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From corn waste to green energy in China

MUDP report

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1. Background

China has vast resources of unexploited biomass. Biomass that can be converted into energy, thereby reducing emissions of CO2. In Jilin Province in Northern China, there is an estimated amount of waste from corn of 12 mio. T. The energy content is enough to replace 50% of the consumption of coal in the province, if utilized in a proper manner.

Before 2017 the normal practice was to burn the corn waste on the fields. This practice caused big environmental problems in form of air pollution and a lot of energy was wasted. Therefore, the local government has forbidden the practice of burning the corn waste at the fields and has at the same time introduced sanctions as well as incentives to support the transformation from black energy to green energy. Denmark is one of the leading countries in the world in using biomass as fuel, and therefore the government at Jilin province has being interested in using Danish technology.

The purpose of the project was to test and demonstrate how corn waste in Jilin Province, China can be converted into a valuable energy source by transforming the corn waste into briquettes with the technology from C.F. Nielsen A/S – to be burned in highly efficient boilers from Linka Energy A/S.

2. Summary and conclusions

The Chinese government is supporting renewable energy and has introduced strong measures and incentives to support the utilization of state-of-the art technologies to reduce CO2 emissions and to be less dependent on coal as energy source. Within the biomass area, heat- and power plants have been established for biomass and others have been converted for biomass or for co-firing with biomass.

China has huge resources of agricultural biomass, but up until now only a smaller part of these resources is being used as fuel for power- and heating plants. The main reason for this is the lack of technology and knowledge about how to convert the biomass into energy.

The purpose of this project was to establish, test and demonstrate a briquetting plant in the Jilin province that converts corn waste into valuable fuel – and to demonstrate how biofuel from a C.F. Nielsen briquetting plant can be utilized in a highly efficient boiler from Linka Energy. Existing biomass boilers in Jilin have an efficiency of less than 60% whereas boilers from Linka Energy have an efficiency of more than 95%.

The province of Jilin has corn waste and rice waste biomass that can be used for fuel amounting to more than 12 mio. T. The local government gives financial support per ton to convert the biomass to fuel, and the power plants and local institutions are willing to buy the fuel.
As per 1.1. 2017 the support from the government is between 75 and 120 rmb per T produced biomass briquettes. This was confirmed at a meeting with a government person in charge of subsidies in Changchun in week 47 – 2016.
Sales price for briquettes is between 600 rmb/T and 920 rmb/T delivered at the customers. The lower price is when delivered to heating plants in Jilin, but if you deliver to the Helongjiang province further north, you can achieve as much as 920 rmb per T, according to our test partner in Dehui.
Sales price for wood pellets which is a substitute to briquettes is ca. 850 rmb per T. Wood pellets have approximately the same heating value as briquettes made from corn waste. The price for industrial gas is 3,85 rmb/m3. The heating value of 1 kg. briquettes equal 0,45 m3 of industrial gas.

Today the corn in Jilin is harvested mechanically as well as manually and by now the major part of corn waste is not being used. However, since 2016 it has been forbidden to burn the corn waste on the fields, and furthermore hard sanctions are given to those who break this rule. Therefore, at the beginning of 2017, you see a lot of corn waste on the fields, just waiting to be baled or something else, just not burned on the fields.

Due to the short season the raw materials need to be stored and new drying and briquetting methods need to be introduced. The project will focus on introducing cutting edge technologies for handling of corn waste; Beside being a good business case the project will solve environmental problems in relation to waste and will directly influence the emission of CO2 by replacing coal with biomass briquettes.

Test and demonstration of the briquetting facility was intended to take place near Dehui City – approx. 80 km away from Changchun. Test and demonstration of a boiler was intended to take place at CGIC – Changhung Guoxin Investment Group, who have made a new energy division, called Changchun Guoxin Heating Engineering Co. – in Changchun – the capital of Jilin Province. CGIG serves urban heating in the scale of 6 mio. m2.

However, many obstacles occurred during the project.

The boiler part, represented by Linka Energy A/S, was terminated after the technical feasibility study (TGU), mainly caused by the fact that it was not possible to come up with a solution that the Chinese found feasible according to their references. This conclusion was made after a comprehensive feasibility study.

According to our research it is though possible to use briquettes in existing Chinese boilers meant for combustion of coal instead. Sometimes minor modifications have to be done. It is however not possible to use pellets in these boilers as the pellets will fall through the grates.

