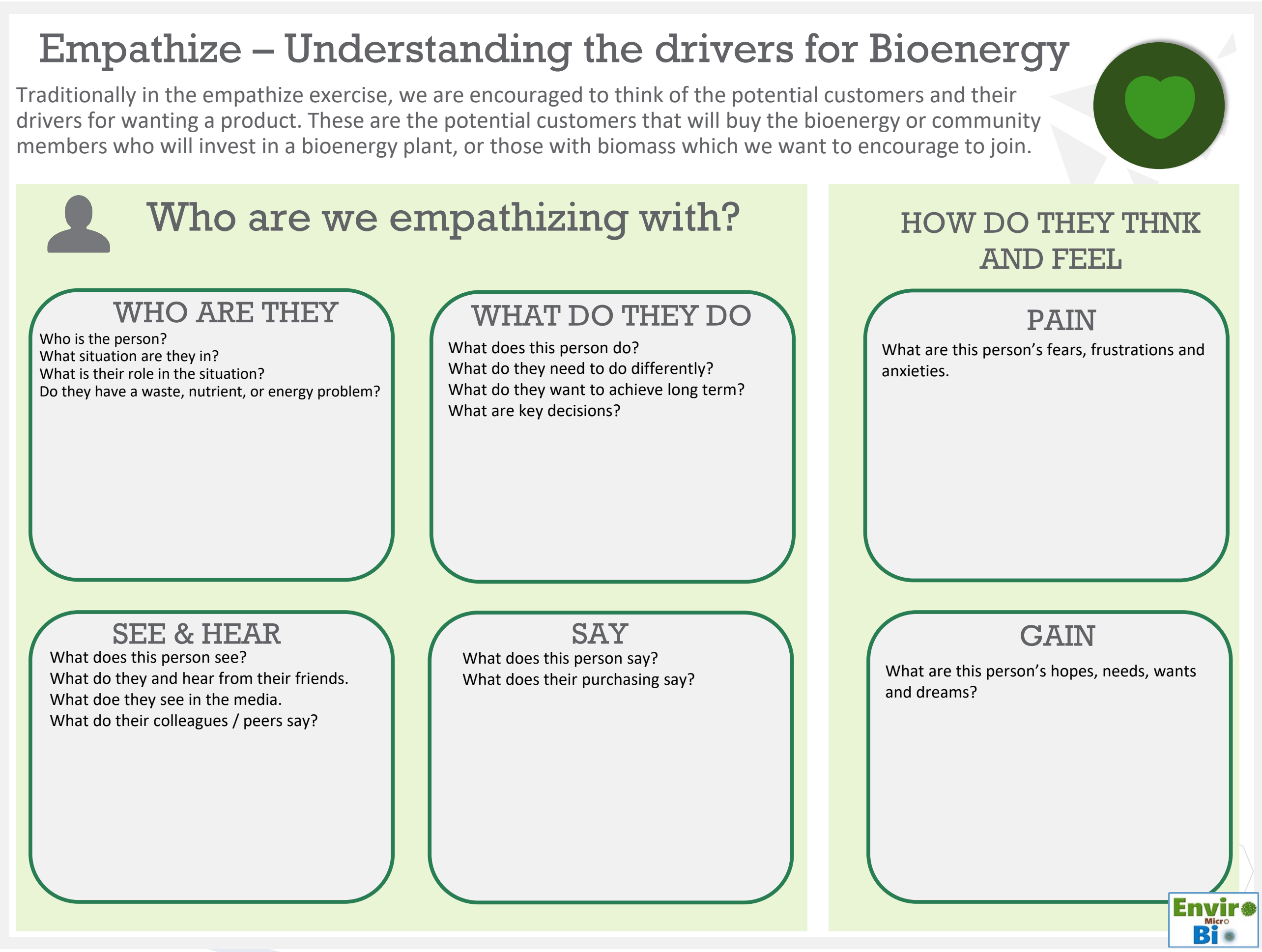
PHASE 1: PRE-FEASIBILITY

Empathise

All bioenergy projects begin with a problem that needs solving or an idea of how things can be done better.

The issue may be demand for electricity, biogas, process steam or heat. It may be the desire to reuse available biomass residues from an organic waste from domestic, commercial or industrial premises, forestry activities or agricultural food production. Alternatively, the idea could be driven by local, state or national government policy to achieve greenhouse gas reductions or the development of a circular economy by replacing dependence on fossil fuels.



The *Project Start-up Guide* contains an exercise to ask questions to help understand the existing needs and who you may need to work with to complete your project. It allows you to empathise with those who may have needs in this area.

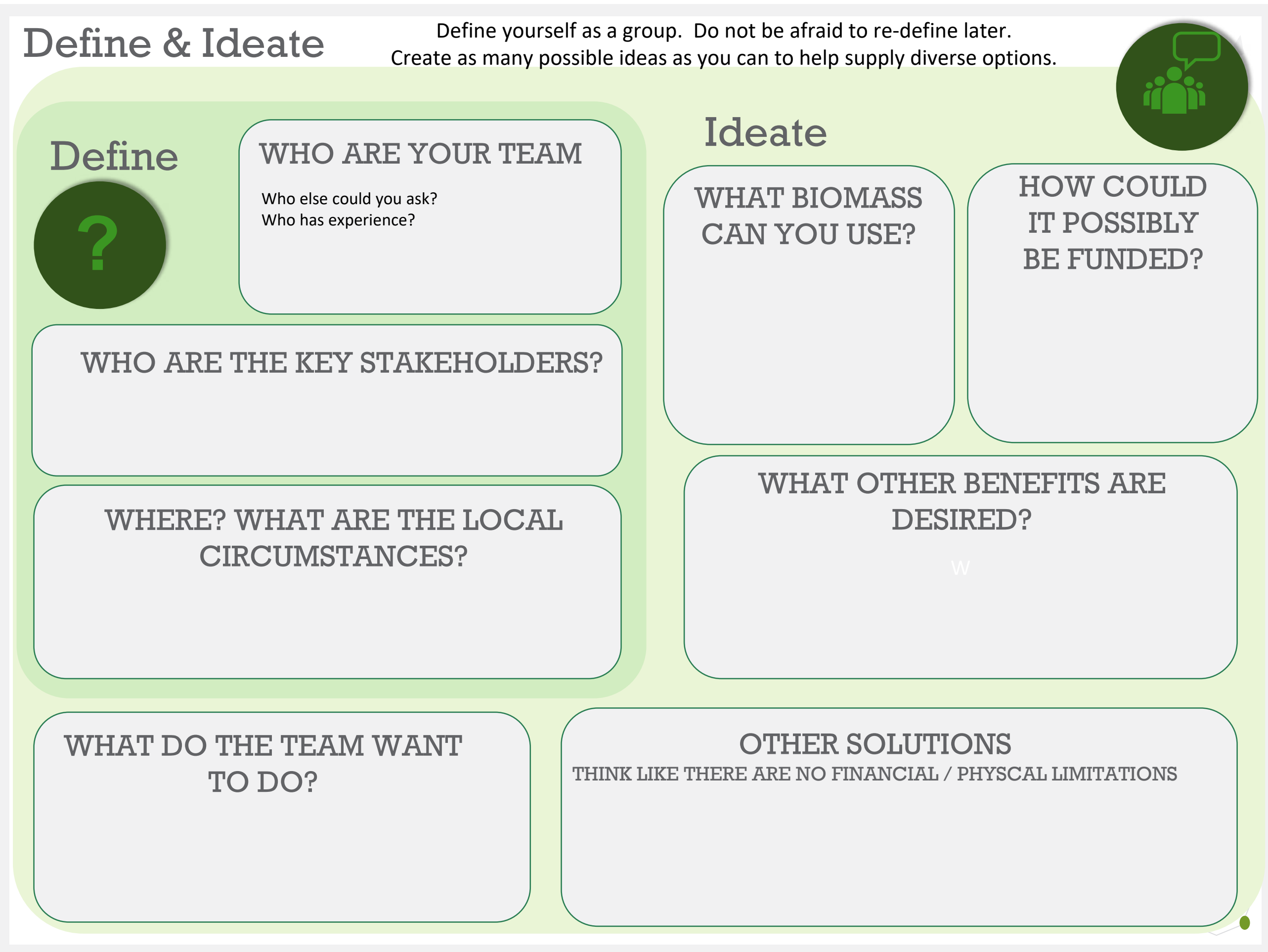
This includes:

