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# Development aid and the diffusion of technology: Improved cookstoves in Kenya and Rwanda

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ABSTRACT

This paper analyses the role of official development assistance (ODA) in the evolution of Technological Innovation Systems (TISs) of improved cookstoves in Kenya and Rwanda. Functionally balanced TISs are central to the diffusion of new technologies and practices. We find that ODA has significantly influenced major innovation activities related to improved cookstoves in both Kenya and Rwanda over the last 30 years. However, donors' funding has been focused mainly on the development and diffusion of technical knowledge. We find that this pattern of ODA support has not fostered balanced and effective Technology Innovation Systems, and that this has contributed to the failure to achieve widespread diffusion of improved cookstoves. We develop a quasi-evolutionary model for the long-term and systematic ODA support of innovation systems to build sustainable renewable energy TISs in developing countries.

## 1. Introduction

Since the 1970s, international aid donors have made efforts to improve energy efficiency and energy access in developing countries. From the early 1970s to mid-1980s, an increasing amount of development assistance was channeled to energy in developing countries reaching over $6 billion in 1985 (Piebalgs, 2012). From the 1980s to the early 2000s, aid to energy declined to $3 billion, whereas recent trends show an increasing interest and reviving optimism in the donor community about support for the energy sector in developing countries. By 2010 the annual average aid commitment to energy has reached to about $10 billion (Piebalgs, 2012).

Although most official development assistance (ODA) is for large-scale electricity generation, it also includes the promotion of small-scale and decentralized energy technologies (e.g. biogas systems, photovoltaic and improved cookstoves) (Martinot et al., 2002). However, historically, the effectiveness of aid in achieving dissemination and use of small-scale renewable energy technologies in developing countries has been mixed at best (Kozloff, 1995; Martinot et al., 2002). A recent study of donor-funded projects in Philippines, for example, shows that while donors have played some beneficial roles, such as in policy advice, they have failed to meet stated objectives due to lack of coordination across interventions (Marquardt, 2015).

The major aim of this study is to explore the effectiveness of ODA in promoting energy efficient technologies. We define ODA broadly as all types of contributions from development partners, such as multilateral organizations, international aid donors, local and international non-governmental organizations (NGOs) and international research institutes for the development, adaptation, diffusion and use of energy efficient technologies. The role of ODA on development more broadly has been discussed by other authors, such as Easterly (2006) and Moyo (2009). Here we only focus on highlighting the role of ODA in promoting energy efficiency through the development and diffusion of improved cooking technologies in two developing countries.

Improving the effectiveness of aid to energy gained a central place in aid policy debates in the 1990s.[1] This resulted in changes in support for renewable energy technology through development aid. More recently, there has been a focus on market and enterprise development, in which donors share risks and costs of sustainable energy technologies (Piebalgs, 2012). While the new paradigm endorses a market-oriented approach, with importance placed on the role of the private sector (Piebalgs, 2012; Kindornay and Reilly-King, 2013), it has not, in

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[1] The early policy efforts of improving aid effectiveness can be traced back to a statement by Organization for Economic Co-operation and Development-Development Assistance Committee (OECD-DAC) in 1995. The 2005 Paris Declaration and the 2008 Accra Agenda for Action and the Millennium Development Goals (MDGs) are among the recent commitments of developed and developing countries to improve the effectiveness of aid (Kindornay and Reilly-King, 2013).

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most cases, achieved breakthroughs in the market penetration of new energy technologies. This is mainly because the full range of institutions, capabilities and activities leading to the absorption and diffusion of technologies are generally fragmented or absent in least-developed country contexts.

Over the last decade, a growing body of research has suggested that absorptive capacity for low carbon technologies can be developed by facilitating a comprehensive approach to the emergence, growth and functioning of innovation systems (see e.g. Sagar and Holdren, 2002; Bruggink, 2012). Yet, little research has investigated what role development aid has played and can play in the evolution of innovation systems of renewable energy technologies in least-developed countries. Building on earlier empirical analyses of the evolution of biogas and improved cookstove Technological Innovation Systems (TISs) in in East Africa (reported in Tigabu et al., 2013, 2015a, 2015b), this paper analyses the role of development aid in the evolution of improved cookstove innovation systems in Kenya and Rwanda. Building on this historical analysis, it develops a conceptual proposal for effective aid interventions which aim at supporting innovation systems for renewable energy in developing countries.

