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Meso-level analysis, the missing link in energy strategies

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Abstract

Energy is essential for human societies. Energy systems, though, are also associated with several adverse environmental effects. So far societies have been unable to successfully change their energy systems in a way that addresses environmental and health concerns.

Lack of policy consensus often resulted in so-called 'stop-go' policies, which were identified as some of the most important barriers regarding successful energy transitions. The lack of policy consensus and coherent long-term strategies may result from a lack of knowledge of energy systems' meso-level dynamics.

The meso-level involves the dynamic behaviour of the individual system elements and the coupling of individual technologies, resulting in interdependencies and regimes.

Energy systems are at the meso-level characterised by two typical aspects, i.e. dynamics driven by interactions between actors, and heterogeneous characteristics of actors.

These aspects give rise to the ineffectiveness of traditional energy policies, which is illustrated with examples from the transport sector and household electricity consumption.

We found that analysis of energy systems at the meso-level helps to better understand energy systems. To resolve persistent policy issues, the traditional 'one size fits all' energy policies are not sufficient. In order to tackle the difficult issues, 'redesign of system organisation', 'target group approach', or 'target group induced system re-orientation' are needed.

Keywords: Meso-level; Energy policies; Complexity

1. Introduction

Energy is essential for human societies. They enable services such as long-distance transport, long-distance communication, labour-extensive agriculture and manufacturing of goods, comfortable housing, and personal entertainment. Energy systems are, however, associated with several adverse environmental effects ranging from perceived landscape distortion from wind turbines (Dohmen and Hornig, 2004) to global climate change from CO_2 emissions from fuel combustion (IPCC, 2001), human deaths because of air pollution (OECD 2001a, Ch 21), and regional climate change (Patz et al., 2005).

Changes in the way societies convert and use energy imply changes in the structure of societies themselves. Mechanisation of all productive sectors increased productivity and improved labour conditions. The downside of these developments is the ever-increasing dependence on energy. While availability of energy services increases the quality of life, changes in energy systems influence human societies. Abrupt increases in oil prices have initiated economic crises in the early 1970s and early 1980s (Doroodian and Boyd, 2003; Farrell et al., 2004; IEA, 2004a), high transport fuel prices have resulted in social unrest and strikes,[1] and high energy prices threaten to push the purchasing power of the poorest households in developed countries below socially acceptable levels. Real shortage, for example due to electricity blackouts, weather conditions, strikes and war, deeply affects the life of virtually everyone in the society concerned (IEA, 2005a). Therefore efficient management of energy systems is beneficial for the wellbeing of societies.

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[1]E.g. French farmers tend to strike when fuel prices are high, Dutch populist politicians often plead for less tax on fuel, and in late 2005 a majority of the Dutch parliament seems to be willing to compensate households for the high oil prices.

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The increasing knowledge of the effects of the current energy system on human health (OECD, 2001a, Ch 21; Or, 2000), global climate change (IPCC, 2001), and security of supply (Helm, 2002; Wit et al., 2003) calls for major changes in energy systems. As a consequence a transition to an energy system that can stand the consequences of major changes in geo-political unstable regions, reduces GHG emissions sufficiently to halt climatic change, and reduces air pollution below (socially) acceptable levels is vital for modern societies.

So far societies have been unable to successfully change their energy systems in a way that adequately addresses environmental and health concerns. Contrariwise, unsustainable[2] fossil-fuel-based energy is heavily subsidised[3] in both OECD and non-OECD countries to secure energy supply and low prices (IEA, 1999; OECD, 2001a; UNEP/IEA, 2002). Consequently greenhouse gas (GHG) emissions are still increasing and the world is more oil-hungry than ever. At the same time, industrialised countries attempt to improve air quality and reduce the emissions of GHGs.[4] Apparently the policy goal of 'security of supply' conflicts with the policy goal of 'environment and health' (see also: Section 4.2). Policymakers have not been able to successfully cope with both 'security of supply' and 'environment and health' due to a lack of coherent strategies. There exists no policy consensus regarding long-term energy strategies, resulting in *ad hoc* policies.

