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Policy dispatch

Entrepreneurship - Financing - Innovation - Intellectual property

Policy Options to Foster the Financing and Development of Clean Technologies[1]

No. 1

The context for public intervention

The public sector plays multiple roles in fostering the development of clean technologies...

Climate change and the environmental pressures resulting from economic growth imply that the importance of eco-innovation and the need to develop clean technologies are being increasingly recognized as mainstream policy concerns with multiple ramifications. The financing and development of clean technologies requires policy efforts to coordinate initiatives across many different areas, involving multiple actors over a sustained period of time. The public sector is bound to play a crucial role not only in defining the regulatory and policy framework that drives change but also in designing and funding arrangements to overcome the market failures that hamper progress.

...including in areas related to innovation policies

The introduction of new environmental technologies and their diffusion within and across countries on a massive scale requires specific interventions in a number of typical innovation-related areas, such as early-stage financing, R&D support and intellectual property rights.

Environmental challenges require innovative policy responses that reconcile the need to reduce the use of resources and to address climate change concerns with sustained improvements in living standards. Innovation, resulting in new technological solutions, provides possible answers to this dilemma. However, while the rationale for public intervention in this area is clear and the rewards significant, the financing and development of innovative clean technologies present particular difficulties that require a suitable policy response.

Policies need to remove disincentives and overcome market failures

The most basic incentive for the promotion of innovative clean technologies is the elimination of price distortions that provide an advantage to existing, more polluting technologies. In some countries, this is due to the existence of explicit subsidies that favour the continued dominance of existing conventional solutions. The presence of market failures - the inability of market prices to reflect the full social and environmental costs of using conventional technologies - is a more common deterrent to the emergence of competitive alternatives. The gap between social

[1] The text of this policy dispatch is based on a document presented to the sixth session of the UNECE Committee on Economic Cooperation and Integration (Geneva, 30 November-2 December 2011), which reflects the discussions that took place at the International Conference "Promoting Eco-Innovation: Policies and Opportunities" (Tel Aviv, 11-13 July 2011).

returns and expected private returns can be particularly large because of the uncertainty regarding the future characteristics of climate policy and environmental regulations over a long horizon, given the absence of clear and well-defined commitments.

The correction of market failures is a basic rationale for the need for policy intervention. Market failures are also present in the diffusion of technologies, in particular, due to the presence of network effects. Other instances of market failures include the lock-in impact of existing technologies and the high costs for early adopters of less environmentally damaging options.

Problems and solutions involve an international dimension

Environmental problems cross boundaries and therefore externalities can only be properly assessed at the international scale. A solution generates benefits for the country involved but this may also involve higher costs in the short term. This negative impact on competitiveness can be a deterrent in the absence of cooperation, which represents an important argument in favour of international collaboration in this area.

Market-based mechanisms are not sufficient

Market-based mechanisms (such as pricing) are important for creating incentives for innovation. A distinct advantage in relation to command-and-control instruments is that market-based mechanisms require less information than regulatory targets. However, price signals for investing in technology development are still weak. Given the pervasive character of market failures in this area, these market mechanisms alone are unable to stimulate change at the scale and speed required. Regulatory intervention is also necessary to complement other types of policies that seek to influence the price system.

A reassuring long-term framework is essential

A fundamental condition to facilitate the transition to a less environmentally damaging economy is the existence of a framework that reassures investors, firms and consumers that their decisions would generate an adequate return that can be estimated within an acceptable range. A long-term perspective is required to reduce the financial risk of investments and to encourage research and development (R&D) efforts. Coordination failures also require the intervention of the public sector. Given the long life of infrastructure used in energy production, long-term price signals are critical in the deployment of appropriate technologies.

Policy options and instruments

Government interventions include supply, demand and coordination mechanisms

Governments are expected to play multiple roles in promoting eco-innovation, i.e. the development of more resource efficient and less environmentally damaging technologies. These roles include not only direct support to R&D and facilitating the exchange of knowledge but also increasing the demand for eco-innovative solutions, raising market acceptance among consumers and providing a source of demand for new technologies through public procurement.

The policy mix should reflect national circumstances

The promotion of eco-innovation requires a balanced strategy that combines different policy tools. The starting point must be the appropriate pricing of environmental goods and services. The appropriate policy mix in different countries depends on national circumstances, including the sophistication of the knowledge base, the size of the domestic market, the industry structure and the degree of development of specialized financial intermediaries, such as business angels and venture capital firms.

