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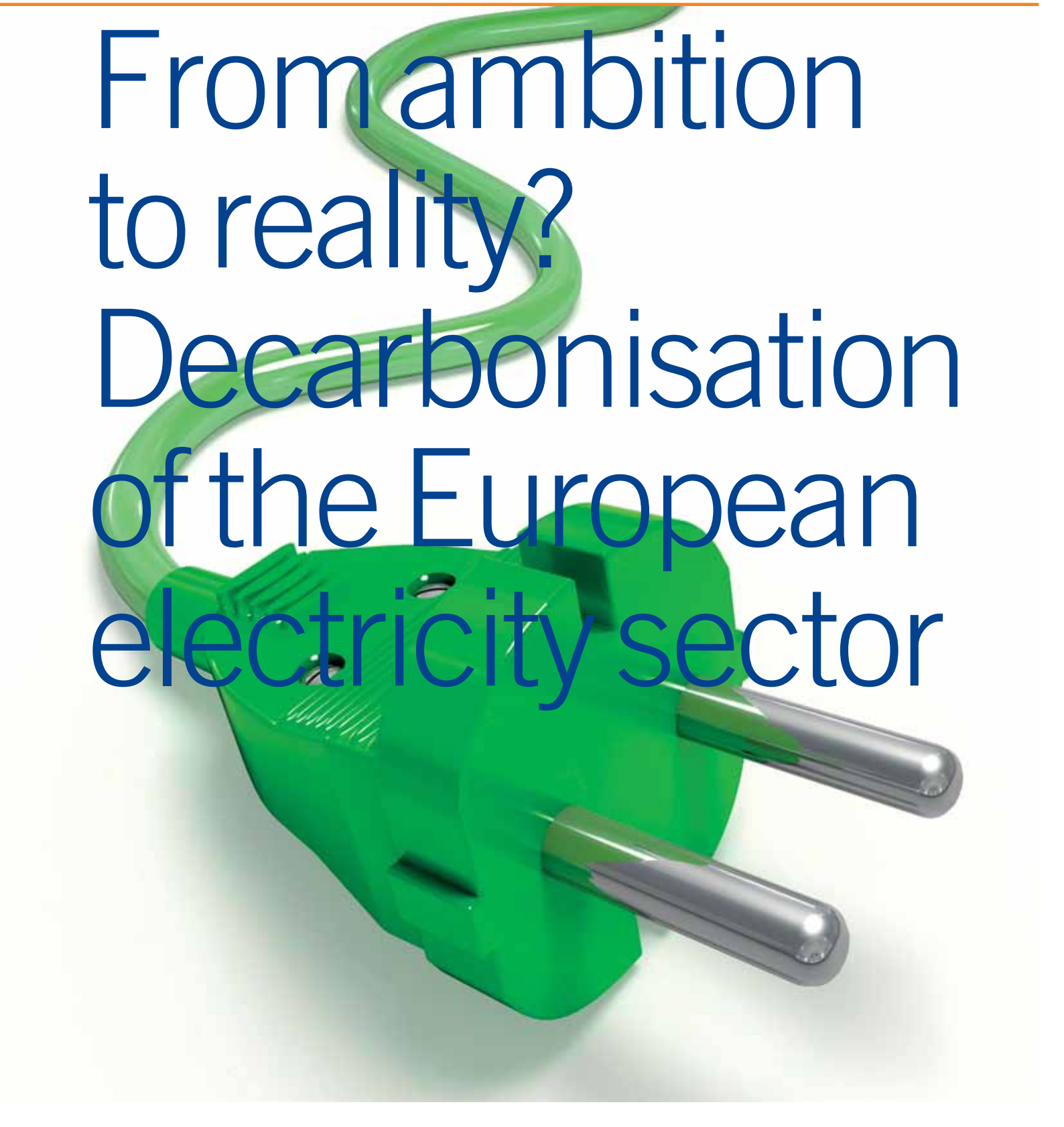
PÖYRY POINT OF VIEW:
SHAPING THE NEXT FUTURE

From ambition to reality? Decarbonisation of the European electricity sector



Delivering decarbonisation - a market led or a regulated approach?

