special

Renewable Energy Europe

A special report on the National Renewable Energy Action Plans outlining goals and measures to boost renewable energy use

Inside

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report

Ambition and action

EREC secretary-general **Christine Lins** offers a forecast of renewable energy growth in Europe and argues for its benefits to member states

It is my pleasure to introduce this ENDS report giving an overview of the National Renewable Energy Action Plans (NREAPs) submitted so far by EU governments to the European Commission. Renewable energy sources (RES) have experienced tremendous growth in recent times in the EU. We believe these NREAPs set the direction for further growth up to 2020.

An analysis of the plans currently on the table*, carried out from a European perspective, reveals the following:

- There will be a surplus in 2020 of about 1% over the 20% renewable energy target. This confirms EREC's view that the EU can surpass the target within its borders, bringing benefits to companies, to citizens and to society at large.
- Seventeen out of the 19 countries are forecast to at least reach their 2020 targets within national borders. Only Italy and Luxembourg plan to resort to cooperation mechanisms to achieve their goals.
- Cooperation mechanisms will mainly be used in meeting the binding target for 2020; the majority of EU countries will not resort to such mechanisms before 2018.

A European Environment Agency analysis of the 20% target shows that electricity (in the current 19 NREAPs) will make up 45% of the EU's renewable energy production, with heating and cooling comprising 43% and transport 12%.

In the EU, 36.1% of electricity will come from RES in 2020. These preliminary results from the 19 member states contradict the commission's most ambitious scenario in its latest *Energy Trends to 2030* update, which foresees the same figure ten years later, in 2030.

In 2020, 21.9% of the heating and cooling demand will come from RES. This lies below EREC's projections in its *Roadmap to 2020*. We believe that member states have not, generally speaking, fully tapped the potential of renewables in the heating and cooling sector. Further measures are needed to awaken this 'sleeping giant'. But in transport they are forecast to reach 11.5% of diesel and petrol consumption, overtaking the binding transport target set by the EU directive promoting the use of RES.

In economically challenging times, Europe needs a strong future-oriented industry and the creation of new jobs. Member states yet to do so should submit their NREAPs to secure the economic, environmental and social benefits of developing renewable energy technologies nationally. ■

** Excluding the Czech and Romanian plans.*

02

Mechanics of balance

Cooperation mechanisms and a stronger focus on heating and cooling are crucial for the plans, urges Eurelectric secretary-general **Hans ten Berge**

The NREAPs are a key element in making transparent the way member states intend to achieve their national targets. Eurelectric is following this process with great interest and welcomes the clarity it brings.

But in order to achieve the renewable targets in a cost-efficient way, Eurelectric believes that it is important to focus on some areas requiring more attention.

The 'cooperation mechanisms' are of prime importance in ensuring delivery of the national targets. Using these mechanisms will be essential for countries with relatively high targets but very limited domestic sources of renewables. Cooperation will allow such countries to use imported cheaper renewables from countries with a surplus – or from non-EU countries – to help meet their targets.

According to the existing plans, only a few countries intend to use the mechanisms, and even then in a limited way. We believe that much greater use will be necessary once member states fully comprehend the reality of meeting their 2020 targets – and the preceding interim targets.

Extensive use of inter-state flexibility mechanisms will be essential not only to achieve the targets, but also in significantly reducing the costs of compliance. It is desirable that the existing system of limited cooperation mechanisms be expanded to full trading of renewables after the 2014 review of the directive.

A second concern is the balance between what the different renewables sectors will have to deliver. While we anticipate RES electricity will make the largest contribution towards reaching the target, we believe that more attention should be paid to RES in heating and cooling. This sector has the potential to deliver relatively low-cost renewables through technologies such as biomass pellet burners, solar thermal and heat pumps.

A greater burden has been placed on the electricity sector than is economically justifiable. It may be because it is easier to set targets for this sector – where obligations can be placed on electricity suppliers – than for the heating and cooling sector, where action must target individual property owners. More emphasis on the heating and cooling sector is needed to reach the targets at reasonable cost.

Although we would like to see some changes to the NREAPs to face up to the reality of delivering targets cost-effectively, we do applaud the initiative to make member states' intentions visible and transparent through the plans. Eurelectric looks forward to making a full review once all 27 national plans are available. ■

ENDS *Europe* Renewable Energy Europe
An ENDS *Europe* special report

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ENDS *Europe* Renewable Energy Europe

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Introduction

This report aims to give a snapshot of EU plans to make the challenging transition towards renewable energy sources. We analysed National Renewable Energy Action Plans from: Austria, the Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Lithuania, Malta, Netherlands, Portugal, Slovenia, Spain, Sweden, UK. We also looked at non-submitted plans from Poland and Slovakia. This report includes data from Bulgaria, Cyprus and Luxembourg, while Belgium, Estonia, Hungary, Latvia and Romania are not included. All information is updated to 21 September 2010.

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How countries are planning to meet their targets

Most member states expect to meet their renewable energy targets, but these vary in ambition and face technological and economic realities

European member states are setting out goalposts but leaving ample room for manoeuvre on the path leading to their stated 2020 renewable energy targets. The plans reveal that most countries expect to meet their commitments with varying degrees of ambition. A common criticism, however, is that they provide precious little detail on how exactly to get there.

Some countries, including Sweden, Finland, Spain and Germany, predict they will generate more energy from renewable sources than their EU targets require. This means they will be in a position to help struggling member states through the cooperation mechanisms the renewable energy directive prescribes.

Others, including Italy and Luxembourg, admit to a shortfall and will likely become the recipients of cross-border cooperation.

On the road to 2020

Leaving aside the possibility of imports from other countries, member states can achieve their targets through adjusting their overall energy mix by introducing renewable sources into the electricity grid, the heating and cooling sector and transport, and encouraging energy efficiency practices that reduce their total energy use.

Germany, traditionally an EU leader in solar installations technology and with strong ambition for biomass in the heating and cooling sector, plans for 19.6% of its overall energy share to come from renewable sources in 2020. However, this relies on efficiency measures reducing overall consumption by 7.7% against the reference scenario. If the energy efficiency drive did not succeed, Germany's renewables share in 2020 would amount to 18.2%.

Spain has ambitious plans for an overall renewables share of 22.7% in 2020, despite recent government reluctance to commit to continued support for high feed-in tariffs for wind and solar power. But one question mark looms large: will Spain be able to upgrade its grid connections to allow cooperation with other countries?

The Irish government is predicting a small surplus of green energy in 2020. Plans are under way to build an interconnection grid with Great Britain and cross-border connections with Northern Ireland. Energy transfers in the medium and long term are envisaged, but details are far from complete.

The UK's 15% overall target for 2020 – given its very low starting point of 1.3% in 2005 – is extremely ambitious. In the electricity sector, for example, the share of renewables needs to rise from 4.7% to 31%.

Devil in the detail

The UK has been investing heavily in solar, biomass and especially wind power. Plans for next-generation wind turbines – such as floating turbines – are under way but the technology is expensive. Some experts consider them an unnecessary indulgence in trying to meet targets.

Huge growth in offshore wind is planned, requiring ambitious financing and planning arrangements. This may potentially hamper developments and ultimately undermine the UK plan's targets.

Another potential barrier to meeting objectives is uncertainty over the support mechanisms the sector will enjoy. The new coalition government has not yet clarified whether it will continue with the current renewables obligation system or shift to feed-in tariffs.

Sweden and Finland have high aims for increasing their renewable energy share. Unsurprisingly for its geographical characteristics, Finland aims to rely on wood products to meet more than half of its 38% target. The government considers the targets challenging but manageable. Forest sustainability is an issue, however.

Second-generation biofuel production is foreseen by 2015, with the government keen to use domestic biomass sources such as wood. However, the cost of producing liquid biodiesel from wood is uncertain and the competitiveness of this approach has yet to be tested against foreign imports.

Sweden estimates an overall renewables contribution of 52.2% in 2020. It is predicting a surplus of 486,000 tonnes oil equivalent in 2020 but has not released details of cross-border transfers or cooperation plans.

According to the Swedish government, any details on cooperation mechanisms will first be developed by the Nordic Council, an intergovernmental body that sets policies across Nordic countries. A renewable energy working group is looking into these issues and will report next year.

Denmark, having initially predicted a deficit of 337,000toe, now believes it will have a surplus of 63,000toe in 2020. Overall, the country envisages a 30% renewables contribution within a decade, to be achieved through more renewables and greater energy savings. In 2012, the Danish government will issue a progress report on how best to facilitate energy transfers to its neighbours and will consider joint projects.

