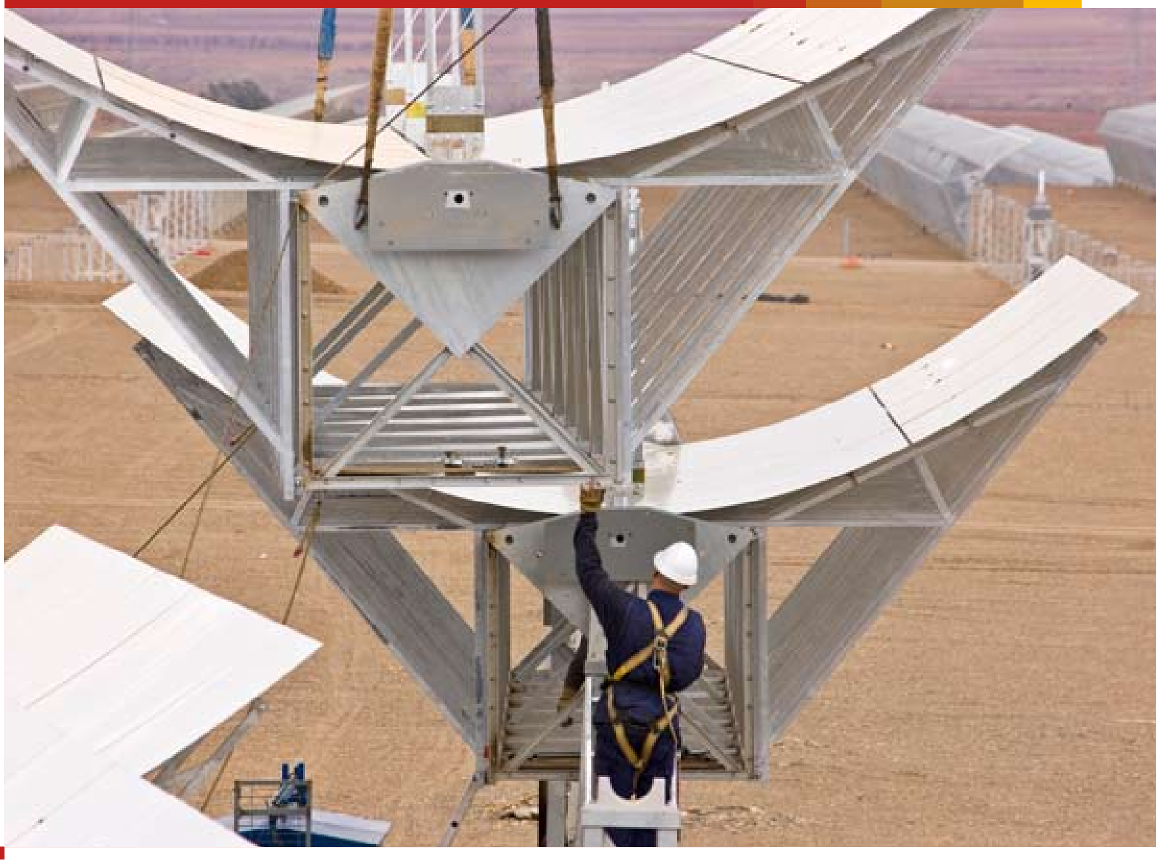
Moving towards 100% renewable electricity in Europe & North Africa by 2050

Evaluating progress in 2010

May 2011



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In spring 2010, European and international climate experts at PwC, the European Climate Forum, the Potsdam Institute for Climate Impact Research and the International Institute for Applied System Analysis published 100% Renewable Electricity – A roadmap to 2050 for Europe and North Africa. The report examined the potential for powering Europe and North Africa with renewable electricity exclusively by 2050. It set out a series of financial, market, infrastructure and government policy steps that would need to occur if such a 'what if' vision was to be achieved.

Now, a year on, this latest report provides a complementary analysis to the original roadmap. PwC, the Potsdam Institute for Climate Impact Research and the International Institute for Applied System Analysis, look at whether the vision of 100% renewable electricity has moved closer or further away as a result of current and recent developments over the last 12 months. The report, intended to support the wider debate in this area, examines five areas that are most critical to achieving progress and, through the lens of these five areas, looks at the impact of recent and current events.

There are, of course, other possible routes to addressing the challenges of climate change and increasing demands for affordable energy besides scaling up to 100% renewables. As noted in our original roadmap report, the expansion of nuclear power and the development and deployment of carbon capture and storage (CCS) for emissions from the burning of fossil fuels could also play important roles in a low carbon future. Our exclusion of these technologies from this report is not intended as any comment on their merit or their eventual role. Indeed, given the scale of the challenge of decarbonising power generation in the region, it is likely that the roadmap to 2050 will involve the deployment of a number of low carbon technologies, alongside the scaling up of a range of renewable technologies.

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Foreword

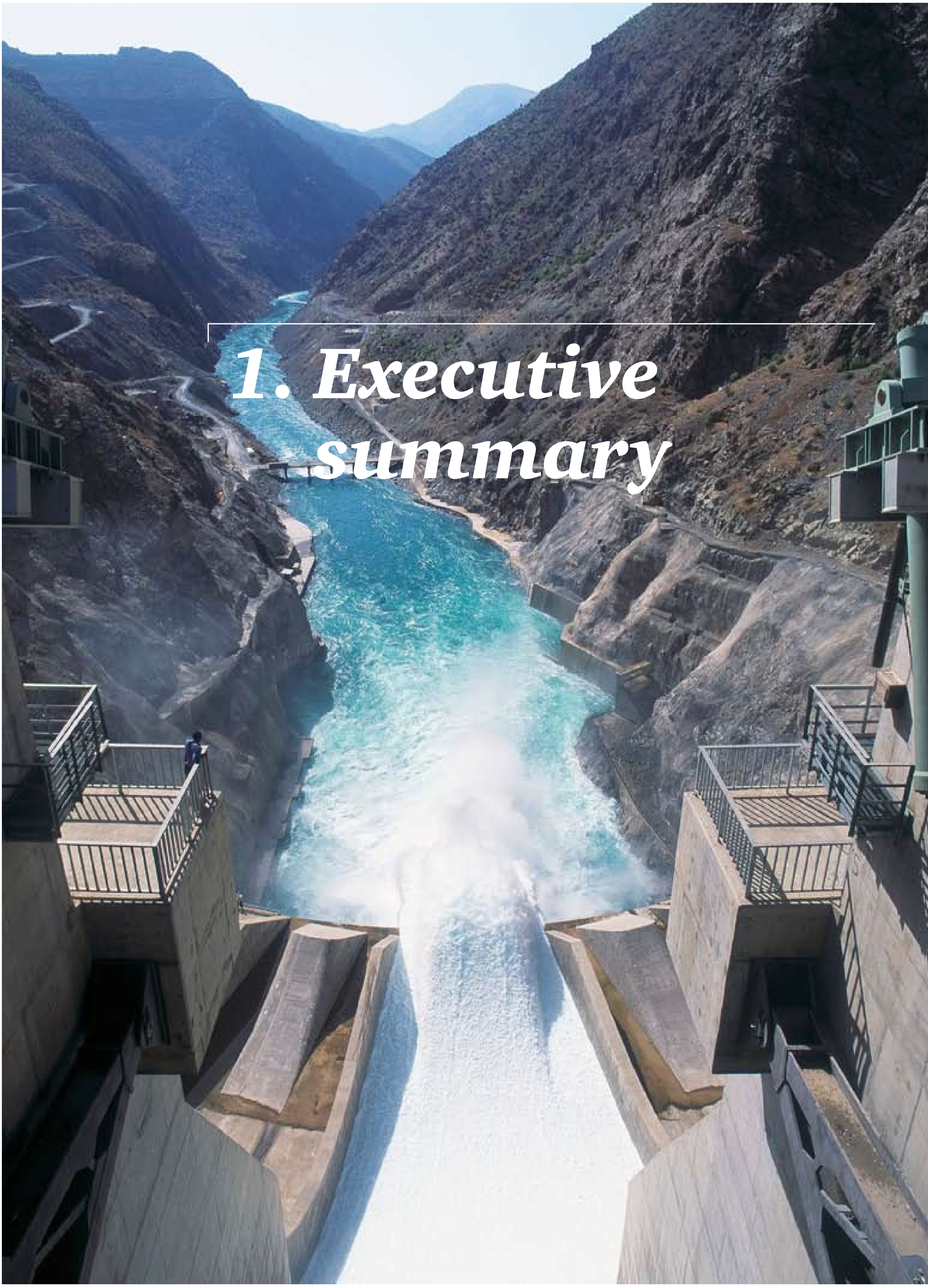
In recent months, after the disastrous Copenhagen climate talks and the (unfounded) allegations brought forward against the IPCC, climate change has crept out of the public spotlight, and was replaced by other pressing concerns. Nevertheless, anthropogenic global warming remains one of the biggest risks humanity is exposed to and ranks among the most important policy challenges of our time. If we do not find a way to stop climate change in its tracks – a complete prevention is already beyond our capabilities – it will cause irreversible damage to ecosystems, to coastlines, to agricultural lands, and most other life-supporting systems, and will require a reengineering of human civilization.

There are two scientific realizations of the last decade that especially matter. Firstly, public policies can unleash tremendous innovation, so that the high road of reducing greenhouse gas emissions and preventing dangerous climate change will cost far less than the low road of living with the consequences of unabated warming. Secondly, taking the high road requires not only a reduction in the use of fossil energy sources, but a complete phase-out of coal, oil and gas in due time. The second realization may support political negotiations, since it would end the fighting over who will get to burn more or less fifty years from now. But it may also require a complete and quick change of the direction of new investments, away from yesterday's fossil-nuclear technologies and towards tomorrow's clean and sustainable energy systems.

The Potsdam Institute for Climate Impact Research (PIK), which I have the privilege to head, is well equipped for researching the scientific basis of climate change and for the educated exploration of solution options. But to address the challenge of altering investment dynamics – to take the high road – we need to build bridges to the business and financial communities. Together we can learn what it takes to change investment behaviour, and why necessary investments have often been blocked in the past. The present report is the result of a fruitful exchange of expertise and knowledge between scientists working at PIK and the International Institute for Applied Systems Analysis (IIASA) in Austria, as well as analysts from PricewaterhouseCoopers, who are embedded in the business community. The cooperation builds one of those bridges between the science and the business communities, which will be crucial in the years to come.

The report is also important because it stresses one of the core challenges: urgency. If stopping global warming is understood in the sense of creating the setting for energy-system investments to move from the old to the new, the question arises whether this will be achievable at the necessary speed. The answer presented here offers hope: In many different ways, and for a multitude of reasons, the setting is already changing for the better before our eyes, suggesting that the task is possible. The efforts of those working creatively and collaboratively on this major challenge of our time are slowly beginning to sprout leaves. As spring will turn into summer, we need to ensure enough nourishment and support, so that they can soon bear fruit.

Prof. Dr. Hans Joachim Schellnhuber CBE
Director, Potsdam Institute for Climate Impact Research
Potsdam, April 2011



1. Executive summary

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Introduction

Climate change and increasing demands for affordable energy are two of the biggest challenges faced by society today. With appropriate scale, a shift to renewable energy could become a self-sustaining, and genuinely competitive investment proposition with the potential to address both of these concerns. Investment in renewable energy reached new heights in 2010, up 30% to US$243bn (Renewable Energy World, 2011). However, even these record levels fall short of what is needed to achieve 100% renewable electricity by 2050 (IEA, 2010).

Government support has played a key role in encouraging this transition, with favourable policies and frameworks being progressed in many countries across the globe. However, it is still far from certain whether these will be sufficient to drive the scale of transition which will be required. This report looks at recent developments and events over the past twelve months to March 2011, to understand whether, for Europe and North Africa, a vision of 100% renewable electricity by 2050 has moved closer or further away.

We assess this progress by looking at five 'enabling factors' that we deem are necessary for renewables to become the dominant generation platform – clear political leadership; a supportive market structure; the right investment climate; adequate planning and permitting for new infrastructure; and technological progress. We identify three relevant criteria for each of these factors against which to assess progress.

We then use this analytical framework to review the impact of nine major events and trends of the past twelve months. These events are by no means exclusive or exhaustive and their inclusion does not reflect any judgement on their relative significance or importance, but all have influenced the transition to greater use of renewables.

Three of these developments are global in nature: the financial and debt crises, the climate negotiations and international policy developments, and the ramifications of the Japanese earthquake, in particular for new nuclear in Europe; three are regional: EU electricity policy developments, regional renewable developments and the civil unrest in North Africa; and three have a more national focus: national renewable electricity developments, capacity expansions and public opposition to major infrastructure projects.

Figure 1: Heat map summarising progress for each enabling factor

Enabling factor	Overall rating	Criteria	Individual rating
Political leadership	Green	Existing leadership and political commitments	Green
		Economic, environmental and strategic arguments	Green
		Interest group politics	Yellow
Market structure	Yellow	Integration	Green
		Adaptation of market design	Yellow
		Competition	Red
Investment climate	Yellow	Sustainable support mechanisms	Green
		Perceived risks in new markets	Red
		Long-term expectations	Yellow
Planning and permitting	Red	International infrastructure planning	Yellow
		Regulatory harmonisation and streamlining	Red
		Public acceptance and a climate of trust	Red
Technological progress	Green	Growth	Green
		Efficiency of renewable power mix	Yellow
		Cost/performance development	Green

Key

- Red: No movement or progress away from a 100% renewable electricity outcome.
- Yellow: Some activity, but progress is insufficient or too slow.
- Green: Good progress with sufficient scope and speed.

Results

Our results are summarised as a 'heat map' to illustrate the progress achieved in each of the five 'enabling factors'. It shows that there has been good progress and a number of positive developments in the last 12 months. Particular areas of contribution include the continued growth of renewables capacity, steps towards market integration and the growing political commitment to renewable electricity generation in Europe through binding targets and the provision of funding. There has been little progress in some areas, such as infrastructure planning and permitting, but no major setbacks.

Looking at each of the five enabling areas in turn, our assessment is that **political leadership** remains supportive of continued development of renewables. Despite the disappointments and delays in the UN climate negotiations prior to Cancun, the development of the National Renewable Energy Action Plans (NREAP) across member states, and announcements by North African governments all demonstrate a continued political desire to aim for more ambitious renewable energy targets, albeit only to 2020 in most cases. The economic, environmental and social arguments underpinning this political leadership have been given further impetus by some of the recent events outlined in this report. Detracting from this has been the comparative lack of political engagement necessary to support new transmission and infrastructure development. Our overall rating for political leadership is therefore 'green', representing good progress with sufficient scope and speed.

Market structure developments are more mixed. While significant steps have taken place in the integration of electricity markets across EU borders, further progress is now becoming more dependent on associated grid developments. There has also not been much in the way of policy developments or progress towards adapting the market design to support increased generation of electricity from renewable sources. Similarly, steps to address competition issues in the electricity market have been well focused but insufficient in their scope, rate of progress and achievements. Our overall rating for market structure is therefore 'amber', representing some activity which is however insufficient or too slow to support a 100% transition.

The **investment climate** is similarly mixed - governments over the past 12 months have in general maintained existing support mechanisms. However, the way in which reductions in support and other changes have been implemented in a number of EU countries have concerned the private sector. Ongoing civil unrest has affected the perception of risk in many North African countries, and as a result, private sector investment has been wary of new commitments. The longer-term expectations for renewables are also uncertain, mainly due to the lack of longer-term political commitments by governments post 2020. Our overall rating for investment climate is therefore 'amber', representing some activity which is insufficient or too slow to support a 100% transition.

The **infrastructure planning and permitting** area is less encouraging. While there has been good progress in the EU with the publication of the European Network of Transmission System Operators for Electricity (ENTSO-E) ten-year network development plan and the EU blueprint for an integrated European energy network, there has been little progress on the ground with only a few projects in development and even fewer of these involving cross border cooperation. In the area of regulatory harmonisation and streamlining, our view is that there has been almost no progress to simplify permitting processes especially on a regional level. Individual member states also lack credible proposals for addressing this area. Without this, new infrastructure development in the EU, as well as greater market integration and capacity expansion, is likely to be held back. Our overall rating for infrastructure planning and permitting is therefore 'red', representing a significant barrier to a 100% transition.

The **technological progress** area has been more positive. There has been a significant expansion in renewables capacity in the region over the past 12 months, especially in solar and wind. This has however been slightly tempered by consolidation within a number of renewable energy industries and supply chain constraints. The renewable power development mix remains skewed towards certain technologies for reasons other than resource abundance and the lack of a supportive and cohesive planning process. Managing this at an EU level may create problems for the longer-term efficiency and acceptability of the renewable power mix. Finally, the growing track record in renewable investment has continued to drive significant and rapid cost reductions across technologies. Planned capacity increases in the coming years will also help less established technologies become more cost competitive, assuming that the finance is available to support these project developments. Our overall rating for technological progress is therefore 'green', which represents good progress with sufficient scope and speed.

Recommendations

Looking ahead, this report identifies three broad areas for suggested consideration by policy makers to keep the region on track towards the vision of 100% renewable electricity in Europe and North Africa.

1. Development of a longer term and international electricity policy perspective

Achieving a 100% renewable electricity power system will require European electricity policies to incorporate a longer-term perspective and a broader geographical scope. Current short-term horizons serve to limit investment confidence and activity. We will need a vision through to 2050, with broad stakeholder involvement in its development. At a more detailed level, clear guidelines and principles would then support the design of regional generation capacity, demand management, the types of market in operation, how the electricity would be supplied, and finally how transmission grids should look and operate.

The development of such a vision will provide a significant boost to a renewables transition, particularly if this is designed with an EU wide (rather than a national) electricity system in mind. The inclusion of both Europe and North Africa in this vision is also critical. It is likely to result in increased efficiency and effectiveness of the regional power markets, which can make a significant contribution to the security of supply concerns if accepted as part of the regional solution.

2. Improvements to electricity market operation

There is also a need for more efficient and effective regional power markets, which not only provide predictability and stability for participants, but also create a level playing field for renewables entering the market. Although the European markets are liberalised and theoretically competitive, in reality most markets do not function in the way that they need to. This is despite various EU market directives (which are embodied in the second and third energy packages) that provide the policy framework needed for power market liberalisation and competition.

For a competitive electricity market to develop at the pace required to support a 100% renewables vision, as a first step, there is an urgent need for both the spirit and the letter of these directives to be implemented more rigorously. Europe could introduce and enforce penalties for non-compliance, to encourage member states to implement the directives in a timely manner. There is also a need to think about further measures that will support the longer-term and international vision for the future power system. This will require addressing a number of controversial questions including whether Europe wants a fully liberalised power market or whether some form of re-regulation would be more conducive to a rapid transition to a low or zero carbon sector. It will also need to address the structure and ownership of the sector and, in particular, of the grid.

3. Accelerating the development of sustainable infrastructure that supports renewables

The transition to renewables relies heavily on the development of an international, and subsequently an intercontinental, transmission grid. However, today it is barely possible to build a single transmission line, especially across national borders, as a result of inefficient regulation and public opposition. There is an urgent need to increase political cooperation between countries, to improve the efficiency of legislation and permission processes for new transmissions projects. Development of consistent standards for infrastructure planning and permitting will make grid expansions across the border less problematic, but changes to make the process more streamlined will certainly be necessary.

In addition, mechanisms to improve incentives to invest in and build grid connections at local, national and regional scales are also required. In some cases this may require additional financial incentives for TSOs to ensure the delivery of key projects. There is also a need for greater engagement with citizens to understand public opposition to new developments and find ways to make projects more acceptable to the local communities. Mechanisms such as benefit sharing and community involvement in the planning processes need to be explored further, and the development of new legislation needs to take citizens' rights into account: co-development of a solution to this underlying problem will be key to achieving any significant renewables based vision.

Conclusion

Our conclusion is that progress over the past twelve months towards a 100% renewable electricity target has been largely positive, with achievements outweighing the negative trends and developments. Progress has been underpinned by good achievements in the areas of political leadership and technological progress – both vital as top down and bottom up drivers of the transition to renewables. The integration of markets has also moved at a good pace and in the right direction, but much more will be needed here in the coming years. In other areas, the impacts of developments are mixed and progress is more fragile. Market competition and infrastructure permitting and planning are the areas of greatest concern. The lack of progress on improvements to planning and permitting is the single biggest threat to future major expansion of renewables technology in Europe and North Africa. Closely linked are also issues associated with project investment, such as regulatory uncertainty (in particular the potentially negative impact of further changes by governments to regulatory regimes and support schemes) and the need for continued market reform to promote access and competition.

All of these areas, along with the engagement of stakeholders and interest groups to increase public acceptance, need to be tackled urgently if the region is to stay on track to 100% renewable electricity vision by 2050. If accompanied by clear and supportive government policies and the continued support of the investment communities, renewable technologies will remain well positioned to address both energy security and climate change for the EU and North Africa.

Progress has been largely positive with achievements outweighing negative developments.

Reflections on 100% Renewables:

"Reports like this one are essential to evidence that real progress is being made towards a decarbonised, largely renewable, reliable and efficient European power system. It is time to act upon these evidences and set up an efficient regulatory framework to stimulate the realisation of innovative projects in generation and in grid infrastructure at EU level."

Ana Aguado Cornago
CEO, Friends of the Supergrid

"It is evident that the expansion of the grid will play a vital role, not only for the integration of European power markets, but also for the full decarbonisation of the European power sector. This report sheds light on Europe's leadership effort to establish suitable legislation and support mechanisms to overcome bottlenecks in grid planning and deployment. The progress made is substantial and fundamental to shape a new, modern and European approach to power generation and transmission."

Jules Kortenhorst
Chairman of the Supervisory Board, Topell Energy BV
Former CEO, European Climate Foundation

"Thirty years ago the EU put forward a completely new concept in the shape of an EU-wide High Speed Rail Network. This visionary plan was supported by industry and politicians alike and today this is considered a world-class reference. We now need a similarly urgent plan to deliver a High-Capacity EU-wide Electricity Network. This would act as a smart and reliable system able fully to incorporate energy generated throughout the EU territory from renewable sources, and cope with the emerging needs and aspirations of our society. It is now high time to start developing the high-tech electricity network of the future. Long- term vision and strong political will are of the essence - EU renewable electricity policy cannot afford to miss this challenge."

Alfonso González Finat
Ex-Director DG Transport and Energy, European Commission

2. Introduction

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In March 2010, we looked at the roadmap steps that could to be taken in order to achieve a 100% renewable electricity outcome for Europe and North Africa by 2050. Since then, the European Commission has begun to talk in terms of an 80-95% target for emissions reduction by 2050. Meanwhile, if they are realised, the national renewable energy plans of the member countries put Europe on course for around 36% of electricity to come from renewable sources by 2020 – about three times more than in 2005.

Now, a year on, in spring 2011, this report provides a complementary analysis to the original roadmap. We identify the critical factors that will determine whether renewable energy moves from a minority share of electricity generation to a position where the vision of 100% renewable electricity in North Africa and Europe by 2050 can be considered realistic.

We suggest five 'enabling factors' that are necessary for renewables to become a dominant generation platform:

- clear political leadership
- a supportive market structure
- the right investment climate
- adequate planning and permitting for new infrastructure
- technological progress.

Against each of these factors, we develop criteria by which we can judge progress or lack of progress.