Decarbonisation of the electricity sector is central to Europe's plans to reduce carbon emissions in an effort to tackle climate change. But the policy and market design framework for delivering decarbonisation remains uncertain.

Most sector stakeholders support a market-based approach in which a strong CO_2 pricing regime drives investment in low carbon generation. However, government-sponsored policies, such as direct financial support or organised mechanisms for capacity procurement, are increasingly being used to deliver the 'required' mix of generation instead. Europe is facing a policy dilemma:

- to rely on markets, European coordination and a strong CO_2 pricing regime;
- or: to build national solutions with government channelled investment.

This Pöyry Point of View examines how European electricity markets could evolve to meet the decarbonisation challenge. It probes both market-based and regulated approaches to understand the implications and credibility of different options in order to consider the question - **what is a workable model for future electricity market design, given stated policy objectives towards decarbonisation?**

A critical underlying factor behind a credible electricity market is acceptance from energy customers that the costs of decarbonisation are acceptable and therefore that they are willing to pay for it. Conversely, a short-term politicised focus on energy prices undermines trust, and the ability of governments to offer longer-term credibility to investors.

Informed by qualitative policy analysis and detailed analysis of power sector investment and market operation, Pöyry's modelling explores how different frameworks operate to deliver power sector carbon intensity levels of 150gCO_2/kWh in 2030 and then 20gCO_2/kWh in 2050 across northern and western Europe and at what cost, whilst also maintaining consistent security of supply. We draw on a selection of four core cases which define different policy permutations. These range from a carbon pricing led market solution (termed Absolute Markets) to a national support payment model (termed Building National Solutions). Key differences between the cases are shown in Table 1.

To explore the underlying question, we explore issues linked to:

- the nature of the decarbonisation challenge, irrespective of the specific route;
- the carbon pricing, market-led route; and
- the support payment, nationally-planned route.

TABLE 1 – BUILDING BLOCKS OF CORE CASES

	Absolute Market (AM)	Dual Support (DS)	Coordinated European Planning (CEP)	Building National Solutions (BNS)
National carbon intensity targets	None	None	None	Yes
Renewable energy source targets	None	None	EU wide	EU wide and national, if set
Power sector CO_2 price cap	None	Moderate	Low	Low
Support payments	None	Available	Available	Available

What are the key challenges of decarbonisation regardless of the route taken?

CHALLENGES OF DECARBONISATION

Delivering power sector decarbonisation poses significant challenges, regardless of the policy route adopted. Specific issues include the following:

LARGE SCALE CHANGE IN THE GENERATION MIX IS NEEDED IN ORDER TO MEET THE STRICT TARGET OF 20GCO$_2$/KWH

Across the cases, there is coal-to-gas switching in the period to 2030, and growing reliance on nuclear and CCS in the generation mix (where politically possible) in the longer-term to 2050. These trends are particularly evident in the market oriented AM and DS cases. Renewable generation increases in all cases, especially in (planned) BNS and CEP, driven by the assumed Renewable Energy Source (RES) targets, with greater volumes of offshore wind and solar generation in particular, relative to (market) AM and DS cases. Figure 1 illustrates the detail of how the generation mix changes over time.

