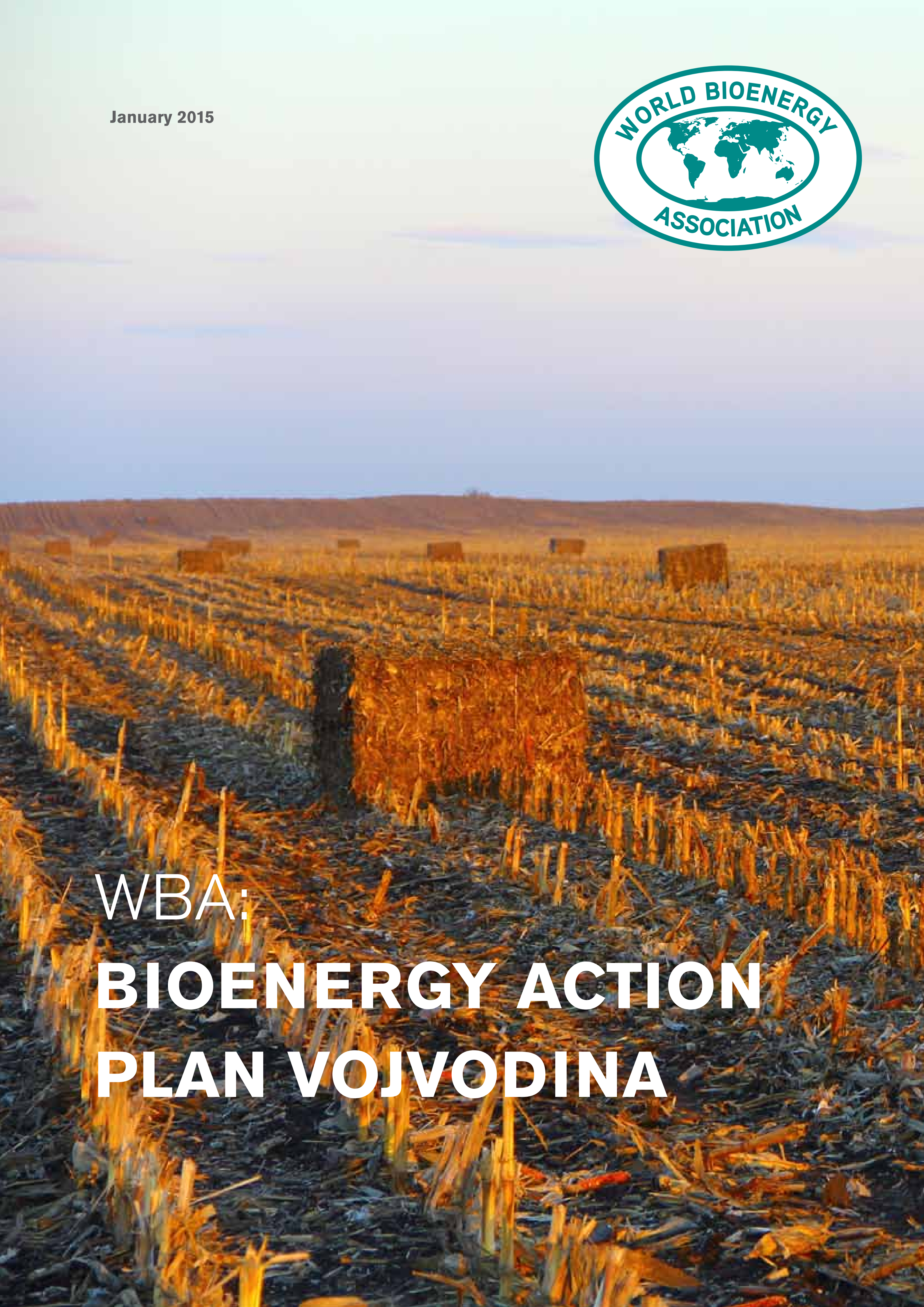
January 2015



WBA:

BIOENERGY ACTION PLAN VOJVODINA

Cover: Corn straw baling in Region of Sombor.

Photo: Hermann Wieser

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1. FOREWORD

The government of Vojvodina asked the World Bioenergy Association (WBA) to elaborate a Bioenergy Action Plan for Vojvodina. WBA was honored to fulfill this task.

In doing so WBA tried to build on the experience in the deployment of bioenergy in other parts of the world and simultaneously to take into account the strengths and peculiarities of the region of Vojvodina.

Biomass is a heterogenic feedstock closely related to the agriculture and forestry of a region. Therefore the pattern for the development of bioenergy has to follow the regional conditions.

A few countries have already a tradition of 30 years development of biomass to energy. During this period a lot of experience could be gained. WBA tried to use this experience in writing this Action Plan.

At present the use of biomass to energy is growing in many parts of the world. WBA expresses the expectation that this Action Plan will contribute to a growing role of bioenergy in the energy system of Vojvodina for the sake of the society, economy and environment of the region.

At the same time WBA thanks the government of Vojvodina for the support in developing this plan.

Heinz Kopetz, President WBA

Stockholm, January 2015

2. EXECUTIVE SUMMARY

This Bioenergy Action Plan for Vojvodina has been written by a team of the World Bioenergy Association (WBA). It is based on economic and natural science based facts as well as on the experience of the WBA in different countries.

Vojvodina has a big potential of biomass, mainly agricultural biomass that is estimated in the size of 20 – 40 PJ in the medium term. It could be increased in the longer run. At present a rather small part of this potential, estimated 6 PJ including wood imports, is used.

In the future this potential should be used to deliver electricity, heat and transport fuels. A clear and strong priority should be given to the transformation of the heat market from fossil fuels to biomass – all heat users included such as private houses, public buildings, the industry and district heating plants (Toplanas). This transformation needs different government activities and an annual budget to grant subsidies to companies and private households that want to invest in biomass heating systems.

The electricity production on the basis of solid biomass and biogas should be developed in efficient cogeneration units and restricted in quantity to avoid a too high burden put on the consumers in financing Feed in Tariffs. The main development of renewable electricity should take place on the basis of wind and photovoltaics.

The development of transport fuels – ethanol, biodiesel, biomethane - should follow the target of 10% biofuels.

The development of the bioenergy sector in the proposed way would create strong economic benefits for the society of Vojvodina in terms of new jobs, savings in energy expenditures and increased regional economic growth, because expenditures for energy now flowing abroad would remain in the region and push forward the regional economy. The development of bioenergy would also help to reduce the greenhouse gas emissions and the dependency on imported energy. It should be pursued within a general concept for renewable energy and improved efficiency.

