Case 105

Clustering Biofuels, Heavy Industry and Forests

Executive Summary:

There are many methods to create biofuels and renewable energy sources for growing and struggling economies, but few are viable solutions offer low carbon emissions with the least amount of negative impact on the environment. Years of research reveals that the biofuel industry is a promising catalyst for job creation, income generation and greener living. Palm oil, sugar and corn used for biofuels are still the leading industries, but fail to be a sustainable source for a renewal of the fuel market. Biomass from pig manure using digesters is a promising revolution, provided it is integrated into a biosystem that generates multiple revenues and benefits. New technologies show it is possible to start from municipal waste and then separate carbon from hydrogen molecules to produce pure carbon and pure hydrogen, making this an ideal option for clean fuel. The technological breakthroughs in syngas are also proving to be sustainable options for the future, while converting a cost into a revenue. The only carbon neutral fuel is turpentine from trees, commercially implemented in Las Gaviotas, Colombia.

Keywords: biofuels, carbon emissions, palm oil, pig manure, digester, hydrogen, syngas, convert cost into revenue, autopoiesis, turpentine, diesel and gasoline engines

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Water as a Power Source: Las Gaviotas

I was inspired when I landed in Las Gaviotas, this far flung space in the Colombian Vichada which forms part of the Orinoco Basin, for the first time in 1984. Mario Calderon Rivera was the president of the Colombian Chapter of the Club of Rome at the time and he invited the visiting Members of the Club to witness the creation of a new development paradigm: the regeneration of the tropical rainforest. It was surprising that the majority of the people on the trip recognized the marvelous ideas and the enthusiasm of Paolo Lugari, the initiator of the project, but the majority of them believed that the propositions would never happen. Even though there were only a few trees standing at the outset of this attempt to replant the savannah with the forest that once stood, I was impressed with the power supply in the middle of nowhere; a one-metre drop of water generated 60kW/hr in a landscape that looked flat to the untrained eye.

Las Gaviotas one metre hydropower station installed in 1984 ©2004, Pauli

Paolo Lugari: The Quest for Forest Regeneration and Clean Drinking Water

Paolo Lugari, who never graduated from high school but benefited from home schooling with his father, had a few principles clear in his mind: in the tropics we find solutions from the tropics. He prefers to work with an enthused apprentice instead of having a team headed by a depressed Nobel laureate. He surrounded himself with a great number of eager apprentices and I have certainly felt that I was an apprentice on every one of the dozen visits to Las Gaviotas, each time prepared to learn more from this marvelous mind who was described by Gabriel Garcia Marquez (the Colombian Nobel Laureate in Literature, 1982) as "the man who has invented the world." He was with Felipe Gonzalez, the former Prime Minister of Spain amongst the early supporters of this breakthrough initiative that changed the rules of reforestation and social-economic development.

The clarity of the proposal for the regeneration of the forest was that the gastro-intestinal diseases could only be resolved if the population has access to clean drinking water. The sustainable production of drinking water depends on the change of the pH of the soil which can only be achieved if and when the land is covered with trees. The only tree that could serve as a pioneer species was the Caribbean pine (*Pinus caribbaea*). Paolo and his team decided to start planting pine trees. It was a clear lesson how systems could resolve the health issues while generating forests, producing drinking water and sequestering carbon dioxide. This initiative required power and therefore the first intervention was to create a line that would supply electricity to the community. The only renewable source was water and it was then that I learned you sometimes have to listen to the experts and work with the pragmatists.

At the time, few considered that a one-metre drop would be sufficient to supply electricity, but that micro-hydropower station is still operational more than 30 years later. It was this experience that motivated me to be alert to the need of energy, but it also taught me that energy is not a purpose on its own; it is a means to an end: water, housing and health are clearly more important but only viable if power is available.

