



# GREEN economy

## Briefing Paper

## Innovation

### Key messages

- *Environmental regulation can induce innovation, which may turn into a competitive edge for domestic industries.*
- *Pricing resources could foster green technological progress by influencing the rate and direction of investment in innovation.*
- *Innovation policies can generate new forms of capital, pushing the industry to advance in a particular direction, or they can relax conditions that are preventing such change; they can also help a country attain technological leadership.*
- *By designing appropriate policies, developing countries can strengthen their capacity to adapt green technologies to their national context and hence become receptive to a flow of benefits from the green economy.*
- *For developing countries, knowledge and technology creation and diffusion have the dual role of not just spreading innovation, but also enabling firms to identify, assimilate and use existing local knowledge.*

### Designing a green economy

Green economy policies, if properly designed, deliver social and economic benefits by improving resource efficiency and inducing domestic companies to innovate, which may provide them with a competitive edge – first mover advantage – vis-à-vis their competitors.

Two questions are at the heart of the pursuit of a green economy:

- How can governments direct economies towards a sustainable growth path?
- How can such policies benefit the society concerned?

Composite policies can be designed that enable a society to pursue multiple objectives, combining environmental, growth and competitiveness goals.<sup>1</sup>

Economies can be directed towards the green economy by means of a combination of resource management and innovation policies. In terms of resource management policies, governments can place appropriate prices on resources.

Appropriate resource prices, reflecting the path of future scarcity, could foster green technological progress by influencing the rate and direction of investment in innovation.

Innovation policies tend to take the form of direct investments by the government to relieve constraints that hinder the development of new technologies. These investments can generate new forms of capital, in order to enable the industry to advance in a particular direction, or they can relax conditions that are preventing change in the society.

For developing countries, the green economy is not so much a question of innovation at the technological frontier but rather one of technology transfer and diffusion. By designing

<sup>1</sup> This policy brief is a synthesis of an economic framework paper, "Green Economy: Economic frameworks for thinking about growth, sustainability, and the role of state intervention," and academic discussions at the "Designing the Green Economy" workshop, which was co-organized by UNEP and Centre for International Environmental Studies (CIES), Graduate Institute of International and Development Studies in Geneva.

# *UNEP defines a green economy as one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities.*

appropriate policies, developing countries can strengthen their capacity to adapt green technologies according to their national context and hence become receptive to a flow of benefits from the green economy.

## **Resource pricing and management**

Societies initially rely heavily upon natural resources – high levels of throughput from the natural environment in the form of natural goods and services. With increasing development and growth, natural capital is progressively transformed into physical, human and social forms of capital. This rebalancing of capital is one of the important drivers of development. For an economy to develop sustainably, its production structure must be flexible enough to allow for substitution between scarce and abundant forms of capital. Technological change must also occur such that productivity is increased in the face of declining resource throughputs.

Some argue that for sustainability to occur, society should “invest all profits or rents from exhaustible resources in reproducible capital”.<sup>2</sup> Whether or not this process can endure indefinitely depends on the extent to which physical capital is substitutable for natural capital. But this is not enough. It is also necessary to combine the conversion of capital stocks with directed technological progress.

This consists of building the current capital stock around future resource scarcities so that companies can fully anticipate the path and direction of innovation. Then prices can be increasingly reflected over time, allowing companies to choose the right forms of capital investment.

Governments must play a leading role in ensuring that resource scarcity is reflected in the prices of inputs. In the presence of market imperfections, where market prices do not reflect real scarcities well, governments must act to direct innovation down the right path toward sustainability, either through resource management or innovation policy.

While innovations react to price signals, path dependency also plays an important role in determining the direction of investments. Companies invest not only in technology but also in a particular variety of human capital that accompanies the applied technologies. As a consequence, the earlier a company switches to green technologies, the less costly the transition will be, and the less likely it will be to find itself locked into dirty technologies. Thus, inducing change towards a green economy will require government policies that enable firms to respond to price signals in resource management.