We then use this analytical framework to evaluate progress by looking at some of the most important developments over the last twelve months. We focus on the implications of the global financial debt crisis, climate negotiations and related policy, EU electricity policy developments, and regional and national renewables developments. We also examine actual renewable capacity expansion, the effects of public opposition that have proved an obstacle to certain renewable power and other infrastructure projects all over Europe, as well as the impact of major events such as the civil unrest and political uncertainty in North Africa, and the Japanese earthquake.

In taking this approach, the report looks to provide a comprehensive analysis of the important factors and developments that will help or hinder the scaling up of renewable electricity in Europe and North Africa. Through 'progress checks' we assess the impact of each of the specific events and developments. We conclude by considering their cumulative impact on the five critical 'enabling factors' outlined above, and by proposing recommendations for policy makers to consider as they look to encourage the greater use of renewable energy.

Of course, there are other possible routes to addressing the challenges of climate change and increasing demands for affordable energy besides scaling up to 100% renewables. As we noted in our original roadmap report, the expansion of nuclear power and the development and deployment of carbon capture and storage (CCS) for emissions from the burning of fossil fuels could also play important roles in a low carbon future. Our exclusion of these routes from this report is not intended as any comment on their merit. Our goal, as in our original report, is to examine what it would take to shift even further to a 100% renewable electricity supply.

3. Our framework for measuring progress

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Every year there is new investment in renewable energy infrastructure, there are new government energy policies, and there are new private sector initiatives aimed at energy. The purpose of this section is to identify and describe a set of criteria that can be used as a framework for evaluating these events. Do they represent real progress towards the target of 100% renewable electricity in Europe and North Africa, and are they taking place with enough speed and ambition to realise the 100% target by 2050?

Renewable energy technologies offer real promise for the power system in Europe and North Africa, but are still largely confined to niche markets. Hydropower plays a major role in a few countries which inhabit the right geography, such as Sweden and Austria. Wind and solar power have a small but growing part to play in the power systems of many countries, but largely only because of special regulatory treatment, which insulates them from the full force of competition from fossil fuels and nuclear power. To stay on target towards a 100% renewable electricity by 2050, the critical challenge for the coming years will be for these technologies to move from being ones that can occupy small niches in the electricity system, to becoming ones that can dominate the system as a whole.

A transformation model for the power sector

History shows that whether promising new technologies move from a niche to a mainstream role depends on events happening at three levels (Geels, 2005). At the most basic level one has to look at whether the new technologies themselves are up to the job: whether they can deliver superior services to those technologies already in use, at a competitive price. Without this, they can never move into the mainstream. At the middle level, one has to examine whether the social and technical systems, within which the new technologies operate, are able to accommodate them. For example, for motor cars to have replaced horses 100 years ago, there needed to be smooth roads and appropriate traffic laws. At the top level, one has to look at whether the overall economic, social, and political climate, set by those in positions of power, is one that is conducive to transformation at the middle level.

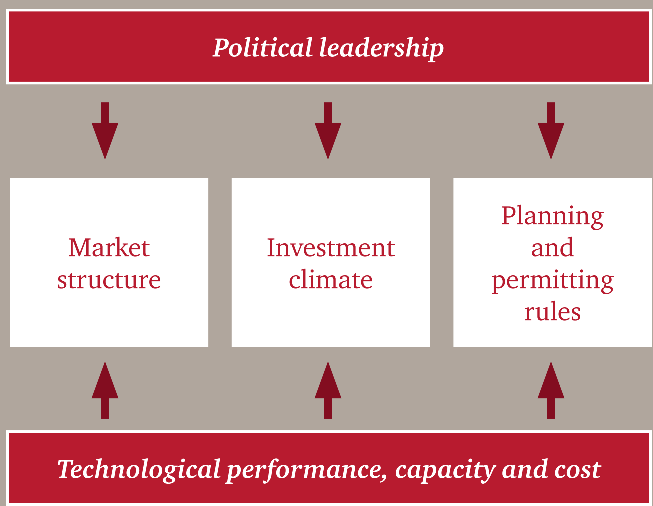


Figure 2: Elements of the power system transformation

Figure 2 applies this three level framework to the power sector, dividing the middle layer into three critical systems: the market structure within which power is bought and sold; the investment climate within which project developers obtain new finance; and the system of rules, influenced by public support or opposition, within which new infrastructure is planned and permitted. Overarching this, political leadership is the key determinant of whether there will be the changes to these middle-layer systems necessary to remove the barriers to renewable electricity market penetration. Underpinning everything, the technological performance, capacity, and cost of renewable electricity generation and associated transmission grids need to be up to standard in order to make these changes attractive.

Having introduced the factors that are critical to renewables' transformation from a niche player to dominating the mainstream in the panel above, we now examine each of these factors in more detail. In particular, we outline the key criteria for evaluating whether each is changing at the pace needed to make a reality of the vision of 100% renewable electricity in North Africa and Europe by 2050.

3.1. Political leadership

The rise of renewable power has and will continue to depend on political leadership. Given that renewable generation options like wind and solar are still not least-cost options, policies need to cover the cost gap, either through direct support for renewables (such as with a feed-in tariff), or through a cost penalty on conventional generation (such as with a carbon emissions permit market). Since it will be necessary to transform each of the three middle-layer systems in Figure 2, political leadership will need to overcome or diffuse opposition from actors and interest groups who would rather remain with the status quo, or would prefer the electricity system to develop in a way that is incompatible with 100% renewable electricity (Jacobsson and Lauber, 2006). An essential aspect of political leadership is that it recognises the long-term value of moving towards 100% renewable electricity rather than being focused on shorter-term routes that head off in different directions.

Events in the last year can serve as signals for whether political leadership is already present. They can also create the conditions that are likely to lead to increased political leadership in the future. Taking both into account, we identify three criteria for evaluating changes in existing or future political leadership:

- Existing leadership and political commitments. Have political leaders demonstrated a willingness and intent, especially in the form of firm commitments, to transform the power system to 100% renewable electricity?
- Economic, environmental and strategic arguments. Do recent events create additional economic, environmental and strategic arguments for achieving 100% renewable electricity, and will these bring about the necessary change to the three middle layers (Figure 2). How do they impact the viability of existing arguments against such change?
- Interest group politics. Do recent events bolster the relative political influence of interest groups that would favour the transformation to 100% renewable electricity? Will they result in greater and more constructive public engagement?

3.2 Market structure

The structure of the market within which electricity is bought and sold is important for several reasons. It has a major influence on the profitability of new investments, and hence whether those investments are actually made. It influences the flexibility of power demand, and the need for peak load power capacity. It also influences the choice of technologies that make up the power system, ranging from completely 'dispatchable' on the one hand to 'intermittent' on the other. Finally, it determines the competitiveness of the market and thereby the cost efficiency of achieving a reliable power system.

As the earlier 100% Renewables Electricity report suggested (PwC, 2010), there are a number of reasons why a market design consistent with 100% renewable electricity, would look different from today's overall structure. First, there is good reason to believe that both Europe and North Africa can most easily achieve 100% renewable electricity by pooling power across the entire region—and indeed, that such pooling may be a necessary condition. This is due to limits on land availability for renewable generation in Europe, and because of the negative correlation in the intermittency of supply across continental-scale distances (Czisch, 2005; German Aerospace Center, 2006; MacKay, 2009).

This implies a need for transmission capacity sufficiently large enough to eliminate long-distance transmission congestion (Economist, 2008; Marris, 2008), and hence a unified market giving grid owners the incentive to build necessary new lines in the right places (Brunekreeft et al., 2005). An important element of this is that unbiased competition is allowed to unfold, as a result of the continued liberalisation of power markets. Particularly important is the unbundling of generation and transmission capacity, which would remove a possible powerful tool to fend off competitors, hence distorting the market, as well as measures to reduce the market power of the large utilities (Battaglini et al., 2009). This market liberalisation would also need to facilitate access to affordable energy, particularly in the context of North Africa.

Second, there is a need to provide consumers of electricity an incentive, and indeed an opportunity, to shift their demand away from existing periods of peak load when power supply is most constrained. Doing so will take a combination of new technology, including technologies that could take advantage of the storage capacity in

electric vehicles, and a consumer power market that offers real-time pricing (Bradley and Frank, 2009; Coll-Mayor et al., 2007). Regional market integration will also contribute to load smoothing, given that peak load periods are asynchronous across all of Europe and North Africa (Battaglini et al., 2009).

Third, there is a need to re-evaluate the design of the power market as renewable sources begin to make up a larger share of total supply, at average generation costs that are competitive with fossil fuels. Currently, the high marginal cost of operating gas-fired power plants pushes up the wholesale price during peak load periods, which effectively guarantees base load power providers with sufficient revenues to cover their high fixed costs. Ideally, a system relying on 100% renewable generation would optimise the use of 'dispatchable' sources, such as CSP, biomass and hydropower, to cover periods with low wind and PV generation, with a portfolio of renewable sources from a wide geographic area to cover base load. However, because renewable power sources have low marginal generating costs, the current auction design which is based on marginal pricing might not generate revenues sufficient to stimulate adequate investment in a firmly 'dispatchable' generating capacity (McKinsey, 2010). Experimentation with different market design options may be needed to address this problem (PwC, 2010).

Recognising the challenges of the current market structure, we identify three criteria for evaluating the impact of recent events:

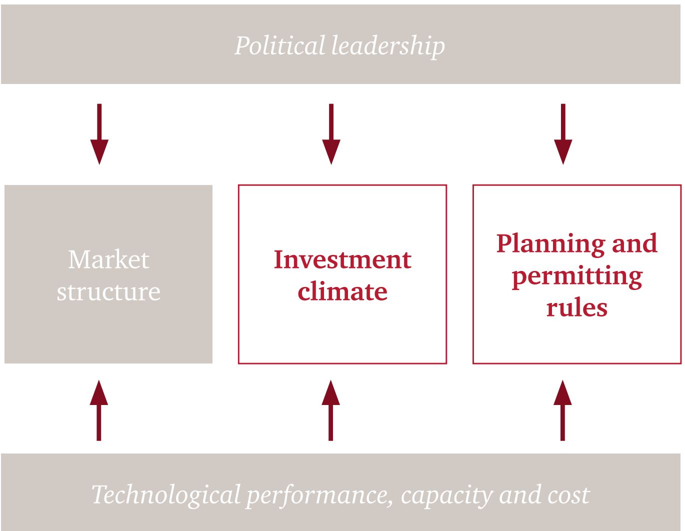
- Integration. Has the integration of markets across national borders increased?
- Adaptation of market design. Has the market design been adapted towards an increasing share of intermittent renewable generation? Have incentives been introduced for 'dispatchability' of renewables, provision of storage and flexibility of demand?
- Competition. Has there been development towards more competition in the European markets? Has there been development towards the introduction of price competition and private sector access in North Africa?

3.3 Investment climate

In 2010, total global investment into renewable energy reached US$243bn, up from US$186.5bn in 2009 (Renewable Energy World, 2011). However, continuing new investment at roughly this level would achieve a scenario by 2030 that would still fall short of what is needed to achieve 100% renewable electricity by 2050 (IEA, 2010). Rather, there is a need to scale up investment in renewable generation capacity and the associated transmission infrastructure, as well as into distribution grids, backup capacity and storage over the next decade at a pace greater than the 25% average annual growth rate in the past decade. At the same time, investment in new long-lived fossil fuel infrastructure will need to be curtailed (PwC, 2010).

So far, the most successful policy instrument to sustain high levels of investment has been the feed-in tariff, followed by other technology-specific subsidies and tax credits (Hillebrand et al., 2006; Mendonça, 2007). There is evidence that carbon markets, such as the European Union Emissions Trading Scheme (EU ETS), have had at best a minor impact on the provision of capital investment, because of the relatively low level of carbon prices (Eskeland et al., 2010), the unpredictability and because carbon markets leave investors exposed to price and other risks (Knight, 2010). The price floor mechanism that the UK announced in the recent budget seeks to provide investors with greater certainty as to long term carbon prices; this may provide a new policy option for other European governments, and so will be watched with interest.

Feed-in tariffs themselves may also have problems. First, there has been something of a reaction in Europe against feed-in tariffs, especially in those countries where the tariffs were very high (del Rio and Gual, 2007; Greenwire, 2009), and this has fed into a perception that investment into renewables may not be sustainable in the long run. Second, while feed-in tariffs reduce the risks to investors associated with future electricity price fluctuations, they do not reduce the risks associated with political and regulatory uncertainty, important in the North African market (Komendantova et al., 2009). Third, feed-in tariffs alone do not necessarily stimulate adequate investments into component supply chains due to the uncertainty of their continuation in the future – as with carbon prices, it is income expectations and certainty over the long term that drive investment. However investment in supply chains remains key to reducing technology costs (European Wind Energy Association, 2007).



Recognising these developments, we identify three criteria for evaluating the effects of recent events on the investment climate:

- Sustainable support mechanisms. Have existing support schemes been improved? Has there been an expansion of well-designed support mechanisms, with appropriate tariff levels, into new countries and markets? Do the support schemes provide stability and certainty for the investors?
- Perceived risks in new markets. Have political and regulatory reform, or the leveraging of finance from multilateral development organisations, served to lower the perceived risks associated with investment in new markets, such as North Africa?
- Long-term expectations. Is there evidence of long-term expectations evolving in order to support increased levels of investment in renewable technologies and reduced investment in fossil fuel related infrastructure?

3.4 Planning and permitting for new infrastructure

A healthy investment climate and appropriate market structures are both necessary to achieve 100% renewable electricity by 2050, but they are not on their own sufficient. One of the most important factors that can hinder the rapid expansion of grid infrastructure is the length of time required and high uncertainty associated with planning and permitting. This is especially so in the case of obtaining rights of way for international power cables, the lack of which is an immediate barrier to further increasing the penetration of renewables into many European markets (Economist, 2008; PwC, 2010).

Even making grid upgrades consistent with the current power system is difficult, because lengthy and uncertain permission processes "endanger the timely completion of infrastructure projects and the achievement of European policy targets" (ENTSO-E, 2010c). The average time to get a construction permit for a new high-voltage priority line in Europe is seven years. A quarter of projects, especially those involving more than one country, take more than twice that time. This makes transmission investments unnecessarily unattractive and risky, which has led to a number of projects being cancelled (ENTSO-E, 2010b; MVV consulting, 2007).

Two main factors underlie the difficulty in gaining regulatory approval for siting new infrastructure – one is a lack of harmonisation between regulators and the second is an absence of public acceptance. The lack of harmonisation between different national systems in obtaining legal rights of way and building permits is a particular obstacle for international lines. The basic building blocks are similar in most European countries – 'public consultations', 'an environmental impact assessment', the 'issuing of a building permit', and 'approval from the regulator' are the main steps - but the different process phases are often done in a different order, in a different number of steps, or involving different authorities (ENTSO-E, 2010b). This lack of harmonisation and coordination between regulators leads to long delays.

The second and more fickle factor has to do with public acceptance. Often, local stakeholders do not see how new lines, especially cross-border lines, will benefit them. Interestingly, public opposition is generally lower against lines built by publicly owned grid operators as opposed to private companies who may be perceived to be profiting from the investment (ENTSO-E, 2010b; MVV consulting, 2007). To win more sustainable popular support, it may be essential to look again at public involvement in grid planning, the relative power of different stakeholder groups in the permitting process, and the issue of compensating landowners for lost property values.

Recognising the need for greater harmonisation and public acceptance, we identify three criteria for evaluating recent events:

- International infrastructure planning. Has there been greater cooperation between countries in identifying priority projects to expand the power grids?
- Regulatory harmonisation and streamlining. Has there been a shift towards the harmonisation of different systems for planning and permitting and an overall streamlining of those rules to reduce delays and uncertainty?
- Public acceptance and a climate of trust. Do recent events indicate or create the conditions for greater acceptance and trust among a wide range of stakeholders concerning new infrastructure projects?

3.5 Technological progress

Generation, transmission, and storage technologies lie at the heart of a power system relying on 100% renewable sources. The quicker these can evolve to enable an energy system relying on renewable sources to be equal or superior to a system which relies on fossil fuels, the more likely there will be a rapid transition to renewables.

The likelihood of a major breakthrough in technology in any given year is quite low. Technological progress occurs more frequently through incremental performance improvements and incremental cost reductions. These are influenced by R&D expenditure but, more importantly, result from 'learning by doing' and from economies of scale in manufacturing and materials supply (Nemet, 2006). Both of these depend on the level of new investment.

As a rule of thumb, the costs associated with a given level of technological performance fall by 10-20% every time the total cumulative investment in that technology doubles (Grübler et al., 1999). A number of technology and policy specific factors influence where in this range actual cost reductions fall (Neij, 2008; Neij and Astrand, 2006). Renewables in Europe are currently moving from a niche market towards the mainstream. In the past, the levelised cost of generation was the main, or only, cost parameter of interest. Now, increasing penetration levels require us to think about how the technologies fit together and what the system costs of a certain expansion path are, as well as the performance of individual technologies, and whether this growth puts us on a path that may lead to an efficient power mix.

Taking these factors into account, the three criteria we identify for assessing recent events' contributions to technological performance, capacity and cost are:

- Growth. Have growth rates increased or fallen in the areas of new capacity expansion, component manufacturing and materials supply chains?
- Efficiency of renewable power mix. Is the observed growth likely to put the power system on a path towards an efficient renewable power mix?
- Cost/performance development. Have the costs of the renewable technologies fallen relative to their performance and have they done so at a sufficient pace?

4. Assessing progress – a look at recent developments and events

4. Assessing progress – a look at recent events and trends

Figure 3: Events and trends

In this chapter, we identify nine major events and trends of the past 12 months that, in our view, have had an important impact on developments in the renewable energy area. Some have emerged over a number of years and their impact is ongoing. Others are more current. Some are at a global level. Others are more of a local issue. What they all have in common is that they have the ability, directly or indirectly, to influence progress towards a 100% renewables outcome.

The nine events and trends that have been selected for analysis are:

1. Global financial and debt crisis
2. Climate negotiations and policy
3. EU electricity policy developments
4. Regional renewable developments
5. National renewable electricity developments
6. Capacity expansions
7. Public opposition
8. Civil protest and unrest in North Africa
9. The Japan earthquake.

We describe each event or trend and then examine it through the lens of the analytical framework outlined in the previous chapter. Has it influenced the long-term political leadership behind renewable power? Has it brought progress in transforming power markets? Has it helped new investment? Has it eased planning and permitting challenges? To what extent has it stimulated continued technological advances? Not all of these questions are relevant for each development or event. We therefore focus on those issues that are most appropriate to the particular topic. We then conclude each topic with a view on its impact on progress towards a 100% renewable electricity scenario.

Before starting the analysis however, it is worth stressing two points. Firstly, the events and trends chosen for the analysis are not meant to be a comprehensive or exhaustive list. Other significant developments have also occurred during the past 12 months and prior to that, which are also likely to shape the growth of renewables and may warrant separate examination in due course. Secondly, the order in which the events have been analysed is not intended to reflect any judgement on their relative significance or importance.

4.1 Global financial and sovereign debt crises

Between 2007 and 2010, Europe and North Africa were buffeted by the global financial crisis and then, in the case of Europe, by a sovereign debt crisis. The financial crisis resulted in a sharp slowdown in economic activity across the region that in some countries continues today. For investors the debt crisis raised particular concerns about the risk profile of several European countries. The cumulative effect of these problems on the renewables sector was hesitation on the part of the investors and lenders.

With few exceptions, the development of large renewable energy projects is heavily dependent on the access to the international financial markets. The crisis and the losses incurred by financial institutions and other investors resulted in a dramatic slowdown in their lending activity. The focus for many financial institutions turned inward as they sought to rebuild their balance sheets, while the approval process for new lending and investments became significantly more cautious and risk averse. For renewables, this led to the withdrawal of financial support for projects especially those using less well-proven technologies or located in new geographical locations with less established track records. A number of developers have also had to sell their permitted sites.

The varying impacts of the global recession on individual countries also influenced investment flows. During 2009, there was a clear shift in focus by the investment community from Europe and North America to Asia. While Europe still attracted the largest amount of financial investment compared to other regions in the world, total investment across Europe in clean energy fell from US$48.4bn in 2008 to US$43.7bn in 2009 (BNEF, 2011).

Recent reports (Renewable Energy World, 2011; BNEF, 2011) indicate that overall, investment in 2010 has rebounded. New global investment in clean energy – especially but not exclusively renewable electricity – is estimated to have reached US$243bn in 2010, up from US$186.5bn in 2009. Perhaps against market expectations, Europe has contributed significantly to this, maintaining its leadership position. This is partly attributed to expansion of offshore wind, which suggests the return of financial flows into the sector, and partly a result of rapid growth in small-scale solar PV generation, boosted by stimulus programmes in some countries. In total, Europe installed 23 Gigawatt (GW) of renewable electricity capacity in 2010, up 30% from 2009 and more than in any previous year.

On the back of the financial crisis, 2010 also saw a sovereign debt crisis develop in Europe. With the possibility of Greece defaulting on some of its debt and the Euro under threat, the EU and the International Monetary Fund (IMF) took rapid steps to agree a €110bn support loan, which was made under the condition of harsh austerity measures. Greece continues to struggle with its recovery and the difficulties there have continued to spark concerns that the crisis could spread further to other European countries with high government deficits.

To defend themselves from speculators, fiscal austerity measures were introduced by governments in Spain, Italy and Portugal, and Ireland was the recipient of a €85bn bailout package from the EU and the IMF. Most recently, Portugal has also had to accept a three-year bailout package worth approximately €78bn. Renewable development activity slowed temporarily in some cases as country credit and risk ratings were downgraded, subsidies and support for renewables were reviewed by governments, and uncertainty remained about the state of many of these countries' finances.

In parallel, a number of governments launched recovery programmes, many of which included measures to promote low carbon and green growth initiatives and help revive national economies and depressed regions. Even countries that have been hit hardest by the financial and debt crisis - Spain, Portugal, Ireland and Greece - have looked where possible to try and protect their green growth industries from the impact of the more extreme austerity measures as other sectors suffered funding cuts. This has helped sustain in part, the levels of renewable investment in the past 12 months.

Looking ahead, the picture seems to be improving. At a European level, lending levels are slowly being restored, the stability of financial institutions is being rebuilt and a number of market-based and regulatory reforms have been implemented or are under consideration by governments and other institutions. Growth in the renewables industry is expected to create new jobs at a time of high unemployment in some countries, particularly in the construction sector, and this could also help to ease what has been a tight renewables supply chain. New investment from government announced economic recovery programmes and from countries that have largely escaped the effects of the financial crisis, in the Middle East and Far East, is helping to restore confidence in the investment community for the renewables asset class.

Renewables progress check

The global financial and sovereign debt crises

Political leadership

Political leaders have showed a continued willingness and desire to support the rollout of renewables despite the impact and distractions associated with the financial and debt crisis. Although overall signs are encouraging, the ongoing fragility of domestic economies may limit further possible leadership and support for renewables.

Investment climate

European renewable support systems have largely been maintained and this has been important to sustain short-term activity and confidence in the sector. Stability and longer-term certainty is still missing in some countries as governments look to address policy cost and implementation issues. With the future still unclear, investment has continued to flow to proven and growing market locations, slowly reversing the earlier dip in activity during 2009.