The forest generates drinking water pumped and filtered with wind energy ©2004, Pauli

Using Vegetable and Palm Oils for Biofuels

The design for the detergents' factory in Belgium had low energy as a target. Living in a comfort zone like Europe, I was not yet keen on moving to a state of total self-sufficiency. However, I had my first experience recycling used vegetable oil from restaurants as a fuel for cars. In 1992, all diesel cars owned by my detergent company in Belgium were running on 100% vegetable oil until our leasing company found out through the media and notified us that it would cancel the warranties for the cars. Because the cars were running fine, I began to wonder what the problem was. I learned my lessons that people are risk averse, and this experience put me on track in the world

of biofuels. While we were pouring filtered restaurant frying oil into the gas tank, I was informed about transesterification and the creation of a few by-products like glycerin.

Since I was confronted in the fall of 1993 with the harsh reality of palm oil and its growth in consumption that led to the destruction of the rainforest, the natural habitat of the orangutan in Kalimantan, I became very sensitive to the emerging enthusiasm that palm oil would also serve as a source of biofuel. Palm oil was not a sustainable source for biodegradable detergents and it was therefore not a sustainable source for renewable fuel either. That is why I was sensitive to the approach of funding institutions to possible new avenues for the production of biofuels. When Peter Goldmark, the president of the The Rockefeller Foundation, learned about our ZERI programs in Africa and especially the mushroom farming initiatives in Zimbabwe, we were invited to cooperate with the planting of *Jatropha curcas*, also known as the hibiscus tree. We studied the options and learned that the oil-bearing fruits were an easy local source of fuel.

At the Fourth World Congress on Zero Emissions, which was held in Namibia in 1998, we had a special session on biofuels with the participation of scientists from Africa and Latin America, and a keynote presentation by Paolo Lugari. Prof. Osmund Mwandemele was the dean of the Faculty of Agriculture and Natural Resources of the University of Namibia at the time, chaired the session. It was the first time that the ZERI network of over 150 participants discussed biofuels as part of a systemic design. Prof. Lucio Brusch, the President of ZERI Brazil, brought insights in the emerging research on biofuels from algae that had initiated as part of the nutrition program based on algae. Those who formed part of the meeting agreed that the top priority was the fight against malnutrition; to fight gastro-intestinal diseases and the secure the provision of drinking water. The by-product of these initiatives was a biofuel and it was the process design of clustering water, food and fuel that would turn all outputs both competitive and self-sustaining.

The tropical forest with moriche palms ©2004, Pauli

The regenerated forest based on Caribbean pine © 2000, Pauli

We discussed these developments in biofuels with Paolo and wondered if the native palm species of the Vichada, known as Moriche or *Mauritia flexuosa*, could serve as a source of biofuel instead of the palm oil. The Moriche could be planted inside the emerging forest as a native species that would allow us to test how its oil, which would not compete with food or land, could contribute to supplying a biodiesel. I discussed the matter with the ZERI Japan office and we decided to raise the money required to undertake the additional planting under the leadership of Mr. Yusuke Saraya the president of ZERI Japan and Mrs. Miyako Yoshino, Director of ZERI Education Japan. Paolo Lugari came to Japan and gave a lecture at the United Nations University which prompted the United Nations Development Programme (UNDP) to administer the funds.

Yusuke Saraya | Miyako Yoshino | Osmund Mwandemele | Bernard Amadei | Robert Haspel and Lynda Taylor

In the year 2000, Paolo received an offer from Professor Bernard Amadei, the founder of Engineers Without Borders in Colorado (USA), to come and build a biodiesel plant. Prof. Amadei had been to my courses and lectures in Santa Fe, New Mexico which were organized by Lynda Taylor and Robert Haspel, who for a decade led the ZERI programs in that part of the United States. Las Gaviotas made space at their centre in Bogotá and the first inner-city biodiesel plant of Colombia (and probably Latin America) was operational within two weeks.

Transesterification of Biomass into Fuel

The processing of biofuels into diesel requires transesterification with methanol (CH_3OH) as a reaction agent and sodium hydroxide (NaOH) as a catalyst which together create a biodiesel with glycerol as a by-product. Paolo Lugari and General Motors agreed to test the effects on their car engines. While this process took its own course, I continued to search the world for other sources of renewable energy that would offer much better carbon balances.

