ELSEVIER
www.elsevier.com/locate/worlddev

World Development Vol. 39, No. 6, pp. 987–1001, 2011

0305-750X/$ - see front matter

doi:10.1016/j.worlddev.2010.01.002

Assessing the Role of Energy in Development and Climate Policies—Conceptual Approach and Key Indicators

KIRSTEN HALSNæS
DTU Climate Centre Risø, Denmark

and

AMIT GARG *
Indian Institute of Management Ahmedabad, India

Summary. — The paper discusses a number of key conceptual issues related to the role of energy in development and its potential synergies and tradeoffs with climate change. The relationship between economic development and energy over time is discussed and illustrated by data from China, India and South Africa, and some other countries. It concludes that energy plays an important role as a productivity enhancing factor in economic development and in human well being. Several policy goals related to sustainable development, energy, and climate can be integrated. However, meeting all these policy goals requires a special effort and has significant cost implications.

Key words — sustainable development, energy policies, climate change, integrated policy assessment

1. INTRODUCTION

The aim of this paper is to assess the role of energy in economic development as a basis for exploring how climate change mitigation can be integrated in development policies. The idea is to assess energy in the context of sustainable development (SD) and to look for potential synergies and tradeoffs between energy consumption, greenhouse gas (GHG) emissions, and costs.

A key issue is here to assess energy policies that support SD objectives that take local and global climate change policy goals into consideration. Several sub-issues are addressed including:

- The role of energy in sustainable development seen in a macroeconomic context as well at household levels.
- The multiple impacts that arise from alternative energy sources and their relationship to various economic, social, and environmental dimensions of sustainable development.
- The costs of including GHG emission reduction policies and other pollution control measures in energy policies.

The paper briefly introduces a conceptual framework that can be used for integrated assessments of SD, energy, and climate policy objectives. The approach is to use a number of key indicators that reflect economic, social, and environmental dimensions of sustainable development, and to use these to examine specific clean energy policies and GHG emissions.

2. SUSTAINABLE DEVELOPMENT AS A FRAMEWORK FOR ASSESSING ENERGY AND CLIMATE CHANGE POLICIES

The sustainable development agenda is very wide and the literature includes hundreds of different definitions. It is beyond the scope of this paper to go into an assessment of the theoretical literature about sustainable development, rather the approach taken here is pragmatic and to consider how current development trends in the energy system can be made more sustainable.

The perspective taken is that climate policy goals are not a major priority area in developing countries since other development goals including poverty alleviation and energy provision are more important immediate concerns. However, many general development policies have large side-impacts on climate change, and in order to capture these, the paper will outline a framework for how SD dimensions, energy and climate can be assessed jointly.

SD and environmental linkages can be understood in many different ways dependent on the underlying paradigm of development (Halsnæs & Verhagen, 2007). Some of the controversies that have been going on in the theoretical debate about sustainable development have been between economists and ecologists. Economists have tended to focus on economic growth patterns and substitutability between manmade and natural capital, while ecologists have emphasized limits to growth and constraints. Recent work by a group of leading economists and ecologists has done an attempt to "merge" the two disciplines in a practical approach that can be used as a background for addressing SD and environmental linkages. A short introduction to this is given in the following.

Arrow *et al.* (2004) summarize the controversy between economists and ecologists by saying that ecologists have deemed current consumption patterns to be excessive or deficient in relation to sustainable development, while economists rather have focused on the ability of the economy to maintain living standards. It is here concluded that the sustainability criteria imply that intertemporal welfare should be optimized in order to ensure that current consumption is not excessive. [1] However, the optimal level of current consumption cannot be determined, that is, due to various uncertainties, and theoretical considerations are, therefore, focusing on factors that could

* Final revision accepted: January 19, 2010.

be predicted to make current consumption unsustainable. These factors include the relationship between market rates of return on investments and social discount rates, and the relationship between market prices of consumption goods (including capital goods) and the social costs of these commodities.

A key issue that arises from this approach is what is meant by consumption patterns, and how these should be understood in relation to human wellbeing and its major components. Energy is as already said a key component in consumption both at macroeconomic- and household levels, and energy to a large extent is based on exhaustible resources and creates pollution.

