Competitiveness of Economy of **Vojvodina**

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Content

ENERGY

Experiment

If everyone does a little, we'll achieve only a little[1]

DJC MacKay

5.1 Introduction

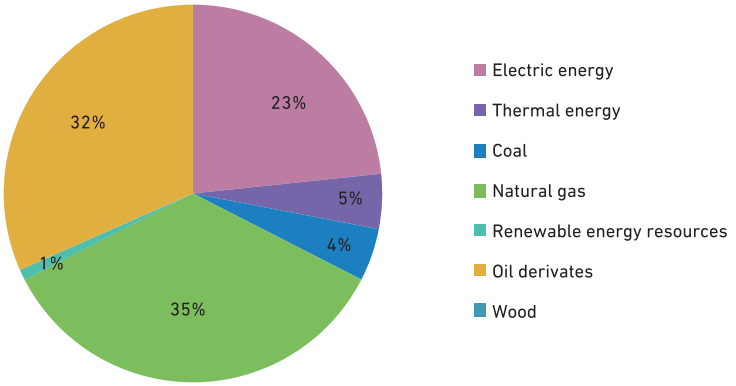
Services of the energy sector and availability of the same obviously make a critical determinant of competitiveness of economy of Vojvodina. There is the traditional link between services of the energy sector, efficiency of use of energy and competitiveness of economy of Vojvodina. In the period from 1952 to 1990, Vojvodina had a relatively high employment rate in industry in the context of the former Yugoslavia, as well as relatively high social product per employee in industry, but also lower fixed assets in industry per employee and, in particular, lower consumption of electricity per employee compared to the average values for the former Yugoslavia. In other words, the efficiency of use of energy in Vojvodina was above the average in the context of the former Yugoslavia. The fact is that industry of Vojvodina used energy and available capital, i.e. available assets under the rates exceeding the country's average and, in such a way, it was achieving a higher social product per employee in industry with approximately average scope of employment in industry. This also points to the fact that the scope of consumption of energy per surface unit was somewhat lower in Vojvodina compared to the average of the former Yugoslavia, meaning that the scope of energy infrastructure was lower than the country's average. In that period, Yugoslavia was the country that consumed energy, i.e. had the average energy efficiency at the level of the world average. Therefore, it can be said that the efficiency of use of energy in industry of Vojvodina was above the world average, which, among other things, lead to utilisation of the available property under the rate exceeding the world average.

In the period from 1990 until today, the national product in Vojvodina has been reduced significantly and consumption of energy, with the exception of liquid fuels, has remained at the approximately same level. It varies year in year out, depending on political potentials and availability of energy. However, in the key sectors, meaning sectors of electricity, heating energy and gas, it remains at the approximately same or similar level.

The energy balances of the AP Vojvodina, which are published by the Secretariat for Energy and Mineral Resources of the Province, show the rate of energy consumption in Vojvodina within the last few years. Therefore, the example of the structure of consumption of energy in Vojvodina is shown in the following Chart:

1 Paraphrased: If only a little is done in all the fields, we will achieve only modest results. In other words, this simple logical dependence shows that through sums of small interventions and small facilities only a small total result can be achieved. In situations when lagging behind in competitiveness is dramatic, as it is the case with Serbia compared to the rest of Europe, a large, strategic undertakings are necessary to achieve a large result and bring the total economy into the comparable category of competitiveness. Measured by relative financial indices or objectified value marks, the competitiveness does not tell enough about the actual physical lagging behind, which is the point in this case. Besides, the energy sector is most often the one with clearly expressed economy of scale. Most frequently, a high level of energy efficiency cannot be achieved at all in small facilities or with lower load coefficients. Those physical or technological circumstances have a strong impact on competitiveness of energy sector and, indirectly, on competitiveness of the whole economic system. We could paraphrase again: a large number of smaller facilities do not yield with energy efficiency of a large facility for the same scope of generated energy.

Chart 5.1.1. Structure of final energy consumption in Vojvodina in 2004



Source: Executive Council of the AP Vojvodina, Integrated Regional Development Programme of the AP Vojvodina, November 2006

However, consumption of energy in Vojvodina is not the only one, and obviously not the main indicator of contribution of energy to competitiveness of economy of Vojvodina. The availability of services in the energy sector and energy infrastructure also determine the attractiveness of certain areas for investments, employment, and accomplishing of relatively high productivity. Services of the energy sector are also a significant consumer of products and services of other industries and they can affect the employment rate in agriculture, industry, forestry, water management, transport, and other fields. The availability of the energy infrastructure affects the existence of opportunities for new investments, namely the openness of economy to competition. This openness to competition can and should exert pressure on the already existing companies to maintain a certain level of competitiveness and, potentially, increase productivity and competitiveness, simply in order to survive on the market.

In other words, energy infrastructure, and availability of services of the energy sector affect all four main competitiveness factors, meaning:

1. Production factors
2. Consumption factors
3. Availability of industries and support to industry, and
4. Strategies of companies and competition

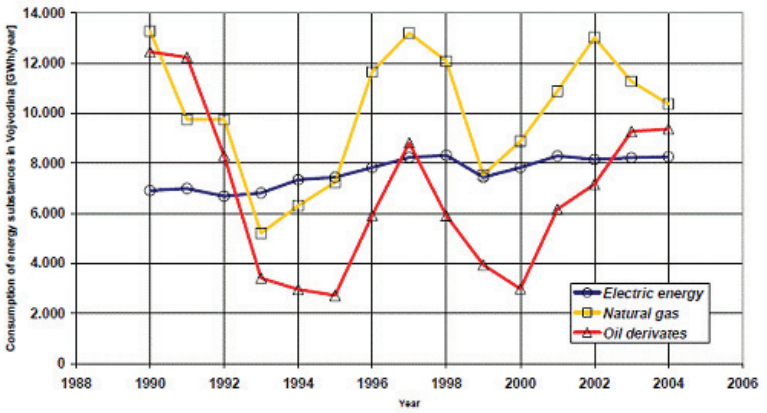
Conventional approach to relations between services of the energy sector and the rest of industries implies that the purpose of energy sector is to place services of the energy sector at the disposal to other forms of consumption of housing, industry, and agriculture. However, in an integrated approach, the energy infrastructure appears in all other forms and affects significantly the total economic environment within a certain area. The conventional approach can lead to an understanding that the source of energy or the type of fuel that is used affects very little the total economic development and competitiveness. Namely, it is believed that it is necessary to ensure certain energy efficiency, namely small energy intensity in relation to the national product and that it is sufficient for accomplishment of competitiveness of economy.

However, services of the energy sector have a much wider impact of competitiveness of economy. We will draw the attention here to numerous and diverse impacts that are or could be exerted on competitiveness of economy of Vojvodina by creating of services of the energy sector in Vojvodina. In addition to energy efficiency we will also analyse the impacts that creating of services of the energy sector in Vojvodina could exert on structure of industry, agriculture, water management, forestry, population and housing and other circumstances that are of significance for competitiveness of economy of Vojvodina.

Having in mind the current status and structure of available services of the energy sector[2] in Vojvodina, as well as the existing plans for development of energy infrastructure and services of the energy sector in Vojvodina, we will also present a certain number of main recommendations for further development of services of the energy sector in the context of support to competitiveness of economy of Vojvodina.

2 The Chart that follows shows the scarce available data on structure and dynamics of services of the energy sector in Vojvodina.

Chart 5.1.2. Consumption of energy substances for energetic purposes in Vojvodina



Source: Executive Council of the AP Vojvodina, Integrated Regional Development Programme of the AP Vojvodina, November 2006

5.2 Competitiveness and services of the energy sector in Vojvodina

Energy is the production factor for agriculture, industry, water management, and transport. However, energy also represents the labour factor. Namely, the population uses energy for housing and main services of the energy sector in the field of housing, as well as for transport, namely mobility. The availability of services of the energy sector for the population affects indirectly the total competitiveness of economy and services within a certain area, via necessary salaries of the population. Therefore, as the factor of competitiveness, energy has both direct and indirect impact of competitiveness of economy, which implies that the unit price of the available energy has a significant direct and indirect impact. The lower the unit price of the available energy gets the competitiveness of services will be higher. This means that industry, agriculture, and transport will have conditions that are more favourable for competitiveness compared to other markets and that they will be in the position to pay lower salaries to their employees, who will still be able to enjoy the appropriate standard of living.

However, the price of services of the energy sector has to be set so that it provides a long-term sustainability of those services. Namely, it is possible to support the competitiveness of economy through lower prices, or sustainability of relatively low salaries of employees, from time to time and within certain periods, without basing it on higher efficiency of the energy sector itself. Such a situation can last for a short time and it can affect the total sustainability of energy infrastructure. In other words, we are dealing here with long-term effects that the price of services of energy sector set on a long-term basis has on total competitiveness of economy, namely labour force in Vojvodina. This long-term dimensions of prices of services of the energy sector is created through a long-term competitiveness of energy infrastructure and sources of energy in relation to competitive regions.

The character of demand for energy is one of the factors through which services of the energy sector affect the competitiveness of economy of Vojvodina. The demand for energy is characterised by certain scope set by seasonal characteristics, certain quality characteristics, i.e. type of energy or services of the energy sector that are required and, naturally, sustainability of such demand. The main characteristics of demand for energy in Vojvodina are currently of emphasised seasonal character. The demand for certain forms of services of the energy sector is significantly increased during the winter period and the demand for other forms of services of the energy sector is increased during the periods of certain works in agriculture or seasonal campaigns in industry. Such an emphasised seasonal character contributes to a relatively decreased use of energy infrastructure, namely total assets involved in providing of services of the energy sector.

A relatively small demand for high quality energy is another main characteristic. In other words, the demand for electricity is relatively low compared to demand for electricity in industrially developed countries. This demand is low both per capita and per unit of national product. A relatively small scope of demand for electricity in industry points to a relatively small productivity rate in industry in relation to the number of employees, and accordingly to a relatively low competitiveness of industry.

A relatively dynamic growth in certain fields is also a characteristic of demand. The dynamic growth of demand for liquid fuels within the last six to eight years is emphasised in particular. Namely, a highly emphasised growth of demand for liquid fuels has been recorded since the year 2000 until today. It can be considered that, up to a certain extent, this growth is the expression of inadequate statistical encompassing of consumption of liquid fuels during the 90s of the last century. However, even if we consider that fact, there is still a comparatively dynamic growth of demand for liquid fuels within the last few years. Such growth cannot be brought in direct connection with growth of national product, in particular in the fields of a physical character. Having in mind that the highest growth of the national product was accomplished in financial services, namely in commerce, or more precisely in retail trade, there is an obvious disproportion between the growth of demand for liquid fuels and the achieved growth of activities in businesses requiring certain physical activities. Furthermore, the researches show a relatively low use of the available fleet of motor vehicles. Vehicles – passengers' cars, trucks, and agricultural machinery – are

used below the average rate that is registered in other European countries. Despite of all that, the consumption of fuel grows year in year out. This points to the growth in consumption of fuel in segments of transport services with the lowest fuel consumption efficiency rate and this probably implies the growth of fuel consumption in urban public transport with small relative speed, small mileage, and relatively high consumption per unit. Judging by all the above, the impact of urban areas in Vojvodina, and of Novi Sad in particular, is the most significant.

However, when it comes to consumption, we should also analyse the impact of services of the energy sector as user of services of other sectors. The conventional analysis shows that energy related industry uses services of other industries in the field of maintenance and construction of energy related facilities etc. However, it should be considered that demand for fuel for energy conversions is actually the most significant impact that industry of services of the energy sector can exert. It should be analysed whether such demand exists in Vojvodina.

The energy related industry should certainly be considered an accessory industry, from the aspect of competitiveness. The reason is the fact that energy is rarely exported in its processed form, or it participates in export only marginally in relation to the total scope of services of the energy sector within certain territory.

The scope of national product that can be generated from the unit of available energy is usually multifold higher than the value of energy itself. In other words, the export of one unit of energy results with the loss of national product within the given territory in much, much higher scope. Therefore, it is believed that trade with energy is only marginal in countries that are net importers of energy and that have little or nothing of their own resources and that it serves only to improvement of the structure of available services of the energy sector. This means that services of the energy sector are always and in all respects the industry that supports development, competitiveness, functioning of other stakeholders of economic activities within the given territory. However, the contribution of energy related industry to competitiveness is reflected in the fact that its efficiency and relations with other branches of economy should be comparable with similar or same circumstances in other territories.

The availability of services of the energy sector and energy infrastructure affects the possibility to set up new industrial or other economic entities within certain territory. When energy infrastructure is relatively small, with a relatively low growth or development rate, the probability that services of the energy sector will be available to new industries is naturally reduced. In that case, the availability of energy infrastructure and services of the energy sector affects the possibility to start up new industries, namely create new jobs within certain territory. The consequences include the increase of barriers for entering into the branch, namely reduced competitiveness or reduced probability to be competitive for the existing industries, namely existing companies within the branch. In this way, the total competitiveness of economy within certain territory is reduced, the companies are retarding, and general effort that companies invest into enhancing of their competitiveness is declining. Therefore, the lack of energy infrastructure, namely total scope of services of the energy sector can be analysed as a kind of barrier for entering into the branch, as well as the way to lower the competitive capacity of economy within certain territory.

5.2.1 Energy efficiency

Energy efficiency is the measure of use of energy per unit of production or per some other physical unit. We can analyse the use of energy per unit of residential or business premise, use of energy per unit of production, or use of energy per unit of national product. According to most of the above-mentioned indices, the consumption, i.e. use of energy in Vojvodina is below the world average, in particular, below the average for the OECD countries, namely developed countries. It is considered that the average consumption of energy per unit of residential and business premise is 2.5 to 3.5 times higher than average in OECD countries in Europe[3]. At the level of the whole country, it is evident that consumption of energy per unit of national product is three and even more times higher than consumption of energy per unit of national product in the developed OECD countries in Europe.

Those calculations take into account the nominal national product and a known, namely statistically registered, consumption of energy. It should be understood that the nominal national product of Vojvodina is increased by the fact that it also includes the calculated financial services, which are not in direct connection with setting of national product, namely circumstances of significantly increased foreign trade deficit. Through those financial effects, national product is calculated as higher than the one that is actually created via added value in the territory of Vojvodina. Furthermore, the total energy consumption in Vojvodina is underestimated for the scope of unregistered consumption of fuel wood and biomass in individual combustion facilities in Vojvodina. Therefore, it should be understood that total energy efficiency is already lower, namely that energy intensity is higher compared to indicators shown by nominal statistical data.

The pressure on competitiveness of economy of Vojvodina is the consequence of such use of energy. When it is necessary to spend more energy for one unit of national product and when that unit of national product needs to be produced by employees whose houses and other activities spend the above-average quantity of energy, it can be said that competitiveness of those services will be relatively reduced. If it is necessary to pay a larger quantity of energy per product unit, i.e. per employee, i.e. per household, it is to be assumed that less newly created value will remain available for consumption of goods

3 According to the data of the International Energy Agency (www.iea.org) that show a relative consumption of energy in Serbia in relation to other countries and regional averages where the share of consumption of energy in Vojvodina compared to consumption of energy in Serbia remains relatively unchanged while the share in the national product and population declines.

and services, which means that the demand for other goods and services will be lower and, accordingly, that economic activity bringing those goods and services on the market will be reduced.

It should be taken into account that consumption of energy in Vojvodina is burdened with another systemic circumstance. Procurement of energy in Vojvodina is more expensive than the average in OECD countries, measured per unit of available energy. Vojvodina is the territory without an access to the sea and, accordingly, without a direct contact with international energy market. Most of the available crude oil is delivered to Vojvodina from the open Mediterranean market via a pipeline that is almost 2,000 km long. Natural gas is also supplied to Vojvodina mainly via pipelines that are more than 5,000 km long. These are two main types of energy in Vojvodina and they make more than a half of the available consumed energy in Vojvodina. Electricity is supplied to Vojvodina from sources that are located in central Serbia, via long-distance power lines with a relatively low utilisation rate and with highly emphasised seasonal and peak characteristics, which means that such delivery of electricity is relatively more expensive than the average price for comparable supply somewhere else in Europe.