Thanks to my exposure to the digesters by Prof. George Chan and the scaling up of biogas installations that Prof. Li Kangmin witnessed in China, I decided to visit some of the largest fermentation facilities around the world. Biomass, in this case pig manure,

was converted into methane gas. I learned the details of fermentation of solids through anaerobic processes and found that the use of excrements made more sense than what we were considering in Colombia with palm oil, even the local palm variety. The size and output was extraordinary and the three digesters processed in excess of 10,000 m³ from the manure of 20,000 pigs, making it a very efficient operation.

A Chinese 12,000 heads piggery with all manure converted to slurry and biogas © 2003, Pauli

The scaling experience in China made it clear that transesterification has certain logic, but it still requires too many external inputs which are not readily and locally available. The biogas production-based pig manure started from a different premise: to convert waste into a fuel. This is not a single focus but rather the cascading of nutrients and energy. The slurry from the digester is an ideal nutrient source for algae which leads to the cultivation of fish feed. We learned our lessons and the biodiesel palm oil project in Colombia continues to operate without the transesterification process, and its use is now restricted to food. The oil is only purified and then sold on the local market as cooking oil. It was time to go beyond the boundaries of what we knew.

Biogas Yield from Biodigesters

We went searching for new possibilities and consulted dozens of our scientists. It was Anders Wijkman, former Policy Director of UNDP and a member of the Royal Academy of Sciences, who steered us to the University of Linköping in Sweden and the work of Professor Jörgen Ejlertsson who was a researcher at the university's Centre for Water and Environmental Studies. He had doubled the biogas yield from biodigesters with a few simple measures and then doubled it again. What seemed like magic to some was basic science for others. It was clear that methanogenic microorganisms need access to metals like nickel to thrive. His insights and the excellent research applied to paper and pulp mills offered a new pathway for Jörgen Ejlersson and his team, which led them to design a new business model.

The Swedish researchers at Linköping University laid the ground work to create a new company: Scandinavian Biogas in Stockholm. Former Swedish Prime Minister Göran Persson is the chairperson for this privately-held company. Their fermentation

technology could be considered a revolution since it combines sludge from waste water treatment plants with solid municipal waste. This is a simple and yet sophisticated blending technique that has been described as ‘smart chemistry’. The nutrients for the microorganisms are well timed and paced. This leads to an increase in the output of methane gas with at least factor four.

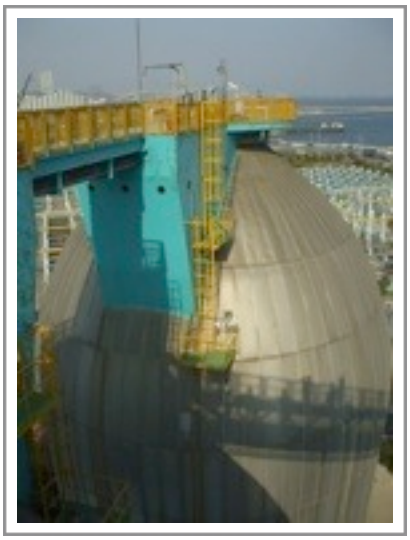
Even though the theoretical and laboratory studies were complete, the real test was performed in Ulsan, Korea where the operation has been evolving from pilot to full industrial scale since 2008 with high profit margins. This logic applied to a waste water treatment facility changed my views ever since. Indeed, if the biodigesters located at the sewage plants can receive solid organic waste which is now diverted from waste dumps or incinerators, then we can increase the output which will reduce the load on landfills and generate income. The amount of income generated is so positive that it creates a shift from a cost to a revenue model.

Anders Wijkman Göran Persson Jörgen Ejlertsson Phil Risby Sir Stephen Tindall Sean Simpson

Instead of cities using licensed companies to treat water at fixed costs over a long period of time, private companies can get the right to treat water and pay the city a license fee based on the revenues they generate. How many cities would not like to shift to this model? There are nearly 10,000 biodigesters in Germany and nearly none of them make money, relying mainly on subsidies to balance the budget. One facility in Korea has been generating income and jobs from the beginning of its operations.

