



IOB Study Newsletter

13 04

Renewable Energy: Access and Impact

A systematic literature review

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Approximately 40% of the world's inhabitants use biomass, such as fuelwood, agricultural waste or manure to cook and keep themselves warm. An estimated 1.4 billion people have no access to electricity. For light they use kerosene or petrol lanterns or candles. Biomass combustion not only generates usable energy but also releases noxious gases, like carbon monoxide and carbon dioxide, and particles that can adversely affect human health and the climate. Large-scale extraction of fuelwood can lead to deforestation, while using agricultural waste and manure as fuel can lead to soil depletion. IOB carried out a systematic literature review of changes in the lives of people in developing countries as a result of using renewable or cleaner energy sources. Of the 558

evaluative articles and reports found on the subject, 66 were scrutinized on a number of predefined indicators. One of the principal findings is that households tend to add new sources of energy to their range of options rather than replace polluting energy sources by cleaner ones. In addition, the effects of interventions aimed at energy consumption strongly depend on human behaviour as a response to change. This is true of cooking, but also of lifestyle patterns made possible by electricity.

Background

In 2013 and 2014 IOB will publish a number of impact studies about renewable energy and development cooperation. The studies will underpin a policy review on renewable energy and development policy (Promoting Renewable Energy Programme (PREP)). In order to gain insight into what is already known about the impact of renewable energy interventions, IOB carried out a systematic literature review.

Research method

This literature review focuses on renewable forms of energy such as biogas, solar energy and pico hydroelectric systems, but also on more energy efficient or cleaner appliances, such as improved wood stoves. We considered the impact on individual households or whole villages, rather than impacts at national or global level. Although the scope of the study was restricted in terms of the number of forms of renewable energy and the focus on the impact on households and communities in rural areas or the urban periphery of developing and middle-income countries, the range of possible effects proved to be extremely broad. After all, energy is key to practically every aspect of life: it is needed for cooking, heating, lighting (which increases the perception of safety and allows people to work and read during the hours of darkness), watching television and using the telephone. In many cases, energy is also necessary for producing, manufacturing and transporting products. Energy impinges on every sphere of

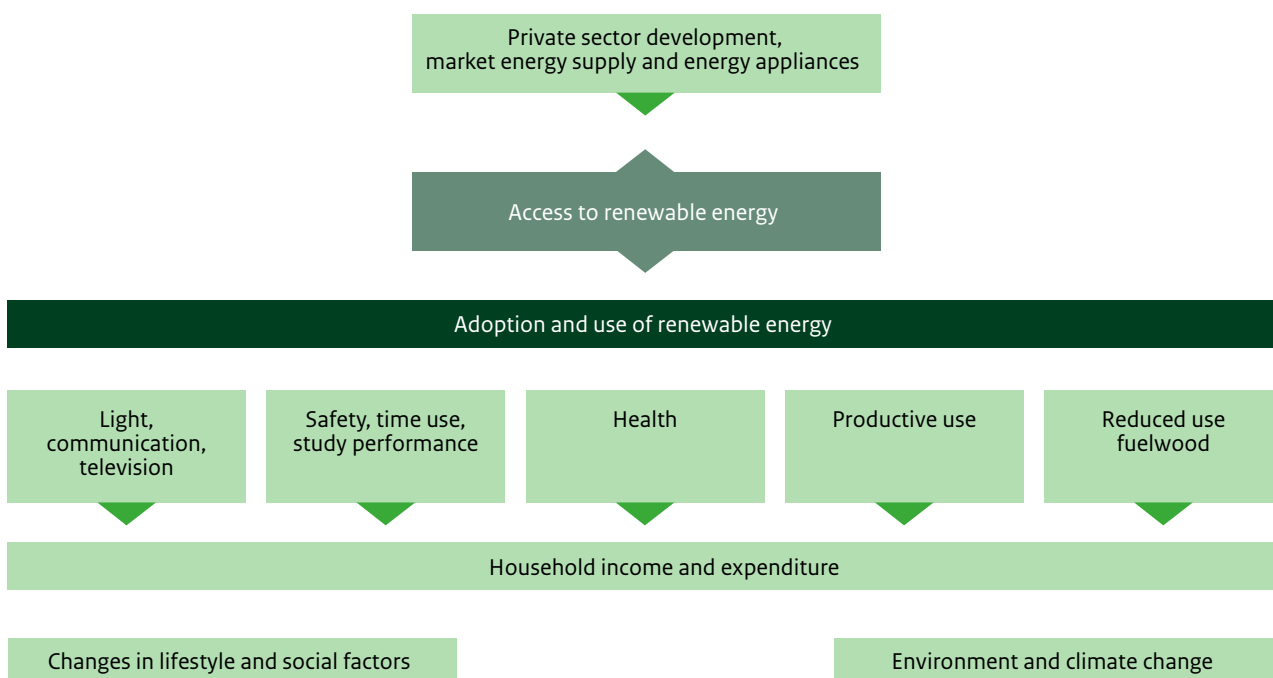
development – economic, social and environmental – and plays a role in agriculture, health, fertility, education and school performance, cultural values and gender equality. The potential impacts of renewable energy interventions and the way in which they occur are indicated in the diagram. This results chain also serves to underpin the motivation for interventions in this area.

