

Green economy and sustainability

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Theoretical framework

THE IDEA of green economy has emerged recently and is soaring into greater prominence through the conference known as Rio+20. To understand it a little better, we must seek the origin of the concept, which is found in the idea of sustainable economic development, also known as sustainable development.

According to the classic definition provided in the so-called Brundtland Report, sustainable development is development that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (World Commission ..., 1987).

Behind this concept was the need to rethink economic development under a new perspective, taking into account the inter-generational equity. Until then, economic development was seen from a slightly narrower perspective that usually considered the fundamental determinants of economic growth, without regard for the environment. These fundamental determinants have ultimately produced changes in the accumulation of factors of production and in productivity (encompassing technological progress and changes in the efficiency with which the factors are used), besides influencing the country’s growth rate. Less orthodox currents also have studied problems of income distribution, among others, using a less rigorous formalization. Currently, less orthodox ideas are incorporated into economic models, largely due to the dissemination of more sophisticated mathematical methods in Economics (Krugman, 1995). The empirical analysis of economic growth models has also gained new momentum since the interest in economic growth models was renewed in the mid-1980s.

The relationship between economic development and environment has become more explicit since 1970s, when researchers began to examine what the limits to growth would be in a context where natural resources are finite. At the time, several disturbing forecasts emerged (Meadows et al., 1972), which later were put into perspective, when the analysis began to incorporate a more sophisticated modeling method that took into account technological progress, the discovery of new reserves of natural resources and the use of reserves that previously had not been economically viable.

Sustainable development is an evolution of the old idea of development to

the extent that it incorporates the need for intergenerational equity. This elimination of intergenerational inequality is a bit farther reaching than the reduction of income inequality usually seen in newscasts, debates and academic texts. Income inequality within a country can be reduced, and the data show that this has actually happened in the world as a whole since the first half of the nineteenth century, although income inequality between countries has increased (Bourguignon & Morrison, 2002). Intergenerational inequality, in turn, is something broader, which involves a measure of welfare rather than merely income comparison (as in Becker et al., 2005).

The issue of intergenerational equity, seen through the prism of sustainability, means that each generation should enjoy the same level of welfare or the same opportunities as the others. This means that the environment should never deteriorate to the point of preventing a generation from achieving the same level of welfare as a previous generation. Therefore, environmental preservation emerges as a way to avoid a rise in intergenerational inequality. Obviously nobody advocates preservation at any cost, but there must be criteria to guide the rational use of natural resources in a sustainable manner.

The concept of green economy is more recent than that of sustainable development. Green economy is one that “results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities” (United Nations ..., 2011, p.16). A green economy has low carbon emissions, efficient use of resources and social inclusion. According to the authors of this research, the empirical evidence shows two points: there is no trade-off between sustainability and economic growth; both rich and poor countries can make the transition to a green economy.

The absence of a trade-off between sustainability and economic growth can be challenged by the empirical evidence that points to a trade-off in the early stages of development followed by growth with reduced pollutant emissions (an empirical regularity known as the Environmental Kuznets Curve). Thus, it can be stated that there is no consensus among economists about the green economy and its guiding principles. One could say that the debate is still on.

The economic analysis of environment-related issues can occur on the side of both microeconomics and macroeconomics. With respect to microeconomics, it enables for example checking whether the adoption of cleaner or more efficient technologies is feasible, or if the adoption of energy policies in one country has an impact on other countries. With respect to macroeconomics, one can make a research on the relationship between environment and economic development, i.e., a proper study on the issue of sustainability. This line of research enables evaluating, for example, the existence of an Environmental Kuznets Curve or lack thereof for a given pollutant, and if the presence of pollutants interferes with both the conditional convergence of countries towards the steady state per capita income and its speed.

Some results related to dissertations and theses defended at the University of São Paulo (USP) from 1992 to date are highlighted below. Our goal is not to comment on individual papers, due to space restrictions, but rather to identify some of USP's main lines of action on the topics of green economy and sustainability.

Dissertations and theses related to the green economy and sustainability at USP

Production on the topic of green economy and sustainability regarding dissertations and theses defended at USP can be divided into two blocks: those that bear some relation to the topic of energy, and those focused on other aspects. The main focus of this section will be energy, which is the main topic of most of the dissertations/theses.

Under the greater topic of green economy and sustainability, the energy issue has had a significant weight in scientific production at the University of São Paulo since 1992.

It is worth remembering that research activities in the field of Energy as an area of knowledge characterized by an interdisciplinary nature, had already been the subject of an initiative by the dean of USP, Professor José Goldemberg, with the creation, back in 1989, through Resolution 3482, of the Chamber of Graduate Studies (CPGR) at USP, and of the Inter-Units Program of Graduate Studies in Energy (PIPGE), with the participation of the Polytechnic School, the School of Economics, Business Administration and Accounting, the Institute of Electrotechnics and Energy, and the Physics Institute.