- Who may want to purchase bioenergy?
- Who might want to purchase the biotechnology co products?
- Who has biomass in the local community?
- Who may want to invest in bioenergy?
- What other problems exist that may be solved by a bioenergy/biomass project?

Define

During this stage of the project, you will need to define the crux of the project:

- Who is in your team and their expertise?
- What expertise gaps do you need to find or develop?
- Who are the key stakeholders?
- What biomass are you going to use?
- What are the local circumstances that allow/demand a project?



Ideate

At this stage, create as many ideas as possible to help supply diverse options. Be creative. Examine where and who will participate. What other benefits are desired? How could it be funded?

The availability, amount and type of biomass will determine the types of technologies appropriate for the specific bioenergy project. Figure 6 shows a conceptual flow chart for biomass waste and biomass crops to bioenergy production.

Generic Conversion of Biomass to Bioenergy

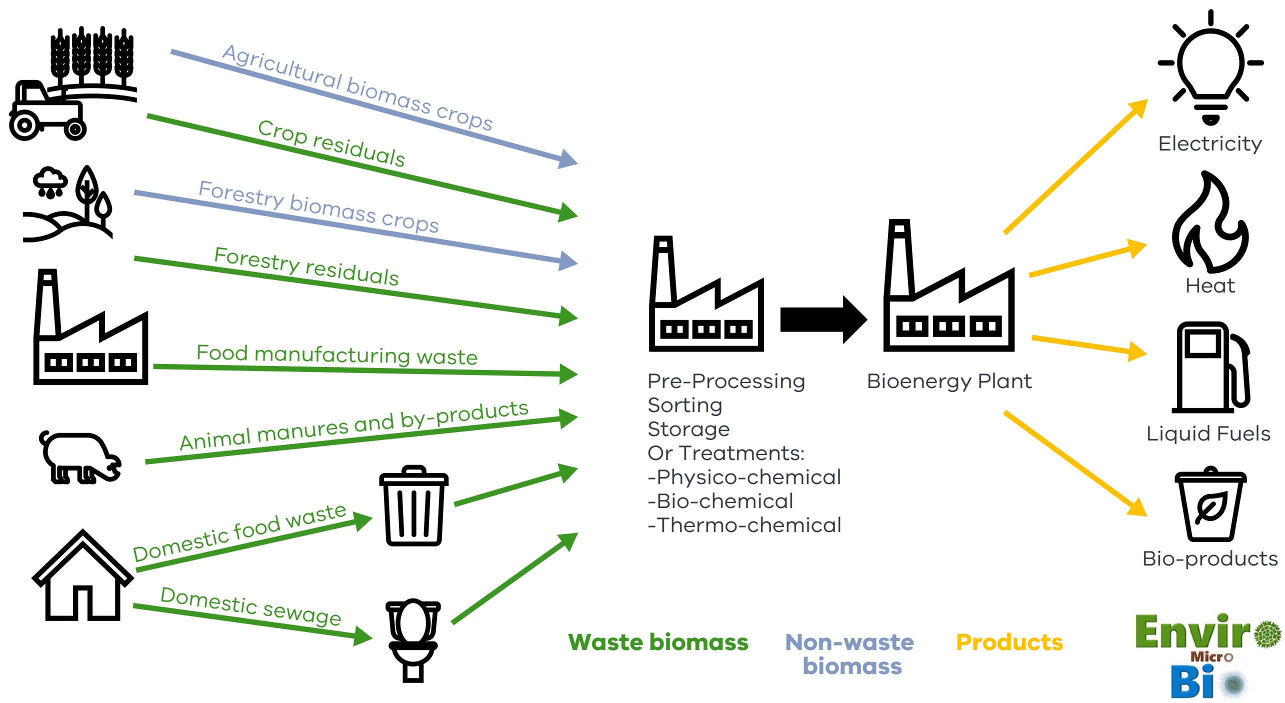


Figure 6: Generic process of conversion of biomass to bioenergy.

The initial idea will need incubation, socialisation and transformation into a preliminary technical concept and plant design, including:

- fuel (biomass) type and sourcing
- site location
- project size
- technology selection.

We have provided a *Start-up Guide* canvas to help you at this stage.

Examining the best idea

Once you have narrowed down the options it is time to examine how the best idea would work. Incorporate data by using the *Bioenergy Checklist* (Figure 7) from the *Start-up Guide*. Engage with key stakeholders regarding your idea and use their feedback to help you model the way forward.

Bioenergy Framework Checklist

This checklist is intended as a prompt for you to gather essential information about the biomass at your disposal and the potential site for your project. It is by no means an exhaustive list of required information, but it should help you to start thinking about the most important factors.

Bioenergy Checklist	Answer
Do you intend to grow a biomass crop? If so which one suits your conditions?	
Is the main project driver to do with waste, nutrient, water or energy?	
How much organic material do you have? What is it on a dry weight basis?	
What are the waste or biomass material characteristics?	
Is the biomass liquid, wet or dry? What are handling implications of this?	
What is your moisture content?	
Is it readily combustible?	
Is it a continual supply, or seasonal in nature? If seasonal can you store it? What is the cost associated with this?	
Do the biomass properties change over the year?	
Where is your biomass compared to where you want to use it? What equipment is required to gather and handle it?	
Are there any potential OH&S issues with the biomass? (for example, sulfide production, flammability, biohazards)	
Is there potential contamination (metals, trace organics, asbestos, plastics / glass, Polyfluoroalkyl substances (PFAS))?	
Are there other sources of biomass in the area which may complement your biomass?	
What energy demands are there on your site?	
Is the network in your area capable of receiving generated electricity?	
Is your site located in a 'sensitive area' (environmental, cultural, social, historical, proximity)?	

Figure 7: The Bioenergy Framework Checklist.

If your answers to the checklist indicate that there are issues with your idea, don't be worried about going back a few steps in the Pathway and rethinking. If the idea seems sound, you can expand on the themes in the checklist. There are many key questions to be answered during prefeasibility, especially concerning biomass, including those below.

Biomass resources in Gippsland

> Biomass resources are readily available in Victoria. Energy produced from biomass can reduce reliance on the existing electricity and gas grids, replace fossil fuels used by local industries and reduce greenhouse gas emissions.