In order to demonstrate that the changes observed are actually attributable to a specific energy source it is important that particular research methods are followed. Ideally, this means assessing the situation before and after the intervention, and comparing households that have and have not participated in the intervention. In addition, the research sample should be large enough to yield 'robust' results.

Results of selection process

A total of 558 articles and reports evaluating renewable energy in developing or middle-income countries were identified. These studies were further sifted on the basis of content and research methodology. Only 66 articles and reports qualified for further analysis. About half of these deal with the relationship between the use of biomass as a fuel and health problems, particularly those affecting the eyes and respiratory organs. Since the impacts are many and varied, it proved difficult to find in-depth studies dealing with the same subject. Moreover, no evaluative studies whatsoever were found on a number of subjects (such as the small-scale hydroelectric systems known as pico hydro).

Figure: Results chain of the anticipated impact of renewable energy interventions.



Nevertheless, it was possible to summarise a number of findings, ranked on the basis of the results chain for providing access to renewable energy sources.

Principal findings

Energy accumulation

Poor rural households in developing countries have to deal with many uncertainties, including sudden fluctuations in the availability and price of energy. In studies aimed at equipping these households to cope better with these uncertainties, the sources already in use were usually supplemented with new forms of energy. It may take between 15 and 20 years before the most scarce or polluting source of energy is abandoned in favour of a cleaner or renewable alternative. Households tend to use several sources of energy at the same time for cooking or lighting. The process of change is slow and non-linear and may display variations over time. Economic motives as well as sociocultural considerations play a part in this process.

Human behaviour is the determining factor

The impact of interventions involving energy sources and appliances is primarily determined by human behaviour and not by the technical characteristics of the energy source or appliance used. For instance, the potential savings in fuelwood by using an improved wood-burning stove may be completely offset by changes in cooking. Because the stove gives off heat more steadily, it is possible to make dishes that require a longer cooking time, or keep a pan of hot water on the go all day long. The same is true of solar energy, when the presence of electricity leads to new forms of energy consumption – for instance for watching television. The use of electricity for light competes with other uses and as a result, the old method of generating light will be maintained while the solar energy will be used largely for the new purposes.

Two-way relationship between income and use of renewable energy

In developing countries renewable energy forms are first used by the higher middle-income classes, in both urban and rural settings. In the short term, their energy expenditure increases, but this pays off in the long run through indirect spin-off, such as greater conduciveness to education. Income appears to increase relatively faster than in households that reject or are slower to adopt the new forms of energy.

Savings in energy expenditure due to innovation are frequently offset by higher energy consumption or a different form of energy consumption.

Whether or not access to other forms of energy results in new ways of generating income, depends partly on specific market conditions and partly on voltage, in the case of electricity. Although solar

energy systems at household level allow for new productive activities within the home, the scale is small and the yield is usually only just enough to repay the investment.

Positive impact on health

Improved stoves and access to electricity reduce emissions of harmful gases and particulates, thus helping to reduce the incidence of lung and eye disorders, particularly in women and children. However it should be noted that the impact of small mobile stoves (such as commonly used in Africa) is much smaller than that of larger stoves with a chimney (such as used in Latin America). In some cases, so little smoke is produced that households stop cooking outside and move this activity indoors, thus negating the positive health effects.

Access to electricity leads to social change

Access to electricity, and with it the facility for communication and television leads to changes in human behaviour, including social and cultural relations. Access to electricity changes the household's daily routine. The feeling of safety is enhanced by the use of electric light. Children learn more effectively, not because they study longer at home, but because electricity at school means better educational facilities and also attracts better teachers. Television leads to a broader view of the world and one's own horizons, prompting young people to aspire to an urban lifestyle.

Impact on the environment inconclusive

In rural locations and on the outskirts of cities in developing countries, only a small percentage of households use electricity for cooking. Although there are no international norms for what counts as an 'improved quality stove', it is evident that savings in fuelwood or charcoal in the home are smaller than in laboratory conditions. If improved wood-stoves are extremely efficient they may replace cookers that run on LPG or ethanol, and thereby lead to greater rather than less fuelwood consumption. Depending on the context, greater energy efficiency may reduce the consumption of fuelwood in industrial and semi-industrial processes such as firing bricks, and drying tea and tobacco. Whether there is any observable positive impact on the environment or climate will therefore vary from one place to another.

It is vital for the full life-cycle of energy sources and appliances to be taken into account in any estimate of impact on the environment and climate. After all, not only the operational period but also the production process, transport and processing of residual products from household appliances have an impact on the environment and climate. Thus, although solar panels generate clean energy, their production and transport and the processing of residual products have a negative impact on the environment.

The Policy and Operations Evaluation Department (IOB) of the Ministry of Foreign Affairs carries out independent assessments of the efficiency, effectiveness, relevance and consistency of Dutch foreign policy.

This includes systematic literature reviews of impact studies. The quality of IOB's assessments is guaranteed by means of systematic and transparent procedures. IOB also seeks to make evaluations accessible to the Dutch public and to partners in the countries concerned. All IOB evaluations are in the public domain and are brought to the notice of parliament. Reports can be freely obtained and a summary of the most important findings is published in the form of the IOB Evaluation Newsletter.

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In conclusion

Although this systematic literature review has produced a number of general findings, there is still a great deal of scope for high-quality research into the effects of renewable energy in the development context. There are hardly any impact studies on biogas or pico hydropower and very few studies that monitor the long-term effects of changes in access to energy sources.