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MAKING LOW-CARBON TECHNOLOGY SUPPORT SMARTER

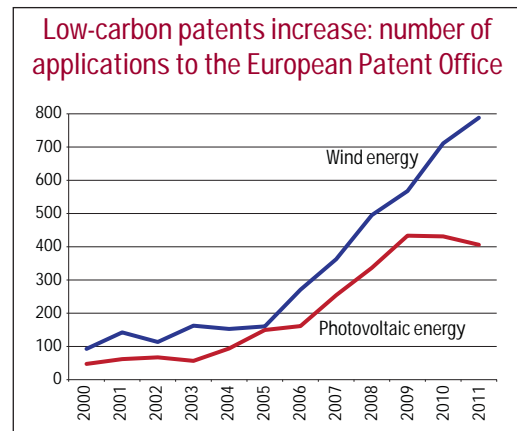
by Georg Zachmann
Research Fellow at Bruegel



THE ISSUE Combating climate change on the global level will be much easier when abundant low-carbon technologies that are competitive in their cost and capabilities are available. But private companies underinvest in low-carbon innovation because they cannot capture the climate benefits. There are three policies to address this issue: pricing carbon, supporting deployment of as-yet uncompetitive technologies and supporting research and development.

POLICY CHALLENGE

Funding all possible low-carbon technologies with all types of support instruments is not a sensible or viable option. Finite budgets need to be allocated to different technologies, but not all innovation policies are equally efficient. However, the combination of the three support policies and their coordination at European level can improve results and reduce costs. To make low-carbon technology support smarter the European Union should (1) improve carbon pricing, especially provide more long-term visibility for the carbon price; (2) enhance European cooperation, both in terms of deployment and R&D support; (3) balance support for deployment and RD&D; and (4) develop a more methodological approach to technology selection.



Source: Bruegel.

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1. A concentration of 450 ppm (see IPCC, 2014). The 2°C threshold has been adopted and reiterated by policymakers in various forums.

2. Lower demand for fossil fuels in some countries might translate into lower global fossil-fuel prices, making it even more attractive for other countries to use fossil-fuel resources.

3. Steinmueller (2011) identifies four main themes: policies affecting supply of technology, complementary factors, policies affecting demand and changes in institutional design.

4. For example, according to Steinmueller (2011): there is a [innovation] p

5. The EU and the Organisation for Economic Cooperation and Development run, for example, monitoring and evaluation of national innovation policies.

WHILE THE SPECIFIC EFFECTS of increasing concentrations of greenhouse-gases in the atmosphere on the climate system cannot be accurately predicted, there is a non-trivial risk that beyond some ex-ante unknown tipping points – in terms of greenhouse-gas concentration and/or global temperature – irreversible and highly expensive events might unfold. This calls for quick action to reduce the probability that such tipping points will be passed. Annual greenhouse gas emissions will have to be reduced dramatically before 2050. In order to stabilise carbon dioxide concentrations in the atmosphere at about 450 parts per million (ppm)¹ by 2050, global emissions would have to decline by about 40-70 percent by 2050.

Such aggressive global decarbonisation requires an international agreement. Otherwise, fossil fuels not used in some countries will be used in others². But an agreement is only feasible and stable if the benefit for each country exceeds the cost, which depends on the cost of low-carbon technologies. Consequently, reducing the cost of these technologies in Europe would not only allow cheaper domestic decarbonisation and for a competitive edge to be gained in selling these technologies overseas, but most importantly it would be a major contribution to an international agreement.

In this Policy Brief, we describe the interaction between three approaches that are effective in driving innovation in low-carbon technologies. Based on that, we provide four recommendations for making low-carbon technology

support smarter: (1) improve carbon pricing; (2) improve European cooperation; (3) combine deployment and research, development and demonstration (RD&D) support; and (4) take a more methodological approach to technology selection.

