

# СЕКЦИЯ «ПРОМЫШЛЕННАЯ ЭКОЛОГИЯ. ЭНЕРГО- И РЕСУРСОСБЕРЕЖЕНИЕ»

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## THE ECONOMIC ISSUE OF WILLOW BIOMASS PRODUCTION FOR ENERGY PURPOSE IN SHORT ROTATION COPPICE PLANTATIONS

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**Резюме.** Ива является одной из перспективных культур для создания коммерческих плантаций с последующим использованием древесины на энергетические цели. Площади культуры в Европе занимают свыше 20 тысяч гектар, в странах, климатические условия которых близки к Республике Беларусь. Важнейшим условием создания плантаций является рентабельность производства биомассы, которая зависит от ряда внешних и внутренних факторов, в том числе рыночных цен на энергоносители, урожайности ивы, себестоимости продукции. На экспериментальных участках Республики Беларусь урожайность ивы составила до 50 тонн древесины с гектара или 16,9 тонн в год с учетом трехлетнего оборочного цикла. Высшая удельная теплота сгорания древесины – 18500 кДж/кг. Расчетный срок окупаемости капиталовложений необходимых для закладки плантации составляет 3-4 года (один оборочный цикл) при условии замещения биотопливом природного газа и 6-8 лет при реализации древесины по рыночным ценам.

**Introduction.** In accordance with prognoses of the World Energy Council in 2050 with increasing of total world energy demand twice, the input of bioenergy will be about 32 %. [1]. There are some different sources of biomass: for examples residues of wood and crops, solid waste or special agricultural crops growing for energy, including short rotation coppice. The climate conditions of Republic of Belarus, like other countries of Eastern and Central Europe and North America are more adopted for willow growing. The area of commercial plantations willow in Europe, mostly in Sweden is more than 20.000 ha. Willow biomass is a low-maintenance crop that stimulates rural economies and enhances the local environment. The yield of willow biomass crops may achieve 10-15 tons of dried wood or 5-6 toe per hectare and plantation may be used for 20-25 yeas with period of harvesting every three years [2]. These indicators it is good basis for economic efficiency of willow plantations. Nevertheless there are several negative factors that have negative influence on spreading of commercial willow plantations: dramatic decreasing of fossil fuel cost in the world market; comparatively high cost of initial input to willow plantations planting and changeable and sometimes non-predictable market of biomass. There are some publications that consider economic issue of willow biomass production. Rosenqvist H, and Nilsson L. estimated cost of energy productions for several crops, where production cost of willows was o about 4-5 €/GJ compared to the poplars (5.5-6 EUR/GJ), reed canary grass (6.4-7.0 €/GJ), and miscanthus – (7.9-8.4 €/GJ). [3]. The goal of our research is estimation of the cost of willow plantation planting and payback perspective in Republic of Belarus.

**Results and discussion.** The profitability of willow biomass production mostly depends of several factors: yield, cost of planting and harvesting machines, prime cost and market cost of biomass [4]. In our experiments, the yield of biomass was about 12 ton of dry matter per ha per year in three years after planting with the height of trees was 5-5.5 meters and diameter of stem was 5-8 centimeter. These parameters are close to parameters of willow trees of the same age growing in Sweden or

Poland. Average unit of prime costs for establishment and growing of willow SRC plantation including the first harvesting is about 3200 \$/ha. These calculations include cost of fuel, fertilizer, planting materials, amortization of machines, salary of employment and so on. Of course startup costs it is basic part of investment to willow plantation. The cost of planter, that you should buy in the first year is 8000-15000 \$, and the price of harvester – 100000-150000 \$. You need to buy it in the 4 year after planting, it is period of first harvesting of biomass in accordance with technology. It is also necessary to add some money that you need to invest for every year supporting of plantation, for pesticides, fertilizer and so on. For instance if startup costs is 3200 \$, cost for 8 year plantation will be 3800 per hectare. The basis expenses are for harvesting and transporting of biomass, including cost of harvester (about 50 %). It is possible to decrease these expenses if not to buy, but to rent the harvester, or spreading of the area of plantations. Fact is, the harvester is adopted only for wood and at the result amortization expenses are going to hectare of plantation. The market cost of biomass mostly depends of calorific value of biomass. In our experiment, calorific value of willow wood was about 18500 KJ/kg. [5]. It means that 1000 m<sup>3</sup> of natural gas may be replaced by 2.4 ton of willow wood. The average yield of willow wood with humidity of 45 % is about 50 ton per hectare in 3 years and 16.7 with calculation per 1 year. It means that we may have 4.4 toe of wood that equivalently 3900 m<sup>3</sup> of natural gas. The average cost of 1000 m<sup>3</sup> of natural gas for legal entity in Belarus is 220 \$. In the case of replacement gas for wood the payback period for company will be 4 years, or first harvesting of willow biomass. It is complicated to calculate of the economic efficiency of willow biomass production for direct selling of wood to companies. The price for wood chips is very flexible and with moisture contents 30-40 % it is about 30-40 \$ per ton. In that case the cost of chips of wood harvested from one hectare of willow plantation is about 477 \$ and 636 \$. In the first case the payback period for startup costs will be 7.9 year and in the second 5.9 year. But for both variants it will be two harvests. Our calculation is close to situation in other countries, for instance in USA, despite of difference cost of materials and labor in USA and Belarus. It is now possible to achieve internal rate of return (IRR) up to 10 percent, with a payback period of three to four harvests (10 to 14 years after planting) with improved cropping systems and no incentive programs [4]. This period of payback more to compare to tradition agricultural crops in USA. In order to stimulate planting of willow commercial plantations incentive programs, such as USDA BCAP, are available for farmers and landowners. If incentive programs and respectively subsidies are available, returns may be 20 percent or greater with a payback as short as one or two harvests (four to eight years).

**Conclusion.** Willow biomass is a low-maintenance crop, but in probability depends of several factors: yield, cost of planting and harvesting machines, prime cost and market cost of biomass. The yield of willow wood obtained in experiments in Belarus was about 50 ton per hectare that comparable to other countries. The basic part of investment to willow plantation it is startup costs including the first harvesting (4 year) is about 3200 \$/ha. The payback period depends of method of calculation. In the case of replacement gas for wood the payback period for company will be 4 years, or first harvesting of willow biomass and with direct selling of wood it is second harvesting (6-8 years).

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