The briquetting part, represented by C.F. Nielsen also ran into problems. The proposed test partner in Dehui City ran into some problems financial wise and in obtaining permissions from the local authorities. As an alternative testing partner, C.F. Nielsen therefore sought another testing partner, namely an organization in Harbin, approx. 300 km. north of Changchun. This partner had previously invested in C.F. Nielsen equipment with the purpose of producing bio-ethanol, but the bioethanol factory was never completed and therefore the equipment from C.F. Nielsen was never installed. However, we made an agreement with the organization from Harbin about using the equipment to test the production of briquettes made from corn waste. Installation and testing of the equipment was performed during November and December 2017, and some briquettes were produced. But the result was poor, as the raw materials were not in the condition as promised. On top of that, there were problems with the energy supply from the local electricity grid that was to be renovated at the testing period, resulting in insufficient energy supply to the briquetting machinery. As a conclusion to that, we found, that it would make a bad impression to the audience, if we were to make a demonstration, and hence we decided to terminate the project without having made demonstrations vis a vis a group of interested parties, including the press. For the same reason it was not possible to describe the empiric results from the period of testing the C.F. Nielsen equipment on corn waste in China. However, our feasibility studies in China including manufacturing prices and selling prices indicates a very good business case, as we will have a payback time of less than 2 years, when the facilities are fully operating. The learning however from our test period is that it is needed to have full control over the upstream supply chain, as a successful production is totally dependent on the quality of the raw materials.

The overall conclusion is that factor conditions are present in Northern China for the use of Danish technology and knowhow in utilizing biomass as a source of energy. Incentives and sanctions are used as an instrument to speed up the conversion from black to green energy. Danish technology is state of the art – compared to Chinese technology, especially when looking at efficiency. We did however not manage to complete our project, but that was not for technical reasons.
Handling of corn waste is not a simple task. If the project shall succeed in a larger scale, training, education is needed at farming level and a compensation system must be established, so that the farmers are paid by value to their customers, not by the weight itself as this causes sub optimizations.

A positive side effect of this project is that rumours about the technology have spread in China, and these rumours have resulted in interest in using the C.F. Nielsen technology in making briquettes from waste from production of cotton in the Heilongjiang province as well as making briquettes from corn waste in the Liaoning Province. As per April 2018, feasibility studies are now on-going with both projects.

3. Corn waste in Jilin province

Jilin Province is the center of corn production in China. The corn is harvested one time per year, and until now the residues were burned at the fields after harvesting. Burning the corn waste at the fields has however been prohibited as per 2016, both because of air pollution but also because the government wants a transmission from coal to biomass as a source of energy.

The government in Jilin gives subsidies between 75 and 120 rmb per T bio energy in 2017. The selling price of briquettes made from corn waste is between 600 and 920 rmb per MT. The price for the straw is between 50 rmb and 280 rmb per T, depending on whether it is delivered, or you collect it yourself at the field. The average price for straw in bales of 250 kg is approx. 250 rmb/T.

There is 12 mio. T of corn waste available in the Jilin Province, which can be converted to fuel. This amount can replace as much as 9 mio. T of coal, if utilized. That equals the energy from 50% of the coal used for heating today in the Jilin province.

98% of the energy for heating in Jiling comes from coal, but the trend is, that coal fired heating and power plants are being phased out in China.

In Changchun, the capital of the Jilin Province, it is no longer permitted to use coal in boilers with a size less than 7 MW. The same rule is applied in other areas in Jilin province.

Instead you must use gas or biomass. We visited a processing plant in Yushu ca. 150 km. north of Changchun in 2017. They had recently converted from coal to wood pellets because they were no longer allowed to use coal as fuel. We asked about the price for wood pellets, and they answered that the price is approx. 850 rmb/T. The price for industrial gas is according to the local government 3.85 RMB/M3.

Larger power and heating plants (mostly public) are now shifting from coal to biomass, and these utilities prefer briquettes more than bales due to logistical matters.

But at the same time these organizations want contracts and stable supply. This is exactly what C.F. Nielsen by its briquetting expertise can facilitate.

Previously there has never been a focus on energy efficiency on boilers in China, as there has always been plenty amount of coal at a relatively low price. The consequence of that is an efficiency of less than 60% with the Chinese boilers, whereas a heating plant from Linka Energy can provide an efficiency of as much as 96%, with lower emission. By now there is becoming higher attention on efficiency and emissions from the Chinese authorities.

4. Reporting of Work package 1 – Technical Feasibility Study

This work package included:

- Investigation concerning outbound logistics of briquettes
- Analysis concerning existing coal fired boilers
- Analysis of existing equipment for collecting and handling of bales
- Analysis of capacity needed
- Analysis of need for drying of feedstock
- Storage of big bales
- Use of Chinese equipment
- Briquetting equipment
- Identification of customer segments, and technical demands
- Analysis of need for training and education

Outbound logistics – briquettes

We have discussed this matter with our intended test partner in Dehui. There are more options; either to store the briquettes in a big pile at the premises before loading to trucks, or they can be dumped into an open container. Alternative big bags with the size of 1, 2 or 3 cubic meters can be used. The important thing is whether the customer has storage space and how the customer wants the briquettes to be delivered.