Conclusion

Undoubtedly, the financial and debt crisis has had a negative impact on renewables, with investment levels dipping as investors reviewed their risk profile and holdings. Supported by largely positive action by governments, levels of activity are now picking up again, although uncertainties remain.

4.2. Climate negotiations and policy

Europe has focused much of its attention on its own internal climate and energy policy following loss of momentum in the United Nations Framework Convention on Climate Change (UNFCCC). In 2010, changes to the European Union Emission Trading Scheme (EU-ETS) for phase 3 were agreed and there was broad acceptance of the 20-20-20 targets for emissions, renewables and energy efficiency. Ongoing discussions about increasing the emissions reduction target from 20% to 30% by 2020 and long-term climate goals are clear indicators that Europe is serious about its climate policy.

United Nations Framework Convention on Climate Change (UNFCCC) process

Given the breakdown of the international climate negotiations at the Conference of the Parties 15 (COP15) in Copenhagen in 2009, expectations for the COP16 in Cancun and the overall UNFCCC process were low. Although some progress was made in Cancun, the most important outcome of Cancun seems to be the continuation of the UNFCCC process. There was no international agreement of binding targets for the post-2012 period. A binding global agreement is the main objective at the COP17 in Durban in late 2011, but this does not seem likely.

The Cancun Agreements confirmed the decision to establish the Green Climate Fund to support climate action by developing countries (see UNFCCC, 2010). This progress was anticipated and widely welcomed. The fund will be governed by a board with equal representation from developed and developing countries. The World Bank will serve as the interim trustee for the first three years. The fund will be used to disburse a “significant part” of the promised funding to help developing countries respond to climate change.

The proposed fund is good news but missing half the puzzle. It is designed to distribute funds, not raise them. More work is needed on potential new sources of funds and the role of the private sector in meeting the goal of mobilising $100bn per annum by 2020 to support climate action. Surprisingly, the work of the High-Level Advisory Group on Climate Change Financing (AGF) on this was referenced, but without mention of a continuing work plan past Cancun.

In addition to this, Cancun agreed on the continuation of the Clean Development Mechanism (CDM) after 2012. This will be the case regardless of whether a binding global climate policy framework is agreed at Durban or not. Carbon capture and storage (CCS) was also included as an eligible CDM offsetting activity. The global impacts of this are unclear. Most CDM credit demand is likely to remain limited to Europe in the absence of a global climate deal The Commission announced further restrictions on the use of CDM credits in the EU ETS post-2012 which ban the use of CERs from industrial gas projects.

European climate target discussions

The main debate among European climate policymakers during 2010 was whether the EU should increase the ambition of its 2020 reduction target. The 20% target is widely accepted; the question is whether member states will agree to a 30% target.

The longer-term targets now conform more to the Intergovernmental Panel on Climate Change (IPCC) recommendations. European 2050 emission reduction aims of 80-95% can now be found in various European documents (for example European Commission (EC), 2010f). This is a clear increase compared to the 60-80% aims in earlier documents (for example 2009/29/EC, 2009). The 80-95% target has been confirmed by the European Council on two occasions in 2010 and 2011 (European Commission, 2011d).

Officially, the EU's condition for a 30% climate target is that other countries commit to "comparable" efforts (Barber, 2010; European Commission, 2010a; Lang and Mutschler, 2010; Tuttle, 2010). During the preparations for Cancun, and regardless of this official European condition, the European Parliament issued a resolution stating that "irrespective of the international negotiations, it is in the EU's interest to pursue an emissions reduction goal of more than 20% because it will promote green jobs, growth and security at the same time" (European Commission, 2010a; European Parliament, 2010).

Overall, the European line has changed from viewing climate policy primarily as a risk mitigation tool to an increasing recognition that "the development of resource-efficient and green technologies will be a major driver of growth" (European Commission, 2010a:4). A large number of scientific reports demonstrating that a low carbon economy may be viable, both technically and economically have contributed to this paradigm shift (for example ECF, 2010; PwC, 2010; Zervos et al., 2010; WWF and Ecofys, 2011; Jaeger et al., 2011). Although there is European-wide support for the 20% target in spite of the ongoing financial and debt crisis, it is unclear whether a target increase to 30% is politically realistic. The March 2011 Roadmap 2050 communication from the Commission did not clarify this matter and concludes that "this discussion continues" (European Commission, 2011d).

The same document sets out the emission reduction pathway for Europe to 2050. It recommends targets for domestic reductions of 40% and 60% in 2030 and 2040, respectively, and an 80% domestic reduction target for 2050. The March 2011 communication also defines sector-specific emission reduction ranges: for the power sector, these are 54%-68% fewer emissions in 2030, and 93%-99% fewer in 2050, compared to 1990. But binding 2030 or 2050 targets have not been adopted (European Commission, 2011d).

Development of the European Emissions Trading Scheme (ETS)

In 2010, the EU ETS cap for 2013 was set at 2,039 Mt CO_2. This will be ratcheted down annually by 1.74% so that in 2020 the ETS cap will be just above 1,800 Mt CO_2. Emissions from facilities covered by the EU ETS declined from 2,165 Mt CO_2 in 2007 to 2,120 Mt CO_2 in 2008 but plunged to 1,873 Mt CO_2 in 2009, following the financial crisis (European Commission, 2009b; 2010e).

The ETS will be expanded by the inclusion of aviation in the trading sector in 2012, increasing the trading sector size by 208 Mt CO_2 (95% of the average 2004-2006 emissions). This is included in the post-2012 caps (European Commission, 2011b; Eurostat, 2010; PwC, 2008). As the aviation sector has grown rapidly in the last few years, and has high avoidance costs, the actual aviation emissions are expected to be higher than the increase in the cap, which will put some upwards pressure on the carbon price (see DECC, 2009).

However, because of the significant decrease in emissions during the financial crisis, the possibility for EU ETS participants to carry over EUAs from the second to the third phase, and the increased investment in renewable energy and energy efficiency, the Commission's latest carbon price projections are only half as high as the projections made in 2008 (€16 in 2020, compared to €32 in previous projections (European Commission, 2010a).

There is considerable doubt whether the EU ETS will drive the scale of required investment in renewable capacity under these conditions (see Figure 4 on next page) In an attempt to address investor concerns about the level of carbon prices and the uncertainty over future prices, the UK government has announced plans to introduce a carbon floor price, starting at at £16/t in 2013 and moving up to £30/t by 2020 (see HM Treasury and HM Revenue & Customs, 2010).

Figure 4: EU Allowance price (Dec 2011) August 2007- April 2011

Source: Point Carbon, 2011

Concerns remain about whether the current emissions trading scheme in the EU will drive sufficient investment in renewable energy.

In early 2011, the Commission said it would "consider" the 2013-2020 caps by withdrawing emission allowances from auctioning, with the aim of creating higher and more stable prices, even if the 20% reduction target is maintained (European Commission, 2011d). If the climate target is increased from the original 20% level, the Commission sees an adjustment of the EU ETS cap as the most important tool to reach the more ambitious objective, along with other measures such as increased carbon taxes and stronger emission performance standards for vehicles. This would be done by reducing the auctioning of EUAs – the Commission suggests a 15% reduction – thus effectively tightening the cap. The Commission expects that member state revenues from auctioning would still be higher, as "carbon prices are expected to increase by more than the reduction of allowances auctioned" (European Commission, 2010a:6).

Renewables progress check

Climate negotiations and policy

Political leadership

The international policy context remains difficult and uncertain. Cancun managed to restart the UNFCCC process, but the prospects for an early legally binding global deal look very challenging.

The outlook in Europe is clearer. Widespread acceptance of the 20% reduction target by 2020 provides the foundation for European energy and climate policy in the next decade, and allows the Commission to lead the process in a clear and stable manner. Many policymakers also recognise the need for substantial emissions reductions (by 80-95%) in the long term in order to achieve the 2 degrees climate goal. However, Europe has not agreed whether to scale up the 2020 target or formally started the process of setting binding emissions targets for 2030-2050 targets.

Investment climate

Historically, the EU ETS carbon price was too low and unpredictable to drive the scale of investment required in the renewable power sector in Europe. Electricity prices have increased as companies passed CO_2 prices on to customers, but without additional incentives these have generally been insufficient to make renewable power competitive. Future investment at scale is likely to be dependent on targeted support schemes for the foreseeable future. However the UK's experiment with a carbon price floor should help to encourage investment.

Conclusion

It is encouraging that the vacuum at the global level has not been used as a reason for a loss of momentum at the national and European level. As a result, progress has not been as slow as it could have been. Concerns remain about the effectiveness of the EU ETS in promoting investment in renewable, but recognition of its current limitations is leading to some changes.

4.3 EU electricity policy developments

The past 12 months have been a period of progress in the European electricity policy and market arenas, although there is still much room for improvement, especially in the area of competition. Much of the progress was initiated by the third energy package. In addition, the shift of energy policy competence to the European level after the Lisbon treaty entered into force seems to have given the Commission new confidence to shape Europe's energy future and this is now starting to have its first effects on European energy policy.

The transmission issue moved to the top of the renewable electricity agenda, with two European medium-term (2010-2020) plans published by the European Network of Transmission System Operators for Electricity (ENTSO-E) and the Commission during the year. These plans represent a major step towards a more unified European grid and better grid planning. The longer term plans (2020-2050) which are now due to be prepared should put Europe on a firm path towards a grid capable of handling 100% renewables in the future.

During 2010, there was development towards a unified internal market through the coupling of the large north-western power markets. Some progress was also made towards competition in the market through the preparations for the third energy package and the unbundling of two large German utilities, but the European power markets are still far from competitive.

A number of large EU energy technology programmes also started during 2010, with a total budget in excess of €90bn over the coming years. These are likely to lead to the construction of a number of new interconnectors and give offshore wind a particular boost. However, much of these funds are directed at carbon capture and storage, as well as nuclear power. Successful investments in these areas could put Europe onto an alternative low carbon pathway, with a lower level of renewables by 2050.

In the rest of this section we look at four important aspects of European electricity policy development:

- Grid expansion and reinforcement plans
- Progress towards a unified, functioning and competitive European power market
- European renewables support
- Smart grid infrastructure initiatives.

Grid expansion and reinforcement plans

Two network development plans were published in 2010: the ENTSO-E's Ten-Year Network Development Plan (TYNDP) and the European Commission's blueprint for an integrated European energy network. These plans were accompanied by announcements of further and longer-term network and energy system plans. Together, they mark a change of direction towards a Europeanisation of network and energy system planning. We discuss them in the two 'in focus' panels that follow.

The TYNDP and the blueprint agree on the most important barriers to achieving the necessary grid expansions: the uncertainty around the future power system, the problems with accessing capital for network expansion and in some cases too low grid tariffs, the low public acceptance for new and upgraded transmission lines, and – most important of all – lengthy, complex and uncertain permission procedures (see also European Council, 2011). The Commission estimates that delays in permitting may "prevent about 50% of commercially viable projects from being realised by 2020" (European Commission, 2010g; i).

To overcome these problems, the blueprint proposes a project to identify transmission projects of "European interest" for which a number of policy measures have been announced:

- Faster and better coordinated permitting procedures, including the establishment of a single competent authority ("one-stop shop"), the introduction of a time limit for permission decisions, and the development of guidelines to increase the transparency and predictability of the permitting procedures. The ENTSO-E agrees with this, but urges the Commission to extend these new regulations to all transmission projects, beyond those of European interest (ENTSO-E, 2010a, see also ENTSO-E, 2010b). This suggestion is in line with what some National Renewable Energy Action Plans (NREAPs) propose on the national level (see section 4.5).
- Improvement of the financing framework, by improving the cost allocation rules – especially for interconnectors and for the introduction of new technologies – and by improving the leverage of public funds that are spent. The Commission will propose, in 2011, new legislation for the cost allocation of technologically complex or interconnector projects, through revised or new tariff and investment rules. Similarly, the Commission will propose new tools for public investment support, in the form of grants or reduced-interest rate loans. It will also consider such mechanisms as equity participation, risk sharing for new technologies, and public-private partnerships loan guarantees. Of particular interest, as it is a move away from previous policies, is the "tax-payer pays" principle for projects that are necessary from a European perspective but not commercially viable in the current transmission regulation setting (see European Commission, 2010f).
- The creation of "regional clusters", analogous to the existing Baltic Energy Market Interconnection Plan (BEMIP) and the North Sea Countries' Offshore Grid Initiative (NSCOGI), will be supported, and a high-level group tasked with developing a regional cluster plan for central-eastern Europe will be set up in 2011.
- Development of tools "to better explain the benefits of a specific project to the wider public" (See below - In focus: European Commission Blueprint).

Encouragingly, both the TYNDP and the blueprint agree that all current transmission development plans "must be compatible with the longer term policy choices" as "the infrastructures built in the next decade will largely still be in use around 2050" (European Commission, 2010g). To support such policies, the Commission will, in mid-2011, publish a scenario for the decarbonisation of the European energy system by 2050 (European Commission, 2010f).

The Commission has identified a long-term need for European "electricity highways", allowing Europe to access the potential of renewables in the peripheral regions and in North Africa and the storage capacities in Scandinavia and the Alps. In the blueprint, the Commission requests that the ENTSO-E develop a "modular development plan" for these supergrid highways, with the aim of having the first lines in place before 2020 (European Commission, 2010f; g). The ENTSO-E, in turn, aims to prepare the plan for such a 2050 study during 2011, and anticipates that the requested modular supergrid development plan will be ready by the end of 2014: It notes: "This means that the proposed realisation of first electricity highways around the year 2020 will be quite challenging" (ENTSO-E, 2010a).

In focus: The ENTSO-E Ten-Year Network Development Plan

The first comprehensive European ten-year network development plan (TYNDP) was published in June 2010 and covers the EU-27, the former Yugoslavian countries, Norway and Switzerland. The regular publication of such rolling ten-year plans is one of the main tasks of the European Network of Transmission System Operators for Electricity (ENTSO-E), as prescribed by the third energy package (ENTSO-E, 2010c). The first TYNDP considers a scenario with only 25.5% renewables in 2020, which means that it does not meet its unofficial 35% target for renewable electricity (although this is part of the mandate for the TYNDP, see Regulation 714/2009, 2009:Art. 8, European Commission, 2010f).

Although the TYNDP assesses a power system that falls short on the 2020 renewables targets, it still foresees a need for massive expansion and reinforcement of the transmission system: in the coming 10 years, Europe needs 42,000 km of new or upgraded transmission lines of European significance, of which almost 10,000 km are new DC subsea or underground cables (see Table 1). The total cost for all 471 single projects of European significance to 2020 was not published, but the costs for the mid-term (2010-2014) projects – which are the smaller part of the required investments – are estimated at €23-28bn. These investments and expansion needs only include transmission projects of European significance – investments that are needed to meet purely national needs and investments in lower voltage grids are not included.

Table 1: Required new and upgraded transmission lines as described in the TYNDP. The length of the current (2010) European transmission system is 300,000 km

	Total length (km)	New connections (km)	Upgrades (km)
AC	32 500	25 700	6 900
DC (almost all subsea/ underground)	9 600	9 600	0
Total	**42 100**	**35 300**	**6 900**
of which until 2014	**18 700**		

Source: ENTSO-E, 2010c

In focus: The European Commission blueprint for an integrated European energy network

In addition to the TYNDP, the European Commission presented the first phase of its "infrastructure package" – a "blueprint for an integrated European energy network" in November 2010. The blueprint identifies "priority corridors" for European energy infrastructure expansion, and proposes (for 2011) a policy "toolbox" to support this expansion. The Commission's scenario considers a renewable power share of 33% by 2020 and is thus clearly more ambitious than the TYNDP's 25.5%. The Blueprint foresees four priority corridors (see Figure 5) to make "Europe's electricity grids fit for 2020":

- An offshore grid in the Northern Seas (North Sea and the seas around the British Isles), including connections to northern and central Europe, to link to offshore wind generation and connect these to hydro storage potential in Scandinavia.
- Improved interconnections in south-western Europe to accommodate an expansion of renewables, in particular solar power, in France, Spain and Portugal, and "to make best use of Northern African renewable energy sources".
- Improved network in central/south-eastern Europe, primarily to allow for better market integration and the integration of renewables.
- Completion of the Baltic energy market interconnection plan, primarily to integrate the Baltic States into the European electricity market.

These priorities coincide with most of the investment needs identified by the ENTSO-E, but the ENTSO-E still sees a need for a detailed elaboration of how the blueprint and the TYNDP recommendations relate to each other and whether they are coherent. This will be one focus of the 2012 TYNDP update (ENTSO-E, 2010a).

Figure 5: European Commission priority corridors for the improvement of electricity, gas and oil infrastructure

Source: European Commission, 2010g

Progress towards a unified, functioning and competitive European power market

Important steps towards an integrated European energy market have been taken in the last 12 months. The Nordic and central-western markets, covering 60% of the demand in Europe, were coupled and the regulatory framework towards further cooperation of regional markets was strengthened with the introduction of the third energy package. However, the European markets are still far from competitive although the new measures and developments go in the right direction.

Increased integration of national markets and international cooperation

Prior to 2010, only the Scandinavian countries had a common power market and market coupling was only in place between France and Benelux. In November 2010, all markets within the central western region (Germany, France and Benelux) were connected via price coupling, leading to highly correlated power prices[1]. This integrated wholesale market was then also connected to the Nordic regions, using interconnections along the German-Danish border in November 2010, and further capacities between Scandinavia and the continent, such as the NorNed and SwePol cables (EMCC, 2010, NordPool, 2010). The resulting coupled market, covering 1800 (terawatt hour) TWh/a of power demand, or 60% of the European electricity consumption, is the largest of its kind in the world (Energinet.dk, 2010a). The northern/north-western market will be extended to the UK by 2012, and additional trading of balancing and ancillary services is planned (TenneT, 2010b).

New European objectives on market unification were defined during the winter 2010/2011: The Commission has set a target of a European-wide market coupling by 2015 (European Commission, 2010h), whereas the European Council aims at completing the internal European electricity market by 2014 (European Council, 2011). It is worth noting, however, that market unification can of course only take place if transmission grids are sufficiently improved to allow this to happen.

The third energy package entered into force in March 2011 and formalised important requirements for a further development of cross-border trading of power. In particular, it enforces a close cooperation of national transmission system operators (TSOs) as well as extensive coordination among the national regulatory authorities, for which two new European organisations were set up. The European Network of Transmission System Operators for Electricity (ENTSO-E) was established and began work in June 2009 (see also In Focus section above). In addition, the European Agency for the Cooperation of Energy Regulators (ACER) will, among other things, work to improve cooperation between national regulators, set up European network rules, monitor the European energy markets and provide guidance on cross-border issues. ACER commenced work in March 2011 (ACER, 2010).

Unbundling and competition

The market structure and functioning of markets in the power sector remains an area of concern, as Europe is still far from a functioning, competitive power market. The past year shows that it is moving in the right direction but that the pace is too slow. Among the positive developments is the strengthening of the unbundling requirements, a considerable amount of market analysis, as well as new initiatives concerned with the wholesale and retail power markets, and perhaps most important of all, the unbundling of two major German TSOs.

Overall, the reality of network operators in Europe remained largely unchanged in 2010 – most TSOs are still not fully unbundled. Developments in Germany however, show that the opposition of the energy giants to ownership unbundling may be changing. Two of the major energy utilities, E.On and Vattenfall Europe, sold their transmission networks in 2010. E.On sold its network to the Dutch state-owned TSO TenneT in January, and Vattenfall followed by selling its network to a consortium of the Belgian TSO Elia, and the Australian investment fund IFM (Tagesschau, 2009; 2010). Media reports have also suggested that RWE planned to sell its transmission grid operator, Amprion, to cut debt, possibly in response to increasing pressure for further unbundling from the Commission. So far, though, no concrete plans from RWE have been made public (Focus, 2010; Spiegel, 2010b).

The unbundling of these large vertically integrated utilities in such a key central market as Germany is an important step towards a more competitive power market structure. In addition, it is likely to soften German political opposition towards stronger European unbundling requirements (see panel).

A new regulation aimed at preventing market abuse in the European wholesale market was proposed by the European Commission in December 2010 (European Commission, 2010j). The main objective is to prevent market participants using their market power to drive up

[1]. Price coupling leads to a single price zone as long as sufficient interconnection capacity is available. Power flows from the cheaper to the more expensive market are determined in a day-ahead auction on an hourly basis (Energinet.dk, 2010a). This leads to a more efficient use of the interconnectors and the dispatch of the cheapest generation. The TSO is rewarded with a congestion charge that is based on the amount of power transferred, multiplied by the momentary price difference between the regions.

prices, for example by withholding electricity production at certain times. The proposed countermeasures would establish a European market monitoring function, ensure sufficient data transparency and prohibit the use of inside information (European Commission, 2010k). The German competition authority recently published an analysis of the German wholesale market and found that competition remains insufficient and that the large power companies have both the possibility and the incentive to manipulate prices. The conclusion was that tighter control of the market and more transparency is required (Bundeskartellamt, 2011).

Electricity consumer rights and a functioning competitive retail market continue to be matters of concern, and a contributing factor to the weak competition on the power markets. Both of these are strengthened by the third energy package's requirements for enhanced information regarding electricity contracts, improved dispute settlement procedures and national institutions to support consumer choice. A recent study shows how far away Europe is from a functioning retail market: European households could save on average €100 per annum by switching supplier but the overwhelming majority of households do not take this opportunity. While most European households have the option to switch their electricity provider, actual switching rates continue to be as low as 12% (ECME, 2010; European Commission, 2010c). In an interesting development, the Nordic countries plan to establish a common international retail market by 2015, possibly providing a pilot case for the larger continental European markets (NordREG, 2010).

European households could save an average of €100 per year by switching their energy supplier.

In focus: The third European energy package

The third European energy package that entered into force in March 2011 pushes for faster unbundling of TSOs and reinforces customer rights and market transparency. While this is a step forwards, the implementation of the second energy package, in force since March 2009, continues to be a challenge. In early 2011, over 60 infringement procedures regarding national-level implementation of this package were still unresolved. Thus, the main tasks for the coming year will be to implement not just the third but, in many cases, the second energy package as well.

As of early February 2011, no member state had fully implemented the directives of the third energy package (European Commission, 2011c). The Commission following the entry-into-force of the Lisbon Treaty, has openly threatened member states and companies by stating that, if the third package is not enough to create real competition in the market, new and stricter legislative action measures will be introduced (European Commission, 2010f).

The unbundling of TSOs, driven by the first and second energy packages in 1996 and 2003, has been a major area of disagreement in the last decade. It will now be complemented in the third energy package by the ISO (Independent System Operator) and ITO (Independent Transmission Operator) models. They allow ownership of both generation and transmission assets and have been the subject of much debate.

In the ITO model, proposed by Germany and France, a vertically integrated company can retain its ownership of the grid. It maintains the control over all investment decisions but it has to give up the daily management of the grid to an independent system operator. In the ISO model, proposed by the Commission, the mother company is allowed to retain ownership but loses operational control of the grid.

It remains to be seen which model the still vertically integrated companies choose, and whether the ITO model is a feasible compromise, achieving the competition benefits but avoiding the legal difficulties of the ownership unbundling model. Either way, the new independent (i.e. fully unbundled) TSOs will need to deliver on their new role, creating new and separate corporate cultures. It will be interesting to see whether the theoretical arguments for ownership unbundling hold, and whether the slow but steady unbundling process actually brings the expected benefits in the future.