3. INTRODUCTION

The global energy system is changing. Fossil fuels are still the dominating energy source but in many parts of the world renewable energies are growing rapidly. The UN General Secretary started a campaign Sustainable Energy for All (SE4ALL) with the target to increase the share of Renewables in the gross final energy consumption from 18% in 2010 to 36% in 2030 worldwide.

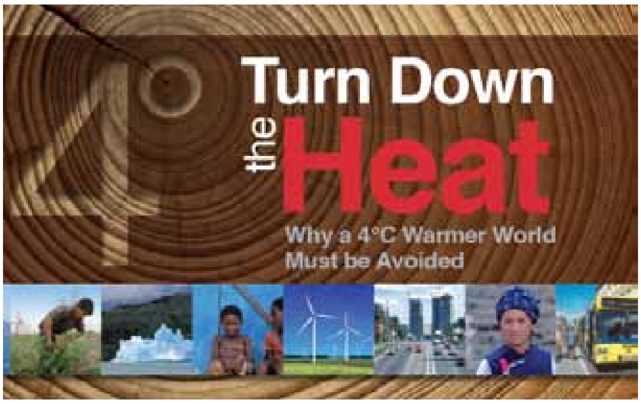
The European Union decided already in 2008 to increase the share of Renewables from 8 to 20% in 2020 and to reduce the CO_2 emissions by 20%. New targets for 2030 are now in preparation. On October 23, 2014 the European Council decided on new binding targets for 2030: minus 40% Greenhouse gas emissions as compared to 1990 and at least a share of 27% renewables.

The main drivers for public policies in favor of Renewables are:

- Mitigation of climate change
- Energy security
- Regional development and creation of new jobs

On the global level – within the UN, the World Bank, and the Intergovernmental Panel on Climate Change (IPCC) – climate change is seen as the biggest threat for a peaceful economic development of mankind in the decades to come.

In 2012, the World Bank published a dramatic report on “Turn Down the Heat - Why a 4°C Warmer World Must be Avoided.” This report not only describes the environmental problems but also the economic losses that will occur if the emissions are not reduced sharply.



Source: “World Bank. 2012. Turn Down the Heat: Why a 4°C Warmer World Must Be Avoided. Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/11860 ”

The IPCC report, published in September 2013 makes clear, that a climate mitigation pathway corresponding to the 2°C target, requires a reduction of global CO_2 emissions per capita below 2t CO_2/year as soon as possible. The current CO_2 emissions in Europe are above 7t per capita a year!! Therefore the European Commission recently proposed a target of 40% less CO_2 in 2030 as a minimum target, the reduction should reach minus 80% as soon as possible in order to comply with the IPCC climate mitigation scenario.

And the second report, published by the IPCC on March 31 2014 in Japan describes in detail the direct consequences of climate change such as considerable risk for the future food supply, death or injuries on massive scale, probable damage to public health, displacement of people and potential mass migrations. *(Source: International New York Times, March 31, 2014, page 1.,6).*

These few examples show that global decision makers are aware of the economic, social and ecological threats linked to climate change.

At national levels the push for Renewables as part of a climate mitigation scenario differs widely. Examples of leading countries are Sweden with a share of more than 50% Renewables, Brazil with nearly 50% Renewables and Denmark which has ambitious targets for the coming years. Other countries lag far behind. The difference in public awareness about the problem of climate change is one of the reasons for these different approaches in countries across the world.

Worldwide the damage caused by climate change is growing. Global acting companies are affected by droughts (Coca Cola) and the interruption of supply chains (Nike) (Source: The New York Times International Weekly, Monday, February 3, 2014). Business leaders are urging the political decision makers to take decisive action against an increase in global temperature (UN-Climate Conference Warzaw, 2013)


Photo: Hermann Wieser

CO_2 is the main greenhouse gas that causes global warming and is mostly released by the man made burning of fossil fuels. The cited IPCC report explains that about 90% of the global CO_2 emissions are caused by burning fossil fuels – coal, oil, gas. Providing 10kWh primary energy the following quantities of climate relevant CO_2 are emitted:

- Coal: 3,3kg CO_2
- Oil: 2,7kg CO_2
- Gas: 1,9kg CO_2

In the case of sustainably produced biomass the climate relevant CO_2 emission is zero kg. The CO_2 released by burning biomass has been previously absorbed from the atmosphere via photosynthesis during plant growth and is returned to the atmosphere, either by natural decay, or by using it as a fuel. Therefore sustainably produced biomass is carbon neutral.

Successful climate policy means above all the reduction of fossil fuel CO_2 emissions. This means reduction in the use of fossil fuels by increasing the use of renewables, achieving better efficiency and less energy consumption.

Biomass plays an outstanding role among Renewables, even in the European Union, where in 2010 more than half of all Renewables, exactly 3 939 PJ, 62% of the total contribution of Renewables to the Final Energy Consumption, came from biomass.

Biomass is organic matter derived from plants or animals; it is renewable.

Bioenergy is energy derived from the conversion of biomass to heat, electricity or transport fuels, also called bio-heat, bio-electricity, biofuels. Biomass may be used directly as a solid fuel or processed into liquids and gases.

Biomass originates from forests, agriculture and waste streams.

Wood is the largest resource of solid biomass. The sector covers a wide range of materials with different characteristics – fire wood, logs, bark, wood chips, sawdust, recovered used wood, and more recently pellets. Pellets, due to their high energy density and standardised characteristics, offer great opportunities for developing the bioenergy market worldwide.

Agriculture can provide dedicated energy crops as well as by-products in the form of animal manure, straw, corn stalks, sun flower shells, rice husks, olive kernels etc. Available land can be used for growing conventional crops such as rape, wheat, maize etc. for energy purposes or for cultivating new types of woody or herbaceous energy crops such as poplar, willow, miscanthus and others.

Biogenic waste is the biomass that can cover or include several forms of waste such as organic fraction of municipal solid waste, organic by-products of the food industry, refuse-derived fuels, sewage sludge, etc.

Each bioenergy systems consists of three parts:

- Supply of biomass – production and transportation
- Conversion of primary biomass to final energy be it heat, electricity or transport fuel
- Sale of the bioenergy to the market - consumption.

Each biomass resource has different characteristics in terms of calorific value, moisture and ash content, etc. that require appropriate conversion technologies for bioenergy generation. These conversion routes use chemical, thermal and/or biological processes such as combustion, gasification, combustion in combination with the steam process or the organic rankine cycle (ORC)-technology, anaerobic fermentation to produce biogas, fermentation of sugars to ethanol, and esterification of vegetable oil to produce biodiesel, to mention just the more important ones. These many elements have a strong influence on the formulation of the Bioenergy Action Plan Vojvodina (BAPV). In the chapter on objectives the criteria for the selection of biomass to energy chains will be developed.