Using Waste to Generate Income

The experience in Korea triggered a wide research on how waste can be considered an income. However, the implementation of this strategy to generate revenue for municipalities has been delayed due to the decisions of the past. Cities have been keen to lock in agreements at fixed costs knowing that the amount of liquid and solid waste would only increase. The draw-back of this strategy is that cities are bound by long-term contracts that cannot be cancelled at short notice.



Digesters at the Ulsan waste water treatment plant designed by Scandinavian Biogas © 2011, Scandinavian Biogas

This means that the opportunities offered by Scandinavian Biogas will only be rolled out over the decade to come. This was yet another case that demonstrates that we have to look beyond 'improving business as usual,' and rather cluster activities together so that the benefits can be reaped in terms of reduced taxes and increased access to renewable energies. At our 10th Anniversary World Congress in Tokyo in 2004, we debated that privatization is no guarantee for sustainability or profitability, but these types of public-private partnerships demonstrate that it is time to change the business model of long term contracts for waste water treatment.

Hydrogen as a Clean Energy Source

I was satisfied to learn first-hand from the Ulsan facilities and Swedish know-how relating to smart chemistry applied to cities' solid municipal waste management and waste water treatment facilities. It shaped my vision on methane gas and the opportunities to treat it as not just another biofuel, but to rather consider it as a chemical feedstock. It was SK Chemicals, the largest chemical company in Korea, and Prof. Dr. Phil Risby who showed that methane is an excellent energy source beyond burning gas. Thanks to new technologies developed by Dr. Risby through spin-off ventures like GasPlas at the University of East Anglia (UK), including the vortex and micro-waves, it is possible to separate the carbon from the hydrogen molecules and produce pure carbon and pure hydrogen. If we are looking for a clean fuel then hydrogen is undoubtedly an ideal option. And if it is produced starting from biogas generated from waste, then the fuel displays a strong carbon balance.

After another inspection of the Montfort Boys Town integrated biosystem in April 2007 and the biodigesters in operation there, I decided to make an exploratory stop in New Zealand and consult on the latest technological developments in this very beautiful

country. Even though it is a small nation that is quite isolated, it has a unique approach to innovation.

Black Smoke as a Fuel Source: New Biofuels from Syngas

In Auckland I met with, among others, Sir Stephen Tindall who was an entrepreneur who created the retail chain, “The Warehouse”. Sir Stephen had left the management of his company and created an investment vehicle called K1W1 which focuses on investing in home-grown technologies in biotech and the environment. While we discussed a portfolio of initiatives, Sir Stephen hinted at a unique bio-inspired technology that would turn ‘black smoke into fuel’. Of course it was too early for him to offer details, but while most people would consider this magic, I knew all too well that he had identified a grand opportunity to create a new generation of biofuels for the future. I followed my intuition and the black smoke stood on my radar screen ever since.

Thanks to this discovery that I came to know Dr. Sean Simpson. Born in England but clearly an adopted “Kiwi,” he was drawn to New Zealand after a career in pharmaceuticals in Switzerland and a research program on cell structures at Tsukuba University (Japan), to study the production of ethanol from wood. While the program was promising and fitted the overall goal of reducing Greenhouse Gases (GHG), his attention was diverted to the unique microorganisms that flourish in the guts of rabbits.

The creative pathway scattered in many directions and arrived at a new fermentation process that is perhaps the oldest on Earth; one that converts syngas (a blend of CO, CO_2 and H) into ethanol, and a few other by-products. The research confirmed that syngas offered a remarkable base to ferment into biofuels with efficiency levels that go beyond the standard. Just like Jörgen Ejlertsson had found a pathway to increase methane gas with factor four, Sean Simpson would emulate the logic of fermentation to gases rich in carbon monoxide and carbon dioxide. It is obvious that this is the type of GHG that we have too much of and the proposed solution would not only change the rules of the game, it redefines competitiveness and is a prime case of creative disruption.