RELIANCE ON IMMATURE TECHNOLOGIES WITH UNCERTAIN DEVELOPMENT PATHS

The current long run supply curve (i.e. taking into account capital investment and financing costs) for low carbon technologies has distinct step changes, given varying capex requirements and short-run cost characteristics. Greater reliance on immature technologies increases uncertainty regarding the future supply curve and the potential for further or larger step changes. As a result, the overall cost outcome (and in some respects the feasibility, at least in terms of credible timelines or the balance of supporting investment which is needed) is highly uncertain. **In essence, the cost outcome is dependent on the development of technologies which are not fully commercially or technologically established, and whose future development is unclear.**

COSTS ARE ALLOCATED UNEVENLY ACROSS EUROPE

The allocation of decarbonisation costs varies between countries depending upon their starting point in terms of carbon intensity, resource availability and the consequences that it has for fuel imports and exports. Figure 2 highlights the difference in power sector emissions intensity for 2012, with a broad spread between Poland and Norway as the nations with the highest and lowest carbon intensities respectively. These starting differences translate into differential cost burdens between countries, and are compounded by altering patterns of use of domestic fuels.

The cost structure of many low carbon generation projects is capex heavy, with low or zero variable costs in operational timescales.

The long-run supply curve takes into account capital investment and financing cost.

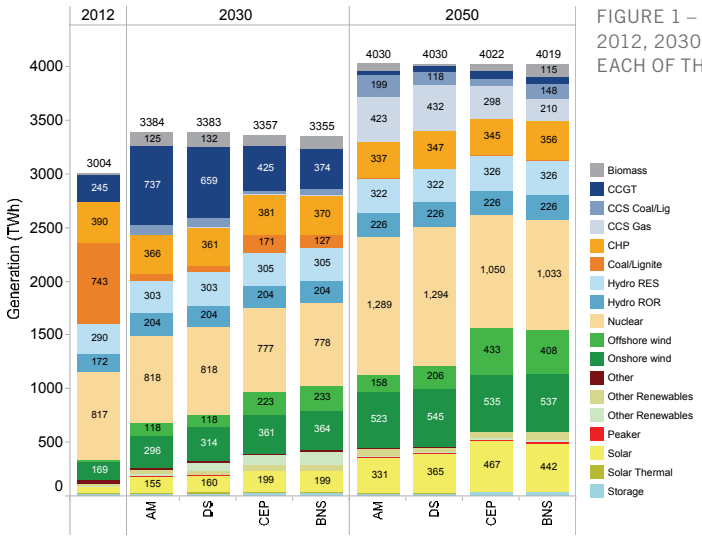


FIGURE 1 – GENERATION MIX IN 2012, 2030 AND 2050 ACROSS EACH OF THE CORE CASES

Different markets face different cost exposure; and to avoid political deadlock, agreement on funding arrangements is required.

DECARBONISATION VIA CARBON PRICING

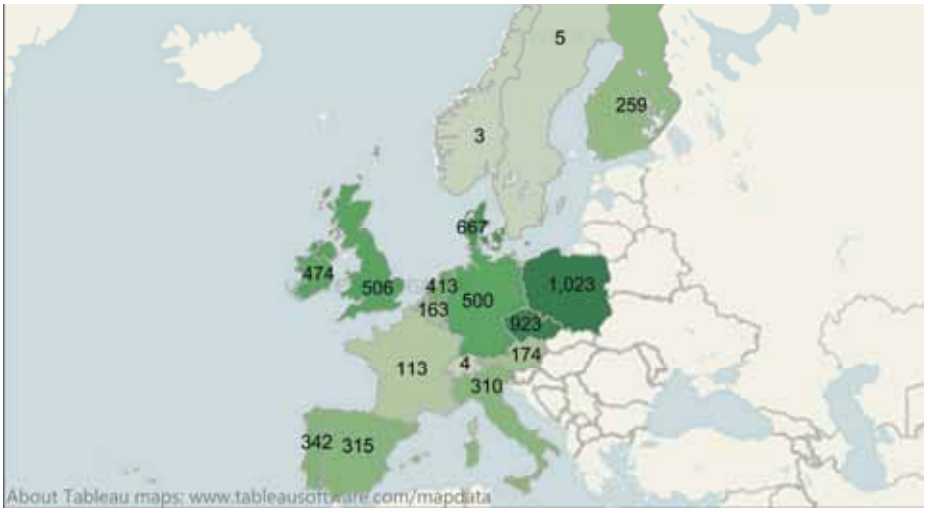
There is a general philosophical preference for market-based solutions. This is based on the presumed benefits of open markets and competition in driving efficient outcomes; relative to more regulated solutions which inevitably involve some degree of central planning and state intervention. But reliance on carbon pricing to drive power sector decarbonisation is not without its issues.

