

Pellets for Power: Sustainable biomass import from Ukraine

Public Final Report

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1 Context and reasons to start the project

This project responds to the mismatch between on the one hand a growing demand for biomass on the Dutch and EU energy markets with a limited biomass potential and on the other hand large amounts of biomass and biomass potential currently underutilised in Ukraine. Ukraine itself is seen as a very promising location for sustainable biomass production but is also plagued by economic depression, land degradation, depopulation and high cost for natural gas.

The Ukrainian company Phytofuel and the Belgian company Tuzetka recognized the opportunity. Together with Wageningen UR in The Netherlands they started the first experiments with switchgrass and also initiated pelletisation of straw and assessed the opportunity to use available reed stands in the Poltava region.

In 2010 the sustainable Biomass Import Programme (DBI) offered the opportunity to speed up the business development and also focus on certification. The programme helped to involve state of the art expertise for developing the total system and assure that the concept would comply with the (future) sustainability demands. This would mean that the pellets would be certifiable (in this case NTA 8080) and would also not compete with food production and would thus be iLUC free.

2 Objectives of the project

The project aimed to:

- Develop a sustainable business model for pelletizing biomass residues and biomass crops in Ukraine for domestic and NL energy markets.
- Test sustainability of underutilized biomass use and energy crop production on marginal land while avoiding indirect Land Use Changes (iLUC).

In Figure 1 the concept of using 3 types of herbaceous biomass (straw, reed and switchgrass) to secure a continuous biomass supply for production of pellets for the local and export markets is illustrated.

Straw is abundantly available in Ukraine and has very limited other uses. It was thought that using this biomass for pellet production and export to Europe through the Netherlands would be an attractive option. Reed is also potentially available in large quantities in Ukraine and has very little uses and is often burnt in winter to allow access to water.

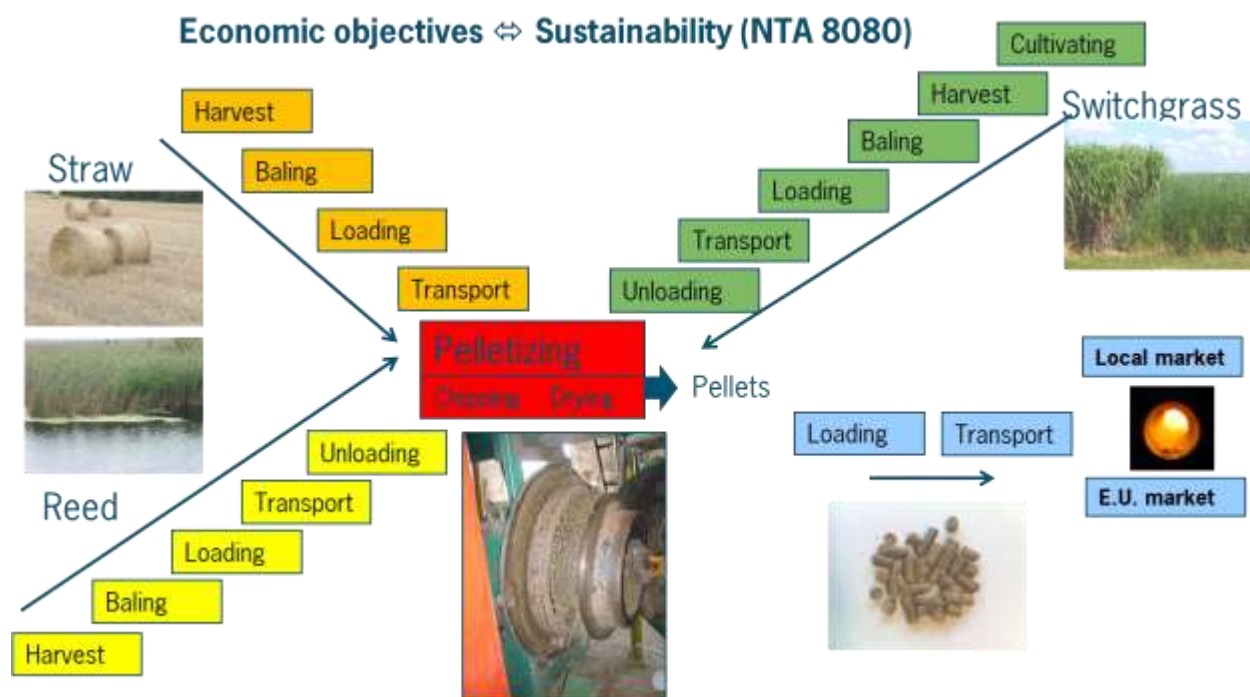


Figure 1. The total concept of the project is to use straw, reed and switchgrass for pelletization and local use or export.

Switchgrass is a perennial grass developed in the USA and later in western Europe as a biomass crop which can be grown at low cost on relatively low quality soils.

By using these 3 different types of biomass for supplying pelleting facilities a more or less continuous biomass supply could be achieved; straw in summer and fall, reed in winter and switchgrass in winter and spring. The business would be started using straw and then switch to also using reed and later switchgrass as these options would become available.

The production chains would be set-up to comply with biomass certification demands as set by the NTA 8080¹ certification standard to be sure the biomass pellets would have access to the European and Dutch biomass markets.

As all 3 three types of biomass could be produced without competing with other (food) applications it would be possible to claim that the biomass would be iLUC (indirect Land Use Change) free. This is one of the large sustainability problems that many other biomass options face at the moment.

¹ <http://www.sustainable-biomass.org/>

3 Activities undertaken in the project

Organizing biomass supply

- Straw supply for pellet production was evaluated and not pursued further.
- The legal framework for securing harvesting rights was analysed and worked out.
- Reed harvesting permits and 10-year harvesting agreements with reed communities for 9000 hectares of reed lands were concluded.

Securing herbaceous pellet Market

- The obstacles for access of herbaceous biomass pellets was mapped (compared to wood pellets).
- Business strategies were identified to seize market opportunities in Ukraine and in Europe (and the Netherlands).
- A viable domestic heating market for herbaceous pellets was identified.
- Herbaceous biomass pellets (reed from Poltava) were imported to the Netherlands and used for heat production at the municipal heating plant in Marum.