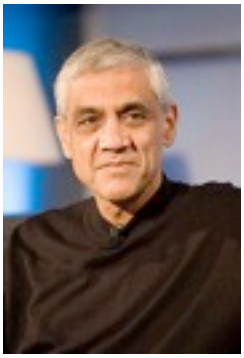
Upon visiting New Zealand again in 2011, the company LanzaTech had been solidly established and locally funded. Sir Stephen's investment fund had played the role of the ‘fund of funds,’ providing capital and mobilizing others to follow suit. Everyone at LanzaTech was keen to prepare for the industrial trial with Baosteel in China. The

results were very encouraging: the black smoke emitted from the steel mill was converted into 100,000 gallons of ethanol.

It was clear for everyone around the table that the successful demonstration at industrial scale equals the advent of a new paradigm for biofuels: black smoke that is a pollutant and a GHG which turns into fuel. Just like hydrothermal vents in the deep sea provide life, food and energy, the emissions from steel mills, petrochemical plants and waste treatment facilities could turn into sources of income which provide renewable energy at a competitive cost. It did not take long for strategic investors in sustainability such as Vinod Khosla to invest $100 million, followed by a large participation of the Mitsui Group of Japan worth $60 million.

Moving Away from Corn Produced Biogas

Converting smoke to fuel and proving that it works is most appealing and I am amazed at the limited number of experts in the field who know about it. Worse still, just like with Scandinavian Biogas, it is surprising that policy makers are totally unaware of these opportunities. LanzaTech was hiding in New Zealand and the principals decided to move where the market is. They set up their new headquarters in Chicago (USA), where the middle of the old smokestacks and the trading hub of the biofuel market were very much controlled by ADM and Cargill, the American leaders in the traditional world of biofuels.


Vinod Khosla


Michelle Gradley


Brian Rudd


Oscar Ayala


Soichiro Honda

The difference is that these companies produce ethanol from corn with billions of subsidies from the tax payers. When we compare this production strategy with the solution offered by LanzaTech, we find that to create biofuels from corn has lost all sense. Such a fundamental breakthrough attracts others to join. Interestingly, none of the large biofuel conglomerates were prepared to take a step and the field was left to a few entrepreneurs and venture capital funds. Even in the new field of biofuels, the technological and institutional lock-in prevented more innovations from being implemented faster.

One competitor that emerged in Europe in 2012, was a team comprising of Dr. Michelle Gradley and Dr. Brian Rudd who spun out from Novacta to create BioSyntha. Whereas Novacta continues to focus on therapeutics, BioSyntha focuses on developing proprietary systems for fermentation from renewable raw materials. The creation of yet another innovative way to convert syngas into ethanol stands high on the agenda. LanzaTech and BioSyntha have patented microorganisms, but with millions of alterations it would not be too difficult to find bugs that no one has seen.

Syngas and Ethanol Technologies

The interest shown in syngas to ethanol technologies by the Japanese, Chinese and Indian partners is remarkable. The Europeans and North Americans on the other hand are reluctant observers, with a few exceptions of course. LanzaTech launched a joint venture with the Shougang Steel Group (首钢集团) to commercialize the technology in China. It was encouraging to observe during the dozens of visits to China in the past few years that this approach to GHG is not a lip service or a window dressing. China is serious about cleaning up its act through the conversion of emissions into revenues and renewable forms of energy rather than increasing the cost of production through the introduction of costly scrubbers and the imposition of high extra taxes. The logic of "cap and trade" as foreseen by the Kyoto Protocol is now clearly secondary to this new logic of biofuels. The New Zealand, Chinese and UK smoke-to-fuel initiatives continue to pursue their promising paths towards the market.

Breakthroughs in Biofuels: Moving Beyond Sugar and Corn

Colombian entrepreneurs like Carlos Ardila Lulle from Colombia followed the Brazilian example and began to invest in the fermentation of ethanol from sugar, which has been the standards in Latin America ever since the sugar barons realized that this natural sweetener has lost its favor. Thanks to Oscar Ayala, our Blue Economy coordinator in Cali (Colombia), I went to visit these sugar mills and noted the massive water consumption, much to my surprise. Each litre of ethanol requires ten litres of water which is not sustainable. We had a discussion with investors about the opportunity to use the water as irrigation for the sugar cane plantations, but it was clear that we could not get much further than the formulation of a few ideas. The quest for sustainable fuels has to go beyond sugar and corn, requiring bolder initiatives that can be translated into a paradigm shift.

