Alternative Energy Promotion Centre, Nepal

Ministry of Science, Technology and Environment, Government of Nepal

GUIDELINES FOR A COMMUNITY BIOGAS PLANT FEASIBILITY STUDY

CONTENTS

1. INTRODUCTION

The following document establishes the guidelines for carrying out a feasibility study for a community biogas plant. A community biogas plant is that plant that serves the members of a particular community who cooperate to manage and operate the biogas plant and share its benefits.

The ultimate aim of the feasibility study must be to determine the feasibility or otherwise of a particular project, explaining the rationale behind the final decision following the structured approach detailed below.

1.1 Executive summary

Should inform the reader about all major findings and recommendations of the study

The executive summary shall include the main findings of the project, conclusion and recommendations. It should clearly state whether the project is feasible socially, technically and financially and therefore whether its implementation is recommended or not.

The following sections should be included in the summary:

The nature of the project shall be described here, including for a brief overview of the type and amount of waste to be treated, the type of digester, volume, its application and the community that will benefit from the implementation of the project.

The general setting of the project location shall also be included in the project summary, supported by a brief justification on why this is the most suitable.

A description of the ownership model of the scheme and the management structure should be included in this section, specifically how will the plant be operated and by whom and the level of training that will be provided.

An overview of the existing market shall be detailed here, identifying the end uses of the product streams from the biogas plant. The executive summary shall also contain the main findings from the financial analysis.

The executive summary shall also present a brief description of the resources, both material and human, required to make the project successful, and what the potential for employment creation will be in the community.

The executive summary shall identify the main findings from the ESMF (Environmental and Social Management Framework) Environmental and Social screening and the main actions recommended.

The executive summary shall conclude on the feasibility or otherwise of the project. A final, clear statement determining whether the project is feasible from a technical, environmental, social and financial perspective, recommending the most suitable alternative if different options have been considered during the FS shall be included here.

1.2 Scope of the project

- **What is the goal of the project?**
- **Where is the project being carried out?**
- **What is the end use of biogas and slurry?**
- **What are the main limitations?**

This section should comprise mainly a description of the content of the project, including the main goals of the project, these being waste treatment, electricity production, thermal energy production or any other applicable, area of the project and main limitations.

This section should describe the technology and location proposed, including the potential uses that the project may give to the biogas or slurry, the type of digestion process or the type of digester to be installed.

1.3 Aims

- **What is the aim of the study?**
- **What are the specific objectives?**
- **Are there different aims and objectives for different stakeholders? Do they have to be considered separately?**

This section shall describe the aims of the study. It is important that these are not confused with the project aims.

1.3.1 Aim of the study and objectives:

The aim of the study is the general statement of intent describing what the FS aims to achieve.

The set of specific objectives are those that will be met by the FS in order to achieve the main goal.

It is important to consider the aims and objectives of the FS, not the project, as the purpose of the FS is to determine the viability of the project and this may be terminated if the result from the FS is negative.

1.3.2 Aims and objectives for different stakeholders

If there are different stakeholders their aims and objectives need to be considered separately.

2. INVENTORY OF CURRENT FRAMEWORK CONDITIONS

The inventory can be carried out stepwise, starting with coarse screening to more detailed data collection. For the selected options and sub-options, data with a high level of detail will be collected, which is required to assess the feasibility of each of these options and compare them among each other.

2.1 Data collection

It is very important for the success of the feasibility study and therefore of the project, that all the main data affecting the biogas and energy production is captured and analysed. The following table presents a non-extensive list of areas that need to be considered. The consultant may include more as applicable:

2.1.1 Climate:

- **What is the area climate?**
- **What are the maximum and minimum temperatures throughout the year?**

It will have an impact on the final design of the biogas system. A cold climate would require longer retention times in the digester to compensate for the lower temperatures. Equally, careful consideration should be given to methods for insulating the digester in order to withstand sharp temperature changes between day and night experienced in most areas in Nepal. The frequency and amount of rain may affect the dry solids content of the waste and thus require larger and more costly digesters, so its effect should also be considered.

