Market potential of Ukrainian herbaceous biomass

Analyzing market obstacles and promoting business strategies

Pellets for Power project

Sustainable Biomass Import program

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Colophon

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Abstract

EU and NL increasingly demand biomass for realization of EU and Dutch ambitions for increasing the amount of sustainably produced energy. To meet this ambition, large volumes of biomass must be imported from non-EU countries, such as Ukraine. This country produces large amounts of cereals and straw (about 40Mios tons per year) as by product of cereal production, large area of reed that can be sustainably harvested on an annual basis and the 6,5 millions of hectares of unused land (*source, Ukrainian statistics, 2009*) suitable for growing biomass crops.

The Pellets for Power project, funded by Agentschap NL under the Sustainable Biomass Import program, is defining ways for sustainable biomass production in Ukraine. It is focused on three biomass sources: straw, switchgrass and reed. However, so far commercialization of Ukrainian non-wood biomass has not been successful.

This report addresses the obstacles for successful commercialization, as experienced by project partner Tuzetka, focusing on biomass for energy (mostly heating and cooling) conversion. Part of the problem is in the quality of herbaceous biomass, when used for energy production. However, other factors in play include the economy of scale and (inter)national regulations that favor wood over herbaceous biomass.

The report also addresses market strategies by Tuzetka. This includes focusing on a domestic Dutch district and domestic heating and cooling market in the frame of twin organization (Bioenergy Trade Centre) with Ukrainian counterparts.

Strategies for heating and cooling will be thee easiest to implement in urban areas or in industrial zones. Small, mid district heating schemes are also an interim pathways to improve the energy efficiency by means of energy storage (cold-heat bank) with heat pumps. For starting such operations, wood pellets will be the adequate bioenergy (better market behavior) while the agro pellets may step by steps increase the supplies.

The Ukrainian market is offering business opportunities also for Dutch companies for the export of biobased goods and services against the supply of a secured feedstock.

Others opportunities have to be mobilized like biomass supply in Poland and other EU or non-EU countries. Also use as bedding material or the fiber market. The report will highlight the opportunities that exist, including non-energy applications.

Content

1 Biomass produced in the Pellets for Power project

1.1 Biomass defined

In the Renewable energy directive (2009/28/EC) biomass is defined as follows: "Biomass means the biodegradable fraction of products, wastes and residues from biological origin from agriculture (including vegetable and animal substances), forestry and related industries including fisheries and aquaculture, as well as the biodegradable fraction of industrial and municipal waste".

In the Pellets for Power project Ukraine, the focus is on three types of biomass: reed, straw and switchgrass (among other perennial grasses). For a description of the production, harvesting techniques we refer to respective reports Production report.

1.2 Reed, straw and switchgrass.

For detailed description of reed, straw, switchgrass production, harvesting and processing we refer to the Reed Report, Straw Report and Switchgrass Report.

1.3 Biomass pellets.

There are several reasons to densify biomass. The densification is reducing logical costs more kilos per cubic meter, so lower costs per ton or MJ. Herbaceous biomass is a voluminous material ranging from 60 to 120kg per m3. Therefore, the transport of such voluminous material will be very expensive. In order to lower transport and storage cost a densification is needed Straw (from reed, wheat, ..) has a density of 80kg/m^3, saw dust has an usual density of 100kg/m^3 after the pelletizing the density of pellets is usually about 650 kg/m^3.

Table 1 Mass balance

Mass Balance	**Wood**	**Agro**
Density of the raw material from field, forest (chips,..)	300	80
Saw dust	100	
Wood chips & trunks (delivered feedstock)	**200**	
Baled straw (delivered feedstock)		**250**
Processing- pellets: Total in kg**/m^3**	650	650
Densification ratio	3,3	2,6

One of the most common densification options is the production of pellets or briquettes.

Pellets are made by a type of extruder technology A pellet is a cylinder of 2 to 14mm diameter made from biomass and extruded with a technology (*source Handbook EN plus standard*).

Pellets production technology is well established; standards and markets for pellets exist. In a range of sectors, this format is allowing a better storage, tradability and traceability of the material. The pellets were very commonly used for animal feeding (hay or straw pellets, or mixed feedstock), animal bedding and for mineral fertilizer.

1.3.1 Increase caloric value per volume.

Biomass aims to replace the fossil energy. One ton of crude oil (ton oil equivalent, TOE) contains about 42GJ.
One ton of biomass can deliver only 15 to 18GJ per ton. Therefore, to be competitive with the cheap fossil energy, the energy density of the biomass needs to be upgraded by means of drying and densification.
After the pelletizing, the energy content from herbaceous biomass (15-16GJ/T) is still twice lower than for crude oil (42GJ) or coal (25-30GJ/T). Biomass is renewable and is matching the EU and national policies to reduce the emission of green house gazes (GHG).
The exact balance is not neutral as production equipment's need to be powered by electrical motors. The thermal energy is required for the drying of the biomass.

1.3.2 Increase the added value of the raw material.

Bulk biomass may have the form of straw bale, brunches and stem, in all case a material difficult to handle.
The pelletizing (and somehow the briquetting) is providing a higher energy content and is also a solution to deliver pretreated raw material to the plant.

This is especially the case for the fiber market (see chapter 2.6).

Later on, it's realistic to imagine that other forms of densification will be proceeded next to the harvesting areas like the pretreatment for the biofuels 2G with steam cracking. Nevertheless a tight collaboration will be necessary between the biofuels producers and the biomass suppliers. It should be organized in a common umbrella organization (see below the Biomass Trade Centre under 5.3).

1.3.3 Logistical cost reduction

The obvious benefit of the densification is the reduction of the logistics costs: more kilos, tons per cubic meter, so lower transport costs per ton or MJ.
The final mass balance of the pellets will impact the transport cost as showed below.

Table 2 Mass balance

Mass Balance	**Wood**	**Agro**
Density of the raw material from field, forest (chips,..)	300	80
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Wood chips & trunks (delivered feedstock)	**200**	
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Processing- pellets: Total in kg**/m^3**	650	650
Densification ratio	3,3	2,6

Currently, some pilot technologies are showing interesting results to increase the mass balance up to one ton of biomass per m3 and even more.

1.4 Biomass production, start of the operations.

Tuzetka as *biomass supplier* produces pellets. The first target was the straw pellets for energy dedicated to the Polish market.

In 2007 Tuzetka started seeding of switchgrass and energy crops in Vinnitsya, in Byla Tserkva and Poltava.

In 2009, a group of investors has incorporated Tuzetka and started the pellet production in Byla Tserkva (100kms south of Kiyv), details are highlighted under 5.2.
In 2010, Tuzetka has joined the consortium “Pellets for Power”.

If the production facility could be managed at a rather affordable price, the main difficulty was to identify the markets (chap. 2), the regulations and obstacles (chap 3 and 4).

2 Dutch market profile, approach and feedback.

2.1 The Dutch targets for renewable energy.

The investigation made by Tuzetka started at the occasion of the project Pellets for Power (P4P). Nearly all pathways were screened: pellets for energy, biofuel second generation (2G) and fiber.
Tuzetka got feed back from the power plants, one district heating operator and step by step follow up from the biofuels producers as well as the fiber based manufacturer.

The general overview about the energy situation in the current Dutch energy situation is characterized by a primary energy consumption of 3495 PJ (2010). The main energy sources are natural gas (1643 PJ), oil (1299 PJ) and coal (318 PJ).

Renewable energy sources currently make a contribution of 94 PJ (avoided primary). Approximately three-quarters of the renewable energy produced in 2010 came from biomass (*source:Goh, Juginger, IEA Task 40, country report the Netherlands, 2011*).

The renewable energy source (RES) share set by the Renewable Energy Action Plan was defined as following for by the Dutch government (with interim milestones) to achieve the Directive 2009/28/EC:

	2011	2012	2014	2016
RES - Heating & cooling (%)	4	4,4	5,2	6,2
RES Energy (%)	9,1	12,5	19	24,4
Transport (%)	4,2	4,6	5,6	6,8
Overal RES share	4,6	5,6	7,7	9,7

The Dutch target toward RED are set at 14% of total energy by 2020. Current situation shows a market share for the RES of about 5%. This should nearly triple at the horizon 2020 to reach the 14% target production with RES i.e. biomass, energy savings, wind, solar.

The scenario in place for the total energy consumption is targeting a substitution of 30% of the fossil energy (3000 PJ, baseline scenario 2010) by biomass PJ for 2030.

Assuming an average of 16GJ per ton biomass, 60.000 tons of herbaceous biomass have the calorific value of one peta joule (1.000.000 GJ).
To substitute 900PJ at the horizon 2020, more or less 50 millions tons of biomass need to be mobilized, at a glance.

Therefore a pellet supply chain from Central Europe could be oriented either to the large scale power plants (utility and co-firing) either to the district or domestic heating to gain substantial benefits.

The Dutch market is characterized by its energy intensive industries, the density of the population (477 inhabitants/km2) with 82% of the population living in urban areas.

2.2 Situation in Europe.

According to EU global figures, in 2011, the share of renewable energy in EU's countries was 12.7%, but the situation was very different from country to country.

- Sweden has exceeded its target in 2013.
- Latvia (32.6%), Finland (32.2%), Austria (30.1%) and Portugal (24.6%) are on track to meet, exceed their targets.
- The lowest achievements are in Malta (0.4%), Luxembourg (2.8%), the United Kingdom (3.3% out of 15%) and the Netherlands (3.8%), (*The contribution of renewable energy up to 12.4% of energy consumption in the EU27 in 2010, Eurostat News release, June 2012*).

As in many others neighboring countries (France, Belgium, UK), the goal is to put in place a national strategy that will allow the reach the "RED 2020" Dutch targets as set in the National Renewable Energy Action Plan.

Some reasons will be detailed below: economical downturn, feed in tariff, the model of the biobased economy.

2.3 Utilities and co-firing.

In the late 1990s, the focus of the energy industry has shifted towards larger amounts of biomass and permanent co-firing. After 2000, all production companies intensified their co-firing activities, the main reason being a covenant between the power producers and the Dutch Ministry of the Environment, signed in 2002, and the increasingly high REB-tax (ecotax) exemption and later the feed-in tariffs for co-firing clean biomass.
The co-firing is not requiring large investment as the biomass is mixed with coal (*source: Junginger, M; Faaij, A 2005, IEA Bioenergy task 40)*.

This incentive will last till 2015 what is a short-term perspective for substantial investment.

2.3.1 Constraints

Nevertheless, the sector is facing several key challenges and constraints explained below under 3.1.

1) Technology
2) Emission and air pollution directive
3) Energy efficiency

2.3.2 Feed in tariff (FIT).

Among the incentives to support the development of the co-firing, the feed in tariff (also named commonly green certificates) are in place.
A power plant is producing one Mwh from renewable energy source and they get 100% feed in tariff per Mwh produced. The production price with fossil fuel is ranging around 50 to 60€/Mwh (benchmark: 35€/Mwh as upper average for energy costs from a nuclear power plant).
With the biomass fuel, some investments at the gate of the power plant are needed into safety devices (wood dust is explosive) and roofed storage.
The aim of the feed in tariff is to cover the difference between the costs of fossil energy and the biomass.

The feed in tariff is covering the price difference between the price of the coal and the price of the imported biomass.

In 2013, thanks to the crisis, coal has reached a very low price while shale gas is an rising and realistic alternative (see 2.3.3).
Coal is traded at 95$ per ton what is about 9 euro per Mwh. Biomass is traded at 130€ per ton (27-30€/Mwh) and gas (for steam turbine power plant) is traded at a similar price +/30€/Mwh.

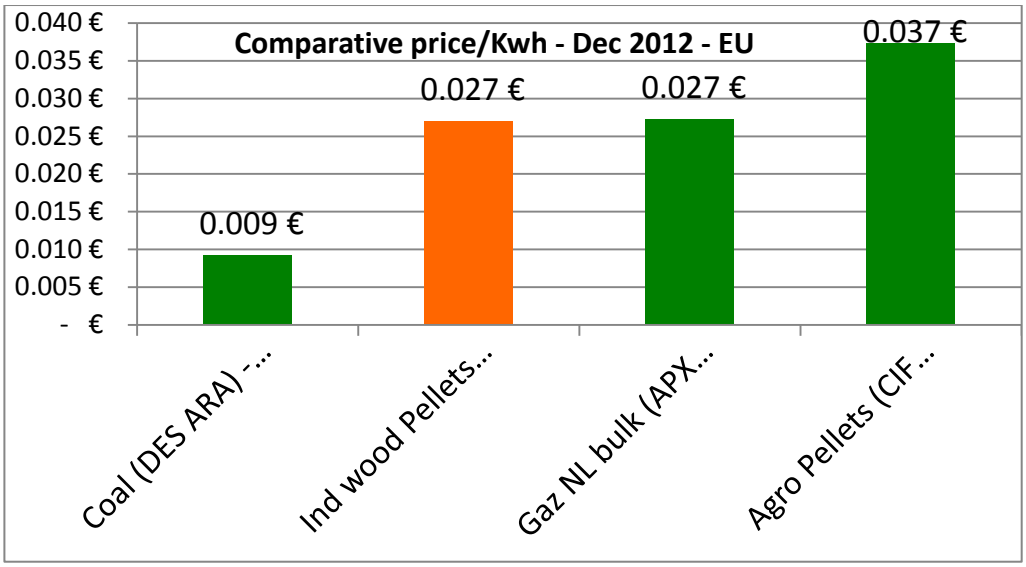


Table 1 Price comparative, coal from Platts (August 2012), Gaz and wood pellets (APXEndex) for energy intensive companies.

Efforts to switch from fossil energy source to renewable source by means of biomass haven't yet taken up.

The biomass suppliers haven't any benefit of the feed in tariff.

2.3.3 A new incomer, the shale gas.

The shale gas billowing out of American soil is a source of concern as well as cheap energy.
Environmentalists worry that fracking, the technique for dislodging gas from shale beds, may pollute the air and local water supplies. The glut of natural gas has a less likely set of victims, too. Instead of banking handsome profits, many of the oil and gas firms that drill for shale gas are suffering from the boom.
Abundant supplies and slow growth in demand have sent gas prices crashing. In 2008, shale gas fetched $12 per million BTU (British thermal units) at Henry Hub, a crossroads of pipelines in Louisiana that serves as the main pricing point for the gas in America. (source The Economist – economist.com)

One million BTU is equivalent to 0,293Mwh. With a price of the shale gaz at 4$/MBtu, this is the equivalent to 2,7€/Mwh (without liquefying and shipping cost), nearly one tenth of the biomass price, a lower price than the coal's reference CIF ARA.

Table 2Price evolution of shale gas in US, Bloomberg, Febr. 2013

Since then the *frackers* have been hard at work. In US, shale gas now provides a quarter of supplies. The rapid rush of gas onto the market has sent prices tumbling.
After falling to below $2 per mBTU in early 2012, prices have now nudged back to $3.40. But for many drillers this is still not enough. Most gas wells require $4 or more to cover costs.

In early 2013, several large European energy intensive industries have announced that the energy price abroad is a serious incentive to relocate their industries to stay competitive at the world wide level.

This is not an issue for the utilities company that need to be located near their domestic market but it may impact the industrial market perspective for these utilities.

2.3.4 Summary of the energy & utility sector, the bio energy model.

Energy infrastructure is long-term investment and is requires long term perspectives.
It takes 3-5 years for the permitting and the construction and then 30 years for operation.
During the 50-70's, the option to produce electricity was managed by State companies (later privatized in the 80's).
Today, in the frame of their development, these large private multinationals have also to face

- many small competitors like developers of wind mill, photovoltaic, small biomass power plant and the energy efficiency of new devices (e.g. the light-emitting diode, LED).
- Longer permitting period for the construction of new power plant, citizens are more and more "NIMBY" minded and NGO's are active against large corporations,
- Uncertainty about the electricity consumption, the energy efficiency of devices is counter balanced by possible new users like the electric cars.

These factors are impacting the size and the maturity of the future EU electricity market. Investments plans need to integrate the competition with others players active in the renewable energy and the reliability of their key large, industrial customers leaving for shale gaz (or cheaper energy) countries.

The long term perspectives of the future market is also not matching the short term expectations of the shareholders and financial market.

The Dutch market is relying on a few large players (Electrabel, Eneco, RWE-ESSENT-Vattenfall, Nuon). Therefore, the common approach will be oriented to "large volume, low price".
Large volume of fuels (biomass, coal) have to be delivered in several locations with a high concentration of utilities. But the fossil model is based on several assumptions:

Fossil model	The biomass model in 2013
- predictible model : based on national planning and implemented by state company (in the 50-60's), then privatised	- unpredictible model : climate change with high variation nof temperature in short period of time (heat) and inpredictible production of renewable electricity (PV and windmill)

Fossil model	The biomass model in 2013
- no environmental constraint	- Kyoto Protocol
- easy acess to cheap primary fuel : coal, gaz	- biomass is not a commodity rather a by-product that has to comply with food security and sustainable criteria
- high concentration of production sites (nearby industries, urban areas)	- the model is highly decentralized and the market is recording the downturn of the intensive energy users
- energy inefficient (65%)	- the production of heat by means of biomass may be efficient with certain conditions.
- emission of air pollutants (CO2, NoX, ..)	- biomass is emitting pollutants with chlorine and alkalis content

Today, the emerging Dutch biomass model for producing energy (heat and electricity) and in operation is a highly distributed concept.
As displayed in the table below, 80% of the electricity production is produced by only 2% of the power plants in term of units in operation (all sizes).

