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Pellet production in Ukraine: a profitable option for sustainable development?

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EXECUTIVE SUMMARY

There is a solid business case for pellet production in Ukraine. Our analysis suggests that in the majority of cases pelleting is a profitable undertaking. However, pellet production remains just a profitable business instead of becoming an industry of national importance that can help to improve Ukraine's energy security. This can be explained by a number of general obstacles associated with the country's legislation and market development as well as specific factors relevant for the pelleting industry.

Pelleting is a way of making use of biomass residues that would otherwise remain unused. Pellets can replace fossil fuels and, thus, cut greenhouse gas emissions and create the conditions for sustainable economic development. However, as of now a large share of the pellet production (about 85%) is exported. This is due to the low demand for pellets from local consumers. Indeed, competition from other, cheaper and often subsidised, fossil fuels used for heating explains why pellet producers derive the largest part of their income from exports. Nevertheless, the market for pellets has significant potential. Indeed, we estimate that about 20 mln t of grain straw, 2 mln cub m of wood residues and up to 1.5 mln t of sunflower husk are currently unused or underutilised. These inputs could be converted into at least about 11 mln t of pellets worth about EUR 1 bn – well above its current estimated size of 240 thd t per year.

The key question when determining if and what potential the market has, is to analyse if there is a business case for pellet production in Ukraine. To answer this question we have carried out a profitability analysis for a number of relevant production facilities. Interviews made with about 20 small Ukrainian pellet producers indicate that there seems to be a good business case for pellet production in Ukraine. This is supported by the results of our profitability analysis. The calculations show that all types of pelleting plants considered could pay back their initial investments in less than two and a half years and could provide returns in the range of 41-300% (measured as Internal Rate of Return). However, the actual profitability depends on the kind of the feedstock used and the capacity of the plant. For example, profitability increases significantly for larger plants. Also it is strongly affected by a list of special conditions that must be met in order to make this business profitable. The majority of these conditions we have accounted for as assumptions in our calculations.

While the results highlight the profitability of the pelleting business, there are some major barriers and bottlenecks on the way of making use of this potential. First of all, the pelleting industry is held back by the poor investment climate in Ukraine. To be more specific, although legislation provides some supportive measures such as VAT and income tax exemption, accessing these is difficult. Second, unstable and unpredictable governmental policies together with the absence of long-term goals deter investment in modern equipment which is required for high-quality pellets. Instead, modernised soviet technologies are used in the majority of pellet production facilities in Ukraine. Besides, the pellet industry faces other obstacles such as difficulties to obtain feedstock in sufficient quantity and quality. This is partly caused by a lack of collection, transportation and storage infrastructure. Furthermore there is a lack of qualified staff to operate and maintain the operations.

Therefore, the first and the most important recommendation is to develop and enforce a long-term strategy and supportive legislative acts that will create a stable basis to develop large-scale and high-quality pellet production in Ukraine. This should include transparent targets and a clear communication of the instruments in place to achieve the objectives. It is important not to introduce any export restrictions and develop the internal market. As our analysis shows, and as opposed to other types of renewable energy, there is already a good business case for pellet production in Ukraine. What potential investors need is therefore legislation that provides certainty for planning and long-term investments. Finally, it is important to develop rural infrastructure in the context of collection, transport and storage of feedstock to stimulate business development in regions.

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INTRODUCTION

Biomass pellets are often produced from wood residues or agricultural crop waste. Hence, pelleting can be considered as way to make use of biomass residues that would otherwise remain unused. The most widely used pellets are wood pellets. However, straw and sunflower husk are also often used as inputs for pellet production. Therefore, we will focus on these three types of feedstock in our analysis.

The main application of pellets is to produce heat. Pellets can partially replace the use of fossil fuels, thus cutting greenhouse gas emissions and creating the conditions for sustainable economic development. Although yet small in overall scale, using pellets for domestic heat production could also help to lower imports of Russian gas. Therefore, development of pellet production should be in line with the government intention to promote alternative energy use in Ukraine. However, as pellets need to compete with cheap, often subsidised, fossil fuels, currently the most viable use is exporting them to the European market.

Given this potential for export and replacing fossil fuels, there may be a case for developing the pellet market in Ukraine. However, the central question should be if it is profitable to produce pellets in Ukraine. Therefore, the main focus of the paper will be to estimate the profitability of pellet production in Ukraine.

The performed profitability analysis consists of two pillars. The first pillar is a cost-benefit analysis based on an estimation of the payback period, net present value and internal rate of return. The second pillar is the calculation of the break-even point and operating leverage. Overall we analysed 18 options for pellet production. Specifically, for each of the three feedstocks (straw, wood residues and sunflower husk) we have considered two different plant sizes (a small scale with the capacity of 1.2 tonnes of output per hour and a large-scale plant with the capacity of 5 tonnes per hour) and 3 cases for each plant size. The cases differ according to the assumptions used. The best case scenario assumes that the producer is exempted from taxes and has enough feedstock to work 365 days per year 20 hours each day. Each of two worst cases relaxes one of these assumptions, i.e. either taxes are paid, or utilisation of the plant is halved to 183 days.

We considered 15 years of the pelleting plant operation. The major costs considered in the calculations are production, operation and maintenance cost. The benefits of pellet production are the revenues from pellet sales. The cash flows are calculated for the 14 years of the plant operation plus the 1st installation year. They are discounted, therefore, with applying a discount rate of 23% and cumulated. Based on the discounted cash flow, the net present value (NPV) and internal rate of return (IRR) are calculated. The payback period is estimated by dividing the initial costs by the annual cash inflows. Break-even point is the point at which costs and benefits are equal. Operating leverage is an indicator that measures profit increment following the production volume increase.

The paper is organised as follows. Chapter 1 describes the Ukrainian market for pellets made from straw, wood residues and sunflower husk. We describe the pellet market size and potential as well as some relevant issues such as pellets quality. Chapter 2 is focused on important issues that affect the business case for pellet producers such as tax legislation, staffing, feedstock and equipment issues. Chapter 3 discusses the results of the profitability analysis. It consists of three subchapters containing the estimation of profitability of pellet production for each feedstock type. The last chapter presents our conclusions and policy recommendations on how to promote development of the pellet market in Ukraine. In particular we consider the main obstacles and challenges to accessing the potential of the pellet market.

