The Role of Government is to Address Market Failures

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Major innovation trends in energy deal with its generation and saving reminding a centuries-old argument of who comes first a hen or an egg. Which sector scored more impressive results so far and why?

In the energy sector, the problem might be even more complicated than the chicken and egg one, because "generation and saving issues" transcend over time and interact not only with each other but also with geopolitical concerns. For example, after the first oil shock the immediate response by governments was to install energy savings measures in the short term, but simultaneously invest in new energy generation technologies that could increase global energy sources in the long term. Nowadays, the increasing growth of energy consumption with imminent finite fossil resources also creates this dual response: governments worldwide are investing in energy efficiency labeling to reduce vulnerabilities, while investments in alternative sources of energy are seen as a longer-term solution for a transition towards a low carbon society.

I think that both the generation and saving innovation in the energy sector do not perform very well in comparison to innovation in other sectors, mainly because incentives for innovation in both sectors are often temporary. Only in those countries and sectors where you see continuous, predictable and progressive incentives with a long-term focus (e.g. CAFE standards for energy efficiency of automobiles in the U.S., or energy efficiency housing standards in the Netherlands), you truly see progress. Unfortunately, limits to such incentives are in place in the generation industry (an exception is the biofuel production incentives by the Brazilian government), which has hampered technological progress.

What institutions set targets for innovations in energy?

In our latest report on energy technology innovation policies in the BRIMCS countries (Brazil, Russia, India, Mexico, China, and South Africa), we identify four institutions that currently play a role in setting national targets for energy technology innovation: 1) intergovernmental organizations, 2) energy ministries, 3) science & technology institutions (or ministries), 4) and, state-owned enterprises. The extent to which these four institutions are involved in setting targets differs per country.

The impact of national targets on energy technology innovation is also difficult to determine. First, the severity of national targets is difficult to compare. For example, Brazil uses electricity-specific targets for renewables (70%), South Africa has an absolute target (10000 Gwh), while other countries use growth targets (eg. Russia's target to double nuclear capacity). Second, targets differ in the extent to which they are translated into responsibilities for individual actors. Except for South Africa (where the main electricity generator was responsible for meeting the targets), governments have paid little attention to translating national targets into tangible goals for individual actors.

In the last two decades international and national standards have been tightened dramatically. How did it affect national innovation strategies? Could you show some most eloquent examples?

Standards can play an important role in promoting energy technology innovation, as long as the standard setting is long-term and transparent. Furthermore, standards work best in environments where solutions for energy efficiency improvements are clear. For example, energy efficiency standards for refrigerators in the United States have created continuous improvement in energy efficiency.

Although government support for the development of standards and labeling for appliances, buildings, and consumer products has increased in the last decade (in Russia, the government has created biofuel standards and building codes), I think that there are still too few international agreements on harmonizing energy efficiency standards. The United States and Brazil are working on the creation of international standards for biofuels, but for most energy technologies there is no consistency between standards in different countries. For example, the fuel economy standards for automobiles differ in Europe, the U.S.A., and China.

To what extent energy innovations can be regarded as integral part of national innovation systems? Or perhaps they are efforts of individual companies either supported by governments or going alone at their own risk?

The concept of "national innovation systems" arose when scholars (Nelson, Freeman, and Lundvall) attempted to compare different countries (nations) to each other. However, this does not mean that the institutions constituting a "national innovation systems" need to be "national", nor that it only includes those institutions that are supported by a national government. Instead, this literature emphasizes that the institutions themselves can be global, national, regional or sectoral (Edquist, 1997), and that the innovative performance of a country depends on how this set of institutions interacts

and affects national firms. In other words, although it is difficult to determine what institutions are part of a "national innovation system", it is important to focus on how these institutions interact with each other and how their interactions affect the innovative behavior of national firms.

The extent to which the structure and interaction in a national innovation system affects the innovative performance of a country is still weak, despite a large number of comparative studies (e.g. Nelson, 1993). Some scholars (e.g. Smits, 2004; Sarewitz & Pielke, 2007) argue that an innovation system requires different actors (supply actors, demand actors, an intermediary infrastructure and a support infrastructure). Other scholars (e.g. Johnson & Jacobsson, 2001; Hekker, 2007) argue that the functions of innovation need to be supported, while others (e.g. Holdren, 1997) argue that a national innovation system requires support of the whole innovation process from R&D to demonstration to deployment.

Our study on Russia's energy technology innovation system attempted to evaluate to what extent Russia's government supports different actors, stages of R&D, and functions of innovation. This analysis took place in 2009 (before Skolkovo) and shows that the Russian government gives little support for demonstration projects for most energy technology areas. Furthermore, there are only a small number of policies in place that support the diffusion of knowledge throughout its innovation system, or support entrepreneurial activities. Finally, the Russian government has no tangible policies in place that promote innovation in fossil energy technologies and transmission, distribution, and storage technologies.

What role should national government play in innovation process?

Many reports argue that the energy sector is especially prone to "market failures", because the price of environmental degradation is not internalized, knowledge created is not fully appropriable, there are long time gaps between R&D and deployment, and energy availability and reliability is a public good. From this perspective, the government role is often defined as "addressing market failures".

