bion Algae

Algae farmed, grown and harvested in Argentina

Business Plan
Executive Summary

Our Vision

To create automated systems for the production of energy and agricultural products that will revitalize earth, air, water and the economy.

Our Mission

To a build a profitable enterprise with minimal or negative carbon footprint while causing the least disturbance to natural systems. Our products are meant to improve existing industries by providing alternative energy, increased efficiency and to aid in the restoration of agro ecosystems.

Our scalable and extensible algae production systems will produce valuable carbon sequestration byproducts derived from bio char, algae and lignocellulose biomass. Deployment of our systems will provide long term employment for skilled and unskilled labor.

Executive Summary

In this day and age, carbon emissions and the greenhouse effect are two issues that the entire world is dealing with. One way that some have tried to resolve these issues is with the movement to implement sustainable living communities.

Sustainability

Sustainable living communities are much like any other community, as they contain homes and businesses, have many kinds of recreation, use business ideas and concepts, and can supply jobs and be profitable. However, sustainable living communities are unique in that they use all natural resources, are completely independent of outside sources, have low to no carbon footprint, and are highly efficient overall. Sustainable living communities are identified by six sustainability factors: jobs, food, energy, water, shelter, and infrastructure.

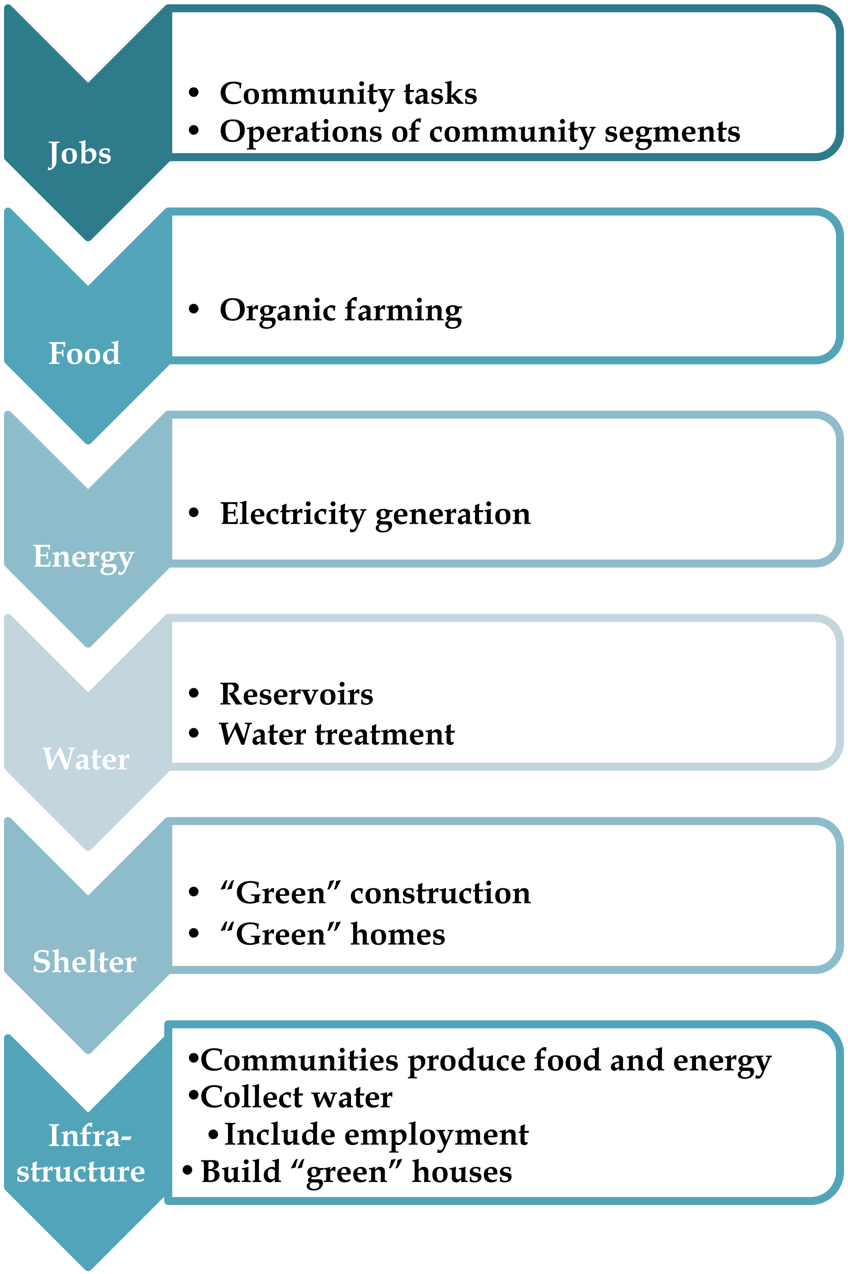
Fossil Fuels and Biofuels

The use of fossil fuels has become increasingly harmful in recent years. For one, the entire world is seeing a shortage in fossil fuels. With this, the resources that are used are now expensive and emit a great amount of carbon into the atmosphere. Part of the sustainable living community mission has been to use alternative fuel resources in an effort to rid the world of its dependence on petroleum and other fossil fuels. Amongst all the array of petroleum alternatives that have been discovered, biofuel (fuel sources produced from living organisms or metabolic by-products) is the most promising. Biofuel can be extracted from many different kinds of things, including corn, soybeans, jatropha, palm oil, sugar cane, and algae. Algae can produce almost four times as much fuel than the next-best crop for biofuel, palm oil. When using the single step process, a highly efficient refining procedure, algae biofuel could also be one of the simplest biofuels to cultivate. Algae biofuel's most major downside is that there is not enough technology to cultivate it, but, fortunately, there are many large companies, including Exxon Mobile that have researched and invested into it.

Implementation

bion Algae, a new company in the algae biofuel cultivation industry, will be implemented as a fuel source as well as a means of livelihood in sustainable living communities. Bion Algae will be marketed in South America, North America, Europe & Asia that value green living and also have temperate or humid climates with considerate rainfall. Its implementation will require a four-step process including recruiting residents as employees for cultivation and maintenance of the resources, developing plans for distribution of the final products, housing ongoing research and development, and recruiting investors to finance costs of initial capital needed. In going about these four steps, bion Algae will go through a "planning" and a "working" business process flow that will call for it to establish its plants, property and equipment, cultivate the algae crop, refine it, distribute it to the community and to Exxon Mobile, and perform continual research and development. In doing all of this bion Algae will have the potential to become the premier company of its kind in Argentina.

Sustainability Factors



The main factors taken into consideration by the members of sustainable living communities are jobs, food, energy, water, shelter, and infrastructure. The diagram to the left illustrates the various aspects of current sustainable community design.

In sustainable living communities (SLC) there are multiple factors to consider. SLCs often include farmland to provide a source of organically grown food for the community members. For energy, SLCs use some form of "green" energy. This means they have an electricity generation facility on site, which provides clean electricity to the SLC usually by either solar panels, wind turbines, or, if there is a quality flowing water source near by, hydropower. For water, most SLCs have reservoirs and a water treatment facility. These reservoirs collect rain water as well as any other excess run off and then the water is purified and distributed. Also, most SLCs include a water treatment facility in order to manage their waste. The majority of SLCs they provide "green" construction (meaning construction with the least amount of pollution and waste as possible). This process includes using recycled materials and more environmentally friendly equipment. Also, the people who live in SLCs maintain a "green" home. This includes using "green" products on a day to day basis as well as practicing energy conservation. Also, SLCs provide two variations of jobs. First, there are general everyday community tasks, this could include simply helping ones' neighbors, do some chores for them. Secondly, there are jobs involved in the operations of the community; these are the most important. They include working on the farm, in electricity generation, in construction, or in the water treatment facilities. These jobs are vital to the continual sustainability of the SLC. The overall infrastructure of these SLCs is based around communities producing their own organic food and "green" energy, collecting and purifying their own water, including employment opportunities within the community, and maintaining a green lifestyle by having "green" homes built by "green" construction.