Develop and test switchgrass as a biomass crop for Ukraine:

- Successful experiments of switchgrass cultivation at 4 sites and different soil types (fertile, less fertile) have been executed to test varieties, and management options.
- Expertise has been developed making it possible to start large scale cultivation for biomass in Ukraine. First large scale (>5 ha) fields were established successfully.
- A manual has been developed for switchgrass cultivation in Ukraine using experience gained from field tests.

Develop sustainable reed harvesting methods

- Harvesting tests for reed were conducted.
- Ecological impact analysis and monitoring was conducted.
- Guidelines for sustainable reed harvesting, minimizing (negative) impact on environment and biodiversity have been developed.

Assessment of the production chain(s) for sustainability (based on the NTA 8080 certification system):

- The total sustainability impact was assessed based on NTA 8080 for the reed to biomass pellet case in Ukraine.
- Guidelines for sustainable reed harvesting were developed (matching NTA 8080).
- The GHG balance was analysed for reed and switchgrass based biomass-to-energy supply chain configurations (for delivery in Ukraine and in the Netherlands).

- The results indicate that the net GHG emission savings are well below minimum requirements in the NTA 8080 standard.
- The ILUC free biomass production concept was developed and analysed:
 - Focus on reed (as an unused or underutilised biomass resource).
 - Focus on cultivation of switchgrass on non-agricultural/abandoned/marginal land vs productive land.
 - Calculation of the economic and GHG cost of biomass production on less productive land (without iLUC) and productive land (with iLUC).

4 Main findings of the project

4.1 What was the case for or against straw pellet production in Ukraine?

The straw potential in Ukraine is very large. Some 10 million tons of DM is assumed to be available every year, mainly because few alternative uses such as animal bedding or other applications like mushroom production or card board production are available. Because it is a by-product a positive GHG balance is very likely. In current practice straw is often burnt in the field (as illustrated by Figure 2).



Figure 2. Straw has few alternative uses in Ukraine and burning in the field is still common.

During the project the commercial partners worked on setting up a production chain for straw pellet production but in the end concluded that straw was, for their business, a less attractive option. Security of supply was a concern due to uncertainty over the honoring of contracts by straw suppliers. Cost of logistics was a problem due to the low amount of straw available per hectare which increased the cost of straw collection. During the project it also became clear that the quality of straw pellets would pose a problem for most boiler systems due to the high potassium (K) and chloride (Cl) content of straw. High K and Cl content will lead to fouling of the boilers and ash melting (see Figure 3). Most existing boilers cannot handle this type of material and the market for straw pellets will therefore be very limited and the price paid will also likely be too low to make an attractive business proposition possible.



Figure 3. Melted ash from a straw burning boiler in Ukraine.

On top of this a model study, in the project², showed that under current conditions the harvest of straw without decreasing the soil carbon is not possible in most cases for the project area (Poltava, Ukraine). This is due to the high soil organic carbon contents of the soils in Poltava, making it very difficult to maintain soil organic carbon levels when used for arable agriculture. Especially given the low cereal yields and consequently low input of carbon through the roots and the stubbles and the low input of other organic matter like manure. The potential for straw harvesting can be increased by increasing cereal yields and more manure application. Maintenance of soil organic carbon is most critical NTA 8080 criterion for the straw chain.

4.2 Why is reed an attractive biomass source and what was achieved in developing this chain?

Wetlands consisting mainly of reed, cover approximately 1,2 million ha in Ukraine. Reed can yield up to 15 tons of dry matter per hectare per year. Most reed in Ukraine has no alternative uses and much reed is actually burned in winter or spring to make hunting and fishing possible. Controlled harvesting can actually benefit key marshland birds.

Using reed for energy pellet production is therefore a potentially attractive option. At the same time the wetlands are a vulnerable ecosystem and care has to be taken to maintain them. Harvesting the reed areas is complicated and potentially costly.

An important challenge (and success) in the setting up of a successful reed pellet production chain by the project was the acquisition of concessions for harvesting reed in the Poltava project region by partner Phytofuels. This involved defining the legal status of reed areas before

² Poppens R., J.P. Lesschen, M. Galytska, P. de Jambline, P. Krajsvitni, H.W. Elbersen. 2013. *Herbaceous biomass supply chains. Assessing the greenhouse gas balance, economics and iLUC effects of Ukrainian biomass for domestic and Dutch energy markets. Pellets for Power project. Wageningen UR Food & Biobased Research.*

concessions from the local communities could be obtained³. This effort should also benefit other initiatives focusing on certified reed harvesting for energy purposes in Ukraine.



Figure 4. *Reed fields in the Poltava oblast and presentation held by Phytofuels about the reed for energy project to villagers as part of the stakeholder consultations.*

The quality of reed is potentially much better than for (summer harvested) straw because K and Cl have been washed out of the reed during winter. Thus ash melting and fouling problems can be reduced or avoided by harvesting reed in winter or early spring. The total ash content can still be a problem and require adaptations to boilers and good production chain management. The viability of reed pellets for thermal conversion was shown by a reasonably successful test in the municipal biomass heating installation in Marum (the Netherlands) in the spring of 2013.



Figure 5. *Delivery of Ukrainian reed pellets for test firing at the municipal heating plant in Marum, The Netherlands in spring 2013.*

³ Poppens, R., P. Krajsvitnii, O. Rii. 2013. *Taking the Law to the People – Mobilizing community ownership for legal reed harvesting in Ukraine Experiences with Ukrainian legislation and stakeholder consultations for commercial reed harvesting in rural communities. Pellets for Power project. Wageningen UR Food & Biobased Research.*

The project provided best practices for reed harvesting⁴ which included recommendations to harvest in winter and to reduce the harvesting frequency to once every two years, and leave at least 25% of older reed and natural areas untouched. It also showed that the use of wetlands can contribute to social wellbeing, and increase income for local communities. It was concluded that the requirements for NTA8080 can be met, though some amendment may be needed to the strict rules regarding wetlands in the NTA8080. Further activities will need to concentrate on development of the local market for reed biomass for heat production and the efficient but still sustainable harvesting of reed. The market acceptance will also depend on the quality of the delivered biomass meaning mainly that it is low in ash and low in K and chloride Cl.

4.3 Why should switchgrass be an attractive biomass crop for Ukraine and what has been achieved in the project?

Switchgrass is a warm season (C₄) perennial biomass grass developed in North America and introduced to Western Europe in the 1990's. Switchgrass was introduced to Ukraine by the project partners in 2008. Switchgrass is seeded and has a productive life of more than 15 years when used for biomass production. To obtain good quality for thermal conversion and reduce the need for nutrient inputs harvesting is recommended after a killing frost preferably in winter or early spring.

