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Risk Analysis and Technical Review Checklist for Preparing Biogas Project Plans

This checklist (as well as the supporting information that follows) provides 35 “best practices” for preparing and evaluating plans for designing and implementing anaerobic digester (AD)/biogas projects. This resource is intended to help project developers, government agencies, financial institutions, and other stakeholders assess the technical and financial feasibility of a proposed AD/biogas project.

The checklist and supporting information should be used to determine if there is sufficient information to assess the technical and financial feasibility of a given project. The checklist also provides project developers with the tools needed to prepare a more complete plan. This checklist can further be utilized by government agencies and financial institutions conducting a systematic review of AD/biogas project proposals for project financing.

This checklist is intended to provide guidance and best practices only. The use of this checklist is not a guarantee that loan support, funding, or other further resources will be awarded to a project plan or proposal, or that a project plan that includes all of these elements will be implemented successfully.

RISK ANALYSIS AND TECHNICAL REVIEW CHECKLIST

Project Overview

1. Does the plan include a project overview that provides a clear, easily understood description of the proposed project?	☐ Yes ☐ No
2. Does the plan include contact information for key project participants, including the site owner, project owner, project developer, and project operator?	☐ Yes ☐ No
3. Does the plan include a process flow diagram?	☐ Yes ☐ No

Feedstock Supply and Characteristics

4. Does the plan adequately describe the source(s), volume, and characteristics of the feedstocks for the anaerobic digester?	☐ Yes ☐ No
5. If feedstocks will be obtained from offsite locations, does the plan present evidence of long-term supply agreements?	☐ Yes ☐ No ☐ N/A
6. Does the plan explain how the daily volume of digester influent was determined?	☐ Yes ☐ No
7. Is the stated digester influent total solids (TS) concentration consistent with the proposed type of anaerobic digester?	☐ Yes ☐ No

Biogas Production Potential

8. Does the plan present calculations for expected volumetric rate of biogas production for each given influent processed?	☐ Yes ☐ No
9. Does the plan demonstrate that the expected rate of biogas production is consistent with the anticipated feedstock supply and estimated volatile solids (VS) loading rate?	☐ Yes ☐ No
10. Are the values utilized to calculate the expected volumetric rate of biogas production the same as peer-reviewed constants for each given influent processed?	☐ Yes ☐ No
11. If the values utilized for calculating the volumetric rate of biogas production are different from values referenced in peer-reviewed resources, does the plan provide clearly documented methodology and laboratory analyses which demonstrate that different values are needed to calculate expected biogas production?	☐ Yes ☐ No ☐ N/A

Biogas Use

12. Does the plan describe the expected use of the biogas produced by the anaerobic digester?	☐ Yes ☐ No
13. Does the plan describe the assumptions used to determine biogas energy content?	☐ Yes ☐ No

Facilities and Equipment

14. Does the plan include a site plan and applicable engineering drawings?	☐ Yes ☐ No
15. Does the plan include appropriate level of detail in the descriptions of the project's physical components (e.g., structures and equipment)?	☐ Yes ☐ No
16. Can the individuals or firms who will be responsible for site preparation, construction, and equipment installation demonstrate appropriate qualifications and experience to successfully complete assigned tasks?	☐ Yes ☐ No
17. Does the plan include a reasonable project construction schedule?	☐ Yes ☐ No

Project Cost Estimate

18. Does the project cost estimate include an adequate level of detail?	☐ Yes ☐ No
19. Does the plan demonstrate measures to control costs for goods and services (e.g. through competitive fixed-price bidding)?	☐ Yes ☐ No

Financing Plan

20. Does the project-financing plan clearly identify all institutions contributing grants, loan guarantees, or loans to the proposed project and strategies to address any identified funding gaps?	☐ Yes ☐ No
21. Is there evidence of commitment from each prospective source of funding?	☐ Yes ☐ No

Permits

22. Does the plan identify all permits needed to execute the plan?	☐ Yes ☐ No
23. Does the plan state (or provide evidence) that the project developer has applied for the necessary permits?	☐ Yes ☐ No
24. Does the plan state (or provide evidence) that the project developer has obtained the necessary permits?	☐ Yes ☐ No

