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Public Support for the Financing of RD&D Activities in New Clean Energy Technologies[1]

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Highlights

- Substantial investments in RD&D in new low-carbon technologies are required to reach the EU climate objectives. Given existing market failures affecting clean innovation, developing a balanced portfolio of existing and new clean technologies will require both demand pull support measures – namely carbon pricing and the Renewables Directive, and direct public support to innovation
- Innovation activities should comprise research, development and demonstration and be aimed at both (i) accelerating the decarbonization of energy systems to reach mid-term 2020 objectives by pushing especially more mature technologies and (ii) developing a diversified technology mix enabling the achievement of long-term 2050 objectives by supporting also still immature technologies
- Cooperation and coordination among Member State and EU support policies have to be improved. The initiation of European Energy Research Alliances is a step into the right direction; their successful implementation should be fostered and progress monitored
- The form of direct public support needs to be tailored to the features of each innovation project – depending on both the technology targeted and its level of maturity – and to the type of entity best placed to undertake the respective RD&D
- Financing instruments need to be implemented in a way that encourages efficiency while not discouraging participation by the private sector. Competition for funds should be used and public funding should be output-driven whenever possible; the institutions set up to allocate funds should be flexible enough to avoid institutional inertia and lock-in

[1] Topic 1 of the EU's FP7 funded project THINK, project report available at: http://think.eui.eu. Project leader for this report is David Newbery; research coordinator: Luis Olmos; research team: Sophia Ruester, Siok Jen Liong, and Jean-Michel Glachant; project advisers: Christian von Hirschhausen and Pantelis Capros.

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Background

If the EU is to meet its 2050 climate objectives, the future energy mix will have to rely on a significantly increased share of low-carbon (low-C) generation technologies, much of which is not yet competitive (nor even technically proven). Substantial additional RD&D activities are required in order to achieve the ambitious target of limiting global warming to a maximum of two degrees Celsius above pre-industrial levels and cut emissions by 80% or more for industrialized countries.

An adequate portfolio of existing and new clean energy technologies will not develop spontaneously: The current EU emission trading scheme does not provide the sufficiently high, credible and predictable future carbon price trajectory. Moreover, there are important additional market failures that undermine the private incentive to invest in clean energy innovation. The two most important are that RD&D has, or should have, a large element of pure public good, as it is both unlikely and may be undesirable that innovators capture all the learning benefits; and second, that there are additional indirect benefits to the EU in encouraging other countries to adopt better low-C solutions to reduce global warming that impacts the EU, again not captured by the innovator. Given the fact that there is high uncertainty about future market revenues from the exploitation of new clean technologies, existing demand pull measures, namely carbon pricing and the Renewables Directive, will be insufficient to deliver an adequate and timely level of private RD&D. Thus, there is a need for direct public support to innovation.

Box 1 - The SET Plan

The SET Plan is divided into eight *Industrial Initiatives* corresponding to eight technology fields identified as potential key contributors to a future clean energy technology mix allowing the EU to meet its 2050 climate targets. Within these Initiatives, strategic objectives have been formulated based on *Technology Roadmaps* that identify priority actions for the next decade (2010 to 2020). More specific *Implementation Plans* are developed for three-year periods. Authorities estimated a financing gap of €47-60 bn, comparing the current level of expenditure with that necessary to undertake the priority actions selected for the coming decade.

The EU's SET Plan is a response to the evident need to stimulate research and development in low-C technologies (see Box 1). However, technologies to be developed within the SET Plan and the associated priority actions have been selected without directly considering the limited availability of public financial resources. Hence, priorities have to be set.

Choosing RD&D projects to support the SET Plan

Public funds are limited. Hence, projects to be publicly supported should be carefully chosen to achieve energy policy objectives. A **balanced portfolio of innovation activities comprising research, development and demonstration** will support (i) the acceleration of decarbonization to reach mid-term 2020 EU climate objectives and (ii) the development of a diversified technology mix enabling the achievement of long-term 2050 objectives. Technologies of different levels of maturity reveal substantial differences in cost competitiveness and uncertainty about their expected market potential and long-run net revenues, which impacts the industry's incentive to conduct RD&D. However, technologies lacking any commercial near- or mid-term potential might become highly important in the longer term.