How do existing coal fired boilers work in China?

Inspection of a 7 MW coal fired boiler near dwelling blocks in Changchun, February 2017

The coal boilers we have inspected have more or less the same design. But the capacity varies from 1 MW up to 58 MW.
Efficiency is quite low – approx. 60-65%, we were told, and this can also be seen from the amount of unburned ash. However, there are several boilers with moving grates, and this means that it is possible to use briquettes from C.F. Nielsen, if smaller modifications are being made. We evaluate that the most interesting range of capacity for C.F. Nielsen will be boilers with a capacity from 1-10 MW, and this is because the smaller heating plants have to pay a higher price for coal compared to the bigger heating plants with larger purchase volume. From CGIG we hear that the current price for coal is approx. 450 rmb/T.

One of the other research questions was whether it was possible to integrate a boiler solution from Linka Energy with existing boilers. The conclusion is that this is not possible, but a Linka Energy boiler can be a supplement to existing heating systems or it can stand alone.

Harvesting and Equipment in Jilin Province
Autumn 2016 Jilin. Harvesting is still done manually

In the Jilin Province and most other places in China the harvesting of corn is still done manually, which can be seen from the above picture. Though harvesting is becoming more and more mechanical. The corn is harvested through October where the corn cobs are cut from the stalks and used for food. Part of the corn stalks – estimated below 20% - are gathered and used for fuel on the farms during winter. The remaining part used to be burned at the fields. It is believed that more than 75% of this “waste” can be recovered for fuel for energy production.

Actual length of corn stalks – Jilin

As it is no longer permitted to burn the corn waste on the fields, it is now more and more common to see that the corn waste is being made to bales.

Round bales from a field near Changchun, November 2017

The most common sort of bales is round bales, weighing 250 kg. These are being baled in the fields. Big bales, as we see them in Denmark are however not made on the fields. The corn waste is in this case collected with smaller equipment to a central and stationary baling machine that makes bales with the size of 1.2x0.9x1.8 meter. These bales are weighing about 600 kg. each. The equipment to make round bales mostly come from Korea.

Capacity and feedstock

In the USA the yield of corn waste on one hectare is approx. 7 T. Our surveys in Jilin in 2016 have given us numbers in the area of 6 T per hectare, so the figures seem to be reasonable. Based on desk research and interviews, we estimate that the total available amount of corn waste in Jilin province corresponds to ca. 12. mio. T in a total area of 30.000 km2 with corn fields. This should leave approx. 4 tons per hectare for energy purposes.

We believe that a reasonable size of a briquetting plant is 24.000 T production per year corresponding to 4 tons per hour and 6.000 hours production per year.

This means that 6.000 hectares of land will be able to support one briquetting factory with raw material. As you have 100 hectares in 1 km2 – it means that 60 km2 of corn fields is necessary to feed one briquetting plant.

If there are corn fields around the briquetting plant, and you make a circle – it means that there are 4.4 km to the most remote fields from the briquetting plant. Interviews with key persons in Jilin, winter 2016, have indicated that transportation distance of corn waste can be up to 10 km. from the corn field to the briquetting production plant.

This is a manageable distance considering logistics. When the concept has proven successful it can be multiplied all over the region.

With a total area of corn fields corresponding to 30.000 km2 – and with a need of 60 km2 of corn field for each production plant – this will leave us a potential of making up to 500 briquette production plants in Jilin Province alone.

