) with those of demand-side measures that the member states have identified over a similar time-frame in their 2007 National Energy Efficiency Plans. If we were to take a comprehensive range of supply-side measures into account, we believe that the benefits would exceed considerably those of demand-side measures in Poland and be similar in scale in the UK. The comparisons are shown in Figure 5.

FIGURE 5: ANNUAL PRIMARY ENERGY SAVINGS BY 2020



Source: Delta Energy & Environment

Employment impact – new European jobs

Achieving the potentials that we have identified for supply-side energy efficiency will clearly create employment, often involving new and highly-skilled jobs – each section of this report contains some sectors-specific data on this aspect. However, we believe that the quality of the employment impact data that we have sourced for this research, along with much of the data that exists for separate studies in other energy sectors, makes it hard to draw firm conclusions about net employment impacts of one form of energy technology against another.

What we can be more confident about is that many of the supply-side technical measures that we have described in this report are sectors in which European-based companies and industries are strong, and in some cases world leaders.

1 Power plant efficiency

TABLE 1: SUMMARY OF POTENTIAL AND BENEFITS FOR POWER PLANT EFFICIENCY IMPROVEMENTS IN THE THREE MARKETS

	UK	France	Poland
Potential for power plant efficiency improvement	▪ Significant potential, 50% of the CCGT capacity is >12 years old. ▪ The coal fleet has potential for improvements but these are unlikely to go beyond regulatory requirements.	▪ Very little CCGT plant. A small amount of potential – the bulk of which will be in the CCGTs >12 years old. ▪ Very little coal plant. The coal fleet is likely to close over time so there is little potential or political drive to improve efficiency.	▪ No CCGT ▪ In the large aging coal fleet, the realistic potential is small because very old plants will be replaced rather than improved.
2020 Benefits	▪ 4.1 Mt CO_2 saved / yr ▪ 22 TWh fuel saved	▪ 0.34Mt CO_2 saved / yr ▪ 1.9 TWh fuel saved	▪ Limited savings possible given the 2020 scenario.
Technical options	▪ Technology upgrades: Fuel saving: 1-2% ▪ Performance monitoring for more efficient O&M practices: Fuel saving: 0.1-4% ▪ Planning dispatch & load patterns to optimise efficiency: Fuel saving: 10s of %		
Barriers	▪ An economic barrier to implementing significant technology upgrades ▪ Small efficiency gains (0.1%) tend not to be valued ▪ Dispatch patterns are not yet determined based on plant efficiency, so there is no incentive for plants to make small efficiency improvements ▪ The focus is on plant replacement rather than upgrade.		
Recommendations	▪ Incentivise implementation of efficiency measures in existing plants through, for example: - Higher carbon prices - Priority dispatch for more efficient plants. ▪ Implement regulatory measures which take into account optimising efficiency in dispatch planning.		

Source: Delta Energy & Environment

1.1 Power plant efficiency improvements

There are various options for making plant efficiency improvements in existing CCGT and coal plants. In this section, we focus on CCGT plants; for coal plants, we have taken the view that the main longer-term decarbonisation options are carbon capture and storage or plant closure, both of which would have carbon benefits in excess of plant efficiency improvements based on prolonging the lifetime of the plants.

These are designed to counteract the efficiency drop over plant lifetime. In more recent plants, implementation of some of these measures may lead to a net efficiency gain, while in older plant these measures will bring efficiency back closer to that of modern plants.

These measures are summarised in the table below. The first two measures – technology upgrades and performance monitoring - can be implemented today to counteract the efficiency drop over the plant lifetime (typically in the range of 2% efficiency loss over ~24 years), and are driven primarily by economics. The third measure, altering dispatch patterns and controlling load, is an issue with major potential efficiency gains, but has longer-term potential, and is more dependent on policy and incentives.

TABLE 2: MEANS OF IMPROVING POWER PLANT EFFICIENCY

Type of improvement / Savings	Description
(i) Technology upgrades **Fuel / CO_2 saving: 1-2%**	Upgrading components & systems for increased efficiency, e.g. to optimize gas turbine output; to increase plant efficiency at part load and at start-up.
(ii) Performance monitoring – influence on O&M practices **Fuel / CO_2 saving: 0.1-4%**	Modern power plants have accurate performance monitoring capabilities, but in less modern plants (> around 6 years old) there is scope for improvement, enabling more efficient operational and maintenance practices. Performance monitoring relies on: (1) More regular performance testing by performance test teams or onsite performance engineers, and (2) Implementation of automated performance monitoring equipment.
(iii) Dispatch & load patterns **Fuel / CO_2 saving: 5-10% (and potentially as much as 20%)**	Planning dispatch and running patterns to maximise efficiency has large efficiency benefits, i.e. by minimising plant cycling (the number of times a plant switches on / off) & the length of time at part load.

Source: Delta Energy & Environment

Types of technology upgrades

There are a suite of technology options for improving the efficiency of CCGT plants, which optimise the control of the thermodynamic cycle, or minimise leaks and losses. These mechanisms will be standard in most modern power plants, but for plants of around 6 years or more, implementation of these measures can bring a plant close to the efficiency of a new build plant. The range of efficiency improvements achievable is from 0.5% to around 2% for a plant half way through its life (~12 yrs). A very old and inefficient plant may benefit from improvements of up to 5% from such measures. Figure 6 illustrates this.

FIGURE 6: EXAMPLES OF MECHANISMS FOR IMPROVING CCGT PLANT OUTPUT

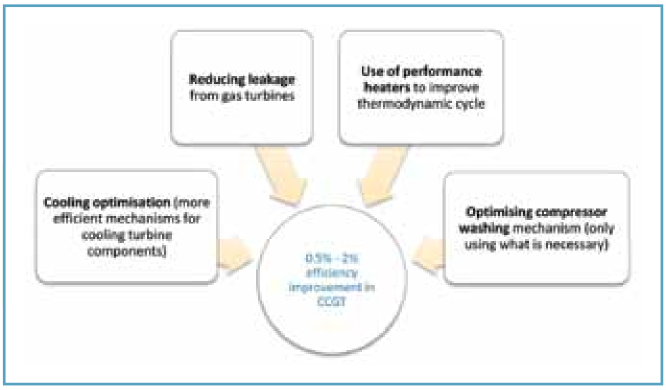


TABLE 3: OTHER TECHNOLOGY UPGRADES WITH EFFICIENCY BENEFITS FOR CCGT PLANTS

Improving efficiency at part load	Fast start – reduces fuel consumption on start-up by half
▪ With a growing trend towards greater cycling of plants (based on increasing shares of inflexible renewable and nuclear generation); it is increasingly important to increase part-load efficiency. ▪ 2% heat rate improvement at 50% load.	▪ With daily start up plants, 5-10% overall efficiency gains could be made. ▪ If start up is only every few weeks or months, the gains could be <0.5%.

Source: Delta Energy & Environment

1.2 UK

Key Message

- A significant opportunity for power plant efficiency improvements in the UK lies in the CCGT fleet – particularly that which will be aged > 12 years by 2020.

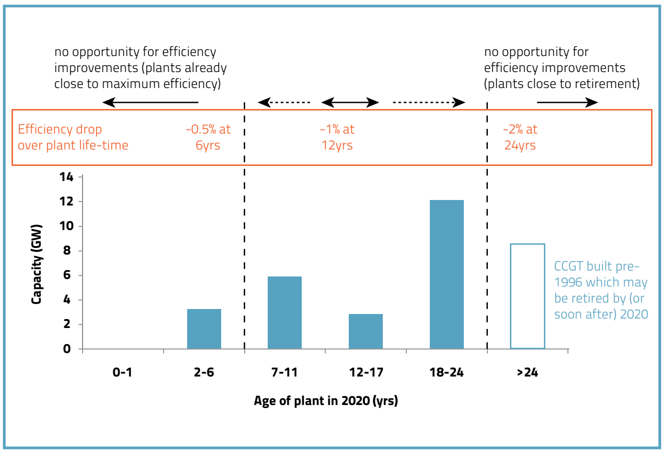
2020 potential for efficiency improvements

Current UK electricity demand is met primarily by fossil fuels with a growing proportion of nuclear and renewables. The existing CCGT fleet is significantly younger than the coal fleet - it has all been built since the 90s, and ~70% of it is likely to still be operational in 2020. The coal fleet is ageing and 95% of capacity has run for more than 24 years and, as we have explained, is not part of our analysis here.

In our analysis of the CCGT efficiency opportunity, we have assumed a 2% drop in efficiency over 24 years of plant operation. The efficiency measures we describe here will go some way to compensate for this efficiency drop.

To assess the potential for efficiency improvements in the UK fleet, we have analysed its age profile to identify those plants where there is scope for efficiency improvement. As Figure 7 shows, over half of the CCGT fleet will be more than 12 years old by 2020. In our assessment of the potential energy savings, we assume that all plants aged 12 and over receive the maximum energy efficiency improvements.

FIGURE 7: PROJECTED AGE PROFILE OF UK CCGT PLANTS IN 2020



Source: DUKES, 2010; New Power, 2010; Delta Energy & Environment, 2011

There are three major areas where efficiency gains can be made in UK CCGT – (1) through upgrading the technology and implementing efficiency measures, (2) through more accurately monitoring plant performance – enabling more efficient maintenance and operational practices, and (3) through altering the overall dispatch patterns to optimise plant efficiency. The table below summarises the scale of the opportunity for elements (1) and (2), and element (3) is discussed separately in the text box below.

TABLE 4: POTENTIAL FOR EFFICIENCY IMPROVEMENTS IN DIFFERENT AGE RANGES OF UK CCGT PLANT IN 2020

The assumptions around this analysis are outlined in Annex 1. Key: Red = <5% of the potential efficiency measures are achieved; Amber = 5 - 50% of the potential efficiency measures can be achieved; Green = 50-100% of the potential efficiency measures can be achieved. In Delta's analysis, we assume that all plants receive maximum efficiency measures at aged 12 – so all plants aged 12 or over in 2020 have had full efficiency improvements made.

Measure		Age of plant				
		<6 years	6-12 years	12-18 years	18-24 years	>24 years
Proportion of UK CCGT plants of age		24%	21%	10%	44%	0%
Measure	Technology upgrade: gas turbines 0.5-2% gain					
Measure	Technology upgrade: efficiency at part-load & at start-up 0.1-5% gain (dependent on operational regime)					
Measure	More accurate performance monitoring 0.1-2% gain					

Source: Delta Energy & Environment 2011

Alternative approaches to planning dispatch patterns: Potential for efficiency gains

Dispatch patterns of power plants – how often they cycle on and off – are key to determining CCGT plant efficiency. During plant start-up, more fuel is consumed than during running – so a plant cycling on and off every day could consume as much as 20% more fuel per kWh of electricity output than a plant running at baseload.

This efficiency loss from CCGT is set to become more of an issue in the UK. The shift towards a low carbon future - involving increased growth in inflexible nuclear baseload and intermittent renewables – means that CCGT will have to shift to increasingly cyclical operation. Annex 1 (Figure 29) outlines Delta's assumptions for how the CCGT fleet will be influenced by this trend. There will be an increasing proportion of CCGT running in cycling operation (as mid-merit and peaking plant), and a reduced proportion running as baseload.

In most EU markets, the UK included, planning of dispatch patterns is not based on avoiding cycling operation in order to optimise plant efficiency, but on economics. If dispatch planning took this into account as the UK shifts towards increasingly cyclical operation of CCGTs (for example allowing plants to keep running at a lower level rather than cease running completely) significant efficiency gains in the order of 5-10% could be made in the UK CCGT fleet. Assumptions are outlined in Annex 1.

Benefits of efficiency measures in existing CCGT plants: fuel and CO_2 savings

As the table below summarises, our analysis of the realistic potential for implementation of efficiency measures in the CCGT fleet can save the UK about 6.9 TWh of primary fuel input, and about 1.26 Mt of CO_2 per year.

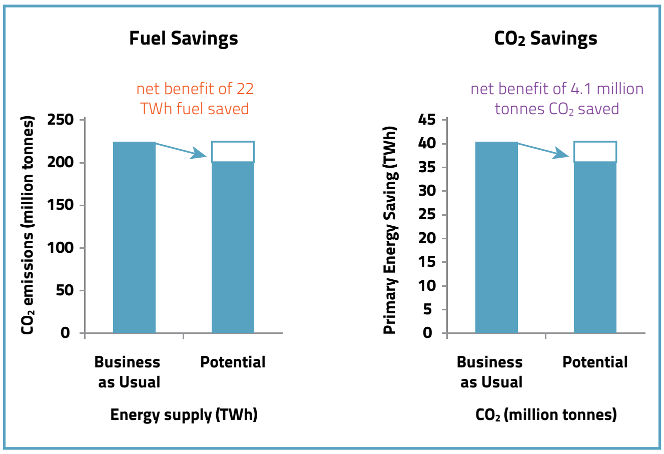
TABLE 5: CARBON AND ENERGY SAVING BENEFITS FROM PLANT EFFICIENCY MEASURES

	Potential
Fuel input to 2020 CCGT fleet with no efficiency improvements (BAU)	224 TWh
Fuel input to 2020 CCGT fleet after implementation of efficiency improvements	202 TWh
Fuel (natural gas) saving by implementing efficiency measures / yr	22 TWh
Contribution to energy saving target	4.8%
CO_2 savings by implementing efficiency measures / year	4.1 Mt
Contribution to meeting national 20% CO_2 target	2.6%

Source: Delta Energy & Environment

In Figure 8, we illustrate this reduction in primary fuel input to CCGT plants, and the associated CO_2 emissions reduction, as a result of implementing plant efficiency measures.

FIGURE 8: CO_2 AND FUEL SAVINGS TO BE MADE THROUGH IMPLEMENTING EFFICIENCY MEASURES IN UK CCGT PLANTS



Source: Delta Energy & Environment 2011

There is as yet no reliable data or research for quantifying the jobs benefits of implementing efficiency measures in existing plants.

1.3 France

Key Message

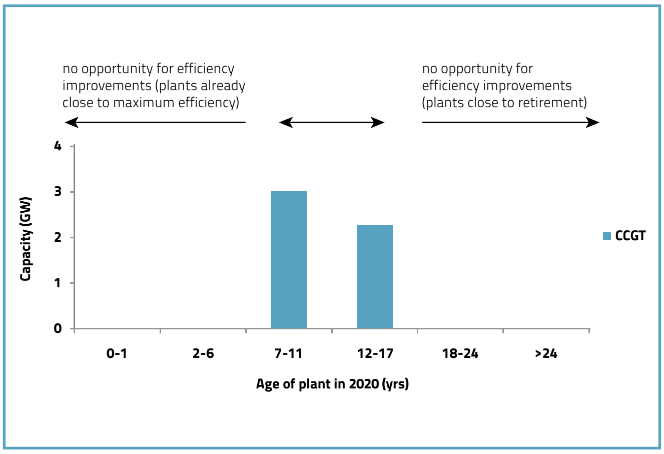
- There is only limited opportunity for improvements to CCGT plants that which will be aged > 12 years by 2020. The French CCGT fleet is young.

Analysis of potential for plant efficiency improvements in France

French generating capacity is dominated by nuclear, with an aging coal fleet (80% of which is over 40 years old), and a small, young CCGT fleet (all built since 2005, with 4 more under construction at present and due online by 2014. Again, we have not included coal plants in our assessments, for the same reason as given under the UK). See Annex 1 for more details.

There is some limited potential for improvements to the 2 GW of CCGT plants which will be older than 12 years old in 2020.

FIGURE 9: PROJECTED AGE PROFILE OF FRENCH CCGT PLANTS IN 2020



Source: Data on existing & planned CCGTs - EDF, 2011; projection to 2020 - Delta Energy & Environment, 2011

Benefits of efficiency measures in existing plants: fuel and CO_2 savings

Due to the very small number of aging CCGT plants in France in 2020, and the initial high build quality, we believe that there is only limited scope for efficiency improvements to be made. These are summarised in the table below.

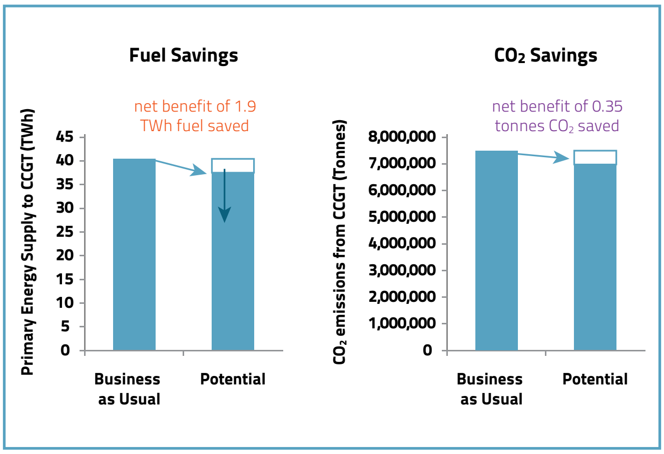
TABLE 6: SUMMARY RESULTS FROM DELTA ANALYSIS

	Economic Potential
Fuel input to 2020 CCGT fleet with no efficiency improvements (BAU)	41 TWh
Fuel input to 2020 CCGT fleet after implementation of efficiency improvements	39 TWh
Fuel (natural gas) saving by implementing efficiency measures / yr	1.9 TWh
Contribution to energy saving target	0.3%
CO_2 savings by implementing efficiency measures / year	0.34 Mt
Contribution to meeting national CO_2 targets	0.3%

Source: Delta Energy & Environment

In Figure 10, we illustrate this reduction in primary fuel input to CCGT plants, and the associated CO_2 emissions reduction, as a result of implementing plant efficiency measures.

FIGURE 10: CO_2 AND FUEL SAVINGS TO BE MADE THROUGH IMPLEMENTING EFFICIENCY MEASURES IN FRENCH CCGT PLANTS



Source: Delta Energy & Environment 2011

1.4 Poland

Key Message

No real potential for plant efficiency measures in Poland because of:

- Aging coal fleet
- Very small, young CCGT fleet by 2020

Analysing potential for efficiency improvements in Poland in 2020

The Polish power sector is dominated by an aging coal fleet, which will be gradually retired and replaced over the next 10-15 years (30% of capacity is due to be retired by 2016). The focus is on new build and fuel switching rather than improving aging coal plants.

However, a small amount of CCGT will have come online by 2020, but this will be so young that there will be no real efficiency gains to be made. More information on the current status of Polish generation and the projected 2020 age profile of plants can be found in Annex 1.

1.5 Barriers

We have identified some potential for efficiency gains in Europe's growing fleet of CCGT power plants, but also some real prospect that these gains may not be achieved.

- The main challenge is the economic rationale for investing in existing plants. Neither the operation of Europe's electricity markets nor the level of the carbon price is sufficient to incentivise plant owners to invest in efficiency improvements.

- There is insufficient economic incentive to invest in more sophisticated performance monitoring regimes – meaning that potential efficiency losses are not identified, and therefore not addressed.

- Currently, the market operates in such a way that plants are generally dispatched on the basis of cost rather than on the basis of energy or carbon efficiency.

1.6 Recommendations

We propose the following options for measures that can be implemented to deliver the potential we have identified:

- Incentivise the implementation of efficiency measures in existing plants.

- Incentivise more rigorous performance monitoring to identify & minimise efficiency losses.

- Develop a regulatory regime which takes into account the optimising of plant efficiency in dispatch planning, especially given the European shift that is taking place from base-load thermal plants to a need for a more flexible type of operation, in response to greater shares of inflexible renewable and nuclear generation, which has negative impacts on plant efficiency.