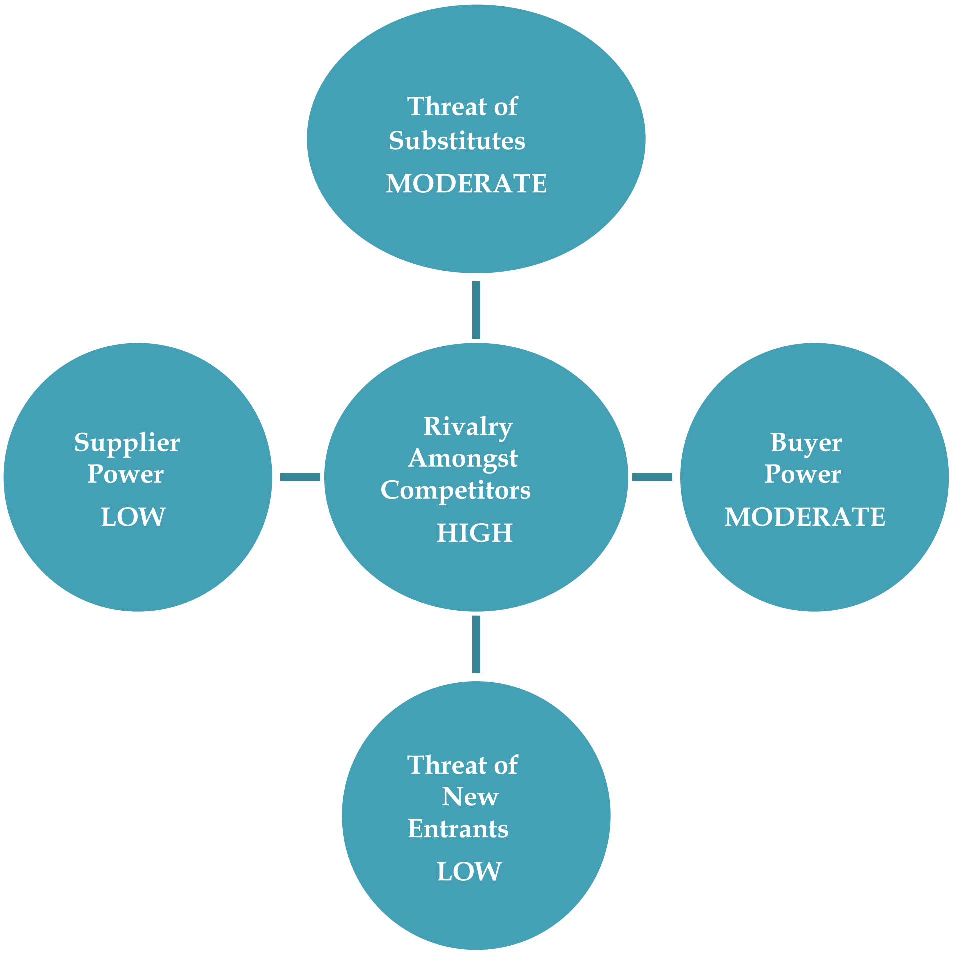
Porter's Five Forces

An analysis of the Porter's five forces model shows that the biofuel industry looks to be a relatively new market that has high potential for future profits. The rivalry among existing competitors in the industry is currently high. The idea of biofuel has been around for years, but in recent years market demand has greatly increased. Gasoline currently dominates the fuel market, but biofuels are becoming a substantial product that energy companies are seriously looking into for the future. These gasoline companies are the main competitors to companies in the biofuel industry because they hold a large portion of biofuel patents. The most promising forms of biofuel are corn, soy bean, and algae. The threat of substitute products and services in this market are moderate. With constant research on biofuels,

scientists are coming up with new and innovative ideas to replace gasoline in the future. There are many possible biofuel products that are being researched, and that have yet to be discovered, that could potentially be the leading producer of energy. However, algae biofuel seems to be the most promising in terms of oil yield and sustainability. The threat of new entrants into this market is low. There are already a small handful of fuel producing companies that control most of the market share. The initial costs of starting a biofuel company are also very

expensive. This pushes away potential investors. The supplier power in the biofuel industry is high. Like the oil industry, the main suppliers of the product are the sole decision makers of the price. Due to the constant demand and need for the product, buyers will have to abide by the price if they want the product. This leads to buyers having very low power when determining the price.

Each of these factors are extremely important in considering whether a company chooses to enter into this industry, although it is also crucial to analyze the advantages and disadvantages of doing so as well.



Overview of Implementations as a Business Process

As stated previously, there will be four major components to the planning and implementation stages of the algae biofuel business, including recruiting investors to finance costs of initial capital needed, recruiting residents as employees for algae cultivation and maintenance, plans for distribution of final products, and housing ongoing research and development. However, along with these four steps, a specific business process flow is needed in order to organize exactly how the business will operate.

The business process for this algae biofuel business has been divided into two major flows: a planning stage as well as a working stage. Both flows illustrate exactly what will occur before, during, and after each of the four steps is completed. More detail of these flows is listed below. For business process flows in chart form, please refer to the Appendix A for the planning stage, and Appendix B for the working stage.

The Planning Business Process Flow

Surveying: As explained in the Current Situation portion of Algae as a Biofuel, there is not yet enough technology available to extract the lipids from algae cells that would make it an excellent petro-oil alternative. With this, it is crucial that the first part of the planning stage funding and investing go towards initial research and development. Once enough R&D is made available to the algae biofuel products, our business could begin looking for an area suitable to use the technology in, and possibly even have the findings of the R&D patented.

Finding a suitable site for the algae biofuel business will rely on several aspects of the land itself. To review what was stated in the Implementation Overview, suitable land should be in a temperate or humid climate with significant rainfall. Also, the land, ideally, would not be completely flat, as it may be cost-efficient to dig a water body on land that already has depressions that easily collect water. Once suitable land is found, its price, along with other PPE pricing, will need to be negotiated and finalized. Upon finalization of pricing our company would hope to complete plans for the rest of the algae biofuel project, and begin recruiting employees to the fueling business.

While working through the surveying portion of the planning stage, the first two steps towards implementation of our business, recruiting investors to finance costs of initial capital needed, and recruiting residents as employees will be completed.

Advantages

Algae has great potential to become the biofuel of the future. Algae can be grown almost anywhere in the world and reproduces very quickly. The only resources that algae needs to grow are water, sunlight, and carbon dioxide. The plant does not require fresh water to grow. Due to algae's structure, it can produce 30-100 times more oil per acre than corn and soy beans (Renewable Energy Sources, 2008). This reduces the need for large, well-kept plots of land. Algae biofuel can be used in modern engines, thus new engines or parts are not needed for compatibility. In addition, there are many different methods of growing algae in water. These algae growing systems consume CO_2 emissions during the process of photosynthesis which increases their growth process. This means they can be placed near high CO_2 outputs, such as power plants and highly populated areas. While more research and testing is needed, the opportunities associated with algae biofuels seem endless. Algae could potentially be the primary source of fuel in the future, replacing gasoline as it becomes more and more scarce. It will provide a large number of jobs including research and development, growing and maintenance, processing, and distribution. Using algae instead of other alternative fuel sources can reduce pollution and deforestation, promoting ecological well being. Algae biofuel also has the potential to be used in other processes like controlling waste water in its growth process.

- **Easy to Grow**
- **Reduces CO_2**
- **High Oil Content**

Disadvantages

Although algae seems to be the perfect solution, there are still problems to overcome. First, the initial investment is very expensive. More research is needed to find the best and cheapest algae to biofuel conversion process. The current processes have too many steps involved, accompanied by large expensive machines. There is also the problem of finding the strand of algae that is most effective in producing the highest and most reliable oil. Scientists are also still trying to find the most effective way of growing this algae, which can be costly.

Algae looks to have a great potential to be the biofuel of the future. Other plants do not threaten to take the place of algae because their oil makeup simply does not measure up to algae's body oil content. A key threat is low funding to research that is needed to perfect the process. Another threat is that gas companies are the key patent holders of algae biofuel for the future.

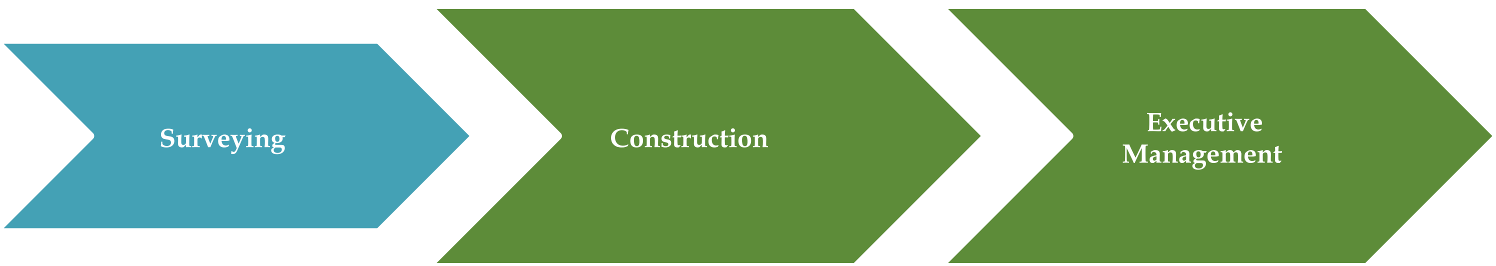
- **High Initial Cost**
- **More Research is Needed**
- **Processes Not Perfected**

Construction: Once initial plans are finalized, construction of all plants, property, and equipment can begin. This will include the digging of the algae location, constructing any factories, warehouses, offices, research centers, and allowing time for water to accumulate in the land. The construction takes time and money, but the overall value will be worth the investment.

Out of all the various ways to grow algae;

bion Algae will develop two plants, one for biodiesel research and production, and the other plant to grow and produce algae biomass because it is the most natural way to grow algae.

Executive Management: While construction is going on, the new elected board of executives should begin to meet. In the meetings prospective employees should be chosen and organized, and official policies and procedures for the business should be developed and finalized. They will come together to see that operations are being ran smoothly, and to the best ability they can be, the managers will work together so that not one person has all the control.



Once all of the executive members' planning decisions are made, and once construction is finished, this completes the planning stage. At this point, normal business operations for the algae biofuel project can commence. In the following, the "working stage" business process flow is explained.

