



CarboRock business plan 2015

Company purpose

The CarboRock company's mission is to develop an industry with a negative CO₂ balance, world wide. The carbon negative industry unique value proposition is to compensate CO₂ in a quantitative, transparent and lucrative manner.

CarboRock will be selling an entire industrial ecosystem that reproduces a natural carbon sink. This ecosystem includes the recycling of industrial waste to produce ZeroCarbon fertilizer, a new generation of algae farm using proprietary microPBR4D technology and a series of products for the applications of the specific raw material.

From problem to solution

It is currently not possible to have at the same time a physically guaranteed carbon compensation and an exposure to low price, carbon neutral, and organic raw material production, which is both safe and very effective.

CarboRock will sell a financial product that allows both a quantitative carbon compensation and an access to the sells of high value carbon neutral organic biomass, with a guarantee long term low buying price. The microPBR4D and ZeroCarbon fertilizer industrial system should obtain a good acceptance as it can solve practical problem for both industrial waste producers, farmers and could be adapted in many industrial context where CO₂ is wasted.

Currently industrial waste incinerators produce ashes that still need management and generate cost. Ashes from waste incineration have to be transported and deposited to a controlled landfill both of which generates significant cost.

The ZeroCarbon fertilizer production unit of CarboRock will take care of the cost of transportation and avoid the use of permitted landfill by taking in ashes as a raw material. For industrial waste incinerator, the CarboRock company will mean a cost reduction and an increased ecological balance.

Farms, especially those raising cattle, are increasing in size and farmers are faced with higher amount of manure and waste to treat. Biogas plants are an economical solution to reduce waste amount, generate green energy and reduce green house gas emissions. However the disposal of digestat can still be an issue because of demanding storage condition and legal limits for



nitrate disposal per surface. Furthermore the CO₂ generated during the process is a good quality raw material that is often wasted.

Farmers with a tailored made microPBR4D can solve their digestat storage and disposal problem, bring value to their CO₂ emission with an additional financial income. CarboRock microPBR4D will mean to farmer a final solution to their waste problem, a new source of reliable weather proof biomass production and an improved ecological balance.

MicroPBR4D can also be well adapted to be used in landfill context where they can reuse both CO₂ burned in methane flare and also reuse the polluted land in a more productive manner.

Road map

The road map has three main phases. The first phase is the production and sells of laboratory microPBR4D (1-2 years from seed money). The second phase will be to build an industrial pilot plant (4-5 years, from a second round of dilution) and test the different product made from these new raw material. The third phase will be to sell larger number of microPBR4D and its ecosystem through franchises and sells of financial product (6-7 years from last phase) to international market.

Why now

Climate change reality caused by CO₂ emissions from human activities has been more widely accepted in recent years. However, despite all the Kyoto promises, the CO₂ level increase has not stop at all, not even slowed down. At the same time, the political decision of the Swiss government to shut down all nuclear power plants has made the development of alternative energy source even more necessary.

Furthermore, addressing both the increase in high quality biomass demand due to world population growth and a reduction in global available resource in the climate change context, has made the need to find complementary biomass production system also necessary.

The climate change consequences are already been felt. For instance even climate change skeptics won't debate the acidification of the ocean due to increased CO₂ level. For instance the coccolithophore limestone shell are already showing visible sign of dissolution due to acidic water (source: CEREG). This could have serious implications on the carbon cycle. Indeed one of the biggest long term carbon sink might stop buffering our emissions as limestone formation becomes chemically impossible due to acidic water. Furthermore possibly due to climate change, a decrease of 6% in the net primary production (NPP) of photosynthesis in the oceans



has been observed during the last two decades (source: Watson Greg, a NASAGSFC researcher). This long term trend could jeopardize primary production of the ocean food chain.

Furthermore the demand for biomass such as lipid, protein and sugar are set to increase up to 70% by 2050 as the world population grows to 9.1 billion (source: FAO organization). At the same time, available cropland has been declining 20% -30% between 1961 to 1991 (source: World Resource Institute). This world wide trend is likely to continue as droughts, flooding and high winds could become stronger due to climate change. This link between extreme event strength and climate change is supported by available observational evidence in the North Atlantic (source:royalsociety.org).

The time to start an artificial carbon sink based on energy positive microPBR4D that guarantee a weather proof primary production from our polluting waste has come.

Large size markets

The carbon offset market was evaluated in 2010 at around 144 billions by the world bank. To have an idea of the dynamics of the markets since 2010, one can observe the evolution of the sub market of carbon offsets from forest preservation, which had a compound annual growth rate of 9.2 percent. (source: Environmental Leader). The CarboRock financial product backed by microPBR4D is an investment that is diversified in the carbon offset business and in the production of several carbon neutral and organic raw materials. This diversification gives a long term protection as the fossil hydro carbon use as an energy source might be fading away, as competing technology and tougher carbon regulations comes into place due to climate change pressure.