Biomass is converted to heat, electricity and biofuels. In EU 27 most of the biomass is used for production of heat. In 2010 the contribution of bioenergy was as follows: 72% went to the heating sector, 12% to electricity generation and 16% to produce transport fuels. The use of biomass is most competitive in the heating sector, and this is one of the reasons for the big share of biomass that goes to the heating market.

In the case of fossil fuels (as well as in the case of biomass) it is important to distinguish between primary energy and final energy. In a simplified form in can be defined:

Primary energy = final energy + energy losses

Primary energy is the energy contained in the energy carriers such as coal, oil gas, wood, straw and any other biomass.

Final energy is the energy consumed by the different sectors (industry, transport, households etc.) in form of heat, electricity and transport fuel.

The differences between primary energy and final energy are the losses that occur in converting primary energy carriers to the utilised heat, electricity or transport fuels. The biggest losses occur in power plants where there is no use of the heat that is generated as by-product of the electricity production. It is clear that these losses should be as small as possible.

The development of bioenergy has to be seen in a broader, global concept. It is part of the global transition of the energy system from fossil and nuclear to renewable sources in combination with an improved energy efficiency.

Renewable energy sources are mainly based on the energy coming from the sun in a direct way such as photovoltaics, concentrated solar power and solar thermal or in an indirect way such as wind, hydro and biomass. In this sense bioenergy is stored solar energy and part of the new energy portfolio of the future.

Agricultural farm in Region of Becej. Photo: Hermann Wieser

4.

THE ENERGY SYSTEM IN VOJVODINA

The energy system of each region is closely related to the size of the population, the land area, the domestic energy resources, the economy and the economic development. The Autonomous Province of Vojvodina is situated in the northern part of the Republic of Serbia.

BASIC ECONOMIC DATA IS AVAILABLE FOR THE REPUBLIC OF SERBIA:

Serbia has a population of 7.2 million people and a size of 77 474 km². The national income per inhabitant was 5 280 US Dollar in 2012; as compared to 44 010 US Dollar in Germany. The currency is one Dinar RSD. 100 Dinar equal 0,87 Euro, one Euro equals 115,6 Dinar. *(Source www.finanzen.net 10 July 2014)*

The total final energy consumption of Serbia was 397 PJ in 2009, with 163 PJ as heat, 131 PJ electricity and 103 PJ transport fuels. 21.2% of the final energy consumption was covered by renewables energy: 44.2 PJ mainly by forest biomass (fire wood) and 36.9 PJ by renewable electricity (hydropower). *(Source: National renewable energy action plan of the Republic of Serbia based on the Directive 2008/29/EC (Decision 2009/548/EC) NREAP, Beograd 2013).*

The Autonomous Province of Vojvodina has a population of 1.93 million people living in 850.000 households.

TABLE 1: BASIC DATA OF THE APV (AUTONOMOUS PROVINCE OF VOJVODINA)

Subject	Unit	Data
Basic Data		
Population	Mio. persons	1.932
Land area	ha	2.150.000
Arable land	ha	1.780.000
Forest land	ha	150.000
Cattle	head	266.000
Pigs	head	1.600.000

Source: Chamber of Commerce, Vojvodina

With 83% Vojvodina has a noticeably high share of arable land in relation to the total land area and a low share of forest area at 7%. This situation has a strong influence on the biomass potential. In many other European regions forest biomass plays the main role, in Vojvodina biomass from agriculture will have to contribute the main part.

The basic data concerning the energy system of Vojvodina are presented in table 2. The primary energy consumption is 185 PJ, renewables contribute 6 PJ, 3.2% of the total.

TABLE 2: ESTIMATION OF PRIMARY ENERGY IN VOJVODINA

	Different units	PJ
Oil	1.65 Mtoe	69,1
Gas	1.67 bn m³	55,9
Coal	0.49 Mio. T	6,0
Transport fuel	649 Mio. L	21,0
Electricity	8 100 GWh	29,2
Renewables		6,0
Stat. difference		-2.2
Total		**184.8**

Source: Province of Vojvodina. Provincial Secretariat for Energy and Mineral Resources, WBA calculations. Assumption: electricity and transport fuels bought from other regions.

As can be seen, oil and gas are the basis of the energy system.

No detailed data was found on the final energy consumption of Vojvodina. Based on international benchmark data the final energy consumption is estimated at about 125PJ. Heat being the biggest part of final energy. The share of bioenergy in final energy is 4,5%.

TABLE 3: ESTIMATION OF FINAL ENERGY IN VOJVODINA

	PJ	%	Here of RES	Share of RES %
Electricity	29	25	30 GWh=0.1PJ	0.4
Transport fuel	21	18	-	-
Heat	65	57	5.7 PJ	10
Total final energy	**115**	**100**	**5.8**	**5**

Source: Calculation by WBA

A more detailed view on renewable energy is presented in table 4. As can be seen, bioenergy in the form of wood is the dominant part of renewable energy at present. Not all the wood comes from Vojvodina. Several 100.000m³ are imported from neighbor regions.

TABLE 4: RENEWABLE ENERGY IN VOJVODINA

RENEWABLE ENERGY		
Hydro	installed capacity	0
Wind	installed capacity	0
Solar thermal	square meter installed	2.233 m^2; 1.5 MW
Biomass for combustion < 100 kW	number units	approx. 100 - 200
Biomass for combustion 100 kW	number units	26
Biomass for electricity	installed capacity	0
Biogas	Number units; MW	4; 4,1 MW
Estimated total use wood for energy	cbm	840.000
Estimated total use of straw for energy	tons	37.400

Source: Chamber of Commerce Vojvodina

The price situation is another important aspect of the energy system. Table 5 gives an overview. The prices are expressed in Eurocent per kWh to make the comparison easier. The prices of Liquefied Petroleum Gas (LPG), of fuel oil, electricity and natural gas are rather high whereas firewood, brown coal and straw in bales are relatively cheap. The energy in transport fuels is most expensive due to the higher taxation, whereas the primary energy in straw bales is the cheapest.

TABLE 5: THE PRICES OF DIFFERENT ENERGY CARRIERS

Energy carrier	Unit	Price per unit (Euro)	Energy content per unit in kWh	Price per kWh in Eurocent
Electricity	kWh	0.066	1	6.6
Natural gas household business[1]	M³	0.40 0.37	10	4.0 3.7
LPG	L	0.906	10	9.1
Unleaded petrol	L	1.196	8.9 (31.9MJ)	13.4
Diesel	L	1.159	9,8 (35.4MJ)	11.8
Fuel oil	Kg	0.618	11.8	5.2
Briquettes, pellets	T	138	4800	2.9
Firewood	M³ stapled	45	1 700	2.6
Straw in bales	T	45	3 900	1.2
Brown coal	1	75	5 500	1.4

Source: Autonomous Province of Vojvodina, Provincial Secretariat for Energy and Mineral Resources

[1] www.energy market price 12.7.2014

The heat supply is a basic need for households, companies and public institutions. In Vojvodina the bigger cities have district heating grids in combination with heat plants (Toplanas), they mainly use natural gas as energy carrier; 21 Toplanas are in operation.