The crop should be attractive in Ukraine because switchgrass can be established at low cost by seed (contrary to *Miscanthus* of short rotation coppice willow) and requires few inputs. Therefore it may be possible to establish large areas at relatively low cost. This is especially attractive when land is inexpensive, capital is expensive and the price of biomass is still low as is the case in Ukraine. Also switchgrass is thought to be able to give reasonable yields under lower quality soil conditions. This last issue is relevant if competition for land for food production is to be avoided.

Within the project, switchgrass experiments were carried out by Poltava State Academy, the Sugar Beet Institute and Phytofuels at 4 sites in Ukraine⁵. Tests showed what varieties are adapted to Ukraine, when and how switchgrass can be established, what row spacing is best suited and what management should be applied. The tests also gave an indication of the potential yields for switchgrass. The project data and experience gained was used to write a first manual for growing switchgrass in Ukraine. Last but not least, expertise was generated in Ukraine to be able to establish large scale switchgrass fields with confidence, as evidenced by the successful establishment of large (> 5 ha) fields in the Lviv region of Ukraine.

⁴⁴ *Sluis van der, T., R. Poppens, P. Krajsvitnii, O. J.P. Lesschen, M. Gabyska and H.W. Elbersen. 2013. Reed Harvesting from wetlands for bioenergy. Technical aspects, sustainability and economic viability of reed harvesting in Ukraine. Pellets for Power project. Alterra report 2460.*

⁵ *Elbersen H.W. and M. Kulyk. 2013. Switchgrass Ukraine. Overview of switchgrass research and guidelines. Pellets for Power project. Wageningen UR Food & Biobased Research.*



Figure 6. *Switchgrass row spacing experiments in Yaltushka, Ukraine.*

Switchgrass is now an option for large scale biomass production, though testing should be continued to optimise production practice, reduce cost and also focus on delivery biomass of the right quality for thermal conversion.

4.4 What markets exist for reed and switchgrass pellets in Ukraine and the EU now and in the future?

At this moment there is only a limited market for “herbaceous pellets”. By herbaceous pellets all non-wood pellets made from grass type biomass like straw, reed and switchgrass is meant. This is mainly due to the higher ash content and risk of ash melting and fouling problems during combustion due to higher K and Cl contents compared to wood. Herbaceous biomass will always have higher ash contents and also more K and Cl. At the same time, as was shown for reed within this project, acceptable biomass quality for thermal conversion can be achieved, though not within the quality standards made for (wood) pellets. The possibilities to get access to market in Ukraine and in Western Europe and the Netherlands were analyzed by project partner

Tuzetka⁶ and options for market development were proposed. It was concluded that project partners should first focus on supplying local (Ukrainian) markets with biomass for heating (this is now taking off) while at the same time focusing on lowering cost in increasing quality. Economy of scale could be increased by collaboration between producers and thus be able to also provide security of supply to customers. Export of pellets for bedding to European markets, may be an option if the right quality is delivered and sanitary concerns can be addressed. Ultimately, herbaceous pellet standards and conversion facilities adapted to herbaceous biomass will be needed to really tap into the potential herbaceous biomass (pellets) provides.

4.5 What has been the contribution to the iLUC debate by the project?

The project proved the viability of harvesting an unused biomass resource, reed, which should not lead to competition with food production and no indirect Land Use Change and the associated GHG emissions.

The project also showed that it may be possible to grow biomass crops (switchgrass) on marginal/underutilised land, which should avoid iLUC⁷. It was also shown that this will lead to higher cost per unit of biomass produced and to higher GHG emissions per ton of biomass produced (within the production chain) when compared to growing the crop on good quality land. Producing iLUC free biomass may therefore only be attractive if iLUC free biomass is somehow rewarded and GHG balance demands are not outside of reach. It may also be necessary to define the “marginal” areas where growing perennial biomass crops is possible or preferred.

⁶ Jamblinne de P. 2013. *Market potential of Ukrainian herbaceous biomass. Analyzing market obstacles and promoting business strategies. Pellets for Power project. Tuzetka S.A.*

⁷ Poppens R., J.P. Lesschen, M. Galytska, P. de Jamblinne, P. Krajsvitnii, H.W. Elbersen. 2013. *Herbaceous biomass supply chains. Assessing the greenhouse gas balance, economics and ILUC effects of Ukrainian biomass for domestic and Dutch energy markets. Pellets for Power project. Wageningen UR Food & Biobased Research.*

5 Summary of the reports

5.1 Report: Switchgrass Ukraine. Overview of switchgrass research and guidelines

Reference:

Elbersen H.W. and M. Kulyk. 2013. *Switchgrass Ukraine. Overview of switchgrass research and guidelines.* Pellets for Power project. Wageningen UR Food & Biobased Research.

Between 2008 and 2013 switchgrass experiments have been conducted in Ukraine which have showed what varieties are locally adapted, how switchgrass can be established, what yields may be expected, what row space should be used, what seeding rate is optimal, etc.

At the moment (2013) the following data on switchgrass are available (see Figure 7).

- 5-year experiments at Veselyi Podil Research Station experiment station
- 4-year experiments at Yaltushka Research Station
- 2-year experiments (on degraded lands) in Poltava.
- 1-year large scale commercial experiment (Lviv region).

