

Energy consumption practices of rural households in north China: Basic characteristics and potential for low carbon development

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HIGHLIGHTS

- ▶ Rural household energy use and CO₂ emissions in China are investigated via a field survey.
- ▶ Energy use and CO₂ emissions are related to separate practices within households.
- ▶ Improvements in CO₂ emission reduction are possible at demand side and supply side.
- ▶ Income and education are proven to be positively correlated with household emissions.

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ABSTRACT

Reducing the climate impact of rural household energy consumption in China is complicated since it is bound up with deeply routinized daily practices and dependent from existing infrastructural systems of energy supply. To assess the potential for low carbon development we first estimate the overall CO₂ emissions of rural households, followed by a more in depth description and characterization of the different energy use practices within the households. Space heating turns out to be the largest emission source among domestic energy practices in north China. We present lifestyle and context related factors that help to explain existing differences in domestic energy use practices of households. The potential for low carbon development is discussed both at the demand side and the supply side. At the demand side, the use of more efficient technologies and cleaner energy sources for space heating seems to be a high potential measure for achieving low carbon households. At the supply side the reduction of rural domestic CO₂ emissions could be effectively supported by making available to householders renewable and cleaner energy sources and technologies. In order to be effective, such low carbon energy options should take into account the (income) characteristics and lifestyles of rural householders.

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1. Introduction

In China, almost one half of the population lives in rural areas. They are usually characterized as being “confronted with economic poverty, with heavy reliance on biomass, leading to damage to ecological environment, etc.” (Zhang et al., 2009). All these features are linked one way or another with the energy usage of rural households. When compared to urban households, the energy consumption of rural households has received limited attention of researchers and policy makers. Reducing the climate

impacts of the energy consumption of rural households can be considered as an important instrument and strategy for climate change mitigation. Moreover, the continuous increase of total and per capita energy consumption in rural areas indicates the urgency to look at possibilities for the mitigation of rural carbon emissions. As yet however, carbon emissions in rural areas – characterized most of the times by ecological systems that are particularly vulnerable for the consequences of climate change – are not specified for their composition and their potential contribution to low carbon development.

The pattern of energy use of rural households seems to be more complicated when compared with urban households. Both kinds of households show similar sets of daily practices of energy consumption, like cooking, heating, cooling and transport. However where urban householders are connected to (energy) infrastructures that

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provide households with energy in a standardized, eco-efficient and regular manner, rural households most of the times lack such a standardized provision. They instead are faced with locally specific options, some of which bring along considerable investments of both time and labor from the side of the householders. They rely to a large extent not just on local resources (wood, straw, biogas installations, etc.) but are dependent as well from local energy providers that offer little guidance for energy saving and climate change mitigation at the domestic level.

In this article, we analyze in some detail the energy consumption patterns of rural household and examine the potential for reduction of GHG emission and for a 'low carbon transition' in the area of rural domestic energy use. First we discuss the aggregate energy consumption of Chinese rural households as addressed by a number of previous studies (Chen et al., 2006; Cohen et al., 2005; Jiang and O'Neill, 2004), and examine the influence of some household characteristics (income, education, etc.) on the carbon emissions. Second we address the nature of the energy consumption practices within Chinese rural households. So far, hardly any study has addressed the question what actually happens within rural households in terms of the existing energy consumption routines that are enacted by the householders in their everyday life. With this study, we try to 'open up the black boxes' of Chinese rural households as far as their energy behaviors are concerned. We try to 'unpack' the household energy consumption both in terms of the different practices of energy use (cooking, heating, cooling, lighting the house, transport) as well as in terms of the different sources of energy (coal, electricity, firewood, straw, biogas, etc.) used for these practices, and the carbon emissions resulting from these energy use practices. Finally, by linking the choices made in the black box – the households – with their relevant context – the local systems of rural energy provision – we explore how (future) decision making of households on low carbon energy consumption is co-determined by factors that are outside their sphere of influence. Our reconstruction and analysis of the 'energy-use profile' of rural households in China makes it possible to suggest some policy interventions for mitigating the carbon footprint of Chinese rural households.

