



low-emission  
Poland 2050

# The role of eco-innovation in a low-emission transition

**Poland is facing a strategic choice – how to handle the low-emission transition. Attempts to postpone it, avoid its consequences and oppose the EU regulations in this area will not be beneficial in the long run.**

Andrzej Kassenberg, Aleksander Śniegocki

Poland can join the club of leading economies only through direct competition. Today it can focus on eco-innovation and enter the low-emission race for efficient use of resources. It can also choose to remain a spectator – risking falling into the low growth trap and missing the right moment to reduce its gap to the global leaders.

> Excerpt from the summary

# 3



# The role of eco-innovation in a low-emission transition

Andrzej Kassenberg, Aleksander Śniegocki

## 1 INTRODUCTION

## 2 1. FEW WORDS ON ECO-INNOVATION

## 4 2. THE GLOBAL RACE TOWARDS LOW-EMISSION MODERNIZATION

4 2.1 Finland and South Korea - from modern electronics  
to clean technologies

6 2.2 USA - innovative clean business

7 2.3 Germany and China - two approaches to support  
of the eco-innovation industry

## 10 3. OPTIONS FOR POLAND

10 3.1 Coal island in the green ocean?

11 3.2 The strengths and weaknesses of eco-innovation in Poland

14 3.3 Opportunities and threats for eco-innovation development in Poland

16 3.4 Recommendations for Poland – conscious eco-innovation

## 18 EXAMPLES FROM POLAND

## 19 SUMMARY

## 20 BIBLIOGRAPHY

## Introduction

The challenge of a low-emission transition will require long-term changes in the patterns of production and consumption in Poland. They will have to include a large-scale implementation of new solutions to improve the efficiency of using energy and other natural resources, and to reduce greenhouse gas emissions. They do not have to rely solely on the introduction of new technologies. Meeting the reduction targets will also require significant organizational changes. This means abandoning inefficient practices and the adoption of new approaches enabling better use of the available resources for the benefit of both producers and consumers. With the increasing impact of climate change, Poland will have to raise its resilience and adaptive capacity at the lowest possible adjustment cost.

The ability to create one's own innovative ideas and to adapt and adjust those invented by others, and then effectively implement them, is a distinct feature of economies coping efficiently with new challenges. In recent years, the public debate in developed countries has clearly focused on the role of innovation, not only as a key growth engine, but also as a solution to the biggest problems of modern civilization. Western countries hold the view that a conscious and persistent effort in dealing with these challenges is a chance to create new incentives for

the development of modern industries. It will bring developed economies onto a path of economic growth based on the solid foundation of improved productivity and more efficient use of available resources, and away from another speculative bubble. Also follower economies, such as Poland, can benefit from the adoption of an active attitude towards a range of global challenges, including foremost the human-induced climate change, dwindling non-renewable resources and the rising cost of food production. The following sections present the opportunities for growth shaped by smart public support for low-emission innovations. These can significantly reduce the cost of abandoning the current emission-intensive growth model and act as a stimulus for modernization which in turn will prevent the stagnation that is usually coupled with imitative growth.

### Box 1.

#### Why eco-innovation? Low emission and the future of Polish growth

As shown by the previous publications of the project Low-Emission Poland 2050, constant changes are an integral part of the development of an economy and its individual sectors. Poland has used the opportunity given by its systemic transition which started twenty years ago, but this growth engine is gradually becoming exhausted. Growth based on low cost competition becomes more difficult as the Polish wages are rising and the global prices of commodities that determine the competitiveness of domestic industry are soaring. The successes and failures of other countries show that in order to maintain rapid economic growth in Poland and to achieve a high standard of living for Poles, improvements are necessary in three key areas. The first of them is the improved functioning of institutions – to create a legal environment that would encourage entrepreneurship, would be predictable and citizen-friendly. The second area is the labor market where an increase in the employment rate is necessary. Societies with low employment rates (as is now the case in Poland) are not able to mobilize sufficient resources to achieve a permanently high level of economic development. The third area is innovation – a shift from competition based on low price to competition based on quality, creativity and more efficient solutions. Merely copying solutions from the leaders will cut off domestic companies from lucrative niches in the global market, and keep the whole country lagging behind the leading economies that benefit from a high return on investment in their own innovative ideas.

It turns out that the path towards a low-emission economy is closely related to the three foundations of future development of Poland. Low-emission investment requires a predictable regulatory environment. The labor market may experience the positive effects of the low-emission transition directly (green jobs) and indirectly (higher productivity as the health of workers improves). Finally, a low-emission transition provides incentives to seek innovative solutions and at the same time benefits from their implementation. This publication focuses on the latter area – eco-innovation.

# 1. FEW WORDS ON ECO-INNOVATION

The deep economic crisis at the end of the 2000s coincided with global trends that permanently changed the balance of power in the world, and posed new economic, social and environmental challenges for both rich Western economies and the new fast-growing powers. Developed countries must now tackle a slowdown and the servicing of long-term debts. Rapidly growing emerging markets – especially China – need to find a way of maintaining the pace of growth necessary to converge to the world's leading economies. Nonetheless, both groups of countries have to address the ever aggravating civilizational challenges. These include environmental, social, demographic and security problems. The most complex and serious are climate change and the rapid increase in global demand for scarce resources, such as fossil fuels and other commodities, prompting increases in their prices. Radical transition to a low-emission and resource-efficient development path has become a necessity.

It is increasingly evident that the answer to these problems in all groups of countries is innovativeness and the conversion of civilization challenges into modernization projects stimulating economic development. In advanced economies this entails effective expansion in emerging technology markets (new energy sector, resource-efficient industry, sustainable low-emission mobility, pro-efficiency services), responding to the need for the efficient use of limited natural resources, as well as human capital (health care, education), and facilitating the smooth functioning of ecosystems whose economic significance we are only starting to fully acknowledge. Developing countries that wish to reach a western level of prosperity must, in turn, gradually shift from price-based to quality-based competition, which in practice requires the development and use of their own innovative solutions instead of imitating existing ones.

## Box 2. What is eco-innovation?

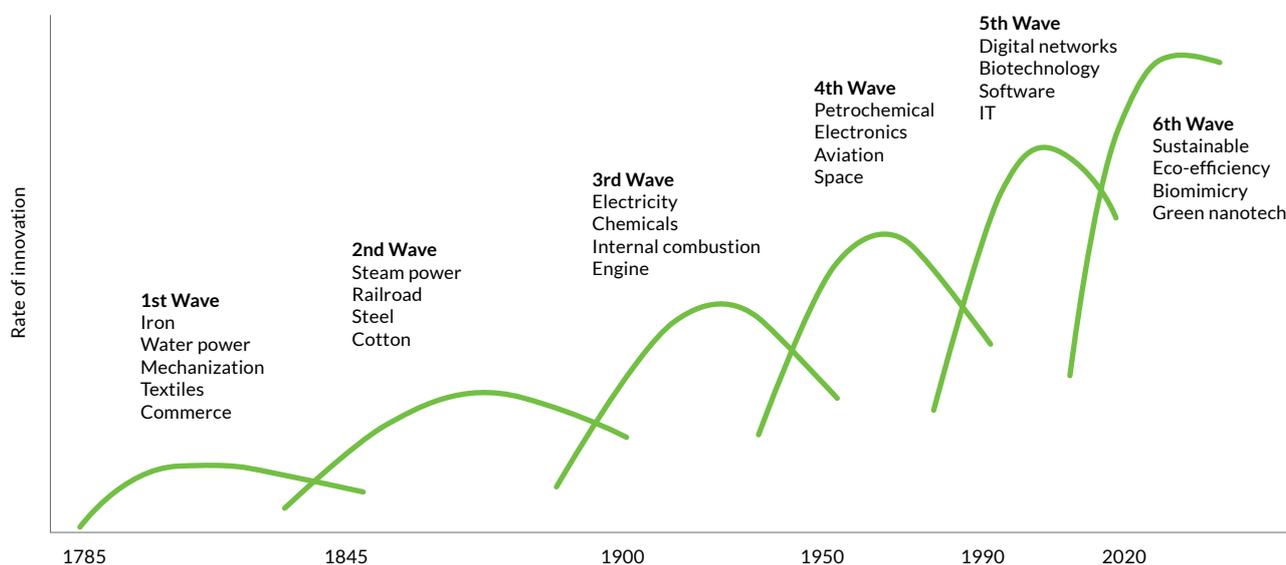
**Innovation** is the implementation of a new business practice or significantly improved product, service or process, including the implementation of a new organizational or marketing method redefining methods of work or a firm's interrelations with the environment.