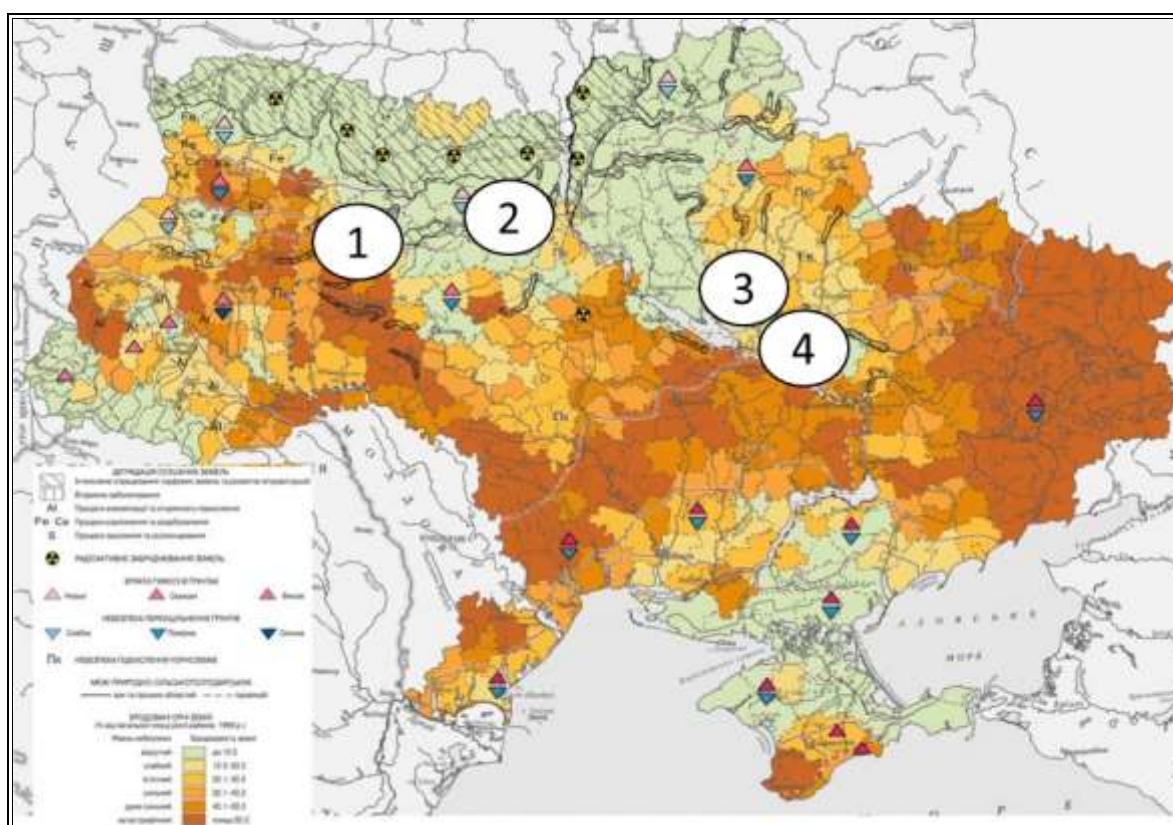


Figure 7. Map of Ukraine showing the locations of the 4 sites where switchgrass experiments have been conducted since 2008. 1) Lviv Branch, 2) Yaltushka Research Station (Vinnitsa oblast), 3) Veselyi Podil Research Station, 4) degraded soils experiments near Poltava.

Switchgrass establishment is inexpensive because it is propagated by seed. Establishment is also difficult due to slow growth in spring, when weeds will outcompete switchgrass and risk of drought later in the season. Optimizing seedbed preparation, exact placement of the seed and using the right weed management will generally lead to a good switchgrass stand that should last for 15 years or more under good management practices.



Figure 8. *Switchgrass in Ukraine has been shown to be quite productive as illustrated by the crop height, with an expected yield of up to 15 tons per ha. Right large scale field > 5 ha established in the Lviv region in fall of the first year.*

Switchgrass establishment is inexpensive because it is propagated by seed. Establishment is also difficult due to slow growth in spring, when weeds will outcompete switchgrass and risk of drought later in the season. Optimizing seedbed preparation, exact placement of the seed and using the right weed management will generally lead to a good switchgrass stand that should last for 15 years or more under good management practices.

Switchgrass takes 2 to 4 years to attain maximum yields. Small plot DM yields of up to 20 tons were measured. Long term data from large fields are still lacking. We made relatively conservative estimates for the expected average switchgrass yield based on extrapolations. Based on this we assumed an average yield of 7 tons DM on a low quality, marginal land that should be less or not suitable for arable cropping and which could be used without causing iLUC (indirect Land Use Change). For good quality land we assumed an average yield of 12 tons DM when harvesting after a killing frost. Based on these preliminary yield estimates and the best available information on inputs, the cost of switchgrass delivery to a pellet plant was estimated at €52 per ton pellet under high productive conditions and €42 per ton pellet under low productive conditions. We concluded that growing switchgrass iLUC free for this case would increase local delivery cost by 22%.

Assuming a cost of €33 per ton for pelletization and a cost for transport to a coal co-firing power plant in The Netherlands of €48 per ton this would give a (preliminary) cost estimate of between €122 and €132 for switchgrass pellets delivered from Ukraine to The Netherlands. Based on the

same data we estimate a GHG emission of between 9.0 and 12.0 g CO₂-eq per MJ pellet delivered to The Netherlands (depending on the transportation mode; train, river, sea). For electricity production this would be equivalent to between 22.6 and 29.9 g CO₂-eq per MJ electricity generated, assuming a conversion efficiency for pellets to electricity of 40%. Compared to the fossil fuel reference (coal) of 198 g CO₂-eq per MJ electricity, the GHG savings of the entire chain would be 85 to 89%, which is above the 70% minimum GHG saving as required under the NTA 8080 certification system.

In the experiments over the past 5 years the Ukrainian experts have gained much experience in establishing switchgrass and in management of switchgrass. This has made it possible to make a description of switchgrass management in Ukraine and to establish with success large fields. Further information is still needed, especially with respect to efficient harvesting on a larger scale and storage and conversion into pellets and conversion to energy. Feedback from switchgrass users should help to optimize switchgrass management and harvest.

The option to produce switchgrass biomass on marginal lands (outside of competition with food) should require investigation into zoning options and related policies for Ukraine.

5.2 Report: Ukrainian biomass sustainability. Assessing the feasibility of sustainability standard implementation and producer compliance in Ukraine

Reference:

Poppens, R., and T. Hoekstra. 2013. *Ukrainian biomass sustainability. Assessing the feasibility of sustainability standard implementation and producer compliance in Ukraine*. Pellets for Power project. Wageningen UR Food & Biobased Research.

Biomass sustainability is determined by the impact of biomass operations on people, climate and the environment. Some impacts are easier to assess than others, with so called indirect effects being the greatest challenge, for they often occur far beyond the project boundary and which are not (yet) included in certification systems. The criteria by which to judge sustainability impacts are laid down in standards. The Dutch NTA 8080 standard is one of the most comprehensive sustainability standards for biomass available and is one of several officially accepted standards by the European Commission. Conformity with standard requirements is assessed in a process called certification. This process is carried out by independent Certification Bodies.