Recruiting Residents as Employees for the Algae Biofuel & biomass business

Once bion Algae is past its planning stage, the sustainable living community will be responsible for its well being. In order to maintain the sustainability of bion Algae , all of the company's employees will have to come from within the community. Being that there will be so many aspects to bion Algae, many different kinds of employees of different backgrounds and abilities will be needed. Below sketches a breakdown of the desired workforce for bion Algae as well as what will comprise the working stage of the bion Algae business process flow. **(all this will be negotiable with future's Board of Directors)**

Cultivation

Treatment: The state of the water where the algae will be grown will need constant treatment and oversight to ensure optimal algae growth. Residents with backgrounds in environmental science would be most apt for employment in this area.

Facility Maintenance and Supervision: To protect the algae crop from outside dangers while ensuring that the algae fields do not harm any community members, water facility maintenance and supervision will need to be implemented. Residents with engineering, management or even law enforcement backgrounds could be considered for this kind of work.

Harvesting: Once the algae has grown, it will need to be transported from the water to the refinery somehow. Employees will be needed to operate machinery to effectively and efficiently harvest the ripened algae. **This kind of work may require physical ability of the employees**, **as well as an extensive understanding of the machinery they operate.**

Refining

At this stage of the manufacturing process, it is most likely that employees will be needed to transport the algae crop, and operate the machinery that will convert the raw algae to an actual biofuel. This stage will require employees who are physically able and have the ability to learn about the equipment they will be operating quickly. Once more research is done to clarify how algae will be converted into a biofuel, more employment positions can be specified. Each position will require training so that the employees to master their job to create the best algae biofuel possible. Bion Algae Will use bioreactor's systems to convert algae to biofuels.

Distribution

Community Distributors: Once the algae biofuel is ready for distribution, employees will be needed to transport the final product to fueling distribution stations. Other employees will be needed to run and manage these stations. This area of the algae biofuel business will not only need higher-level managers and efficiency specialists to ensure this process is completed optimally, but also lower-level clerks and drivers to complete the actual labor of the process.

Exporters: The algae biofuel sold to outside distributors will need to be regulated, managed, sold, and transported. Doing all of this will require a significant amount of employees that will focus just on the exportation of the algae biofuel. Some ideal employees for this area would be those experienced in management, finance, and sales. Also, just as in community distribution, lower-level clerks will be needed to operate machinery and transport fuel.
(Check Logistics File Attached)

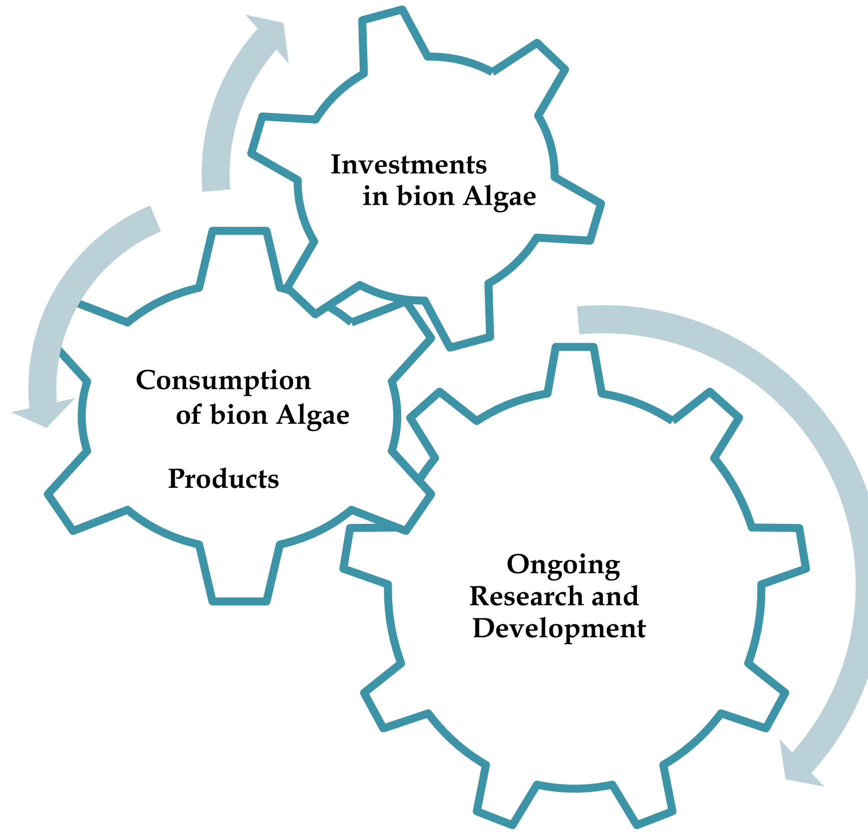
Research and Development

Researchers: As explained in the next several pages, research and development will be a vital part of the bion Algae business. Implementing a significant R&D department will require several highly-trained searchers. Ideally, residents with highly scientific, engineering, and research backgrounds would be most appropriate for this kind of work. For further information on these process, refer to York Argentina Group files..

Housing Ongoing Research and Development

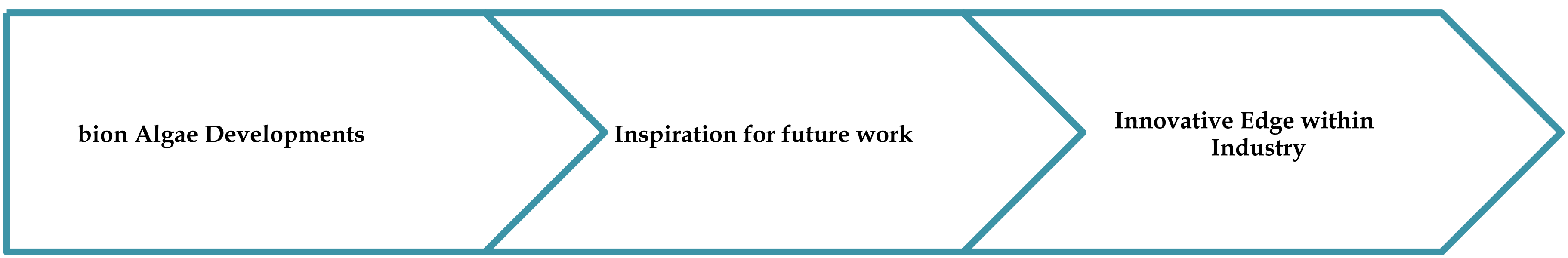
It is expected that bion Algae will be able to research algae biofuel continuously. To recall evidence from the Current

Situation section of this report, we will be researching algae biofuel just as other major oil companies have. Once enough research is completed to implement an initial algae biofuel refining process, the key to creating the best algae biofuel will be to constantly improve that process. It is our hope that Algae Unlimited will make these improvements constantly. In the best interest of investors and employees, bion Algae will tirelessly seek newer, more efficient, faster, and cheaper means to cultivate algae biofuel. All of these improvements will allow consumers of the algae biofuel to greatly benefit from the endless possibilities of the budding algae biofuel market.



Being that algae biofuel is such a new product, the ongoing research and development that bion Algae will perform will

be crucial. We anticipate bion Algae to be one of the frontiers in the algae biofuel. With this, the research that comes of the bion Algae operation will set the path for the entire industry. Additionally, bion Algae constant development will give it an innovative edge, making it very appealing to potential investors and major oil companies that may purchase bion Algae products.



Cost of Implementation

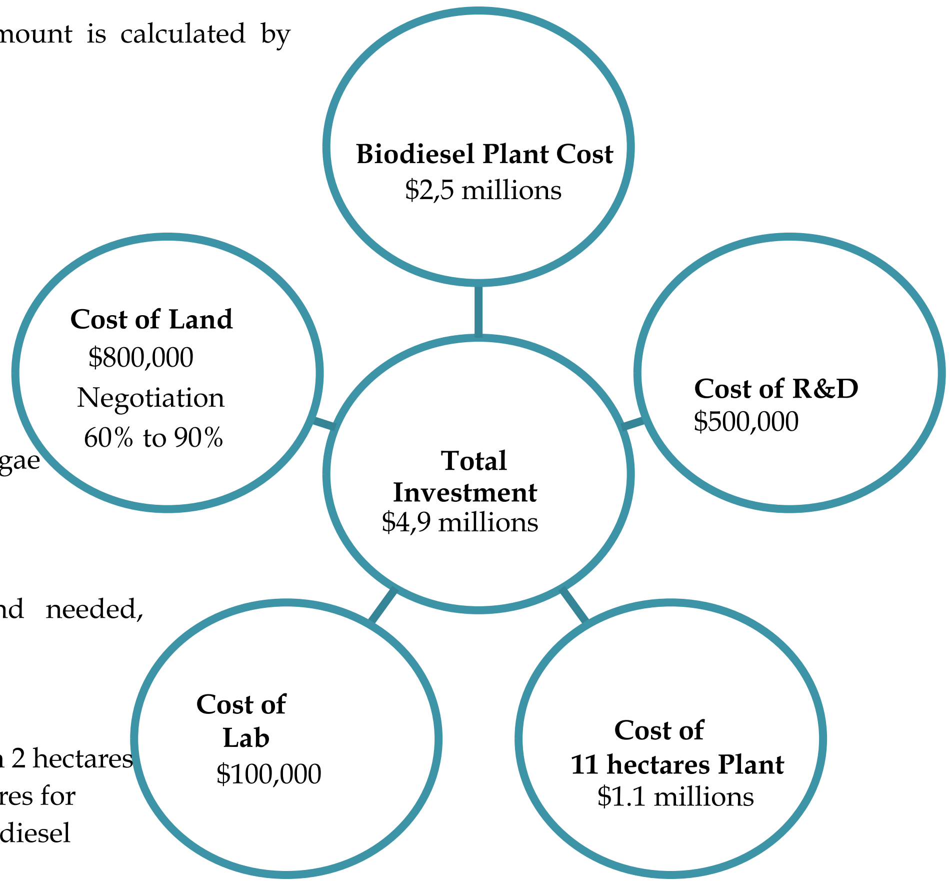
The implementation of this full equipped system (two plants) would require an initial investment of $4,9 million. This amount is calculated by combining the cost of research and developing the new technology, the cost of the physical machinery, the cost of training employees, cost of the construction of structures along with algae ponds needed, and the cost of the land. The cost of researching and developing the new technology necessary for our machine, to not only create oil from algae, but also refine the oil to output biofuel, will cost an estimated $ 100,000 The cost of the physical machinery was estimated based on a combination of cost of

