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Towards a sociology of energy and globalization: Interconnectedness, capital, and knowledge in the Brazilian solar photovoltaic industry

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ABSTRACT

Brazil has enormous silicon reserves and solar irradiance levels, but the participation of solar energy in its electricity mix was inexpressive until recently. However, the current policies of the Brazilian government have been responsible for an increasing deployment of photovoltaic (PV) systems and thus provided more favorable conditions for the emergence of a national PV industry. This article analyzes the development of the Brazilian PV sector in its "interconnectedness" with the global renewable energy market and therefore is presented as a contribution for the energy studies, as well as an empirical case for the "sociology of globalization". The Chinese policies for photovoltaic energy are taken as parameter for the discussion of the Brazilian experience in order to highlight the growing importance of renewable energy investments in emerging economies and the decisive role played by the national States in pushing forward the renewable energy industry as a strategic sector for their privileged insertion in the competitive global order.

1. Introduction

Mainly due to the contribution of sugar cane products (7.3%) and hydropower (65.2%), the share of renewable sources accounts for 74.6% of the Brazilian electricity mix, thus placing the country above the international renewable energy (RE) average [1]. However, in the field of solar energy the country performed poorly until 2013, when the on-grid installed capacity for photovoltaic (PV) generation was restricted to only 5 MW. In Brazil, PV energy was usually deployed in remote areas without access to the transmission lines, but even if we consider the capacity of 30 MW registered in 2011 for off-grid systems, the total participation of PV was still very modest. The main reason for that was associated to the fact that other renewable energy technologies presented lower costs than PV. Therefore, PV was not listed in the PROINFA (Incentive Program for Alternative Sources of Electricity, decree n. 5025, 2004), which established minimum deployment targets and a complementary tariff for small scale hydropower stations, wind power and other plants fueled by biomass in order to compensate the disadvantages of such technologies in relation to the more competitive prices of the electricity generated by conventional power plants.

In spite of that, Brazil is currently undergoing a major turning point in its policies for solar energy. The government assigned the PV industry as a strategic sector and also established a set of measures to promote more investments in this area. The institution of the net metering system enabled the independent generators to feed the grid with their exceeding electricity, using it as a battery, and compensate with the same amount of electricity in the periods when solar irradiance is not enough to supply their consumption. Besides, the National Agency of Electric Energy (ANEEL) has promoted several exclusive auctions for solar energy. As a result, the registered number of small generators rose from 189 in June 2014 to 1232 in October 2015, and the stakeholders in the PV industry estimate that 3.5 GW of solar energy might be deployed in the next

Abbreviations: ANEEL, National Agency of Electric Energy; BNDES, National Bank for Socioeconomic Development; CDB, China Development Bank; CNY, Chinese Yuan; CO_2, carbon dioxide; EU, European Union; FCO, Midwest Development Fund; FDI, Foreign Direct Investments; FDNE, Northeast Development Fund; FIT, feed in tariff; FYP, Five-Year Plan; GW, gigawatt; GWh, gigawatt-hour; IEA, International Energy Agency; kWh, kilowatt-hour; LCOE, levelized costs of electricity; MW, megawatt; NDRC, National Development Reform Commission; PADIS, Program for the Technological Development Support of the Semiconductor Industry; PRODEEM, Program for Energy Development of States and Municipalities; ProGD, Development Program for Distributed Power Generation; PROINFA, Incentive Program for Alternative Sources of Electricity; PV, photovoltaic; R&D, Research and Developmen; RE, renewable energy; SWH, solar water heater; WTO, World Trade Organization.

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four years [2]. Moreover, the government provided the auction winners with low interest rate loans on condition that they purchase local assembled PV panels. This local content rule incentivized the establishment of PV factories, although with uncompetitive prices comparing with the imported Chinese PV panels.

Consequently, the purpose of this article is to analyze the emergence of the PV industry in Brazil and the importance of the measures implemented by the government to boost the national PV market. Nevertheless, a comprehensive view on this process can only be achieved if the Brazilian scenario is analytically situated in the framework of the global energy markets. First of all, because the discourse of climate changes to which the deployment of renewable energies is associated, constitutes an international narrative. Secondly, the energy market is highly globalized, as the research and development of RE technologies and the manufacturing value-chain of energy equipment are geographically distributed in several countries [3]. Finally, we argue in this article that national States seek to promote the internal development of the renewable energy industry because they consider this sector fundamentally strategic for the good positioning of their respective economies in the global market.