Therefore, not only that the energy efficiency of energy use in Vojvodina shows negative characteristics from the aspect of physical consumption per unit of the generated product but it also shows negative financial characteristics, namely unfavourable economic characteristics since the energy that is used in such an inefficient way has been provided with the increased unit costs. It is the opinion that increase of energy efficiency, which is traditional in Vojvodina, is of exceptional significance for enhancing of competitiveness of economy of Vojvodina. Namely, not only that the increase of energy efficiency results with reduction of unit energy consumption per unit of national product but it also results with reduction of financial costs that deteriorates the financial balance of Vojvodina. Thus, the energy is considered to be relatively above-average expensive input for economic activities in Vojvodina and hence, the reduction of energy consumption per unit of product contributes significantly to enhancing of competitiveness.

However, the energy infrastructure that is relatively limited and that is oriented in a comparatively planned way exerts the additional impact on effects of increase of energy efficiency of Vojvodina. Namely, considering a relatively low economic activity in Vojvodina compared to economic activities from 1970s and 1980s, the increase of energy efficiency per unit shows that the available energy infrastructure will be used much less on the average. Currently, the utilisation rate of available capacities of gas pipeline, oil pipeline and electricity network is already unusually low. The gas network is used with less than 1/3 of its available capacity. The pipelines for oil transport are used below one half of available capacities and available electricity infrastructure is also used below one half of available capacities. In addition to favourable effects from the aspect of energy efficiency, the potential decrease of energy consumption also has the effect of increase of individual costs of infrastructure in energy unit costs. In other words, the total fiscal costs of infrastructure are divided on the reduced number of energy units that are provided with such infrastructure, so that the costs per unit are increased accordingly. It should be expected that there is certain optimum measure of increase of energy efficiency that could result with the optimum utilisation rate of the available energy infrastructure. However, it could happen that the effect of energy efficiency increase on total energy costs is negative in a long run.

This means that Vojvodina could find itself in a situation when further reduction in energy consumption, either due to the increase of energy efficiency per unit or due to total decline of economic activities, or combined action of those two factors, could result with such high costs of available infrastructure that they exert a highly negative impact on total competitiveness of economy of Vojvodina that would be practically prohibitive for further continuation of economic activities in certain fields.

The increase in use of energy infrastructure independently from the increase or reduction of energy efficiency could also be contemplated in Vojvodina. Energy infrastructure in Vojvodina is mainly of a transit character. Oil pipelines, gas pipeline and electricity network are designated not only to supply Vojvodina but also to transit of energy through the territory of Vojvodina. Should the total scope of transit of energy for the neighbouring markets increase that could lead to reduction of costs of infrastructure per unit of the used energy in Vojvodina. This implies a significant opening of Serbia towards the development of regional energy markets and significant increase of total transits of gas, oil, and electricity through the territory of Serbia - meaning the territory of Vojvodina as well. The optimum solution would be accomplished by simultaneous increase of transit, reduction of consumption per product unit and increase of total energy consumption, i.e. increase of national product. Only with such development, the increase of energy efficiency in Vojvodina can result with net improvement of impact of the energy sector onto competitiveness of economy of Vojvodina.

5.2.2 To buy or to produce

The above-mentioned circumstances in the field of energy efficiency refer primarily to imported energy. Namely, a larger portion of oil, gas, and electricity is imported in Vojvodina. In that case, the above-mentioned circumstances related to the use of infrastructure and energy efficiency are of relevance. However, a smaller portion of energy consumption is covered via utilisation of domestic sources of energy in Vojvodina. Whether to buy or produce energy is the dilemma that is probably crucial for further development of competitiveness of economy of Vojvodina due to the following reasons:

Import of energy implies payment of the imported energy under the prices that are higher than average world prices, as it has been explained above. This results with the elevated pressure on foreign trade balance of Vojvodina. It would be necessary for economy of Vojvodina to accomplish export of such a scope that would cover the costs of import of energy. However,

such export should be accomplished with the negative impact of services of the energy sector on other sectors of economy of Vojvodina. This negative impact is reflected in increased costs of energy per product unit, and, accordingly, the increased labour costs per product unit, or reduced effect of labour force productivity due to the insufficient level of standard of living. Therefore, it is very difficult to accomplish competitive export in other industries if those industries are not supplied with the quality of services of the energy sector that are at least comparable to those of the neighbouring markets.

Furthermore, the payment of energy to foreign suppliers implies automatically the reduced demand for domestic services. This means that potential added value, namely the potential employment rate or potential national product in the territory of Vojvodina is reduced up to the equal extent.

If high quality energy, i.e. the energy the quality of which is much higher than the quality of energy that can be produced in the territory of Vojvodina can be bought and imported, the crucial factor in making the decision whether to buy or produce will be the difference in efficiency, namely quality of energy that can be bought compared to energy that can be produced.

The decision whether to buy the imported energy or produce it within one's own territory depends on possibility for production and possibility for procurement of energy from import. As we have already seen, import of energy in Vojvodina is aggravated and it implies significant additional costs of transport of energy from some bigger energy market in the Mediterranean or east Europe up to the consumers, namely conversion site in Vojvodina. In compliance with that, there is also a technical advantage of reduced costs if energy could be provided within the territory of Vojvodina itself. This implies that energy produced in Vojvodina has comparable production costs in relation to energy produced at other places increased for (above the average) transport costs. The following chapter presents the analysis of possibilities of use of available energy resources in Vojvodina.

5.2.3 Use of available energy resources

The available energy resources in Vojvodina contain certain stocks of oil, gas and lignite, namely fossil fuels, certain volume of hydro-power, biomass and other renewable sources of energy.

It can be said that oil, gas, and lignite resources are not big, that they are not of comparable quality in relation to similar resources at other places in Europe or other places in the world, and that additional costs of exploitation of those resources also need to be taken into account. In addition to that, oil and gas exploitation involves relatively small quantities of local resources, labour and capital so that it can be said that potential exploitation of those resources is equivalent to import of the same or same type of energy resources. Exploitation of lignite in Vojvodina implies significant intervention in space. Analysing two sources of lignite within the area of Fruska Gora, namely around Kovin, it can be seen that exploitation in both cases implies significant intervention in space. In the case of Fruska Gora, those interventions in space are carried out within the protected area of Fruska Gora National Park, or at the edge of this protected area. In the case of exploitation of lignite around Kovin, it implies the exploitation fields located within the Danube watercourse, in the river itself, or directly along the river in the area that is certainly under hydrological influence of the river Danube. It can be assumed that this implies additional exploitation costs, either in the sense of drainage, or in the sense of increased costs of excavation, namely increased costs of drying of lignite obtained in such a way. In short, the use of available fossil fuels in Vojvodina can be considered comparable with import of the same or same type of fossil fuels. The use of those fossil fuels within the territory of Vojvodina does not affect significantly the domestic product in the sense of increased added value, nor does it affect the employment rate and domestic demand.

The use of other energy resources implies, or it can imply significant involvement of domestic capital and labour. In the case of hydro-power, it is the matter of construction of hydro-power plants, structures and of interventions in space, in hydrological system of Vojvodina, which can, but do not have to bring positive effects onto other branches of economy: agriculture, water management, forestry etc. In any case, the potential use of hydro-power resources can result with increased employment rate, increased production of building material, increased involvement of building industry business in Vojvodina.

Similar can be said for some other renewable sources of energy, such as wind energy that can, but naturally does not have to result with involvement of industrial resources in Vojvodina. There is also the use of biomass, which naturally implies not only a singlefold involvement of work and capital, namely the industrial equipment but also a relatively constant involvement of employment, equipment and capital as well as industrial production for regular biomass production. In the sense of energy resource, biomass is an industrial product in all respects.

The use of available energy resources in Vojvodina is connected with additional problems. Namely, the available resources of fossil fuels such as oil, gas and lignite, as well as biomass hydro-power or other renewable sources of energy, are distributed along a relatively large surface and they have a small average density per unit of territory. In other words, the density of those resources per square kilometre or hectare is relatively small and certain interventions in space are necessary so that those resources could be concentrated in the volume that is significant for industrial exploitation, i.e. industrial production of energy, namely services of the energy sector. Those interventions in space can be voluminous and they certainly imply certain involvement of employment, labour and capital, as well as appropriate planning and management. It can be assumed that the use of domestic resources can have certain conflicts in space with some other uses of the same space, namely the same logistic and transport resources.

5.2.4 Density of energy, density of economic activities and density of economic values

As we have said, the density of energy, i.e. density of energy resources is relatively small in the territory of Vojvodina. If we look at biomass, the highest density that could be achieved is below 260 GJ per hectare, which is significantly less than density of energy that is achieved at ordinary coal mines or oil and gas fields at corresponding markets in the world. Considering the reduced density of energy the question arises where competitive density of energy could be achieved, where it is achieved at the moment and what is the connection between the sites with the increased density and sites with the increased density of economic activities, namely increased density of some other economic activities.

The territory of Vojvodina shows a clearly emphasised density of economic activities. It is concentrated in towns – industrial centres, in particular in Novi Sad, and there is the intention to concentrate it in certain clearly defined industrial zones. Currently, those zones do not have a specific purpose, with several exceptions, and they can be considered industrial zones of general purpose at the moment. Furthermore, other activities connected with the population, housing, education, transport etc. could also fall in the category of economic activities. By the nature of things, they are also concentrated in urban centres. Urban agglomeration of the city of Novi Sad could be singled out as the site where one fourth or more than one fourth of the population of Vojvodina, meaning more than one fourth of economic activities of Vojvodina, is concentrated.

It is understood that density of economic values differs from density of economic activities. Economic activity does not necessarily result with the increased generating of economic values. Economic activity and economic value do not have to be carried out within the same space. Creating of economic value in Vojvodina is largely distributed along the territory of the whole Vojvodina, where there is a significant quantity of arable land, significant volume of agricultural activities and where a significant part of newly created economic value is generated. It is to be expected that concentration of those agricultural produce and their processing adds value to those produce and that such processing, namely such value adding happens at certain sites, i.e. in industrial zones – urban centres.

However, traditional resolving of logistic problems, collecting of economic values, their concentration in industrial production and further enlargement of their economic value implies that industry of processing of agricultural produce spreads actually across the whole territory of Vojvodina. The plants and facilities for manufacturing of products, meat manufacture, meat processing and further processing of those semi-finished products can be found practically in the whole territory of Vojvodina. The insight into the list of available industrial facilities, farms, slaughtering houses and other plants of similar type shows that there is no particular territorial concentration of those industrial facilities. A small number of relatively large farms are actually distributed in the whole territory of Vojvodina. The largest complex of farms in the territory of Vojvodina within one industrial company is at least three times smaller than the lower economy of scale for that type of production.

Naturally, this raises the issue of concentration of production, which is obviously emphasised with the current liquidity of economy of Vojvodina. A simple economic calculation shows that processing of basic agricultural produce into products of higher processing rate, smaller density, and smaller weight per value unit would have significant advantages. However, a parallel need of producers of basic agricultural produce to keep the current liquidity, to realise their produce into cash value within a relatively short period from the moment of production, shows that Vojvodina is still largely selling the basic agricultural produce. A part of that production is exported, a part is sold at the domestic market, but there is also a significant part of agricultural production that is not processed and that is not turned into a final product in the territory of Vojvodina. The remaining part that is processed into semi-finished products is sent to a relatively small number of industrial facilities for processing of the basic agricultural produce. Those industrial facilities include sugar refineries, vegetable oil refineries, corn processing plants, silos, drying plants, slaughtering houses, meat processing plants and some other facilities. The characteristic of those facilities is that they are unusually energy intensive and that such energy intensiveness is practically distributed across larger territory. This results with high energy intensiveness spots. Those spots are not big themselves, but they are distributed across a relatively large space. It was believed that relatively efficient transport of natural gas that was used there as the main energy resource was sufficiently efficient to satisfy the spotted energy needs within a relatively large space.

Therefore, the traditional energy infrastructure of Vojvodina used to include basically the following elements:

- Production of gas and oil in areas where such production had the basic economic justification.
- Transport of produced oil and gas up to the processing, i.e. consumption/utilisation site, and
- Sites – plants used for processing, i.e. consumption/utilisation of oil and gas.

In the case of oil there are clearly defined production fields, there are pipelines leading from those production fields to the appropriate storing facilities, or refineries and there are processing facilities in Novi Sad and Pancevo, distribution from refineries to the end-users, namely petrol stations. There are many petrol stations, i.e. service centres - more than 1,000 stations that are designated to agriculture and several hundreds of petrol stations that are designated to wide consumption. Furthermore, import of oil ensures the minimum economy of scale in oil refineries and minimum economy of scale in further distribution of oil derivatives up to the end-users. The consequence of this process is the fact that the market of Vojvodina is supplied with oil derivatives of imported oil with the increased procurement costs and domestic oil with the increased exploitation costs, which is processed in refineries of relatively small capacities, with comparatively increased costs of processing per unit, meaning small or insufficient economy of scale.

The consequence of such supply with oil derivatives includes relatively increased costs of agricultural production, transport of agricultural produce from production to processing site, namely storing or reloading site. Further consequence is a relatively dispersed structure of processing, storing, and reloading sites aimed at minimising those basic transport costs.

Gas production is carried out at clearly defined gas fields and produced gas is transported to end-users via the pipeline system. Import of gas supplements the domestic production, namely provides the gas transport system with the basic economy of scale, and ensures the supply of domestic producers in a larger volume compared to the one that could be ensured by domestic gas production. Domestic gas consumption is of an emphasised seasonal character so that pipelines need to be individually dimensioned in accordance with the maximum expected consumption. The above-mentioned consumption happens within a clearly defined season (period) for each individual segment of the gas pipeline system. In the case of industrial consumption those periods include the periods of processing campaigns of certain agricultural produce that certain industrial facilities are designated to, periods of increased demand at domestic or foreign markets for particular products that result with necessity or economically justified type of certain processing, namely periods of the heating season that result with the necessity for additional services of the energy sector either in heating plants or in urban agglomerations. During clearly defined periods of the year, the gas pipeline system shows a high density of flow of economic values. However, this density lasts for proportionally short time and it is certainly not present throughout the whole year.

A good example of such practice is increased consumption in district heating systems in urban centres in Vojvodina where the average utilisation rate of heat generating facilities, meaning gas pipeline network capacities is about 1,000 hours a year out of 8,760 of available hours a year. In other words, the utilisation rate or utilisation coefficient of available capacities is below 15%.

A simple economic analysis of this practice shows that irrespective of the fact that direct costs of gas supply and use could be considered relatively low since the infrastructure is already mainly depreciated, the opportunity costs of use of this infrastructure are not small and they have to be taken into account in calculation of economic effects.

If available gas infrastructure was used for transit of energy for third markets in one or several directions that could be defined within a regional gas market of the south east Europe, it could emphasise the fact that domestic use of gas had its clearly defined additional price of opportunity cost. Namely, the use of gas in industrial facilities and heating plants, which is in progress on a seasonal basis and in short and clearly defined periods of time during the year, would result with reduction of transit capacity during that period. In that case, the question of competitiveness of such use of gas arises in relation to the use of the gas pipeline system for transit of gas to some third markets. If the use of gas at such markets is more efficient, we come up with the situation that facilities using gas in Vojvodina would have to pay one premium for utilisation of gas infrastructure capacities and only after that, we would be able to calculate the actual economic value of this process.

In this situation the economy of scale, namely economy of time and utilisation rate of those facilities should be taken into account and, naturally, the reduced economy of scale would result with closing down of not a small number of those facilities.

The current characteristics of density of economic activities of Vojvodina have a negative effect on generating of density of actual economic values. In other words, irrespective of the fact that it currently shows certain advantages in the sense of direct costs, the dispersed economic activity has also got its strategic costs in the sense of competitiveness of the whole system.

In such circumstances, the problem of co-ordination between density of energy, density of economic activities, and density of economic values does not arise. Therefore, if we take the problem of utilisation rate of energy infrastructure per volume and time out of the calculation, the currently available industrial structure of Vojvodina corresponds to economy of collecting of agricultural produce, which is distributed across the whole territory. However, taking into account the opportunity cost of utilisation of energy infrastructure, namely agricultural production, we come up with the situation that such production is not actually competitive any more. In other words, the available industrial structure with its spatial distribution, its economy of scale, is not sustainable in a more competitive environment.

