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Productive use of energy – Pathway to development? Reviewing the outcomes and impacts of small-scale energy projects in the global south

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ABSTRACT

It is widely recognised that access to sustainable and affordable energy services is a crucial factor in reducing poverty and enhancing development. Accordingly, various positive effects beyond simple access to energy are associated with the implementation of sustainable energy projects. One of these assumed positive outcomes is the productive use of energy, which is expected to create value – for example in the form of increased local availability of goods or higher incomes – thereby having a positive impact on local livelihoods. Many projects and programmes are based on such expectations regarding the productive use of energy but systematic evidence of these outcomes and impacts is still limited. This study analyses the results of an impact evaluation of 30 small-scale energy development projects to better understand whether and how the supply of sustainable energy services supports productive use activities and whether these activities have the expected positive impacts on local livelihoods. A contribution analysis is applied to systematically evaluate the impact pathways for the productive use of energy. The results show that access to sustainable energy does not automatically result in productive activities and that energy is only one of the input factors required to foster socio-economic development. Furthermore, the results demonstrate that activities, materials and information to support the productive use of energy – such as training, equipment or market research – need to be an integrated part of the energy project itself to allow for productive activities to develop on a wider scale.

1. Introduction

Energy development projects are associated with various outcomes and impacts expected to improve the living conditions of the beneficiaries and ultimately lead to sustainable development. One of the assumed positive outcomes is the productive use of energy, which is expected to create value [1], for example in the form of increased income or reduced hardship [2,3], resulting in positive impacts on local livelihoods [1–3]. There are high expectations concerning the positive impacts of productive use activities triggered by access to energy or improved supply, but actual evidence of these impacts is scarce [2]. Rao [4] highlights that the understanding of the causal chains linking electricity supply and income benefits and the conditions that enable these causal links is still limited. Likewise, Kooijman-van Dijk [5] states that insights into the causality chain between energy supply and impacts on income generation are lacking in many macro-economic or micro-economic studies. An analysis by UNDP [6] asserts that although potential productive use is frequently reported, only a small number of people benefit from these activities. This is also supported by Brüderle et al. [7], who maintain that many energy access programmes in developing countries mention the productive use of energy as an intended outcome, but the level and pace of uptake of productive activities often falls short of these expectations.

Despite the sparse evidence, many government programmes and development projects are based on this assumed positive relationship between energy and productive activities which are expected to contribute to social and economic development [5,8]. Therefore, to improve future strategies and project designs, it is crucial to analyse more closely how and why energy development projects support productive use activities and whether these activities translate into positive development effects. Although it is important to provide evidence for both large and small-scale projects, larger projects are more regularly evaluated than small-scale energy projects (≤ 100 kW). Small-scale, local efforts often address under-served populations at the base of the pyramid [9], making it imperative to analyse how these types of projects can translate into positive livelihood impacts and support sustainable development at local level.

The research presented aims to address these questions and, by doing so, to contribute to strengthening the evidence base of the role of productive use activities in small-scale energy projects in developing

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countries. The analysis is based on the results of a systematic impact evaluation conducted in 2015 of 30 local development projects. This post-evaluation represents the second evaluation cycle of projects supported by the "WISIONS of sustainability" initiative.[1] Since 2004, WISIONS has supported 110 projects and capacity development activities responding to energy needs at local level via its Sustainable Energy Project Support (SEPS) scheme. The projects apply different technologies, use diverse energy sources and address different energy needs in distinctive geographical locations. By evaluating projects implemented within a common framework but in diverse contexts, this study aims to provide better insights into how the productive use of energy can be fostered and how it can contribute to achieving development impacts across project boundaries.

Consequently, the research questions this paper attempts to answer are: whether and how energy development projects lead to productive use activities; and whether these activities contribute to achieving development. To answer these questions the detailed research objectives are (a) to establish impact pathways for the productive use of energy and (b) to evaluate the links, assumptions and risks associated with these impact pathways, thereby (c) strengthening the evidence base and confidence level with regards to the anticipated positive effects of small-scale energy projects beyond simply providing access to sustainable energy.

