Annexure B: Biogas project development life cycle

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This annexure is to be used to complete the checklist below. The checklist provides a sequence for assessing the bankability, financial viability and potential successful implementation of a biogas project based on market conditions as of 23 March 2018.

Table 1: Feasibility conditions and viability model checklist to assess a biogas project model for potential successful implementation

Assessment Checklist				
(a) Is the project privately financed (Yes/No)				
OR (b) is the project funded through project finance or a SPV? (Yes/No)				
Based on your answer above, please complete the appropriate checklist [Answer (a) is associated with the left list – red; and answer (b) is associated with the right list – blue]				
Complete for privately financed projects (assumption <500kW)	**Yes**	**No**	**N/A**	**Complete for projects funded through project finance or a SPV (assumption >500kW)**
Feedstock supply considerations				
Can sufficient feedstock be supplied to allow for a 50% buffer?				Is there a feedstock guarantee for the full term of project?
Has analyses on a 12 month supply been conducted?				Are there letters of intent/agreements with alternate suppliers to provide feedstock?
Has a BMP test been done?				Has a BMP test been done?
				Is there a long-term feedstock analysis process (visual, testing etc.)?
				Has an external party independently assessed supply and quality?
Revenue considerations				
Are there two revenue sources/savings (electricity and heat or gas and heat) on site?				Is there a guaranteed off-take of electricity (total revenue equivalent of R1.4/kWh) OR gas (total revenue equivalent of R145/GJ) for the full contract term of project?
Are savings greater than existing expenses (electricity, heating costs, landfill disposal)?				Has the financial model been independently assessed by a qualified independent party?

Complete for privately financed projects (assumption <500kW)	Yes	No	N/A	Complete for projects funded through project finance or an SPV (assumption >500kW)
Collateral/bankability requirements				
Does the site owner/developer have sufficient collateral/assets to cover project loan / finance value (are there revenue streams that can be linked to repayment of debt)?				Is the off-take secured? (insurance policy, parent guarantee, collateral, balance sheet cover)
				Are there sufficient penalties imposed upon default of agreements to cover the losses that would be suffered?
				Is there sufficient insurance over the project risks? (feedstock, indemnity, equipment, etc.)
Permitting and licensing requirements				
Has a basic assessment or full EIA been completed?				Has a basic assessment or full EIA been completed?
Has a waste management licence been obtained (>1 tonne/day hazardous waste, >100 tonnes/day organic waste)?				Has a waste management licence been obtained (>1 tonne/day hazardous waste, >100 tonnes/day organic waste)?
Has an air emissions licence been obtained?				Has an air emissions licence been obtained?
				Is there a grid connection agreement? (Enter N/A if not generating electricity.)
				Does the project have a generation licence (>1MW, supplying to off-site location)**?** (Enter N/A if not generating electricity.)
				Is there a land lease agreement if the property is not owned by the SPV?
Technical considerations				
Does the construction and design team have sufficient experience/references (2-3 local projects of equal size that have met those contract requirements)?				Does the EPC have sufficient experience/references (2-3 local projects of equal size that have met those contract requirements)?
Is there a guaranteed performance ratio for the plant? (Is the guarantee secured)?				Is there a guaranteed performance ratio for the plant? (Is the guarantee secured)?
Has the O&M risk been mitigated? (i.e. Is the O&M part of the construction team or has there been a sufficient handover period allocated.)				Is there a base warrantee on equipment of at least 2 years?
Is there a base warrantee on equipment of at least 2 years?				Are there any liquidated damages on the EPC or O&M?
				Has the technical design been reviewed by a qualified independent party?

Complete for privately financed projects (assumption <500kW)	Yes	No	N/A	Complete for projects funded through project finance or an SPV (assumption >500kW)
Contracting requirements				
Is there an understanding of the roles between site owner and developer in the form of a signed agreement?				Have the rights of project been ceded to the SPV (land lease, permitting, licences, offtake agreements)?
Have the construction, O&M, off-take and feedstock agreements been compiled by parties experienced in biogas projects?				Have the EPC, O&M, off-take and feedstock contracts been validated by qualified external parties, ideally experienced in biogas projects?
Additional considerations				
Has the business model included a 6-12 month commissioning time at zero revenue?				Has the business model included a 6-12 month commissioning time at zero revenue?
Is there an environmentally responsible digestate management plan?				Is there an environmentally responsible digestate management plan?
Is digestate considered as zero revenue or zero saving?				Is digestate considered as zero revenue or zero saving?

If "Yes" is answered to each of the questions in the checklist above, then there is a high chance that the project is bankable and financially viable with a high potential for successful implementation. If any of the assessment checklist questions in Table 1 are not satisfied, the project is likely to face issues with obtaining finance and with implementation.

NOTE*:* As the assessment checklist for a viable biogas project model serves as an indication of the bankability, financial viability and potential for successful implementation, it does not guarantee that the implementation of the project would be successful should all the conditions be satisfied. However, using the feasibility components (refer to Section 2) and project development methodology (refer to Section 3), the likelihood of successful implementation improves.

1. Biogas project development life cycle

There are numerous complexities (including multiple revenue streams and the need for feedstock security) and several market barriers (including cost of digestate management and low landfill gate fees) in the biogas sector in South Africa. For projects to reach bankability and to be successfully implemented, project stakeholders need to understand the current viable project models in South Africa, those feasibility components that are critical to the project's success and follow a comprehensive project development methodology.

Thus, because of the complexity involved in developing successful biogas projects in South Africa, a project life cycle approach was taken that speaks to critical feasibility components, a best practice project development methodology and the current viable project models.

The biogas project development life cycle, shown in Figure 1, has four stages, namely biogas feasibility component decision trees, the development methodology, viable project models and implementation. The goal of the biogas project development life cycle is to assist project stakeholders or evaluators to either develop a viable project and/or assess the viability of a project.

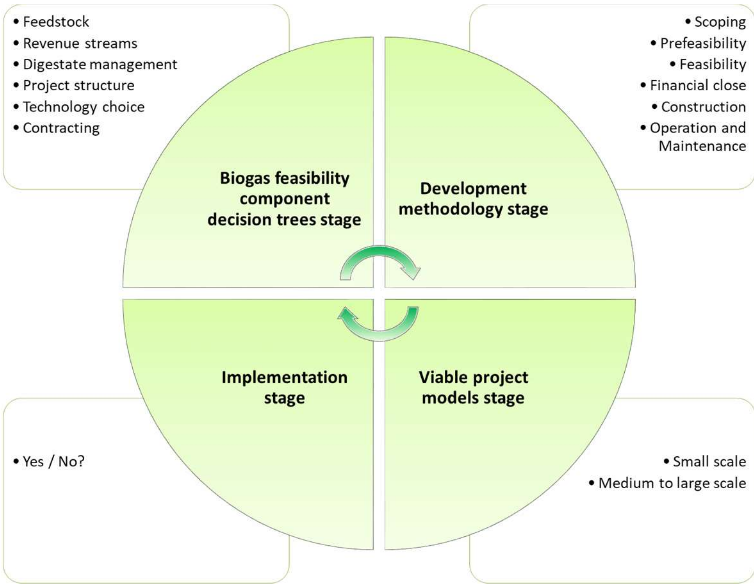


Figure 1: Biogas project development life cycle

1.1. Overview of the biogas project development life cycle

The biogas project development life cycle is an iterative process that continues until the implementation stage can be achieved. Implementation is only feasible once the biogas feasibility component decision trees, development methodology and viable project models stages have been fulfilled to mitigate the risks associated biogas project development to the highest degree possible. A checklist (see Table 1) has been developed that aims to ensure that all project risks have been mitigated, the project is financially viable and is likely to be successfully implemented.

An overview of each stage of the biogas project development life cycle is provided below in Table 2. Key considerations and/or specific South African market conditions are highlighted for each stage that will enable successful implementation of a financial viable biogas project within the current South African context. A more detailed breakdown on the stages is provided in Sections 2, 3 and 4.

Table 2: Details of biogas project development life cycle

Stage	Description	Key considerations and/or South African market conditions
Feasibility component decision trees (See Section 2)	These are the key criteria that require fulfilment to create a viable and successful biogas project.	
Feedstock	Highlights the criteria related to feedstock that are required to mitigate the risks they may bring to the success of a project.	• Current most likely viable feedstock include abattoir waste, manure and uncontaminated food waste • Feedstock that can be secured on-site are more likely to lead to a viable project • Due to short-term contracts in waste industry, it is difficult to secure feedstock for full life term of project
Revenue Streams	Highlights potential revenue streams and the criteria required to mitigate the risks these may bring to the success of a project.	• Electricity, biogas (either cleaned, compressed or liquefied) and waste management fees are the only current viable revenue streams • Heat generated either from a CHP engine or from burning biogas as a fuel requires a market baseline that can be compared to favourably in order for it to be viable • Carbon dioxide, as a product, and water treatment and reticulation can be used as revenue streams in unique circumstances
Digestate	Highlights how to manage digestate and mitigate the risks it may bring to a project.	• In the current SA context, digestate cannot be viewed as a revenue stream • It should be included as a cost centre • A zero cost to project is currently considered the most ideal scenario to enable project viability
Project structure	Highlights the components that are associated with a robust project structure and / or stakeholder relationships.	• Minimum 2 year O&M agreement to be signed with technology supplier • Key to obtain a commercial operational date from EPC / construction contractor. • Site owner / project developer balance sheet strength that includes various revenue stream options for small scale projects • Feedstock and offtake agreements / guarantees
Technology choice	Highlights suitability and requirements for successful technology integration within a project.	• Good engineering practices to be followed, i.e. are all certifications complete; proper engineering drawings completed; work signed off by professional engineer • Use locally sourced and certified technology where investment costs could possibly be reduced • Global technology is not fully transferable to a South African context

Stage	Description	Key considerations and/or South African market conditions
Contracting	Highlights the technical review phase of contracts to ensure agreements between partners, contractors, suppliers, offtakers, etc. are formalised and fair.	• Feedstock suppliers are hesitant to sign an agreement for longer than 2 years due to competitive market price of feedstock • Performance guarantees from technology suppliers are often linked to feedstock description provided and its consistency. This causes issues if commercial operational date is not achieved, as there are always changes in feedstock plan and operations.
Development methodology (See Section 3)	Methodology for the development of a project	
Scoping	Define project parameters	Key considerations: • Feedstock availability • Stakeholder assessment • Foreign exchange rates because of high percentage of equipment are imported
Pre-feasibility	Assessing viable options	• Technical review to ensure no project limiting factors including feedstock analysis, site assessment, revenue stream assessment and digestate assessment.
Feasibility	Confirming key variables	Key considerations: • Financial viability • Risk mitigation • Execution
Financial closure	Concluding project development	Key considerations: • Commitment from finance agreements and build contract on terms and conditions • Conclusion of contracts (feedstock supply, offtake agreements, etc.) • All agreements should be signed simultaneously
Construction	Building project	• Management of contractor to meet agreed terms • EPC / construction team need experience in build biogas plants • EPC / construction team need to deliver on time
Commissioning	Starting up and testing equipment	• Assessing equipment performance and fine tuning operation including provision of feedstock and production of outputs
Operation and maintenance	Ongoing operation and maintenance of the stabilised plant	• Performance guarantees if all terms and conditions are met, e.g. feedstock consistent and the same as provided when selecting technology. • Two year management and training hand over provided by EPC / technology supplier with signed guarantees for any damages incurred

Stage	Description	Key considerations and/or South African market conditions
Viable project models (See Section 4)	Current project models that are viable in the current South African context	
Private	Model for projects that are privately funded	Among others: • Requires site owner collateral • Requires electrical and heat/gas/disposal savings
Project finance or SPV	Model for projects that are funded through project finance or SPV	Among others: • Requires offtake guarantee • Biogas sales only viable in the case of facilities > 1.5MW capacity • Electricity sold at a premium rate of R1.4/kWh • Biogas sales sold at a rate of R145/GJ
Implementation	The execution of bankable biogas project	

1.2. How does biogas project development life cycle work?

A step-by-step illustration of the iterative process of the biogas project development life cycle is shown in Figure 2 and explained below.