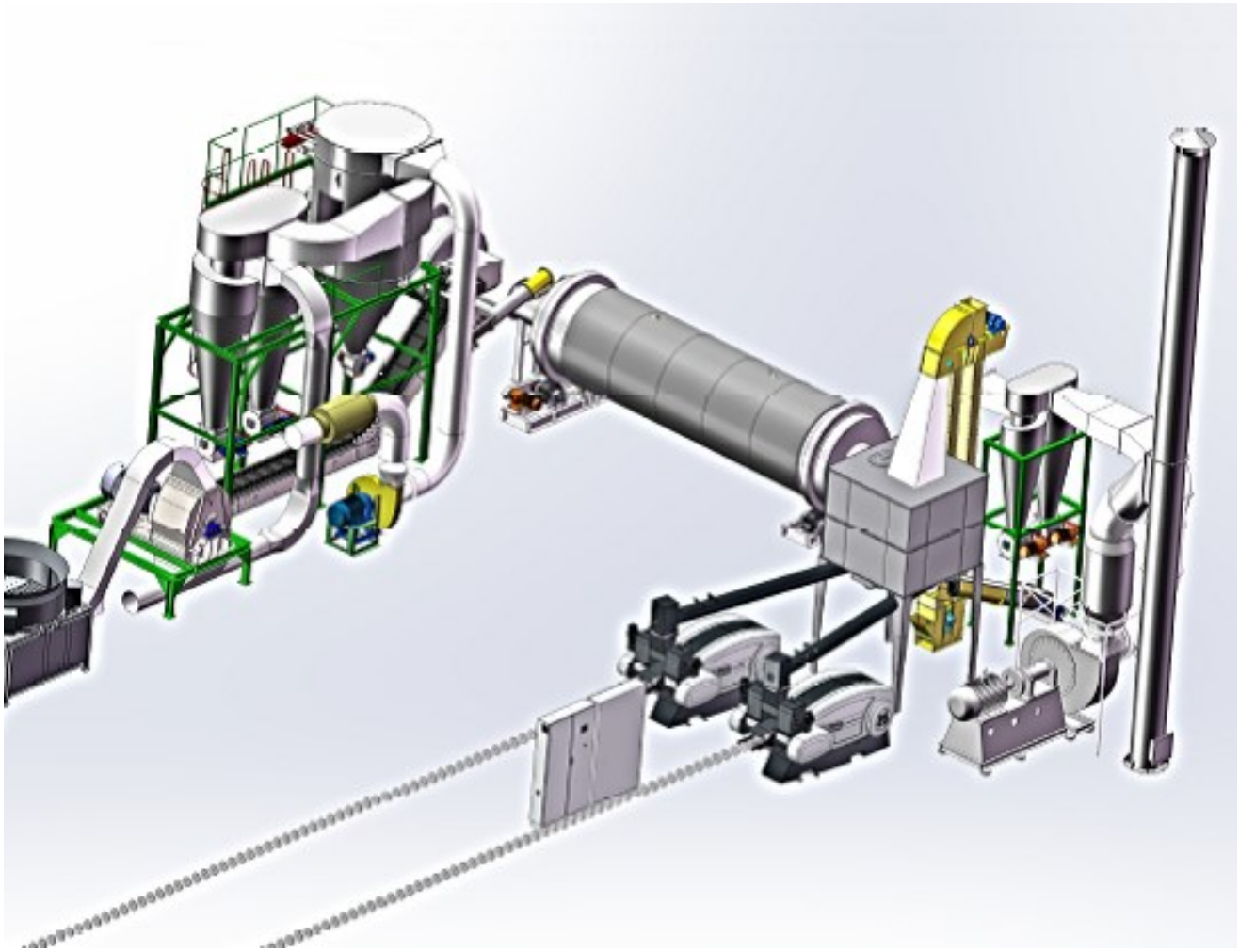
Moisture in the bales with corn waste in Jilin
Our "field research" has indicated that the level of moisture in the bales is between 30% and 45%, when the bales are made shortly after harvesting. We do not know, however, to which degree the moisture can come down, if the straw is dried on the fields before baling.

However, if making briquettes out of the corn waste, the straw needs to be dried down to ca. 15 % moisture. At the same time, the heating value per T will increase. We have searched for a solution in China, and have identified, and have had meetings with a Chinese company that can manage this part at a fair price.

Storage of big bales
One solution is to use equipment from POMI ApS. Bales can be stored at the fields until they are ready to be processed. POMI has been to China during autumn and presented its products, and the Chinese seems to be interested in the solution.

¨Storage solution from POMI ApS

Drying equipment – Only bales with 15% and under moisture can be handled for briquetting. All bales above 15% in moisture will need to be dried. The drying equipment's capacity will depend on the moisture level in the bales. We have identified a Chinese supplier of drying equipment – which can be combined with the equipment from C.F. Nielsen. (See figure below). We intend to test this equipment in the case of drying corn waste. It is the intention that this equipment shall be used in the demonstration plant. The fuel to the drying equipment is corn waste, but it can also be power, depending on what is most feasible in the given situation.



Drying equipment – “the drum” (Chinese) for bales – never tested on corn waste

Shredder and hammer mill – After drying the corn stalks will be shredded down to minimum 50-100 mm. Stones and impurities are taken away and the shredded material are transported to the hammer mill and downsized to 15-20 mm. The capacity of this equipment will be fitted to the briquetting equipment. The shredder and hammer mill are included with the Chinese drying solution. Normally we use equipment from Danish Cormall A/S, but this equipment cannot handle biomass with high moisture content, so therefore we want to use the Chinese solution which can handle corn stalks with higher moisture content than we see from e.g. straw from Danish fields.