KEY STRATEGIES TO DRIVE LOW-CARBON INNOVATION

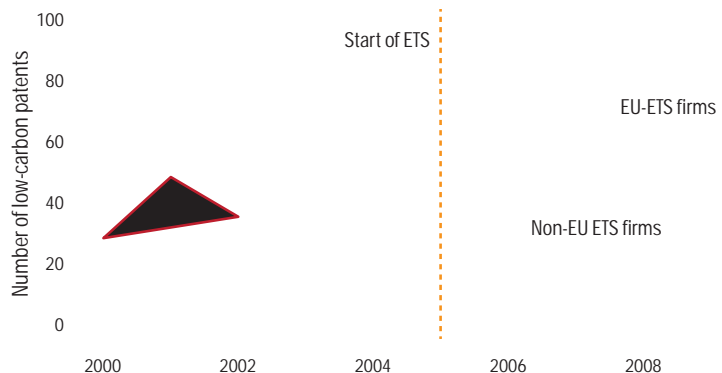
Numerous policy instruments support innovation, ranging from patent protection to public research funding and public procurement, to subsidies for private investment in innovation³, but there is no consensus on a single best practise⁴. There are, however, conventional 'dos and don'ts'. For example, do regularly conduct independent evaluations of innovation policies, do avoid excessive risk aversion in project selection and do determine clear triggers for cutting support⁵.

This is also true for low-carbon innovation, but supporting low-carbon innovation involves the particular challenge of targeting innovation that brings down the decarbonisation cost. For this, there are three main policies: (i) a

price on carbon, (ii) directly support public and private RD&D investment in the targeted low-carbon technologies, and (iii) create demand for technologies to foster private innovation.

Pricing carbon

If companies know that they or their (potential) customers will be faced with high carbon prices in the future, they will have every incentive to invest in development of low-carbon alternatives. Caelen and Dechezleprêtre (2015) provide evidence that carbon pricing in the EU has increased low-carbon patenting by companies directly covered by the EU emissions trading system (ETS)⁶ (Figure 1). Creating the expectation of a high future carbon price has one big advantage over all other innovation policies (such as predictably tightening fuel standards) – it is completely technology neutral. At the same time, carbon pricing incentivises investment in low-carbon power technologies (eg solar photovoltaic), energy-efficient appliances, carbon capture and storage or more resource-efficient processes (eg recycling of alu-





6. Caeli and Dechezleprêtre (2015) find that the EU ETS has increased low-carbon innovation among regulated firms by as much as 10 percent, while not crowding out patenting for other technologies.

7. See for example Dechezleprêtre [et al.](#) (2013), who show that 'green patents' are cited more often in other patents than 'non-green patents', even when controlling for numerous third factors.

8. This European target was broken down to national targets (eg 18 percent for Germany or



tion technology? (iii) How openly does the policy deal with different technologies (eg German feed-in tariffs support only a narrow set of 'proven' technologies)?

Public RD&D spending and support for private RD&D

Public research is an important source of basic innovation. In addition, the publicly-funded education of researchers reduces the private sector's cost of innovation. Furthermore, all OECD countries have specific policies to support private investment in RD&D. Zachmann et al (2014) provides evidence that increased public RD&D spending coincides with more patents in the corresponding technology (Figure 3 shows this for Germany).

While some of the mechanisms work irrespective of the area of innovation (eg investment in RD&D is tax-deductible in some countries), most public funding for RD&D is explicitly or implicitly targeted at certain sectors. History shows that targeted technologies and sectors do not necessarily meet initial expecta-

tions. For example, nuclear fission, nuclear fusion and hydrogen have received significant support but have not yet achieved the hoped-for commercial break-through. So, betting all support on a single 'silver bullet' is too risky. The increasing diversification of the portfolio of supported technologies goes in the right direction (see Figure 4 on the next page). But the EU lacks a process that aims at optimal allocation.

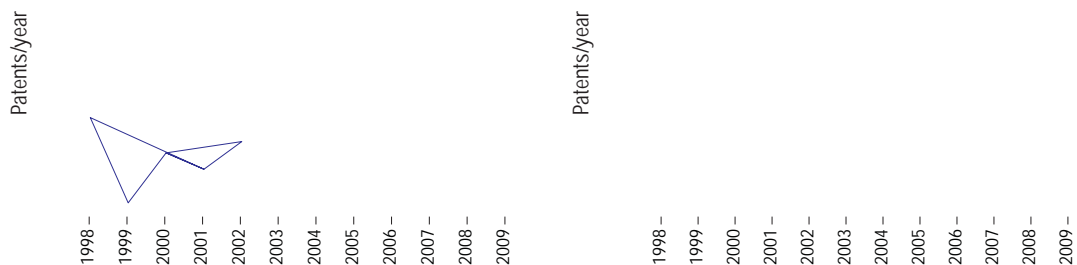
So a key question is: how should public spending be targeted at individual technologies or objectives? This is particularly relevant when the aim is to develop technologies that make decarbonisation cheaper, because those technologies often compete with each other. In addition, not only individual technologies (such as solar PV and onshore wind) compete for future markets, but also entire energy systems. Decarbonisation might take very different routes, such as: (i) low-carbon electricity production (from either renewables, nuclear or power plants equipped with carbon capture

and storage) plus electrification of transport and heat versus hydrogen as a new carrier and storage for energy; (ii) centralisation of energy supply with strong networks versus decentralised solutions with local storage; (iii) massive reduction in energy demand versus decarbonisation of energy supply.