2.1.2 Seasonality:

- **Does substrate availability vary depending on the season?**
- **Can seasonal variation be compensated?**
- **What is the community population? Is it growing or decreasing? How will it affect substrate availability?**

The availability of substrate may depend on the time of the year, for instance if agricultural waste is used as feedstock, or during school holidays, or if a residential complex changes the number of guests during different seasons or during the week and weekends.

The FS shall consider alternative scenarios by which the lack of one type of substrate could be balanced by using a different type of substrate or operating in a co-digestion mode in order to maintain a constant biogas production, when possible. If the reduction of substrate availability cannot be compensated, this should be accounted for in the design and economic analysis.

Community population data should be gathered, including for estimates of future changes. Variations in population will impact substrate availability, which may result in an overdesign or underdesign biogas plant leading to frustration if expectations are not met.

2.1.3 Natural resources:

- **How much water is there available? Where is the source?**
- **Who owns the water source? Is this an issue for the biogas application?**
- **What are the community's priorities for water usage?**
- **Any past conflicts regarding water usage?**
- **Is there a sun-heated area for the biogas plant location?**

The biogas plant will most likely require water to dilute the substrate and facilitate the digestion process. It is therefore essential that availability of water is assessed in the FS, and that local water supplies are identified as potential sources.

The water needs and current uses of the community have to be evaluated to see how biogas application is affected. This may become a controversial issue its use should be agreed with all stakeholders involved and respect the hierarchy of water usage (i.e., human consumption is the main priority, domestic use, irrigation and commercial and industrial uses).

Water source ownership needs to be determined, whether public or private, and assess whether this may become an issue regarding its usage.

Availability of solar energy will also play a part. The digester should be located in an area in which direct solar radiation reaches it to optimise heating from natural sources and hence increase gas production. If solar systems are used for heating the digester then careful consideration should be given to the parameters affecting the performance of the solar system.

2.1.4 Geology and location:

- **What is the community location?**
- **Are there good transport links to main roads?**
- **How far is the community from the nearest market? Distance to nearby farmers (potential fertilizer consumers)?**

Parameters such as the general geological conditions and location are keys for the success of the project. GPS location data shall be provided together with the boundaries of the community referenced to the biogas plant in a map.

Transport links to main roads and ease of access to the site should be described here.

Distance to closest market should be detailed here, as it may impact whether fertilizer can be easily sold in the market. If the community is planning to sell fertilizer to farmers who would come to the community to collect it, distance from nearby potential customers should be included here.

2.1.5 Human background:

- **Who are the main authorities in the area? What is their interest in the biogas plant?**
- **Are there any religious, cultural or social barriers to the implementation of a biogas plant? If so, what are these and how can they be overcome?**

In this section the FS should evaluate the human context that may affect the project. It should identify local authorities, community management committees, administration units and other relevant parties interested in the project.

A stakeholder matrix could be used as a tool to determine the interest and influence of each party in the project development.

Furthermore, any religious or cultural features of the local population that may affect the delivery of the project should also be noted here, identifying clear strategies to minimise any potential negative impacts.

2.2 Legislative framework

2.2.1 Legal framework and permit requirements

This section of the FS shall include a thorough assessment of the legal framework affecting the project delivery to ensure that there are no major obstacles in the implementation of the biogas plant.

- **Which legal bodies need to be asked for permission or should be involved in the development of the project?**
- **Is there a plan to support this type of projects?**
- **Are planning permissions required? Has the local authority been approached?**
- **Is there a land-lease agreement in place? How long for? Is land owned by the community?**

Current legislation, both national and local, should be reviewed to determine whether there are any showstoppers for the implementation of a biogas plant. The organisation implementing the project shall also list all relevant legislation applicable to the project, outlining a plan on how it is proposing to comply with such legislation. Any other permits,

such as planning permission from local authorities and strategies to overcome potential challenges, land-lease agreements or environmental licenses should be included here.