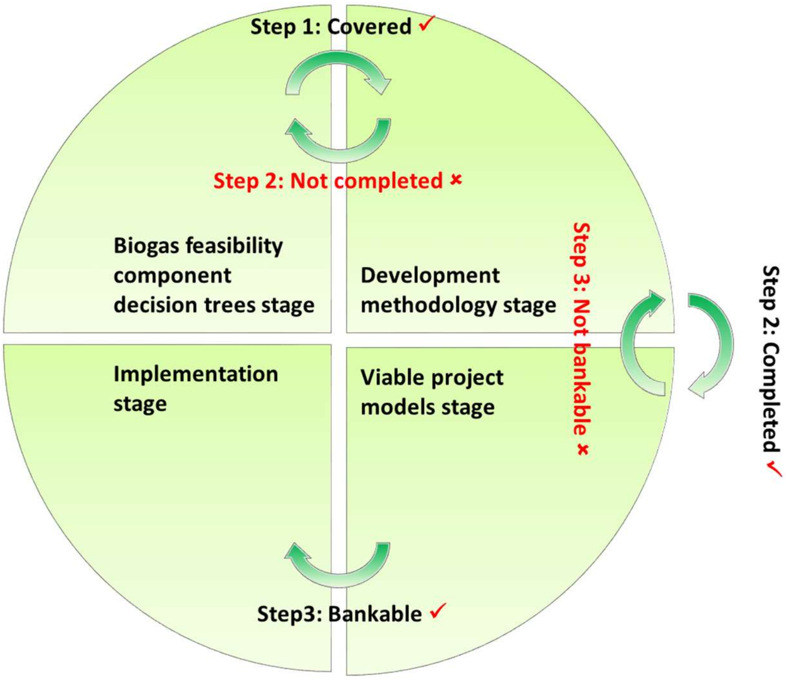


Figure 2: Procedure for using the biogas project development life cycle

Step 1: Assess the biogas feasibility component decision trees applicable to the project in question. Once the biogas feasibility component decision trees have been satisfied, i.e. component risks have been mitigated and the project is deemed viable, proceed to the development methodology.

Step 2: Proceed through the development methodology. If a sound project development methodology has been used, i.e. the project has systematically progressed and the project has been deemed viable at each phase of project development, proceed to the viable project models stage.
If the project has not followed a sound development methodology, the biogas feasibility component decision trees should be used to identify those risks that have not been considered and/or mitigated (back to step 1).

Step 3: The viable project models outline key characteristics of bankable biogas projects within the current South African context. If a project is unable to fit into one of the viable project models, refer back to the development methodology stage to address the missing criteria (back to step 2).

*****NOTE:** The procedure highlights the steps for the development of a successful biogas project. However, **a quick-check for viability would be to assess whether a project fits one of the viable project models**.

2. Biogas project feasibility component decision trees

Biogas feasibility component decision trees (BFCs) constitute one of the stages of the biogas project development life cycle and were developed to provide insight as to what considerations are required for the successful implementation of a biogas project. The BFCs cover six key criteria that need to be assessed for risk mitigation. An overview of the BFCs is provided in Figure 1 below. Because the decision tree for each BFC is extensive and may cover multiple pages, each BFC decision tree is depicted in a single colour. The colour code is also shown in the figure below.

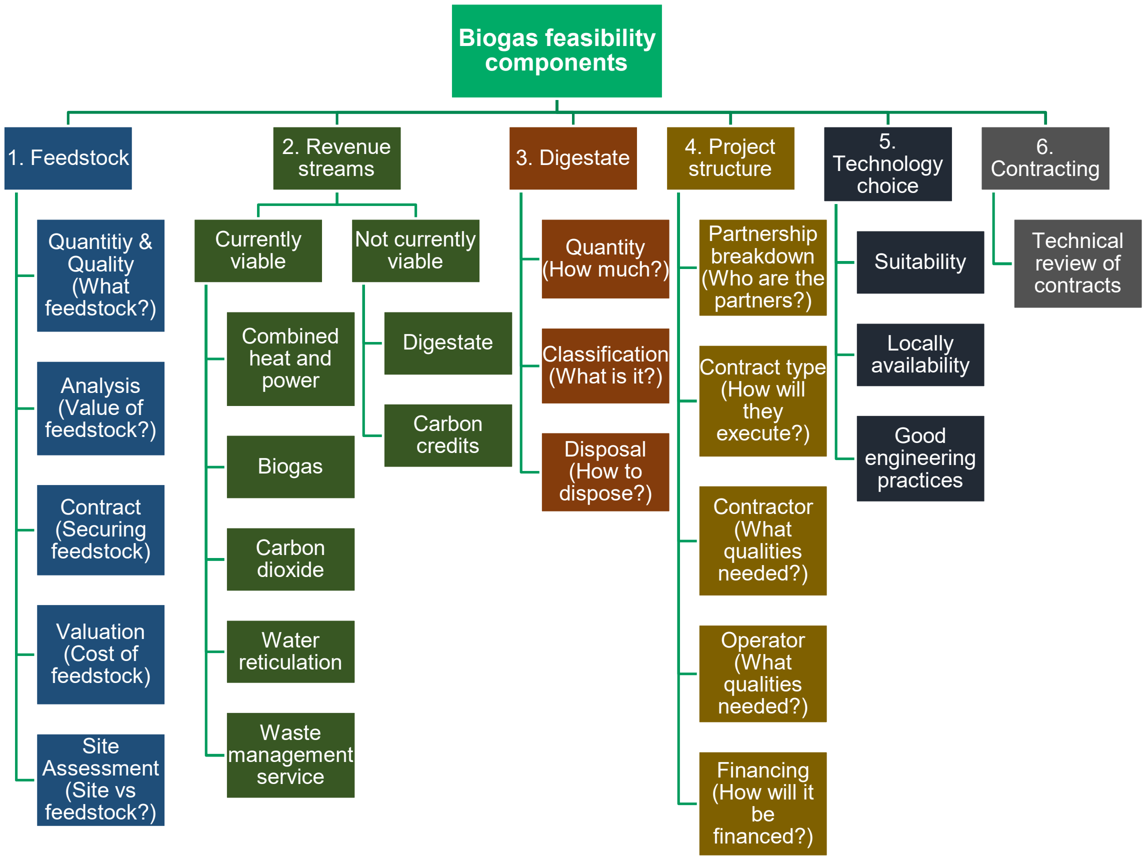


Figure 3: Biogas feasibility component decision tree overview

The BFCs can be covered individually or concurrently when developing a project.
The BFCs are designed to guide and assist any stakeholder involved in the development of the biogas project.
The decision tree has a number of different types of nodes – some are for recording information, others are noting key decision-making points and others are "GO/NO GO" decision points, where

the project's viability is in question. In order to proceed through the development methodology, the GO/NO GO decision points need to be answered affirmatively.

In addition, nodes where a cost is involved or the aspect is considered critical to the project's success are also highlighted as shown in Figure 4 below.

Decision tree key	Description
= Cost involved	This particular aspect has a possible cost involved in addressing it.
= Key requirement	This aspect is considered critical for the subcomponent to be addressed effectively.
NB!!! –GO or NO GO point	This is considered a key point in the development of a project. Depending on the outcome of branch covered, a decision would be made whether the outcome allows for further development of the project or whether the outcome is not viable for a successful project.

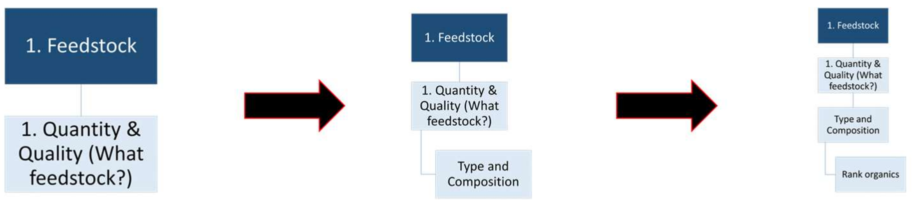
Figure 4: Decision tree key

The intent is to work through the decision tree and record information / answer questions and affirm that risks are mitigated as far as possible and the project is viable.
Each decision tree has an accompanying table that provides a description and action required for each node as well as how it is linked to the project development methodology stage.
An example of how a criterion would be unpacked and addressed is provided below in Box 1.

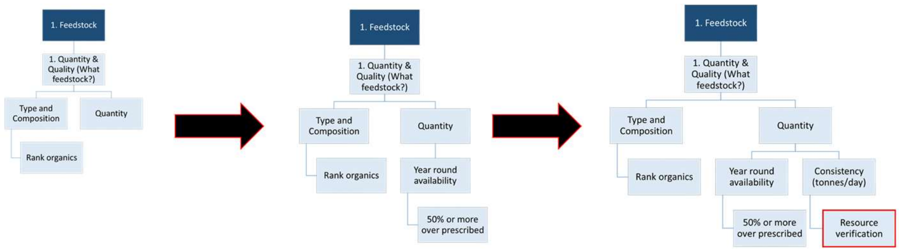
Box 1: Example of how each FBC is assessed using its decision tree

1. Select a criterion that is to be covered, e.g. Feedstock

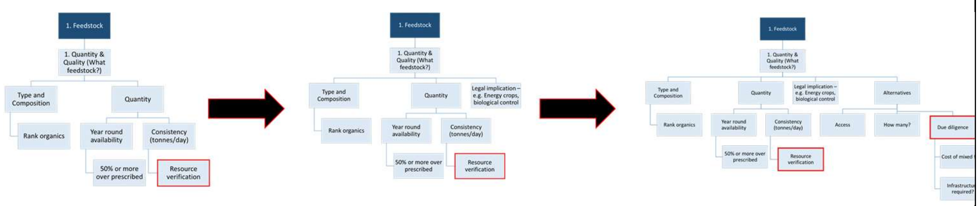
2. Begin with the first sub-component (e.g. Quantity and Quality – What feedstock?) of the selected criterion. Unpack the first branch (e.g. Type and Composition) for that sub-component and ensure that it completely addressed (i.e. address "Type and Composition" and then "Rank organics" below within the "Quantity and Quality" sub component branch, before shifting onto the next branch).



