



PROVARIS

**FOREST INDUSTRY AND POWER
PROJECTS BASED ON**

**HIGH YIELD
NON-WOOD FIBRES**

PROVARIS

Provaris offers **unique** skills necessary to carry out cradle-to-grave development of environmentally-sustainable, economically viable integrated agro-industrial projects.

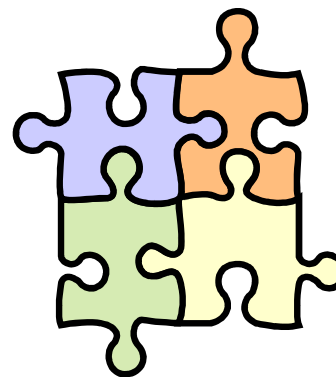
Provaris is a member of the
Clearwater Technology Group
of companies

www.clearwatergroup.org

PROVARIS

Provaris was formed to offer a comprehensive packaged approach to the development of integrated forest industry projects based on:

1. Advanced, high yield, fibre (raw material) bio-technology
2. Advanced pulp, paper and environmental technologies
3. Sustainable, locally-based construction materials
4. Totally packaged, turnkey solutions including:
 1. Financing
 2. Commercialisation
 3. Management
 4. Technology Transfer



THE UNIQUE CAPABILITY OF PROVARIIS

ONLY PROVARIIS CAN OFFER THE UNIQUE COMBINATION OF:

- PLANT BIO-TECHNOLOGY
- FOREST INDUSTRY TECHNOLOGIES
- ENVIRONMENTAL TECHNOLOGIES
- COMMERCIALISATION
- FINANCING
- MANAGEMENT
- TECHNOLOGY TRANSFER
- CRADLE TO GRAVE DELIVERY

OVERVIEW



- Pulp, paper, paperboard, and packaging industries > \$700 billion of sales globally
- 80% of pulp produced from indigenous forest resources → rapidly depleted
- Only circa 20% is derived from plantations.
- 100,000 square miles of forest lost each year
- The critical question from industry experts, government leaders and environmentalists is how to meet the future demand for paper and paper products in a financially viable, environmentally friendly and ecologically sustainable manner?
- The answer lies in the planting of selected “elite” high-yield, fast-growing non-wood species eg members of the grass and reed family such as; ***Arundo Donax*** and ***Bamboo***, and the use of advanced, yet proven, forest-industry technologies
- Recover land that has been cleared by slash & burn and other non-sustainable practices
- Coupled to advanced pulp and paper making technologies to form the basis for the development of **strong, sustainable, highly-profitable, and environmentally-friendly** forest industries

Why use PROVARIS bio-technology?

- A. Until recently it has proved almost impossible to produce large quantities of propagated elite strains, such as ***Arundo*** and ***Bamboo***
- B. These elite species have been developed to heighten natural characteristics such as:
 1. The ability to thrive on waste, or poor, soils
 2. Extremely rapid growth
 3. Resistance to pests and diseases
 4. Prevention of uncontrolled environmental spread or escape
 5. Selection for development of specific fibre qualities
 6. Long life, with minimal irrigation & fertilizer demands

ARUNDO DONAX and "elite" BAMBOO

- In the recent past, wood as a renewable, natural resource had no competition.
- But now, for countries with tropical or sub-tropical climates, **Arundo** and "**elite**" **Bamboo** have little competition
- The proven technology now exists to create efficient, sustainable, environmentally-friendly, and highly profitable pulp & paper and forest-industry businesses based on **Arundo** and similar non-wood species such as "**elite**" **Bamboo**



Uses of **Arundo** and “Elite” strains of **Bamboo**

Arundo and “elite” **Bamboo** have wide-ranging and similar properties. Both are:

- Fast-growing → ultra-high yields / hectare
- Fibre strength and suitability for paper and construction materials
- Suitability for bio-fuels and biomass-based energy generation
- Useful as sources of good quality textile fibres

Some differences exist; so some differentiated uses are:

- **Arundo** is easier to bleach → better for white grades of pulp & paper
- “elite” **Bamboo** is suitable for brown (unbleached) grades of paper such as fluting and liners (used in corrugated cases)