In Italy, the plan was drafted by the economic development ministry, which has been without a minister for months. According to green campaigner Edoardo Zanchini of Legambiente, the plan does not enjoy the support of other key ministries, such as the treasury.

Technology choices

In most of the plans ENDS analysed, wind and solar power dominate growth over the next decade. Hydropower will retain its place as one of Europe's leading sources of renewable energy but will only grow slowly. Biomass generation is set to increase, especially in the heating and cooling sector.

Wind power is the undisputed rising star in the plans. Germany plans to increase its wind capacity to 45,750 megawatts in 2020, from just under 28,000MW, mainly from onshore sites.

Spain is also planning a large increase from onshore wind farms, while the UK plans a more even distribution, with the final 27,880MW coming mainly from onshore (14,890MW) but also from offshore (12,990MW).

Denmark, an early pioneer of wind power installations, stands out with its plans to decrease onshore wind farm capacity while increasing offshore to 1,339MW by 2020.

France, Italy, Spain and Sweden – the largest generators of hydropower at present – are not planning to grow much beyond what is already installed.

Solar energy looks set to dominate in Germany, where capacity is planned to jump to 51,000MW over the next decade. Very significant increases are planned in Italy, Spain and to some extent France. Smaller markets like the Czech Republic and the UK could also perform quite well.

Analysing the plans and speaking to experts, its has emerged that technology choices depend on political and strategic reasons as much as more obvious ones based on natural resources or geographical characteristics.

For example, France is keen to build integrated photovoltaics (BiPV), which eases the integration of PV in buildings and therefore public acceptance. Some experts consider BiPV unreasonably expensive compared with other PV technologies. But others point out that, once the money saved by not using conventional building materials is factored in, the expenditure can be considered an investment for the future.

Industrial policy may be an extra driver for BiPV because the French industry is better represented in this technology, according to Gaëtan Masson of European PV association EPIA.

Mr Masson believes the French government is keen to support emerging technologies where France can play a major role. As a result, it has introduced a specific feed-in tariff for BiPV, set at €0.37-0.58 per kilowatt hour. Italy is the only other EU country to have introduced such a feed-in tariff.

Measuring ambition

Spanish plans to significantly increase wind power capacity are not ambitious enough, according to some observers. "Five thousand megawatts of offshore capacity might sound optimistic, but history here shows that ambitious targets can be achieved and surpassed," says Heikki Willstedt of wind sector association AEE.

But this viewpoint does not take into account the current economic climate, others have noted. Wind power is an expensive start-up technology that also requires large infrastructural changes.

Ireland is reviewing planning legislation to facilitate installation of onshore wind farms. These are cheaper than offshore installations but are more likely to come across other obstacles, for example nature protection laws because the most suitable locations for wind farms are often on protected Natura 2000 sites.

Germany is leading the way in wind and solar installation. But some commentators are not overwhelmed by the government's ambition – an opinion further reinforced by its recent decision to postpone the shutdown of several nuclear power plants.

Having removed a number of obstacles to wind farm expansion, the German government can potentially look forward to a large-scale increase in wind power installations. But industry associations say the plan's targets are too weak: the German wind association, BWE, contends that another 10,000MW could be achieved on top of the government's figures.

Despite ambitious growth plans for wind and solar capacity, and uniquely good growth for hydropower too, the Spanish government is being criticised for a lack of political will to truly support renewables.

Critics say the solar and offshore wind targets are less ambitious than they could be because the government is finding it politically difficult to justify the higher feed-in tariffs these technologies attract. Both Spain and Italy are cutting subsidies for solar.

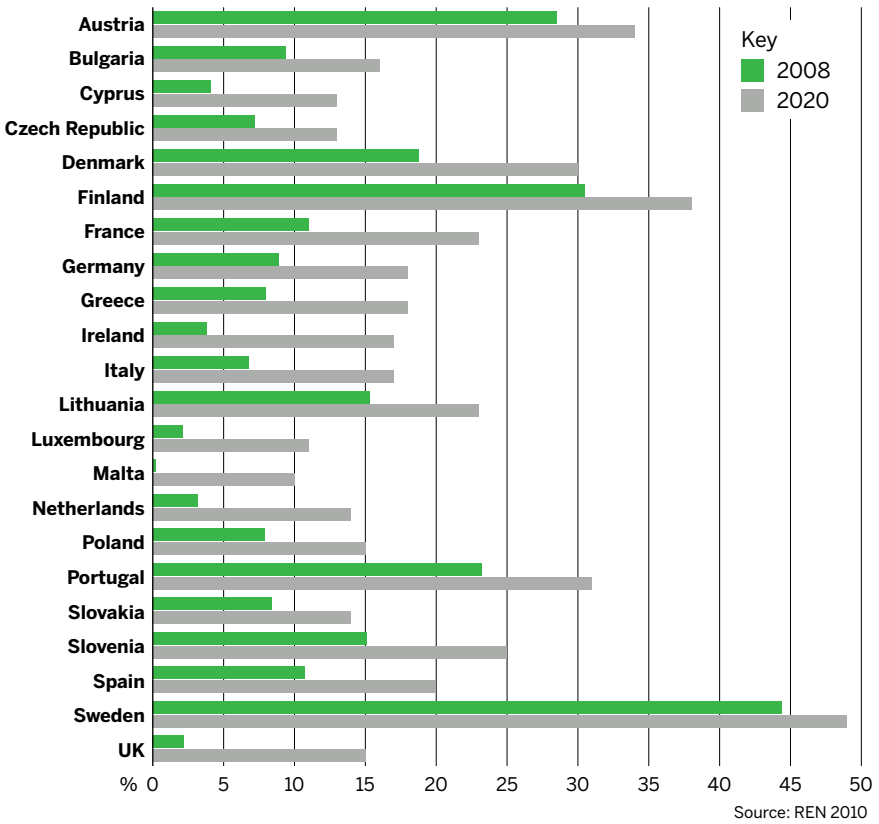
By 2020, Spain and Italy's combined solar power capacity should be nearly four times what it is today. And yet Italian experts have complained of a lack of ambition for photovoltaics, which they say exposes the country to expensive renewable energy imports.

Falling feed-in tariffs are affecting German photovoltaics too. Some experts believe demand could fall within the next few years if electricity prices increase.

Still in Germany, it is now a legal requirement for renewable energy sources to be incorporated into micro grids. And German development bank KfW is offering subsidised loans for renewable energy installations in residential properties.

Plans to use more biomass for heating are in place in countries with a long tradition and solid infrastructure to support these developments, for example Sweden and Finland. Progress appears much slower in countries where this type of infrastructure is nearly non-existent. ■

Figure 1
Share of final energy from renewables



Source: REN 2010

Enter the renewables revolution

Scratching the surface of EU countries' renewables goals reveals a tortoise and hare race to greening energy supplies

Big disparities exist between countries when it comes to the ambition of targets in the different sectors of heating and cooling, electricity and transport. The measure of how much farther each country will go is largely determined by how developed these sectors are today.

Ironically, member states with the lowest 2020 targets have the most ambitious plans. Countries such as Poland, the Netherlands and the UK, which are starting from a low level of renewables penetration, have a long way to go to reach their targets required under the renewable energy directive.

The plans submitted by countries such as Austria and Sweden, which have targets four times as high as the Netherlands or the UK, are far less onerous because they are already starting from such a high level. This is clearly visible in a breakdown by sector.

Across member states, targets for electricity are the highest and plans for increasing renewable energy in electricity generation are the most clearly laid out. Targets for heating and cooling are generally the second highest, but concrete policies for attaining these targets are often lacking. Targets for renewables in the transport sector are low across most member states, with few clear policies that would result in a significant uptake in biofuels or electric vehicles.

Heating and cooling: a challenge

Targets for the heating and cooling sector are the most divergent between member states: some countries already have well-developed renewable heating and cooling systems such as district heating; others have nothing at all.

The Netherlands has a 2020 target for the sector of just 8.7%, and the UK and Ireland each have a target of 12%. By contrast Denmark, where district heating is very important, has a 2020 target of 39.8%. That number might seem unusually high, but renewables already make up 30.8% of heating and cooling in Denmark. The country's 2020 target involves growing by less than a third.

In the UK, where renewables make up just 1% of heating and cooling, the target requires a 12-fold increase in renewables in the sector. But is it realistic? "The target for heating and cooling is very aggressive because district heating doesn't exist in the UK," says Ronan O'Regan, an energy and utilities analyst with PricewaterhouseCoopers. "The new coalition government has been basically silent on what they're going to do about renewable heating."