Briquetting equipment

Briquetting equipment – When the material is down sized it will enter the briquetting machine, which will make briquettes of 90 mm in diameter and 50-80 mm in length. The briquettes are via the cooling lines sent to the storage area for later shipment to heating plants. The capacity of each briquetting machine is approx. 1,5 T per hour. The briquetting equipment is produced by C.F. Nielsen A/S

To our knowledge none of the above equipment or similar equipment is being used in China today for handling corn waste, and the purpose of the project was to demonstrate that the technologies will work and that it will be economically feasible.

Need for training and education

Re: Briquetting plant (C.F. Nielsen)
As it is quite complicated to run a briquetting plant, we estimate that it will be needed to place an employee from C.F.Nielsen in three months at the test site, to take care of both site management and training of local employees. We estimate that it is needed to educate 4 Chinese employees at our test partner in Dehui in running the equipment as well as optimizing the production flow.

Re: Use of biomass boiler (LINKA)
The proposed Linka Energy boiler equipment is more or less a "plug and play" solution. However, some instructions are needed to ensure smooth operation. We estimate that it is enough to have one person from LINKA at the test site i.e. at CGIG Heating division in Changchun in a period of 1-2 weeks.

The Market for briquettes
Fuel briquettes made from corn is a commodity and the demand by definition thus infinite at the Chinese market.

The potential buyers of biofuel are divided into 5 different segments:

- Power plants
- Dwelling blocks
- District heating plants (private or public)
- Hotels, industries, institutions with biomass boiler plants
- Processing plants
-

However, biomass cannot compete with coal in the free market, as coal per T is cheaper and contains more energy per T. than briquettes made from corn waste. Hence the transmission from coal to biofuel is very much dependent on subsidies and government regulations.

Power plants and district heating plants
Power plants and district heating plants are typically companies that currently are using coal today. The incentive for the larger power plants to change to biomass briquettes will be to reduce CO2 emissions – as this is a part of the overall Chinese policy about reducing CO2 emissions.

The local government is giving subsidies to biofuel. We had a meeting with a person from the local government in Changchun in week 47, 2016, and he said that subsidies in 2017 will be between 75 and 120 RMB per T biofuel.
According to our research, the power plants and heating plants strongly prefer briquettes over bales, due to logistical matters. Often these plants are situated within the cities, and therefore briquettes are much more convenient from a logistical point of view.

The requirements from power plants and district heating plants are that the briquettes can be used directly in their boiler and feeding systems and that the briquettes burn well in their boiler. In some instance the in-feed systems have to be modified or changed for the new type of fuel. In other places a conversion from 100% coal to 80-90% coal and 10-20% biomass briquettes can be done without changes.

Technically the demand is for relatively small briquettes, typically with maximum diameter of 75 mm and cut of in length from pucks of 15-20 mm to 100 mm length. Another option is to make larger size briquettes, which is the most efficient way and position a small crusher in

front of the infeed system for the boiler, to reduce the size. In some case this is the easiest and cheapest way of fitting the briquette size to the boiler infeed system.

Hotels, Industries and institutions with biomass boiler plants

Many hotels, industries and institutions already have biomass boilers installed or boilers that will be able to handle biomass. They are now typically using coal for fuel, because of price, storing and availability. The transmission from coal to biomass will take some time, as we are at the beginning of this transmission process, but for new buildings, coal fired heating plants are no longer allowed in Jilin Province – if the boiler has a capacity of less than 7MW. For existing entities, coal fired boilers with a capacity of less than 7MW must be phased out and replaced by either bigger boilers > 7 MW, or being replaced by boilers fueled by gas or biomass.

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Processing plants/smaller industries
Processing plants with a need of less than 7 MW are no longer permitted to use coal as fuel. Instead they are obliged to convert to either biomass or industrial gas.

Market Potential for briquette machines in Jilin province
We have previously estimated that in Jilin Province there is enough available corn waste to establish 500 briquette factories each with 2 briquette machines from C.F. Nielsen A/S. So far there are no Chinese briquette machines that have the quality to make a stable production of briquettes. Although our feasibility studies have shown very good profitability, there is still a major hurdle to overcome, and this is especially about financing and subsidies. Another hurdle to overcome is that the farmers are educated in handling the most suitable way in order to ensure that the raw materials are in a proper quality for making briquettes.

Market potential for bio mass boilers
The potential market for highly efficient biomass boilers is also very large for 2 reasons. A lot of existing coal boilers must be replaced by biomass boilers due to government regulation.