Operation, Maintenance, and Monitoring

25. Does the plan include a detailed plan for project operation and maintenance?	☐ Yes ☐ No
26. Does the plan identify the individual or individuals responsible for operation and maintenance?	☐ Yes ☐ No
27. Does the plan present the responsible individual(s)' qualifications for operation and maintenance?	☐ Yes ☐ No
28. Does the plan provide a detailed safety plan for the operation of the project?	☐ Yes ☐ No
29. Does the plan provide a process-monitoring plan?	☐ Yes ☐ No
30. Does the plan provide a digester effluent disposal plan, if applicable?	☐ Yes ☐ No ☐ N/A

Financial Feasibility Assessment

31. Does the plan clearly describe how the expected income from biogas was determined?	☐ Yes ☐ No
32. Does the plan provide sufficient justification for expected expenditures over the project life imbedded in the pro forma income and expense statement?	☐ Yes ☐ No
33. Is there documentation of the current on-site load or projected demand, if the generated biogas or electricity will be used onsite?	☐ Yes ☐ No ☐ N/A
34. If processed biogas or electricity generated using biogas will be sold to a third party, does the plan provide copies of contractual agreements or letters of intent?	☐ Yes ☐ No ☐ N/A
35. If the project will claim income from other sources, such as certified carbon emission credits or Renewable Electricity Certificates, does the plan demonstrate the validity of these income streams (e.g., contracts, letters of intent, etc.)?	☐ Yes ☐ No ☐ N/A

Supporting Information for Risk Analysis and Technical Review for Biogas Project Plans

The Supporting Information in this section outlines details of the checklist for preparing and evaluating plans for designing and implementing anaerobic digester (AD)/biogas projects. Projects should address each of the topics listed below when assessing the technical and financial feasibility of the proposed project.

SUPPORTING INFORMATION

Project Overview

1. Does the plan include a project overview that provides a clear, easily understood description of the proposed project?

The project plan should demonstrate the purpose and scope of the project. Specifically, it should state, in general terms, what the plan proposes and how the project will be developed and managed. The plan should also include a summary table of expected project performance, including the following:

- Source(s) of feedstock(s) to be anaerobically digested,
- Rate of expected raw biogas production for specific feedstocks,
- Income derived from biogas production, and
- Project cost.

2. Does the plan include contact information for key project participants, including the site owner, project owner, project developer, and project operator?

The project overview should provide the following information:

- Location of the project site,
- Name of the site owner with contact information,

- Name of the project owner with contact information if different from the site owner,
- Name of the project developer with contact information if different from the site or project owner,
- Name of the project operator with contact information, if different from the site or project owner, and
- Name of the engineering firm responsible for the project design with contact information.

3. Does the plan include a process flow diagram?

The project overview should include a process flow diagram that includes the components of the digester system, as well as the flows and loadings of feedstocks, biogas, digestate, and other materials into and out of the facility.

Feedstock Supply and Characteristics

4. Does the plan adequately describe the source(s), volume, and characteristics of the feedstocks for the anaerobic digester?

A digester's designed capacity should be fully utilized with a ready supply of adequate and appropriate feedstocks. Therefore, the plan should include a feedstock resource availability report, with the following information about the supply of each feedstock:

- Source and type of feedstock,
- Daily volume to be digested, and
- Physical and chemical characteristics, including total and volatile solids and biochemical oxygen demand, or chemical oxygen demand concentrations and pH.

The plan should describe all practices to ensure that feedstocks do not contain any toxic compounds that would interfere with the microbiology of the AD process, and all measures that will be taken to ensure that foreign objects, such as rocks and sticks that could damage pumps and mixers, are not present in the digester influent.

For projects that will use livestock manure as a feedstock, the plan should also include the following information:

- Livestock species (e.g., dairy cattle, buffalos, swine),

- Average number of head (standing population) by age class (e.g., lactating cows, dry cows, buffalos, heifers),
- Type of livestock bedding material used (e.g., straw, sawdust, sand), and
- Method of manure collection (e.g., manual, scrape, or flush).

