Impact Evaluation of the Indonesia Domestic Biogas Programme

A Baseline Report

Arjun Bedi[b1], Gunther Bensch[a], Rebecca Niemann[a], Jörg Peters[a],

Robert Sparrow[b] and Luca Tasciotti[b]

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This baseline report is part of an evaluation commissioned by the Policy and Operations Evaluation Department (IOB) of the Netherlands Ministry of Foreign Affairs. It belongs to a series of impact evaluations of renewable energy and development programmes supported by the Netherlands, with a focus on the medium and long term effects of these programmes on end-users or final beneficiaries. A characteristic of these studies is the use of mixed methods with the aim of gaining insights on the magnitude of the effects of the programme. The purpose of the impact evaluations is to account for assistance provided and to create the possibility to draw lessons from the findings for the improvement of policy and policy implementation. The results of these impact evaluations will be used to provide input to a policy evaluation of the "Promoting Renewable Energy Programme" (PREP) to be concluded in 2014.

[a] Rheinisch-Westfälisches Institut für Wirtschaftsforschung, Essen, Germany. [b] International Institute of Social Studies, Erasmus University, Rotterdam, The Netherlands.

[1] Corresponding author: Arjun Bedi, International Institute of Social Studies, Erasmus University Rotterdam, Kortenaerkade 12, 2518 AX The Hague, The Netherlands, Phone: +31-70-4260 493, E-mail: bedi@iss.nl. We would like to thank Ralf Kossmann for his help in the preparation of graphs and tables.

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1. Introduction

This report presents the baseline survey results for the impact study of the BIRU programme. BIRU (*Program Biogas Rumah* – Household Biogas Programme) is a programme designed to facilitate household access to biogas in Indonesia and is supported by the Dutch Ministry of Foreign Affairs. It is managed and implemented by the Dutch development organisation Hivos with the technical assistance of the SNV Netherlands Development Organisation and in cooperation with Indonesian stakeholders. The BIRU programme provides digesters to rural households in Java, Bali, Lombok, and South Sulawesi. The objective is to disseminate 8,000 digesters by the end of 2012 and to generate benefits to farm households in the form of monetary and time savings, increased agricultural output as well as better health conditions.

This baseline report is part of an evaluation study that has been commissioned by the Policy and Evaluation Department of the Dutch Ministry of Foreign Affairs (IOB). The purpose of the study is to measure the impact of the BIRU programme on various socio-economic outcomes. The impact evaluation relies on both quantitative household survey data and qualitative information. The baseline survey was conducted in May and June 2011 in one of the BIRU target areas in East Java province. This is the region where the programme is most active and accounted for, in May 2011, 75 percent of the digesters that have been disseminated by BIRU. This report provides an account of the information obtained from the baseline survey and focuses on farm household specific socio-economic characteristics and energy related issues. These data constitute the benchmark against which the follow-up data to be collected in 2012 will be compared. Additionally, in order to account for the potentially different programme set-up in other target areas of the programme, the study addresses BIRU activities on the island of Lombok using a qualitative approach. This allows us to gain insights on differences in the geographical, institutional, and operational context.

The report is structured as follows. Section 2 describes the BIRU programme and the context in which it operates. Section 3 sets out the methodology and describes the survey tools and sampling design. Section 4 assesses the quality of the collected data, and presents information regarding household structure, dairy farming, and energy use. The qualitative analysis of the biogas programme on the island of Lombok is presented in Section 5. Section 6 concludes the report.

2. The intervention and the context

2.1. Description of the BIRU intervention

The BIRU biogas programme started its activities in 2009. By the end of 2012, it is expected to disseminate about 8,000 biogas digesters (see Table 1). Although the programme had a slow start, initially failing to achieve its targets for 2009, it has picked up momentum. By May 2011 the target for 2011 had already been achieved, with over 2,700 installed digesters and over 900 applicants awaiting construction of a digester.

In May 2009, after the completion of feasibility studies in several districts, sub-districts in three districts were selected for programme roll out: Bandung (Western Java), Yogyakarta (Central Java), and Malang (Eastern Java) (see BIRU 2011). The dissemination of digesters is ongoing in these districts and digesters are installed on a regular basis. Beyond Java, the programme is also being implemented in Lombok, Bali, and South Sulawesi, where activities started in the second half of 2010.

Table 1: Target figures for biogas digesters to be disseminated

Year	2009	2010	2011	2012	Total
Number of sold digesters	150	1,150	2,600	4,100	8,000

Source: BIRU (2011)

The main intermediaries in the BIRU programme are so-called Construction Partner Organizations (CPOs) and biogas supervisors. The CPOs are operated by one or several cooperatives or by local NGOs. On the island of Java, the programme focuses on dairy farmers, as this sector has a large production potential for biogas. Thus, dairy cooperatives are a pivotal partner in the BIRU programme and help disseminate the biogas concept among dairy farmers.[2] The BIRU CPOs raise awareness about the BIRU biogas digesters among their members in their regular meetings or in special gatherings explicitly for the purpose of discussing the digesters. If members show interest, the CPO carries out a farm eligibility assessment of the farm, which is based on criteria such as having at least two cows, a positive cash flow from milk revenues supplied to the cooperative, and the farmer's debt history. In addition, the CPO verifies whether the farm plot is large enough to install a digester. If the farmer qualifies, financial arrangements are negotiated and subsequently masons especially trained by BIRU are deployed to construct the digesters.[3] After the digester has been installed, the mason fills a completion report, which is submitted to BIRU. BIRU's quality assurance agent in the respective district controls the quality of the work delivered. Users are trained on the proper usage of digesters through targeted training provided by BIRU. They receive a user manual and a mason is present during initial plant feeding.

The total investment costs per digester may amount to € 550-600, depending on the size. The programme provides a subsidy of € 160. The remainder is paid by the farmer, usually through a loan obtained from credit schemes offered by the cooperative. The instalments are financed by deductions from the payments the farmer receives for the delivery of milk. Interest rates differ across cooperatives, depending on the source of the loan. A range of partners have made resources available for the credit schemes, and while there is no interest on the loans provided by Nestlé, other partners such as Rabobank or Bank Syariah Mandiri (BSM) charge interest rates of 8 to 16 percent. Repayment rates are reported to be very high.

2.2. Regional context

Indonesia, with a population of 222 million people, is the fourth most populated country in the world. Administratively, Indonesia consists of 33 provinces, five of which have special autonomy

[2] Traditionally, milk production has never been a prominent business in Indonesia. However, due to substantial economic growth in recent years, multinationals have started to produce powdered milk and other dairy products locally. Production is sourced mainly through dairy farmers organized in cooperatives.

[3] By October 2010, around 200 masons had been trained. The intention is that the training will be taken over by local institutions, such as technical and vocational schools. BIRU strives to include biogas digester-technology into the curricula of these schools. The purpose is to not only build up demand for biogas, but also to ensure the supply of properly installed digesters and their maintenance.

status. The provinces are subdivided into rural districts (*kabupaten*) and municipalities (*kotamadya*), which are further divided into subdistricts (*kecamatan*), and villages and urban precincts (*desa* or *kelurahan*, respectively).

The study area consists of five rural districts located in the province of East Java, which is the most populated province of the country, with a population of 36 million people and slightly less than 10 million households. Although Java in its entirety is the most developed region of Indonesia, East Java is a fairly poor province and was ranked 18th out of 33 Indonesian provinces in the 2009 HDI ranking and 8th in terms of the MDG-Index ranking (BPS 2009, UNNDPA 2007). The Indonesian Socioeconomic Survey 2008 shows that agriculture is the main activity in East Java, with 38 percent of the active labour force engaged in agricultural activities (Table 2), which is slightly higher than the national average. In particular the poorer households in the study area are more likely to be farmers (43 percent). The occupational structure in the study area is quite similar to the rest of East Java and is comparable to the national occupational distribution.

Table 2 shows that the literacy rate of around 90 percent among adults in East Java is also very similar to the Indonesian average. However, the level of education is relatively low compared to the national average. The differences are particularly pronounced at the senior secondary and higher levels of education. Within the study area there are large differences in educational attainment between the bottom and top 50 percent, with the first group clearly showing a higher level of education.

Table 2: Socio-economic and labour market characteristics in the sampled districts in East Java

Socio-economic group	Sampled districts			East Java	National
	Total	Bottom 50%	Top 50%		
Agricultural sector	38.41	42.91	25.39	38.42	35.84
Self-employed without workers	16.38	15.97	17.58	17.73	20.06
Self-employed with workers	19.32	18.10	22.85	18.96	17.69
Workers/employees	33.07	30.98	39.08	33.84	35.69
Free lance	15.96	19.21	6.60	13.24	10.87
Unpaid workers	15.26	15.74	13.89	16.24	15.69
Inactive	25.48	25.34	25.88	25.47	27.49
Education level					
No primary school completed	27.81	30.92	18.47	27.65	24.79
Primary school	34.07	36.81	25.85	31.93	28.87
Junior secondary school	18.14	16.89	21.91	16.44	16.75
Senior secondary school	11.69	8.88	20.14	14.67	17.18
Higher	8.29	6.51	13.64	9.32	12.42
Literacy	89.64	88.16	94.09	86.48	91.56

Notes: Labour market characteristics relate to the age group 16-60 years, while education attainment and literacy is reported for individuals aged 18 and older. Inactivity is defined as adults aged 16-60 years who are not working, looking for work or temporarily not working but otherwise do work. The bottom/top 50% refers to the position in the distribution of total household expenditure per capita.
Source: Own computations based on Indonesian Socioeconomic survey 2008.

2.3. Energy Sector

Indonesia lags behind most other Asian countries in terms of its electrification rate and even when compared to other less developed economies. For 2009, the electrification rate in Indonesia was 64 percent, compared to 90 percent in the Philippines, 77 percent in Sri Lanka and 75 percent in India (IEA 2011). At the moment the energy sector in Indonesia faces supply constraints as the demand for energy was expected to grow at six percent per year between 2004 and 2012 and since the government plans to further increase the electrification rate with rural areas and the eastern part of Indonesia representing the main target regions; power supply shortages have already begun to show in areas outside Java and Bali (IEA 2008). International investors, who are needed to fill the substantial funding gap, have been reluctant to invest due to a less than attractive investment climate resulting from legal risks, subsidised pricing, unclear tendering processes and a lack of transparency, among other factors (IEA 2008).

While the energy sector accounts for nearly 30 percent of total Indonesian exports (IEA 2008) and generates substantial revenues for local and national government, large scale national energy subsidies are a burden on the government's budget. In the 2008 national budget, an amount of approximately USD 13.5 billion was allocated to fuel subsidies with the subsidy for kerosene accounting for about USD 3.2 billion (SNV 2009). Over the last decade, subsidies have been reduced, leading to price hikes. At the same time, to encourage the use of a more efficient fuel, a kerosene-to-LPG conversion programme was launched in 2007. Since then, kerosene subsidies have been significantly reduced but have been replaced by subsidies for LPG (for details see Beaton and Lontoh, 2010).

Although the majority of the population does have access to electricity for lighting, biomass – mostly wood – still represents the primary source of energy for cooking (Table 3). Approximately 48 percent of Indonesian households and around 55 percent of households in East Java use firewood as a primary cooking fuel. The use of kerosene and LPG is also quite widespread with more than 42 percent of households using these fuel sources in East Java. In light of the relative abundance of firewood at no cost, the share of charcoal lies below 1 percent.

Table 3: Access to electricity and energy for cooking in sampled districts in East Java, in percent

	Sampled districts	East Java	National
Use electricity for lighting	99.41	98.64	92.71
Energy source for cooking			
Electricity	1.08	0.71	0.86
LPG	10.2	15.68	19.48
Kerosene	21.36	27.2	30.7
Charcoal	0.46	0.41	0.86
Firewood	66.65	55.45	47.57
Other	0.25	0.55	0.54

Source: Indonesian Socioeconomic survey 2008, own computation.

Table 4: Socio-economic structure and monthly energy expenditure in sampled districts in East Java, in thousands of Indonesian Rupiah

Type of expenditure	Sampled districts			East Java	National
	Total	Bottom 50%	Top 50%		
Household expenditure	1,246	994	2,043	1,479	1,958
Household energy expenditure					
Electricity	30	25	44	40	49
LPG	4	2	10	7	9
City gas	0.1	0.1	0.2	0.3	0.3
Kerosene	20	18	29	25	29
Total expenditure for energy	55	45	84	73	89
Share energy expenditure	4.4%	4.6%	4.1%	4.9%	4.5%
Per capita expenditure	303	229	537	356	437
Per capita energy expenditure	14	11	23	18	20
Household size	4.31	4.44	3.88	4.31	4.65

Notes: The bottom/top 50% refers to the position in the distribution of total household expenditure per capita.
Source: Own computations based on Indonesian Socioeconomic survey 2008.

Table 4 shows household expenditures for energy. As displayed, households in Indonesia spend between four and five percent of their budget on energy.[4] Electricity, mainly used for lighting purposes, is the most important item, accounting for more than 50 percent of the total energy expenditure. The second most important item with a share of 33 percent is kerosene, which is used both for lighting and cooking purposes. The energy share of total expenditures is only slightly higher in the bottom 50 percent of the income distribution compared to the top 50 percent. However, in absolute per capita terms, energy expenditures for the top 50 percent of the population in the sampled districts are more than twice as high compared to the bottom 50 percent.

In recent years, due to the expected increase in energy demand and the associated environmental costs, promoting efficient use of energy and developing alternative energy sources and technologies has become a policy priority.[5] In particular, with regard to biogas, although knowledge of the energy potential of biogas is not new, dissemination of this technology proceeded quite slowly until 2000. Firewood was freely available and kerosene was still heavily subsidised, factors which hindered

[4] Bacon et al. (2010) provide information on energy expenditure from a range of developing countries including Indonesia. Household expenditure on modern energy in Indonesia is higher than in India and Pakistan but lower as compared to Vietnam and Thailand.

[5] See, for example, the Indonesian Economic Development Masterplan MP3EI (Ministry For Economic Affairs, 2011).

investments in biogas. After kerosene prices increased in 2002, various institutions and organizations began developing activities to disseminate biogas digesters. Most prominently, in order to promote the use of renewable cooking fuels and to reduce the consumption of kerosene and wood the Indonesian government launched a national biogas programme in 2006 through BATAMAS (Community Livestock Biogas Programme) and Rural Bio-Energy Programme.[6] Through this programme, at the end of 2007, almost a thousand units had been installed involving 1,693 families spread over 121 districts in 26 provinces (SNV, 2009). Other prominent initiatives include the development and installation of digesters by Padjajaran University, a biogas programme implemented by the Department of Agriculture and a programme implemented by LIPI, the Indonesian Institute of Science. In total, at the end of 2009, through fifteen initiatives about 6,000 digesters had been installed for domestic use (SNV, 2009). The principal problems of the biogas sector seem to be the lack of standardization and lack of information on uptake and use of biogas as the various initiatives tend to operate in isolation.

In this context, the BIRU programme with its envisaged output of 8,000 digesters in 6 provinces is clearly designed to provide a large fillip to the use of biogas in Indonesia. The innovative aspects of the BIRU programme are its co-operation with international private sector dairy companies (for example, Friesland-Campina and Nestle), which makes it easier for (dairy) farmers to access credit, training of masons and provisions for quality control.