1. THE MARKET FOR PELLETS

Ukraine has significant biomass potential in the shape of unused grain straw, wood residues and sunflower husk that can be used as inputs for pellets production. Currently 150 pellet plants in Ukraine annually produce about 240 thd t of pellets. This is much lower than in the EU where about 650 pellet plants produced above 10 mln t of pellets in 2009. However, the development of the pellet market has started in Ukraine only recently, while in many European countries it has been developing over 25 years. Despite this head start, pellet production in the EU cannot satisfy European demand for pellets offering export opportunities for Ukrainian producers. Currently, however, pellets of Ukrainian origin constitute only about 2.5% of the European pellet market. To further increase their market share Ukrainian pellet producers have to improve the quality of the exported pellets. Two main factors influence how successful they will be in the process: the quality of the feedstock and the quality of the equipment. The first factor is hard to control because the feedstock market in Ukraine is not well-developed. Well targeted government policies can lead to improvements here. For example, the lack of quality equipment is partly explained by producers' limited financial resources. This is aggravated by the absence of a long-term and consistent governmental strategy to support alternative energy production. However, the main barrier to the development of the pellet sector is associated with the problematic investment climate in the country. Currently Ukraine ranks 152nd among 183 countries in the World Bank 2012 rankings on the ease of doing business.

Pellet market size and potential

Pellets have been widely used since the 1980th in the USA and Canada, since the 1990th in Austria and Scandinavian countries and since 1999 in Germany. For Ukraine it is a relatively new market but the amount of pellets produced is increasing each year. In 2009 around 650 pellet plants in Europe produced above 10 mln t of pellets¹ - more than 40 times higher than the current annual volume of pellet production in Ukraine. The European Union's policy targets for renewable energy and greenhouse gas (GHG) emissions reduction and connected subsidies are the main driver of growth of the pellet market in Europe. Globally production of biomass pellets is expected to reach 46 mln t by 2020, reflecting an annual growth rate of roughly 11%.²

This growing global demand also stimulates Ukrainian production. Total pellet production in Ukraine is estimated to have reached 240 thd t per year. 50% of this amount are pellets and briquettes from straw and sunflower husk. Currently, the Ukrainian pellet market is represented by about 150 companies that use wood, sunflower husk and straw feedstock. However, within a year some producers switch between several kinds of the feedstock depending on its availability on the market since it is subject to seasonality.³

BOX 1: Important characteristics of pellets

Although the chemical constituents and moisture content of biomass materials vary, there are common characteristics that include:

Density - consistent hardness and energy content (minimum 40 pounds/cubic foot);

Dimensions - length (1 ½ inches or up to 4 cm maximum) and diameter (1/4 to 5/16 inches, or 6 to 8 mm) to assure predictable fuel amounts and to prevent fuel jamming;

Fines - limited amount of sawdust from pellet breakdown to avoid dust while loading and problems with pellet flow during operation (amount of fines passing through 1/8 inches screen is no more than 5% by weight);

Chlorides - limited salt content (no more than 300 parts per million) to avoid stove or vent rusting; and

Ash content - important factor in frequency maintenance.

Premium grade pellet fuel has less than 1% ash content. High ash content remains the major problem for Ukrainian pellets. Some producers achieve ash content up to 1% in wood pellets and up to 3% in straw and sunflower husk pellets; while others finish with 3% and 5-8% respectively. As market develops, ash content becomes a better controlled factor. We found evidence that more producers finished with lower ash content in 2011 comparing to our findings made in 2009-2010.

Differences in pellet fuel include Btu range. For example, Btu (heat) content may range from just under 8,000 to almost 9,000 Btu, depending upon species and region of the country.

Source:

http://www.wdpellet.com/wood_pellet_traits_and_standards.php

¹ <http://onlinelibrary.wiley.com/doi/10.1002/bbb.277/full>

² <http://www.thebioenergysite.com/news/8814/biomass-pellet-market-forecast-to-treble>

³ Interview with the UTEM's representative: <http://www.udem-group.com>

While the market is still in its infancy, it is developing rapidly with annual growth rates of 15-20%.⁴ Furthermore, the theoretical growth potential is significant. It has been estimated that about 20 mln t of grain straw, 2 mln cub m of wood residues and up to 1.5 mln t of sunflower husk remain behind unused on the fields or in the forests.⁵ Clearly, one option would be to use this biomass to produce pellets.

However, since pellets need to compete with low priced traditional sources of energy used for heating, the domestic Ukrainian market for pellets is yet underdeveloped and the majority of producers are export oriented, mostly to the European market. Indeed, around 85% of Ukrainian pellets are exported. They currently constitute about 2.5% of the European pellet market.

The prices that can be achieved for pellets depend on a number of factors. The major factors are the pellet types, their quality (here mostly ash content) and terms of delivery. Prices for straw pellets in Ukraine currently vary between 60-125 Euro/t, those of wood pellet from 80 to 160 Euro/t and sunflower husk pellets – from 60 to 100 Euro/t. The standard supplied size is 8 mm in the majority of cases; sometimes, 6 mm is also offered. Moisture content is up to 10%. The content of other elements comply with the European standards. The majority of pellets produced in Ukraine are able to satisfy German DIN standard, and they are in the process to satisfy the European EN Standard⁶ like EN 14961.⁷

Segments of the pellet market

The pellet market is not uniform. Pellets can be produced from different inputs. In Ukraine wood residues, straw and sunflower husk are the main feedstock. As each input has different requirements in terms of costs and availability, transport and market value of pellets, we will review three categories separately here and afterwards in the profitability analysis.

Straw pellets

As of 2011, there were about 40 straw pellet traders in Ukraine⁸ but only four large pellet producing plants which specialise only on straw pellets. Two more large straw pelleting plants with a joint capacity of 80 thd t/year in Kirovograd region and one in Odessa with the capacity of up to 9 thd t/month⁹ are expected to start operation in 2012. They will be among the largest straw pellet producers in Ukraine.

Straw pellets are mainly exported to Austria, Germany, Poland and Czech Republic. Lesser amounts are also sold on the domestic market. Straw pellets have a high sulphur content that sometimes decreases their competitiveness in comparison with wood and sunflower husk pellets. Besides, alternative competing use for straw means that straw price can already achieve up to 600 UAH (around EUR 60) per bale. If purchased as loose straw from the field, the cost can be as low as 50 UAH per tonne. But collection and transport costs can be significant. For example, a straw pelleting plant with a capacity of 150 thd t/year in the Vinnitsa region which plans to start working in 2012, has already contracted about 100 thd t of straw from 57 households at a price from 40 UAH/t (4 EUR) from the field.¹⁰

Wood pellets

During the period from 2008 to 2010 the number of wood pellet traders in Ukraine increased from 34 to 103. There were 38 wood pellet producers in Ukraine in 2010: Kharkov, Kyiv, Zhytomyr, Poltava and Zakarpattia were the leaders in wood pellets production in 2010.¹¹

⁴http://ecotech.zenako.ua/products_mar.htm

⁵Kuznetsova A. (2012). Options for biomass utilization in Ukraine: estimation of the profitability of straw, wood and sunflower husk pellets production. Working paper. Forthcoming.