comparable sized bioreactors and cost of refining equipment. The comparable sized bioreactor would cost approximately $3 millions The cost of construction of the facilities to house the machinery and the algae ponds were estimated based on costs of constructing similar sized refineries and digging cost. The cost of construction is estimated to be $100.000 thousands per hectare ($1,1 million/11 hectares). The cost of the land was calculated by determining the amount of land needed, 45 acres, so the cost of the land came to a total of $800,000 (18 hecatres/45 acres).

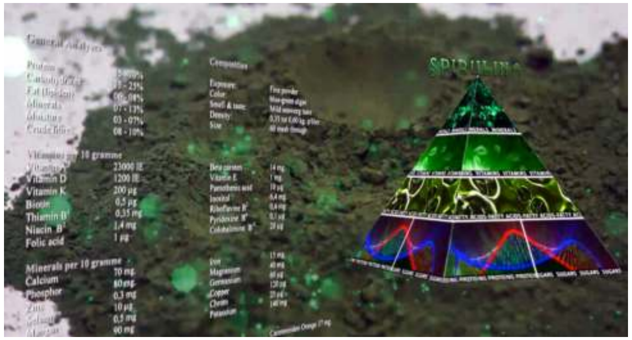
On the initial investment will be for the construction of two plants, one on 2 hectares (biodiesel production plant), and the other Greenhouse Plants on 11 hectares for Indoors Raceways ponds & facilities. Leaving 6 hectares for a scale up biodiesel production or **Algae Bio refinery Facility.(see info below)**

Note: this initial investment is for a full equipped plants, we could start with only $750,000 thousands for two pilots plants. Adding land value will require $ 1.550.000 M

Factors of Total Investment



11 hectares bion Algae Plant:
Generating a Profit



The capacity of this algae production facility on 11 hectares will be

200,000 kilos of dry algae biomass products per year.

Spirulina, Chlorella Vulgaris & Dunaliella Salina biomass will be the main production.
The average sales of this algae's per kilo is between $50 to $2000
Spirulina sales are bewteen $50 to $120 per kilo depending Countries
Markets. (Health)
Chlorella Vulgaris sales are between $80 to $220 per kilo.(Health & Biodiesel)
Dunaliella Salina Powder sales are between $225 to $2000 per kilo. (Health & Pharmaceuticals)

Example:
Spirulina 200.000 kilos facility (target sales per year)

$50 − $7 = $43 − $180,600 = $8.419.800 millions

Sales Price (minimum) | Operational cost | Before Tax Profit | **Taxes (21%)** | After Tax Profit

All figures(usd) are based on amounts per kilo sold

Initial Investment
$4,9 millions

Year 2

Annual Net Income
$1,019,400
million

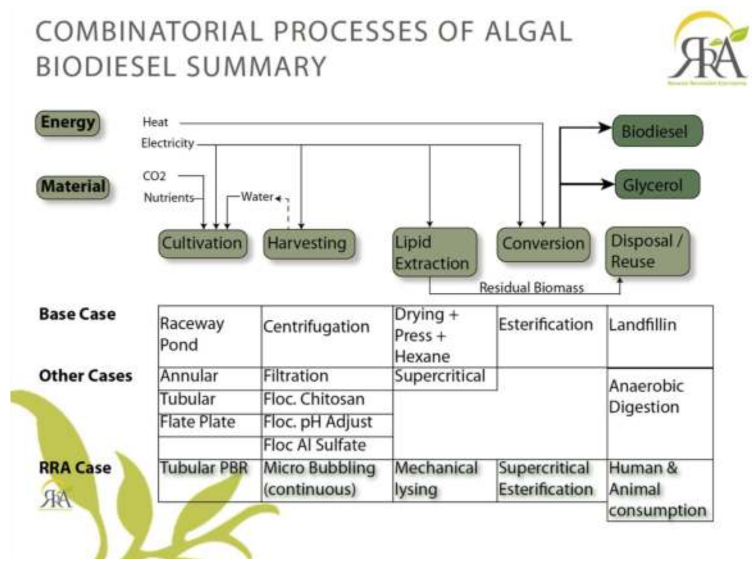
2 hectares bion Algae Biodiesel Plant: Generating a Profit

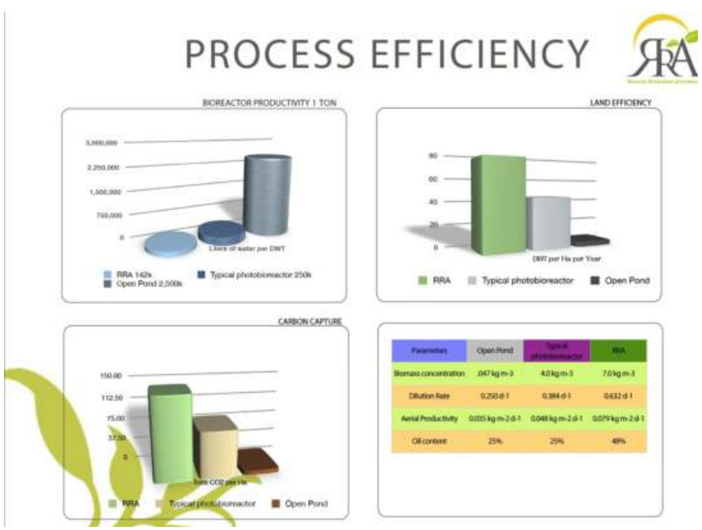
The capacity of this algae production facility on 2 hectares will be

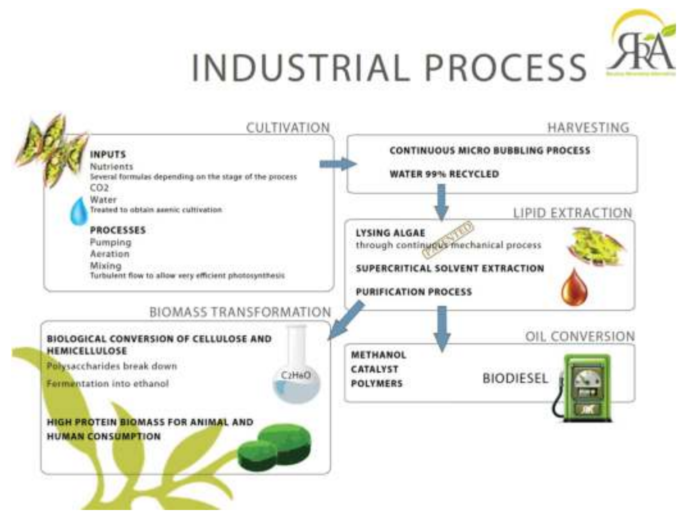
200,000 tons of algae oil per year. Sale price per ton today:

Between $1500 to $3000

Productivity: 100,000 ton/ha year
Lipid concentration: 35%/wt biomass
Biodiesel yield: 39.500 L/ha
Capital costs: $112.400/ha
Fuel operating costs: $39.300/ha



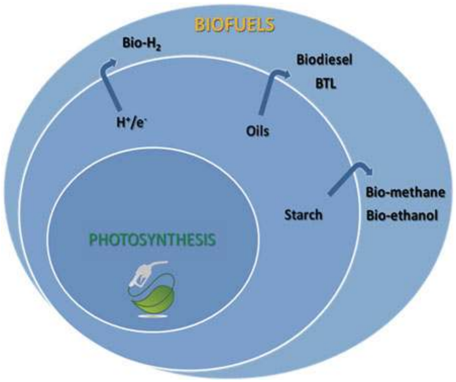


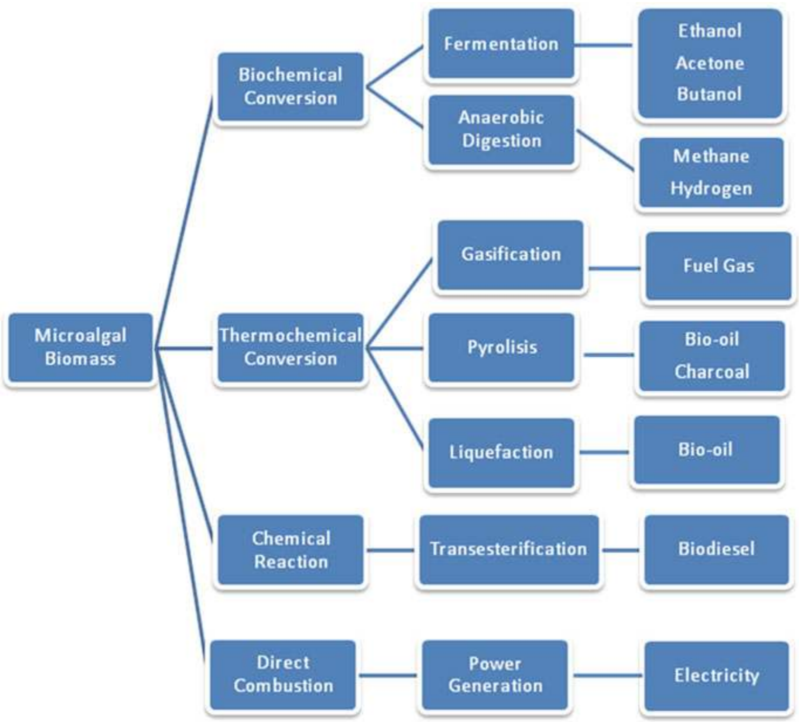


The rule of photosynthesis in biofuel production

Algae strains Carbohydrates (%/wt biomass)