There is a tendency to take the existence of global energy markets as a given, a function of the power of transnational corporations and the guidelines of national energy agencies. Nonetheless, a sociological inquiry needs to go beyond givens and attributes and examine the making of these conditions, as well as the dynamic rules according to which the involved actors design their strategies [4]. Hence, our research is situated in the intersection of energy studies and the sociology of globalization: We will shed some light on the global circuits for capital, knowledge, investment and trade in the PV industry and thoroughly discuss the initiatives of the Brazilian government to insert the country in the transnational PV production chain.

Because China represents the gravitational center of the global PV manufacture, it will be taken as a reference for the analysis of the Brazilian case. However, rather than merely comparing these countries' policies for the solar sector, we intend to highlight the worldwide interconnectedness of production and markets that constitutes the basis for the local development of the Brazilian industry. In other words, the concept of "interconnectedness" aims to clarify those international links that function as causal implications for determining the dynamic contexts in which the national States and energy enterprises define their plans. We will also demonstrate that in a globalized economy the interconnected features of the PV sector must be dialectic identified as both cooperation and competition. Brazil is favored by the international research and development of solar panels, and its industry will initially begin as an element of a transnational chain of the PV manufacture, but the *telos* underlying the governmental solar policies was conceived according to the goal of progressively upgrading the Brazilian participation in the global RE markets. On the theoretical level, this article investigates the emergence of the Brazilian PV industry in order to shed some light on how nation States are promoting the local renewable energy industry in the context of global interconnectedness and competitiveness.

2. Theoretical framework and methodological approach

The evidence of globalizing dynamics in the energy sector demands a corresponding theoretical view. It means that instead of following the mainstream approach in energy studies—according to which the "nation State" is regarded as a closed unit and the energy policies analyzed in the context of its limited territorial jurisdiction—we intend to highlight the transboundary flows of capital and know-how in the renewable energy sector in which the current Brazilian solar policies are embedded. In line with the "methodological cosmopolitanism" required by the object of this research, the present article aims to contribute for the investigations on renewable energy deployment in emerging economies and also investigate the emergence of the Brazilian PV industry as an empirical case for the social studies of globalization [4].

The sociology of globalization has largely emphasized that an important set of phenomena—climate changes, migrations, finance market, identity—can no longer be understood in reference to the analytical framework of the national States [4–7]. Local transformations are due to more complex causal chains that cannot be circumscribed within national territories—and the more compact dimension of the global instances that followed the technological innovations in the transport and communication infrastructures has reconfigured the idea of national sovereignty in the sense that changes in the local contexts might be associated with processes that are not completely under the legislation of national authorities.

The emergence of the PV industry in Brazil will be thus analyzed in consonance with the principles of "methodological cosmopolitanism", such as developed by Ülrich Beck [7–9]. This theory is relevant because it radically questions the division between the "inside" and the "outside" of social phenomena in relation to their national borders. In the field of energy studies, it is especially important because it offers an alternative reference for the widespread research pattern that defines the problems of investigation by focusing on the deployment of a certain technology in a given country (e.g. the prospects of nuclear power in France, hydropower in China, wind power in Argentina). In short, one can hardly provide comprehensive studies on national energy policies, unless they are presented in connection to the dynamics of the global energy markets in which they are embedded [10]. That is why, rather than insulating the emerging Brazilian PV industry from the international arena, we will focus on the process by which the Brazilian government is developing measures to contribute for the endogenization of the global dynamics in the national solar industry.

Thus, we will consciously avoid treating the nation State as a closed unit, as well as any sort of rigid conception of the "global" and the "local" as dualistic analytical categories. The theoretical divergences with the "methodological nationalism" do not imply, however, any underestimation of the actions taken by national governments to place their countries in a favorable position within the competitive world economy. Rather, we demonstrate that national States played a decisive role in enabling the capabilities for global operation and coordination of the renewable energy market and were also responsible for the policies that internalized the specific rules of the globalized PV market in national energy planning with the purpose of strengthening the local manufacturers and their competitive insertion in the international arena.

In regard to our methodological approach, we based the arguments developed throughout this article both on primary and secondary data. The secondary data were obtained in scientific articles on the perspectives of PV energy in Brazil and China. The existing literature raised a number of questions, though, that demanded the gathering of original information. Hence, our primary data consist of five semi-structured interviews conducted along 2015: In China, we interviewed Shi Jingli, an energy researcher from the Center for Renewable Energy Development and Research Institute/National Development and Reform Commission. In Brazil, we interviewed the director Carlos Mattar and regulation specialist Daniel Vieira from the distributed generation department at ANEEL, Professor Rafael Shayani from the University of Brasilia, as well as two representatives of the PV manufacture company: Thatiane Roberto from Globo Brasil and Abdias Pontes from Minasol, both listed in the BNDES (National Bank for Socioeconomic Development) catalogues of local manufactures. We also requested