PHASE 3: DESIGN

Project development

A concept design provides a detailed technical description, plant layout, plant equipment list, civil design and geotechnical assessment. Sufficient detail will be needed in order to estimate the capital and operating costs with a sufficient degree of confidence to satisfy investors.

Designing a bioenergy plant is a complex process that requires considerable technical experience and knowledge. It requires the engagement of professional service providers who can take the project from concept to detailed design. The service provider and their subcontractors should be able to:

- demonstrate capability and understanding of the technology and technical aspects of the project (a proven track-record is preferable)
- carry out the detailed design of the bioenergy plant, including all aspects of engineering
- guide the project through the environmental planning and approvals processes
- demonstrate appropriate project management skills to ensure the project is delivered on time and within budget
- demonstrate appropriate quality assurance and quality control qualifications and are preferably ISO accredited
- have the capability to develop contractual and tender documentation for commercial pricing
- participate in the tender evaluation process
- have the capability to support the project through the construction phase
- have appropriate insurances.

The content of the concept design will vary but will typically include:

- definition of biomass characteristics, including testing to confirm calorific value or biochemical methane potential
- description of the preferred technology, including:
  - fuel handling
  - combustion system
  - boiler
  - ash handling and disposal
  - flue gas treatment technologies to meet applicable and relevant air emission standards
  - energy recovery system
- identification of suitable technology providers
- process flow diagram, including a mass and energy balance
- site layout and general arrangement of the site
- site access, security and road layout

- confirm grid connections with local energy companies
- assessment of potential plant location(s) following an evaluation of technical, environmental, geotechnical, economic aspect and community acceptability
- a secured sustainable long-term supply of biomass (volume, heating value/properties and price)
- financial and economic analysis including cost-benefit calculations, calculations of net present value and return on investment (ROI) and similar analyses
- overview of current relevant regulatory and policy frameworks
- assessment of potential additional sources of financing, sensitivity analyses and risk assessment important to financial partners
- assessment of potential risks to the financial viability of the project and associated mitigation measures
- environmental and social impact assessment, including identification of mitigation measures
- organisation studies of potential operations and maintenance service providers
- procurement plan and identification of potential equipment suppliers and construction contractors
- implementation plan including time, resourcing and financing schedule
- skills and gap analysis of local workforce
- community and stakeholder management plan.

The Concept Design Report

A Concept Design Report outlines the findings of the feasibility study and includes the development of key design decisions to sufficient detail for a robust capital and operating cost estimate. The report should include the following:

- confirmation of financial viability
- key contracts
- supplementary biomass mapping if required
- robust projections of capital, operating and maintenance costs
- confirmed technical design detail
- geotechnical investigations
- conceptual operational hazards analysis
- operating plan
- key engineering drawings
- equipment and instrumentation list
- site layout
- interface report (grid connections, water/sewer, emissions connections, gas connections)
- utility services plan
- environmental approvals (including EPA licence conditions)
- risk register
- health and safety plan

- traffic management plan
- community engagement plan
- commissioning plan
- decommissioning plan.

It should also include financial models and the business case demonstrating the economic and financial viability of the bioenergy project to the satisfaction of investors and stakeholders. A capital, operating and maintenance cost estimate in line with estimating principles is also essential. Ideally the costs will be verified by an independent Quantity Surveyor or Professional Estimator with experience with similar types of projects.

At the end of the concept design the developer should be able to procure the services of a contractor(s) to carry out detailed design and construction of the project.

The project development phase will show whether cooperating with a host or nearby industrial complex is feasible. A bioenergy plant can, to some extent, be designed for monitoring and control of operation from a remote-control facility, such as at night and weekends.

Finalise planning approvals

Investors normally seek to obtain approvals before reaching financial closure. Once financial closure is reached, detailed design and procurement can start unless the owner intends to proceed at their own risk.

The following elements are normally part of the planning and approval process:

- environmental permit based on the EES (prepared as per regulatory requirements)
- planning permissions (local, state and federal)
- land use
- business documentation and approval to operate
- import licences for equipment
- grid connection approval
- approval for wastewater discharge.

Depending on the environmental and social impacts, the associated costs and the planning and environmental authority involvement, a feasibility study can generally be completed in 12–18 months. The associated costs can vary substantially but typically range between $300,000 (for a small and relatively simple project) and $1,000,000 (for a large and complicated project).