Acceptance of risk and mutual consistency of actions are important principles

Technological innovation avoids the need to make hard choices and negotiate difficult trade-offs between environmental protection and economic growth. However, technology support policies provide no certain outcomes and risk is an inherent element of these activities. The intensity of the R&D efforts required depends on the incentives created by the price system and other policy actions, so there is a need to pay attention to the consistency of public initiatives. R&D policies need to be complemented with mutually supporting actions in other areas.

The maturity of technologies determines the type of policies that are appropriate

The type of appropriate policies depends also on the maturity of technologies. At the very initial stage, covering the development of prototypes and demonstration of new technologies, public support focuses on infrastructure planning, R&D financing and contribution to capital costs of large-scale demonstrations. At a later stage, some technologies may be already suitable for niche markets but they still find significant cost disadvantages. At this point, technology-specific incentives, such as feed-in tariffs, tax credits or loan guarantees could be appropriate. As technologies mature and become more competitive, support can be reduced and become more general. For mature technologies, the key policy question is how to accelerate its adoption by addressing market barriers through instruments, such as building codes, efficiency standards and information campaigns.

However, in the search for new technological solutions, it is important that policies do not appear excessively prescriptive, imposing both solutions and the way to reach them. On the contrary, a certain degree of experimentation and technological portfolio diversification is useful to identify successful technologies.

Policies should not aim to "pick winners" but make more general technology bets and rely on incentives

"Picking winners" when developing clean technologies, as in other forms of government support, is fraught with dangers, as the information to make appropriate choices is not available. Promoting general support technologies avoids the pitfall of making specific technological choices while providing flexibility. Clean technologies is a very broad concept and potential solutions may come from many different areas of sciences. From this point of view, policies that would support very concrete technologies cannot be efficient. Instead of this, policies should be horizontal, rely on incentives and make more general technology bets.

Not only new breakthroughs but increased affordability is necessary

An R&D effort is necessary not only to develop new technologies but also to make existing ones more affordable. Climate change mitigation policies and, more generally, the drive towards more environmentally friendly solutions, are prompting technological change in areas with traditionally low technological content, such as utilities. This increases the scope for technological innovation and the areas where R&D initiatives could yield positive results.

Innovation can also concern the production, use and distribution of conventional sources of energy

The debate on energy and clean technologies in general should not be limited to the merits of the different sources of energy in isolation from the ways in which energy is produced and distributed. Work should also be devoted to identify the ways in which conventional forms of energy could be utilized in a cleaner, more efficient way. Energy distribution is an important dimension of overall efficiency and should be an important element in devising innovative solutions to energy challenges.

Demand policies are an essential complement to supply-side interventions

In both developed and emerging markets, supply-side, technological-push solutions are insufficient to bring about the desired outcomes – technologically superior solutions that are widely used. Supply-side measures, such as R&D tax credits or subsidies, need to be accompanied by initiatives that increase the demand for eco-innovative products.

Pricing, regulations and green public procurement can raise the demand for clean technologies

Changes in relative prices can raise the demand by the private sector of clean technologies. Environmental needs are strongly influenced by policy and regulatory processes. These can provide a critical input for innovative activities, thus clarifying the desired results of this process. The articulation of credible demand through the regulatory process is an essential requirement for the success of innovative activities and standards can play an important role in this regard.

Green public procurement, in particular, in construction, where the public sector has a large presence, is a powerful policy lever in encouraging innovation, if it goes beyond conventional specifications to allow innovative solutions to reach commercial size.

New infrastructure is required to avoid lock-in effects

The provision of new infrastructure is required to avoid the lock-in of existing patterns of demand. A good example is the need for electric cars charging points. A long-term vision for the future is necessary to shape appropriate investment policies.

Internationalization increases the size of the market

Removing barriers to trade is also important to facilitate the development of clean technologies, as the size of the market is an important determinant of the development of eco-innovative solutions. This suggests that appropriate support should be given to initiatives to encourage the internationalization of small and medium-sized enterprises (SMEs), as these can make an important contribution in developing new environmental technologies.