2. Conceptual framework and research methodology

2.1. The concept of a low carbon rural development

It had been commonly believed that, along with economic development, societies especially in developing countries undergo an "energy transition" in which households generally choose to switch from traditional biomass fuels to more convenient energy sources such as electricity, liquefied petroleum gas (LPG) and more efficient energy systems for their domestic energy needs. This transition has been conceptualized in the form of the "energy ladder" (Leach, 1992; Kirk et al., 1994) and is proved to follow different pathways in different countries. For instance, some studies on China and India confirmed the prediction of the "energy ladder" theory by showing that households shifted to more convenient, cleaner and more efficient modern energy sources due to the rapid increases in the levels of urbanization and economic development (Cai and Jiang, 2008; Pohekar et al., 2005; Dhingra et al., 2008). Until a decade ago, the energy ladder served as the prominent model for explaining household energy choices in developing countries (Elias and Victor, 2005). Since the turn of the millennium however, its validity has been questioned by a number of studies (Masera et al., 2000; Heltberg, 2004; Bhutto et al., 2011). It has been suggested that, instead of switching between fuels, households choose to use a combination of both fuels and conversion

technologies. This process of diversifying their energy sources is referred to as switching to multiple fuels, resulting in a so called "fuel stacking" model. This model predicts that, when a modern fuel is adopted, traditional fuels and devices are still (at least temporarily) kept in place or in store, so that it can be concluded that households make the shift or transition only gradually and partially (Kowsari and Zerriffi, 2011). Empirical studies on many developing countries (Jiang and O'Neill, 2004; Masera et al., 2000; Heltberg, 2005) and even from developed countries (Paul et al., 2006) show results that fit well into this fuel-stacking model. Whatever model Chinese rural households may follow when going through the process of modernization that results from higher incomes and increasing levels of consumption, this transition always implies higher levels of energy consumption and therefore a potentially higher impact in terms of carbon emissions. The challenge for rural households is to find ways to combine economic development with reduced pressures on the environment. This is the meaning of the concept of a 'low carbon development for rural households'.

2.2. The social practices model for studying domestic energy consumption

When investigating the potential for a low carbon energy transition it is important to first establish the levels of energy consumption by rural households and to relate these overall levels with relevant background variables such as household incomes. Second, it is important to explore in some detail the energy profiles of rural households in terms of their composition. The rural 'domestic energy profile' needs to be specified in terms of what practices are enacted, how much energy is needed for this, and from what different energy sources this energy is derived. To make possible such a detailed analysis of the internal rural household energy systems, we suggest using the 'social practice approach' as developed in the sociology of consumption (Spaargaren, 2003; Van Vliet, 2002) and shown in Fig. 1. At the right-hand side of the model, a system for energy production and provision is depicted to indicate the relevance of these systems for the analysis of domestic energy consumption practices. It is important to find out what kind of choices households have when it comes to using certain energy sources for their daily consumption practices. So for instance when no firewood is around or within reasonable distance, there will not be much cooking with firewood going on. When biogas-programs are strongly pushed by

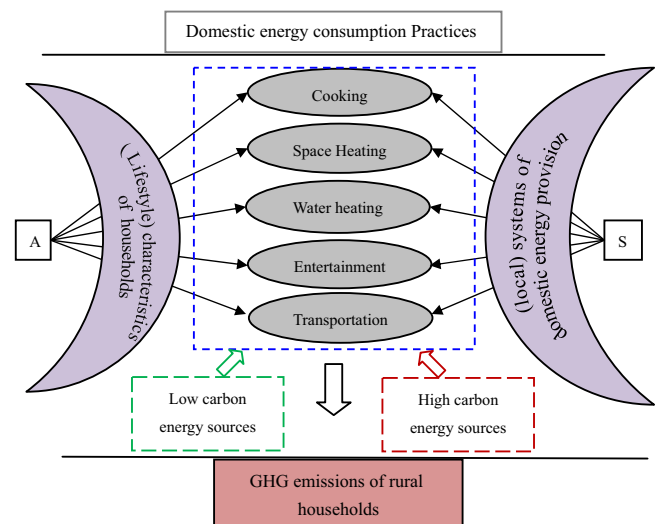


Fig. 1. The social practice model for rural household consumption.

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