IEA Bioenergy
Liege
1 October, 2009

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Agenda

- Algae
  - Organism
  - Markets
  - Growing Process
- AlgaeLink
  - Company
  - System
  - Project Outline

'The simplest organism on the planet could be the solution to the world's most complicated problems'

Algae

Organism – What is it?

- Algae are a large group of organisms, which flourish in the sea, in fresh-water and in damp places on land.
- They have been classified in a separate kingdom called Protista.
- Algae growth is a natural occurrence in all water bodies.
- They are the base of the aquatic food chain
- Algae thrive on hot weather when it reproduces more rapidly. It is stimulated by nutrients.
- Most algae contain green chlorophyll, and can produce foods, such as sugars, from the sun.

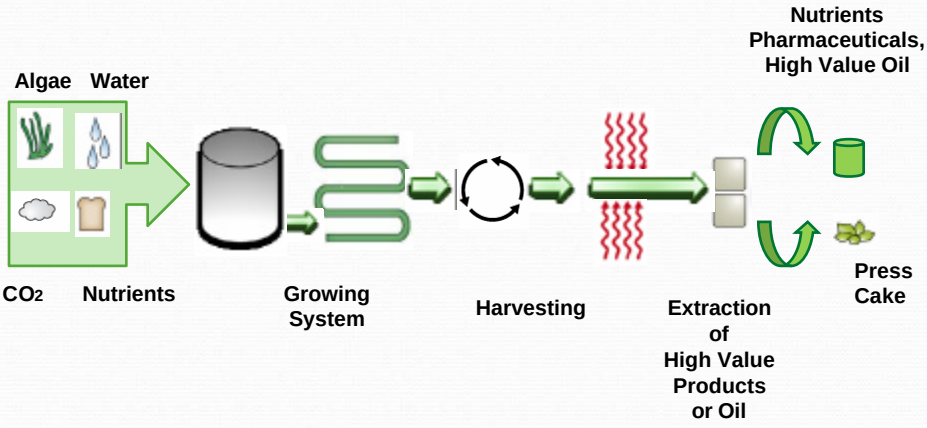
Algae

Characteristics – Why is it exciting?

- Some species have a high oil content;
- Micro-algae are photosynthetic and one of the most efficient organisms in converting the sun's energy into chemical energy;
- Micro-algae can produce more than 30 times the amount of oil (per year per unit area of land) when compared to oil seed crops.
- Some algae can grow in saline/fresh/brackish water.
- Micro-algae are the fastest growing organisms. They can complete an entire growing cycle every few days.
- Algae production can be increased by increasing the carbon dioxide concentration in the water.

Algae to Value

Algae Process



Algae

Markets

- Output: Markets for Algae
  - **Food**: Nutrients, Pharmaceuticals, Omega Oils,
  - **Feed**: Animal Feed, Fishfarms
  - **Fuel**: Biofuel (diesel, ethanol, gas), Bioplastics

  These markets are large, global, high value; timing is very appropriate

- Input: Algae Farms as Cost Savings for Existing Industries
  - **CO_2** Sequestration
  - **Waste Water** Treatment

  These drivers for cost savings and environmental measures are very powerful and truly global.