> "The 'market' pathway for decarbonisation therefore relies heavily on the credibility of the carbon scheme for long periods into the future, and the compatibility of this with democracy needs to be demonstrated."

INVESTOR CERTAINTY WITHIN A MARKET-WIDE CARBON PRICING REGIME

Carbon markets are a political construct. As such, the carbon regime is entirely open to future policy change. We live in a democratic society in which legislative frameworks can (and must) evolve in response to changing political and public will (as well as potential changes in the underlying science). However, the economic life of a generation asset spans multiple political cycles – something which has led to the creation of independent regulators at country level, shielded to a certain extent from regular political changes. Policy changes can occur during an asset's lifetime that can undermine its commercial and/or operational prospects. Without

FIGURE 2 – 2012 CARBON EMISSIONS INTENSITY IN EACH OF THE MODELLED COUNTRIES (GCO_2/KWH)



Carbon pricing - what are the issues and mitigation options?

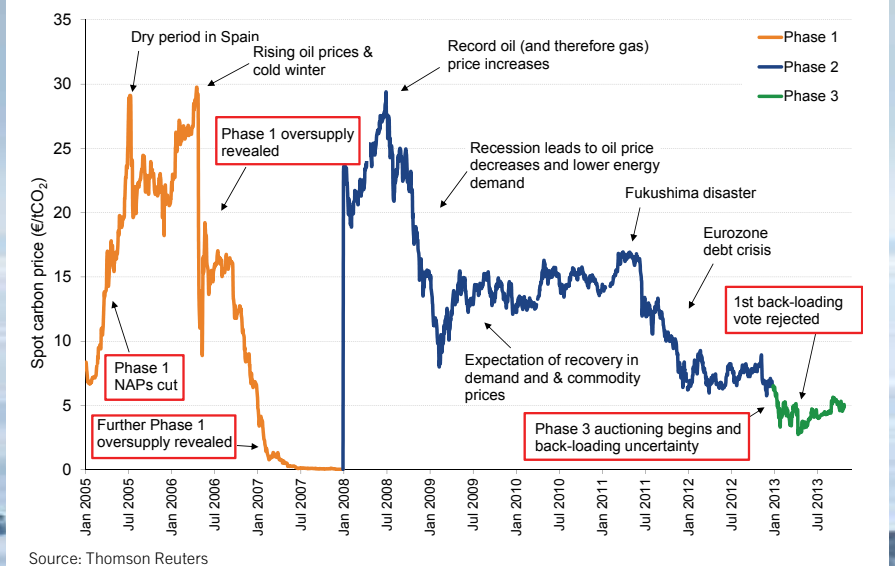
project-specific support (such as a feed-in tariff), investors considering a potential low carbon project backed by a carbon price regime will need to form a view of the carbon price trajectory and the resultant power price for the economic lifetime of the project. Critically, this view needs to be bankable. Any deviation between outturn carbon (and therefore electricity) prices and those anticipated at the point of investment results in the risk of financial exposure, increasing project costs (risk premia) or delaying investment. Importantly, any policy change that results in a weakening of the decarbonisation aspirations and/or a downward impact on future carbon prices affects all low carbon plants, existing and new alike, as all rely on a common carbon price, and there are no obvious ways of hedging this political risk. **The 'market' pathway for decarbonisation therefore relies heavily on the credibility of the carbon scheme for long periods into the future, and the compatibility of this with democracy needs to be demonstrated.**

