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COLD START FOR THE GREEN INNOVATION MACHINE

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Highlights

- The private green innovation machine has not yet taken off. The number of green patents is still small and not growing as fast as other emerging technologies. R&D and innovation activities in the electricity generation and distribution sector, having a central role to play in the fight against climate change, are weak.
- Government intervention is needed to turn on the private green innovation machine. As an accompanying Policy Brief demonstrates, this government intervention requires a combination of carbon pricing and R&D subsidies.
- The two instruments of policy intervention, carbon pricing and R&D subsidies, are currently shapeless and do not manage to create the necessary incentives to invest in clean innovation:
  - The implicit tax rate on energy in the EU27 is low and fragmented. The carbon price in the EU Emissions Trading System is too volatile;
  - Public R&D expenditures dedicated to energy and environment are relatively low and not coordinated among countries. Moreover, its dynamics send mixed signals to investors.
- With signs from the venture capital market that the green innovation machine is ready to take off, but waiting for the push from government, this momentum is not to be wasted.

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COLD START FOR THE GREEN INNOVATION MACHINE

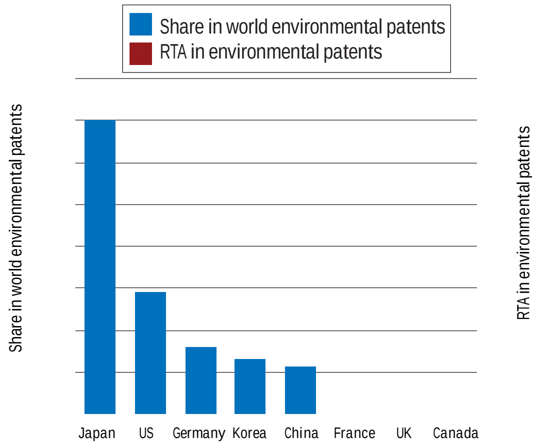
REINHILDE VEUGELERS AND CLÉMENT SERRE, NOVEMBER 2009

1 THE IMPORTANCE OF THE INNOVATION MACHINE FOR TACKLING CLIMATE CHANGE

The evidence provided by climate scientists clearly signals the size of the climate change challenge, meaning that a large-scale and speedy reaction is required. Economic simulations (eg Carraro *et al*, 2008) show that to keep the costs of mitigating and adapting to climate change 'manageable', we need a sufficiently broad portfolio of active technologies. For mitigation these include (i) technologies to reduce emissions such as energy efficiency, carbon capture and storage, and (ii) low-carbon technologies such as renewable-energy generation and nuclear power. Although much can be done if existing technologies are diffused (McKinsey, 2009), new technologies also need to become available, particularly backstop technologies that are zero-emission and not dependent on constrained resources. These new technologies are not yet available or still far from large-scale commercialisation.

Given the size and nature of the climate challenge, the innovation machine needs to work optimally. Will it be effective to deal with the climate challenge if left operating as it currently does, ie if we follow a business-as-usual scenario? To answer this question, we look in this policy contribution at the recent performance of the green innovation machine. We first provide evidence showing that the innovation machine has so far not functioned as it needs to in the face of the climate challenge. We explain why private green innovation cannot be expected to do the job without proper government intervention. We then illustrate the poor historical record of green public intervention, before concluding with some more hopeful signals for the future. In an accompanying policy brief[1] we discuss in more detail how policy should be (re)designed to build and sustain a well-functioning private green innovation machine, capable of dealing with the climate-change challenge.