Algae

Applications


Cancer research


Food supplements


Nutritional


Biopellets

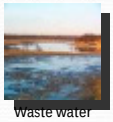

Animal feed


Aquaculture


Proteins


Vitamins


Omega 3&6


Waste water treatment


CO_2 reductions


Fertilizer

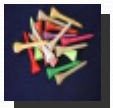

Oil

Ethanol


Jet fuel

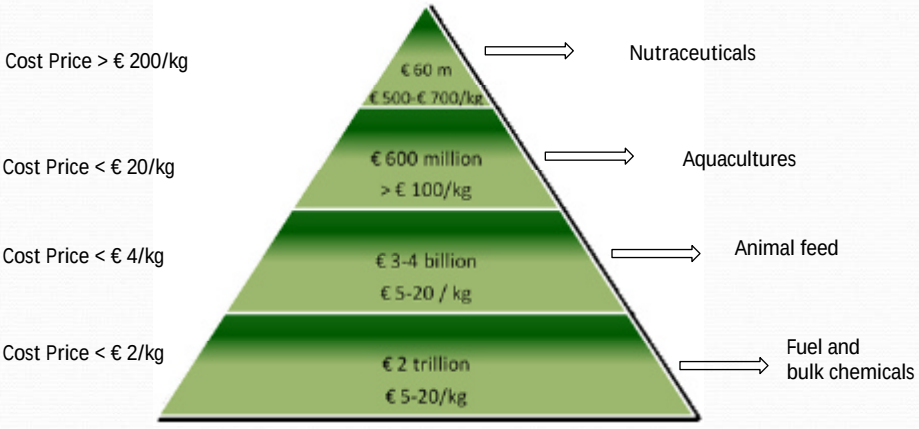
Biodiesel


Biogas


Bioplastics

Algae

Market Values



Algae

Many strains, different values

Strain	Protein (%)	Carbohydrates (%)	Lipids (%)
Fresh water algae:			
Scenedesmus obliquus	50-56	10-17	12-14
Scenedesmus quadricauda	47	-	1.9
Scenedesmus dimorphus	8-18	21-52	16-40
Chlamydomonas rheinhardii	48	17	21
Chlorella vulgaris	51-58	12-17	14-22
Dunaliella bioculata	49	4	8
Euglena gracilis	39-61	14-18	22-38
Prymnesium parvum	28-45	25-33	22-38
Tetraselmis maculata	52	15	3
Porphyridium cruentum	28-39	40-57	9-14
Spirulina platensis	46-63	8-14	4-9
Spirulina maxima	60-71	13-16	6-7
Anabaena cylindrica	43-56	25-30	4-7
Marine algae:			
Isochrysis sp Clon T-ISO	44	9	25
Isochrysis galbana	41	5	21
Paulova lutheri	49	31	12
Chaetoceros calcitrans	33	17	10
Phaeodactylum tricornutum	33	24	10
Skeletonema costatum	37	21	7
Thalassiosira pseudonana	29	17	10
Dunaliella salina	57	32	9
Tetraselmis suecica	39	8	7

Algae

Many variables

- Economic Model Depends on
  - Location
    - Climate
    - Input Costs
    - Logistics, Labour
  - Selected End Markets, Which Combination
  - Technology, Scale

AlgaeLink

Company

- AlgaeLink's Offering:
  - Developing and Manufacturing **Algae Growing Systems**
    - Closed: Photo Bio Reactors
    - Open: Open Ponds
    - Downstream processing: Harvesting, Extraction, Biodiesel Equipment
  - **Consultancy** Services, Training
    - Engineering, Biology, Biotechnology, Chemistry
  - **Joint Venture** Algae Farms, Operations, Maintenance

- Patented and Proprietary **Technology**

- Strong **R&D** Team

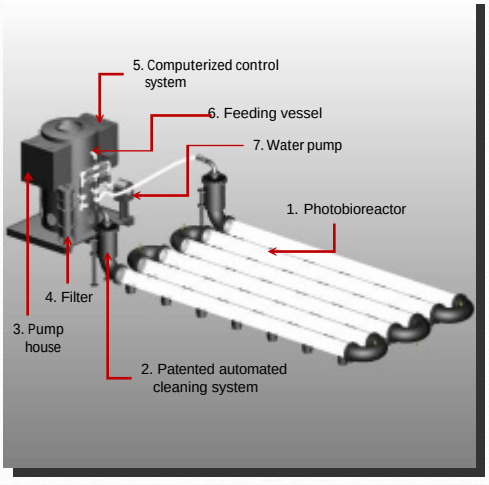
Global Leader in Algae Solutions

AlgaeLink

Photo BioReactor PBR

- Proven, Patented Technology
  Improves Yield by Factor 50
  1,5 kg/m3, 50 – 150 ton/ha/yr