The creation of the Program represented the recognition, by the University, that the studies on energy produced separately by the different units, now unified by this goal, were failing to comprehensively address issues related to the process of energy production and use. At both the official and academic level, the more traditional approach according to which increasing consumption should be met by increasing supply was still being used. The PIPGE was starting its activities from a theoretical line that emphasized the use of energy as guiding parameters for planning and decision making, and in this regard it was original.

The first efforts were directed to the areas of research into end use and demand for energy, resources and supply of energy, energy and society, and conservation and impacts, which were the pillars supporting the spirit that guided the implementation of the PIPGE: the possibility of treating consistently the entire energy chain, from the needs for energy services and socioeconomics to the primary sources of energy. This pioneer methodological approach, coupled with the emphasis on renewable resources, was the core of the response to the main challenges identified in meeting the social energy needs in a balanced way and mitigating the problems of global, regional and local impacts of energy use and production. This major topic was thrust into the global spotlight by a ground-

breaking conference held in Stockholm in 1972, and further discussed at the United Nations Conference on Environment and Development (also known as the Earth Summit or Rio-92), which took place in Rio de Janeiro in June 1992. The productive restructuring resulting from the economic liberalization of the 1990s, including privatization, competition and regulation, with huge impacts on infrastructure sectors (particularly the energy sector in Latin American countries) and carried out based on the theoretical review of regulation, the new economic theories of production process organization, contestable markets and incentive regulation, would raise new demands for research and teaching, especially for assessing the economic, social and environmental impacts of the restructuring process.

Since 1992, this effort around the topic of energy within the scope of Graduate Studies at the University of São Paulo aimed to encourage the development, qualification and training of quality human resources for the development of Science, Technology and Innovation, has counted on the active participation of other units besides the PIPGE (which was renamed PPGE-Graduate Program on Energy in 2009), including: Polytechnic School (Department of Electrical Energy and Automation - PEA; Department of Hydraulic and Environmental Engineering – PHD; Department of Oil Mines Engineering - PMI; Department of Naval and Ocean Engineering - PNV); School of Economics, Business Administration and Accounting (FEA); School of Agriculture (Esalq); School of Philosophy, Letters and Humanities (FFLCH/ Department of Geography); School of Architecture and Urbanism; School of Engineering of São Carlos (Eesc); Graduate Program in Environmental Sciences (PROCAM); and Institute of Energy and Nuclear Research (IPEN).

The results of scientific production at USP on the topic of Energy are extremely significant in the period that followed Rio-92. For evaluation purposes, and in order to systematize this production, the subjects of dissertations and theses developed at USP were divided into four subtopics, in tune with the lines established to guide the debates and propositions to be developed at Rio+20: 1) Energy, Environment, and Development; 2) Renewable Energy; 3) Energy Efficiency; 4) Energy and Social Inclusion.

With regard to the first subtopic - Energy, Development, and Environment -, which seeks to reflect on public policy, on the role of the State, on energy production and consumption patterns in Brazil and worldwide, as well as an environmental assessment of energy projects, USP's contribution totaled 38 master's dissertations and 16 doctoral theses developed under the PPGE; another 11 master's dissertations distributed between Cena-Esalq (1), the Polytechnic School (2), FEA (2), FFLCH (1) and PROCAM (5); and 4 other doctoral theses - three at EPUSP and one at IPEN.

This production sought to define new methodologies and differentiated approaches for issues that emerged during Rio-92, such as the challenge posed

by the increasing pace of greenhouse gas emissions and the result thereof - climate change. One of the highlights of USP's scientific production was the evaluation of the Kyoto Protocol developed in 1997 during the United Nations Framework Convention on Climate Change, and of its instruments, particularly the Clean Development Mechanism, as well as the possibilities to reverse the world energy scenario based on fossil fuels through the sale of carbon credits. Other studies included the environmental licensing process in our country, its limitations and ability to guide energy production towards sustainable standards, with social justice and respect for the environment.

With special emphasis, the second subtopic on Renewable Energy presented a remarkable production, with 68 dissertations and 13 theses developed under the PPGE and three dissertations distributed between Eesc (1), Esalq (1) and Procam (1) and three theses - two at Eesc and one at Procam.

The papers on Renewable Energy comprise thermal solar energy, particularly for heating household water with a view to replacing the electric shower, and photovoltaic solar energy, especially for application in rural isolated communities, either to supply electricity for lighting and water pumping systems, or for application in urban areas in grid-connected systems.