The UK's action plan does not contain any precise measures to achieve this ambitious target. The previous Labour government planned to bring in a 'renewable heat incentive' from next April, but the new Conservative–Liberal Democrat coalition government has not indicated whether it will be introduced. "If they do decide to keep it and it were implemented well, it could be enough to meet the 12% target," says Gaynor Hartnell, chief executive of the Renewable Energy Association. "But if they're not going to keep it, the coalition government hasn't suggested any alternative policies."

Germany has set a goal of 15.5% renewables by 2020, representing a 72% increase from today's 9%. Renewables advocates have criticised Germany's target for being similar to other countries that are starting from much lower district heating penetration.

Martin Bentele, spokesman for the German Renewable Energy Federation (BEE), says a target of 25% would be both achievable and realistic: "The heating sector accounts for more than half of energy consumption in Germany," he says. "There is an urgent need for a change to renewables [in that sector], otherwise it will be difficult to reach the German climate protection goals." BEE is calling for a renewable heat premium modelled after the feed-in tariffs for solar power.

The transition to heating and cooling is not easy: "We have to take stock of the existing system and acknowledge that it needs to change radically," says Marco Pezzaglia of Italian renewable energy association APER. For a country that relies heavily on natural gas for its heating, replacing this with a source that is distributed locally, for example biomass, is very complex. According to Mr Pazzaglia, costs will be significant but are not the only problems that need addressing. "Optimising the new system will require a lot of hard work," he told ENDS.

By far the most ambitious targets – and the most concrete policies – have been set in the electricity sector.

Eastern European countries are generally starting from the lowest points. Poland has a renewables share of just 6.2%. Lithuania has 8%, and the Czech Republic has 7.6%. They have set 2020 targets of 19.43%, 21% and 12.7% respectively, roughly double or triple their current share. But it is unclear whether the policies listed in the plans can deliver this growth.

Europe's renewable energy leaders, which are already starting from a relatively high base, have tended to commit only to modest growth over the next ten years. Finland, which currently has a 26% share of renewables, has set a 2020 target of 33%.

Sweden, whose hydropower capacity has given it a 2010 share of 54.9%, has set a 2020 target of 62.9%. Austria, which also has a massive hydropower infrastructure, has a 69.3% renewable share in its electricity sector today. But at 70.6%, its target for 2020 essentially commits it to no growth in renewables within the electricity sector for a decade.

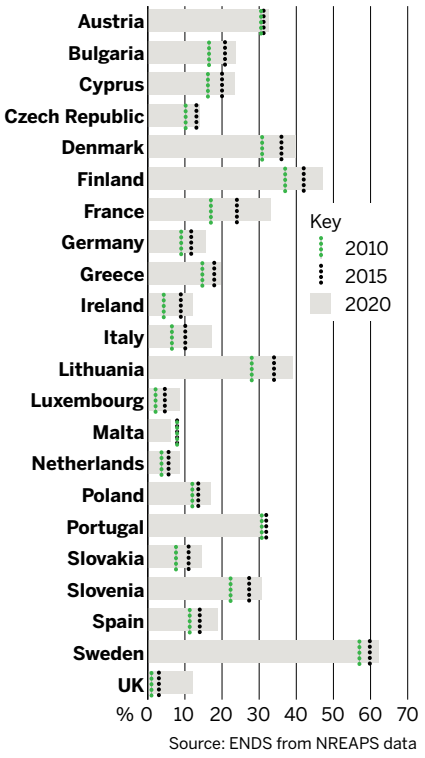
Ambitions disappoint

It is easy to understand why countries that are already close to the Renewable Energy Directive's requirements would not want to commit to extra growth unnecessarily. But environmentalists and politicians in the Nordic countries and in Austria are disappointed with ambition levels in action plans, especially when compared with those of other EU member states that are starting from much lower levels.

Austrian MEP Rainer Widmann, who speaks on energy issues for his party BZO, has called Austria's effort a "non-action plan". Rudi Anschober, the state of Upper Austria's energy minister, has called Austria's targets "unbearably unambitious".

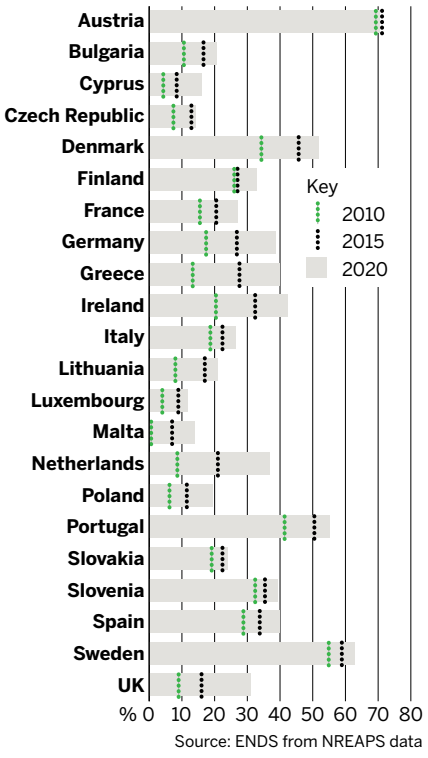
Lauri Myllyvirta, energy spokesman for Greenpeace in Finland, is disappointed with his country's targets. "The target for electricity is pathetically low, due to the Finnish government's present philosophy of taking care of electricity demand through major investments in nuclear capacity," he says. "Some increases are projected for wind power, but these are quite unambitious – as are targets for using forest biomass to generate electricity."

Figure 1
Renewable energy in heating and cooling



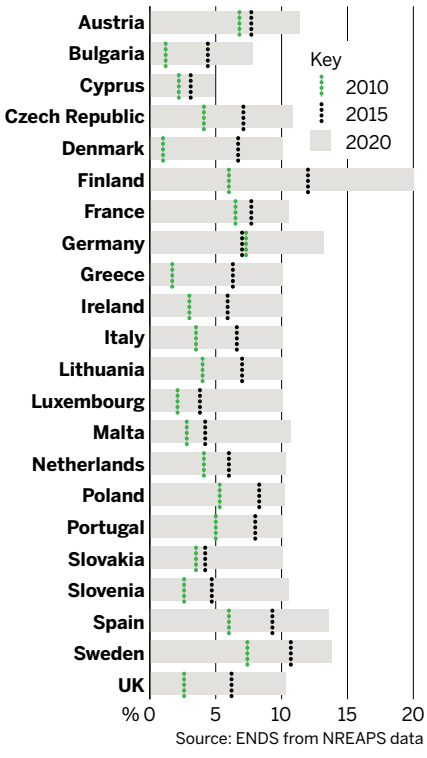
Source: ENDS from NREAPS data

Figure 2
Renewable energy in electricity



Source: ENDS from NREAPS data

Figure 3
Renewable energy in transport



Source: ENDS from NREAPS data

Nobody can accuse the UK of low ambition. With renewable energy currently contributing just 9% to electricity generation, the 2020 target has been set at 31%.

The British government has put most of its eggs in one basket: offshore wind power. Mr O'Regan says that, because of the UK's huge potential for wind power, offshore wind would be enough to deliver the targets if the financing could be found. "Delivery of a few offshore wind farms could achieve this target," he says. "This will be the easiest sector for the UK to meet [its targets]."

The Netherlands' target is ambitious but experts question whether current policies can deliver it. Because the Dutch have favoured coal plants, their renewable energy share rests at just 8.6% in 2010. The action plan sets a target of 37% by 2020, representing a 430% increase in ten years.

Such an ambitious target would be a stretch at the best of times, but it is even more of a challenge now because there is currently no Dutch government and ongoing coalition talks are pointing at a likely minority coalition between Conservatives and Liberals. The latter party has been sceptical of climate change and renewables policies.

Neighbouring countries have far more realistic targets, but they are starting from a higher level. Germany, Italy and France are starting from 'teen' levels and aiming to reach the high twenties or – in the case of Germany – a solid 38.6%.

The transport sector has the lowest targets in each member state. It is also the sector with the most consistency between countries, with most targets hovering around the 10% EU target.

The UK and Ireland have set targets of 10% by 2020, up from about 3% each in 2010. Germany's 2020 target for transport is 13.2% from 7.3% in 2010. France has a 2020 target of 10.5%, from a 2010 share of 6.5%. Even in Austria, where the other sector targets are quite high, the transport target is only 11.4%, up from 6.8% in 2010.

Few transport options

One of the reasons the targets appear less ambitious than in the other sectors may be that this is an area with relatively few policy options. "There are three ways to increase the share of renewables in transport: biofuels, better vehicle efficiency and a move to electric cars," says PwC's O'Regan.

Electric vehicles and better vehicle efficiency rely on the private sector for technical innovation, leaving biofuels as the main policy area for government. But the action plans contain few concrete policies for biofuels.