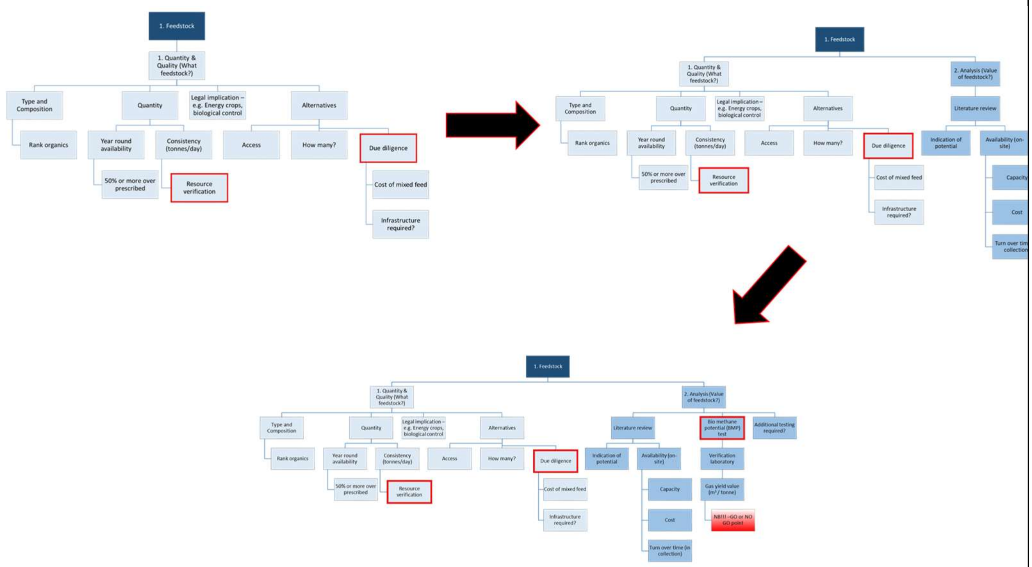
3. Once a branch for a sub-component has been completely addressed (i.e. in the case of the “Quantity and Quality” sub-component with “Type and Composition” and “Rank organics” nodes within its branch), begin to unpack the next branch for that sub-component (e.g. Quantity) and address completely. Once the branch has been completely addressed, move onto the next branch for that sub-component.



4. Continue until every branch for each sub-component has been covered and addressed.

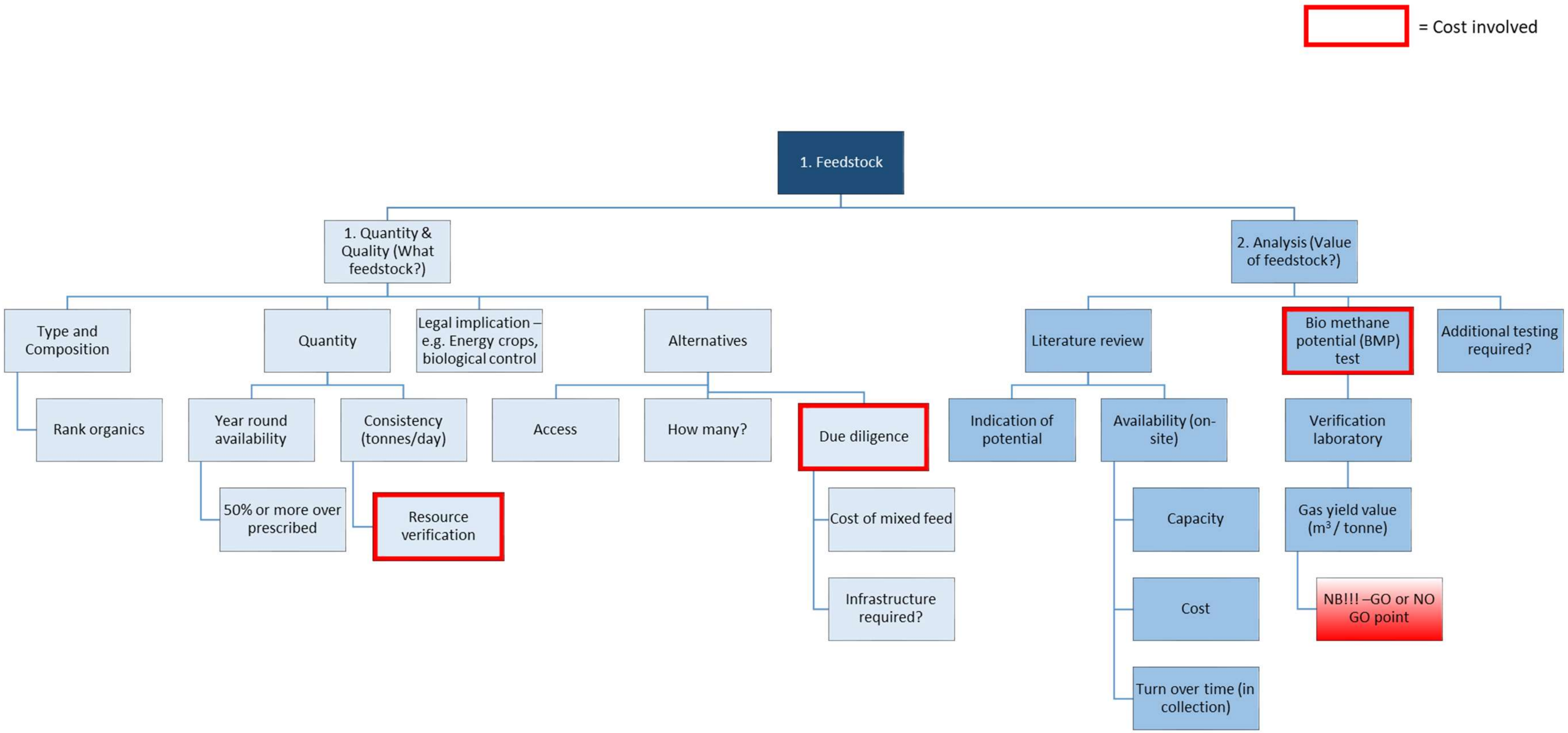


5. Once all the branches for a sub-component has been completely addressed, move onto and begin to unpack the next sub-component (e.g. Analysis – Value of Feedstock?) and its branches.



6. Continue until all sub-components have been covered for a criterion.

2.1. Feedstock



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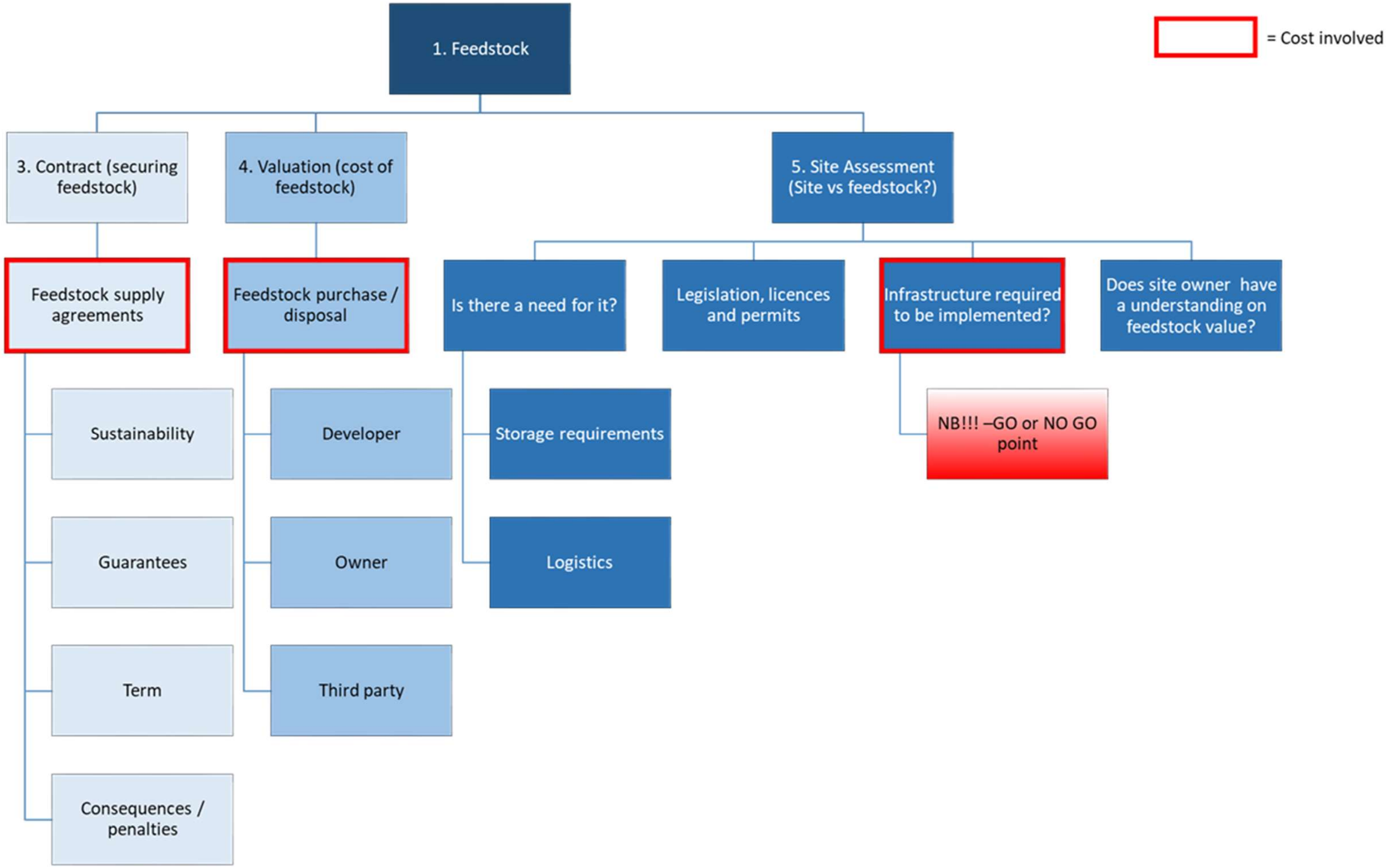
1. Feedstock
= Cost involved
3. Contract (securing feedstock)
4. Valuation (cost of feedstock)
5. Site Assessment (Site vs feedstock?)
Feedstock supply agreements
Feedstock purchase / disposal
Is there a need for it?
Legislation, licences and permits
Infrastructure required to be implemented?
Does site owner have a understanding on feedstock value?
Sustainability
Guarantees
Term
Consequences / penalties
Developer
Owner
Third party
Storage requirements
Logistics
NB!!! –GO or NO GO point