The Australian Biomass for Bioenergy Assessment scheme, funded by the Australian Renewable Energy Agency (ARENA), has performed an assessment of biomass Australia wide. The results for Victoria are available at Gippsland ARENA data.

In this report Gippsland has been identified as having an estimated 793,720 tonnes of organic waste (2014–15). *The Gippsland Biomass Audit and Opportunity Analysis* (the sister project to this Framework by Frontier Impact Group) delivers more detail around biomass sources and potential sites for projects in Gippsland.

The region is already home to Opal, Australia's Maryvale Paper Mill (formerly Australian Paper) which is Victoria's largest generator of baseload renewable energy. In this system, black liquor (lignin dissolved in caustic) is burned to produce electricity and recover the chemicals for reuse.

Biomass types and qualities

Biomass crops are grown for the purpose of creating bioenergy/bioproducts. In this case the crop/s must be carefully chosen and matched to the location and desired bioproduct. Information such as plant selection and their attributes, water and fertiliser requirements, salinity and temperature tolerance must be well defined, as well as its weed status. Chosen strains should be grown under trial situations to test and evaluate anticipated yields and harvest times.

Secondary/waste biomass sources include crop residuals after the bulk of a crop is harvested for food or fibre. In these cases, the by-products are used for energy production and can include materials such as straw, husks, shells, pruning waste etc. Similarly, for woody biomass the main crop is not used for energy generation (for example, wood is harvested for use as timber or paper production), while timber harvesting by-products can be used for energy generation. Other secondary sources are any organic by-products from animal production, such as slurry from pig farming or animal fats collected during abattoir operations.

To help understand your biomass resources consider:

- Are biomass resource records up to date?
- Are you planning to grow biomass crops?
- Are you using wood products and forestry residues as your biomass source?
- Do you have relevant characterisation information on your biomass and how it will impact the technology selection and energy potential?
- Are there any municipal and/or industrial organic waste streams available?

- Do you have characterisation information on locally available industrial, commercial and municipal wastes?
- Have you carried out a waste hierarchy review?
- What are the current land uses for arable, forest and pasture?
- What underutilised land is available?
- Can underutilised land be used for food production?
- Have you assessed if biomass cultivation is the most preferable use of the land?
- What are the current production levels and uses of local biomass resources?
- What is the current use of the biomass resources?
- Is there a biomass market or are costs stable?
- How will biomass and biofuel developments affect water resources, soil quality and carbon sequestration?

Once the biomass resources have been identified, it is important to determine their physical and chemical characteristics. This will help assess the energy output when applying different technologies and estimating the associated investment and other costs. The key characteristics which need to be understood are:

- moisture content
- biomass quantity
- frequency of biomass availability
- biomass form: chips, logs, bales, solid, liquid
- bulk density
- ash content
- approximate chemical composition (carbon, nitrogen, phosphorous)
- level of contamination (plastics, glass, metals, trace organics)
- calorific value (if combustion is anticipated)
- biochemical methane potential (if anaerobic digestion is anticipated).

To help understand biomass and bioenergy markets, consider:

- How does the cost of locally-produced bioenergy compare with current alternative local energy sources?
- What are the current market trends in the production of green energy?
- Could bioenergy affect the profitability of food crop and woodland production?
- Will this impact food security?
- Is there a bioenergy supply chain and how is it structured?
- Are there opportunities for potential synergies with existing commercial, municipal and industrial activities?
- Are you aware of the current regulatory framework affecting bioenergy projects?
- Are you planning on transporting biomass? If so, have you considered biosecurity issues?

Test

At this point you should have a very detailed picture of your biomass and you probably have some ideas about the technology you may want to use to make bioenergy.

We have produced two *Bioenergy Decision Trees* (dry biomass decision tree (Figure 8) and wet biomass decision tree (Figure 9) to help guide developers, technology suppliers and biomass producers to the technologies which suit different circumstances. The decision trees identify key factors which influence the viability of a project and flag some risks.

Technology options

The *Bioenergy Decision Tree* is designed to guide you to the most appropriate technology for your biomass type and volume, but it also asks about your preferred form of bioenergy. As discussed above, this guide focusses on the six technologies with the highest technology readiness level:

- anaerobic digestion
- advanced combustion
- pyrolysis
- gasification
- transesterification
- fermentation.

Please note that this does not automatically mean that these technologies are financially viable for any specific locations, feedstock types, equipment vendors or geopolitical/regulatory situations.

Furthermore, there are three other decision tree endpoints:

- The food security need is greater than bioenergy.
- There is an opportunity to integrate with other bioenergy project.
- You are attempting an R&D project.

Food security is a greater need than bioenergy

The initial global wave of bioenergy largely generated bioethanol and biodiesel from food crops (corn, wheat, sugar beet and oil seeds). While this successfully introduced the idea of bioenergy, it competed directly with food production (Liew, Hassim and Ng, 2014). This 'food versus fuel' conflict created undesirable social, environmental and economic impacts. Subsequent generations of biofuel have moved away from direct competition, recognising that food production is more important to society than fuel production.

Opportunity to integrate with other bioenergy projects

If you have arrived at this end point it means that you:

- do not have sufficient biomass to justify the required capital expense based on your feedstock alone
- may have enough biomass but your production of this biomass is temporary (for land remediation purposes)
- have sufficient biomass but it is not able to be stored economically to produce bioenergy over enough of the year to make the project viable.

You are attempting an R&D project

While there are other ways of producing energy from biomass, if you choose a technology outside of these six technologies you will need to undertake a substantial degree of research and development to establish the technological and later financial viability. This will involve greater financial risk, higher technical barriers and is time consuming. Projects which fit in this R&D category are not covered by this guide and we suggest that you engage with a university or research consultancy.