Practically, we need a new paradigm, namely a new system of co-ordination between density of energy, density of economic activities and density of economic values. We need to find the way to develop a high density of economic activities at places where the corresponding economy of scale can be realised, in a volume that can ensure realisation of high density of economic values at the same place. We need to develop such a system and such distribution of industrial facilities that will ensure the existence of economy of scale that is sufficient to accomplish of competitiveness in relation to the neighbouring markets, so that high economic competitiveness and generating of more significant economic value can be expected in the relevant future period on the same basis. Density of energy that can be accomplished at a certain site makes one of the parameters in creating density of economic activities. Considering that imported energy, gas, oil, electricity implies the increased costs and that domestic energy is relatively dispersed across the whole territory of Vojvodina, creating the appropriate density of energy at certain places implies the analysis of a complex logistic problem.

5.3 Analysis of competitiveness of available sources[4]

The available sources in Vojvodina can be used under the condition that they are competitive compared to sources of energy that can be procured from export and that there is certain structure of competitiveness between local sources. The issue of competitiveness of domestic sources in relation to imported oil and gas, namely imported electricity is very important when it comes to imported energy. Furthermore, the analysis of competitiveness should also take into account the security of supply, namely the appropriate diversification of sources of energy. Diversification of sources of energy is analysed from the aspect of the very source of territorial distribution, suppliers, character of energy, seasonal distribution and other circumstances of relevance for diversification of the source itself. It is to be expected that Vojvodina will try to create the appropriate relatively diversified portfolio of sources of energy that should and can include different sources, different character of energy, different seasonal character and, naturally, those that are obtained in different ways in different contractual and other arrangements.

The possibility for the portfolio of energy sources of Vojvodina to include some sources that are not directly competitive with comparable sources from abroad can be imagined since they might provide competitiveness of some other sources or contribute in some other way to security and supply in the context of available portfolio of energy sources in Vojvodina. The analysis of competitiveness of available sources is not single fold, uni-dimensional analysis and it implies a whole range of different properties that are linked with this or that source, as well as the whole range of circumstance that should be taken into account in creating of portfolio of different energy sources.

We will analyse four groups of energy sources here. They are: oil, gas and lignite (namely fossil fuels), hydro power, biomass and other renewable sources of energy.

A very simple analysis of portfolio shows that those sources and derivatives of those sources should participate in the total consumption of energy of Vojvodina from several sources at an approximately same rate. It is believed that relatively well-balanced portfolio is the one that is divided on approximately same shares between different sources. However, those four categories of energy sources can be divided into a whole range of sub-categories with different character, different seasonal, contractual, and other circumstances.

5.3.1 Oil, gas and lignite

Oil is considered domestic source of energy in Vojvodina, up to a certain extent. There is a domestic oil production that ranges at the level from 600 to 700,000 tons of crude oil a year. There is also the tendency of decline in oil production at available oil fields in Vojvodina. Having in mind the total consumption of oil derivatives in Vojvodina it can be said that this oil production covers approximately one half of local domestic needs. The other half of domestic needs is covered by import of crude oil. Domestic and imported oil is processed in two refineries – in Novi Sad and Pancevo, which are located in the territory of Vojvodina. Oil processing, namely production of oil derivatives in Vojvodina is designated to supply not only of Vojvodina market but also of the Serbian market and markets of some of the neighbouring countries. This leads us to the fact that total oil production in Vojvodina makes about one fifth of total oil processing in Serbia. Import of oil ensures the appropriate economy of scale in refineries in Novi Sad and Pancevo so that the fact that imported oil is the subject of processing provides for the appropriate economy of scale in processing of oil from domestic sources. The volume, characteristics, and potential of domestic sources of oil are defined in the appropriate documents of the Secretariat for Energy and Mineral resources of the Province. However, it can be said that domestic sources of oil are of lower quality, and higher individual exploitation costs in relation to comparable sources in the world, in particular in relation to sources from which the imported oil is imported. Consequently, domestic oil production has a limited competitiveness in relation to import of oil and only the fact that imported oil is burdened with additional transport costs, namely additional commercial, and transit rents, meaning political security, provides for economically efficient, i.e. profitable exploitation of domestic oil. In the current political and technical circumstances that prevail at the world oil market, it can be said that domestic oil production is still of significant economic benefit for Vojvodina and for Serbia on the whole.

The Company "Naftna industrija Srbije" ("Oil Industry of Serbia") is entrusted with domestic oil production. A foreign partner is the majority owner of the Company. The owner disposes with its own oil sources and with significant capacity to procure oil at the international oil market. Fluctuations in oil production at domestic fields can be expected depending on price trends at the international oil market, i.e. available oil production resources that the owner has or can have. Currently, there is no process through which the oil production at the existing or some new oil fields in the country could also be entrusted to some other domestic or foreign investors. At this point, and in the foreseeable future, domestic oil production depends on investment plans, intentions, and comparable economic analysis from the aspect of the dominant owner of NIS.

Currently, the domestic oil production brings modest revenues to municipalities in the territory of which it is carried out, in the form of modest mineral resources utilisation fee, namely the fee for exploitation of domestic mineral resources. Further-

4 Where it is not emphasised specifically, the maps presented in this Chapter have been taken over from «Virtual Balkan Power Centre for Advance of Renewable Energy Sources in Western Balkans», Project (WBPC – RES), Project co-funded by European Commission within the Sixth Framework Programme (2002-2006), D20: Report from local conference in Serbia and Montenegro, December 2007.

more, relatively modest investments in development of those sources involve relatively small resources of domestic industry, as well as relatively small employment of domestic labour force.

The volume of gas production in Vojvodina of about 200 million cubic meters of gas a year makes less than one tenth of the total gas consumption in Serbia. A significant part of the total gas consumption in Serbia is consumed in the territory of Vojvodina. Domestic gas production is of a very small volume and very specific quality. This volume and quality of domestic gas production require additional processing of the gas in processing facilities, in the facilities for mixing of domestic gas with imported gas in order to obtain fuel within limits of acceptable quality for final consumption. In other words, a large volume of import of gas is the precondition for economically efficient, i.e. profitable exploitation of domestic gas sources.

The Company "Naftna industrija Srbije" ("Oil Industry of Serbia") is entrusted with exploitation of domestic gas sources. A foreign partner, which is also one of the world largest gas producers and exporters, is the majority owner of the Company "Naftna industrija Srbije" (Oil Industry of Serbia). "Gasprom" is also the largest gas supplier for the market of Serbia, meaning the market of Vojvodina. There is a certain conflict between the volume of domestic gas production and total supply of foreign gas, which could in certain market, political and other circumstances, result with a relatively low interest in investments into domestic gas production. There is also the fact that domestic gas production depends on investment plans of the dominant foreign partner. Domestic gas production brings relatively modest revenues to municipalities in the territory of which it is carried out, in the form of modest mineral resources utilisation fee.

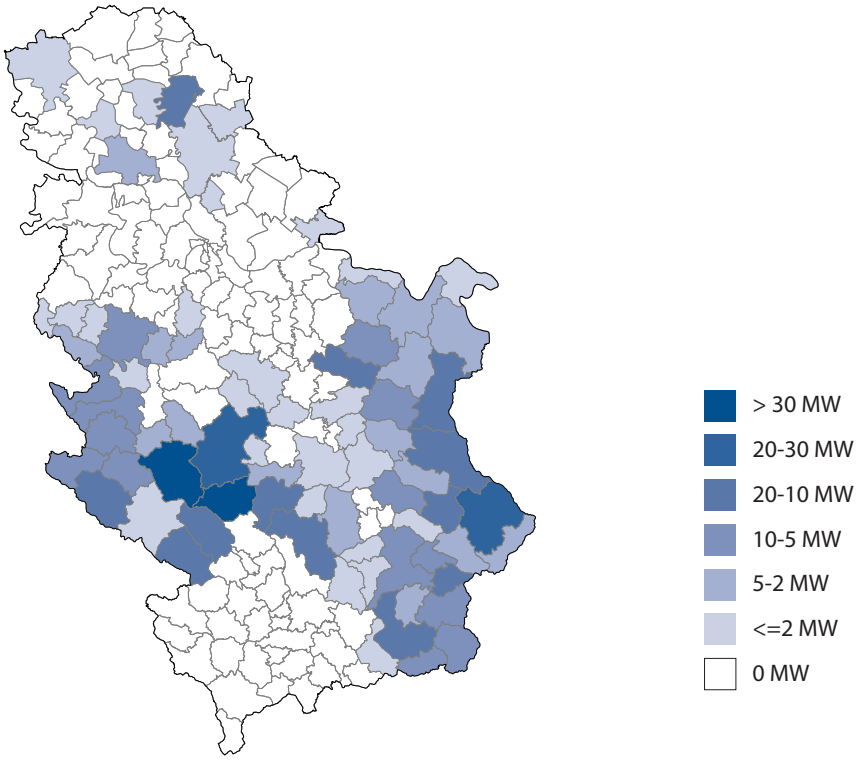
Lignite production in Vojvodina is carried out at one exploitation site in the vicinity of Kovin, in the mine where exploitation is carried out beneath the Danube surface. The volume of production amounts to about 150,000 tons a year. This lignite production is insufficient to provide the acceptable economy of scale and its economic efficiency is supplemented with exploitation of some other materials that can be produced at the same mining area. There is the possibility for exploitation of lignite at the remaining part of the same mining body, but it is not organised at the moment. It is probably necessary to consider the exploitation rights and elaborate the appropriate explanations for exploitation rights belonging to the foreign owner of the existing exploitation field and possible exploitation rights over the remaining part of the lignite mining body in the vicinity of Kovin.

By its nature, lignite is a coal of low caloric value where exploitation costs are certainly several times higher compared to exploitation costs of equal volume of energy in the form of hard coal. It is believed that lignite of such energy contents is fuel with three to four times lower quality compared to hard coal that is traded with at international markets. Lignite is delivered to lignite consumers, primarily to Elektroprivreda Srbije and some other smaller consumers in the territory of Vojvodina. These lignite deliveries are of very small volume and of very small economic and technical significance compared to lignite sources managed by Elektroprivreda Srbije.

5.3.2 Hydro-electric potential

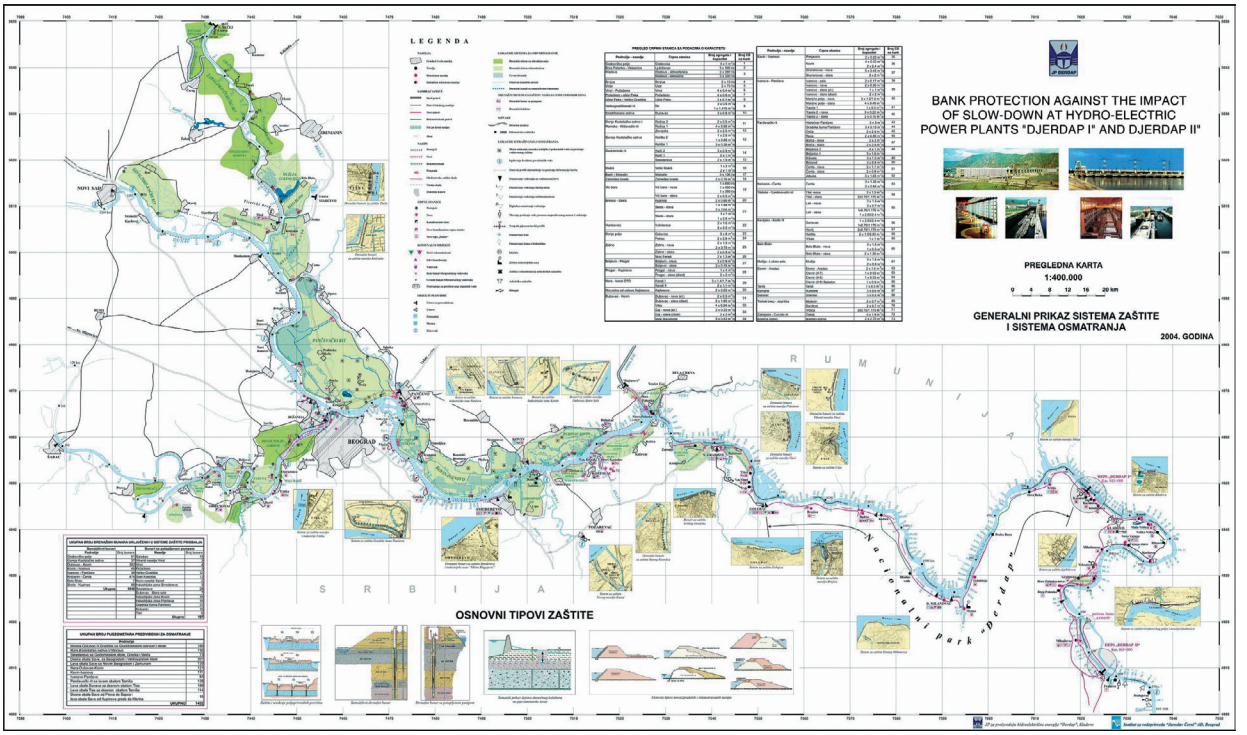
Hydro-electric resources of Vojvodina are highly modest. The whole territory of Vojvodina is located within a very small span of altitudes. The precipitation volume in Vojvodina is also not big compared to precipitation volume in the regions of the Balkan Peninsula. Taking into account the formation of Great Djerdap Lake at the altitude of about 68 meters, the remaining territory of Vojvodina (with the exception of Fruska Gora and some smaller areas) is located at the altitudes that are below 80 meters. Hence, there is a small difference in altitude. Djerdap slow-down, or the reach of Djerdap Lake along the river Danube, up to the confluence of the river Tisa, shows more significant effects on the rivers Tamis and Sava, which also affect the territory of Vojvodina. The hydro-electric potential of Vojvodina is created outside the impact of Djerdap Lake on the rivers of Sava and Danube alike, as well as on a certain number of rivers and canals in Vojvodina. There are several plans for construction of small hydro-electric power plants on the canal network in Vojvodina, mainly on the existing locks, dams, over-flow fields and other similar structures. Those small hydro-electric power plants can be considered local sources of energy. Furthermore, hydro-electric power plants are not necessarily located in centres of consumption, namely the location of those small hydro-electric power plants is not necessarily connected with the corresponding energy consumption site. Contrary to that, there is also the option of construction of two larger hydro-electric power plants: one in Novi Sad and another on the river Sava near Kupinovo. For both of those hydro-electric power plants, Novi Sad and Kupinovo, there are preliminary studies and basic technical concepts. Those concepts should probably be considered in the context of new available technologies for hydro-electric power plants with small differences in altitudes.

Map 5.3.1. Total power from small hydro-electric power plants



Nevertheless, despite of everything, hydro-electric power represents a significant energy resource in Vojvodina. Taking into account the existence of a large Hydro-electric power plant "Djerdap"on the Danube, between Serbia and Romania, and slow-down of the Djerdap Lake that penetrates deeply into the territory of Vojvodina, i.e. up to the confluence of the river Tisa into the Danube, it can be concluded that water conservation, use and mobility in canals in Vojvodina can have a significant impact on production of electricity on the Djerdap dam. Currently, Djerdap dam uses the available accumulation from the Djerdap Lake and the corresponding water inflow along the Danube and the whole Danube basin. When it comes to the Danube basin, the rivers of Sava, Tisa, and Tamis, as well as the influence of the river Drava are of significance for the territory of Vojvodina. The Danube-Tisa-Danube system of canals and the accompanying system of over-flow fields, lakes etc. has been created in Vojvodina between the rivers of Danube, Tisa and Tamis. This system can have the relevant hydraulic significance for production of electricity in the Hydro-electric power plant "Djerdap". If appropriate management with the system of canals, locks and over-flow fields is provided in the Danube-Tisa-Danube system, the system could function in the context of production of electricity at the Hydro-electric power plant "Djerdap". In addition to that, any form of irrigation in the territory of Vojvodina that uses water from canals, namely each form of water conservation in the territory of Vojvodina affects positively the production of electricity at the Hydro-electric power plant "Djerdap". This refers in particular to situations when inflows into the Danube are voluminous and when without appropriate activities in the canal network the Hydro-electric power plant "Djerdap" would be forced to overflow water without production of electricity. In other words, there two main impacts on production of electricity at the Hydro-electric power plant "Djerdap". The first refers to the total volume of production, where the use of canals and over-flow fields in Vojvodina could provide for significant reduction of water flow over the dam without production of electricity, which affects directly the total volume of production of electricity. Second, it is possible to provide higher accumulation of energy in available spaces of canals and over-flow fields, which would increase the flexibility of the Hydro-electric power plant "Djerdap" and higher production of peak, more valuable electricity[5].