Germany's plan, for instance, has no new policies for encouraging biofuels use despite falls in subsidies and market share. "The biofuels sector faces the biggest obstacles," says Claudia Kemfert, head of the energy department at the German Institute of Economic Research. "The reduction of tax breaks has led to a decline in sales, in particular of biodiesel. Although the use of ethanol has increased, assuming a doubling of the use of biofuels is very optimistic."

The Spanish action plan sets a 18.8% 2020 target from a 2010 level of 7.4%. Beatriz Álvarez, a project manager with APPA Biofuels, says while that target may be in line with other member states, the plan is not making full use of existing law in Spain. "The compliance path has no growth projected in 2010-13 for biodiesel or 2010-16 for bioethanol," she says. "This is too pessimistic and doesn't reflect reality. The new regulations due to come into force will raise from 5% to 7% the allowed additive of biodiesel and from 5% to 10% the allowed additive of bioethanol to petrol."

As for buildings' energy performance, there are drastically different targets – and several ways of accounting for them. The figures are quite simply all over the place. ■

The economics of renewables

Countries' ability to build capacity will determine whether they can meet their targets. Financing this growth will pose a major challenge

The National Renewable Energy Action Plans (NREAPs) give a detailed picture of how much extra capacity is needed to meet national targets for the electricity, heating and cooling, and transport sectors. But while they display some sound planning and a significant amount of goodwill on the part of member states, the plans are just figures on paper. The challenge will be to deliver the investments needed to build capacity.

Little information on future investments in renewable energy appears in the action plans. Member states were invited to provide data on the costs and benefits of the measures detailed in their plans but few did so. A reason often given is that it is too early to make such predictions.

Some plans are based on calculations and assumptions made by national energy agencies or government departments in earlier reports, but these documents are generally not mentioned. Only the UK plan, which is expected to be revised by the new coalition government, refers to the impact assessment of a 2009 renewable energy strategy.

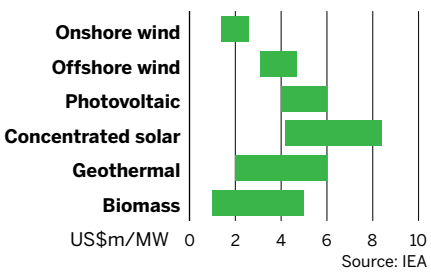
Sketchy details

The information available is sketchy. Some countries give figures. For example, Slovenia predicts that measures in support of renewables will cost about €456m for electricity and €442m for heating and cooling in 2010-20. In July, the Luxembourg energy ministry said implementing its plan would cost about €830m, including €231m for electricity, €178m for heating and cooling, and €143m for biofuels.

Other countries have chosen to focus on their plans' benefits. Spain predicts jobs in the renewable energy sector to rise from 70,152 in 2010 to 128,373 in 2020. Portugal expects to employ about 100,000 green energy professionals, compared with 400,000 in Germany. Some plans include information on the expected greenhouse gas emission savings and reduced oil and gas imports. Portugal, for example, says it could save up to €2.3bn on imports annually if the plan is fully implemented.

Working out what the extra capacity will cost is a tricky business. There are figures on the cost of each technology but these can vary greatly depending on location. For example, the cost of buying and installing a three-kilowatt photovoltaic (PV) installation is much lower in Germany, at about €9,000, than in France at €15,000.

Figure 1
Estimated capital costs



Source: IEA

The figures are also difficult to compare because they often include differing kinds of costs. There are capital costs, also known in the jargon as 'turn-key prices', and operation and maintenance costs. Capital cost figures can be misleading because they may not include consultancy fees, the price of equipment such as wind turbines and construction costs.

Using such data to estimate investment needs risks amounting to nothing more than wild guessing. But reliable information on standard costs does exist, in technology roadmaps and sectoral papers called Renewable Energy Essentials produced by the International Energy Agency (IEA).

Even these figures must be taken with a pinch of salt, however. Technology prices drop regularly making the figures date rapidly. PV industry body EPIA's Gaëtan Masson says his sector is already assuming a cost of €2m per megawatt of installed capacity compared with the IEA's $4-6m/MW range (€3.14-4.72m/MW). It is safe to assume that current prices are slightly lower than those cited in the most recent IEA literature.

In its *RE-thinking 2050* report, renewable energy umbrella body EREC predicts total cumulative investments will be €963bn by 2020, rising to about €1,629bn in 2030. Dörte Fouquet, director of the European Renewable Energies Federation, believes PV investments will be higher than current estimates given this sector's rapid development. She predicts slightly less investment in biomass than anticipated because of the ongoing debate over its sustainability.

The bulk of renewable energy investments will cover capital costs. Operational and maintenance costs tend to be low. For PV they represent 1-1.5% of an instilation's initial cost. Investment needs will depend on technology prices and planned extra capacity.

An analysis of future capital costs based on IEA prices shows funding requirements to meet national targets. Costs vary greatly because of technologies' large price range, and are generally expected to fall as technologies become more competitive.

The largest PV investment is set to be in Germany, with planned additional capacity of 35,969MW between 2010 and 2020 and capital costs amounting to €112.9-169.7bn. EPIA estimates investment in Germany to be €72-79bn.

Italy and Spain are also planning massive investment in PV capacity, with €19.8-29.7bn and €13.6-20.5bn respectively. Costs are higher than for other technologies because PV is still relatively expensive.

Spain will be the largest investment hub for onshore wind power, with €16.3-30.2bn, followed by the UK and Italy. The UK is set to invest the most in offshore wind power with €28.3-42.9bn. Germany and the Netherlands come second and third with €24-36.4bn and €12-18.3bn respectively. Investments in electricity from biomass are much lower compared with other renewable technologies.

Financing projects

Most funding is expected to come from the private sector. Banks will finance the construction of extra capacity, especially for large projects, with investments being paid back through feed-in tariffs and other support schemes. Some funding is also expected to come from the EU's Strategic Energy Technology plan, which will invest several billions of euros in major renewable energy projects.

Some projects are easier to finance than others. For example, onshore wind power projects are quite straightforward. Western Europe is dominated by small onshore farms with an average capacity of 100MW. The largest project is a 600MW installation in Romania.

Projects of this size can be managed by a small- or medium-sized company, according to Jacopo Moccia of wind power trade association EWEA. "The banks will give out a loan without great difficulty because the economics are straightforward," he says. Installations in France will get €80/MW hour produced over their 15-20 year lifetimes. It will take 7-12 years to pay off the loan, which means investors will cash in on these projects for about eight years.

Offshore wind projects have more complex funding structures because they are much larger projects based on a technology that is not yet mature. Projects always involve more than one bank, plus utilities and several other participants. Costs are reflected in the feed-in tariffs: €130 per MWh produced in France, which is a mark-up of nearly 50% on the onshore support.

Few EU countries plan a major increase in offshore capacity. But for those that do, such as the UK, raising the funds could be a challenge. Andrew Buglass of the Royal Bank of Scotland, one of the largest investors in renewable energy, told a conference in June that "fear of the unknown" and the complexity of deals were making lenders cagey.

Lack of finance – due to banks' reluctance to lend following the global financial crisis – remains a problem, especially for the offshore wind sector. Projects led by utilities are less affected because they can fund investments from their own balance sheets. But independent developers are severely constrained, according to EWEA.

However, utilities' spending power is not unlimited because they are also investing heavily in other areas such as nuclear reactors and grid upgrades. Another key player is the European Investment Bank. The bank's loans are instrumental in the construction of the one-gigawatt London Array wind farm in the North Sea. A total of £500m (€611m) has been granted so far, a second loan having been agreed in July.

Finance remedies

Consultancy PwC recommends several remedies to address the scarcity of pre-construction finance in the UK. These include underwriting risks through new taxes such as a levy on electricity consumers, additional Renewable Obligation Certificates (ROCs) for a limited period, or making offshore investments tax free for the public through individual savings accounts (ISAs).

Investment in the sector could also be opened up to pension funds if risk prospects were lowered, perhaps through a regulated asset scheme with capped liabilities for cost over-runs.

A key condition for attracting investors is to provide a stable regulatory framework. Feed-in tariffs provide stability because they remain valid for 15-20 years depending on projects. But tariffs for new projects are regularly reviewed, with the possibility of significant cuts in the subsidies.

These cuts generally reflect the increasing competitiveness of renewable energy technologies. In July, German environment minister Norbert Röttgen defended cuts in his country following a steep drop in the price of solar panels, leading to "unacceptably high returns" for operators in the sector and much higher prices for consumers. In 2010, solar power incentives will cost German consumers an extra €0.02 per kilowatt hour of electricity.