**Eco-innovation** is an innovation that improves the efficiency of natural resources' use in the economy, reduces the impact of human activity on the environment or reinforces an economy's resistance to environmental pressures.

Sources: OECD and Eurostat (2008), Szpor and Śniegocki (2012)

In the public debate in developed countries the emphasis on eco-innovation as an effective solution to environmental problems is ever stronger. New methods for the efficient use of depleted resources and the reduction of the impact of harmful anthropogenic impacts on the environment are perceived not only as an important long-term environmental policy tool, but also as part of economic policy. Actions in the area of eco-innovation are referred to as 'no regrets policies', i.e. those that would be profitable even without taking into account their positive impact on the environment. The 'greening' of economic growth translates into new areas of growth, fast-growing markets offering both 'greener' solutions, a chance of generating cheaper energy and gaining independence from unreliable supplies of scarce, expensive resources.

Diagram 1. Long waves of innovation



Source: Worldwatch Institute (2008) cited in Tekes (2011)

It must be kept in mind that it is not only technology providers that benefit from the development and diffusion of technologies. In view of the limitations of international negotiation processes, the pioneers of emerging low-emission innovation markets will be able to count on significant gains only when their solutions are profitable to customers. Therefore, the better the technical and diplomatic issues of reducing greenhouse gas emissions are understood, the greater the emphasis on investment in long-term cost-effective solutions. This means that customers will also benefit from the diffusion of eco-innovation, while pioneer countries' profits will be twofold - both through more efficient management of resources and through the export of solutions to global markets.

In the context of a low-emission transition, eco-innovation primarily relates to the reduction of the energy intensity of production and consumption, and modification of the energy mix. Greenhouse gas emissions associated with energy generation from fossil fuels are the most significant human contribution to climate change. Development of low-emission energy sources and the reduction of emission intensity resulting from fossil fuel use (more efficient energy transformation, efficient renewable energy sources etc.) require innovative and cost-effective solutions. Eco-innovations in the area of resource-efficient and low-emission production processes in industry, transport, construction and agriculture should not be ignored since they reduce greenhouse gas emissions not related to energy production.

**(Eco-)innovation can transform the great challenge of reducing emissions into the economic and social benefits of more efficient use of resources and development of new industries.**

Focusing on eco-innovation and 'green growth' requires treating contemporary environmental and resource security problems as challenges rather than obstacles. Dedication to dealing with these challenges, instead of disregard, is an opportunity to improve the quality of life and provide the economy with new incentives for growth. The only condition is the readiness to seek and implement new solutions, better adapted to the changing environment.

## 2. THE GLOBAL RACE TOWARDS LOW-EMISSION MODERNIZATION

Recent years have shown that reaching a global consensus on climate policy is an extremely difficult task. The reluctance of many developed and developing countries towards the international reduction obligations apparent at climate conferences does not mean abandoning plans regarding a low-emission economy. Insight into the policies of particular countries reveals that an increasing number of countries reinforce their involvement in the race towards low-cost alternative energy technologies and efficient use of scarce resources, including those of strategic importance, to improve their competitiveness and to ensure a strong position in global markets in the coming decades.

### 2.1 Finland and South Korea – from modern electronics to clean technologies

Finland and South Korea differ in terms of geographic location, history, culture and economic environment. Despite this, both their previous experience and current growth policies confirm the economic importance of innovations and the benefits of focusing on the efficient use of natural resources.

The previous 25 years proved a difficult time for both nations, affected by the crises which exposed the weaknesses of their development models, and calling into question the prospects of their growth. However, they passed the test. When the shocks occurred, these countries were at different stages of development. The disintegration of the Soviet Union which affected Finnish exporters, happened while the Finns were at a relatively high level of development. However, even before

the crisis Finland had already ceased to catch up with the global leaders, stuck in the middle-income trap for twenty years. South Korea was affected by the Asian financial crisis after years of rapid growth when it just approached the middle level of income.

#### Box 3. Middle-income trap

The zone of middle-income is defined as the range of 50-70 percent of GDP per capita in the United States. With an average growth rate of 1.5-2% per year, this translates into a 20-40 years' gap in development relative to the United States. A country may fall into this trap due to the depletion of basic sources of economic growth (capital accumulation, labor costs, competition, technology transfer) which drove the economy in the early stages of its development. If they are not followed by new ones – especially innovativeness and efficient institutions conducive to doing business – the country falls into stagnation and permanently assumes the role of a supplier in the global value chain.

*The middle income trap is discussed in detail in 'Between the North and the South – opportunities and traps in the development of Poland until 2050' (Bukowski et al. 2012a).*

Despite the difficult situation, both countries, after the initial shock, were able to avoid long-term stagnation and achieve growth rates that secured them a permanent place among the most developed countries after recession. How did they

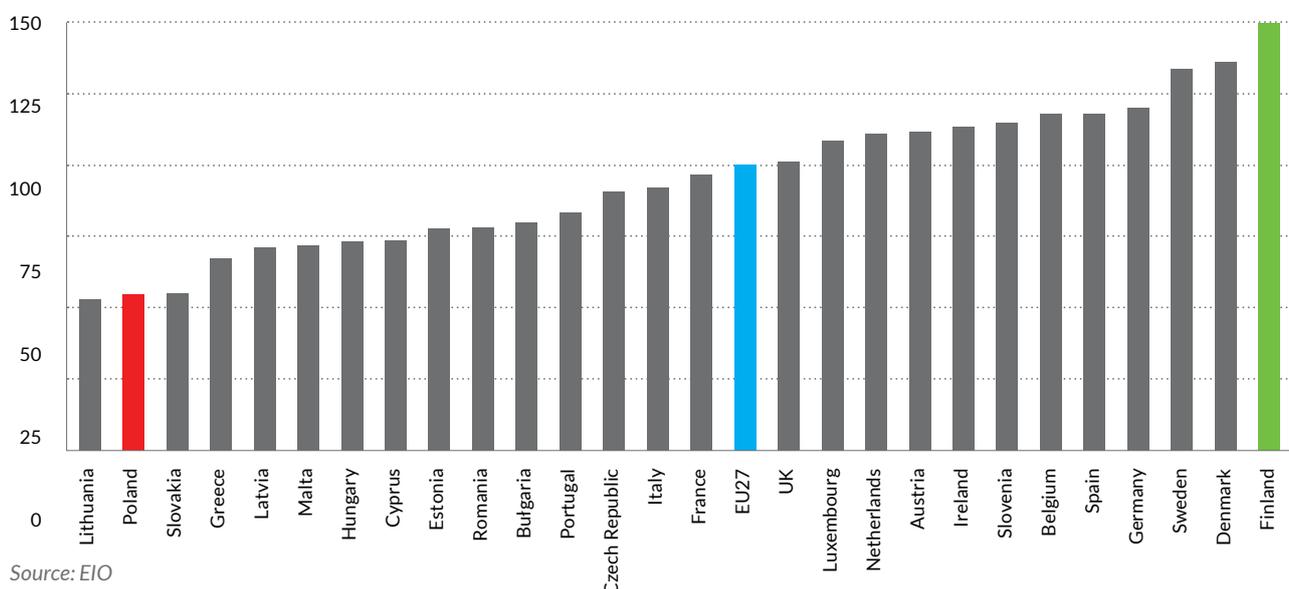
succeed? Long before the crisis, both countries decided to focus on the development of domestic capacities to create innovative solutions that could allow them to compete in attractive global markets. To this end, they spent significant resources on the development of R&D infrastructure, education of researchers and support of investments in modern industries. Thanks to the years of acquiring knowledge and experience, Finnish and South Korean companies were ready to enter the consumer electronics market, rapidly growing over the last two decades. The example of these two economies shows that the problem of the middle-income trap can be overcome by focusing on innovation potential which prepares an economy for crises as well as new development opportunities.