- Both PBR's and Open Ponds:
  Hybrid mix of both systems

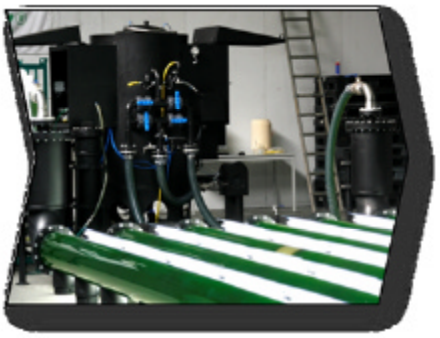


AlgaeLink

Photo BioReactor PBR

Advantages of closed systems:

- Better control of algae culture
- Large surface-to-volume ratio
- Reduction in evaporation of growth medium
- Better protection from outside contamination
- Higher biomass – can sustain higher cell density
- Diverse algae species – because of reduced hydrodynamic stress more diverse algae species can thrive



AlgaeLink

Status Summer 2009

- AlgaeLink's Technology Confirmed by Reputable Companies and Organizations:
  - KLM – Royal Dutch Airlines
  - Bellona Foundation
  - Club of Madrid
  - Governments of United States, Australia, China
  - US - National Algae Association

- More than 30 Algae Growing Systems sold:
  - Europe: e.g. Netherlands, Spain
  - Australia, Asia: e.g. India, Taiwan, China
  - South Africa
  - North America, South America

AlgaeLink

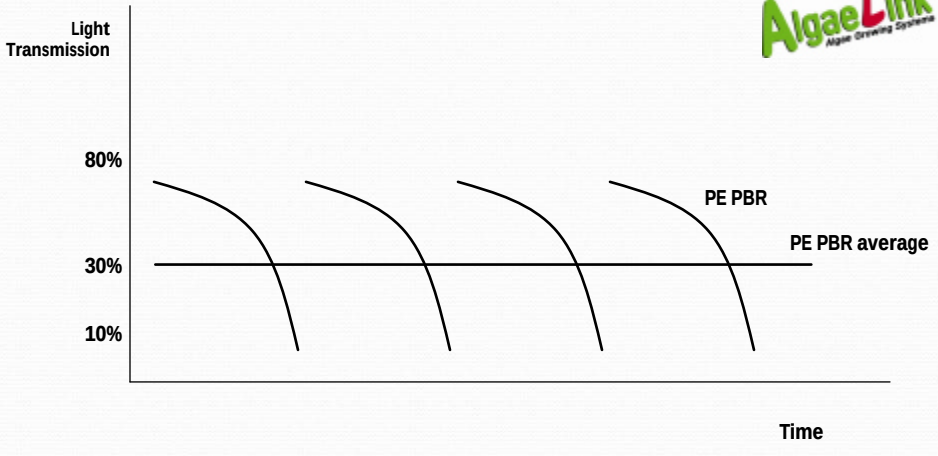
Market Segments

International Projects covering all Continents and all Market Segments.