Governments can address some of these market failures by e.g. creating a price for carbon (either through tax or emissions trading), R&D support, and incentives for energy companies to improve the energy efficiency of their generation activities. I do believe that taking away these "market failure" is a necessary condition in which governments play an important role, but I also believe that businesses have an important role in supporting government incentives that try to address these "market failures".

However, I believe that addressing "market failures" is not sufficient for stimulating innovation in the energy sector. In particular, the fact that the energy sector is dependent on a very rigid infrastructure to deliver energy services to their customers warrants a more pro-active approach by governments. First, governments have to provide more incentives for customers and suppliers of energy to find innovative solutions. Second, the government has to support high-risk technology development that does not have any market potential now, but might have transformative power in the future or which could provide the infrastructure of the future. Third, the government has to attract the "young and the bright" to study STEM, and instill a sense of urgency and pride in working on energy related issues. I believe that the nuclear energy sector in Russia still attracts young and bright employers, but that the Russian government can do more to stimulate human capital for other energy technologies.

In the age of globalization is it appropriate to say that a universal innovation system is in the offing? To your opinion how Russia may effectively participate in it?

In a preliminary analysis of scientific collaborations in "international highly ranked applied science journals" in the areas of nuclear energy, fossil energy, and renewable energy (to be published shortly), our data shows that between 2000 and 2009 the number of international collaborations by Russian institutions has increased between 2.5 and 5 times. Globalization of science collaborations is thus an ongoing process. However, the extent to which Russian institutes participate in international collaborations differ substantially between nuclear energy research, fossil energy research, and renewable energy research. For example, in our dataset Russian institutions collaborate in 2009 372 times on nuclear energy with 32 different countries, while Russian institutions only collaborate 5 times with 5 different countries. In the same database, Russia is ranked the 9th highest international collaborator in nuclear energy, while it is ranked 58th highest international collaborator in renewable energy.

However, it is important to recognize that scientific collaborations is only one of many avenues for international cooperation. Russia's cooperation with the Chinese government on developing new nuclear reactors is an example of another, high-impact international cooperation activity.

No single country can participate in the fullest extent on all technology areas. It is therefore important to develop international cooperation strategies that 1) complement existing international cooperation activities, and 2) support national priorities. In a nutshell, an effective Russian policy on international cooperation requires a pro-active approach. It needs to 1) support Russian scientific institutions and companies to instigate international R&D activities, contribute to international demonstration projects, or provide support for international deployment opportunities and, 2) identify national problems that could benefit from R&D activities, demonstration projects, or deployment support that attract clever solutions from other countries to Russia.

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How tough is international competition in the energy innovation market? What did it bring about and what may it introduce in practice?

The economic downturn, and the increase in unemployment rates in many developed countries, did increase awareness about "green jobs" moving from one country to another. Furthermore, the combination of an economic downturn and concerns about climate change in 2009 made many countries invest a large proportion of their stimulus packages in green energy technologies. For example, a HSBC report estimated that more than USD 430 bn in fiscal stimulus were invested in climate change investment themes worldwide. Furthermore, our report on energy technology innovation policies in BRIMCS countries shows that almost all of these countries have policies in place that support the manufacturing, and deployment of renewable energy and energy efficiency technologies through tax credits, feed-in tariffs, loans, or grants.

So, the number of activities, and the number of companies, involved in the development of renewable energy and energy efficient technologies has increased in the last couple of years. Furthermore, we've seen a spectacular growth of manufacturing capacities in some countries, for example the production of PV panels in China.

However, I believe that the issue of international competition on energy innovation markets is more complicated than simply an increase in manufacturing capacity in individual countries. Most energy technologies, renewable energy technologies included, are complex technologies, which are often assembled based on multiple components. For example, the turbines of wind mills might be manufactured in China, while its gearboxes and propellers are manufactured in the U.S.A. Similarly, many of the manufacturing equipment for the production of PV panels in China are sold by U.S. manufacturers. Furthermore, there is often a very important "local" component to energy technologies, which reduces the ability of one company to dominate the market. Finally, there is still an important role for companies in installing, maintaining and improving new energy technologies.

Finally, the growth in renewable energy technologies (PV and wind) is continuing and with increased energy demand in emerging economies, the Middle East, and Africa there is a growing market for energy technologies. Finally, much of the energy infrastructure in the U.S.A. and Europe need to be replaced in the forthcoming years. All in all, this means that markets for new energy technologies will continue to grow. A growing market attracts international competition, but it simultaneously provides sufficient opportunities for a range of countries to participate.

How effectively energy innovation may influence national policies and international relations?

Energy is critical for economic and social development, and will remain to play an important role in both national policies and international relations. Furthermore, energy security is a key element in international relations.

It is important to recognize that there is a two-way relationship between science and technology and policy. New developments in science and technology will shape national and international policies. For example, the discovery of shale gas in America and Europe has shifted national policies and international relations very rapidly. Similarly, the development of nuclear capabilities in the U.S.A., Russia and a number of other countries has shaped national policies and international relations for centuries. Simultaneously, policy shapes the direction of science and technology. The cases in both Denmark and Brazil show how government policies can support the development of competitive technologies for wind energy and biofuels, respectively.

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The following types of companies should seek to participate in the Fair:

- *companies interested in private equity for their business development;*
- *companies that develop products and services with high added value;*
- *companies with high growth rates;*
- *companies that are capable of demonstrating project IRR no less than 30% per annum.*

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