Report on experiences from conferences in Sweden & Germany, June 2014

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Part One: Summary

Recently, I attended and presented papers at conferences in Sweden and Germany on the subject of Sudan's potential for renewable energy from municipal and agricultural wastes, and on production of biodiesel and jet biofuels.
The day before the start of the Swedish conference, I was elected as an associate board member of the World Bioenergy Association (WBA). The WBA is the world's peak bioenergy organisation and I will represent North Africa and the Gulf States for my four year term.
In the following week I presented on jet biofuels development worldwide at the Oleofuel 2014 conference in Düsseldorf in Germany where I met people from Industry and policy makers. It was joint presentation with Andrew Lang, a vice president of World Bioenergy Association.

Part Two: 1. World Bioenergy 2014 Conference, Jönköping – Sweden, 3-5 June 2014.

While I had one paper on Sudan's potential for bioenergy production accepted at the conference, I also had a surprise invitation to present in the conference's closing session on the potential in Africa for bioenergy development.
I was excited to get this opportunity to talk more about the potential for this region. For many people at this conference this was the first time they had heard that Sudan has the water, the land, manufacturing industry and the trained people with technical skills, and so can play an important role as a biofuel supplier.

An important part in the conference was going out in groups for field trips to places using bioenergy technologies that we could have here, whether it is in using biodiesel on farms, producing pure methane from cow manure, or more efficient harvesting and handling of plantation thinning.
In the one field trip, I went to a biogas plant producing biogas from manure in a commercial collaboration between farmers and a city energy utility. The production capacity is 19 GWh of biogas per year, and the gas is up graded to vehicle quality. The biogas plant also produces certified organic fertilizer.

Sävsjo Biogas Plant, *www.savsjo.se*

Sävsjo Biogas fuelling station

Biogas-fuelled public bus

One of the best parts in this conference was to meet a whole range of people from industry, NGOs and government who can supply information or equipment and possibly help in other ways.
For example, in three pre-arranged meetings in a Business to Business session I talked with people from Tunisia, Sweden and Paraguay. Each had some useful expertise or information.

Within the conference days, there were also parallel workshops in certain topics chaired by experts and companies sharing their experience. In this context I have attended two workshops, the first one was: When will aviation fuels fly? The chairperson was Martin Porsgaard from NISA in Denmark. The discussion was in: which are the most prominent production pathways and key players in building new market for aviation biofuels?
The experts and companies shared their experience were; Tomas Ekbom from Grontmij in Swdedn, his talk was in technological challenges for a biobased aviation sector. Erik Wormslev from NIRAS in Denmark talked about the sustainable fuels for aviation – An analysis of Danish achievements and opportunities. The last talk was from Maria Gelin from Swedavia in Sweden; her talk was in their work in becoming carbon-neutral in 10 airports in Sweden by using biofuels for vehicles and renewable heat and electricity for providing all the services for the airports.
The second workshop I attended was chaired by Andrew Lang as expert and president of SMARTimbers in Australia in the topic of Pyrolysis and Torrefaction. The discussion was mainly about the developed techniques for pyrolysis and torrefaction and if there is a demand for the products. Two experts from Sweden and Finland shared their experience in the production and use of renewable heating oil and of production of torrefied pellets.

2. Bioenergy in Sweden

The political responses in Sweden to the growing concern about global warming have been taking visible shape in the strong push for ambitious targets for reducing use of fossil fuels and reducing green house gas emissions from industry, transport and domestic sectors.
It is this combination of forestry management, an extensive modernised multi-track rail system, and investment into high efficient biomass-fuelled plant, that makes Sweden's development of renewable energy based on biomass all possible. It also obviously requires bi-partisan political support and a well-educated population.

Bioenergy in Sweden provides a larger share of final energy (over 34%) than comes from any other source, including from nuclear, hydro or oil. The Swedes say their target of getting 39% of final energy from biomass by 2020 will be exceeded, and their target of 49% overall of final energy from renewables has already been passed. The other renewables are principally of hydro (providing about 10% of final energy and 45% of electricity), with wind making up on a very minor contribution of 1% of final energy and 2% of electricity. The Swedes have another target – to cease to import fossil fuels including for transport by 2030, and to replace all fossil transport fuels with biofuels. Their progress in this is really obvious. All the buses into Stockholm from Arlanda airport ran on biodiesel, and all the city buses ran on one or other of upgraded biogas, ethanol or biodiesel.

Biodiesel airport bus and public bus (biodiesel from rape seed oil)

Ethanol-fuelled public Bus

Swedavia, the corporation that manages Sweden's ten main airports, has a ruling that all taxis serving these must be hybrids or run on biofuels. Since airport business makes up a lot of taxi income the result is that most taxis now run on what the Swede's call 'safe fuels', meaning that they are able to run on 85% ethanol, upgraded biogas or biodiesel. In fact this is now a feature of up to 90% of new cars sold in Sweden.