DIMINISHING RETURNS FROM CARBON PRICES AND REVENUE VOLATILITY

Delivering low carbon investment without direct support requires a carbon price (and associated wholesale electricity prices) that can incentivise delivery of the marginal low carbon technology. However, as the generation mix becomes less carbon intensive, the influence of the carbon price upon wholesale electricity price formation starts to reduce. **There are, therefore, diminishing returns from increases in carbon prices.**

Combined with the lumpiness of the supply curve and uncertainty regarding future costs, this means that the future carbon price required to drive further decarbonisation ultimately becomes high, uncertain and sensitive to marginal technology costs. This is illustrated for markets cases in Figure 3, with prices increasing over time from today's levels on the assumption of a credible carbon regime capable of delivering carbon prices that enable market-led investment in low carbon technologies. It shows the implications of higher and lower 'flexibility' (from demand response) in the electricity system, a less optimistic view of the development of CCS and nuclear costs, and a hybrid case in which the CO_2 price is limited.

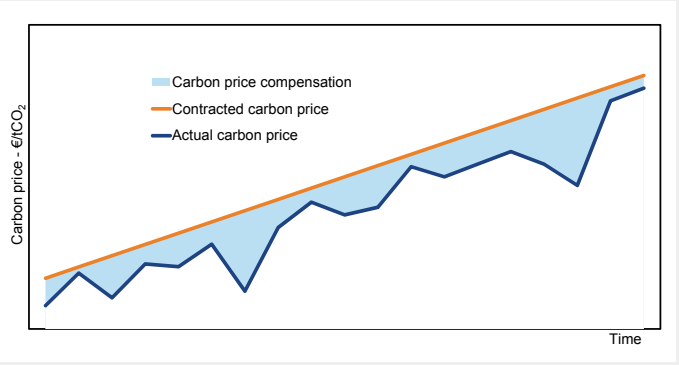
The carbon market is a political construct and carbon prices are consequently affected by political decisions, as well as economic drivers. Low prices emerging from the EU ETS during Phases II and III have not been sufficient to deliver investment in lower carbon generation, increasing reliance on support mechanisms.



Source: Thomson Reuters

HOW DOES A CARBON PRICE 'PUT OPTION' FUNCTION?

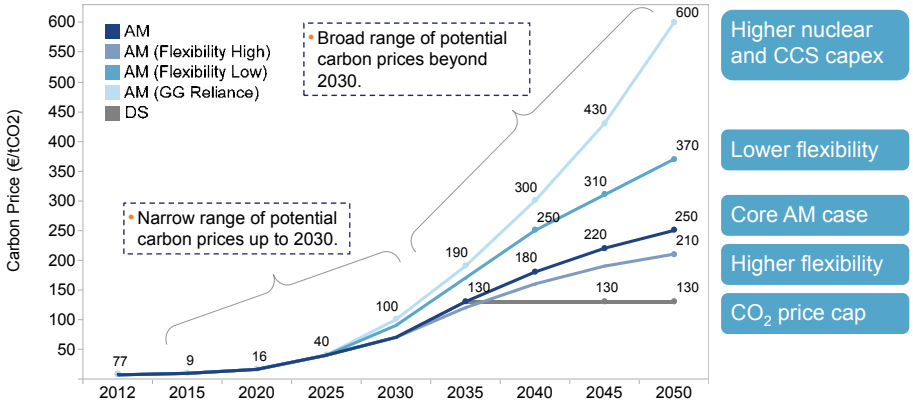
- A contract is struck between a low carbon generator and the government
- The contract assumes a certain carbon price trajectory which makes the project commercially viable
- Any shortfall in the contracted price is compensated for by the government
- Investment in low carbon generation is achieved due to lower risks to investors



DISTRIBUTIONAL IMPACTS AND WEALTH TRANSFERS

A carbon pricing solution is technology neutral; with the marginal carbon price, through its influence on the wholesale price, forming an important element of remuneration for all low carbon investors. It is not possible to price discriminate between different low carbon options and offer differentiated or banded support to individual technologies or projects based on underlying costs. This technology neutrality provides incentives for delivery of cheaper alternatives as it allows inframarginal rent to be earned. **As a consequence, this would deliver substantial gains to existing nuclear and hydro and to onshore wind generation, funded, ultimately, by the consumer.**