The following technical elements should be included in each plan:

- If sand is being used as a bedding material, the plan should include provision for sand removal before digestion to prevent sand accumulation and continual reduction of digester hydraulic retention time (HRT).
- The plan should describe the processes for removing manure from paved surfaces. For maximal effectiveness, manure would be scraped from a paved surface, because manure collected from unpaved surfaces includes soil, which reduces the efficiency of the digester, due to the settling and accumulation of soil particles in the digester that reduce the HRT.
- The plan should describe the frequency of manure collection, which should be at least daily to prevent significant uncontrolled decomposition and loss of biogas production potential. The plan should discuss how the feedstocks will be stored and for what time period before they will be added to the digester.

5. If feedstocks will be obtained from offsite locations, does the plan present evidence of long-term supply agreements?

If the project will use feedstocks obtained from offsite locations, the plan should include:

- Evidence of feedstock supply agreements specifying the quantity of feedstocks that will be supplied to the project and the duration of the agreement,
- The duration of the agreement, which should ideally be the same as the expected useful life of the project, and
- The method of transport of feedstocks from offsite locations.

6. Does the plan explain how the daily volume of digester influent was determined?

The plan should include an estimate of the volume of feedstocks available for daily digestion. For projects that will use manure as a feedstock, this estimate can be based on either direct measurement or on the livestock species and average number of head by age class. This estimate should be based on published estimates of manure excretion rates such as those published in peer-reviewed research literature or by a national source of engineering data, such as the American Society of Agricultural Engineers (2005).

Accurate estimates of daily digester influent volume are critical for determining the necessary digester volume needed to realize the desired HRT, which is calculated as follows:

HRT = Digester operating volume (m^3) / Daily digester influent volume (m^3)

The appropriate HRT depends on the type of digester used, as discussed in the supporting information for question 7.

- When manure is or will be collected by flushing, the expected daily digester influent volume should be based on onsite measurement.
- When manure is or will be diluted by adding other waste, such as milking center wastewater, the volume of dilution water also should be determined by onsite measurement and the total expected daily digester influent volume stated.

7. Is the stated digester influent total solids (TS) concentration consistent with the proposed type of anaerobic digester?

The plan should include an estimate of the TS concentration in the digester influent based on values obtained from the literature or sample analysis. This estimate of TS should account for the effect of dilution, if applicable. The digester influent TS concentration is important to confirm that the correct type of digester is utilized on-site. See the table below for acceptable ranges of TS and typical HRT for different digester types.

Operating parameters for digester types

Type of AD System	Acceptable Range of TS	Typical HRT
Plug Flow Digester	10-14%	15-20 days
Complete Mix Digester	3-10%	15-20 days
Covered Lagoon	0.5-3%	35-60 days
Up-Flow Anaerobic Sludge Blanket	Less than 3%	5 days or less
Induced Blanket Reactor	6-12%	5 days or less
Fixed Film/Attached Media Digester/Anaerobic Filters	1-5%	5 days or less
High Solids Fermentation/" Batch" Style Dry AD Systems	More than 18%	20-30 days
Anaerobic Sequencing Batch Reactors	2.5-8%	5 days or less

Biogas Production Potential

8. Does the plan present calculations for expected volumetric rate of biogas production for each given influent processed?

Possibly the most important component of a biogas project plan is the estimate of the expected volumetric rate of biogas production. This quantity is a function of the:

- Concentration of VS in the digester influent,
- Volumetric loading rate, and
- Expected rate of biogas production as a function of volatile solids added (VS_a).

Ideally, the plan should present the following calculations to demonstrate the validity of the expected rate of biogas production:

Mass of Influent TS (kg/day)	=	Influent Volume (m^3/day) × Influent Density (kg/m^3) × TS Fraction (decimal)
Mass of Influent VS (kg/day)	=	Mass of Influent TS (kg/day) × VS as a Fraction of TS (decimal)
Rate of Biogas Production (m^3/day)	=	Mass of VS Added (kg/day) × Biogas Production Rate (m^3/kg VS Added)

9. Does the plan demonstrate that the expected rate of biogas production is consistent with the anticipated feedstock supply and estimated volatile solids (VS) loading rate?