⁶ About DIN and ONORM quality standards: http://uavatp.org/index.php?option=com_content&view=article&id=57&Itemid=61 About EN quality standards see EUBIONET publication on the New European Pellet Standards: http://www.propellets.at/images/content/pdfs/alakangas_new_european_pellets_standards_10032010.pdf

⁷ Interviews were made among Ukrainian pellet producers and traders listed at Global Trade Database: <http://www.alibaba.com> Also some prices are listed here: <http://price-list.kiev.ua/word/43/6743/index.html>

⁸ There are about 80 advertisements on the straw pellet supplies but according to our phone interviews about half of them propose pellets from different kind of the feedstock: <http://www.ua.all.biz/uk/buy/goods/?group=1073198>

⁹ Interview with the BIO FUEL ENERGY company's representative: <http://112795.ua.all.biz/uk/>

¹⁰ "Investments ... into straw", Uryadovi Kurier from September 10, 2011: <http://www.ukurier.gov.ua/uk/news/investiciji-v-solomu/> and "Straw Investments: Ukraine is increasing the production of straw pellets", Energo Business 38/724 from September 27, 2011.

¹¹http://pelleta.com.ua/pellets-pellet_producers_ukraine_2010.html

In 2011 demand for Ukrainian wood pellets came from Poland, Italy, Greece, Germany, Denmark, UK, Czech Republic, Latvia, US, Lithuania, France and Russia. In total, wood pellets have been exported to 22 European countries in 2010.¹²

Sunflower husk pellets

In the sunflower husk pellets market a growth rate of 27% in the number of pellet traders and of 50% in pellet producers has been observed in the first half of 2011 compared to 2010. Whether this growth tendency was kept until the end of 2011 is difficult to state since sunflower husk pellets production is subject to seasonality. Sunflower husk feedstock is naturally cheaper during the oil-extracting period (cold season of the year with the peak of sunflower oil production lasting from October to December). In summer, most of the oil-extracting factories do not work.

In 2010 until the first half of 2011 there were 102 sunflower husk pellets traders and 32 producers operating in the market. Among the regions, the largest number of traders came from Zaporizhia, Kyiv, Kherson and Donetsk regions.¹³

Summing up, our analysis of the market structure of the pellet market shows that the volume of production and trade of pellets from wood, straw and sunflower husk increased rapidly over the last years. This supports our notion that the market for pellets, while yet small in comparison to other countries, is undergoing dynamic development.

2. IMPORTANT ISSUES AFFECTING THE BUSINESS CASE FOR PELLET PRODUCTION

*Doing any business is not easy in Ukraine. The pellet business is not an exception. Owing to the bad business climate there are a lot of obstacles that should be accounted for. **The first issue is legislation.** Legislation is subject to frequent and not always transparent changes. This increases risk and hence the returns investors demand to be willing to invest. Nevertheless, pellet producers can benefit from several types of the tax exemption. To be granted these tax exemptions, however, they must have a so-called alternative energy producer certificate. The procedure of obtaining this certificate is complicated with much leeway for the issuing authority. **The second issue is feedstock supply.** Since the feedstock market is underdeveloped, pellet producers face difficulties with the quantity of feedstock supply and its quality. Low availability of the collection equipment and poor rural and forest infrastructure are obstacles for efficient feedstock collection. Furthermore, as demand exceeds supply for transportation services, cost of transport are high. The collection and transportation problems create obstacles for the constant feedstock supply. It may therefore influence the process and volume of production. Additionally the feedstock can have excess moisture and rubbish content which increases the required quantity per ton ratio of pellets. **The third issue concerns the pelleting equipment used.** Ukrainian producers use modernized soviet technologies. Those are cheaper in comparison to the foreign analogues; however, the lifecycle of such equipment is shorter and the quality of the produced pellets is often lower. **The fourth issue** is the lack of well qualified personnel in rural areas. Underdeveloped infrastructure in rural areas leads to young people moving to bigger cities. Therefore, investors/ producers in rural areas can only attract them by paying above average wages or make additional investments to increase local personnel's qualifications.*

Legislation

Legislation is one of the main features which shapes the business rules in Ukraine. In line with the privileges given to alternative energy producers pellet producers are exempted from profit tax and VAT for pellets sale until 2020¹⁴. Furthermore, producers do not have to pay import duty and VAT for purchased pelleting

¹²<http://pelleta.com.ua/>Note: the information presented in the free access at the given website changes frequently with no free access to the previously given data.

¹³http://pellets-wood.com/pl-pelletbase_2011_husk.html

¹⁴ Concluding Remarks of Tax Code of Ukraine (sub-chapter 4, item 15). Previously, VAT for the feedstock was reimbursed to pellet producers (according to the Law of Ukraine # 168/97-VR "On value added tax" from April 3, 1994.).

equipment until 2019¹⁵ in case they have a certificate conforming that they produce alternative fuel.¹⁶ This temporal tax exemption contributes significantly to the high profitability of the pelleting business in Ukraine. However, Ukrainian legislation is subject to frequent changes. Thus, pellet producers who benefit from the current tax exemption cannot be sure that those benefits will last until 2019/20. Moreover, the Energy Strategy until 2030 is mostly based on fossil fuels instead of alternative energy development.

Equipment

As noted above the bad business and investment climate remains the main barrier to the development of the pellet industry. Combined with unpredictable changes of

governmental policy this often leads to underinvestment. This partially explains why the majority of pellet producers in Ukraine use cheaper modernised soviet-type technologies instead of investing into high-quality equipment. A lot of the equipment is produced or assembled in Ukraine.¹⁷ Indeed, Ukrainian equipment is cheaper than foreign equipment while the latter is believed to be more reliable. Therefore, Ukrainian enterprises who have good funding opportunities and have long-term production plans often buy foreign equipment. In most cases, big international pelleting equipment traders specialize in large plants.

Pelleting equipment is rather expensive. However, possibilities to extend the payment for several years using bank or state credits exist. Ukrainian banks can propose special trade financing and credit programmes. Trade financing is usually applied to short-term programmes under one year while credit programs are usually applied to long term programs which can take up to 5 years. Average standard interest rates are 18-25% in Ukrainian hryvnas and 10-18% in Euro.

In addition to bank financing, the Ukrainian government offers state-supported programs for agricultural producers. In case that domestic equipment is bought for the pellet production in Ukraine, a company can get a loan from Ukragroleasing with a reduced interest rate of 7% in Ukrainian hryvnas (80 mln UAH are allocated to Ukragroleasing in the State Budget for 2012). There is also the possibility to get 30% of the total equipment cost paid by the Ministry of Agrarian Policy and Food of Ukraine.¹⁸ Interest rates for loans taken to buy pelleting equipment can also be partially compensated.¹⁹ However, access to state funding is not assured. Applicants have to undergo a selection process. The selection criteria of such state competitions are often not transparent and selection can be arbitrary. Therefore, many agricultural producers have to use bank credit programs or own funds to finance their business (i.e. purchase of the equipment) and do not rely on the state support.