But feed-in tariff revisions can come across as arbitrary, fuelling uncertainty among prospective investors. Spain's response to its overly generous regime has been seen as too harsh, with some saying the cuts could damage the entire PV sector for years.

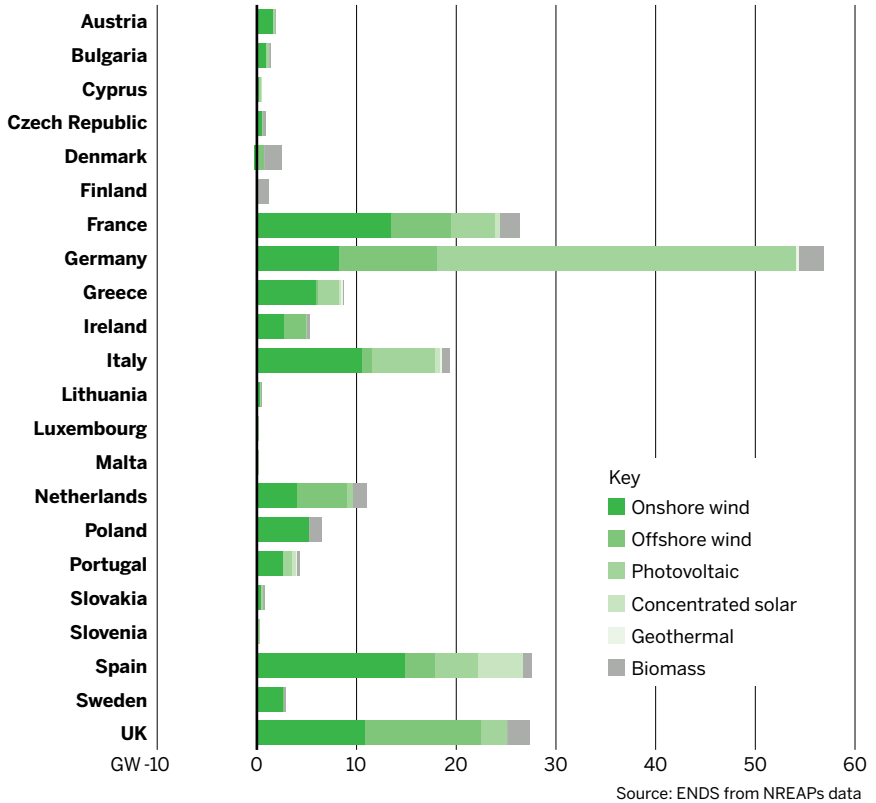
While the European economy is recovering slowly, the use of incentives for PV should remaine measured and proportionate – and follow the price evolution of PV systems – according to EPIA's Mr Masson.

With grid parity starting to become a reality in some southern European countries, guaranteed support for PV deployment in the coming years is crucial. Without a commitment of this kind, policymakers may be pressured into reducing or stopping incentives altogether.

According to Mr Masson, the Spanish government even tried to revise downwards previously agreed tariffs, which could have seriously undermined the confidence of investors in any environment that is highly reliant on stable regulation.

In the UK, the reform of the renewables obligation in 2009 boosted morale in the offshore sector. Operators will be awarded 1.5 certificates per MWh produced – compared with one for onshore projects – which is more generous than some had anticipated. But there is uncertainty over how the new government will take the support scheme forward. A possible switch to feed-in tariffs is causing concern at a time when investment in new offshore capacity needs to grow significantly. ■

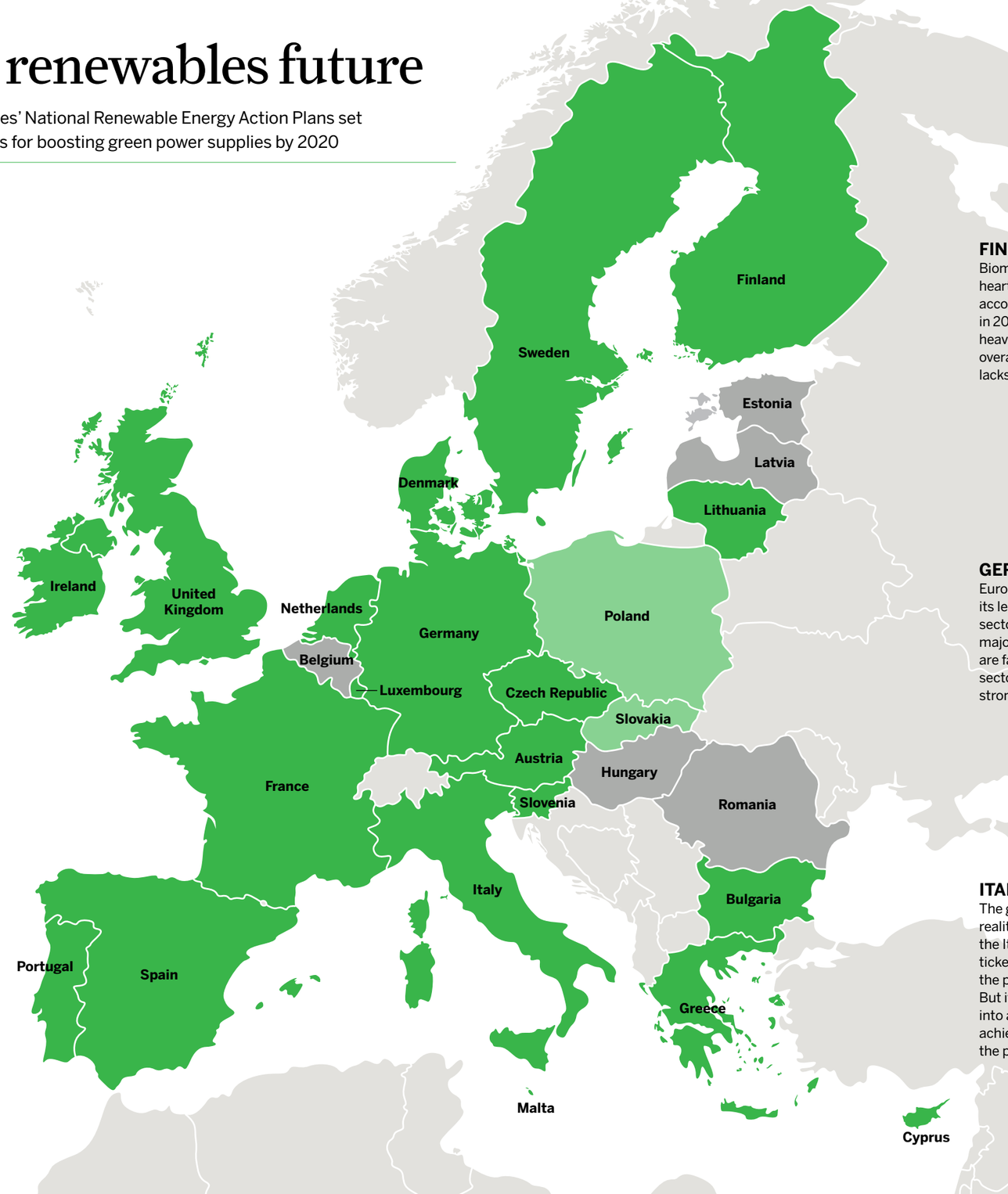
Figure 2
Additional installed electricity capacity 2010-20



Source: ENDS from NREAPs data

Europe plans renewables future

Member states' National Renewable Energy Action Plans set out strategies for boosting green power supplies by 2020



UNITED KINGDOM

The UK has a mountain to climb, having to grow the share of renewables in its energy mix from 2.2% in 2008 to 15% in 2020. The UK's ambitious plans are heavily reliant on offshore wind, a costly and relatively new technology. Critics say action on the energy efficiency front is still too timid.

FRANCE

Hydro and wind power will provide the bulk of French renewable energy in 2020. Electricity generation from biomass is seen as more efficient than solar power. But green campaigners have criticised the government for lacking ambition in the development of photovoltaics.

SPAIN

A renewables success story, Spain is planning to increase its onshore wind power capacity and boost solar power production through photovoltaics and concentrated solar power. Concerns exist that recent government action to cut subsidies might hinder the sector, but interconnection links with the rest of Europe remain the biggest challenge.

FINLAND

Biomass – specifically wood – will be at the heart of Finland's green energy revolution, accounting for 55% of renewable sources in 2020. The Finnish government is relying heavily on heating and cooling to reach its overall target, leading to claims that the plan lacks ambition for the electricity sector.