3. Methodology/Evaluation Approach

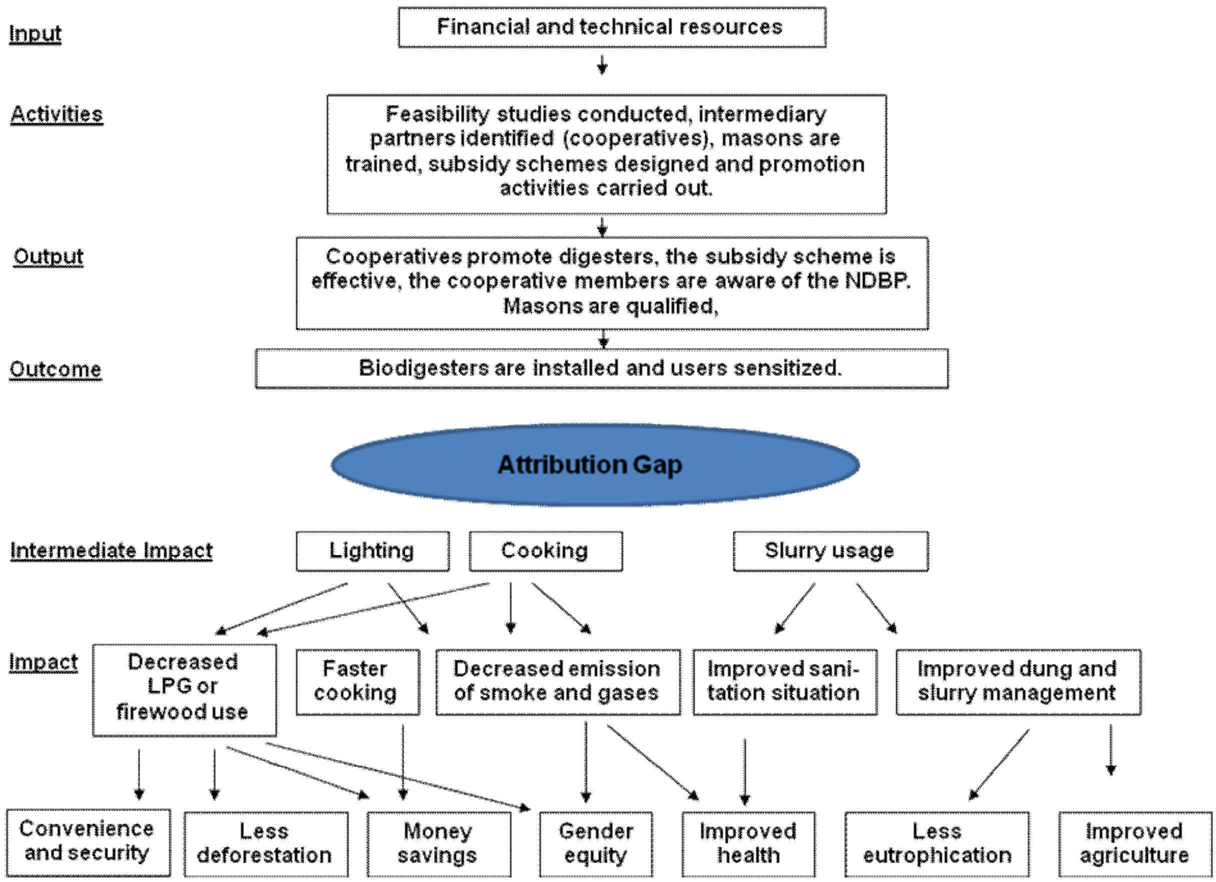
3.1. Evaluation objective

The objective of the study is to measure the effects of the BIRU biogas programme on a selection of socio-economic, health and farm specific indicators. The expected impacts of the intervention are health effects, savings in cash outlay (in case LPG is displaced), convenience (the biogas is directly "delivered" to the kitchen through a pipe instead of an LPG bottle that has to be replaced), time savings in case firewood is replaced, reduction in deforestation pressures, and higher security (occasionally, LPG causes explosions mainly due to inadequate connections).

In addition, it is expected that the programme will lead to greater use of (residual slurry) dung as a fertilizer. At the moment, some farmers directly use dung as a fertiliser, while others do not use it at all. In both cases, it flows – in part or its residuals – into the subsoil and groundwater as well as into natural streams and may lead to both environmental and health hazards. In contrast, biogas digesters produce nutrient rich slurry as a by-product which may be used as a fertilizer. Thereby, the use of biogas digesters might contribute to a reduction of environmental risks. Figure 1 provides a depiction of the intervention and the results chain.

[6] This programme promoted the use of three types of plants for household use: 'Masonry fixed dome' for communal use (10, 25, 50 and 100 cubic meters); plastic bag (9 cubic meters) and glass-fiber fixed dome (from 5 to 10 cubic meters).

Figure 1: BIRU biogas results chain



Source: Own illustration

The evaluation of the digester programme will address the following research questions:

Output:

- Which socio-economic groups have applied for a digester?
- Have households made use of credit schemes or other loans to obtain a digester? What percentage of the total investment cost was financed through such means?
- Were users properly informed on how to use the digester (e.g. plant initial feeding, presence of user manual)?
- How many of the applicants (or actual biogas users) were using LPG, kerosene, electricity or firewood prior to the intervention?

Outcomes:

- As compared to the applicants, which socio-economic groups obtained digesters?
- Which household member/s decided on purchasing a digester, disaggregated by gender?
- How reliable is the gas supply?
- How many digesters have been installed and how many are being used?

Impacts:

- To what extent have the installed biogas plants actually been used for gas production? If they are not being used, why?
- Which expenditures did the household reduce in order to finance investment in the digester?
- For what purposes is biogas used (cooking, lighting, other)?
- What is the relative share of the various sources of energy for cooking and lighting? (biogas, LPG, kerosene, electricity, candles, charcoal, firewood, others)?
- To what extent are traditional stoves still used?
- How much is saved in total (per week or month) on 'traditional' energy sources (LPG, kerosene, firewood, candles)? How have expenditures for energy changed over time?
- How have cooking and lighting habits changed due to the use of biogas?
- Has there been any change in time/ workload, disaggregated by gender?
- For what purposes has the saved time been used, disaggregated by gender?
- To what extent did indoor air pollution reduce (perception of users only)?
- To what extent have health conditions (in particular respiratory illnesses) changed, specifically among women and children?
- Does the household use the slurry as fertiliser? How did the households use/dispose the dung before the intervention?
- What is the effect of digester slurry on agriculture (use and sale of fertiliser, expenditure on fertiliser, frequency of manure collection, crop yields)?
- To what extent has comfort/convenience changed, disaggregated by gender? What monetary value do households attribute to this increased convenience?
- To what extent have activities during evenings changed due to improved lighting usage? Have study hours/reading time of children changed?
- Have additional jobs been created in the biogas business sector (contractors, masons, input supply), disaggregated by gender?
- Has the availability of biogas triggered new economic activities or displaced old ones?
- What (if any) are the un-intended or negative impacts?
- Are there more or less accidents (explosions etc.) as compared to LPG usage?

Sustainability:

- Notwithstanding the short experience with the HIVOS-SNV biogas installations, what observations can be made about the technical sustainability of the equipment, for example when it comes to availability of materials for repairs, special cooking and lighting equipment?
- What is the financial sustainability of the BIRU programme from a) the perspective of the biogas client; b) from the perspective of the mason and small construction enterprises that install and maintain the biogas installations and c) from the perspective of a public sector support programme as far as it concerns the incentives, the advertisement and other dissemination activities.
- To what extent do the biogas installations exert an influence on environmental sustainability?

3.2. Identification strategy

The key challenge of the impact evaluation is to identify to what extent changes in indicators of interest can be attributed to the BIRU programme. This is not straightforward, as there may be systematic differences between participating and non-participating farmers, which are not brought about by the programme and thereby confound our impact estimates. First, there is an element of self-selection, as dairy farmers need to take the initiative to apply. This application decision may be partly determined by the financial commitment and the potential future benefits of installing a biogas digester, as perceived by the farmer. Hence, the (latent) ability and productivity of the farmers as well as their risk taking behaviour may affect the probability that farmers apply. At the same time, these factors could also affect the outcomes of interest for this study. Second, the application process involves certain selection criteria that are considered by individual CPOs, and which relate to the physical attributes of the farm (e.g. size, number of cows) as well as financial viability (such as milk sales figures and outstanding debt) of the farm. Not accounting for such factors may result in biased estimates of the effect of the BIRU programme.

The evaluation design will therefore be based on a difference-in-difference (DiD) approach: farms with biogas digesters will be compared to farms that do not have a digester, before and after the digesters have been installed. That is, programme participants will be interviewed before and after implementation of the programme, and they will be compared with an appropriate control group. The difference between these two trends will be interpreted as the causal effect of the BIRU programme, based on the assumption that the control group reflects the development that the programme participants would have experienced if they had not had a biogas digester installed. By comparing differences in trends, and not differences in levels, it will be possible to eliminate confounding innate unobserved differences between the treatment and control groups.

However, this approach still suffers from three potential threats: (i) the parallel trends assumption could be violated, (ii) the designated control group could apply for – and receive – a biogas digester during the period between the baseline and follow up survey, and (iii) the designated treatment group – the applicants – may decide to resign from the BIRU programme and not install a biogas digester before the follow-up survey. The last two sources of risk refer to so called “non-compliance” to the designated treatment status. The nature of the programme and the study design reduce these threats to some extent, because focussing on a relatively homogeneous group of farmers who operate in a similar production and institutional context supports the credibility of the parallel trends assumption. Furthermore, oversampling of the control group gives us more scope to deal with so called contamination of the control group. Nevertheless, we cannot a priori rule out these three threats, and a robustness analysis and careful risk assessment is prudent.

Therefore, in addition to the difference-in-difference analysis, we will also consider a cross-section based pipeline comparison approach. This method exploits a particular feature in the design of the application process, in that some programme applicants have already received a digester and some have not, bypassing potential bias due to eligibility or self-selection. This approach is not reliant on the parallel trends assumption or threatened by potential control group contamination, problems that are typical for longitudinal analysis (such as difference-in-difference estimation). However, the cross-sectional approach of pipeline comparison introduces other problems. For example, there may be systematic differences between early and late adopters of an innovative technology, a problem that difference-in-difference analysis can deal with more effectively. Thus, while this approach is not a substitute for the difference-in-difference approach, it does provide an alternative evaluation methodology. Furthermore, information on users does provide interesting insights at this stage already on energy usage patterns across users, applicants and non-applicants. The use of both approaches will allow us to evaluate the robustness of the results.[7]

To support the evaluation strategy outlined above a baseline survey was conducted in May 2011 and a follow-up survey is planned for May 2012. For the difference-in-difference evaluation, two groups of households were interviewed: First, the treatment group consisting of dairy cooperative members that have applied for the programme and are about to obtain a biogas digester. We refer to them as *applicants* in the following. Second, the control group consisting of farm households with comparable features (e.g. cooperative members, the same villages, similar number of productive cows) that have not applied for a digester. We refer to them as *non-applicants* in the following. For the cross-sectional pipeline comparison approach, a second treatment group was defined, consisting of farms which are already using biogas digesters, while the applicants (i.e., the first treatment group) will now serve as cross-sectional control group. The farmers in this group are called *users* in the following. Table 5 summarises the choice of treatment and control groups for the different evaluation strategies.

Table 5: Treatment and control groups, by evaluation strategy

Sample	Definition	Cross section Pipeline comparison	Difference-in-difference
Users	Have fully operational biogas digester installed at the time of baseline survey	Treatment group	
Applicants	Have applied for a biogas digester, which is expected to be installed within 2-3 months after the baseline survey is conducted	Control group	Treatment group
Non-applicants	Do not have a biogas digester, and have not applied for one		Control group

3.3. Survey Tools

In order to achieve the evaluation objectives outlined in Section 3.1 several qualitative and quantitative survey tools were developed and applied. These included structured household questionnaires, semi-structured interviews at the household and community level, focus group discussions and expert interviews with stakeholders involved in the programme, or in regional biogas development in general, as well as experts on energy policy development and animal husbandry. In East Java, structured questionnaires were the principal tool, accompanied by the qualitative methods mentioned above, whereas in Lombok semi-structured household interviews were the most important tool, along with stakeholder interviews.

The head of the household, who is usually in charge of running the dairy business and a member of the dairy cooperative, provided responses to the main part of the questionnaire. The section on

[7] An added advantage of surveying users is that we will be able to examine changes in biogas usage patterns for users and will be able to assess the challenges they may face in maintaining and working with digesters. In short, we should able to assess the medium and longer-term effects of the digester intervention.

cooking called for responses from the household member in charge of cooking, which in most cases is the wife of the household head. The general socio-economic parts of the questionnaire included questions on demographics, health, financial situation, security, and gender relevant issues. Furthermore, the questionnaire included a time activities profile for children and adults, several sets of questions on energy related topics such as cooking, lighting and energy sources in general, a section on agricultural activity, and on the digesters themselves. The latter focussed on perceptions linked to digesters, and, in the case of users and applicants, motivations for applying, the construction and application process, biogas and slurry usage, and general satisfaction with the programme and the functioning of the digesters.

In East Java, in addition to the household interviews, a community survey (see Appendix 2 for the questionnaire (file)) was conducted in order to collect information about regional characteristics. This included general demographic questions, as well as questions on infrastructure provision, accessibility and quality, local economic conditions such as cash crop cultivation and employment opportunities, and the availability of energy sources and energy usage patterns in the village. This information provides broader knowledge about the circumstances under which the households live and can therefore be linked to the household-specific data stemming from the household questionnaires. In addition, this provides a cross-check on some parts of the information obtained from the household survey. Both in East Java and Lombok, semi-structured interviews were conducted with households and with key informants on issues related to the region. The key informants were village heads, heads of farmer groups and cooperative heads, and biogas masons. In both regions, the most important stakeholders for the programme were identified and interviewed, including the heads of the CPOs, university professors, representatives of public institutions (e.g. BLPP - Agency of Agriculture Training and Consultation/Extension, the regional environmental department or the department for mining and mineral resources), and private companies involved in the programme (e.g. Nestlé, stove manufacturers and fertiliser producers).

A focus group discussion (FGD) was conducted prior to the start of the survey in East Java to learn more about the households' perceptions and attitudes linked to energy and biogas and their energy consumption patterns. [8] In Lombok, three focus group discussions were conducted on similar topics, one in East Lombok, one in Central Lombok and one in West Lombok. In the context of the survey, FGD help to relate survey results to the broader context (Schutt 2004). In Lombok, the FDG helped to gain insights on energy related problems, group attitudes and perceptions in the respective regions.

The FGD in East Java was held with biogas users, whereas in Lombok groups included women and men, users, applicants and non-users (for more information on the methodology applied in Lombok, refer to Annex 1). The FGDs addressed questions on the use of energy for private consumption and for productive use, perceptions linked to energy, and topics related to biogas and slurry usage. For example, people were asked which energy sources they prefer and how access to energy affects their daily lives. To ensure that all the opinions of the five to ten participants were reflected in the FGD, the facilitator (an ISS/RWI team member) attempted to include each individual in the discussion.

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[8] A focus group is a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research (Powell and Single 1996).

3.4. Sampling Strategy

The survey was conducted in East Java, where the BIRU programme is active in nine rural districts (around the municipality of Malang) and involves 11 CPOs. The CPOs are in charge of the construction of digesters and each serves one to three dairy cooperatives. Each of the, in total, 19 involved cooperatives has a biogas supervisor who disseminates information about the BIRU programme, the eligibility assessment, and the selection of farms. The supervisor also manages the credit schemes. These services are only accessible to farmers who are members of the cooperative and hence, the survey population is restricted to cooperative members. The treatment groups of users and applicants are by programme design confined to the cooperative members, and consequently, non-applicants who serve as controls are also recruited from the same cooperatives.

The total sample size was set at 700 households, and consists of 250 households that belong to the to-be-treated group of applicants, 100 households are digester using households ("users") and 350 households belong to the control group (i.e. those who have not yet applied for a digester).

A sample size of 700 households is likely to be sufficient, in terms of power, to detect impacts on energy expenditures, firewood consumption, firewood collection time, and convenience indicators. For these indicators, changes after switching from firewood to biogas are likely to be pronounced, which is partly also the case for LPG. However, health effects caused by a reduction in smoke emissions are likely to be more subtle, and hence, it is questionable if the power of the study is sufficient for this indicator. As a rule of thumb the more homogenous the sample, due to increases in the effect size, the higher the power. The fact that we recruit very similar households – i.e. dairy farmers with a certain number of cows and comparable revenues living in the same region – should therefore have a positive effect on the power of the study. A precise power calculation could not be done beforehand, as data on the impact indicators was not available from any other data set.

Furthermore, control households were oversampled in the baseline phase for two reasons: (i) Presence of "non-compliant" control group households, as it is possible that some of the households interviewed for the control group at the baseline stage decide to obtain a digester at a later stage (between the baseline and follow-up surveys). This group of households would then shift to the treatment group and the control group would get smaller (ii) Non-comparable control group households: The selection of biogas non-applicants for the control group was based on information available at the cooperative level (i.e. without doing a survey and based on the number of cows and their milk revenues). During data analysis comparability of the two groups will be checked with regard to further characteristics. As a consequence, some control group households might be non-comparable and may have to be dropped from the sample.