Policies working together

Public funding of RD&D, public support for deployment of low-carbon technologies and a forward-looking carbon price can all contribute to innovation. Figure 5 on the next page illustrates the interaction. Before a technology is deployed, some basic RD&D brings down the cost to a level at which some deployment can be started. Deployment leads to learning – so the more a new technology is deployed, the lower the cost becomes. Learning can be speeded up by continuous funding of RD&D. At some point the technology will be able to compete with other technologies on the market. This point will be reached earlier (and hence encourage private investors to do

Solar patents



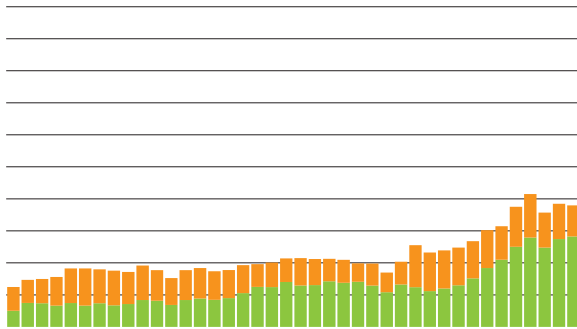


more RD&D and deployment on their own) if there is a predictable carbon price.

For any given technology, one might ask what is the right timing

and combination of these three major instruments to most effectively and efficiently bring down their cost.

In Zachmann ⁴ (2014) we find



that both deployment and public RD&D support matter in terms of innovation. Our results indicate that there is a benefit in combining deployment and RD&D. The patenting of wind turbine technology in particular is strongest in countries that combine strong RD&D support and deployment. Figure 6 illustrates our estimates derived for OECD countries using the example of Germany. The impact of only RD&D plus the impact of only deployment is smaller than the impact of a combination of the two. In fact, support for deployment some years after substantial investments in R&D coincided with the strongest development of corresponding patents. That would be in line with the hypothesis that it is not massive actual deployment, but the prospect of deployment, that is the carrot for industry to commercialise the technologies developed through publicly-supported R&D.

Europe's recent focus has been on deployment. Public spending on deployment of wind and solar technology has, for example, been vastly greater (about €48 billion in the five largest EU countries in 2010) than spending on RD&D support (about €315 million). This raises the question of whether this bias is the most efficient way to stimulate innovation.

FOUR RECOMMENDATIONS FOR SMARTER TECHNOLOGY SUPPORT

Better carbon pricing

The EU ETS could in principle provide a valuable signal for low-carbon investment. In its current design, about 54 billion



allowances (each worth one ton of CO₂) will be issued between 2015 and 2067¹¹. Given the allocation schedule over time and the expected annual emissions, allowances are likely to become scarce in the late 2020s. From then on the market will rapidly tighten. This future scarcity of allowances should translate into a high price. Market participants should anticipate the rising price and buy unused allowances today and set them aside – thus raising current prices. Consequently, the ETS would bring about a valid and forward-looking carbon price signal. However, the allowance price today does not reflect future scarcity (expected prices in 2030 are about €40 while prices today are below €10). Given that traders could buy allowances today and sell them in 2030, the low current prices indicate a lack of confidence in the instrument, which can be explained by volatile policies driving the supply and demand of allowances. Accepting 1.4 billion international carbon credits into the system¹² and constantly discussing the allocation mechanism showed market participants that the cap of 54 billion allowances is not set in stone. And national decarbonisation policies in sectors covered by the ETS – such as the UK carbon floor price or the discussion about a forced German coal-phase-out – undermine the efficiency of the instrument. Lower demand for allowances in member states that conduct additional decarbonisation in sectors with high abatement costs will free up allowances in those countries. Other sectors and member states will be able to use those

11. Pending the adoption of new ETS rules for the post-2020 period.

For the third phase of the ETS (2013-20), the annual number of emission allowances issued decreases by 38 million each year – starting from a value of 2084 million in 2013 – hence reaching, in principle, a negative value in 2068 if the reduction is continued at this rate.