GERMANY

Europe's industrial powershouse extends its leadership to the renewable energy sector, where it plans to dominate in all the major technologies. Government subsidies are falling but observers are confident the sector will continue to thrive on the back of strong public and industry support.

ITALY

The gap between its ambition and the reality of delivering on it looms large for the Italian plan. Critics say the government ticked the right boxes on paper but lacks the political will to make things happen. But if the current lack of focus translates into a flexible, open-minded approach to achieving the targets, they see Italy having the potential to seize this opportunity.

Will government policies rise to the renewables challenge?

Feed-in tariffs and planning reforms are on the cards, but few governments are ready to spell out detailed policies

Countries' action plans differ significantly in terms of the quality and quantity of information they provide. Some extensively outline the policies the governments are planning to introduce to help meet the targets they have set, while others list next to nothing.

In many cases, the lack of detail is the result of a recent change in government. In others, member states have told ENDS that decisions on policies are still being taken. For instance, a representative for the Finnish energy ministry said full details are missing because new support systems are being developed and final decisions on them will not be taken until 2011.

But a pattern is emerging for those countries that have outlined concrete new policies: financial incentives for renewables, such as feed-in tariffs, are a popular choice, though timelines are less clear.

Other more specific policies, such as programmes to encourage take-up of biogas, are thin on the ground. And while some countries have chosen to tackle planning permission problems for onshore wind and solar, others have for the moment left those problems unresolved.

Price stability

Financial incentives are a particular focus of most policies for which details are presented. Countries that experienced recent fluctuations in their feed-in tariffs for solar energy were particularly keen to indicate some price stability.

Spain, which has caused some market turbulence by lowering its subsidies, says in its plan that it has a policy goal of "creating a stable and predictable price framework for renewables producers by 2011". But there is no indication of how this might be achieved. Heikki Willstedt from wind sector industry association AEE told ENDS she sees no sign that the creation of a stable and predictable price framework is imminent.

Neighbouring Portugal faced a similar problem when it lowered its feed-in tariffs in 2005. But its action plan contains no mention of a policy goal to create a stable price framework. Antonio Sá da Costa of Portuguese renewable energy association APREN says this is a problem because the government has failed to take into account the impact of the economic crisis coupled with increasing expense and requirements from grid operators.

Lithuania plans to introduce incentives to boost wind power installed capacity to 500 megawatts, solar power installations to 10MW, and bio-cogeneration to more than 162MW in 2014. And in the UK a feed-in tariff structure was introduced for installations under five kilowatts.

> **"An area of concern that most plans have focused on is how to facilitate access to electricity grids for renewable energy generators**

Another area of concern that most plans have focused on is how to facilitate access to electricity grids for renewable energy generators. In the Netherlands, it is the only planned measure listed.

The Dutch Priority for Renewables legislative proposal would give priority grid transport to renewables from 2010 onwards. Under the proposal, new entrants will be connected immediately instead of having to wait for sufficient grid transport capacity to become available. But consultancy CE Delft says this proposal would have little to no effect. The measure will give physical priority to renewables but without significant funds allocated to it – in other words, it does not give them economic priority.

By contrast, Lithuania intends to take some extensive measures to ensure access to the grid for renewables. In its action plan, the Lithuanian government says it is preparing draft laws that will oblige transmission and distribution system operators to provide access for renewables producers. It will also force them to upgrade and manage the grid so that its capacity allows renewable energy producers to increase production. A financial support scheme to turn the grid into a smart network in 2011-15 is to be put in place using EU structural funds.

Spain is also planning to roll out smart grids for electricity transport and distribution in 2012-20. Experts have observed that the planned measures are promising, but that gauging their efficacy over the next decade is a tall order. According to Ms Willstedt, the level of investment into research and development needs to be raised.

Planning reform

Beyond electricity grid access, another big problem for renewable energy generators has been obtaining permission to build facilities. Countries have a wide range of proposals for dealing with the problem, with varying degrees of ambition.

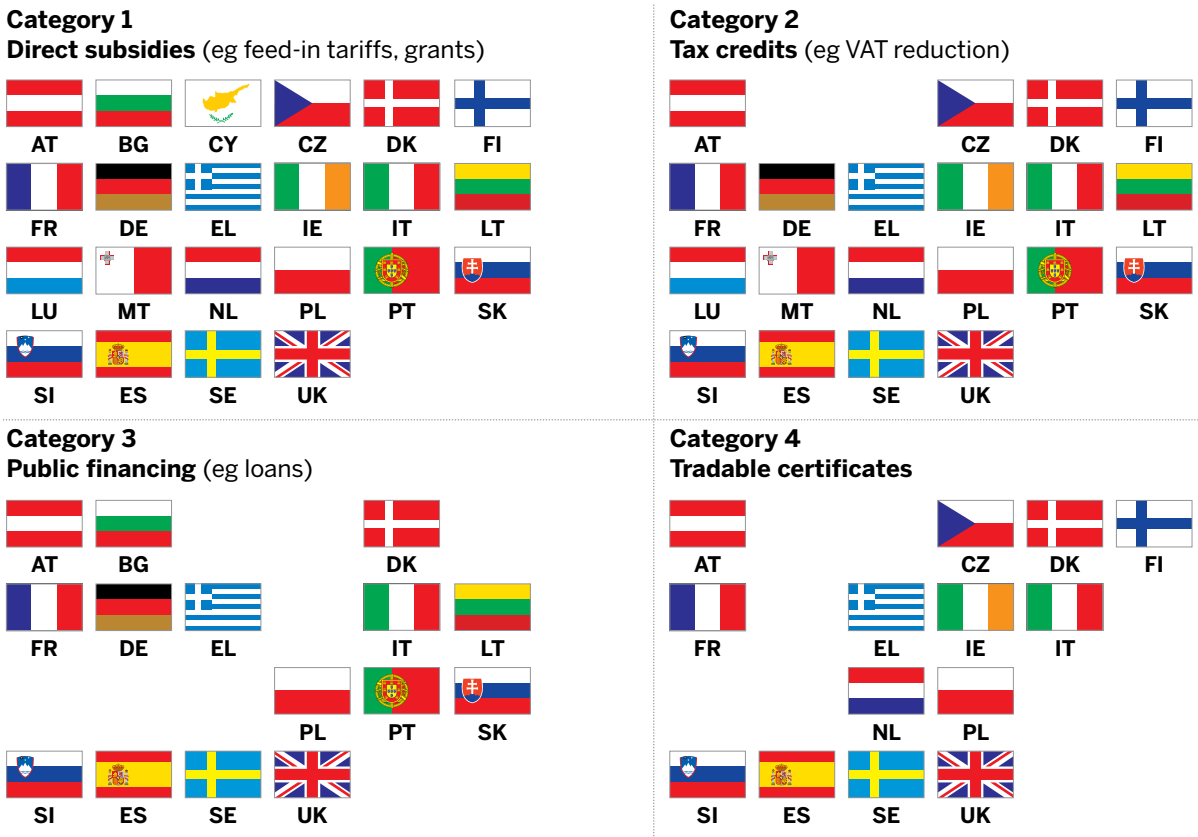
Lithuania is planning to pass legislation in 2010 to force local authorities to promote renewable energy sources. Portugal wants to revise its wind generation regulation in 2010-11 to reduce red tape and increase production. It is also planning to create a one-stop shop for licensing new installations – a facility other countries are also considering.

In Ireland, a planning bill currently going through the legislative process would make it easier to build large-scale projects. Another planned change in legislation would make permissions for offshore development closer to land-based planning.

The European country where planning difficulties have got the most attention is the UK, where many blame the 'not in my backyard' stance of local planning authorities for the failure of the UK to fully harness its significant onshore wind potential.

The British government has created an infrastructure planning committee to authorise projects over 50kW. But this would still leave small- and medium-sized projects exposed to the vagaries of local councils' decision-making processes.

Figure 1
How member states plan to encourage renewable energy production and use



Source: Energy research Centre of the Netherlands

"An installation under 5kW will fall under the feed-in tariff scheme, and over 50kW will fall under the Infrastructure Planning Committee," says Ronan O'Regan, an energy analyst with PricewaterhouseCoopers. "But in between there is a gap with no remedy to solve the planning permission problem, so it will still be difficult to have medium-sized onshore installations."

The new British government is considering another policy option, which is not mentioned in the plan. "The new government is talking about local communities keeping business rate proceeds for the first six years of a project, which would make it much more likely to receive their approval," says Gaynor Hartnell, chief executive of the Renewable Energy Association.