In terms of sampling, the first step involved the selection of CPOs to be included in the survey. Two CPOs, the cooperatives Kud Sri Sedono and Kud Tani Makmur were dropped, as they only had a small number of installed biogas digesters and applicants among their members and are located relatively far from the Malang area. At a later stage of the sampling process, one of the three cooperatives served by the CPO LPKP had to be dropped due to unavailability of information on the cooperative's members. This left us with the 9 CPOs listed in Table 2. The sample thereby covered 11 cooperatives in 30 sub-districts in 5 districts.

In the second step, the applicant group to be sampled was randomly drawn from the reservoir of all applicants in the 11 cooperatives. Initially, the intention had been to use the list of applicants provided by BIRU. The individual lists available at the cooperatives, however, turned out to be more up-to-date. In total, the lists of all 11 cooperatives contained 497 applicants (**Error! Reference source not found.**). After 250 applicants had been randomly selected, sub-districts with less than two selected farms were dropped for logistical reasons. The random selection was then repeated for the remaining sub-districts. The 250 sampled applicants are drawn from all five districts, while the number of covered sub-districts is 13. The distribution of the applicants among the 9 CPOs and 11 cooperatives is given in Table 7. Same as **Error! Reference source not found.**, this table provides also for the other two analysed groups, non-applicants and current users, an overview on the population from which we drew the samples and the sample sizes, each by CPO. These samples have been determined in subsequent steps as described in the following.

Table 6: Total number of BIRU applicants, installed digesters and active cooperative members, by districts and CPO

District	CPO	Cooperative*	Applicants	Digesters installed	Active members
Kab. Malang	KAN Jabung		14	164	453
	LPKP	DAU Kud Karang Ploso	47	184	900
	Sumber Makmur Ngantang		41	299	6,740
	Sae Pujon		115	441	4,126
Kab. Pasuruan	KUD Dadi Jaya		30	93	747
	Setia Kawan		175	457	4,050
Kab. Kediri and Kab. Jombang	KPUB Sapi Jaya		34	51	199
	Sami Mandiri	Sami Mandiri Karta Jaya	28	249	761
Kab. Blitar	KUD Semen		13	148	345
Total	9	11	497	2,086	18,321

Note: The cooperative names are given for those cases where the CPO is not a single cooperative.

Source: BIRU project data; Cooperative members' lists

Table 7: Number of BIRU farmers sampled for the three groups, by CPO

CPO	Cooperative*	Applicants	Non-applicants	Current users	Total
KAN Jabung		4	5	8	17
LPKP	DAU	11	15	4	30
	Kud Karang Ploso	12	17	5	34
Sumber Makmur Ngantang		21	29	14	64
KPUB Sapi Jaya		15	21	2	38
Sami Mandiri	Sami Mandiri	7	10	4	21
	Karta Jaya	7	10	8	25
SAE Pujon		65	87	21	173
KUD Dadi Jaya		13	18	5	36
Setia Kawan		86	119	22	227
KUD Semen		9	13	8	30
Total	11	250	344	101	695

Note: The cooperative names are given for those cases where the CPO is not a single cooperative.

Source: BIRU project data; Cooperative members' lists

The non-applicants were sampled from the lists of cooperative members. In order to serve as suitable controls for our applicants, non-applicants had to comply with three criteria. First, they were supposed to – in principle – qualify to obtain a digester by keeping at least one productive cow and regularly delivering milk to the cooperative.[9] Second, those members were supposed to be excluded who already own a digester provided through a different programme or have applied for one through the BIRU programme. The third criterion was that control farmers live in villages from which treatment farms had already been selected in order to retain homogeneity in village characteristics. Provided that the cooperative member lists included information about these criteria, we pre-selected in total 18,321 active members as potential controls for this study. For each cooperative individually, the control farms were then randomly sampled from the lists of farms that met the above mentioned criteria. The number of control farms randomly drawn from each cooperative was proportional to the share of applicants drawn for the respective cooperative in order to achieve a similar sample composition among treatment and control households. Enumerators had been sensitized to verify before each interview that these criteria were actually met and to replace the household otherwise (see also Section 3.5). Finally, the biogas users that had already installed a BIRU digester were randomly sampled for each CPO from the official BIRU list which only includes households with already functioning digesters for which a completion report has been submitted. The users were as well only selected in the villages in which applicants had been selected to be surveyed. In order to obtain a sample of users that are representative of the programme, the number of users drawn from each CPO was proportional to the number of biogas digesters installed through the programme in the respective CPO.

In the field, some problems had to be overcome. For example, the survey team had difficulties finding the selected households. In some cases there were no household members at home at the time of the survey, or certain households could not be located by the survey team due to a change in address. Sometimes the lists provided by the cooperatives were flawed. For example, some households were listed twice under a different name. In a few cases, applicants' digesters were already under construction or households had deregistered in the meantime. In these cases, a neighbouring farmer in the respective group (i.e. applicant, non-applicant or user) was selected and interviewed.

A summary of the distribution of applicants, installed digesters and active members from which the sample was drawn is given in

Table 6. The distribution of the sampled farms across the CPOs is given in Table 7. Eventually, we conducted 695 interviews using a structured questionnaire. The sample consists of 250 applicants, 101 users and 344 non-applicants.

[9] Sufficient space close to the dwelling (24 m^2) to build a digester was not applied as an eligibility criterion, since it is implausible that this household characteristic has an effect on any of the outcome variables. Not disposing of this space therefore does not prejudice comparability in our context (while – on the positive side – implying a lower likelihood of non-compliance). In any case, this is the case for only less than 10 percent of control households. Applying the criterion of outstanding debts turned out not to be feasible and also of less relevance.

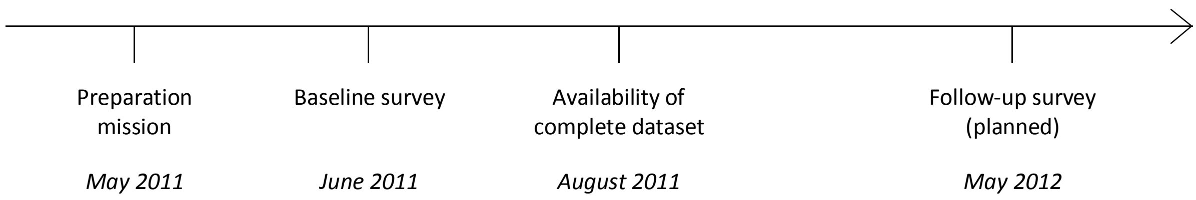
3.5. Survey implementation

For the implementation of the survey we contracted the Jakarta based research institute *JRI Research*, an experienced organization in the field of socio-economic surveys that has already worked for Columbia University and World Bank, for example. JRI was responsible for the logistics of the survey including the recruitment and supervision of enumerators as well as ensuring the quality of the collected data, of the sampling and the data entry. They also conducted the enumerator training together with two team members of ISS/RWI and provided input on the preparation of the questionnaire. Throughout the survey implementation, JRI was supported by an ISS/RWI team member. BIRU's role in the survey implementation phase was limited to the provision of information upon the request of the survey team.

The preparation mission for the baseline surveys was undertaken by ISS/RWI researchers in May 2011 (see Annex 2). A focus group discussion with a random selection of target group members was conducted by JRI in the pre-test phase in order to check whether all dimensions of the potential impacts were covered by the structured questionnaire. A four-day training workshop was held by JRI, accompanied by two ISS/RWI researchers to prepare 30 enumerators and eight operators for data entry. As a final preparatory step, the survey itinerary was planned by the JRI supervisors.

The interviews took place between June 1st and June 14th 2011. The survey was conducted by six teams, each consisting of three to five enumerators and one JRI team leader. There were two supervisors in charge of managing the survey and two so-called data editors who checked the completed questionnaires on behalf of JRI. JRI was also in charge of conducting interviews at the community level. In total, representatives of 35 of the 60 surveyed villages have been visited. These 35 villages have been selected in such a way that all sub-districts were covered. Throughout the survey an ISS/RWI team member was present to support the JRI supervisors, to assure that the survey was implemented according to the methodological requirements and in order to conduct qualitative interviews with cooperative heads, masons, and households.

Figure 2: Stages in survey implementation



Data entry took place at the JRI office in Jakarta parallel to the survey. One month after the survey, JRI submitted the entered data to ISS/RWI. The accuracy of the entered data was checked and final revisions were made by JRI. The final version of the data was handed over to ISS/RWI in early August.

4. Baseline Results

4.1. General Data Quality Assessment

The quality and completeness of the data may be judged by the non-response rate for various questions. From the 695 surveyed households we collected individual-level data on all household members older than six. This includes information on gender, age, educational level, primary and secondary occupation as well as information on agricultural and non-agricultural income. Household members under the age of six were only counted for each household without collecting individual member data. The non-response rates for these 'individual member questions' was low and in most cases under two percent. Even for the questions on non-agricultural income the rate of non-response is quite low (in 5 percent of cases, interviewees could not specify the non-agricultural income of a household member), although such information is generally considered very sensitive. The response rate to questions on land ownership and cultivation and total income from selling transformed agricultural products was also close to 100 percent. Questions related to energy use including energy expenditures were answered by all households. Response rates for the questions on biogas usage and benefits were around 100 percent. Also, questions related to the financial situation and general expenditures were fully answered or exhibit non-response rates below one percent. Data quality on the community level was impeccable.

Another instrument for verifying data quality is to cross-check the data with indicators from the Indonesian Social and Economic Survey (*Susenas*), which is conducted annually and nationwide. As discussed below (see Section 4.3) there is a high degree of consistency between expenditure patterns based on the *Susenas* and the data set under scrutiny. In addition to the quantitative study, we collected qualitative information that was also used to cross-check the quantitative data. For this purpose, we conducted 23 household interviews in East Java among biogas users, applicants, and non-applicants and organized focus group discussion with households. Moreover, stakeholders and representatives of dairy cooperatives were interviewed. In essence, these complementary interviews did not raise suspicions about inconsistencies in the quantitative data. Along with the above presented response rates they indicate that the data mirrors the information that was intended to be collected and that questions were understood correctly.

4.2. Village characteristics

The *'Community Questionnaire'* was designed to collect information at the community/village level on aspects such as village size, geographical features, income sources, business development, energy sources, access to infrastructure such as roads, schools, health care facilities and communication facilities. In seriatim, this section describes each of these characteristics.

We have information on 35 villages located in 4 districts. This includes 18 villages in Malang, 13 in Kediri, three in Jombang and one in Blitar. On average, with respect to population, villages in Malang are substantially larger (about 6,400 inhabitants) as compared to villages in Kediri (4,000) and in Jombang (2,600). A geographical feature of interest with regard to digesters is that all villages have access to river water.

With regard to income, in order to identify the relative importance of different income sources, village heads were asked to rank different sources in order of their contribution to the local economy. As displayed in Table 8, across almost all the surveyed districts, income from agricultural activities is the most important income source followed by dairy farming. Another notable feature is the importance of manufacturing as an income source in Malang and Jombang as compared to the other districts where manufacturing tends to be ranked (next to) last. In term of other features of the village economy, most villages are well-served with respect to a range of businesses. For instance, grocery stores, and carpentry and tailoring services are available in all villages. Agriculture related businesses (flour and rice millers) are available in about two-thirds of the villages while non-agriculture businesses such as beauty salons and auto workshops may be found in about half the villages. Financial services are also widely available (see Note: The various income sources are distinct and do not overlap.

Table 9).

Table 8: Average reported ranking of main source of income

Main income source	Malang	Blitar	Kediri	Jombang
Agriculture	1	3	1	1
Dairy Farming	2	2	5	2
Livestock	7	1	3	3
Sugar Cane	6	7	2	n/a
Food processing	3	4	7	6
Services	5	5	4	5
Manufacturing	4	6	6	4

Note: The various income sources are distinct and do not overlap.

Table 9: Availability of financial services

Village location	Total number of villages	Availability of financial services	Availability of micro credit inst.	Availability of bank	Availability of cooperative
Malang	18	17	7	0	17
Blitar	1	1	1	0	1
Kediri	13	7	4	2	5
Jombang	3	0	n/a	n/a	n/a

Note: Figures in number indicate the number of villages where the respective service/institution is available.

All conventional energy sources (LPG, diesel, gasoline, kerosene, charcoal and firewood) are available in the surveyed villages. Virtually all villages are connected to the PLN electricity grid and consequently decentralized electricity sources like solar panels or generators are rarely used.

Access to education and health care services is widespread and except for a few villages in Malang district, primary, junior high and senior high schools are available in all villages. Additionally, all villages have access to a health centre (puskemas), and barring a few exceptions all villages have access to subsidiary health centres (pustu) and integrated service posts (posyandu).[10]

Table 10: Availability of health care facilities

Village location	Total number of villages	Community health sub-centre (Pustu)	Integrated service post (Posyandu)
Malang	18	17	17
Blitar	1	1	1
Kediri	13	11	13
Jombang	3	3	3

[10] The health services are organized in a three stage system with community health centers (Puskesmas) at the top. These centers provide maternal and child health care, general outpatient curative and preventative health care services, pre- and postnatal care, immunization, and communicable disease control programmes. Second-level community health sub centers (Pustu) which consist of small clinics and maternal and child health centers, staffed with between one and three nurses and visited weekly or monthly by a physician. The third level of community health services are the integrated service post (Posyandu). These posts are not permanently staffed facilities, but are monthly clinics on borrowed premises, in which a visiting team from the regional health centre reinforce local health volunteers.

Turning to other traits, the five surveyed districts are similar in terms of access to roads. All the villages are able to access main roads through asphalted routes which are accessible throughout the year. On average, the villages are located within one to three kilometres of a main road connected to a neighbouring city. With regard to media and telecommunications, while all districts do receive a signal for radio, mobile phone, television and internet, there are substantial cross-district differences in signal quality (see Table 11).

Table 11: Reception of mass media devices

Village location	Device	Good	Average	Bad
Malang	Radio	11	4	3
	Cell phone	15	3	0
	Television	16	2	0
	Internet	9	9	0
Blitar/ Jombang	Radio	3	1	0
	Cell phone	0	4	0
	Television	3	1	0
	Internet	0	4	0
Kediri	Radio	13	0	0
	Cell phone	11	1	1
	Television	13	0	0
	Internet	5	7	1

4.3. Household characteristics

In this section we provide descriptive statistics on the socio-economic structure of the households in the project area. The focus is on comparing differences between users, applicants and non-applicants. The underlying aim is to provide a preliminary assessment of the comparative credibility of the two empirical strategies outlined in Section 3. As outlined in Section 3, the pipeline-comparison design will be based on comparing users (treated) and applicants (control) while the DiD design will rely on comparing applicants (treated) and non-applicants (control).

We begin with a comparison of various demographic characteristics. As shown in Table 12, there seems to be a greater degree of similarity between the applicant and non-applicant groups as compared to users. Users report a smaller percentage of households headed by females and tend to have a smaller number of individuals who are above 65.

Table 12: Households composition

	Applicant (N = 250)	Non-applicant (N = 344)	User (N = 101)
Household size	4.1	4.0	4.2
Female head of household (%)	6.8	6.1	2.0
Share aged 0-6 years (%)	7.0	9.2	8.2
Share aged above 65 (%)	3.7	4.0	1.6

The three groups appear to be quite similar in terms of their occupational distribution. The bulk of household heads (85-87 percent) work as independent farmers and the remainder are spread over a range of activities (**Error! Reference source not found.**). The key difference is that users are substantially more likely (7 versus 1 percent) to be employed in the formal sector (private or public) as compared to applicants and non-applicants.

Probing further we see in Table 14 that almost all households own some land and have access to pastures for grazing. The size of land holdings is very similar across the three groups and while there are some differences, cultivation patterns appear to be similar, with maize and coffee constituting the two main crops.