2 Fuel switching

TABLE 7: SUMMARY OF THE POTENTIAL AND BENEFITS FOR FUEL SWITCHING FROM COAL TO GAS CCGT IN KEY MARKETS

	UK	France	Poland
Current generation mix – installed capacity	▪ ~29 GW coal ▪ ~25 GW gas ▪ ~11 GW nuclear	▪ ~7 GW coal ▪ ~7 GW gas ▪ ~63 GW nuclear	▪ ~30 GW coal ▪ ~1 GW gas
Potential for fuel switching	▪ We assume that closing coal capacity can be replaced by a combination of renewable and gas CHP, not gas CCGT.	▪ We assume that closing coal capacity can be replaced by a combination of renewable and gas CHP, not gas CCGT.	▪ A potential for about 30% (4.1 GW) of the existing coal, scheduled for closure by 2020, to be switched to gas CCGT.
Benefits	-	-	▪ Saving of 8.4Mt CO_2/yr (a 9.5% contribution to the 2020 target). ▪ Primary energy savings of 6.5 TWh/per year (a 2.5% contribution to 2020 target). ▪ 4,000 new jobs in construction, O&M.
Barriers	-	-	▪ Energy security concerns ▪ Economic impacts ▪ New gas infrastructure requirements
Recommendations	-	-	These include: ▪ Continued diversification of the gas supply ▪ Encouraging investment in gas pipeline infrastructure though appropriate tariff policy.

Source: Delta Energy & Environment

2.1 The scope for fuel switching

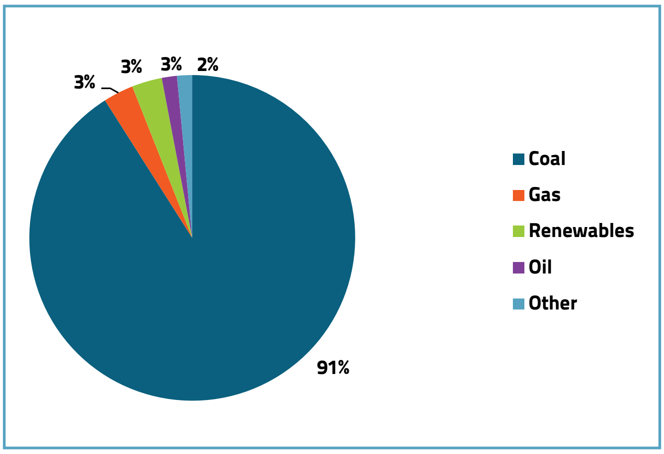
In some countries, there is a potential for increasing supply-side efficiency and reducing carbon emissions by replacing closing coal generation with new gas CCGT generation. Coal power plants emit around twice as much CO_2 per kWh of generation as gas-fired CCGT. New CCGT plants are also more efficient than coal plants, so reducing overall fuel use. The typical operational efficiency of a new gas CCGT is ~50%, while a 25 year old coal plant may have a typical operational efficiency of around 35%, often less.

2.2 Poland

Current generation mix

Polish electricity generation is dominated by coal power plants with over 90% generation from coal (see Figure 11)

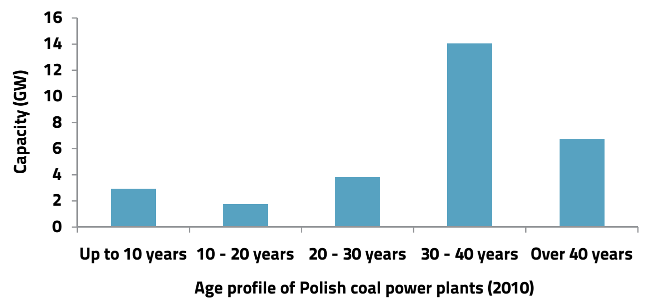
FIGURE 11: 2007 POLISH ELECTRICITY GENERATION MIX (%) – COAL DOMINATES



Source: World Bank 2011, IEA 2011, EU 2010

Poland has an aging generation base; a majority of existing capacity is over 30 years old (see Figure 12). Since 1990, only 7.5 GW of new generation has been built – all of which has been coal (IEA 2011, Citigroup Global Markets 2010).

FIGURE 12: AGE STRUCTURE OF POLISH POWER PLANTS – MAJORITY OVER 30 YEARS



Source: IEA 2011, Citigroup Global Markets 2010

The potential for fuel switching

To determine the economic potential for fuel switching, we need to understand the decommissioning schedule for existing coal plants and estimate any increase in generation that will be required to meet projected additional demand in 2020. This way we can identify the 'generation gap' that needs to be bridged through a combination of new coal, new gas CCGT, new gas CHP and renewables (no new nuclear is projected to come on-stream before 2020, IEA March 2011):

- **Decommissioning schedule:** By 2020 around 13.5 GW of installed coal capacity (40% of the existing fleet) is likely to be decommissioned, resulting in lost generation of around 68 TWh.

- **A demand increase:** By 2020, we expect national electricity demand to increase by around 12.4 TWh (IEA 2011, EU 2010) above the 2010 level.

In total, therefore, we estimate that around 80 TWh of new electricity generation will be required in Poland by 2020.

To assess a realistic potential for new CCGT, we have assumed the following:

- **National renewable energy targets will be met:** Poland has a binding target to meet 15% of energy demand from renewables by 2020, which includes a target for a 19% share of total electricity generation. This equates to around 26 TWh of new renewables generation by 2020.

- **Coal plant already under construction will be built:** Around 2.6 GW of new coal is already under construction (IEA March 2011), providing about 13.1 TWh of electricity in 2020. We assume that this will be completed, but that no other new coal plant will be constructed.

- **High efficiency gas-fired CHP can have an important new role:** CHP is already well-known in Poland, with many existing coal plants providing district heat. Chapter 3 of this report has identified a 2020 potential of around 20.0 TWh of new gas-fired CHP electricity generation.

Taking these assumptions into account, we estimate that there is both technical and economic potential for around **20.9 TWh of new generation based on CCGT**, equivalent to about 4.1 GWe of new capacity. Figure 13 below provides a summary of Delta's view of realistic potential for fuel switching to gas CCGT in 2020.

Delta's view of realistic potential

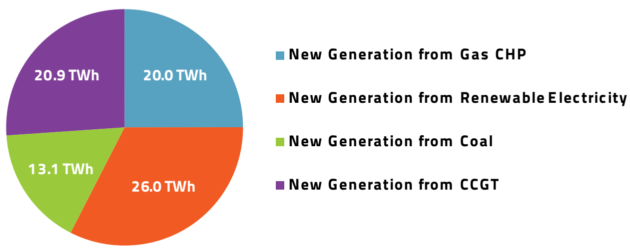
Generation gap 2010 - 2020:

- **Increase in demand:** 12.4TWh
- **Decommissioned coal:** 67.6 TWh
- **Total:** around 80 TWh

How it can be filled:

- **Coal:** 13.1 TWh
- **Gas CCGT:** 20.9 TWh
- **Gas CHP:** 20.0 TWh
- **Renewables:** 26.0 TWh

FIGURE 13: NEW GENERATION SOURCES, 2010-2020



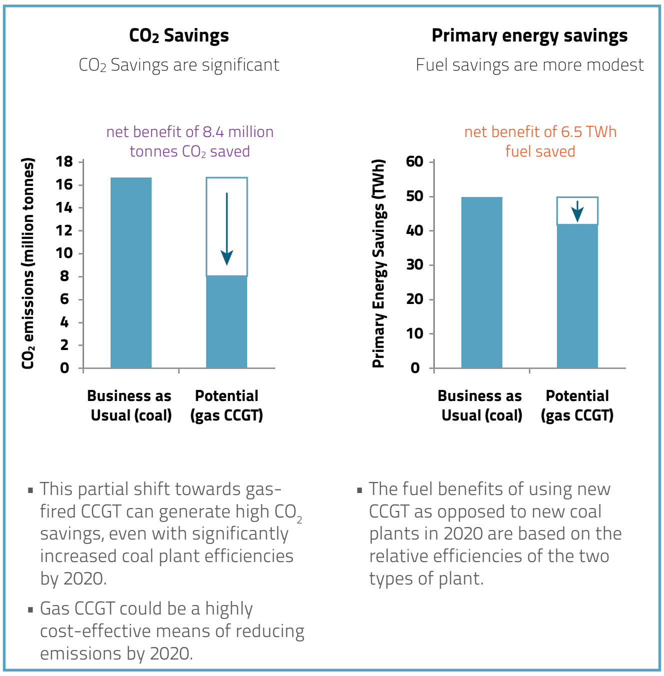
Source: Delta Energy & Environment 2011

Benefits

To calculate the energy saving and carbon benefits of the approach we have described, we have compared our scenario with an alternative business-as-usual scenario in which new coal generation is developed instead of new CCGT to provide around 20.9 TWh of new generation. Our assumptions on the average 2020 operational efficiencies of each type of plant are 48% for new gas CCGT and 41% for new coal based on conversations with industry professionals.

Figure 14 summarises the comparison.

FIGURE 14: CO_2 AND FUEL SAVINGS TO BE MADE THROUGH FUEL SWITCHING IN POLAND



Source: Delta Energy & Environment

Table 8 below summarises the potential contribution of fuel switching to the achievement of national targets.

TABLE 8: FUEL SWITCHING'S POTENTIAL CONTRIBUTION TO NATIONAL CO_2 AND PRIMARY ENERGY SAVINGS TARGETS

Potential CO_2 savings from fuel switching		Potential primary energy savings from fuel switching	
Total potential for CO_2 savings ($MtCO_2$/year)	8.4	Total potential for energy savings (TWh/year)	6.5
20% reduction required by 2020 in Poland ($MtCO_2$)	88	20% of 2020 forecast primary energy consumption (TWh)	261
Fuel switching contribution to CO_2 target (%)	9.5%	Fuel switching contribution to energy saving target (%)	2.5%

Source: Delta Energy & Environment

New jobs

Building the 4.1 GW of new gas CCGT plant that we have assumed will generate around **4000 new jobs in construction, operation and maintenance of the plant** (Wei et al 2010).

There will also be additional indirect job creation in associated industries, including in upgrading the gas network, building additional gas storage and, potentially, the exploration and production of domestic gas resources.

2.3 France and the UK

By applying the same methodology as we have used for Poland to the UK and France, we have come to the view that there is no realistic potential for new CCGT once we have included new gas-fired CHP and new renewables in the 2020 generation mix. In general, we believe that the optimal strategy for using natural gas in the power sector is to prioritise high efficiency CHP, for which there is high remaining economic potential in all countries, and only to trigger new CCGT investment where the economic potential for CHP is exhausted – as is the case in Poland.

2.4 Barriers

These barriers refer only to Poland, as there is no fuel switching potential in the UK or France.

Political context

Poland is already highly dependent on imported gas, **over 80% of gas imports come from Russia** (IEA 2011). Although the government is exploring ways to diversify supply, it signed an agreement last year for an increased supply from Russia until 2022. However, in addition to diversifying external supply there are a number of measures that could be taken to improve gas security, including:

- The development of domestic gas supply
- Continued upgrading of the gas transmission and distribution system
- Development of gas storage capacity
- Construction of an LNG terminal.

Infrastructure requirements

Overall the gas supply structure in Poland is far less developed than it is for coal. If Poland commits to building some new CCGT plants, there may well be costs associated with developing domestic supplies of gas, upgrading the gas transmission and distribution network and increasing storage capacity.

Conversely, the up-front and O&M costs of CCGT are lower than for new coal plants. In this sense, investment in new CCGT represents a highly cost-effective means for reducing Poland's overall costs of carbon abatement.

2.5 Recommendations

These recommendations refer only to Poland, as there is no fuel switching potential in the UK or France.

Options for recommendations in relation to Polish fuel switching potential: Delta recognises the strong rationale for maintaining energy security of supply through the use of indigenous coal production. However, we believe that energy security can be maintained while enabling the replacement of some of the closing coal by new gas CCGT through, for example:

- Continued diversification of the gas supply
- Encouraging investment in gas pipeline infrastructure though appropriate tariff policy
- Developing a plan to manage and extract domestic gas resources
- Creating investment incentives for expanding gas storage capacity
- Continued liberalisation of the gas market
- Construction of LNG Terminals.

3 Combined Heat and Power (CHP)

TABLE 9: CHP - SUMMARY OF STATUS AND POTENTIAL FOR CHP

	The UK	France	Poland
Potential for CHP	▪ Potential for 6.3 GWe of new gas-fired CHP beyond BAU	▪ Potential for 2.6 GWe of new gas-fired CHP beyond BAU	▪ Potential for 2.6 GWe of new gas-fired CHP beyond BAU
Benefits	▪ 14.8 Mt CO_2 can be saved ▪ Energy savings of 47.9 TWh ▪ Potential for around 50,000 new UK jobs by 2020.	▪ 6.8 Mt CO_2 can be saved ▪ Energy savings of 20.7 TWh ▪ Potential for 100,000 new jobs per year across the EU by 2020.	▪ 13.6 Mt CO_2 can be saved ▪ Energy savings of 26.5 TWh ▪ Potential for 100,000 new jobs per year across the EU by 2020.
Barriers	General barriers include: ▪ **Regulatory challenges:** Complex and inconsistent interconnection and administrative procedures can delay projects and so increase costs ▪ **Lack of a full understanding of CHP benefits:** Policy makers, in general, do not fully recognise CHP's energy and carbon benefits ▪ **Investment uncertainty:** CHP usually needs a long-term stable heat load over a 10-15 year period. While complete certainty can never be achieved, the commercial risks facing CHP over a project lifetime are relatively high compared with power-only generation. There are also some country-specific barriers.		
Policy Recommendations	Options include: ▪ Introduce / increase modest utility supply obligations to guarantee a market for CHP electricity ▪ Make interconnection procedures more transparent and consistent ▪ Ensure that the CO_2 benefits of CHP are better reflected in EU emissions regulations ▪ Encourage local heat planning to create more stable heat loads for CHP.		

Source: Delta Energy & Environment

3.1 CHP today – contributing around 11% of EU electricity generation

CHP, also known as cogeneration, is the simultaneous production of electricity and heating (and sometimes cooling) from a single process. CHP systems are located at, or very close to, the point of energy use, and it is this feature that enables the heat, that is normally wasted in conventional electricity generation, to be recovered and used[1].

The user and type of heat defines the type of CHP application, of which there are several:

- **Micro-CHP** – very small systems (1 – 5 kWe) located in individual residential homes or in buildings with a small number of residential units. The CHP provides electricity, hot water, heating and / or cooling.
- **Commercial / institutional CHP** – also known as 'mini' and 'small-scale' CHP (larger than 5 kWe and up to around 1-10 MWe), located in light industry, supermarkets, public buildings, offices etc. The CHP provides electricity, hot water, heating and / or cooling.
- **Industrial CHP** – larger systems (1 – 500 MWe+) located in industrial facilities, with the CHP providing electricity and steam for process use.
- **District heating (DH) and cooling (DHC) CHP** – similar to commercial / institutional CHP, but provides heating / cooling to multiple buildings (including residential) connected together through a heat distribution network.

CHP is an established technology in Europe. Over 100 GWe of CHP is already installed across EU-27, and its share of total electricity generation is around 11% - it is a proven, cost-effective and reliable form of energy supply. Table 10 summarises the position of CHP today in the EU, across the three focus countries and, for comparison, in three countries where CHP is well developed (Denmark, the Netherlands and Finland).

TABLE 10 – CURRENT STATUS OF CHP IN THE EU AND SELECTED COUNTRIES.

	Installed CHP (GWe)	CHP as % of electricity generation	CHP - Gas share (%)	Coal share (%)	Other (incl renewable) share (%)
EU-27	100.2	11.0	39.4	34.8	25.8
Denmark	5.4	46.1	23.8	52.2	24.0
Finland	5.7	35.6	21.6	26.5	51.9
France	5.1	3.1	57.2	4.4	38.4
Netherlands	9.0	33.6	70.3	11.5	18.2
Poland	8.8	16.9	2.5	91.1	6.4
UK	5.5	6.4	70.5	4.3	25.2

Source: Eurostat 2010

[1] For an introduction to CHP, its global benefits and potential, see 'Combined Heat & Power – Evaluating the benefits of greater global investment', produced by Delta Energy & Environment and published by the International Energy Agency as part of its CHP Collaborative Programme, 2008, www.iea.org.

The high degree of CHP penetration in some countries is an indication that the economic potential of CHP in the three focus countries (France, Poland, the UK), and across the EU as a whole, is likely to be higher, possibly significantly higher, than that achieved so far.

There is also a diverse fuel mix for CHP across all countries, reflecting historic fuel source choices. In general, gas-fired CHP is the norm for new CHP projects developed today, with an increasing focus on renewable-based CHP, using biomass and various biogases as the fuel.

CHP in France – nuclear power is the priority

CHP development in France has been limited due to relatively low electricity prices that are based on a large fleet of nuclear plants that were developed when the electricity sector was under full state ownership. The installed capacity for CHP today is 5.1 GWe, which supplies only 3.1% of total electricity generation

With nuclear dominating electricity generation in France, the government believes that that there is only limited scope for new CHP development in the future. While we believe that there is some significant remaining economic potential, CHP activity in France is likely to be restricted to maintaining and repairing existing plant unless policy is implemented to drive new market growth.

CHP in Poland – coal dominates

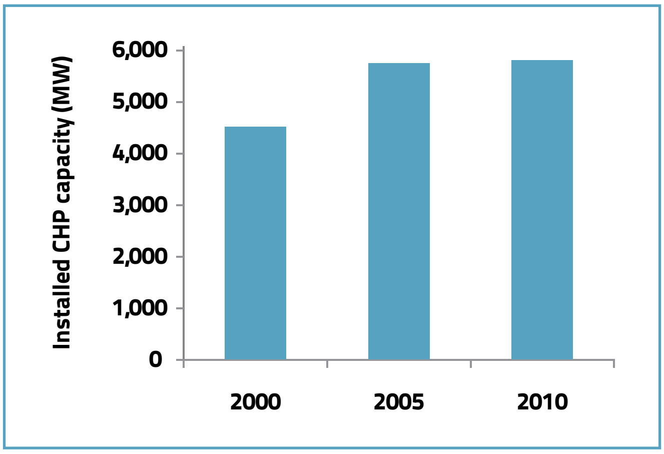
Polish electricity and heat supply is based predominantly from coal – with more than 90% of electricity generation in 2009 being from this fuel. Around 8.8 GW of CHP is installed today, delivering 16.9% of total electricity generation – with coal again being the predominant fuel used. Gas-fired CHP is currently limited to the south of the country where gas is more widely available. Most of today's CHP serves large DH networks.

With an aging coal fleet, and with energy security as a key priority for the Polish government, new coal and nuclear tends to be favoured as replacement capacity. CHP also continues to receive some support.

CHP in the UK – market stagnation since 2005

Today, 6 - 7% of total electricity generation in the UK comes from CHP. This has remained largely unchanged since 2005, with the market stagnating at around 5.5 GWe (Figure 15).

FIGURE 15: CHP INSTALLED CAPACITY IN THE UK



Source: Delta Energy & Environment

The UK market has struggled to develop further due mainly to:

- Market uncertainty around future policy support for CHP.
- The electricity market regulatory framework tends to favour smooth market operation rather than energy efficiency.

3.2 The 2020 potential for CHP

To understand the various benefits of the wider use of CHP by 2020, a solid understanding of the realistic potential for CHP is needed. Here, we focus on the potential for gas-fired CHP in particular. The reason for this is that the challenges facing the achievement of economic potentials are greater for gas-fired CHP, where barriers are greater and incentives are weaker, than for renewable-based CHP.

Indeed, we expect renewable-based CHP markets to develop strongly up to 2020, driven largely by the member state incentives that are being introduced to meet their commitments under the 20% mandated renewable energy targets. In short, there is every likelihood that the full economic potential for renewable CHP will be reached and exceeded by 2020. In this sense, the potential for renewable CHP is equivalent to a business-as-usual scenario (we also note that the greening of the Common Agricultural Policy can be enhanced by increased supply of biogas to high efficiency CHP systems).

Conversely, for gas-fired CHP the prospects are today much more problematic, with almost no EU-level incentive measures, and only very patchy member state level incentives. Hence the focus here is on understanding the economic potential for gas-fired CHP and, importantly, the challenges that are currently preventing this potential from being achieved. In this sense, we believe that the economic potential exceeds a business-as-usual scenario.

To identify and inform our view of the economic potentials for gas-fired CHP in 2020 in our three focus countries and across EU-27, we have used various sources, including:

- The European Commission's Strategic Energy Technology Plan (SEC 2007 1510).
- The European Commission's EU Energy Trends to 2030 (2009 update).
- The International Energy Agency's CHP – Evaluating the benefits of greater global investment (IEA 2008).
- The National Potential Studies undertaken by EU Member States under the terms of the EU CHP Directive (2004/8/EC). These have been consolidated within the European Commission funded project, CODE - Cogeneration Observatory and Dissemination Europe. Each member state made its own assumptions to assess their national potentials.
- Eurelectric's 2010 European Power Statistics, which includes projections to 2020 and 2030, with data provided by the major electric utilities in each member state.
- Various independent national studies.