How to build this balanced portfolio? Even though EU climate policy objectives are related to two different time horizons, project selection needs to be based on one single evaluation criterion that balances the importance of reaching the 2020 targets at least cost against the need to support immature technologies that hold greater promise for the longer term. One also has to take into account the probability of success of innovation projects, the impact of this success on the development of new technologies, and the expected contribution of the latter to emission reduction once they reach the deployment stage. At the same time, innovation expenditures need to be within the respective budget constraints.

More *mature technologies* with a large expected potential need to be brought to competitiveness quickly to reach 2020 objectives. The allocation of funds among technologies (i.e. "Industrial Initiatives") and within Technology Roadmaps should be based on detailed quantitative cost-benefit analyses building on objective estimates of technology success probabilities and CO_2 saving potentials. Regular updates of the allocation of available funds within allocation periods, taking into account knowledge gains, are important. As the probability of success increases, funds should be more concentrated and competition among alternative research paths becomes less relevant.

Immature technologies, which have to play an important role in the future technology mix to achieve 2050 climate objectives, require persistence in the research strategy. Project evaluation typically will be based on ordinal rankings according to the expected project contribution to CO_2 emission reduction taking into account that early research mainly generates options for new low-C technologies. Very high predicted CO_2 savings potential in the case of successful innovation can support the acceptance of very low success probabilities and/or delays in the achievement of technological milestones. The lower the projects' success probabilities, the more research path options should be investigated in parallel.

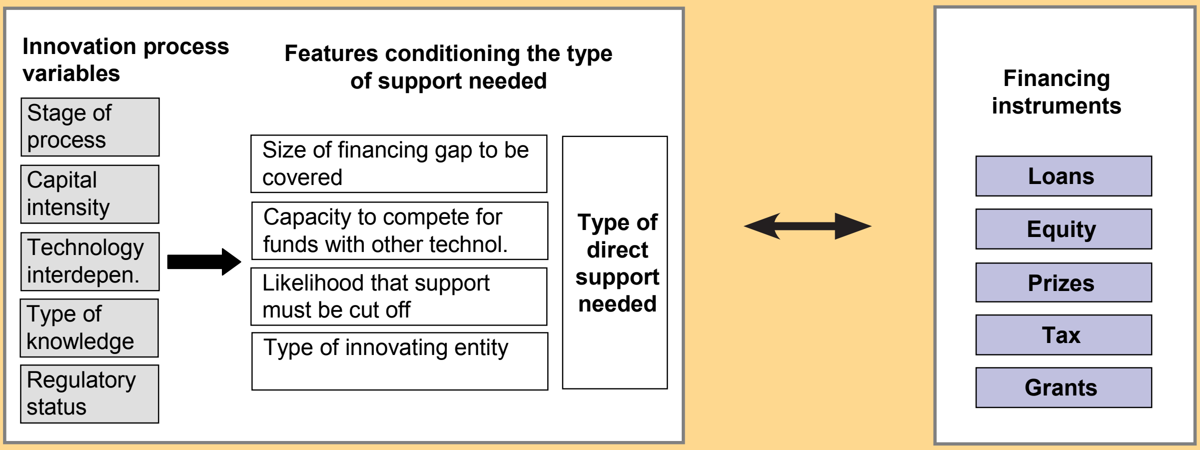
Cooperation among innovators might facilitate the realization of higher-cost projects that otherwise would not be undertaken (fusion is the obvious example). For projects whose returns are subject to very high uncertainty, which involve large investments and address low-maturity technologies, coordination of RD&D activities among Member States and between them and the EU (joint programming) is highly recommended, since these projects can represent a challenge even for the bigger Member States. An agreed and committed centralized research strategy can provide the necessary assurance of long-term funding for R&D and the capturing of knowledge spillovers.