Table 13: Sector of activity of the household head, in percent

Sector of activity	Applicant	Non-applicant	User
Independent farmer	86.4	87.2	85.2
Agricultural worker	0.8	1.7	1.0
Private employee	0.8	0.9	5.9
Civil servant	0.4	0	1.0
Trader	3.2	1.2	1.0
Food stall	0	1.2	0
Construction	0	1.2	0
Unpaid family worker	2.0	1.2	0
Household, retired	2.8	2.3	1.0
Other	5.6	4.3	4.9

Table 14: Land ownership, land size, livestock and agricultural activities

Agricultural and livestock activities	Applicant	Non-applicant	User
Land owners (%)	94.0	91.0	96.0
Size of land owned (ha)	0.7	0.6	0.8
Households with certified property rights for their land (percent)	18.3	12.1	16.5
Pasture for grazing (%)	99.1	97.1	97.9
Livestock owners (%)	100	100	100
Crops cultivated (%)			
Maize	33.2	32.6	35.0
Coffee	27.2	31.0	29.9
Hot peppers	23.4	15.0	22.7
Banana	22.6	19.5	17.5
Rice	8.1	8.0	16.5
Cassava	12.8	10.9	13.4

Note: The statistics on the share of household cultivating a specific crop are conditional on owning and cultivating land.

The educational distributions of the household head, spouse of the household head and their children are provided in Table 15. Almost all household heads and spouses have some education and more than 90 percent of children aged 6-13 are enrolled in school. Clearly the user group (head and spouse) are more educated than the applicant and non-applicant groups. Differences in educational attainment between the applicant and non-applicant group are limited.

Table 15: School enrolment and educational attainment, in percent

School enrolment and educational attainment	Applicant	Non-applicant	User
Head of the household (educational attainment)			
None	4.4	4.1	2.0
Primary education	78.4	79.4	69.3
Junior secondary education	10.4	12.5	14.9
Senior secondary education and higher	6.8	4.1	13.9

Spouse of the household head (educational attainment)			
None	4.4	2.4	1.1
Primary education	74.1	77.8	65.9
Junior secondary education	12.9	14.0	23.9
Senior secondary education and higher	8.6	5.8	9.8
Children aged 6-13 (school enrolment)			
All children	92.0	91.1	94.5
Boys	94.2	90.5	100.0
Girls	89.7	91.8	88.9

The distribution of annual per capita expenditures and expenditure shares is provided in Table 16. As may be expected, across all groups, food accounts for the bulk of household expenditure. Highlighting their relatively better economic status, food accounts for 45 percent of total expenditure in the case of users while the corresponding figure is about 50 percent for the other two groups. Conversely, user households spend a greater proportion of their resources on transport (18 versus 14) and education (10 versus 6 percent) as compared to applicants. The share of expenditure on other items is quite similar. A strikingly high share of household resources is spent on cigarettes (7-10 percent of total expenditure). Expenditure on energy accounts for about 5 to 7 percent of total expenditure.

As an additional consistency check some of the expenditure shares reported here may be compared with expenditure data from the widely used SUSENAS surveys (see

Table 4). For example, the SUSENAS data show that in 2008, energy accounted for 4.4 percent of household expenditure in the districts where the baseline survey was conducted. The expenditure analysis reported below displays a similar figure.

Table 16: Distribution of annual per capita expenditure, in thousands of Indonesian Rupiah (expenditure shares are in parentheses)

	Applicant	Non-applicant	User
Food	1,987	1,843	1,866
	(49%)	(49%)	(45%)
Energy	275	244	171
	(7%)	(7%)	(5%)
Transportation	640	500	809
	(14%)	(13%)	(18%)
Cigarettes	403	397	313
	(9%)	(10%)	(7%)
Clothes	262	269	285
	(6%)	(5%)	(5%)
Education	250	380	498
	(6%)	(7%)	(10%)
Total per capita expenditure	4,192	4,017	4,366

Table 17 displays information on household appliance and vehicle ownership. Households in the user group are clearly better endowed in terms of ownership of a wider range of appliances and vehicles as compared to the applicant and non-applicant groups. While there are differences between the applicant and non-applicant groups they are not as pronounced as compared to the user group.

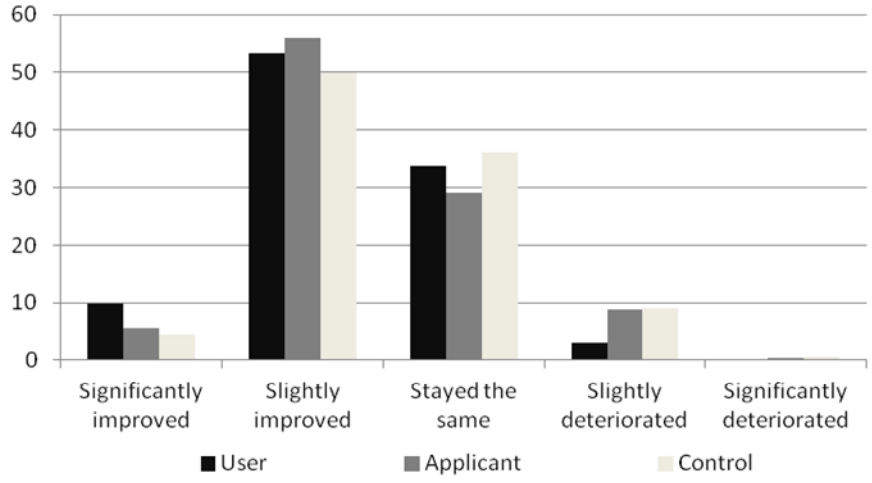
Table 17: Share of households owning appliances and vehicles, in percent

	Applicant	Non-applicant	User
Appliance ownership			
Television	97.2	92.4	99.0
CD / VCD	64.8	59.0	79.2
Radio	29.2	31.7	36.6
Mobile phones	78.0	70.6	83.2
Fridges	19.6	11.3	31.7
Vehicle ownership			
Bicycle	16.4	16.0	26.7
Motorcycle	86.0	81.1	95.1
Car	9.6	5.5	18.8
Tractor	0.4	0.3	1.0

Finally,

Figure 3 suggests that the three groups have a comparable perception of their economic situation and how this perception has developed over the last three years.

Figure 3: Perception of changes in households' living conditions, in percent



Overall, the impression from these descriptive statistics is that applicants and users do differ in terms of characteristics that are likely to be exogenous to the BIRU programme. At the same time, the analysis shows that, on average, differences between applicants and non-applicants are not pronounced. Although preliminary, these patterns suggest that an empirical design based on comparing applicants to non-applicants is more likely to yield credible estimates. Nevertheless the analysis underlines the point that the subsequent impact evaluation needs to deal with confounding factors resulting from the combination of the programme's selection criteria and the probability that farms take the initiative to apply for a digester. Hence, participation in the BIRU programme, as well as the timing of adoption, cannot be regarded as a random process. In general, though, by focusing only on dairy cooperative members and not a random sample, we are working with a relatively homogenous group. The following paragraphs take a closer look at the characteristics and activities of farm households that are likely to be endogenous to the BIRU programme, such as dairy farming, and fertiliser and energy use.

4.4. Dairy farming and slurry management

There are some clear differences in dairy farming activities between the different sub samples.

Table 18 shows that biogas users on average own more dairy cows (4.6) as compared to the two other groups. Revenues from milk are almost twice that of the non-applicant group and almost 50 percent higher as compared to applicants. The differences are again more pronounced for the revenues from the sale of cows, including dairy and beef cows.

While all biogas users keep their cows in stables, this is far less likely for applicant and non-applicant households (Table 19). Practically all digester owners collect dung, while the corresponding figure is less than half for non-users. This is also reflected in the amount of dung collected per day, which varies from 92 kg for biogas users to 29 kg for non-applicants. Most of the dung collected by biogas users is intended for the biogas digester (65 percent), while non-users mostly use dung as fertiliser or dispose it in open drains, lakes and rivers.

Table 18: Average number of cows kept per household and revenues from the sale of milk and animals

	Applicant	Non-applicant	User
Number of dairy cows	3.5	2.7	4.6
Number of non milking cows	2.5	2.3	3.5
Revenues from milk (1000 Rp.)	2,196	1,700	3,271
Share of total expenditures	15.5%	13.6%	21.3%
Revenues from the sale of milking cows (1000 Rp.)	1,378	961	2,296
Share of total expenditures	12.9%	8.1%	14.2%
Revenues from the sale of non-milking cows (1000 Rp.)	1,158	971	2,045
Share of total expenditures	7.9%	7.4%	13.4%

Notes: Revenues are expressed in local currency unit.

Table 19: Households' behaviour concerning cattle keeping and manure management

	Applicant	Non-applicant	User
Cattle kept in stables (%)	66%	61%	97%
Household collects the dung (%)	64%	57%	95%
Amount of dung collected daily (kg)	45	29	92
Main use of dung	Fertiliser (53%)	Fertiliser (39%)	Digester (65%)

Bio-slurry is only used by the user group (Table 20) and apparently not sold to other farmers in our sample. For farmers without biogas digesters, chemical fertiliser is the main source of fertiliser, followed by cow dung. As may be expected, farmers with a biogas digester seem to be replacing the use of cow dung by slurry, however, they continue to rely heavily on chemical fertilizers (Table 21). Around 63 percent of biogas users use the slurry as a fertiliser (not in table). The most common reason for not using the slurry is lack of space to collect and dry it (stated by 62 percent of the users who do not use the slurry as a fertiliser). Other reasons were lack of awareness or conviction of the value of bio-slurry as a fertilizer (11 percent each), or lack of knowledge on how to use the slurry (8 percent). About 3 percent did not have enough time or thought that it was not worth the effort.

Table 20: Different types of fertiliser used each month, in percent

	Applicant	Non-applicant	User
Organic matter	3.1	1.3	1.1
Cow dung	42.6	45	19.6
Other dung	4.8	6.3	5.5
Bioslurry	0	0	18.6
Chemical fertiliser (UREA, ZA, TS)	45.9	45.1	53.7
Other fertiliser	3.7	2.3	1.5

Table 21: Average amount of fertiliser bought each month for households who buy the respective fertiliser, in kilograms (share of households buying in parentheses)

	Applicant	Non-applicant	User
Organic matter	85	66	63
	(6.8%)	(3.8%)	(3.0%)
Cow dung	507	383	350
	(4.4%)	(3.2%)	(4.0%)
Other dung	198	195	170
	(7.2%)	(9.9%)	(7.9%)
Bioslurry	0	0	1400
	(0%)	(0%)	(1.0%)
Chemical fertiliser (UREA, ZA, TS)	115	104	176
	(83.2%)	(74.4%)	(81.2%)
Other fertiliser	92	63	238
	(12.4%)	(10.5%)	(6.9%)

An assessment of time-usage patterns shows that users spend relatively more time buying or collecting fertiliser, on average about one hour more per week (Table 22). This is mainly due to time spent collecting cow dung, the mixing process, and preparing the slurry to be used as fertiliser (e.g. composting it). On average, the filling process takes 15 minutes per day.

Table 22: Amount of time spent on buying or collecting fertiliser per week, in minutes

	Applicant	Non-applicant	User
Organic matter	22	20	18
Cow dung	66	54	80
Other dung	34	31	29
Bioslurry	0	0	60
Chemical fertiliser (UREA, ZA, TS) [a]	24	22	23
Other fertiliser	20	27	19

[a] Maximum amount of time for either type of chemical fertilizer, not the aggregate.

4.5. Energy sources and usage

The following section uses the household data to describe current energy usage patterns and examine socio-economic and behavioural characteristics that might be influenced by the usage of biogas for cooking and lighting instead of LPG, kerosene, or firewood.

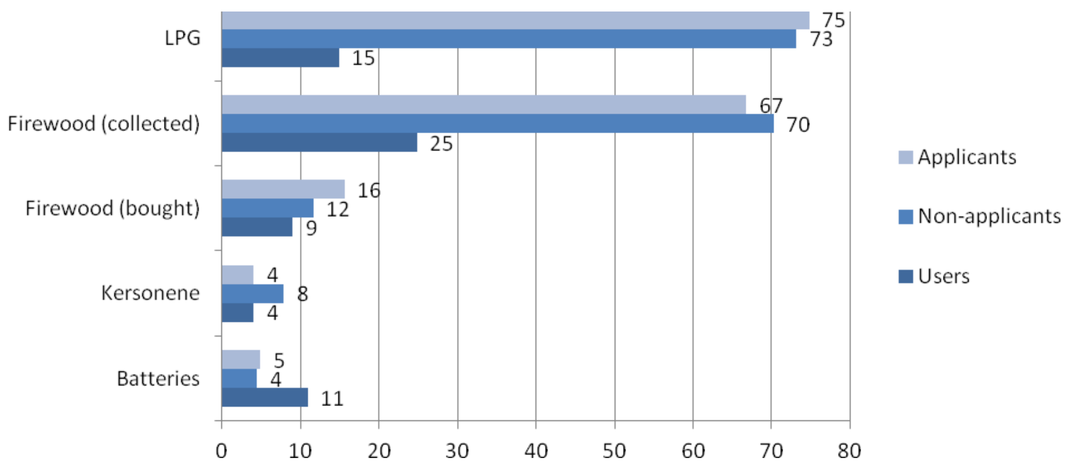
According to the International Energy Agency (IEA 2008), in 2006 between 55 and 70 percent of the rural population in Indonesia had access to electricity in their homes and 85 percent of villages had access to electricity. In the study area, access to electricity is at the upper end of this range. Among the surveyed households, all have access to electricity and 647 households (93 percent) are directly connected to the national electricity grid run by the national energy company PLN and the remainder are connected to a neighbour’s electricity meter. Only one household owns a generator set in addition to having access to PLN. About 86 percent of households have had electricity for more than ten years.

Figure 4 shows all non-electricity energy sources used by the surveyed households. Potentially due to subsidies (see Section 2.3), LPG use has increased significantly since 2007. In the study area LPG use is widespread, with 73 percent of non-applicant households and 75 percent of applicants using LPG. Only 15 percent of the biogas users also use LPG. This suggests that biogas may be substituting LPG as the main source of cooking energy. LPG is consumed in 3 kg cylinders, which are distributed to LPG vendors by Pertamina, the national energy company. Among those households that use LPG, the average monthly consumption of LPG was 7.5 kg for non-applicants, almost 9 kg for applicants, and only 4 kg for users with a median of 3 kg. The substantially lower LPG consumption rate of biogas users suggests that LPG is used as a supplementary source of energy.

A large share of households still uses firewood for cooking as well as for bathing and agricultural purposes. In total, 72 percent of interviewed households still use firewood, of which 82 percent collect the firewood, 13 percent buy it, and four percent combine buying and collecting firewood. Across the three comparison groups, 70 percent of non-applicants and 67 percent of applicants gather firewood, while only 25 percent of biogas users collect wood on a regular base. Furthermore, 16 percent of non-applicants, 12 percent of applicants and only 9 percent of biogas users buy firewood. In 68 percent of households, firewood is collected by the head of household who is usually male, while in 15 percent of the cases, it is collected by the spouse. On average 1.2 household members collect firewood in these households with an average of 6.6 hours per week spent on firewood collection. However, for many households the actual time spent collecting firewood is hard to estimate, since households often combine firewood collection with other tasks such as collecting grass for cows. In general, households who live in more urbanised areas tend to buy firewood or to use other energy sources (mainly LPG), whereas households in rural areas often collect firewood from their farmlands or from neighbouring forests. Charcoal is not used by any of the sampled households.

Probably, due to increasing kerosene prices, which is partly linked to the cutting of kerosene subsidies by the government (see Section 2.3), kerosene use has decreased significantly in the past few years. Among the three groups that were compared, only four to eight percent used kerosene for lighting or cooking. The average consumption of kerosene is 1.5 litres per month for applicants, 2.3 litres for non-applicants and 1 litre for users, with around half the amount used for cooking. The average kerosene consumption for lighting is around 0.5 litres for all three groups. Similarly, the use of dry-cell batteries is low. Only four percent of non-applicant households, five percent of applicants and 11 percent of users use batteries. On average, battery users consume two batteries per month. Batteries are primarily used for TV remote controls, with only very few batteries used for lighting or running radios. Most households use chargeable flashlights and run radios and similar appliances using grid electricity.

