

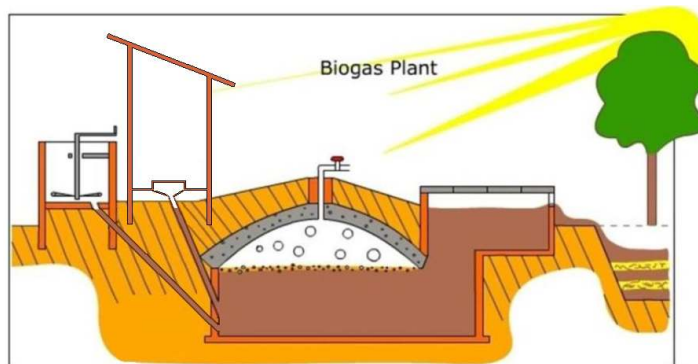
Terms of Reference

**Expert Group on technical innovation on domestic biogas plants to reduce costs, increase reliability and meet untapped market demands**

**Introduction:**

The Energy for All Partnership (E4ALL) was launched in June 2009 at the Asia Clean Energy Forum in Manila as a response to the challenge of regional energy poverty. The Partnership provides a platform for cooperation, knowledge and technical exchange, innovation, and project development, bringing together key stakeholders from business, financial institutions, governments, and non-government organizations. The Partnership is focused on action, with a goal to provide access to energy to 100 million people in Asia and the Pacific region by 2015<sup>1</sup>.

SNV Netherlands Development Organisation was invited by the Steering Committee of E4ALL to lead a Working Group on Domestic Biogas. The objective of this Working Group is the innovative dissemination of 1 (one) million domestic biogas plants in about 15 Asian countries by 2015/2016, providing access to sustainable energy to about 5 million people. In addition, the Working Group aims to make an important contribution to the development of sustainable, commercial biogas sectors in these countries. SNV will actively pursue the achievements of these objectives as a follow-up of its present biogas practice in the region covering seven countries (Nepal, Vietnam, Bangladesh, Cambodia, Lao PDR, Pakistan and Indonesia)<sup>2</sup> through innovation, partnering, networking, knowledge brokerage and resource mobilisation.



The current domestic biogas market consists of livestock farmers who are able to collect a minimum amount of 20 kg of animal manure every day, possibly in combination of toilet waste, as feedstock for the biogas plants. For Asia, this market potential is roughly estimated at 110 million households out of which about 40 million have installed a biogas plant. To tap this market, three different types of domestic biogas plants have been developed over time: the floating drum, fixed dome and plastic bag digesters. The most popular type (“existing product”) is the fixed dome plant being constructed *in situ* by skilled labour out of conventional, locally available materials like bricks, stones, cement, sand and gravel. The most crucial part of the construction is the dome, to be treated with a sealant like paint for gas tightness. The gas storage capacity varies between 33 and 60% of the daily nominal gas production. If constructed as per the standards and with a reasonably developed service infrastructure, the plant has a technical life of 15 years minimum, is easy to operate and requires little maintenance. The investment cost of the plants depends on size and location and usually includes all required costs for overhead, profit, guarantee and after sales service for a minimum period of two years. The smallest size being promoted is 4 m<sup>3</sup> (volume of digester and gas storage)<sup>3</sup> requiring a minimum daily feeding of 20 kg animal manure.

<sup>1</sup> For more information, see [www.energyforall.info](http://www.energyforall.info)

<sup>2</sup> For more information, see [www.snvworld.org/en/ourwork/Pages/Renewable%20Energy.aspx](http://www.snvworld.org/en/ourwork/Pages/Renewable%20Energy.aspx)

<sup>3</sup> From FY 2009/2010 onwards, the Biogas Support Programme (BSP) in Nepal is also promoting a 2 m<sup>3</sup> biogas plant requiring 10-15 kg of animal manure per day

Recently, new construction materials like polyethylene and fibreglass have been introduced, especially in China and India, to partly or fully replace conventional construction materials. These materials make pre-fabrication possible, reducing the time for construction/installation at the premises of the biogas household. Also new sealants have been developed that could increase the reliability of the treatment for gas tightness and reduce construction time. The time is right to assess in a comprehensive manner the opportunities for technical innovation of all types of domestic biogas plants to reduce overall costs, to increase reliability, but also to meet untapped market demands.

This paper provides the Terms of Reference (ToR) for the establishment and operation of an Expert Group in this field. An earlier version of this ToR was commented by over 20 practitioners. In addition, an international workshop was conducted on 21 and 22 April 2010 in Dhaka to further elaborate the ToR.

### **Objective of the Expert Group:**

The objective of the Expert Group is to provide the E4ALL Working Group on Domestic Biogas with informed recommendations on technical innovation on domestic biogas plants to reduce costs, to increase reliability and to meet untapped market demands.