The public sector should encourage cooperation across productive and institutional sectors

The role of governments to promote clean technologies concerns not only new regulatory or economic instruments but also facilitating partnerships and encouraging cooperation. Cooperation is important at the national level, due to the existing challenges and the multisectoral character of the necessary policy interventions. Different stakeholders need to be involved and an institutional space needs to be created for private-public cooperation.

Collaboration between the public and private sector serves to address risks and overcome weak market incentives

Collaboration between the public and private sectors serves to overcome barriers to innovation. Some large projects with significant costs and large risks can only be taken through joint efforts. A good example are the pilot projects on carbon capture and storage technologies, which are able to reconcile projected increases in energy consumption and coal use with the achievement of low emission targets.

The cooperation between the public and private sectors can serve to overcome weak market incentives for the emergence of new technologies. Public involvement may be a pre-condition for the development of some risky commercial projects. Public initiatives can work as a catalyst of links between established companies and academic institutes to set up and implement research projects that can result in commercial technologies.

Bringing together different partners, including researchers, facilitates the thinking on new ways of doing business and innovative concepts for products and services, which are attentive to lifetime considerations and help to reduce environmental pressure to a minimum.

A life-cycle approach integrates all partners and facilitates multiple interventions

A life-cycle approach in the conception and design of public policies promoting clean technologies appears most fruitful, as it provides a framework to integrate a large set of interventions in different areas under appropriate time frames to assess fully their implications.

Chain-oriented policies can identify actions with the largest environmental impact

Chain-oriented policies aim to bring together economic agents and encourage them to achieve a reduction of environmental pressures beyond what is required by legislation. Policymakers should focus their efforts on chains with the highest environmental pressures, which may be different from country to country. The acceptance of wide ranging eco-innovation initiatives depends on the support of users and this can be boosted through collaboration.

In order to successfully address sustainability issues, it is important to consider the design, production and manufacturing of a product across its entire life cycle. The use of a holistic life cycle perspective helps manufacturers and policymakers to identify improvements that could be made at any stage.

Collecting the information for life-cycle policies requires standards to facilitate collaboration

Information through the whole life cycle of a product should be collected to identify possible actions. The data need to be shared and exchanged between many different organizations. This complex web of collaboration can only be managed through standards to facilitate communication. The usefulness of standards depends on how widely disseminated they are. From a more general point of view, standardization is important to facilitate innovation and can be developed more efficiently through the collaboration between different stakeholders.

National collaboration among stakeholders provides a basis for international cooperation

National programmes have to be implemented to integrate all relevant stakeholders in a particular sector or project, which provides also the basis for successful international cooperation, building on the linkages developed at the national level. Collaboration is necessary to accelerate the implementation of solutions that have been proven in a certain context, facilitating the necessary adaptation.

The development of a shared long-term vision can only come across as a result of collaboration

Given the nature of the challenges involved and their enduring character, innovation concerning the development of clean technologies requires a long-term vision that involves different stakeholders and provides an institutional space for public-private cooperation. Wide stakeholder consultations are necessary to achieve consensus on long-term priority directions to support eco-innovation.

Technology foresight exercises provide a guide into the future

This is similar to the technology foresight exercises underpinning the formulation of innovation policies in many countries, thus providing a broad roadmap for technological change that reconciles both demand and supply considerations. Environmental aspects should therefore be included in these broader technology foresight exercises. Technology foresight centres can facilitate the development of common views on a green growth strategy that provides guidance and reassurance to relevant parties.

Diffusion of existing technologies is important for innovation....

The impact of new environmental technologies depends on the extent of their diffusion and wide acceptance. This is related to absorptive capabilities, namely, skills but also to the existence of open markets, which is also the result of continued collaboration across borders.

... and can be fostered by multilateral cooperation

From a broad policy perspective, it is important that the focus is not only to achieve particular technological breakthroughs but to facilitate the dissemination, both within and across countries. Multilateral cooperation should also involve developing countries, emphasizing capacity-building activities that facilitate technology transfer. This needs to be supported by appropriate funding arrangements.

The diffusion of clean technologies is to a large extent a process driven by market forces. As these new technologies have substitutes, there is a competition with conventional sources with a larger environmental impact. Therefore, policies to facilitate diffusion should ensure the increased competitiveness of eco-innovative solutions.