2 EVIDENCE FROM THE PAST PERFORMANCE OF THE PRIVATE GREEN INNOVATION MACHINE



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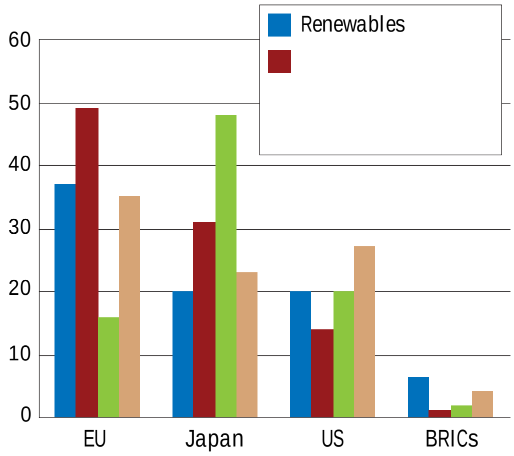
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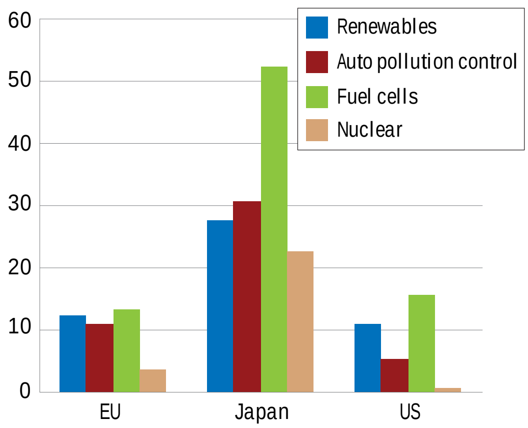
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The European Commission's R&D scoreboard (European Commission, IPTS, 2009) provides more recent information on R&D spending by large companies[15]. The latest data (2009) confirm the weak R&D picture for the EGD sector. For the EU, there are 15 EGD companies among the top thousand EU R&D spenders. These companies have an average R&D-to-sales ratio of only 1.3 percent in 2008. Of these 15 companies, only two – Areva and EdF, both French – are among the EU's top 100 R&D spenders. In the non-EU scoreboard of the top thousand R&D spenders, there are 11 EGD companies (of which none are from the US) with an average R&D-to-sales ratio of 0.8 percent in 2008, compared to a 3.7 percent average in the non-EU scoreboard. These figures show the low innovation activity of EGD companies generally, with low R&D-to-sales ratios compared to other sectors.

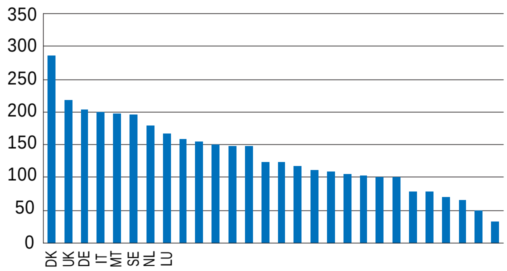
The low rate of R&D spending in the EGD sector implies that this pivotal sector will not be active in generating its own innovations to reduce emissions of greenhouse gases. Furthermore, marginal R&D activity in this sector hampers the effective adoption of innovations developed elsewhere. The innovation data for this sector show that in most EU countries, EGD firms are less active than firms from other sectors in implementing new innovations (CIS, 2004-2006). Furthermore, 'green' motivations for R&D seem to be given a low priority by the EGD sector, as is the case for other sec-torJT(h)17.1fr0.0653a0a0a5.2(7.1(s) 7t7t7t7.9(h)17.1(e c.1(.)0((h)(s)6.TJT*0.0055 Tc0.0375 Tw[(t)23.9(h)17.1(o)13.2(u)12(.)0(16)

reaching their most cost-efficient configurations.

- Once on the market, new green technologies face competition from existing dirtier technologies, which enjoy an initial installed-base advantage. As discussed in more detail in the accompanying policy brief (Aghion *et al*, 2009), taking into account that R&D resources will be dir8(tin)22(g dir;T3(r t)28.8(e)14d .8(s)11.2ge)11.2a2(r)23.c9u11.3vdlns

Denmark and the UK have the EU's highest rates, while Romania and Latvia the lowest rates (Figure 5).

Figure 5: EU states, implicit tax rate on energy



Source: Eurostat (2009).

Cap-and-trade systems also generate a carbon price, but because a great deal of information and expertise is needed to get the emissions-capping and allowance-allocation processes right, there is more room for error and exposure to political pressure, compared to carbon tax schemes. The European Union's Emissions Trading System (or EU ETS) opened in 2005 and can still be considered to be in a learning phase. Carbon-price volatility has proved to be an issue for the ETS in its early years.

The EU carbon price reached its highest level of €32.90 in April 2006, but stood at around €13.70 in mid-November 2009. The drop in the price in early 2007 (the spot price reached almost zero in April 2007) marked the end of the first phase of the EU ETS. This was due to the absence of bankability between the first and second ETS phases (2005-07 and 2008-12), as first-phase allowances could not be used for later phases[19].

Reforms have been introduced to make the ETS more predictable after 2013 (for example through a more centralised allocation of allowances), but factors such as the uncertainty about the allocation of emissions allowances for free for some sectors could continue to disrupt the carbon price.

Overall, the evidence on carbon pricing is consistent with the inadequate performance of the private green innovation machine. Current carbon-tax levels and cap-and-trade systems are not generating a sufficiently high carbon price to induce green innovation. Furthermore, the carbon price has not been stable, which is a disincentive for green innovation.