A one-off economic success is not enough to build lasting prosperity. Over time, even the most attractive markets saturate, and the world economy's centre of gravity is shifting to new areas. Therefore, governments and the private sector both in Finland and in South Korea are ready to continue their modernization efforts and adapt to the new conditions in the world markets. Over the past few years, both countries have clearly indicated which area they consider to be the growth engine in the future – green economy. In 2009 South Korea adopted the National Strategy for Green Growth and the related Five-Year Plan for Green Growth. With the annual investment of about 2 per cent of GDP, South Korea intends to build economic foundations of the development of innovative industries and clean technologies, and to launch the process of introducing its economy to low-emission and resource-efficient growth path. South Korea also promotes the idea of green growth in other countries on its own example (GGGI 2011). On the other hand,

**South Korea and Finland have shown that regardless of the differences between countries, success depends mainly on the ability to continuously modernize and seek new development opportunities in a rapidly changing world. In line with this philosophy, these countries currently focus on eco-innovation.**

Finland – with the still important role of the extraction and export of natural resources – has been investing in technologies that allow a more efficient use of resources and reduce the negative anthropogenic impact on the environment. Thanks to its significant overall innovation potential and additional support for sustainable development, Finland is Europe's leader in eco-innovation (Figure 2). Despite this, the Finns are not complacent and continue to invest in further development of eco-innovative solutions (Tekes 2011), e.g. 'Green Growth 2011-2015' program implemented by Tekes – a Finnish innovation support agency.

Figure 1. Eco-Innovation Scoreboard 2012



Source: EIO

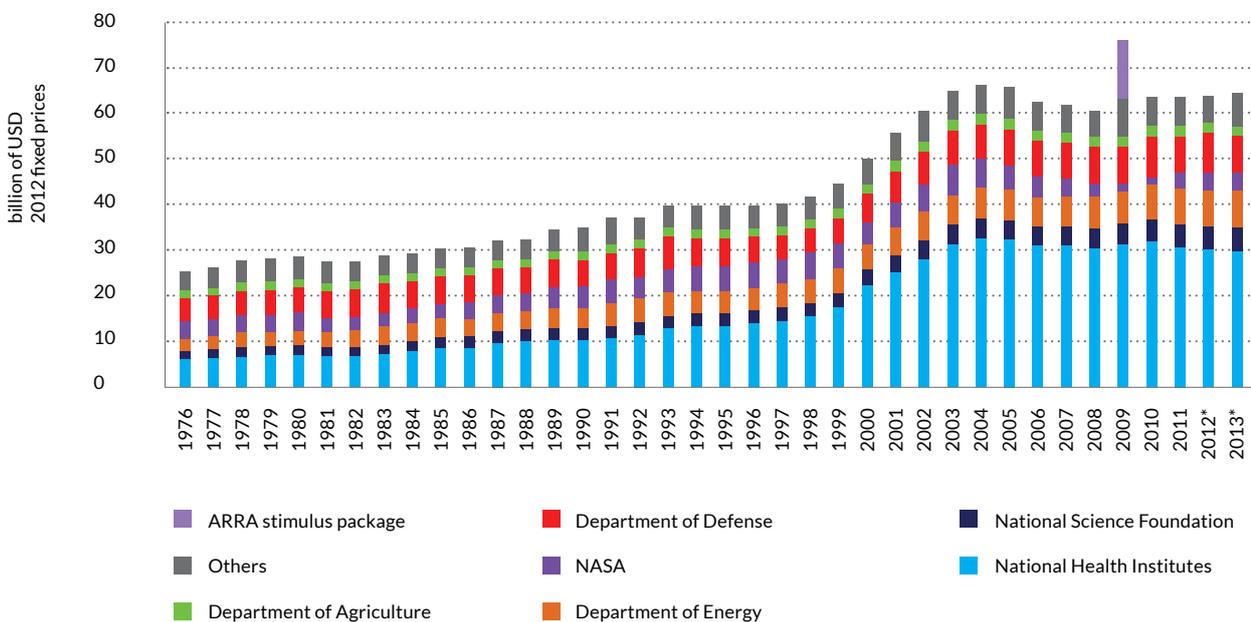
The ability to switch to new sources of growth, and the related willingness to continuously rebuild and adapt the economic base to the changing global environment is crucial for joining and staying in the club of the most developed economies in the world. Over the past decades South Korea and Finland have proved capable of it. Even more significant is the fact that both countries see the chance for further development in broadly understood green technology.

## 2.2 USA – innovative clean business

The U.S. has long been a leader in innovation thanks to the scale and quality of its system of knowledge creation and commercialization, expertise in science-business-government cooperation, and its open-minded attitude to continuous change forced by competition in the large, absorptive, but also demanding, U.S. market.

Eco-innovation – primarily related to alternative energy sources – have been present on the agenda of the United States for years, although the term itself appeared relatively recently, and the Americans prefer the notion of ‘cleantech’, i.e. clean technologies. Expenditure on research and development in the energy sector are comparable with the expenditures of the Department of Defense. It is not a coincidence that the ARPA-E (Advanced Research Projects Agency – Energy), established in 2007, is based on the model of the famous DARPA (Defense Advanced Projects Agency for Research). Energy sector development in the U.S. – as well as in Europe and Poland – is considered to be a matter of national security. In recent years, increasing attention has been also given to other areas of eco-innovation – primarily related to material efficiency. In times of conflicts over the access to scarce resources (such as rare-earth metals), discoveries of new methods of production allowing independence from the suppliers of resources has become a priority in the long-term security policy.

Figure 2. Federal spending on R&D in the United States, 1979-2013



Note: Estimates for 2012-2013

Source: AAAS (2012)

In contrast to the Department of Defense which allocates large amounts to the implementation of DARPA inventions in the army, the Department of Energy leaves the task to the private sector and focuses on the early stages of R&D. Although in the American public debate there are ever louder calls for increased funding for the implementation of clean technologies (e.g. ITIF 2012, the Center for American Progress 2012),

it should be noted that currently both at state and federal level there are a number of support mechanisms for the diffusion of low-emission technologies and ‘green investments’ were a major part of the ARRA stimulus package adopted during the crisis (Cunningham and Roberts 2011).

#### Box 4.

### Breakthrough innovations and the American 'Kodak moment'

The supporters of increased investment in RES argue that even strong leaders can quickly lose their position if they miss the timing for changes and are not ready for the opportunities that they bring. An example from the business world is Kodak, an undisputed market leader in cameras in the 1990s, with a technological advantage over its competitors in the traditional photography. The corporation for a long time neglected the new technology – digital cameras, initially more expensive and offering poorer image quality. However, over several years, thanks to technological progress, digital cameras significantly improved their performance and their prices dropped. It turned out that Kodak's ability to slightly improve the traditional technology was not enough to compete with the new products. During the 2000s, the market situation was reversed – traditional cameras practically disappeared and Kodak lost its position. This story is a part of a broader trend of change acceleration in the economy, which leads to a much faster turnover of leading companies and industries than in the past.

The story of Kodak provides countries with two important conclusions. Firstly, reliance on any of the industries in which the country currently has a competitive advantage does not guarantee future growth, in fact leaving the opposite much more likely. Moreover, in the case of the energy sector, which indirectly affects many other industries, focusing on exploration of currently dominant technologies may result in a significant decline in competitiveness when alternative technologies, with a greater potential for development, are ready to be marketed. The shale gas revolution and the wave of RES investments in major economies indicate that this type of qualitative change is also possible in the energy sector and might occur relatively quickly. Although in the case of energy technology the breakthrough will not be a rapid process (as is the case in consumer electronics market), sticking to old energy technologies also means keeping them – for better or for worse – for decades.

From the perspective of a country catching up with the world's leaders, the U.S. debate on the „Kodak moment“ poses a question whether it is possible to achieve a high level of prosperity by focusing on maintaining and developing existing advantages in the traditional areas of expertise and trying to secure a position in already saturated markets that are bound to change within the next 10 or 20 years. This question is particularly important in the case of the energy sector - are we positive that focusing on a slight improvement in coal technologies and the related model of development of energy infrastructure will be the most secure and cost-effective choice for Poland in the perspective of forthcoming decades?