Transport

Transport distance is one of the most important factors influencing the feedstock price. This could be explained by the small value of the ratio of feedstock's density to weight.²⁰ Therefore, transport distances of

BOX 2: Main Legislative Acts regulating Pellet Production in Ukraine

Tax Code of Ukraine # 2755-IV with the last changes from January 14, 2012.

Law of Ukraine # 1391-VI "On amendments to some Laws of Ukraine as for stimulation of production and consumption of alternative fuels" (last changes were introduced on April 1, 2011)

Resolution of the Cabinet of Ministers of Ukraine # 1307 "On the rules of issuing of the certificate conforming that the fuel belongs to the alternative fuels" from October 5, 2004 (last changes are from August 3, 2011).

Law of Ukraine # 1391-XIV "On Alternative Fuels" from January 14, 2000 (last changes are from June 19, 2009).

Law of Ukraine # 555-IV "On Alternative Sources of Energy" from February 20, 2003 (last changes are from October 21, 2008).

Energy Strategy of Ukraine until 2030. Decision of the Cabinet of Ministers of Ukraine # 145-p from March 15, 2006.

¹⁵ Law of Ukraine # 1391-VI and Concluding Remarks of Tax Code of Ukraine (sub-chapter 2, item 2b). Note: it is applicable in case the analogous equipment is not produced in Ukraine.

¹⁶Resolution of the Cabinet of Ministers of Ukraine # 1307 (see Box 2).

¹⁷ Information is given by Ukrainian Association of alternative solid fuel producers: <http://www.uavatp.org/>

¹⁸Resolution of the Cabinet of Ministers of Ukraine # 647 "On approval of the use of Stabilization Fund funds to partially compensate the cost of domestically produced agricultural equipment" from July 28, 2010.

¹⁹ Foreign equipment is considered only if such equipment is not produced in Ukraine. Interest rates for credits can be compensated in the amount of double NBU's discount rate (for national currency) or on the level of 10% (for foreign currency). For further information see the Resolution of the Cabinet of Ministers of Ukraine # 794 "On approval of the use of State Budget funds to support agricultural enterprises via the mechanism of reducing of the credit rates" from August 11, 2010.

more than 50 km are not economically feasible. Furthermore, truck renting services has not been properly developed in Ukraine yet and their costs remain high. As a result, pellet producers sign individual contracts with private transporters. For example, a truck of 40 cubic meter body volume can transport 10 large straw bales or 26 medium straw bales. Each transportation kilometre in Ukraine costs about 0.3-0.8 UAH/t. Medium straw bales are cheaper to transport than large ones due to their lower size to weight ratio. Transportation of straw bales for the distance of 10 km costs about 7 UAH/t and of 50 km – up to 37 UAH/t.

Transporting wood residues is cheaper in comparison to transporting straw bales. However, it should be accounted that supplied wood feedstock can be of different sizes (from large parts of trees to small particles like sawdust or wood chips), thus leading to the actual volume of delivered feedstock differing significantly due to different fraction sizes and ways of loading. For example, transportation of small wood residues for the distance of 10 km costs about 5 UAH/t while transportation of large wood residues is about 2 times cheaper (for calculations see Annex A). Sunflower husk is light by weight and thus requires large truck body volume to transport. According to the market information, the largest truck used to transport sunflower husk has a body volume of 60 cub. m and can contain up to 9 t of the feedstock.²¹

Since transport distances or more than 50 km are not economically feasible, in our profitability calculations the total costs of feedstock used is calculated by the price of the feedstock itself plus the price for its transportation in the 50 km zone (see Annex B).

Quantity of the feedstock

The quantity of the feedstock required to produce each ton of pellets depends on several factors. The most important of them are moisture and rubbish content. The optimum moisture content is 10-12%.²² However, this level of moisture is often achieved only after drying (except sunflower husk). Initially the feedstock can contain up to 60% of water.²³ In Ukraine straw bales often have a moisture content of more than 20% and sometimes up to 60% when collected after or during rainy weather and kept outdoors uncovered. Fresh wood contains around 50% of water. During drying and storage its water content is often reduced to 30-40%. As a basic principle one can note that the smaller the wood residues are, the less water they contain. Sometimes sunflower husk as well as wood dust can be too dry and need some water to moisten before the start of the pellet production process.

Another issue is rubbish content. Straw bales can contain different non-organic content and rubbish. Moreover, too wet straw bales can be partly rotten. Small wood residues and sunflower husk can contain rubbish as well. Therefore we assume in our calculations that 10% of the feedstock is rubbish.

We also assume that straw and wood have an initial moisture content of 30%. Before pelleting starts it is dried to 12% resulting in a 18% loss of the initial feedstock's weight. Other 10% are lost because of rubbish and rot. Thus, to produce 1 t of pellets 1.36 t of the feedstock is used.²⁴ For sunflower husk we account only for the rubbish content. It means that to produce 1 t of pellets 1.1 t of the feedstock is used.

Staffing issues

Ukraine is characterised by high urbanisation which has increased since independence. Currently the rural population constitutes about one third of the total population in Ukraine. This is associated with underdeveloped infrastructure in rural areas. Since wages are low, the highly qualified workers tend to move to the cities. This creates difficulties for employers to find appropriate staff in villages to operate the pelleting equipment. Often they have to attract them by relatively high wages. Statistically reported wages in the agricultural sector are lower than 2000 UAH per month. A pellet plant needs four well-qualified engineers to handle the automatic equipment. We assume that the gross wage of each of them costs the producer 5500 UAH (meaning about 4470 for each employee). Taking into account that this level is already higher than the

²¹ Sunflower husk density is from 0.12 to 0.15 kg/cub. dm.

²²Shaw M. (2008). Feedstock and Process Variables Influencing Biomass Densification. Master Thesis. <http://library.usask.ca/theses/available/etd-03092008-115636/unrestricted/Thesis.MarkShaw.FinalR3.pdf>

²³ICK's equipment specifications.

²⁴ When we distract 10% of the rubbish from the 1000 kg of the feedstock, 900 kg are left. Then, we distract 18% more from the remaining quantity to get the needed moisture content of 12%. It means that 738 kg of straw or wood are left. Thus, 1.36 more t of straw and wood are used to produce 1 t of pellets.

average wage level in Ukraine and the fact that during the last 15 years the growth of wages in Ukraine did not exceed 2%, we assume that the set wage will be relevant for the entire 15 years of the plant's use.

3. PROFITABILITY ANALYSIS

Our calculation suggest that pelleting is a profitable business in Ukraine. Under our assumptions the initial investment pays back in less than 2.5 years and can provide a return of up to 300% over the 15 years of operation. Our results are based on the most widely used indicators to estimate profitability, i.e. payback period, internal rate of return and net present value. We considered 27 different cases that vary in the feedstock (straw, wood and sunflower husk), capacity (1.2 t/h vs. 5 t/h) and other assumptions. The break-even-point analysis suggests that pelleting becomes profitable after it exceeds a capacity of 1.3 t/h, 0.4 t/h and 0.6 t/h for straw, wood and sunflower husk respectively. Our calculation of the operating leverage indicates that increasing the capacities of small pelleting plants can bring higher profit increments in comparison to the large ones. At the same time large pelleting plants are several times more profitable than small ones suggesting that economies of scale exist.

