

Summary

Worldwide, over 3 billion people still rely on traditional biomass fuels for their daily energy needs and incur the health and environmental consequences. Projections indicate that this number will only increase further over the coming years especially in sub-Saharan Africa. To overcome the negative effects of the inefficient traditional use of biomass, a transition towards cleaner and more efficient fuels and technologies is needed. However, the transition away from biomass to modern fuels is slow.

Energy access is generally perceived a rural problem as access to modern alternatives is limited as a result of low levels of availability and affordability. In sub-Saharan Africa the urban dimension of the energy problem is substantial as well. Majority of people still depend on biomass and the projected increase in energy demand driven by the rapid urbanization stresses the need for a transition to modern fuels. For those households that cannot make the switch to modern fuels improved cook stoves could serve as a low cost “bridging alternative”.

To stimulate the adoption of modern fuels and technologies, a better understanding of households’ fuel choice behaviour and product preferences is paramount. This dissertation aims to improve the understanding of the behavioural drivers of decision-making related to available improved cookstoves and associated fuel sources, which are crucial for explaining and predicting the energy choices made by households.

Following this main objective, the following main research questions are addressed:

- i) How is the current energy transition in both urban and rural areas of developing countries best described in general?
- ii) Which behavioural drivers play an important role in explaining and predicting household energy transitions?
- iii) How do external local conditions influence the energy transition process?
- iv) What role can improved cookstoves play in the energy transition process?

To answer the research questions a literature study and two case studies have been carried out. The empirical data for this study have been collected in rural, peri-urban and urban locations. This geographical spread allows us to study and analyze the different stages of energy use. The study takes part in Kenya and Mozambique

between which we find a distinct difference in socio-economic development as well as advancement in diffusion of renewable and efficient energy technologies.

Chapter 2 starts with a critical review of the existing theories used to assess energy transitions in a developing country context. The energy ladder and fuel stacking model are commonly used to explain household choice behavior. The main limitation of these models is the overemphasis on the role of income as the main determinant for fuel switching behavior. Chapter 2 focusses on the development of a new conceptual framework to analyze the decision environment underlying fuel choices. This framework is applied in a meta-analysis of existing choice models investigating fuel switching and stacking behaviour. The meta-analysis finds that socio-economic factors are most often studied to explain household choice behavior. Factors such as age, education, habits and traditions are found to influence fuel choices. This shows that fuel switching behavior depends on more factors than just income. Further, the meta-analysis shows that little attention has been given to the impact of external conditions on choice behavior.

Chapter 3 pays specific attention to the impact of external conditions on household fuel switching behavior. The case study zooms in on three rural and peri-urban areas in Kenya with distinct local natural resource and infrastructure conditions. Fuel switching behavior of households is studied in these distinct external contexts to gain insight into the specific energy strategies applied by households and to evaluate the determinants steering their choice behavior. For the analysis of household fuel switching behavior we apply a multinomial logit model which enables the systematic analysis of household switching behavior between different types of fuels.

The results show that the ongoing transition process in the study areas is best described by multiple fuel use representing an energy portfolio. The transition process still finds itself in the initial stages where energy stacking is common even among the wealthiest households. Households in the peri-urban location were found to have a significantly more diversified fuel portfolio than households in the two rural areas. A significant effect for resource scarcity on fuel switching behavior was not found. In both locations the fuel portfolios are almost identical. The main difference between the two rural locations relates to the method used to acquire the biomass fuels needed. Although the resource scarce locations is less favorable for firewood collection compared to the forested area a higher share of households fetches firewood in the rural scarce location. Instead of switching to modern fuels, households seem to have adapted to the relative scarcity of firewood by exploiting their farmland resources as a strategy to fulfill their energy needs.

Chapter 4 assesses the internal household characteristics driving choice behavior for fuels and alternative cookstove technologies in Kenya. By means of a choice experiment, the impact of the household decision environment on fuel choice and improved cookstoves is tested. The potential for a transition towards cleaner and more efficient fuels and technologies is assessed by zooming in on three fuel-stove combinations that represent different stages on the energy ladder. By specifically focusing on the relationship between product choice and the external decision environment insights are provided in the impact of contextual factors on fuel choice behaviour.

The results show a clear demand and positive willingness to pay for the presented fuel-stove combinations. The charcoal and ethanol stoves are preferred over the firewood alternative. Given current energy stacking behaviour, charcoal and ethanol are more likely to function as additional fuels, used to extend a household's energy portfolio. Firewood remains a product of interest and continued usage is expected.

Reductions of smoke levels and the implied positive health effects appeared strong drivers for consumer choices. With respect to the limited knowledge of the health complications related to traditional cooking practices, much is still to be gained from improving awareness on this topic. Especially women who spend most time in the kitchen, turned out to know less about the health risks they face than men. Furthermore, it is generally believed that the cost of degrading the environment does not enter into resource users' decision making due to a poverty-related short term planning horizon. Yet, we showed that people are aware of the increasing pressure on their natural environment and are willing to pay to reduce the impact of their energy needs on the environment.

Further, the results suggest that marketing attention should be spent on the financial decision maker in the household regardless sex. Men and women who are the head of the household have a significant higher willingness to pay for improved cookstoves.

Finally, chapter 5 concentrates on energy transitions in an urban context. The study is carried out in 'Greater Maputo' where rapid urbanization and increasing demand for charcoal are a major cause for concern. The drivers of fuel switching behavior are assessed based on current urban household fuel profiles using revealed preference data. These fuel profiles form the basis for the analysis of potential demand and future fuel switching behavior for alternative fuel sources and cooking technologies. Using a choice experiment, we analyze how household choices are

influenced by current fuel profiles in order to improve insight in demand-side features for the development of energy products and market segments.

The results from the choice experiment show a clear demand and positive willingness to pay for the presented modern fuel-stove combinations. The reduced smoke emissions and implied health effects appeared a strong driver for product choices. The LPG stove is preferred over the ethanol and charcoal alternatives. Nevertheless, the inclusion of modern alternatives in the choice mix has not eliminated the interest of households to cook with charcoal as it remains a product of interest and continued usage is to be expected. The positive interest in the improved charcoal stove allows for a cleaner and environmental friendlier use of charcoal for cooking.

The inclusion of the fuel portfolios in the estimated choice model mainly showed that LPG-biomass users were less inclined to adopt an improved charcoal or ethanol stove despite the fact that charcoal still plays an important role in their cooking habits. Households who use a combination of firewood and charcoal have a significantly higher preference for the improved charcoal stove than charcoal only users, indicating that charcoal only users prefer to extend their fuel portfolio with modern fuels rather than investing in improving their current cooking facilities.

The results presented in this PhD dissertation show that households have a clear interest for clean fuels and technologies. They tend to prefer and choose complementary products instead of substituting their traditional stoves by an improved version using the same fuel type. This behavior is inherent to household fuel stacking behavior. Diversifying the fuel portfolio seems to be households' priority as a livelihood coping strategy.

Investments in improved cookstove programs in rural locations where households' monetary fuel cost are relatively small to non-existent will most probably run into a number of problems and potentially experience low success rates. Most importantly, because households in such locations are not strongly motivated to use expensive technologies, which promises them a reduction in fuel consumption as their need to reduce fuel costs is not pressing. Locations that seem suitable at first sight, such as resource scarce locations, can be less suitable for the diffusion of improved cookstoves as households develop alternative coping mechanisms to solve local and temporary shortages.