One of the objectives of the Pellets for Power project was to align biomass operations with the NTA 8080 standard. With no functional supply chains developed during the course of the project, a complete conformity assessment, covering all NTA 8080 provisions, was not possible. For the remaining provisions, the project has had to rely on assumptions based on fictional but realistic supply chains as planned by the project partners with emphasis on the reed chain. With project partners successfully obtaining reed harvesting permits, reed became the most realistic resource for development in the short term and conformity of the proposed reed chain set-up was analysed against NTA 8080 certification system. Generally, the analysis shows that NTA 8080 certification for reed based pellets, under our set-up, should in principle be possible in Ukraine.



Figure 9. NTA 8080 promotion event in Kyiv, September 2012

First the legal issues were addressed. Project partner Phytofuels identified Ukrainian laws and legislations regarding the right to use Reed biomass in conformity with the NTA 8080 principles. This focused on analysis of reed legislation and permit procedures and on how to obtain licenses and for mobilizing community ownership for legal reed harvesting. This was essential for the stakeholder consultation process, which resulted in broad support within the community, making the project at the same time less vulnerable to corruption and helped to acquire the permits and agreements for reed harvesting.



Figure 10. Phytofuels engaging with village people

The issue of minimal GHG (greenhouse gas) balance was analysed for the proposed production chain from harvest to utilisation in Ukraine or the Netherlands. It showed an improvement of more than 70% over the fossil fuel equivalent when used for electricity production in The Netherlands or for heat production in Ukraine.

Both in the RED (renewable energy directive) and in the NTA 8080 there are limits to the use of peat land. Reed lands in the project area can be found on both mineral soils and peat land. One of the main reasons to prohibit the use of peat lands both in the 2009/28/EC Renewable Energy Directive (Article 17.5) and the NTA 8080 (Article 5.2.2) is that exploitation of these areas will result in large CO₂ emissions when draining of the area takes place. Emissions will amount to such levels, that it becomes impossible to regain these losses by means of renewable energy production. The RED provides the exception where “evidence is provided that the cultivation and harvesting of that raw material does not involve drainage of previously undrained soil. It is fair to assume that this exception should be acceptable to NTA 8080 as well, but some addendum may be needed.

Competition with food and local biomass uses was also analysed and this is also related to the so called iLUC effect (indirect Land Use Change). Here it was argued that the reed has no or few alternative local uses and is often burned to provide access to water. It was concluded that a large part of reed can be used without effect on competing applications.

For switchgrass produced on previously unused or marginal land a similar conclusion could be drawn. The conclusion is that ILUC can be minimized by growing switchgrass when cultivated on less productive or abandoned land, but this comes at an expense, in the form of higher cultivation costs and a less favourable – though still adequate – GHG balance.



Figure 11. Burnt reed areas are common

Biodiversity and environmental integrity was assessed in depth for the proposed reed chains in the project area. A set of best practices for biodiversity in reed harvesting was developed, which include a recommendation to harvest only part of the area, and leave at least 25% of older reed and natural areas. Further, the site selection is important, taking care to avoid protected areas and wetlands to abide with Ukrainian law. The wetland should be maintained as much as possible in its natural state, and protected against fires. It was concluded that biodiversity can be maintained or even improved if best practices for reed management are implemented.

Regarding the provisions about the Environment, emphasis was placed on soil quality issues regarding the straw chain. Model simulations showed that when straw is removed for bioenergy, under current management practices, there is a risk of decline in soil organic matter which is explained by a relatively low productivity, low nutrient applications and little use of organic manure. Straw harvesting may therefore lead to non-compliance with provision 5.5.1.2 of NTA 8080 and is thus not recommended under current management practices.

Overall NTA8080 certification seems possible. However, also some non-conformity risks were identified, regarding certain provisions for legislation and stakeholder consultations. These issues are strongly related to the difficult circumstances in Ukraine, with legislative ambiguity, poor law enforcement and particular power balances in communities. Therefore, the future for certified sustainable biomass produced in Ukraine depends on concerted action on multiple levels, between governments, legislators, law enforcers and biomass producers. But also standard developers and Certification Bodies can help improve the implementation of sustainability

standards. Among other, this requires adjustments to used terminology and improved methods for verification for better practicality in the context of Ukraine.

5.3 Report: Reed Harvesting from wetlands for bioenergy. Technical aspects, sustainability and economic viability of reed harvesting in Ukraine

Reference:

Sluis van der, T., R. Poppens, P. Kraisvitnii, O. J.P. Lesschen, M. Galytska and H.W. Elbersen. 2013. *Reed Harvesting from wetlands for bioenergy. Technical aspects, sustainability and economic viability of reed harvesting in Ukraine*. Pellets for Power project. Alterra, Wageningen UR..

In this report the different aspects of reed and reed lands are discussed related to sustainable harvesting of biomass. This is based on a pilot project for Poltava Oblast, funded by Agency NL of the Dutch Ministry of Economic Affairs. With several partners steps are taken for development of a reed chain, in accordance with the certification system NTA8080. The report describes all aspects which are relevant in the light of biomass harvesting, sustainability, social aspects, technical features of reed harvesting and Greenhouse Gas balance.

Within this project we test whether all aspects of NTA8080 can be met through collecting relevant data, testing the approach regarding stakeholder participation, and developing criteria for sustainable harvesting and monitoring of reed land.

Common Reed (*Phragmites australis*) is a grass species, and one of the most widely distributed vascular plant species in the world. Reed has a high potential for biomass production with a sustained harvest of 15 t DM/ha/year. Reed can be utilised both as an energy source, construction material and industrial raw material. Reed is a key species in wetland ecosystems, it has the highest biomass and abundance within wetlands. Ukrainian wetlands cover over 1,200,000 hectare, most of the wetlands are in Polissya (900,000 ha). In Poltava region there are 53.200 ha of wetlands (around 2% of the total land area). In the Ukraine burning of reed land in winter is common practice. Reasons may differ, often it is related to hunting practices, which requires open reed land, or burning may drive out animals. Also fisherman (which are usually also the hunters) may acquire easier access to the water after burning.