The paper is organized as follows. Section 2 presents an overview of changing technology diffusion perspectives and how this has influenced aid strategies in developing countries, particularly in the rural renewable energy sector. It sets out the link between innovation systems, absorptive capacity and technology diffusion, and goes on to argue that public policy, including development aid, should be directed at creating an enabling framework for greater diffusion of renewable energy technologies. Such enabling frameworks include specific conditions and policies that accelerate diffusion of renewable energy technologies (see Haselip et al. (2011) for more on the concept with case studies). Sections 3 and 4 present a brief overview of Technological Innovation Systems approach and the methodology used in this study. Section 5 analyses the role of ODA in the functional evolution and accumulation of improved cookstove technology innovation systems (TIS) in Kenya and Rwanda over periods going back to the 1950s. Section 6 presents a conceptual proposal for sustainable energy aid intervention from a TIS perspective, and Section 7 presents concluding remarks.

## 2. Historical overview on perspectives of technology diffusion and development aid in developing countries

Supporting the diffusion of technologies in developing countries has been among the areas that donors and non-governmental organizations (NGOs) have focused on since the 1960s. Finding a feasible approach to support technology diffusion and adoption has therefore been a crucial question. In this section, we summarize changing donor approaches to the diffusion of energy technologies.

Diffusion of technologies in rural areas of developing countries caught the attention of social researchers in the 1960s, inspired by an emphasis placed on technology transfer by international development assistance organizations to alleviate poverty (Ruttan, 1996). During this period, most diffusion studies (mostly in agricultural sector) focussed at identifying variables (e.g. socio-economic and behavioral traits) related to 'innovativeness' of individuals and understanding the role of communication channels at various stages in the innovation-decision process (Rogers, 1995).

This early perspective was criticised for its failure to take into account the characteristics of technologies. Beginning in the 1970s, a shift in perspective took place, characterized by an emphasis on attributes of technologies in relation to the social, economical and cultural attributes of adopters (Barnett, 1990). This approach, associated with the Appropriate Technology Movement, built on the view that adoption of technologies was linked to the modification of technologies to developing country contexts and users' needs (Bonair et al., 1989). In this approach, designing technologies fitted to specific contexts of technology adopters was considered crucial to their successful adoption and utilization. Appropriate technologies were characterized as being small, simple, labor-intensive, energy efficient, and environmentally sound (Akubue, 2000). The appropriate technology approach focused on supporting people in rural areas to apply indigenous knowledge, through training and capacity building, to produce 'backyard' technology on one hand, while deploying cheaper and simple technologies suitable for village-level uses on the other. There was little commercial focus (Kaplinsky, 2011).

Lessons from project implementation further emphasized the need for users to participate in the design and testing of 'appropriate' technologies (Gamser, 1988). Gender issues were emphasized, with women given roles as designers and beneficiaries in development projects (State and Mavima, 1996). In the rural energy sector, donor interventions at this time largely followed a technology-focused and project-based approach in which the aim was to identify and promote the 'right' energy technologies, including free provision of equipment (Kozloff, 1995; Martinot et al., 2002). Such interventions were generally considered to be ineffective in practice. In their review of the historical role of donor interventions, Martinot et al. (2002: 313) noted that "... much of the development assistance, particularly aid for rural areas, focused on technical demonstrations or on projects that were narrowly self-sustaining but could not be replicated. Projects often did not demonstrate institutional and commercial viability, and lacked mechanisms for equipment maintenance, sustainable sources of credit and expertise, and incentive structures for sustained operating performance."

Recent research on the diffusion of renewable energy technologies in least-developed countries suggests that elements of these approaches persist in international policy. Econometric models point to household socio-economic characteristics, technological attributes, and communication and institutional incentives as the main explanatory factors of adoption decisions by beneficiaries (see e.g. Walekhwa et al., 2009; Gebreegziabher et al., 2012).

The paradigm guiding donor policies however has changed its emphasis from technology-focused to market-oriented approaches. This change has been characterized by a focus on the private sector and entrepreneurship in which donors aim to fill financial, technical and regulatory gaps in the promotion of energy and environmental technologies (Martinot et al., 2002; Kindornay and Reilly-King, 2013). Recent attention to the business value of the 'base of the economic pyramid' (BOP) (4 billion low-income people with an aggregate market potential of $ 5 trillion) to transnational corporations (TNCs) (Prahalad and Hart, 2002; Hammond et al., 2007) has also had an influence. Most donors follow 'neo-liberal' strategies to catalyse private sector development, with a limited role for the state (government) of recipient countries (Kindornay and Reilly-King, 2013). Neoliberalism policies have been followed by many developing countries, although some countries have undertaken post-neoliberal market re-reforms, moving away from market policy prescriptions (see Haselip and Potter (2010) for the case of Argentina). Market-based mechanisms have also influenced technology transfer perspectives within climate change negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) (Haselip et al., 2015a).

On the other hand, since the early 1990s, new insights into the diffusion of energy technologies in developing countries have been suggested (see e.g. Barnett, 1990; Bhatia, 1990). These studies view adoption and diffusion of renewable energy technologies from a wider perspective, including the importance of user capabilities, the market and regulatory context, interactions among users, producers and other actors, and market preferences as determining factors. Such insights