Some of these sources are based simply on market projections under existing policies and measures. Others are based on a more ambitious analysis of what is technically and / or economically feasible. Some of these outputs are summarised in the table below.

TABLE 11: SELECTED POTENTIALS AND PROJECTIONS FOR CHP CAPACITY IN 2020 (GWE)

Source	France	Poland	UK	EU
EU Energy to 2030 (reference scenario)	5.8	10.3	8.7	Baseline – 115 GWe (18.4% of total power generation).
Eurelectric 2010	No data	6.4	11.0	140 GWe (aggregate member state data[2]).
IEA CHP Collaborative (accelerated CHP policies & measures).	2015 – 8.9 2030 – 16.9	-	2015 – 9.3 2030 – 18.4	-
EU SET Plan				Baseline - 160 GWe. Maximum – 185 GWe.
National Potential Studies (Economic and Technical Potentials)	Economic – 5.7 Technical – 30.0	Economic – an additional 8.8 GWe – i.e. c 17.6 GWe. In a separate natural gas scenario, additional potential of 20.5 GWe (see CODE).	Economic – an additional 10.6 GWe (by 2015) – i.e. c 16.1 GWe.	Additional economic potential of 122 GWe, giving total of 222 GWe in 2020.

Source: Delta Energy & Environment

Building on these diverse sources, our view of the economic potentials are summarised in the box below.

Delta view on economic potential for CHP - 2020

France

- The national potential study indicates a low figure of 5.7 GWe by 2020. We have used this for our BAU assumption.
- Delta assumes an economic potential of 8.9 GWe based on IEA potential study which gave an equivalent capacity for the year 2015.

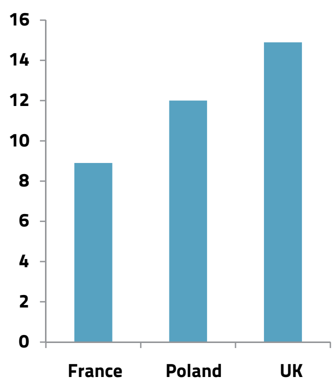
Poland

- The national study indicates an economic potential for an additional 8.8 GWe CHP by 2020, giving around 17.6 GWe in total.
- Delta believes new renewables will displace some of this potential, and assumes a potential for 12 GWe in 2020 – an additional 3.2 GWe.
- We have assumed no net growth in CHP for our BAU based on a combination of sources, including EU projections for only modest growth, and Eurelectric projections for a 20% fall in CHP capacity.

UK

- There is an economic potential for 16.1 GWe by 2020 indicated by the 2005 national study.
- Delta believes this is slightly ambitious, and assumes an economic potential of 14.9 GWe in 2020 – more in line with the IEA's analysis.
- We have assumed BAU development based on the historic 10 year trend.

FIGURE 16: DELTA VIEW OF THE ECONOMIC POTENTIAL FOR CHP IN 2020 (GWE)



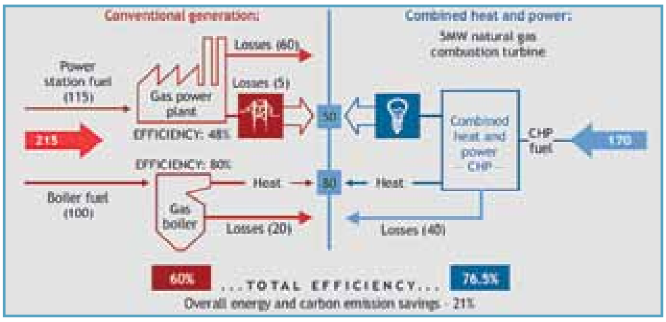
Source: Delta Energy & Environment

[2] The Eurelectric data is sourced from the national members of Eurelectric, consisting of Europe's major electricity companies. We believe that this figure is likely to represent a lower end forecast of what is feasible.

3.3 CHP benefits – significant carbon emissions and energy savings can be made

The degree of energy and carbon savings from CHP depends on the technology and fuel used in the CHP scheme and on the alternatives displaced. The technical characteristics of a CHP scheme are generally well defined, so the main uncertainty in assessing energy and carbon savings is in the fuel and efficiency assumed for alternative sources of the heat and power displaced. Figure 17 illustrates how CHP increases energy efficiency, and so reduces fuel use and cuts carbon emissions.

FIGURE 17 – EFFICIENCY GAINS FROM CHP – ILLUSTRATIVE EXAMPLE (ALL VALUES HHV, HIGHER HEATING VALUES)



Source: International Energy Agency, 2008

An additional benefit of CHP, not included in the illustration above, relates to its potential to contribute to electricity system supply / demand balancing. For example, through the use of heat storage systems, CHP in buildings can be scheduled to operate at times of electricity demand rather than heat demand. Industrial CHP systems also have the capacity to 'flex' their operation, through changes in its heat / power ratio, to generate more or less electricity depending on market prices.

Delta has modelled the CO_2 savings and energy savings for each of the three markets based on CHP achieving the economic potentials outlined above (our main assumptions for this modelling are given in Annex 2). The table below summarises the key data and benefits.

TABLE 12: BENEFITS RESULTS OF ACHEIVING CHP POTENTIALS

	France	Poland	UK
CHP potential in 2020			
Current CHP capacity (GWe)	5.1	8.8	5.5
2020 BAU installed CHP capacity (GWe)	5.7	8.8	7
CHP economic potential 2020 (GWe)	8.9	12	14.9
Difference between BAU and economic potential to 2020 – stretch (GWe)	3.2	3.2	7.9
Gas-fired CHP share of stretch (GWe) (the rest is renewable-based)	**2.6**	**2.6**	**6.3**
▪ Share which is CHP in buildings / DH	0.6	0.6	2.1
▪ Share which is CHP in industry	1.9	1.9	4.2
Potential CHP CO_2 savings			
Total CO_2 savings realised by building / DH CHP (Mt CO_2/year)	1.3	2.6	3.9
Total CO_2 savings realised by industrial CHP (Mt CO_2/year)	5.5	11.0	10.9
Total potential for CHP carbon savings in 2020 (Mt CO_2/year)	**6.8**	**13.6**	**14.8**
CHP contribution to achieving 2020 CO_2 targets			
20% reduction required by 2020 (Mt CO_2)	111	88	155
CHP contribution to CO_2 target (%)	**6.1**	**15.5**	**9.5**
Potential CHP primary energy savings			
Total energy savings realised by building / DH CHP (TWh/year)	3.8	5.0	12.0
Total energy savings realised by industrial CHP (TWh/year)	16.9	21.5	35.9
Total potential for CHP primary energy savings in 2020 (TWh/year)	**20.7**	**26.5**	**47.9**
Contribution to achieving 2020 primary energy reduction targets			
20% of forecast primary energy consumption (TWh)	640	261	468
CHP contribution to energy saving target (%)	**3.2**	**10.2**	**10.2**

Source: Delta Energy & Environment

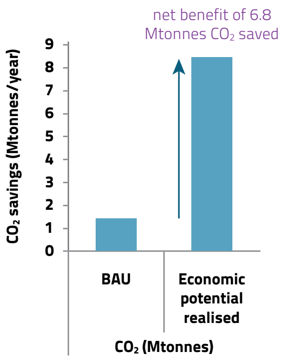
The benefits of CHP in France: CO_2 and energy savings

The figure below summarises the benefits of greater CHP deployment in France.

FIGURE 18: CO_2 AND FUEL SAVINGS TO BE MADE THROUGH CHP DEPLOYMENT IN FRANCE

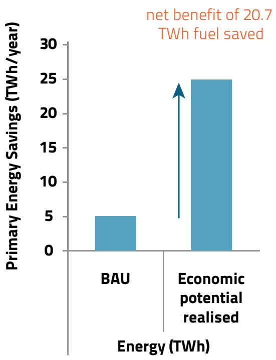
CO_2 Savings

Realising France's full economic potential for gas-fired CHP delivers an additional 6.8 Mt of CO_2 savings. This is relatively small because of the strong position of nuclear generation in France.



Primary energy savings

Realising France's full economic potential for gas-fired CHP delivers an additional 20.7 TWh of primary energy savings.



Source: Delta Energy & Environment

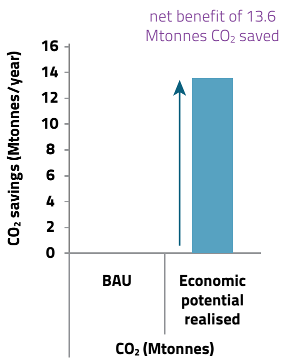
The benefits of CHP in Poland: CO_2 and energy savings

The figure below summarises the benefits of greater CHP deployment in Poland.

FIGURE 19: CO_2 AND FUEL SAVINGS TO BE MADE THROUGH CHP DEPLOYMENT IN POLAND

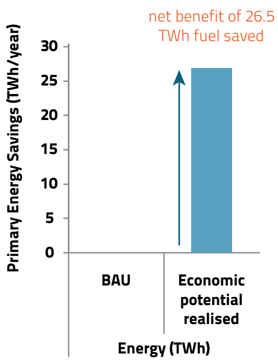
CO_2 Savings

The large penetration of existing coal generation in Poland means high carbon savings when replaced by gas-fired CHP – a potential of 13.6 Mt of CO_2 savings for 2.5 GWe new CHP – can be made by 2020 compared to the BAU scenario (no CHP growth).



Primary energy savings

Significant primary energy savings of 26.5 TWh can be achieved by gas-fired CHP compared to the BAU scenario (no CHP growth).

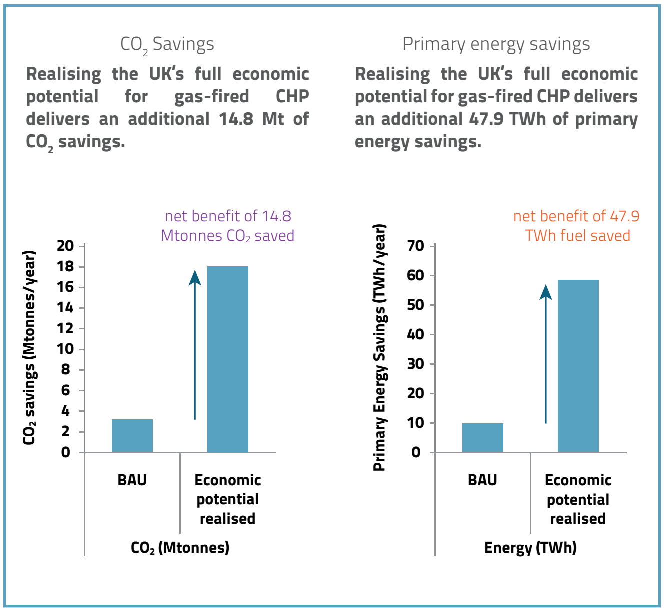


Source: Delta Energy & Environment

The benefits of CHP in the UK: CO_2 and energy savings

The figure below summarises the benefits of greater CHP deployment in the UK.

FIGURE 20: CO_2 AND FUEL SAVINGS TO BE MADE THROUGH CHP DEPLOYMENT IN THE UK



Source: Delta Energy & Environment

3.4 The benefits of CHP: jobs

There has been little research undertaken into the employment impacts of new CHP development. The existing data is summarised in the table below.

TABLE 13: EXISTING DATA ON THE EMPLOYMENT IMPACTS OF CHP

Source	CHP employment impacts
EU	▪ Cogen Europe has estimated that the achievement of the EU's economic potential for CHP by 2020 would result in the creation of 100,000 new jobs per year.
France	▪ According to Club Cogénération, there are around 30,000 direct employees today in industrial CHP in France – amounting to 2.2 GW of industrial CHP. The employees carry out O&M activities. ▪ Based on Delta's assumption of an economic potential for a further 3.8 GWe of CHP, and extrapolating the existing jobs per GWe installed figure in French industry to DH & buildings CHP, this equates to around 50,000 permanent new jobs by 2020 for operating and maintaining new CHP plants.
UK	▪ Based on research undertaken for the UK CHP Association by Delta in 2009, the existing 5.5 GWe of CHP provides: - 5,000 jobs operating, developing and maintaining CHP plants. - 25,000 additional jobs in the supply chain. ▪ Based on Delta's assumption of an economic potential for a further 9.4 GWe of CHP and the existing jobs per GWe of CHP installed, the aggregate number of new jobs generated by 2020 will be around: - 8,000 – 9,000 jobs operating, developing and maintaining CHP plants. - 40,000 additional jobs in the supply chain.
CHP / DH	▪ The 1.2 GWth CHP DHC project in Mannheim, Germany, resulted in the creation of 4,000 new job years.
USA	▪ To achieve a growth in US CHP capacity from 85 GWe today to 240 GWe in 2030 (not dissimilar to some projections of the EU potential) will result in almost 1 million new jobs created by that year. This corresponds to around 6,400 new jobs per GWe of new CHP.

Source: Delta Energy & Environment

EU level benefits of CHP

By extrapolating the CHP benefits in these three major member states to an EU-27 level, on the basis of comparison of their combined final energy demand, we can derive an indication of the EU-wide benefits of CHP deployment on the basis that we have described here.

We find that gas-fired CHP can achieve around 328 TWh of primary energy savings and 113 Mt CO_2 / year of carbon emissions reductions by 2020 at the EU level. Thus gas-fired CHP alone (and not including renewable-based CHP) can potentially deliver around 8% and 10% respectively of the EU 20% objectives for both energy efficiency and carbon emissions.

3.5 Barriers

CHP has been successfully deployed in several markets across Europe, without the need for significant incentives. This success has largely been due to targeted policy support that has addressed key barriers – some of which are common across all European markets.

Common barriers to CHP development in Europe include:

- **Regulatory issues.** Interconnection procedures and administrative processes are often complex, inconsistent and time consuming, creating delay, and therefore additional cost, for developers of CHP.

- **Investment uncertainty.** CHP usually needs a long-term stable heat load over a 10-15 year period. While complete certainty can never be achieved, the commercial risks facing CHP over a project lifetime are relatively high compared with power-only generation.

- **Lack of awareness of CHP benefits**. A lack of understanding of the true value and benefits of CHP means it has not always been high up on political agendas, or received the necessary policy support to reach its full potential.

- **Challenge of incorporating CHP emissions benefits into European regulations.** Due to the combined generation of heat and power from a single process, it has proved hard to integrate the CO_2 benefits of CHP into the EU emissions trading scheme.

There are also market specific barriers in each country, for example:

- France: National energy policy has tended to prioritise nuclear power.

- Poland: there are concerns that the development of gas-fired CHP would unduly increase energy supply security concerns.

- UK: the regulatory framework for the electricity sector tends to prioritise smooth market operation over energy efficiency.

3.6 Recommendations

It is likely that modest policy measures would be sufficient to overcome these and other barriers to CHP development, and so enable the economic potentials to be achieved. There are several such options for policy recommendations that can be considered for implementation at EU and national levels. These include:

- **Energy supply obligations.** Through the set up of an obligation on electricity suppliers to source a certain proportion of their electricity from CHP, a market for new high efficiency CHP electricity can be accelerated. Such a system could become a part of a new EU wide White Certificate system.

- **Modest financial and fiscal support.** Increasing the financial/fiscal support for CHP can provide the additional push needed to enable CHP development, supporting countries in achieving their policy goals such as emissions reductions and energy efficiency targets. This can be administered as up-front investment subsidies, or ongoing operational support in the form of feed-in tariffs and fuel tax exemptions. Such funding could be sourced from the proceeds of EU ETS allowance sales.

- **Interconnection measures.** It is necessary to provide CHP developers with more clear and consistent rules and regulations for connecting to the electricity network – and with sufficient incentives for exporting electricity onto the grid. This has traditionally held back development of CHP at industrial and commercial sites.

- **Recognition of CHP in supporting climate change mitigation and emissions trading.** Emissions trading places a cap on greenhouse gas emissions allowances at the national level, and introduces a price for carbon emissions. The design of such systems should be such that CHP should benefit from the value of carbon saved. The current EU system does not achieve this.

- **Local heat planning.** Better heat planning can support the identification of suitable and stable heat loads for CHP, and the development of links to a heat supply at the local level. DH infrastructure can create the necessary network to link heat supply and demand – optimising energy supply in a highly efficient way through CHP.

4 Smart Grid

TABLE 14: SUMMARY OF POTENTIAL AND BENEFITS OF SMART GRID IN KEY MARKETS

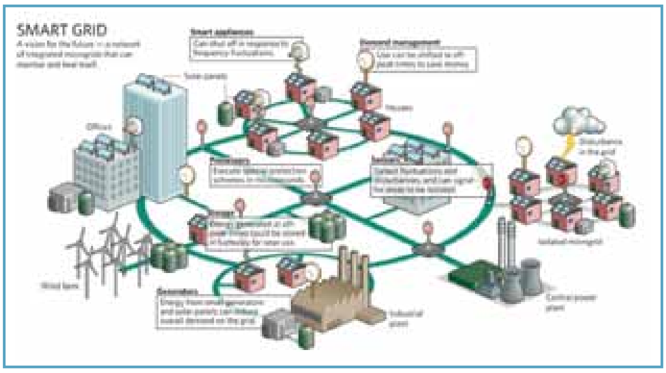
	France	Poland	UK
2020 benefits	▪ 4 Mt of CO_2 saved / yr ▪ 49 TWh of primary energy savings	▪ 7 Mt of CO_2 saved / yr ▪ 30 TWh of primary energy savings	▪ 13 Mt of CO_2 saved / yr ▪ 60 TWh primary energy savings
Options	▪ Continuous diagnostics of energy consuming equipment in commercial and residential buildings: CO_2 saving: 7 Mt CO_2 across three markets ▪ Improved operational efficiency of the T&D system (reduced losses): CO_2 saving: 7 Mt CO_2 across three markets ▪ Smart demand - time-shifting of end-use electricity consumption through technologies enabled by the Smart Grid: CO_2 saving: 1 Mt CO_2 across three markets ▪ Influencing customer behaviour to reduce energy consumption through feedback: CO_2 saving: 9 Mt CO_2 across three markets		
Barriers	▪ Lack of clear national frameworks for Smart Grid among the member states ▪ Difficult to justify business case for investment in Smart Grid assets ▪ Regulatory risk in investment – potential for stranded assets if regulation changes e.g. around standards or minimum functionality requirements ▪ Unbundling can create issues around e.g. who owns the smart meter		
Recommendations	▪ Ensure sufficient incentive for investment ▪ Prioritise customer awareness of the benefits of the Smart Grid ▪ Develop an EU-level framework for Smart Grid development, with particular emphasis on: - Standardisation of smart grid technologies and communications protocols - Security and data protection - Minimum functionalities of Smart Grid hardware and software		

Source: Delta Energy & Environment

4.1 The Smart Grid in Europe today

There are many definitions of the widely used term, Smart Grid. The European Technology Platform (ETP), SmartGrids[3], defines it as follows: electricity networks **that can intelligently integrate the behaviour and actions of all users connected to it - generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies.** The figure below provides an illustration of how the various users can be inter-linked.

FIGURE 21: THE SMART GRID



Source: Data Centre Pulse, 2011

The Smart Grid can also deliver energy efficiency benefits. Our approach to understanding this potential for energy and carbon emissions savings is, however, greatly limited to the extent that it is still very much in the planning and demonstration phase in Europe, and the potential benefits have not yet been assessed in any detail. We have therefore applied high level results, data and analyses from elsewhere, largely North America, to the European electricity system. A key element of our assessment is the smart meter: not highlighted in the diagram above, but integral to many of the energy benefits that we review.

We have also found that the Smart Grid opportunity receives significant attention at the EU-level, but so far this has not been fed down well to the national level – there appears to be a distinct lack of proper national frameworks for Smart Grid development in many member states. The following section summarises some relevant national activity.