Within the Pellets for Power project several areas were identified, to test the approach and criteria applied for NTA8080. After establishing local contacts with the villages, field work was done in those areas, to collect baseline data for the area, assess the vulnerability, prepare maps which can eventually form the basis for harvesting. The reed harvesting process is described step by step in chapter 4, with details of the equipment and technical specifications in Annex III.



Figure 12. *Reed is currently often burned in winter to get access to make hunting and fishing possible. Reed is often more than 4 meters high illustrating the high productivity of the system.*

Stakeholder consultation is an essential element in developing, implementing and operating a biomass project. It plays a critical role in awareness raising of the project's impacts and helps to achieve agreements on the approach. The report describes how the consultation took place, and what problems were encountered in this process. The community consultations have resulted in broad support within the community, making the project at the same time less vulnerable to corruption and abuse by individual village council members and officials. Long-term reed harvesting programs were signed with thirteen villages.

The overall reed biomass chain has a highly positive GHG balance with 75% savings. In case of export to the Netherlands (when used for co-firing with coal) and 86% when used for domestic heat production in Ukraine (replacing natural gas). The GHG savings comply with the minimum requirements as stated in the NTA 8080 (70% for Dutch mixture of electricity production). From a global climate change point of view it should be more efficient to use the biomass in Ukraine itself for energy production, instead of exporting it. However, the import of reed biomass from the Ukraine is still an alternative which would comply with the sustainability criteria of the RED and NTA 8080.

Also, reed pellets could become one of the feed stocks for second generation fuel and chemicals production. Ten tons of reed pellets from Ukraine were tested in the municipal heating facility of Marum in the Netherlands. The system has been designed for locally sourced wood chips. Overall the test showed that reed pellets can be used for local heat production. Improvements in pellet quality are possible in the pellet production process. Also some adaptations should be made to the boiler system to handle the higher ash content and ash behaviour.

We show in this report that ILUC free reed harvesting is possible. Reed in the project area is harvested on land not used currently for agricultural purposes. And even in case of reed occupying land that was formerly used for agriculture (some of the area has been grazing land), this still refers to 'abandoned land' and thus there is no competition for food production.

We provide best practices for reed harvesting. To prevent nutrient depletion and a negative soil

carbon balance we recommend not to harvest all reed area every year, but to reduce the harvesting frequency to once every two years. In this way there is more time for input of nutrients via natural sources, i.e. deposition and flooding, which reduces the risk on nutrient depletion. This is also in line with the 'best practices for biodiversity', which include a recommendation to harvest only part of the area, and leave at least 25% of older reed and natural areas. Further, the site selection is important, taking care to avoid protected areas and wetlands to abide with Ukrainian law. The wetland should be maintained as much as possible in its natural state, and protected against fires. Careful monitoring will ensure sustainable development. If all these aspects are taken care of, our study shows that wetlands can contribute to social wellbeing, and increase income for local communities.

It is concluded that the requirements for NTA8080 can be met. However, in some aspects, we suggest a wider interpretation of the criteria for NTA8080 (or a specific addendum to the NTA 8080 has to be made with regards to wetlands). This is in particular necessary where rather strict rules apply regarding wetlands, which should not be used for biomass. We show that biomass harvesting is in support of wetland protection, and can result in increased biodiversity, provided that the necessary precautions are taken, as described in the 'best practices'.

5.4 Report: Herbaceous biomass supply chains. Assessing the greenhouse gas balance, economics and ILUC effects of Ukrainian biomass for domestic and Dutch energy markets

Reference:

Poppens R., J.P. Lesschen, M. Galytska, P. de Jamblinne, P. Kraivitnii, H.W. Elbersen. 2013.

Herbaceous biomass supply chains. Assessing the greenhouse gas balance, economics and ILUC effects of Ukrainian biomass for domestic and Dutch energy markets. Pellets for Power project.

Wageningen UR Food & Biobased Research.

This report describes the supply chain performance for three types of biomass feedstock (Figure 13) and for three sustainability aspects, i.e. the greenhouse gas balance, economics and Indirect Land Use change effects (ILUC). Calculations are based on a fictional supply chain set-up, as no large-scaled commercial biomass operations have been initiated yet by the project partners. The analysis was performed for use of biomass pellets both on the domestic energy market and the Dutch electricity market, in four different supply chain configurations. Scenario 1 is the use of pellets for the domestic heating market, in this case for the town of Lubny. In the other scenarios the biomass is exported to the Netherlands for electricity generation. Scenario 2 involves transporting of biomass pellets from the production site by train to the city of Kherson and subsequent transport by sea vessel to Rotterdam. Scenario 3 is pellet transport by train to Izmail and further transport by river barges to Rotterdam. Scenario 4 is transport by truck from Ukraine directly to the Netherlands.



Figure 13. Reed, straw, switchgrass

Results (Table 1) show overall positive Greenhouse gas balance for all three biomass types, with GHG savings well within the allowable limits set by the NTA 8080 standard (> 70% GHG savings), except for straw pellet transport by truck to the Netherlands. Not surprisingly, the domestic supply chain shows higher GHG savings than the international supply chain configurations. Switchgrass has the highest GHG savings, which is mainly because of the additional soil carbon sequestration by switchgrass. GHG performance can be further improved, through larger volumes (allowing use of larger-scaled equipment and shipment options) and use

of renewable energy in the pelletizing process, possibly through combined heat-power systems running on biomass.

Economy wise, the analyzed supply chain configurations only show promise on the domestic heating market. This is true particularly for reed, which is the most economical to produce of the three biomass feedstocks. Biomass costs for export markets are currently too high to compete with other fossil and renewable alternatives (Table 1). Further reductions in pelletizing costs may be expected in the future, in case larger traded volumes become reality. Economic cost advantages can be achieved by pooling local producers in Ukraine, such as through Biomass Trading Centers, which enable cost sharing and use of large-scaled pelletizing equipment and shipment options. Moreover, switchgrass establishment costs are based on US figures and it seems safe to assume its production in Ukraine would be more economical. Of all three biomass feedstocks, straw pellets seem the least attractive, due to its lower quality and competing uses on the domestic market.