European renewables support

Renewable power technologies are not yet ready to compete on their own in the power market as it functions today, mainly because they are still too expensive and do not fit well into current market structures. The market reality for renewables is therefore still mainly determined by the national support schemes in place in all EU member states (see section 4.5).

EU-wide harmonisation of support schemes

From time to time, the question of whether a harmonised EU-wide renewable energy support scheme would make sense from a cost-efficiency perspective is raised. Proponents argue that such an approach could better utilise the potential of regionally different renewable sources. The debate is also typically linked with the question of whether quotas or feed-in-tariffs (FITs) are better.

This issue is still vigorously debated. Arguments range from the supposed theoretical superiority of an EU-wide quota system (see Fürsch et al., 2010; Mennel, 2010), to the empirical superiority of the national FIT model (see Couture et al., 2010), to doubts whether there are any efficiency gains to be made from an EU harmonisation, regardless of which instrument is chosen (see EurActiv, 2010a).

In 2010, Energy Commissioner Oettinger proposed an EU-wide feed-in tariff (see EurActiv, 2010b). This was in contrast to the 2008 line of the previous Commission which concluded that: “The harmonisation of support schemes remains a long term goal on economic efficiency, single market and state aid grounds, but that harmonisation in the short term is not appropriate” (European Commission, 2008a). The Council refused Oettinger’s proposal, and the matter was postponed to the coming debate on reporting procedures for the renewables directive. The highly controversial harmonisation debate is thus likely to continue in the coming years. It remains to be seen what the outcome of this will be.

European funding programmes

Europe is a major funder of R&D and projects to demonstrate new technologies for power generation. Three major funding programmes started in 2010: the European Energy

Programme for Recovery (EEPR), the New Entrants Reserve programme (NER300), and the European Strategic Energy Technology Plan (SET Plan).

Following the financial crisis, the European Commission in November 2008 adopted the European Economic Recovery Plan. This plan is a combined EU and member state stimulus package of €200bn (European Commission, 2008b). The EU contributed €30bn, of which €4bn was allocated to energy projects within the EEPR (Regulation 663/2009, 2009; European Commission, 2009a; 2010d). Of the EEPR funds, €900m was awarded to electricity interconnectors[2], €565m to offshore wind projects[3], and €1bn to CCS projects[4], focused on 25 projects (European Commission, 2010b). The Commission expects the €2.4bn EEPR funds for electricity and gas transmission to catalyse €22bn of private investments in 2010-2015 (European Commission, 2010m).

In focus: the SET Plan and NER300

The SET Plan supports the development of a range of low-carbon technologies with up to €57bn for the period 2010-2020. All in all, about 40% of these funds will be used for renewable power and grids, 40% for CCS and nuclear power, and 10% for other energy areas (European Commission, 2010l).This means that €13bn will be spent on CCS (activities include 12 industry-scale pilot projects by 2015), €7-10bn on nuclear research (focus on a generation IV demonstration plant), €16bn on solar power research (focus on large-scale demonstration plants for concentrating solar power (CSP) and photovoltaic solar power (PV), and €6bn on wind power development (wind mapping, prototype development for offshore wind, 5 demonstration onshore wind turbines of 10-20 MW).

NER300 is the world's largest funding programme for innovative low carbon energy projects and a key part of Europe's strategy to tackle climate change. The Commission will raise approximately €5 billion from the sale of 300 million EU carbon allowances held in the New Entrants Reserve of the EU Emissions Trading System. The funds will incentivise investment in a portfolio of carbon capture and storage projects and nine categories of innovative renewable energy technologies including wind, solar, bioenergy and smart grids. The programme will advance the development and commercialisation of these technologies by co-funding the projects and sharing the knowledge gained from them. The Commission launched the funding programme in late 2010; award decisions for the first round are expected in mid-2012 and projects should be operational by 2015. (http://ec.europa.eu/clima/funding/ner300/index_en.htm)

Smart grid infrastructure initiatives

Numerous public and private smart grid initiatives are in operation in various member states, but there were no big breakthroughs in these technologies in 2010. Some countries, for example Germany and the UK, set the course for equipping customers with smart meters within the next decade through a variety of political decisions. In Germany, a new law entered into force in early 2011 which obliges electricity suppliers to offer variable tariffs, thereby incentivising customers to use smart meter technology (Renner et al., 2011). To date, however, Italian company ENEL remains the only major electricity utility with nearly complete smart meter coverage.

In most member states, the industry remains reluctant to invest heavily in this area due to the lack of technical standards. To solve this problem and spur large-scale smart meter expansion, the European Council "invited" member states and their respective standardisation organisations to define standards for electric vehicle charging systems by mid 2011 and for smart grids/meters by the end of 2012 (European Council, 2011).

In countries where a roll-out of smart meters is "assessed positively", the Commission has set a target of 80% smart meter coverage by 2020 (European Commission, 2011c). In parallel to this, the Commission's smart grids task force started its work in late 2009, with the goal of providing the Commission with policy and regulatory direction. The task force is coordinating the first steps towards a large-scale rollout of smart grids under the provision of the third energy package by mid-2011 (TFSG, 2009).

[2] The largest grants went to a new 2 GW interconnection Spain-France, which will be partially laid as underground HVDC cables (€225m grant), the intra-German control-zone interconnector Halle-Schweinfurt (€100m), and new subsea cables Sweden-Latvia (€131m), Sicily-mainland Italy, Ireland-Wales (€110m each)

[3] More than half of the offshore wind funds went to grid projects: to connect Kriegers Flak (Baltic sea) to the mainland (€150m), and to two grid projects in the North Sea (Cobra cable, Denmark-Netherlands, €87m; offshore HVDC hub, Scotland, €74m).

[4] Five projects in Germany, UK, Netherlands, Poland and Spain received €180m each; one project in Italy received €100m.

EU electricity policy developments

Political leadership

The developments in the European electricity markets in 2010 show that the European Commission is serious about its plans to create a functioning, competitive and unified internal European power market. The political direction is clear to all market participants: the European market will be both liberalised and unified.

Nonetheless, the influence of certain national governments is evident in the unbundling requirements of the third energy package, which was diluted at the last minute through the introduction of the ITO unbundling alternative. It will be up to the European Commission, supported by competition-friendly member states, to sustain the pressure towards a competitive and unified European market.

The ENTSO-E TYNDP and the Commission's blueprint, as well as the announced updates and longer-term (2050) plans, show the rapidly increasing European policy focus on transmission. They increase the credibility of the commitment to a unified European power market with a high share of renewables.

Markets

Europe is on track towards a unified European wholesale power market. The implementation of the market coupling of central-western Europe and Scandinavia in late 2010 was a very important step towards this. The implementation of the third energy package – including the creation of ACER and ENTSO-E – will also lead to better coordination at a European level. The new target date for a complete internal market (2014/2015) is important, but must be followed by action towards this goal, also from the member states.

In terms of market structure and competition, Europe continues to struggle. Progress is positive but insufficient and too slow. On the positive side, 2010 has seen the unbundling of two major German TSOs, as well as a number of initiatives by the Commission that will support better functioning wholesale and retail markets.

Detracting from this, the implementation of the power market directives remains a major weak point, and the unbundling requirements contained in the third energy package have been considerably weakened through political concessions to the large power companies. Market transparency and effective functioning remains a concern. The Commission's transparency initiative could prove to be an important measure in helping promote efficient markets.

Little progress has been made in adapting the market design towards the integration of renewables. Only the European Commission's support for smart meter technology and, for instance, Germany's introduction of a law demanding variable power tariffs constitute a step in this direction.

Investment climate

The European power market is in a period of rapid change, which may cause some uncertainty and delay certain investments. Much of this uncertainty originates in areas that are not directly part of the market design, such as the ETS or the success of the feed-in tariff systems (see sections 4.4 and 4.5). Although some of the details are not yet clear, the direction of travel – towards more market integration, more competition, and more renewables – is increasingly apparent. The unbundling process may strengthen the business cases for the TSOs to reinforce their grids, but the incentives for new transmission lines are still insufficient to trigger investments of the required orders of magnitude. The Commission's proposal may help to address this issue.

Planning and permitting for new infrastructure

The definition of the first 10-year rolling network development plan is a very important first step towards a truly European power grid, able to support the market unification plans of the EU and enable much higher shares of renewable generation than today. It is surprising, however, that the ENTSO-E scenario does not reflect the 2020 renewables target. The recognition of the main obstacles – insufficient incentives for infrastructure investments and the lengthy and uncertain permission processes for new transmission – is also of great importance, although this has not yet been followed by action.

So far, insufficient improvements have been made and investments in grids are still far too low and likely to remain so in the coming years. This could endanger the expansion of renewables and may well be the single most important obstacle in the pathway to 100% renewables. The Commission's announcement of regulations to simplify the permission processes for transmission that is in Europe's interest is significant but it remains to see what the member states will do in terms of legislation to facilitate the expansion of national transmission. The introduction of smart meters is slower than anticipated a few years ago, despite some quite ambitious legislative initiatives in the member states. The hope is that the standardisation process will speed up, with the political support of the Commission and the Council.

Technological progress

The EU spends large amounts on the development of new and improved generation technologies and electricity concepts - efforts and achievements in 2010 have been significant and positive. The EEPR investments may eventually stimulate further investments as well as the developments needed to make further offshore wind and transmission projects more bankable. Similarly, the NER300 support programme may contribute to this in the same way, depending on what types of projects are accepted. The economically very potent SET Plan is likely to play a decisive role in the development of new low-carbon technology development. However, in considering the vision of 100% renewable electricity, it is worth noting that the large share of support being given by these programmes to non-renewable technologies, may contribute to moving Europe away from a 100% renewable pathway or, if Europe stays on this path, resulting in R&D funds being committed to non-renewable technologies that may not be used in the future power system.

Conclusion

There have been both positive and negative developments in the last year. After a period of impasse, new momentum has returned to unbundling. The implementation of the third energy package – including the creation of ACER and ENTSO-E – is significant. There is increasing recognition of the need to focus on transmission infrastructure and address obstacles such as planning and permitting delays. Progress on the ground is far too slow, however, especially in market competition and with steps to speed up planning and permitting for new infrastructure and initiatives such as smart grids still in their infancy in most countries.

4.4 Regional renewable developments

The last three years have witnessed a number of governments, businesses and financial organisations collaborating on ambitious plans to develop new infrastructure for renewable energy generation and transmission in Europe and North Africa. Whilst these initiatives are a long way from being translated into concrete action, together they are proving an important contribution to support political thinking about a major and radical shift towards renewables. We describe some of these initiatives and their progress over the past year below, grouping them by their geographic focus.

European - MENA cooperation

- **The Union for the Mediterranean (UfM) Mediterranean Solar Plan (MSP)**. Launched in July 2008 by the French EU presidency as one of the flagship programmes of the UfM, the MSP is a political partnership to achieve 20 GW of new renewable electricity capacity by 2020 across Mediterranean countries, improving the transmission grid infrastructure with a view to enabling imports of electricity to Europe, and creating an appropriate framework to support stable investment and development. A key enabler of the MSP is the European Investment Bank (EIB), which has proposed a roadmap for renewable energy and energy efficiency investment in the Mediterranean region, and has earmarked €5bn in financing. The major activity of the MSP in the last year was a conference on technologies, regulation and financing, organised by the Spanish EU presidency in May 2010. In October 2010, UfM countries launched a second political initiative to supplement the MSP with a broader set of cooperative actions on climate change adaptation and greenhouse gas emissions reduction, but it is not yet clear what the specific goals of this initiative will be.
- **Desertec Industrial Initiative (DII)**. Launched in July 2009, the DII is a consortium of large firms from the energy, technology and financial sectors. Each of these firms has an interest in developing renewable generating capacity in North Africa as well as transmission lines to feed some of that power into the European grid. On its formation, the DII announced a target for new investments of €400bn to make it possible for North African renewable generation to supply 15% of the European market and a large share of the North African market by 2050. Subsequently, and more in line with a role as an industry advocacy group, the DII has identified its core

tasks as stimulating the creation of a favourable regulatory / legislative environment through analysis and advocacy, as well as proposing and specifying a set of proof-of-concept reference projects. In the last year, the DII announced that it hopes to have identified the first set of reference projects by 2012, and has been engaging in the necessary analysis for this.

- **MedGrid.** Launched in May 2010, MedGrid, originally named TransGreen, is a forum for firms that are likely to be involved in building and operating a trans-Mediterranean supergrid to cooperate on their research and political lobbying efforts. It is, similar in purpose to the Friends of the Super Grid (see below), but covers a different geographical region. MedGrid announced that its first major task is to conduct a set of feasibility studies to support electricity imports to Europe from North Africa by 2020 and plans to have completed these by 2012.

Europe

- **North Seas Offshore Grid Initiative (NSOGI)**. Announced in December 2009, eleven northern European countries have agreed to work together on this initiative to develop a common vision for a North Sea and North West offshore grid. In the last year, energy ministers from the associated countries have met together and, in January 2011, announced the intent to cooperate on issues of planning and regulatory reform in order to stimulate the offshore grid's development.
- **Friends of the Super Grid (FOSG)**. Launched in March 2010, FOSG is a group of companies that are likely to be involved in building and operating a European network of high voltage direct current (HVDC) power cables. It provides a forum for them to coordinate their lobbying efforts, particularly with respect to the North Seas Offshore Grid Initiative. The group announced the hiring of a CEO in October 2010, released a position paper on the EC Communication for a European Infrastructure Package in December 2010, which included a plan for a phase 1 offshore grid, and issued several press releases commenting on policy developments. The FOSG has commenced work on a longer-term roadmap to be released in mid-2011.
- **Renewables Grid Initiative (RGI)**. Launched in January 2009, RGI is a forum bringing together for the first time transmission system operators (TSOs) and environmental NGOs to support grid expansion and grid integration of renewable electricity. Since its launch, RGI has worked to increase transparency in transmission operation by addressing technical questions which are perceived to be controversial especially by populations affected by grid expansion. RGI has made much progress in identifying and evaluating the concerns of stakeholders adding important shared knowledge among the partners on the need to address these concerns exhaustively. RGI is the only international forum

addressing public acceptance for grid expansion and working in identifying and implementing benefit sharing and compensation mechanisms, which could help to shorten timelines for permitting and building new grids, without cutting short the democratic rights of citizens or the efficacy of environmental impact assessments.

Middle East and North Africa (MENA)

- **The World Bank Clean Technology Fund (CTF) and CSP Investment Plan (IP)**.
- In December 2009, the CTF trust fund committee of the World Bank endorsed a Middle East and North Africa regional CSP IP. The IP covers a set of CSP projects in five MENA countries, all of them looking to supply local markets. They total 1.2 GW of generating capacity along with associated transmission capacity, requiring aggregate investment of US$5.6bn, with US$750m of this to come from the CTF. The first of these projects for the local market is planned to go into operation by 2014. The expressed hope of the World Bank is that this IP will stimulate further interest in CSP development in the Middle East and North Africa region (MENA), ultimately leading to the development of up to 5 GW in new capacity by 2020. At a project development and financing level, work has been progressing on the IP. To assess the benefits of the IP and the further development it might stimulate, the World Bank commissioned a study on the employment effects of CSP in the MENA region, which was completed in February 2011. The World Bank is in the process of commissioning a follow-up study, assessing the net economic benefits of the IP.

Renewables progress check

Regional Renewable Developments

Political leadership

The announcements by various initiatives across the region have helped to create a point of focus for industry and lobbying groups, and a possible vision for other stakeholders involved in the large-scale expansion of renewable electricity. This is an important change to the interest group landscape and could lead to future political leadership in market reform, support for the investment climate and harmonisation of planning and permitting rules. However, the lack of visible results to date, compared to the initial expectations that many of these high profile and visionary initiatives generated, could lead to scepticism about the actual feasibility of the grand visions that the individual initiatives support.

Investment climate

Were it not for the World Bank's CTF investments, the investment climate for renewable energy in North Africa would be very poor. Other investors have scaled back their plans following the 2009 financial crisis and, more recently, the political developments in a number of countries in the region. The IP projects, made possible by the CTF, have kept new project finance from drying up entirely and in doing so, are instrumental in maintaining forward momentum in North Africa.

Infrastructure

One of the concrete activities of the NSOGI is political cooperation to reduce the barriers to the planning and permitting of international offshore grid connections. To the extent that the NSOGI (and other initiatives like RGI, MSP, FOSG, DII and MEDGRID) do lead to concrete results, it in turn could lead to greater regulatory harmonisation and streamlining.

Conclusion

The various initiatives bring focus on key elements of the infrastructure needed to deliver a vision of 100% renewable electricity in Europe and North Africa by 2050, and may increase publicity for these. To date, however, the majority of the effort on these initiatives thas been expended on communications and outreach activities, rather than on concrete progress on the ground.

4.5 National renewable electricity developments

Ongoing changes to renewables feed-in tariffs continue to disrupt investments.

Developments over the past 12 months at national European level show significant progress in creating the enabling environment for a 100% renewable electricity supply by 2050, but the process remains fragile. In general, adjustments to renewable energy support schemes were in line with recent market changes: however, some of these were implemented in a disruptive way threatening investor confidence. What is also clear is that a long-term goal beyond 2020 is still missing. In the case of North Africa, while 2010 did not bring any significant developments in renewable electricity, the little progress that was made may be as important as it provides some proof-of-concept for certain technologies in the region.

National Renewable Energy Action Plans

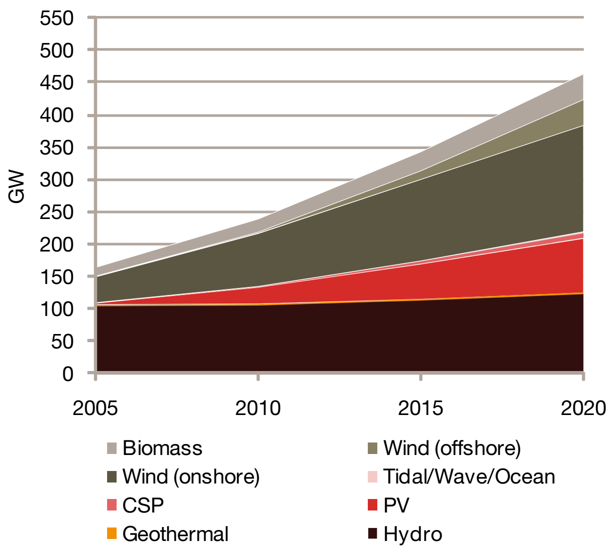
Article 4 of the European Renewable Energy Directive (2009/28/EC) requires each member state to submit a National Renewable Energy Action Plan (NREAP). The deadline for submitting the plans to the Commission was June 2010, but due to delays and various difficulties, not all countries managed this and the last country, Hungary, submitted its NREAP by late January 2011. The plans include the expected trajectories for the achievement of each country's 2020 targets, expected energy and power mixes and the measures by which the member states intend to achieve the target trajectories in the next 10 years.

What the energy plans add up to

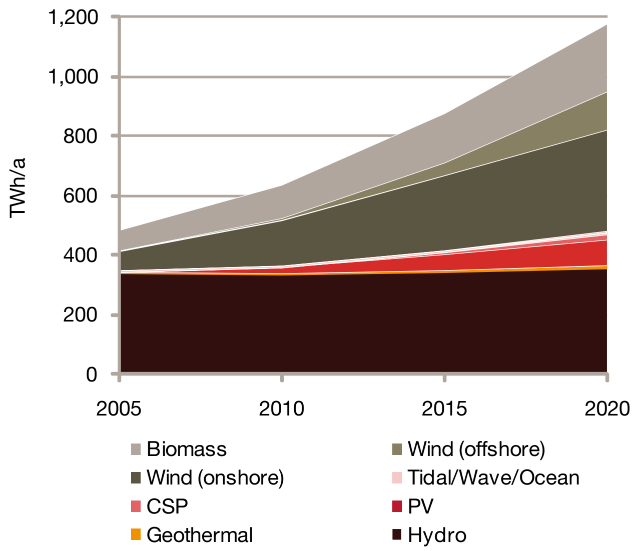
The NREAPs foresee an expansion of renewable electricity generation to about 36% of electricity consumption in 2020, which is about three times more than in 2005 (REN21, 2011). Most of the new capacity and the new generation is planned to be onshore wind power (33% of renewable capacity in 2020; 28% of renewable generation), offshore wind power (8% of renewable capacity; 11% of renewable generation), and biomass-based generation (8% of renewable capacity; 19% of generation), see Figure 6. Hydropower is projected to remain more or less constant in terms of its share of generation. Remarkable progress is expected to take place in PV: in the NREAPs, PV will increase from 2.2GW in 2005 to 84.3 GW in 2020, by which time it is projected to contribute almost 7% of European renewable generation.

Figure 6: Renewable capacity (GW) and electricity generation (TWh/a) as given in the NREAPs of the EU member states

Renewable energy capacity EU27



Renewable energy generation EU27



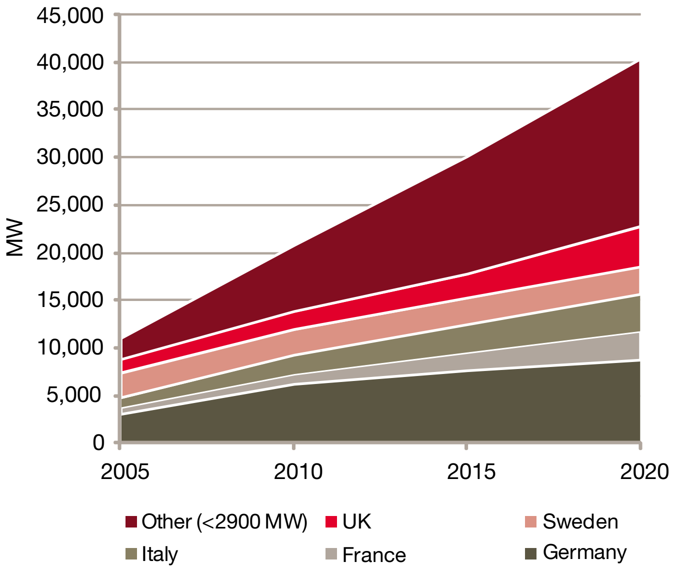
Source: Beurskens and Hekkenberg, 2011

The pattern and size of growth reflects each country's renewable resources and market size. Figures 7, 8 and 9 show the technology-specific capacity growth paths of the countries that are looking to install the most new renewable energy capacity by 2020. Overall, the expansion of the different technologies is quite diverse and growth is closely linked to the availability of domestic renewable resources and electricity market size. Capacities of onshore wind and biomass are expected to approximately double within the coming ten years, with installations spread broadly across the European countries, as shown in Figure 7.

