Biomass Conversion Technologies

Due Diligence and Technology Evaluation

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Outline

Definitions

Technology The specific unit or package being considered for purchase from a given vendor. Could include one or more of:

- Firewood processor
- Gasifier
- Boiler
- Hamermill
- Doweling mill
- Engine
- Turbine

Vendor Entity selling the technology

Conversion Process inclusive of all intermediate steps, of converting the raw material (wood chips, debris, pellets) into the final product (electricity, heat, densified fuel)

Definitions continued

Project Set of values, goals, and objectives that lead evaluating conversion technologies

Values Set of principals or ideals that guide and define the project
eg: *profit, environmental stewardship, social responsibility*

Goals General statements aligned with values that express intangible or abstract mission
eg: *"Provide sustained economic opportunity for our community"*

Definitions continued

Objectives Specific tangible outcomes

- create 10 long-term, living wage local jobs
- treat 10,000 ac of forest annually,
- produce 10MWe of renewable electricity,
- realize 7% return on investment in 15 years
- reduce heating costs by 5%
- reduce conversion costs by 10% in 5 years for an emerging technology

Team Specific individuals with defined roles.

Before the technology

Defining the project

Define the project Take time to think carefully about the project. Among core project developers agree on at least the following:

- Values
- Goals
- Objective
- Team

Before the technology

The known unknowns

Know what you don't know...

- what don't you know?
- where are you uncertain.?

Ask yourself:

- What expertise do you lack on your team (technical, finance, etc.)?
- Do you have a realistic estimate of supply in terms of cost and volume?
- Do you know what your product market is? How to access it? At what price you can sell your product for?
- Who will profit from sales? If a business, who will be the entrepreneur/business owner?

What is due diligence?

Evaluating *capability* and *efficacy* of a specific technology to achieve your goals and objectives.

Capability Does the technology do what I want it to?

Efficacy How well does it perform

- Process efficiency $/unit output
- Product quality relative to customer specification

Capability

Categories

- What are the specifications of the technology package?
  - operating conditions
  - feedstock requirements
  - duty cycle
  - maintenance cycle
  - emissions/residuals
- Do the specs meet with your operational conditions?

Capability

Operating conditions

Operating environment

Temperatures Min, Max

Dust Air filtration requirements?

Capability

Feedstock specification

Consumption Feedstock consumption (eg: tons/day, green tons ≈50% MC, oven dry tons 0% MC)

Piece size Dimensions of minimum and maximum piece size?

Moisture Content What is the maximum and minimum moisture content for feedstock? Dry or wet basis?

Moisture Content measurement

Generally reported on dry basis:

$$\frac{m_g - m_{od}}{m_{od}}$$

Where m_g is green mass and m_{od} is oven-dry mass

Capability

Operation

Mode of operation Batch or continuous?

Duty cycle Does the unit operate continuously between maintenance cycles or is operational down time required?

Maintenance cycle How many operational hours between maintenance?

Replacement schedule and cost How often do components need to be replaced? At what cost? Major cost centers?

Operation How many people are required to operate the system? How automated is feedstock handing?

Capability

Emissions and residuals

Air emissions Ask for criteria pollutant emissions reported in lbs/ton of feedstock consumed.

Criteria pollutants Ozone (O_3), Nitrogen Dioxide (NO_2), Sulfates,Carbon Monoxide (CO), Sulfur Dioxide (SO_2), Visibility Reducing Particles (AKA 'dust'), Lead (Pb), Hydrogen Sulfide (H_2S), Vinyl Chloride

Liquids Does effluent need to be treated? Is treatment system included in package?

Residuals Other solid residuals in lbs/ton of feedstock.

- Char
- Ash

Capability

Track record

Its criticaly important to understand the development status of the technology.

Development Stage Lab scale? Pilot scale?

Production Ask vendor for a list of installations or client references.

- Operating hours?

Guarantee, service Can reflect vendors true feeling about reliability.

Evaluate track record against project goals. A technology in development stage may be the best fit if R&D or public investment in novel technologies are important.

Efficacy

Matching project objectives

Does the technology meet your project needs?

Criteria	**Mfg. A**	**Mfg. B**
60 psi steam	X	
wood pellets		X
wood chips	X	
$\geq 170^{\circ}$ water		X
10 kWe electricity	X	
$\geq$ 20,000 GT/year		

Table: Example evaluation matrix

Efficacy

Product Quality

Product specifications Does the product meet known market specs?

- **Densified fuels:** Ash content, moisture content. Check standards bodies (American Pellet Fuels Institute, ASTM International, etc.)
- **Co-firing:**

Boiler Type	**Piece size (in)**
Pulverized coal	$\leq 1/4$
Stoker	≤ 3
Cyclone	$\leq 1/2$
Fluidized bed	≤ 3

Table: Co-firing fuel specification from NREL

Efficacy

Product quality continued

Latency If demand is variable (eg: heat loads in manufacturing), how quickly can production ramp to meet demand?

Consistency If demand constant and critical (ie baseload Power Purchase Agreement) can the capacity factor meet the demand?

Cost

Fit with project finance

Does the technology allow you to meet project revenue expectations?

$$\sum_1^n R - \sum_1^n C \geq P$$

Where n is the project planned lifetime in years, R are revenue streams (heat, electricity, etc) and C are costs (capital, finance, operations, taxes, permit fees,etc.) and P is desired profit.

Cost

Evaluation

Production context Multiple bids will reinforce bid legitimacy

Demonstration context Attempt to quantify expected benefits from demonstration in terms of long term goals and objectives (eg: SB1122)

- public benefits
- technology maturation
- reducing costs for primary industry (wood products, recycling, etc)

Sources of information

Vendor Ask for data from installed (production) units. Ask for reference to corroborate.

Client Understand relationship to vendor. Ask for raw data if available. Summary data should be examined closely.

Vendor types

Original Equipment Manufacturer (OEM) Company actually fabricates unit components (gasifier, engine, dye)

- May own intellectual property
- Usually unit sales

Retailer and/or installer Provides comparable unit components from a multiple OEM mfg. May provide system engineering services.

Consulting Engineer Combines best fit parts/pieces from OEM to fit system specification. Can provide construction-ready plans. Usually bill T&M or lump sum, no equity.

System integrator Energy companies. Procure financing, design, construct, operate.

Who you are doing business with

Company history How long have they been in business?

Product Lines What other product do they produce?

Management Who is the management team?

Other project references Other projects and clients. Be sure to understand the relationship between client and vendor for references.

Due diligence and values

Demands reflection on core values and goals Technology due diligence requires a clear vision of the project values, goals, objectives. This is the measuring stick.

Know just enough about all system components Easy to get lost in the detail. Focus on important things.

- input
- output
- costs/benefit alignment with goals and objectives

Questions?

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