See supporting information under question 8.

10. Are the values utilized to calculate the expected volumetric rate of biogas production the same as peer-reviewed constants for each given influent processed?

The plan should clearly document all assumptions and inputs used in the biogas production potential calculations. Reasonable expectations for biogas production per unit of volatile solids added are listed in the table below for common feedstocks.

Biogas Production Rates for select common feedstocks

Species	Biogas Production Rate, $m^3/kg\ VS_a$	Source
Lactating dairy cow manure	0.09	Chen and Hashimoto 1980
Feeder pig manure	0.12	Chen and Hashimoto 1980
Crop residues	0.4 – 0.8	Ward et al. 2008, IEA Bioenergy 2010, Weiland 2010
Municipal solid waste	0.2 – 0.8	Ward et al. 2008

Influent density will also depend on the type of feedstock used. As discussed above under question 7, acceptable values for TS will depend on the type of digester. The feedstock VS concentration should be determined either by sample analysis or from published values from peer-reviewed research literature.

11. If the values utilized for calculating the volumetric rate of biogas production are different from values referenced in peer-reviewed resources, does the plan provide clearly documented the methodology and laboratory analyses which demonstrate that different values are needed to calculate expected biogas production?

If the assumptions used in the biogas production potential calculations are not compatible with standard assumptions, the plan should include the results of laboratory analysis of the feedstock that will be used in the digester supporting their use of alternate assumptions.

Biogas Use

12. Does the plan describe the expected use of the biogas produced by the anaerobic digester?

The plan should describe how the produced biogas would be used. Options include:

- Direct combustion in a boiler or furnace for process heat,
- An engine-generator set fuel to generate electricity,
- Motor vehicle fuel after processing to remove carbon dioxide, hydrogen sulfide, and other impurities, or
- Injection into a natural gas pipeline, as renewable natural gas.

13. Does the plan describe the assumptions used to determine the biogas energy content?

The energy content of biogas can help determine the amount of energy an AD project can generate. The calculation of the energy content of raw biogas should be based on the lower heating value (LHV) of the methane fraction of the raw biogas, which accounts for its moisture content. The LHV of methane is approximately 39,800 kilojoules per m^3 (37,700 BTU per m^3). To estimate the LHV of the produced biogas, multiply the estimated percent methane in the biogas by the LHV of methane:

$$\text{LHV of dry biogas} = \text{LHV of methane} \times \text{Methane percentage of biogas}$$

Biogas is generally 50-60 percent methane. With an assumption of 55 percent methane, the LHV of dry biogas is approximately 21,900 kilojoules per m^3 (20,700 BTU per m^3). However, accounting for the moisture in biogas reduces the energy content by up to 10 percent. Therefore, to estimate the LHV of wet biogas, multiply the LHV dry biogas by 0.9.

$$\text{LHV of wet biogas} = \text{LHV of dry biogas} \times 0.9$$

The LHV of wet biogas with 55 percent methane content is approximately 20,000 kilojoules per m^3 (19,000 BTU per m^3).

If the plan uses other assumptions for the energy content of the biogas, these assumptions should be clearly documented, including the expected methane and moisture content of the biogas.

Facilities and Equipment

14. Does the plan include a site plan and applicable engineering drawings?

A detailed description of the site work should include all structures, such as the digester and feedstock pre-treatment/handling systems and the equipment that will be installed. This description consists of a site plan, with applicable engineering drawings, showing the location of the project relative to existing structures.

A biogas project will have the following key components:

- Feedstock reception pit to collect and temporarily store digester influent,
- Pre-treatment/slurry preparation and handling system,
- An anaerobic digester or a covered lagoon,
- Digester effluent storage facility, and
- Boiler, engine-generator set, or gas processing facility.

The type of digester used is dependent on the influent TS concentration as discussed under question 7.

Typically, a reception pit will contain an agitator and a pump to transfer the accumulated feedstocks into the digester. Note that the reception pit should provide no more than three days of storage. Retention times longer than three days significantly degrade biogas production potential of held feedstocks, especially in warm climates.