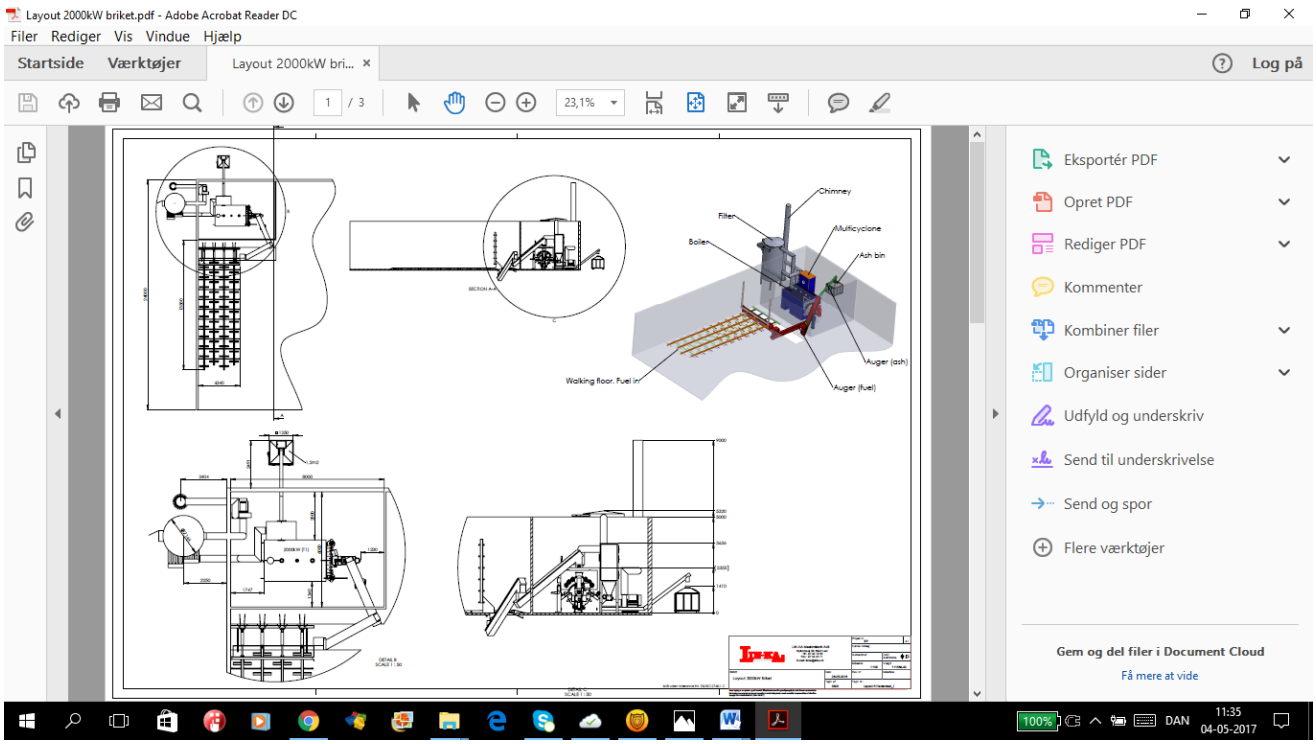
As an indicator of the size of the market potential, we asked the general manager at CGIG, about the current rules and regulations concerning use of coal in the future.

Q: How are the rules about using coal as energy in small and medium sized boilers (1-15MW) in Jilin in 2017 - and in the coming years
A: According to No.20 Document [2014] issued by Changchun government office, by the end of 2016, coal boilers of size of 10 T (7MW) and below are completely forbidden in built up areas in Changchun, i.e. within Ring 3, and there’re no documents about those above 10 T (7MW).
We asked the company about the most normal boiler size, that must be converted to use other energy sources than coal in the future.
Q: Within the range 1-15 MW biomass boilers - which size will be most normal in the Changchun area?

A: According to the statistic from the dozens of coal burning boilers in small boiler room banned by the authorities, the most used sizes are 2 tons (1.4MW), 4 tons (2.8MW) and 6 tons (4.2MW).
Q: Within the range 1-15 MW biomass boilers - where do you see the biggest growth in the future?
A: The most normal used boilers are the size of 4tons (2.8MW), most of them are for some old communities and new plant areas with heating area of 30,000 to 40,000 m2.

Solutions and feasibility

C.F. Nielsen briquetting equipment
From different side we have heard that the selling price of briquettes is between 550 and 900 rmb per T. We know that the purchase price of the stalks delivered in bales is approx. 250 rmb and that there is a production subsidy of approx. 100 rmb per T. Given these conditions are right, we have calculated a payback time of less than 2 years of the equipment from C.F. Nielsen. The managing director from the intended test site in Dehui came to the same conclusion, so this conclusion seems to be valid.



Linka Energy Boiler System
The proposed 2 MW Linka Energy solution for testing

The above image shows the proposed boiler solution, which includes a transportation system.