However, the prices of resources are not always a matter of domestic interest or control. Where global environmental goods such as climate change mitigation are concerned,

<sup>2</sup> Hartwick, J. M. (1977). “Intergenerational equity and the investing of rents from exhaustible resources”. *The American Economic Review* 67(5), 972–974.

policy outcomes rely on international cooperation. Effective resource management policies will often require that resources be managed at the level where they exist, whether it is local, national, regional or global.

## **Directing innovation policy**

Another area of policy that may be pursued is that of directed innovation policy, where innovation is induced through incentives other than resource pricing.

To shift economies towards a green economy is a complex issue, one that comes from various sectors and different types of technologies. For example, a challenge like climate change has no single technological answer and the space of potential solutions is large. This poses a challenge involving the trade-off between knowledge creation versus diffusion. For example, climate change problems require that innovations, once they exist, also be applied widely and not used by only a few technology leaders.

Additionally, much of the conventional wisdom about innovation policy, such as notions of proprietary or intellectual property rights, may not be sufficient in the case of a green economy transformation, because such systems may influence the rate but not the direction of innovation. Also, they often only confer incentives upon those innovators whose innovations are sold within existing markets.

Thus, the pursuit of sustainability may require some combination of policies – resource management and direct innovation – to fill the gaps left by the market.

## **Technological and policy leadership and competitiveness**

Appropriate resource management and innovation policies may induce investments and innovation that result in the country achieving “technological leadership”. Denmark with its wind turbines and Japan with hybrid engine and catalytic converter technologies are two good examples of countries that embarked upon costly resource management and innovation programmes early, and then benefited when other states needed to license their proprietary technology.

Secondly, a country may attain “policy leadership”, when a state adopts a particular resource management policy that is later adopted by many others, resulting in national investment responses similar to the initial adopters. Here the technological leadership is a direct result of making a particular policy move first, rather than the general desirability of the technology involved.

However, forecasting future resource scarcities is an exercise in speculation, always uncertain and never without risk. Nevertheless, the point of investing in a green economy is to

## *UNEP launched its Green Economy Initiative in 2008, and is currently supporting over 20 countries around the world in their transition towards a green economy.*

recognize those resource scarcities that are clear, unavoidable and (currently) un-priced, and to be one of the first to build these unavoidable scarcities into the economy.

### **Greening developing economies through innovation**

For most emerging markets and developing countries, the competitiveness benefits of a green economy are not about innovation or gaining first mover advantages. By investing in their capacity to adapt green technologies in their countries, these economies could become receptive to the benefits of green innovation and avoid being locked into obsolete technologies and capital stocks.

To benefit from technological transfer and diffusion, developing countries need to invest in their capacity to adapt technologies to their respective local settings, aided through structured government interventions. In the case of least developed countries (LDCs), support for adequate capacity development would be required to benefit from such green innovation.

Diffusion has the dual role of not just spreading innovations but also enabling firms to identify, assimilate and use existing local knowledge.

In order to do this smoothly across nations, it is important for firms that hold proprietary rights to invest in their diffusion, and for public systems to coexist with proprietary ones in order to enable diffusion and licensing. It could also be an opportunity for developing countries to enhance their chances of success through policies, emphasizing investments in human capital and the encouragement of capital markets, as well as an openness to global technology markets and general foreign direct investment.

Furthermore, policy-makers should facilitate information flows about promising areas of science and engineering and put in place incentives to build up research and development capacity in local enterprises. This may require far more complex policy interventions than for innovation itself.

### **International institutions**

International trade and investment regulations can foster the green economy by providing a solid and secure context for flows of innovation and investment. Certainty regarding trade and investment regulation is particularly important to the green economy due to interlinked and global supply chains.