Scenedesmus obliquus 10–17
Scenedesmus dimorphus 21–52
Chlamydomonas reinhardtii 17
Chlorella vulgaris 12–17
Chlorella pyrenoidosa 26
Spirogyra sp. 33–64
Dunaliella bioculata 4
Dunaliella salina 32
Euglena gracilis 14–18
Prymnesium parvum 25–33
Tetraselmis maculate 15
Porphyridium cruentum 40–57
Spirulina platensis 8–14
Spirulina maxima 13–16
Synechoccus sp. 15
Anabaena cylindrical 25–30





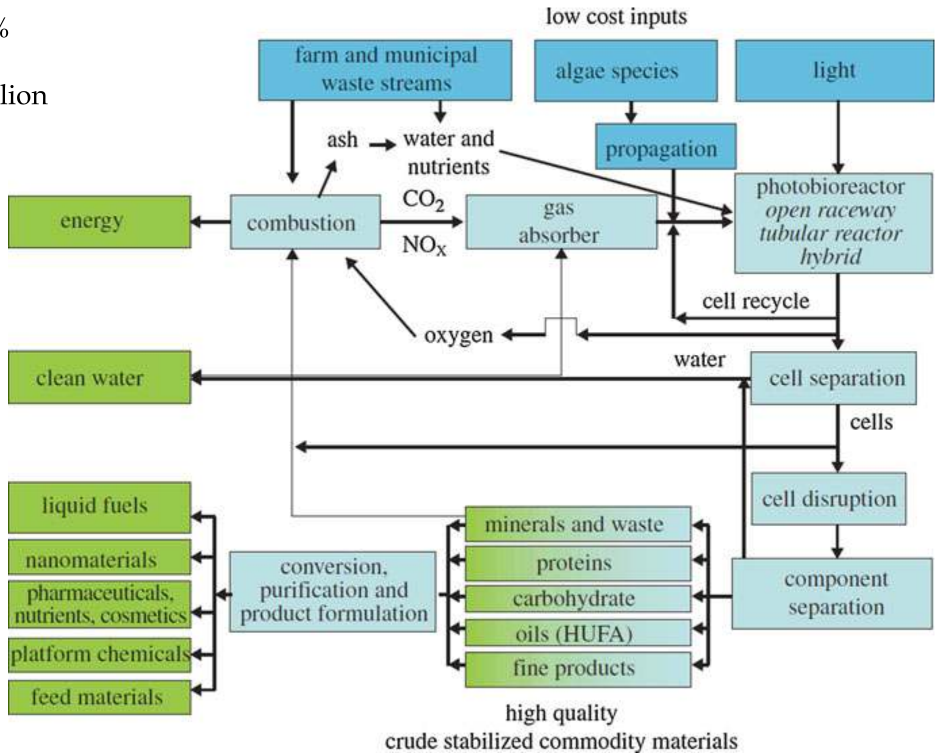
Energy production by microalgal biomass conversion using biochemical, thermochemical, chemical and direct combustion processes

Biofuel potential in 2014 (billion gallons)

Total oil consumption in 2014	1,500
Total projected supply by traditional biofuels	41
Total ethanol production in 2014	26
Total biodiesel production in 2014	15
Share of traditional biofuels in total oil consumption	2.73%
Projected market size for traditional biofuels	$123 billion

Assumption: one gallon of oil = $3

From the above table, it is clear that even by 2014, less than 3% of total fossil fuels will be replaced by biofuels from traditional sources.
Even this small percentage represents a market share of over $100 billion.
Algae have the potential to replace a much higher percentage of fossil transportation fuel than traditional feedstock.
This implies that fuel from algae represents a market share that is worth hundreds of billions of dollars.



Schematic of a microalgae biomass biorefinery concept based upon the production of several products from waste materials allowing their complete utilization, such as liquid fuels,
commodity chemicals and materials for high-value formulated products (Greenwell et al. 2010)

Microalgae Biodiesel Graphics

Feature	Open systems	Closed systems
Cultivation		
Area-to-volume ratio	Large (4–10 times higher)	Small
Algal species	Restricted	Flexible
Species selection	Growth competition	Shear-resistance
Contamination	Possible	Unlikely
Cultivation period	Limited	Extended
Water loss through evaporation	Possible	Prevented
Controlling of growth conditions	Very difficult	Easy
Light utilization efficiency	Poor/fair	Fair/excellent[a]
Gas transfer	Poor	Fair/high
Temperature	Highly variable	Required cooling
Temperature control	None	Excellent
Automatic cooling system	None	Built in
Automatic heating system	None	Built in
Cleaning	None	Required due to wall growth and dirt
Microbiology safety	None	UV
Harvesting efficiency	Low	High
Biomass production		
Biomass quality	Variable	Reproducible
Biomass productivity	Low	High
Population density	Low	High
Operational mode		
Air pump	Built in	Built in
Shear	Low	High
CO_2 transfer rate	Poor	Excellent
Mixing efficiency	Poor	Excellent
Water loss	Very high	Low
O_2 concentration	Low due to continuous spontaneous out gassing	Exchange device
CO_2 loss	High	Low
Economics		
Land required	High	Low
Capital investment	Small	High
Periodical maintenance	Less	More
Operating cost	Lower	Higher
Harvesting cost	High	Lower
Most costly parameters	Mixing	O_2, Temp[a] control
Scale up technology for commercial level	Easy to scale up	Difficult in most PBR models

[a] Dependent on transparency of construction material

Source	Ethanol yield (L/ha)	References
Corn stover	1,050–1,400	Tabak (2009)
Wheat	2,590	Cheryl (2010)
Cassava	3,310	Cheryl (2010)
Sweet sorghum	3,050–4,070	Lueschen et al. (1991); Hills et al. (1983)
Corn	3,460–4,020	Tabak (2009)
Sugar beet	5,010–6,680	Hills et al. (1983); Brown (2006)
Sugarcane	6,190–7,500	Brown (2006)
Switch grass	10,760	Brown (2006)
Microalgae	46,760–140,290	Cheryl (2010)

Microalga	CO_2 (%)	Temperature	Biomass productivity (g/L day)	CO_2 fixation rate (L day)
Chlorococcum littorale	40	30	N/A	1.0
Chlorella kessleri	18	30	0.087	0.163[a]
Chlorella sp. UK001	15	35	N/A	>1
Chlorella vulgaris	15	–	N/A	0.624
Chlorella vulgaris	Air	25	0.040	0.075[a]
Chlorella vulgaris	Air	25	0.024	0.045[a]
Chlorella sp.	40	42	N/A	1.0
Dunaliella	3	27	0.17	0.313[a]
Haematococcus pluvialis	16–34	20	0.076	0.143
Scenedesmus obliquus	Air	–	0.009	0.016
Scenedesmus obliquus	Air	–	0.016	0.031
Botryococcus braunii	–	25–30	1.1	>1.0
Scenedesmus obliquus	18	30	0.14	0.26
Spirulina sp.	12	30	0.22	0.413[a]

[a] Calculated from the biomass productivity according to equation, CO_2 fixation rate = 1.88 × biomass productivity, which is derived from the typical molecular formula of microalgal biomass, $CO_{0.48}\ H_{1.83}N_{0.11}P_{0.01}$ (Chisti 2007)

Table 1 Comparison of microalgae with other biodiesel feedstocks (Chisti 2007; Mata et al. 2010)

Plant source	Seed oil content (%/wt biomass)	Oil Yield (L/ha year)	Land use (m^2 year/kg biodiesel)	Biodiesel productivity (kg/ha year)
Corn/maize (*Zea mays* L.)	44	172	66	152
Hemp (*Cannabis sativa* L.)	33	363	31	321
Soybean (*Glycine max* L.)	18	636	18	562
Jatropha (*Jatropha curcas* L.)	28	741	15	656
Camelina (*Camelina sativa* L.)	42	915	12	809
Canola/rapessed (*Brassica napus* L.)	41	974	12	862
Sunflower (*Helianthus annus* L.)	40	1,070	11	946
Castor (*Ricinus communis*)	48	1,307	9	1,156
Palm (*Elaeis guineensis*)	36	5,366	2	4,747
Microalgae (low oil content)	30	58,700	0.2	51,927
Microalgae (medium oil content)	50	97,800	0.1	86,515
Microalgae (high oil content)	70	126,900	0.1	121,104

Algal Bio refinery Strategy (Important)

The term biorefinery was coined to describe the production of a wide range of chemicals and biofuels from biomasses through the integration of bioprocessing and appropriate low environmental impact chemical technologies in a cost-effective and environmentally sustainable manner (Li et al. 2008).