Despite the fact that Ukraine ranks on the bottom positions in the World Bank's rating of doing business, many businesses in the country are quite profitable. A good example of this is the pelleting business. This was revealed during our interviews made among twenty small Ukrainian pellet producers. To cross-check the interview results we decided to carry out our own profitability analysis.

To estimate the profitability of pellet production in Ukraine, we consider 18 different cases for pellet production. For three different kinds of feedstock (grain straw, wood residues and sunflower husk) we consider plants of two different capacities (the small one of 1.2 t/h and the large one of 5 t/h) to observe the economies of scale. Also for each feedstock and each capacity we consider three different production cases. The first one, the best-case scenario, assumes that producers are exempted from taxes and works the whole year with minimal interruptions. Two other cases considered relax these assumptions thus creating a more challenging business environment.

- Scenario 1 assumes that producers have lower load factors (for example due to interruptions in the feedstock supply) and the equipment is only used 183 days out of 365.
- Scenario 2 assumes that producers are not granted the generous tax exemptions that have been put in place to stimulate renewable energy production in Ukraine. Specifically, in this scenario a pellet producer sells the pellets for a 20% lower price as VAT is deducted i.e. straw pellets for 83.3 EUR/t, wood pellets for 100 EUR/t and husk pellets for 75 EUR/t. Also a 21% profit tax is deducted from his profits.

The major groups of costs in the calculations are production, operational and maintenance costs. Production costs are costs for pelleting equipment purchase (plant itself), purchasing land and the building needed to construct the plant, wages and social security outlays and the cost of electricity and water use. Operational and maintenance costs include costs to provide the pelleting plant with feedstock and bags to pack the final product on a regular basis as well as annual maintenance (and repair) costs of the equipment. Feedstock transportation costs assume a supply radius of 50 km (see Annex A for detailed calculations). Other costs are case specific (administrative costs range from 2% to 10% of the total benefit, some other additional transaction costs, etc.). Those are excluded from the calculations. To compensate for these costs we take the maximum threshold of prices for equipment maintenance and plant construction.

The benefits of pellet production are generated from the sale of pellets. We assume that they are sold in big standardized one tonne bags. The detailed description of each category of costs and benefits of the pellet production is given in the Annex B.

Profitability is evaluated using Net Present Value, Payback Period and Internal Rate of Return²⁵. These are easy-to-understand indicators, which are used worldwide to estimate the profitability of different businesses

²⁵Payback period refers to the period of time required for the return on an investment to "repay" the sum of the original investment. Payback period as a tool of analysis is often used because it is easy to apply and easy to understand for most investors. However, this

and to decide which business is worth investing in and how the investment opportunities compare. The value of the Break-Even Point is calculated to show the minimum capacity of the pelleting plant needed to cover costs. Also we calculated the value of the Operating Leverage to demonstrate how the profits would increase with an increase of the capacity of each estimated plant.

As noted above, the calculations are made for three cases. To simplify the calculations for all three cases we assume that the prices/ tariffs for the following indicators remain at the levels set out below:

Land purchase: 24 UAH/ sq.m

Water tariff: 0.00589 UAH/l (VAT included)

Electricity tariff: 1.12 UAH/kWh (VAT included)

Wage per person employed: 5500 UAH/ month (gross cost for the producer)

Packaging (1 tonne bag): 58 UAH / 1 piece

Feedstock price: 250 UAH/t of straw; 50 UAH/t of small wood residues; and 200 UAH/t of sunflower husk

Feedstock transport cost: 31.91 UAH/t of straw and 24.38 UAH/t of wood residues and sunflower husk

Weight ratio feedstock/pellets: For straw and wood residues 1.36 t of feedstock per tonne of pellets; for sunflower husks 1.1 tonnes of feedstock produce one tonne of pellets.

Sales price of pellets: 100 EUR/t of straw pellets; 120 EUR/t of wood pellets; and 90 EUR/t of husk pellets

Exchange rate: 10.6 UAH/EUR

Discount rate: 23%

Having clarified the underlying assumption, we now present the actual results of our analysis in the following sections starting with straw pellet production.

2.1 Straw pellets production

Our results suggest that straw pellet production profitability differs substantially depending on the underlying assumptions. Looking first at the large plant (5 tonnes per hour output), in the optimistic base case the initial investment will pay back quickly in less than a year. This is also reflected in the high internal rate of return of 177% which is substantially above the cost of capital of 23%.

In case this plant will experience a lower load factor – e.g. due to feedstock supply problems - and therefore work only 183 days per year instead of 365 days, the IRR reduces to 85%. In the second scenario which assumes that producers are not able to get the alternative energy producer certificate, the payback period will double compared to the base case and the IRR reduces also to 85%. Nevertheless, the plant remains

method of analysis has serious limitations because it does not properly account for the time value of money, risk, financing or other important considerations such as the opportunity costs. There is no formula to calculate the payback period, excepting the simple case of the initial cash outlay and further constant cash inflows or constant growing cash inflows. Thus, alternative measures of "return" preferred by economists are Net Present Value (NPV) and Internal Rate of Return (IRR).

NPV is defined as the total present value (PV) of a time series of cash flows. It is a standard method for using the time value of money to appraise long-term projects (we consider 15 years for our project). It measures the excess or shortfall of cash flows, in present value terms, once financing charges are met. In general, if NPV value exceeds zero we conclude that our project will generate profit in the future taking into account cash flows discounting by the current discount rate for credits in UAH that we take at the level of 23%.

The internal rate of return (IRR) is a rate of return used to measure and compare the profitability of investments. In the context of savings and loans, the IRR is also called the effective interest rate or the annualized effective compounded return rate that can be earned on the invested capital. In more familiar terms, the IRR of an investment is the interest rate at which the costs of the investment lead to the benefits of the investment. This means that all gains from the investment are inherent to the time value of money and that the investment has a zero NPV at this interest rate. Therefore, we should compare the received IRR value to the current market interest rate (which is considered as a cost of capital rate) that is currently about 23% in Ukraine. This ensures that investment which IRR exceeds its cost of capital adds value for the company.

Source: Description of the terms Net Present Value (NPV), Payback Period (PP) and Internal Rate of Return (IRR) are taken from the Online Free Encyclopedia "Wikipedia". For details see:

http://en.wikipedia.org/wiki/Internal_rate_of_return

http://en.wikipedia.org/wiki/Payback_period

http://en.wikipedia.org/wiki/Net_present_value

highly profitable with IRR values about four times higher than the current market interest rate of 23% and positive NPV values.