The biomass model is highly decentralized and working very close with the sourcing.

	Mwel	%	Units in operation	%	average Mw_{el} per unit
methane from water waste plants (biomass)	40,17	0,9%	78	33,6%	0,5
digester from waste (biomass)	14,64	0,3%	23	9,9%	0,6
Fruit, waste fermentation (biomass)	6,12	0,1%	6	2,6%	1,0
Co-digester (biomass)	94,54	2,2%	92	39,7%	1,0
methane from industrial waste (biomass)	14,58	0,3%	11	4,7%	1,3
Small scale power plant (<50MWe)	117,1	2,7%	7	3,0%	16,7
waste combustion (biomass)	576,85	13,4%	10	4,3%	57,7
Large scale power plant (>50MWe)	**3445**	**79,9%**	**5**	**2,2%**	**689,0**

Table 3 Distribution of biobased energy production (biomass, biomethanisation) in the Netherlands, 2012.

Therefore the project to convert existing large power plants to biomass power plant is perhaps not the most accurate.
On the other hand, this is the easiest way for governments to reach the binding RED targets for 2020. Similar supports for the co-firing are in place in UK, France.

2.4 Heat and household. and co-firing.

The household heating market by means of domestic boilers or district heating is an interesting market and could be put in place at a faster tempo.

The density of the population (477 inhabitants/km2) among which 82% is living in urban areas is an asset to promote such policy.

According to the medium version prognosis of the Dutch statistic office (CBS), *the Dutch population will increase from 15.9 million in 2000 to 17.9 million in*

2030. The number of households will increase from 6.8 million to 8.3 million. Most of the residences in 2030 have been constructed before 2000 and will therefore be heated with natural gas. The average consumption per residence will decrease because of the demolition or renovation of old houses and because of energy-saving new houses. The demand will also decrease, because more heat will be released by increasing production and consumption of electricity (by means of CHP).

The consumption of warm tap water per person will remain the same and will decrease per residence. A part of the growth, which results from a growing population, can be met by a growing use of sun collectors.

The average lower heat demand per house, certainly in new houses, will decrease the economic advantages of district heating. The contribution of district heating will therefore stay more or less equal. By stimulation of the consumption of residual heat

The expected consumption for the households is expected to be 235PJ from natural gas (cooking and heating) while the electricity should reach 115PJ at the horizon 2030 (*Biomass in the Dutch Energy Infrastructure in 2030,Rabou and Deurwaarder, Elbersen and Scott, 2006*).

The intensive promotion of electricity use was the business scenario in the 80's and 90's for countries having nuclear electricity production, at relatively cheap price.

Wind and photovoltaic are not a predictable and storable energy.
The climate changes shows extreme upper and lower limit in temperature with very cold winter during a short period of time while hot temperature may arise in the summer for a few days.
Therefore heating and cooling will be very probably used in excess during the peak load periods (warm or cold).

Nevertheless, two favorable elements may bring a significant benefit to new small scale district heating scheme.

a) Price of biomass, even if imported is much lower than the current price for fossil energy (see below).

b) Energy storage (with water tank) may play a significant role for buffering heat production during the base load and release the energy especially during the peak load for delivering warm tap water or warmth for heating.

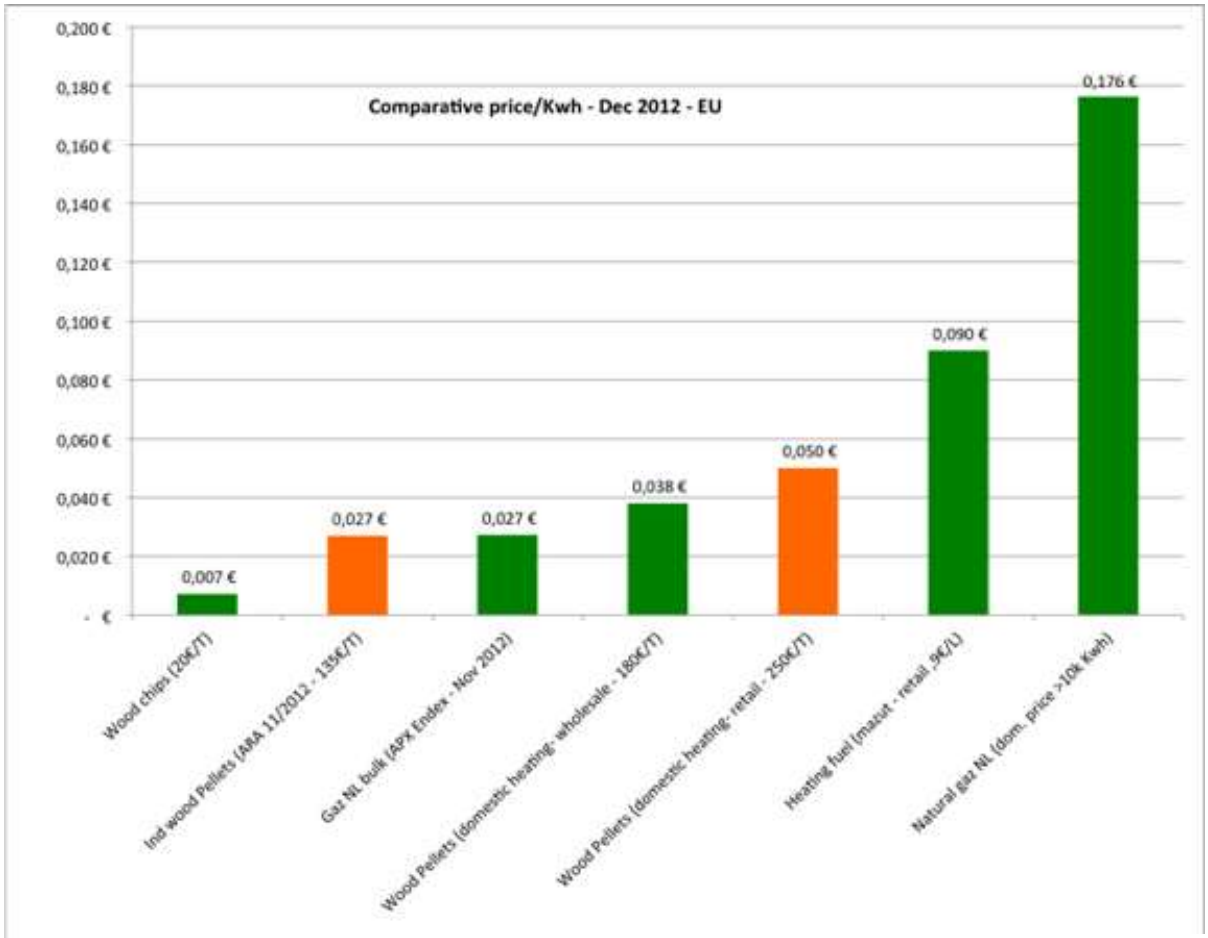


Table 4 Price comparative of the fuel as primary energy for domestic heating: coal, biomass, gaz.

2.5 Straw for animal bedding

About 110.000 tons of straw husks, straw bales are yearly imported in the NL *(source Faostat, 2008*). This market could be a complementary market to the agropellets for energy. The quantities in demand are today supplied in bales from France, Turkey and Central Europe i.e. also some from Ukraine.

The straw bales delivered are ranging from 130 to 150€/ton delivered in NL by truck or by containers and sea vessels.

The interest of the herbaceous pellets is the high absorption rate by comparison with the baled straw. Therefore, the GHG balance during the transport to the farm is favorable and must be also considered.
At a price of 170-180€/ton, straw pellets are offering an economical advantage of 30 to 50€/ton vs. the baled straw thanks to the higher efficiency and absorption rate (twice the rate of the baled straw).

Animal bedding is used the whole year (broiler, turkey litter) and the same pellet format can also be used in winter for heating the broiler stable.

Wheat, barley straw is harvesting during the summer (reed straw during the winter), but its use is in the winter time, this market will need to rely on roofed storage capacity.

With 40 millions broilers, the market potential for the poultry bedding is estimated to 3-4kgs per broiler or +/-120.000tons per year.

Cascade in use: reed straw with chicken manure could be used later on for biogas plant. Then the digestate could be somehow densified, pelletized and used as organics fertilizers.
According to the main farmers cooperative (DEP) in the NL, more than 400.000tons of chicken manure (on a total of 1,2mios tons) could be used as organic fertilizer either in the NL either exported abroad to Ukraine or others countries that are importing massively mineral fertilizers.
Organic fertilizer may be a valuable freight for the reverse logistic.

The final price is an issue and the organic fertilizer will need to compete with the mineral fertilizer (by mean of price and/or urea and ammonia content) for the very large crops farm in Ukraine.
For agri sectors with a higher added value (vegetables, wine yard), organic fertilizer is a serious often missing binding block to get the certification of their entire organic supply chain. This market is in development.
The market behavior among the farmers and wine makers is rather positive.

2.6 Fiber market, bio-Composite panels materials and applications

Bio-composites are engineered agri-fiber panel products for use in many applications where wood based particleboard, MDF, hardboard, soft board and some grades of plywood are currently used.
The world fiberboard market, mostly using wood, is estimated to 11Bios $ with a wider interest for the herbaceous based fiberboard.

These bio-composite panels are manufactured using MDI polyurethane as a binding agent which produces a "Zero Formaldehyde" or "Formaldehyde Free"material.

This means that bio-Composite panels have emissions far below the strict E1 European low formaldehyde (LF) standard and the USA (HUD 24) standard. These materials are therefore suitable for specification in environmentally sensitive areas such as schools, nurseries, hospitals, public buildings, laboratories, museums and nursing homes, or any domestic application where the end user has concern for their living environment (*source CS Process Engineering*).

Figure 1 sample of fiber panel boards from herbaceous biomass.

One company was identified in the NL. Compakboard Heerenveen bv will launch a production facility in Heerenveen (northern part of the Netherlands) being operational in 2014. They are intending to use up to 28.000tons per year of straw based material. The process can accept nearly any kind of herbaceous material.

In Belgium, the company Unilin is working on a similar development, without more information delivered. The French company Demeyere in France is also intending to expand in herbaceous based fiber board and looking for an affordable supply.

The interest of the formaldehyde free particle board is the life cycle assessment (LCA) with a possible use of the fiberboard waste for energy (if exempt of fossil based coatings).

With *Compakboard's* staff and their engineering supplier, it was noticed that the pretreatment of the herbaceous biomass *in situ*, especially the milling and the drying of the material can be performed outside the plant.
For producing particle board, usually from woody and more and more project based on herbaceous, the biomass is shredded, milled and dried. This pretreatment usually made in Western European plant is also performed during the pelletizing process.
Especially the length of the fiber can be adequately sized up to the requirement of the end-users what is usually a length exceeding 5-6mm (while for the energy purpose, the particle length cannot exceed 3mm).

The benefit is to deliver a pretreated raw material, milled and dried, so with more added value from the sourcing area to the plants.

The drying in the sourcing area will get the benefit of a lower energy cost. Assuming that in average, the moisture content has to be reduced by 10% in average (about 100liters of water), 100kwh or 10 liters of heating oil, m3 of gas will be necessary at a cost of (0,09€/kwh) or a total cost of 9-10€ per ton.
The costs of bioenergy in the sourcing area will be performed at a fuel cost of 0,018€/kwh (assuming a price EXW of 75€/ton) what is 80% lower than in Western Europe with a fully renewable energy and a contribution to the LCA and the energy balance of the final product.

The market players are in the development phase. The quantities in request per project and location are ranging from 20.000 to 100.000tons per year.

2.7 Tissue paper market.

This market was not investigated but will become also a challenger for the resource.
World demand for tissue paper rose more than 4% in 2011 to 30.5 million tons while it soared by 18% to 7.3 million tons in China.

It takes 4.5 m3 of green wood to produce a ton of tissue paper whilst it takes 2.15 m3 to produce a ton of pellets.

Assuming world paper and paperboard production grows by 2% per year through 2011–2021 and that the share of recovered paper is held constant at 55%, demand for market pulp could increase by around 30 million tons or 50% over that period.

2.8 Biofuels second generation.

Transport and biobased industries are also promising end user. Technical parameters and quantities in demand are kept confidential by the corporations active in the sector.

Two initiatives are today launched by several key players:

- sustainable leaders of biofuels: an initiative from Clariant, Dong Energy, Chemrec, British Airways, BTG Group, UPM Kymene, "the Leaders of Sustainable Biofuels are determined in stimulating the EU policy towards accelerated industrial research and innovation into emerging biofuel technologies, including algae and new conversion pathways, supported by

public and private policies promoting deployment",

- Bridge 2020: Our vision is for a competitive, innovative and sustainable Europe: leading the transition towards a post-petroleum society while decoupling economic growth from resource depletion and environmental impact. In this vision, the Biobased Industries will optimize land use and food security through a sustainable, resource-efficient and largely waste-free utilisation of Europe's renewable raw materials for industrial processing into a wide array of biobased products:advanced transportation fuels, chemicals, materials, …. In doing so, biobased industries will play an important role in spurring sustainable growth and boosting Europe's competitiveness by re-industrialising and revitalising rural areas, thus providing tens of thousands of high-skilled research, development and production jobs over the next decade.

The aims are to foster the long-term policies necessary for such investment. Most of these corporations have launched pilot scale plant but are facing a shortage of structured supply chain. No security of supply will drive a reluctance of the investors to acquire licenses or invest into the new industrial plants.

This market is only emerging and is complicate to size.

Most of the best available technologies for biofuels 2G are heat intensive model. The exact concept of bioefinery, an industrial combination of heat production and recuperations seems to be most sustainable model.
The Danish Maabjerg project of Dong Energy or the Lappeenranta Biorefinery model managed by UPM in Finland seem to the most efficient models. They are relying on existing plants like waste incinerator or pulp factory; The heat and residues are cascading among the facilities inside the biorefinery project.

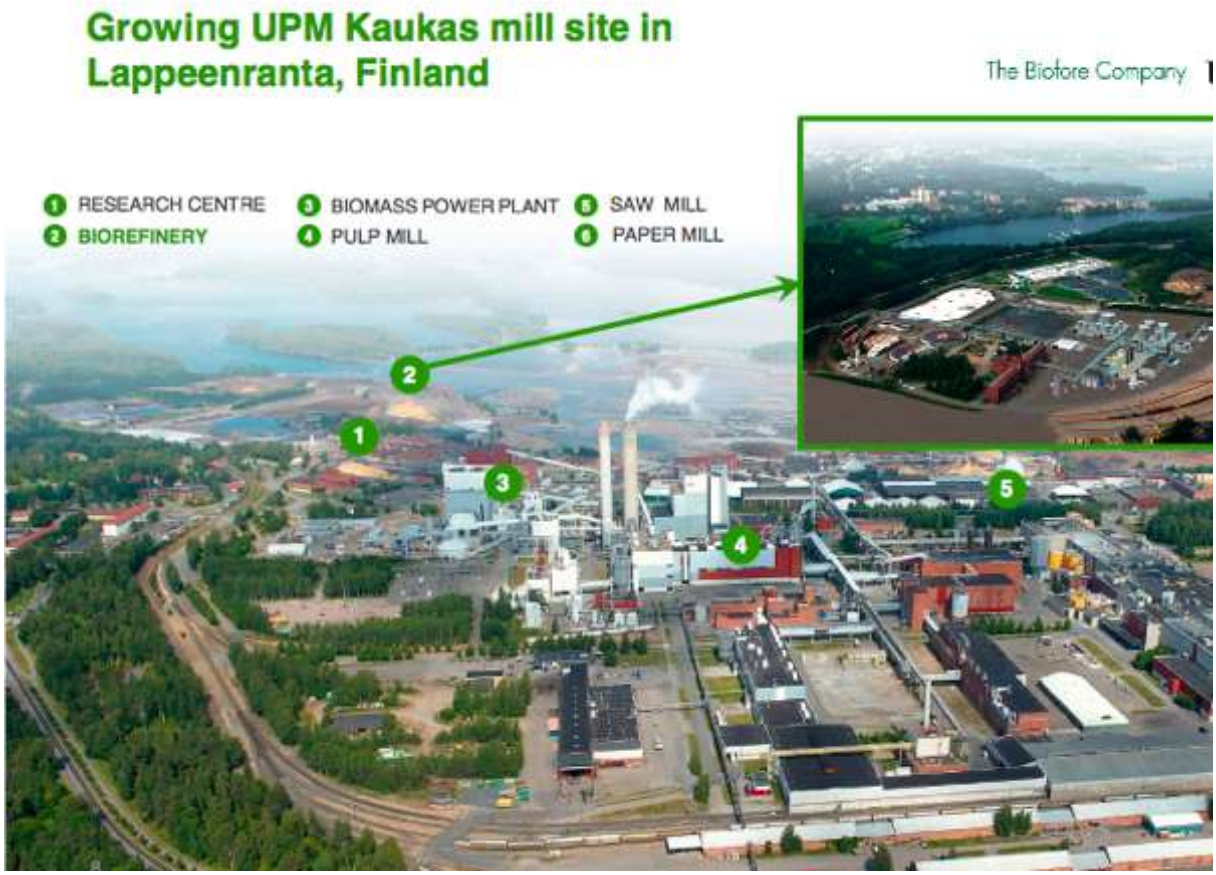


Figure 2 UPM Biorefinery concept.