FIGURE 3 – POTENTIAL CARBON PRICE TRAJECTORY UNDER DIFFERENT MARKETS CASES



MITIGATION OPTIONS

Certainty for investors could be improved through enhanced institutional credibility for the carbon regime. Ideally, this would be in the form of broad international agreement (preferably global or, as a second best, European) with associated treaties. To the extent that governments grow to rely on revenue from allocations of CO_2 (or its taxation); or alternatively the scale of the 'green economy', this also enhances future credibility of a strong CO_2 pricing regime. Other measures could include an independent carbon bank to reduce political influence and pre-determined adjustment mechanisms to improve market functioning.

Risks linked to the impact of future policy variations on the market wide carbon price could be addressed through project-specific 'safety nets', for example a 'put option' on the price of carbon or some other form of project-specific compensation in the event that the CO_2 regime is weakened in the future.

In order to reach a broad agreement across Member States to pursue decarbonisation goals, the distributional implications between countries must be explicitly acknowledged from the outset. To progress an agreement, it may be necessary to make direct provisions for compensation or sharing to smooth the distributional impacts between Member States as part of the process of securing political agreement.

If there is a perception that infra marginal rent (profit) is 'too high' (e.g. for existing wind or nuclear), leading to issues of public acceptability, there are additional options available to reduce the impact on consumers. One option is to recycle carbon auction revenue back to electricity consumers. Another option is to selectively tax generator profits. However any action of this type would need to be carefully thought through, to ensure the incentives for the cheapest technologies to be built are not significantly diminished.

Choosing a pathway for decarbonisation

DECARBONISATION VIA SUPPORT PAYMENTS

Recent experience suggests growing reliance on national, government administered support schemes to stimulate investment in low carbon generation technologies. Continued dependence upon systems of support payments presents its own set of issues:

- inefficiency potential under central planning;
- growing risk for supported generation; and
- distortionary impacts of RES targets on operation and investment.

For example, **support regimes require central planning** to varying degrees, risking inflated costs through decisions on location, technology choice and payment, as shown in Figure 4. Additionally, **existing support mechanisms distort price and dispatch whilst still leaving volume risk which becomes an ever greater issue under the existing 'production-based' support schemes.** As penetration of 'autonomous-fuelled' generation increases, the ability for all low carbon generation to be accommodated on the system becomes more problematic. **Ultimately, not all generation can run in all circumstances.** This issue is particularly pertinent for low carbon generation that has a positive Short Run Marginal Cost or SRMC (i.e. the cost of producing an additional MWh of generation), such as CCS or biomass. Finally, linking support payments to RES targets can, without specific adjustment, have a distortionary impact on CO_2 price and other carbon abatements. It can also have a distortionary impact upon the balance of investment across the range of low carbon generation options.

CHOOSING A PATHWAY TO DECARBONISATION

The 'markets' approach requires a credible long term policy framework (within the constraints of a democratic framework whose legislature is ultimately drawn towards short term issues), and delivers the conventional market results: risks, profits and innovation to deliver lower cost solutions. The balance must ultimately be acceptable in the short and long term to the voters and customers for long-term credibility to be possible. Conversely, the regulated approach includes a centralist view which mitigates market risks, but may in turn stifle innovation and efficiency and thereby deliver higher overall costs to consumers.

Overall generation costs, particularly total capex requirements, are lower in market cases, particularly to 2035. Capex investment is higher overall in the BNS case due to higher levels of renewable generation with high capital costs and, for variable technologies, lower load factors. The (market) AM and DS scenarios require much lower capital investment in the medium term to 2035 as significant decarbonisation takes place through the fuel switching of existing assets and investment in cheaper low carbon generation technologies like onshore wind. Average annual capex spend increases in the market cases beyond 2035, as more expensive options need to be progressed (e.g. CCS). Efforts to use innovation funding to pursue cost reductions in critical immature low carbon technologies in the run-up to this period could help to mitigate the capex requirements.