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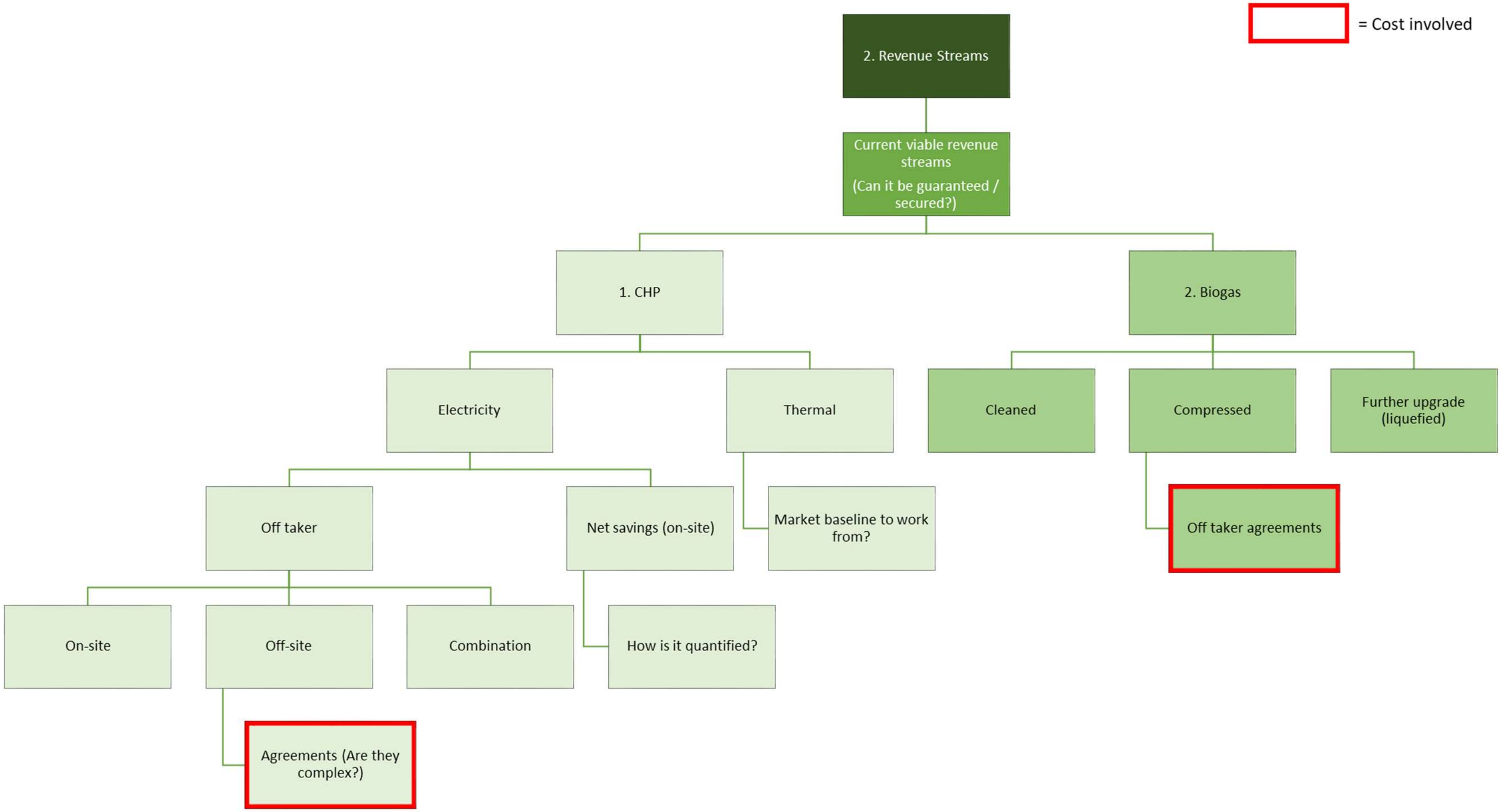
Feedstock sub-component	Description	Action	Applicability in development methodology (see Section 3)
1. Quantity & Quality	**"What feedstock?" in terms of quantity, quality and availability**		
Type & composition	What type of feedstock is available and what is the composition of available feedstock?	Confirm type and composition with feedstock owner and sampling of the feedstock.	• Scoping • Pre-feasibility
Quantity	Is there enough feedstock available?	Confirm the amount and consistency year round of the feedstock available. There will be a cost involved with verifying the feedstock resource. Make sure that the feedstock is 50% or more over the required quantity..	• Scoping • Pre-feasibility
Legal implication	Is there a legal impact for the feedstock being used?	Confirm and address any legal implications and / or limitations on the feedstock available. e.g. energy crops	• Pre-feasibility
Alternatives	Do you require additional feedstock streams?	Confirm if any additional feedstock streams are required, and how many. The additional feedstock streams would need to undergo the same verification process, which has a cost, as the initial feedstock. Confirm if there will be any additional costs incurred due to mixing of feedstock streams and infrastructure required.	• Scoping • Pre-feasibility
2. Analysis	**What is the potential of the feedstock?**		
Literature review	Is there any background information that provides an indication of the feedstock potential?	Confirm what bio methane potential (BMP) the feedstock may have through background information. Confirm the availability, capacity available to process, cost and turn over time to collect the feedstock.	• Pre-feasibility

Feedstock sub-component	Description	Action	Applicability in development methodology (see Section 3)
2. Analysis	**What is the potential of the feedstock?**		
Bio methane potential (BMP) test	Has a BMP test been completed?	Conduct a BMP test through a verified laboratory. There will be a cost involved to complete BMP test, which determines the biogas yield volume. **GO/NO GO:** The results of the BMP test provide insight to assist in a critical decision point within the project development timeline.	• Pre-feasibility
Additional testing required?	Are there any additional testing on the feedstock that is required?	Confirm if any additional testing of the feedstock is required and what costs are involved. e.g. Implications of mixed feed, etc.	• Pre-feasibility
3. Contract	**Have you and how have you secured the feedstock?**		
Feedstock supply agreements	Has the feedstock been secured by the means of a signed contract?	Confirm the sustainability, term, guarantees and penalties agreed upon for the feedstock agreements. There will be a cost involved to ensure that these agreements have legal standing.	• Feasibility
4. Valuation	**What is the financial value of the feedstock?**		
Feedstock purchase / disposal	Does the feedstock need to be purchased? Does the owner consider the feedstock as a waste?	Confirm if the feedstock streams will be a cost centre or if it can be obtained for free.	• Pre-feasibility • Feasibility
5. Site assessment	**How does the site location affect the availability of the feedstock?**		
Is there a need for a site assessment?	Does the handling of the feedstock require that the site be assessed from the point of view of both site owner and project developer?	Confirm if handling the feedstock requires any changes to be made to the site location in terms of feedstock storage and logistics.	• Pre-feasibility
Legislation, licences and permits	Are there any legal implications for the site for both handling the feedstock and project operation?	Confirm if any form of legislation is currently regulating the feedstock. Complete all licences and permits required for operation of the project.	• Pre-feasibility • Feasibility
Infrastructure required to be implemented?	Is there any additional infrastructure required for handling the feedstock?	Confirm if there is infrastructure that needs to be constructed to accommodate the feedstock. **GO/NO GO:** The requirements and costs for additional infrastructure will provide insight to assist in a critical decision point within the project development timeline.	• Feasibility
Does the site owner have an understanding of feedstock value?	Does the site owner understand the value of the feedstock to the project?	Confirm if the site and feedstock owners have a good understanding of the value the feedstock brings to the success of a biogas industry.	• Scoping

2.2. Revenue streams



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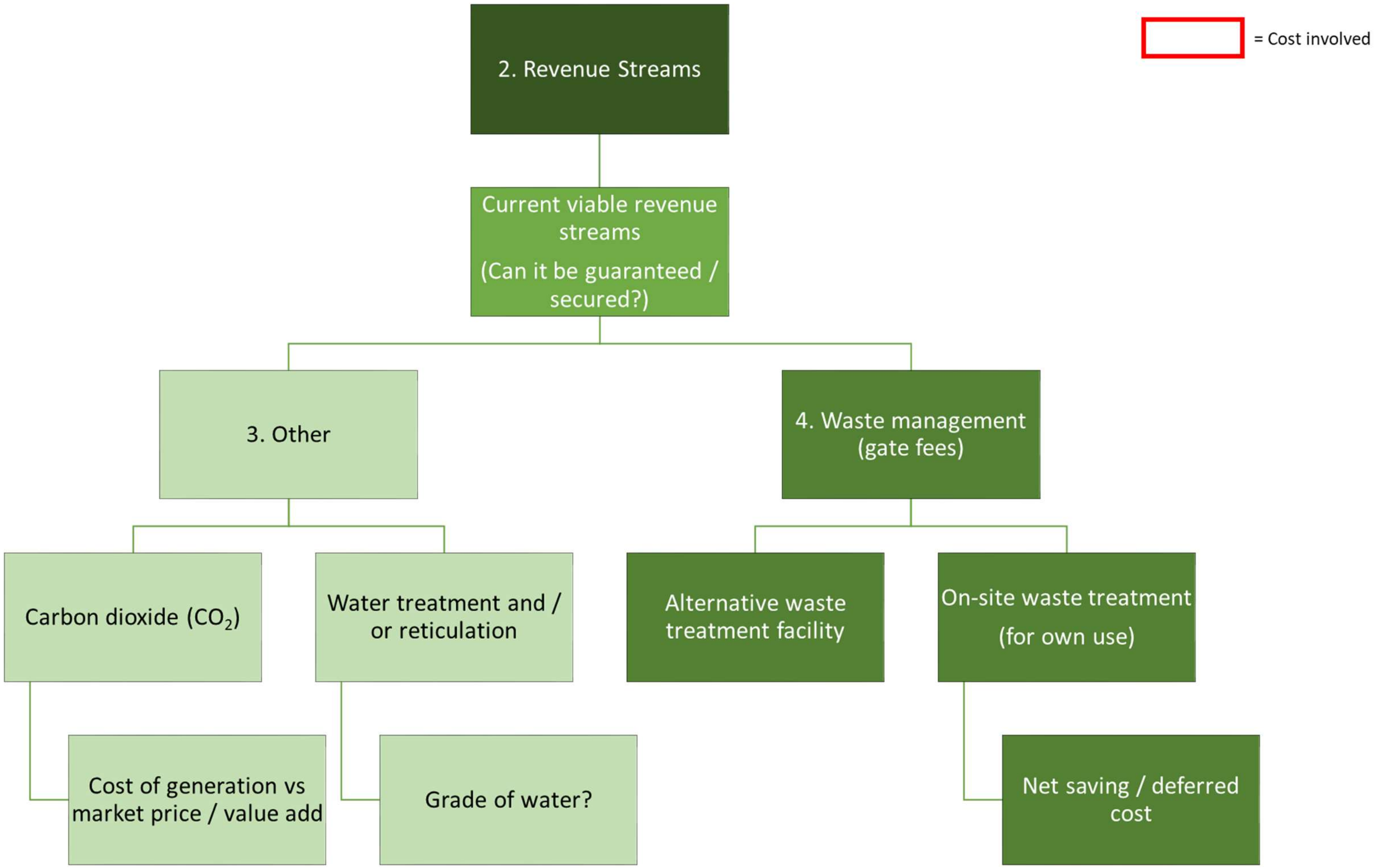
= Cost involved
2. Revenue Streams
Current viable revenue streams
(Can it be guaranteed / secured?)
3. Other
4. Waste management (gate fees)
Carbon dioxide (CO_2)
Water treatment and / or reticulation
Alternative waste treatment facility
On-site waste treatment
(for own use)
Cost of generation vs market price / value add
Grade of water?
Net saving / deferred cost