Table 1. Summary of biomass cost, GHG emission and biomass yield for the different scenarios and the low ILUC biomass chains

	Biomass cost (€/GJ pellet)	GHG emission (kgCO ₂ /GJ pellet)	GHG savings (%)	Yield (MT/ha)
Scenario 1 (Local heat application)				
Reed	5.0	11.2	85.7	14.7
Switchgrass	7.2	2.0	97.5	7.0
Straw	8.3	13.2	83.2	2.7
Scenario 2 (Dutch electricity market, sea vessel)				
Reed	10.6	18.5	76.6	14.7
Switchgrass	12.3	9.0	88.6	7.0
Straw	14.8	21.8	72.5	2.7
Scenario 3 (Dutch electricity market, river barge)				
Reed	10.3	19.5	75.3	14.7
Switchgrass	12.0	10.0	87.4	7.0
Straw	13.6	22.9	71.1	2.7
Scenario 4 (Dutch electricity market, truck)				
Reed	10.8	21.7	72.6	14.7
Switchgrass	12.3	12.0	84.9	7.0
Straw	14.9	25.3	68.0	2.7

It remains doubtful whether biomass export to the Netherlands for energy purposes will ever become economically viable, for any of the three biomass feedstocks. This will depend on further shipment cost reductions due to higher traded volumes and price developments for fossil alternatives and wood pellets.

As to the risk of Indirect Land Use change (ILUC), reed may be the most favoured biomass, although much of current reed lands were formerly used for agriculture and it is not clear whether or how this should be taken into account in ILUC assessment methodologies. Fact is that reed is currently not used on any scale in the project area and often burned by the local population.

For switchgrass a new approach to ILUC assessment was taken by the project, by comparing the greenhouse gas balance and economics of growing switchgrass on two sites, on good soil and on less fertile soil. Results showed that ILUC can be avoided on less fertile soils abandoned soils, but this comes at a cost, with a less favourable GHG balance and increased economic production costs. The increased cost of avoiding ILUC is estimated at 22% for the production of switchgrass or €0.59 per MJ pellet and the GHG cost was in this case 12.5 g CO₂-eq MJ⁻¹ pellet. For a crop with higher establishment cost, such as Miscanthus, both the relative and absolute cost of avoiding ILUC will be higher.

According to the NTA 8080 standard, straw is a by-product of grain production. As such, its use for bioenergy purposes should have low ILUC risks. However, ILUC risks of straw depends much on current uses such as animal bedding or in maintaining soil organic content. scientific models show that extraction of straw for biomass purposes in the project region may affect soil carbon stocks in the long run, with negative consequences for soil fertility. This would then have to be compensated for by additional fertilizer or manure applications, which would lead to additional GHG emissions.

5.5 Report: Market potential of Ukrainian herbaceous biomass. Analyzing market obstacles and promoting business strategies.

Jamblinne de P. 2013. *Market potential of Ukrainian herbaceous biomass. Analyzing market obstacles and promoting business strategies*. Pellets for Power project. Tuzetka S.A.

In the EU and the Netherlands there is an increasing demand for 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.



Figure 14. *Tuzetka first focused on pelletisation of straw and export to Poland as illustrated in the pictures here showing how straw is currently often burned in the field and how it is pelletized in a small scale local pelletization plant.*

The analysis of obstacles for successful commercialization, as experienced by project partner Tuzetka, were focused on pellet biomass for energy (mostly heating) 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 favour wood over herbaceous biomass.

Market strategies by Tuzetka focused 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 easiest to implement in urban areas or in industrial zones. Small and mid-sized 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. Pellets could also first find an application as animal bedding material or the fiber market. This could bridge the time until a real herbaceous pellet market for energy develops and can help producers optimise the chain for quality and cost.

5.6 Report: Taking the Law to the People

Reference:

Poppens, R., P. Krajsvitnii, O. Rii. 2013. *Taking the Law to the People – Mobilizing community ownership for legal reed harvesting in Ukraine Experiences with Ukrainian legislation and stakeholder consultations for commercial reed harvesting in rural communities*. Pellets for Power project. Wageningen UR Food & Biobased Research.

Pellets for Power project

This report is an account of experiences of a Ukraine based company, Phytofuels Investments, operating in the framework of the Pellets for Power project. This project was carried out in Ukraine and funded by NL Agency under the Sustainable Biomass Import program in the Netherlands. The project aims at developing models for sustainable biomass supply chains, including production, processing and commercialization of reed, straw and biomass crops for energy purposes. So as to guarantee sustainability, all biomass operations were designed in accordance with the Dutch NTA 8080 standard. As one of five project partners, Phytofuels' tasks included the development of sustainable reed production methods. Two aspects of this endeavor are zoomed in on in this report: reed legislation and engagement with authorities issuing permits on the one hand and engagements with local reed owning communities on the other. Both aspects are strongly interlinked and cover two sets of requirements in the NTA 8080, i.e. compliance with national legislation and performing stakeholder consultations.



Figure 15. *Phytofuels engaged with stakeholders. Phytofuels had to solve the unclear judicial status of reed land ownership before obtaining the reed harvesting concessions.*

Studying legislation and engaging authorities

The first step was to study legislation, to find out what is regulated in Ukraine about reed. For that purpose and for other studies on sustainability issues, the Institute for Biomass and Sustainable Development was founded. This independent institute helped increase credibility of the project when engaging with authorities and rural communities. In this process, both

Phytofuels and the Biomass Institute relied on methodological support and applied research conducted in the Pellets for Power project. Research topics covered legislation, biodiversity, greenhouse gas emissions and other sustainability topics. The importance of this research based approach soon became evident, when facing government officials with no clue as to on what grounds and by which procedures reed harvesting permits were to be issued. In much of current Ukrainian legislation there is no clear reference to reed as a particular category of plant, natural resource or ecosystem. So, in order for authorities to make any informed decisions about issuing permits, the project partners first had to develop a reed harvesting protocol, based on research data from this project.

Taking the Law to the People

According to Ukrainian legislation, the rightful ownership and decision power regarding natural resources lies with “Territorial Communities”, i.e. villages in rural areas of Ukraine. Yet, this does not reflect reality in Ukraine. In the current situation, power is very much concentrated in Kiev and little decision power trickles down to the villages, with village councils having to collect state money from district councils. The financial situation is appalling in most villages, including with underpaid village deputies, making corruption difficult to erase. Obviously, this situation is also bad for business operations, that often depend on bribes and personal favors, affecting the continuity of such operations. The challenge for the project partners was thus clear: creating awareness among village people and setting up sustainable, socioeconomic development programs that work directly with the local population, designated by the law as the rightful owners of reed resources.