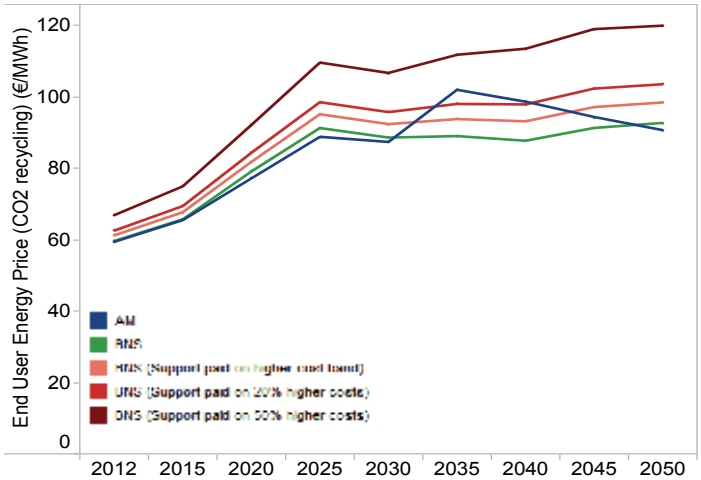
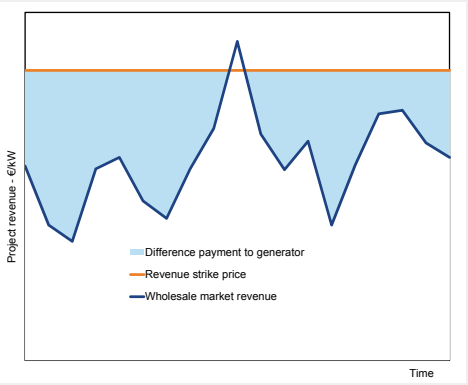


FIGURE 4 – END USER ENERGY COST UNDER THE AM SCENARIO AND THE BNS SCENARIOS WITH DIFFERENT LEVELS OF IMPERFECTION

HOW COULD A REVENUE SUPPORT CONCEPT OPERATE IN PRACTICE?

- An overall revenue requirement for each low carbon technology is agreed up front
- Wholesale market revenue expectations are determined ex-ante, potentially each year
- The revenue support is set based on difference between revenue requirements and anticipated wholesale revenue
- Payment is not made based on production, which removes incentive to bid below SRMC and so dispatch reflects 'true' short-run costs
- The generator trades through the wholesale market, incentivised to beat expectations – projects have a commercial interest in wholesale market operation



Customers face lower costs under a carbon pricing regime to 2030's even when compared to the assumed 'perfect' support payment regime. Once potential support payment imperfections are built in, the markets-based solution looks favourable in the longer-term also, as shown in Figure 4. However, efforts to reduce the costs of critical low carbon technologies in the run-up to 2030/35 will also help to reduce the extent to which prices increase at that point.

MITIGATION OPTIONS

If support payments are to be used to deliver low carbon investment, it is important that they work in the context of the wholesale electricity market, as well as for the investor. This requires that support is non-distortionary in terms of its interaction with the market (e.g. avoids the incentive for negative pricing in order to secure support payments), supporting the delivery of 'flexibility' whilst also appropriately mitigating the evolving risks expected to be faced by low carbon generators. One possibility is to adopt a revenue support concept, which provides improved long-term revenue certainty while retaining commercial exposure to the wholesale market in the short-term.

Within the power sector specifically, if targets are to be set, they should be based on carbon-related metrics, given that decarbonisation is the primary focus, and not focused on delivery of RES generation (or any other subset of low carbon generation).

What is the Pöyry recommended policy for delivering a low carbon future?