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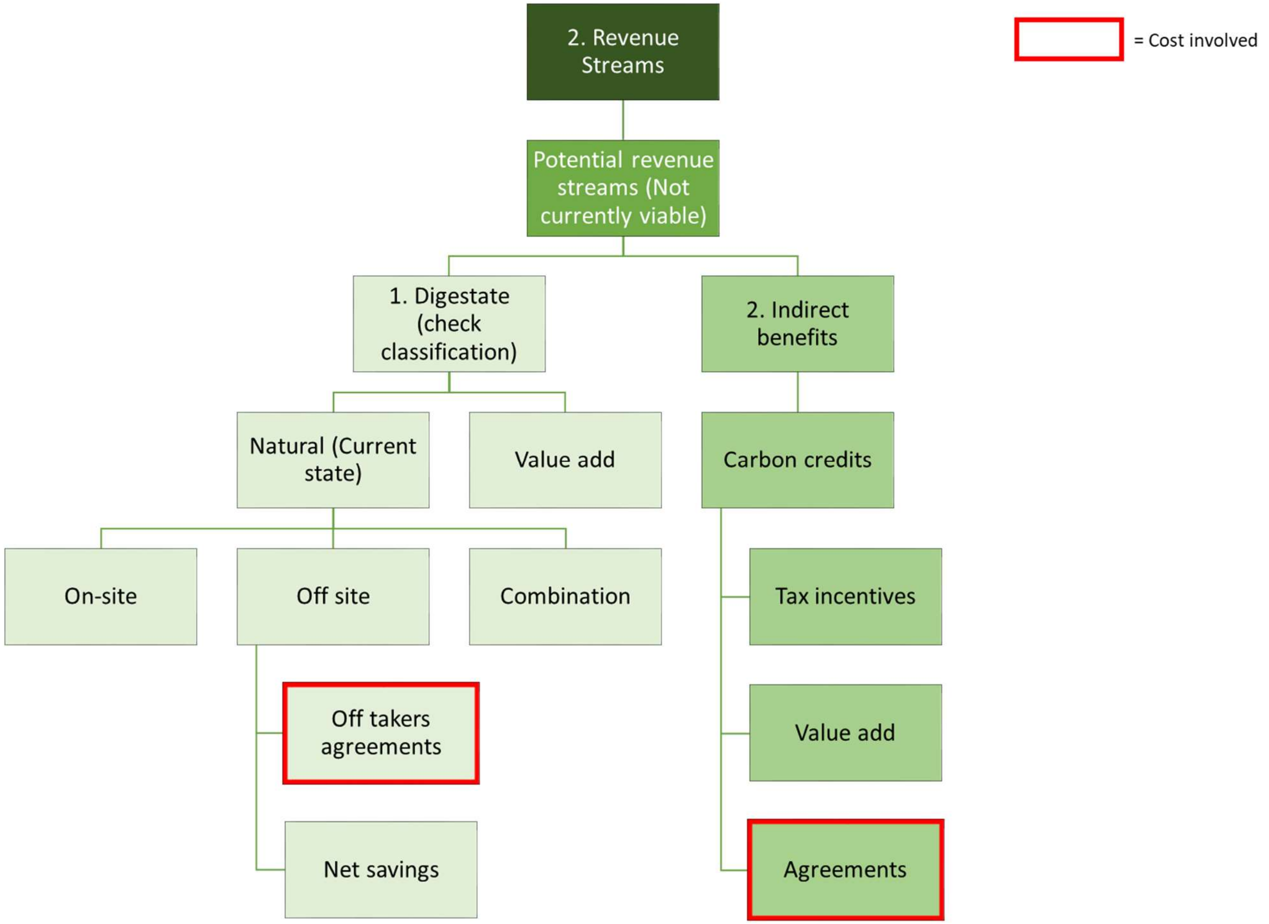
= Cost involved
2. Revenue Streams
Potential revenue streams (Not currently viable)
1. Digestate (check classification)
2. Indirect benefits
Natural (Current state)
Value add
Carbon credits
On-site
Off site
Combination
Tax incentives
Off takers agreements
Value add
Net savings
Agreements

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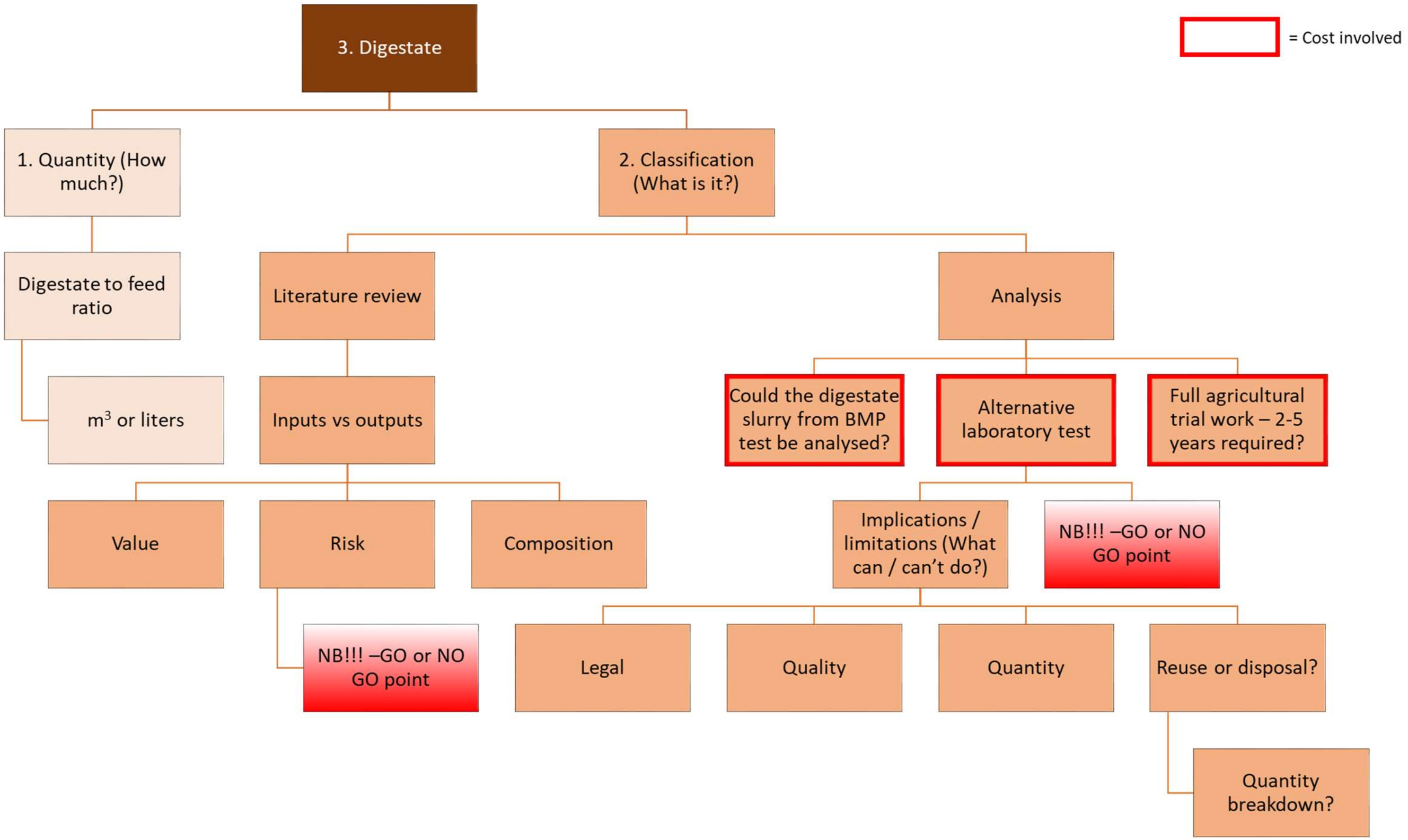
Revenue stream sub-component	Description	Action	Applicability in development methodology (see Section 3)
Current viable revenue streams	Revenue streams that can be monetarised and secured / guaranteed	Confirm that these revenue streams are acceptable when presented in a financial model to finance institutions.	• Scoping
1. CHP	**Revenue stream based on products produced by a combined heat and power (CHP) engine**		
Electricity	Is there an offtaker for electricity generated?	Confirm if the offtaker is on-site, off-site or a combination of the two. Confirm if the revenue is quantified as a net saving and how this is achieved. There will be a cost involved to ensure that these agreements have legal standing.	• Pre-feasibility • Feasibility • Financial closure
Thermal	Is there an offtaker for the thermal energy generated?	Confirm if there is a market baseline that can be used favourably for comparison, if thermal energy is generated either from a CHP engine or from burning biogas as a fuel and is stated as a revenue stream.	
2. Biogas	**Revenue stream based on direct biogas sales**		
Cleaned	Is there an offtaker for biogas after basic cleaning?	Confirm if there is an offtaker for cleaned (water and hydrogen sulphide removed) biogas. There will be a cost involved to ensure that these agreements have legal standing.	• Pre-feasibility • Feasibility • Financial closure
Compressed	Is there an offtaker for compressed biogas?	Confirm if there is an offtaker for compressed biogas (CBG). There will be a cost involved to ensure that these agreements have legal standing.	
Further upgrade (liquefied)	Is there an offtaker for liquefied biogas?	Confirm if there is an offtaker for liquefied biogas (LBG). There will be a cost involved to ensure that these agreements have legal standing.	