2. Background: productive use of energy

The term "productive use of energy" was traditionally associated with impacts at macro-level measuring the economic impact of energy on gross domestic product (GDP) [10]. Focusing on the micro-level and reflecting the shift to measuring development against the MDGs and now the SDGs, the definition of "productive use of energy" has been adapted. In this paper, we generally follow Kapadia [11] who defines the term as "*utilization of energy – both electric, and non-electric energy in the forms of heat, or mechanical energy – for activities that enhance income and welfare.*"

This definition includes both electrical and mechanical power. This is important because although research into productive use activities often focuses on "electricity" [1], thermal and mechanical energy play an equally important role for productive uses, especially for the activities of people at the base of the economic pyramid (Table 1). Furthermore, this definition not only focuses on economic gain, such as income, but includes improvements to welfare. While the creation of economic value is an important impact, improvements to welfare in the form of freeing up time and reducing effort and labour are equally important – especially for the small-scale projects analysed in this study. However, it should be recognised that this definition implies that the productive use of energy automatically leads to income generation and/or improvements to welfare. While this should be the objective, these are exactly the type of assumed causal relationships for which there is still a lack of evidence and which need to be analysed in more detail.

Linked to the assumed economic benefits, it is also often assumed that the productive use of energy increases both the demand for energy and the ability to pay for it, which in turn contributes to the financial viability of the energy infrastructure implemented [5]. Productive activities are also assumed to increase the overall load factor as they often require energy during the day, while consumptive uses are concentrated in the evenings [12]. Although this makes sense in theory, little empirical evidence exists to underpin these assumptions and practical experiences have demonstrated that the ability of beneficiaries to repay or pay up front for technology costs is often overestimated. The IEA [13] special report on energy access states that the upfront technology costs have traditionally been a significant barrier to uptake in poor communities. Williams et al. [14] highlight the fact that the ability to pay varies between countries, regions and even within communities, and that poor farming households might not have a regular cash flow to pay for energy services.

Although this paper focuses on productive use, it is important to mention that the distinction between productive and consumptive use is not always straightforward, especially for small-scale projects addressing household energy needs [11]. A good example is a household which uses energy originally provided for consumption for productive use. Furthermore, it is important to bear in mind that although productive use activities are important, the benefits of energy consumption are often equally or more important to the beneficiaries [2]. In addition, investing in productive use activities may entail financial risks, such as debt for the beneficiaries, which need to be taken into consideration when planning these activities.

3. Materials and method

This study applies a theory-based evaluation approach to shed light on the causal links between access to sustainable energy solutions and the establishment and resulting benefits of productive activities.

3.1. Evaluation approach: contribution analysis

To answer the questions whether and how the analysed development projects lead to productive use activities and contribute to achieving development outcomes and impacts, it is necessary to draw causal links between observed changes and the intervention. To establish causality, this study applies a theory-based impact evaluation approach focusing on the question "how" an intervention caused intended effects by examining the causal chain from inputs to outcomes and impacts [15,16].

The applied contribution analysis approach, developed by Mayne [17,18], represents a systematic and structured evaluation approach for analysing and reporting data on impacts. The aim is not to measure the impacts, but to increase confidence in the likelihood that the intervention contributed to an outcome or impact [15]. To conduct a contribution analysis, Mayne [18] proposes six iterative steps[2]: (1) set out the cause-effect issue to be addressed; (2) develop a theory of change and identify risks; (3) gather evidence on the theory of change; (4) assemble and assess the contribution story and challenges to it; (5) gather additional evidence; (6) revise and strengthen the contribution story. However, as Mayne [18] points out, these steps can be modified in practical applications of the contribution analysis to fit the specific circumstances. In this study, we applied a four-step contribution analysis approach as presented in Fig. 1.

The first steps represent the conceptual part, which describes the contribution challenge and develops the theory of change (ToC). The ToC represents a logical model for an intervention, showing how outputs are expected to lead to a series of outcomes and impacts. The established ToC is then tested in the ensuing empirical section against the observed results, taking different sources of evidence and other influencing factors into account [18,20].

The existing literature provides some guidance and

[1] "WISIONS of sustainability" is an initiative by the Wuppertal Institute supported by the Swiss-based foundation ProEvolution. It was launched in 2004 to promote practical and sustainable energy projects. To ensure the sustainable character of the projects supported by the SEPS scheme, they are selected based on the following criteria: technical viability, economic feasibility, local and global environmental benefits, replicability and marketability, potential for poverty reduction, social equity and gender issues, local involvement and employment potential, sound implementation strategy and dissemination concept. For more detailed information on the programme, please visit the website www.wisions.net.

[2] For a more detailed description of the contribution analysis, please refer to Mayne [17,18,23,24].