500 tpa Global Capacity

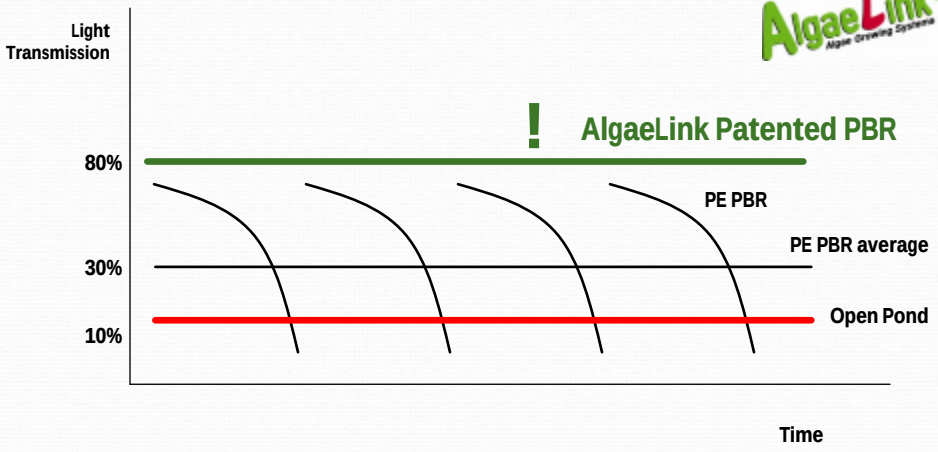
Key Differentiator 1

Productivity
Light Transmission



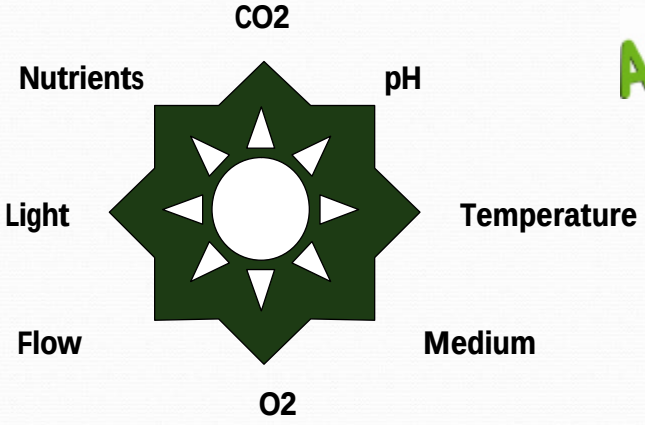
Key Differentiator 1

Productivity
Light Transmission



Key Differentiator 2

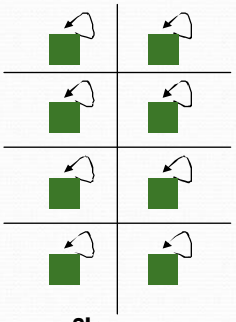
Process Stability
Continuous Process Control & Optimization



Key Differentiator 3

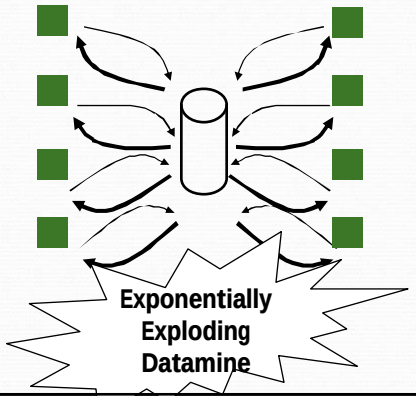
Continuous Improvements
Global Algae Growth Database

Individual Projects



Slow, Inefficinent, Sub-optimal

AlgaeLink R&D and Consultancy



Exponentially Exploding Datamine

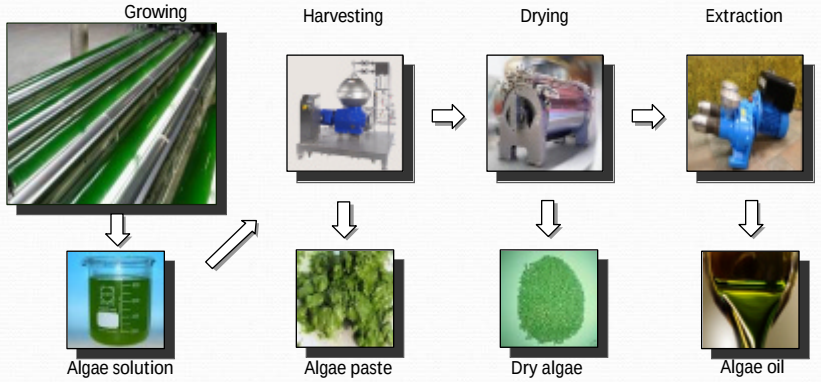
Algae

Growing – Required Inputs

CO_2	Algae require between 1.7kg – 2.8 kg CO_2 per 1 kg of algae. This is injected in a controlled manner into the system to optimize growth. You can utilize local sources.	Cost range per kg: From negative € 0.20
(Sun)light	Light must not be too weak or too strong. Algae use only a small amount of light they receive from direct sunlight. Our system circulates the algae so that it does not remain on the surface which would cause over-exposure.	Cost range per kWh: From zero to € 0.25
Nutrients	Algae requires Nitrogen and Phosphorus. This can take the form of expensive chemicals, basic fertilizer or optimally waste water streams.	Cost range per kg: From negative to €1,50
Water	The water required for algae can be fresh, brackish or salinated. The cost associated will vary from country to country, location to location.	Cost range per liter: From zero to € 0.20