15. Does the plan include appropriate level of detail in the descriptions of the project's physical components (e.g., structures and equipment)?

The site plan should include:

- The materials that will be used to construct the digester,
- The dimensions of the digester, and
- The assumed values for daily digester influent volume and HRT.

These values are necessary to calculate the required digester operating volume.

The plan should also include a list of all mechanical and electrical equipment that will be purchased for the project. The information provided by this list should include the name of the manufacturer, the model, technical specifications, and warranty terms and conditions. The plan should also include a discussion of the plan for addressing equipment malfunction, including maintaining a proper inventory of spare parts.

The plan should also demonstrate that projects using engine-generator sets or biogas processing equipment have adequate but not excessive capacity based on the expected rate of biogas production.

16. Can the individuals or firms who will be responsible for site preparation, construction, and equipment installation demonstrate appropriate qualifications and experience to successfully complete assigned tasks?

The plan should include a list of the individuals or firms who will be responsible for site preparation, construction, and equipment installation. Degrees in Agricultural, Environmental, or related engineering fields are preferred along with experience in livestock and biological waste management. Include evidence that individuals or firms associated with the project have professional licenses, such a professional engineering license. Evidence of previous experience in developing completed biogas projects is desirable.

17. Does the plan include a reasonable project construction schedule?

A project construction schedule lists key milestones covering the expected dates of completion for:

- Site preparation,
- Digester and any related structure construction,
- Equipment installation, and
- Project start-up.

A project construction schedule also includes expected delivery dates for key equipment items. Project construction schedules are often represent a best-case scenario but can be overly ambitious. Construction delays can occur as weather, fulfillment schedules, shipping times, and staff availability fluctuate over the execution of the project plan. The project construction schedule should account for such potential delays to the extent possible.

Project Cost Estimate

18. Does the project cost estimate include an adequate level of detail?

The need for a precise project cost estimate is critical to determine the financial feasibility of the project, ensuring that the annualized costs of the project do not exceed the projected income (discussed in more detail in the supporting information under question 31). If additional funds are necessary to complete the project, the project may experience delays in the completion of construction and equipment installation, and the start of biogas production. Items in an acceptable cost estimate include:

<u>Capital costs</u>

- Land acquisition (if applicable)
- Pre-development costs (e.g. clearances, licenses, proposal preparation)
- Civil works (site preparation),
- Feedstock reception pit construction,
- Digester construction,
- Control building construction,
- Digester effluent storage structure construction (if required),
- Piping and electrical work,
- Equipment including:
    - Pumps,
    - Biogas processing equipment,
    - Biogas purification equipment (if applicable),
    - Electricity generation and transmission interconnection equipment (if applicable), and

    - Bio-CNG equipment, such as compressors, dispensers, cylinders (if applicable).
- Permits,
- Engineering and project management fees, and
- Contingency allowance

Services and Operation and Maintenance Costs

- Feedstock pre-treatment and handling,
- Annual costs to purchase feedstocks (if applicable)
- Digester effluent costs (including management, transportation, and disposal costs), and
- Annual labor and monitoring costs.

19. Does the plan demonstrate measures to control costs for goods and services (i.e. through competitive fixed-price bidding)?

The project cost estimate should be developed using measures to control costs for goods and services, such as competitive fixed-price bids for all goods and services that are included in the project plan. Evidence of soliciting and receiving multiple bids for each of the goods and services that will be used to develop the project should be included in the plan. The plan should provide explanations for any situations where a lowest cost bid has been rejected. For cases where the project developers intend to complete construction activities themselves, rather than utilizing third-party contractors, the plan should include an estimate of the cost involved. These factors should demonstrate to potential investors that planners have performed their due diligence to find suppliers that offer the best value to the project plan.

Financing Plan

20. Does the project-financing plan clearly identify all institutions contributing grants, loan guarantees, or loans to the proposed project and strategies to address identified funding gaps?