3. Other	**Additional revenue options that are currently viable**		
Carbon dioxide (CO_2)	Is there an offtaker for carbon dioxide?	Confirm if there is an offtaker for carbon dioxide. Conduct a cost of generation vs market price / value analysis.	• Pre-feasibility • Feasibility • Financial closure
Water treatment and /or reticulation	Is there a demand for water treatment and /or treated effluent?	Confirm if a revenue can be generated through providing water treatment service. Confirm if treated effluent has an offtaker.	
4. Waste management (gate fees)	**Revenue stream based on providing a waste management and /or disposal service**		
Alternative waste treatment facility	Is the project providing an alternative waste disposal solution to a region?	Confirm if plant is or can be designed to generate a revenue by providing a waste solution service in the region it is located.	• Pre-feasibility • Feasibility • Financial closure
On-site waste treatment	Is an on-site waste disposal service being provided?	Confirm if the on-site feedstock owner will be paying a processing fee. Confirm if the revenue is quantified as a net saving / deferred cost and state how this is achieved	
Potential revenue streams	Revenue streams that have potential but cannot currently be monetarised and secured / guaranteed	Confirm that these revenue streams are not currently acceptable when presented in a financial model to finance institutions.	• Scoping
5. Digestate	**Potential for generating revenue from digestate but not currently viable**		
Natural (current state)	Can the digestate be sold in its natural state?	Confirm if there is value for the digestate usage, in its natural state, on-site, off-site or both. There will be a cost involved to ensure that these agreements have legal standing.	• Pre-feasibility
Value add	Can the digestate be sold after it has been processed further?	Confirm if there is value for the digestate, after it has undergone a process to add value, on-site, off-site or both. There will be a cost involved to ensure that these agreements have legal standing.	• Pre-feasibility
6. Indirect benefits	Additional potential revenue streams that could be established but not currently viable		
Carbon credits	Can a revenue and/or cost saving be generated through carbon mitigation?	Confirm if there is any value that can be gained through carbon credits, carbon tax and / or carbon mitigation.	• Pre-feasibility

2.3. Digestate management



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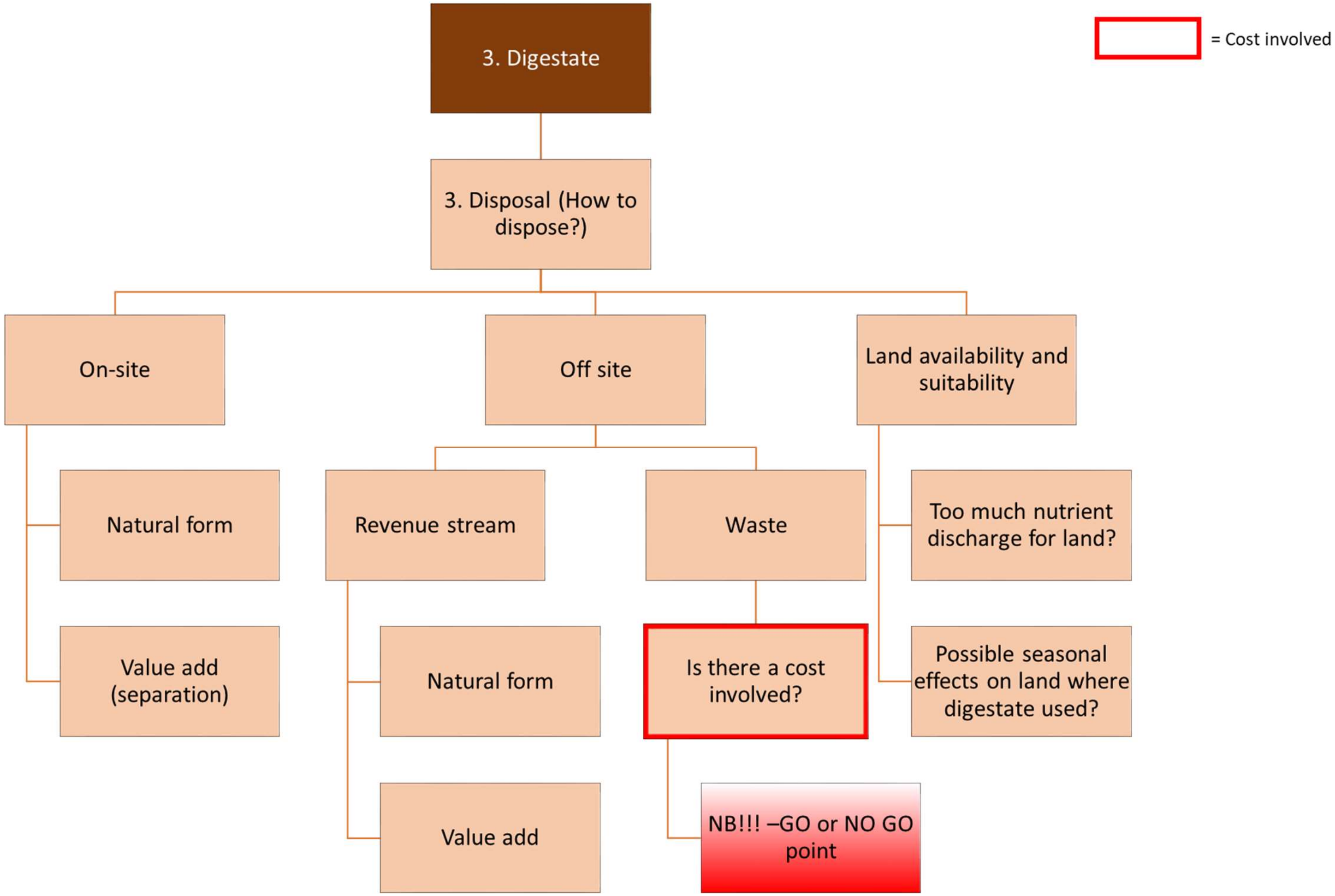
= Cost involved
3. Digestate
3. Disposal (How to dispose?)
On-site
Off site
Land availability and suitability
Natural form
Value add (separation)
Revenue stream
Waste
Too much nutrient discharge for land?
Natural form
Is there a cost involved?
Possible seasonal effects on land where digestate used?
Value add
NB!!! –GO or NO GO point

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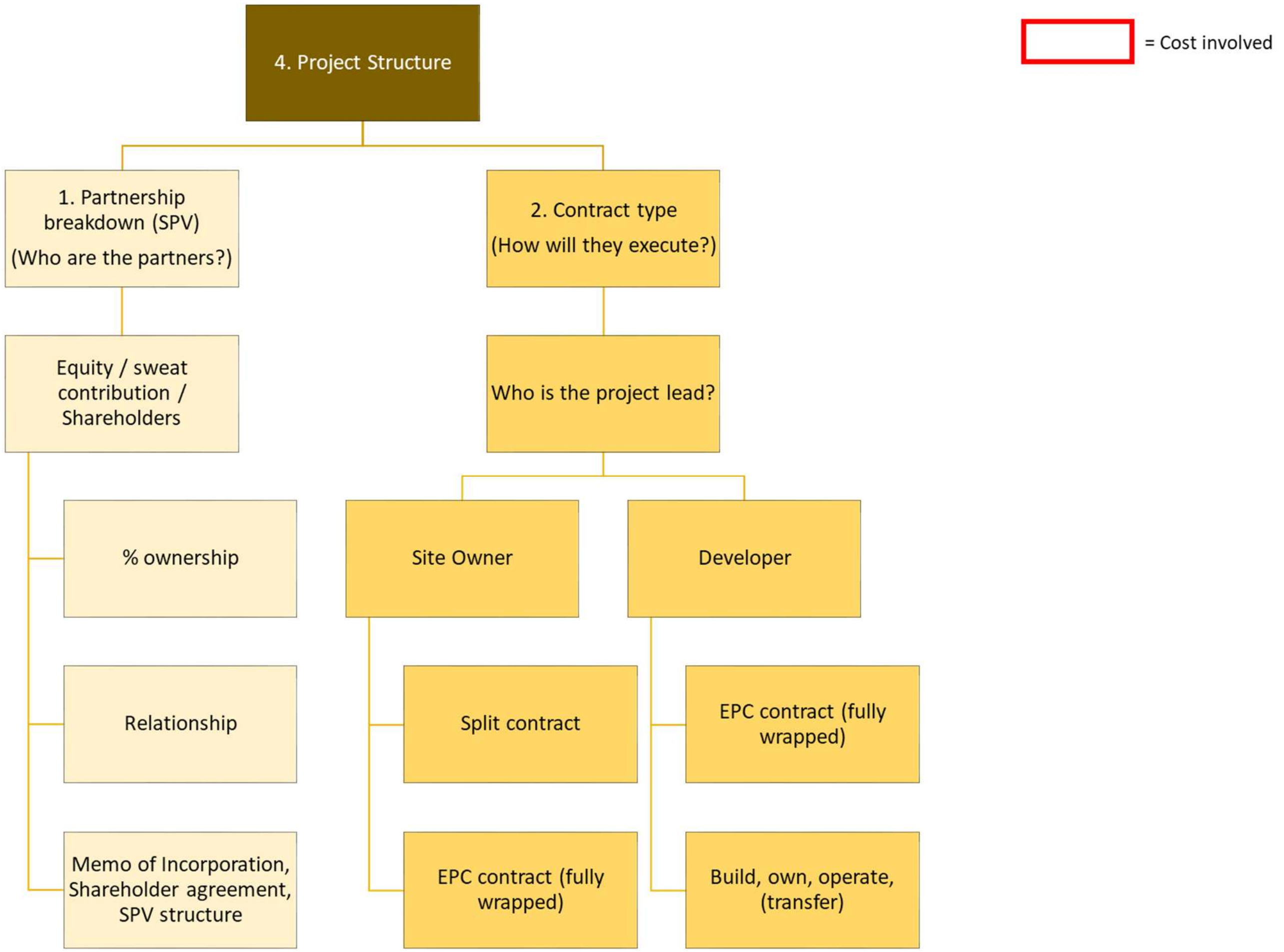
Digestate sub-component	Description	Action	Applicability in development methodology (see Section 3)
1. Quantity	**How much digestate will be generated?**		
Digestate to feed ratio	Can the quantity of the digestate generated be determined by the feedstock quantity?	Confirm the amount, in volume or mass, of digestate that will be generated based on the amount of feedstock being processed.	• Scoping • Pre-feasibility
2. Classification	**What is the composition of the digestate?**		
Literature review	Is there any background information that provides an indication of the digestate composition?	Confirm the quantity, composition, value and risk implications of digestate generated through background information. **GO/NO GO:** The results of the literature review of the digestate will assist in a critical decision point within the project development timeline.	• Scoping • Pre-feasibility
Analysis	Are there any tests on the digestate that is required?	Confirm what tests (slurry analysis of BMP test material, alternative laboratory test, full agricultural trial work) need to be conducted for analysis of digestate. There will be a cost involved to complete any analytical test that assists in classifying the digestate generated. **GO/NO GO:** The implications and limitations of the physical analysis of the digestate will assist in a critical decision point within the project development timeline.	• Scoping • Pre-feasibility
3. Disposal	**How will the digestate be management / disposed?**		
On-site	Can the digestate be disposed of on-site?	Confirm if there is a usage for digestate on-site and in what form.	• Pre-feasibility • Feasibility
Off-site	Can the digestate be disposed of off-site?	Confirm if there is a usage for digestate off-site and in what form. Confirm if the digestate needs to be disposed of, and what cost will be involved. **GO/NO GO:** The cost of disposing the digestate will assist in a critical decision point within the project development timeline.	• Pre-feasibility • Feasibility
Land availability and suitability	Is there sufficient and appropriate land available for the disposal of digestate?	Whether on-site or off-site, confirm if land where the digestate is being discharged on is sufficiently large and whether there might be any nutrient and / or seasonal limitations.	• Pre-feasibility • Feasibility