Source: Dolezalek and Freed (2012)

New proposals (mainly by the Democratic Party) regarding the introduction of a federal *cap and trade* system and supporting the development of renewable energy sources (e.g. certificates for low-emission energy sources in the draft bill *Clean Energy Standard for America* from 2012) are regularly presented. Although the climate debate in the U.S. is highly politically polarized, in the area of clean technology (primarily energy technologies) the discussion revolves around the means of support, not whether the government intervention is required at all. The Americans do not need to be convinced about the importance of investing in innovative solutions to the national strategic problems. The American policy of fostering innovation in the energy sector has played a significant role in the current shale gas revolution in the U.S. which has improved the country's energy security and reduced greenhouse gas emissions through a shift from coal to cheap gas. As indicated by the Breakthrough Institute (Trembath et al. 2012), several decades of R&D expenditures incurred by the Department of Energy has enabled the accumulation of the knowledge base necessary to develop the technology of hydraulic fracturing, which can now be used effectively by the private sector in the process of shale gas recovery.

Another example is the projected federal subsidy scheme for large wind farms, for which the Department of Energy is going to allocate \$167 million. Currently there are nine such facilities at an advanced stage and further 24 still in the initial phase. Commercial electricity generation is to be launched near 2017 at seven selected sites.

### 2.3 Germany and China – two approaches to support of the eco-innovation industry

China and Germany are the two largest exporters in the world. The German economy has been long recognized for the focus on the production of highly processed goods and high-tech devices. Chinese exporters, on the other hand, are gradually shifting towards high value-added goods. Through their strategic documents (the Twelfth Five-Year Plan for China, and the High-tech Strategy for Germany 2020) both countries indicate a strong interest in new and prospective markets providing goods and services that will respond to the challenges of the coming decades. These include environmental issues, broadly defined safety, health care problems associated with demographic change, and the challenge of further digitization of the economy. Innovative low-emission technologies are the key elements of the solutions and thus play an important role in both the Chinese and German development policies.

Table 1. Low-emission innovation in China and Germany

China's 12th Five-Year Plan priority industries	High-tech Strategy for Germany 2020 Key fields of activity
<ul style="list-style-type: none"> <li>• New energy (nuclear, wind, solar)</li> <li>• Energy conservation and environmental protection</li> <li>• Biotechnology (drugs, medical devices)</li> <li>• New materials (rare earths, high-end semiconductors)</li> <li>• New IT (broadband networks, security infrastructure, network convergence)</li> <li>• High-end equipment manufacturing (aerospace, telecom)</li> <li>• Clean energy vehicles</li> </ul>	<ul style="list-style-type: none"> <li>• Climate / energy (low-emission cities, restructuring of energy supply system, renewable resources as an alternative to oil)</li> <li>• Health / nutrition</li> <li>• Mobility (including electric vehicles)</li> <li>• Security</li> <li>• Communication</li> </ul>

Source: BMBF (2010), KPMG (2011)

Differences between the German and Chinese approach to promoting the domestic eco-innovation industry and their impact on the global market can be seen particularly clearly in the case of photovoltaic panels.

The German approach is characterized by a strong emphasis on *demand-pull* policies, stimulating demand for innovative solutions. This differs from the U.S. model which focuses primarily on *supply-push* policies i.e. strengthening innovation supply, e.g. through direct support of R&D. Demand for innovative German technologies is supported by lead markets support schemes. Their functioning is based on the assumption that domestic firms will be able to develop much faster in the promising emerging markets thanks to indirect government support. Such policies are also applied at the EU level – the climate package is meant to help achieve the environmental goals while also stimulating development of the European green industry. In the case of photovoltaics and other RES, the German government has decided to boost the demand through a *feed-in tariff* system, where the prices of electricity generated from RES are determined in advance at such a level that makes investment in this technology profitable. The level of subsidies is being reduced as the RES technologies come close to grid parity and the targets for the share of renewable in the energy mix are reached (Fulton et al 2012).

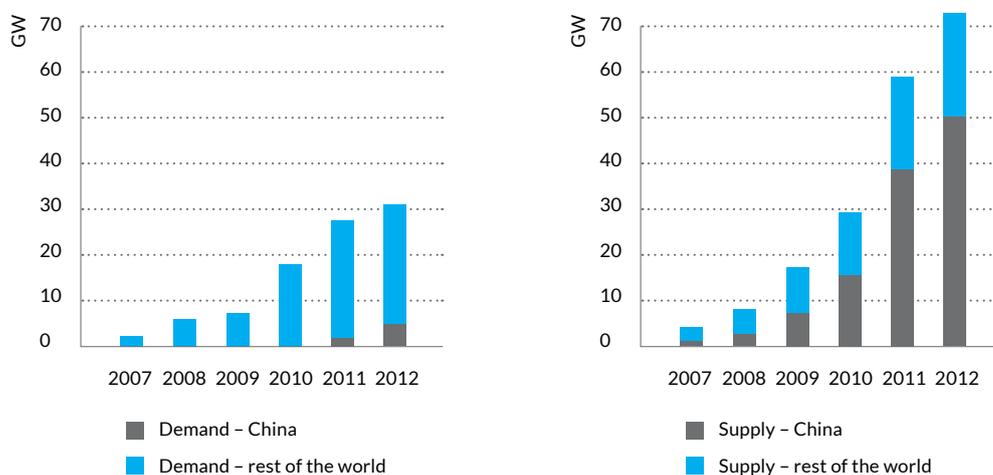
China has applied yet another set of policies, different than in Germany or the U.S. Despite heavy investment in the Chinese R&D sector, it still lags behind the Western competitors. Therefore, China has focused on conquering new markets by achieving economies of scale realized with the government's support for the development of existing production capacity in the area of well-established technologies. Chinese companies are supposed to gain the necessary expertise needed for the

future implementation of innovation and a strong position in key markets thanks to the strong state support. It is worth noting that in this case, the strategy does not rely on the alleged 'imitation of Western ideas', but the significant initial government support for Chinese producers.

Thanks to governmental programs, China has enjoyed a rapid rise in demand for their photovoltaic modules, and the Five-Year Plan assumes sustaining this trend in the coming years. Over the past few years, China's plans to enlarge PV power plant capacity by 2015 have been multiplied – from 5 GW to 40 GW at the end of 2012. However, the increase in Chinese production capacity has exceeded even fast-growing global demand driven mainly by the *feed-in tariffs* in several EU countries, including Germany and Italy.

The Chinese mercantilist strategy of conquering new green markets has led to significant turmoil in the photovoltaics market – oversupply of modules, a drop in prices below the cost of production, and crowding out of Western producers. This policy is likely to be ineffective, harmful and expensive for the Chinese economy (it means the hasty development of few industries at the expense of citizens and other sectors), not just the West. At present, European consumers are being subsidized by Chinese manufacturers, while the vast majority of jobs and value added in the green industries (connected with construction and maintenance of renewable energy sources) remains in the European Union. However, in the long run, sustaining the current market imbalance would lead to the disappearance of the European eco-innovative manufacturing industry and know-how. Therefore, it is hardly surprising that both the EU and the U.S. have already taken measures to protect their manufacturers from unfair competition.

Figure 3. Supply and demand in the global market for photovoltaic panels, 2007-2012.



Note: demand – solar module installations in a given year, supply – manufacturing capacity in a given year

Source: GTM Research, after NYT

But do the difficulties of the PV market and competition from China indicate that the German – and, more broadly, European – focus on eco-innovation has been a mistake? The contrary seems to be true, as indicated by the above examples. Key market players are willing to invest in this industry, and failures result from fierce and not always even competition with the old and emerging economic powers. The ‘green’ mindset observed in Germany and the whole EU is therefore shared by other major economies – and that makes the policy objectives much more difficult to achieve. Therefore, Europe’s withdrawal from the global eco-innovation race is clearly suboptimal. From the Polish perspective, it means that the quest for low emission technologies is a worldwide trend which will not be reversed by any changes in the EU climate policy.

**The global eco-innovation race would not stop even if the EU reduced its emphasis on climate policy - Europe would just be left behind.**

# 3. OPTIONS FOR POLAND

## 3.1 Coal island in the green ocean?

Regardless of the position of individual countries in climate negotiations and instruments applied to support eco-innovation, the transition to low-emission and resource-efficient ways of generating energy, in production of goods and services is becoming a reality. With tens of billions of dollars in investment in the EU, China, the U.S. and other countries interested in green technologies, a gradual reduction of costs takes place – research and development activities are being performed, economies of scale are appearing, infrastructure is slowly being adjusted to new technologies. This process can radically change the relation between costs of old and new technologies within a decade or two. For example, in the case of wind power and photovoltaics, the increasing use of these technologies has been accompanied by falling prices. The long-term trend – consistent with the economic concept of learning curves – indicates that within a decade RES will become a cheaper energy generation option than fossil fuel energy, regardless of short-term market fluctuations. At the same time the array of RES technologies is so wide, and current search for breakthrough energy innovations is so intense, that the possibility of emergence of qualitatively new and more competitive solutions cannot be excluded. These could accelerate cost reductions in renewable energy sources or solve the issue of intermittence of wind and solar power sources. Development of efficient renewable energy storage solutions might further strengthen the role of the RES in energy mix.

