Empty promises or promising futures? A critical assessment of the role of smart grids in the transition towards renewable energies.

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Abstract

The scarcity of non-renewable energy sources and the increasing concerns with global warming and CO2 emissions derived from the burning of fossil fuels have brought renewable energies under the spotlight. This paper offers a critical assessment of the viability and feasibility of a transition towards renewable energies, and of the potential contribution of smart grids to this transition. The research is based on empirical evidence from the European context. The assessment is based on a comparison between (a) the viability of a transition to renewable energies, based on the internal requirements of the societies under analysis in terms of energy consumption and societal metabolism, and (b) the feasibility of the aforementioned transition, based on an external view of the economic process in relation to the availability of renewable and non-renewable energy sources. Smart grids offer a relevant case study to assess the potential of technological innovations in the envisioned transition.

Paper

The scarcity of non-renewable energy sources (Hall and Klitgaard 2012) and the increasing concerns with global warming and CO2 emissions derived from the burning of fossil fuels (IPCC 2007) have brought renewable energies under the spotlight. Within the very broad scholarship on the transition towards renewable energies, I focus on the role of emerging technologies and on the promises and imaginaries associated with smart grids. This paper provides a critical assessment of the role of smart grids in the transition towards renewable energies.

Smart grids are defined as highly automated electric grids based on the use of Information and Communication Technology (ICT) (Giordano et al. 2013). Smart grids are related to a myriad of different promises such as the transition to renewable energies (Blumsack and Fernandez, 2012), securing energy supply, reducing blackouts (Beyea, 2010), more efficient use of resources (Wissner, 2011), universal access to electricity and a decentralised system of electricity generation where producers, distributers and consumers assume new roles (Wolsink, 2012). Visions of smart grids are often at odds with each other (for instance, controlling energy supply and decentralising electricity generation), due to the fact that the technology in Europe has not been applied beyond pilot projects at a large enough scale to be able to define precisely its function and scope of application (Giordano et al. 2012).

This paper addresses the challenge of evaluating the plurality of promises associated with smart grids. The analysis is divided in two sections: (a) a multi-scale assessment of the challenges involved in the transition towards renewable energies from a biophysical point of view; and (b) a reflection on the social robustness of the scientific information used in the debate about smart grids.

With regards to the challenges associated with energy transitions, I use a multi-scale analysis in order to compare the internal view of the economic system with the external view of how the system is embedded within the ecosystem. This comparison makes it possible to assess the economic process from different points of view and to identify the feedback loops and constraints generated by the use of a given energy source and its associated technology. Smart grids can then be analysed not only in their own terms in relation to the technological advantages that they may offer, but also in relation to the broader picture of societal metabolism and resource management.

The internal view is based on the analysis of societal metabolism, that is, energy consumption is related to the structure and organisation of the economic process (Giampietro et al. 2013). The case study of Spain is used to illustrate the relationship between the allocation of energy throughput and the distribution of human activity in different economic sectors. In Spain, the use of high quality of primary energy sources implies that only 0.1% of Total Human Activity is deployed in the Energy and Mining sector and only 8% of the Total Energy Throughput is used to produce the flow of energy carriers consumed by society. Given that renewable energies at the moment have a much lower quality than fossil energy (Hall and Klitgaard, 2012), one should expect that a transition to an economy based on 100% green electricity would either (i) provide a lower electricity supply, keeping the fraction of human activity and the fraction of total energy used in the energy sector constant, or (ii) it would require a significant increase in the fraction of human activity and energy used by the energy sector, in order to maintain the current energy supply levels, reducing the amount of human activity available to other activities.

The external view is based on the consideration of the biophysical constraints posed by the limited availability of non-renewable energy sources and by the fixed rate of consumption of renewable energy sources. The feasibility of economic growth based on an increased use of energy sources is thus questioned.

The role of smart grids is assessed in relation both to the internal view and the external views, highlighting the challenges of dealing with complex sustainability issues. Whereas the technology plays a role in addressing the challenges of integrating different energy sources in the electric grid, technological solutions have little to offer with regards to the social and political challenges raised by sustainability issues.

For this reason, the analysis turns to the assessment of the social robustness of the promises associated with smart grids. The involvement of the public in the assessment of smart grids is very limited. Out of the 281 smart grid projects registered by the European Commission, only 65 (20%) engage with consumers (Giordano et al. 2013). Public debate around smart grids is centred on the issues of privacy and data protection.

The analysis shows that in order for smart grids to play a role in the transition to renewable energies, it is essential, first of all, to clarify their definition (what they should be) in relation to their performance (which functions they should express). This way, it becomes possible to address the existing challenges associated, on one hand, with the complexity of energy transitions in modern societies and the rigidity of societal energy requirements and, on the other hand, with the lack of public debate on the future visions guiding the development of the technology at its early stages.

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