The microalgal biomass biorefinery concept is not new; however, it assisted in making biofuel production economically viable. An algal biorefinery could potentially integrate several different conversion technologies to produce biofuels including biodiesel, green diesel, green gasoline, aviation fuel, ethanol, and methane, as well as valuable co-products, such as fats, polyunsaturated fatty acids, oil natural dyes, sugars, pigments (mainly **b** -carotene and astaxanthin), antioxidants and polyunsaturated fatty acids (EPA, DHA).

Conceptually, the biorefinery would involve sequentially the cultivation of microalgae in a microalgal farming facility (CO2 mitigation), extracting bioreactive products from harvested algal biomass, thermal processing (pyrolysis, liquefaction or gasification), extracting high-value chemicals from the resulting liquid, vapor and/or solid phases, and reforming/upgrading biofuels for different applications (Li et al. 2008).

After oil and/or starch removal from the microalgal biomass (for biodiesel and/ or ethanol production, respectively), the leftover biomass can be processed into methane or livestock feed, used as organic fertilizer due to its high N:P ratio, or simply burned for energy cogeneration (electricity and heat) (Wang et al. 2008).

The high-value bioactive compounds could be used in nutritional supplements, food/feed additives, aquaculture, cosmetics, pharmaceuticals, biofertilizers, edible vaccines through genetic recombination (Chisti 2006 ; Rosenberg et al. 2008) and pollution prevention. Microalgae play an imperative role in bioremediation and wastewater treatment. They can eliminate heavy metals, uranium and other pollutants from wastewater, and they can degrade carcinogenic polyaromatic hydrocarbons and other organics. Furthermore, algae are accountable for at least 50% of the photosynthetic biomass production in our planet and they are great sources of biofuels (Chisti 2006).

Nevertheless, several authors (e.g. van Harmelen and Oonk 2006 ; van Beilen 2010 ; Park et al. 2011), point that only if the algal biomass is a by-product of wastewater treatment systems, GHG abatement and/or of the production of highvalue compounds, such as astaxanthin, **b** -carotene, EPA and DHA, commercially viable energy production from algal biomass might be feasible.

Mussgnug et al. (2010) proposed another approach for the microalgae producers of H2 . The cells, response to the induction of H2 production cycle is the strong increase of starch and lipids (high fermentative potential compounds), which results in an increase in the biogas production (second step), after a first step of H2 production, showing a synergistic effect in a biorefinery concept.

A microalgae biomass biorefinery proposed by PetroAlgae company is represented in Fig. , whereas the one projected by Greenwell et al. (2010) is shown in Fig. where little or no waste products are present and allows for residual energy capture, recycling of unused nutrients, and water purification and recycling. This system would mean low environmental impact and maximization of the value of products from the system (Greenwell et al. 2010).

Subhadra and Edwards (2010) stated that is would be better to integrate a renewable energy park (IREP) where the facilities are centralized, instead of a single central facility, such as giant petroleum refineries operated by a single firm.

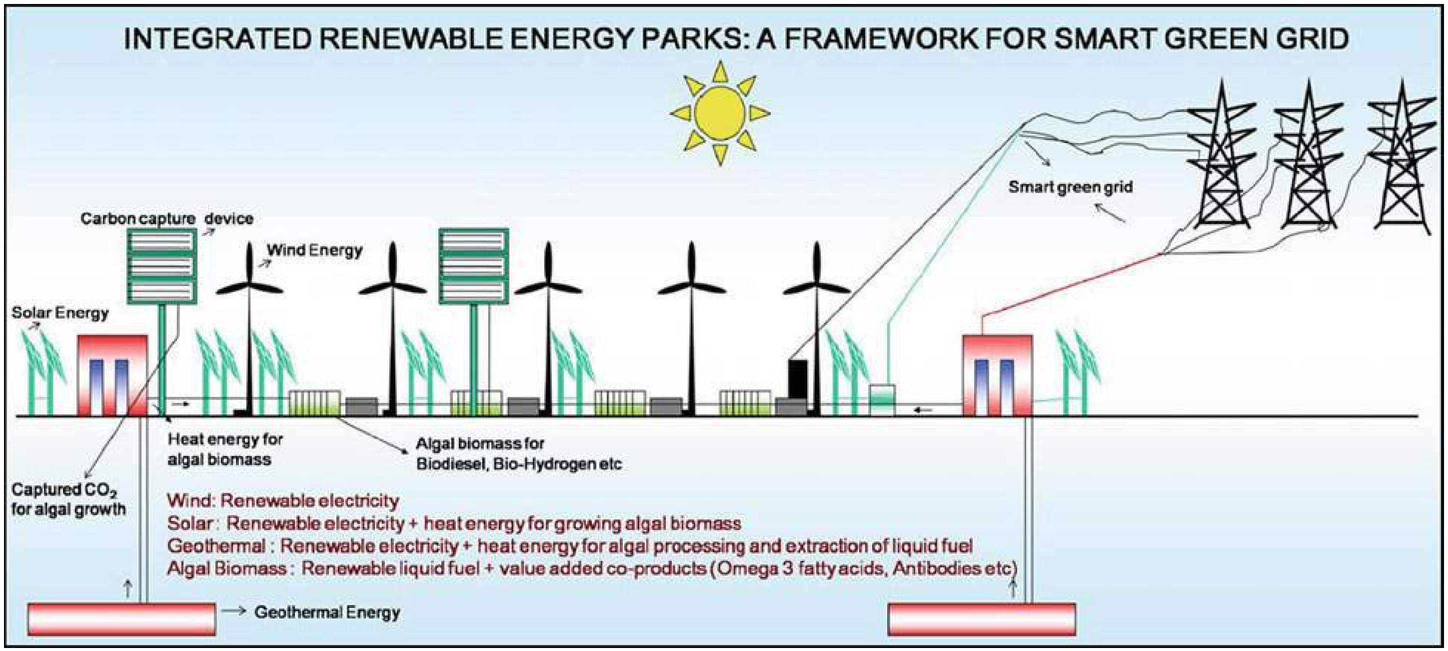
Major firms can be a part of IREPs and might play an important role in the development of this concept. However, other small-scale renewable energy (wind, solar, geothermal and biomass) firms, working as a consortium, may also be an integral component of IREPs. Together, these firms can cross-feed power, heat, raw materials and products with the shared goal of minimizing emissions to the atmosphere and optimizing the utilization of natural resources such as land, water and fossil fuels, and fossil agricultural chemicals.

The integration of established prototype carbon capture devices, which feed algal cultures, should also be examined (Fig. 18). Several novel green technologies such as geothermal heat pumps (Dickinson et al. 2009), dual fuel (bivalent) ground source heat pumps (Ozgener and Hepbasil 2007), solar-assisted heat pump systems,

solar wind turbine (which harvest wind and sun energy in one element) have been receiving increased attention because of their potential to reduce primary energy consumption and thus reduce GHG emission. Further, newer energy conservation and utilization concepts such as bioheat from wood (Ohlrogge et al. 2009), bioelectricity from biomass (deB Richter et al. 2009) and hybrid hydrogen–carbon process for the production of liquid hydrocarbon fuels (Agrawal et al. 2007) can also be envisioned into the broader design concept of IREPs. Together, these technologies and concepts can maximize the ecological and environmental benefits of energy production from IREPs. The green electricity from these IREPs may flow into the existing grid (Fig. 18).

OriginOil (2010) proposed an integrated system called Optimized Algae Production System (Fig. 19) where the first step is a low-pressure Quantum FracturingTM. It works by breaking up carbon dioxide and other nutrients into micronsized bubbles and infusing them into the growth vessel. The growth occurs in OriginOil's Helix BioReactorTM, which features a rotating vertical shaft of low energy lights (highly-efficient LEDs) arranged in a helix or spiral pattern are tuned precisely to the waves and frequencies for optimal algae growth. They claim that in the Cascading ProductionTM and Single-Step ExtractionTM, the oil and biomass are separat without having to dewater the algae, and the continuous process is called Live ExtractionTM.