Furthermore, it is important to recognize that developing countries exhibit some specific institutional factors that are key framework conditions for individual and collective consumption choices, which go beyond market frameworks due to inefficiencies, limited information, and weak institutional capacities. One of the implications of these institutional weaknesses in developing countries is that the use of various production factors including energy is very inefficient, which both implies supply constraints, high costs, and high pollution intensity.

The next section will briefly introduce a conceptual background for identifying key elements of human wellbeing that can be addressed in studies of SD, energy, and GHG emissions and will suggest some indicators that can be used to present empirical aspect of development, energy, and climate change policies.

3. ENERGY ISSUES AS PART OF A LARGER SUSTAINABLE DEVELOPMENT MENU

Many studies of development and energy linkages assume that energy is a key component in development without a further examination of, in which way and in which configurations energy most effectively supports development. This is a limitation since investments in energy provision compete with other investments about scarce resources, and energy consumption has several externalities including local and global pollution, which negatively affects human wellbeing. Furthermore energy investments tend to create lock-in to technology trajectories, which can make it very expensive to change track later if there is a need for managing externalities or other concerns. In this context, the paper suggests to assess energy policies as part of a broader SD framework, where market failures including GHG emissions are considered jointly with other development goals.

Energy has a key role in economic development through its role as a production input, and as a direct component in human wellbeing, and any climate change policy framework, therefore, needs to find ways that ensure energy provision. Toman & Jemelkova, 2002 in an overview paper provide a number of key arguments for how and in which way energy plays a role in development. They note that "There are several ways in which increased availability or quality of energy could augment the productivity and thus the effective supply of physical and/or human capital services. The transmission mechanisms are likely to differ across the stages of development and not ... For more advanced industrialised countries, increased energy availability and flexibility can facilitate the use of modern machinery and techniques that expand the effective capital–labour ratio as well as increase the productivity of workers. Whereas supply-side energy changes in less advanced countries economise on household labour, here energy availability can augment the productivity of industrial labour in the formal and informal sectors" (Toman & Jemelkova, 2002).

The general conclusion that arrives both at macro level and at household level about the relationship between economic development and energy consumption is that increased energy availability dis-proportionally could affect economic development. Toman & Jemelkova, 2002 identify the following factors behind this as:

- Reallocation of household time (especially by woman) from energy provision to improved education and income generation and greater specialization of economic functions.
- Economics of scale in more industrial-type energy provision.
- Greater flexibility in time allocation through the day and evening.
- Enhanced productivity of education efforts.
- Greater ability to use a more efficient capital stock and take advantage of new technologies.
- Lower transportation and communication costs.
- Health related benefits: reduced smoke exposure, clean water, and refrigeration.

In addition to energy's potential for supporting economic growth dis-proportionally, there can also be a tendency to see decreasing energy/GDP intensity with economic development, as a consequence of increasing energy efficiency with the introduction of new energy technologies.

The conclusions by Toman and Jemelkova regarding industrialized countries, are based on detailed empirical analysis from the United States on the role of energy in industrialization processes including work by Schurr (1982) that identifies more flexible energy forms (like electricity) and higher energy conversion efficiency as major factors in productivity increases for non-energy production factors.

A consequence of this is that energy/GDP intensities tend to increase or to be stable in earlier phases of industrialization, while they later tend to decrease. This suggests that economic development and energy consumption, and in some cases [2] pollution, can be decoupled in a way where economic output growth is met with less resource consumption. This tendency will subsequently be illustrated with data for some industrialized and developing countries.

Based on this general understanding, the Development, Energy, and Climate Project has developed and tested an operational approach for how key economic, social, and environmental SD dimensions can be linked to energy provision. The approach is tested in studies for Bangladesh, Brazil, China, India, Senegal, and South Africa (Halsnæs, Garg, Denton, & Olhoff, 2006). The results also include an examination of how a larger and cleaner energy provision can support human wellbeing through several channels including increasing opportunities for income generation activities and a number of benefits in relation to education, health, decreased time for household chores, and increased leisure time. The magnitude of these benefits is illustrated by case examples from developing countries.

4. METHODOLOGICAL APPROACH AND FRAMEWORK

The starting point for the methodological approach is that an assessment of human wellbeing aspects of energy provision can be structured around an evaluation of specific policy cases in relation to a number of focal indicators that reflect key SD dimensions. One way to organize such an analysis is to formulate a general objective function for policy evaluation that includes arguments in terms