[3] http://www.smartgrids.eu/

4.2 Current status of Smart Grid activity in France, Poland and the UK

TABLE 15: SUMMARY OF SMART GRID ACTIVITY IN FRANCE, POLAND AND THE UK

Market	Details
France – developing a national framework; ahead of Poland, behind the UK.	▪ Developing a national framework for Smart Grid deployment, but this is not as advanced in its development as the UK. The French Smart Grid Roadmap sees a strong role for demand flexibility and electricity storage. ▪ In September 2010, the French government issued a decree that 95% of its smart meters must be deployed by year end 2016, well ahead of the European Union's mandate of 80% deployment by 2020. The French decree says all new meters deployed from 2012 onward must be smart meters and that daily data collection is required.
Poland – no clear national framework; only a focus on smart metering.	▪ Poland will begin to pay for its EU ETS emission allowances from 2016 onwards, at which point it is expected that electricity prices will rise sharply. Therefore, the regulator is keen to implement tools that enable customers to lower consumption. This includes a roll out of smart meters, although this is more or less the extent of smart grid plans so far. ▪ In late 2010, Poland's National Fund for Environmental Protection and Water Management announced a new €138m programme to fund feasibility studies, upgrading infrastructure and improving the energy efficiency of distribution networks. This fund is open for all DSOs to bid for, but they have to demonstrate an 8% energy saving to do so. There are few bids so far.
The UK – one of the leaders in developing a national Smart Grid Programme.	▪ The energy regulator, Ofgem, recognises the need for major investment in infrastructure. Ofgem has stated: "We estimate that around £32 billion will have to be spent on pipes and wires over the next ten years to meet the challenging needs of energy producers and consumers as we decarbonise the energy sector". ▪ The introduction of the Low Carbon Networks (LCN) Fund, with a budget of £500 million over 5 years, is a major measure to incentivise innovation in distribution networks, including Smart Grid initiatives. The LCN Fund has two major parts, one of which requires Ofgem to hold an annual competition to enable a small number of significant scale projects to receive funding.

Source: Delta Energy & Environment

4.3 Key mechanisms through which Smart Grids can deliver energy and CO_2 savings

In identifying the energy and carbon savings benefits, we have considered the following Smart Grid mechanisms:

1. Continuous diagnostics of residential and commercial buildings

2. Improved operational efficiency

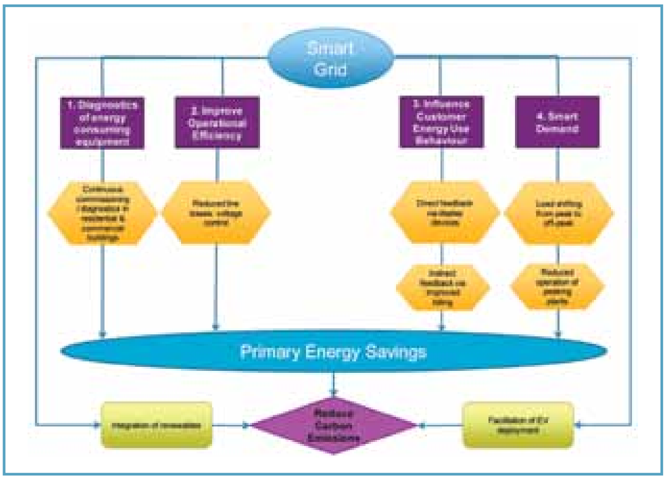
3. Changing customer energy use behaviour through direct feedback.

4. Smart demand

In addition, Smart Grid can facilitate greater integration of renewable power generation and the deployment of electric vehicles (EVs). These both result in CO_2 savings (discussed further on page 45).

These are all highlighted in the figure below.

FIGURE 22: SELECTED SMART GRID DEVELOPMENTS THAT CAN DELIVER ENERGY AND CARBON SAVINGS



Source: Adapted from EPRI (2008) and Pacific Northwest National Laboratory (2010)

Below, we summarise the assumptions we have made in identifying the benefits that these mechanisms can deliver.

Our sources and assumptions

We have aimed to assess the absolute benefits to be derived from wide scale Smart Grid deployment, rather than the marginal benefits compared to a business-as-usual scenario, which is near-impossible to identify given the lack of clarity over future national plans.

The sources that we have used to provide the necessary data and assumptions are summarised in the table below.

TABLE 16: SELECTED STUDIES THAT HAVE QUANTIFIED THE BENEFITS OF SMART GRID DEPLOYMENT

Study	Geographical coverage	Analysed benefits from	Energy savings 2020 (TWh)	CO_2 savings 2020 ($MtCO_2$)	Jobs
SMART 2020: Enabling the low carbon economy in the information age The Climate Group, Global, 2008	Global	▪ Integration of renewable energy ▪ Reduction in network T&D losses ▪ Demand management ▪ Reduce consumption through user information ▪ Intelligent load dispatch	1,540	2,030	NA
The Smart Grid: An Estimation of the Energy and CO_2 Benefits Pacific Northwest National Laboratory (PNNL), US, 2010	US	▪ Diagnostics of energy consuming equipment ▪ Consumer feedback ▪ Load shifting ▪ Integration of EVs ▪ Integration of renewables ▪ Joint marketing of energy efficiency and demand response ▪ Measurement and verification of energy efficiency programmes ▪ Reduced network T&D losses	467 – 606	277 - 359	NA
The Green Grid: Energy Savings and Carbon Emissions Reductions Enabled by a Smart Grid EPRI, US, 2008	US	▪ Diagnostics of energy consuming equipment ▪ Consumer feedback ▪ Load shifting ▪ Integration of EVs ▪ Integration of renewables ▪ Reduced network T&D losses ▪ Accelerated deployment of energy efficiency programmes	56-203	60 - 211	NA
The U.S. Smart Grid Revolution KEMA's Perspectives for Job Creation KEMA, US, 2009	US	Discussed on page 47	NA	NA	280,000 (deployment period of 3 years) 140,000 (steady state after deployment)
The IEA Smart Grids Roadmap IEA, Global, 2011	Global	▪ Peak load management ▪ Diagnostics of energy consuming equipment ▪ Reduced network T&D losses ▪ Consumer feedback ▪ Accelerated deployment of energy efficiency programmes ▪ Integration of EVs ▪ Integration of renewables	NA	Global: 800-1,100 by 2030 Europe: 70-90 by 2030	NA

Source: Delta Energy & Environment

Our assessments of the various Smart Grid mechanisms that we have reviewed are given below.

Continuous diagnostics in residential and small / medium commercial buildings

Heating, cooling and energy management systems in buildings degrade over time, leading to steadily increasing energy consumption which customers are frequently unaware of. The Smart Grid can enable these problems to be detected early by providing diagnostic services in residential and small / medium commercial buildings through automated real-time sensing and communication.

Examples of diagnostic checks that the Smart Grid can provide include:

- The efficiency of refrigerant cycles in heat pumps and air conditioners fall over time. The Smart Grid can detect declining efficiencies long before any equipment failure makes them obvious. Heat pumps that are providing unusual amounts of back-up electrical resistance heating (expensive and highly inefficient) can also be quickly detected.

- Economisers in building ventilation systems can save large amounts of energy as they provide 'free cooling' from outside air. They are, however, notorious for failing. When they do so, they can remain open all the time. The Smart Grid can enable continuous monitoring and optimising of the economiser's position.

- A 'smart' HVAC (heating, ventilating and air conditioning) system can reduce energy consumption by around 10% by adjusting thermostats.

PNNL has estimated that the following reductions in electricity consumption are achievable through implementation of Smart Grid technologies:

- 15% in the residential sector for electricity serving heat pumps and air conditioners

- 20% in small / medium commercial buildings for HVAC and lighting.

Improvements in transmission and distribution (T&D) network operational efficiency

The Smart Grid can enable real-time monitoring and adjustment of some of the important operating parameters of the T&D network. Of particular concern is the system voltage. End-use energy consumption has been shown to drop when the electric service voltage is reduced. A strategy known as conservation voltage reduction (CVR) works on the principle that the energy consumed by certain end-use loads such as incandescent lights and some electronics is reduced as the voltage is decreased.

Conversely, losses in the distribution system tend to increase as the voltage drops, and as motors and other constant power loads draw more current to compensate. In the US, losses usually average around 5% and increase to 8% or more during peak loads when voltage drops and current increases[4]. A Smart Grid can provide the measurement and communication functions to continually optimise trade-offs in system voltage and energy use by precisely controlling the voltage within acceptable limits. This optimisation process, which includes CVR, is known as advanced voltage control.

CVR: a comprehensive study[5] of CVR involved 31 feeders at 10 different substations and 11 utilities in the Pacific Northwest in the US. It showed that a 1% change in the distribution line voltage provided a 0.25% to 1.3% change in energy consumption, and that voltages could be reduced from 1% to 3.5%.

Advanced voltage control: PNNL estimated that it is possible to reduce existing consumption of electricity by approximately 1% with relatively little investment. Deploying full advanced voltage control could potentially increase this from 3% to 4%.

For the purposes of this assessment, we have assumed an average of 2% reduction of electricity supplied to the grid for the three countries through the implementation of these mechanisms.

Smart demand

The term 'smart demand' refers to the time-shifting of end-use electricity consumption through technologies enabled by the Smart Grid. For example:

- Incentivising customers to run their energy consumption appliances during the night through time-of-use tariffs delivered through smart meters. The appliances could be controlled automatically by a Home Energy Management (HEM) system.

- In the commercial or industrial sectors, Information and Communications Technology (ICT) solutions can be integrated to receive signals from the network operator that the local network is congested, and the customer will be rewarded if they reduce or cut non-critical loads.

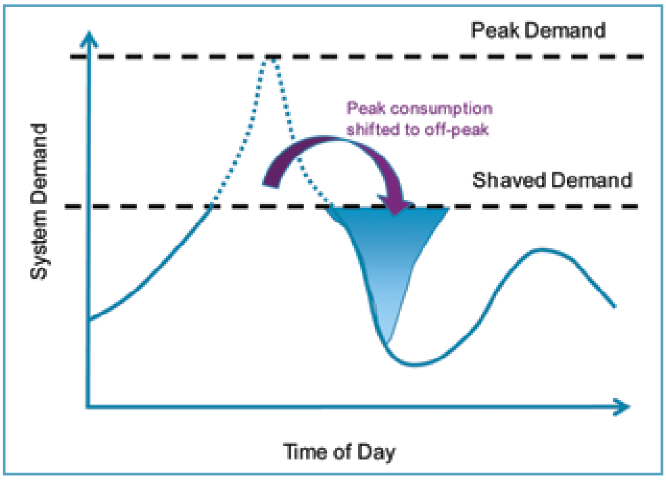
The benefits of load-shifting are primarily:

- To shave system 'peaks' – this reduces the need for peaking plants which are often less efficient and/or use more polluting fuels, to run; it can also enable delay or prevention of the need for investment in new network capacity.

- To fill system 'valleys' – this can help increase and optimise the operation of lower carbon baseload plant (including nuclear and some renewable plant).

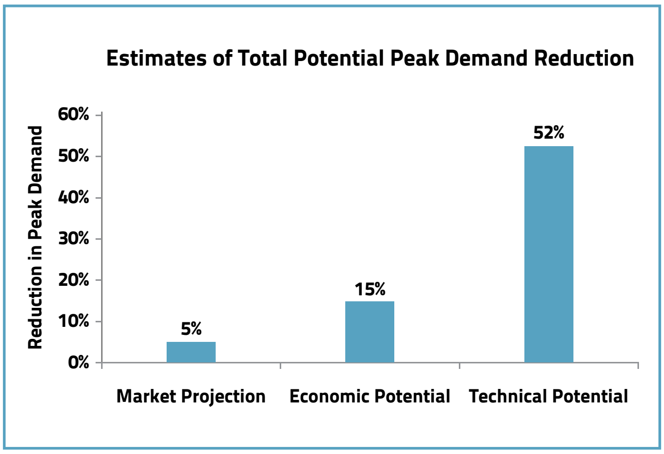
[4] We recognise that the general condition of European electricity networks is higher than that of networks in the US.
[5] http://www.comedamifuture.com/Resources/DEI%20Final%20Report%201207.pdf

FIGURE 23: ILLUSTRATIVE EXAMPLE OF LOAD SHIFTING



Source: Delta Energy & Environment

FIGURE 24: THE BRATTLE GROUP ESTIMATES A 5% REDUCTION IN SYSTEM PEAK DEMAND FROM DEPLOYMENT OF THE SMART GRID



Source: The Brattle Group, 2007

The Smart Grid can facilitate shifting load from peak periods to off-peak periods through various means, including demand response (either direct control of loads or, more commonly, using dynamic or time-of-use tariffs to incentivise off-peak consumption), distributed generation (DG) and electricity storage.

The energy and carbon emissions savings that will result from load shifting will depend on the mix of baseload, intermediate and peak generating resources being used at a particular time. However, the highly dynamic nature of power plant dispatch options makes the assessment of these energy and carbon savings highly complex. To do so fully requires detailed modelling of wholesale market operation, generation plant merit orders, etc.

We have therefore derived our assumptions on peak demand reduction from the Brattle Group . Its analysis concluded that demand response across all sectors (through the use of time-of-use tariffs) can shift 5% of the system peak to off-peak times . This estimate is based on the assumption that 43% of customers in each sector (residential, commercial and industrial) implement a cost-effective combination of demand response enabling technologies (such as smart meters, load controlling devices in industrial and commercial buildings, home energy management systems, or controllable heat pumps or air conditioners).

The carbon savings that will arise from shifting 5% of peak demand will depend on the difference in the carbon intensity of the generation meeting peak demand, and that of the off-peak generation:

- This is most relevant in France in 2020, where we assume that peaking generation will be a mix of open cycle and combined cycle gas turbines, and off-peak electricity will be largely nuclear and renewables.
- In Poland and the UK in 2020, there is not likely to be such a significant difference in the carbon intensity of peak and off-peak generation, so we have not assessed these two countries for this mechanism.

In respect of energy savings, results from Pacific Gas and Electric's (PG&E, USA) Critical Peak Pricing (CPP) tariff programme show that for every kWe of peak demand reduction, 65 kWh of energy savings result. The results of this programme apply to commercial customers only, but for simplicity we assume (as EPRI has also done) that this assumption applies to residential and industrial customers too.

Customer behaviour

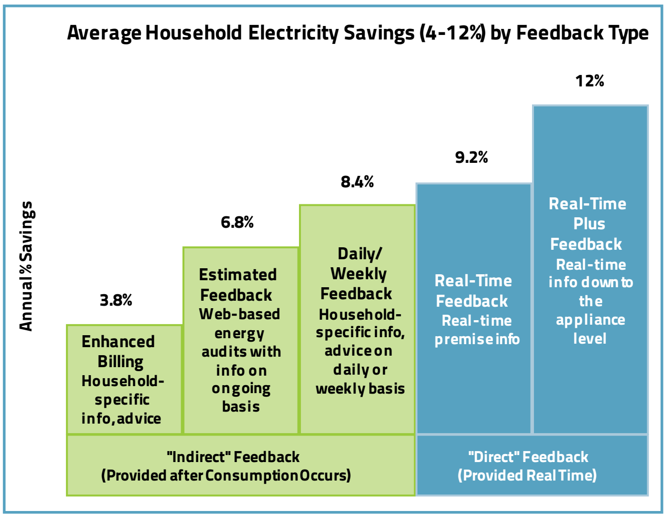
The Smart Grid can enable energy consumption feedback to be delivered to consumers in a range of ways, from more accurate billing (e.g. from data communicated by smart meters) to feedback down to the appliance level (through the most advanced HEM systems). There has been a general supposition that this causes consumers to manage and reduce their demand, but the direct impact of such feedback on consumption is subject to debate.

[6] http://www.brattle.com/_documents/UploadLibrary/Upload578.pdf

[7] For example, the system peak in the UK in 2020 is projected to be 68.5 GW. Shifting 5% of this peak for 500 hours (2 hours per working day, the assumption used in the analysis of each of the three markets) means that 1.7 TWh of electricity is generated by off-peak power plants, as opposed to peaking plants.

Figure 25 below was taken from a 2010 meta-analysis[8] of 36 separate studies on the effects of customer feedback on household electricity savings. The results vary between 4 and 12%, depending on the method and time of feedback.

FIGURE 25: THIS META-ANALYSIS SHOWS THAT UP TO 12% ENERGY SAVINGS ARE ACHIEVABLE IF REAL-TIME FEEDBACK AT THE APPLIANCE LEVEL IS PROVIDED



Source: Advanced Metering Initiatives and Residential Feedback Programs: A Meta-Review for Household Electricity-Saving Opportunities, American Council for an Energy-Efficiency Economy (ACEEE), US, 2010

Finally, for its 2008 study, EPRI assumed that consumer information and feedback systems resulted in electricity savings of:

- 5% for residential customers
- 2.5% for non-residential customers.

Based on the data from the sources above, the EPRI assumptions for residential customers appear to be solid, even conservative, and we have chosen these values as the basis of our assessment. As there is no available data for non-residential customers, we have assumed a more conservative value of 2%.

Enabling the wider penetration of electric vehicles (EVs) through smart charging

The replacement of petrol vehicles with electric vehicles will also result in primary energy savings and CO_2 emissions reduction. If EV charging times are managed through the Smart Grid, as they are likely to be in due course, it will be possible to enable 'smart charging' of EVs to take advantage of greater inflexible renewable and nuclear generation, and to manage the increased electricity demand in such a way as to minimise the need to build out additional generation or T&D networks.

The Smart Grid can facilitate increased penetration of renewables

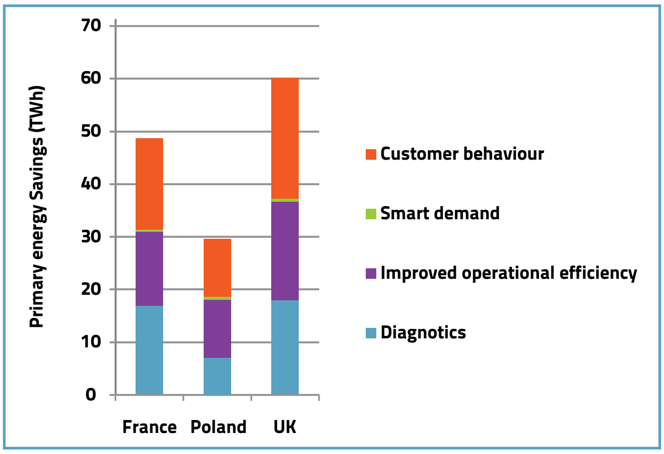
Increasing penetration of intermittent renewable generation increases the need for load following services, currently provided by fossil power plants. As we describe in Chapter 1, these plants are ramped up and down as renewable generation and final demand rise and fall, wasting fuel and increasing wear and tear on the plants. Smart Grid resources (for example demand response, distributed generation and electricity storage) can help to balance supply and demand more effectively.

4.4 Benefits of smart grid deployment

Our main assumptions used in the calculation of the energy and CO_2 benefits of the Smart Grid are described in Annex 3.

Figure 26 describes the primary energy savings potential from a widescale Smart Grid deployment in the three focus markets. There are considerable savings to be gained from all but smart demand, where the focus is on shifting the peak, not on actual energy savings.

FIGURE 26: PRIMARY ENERGY SAVINGS FROM DEPLOYMENT OF SMART GRID, 2020

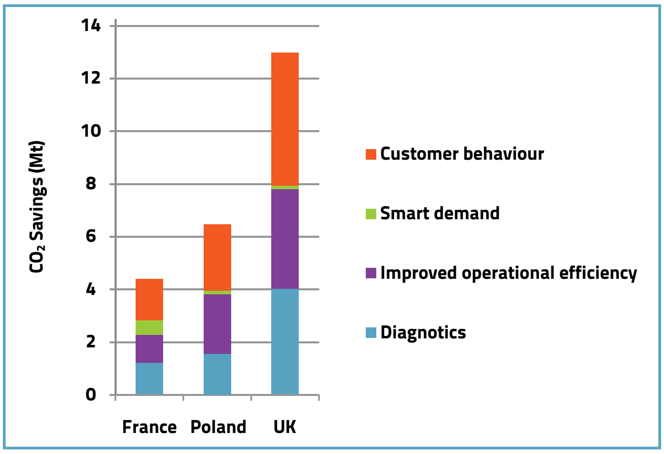


Source: Delta Energy & Environment, 2011

[8] A meta-analysis combines the results of several independent studies that address a set of related research hypotheses

Figure 27 illustrates how these primary energy savings translate into CO_2 emissions reduction. The clearest opportunity is in the UK, where there is the potential to reduce CO_2 emissions by around 13 Mt CO_2 per annum by 2020.