Technology transfer needs supportive conditions beyond availability of financing

Technology transfer is critical to ensure that environmentally sound technologies are widely used, thus contributing to the solution of global problems. This stresses the importance of global cooperation. Low-carbon, energy-saving technologies should flow to the developing world where energy efficiency is lower. However, the adoption of a technology (and its diffusion through the economy), including in areas relevant for climate change mitigation and other environmental purposes, requires a number of supportive conditions. Financing and technological availability are not a guarantee of successful and efficient outcomes.

Increasing absorptive capacity should be a primary policy target to facilitate technological diffusion

A primary policy target to ensure technological diffusion is the increase of the absorptive capacity, which is determined by factors, such as the existence of complementary infrastructure, the quality of human capital, the linkages between the various actors of the national innovation system or the type of governance. Barriers to technology transfer may be related to intellectual property rights or trade systems and have to be addressed as part of the overall country development policies. Initiatives to increase the absorptive capacity of an economy take time to deliver results and therefore should be undertaken early as part of wider innovation strategies.

International cooperation is required to address disincentives to innovation

International cooperation is necessary to avoid the disincentives to innovation that emerge when the outcome of national efforts cannot be fully appropriated at the national level. International trade raises a number of questions that need to be addressed, including the diversity of environmental standards and the different policy importance attached to environmental targets.

A suitable balance should be found regarding IPR, considering both incentives to innovation and technological diffusion

The question of patents is also problematic. Intellectual property rights (IPR) provide innovators with a degree of protection over the results of their efforts and are thus a basic component of the incentive system to encourage innovation. However, there is a need to reach a suitable balance between the creation of conditions for the rapid diffusion of climate change technologies and the incentives for innovation through the protection of IPR.

Patents are also a source of information that can facilitate collaboration

Patents serve to protect inventions but also to disseminate information about technology, which otherwise would remain unknown. Therefore, they also provide a basis for collaboration. There are also "green patents" which have been made available by businesses free of charge to facilitate technological diffusion. In particular, the needs of technology transfer to developing countries may require special arrangements, similar to those observed in the pharmaceutical industry, to make technologies available to developing countries at lower costs.

Entrepreneurship promotion and firm-level support can contribute to the development of clean technologies

Entrepreneurship is the key driver for change, including regarding the development of clean technologies, so policies need also to pay attention to the removal of barriers to entry and exit of enterprises while addressing problems of access to finance, which are particularly acute for small and medium-sized enterprises. Younger firms tend to be greener innovators and should be the object of special policy attention as part of the effort to encourage the transition towards a more resource-efficient, eco-innovative economy. More generally, this shift would also be facilitated by firm-level support to upgrade the skills and production processes of companies, so they can adapt to new market conditions and actively promote change.

Information on support instruments facilitates coordination and the exchange of experiences

The development of clean technologies and, more broadly, eco-innovation are influenced by a wide portfolio of policies. It is therefore important that appropriate institutional mechanisms of collaboration are put in place to ensure the consistency of different initiatives. More and better information on support instruments is required to facilitate coordination of national policies, to identify best practices in an international context and create channels to sharing them.

Financing innovation

Environmental innovations open a wide range of investment opportunities

The strong projected demand for environmental innovations and clean technologies represents a source of business opportunities. Environmental innovations or clean-tech include new technologies that are able to compete on price and performance, while reducing environmental impact. This implies a wide range of potential sectors for investment, encompassing energy, transportation, industrial processes, production of materials, recycling and waste, among many others.

As is the case with other innovative technologies, there is a financing gap that needs to be covered so promising ideas can become fully-fledged commercial proposals. Environmental innovations need to overcome the "valley of death" - the period during which significant development resources are required that cannot yet be offset by revenues. The size of this gap and the possibilities to finance it depend on perceived risk, capital intensity and the time required for commercialization and scaling up. Potential investors have only an imperfect knowledge of business opportunities, so market mechanisms may lead to insufficient funding of ideas which are socially relevant and with the potential to be commercially successful.

Regulatory changes are a source of risk for investors

There are a number of characteristics of clean technologies which make raising finance particularly difficult. Business opportunities are largely linked to regulation and government policies, which determine to what extent new technologies face competition from existing ones. As regulations and policies can change, this creates a source of uncertainty. When opportunities are driven by subsidies, markets may collapse if this form of support is abruptly removed.

