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The impact of a household biogas programme on energy use and expenditure in East Java

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ABSTRACT

Biogas has been promoted as a renewable, cleaner and cheaper energy source. While there are several initiatives promoting the use of biogas, credible analyses of its effects on the use of alternative energy sources and energy related expenditure are limited. This study uses panel data from households engaged in dairy farming in rural East Java to assess the impact of a household level programme, which promotes the construction of digesters that produce biogas, on energy use and expenditures. Both a difference-in-difference analysis and a pipeline comparison show that the use of digesters leads to a sharp reduction in energy related expenditures and a reduction in the use of firewood and liquefied petroleum gas. However, without subsidies, the payback period of between 11 and 14 years, albeit based only on reductions in energy costs accruing from investing in a digester, is perhaps too long to justify the investment.

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1. Introduction

In a number of developing countries, biogas has been promoted as a renewable, cleaner and cheaper energy source, especially for cooking, as compared to alternatives such as firewood and kerosene. For instance, countries such as China and India have a long history of promoting biogas. However, it is only in the last twenty five years that household level biogas programmes, which promote construction of digesters or tanks which convert organic waste into biogas, have spread across the globe.[1] According to Rakotojaona (2013), >250,000 digesters have been installed in Nepal since 1992 and about 125,000 in Vietnam in 2003. Other Asian countries with household biogas programmes include Cambodia and Bangladesh which launched their biogas programmes in 2006 and most recently, Pakistan and Indonesia in 2009.[2]

In the Indonesian context, while a majority of the population has access to electricity for lighting, biomass, mainly wood, remains an important energy source for cooking (see Table 1). At the national level, in 2011, for 40% of Indonesian households, firewood was their primary cooking fuel, while in East Java, 43% of households relied mainly on firewood for cooking and about 52% used liquefied petroleum gas (LPG). The substantial use of LPG is relatively new and is a consequence of the country's large-scale kerosene to LPG conversion programme (2007–2012) which was motivated by a desire to reduce the budgetary burden of the kerosene subsidy.[3] Despite the conversion programme and other reforms which have reduced the subsidy burden, the growth in energy demand combined with declining domestic production and an increase in fuel imports continues to ensure that subsidies for oil-based fuels remain a large burden on the budget (see Asian Development

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[1] The main element of a biogas digester is a tank in which bacteria converts organic waste into biogas through a process of anaerobic digestion.

[2] A number of African countries have also launched household biogas programmes. Rwanda launched its national domestic biogas programme in 2007, followed by Cameroon, Ethiopia, Kenya, Tanzania and Uganda in 2009 and Burkina Faso, Benin and Senegal in 2010. See Hessen (2014) for details.

[3] Based on the view that ensuring access to energy is the responsibility of the state, the Indonesian government provides energy at subsidized prices to its citizens. Between 2001 and 2008, energy subsidies accounted for 9 to 18% of total public expenditure. In 2006, before the launch of the kerosene to LPG conversion programme, kerosene accounted for 57% of the total subsidy for petroleum products or about USD 3.64 billion (see PT Pertamina and WLPGA, 2012).

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Table 1
Access to electricity and energy for cooking in sampled districts in East Java, in percent.

	Sampled districts	East Java	National
Use electricity for lighting (%)	99.24	99.49	95.43
Primary energy source for cooking (%)			
Electricity	0.85	0.90	0.98
LPG	52.28	51.67	46.78
Kerosene	1.30	3.55	11.18
Firewood	44.92	43.09	39.60
Other	0.64	0.80	1.48

Source: Indonesian Socioeconomic survey 2011, own computation.

Bank, 2015; International Institute for Sustainable Development, 2011).[4]

At the same time as attempting to reduce the subsidy burden through the conversion programme the government passed a number of decrees and acts which recognized the importance of promoting and developing alternative energy sources and technologies, both from an environmental and a budgetary perspective (see SNV, 2009). Specifically, a presidential decree (No.5/2006) on National Energy Policy released in January 2006 stated the government's goal of ensuring security of energy supply by reducing the share of oil-based fuels in the country's energy mix from 51% in 2006 to 20% in 2025, primarily by increasing the share of renewable energy.

Specifically with regard to biogas, mainly due to the widespread availability of firewood and heavy subsidies for kerosene, its use in Indonesia has been limited. However, since 2005, following the reduction of kerosene subsidies and consistent with the National Energy Policy of reducing reliance on oil-based fuels, various institutions and organizations began developing activities to disseminate manure fed biogas digesters. By the end of 2009, through fifteen initiatives about 6000 digesters had been installed for domestic use (SNV, 2009). To consolidate these scattered efforts and to boost the spread of biogas, in 2009, the Indonesian government launched a Household Biogas Program (*Programme Biogas Rumah* – BIRU). The key objective of the programme was to install 8000 digesters by 2012 in rural dairy farming households located in eight provinces. The focus of the program was on East Java. The program operates through dairy cooperatives and is voluntary. Dairy farmers who fulfil eligibility conditions such as ownership of at least two cows and who have an established record of delivering milk to a cooperative are offered a chance to purchase a digester. An innovative aspect of the BIRU program is its co-operation with international companies, which makes it easier for dairy farmers to access credit.