5 Some impacts of the Hydro-electric power plant "Djerdap" on the bank area and water resources in Vojvodina are presented in the map that follows.



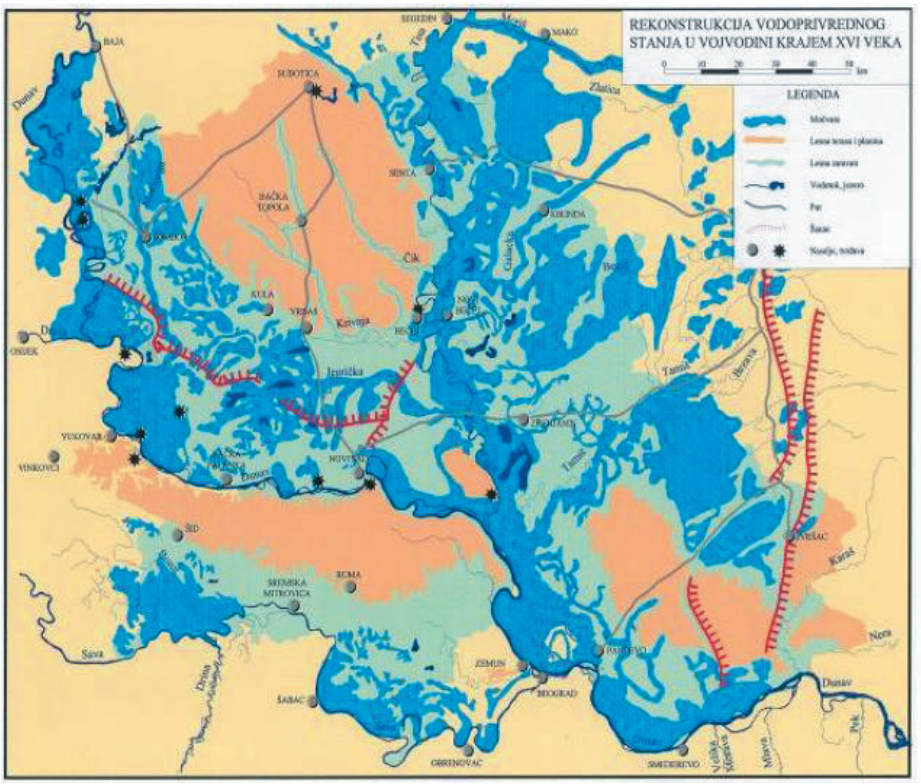
Source: Hydro-electric power plant "Djerdap"

The works on increase of power of all sets of mechanisms are currently in progress at the Hydro-electric power plant "Djerdap" and this will increase the capacity of the power plant to generate peak energy and use the available water inflow in a better way. The result will be the reduction of water flow over the dam, but there is the threat of potential negative effects along the slow-down of the Djerdap Lake, in particular in the territory of Vojvodina where the left bank is lower than the right bank of the Danube downstream from Belgrade. Therefore, it is necessary to set up the appropriate system of management with water resources in Vojvodina, in the system that is managed by the Public Company "Vode Vojvodine" in order to increase the total production and increase values of electricity that is generated at the Hydro-electric power plant "Djerdap"on the one hand, and, on the other hand, reduce negative effects that higher fluctuation of the Djerdap Lake water level can have or already has in the territory of Vojvodina.

This effect could be the subject of the appropriate fee that Hydro-electric power plant "Djerdap" would pay to the appropriate water resources management authority in Vojvodina and that would be used for improvement of water utilisation in the territory of Vojvodina, improvement of irrigation, land reclamation and further construction of water management structures in the territory of Vojvodina.

Article 3 of the Directive 2000/60/EC of the European Parliament and Council dated October 23rd, 2000 that sets the framework for the Community activities in the field of water policy, promotes co-ordination of administrative arrangements within a river basin. In our case, this refers to the Danube basin, from the border with Hungary up to the Djerdap 1 dam. The effective administrative co-ordination that includes the whole area of this water basin and that implies effective economic arrangements makes one of the main preconditions for accession into the European Union, as it has been set forth by the Stabilisation and Association Agreement. This implies, at least, an effective co-ordination between public companies and territorial administration bodies and setting up of sustainable mutual economic relations.

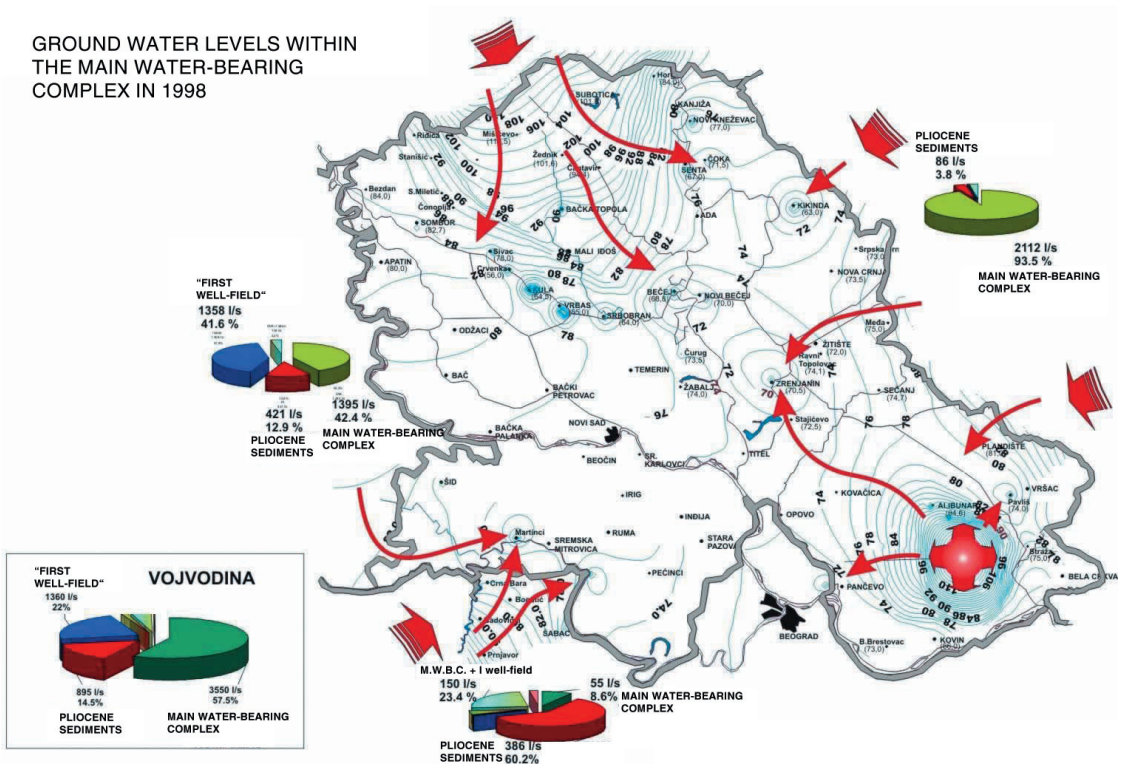
The exposure of the territory of Vojvodina to impact of ground and surface waters should be taken into account in cases of absence of appropriate services of water management infrastructure. The map that follows is a graphical presentation of water management status in Vojvodina before the completion of the current infrastructure:

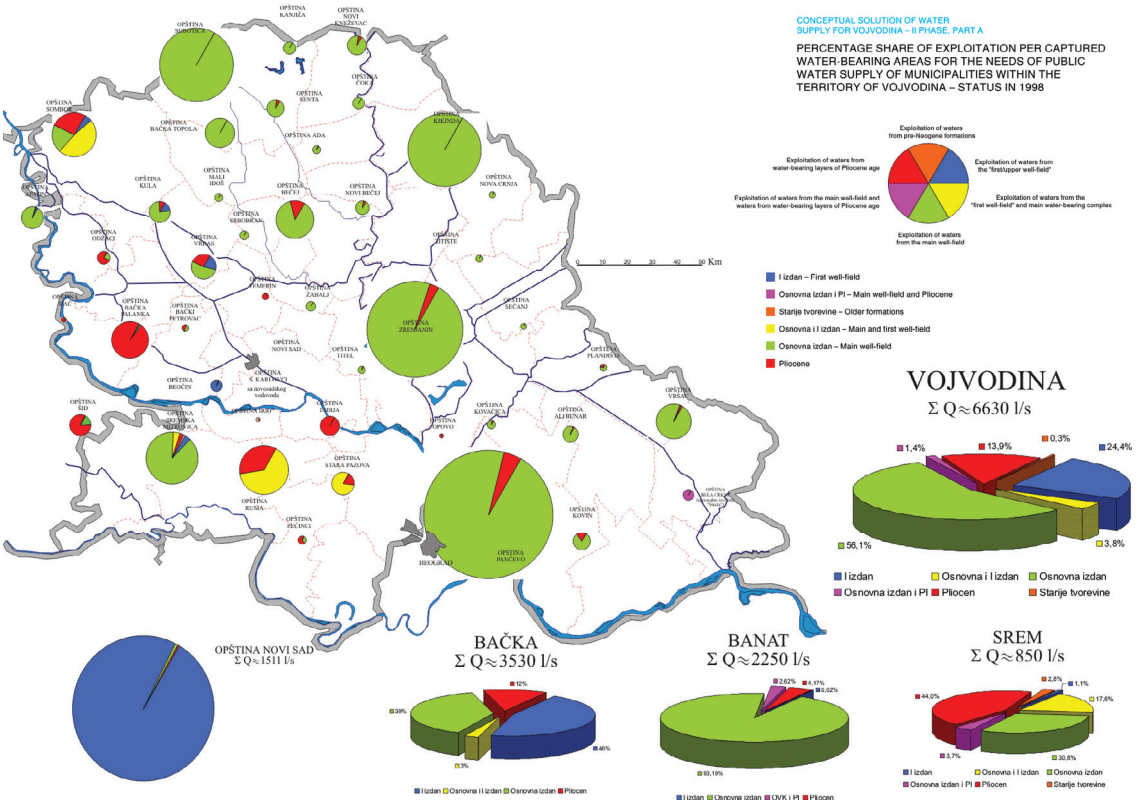


RECONSTRUCTION OF THE WATER MANAGEMENT STATUS IN VOJVODINA BY THE END OF THE 16th CENTURY

Source: Djekic, Mirjana, MSc, Sogorov Mirjana, "Hydraulic Structures as Industrial Heritage of Vojvodina", Public Company "Vode Vojvodine", Novi Sad

Maps of the Public Company «Vode Vojvodine» enable the insight into other aspects of use of waters in the territory of the Province:

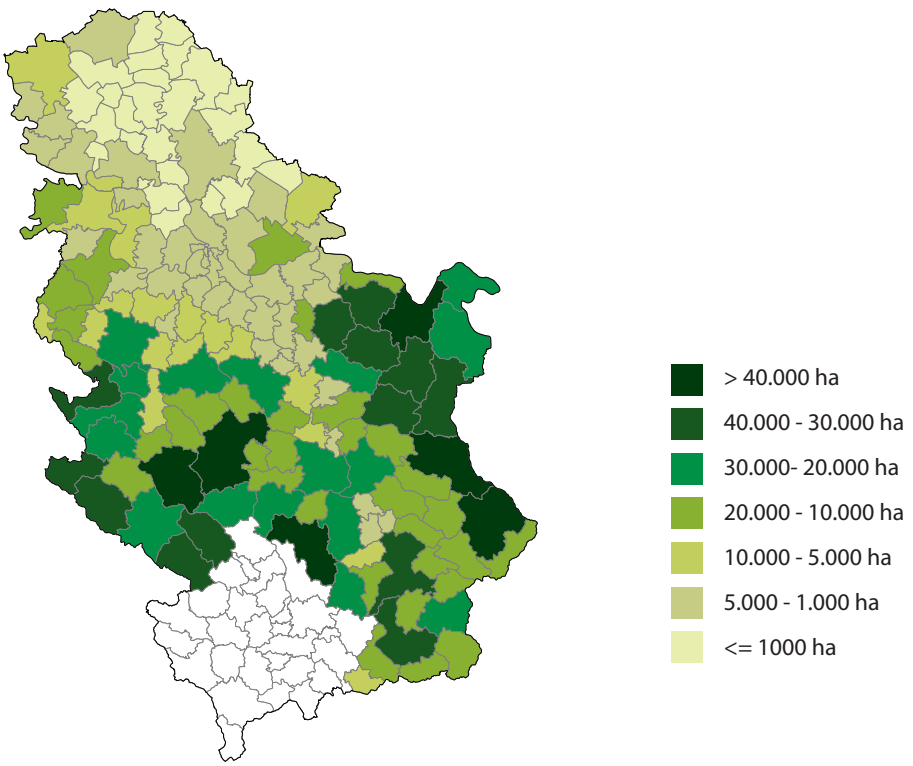




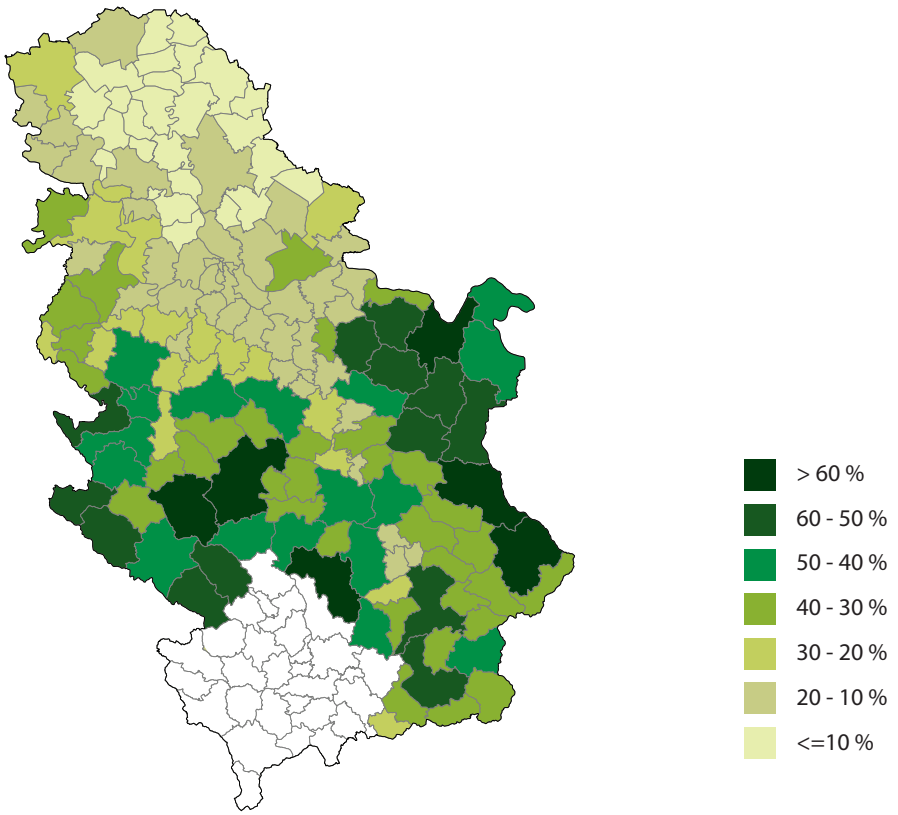
5.3.3 Biomass

It is believed that Vojvodina disposes with significant quantity of biomass. Here, we can analyse two circumstances related to biomass production in Vojvodina. The first is the current production of biomass and the second is potential, or expected biomass production.