Such biorefinery project is requiring several industries and large financing. Therefore, a stable policy framework is mandatory.

2.9 Dutch market approach.

2.9.1 Utilities, trial delivery in Poland.

Before the project P4P has started, during July-September 2009 and then in 2010, trucks were shipped by Tuzetka to **Poland** where the supplied pellets were qualified as "good" (*Source Vattenfall Poland*).
The quantities that have to be delivered had to be larger and regular with deliveries per wagon (the usual transport mode for coal) rather than by trucks.

For its renewable energy policy, Poland had established very interesting feed in tariff for agro biomass. Wood was originally not included in the FIT program. Nevertheless, the policy that should come into force by 2013 was postponing at the demand of the Polish utilities company (with domestic capital).

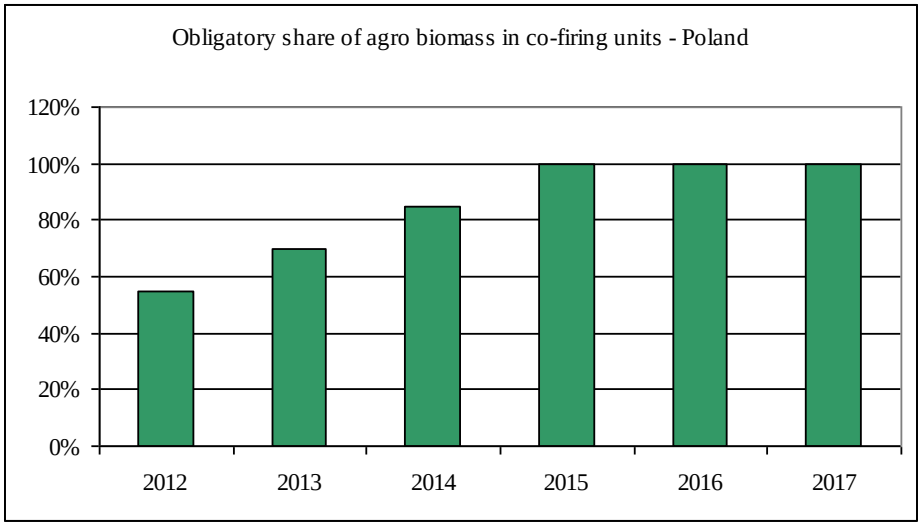
Poland has an ambitious program of a twofold increase in power generation with the use of highly efficient cogeneration technology by 2020. They are targeting to reach 15% of renewable energy by 2020 and 20% by 2030.
Further certificates, namely red and yellow ones, have been introduced. They are given to heat and electric power plants, also those using biogas plants, which produce both heat and electricity and have high energy efficiency. By specialists, this is called highly efficient co-generation.

Producers of energy from renewable sources can receive two kinds of colour certificates green as well as yellow or red.
Currently the price of green certificates is over ZL270 (€67,1) per 1MWh.
Yellow and red certificates cost even more.
At the same time the average market price of 1MWh is ZL195 (€48.5). For producing electricity from renewable sources using highly efficient co-generation, the producer can earn almost ZL800 on every Mwh (€200). This means that now the Polish system of support for renewable energy industry is the European most attractive, especially for companies that want to use biomass and biogas.

As a result of negotiations on the assumptions of the draft Directive on the system of trade in emissions, Poland was granted the possibility of applying a transition period to the obligation of purchasing all authorisations to emit greenhouse gas since 2013 by electrical systems.
The said transition period will prevent eliminating coal from the portfolio of primary fuels, which would result in weakening Poland's energy security.

Introducing standards for building coal-fired power plants within the system of preparation for CO2 capture (CCS) resulting from the new EU regulations will allow fast introduction of those technologies when they are ready for commercial use.
The combustion of biomass from forestry will (would) be limited. After 2015 co-firing with forestry biomass will not be seen as renewable technology and not be granted the feed in tariff (100% phasing out for the existing co-firing) as showed on the table below.

Table 7: Obligatory share of agro biomass in co-firing units – Poland



Nevertheless, the policy that should come into force by 2013 was postponing at the demand of the Polish (with domestic capital) utilities company.
Another uncertainty for the Polish utilities but also for the biomass suppliers.

2.9.2 Utilities in the NL, mailing & request.

The first step for approaching the Dutch market was the easy contact with the power plants and their demand.
Among the five main utilities (Electrabel, Nuon-Vattenfall-RWE-Essent, Eneco, E-On), the last merging and acquisitions in the sector didn't ease to identify the who's who in the utility sector in 2011.

[1] *Exchange rate : 4,34PLN for 1€ as of 18/09/2011*

During the last quarters 2012, several mails and request were sent to potential off takers, mostly the utilities active in the NL.

Among the five main utilities, only one negative answer was received so far.

For this market, the main hurdle is the selection's criteria for the biomass which is keeping only the woody biomass eligible which is the most compliant fuel with the PF boiler technology (see regulatory obstacles under 4.1).
Then the scale of the supply was not enough in comparison with the large US and Canadian pellets plants.

The perspectives for 2013 and over remain positive. The NL is expecting to release its new policy for co-firing.

2.9.3 District and domestic heating market.

The Dutch district and domestic heating are a promising sector. The approach was oriented to the reseller of pellets. For the domestic heating, they also are relying on the wood pellets. Their choice was not commented
New projects are arising across the NL. The power usually installed is ranging from 500kw to several MW thermal output. Most of them are today supplied by local biomass: woodchips, straw, manure.

These new investment are installing new technologies like the fluidized bed boilers. This kind of boiler is working efficiently with herbaceous biomass and local biomass like woodchips, biomass with high ash content.

Several others market players were approached, like the company Bioforte with the very first district heating fuelled with biomass (wood chips) and a running new installation in Marum with a thermal output of 500kw, the first fully dedicated biomass district heating plant in the NL.

All of the districts heating projects are interested to be supplied with herbaceous pellets with several conditions:

1) they need to install the technology and realize the investment (Rotterdamse Hogeschool)
2) they will rely on sustainable import when the local sourcing will be in shortage.
3) sustainable criteria is a selection criteria.

Some others program were also identified which needs to make the prior investment into a new boiler.

In 2011 a project named *Holy Warming* started to find sustainable ways to heat one of the largest church buildings in the Netherlands. This was the reason to explore the market segment for churches in more detail, to learn about possibilities and thresholds regarding the introduction of agro pellets for heating. Most of the aspects mentioned here are more generally applicable regarding the agro pellets market.
Total number of religious buildings in the Netherlands is estimated 8.100. Of these, a number of 500 Roman Catholic churches are counted in two western provinces in the Netherlands (Zuid- en Noord- Holland; respectively diocese Rotterdam and Haarlem). In average a boiler heating capacity of 270 Kw $_{th}$ is installed in every of these churches, according the architectural bureau of the Rotterdam diocese.

The relationship between heating capacity and annual consumption is expressed in operating hours, and for a church building these are low, often less than 1.400 hours/a. A church with a capacity of 270 kWth has a natural gas capacity of approx. 30 Nm3/h and thus an expected annual consumption of about 40.000 m3, however with a high peak load what is the equivalent of 90 tons of herbaceous biomass per year.

Hellemans Energy Consultancy acts as central buying organization for a churches collective. They serve a number of over 3.000 gas connections in this collective and conclude that 40.000 m3/a should be regarded as a major consumer.
Only 50 gas connections within the total of 3.000 within the collective have a consumption of over 40.000 m3/annum (1.000m3 of gaz is the equivalent energy value of 2,2tons of herbaceous biomass).

On average the 3.000 connections use 9.500 m3/a, the equivalent of 20tons of herbaceous biomass, not only for church buildings, but also for many smaller parish halls and other buildings in the vicinity that make use of a gas connection.

Consumption of natural gas will take place during about 8 months of the year, with a peak in consumption in wintertime. Interesting was a remark from diocese Rotterdam regarding the possible need to replace direct heating systems (with direct blow out of hot air) by heating boilers to protect often delicate church interiors. District heating is not included in the collective that Hellemans serves. There are however churches that are served by district heating, like in Rotterdam. Hellemans estimates that they have a market share of 50%, which fits quite well with the total number of religious building.

The company Hellemans is an interesting party. Hellemans Energy Consultancy specialises in managing and advising clients in the purchase of energy. In addition to energy procurement, they offer many other services in the energy field.

A test delivery couldn’t be attempted. The prior condition is to convert an existing boiler with the adhoc device for biomass. Therefore, the test need to be turned into operations.

Therefore, the sustainable import is in a loop “ chicken and egg”. Who is going to start in first? How to supply a trial load, if the off takers don’t have the installed technology.
This is the operational solution to supply herbaceous pellets in the NL.

For the holly warm program, the potential market is estimated to be around 60.000tons of biomass per year.

2.9.4 Biofuels 2nd generation.

The Spanish Abengoa company is active in Rotterdam (Europoort) wit an output of about 30mios liters produced from 360.000t of grain (biofuel 1st generation). In US, Abengoa Bioenergy Biomass of Kansas (ABBK) is a company of Abengoa Bioenergy that will operate the new biomass-to-ethanol biorefinery located in Hugoton, Kansas. The construction of this "first of a kind" commercial scale biorefinery facility will allow ABBK to utilize their proprietary technology that has been developed and proven over the last 10 years to produce renewable liquid fuel from earth´s most abundant organic feedstock source – plant fiber, or cellulosic biomass (biofuel 2nd generation).
Outline of the project:

- The 6 millions liters/year biorefinery will be on-line and expected to be in full production by the end of 2013 or by early 2014.
- The refinery - which will be fueled 100% by biomass- will produce 6 million liters of ethanol derived from nearly 350,000 tons of biomass annually.
- The plant will utilize approximately 1,100 dry tons of biomass per day in the ethanol production process.
- The residue of that process will be combusted along with 300 tons/day of fry, raw biomass material (feedstock) to produce 18 megawatts of electricity. This power will make the entire facility energy efficient and environmentally friendly.

Up to now there is no other commercial scale project in the NL.

Market potential as targeted is about 200 to 400.000tons of biomass per plant. An important criteria is the conversion factor, how many liters can be obtained from one of biomass what is highly depending of the technology. Usually, a factor 3 is used.

Nevertheless, most of the technology supplier recommend to build up new plants in areas rich of raw material.

2.9.5 Survey: herbaceous biomass supply chain.

In August 2012, a market survey was performed near 115 recipients from a bulk mailing list. The answers collected from 24 recipients are rather positive.

The survey was neutral meaning that the respondents could not be identified if they didn't post their mail address.

The purpose was to identify some interest to supply a test load and also to establish a common supply chain.
The survey was open to Benelux, German and Danish stakeholders, as usually the primary energy is traded between these countries.

Among the answers, the last one was promising with the amount of positive recipients: more than 70% are interested "to join a consortium willing to establish a common supply chain".
This is stressing on the commodity trading which is still missing for biomass despite large import North America.

2.10 Conclusion: what are the obstacles for herbaceous biomass import to the NL?

a) Utilities and power plants are doubtful as to the quality of biomass pellets, hence their rejection. Calorific value is lower due to higher ash and more risks of fouling, corrosion, slagging and emissions.
Technologies, especially by means of additives like lime, exist to tackle the problems arising from the organic parameters of the biomass.
Consistency of volumes and qualities remain a concern, as the combustion parameters require continuous adaptation and monitoring to the biomass source.
The volume available and the lack of contractual frame agreement is certainly the main hurdle.

b) Herbaceous biomass for bedding is an interesting solution for poultry farm. The cascade in use, the favorable GHG balance for the transport are among the two criteria for promoting this kind of bedding. The supply chain from Ukraine will compete with the Danish and German traders. The price has to be the lowest

(even the absorption rate can easily explain the difference).
Nevertheless, the sanitary certification will be the main hurdle. Agro byproducts from Ukraine are often facing import restriction and the reliability of the Ukrainian sanitary certification scheme must be solved. This hurdle is of course accurate in period of bird flu.

c) The fiber market is in development and some follow up may be expected in 2014.

d) The district heating market is probably the easiest to supply and will offer the best benefits to the customers. A specific recommendation is addressed below under 2.9.

e) Some perspectives can be expected from the biofuels 2G. The necessity to build up the biorefinery concept is not an incentive to speed up the emergence of such fuels.
A more stable and binding policy framework at the EU level is expected.

The main conclusion is the development of the biomass supply chain that should be developed under an umbrella organization ensuring the quality and the most important the reliability, security of the supply for a stable price.

Such concept, the "Bioenergy Trade Centre" is developed below under 5.3 and is similar in his approach the warehouse grain receipt which has fostered the development of the grain industry in US and Poland or the successfully agro cooperative model in France, Germany, Denmark and in the NL.

3 Qualitative obstacles for herbaceous biomass.

Previous chapter concluded there might be a problem with herbaceous biomass in terms of the chemical composition, which causes problems in the combustion process.
This chapter provides a analysis of this problem.
Herbaceous pellets generally perform below wood norm combustion. Utilities report increased problems with fouling, slagging, corrosion, and emissions. This is related to a difference in chemical composition among types of biomass and among batches from different areas and harvesting seasons.

3.1 Utilities and power plants, qualitative obstacles specific to the sector.

3.1.1 Co-firing.

The co-firing of the pellets with the coal is the easiest way to achieve the RED target. In this respect, old power plants have been revamped for biomass co-firing by means of new storage and handling technologies.
For the co-firing, one of the constraint are the ash melting point that need to be in line for the two fuels: coal and wood.

Coal is a common commodity while biomass is not yet becoming a commodity. The security of the supply, moreover on long-term period, is hard to secure.

3.1.2 Technology.

The technologies of the power form (PF) power plants are largely based on large combustion chamber where the coal is pulverized (powder form).
The wood pellets are crushed before the pulverization in the combustion chamber and mixed (or not) with coal.
This combustion with pulverized particle is causing ash slagging and ash ring especially when the raw material is already with a high ash content like the herbaceous biomass, pellets. The PF boilers burns coal at temperature exceeding 1.000C°. For the reed pellets from Poltava, the shrinkage starting temperature is around 830°c.

The new technologies and especially the fluidized bed combustion (FBC) burns fuel at temperatures of 760 to 930C°, a range where nitrogen oxide formation is lower than in traditional pulverized coal units.
Fluidized-bed combustion evolved from efforts in Germany, Europe to control emissions from roasting sulfate ores without the need for external emission controls (such as scrubbers-flue gas desulfurization).
The mixing action of the fluidized bed brings the flue gases into contact with a sulfur-absorbing chemical, such as limestone or dolomite.
More than 95% of the sulfur pollutants in the fuel can be captured inside the boiler by the sorbent.

The sorbent also captures some heavy metals, though not as effectively as do the much cooler wet scrubbers on conventional units.
Commercial FBC units operate at competitive efficiencies, cost less than today's units, and have NO2 and SO2 emissions below levels mandated by most of European and international standards.

3.1.3 Emissions, air pollution directive.

With their old technology, current coal powered electricity plants will not comply

with industrial emission directive, will need to be replaced also considering their lifetime (*source: www.eurelectric.org*). The directive on air pollution is stipulating that the emission should not exceed the PM10 level (10 particle per million) and go below. Biomass is emitting more NOX than coal (source: Directive 2008/50 prevention of air pollution).

Being installed near urban areas, the power plants have also to comply with the NOx emissions. The nitrogen used in agriculture is contributing to the NOx during the combustion. In this respect, the reed pellets analyzed have higher nitrogen content (0,55%) than the straw pellets (0,44%).

"Given the lifetime of the power plants and the pollution directive, governments should include the opportunity to change both technology and fuel (biomass) and modernize the power plants" (*source: www.eurelectric.org*).

The Netherlands have also very strict regulations in this respect. For the region Rotterdam, the matter of objection regarding any possible additional emissions of Particulate Matter (PM) and NOx should be taken into account. Starting 1.1.2013 in the Netherlands the BEMS-regulation regarding emissions will apply also for smaller boilers, up to 400 kW capacity, or maybe even below (discussions are pending). For smaller boilers, the NeR applies. Local governments can not deviate from the BEMS once determined. Pilots on woodchips showed NOx-emissions can be problematic. The BEMS should be regarded a very strict Regulation, even more strict that for instance in Germany.

3.1.4 Energy efficiency.

The power plants, most of them built up in the 60's-80's, are based on old technology. The steam turbine efficiency in converting the energy content of the steam into mechanical energy is limited to about 40%. (Carnot's Efficiency Law) while most of the heat is released in the atmosphere.
Three tons of biomass will deliver after combustion 1 ton equivalent of electrical energy.
Cumulated with the possible losses during the transport, the handling, the global efficiency of a biomass supply chain for producing electricity is probably not the most convenient. Electricity is also part of the clean transport roadmap by means of electrical vehicles, train transport.

The low efficiency will impact the price of the primary fuel. A low price for the primary fuel means that a reliable and sustainable biomass supply chain will be not easy to establish with a long-term perspective (for the security of supply).