The CarboRock microPBR4D need to be integrated into an industrial ecosystem to have a negative CO₂ balance. One of the most attractive industrial ecosystem is using biogas plants. So the number of biogas plant gives a rough estimates of the total available market. Switzerland is one of the country with the highest installed capacity per million inhabitants. There are 147 active biogas plants divided between biogas plant in farm (96), industrial biogas plant (29) and in waste water plants (22) (source: mathieu Buchs, OFEN). In Europe there are 244 installations dealing with the organic fraction from the management of municipal solid waste (source: Luc De Baere, Bruno Mattheeuws, Anaerobic digestion of the organic fraction of MSW in Europe). If other countries in Europe join the leading countries in the amount of installed capacity per million inhabitants, the demand for more plant can be expected to grow in several countries during the next decade. Internationally the number of plants are already significant for instance in China, where there are 3,691 units of medium and large-scale biogas plants and 80,500 units of biogas plants in animal farmers (source: Biogas Production in China: current status and future



development Dr.Xiujin Li).

From current estimates a microPBR4D with a hectare equivalent of heliostat could handle all the CO₂ emission of a small biogas plant of around 1000 cubic meter, with a 50kWh generator. It can largely vary depending on solar and UV irradiation. To give an example in the US, an average 1000 dairy cow can generate 250kWh. With an equivalent solar irradiation to Switzerland, it would take a microPBR4D with a capacity of 5 hectare equivalent of heliostat. In the US, there are currently 60 MW coming from cow energy and it could climb to 1'600 MW according to some estimate (source: Biogas Technology: "Cow Power" Catching On in US, Bruce Dorminey, Contributor).

The solar irradiation can be a lot higher in the US than in Switzerland, which could mean a lower surface of heliostat for the same volume of microPBR4D unit of around 3000 cubic meter. A microPBR4D unit could handle 0,05MW. This would mean that in the US alone there is currently a total potential for 1200 units equivalent. With a current estimation of 6'900'000 CHF, there could be currently a total available market of around 8'280 CHF millions in the US alone for the microPBR4D for farm only, with a 26 times increase potential according to presented estimates (source: ArrCO₂ research).

Competition

The CarboRock project is looking at a very specific market niche that includes both algae culture, waste management and carbon compensation. However there are several major project that are in related field such as BFS petroleum replacement. Another type of competitor is the BECCS technology that couple bio energy and underground carbon storage.

The CarboRock project has its strength and its weakness compared to these project.

Strength

Compared to any other algae production system, the microPBR4D should have the best energy balance, highest density and best conversion rate from solar energy to biomass.

The development of an optimized, high quality and still low cost industrial microPBR4D will take a high level of skill, important investment and continuous improvement through R&D to keep microPBR4D copy cat away.

As for the coccolithophore culture it has the advantages to store twice as much CO₂ for the same amount of usable photons. It also concentrate a high amount of high quality oils and complex sugars both of which have interesting market prospect. The limestone shell physical properties and high density growth should allow to reduce the amount of energy to separate the



biomass from the water.

The advantages compared to the BECCS system is the higher value creation and financial return. It also offers more potential implementation sites. The carbon negative industry is offering active compensation physically based but also passive compensation by replacing raw material with higher CO₂ equivalent for their production. The carbonate product can also guarantee long term CO₂ storage.

Weakness

The microPBR4D technologies are still in their infancy and need an industrial development and laboratory validation of many new technologies. In comparison there are several well established and tested technologies already in place.

In comparison to other algae, the coccolithophores are not growing the fastest and do not have the highest protein concentration.

In comparison to the BECCS system, the volume of CO₂ treated per year is small per installation and the BECCS system can treat lower quality emissions.

Products

Laboratory microPBR4D

The first product of CarboRock will be microPBR4D like pressPBR, cubePBR and laboratory microPBR4D for research purposes. Our first customer are likely to be laboratories in the private and public sector in the field of algae culture. This laboratory microPBR4D will be used to assess potential of different strains in the digital photosynthesis conditions for high value compound production, environmental remediation and fundamental research with a system that has superior biological control. These PBR can test several critical factor separately and obtain data usable for the industrial and agricultural microPBR4D. Those data will be used for the scaling up of microPBR4D and its adaptation to a specific location and industrial ecosystem.

It has a market in the academic and research world and will have an industrial future as a way to launch and maintain start culture. The laboratory microPBR4D will also be used to give data to develop and test final products. CarboRock will try to develop a laboratory product with 3D printable parts that can offer a high level of customization and easy upgrades.

Industrial microPBR4D and ZeroCarbon fertilizer

An industrial microPBR4D can take two basic shapes depending on available land, either with vertical heliostat on top of the microPBR4D or with added heliostat on the surrounding land. The



microPBR4D are automated biomass, oxygen and energy production system. The heliostats follow the sun and manage the energy flow between electricity production and biomass production. The microPBR4D can produce and store purified oxygen, make primary refinery like separating oil, sugars and protein rich cake. The microPBR4D features a light processing unit that converts UV into usable wave length for photosynthesis, convert infrared into electrical energy, heat and distribute light into the culture space at the right timing for optimal photosynthesis (digital photosynthesis). They can use ZeroCarbon fertilizer container, CO₂ from biogas plant and excess nitrate from digestat. The intellectual property will be made of the copyrights for the carbon negative industry description, numerical models, parametric program of the microPBR4D, its design and the patents for the technical solution for the microPBR4D.