FIGURE 27: CO_2 SAVINGS FROM DEPLOYMENT OF SMART GRID, 2020



Source: Delta Energy & Environment, 2011

Jobs benefits

There have been no studies into the potential job creation from a Smart Grid deployment in the UK, France or Poland, or in the EU. The most comprehensive study looking at this issue was undertaken by KEMA, again in the US, in 2009. Smart Grid jobs are created directly from the following categories:

1. Direct utility employees[9] – the net addition of new skills less the displacement of lower-skilled workers (e.g. meter readers).
2. Contractors – employed to accelerate installation and deployment of Smart Grid services.
3. Direct utility suppliers
    a. Meter vendors
    b. T&D automation device providers
    c. ICT product & service providers
    d. Software system providers & integrators.
4. There is also indirect job creation from, for example, the supply chain and EV providers.

Table 17 outlines the job creation potential from Smart Grid deployment in the three focus markets. The KEMA study uses the following assumptions:

- 1 Smart Grid project per 1 million smart meters deployed.
- An overall cost of €350 million per project, with labour costs comprising 30% of this.
- An average cost of around €50,000 per employee.

We have applied these parameters to the 3 focus markets based on our assumptions on smart meter deployment.

TABLE 17: NEW JOBS CREATED BY SMART GRID DEPLOYMENT, 2012 TO 2020

	France		Poland		UK	
	Deployment period (2012 to 2014)	Steady state period[10] (2015 to 2020)	Deployment period (2012 to 2014)	Steady state period (2015 to 2020)	Deployment period (2012 to 2014)	Steady state period (2015 to 2020)
Direct Utility Smart Grid	13,500	1,500	5,000	500	11,000	1,500
Transitioned (Lost) Utility Jobs	- 3,000	- 9,000	-1,000	-3,000	-2,500	-7,500
Contractors	5,500	500	2,000	200	4,500	500
Direct Utility Suppliers	33,000	25,000	12,000	9,000	27,000	21,000
Total Jobs excluding indirect	**49,000**	**18,000**	**18,000**	**6,700**	**40,000**	**15,500**

We recognise that this does not, indeed cannot, represent a rigorous analysis of the Smart Grid job creation opportunity in Europe, but a high level and indicative view. In comparing the US with Europe for example:

- The staging of deployment of the projects will be different.
- The cost of labour in the three markets will vary widely, with Poland being lower than UK and France.
- In respect of domestic jobs created in the supply chain, the US has a stronger domestic industry servicing the sectors mentioned than in our three focus countries.

[9] Direct utility employees are those with the new skills required to implement a Smart Grid, such as installers, IT and communications experts, project managers etc.
[10] Steady state jobs will persist beyond the Smart Grid deployment period as permanent, on-going and high-value positions.

4.5 Barriers

The development of the Smart Grid in Europe appears to be a question of 'when?' and not 'if'. But it appears as if Europe could be moving faster in this area and that other parts of the world may already be ahead. This might explain why much of the research that has been undertaken on the benefits of Smart Grid is from the US. Some of the member states in particular could perhaps 'up their game' in this area.

For example, we have found that

- There are large sums of money for Smart Grid being discussed at EU level, but in some member states there is only modest activity.

- Justifying the business case for investment in Smart Grid can be difficult. Traditionally, network assets have long lifetimes – often several decades – from which to earn revenue. Smart grid technologies have shorter lifetimes, as low as 5 - 10 years. In addition, a priority for network operators has traditionally been to limit risk and reduce costs rather than to innovate.

- The unbundling of Europe's utilities is creating some challenges. For example, who should own the smart meter?

- There is the potential for regulatory risk. Utilities will want to avoid any risk of stranded assets, or having to install infrastructure more than once.

- In Poland, we have found that considerable emphasis is being placed on smart meter roll-out and very little to wider Smart Grid development linked, for example, to infrastructure renewal.

4.6 Recommendations

We propose the following options for measures that can be implemented by regulators and policymakers to deliver the potential that we have identified:

- Ensure that there is sufficient incentive for energy companies and others to invest in Smart Grid R&D and infrastructure development. This can include funding member state research into cost / benefit analyses, e.g. for smart meter deployment (there remains considerable uncertainty around the business case for smart meters (e.g. DONG Energy, in Denmark, is suspending its plans for full roll-out). It can also include allowing DSOs to gain a sufficient return on investment in Smart Grid initiatives.

- Ensure that energy suppliers and others prioritise customer communication throughout the transition – it is important that benefits accrue to customers since their engagement will be necessary for delivery of many of the key benefits.

- An EU-level framework will be needed to address some key elements of Smart Grid development, for example:

    - Standardisation of smart grid technologies and communications protocols

    - Security and data protection

    - Minimum functionalities of Smart Grid hardware and software.

5 Waste Heat Recovery

TABLE 18: SUMMARY OF POTENTIAL AND BENEFITS OF WASTE HEAT RECOVERY (WHR) IN KEY MARKETS

	France	Poland	UK
2020 benefits	▪ 0.7 Mt of CO_2 saved / yr ▪ 9.5 TWh of primary energy savings	▪ 2 Mt of CO_2 saved / yr ▪ 9.4 TWh of primary energy savings	▪ 2.4 Mt of CO_2 saved / yr ▪ 11.3 TWh of primary energy savings
Options	▪ WHR from baseload reciprocating gas engines and larger gas turbines used in natural gas compression stations: CO_2 saving: 1.1 Mt CO_2 across three markets ▪ WHR from non-residential biomass boilers: CO_2 saving: 2.4 Mt CO_2 across three markets ▪ WHR from industrial processes: CO_2 saving: 1.6 Mt CO_2 across three markets		
Barriers	▪ Lack of awareness of waste heat recovery – not recognised by policy ▪ Economics – paybacks slightly too long for some applications ▪ Uncertainty of heat supply – needs to be continuous for waste heat recovery to work		
Recommendations	The key recommendation for waste heat recovery technology is simply for policy makers to recognise the energy and carbon savings that WHR offers and to ensure that appropriate incentives include it.		

Source: Delta Energy & Environment

5.1 Waste Heat Recovery Today

Waste heat from various processes can be captured and reused for useful heating or for generating mechanical or electrical work. We focus here on the opportunity to generate electricity from waste heat in applications where there is little or no local need for extra heat. The 3 main applications that we cover are:

1. Reciprocating gas engines and gas turbines that do not already recover waste heat
2. Waste heat recovery from industrial processes
3. Waste heat recovery from biomass boilers

There are other applications being trialled for waste heat recovery, most notably geothermal and solar thermal, however evidence to date suggests that these applications are generally not economic so will not be included in this analysis.

Generating power from waste heat typically involves using the waste heat to create mechanical energy that drives an electric generator. In a waste heat-to-power scheme, the waste heat is converted into electricity that can be either used onsite or sold to the grid, delivering direct energy savings and associated carbon emission reductions.

The efficiency of power generation is heavily dependent on the temperature of the waste heat source. The lower the quality of heat, the less efficiently it can be converted into electricity. In general, power generation from waste heat has been limited to only medium to high temperature waste heat sources, converted to power in traditional steam cycle turbines. However, advances in alternate power cycles, in particular the Organic Rankine Cycle (ORC), have improved the feasibility of generation at low temperatures. While the maximum efficiency of electricity generation at these temperatures is lower, these systems can still be economical in recovering large quantities of energy from waste heat. The table below summarises these two most common power generation technologies.

TABLE 19: THE MOST COMMON WHR TECHNOLOGIES FOR POWER GENERATION

Technology	Temperature range	Typical source of waste heat	Efficiency
Traditional steam cycle	Greater than 350°C	Exhaust from: ▪ Incinerators ▪ Furnaces	25 – 40% Average assumed 32.5%
Organic Rankine Cycle (ORC)	As low as 90°C	▪ Gas turbine exhaust ▪ Reciprocating engine exhaust ▪ Boiler exhaust ▪ Heated water ▪ Cement kilns	7 – 19% Average assumed ~ 13%

Source: Conversations with various WHR technology manufacturers

5.2 Current status of WHR activity in France, Poland and the UK

The current level of WHR activity in the three markets is very low – only a handful of projects go ahead each year. However, across all markets, WHR may be on the cusp of being economically attractive, with payback times usually of 3.5 to 7 years (based on offsetting electricity on an industrial tariff), just slightly too long to be prioritised by the customers in question.

None of the markets have policies that specifically recognise WHR:

- France has a system of White Certificates in place to promote energy efficiency in the industrial sector, but only a few measures are rewarded and power generation from WHR is not among them. Policy support for electricity from landfill gas actually disincentivises WHR – if power conversion from landfill is maintained at 85%, then a tax credit is awarded at a level of €7 per tonne of landfill converted. Adding WHR would push conversion above this threshold and the tax credit would be lost.

- Poland's Certificates of Origin system (supporting energy from renewable and low carbon sources such as biomass, biogas and

CHP) does not explicitly recognise WHR. However there are a number of industrial customers paying very high electricity rates, therefore a handful of WHR projects have gone ahead based on good payback times alone (less than 4 years).

- The UK has several policies that could potentially reward electricity from WHR, but as yet do not. Electricity generated from biomass and biogas is eligible to receive Renewables Obligation Certificates (ROCs) – tradable certificates given for each MWh of electricity produced. Heat produced from biomass and biogas is to be rewarded by the Renewable Heat Incentive (RHI) from July 2011.

5.3 Key mechanisms through which WHR can deliver energy and CO_2 savings

WHR from baseload operation reciprocating engines and gas turbines

According to GE, there are more than 130,000 gas and diesel reciprocating engines (1 MW+) worldwide. About 30,000 units are running continuously, and over half of these are in applications with no onsite use for waste heat, such as landfills, waste water treatment and grid support. This application presents a considerable opportunity for the conversion of this waste heat into power. However as there is a lack of robust data available in Europe on the current and future installed capacity of engines suitable for waste heat recovery, this application will not be quantified in this analysis.

Another clear opportunity for waste heat recovery is from gas turbines in natural gas compressor stations. Natural gas pipeline networks rely on compressor stations to maintain a continuous flow of gas between supply areas and delivery to customers. Compressor stations are usually situated between 50 to 150 miles apart along the length of a pipeline system, and are typically designed to operate on an unattended and non-stop basis. These turbines are usually simple cycle, around 25 to 30 MW in capacity and generally do not recover the waste heat.

Based on GE Energy guidance, we have assumed in our analysis that for every MW of gas engine or gas turbine capacity, 100 kW of power can be recovered from the waste heat (assuming ORC technology is used)[11].

Industrial processes

According to the US Department of Energy (DOE), as much as 20% to 50% of industrial energy consumption is ultimately discharged as waste heat. Much of this waste heat (around two thirds) is of too poor a quality to enable waste heat recovery, but a US study from the DOE[12] indicates that a potential 190 – 200 TWh of waste heat could be captured from the 'useful waste heat' for electricity generation. This equates to 2.6% of the final energy consumption by US industry.

Unlike the US, however, research on the potential for waste heat recovery in Europe, and data on the amount of industrial waste heat is simply not available. The proportion of industrial energy consumption in Europe lost as waste heat may be lower than the US in some EU member states but likely to be higher in others. In the absence of European data (we recommend new research into this area) we therefore apply the same factor for the three focus countries to determine the potential waste heat available for conversion to electricity.

The most energy intensive industries identified, with the greatest potential for waste heat recovery, include:

- Cement
- Iron and steel
- Glass

Waste heat from these industries is generally categorised as in Table 20.

TABLE 20. QUALITY OF WASTE HEAT FROM INDUSTRY

The majority of waste heat from industry is low grade, at temperatures <230 C.

Heat quality	Temperature	Typical sources	Suitable WHR technologies for electricity generation
High grade	> 650 C	▪ Coke ovens ▪ Metals furnaces ▪ Glass furnaces ▪ Incinerators	▪ Steam turbines
Medium grade	230 – 650 C	▪ Cement kilns ▪ Exhaust gases ▪ Drying ovens	▪ Steam turbines ▪ Organic Rankine cycle
Low grade	< 230 C	▪ Exhaust gases ▪ Cooling water from furnaces, compressors ▪ Steam process condensate	▪ Organic Rankine cycle

Source: BCS, Incorporated, 2008

The DOE found that around 60% of the useful industrial waste heat is low grade for which Organic Rankine Cycles can be implemented. A further 30% is typically medium grade heat, with only 10% being high grade. Assuming that half the medium grade heat is suitable for steam turbine based WHR, this limits the total amount of industrial waste heat for which steam turbine waste heat recovery is suitable to around 25%.

Biomass boilers

Biomass heating plays a vital role in the 2020 renewable energy strategies of the three focus markets. Biomass boilers are typically 60% to 80% efficient, depending largely on load factor. This implies that 20% to 40% of the fuel input to these boilers is lost as waste heat to the atmosphere, a prime opportunity for waste heat

[11] Source: GE Energy

[12] Source: BCS, Incorporated, Waste Heat Recovery: Technology and Opportunities in US Industry, 2008

recovery. Boiler exhaust is low grade heat so the ORC technology is most suitable.

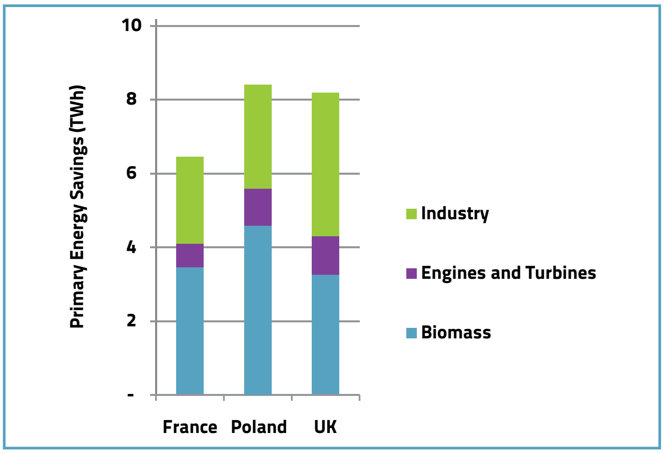
Using data from the national renewable strategies, we have assessed the opportunity to recover the waste heat from non-domestic biomass boilers, not including heat from biomass CHP. The assumptions we make for the analysis are in **Annex 4**.

5.4 Benefits of WHR deployment

All assumptions used in the calculation of the energy and CO_2 benefits of WHR are described in **Annex 4**.

Figure 28 describes the primary energy savings potential from widescale WHR deployment in the three focus markets based on the three technical options we have described.

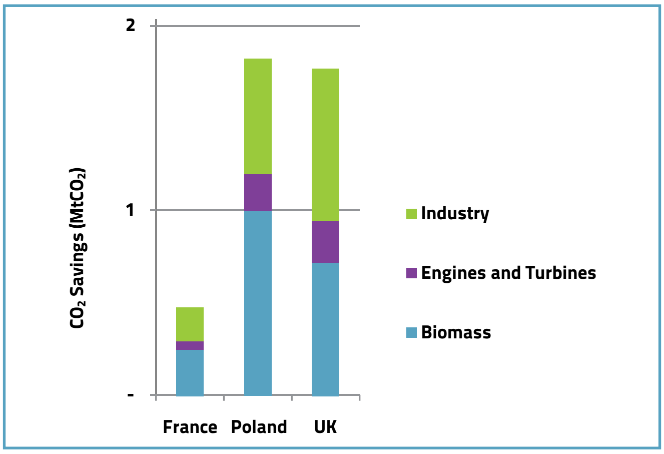
FIGURE 28: PRIMARY ENERGY SAVINGS FROM DEPLOYMENT OF WHR, 2020



Source: Delta Energy & Environment, 2011

Figure 29 illustrates how these primary energy savings translate into CO_2 emissions reduction. The assumptions we use for these calculations (for example the carbon intensity of the displaced electricity) are the same as those used for the CHP analysis.

FIGURE 29: CO2 SAVINGS FROM DEPLOYMENT OF WHR, 2020



Source: Delta Energy & Environment, 2011

5.5 Barriers

The main barriers to the uptake of waste heat recovery that we have identified are:

- Lack of awareness of WHR. Unlike in some parts of the US, WHR technology is not recognised by policy makers in Europe as a source of carbon free energy, and therefore is not directly incentivised or supported by policy.
- Economics. Paybacks on WHR technology usually range from 3.5 – 7 yrs or more, too long for many applications – particularly in industry. Investment in this technology is made more challenging by the capital constraints and small profit margins in some industries.

5.6 Recommendations

The key recommendation for waste heat recovery technology is for policy makers to increasingly recognise the energy and carbon savings that WHR offers and to ensure that appropriate incentives include it.

6 Comparing supply-side with demand-side

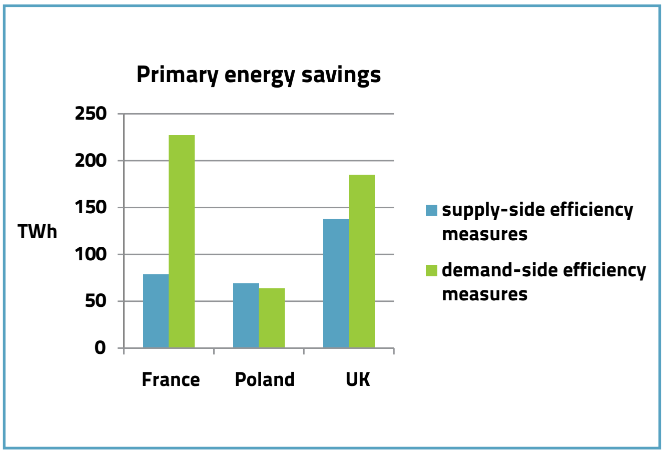
The high importance of cost-effective demand-side efficiency measures has been well recognised by the EU institutions and by many member states - most recently the EU Energy Efficiency Plan published in March 2011.

As part of our analysis, we have also compared the primary energy saving benefits of the supply side efficiency measures that we have assessed (there are other options that we have not assessed) with those of demand-side measures that the member states have identified over a similar time-frame in their 2007/08 National Energy Efficiency Plans (of the three, only the UK also stated its associated CO_2 savings).

Using European Commission energy statistics data from 2009, we have stripped transport measures out of the analysis to enable a fairer comparison, and have converted the demand-side efficiency potential into equivalent primary energy savings.

The comparisons are shown in the figure below.

FIGURE 30: ANNUAL PRIMARY ENERGY SAVINGS BY 2020



Source: Delta Energy & Environment, 2011

If we were to take a comprehensive range of supply-side measures into account, we believe that the benefits would exceed considerably those of demand-side measures in Poland and be similar in scale in the UK. The UK comparison is an interesting one: its demand-side efficiency potential is particularly high in part because its building stock is notoriously energy inefficient.

Technical Annex

Annex 1: Power Plant Efficiency

Assumptions on potential for efficiency improvements to 2020 UK CCGT fleet

- **Plants less than 12 years old:** Delta assumes no improvements would be made to these plants

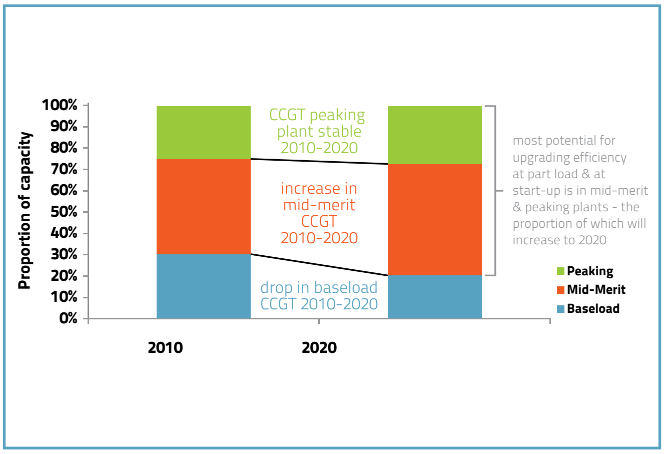
- **Plants of 12-24 years:** 10% of the 2020 fleet will be between 12 and 18 years old, and 44% will be between 18 and 24 years old. Technology upgrades and implementation of advanced performance monitoring could yield benefits in the order of 2% - counter-acting the effects of degradation over time, and potentially raising the efficiency to close to the efficiency of a new plant built in 2020.