2.4. Project structure



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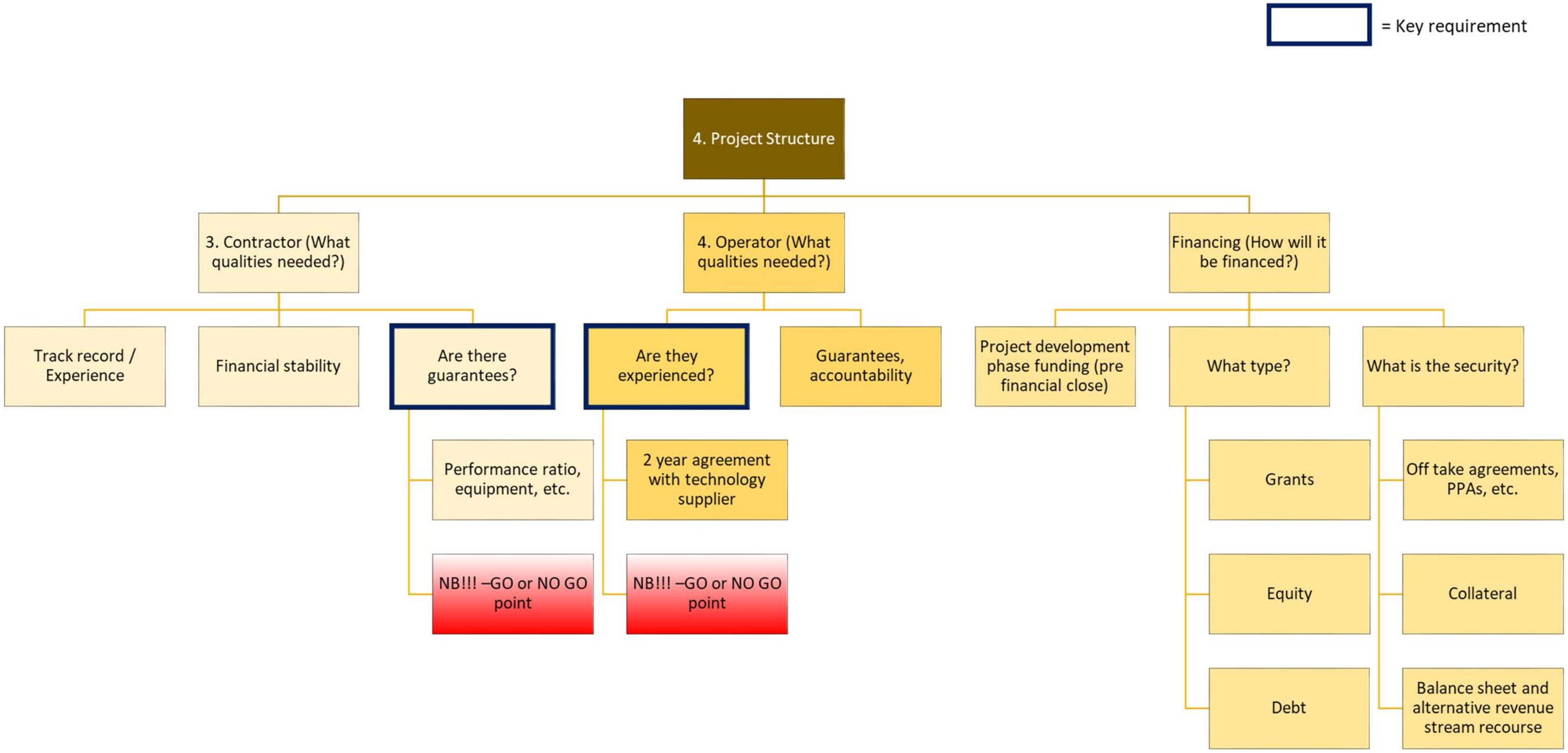
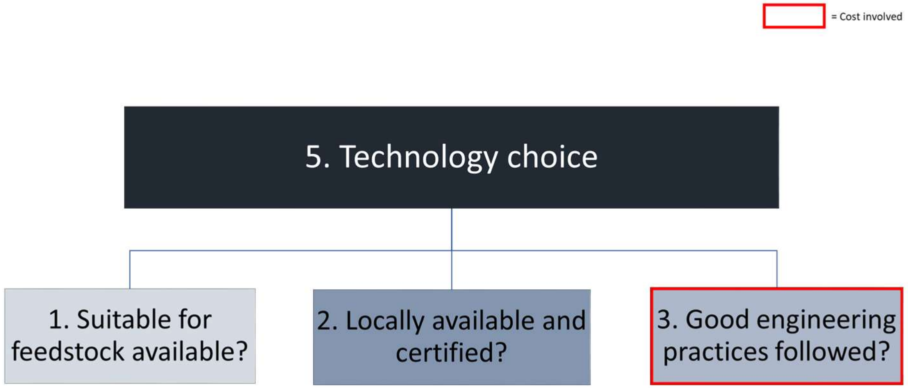

= Key requirement
4. Project Structure
3. Contractor (What qualities needed?)
4. Operator (What qualities needed?)
Financing (How will it be financed?)
Track record / Experience
Financial stability
Are there guarantees?
Are they experienced?
Guarantees, accountability
Project development phase funding (pre financial close)
What type?
What is the security?
Performance ratio, equipment, etc.
2 year agreement with technology supplier
Grants
Off take agreements, PPAs, etc.
NB!!! –GO or NO GO point
NB!!! –GO or NO GO point
Equity
Collateral
Debt
Balance sheet and alternative revenue stream recourse

(Page 2 of 2)

Project structure sub-component	Description	Action	Applicability in development methodology (see Section 3)
1. Partnership breakdown	**Who are the partners involved in the project?**		
Equity / sweat contribution / shareholders	Has the partnership breakdown been defined?	Confirm how the partnership breakdown will be finalised in terms of ownership, relationships and agreements.	• Scoping • Pre-feasibility • Feasibility
2. Contract type	**How will the project be executed?**		
Who is the project lead?	Does the project require a project lead? (as a result of the number of partners)	Confirm if a project lead is required and what role the project lead will play. Confirm whom the project lead will be and what contracts will be applicable to the project structure.	• Scoping
3. Contractor	**Who will be constructing the plant and what qualities do they require.**		
Track record / experience	Does the contractor have the required skills and sufficient experience?	Confirm the contractor's previous experience and track record by checking outcomes of previous projects the contractor has worked on. (This is a key consideration as it may have a negative impact on project implementation if not addressed correctly).	• Scoping • Pre-feasibility • Feasibility
Financial stability	Does the contractor have a strong financial balance sheet?	Confirm how strong the balance sheet of the building contractor is. This ensures that the contractor does not run into financial troubles before completing construction.	• Pre-feasibility • Feasibility
Are there guarantees?	Have the necessary building guarantees been negotiated and confirmed?	Confirm the guarantees (performance ratio, equipment, etc.) are required and the terms of those guarantees. <u>**GO/NO GO:**</u> The guarantees offered and confirmed by a contractor will assist in a critical decision point within the project development timeline. This go/no go will be in relation to the contractor rather than the project as a whole.	• Feasibility • Financial closure • Commissioning • Construction
4. Operator	**Who will be operating and maintaining the plant and what qualities do they require.**		
Are they experienced?	Does the operator have the required skills and sufficient experience?	Confirm the operator's previous experience and track record by checking outcomes of previous projects the contractor has worked on. (This is a key consideration as it may have a negative impact on project implementation if not addressed correctly). Confirm whether a minimum two-year O&M agreement is in place for the project with the technology supplier. <u>**GO/NO GO:**</u> The securing of an O&M agreement and its terms will assist in a critical decision point within the project development timeline.	• Scoping • Pre-feasibility • Feasibility

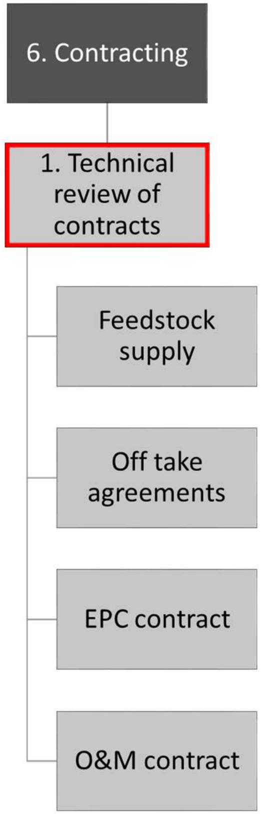
Guarantees, accountability	Have the necessary performance guarantees been negotiated and confirmed?	Confirm the guarantees (performance ratio, etc.) that are required and the terms of those guarantees.	• Feasibility • Financial closure • Commissioning • Operation and maintenance
5. Financing	**How will the project be financed?**		
What type?	Have the types of financing available been assessed?	Confirm if finance has been secured for project development phase. Confirm what finance is suitable for the project structure proposed. e.g. corporate or project finance, lease to own, build own operate transfer (BOOT), etc.	• Scoping • Pre-feasibility • Feasibility • Financial closure
What is the security?	Has the security appropriate to the financial model been confirmed?	Confirm what securities (offtake agreements, collateral, balance sheet and / or alternative revenue streams) are required for securing finance.	• Feasibility • Financial closure