Map 5.3.2. Forests in Serbia



Map 5.3.3. Forests Percent in Serbia



From another point of view, biomass, i.e. both the current and expected biomass production, can be based on agricultural and wood biomass. Wood and agricultural biomass differ in energy aspect in terms of possibility of use in currently available energy related technologies. Agricultural biomass can be used dominantly in mixed combustion with coal or lignite, whereas wood biomass can be used independently, as the basic source of energy. Naturally, mixed combustion with lignite makes it possible for biomass to achieve the appropriate economy of scale and get combusted in boilers with relatively high energy efficiency. Contrary to that, the potential use of agricultural biomass in small boilers is directed towards very small energy efficiency, which is significantly lower than energy efficiency achieved in larger volume boilers. There is an emphasised possibility here of use of agricultural biomass in the already existing power plants in Obrenovac, and Kostolac, which are not in the territory of Vojvodina, but which are located directly beside the Sava, and Danube watercourses offering a direct transport route to practically whole territory of Vojvodina. The difference in efficiency of use of agricultural biomass in smaller boilers and in large boilers when it is combusted together with lignite is almost double. The efficiency that can be achieved in smaller boilers for production of electricity ranges from 20 to 28%, while energy efficiency for production of electricity in updated boilers for mixed combustion of lignite of biomass amounts to 45%. It should be considered that it is economically justified , as well as environmentally justified to use agricultural biomass in large industrial boilers for mixed combustion with lignite. At the currently technology level, and at the level of technology that can be expected to dominate large-scale energy production within the next 10 years, it can be expected that up to 30% of agricultural biomass could be used in the total volume of energy transformed in a boiler. In other words, agricultural biomass would make approximately up to 30% of energy, namely about 15% to 20% of the mass of material that enters the boiler in co-firing with lignite.

Taking into account the current scope of use of lignite in Serbia, that amounts to about 35 million tons, with the assumption that such scope of energy could still be used in the forthcoming period lasting from 10 to 20 years, one can notice the possibility to use from about 5 to 6 million tons of agricultural biomass in the currently existing power plants. This reconstruction is certain and it is practically necessary from the aspect of satisfying the obligations set forth by the contract on Energy Community of the South-east Europe that Serbia signed in 2005 and ratified in 2006. This contract implies the obligation to fulfil the conditions from the so-called Large Combustion Plant Directive, namely Directive on large combustion sites of the European Communities starting from December 31st, 2017. Taking into account the time that is necessary for reconstruction of the existing thermo-electric power plants in order to fulfil the technical conditions set forth by the Directive, it can be assumed that the use of biomass in those power plants could start within the period of the forthcoming two years and develop its full scale within the period of 8 years from today. This volume of biomass is larger than the current production of agricultural biomass in Vojvodina. There are three possibilities to increase the currently existing volume of production of agricultural biomass. They are:

1. Increase of total agricultural production and, in particular, increase of yields in agricultural production per hectare. This can be accomplished with the increased intensity of agricultural production, on the one hand, and introduction of irrigation of the largest possible surface of agricultural land in Vojvodina. The increase of irrigated surfaces can be financed by water contributions coming from better use of available hydro-resources of the Danube-Tisa-Danube system in the context of improvement of utilisation rate of the existing Hydro-electric power plant "Djerdap"

2. Introduction of the so-called second harvest. Namely, certain quantity of water is lost from the territory of Vojvodina due to evaporation from deserted and neglected fields. The fields remain deserted after the harvest of the main agricultural crop up to the moment when they get covered with a new agricultural crop. In that period, it is possible to seed the appropriate grass that would be suitable for use in energy related purposes. This would result with two main effects: reduced evaporation of water from the territory and additional quantity of biomass; and

3. Supplementing of agricultural biomass with the increased production of wood biomass.

Production of wood biomass is carried out at only 6.5% of the territory of Vojvodina. In that way, the whole territory of Vojvodina is exceptionally scarcely forested. Considering the coverage of the remaining territory of Serbia with forest of about 47%, the coverage of the territory of Vojvodina with forest of about 6.5% can be considered exceptionally low. It is considered that total surface in Vojvodina covered with forest has to be increased to about 27% in order to achieve the optimum level of coverage with forest, where forests exert the corresponding effects on protection against wind, evaporation, namely the corresponding coverage of water surfaces with shadows etc. Furthermore, the surface of forests along the canals, namely watercourses has significant ecological effects, which are probably necessary for the purpose of protection of those watercourses against ecological effects of increased intensive agricultural production.

Out of 6.5% of the territory of Vojvodina that is currently covered with forests, 130,589 ha are managed by the Public Company "Vojvodina Sume", while 7,575 ha are managed by the Public Company "Vode Vojvodine". There are also 22,450 ha that belong to the National Park "Fruska Gora", 2,243 ha that belong to the public Military Institution "Karadjordjevo", and 5,567 ha of forests that are privately owned. It is considered that all those forest resources produce currently about 1.6 million tons of wood biomass. Forest resources of the National Park "Fruska Gora" and Military Institution "Karadjordjevo" have currently non-energetic purposes and they cannot be considered commercial forest resources in this sense. However, those resources still produce certain quantity of secondary wood biomass that can be used in energetic purposes. The resources that Public Company "Vojvodina Sume" disposes with are largely commercial forest resources, taking into account that more than 80,000 ha are plantations of fast growing poplar tree. Those plantations are located in seven clearly defined areas mainly along the river Danube, or some other water transport routes in Vojvodina. Forest resources that the Public Company "Vode Vojvodine" dispose with are located along water transport routes in Vojvodina and they represent an evident commercially usable forest resource.

The abundance of those resources should be considered from the aspect of their actual commercial potential. The current utilisation rate of those resources is exceptionally low. The reports that come from those public companies tell about very small wood biomass production from the available forest resources, which ranges from one to two tons of available forest mass per hectare. In addition to that, this wood biomass is spent for the needs that are of significance for liquidity of those public companies, but of a very small economic significance compared to potential electricity production from those wood resources. Contrary to that, the available data of the International Energy Agency for the territory of north Europe show that on a comparable land 15 and more tons of commercial usable wood biomass per hectare could be produced a year. This shows that 11,250 ha is sufficient for economically efficient, i.e. profitable utilisation of the power plant with 30 MW of capacity, which is considered the lower limit of economy of scale in electricity production. Thus, we can conclude that the existing forest resources can ensure the valid functioning of at least one thermo electric power plant in Vojvodina with the capacity of 250 MW.

Furthermore, considering the need for afforestation of the additional 460,000 ha in Vojvodina (in order to achieve the forestation rate of 27%) and with the assumption that this afforestation would be carried out with fast growing poplar tree in the areas along the navigable routes of rivers and canals as well, it can be considered that this additional afforestation would provide about 6 million tons of wood biomass a year. This quantity of biomass is sufficient for production of electricity in large facilities with the total capacity of about 1,200 MWe.

Wood biomass represents a significant energy resource of Vojvodina.

There are the analyses and comparisons of biomass production from the fast growing poplar tree in the USA in relation to utilisation rate of coal in the USA. It should be taken into account that coal industry of the USA is the most developed, most competitive coal industry in the world that disposes with quality resources, exceptional human potential and exceptional quality of use of available machinery. Under such conditions, the average production of poplar tree in the USA, including the areas of relatively northern geographic latitude, is considered a competitive source of energy at this highly developed energy market. The circumstances in Vojvodina are naturally completely different. Production of wood biomass in Vojvodina should be competitive in relation to highly low quality resources of lignite in Serbia, namely in the whole region, and on the other hand, it can be considered that due to availability of transport routes, favourable climate and favourable geographic latitude, production potential of poplar tree in Vojvodina is absolutely above the average compared to the average that is accomplished in the USA or north Europe.

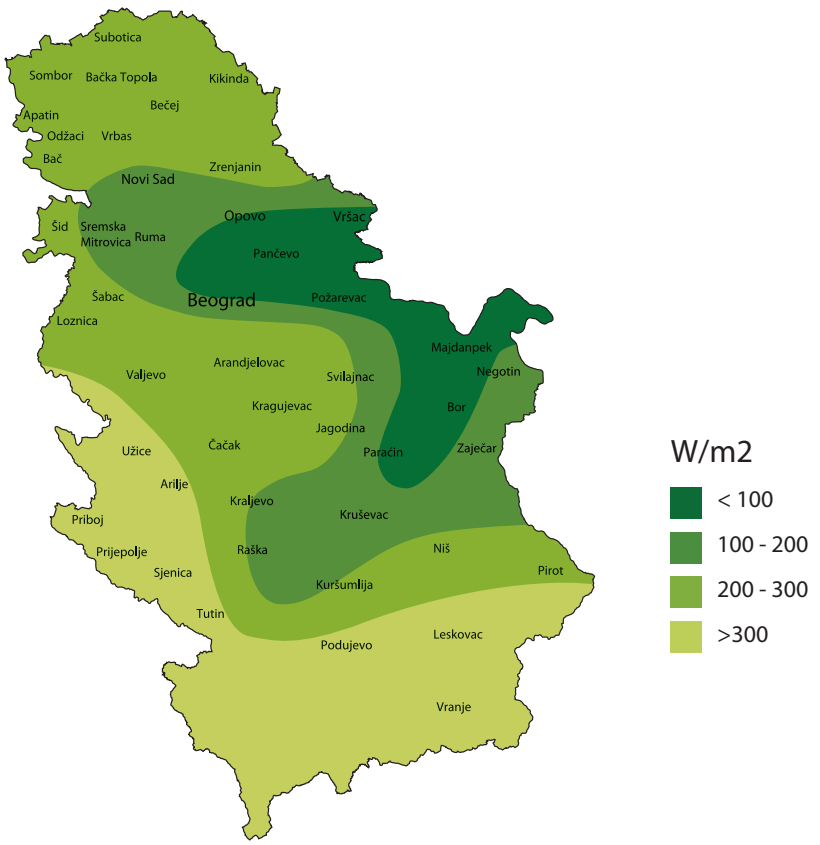
5.3.4 Other renewable sources of energy

There are also other renewable sources of energy in Vojvodina. They include:

- Wind power,
- Solar energy,
- Biogas energy, and
- Industrial, namely communal biomass energy.

Wind power is present in Vojvodina up to a smaller extent than in other regions in Europe, which are known after significant wind power resources. Nevertheless, it is above the average compared to some other regions in Serbia. It is believed that availability of wind power in some areas of Vojvodina is such that it provides basic preconditions for investments in utilisation of this type of energy. However, the use of wind power in Vojvodina should be analysed in the context of total use of the territory of Vojvodina for biomass production, for agricultural production etc. This refers primarily to use of wind power for irrigation of larger surfaces. Currently, only 2% of the territory of Vojvodina is irrigated, or less than 2% of available agricultural surface and exceptionally small quantity of energy is used for that purpose. It is believed that total use of energy for that purpose is much lower than 1 MW. However, if much higher utilisation rate of irrigation is planned, it could be assumed that several tens of MW of wind power would be used for the needs of irrigation. Another possibility is the use of wind power for production of electricity. This is possible in regions with the available wind power resource and at places where the use of wind power is not in conflict with some other significant economic objectives in Vojvodina. Currently, the use of wind power is not regulated in an adequate way.

Map 5.3.4. Average wind power at 100m altitude



There is no adequate detailed wind atlas in Vojvodina based on which the appropriate policy of granting of concessions or public-private partnerships in the field of wind power use could be created[6]. Naturally, the wind power resources should be analysed in the context of other alternative use of the territory of Vojvodina. Besides, the potential setting of windmill farms

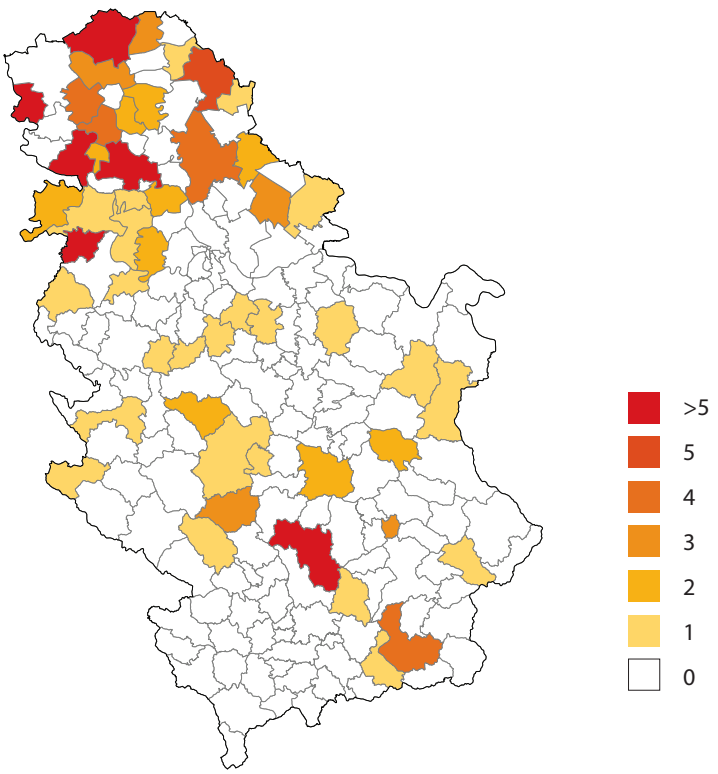
6 The Study on Atlas of winds in the AP Vojvodina, which was developed for the needs of the Secretariat for Energy and Mineral Resources of the AP Vojvodina in December 2008 by the Faculty of Technical Sciences of the University in Novi Sad, represents the basis for further and more detailed study of wind power resources in this region. Bringing those analyses in the context of the spatial plan of Vojvodina and land use purpose will result with the basis for issuing of concessions for wind use and regulate currently chaotic efforts of certain investors, namely local self-governments to start with wind power use within the shortest possible period.

for production of electricity in Vojvodina can have significant impacts on significant afforestation in Vojvodina. Namely, taking into account a high resistance of poplar tree to different types of diseases and also a relatively high survival rate of poplar tree, we can conclude that potential wind blow and potential mechanical damages caused to poplar trees are the only limiting factors for the fast growth of poplar tree. In this sense, the strategic setting of wind-generators, namely windmill farms, can reduce the effect of wind on areas that are planned for afforestation with the fast growing poplar tree. Furthermore, if we count on significant increase of flexibility, that is production of peak electricity in the Hydro-electric power plant "Djerdap" thanks to a higher quality use of water resources in the territory of Vojvodina, it can be assumed that such increased regulation potential can contribute or provide for the increased use of wind power in Vojvodina. There are no corresponding calculations so that we can only deal with appropriate assumptions here.

It is necessary to analyse the possibility of wind power use for irrigation within a wider region, namely for production of electricity in clearly defined areas where the wind resources exceed the average and develop the appropriate public policy for issuing of concessions, namely use of those resources.