Based on that proposal we made a spread sheet and feasibility study with the relevant parameters included together with the testing partner CGIG. However, this calculation revealed that a biomass boiler can never compete on price per heating unit with a coal fired boiler, and therefore, in most cases, the payback time will be infinite, if coal firing is an option.

Other parameters such as level of emissions, banning of coal and certain incentives must be taken into consideration.

5. Work Package 2 – Preparation for testing

Preparation for testing of the C.F. Nielsen briquetting solution took place from August to December 2017. It included a lot of correspondence with the testing partner in Harbin. As previously mentioned, our first test partner backed off, but we managed to make an agreement with a new testing partner. The original test partner on the boiler side also backed off (with the Linka Energy solution) and therefore we decided to continue with testing at an existing Chinese boiler, normally designed for burning of coal. Needed for testing was estimated to be 100 tons of briquettes.

This work package concerns:

Research design
Parameters to measure and success criteria
Plan for execution of tests/measurements

Research design
As conditions changed during the project period, we had to revise the research design as well as success criteria. The main change in research design was that the period of evaluation was shortened, mainly due to the fact that the project was delayed caused by various reasons. Hence, we decided to run the testing period for the briquetting part for a month, instead than over a longer period, and to make measurements once a week on certain parameters. Tests and measurements were decided to be made by internal staff, as there are no third party with the necessary knowledge about this very specific sort of production. For the boiler part, we decided to test the boiler over 7 days. Tests should be done with internal staff from the heating plant together with an expert from Changchun Technical University.

Parameters to measure and success criteria
We decided to measure on payback time as well as quality of the briquettes. Payback time was to be calculated based on 1 week of production, from which we could extrapolate on productivity per hour, and add already obtained figures about selling prices, price of power, cost of man power and prices of raw materials. For the boiler part, we decided to measure on energy output per T of briquettes, and to compare the energy output with the energy output from coal. Our success criteria remained the same, namely that there should be a payback time of less than 2 years for a C.F. Nielsen solution. Based on experience from other deliveries and based on theoretical calculations, it seems plausible to obtain a payback period of 1.5 years, when the system is fully operating. Due to problems already mentioned with the briquetting test, the results remain theoretical for the briquetting part as well as for the boiler part as we were never able to test in a “natural” situation.

Plan for execution of test and measurement
Testing and measurement were to take place ultimo 2017. Testing of the briquetting was to take place first, to be ready for demonstration after finishing the testing period. However, we planned to make test and demonstration within the same period for the boiler part. But testing the boiler is depending on a sufficient amount of fuel in form of briquettes. As we only managed to produce 500 kg briquettes we did not have sufficient fuel to make a test on the boiler part.

6. Evaluation of success criteria

As our starting point, we had 4 success criteria:

High efficiency at Linka Energy boiler, success criteria:

Test and demonstrations showing that we can achieve an efficiency of 96% in a Linka Energy boiler, fuelled with briquettes from corn waste.
Outcome: Due to various reasons, as previously described, we were never able to test the combustion of briquettes in a Linka Energy Boiler in China.

Minimum emission of particles, success criteria:

CO emission < 12 mg/MJ
NOX emission < 120 mg/MJ
OGC emission < 4 mg/MJ

Outcome: Same as above

Sound economy in production of briquettes, success criteria:

Payback time 2 years for a briquetting facility.
Outcome: We are convinced that we, given, the right conditions, and more experience from the partner side can achieve a payback time of less than 2 years, based on experience with other feedstock and calculations on production price and selling price of the briquettes. We have made feasibility studies based on actual prices indicating a payback time of 1.5 years, when production is running smoothly.

Reduction in CO2 footprint. Success criteria: Every ton of briquettes of corn waste reduces consumption of 750 kg. of coal, equaling emission of 1.875 kg. of CO2.
Outcome: As we did not test the combustion part, due to reasons previously mentioned, we could not make actual measures on savings of CO2 but for sure, there will be a derived effect on CO2, when converting from black energy to green energy.

A conclusion to the success criteria is that it was not possible to measure the outcome, due to various problems with the testing part.

However, a derived effect of this project is that word of mouth has spread in China, causing the onset of feasibility studies regarding use of C.F. Nielsen equipment in Liaoning Province as well as further north in Helongjiang Province. In the province of Liaoning the feasibility study is concerning making briquettes from corn waste. In Helongjiang province, where Harbin is, it is about making briquettes from cotton waste.

7. Work package 3 & 4. Installation and adjustment

This work package included:

Installation
Training
Adjustment
Supervision
Measurement of effects

Installation and adjustment

During December 2017, a service engineer from C.F. Nielsen, were in Harbin to install the equipment, which had never been in use.
Apart from briquetting presses, the system also included a shredder from an external supplier. During the installation period many problems appeared: The corn waste was very humid and filled with dust and stones.