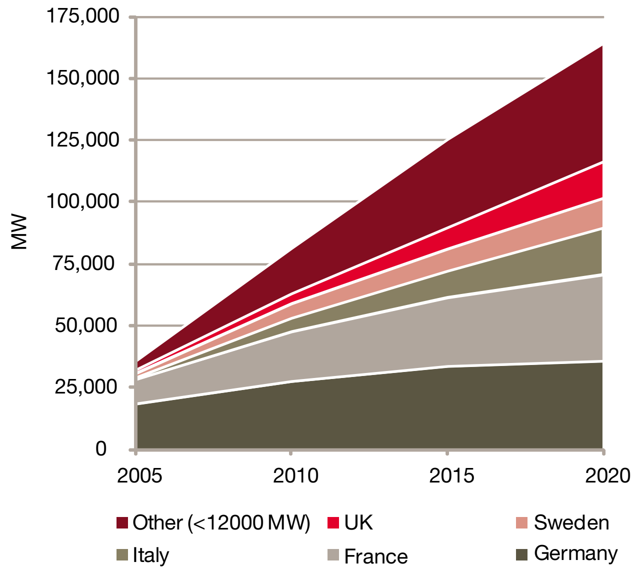
The largest share of overall biomass capacity is likely to be installed in Germany (8,825MW) and the UK (4,240 MW) by 2020. In the case of onshore wind capacity, Germany and Spain are still leading by 2020 with 43% of total onshore wind capacity, but considerable progress elsewhere, for instance, in Italy, UK, France and Greece, will lead to a higher diversification in the onshore wind sector.

Figure 7: Projected capacity growth of biomass-based and onshore wind capacity for the EU27 as presented in the NREAPs

Biomass-based capacity EU27



On shore wind capacity EU27

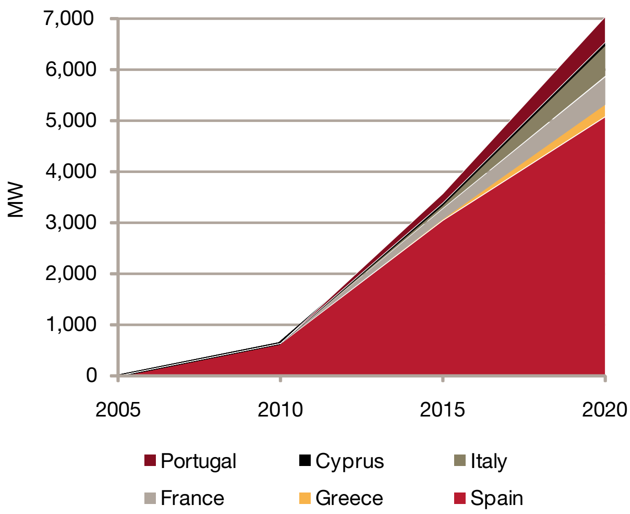


Source: Beurskens and Hekkenberg, 2011

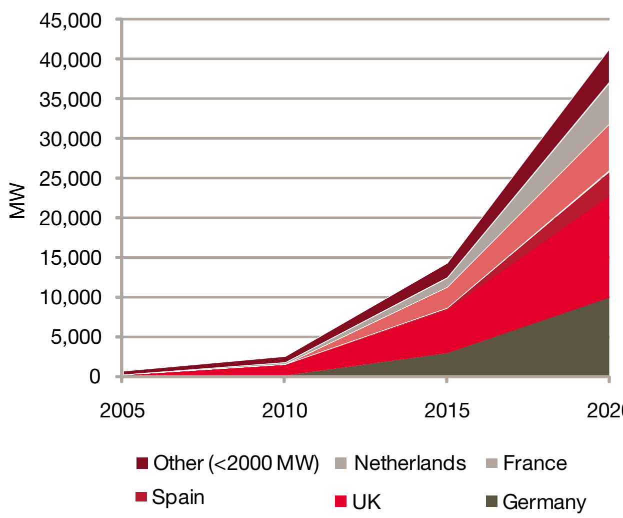
Figure 8 shows the expansion of the less mature renewable technologies, CSP and offshore wind, which is projected to be less evenly spread. More than 80% of the projected offshore wind capacity growth in the NREAPs takes place off the coasts of Germany, France, the Netherlands and the UK, whereas 70% of the planned CSP capacity growth takes place in Spain. Much of this is driven by resource distribution: the largest potentials for offshore wind power are found in the North Sea, and the best European CSP sites are found in Spain.

Figure 8: Projected capacity growth of CSP and offshore wind capacity for the EU27 as presented in the NREAPs

CSP capacity EU27

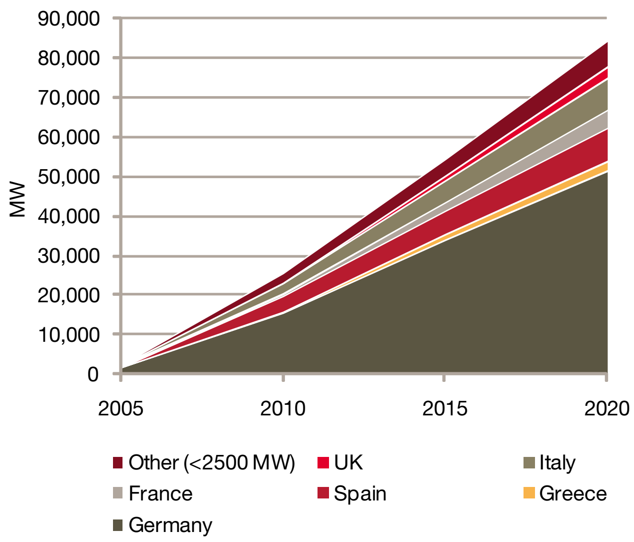


Off shore wind capacity EU27



Source: Beurskens and Hekkenberg, 2011

Figure 9: Projected capacity growth of solar PV for the EU27 as presented in the NREAPs



Source: Beurskens and Hekkenberg, 2011

Interestingly, in comparison to other technologies, expansion plans in PV capacity do not follow the distribution of natural resources: Figure 9 shows that more than half of the 84 GW of PV capacities are likely to be installed in Germany, where solar radiation is considerably lower than in other European countries, such as Spain, Italy and Greece.

Overall, the NREAPs envisage that the EU will reach a renewable energy share of 20.3% in 2020 (representing a 36-37% renewable electricity share), with Germany (+2.7 Mtoe) and Spain (+1.4 Mtoe) having the largest surpluses, and Italy (-1.2 Mtoe) having the largest import/transfer need.

Renewable electricity trading

Most member states expect to fulfil their renewable energy obligations on their own, without imports or statistical transfers of Guarantees of Origin (GOs). Only five countries (Belgium, Denmark, Italy, Luxembourg and Malta) do not expect to reach the 2020 targets using only domestic renewable energy. In addition, the UK does not expect to reach its 2012-2016 interim targets. These countries will need to make use of Articles 6-9 of the Renewables Directive and either buy GOs from another member state, or implement joint projects with another EU or non-EU country.

Most countries requiring GOs plan transfers from other EU countries. Only Italy foresees renewable electricity imports from non-EU countries: the Italian NREAP envisages imports of 4 TWh from Switzerland, 6 TWh from Montenegro and Balkan states connected to the Montenegrin network (projected start 2016), 3 TWh from Albania (projected start 2016), and 0.6 TWh from Tunisia (projected start in 2018) (Beurskens and Hekkenberg, 2011; European Commission, 2010n).

Expansion of the power grid: acceleration of authorisation and permitting procedures

Given the vast amount of new renewable electricity that will be connected to the grid by 2020, substantial refurbishment, extension and EU-wide integration of national power grids is urgently needed. This challenge is only partially addressed in most NREAPs. A number of new interconnectors and new transmission lines of varying capacity are planned (e.g. Austria, Belgium, Spain, France, UK, Ireland) to support the growth in renewable energy and in the trade of electricity in Europe (see also section 4.3).

In order to accelerate electricity infrastructure development, most NREAPs also aim to improve and simplify authorisation and permitting procedures. The length of licensing and authorisation procedures differs greatly across countries, ranging from several months to up to 16 years. On average, approval time in most countries is about 5-10 years. To meet the urgent need for expansion of their electricity grid infrastructure, most NREAPs refer to measures to simplify authorisation procedures and regulation of renewable energy installations and the associated transmission and distribution infrastructure network.

Ideas to reduce permitting delays range from one-stop-shop-systems for authorisation, certifying and licensing of renewables (e.g. Belgium, Malta, Austria), a “one-in-one-out” approach to improve the way in which regulation is managed (UK), to substantial amendments to legislation (e.g. Czech Republic, Greece). Almost all NREAPs recognise that permitting and authorisation procedures related to new electricity infrastructure is a major obstacle to the further expansion of renewables. However, although some countries (e.g. Italy, Ireland and Greece) declare the construction of electric power lines to be of “primary national interest”, there is much scepticism about what real progress will be made in the next few years, as most NREAPs are much too vague on how to really shorten authorisation and permitting procedures.

Support for flexibility options (storage, demand side management (DSM) and virtual power plants (VPP))

While awareness about the need for increased flexibility is rising, no additional support schemes to incentivise flexibility options have been implemented so far in the EU. A large number of reports from research institutions, non-governmental organisations (NGOs) and political institutions stress the importance of flexibility solutions, such as storage technologies or 'virtual power plants', in order to make up for the intermittent nature of renewable generation (ECF, 2010; European Commission, 2010l; McKinsey, 2010). NREAPs reveal that in some countries, the need to incentivise the provision of such flexibility has been recognised and brought into the political arena.

In Germany, France and UK, where long-term plans up to 2050 have been developed, governments intend to adapt the market design towards the integration of a large amount of intermittent renewable generation (cf. Pöyry, 2011; R2B and Consentec, 2010). Elsewhere, the NREAPs of Spain, Ireland, Greece, and Italy also point (implicitly rather than explicitly), to the need to support the faster integration of renewable energy by adjusting the current design of the power market.

Renewable energy specific support scheme changes

A range of decisions concerning the deployment of renewable electricity have been taken in the past 12 months by European and North African countries. It has not been possible to provide a comprehensive synopsis of all these changes; instead we outline below some of the more significant support scheme changes.

Solar photovoltaic (PV) support

The most significant support scheme reform trend in Europe during 2010 was PV subsidy cutbacks (e.g. in Germany, Spain, Czech Republic, France, Italy), although in some countries PV support was increased (e.g. Turkey, Romania, Greece).

- Germany – The feed-in-tariff (FIT) law was amended on 5th July 2010, causing a decline in PV FITs of 8-13% by 1st July and another of 3% by 1st October 2010. A further PV FIT reduction of 13% came into effect on 1st January 2011. In order to avoid a yearly cap on PV electricity production, the solar industry and the government agreed on more flexible tariff adjustments from July 2011 onwards. Depending on the level of newly installed capacity between March and May, another reduction of the FIT of up to 15% may take place.
- Spain – After the introduction of Royal Decree (RD) 1578/2008, which put a cap of 500 MW/year on solar PV development and tariff reductions of up to 30% in 2009, the national government introduced RD 1565/2010 which cut the PV premium by another 5% to 45%, depending on the size of the PV facility. In addition, the RD-L 14/2010 brought a temporary (2011-2013) retroactive tariff reduction for existing solar plants (installed under the energy plan 2005-2010)[5] (MITyC, 2010; Navas, 2010; Mallet, 2010; ASIF, 2010).
- Czech Republic – Aside from the approval of a new law that levies a tax of 26% on revenues from PV generation (2011-2013) as well as a 32% tax on carbon credits awarded to solar companies (2011-2012), the national Energy Regulation Office announced that it would cut PV FITs by 50% for PV systems over 100 kW during the course of 2011 (Bauerova, 2010; Dorda and Stuart, 2010). The new solar tax retroactively applies to all ground-mounted PV plants built in 2009-2010 that were guaranteed to receive a fixed FIT in the course of the next 20 years (Hughes, 2010).
- France – The French Ministry of the Environment and Energy modified the PV FIT scheme three times in 2010. The changes made in August 2010 apply in particular to industrial large-scale ground and roof mounted system above 30 m2, reducing their tariff rates on average by 12% from September 2010 onwards (Ernst & Young, 2010c).
- UK – An early cut-back of FIT payments for solar installations above 50KW and standalone installations is the subject of current consultation. The government cites emerging evidence suggesting that PV system

[5] Tariff cut-backs come into play when a number of working hours is surpassed (1,250 hours/year for fixed plants; 1,644 hours/year for plants with trackers (Navas, 2010)

costs are now approximately 30% lower than assumed in the original FITs modelling undertaken before scheme launch. Nonetheless, the proposals go further by significantly reducing the FIT payment for larger projects to a point where the business case for the developing these project is no longer attractive to investors.

- Italy – The national FIT scheme has been changed twice in 2010, leading primarily to modest reductions of PV tariffs. Project developers who connect their solar systems to the grid before July 2011 will still benefit from the generous tariffs of Italy's Conto d'energia II, guaranteeing an internal rate of return (IRR) of 15%-18% (Wicht, 2011). A new tariff structure entered into force in January 2011 and foresees gradual tariff reductions every four months in 2011. Tariffs for open space systems (< 5 MW) are to be cut by 9% on average during the first four months of 2011, whereas the tariffs for systems larger than 5 MW will be decreased by 14%. Rooftop system tariffs are reduced by between 4.8% and 13.3%, depending on the size of the system (Solarserver, 2010).
- Romania – Romania's national support scheme for PV was changed twice in order to improve the investment environment as the country has a large solar PV resource but still low generation capacity (500 MW by 2010) (Lee, 2010). Initially, all renewable energy technologies were awarded one tradable green certificate (TGC) per MWh. However, as this did not set adequate investment incentives, the renewable energy law 220/2008 was introduced, awarding renewables with 2-4 TGCs/MWh depending on which technology is deployed. Law 220/2008 was then revised partially by law 139/2010 which offers now, for instance, 6 TGCs/MWh to PV electricity production (Ernst & Young, 2010c).
- Turkey – The Turkish government improved the level of support to renewables in order to overcome the structural weakness of the former energy law. Besides changes to other renewable power tariffs, the PV tariff level was more than doubled, increasing from US$c5.5/kWh to US$c13.3/kWh. In addition to the FIT, an extra payment of US$c 6.7/kWh and US$c9.2/kWh is given to PV and CSP plants that are manufactured in Turkey (Lipsky, 2011).
- Portugal – Licenses for solar projects with a combined capacity of 150M W were tendered for a minimum price of €400,000; earliest results revealed that highest bid price was about €1m/MW, which means good news for the solar sector (Ernst & Young, 2011).

Concentrating solar power (CSP) support

The support for CSP has undergone similar changes as PV, with decreased support in some countries (e.g. Spain) and increased support in others (e.g. Greece).

- Spain – The experience of rapidly increasing costs in the PV sector caused public decision-makers to cap the number of working hours of CSP plants and make new plants subject to a premium-tariff moratorium during their first year of operation (Ernst & Young, 2010b; c).
- Greece – The new energy law foresees higher tariffs than in the old FIT, which was already among the highest in Europe. The Greek CSP FIT increased from an average of 257 €/MWh to 285 €/MWh, guaranteed for 20 years and including an inflation adjustment clause (Chhabara, 2010).

Wind power support

Although PV overtook wind in terms of generation capacity installed in 2010, investment in wind energy remained at a high level, amounting to €12.7bn in Europe in 2010 (EWEA, 2011). Public support for (off- and onshore) wind energy increased or remained stable in most countries (e.g. Germany, France, UK, Romania, Greece) and decreased in Spain over the course of the last 12 month.

- Spain – Due to public budget consolidation pressure, the Spanish wind energy sector was also affected by FIT reductions, an average of about 35% in benchmark premium until 2013. Like the solar sector, the working hours of wind power plants are limited. Beyond this limit, the installation does not receive FIT support (Ernst & Young, 2010b; c; MITyC, 2010).
- Ireland – A new FIT programme, the REFIT II, which is currently being negotiated between the EU Commission and the Irish Department of Communications, Energy and Natural Resources, suggests a new tariff for offshore wind (€120/MWh).
- Germany – While the FITs for on- and offshore wind were kept mainly unchanged in Germany during 2010, the federal government pledged to invest €5bn via loans from Kreditanstalt für Wiederaufbau (KfW) in order to boost investment, in particular in offshore wind energy parks. In addition to this, a temporary increase of the FIT has been announced by the German Ministry of Environment (Ernst & Young, 2011).
- France - Due to France's goal to boost, in particular, the offshore wind energy sector, no significant changes were made to wind FITs. However, the new FITs for wind power apply only to facilities with at

least five turbines (Ernst & Young, 2010b). The French government also intends to announce the issue of a tender worth up to € 10 bn for 2-3 GW from offshore wind farms soon (Patel, 2011; Williams, 2010).

- UK – Drawing on a new FIT scheme with stable support for wind energy, the British government also decided to encourage investment in high-voltage transmission links for up to 50GW of new offshore wind generation. It announced a tender for nine offshore transmission links worth £1.1bn in early 2010 by guaranteeing 20 years of regulated revenue for investors. (Newnet, 2010). The first successful tender, worth €835m (£700m) for the connection of 2GW of offshore wind power electricity from seven offshore wind farms, ended in August 2010 (Offshorewind.biz, 2010).
- Romania – In order to boost the Romanian wind energy market, the government's renewable energy law foresees that wind energy generators will receive 2 TGCs/MWh until 2017, and 1 TGC from 2018 onwards.
- Turkey – New FIT conditions for wind power have improved on the previous flat rate tariff. Their impact remains to be seen. Some investors remain sceptical, because of unfavourable local wind conditions and increased risk due to switching from Euro to Dollar in the FIT base rate currency (Ernst & Young, 2011).
- Greece – Like CSP, the FIT for development of wind power plants has been improved. With favourable wind conditions in many parts of Greece, the expectation is for further substantial investments in wind power generation. However, crucial questions remain about whether these generous FITs can really be sustained at such high levels with austerity measures increasingly affecting public spending.

Biomass power support

No clear trend regarding support scheme changes for electricity generation from biomass was identified. While it has been tightened in some countries (e.g. Czech Republic), conditions have improved in other countries (e.g. Portugal, France, Romania).

- Czech Republic – Due to the country's large biomass potential, biomass FITs were adapted: under the new renewable law, only those biomass facilities that produce heat and electricity will be supported in future (Contiguglia, 2010).
- Portugal – An agreement for higher biomass tariffs was reached at the end of 2010 (Ernst & Young, 2011).
- France – Support for biomass has increased since early 2010. FITs for installations with 5-12 MW have doubled, setting a price of €0.125/kWh (Ernst & Young, 2010a).
- Romania – Large biomass resources are mainly used for heating and not for electricity generation, but Law 220 offers biomass power 3 TGCs/MWh, which is a considerable increase and is expected to trigger some new investment.
- Portugal – Despite public budget consolidation pressure, an agreement for higher biomass tariffs was reached at the end of 2010 (Ernst & Young, 2011).

Europe roundup – other national level changes affecting renewables

As well as the technology specific support scheme adjustments outlined in the main text, a number of other encouraging developments also took place. These included changes to national energy legislation and the launching of a number of new renewables investment programmes.

- France – The new French national investment programme promises to further support the development of marine, geothermal, CCS, solar and biomass projects by subsidies (€450m) and loans (€900m) until 2014. France has traditionally focused on more mature low carbon technologies, such as nuclear power and onshore wind. The new investment programme clearly marks a paradigm change as it seeks to support immature renewables technologies at the other end of the cost spectrum. The French government aims to stimulate €2bn of private funding through the programme (Envido, 2010).
- UK – The UK government will publish in summer 2011 a White Paper outlining a number of significant reforms to the country's electricity market. These are expected to include the replacement of the current Renewable Obligation Certificate scheme with a "contract-for-difference" FIT program and the introduction of minimum carbon prices. These, and other, reforms are expected to be introduced from 2013. Meanwhile, and despite record cutbacks in public spending, the government announced in 2010 development funding of £2.2bn (€2.5bn) for CCS, the Green Investment Bank and offshore wind-related projects. In the meantime, the government is bringing forward its 2012 review of ROC bandings to summer 2011 in an effort to reduce investor uncertainty (HM Treasury, 2010).
- Italy – After many controversial debates, an amendment of Article 45 of the New Financial Law (NFL) has been approved which reconstituted renewable energy investment security (Bloomberg, 2010).
- Greece – A new energy law that reduces the number of authorities involved in the approval process has been introduced. It is expected to reduce approval time for investment from an average of three years to about eight months. The time to get a permit from the regulator is expected to be shortened from twelve to two months (Ernst & Young, 2010b; Weeks, 2010).
- Turkey – The Turkish government launched a new energy law. However, restrictions in licensing processes and comparatively short-term price guarantees for only 7-10 years have left some investors still sceptical about the impact the new law will have on the investor community and renewables industry (REF, 2011).
- Portugal – With the launch of the new National Energy Strategy (ENE) in spring 2010, the Portuguese government renewed its commitment to stay on a renewables pathway (e.g., by increasing the share of total electricity from RES up to 60% by 2020). PV and CSP are at the forefront of the new strategy. The government has also worked towards facilitating licensing process for small-scale hydro power plants (Ernst & Young, 2011).

North Africa roundup – other national level changes affecting renewables

- Morocco – Both wind and solar projects are under active consideration. Morocco is currently the only North African country to have a grid interconnection with Europe. The Moroccan Agency for Solar Energy has helped mobilise investment. The first plant under the Moroccan Solar Energy Plan, the 500MW Ouarzazate plant, was launched with a call and bidders' pre-qualification in July 2010. A public-private partnership is due to be commissioned to undertake the project with an official start scheduled for 2014-2015 (World bank, 2010).
- Algeria – A new national energy strategy has been launched in order to increase renewable energy capacity by up to 22,000MW by 2030, doubling the current generating capacity and creating 100 000 new local jobs. In order to push investment in renewable energy production, the national government is looking to provide subsides worth €119m. A further €19.8m will be provided for R&D. A number of preferential loans worth €495m, to enable the building of experimental units, have also been made available. A directorate for new energy was created and plans to allocate 1% of the tax on hydrocarbons to the development of new energies have also been implemented (Ouali, 2011).
- Libya – In order to promote the development of renewable energy, the REAOL (Renewable Energy Authority of Libya) has been established. It has a goal to reach 1,000 MW of installed renewables by 2015, to have 10% of the energy supply coming from renewable energy resources by 2020, 25% by 2025, and 30% by 2030.
- Egypt – The government proposed a New Electricity Act in 2010 aiming to encourage private investment in renewable energy technologies via a FIT-scheme similar to the German one. In parallel, a World Bank loan worth €194m to build a solar plant in the south of Egypt (Ernst & Young, 2010c) has also recently been announced.

Renewables progress check

National renewable electricity developments

Political Leadership

In terms of setting clear and credible signs towards a renewable power sector, the NREAPs of European countries point in the right direction. The development of these binding, country-specific trajectories is an important step forward towards achieving the 2020 renewable targets in Europe. However very few member states have embedded their 2020-NREAP into a longer-term perspective. Only five NREAPs mention 2050 at all[6].

An aggregated analysis of the NREAPs shows that Europe will significantly expand its renewable electricity capacity. However, the policy-driven nature of the PV expansion raises concerns about cost-efficiency: More than 60% of the installed PV capacity in 2020 is expected in the not so sunny Germany rather than in the much sunnier regions in southern Europe. This may undermine public acceptance of the FIT schemes and the scaling up of other renewable power technologies. In North Africa, Algeria's new energy strategy also shows a political willingness to pave the way for a more sustainable energy supply.

Market structure

Recent national developments do not present a clear picture regarding the market dimension. There are few indicators that point towards greater regional market integration and it remains to be seen how the NREAP trajectories will actually contribute to a more unified European power market, or how market integration will contribute to the NREAP targets. Given the current projections of the NREAPs and the large amounts of renewable electricity entering power markets in the coming years, it is likely that this will have a significant impact on the integration of power markets across Europe, but this is difficult to assess at this time.

