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An economic model for energisation and its integration into the urban energy planning process

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ABSTRACT

It is widely recognised that access to and supply of modern energy play a key role in poverty alleviation and sustainable development. The emerging concept of energisation seems to capture this idea, and if implemented in its full complexity it should have multiple beneficial effects. To demonstrate this, an economic model is developed for an urban developmental context, drawing on the theory of urban ecosystems and illustrating energy and waste production and consumption issues with current South African data sets. This new understanding of the concept of energisation is then integrated into a local government energy planning process, by means of a checklist for energy planners, covering 18 aspects that between them affect all 7 identifiable tiers of the energy service supply network. A 6-step structured approach is proposed for integrating sustainable energisation into the first four phases of the advanced local energy planning (ALEP) tool.

1. Introduction

The access to modern and appropriate energy supply has been recognised as a key enabler of poverty alleviation and sustainable development by the UNDP (2005): Although no millenium development goal (MDG) has specifically been defined for energy issues, the access to modern energy plays a fundamental role in their achievement. Energy planning processes therefore hold the potential to enable socially meaningful development in an environmentally sustainable manner, if they focus strongly on detailed socio-economic development needs and couple these directly to renewable energy supply options.

As we have recently argued, *energisation* can address all three aspects of sustainable development, specifically also in the urban development context (Nissing and von Blottnitz, in press). Here, we aim to translate this extended version of the concept of energisation into an economic model in order to visualise its multiple effects. Furthermore, we elaborate how this new understanding of energisation could be integrated into the technical energy planning process, by developing guidance for energy planners.

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2. An economic model for energisation

In this paper, energisation is considered in the context of an urban development situation, such as that commonly associated with the cities of the global South. Cities are viewed as urban ecosystems.[1] In the following section, a conceptual economic model will be developed and its significance will be illustrated by the use of current South African energy and waste production and consumption data sets. The purpose of the model is to serve as a basis upon which the newly defined approach of energisation can be demonstrated.

2.1. Model development

Fig. 1 represents a basic economic input–output model, its main elements being sectors of production/provision or consumption of commodities within the economy (represented by boxes), flows of commodities in form of goods (including waste) or services in the direction indicated by the arrows, and

[1] According to Hughes (1974), the term 'Ecosystem' refers to the totality of living and non-living things on an area of the earth's surface, interacting to produce a characteristic flow of energy and cycling of materials. Even though the city is commonly described in terms of economic activity or intensified social interaction, Hughes (1974) proposed that it should be considered as an ecosystem, as the city is closely linked to the physical and biological world both within its own boundaries and without. The main difference of an urban ecosystem to other land ecosystems is its massive energy flow.

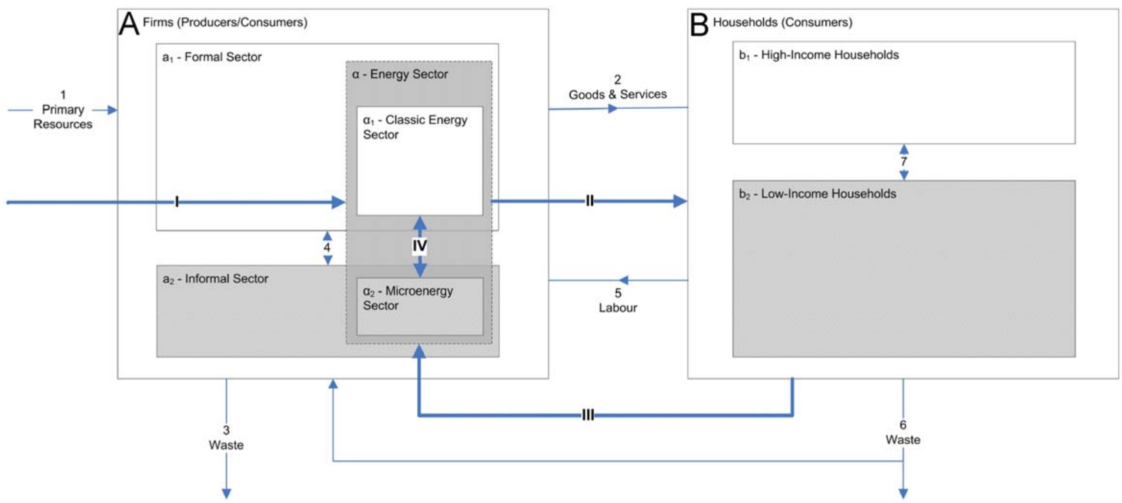

Fig. 1. Economic model—energisation.

the flow of financial commodities in the opposite direction of the arrows.