Algal Bio refinery Strategy



Integrated renewable energy parks: a frame work for a ‘‘smart green grid’’ with net zero carbon emission (Subhadra and Edwards 2010)

Algal Bio refinery Strategy

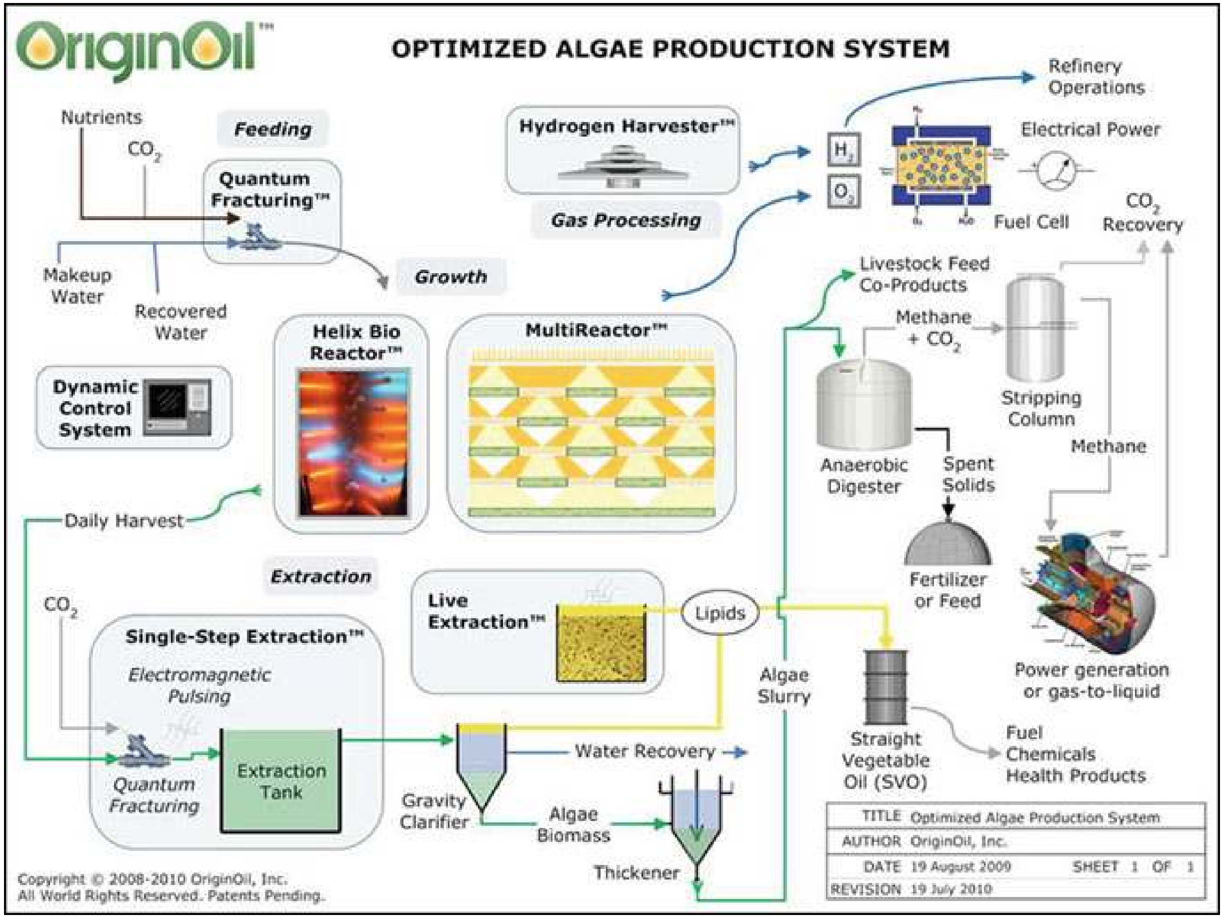


Fig. 19 Optimized algae production system (OriginOil 2010) (http://www.originoil.com). Photo courtesy of OriginOil Inc

Geographic "Sweet Spot"

- Almost perfect growing environment
- Moderate temperatures
- High duration and intensity of sunlight

- Low labor costs
- Convenient rail and highway access
- Location near port, wastewater, Ocean, river, CO_2 companies & highway

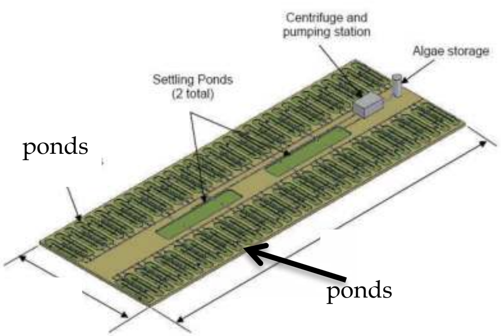
Plants:

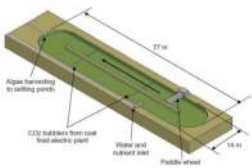
bion Algae

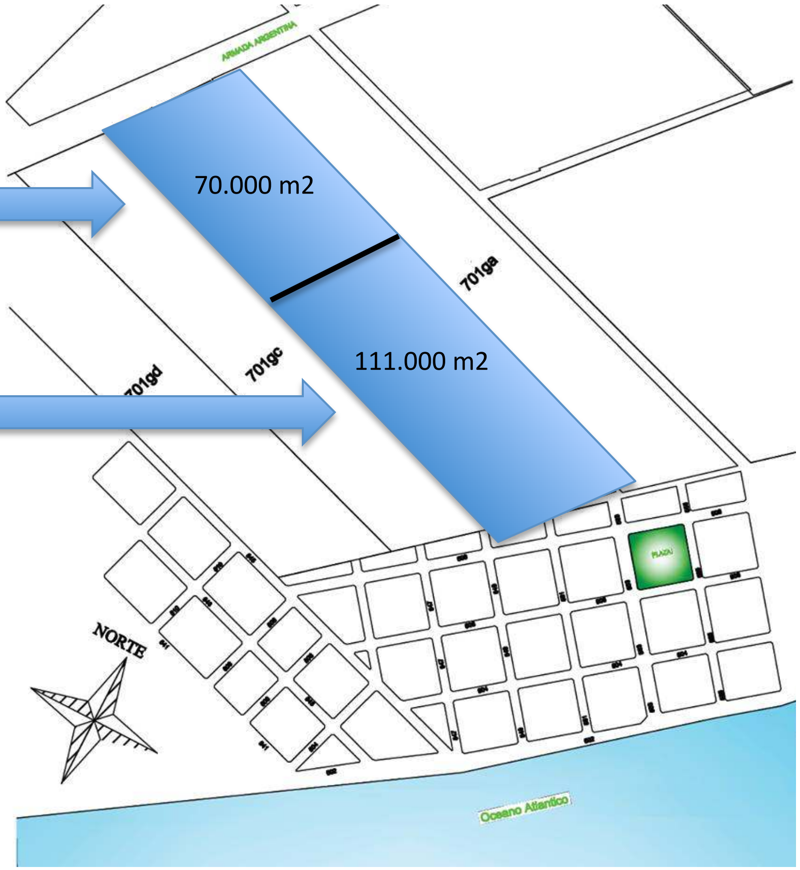
20.000 m2

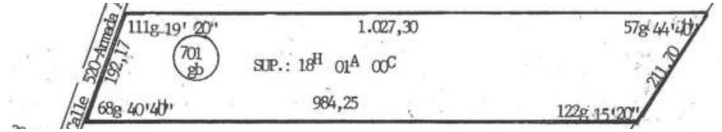
bion Algae

111.000 m2









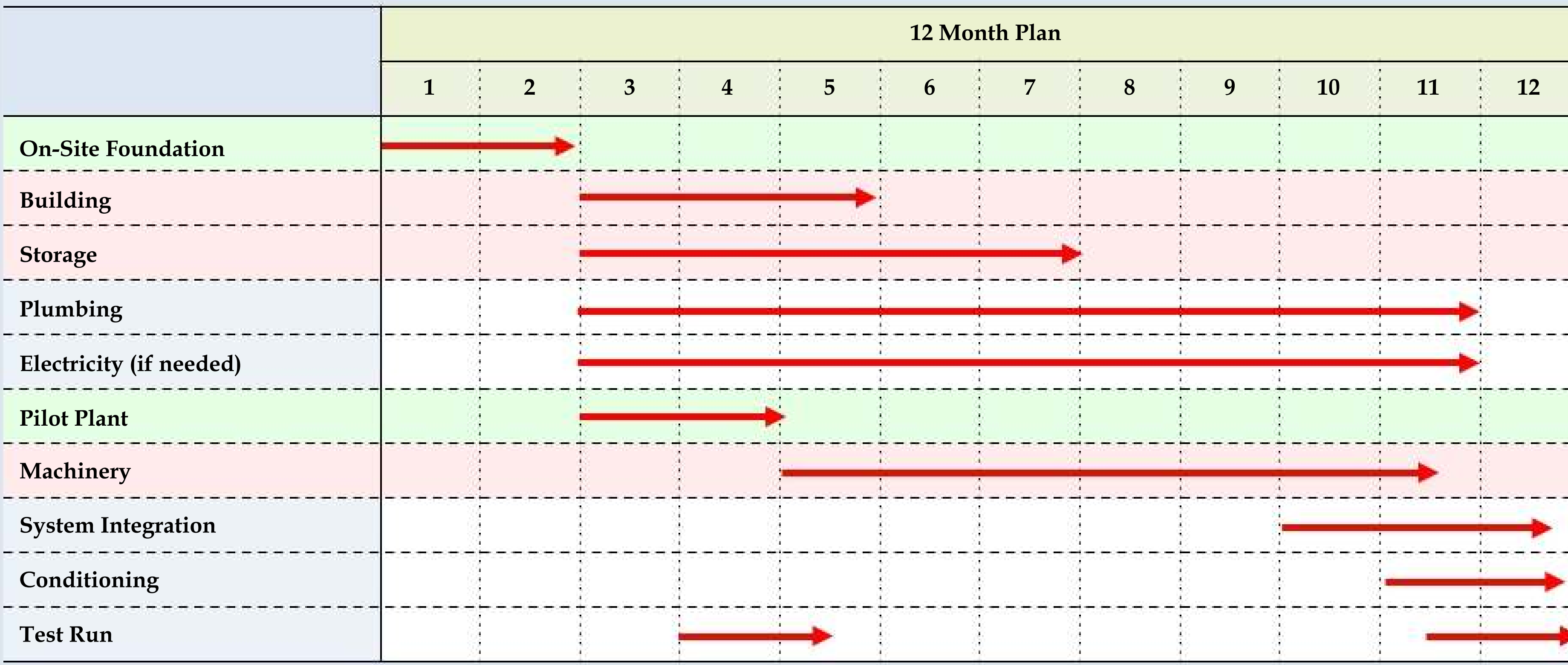
Land: 180.000 m2 total

Facility Overview

- Algae oil production plant & Algae plantation
- 200.00 tons/year of algae oil production capacity
- Oil plant, power plant & Biodiesel on 20,000 m^2 land size
- Greenhouse plantation/Lab on 111,000 m^2 land size
- Location near port, wastewater, Ocean, river, CO2 companies & highway