- **Plants over 24 years:** Delta assumes plants of over this age in 2020 are close to being decommissioned. The efficiency gains will be very limited as less investment is likely to be made in them.

NOTE: Technology upgrades – improving efficiency at part load & at start-up: Potential efficiency gains through these mechanisms are dependent on the way the plant is running. If the plant is in a peaking role, stopping and starting every day, efficiency gains in the order of 5% are possible. If the plant is baseload, efficiency gains through implementation of this technology will be minimal. Improving efficiency at part load will have an impact where plants are ramping up and down often between full and part load (mid-merit plants). The following graph shows the assumptions we use, based on UK National Grid information, about the proportion of CCGTs running as baseload, mid-merit and peaking plant in 2020. Based on Delta's conversations with industry experts, we have come to a view of how this proportion of baseload / mid-merit / peaking will change to 2020, with a reduction in baseload being taken up by an increase in the more cyclical plants.

FIGURE 31: ASSUMPTIONS ABOUT OPERATIONAL REGIMES OF UK CCGT PLANTS IN 2010 & 2020

There are no well-defined projections for the exact proportion of baseload / mid-merit / peaking plant in 2020, but based on conversations with our industry networks, Delta is of the view that baseload CCGT may reduce to <10%, while peaking plant may increase to 30-40% by 2020 – in response to the need to balance the growing nuclear baseload and intermittent renewables.



Source: 2010 - National Grid Winter Outlook 2010; 2020 projection – Delta Energy & Environment, 2011

Assumptions on generic efficiency gains & efficiency degradation over time in CCGT plants

TABLE 21: ASSUMPTIONS ON EFFICIENCY GAINS

Efficiency mechanism	Type of plant	Potential for improvements (max % efficiency gain)
Technology upgrades: overall efficiency	baseload	2.0%
	mid-merit	2.0%
	peaking	2.0%
Technology upgrades: efficiency at start up	baseload	0.05%
	mid-merit	0.5%
	peaking	3.0%
Technology upgrades: efficiency at part load	baseload	0.0%
	mid-merit	2.0%
	peaking	0.0%
Performance monitoring, & operation & maintenance practices	baseload	1.25%
	mid-merit	1.25%
	peaking	1.25%
Dispatch patterns	baseload	0%
	mid-merit	5%
	peaking	10%

Source: Delta conversations with E.On UK, ESB Ireland, GE Energy

TABLE 22: ASSUMPTIONS ON DEGRADATION OF CCGT PLANT EFFICIENCY OVER TIME

	Age of plant (yrs)				
Type of operation	**0**	**6**	**12**	**18**	**24**
Baseload	50.7%	50.2%	49.7%	49.2%	48.7%
Mid-merit	48.2%	47.7%	47.2%	46.7%	46.2%
Peaking	45.7%	45.2%	44.7%	44.2%	43.7%

Source: Delta conversations with E.On UK, ESB Ireland, GE Energy

Technology upgrades for CCGT plants

Cooling optimisation in CCGT plants: 0.5% heat rate improvement

Gas turbine combustion takes place at higher temperatures than the metal of the turbine can stand, so cooling mechanisms are required to avoid damage or melting. One mechanism to deal with this is through extracting air from the compressor to create a film of cool air around the turbine. This process can be optimised to maximise efficiency of the process:

- **Traditional cooling control systems** - these extract sufficient cooling air to meet a 'worst case scenario', so turbines are cooled more than necessary, resulting in reduced efficiency.
- **Cooling optimisation** - air used to cool components is used more efficiently (only as much as is necessary) through active control of cooling flows – a 'compressor ejector' modulates the airflow around the turbine, and reduces the amount of air the compressor needs - improving the process efficiency.

Reducing leakage in a gas turbine

Through more sophisticated control over the clearance between rotating and stationary parts within a gas turbine, leakage can be minimised and thus efficiency increased.

Automated performance monitoring

There are many packages on the market which deliver performance monitoring. The technology continually monitors the performance characteristics of key assets in the plant (e.g. boilers, water-steam cycle, cooling water cycle, auxiliary systems), comparing the effectiveness of current performance to an optimal performance based on a computer-based thermodynamic model of the power plant.

Implementation of such performance monitoring packages means that:

- The causes of reduced efficiency can be identified early.
- Operational practices can be adjusted (more informed decisions are made by the plant operator) to improve performance.
- Losses resulting from equipment degradation, downtime and emergency repairs can be prevented.
- Maintenance strategies can be optimised, avoiding reactive emergency maintenance & associated (un-planned) plant down-time which result in efficiency losses.

Annex 2: CHP

The assumptions used for modelling the CO_2 and energy savings from CHP are as follows:

- For all countries, we assume that the CHP displaces separate generation of electricity and heat as described below. We do not consider that the shares of CHP in the overall power generation market are high enough in any of the countries to require that new CHP displaces existing CHP plant.

- Electricity displaced by new CHP. We assume an average fossil carbon intensity of grid electricity. This excludes nuclear power and renewable energy sources. In practice, these are unlikely to be displaced by CHP. For example, existing nuclear power is usually fully depreciated and a low price generator, while renewables often benefits from obligations or feed-in tariff incentives that ensure dispatch[13]. To assess this average, we have assumed the following electricity fossil mixes for 2020:
    - France
        - Fossil generation – 54% natural gas, 43% coal, 3% oil.
        - 44.5% average efficiency of fossil fuel generation.
    - Poland
        - Fossil generation - 84% coal, 16% natural gas.
        - 40.0% average efficiency of fuel generation.
    - UK
        - Fossil generation – 63% natural gas, 37% coal.
        - 45.5% average efficiency of fuel generation.

- **Heat displaced by new CHP**. A CHP scheme is installed to meet a heating (and occasionally a cooling demand), either existing or new. An existing heat demand would otherwise be provided by boilers. Existing boilers have well-known characteristics and it is relatively straightforward to calculate avoided emissions. There are now very limited opportunities to increase the efficiency of new boilers. For France and the UK, we assume that the CHP displaces gas boilers. For Poland, because of the high use of coal in the country, we assume a 50/50 mix of gas and coal boilers are displaced.

- For building / DH CHP in 2020, we have modelled:
    - 1 MWe Gas engine CHP
    - Fulfils EU CHP directive definition of high efficiency cogeneration.
    - Electrical efficiency (LHV) 40%
    - 5500 hrs/yr operation
    - Heat / power ratio 1.29
    - 100% electricity used on-site

- For industrial CHP - 2020, we have modelled
    - 50 MWe Gas turbine CHP (note: CCGT based CHP can also be applied at large industrial sites)
    - Fulfils EU CHP directive definition of high efficiency cogeneration.
    - Electrical efficiency (LHV) 39%
    - 8.200 hrs/yr operation
    - Heat / power ratio 1.11
    - 75% electricity used on-site
    - Displaces gas boiler (except Poland, displaces 50/50 mix coal/gas boilers)

- Average T&D losses – 2020
    - France 6.7%
    - Poland 8.7%
    - UK 7.7%
    - We assume a non-industrial CHP, connected at lower voltage, avoids a higher share of network losses than an industrial CHP, which is connected at higher voltage.

- **Share of new industrial & building DH / CHP**. We have assumed a ratio of around 2:1 of industrial: building & DH CHP. In general, the economic conditions are more favourable for industrial CHP based on their high load factors. DH projects tend to face high up front capital costs associated with the development of heat distribution infrastructure. All three countries have significant additional economic potential for industrial CHP development.

[13] Other examples of this approach include:

1. The UK – "in practice, fossil fuel fired generation is reduced more quickly in response to falls in electricity demand. Renewable and especially nuclear generation tends to operate at maximum capacity as much as possible". Savings in carbon emissions resulting from the use of Combined Heat and Power, Energy Trends, UK Government, 2003.

2. France - French electricity transmission operator RTE is supportive of using marginal grid factors for CHP and renewables (equivalent to average fossil) but that the issue should be addressed on a case by case basis.

3. Germany - For the purposes of voluntary CHP user calculations, the German government bases the methodology on the average grid mix, but also presents calculations based on the fossil-only part of the grid mix, when projecting the development of the power sector in the future.

Annex 3: Smart Grid

TABLE 23: ASSUMPTIONS USED IN CALCULATION OF BENEFITS

	France	Poland	UK	Source
Average grid carbon contents in 2020 (gCO_2/kWh)	83	625	425	France: assumed same as today, Poland assumed slightly lower than today with more gas and renewables UK: CCC, 2008
Total electricity supplied to the grid in 2020 (GWh)	637,250	187,136	451,496	EU Commission, 2009
T&D losses in 2020	6.7%	8.7%	7.7%	Delta assumptions based on IEA data
Total fuel input to generation in 2020 (GWh)	728,959	546,037	889,127	EU Commission, 2009
Average conversion efficiency in 2020	87%	34%	51%	Calculated
1. Diagnostics				
Number of residential heat pumps in 2020	2,000,000	50,000	635,000	Delta, 2011
Number of residential air conditioners in 2020	3,754,311	93,905	4,270,398	DGTREN, 2008
Electricity consumption of heat pumps per home (kWh)	9,500	9,500	9,500	Delta, 2011
Electricity consumption of air conditioners per home (kWh)	5,000	3,500	3,000	Delta, 2011
Total electricity consumption in commercial buildings (GWh) 2020	150,900	39,200	109,900	Eurelectric, 2010
% share of HVAC and lighting in small/medium buildings	26%	26%	26%	PNNL, 2010
2. Smart demand				
Carbon intensity of peak (g CO_2 / kWh) in 2020	545	545	392	UK: Predominantly gas CCGT, with some distillate, pumped storage and oil. (National Grid, 2010). France assumed mix of gas CCGT and OCGT. Poland assumed equal mix of coal and oil.
Peak shifted (hours)	500	500	500	Estimated, 2 hours per working day, GE Energy, 2011
Peak Demand (GW) 2020	90.9	28.9	68.5	Eurelectric, 2010
3. Customer behaviour				
Total final electricity consumption by sector (TWh) in 2020				
Households	157.4	34.8	127.4	Eurelectric, 2010
Industry	171.6	54.5	127.1	Eurelectric, 2010
Services	150.9	39.2	109.9	Eurelectric, 2010

Source: Delta Energy & Environment

Annex 4: Waste Heat Recovery

Gas turbines used in natural gas compression stations

TABLE 24: ASSUMPTIONS USED IN CALCULATION OF WASTE HEAT RECOVERY POTENTIAL FROM GAS TURBINES IN NATURAL GAS COMPRESSOR STATIONS

	France	Poland	UK	Source
Turbines	25	14	23	GRTgaz, GAZ-SYSTEM, National Grid, GE Oil & Gas
Capacity (MW)	750	350	690	Average unit capacity 25 MWe: GE Oil & Gas
Running hours	8500	8500	8500	GE Oil & Gas
Gas turbine generation (TWh)	6.375	2.975	5.865	
Potential from ORC (TWh)	0.64	0.30	0.59	GE Energy

Source: Delta Energy & Environment

Industrial processes

TABLE 25: ASSUMPTIONS USED IN CALCULATION OF WASTE HEAT RECOVERY POTENTIAL FROM INDUSTRIAL PROCESSES

	France	Poland	UK	Source
Final energy consumption by industry (TWh) in 2020	403.4	218.9	385.7	EU Energy Trends to 2030, 2009
Proportion of industrial energy demand from which suitable waste heat is produced (%)	33.6	33.6	33.6	BCS, Incorporated, Waste Heat Recovery: Technology and Opportunities in US Industry, 2008
Energy consumption on which WHR is possible (TWh)	135.6	73.6	129.6	
Proportion of energy demand that result in useful waste heat (%)	7.9%	7.9%	7.9%	BCS, Incorporated, 2008
Waste heat potential (TWh)	10.7	5.8	10.2	
Proportion of waste heat by grade	▪ Low grade = 60% ▪ Medium grade = 30% ▪ High grade = 10%			BCS, Incorporated, 2008
Proportion of waste heat used by ORC (%)	75	75	75	BCS, Incorporated, 2008 Recycled Energy Development, 2011
ORC efficiency (%)	13	13	13	Numerous manufacturers, 2011
Proportion of waste heat used by steam turbines (%)	25	25	25	BCS, Incorporated, 2008 Recycled Energy Development, 2011
Steam turbine efficiency (%)	32.5	32.5	32.5	Numerous sources, 2011 Recycled Energy Development, 2011
Electricity from WHR ORC (TWh)	1.04	0.56	0.99	
Electricity from WHR ST (TWh)	0.87	0.47	0.83	

Source: Delta Energy & Environment

Biomass boilers

TABLE 26: ASSUMPTIONS USED IN CALCULATION OF WASTE HEAT RECOVERY POTENTIAL FROM BIOMASS BOILERS

	France	Poland	UK	Source
Biomass heat suitable[14] for WHR (GWh)	60,476	31,300	33,762	2020 Renewable Action Strategies for each Member State.
Running hours	5,000	5,000	5,000	Intermediate load based on approximated annual heating hours.
Capacity suitable for WHR (GWth)	12.10	6.26	6.75	
Biomass boiler efficiency	75%	75%	75%	Biomass Energy Centre (UK), 2011
Waste heat potential (GWth)	5.18	2.68	2.89	
Electricity potential from ORC WHR (GWe) based on electrical efficiency of 13%.	0.67	0.35	0.38	

Source: Delta Energy & Environment

[14] Suitable biomass heat refers to that from larger (non-domestic) boilers, and not already CHP

Technology Focus

FlexEfficiency 50 Combined Cycle Power Plant

New Power Plant with Breakthrough Flexibility and Efficiency to Enable Greater Use of Wind, Solar and Natural Gas on Power Grid

The FlexEfficiency 50 Combined Cycle Power Plant is GE's latest innovation in combined cycle technology engineered from the ground up to deliver cleaner, more efficient energy onto the grid and into our homes. Combining GE's unique aviation technology and power generation expertise, the FlexEfficiency 50 plant is engineered to provide an unprecedented combination of efficiency and flexibility. This means it can quickly and efficiently ramp up when the wind is not blowing or the sun is not shining and can ramp down when they are available. Ecomagination-certified, this advanced power plant was developed by GE engineers and technologists to create a clean energy future. It will enable utilities to take advantage of the benefits of abundant natural gas, the cleanest-burning fossil fuel, and avoid 12,700 metric tons of carbon emissions per year relative to GE's existing technology. This power plant will save money for our customers and is better for the environment.

This is a first-of-its-kind power plant engineered to deliver an unprecedented combination of flexibility and efficiency. By rapidly ramping up and down in response to fluctuations in wind and solar power, the technology will enable the integration of more renewable resources into the power grid. The FlexEfficiency* 50 Combined Cycle Power Plant is rated at 510 megawatts and offers fuel efficiency greater than 61 percent. The plant is the result of an investment of more than $500 million in research and development by GE and a key part of its ongoing work to create and manufacture technologies around the globe that deliver cleaner, more efficient energy which is essential if renewable power is going to cost-effectively integrate into power grids around the world on a large scale.

*FlexEfficiency is the powerful combination of flexibility and efficiency; a new tool to help plant operators balance the intermittency of wind and solar power. GE believes FlexEfficiency is the future of the power generation industry and the only way to meet emissions targets and create a cleaner energy future.

GE drew from the company's jet engine expertise to engineer a plant that will ramp-up at a rate of more than 50 megawatts per minute, twice the rate of today's industry benchmarks. Operational flexibility at these levels will enable utilities to deliver power quickly when it is needed and to ramp down when it is not, balancing the grid cost-effectively and helping to deploy additional renewable power resources like wind and solar. A typical plant will deliver enough energy to power more than 600,000 EU homes.

Increasing Renewables With Natural Gas

"As our customers seek to increase their use of renewable energy, the challenge of grid stability sharpens. They are under added pressure to achieve higher levels of efficiency and lower emissions for natural gas power plants. The FlexEfficiency 50 plant creates an immense growth opportunity in a new segment for our gas turbine technology and is in lock-step with our commitment to build a cleaner energy future," said Paul Browning, vice president of Thermal Products. "For years we have been working to develop technology that can, in the same breath, deliver breakthrough efficiency and deal head-on with the challenge of grid variability caused by wind and solar. The need for combined flexibility and efficiency is even more pressing today as countries around the world establish new emissions standards."

The FlexEfficiency 50 plant is the first product in GE's new FlexEfficiency portfolio and part of GE's ecomagination commitment to drive clean energy technology through innovation and R&D investment. The launch follows GE's recent announcements of the world's most efficient wind turbine, the highest reported efficiency for thin film solar and $11 billion in acquisitions that strengthen a portfolio supporting natural gas and power transmission.

"Much of today's power generation technology is serving yesterday's power grid. Institutions and individuals everywhere are looking for cost-effective ways to use solar, wind and gas energy on a large-scale. But they often assume that renewable energy can simply plug-in to the existing power grid," said Steve Bolze, president and CEO of GE Power & Water. "Throughout GE, we have invested to strengthen our global portfolio with a view to delivering efficient power generation across clean energy technologies. We expect this FlexEfficiency breakthrough to help take advantage of abundant natural gas while we simultaneously carve a fresh path to accelerate wider adoption of renewable energy, all with less impact on natural resources."

Sustainability By Design

GE engineers were able to avoid the typical trade-offs between flexibility and efficiency by approaching the plant design from a total equipment and control systems perspective. The FlexEfficiency 50 plant is engineered for flexible operation by integrating a next-generation 9FB Gas Turbine that operates at 50 Hz, which is the power frequency that is most used in countries around the world; a 109D-14 Steam Turbine, which runs on the waste-heat produced by the gas turbine; GE's advanced W28 Generator; a Mark* VIe integrated control system that links all of the technologies; and a heat recovery steam generator.

"With global energy demand expected to double by 2030 and electricity generation accounting for 40 percent of greenhouse gas emissions, utilities and government bodies are taking a hard look at how to produce power more efficiently," said Ricardo Cordoba, president of GE Energy for Western Europe and North Africa. "This innovation can have a dramatic effect on CO_2 emissions and offers a nimble, efficient and cost-effective way for us to help EU countries in their pursuit of 20-20-20 energy goals.

The 9FB Gas Turbine will be manufactured at GE's facility in Belfort, France, which is the largest gas turbine manufacturing facility in the country and employs more than 2,000 people. The steam turbine and generators will be manufactured in the United States in GE's facility in Schenectady, NY, which employs more than 3,800 people. GE is also investing $170 million to create a full-speed, full-load testing facility in Greenville, South Carolina, allowing the 9FB Gas Turbine to be factory validated at full capacity in real-world power plant conditions.

Interview

Bob Gilligan

Bob Gilligan is vice-president of 'Digital Energy' business at GE Energy Services, which aims to provide integrated smart grid solutions for electric utilities. Smart grids refer to the marriage of information and automation technologies with existing electrical infrastructure.

Q: Some smart grid experts have compared it to publishing: with magazines it was all one-way, and like Web 2.0 now it goes both ways.

Yes, it's an interactive system now. For our whole history, the way they've managed electricity – because storage is so inefficient for electricity – they did not try to control demand, so they just tried to match supply, whatever that demand was.

Well, the variability in demand has continued and that is why variations have become such a huge issue. It is harder and harder for supply to chase that moving demand. So one of the big opportunities here is that we're beginning to manage the timing of demand. I'll give you some examples from our clients division. For those of us that are over forty, we remember our mothers defrosting the freezer, now there is automatic defrosting, but that more than doubles the electric consumption of the refrigerator. Today it goes on whenever it wants to, but you can easily time it to come on when power is readily available – off-peak times.

So simple things like that, having those less time-dependent loads programmed to come on when power is readily available. And electric cars are a huge opportunity: not to charge it at six o'clock when you come home but just set it up and say, 'I want to charge it when the power is really cheap but it has to be fully charged by 6 a.m.'. So now you have dispatchable demand, just like you have dispatchable supply.