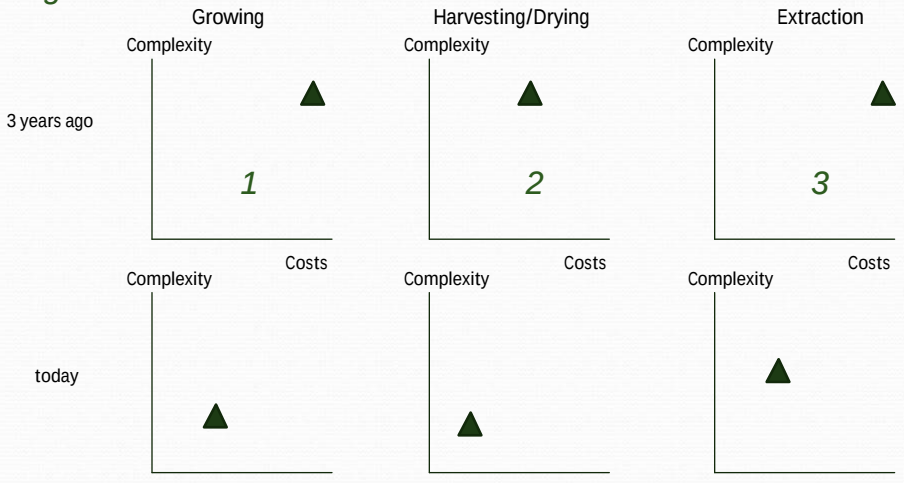
Algae to Value

Algae Process in Detail



Algae to Value

Algae Process in Detail



Algae to Value

Harvesting / Dewatering

Once the desired concentration of algae is reached in the photobioreactor, the next stage is removing the algae from the photobioreactor. On leaving the system, there is a large amount of water and a small percentage of algae.

There are a number of methods to harvest algae. This method depends on the algae species, the medium, end product and production costs.

Algae can be harvested using:


Filter


Centrifuge


Flocculation


Froth flotation

Algae to Value

Drying

Depending on the purpose of your algae, either the final step (or step prior to oil extraction) is drying the slurry to a moisture content of approximately 10-15%. By drying, the algae biomass is converted to a stable, storable product. Dehydration can be costly depending on the purpose and method chosen. The various systems for drying differ, both in the extent of capital investment and the energy requirements.

Selection of the drying methods depends on the scale of operation and also the use for which the dry product is intended.

Different methods of drying are:


Flash drying


Drum drying


Sun drying


Solar power drying

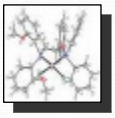
Algae to Value

Oil extraction

Algae oils have a variety of commercial and industrial uses, and are extracted through a variety of methods.

The simplest method is mechanical crushing. Since different strains of algae vary widely in their physical attributes, various press configurations (screw, expeller, piston, etc) work better for specific algae types. Often mechanical crushing is used in conjunction with chemicals (see below).

Different methods for oil extraction are:


Chemicals


Supercritical


Press


Cavitation

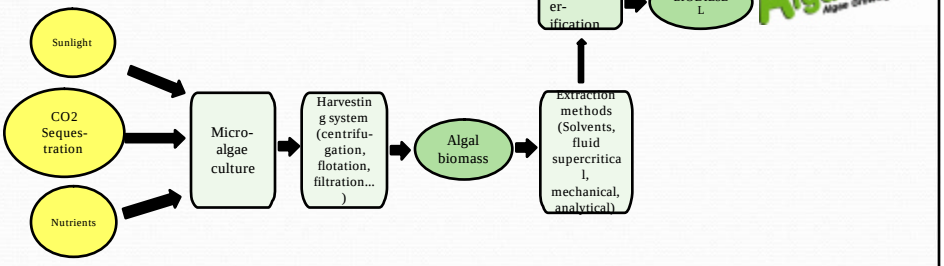
CO_2 to Algae

Waste to Value

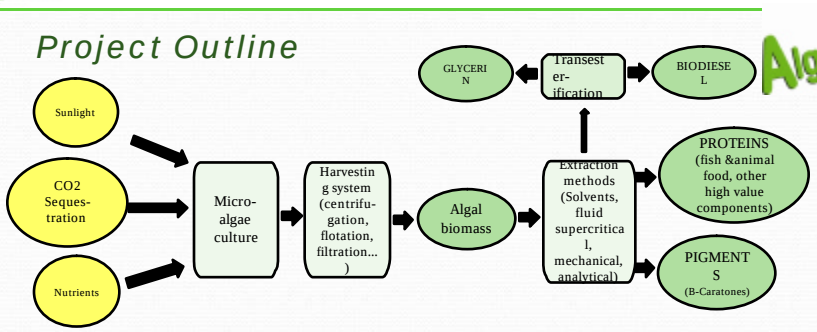
Capturing CO_2 can be applied to large point sources, such as large fossil fuel or biomass energy facilities; industries with major CO_2 emissions, natural gas processing, synthetic fuel plants and fossil-based hydrogen production plants. Broadly three different types of technologies exist:

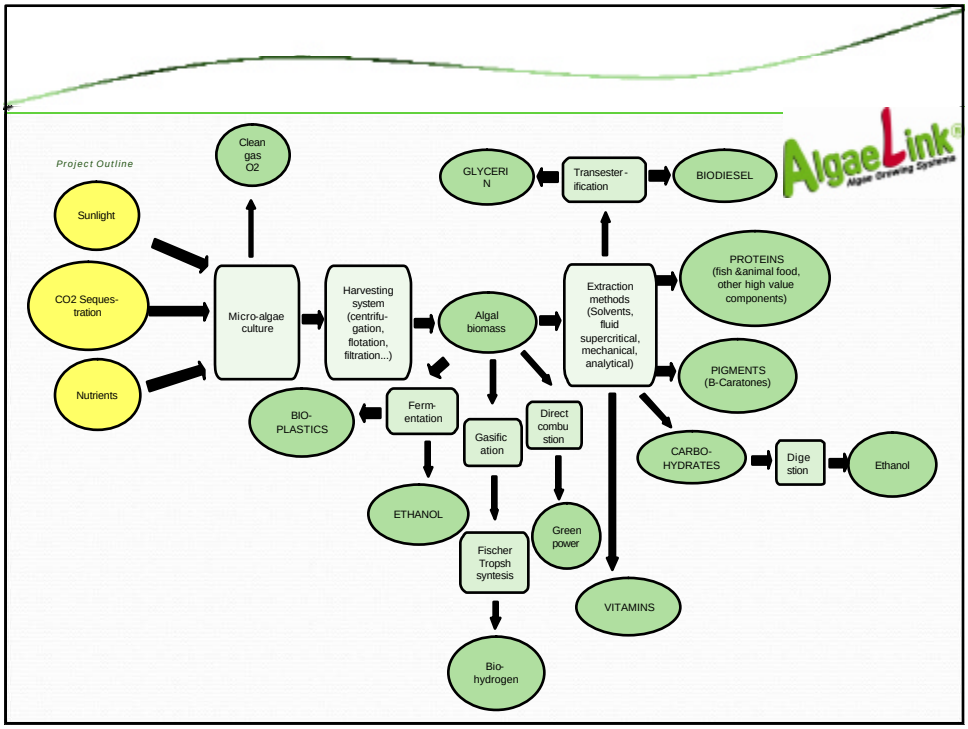
- Pre-combustion;
- Post-combustion;
- Oxy-fuel combustion.