Figure 6: Carbon price, Dec 09 futures contract

Source: ECX historical contracts data (daily futures, futures and options).

4.2 EVIDENCE ON PUBLIC GREEN R&D

Alongside carbon prices, green R&D subsidies are a complementary policy instrument. Subsidies are particularly important in the early phases of development of new green technologies, for addressing the installed-base disadvantage of new technologies and the financing barriers faced by new innovators.

In this section, we look at the most recent evidence on the size of public green R&D expenditures, in the form either of financing of R&D by public-sector research organisations, or of subsidies to private sector R&D [20].

Public R&D spending for the 'control and care of the environment' category is almost negligible as a share of total public R&D spending. Furthermore there is little indication in the data that this share is increasing, at least for the period up to 2005. Compared to the US and Japan, the EU27 as an aggregate performs relatively well. But this European Union aggregate hides a lack of coordination by EU countries of these outlays, making them less effective compared to US or Japanese public spending.

18. Calculating the standard deviation over 3 years across all EU 27 countries (+Norway), it evolves from 10 in 1996-1998 to 6 in the last period available (2005-2007). Source: Own calculations on the basis of Eurostat.

19. See also Tirole, 2009.

20. Unfortunately, there is little data available on public spending that is comparable across countries. As a source for R&D subsidies, we use the GBAORD Government Budget Appropriations or Outlays on R&D data (Eurostat). Although the data has serious limitations and was only reported after a large time lag, it is available for a wide set of (OECD) countries. GBAORD is split according to 'socio-economic objectives' (NABS classification). These include the two groups we are interested in: NABS03: control and care of the environment, and NABS05: production, distribution and rational utilisation of energy.

pattern to 'environment'. Again, the US is doing badly both in levels of public spending and in growth rates (at least up to 2005). The EU spends moderately with little growth. Japan is a strong public spender on energy, though its spending is declining. This correlates with the relative strength of Japan in energy technologies, as illustrated by the patent applications data.

Figure 8: Public R&D expenditure on 'production, distribution and rational utilisation of energy'

Source: Own calculations on basis of Eurostat, Statistics in Focus, 292008. 'Production, distribution and rational utilisation of energy' corresponds to NABS05 in the GBAORD classification. EU-27 is a Eurostat estimate; EU average annual growth rate is for EU15; US values are provisional; total GBAORD excludes General University Funds; Japanese values are provisional.

Within the EU, France and Germany are the most important public funders of energy R&D, but with little or negative growth rates. The UK again lags behind. Spain is expanding its public R&D budgets for energy, correlating with a higher level of innovative behaviour in its electricity sector (cf supra).

More recently (2007), US federal government downward trend may have started to reverse in 2008, with the $1.5 billion for the US Climate Change Science Program and Hydrogen Fuel Initiative.

Table 4: Public R&D expenditures for 'production, distribution and rational utilisation of energy'
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tervention seems to be developing.

Venture capital financing gives a more recent overview of green innovation trends. Data from Dow Jones VentureSource shows the increasing interest from venture capitalists in the 'cleantech' category, which includes not only renewable energies but anything associated with alternative energy. As Figure 10 shows, this interest has taken off since 2007. Although both the US and EU saw a similar increase in the number of cleantech deals, the US outperformed the EU in terms of the amounts raised.

Figure 10: Euro raised in Europe and the US by venture-backed cleantech companies, annual data

Figure 11: Growth rates of amounts raised by venture-backed companies by sector

Source: Dow Jones VentureSource.

In terms of growth rates, venture capital investment in cleantech outperforms any other venture capital sector. In 2008 especially, when other sectors have seen declining rates of investment, renewable energy continued its growth (Figure 11). Interestingly, the dip in the renewable energy growth rate seen in 2007 (Figure 11) corresponds to a drop in EU ETS carbon prices from mid-2006, illustrating the sensitivity of the green innovation machine to too-low carbon prices.

Despite increasing venture capital volumes, cleantech only accounts for seven percent of all equity investment into European venture capital backed companies in 2009 (second quarter). Nevertheless, momentum seems to have been created. Deloitte in their 2009 Global Trends in Venture Capital[23] report note that, despite the economic and financial crisis, 63 percent of surveyed venture capitalists anticipate an increase in their cleantech investments. This was the highest score among all sectors considered (Figure 12). This increase is particularly high in the Asia-Pacific region and for continental Europe, but less so(t)28.8(e)14.2(d)