There is also a rising public opinion supported by NGO to criticize such large project (Nymby effect).
In conclusion, a revamping is the faster and more affordable solution by using existing centralized production units for achieving the national RED targets.

3.1.5 Commodity trading (quantitative obstacle).

The biomass market is emerging and the biomass for energy *per se* is not yet a commodity. Most of the purchasing department of the energy intensive industries are used to deal with a commodity like coal, gas. This a reason of the lack of mutual understanding between suppliers and of takers.

In the case of the biomass, the purchasers have various demands such a long term contract and guarantees of the feedstock, very sharp contractual dispositions with most of the risks beard by the suppliers.

Suppliers don't have any support, feed in tariff to launch a specific supply chain.

3.2 The dutch heating market.

Others markets should be more promising: industrial and domestic heating markets.
Such market is driven by many customers and to trigger the market behavior, serious arguments have to be presented, benefits and constraints of a shift from fossil to renewable energy:

3.2.1 Energy efficiency.

Biomass used for heating will be the most convenient use for energy. Indeed, the efficiency of a biomass boiler is reaching 80% and over. Nearly each Mwh is used for energy, heating supply. The global energy balance may remain efficient.

On the other side, the households will need to be well insulated for reducing its energy needs, footprint. The situation in the NL is at the edge in Europe. With an average 90kwh/m2/year energy consumption, this is among the best result in Europe and is driving low energy consumption for heating.

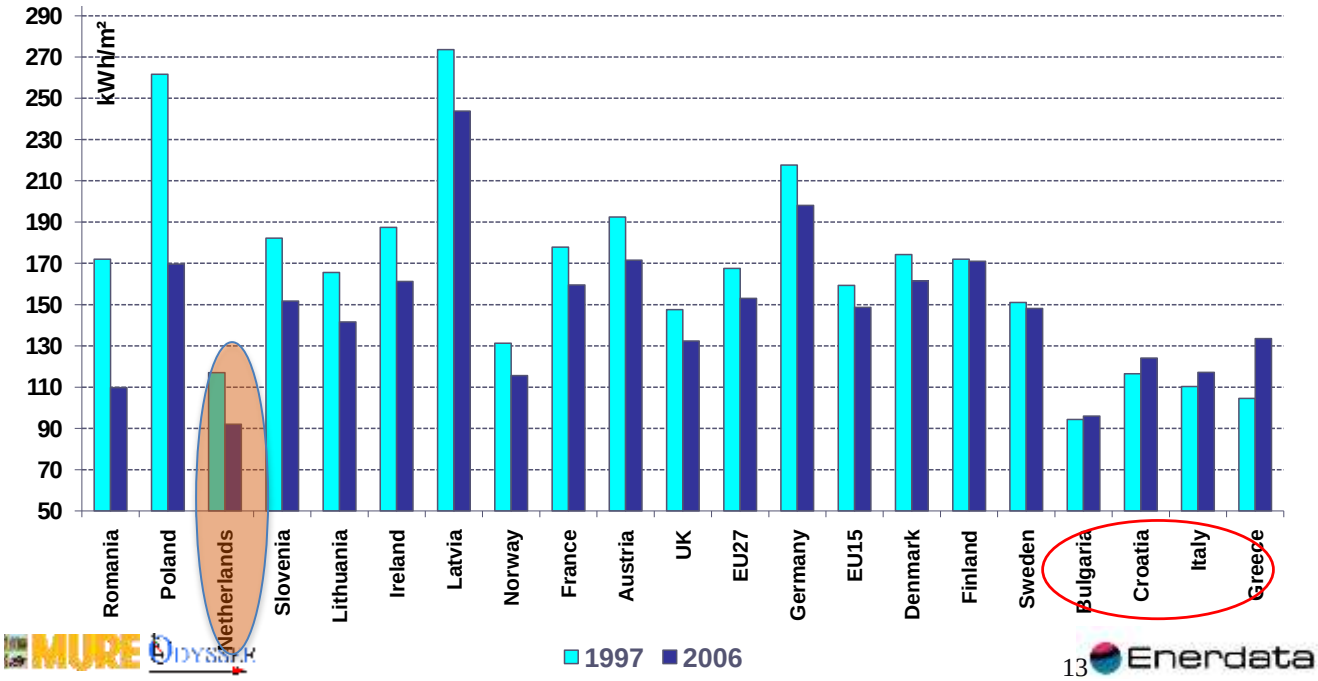


Table 5 Source MURE, Energy consumption in households, EU 27,

Therefore the economical benefit of a better insulation, comfort at home is probably not powerful enough to trigger the market behavior.

B) Emissions and air quality.
Installed in urban areas, biomass is emitting fine particle during its combustion. The size of the particle (PM2,5) is seen as the source of many breath and cardio-vascular diseases which have a social impact and costs. Technologies are available to reduce substantially the fine particles emission in urban areas by means of ceramic filters. Such system is affordable for boiler from 200-300kw.

C) The price of the fuel for heating.
The rising cost of the fossil energy for heating is becoming a serious expenditures for households and some SME's.
With an average price of 9€ç/kwh for the heating oil (based on the cost of 0,9€/liter with a calorific value of 10kwh/liter) or the gas, the delivered cost of the herbaceous biomass is reaching 5 to 6€ç/kwh.
The Dutch households are dominantly heated by natural gas (80%) used for both heating (95% of the consumption) and cooking (5%).

The benefit is immediately accounted by any household when refilling their heating oil tank (or preferably their pellets tank) with a prior condition to change either the boilers (if the model is with a low efficiency) or the burner that will use herbaceous pellets as fuel.

Individually, each argument may not contribute to a global market behavior to shift from fossil energy to renewable energy. Together, with a sustainable approach, there is a room to incentivize the citizens or group of citizens to shift from fossil to renewable energy and its efficient use.

Heat and food are the primary comforts expected by any citizen.
Sustainability and fair trade are deeply rooted in the Netherlands.

3.3 Different qualities of herbaceous biomass, biomass test reports.

Among the sales criteria, the suppliers need to perform analysis and to issue a kind of material data sheet (MDS).

Herbaceous biomass varies in quality, from one biomass type to the other (wheat straw vs. reed straw) and within the same type of biomass from one location to the other (e.g. reed form Poltava or from Odessa) and from one season to the other. The certification and pre-analysis before shipping is mandatory.

	November 2011	December 2011	January 2012	February 2012	March 2012
Ash %	7,07	9,77	3,32	5,05	3,91
S %	0,14	0,14	0,09	0,08	0,08
Cl %	0,189	0,156	0,052	0,081	0,056
N %	0,53	0,66	0,54	0,56	0,43
P %	0,03	0,03	0,01	0,02	0,02
SiO2 %	86,51	91,3	79,9	90,57	87,51
Al2O3 %	0,9	0,94	0,94	0,94	1,88
CaO %	1,76	1,51	3,77	1,51	4,02
K2O %	4,56	2,03	0,82	2,42	1,01
Na2O %	2,11	0,67	0,77	1,28	1,06
Q min MJ/kg	15,2	15,3	16,5	16,1	16,0
Q maxMJ/kg	18,9	19,7	19,6	19,7	19,3

Table 6 Seasonal quality variations (reed test report by Phytofuels, Poltava region, 2011).

The analysis performed during the project are showing a high ash content for the straw and the reed pellets.
The main parameters to be analyzed for the trade are the moisture content, the ash and alkalis content.

The moisture content is directly impacting the calorific value. More the product is wet, less is the energy content. This price is highly dependent from the calorific value as the customers, the utilities, are purchasing primary energy.

The moisture content has also an effect on the grindability (abrasion), the property of the pellets to be turned into dust during the transport and transboarding operation.
For wood pellets, dry dust is an explosive material and therefore needs to be manipulated carefully.
Dust is also not burning very properly; therefore, the power plant is emitting flying ashes (or solid unburned particles) in the exhaust of the combustion.

Purpose		**Energy, bedding**	**Energy, bedding**	**Energy**	**Energy**	**Energy**
Raw material		straw (June 2009)	straw (June 2009)	sawdust (Avril 2011)	woodchips (Avril 2011)	Reed (Odessa) March 2013
analysis performed by:		SGS Odessa	OFI Vienna	SGS Lviv	SGS Lviv	SGS Bremen
Species		barley, wheat	barley, wheat	pine, broadleaf	pine, broadleaf	data as received
Format		pellets	pellets	sawdust (Avril 2011)	woodchips (Avril 2011)	pellets
Size						
Length		20-40	20-40	2-5	20-20/30	20-20/30
Diameter	mm	6-8	6-8	2-5	20-20/30	8
Volatile mater						
moisture content	%	11,15	19,2	62,2	18,5	9,4
Bulk apparent density	kg/m3	623		175	238	684
Abrasion/Grindability	%		19,2			2,7
Gross calorific value (as received)	GJ/ton		15,1	5,3	11,4	16,3
Net Calorific Value (dry basis)	GJ/ton	14,6	16,8	16,3	13,9	15
ash content as received basis)		9,57		0,48		8,2
ash content (dry basis)	%DM	10,77	8,41		2,91	8
Bark content						0
Initial softening t°			800			
Initial melting t°	C°		1325			
Chlorin content	%DM	0,04	0,04	0,09		0,073
Sulfur Content	%DM	0,12	0,07		0,13	0,049
F	ppm					
Kalium	mg/kg	5500	5500			
Nitrogen	%DM	0,09				0,44

Table 7 Analysis of various kind of biomass, Tuzetka, 2009-2013 .

The second key element is the ash content.
The ash has also an effect on the calorific value (less carbon) but has a specific effect during the combustion due to the softening or melting point of the ash. Usually, biomass is co-fired with coal which has a higher softening and melting point. This figure is not easy to measure and therefore the exact explanation of the impact is not always obvious.
The combination of both fuels needs to adapt the combustion to the lowest figure what has an impact on the efficiency of the boiler.

Chlorine is the third exclusive criteria. A high ratio of chlorine has a corrosive property in the boiler room but is also emitting dioxin what is not recommended in urban areas. Sulfur is playing a protection role vs. chlorine.

The solution to tackle the ash and alkali effect are existing by means of selective harvest time or additives and were tested by several companies and Universities.

4 Economic and regulatory obstacles for herbaceous biomass.

After the qualitative obstacles, the regulations and the economical aspects may impact the feasibility and the development of a biomass supply chain.

4.1 Regulatory and certification issues.

4.1.1 CEN wood pellets standard

EU pellet market is regulated by several standards focusing mainly on the use of wood pellets.

Several schemes are in place to standardize the pellets: ISO at the international level, the CEN is relying the ISO norm for Europe.
From the operational point of view, the CEN standard is elaborated in collaboration with the European Pellet Council (EPC), an umbrella organization representing the interests of the European wood pellet sector.
The aim of EPC is to establish European standards for the pellets for co-firing or for heating (*source EPC website*).

The ENplus quality certification is a major step towards establishing pellets as a widely used energy commodity. For the first time numerous national standards and certification, like the famous German DIN+ or Austrian Ö-Norm which are a quality label, are replaced by one uniform system based on the EN 14961-2 standard for wood pellets.
This system has been agreed upon by the European Pellet Council in January 2011 and thus enjoys the support of large parts of the European pellet sector.
A key advantage of ENplus is, that pellet quality is managed throughout the entire supply chain including production, storage and transport all the way to the end consumer.

The standardization has the aim to boost technical standard and to establish a European grade biofuel mostly for domestic heating device not for industrial purpose.
Three standards are in use and based only on woody raw material. The difference between each standard is mostly driven by the origin of the wood. The matter has the aim to avoid contaminated wood for example waste wood from the construction sector with varnish or similar treated products that could emit pollutants during the combustion (EN-B, below).

ENplus-A1	ENplus-A2	EN-B
Stem wood Chemically untreated residues from the wood processing industry	Whole trees without roots Stem wood Logging residues Bark Chemically untreated by- products and residues from the wood processing industry (no wood from the demolition industry).	Forest, plantation and other virgin wood Chemically untreated by-products and residues from the wood processing industry Chemically untreated used wood

The European Pellet Council is working on a fourth category for industrial pellets mostly for power plant in close relationship with the utilities.

Another category, dedicated to agropellets, is smoothly under investigation. This project is now carried out under name **MixBioPells** and funded by the Intelligent Energy Europe initiative. The market is not taking of therefore and there is no reason to standardize such kind of herbaceous, agro pellets.

4.1.2 IWPB Standard

In addition to the CEN standard and the EN certification scheme, several corporate standardization initiatives have been taking place.
IWPB is a group of Europe's largest power utilities, including GDF Suez, Vattenfall, Dong Energy, Eon, RWE-Essent, Drax, and Delta. Fortum was a member until recently, but dropped out due to differences on how best to demonstrate sustainability.
Many wood pellet contracts traded today certified with either the Green Gold Label certification scheme (ESSENT), the Laborelec-SGS Solid Biomass Sustainability Scheme (GDF Suez) or the Drax Biomass Sustainability Implementation Process.
IWPB's goal is to "facilitate trade between utilities through uniform contracting." To accomplish this, the group's objectives are to create a standard contract for wood pellet trading, to create uniform specifications for industrial wood pellets, and to create common sustainability criteria" (*source Canadian Biomass Association website*).

Until the most recent meetings, wood pellet producers were not allowed to participate, leading them to view the IWPB utilities as colluding to control the pellet market by dictating pellet specifications, contracts, and sustainability verification procedures to producers.
The IPWB working group does not take into account herbaceous biomass, only wood pellets. The reason for excluding herbaceous biomass is the high ash content of the herbaceous biomass and the N-K-P (alkalis) and the constraints are developed above (see under 3.3).

The CEN certification is dedicated to set up common rules for pellets producers and domestic heating boilers producers. In the case, of IWPB, the outcomes of the regulation is to establish one common regulation for all pellets producers (vs. 4-5 in the past) and also to transfer most of the risk on the head of the pellets producers.

Nevertheless, a contribution of the IWPB was the definition and implementation of the sustainable criteria.
Recently, Eurelectric, the sector association representing the common interests of the electricity industry (some are members of the IWPB consortium) at pan-European level, asked for "EU harmonized, mandatory sustainability criteria that will provide a stable investment climate for energy producers and biomass suppliers," according to Hans ten Berge, Secretary General of EURELECTRIC in a common declaration with AEBIOM, the European Biomass Association.

"Over the last years, the absence of such harmonization has led to varying national sustainability rules, undermining the goal of achieving an EU-wide internal energy market by 2014. This regulatory complexity hampers trade both within the EU and internationally and increases costs. The current uncertainty on the outcome and timetable of possible new EU measures on biomass sustainability is now delaying biomass investments. Immediate establishment of mandatory criteria will support the continuity of sustainable biomass deployment". (*source Eurelectric, March 2013*).

The industrial pellets norm, the fourth category mentioned above will be released by the end of 2012 by the EPC in close collaboration with the IWPP.

The working group has collected and established a list of criteria for the Biomass sustainability standards that are acceptable by all the power plants owned by the consortium members.
The same criteria are used by others players like the Ap-Endex (see below 4.2.5).

4.1.3 Biomass sustainability standards

In addition to technical pellet standard, there are initiatives for sustainability standard. Here again, standardization initiatives are based on wood pellets, not herbaceous.
Within the IWPP group and in collaboration with the European Pellets council, a specific committee is working on the EN Plus sustainability principles.

1) GREENHOUSE GAS BALANCE (GHG); the greenhouse gas (GHG) savings along the entire life-cycle, taking into account the whole supply chain including production, processing, transport and end-use are at least 60% with respect to reference fossil fuels,
2) CARBON STOCK; production of woody biomass does not significantly take place at the expense of the net carbon balance of carbon reservoirs in vegetation and soil.
3) BIODIVERSITY; production of woody biomass may not take place in areas with high biodiversity value, unless evidence is provided that the production of that raw material did not negatively interfere with nature protection purposes;
4) PROTECTION OF SOIL QUALITY; production of woody biomass should maintain or improve the soil quality.
5) PROTECTION OF WATER QUALITY; production of woody biomass should not exhaust ground and surface water and should avoid or significantly limit negative impacts on water resources.
6) PROTECTION OF AIR QUALITY; production of woody biomass should avoid or significantly limit negative impact on air quality.
7) COMPETITION WITH LOCAL BIOMASS APPLICATIONS; production of wood pellets should not endanger food, water supply or subsistence means of communities where the use of this specific biomass is essential for the fulfilment of basic needs.
8) LOCAL SOCIO-ECONOMIC PERFORMANCE; production of wood pellets should respect property rights and contribute to local prosperity and to the welfare of the employees and the local population.
9) ETHICS; ethic principle covering at least health & safety, human rights, freedom of association, compulsory labour, child labour, discrimination, environmental responsibility, business integrity, corruption in all its forms.

The order and numbering of the Principles do not reflect any priority ranking. ENPlus requests the same realization level for all principles from its biomass suppliers.

This draft document was presented in June 2012. A join document was prepared for a join presentation to the European Parliament.

Today, the situation is a request form the players to get a mandatory framework. It will result in postponing policies, investments to achieve the RED by over

2020.

4.2 Economical and operational issues.

4.2.1 Critical scale of biomass supply and production

If any producer wants to be accepted by the customer e.g. a utility company as a regular supplier, the power plant, he should have minimum quantity 20.000 to 40.000 tons of pellets per year. This is a requirement from company like EDF trading and Vattenfall Poland. This is a strong buyer's power market.