The advantage of eco-innovation, especially in the energy sector, is its great and yet undiscovered technological potential. On the other hand the use of fossil fuels is based on mature technologies, with hardly any room for improvement – particularly in the area of emission intensity. Technological breakthroughs like shale gas revolution, occur rarely and attempts at ‘cleaning’ fossil fuels have encountered major technical problems

– simple and cost-effective options for improving the competitiveness of traditional energy generation technology are running out. Thus, it might occur that the most dangerous option for the Polish economy is to avoid any risk and stay with the old model of energy sector for as long as possible. New technologies based on renewable energy sources may prove more cost effective than traditional ones, even without taking into account the high environmental and health costs of emission-intensive energy sources. Then the energy revolution will force changes in the Polish energy mix without policy interventions. But then Poland probably will have to spend decades catching up and bearing higher energy costs than countries that have systematically prepared for the transition.

**Given the abrupt changes in energy generation technologies, the conservative approach towards the energy sector may turn out to be the most hazardous strategy.**

Fully embracing the possibility of wide implementation of energy-related eco-innovations – and a distributed and systemic generation of power based on renewable sources – is vital in the design of long-run strategic policies and decision making processes. Flexibility and readiness to carry out transition in the energy as well as other sectors of the economy, induced by global trends, is the bare minimum for Poland. Apart from

preparing the Polish economy for highly probable low-emission transition (ex. diversification of energy mix, improvement in flexibility and internationalization of the energy system), the benefits for the Polish economy resulting from expansion of domestic firms into new markets should be considered. Therefore transition into low-emission economy should not only be seen as a pro-modernization stimulus, but also as a business opportunity for Polish entrepreneurs.

### 3.2 The strengths and weaknesses of eco-innovation in Poland<sup>1</sup>

Expansion of eco-innovation in Poland faces many obstacles; the most important include the following (Grodzka D., Zygierewicz A. 2008):

- Underestimating the innovation potential of the economy as a growth engine, and therefore its ability to create new technological and organizational solutions, raising labor productivity and improving efficient use of scarce resources – labor, capital, energy and materials. Innovation and particularly eco-innovation remain beyond the scope of interest in the Polish public policy, thus shaping the expectations towards the EU and ways of distribution of structural funds. As a result, the policy in Poland puts an emphasis on the modernization of infrastructure and acceleration of extensive economic growth, instead of preparing for changes in economic sectors' composition and the limitations of the currently exploited growth model based on competing on price rather than on quality (Bukowski *et al.* 2012b).
- The attitude towards the EU funds is focused mainly on their availability and prompt use. Focus on maximum absorption of the funds does not stimulate debate on improving efficiency of their use. We need sustainable mechanisms (like the Finnish experience) that will kick-off the development of new competitive branches in the economy. There should be a greater pressure on quality of ideas, selection and promotion of radical innovations. The structural funds offer new funding opportunities for initiatives at the universities. Unfortunately, as a result of excessive formalization, the objective tends to lose significance, while bureaucracy is expanding. As the result the sound paperwork gains the importance at

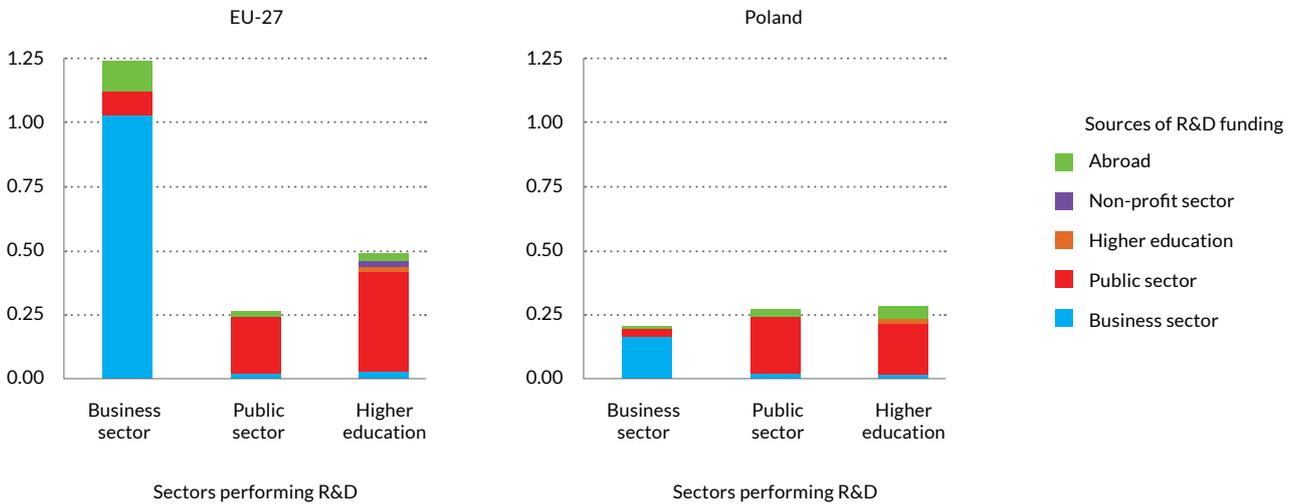
<sup>1</sup> Subsections 3.2-3.3 are based on reports by Kassenberg A., Kassenberg P. *EIO country brief 2010, 2011, 2012: Poland*. Subsection 3.4 is based on publications under the Institute for Structural Research project (*Eco*)*innovation – opportunity for Poland*.

## The Polish policy puts emphasis on modernization of infrastructure and acceleration of extensive economic growth, instead of focusing on restructuring of the economy and limitations of currently exploited growth model, based on competing on price rather than quality.

the expense of achieving project's goals and providing with long-run benefits.

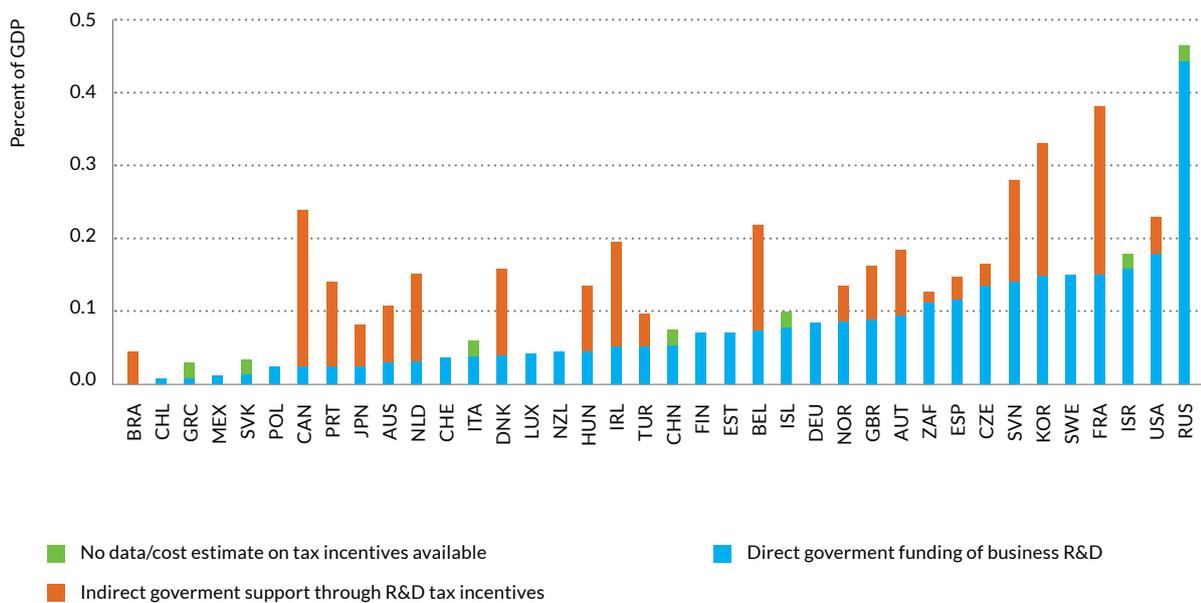
- The key obstacle to the development of eco-innovation in Poland is the lack of qualified and experienced personnel. This is mainly due to the weakness of education system and its low efficiency. A significant share of university students graduate in non-technical majors like law, sociology linguistics and literature, but the market is short of engineers or bio-scientists. Therefore the human resources in the field of eco-innovation are scarce. There is a gap between entrepreneurs (very innovative but at a basic level), administration and science. Another issue is inefficient cooperation between scientists of different disciplines, even from one university, and also between scientists and business. Academics are concerned with achieving a sufficient number of publications, rather than facilitating business activities or commercializing their findings. There is a low mutual interest in collaboration between R&D institutions and companies. Interdisciplinary research is seldom ever conducted. At the same time, the infrastructure for commercialization of R&D – i.e. business environment – is underdeveloped. There are also difficulties with an access to eco-innovative solutions developed by the scientific community. Supporting innovation and in particular eco-innovation is a serious challenge, as Poland has a huge problem with innovativeness as such.
- High risk of investing in innovation, especially in eco-innovation. Costs of the technological investment are high– and the access to external sources