Establishing socioeconomic programs and acquiring permits

With legal ownership lying with local communities as the primary stakeholders, Phytofuels and the Biomass Institute have put a lot of effort in engagements with village people, on the street, in public meetings, visiting local leaders, local newspaper articles, educational programs held at schools and other social events. This resulted in broad support within the community, making the project at the same time less vulnerable to corruption and abuse by individual village council members and officials.

The approach by Phytofuels and the Biomass Institute proved overall successful. By September 2012, long-term reed harvesting programs were signed with thirteen villages. And with each program laying out clear responsibilities for the partners, based on legislation and research conducted in the project, the environmental authorities were keen to issue the required permits.

Setting a standard for biobased development in Ukraine

These experiences may have shed light on a potentially effective mechanism for stable biomass business development in Ukraine, by mobilizing local villages as the lawful owners of natural resources. Phytofuels and the Biomass Institute have done important pioneering work, setting a standard for current and future biobased practices in Ukraine.

Yet, still much work remains to be done after the project. It is likely that Phytofuels' business operations require adjustments before deserving the label "sustainable". Its compliance with NTA 8080 is not guaranteed until proven otherwise by an independent auditor. And given its strong ties with Phytofuels, the role of the Biomass Institute has not been truly independent so far. Moreover, in the larger institutional framework, it remains to be seen whether policies are adopted that are favorable to development of sustainable biomass based programs.

Fortunately, both organizations will continue on their chosen paths. Phytofuels intends to expand its biomass business activities, in line with NTA 8080. And the Biomass Institute has the ambition of becoming a recognized, truly independent research organization, aiming at development of research programs and the promotion of NTA 8080 in Ukraine. For this purpose, during the 8th Biomass Conference in Kyiv held in September 2012, a Memorandum of Understanding was signed between the Biomass Institute, Wageningen University Food & Biobased Research and the Dutch National Standardization Organization (NEN). In addition, the Biomass Institute seeks participation in public councils on regional and state level, advising on sustainability and legislation for development programs.

6 Lessons learned

6.1 Project management

- Organize frequent communication moments with local partners. Given cultural differences, the language barrier and frequent lack of experience with international projects, saving on communication will cost the project in the longer run.
- Start as soon as possible with making report structures for deliverables, so as to guide activities and results in the right direction and to facilitate constructive thinking and communication among partners.
- Involving the right experts from the start of the project should have saved a lot of time and efforts.

6.2 Starting biomass business in Ukraine

(See paragraph 4.6)

- (Future) biomass businesses must invest much in the local producer community, assuming a bottom-up approach, ensuring commitment through long-term agreement with the village council. This reflects legislation, helps minimize corruption by officials and ensures long-term commitment by both authorities and the local population (Poppens et al, 2013).

6.3 Herbaceous biomass market focus

(See paragraph 4.5)

- For now biomass businesses should focus on domestic biomass markets, particularly for heating purposes, given high natural gas price. No demand in EU/NL, due to quality issues and economy of scale requirements among other.

6.4 Reed/wetland management

(See paragraph 4.3 and 4.4)

- Sustainable reed harvesting is very well possible. Regular reed harvesting helps maintain wetland areas, may help emissions and may increase biodiversity. With the right methods, such as harvesting on ice in winter, the environmental impact can be reduced to a minimum.

6.5 Biomass sustainability

(See paragraph 4.2, 4.3, and 4.4)

- Biomass production, for all three biomass types, results in a positive GHG balance and emission savings well below thresholds set by NTA 8080.
- Use of agricultural by-products and reed help reduce ILUC to a minimum. Also ILUC may be avoided with switchgrass cultivation, provided cultivated on abandoned/less fertile and/or abandoned lands.

- With the right methods, such as harvesting on ice in winter, the environmental impact of reed harvesting can be reduced to a minimum.

6.6 NTA 8080 implementation

(See paragraph 4.6)

- NTA 8080 presupposes legislation regulating reed resources, which is often not reality in non-EU countries such as Ukraine. There is a need for a more local approach in implementation of sustainability criteria.

6.7 Market access for herbaceous pellets

(see paragraph 4.5)

- Wood pellets are the norm on the biomass markets in the EU. They are essentially a commodity with all the attributes of a commodity including standards for quality, handling and conversion and exchange system facilitating trade and financing.
- Herbaceous pellets are not a commodity and currently have no defined market in the EU. Defining herbaceous pellets as a biomass commodity would be necessary to fundamentally solve this problem (defined quality standards, trade system, certified handling and conversions systems).
- In order to have access to market for herbaceous pellets in the EU it is necessary to have a large scale (say > 50.000 tons per year) is necessary. To overcome this up-scaling problem focus on supplying the local market or smaller scale markets such as bedding is the best avenue.

6.8 Switchgrass production

(see paragraph 4.1)

- Switchgrass can be grown in Ukraine and should yields of up to 15 tons DM per year may be possible.
- It is necessary to execute local experiments in order to gain local experience with switchgrass.
- The option to produce switchgrass biomass on marginal lands (outside of competition with food) should require investigation into zoning options and related policies.

7 Follow up of the project

- Phytofuels is now focusing on setting up a business in supplying local markets in Ukraine for heat production. The first local heating system using reed has recently been opened in the village of Grebinka⁸. The economics for these initiatives are fast becoming viable due to the increasing cost of natural gas in Ukraine.
- Another option for pellet supply is animal bedding. This is a niche market which may allow for kick-starting export of pellets at a relative small volume.
- Tuzetka is working on pooling pelletisation initiatives (Biomass Trade Centre concept) to have a critical mass to obtain financing, access to market and provide security of supply.
- Switchgrass has proven to be a productive low cost crop in Ukraine. It is necessary to continue the experiments to obtain long term data on the crop in Ukraine.
- Switchgrass as a perennial crop, may not be an attractive crop on current agricultural land. The option to produce switchgrass biomass on marginal lands (outside of competition with food) should require investigation into zoning options and related policies in Ukraine (and also other countries).
- Developing herbaceous pellets as a commodity is necessary for real market access. Projects to define herbaceous biomass pellet standards would be a logical follow up.
- A recognition in the market of iLUC free biomass could much help to bring the biomass options developed in this project into practice.

⁸ http://www.ltava.poltava.ua/index.php?option=com_content&view=article&id=5459:2013-10-14-13-00-56&catid=5:2011-03-10-11-07-49&Itemid=1