All risks for transport up to the gate are endorsed by the producer or the trader. Then only large trading companies are active now in the pellets supply chain for selling the pellets because they can bear these risks.
They have the logistics knowledge what is not the case of the producer, farmer. This means they have strong bargaining power as compared to producer.

A pooling of the supply is a solution to offer a reliable and sustainable supply chain from European countries and better balance the interests of both supplier-producer and the customers.

4.2.2 Perspectives for the pellets market in the NL.

The Dutch electricity market is awaiting the future co-firing policy (3Q2013).

Projects in the NL, the Benelux will definitely increase the pellets consumption for the future.

Company	Potential Demand (t)	Countries	Likely Timing
UPM	TBC	Finland	2013-2014
Eesti Energia	90,000	Estonia	2014
Helsingin Energia	100,000-200,000	Finland	2014
Eneco	300,000-700,000	Netherlands	2014
Ence	100,000-150,000	Poland	2014
Foresta Capital	75,000-125,000	Spain	2015
Antwerp Biopower	600,000-1,200,000	Belgium	2016
Belgium Eco Energy	650,000-700,000	Belgium	2016

Table 8 Argus Media, New sources of European pellet demand, AEBIOM conference 2013

But the significant take up will come from UK where several large power plants will be converted to co-firing or fully dedicated plant.

Company	Plant	Generating capacity	Estimated volumes	Completion	Status
RWE	Tilbury, 2 units	750MW	2-3mn t/yr	Dec-11	Operational
E.ON	Ironbridge, 2 units	900MW	2-3mn t/yr	Jan-13	Ramping up
Drax	Drax, 3 of 6 units	600MW per unit	7-8mn t/yr	Apr-13, 2014, 2017	First unit operational
Eggborough Power	Eggborough Power Station, 4 units	2000MW	7-8mn t/yr	first unit 2015?	Formal equity-raising process launched
RWE	Lynemouth, 3 units	330MW	1mn t/yr	No date	Planned
International Power	Rugeley, 2 units	1000MW	3-4mn t/yr	No date	Planned

Table 9Source Argus Media, UK conversion from coal to biomass, AEBIOM conference 2013

UK and its aggressive support scheme may redraw the maps of pellets in Europe with a favor for US and Canadian import.

The wood resources will be more under pressure. There is a room to co-fire wood pellets with herbaceous pellets. In this respect, the regulatory authorities should enlarge a bit the threshold criteria for accepting herbaceous pellets.

4.2.3 Security of supply (in Ukraine).

Any producer must provide a proof of supply. The need is to proof supply from field to the plant. Of course, nobody wants or is able to sign upfront this contract and related penalties at the beginning of the season. Too many uncertainties at the upstream supply chain: time slot for harvesting, climate conditions,….

The solution is again to aggregate/pool the resource.
The biomass feedstock his a highly volatile market:

- 100% seasonal feedstock,
- narrow harvesting time slot, sometimes not exceeding 15-20 days only to bale the straw.

If a supplier is bound per contract by 40.000 tons then he must deliver.
There is no room for error. One week delay production delay (for climatic reason) could represent 20% of the total amount.
Sometimes straw yields are also lower. For example in 2011, Ukraine (and several countries in Europe) have a encountered a very low straw yields per hectare because of drought and frost damaging the harvest (winter grains).
The equipment ratio of tractor and combiner is also very low in Ukraine. According to the EBRD, 70% or agricultural equipment operating in Ukraine is obsolete, cutting the efficiency of the production.
It means producers have to invest in baling equipment, even new tractors to secure his feedstock needs, adds more capital expenditures and costs to pellet plant.

Figure 3 Second hand straw baler, Ukraine


Figure 4 Loading and interim transport of straw, Ukraine, winter 2010-2011

The farming sector in Ukraine may benefit of loan support form commercial banks in Ukraine. Interest rate are ranging from 20 to 25% interest per annum while the own contribution is averaging 15 to 50% (*source KyivPost, March 2013*).

On the top of these amazing conditions, Ukraine is not exactly listed on the short list of the of takers even if everybody is recognizing the untapped potential of the country.

The situation is very similar in the neighboring countries like in the Balkans, Serbia, Bosnia, Macedonia), Moldova and also Romania and Bulgaria.

4.2.4 Biomass is not yet a commodity.

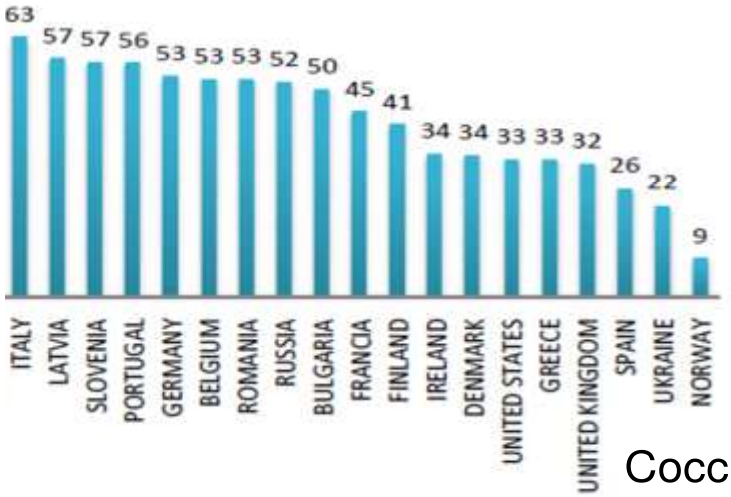
To supply power plants or others customer with, for example, 40.000 tons per year, you need to secure the funding, the upstream supply and the downstream delivery.

Assuming that one investor says "ok", in Europe, 2-3 years are necessary to get permits and the civil engineering works for the construction of the plant, secure the supply and finalize the 10 million euros investment in this plant with a capacity of 5 tons per hour (40.000tons per year).
Price of a pellet plant is ranging from 0,7 to 1,5mios€ per ton/hour of production capacity.
This (stationary) activity is highly dependent from upstream supply usually the sawdust and more and more round logs.

The demand for wood pellets already outstripped the supply of sawmill residues. Trend towards *verticalization* of the sector with larger pellet manufacturers, even some energy producers moving upstream along their supply chain (i.e. RWE – Georgia Biomass in U.S. see below under 4.3.1).

Sawmill residues is still the main feedstock, but difficulties in sourcing feedstock at competitive prices will increase what will drive the sector to low utilization rate of the installed capacity in many pellet mills, only 53% on average with large difference between the countries what is not always reflecting the sole feedstock problem.

Capacity utilization rate (%)



Cocchi et al. 2011

Table 10 Utilization rate of pellets plants in the World, Cocchi et al. 2011

A need for a more stable and secure supply of feedstock has emerged the interest of producers in the supply of alternative feedstock such as roundwood and forest residues is growing.

Downstream customers, the utilities, are looking for medium/long term supply agreements with well-defined volumes and prices

Biomass is mostly an emerging B2B market with very high price volatility, subject to sudden changes due to events.
A British power plant burned down in February 2012, in less than 1 week priced of biomass in stock exchange dropped (*comment from a Utility's head of biomass supply*).

4.2.5 A rising commodity platform, APX-ENDEX biomass exchange

In 2008, APX-ENDEX launched the Industrial Wood Pellets price index in response to the market's need for price transparency. There has been increased interest in the trade of biomass contracts and, as standardized exchange-traded contracts did not exist.
APX-ENDEX saw this as an opportunity to respond to the requirements of the market.

APX-ENDEX and Port of Rotterdam announced their cooperation in July 2010. A joint feasibility study to investigate the possibilities of establishing a biomass exchange was finalized in November 2010.
http://www.apxendex.com/index.php?id=291

On 3 November 2011, the world's first Biomass exchange was launched by listing industrial wood pellet products, including 3 month, 3 quarter and 3 calendar contracts.

The AP Endex is also an adequate solution for more transparency.
Brokers and traders are showing another wider picture of the biomass market. As the power plants want to mitigate the single supplier's risk, but instead focus on

multiple suppliers, they rely on several traders. The traders are in contact with several suppliers
Suppose three power plants, the first is requiring 50.000 tons, plant B another 50.000 and the same for the plant C. The real market demand is 150.000 tons.

Each power plant gives mandate to two different traders to source 150.000, so it appears to the market that there is a demand of 300.000 tons.
Consequences, the producers are investing in equipment based on the prognosis, but can only sell only (e.g. half). So market is over supplied, price is going down. Combined with rising price of the feedstock (see above 4.2.1), pellets plants are facing some financial problems.

4.3 Is the pellet production a profitable and bankable business?

The banks/investors understand that power plant get feed tariffs, a kind of state guarantee, to guarantee safely revenues.
But a producer of pellets doesn't get feed in tariff, no likely "state guarantees.

Without "strong guarantee", the operational risks especially in the remote areas of Ukraine are too high for investors and banks.

4.3.1 Large subsidized wood pellet import volumes.

The Dutch pellet market is largely driven by imports from US, Canada, Europe (Portugal) and Russia. The main exporting countries are outside the EU.

For large volume, large pellets plants are a more suitable solution allowing industrial scale benefits. Most of the plant's locations are next to a harbor for a direct loading of the production into vessel.

In Western Russia, Vyborgskaya is the largest plant (1Mio tons/year) located near St Petersburg.
Waycross in Virginia, US, this plant (150Mios€ investment) is operated by BMC and RWE with a production of 750.000Tons per year. The production of Waycross is transported by railcar to Savannah (200kms). *"Around 1.5 million tons of green wood is required annually to manufacture the pellets. In contrast to Europe, the southeast of the USA has a significant surplus of wood. This is particularly true in the state of Georgia which has a highly developed forestry sector. Forestry growth here is far above the regional consumption thanks to the favorable prevailing climatic conditions".* (*source RWE website*).

Canada is also exporter of wood pellets from Alberta and British Columbia. The production in Canada was driven by the mountain pine beetle bug epidemic impacting huge swaths of forests in British Columbia and parts of Alberta, a result of the climate change with a succession of hot, dry summers and mild winters.
The allowable harvest in British Columbia fallen by 10 million cubic meters since 2008 (a *shade* over one-tenth of the allowable cut) and could be reduced by another 20 or 30 million square metres over the next few years.
Combined with an increase in demand from China – which now represents around 7 per cent of all North American production – the overall reduction in the volume of timber available for use in Canada and the US to the tune of 12 to 22 per cent.
Add that to demand pressures associated with a likely recovery in US housing construction, this is a recipe for long-term upward pricing pressure exists and a

good news for the timber industry. (*source Timber Prices to Surge Following Beetle Epidemic: Report, Design Build Source Canada, March 2013*).

In the next years, several very large plants are scheduled to be operational in Brazil. The Group Suzano (pulp & paper) is intending to build up production facilities of 3 Mios tons/year.

Such project are backed up by large corporations already active in the sector: RWE (German utility working with Blue Circle), UPM Kymene, Suzano (pulp & paper) or new players like ENVIVA able to raise funds especially on the American financial market.

They are also relying on some state support for cleaning the forest contaminated with beetle pine or in regions with a low employment rate (Georgia and others South Eastern US states).
This is still a subsidized market model: production and combustion of the pellets. Will it last?

Nevertheless, the bioelectricity market is driven by the production capacity. This is the rule for the biobased economy: the supply is the main driver.

4.3.2 Distributed model for biomass supply.

The model, promoted by Tuzetka, is based on small scale pellets plant with an output of 20 to 30.000tons per year in a distributed network across a region for the production of pellets for the local supply (local district heating, see below Biomass Trade Centre under 5.3) and the export.

Risk mitigations are higher (no risk of shortage of biomass in the region, the equipment can be removed), the risk on the equipment is distributed on several locations and plant.

The twin markets, local and export, can mitigate the trading risks with local benefits.

The small scale model has an effect on the size of the business plan. Investments (CAPEX, capital expenditures and working capital) are lower and in the case presented in the production report is including also tractors and combiners to collect and process the biomass.

This size of investment (1,5Mios€ per equipment) is not the favorite model of private investors and commercial banks.
Development banks and international financing institutions (international financial institutions –IFI- like EBRD or similar active in Central Europe) are funding a local biomass production for the local market, not for export or even a twin marketing (export and local) and moreover, the priority is given to the production of electricity which may rely on the feed in tariff.

In the distributed model, the price (€ per ton) shows an attractive level of price. The prices ex works are in average 86-88€/T. The assumption is based on 75€/T FCA (EXW with custom clearance costs) for export and 110€/ton for the local market incl. transport to the customer's plant in Ukraine.

€/Ton (revenues or expenditures/total yearly production)	2014	2015	2016	2017
average inflation 3-5%/year	**€/T**	**€/T**	**€/T**	**€/T**
Revenues (VAT excl.) - 30 days vendor credit – average price :75€/T FCA for export and 110€/T for the local market.	**66**	**86**	**88**	**89**
Operational Expenditures (VAT excl.)	**-62**	**-65**	**-67**	**-69**
Feedstock	-19	-19	-20	-21
Average purchase biomass + harvesting	-12	-12	-13	-13
Transpor & distrib (fuel (@30L/hour-1,2€/liter)	-6	-5	-5	-6
Manpower (€/mill, x shifts*3 workers+soc ins.)	-2	-2	-2	-2
Processing	-27	-27	-28	-28
energy (0,12€/Kw/h x time/month)	-15	-16	-16	-17
packaging	-2	-2	-2	-2
Storage (net production + security)	-5	-5	-5	-5
Insurance material	-1	-1	-1	-1
Maintenance & Repairs (€)/ pelletiser-month	-4	-3	-3	-3
Transport International - Export	-5	-5	-5	-5
National transport & distribution	0	0	0	0
Custom clearance (INT)	-5	-5	-5	-5
Administrative & manpower	-8	-8	-9	-9
Management,admin & travel costs, permanent staff	-3	-2	-3	-3
Manpower (€/mill, x shifts*3 workers+soc ins.)	-4	-5	-5	-5
Certification (SGS, Veritas or =) per pelletiser	0	0	0	0
Rent factory (or mobile installation)	-1	-1	-1	-1
Gross margin	**4**	**21**	**20**	**21**
Costs (coaching+mutual fund BTC projects)	-3	-2	-2	-2
R&D + Devlopment energy crops	0	0	0	0
"Varia" > crops establishment, R&D,	0	0	0	0
External advisors (certification)	-1	1	1	1
Overheads	-1	-6	-6	-6
EBITDA (income-curr. exp.)	-1	14	13	13
Depreciation (material,…)/4 years	-7	-6	-7	-7
EBIT	-9	8	6	7
Interest (rate): 10,0%	-3	-2	-1	0
EBT	-9	8	6	7
Corporate Income Taxes (average)	0	-2	-3	-3
EAT (Earning after taxes - 25%)	-1	15	16	17
Cash flow	**5,99**	**20,74**	**23,01**	**23,40**
Net operational cash flow (excl. Depreciation)	**-1,44**	**15,16**	**16,32**	**16,71**

Table 11 cost breakdown about the operations of 20.000tons of pellets p.a.

5 Business strategies for supplying herbaceous biomass to the NL.

In the previous chapters, we have reviewed that the market sends some good signal, a demand exists. The supply chain is not yet structured and the herbaceous biomass is missing the commodity label.

Biomass currently meets 4% of the EU's energy needs (69 million tonnes of oil equivalent (toe)). The aim is to increase biomass use to around 150 million toe by 2010. An increase of this magnitude could bring such benefits as:

- diversifying Europe's energy supply across Europe;
- significantly reducing greenhouse gas emissions * (209 million tons);
- direct employment for 250 to 300 000 people;
- potentially lowering the price of oil as a result of lower demand.

Over the legal environment the market is not relaying the efforts.
Nevertheless, the focus should be stressed on bottom up actions instead of a top down approach.

5.1 Start of the operational production, Tuzetka's case in Ukraine.

In 2007, Tuzetka started seeding of switchgrass in Vinnitsya, in Bila Tserkva (100kms south of Kyiv) and in Poltava.

In 2009, Tuzetka was incorporated under the Belgian law.
Tuzetka aimed at producing pellets, considering at the time apparent easiness of market, the low investment and the regular incomes by selling pellets.

Figure 5 Workshop of Tuzetka in Byla Tserkva, Ukraine

The first target of the company was to produce agropellets from various kind of biomass. The workshop in Byla Tserkva was surrounded by straw and the decision was to produce straw pellets for energy to the Polish market.

After the quick installation of the plant in Ukraine in May 2009 with an output of one ton per hour, the production was sold to the Polish power plants.
Quickly, one bottle neck appeared: the too small production capacity.

One ton per hour is rendering a mere 100tons per week (equivalent to 4 trucks as the maximum loading in Ukraine is limited to 22tons (vs. 25-30 in Europe).

With a running production, the solution was to identify new markets potential and it was the case with the animal bedding.

The Benelux is net importer of straw, Germany has a low production of straw for animal bedding or feeding with the extensive production of maize for the biogas plants.

Locally in Ukraine, it was noticed that the energy became a hot topic. The embargo on the gas by Russia (Winter 2009 and 2010) have demonstrated the dependency of the country toward the energy imported. The management of the power plant of Byla Tserkva (200.000 inhabiants) was looking to convert one of their boiler to biomass boiler at least for heating purpose. In several villages visited, the same question did arise: how to use the local feedstock for heating purpose.