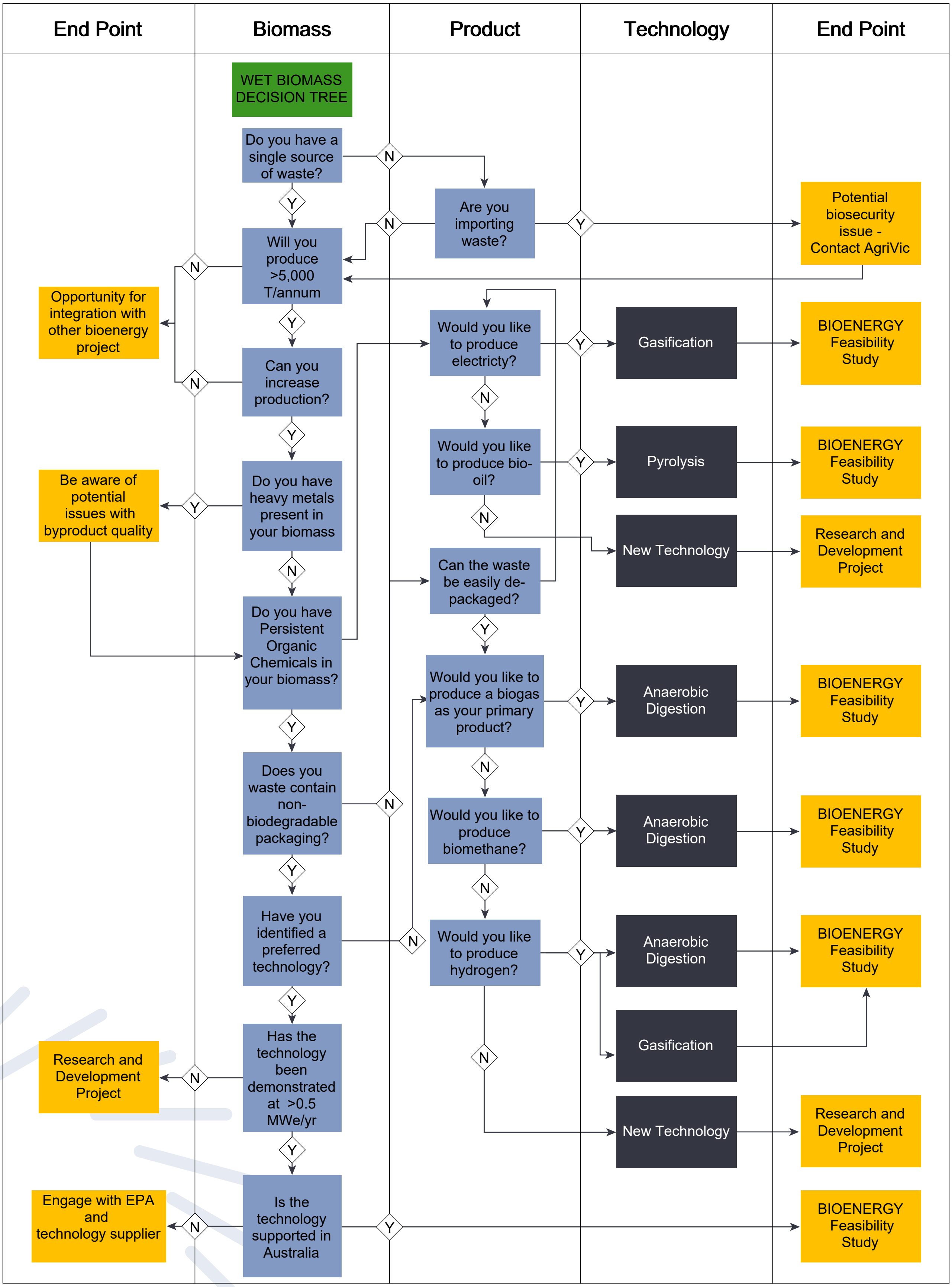


Figure 8: Dry biomass technology decision tree.

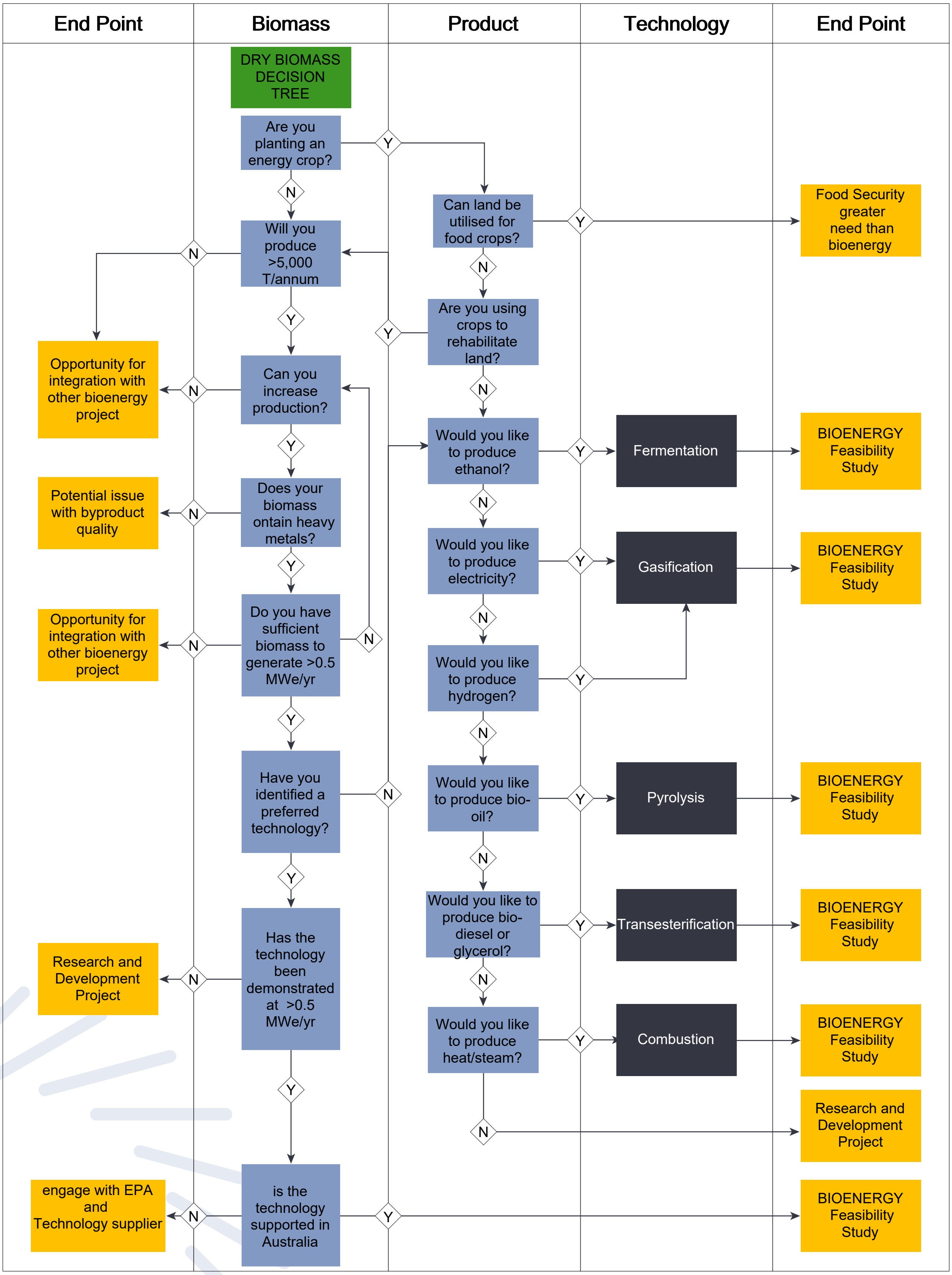


Figure 9: Wet biomass technology decision tree.

The six technologies

Below is a brief overview of the feedstocks, products, benefits and drawbacks of each of the six technologies. This information is generic in nature and provided primarily to assist in use of the decision trees. This information does not replace the need for independent research and verification for each project.

Please note that terminology (particularly around liquid fuels: biodiesel, biofuel, renewable fuel, bioethanol) can refer to differing things. Combustion, gasification and pyrolysis are listed as three separate technologies, but there is often some overlap.

Anaerobic digestion

Anaerobic digestion is a natural process in which microbes (bacteria and archaea) convert organic material to biogas (methane and carbon dioxide) in the absence of oxygen.

Biogas can be burnt to produce electricity, heat or steam. It can be converted into biomethane or hydrogen

A wide range of feedstocks can be used. Most commonly these are moist substances like sewage sludges, food waste, animal manures and industrial wastes.