If there is a national support plan in place this should be noted here together with its influence on the project development.

2.2.2 Past examples, lessons learned.

- **Have there been any renewable energy projects in the past carried out in the same location?**
- **Did the previous projects succeed? If not, what are the lessons that could be learned?**

The consultant should also note the views of the local community on previous projects to address their concerns during the FS, including their outcome and lessons learned. All relevant stakeholders should be part of the design and review process.

2.3 Economic framework

- **What is the average household income in the community?**
- **How would the main economic activities present in the area affect or be affected by the project?**
- **What could be affordable and realistic rates for electricity, biogas, fertilizer, etc?**

This section should present an outline assessment of the main economic activities present and their potential impact on the project.

General economic data that may apply to the project shall be gathered in the FS, such as household income, employment rates, shop ownership, agricultural sector or other productive activities. These will help to assess whether the cost of the biogas plant can be met by the local community and determining the price of electricity, fertilizer or biogas to affordable rates, hence favouring the project feasibility. This evaluation should include predictions for short and mid-term development of the local economy.

Following on from the general assessment, a more detailed look into the particular characteristics of the local economy should be carried out. This may comprise an assessment of the local agricultural sector, as its size and activity is likely to play a key role both from the supply aspect and as a destination for the fertilizer produced in the biogas plant. It should also include details of other commercial activities that may benefit from the implementation of a biogas plant, either from thermal or electrical consumption, or whose livelihood may be affected by the biogas plant impact.

2.4 Energy

The organisation carrying out the FS shall perform a detailed assessment of the energy needs of the community benefiting from the plant.

- **How many households are there in the community? How many meals a day do each household prepare? Average household size?**
- **How much and what fuel is currently used for cooking?**
- **What are the current electricity consumption patterns?**

2.4.1 Thermal energy consumption

This section shall contain an assessment on the fuels used for cooking that are likely to be replaced by biogas. The number of households should be determined and their current consumption patterns. In the case of some fuels, such as wood, where collection time may be significant, this should be noted as it can then be portrayed as a positive impact in the routines of women.

2.4.2 Electricity consumption:

In this section the FS shall describe the current electricity consumption of the community. It is encouraged that potential productive end-uses of biogas are investigated, for instance, as part of the communities existing or future economic activities, as it may drive the biogas use towards thermal or electrical applications.

2.5 Financial and Investment Assessment

- **How will the project be financed?**
- **Can the community afford to fund the gap between the government support and the total investment required?**
- **Is the community willing to take a loan to finance the gap? How will this be repaid?**
- **Are there going to be entry tariffs to benefit from the service?**
- **If there are households that decide to use the biogas at a later stage, would the community be willing to apply progressive tariffs?**
- **Bill of Quantity and Estimates of Cost**

The organisation conducting the FS shall describe how the project will be financed:

It is important to determine whether the community would be willing to take up a loan to fund the gap between the government support and the total investment required or any other private investor contribution, CDM credits, NGO or other ODA (Official Development Aid) funding.

The financial assessment shall assess the ability of the community to raise funds within itself to pay back the loan, and discuss with the community an initial tariff strategy so all members of the community can benefit from the biogas plant, even latecomers.

Provide the bill of quantity and estimates of cost.

3. ASSESSMENT OF FEASIBILITY

3.1 Organisational capabilities:

The purpose of this section is to determine the capability of the organisation for managing and operating the biogas plant.