Time-Frame for Facility

Year 1 Schedule



- Set-up pilot plant to optimize production condition
- Construct 200 tons/day algae oil production system

R & D Expansion

	Year2	Year3	Year4	Year5
Investment Amount	US$500,000	US500,000	US$500,000	US$2,000,000
	•amortize 2% of sales revenue to R&D every year			

R&D Scientist Addition (6 persons total)

Ph.D in Chemical Engineering, Chief researcher	1 person
Ph.D in Chemical Engineering, Senior level researcher	1 person
MS in Chemical Engineering, Junior level researcher	1 person
MS in Chemical Engineering, Associate level researcher	2 persons
BS in Chemistryor C.E, researcherwith at least 3 yearsof experience	1 person

- **Total US$3.5 million investment on R&D over 4 years**
- **Main objective of R&D: improve and develop highly efficient algae reproduction process**
  improve and develop highly efficient algae oil extraction process
  improve and develop highly efficient algae oil purification process

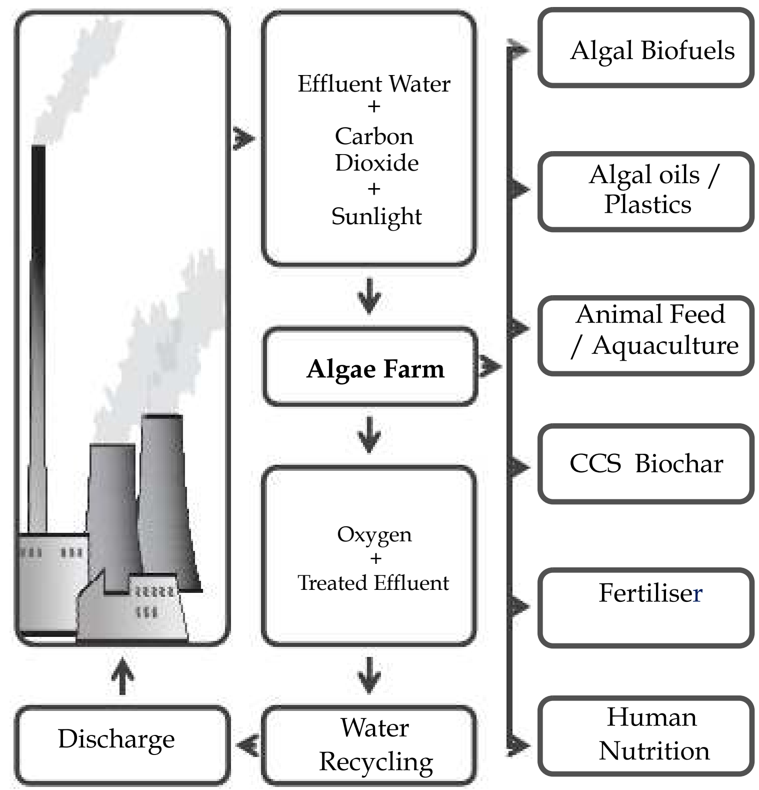
In very simple terms, here's how it works:

- bion Algae will capture emissions at the-smokestack, cool them and pipe them into growth membranes.

- The waste water is infused with the waste smokestack emissions.

- local strains of algae are introduced into this carefully controlled environment.

100% of the algae is then sold as biomass, oils, feeds and food.

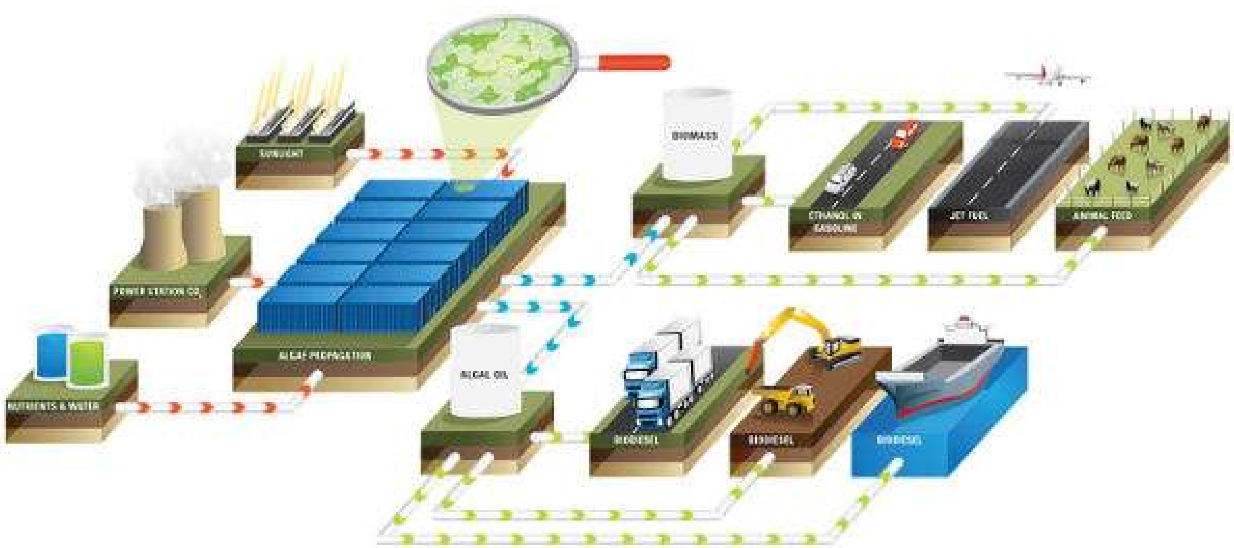


"Algae is the only organism that converts CO_2 to oil."

Unique Initial & Future Products

bion Algae Fuel (Division)

- Biofuels (biodiesel, alcohols)
- Lubricants for diesel fuel
- Jet Fuel
- Ethanol



Proprietary Manufacturing Process

- Algae are cultured in a sterilized, fertilized, saline groundwater within proprietary bioreactors.
- A fresh "crop" is harvested every 24 hours using proprietary techniques.
- Algae paste biomass is dried/packaged for sale or processed to extract oils and other valuable compounds.

Markets & Marketing

- Market demands for omega-3 fatty acids exceed current industry production capacity:
  - Current world demand = $4.6 billion U.S.
  - 2014 estimate = $8.2 billion U.S.
- Many current market suppliers of omega-3s are experiencing over 20 percent annual revenue growth for algae-based ingredients in food and nutritional products – with premium prices paid for the purest products

Markets & Marketing

Brand-within-a-Brand Marketing Strategy

- Applied to products whenever possible (e.g. CocaColaTM with NutraSweetTM)
- Distributed through major nutritional supplement companies as base ingredients for their products
- Sold in bulk to food-product manufacturers (e.g. General Mills)
- Use of strong agency relationships
- Use of multiple distribution channels

bion Algae

CO_2 to energy Process Summary

Sunlight

Waste Nutrient

N, P, K, S
- Sewerage
- Waste from feedlot
- Waste water

Supplemented with
- Commercial fertiliser

CO_2 Emitter

Greenhouse gases collected at the base of the chimney and piped to bion Algae Farm. (CO_2 NO_x SO_x)
- Power Plant
- Gas Plant & Refineries,
- Cement Kiln,
- Cargill Facility,
- Other processes

bion Algae Farm

Land (great location)

Each million tonnes of CO_2 e sequestered produces the following outputs:

550,000 tonnes of algae:
- 180,000 tpa algae oil
- 370,000 tpa nutritious livestock feed

O_2 H_2O

Algae Oil (1/3rd)

Oil Options Include

Biodiesel Production

Plastic Production

Jet fuel, other fuels

Algae Meal (2/3rd)

Meal Options Include

Feed for livestock industry

Feed for fertilser

Biomass for bio-plastic production

Biomass for electricity production

Key consumption / output rates
- 100%of algae used as value added product
- Typically, 1 tons $C0_2$ emitted per MWhr generated
- Require ~2 tons of $C0_2$ per 1 tonne of algae grown

Figure: In the context of climate change and changing patterns of rainfall, the decrease of runoff water may put at risk large areas of arable land. The map indicates that some of the richest arable regions (Europe, United States, parts of Brazil, southern Africa) are threatened with a significant reduction of runoff water, resulting in a lack of water for rain-fed agriculture.