A range of reactor styles and sizes can be used to suit the type and volume of feedstock.

Anaerobic digestion can have a range of benefits other than bioenergy production.

They reduce biomass volume, decrease chemical use and the digested biomass is called 'digestate' and can be cycled back to farms as a fertiliser.

Figure 10: Summary of the characteristics of anaerobic digestion.

Products: Biogas, digestate (treated biomass)

Reasons to choose anaerobic digestion technology:

- it is a good choice for wet feedstocks as no energy is expended to dry feedstocks before the process can begin
- it can deal with mixtures of feedstocks and variations in feedstock type (although the process works best when changes are introduced gradually)
- it does not need any energy inputs (although use of biogas for temperature control may be advisable in some cases)
- it can destroy weeds and pathogens in the feedstock
- it produces digestate which can be applied to land as fertiliser (thus it can help manage nutrients).

Anaerobic digestion complications and considerations:

- There is potential for odour related to handling of feedstocks and its management will require design effort and incur infrastructure costs.
- The degradation of organic feedstocks high in nitrogen will result in high ammonia levels in the digestate and its handling and/or distribution will require careful consideration.
- A hazardous zone will be created around the digestion unit and engineering. Procedural controls (and stringent adherence to them) will be necessary.
- The production of electricity requires a cogeneration engine which can be capital-intensive and expensive to maintain.
- Any non-biologically degradable materials (plastics, metals etc.) will be present in the final digestate. These will need to be separated or the digestate will be contaminated.

For export of the energy, an alternative to electricity is gas-to-grid. Biogas can be upgraded and turned into biomethane. Gas to grid projects can be complex since there are specific gas quality standards covering methane, carbon dioxide, hydrogen sulfide and moisture content as well as requirements for odourisation and gas grid injection. The process of turning biogas into biomethane involves the removal of contaminating compounds (water vapour, hydrogen sulfide, siloxanes, hydrocarbons, ammonia, oxygen, carbon monoxide and nitrogen) and the upgrading of the calorific value by separation of carbon dioxide from methane (Ryckebosch, Drouillon and Vervaeren, 2011).

Production of gas to put into the grid requires constant online monitoring of all these factors (and gas flow) to enable assurance and correct billing. The capital cost of the necessary equipment is in the order of hundreds of thousands of dollars and is maintenance-intensive.

A gas-to-grid project usually requires involves a gas energy infrastructure business that understands these complexities and has established relationships with gas grid operators. Although gas-to-grid is likely to become one main ways bioenergy is used in future, there is currently no mainstream or documented process. However, there are pilot scale projects underway in Australia.

Advanced combustion

Highly controlled combustion processes operate in the presence of oxygen at a high temperature (800–1000° C).

Thus they efficiently convert solid/woody biomass into steam which can then produce electricity and heat.

A wide range of solid feedstocks can be used. Most commonly these include agricultural residues, forestry wastes, the organic fraction of domestic wastes, digestate from anaerobic digestion or specially made biomass pellets.

Combustion massively reduces the volume of most wastes, leaving only ash. This reduces landfill volumes.

Biomass combustion technologies can help reduce reliance on fossil fuels.

Figure 11: Summary of the characteristics of advanced combustion.

Products: Heat, steam, carbon dioxide and ash

Reasons to choose advanced combustion:

- Advanced combustion can be used to meet on-site heat or steam demand.
- Conversion of organic material to energy leaving only inorganics (reducing volume to landfill).
- Can be used with diverse feedstocks (although solids are preferred).
- If you have a requirement for carbon dioxide (e.g. protected cropping or industrial process).
- A wide variety of sizes of combustion unit is available, but needs to be sized correctly for your biomass supply.
- Combustion of non-renewable resources can be considered to supplement biological sources.

Advanced combustion complications and considerations:

- Depending on what you are burning, the ash may need to be disposed of in landfill due to contamination.
- Will produce carbon dioxide (CO_2), nitrous oxides (NOx) and sulfur oxides (SOx) as combustion involves reaction with oxygen, therefore this option is not as environmentally advantageous as some others.

Pyrolysis

Pyrolysis is the heating of generally dry biomass in the absence of oxygen.

This process causes the biomass to decompose into a range of by-products which vary according to the temperature used and source of the feedstock (including biochar, wood vinegar and bio-oils).

A wide range of solid feedstocks can be used. Most commonly these include agricultural residues, forestry wastes, specially grown crops. Some crops can produce specific and valuable products when pyrolysed.

Biochar is a by-product which has a proven role in helping build soil carbon and can have a range of higher value uses.

Wood vinegar (condensate) has agricultural application.

Bio-oils can be further processed to bio-diesel.

Figure 12: Summary of the characteristics of pyrolysis.

Products: Biochar, bio-oils (can be made into biodiesel), wood vinegar

Reasons to choose pyrolysis:

- You wish to generate bioenergy even though exporting energy from your site is prohibitively difficult.
- You have identified a high-value biological oil/grade of biochar that can made from your feedstock.
- You have a large volume of relatively clean biomass which will produce dependable quantities and quality of products.
- You need biochar to build soil carbon and can use wood vinegar to assist in crop fertilisation.
- Pyrolysis plants come in many different types and sizes.

Pyrolysis complications and considerations:

- Pyrolysis products have an immature market in Australia and you may have difficulty selling your products.
- Pyrolysis is a technical process and minor variations (in feedstock, conditions or timing) may produce inconsistent products.
- For consistent product you require consistent feedstock with year-round availability (beware of seasonal property changes or effects of feedstock storage).
- Heavy metals present in your feedstocks will most likely concentrate in the biochar.

Pyrolysis can produce a range of bioproducts (biochar, wood vinegar, bio-oils) which may provide a source of income. However, the market for these products in Australia is very immature. We do not recommended relying on the sale of these products to support a business case unless you have a contract and are certain you can meet any quality requirements with your chosen technology. You should pilot your technology on your specific feedstocks, or at minimum run a lab-scale test to reduce the risk to your project. We also strongly recommend working backwards from a product which is in demand and determine if any technologies will make your biomass into that product. However it may not be amenable.

Biochar

Biochar is the solid which remains after pyrolysis. The properties of this depend greatly on the feedstock and the time and temperature of the pyrolysis process. Biochar is a good soil amendment to boost soil carbon. The structure of the biochar provides an environment for microbes to populate which also boosts soil health. Biochar can also be processed to make activated carbon for filtration of air and water and adsorption of pollutants.

Bio-oils

There is considerable variation in the terminology for various liquid fuels derived from biological/renewable sources. Bio-oils (sometimes called biocrude) from pyrolysis can be converted into biodiesel or renewable fuels/oils. The properties of these vary based on feedstocks, the specific technology and conditions applied. Generally, the aim is to directly replace fossil fuel-based products and not require specialised equipment to use them.

These bio-oils may be sold 'as is' but will require purification and further processing to become useful end products. In their original state they can be highly corrosive and contaminated with water and biochar. Processing requires equipment, chemistry knowledge and skills. This may be viable on a small scale for some specific high-value products, but economically viable projects generally require large-scale production.

Wood vinegar

Wood vinegar is an acidic (pH 2.4-3.0) amber liquid condensate produced during pyrolysis. It can contain a wide range of organic acids and alcohols, the most common of which are acetic acid and methanol. The composition and properties of wood vinegar depend on feed source materials as well as the method (time/temperature) of the pyrolysis.