During this period, new challenges have arisen like the indirect land use change (ILUC), the carbon debt etc… All these new questions haven't yet found a solution but have definitely assessed question marks about the biomass as a sustainable renewable energy and of course among the customers and the investors.

5.2 Strategy for a sustainable supply chain to the Netherlands.

The renewable electricity market is characterized by very large players.
The heating & cooling market is a more disseminated and wider market with domestic customers, district heating, the market of the greenhouses and industrial zoning with SME's.
A market approach needs indeed many players and no oligopolistic player.

Sustainable approach by the suppliers, a behavior in favor of the sustainability from the customers and a sustainable price are the key elements to foster a long term sustainable development.
The oil & gaz (O&G) market needed more than one century to take over and to become mature and was largely supported and/or owned by the States mostly for the infrastructure expenditures. Coal, oil and gas were also the root of the EU with the European Union for Coal and Steel.

The renewable energy market, especially renewable electricity is also largely supported by the Member States. Nevertheless, the feed in tariff for wind energy or photovoltaic have showed some limit to be supported only by the state budget what means also to be paid by the current and future generations of tax payers. For example, the bill presented to the customers for Wallonia is estimated at 6Bios€ up to 2020.

In this respect, biomass for heating and cooling is representing an affordable and sustainable alternative combined with others energy efficient and affordable technologies.
Such project can be implemented in the Netherlands as following.

5.2.1 Focus on district and domestic heating applications in the NL.

a) Some situations in Europe.
In **Denmark**, district heating has been the central instrument in shaping one of the most efficient energy sectors in the world. While natural gas and oil prices have been soaring over the last decade, district heating customers have benefited from green comfort at very stable prices (*Euroheat & Power, press release may 2012*). Denmark is proving that's possible.

In **Belgium**, the city hall of **Nivelles** (city of Tuzetka) has an heating bill of 900.000€ per year for its public building (library, swimming pool,..). The price of

the heating oil is rising for reaching 0,09€/kwh. A shift from the heating oil to the biomass will offer 40% savings on the fuel's bill (at the wholesale price) but will require of course the installation of either new boilers either new burners.

The city of **Aachen** in Germany is consuming 80.000MWh of energy per year (16.000tons of equivalent biomass) to heat its public buildings. The savings can represent up to 4Mios€/year for the municipal budget and a savings on the fuel's expenditures of about 16.000tons of CO_2 per year.

In **France**, 30% of the households (what is representing 150.000 households) in the Northern part of France, Picardie, are in *energy poverty*. The energy bill is exceeding 10% of the monthly revenues of the household. The average energy bill per household is 3.000€/year (1/3 electrical appliances, 2/3 heat and cooking). The government is seriously considering the policy to renew the old building stock (500.000 households per year).

b) **The Netherlands**.
As highlighted above, the 82% of the Dutch population is living in urban areas. This is the perfect spatial structure to promote the district heating based on the energy contracting model.
Since 2009, the local municipalities have launched building awareness campaigns to promote the use of renewable energy and energy efficiency.

In the Netherlands, natural gas is the preferred fuel for almost all heating in buildings and in industry. According Agentschap NL, approx. 4% of the housing market uses collective heating, run by either housing corporations or apartment owners organizations. Next to this, approx. 4% uses district heating to replace natural gas heating.

For the industrial and utility segment, district heating replaces natural gas for 10% as an order of magnitude. Basically, the collective heating and the district heating segments are two more segments that are attractive for wood and agro-pellets heating.

c) Conclusion about the economical and environmental benefits.
In Western Europe, a conversion of the current gas or heating oil (*mazut*) to the biomass will offer a 50% reduction on the yearly bill for the fuel and it will reduce by 20% the electricity used for producing hot water and heat (*source C. Rakos, Propellets Austria, Aebiom conference, Brussels, 2013*). It makes economic sense to shift from fossil to RE heating & cooling.
Only very few countries do e.g. Austria, Germany, Denmark, Italy, Greece, Spain. In many other markets pellet use for heating is growing but has marginal overall importance.
Introduction of a new heating technology is a very complex task. The involved industries are still small and do not have the resources to perform this task reasonably quickly especially considering the specific technical criteria for the herbaceous biomass (ash content,…). Existing players in fossil heating business have not engaged (except fuel distributers).

It's requiring investment in the boilers or the burners (in the case of the replacement of gas or heating oil burners). The savings from the fuel costs should be used to repay the financing of the investment in the frame of an energy contracting scheme.

Some others hurdles must be noticed:

- it's a challenge to convince and educate relevant professionals on how to plan and install the new technology i.e. biomass boilers
- it's mandatory to synchronize fuel supply and fuel demand

Heating markets (i.e. fossil energy suppliers and public, private distribution companies) are dominated by mature and financially strong industries not interested in many competitors.

Nevertheless, solutions could be implemented to tackle these above mentioned hurdles and to implement renewable energy for the heating and the cooling.

5.2.2 The case in Marum.

The project "P4P" has delivered a trial shipment of pellets to the new local district heating (500kw th).
Marum is a city with about 10.000 inhabitants.

The boiler installed was mostly fuelled with local wood chips sold at about 80€/wet ton, a competitive price of 0,026€/kwh.

In the vicinity of Marum a supply chain of pellets is already in place for the supply of the ENECO power plant. The port of Delfzijl (50kms far from Marum) is used as a platform for the import of wood. The activity is managed by the local company N+P. The company is also operating a pellets plant.

From the port of Delfzijl, the innerland transport can be relayed by trucks and or river barges.

In Marum, the world company Friesland Campina, a dairy factory, has also started a revamping of their local facility to become energy efficient. A dairy factory needs both heat for the pasteurization and cooling for the storage of the dairy products.

At this stage of the report, the target was not to describe a complete case, but much more to assess the feasibility of a supply chain.
Tuzetka, the project partner hasn't investigated the available local renewable fuel such as wood chips, straw, sludge from waste water treatment, organic waste from the dairy industry or agro industries, etc…

Nevertheless, many assets are in place such as an energy demand, a network for the transport.

Delfzijl could be a port of destination for pellets. Wood pellets from Russia or the Baltic countries is perhaps a most accurate fuel.

From the general feasibility, the approach must become more realistic.
Several hurdles need to be identified.

5.3 Main hurdles to overcome.

5.3.1 Hurdle#1: Control the magnitude of the demand, 1 to x0.000.

a) Domestic demand: domestic heating for households is requiring about 4 to 5 tons of biomass per year. As showed above (3.2), the Dutch dwellings and family houses are in average energy efficient. A family house of 200m2 using 90Kwh/M2/year would need about 18.000Kwh or the equivalent of +/-4 tons of biomass per year.

b) Mid size demand: for the supply to local district heating installations of 1MW thermal, the minimum quantities requirement is around 1.000 tons per year (2 tons per hours for 4.000 hours operations per year per one MW or thermal power). In this category, the greenhouses are included and their demand can be mobilized via the the existing agreements with the LTO glaskracht [LTO Greenhouse Growers' Association], the FNLI [Federation of the Dutch Food and Grocery Industry], the platform Agrologistiek, NZO [Dutch Dairy Association].

The utility buildings market segment comprises a large number of buildings, ranging from office, educational, hospitals and nursing homes, shops, hotels, industrial, swimming pools and sports halls, meeting and assembly, governmental. According a study for AgentschapNL a total of approx. 437.000 utility buildings could be identified in the Netherlands in 20091.Industrial heat production by means of steam boilers is a relative small market, but interesting as there is a continuous, non-seasonal, heat demand.

c) For the large "utilities" requiring 70.000 tons (10Mwth operating 7.000h/year with an average of 3Mwh electricity), one or several pellet plants will need to supply a minimum of 20.000 to 40.000 tons per annum.
The magnitude is very important and of course the upstream investment are in line. The potential biomass in demand from the utilities by 2016 is estimated to 7-8mios tons/year.

5.3.2 Hurdle#3: What are the solid biofuels available locally?

a) The renewable energy sources are a mixt of storable and intermittent energies.
Wind and solar didn't supply regular and storable energy even if the wind may rely on a regular base load.
Biomass, heat pump, geothermal and biogas are available energy on demand.
For the biomass and the biogas, the equipments will need the primary fuel.

b) Among the bioenergy available in the NL and more specifically for Marum, several solid bioenergy are available.
The focus of the Pellets for Power project was clearly herbaceous pellets. Nevertheless, wood pellets should not be excluded. Others renewable solid fuels are also locally available.
Waste to energy is an advanced model in the NL for the production of energy (see the table under 2.3.4.). Wood chips like in Marum, or biomass waste (from vegetables) is also used.

c) Wood chips should be considered as an interim stage. Indeed, the EC is preparing directives for enhancing the performance of the boilers and stoves for which the wood chips will not comply (ecolabel and ecodesign directive in preparation for heating devices).
In the future, will wood chips and pellets comply with the pending question about the carbon debt? Herbaceous pellets may somehow comply to this issue thanks

to their short rotation if the *adhoc* devices (boilers,..) will be available on the market especially with a higher performance ashtray.
Therefore, considering the existing flow of solid renewable fuels, imported pellets should come in third or fourth position as a suppletive supply
A secured supply chain with imported pellets must rely also on anchor customers and firm orders to be profitable.

d) Energy storage by means of hot, cold water tanks is an important asset to store the intermittent energy of such project.
The heating and cooling is usually facing peak demand the morning and the evening.
An water tank with hot water is charged the energy produced by means of cold or hot water (expressed in Kwh or Mwh) during the night or period of weak demand to discharge the excess during the peak period.

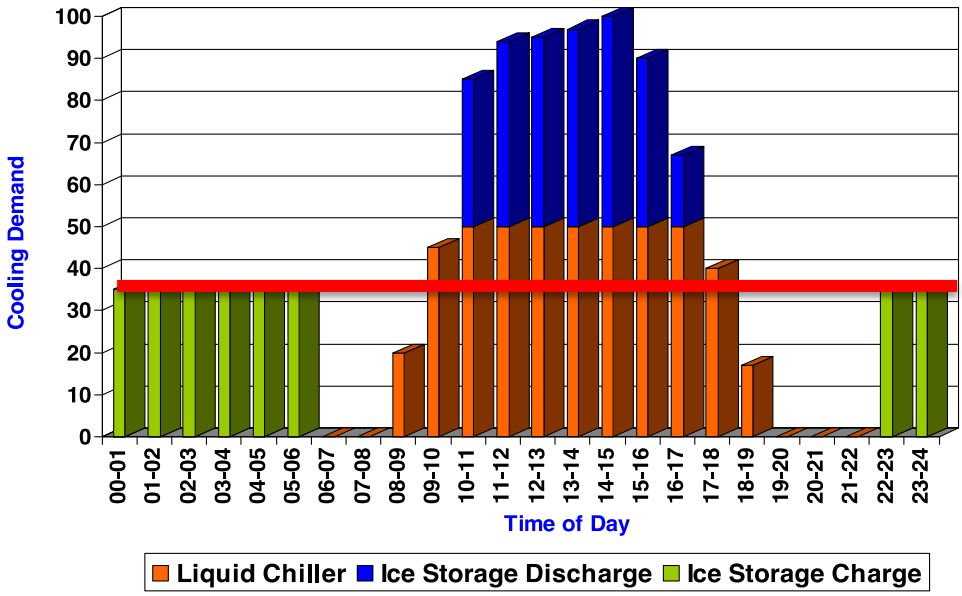


Figure 6 Charge and discharge of an energy storage, the red line is the power capacity

The advantage is to size the energy production on the averaged needs (red line in figure 6) and not on the peak needs what means savings up to 30-50%. The energy storage can be used as a buffer for the security of supply for heating or cooling release.

This concept is already in operation worldwide for heat or ice storage (cooling demand in hospital, commercial malls, dairy industry,..).

Figure 7 Energy storage, hot water or ice bank, courtesy by FAFCO – www.fafco.ch

The warmth (or cold) bank can also be charged by the residual heat recuperated via heatpumps from ventilation system, chimneys,...

The heating and cooling bank may be operated on stationary (figure 7, on the left) or portable mode (figure 8, right).
In this last case, a module of xMWh is connected to the network.

Figure 8 Portable heating and cooling bank

d) From the production side, the model promoted by Tuzetka is focusing on output from 20.000 to 30.000T p.a.which is the minimum economical viable threshold considering the Ukrainian expenditures level.

For 20.000 tons yearly output concept as suggested by Tuzetka, the plant operator, owner will need to identify directly or via traders 4.000 customers up to a partial supply to one power plant.
If more customers are needed, higher will be the logistic and distribution costs.

Magnitude of the market			domestic heating	"Holly warmth" churches, public buildings	District heating mid-user	Power plant
Estimation consumption						
consumption	*Kwh*		*90*			
surface	*m2*		*200*			
Thermal Power installed	Kw th			450Kwh th	1 000Kwh th	15 000Kwh th
Hours of production			*5.000*	1.500	5.000	7.000
Efficiency (averaged)	%		90%	90%	85%	35%
Primary biofuel supply	Kwh		20.000	750.000	5.883.000	300.000.000
Primary biofuel	MWh		20	750	5.883	300.000
Equivalent Mwh/T biomass						
Wood	4,8	Mwh/T				
wood pellets supply	T/year		4	160	1.230	62.500
Herbaceous pellets	4,5	Mwh/T				
Herb. Pellets supply	T/year		4	170	1.310	66.670
Economical break even for the production capacity (min.)			20.000	Tons/year		
Customers requested to sell the production			4.800,0	125,0	16,3	0,3

Table 12 Breakdown of the amount of customers in request for a producer of 20.000Tons of pellets per year.

Up to now, nobody has succeeded to identify the right distribution model.
The US and Canadian pellets plants are delivering most of their production to power plant in the Benelux in the frame of long term contract with the power plants as a captive business model.

e) Last but not least, the energy efficiency of actual or future devices and consumption will improve in the next years and decades. The impact will be more on the use of renewable primary energy that will stagnate or, fortunately decrease.

5.3.3 Hurdle#3: Price stability for confidence in long term, stable supply.

a) During the winter 2006-2007, many German, Italian private customers have made the choice to switch from fossil to renewable. Boilers and stoves were massively installed.
The pellets production capacity was not ready to supply the demand and of course a significant price increased has followed the boom with a decrease in boilers and stoves installation in the following years. The missing capacity is estimated to be around 50 to 80.000tons in 2006.
In 2012, the shortage of supply for domestic heating was estimated about 150.000tons mostly for Italy, Austria, Germany.

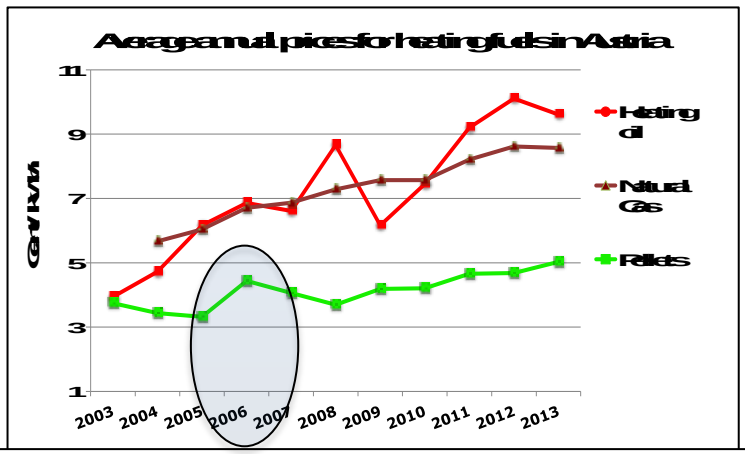


Figure 7 Average Annual price for heating fuel, C. Rakos, AEBIOM conference, Brussels 2013

The figures are showing the impact of the pellets increase (fig. 6) and the correlated price increase of the feedstock (fig. 7) i.e. sawdust and debarked wood chips in Austria one year later.

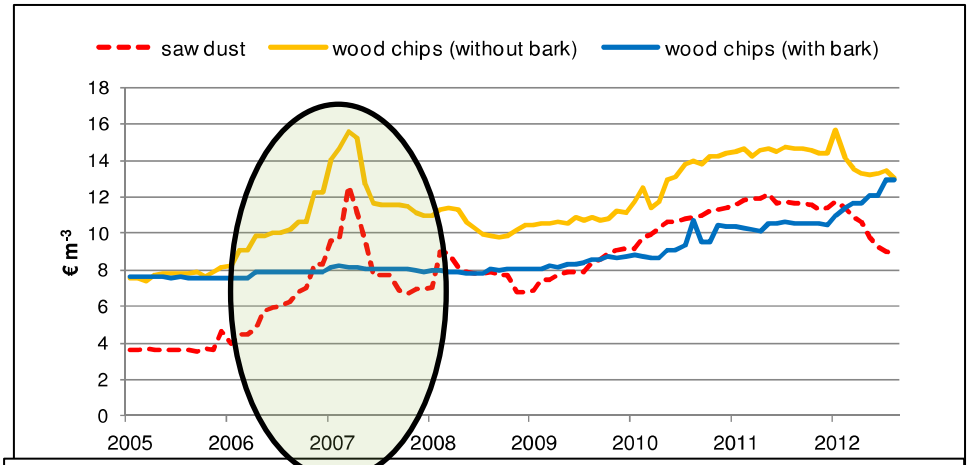


Figure 8 Biomass price volatility, in Austria, C. Kristöfel et al. , BIOENERGY 2020+ GmbH, 2013

b) The price volatility is an important point of control for this still immature market.