A recently published book reports details about 19 Toplanas. The 18 Toplanas elsewhere from Novi Sad have a total installed thermal capacity of 482 MW. The Toplanas are using natural gas to generate heat with one exception. The fuel consumption in an average year amounts to 545 GWh (2 PJ) excluding Novi Sad.

Novi Sad has the biggest heating plant with 900 MW installed capacity, 92.000 clients, a grid of 222km and an annual fuel consumption of about 1 200 GWh (4.3 PJ) in the form of natural gas. More details can be seen in table 6.

TABLE 6: TOPLANAS IN VOJVODINA

Name	Region of Vojvodina	Thermal power of heated buildings MW	Thermal power of boilers MW	Fuel con-sumption GWh	Network length km	Number thermal substa-tions
Novi Sad			900	1 299	222	
Subotica	Batschka	108	111	118	38	933
Pancevo	Banat	105	90	134	70	310
Zrenjanin	Banat	92	70	95	33	280
Sremska Mitrovica	Srem	35	11	10	49	187
Sombor	Batschka	33	37	39	23	130
Kikinda	Banat	32	59	43	9	123
Ruma	Srem	22	23	24	7	59
BEcej	Batschka	20	20	19	22	427
Novi Sad Gas		9	9	10	3	31
Backa Palanka			-			
Beocin	Srem	6	11	9	3	18
Temerin	Batschka	4	9	6	2	34
Pecinci	Srem	3	4	4	1	13
Vrbas	Batschka		16	16	3	44
Srbobran	Batschka		7		2	
Zitiste	Banat		5	7	2	5
Kovin			-	11		

Source: book: fifty years of district heating in Subotica, Subotica 2013;
Novi Sad personal communication on 27 March 2014.

Outside the heating grids different energy carriers are used. Firewood and corncobs play an important role as cheap energy carriers. Also natural gas, coal and electricity are used for heating to a smaller extent.

The Republic of Serbia introduced feed in tariffs for electricity from biomass and biogas for the whole republic. These tariffs are reported as follows:

TABLE 7: FEED IN TARIFFS FOR ELECTRICITY FROM BIOMASS & BIOGAS

Type of facility	Installed power MW	Feed in tariff Euro Cent/kWh
Solid biomass	Up to 0.5	13.6
	0.5 – 5	13.6 – 11.4
	5 – 10	11.4
Biogas	Up to 0.2	16.0
	0.2 – 2	16 - 12
	Over 2	12

Source: Autonomous Province of Vojvodina, Provincial Secretariat for Energy and Mineral Resources

The difference between these tariffs and the market price is paid through a surcharge to the electricity price paid by the consumers. This system was first introduced in Germany 20 years ago and has since been adopted by more than 60 countries.

Wheat and corn field in Region of Kikinda. Photo: Hermann Wieser

Corn straw storage at biomass Pellet Plant Dorodoslovo of company Bridge Power Investments d.o.o.

Photo: Hermann Wieser

5.

BIOMASS IN VOJVODINA – PRODUCTION, POTENTIAL, CURRENT ROLE

In the Autonomous Province of Vojvodina the agricultural resources with total arable land of 1.780.000 ha are dominating the forest resources of 150.000 ha. The region in general has significant potential of agricultural biomass in particular from corn, cereals, soya and sunflower. Table 8 shows the average for the years 2009 – 2011 for the production of agro biomass for selected crops.

TABLE 8: AGRO-BIOMASS PRODUCTION OF MAJOR ENERGY CROPS

Crop	Surface [ha]	Yield of grain [t/ha]	Mass of grain [t/ha]	Ratio of masses [t/t]	Yield of straw [t/ha]	Mass of straw [t/year]
Wheat	262.900	3.7	972.730	1:1	3.7	972.730
Other cereals	62.800	3.0	188.400	1:1	3.0	188.400
Corn (stalk+corncob)	703.100	5.2	3.650.000	1:1	5.2	3.650.000
- Corncob	-	-	-	1:0.2	1.04	940.000
Sunflower (stalk+head)	153.000	2.0	306.000	1:2	4.0	612.000
- Shell	-	-	-	1:0.3	0.6	91.800
Soya	148.000	2.4	355.200	1:2	4.8	710.400
Oilseed rape	4.204	2.090	8.786	1:2	4.180	17.500
Tobacco (leaf : stem)	4.321	1.475 (leaf)	6.373 (leaf)	1:0.35	0.516 (stem)	2.230 (stem)
Total	**1.338.325**	**4.25**	**5.487.489**	**1:1,2**	**4.76**	**6.245.060**

Source: Chamber of Industry, Commerce and Agriculture Vojvodina

This quantity of 6.2 million tons relates to by-products only and is slightly bigger than the main product – with an amount of 5.5 million tons. These by-products are the main basis for a program of biomass to energy in Vojvodina. The yields per ha are rather low as compared to average yields in the European Union, and one reason might be that on many smaller plots the yields are much lower than these average yields. In any case, only a small portion of these by-products – about 10% in the beginning, increasing to maybe 25% with experience, will be available for energy. Data is also available for the biomass production in livestock breeding, in forestry and for municipal waste. The data on livestock is presented in table 9.

TABLE 9: BIOMASS PRODUCTION IN LIVESTOCK BREEDING

Type	Number of heads	Manure in t/year
Cattle	266.000	1.900.000
Pigs	1.600.000	1.500.000
Poultry	6.400.000	180.000
Total		**3.580.000**

Source: Chamber of Industry, Commerce and Agriculture Vojvodina

Manure is of importance because it is the basis for biogas production; but only a small portion of these quantities will be available for use in the next decade due to various limitations.

No data was available on the energy content of biomass from landscape cleaning, which includes wood from non-forest areas like gardens, parks, trees along the roads and rivers and from recycled wood material that originally went to landfills. In many countries this cleaning has become an important feedstock for biomass supply. Even without these biomass sources the summary of all data on biomass production in table 10 is impressive.