Similar to biogas programs in other countries, the expectation is that the use of biogas will generate immediate benefits by reducing the use of traditional fuels and energy-related expenditures, as well as lead to time-savings due to a reduction in time spent gathering wood. Longer-term benefits include enhanced agricultural productivity due to the use of bio-slurry, a by-product of biogas production which may be used as a fertiliser, improvements in indoor air quality and subsequent health benefits. Despite these expectations and the large number of initiatives in a number of Asian and African countries (see Rakotojaona, 2013; Hessen, 2014), credible evidence on the actual impacts of such household biogas programs on short-term outcomes such as use of traditional fuels and energy-related expenditures as well on longer-term outcomes such as agricultural productivity and health outcomes is limited. The bulk of the evidence is based on either before-after comparisons or single-period comparisons between households with and without a digester.

For instance, based on a before-after comparison of a sample of 461 biogas users in Nepal, Katuwal and Bohara (2009) report a 53% reduction in the use of firewood and an 81% reduction in the time spent collecting firewood. Employing a similar approach but working with a sample of only 12 users, Garfí et al. (2012) report a 50 to 60% reduction in the use of firewood. Despite these effects, the lack of a control group hampers the credibility of the analysis.

Alternatively, based on single-period comparisons between 615 biogas users and 740 non-users drawn from 133 villages, a study of India's National Biogas Development Project (Program Evaluation Organisation, 2002) found that a majority of digesters (55%) were not operational. Nevertheless, user households reduced their monthly consumption of firewood by 10 kg. Based on data from three villages in Western China in 2006 (239 households; 183 users and 56 non-users), Groenendaal and Gehua (2010) concluded that despite working with a sample of relatively long-term digester users the many benefits attributed to the use of digesters had only partly been realized, if at all. For most of the outcomes there were no statistically significant differences between users and non-users. In both these studies the approach used to determine the control group was not clear and assessments were based on differences in means, without controlling for variables which might influence both uptake of digesters and outcomes.[5]

A perhaps more rigorous assessment of the effect of a biogas initiative, Rwanda's National Domestic Biogas Program (NDBP), is provided by Bedi et al. (2015). While their study also uses cross-section data and compares outcomes for users and non-users, the non-users were selected from a list of "potential applicants" that is, those who had shown an interest in purchasing a digester and at the same time the non-users needed to fulfil the most important eligibility condition to become a user, that is, own at least two cows. Their multivariate analysis showed that owning a digester was associated with a 31 to 32% reduction in annual energy expenditure and a five kilogram or 34% reduction in daily consumption of firewood. At the same time they reported that about 10% of the supposedly completed digesters were producing no gas, and that the cost of installing a digester was prohibitive leading to a large gap between the number of digesters that were expected to be set up (15,000) and the number that were actually installed (1800).

The aim of this paper, which focuses on dairy farmers in East Java, is to examine the impact of Indonesia's Household Biogas Program (BIRU) on two main outcomes, that is, fuel use - whether access to digesters leads to reductions in the use of an oil-based fuel - liquefied petroleum gas and the use of a traditional fuel - wood, and whether it leads to a decline in energy-related expenditure. In order to assess the viability of the intervention we provide an exploratory payback analysis. Methodologically, the paper extends the literature by using multiple evaluation strategies and providing estimates based on both cross-section and panel data. In doing so, we attempt to place the literature on the effects of household biogas initiatives on a stronger empirical footing.

The paper is structured as follows. Section 2 contains a description of the program. Section 3 outlines the empirical approach, Section 4 lays out the sampling strategy and discusses the data and descriptive statistics. Section 5 discusses the findings and presents a payback analysis while Section 6 concludes.

[4] The conversion programme was rolled out successfully and by 2009 large parts of the country including all of East Java had been covered by the programme. With regard to the subsidy, in 2011, the kerosene subsidy amounted to USD 1 billion while the LPG subsidy amounted to USD 2.11 billion.

[5] Laramee and Davis (2013) work with a small sample of 40 households (20 users and 20 non-users) and conclude that in Tanzania, biogas almost completely replaces the use of firewood and kerosene. While the effects in this case are in marked contrast to the papers on India and China, the estimates are based on a much smaller sample and the control group was identified by asking user households to nominate a control rather than through an objective approach.

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