### **Market demands:**

The Expert Group shall relate possible innovations to the following four product/market combinations:

- A. Improvement/development of the existing product for the existing market: The untapped market for the existing product is still large, especially when costs could be reduced and/or reliability could be increased. Annex 2 provides some references on technical problems related to the existing product;
- B. New/developed product for potential users living in areas with high water table;
- C. New/developed product for potential users who have limited space to install the biogas plant;
- D. New/developed product for potential users who have limited feedstock (minimum 10 to 15 kg of animal manure per day) available to feed the biogas plant.

### **Product Design Specifications:**

Though compromises may be reached between some of them, the Expert Group shall focus its efforts on the following Product Design Specifications (PDSs): Inlet (optional) for cattle urine; inlet (optional) for toilet attachment; easy to operate and maintain by user among others through minimal touching of the feedstock, easy removal of sedimentation or scum from the digester, and enabling easy preparation of bio-slurry; technical life of at least 15 years; low investment and annual costs; low related programme support costs (training, quality control).

### **Composition of the Expert Group:**

The Expert Group will be convened by the E4ALL Working Group on Domestic Biogas and consist of six to eight, commercially independent members including a Group Leader, all qualified and experienced in the construction or manufacturing, operation and maintenance of domestic biogas plants. The Group shall have a good mix of academic and practical members. At least one member will be from PR China and India respectively; preferably also other countries in the region will be represented. Two members will be appointed by SNV and form the secretariat of the Expert Group. The other members will be selected by SNV and ADB based on CV submission and assessment. The Expert Group will intensively interact with key respondents and informants in all relevant Asian countries, and if required, also in other parts of the world. A draft and final report will be presented with detailed recommendations including drawings and bills of quantities.

### Methodologies:

The Expert Group will make use of the following and other methodologies:

- Review of literature covering also possible innovations in other parts of the world;
- Face to face meetings;
- Involvement of key respondents and informants, not limited to Asia;
- Field visits to investigate and verify promising technical innovations;
- Rough design sketches of innovative products for each market.

The innovations will be compared to a baseline; the traditional dome plant (Nepalese GGC model, Indian Deenbandhu, and/or concrete models used in China) operated by single households. Animal manure is the default feedstock for the plants, but other feedstock may be proposed for co-digestion as long as the smooth operation of the biogas plants by the households will not be endangered<sup>4</sup>. Innovations related to the consumption of biogas are beyond the scope of the assignment.

### Reporting, time schedule, budget and financing:

The Expert Group will elaborate on a brief work plan and present a progress report during the Workshop of the Working Group on Domestic Biogas scheduled for 10-12 November 2010 in Cambodia. All activities of the Expert Group will be finalised before the end of 2010. Each non-SNV member will engage for 20 days and receive a remuneration of USD 3,000; the Group Leader will spend 25 days and receive a remuneration of USD 5,000. In addition, budget will be available for travelling and accommodation and to make small payments to key respondents and informants who will provide inputs. The total budget amounts to USD 40,000 and will be made available by SNV and the ADB under the E4ALL.

### List of possible key respondents and informants:

Among others, the following organisations may be contacted (through SNV) for information and experience:

Country	Organisation
Bangladesh	Infrastructure Development Company Limited (IDCOL)
	Bangladesh Agricultural Research Institute (BARI)
	Grameen Shakti (GS)
	Bangladesh Council of Scientific & Industrial Research (BCSIR)
Cambodia	Ministry of Agriculture, Forestry & Fisheries (MAFF)
	National Biodigestor Programme Office (NBPO)
	Cambodian Rural Development Team (CRDT)
China	Ministry of Agriculture (MoA)
	Biogas Institute of Ministry of Agriculture (BIOMA)
	Shengzhen Puxin Science and Technology Co. Limited
	China Association of Rural Energy Industry (CAREI)
	Yunnan Normal University/Solar Energy Research Institute
India	Global Environment Institute (GEI)
	Ministry of New and Renewable Energy (MNRE)
	Appropriate Rural Technology Institute (ARTI)
	Sintex Industries
	Centre for Renewable Energy and Appropriate Technologies (CREAT)
	Asian and Pacific Centre for Transfer of Technology (APCTT)
	The Energy and Resources Institute (TERI)
	Khadi and Village Industries Commission (KVIC)
	Department of Renewable Energy Sources (DRES), Udaipur
	BIOTECH
Sintex Industries	
Indonesia	Ministry of Energy & Mineral Resources
	Hivos
	Mr. Bambang Boedi Canyon, Bandung (plastic digester)
Lao PDR	Ministry of Agriculture & Forestry (MAF)
	Biogas Pilot Program Office (BPPO)

<sup>4</sup> The Expert Group should focus on the hardware; not on the process of anaerobic digestion