3.1.1 Staffing and Operations

- **Who and how will be operating the plant?**
- **What is the management structure and who owns the plant once commissioned? Will it be formalised and transparent?**
- **Have the responsibilities of the managers and operators been clearly defined? How will they be regulated and accountability enforced?**
- **Is the proposed management system compatible with local customs and traditions?**
- **How organised, united and cooperative is the community within itself? How will this affect the choice of management? Are there any existing organisations, cooperatives, etc that could be used for managing and operating the biogas plant?**
- **Is there additional management training requirement for the community?**
- **How will tariff collection be enforced?**
- **How will the income of the plant be utilised?**
- **What are the training requirements? When and how will these be done?**

The organisation carrying out the FS shall also specify the structure in place for operating the biogas plant, including a chart describing the roles and responsibilities of each member from managing, feeding, monitoring, managing the slurry, draining the water traps and any other routines that may be required.

Any regular community meetings, participatory approaches from the community and procedures for dealing with complaints, defects, etc should be stated here.

An assessment on the cohesion of the community should be carried out. Any previous common enterprises, cooperatives, etc. may help determine the level of unity and capacity of the community for organising itself and managing a common project. This may also highlight if any further management training is required.

Enforcement procedures for collecting tariffs should be detailed here. Management of income from biogas and fertilizer sales, tariffs, investment required in the biogas plant repair and maintenance, and general accounting practices should be detailed here. Transparency is essential in this aspect.

Training to be provided to staff shall be detailed here.

3.2 Location:

- **Is the location easy to access for construction?**
- **Is the location easy to access for routine operation?**
- **Is the biogas plant close to consumer points/generator?**
- **Is there an easy biogas pipeline or electricity route to consumer points?**
- **Are ground conditions favourable for building a biogas plant?**
- **Is the plant far enough from water sources?**
- **Is there enough area to build the biogas plant?**
- **Is the plant in a sun-heated area?**
- **Have photographs been provided?**
- **Has a site plan schematics been provided?**

If there are different potential locations, the most appropriate shall be recommended here based on the criteria below.

The FS should analyse in detail the effect of location selected on the biogas plant.

The following should be considered when assessing the most suitable location for the biogas plant:

- Ease of access for construction, i.e., delivery of materials, man access, etc.
- Ease of access to feed chamber to facilitate substrate feeding to the plant. For instance, feed chamber located close to a cattle shed if cow dung is used, or an easy path for households if kitchen waste is fed to the plant.
- Distance from consumer points: the biogas plant should be as close as possible to the consumer points to minimise pressure losses in the gas pipe, cost of gas pipe, minimise gas leakage as joints will be reduced, minimise transmission costs if electricity is generated, etc.
- Enough area for compost pits and ease of access to favour collection of fertilizer for sales.
- Ease of access to any equipment requiring regular maintenance and operation.
- Distance from nearby houses should be at least 2 m to avoid damages during construction.
- Distance from any water source should be at least 10 m to avoid water contamination.
- Assessment of the water table should be carried out to determine whether there is enough depth available for digging and constructing the biogas plant without reaching groundwater.
- Enough area should be available for building the biogas plant. Site measurements need to be carried out.
- Plant needs to be built away from trees or tree roots to avoid shading and future damage to the structure.

Photographs and schematics for a site plan, including a services plan indicating water, electricity and biogas routes shall be provided in the report to back up the decision on the best location justifying it as per the items above.
The consultants carrying out the FS shall make a recommendation on what the best location would be based on the above considerations.

3.3 Technical

Main question to be answered:

- **Is the project technically feasible?**

3.3.1 Substrate supply chain:

Questions that may help:

- **How will the substrate be collected?**
- **How much substrate is available?**
- **Is the substrate going to increase or decrease with time? Will it be affected by immigration patterns? If so, how?**
- **Will toilet waste be fed to the digester? What is the toilet flushing system?**
- **Is the substrate source well known and have the main parameters been confirmed (biogas yield, volatile solids, substrate production yield, etc)?**
- **Is there potential for inhibition?**
- **What are the current waste water treatment practices?**

It is essential to determine how the feedstock will be collected. It is also important to determine who will be the main actors involved in order to later devise strategies to develop a management structure to ensure the correct operation of the waste collection and feeding regimes.