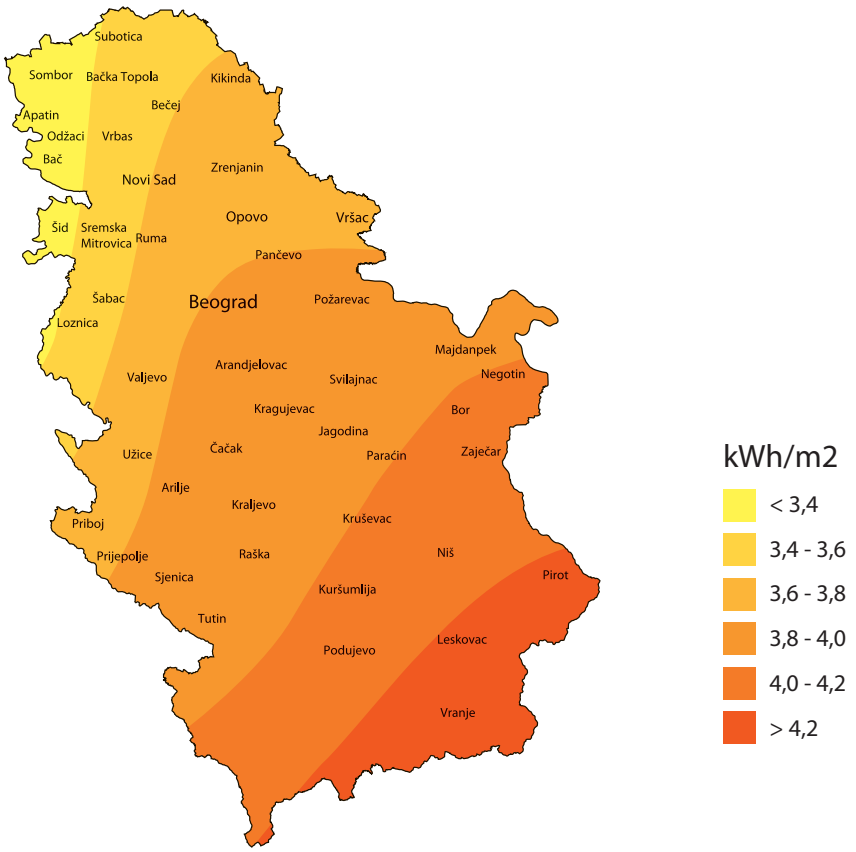
There are also the appropriate geo-thermal energy resources in Vojvodina that can be used either directly or together with heat pumps and this form of use of geo-thermal energy could become the dominant form of energy for heating of residential and business premises.

Map 5.3.5. Number of geo-thermal sources in municipalities



Vojvodina disposes with average solar energy that corresponds to its geographic position. Solar energy cannot be considered as particularly significant from the aspect of production of electricity, but the use of solar energy for production of thermal energy can be significant. Here we have in mind in particular the form of solar energy that is used for heating of sanitary or industrial hot water, for drying of biomass and other agricultural crops. We should also take into account the possibility of use of solar energy as supplementary source of thermal energy in the context of thermo-electric power plants, namely industrial production of high temperature thermal energy.

Map 5.3.6. Annual average of daily global radiation energy on horizontal surface



The attention should be drawn to possibilities of use of solar and geo-thermal energy for drying of biomass in the areas where availability of water transport is below the average. In such areas where biomass and agricultural produce have to be transported by other, more expensive forms of transport it is useful to organise drying and reduce the total transported mass of material. It is believed that the use of solar/geo-thermal energy can ensure relatively efficient elimination of about 20% of the total mass in humid raw biomass. Taking into account the total volume of biomass, the collection of which is assumed in the quantity of several million tons, we can anticipate that the use of solar energy reduces the total need for transport approximately for one fifth, or more than a million tons a year.

Biogas is a significant potential source of energy in Vojvodina. There are three main sources of biogas: biogas from landfills, biogas from wastewater processing and biogas from animal faeces, namely animal waste. Energy of biogas from landfills, namely biogas from wastewater processing is naturally located in the close vicinity of urban, namely industrial centres. This energy can be used as a local source of energy in such urban, namely industrial centres. Energy of biogas from animal waste, namely faeces, is naturally located in the close vicinity of large concentrations of animals (swine, cattle, and other) and it can be used directly in industrial plants that are connected to those farms.

Considering the environmental sensitivity of the territory of Vojvodina, small differences in altitude and high productivity that can be achieved with alternative uses in the territory of Vojvodina, it is believed that further formation or widening of the existing landfills is not economically efficient solution. Alternative solution for waste disposal is certainly the transport of waste up to appropriate sites where waste combustion or large-scale production of energy could be organised. The total volume of urban waste in Vojvodina is not sufficient for construction of economically efficient, thermo-electric power plant based on that source. It should be considered that waste that is generated in Vojvodina can be used together with waste of a large urban centre such as Belgrade in order to achieve economically efficient, i.e. profitable volume necessary to set up a large waste combustion industrial plant. "Kostolac A" site obviously offers a good environmentally defined location for such a plant. Such plant would have the capacity of up to 80 MW and it can be considered a lower/bottom limit of economically efficient, i.e. profitable plant of this type.

5.4 Competitive use of biomass and reasons for its significance

From the aspect of use for the needs of production of useful energy, biomass is an industrial product. Since its price as industrial product depends essentially on productivity of the involved capital and involved time for production of a certain volume of biomass. Furthermore, its competitiveness depends also on the quantity of energy that certain measure unit of biomass contains. In that sense, Giga Joule (GJ) is the most frequently used energy unit measure. The quality of biomass from the aspect of production of useful energy is determined taking into account the quantity of energy that one ton of biomass or one cubic meter of biomass contains.

5.4.1 Technical concentration of density of energy

Biomass contains certain volume of energy per ton, or per cubic meter. The quality of biomass will depend on that unit quantity of energy. The bigger the quantity of energy per ton or per cubic meter gets, the higher quality of biomass for production of energy is obtained. Besides, there are also many other qualities of biomass, such as its chemical composition, mechanical properties and other that determine its usability for production of energy.

From the aspect of mechanical and chemical properties, we distinguish between agricultural biomass and wood biomass. A part of agricultural produce can also be categorised as wood biomass due to its mechanical structure and chemical composition. Thus, those two forms of biomass are not defined in the same way as agricultural, i.e. forest biomass is defined from the aspect of forestry, i.e. agriculture.

At the contemporary technology level, agricultural biomass can be used in collective combustion with some other fuel such as coal and lignite. The reasons are reflected in certain chemical properties of agricultural biomass.

Wood biomass can be used in large boilers of industrial category, independently or together with agricultural biomass, namely some other fossil fuel such as oil, oil derivatives, gas, or coal.

Agricultural and wood biomass can both be used in smaller boilers with much lower energy efficiency. Smaller boilers usually have the energy efficiency in electricity production, namely production of steam with high characteristics of less than 30%. This means that less than 30% of available biomass energy is converted into steam with high technical characteristics, or electricity. Large boilers usually have efficiency coefficient above 30% and even up to 40%.

In order to accomplish combustion of biomass in large boilers, it is necessary to concentrate the appropriate biomass. Large boilers require much bigger quantity of biomass per hour or day than small boilers under equal quantity of energy per unit of biomass, i.e. one ton or one cubic meter. The higher the unit energy value of biomass gets, the number of tons, i.e. cubic meters that should be collected at one place is smaller for the same quantity of useful energy.

In accordance with that, we distinguish two types of biomass concentration:

- Technical concentration implies that we have a larger quantity of energy per unit of biomass, i.e. per one ton or one cubic meter. Technical concentration also implies that there is a larger volume, or larger weight/quantity of biomass per one land surface unit.
    - The increase of energetic quality of biomass at the site of use based on drying makes a special type of technical concentration. Waste heat – low value energy from the main energy related process is used for biomass drying. This is the way to cut down losses of high value energy in a high temperature process needed for moisture evaporation. Low quality energy (low temperature heat) is efficiently added to energy of small density (biomass) in order to maximise the production of high value energy and increase the utilisation rate of the involved capital.
- Geographic concentration implies that biomass from a larger space can be concentrated at one site where biomass could be combusted in large industrial plants. This enables, at the same time, the economy of scale for drying and mechanical preparations of biomass.

Biomass occupies certain surface of land. There are certain fixed costs of land cultivation and maintenance of land quality. It can be considered, in principle, that costs of land irrigation and cultivation, and costs of biomass collecting depend on surface of land and that they are mainly independent from quantity of biomass that will be produced at that land. In accordance with that, we can consider that there is a fixed cost in biomass production and that it represents the core of production costs. The bigger the production of biomass in the sense of quantity, namely weight per unit of surface, i.e. hectare, gets, we accomplish lower the costs per unit of produced biomass. This effect can be achieved in several ways, including the improving of quality of biomass that is produced and relatively intensive agro-technical measures, proper process management, irrigation and in other ways.

Table 5.4.1. Average yields (t/ha) of maize hybrid under conditions of irrigation and natural rainfall

Hybrid	1998		1999		2000		Mean	
	rainfed	irrigation	rainfed	irrigation	rainfed	irrigation	rainfed	irrigation
ZP 360	10.86	14.63	11.76	12.13	6.06	12.97	9.56	13.24
ZP539	11.01	14.56	10.59	11.00	6.93	13.81	9.51	13.12
ZP580	11.37	14.83	11.85	12.18	5.41	12.88	9.54	13.30
ZP 633	11.79	13.78	11.62	11.37	5.90	12.62	9.77	12.59
ZP 677	12.03	13.50	11.30	11.49	5.69	12.23	9.67	12.41
ZP 704	12.05	14.48	10.99	12.00	6.32	13.49	9.79	13.32
Average	11.52	14.30	11.35	11.69	6.05	13.00	9.64	13.00
				rainfed			irrigation	
Factor			LSD:	0.05	0.01	LSD:	0.05	0.01
Year				0.167	0.220		0.182	0.240
Hybrid				-	-		0.258	0.339
Year x Hybrid				0.409	0.539		0.446	0.588

Source: Kresovic, Branka J., Z. V. Videnovic, M. M. Tolimir, Genotype and environmental interaction effect on heterosis expression in maize. – Genetics, Vol. 36, No. 2, 171-180.

Availability of machinery, namely equipment that is used for land cultivation, and cultivation and collecting of biomass make special characteristics of those fixed costs. Principally speaking, the machinery falls under fixed capital and it is available throughout the year. Agricultural biomass has a seasonal character and it is cultivated and collected in clearly defined seasonal periods. The available machinery is not in use beyond those seasonal periods, which increases additionally the fixed costs of production.

Wood biomass is a multi-annual crop; it is produced more or less continuously throughout the year and collected during several appropriate periods during the year. The consequence is the fact that the use of available machinery in production and processing of agricultural biomass is much higher since the machinery is used practically more or less continuously throughout the year.

It is believed that special industrial types of biomass, such as genetically modified poplar tree, some grass varieties, some other varieties of fast growing woody plants etc. achieve necessary density of production in time so that they can ensure the valid use of machinery.

However, some of those biomass types require the increased variable costs, i.e. they require the additional application of fertilisers, certain chemicals, or additional land cultivation. Such additional land cultivation affects, or can affect the land quality in a long run, environmental pollution, pollution of watercourses and it can also affect some other agricultural crops on the neighbouring or land plots set downstream.

Currently, two economically most viable types of biomass production can be implemented:

- Production of fast growing genetically modified poplar tree that does not require special chemical preparations, special fertilisers, or other special methods of land cultivation, that is a multi-annual crop and that accomplishes proportionally high yields of biomass per surface unit.
- Use of secondary biomass from agriculture. This biomass is the consequence of growing of some other agricultural crops of maize, soybean, wheat etc. and it can be considered a by-product. In addition to that, if there are appropriate geographic and meteorological conditions, the second harvest could be yielded on the same surface with special grass varieties. This second harvest enables the increased use of the same or already available machinery, with additional biomass production.

Irrigation is of special significance when it comes to preparation or mechanical cultivation of land. It is believed that proper irrigation contributes significantly to increase of biomass yields per surface unit. Therefore, the land that is irrigated or can be irrigated has an added value in the sense of productivity of biomass production. The experiments that have been conducted in the Institute for Maize in Zemun Polje show that irrigation helps to achieve about 24% higher yield compared to the same kind of production without irrigation, provided that other circumstances are the same. Furthermore, irrigation enables successful use of other, secondary harvest on the same land.

It can be considered that the optimum density of biomass makes about 65 MW per hectare a year. This density is achieved in well-managed multi-annual crops of genetically modified poplar tree or with certain agricultural produce. Naturally, those agricultural produce do not have completely energetic purpose. Only the secondary biomass, namely second harvest that can also be considered secondary biomass in another sense, can be used for energy needs. This aspect can be the basis for

land categorisation. On the land with high fertility category people will grow classical agricultural crops with secondary use of biomass, while on the land of lower fertility category they will prefer to grow multi-annual poplar trees.

This categorisation was carried out in Serbia pursuant to the new decrees of the Government of Serbia that were enacted in summer 2009.

5.4.2 Geographic concentration

For the purpose of rational and justified use of biomass, it is necessary to categorise the available biomasses at certain places. The main characteristics of places where concentration should be carried out include:

- The existence of transport infrastructure.
- The existence of energy infrastructure, i.e.:
  - Electricity network,
  - Coal, i.e. lignite combustion plants,
  - Infrastructure for heat distribution.
- The existence of concentration of energy consumption, i.e.:
  - Concentrated residential area,
  - Concentration of economic activities.

Biomass concentration can be achieved in the following ways:

It is possible to transport biomass from the place of origin to the place of consumption, provided that the minimum economy of scale is provided at the consumption site. This refers in particular to consumption of biomass in production of electricity where large facilities have objective advantage in the sense of economy of scale compared to smaller facilities.

It is possible to concentrate biomass production and consumption at one place. This refers in particular to industrial facilities such as slaughtering houses, sugar refineries, and edible oil refineries etc. where the appropriate quantity of biomass is created simultaneously with the existence of appropriate consumption of energy. This requires specific vertical integration of industry. Namely, in order to achieve the appropriate concentration between biomass production, production of the basic agricultural or industrial product and consumption of energy at the same place, it is necessary for the whole process to be the responsibility of one vertically integrated company. This vertical integration brings obvious economic benefits. Necessary investments per unit of production of both industrial and agricultural products and per unit of energy are being reduced. Therefore, it can be expected that production of live cattle, in particular of swine and poultry, will be co-ordinated or vertically integrated with the slaughtering house and meat processing. This vertical integration enables the rational and justified use of biomass originating from feed for animals in industrial facility. There is an obvious need for appropriate co-ordination in time. Namely, production of biomass at swine, o poultry farm is continuous and has a significant problem of concentration that can be overcome only through continuous production of energy. It is necessary to adjust consumption of energy so that it is continuous in the same sense. It is possible to make an integrated industrial facility and slaughtering houses and meat processing into final products that works fro 24 hours a day, 365 days a year. Such facility would have a continuous consumption of energy, steam, and heat. However, there is the minimum economy of scale for such facility since the minimum industrial capacity is clearly defined with available technology. There is also the minimum technology of scale in production of electricity, namely steam from biogas from swine farms, namely poultry farms. Placing into mutual relationship those two variables, we come up with the minimum size of a farm, namely minimum size of industrial facility that is necessary. Optimisation of those two variables results with the minimum optimal size of a farm and industrial facility in vertical integration. It can be considered that all other forms of co-ordination of this process, such as market co-ordination or planned co-ordination, do not bring the desired results and they both require the intervention of commercial production of energy, namely the appropriate public subsidies.

Such concentration shows that it is necessary to implement certain planned distribution schedule of possible farms with integrated industrial facilities in the territory of Vojvodina. The number of such farms is clearly defined by their territorial distribution, available territory, available production of animal feed and transport potentials. Namely, in addition to being a tool for concentration of energy and rising of productivity of industrial production, such vertically integrated industry is also a tool for concentration of economic value, i.e. economic product of agriculture. Taking into account that marine transport is not available in Vojvodina, it is necessary to maximise, as it has been said earlier, the value of industrial agricultural product per mass unit, namely per unit of volume prepared for transport. The best concentration of value is achieved with production of high quality prepared food, namely of food containing a significant percentage of meat. Production of high quality product with high meat content is superior in the sense of competitiveness compared to, for example, production of maize, wheat, soybean, or other agricultural produce of high volume and small unit value.

Taking into account the necessary safe distance between certain swine farms, namely poultry farms, we are faced with the available territory of Vojvodina, available transport potentials for transport and concentration of maize, soybean and other agricultural produce for the needs of animal feeding and we can conclude that it is possible to distribute 14 farms across the territory of Vojvodina with the minimum size of about 300,000 swine a year, namely the equivalent number of poultry farms.

Such distribution enables the optimum concentration and processing of agricultural produce into meat, processing of meat into final products suitable for export and competitive at international market within the reach of available transport from Vojvodina. We think that this transport should be water transport, i.e. combined river and river-to sea-going transport.

Furthermore, such concentration enables the optimum supply of this industrial process with corresponding continuous energy.