12. In the second phase of the ETS (2008-12), it was possible to exchange a certain volume of international carbon credits for European credits. As the price of international credits was very low because of the absence of carbon trading outside Europe, all the permitted volumes were exchanged for EU allowances.



A more European framework for support to green innovation makes sense because the positive effects of supporting innovation tend to spillover to neighbouring countries. Zachmann *et al.* (2014) finds, for example, that deployment appears to have substantial cross-border effects on innovation – increased deployment in one country coincides with increased patenting in nearby countries. Consequently, a national evaluation of the costs and benefits might underestimate the benefits of deployment – hence a more European approach would be more suitable.

In terms of technology choice more European coordination is also worthwhile. Individual member states cannot meaningfully support a sufficiently large portfolio of technologies necessary to ensure resilient decarbonisation. For transport decarbonisation, for example, there is still no certainty whether the future will be fuel-cell hydrogen, battery electric, modal shift, biofuels or something else. So European coordination should ensure that we do not put ‘all eggs in one basket’ by only going big on one single technology, but coordination should also ensure that fragmentation cannot prevent efficient support to the most promising technologies.

Support deployment and RD&D

Support for renewables in Europe has been focused on deployment, while support for other technologies (eg hydrogen) has been focused on RD&D. There is no clear innovation-economic rationale for this dichotomy,

which appears to have arisen for political-economy reasons. As a consequence, policymakers should reconsider this balance by, for example, shifting support from deployment to RD&D funding for renewables. The focus of renewables support should be shifted from a ‘deployment target’ that encourages the quick build-up of the cheapest currently-available renewable energy technology, to an ambitious ‘innovation target’ that encourages investment in reducing the cost of renewable energy technologies. In addition, deployment programmes should be coordinated with RD&D programmes. It should be ensured that technology-specific deployment is organised in a way that stimulates competition between providers, especially through the development of programmes with a volume and time horizon that will enable the build-up of innovative value chains. If successful, an ‘innovation target’ will be the greatest possible contribution of Europe (and its partners) to saving the global climate, and it might be instrumental in developing a competitive edge in what will eventually become an important global market¹³.

Technology support mechanism

Political decisions about which technology to support, and when and how to do so can have very far-reaching consequences. Without public support for the nuclear industry in the 1960s and 1970s, for example, the fuel mix, electricity networks and even electricity consumption patterns¹⁴ would look markedly different today. Policymakers cannot and will not

abstain from technology choices. The challenge is therefore to enable them to make good choices.

One proposal in Zachmann *et al.* (2012, p96ff) is to set up a transparent evaluation process of ‘support schemes for individual technologies’. A level playing field for public support for new technologies requires that governments’ choices of a technology portfolio should not be driven by the question of ‘which’ but by the question of ‘how’. Governments should adopt choice mechanisms that are dynamic and adaptable, able to digest new information and optimise support in a quick, reliable and effective manner. Transparency is critical for the success of any choice mechanism, so that industry and consumers can form the right expectations about the direction of technology. The only way to control the potential impact of public policy on industry investment choices is through a transparent policy that clearly communicates government priorities and decision-making parameters. Transparency also promotes fair competition and inspires trust on the part of industry and consumers. Stakeholder trust is fundamental to the success of energy transition policy. Finally, it is important to note that the mechanism should be utilised to select not only one, but a portfolio of technologies.

The first step in constructing a technology-choice mechanism is to define a transparent set of metrics and priorities (which can later be updated, as the demands of society and climate action

13. Primary energy consumption of oil, natural gas and coal amounts to about 6 percent of global GDP. Adding the value of existing non-fossil electricity production (about \$2 trillion) and all the energy downstream cost and the demand side appliances (from cars to heat pumps to refrigerators) it is likely that a global market for new energy technologies would amount to more than 10 percent of world GDP.

14. The role-out of electric heating in France and Germany can partly be explained as a response to the availability of unused electricity at night-time.



change). The interest of governments is to support the optimal portfolio of technologies in terms of certain metrics – such as cost, timeline, efficiency, benefits and safety. These metrics and priorities should be as technology-neutral as possible, and should be the driving force behind the technology-choice mechanism.

All stakeholders involved in the selection of new technologies face the problem of imperfect information. However, the developers of different technologies might have an interest in overstating the capabilities, or understating the cost, of their respective technologies in order to attract more support (or even lock out competitors).

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