Project financial close

The technical complexity of a project can absorb much of the initial focus of the project developer, but difficulties of assuring the necessary financing can also be substantial. Before initiating the search for finance, the project developer should bear in mind:

- the process of acquiring finance can be time consuming
- the technical, contractual and permitting aspects of a bioenergy project all affect the opportunities for securing financing
- project lenders will carefully assess all aspects of the project, with specific attention to the risks involved.

Therefore, attention to detail, risk mitigation and anticipation of lender concerns are very important.

The key financing considerations of bioenergy projects that should be considered before approaching a potential source of finance include:

- a stable and sufficient supply of sufficient quality biomass is available within a reasonable distance
- the project is based on own-use of generated heat and power or has easy access to grid connection or a large local user
- the proposed technology is proven and suitable in the local circumstances
- capital costs and operation and management costs are estimated
- the project lifespan allows for recovery of the investment
- environmental and social considerations are identified and adequately mitigated.

There are many ways of securing financing for a biomass project. The most common ways are described below, along with a brief assessment:

- Own equity: must be able to ensure a reasonable ROI, but also consider the overall benefits to the owner (for example, the use of biomass from existing production).
- Bank loans: international commercial banks, local banks or multilateral financing institutions (for example, ARENA). Financing through commercial banks often entails high interest rates, whereas development banks may offer more favourable interest rates.
- Investment by technology supplier: as the technology supplier has an interest in seeing the project succeed, the technology supplier may be willing to offer loans at interest rates lower than the banks.
- Investment by biomass supplier: biomass suppliers could typically be cooperatives of farmers or biomass processing companies with significant biowaste. The chance of being able to sell their biowaste provides an incentive for suppliers to contribute to the success of the project. They could provide capital as investment or loans at reasonable rates.
- Build-operate-transfer: in a build-operate-transfer (BOT) framework, a third party (the BOT contractor) takes responsibility for financing, designing, building infrastructure and operating the plant for a fixed period.
- Private equity funds: capital for private equity is raised from retail and institutional investors and can be used to fund new technologies. The majority of private equity funds consist of institutional investors and accredited investors, who can commit large sums of money for long periods of time.

Procurement and implementation

The procurement process can be structured in many ways and the size of the project will influence the approach. It is important to discuss and decide the procurement strategy in the early stages of the project, since this can influence some of the initial decisions. The procurement strategy is of significant interest to investors, as it identifies who is responsible for design and interface risks, the risks associated with final capital cost and the project delivery timeline.

Procurement and contracting of bioenergy plants may use a variety of models that reflect the scale of the project and the increasing transfer of risk and responsibility from the owner to the contractor(s). Some typical models include:

- traditional contracts, dividing the plant into several partial contracts with separate detailed designs. This requires a project manager to supervise and manage the contractor's performance.
- DB (design-build)/EPC (engineering, procurement, construction)/turnkey contract, with one contractor being responsible for design and construction of the entire plant. The plant owner is responsible for the operation and maintenance of the facility.
- DBO (design-build-operate)/BOT (build-operate-transfer) type contracts, where a third party operator (sometimes the main contractor) is engaged to operate and maintain the plant. The operator should be involved during the detailed design of the project.
- DBFO (design-build-finance-operate), where the contractor and a third party operator (sometimes the main contractor) takes full responsibility for the provision of a biomass-based power plant and is remunerated through the provision of heat and power.

Typically, bioenergy projects will use an EPC approach as this is the most prominent form of contracting agreement in the construction industry. The engineering and construction contractor is responsible for:

- detailed engineering design
- procurement all necessary equipment and materials
- construction and commissioning of the facility
- delivery of a functioning plant or asset which meets the client's performance requirements.

The DBO or DBFO approaches can be modified to negotiate an optional right to take over the operation and maintenance of the biomass plant after the initial two to four years of plant operation. This approach allows for the initial processing risk to be mitigated and for the owner to familiarise themselves with the plant and its operation and ensure it has adequate skilled resources to operate and maintain the plant to achieve maximum performance.

The decision on the type of contract will depend on the degree to which the bioenergy plant is integrated with the owner's existing facilities and on the owner's ability and willingness to transfer design decisions, operational control and project risks to the contractor.