Nepal	Alternative Energy Promotion Center (AEPC)
	Biogas Sector Partnership – Nepal (BSP/N)
	Nepal Biogas Promotion Association (NBPA)
	Center for Energy Studies (CES)
Netherlands	Ecofys
	SimGas
	Lettinga Associates Foundation (LeAF)
Pakistan	Rural Support Programmes Network (RSPN)
	Ministry of Environment (MoE)
	Alternative Energy Development Board (AEDB)
	Agriculture Mechanical Research Institute, Faisalabad (plastic floating drum)
Thailand	Asian Institute of Technology (AIT)
Vietnam	Ministry of Agriculture & Rural Development (MARD)
	Biogas Programme Division (BPD)
	Institute of Energy (IoE)
	VACVINA
	Can Tho University
	Biogas Composite Tanks Maker
Biogas Technology Centre	

## **Annex 1: Working Group on Domestic Biogas under the Energy for All Partnership**

### **1. Introduction**

In the framework of the Energy for All Partnership, SNV Netherlands Development Organisation was invited by the Steering Committee to lead the proposed Working Group on Domestic Biogas. After providing the background on SNV and its activities in domestic biogas, this paper presents the objective, activities, timeline and indicative budget.

### **2. SNV Netherlands Development Organisation**

SNV is dedicated to a society where all people enjoy the freedom to pursue their own sustainable development. We contribute to this by strengthening the capacity of local organisations aiming at promoting sustainable development by means of generating production, income and employment opportunities, and of improving access to basic services including renewable energy. Our core activities are advisory services, knowledge brokering and development, advocacy, and setting up local capacity development funds. We are actively present in more than 30 countries across the world and employ more than 1,500 staff. The head office of SNV is in The Hague, the Netherlands<sup>5</sup>.

### **3. SNV and domestic biogas**

From 1989 onwards, SNV has been successfully involved in domestic biogas produced from animal manure and where possible in combination with human excreta. Supporting the establishment of a viable biogas sector in Nepal, distinctive experience and international recognition was gained and used in the beginning of the new millennium for up-scaling to Vietnam. From 2005 onwards, Cambodia, Bangladesh, Lao PDR, Pakistan and Indonesia were gradually added to the market-based biogas practice of SNV. The so-called 'multi-stakeholders sector development approach' applied by SNV is yielding results and has become a strategic asset<sup>6</sup>. Up to December 2009, about 300,000 biogas plants have been installed in the Asian countries providing access to sustainable energy to almost 1.85 million people. Surveys indicate that minimum 90% of these plants are still in operation<sup>7</sup>. Equally important is the development towards sustainable, commercial biogas sectors in the respective countries and a supportive public environment. In each country, SNV partners-up with private sector (construction companies; financial service providers), public sector (regulation, standard-setting, policy) and local service providers. In addition, local financing, donor partnerships and carbon funds (both in the compliance market as well as voluntary) are mobilised to increase the financial support to the sector. Knowledge networks have been actively set up since 2004, connecting professionals, policy makers, practitioners and scientists on domestic biogas around the world.

### **4. Objective of the Working Group**

The objective of the Working Group on Domestic Biogas is the innovative dissemination of 1 (one) million domestic biogas plants in about 15 ADB member countries by 2015/2016, providing access to sustainable energy to about 5 million people (5% of the target set by the E4ALL). Equally relevant, an important contribution will have been made to the development of sustainable, commercial biogas sectors in these countries.

Based on an initial assessment of the technical potential number of biogas plants, among others, the following countries may be included<sup>8</sup>: Bangladesh, Cambodia, China (innovative programmes only), India (innovative programmes only), Indonesia, Kazakhstan, Lao PDR, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam.

### **5. Activities of the Working Group**

The Working Group will undertake the following activities:

- I. Participatory studies on the feasibility of domestic biogas in about 10 ADB member countries without a significant programme so far ("new biogas countries");

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<sup>5</sup> For more information on SNV, see [www.snvworld.org](http://www.snvworld.org)

<sup>6</sup> *Building viable biogas programmes; success factors in sector development*. SNV, June 2008

<sup>7</sup> Dissemination rates in India and PR China are much higher with more than 4.5 million respectively 35 million units installed. Data on the operation rate of these units are difficult to obtain

<sup>8</sup> This outcome of this assessment still needs confirmation

- II. Formulation of detailed implementation plans for feasible national programmes on domestic biogas in about 15 ADB member countries consisting of about 8 countries with an already ongoing programme (“existing biogas countries”) and about 7 new countries;
- III. Establishment of a donor basket fund (grant) amounting to about Euro 300 million for the co-financing of the implementation of national programmes on domestic biogas in about 15 ADB member countries, covering the costs of programme support activities including investment incentive, technical assistance and fund management;
- IV. Contracting and implementation of national programmes on domestic biogas in about 15 ADB member countries including mobilisation of about Euro 180 million (loan) for the provision of biogas credit to livestock farmers;
- V. Networking and joint learning involving all relevant stakeholders in existing and new biogas countries, as well as experts around the world, among others through internet, workshops, study tours and joint research, resulting in supra-national synergies to increase efficiency, effectiveness, innovation and accelerated growth of the sector.