Figure 4. Sources of funding and sectors performing R&D in Poland (2010) and EU-27 (2009), as percentage of GDP



Note: Non-profit sector performing R&D has been omitted (no data for Poland available, 0.02 percent of GDP in the EU-27)  
Source: Bukowski et al. (2012b)

Figure 5. Direct and indirect support to private R&D in the OECD countries, 2009



Note: For some countries, data from 2007 and 2008. Data for Poland from 2009  
Source: OECD (2011)

of funding, especially for SMEs, is difficult. Currently the state support is hardly perceptible. Except for the Operational Programme 'Innovative Economy' and regional operational programs, there exists no other significant support. The main barrier is the shallow market for many technologies. The commercialization of many interesting ideas would require large-scale production. Limited scale of production addressing niche markets translates into relatively high marginal costs. As a consequence Poland faces either a barrier of heavy investment expenditures or operational costs. Model examples are the automotive industry and solar energy sector. A significant barrier for the domestic companies to get involved in eco-innovation is insufficient capital to develop and implement their ideas. From the point of view of the financial institution considering engaging in eco-innovative projects the more serious issue is the high technological risk instead of financial. There are no means to verify proposed solutions neither on a pilot-scale nor half-technical scale. In particular, this concerns *project finance* case where the sole task of a founded company is to carry out a given investment project. Preliminary examination of the project makes banks and other financial institutions more eager to provide the project with

## The protection of sunset industries is a significant barrier to the development of eco-innovative solutions and lowers the chances of economic success in the near future

capital along with decreasing risk of project's failure. There are also hardly any venture capital funds that invest in small projects, that in many countries are core instrument for the implementation of scientific research and development, and innovation into business practice.

Two characteristic syndromes can be observed. On the one hand the level of overall development is insufficient for a meaningful increase in demand for eco-innovative from business entities. On the other hand – due to this demand gap – substantial resources are not allocated as they are not going to be used.

Table 2. Strengths and weaknesses of eco-innovation in Poland

Strengths:	Weaknesses
<ul style="list-style-type: none"> <li>• Many provisions in strategic documents on the role of eco-innovation in the future development.</li> <li>• Growing number of well-educated young people with experience from internships and education abroad.</li> <li>• Gradual development of the scientific and technological facilities, potentially leading to the emergence of a 'critical mass' for eco-innovation.</li> <li>• Numerous local initiatives that can evolve into movement promoting eco-innovation.</li> </ul>	<ul style="list-style-type: none"> <li>• Unfavorable political and social climate for the development of eco-innovation.</li> <li>• Insufficient funding.</li> <li>• No systemic support for eco-innovation.</li> <li>• Lack of qualified and experienced personnel.</li> <li>• High risk of investing in innovation, and in particular eco-innovation</li> <li>• Insufficient collaboration between research centers, business units and financial institutions.</li> <li>• While obtaining funding focus purely on availability of resources and their prompt spending, rather than on the objectives and long-lasting benefits that are especially important in eco-innovation.</li> <li>• The innovation policy actions aimed at strengthening the economy are dispersed and fragmented.</li> </ul>

Source: Institute for Structural Research

### 3.3 Opportunities and threats for eco-innovation development in Poland

To substantially improve the situation it is necessary to take the following actions and achieve these goals (Iskrzyński 2010, Matusiak 2010):

- Selecting areas in the field of eco-innovation that are important from the viewpoint of the state needs and interests, like energy and climate. Strengthening the scientific and technological facilities in order to achieve 'critical mass' resulting from creation of more focused and competitive funds that reward high quality, and also target resources on institutions and organizations able to succeed, consolidation of public research institutions and implementation of joint projects.
- Strong support for education among entrepreneurs to maximize the potential, promote best practices, cooperate with the EU in order to gain best practices and experience of business leaders.
- It is necessary to focus on the creation of support services for entrepreneurs, popularization of coaching, pre-incubators, university incubators, clusters, networks and platforms. Institutional incentives should be created to foster closer practical cooperation between business, universities and government.
- It is necessary to focus on the creation of support services for entrepreneurs, popularization of coaching, pre-incubators, university incubators, clusters, networks and platforms. This should generate institutional incentives for efficient cooperation between business, universities and administration. Innovation is born as a response to the shortcomings of current solutions. The development of eco-innovation does not depend solely on the level of available funding of scientific projects in this area. Most of all, there need to be a demand for such solutions. Of particular importance are dedicated financial instruments, including seed capital, in the environment of research institutions.
- Development of a system of incentives for entrepreneurs to commercialize eco-innovations through the simplification of legal regulations, boosting competitiveness, simplifying the tax system and ensuring long-term stability of legislation and mechanisms supporting innovation. The introduction of tax incentives related to the implementation of innova-

**It is necessary to focus on the creation of support services for entrepreneurs, popularization of coaching, pre-incubators, university incubators, clusters, networks and platforms. This should generate institutional incentives for efficient cooperation between business, universities and administration.**

tions, based on clear principles, and greater availability of external financing for innovative projects (the EU funds, preferential loans, venture capital). Creating a state-funded guarantee fund for bank loans to eco-innovative solutions should be considered.

- Improvement of the innovation and eco-innovation management system, to shape a system of a long-term planning in public research and innovation. Increased involvement of business in policymaking process in fields of science and technology and participation of business sector representatives at the university and research institutions councils. Strengthening the role of evaluation as a key element of efficient science and innovation policy. Fostering the scientific background for the innovation policy by conducting relevant research and analyses.
- Development and improvement of training and teambuilding; gaining skills necessary to develop programs and prepare the applications; advanced education for business advisors and technology transfer. Widespread application of information and communication technologies.
- Encouragement of regional eco-innovation systems development in form of networks of cooperation between administration, research institutions and centers of innovation and entrepreneurship. Promotion of up-to-date support instruments among administration and local government authorities on the regional level. Assistance in feasibility studies and business plans preparations, and attention to balanced development across the entire country.