Table 2-1: Profitability results for pellets production from grain straw

Parameter	Best case scenario: tax exemption, full working hours (20 h/day and 365 days/year)	Scenario # 1: half load factor (20 h/day and 183 days/year) in the case of tax exemption	Scenario # 2: No tax exemption
	<i>1.2 t/h capacity</i>		
Payback period, years	5.21	-	-
Net present value, mln UAH (15 years, discount rate 23%)	- 1.02	-3.81	- 6.84
Internal rate of return, %	17%	-	-
	<i>5 t/h capacity</i>		
Payback period, years	0.57	1.18	1.17
Net present value, mln UAH (15 years, discount rate 23%)	58.55	23.24	23.38
Internal rate of return, %	177%	85%	85%

Source: Own calculations.

However, our analysis also shows that the smaller 1.2 t/h straw pelleting plants are significantly less profitable or even loss making. In the base scenario the IRR is only 17% - below the prevailing market interest rate in Ukraine. Even worse, if producers are not able to utilise the plants continuously (as assumed in Scenario 1) than chances are high that the plant will be loss-making. Similarly, it is likely that small straw pellet plants will not be economically viable in case that the tax incentives are not granted (Scenario 2). Table 2-1 summarises the results for straw pelleting plants.

As there are many small scale pelleting plants, including those working on straw, in Ukraine, the question is which minimum capacity is required for straw pelleting plants to become profitable. Calculating the Break-even point (BEP²⁶) helps to answer this question. In our case BEP is about 1.3 t/h assuming current tariffs and prices. Therefore, the estimated plant capacity of 1.2 t/h is very close to its break-even point. This explains how small straw pelleting plants can operate in Ukraine. However, as our assumptions are closely aligned to reality, producers are advised to double check the market situation before starting small pelleting businesses in Ukraine.

On the other hand, small businesses may be more flexible and easy to manage in comparison to large ones. This is especially relevant in Ukraine, since governmental regulation is not always predictable and transparent. Moreover, increasing the capacity of small straw pelleting plants (1.2 t/h) leads to higher revenue increases compared to a similar capacity increase of larger plants (5 t/h). Indeed, the Operating Leverage of the 1.2 t/h plant suggests that an increase of the production volume by 1 t/h can increase profits 5.8 times. For a plant of 5 t/h an increase of the production volume by 1 t/h can increase profits by 1.4 times. However, higher profits are associated with the higher risks. The higher the degree of operating leverage, the greater is the potential threat that reduced capacity can lead to losses – as our results for the small plant vividly underline. This is an additional argument for the benefit of building large straw pelleting plants in Ukraine.

2.2 Wood pellets production

Our analysis suggests that wood pellet production is profitable under all considered options and scenarios. The main reason for the robust business case is that using wood as feedstock is five times cheaper than the use of straw. Indeed, feedstock cost remains to be the most important cost driver in pellet production. We find that in the base case large wood pelleting plants can achieve an IRR of 279% while small plants still yield 170% interest.

²⁶ The break-even point (BEP) is the point at which costs (expenses) and benefits (revenue) are equal. BEP is calculated by dividing the Fixed Costs by the difference between the Unit Price and Variable Unit Costs, or by the Marginal Unit Profit. Graphically BEP is an intersection of Costs and Benefits lines (y-axis) at a certain production volume (x-axis).

Obviously, reduced utilisation (Scenario 2) would significantly influence profits. However, this does not make the wood pellet businesses case unprofitable. As table 2-2 shows, profits still remain high and the payback period short with 1.2 years and 0.7 years for 1.2 /h and 5 t/h, respectively. Similarly, removing, or not granting, the tax benefits would reduce the IRR of the large plant to 161% and of the small plant to 96%.

Table 2-2: Profitability results for pellets production from wood residues

Parameter	Best case scenario: tax exemption, full working hours (20 h/day and 365 days/year)	Scenario # 1: half load factor (20 h/day and 183 days/year) in the case of tax exemption	Scenario # 2: No tax exemption
	<i>1.2 t/h capacity</i>		
Payback period, years	0.59	1.24	1.05
Net present value, mln UAH (15 years, discount rate 23%)	22.56	8.75	11.02
Internal rate of return, %	170%	81%	96%
	<i>5 t/h capacity</i>		
Payback period, years	0.36	0.73	0.62
Net present value, mln UAH (15 years, discount rate 23%)	107.28	47.05	57.56
Internal rate of return, %	279%	136%	161%

Source: Own calculations.

Interestingly, the observed contraction of profits associated with a reduced load factor or tax payments is softer for large wood pelleting plants in comparison to small ones. The operating leverage shows that for the 5 t/h plants the NPV contracts only by a half, if working hours decrease by a half. For the same decrease of working hours the NPV of 1.2 t/h plants decrease by almost two thirds. However, the results of calculating the Operating Leverage for wood pellets production need to be treated with some caution since increases of wood pellet equipment costs associated with plant enlargement are higher than for straw and husk cases.²⁷

Our analysis also suggest that the minimum capacity to overcome the threshold of producing profitably is low, at around 0.4 t/h. These calculations were made taking into account the structure of costs and benefits for the small scale wood pelleting plant, and sticking to our assumptions.

2.3 Sunflower husk pellets production

Finally, we consider the business case for sunflower husk pelleting plants. Here, our analysis suggests that this type of pellet production is profitable as well. Again the numbers suggest that larger plants of 5 t/h capacity have the shortest payback period with 121 days (about 4 months) and the highest IRR of 300% in the base scenario. Indeed, all 6 business cases considered here that produce sunflower husk pellets seem to be one of the most profitable investment. However, NPV values for 5 t/h plants here are lower in comparison with plants, which use wood residues. 1.2 t/h plants are less profitable than the equivalent wood pelleting plants. Nevertheless, the high IRR and NPV values and short payback periods suggest a profitable investment.

As table 2-3 below suggest relaxing assumptions of the best case scenario considerably affects profitability. Reducing the days, on which the plant operates, by 50% reduces the IRR to 147%. Similarly, removing the tax incentives would reduce the IRR to 168%. However, both cases are still substantially higher than the prevailing interest cost of 23%.

²⁷ The equipment for the large wood pelleting plant includes a large section for the feedstock preparation for pellets production in case the feedstock is of large sizes and high moisture. It results in higher equipment costs as well as higher costs for the electricity consumption implying higher total fixed costs. Overall, the fixed costs for the 5 t/h plant triple in comparison with 1.2 t/h plant while for the cases of the straw and sunflower husk pelleting plants they grow just by about 40% (and are in line with theoretical assumptions behind the Operating Leverage indicator).