Regarding biofuels, cogeneration from sugarcane with the use of new technologies for the production of surplus electricity and the production of ethanol to replace gasoline in vehicle engines, whether individual or collective, were areas that enabled extensive academic production. This production also included working conditions in sugarcane plantations and barriers to exporting Brazilian ethanol.

Research into vegetable oils and their use for the production of biodiesel was also significant, with studies that went beyond the boundaries of the national territory. The use of palm oil, soy and other raw materials such as coffee dregs was studied for assessing economic and environmental aspects and technological routes of transesterification.

With regard to wind energy, several studies were developed covering technological, economic and environmental aspects. In turn, Small Hydropower Plants (SHP) were studied with a view to their optimization, market integration and repowering of old units. As for large hydroelectric plants, several studies were dedicated to the social and environmental aspects arising from their construction.

Finally, there was no lack of papers dedicated to the geothermal source and its applications and the use of biogas in landfills and sewage treatment plants.

On the third subtopic - Energy Efficiency - 48 dissertations and nine theses were developed under the PPGE, in addition to three dissertations distributed between FEA, FAU and the Polytechnic School.

It should be noted that the subtopic Energy Efficiency counted on the support of the International Energy Initiative (IEI) during the period in which

the IEE-USP housed the representation office of that non-governmental organization in Latin America (1993-2000). This situation allowed the PPGE to receive a large number of employees from energy companies in various countries in Latin America and the Caribbean, who sought in the Program specialized training focusing on End Use (Demand Side Management).

The result of this process of internationalization of USP was significant. Even after the support of the IEI, the topic of Energy Efficiency as a strategy to ensure energy sustainability has been present in human resource training and research activities under the PPGE.

The subtopic of Energy Efficiency encompasses aspects regarding the rational use of energy, efficiency evaluation methodologies aimed to reduce consumption in industrial plants, public buildings, commercial and service facilities, and homes. The research was developed with a special focus on the end uses of lighting and refrigeration, as well the optimization of engine performance. Another aspect that also deserved attention in the studies was street lighting, with particular interest in technological advances and methods for improving this public service.

Finally, the fourth subtopic, related to Energy and Social Inclusion, led to the production of 11 dissertations and seven theses developed under the PPGE.

Social programs for the electrification of low-income residential areas, the context of small isolated communities and challenges for access to electrification, technological alternatives and technical and economic feasibility aspects were also the object of studies and reflection, with a view to ensuring public policies for social inclusion from the access to electrification.

In summary, the topic of Energy resulted in the production of 184 master's theses and 52 doctoral theses developed at the University of São Paulo over the last twenty years. This result highlights the importance of the energy topic as well as USP's capacity to contribute to the advancement of knowledge in this area, which is essential for society to achieve an environmentally sustainable and socially just development.

We have highlighted the dissertations and theses concerning energy. However, the study of the green economy and sustainability can involve other aspects. A review of dissertations and theses in the various graduate programs at USP shows different subjects related to the topic. One of the most important is the issue of water, in which the management of water resources is an important point of debate for the future, together with payment for water use. A total of 49 doctoral theses and 79 master's dissertations related to water were identified, excluding those strictly related to Energy. Most of them are concentrated at Eesc (16 theses and 15 dissertations), the Polytechnic School (7 theses and 16 dissertations) and PROCAM (3 theses and 14 dissertations). Sanitation, with three theses and six dissertations is another relevant topic to reduce mortality and foster development. Other topics more closely related to the economy and

that were the focus of studies included assessing the impact of environmental policies implemented by other countries on Brazil (School of Economics, Business Administration and Accounting of Ribeirão Preto - FEA-RP, two dissertations) and the estimation of the Environmental Kuznets Curve for greenhouse gases (FEA-RP, one dissertation).

We can conclude our discussion by saying the Green Economy is expected to lead to a growing number of studies in the future. Therefore, USP should continue to serve as a guiding light for the scientific community.

References

BECKER, G. S. et al. The Quantity and Quality of Life and the Evolution of World Inequality. *American Economic Review*, v.95, 2005.

BOURGUIGNON, F.; MORRISON, C. Inequality Among World Citizens: 1820-1992. *American Economic Review*, v.92, 2002.

KRUGMAN, P. The Fall and Rise of Development Economics. In: KRUGMAN, P. (Org.) *Development, Geography, and Economic Theory*. Cambridge, MA: MIT Press, 1995. p.1-29.

MEADOWS, D. H. et al. *The limits to growth*. New York: Universe Books, 1972.

UNITED NATIONS ENVIRONMENT PROGRAMME. *Towards a green economy: pathways to sustainable development and poverty eradication*. S. l.: Unep, 2011.

WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT. *Our Common Future*. Oxford: Oxford University Press, 1987.

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