Q: Moving on to standards and interoperability, how do you make sure that machines can speak to each other?

Yes, if you want to have efficiency and competitive systems, you've got to have open standards and interoperability. Nobody is going to buy one smart grid from one vendor. Nobody would want to do that, no one vendor can do it. So you have to establish these standards. And there is a ton of work going on to ensure that this is happening in the right way. Appliance manufacturers are all working together to establish proper standards for communication for their devices, so that in the home you can unplug a GE refrigerator and plug in another.

Now what we want is that they become more international standards, not US standards, European standards, Chinese standards. Because then you're really opening up competition globally. That is what we want as a vendor, but it is also what consumers and utilities should want, because now it's a more competitive market system.

Q: The next question leading from that, then, is what's the cost of this infrastructure and the role of public and private funding?

The unspoken secret is that whether we like it or not, huge reinvestment has to go into the grid. The grids were built largely after World War II in mature markets, so when you look at the age of the equipment in the grid today, 50% of the assets are reaching the end of their useful life. The average age of the transformer in the United States is over 40 years old, and these things were typically designed with a 30-year lifespan. So you've got a lot of assets that have to be replaced - and the same thing in Western Europe.

So the challenge is – are you going to just replace them piecemeal as they fail, in other words do spot repairs to an old system, or are you going to plan on the renovation of the system? It's the 21st Century, digital infrastructure supporting digital society needs, not a 19th Century analogue system that has been updated. That is our challenge.

For consumers, they are not going to like it, because the fact is, this infrastructure we have been working with has been fully depreciated, so the cost of electricity appears low. But now you have to go and reinvest and put money back into the system and that is going to raise their cost, but I do not see any way to avoid it. What I do see is a way to optimise this investment so that it supports a more green, environmentally-friendly energy system.

Q: Economists say the amount we pay for energy is artificially low, as oil subsidies are so high. And until there is some balancing, renewables won't be price competitive, right?

We want to have a plan as we are updating the grid we are moving towards that 21st Century infrastructure. This is going to be a 10- or 20-year transformation, it's not a 2- or 3-year challenge. The carbon-based generation that we have all grown up with has really been in place for over 100 years. We have had 100 years to work at the cost of that.

Wind generation has been around for 20 years. From a scale standpoint we are nowhere near the steam and gas turbine, so there is a lot more to be learned: how do you build them, how do you optimise their use, how do you optimise them for maintenance?

On solar, we are projecting that we are going to get to parity in the cost of photovoltaic electricity sometime in the next 10 or 20 years without subsidies. So certain markets will get there sooner than others, because the cost of conventional electricity is already higher in certain markets. It depends on their fuel, the age of their fleets, etc., but the cost for photovoltaics is really dropping quite substantially because the efficiency of electric generation is evolving so much from the cells.

Q: There is a possibility that large amounts of public finance will be needed. Where do you see this going, what sort of magnitude are we talking about, and what sort of time frame?

If you assume that the cost for smart-grid implementation is something like $500 per metered endpoint - not just the meter, but the sensors, communication, software, etc., that are required - we think around $500 per meter endpoint is reasonable.

When we look at the United States today, we are only about 5% penetrated with smart meters. The cost for that four million meter points is somewhere around $2 billion.

That is displacing the need for five coal plants. So five new coal plants would cost somewhere around a $1.5 billion. And it is reducing the operating maintenance expense associated with the coal plants and other activities by more than $250 million.

And then it is also having a positive impact on (gross domestic product), because we see fewer customer minutes interrupted. So that reliability has a real impact on our digital economy. That is worth about $2.5 billion. So when you just look at that math – this makes sense. Now it takes a while to get to that.

The reality is, when you talk to a utility executive, they'll tell you, the operational benefits of a smarter grid give a good pay back. And they are talking about less than a four-year pay back because you are able to minimise their investment in new plants and to optimise their mobile work crews, able to extend the life of old assets, so it just makes sense from an economic standpoint.

It's hard to get there, though, because the problem for us is the consumers. One day, you get a notice when someone is going to put a smart meter in your house. Months go by and nothing changes. Maybe your bill will go up because you are paying subsidies for that cost. It's going to be a year before you see new information come to you that helps you manage your bill better. And still you are going to say, 'well, did my cost, my total bill, really go down?' Well, it may not have because you are avoiding some other cost that may have come to you.

That is the problem: everybody is expecting costs to drop when they do this but the reality is that costs are going to go up. The question is: can we reduce the rate at which they increase?

Q: Of all the technologies to combat climate change, do you think there is one that stands out which is going to make more of a difference than others?

There is no one thing. You have to do many different things and the smart grid is the enabler. So I am a proponent of the smart grid, not just because it is part of my business but because it is an enabler for everything else, whether it is electric vehicles, photovoltaic or wind or more efficiency.

Q: We have been talking about the number of jobs that green energy could produce. How many do you think will be created by introducing smart grids in the United States?

Kema, the consulting company, did a study for the Department of Energy, with respect to smart grid and the jobs that would be created by that, and they are projecting 140,000 new jobs generated through the creation and support of the smart grid. That's the US number.

Q: And in Europe?

I don't have a figure for Europe. But we are seeing developing markets moving quickly to a greener energy infrastructure. As they are putting in their first investment, they are doing it with a digital energy infrastructure. It's easy for them and because they are making such huge investments anyway, it creates the opportunity to develop an industry for export.

That is what China is all about. China is going really big after wind energy, solar energy and smart grid technology today. And if we are not careful - and the rest of the world - we are going to find that they have the Internet industry of tomorrow.

Regional Focus: Lower Silesia

New Biogas Plants

In the Lower Silesia region of Poland energy officials are currently accepting applications to build biogas plants

Poland's Ministry of Economy is expected to publish a draft of the country's new renewable energy policy before the country takes over the rotating presidency of the European Union on July 1. Currently, Poland is close to achieving its 7.5% target for renewables and the next goal is to double that figure by 2020 and to have almost 20% of its electricity generation from renewables.

The Ministry of Foreign Affairs has said there will be two key priorities during its six-month EU presidency: energy infrastructure and the Eastern partnership. The grids across Europe need to be improved for wider use of renewables. And energy is a key part of the Eastern partnership.

Poland is going to work on the Baltic grid circle, to find a way to link Baltic states and countries around the Baltic Sea to better use the potential for energy sources in the region. This is one of the priority EU projects -- along with off-shore wind transmission grid in the North Sea -- linking Western and Central European infrastructure, linking Southern and Western Europe over the Pyrénées and strengthening Central and Southern European energy infrastructure to be able to build a truly European energy market.

Polish energy policy is decided at a national level, while local authorities are responsible for preparing energy plans. Regions are active in initiating strategies to develop energies to be more sustainable, to support local authorities in their efforts to create sustainable energy planning for the next 20 years. But regions also have an important role to play in creating zoning areas for land use and for educating the public, which has veto-rights in approving projects.

Renewables in Poland are mainly wind, biogas and hydro, however hydro power is nearly at its limits. Photovoltaic is less developed and less used in Poland.

In general, the wind power sector is one of the best success stories in Poland. In 2010 it reached 1,000 megawatts and this year wind power will top 1200 megawatts. The National Renewable Energy Action Plan assumes growth up to 6600 megawatts, and the industry is certain the growth could double.

Poland also has a big agricultural sector, which could provide an estimated 1.8 gigawatts electrical capacity through biogas. Right now, there's less than 100 megawatts running under biogas. It's mainly landfill and sewage water. In terms of landfill, it's similar to hydro and near its limits.

In Lower Silesia, there is little room for wind farms, so Mieczyslaw Ciurla, director of the economic development department in the Marshal's office, is currently reviewing proposals for new biogas plants to replace old, coal-fired plants, which account for 90% of electric power in Poland.

Q: What are the energy priorities for your region?

MC: The energy strategy for the lower Silesia was created in 2005. From this, the Regional Operational Programme was created to finance concrete tasks from the energy strategy, targeting energy efficiency and renewable energy projects: biogas plants, bio-refineries and hydroelectric power plants. There will also be a special focus on projects aiming at lowering low-lying emissions, such as smog, in rural areas through cogeneration based on biogas.

We are also looking at projects that will modernise the electricity grids (medium and low voltage) and pipelines, because the current infrastructure is very old and could break down. These are the projects that we would like to finance.

To educate and motivate the public, we also organise study visits for representatives of communes to show how a biogas plant works and encourage the communes to build their own plants.

Q: Have any of these priority projects been implemented?

MC: Currently we are accepting applications for construction of biogas plants. In a year we will be able to show these biogas plants. In Poland we have very complicated legislation regarding investments in this area, unlike in Germany where these things take much less time. In Poland it is very slow; the preparatory phase of building a biogas plant can take up to two years.

Q: What will be the biggest challenges to overcome?

MC: Skills, finding the people with the right knowhow and skills to run plants. And resources -- the communes should pool their resources to see if it is not worth applying for and building a biogas plant together rather than separately.

Q: What about smart grids?

MC: This is the future. We are at stage of case studies and analysis of smart grids, etc., but those are quite costly.

Q: What are the sources of financing for these projects?

MC: They are co-financed, mainly with (EU) structural funds.

Q: What financial schemes (if any) do you offer for businesses and industrial companies?

MC: There are several credit lines available from the Environmental Protection Fund. Companies can also benefit from favourable loans for the construction of passive houses. And some communes co-finance the installation of solar panels.

Q: How does your programme fit into the broader Polish energy strategy?

MC: Our regional energy strategy has been created long before the Polish energy strategy so we are currently updating it and fine-tuning it to the national priorities. For example, we will include the construction of a peak pump power station.

Technology Focus

Improving Power Plant Efficiency

Electricity power plants will play a central role in the low carbon economy. The European Commission's analysis shows this sector can almost totally eliminate CO_2 emissions by 2050, and offer the prospect of partially replacing fossil fuels in transport and heating.

The share of low carbon technologies in the electricity mix is estimated to increase from around 45% today to around 60% in 2020, according to the EC.

As the share of intermittent renewables and inflexible nuclear generation increases in Europe, existing thermal plants will need to operate in a more flexible way to ensure that electricity supply and demand balances. Combined-cycle gas turbine plants, for example, will need to cycle more than they may have been designed to do and, in so doing, their operational efficiency will decline. However, there are technical measures, that can enable these efficiency impacts to be minimised – so increasing primary energy savings and reducing carbon emissions.

While new power plants based on renewable fuels and other cleaner-burning technologies are part of the long-term solution, there are significant steps that can be taken to improve the performance of existing power generators. Improvement in power plant efficiency falls under three categories: technology upgrades, performance monitoring, and dispatch and load patterns.

These are designed to counteract the efficiency drop over plant lifetime (typically in the range of 2% efficiency loss over 24 years), and are driven primarily by economics. For modern plants, these measures can lead to greater efficiency, while in older plants they can raise efficiency to modern levels.

Turkish energy provider ENKA, for example, worked with GE Energy over two years to implement an efficiency improvement upgrade on its Frame 9FA gas turbines at the Adapazari and Gebze power plants. As a result of the efficiency upgrade, gas turbine output increased by 2% and the average combined-cycle efficiency reached 55.7%. And last year ENKA set a new standard for global power plant availability – 99.8% -- nearly 7% higher than the industry average.

And earlier this year, a Spanish recycling paper mill owned by S.A. Industrias Celulosa Aragonesa completed a major "flange-to-flange" upgrade of a Frame 6B gas. Replacing the key components of the gas turbine increased the operating efficiency, significantly reduced emissions and considerably extended the life of the plant.

However, there can be significant barriers to improving power plants. The main challenge is the economic rationale for investing in existing plants. Neither the operation of Europe's electricity markets nor the level of the carbon price is sufficient to entice plant owners to invest in efficiency improvements.

There are not adequate economic incentives to invest in more sophisticated performance monitoring measures. But more simply put, potential efficiency losses are not identified, and therefore not addressed. Currently, the market operates in such a way that plants are generally dispatched on the basis of cost rather than on the basis of energy or carbon efficiency.

Technology Focus

Smart Grid

In the 2050 roadmap for a low carbon, competitive economy, the European Commission was clear about smart grids. The future deployment of a European smart grid will bring about a step change that will help consumers to save energy.

Member states, for example, are obliged to roll out smart electricity meters for at least 80% of their final consumers by 2020, provided it makes good financial sense.

Smart grids and smart meters will serve as a backbone for smart appliances, such as freezers that defrost during the night when electricity is cheaper. And the Commission will ensure that energy labels and standards for future buildings and appliances incorporate technology that makes appliances and buildings "smart grid ready." First on the list: refrigerators, freezers and heat pumps.

Investments in smart grids are also a key factor for a low-carbon electricity system, allowing for a larger share of renewables and powering more electric cars.

Opportunities to develop smart grids are receiving significant attention at the EU level, but so far these have not gained traction in the member states. In fact, there appears to be little to no national framework for smart grid development in many member states.

So what does a smart grid do?

According to the European Technology Platform, it's an electricity network that can intelligently integrate the behaviour and actions of all users connected to it - generators, consumers and those that do both – in order to efficiently deliver sustainable, economic and secure electricity supplies.

Continuous diagnostics in residential and commercial buildings

Heating, cooling and energy management systems in buildings degrade over time, which leads them to consume more energy – unbeknown to most customers. The smart grid can detect these problems early by providing diagnostic services in residential and commercial buildings through automated real-time sensing and communication.

Examples of diagnostic checks include:

- The efficiency of refrigerant cycles in heat pumps and air conditioners declines over time. The smart grid can detect declining efficiencies long before any equipment failure makes them obvious. Heat pumps that are providing unusual amounts of back-up electrical resistance heating (expensive and highly inefficient) can also be quickly detected.

- Economisers in building ventilation systems can save large amounts of energy as they provide 'free cooling' from outside air. They are, however, notorious for failing. When they do, they can remain open all the time. The smart grid can enable continuous monitoring and optimising of the economiser's position.

- A 'smart' HVAC (heating, ventilating and air conditioning) system can reduce energy consumption by about 10% by adjusting thermostats.

Improvements in power transmission and distribution

The smart grid can enable real-time monitoring and adjustment of the transmission and distribution of power, particularly the voltage system. End-use energy consumption has been shown to drop when the electric service voltage is reduced. A smart grid can provide the measurement and communication functions to continually optimise trade-offs in system voltage and energy use by precisely controlling the voltage within acceptable limits.

Smart demand

The term 'smart demand' refers to the time-shifting of electricity consumption through smart grid technologies. For example: offering customers discounts if they run their washing machines and dryers the night through time-of-use tariffs delivered through smart meters. The appliances could be controlled automatically by a Home Energy Management (HEM) system.

For business customers, Information and Communications Technology (ICT) solutions can be integrated to receive messages that the electricity network is congested, and the customer will be rewarded if they reduce or cut non-critical loads.

Curbing demand like this reduces the peak production at energy plants, which are often less efficient and/or use more polluting fuels. This also helps fill system 'valleys' which can help increase and optimise the operation of lower carbon baseload at the plant. The energy and carbon emissions savings depends on the mix of resources being used at a particular time, but it can be significant.

Powering more electric vehicles (EVs) through smart charging

The replacement of fossil fuel-powered vehicles with electric vehicles will also save energy and cut CO_2 emissions. If electric vehicles charging times are managed through the smart grid, as they are likely to be in time, it will be possible to enable 'smart charging' to take advantage of inflexible renewable and nuclear power. This could also reduce the need to build out additional electric generation or transmission and distribution networks.

Customer behaviour

The smart grid can empower consumers by giving them feedback about their energy consumption in a range of ways, from more accurate billing to the energy cost of their appliances. The graph above was taken from a 2010 meta-analysis of 36 separate studies on the effects of customer feedback on household electricity savings. The results vary between 4 and 12%, depending on the method and time of feedback.

In addition, for its 2008 study, the Electric Power Research Institute found consumer information and feedback systems resulted in electricity savings of:

5% for residential customers

2.5% for non-residential customers.

SMART GRIDS: an opportunity for job creation

This table outlines the job creation potential from smart grid deployment in the three focus markets.

The KEMA study uses the following assumptions:

- 1 smart grid project per 1 million smart meters deployed.
- An overall cost of €350 million per project, with labour costs comprising 30% of this.
- An average cost of around €50,000 per employee.

Delta applied these parameters to the 3 focus markets, France, Poland and the UK, based on its assumptions on smart meter deployment.

While this does not represent a rigorous analysis of the smart grid job creation opportunity in Europe, it does provide a high level and indicative view. In comparing the US with Europe for example:

- The staging of deployment of the projects will be different.
- The cost of labour in the three markets will vary widely, with Poland being lower than UK and France.
- In respect of domestic jobs created in the supply chain, the US has a stronger domestic industry servicing the sectors mentioned than in the three focus countries.

Regional Focus: Midi-Pyrénées

The Power of Research

One of the more comprehensive regional programmes in France is in the Midi-Pyrénées where the "Regional project for the fight against climate change and for sustainable development" is changing the way residents, businesses and public authorities think about energy.

Known as by its French acronym, PRELUDDE II, the six-year programme (2007-2013) has a total budget of €48 million, equally funded by the region and the national Agency for Environmental Development and Energy Efficiency.

The plan aims at promoting low-consuming and efficient energy, development of renewable energy sources in concordance with the principle resources of the Midi-Pyrénées (solar energy, wood, wind, geothermal), and support changing behaviour of consumers and industry.

The experience of the Midi-Pyrénées shows how interdependent regional programmes are on national and European policies and funding. A recent French moratorium on photovoltaic projects, for example, forced the Midi-Pyrénées to stop the installation of 200,000 m^2 of solar panels on school rooftops, underscoring the need for better communication and cooperation to achieve energy goals.

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Françoise Dedieu-Casties, vice president of the Department for the Environment and Sustainable Development in the Midi-Pyrénées, and Stéphane Leroy-Therville, head of the department's energy and climate section, explain the impact of PRELUUDE II:

Q: You are near the mid-point of the programme, what have been the greatest results?

FD: The most tangible results have been on developing renewable energies: Since 2000, the region has supported the installation of more than16,000 solar-water heaters in homes, 30 wood-heat networks for commercial use and 100 wood-heated boilers. And these are just a few examples.

From a financial point of view, the most effective part of the project has been research and development and investment in renewables. We finance about 250 projects a year, with grants ranging between a thousand and several hundred thousand euros. You can give €1,000 for a little feasibility study or an energy diagnosis in a small community, or several hundred thousand euros on a photovoltaic project or a methanisation project in renewable energy.

That is a rather quantitative element, in terms of euros and number of projects. In terms of the qualitative aspect, right now we have trouble measuring it well. These are long-term effects, especially as we fund awareness raising campaigns or feasibility studies that will lead to real investments in the future.

Q: What progress have you made in making your energy sources more efficient?

FD: Part of the programme calls for energy-efficient buildings, which allows partners to start and finance projects that are star examples of construction or renovation; examples that go beyond the regulations for insulation and heating. This involves thinking about materials, the building site itself, its impact, the functioning of the building for the 30 to 40 years, and raising awareness about consumer behaviour. In May, I will present a new program to support this.

With buildings we can have a high impact and there is plenty of room for improvement. We are using an approach, whether new construction or renovation, the materials used must be better for the environment, it must use renewable energy sources, consider interior air quality, climate design, which considers how the building is positioned, the size of the windows and which way they are facing.

Q: What were the biggest obstacles you had to overcome?

SL: Communicating this vast programme into something more sector-specific and accessible. This can create obstacles and delays at the beginning. There are numerous criteria within the programme, with the contracting authorities, etc. On top of that, in each area there are specific ways in which subsidies will be granted. There is therefore an issue, which must not become an obstacle, in communication, information, startup-aid, etc. The programme has worked well in terms of the number of projects, but there have been few projects regarding environmental management, so we must qualify that success.

Q: What financial schemes did you provide, if any, for energy suppliers or large energy consumers to become more efficient?

SL: Financing is an integral part of the programme. We encourage the producers of renewable energy financially, as long as this energy is planned in the programme. This element is a strong focus of the programme. Regarding the energy consumers, it is more about helping them to reduce their consumption, to increase efficiency in their behaviour or in their project.

Q: What is the next strategy beyond 2013?