### 6. Timeline and indicative budgets

The following table provides the timeline and indicative budgets required to implement the activities of the Working Group:

<i>SN</i>	<i>Activity</i>	<i>Timeline</i>	<i>Indicative budgets (EUR)</i>
I	Feasibility studies	2009/2010	600,000
II	Formulation of implementation plans	2010/2011	900,000
III	Establishment of basket fund	2010/2011	Included under IV
IV	Implementation	2011/2016	-300 million as grant -300 million investment by farmers (cash/loan)
V	Networking/learning/innovation/R&D	2009/2016	1,200,000

Local, national and external resources will have to be mobilised at country or partnership level to finance all activities, if feasible in combination with carbon financing. Eligible households will finance the major part (on average 75%) of the capital costs of the biogas plants and 60% of the households are expected to use for this a credit.

## Annex 2: Reported problems (indicative only) related to the existing product<sup>9</sup>

Bangladesh	Plant takes more space for inlet and hydraulic chamber; high water table does not permit underground digging of earth; can not shift, if source of raw materials stopped; needs extra labour for carrying raw materials and mixing; slurry collection pit needs improvement; can not construct during monsoon; construction cost is high; takes 10-15 days to construct; slurry enters into pipeline; gas production is not up to expectation; gas leakage in the dome; settlement of hydraulic chamber; mixing device is difficult to repair and not used in mixing the large quantity of dung resulting in the deposition of lumps in the bottom of the digester
China	Gas and water leakage due to poor quality of construction (as some good technicians could not be retained) or poor sealing material; difficulty in discharge due to old designs; lack of raw materials due to lack of animals; low or zero gas production due to management or low temperature in cold regions; lack of post service system; lack of daily maintenance with some spare parts etc.
Cambodia	Plant construction in areas with a high water table; plant construction in areas with rocky soil; time consuming process of applying the plaster layers in the dome. The five layers take 4 days if proper process is observed. Often this is not done to save time (and therefore money) which can lead to gas leakages; time consuming and cumbersome testing process of the dome on gas tightness
India	-KVIC (steel dome and brick masonry digester): needs mandatory regular maintenance or else prone to rusting; manufacturing needs skill limited in rural areas; alignment of dome over the digester through guide pipe needs trained skills; cost as per technical specifications is very high; compromise to thickness for economy not only reflects on longevity, but also on gas pressure; repair not possible in situ with few workshops in rural areas for repair; unsuitable/difficult for high water table areas; -Deenbandhu (brick masonry): construction of radius of curvature needs both theoretical and practical training; building materials, especially the bricks must be of good quality otherwise both strength and gas tightness is a threat; jointing brick to brick with 'V' groove cutting needs skill and training; inside plastering, outside plastering in coats, curing, and painting needs specified time and strict adherence to guidelines; compromise to thickness of dome is not only a threat to strength, but also for gas tightness; construction of dome radius and outlet tank needs skill
Indonesia	High investment costs (USD 650 for 6m <sup>3</sup> plant); quality sand is not easily available in local areas; needs more space for plant installation; gas leakages from dome; gas is still being produced from slurry pits; farmers prefer to have direct feeding (connect inlet pipe to cattle shed); water scarcity (some places)
Nepal	Lack of top filling over dome; feeding not convenient; water scarcity (hilly areas); high water table (lowlands); gas escaping through outlet; feeding material (cattle dung) less available
Pakistan	Lack of enough space for plant installation; gas leakage from dome; positioning of water trap and pipe profile; many joints in the pipeline; large distance to the kitchen (low gas pressure)
Vietnam	The lit in the neck is vulnerable to leakage, especially when no clay available. Concrete is used but this makes re-opening and maintenance more problematic; due to the small outlet pipe diameter, scum formation is prevalent in any KT digester. Each 1.5 year a bog-like substance needs to be removed; gastight additive it not always used or available, making leakage gasholder likely to occur; the lit is too small to get in easily and needs some skilled labour to properly close again with clay and wedge system; most digesters are built under stable floor making quality control after construction is very difficult; no compost pit in design; liquid slurry used for irrigation rather than composting; dimensions are not followed according to drawing; inlet-outlet angle sometimes not in line (180 degrees); high investment costs of about USD 600 for average 10 m <sup>3</sup> plant

<sup>9</sup> SNV will provide the Expert Group with all available documents on the problems with the existing products in the various countries