Project Outline



Project Outline





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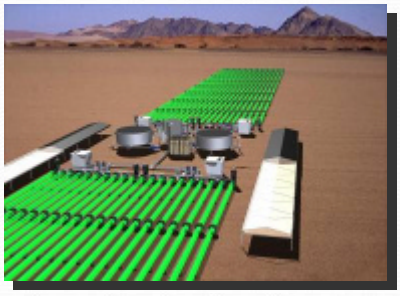
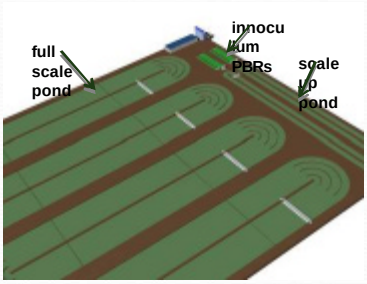
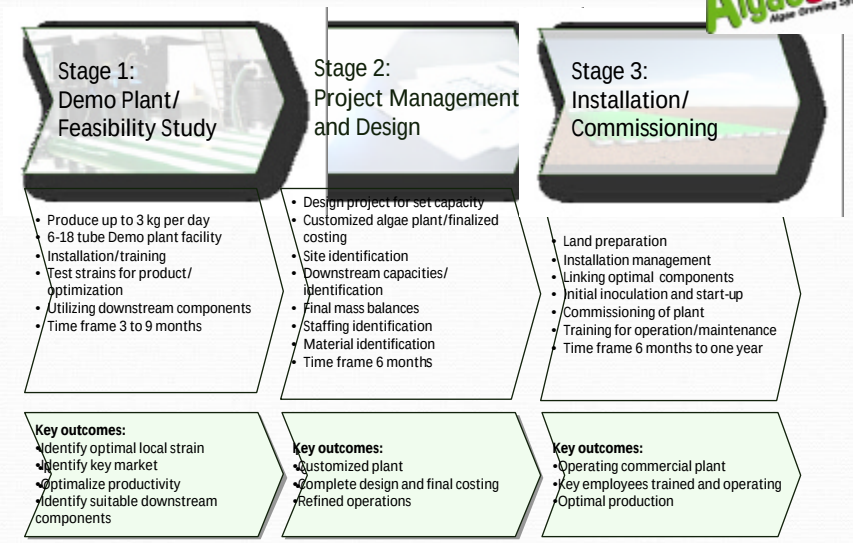
Commercial Systems – PBR or Hybrid





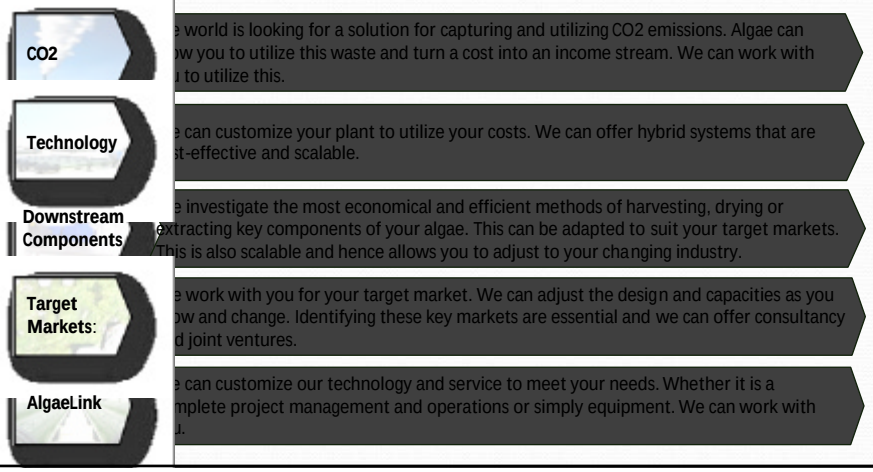
Project Stages



AlgaeLink

Optimizing your project

The key to your success is linking the right technology for your optimal performance and creating the optimal income streams.



AlgaeLink

Contact Details

Our Business is Helping Yours

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