Pellets for energy are offering a significant 30 to 40% rebates vs. the heating oil and the natural gas, the predominant energy in the NL.
Cheap fuel is definitive asset for the market behaviour ("goodkoopste brandstof").

In the same time, the market operators must deliver clear message that the price will be under control with a long-term perspective.

In real market conditions, the year on year inflation of wood pellets in Austria is about 10 to 12% as showed below.

Gewerbetarif:

Pelletpreis bei Bestellung von 17 Tonnen, exkl. Ust.

pro»pellets Austria

2010		2011		2012		2013	
Jan	181,51	Jan	201,97	Jan	204,63	Jan	220,56
Feb	181,22	Feb	205,18	Feb	204,68	Feb	222,38
Mär	180,78	Mär	205,85	Mär	205,13	Mär	220,69
Apr	177,94	Apr	201,51	Apr	199,01	Apr	214,31
Mai	176,29	Mai	201,99	Mai	197,40	Mai	213,78
Jun	179,28	Jun	201,81	Jun	197,77	Jun	218,31
Jul	182,47	Jul	202,34	Jul	199,16	Jul	223,59
Aug	183,00	Aug	202,61	Aug	200,70	Aug	
Sep	184,34	Sep	202,97	Sep	201,92	Sep	
Okt	189,47	Okt	205,04	Okt	205,40	Okt	
Nov	191,07	Nov	204,30	Nov	209,99	Nov	
Dez	192,27	Dez	204,34	Dez	212,70	Dez	

+7%

Quelle: proPellets Austria, Stand: Juli 2013

Table 13 Price increase for wood pellets, Austria, wholesale price per ton for delivery from 17T, Propellets Austria, July 2013

This is a win-win situation that will offer stable frameworks to implement the market conditions. This economical rebate should not drive the end users to over use cheaper bioenergy as it's usually the case (1°) and must include a sustainable development fee amounting 2-5% of the sales price (2°). This point will be explained below under.

A this stage, no subsidies should be offered on the energy produced (like feed in tariff).
For the promotion, the NL have already several acts in place to support the local initiatives like the subsidy made available by the government for the Promotion of Local Climate Initiatives (SLOK). According this act, most of the 441 municipal authorities have drawn up a climate policy for the next four years. In almost every case, these policies include projects aimed at creating awareness of renewable energy.
This local approach is the most appropriate tool to give the pitch for expanding the operations.

5.3.4 Hurdle#4: sustainability, to remove the pending question.

During the market survey performed by Abstraction and Tuzetka, several other challenges have been met.

a) To build up the technical skills.
Natural gas is a very easy-to-use fuel, but has to be purchased, stocked, regular monitoring of the boiler system is needed, maintenance, removal of ash, etc. A boiler operator should take care of this, but institutions like churches in most cases will lack expertise and manpower to do this by themselves. Apart from this, organizations like apartment owners that run a collective heating system will probably proof to be a difficult market as they will lack knowhow and interest regarding the heating boiler they are running. A services package should be available in order to turn wood, agro-pellets into an accepted fuel. Are they enough skilled workers, employees?

A company like Hellemans is certainly one of the adhoc partner. With the risk to create again an oligopolistic market?
Central buying organizations like Hellemans seem very attractive as these can coordinate and supply a package of services. As it is, it is concluded from the interviews that it's not the technology only which is important. The technology - fuel combination that proves to be crucial; competent advice on this aspect is not easy to be found.

b) To apply the sustainable criteria on a voluntary basis.
The recent debates about the indirect land use change (ILUC), low indirect impact biofuels (LIIB) and the most recent draft from the European Parliament on "sustainability criteria for solid and gaseous biomass" are not sending clear signals to the market. The sustainable criteria are the main criteria for building momentum among the Dutch population.
It will be not easy to implement clear and comprehensive criteria at the EU level. The concept of low indirect impact biofuels (LIIB) experienced during the project P4P is certainly the most realistic approach and could be performed on a voluntary basis what is the purpose of the NTA8080..

c) To push the market behavior toward higher targets?
The magnitude of the H&C market is significant and can easily excess the 2020 targets with an average yearly increase of 8%.

The renewable electricity is accounting fort the double of the H&C. This is probably the result of strong lobbying. Renewable H&C may overcome its specific share for a more affordable price (no feed in tariff).

NREAP (in Ktoe)	2013	2014	2015	2016	2017	2019
Heating & Cooling	1.172	1.276	1.380	1.540	1.700	2.019
Market share increase (y/y)		*9%*	*8%*	*12%*	*10%*	*9%*
market increase, cumulated		*9%*	*18%*	*31%*	*45%*	*72%*
Equivalent Ktons biomass	2.696	2.935	3.174	3.542	3.910	4.644
conversion factor	*2,3*	*1TOE=2,3T biomass*				
Electricity	1.683	2.108	2.360	2.753	3.146	3.033
Transport	482	537	591	654	717	842
source NREAP NL - 2010, p26						

Last but not least, the implementation of the new H&C scheme would need to be taken over by citizens initiatives at the local level by offering a significant rebate on the energy expenditures per household, dwelling.

5.3.5 Hurdle#5 How to finance?

a) For local financing, innovations in mortgage financing during the 1990s have played a particularly important role in driving developments in the housing market of the Netherlands, amplifying the impact of taxation policies: the availability of more diversified and lower cost instruments, with longer maturities and more flexible terms, considerably expanded the credit scope of Dutch households, enabling them to take up larger amounts of debt.
The leveraging of household and bank balance sheets has increased vulnerabilities of the banking sector, although these are mitigated by a strong net asset position of households and low delinquency ratios in housing debt. In spite of the traditional bias towards housing loans with long maturities, a fair

proportion of households have only short interest rate fixation periods. Hence, households could face an increased debt service burden should interest rates rise (*source The housing market in the Netherlands, European Economy. Economic Papers. 457. June 2012. Brussels*).

b) The financing should come form the EIB funding scheme like Jessica what means a minimum of 20-30mios€ per request. This is impossible for a single household, perhaps not recommended for the communal authorities which are also facing budget restrictions, more adequate for an energy contracting company with several stakeholders acting locally:

- specialized energy companies for the technical coaching,
- the local authorities as anchor customer for their public buildings and acting also as "facilitator",
- and of course local citizens that will buy an expected cheaper energy in kwh thermal instead of m3 of gas.

The common commercial organization umbrella will target the use of biomass and others affordable technologies like heat pump, geothermal and energy storage.

5.4 Actions to undertake:

In the previous paragraphs, we have reviewed that the Dutch renewable heating and cooling market has an interesting potential:

- large urban population with small market share for the district heating in the NL, only 4-5% of the H&C
- primary energy for heating and cooling is cheaper (*goedkoopste*) even others solid biofuels are available in the NL and will be preferred toward imported pellets for the beginning (1°), the magnitude of the current and future demand cannot be precised exactly (synchronizing demand and supply)
- positive behavior from the population toward a certified and sustainable supply of biomass.
- Building awareness actions are in place at the local level (SLOK) but will require from the operational point of view a package of services to implement the technology-fuel solutions
- Gas, and the distribution companies, are the dominant primary fuel, with a *de facto* monopolistic market presence.

5.4.1 Pooling the demand (Bioenergy Trade Centre - BTC).

The demand driven by the local authorities acting as a facilitator with others stakeholders in the frame of a commercial umbrella organization (Bioenergy Trade Centre, BTC) and delivering a services package for local domestic customers, SME's, greenhouses will foster the first demand for solid bioenergy from waste, local biomass or imported pellets.
Each local BTC could be managed by the local energy agencies or group of interest with a leading team.

The first aim of the BTC is to synchronise demand and supply of renewable (and storable) energy for heating and cooling by means of local or imported biomass, thermal solar panels, heatpumps, heating and cooling bank.
The expected outcomes are a real local strategic actions plan with facts, figures and targets and the financing in place.
The local approach is very important to keep in mind the local behavior, infrastructures and demand.
Over the case of Marum-Delfzijl highlighted above (see under 5.2.2), three of four more regions could be shortlisted:

- Rotterdam which has already a Climate Initiative plan in place,
- Bergen op Zoom
- Brabant with the platform REWIN and he vicinity with Luxemburg, Germany an served by the Maas as a transport corridor.
- Some more?

With this approach, we assume that market development will be less hectic (peak and down) and the use of state incentives for the boiler's acquisition more under control. The real market must overcome the opportunistic market.

5.4.2 Pooling the supply, feedstock and equipment.

A prerequisite solution is the development of a mirroring local or regional Bioenergy Trade Centres (BTC) in Ukraine, that can pool and match offers on local and multi-regional level and Dutch or local demand.
Each BTC's could roof multiple –pre-treatment services (e.g. wood drying), as well as certification, sustainable management, farmers offers and interests and security of supply.
Tuzetka is working on development of such BTC in Western Ukraine, among other locations (*source paper presented in Kyiv conference 2011*).

5.4.2.1 Pooling the feedstock.

Herbaceous biomass is a highly seasonal product. The harvesting time slot has several impacts on the harvesting potential (combiners,..), the quality of the feedstock with the ash content, chlorine,…

Nevertheless, for straw, this activity is very often considered by the Ukrainian farmers as an additional activity and not a by-activity in line with their main agricultural operations.
A specific supply chain must be triggered.

Figure 9 Straw fired in Byla Tserkva, July 2010

For Ukraine, straw is preferably burned instead to be baled. There are not enough tractors and balers available to mobilize the straw in the summer.

The situation is the same for the reed harvesting. By shortage of equipment most of the reedbed are burned. Usual season is the winter months.

The third kind of biomass, the Ukrainian wood feedstock must be cut preferably in the fall or winter month but can be stored outside. The timber industry is also facing a shortage of investment, outdated equipment resulting in a poor mobilization of the wood resource. Most of trees are left on the soil. On an impressive 1,7 billion m3 of natural growing wood, only 40% of the wood stock is mobilized in Ukraine (for 70-75% in Scandinavia, 65% in France (*source in Wood resource in Ukraine,*

Figure 10 Forest Ukraine, shortage of management and equipment.

Alexandr Prystaia et al., Biomass Conference, Kiev 2012).

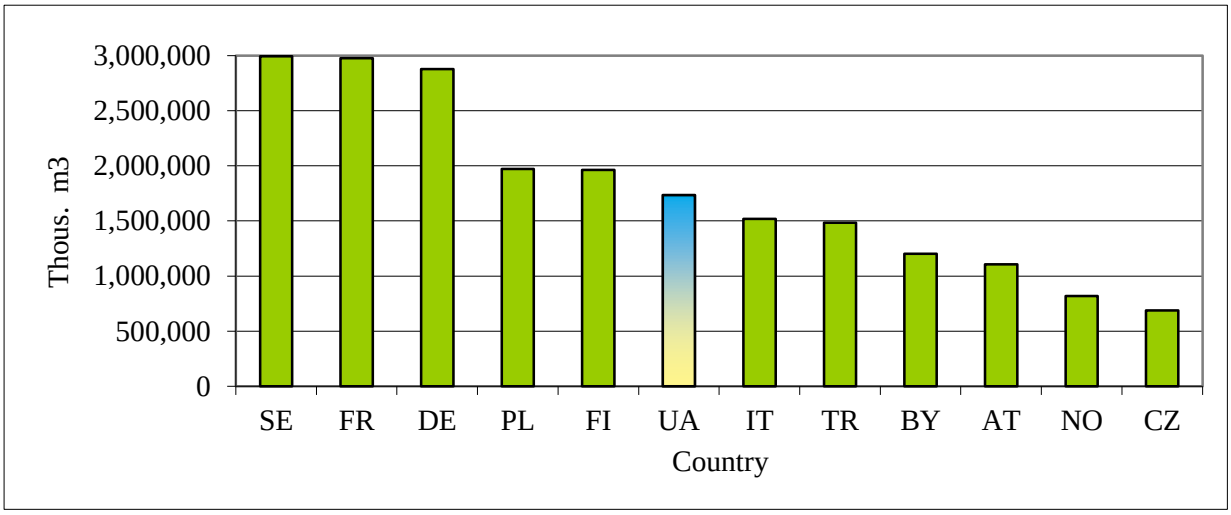


Table 3 Wood natural growth in Europe vs. Ukraine, source Igor Buksha, Ukrainian Research Institute of Forestry & Agroforestry

5.4.2.2 Pooling the equipment.

Reed harvesting is requiring more specific equipment with very light footprint.

The timber companies in Ukraine (and also in the Balkans) are also facing a shortage of equipment.

For the summer harvesting of the straw, same bottle neck with tractors and balers in demand.

The common point of a distributed network of Bioenergy Trade Centre is to have the pretreatment equipment to densify, to pelletize the biomass but also the upstream equipment to collect the biomass from the forest, the fields. This is a mandatory prerequisite for an efficient organization of the supply chain.

A common model of tractor (see Figure 11) can be used for the timber activity as well as for the straw or reed harvesting.
Specific device like tracks for the maneuverability on reed bed, crane for wood puling and baler will need to be mounted on the same tractor (multi purpose tractor) or available in then Bioenergy Trade Centre.

The mobilized biomass will be pelletized according to the supply, the certifications scheme in place.

Figure 11 Multi purpose tractor for reed harvesting (with tracks, cuter bar), for straw (with baler) and timber (with crame); biomass is pelletized in the BTC.

5.4.2.3 Pooling the services in Ukraine: certification and financing

Ukraine is not exactly a country "service minded".
a) By pooling small supplies of individual biomass suppliers and producers, it becomes possible to improve the reliability of supply, a consistent quality and quantity and a centralized communication, processing and commercialization.

Training for the certification can be organized more easily. The final certification will be delivered by the adhoc organization like Control Union (partner in the project P4P), TÜV or SGS.

b) Moreover, this platform by aggregating more feedstock, more capital expenditures should have an easier access to the financing what is definitely the main bottle neck.
By its high replicability, the project is matching the investment criteria of the development finance institutions and is willing to become self sufficient.

The BTC is a tool to turn pellets into commodity.

At a very local level, this model of platform is already in operations in Slovenia, Poland, Austria mostly for wood fire or logs and wood chips.
Local forest organization have seen an direct interest to join this trading organization as well as the local authorities and citizens to switch from gas, coal, "mazut" (heating oil) to wood (see e.g. http://nuke.biomasstradecentres.eu/).

According calculations, one BTC fully quipped in Ukraine should need to mobilize one million€ for the capital expenditures and the working capital.

A distributed network of 25 BTC across Ukraine, fully equipped, at the horizon 2015 should delivered about 480-500.000T p.a. of biomass for a total project costs of 29Mios€ and aiming at a 540 direct jobs creation in rural and forest areas. The job creation in Ukraine average is about 1 per 1.000tons what is contribution for a sustainable development.

Last but not least, the twinning Ukrainian-Dutch BTC will be a room to trade more goods or services for Dutch and or Ukrainian companies.
For the devices in relations with biomass, the company NetteEnergy (www.nettenergy.com) may offer gasification devices for producing energy. The woodgas and syngas from the biochar are far easier to use in a gas generator very useful in remote areas. These are typically converted diesel engines adding spark ignition and gas injection system.
Greenhouses are a technical solutions in Ukraine where most of vegetables are imported. The costs to heat the greenhouses in the winter with gas is not boosting the demand.
The dutch NUSEP association has a list of Dutch and Ukrainian companies willing to expand.

The BTC is a biobased operational solution to achieve the mobilizing and the supply of certified bioenergy and related devices and services.

5.5 Supply of the local market for district heating in Ukraine.

Then for the marketing of the production pooled by the BTC, the first coordinated action is to promote the local switch in the supply side from fossil to renewable fuel.
It is especially in the new EU Member States, that the large market penetration of district heating offers tremendous opportunities for supplying customers with not only affordable but also environmentally sustainable comfort (*Euroheat & Power, press release may 2012*).
It's important not to throw this heating system as a part of the "former (communist) regime".

The demand from the local Ukrainian authorities is rising.

The financial earnings from this conversion will be immediate but it will require a prior investment in the outdated boilers and the improvement of the networks. These works are undergoing but often only the boilers are modernized without any fuel switch.
The promoters are facing also a lack of organized supply chain of biomass.

The main economical incentive is based on the difference from the fossil by comparison with the biomass fuel: 25% in average.

21/09/12	*Price/Kwh*	*Difference*
Straw raising (fields > plant)	0,004 €	-90%
Sawdust raising (60%Moisture)	0,004 €	-88%
Straw Pellets (wholesale Ukraine 90€/T)	0,022 €	-38%
Straw Pellets (district heating -UA 110€/T)	0,026 €	-24%
Natural Gaz (440$/1.000m³), import price	0,035 €	0%

The price of 110€/T is considered as a maximum price incl. the interim storage, fair purchase price of the feedstock (straw, wood) and the supply from a local BTC to the district heating.
For reed, energy crops, price should a bit higher or the delivery will be without pelletizing, then crushed at the plant.