Biogas projects are often financed by a combination of grants and loans. Therefore, an acceptable project plan must include detailed information which explains how estimated total project cost will be covered by expected grants or financing.

21. Is there evidence of commitment from each prospective source of funding?

When borrowed capital from a commercial source is involved, a copy of the letter of commitment from the lender that specifies the terms and conditions of the loan must be part of the plan package. When there will be project-owner financing, a net worth statement that demonstrates the capacity to supply the specified sum funds also must be part of the plan package. Documentation of adequate funding for the execution of a project plan is needed for banks and lending agencies to ensure that funds are not committed to projects that will never be started due to lack of adequate funding.

Permits

22. Does the plan identify all permits needed to execute the plan?

Permitting requirements for biogas projects can be highly variable. The plan should include a list of required permits and indicate that all needed permits have been obtained or at least applied for. The absence of necessary permits from national and local authorities could result in the delay of construction and the expiration of fixed-price bids. A possible consequence is an unnecessary increase in the project cost.

23. Does the plan state (or provide evidence) that the project developer has applied for the necessary permits?

Demonstrating filed application(s) for the necessary permits offers an additional level of assurance that the project plan is underway. See supporting information under question 22.

24. Does the plan state (or provide evidence) that the project developer has obtained the necessary permits?

If the necessary permits have been obtained, investors and supporters of the project plan have concrete evidence that construction and/or operation can begin. See supporting information under question 22.

Operation, Maintenance, and Monitoring

25. Does the plan include a detailed plan for project operation and maintenance?

The success of a biogas project depends on uninterrupted operation of all of the system components. Unplanned digester downtime equates to lost revenue and increased operating expenses. While operation can be largely automated, achievement of this objective requires routine system inspection and a program of scheduled maintenance. Therefore, an acceptable project plan should include a detailed plan for operation and maintenance (O&M) that identifies the responsible individual or individuals and present their qualifications based on training and experience.

26. Does the plan identify the individual or individuals responsible for operation and maintenance?

See supporting information under question 25.

27. Does the plan present the responsible individual(s)' qualifications for operation and maintenance?

If the individual or individuals who will be responsible for O&M lack the required skills (from question 16), a plan for training should be presented in this section. See supporting information under question 25.

28. Does the plan provide a detailed safety plan for the operation of the project?

The plan should provide detailed guidance for the safe operation of the digester including:

- Maintenance of a no smoking/no open flame buffer area around the project with appropriate signage, due to the flammable and potentially explosive nature of biogas.
- Provisions for confined space entry procedures, as biogas can cause asphyxiation and the presence of hydrogen sulfide in biogas is extremely poisonous.
- An O&M plan should include a schedule for daily inspection to:
    - Ensure proper operation of biogas utilization and/or processing equipment, and;

- Identify physical damage to structures and equipment that could be the source of a biogas release to the atmosphere.

29. Does the plan provide a process-monitoring plan?

Monitoring the performance of anaerobic digestion processes is critical for long-term project success. Process failures translate directly into the loss of biogas-derived income and the possibility of invalidating contractual agreements. Both the rate of biogas production and methane content should be recorded and reviewed daily. Both values are important indicators of the stability of the microbial activity responsible for biogas production.

If the biogas produced is to be used onsite, the reduction of moisture and hydrogen sulfide are minimum requirements to reduce the corrosion potential associated with combustion equipment such as a boiler or electric generator. Therefore, the plan should include monitoring of the performance of the processes employed.

For the conversion of biogas to renewable natural gas, additional processing to remove carbon dioxide and other impurities along with compression is necessary. Thus, a provision for monitoring the additional conversion equipment will be necessary to ensure satisfaction of any specifications required.

30. Does the plan provide a digester effluent disposal plan, if applicable?

The plan should include a plan to address the disposal of the digester effluent (digestate). The plan should be based on generally accepted primary plant nutrient (nitrogen, phosphorus, and potassium) management practices. If the project incurs disposal costs for the digester effluent, this represents an operating cost in the evaluation of the project's financial feasibility.