Bales of corn waste for test of briquetting, Harbin December 2017

The shredder was placed at another location than the briquetting equipment, which meant that we had to move and install the shredder at another location. The local power grid was renovated at the time of the installation. Lack of power from the grid meant that the briquetting press and the shredder could not be in operation at the same time, which they were supposed to be.

Installation of the briquetting product line, Harbin December 2018

The poor quality of the corn waste resulted in blockage of the compression screws on the briquette press. After having adjusted the dies to a bigger diameter, the production ran more smoothly.

Due to the poor raw material we estimated that the dies would not last for more than 100 hours. The learning from that experience is that it is necessary to have full control over the supply part and to educate the primary producers of feed stock in handling the feedstock in a proper way, especially concerning moisture and dirt.

Lack of power from grid causes problems, Harbin December 2017

Lack of power from the grid meant that the briquetting press and the shredder could not be in operation at the same time which they should have. We did not have that information before we arrived at the production site and off course this was a major obstacle for the entire test.

But at the end we managed to install the entire system, so we could begin on the testing of production of briquettes.

Training and supervision

As the testing period became shorter than intended, so did the period of training and supervision. We did however hold a couple of sessions where our service engineer explained the do`s and don’ts when it comes to producing briquettes. These sessions were of technical content as well as explaining the importance of the entire supply chain, quality of raw materials and why moisture is very critical in the process of producing briquettes. Supervision of the staff, equipment and raw materials were on-going throughout the entire testing period.

Training and supervision, Harbin December 2017

Measurements of effects

At the beginning, the density was too high, but by increasing the diameters of the dies we ended up with a quality, that was very suitable for combustion.

Despite the difficulties we managed to produce 500 kilos of briquettes during the testing period. But it was our plan to produce 100 T of briquettes during the testing period, both for testing the briquetting part, but also to have enough fuel for making a proper test on the combustion part.

Briquettes from corn waste produced December 2017 in Harbin, China

8. Work Package 5: Demonstration

This work package included:

Invitation
Demonstration
Dissemination of results from tests and demonstration

It was our intention to make demonstration of both the briquetting part and the combustion part in the beginning of January 2018. A list of invitees was prepared consisting of governmental representatives, press and potential customers. The demonstration period was set to be in 2 sequential days. Day 1 in Harbin concerning demonstration of briquettes and day 2 in Changchun concerning demonstration of combustion of briquettes.

However, it quickly became clear, that there were too many problems in the production of briquettes in Harbin, which should be the basis for demonstration of both the briquetting solution and the combustion part. Based on that that we ended up with the conclusion that a demonstration would backfire to our reputation and the whole idea of making a feasible production of biomass briquettes meant for heating purposes. Hence it also would make no sense to disseminate the results.

9. Lessons learned during the project period

Production of briquettes from corn waste is a complicated task, and it is even more complicated when the production is to take place at a location where the spatial and not least the cultural distances are very large.

If you are to run a 24/7 production a lot of parameters are to be considered. The equipment from C.F. Nielsen is well proven and this is not where the pitfalls lie. The potential problems are more of human nature. Danes and Chinese are very different when it comes to communication and the interpretation of what is explicitly said, and what you have to “read” between the lines. This difference causes a lot of misunderstandings and frustrations, which was apparent in our case.

China does not have the experience and understanding of how to handle biomass for fuel purposes, as we have in Denmark. A lesson learned is, that there must be high focus on the entire upstream supply chain, if we shall succeed in making a smooth operation. This means that the farmers must be educated in how to handle the feed stock for briquetting purposes combined with a suitable incentive system. The latter could indicate that we in the future should focus on organizations that are vertically integrated, where the briquette press owner is the same as the field owner. That would increase the probability of shared interests along the supply chain.

All the above is what we will take into considerations in future ventures in China.

From corn waste to green energy in China

China has a huge resource of agricultural biomass. In Jilin Province in Northern China it is estimated that proper utilization of waste from corn could replace 50% of the coal consumption in the province. Converting biomass into energy would be a good business case and reduce environmental problems such as air pollution and energy waste.

The purpose of the current MUDP- project was to establish, test and demonstrate a briquetting plant in the Jilin province that converts corn waste into valuable fuel – and to demonstrate how biofuel can be utilized in a highly efficient boiler. However, the project ran into problems regarding incorporation of an energy efficient boiler solution in existing boilers, the quality of the corn waste and the local energy supply, which lead to termination of the project. This was not for technical reasons and several positive outcomes have followed from the project efforts including increased interest in converting waste from agricultural production into briquettes. The project identifies a need for more knowledge about handling corn waste and greater control over the upstream supply chain in order for the project to succeed at a larger scale.

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