Collecting and concentration of biomass originating from agricultural production aimed at rational and justified production of electricity and heating energy makes another form of concentration. As it has already been said, the optimum use of agricultural biomass is the one combined combustion with coal, namely lignite in large boilers. There are no appropriate large facilities for lignite combustion in Vojvodina. However, there are such facilities in Obrenovac and Kostolac, and they are located on the waterway that is directly connected with waterways in Vojvodina. There are appropriate storing capacities at those places, as well as the access to river transport and appropriate energy infrastructure that is necessary for biomass use. There is also an appropriate solution at those places for disposal of effects of combustion, namely ash. A simple calculation shows that agricultural biomass can be collected in economically efficient, i.e. profitable way and transported to Obrenovac, or Kostolac by water transport within the price that is equivalent to the price being currently paid for lignite per corresponding energy unit. Biomass that is transported to this site is processed in an appropriate way, dried, and stored in order to be used in production of electricity or heating energy. Such use of biomass results with a number of positive effects. The pollution caused by sulphur dioxide, and nitrogen oxides from large boilers is reduced, as well as emission of carbon dioxide and other greenhouse gases, the quality of ash is improved along with the possibility of use of such ash in further industrial process, such as production of cement or production of corresponding low quality products made of concrete.

The possibility to produce cement, i.e. low quality concrete elements in Obrenovac and Kostolac opens the possibility of production of corresponding materials for construction of dikes, dams, bank regulation and other necessary activities in water transport system that currently exists in Vojvodina. This implies in particular the construction of appropriate hydroelectric power plant in Novi Sad, namely near Kupinovo on the river Sava and regulation of dikes and banks along waterways and systems.

We are faced with the situation that the same waterway is used in both directions in transport of biomass to thermoelectric power plants in Obrenovac and Kostolac and transport of building material, concrete elements, and cement from Obrenovac and Kostolac to different destinations in the territory of Vojvodina. This optimises transport and reduces necessary investments per unit leading to and raising the competitiveness of the whole process. The availability of waterways and possibility of large scale biomass collecting by means of water transport represents the most significant competitive advantage of Vojvodina. This is a unique situation in Europe, which, if it is used, enables exceptional cost advantages.

Transport of wood biomass in the territory of Vojvodina represents the third possibility of biomass concentration for the needs of production of rational and justified energy. Wood biomass can be rationally combusted for the needs of production of energy and heat in boilers with the capacity of 30 MW and higher. Such production requires the concentration of several hundreds of thousands tons of wood biomass at one place. Taking into account a high energy value of wood biomass in relation to agricultural biomass and favourable chemical and mechanical properties, it is justified to consider the possibility of construction of significant facilities for production of electricity and heating energy from wood biomass in the territory of Vojvodina. This is justified taking into account in particular the need for additional afforestation in the territory of Vojvodina. The coverage of the territory of Vojvodina with forests should be increased from the current 6.5% to approximately 27%. This means that it is necessary to plant additional 21% of the territory with forests, which means more than 450,000 ha of land. If planted with standard poplar trees this surface should produce more than 6 million tons of wood biomass, which should be sufficient for more than 1,000 MW of additional production of electricity.

5.4.3 Energy, housing and economic activity

There are two main types of housing in Vojvodina - a densely populated urban housing and medium dense housing in rural areas. In the case of dense system of housing in highly urbanised areas, it is necessary to provide the appropriate density of supply with electricity and heating energy.

In the case of housing with smaller density, where each housing unit disposes with appropriate surface of land, it is necessary to provide much smaller density of supply with electricity and heating energy. This type of housing is already covered with electricity production and supply of a relatively good quality. The whole territory of Vojvodina and all the settlements are electrified, so that electrification coefficient makes practically 100%. Furthermore, there is quite a large number of settlements that are also supplied with the appropriate gas distribution network so that more than 180.000 residential gas consumers are located in the territory of Vojvodina.

However, direct use of gas for production of low quality heating energy is not economically justified any more. The alternative use of gas in intertwined production of electricity and heating energy is much more efficient and has significant economic advantages, such as higher efficiency per unit and corresponding economy of scale. In relation to efficiency of gas combustion for the purpose of production of low quality heating energy where the maximum efficiency coefficient is something more than 90%, production of electricity from the same quantity of gas with the intertwined production of heat and use of thermal pump at places of consumption of heating energy the efficiency coefficients ranging from 220 to 270% could be achieved. Naturally, this reduces residence costs per unit and results with much more favourable ratio between income and quality of life of the population. It should be considered that the largest part of population of Vojvodina in less dense forms of housing would transfer to the use of thermal pumps instead of use of gas or biomass. Naturally, not a small number of residential users in rural settlements have the opportunity to use agricultural or wood biomass for production of heating energy. This opportunity has its opportunity costs. The use of wood biomass in large centralised facilities probably means paying of significant price for wood biomass, which in that case makes the opportunity cost for alternative use of wood biomass in a small poor quality burner. However, modern burners achieve high efficiency coefficients so that it is possible to expect alternative use of wood or agricultural biomass in individual burners in areas where costs of transport from production site to a centralised power plant are higher. The use of thermal pump and use of high quality efficient individual burner for biomass are competitive forms of production of heating energy in relation to currently spread production of heat by means of natural gas combustion.

Urban areas in Vojvodina require complex energy related solutions. Currently, a larger number of towns are supplied with district heating systems. However, the district heating systems are mainly supplied with heating energy from centralised boilers where coal or natural gas or mazoute are combusted.

Combustion of original fuel for production of low quality heating energy in district heating systems has a low efficiency due to several reasons. The main reason is the reduced quality of energy, i.e. production of low quality heat from high quality sources. This is the way to record economic loss irrespective of the fact that nominal energy efficiency can seem acceptable. High nominal efficiencies recorded in available boilers in Vojvodina are above the average compared to similar circumstances in other parts f Serbia or in some other countries of central-east Europe. However, the fact that this results with economic loss in relation to alternative use from that energy for production of electricity still remains. For example, one kilowatt hour of electricity can produce 4.5 or more kilowatt hours of heat on the used thermal pump in relation to only one kilowatt hour of heat generated by production of heat in a heat generating boiler. Electricity can be considered, in economic sense, four or five times more valuable product compared to heat. Taking into account that heat in a heat generating boiler can be produced with 90% of efficiency in ideal conditions and that electricity can be produced with the efficiency of up to 60% it is obvious that available efficiency favours significantly the production of electricity.

Furthermore, the consumption of electricity and heat in urban areas is not uniform. There are significant seasonal, daily, and weekly variations in consumption of heat and electricity in each urban area. Such variations can be accompanied only by flexibly well designed centralised power plant. Taking into account losses in transport, in particular in transport of heating energy, it is necessary for such facility to be located in a direct vicinity of the relevant urban area. Urban areas are centres of economic activities at the same time. This includes industry, education, different cultural activities, civil engineering, transport, and other activities. All those activities require significant quantities of high quality energy, in particular of fuels for transport and electricity. Efficiency and competitiveness of urban centres depend essentially on competitiveness of supply with electricity, fuels for transport, heating energy, building material, food, and industrial raw materials. A relative price of those inputs will determine the potential competitiveness of an urban centre in relation to other urban centres in the neighbourhood, in central Europe, south-east Europe, and elsewhere on the European continent. Furthermore, the appropriate competitiveness of transport systems that are used to bring those inputs to the urban centre and take all industrial outputs from the urban centre is also necessary. Each competitive transport system requires the appropriate economy of scale. Considering the distance of Vojvodina from majority of international transport, meaning marine transport, the economy of scale in transport can be achieved only via internal transport processes. This points in particular to the need for economy of scale to be achieved by transport of biomass from agricultural produce and building material.

When economy of scale is achieved on those basic products, it is to be expected that low transport costs will be also placed at the disposal to other industrial products, which can be produced potentially in urban centres. Such a situation favours industry with a high value of the final product and provides significant concentration of value per volume unit, i.e. weight unit. Taking into account the availability of water transport in Vojvodina compared to other parts of central Europe and south-east Europe, there is the possibility for high value products to be optimised only from the aspect of weight and value, and from the aspect of volume up to a lower extent. Namely, it is possible to imagine the efficient competitive transport of goods of a relatively higher volume but of high concentration of value per weight unit.

This opens the possibility for the development of branches of agriculture with small and medium-sized enterprises in areas requiring significant innovations, creativity and craftsmen's skill such as production of houses, furniture, further food processing, production of ready-made dishes of specific character, production of other products made of wood and secondary processing of industrial products that are imported from the third countries.

5.4.4 City of Novi Sad

The City of Novi Sad is the most important urban and industrial centre in Vojvodina. It takes the central place in Vojvodina, both in geographic and in the sense of available transport roads, water transport, railroad and highway transport. The City disposes with the planned industrial zones, residential zones and developed conventional industry that occupies a significant geographic space.

With more than 300,000 inhabitants, the City of Novi Sad represents the largest urban concentration in Vojvodina. At the same time, it is also the largest concentration of consumption of electricity, heating energy, gas, and transport services in Vojvodina.

Currently, the supply of the city with energy is provided from four completely non-co-ordinated energy systems. Supply with heating energy is provided from the district heating system with four heating power plants in the central city area and two other smaller plants. Supply with natural gas is provided through distribution of gas in the outskirts settlements and a part of an urban area. Supply with electricity is provided from electricity supply network. In addition to that, there is also the Thermo-electric-heating power plant Novi Sad that generates electricity only occasionally in periods when it is possible to generate both electricity and heating energy due to low economic efficiency. The opportunity cost of such production of electricity and heating energy is exceptional and this means that practically no economic activities not only in Novi Sad but also in the whole Vojvodina are competitive. We have the situation that one kilowatt hour of heating energy reaches in price one kilowatt hour of electricity (which is, as we have seen, four times more expensive than the price of competitive heating energy in Sweden, or some other west European country) and kilowatt hour of electricity is approximately twice higher than the price of electricity that can be produced in other parts of Serbia. Taking into account an exceptionally small use of plants for electricity and heating energy (about 1,000 hours a year for heating energy plants and less than 2,000 hours a year for production of electricity, based on a year with 8,760 hours) we can conclude that the total capital infrastructural cost of all those plants is divided onto smaller number of hours of use, i.e. small quantity of generated energy, which makes the capital cost per unit exceptionally high. From the aspect of variable costs, i.e. costs of fuel and from the aspect of capital cost, both processes are exceptionally inefficient and this practically means that no other imaginable economic activities in Novi Sad are competitive.

It is obviously necessary to replace those energy related processes with well co-ordinated, much more efficient and energy related processes that are economically much more favourable.

The main requirement is that most significant capital infrastructure in the energy sector has to be used from 6,000 to 8,000 hours a year. Furthermore, it is also necessary to provide for appropriate energy efficiency and use of fuel the procurement of which implies transfer of economic values to suppliers in Vojvodina instead of transfer of economic values to suppliers outside Vojvodina.

Taking into account the available infrastructure and using components of such infrastructure that can be used up to the maximum extent, we can suggest the following solution:

- Termination of use of the existing heating plants in urban core of Novi Sad used to produce low quality heating energy
- Thermo-electric-heating power plant Novi Sad is converted via replacement of boilers and adding of appropriate devices for transport into power plant using biomass. This power plant would have three boilers, with the capacity of at least 80 MW each, and it would be specialised for wood biomass combustion. The generated steam from those boilers would be used in the existing plant with electricity turbines with appropriate uptake of steam for production of heating energy
- Cooling water for turbines in thermo-electric-heating power plant Novi Sad is taken to the heating pump plant driven by natural gas where the appropriate quantity of low-temperature heating energy is generated
- The necessary heat storage is added in the form of hot water tank
- The available connection onto the natural gas network is used in a new plant with gas operated engines with appropriate heat utilisation. This plant is designed with the capacity of 100 MWe and 110MW of heating power
- Gas driven engines that are used to operate heating pumps and gas driven engines for production of electricity as well as gas driven engines that are used to operate circulation pumps involve together the capacity of gas network of 100,000 m3/h, which already exists in thermo-electric-heating power plant Novi Sad
- The heating system is used in winter periods for heating of the city of Novi Sad whereas in summer periods it is used for drying of available biomass in the storing facility of thermo-electric-heating power plant Novi Sad
- Building of the facility for acceptance and despatch of ash, i.e. mineral fertilisers that are returned to agriculture, and forests.
- The use of the existing electricity infrastructure, heating system network and infrastructure of the existing thermo-electric-heating power plant Novi Sad.

This plant has an exceptionally high capacity of flexible production of heating energy and electricity. The properties of

this production compared to conventional gas operated power plant are presented in the following Table:

The planned outline of a new plant within the currently existing thermo-electric-heating power plant Novi Sad is presented in the following picture:

As an annex to the existing facility of the currently existing thermo-electric-heating power plant Novi Sad, the space is left for building of a uniform biomass operated plant with the capacity of at least 250 MWe.

The extension of the biomass operated plant will depend on the dynamics of afforestation in Vojvodina and the needs for energy in the city of Novi Sad itself, and in other parts of Vojvodina.

Such an arrangement enables:

- Supply of the city of Novi Sad with cheaper heating energy compared to the current situation
- Supply of the city of Novi Sad and the rest of Vojvodina with electricity under prices that are lower than prices of electricity that can be obtained from lignite operated power plants Obrenovac and Kostolac
- Support to afforestation activities in Vojvodina, including use of the current forest resources through buy-up of entire poplar tree biomass production
- Supply of agriculture and forestry in Vojvodina with the mass of mineral fertiliser – ash
- Available electricity for industrial plants in industrial zones 1, 2, 3 and 4 in Novi Sad, as well as the corresponding heating energy for drying either of agricultural produce or wood biomass that is to be used in those industrial zones
- Appropriate flexibility of production of electricity and heating energy that enables satisfying of all current and expected needs of the city of Novi Sad and industrial zones in the close vicinity of the plant
- Involvement of significant transport capacities of barges, pushers, vessels, terminals and other reloading sites
- Additional revenue for suppliers of wood biomass that is competitive in relation to alternative revenues, or alternative use of land
- Increased purchase power of population involved in production of wood biomass, transport and processing.

It should be considered that such plant is essentially economically competitive in relation to alternative project of gas operated power plant in Novi Sad due to the following reasons:

- Much higher flexibility,
- Much lower investments costs,
- Use of domestic fuel,
- Payment of fuel to domestic suppliers and use of that economic flow for the purpose of increase of national/domestic product of Vojvodina,
- Increase of employment rate in Vojvodina,
- Reduction of green house gas emissions,
- Better use of available land in a significant part of Vojvodina,
- Reduction of prices of energy in the city of Novi Sad.

This can be taken as an example of efficient concentration of economic values in the field of energy. It is obvious that low-value biomass could be concentrated in high-value electricity, and heat energy. A value of electricity and heat energy is increased with flexibility of delivery of electricity and heat energy. This is the way to maximise the flow of economic values and increase general competitiveness of economy of Vojvodina. The effects in the terms of employment, growth of national product and opportunities for the development of small and medium-sized enterprises resulting from this can be calculated in the context of elaboration of complete feasibility study for this type of facility.

It is believed that the price of fuel-biomass can be reduced further if higher quality parts of wood biomass are used in industrial process for production of some high value product made of wood. We should in particular have in mind the possibility of production of composite boards made of poplar tree. If such industrial process is integrated with the suggested development of thermo-electric-heating power plant Novi Sad, it can be concluded that the use of about 20% of biomass for production of boards and the rest of it for production of electricity, would lead to the optimum reduction of unit prices, namely variable marginal cost of electricity. It is understood that wooden boards are a promise able material both in production of furniture and in production of houses and other building equipment.

5.5 Hydro energy, water regime and biomass

Based on the above it can concluded that relationship between energy, water regime in the territory of Vojvodina and biomass production in the territory of Vojvodina represents an essential infrastructure for accomplishment of certain level of competitiveness. Water regime in Vojvodina depends on the way, namely management with use of hydro power, primarily in the hydro-electric power plant "Djerdap 1". As we have seen, the level of the Djerdap Lake, which affects the water regime in a large part of Vojvodina with respect of inflow of water in the rivers of Drava, Danube, Tisa, Tamis, and Sava, makes practically the core of water regime maintaining in Vojvodina. This use of hydro power should enable the enhancing of water regime in Vojvodina in a certain way. On the other hand, water regime and enhancing of water regime via irrigation and other ways of water use enables higher productivity in biomass production. Let us analyse the problems that occur in this context.