Figure 4: Energy sources by group, in percent



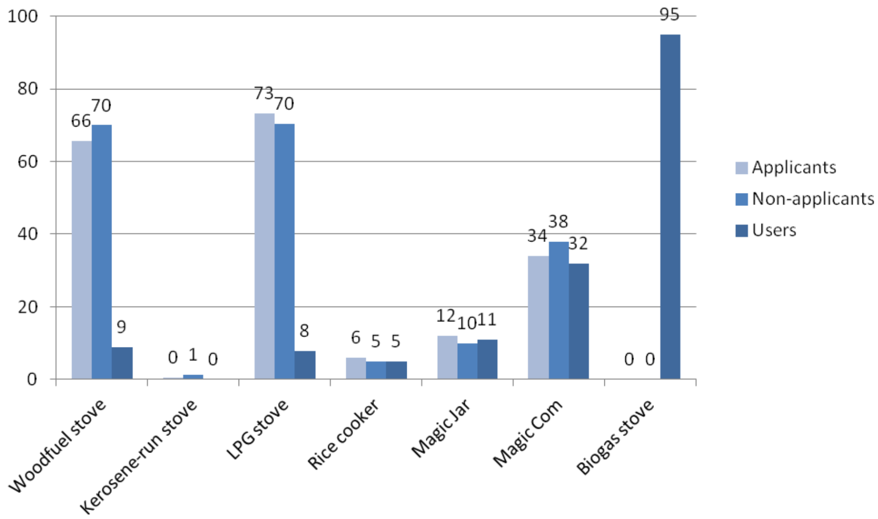
Cooking

In rural areas in Indonesia, cooking is the most energy-intensive household activity. The domestic biogas programme targets exactly this energy service by making biogas available for cooking purposes. The following section describes energy usage patterns for cooking and stove types for users, applicants and non-applicant households. It is very common for households to use several types of stoves, including stationary fuelwood stoves, gas stoves, electric cooking devices, and in some cases kerosene stoves or, as a matter of course, biogas stoves in the user group. Electric cooking devices are heating plates, rice cookers, Magic Coms and Magic Jars. Magic Jars are used to warm rice – often all day long – whereas Magic Com is not only for cooking rice, but also for warming the rice. On average, a household uses 1.9 different types of stoves.

In general, households cook only one or two times a day, usually in the morning, and just heat the food for lunch or dinner. Around 90 percent of households do not cook lunch on a regular basis, while 40 percent of applicants, 38 percent of non-applicants but only 18 percent of users do not cook in the evenings but prepare the meal beforehand. In the mornings, many households use a second or a third stove. These are electric cooking devices (mainly Magic Coms) or LPG in most cases. Only very few households use a second or third stove to cook dinner. Particularly the rice prepared and warmed with electric cooking devices often serves for several meals. Hence, their usage frequency is relatively low compared to their contribution to the daily households' nutrition. Rice is usually accompanied by different vegetable, tofu, meat or fish dishes (referred to as *lauk* in Bahasa Indonesia).

LPG stoves are the most widespread stove type among applicants and non-applicants, followed by woodfuel stoves (Figure 5). Around 73 percent of applicants and 70 percent of non-applicants use LPG stoves for cooking, while 66 percent of applicants and 70 percent of non-applicants use stationary woodfuel stoves. Only 15 percent of biogas users continue to use woodfuel or LPG stoves. Instead, almost all of them (95 percent) use their biogas stoves. Just 5 households have an installed biogas digester but do not use it (in the case of one household, according to the interview, the digester was not producing a sufficient amount of gas). The use of electric cooking devices is not significantly affected by the availability of biogas. Across all three groups, around 50 percent use any such device with only very few owning more than one. Particularly Magic Coms are fairly widespread. Three-stone stoves or open fires are not used by any household for meal preparation.

Figure 5: Stove types used for cooking by group, in percent



The composition of stove types used by a representative household in the three comparison groups (hence also including households not owning the respective stove type or using it for cooking) is given in Table 23. Consistent with the preceding discussion and stove ownership patterns displayed in Figure 5, the figures in Table 23 clearly show sharp differences in stove usage patterns across the three groups. These patterns suggest that the availability of biogas leads to a movement away from LPG and woodfuel stoves. It can thus be concluded that – even though biogas users cook more often in the evening than their non-biogas-using counterparts (see above) – they use multiple stoves less frequently for the preparation of a single meal and therefore in sum show lower usage frequency figures.

In the last column of Table 23, the analysis is restricted to only those households who actually use the respective stove type for cooking. It becomes evident that – in case they are regularly used – stoves fuelled with woodfuel, LPG and kerosene are used around 10 times per week. They are, hence, on average used 1.5 times per day, whereas electric cooking devices are only used once and biogas stoves twice per day.

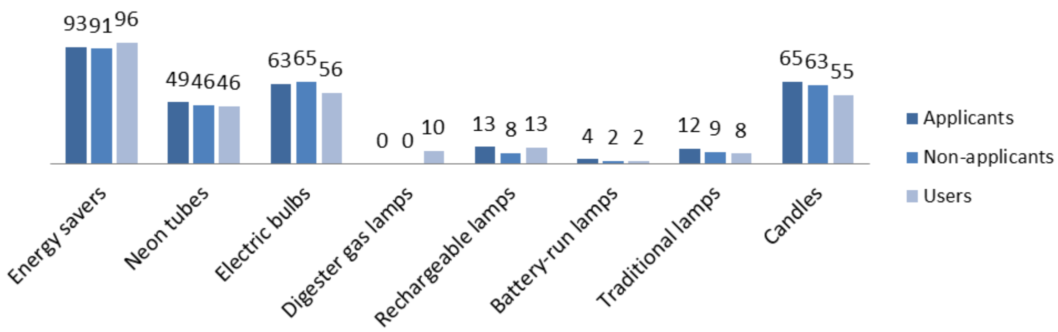
Table 23: Usage frequencies per week of different stove types

	Applicant (N = 250)	Non-applicant (N = 344)	User (N = 101)	Households using the respective fuel type
Stationary woodfuel stove	7.3	7.3	0.8	10.5
Kerosene-run stoves	0.05	0.1	0.0	9.3
LPG	8.5	7.9	0.9	11.4
Electric cooking device	3.9	3.9	3.1	7.4
Biogas	-	-	12.8	13.4
Total	19.7	19.2	17.6	-

Lighting

Biogas can also be used for lighting. In this section, we therefore look at energy usage for lighting and general habits related to lighting.

Figure 6: Usage of different types of lighting devices, in percent



With regard to the use of lighting sources, there are no stark differences between the three groups (Figure 6). Electric lighting devices are used in every surveyed household, mostly compact fluorescent lamps (energy savers, used by 93 percent of households). Incandescent light bulbs or simply “electric bulbs” are employed in 63 percent and neon fluorescent tubes by 47 percent of households. About ten percent of households use additional lighting devices such as rechargeable lamps or traditional lamps. Candles are used in 62 percent of households, however, the vast majority uses them only in case of a blackout (85 percent). Only 10 out of 100 biogas users use a biogas lamp.

Table 24: Electric lighting devices and consumption

		Number of lamps used per household			Lighting hours per day and lighting device		
		Applicant	Non-applicant	User	Applicant	Non-Applicant	User
Electric bulbs	outside	0.4	0.4	0.4	8.7	9.9	8.8
	inside	1.3	1.3	1.0	6.1	5.9	5.9
Neon tubes	outside	0.1	0.2	0.2	9.1	8.9	9.7
	inside	0.7	0.6	0.7	5.5	5.2	4.8
Energy savers	outside	1.0	0.8	1.5	10.0	9.7	10.1
	inside	3.7	3.5	4.7	6.0	5.5	6.3
Total		7.1	6.8	8.4	6.8	6.5	7.0

Table 24 shows the average number of lamps used inside and outside the house for each type of household. In general, very few lighting devices are used outside. On average, the three compared groups have seven to eight lamps, which are lit on average six to seven hours. Electric fluorescent tubes are the most frequently used type of lamp. On average, the lamps are used ten hours outside and six hours inside.

Table 25: Non-electric lighting devices and consumption

	Number of lamps used per household			Lighting hours per day and lighting device		
	Applicant	Non-applicant	User	Applicant	Non-applicant	User
Digester gas lamps	-	-	0.1	-	-	0.7
Total*	0.3	0.3	0.5	0.2	0.0	0.1
Candles	4.2	3.8	3.0	-	-	-

Note: The total for non-electric lighting devices comprises rechargeable lamps, traditional lamps, battery-run lamps, hurricane lanterns, digester gas lamps and Petromax gas lamps.

As a consequence of high penetration rates of electric lighting devices, non-electric lighting devices including biogas lamps are of less importance in everyday lighting. Only 49 percent of users, 29 percent of non-applicants and 32 percent of applicants use non-electric lighting devices. These households use rechargeable lamps most frequently and sometimes traditional lamps. Among the users, 10 percent use gas lamps fuelled by biogas. Every eighth household has a rechargeable lamp or a traditional lamp which is lit very irregularly. When looking at the lighting hours the limited importance of non-electric lighting devices becomes manifest. They sum up to less than 30 minutes per day on average across all non-electric lighting devices at most. Also, the biogas users use their biogas lamps for only a few minutes per day on average.

Table 26: Lighting hours and lumen hours consumed per day

	Applicant	Non-applicant	User
Lighting hours	48.66	44.34	59.19
Lumen hours	34,924	32,275	41,462

Table 26 shows the lighting and lumen hours including both electric and non-electric lighting devices. Some differences are observable between the users and the other surveyed households, but not so much between applicants and non-applicants. Users consume some 59 lighting hours per day, whereas the non-users only used them for 46 hours.

Figure 7: Satisfaction with lighting quality of different lighting devices, in percent

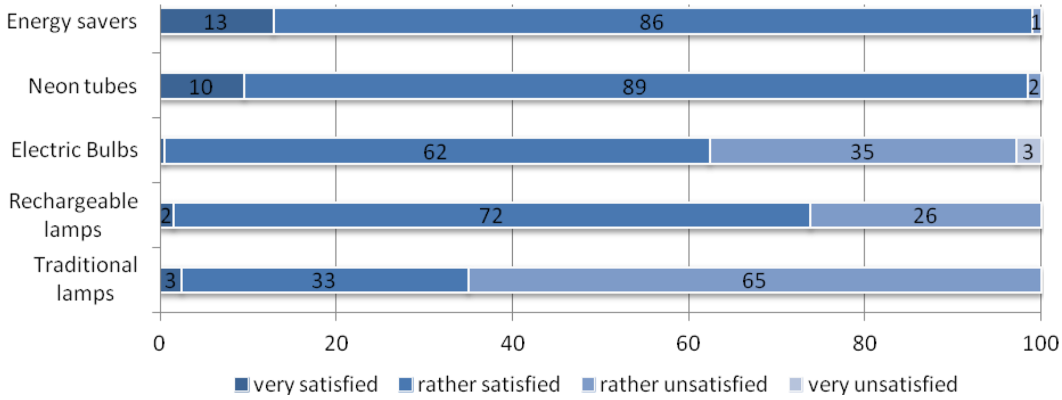


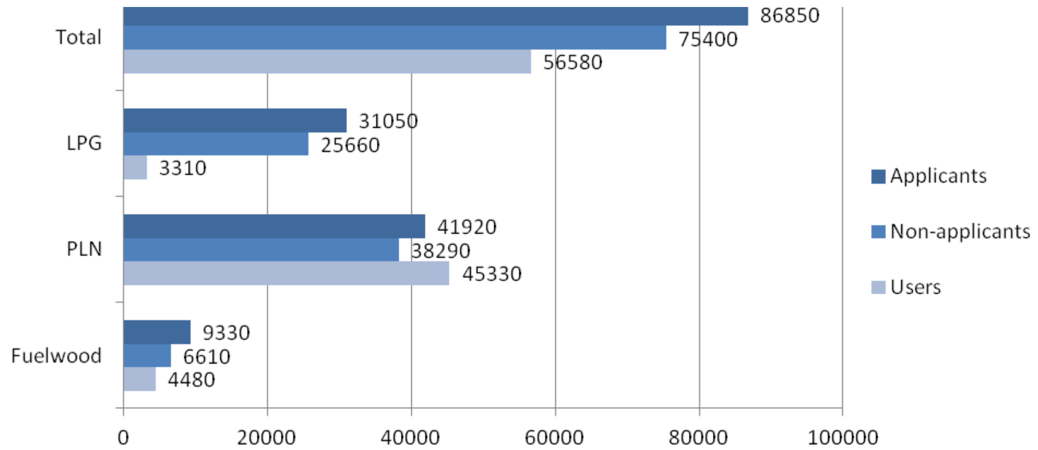
Figure 7 shows the respondents' satisfaction regarding modern lighting devices, traditional lamps and rechargeable lamps. Not surprisingly, households are in general more satisfied with modern lighting devices, energy savers are favoured most, followed by neon tubes, and rechargeable lamps. The highest level of dissatisfaction can be observed for traditional lamps, with 65 percent of households stating that they were dissatisfied with lighting quality. Biogas lamps are not displayed, since they are only available in a few households in the survey sample. The picture related to the satisfaction of households using a digester lamp seems to be mixed. Most households use their biogas lamp as a back-up lamp, in the case of blackouts, or complementary to electric lighting sources, e.g., in the barn or outside kitchen. Thus, in general, biogas lamps are not used as a primary lighting source. During the qualitative interviews households mentioned that, although they were satisfied with their lamps, they do not use them as a main source of lighting as they are too dim.

Energy expenditures

On average, energy-related needs account for 7 percent of total expenditure for applicants and non-applicants and about 5 percent for users. These differences are mainly due to differences in expenditures for LPG. While users only spend IDR 3,310 per month, applicants and non-applicants LPG expenditures amount to IDR 31,050 and IDR 25,660 respectively (see

Figure 8). At around IDR 40,000 IDR per month, expenditures for grid electricity (PLN) represent the main energy expenditure category for all three household types.

Figure 8: Average monthly expenditures for main energy sources, in IDR



Note: Candles, kerosene, batteries and generator fuel are included in the total but not presented individually as they are rarely used.

In East Java, a 3 kg cylinder costs around IDR 12,500-14,500. The average price that the surveyed households paid was IDR 4,710 per kg of LPG. Kerosene was used by very few households. Expenditures for batteries were low across all households averaging IDR 220.

4.6. Biogas

Background and financing

There have been several prior attempts by other programmes to introduce biogas in the BIRU intervention area in East Java. These initiatives have been funded by government agencies or Nestlé and have often been executed in cooperation with regional universities and research institutions. Some farmers have also built digesters on their own initiative and with their own money or with financial assistance from their cooperative. However, success has been limited due to technical problems with the digesters and lack of user training, as well as the relatively small scope of the programmes. It seems that many digesters built in the context of these programmes are already out of order which is in part linked to the design of the digesters. According to expert interviews there are generally three types of digesters in Indonesia: plastic bag digesters, fibreglass digesters, and concrete digesters. The plastic bag digesters are not built anymore as they are easily damaged and often do not function well. Likewise, the fibre digesters are also more sensitive than BIRU's concrete digesters. Another reason for problems of previous programmes is a lack of formal standardisation, user training, and maintenance. In some areas, bad experiences with previous biogas programmes posed a problem for the dissemination of the BIRU digesters at the beginning of the programme because households had lost trust in the technology. BIRU digesters are available in different dome sizes: four m^3, six m^3, eight m^3, ten m^3 and twelve m^3. The most commonly used dome size is six m^3 (56 percent of users), followed by eight m^3 (30 percent of users).

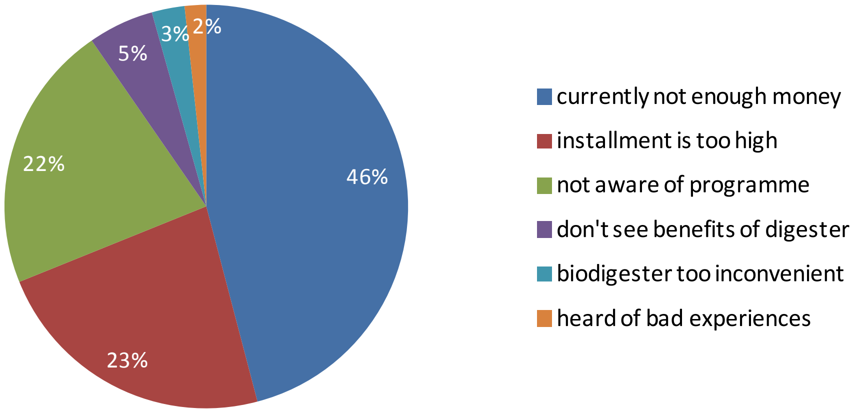
Of the 695 interviewed households only three had had previous experiences with biogas, one of whom is a user. Most households declared that they first heard of digesters from a representative of their cooperative. In most cases, the cooperatives acted as construction partner organizations (CPO) and played a fundamental role in promoting the technology and the programme as well as communicating it to the community. Households also stated that they heard from other cooperative members, from neighbours, friends or relatives. Very few households heard about the digesters from the local authorities, on TV, or from other sources.

