Facing up to the "energy trilemma": A Brazilian perspective

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Energy systems are the basis for developing our societies. The power and economic supremacy of social groups or countries depend heavily on the methods to generate, transform and use energy. Despite being a recent announcement, the trilemma between energy security, social equality and environmental impacts has been evident in several forms since the 19th century, when the Industrial Revolution transformed the landscape and the infrastructure of cities.

The accelerated dissemination of fossil fuels resulted in economic and social progress which was accompanied, for example, by the negative effects of unbreathable air in the surrounding areas of factories, as happened in Paris and London at that time. Sources of new energy were already a choice among the elements of the trilemma. We could say that the trade-offs between such elements were always inscribed in the nature of the way energy systems evolved.

Today, challenges posed by the energy trilemma have risen to a global scale. The energy sector has overcome enormous challenges, especially from a technological point of view, but we have reached the 21st century in an energy scenario that is associated with excessive social inequalities and generating negative environmental impacts. While previous evolution met specific needs, the ongoing challenge should be to meet multiple goals on a scale not achieved by former transformations. What steps can we take in the coming decades to implement green and socially-inclusive development in a scenario in which fossil fuel sources still predominate as the primary supply of energy?

In practical terms, the trilemma comprises several dilemmas. The way in which each nation establishes its policies and investments in energy depend on the characteristics of each country or region: availability of natural resources, income per capita, institutional and regulatory reach, existence of an industrial base and technological development.

For example, countries whose economies are focused on exporting energy tend to have higher levels of energy equality, with lower energy prices for the population. On the other hand, due to the scarce diversity in energy sources, long-term energy security may come under threat.

Countries with no abundant energy sources, which are generally heavy importers of energy, after presenting increased income per capita, have more difficulties in providing modern energy at competitive prices to the populace. For countries with higher income and lower energy sources, which generally have a small territory and population, mitigating environmental impact may be effective despite strong industrial companies in some sectors.

Developed and developing countries with extensive energy sources and strong existing or growing energy infrastructure tend to show a more harmonious balance between higher level of energy security, equality and accessibility to modern energy.

What can we learn from the many different examples around the world? First, there is no single solution when seeking sustainability in energy. While there is a certain level of inertia in the evolution of economic systems, the paths taken by developing countries do not necessarily have to be the same as those taken by more industrialised countries.

Second, in spite of the complexity of the energy trilemma and the weak articulation presented by the international community becoming hurdles for sustainable energy solutions, specific initiatives from several countries may be shared and assessed as national alternatives. Brazil is one of these countries and has experience that can be replicated in other regions around the world, namely:

Public Policies and Environmental Externalities: The strategy to expand the Brazilian energy grid is associated with the energy auctions for projects related to the National Interconnected System (SIN). The auctions guarantee predictability and stability and, coupled with the long-term Power Purchase Agreements, they make it feasible for private institutions to take part. In addition, the Brazilian Development Bank (BNDES) offers financing to raise other resources. The BNDES fosters renewable energy by offering attractive financing conditions, which increases the competitiveness of renewable energy in the energy auctions, thus reducing the market distortions caused by environmental externalities, as happened recently with the historic increase in wind energy projects in the country.

Universalisation: To make electricity available in regions where investments in distribution are not attractive, the federal government launched the Electricity for All Programme. In the first nine years of the Programme, investments managed to reduce the numbers of those with no access to energy in the country to a mere 1.4 per cent of the population, one of the lowest rates among developing countries.

Mitigating the Environmental Impact of Hydroelectric Plants: To reduce the socio-environmental impact of hydro-electricity, which is an energy source with low greenhouse gas emissions (GGE) and which is of great importance to the energy security of the country, the socio-environmental

scale has become part of all new projects from their initial conception, when structural elements have not yet been defined. This approach enables the drastic reduction of negative impacts, such as a reduced number of flooded areas. Besides this, today, investments in economic and social development in municipalities surrounding the hydroelectric plants are much more significant.

Sustainable Biofuel Production: Brazilian ethanol has been deemed the most "carbon efficient" biofuel produced in the world. It can now be used in up to 84 per cent of the new cars manufactured in Brazil. So that expanding sugarcane production does not impact the production of foodstuffs and native forests, the Brazilian government established Sugarcane Agroecological Zoning, as the inhabited regions expanding their plantations are defined. Furthermore, this instrument has identified 65 million hectares in degraded areas that may be used to expand the sector (this is eight times the area of planted sugarcane today), which means that the growing production of Brazilian ethanol will not generate negative impacts related to the use of soil, thus maintaining its eminently sustainable nature.

Brazilian Labeling Programme: This is aimed at increasing the dissemination of more efficient machinery and equipment by establishing minimum technological standards for energy efficiency and providing information to consumers.

Facing the trade-offs of the energy trilemma has offered some new possibilities:

- Planning and governmental efforts are fundamental in establishing regulatory policies, fostering incentives and attracting private resources needed for investments in energy infrastructure, especially in renewable energy;
- With no advance in international coordinated support for energy sustainability, national efforts will remain isolated policies;
- The main focus of sustainability policies should be the least economically-developed countries and the lowest-income classes in all countries. Universalising access to electric power and modern sources of biomass should become a global target for the international community;
- Large-scale gains from specific energy areas should not restrain the search for more diverse sources, with the aim of increasing energy security and resilience in countries. A mix of national sources and imports should focus on guaranteeing a long-term energy supply;
- Establishing standards or technological paths for machinery, equipment and industrial processes should be flexible and varied, as well as adapted to the stage of development in each country so as to avoid excessive imbalance and technological dependence;
- Transition to an economy with lower carbon emissions requires new technological levels, investments and public administration. Additional costs of this transition for less developed countries should be distributed across temporary bases that are socially acceptable, in accordance with the capacity of more developed countries to collaborate;
- While they are important, market solutions to reduce carbon emissions, such as the cap-and-trade system and carbon tax, are not enough to foster the needed transformations. Establishing deeper commitment from the developed countries and the voluntary participation of the more advanced developing countries may bring about solutions that combine planning and the market;
- Incentives for researching, developing, demonstrating and disseminating low-carbon technologies require substantial financial resources and long-term foresight. Development banks the world over are capable of leveraging investments and are natural channels for foreseen international financial flows, such as the Green Climate Fund.

The capacity of the world in integrating isolated initiatives that contribute to the sustainability of the energy sector requires a change in society as a whole, and our capacity to implement such a change will only be revealed over the coming years. Natural tensions within and stemming from the energy trilemma will not be entirely overcome. But today there is a wide array of national experiences that can be of great value in making the related and difficult choices. ❑

Brazil's Itaipu hydro plant: The world's largest by generating capacity