The quantity of each substrate should also be established, both current and future predictions, accounting for projected population and industrial growth, as this will have an impact on the size of the digester.

When toilets are connected to the biogas plant, the consulting firm should assess the water currently used to flush the toilet, as this may lead to the need of a pre-treatment stage to separate solids to be fed to the digester in order to avoid oversizing of the plant or disregarding the treatment of toilet waste. The consultant shall recommend what alternative is more economically viable.

Each of the potential options shall be evaluated in this section regarding the substrate supply chain.

Inhibition potential:

Within the sources of waste section, the organisation carrying out the FS should also investigate whether there is potential for contamination of the substrate from inhibitory substances, this may be the case if antibiotics (for instance in the case of hospitals), heavy metals or detergents are present in the feedstock. The potential for inhibition should be ultimately determined empirically in a certified laboratory.

Waste water treatment practices:

This section should also describe current waste water treatment practices and what changes are proposed, if any, as part of the implementation of the biogas plant. If any effluents arise from the plant they have to be treated as per the government guidelines (ESMF assessment will trigger these).

3.3.2 Process design:

Questions that may help:

- **What are the design criteria?**
- **What are the main design outputs (digester volume, dimensions, electrical and thermal energy production, etc)?**
- **Purpose of biogas generation and utilisation?**

This section shall include an outline description of the design proposed for each option evaluated. The type of biogas plant recommended shall be stated here. This could be the modified GGC 2047 or other biogas technology, particularly for large digesters. Initial details of the description of the type of technology shall be provided here.

The following shall be provided

- Type of biogas plant and justification for the selection of that technology.
- Technological option chosen: wet vs dry digestion, methane end use utilisation, multi-stage vs single stage digestion, operating temperature, continuous vs batch, etc) and reasons why.

Type of digestion		T	
Stage		Continuous/batch	

- Design and sizing criteria for all project processes. Biogas yield rate, electricity production rate, slurry production rates, thermal energy production rate. Operational parameters such as feed rate, pressure, temperature, biogas production, expected VS destruction, hydraulic retention time, water requirements for dilution, feed dry solids, pH, etc.

- Size and volume of the biogas plant (including biogas storage) and engine rating if used for electricity generation,
- Pre and post treatment equipment description
- Process flow diagram (this is a schematic diagram showing all the mainstreams and their composition i.e., mass and volume flowrate and dry solids, quantity of different feeds, etc) and main process parameters such as temperature or pressure. This shall include main process units.

3.3.3 Construction aspects:

- **Is there enough area to build the plant?**
- **Are ground conditions favourable for a biogas plant?**

The consultants should evaluate the biogas plant from a constructability perspective. This analysis should include the land area required to build the plant, ground conditions and underground water evaluation.

3.3.4 By-product use:

Each option should be assessed on its potential for the production and distribution of fertilizer or any other by-products from the plant. Quantity produces shall be detailed here.

3.4 Financial, commercial assessment and market study

Main question to be answered:

- **Is the project financially feasible and is there an appropriate market for the products from a biogas plant?**

3.4.1 Financial and commercial analysis

In this section of the FS the consulting organisation shall carry out a financial analysis of the biogas plant proposed and determine its financial feasibility.

- **Have all costs, capital and O&M costs been considered?**
- **Have all revenue streams and savings been identified?**
- **Do the main financial indicators favour the project?**
- **Has the impact on the existing economy been considered?**

Costs:

- Capital investment costs (biogas plant and ancillaries)
- Construction labour costs
- Leasing costs (if required)
- Operational and maintenance costs
  - Labour

- Water
- Food for animals acting as feedstock
- Maintenance and replacement parts (pressure meters, engine-generator maintenance, H2S scrubbing unit maintenance, valves, etc)
- Transport costs (feedstock and fertilizer)
- Other

o Revenue streams:
- Connection tariff to biogas grid
- Connection tariff to electricity grid
- Biogas monthly fees
- Fertilizer sales
- Cooking fuel savings
- Electricity savings
- Diesel and other Savings
- Chemical fertilizer savings
- Other

o Cash flow analysis
o Key financial indicators: NPV, payback period, IRR, etc.