Table 3. Opportunities and threats for eco-innovation in Poland

Opportunities	Threats
<ul style="list-style-type: none"> <li>• New requirements of increasingly refined and ever more stringent environment protection law.</li> <li>• The new EU financial perspective 2014-2020 focusing on innovation, low-emission economy and sustainable development.</li> <li>• Low energy efficiency and resource productivity enabling the effect of a sharp increase in eco-innovation (e.g. the necessity for a transition to a distributed energy system)</li> <li>• Recognition of the significant potential for advancement of eco-innovative products and services in Poland by foreign investment.</li> <li>• Development of domestic eco-innovation may make Poland a net- exporter.</li> <li>• The EU policy regarding energy and climate issues.</li> </ul>	<ul style="list-style-type: none"> <li>• The perception of a low-emission economy solely as a threat weakening the foundations of economic growth.</li> <li>• Focus on sunset industries induces less attention to the development of eco-innovation.</li> <li>• The innovation system – universities, research institutes and R&amp;D units – may be specialized in the development of ‘dirty’ technologies and may not be able to automatically switch to ‘clean’ ones.</li> <li>• Over-allocation of the EU funds to traditional areas and the development of transport infrastructure, instead of broader support for research and development and implementation of innovative solutions.</li> <li>• Eventual financial crisis can significantly slow down the process of eco-innovation development given high risk and high marginal cost of entry.</li> <li>• Further delays in the implementation of eco-innovative solutions will lead to increased costs of importing them.</li> </ul>

Source: Institute for Structural Research

Recently some meaningful initiatives were introduced, however they do not indicate a systemic change. The most important include:

1. The ‘Strategy of innovation and efficiency in the economy for 2012 to 2020. Dynamic Poland’ has been presented by the Ministry of Economy. The strategy highlights low awareness of environment-related issues and indicates a need to allocate knowledge, competencies and skills throughout the development of eco-innovation.
2. The agreement between the National Fund for Environmental Protection and Water Management, and the National Research and Development Centre in order to create the ‘Ecological Concepts Generator – GEKON’, to jointly support the scientific institutions and enterprises involved in developing environmentally friendly technologies in Poland.
3. Continuation of the successful Green Technology Accelerator GreenEvo. This program is, an initiative of the Ministry of Environment, to support the internalization of Polish eco-innovators on the global market. The Program has raised the interest of

approximately 700 companies. In 2011, companies participating in GreenEvo recorded revenue growth of 31 per cent on average, and their revenue from exports increased by 58 per cent. At the same time 86 per cent of the companies involved in this program trade with foreign partners, and 50 per cent signed cooperation agreements.

4. Establishment of multiple eco-innovation-oriented clusters, such as the Silesian Cluster of Environmental Technology, Baltic Eco-Energy Cluster and the Cluster of Clean Energy in Southern Poland.

Despite these positive signs, it is still critical to recognize innovation and eco-innovation in both political and economic contexts as a strategic force enabling the third transformation of Poland (after the change of political system and the EU accession). Despite significant progress, the Polish economy is still characterized by low productivity and high emission intensity. Energy- and material-efficient economy is still a long way off. The transition requires not only institutional adjustments but also changes in educational system and consumers’ and producers’ behavior, mainly towards sustainable consumption and a green economy which growth will decouple from use of

natural resources, and increasingly focus on the full use of the inventiveness and creativity of its people.

It is inevitable to develop business friendly economic policy, seeking and implementing innovation and eco-innovation. The primary goal should be to encourage business to become more involved in financing and cooperating with the R&D sector. There is also a need to improve the quality and efficiency of this sector and of the institutional framework supporting innovation and technology transfer to companies.

### 3.4 Recommendations for Poland – conscious eco-innovation policy

From the Polish perspective, two main reasons can be put forward to explain the need for promoting eco-innovation in a long-term development policy:

1. **‘supply-side motivation’ – growth potential of Polish environmental technologies and eco-innovative solutions** – environmental technologies can become Polish export products. In the area of *supply-push* instruments, it seems more important to regard the issue from the perspective of regional specialization (endogenous development potential of the region - an emphasis on green R&D and implementation of new solutions). The *demand-pull* instruments should be used on a national scale to reach economies of scale (e.g. green procurement).
2. **‘demand-side motivation’ – potential cost reductions in necessary pro-environmental actions in the Polish economy, over the long term providing reductions in the total cost of consumption of materials and energy.** The most important challenge is the low-emission transformation of the economy. Obviously, other environmental problems, e.g. those associated with high healthcare costs, are not to be ignored. There are many areas where Poland lacks the technological capacity for fast, low-cost solutions to environmental problems.

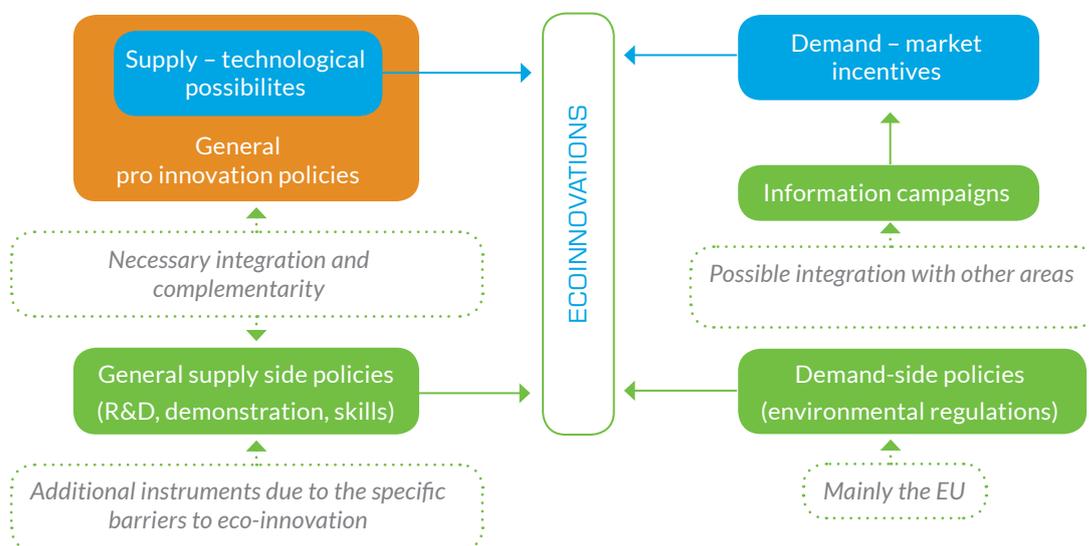
Naturally, both motivations may coincide. The situation where domestic demand for a given type of technology can be a stimulus for the development of Polish eco-innovation is especially advantageous. In this case, domestic companies benefit from the knowledge of local conditions and specific market needs. The development of domestic market can be the basis for international expansion. An example of such a situation in another sector - transport – can be observed in the case of Polish manufacturers of public transport vehicles. Their development was fos-

**The Polish Government may support national eco-innovators by creating a predictable regulatory environment rewarding innovative environmentally friendly solutions.**

**Polish companies will be given the chance to build a position in attractive markets in Europe and the world, and the whole economy will benefit from more efficient management of available resources and improving the health and wellbeing of citizens.**

tered by a considerable size of the Polish domestic market, relatively low barriers to entry in the industry (compared to the passenger car market) and the initial potential of Polish human and physical capital in this area. In the case of eco-innovation, a similar situation can occur in distributed energy sector, where Polish producers would be able to launch new products onto the domestic market first, and then enter the global markets. To do so, the Polish market should be sufficiently absorptive. This requires a stable and predictable regulatory environment and sensible support for distributed energy producers, thereby allowing domestic producers to conquer attractive niche markets and enter the global value chains.

Diagram 2. Key fields of eco-innovation support policies



Source: Institute for Structural Research

It is important to learn from the problems encountered during the implementation of support policies for alternative energy sources in other European countries, so as not to repeat their mistakes. However, Poland should not rest hope in these policies being abandoned by the European countries. Presented examples of major economic powers involved in the low-emission race show that its participants do not intend to give up easily. They are bound to continually improve their policies to support eco-innovation. If Poland does not want to remain on the sidelines of global modernization trends, it must take up the challenge of an ambitious long-term policy intended to promote innovative and environmentally friendly solutions.

Diagram 3. Areas of eco-innovation support broken down by the justification of intervention



Source: Institute for Structural Research

On the basis of these two motivations, three areas of public intervention requiring different policy mixes may be identified:

- eco-innovation in areas in which Poland has a significant advantage or supply potential which can be

used in global markets, being less important for national environmental challenges. This area requires supply-side policies and assistance in entering international markets;

- eco-innovation in areas where Poland has large domestic needs, but low potential. In this case, the most important are diffusion policies and promotion of the development of these areas at a European level;
- eco-innovation in areas where Polish supply potential corresponds to domestic needs. In this case, it is important to apply a mix of supply, demand and diffusion policies. It is important to expand this area to include the innovators described in point 2. At the same time, Poland should not give up supporting the diffusion of foreign innovation - although the development of this third area is a 'double benefit' to Poland, it should not be assumed as always available. Otherwise, the benefits of 'demand motivation' (lowering the cost of environmental adjustments) might be jeopardized. It is necessary for Polish enterprises to focus on using additional domestic demand for eco-innovative solutions and to encourage enterprises to compete in quality. This will benefit both domestic buyers and suppliers, who will reach the level of competitiveness necessary for further expansion into foreign markets.