TABLE 10: OVERVIEW OF BIOMASS IN PROVINCE OF VOJVODINA

Biomass type	Tons per year
Agro-biomass from crop production	6.245.000
Livestock manure	3.600.000
Forest biomass (residues)	351.000
Municipal waste (organic)	393.000
Total	10.589.000

Source: Chamber of Industry, Commerce and Agriculture Vojvodina

The energy content of this diverse biomass material differs widely. Based on default values about the energy content an estimation of the energy content of this material is presented in table 11.

TABLE 11: ESTIMATION OF THE ENERGY CONTENT OF BIOMASS BY PRODUCTS IN VOJVODINA, PJ

	Tons/year	Average energy content per ton, kWh	Primary energy GWh	Primary energy PJ
Agro biomass as byproduct	6.245.060	3.200	19.984	61.5
Agro biomass for 70 Mio. litre biofuels [1)]	58.000	8.900	516	1.9
Livestock manure	3.600.000	130	468	1.7
Forest biomass	351.000	3.400	1 190	4.3
Municipal waste	393.000	550	216	0.8
SUM of by-products And biofuels				70.2
In addition 100 000 ha short rotation forest	1.200.000 dry matter	5.000	6.000	21.6
Fire Wood import	250.000	3.900	900	3.2
Crops for transport fuels	52.000	11.000	572	2.0
Total				**97.0**

Source: tables above and WBA calculations

[1)] Half ethanol, half biodiesel

As can be seen the energy content of the biomass by-products is estimated as 70,2PJ. When including figures for wood imports, the cultivation of fast growing trees and energy crops for biofuels this figure increases to 97,0 PJ. But only a limited part of this potential can be used for energy purposes (for reasons such as animal bedding). A significant amount of agricultural residues or by-products has to remain on the fields to maintain the soil quality, and other parts will be used for other purposes or not used due to economic restraints. On the other hand it is possible to increase the quantity of biomass by planting energy crops with high yields. This might become interesting in the future, at the point when the available by-products are being fully used and the demand is still increasing. It is possible to analyse the potential in Vojvodina in a more scientific way distinguishing between theoretical, technical and economic potential, but this is not the purpose of this action plan. The purpose of this analysis is to come up with a pragmatic and cautious estimation of the potential of biomass as basis for the deployment of bioenergy over the coming 15 years.

Based on a realistic and cautious approach a quantity of 20 – 40 PJ biomass can be used annually for energy purposes in the long run – not in the next few years. This figure might be defined more precisely after 5 – 10 years based on the experience that will be gained. Different forms of straw, cornstalks, corncobs are dominating this total, and forest biomass follows at a much lower level. This is a long term vision, because it will require much efforts to push the use of biomass from the present 6 PJ to 12 PJ within the next years.

6. ECONOMIC, SOCIAL AND ENVIRONMENTAL ISSUES CONCERNING BIOENERGY

The use of biomass for energy is nothing new –mankind has used firewood for cooking and horses and other animals for work and transport for thousands of years. In the history of mankind a considerable share of the land was needed to produce feed for these animals.

Over the past 100 years fossil fuels have become the basis of a much higher energy consumption, more than at any time in man's history. Now, climate mitigation, high prices and scarcity of resources are the main drivers of a renaissance of renewable energies that will be based on completely different technologies when compared to the past. This is valid for wind, and solar but also for bioenergy.

The present level of consumption of energy in developed countries can barely be covered by renewables alone. The reduction of the demand for energy by improved efficiency and energy saving is as important as the push for renewable technologies.

Efficiency is a central issue in the new energy policy and comprises different elements. A first connotation of efficiency concerns the conversion of primary to final energy. In the future the losses connected with inefficient conversion of primary energy such as coal, gas or biomass to electricity only will have to be strongly reduced.

A second connation of efficiency concerns the transformation of the final energy to the used energy in terms of kilometres driven, lighting rooms, comfortable temperatures in houses etc. Many activities are going on to improve this efficiency. Example: car engines that use less petrol per kilometre, new equipment such as more energy efficient refrigerators, washing machines, light bulbs that use less electricity with the same performance, better insulated houses using much less energy per m² than old ones. In summary the efforts to improve all forms and areas of efficiency play a central role in transforming the present energy system. The efforts are supported by the 2nd pillar of the future sustainable energy system – the renewable energies with bioenergy playing a very important role within them.

Biomass is a renewable energy source, CO_2 neutral, if produced and used sustainably. But also the use of biomass in some circumstances can lead to problems that should be avoided to maintain a high acceptance of bioenergy in the public.

The transport of natural gas to Toplanas for example is not visible. But even a rather small Toplana using 40 GWh fuel needs about 10.000 tons of straw to replace natural gas. Even if a truck transports 18 tons of straw three truck loads per day are needed to supply the plant with feedstock. This transport volume has to be considered when planning new heating boilers using biomass. Normally heating plants using biomass are located at the periphery of the cities to avoid a disturbance of the citizens by noise and dust.

The emissions of biomass boilers also can become an issue. Modern biomass boilers have more than 90% less emissions than old ones. It is necessary to warrant that only modern, tested boilers are installed that comply with all legal regulations.

In some regions of Europe the strongly increased use of maize for biomass is criticised, in other regions the competition between the paper industry and the bioenergy sector for forestry products is discussed, or the overharvesting of forests. On the European level the competition between fuel and food in respect to edible crop products was a main issue in the past. This concern of the public has to be taken seriously and each extreme development should be avoided.

On the other hand many of the critical voices don't have solutions but argue in favour of the status quo and against changes in the energy system. Yet, this standpoint cannot be the solution as it leads to increased climate change, to more insecurity and permanent higher prices for fossil fuels and so reduces the standard of living of the population.

In developing bioenergy as an energy source it is important to avoid mistakes and to inform the citizens or the public about the advantages of bioenergy and show how any justifiable concerns are taken seriously. The development of projects in cooperation with the population is a well proven method for successful project realization.

Traditional family-farming corn straw baling in Region of Becej. Photo: Hermann Wieser

An important argument in these discussions is the drain of money abroad to pay for fossil energy imports. It costs more than 1 billion Euro to buy 100 PJ fossil energy on the world market. Each PJ that can be replaced by bioenergy means that 10 million Euro remain in the region and create new income, new jobs locally. This aspect is a main driver in many European regions to promote bioenergy.

The deployment of biomass to energy offers a variety of advantages and opportunities to a region or a country. The advantages of bioenergy can be summarized as follows:

Job creation: The implementation and the operation of bioenergy chains create more jobs per PJ than any other form of renewable energy.

Activating the local and regional economy. Bioenergy makes it possible to keep the energy expenditures of the consumers in the region instead of paying this money abroad. Therefore biomass strengthens the regional circle economy.