Table 2-3: Profitability results for pellets production from sunflower husk

Parameter	Best case scenario: tax exemption, full working hours (20 h/day and 365 days/year)	Scenario # 1: half load factor (20 h/day and 183 days/year) in the case of tax exemption	Scenario # 2: No tax exemption
	1.2 t/h capacity		
Payback period, years	1.02	2.23	2.42
Net present value, mln UAH (15 years, discount rate 23%)	9.18	2.55	2.11
Internal rate of return, %	98%	45%	41%
	5 t/h capacity		
Payback period, years	0.33	0.68	0.60
Net present value, mln UAH (15 years, discount rate 23%)	74.99	33.34	39.07
Internal rate of return, %	300%	147%	168%

Source: Own calculations.

Our calculations show also the same effect for economies of scale for sunflower husk pelleting plants as for the other two types of pelleting plants. The Break-Even-Point Analysis suggests that sunflower husk pellet production requires a minimum output of about 0.6 t/h for the large plant. The operating leverages do not differ much for this case. So profit increase can only be partially explained by feedstock increase, implying that other costs also have a significant impact on profitability. However, most possible opportunities to use sunflower husk are already utilised on the Ukrainian market. This leaves fewer possibilities for further development/ increase of pelleting production based on sunflower husk in comparison with straw and wood pellets.

Taking the high profitability of large pelleting plants and Ukraine's dependency on imported energy sources into account, building large scale pelleting plants can effectively provide additional energy for Ukraine. Indeed, our analysis suggests that there is a solid business case for most pellet production types under current economic and legal conditions. As such, the government is well-advised to remove the remaining barriers so private investors are able to utilise this potential.

CONCLUSIONS AND POLICY RECOMMENDATIONS

Our analysis shows that Ukraine has a thriving but yet underdeveloped market for pellets. 240 thd t of pellets are produced annually by about 150 small pelleting plants. We also estimate that about 20 mln t of grain straw, 2 mln cub m of wood residues and up to 1.5 mln t of sunflower husk are currently unused or under-utilised. These inputs could be converted into at least about 11 mln t of pellets worth about EUR 1 bn at current prices. On top of this potential, most types of pellet production already show a convincing business case. Our calculations show that pelleting plants working either on grain straw, or wood residues, or sunflower husk are highly profitable (except for the small 1.2 t/h capacity grain straw plants). This raises the question which obstacles hold investors back from realising the potential?

Obstacle 1: Supply and quality of the feedstock. Despite the fact that Ukraine has a high biomass potential providing a continuous supply of feedstock in the right quality and quantity remains problematic. Indeed, the market for wood and straw feedstock is underdeveloped. Many farmers do not have straw balers and either require the buyers to collect the straw themselves or just burn it on the field. Furthermore, Ukraine lacks forest roads impeding the collection and delivery of wood biomass. Pellet producers have to buy small amount of wood and straw biomass from various farmers – increasing the transaction costs and, in turn, the feedstock costs unnecessarily. Furthermore, different traders provide feedstock in different quantities and characteristics. This influences the quality of pellets. The situation on the sunflower husk market is that the husk is used by oil-extracting plants in order to produce energy. This significantly limits the supply of this feedstock. For all three feedstock insufficient collection, delivery and storage of the biomass decrease the quality of the pellets.

Obstacle 2: Production issues: soviet equipment use and small-scale operations. The majority of Ukrainian pellet producers use modernised soviet technologies. The main reason for that is that this kind of equipment is cheaper. As such it also reflects high capital cost, lack of financing and lack of confidence in the economic and political environment. However, such equipment is less capable to produce high quality pellets that can be easily sold on the international markets. Furthermore, small-scale production facilities are less likely to benefit from the economies of scale observed in our profitability analysis. Consequently, Ukrainian producers are less competitive which is reflected in a low international market share.

Obstacle 3: Predictability of governmental policies. State-supported programs help to improve the profitability of pellet producers by exempting them from the import duty for the equipment, from the profit tax and from the VAT for the equipment and for the pellets produced. At the same time to obtain these privileges pellet producers have to receive a certificate conforming that they produce alternative energy. The procedure of getting such a certificate is not always transparent and leaves ample of space for arbitrary decisions and extracting bribes.

Besides, taking into account that Ukraine has one of the bottom positions in the World Bank's ranking of doing business, producers are not be certain about the long-term prospective of their pelleting businesses. Additionally, there is an absence of long-term policy targets for the growth of renewable energy use in Ukraine. This impedes the development of the feedstock markets and also affects the long-term production plans typical for this kind of investment. Finally, improving rural infrastructure is necessary to develop the regions and attract businesses to operate there, which would provide the rural population with economic and employment opportunities.

Obstacle 4: Subsidies for fossil fuels.

Finally, subsidies for fossil fuels through artificially low gas and heating tariffs remain a major barrier for the development of the entire renewable energy industry. Indeed, as pellets need to compete with subsidised fossil fuels the only route to marketing them is currently through exports into the European Union. Reducing the subsidies would open up a domestic market which is yet in its infancy and thus help to reduce Ukraine's energy dependency.

Overall, our analysis draws an optimistic picture of the future prospects of the industry suggesting that by removing these barriers the pelleting industry could provide a much needed stimulus for rural areas.

ANNEX A: FEEDSTOCK TRANSPORT COST CALCULATION.

To calculate transport costs of delivering straw or wood residues to the pellet producing plant, we assume the following:

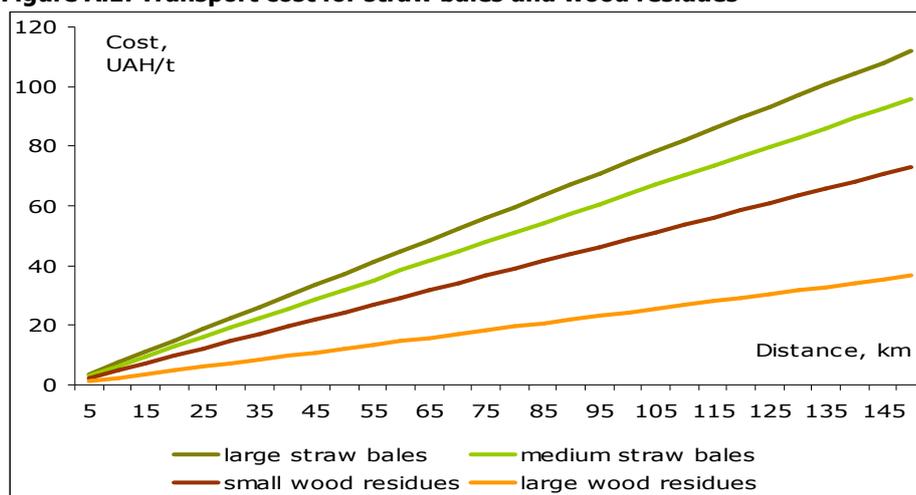
- 1) the volume of truck body is 40 cub. m (including the volume of a trailer),
- 2) full truck consumes 40 liters of fuel per 100 km driving 60 km/h,²⁸
- 3) diesel fuel price is 9.75 UAH/l.
- 4) big and medium straw bales volumes are 3.74 cub. m and 1.53 cub. m (and their weights are 523 kg and 235 kg respectively)²⁹,
- 5) small wood residues (like sawdust, wood shavings and chips) can be strongly rammed to fully fill the whole truck body volume, i.e. 40 cub. m,
- 6) price of small wood particles is given per apparent density. To get strong density we multiply apparent density by 0.4³⁰
- 7) large wood residues (like saw mill waste and strips) have infill coefficient of 0.5 that means half of a truck body volume, i.e. 20 cub. m,
- 8) densities of small and large wood residues are assumed on the levels of 0.5 kg/ cub. m and 0.8 kg/cub. m. respectively³¹