The intellectual property will also be made of recipes and branding for final products made with the different organic and carbon neutral raw material produced. It will include low cost high volume products like soil fertilizers, (proposed brand, CarboWhite, CarboBlack) made from carbonate sand and by products, animal feedstock for fish and chicken (CarboChick, CarboFish), and high value low volume market like omega-3 food supplement for human (CarboMega-3), vitamin E and omega-3 rich margarine and face cream.

Business model

Laboratory microPBR4D sells

The laboratory microPBR4D and their accessories will be sold through CarboRock website and advertise on other specialized website. The research microPBR4D production is going to be customized and highly flexible. It will be using the latest techniques of on demand factory. According to recent research, this paradigm shift in mass production should lead to mass customization (Ref: Factory on demand: the shaping of an agile production network [W.B. Lee](#) [H.C.W. Lau](#) ;The Hong Kong Polytechnic University, Hong Kong).

These latest production techniques should allow a nimble and agile company with high level of skills to compete on a global market.

Customer for research microPBR4D

Even in Switzerland, we have some algae research program like SunChem. However the trend behind algae research is large and strengthening internationally. The market for research microPBR4D is booming as the number of algae research groups are becoming very important in many major countries. There are several high impact scientific publication journal, like " Algal Research" which is "an international phycology journal covering all areas of emerging



technologies in algae biology, biomass production, cultivation, harvesting, extraction, bioproducts, and econometrics”. There are numerous other examples of private research group behind this trend like www.algaeindustrymagazine.com or www.oilgae.com.

Industrial microPBR4D and ZeroCarbon fertilizers sells

To make a comparison, the microPBR4D building will be sold as a building that sells its flats before construction. The use of those buildings will be sold to operators, mainly farmers, through a franchise that includes a fee for the sales of the ZeroCarbon fertilizer and biological control during the life span of the microPBR4D. The microPBR4D ownership will be sold through a financial product combining carbon compensation and futures on carbon neutral organic raw material. This financial product will be backed by a physical part of microPBR4D. It will be corresponding to carbon compensation rights of a certain quantity of CO₂ physically certified and futures on the raw material produced by a cubic meter of a new generation algae farm for 20 years in a specific location. The holder of futures on the raw material like the oils, complex sugars, protein cakes, oxygen, carbonate sands and renewable energy will have a guaranteed low price for a long time period (20 years).

Sales & distribution model of industrial microPBR4D

The financial product and the franchise sold by CarboRock will make short term and long term returns. The CarboRock revenue model is based on a one time profit from the sales of future backed by microPBR4D and the exploitation franchise. It will also make a recurring profit from the ZeroCarbon fertilizers sales and biological services by taking a fee on the gross margin. The current early estimates, that need experimental confirmation, shows that the cost of a microPBR4D with a capacity of a hectare equivalent of heliostat, is around 6,9 Millions CHF. It should have a gross sales of 565'000CHF a year in Switzerland. It would have a quantitative compensation capacity of 1,31 tonnes of CO₂ “fossilized” a year (source: ArrCO₂ research). The CO₂ equivalent avoided with the renewable energy, the oxygen production, the nitrous oxide avoided and the local raw material are not accounted for.

The models of this industry is based on attractive low price for organic and carbon neutral raw material, such as a 2'200CHF for a tonne of raw cellular biomass, 2'800CHF for extra cellular biomass (sugar rich), 200 CHF a tonne of oxygen, 250CHF a tonne for high quality carbonate sand and a 0.12CHF for a kWh of renewable solar energy.

The average life span of a microPBR4D is expected to be at least around 25 years. The profits will be split between CarboRock for its ZeroCarbon fertilizer and its biological control services



and its franchises.

Rich customers now and in the future

Currently many internet giant like Google or Yahoo are looking at ways to reduce their massive carbon footprint. In the future, these communication or internet giant will have the alternative to use cheap solar energy as a way to reduce their carbon footprint. However company like cement producer such as LaFargeHolcim and other heavy industries, will most probably remain heavy CO₂ producers, even if the energy source is no longer coming from hydro carbon. For them the CarboRock industrial ecosystem might be a way to economically reduce their CO₂ footprint now and in the future. Big food processing industry could also be interested to secure their raw material supply chain at a constant low price, as climate change consequences such as flooding, droughts, high wind might lead to wide supply and price swing.

Team

The CarboRock start-up is likely to start as a simple partnership that should evolve into a public stock company. It will have a formal board of directors. According to current plan, there should be a parallel development of a non lucrative association, ArrCO₂, whose purpose is to continue scientific research and raising public awareness of the carbon negative industry importance. This structure should be part of the CarboRock advisory board.

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