The claimed uses of this liquid are numerous but are mostly confined to agricultural use for partial replacement of fertiliser and insecticide, as well as a base source of acetic acid and methanol for industrial use.

Gasification

Gasification is a highly controlled processes which operates at temperatures in excess of 700°C in the presence of controlled amounts of oxygen and or steam.

The process produces gas called syngas (H_2 and CO) and biochar (a solid product).

In the gasification process, the input biomass is not a fuel, but a feedstock for a high temperature chemical conversion to syngas and biochar.

Syngas may be burned directly in gas engines, or used to produce methanol or purified to hydrogen.

Gasification is more efficient than combustion at converting biomass to energy. The low oxygen conditions also mean that it is superior to combustion for the control of emissions such as SOx, NOx and dioxins.

Figure 13: Summary of the characteristics of gasification.

Gasification is the high temperature conversion of carbon-containing matter to syngas (H_2 and carbon monoxide (CO)) using limited amounts of oxygen and steam. The use of syngas directly is more efficient than direct combustion of the original fuel. There are numerous designs of gasifier depending on the desired feedstocks and outputs. Gasification can be used for 'waste to energy' processes and to produce energy from conventional fossil fuels. One of the steps of gasification is pyrolysis and thus drawing a definite line between pyrolysis and gasification technologies is difficult.

Products: syngas and biochar.

Reasons to choose gasification:

- You have very significant volumes of biomass.
- You have biomass which is contaminated by plastics/metals or organic pollutants.
- You want to produce hydrogen.
- You have heat, steam or electricity needs on-site.
- You want to produce ammonia and methanol or ethanol.

Gasification complications and considerations:

- Scrubbing of gases for specific uses is expensive for small scale systems.
- The history of small scale gasification from biomass overwhelmingly indicates difficulty achieving long-term economical operation (often due to reliability, maintenance and labour costs).
- Plants are designed to run optimally at certain volumes and generally cannot be operated at significantly lower volumes.

Hydrogen

The development of a National Hydrogen Strategy has signalled hydrogen production as a high priority for development in Australia. This report highlights that the environmental credentials of hydrogen largely depend on the source of energy used in its production.

Table 2: Emissions intensity of hydrogen production via various methods supplying the energy (COAG Energy Council Hydrogen Working Group, 2019).

Production technology	Emissions (kg $CO_{2\text{-}e}$/kg hydrogen)
Electrolysis – Australian grid electricity	40.5
Electrolysis – 100% renewable electricity	0
Coal gasification, no carbon capture and storage (CCS)	12.7 – 16.8
Coal gasification + CCS – best case	0.71
Steam methane reforming (SMR), no CCS	8.5
SMR + CCS – best case	0.76

Hydrogen may be a highly desirable fuel of the future, but for it to have environmental credibility it must be created using renewable energy. The European experience indicates that a small volume can be blended with the natural gas grid without impacting current natural gas equipment. It can also be used to power vehicles (such as buses or farm machinery) which are equipped with specialised engines. It should be noted that there is currently no real market for hydrogen in Australia at this time.

Fermentation

Fermentation is a biological process (involving yeasts) which produces ethanol from plant sugars, starches and cellulose.

A wide range of plant material (corn grain, sugar cane) can be used as feedstock for fermentation. Commonly plant material will have to undergo some sort of processing prior to fermentation to make these molecules available to yeast.

EtOH

Ethanol is an ideal biofuel as it can be an added to petrol and used in most current machinery without modification.

Newer biofuels try to use waste products or crops which can be grown on dryland without fertiliser.

Figure 14: Summary of characteristics of fermentation.

Products: bioethanol, spent fermentation mash.

Reasons to choose fermentation:

- You have land which is not suitable for food production (e.g. may be contaminated) but can produce cellulosic biomass.
- You have crop stubbles/agricultural wastes which can be fermented.
- You have a supply of food processing waste which is high in cellulose/starch/sugars.
- Bioethanol can directly replace or complement regular fuels and is already supplementing existing fuels at around 10 per cent concentration (E10) without great modifications of existing engines.

Fermentation complications and considerations:

- The fermentation of 'sugary' cellulosic based plant matter, which includes feedstocks such as sugarcane, corn, maize and wheat crops, waste straw, willow and trees, sawdust, reed canary grass, cord grasses, Jerusalem artichoke, miscanthus and sorghum plants. However, many of these may be replacing food production.
- Matching a crop to your land is a matter of balancing many factors such as sugar content, climate, soil and processing ease.
- The existence of Australian Government taxes and excise (from July 2020) may have a major impact on the financial viability of a bioethanol project.

Bioethanol can be manufactured in two ways: by reforming some of the products of gasification (see above) and via fermentation from starches and sugars in plant materials (the most common method).

Plant materials (fruits, grains, stems and leaves) are composed mainly of sugars, so in principle almost any plant can be a feedstock for ethanol manufacture. However, the ability to achieve economical fermentation depends entirely on the properties of the feedstock, how well it grows on the selected land and how difficult it is to access its sugars. The European Biomass Industry Association provides good information regarding bioethanol.

The food vs fuel debate tainted public perception of the first generation of bioethanol. However, progress has been made in developing suitable plants which grow in conditions and on lands not suitable for food production. Nevertheless, food crops (sugar cane, molasses, wheat and sugar beets) make up the bulk of the feedstock for bioethanol in the two countries with the largest uptake of bioethanol (USA and Brazil).

Much research and development is going into lignocellulosic bioethanol production. These feedstocks include short rotation biomass crops (such as willow, popular, miscanthus and eucalyptus), agricultural residues (straw and sugar cane bagasse), forest residues, woody waste and municipal solid wastes.

It should be stressed that this technology is yet to reach its potential as the relatively inaccessible molecular structure of these biomasses makes it more difficult to convert to sugars.

Transesterification

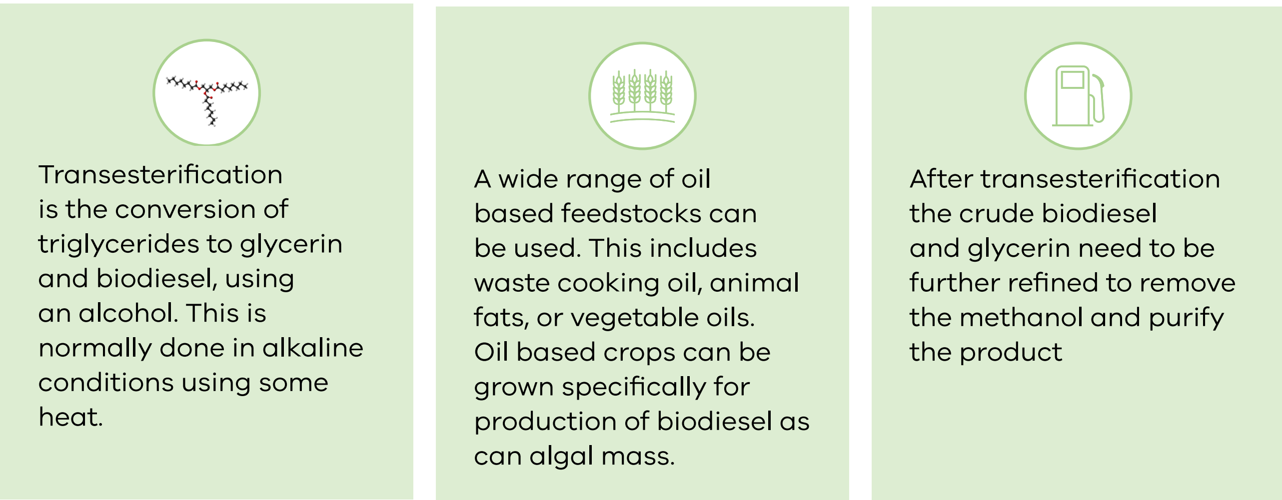


Figure 15: Summary of characteristics of transesterification.