Among the users, 85 percent financed the digester exclusively through a loan, while further 5 percent combined credit financing with other funding sources such as the disposable income or savings. The intention to finance the digester investment with a loan is even higher among applicants. As many as 89 percent of them intend to rely completely on the offered loans and 8 percent at least partly. According to BIRU, 60 percent of users financed their digester through a loan provided by Nestlé, while the rest of the loans were provided by Bank Syariah Mandiri (BSM), Rabobank or by the cooperatives themselves (sometimes with financial support from government institutions), and in some cases through funding from the government. The source of funding for the instalment scheme depends on the partners the cooperative chooses to cooperate with. Nestlé provides loans without interest, while Rabobank charges an annual interest rate of 8 percent over a period of three years and BSM a flat rate of 11 percent over five years. The rest of the users financed their plants through their current income (six percent), savings (four percent), or other sources (three percent) such as selling land, cows or gold. In general differences between users and applicants in terms of plant financing are small.

Reasons for not applying

When asked for their reasons for not applying for a digester, 46 percent of non-applicants stated that they cannot afford it currently, and for 23 percent the instalment for the loan was too high. 22 percent are simply not aware of the programme. Only five percent of households do not see the benefit of a digester, about three percent think digesters are inconvenient, and around two percent have heard of bad experiences from others. None of the households stated having had bad experiences with biogas themselves.

Figure 9: Reasons for not applying for a BIRU digester



Note: Households could give multiple reasons.
Source: BIRU Baseline dataset 2011

Often, households who cannot afford to build a digester alone or who face other constraints such as lack of suitable land or too few cows apply for a digester together with another household. 43 percent of applicants applied together with another household, while only 20 percent of users are sharing their digester. This supports the observation that the programme may now be reaching relatively lower income households as compared to the early phase.

Biogas usage

Although in principle possible, biogas is hardly used for lighting (see Section 4.5). 95 percent of users state that their digester is producing gas as expected, while four percent say that it is producing less gas, and one percent that it is not producing any gas at all. One household stated in an additional qualitative interview that their digester had never worked and that they had not received satisfactory support from the CPO. However, overall households seem to be very satisfied with the performance of the digesters and only ten percent of users would like an increase in biogas supply.

Biogas is used for cooking by 97 percent of the households that have a biogas stove. One biogas stove produced by Metalindo factory in Surabaya is part of the BIRU package, and households buy an extra stove on their own or have a mason help them modify their LPG stove. The average number of biogas stoves per household is 1.8. Other uses of biogas are heating water for tea and coffee, cleaning milk cans or for bathing (see Table 27). Applicants and non-applicants use either firewood or LPG to boil water.

Table 27: Other purposes of stove usage

Stove type	Biogas	LPG			Woodfuel		
	user	Applicant	Non-applicant	User	Applicant	Non-applicant	User
Cow rearing (e.g. clean milk cans)	59 %	16 %	10 %	2 %	55 %	52 %	9 %
Heating coffee/ tea	89 %	65 %	62 %	6 %	34 %	33 %	0 %
Heating bath water	31 %	5 %	4 %	2 %	11 %	10 %	2 %
Heating house	-	-	-	-	17 %	17 %	20 %

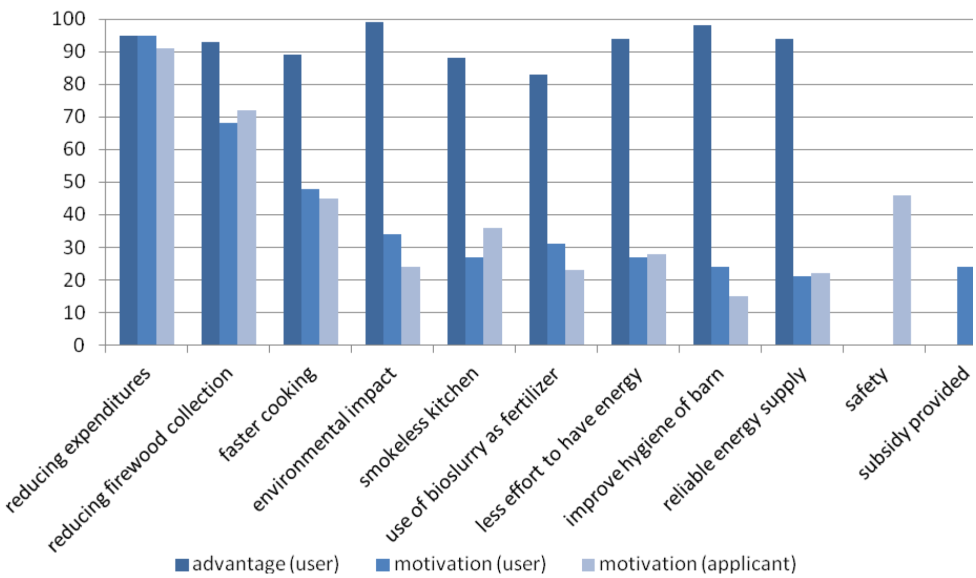
In principle, the toilet can be connected to the digester in order to increase biogas production. In qualitative interviews households stated that they do not want to do this as they found it disgusting. Representatives of BIRU East Java confirmed this view. However, the survey reveals that seven percent of users have connected their toilets to the digester.

Motivations for applying compared to perceived benefits and problems

In most households, the application for a digester was a collective decision. For 64 percent of users and 67 percent of applicants it was a family decision, while the household head (in 94 percent of cases the husband) decided in 28 percent of user and applicant households. For five percent of users and three percent of applicants, the spouse was the decision maker – all of them being females.

Users were asked about their motivation to obtain a digester. They were also asked to point out the perceived advantages of digester usage. Respondents were first asked to list the various advantages and then indicate the most important advantage. Applicants were also asked to provide their motivations for applying. The two most common reasons were the possibility of reducing expenditures and saving time. For 56 percent of applicants reducing expenditures was their most important motivation for applying, while 20 percent highlighted the reduction in time spent on firewood collection. Safety issues and faster cooking are decisive only for nine and five percent, respectively. Convenience – the biogas is piped directly into the kitchen – is hardly mentioned as an important reason to obtain a digester.

Figure 10: Motivations for applying and perceived advantages of owning a digester, in percent



Note: Concerning safety, there are no results for users, since they were not asked whether they saw safety as a motivation or an advantage.

Biogas users see a reduction in firewood collection as the most important benefit aside from monetary savings[11] (almost 40 percent of users see this as the main advantage), followed by faster cooking (17 percent), the environmental impact (10 percent), reliable energy supply and easy access to energy (6 percent each).

[11] Expenditures were excluded here, since – based on the results of the pre-test – it was assumed that most households would state this as their primary advantage.

Over 90 percent of households cook in a kitchen inside their house both in the dry season and in the rainy season. 98 percent of users are satisfied with the air quality in their kitchen, while the percentage of applicants and non-applicants who are satisfied with the air quality in their kitchen is significantly lower at 78 percent and 72 percent, respectively. Most households link the poor air quality to the use of firewood for cooking.

As can be seen in

Figure 10, only 27 percent of users applied for a digester in order to reduce air pollution. Afterwards, though, 88 percent perceive this as an advantage of having a digester. This might indicate that they only became aware of household air pollution problems after having changed to a cleaner fuel. Similarly, only 36 percent of applicants see the reduction of air pollution as a motivation for applying.

Improving the properties of dung as a fertilizer through the fermentation process in the digester is one of the main components of the programme (see Section 4.4 on dairy farming and slurry usage). The usage of slurry as fertiliser was a motivation for 31 percent of users and 24 percent of applicants and 84 percent of users saw this as an advantage. Safety is a motivation for 46 percent of applicants (see

Figure 10). This may be connected to the high perceived risk of cooking with LPG which is affirmed by the fact that many households express fear of LPG explosions as a motivation for applying in qualitative interviews.

When asked in the qualitative interviews who benefited most from the biogas installation, in most interviewees' perception all family members benefit equally. However, in many cases interviewees consider the wife to benefit most, since she is the one in charge of cooking. Some female interviewees mention that cooking is easier and they have more time to rest or for other housework duties. Another point mentioned sometimes is that they are not dependant on their husbands anymore to exchange the LPG cylinder. Some women were also scared of using LPG and happy that they are not forced to use it anymore.

Technical problems mentioned in the qualitative interviews include problems related to the biogas stoves (mainly corrosion), problems with the mixer and leaking pipes. Many households perceive biogas as being safer than LPG. However, none of the households have experienced accidents with LPG in the last 12 months and only four have experienced accidents with lamp-related fires. According to the head of BIRU East Java so far there has only been one lethal accident caused by a user lighting a cigarette while cleaning the digester. A similar accident also occurred in Lombok.

5. The Intervention in a Different Context – BIRU Lombok compared to BIRU East Java

5.1. Background BIRU Lombok

A qualitative evaluation in the BIRU intervention region in Lombok was conducted in order to place the survey results from East Java into perspective and to assess how far usage and impacts may differ across the regions. In general, the province of West Nusa Tenggara (NTB – Nusa Tenggara Barat) is less developed than the province of East Java. This is reflected by the fact that the province ranked 32nd of 33 provinces in the 2009 HDI ranking for Indonesia, and 27th in the 2007 MDG-Index ranking and has a poverty rate of 28 percent (as compared to East Java which ranked 18th and 7th, respectively, and has a poverty rate of 11 percent; BPS 2009, 2011; BPS et al. 2004 and UNNDPA 2007).

The fact that there is no dairy sector in Lombok is a crucial obstacle hampering the diffusion of digesters, along with financial constraints and lack of access to credit. Differences in attitudes and culture also play a role. Additional factors that affect the development of a biogas sector are the low level of education, a lack of a well-functioning infrastructure (including energy infrastructure, water and sanitation infrastructure and roads), a low level of integration in the national and global economy, physical conditions (e.g. dependency on rain due to the lack of rivers), and factors linked to farming and livestock practices.

The BIRU biogas programme is active in 30 villages in the region and is spread across all four districts of Lombok. Activities in Lombok started in July 2010, following a market study. The first digesters were installed in Central Lombok in Gapura village, in the district of Pujut, which is also the site of almost half the 107 BIRU digesters installed in total in Lombok.

The evaluation of the programme in Lombok was conducted two weeks after the data collection in East Java had ended and was based on qualitative methods, including semi-structured interviews, focus group discussions and field observations. Interviews were conducted with households, biogas masons, village heads, BIRU staff and other key informants such as representatives of the provincial and regional branches of the Ministry of Energy and Mineral Resources (ESDM), the Ministry for Environment, researchers from the University of Mataram (UNRAM), and a researcher involved in the Dutch capacity development programme Casindo.[12] These interviews provided valuable information on the energy sector in Lombok, the provincial government's overall energy strategy, other energy initiatives and development programmes in the region as well as on potential and obstacles for biogas development.

To get an overview of the study regions and of issues relevant for biogas, the field work began with focus group discussions and was followed by semi-structured household interviews. These discussions were conducted in three of the four districts. Household interviews and focus group discussions included topics related to energy usage and attitudes, in particular concerning biogas. The interviews also gathered information on some demographic issues. In total, 37 semi-structured interviews were conducted with households and village heads in all four districts of the island. In addition, 5 interviews were conducted with masons working for all three CPOs.

[12] Casindo aims at strengthening capacities for energy policy formation and the implementation of sustainable energy projects in West Nusa Tenggara and four other Indonesian provinces.

The villages for this study were selected in such a way that in each district one to four villages were included. In Gapura village, where the highest number of digesters had been built at the time of the field work about twice as many households as in the other villages were interviewed, along with several key informants.

5.2. Findings

The following summarises the most important findings. At the time of the field work a total of 107 digesters had been installed, of which eleven were demo-plots financed completely by BIRU. Interestingly, seven of the eleven demo-plots are located in East Lombok where the CPO obtained money from the local government. At the time of the study BIRU was working with three CPOs, all of which are local NGOs. There are plans for another NGO and another cooperative to become CPOs. Although there have been talks with several banks and cooperatives, so far, there has been no agreement on a credit scheme for the financing of the digesters.

When comparing the outcomes of the BIRU programme in East Java and in Lombok, it becomes obvious that the programme in East Java is more advanced in terms of the number of digesters built, as well as the development and institutionalisation of a biogas sector which is likely to ensure the continued usage of biogas after the end of the BIRU programme. The successful institutionalisation becomes manifest in the infrastructure provided by the dairy cooperatives in East Java, private sector support by Nestlé, the involvement of vocational schools and the national animal husbandry training centre BBPP in Batu near Malang. Furthermore, local production of biogas equipment in Surabaya has been established and a local fertilizer producer is planning to market organic fertilizer based on bio-slurry to palm oil plantations throughout Indonesia. The conditions in Lombok are different. So far, there is no support for the programme through the private sector or financial institutions. Organisations and companies interested in the development of a biogas sector are lacking – except for government institutions and the University of Mataram. However, both in Bali and in Lombok there are plans to integrate bio-slurry in the development of organic agriculture, which may increase the attractiveness of biogas usage. Based on the development of the programme in Lombok to date, it seems that it will be hard to meet the initial target of 1500 units by the end of 2012.

At the same time, the pre-conditions (space and ownership of cows) for the success of biogas as a technology do prevail in Lombok, especially in light of the provincial government's programme of subsidizing cows (Bumi Sejuta Sapi (BSS) – "Land of one Million Cows Programme") and the fact that most livestock keepers are also farmers and can use the slurry. The incentives for households to apply for a digester seem to be higher than in East Java, as LPG and electricity are much more difficult to access. Most households use firewood, so that the potential for time and monetary savings and, hence, socio-economic benefits are higher. Biogas lamps may additionally produce larger impacts on households' life in Lombok compared to East Java given that households in more remote areas still use kerosene for lighting.

The BIRU programme in Lombok started a year later than it did in East Java. While this has to be factored in while making comparisons, the qualitative interviews and field observations reveal that there are several obstacles which may hinder the dissemination of digesters. First, at the household level, there are stark differences between the two regions. On the institutional level, the CPOs differ very much in terms of size, biogas experience, human resources, and budget. These differences between Lombok and East Java will be summarised in the following.

A) Obstacles linked to regional conditions and household characteristics

Physical conditions and infrastructure provision: Many regions in Lombok face water scarcity in the dry season and changes in rainfall have led to lower harvests for many farmers. This is a factor of insecurity which may make farmers less likely to make an investment. Some farmers stated that they did not have enough water for the cows, which may also keep them from investing in a technology that is dependent on cow dung. Lack of water might also represent a problem for the filling process and, as a consequence, time for fetching water has to be included in the process. Bad road conditions and a lack of accessibility of some regions make it more difficult and expensive for the CPOs to promote and construct digesters in certain areas. In most areas firewood is still available, even if the gathering process takes a lot of time. This combined with the fact that many households are not accustomed to cooking with gas, as LPG is not widely available, may reduce the incentives to apply for a digester.

Degree of cooperative organization: Households are not organised in one institution like a cooperative with a common interest and fairly hierarchical structures as is the case in East Java, making it harder to successfully promote the programme.

Financial constraints and lack of access to credit: The general income level in NTB is lower than in East Java and, therefore, the cost of the digester relative to household income is higher. At the time of the field work, no credit scheme had been established, which posed a major obstacle for many households. Large parts of the yearly household income stems from the rice harvest. This implies that households are most likely to be able to finance a digester right after the harvest season. This also means that in most cases there is no regular monthly income, making it harder for households to plan ahead and make long term financial decisions. Banks and other credit institutions are reluctant to provide loans to households.

Animal husbandry: Households keep cows in order to produce beef, not milk. Therefore, cows are sold every couple of years and do not yield a regular income. Households do not know for how long they will have their cows making it risky to invest in a digester. Furthermore, all cows in a village are kept in a communal stable from where the dung has to be fetched. Likewise, water has to be obtained from a shared well or spring. This was also mentioned as one of the reasons, why some biogas users only fill their digester once or twice a week.

Lack of private sector support: So far in Lombok there are no private sector stakeholders who are interested in supporting the programme. Cows are usually sold at the local market and there are no powerful stakeholders with an interest in promoting the biogas technology such as Nestlé in East Java.