HIGH GROWTH + HIGH YIELD

- ***Arundo donax*** or “Giant Reed” grows well in sub-tropical and tropical areas. Roots can extend up to 5.5 metres deep
- Similarly "***elite***" ***Bamboo*** originates from these areas and is well adapted
- Among the fastest growing plant types known
- Excel in fuel and fiber production
- Paper made from "***elite***" ***Arundo*** or ***Bamboo*** costs less than wood
- Paper made from ***Arundo*** is superior to paper made from many traditional hardwoods
- Building products made from "***elite***" ***Bamboo*** are lower cost and often superior to traditional products

"Elite" Arundo & Bamboo

ADDITIONAL BENEFITS

- Extremely hardy plants – **Arundo** and **Bamboo** grow best in tropical and sub-tropical areas of the world.
- Excellent for phyto-remediation of sewage wastewater. Grow in poor soils. Drought resistant. **Arundo** can even stabilize sand dunes
- "**Elite**" **Arundo** and **Bamboo** are both highly efficient at removing Carbon Dioxide from the atmosphere (Carbon sequestration)
- Commercial, and efficient production of "**elite**" **Arundo** and "**elite**" **Bamboo** strains has been accomplished by Provaris

"elite" Bamboo AS A RAW MATERIAL

"elite" Bamboo has dozens of uses with at least 6 major markets:

1. Pulp & paper
2. Building materials
3. Food
4. Ethanol
5. Composites
6. Biomass power



Paper



Ethanol



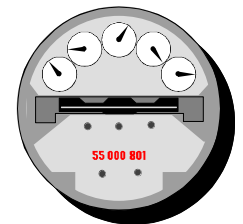
Food Shoots



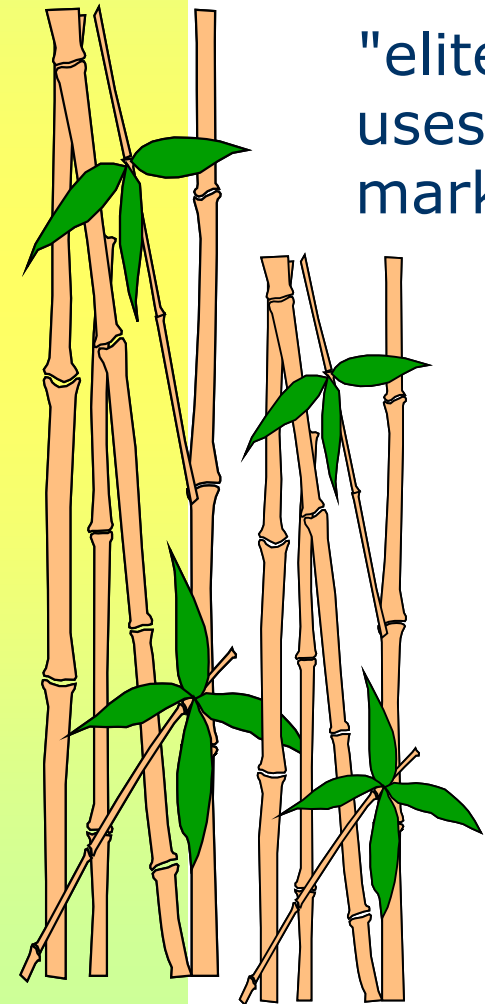
**Building
Materials**



Composites



**Biomass
Electricity**



Arundo & "elite" Bamboo PROPAGATION

- Provaris uses patented propagation bio-technologies
- Highly efficient plant generation from nursery
- Hardy, "elite" fastest-growing plants
- Lowest plantation costs
- Suitable for outgrowing by local farmers





Top Left: Arundo
Donax plantlets

Top Right: vigorous
root development

Left: "Elite" Arundo
90 days after planting

ENVIRONMENT



When implemented using Provaris technology, *Arundo Donax* and "*elite*" *Bamboo* based forest industries have environmentally **positive** effects:

- Reclamation of degraded land
- Prevention of erosion
- Carbon sequestration
- Carbon-neutral biomass fuels
- Substitution for indigenous forest tree felling
- Closed water loops – virtually zero discharge
- TCF - Totally Chlorine Free bleaching (no AOH compounds, eg. dioxins)
- Energy-efficient pulping
- No replanting required for many decades