Products: Biodiesel and glycerin

Reasons to choose transesterification:

- You have waste vegetable oils and fats.
- You have animal fats.
- You are able to grow oil-based crops on non-food producing land.
- You have need of on-farm use for transport fuel (specialised models of equipment are available for this fuel source).
- The process can work even at very small scales (it is a good lab demonstration for students).

Transesterification complications and considerations:

- Biodiesel produced by transesterification is often of low quality. Increasing quality requires pre-treatment of feedstocks (particularly removal of water) and/or post reaction purification.
- Biodiesel will be subject to Australian Government Taxes and Excise from 2030 which could significantly alter the economics of transesterification.
- Modified engines are required to run this fuel, but these engines are available.

The transesterification process requires fatty acids, alcohol and a catalyst (usually a strong base).

The end products of the transesterification process are raw biodiesel and raw glycerin. When using methanol as the alcohol, FAME (fatty acid methyl ester) biodiesel is produced. These raw products need to undergo a cleaning step. Purified glycerin can be used in the food and cosmetic and chemical industry and raw glycerin can be used as a substrate for anaerobic digestion.

Relevant standards/regulations defining the specification of biodiesel are European Committee for Standardization EN 14214, EN 590 and ASTM D 6751.

Technology questions

Once you have decided on the technology, located case studies and read technical information you should have a broad picture of how it will transform your biomass. It is useful at this stage to engage technical experts for comment and start discussions with technology vendors as to whether your biomass fits with their technology.

You could ask a range of questions, including:

- Which bioenergy processing technologies are already deployed in Australia?
- Which vendors supply your specific technology?
- What are the available end-use options for the bioenergy produced?
- Are there opportunities to reuse waste products produced by the bioenergy process?

Once you have developed a level of confidence about your technology, it is time to socialise the idea and gauge the level of community support. It is also advisable to engage with Sustainability Victoria to understand what funding and assistance may be available to you.

Examining your social risk

Once you are ready to move into the feasibility stage of your project, it is necessary to understand the social risk to your project. Work through the *Social Risk Guide* to ensure that you are aware of any factors which need to be managed.

What is social risk?

Social risks to a project generally arise from the dissatisfaction and grievances of external community and stakeholders and more rarely from internal objections. These can arise from a failure to understand the differences in experiences, perceptions and cultures between the parties involved. They almost always arise in circumstances where there is little demonstrated benefit to those outside a project. These cases can also arise from a company's or project's desire to put profit before any other considerations, to the maximum extent allowable by law. In some cases, the legal ramifications may be factored into the cost of doing business.

Social risks to a community arise from the impact of a company's operations. These include community health, safety and environmental harms and can extend to social harms and impacts on visual amenity, restricted access to lands and impacts upon culturally significant locations.

Social risk can manifest as conflict, which may include:

- resistance to a project being located in that community
- active lobbying to prevent a project establishing, or stop a project operating where it already does
- interaction with politicians to apply pressure for a project to withdraw or stop
- legal action (for example, in a civil appeals tribunal).

Failure to manage social risk can have enormous economic costs, significantly damage the reputations of organisations involved and put investments at risk.

Factors governing social risk

The factors linked with increased social risk to a bioenergy project are displayed in Figure 16. A large number of these risk factors can be identified at the pre-feasibility stage of a project and plans formulated to address them (see *Analysis of social risk* below). Community and stakeholder engagement should start as early as possible and continue regularly throughout all further stages of project development.

Genuine, concerted efforts to achieve positive social impact can reverse many of the factors that increase social risk. This often requires targeting a level of community education, ownership and connection. While this may increase costs (or slightly decrease profitability) the trade-off is a smoother project Pathway that benefits more stakeholders. It requires two-way communication to commence as early as possible to actively engage with influential community members to head off misinformation, poor perceptions, misconceptions and negative stakeholder activation.

PERCEPTION

Existing Information on company (social or conventional media) is negative.

Perception of local governments and NGOs is negative

Own media efforts are continually polluted by anti-project rhetoric, making perception change difficult.

MEANS

Opposing parties have strong networks.

Opposing parties are highly mobilised on social media.

Opposing parties have good access to conventional media or political contacts

TRIGGER ISSUES

Previous attempts at similar projects have created negative air around the issue.

Historical circumstances of an area causes friction (eg history of coal based power production).

Project triggers underlying social or environmental issues, which increases resistance

LOW CONNECTION

Project has no local ownership

Project has low employment (eg fly-in fly- out workers)

Project procures equipment and construction workers from outside the area.

Project builds no mutually beneficial infrastructure

STAKEHOLDER ACTIVATION

Prominent individuals become opposed (eg religious leaders, union leaders, environmental group leaders

Institutions such as NGOs, unions, citizens association take an official publicised opposing position.

Government or semi-government departments take an opposing view.

POOR UNDERSTANDING

Locals do not understand the technologies being proposed.

The benefits of the technology are not communicated to the public or are only done so after negative publicity.

Attempts to explain the technology or project focus on the technical and are not 'received' by the public.

Figure 16: Factors which increase social risk.

Social risk vs social impact

Figure 17 shows the degrees to which investment can be extended to become social impact investment. A traditional approach to investment pitches risk against return, and the higher the risk involved, the higher the judged return must be in order to justify investment. Investment in the 'impact economy' offers a more community-centred approach which actively reduces social risk.

It remains to be seen how impact investment fits into a capitalist society, where public company boards have the responsibility to maximise profits for shareholders. However, there is clearly scope for the non-corporate/governmental sector to invest in the impact economy. Business structures such as cooperatives and social enterprises may be better suited to this section of the economy. Partnerships or cooperation between two privately owned companies with similarly holistic views may also enable positive impact.