Lack of policy consensus—and the associated *ad hoc* policies—often resulted in so-called 'stop-go' policies of which the 'Californian wind rush' (see e.g., Junginger, 2000) is an infamous historical example. Stop-go policies are the result of over-enthusiasm (hype) followed up by reduction or removal of tax incentives, resulting in a retreat of investments, followed up by the next hype. Stop-go policies have been identified as one of the most important barriers regarding successful energy transitions (IEA, 2004b; Lensink, 2005).

The lack of policy consensus and coherent long-term strategies presumably results from several factors, including conflicting interests of energy suppliers and users, and lack of knowledge of energy systems' meso-level dynamics.

This paper aims to increase understanding of the dynamics of energy systems and to increase insight on the possibilities and limitations of energy policies. Better understanding can contribute to increased scientific consensus and consequently political consensus on long-term energy strategies. The meso-level is taken as relevant for the understanding of energy systems, specifically regarding changes in the energy system. It is acknowledged that energy systems need to be known at the micro-, macro-, and the meso-levels (Lifset, 1999; Rotmans et al., 2003). Increased insight into the meso-level of energy systems can contribute to a more consistent and coherent understanding of energy systems, and thus enhances existing energy analysis methods rather than replaces them.

This paper assesses the additional insights that meso-level research can offer in addition to those at the micro- and macro-levels. Focus is on the relevance of two specific meso-level characteristics—interdependencies and heterogeneous actors—for energy policies. Increased insights in energy systems should contribute to establish consensus in both the scientific and policy arenas. Policy consensus is needed to end stop-go policies and to implement effective long-term energy strategies.

Section 2 defines the meso-level and elaborates on differences between micro-, macro-, and meso-levels. Section 3 elaborates on specific characteristics of meso-level analysis and the theory of systems changes, which is relevant for meso-level energy analysis and policy options. Section 4 applies meso-level analysis to the transport sector, and Section 5 applies meso-level analysis to the electricity sector.[5] Section 6 concludes with policy recommendations and guidelines for dealing with the meso-level.

2. Positioning the meso-level

Energy systems can be assessed on three distinguished levels: micro, macro, and meso. Fig. 1 shows all three levels and their interrelations.

Energy systems are—in general—considered from the micro- and/or macro-level. We consider the meso-level perspective of energy systems. In the sections below we first elaborate at the micro- and macro-levels. Next we consider the potential contribution of meso-level analysis of energy systems to increased understanding of energy systems.

2.1. The macro-level

Macro-level perspectives on energy systems regard the energy system at high aggregation levels and are associated with 'top-down' analysis. Highly aggregated data are favoured when dealing with general problems that require 'policy solutions'. Macro-level energy analysis describes the over-all functioning of systems and is therefore a valuable monitoring and prognostic instrument (see e.g., Focacci, 2003; Kaya, 1990).

A disadvantage of top-down energy analysis is the lack of structure due to the high aggregation level. Decomposition partly helps to overcome this shortcoming; however, the heterogeneity of the underlying data remains neglected.

As a result of neglecting the heterogeneity of the underlying data and following top-down logic, in maco-level analysis the processes at meso- and micro-levels are determined by macro-level dynamics. As a consequence,

[2]'Sustainable development' relies on two key concepts: first, the idea of 'needs', and second, the idea of 'limitations' on the environment's ability to meet present and future needs (OECD, 2001c, p. 38).

[3]"Subsidies continue to distort the energy market in favour of fossil fuels" (EEA, 2002, p. 59)

[4]As agreed in the Kyoto protocol (UNFCCC, 1997).

[5]Transport energy use and household electricity consumption are known to be persistently increasing in OECD countries (EEA, 2005; IEA, 2005a; IEA, 2005b; OECD, 2001a).