The results of transport cost calculation show that wood residues are cheaper to transport than straw bales. Wood residues have higher densities and can be rammed better than straw bales. Medium straw bales are cheaper to transport than large straw bales. A truck with a body volume of 40 cub. m can transport 10 large straw bales or 26 medium straw bales. Given quantity of medium straw bales provides higher weight in tons and decreasing transport costs per km. Small wood residues have lower densities in comparison to large wood residues. These differences decrease their total weight/volume ratio. Therefore, costs of transportation for small wood residues per km are higher than for large wood residues.

Each additional kilometre of transportation adds:

- 0.75 UAH for large straw bales,
- 0.64 UAH for medium straw bales,
- 0.49 UAH for small wood residues,
- and 0.24 UAH for large wood residues.

Figure A.1: Transport cost for straw bales and wood residues



²⁸ Data of possible truck body volume and nominal fuel consumption is given by official Kraz and MAZ trucks dealer in Ukraine PKP Alfatex: <http://autokraz.biz>

²⁹ Straw for Energy Production: Technology – Environment – Economy. The Centre for Biomass Technology, 1998.

³⁰ Market information: <http://forums.wood.ru/showthread.php?threadid=32637>

³¹ Density of wood residues depend on a range of factors such as humidity content or part and size of the wood (residue). Detailed information on densities can be found here: <http://www.wood.ru/ru/othod02.html> During transportation wood residues ram that decreases their total volume. We assume that wood residues were strongly rammed and, therefore, omit this factor.

ANNEX B: COSTS AND BENEFITS OF PELLETING

Description of costs of the pellet production from grain straw, wood sawdust and sunflower husk in Ukraine

Costs of land purchase:

Purchasing land to build a pelleting plant is not difficult in Ukraine. In Ukraine average prices for one hundred square meters (standard measure of land plots in Ukraine is "sotka") which are about 100 km far away from oblast centres have been 300 USD in June 2011. In our calculation we assume that all accompanying land sale costs are included in this price (legalization costs and payment to the realtor). 400 sq. m and 800 sq. m are needed for pelleting plants of 1.2 t/h and 5 t/h capacities respectively. Therefore, they cost 9600 and 19200 UAH respectively (average exchange rate is 8 UAH/USD).

Costs of building construction:

As mentioned above, 400 sq. m and 800 sq. m are needed for pelleting plants of 1.2 t/h and 5 t/h capacities respectively (it includes the free space to store a certain amount of feedstock). There are no strict requirements for the buildings. They can be of any not highly inflammable material of about 10-12 m height with a good insulation to maintain positive temperature in winter. The Ukrainian company Averbud³² proposes to use metal constructions of sandwich panels using mineral wool or to use standard brick buildings. Since large doors (for the tractor) are needed, extra costs of 4-10 thd. UAH must be added. It is suggested that the large outside doors are built of profiled sheet with mineral wool insulation. The building firm sets the price at 3500 UAH/sq.m, assuming that all building materials (including doors) are included in this price.

Costs of electricity consumption:

Tariffs for electricity consumption are officially published by the National Electricity Regulatory Commission of Ukraine (NERC). Taking an average tariff (without VAT tax) for consumers of 2nd voltage class from the list of energy supplying companies we get 0.9302 UAH/kW*hour.³³ Adding VAT tax this tariff equals 1.12 UAH/kW*hour. To get the total cost of electricity consumption we will multiply this tariff by the amount of electricity that pelleting equipment of different capacities consumes. The different types of plants consume between 279 and 1336 kW/h depending on the capacity and the feedstock.

Costs of water consumption:

Tariffs for water consumption are officially published by the Ministry of the Regional Development, Construction and Housing and Communal services of Ukraine. The average tariff for water consumption by commercial consumers was equal to 5.89 UAH / cub. m or UAH / t in March 2012.³⁴ Pelleting equipment consumes about 80 litres of water per ton of pellets produced.

Costs of personnel:

Taking into account the current market situation and common business practice in Ukraine, we use the wage of 5500 UAH/month in our calculations. 4 engineers are needed to keep a plant up and running (2 + 2 in two shifts). We assume the plant works 20 hours a day.

Costs of the pelleting equipment:

The data for the equipment we considered is provided by the ICK Group³⁵. The technology of the equipment is German; the details are different: some are of the foreign production, and some are of the Ukrainian production. It makes the equipment cheaper. The prices for plants of 1.2 t/h capacity go up to 3.2 mln UAH; of 5 t/h capacity up to 6.8 mln UAH EXW Kiev Oblast (Doslidnytske). Projection and design work as well as set-up of the equipment is provided by the same company and accounts for 10% of the total equipment costs.

Costs of the pelleting equipment's maintenance and repair:

³²<http://averbud.com.ua>

³³ See tariffs for March 2012 http://www.nerc.gov.ua/control/uk/publish/article?showHidden=1&art_id=114313&cat_id=34446

³⁴<http://minregion.gov.ua/>

³⁵<http://www.ick.ua/>

The maintenance costs of equipment equal 7-10% of its total costs. We use 10% to compensate for non-accounted costs.

Costs of the big bags:

The one big-bag costs about 58 UAH. It is a bag of sizes 90x90x180 with the solid bottom and apron upper. It has 2 loops, 2 slings and is made of a material with the density of 130 g.³⁶

Costs of the feedstock:

According to market information the average prices for loose straw on the fields are 250 UAH/t, wood sawdust and sunflower husk EXW are 50 UAH/t and 200 UAH/t respectively. Transportation costs in the 50 km zone go up to 32 UAH/t (see Annex A). We apply 31.91 UAH/t for straw, 24.38 UAH/t for wood residues and sunflower husk.

Description of benefits of the pellet production from grain straw, wood sawdust and sunflower husk in Ukraine

Benefits of pellet production are obtained by pellets sale itself. We assume their sale in big bags of 1 ton. Average EXW prices for pellets from straw are 100 EUR/t, wood sawdust – 120 EUR/t and sunflower husk – 90 EUR/t. We use these prices in our calculations with an exchange rate of 10.57 UAH/EUR (March 2012).

³⁶ Info from Ukrpak and Dnepr-pak: <http://spravka.ua/goods/big-bag/230974.html>.