## Examples from Poland

### Smart grid on the Hel Peninsula

Smart grid is a power system supported by modern software and telecommunications, which integrates the production, transmission and distribution of energy, and allows to reduce energy consumption and better protect customers against power failures. Such a network integrates power plants, large and small, and energy consumers into one overall structure. The effects are as follows:

- **reduction of energy prices,**
- **increased share of base load power generation, lower investment costs, reduced risk of failed investment**
- **increased operational efficiency,**
- **radically reduced number of power outages and the possibility of connecting small energy producers.**

Without adequate investment in the power transmission infrastructure, Poland will not be able to take full advantage of the opportunities offered by the emergence of alternatives to traditional ways of generating electricity.

### Ship for building offshore wind farms, with transport barges

Offshore wind energy sector, i.e. electricity generated by wind turbines located far from the coast, is a sector with high growth prospects, also associated with new opportunities for Polish shipyards.

For example, manufacturing a new generation ship for offshore installations and the maintenance of towers and wind turbines (>6 MW, total height 120 m and water depth 50 m) costs about 800 million PLN (~EUR 200 million).

Shipyards can also provide structural components for wind turbines – Polish companies are already active in this field.

### Energy-efficient Rondo 1 office complex in Warsaw

Rondo 1 is a complex of buildings characterized by low consumption of water and energy, with as much as 10% energy coming from renewable sources (wind). The building does not use environmentally harmful materials or pesticides, and all cleaning agents are biodegradable. The building provides office space for a total of 5500 people.

Environmental effects include a reduction in CO2 emissions by 1.7 thousand tons per year. Thanks to the educational campaign, almost 63% of people working in the Rondo 1 get to work by bike or public transport.

## Summary

Poland is now facing a strategic choice - how to handle the low-emission transition. Attempts to postpone it, to avoid its consequences and to oppose the EU regulations in this area will not be beneficial in the long run. The EU's climate policy and attitude to supporting renewable energy sources is not the cause, but rather a consequence of deeper economic and technological processes currently taking place around the world. As threats to the environment and national energy security intensify, global powers are preparing to gradually move away from fossil fuels towards new alternative energy sources with a high technical potential. They intend to gain independence from fuel suppliers and to reduce high externalities of energy use (including health problems). At the same time, they are going to maximize opportunities for their businesses in the new markets. Poland, by trying to postpone these changes, takes a losing position in this race.

An inviting alternative is a conscious and resolute policy of low-emission transition, using all available resources to support the Polish economy in new growth areas. Polish companies may compete with the global leaders in many fragmented global markets of eco-innovative technologies. In contrast to the most complex energy technologies (nuclear, CCS), there is a realistic scope for success in renewable energy and distributed generation for Polish companies, taking into account the required potential and support to Polish business from national and EU funds.

Thanks to technological progress and economic development achieved during the eco-innovation race, both providers and users of cost-effective low-emission solutions will be able to enjoy a faster economic growth. Countries that ignore the changes and will not be ready for them will have to adapt to the new rules of the game either way, but at a high cost of delay. Poland can avoid this fate, if it applies its resources and available EU assistance to the implementation of a conscious development policy embracing low-emission transition through the modernization and maximal use of chances created by eco-innovation - both as a producer and a consumer.

**Poland can join the club of leading economies only through direct competition. Today we can focus on eco-innovation and enter the low-emission race for the efficient use of resources. We can also choose to remain a spectator – risking falling into the low-growth trap and missing the right moment to close the gap to the global leaders.**

## Bibliography

- AAAS, *AAAS Report XXXVII: Research and Development FY 2013*, the American Association for the Advancement of Science, Washington, DC 2012.
- Alternative Polish Energy Policy until 2030*. Technical and Methodological Report. Institute for Sustainable Development, Warsaw 2009.
- BMBF, *Ideas.Innovation. Prosperity. High-Tech Strategy for Germany 2020*, Innovation Policy Framework Division, Federal Ministry of Education and Research (BMBF), Bonn 2010.
- Bukowski M., Gaška J. and Śniegocki A., *Between the North and the South – opportunities and traps in the development of Poland until 2050*, Low-Emission Poland 2050 project publication, Warsaw 2012a.
- Bukowski M., Szpor A. and Śniegocki A., *Sleeping tiger, entangled eagle – dilemmas of Polish innovation policy debate*, Institute for Structural Research, Warsaw 2012b.
- Center for American Progress, *Taking Action on Clean Energy and Climate Protection in 2012. A Menu of Effective and Feasible Solutions*, Washington, DC 2012.
- Cunningham LJ and Roberts BA, *Renewable Energy and Energy Efficiency Incentives: A Summary of Federal Programs*, Congressional Research Service, Washington, DC 2011.
- Dolezalek S. and Freed J., *An American Kodak Moment*, Third Way, Washington, DC 2012.
- EIO, *The Eco-Innovation Challenge: Pathways to a resource-efficient Europe*, Eco-Innovation Observatory, funded by the European Commission, DG Environment, Brussels, 2011.
- Ernst & Young, Institute for Sustainable Development, *Report on the evaluation of the debt-for-environment swap program implemented by the EcoFund*, Ernst & Young and Institute for Sustainable Development, Warsaw 2010.
- Fulton M., Capalino R. and Auer J., *The German Feed-in Tariff: Recent Policy Changes*, DB Research, Frankfurt 2012.
- GGGI, *Green Growth in Motion: Sharing Korea's Experience*, Global Green Growth Institute, Seoul 2011.
- Grodzka D. and Zygierewicz A., *Innovativeness of the Polish economy*, Parliamentary Bureau of Research, Infos No. 6, Warsaw 2008.
- Iskryński M., *Innovativeness of the Polish economy*, PKPP Lewiatan, Warsaw 2010.
- ITIF, *Clean Energy, Winning the Race 2012: # 8*, Policy Brief, Information Technology and Innovation Foundation, Washington, DC 2012.
- Karaczun Z., Kassenberg A. and Sobolewski M., *Polish climate policy – a challenge to the twenty-first century* Polish Ecological Club Mazovian Branch, Institute for Sustainable Development, Warsaw 2009.
- Kassenberg A. and Kassenberg P., *EIO country brief 2010, 2011, 2012: Poland*, the Eco-Innovation Observatory, funded by the European Commission, DG Environment, Brussels 2010-2012.
- KPMG, *China's 12th Five-Year Plan (2011-2015)*, KPMG Insight Series, Beijing 2011.
- Matusiak KB (eds.), *Innovation and entrepreneurship in Poland. Report 2010*, Polish Agency for Enterprise Development, Warsaw 2010.
- OECD and Eurostat, *Oslo Manual: Guidelines for Collecting and interpreting innovation data*, third edition, Ministry of Science and Higher Education, Warsaw 2008.
- Szpor A. and Śniegocki A., *Eco-innovation in Poland. Current status, barriers to development, support opportunities*, Institute for Structural Research, Warsaw 2012.
- Tekes, *Towards green growth? The position of Finland in environmental technology*, Tekes Review 282/2011, Helsinki 2011.
- Trembath A., Jenkins J., Nordhaus T. and Shellenberger M., *Where the Shale Gas Revolution Came From. Government's Role in the Development of Hydraulic Fracturing in Shale*, Breakthrough Institute, Oakland 2012.
- Worldwatch Institute, *State of the World 2008: Innovations for a Sustainable Economy*, Washington, DC 2008.
- Wozniak L., Strojny J. and Wojnicki E. (eds.), *Eco-innovation in practice for SMEs.*, Polish Agency for Enterprise Development, Warsaw 2010.

The role of eco-innovation in a low-emission transition

Andrzej Kassenberg, Aleksander Śniegocki

ISBN 978 83 63857 00 4



Institute for Sustainable Development  
Nabielaka 15, r. 1  
00-743 Warsaw  
Poland  
[www.ine-isd.org.pl](http://www.ine-isd.org.pl)



Institute for Structural Research  
Rejtana 15, r. 28  
02-516 Warsaw  
Poland  
[www.ibs.org.pl](http://www.ibs.org.pl)



European Climate Foundation  
48 Rue de Stassart, Bldg C  
1050 Brussels  
Belgium  
[www.europeanclimate.org](http://www.europeanclimate.org)

This publication was written under the project 'Low-emission Poland 2050'  
financed by the European Climate Foundation.