The basis of the economic model is a free market approach, based on the dynamics of supply and demand, where consumers and producers are the main players.

As can be seen in Fig. 1, specific elements regarding the energy sector as well as the waste management sector have been added to the system, as both influence each other, and have furthermore an impact on the economic macro-system. IEA (2004) states the following with regards to the integration of aspects of the waste management sector: "*[…] Energy-environmental planning, which until now has focused primarily on energy and productive systems, also deals with waste management problems. Here it has to deal with the feedback of energy and material flows from the waste disposal system into the energy and production system. To fulfil these requirements, energy models have been expanded to also include waste and material flows.*"

The producers buy resources (arrow 1) in order to produce goods and services that are bought and used by the consumers (arrow 2). On the other hand, households lend their labour force to the producers in exchange of a salary (arrow 5). Furthermore, the firms of the formal sector produce goods and services that are consumed by firms in the informal sector, and the firms in the informal sector might act as suppliers for the firms in the formal sector (arrow 4).[2] An exchange of goods and services is also observed between high-income and low-income households (arrow 7). The sole exception to the exchange of goods and services for financial commodities might be the case of waste flows (arrows 3 and 6), where consumers might have to pay for getting rid of waste materials generated.

Households, which have been qualified strictly as consumers, can be divided according to their average income, featuring specific characteristics, inter alia differing consumption patterns in general and energy consumption patterns more specifically, differing access to energy services, and differing waste generation patterns, as illustrated by the example of South African households in Fig. 2 for energy and in Fig. 3 for waste. Furthermore, they have a different level of skills and education, and have access to a different level of health care services.

Fig. 2 (adapted from Winkler et al., 2006) depicts final energy demand by household type and end use. It shows how urban high-income electrified households (UHE), which account for 36% of all households, consume 75 PJ/a out of a total of 130 PJ/a in this sector. By comparison, urban low-income electrified households (ULE, 11% of total) and urban low-income non-electrified households (ULN, 12% of total), consume <20 PJ/a combined. A different pattern is also noticeable for the purpose of the energy usage. For UHE, energy is mainly used for water heating, followed by space heating and cooking; interestingly, there is a demand of approx. 10 PJ for other electrical purposes. For ULE, the main energy usage is dedicated to water heating, followed by approx. equal shares for space heating, lighting and cooking. For ULN, water heating has the lowest energy usage, whereas the most energy is consumed for relatively equal shares of space heating, lighting and cooking.

Moreover, the types of energy carriers consumed differ by income group. For the same South African households, Prasad (2006) reports an increase of electricity usage from 30% to 95% and a decrease of wood and kerosene usage from 30% to <5%, respectively, in relation to increased household income.

From a waste generation perspective, different generation patterns are noticeable. Jeffares & Green (2004) state that waste generation figures for South Africa vary from 0.5 up to 2.5 kg/c∗d, respectively, for low-income up to high-income households. As can be seen in Fig. 3, there is a difference especially in the share of organic waste. For high-income households, the share of organic waste represents approx. 30%, whereas for low-income households, the share represents approx. 60%. Waste generation patterns for low-income households in Khayelitsha have been confirmed by Brill et al. (2006).

However, as an urban context is being considered, household groups with different average incomes share several similarities due to their geographic proximity, which would not necessarily be a given in a rural context. These similarities are i.a. the same service infrastructure (to some extent—e.g. roads, energy supply, waste management, access to shops), the same ecological environment and the same overall economy.

ClusterPlus[3] segments the South African population into 10 main groups, which are further divided into 38 clusters. These groups and clusters have been defined in terms of the socio-economic rank, life stage and dwelling type (Knowledge Factory,

[2] The goods produced and consumed by the firms of the formal sector have not been represented by an arrow for the sake of transparency; the same applies to the firms in the informal sector.

[3] According to Knowledge Factory (2005), "ClusterPlus is a geo-demographic segmentation system which provides remarkable insight into the behaviours, characteristics, lifestyles and locations of the people of South Africa. Developed at a suburb level, ClusterPlus is an essential component of any micro-marketing model allowing for the meaningful targeting of prospects in specific areas".