FD: Regional officials will define the next strategy in the coming months. There will be many things to renegotiate because the programme is both regional and European. For example, what will become of the European Structural Funds? This programme ties in with European Structural Funds which will also be renegotiated. The regional strategy must take into account these potential financial impacts.

Q: What advice would you give to another European region that was just beginning a strategy like yours?

FD: We don't pretend to be a model. We have been working in the environment for a long time in the Midi-Pyrénées region , but we are becoming more professional, there are now deadlines for national and international engagements where we try to take part … We apply this logic to our own case to make sure to measure the impact of our policies, to be more efficient and to act in the most energy-hungry areas that have the highest influence on climate change: transport, companies, economic and industrial activity, agriculture and buildings. We must also say that each actor has specific competences and does not act in every field. It is great that we have international framework agreements, national and regional ones, but you have to always remember that the action will be taken on a local level. The challenge today is to put theory into practice, from pilot to full scale.

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Regional Focus: Hampshire County

Lighting Up a Town

© Veolia Environmental Services

Hampshire County aims to be carbon neutral by 2050.

It's an ambitious goal, but over the past 20 years Hampshire has earned a reputation – bumps, bruises and all – as one of the forerunners in energy efficiency.

Today, Hampshire sends a smaller proportion of waste to landfill than any county in the United Kingdom. The county collects 420,000 tons a year of non-recyclable trash, which its partner, Veolia Environmental Services, turns into 38 megawatts a year of electricity for the national grid, enough to power 53,000 homes. The leftover ash is then used in building materials. The county has a recycling rate of 40%, and has slashed the amount of waste dumped into landfills by 90%.

Now, Hampshire wants to create its own energy generating company that sells power to the UK's national grid.

"We're now concerned with meeting our energy requirements in a sustainable and green way. Energy has become the new driver for that," said Mel Kendal, a County Councillor and vice chair of the county's Climate Change Commission, formed a couple years ago.

The county is finalising a feasibility study to produce its own heat for public buildings, schools and hospital in the town of Winchester and possibly Basingstoke, and to sell the excess power. The heat would be produced with a gas-fired generator, and eventually converted to bio-fuels.

But first things first. Hampshire has to set up a legal entity with a governing structure, get regulatory approvals, apply for grants and loans.

For funding, the county will shop for the lowest interest rates from eco-lenders, the bond market and the UK's Public Works Loan Board.

Hampshire looked at using the EU's European Local Energy Assistance (ELENA) facility, but Kendal said, "The hurdles and the time frames are such that by the time there's an agreement, the opportunity is gone to get the job done. There is too much bureaucracy."

Hampshire is also considering plans to install 150,000 m^2 of solar panels on the roofs of 4,000 public buildings to generate power.

Though Kendall admitted, "We might get some objections (from residents) who would regard them as ugly additions to the buildings," he said, "We have a lot of good will in the community."

And that good will was earned the hard way.

When Hampshire County confronted its waste management crisis in the early 1990s, it made enemies before it made friends.

The first winning tender (not Veolia) was for a plan to build a 350,000 tons-per-annum facility in Portsmouth to serve all of South Hampshire. There were a number of objections, including: other sites had not been fully considered; the plant would be too big; the choice considered financial issues over environmental ones; overwhelming traffic issues, no architectural merit; concerns about pollution and health; better ways of managing waste.

That prompted the local newspaper to run an effective "Ban the Burner" campaign. The contractor didn't appear to understand the community's concerns and responded poorly to the public outcry. The Hampshire County Council had to backtrack and re-approach its entire waste strategy.

The ultimate solution, called Project Integra, was a comprehensive waste management strategy that includes: three energy recovery facilities, three green waste composting facilities, 26 (five of which are new) household waste recycling centres, 10 waste transfer stations, and two material recovery facilities.

The partnership with Veolia Environmental Services, started in 1997, required an entire infrastructure network and cost the county £200 million (€226 million). Since then, the partnership has saved the region more than £100 million (€113 million) based on savings/returns as a result of landfill tax avoided, income from recyclables, etc.

And county officials learned these important lessons they will apply to their new energy projects:

Perception

Energy Recovery Facility projects often suffer – and fail – because of public perceptions about incineration solutions to waste management problems. The success of the Hampshire project revolved around an application in which the ERF was just one part of a broader strategy that included composting, recycling and other supporting facilities.

Partnership

Another key to the Hampshire approach were the partnerships between the county council and 13 district and unitary councils. This showed the community that there was a broad and cohesive approach. In addition, the partners engaged regulators at an early stage, keeping regulators informed and seeking advice when needed.

Spatial planning

One critical element to Hampshire's success was the establishment of a land-use framework that identified areas for major waste developments. Identifying potential sites early allowed the project to withstand the challenges to the planning applications.

The planning system also better integrates national, regional and local policies for infrastructure and development. And it identified spatial options for waste management development in relation to environmental and other sustainable development goals.

Design

All three ERFs were designed to a high standard by French architect Jean-Robert Mazaud of S'pace, and two won engineering and design awards. This set the bar for future infrastructure in Hampshire and fostered public acceptance for the waste management project.

Details

In preparing the planning applications, great efforts were made to address the issues raised during extensive community consultations, including visual impact, traffic, air quality and ground contamination, among others. As a result, the applications were detailed models for this type of development, and this helped planning authorities process the applications efficiently.

Consultation

Transparency was essential. The preparation of the planning framework included broad public participation and was subject to the scrutiny of public enquiry. The drafting of the planning application involved local interests through contact groups. Planning authorities arranged meetings and allowed people to speak at meetings where decisions were made.

Communication

A proactive media campaign helped garner support. Key opinion-makers and media editors were briefed. There were local liaison groups. And the fact that the proposals were subject to discussion and community involvement helped make the project more acceptable, or less unacceptable, to the local population.

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Regional Focus: Baden-Württemberg

Bio-Energy Villages


© Bruno Lorinser

Co-generation of electricity and heat has played an important role in the success of "Bio-energy Villages" in the countryside of Baden-Württemberg, in the southwest of Germany. Biogas plants are producing electricity and capturing lost heat, generating significant savings.

In less than two years, Baden-Württemberg has created an energy strategy that is one of the most progressive in Europe. And that trend is expected to continue following elections in March that put the Green Party in charge.

This region in the southwest of Germany is home to 11 million people as well as industry giants like Daimler, Porsche, Bosch, and SAP. But Baden-Württemberg is striving to support its export-led economy while protecting its environmental resources and picturesque landscape that includes the Black Forest.

In the summer of 2009, the state government designed a new energy policy focused on five components: saving energy; renewable energies; a balanced mix of energies (including renewable energies, coal, fossil, nuclear); ensuring an affordable energy supply; and promoting energy-related research.

Karl Greissing, director and head of the Department for Energy Policy and Buildings for Baden-Württemberg, discussed the region's strategy:

Q: What are the goals of your energy strategy?

KG: We want to increase efficiency in primary energy by 2% per year, and reduce energy consumption, but we don't have an exact number. Combined heat and power currently accounts for 10% of our power production. We want to double that by 2020.

The most important thing is to have renewables account for at least 20% of electricity production. Right now, we're at 14%, and it's not easy to go from 14% to 20%.

For example, we have little possibility of increasing the share of hydro power (currently 8%), because we have few sources in Baden-Württemberg. We want to increase photovoltaic power generation up to 2,7 TWh in 2020, but that will only account for 3,7% of electricity production. And wind energy is difficult to increase, politically, because not everybody wants to have a wind farm in their backyard. So we have to discuss the matter with our citizens, we have to convince people wind generation is a good thing.

Q: What part of your programme has had the greatest results?

KG: We are making good progress increasing the share of renewable energies in the fields of electricity and heating.

Q: What made that part of your programme so successful?

KG: In these two areas, we have real targets. In the other components of our strategy, we don't have targets. For example, for energy-related research, it's difficult to have exact targets. We spend money for research, but the results are difficult to quantify.

Q: So you are on track to meet or exceed your targets?

KG: I think we're going to reach our targets, especially for renewable energy. We will have more than 20% of our power production from renewable sources, and I hope we'll have 25%. But that will also be the result of Germany's Renewable Resources Act; we would reach these targets without it.

Q: Can you give an example of how you have made your region's energy supply more efficient?

KG: In Mauenheim, the biogas plant produces electricity and heat, but lost heat was not recovered. We helped the village to recover the lost heat. They are now saving 300,000 litres of oil a year. At the current price of oil (90 cents per litre), that means more than €270,000 in savings, and that money stays in the region.

We call this project a "Bio-energy Village". We have 15 villages like that like that and our aim is to have 100 (with populations of up to 1,000 residents).

Q: What were the biggest obstacles you had to overcome?

KG: The question of acceptance depends on public education. Because we have 11 million residents and a lovely landscape, we don't have a lot of space open space. So we have to hold many discussions with residents, environmental groups and farmers.

Q: What financial schemes did you provide, if any, for energy suppliers or large energy consumers to become more efficient? How important were those financial incentives?

KG: At a federal level, Germany has a lot of programmes to increase energy efficiency. The programmes from the federal ministries and banks make a lot of money available to increase energy efficiency in industry and homes.

Homeowners, for example can get money from a state bank, they can get low-interest loan for energy improvements and/or a direct subsidy starting at €500. For example, I refurbished, spending €15,000 on a new heating system in the basement and solar panels on the roof for heating, and I got €800 back from the state.

Q: What advice would you give to another European region that was just beginning a strategy like yours?

KG: It's important to inform people about what is possible. We live in a world of increasing crisis for fossil energy. Financial incentives are important, but we also have a regulatory system that is equally important. For example, in Baden-Württemberg we have a law that if a homeowner wants to install a new heating system, it must be a really modern system that includes roof solar panels. If it's not possible to have solar panels, other measures must be taken to save energy, like better insulation, biogas or combined-heat and power.

Q: How does your overall strategy fit into the German federal energy strategy? What kind of coordination, financial support, etc. do you have?

KG: When we created our energy strategy, we looked to Brussels, then we looked to Berlin. Two or three years ago, Berlin didn't have its own energy strategy. In September last year, Germany drafted its own energy strategy, and I think Baden-Württemberg contributed some good ideas.

In the next two years, we will have to raise our targets in line with the federal strategy, though it will be difficult in some areas. For example, in the field of renewable energy, the federal aim is 30% renewable by 2020. The German government plans to generate a lot of off-shore wind energy from the Baltic and North seas. But in the south of Germany, we don't have as many options for wind power, so we cannot meet the federal targets. Nevertheless, we will discuss our strategy, we have to raise the targets.

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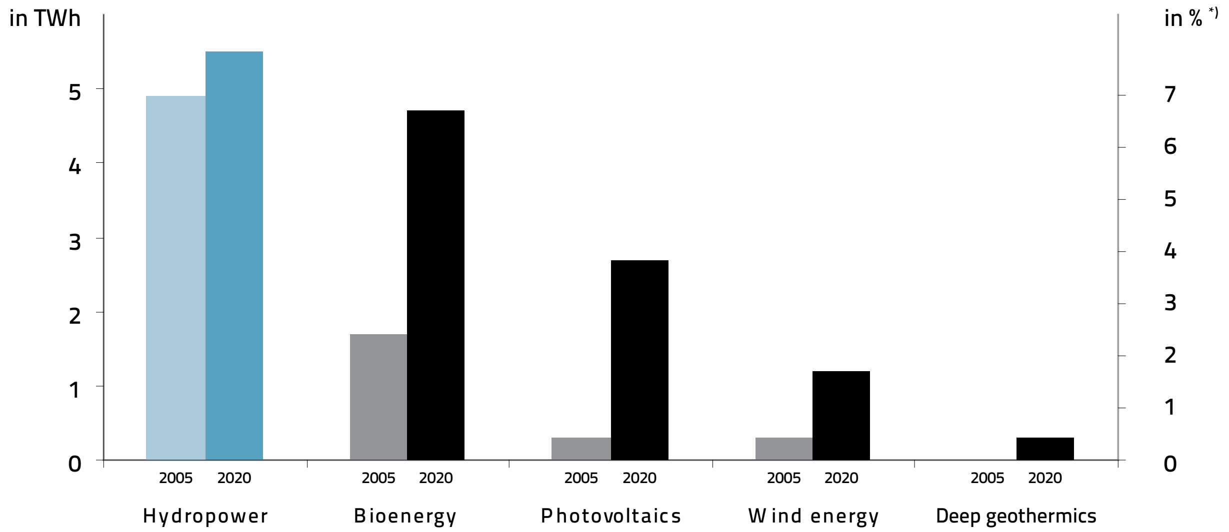
Targets for the gross electricity generation from renewable energy sources by 2020



*) with regard to the gross electricity generation in 2005

Baden-Württemberg

	2005 in TWh #)	2005 in %	2020 in TWh	2020 in % *)
Hydropower	4,9	6,8	5,5	7,7
Bioenergy	1,7	2,4	4,7	6,5
Photovoltaics	0,3	0,4	2,7	3,7
Wind energy	0,3	0,4	1,2	1,7
Geothermal power	0,0	0,0	0,3	0,4
Sum	7,2	10,0	14,4	20,0
Gross electricity generation	72,0	100,0	72,0	100,0

#) The table is based on the ZSW's report /2/, which relates to the electricity generation from 2005. In the meantime, the share of renewable energy sources in electricity generation has risen.

*) with regard to the gross electricity generation in 2005

René Rouquet, MP and Mayor of Alfortville

Alfortville swimming pool and leisure centre:

sustainable development a central concern

On the banks of the Seine at Alfortville (94), the new swimming pool and leisure centre has been visible for a few weeks now. In a leafy setting, an ambitious and environmentally-friendly sports and leisure facility has come into being.

It's eight years now since the idea of a swimming pool was floated. The town used to have, on the same site, a facility at the end of its useful life. The compulsory closure of that facility made it necessary to build a new swimming pool.

No increase in the financial cost to the town

Unfortunately, Alfortville did not have the resources to build a new swimming pool. But the people in charge of the project found a solution: not increasing the financial cost to the town for this facility, which was 690 000 euros a year in 2005 or approx. 900 000 euros in terms of value in 2010. This amount had to cover running the facility and repaying the loan. So, half of the sum was allocated to each part. "We approached a contracting authority assistant, D2X. With its assistance, we quickly realised that, in order to achieve this objective, we needed to provide for fitness activities as well as traditional pools in order to restore balance to the operation," says Joseph Loreau, project manager. After several programme simulations, the town chose a project and, with no experience in managing a fitness centre, decided to look for an agent, before opening the architectural competition. "It was important to see that our hypotheses were right. What's more, the agent, Carilis, helped to draw up the schedule of conditions to ensure that all the parties were in agreement," he adds.

An exceptional site ... but in an area liable to flooding!

The main asset of this new pool and leisure centre is undoubtedly its site: standing on the banks of the Seine, the facility overlooks the river among trees and gardens and looks out onto a lock. This setting is a real advantage in an urban environment. But it has one disadvantage that had to be taken into account during construction: this is an area liable to flooding! In 1910, the town had, in fact, suffered a very high water mark. Jacques Rougerie, the architect selected for the project, therefore favoured a three-storey building while, at the same time, taking various precautions. For example, beneath the sports pool on the first floor are technical tanks installed in watertight rooms. Similarly, on the ground floor, the car park with eighty spaces is easy to evacuate in the event of flooding. In terms of architecture, in order to make it in keeping with the site's environment, the architect chose the shape of an upturned boat, moored on the bank. The building is also open onto the Seine.

Swimming and wellness: two truly independent centres

The architect decided to make a clear separation between the swimming and wellness centres by giving each of them one whole floor. The first one, dedicated to swimming, includes: a 25-metre pool surrounded by tiers of seats with a capacity of 150 people, a 268-m^2 leisure and activity pool including a river with current, a 54-m^2 paddling pool, changing rooms, toilets and showers covering a surface area of 530 m^2 and a 738-m^2 circulation area. In addition, it was decided to set aside a 30-m^2 office each for the swimming and diving clubs. "It's only natural that they should have their own space and that it should be large enough for them to hold their meetings in," argues Joseph Loreau. On the second floor, in the wellness area, there's a 120-m^2 balneotherapy pool, a 240 m^2 room for weights, cardio-training and group classes, two saunas, a hammam (Turkish bath) and a recreation area and relaxation corner covering 180 m^2. The mayor's adviser sees this as a centre which is increasingly developing and which enables more benefits to be generated with special rates. The independence of the place being a crucial factor for the users.

The environment aspect a central concern

The environmentally-friendly approach is usually chosen out of conviction on the part of elected representatives and in order to be in step with present-day society. But Alfortville also spotted a considerable financial attraction in regard to the various elements chosen:

- A heat pump: this thermodynamic equipment draws heat from a water table lying 55 m underground and makes it possible to cut energy consumption to less than a third compared to a conventional solution;

- Photovoltaic panels: the roof of the swimming pool is covered with 1100 m^2 of flexible photovoltaic panels that can generate an annual output of 65 000 kWh/an. This is sold to EDF within the framework of a purchase obligation contract;

- Illuminating the pools with LED lights: the lighting for the pools will be achieved with LED-type electroluminescent diodes. The advantage of these is that they consume very little power and have a long lifespan of more than 30 years. In addition, motion sensors have been installed widely to avoid lighting empty changing rooms for example. In total, electricity consumption should be cut to a 20th;

- Water treatment with ozone: The water of the pools will be purified with a system that uses ozone. Using this gas obviates the need for chlorine. So, it will be possible to empty the pools directly into the Seine as part of the statutory draining operations. The advantage of this arrangement is that this volume of water does not then have to be treated in the local water purification plants.

Added to this is the use of suitable construction materials, in particular wooden weatherboarding, and a watering system for the plants using recovered rainwater.

TECHNICAL DATA SHEET

Contracting authority: Alfortville
Contracting authority assistant: D2X
Total surface area: 5 000 m^2
Duration of construction works: 18 months
Access control supplier: Elisath
Cost: 15 000 000 euros before tax
Grants:
- Regional Council of Ile-de-France: 2 750 000 euros
- CNDS: 800 000 euros

Key points:

- Standing on the edge of the Seine and overlooking the river, the swimming pool and leisure centre is in an area liable to flooding, a disadvantage that had to be taken into account during construction.

- To reduce the financial cost, the town decide to include a wellness centre independent of the designated swimming facility.

- The installed heat pump will help to cut energy consumption by more than a third compared to a conventional solution.

Conclusion

With energy efficiency gains in Europe running at half the target level, and the European Commission threatening binding national targets to meet 2020 goals, now is the time for regional authorities to pick up speed. The European Union has adopted a target of 20% primary energy savings by 2020 (compared with a "business as usual" scenario). In the words of the European Commission, "Energy efficiency can be seen as Europe's biggest energy resource." This is true. Primary energy savings on this scale will contribute to a more resource-efficient economy, green-house gas emissions reductions, energy security, and ultimately to Europe's global competitiveness.

Unfortunately, the EU energy savings policy debate and implementation has so far been focused almost exclusively on reducing final energy consumption on the demand side – notably in the building, appliances, transport and industrial process sectors. Only recently in the energy efficiency plan of March 2011, attention was paid to the potential contribution to primary energy savings from more efficient supply-side production and delivery of energy.

The regions profiled in this report and in the survey by the Assembly of European Regions show there is real progress being made, despite the financial crisis and budget cuts in some areas. Energy efficiency must be approached with a comprehensive, long-term strategy that takes into account both the supply of more efficient energy production and delivery as well as the demand for compact fluorescent lights and "smart" appliances.

The regional experiences show that investing in energy efficiency is good for local industry and job creation. And that is especially true for large-scale investments like infrastructure and power plants.

Working within an evolving EU framework has its own challenges: double the rate of public building renovations, energy-efficient public procurement, under-funded and overly complex financing schemes, to name a few.

And regions have their own hurdles, including specific natural resources and landscapes, overlapping local and national legislation, limited funding and lack of public education.

The annual Energy Day, sponsored by the Assembly of European Regions and GE Energy, aims to be more than a brief and hurried exchange of best practices and business cards. That is why the "Responsible Energy for European Regions" (REFER) partnership will support an on-going online social network to host more discussions around events throughout the year. We invite you to join the community of energy professionals on the ground and in the institutional sphere at www.refer.eu.com, to contribute your questions and suggestions.