3.4.2 Market study

Potential market for electricity or biogas sales shall be described here.

- **Is there a market for the biogas products? Please describe briefly.**

3.5 Environmental and Social Impact:

3.5.1 Social Impact

- **Has the social screening been completed as per SMF?**
- **Have the main recommendations from the screening for further assessment been included?**

The developer will have to comply with the safeguard policies. The Social Management Framework (SMF) shall be taken as reference document for complying with social safeguards. These cover the following aspects:

- Impact on specific assets due to project intervention
  - Land
  - Structures
  - Community resources properties
  - Natural resources
- Impact on livelihood
  - Loss of shelter or housing structure

    - Loss of income source
    - Loss of grazing field
    - Loss of agricultural land
    - Other
- Impact on trees and crops
    - Vegetation clearance
    - Agricultural crop/fruit bearing tree loss
- Vulnerable groups
    - Adibasi/Janajati/Dalit/Women headed households residing within or adjacent to project site
    - Displacement of the above
    - Threats to cultural traditions or ways of life of vulnerable groups
- Perception of community towards the project (positive or negative)

Please refer to the SMF guidelines for further details. The social screening process shall be completed at the feasibility stage and is included in the Report Format of these guidelines. The main recommendations from the SMF screening shall be included here.

3.5.2 Environmental Impact

- **Has the environmental screening been completed as per EMF?**
- **Have the main recommendations from the screening for further assessment been included?**

The developer will have to comply with the safeguard policies as well as governmental requirements. The Environmental Management Framework (EMF) shall be taken as reference document for complying with environmental safeguards. These cover the following aspects:

- Impact to forests or vegetation due to the project location
- Water sources/bodies affected by the project
- Air pollution
- Land use
    - Loss of private land
    - Loss of agricultural product
    - Loss of private structures/community structures
    - Loss of forest and vegetation
    - Other
- Waste
- Technology description and outputs
- Odour
- Slurry use
- Health and safety

Please refer to the EMF guidelines for further details. The Environmental screening process shall be completed at the feasibility stage.

The main recommendations from the EMF screening shall be included here.

4. RISK ASSESSMENT

Relevant questions:

- **What are the main risks for the implementation of the project?**
- **Consequences?**
- **Strategies or control measures in place to overcome these?**

Once the analysis above has been carried out, a risk assessment shall be conducted in order to identify the main hazards to the project success, their consequences, and control measures that will be put in place to mitigate them. The risk assessment should evaluate the risks from technical and financial to social, environmental or regulatory, explain and discuss the criteria for the assessment and whether it is a quantitative or qualitative evaluation.
The risk assessment should consist of three parts:

- Identify the hazard and its consequences
- Evaluate the chance of that particular hazard occurring
- Establish a control measure for each hazard

Hazard	Likelihood	Consequence	Mitigation
...	...		...
...	...		...
...	...		...

5. RECOMMENDATIONS

Main questions to be answered:

- **Based on the overall Feasibility Study, is the project feasible or not?**
- **What are the next steps?**

In this section the consultant performing the FS should recommend the best option, explaining the reasons why, based on the comparison carried out above.

This section shall clearly determine whether the project is feasible or not based on the overall study. The conclusion should account for all the criteria followed during the study.

Any further actions recommended for the project development should also be described here.

6. APPENDICES

This section is used to provide the detailed data on which the main text of the FS is based, and to provide extra information of interest to the readers of the FS. Items would normally include some of the following. This is a non-exhaustive list:

- Detailed Technical calculations (mandatory)
- Detailed financial and commercial calculations (mandatory)
- Market research findings (mandatory)
- Records of community meetings, surveys, feedback from interviews, etc. (mandatory)
- Others