CHAPTER 10

Energy Transition from Fuelwood to Electricity

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10.1 Introduction

More than 2.5 billion people around the world, particularly in developing countries, rely on biomass fuels such as fuelwood as a primary source of energy to meet livelihood needs (Global Energy Assessment, 2012). The environmental and health impacts of using fuelwood are enormous. Indoor air pollutants emitted through the combustion of these fuels are responsible for over 2 million deaths per year (World Health Organization, 2009). Their use is also associated with serious environmental threats such as deforestation (An et al., 2002, He et al., 2009, Heltberg et al., 2000) and global climate change (Bond et al., 2008, Clancy, 2008). Thus, the transition from energy sources such as fuelwood to safer and more efficient alternatives has the potential to improve not only the global environment but also human well-being.

Energy transition from biomass fuels (e.g., fuelwood, charcoal, animal droppings, and agricultural residue) to alternative energy sources is often depicted using two models: the energy ladder model and the leapfrogging model. The energy ladder model argues that as income increases, households cease using biomass fuels and adopt energy alternatives (Barnes and Floor, 1996, Holdren and Smith, 2000, Leach, 1992, Macht et al., 2012). Thus, the model contends that income is the most important factor influencing fuel choice (Figure 10.1). The energy ladder model distinguishes three essential phases. These include reliance on (1) biomass fuels; (2) fossil fuels such as kerosene and coal, also called transitional fuels; and (3) modern energy sources such as natural gas, liquefied petroleum gas, and electricity (Heltberg, 2004, Holdren and Smith, 2000). This model has been criticized because fuel shifts rarely follow a linear path from one fuel source to another. In reality, shifts follow a multiple fuel adoption strategy in which new fuels are added while biomass fuels are seldom completely abandoned (Masera and Navia, 1997, Masera et al., 2000). The model has also been criticized because it mainly focuses on economic processes and disregards the effects of social and cultural processes on fuel choice (Jebaraj and Iniyan, 2006). Energy transition occurs in part because modern energy sources achieve higher efficiency or reduce the exposure to indoor pollutants. Another important cause is that modern energy use signifies higher socioeconomic status (Masera et al., 2000).

The leapfrogging model, on the other hand, purports that developing countries learn from developed countries. Developing countries are thus expected to adopt the most recent technologies rather than going through different steps of technological innovation. Under leapfrogging, households are introduced to modern sources of energy in a fast and cost-effective way. Example mechanisms include infrastructure development (e.g., electricity grids) and distribution of modern appliances (e.g., energy-efficient stoves) through subsidy programs (Goldemberg, 1998). Under such conditions, the energy ladder is replaced by a two-step path going

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economic, demographic, geographic, and governance factors exhibited stronger relationships with the switch from fuelwood to electricity than the changes in income alone. Contrary to what seems to be occurring at the national level, the leapfrogging model constitutes a better theoretical construct than the energy ladder model for explaining the patterns of energy transition in Wolong. However, similar to many other rural areas in China and around the developing world, households in Wolong so far have ended up utilizing both fuelwood and electricity simultaneously to fulfill their energy needs. Therefore, energy transition in Wolong seems to be better represented by the multiple fuel adoption strategy (Masera and Navia, 1997, Masera et al., 2000).

Energy transition in Wolong has a positive effect on the terrestrial ecosystems of the reserve. Local residents have used less fuelwood, and thus both forests (Chapter 6) and giant panda habitat (Chapter 7) have experienced a conspicuous continuous recovery since the early 2000s. The overall effects on the human system appear to also be positive, although the impact of hydropower plants on aquatic ecosystems is not clear. However, despite the expected reduction in indoor pollution through the adoption of cleaner energy sources such as electricity, little is known about the health benefits of the energy transition that have accrued to local residents. Studies should, therefore, be performed to evaluate the effects of the switch from fuelwood to electricity on aquatic systems and human health in Wolong.

Finally, additional longitudinal studies, combined with modeling following a coupled human and natural system framework (Liu et al., 2007a, b), need to be conducted. Researchers should try to determine what would be a sustainable energy structure for communities in Wolong, and if and when Wolong will eventually experience a complete switch to electricity, together with the conditions required for such a transition and the impacts on human and natural systems. Such evaluations will be valuable for further development of policies that effectively incentivize energy transitions in rural areas without negative impacts on local culture and human well-being. These policies can have an impact not only across China but around the developing world for achieving both environmental sustainability and human well-being goals.

10.8 Summary

More than 2.5 billion people around the world, particularly in rural areas of developing countries, still rely on biomass fuels (e.g., fuelwood) to fulfill their household energy requirements. This chapter described the patterns of energy transition from fuelwood to electricity and their main drivers in Wolong Nature Reserve. We conducted a longitudinal survey on this topic in a random sample of 189 Wolong households during 1998 and 2007. Contrary to what seems to be happening at the national level, Wolong is experiencing an energy transition that is occurring at a fast pace. From 1998 to 2006/2007, the mean household annual fuelwood consumption decreased by almost 75%, while the mean household annual electricity use increased more than twofold. This transition is related to a series of economic, demographic, geographic, and governance factors. Factors positively related to fuelwood reduction included operating a tourism business, educational level, elevation, and household density. Factors negatively contributing to the fuelwood reduction included distance to the main road and participation in incentive-based conservation programs. The transition does not constitute a complete switch from biomass fuels to electricity, but rather a simultaneous use of these different energy sources. Therefore, the theoretical construct that better explains the patterns observed in Wolong is the leapfrogging model combined with a multiple fuel adoption strategy. Future work should evaluate if the energy transition path observed in Wolong could be used for better policy development to help reach both human well-being and environmental sustainability goals.

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