The cheaper fuel, combined with a modern technology should allow improving the global economical efficiency of the heating delivery. It will not have à lot of sense to supply cheap fuel that will not change the consumers behavior for reducing the energy consumption.

The final target will be to insulated the building stock, usually build up in the 50's-80's without sharp efficient criteria.

Some additional benefits will be gained by the local implementation of a supply chain managed under the umbrella of one or several BTC:

- more revenues for local farming organisation for "waste" or by products usually not used,
- an easy step to reduce the energy dependency and to comply with the IMF requirement to increase the gas price from 30 to 50%, biomass will represent the alternative for local affordable and non imported energy.
- a solid biofuel may be used also for drying corn crop usually requesting 15m3 of gaz per ton of grain; as indicator 12mios tons was harvested in 2012 representing a consumption of 180Mios m^3 of gas (vs. 47Bios m^3 for the country total consumption). In fall 2012, several farmers haven't harvested corn as the elevator, the drying station haven't paid their energy bill (*source Hamilton Group cited in Kyiv Post, March 2013*).
- …

5.6 Supply alternative product markets.

Biomass for energy is a hot topic but others markets need to be investigated.

Animal bedding is an solution to use herbaceous biomass like the straw from the maize or raps. As animal bedding, the quantities in demand for straw as animal feeding will be lower and the price should be decreased a bit. Currently, wheat bale straw are traded at 170-180€/T delivered (by trucks) in the NL. Import restriction of Ukrainian straw for sanitary reason (lack of accurate certification) is remaining a hurdle.

Usually, animal litter is used as organic fertiliser and sprayed on the fields. It could make sense to convert the manure and litter into biogas, with a conversion of the quantities into energy (usually 10 to 15%) and the remaining digestate (mixed with green compost and additives) into organic fertilizers either for domestic use or for export.

The exported fertilizers can be traded with the supplying countries for the biomass. The consequence will be an ideal optimization of the reverse logistics.

5.7 Anticipate future (stricter) regulations and sharper conditions.

The economical environment is becoming more and more complicate.
We can expect several stricter and sharper rules and conditions.

1) Possible increasing energy and oil prices for the end users.
   During the last crisis, the price of oil was usually one variable parameter. Since 2010, the price of energy has nearly not changed.

The energy price increase in Europe will come from the subsidized renewable energy source like wind mill or photovoltaic and will be charged by the distribution companies.

a) The climatic variation experienced this year is showing very extreme situation: very cold winter and very hot summer during a short period of time.
   The peak load will need to be supplied by the energy producer or a black out situation will occur. Usually the peak load for heating in case of very cold winter is produced by electrical devices (or the air condition units in case of warm summer) and electricity has a poor efficiency ratio. Energy storage is a buffer solution.
b) Last but not least, the renewable energy directive has also partially harm the state budget (feed in tariff, incentives).
   The result will be (is already) a lower input of the national state budget into national strategies for improving the energy independency and efficiency.
   Will the markets take the relay the States to organize it's own supply and delivery of energy?
   We know that multinationals companies may take the lead.
   The solution should come from the citizens themselves organized in a social "energy" network especially for distributed district heating networks under the BTC scheme.
c) Possible organization of <u>abrupt reduction of energy consumption</u> in case of peakloads. This abrupt reduction is already organized at the industrial level, for example cement plant of steel mill may interrupt within 2-3 minutes their production and decrease the total (electrical) energy in demand.
   Such policies are in preparation for the household. It was the case in Japan after Fukushima, it's in preparation in Belgium.
   Will be these emergency plans an incentive for changing the market's behavior?

Stricter regulation will come from the

d) <u>sustainable regulation</u> for wood/biomass chains, with consequences for cutting (virgin) forests, with inclusion of benefits for using (herbaceous) by-products and better use of agricultural land without competing for food production and excluding *de facto* agricultural/herbaceous crops on unused land, to avoid Indirect Land Use Change effects. Intensive short rotation coppices (e.g. willow, poplar) produced on fertile soils may become more difficult for the same reason. Energy crops, reed, straw and other byproducts do not depend on (fertile) land.
e) <u>Carbon debt</u> is a rising question. The CO2 emitted during the combustion with imported biomass is not captured by the growth of the neighboring biomass (trees, straw,…). Therefore, the carbon debt is very probably increasing without capture by the sourcing areas of the biomass. The short rotation coppices are representing an alternative solution.

6 Conclusions and recommendations.

The sustainable import of herbaceous biomass to the NL is not an utopia. The demand for sustainable solid bioenergy is a rising demand from the population for a cheaper and sustainable energy ("goedkoop brandstof").

a) The logistic infrastructures in the NL are existing with a clear favor for the wood pellets. It will be easier to organize the delivery of a bioenergy that has already a good market resilience, acceptance. Equipment (and infrastructure somehow) for mobilizing the raw material are missing in Ukraine. The wood supply chain will trigger the development of the local Ukrainian infrastructure and certification scheme (and skills). Ukrainian wood pellets will compete with North American imports to the NL. This is also a way to diversify the energy sources and to prepare the ways or the Ukrainian agropellets.

b) The wood pellets fuel is ILUC free but is challenged by the "carbon debt" debate. Therefore, the herbaceous biomass (shorter rotation and carbon capture) must be a complementary bioenergy that should be clearly included in the future energy mixt as it was in Poland.

c) For the energy conversion, a building momentum for the domestic or, preferably, district heating and cooling seems the more appropriate target but needs, in the Netherlands, a local mobilization of skills and a vision at 5-10 years (like it is in Denmark) co-managed via an umbrella organization, the Bioenergy Trade Centre (BTC) for the supply.
Each local Dutch BTC, or energy agency, must promote solid and storable energy among which the imported herbaceous biomass. Some Dutch municipalities are targeting such initiatives like the Rotterdam Climate Initiative. More municipalities could be interested to target similar clean energy targets, at least for their public buildings or industrial zones. They were not identified during this project (except Marum).
With a rising demand in the NL, the target of 2 to 3mios tons of biomass imported from Ukraine (50% of the NREAP targets for H&C) is a realistic issue for 2020 (see figures under 5.3.4).

d) The financing will remain the main issue, therefore join effort from the Dutch and the Ukrainian (exporting) partner in a twinning organization (mirroring BTC both in the NL and in Ukraine) should be promoted.
The scale of such project will allow access to international financing schemes in place (EIB, IFC) and not rely only on the local or state budget (Dutch or Ukrainian).
For the peaceful development and the confidence for such project, the stability of the price is a prerequisite for a common and mutual sustainable development in Ukraine and in the Netherlands working in parallel with a guarantee of supply. Everybody has still in mind the hectic price of the crude oil and others fossil energy.

7 Appendicies.

7.1 Market survey – august 2012

The questions (and answers) of the market survey were as following:

1	**What is your current or future purpose for biomass**		
	Utility large power plant	6	27,3%
	District heating	2	9,1%
	Pellets production (torrefied or not)	3	13,6%
	Wholesale of pellets for energy	2	9,1%
	Wholesale of pellets fro animal bedding or others similar purposes	0	0,0%
	Biobased production, biochemistry	3	13,6%
	Biofuel production	1	4,5%
	Bulding material	0	0,0%
	Research organisation	1	4,5%
	Investors in biomass related projects	1	4,5%
	Others (specify), cement industry, governemental agency	3	13,6%

Dominant contribution from the utility companies and torrefaction developers (40%). Interest from the biobased chemistry is arising.

2	**Why is your organisation looking for biomass?**		
	We must apply the RE directive	4	20,0%
	We get more feed in tariff incentives	4	20,0%
	we are switching from fossil to renewable feedstock (to decarbonate our activity)	9	45,0%
	Biomass is a cheaper material	4	20,0%
	Social and corporate responsibility	6	30,0%

The interest to switch from fossil to renewable is a rising interesting.

3	**For the supply of the biomass, what kind of feedstock are you looking for?**	
	Only wood biomass	5
	Mix composition wood and herbaceous.	14
	Only herbaceous is good (straw, reed, energy crops)	4

It was noticed also that herbaceous could be supplied but not mixed with any kind of other feedstock. The traceability is an important issue: "all possibilities are open as long as the material is within spec of the powerplants"

4	**Among the conditions to select a biomass supplier, what are your main criteria?**		
	The track of record and experience of the supplier and its financial structure?	13	59,1%
	The available feedstock secured (per contract)?	13	59,1%
	The duration of the supply contract?	11	50,0%
	The ability to aggregate several co-suppliers (risk mitigation)?	11	50,0%
	The country of origin (Central Europe)?	9	40,9%
	The country of origin (North America)?	5	22,7%

	The sustainability of the processing and the supply chain (like NTA8080, ISCC, FSC, PEFC,..)?	12	54,5%
	Others	5	22,7%

The most important criteria was the available feedstock secured per contract ranked as prior condition or very important conditions by 92% of the respondents.

The duration of the supply contract is a very important condition for 73% of the respondent while the track of record of the supplier(s) is sorted third as "very important condition" by 51% od the respondents.

The sustainability criteria is ranked first by 96% of the respondent as "prior condition" or "very important condition".

5	**For the quality of the biomass, what are the main hurdles to select a specific herbaceous biomass**		
	ash content	12	54,5%
	Alkalis	7	31,8%
	Chlorine	7	31,8%
	Humidity	4	18,2%
	Price	13	59,1%
	I don't know much more about herbaceous biomass?	3	13,6%
	Others (please comment)	1	4,5%

Price and ash content are not very surprisingly among the first selection criteria.

6	**Do you know that combustion problems arising from ash and, or alkalis could be significantly decreased by an adhoc harvesting or by additives?**		
	Yes	12	54,5%
	No	10	45,5%

Addressed to professional, the ash and alkalis effects are still not very well known by the off takers, traders.
Therefore, the traceability, the analysis are important assets as well as the skills of the pellets producers to deliver reliable data.

7	**Is your organisation ready to test some herbaceous biomass or mixed feedstock (i.e. wood and reed or wood and straw) ?**	
	Yes	13
	No	10

This question about testing was surprizing. Off takers are keen to test truck load of herbaceous pellets. This is still a minority, but an encouraging minority.

8	**For feedstock supply, do you think that Ukraine may play a significant rol for the Dutch (Benelux) market, please, comment your reason.**		
	They have obviously the feedstock (wood or herbaceous).	19	90,5%

	Local sourcing in less favoured areas will create a local positive dynamic	15	71,4%
	Ukraine is far away, the logistic costs will be too expensive	20	95,2%
	For political or others reason, Ukraine cannot be shortlisted as potential supplying country by our company.	17	81,0%
	Weak local financing/banking to support local projects (financial risk too high)	18	85,7%
	Others (please comment)	2	

For the positive criteria, the available feedstock and the less favoured area are ranking first (80% of respondents considering these criteria as "main driver" or "will be considered").
Logistic costs (75%) and local available financing (61%) are part of the negative. Criteria.
The blacklisting of Ukraine is ticked by 47% of the respondents and should be balanced with the development of the less favoured areas.

9	**Could your organisation be ready to consider the establishment of a common supply chain organised by Western companies with several Ukrainian producers/suppliers for the benefit of Dutch off takers?**		
	Yes, we could join this kind of consortium and contribute to build up the consortium.	3	14%
	We are keen to join a solid consortium but will not contribute to the local financing or will not be involved in the local operations (matter of core business).	12	55%
	No, we are preferring to work on a stand alone position.	7	32%
	Others reasons (please specify)	4	

The last question was promising with the amount of positive recipients: more than 70% are interested to join a consortium willing to establish a common supply chain.
This is stressing on the commodity trading which is still missing for biomass despite large import North America.

7.2 Biomass supply from Ukraine: scenario for mid term perspective.

Technical biomass that could be mobilized from Ukraine with the BTC should be about 750.000tons from which 25-30% dedicated to Ukrainian district heating. The *technical* biomass will need to be operational within 2-3 years, at the horizon 2016.

RES in 2016	2016	in PJ	in tons biomass *(rounded up)*	Possible sourcing from Ukraine (2016)
baseline scenario (PJ)		3495PJ		
equivalent tons biomass/PJ		*60000*		
RES - Heating & cooling (%)	6%	21PJ	1.300.000	300.000
District heating "holly warm"		*1PJ*		*60.000*
RES Energy (%)	24%	83PJ	5.000.000	
Transport (%)	7%	23PJ	1.400.000	
Overal RES share	10%	339PJ		

Others market				
District heating in Ukraine				*200.000*
Fiber				*50.000*
Biofuels (2G)				*300.000*
Bedding			*120.000*	*30.000*
Total (tons)			**7.820.000**	**950.000**

In the technical biomass, 200.000 will be delivered for the local Ukrainian district market (e.g. Poltava region, Loubny,…).

As detailed above (5.3), the magnitude of the supply may range from 30.000 tons (bedding) to 3 millions tons (energy).
Solutions are in place for the production of pellets with large facility.
Nevertheless, the security of supply is the main hurdle.

Stationary plants are not always offering enough security (see 4.2.4). Moreover, the climate change will influence the availability of the feedstock. Beetle pine in North America have devastated large sourcing areas, beech trees are diseased in France, Belgium and others North European country.

Straw collected in areas threated with bird flu (H1N1 or the more recent H7N9) could face EU sanitary restrictions on import as it was the case with the Turkish straw.

7.3 Profit and loss accounts of a pellets distribution center.

For the distribution of pellets in the NL, a business plan was drafted.
Assuming a price of 260€/ton (VAT 6% included), the break even is reached at approximately 25-30.000T of pellets sold each year considering the Dutch expenditures (wages, storage, marketing,…). This the consumption of 6.000 households, twice the potential of Marum's households.

BTC		**25/08/2013**	**Y1**	**Y2**	**Y3**	**Y4**
Revenues (VAT excl.)		**49.981.000**	**6.450.000**	**7.753.000**	**9.586.000**	**11.732.000**
% increase YtoY - averaged >				*15%*	*20%*	*20%*
Tons/year (target)			**28.000**	**33.000**	**40.000**	**48.000**
Loss coefficient (damaged, lost,..)		*2%*	-560	-660	-800	-960
Netto sales (T)			27.440	32.340	39.200	47.040
Operational Expenditures (VAT excl.)		**-40.203.000**	**-5.504.000**	**-6.425.000**	**-7.838.000**	**-9.382.000**
Purchase goods						
Price pellets (FCA)	85€/T		*-2.635.000*	*-3.060.000*	*-3.655.000*	*-4.420.000*
Storage & certification			*-121.763*	*-124.950*	*-225.413*	*-231.150*
Transport Import						
Transport & distribution	€/T	*80*	*-2.480.000*	*-2.886.000*	*-3.455.000*	*-4.186.000*
Human resources			*-267.000*	*-354.000*	*-502.000*	*-544.000*
Gross margin		**9.778.000**	**946.000**	**1.328.000**	**1.748.000**	**2.350.000**
Marketing			*-437.000*	*-492.000*	*-601.000*	*-495.000*
sustainable marketing (increasing trend)			*1,0%*	*2,0%*	*2,0%*	*4,0%*
			-64.500	-77.530	-95.860	-117.320
Distribution (retail: bulk & bags)			*-309.150*	*-325.146*	*-325.318*	*-410.689*
Varia & overheads			*-141.000*	*-155.000*	*-188.000*	*-201.000*
Corporate Income Taxes (average)	30,0%	-1.120.887	0	-74.575	-140.389	-325.740
EAT (Earning after taxes - 30%)			-48.450	174.009	327.574	760.060
Cash flow		**2.966.952**	**1.550**	**224.009**	**427.574**	**860.060**

For the sales, the target s to keep a voluntary indexation not exceeding 3% per year. The stability of the price is a competitive advantage and a booster for such energy mix.

The requested investment is calculated at about 700.000€ mostly for goods in stock and the vendor's credit cost.
These are not subsidies, only private-public investment to foster a bioenergy market for 5 to 6.000 local domestic customers or a mix of private and local public users as an operational consequence of the SLOK.

WORKING CAPITAL		**Y1**	**Y2**	**Y3**
GOODS IN STOCK (1)	**In days**	**340.000**	**390.000**	**468.000**
Purchase pellets (yearly turn over/300days)	25 days	340.000	390.000	468.000
VENDOR CREDIT (2)		**1.015.851**	**997.695**	**986.383**
monthly turnover VAT incL		*677*	*798*	*986*
Vendor credit in days		30	25	20
Turnover€ VAT incl./operat. days=vendor's credit value		33.862	39.908	49.319
SUPPLIERS CREDIT (3)		**567.480**	**652.367**	**782.117**
Purchase goods	20 days	272.000	311.667	374.000
Transport & distribution	20 days	256.000	294.000	353.467
Leasing vehicle: monthly leasing fee (all-in)	15 days	4.200	6.300	6.300
Fuel (40L/100Kms)	10 days	2.880	3.551	3.551
Marketing	15 days	32.400	36.850	44.800
WORKING CAPITAL= 1+2+3		**788.371**	**735.328**	**672.266**
Working capital change			**-53.043**	**-63.062**

Among the expenditures, a sustainable marketing fee is charged on the sales price to cover the sustainable development of the twin BTC in Ukraine. This is representing in average 100.000€/year per Dutch BTC with a debt equity leverage of 3/1 i.e. an investment capability of 300.000€ per year, one third of the needs for the Ukrainian twin BTC.