A carbon dioxide tax imposed since 1991 is the main driver of all this change. As well as stimulating the change toward renewable energy it has also meant that air and water quality has measurably improved since the old days of reliance on oil and coal for heating and electricity. For instance, in the conference city of Jönköping the 19 oil-fired heating plants supplying the district heating system have been replaced by one super-low-emission waste to energy plant. This use of biomass and waste to generate heat and electricity is the case in all cities across Sweden. Outside the cities heating is either by a small district heat system or by highly efficient, smokeless wood chip or pellet fuelled heaters.

Now in the Sweden of 2014 renewable energy makes up over 50% of the nation's final energy (the total of heat, electricity and transport fuels that is utilised). The national target was for 49% of energy to be renewable by 2020 but in typical Swedish style this mark has been passed six year early, and it is likely that it will be closer to 60% by 2020. This will be because of ongoing investment in biomass fuelled heat and power, but also due to the drive to replace all fossil transport fuels by biofuels by 2030. Already many taxis and most new cars sold are configured to run on one of the 'safe' fuels – 85% ethanol blend, biodiesel blend or upgraded biogas, or are hybrids of one sort of another. Buses in many cities also run on one or other biofuels – 100% ethanol, biodiesel or bio-methane. Almost all trains in the country are electric and that electricity is generally 'green', coming from either hydro dams or biomass-fuelled combined heat and power plants.

Sweden takes its position as a world middle power very seriously and projects this concern as in the form of aid and development into both developing and developed countries. Sweden has agreements to supply input and technical assistance into such developed regions as Russia, USA, California and Poland. Naturally much of this will be to the benefit of Swedish research and manufacturers. And just remember we are talking here of a country of only 44 million ha in area and nearly 1/3 population of Sudan, but with a far shorter growing period and with relatively few resources of minerals or energy.

3. Opportunities for Sudan

While Sweden is a small country compared to Sudan (about 9 million people in 44 million ha), there is a highly efficient use of all resources available to produce bioenergy and meet their targets of 2020 and 2030.
In Sudan there is a high potential to start using the available resources to produce bioenery in different scales. The most efficient/ economic technologies for short term are:

- Wet organic wastes to biogas (to electricity)
- Dry wastes to heat
- Starches and sugars to ethanol
- Fats and oils to biodiesel
- Dry wastes to combined heat and power

Other technologies are more complex, costly, and need large scale plant and feedstock volumes and they could considered for longer term strategies.

The most different forms of energy most needed are summarized as follows:

1. For Industry heat, cooking, and cooling;
    - Using biogas
    - Using jatropha seedcake
    - Using plantation grown wood
    - Using efficiently-produced charcoal (from plantation wood)

2. Electricity and heat/cooling for off-grid sites (replacing diesel generators)
    - Using gasification (agrobiomass, jatropha seedcake, woody weeds, plantation wood…)
    - Using biogas from human and animal wastes, slaughterhouses wastes and food wastes
    - Using Solar to electric systems (PV or stirling engines, plus battery storage).

With land, water, sun, skills and investment Sudan's arid land becomes forest and farm and this will lead to:

- Trees available for reducing wind and evaporation
- Water for higher value crops
- Export income from fruit, vegetables and livestock
- Wastes and residues for energy and fuel
- Reduction of imports of fossil fuels
- Manufacturing of bioenergy technologies

The future options: for Biofuels

- Biogas and bio-methane (upgraded biogas)
- Cane ethanol (or from sweet sorghum or industry/food residues)
- Cellulosic ethanol from agrobiomass
- Biodiesel from used cooking oil (UCO)
- Biodiesel from jatropha or other oil seeds
- Aviation bio-jet fuel
- Other advanced biofuels using pyrolysis and catalytic reforming

Part 3:
Oleofuels 2014 conference,
Düsseldorf – Germany,
11-12 June 2014.

1. Pre-conference tour to Petrotec used cooking oil to biodiesel plant.

Düsseldorf is the capital of NRW, the state of Nord Rhine-Westphalia (NRW) in the west of the country, bordering the Netherlands and Belgium, and with the major transport artery of the Rhine River flowing through it from south to north. Just on the northern part of the city is Germany's third largest airport, and access by fast electric train is less than two hours from Frankfurt airport to the south. Just before starting the conference we went in a tour bus to the small town of Südlohn-Oeding where the Petrotec biodiesel plant was located.

Petrotec say they are the largest producer of biodiesel produced from used cooking oil (UCO) in Europe, and source it from all over Europe and from as far afield as the Gulf States and Australia. This plant has a capacity of about 85,000 tonnes, while another plant at Emden, on Germany's northwest coast, is able to produce about 100,000 tonnes. A smaller plant at Seville in Spain has the capacity of about 20,000 tonnes.