The next phase of power sector decarbonisation can be delivered with the carbon price gradually rising to €70/tCO$_2$, before issues of diminishing returns intensify and the range of potential future carbon prices widens. Our analysis indicates that power sector carbon intensity can be reduced from 350gCO$_2$/kWh to around 150gCO$_2$/kWh with a carbon price below ~€70/tCO$_2$, as shown in Figure 5. Some of this reduction can be attributed to the impact of renewables investments expected in the immediate future as a result of existing direct support payments or those that are already locked in for investments already planned to 2020 and it is important that commitment to make support payments to these projects is not reneged upon.

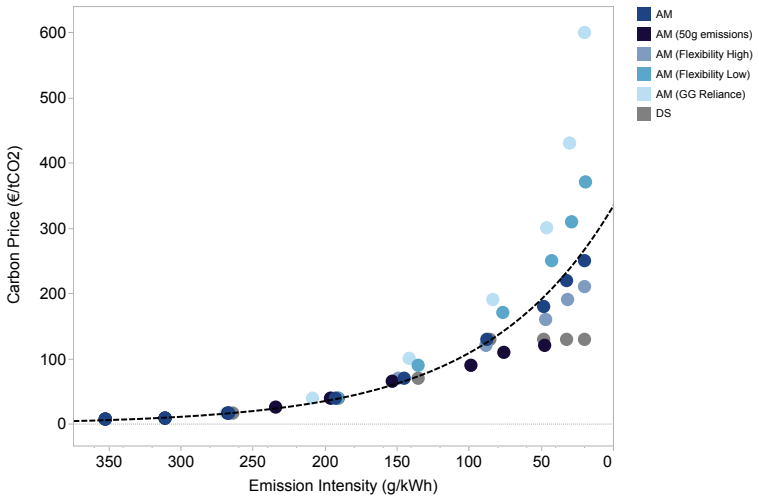
POLICY RECOMMENDATIONS FOR DELIVERING DECARBONISATION

Pöyry's team of experts have produced an in-depth study regarding the options and their associated impacts upon achieving the goal of decarbonisation of the European energy sector. The key components of our recommended policy approach are as follows:

- Commit now to a clear carbon pricing framework to deliver the next phase of power sector decarbonisation to 2030:
  - from today's starting point, this requires improved institutional credibility (e.g. independent carbon bank, pre-defined adjustment mechanisms) and, where possible, international agreements and consumer acceptance of the cost implications of pursuing decarbonisation.
- Pursue policy initiatives that support the effectiveness of carbon pricing:
  - Governments should pursue cost reductions for critical low carbon technologies, including nuclear, offshore wind and solar technologies.
- Build in an option for structured transition to incremental support in future:
  - we have identified a potential 'divergence point' linked to diminishing returns from incremental carbon price increases which may, in time, impair the effectiveness of carbon pricing and may necessitate a transition back to incremental support payments to deliver the highest cost technologies in the future.
- Enhance existing support payments, balancing revenue certainty and short-term efficiency:
  - there is an opportunity to switch to new forms of revenue support scheme, not paid on output, which would improve longer-term certainty while providing commercial exposure to short-term operation of the wholesale market and thus improve incentives for efficiency.

Contact Pöyry to understand in detail our recommendations and the impact each has on the electricity sector and its stakeholders including generators of electricity, governments and regulatory bodies, and of course consumers.

FIGURE 5 – CARBON PRICE VERSUS EMISSIONS INTENSITY UNDER MARKETS CASES



About the Pöyry Point of View

Staying on top of your game means keeping up with the latest thinking, trends and developments. We know that this can sometimes be tough as the pace of change continues...

At Pöyry, we encourage our global network of experts to actively contribute to the debate - generating fresh insight and challenging the status quo. The Pöyry Point of View is our practical, accessible and issues-based approach to sharing our latest thinking. We invite you to take a look – please let us know your thoughts.

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