Biowaste and biogas

Several countries are planning to introduce new measures to encourage the generation of heat from biowaste. In 2014-20, Spain aims to use 5.5 million tonnes per year of agricultural and forestry waste for energy production. It is also earmarking public sector investment for research into energy storage, cost reduction in solar and wind generation, and into developing deep-sea energy generation. In addition, Spain plans to promote the diversion of combustible material from landfill in 2016-20.

In Portugal, the government's Calor Verde programme will finance installation of biomass heat recovery systems and microgeneration from 2010, with the aim of saving 16,020 tonnes of oil equivalent in 2015 and 25,094toe in 2020.

This would not be making adequate use of Portugal's potential, according to some. "We believe there should be specific regulatory measures to aid the incorporation of electricity production with biogas," says Rita Antunes of environmental NGO Quercus. "Portugal could produce an estimated 660 gigawatts per year, which is equivalent to 150MW of installed capacity. The burning of waste is being given priority to the detriment of the more environmentally friendly combustion of biogas."

According to Ms Antunes a re-evaluation of biomass plants is needed, so they can produce heat as well as power.

In the UK, a biogas feasibility study accompanied by demonstration projects is set to begin by 2011. Its aim would be to support the construction of new composting and anaerobic digestion facilities that process food waste.

Heating measures

Member states have also outlined several policies to encourage renewable heating. Lithuania is amending legislation to ensure new property developments can be heated and cooled with renewables.

Spain is planning incentives for renewable heat in thermal renewable energy installations. Portugal is introducing measures to promote the production, certification and storage of biomass and geothermal pilot projects.

Portugal is also planning to allow biogas to be transported in the gas grid so it can be used for heating and cooling.

In the UK, a renewable heat incentive announced by the previous Labour government was scheduled to go into effect in April 2011, but the new Conservative-Liberal coalition has not yet announced whether it will keep the policy. ■

What stands in the way of renewables development?

Electricity grid access and public acceptance of infrastructure upgrades pose significant challenges for bringing more renewables on-line

Even though it remained the world's top destination for renewable energy investment in 2009, the EU saw funding drop by about 10% compared with the previous year. The drawn-out financial-cum-economic crisis is clearly hindering a sector that is so heavily dependent on fresh financing to pursue its development.

But despite growing financial problems and renowned planning permission nightmares, the biggest obstacle to the large-scale deployment of renewables in Europe is the electricity grid.

The existing grid was built to handle large, predictable volumes of fossil-fuel energy, not unpredictable, fluctuating volumes of renewables. Nor was it designed to connect areas across Europe.

More transmission lines are needed to connect new renewables projects and enable energy to flow across the EU. Better grid connections also reduce the need for energy storage technologies. The grid must become more resilient and flexible, ultimately becoming a 'smart' grid that can absorb the variability of renewables and modulate demand in response to supply.

A monumental task

Many large-scale renewables projects are in the works, from vast wind farms in the North and Baltic Seas to concentrated solar power plants in Spain and North Africa. These will require a whole new infrastructure of monumental scale to transmit their produce. Getting this infrastructure in place is a make-or-break challenge, for Europe and for its members.

Malta's 10.2% renewables target for 2020, for example, hinges on the construction of a grid interconnector between it and the Italian island of Sicily. Its own grid could not handle the peak-time input from the offshore wind farm the space-constrained island needs to meet its goal.

Potential renewable energy exports from Ireland and Portugal are contingent on new interconnectors. Similarly, a giant 47 gigawatt interconnector between France and Spain will be essential to transport renewables power from Spain to the rest of Europe in future. Spain will provide a large amount of Europe's wind and solar power. These two technologies together will make up most of Europe's energy supply by 2050, the European Climate Foundation (ECF) predicts.

Cross-border interconnection remains poor in Europe today. The European Commission in June admitted that Italy, Ireland, Spain and the UK have still not met a non-binding interconnection target of 10% for 2005 set at a Barcelona summit in 2002.

> **"A stable and predictable support system will attract investors and commercial lenders into the renewables sector because outlays that they will need to commit will effectively be smaller**

Of the new member states, Cyprus, Malta and Poland are poorly connected.

To address this, the companies running Europe's high-voltage transmission grids set out a cross-border investment plan for the next ten years this summer. The European Network of Transmission System Operators for Electricity (ENTSO-E) released a preliminary version of the ten-year network development plan it is required to draw up under the EU's third energy package.

Excluding national and local investments, this foresees the operators building or refurbishing over 40,000 kilometres or 14% of the European transmission grid by 2020, at a total cost of €23-28bn. A super grid for offshore wind power in the North Sea accounts for about half the investment.

For all transmission projects, social acceptance remains the biggest obstacle, leading to long delays in obtaining permits for new transmission infrastructure. But financing is also becoming more of a problem, according to Konstantin Staschus, secretary general of ENTSO-E.

Where is the money?

Financing is perhaps the second biggest challenge facing renewable energy projects today. The impact of the economic crisis cannot be underestimated. But a look at Europe's most successful renewables stories – take Germany – reveals the role that subsidies can play.

Germany's feed-in tariff system is credited with creating the country's enviable renewables capacity. A renewable heat premium modelled on this tariff is what is needed now to boost the green heat sector, according to the German Renewable Energy Federation BEE.

Investments in renewables can be a risky business and a feed-in tariff provides investors with a guaranteed revenue stream. "A stable and predictable support system will attract investors and commercial lenders into the renewables sector because outlays that they will need to commit will effectively be smaller," says Andrzej Dejneka, director general at the Polish Economic Chamber of Renewable Energy (PIGEO). He says Poland will not meet its 2020 renewables target without introducing a feed-in tariff.

The very success of feed-in tariffs in some countries – Germany, Spain, Italy and France – has led to recent cuts in their levels to avoid overheating the market. These cuts do not appear to be having a negative impact so far, although the representative industry associations have uttered warning cries about cutting too much too soon.

In countries where feed-in tariffs have not been used, like the UK for example, renewable growth has been much slower. Offshore wind, which is at the heart of British plans to boost renewables capacity, needs a flow of up to €12bn a year, developers estimate.

A study by consultants PwC suggests tapping into a new Green Investment Bank announced by the British government, alongside a number of other meas-

ures. These include additional renewable obligation certificates for a limited period; underwriting risks through new taxes such as a levy on electricity consumers; making offshore investments tax-free for the public; and opening up the sector to pension providers by lowering risks through, for example, a regulated asset scheme with capped liabilities for cost over-runs.

Finding the perfect place

In some cases, planning permission presents the greatest challenge. Planning decisions are taken at local level and opposition to a useful but 'ugly' wind park can be hard-bitten. For onshore wind in the UK, obtaining a permit to build is the biggest problem, says Ronan O' Regan at PwC.

A recent decision to do away with regional development agencies has removed a check on local authorities' rulings on small wind projects that will only increase the difficulties, adds Gaynor Hartnell, chief executive of the British Renewable Energy Association.

The Italian association of renewables producers (APER) has said that better planning procedures – not higher incentives – will enable the country to meet its energy and climate targets. Maja Wessels, executive vice-president for global affairs at solar panel maker First Solar says "40 levels of permission" can be needed for a solar installation permit in Italy.

Apart from public opposition, nature conservation can also block planning permission. Already in 2007, Poland's Chamber of Renewable Energy warned that implementing the EU's Natura 2000 network of protected sites could undermine the development of green energy. The Irish and Slovenian governments too have recognised that the prime sites for wind turbines tend to be the most environmentally sensitive.

Wind projects must undergo environmental impact assessments to get the go-ahead. Some say these are only as good as people want them to be, others cite examples of wind farm proposals being rejected on biodiversity grounds – for example on the Isle of Lewis in Scotland in 2008.

Delays in implementing biodiversity legislation are also problematic for renewables development. Offshore wind faces great uncertainty over its future in part because most member states have yet to designate protected marine areas.

Some problems are unique to specific countries. For example, Finland foresees a bright future for biomass, but acknowledges this is highly dependent on trends in the Finnish forest industry, strong sustainability standards and enough labour for harvesting.

Other countries spell out problems they perceive as unique but which seem to crop up elsewhere and may yet spread further. This is the case for the Netherlands, where energy experts say looming excess coal and gas capacity will make it uninteresting for utilities to invest in renewables.

A new "Priority for Renewables" law gives physical but not economic priority to renewables on the grid, CE Delft director Frans Rooijers told ENDS.

In Germany, green group Deutsche Umwelthilfe (DUH) warns of a similar problem: the government will be under pressure to curtail the priority it gives to renewables the more nuclear and coal power plants are operating in 2020.

