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Energy Procedia 142 (2017) 2655–2660

Energy Procedia

www.elsevier.com/locate/procedia

9th International Conference on Applied Energy, ICAE2017, 21-24 August 2017, Cardiff, UK

Social patterns of energy usage: An international comparison

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Abstract

In order to reduce the enormous environmental footprint of the contemporary society, it would be necessary to diminish the energy wastes in human activities. To tackle these objectives, it is important to identify the sources of this reduction from the point of view of both technical systems and social practices. With this perspective, an analysis of the social patterns of energy usage is presented in this work for a number of different regions among the five continents. As a first approach, this study is mainly based on the official data found from international organisms. The urbanization rate for every region is considered here as the central point of a model at three different scales: (i) the World, (ii) subcontinents or groups of countries, and (iii) single countries. With this methodology, it is possible to classify a number of patterns of social energy consumption and its evolution with time for the last two decades. A transition point is regarded for a number of regions, while stability or instability is found for others regions.

Peer-review under responsibility of the scientific committee of the 9th International Conference on Applied Energy.

Keywords: energy supply; social patterns; urban population.

1. Introduction

Complexity is a term widely used to analyze a number of systems in nature and science. Chaisson [1] has proposed a very extensive methodology to correlate the mass-normalized free energy flow of natural systems with their evolution on time and complexity. This proposal includes astronomical processes, but also in the Earth throughout living systems, and including human societies. In the scale of time, ancient systems are simpler and its energy rate density growths logarithmically with time. Therefore, energy is proposed as a unifying common feature among organized structures, including living or non-living systems.

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1876-6102
Peer-review under responsibility of the scientific committee of the 9th International Conference on Applied Energy.
10.1016/j.egypro.2017.12.207

Analyzing social groups, it has been demonstrated that, through the history of some important empires of the World, increasing hierarchical complexity is a result of the growth in population size [2]. This hierarchy can be modeled with a multi-agent paradigm and the results let show that there is an extra administrative level added when population increases by an order of magnitude. Furthermore, an analysis of the labor structure in the last century allows finding that, at the global economy level as well as in the USA, increases in *per capita* energy consumption are associated with an increase in the service share of employment and a decrease in the agricultural employment [3]. A model proposed for these results let explain also the virtual stability of industrial employment as a consequence of the productivity growth of the sector at the same rate that the growth of energy use *per capita*.

Going back to the complexity-energy relation, a number of productive transitions can be found during the existence of the human being, in relation with the social, cultural, economical and political structure, and their levels of complexity. One can distinguish four main productive modes: forager, agricultural, industrial and technological societies, which are all found along the history, but also nowadays around the world [1,4]. It appears that this complexity is strongly related to the energy consumption through the diversification of activities and the development of new technologies. The more complex is the society, the more the investment (and waste) of resources is observed.

Being the cities at the top of complexity in the human organization, the percentage of urban population is proposed here as an indicator of complexity for social groups. For the first time in the history, the rural households represent at this moment less than the half of the population in the world (Fig. 1a). At the scale of the planet, the increase in urban population from 1990 to 2014 presents a strong correlation with the total primary energy supply (TPES) (Fig. 1b). In this work it is proposed a model to study the social patterns of energy usage, the TPES are considered for selected regions and countries from the five continents during the last two decades, and analyzed in relation with the urban population for every region or country.

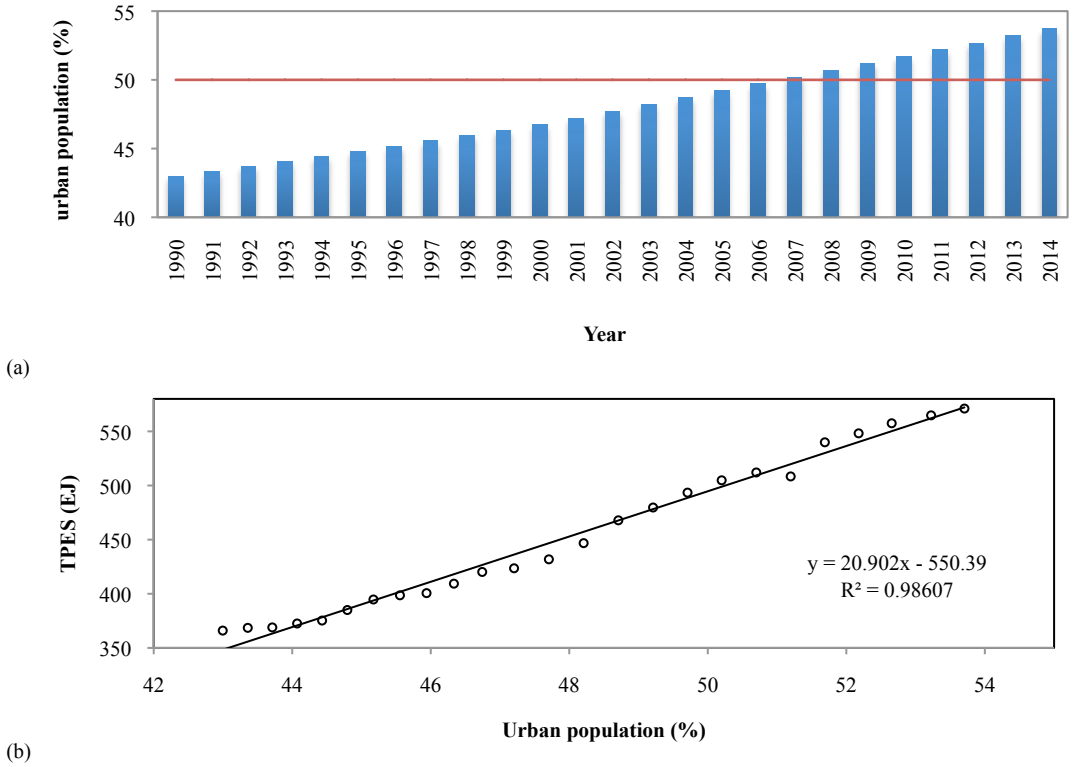

Fig. 1. (a) The growth of the urban population in the World has trespassed half of the total population in 2007 [5] (b) this urban population is linearly correlated with the global Total Primary Energy Supply (TPES) per year [6].