Up until now, the national perspective has prevailed. This is likely to make the path to reaching the 20% target less economically efficient than if considered from a more effient, Europe-wide perspective.

[6] Some countries, like Germany, UK and the Netherlands, make a reference in their NREAPs to other longer-term national energy plans, whereas other countries, like Sweden and France, make a reference to a general "vision" for 2050 (a completely carbon-neutral society (Sweden); to reduce greenhouse gas emissions by a factor four (France)).

National renewable electricity developments *(cont'd)*

While EU member states are planning to build new interconnectors and international transmission lines which would further help market integration, most of these are still in the planning stage. It is also not clear how long it will take to achieve further power market integration across Europe. Some countries have recognised the need for the adaptation of market design to integrate intermittent renewable electricity. Whilst this is an important first step, no concrete measures have been implemented yet.

Investment climate

In terms of investment, it is still unclear what effects national electricity developments in the last 12 months have had on investment flows. While NREAPs show investors the general direction of renewable electricity policy, the lack of a clear, long-term vision may not provide the level of confidence needed by investors and project developers.

Existing national support schemes need to be responsive to market changes, but changes need to be necessary and reasonable, supported by a rational government strategy, and as far as possible, be anticipated by the investor community. The ways in which recent modifications to governing legislation were carried out ranged from lengthy discussions and compromises with business (e.g. Germany) to retroactively applied tariff cut-backs (e.g. Spain, Czech Republic). The latter approach is of major concern to investors, affecting confidence and likely to result in new, urgently needed funding being delayed.

Planning and permitting for new infrastructure

National level developments show no clear direction with regard to infrastructure planning and regulation. The NREAPs underline the urgent need to make faster progress in the areas of electricity infrastructure development and also regulatory harmonisation and streamlining. They are compatible with the suggestions of the Commission (see section 4.3). Nevertheless, it remains rather unclear whether innovative and more efficient regulations will actually be implemented, or what effects they will have. Only Greece has successfully removed some red tape in the last 12 months, significantly shortening its permitting process.

Technological progress

National developments have had a positive effect on technological progress. The continued market support for renewable electricity has increased the European installed capacity (see section 4.6) which in turn has helped to push technologies further along the learning curve. This is particularly the case for the solar PV sector and, even though most NREAPs do not currently provide a vision beyond 2020, this trend looks set continue. Binding national renewables trajectories should encourage faster technological improvements in renewable energy technologiesthan in more mature technologies, such as nuclear, where marginal utility gains are harder to obtain. Over time, as government actions remain in line with published plans, the trajectories may also begin to offer some medium to long-term clarity of intention for business and investors. This is urgently needed to allow the development of the necessary supply chains to support the delivery of European targets for 2020 and beyond.

Conclusion

The cumulative outcome of the NREAPS is estimated to be an expansion in renewable electricity generation to about 36% of electricity consumption in 2020. While this represents significant progress, set against this is the uncertainty that has been created by the way some recent revisions to national subsidy arrangements have been handled. Clearly public finances have been under pressure in Europe in recent times; however, if politicians make a habit of changing the rules and reducing incentives, this is likely to undermine the foundations for longer-term growth in renewables.

4.6 Capacity expansions

A total of 23 GW additional European renewable power generation capacity was installed in 2010 (see Figure 10)(EWEA, 2011). Despite the economic downturn, this was more than any previous year. It represents an impressive growth rate of 30% against the previous year, continuing the yearly growth rates observed in 2009 and 2008. On an aggregate basis, Europe reached 18% renewable electricity in 2010, which means that it failed the non-binding renewable electricity target for 2010 in the 2001 renewables directive. Nevertheless it is well on track to reach or even surpass the 2015 renewable energy targets laid out in the NREAPs (European Commission, 2011a). North Africa saw a continued expansion of renewable capacities, although at the much lower level of 0.4 GW.

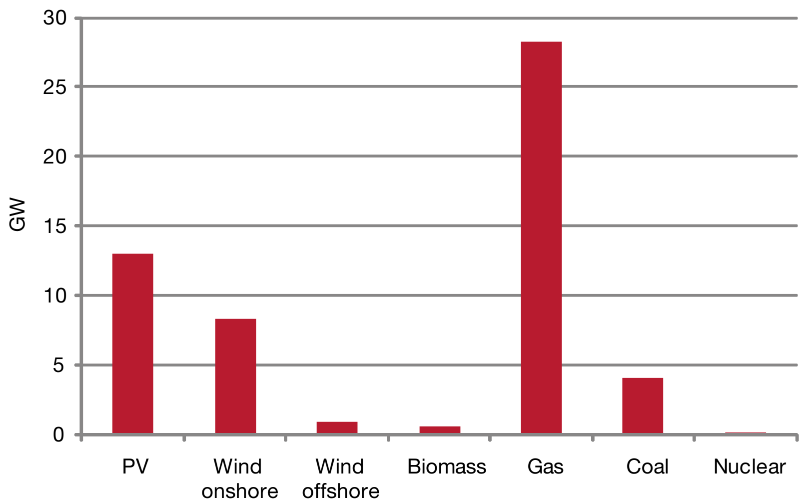
At the same time, 2010 was an exceptional year for the expansion of fossil fuel generation capacity, with 28 GW of new gas power capacity, thus reducing the share of new renewable capacity of total new build capacity to 41%. Coal power plants with a total of 4 GW were added in 2010 but a total of 67 GW of projects have currently been abandoned or delayed. In the absence of widespread deployment of carbon capture and storage, this shift from coal to natural gas will be positive from a climate perspective and gas may be an important temporary stepping stone to a 100% renewable power system.

The development of Europe's electricity grid has made some real but slow progress in the last year. Much of the progress has been with subsea cables, whilst onshore grid expansions affecting inhabited areas which are urgently needed, are rare.

Renewable power generation capacity

PV dominated new construction in 2010, with almost 13 GW installed during the year (EPIA, 2011), almost three times as much as in 2009. This enormous growth almost doubled the total installed capacity in Europe, which was 15 GW at the end of 2009 (EPIA, 2011). The largest share of new PV capacity was installed in Germany (7 GW), followed by Italy (3 GW), Czech Republic (1.3 GW), France (0.5 GW) and Spain (0.4 GW) (EPIA, 2010). The price of large PV installations fell to 2.5 EUR/Wp for large systems (EPIA, 2010). This appears to support a continued downward trend in the cost of PV. Grid parity is now likely to be reached soon in specific geographies at specific times of the year. However, PV remains far from cost competitive with conventional fuels and wind power in Europe.

Figure 10: New installed capacity for different power technologies in 2010



Source: EWEA, 2011

The new installation of onshore wind power plants slowed in 2010, with a total of 8.4 GW installed (EWEA, 2011). This is a reduction of 15% compared to the 9.9 GW installed in 2009, reflecting the impact of the financial crisis and, probably, some saturation in the big markets. Despite this overall slowdown of growth, an important geographical shift took place. Expansion in countries with large existing onshore wind capacities slowed down, to an average of 10% capacity increase per year[7]. However, new players in Eastern Europe have entered the picture. A total of 1.1 GW of onshore wind was installed in Bulgaria, Hungary, Poland and Romania, representing a 100% increase in installed capacity in these countries in 2010 alone.

The price for onshore wind turbines has continued to fall to an average of 980 €/kWp, which is 7% below prices paid in 2009 and 19% below the temporarily high prices paid in 2007-2008[8] (Bloomberg, 2011). This continues the trend of bringing the levelised cost of electricity of onshore wind power within a competitive range of that of fossil fuel power – with several projects in high resource areas already being competitive from a purely financial point of view (Bloomberg, 2011).

With a total of 0.9 GW new offshore wind capacity, this new technology contributed 10% of the total wind power installations added in 2010. Together with the expansion of 0.6 GW in 2009, the last two years have doubled the total capacity of offshore wind to almost 3 GW. This has been a major step forward. Offshore wind has now started moving away from pilot projects towards mainstream electricity generation. The strong expansion prospects, especially in the UK, have led to considerable investments into supply chain infrastructure, such as the ~€100m investment by Siemens into a production factory for offshore wind turbines in the UK (Siemens, 2010). In Yorkshire alone, it has been reported that the regional development agency expects a total of 10,000 jobs to be created (Offshorewind.biz, 2011).

Estimates of the total cost for building, connecting and operating offshore wind farms remain difficult, given the early stage of the technologies involved and the lack of scale effects. While it will still require several years to reach cost competitiveness with fossil fuel generation, the immense effects of technological learning as well as scale effects inherent in this technology (such as grid networks connecting several wind farms, shared construction and maintenance ships, etc.) are likely to drive down cost significantly within the next few years provided the expansion programmes continue as planned.

Other renewable technologies contribute another 1.4 GW and continue to play a small but important role in new installations. Biomass power capacity in Europe was increased by 0.6 GW. Solar CSP saw an increase by 0.4 GW. While CSP continues to play only a minor role in Europe's power mix, this expansion in 2010 implies a continuation of the move from a pilot-stage technology towards a mainstream generation technology. In Spain alone, a total of 0.9 GW is currently under construction and another 0.8 GW has been pre-assigned (Protermo, 2011). Besides these, large hydro power capacity was increased by 0.2 GW, waste-to-electricity by 0.15 GW and small hydro power and geothermal power by 25 MW each (EWEA, 2011).

In North Africa, a limited expansion of renewable generation capacities took place in 2010. A total of 210 MW of onshore wind capacity was installed, of this 120 MW in Egypt, 60 MW in Tunisia and 30 MW in Morocco. This increased total installed wind capacity by about 15% (GWEC, 2011). Other important developments were the grid connection of the first CSP stations in North Africa, in Kuraymat, Egypt, and Ain Beni Mathar, Morocco. These integrated solar combined cycle (ISCC) hybrid plants have total capacities of 150 MW and 470 MW respectively but only 20 MW of each is solar capacity (the rest is powered by fossil fuels) – considerably smaller than the solar-only projects developed in Spain (Solar Millennium, 2010; World bank, 2010).

[7] This applies to the group of countries with more than 3.5 GW installed onshore wind capacity, namely Denmark, France, Germany, Italy, Portugal, Spain and the UK.

[8] Average global prices for turbines, excluding construction and connection.

Conventional power capacity expansion

There was a major increase in natural gas capacity in 2010, with 28 GW of new capacity. From an energy system perspective, this is a positive development which should encourage the scaling of renewable investment. In contrast to coal and nuclear plants, natural gas plants are technically well equipped to complement the intermittent nature of wind and solar power generation. A gas plant built today is likely to be decommissioned by 2040 and so does not create a non-renewable lock-in. Even more importantly, it may be able to provide the cheapest option for much needed backup capacity in the years after its scheduled retirement (McKinsey, 2010).

What may perhaps detract from longer term plans for a renewable powered Europe are existing and pending plans to develop further coal and nuclear power plants. Question marks hang over some of the nuclear plans following the events in Japan in early 2011. It is important to note that coal and nuclear are vastly different in terms of their levels of carbon emissions. However, they are investments that will last for at least the next 40 years and are both only economical when run at consistently high capacity factors.While nuclear does represent a step away from high carbon emissions, it is potentially a step away from, rather than towards, a system reliant on renewable generation by 2050.

A total of 4GW of coal power capacity was installed in Europe in 2010. At the same time, only 1.5 GW have been decommissioned, making 2010 the first year since 1998 when net capacity has been added in Europe (EWEA, 2011). Another 12 GW of new coal power plants are under construction and 28 GW are in various stages of planning. Besides these developments, subsidies for the European coal mining industry were extended. A German-led group of coal-mining countries managed to postpone the phase out of public subsidies to loss-making European coal mines until 2018 (Reuters, 2010). However, a total of 24 GW of coal power plant projects have been abandoned, and another 47 GW coal power that have been delayed or have an unclear project status (see Figure 11). Overall, these developments represent real progress towards the political goal of substantial and sustained greenhouse gas emission reduction in Europe.

The most important developments in the last year may have been those regarding nuclear power. While the actual capacity expansions (capacity increases in existing reactors) were very small and the net nuclear capacity in Europe decreased slightly in 2010 (EWEA, 2011), existing construction projects continued, despite significant time delays and cost overruns. Construction continued on three[9] nuclear power plants with a total capacity of 4 GW in 2010 - Finland (Olkilouto 3, 1.6 GW), France (Flamanville 3, 1.6 GW) and Slovakia (Mochovce 3 and 4, 0.4 GW each).

A number of countries also moved forward on plans for new nuclear capacity. In the UK, the decision to build new nuclear plants was confirmed and the planning process for a total of 6.4 GW of new nuclear capacity by 2019 moved ahead (WNA, 2011b), as did Finland's plans for a fourth reactor at Olkiluoto. In Poland, policy makers have reconfirmed their support for a nuclear programme and have signed cooperation agreements with equipment suppliers (WNA, 2011d). In Estonia, the site selection for a nuclear plant was finalised and public information campaigns started (WNA, 2011a).

On top of this, a large number of European countries have announced more or less realistic and concrete plans to expand their nuclear capacities – namely Czech Republic, Finland, France, Italy, Lithuania, Romania, Slovenia and Sweden (WNA, 2011c; d). The 12 GW of new nuclear capacity that is under construction or in planning or development today would make up approximately 2% of European electricity consumption in 2050[10]. It remains to be seen just what long-term impact the Fukushima nuclear emergency in Japan will have on nuclear power expansion plans in Europe (See section 4.9).

With the construction of new nuclear plants being subject to long construction and planning timescales, the amount of new capacity being introduced will not be enough to compensate for the decommissioning of old plants in the coming years. As a result, the total installed nuclear capacity is likely to decrease from today's level.

Grid capacity

Developing the required electricity transmission network in Europe will be a major challenge. The last 12 months has seen some slow progress with this investment challenge. Most importantly, a new 1 GW cable linking the UK to the Netherlands ("Britned") became operational and various projects continue to make progress. Most current plans for construction are subsea cables, which are less vulnerable to public opposition than

[9] The Bulgarian Belene NPP is often mentioned as another European reactor under construction. However, this reactor has been "under construction" since 1987, and construction was stopped following the breakdown of the socialist regime in 1990. In June 2010, the project was officially abandoned (Illev, 2010), and is therefore not considered as "under construction" here. Nonetheless, the project may still be continued - a memorandum of understanding for the realisation of the project was recently signed between the Bulgarian state-owned utility NEK (51%) and Rosatom (47%), Fortum and Altran (1% each) (Sofia Echo, 2010).

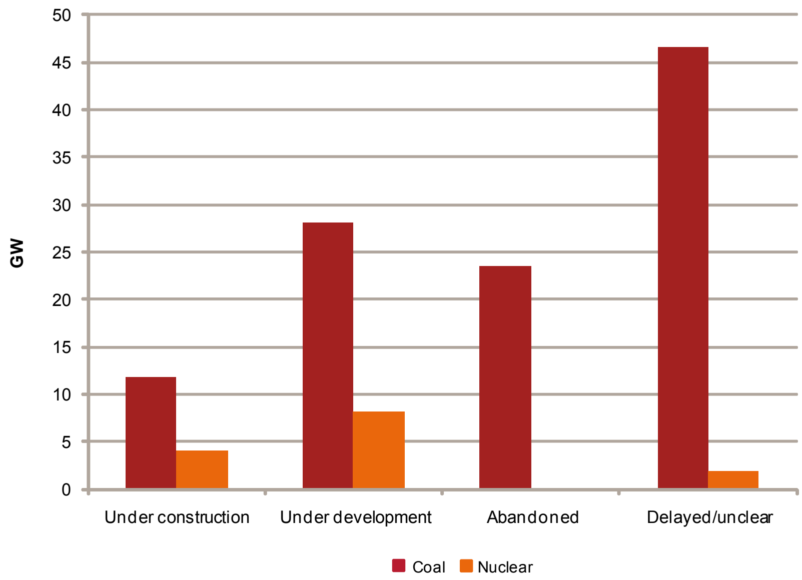
onshore projects. Onshore, 2010 saw only insignificant transmission capacity increases.

The Britned cable is a 1 GW HVDC subsea cable which will increase the net transfer capacity between the UK and continental Europe by 50% to 3 GW (BritNed, 2011). In view of the ambitious targets for offshore wind in the UK, this link to continental Europe is an important first step to enhance stability and power interchange within the European electricity system.

The StoreBaelt cable is another recent addition to Europe's transmission network. Since its inauguration in September 2010 it has linked the power markets in eastern and western areas of Denmark with a 0.6 GW high voltage direct current (HVDC) subsea cable (Energinet.dk, 2010b). Progress was also made in a number of ongoing projects in Northern Europe and the Mediterranean. In northern Europe, two HVDC subsea cables are currently under construction: the East-West Connector between the UK and Ireland (0.5 GW) and the Fenno-Skan II between Sweden and Finland (0.8 GW) (ENTSO-E, 2010c). Planning progressed for numerous projects, among them the Skagerrak 4 cable (Norway-Denmark) (Statnett, 2011), the Cobra cable (Denmark-Netherlands) (TenneT, 2010a) and the NordBalt cable (Sweden-Lithuania) (SVK, 2010).

In the Mediterranean, a number of subsea HVDC cables are under construction which will improve the linkage of Sicily, Sardinia and Mallorca to continental Europe (ENTSO-E, 2010c). These will also facilitate the future build-up of connections to Northern Africa. Various other projects linking

Figure 11: Coal and nuclear power capacity under construction, in planning/under development, abandoned during planning/construction, and capacity which is delayed or has an unclear construction/planning status, as of September 2010



Source: Own data

Europe and North Africa are under development, albeit at an early stage.

To give a sense of scale, the current expansion projects in Europe need to be contrasted with developments in the rest of the world. The four largest European grid expansion projects recently completed or currently under construction (Britned, StoreBaelt, East-West Connector and Fenno-Skan II) add to a total of less than 1000 km with 2.7 GW transmission capacity. At the same time in China, some 3500 km with more than 5 GW transmission capacity were scheduled to start operation in the last year (Taylor, 2008).

[10] Assuming a total of 4 900 TWh energy consumption in Europe in 2050 (ECF, 2010) and 7 800 full load hours per year for a nuclear plant.

Renewables progress check

Capacity expansions

Political leadership

The capacity expansions in the last 12 months have contributed to the political momentum towards a 100% renewable electricity system. The continued 30% growth in new renewable installations, and the move from pilot-scale to mainstream technologies in offshore wind and CSP, has helped establish the renewable energy industry as a stable pillar of economic activity in Europe. This is likely to strengthen the position of the proponents of a renewable energy industry in the political arena, as the contribution of the industry to "green growth" and "green jobs" is more visible.

Market structure

The mix of non-renewable capacity that was built in the last 12 months has contributed positively to the market changes needed for renewables. The addition of 28 GW of natural gas capacity is likely to have a positive long-term effect on Europe's wholesale power market – its flexibility is likely to reduce occurrence of market distortions such as extreme negative prices, and its ability to provide cheap backup and reserve capacity is likely to reduce system cost in the long term.

Investment climate

The increased linking of regional power markets, such as the 1 GW link between UK and Netherlands, is an important step towards better integration of markets. It sends another strong signal that system integration of renewable technologies is a challenge that is being tackled and will not be a limit to investments into renewable energy in the future.

For less mature technologies, such as offshore wind and CSP, the move from pilot-level plants to mainstream energy production is an important step for investor sentiment. Increasing experience in the operation of large capacities will reduce the perceived investment risk, reducing the capital cost for new projects. The pilot-scale ISCC power plants in Egypt and Morocco are important steps, as they demonstrate the feasibility of CSP in North Africa.

Technological progress

For investments into established technologies (PV and onshore wind), the reduction in cost of installations and the ongoing expansion of the transmission network have been the most important developments. The last 12 months, for example, have seen cost reductions of a further 7% in onshore wind. These improvements have helped to bring this technology closer to cost parity with fossil fuels, as well as helping to raise market awareness and support for renewable power more generally. Finally, the move from pilot plants to mainstream energy production for offshore wind and solar CSP represents significant progress for both technologies.

Conclusion

The record growth rate of renewable electricity generation capacity in 2010 keeps Europe on track to reach, or even surpass, its short to medium term renewables targets. The parallel growth of gas-fired capacity complements this growth, providing a balance to the intermittent nature of wind and solar power. Set against these developments, nuclear and coal capacity growth and plans for carbon capture and storage represent a possible non-renewable lock in and a challenge to the transition to 100% renewable by 2050.

4.7 Public opposition

Recent developments across parts of Europe indicate that local public opposition could have the potential to become a threat for all forms of climate action. The "Not in my Backyard" or "NIMBY" issue is typically borne out of localism and short termism but is also becoming more of a regional concern. In the last year, Europe witnessed a number of major protests that are increasing in frequency and relevance, and which have emphasised the importance of public support for the implementation of infrastructure projects. Without sufficient public acceptance, quick expansion of the transmission grid and construction of renewable generation facilities will not be possible to the extent required or at the necessary speed to achieve 100% renewable electricity by 2050.

13,000 objections were made against a new 190 km power line.

To give a sense of the political and practical impact that public opposition can have, we have outlined below two recent developments in Germany: the reconstruction of the railway station in Stuttgart, a project that has been in preparation for decades and is popularly known as "Stuttgart-21 (S-21)"[11], and the lifetime extension of German nuclear power plants.

- Stuttgart-21: The conversion of Stuttgart's existing railway station into an underground station is one part of a broader European infrastructure project aiming to improve the overall railway connection between Stuttgart and neighbouring German and European regions. This development has been criticised for many years, but street protests intensified after construction started resulting in the postponement of the start of the project. The general message coming out of this is that more should be done to integrate the local population in the decision making process, but also that planning procedures should be accelerated.
- German nuclear: Anti-nuclear power protests also attracted public attention in Germany after the German government announced plans to extend the life span of its nuclear plants in late 2009, revoking an earlier agreement to phase out nuclear power. The earlier agreement between the German Government and the industry to phase nuclear power out had been accepted by the majority of the German population. The new Federal Government then decided to extend the life span of the nuclear plants, which only then raised strong public opposition. In April 2010 this protest took the form of a 120km long "human chain" built by 100,000 people between Brunsbüttel and Krümmel power plants in Northern Germany, symbolising people's rejection of the liberal-conservative government's plans (Spiegel, 2010a; Stuttgarter Zeitung, 2010; ENTSO-E, 2010c).

Both these issues highlight the substantial impact at both a project level (S-21) and a general political level (anti-nuclear protests) that public resistance against infrastructure and energy projects can have, and the urgent need for policy that will do a better job of ensuring that the public's concerns are taken into account. Left unaddressed, this threatens to become a major obstacle for the expansion of renewable electricity more widely across Europe as well. Although

[11] The planning process for this started in 1994. As the project developers expected it to be one of the largest and most prestigious projects to be realised in Baden-Württemberg in the 21st century, it was given the name Stuttgart 21.

One online platform against wind energy consists of 461 member organisations in 21 European countries.

non-harmonised, inefficient legal and regulatory frameworks (see section 4.3) are a major part of the problem, evidence already indicates that the main obstacle towards faster progress in grid extension and implementation of renewable power plants is, indeed, increasing local public resistance, sometimes related with NIMBY protests (Battaglini and Lilliestam, 2010; ENTSO-E, 2010b).