5.5.1 Problem of co-ordination

First of all, there is the problem of co-ordination between hydro-energy production, water regime maintenance and biomass production. Biomass production has got its clear seasonal characteristics. However, inflow of water originates from two different water systems. The inflow of the river Sava is determined by both water regime of the Alps and water regime of the Dinara region in the river Drina basin. In accordance with that, there is the difference in inflow of the rivers Sava and Danube. On the other hand, the inflow of water in the river Danube is determined with both waters from the upper Danube course, namely the region of the Alps and waters from the Carpathian region – the rivers of Tisa and Tamis that merge in the territory of Vojvodina. In other words, water regime is divergent and, as a sum, it has a different seasonal, namely temporal characteristics compared to seasonal characteristics of biomass production. Furthermore, the use of hydro energy in the power plant "Djerdap" has to be in certain proportion with the needs for electricity, namely possibilities to realise the generated electricity on the market.

There is a clearly emphasised problem of co-ordination between those three main processes. It is certain that this problem can be resolved through appropriate solutions in better management, better economic relation, better contractual and political relations between all stakeholders in this process. However, there are also mechanical aspects of this problem. It can be considered that construction of the power plant "Kupinovo" and power plant "Novi Sad", as well as construction of smaller hydro-electric power plants on canals, namely sluices in Vojvodina, is relevant for this problem of co-ordination. The construction of those structures can join somewhat larger selection of tools for quality co-ordination to a well-developed

co-ordination system. The majority of co-ordination problems is still reflected in economic contractual and political relations between public administration in Vojvodina, on the one hand, owners of land in Vojvodina, on the other hand, management of the power plant "Djerdap" as the third stakeholder, and relevant water management authorities in the territory of the Republic of Serbia and Vojvodina. In other words, it is necessary to set up an advanced co-ordination that would be supported by advanced computer models and management systems with those water resources. Naturally, it will be difficult to accomplish the appropriate co-ordination level without corresponding contractual and economic relations between those stakeholders. Here, we have in particular in mind the price of electricity that is produced in the power plant "Djerdap" and costs that such production creates in the territory of Vojvodina, as well as distribution of economic results of this power plant.

5.5.2 Problem of productivity

Increase of productivity is the purpose of co-ordination. In our case, the essential question is the productivity of production of agricultural produce and biomass in the territory of Vojvodina. On the other hand, we have productivity of use of hydro power in the power plant "Djerdap", taking into account a very high efficiency of turbines of the Hydro-electric Power Plant "Djerdap" and the fact that they are currently increasing the capacity of those turbines, which will again enable higher flexibility of production of energy in the power plant "Djerdap" compared to water inflow into the Djerdap Lake. We can conclude that this triangle of productivity consisting of agricultural biomass, wood biomass, and production of electricity at Djerdap should be defined and resolved in a certain way.

Productivity of use of hydro-power at Djerdap is determined more by the average unit price under which that hydro energy is valorised on the market than by volume of produced hydro power. The volume of produced hydro power is defined by the volume of water inflow, dynamics of water inflow and turbine efficiency. Having in mind that efficiency of turbines is technically determined variable and that it is always fixed, what remains is the volume of water inflow and volume of water use. There are situations when volume of water inflow exceeds the available capacity of the power plant. It is certain that those situations will become rare in time, i.e. when capacity of aggregates at the power plant "Djerdap" gets increased. However, there is still a problem that is not too big, but that is significant. In addition to the Djerdap Lake with its large accumulation capacity, the additional accumulation capacity of water resources in Vojvodina can be utilised usefully. It should be considered that starting from original idea for construction of hydro-electric power plant "Djerdap" until today, the quantity of water can be brought into dynamic harmony with available capacities of production of electricity in the hydro-electric power plant "Djerdap".

Furthermore, in periods when water inflow is smaller than available processing capacities of the hydro-electric power plant "Djerdap" there is the possibility to enable increased flexibility of production of electricity through appropriate water management, and use of water systems in Vojvodina. All this should result with better valorisation of generated electricity from the hydro-electric power plant "Djerdap". Better valorisation means higher production of peak energy and smaller average production of basic energy in this power plant. Productivity of the hydro-electric power plant "Djerdap" is determined by selling price of generated electricity. Selling price of generated electricity is determined by flexibility of this power plant. The higher the flexibility gets the possibility increases to sell more peak electricity available in accordance with the needs of buyers, while possibility to sell electricity for continuous supply of the so-called basic electricity, which is less valuable per unit, i.e. per one kilowatt hour, becomes less likely. The use of water resources in Vojvodina can change, i.e. enhance the ratio between generated peak and generated basic electricity. However, the final selling price is also affected by the skill necessary for selling, namely valid market evaluation. It should be considered that international market is the market for this peak, full value electricity. It is in the interest of al stakeholders that Serbia gets included up to the highest possible extent into European electricity market.

On the other hand, productivity of biomass production depends on availability of irrigation during the periods and in the scope when irrigation is needed.

Those two productivity streams are not in mutual conflict since more intensive irrigation results with higher probability of co-ordination of available inflow of water and production of electricity. It can be concluded that high productivity in biomass production and in production of electricity in the hydro-electric power plant "Djerdap" can be achieved simultaneously.

5.5.3 Circumstances for reduction of productivity and competitiveness

There are many circumstances when productivity and competitiveness of the biomass-hydro power system can be reduced. Decline in productivity can be recorded mainly due to poor co-ordination and inadequate economic mechanism between water resources management in Vojvodina, spatial planning, land resources management, biomass production and production of electricity in the hydro-electric power plant "Djerdap".

There is the need for increased revenues from sale of electricity from the hydro-electric power plant "Djerdap" so that investments into increased irrigation systems in Vojvodina could be paid out of those revenues, as well as the appropriate fee for utilisation of water resources in Vojvodina.

Naturally, if hydro power from "Djerdap" is used to supply domestic market with small payment capacity and small level of demand for flexibility, the total revenues will be lower, and so will the opportunities for accomplishing of productivity and competitiveness.

5.5.4 Spatial plan and other co-ordinated instruments

Public administration in Vojvodina disposes with several co-ordination instruments aimed at increasing productivity in the field of hydro power and biomass production. Spatial plan of Vojvodina is the main co-ordination instrument. Passing of this document is in progress or it is the process of direct preparation.

Spatial plan regulates the use of land, use of water resources, use of transport potentials, construction of new transport roads, construction of power plants such as hydro-electric power plants, spatial distribution of industrial plants, and in particular of vertically integrated systems of farms and meat processing, namely other agricultural produce. This spatial plan should be considered critical for further development of competitiveness of economy of Vojvodina due to the previously mentioned reasons.

Furthermore, the development plans of public companies such as „Vojvodina Sume" and "Vode Vojvodine", namely of ports and terminals in Vojvodina will contribute significantly to potential development of productivity and competitiveness in Vojvodina. It should be expected that spatial plans, in particular the one of the Public Company "Vojvodina Sume" are focused on increase of biomass production at available forest surfaces and support to production of wood biomass at private estates. The development plans of the Public Company "Vode Vojvodine" should also be focused on better water resources management in the sense of maximisation of results of production of electricity in the hydro-electric power plant "Djerdap". This requires the existence of an appropriate contract between the PC "Vode Vojvodine" and "Djerdap" hydro-system.

In addition to that, the PC "Vode Vojvodine" disposes with the land that is planned for afforestation along certain water resources, canals and overflow fields. The use of those surfaces of land should also be organised in such a way to maximise the productivity of biomass production on that land.

Planning of development of the energy system of the City of Novi Sad is the following co-ordination instrument. For that purpose, the City of Novi Sad and "Elektroprivreda Srbije" established a joint company "Elektrane Novi Sad – ENS". This company should enable the introduction of a foreign investor in the development of energy systems of Novi Sad. The selected technology, as it has been explained above and technical, namely managerial capacity of potential foreign investor are of crucial significance for future productivity and competitiveness in the territory of Novi Sad. In addition to a number of technical issues related to selected technology, we need to emphasise here the main strategic commitment for the main fuel that will be used for production of electricity and heating energy in Novi Sad. It should be considered from the aspect of development of employment rate, productivity, and competitiveness of Vojvodina it is of exceptional significance for this facility to start using wood biomass. Necessary quantity of biomass is about 1.5 million tons a year, which enables rational employment of more than 80,000 ha of land that are currently available in the companies "Vojvodina Sume" and "Vode Vojvodine". This implies a dramatic increase of productivity of use of land in those public companies, and accordingly a dramatic increase of their total employment revenues and other financial performances of those public companies. The consequence of that is the increased purchase power of current and new employees of this company, which is the first impulse for increased competitiveness of economy of Vojvodina as a whole. Consequentially, favourable circumstances are created for detailed planning of industrial zone "North 4" in Novi Sad and for widening of such planned development onto other planned industrial zones on the left bank of the canal in Novi Sad.

Furthermore, it should be considered that elimination of subsidies from public sources for district heating in Novi Sad is of exceptional significance since the funds that are not spent, i.e. which are not spent from the city budget for the support to heating, can be spent for other purposes in the sense of development of the city, development of municipal infrastructure, industrial zones and support to employment.

Strategic management of financial resources that are available in Vojvodina from foreign sources, namely development loans, development assistance, and grants should also be analysed in this context. Those funds should be directed rationally onto maximisation of productivity, as it has been explained above. It should be taken into account that co-ordination with foreign assistance, i.e. funds from abroad makes one of the basic co-ordination mechanisms in the sense of this analysis.

5.6 Conclusion

Afforestation of one hectare of agricultural land brings a lump profit that is equivalent to 70 metric tons of carbon dioxide. Afforestation of about 450,000 ha of flatland agricultural land that can be carried out with appropriate machinery and with implementation of appropriate economy of scale should cost the same or less than the value of such lump savings of CO_2, or about 800 million euros.

Irrigation of about 700,000 ha of agricultural land from already available canals, or ground springs should cost up to 1,400 million euros. Here, we take into account the cascade use of geo-thermal waters (take over of heat from geo-thermal water and later on the use of that same water for irrigation) and multifold reduction of use of water per product unit in food industry. The average realised selling price of electricity from the power plant "Djerdap" is about 12 euros per MWh. The market price is at least 35 euros per MWh. Taking into account that more than 5,500,000 MWh are produced a year we can see the scope of rent for water resource utilisation that is transferred to consumers of electricity. It should be considered that peak energy could be valorised on the market in an even better way with water resources in Vojvodina. This is the way to provide at least 120 million euros of additional revenues of water management industry in Vojvodina, which are sufficient for the initial financing of development of the irrigation system. Wind power in Vojvodina is sufficient to provide mechanical energy that is necessary for pumping of water for irrigation. Taking into account the growth of yields due to irrigation of 24% we can conclude that the increased yields would be sufficient for maintenance of the system and that revenues coming from the rent for use of water resources would be sufficient to develop an appropriate irrigation system along with the accompanying system for wind power use within the period of 20 years.

Considering the price of district heating in Novi Sad in relation to alternative forms of heating generated with updated heat pumps, the development of the project of thermo-electric-heating plant Novi Sad in the form of transformation of the existing facility for the use of biomass as the main fuel makes an attractive commercial investment. This project can be multiplied further in Zrenjanin and Sremska Mitrovica as well as through additional extensions of thermo-electric-heating plant Novi Sad.

The increased production of agricultural produce and biomass, as well as transport of about 7 million tons of concrete elements a year from the existing thermo-electric power plants Obrenovac and Kostolac, and production and transport of wood biomass and mineral fertilisers are sufficient to employ available capacities of canals in Vojvodina and significant part of river transport routes and to provide for necessary exploitation rate of the existing and new fleet with the accompanying shipbuilding and machine-building industries.

The planned scope of afforestation and increased production of agricultural biomass enable satisfying if needs for electricity and thermal energy in Vojvodina at the current level and growth of production of electricity that is necessary to satisfy the consumption of heating pumps that can be used to replace the use of imported natural gas for heating.

Unit costs of primary energy from biomass, in particular from wood biomass, come down to the level that is below the European average costs of energy per unit.

The increased flexibility of production of electricity in the hydro-electric power plant "Djerdap" enables the construction of up to 700 MWe of wind generator capacity.

Production of bio-diesel from waste animal fats satisfies (the increased) needs of agriculture and forestry in Vojvodina for liquid fuels.

The use of the total urban waste and a part of waste biomass is planned in one central electricity production plant at thermo-electric power plant Kostolac A. An adequate river transport is organised for the purpose of waste disposal.

It is also planned to build the hydro-electric power plants in Novi Sad, Kupinovo and several smaller facilities on other watercourses in Vojvodina.

An entire river transport is transferred onto the use of compressed natural gas as the main fuel. The compressed natural gas is also used as the main fuel in public transport.

The transit of at least 10 billion cubic meters of natural gas is planned through the existing gas network with necessary extensions.

It is planned to increase the use of liquid oil gas in passengers' vehicles (in particular in taxi vehicles) to up to more than 50% of the total fuel consumption. It is also planned to increase the use of public municipal, inter-municipal railroad and passengers' water transport at the expense of reduction of transport with individual cars. The increase of pedestrian and bicycle transport is also planned.

There are plans to cover all the needs for heating of space and sanitary and industrial hot water with the use of combined facilities with thermal pumps and solar thermal collectors. This includes industrial drying of agricultural produce and biomass.

Apart from the initial reduction of CO_2 emission due to afforestation of agricultural land, it is also planned to make Vojvodina carbon neutral economy in a long run.

Such a development in the energy sector enables the accomplishment of full employment of labour force in Vojvodina

in the period of 10 years.

This will contribute to the accomplishment of the following objectives:

- To supply Vojvodina with energy per unit costs below the European average
- To reduce transport costs of imported energy to the level of the European average
- To create conditions to exchange energy in export and import under the prices and conditions comparable with other European countries
- To reduce costs of pollution from EU LCPD and CO_2 much below the European average
- To convert the largest portion of costs of primary energy into revenues of the local population, which further enables growth of domestic demand with payment capacity
- To reduce costs of heating for the population and sanitary hot water below the European average
- To produce and transport primary agricultural produce and industrial wood with unit costs below the European average up to the processing facilities
- All this creates preconditions for concentration of economic values (selling value per volume or weight unit) above the average unit value of goods in transport in the Mediterranean basin
- This also means creating of preconditions for economy that would be neutral with respect of carbon dioxide emissions.

The above-mentioned elements create basic preconditions for competitiveness of economy of Vojvodina within the reach zone of river-to-sea-going vessels from the river Danube.

5.6.1 SWOT Analysis

Advantages	Weaknesses
▸ Geographic position, soil quality and other exceptional advantages for biomass production ▸ Experiences and knowledge in highly productive biomass production ▸ Available economic resources for land regulation, afforestation and increase of productivity in biomass production ▸ Available energy and transport infrastructure for biomass collecting and use ▸ Exceptional water transport infrastructure ▸ Development support from European integration processes ▸ Nominal openness of the most significant export markets	▸ Lack of development planning and management capacities ▸ Initial funds for development directed by competition up to a certain extent ▸ Inadequate structure of property rights ▸ Inadequate definition of public property and inadequate public property management ▸ Setting of structures of interests in connection with distribution of rents from natural resources (hydro power) ▸ Necessary time for accomplishment of the minimum economy of scale ▸ Conventional system of land rights codification ▸ Insufficient development ambitions
Opportunities	**Threats**
▸ Developed European market of services in connection with green house gas emissions ▸ Developed European energy market ▸ Better valorisation and better use of rents for the use of natural resources that is already in progress ▸ Multipliers of productivity growth, economy of scale and use of assets ▸ Opportunity for development of economy that would be neutral with respect of carbon dioxide emission	▸ Slowed down integration into the European market ▸ Political instability due to changes of relations in connection with the rent for use of natural resources ▸ Increase of costs of implementation of strategic measures due to partial implementation of palliative solutions

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