The most profound breakthrough in biofuels that we witnessed the last few years emerged at Las Gaviotas. The biodiesel factory in Bogota stopped operations less than 3 years after its construction, but a new insight permitted Las Gaviotas to pioneer once more. The plantation of 8000 ha of pine trees created a continuous revenue from the resin. The tapping of the trees turned out to be one of the best job creators and the local processing provided a high quality of colophon and pure turpentine. The colophon was

sold on the Colombian market at competitive prices in spite of hard competition from China, but there were no takers for the turpentine.

Turpentine as a Fuel

I remembered my scholarship from the Honda Europe Foundation which allowed me to spend time at the office of Honda in Tokyo in 1981. I had the unique opportunity to meet Mr. Shoichiro Honda on numerous occasions since he was the chairman of the Belgian-Japanese Friendship Society. As a fresh graduate I was indeed keen to learn from this icon of the automotive industry. Mr. Honda explained that he started selling motorbikes with a contract to supply turpentine as fuel. There was no fuel readily available after the Second World War and the only way to be successful in the sales of motorized vehicles would be through offering a fuel supply contract.

Tapping resin in Gaviotas

Processing plant of colophon and turpentine © 2013, Pauli

No one could guarantee imported gasoline but 70% of Japan is covered with forests, so pine trees were tapped for resin which offered the supply of a renewable fuel in the form of turpentine. I had nearly forgotten the story until Paolo Lugari explained the need to transform fuel sources for tractors, motorbikes and back-up generators. He had resolved to convert turpentine into fuel just like Mr. Honda had done 70 years earlier. This process requires no chemical reaction but rather purification through decanting. It was a simple concept that only required patience for the impurities to settle on the bottom of the vats. The laws of physics would prevail and chemistry would not be needed anymore. The Blue Economy principle of using physics first provided us with an opportunity to demonstrate that turpentine, extracted from a tree at a rate of one gram per day, provides remarkable additional revenue to the forest operator who is already

selling water and colophon, while generating top soil, strengthening biodiversity and sequestering carbon dioxide

We had a hard time containing our excitement but agreed to keep this breakthrough under the radar until we were certain that there would be no unintended and unforeseen consequences at the outset. There were no surprises and as of 2013, visitors can ride motorbikes running on turpentine, tractors operate the fields that smell like a pine forest, and diesel generators hum through the night without a drop of petroleum spent. The key number is one drop per day per tree. This represents a potential of 8000 litres per day, but it is limited to 2000 litres per day as not all trees are tapped. Considering that a litre of fuel costs US$3 to land in this remote part of the world, it is a potential revenue of + $2 million per year.

Substituting Fuel as an Income Source

First of all, the creation of revenue by substituting fuel is a solid cash income. This is not a mere replacement of one product with another, but rather circulating money in the local economy which used to flow out, in turn increasing the value of the forest. While Las Gaviotas aimed at eliminating gastro-intestinal diseases from the outset by creating local water sources through the regeneration of a forest, it has now clearly embarked on an autopoietic[1] development where constant innovations lead to a continuous improvement of operations. It is remarkable that people in this part of the world, where government excels through its absence, have succeeded in lifting themselves from the status of refugees into members of the middle class.

The colophon and turpentine factory in Las Gaviotas © Pauli, 2011

The remarkable observation is that both diesel and gasoline engines can operate with turpentine. The pre-condition is that the turpentine fuel is very well purified and all particles up to 3 micron have been removed. Las Gaviotas and the whole team are very

[1] "**Autopoiesis**" (from Greek αὐτο- *(auto-)*, meaning "self", and ποίησις *(poiesis)*, meaning "creation, production") refers to a system capable of reproducing and maintaining itself. The term was introduced in 1972 by Chilean biologists Humberto Maturana and Francisco Varela to define the self-maintaining chemistry of living cells. Since then the concept has been also applied to the fields of systems theory and sociology. (Source: Wikipedia)

well aware of the game changer that this represents. If the regeneration of the forest provides a fuel that is sequestering more carbon dioxide in its system than it ever emits, then we have a zero-emissions society that can succeed in creating sustainability with biofuels that do good. We are clearly shifting from doing less harm to doing more good.