Reducing CO_2 emissions: Biomass from sustainable production when burned is carbon neutral. Yet not more biomass must be used than can be sustainably produced. This is one of the basic rules of sustainable biomass production.

Affordable energy: if biomass is used in the heating sector it is in most regions cheaper than alternative heat sources, if no subsidies to heating with gas are allocated or if the same subsidies as for gas are also allocated for heating with biomass. Therefore the switch to bio-heat can help to reduce the energy bill and ease social tensions.

Security of supply: in many cases biomass can be supplied from the region for the region. The risk of supply interruption is smaller than using fuels imported from other continents or countries.

Biomass is renewable: the most important point – biomass grows every year and is therefore renewable. An energy system based on Renewables such as biomass can last for ever. Yet the production of biomass has to be sustainable. Therefore a close cooperation with the research community and development of effective laws or regulations are needed to avoid negative impacts on the soil fertility, the forests and the environment as whole due to using more biomass.

The various positive effects of bioenergy can be studied more in detail in countries with a high share of bioenergy such as Sweden, where biomass provides more than 30% of the Gross Domestic Consumption of Energy and in Austria with a bioenergy share of more than 16%.

7. THE FINANCIAL IMPACT OF DIFFERENT BIOENERGY SUPPORT SCHEMES ON THE ECONOMY AND THE ENERGY SYSTEM

7.1 PRELIMINARY REMARKS

At the beginning of this century, 12 years ago, the European Union started its policy for renewables with two directives, one on electricity and one on transport fuels. Although 50% of the final demand for energy in Europe is heat, the European Commission never published a directive on renewable heat due to different administrative and political reasons. Since then the European policy overemphasizes the electricity generation and overlooks the importance of the heat market.

In 2009 the European Union introduced its 20:20:20 policy on targets for renewable energy, for the reduction of emissions and on efficiency. Each Member State set a target for the share of renewables; it is up to the Member States how they reach these targets. This can be done by pushing for renewable electricity, renewable heat and transport fuels. Only for transport fuel a minimum share of 10% from renewable sources was decided as mandatory in 2009. In the meantime a controversial discussion on the biofuel target started, at the end of 2014 the outcome is not clear. The member states have to elaborate National Renewable Energy Action Plans (NREAP) in which they define in detail how they will proceed to achieve the overall target and which support mechanisms they apply for this purpose. Within the Energy Community also the Republic of Serbia made a NREAP with a target of 27% of energy from renewables by 2020.

Different support mechanisms exist to promote renewable energies in Europe as the following overview shows:

- For electricity: feed in tariffs (FITs), green certificates, quota
- For heat: carbon taxes on fossil fuels, government grants for investments in renewable heat.

FITs are the most commonly used instrument for electricity; carbon taxes, grants or a mix of both instruments are in use to support renewable heat.

Germany is the leading country in applying FITs to promote renewable electricity,

Sweden is leading in applying carbon taxes to promote renewable heat; in addition, Sweden introduced green certificates to promote renewable electricity a few years ago.

Austria uses FITs with strict limitations to promote renewable electricity and a mix of small carbon taxes and government grants to promote renewable heat. According to Austrian's experience the amount of public money available per one million inhabitants is a key figure for a substantial transformation of the heating system in a region. This figure is about 8 million Euro per one million inhabitants per year needed to finance grants for new biomass heating systems of all sizes.

If this is related to Vojvodina it means an amount of about 15 million Euro per year would be needed for many years to transform the heating systems from fossil to renewable sources.

The most successful country in promoting renewables is Sweden with a share of 50% renewables in the energy mix in 2012 as compared to 13% in the European Union.

7.2 COST CONSIDERATIONS

The cost of final energy, be it heat or electricity, depends upon the cost of the primary energy, the cost of the conversion from biomass to bio-heat (= heat from biomass) or bioelectricity (= electricity from biomass) and the cost of the losses.

The conversion of biomass to bio-heat in modern combustion boilers reaches an efficiency of 80 -90%; this means an amount of biomass with an energy content of 1000kWh primary energy delivers as an average 850 kWh heat. The cost per unit of primary energy in biomass is lower than in natural gas, the cost of the combustion system is higher, because the equipment to burn biomass is more expensive than a gas boiler with the same capacity. Government grants for the installation of biomass boilers can help to reduce the cost of combustion of biomass and thus make bio-heat cheaper.

TABLE 12: ESTIMATED COST OF HEAT GENERATION IN VOJVODINA

	Cost of primary energy in Euro/MWh	Cost of conversion to heat Euro/MWH	Cost of heat at the site of production Euro/MWh
Natural gas	37 (40)	7	44 (47)
Straw pellets	29	10*	39
Firewood	26	5	31
Straw in bales	13	11*	24

Source: WBA calculations, based on tables before, August 2014

*Grants for investment included

As table 12 above shows, the cost of primary energy is lowest in straw bales and highest in natural gas (first column). The price of natural gas in brackets is the price for households, the figure without brackets is the cost for business clients.

The cost of conversion to heat (cost of combustion, second column) comprises the depreciation, the operating expenses including staff, and maintenance and other costs such as electricity, chemicals, ash removal etc. These cost depend on a variety of parameters such as cost of investment, operation hours per year, size of the boiler etc. and therefore these costs are specific for each boiler. In this table 12 an average cost figure is presented based on internal WBA calculations. These figures should not be used for the planning of a specific project rather they serve to make the differences in the cost of combustion between a fossil fuel burner and a biomass boiler more understandable.

The cost of conversion is low for natural gas and firewood and rather high for straw pellets and straw bales.

In the case of straw bales and straw pellets a grant of 50% of the cost of investment is assumed. Without the grant the cost of conversion to heat would be 5 -10 Euro/MWh higher depending upon the size of the plant and the operation hours per year.

In the case of firewood small cheap boilers with manual feedstock supply were assumed as basis for the calculation.

It can be concluded that the cost of the heat using straw bales in heating plants financed with a 50% grant are in the order of 24 Euro/MWh that is 20 Euro/MWh less than using natural gas. It has to be added, that in many cases the heat generated with natural gas is subsidized and therefore cheaper than presented here. The comparison is valid in the situation of no subsidies per kWh, either for gas nor for biomass.

The conversion of solid biomass to electricity reaches on average an efficiency of 26%, meaning that biomass with an energy content of 1000 kWh energy delivers 260 kWh electricity. In an electricity alone mode 74% of the energy in solid biomass is lost as heat. In a combined heat and power (CHP) plant where all the heat produced is utilized efficiencies between 85 and 90% are reachable. The efficiency of gas engines used in biogas plants is about 37% for generation of electricity.

In addition the equipment to convert solid biomass to electricity is complex and more expensive than for a biomass to heat boiler. This explains why the costs of electricity from biomass are higher than the market price; this difference is compensated by FITs in many countries. Table 13 gives an overview.