Such protests and interventions are becoming more frequent across Europe and further examples can be found in other countries. In France, despite the government's promising initiatives for wind power tendering, not a single project was implemented by the end of 2010, mainly due to local protests against both off- and onshore wind power projects. As a result, although 95% of the French public claims to support wind energy and the French government has plans to install 10,000 MW onshore wind, by late 2010 only 5,500 MW had been authorised (Louis, 2011). In Spain, the local population's opposition to onshore wind power plants in Andalusia threatens the continued expansion of wind power there (cf. Prados, 2010). In Germany, although the energy strategy of the Federal State of Brandenburg, Germany, estimates that more than 20% of electricity will come from renewables by 2020, the local population strongly questions the local economic benefits of more onshore wind power plants. As a result, regional planning authorities are faced with less land available for new wind power plants (Ernst & Young, 2011; Vogel, 2010) and one anti-wind movement even campaigned in the 2009 federal state elections in Brandenburg. In England, plans to build five onshore wind turbines near to Bishampton Bank in the Vale of Evesham were recently rejected by the district council during a meeting packed with dozens of local protestors (BBC News, 2011).

To date, protests against renewables have tended to be focussed regionally (as opposed to nuclear, which in the case of Germany at least have had a more national focus). This may be linked to specific concerns with a technology e.g. wind turbines (altitude, noise and distance from the community) and the consequences of the proposed location, which may then necessitate extensive network connections e.g. to transport electricity generated by wind from North to South Germany. However, this may be changing. One online platform against wind energy consists of 461 member organisations in 21 European countries as of February 2011[12]. In other parts of the world, a similar picture is emerging. US experience from anti-wind power campaigns also reveals how long 'Nimby' protest can delay projects: a 130 turbine offshore wind power project off Cape Cod was finally approved by the national government in 2010 after a decade of uncertainty and considerable opposition from wealthy and politically-influential property owners.

It is evident that the de-carbonisation of the power sector will not be achieved without a fundamental restructuring and faster extension of the existing electricity infrastructure in Europe (see section 4.3). However, progress is slow. For instance, in Germany a total of 3500 km of newly constructed transmission lines are planned by 2020, but already the 2005-2010 objective of 460 km has not been met, with only 80 km actually built (von Hirschhausen et al., 2010). One significant factor in this outcome has been objections by individuals and/or entire communities. In the case of the new 190 km 380 kV overhead Wahle-Mecklar power line in Lower Saxony and Hesse, some 13,000 objections were made; statistically one for every 14 metres of power line (Siegmann, 2010).

Under these conditions, the expansion and restructuring of the transmission infrastructure also threatens to become a bottleneck for the more immediate EU 2020 renewables targets. This is shown by recent developments in the UK where communities have indicated that they will not accept more 'super pylons' needed to carry electricity from offshore wind plants to the grid. Fearing that the landscape will be blighted they have suggested using underground cables instead, an option ruled-out by project planners because of the high cost (Elliot, 2011).

A common reason for fierce local resistance against important renewable energy infrastructure projects is inadequate engagement by the government and developers of local communities in the early stages of the planning process (Battaglini and Lilliestam, 2010; ENTSO-E, 2010b). Projects often do not satisfactorily

[12] See: http://www.epaw.org/

address legitimate concerns about possible impacts on health, environmental impacts and the local economic benefits and/or impacts. As a result, they can then end up facing increasingly strong opposition. Again in the UK, one estimate suggests that a lack of inclusion can cost dearly – the economic loss caused by opposition to wind energy in the UK could amount up to £1.3bn (REF, 2010).

A second reason is that compensation measures are often not considered or are not thought to be necessary. This may be because they do not lead to benefit sharing in the affected communities (e.g. for wind expansion in the North Sea area). Whatever the reason, the timely integration of local communities into infrastructure planning is a crucial issue, as in many countries electricity infrastructure projects can be paralysed by just one single landowner (Bittner, 2010).

Renewables progress check

Public opposition

Political leadership

Increasing public concerns have not yet been sufficiently addressed by politicians at local and national levels. If the current reaction to new renewable projects continues, local protests are going to make it extremely difficult to expand the electricity infrastructure to the required levels and as the size and impact of renewable power and infrastructure projects continues to grow, local public protests can be expected to play an even more dominant role in the future. While there is perhaps no ideal or single solution to this, the main difficulties seem to originate from the communications with local communities and stakeholder groups about the social and local economic benefits of renewable energy[13]. Tied closely to this are also concerns about both health and environmental impacts of transmission and renewable generation projects.

Investment climate

The impact of local public opposition on investment to renewable electricity projects and new transmission lines is potentially very damaging. It increases investor uncertainty, creates additional costs and reduces the attractiveness of business cases. All of these are likely be exacerbated if there are also long delays in permission and implementation procedures. Currently, even after a project has been approved by the regulatory agency, uncertainty remains because of the possibility of intervention by courts and local legal action against a project. This clearly has an impact on the attractiveness of a renewable energy business case and can lead investors to look elsewhere for other opportunities or countries to invest in.

Planning and permitting for new infrastructure

Many of the parties involved, including transmission system operators, have serious doubts about whether the growing need for new transmission lines and electricity infrastructure expansion in Europe can be met by 2020. While many of the problems originate in inefficient legal frameworks, local protests are also having an increasingly significant adverse impact on the building of new infrastructure.

Conclusion

The power generation and transmission sector is becoming more of a target for public protest. New policy and legislation can quickly be rendered ineffective by public protests and 'nimby-ism' which then lead to long delays and increased costs for developers and other parties. There is need for more engagement with interest groups to increase the levels of acceptance for new infrastructure and renewables projects and to create win: win benefit-sharing mechanisms.

[13] The local benefit of renewable energy projects can be enormous. It is documented that renewables accounted for about €6.75bn of local added value in Germany in 2009. Local tax revenues of €0.6bn could be levied (Hirschl et al., 2010).

4.8 Civil unrest and protest in North Africa

On the morning of 17 December 2010, following a confrontation with police over lack of payment for a bribe, a 26 year-old street vendor called Mohamed Bouazizi, tired of poor treatment, went to the nearby governor's office to complain. When he was denied a hearing, he bought some gasoline, poured it on himself and, standing in front of the government building, set himself on fire. He died of his burns 18 days later at a hospital in Tunis (Beamont, 2011).

There has been significant media coverage of the event in Tunisia in December 2010 that subsequently unleashed further protests across much of the region. Mohamed Bouazizi's self-immolation became the rallying cry for popular and largely non-violent protests, and these quickly brought down the Tunisian government. Similar protests then erupted in Egypt, where the political opposition was well organised, with the same result. At the time of writing, violence in Libya dominates the headlines. In several other countries in the Middle East and North Africa (MENA) region, popular protests have also started to expose widespread discontent with the political status quo.

To evaluate the effects of these protests on renewable electricity development, it is important to consider their immediate effects on the one hand and their potential longer-term effects on the other. The immediate effects are to heighten uncertainty in the region, with a significant adverse effect on the investment climate across the economy, not just for renewables. While the activities of organisations like the World Bank and the European Investment Bank, in terms of project planning and finance, do not seem to have been affected, project developers doing business in the region have in many cases suspended operations and evacuated key personnel (Kanter, 2011).

The longer-term future is highly uncertain, not just in Tunisia, Egypt, and Libya, but also in many other MENA countries. Whether or not the protests result quickly in more democratic government, investors also need stability, transparency and accountability, in the machinery of government and regulation, as well as the political process. A shift towards this as a result of the political reforms could set the scene for renewed economic growth and accelerated investment. On the other hand, continuing turmoil and uncertainty could undermine progress and investment.

Investors also need stability, transparency and accountability in the machinery of government and regulation, as well as the political process.

Renewables progress check

Civil unrest and protest in North Africa

Political leadership

The results of political protests and upheavals in the MENA region are likely to have an important effect on political leadership for renewable energy development in the region and cooperation with Europe. It is too early to predict whether the effect will be positive or negative, and over what time frame this will occur. As long as the current events fail to result in greater inclusiveness, then the visible levels of popular discontent provide powerful strategic arguments against Europe becoming dependant on electricity imports from North Africa as well as political arguments against supporting some North African governments through foreign direct investment.

To the extent that current events do result in greater democracy and accountability, either throughout the entire region or on a country-by-country basis, then it could eventually have the opposite effect, creating political arguments for European support to new governments in the region. To the extent that a democratic shift takes place across many countries, it could also create the conditions for greater cooperation between North African countries, with a spillover into market integration and harmonisation of planning and permitting rules as envisaged by the original 2050 roadmap.

Whether or not the political events result in greater democracy, one can speculate that a response of governments in North Africa will be an increased attention on job creation. Given the substantial employment benefits associated with e.g. Concentrating Solar Power development in North Africa (Gazzo et al., 2011; Komendantova and Patt., in review), this could create an additional political argument for renewable energy expansion.

Investment climate

In the short term, the political turmoil in North Africa is likely to have a negative effect on investor confidence, with investors waiting to see how the situation in individual territories and across the region develops.

Longer term, a move to more open and transparent government with clear governance and accountability could provide a stimulus to investment - earlier research found that the single largest perceived risk for the private sector associated with doing business in the region was not political turmoil or terrorism, but rather the threat of delays and cost overruns resulting from bureaucracy and corruption (Komendantova et al., 2009).

However continued political instability – politically, economically or socially – is likely to deter foreign investors in particular, whilst any changes to legal or regulatory regimes will need to be evaluated, with investors looking for political commitment and a track record of delivery.

Conclusion

Undoubtedly, recent civil unrest and turmoil has had a negative impact on renewables development in the region. Whether this negative impact is short-term or long-term depends on whether and how quickly the countries involved can move towards more stable and effective governance.

4.9 The Japan earthquake

The 9.0 magnitude earthquake that hit Japan on 11 March 2011 was one of the most exceptional in known history. According to the US Geological Survey (USGS, 2011), it was the fourth largest in the world since 1900 and the largest in Japan since modern instrumental recordings began 130 years ago. It was followed by a tsunami of similarly exceptional destructive power. The earthquake and the resultant tsunami caused considerable damage and destruction to Japan's energy infrastructure. The greatest challenge is managing the cooling and containing contamination problem at the six-unit Fukushima Daiichi nuclear power plant but the disaster has also had a major impact on three other nuclear reactors and other energy infrastructure.

The nuclear emergency in Japan will reopen discussion and debate on nuclear power. Most immediately, discussion will focus on safety considerations and learning from the unfolding events in Japan. More widely, the events are likely to spur debate on the overall role of nuclear power in the energy mix as governments seek to balance a range of public and stakeholder viewpoints. It is too early to reach any kind of definitive view on the likely outcomes of such discussions in the years to come, however most countries with a nuclear power program have already announced safety reviews.

The exact impact on climate policy and greenhouse gas emissions depends on a number of variables, including:

- How far a more stringent or restrictive policy or regulatory regime for nuclear power translates into reduced investment in new nuclear capacity (either because of delays or cancellations).
- What mix of fuel sources are mobilised to replace reduced or delayed nuclear capacity.
- The extent to which market and policy reactions spur added investment in renewables.

It is still too early to reach any kind of definitive view on the likely outcomes of the Japanese earthquake.

One immediate market reaction, for example, was a 10% rise in EU carbon allowance prices following the German moratorium on its nuclear programme and closure of older plants. Wholesale gas prices in Europe have also risen strongly on anticipation of LNG diversions to Japan. A continuation of these trends would help the cost position of renewables, as would the impact of any increase in nuclear capital costs following the current round of safety reviews.

The extent of the longer-term impact on the global energy market will depend on how far government reviews of nuclear energy are confined to safety modifications or whether they extend into wider shifts in the energy mix. Even without changes in new build plans, safety audits of existing nuclear plants may result in significant upgrades or, in some cases, plant being shut down. However, any reductions in current and planned nuclear capacity will have a profound implication for energy security and the need to source power from other sources. Nuclear power accounts for 14% of world electricity generation and is projected maintain that share, and climb from 2 731 TWh in 2008 to 4 900 TWh in 2035, with 40% of this growth from China alone (IEA, 2010).

In summary, it is not clear yet what impact these developments will have on government policy or on the desire to have nuclear play a large role in electricity generation globally going forward. It seems clear that Fukushima will not strengthen the nuclear power proponents' argument, but it is also not obvious that their argument will be significantly weakened.

Renewables progress check

The Japan earthquake

Political leadership

It has taken twenty-five years for the memory of the Chernobyl disaster to grow faint enough to allow renewed enthusiasm in nuclear power. The events in Japan will mean that the nuclear debate is higher up the political agenda in many countries. Governments, regulators and operators will need to work hard to reassure their citizens about their own installations and expansion plans.

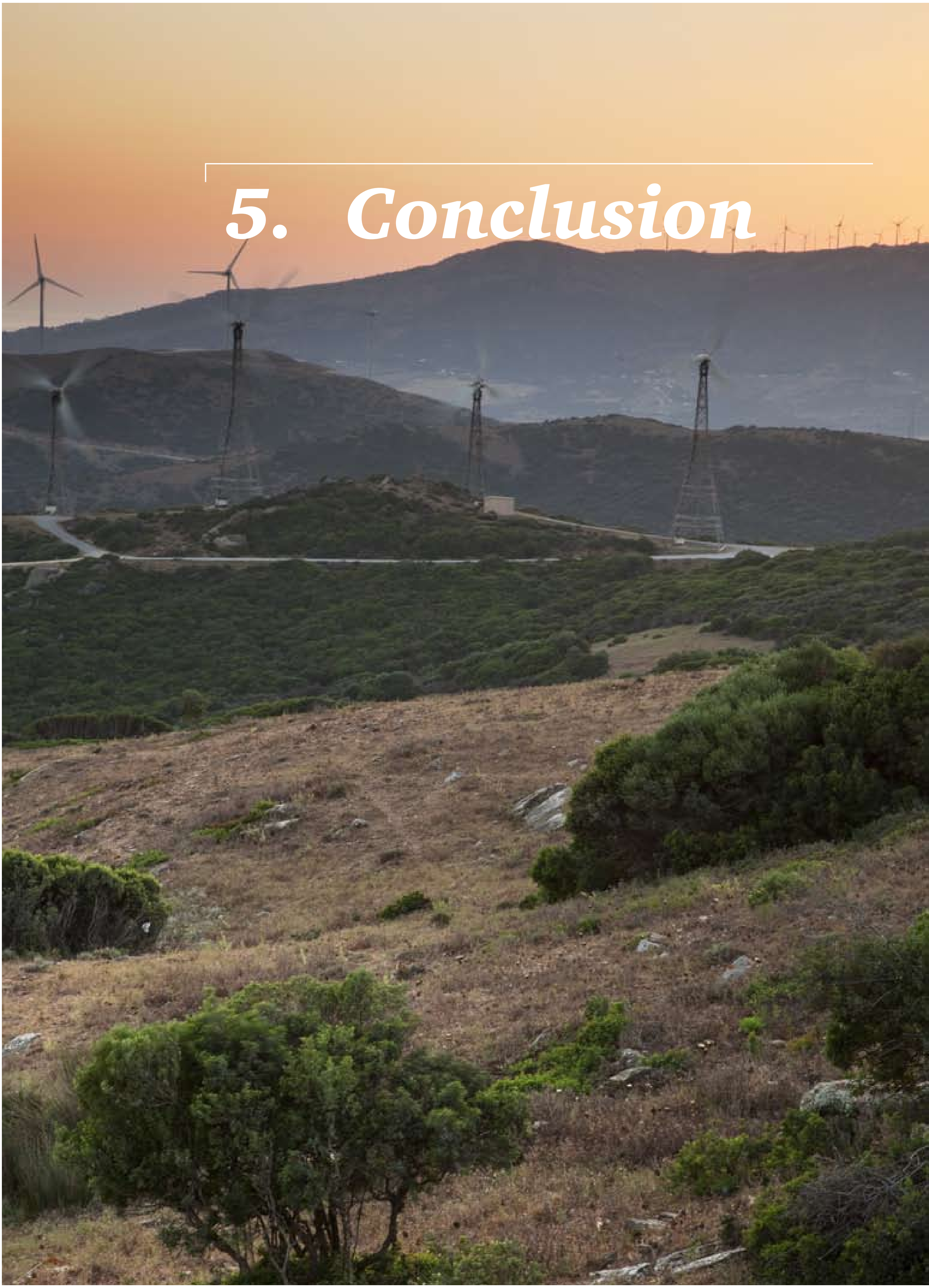
Investment climate

Policy and market reactions to the Japan nuclear emergency are likely to encourage investment in renewables, but it is not yet clear how significant these reactions may be. Price reactions, for example following a shutdown of a number of European reactors, may improve the cost position of renewables, as would the impact of any increase in nuclear capital costs following the current round of safety reviews.

Conclusion

The nuclear emergency in Japan will once again highlight nuclear safety concerns and reduce the immediate public and political acceptability of nuclear power, particularly in higher risk geographies. We do not know today how large this effect will be – it will depend in part on the ultimate outcome at the Fukushima Daiichi plant – but increased concerns about nuclear will improve the case for renewables.

5. Conclusion



5.1 *The impact of recent events on a 100% renewable future*

Europe and North Africa have experienced rapid and sometimes unpredictable change in 2010 and early 2011. - economic upset and recovery in Europe, political change in North Africa, but also dramtic shifts in energy policy, planning, technology and investment. We conclude our analysis with a look at these developments as a whole through the lens of the five 'enabling factors' – political leadership, market structure, investment climate, planning and permitting rules for new infrastructure, and technological progress – outlined in the analytical framework set out in chapter 3.

Political leadership

Existing leadership and political commitments: Our view is that political leaders in Europe have demonstrated a continued willingness and desire to support the rollout of renewables despite stalled international negotiations. The NREAPs make firm political commitments for 20% renewable energy by 2020. In the longer term, discussions around an 80-95% emissions reduction target by 2050 are in process and this appears close to becoming the firm EU target. The discussion of these targets puts Europe politically on the right path to a commitment to achieving 100% renewable electricity by 2050. There is also a clear commitment for the continued development and rollout of renewable energy and the commission has made the direction of future market change clear - it is towards increased competition and unification. Against this however, most NREAPs have not been drawn up with a longer-term perspective. Political leaders have not yet begun the process for setting commitments beyond 2020 and have yet to take a regional view on policy commitments. Continued political support for fossil fuels and nuclear power in many countries are also a challenge to the vision of 100% renewable electricity, as they are likely to lock Europe into traditional power generation for the longer term.

Economic, environmental and strategic arguments: Recent events create additional arguments to achieve 100% renewable electricity. There is evidence that political leaders and the European Commission in particular have moved from an approach to renewables focused on moral obligations to protect the climate more to a view that a shift towards renewables would be economically and strategically beneficial in the longer term. In addition, political developments in North Africa and eventual changes may also support arguments for more local renewables development. However, if countries remain unstable, barriers against renewable energy developments will remain. Recent events at the Fukushima nuclear reactor in the aftermath of the Japan earthquake may also present additional arguments against nuclear expansion and provide some further support for renewables. However it remains to be seen how government commitments to nuclear power will change in the medium to long term in response to this.

Interest group politics: There is little evidence of better public engagement. This is particularly important if public protests against new infrastructure are to be reduced to allow development to proceed at the necessary pace to meet targets. Some high profile regional renewables initiatives have built expectations and publicity around renewables, but little concrete progress has been made. The activity around these has, however, provided a focus to lobby and influence political leaders and other stakeholders such as investors to support the renewables transition. There has been increased political influence from groups that favour alternatives to renewables, such as the nuclear and coal mining groups, which have made some progress in influencing policy in the last 12 months. The effects of the situation in Japan on the continued progress of the nuclear lobby remain uncertain.

Market structure

Integration: Significant progress has been made in the integration of markets across international borders, with about 60% of European electricity markets now coupled. This is a strong and rapid trend in the right direction. The implementation of the third energy package and the work of the ENTSO-E and ACER agencies serve to further encourage and coordinate this trend. The EC has demonstrated its commitment to an integrated power market through the publication of targets for unification by 2014/15. It should be noted that full market integration is reliant on associated improvements and developments in the regional grid. The distinct lack of developments in infrastructure planning and permitting to date could be a major inhibitor to the achievement of the proposed market integration targets.

Adaptation of market design: To date there has been little policy or progress towards the adaptation of market design to support increased renewables generation in the European power system. Currently this is not a critical issue in the system and understandably the focus has been and should be, on other areas such as market competition. However, in the future, as the renewables generation capacity increases, the market design will need to be adapted to support increased intermittent generation from renewable technologies and to incentivise the construction of dispatchable, flexible capacity.

Competition: Progress to address competition issues in the electricity markets has been in the right direction but insufficient in its reach, achievement and speed. There have been some positive developments such as stricter, but still insufficient, unbundling requirements through the third energy package, other new initiatives announced to tackle competition issues in markets and the unbundling of two major TSOs in Germany. Policy commitments acknowledging competition issues show that the EC is committed to tackling them, but concrete progress remains very limited. The implementation of the power market directives in member states is weak, with the large power companies able to influence policy concessions around unbundling. Electricity consumer rights and competition within the wholesale and retail power markets remain a large concern.

Investment climate

Sustainable support mechanisms: There have been a number of changes to support mechanisms for renewables in Europe. There were reductions to PV tariffs in a number of countries, but no general trend towards cutting back government tariffs for renewables as a whole. In fact, support for renewables technologies remained stable in most countries and increased in some, despite public spending cuts triggered by the financial and debt crises. Reductions in PV tariffs can be positive if they make future government subsidies more sustainable, by keeping costs reasonable and so not threatening public acceptance of government spending on renewables. The concern around changes in subsidies stems more from the way in which some have been implemented. The retroactive tariff and tax changes in Spain and the Czech Republic, in particular, have undermined investor confidence.

Perceived risks in new markets: In the short term, despite continuing commitments from donors such as the World Bank, civil and political unrest in North Africa has acted to increase the perceived risk of investment in these countries. Until new stable governments and policies are in place and order is re-established, investors will be wary of putting forward capital to support projects and companies may be unwilling to send employees to the area. In the longer term, the perceived risk will depend on the quality of governance and accountability, as well as political developments in the region. If changes to more democratic regimes in North Africa are accompanied by stable and effective government and increased transparency, key concerns of developers and investors in relation to possible delays and corruption may be reduced.

Long-term expectations: In the longer term, the investment climate for renewables remains uncertain. This is because firm political commitments and targets post-2020 have not been made and there have been ongoing changes to support schemes. Since renewables projects typically have long payback times that are less attractive for investors, policies are needed that support private sector investment. Political commitments to 2020 have improved investor confidence but binding longer-term targets to 2050 are needed. Sustainable sources of public and private sector capital are also needed to increase renewable capacity in Europe and North Africa. Currently many of the sources of funding and EU programmes have a timescale of between five and ten years, rather than a path towards 2050. There is also little evidence of reductions in fossil fuel investment – e.g. funds such as the SET plan to allocate a greater percentage of funding to non-renewables and CCS.