Nothing will show up if anyone searches for this breakthrough on the internet as it is kept subdued for the time being. It is important to run more tests and trials, and to study the resilience of these findings as well as the wear and tear on the engines. For now, the diesel and gasoline engines running on Gaviotas Fuel from the trees are cleaner than any other. We still need to build up the experience so that when close friends would like to see the results for themselves, we can always arrange an on-site visit.

Bhutan's Potential: Revenue Through Tree Tapping

While the production was already operational in June 2012, the Bhutanese Minister of Agriculture and Forestry, Lyonpo Pema Gyamtsho, decided to return home with his colleagues from the Rio+20 passing by Las Gaviotas. Forests make up 70% of Bhutan but the nation had stopped tapping pine trees since the practice damaged trees and the Indian competition did not leave much room for profit. As a result, the forests are left untouched.

Pema Gyamtsho

When the minister realized the opportunity offered by this tropical pine forest, and considering the rise in fuel imports in Bhutan, the option to start tapping trees again seemed like an opportunity. We agreed to cooperate and Paolo Lugari was ready to share his knowledge starting with the trial production of turpentine from Bhutanese resin. Then the incumbent government lost the elections and the new prime minister did not want to know about tapping trees. He was keen on getting electric cars with batteries as his way of promoting mobility with renewable energy. Unfortunately we have no means of producing strong enough engines or batteries to power electric cars across the mountain tops of the Himalayas.

We were fascinated by the numbers for Bhutan; the country could produce 50,000 litres of pure turpentine per day from tapping 10% of the pine trees using at least 20 local processing centres. This translates into nearly $60 million in revenue per year which is the amount Bhutan spends annually on imported petroleum. This is the window of opportunity: turn imports into revenues and jobs. The biofuel industry in Bhutan would turn into the largest employment generator within a decade, easily creating 40 to 50,000 direct and indirect jobs. We have not had the opportunity to run more detailed numbers

Mpho Parks Tau, Mayor of Johannesburg

for more nations but the message is clear that biofuels are going to be a major growth opportunity in the energy market, provided we get beyond the logic of ethanol from corn. Mr. Parks Mpho Thau, the Executive Mayor of Johannesburg is sensitive to this opportunity. He has decided to convert public transport to biofuels and with 70,000 hectares of mining land that is inappropriate for agriculture for human consumption, the introduction of biofuels along the lines of Gaviotas and Bhutan could be an option that allows the regeneration of top soil and a substitute for petroleum while generating thousands of jobs.

The Best Sustainability Options

While sugarcane and vegetable oils from corn and palm may still be a priority on the minds of people and the investment community; it is the breakthroughs in syngas from heavy industries and forestry management that will offer the best sustainability. These breakthroughs will grow the local economy and provide it with a resilience that is urgently needed in the wake of the next financial crisis. It may be a surprise that the dirtiest industries and the preservation of forests offer the most solidly proven game changer. The production of biofuels that are carbon neutral are within reach.

We have monitored the investments amounting to US$230 million in these breakthrough initiatives (Lanzatech, Scandinavian Biogas, BioSyntha) and know that capital is ready to flow in these types of projects. The job creation opportunities are impressive. While the technology companies that drive the turnaround have only generated 260 jobs as know-how and engineering enterprises, the indirect job creation of the projects reaches 2400 employees, approximately ten times more. As we state at the conclusion of my fables "… and it has only just begun."

Translation into Gunter's Fables

The business of biofuels is translated into fable #63 entitled "Rabbit Fuel", dedicated to Sean Simpson, and fable # 41 entitled "Fuel from the Tree" dedicated to Paolo Lugari. They inspired the creation of this cluster already back in 1984 with my first visit to Las Gaviotas in Colombia, and my discussions with Stephen Tindall in 2007.

Documentation

www.youtube.com/watch?v=xogJew_nlko