Coordination needs and complementary infrastructure requirements create financing challenges

Clean technologies and, more generally, eco-innovations often require new business models and involve changes along the complete value-chain, resulting in the transformation of whole sectors. This goes well beyond the adoption of end-of-pipe solutions to encompass more comprehensive changes with a larger transformative potential. Given these characteristics, which impose significant coordination requirements and require costly and time-consuming infrastructure investments, financing problems are particularly acute.

The need for life-cycle assessments increases uncertainty and the difficulties of estimating the cost of new clean technologies. Unintended consequences resulting from the impact of eco-innovations on other environmental dimensions (for example, the introduction of biofuels) cause problematic effects on other aspects of sustainability, which may affect the ability to raise finance.

Scale issues create difficulties when trying to raise financing

Scale issues also complicate efforts to obtain financing. Some projects, especially in renewable energy, are small, which implies that transaction costs are high. At the same time, in comparison with other early-stage high-growth areas typically targeted by venture capital (for example, information and communication technologies), the scale of many clean technologies projects is far larger and more capital intensive. Scaling up projects from the demonstration phase to commercial operations requires significant resources. This implies that the financing gap is a particularly strong constraint in some innovative environmental technologies that require significant upfront capital investments.
Conventional financial intermediaries, such as banks, tend to avoid early-stage

Lack of specialised expertise in banks discourages lending

activities where risks are high, cash flows uncertain and there is little collateral available to back up requests for financing. This is also observed in relation to new environmental technologies. However, even at a later stage when bank lending may come into play, environmental technologies are at disadvantage because of the lack of specialized expertise in financial institutions to assess associated risks.

Venture capital is increasingly targeting the development of clean technologies in many areas

As in other sectors, venture capital financing (both formal and informal) provides access to capital and managerial guidance in the early stages of development of innovative enterprises when other sources of financing are not yet available. An increasing share of global venture capital is targeting the development of clean technologies as investors seek to take advantage of a growing (existing and anticipated) demand for green technologies. This concerns a wide range of areas, including energy, waste treatment and water but also industrial processes and product design.

Hybrid funds with public participation can mobilise private venture financing...

Venture capital backed companies can play an important role in generating disruptive technologies, which are unlikely to originate in established firms. Public support can serve to encourage the development of venture capital financing. In particular, public-private funds can improve the risk-return profile of investments, making opportunities more attractive to would-be private investors and thus increasing the amount of private financing available for new clean technologies.

...but other types of financial intermediaries should also be targeted

However, venture capital financing can only be seen as a partial solution to the problems of financing eco-innovation, which should be dealt with in a more comprehensive fashion, paying attention to the different stages in the development of clean technologies and the changing levels of risk and financing needs.

Other financial intermediaries need also to be engaged in these efforts. Established companies are unlikely to be a source of capital in the way, unlike the symbiotic relationship observed between large pharmaceutical companies and small biotechnology firms. Clean technologies can be associated to structural changes that undermine the market power of incumbents, resulting in a reluctance to change.

Business angels can provide financing when requirements are low ...

Clean-tech is not only about renewable energies, which have strong capital requirements. There are also other areas, which may face significant technology and commercial risks but where financing needs are smaller, thus opening the door for the involvement of business angels (informal venture capital investors).

...and syndication serves to overcome deal size limitations

Business angels can play an important role in exploring the potential of new ideas, as they are able to consider a number of small size investments which would not attract the attention of other investors. Investment clubs operating through syndication facilitate pooling financial resources and developing a specific investment focus backed by specialised expertise to source and select investment opportunities.

Direct and indirect public support have an impact on deal flow and profitability

Grants and technology incubators help to develop new ideas so as to generate a deal flow that can be considered later by formal and informal venture capitalists. Tax credits and other forms of public support often have important implications for the profitability of the projects undertaken and the available choices regarding the financing structure.

Interventions should be comprehensive to avoid financing gaps

Public support is important to address financing gaps. It is therefore critical that schemes are comprehensive enough so any bottlenecks are fully covered. Partial coverage is only a waste of resources. Specific forms of support, with a sectoral orientation, may be required to spearhead the interest of venture capital companies in areas where particular financing "bottlenecks" have been identified.

Besides financing, other companies' needs should be considered

Financing support should not be provided in isolation but taking into account other needs of eco-innovators, which include the development of links with potential customers, collaboration agreements with holders of complementary technologies, among others.

