



A peer-to-peer approach to energy production



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ABSTRACT

This paper strives to provide a theoretical study for energy production and distribution. We thus examine and discuss the evolution of energy systems technologies and their impact on the global socio-economic structure. We critically analyze the evolution of the energy production infrastructure and then review the renewable and decentralized energy production technologies, while focusing on the concept of microgrids. Ultimately, we propose an alternative model, inspired by the commons-oriented practices, currently observed in the production of information, that utilizes microgrids in order to create a peer-to-peer energy grid and then discuss the conditions necessary for the “energy commons” to emerge.

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1. Introduction

Since their ancestors gained the ability to control fire, humans have striven to harness energy to satisfy their needs. In the quest for efficient energy sources we have been through several periods of development. Up to this point, what energy production sources had in common was that it made sense, economically and efficiency-wise, to be centrally controlled, distributed and produced in big plants, in a system whose driving force was fossil fuels [65], a logic densely dependent with capital accumulation and scale economies.

The advancement of Information and Communication Technologies (ICT) have arguably provided the opportunity for a “paradigm” shift in the way energy is produced and distributed. An increasing number of people have

been experimenting through a variety of participatory networks allowing them to manage, share and produce in a collaborative manner. The foundations of a new social order have been set, based on meaningful cooperation and active participation [8,10,45], intensifying the intellectual discussions that explore its applicable political and economic range. The emergence of a new mode of social production, named commons-based peer production (CBPP), has signified an alternative way to create information, i.e., software, design, culture and content [10]. In the CBPP, openness and collaboration are embraced to create common value. Prominent examples of this new mode of production are the Free/Open Source Software (FOSS) projects, the free encyclopedia Wikipedia, but also open hardware projects like the Open Source Ecology or the Wikispeed car. People have been exploiting these interconnected spaces to actively shape and reproduce technological advancements according to their needs, in a paradigm where profit, power and control seem to deteriorate in significance in the shade of values like openness, sharing, cooperation and participatory production.

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Growing concern about global environmental and social issues has stimulated a pursuit of a more sustainable approach of how energy is being produced, valued and consumed and more environmentally friendly, socially responsible innovations have been gaining ground. Yet the transition to a distributed, recourse-efficient approach in the energy sector seems to be stalled by the still prevalent logic of the past [65]. Following this logic, some of the most promising technologies are pushed into the wealth-creating centrally controlled pit of industrial production and large solar energy fields are created in the desert and big wind farms are set up, having a negative impact on the environment instead. A revolutionary alternative of a decentralized, smart energy grid where producers and consumers merge via small-scale energy production is necessitated, not only for the feasibility of the CBPP model, but more importantly for the formation of a more feasible, sustainable future of human societies.

This paper is using the experience gained by the CBPP as a point of departure to explore its potential within the energy sector, mainly focusing on electricity production and distribution, valorizing practical evidence from the implementation of existent microgrid projects (a form of decentralized, small-scale energy production). The focus on the electricity sector is not only based on the practices documented, but more importantly in an attempt to develop a socio-economic approach, emerging from a significant milestone in the evolution of the energy sector, energy transmission in the form of electricity. A revolution closely bound with some of the main dynamics of the current dominant mode of production and growth, which is large scale manufacturing and domestic consumption. Other energy sectors in society, such as transportation, should not be underestimated however. This paper is only narrowing down to this specific sector in order to emphasize its main approach to the theoretical discussion towards a commons-based energy production and management as opposed to the centralized energy production and transmission in the form of commodity or service, in the sense of contrasting the centralized, one-to-many structure to a P2P (peer-to-peer) network. The characteristics determining the operation of highly decentralized energy networks (like the transportation system), which transcend the operational and productive range of society exceed the limitations of the current study.

Hence, our aim is to develop a critical look on the evolution of the energy system until today and then attempt to tentatively propose a theoretical application of the mode of production currently utilized in the information commons towards the creation of energy commons. Specifically, the structure of the paper is as follows: First the methodological approach is explained. Then a historical account is provided of how energy has evolved and how the industry took shape till the current ICT-driven techno-economic paradigm. Further, we provide the context in which our theoretical proposal takes place, so renewable and distributed energy are explained. Next, the P2P networks and the CBPP are introduced with a description of the proposed model to follow. Then, we discuss the possibilities of a different energy paradigm. Last, the concluding remarks of the paper are presented.

2. Methodology approach

This work strives to provide a theoretical study for energy production and distribution. We aim to critically analyze the evolution of the energy production infrastructure and ultimately propose an alternative path, inspired by the commons-oriented practices that have been observed, up to this point, in the production of information. In other words, the goal of this study, as a theoretical attempt to enrich the current literature and understanding of the phenomenon in question, is to tentatively explore the possibility of the currently evolving market-driven energy production system into one that is promoting the decommodification of energy in the vein of the commons-oriented practices. Hence the following questions can be generated by the research goal: i) How are the new technologies revolutionizing the energy system? ii) What role could the CBPP acquire in this context? iii) What are the strengths and weaknesses of a proposed approach system?

The sources of information relevant to this study include interviews with experts on the field; academic literature; exemplary cases that support our theoretical claim; and press and other media sources. The research strategy of choice in this project is literature review, enriched with interviews and data from relevant practices. It would be important to emphasize that there is a lack of extensive research and literature on the subject, since it is an emerging phenomenon-structure. What should be expected from such a study is to develop our partial answers to our questions, which would be “input to the ongoing social dialogue about the problems and risks we face and how things may be done differently” [[23], p. 61]. Therefore, significant contribution to the formation of the proposed model is provided by semi-structured interviews (see Appendix for the list of interviewees), conducted with Eric Hunting, a sustainable architecture and renewable energy activist and technical writer as well as with four engineers-researchers (Ioannis Margaritis, Panos Kotsampoulos, Kostas Latoufis and Iasonas Kouveliitis-Lysikatos) from the research unit behind the Kythnos microgrid (one of the first and most innovative microgrid implementations).

3. Evolution of energy production

3.1. Energy in history

Energy flows define and determine life itself, so it makes sense that they also influence human societies greatly. For the largest part of the human species' history, energy surpluses were minimal. According to Ref. [75] approximately 250,000 years ago began what could be described as the first energy era, with two consecutive transitions to follow and the last one still running its course. During that first era, energy transformed from the simple process of metabolizing food procured with foraging, to the utilization of domesticated animals and a scarce use of fire. This shift from foraging to cultivation assisted with energy harnessed from animals could increase productivity in agriculture and transportation up to 15 times to that of a farmer [74]. Innovations like the wheel, metallurgy, the plough and the

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