Cultural factors and perception of biogas: Especially in the first stage of the programme people perceived biogas as being *haram* (unclean/ forbidden by Islamic law), since it is produced on the basis of dung. Some untreated households stated that they thought biogas was disgusting or impractical because of the filling process. In some regions previous biogas projects have failed, which has led to a negative image of biogas.

B) Obstacles linked to the CPO's capacities

Problems that the CPOs face: All three CPOs are small local NGOs without much experience in implementing a programme which has the scope of the BIRU programme. They have limited personnel and financial capacities. They are also not familiar with all of the regions where they are implementing the programme and have to find a way to identify target households, build trust among the local population and build structures to disseminate and construct the digesters, as well as ensuring payment. This is especially difficult, as they are often seen as organizations coming from outside the village. Building the digesters is only profitable once a certain number has been reached, meaning that at the beginning, the programme can lead to financial losses for some of these small organizations. Two of the three CPOs have financial difficulties and have not reached the stage yet at which building digesters becomes profitable. While the CPOs in Lombok only have a few part-time employees, the dairy cooperatives in East Java have a larger overhead and better qualified staff.

While in Lombok the CPOs follow ideological and humanitarian goals, the cooperatives in East Java seek to improve business opportunities of their members and to bind their members to the cooperative. They can use the structures that are in place for collecting and processing milk for the dissemination, construction, and payment of the digesters, which reduces the cost of running the programme, while the CPOs in Lombok have to create these structures first and build up trust in the local community. In East Java, the target households and many of the masons are cooperative members, so the CPOs are very well informed on the households' needs, but also on their financial situation. Biogas can be promoted at regular cooperative meetings and households trust the institution they are dealing with. In Lombok, however, it is a lot more difficult for the CPOs to find potential target households and in some villages in West Lombok there was great mistrust towards the CPO. Success of the programme in Lombok heavily depends on whether the CPO had already been active in the respective biogas target region and has established trust in the community prior to the BIRU intervention.

Problems resulting from the CPOs' limitations: Some problems are linked to the implementation of the programme, and include issues such as a lack of transparency, miscommunication with households, masons and with BIRU staff, and a lack of standardised procedures for the construction process and the payment of the digesters. Masons received different payments for the same work from the same CPO and households had to pay different amounts of money for the same plant size due to variations in material and transport costs. This has led to conflicts between households, masons and the CPO or BIRU. In general, the NGO YSLPP seemed overstrained with the role as CPO.

Selection of target regions: The CPOs did not seem to have a clear system of selecting target regions based for example on potentials for biogas development. As a consequence, there were only one or two digester in one village, and households were very spread out which lead to logistic problems and increased transportation costs.

Selection of and communication with households: While in Central Lombok the programme is running quite well and the CPO is quite familiar with the target population, especially in West Lombok, there seemed to be a lack of pre-selection criteria for households, based, for e.g., on financial criteria. In several cases, households received a loan from someone connected to the CPO although they actually could not afford to build a digester and already had a substantial amount of debt. They turned out to be unable to buy the materials and to pay the masons for their labour. In one case the digester was never finished and was not functioning at the time of the study, implying a substantial financial burden for both the masons and the households. In one village in West Lombok several applicants also resigned because they had not been adequately informed of the costs of building a digester prior to registration. These aspects led to a negative image of the programme in the region, making it hard to convince households to apply for a digester.

6. Evaluation risk

The baseline data permit an initial assessment of the potential risk to the planned evaluation strategy, and to flag potential caveats that we need to consider for the follow up study. As set out in Section 3.2, the evaluation strategy and survey design was based on a difference-in-difference approach (DiD) with a cross-sectional pipeline approach as robustness check. For the principal strategy, the DiD approach, three main sources of risk have been raised. First, the parallel trends assumption could be violated. Second, the designated control group could apply for – and receive – a biogas digester during the period between the baseline and follow-up survey. Finally, the interviewed applicants may resign or not receive a biogas digester before the follow-up.

As for the first risk, the parallel trend assumption seems credible within the BIRU programme context, as we are focussing on a relatively homogeneous group of farmers who operate in a similar economic and institutional environment. This is further supported by the baseline data, showing applicants and non-applicants to be quite similar in many regards. For the remaining differences, there is no indication that these are systematic and due to the biogas treatment. Moreover, the extensive survey data that was collected would allow us to detect such differences and control for them.

Regarding the second risk, oversampling of the control farmers provides more scope to deal with contamination of the control group. Given the large number of cooperative members that – in principle – qualify for the digesters, it is very unlikely that a large share of the non-applicants will apply for a digester and have one installed before the follow-up survey. The decision to conduct a follow-up survey already one year after the baseline is partly driven by the aim to reduce the risk of treatment contamination of the control group. The third risk is perceived as negligible, since most users have so far received a digester two weeks to three months after application. There is no indication that this should change in the months after the baseline. Although the BIRU programme has gathered speed in recent months, there is also no sign of a serious bottleneck that might hamper an installation of most foreseen digesters in due time.

The second evaluation strategy, the cross-sectional pipeline approach, is immune to these three risks, since it does not require on a follow-up survey. A major risk for this approach, however, is apparent from the baseline analysis: The two groups that need to be compared for the implementation of this approach (i.e. users and applicants) seem to differ in a number of relevant observable characteristics. We may balance the samples by regression and matching techniques, but given the pronounced differences we cannot rule out remaining differences in unobservable characteristics and need to take care when interpreting pipeline comparison based impact estimates.

7. Summary: Answers to the evaluation questions

7.1. Output

Which socio-economic groups have applied for a digester?

See Section 4.3 'Household characteristics': The baseline data show that, on average, farmers who already used biogas at the time of the survey have different characteristics as compared to applicants and non-applicants. Differences between applicants and non-applicants are smaller. Most notably, users have higher incomes, a higher level of education and larger farm sizes. This indicates that these "early adopters" differ on characteristics exogenous to the BIRU programme.

Have households made use of credit schemes or other loans to obtain a digester? What percentage of the total investment cost was financed through such means?

See Section 4.6 'Biogas': In East Java the dairy cooperatives provide loans financed by Nestlé (60 percent of loans), local banks or their own money to their members. 85 percent of users and 89 percent of applicants exclusively used these credit schemes. For an additional 5 and 8 percent of users and applicants respectively, at least part of the investment cost was financed through loans. In Lombok, so far, there are no credit schemes.

Were users properly informed on how to use the digester (e.g. plant initial feeding, presence of user manual)?

See Section 2.1 'Description of the BIRU intervention': Users were informed by their cooperative on the usage of the digesters. They are trained on the proper usage of digesters through targeted training provided by BIRU and receive a user manual. A mason is present during the initial plant feeding. In Lombok, so far, there has been no regular user training and there were some indications that digesters are not used properly.

How many of the applicants (or actual biogas users) were using LPG, kerosene, electricity or firewood prior to the intervention?

For baseline information on energy usage see Section 4.5 'Energy sources and usage', particularly Figure 4 on energy sources by analysed group. All surveyed households have access to electricity, and 86 percent have been connected for over ten years. LPG is used by 75 percent of applicants and 73 percent of non-applicants. Kerosene is used by 8 percent of non-applicants and 4 percent of applicants. 72 percent of interviewed households use firewood.

7.2. Outcomes

As compared to the applicants, which socio-economic groups obtained digesters?

See question above: Which socio-economic groups have applied for a digester?

Which household member/s decided on purchasing a digester, disaggregated by gender?

See Section 4.6 'Biogas': In most households, the application for a digester was a collective decision: 64 percent of users and 67 percent of applicants decided within the family, while it was the household head (in 94 percent of cases the husband) who decided in 28 percent of user and applicant households. For only five percent of users and three percent of applicants, the spouse was the decision maker.

How reliable is the gas supply?

For baseline data, see Section 4.6 'Biogas': In general, gas supply is reliable. 95 percent of users state that their digester is producing gas as expected, while four percent say that it is producing less gas, and one percent that it is not producing any gas at all. In a qualitative interview, one household stated that their digester had never worked and that they had not received satisfactory support from the CPO. However, overall households seem to be very satisfied with the performance of the digesters and only ten percent of users wished an improvement in biogas supply. In Lombok, there were two cases where digesters were not working properly and several households stated that they did not have enough gas.

How many digesters have been installed and how many are being used?

See Section 2.1 'Description of the BIRU intervention': By May 2011, 2,700 digesters had been installed (4,000 by the end of 2011). 2,086 of the 2,700 had been constructed in East Java, and 107 in Lombok. These figures are based on the BIRU database, which meticulously records information on the installed digesters. Its accuracy could be verified by means of the random sampling of biogas users based on this list. In this context, it should be mentioned that a total of 18 sampled users who had been selected based on the BIRU database had to be replaced as they could not be located. However, these difficulties are mainly linked to the fact that traditionally there are no surnames in Indonesia, making it hard to identify and locate households.

All but one of the 101 surveyed users were using their digesters. Furthermore, two sampled users were not interviewed and were replaced because they did not own cows at the time of the survey and therefore did not feed the digester.

7.3. Impacts

To what extent have the installed biogas plants actually been used for gas production? If they are not being used, why?

See Section 4.6 'Biogas', and the last two questions on the reliability of gas supply and the number of digesters used.

Which expenditures did the household reduce in order to finance investment in the digester?

Will be addressed during the follow-up survey through the structured questionnaire.

Most households in East Java mentioned in qualitative interviews that they did not perceive a significant reduction in other expenditures to finance the digester. As mentioned above, the bulk of the digesters were financed through loans and the repayment method of reductions in milk payment significantly reduced the perceived burden of financing the digester and is thereby unlikely to have led to major changes in expenditure patterns. In Lombok, however, some households said that they had to cut back on basic living expenses and others who had a loan did not know how to pay it back.

For what purposes is biogas used (cooking, lighting, other)?

For user data at the time of the baseline see Section 4.6 ‘Biogas’ and Section 4.5 ‘Energy sources and usage’: Biogas is mainly used for cooking (by 97 percent of biogas users) and to heat water (88 percent of users). 89 percent of users use biogas to heat water for coffee or tea, and 31 percent for bath water. Biogas is also used by 59 percent of users for cow rearing purposes such as the cleaning of milk cans or the washing and softening cow udders with warm water. In principle it is possible to use biogas for lighting. However, only 10 out of 100 users are using biogas lamps. This is no surprise, as all households in East Java have electricity.

What is the relative share of the various sources of energy for cooking and lighting (biogas, LPG, kerosene, electricity, candles, charcoal, firewood, others)?

For cooking, see Section 4.5 ‘Energy sources and usage’. Around 73 percent of applicants and 70 percent of non-applicants use LPG stoves for cooking, while 66 percent of applicants and 70 percent of non-applicants use stationary woodfuel stoves. Among users, only 15 percent continue to use woodfuel or LPG stoves. Almost all of them (95 percent) use their biogas stoves, sometimes in combination with other stove types. Across all three groups, around 50 percent of households use electric cooking devices. Charcoal is generally not used for cooking and kerosene by only 5 households in the sample.

In terms of stove applications, applicants and non-applicants show a virtually identical profile: Around 38 percent of hot dishes are prepared with firewood, 42 percent with LPG and 20 percent with electric devices. Particularly the rice prepared and warmed with electric cooking devices often serves for several meals. Hence, their usage frequency is relatively low compared to their contribution to the daily households’ nutrition. For users, the shares are as follows: 5 percent each for firewood and LPG and 18 percent for electric devices – the remaining 72 percent of stove applications are fuelled with biogas.

For lighting, refer to Section 4.5 ‘Energy sources and usage’: Across all three analyzed groups, virtually all lighting, i.e. more than 99 percent, comes from electric lighting devices – both in terms of lighting hours and lumen hours, which is the unit for the quantity of light radiated by the different lighting sources. First of all, this is due to the fact that only about ten percent of farm households use lighting devices that are not fed by grid electricity at all – for example rechargeable lamps or traditional lamps. Candles are used in 62 percent of households, however, the vast majority uses them only in case of a blackout (85 percent). Only 10 out of 100 biogas users use a biogas lamp and if so only occasionally such that biogas lamps so far only represent 0.1 percent of total lighting hours consumed in biogas using households.

To what extent are traditional stoves still used?

Traditional stoves still in use are woodfuel stoves, which are exclusively fuelled with firewood, and kerosene stoves. For details see the previous question.

How much is saved in total (per week or month) on ‘traditional’ energy sources (LPG, kerosene, firewood, candles)? How have expenditures for energy changed over time?

Baseline data that will be used to assess this question is presented in Section 4.5 'Energy sources and usage'. In addition, biogas using farmers were asked in the baseline survey how much they thought they saved on energy expenditures per month. The average self-reported savings were IDR 89.532,65 (€ 7.50) per month. One third mentioned savings between IDR 10.000 and 40.000, a second third between IDR 40.000 and 55.000 and another third higher values of up to IDR 600.000 (ca. € 50).

How have cooking and lighting habits changed due to the use of biogas?

Changes in cooking and lighting habits can only be determined after the follow-up survey and the impact assessment has been conducted. For baseline data on cooking and lighting habits see Section 4.5 'Energy sources and usage'. Based on the user data, the following statements can be made: Only few users own a biogas lamp so far and those who do use their biogas lamp rather as a back-up lamp. Almost all user households cook with biogas, which partly replaced both firewood and LPG. Beyond monetary savings, 17 percent of the users see faster cooking as the biggest advantage of having a digester, which indicates that biogas usage may have an impact on the cooking process. In qualitative interviews, several users stated that cooking was faster and easier, that they could do other tasks while cooking instead of watching the fire, or that they had changed their kitchen arrangement since they got the digester.

Has there been any change in time/ workload, disaggregated by gender?

Activity profiles were included in the baseline survey but not reported in the baseline report. They will be used to determine changes in time/ workload, disaggregated by gender in the follow up survey. It can be expected, however, that male household members will benefit most from time saved on firewood collection (on average 6.8 hours per week), since they are more likely to collect wood than women, while women are expected to benefit from time saved on cooking. On the other hand, men are usually in charge of filling the digester which takes on average 15 minutes per day.

For what purposes has the saved time been used, disaggregated by gender?

Activity profiles are available from the baseline, but are not reported. In the follow-up they will provide information on changes in time usage.

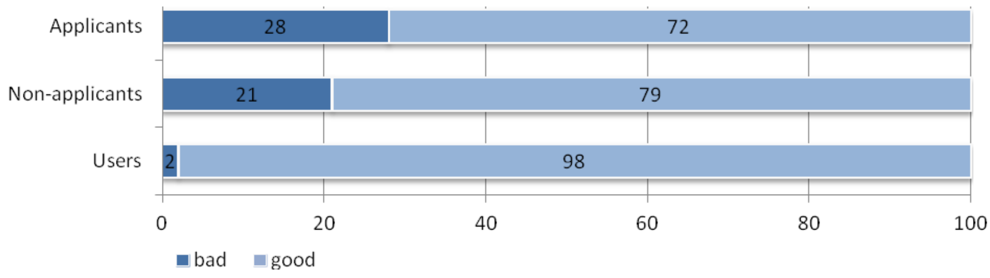
In qualitative interviews several women mentioned that they had more time to rest or for tasks in the household now that they had the digester, while men stated that they had more time for farm work, other income generating activities, or to spend with their family.

To what extent did indoor air pollution reduce (perception of users only)?

Effects on air pollution will be determined in the follow-up survey. Two descriptive figures on the perception related to household air pollution are given below.

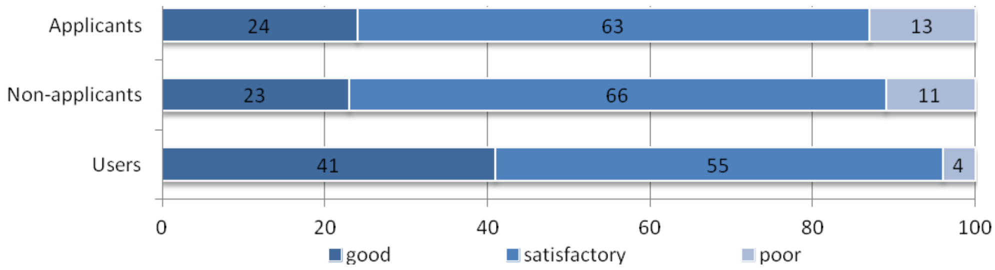
In qualitative interviews especially women mentioned that they felt that there had been a reduction in indoor air pollution.