Planning and permitting rules for new infrastructure

International infrastructure planning: The publication of the ENTSO-E Ten Year Network Development Plan and the EC blueprint for an integrated European energy network were important steps towards greater regional planning around the development of the grid and the upgrade of transmission to support the growth of renewables. Organisations coming together to co-develop plans is an important step forward. However, despite increased awareness of the need to make progress quickly, there has been very limited actual progress on the ground, with few projects in development and little commitment to new infrastructure projects. To date, many of the planning announcements have come from the European public bodies, with little cooperation between individual member states on planning or on the ground.

Regulatory harmonisation and streamlining: The long lead-time for implementation of infrastructure projects is the single biggest threat to the transition to renewable energy and the target of 100% renewable electricity by 2050. There has been almost no progress in the streamlining of planning and permitting for infrastructure in Europe. The EC has announced the development of regulations to simplify the permitting process for new regional infrastructure developments. At a national level, there are no sufficiently credible and far-reaching proposals in the NREAPs or other plans that show how member states plan to deal with issues surrounding the planning and authorisation of infrastructure. Without regulatory streamlining, investment and development of infrastructure remains unattractive, expensive and painfully slow. A lack of infrastructure development will hinder not only capacity expansion, but also market integration and other interrelated factors.

Public acceptance and a climate of trust: Public acceptance of new infrastructure projects has not improved. This is due to limited progress on specific infrastructure projects, complex and lengthy planning and permitting processes and a lack of engagement with stakeholders on the issues associated with infrastructure development. Without specific infrastructure projects in planning or underway, it is difficult to develop and test new methods of stakeholder engagement and benefit sharing to reduce protests and create trust between different interest groups. The number and frequency of public protests has increased, causing increasingly serious problems and delays for transmission projects, and in some cases also for renewable generation capacity. This makes it difficult to expand capacity and increases investor uncertainty. More needs to be done to develop good practice in community engagement, to be shared for the benefit of the region as a whole, whilst improving the regulatory process around new infrastructure developments.

Technological progress

Growth: The last 12 months have seen a strong expansion of renewables capacity in the EU, particularly in PV and wind. Supply chains are cautious about major expansion due to the uncertain nature of project finance and may wait until the future scenario for renewables is clearer. This may act to constrain future capacity growth rates.

Efficiency of renewable power mix: The 2010-2020 outlook for renewables is for a generally balanced and efficient renewable power mix, largely based on the renewables potentials in the different countries. This is likely to be more efficient and reliable than a mix that is too heavily focused on one particular technology. However, the growth of renewables shows some signs of being skewed towards certain technologies for reasons other than resource abundance.

Due to the scale of incentives in some countries, in particular for PV in Germany, there has been an over-expansion of the technology there, relative to sunnier parts of Europe. This is a threat to the longer-term efficiency of the renewable power mix. There is no cohesive planning process on a European level to align the siting of renewable plants and ensure a balanced mix of technologies.

Cost/performance development: The major increase in renewables capacity has led to significant and rapid cost reductions, especially for onshore wind and solar PV technologies. Onshore wind is now almost competitive with traditional power sources. Offshore wind and CSP have started moving from pilot to mainstream technologies, but remain expensive despite strong cost reductions.

The planned capacity increases will act to further reduce the costs associated with these renewables and improve competitiveness. Research and development into renewable technologies is important for improving performance. Funding from the SET Plan should act to leverage further private investment in technology to bolster research and development.

Summary – a review of progress on the five 'enabling factors'

It is apparent that there has been a good deal of positive development in the last 12 months and we can continue to be confident that the transition to renewables in Europe will continue. Particular areas of strength include the continued growth of renewables capacity, market integration and political commitment to renewable electricity generation in Europe through binding targets and the provision of funding. Despite a lack of progress in some areas, there have been no major setbacks and no important movements in the wrong direction.

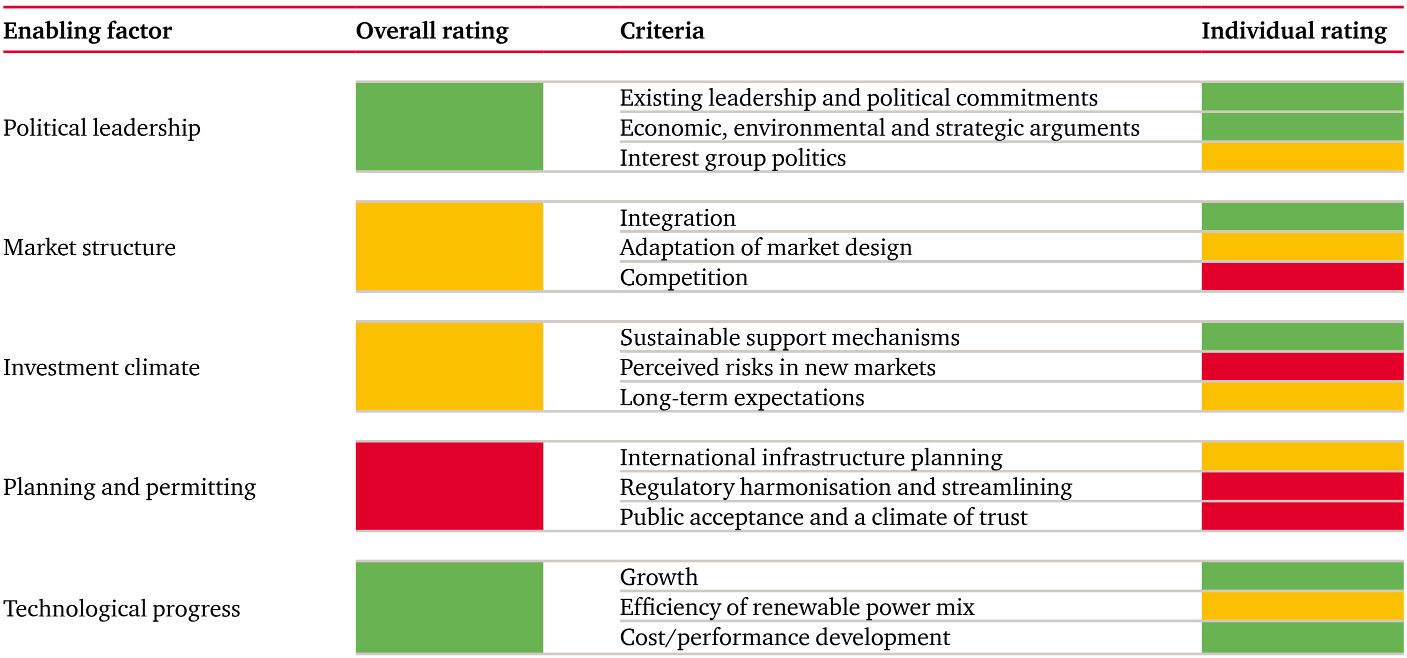
Overall, the direction of European energy policy is getting clearer. Renewables are here to stay and there is growing momentum for them to be the main foundation of European electricity generation in 2050.

We have looked to summarise this in the form of a 'heat map' (see Figure 12) to show the rate of progress in the five 'enabling factors' set out in chapter 3. Ratings are given to each factor based on developments of the last 12 months. Like our review of recent developments in chapter 4, there are positives and negatives but on balance, the former marginally outweigh the latter. The positives are most evident in the area of political leadership and technological progress. The integration of markets has moved at a good pace and in the right direction. It is now critical that this pace is sustained to ensure that the wider markets are integrated in the coming years.

In other areas, the impact of developments has been more mixed. Market competition and infrastructure permitting and planning are the areas of greatest concern. The lack of progress on improvements to planning and permitting is the single biggest threat to future major expansion of renewables technology in Europe and North Africa. Closely linked to the problems around infrastructure are the issues associated with project investment, such as regulatory uncertainty and the need for continued market reform to promote access and competition. These areas, along with the engagement of stakeholders and interest groups to combat public opposition, need to be tackled urgently if the region is to stay on track to 100% renewables by 2050.

Improving public support is crucial to achieving 100% renewable electricity by 2050

Figure 12: Heat map of the progress in each of the five enabling areas



Key

No movement or progress away from a 100% renewable electricity outcome.

Some activity, but progress is insufficient or too slow.

Good progress with sufficient scope and speed.

5.3 Outlook

Renewable electricity is well positioned to play an important role in the future to address both energy security and climate change concerns. Policy has done much to support this development, but continued progress and the leap from a niche to the mainstream market will not be easy. Analysis of the events of the last twelve months show that achievements in different areas are mixed, but that positive trends outweigh the negative trends. Support for the areas that have shown good progress to date need to be maintained and weak areas need to be reinforced. Overall, the pace needs to be increased in most areas for 100% renewable by 2050 to be a realistic objective. We see three immediate priorities that policymakers should focus on in the near future:

- develop a long term and EU-wide electricity policy planning
- create market conditions that support renewables
- support faster grid expansion through participatory processes.

The remainder of this section contains more detailed recommendations for each priority. These recommendations are not all necessarily supported by our findings but are based on progress to date and the opinion of the authors going forward.

Developing a longer term and international electricity policy perspective

To achieve the vision of a completely renewable power system for Europe and North Africa, national electricity policies will need to adopt a longer and geographically broader scope. Currently, a major risk to investment is the short-sightedness of electricity policy and the short-term changes of many national support schemes. This is the result of a general lack of a longer-term policy view. An essential aspect of political leadership is that it recognises the long-term value of moving towards 100% renewable electricity rather than being focused on shorter-term routes that then head off in different directions. A longer term planning and visioning horizon, defining the overall direction of European energy and resulting in ambitious and credible long-term political commitments, will increase investor confidence and make funding for renewables projects more easily available. Such a visioning process must provide a credible and appealing narrative for the future power system. At a more detailed level, clear guidelines and principles would also be needed to support the design of regional generation capacity, demand management, the types of market in operation, how the electricity would be supplied, and finally how transmission grids should look and operate.

Europe is now moving beyond a period in which renewables need market introduction support and is entering a period where renewables have been scaled up to a point where they are able to satisfy large shares of the power supply. In the past, economic inefficiencies were small as a result of the small niche-scale of renewables, but in the future, these inefficiencies will be magnified by the vast amount of new capacity installed. There is considerable evidence that Europe can reach its long-term targets much more efficiently if it abandons the national energy paradigm and reaches for a truly European renewable power system. This efficiency will be even larger if the deserts of North Africa are included, and benefits will then also reach the North African countries as well as improving access to capital and technological knowhow for the energy sector there.

This raises questions about how much European influence we need and how much national focus we want in the future energy policy. This also raises questions about acceptable trade-offs between economic efficiency and Europeanization on the one hand, and economic inefficiency and national control on the other. It requires each country to ask how it can coordinate its renewable electricity action with its neighbours in a way that leads to win-win situations. In the short term it requires Europe and North Africa to answer questions about how the two can work more closely together and in the longer term how they must look into possible designs for cooperation on energy production.

Creating market conditions that support renewables

If renewables are to make the leap into the mainstream and shoulder large parts of the power supply in Europe and North Africa, the market must be designed accordingly. In the short term, this requires that current policy is correctly implemented and in the long term that policy makers think about how a market structure which supports renewables may look.

Various EU market directives of mainly the second and third energy packages provide the current policy framework associated with power market structure and competition, but this is obviously not enough: the competition is still much too weak. For progress towards greater competition in the energy markets moving at the necessary pace, these directives, as well as the 2009 renewables directive, need to be implemented more rigorously. As a first step, Europe needs to outline and enforce penalties for non-compliance with the existing energy packages and make sure that the member states actually implement the directives, not only to the letter but also to the spirit.

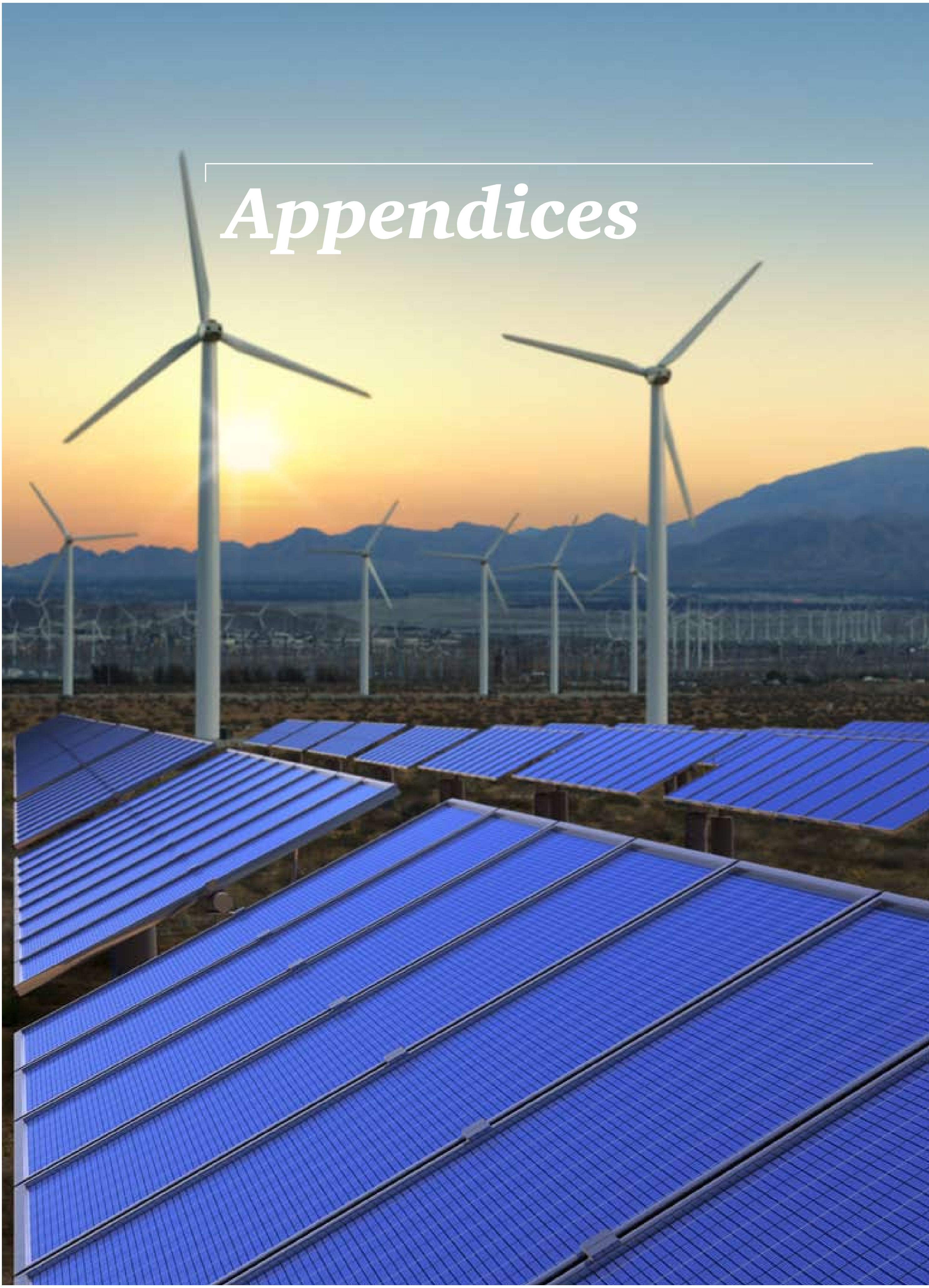
However, given the dilution of the third energy package and the unclear evidence that effective competition can only be achieved in a fully deregulated power market, policymakers will also need to think about further measures to support its longer term vision for the future power system. This will require addressing a number of controversial questions including whether Europe wants a fully liberalised power market or whether some form of re-regulation would be more conducive to a rapid transition to a low or zero carbon sector. It will also need to address the structure and ownership of the sector and, in particular, of the grid.

Creating sustainable infrastructure that supports renewables

The renewables transition relies on the development of an international, and at a later point an intercontinental, transmission grid. Today, it is barely possible to build a single transmission line, especially across national borders, due to inefficient regulation and public opposition. Increased political cooperation between countries is therefore required to find a way to improve the efficiency of the legislation and permission processes for new transmissions projects. Development of consistent standards for infrastructure planning and permitting and will make grid expansions across border less problematic, but changes to make the process more streamlined will also be necessary. In addition, mechanisms to improve incentives to invest in and build grid connections at local, national and regional scales are also required. This may mean that investors in certain projects will need to be granted higher returns on their investments for these projects to happen.

At the same time, streamlining permission processes is not the entire solution to the problem. Public opposition is what turns inefficient permission processes into processes that take 10 years or longer to complete and can completely block the development of new transmission lines. In the short term policy and the transmission companies need to take this problem more seriously and look to engage better with stakeholders and citizens. This would help to both improve the understanding and knowledge of the main reasons for opposition against power lines, and support the identification of ways to make projects more acceptable to local communities. Mechanisms such as benefit sharing and community involvement in the planning process should also be explored further. These would help to increase public understanding and acceptance of the need for new power lines to support the need for transmission capacity increases. Finally, at a political level, it is of crucial importance that new legislation takes the citizens' rights into account. A solution in which citizens are simply bypassed by the interests of the power companies is unlikely to be a democratic or sustainable approach to achieving a 100% renewable electricity outcome by 2050 across the region.

Appendices



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B. Acronyms and Glossary

Acronym	Explanation
ACER	Agency for the Cooperation of Energy Regulators
BEMIP	Baltic Energy Market Interconnection Plan
BNEF	Bloomberg New Energy Finance
CCS	Carbon capture and storage
CDM	Clean development mechanism
CER	Certified Emission Reduction
CO_2	Carbon dioxide
COP	Conference of the Parties to the UNFCCC
CSP	Concentrating solar power
CTF	Clean Technology Fund
DII	Desertec Industrial Initiative
DSO	Distribution system operator
DSM	Demand Side Management
EC	European Commission
EEPR	European Energy Programme for Recovery
EIB	European Investment Bank
EMCC	European Market Coupling Company
EMU	Economic and Monetary Union
ENE	National Energy Strategy
ENTSO-E	European Network of Transmission System Operators – for Electricity
EU ETS	European Union Emission Trading Scheme
EU	Unless specified (e.g. EU-27), we have used EU interchangeably with Europe to represent all present and potential future European Union member states
EUA	EU Allowance (as used in the EU ETS)
EU-NA	Europe and North Africa
FIT	Feed in Tariff
FOSG	Friends of the Super Grid
GDP	Gross domestic product
GEF	Global Environment Facility
GO	Guarantee of Origin
GW	Gigawatt
GWh	Gigawatt hour
HVAC	High voltage alternating current
HVDC	High voltage direct current
IEA	International Energy Agency
IIASA	International Institute for Applied Systems Analysis
IMF	International Monetary Fund
IP	World Bank CSP Investment Plan
IPCC	Intergovernmental Panel on Climate Change
IRENA	International Renewable Energy Agency
ISCC	Integrated Solar Combined Cycle
ISO	Independent System Operator
ITO	Independent Transmission Operator
JI	Joint implementation

Acronym	Explanation
kWh	Kilowatt hour
LCOE	Levelised cost of electricity
MDB	Multilateral development bank
MEF	Major Economies Forum on Energy and Climate
MENA	Middle East and North Africa
MSP	Mediterranean Solar Plan
MW	Megawatt
NA	North Africa
NER300	New Entrants Reserve Programme
NFL	New Financial Law
NGO	Non-governmental organisation
Nimby	Not-in-my-backyard
NREAP	National Renewable Energy Action Plan
NSCOGI	North Sea Countries' Offshore Grid Initiative
OECD	Organisation for Economic Co-operation and Development
PIK	Potsdam Institute for Climate Impact Research
PV	Photovoltaic solar power
PwC	PricewaterhouseCoopers
R&D	Research and development
RD	Royal Decree
REAOL	Renewable Energy Authority of Libya
REEEP	Renewable Energy and Energy Efficiency Partnership
RGI	Renewables Grid Initiative
SEGS	Solar Energy Generating Systems
SET	Strategic Energy Technology (Plans)
SSG	SuperSmart Grid
TGC	Tradable green certificate
TSO	Transmission system operator
TYNDP	Ten-year network development plan of the ENTSO-E
TWh	Terawatt hour
UCTE	Union for the Coordination of Transmission of Electricity
UfM	Union for the Mediterranean
UNFCCC	United Nations Framework Convention on Climate Change
VPP	Virtual Power Plants
WNA	World Nuclear Association

Glossary Term	Explanation
Base load	The minimum amount of power that a utility or distribution company must make available to its customers, or the amount of power required to meet minimum demands based on reasonable expectations of customer requirements.
Dispatchability	The ability of sources of electricity to be dispatched at the request of power grid operators, i.e. to be turned on or off at on demand.
Electromobility	The electrification of transportation through the use of hybrid electric and all-electric vehicles instead of petroleum vehicles. Generally includes trains and road transport.
Europe	Unless specified (e.g. EU-27), we have used Europe interchangeably with EU to represent all present and potential future European Union member states
Feed in tariff	A government-set rate that utility companies pay for 1 kWh of renewable electricity fed into the electricity grid by 'third parties' (private investors including households).
Grid parity	The situation where the generation cost of electricity is equal to the price of electricity in the market, including grid fees and taxes, at the point of connection.
Horizontal integration	Companies who are active in a number of different generation technologies.
Insolation	The measure of solar radiation received on a given surface area of the Earth at a given time.
Levelised cost of electricity	The cost of generating electricity for a particular system. It includes all the costs over its lifetime (typically 20-30 years) including initial investment, operations and maintenance, cost of fuel, cost of capital.
Levelised transmission cost	The whole life cycle costs of transmitting electricity.
Liberalised market	A market in which every customer has the right to procure electricity from an electricity provider of their choice and network operators are legally obligated to grant network access to all authorised producers and customers
Meshed grids	A highly interconnected transmission and distribution grid.
North Africa	The five countries in the north of Africa: Morocco, Algeria, Tunisia, Libya and Egypt.
Peak load	The maximum energy demand or load during a specified time period.
Reserve capacity (spinning reserve, non-spinning reserve)	The generating capacity available to the system operator within a short interval of time to meet demand in case a generator goes down or there is a disruption to the normal supply. Spinning reserve is the extra generating capacity that is available by increasing the power output of generators that are already connected to the power system. Non-spinning reserve is the extra generating capacity that is not currently connected to the system but can be brought online after a short delay.
Smart Grid	A grid which uses digital technology to deliver electricity from suppliers to consumers. The technology interacts with consumer appliances (business and residential) to save energy, reduce cost and increase reliability and transparency.
Subsidy (implicit and explicit)	A form of financial assistance paid to a business or economic sector, often to encourage it to undertake certain activities. An explicit subsidy is directly giving a business money to do something, while an implicit subsidy is giving them some other benefit which is equivalent to giving them money.
Super Grid	A wide area transmission network that makes it possible to trade high volumes of electricity across great distances. HVDC technology is typically used.
SuperSmart Grid	A hypothetical system which would unify Super Grid and Smart Grid capabilities and technologies into a comprehensive network. Envisaged to connect Europe with northern Africa, the Middle East, Turkey and the IPS/UPS system of CIS countries.
Synchronous grid	A power grid at a regional scale or greater that operates at a synchronised frequency and is electrically tied together during normal system conditions.
Unbundling	Uncoupling the electricity sector by ensuring the companies controlling the transmission networks are independent of the companies responsible for production and supply side activities.
Vertical integration	Utilities companies who are active in more than one, or all, aspects of the power market, i.e. generation, transmission, distribution and retailing.
Virtual power plant	A virtual power plant is a cluster of distributed generation installations which are collectively run by a central control entity.

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