TABLE 13: FITs FOR ELECTRICITY FROM BIOMASS AND BIOGAS
AND THE DIFFERENCE TO THE MARKET PRICE

	Electricity, Feed in tariff, Euro/MWh	Electricity, Difference FIT and market price, Euro/MWh
Solid biomass	120	80
Biogas	150	110
Market price electricity	40	-

Source: Province of Vojvodina. Provincial Secretariat for Energy and Mineral Resources, 2014

The difference between the FIT and the market price is 80 Euro/MWh in the case of solid biomass and 110 Euro/MWh in the case of biogas. The economics of solid biomass for electricity and biogas for electricity differ. The main reason lies in the higher investment cost per MWel in a biogas plant.

7.3 MACROECONOMIC CONSIDERATIONS – HOW TO INCREASE THE BENEFIT FOR THE SOCIETY?

In the National Renewable Energy Action Plan (NREAP) for the Republic of Serbia the targets for 2020 are 100MW installed capacity for electricity from solid biomass and 30 MW from biogas. Based on the distribution of the population it is assumed that 30 MW solid biomass and 10 MW biogas are being implemented in Vojvodina.

CHP plants with an electrical capacity of 30 MW producing year round electricity and selling heat only during the winter period, needs 230.000 tons straw per year (see calculations in the annex II). Let us now compare two options:

Option A: 230.000 tons of straw used for heat plants. The heat plants sell heat only during the winter and don't generate electricity, a financial support - 50% of the cost of investment - is granted. The heat is sold at a price of 23 Euro/ MWh to the district heating grid as compared to 44 Euro/MWh using natural gas.

Option B: 230.000 tons of straw used for CHP plants

The CHP plants generate electricity all the year and sell heat during the winter; they get FITs and no investment support.

TABLE 14: COMPARISON HEAT ALONE OPTION VERSUS CHP OPTION

Option A – heat alone		Option B – CHP plant
230.000	Straw needed tons	230.000
------	Annual subsidy for FIT Mio. Euro	19.2
-------	Subsidy over 12 years Mio. Euro	230.4
37.5	Grant/subsidies for the construction Mio. Euro	-------
828	Delivered heat GWh	271
------	Generated electricity GWh	240
17.4	Savings in heat expenditures for the heat consumers per year, Mio Euro	5.7

Source: WBA calculations

AN EVALUATION OF THESE TWO OPTION:

Use of feedstock: the same amount of feedstock is used in both cases: 230.000ton straw.

Public funding: Calculated over 12 years public funding in case B requires 230 Mio. Euro for the financing of the FiTs versus 37,5 Mio. Euro in case A for the investment grant for the construction of the heat plant, the difference being 230,4 – 37,5 = 192,9 million Euro. In case A the public would save 192,9 million Euro over a period of 12 years.

Savings on heat expenditure: In case A 828 GWh cheap heat from biomass is delivered versus 271 GWh in case B. This means in case A the number of households getting cheaper heat is 40 000 units higher than in case B!

In case B the amount of generated heat is much smaller than in case A because one part of the primary energy in the straw is used for the electricity generation and a rather large part is lost as waste heat during the summer period.

Renewable electricity generation: would be 240 GWh higher in case B than in case A. The existing power plants would have to continue to generate this amount of electricity.

Conclusion for this example: If you use the 230.000 tons of straw in heat alone plants instead of CHP plants without heat use in the summer period, the public saves money and many consumers get cheaper heat.

Which option brings a higher benefit to the society? The answer is clear: option A, the heat option! The difference is remarkable: more than 330 million Euro over 12 years. Option A means: No public expenditures for FiTs and additional annual savings for heat consumers.

No recommendation is derived from this example at this point. It only should help to better understand the economics of the different options.

View of buildings at Toplana (District Heating Company) in Subotica. Photo: Hermann Wieser

8. OBJECTIVES AND PRINCIPLES

The objectives for the Bioenergy Action Plan Vojvodina (BAPV) shall be set in such a way that the benefits of bioenergy can be optimized in favor of the society of Vojvodina.

In addition:

- The EU targets for Renewables and CO_2 reduction for the years 2020 and 2030 shall be taken into account.
- The UN targets for Renewables for 2030 and the proposals of the IPCC concerning the climate mitigation policy in the future shall also be considered in developing the targets.

In this phase of developing the BAPV the objectives are not formulated in figures but in relative terms such as weak - normal - strong - very strong.

8.1 PRESENT SITUATION

Starting point for developing targets is the status quo as described in chapters 2 and 3.

Table 15a presents the present contribution of biomass to the primary energy supply as derived from the Vojvodina statistics.

TABLE 15A: CURRENT USE OF BIOMASS AS PRIMARY ENERGY,
SUPPLY SIDE, AGRICULTURAL AND FOREST UNITS

Biomass from	Unit	Current situation
Agriculture		
Straw	tons	37.000
Biogas	M^3 biogas	14.000.000
Ethanol	l	
Biodiesel	l	
Forests – wood, wood residues	M^3	840.000
Waste	tons	-
Dedicated energy crops	ha	-

Source: Chamber of Commerce Vojvodina

These figures in units used in agriculture and forestry have to be converted into energy units to relate these data to the energy statistics. This is presented in table 15b. This table shows the present contribution of biomass to the primary energy supply.

TABLE 15B: CURRENT AND PROPOSED FUTURE USE
OF BIOMASS AS PRIMARY ENERGY, SUPPLY SIDE, ENERGY UNITS

Biomass from	GWh	PJ	Proposed future growth
Agriculture			
Straw, agro by-products	144	0.52	Very strong
Biogas	85	0.31	medium
Ethanol, biodiesel			medium
Forests	1.428	5.14	strong
Waste	-		strong
Dedicated energy crops	-		medium
Total	**1.657**	**5.96**	

Source: WBA calculation based on table 15a

As can be seen, wood coming from forests in Vojvodina and neighboring countries is the most important biomass source. In the right column the future development is expressed: the use of agricultural by-products and straw should be promoted with priority but also the other biomass sources have to be developed.

Not only the supply of biomass but also the demand for final energy is of importance. This is presented in table 16.

TABLE 16: ESTIMATED USE OF BIOMASS AS FINAL ENERGY AND PROPOSED FUTURE DEVELOPMENT

		Current situation	Future growth of bioenergy
	Energy demand PJ	Bioenergy PJ	
Gross final energy consumption	115	5.8	
Heating sector	65	5.7	Very strong
Electricity sect	29	0.1	Weak
Transport fuels	21	-	Normal

Source: WBA calculations based on table 15b

The promotion of biomass for heat should get a clear priority.