Financial Feasibility Assessment

31. Does the plan clearly describe how the expected income from biogas was determined?

It is critical that a project developer be able to demonstrate the annual income generated by the project at least equals and preferably exceeds costs over the expected life of the project. To do so, the plan must include a pro forma income and

expense statement identifying and quantifying expected sources of income and expenses annually over the expected life of the project, typically 20 years.

The pro forma income and expense statement should include:

- A detailed accounting of expected expenses including operating, maintenance, and monitoring costs.
- The cost of energy for project operation based on parasitic load should be accounted for as a project expense.
- Many components of a biogas project, such as pumps, agitators, heat exchangers, flexible digester covers, engine-generator sets, and biogas processing components, will have an expected useful life that is less than the project expected life. The pro forma statement should include replacement expenses for this equipment.
- Insurance costs for the plant and equipment.
- If the project is partially owner-financed, the return of capital with a reasonable rate of interest should be treated as a project expense.

32. Does the plan provide sufficient justification for the assumptions embedded in the pro forma income and expense statement?

See supporting information under question 31.

33. Is there documentation of the current on-site load or projected demand, if the project's resultant biogas or electricity will be used onsite?

If the produced biogas or electricity will be used onsite, the plan should include a projected amount of biogas to be used as a boiler, furnace, or vehicle fuel, and/or the electricity to be used for buildings or equipment.

The electricity generation potential can be estimated by using the thermal efficiency provided by the manufacturer of the engine or generator. The plan should also include documentation of sufficient historical demand for the amount of energy consumption comparable with the expected energy production from the biogas project.

For projects at new facilities or existing facilities that are expected to see a large increase in energy demand, the plan should include:

- Documentation of the expected energy demand, and
- An explanation of assumptions used to estimate the energy demand.

For example, a dairy facility could plan to add a new refrigeration unit that will be powered by the energy produced by the biogas system. In this example, the plan should include an estimate of the energy demand for the refrigeration system based on the manufacturer's specifications, as well as energy demand from other systems at the facility.

The documentation of historical and/or expected energy demand should account for seasonal variation in demand, if applicable. The purpose of this documentation is to ensure that the project will not produce substantially more energy than can be used on-site.

34. If processed biogas or electricity generated using biogas will be sold to a third party, does the plan provide copies of contractual agreements or letters of intent?

If the project will sell processed biogas or electricity to a third party, the plan should provide copies of contractual agreements or letters of intent covering the sale of the biogas. For example, projects where biogas is used to generate electricity should include a Power Purchase Agreement. Documentation of similar biogas off-take agreements are needed to support the validity of all expected sources of income.

35. If the project will claim income from other sources, such as certified carbon emission credits or Renewable Electricity Certificates, does the plan demonstrate the validity of these income streams (e.g., contracts, letters of intent, etc.)?

For projects claiming income from carbon emission credits, Renewable Electricity Certificates, or other sources, the plan should include the contract or letter of intent for the purchase of the credits or certificates. For projects claiming income from carbon emission credits, the plan should also include the calculations of the carbon emission reductions for which they will be claiming credit.

Summary

This checklist and supporting information should be used to review project plans or proposals to determine whether there is sufficient information to determine the technical and financial feasibility of the project. The checklist provides project developers with an outline of the information needed to prepare more complete plans or proposals for

project financing and is also designed to assist government agencies and financial institutions conduct a systematic review of proposals for project financing.

Reviewers should pay particular attention to four critical, overarching questions in determining whether to approve a project plan or proposal for funding:

- Has the plan demonstrated the ability to obtain a sufficient and consistent supply of feedstocks for the project?
- Do the individuals responsible for construction, operation, and maintenance have the necessary skills, education, and/or experience with AD systems?
- Has the plan demonstrated the ability of the project to produce sufficient quantities of biogas?
- Has the plan demonstrated the financial feasibility of the project, including executed contracts or binding letters of intent covering the sale of the biogas, electricity, and/or other products from the project?

Project developers should provide enough information in their plans to answer these four critical questions.

Abbreviations and Acronyms

AD	anaerobic digester
HRT	hydraulic retention time
LHV	lower heating value
O&M	operation and maintenance
TS	total solids
VS	volatile solids

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