The challenge of upgrading the grid comes down not nearly as much to national renewables action plans as to implementation of the third EU energy package. In the end, EU regulators need to set the right incentives to make network operators' investments profitable. ■

Conclusion

Addressing grid, social and funding obstacles is the key to bolstering the renewables revolution swiftly taking hold in Europe

If there is one conclusion to draw from our analysis of the National Renewable Energy Action Plans, it is that the challenges for member states as they prepare to embrace the renewables revolution are multi-faceted. They range from the financial to the social, from the political to the environmental.

The European Commission's latest energy scenario for 2030 points to demand falling even further than previously expected. And EREC has announced that renewable energy sources are growing much faster than the EU estimated a decade ago.

With renewable sources quickly becoming a major part of the EU's energy mix, it is important to face the obstacles in their way.

Grid connections, social acceptance and funding are the three key hurdles. On the issue of grids, all eyes are on the commission's eagerly awaited energy infrastructure package, due in November. It is hoped it will provide a clear way forward.

Better communication with the public can smooth out parts of the planning process. EU member states are starting to recognise this: a pan-European initiative led by the Scottish government to study examples of good practice in planning and approval of wind farms, led by the Scottish government, will produce a toolkit to generate better quality wind farm proposals.

Future reforms must avoid sudden drops in confidence delaying project developments. Investors are sensitive to panic reactions: hurried decisions could undermine member states' efforts to meet renewable energy targets.

The technology is there and governments have introduced incentives and support for renewables. Now policymakers must take an axe to the obstacles that remain. ■

Data tables

Table 1
Final energy from renewables (%)

Country	2008	2020
Austria	28.5	34
Bulgaria	9.4	16
Cyprus	4.1	13
Czech Republic	7.2	13
Denmark	18.8	30
Finland	30.5	38
France	11	23
Germany	8.9	18
Greece	8	18
Ireland	3.8	17
Italy	6.8	17
Lithuania	15.3	23
Luxembourg	2.1	11
Malta	0.2	10
Netherlands	3.2	14
Poland	7.9	15
Portugal	23.2	31
Slovakia	8.4	14
Slovenia	15.1	25
Spain	10.7	20
Sweden	44.4	49
UK	2.2	15

Source: REN 2010

Table 2
Population and surface area per country

Country	Population (2008)	Surface area (km^2)
Austria	8,318,592	83,871
Bulgaria	7,640,238	111,002
Cyprus	789,269	9,250
Czech Republic	10,381,130	78,867
Denmark	5,475,791	43,098
Finland	5,300,484	338,145
France	63,982,881	632,834
Germany	82,217,837	357,030
Greece	11,213,785	131,957
Ireland	4,401,335	69,797
Italy	59,619,290	301,336
Lithuania	3,366,357	65,300
Luxembourg	483,799	2,586
Malta	410,290	316
Netherlands	16,405,399	41,528
Poland	38,115,641	312,685
Portugal	10,617,575	92,002
Slovakia	5,400,998	49,034
Slovenia	2,010,269	20,273
Spain	45,283,259	505,997
Sweden	9,182,927	441,370
UK	61,179,256	243,069

Source: Energy research Centre of the Netherlands

Table 3
Renewable energy in heating and cooling (%)

Country	2010	2015	2020
Austria	30.5	31.2	32.6
Bulgaria	16.5	20.8	23.8
Cyprus	16.2	20	23.5
Czech Republic	10.2	13.1	14.1
Denmark	30.8	36	39.8
Finland	37	42	47
France	17	24	33
Germany	9	11.7	15.5
Greece	14.7	17.9	19.7
Ireland	4.3	8.9	12
Italy	6.5	10.1	17.1
Lithuania	28	34	39
Luxembourg	2.1	4.6	8.5
Malta	7.9	7.9	6.2
Netherlands	3.7	5.6	8.7
Poland	12	13.6	17
Portugal	30.7	31.9	30.6
Slovakia	7.6	11	14.6
Slovenia	22.3	27.3	30.8
Spain	11.3	14	18.9
Sweden	57	59.8	62.1
UK	1	3	12

Source: ENDS from NREAPs data

Table 4
Renewable energy in electricity (%)

Country	2010	2015	2020
Austria	69.3	71.2	70.6
Bulgaria	10.6	16.6	20.6
Cyprus	4.3	8.4	16
Czech Republic	7.4	12.9	14.3
Denmark	34.3	45.7	51.9
Finland	26	27	33
France	15.5	20.5	27
Germany	17.4	26.8	38.6
Greece	13.3	27.6	39.8
Ireland	20.4	32.4	42.5
Italy	18.7	22.4	26.4
Lithuania	8	17	21
Luxembourg	4	8.9	11.8
Malta	0.6	7	13.8
Netherlands	8.6	21	37
Poland	6.2	11.5	19.4
Portugal	41.4	50.5	55.3
Slovakia	19.1	22.4	24
Slovenia	32.4	35.4	39.3
Spain	28.8	33.8	40
Sweden	54.9	58.9	62.9
UK	9	16	31

Source: ENDS from NREAPs data

Table 5
Renewable energy in transport (%)

Country	2010	2015	2020
Austria	6.8	7.7	11.4
Bulgaria	1.2	4.4	7.8
Cyprus	2.2	3.1	4.9
Czech Republic	4.1	7.1	10.8
Denmark	1	6.7	10.1
Finland	6	12	20
France	6.5	7.7	10.5
Germany	7.3	7	13.2
Greece	1.7	6.3	10.1
Ireland	3	5.9	10
Italy	3.5	6.6	10.1
Lithuania	4	7	10
Luxembourg	2.1	3.8	10
Malta	2.8	4.2	10.7
Netherlands	4.1	6	10.3
Poland	5.3	8.3	10.2
Portugal	5	8	10
Slovakia	3.5	4.2	10
Slovenia	2.6	4.7	10.5
Spain	6	9.3	13.6
Sweden	7.4	10.7	13.8
UK	2.6	6.2	10.3

Source: ENDS from NREAPs data

Table 6
Estimated capital costs
$USm dollars per megawatt

Technology	Min	Max
Onshore wind	1.4	2.6
Offshore wind	3.1	4.7
Photovoltaic	4	6
Concentrated solar	4.2	8.4
Geothermal	2	6
Biomass	1	5

Source: International Energy Agency

Table 7
Additional installed electricity capacity 2010-20 (megawatt)

Country	Onshore wind	Offshore wind	Photovoltaic	Concentrated solar	Geothermal	Biomass
Austria	1,567	0	232	0	0	70
Bulgaria	920	0	294	0	0	158
Cyprus	218	0	186	75	na	11
Czech Republic	500	0	45	n/a	4.4	304
Denmark	-302	678	3	0	0	1,762
Finland	na	na	10	0	0	1,130
France	13,458	6,000	4,356	540	54	1,955
Germany	8,224	9,850	35,969	0	288	2,513
Greece	5,873	300	2,016	250	120	190
Ireland	2,685	2,272	5	0	0	318
Italy	10,513	1,000	6,307	500	283	785
Lithuania	321	0	9	0	0	190
Luxembourg	96	0	86	0	0	46
Malta	14.4	95	23.8	na	na	19.7
Netherlands	4,007	4,950	630	0	0	1,462
Poland	5,200	0	2	0	0	1,311
Portugal	2,544	75	844	500	50	305
Slovakia	345	0	240	0	4	162
Slovenia	104	0	127	0	0	45
Spain	1,4845	3,000	4,346	4,447	50	835
Sweden	2,568	106	2.7	na	na	231
UK	10,850	11,600	2,630	0	na	2,320

Source: ENDS from NREAPs data

Table 8
Per capita electricity generation (kilowatt hours per capita)

Country	Wind	Solar	Tidal, wave and ocean	Hydro	Geothermal	Biomass
Austria	578	37	na	5,062	0	619
Bulgaria	296	59	0	517	0	114
Cyprus	632	675	na	na	na	181
Czech Republic	144	166	0	2,191	2	594
Denmark	2,139	1	0	6	0	1,615
Finland	1,149	0	0	2,719	0	2,436
France	905	108	18	1,121	7	268
Germany	1,270	503	0	243	20	602
Greece	1,498	321	na	586	66	112
Ireland	2,720	0	52	159	0	229
Italy	335	190	0	704	113	315
Lithuania	371	4	0	140	0	363
Luxembourg	494	174	0	256	0	690
Malta	621	104	na	na	na	330
Netherlands	1,975	35	0	44	0	1,014
Poland	355	0	0	68	0	377
Portugal	1,375	233	41	1,326	46	331
Slovakia	104	56	0	995	5	316
Slovenia	95	69	0	2,547	0	336
Spain	1,728	655	5	874	7	221
Sweden	1,361	0	na	7,405	na	1,817
UK	1,279	37	65	104	na	428

Source: ENDS from NREAPs data