It is of utmost importance to specify and agree upon the performance of the biomass plant. Sufficient time must be spent, and the necessary technical expertise engaged, to

Other considerations that will influence the type of contract are:

- the degree of owner involvement in the selection of subcontractors, technology supplier and detailed design
- ownership of the price and time risk
- the certainty of price
- certainty of project delivery time
- certainty of performance
- minimising the number of contractual interfaces.

define a sound contractual basis to cover plant performance risks. This should include general project warranties and process performance guarantees including energy generation and waste production, equipment reliability guarantees and plant availability guarantees.

Form of contract

Choosing the right form of contract is an important decision and technical and legal advice should be sought as to which form of contract is best for your bioenergy project. The first form of contract to be considered should be standard forms of contract. In Australia there are a set of Australian Standard forms, and the most common standard forms of contract used in construction are:

- AS4300
- AS4000
- AS2124
- AS4902.

Alternative standard contract templates are available from sources such as the International Federation of Consulting Engineers (FIDIC). FIDIC standard forms are widely used for international procurement in the energy sector. FIDIC contracts are written in formal legal English and are drafted based on common law. They have been developed over decades and are well-respected among owners, contractors and investors. FIDIC forms are only used on relatively high-value projects (>$100 million) involving the private sector and process engineering projects, such as bioenergy plants.

> Useful references include *Standard Forms of Contract in the Australian Construction Industry* from the University of Melbourne School of Law and National Guidelines for Infrastructure Project Delivery.

Tendering

The tendering procedure must comply with state and national laws covering construction contracts. Legal and transaction advisers can advise regarding the laws pertaining to the scale of the project and the best options to engage with the market. Alternatively, direct contracts with selected contractors may be used if the project is sufficiently small scale.

A public procurement approach offers the advantage of being able to interact with potential bidders during the procurement process. Conducting an initial market sounding prior to the tendering procedure is an excellent way to gain an understanding of the competition in the marketplace, potential bidders, available technologies and to gain feedback on various forms of contract. The market sounding may include the following questions:

- Which technology or technology supplier is the contractor offering?
- Is the contractor offering suitable alternatives that are proven for the biomass project?
- Does the contractor have experience with the biomass to be used?
- Does the contractor have experience and suitable reference plants in Australia?
- Does the contractor have a strong financial track record?
- Does the contractor offer a parent company guarantee?

- Does the contractor offer a process guarantee?
- Does the contractor possess the necessary technical capability in-house?
- Does the contractor have sufficient skilled labour for the construction and commissioning?
- Does the contractor and/or technology supplier have a local service capability?

If a public procurement process is used, we recommend that a prequalification stage is included and that only experienced, financially sound and capable contractors are selected for the formal tendering phase. The tender specification should be ready at the time of prequalification and the evaluation criteria clearly outlined in the tender documentation.

When applying a private (non-public) procurement system, it is possible to use a similar approach to the public procurement process by including a prequalification stage and tendering based on a detailed tender specification. To elicit best value, it is important that the tendering procedure be competitive and transparent.

In a private procurement system, bidders are invited by the developer to submit a bid, usually based on the tender specification. The bid can be as detailed as a public tender or a simpler performance-based specification can be used, stating the overall requirements of supply. Following an evaluation of the budgetary bids received, all details must be discussed with the preferred bidder and incorporated in the draft contract.

Recruitment and training plan

At the end of the design period you will have a good idea of the important processes to produce bioenergy from your chosen feedstocks and your plants design should be largely fixed. You should therefore be able to identify the specific roles and skills that will be necessary to operate your plant and associated critical procedures.

Building on the relationships you established during your initial workforce analysis, you should explore how to ensure that your operators have the required skills. For most projects there will be roles that require officially recognised skills (such as electricians, gasfitters, high voltage operators). Tasks involving high-risk work (such as confined space entries and operation of forklifts and cranes,) must be carried out by staff with specific accreditation, as dictated by WorkSafe. There are other tasks where a Bachelor of Science degree qualification may be required (e.g. operating biological processes) but other roles might be filled by people who learn scientific skills on-the-job or via a suitable Technical and Further Education (TAFE) course.

A job skills/task analysis should be carried out to identify the types of roles for each major task on site. Both a recruitment plan and a training plan should be devised to decide when and who to hire, and when and what training should be delivered. The training plan will be based on an analysis of the skills, knowledge and attributes held by each of the individuals chosen for the roles. It is advisable that some operational staff be involved in the commissioning process so that they can learn directly from the vendors of the plant and from commissioning engineers.