2.5. Technology choice



Technology choice sub-component	Description	Action	Applicability in development methodology (see Section 3)
1. Suitability for feedstock	Is the technology selected suitable for the feedstock available?	Confirm if the technology selected is suitable to be used for the feedstock available through third party that technology is compatible. (It is recommended that expertise advice be obtained.)	• Pre-feasibility • Feasibility
2. Locally available and certified?	Can the technology selected be locally sourced and has it been certified according appropriate legislation?	Confirm if the technology can be locally sourced and what certifications are required.	• Feasibility
3. Good engineering practices followed?	Were good engineering practices followed in selecting technology?	All equipment required adhering to relevant certifications. Proper engineering drawings completed. Work signed off by a professional engineer.	• Pre-feasibility • Feasibility • Construction • Commissioning

2.6. Contracting



Contracting sub-component	Description	Action	Applicability in development methodology (see Section 3)
1. Technical review of contracts	**Technical review of all contracts by a third party.**		
Feedstock supply	Have the details of the feedstock supply agreements been reviewed?	Confirm that a suitably qualified /experienced third party, with experience in biogas projects, has reviewed the feedstock agreement contracts.	• Feasibility • Financial closure
Offtake agreements	Have the details of the offtake agreements been reviewed?	Confirm that a suitably qualified /experienced third party, with experience in biogas projects, has reviewed the offtake agreement contracts.	• Feasibility • Financial closure
EPC contract	Has the details of the EPC / construction agreement been reviewed?	Confirm that a suitably qualified /experienced third party, with experience in biogas projects, has reviewed the EPC/ building contractor contract.	• Feasibility • Financial closure
O&M contract	Has the details of the operation and maintenance agreement been reviewed?	Confirm that a suitably qualified /experienced third party, with experience in biogas projects, has reviewed the operation and maintenance contract.	• Feasibility • Financial closure

3. Best practice project development methodology

The project development methodology (PDM), shown in Table 3, is a guideline for executing a biogas project in South Africa. The PDM has been created to assist developers and site owners plan their development approach, whilst keeping aligned with financial due diligence requirements.

The project costs and timelines provided are indicative values based on stakeholder interviews and project examples as of 23 March 2018. The PDM details and costs will vary on a case-by-case basis, but it is expected that over time when major market enablers (e.g. simplified EIA process, organics not declared a waste) are implemented, the PDM process will become quicker and costs will reduce over time.

The feasibility portion of the PDM has the greatest impact on time and finances of a project. It is therefore recommended to phase the approach to limit investment spend at key GO/NO GO points. The three phases include:

1. Financial viability – making sure the business case works to a certain degree of accuracy
2. Risk assessment – management of key risks and finding suitable risk mitigation options
3. Execution – final quotations, head of terms agreements, project agreements and third party review

Table 3: Best practice project development methodology

Project Development Methodology	Participants	Notes	Small <500kW	Medium >500kW	Cost	Timeline
Scoping	**owner/developer**	**Define project parameters**				**1-3 months**
Feedstock Availability	developer/owner/3rd party	quantity and alternatives	x	x	R50 000 -R150 000	1 - 3 months
Site location	owner/developer	no major barriers - grid access, protected rivers etc.	x	x		
Digestate options	developer/3rd party	disposal options	x	x		
Revenue options	owner/developer	current energy requirements/nearby off takers	x	x		
Partner options	owner/developer	land owner, feedstock supplier, developer, technology provider	x	x		
Project Budget	owner/developer	CAPEX costs, revenue assumptions, savings, development costs	x	x		
Pre - Feasibility	**owner/developer**	**Assessing options**				**1-3 months**
Feedstock alternatives - due diligence	developer/3rd party	Options, distance, availability		x	R150 000 - R500 000	1 - 3 months
Feedstock Analysis - BMP test	3rd party	Quality, Quantity and consistency	x	x		
Site Assessment/ Scoping report	developer	Grid access, permitting, lease agreement	x	x		
Revenue stream Assessment	developer	On site savings, Off site sales	x	x		
Digestate Assessment	developer/3rd party	Quantity, disposal/value add costs	x	x		
Technology Options	developer/3rd party	System sizes, costs, tech options	x	x		
Partner Options	owner/developer	Partnership contributions, collateral	x	x		
Legal costs	3rd party	Legal quotations for contracting		x		
Project Information Memorandum	owner/developer	Preliminary review for Bank	x	x		

GO/NO GO decisions

Project Development Methodology	Participants	Notes	Small <500kW	Medium >500kW	Cost	Timeline
Feasibility	**developer/3rd party**	**Certifying key variables**				**6-12 months**
1. Financial Viability					R400 000- R3 million	6 -12 months
Financial viability and Business case						
Detailed business case	developer/owner/3rd party	Detail Revenues, Feedstock, Digestate Equipment	x	x		
Confirm/approve financial model (Audit)	3rd party	Auditor/Bank review		x		
Indicative Terms	3rd Party	Finance institution	x	x		
Plant Design and costing						
Design and layout	3rd party/developer	Plant design options	x	x		
Plant costs	3rd party	Technology options, quotes	x	x		
2. Risk Assessment						
Environmental Impact Assessment						
Basic Assessment	3rd party	site area, waste mgmt/day, >1 ton/day etc.	x	x		
Full EIA	3rd party	site area, waste mgmt/day, >100 ton/day etc.	x	x		
Feedstock Supply, Storage and Alternatives						
Feedstock supply agreements	owner/3rd party	Guarantees (quantity, quality, term), penalties		x		
Feedstock purchase options	Developer	Confirm supply and establish preliminary agreements		x		
Feedstock storage options	Developer	Cost, quantity	x	x		
Independent advisors						
Owners Engineer	3rd Party	Ensure plant is designed to specifications		x		
Lenders Technical Advisor	3rd party	Ensure feedstock and design are sufficient		x		
Permitting						
Water use, Grid connection, Land use (division),	3rd party/owner	Refer to updated licensing requirements	x	x		
Generation license, Waste license, Emissions	developer/owner/3rd party	Refer to updated licensing requirements		x		
3. Execution						
Legal contracting						
Structure of SPV	3rd party	setup separate entity to cede rights of projects		x		
Shareholders agreements	3rd party	equity stakeholders of project	x	x		
Prepare and negotiate off take agreements	developer/3rd party			x		
Prepare and negotiate EPC and O&M contracts	developer/3rd party		x	x		
Insurance	3rd Party		x	x		
Financial/Legal/ tax review	3rd party			x		
Engineering Procurement and Construction, O&M						
Head of Terms	3rd party	Terms and costs - PR guarantees, defects liability	x	x		

GO/NO GO decisions (highlighted rows: Confirm/approve financial model (Audit); Basic Assessment; Feedstock supply agreements; Prepare and negotiate off take agreements)

Project Development Methodology	Participants	Notes	Private <500kW	Project finance >500kW	Cost	Timeline
Financial close	**owner/developer/3rd party**	**Concluding project development**				**1-6 months**
Commitment of capital and build	EPC/financier/developer/owner	Sign finance agreements and build contract	x	x	R50 000 - R250 000	1 -6 months
Conclusion of contracts (offtake, EPC, feedstock, O&M, digestate, SPV)	3rd parties, developer, land owner			x		
Construction	**owner/developer/3rd party**	**Building project**				**6-12 months**
Lead contractor management	developer/3rd party		x	x	R50 000 - R250 000	6 - 12 months
Owners engineer, lenders technical advisor	developer/3rd party			x		
Commissioning	**owner/developer/3rd party**	**Testing project**				**6-12 months**
6-12 Month Commissioning	3rd party - EPC		x	x	Contractor Cost	6-12 months
Operations and maintenance	**owner/developer/3rd party**	**Operating project**				**2-20 yrs.**
Two year EPC management and training - performance guarantee	O&M/owner		x	x	O&M cost	24 months
Total					R700k - R4.15 mill	21- 48 months (ex O&M)

GO/NO GO decisions

4. Current viable project models

One of the key outcomes of the development of the feasibility components and PDM is the derivation of viable project models that exist in the current SA biogas market as of 23 March 2018. Based on stakeholder input and project examples, key distinguishing factors arose between two main models (small and medium).

The division is not only a result of investment/project size, but also financing requirements, offtake guarantees, revenue models and collateral needed. The table below has been developed as a typical separation between two key project models in the current market context. It should be noted that figures are indicative in nature and are based on stakeholder feedback for the market as a whole. Each project is unique and will differ on a case-by-case basis, but these models can be used to obtain an indication of the likelihood of financial viability.

Table 4: Current viable project models

Size	Small	Medium
Type	Private	Project finance or SPV
ZAR value	*R2 - R20 million	*R20 - R400 million
Typical project size	< 500kW	> 500kW
Key component	**Site/developer collateral	Off-take guarantee (gas and or electricity), Wheeling agreement, Feedstock guarantee/security with alternatives
ZAR/kWh	***R1.4- R1.5/kWh	***R1.4-1.5/kWh; R145-R180/GJ of CNG
Site conditions	Feedstock on-site Offtake on-site Digestate zero cost to project	Portion of feedstock or offtake on-site Need digestate management process (net zero financial impact)
Site options	Abattoir, feedlots, chicken farms, malls, piggeries, food processing, fruit and vegetable processing	Mega farm (single supply), centralised farm (multiple feedstock supply)
Revenue model	Electricity and heat and /or gas and offset disposal fees	Premium on electricity sales (banking on green energy premium or Eskom rising above fixed escalation), Gas sales - CNG projects > 1.5MW, Combination of on-site use, offset disposal fees and heat use
Financing	D:E - 60:40 IRR - 18-25% Debt tenor - 7- 10 years Rate - 10.5- 12% Fund 5 years with options to refinance residual value (Debt requires min tail of 3 years) DSCR - 1.3	D:E - 70:30 IRR - 18-25% Debt tenor - 12 years Debt requires tail of 3 years DSCR - 1.3, Debt reserve account 6 months (interest and capital)
Cover	Site owner/developer balance sheet strength (different revenue stream options), land collateral	Cession rights, buy back options Independent assessment for feedstock/design PR guarantees of plant Continuous feedstock analysis (visual or test) Insurance options
Key considerations	No revenue considered during first 6-12 month commissioning	No revenue considered during 6- 12 month commissioning 50% buffer on feedstock supply 1 main feedstock supplier with 2 secondary options

*An indicative CAPEX cost for a biogas plant is R40 million/MW provided by industry experts.

**How a developer would finance a biogas plant would be through their own balance sheet or through an offtake agreement with the site owner. This could be included as developer collateral.

***An indicative value provided by industry experts.

NOTE: A project can still financially viable if a value above or below is quoted, but it requires a justification for the value quoted.

Acronyms:

D:E – debt to equity ratio, IRR – internal rate of return, DSCR – debt service cover ratio,
PR – performance ratio