With the application of the correct technologies **ALL** environmental issues associated with traditional forest industries can be eliminated

ENVIRONMENTAL ISSUES



Forest industries based on traditional (wood-based) technology have suffered from perceptions of poor environmental performance. This has also been true of some early Bamboo-based projects. Issues have included:

- ❖ Gaseous emissions
- ❖ Fresh water demand from water courses and rivers
- ❖ Heavy metal contamination
- ❖ Waste water discharges and river pollution
- ❖ Aromatic Organic Halogenated compounds (AOH) – eg. Dioxins
- ❖ Loss of indigenous forests
- ❖ Soil erosion and degradation

All these issues can be avoided, and many can be rectified by the use of Provaris **Arundo** and “elite” **Bamboo** based forest industry technologies

ADVANTAGES OF NON-WOOD FIBRES IN PULP

SPECIFIC AND GENERAL ADVANTAGES INCLUDE:

- 1. Short growth seasons**
Non-wood species used in paper making grow to maturity within a short time relative to wood species.
- 2. Use of waste fibre**
Other parts (eg. leaves and stems) of non-wood plants have secondary uses such as valuable animal feeds and textile fibres.
- 3. Low cooking and refining energy**
Non-wood fibre sources are usually supplied to the pulp digester in smaller size fractions than wood chips, and they have weaker inter-fibre lignin deposits, resulting in lower cooking energy requirements.
- 4. Lower cooking and bleaching chemical requirement**
It is also a fact that the cooking chemical and bleaching chemical requirements for non-wood species are lower than for wood fibres
- 5. Quality**
For example, *Arundo Donax* is capable of producing pulps that are superior in quality, at significantly lower cost, than any other hardwood type of pulp (eg. Eucalyptus)

SUMMARY OF SOME NON-WOOD PROPERTIES

Fibre	Advantages	Disadvantages	Technologies	Uses
Bagasse	Short grow time 1 year rotation. Waste fibre source	Requires depithing.	Well developed pulp technologies available	Most paper types
Hemp	Rapid growth 8-10 ft in four months	Requires decortication and retting. Perceptual problem due to drug association. Long fibre wraps round equipment.	Well-developed pulp technologies available. Drug free variety available.	Cigarette paper, strength additive to waste paper, light weight papers
Kenaf	High yield 21.3 mt/ha in 3 years.	Dual source: 57% long bast fibre, 41% short core fibre, therefore bark and core separation required.	Excellent papers have been made using existing technology.	Wide range due to variety of fibres.
Wheat straw	Short grow time 1 year rotation. Waste fibre source	Problems with black liquor treatment. Perceptual problems	Well-developed pulp technologies available. Successful work on black liquor done.	Most packaging paper types
Linseed Flax	Byproduct of linseed industry. Low cooking and TMP refining energy. Similar cost to hard wood in Canada (\$60/ton)	Needs decortication before cooking. Lower brightness than wood after TMP Pulping	Well documented as beneficial in blends with wood pulps. Processing technology is understood.	Used in wood pulp blends to improve strength.
Perennial Grasses	Fast growing. Environmentally friendly	Not established. High ash.	Not yet developed	Potential supplement to hardwood.
Arundo donax	Ultra-high yield - Fast growth-5m tall in 6 months. More than 30 BDT/ha/year Can be used in hard wood pulping mill as alternative.	Rapidly developing acceptance in the industry.	Can use same technology as hardwood pulping.	As for ALL hardwoods

PULP & PAPER TECHNOLOGY



- Traditionally the paper industry focussed on wood as the only significant global source of paper fibre
- This was partly due to the dependence on wood in the countries in which most technological development has taken place
- There has been a reluctance to invest in alternatives due to the retro-fit costs involved and resultant lack of urgency in developing non-wood pulp & paper technology
- However, the potential to solve the problems encountered is highlighted by the fact that over the past 30 years Eucalyptus has grown from being regarded as a poor quality fibre source to being the world's premier fibre source - due to adaptation of technology to suit the fibre
- The same is now happening with Arundo and "elite" Bamboo. **Provaris is at the forefront of these technological developments**

Non-wood species AS A SUBSTITUTE FOR WOOD FOR PULP & PAPER

Research has established the following facts:

- Yield per Acre - **Arundo** and **Bamboo** produce at least **TEN TIMES** the usable fibre compared to indigenous wood fibre resources.
- Yield per Ton – **Arundo** yields 49.5% of the bone dry amount harvested as fibre verses typically 43-47% for wood
- Quality of Paper – **Arundo** produces high quality pulp that mimics both hardwood and softwood characteristics.
- **Kenaf** (tropical grass) produces high yields of fibre on tropical savannahs
- **Bagasse** (sugar cane fibre) is used for various paper grades
- **Arundo** contains both long and short fibres – very useful for controlling pulp quality
- **Flax, Jute, Cotton** and **Hemp** produce immensely strong, premium quality paper-making fibres
- Even in temperate climates, **Linseed, Flax, Canary Reed Grass,** and **Wheat** straw produce viable quantities of useful fibre – along with valuable primary products (eg. vegetable oils, animal feeds, etc)

Non-wood species ADVANTAGES OVER WOOD IN PULP & PAPER PRODUCTION

- Tear and tensile strength indices can be more than 40% greater than wood derived pulps.
- Less energy is used in the papermaking process.
- Easily harvested and delivered to the mill.
- Substantially lower manufacturing cost and chemical use compared to wood

A HIGH QUALITY LOW COST SUBSTITUTE FOR WOOD PULP

EXAMPLE:

- Results indicate that commercial **Arundo** pulp production costs are at least 25% lower than pulp from wood
- Calculated costs of producing 1 tonne of **Arundo** pulp are circa US\$ 205-230. Current market price for equivalent pulp is >US\$ 650 per tonne.
- If **Arundo** were fully substituted for wood worldwide a \$50 Billion dollar annual cost reduction could occur.
- The amount of land **Arundo** farmers require would be one quarter of that used by trees.

Arundo PAPER PROPERTIES

- A commercial blend of 50% bleached aspen hardwood and 50% bleached Canadian softwood was used to produce a 75 gsm sheet. Precipitated calcium carbonate was added to produce a 90 gsm sheet.
- This was repeated, replacing the hardwood with **Arundo donax**. The paper made with **Arundo** exhibited superior paper properties:
 - The machine direction properties and the cross direction tear show vastly superior improvements.
 - This is due to the long thin fibers of Arundo donax. These fibers may align easier than hardwood fibers.
 - The average fiber length of the Arundo donax is 1.2mm. The fiber length of the aspen was only 0.86mm.
 - The Arundo fibers have a bimodal fiber distribution with a significant proportion of long fibers between 2.5 and 3.5mm.

PULP & PAPER TECHNOLOGY



A combination of the right technologies is required to exploit all the benefits of **"elite" Arundo** and **"elite" Bamboo** fibres to the full:

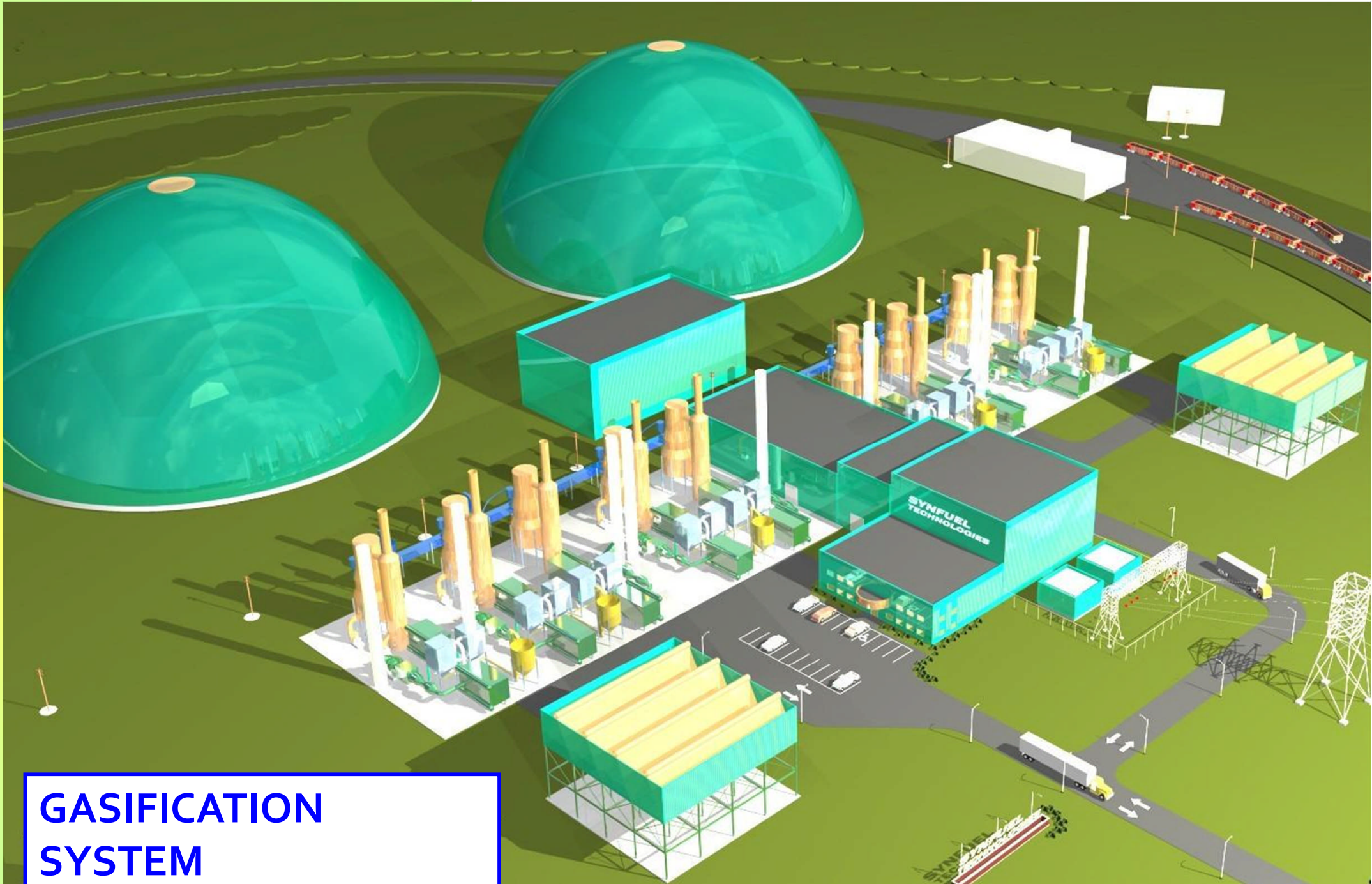
- Pulping – energy and chemical efficient processes
- Recovery – processes must permit effective internal recycling
- Bleaching – TCF – Totally Chlorine Free to eliminate AOX discharges to environment
- Process water recovery – use of advanced recycling technologies = minimal environmental impacts

PROVARIS, UNIQUELY, DELIVERS THE COMPLETE SOLUTION AS A FULLY INTEGRATED PACKAGE

BIOMASS POWER GENERATION

- *"elite" Bamboo* is being used in Brazil to produce electricity
- In Honduras a 100% biomass electrical generation plant is being developed
- *"elite" Bamboo* and *Arundo* can also be used for co-firing with coal and petroleum coke
- *"elite" Bamboo* produces about 8500 BTU/LB bone dry (for an annual production per acre of about 170 mBTU)





**GASIFICATION
SYSTEM**

GASIFICATION

As a means of transforming biomass fuels into energy supplies, **gasification** offers many possibilities:

- Clean electricity (via combined cycle or CHP)
- Synthetic natural gas (Syn-Gas)
- Propane substitution using catalytic conversion
- Bio-fuel base (methanol / ethanol)
- Hydrocarbon replacements
- Solid fuel replacement

THE PROVARIS APPROACH TO SUCCESSFUL PROJECT DELIVERY

Many options – but typically:

- Conduct a thorough and detailed feasibility study covering all aspects of markets, bio-technology, engineering, environment, finance economics & commerce
- Create a premium-quality Business Plan to verify the commercial viability of all options
- Establish initial connections with end-user customers for the products
- Organise equity and debt finance
- Implement projects in conjunction with our Clients (via JVs, SPVs, strategic partnerships etc.)
- Provide operational and senior management resources and support
- Conduct technology transfer