Figure 11: Farmers' assessment of household air quality



Note: Only one household mentioned cooking exclusively outdoors.

Figure 12: Interviewers' assessment of kitchen ventilation



To what extent have health conditions (in particular respiratory illnesses) changed, specifically among women and children?

Questions concerning health conditions were included in the baseline survey, but are not reported. The follow-up report will address questions of changing health conditions.

Baseline figures on the incidence of diseases that affected the respiratory system, eyes or head of household members of surveyed farming households are given in Table 28 below. Beyond the reduction in indoor air pollution, especially women mentioned in qualitative interviews that they felt healthier and had fewer problems with watering eyes, cough, and colds since they started using the digester.

Table 28: Incidence of specific diseases, in percent

	Applicant (N = 250)	Non-applicant (N = 344)	User (N = 101)
Any household member suffers from respiratory diseases	16	17	11
Any household member suffers from eye diseases	5	3	1
Any household member suffers from headaches	41	40	45

Does the household use the slurry as fertiliser? How did the households use/ dispose the dung before the intervention?

Around 63 percent of biogas users use the slurry as a fertiliser. Most households who do not own a digester either use the dung as fertiliser or dump it into a lake or river, the irrigation system or an open drain. For specific values, refer to the baseline information presented in Section 4.4 'Dairy farming and slurry management".

What is the effect of digester slurry on agriculture (use and sale of fertiliser, expenditure on fertiliser, frequency of manure collection, crop yields)?

For baseline information on expenditures for fertiliser and frequency of manure collection.See Section 4.4 'Dairy farming and slurry management'.

To what extent has comfort/convenience changed, disaggregated by gender?

Several questions in the baseline survey address issues like improvement of subjective well-being or general amelioration of living conditions (see baseline report Section 4.3 'Household characteristics'). Changes of these issues will be reported in the follow-up survey.

In qualitative interviews, some women said that they got more rest and that the cooking process was faster and more comfortable because the stove was on a table instead of on the floor like the stationary woodfuel stove, so they could stand up while cooking instead of crouching. They also said that they could perform other tasks while cooking because they did not have to watch the fire, and some said that they felt it was safer. In the case of LPG, safety was the main issue, and many women said that they felt safer using biogas. Men stated that they could save time collecting firewood. Both men and women stated that it was easier to clean the barn thanks to the effluent drain connecting the barn to the digester.

What monetary value do households attribute to this increased convenience?

The baseline questionnaire did not include a question related to this.

To what extent have activities during evenings changed due to improved lighting usage? Have study hours/reading time of children changed?

Information on activity profiles is available from the baseline, but not reported. In the follow-up this information will be used to assess changes in time usage and activities. However, no major changes in evening activities can be expected, since all households have access to electricity and use electric lighting devices. Consequently, among households that already use biogas, biogas lamps are neither widespread nor do they remarkably change lighting usage patterns.

Have additional jobs been created in the biogas business sector (contractors, masons, input supply), disaggregated by gender?

The full impact of the programme on job creation will be addressed qualitatively during the follow-up mission. In Lombok, 30 biogas masons have been employed, while in East Java there were 200 biogas masons at the time of the survey. All the masons were men. Every mason also had one to four helpers. In Lombok some new jobs were also created for biogas supervisors, among them one woman. Other sectors that might benefit from the project are suppliers of materials, producers of stoves and lamps and fertiliser manufacturers. Most of the materials are supplied locally, so that local producers are expected to benefit. However this would have to be investigated in order to make a sound statement on the actual impact of the programme on job creation.

The lamp and stove producer in East Java, Metalindo, is a fairly large international company, with several hundred employees in Surabaya alone, and the owner said that no new jobs had been created to produce the biogas lamps so far. According to information provided by HIVOS this is different in other areas of Java where smaller local producers produce the lamps and stoves. A limited number of jobs (approximately ten according to the head of the fertiliser producer CV Roda Tani) may also be created in the production of fertiliser from bioslurry.

Note that these are only gross effects. To the extent that investment in the digester requires funds that have to be retracted from other purposes, jobs are lost (or at least not created) elsewhere. Likewise, biogas replaces LPG in many cases so that local LPG retailers as well as the LPG industry may lose. While this, as a matter of course, might be intended for political reasons, it has to be taken into account in order to estimate the net job creation effect of the programme.

Has the availability of biogas triggered new economic activities or displaced old ones?

A market for fertiliser is developing in East Java. The usage of slurry may lead to reduced usage of other raw materials such as animal dung. Other economic activities benefitting from biogas are small home industries like the sale of prepared food. Some farmers also use the biogas for agricultural activities, like heating water for their cows. In general the digesters can be expected to have a positive impact on the productivity of milk cows because they tend to improve hygiene in the stable (as expressed in qualitative interviews with users and cooperative members as well as according to visual inspections during field visits).

Local kerosene, LPG and firewood sellers might experience negative impacts from the project due to reduced demand for other energy sources. However, both kerosene and purchased firewood are only consumed by few households (less than 20 percent).

What (if any) are the un-intended or negative impacts?

So far there do not seem to be any unintended negative impacts. One issue that needs to be further investigated is the emission of methane into the atmosphere by the digesters. Once the gas pressure rises above a certain level the digesters automatically emit the gas in order to reduce the pressure in the digester dome. CPOs, farmers and BIRU in East Java mentioned that this happens quite frequently, since gas production for some farmers exceeds gas demand, at least during certain periods. While this may not be considered a negative impact compared to the no-digester-situation, since methane would continue to be emitted, it has to be taken into account while calculating the net amount of avoided methane gas emissions.

Are there more or less accidents (explosions etc.) as compared to LPG usage?

None of the surveyed households had experienced accidents with LPG in the 12 months prior to the survey. In the public perception, LPG accidents are frequent and are extensively reported on by the media. However, biogas usage is not without risks. There were two lethal accidents, one in Lombok and one in East Java, because users lit cigarettes while cleaning their digesters.

7.4. Sustainability

Notwithstanding the short experience with the HIVOS-SNV biogas installations, what observations can be made about the technical sustainability of the equipment, for example when it comes to availability of materials for repairs, special cooking and lighting equipment?

It is not clear what will happen after the 3-year warranty is over and technical problems occur. This may be a problem especially in areas where CPOs are not cooperatives. Cooperatives will most probably stay in contact with the biogas users, simply because they are members. It will, hence, be easier for them to facilitate maintenance and contact masons. In Lombok this might be more difficult, since the contact between CPOs and users and CPOs and masons is not as good as in East Java. This might lead to a lack of persons qualified to maintain the digesters in some regions. However it is too early to make a sound judgment on this issue.

Concerning the technical sustainability – this is the sustainability of materials and the supply thereof –, particularly the involvement of the cooperative-CPOs in East Java makes it likely that after-sales technical assistance will be assured at least in the medium term. Technical problems that could be observed so far mainly relate to leaking pipes and the quality of the biogas stoves both in East Java and in Lombok. The leakages, however, could be repaired swiftly, except for the case of one CPO in Lombok. For the biogas stoves, it has to be noted that, first, the production of these stoves has only started recently and that, second, at least households in East Java usually have the alternative of having their LPG cookers modified. Other problems that have occurred mainly in Lombok are problems with the mixer. The digester domes seem to be constructed in a reliable and high-quality manner. Only three cases are reported where problems with the construction have been detected.

The technical sustainability issue will be further addressed during the follow-up study.

What is the financial sustainability of the BIRU programme from a) the perspective of the biogas client; b) from the perspective of the mason and small construction enterprises that install and maintain the biogas installations and c) from the perspective of a public sector support programme as far as it concerns the incentives, the advertisement and other dissemination activities.

Concerning aspect a), the question of the payback period of the digesters for the clients will be addressed in the follow-up evaluation report.

As far as b and c) are concerned, it is in general too early to judge the financial sustainability of the programme and therefore how far the promotion activities will be continued beyond the project phase. However, so far, in Java, building biogas digesters is financial sustainable for both biogas masons and the CPOs since most of them are cooperatives and can make use of existing infrastructure and managerial structures. While representatives of CPOs run by larger cooperatives who had already had prior experience with biogas stated that it would be possible to continue the programme even without BIRU funding, and that they would either search for alternative funding sources (e.g. Nestlé or government agencies) or use their own funds, representatives of CPOs run by smaller institutions felt that it would be hard to continue the programme without the subsidy. Similarly, opinions diverged on whether households would be able and willing to pay the full price of a digester. However, most interview partners felt that this would at least pose a problem to the households.

The picture is a bit different in Lombok where some of the CPOs run by small local NGOs have difficulties operating economically, since they cannot make use of existing infrastructure and have small budgets. Several masons also complained that the payment for building the digester was very low or that they had not been paid at all, which made some of them quitting the cooperation with the programme. This will definitely make it difficult for the programme to continue when funding is cut.

To what extent do the biogas installations exert an influence on environmental sustainability?

The overall environmental impact of the programme on the local level (water quality and soil fertility, reduced use of chemical fertiliser) and global levels (greenhouse gas emissions) cannot be assessed at this point. However, there is some indication, as for example in Gapura village, that the digesters are having a positive impact on soils and water quality. Although the bioslurry produced by their digesters is used as fertiliser by 63 percent of biogas users in the East Java sample, there is no market yet for this product beyond self-consumption. Virtually none of the farmers sell slurry yet. Instead, the slurry is left where it is or disposed of by dumping it in rivers, open drains, or the irrigation system. Thus, the impact of the programme on the local environmental conditions may be limited unless ways are found and farmers are trained on how to use the excess slurry and dung (e.g. composting). Concerning greenhouse gas emissions, the positive effect through the reduction of dung bio deterioration may be to some degree lowered through the uncontrolled release of methane gas by the digesters. Some farmers and CPOs were therefore searching for ways to use excess gas, e.g. by using more stoves or increasing the usage of biogas for lighting. This may also further reduce the usage of other energy sources.

Concerning the impact of biogas usage on deforestation pressure, baseline data was collected on the amount and source of fuel wood collected (see Section 4.5 'Energy sources and usage'). More detailed information on changes in the amount and source of firewood collected will be provided in the follow-up report.

8. Conclusion

This report presented the results of a baseline survey which is part of an impact evaluation of the Indonesian Domestic Biogas Programme (BIRU). The programme is implemented by the Dutch NGO Hivos in cooperation with so called construction partner organisations (CPOs), which are predominately dairy cooperatives in East Java and NGOs in Lombok. The baseline survey was conducted in May and June 2011 and will serve as a yardstick for the follow-up survey which is planned for the same period in 2012. Both surveys will then be used to provide a difference-in-difference estimate of the programme's impacts. In addition, the data will be used to provide impact estimates on the basis of a pipeline comparison approach.

A major objective of the report was to verify the quality of the collected data. Our analysis indicated that the data are complete and estimates based on the data are consistent with other sources of information such as the Indonesia Social and Economic Survey (SUSENAS). Even for questions that are considered sensitive (e.g. income) the non-response rates are in most cases below 2 percent. The vast majority of questions were fully answered.

Perhaps, not surprisingly, the survey showed that households benefiting from the BIRU programme, so far, have an above average income and level of education as compared to the average for their region. Even though we are looking at a relatively homogenous group of dairy cooperative members, there are differences in terms of socio-economic characteristics and milk production between biogas users and non-users. The survey also reveals pronounced differences between farmers who have already adopted biogas and farmers who have applied for a digester. While this makes the cross-sectional impact estimation difficult, information on users does provide interesting insights on energy usage patterns across users, applicants and non-applicants. Differences are less pronounced between the two groups of non-users, that is, non-applicants and applicants. These two groups will be used to compute difference-in-difference estimates and enable us to control for time invariant differences across groups. Therefore, the use of households that have not yet applied for a digester as a potential control group seems to have been successful.

In addition to the description of household and village characteristics, the report provides information on household energy usage patterns, attitudes towards energy, energy consumption, biogas usage, reasons that households apply for a digester and the perceived impacts of having a digester. The range of collected information will make it possible to assess the direct impacts of biogas usage on household expenditures, energy use, firewood, kerosene and LPG consumption as well as cooking habits. The type of fuel used before the adoption of a biogas digester suggests the kind of impacts which may be expected. While LPG is widely used, also among farmers that have applied for a digester, firewood is also used in many households. If LPG is replaced, the likely impact of biogas digesters relates to the reduction in energy expenditures. If firewood is replaced, time savings and improved air quality could be expected. One slightly surprising finding is that so far only 63 percent of households are using the bio-slurry as a fertilizer, while the others dispose of the slurry by dumping it in a river or other places. Furthermore, only 10 percent of the surveyed users use biogas for lighting. After the follow-up survey we will be able to examine if digester malfunctions occur and if the low rates of slurry and lighting usage change after some time.

In addition to the quantitative baseline information collected in East Java, the main focus of the programme, we also examined the functioning of the programme in, Lombok. The assessment in Lombok relied on qualitative methods. Lombok was chosen as it is a poorer and less developed region of Indonesia where access to modern cooking fuels such as LPG and kerosene is limited. Wood is the primary source of fuel for cooking and electrification rates in rural areas are lower than in East Java. There are also several constraints to the implementation of the programme linked, for example, to infrastructure provision, access to credit, human resources, and a lack of interested stakeholders in the programme. The analysis shows that while some success has been achieved, the programme faces difficulties. This may be attributed mainly to the lower living standards of households and the institutional weaknesses of the CPOs as well as a less intensive contact between the cooperatives and their members

Overall, the analysis of the baseline data shows that the data are complete and consistent and that the foundation for executing a credible impact evaluation of the BIRU programme is in place.

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Annex 1: Methodology for focus group discussions in Lombok

The focus group discussions involved five to ten households. Groups were mixed and included users, applicants and non-users. We selected the villages for this study in such a way that in each district one to four villages were included. In Central Lombok four villages were visited, in North Lombok only one and in East and West Lombok three villages each. The plan was to select villages based on the number of biogas users and socio-economic criteria. In this context we tried to select at least one wealthier and one poorer village in each district. However this procedure only worked out well in the case of Central Lombok and East Lombok where it was possible to select villages according to both criteria. The selection was based on information obtained from BIRU, village heads or the CPOs. In the other districts, the implementation of this procedure was difficult as the programme was not very advanced and we lacked information on the socio-economic status of villages. Furthermore, some regions were difficult to access. In West Lombok there was no village with more than two digesters, and in North Lombok the programme was just starting and had only been active in one village with two users.

Annex 2: Study timeline

Pre-Departure Preparation of the Studies	*April and May, 2011*
Desk Study of relevant project documents and literature; adaptation of existing survey methodology; questionnaire design in English; Excel matrix for data entry; coordination with local partner JRI; translation of questionnaire into Indonesian by JRI	
In-Country Preparation of the Studies (ISS/RWI Mission – Biogas Baseline Indonesia)	*May and June, 2011*
May 9th to 16th 2011 ▪ Pre-test conducted by JRI; ▪ Evaluation of pre-testing; ▪ Revision of the questionnaire May 23rd to June 3rd ▪ Coordination with JRI, project staff and national partners concerning the Biogas Baseline study; ▪ Field trips to cooperatives and CPOs; ▪ Design details of the study; ▪ Choice on survey sites and planning of survey organisation and logistics with the assistance of the supervisors and project staff; ▪ Training of a survey team in Batu, Eat Java, conducted by JRI (including six survey supervisors from JRI, 30 enumerators and operators for the data including a pre-test of the questionnaire conducted in Pujon District; ▪ Final review of questionnaire and survey organisation and logistics	
Realization of the Biogas Baseline Survey	*June 2011*
May 31st to June 14th 2011 ▪ Survey implementation of the Biogas Baseline Survey in East Java by RWI research assistant, JRI supervisors and several teams of enumerators	
Qualitative Assessment of the BIRU Project in Lombok	*June and July 2011*
June 27th to July 1st ▪ Coordination with project staff and national partners concerning the BIRU Programme in Lombok; ▪ Preparation for field work July 3rd to July 16th ▪ Field work, data collection, including FGDs, expert interviews and semi-structured household interviews	
Data Compilation	*June and July, 2011*
Data entry by operators for the data; data processing	
Data Analysis and Reporting	*August to November 2011*

Electronic Appendices

Appendix 1 (file): Household questionnaire

Appendix 2 (file): Village questionnaire

Appendix 3 (file): "The Intervention in a Different Context – BIRU Lombok" (full report on Lombok assessment)