Petrotec Biodiesel Plant (UCO), Düsseldorf (Südlohn-Oeding) – Germany

The used cooking oil is collected initially by collectors from thousands of restaurants and institutions. It goes through a series of aggregations and finally comes in bulk shipments to a nearby initial processing plant. Imported UCO will have been through a pre-treatment process before shipping.
UCO is more expensive than clean vegetable oil to convert into biodiesel for a number of reasons, and these are the costs of collection and aggregation and the costs of dealing with the contaminants (including water) and the high levels of free fatty acids (FFAs). While new vegetable oils have FFA levels of around one percent or less, even properly handled UCO may have FFA level of 6-7%, and UCO that has been affected by time temperature and oxidation may have FFS as high as 10-15%. Several tests are done on any UCO shipment to reach the Petrotec treatment plant. This identifies the main type of oil and also the FFA level and any level of problem contaminants.
An initial treatment involves filtering out contaminants (including salt, water and solids) and stripping the FFAs to bring the level of these down to below 1%. The raw feedstock then goes into

a flow process of transesterification with methanol and an alkali catalyst, followed by purification, washing and drying. After a final distillation stage the final product is used cooking oil methylester (UCOME) or biodiesel.
A feature of the processing is that all extractives and by-products are purified and sold into various markets. Examples of this include glycerine produced early in the process, and polymers produced near the end of processing. During the processing almost all methanol is recovered. The stripped FFAs are put though a separate esterification process with an acid catalyst and then rejoin the main process line. The final oil is a pure product that complies with the EU standard 14214. The main customers for this are companies and organizations that are obligated to blend biodiesel into fossil diesel by national legislation. Petrotec claims that using this UCOME results in a reduction of GHG emissions of 83%. They say by the same life cycle analysis measure using biodiesel from palm oil reduces GHG emissions by 19% and ethanol from wheat only by 16%.

The managers at the processing plant were interested in the possibility of buying the used cooking oil that is generated in Khartoum/Omdurman, but obviously we'd first need to look at how to collect this and whether it is more preferable to process it here for domestic use.
But it is clear that there is a very large and fast growing demand for vegetable oils for use for making biofuels for land, air and marine transport, and that Sudan could have a real role to play in this, including by growing the oil-producing plant Jatropha.

2. **The conference**

The conference was organised by the company ACI, based in the UK, About 60 people attended the conference, coming from over 11 countries, including from USA, Sudan, Argentina, Hong Kong, Israel and Australia. The main part of the number naturally came from the various EU countries, including Germany, Italy, Spain and Portugal.
While a significant part of the conference was concerned with used cooking oil as a sustainable and economically viable source of biodiesel, speakers during the two days of the conference covered a wide range of topics including the cost of new plant on a greenfield site versus the costs of retrofitting and modernising older plant, life cycle analysis and use of catalysts, and some of the new developments in the production of vegetable oil by yeast or bacteria.
Several themes ran through the conference. One was about sustainability and certification, another was about the promotion of the monitoring and reliability of sourcing of UCO, and a third was to do with the future of the industry within the changing EU legislation on biofuels and GHG emissions reduction. There were some presentations about the recent history of biodiesel industry in the EU and the international trade of vegetable oils and how they related to the fossil fuel industry.

One challenge for the sector is how to increase the amounts of UCO available and Francisco Mora Jordano, business development manager for Eko3r, one of the conference sponsors, was most active in promoting his company's system for collecting household cooking oil in order to open up the large source that is as yet largely untapped in many EU countries.

Spanish collecting system for UCO, *www.eko3r.com*

One very lucky contact I made was with Professor Klaus Becker, the CEO of JatroSolutions, one of the leaders in the development worldwide of improved jatropha genetics. Getting the best available genetics that will mean all the difference for a jatropha oil-to-biodiesel industry in Sudan. Professor Klaus Becker, CEO of JatroSolutions (another conference sponsor), provided a comprehensive talk on the potential of jatropha and the yields being produced from some of the elite cultivars being grown in the company's trial sites around the world. The oil-producing plant Jatropha was mentioned in a number of other presentations. The potential of this plant is now reported to be approaching its original claims of oil production per hectare but only when properly managed and watered and of improved genetics.

One welcome aspect of the conference was a number of panel sessions. In one, industry company representatives gave a quick summary of their products or company. In another, some long standing biodiesel-production professionals reviewed the status and recent history of the sector.
Overall it was clear from this conference that while there is a well-developed industry making biodiesel from a range of source oils and fats including UCO, the investment in expansion of production within the EU will depend on both supportive policy that is no biased against biodiesel from these 'traditional' sources, and also in developing now sources that are no food-type oils. These will include the possible supply from perennial land plants like jatropha, from salinity-tolerant plants like halophytes, and from microalgae and other oil producing microorganisms, including bacteria and yeasts, that use an aqueous medium.
In this context there are high possibilities for Sudan to collaborate with European industry.

2. Summary of Topics Presented:

1. Biofuel support policy and economics,
2. Food vs fuels, sustainability and certification,
3. Used cooking oil and biodiesel Europe,
4. Used cooking oil collection systems,
5. Processing, cost of new greenfield sites vs upgrading existing plants,
6. Soybean biodiesel- Argentina,
7. Costs of clean vegetable oil around the world and movement over world against crude oil,
8. Catalyst use in HVO, blend and re-refining,
9. Fisher Tropch process technology,
10. Life cycle analysis of blending pre and post refinery
11. Jatropha, development of genetic selection and yield site, sustainability and cost of seed
12. Today's global biojet fuel industry

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