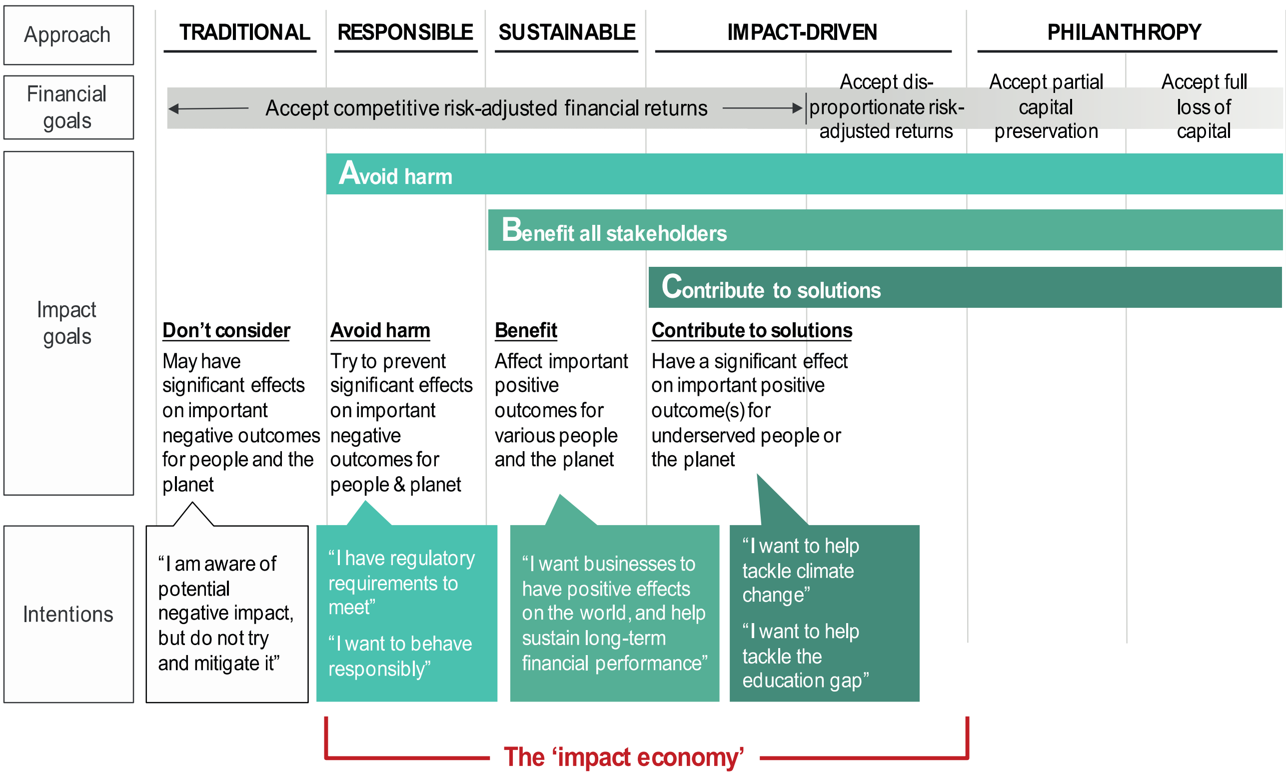


Figure 17: Traditional investment approach versus responsible, sustainable and impact-driven investment. (Pasi, Misuraca and Maduro, 2018).

Analysis of social risk

An analysis of the social risk involved in the project should be performed early and often throughout all stages of a project. A helpful document in developing an understanding of social risk is the Victorian Government (DELWP) *Community Engagement and Benefit Sharing in Renewable Energy Development* (Lane and Hicks, 2017).

Their process recommends four steps:

- context narrative
- social impact site map
- social risk matrix
- stakeholder mapping spreadsheet.

To aid you through your projects journey we have developed a **Social Risk Guide**. This is an A3 printable package containing a series of exercises.

Context narrative

A context narrative involves constructing a 'story' of the local context. This includes an area's key attributes, values and features, local demographics, culture and history of the area. The aim is to become familiar with the local context to ensure alignment with the proposed development.

Social impact site map

Developing a **Social Risk Matrix** – A Social Risk Activity

The Social Risk Matrix should be used to register and rank all the possible risks. Please see the risk matrix in the Bioenergy framework to rate the various risks. Most attention should be given to mitigating the risk of those highest scoring risks.

Potential Issue	Likelihood	Consequence	Risk Score	Mitigating Actions

A social impact site map is a map of the bioenergy project's location and its associated infrastructure in relation to the local community and residents. The purpose of the map is to physically locate features such as houses, valued landscapes, schools and areas of recreation. Impacts of increased traffic and truck movements should be considered in relation to these features.

Social risk matrix

Inclusion of a risk assessment for a wide range of factors (policy, economic, social, environmental) which may negatively impact a project is essential. The activities and matrix in the Social Risk Guide can assist in this process and use the risk = (likelihood x consequence) equation.

Stakeholder mapping spreadsheet

Stakeholder Mapping Spreadsheet – A social risk activity

The stakeholder mapping exercise should assess the appropriate level of engagement required with each stakeholder. These should be given a category from the following: Inform, Consult, Involve, Collaborate, Empower.

Stakeholder Type	Name	Role in organisation	Contact Details	Interest in project	Ability to influence	Category of engagement

Stakeholder mapping is a process that identifies relevant stakeholders for a given project and records information about them in order to determine how best to engage with them. Stakeholders can be individuals, businesses, organisations and government/semi-government departments or simply be the adjacent landholder. In order to achieve this mapping, specific information needs to be gathered, including:

- local Traditional Owner representatives, organisations and elders
- local sustainability, climate action groups and academics in the environmental sciences
- environmental, conservation and outdoor recreation organisations, including bird watchers, photographers and walking groups
- local progress associations (Lions, Apex etc.) or chambers of commerce
- trade unions
- political stakeholders at all levels of government.

Not all stakeholders need or want to be engaged in the same way or at the same time. In addition, not all stakeholders have the same level of interest in, or influence on, the project. The stakeholder mapping exercise should assess the appropriate level of engagement required with each stakeholder. These should be assigned a category from the following: inform, consult, involve, collaborate, empower. A stakeholder mapping spreadsheet is provided in the *Social Risk Guide*.

Social factors identified as being specific to bioenergy projects are listed in Table 3.

Table 3: The social risk factors associated with bioenergy projects as identified by the DELWP publication Community Engagement and Benefit Sharing in Renewable Energy Development.

Bioenergy
Community understanding and perception of the technology
Sustainability (including growth, harvesting and transportation) of feedstock
Visual amenity of the generator facility
What removal of the resource may mean for other value chains in the local area and ecosystems
Competition of supply in the region and what this means for viability
Animal welfare (if animal waste is a feedstock)
Larger scale plants competing for feedstock and potentially increasing prices for other farmers
Transportation of the stock streams — nuisance and dust concerns
Odour concerns

Producing a Pre-feasibility Study Report

Before progressing to the feasibility stage of the project you should produce a report summarising all of the information you have gathered so far. It outlines the findings of your assessment, summarises conclusions and makes recommendations concerning the worth of progressing to the feasibility stage.

The report should include the following:

A typical Pre-feasibility Study Report includes:

- description and quantification of the biomass
- bioenergy end-use
- barriers for the project
- identification of strategic stakeholders
- identification of government funding opportunities
- identification of preferred technology and potential technology concepts
- calculation of expected energy output
- preliminary assessment of site(s) and preliminary site layout
- preliminary footprint and unit sizing
- potential to grid connections
- preliminary identification of environmental and social risks and issues
- preliminary assessment of capital costs
- preliminary assessment of operating and maintenance costs
- preliminary financial analysis
- preliminary risk assessment
- preliminary assessment of planning and environmental approvals required
- planning and project implementation, including tentative time schedule
- list of assumptions.

Depending on size and complexity, the costs and time associated with undertaking a pre-feasibility study can vary substantially. Planning and environmental authorities are not normally involved at this stage, so the study can usually be completed within six months. The associated costs also vary but typically range between $20,000 (for a small and less complicated project) and $100,000 (for a large and complicated project).