At the same time, in international trade law, there is also a set of rules that places constraints on the policy instruments that might be used to support the transformation towards a green economy: 1) the non-discrimination principle; 2)

### **The case of biofuel in Brazil**

*Brazil is currently a global leader in producing ethanol-based biofuels and many countries are following in order to reduce their dependency on petroleum-based fuels. The success of its programme has been largely driven by the government's support of the ethanol industry, making it the largest bioenergy programme in the world.*

*Government policies include:*

- *Tax benefits for alcohol-run cars*
- *Ceilings on ethanol prices (up to 65 per cent of gasoline prices)*
- *Requirements on high ethanol fuel blends*
- *Mandates for ethanol-based fuelling stations*
- *Support for car companies to manufacture vehicles that can use gasoline and ethanol for fuel.*

*By the end of 1980, cars that could run on alcohol accounted for 73 per cent of total car sales. Then came the flex fuel car in 2003, where owners can alter the ratio of ethanol to petroleum in order to adapt to fluctuating prices of oil and sugar. As a result, changes in petroleum prices no longer affect the production of alcohol-run cars. Some 90 per cent of cars produced in Brazil today are dual fuel.*

*The expansion of the biofuel industry has, however, raised concerns that it could counteract carbon savings through deforestation. In addition, increased sugarcane production will be needed to meet increasing ethanol demands, which will have significant implications for deforestation.*

*Nevertheless, Brazil's success in transitioning to biofuels has demonstrated both "policy leadership" and "technological leadership" for innovation.*

# *The Green Economy Report, published by UNEP in 2011, makes a compelling economic and social case for investing two per cent of global GDP in greening 10 central sectors of the economy.*

In summary, it is important for green economy strategies to take into account the legal realities of the trading system and to design policies that are as compatible as possible with World Trade Organization regulations. However, it is also important to recognize that policies that are built around composite goals (such as innovation, environment and economic growth) must necessarily involve in-built trade-offs between these multiple objectives.

Thus, policy-makers must work together to encourage both innovation and diffusion to make this a reality. In some contexts, there can be conflicts between these two objectives, and these conflicts need to be both recognized and addressed. This can be done through a strategy that combines policies, e.g. proprietary rights for innovation and public sector investments for diffusion, or it can be done by recognizing the inherent trade-offs between them, and choosing a policy that balances both objectives (in other words, some compromise between innovation and diffusion).

## **Designing green economy policies**

Through appropriate resource pricing, countries can benefit from first mover advantages by directing their economies towards green innovation and anticipating future resource scarcities. When governments anticipate either what the correct resource scarcity values will be or in which direction environmental regulation will develop in the future, companies can incorporate those scarcity values into their investment decisions, including investment in research and development.

Directed innovation policy can also be an equally important part of the policy environment in achieving the advantages of the green economy. For example, targeted policy in this area can be crucial to reaching a particular goal or to relieving a particular constraint. Policy-makers should consider a combined policy of resource management and innovation in order to achieve a green economy advantage.

Diffusion and technology transfer is the key to success for developing countries to benefit from green innovation. The priority for developing countries should be to invest in their capacity to adapt green technologies, and to encourage diffusion. Early adoption of policies and technologies is also crucial for developing countries. Due to path dependence (sunk costs), firms in such countries may get locked into an inferior production technology that is difficult to alter.

Growing recognition of increasingly complex policy environments and the need for international institutions to evolve in order to accommodate such complexity and their trade-offs are important to the green economy transition. International institutions must recognize that single-policy objectives are no longer the best way to progress.

## **What UNEP is doing**

UNEP, together with (CIES), organized an expert workshop on "Designing the Green Economy" in December 2011 in Geneva.<sup>3</sup>

Following-up on this joint endeavour, UNEP is focusing its research on addressing policy actions for the diffusion of low-cost green technologies and the promotion of green innovation in low-income countries that could help their transition to a green economy.

The choice of the most adequate green technology depends on local circumstances. UNEP is currently supporting 36 countries through the Global Environment Facility Technology Needs Assessment project.<sup>4</sup> Building on a Technology Needs Assessment, the project identifies low-cost green technologies that are needed by and of priority to low-income countries, and carries out case studies in countries where UNEP provides Green Economy Advisory Services.

<sup>3</sup> See [http://graduateinstitute.ch/cies/UNEP\\_Workshop\\_2.html](http://graduateinstitute.ch/cies/UNEP_Workshop_2.html) for more details.

<sup>4</sup> See <http://unepiso.org/TNA/index.htm> and <http://climatetechwiki.org/> for more details.

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