RD&D support takes place both in a decentralized manner on a Member State level as well as via a centralized distribution of EU and pooled Member State funds. However, support programmes are hardly coordinated currently – neither between different Member States, nor between them and the EU. This restricts knowledge sharing, increases the likelihood of costly duplication of similar research and fails to exploit potential benefits from economies of scale and scope via a pooling of resources and active networking. In order to achieve the SET Plan objectives, **cooperation and coordination among Member State and EU support policies have to be improved**. The initiation of European Energy Research Alliances – aimed at conducting pan-European RD&D by pooling and integrating activities and resources, combining national and EU sources – is a step into the right direction. Their successful implementation should be fostered and progress monitored.

Choosing appropriate financing policy instruments to induce innovation

Financing instruments are policy instruments. In addition to their function of closing the gap between the cost of innovation and funds private parties are willing to contribute, direct support instruments show features that make them suitable for

Box 2: Analytical frame to be applied to select financing instruments to apply



Thereby, social welfare should be maximized by (i) matching the type of support needed with the support provided by instruments at the lowest public cost possible; and by (ii) employing financing instruments of an efficient design to avoid 'funding failure'.

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specific types of innovation. They (i) might be able to target specific technologies (public loans/guarantees, public equity, subsidies in the form of prizes, grants or contracts); (ii) show a certain flexibility in (re-) directing funds to alternative innovation projects (e.g. lower for public loans than for subsidies in the form of benefits related to RD&D investments); and (iii) typically are better suited to support certain types of innovating entity.

The form of direct public support needs to be tailored to the features of each innovation project and to the type of entity best placed to undertake the respective RD&D. The aim is to maximize the amount of RD&D subject to public sector's funding by leveraging private sector funding as far as possible within each stage of project maturity. See Box 2 for a summary of the analytical frame developed within the project to select the format of support to clean innovation.

Public loans are well suited to finance lower cost innovations with well quantifiable future market prospects carried out by large companies. They become relevant if the liquidity of the capital market is low or if the innovation targeted is related to activities where the public sector is more experienced. Public loans are also attractive in recessions when private credit markets' appetite for risk is unduly depressed. *Publicly owned equity* is suitable to finance risky, potentially highly profitable, innovation preferably undertaken by small entities. These investments should be of modest size, though they may be used to marginally fund expensive innovation to signal that it has a high potential. Subsidies in the form of *technology prizes* shall fund early low-cost innovation preferably undertaken by universities and research institutes. Tax credits and other *benefits related to RD&D investments* are best suited to supporting near-market, incremental innovation conducted by large companies, as well as to innovation conducted within regulated entities. *Grants and contracts* – on the one hand the most attractive form of support from the innovators' perspective but on the other the most expensive instrument – should only be awarded to socially desirable clean energy innovation that would not be undertaken otherwise and where all other instruments would fail. This is clearly the case for most early-stage, capital-intensive processes as well as for many other pre-deployment RD&D activities. They may also be especially relevant to support innovation in regulated entities.

Financing instruments need to be implemented in a way that encourages efficiency while not discouraging participation by the private sector. This implies that first, competition for funds should be used whenever possible in order to set incentives for high efficiency in RD&D and to minimize public intervention. The public sector should, if possible, avoid having to identify 'winning technological options' and instead leave these decisions to the industry. Second, public funding should be output-driven whenever this is compatible with the engagement of innovators in the RD&D addressed. This involves making the release of funds and their amount conditional on the achievement of some minimum objectives; i.e. linking support to performance. Funds should be provided either ex-post after a project's successful conclusion or sequentially based on the achievement of intermediate objectives in order to allow for early termination if the project is not delivering expected results or for a re-orientation in objectives or research strategy if that raises the success probability.

However, the presence of high project costs may require releasing at least part of the funding up-front. For low-risk projects this could be done under the condition that funds have to be returned if the project is not undertaken as agreed. Support to projects whose probability of failure is high may probably have not to be linked to performance in order to attract private investment, which is especially relevant for capital-intensive innovation in technologies of low maturity.

Finally, the institutions set up to allocate funds to clean energy RD&D should be lean and flexible enough to avoid institutional inertia and lock-in, which make it hard to reallocate funds when it becomes clear that the original projects turned out to be less promising than expected and other projects now look more promising. The risk of financial lock-in is especially high for technologies of a low maturity.