Companies should be helped to become "investment ready"

On the demand side, there is a need to increase awareness and expertise among technology developers on the forms of support available and to enhance skills that help them to become "investment ready".

Supply-chains can be developed with the help of the public sector

Given the difficulties involved in different alternatives for the commercialization of technology, it is also important to target the creation of consortia between various types of companies to develop supply chains thus providing new possibilities for the development of small and medium-sized companies. The coordination role of the public sector, besides the direct provision of resources, can make an important contribution to address financing problems.

Public initiatives can contribute to reduce risk perceptions, thus facilitating raising finance

Strategic intelligence developed with the input and guidance of public initiatives can help to improve risk perceptions and therefore facilitate raising finance. Developing predictable policies with a long-term orientation is a major responsibility for the authorities who need to anticipate changes and encourage the private sector to take adaptative actions before sharp adjustments are imposed as a matter of necessity.

Internationalization opens new markets and provides access to financing and expertise

The development of clean technologies is a global opportunity and, therefore, it is important to facilitate international contacts to exchange knowledge and pool resources. While environmental challenges are global, a patchwork of regulations across multiple jurisdictions creates difficulties for eco-entrepreneurs, when trying to develop and commercialize new technologies. Facilitating cross-border investments is important to attract financing but also to gain access to associated expertise to develop and scale-up local innovations.

Policy actions aiming to foster the financing and development of clean technologies should consider the following

principles and recommendations:

- The promotion of eco-innovation requires a comprehensive strategy that pays attention to both supply and demand-side measures. Policies should target both the generation of innovation and the dissemination of existing technologies within and across countries.
- Effective policies require also the development of supportive framework conditions that enhance the impact of individual initiatives. In particular, obstacles to technology absorption and diffusion have a more general significance but should also be addressed when promoting the development of clean technologies.
- Changes in relative prices can increase the attraction of new clean technologies but these economic incentives may not be sufficient. Investment in infrastructure is necessary to break path dependency that blocks innovation. Regulatory measures may also be required to overcome market failures and to generate demand for environmentally friendly technologies.
- Policies should not attempt to "pick winners" when promoting the development of clean technologies. Policies should be horizontal, rely on incentives and make more general technology bets.
- Collaboration, in particular at the international level, is essential for the development of clean technologies and, more broadly, the advancement of eco-innovation. Such collaboration facilitates the exchange of policy experiences, the pooling of resources and the achievement of scale effects. It is important to establish the appropriate institutional, regulatory and policy frameworks that create a solid basis for this cooperation.
- Life-cycle considerations and chain-oriented policies are important for devising effective solutions to environmental challenges that take into account the full impact of proposed interventions. Governments have an important role to play in facilitating partnerships and encouraging cooperation among all relevant parties, including through the development of appropriate standards and channels of communication.
- Eco-innovation is increasingly perceived as a business opportunity, which could emerge in many different sectors. Predictability and stability of policies and regulations are essential to ensure the growing engagement of the private sector in financing and developing clean technologies.
- Financing eco-innovation requires the combination of public and private efforts. Eco-innovative initiatives face particular difficulties in raising finance, given the characteristics of some environmental innovations, which makes public intervention necessary. The ultimate aim is not to replace private financing but to encourage it, lowering risks and providing strategic intelligence to reduce uncertainty.
- Strategies regarding the financing of clean technologies should be comprehensive, addressing any "bottlenecks" that may arise at different stages in the development of eco-innovative companies, so to avoid any gaps. Policy interventions are more effective, when financing support takes into account other needs of these companies.

The UNECE Knowledge-Based Development (KBD) Policy Dispatches present selected results of the policy-oriented work on innovation and knowledge-based development of the Committee on Economic Cooperation and Integration. The Committee develops policy recommendations and good practices on innovation and competitiveness policies, the financing of innovation, entrepreneurship and enterprise development, and the commercialization and enforcement of intellectual property rights. The KBD Policy Dispatches are designed to disseminate the results of the Committee's work to a broader audience. They are prepared by the Economic Cooperation and Integration Division reflecting the outcomes of Conferences, Seminars and other activities and the contributions of the networks of experts that support the work of the Committee.

KBD Policy dispatch

For more information and subscriptions, please contact:
Mr. Ralph Heinrich
E-mail: ralph.heinrich[at]unece.org
Telephone: +41 22 917 1269
Website: www.unece.org/ceci/Welcome.html