8.2 OBJECTIVES

SUPPLY OF BIOMASS

Vojvodina has a well-developed agriculture and a big potential for biomass supply, especially in the agricultural sector. This potential shall be developed step by step with the development of new domestic and international markets for biomass to energy.

Agricultural biomass can be straw from corn and cereals, corn cobs, shells from sunflowers, other byproducts of agricultural crops, manure from animal production and crops for first generation (1G) transport fuels such as ethanol or biodiesel.

Forest biomass is fire wood and residues from the forest and wood industry.

The forest companies – state owned or private- must be willing to make long term contracts with future clients as a prerequisite for the investment in biomass plants.

The waste streams of municipalities and the food industry offer also an important potential for bioenergy.

And finally several percent of the agricultural land should be used to produce biomass planting energy crops such Short Rotation forests, Miscanthus and others. In this case the land owners – public or private – must be able and willing to lend land for 25 or 30 years to investors that intend to establish and harvest short rotation trees.

It is the objective to develop all forms of biomass supply in coordination with the creation of an increasing demand by investing in installations using biomass for energy.

HEAT

In Vojvodina as in many countries of Central and Eastern Europe more than 50% of final energy used is as heat. At present a big share of this heat demand is covered by fossil fuels. Different forms of biomass are used for delivering heat such as fire wood, wood chips, wood pellets, agricultural by products and biogas.

Biomass to heat can serve all forms of heat consumers: individual houses, larger family housing, public buildings, district heating grids, the production sector and the industry.

There are also different legal and organizational structures possible such as single company solutions, community solutions, or heat contracting by private companies.

It is the objective of the Action Plan to put very strong emphasis in developing all forms of biomass to heat.

ELECTRICITY

Electricity is a high quality energy form that can be produced by different renewable technologies, not only biomass, but also wind, photovoltaics and hydro. These technologies deliver electricity partly at lower costs than biomass. On the other hand biomass delivers electricity on a stable, reliable basis at any time of the year.

Therefore the option of biomass to electricity shall be developed, especially biogas to electricity but within defined constraints in terms of efficiency, production cost and acceptable financial burdens to society.

TRANSPORT FUEL

Biofuels for transport is the only renewable alternative for long distance transport, for trucks and planes. First generation (1G) biofuels, such as ethanol and biodiesel, are well developed; the crops cultivated for the production of the feedstock not only deliver biofuels but also valuable protein feed. Second generation biofuels (2G) are at the beginning of the commercial development in some parts of the world. Also biogas upgraded to bio-methane, that has the same properties as natural gas, can be used as transport fuel in vehicles. In Stockholm for example public buses are running on biogas.

It is the objective of this action plan to develop biofuels within the targets defined by the European Union with the priority on 1G fuels and biogas as biomethane and 2G fuels as part of research programs. In addition specific activities to encourage the use of biofuels in agriculture – biodiesel – might be developed.

8.3 PRINCIPLES

In pursuing these targets a set of guidelines shall be taken into account:

<u>Principle: Regional use</u>

If biomass is used in the region where it grows the logistic cost can be minimized and the consumer's expenditures for energy can be kept in the region thus creating regional economic growth. Therefore local and regional production and utilization of biomass should be given a first priority. This principle finds its limitation in areas where the production of biomass is bigger than the demand for bio-energy. Under these circumstances the national or international trade of biomass makes sense.

<u>Principle: efficient conversion of biomass to bioenergy</u>

Although biomass is renewable its availability is not unlimited. Therefore as much as possible of the primary energy available in biomass should be converted to final energy that is used as heat, electricity or fuel. The efficiency in the conversion of biomass to bioenergy should reach 65% or more. Electricity only plants using biomass are therefore not part of this action plan.

<u>Principle: optimal use of public money</u>

The rapid promotion of biomass to energy requires public support. The public funds should be allocated in such a way, that per unit of public money the following criteria are considered:

The contribution to the final energy supply,

The creation of new jobs in the region.

Those biomass to energy chains should be prioritized that deliver over the time the best performance measured on these criteria.

<u>Principle: Sustainable production of biomass</u>

The supply of biomass has to follow the rules of sustainability. No more biomass for energy must be harvested each year than is produced and simultaneously the fertility of the soil, the water supply and the biodiversity have to be safeguarded.

<u>Principle: Coordination with the research community</u>

The accelerated development of the biomass to energy chains will raise different questions that are closely related to the agricultural and forest conditions of Vojvodina. A close cooperation with the research community should be realized to solve new problems on the basis of a scientific approach.

Principle: Stability of support measures

As the experience in many countries shows, a stop and go policy in the support measures has negative consequences for the development of renewables; it undermines the confidence of investors in the policy. Therefore support measures shall be well considered and as soon as they put in operation they should remain stable for a given period of time.

Principle: Integration with other renewable energy sources

Biomass is an important renewable energy source but also other renewables such as wind, photovoltaics, and solar heat, hydro and geothermal have to play their role. Biomass is stored solar energy and therefore biomass can supplement other renewables. Biomass is particularly well suited to supply energy during winter time when the demand is high and other renewables like hydro, solar heat and photovoltaics have a rather low performance.

Biogas plant of company Mirotin Energo d.o.o. in Vrbas. Photo: Hermann Wieser

Baling of corn straw after swathe. Photo: Hermann Wieser

9. THE MAIN ELEMENTS OF THE BIOMASS ACTION PLAN FOR VOJVODINA

9.1 SUPPLY AND CREATION OF MARKETS

All installations converting biomass to final energy need a reliable supply of biomass – this is valid for small biomass boilers, industrial users of biomass, biogas plants as well as Toplanas. The biomass can be sourced from different origins:

- Straw from cereal, corn, soybeans in different form: pellets, briquettes, bales
- Corncobs from maize
- Energy crops for transport fuels – maize, canola etc.
- Wood, wood residues, fire wood, wood chips or pellets
- Biomass from short rotation forests
- Demolition wood
- Manure
- Organic waste from municipalities, farms, the food industry.

As long as there are no consumers of biomass there is also no market. At the beginning the operator of bigger biomass plants have to organize their supply by themselves, in a second phase these pioneer plants can become the nucleus of biomass market places. Such biomass market places should offer storage facilities for wood, fire wood, wood chips, wood- and agro pellets, straw bales and make it easier for consumers to buy the biomass they need. At the beginning it is a big help if the government support these storage facilities yet they should be organized on a private commercial basis.

Big biomass installations like district heating plants switching to biomass have to pay specific attention to a reliable and cost competitive supply of biomass. The harvest of the crop, be it cereal, corn or sunflower, fast growing trees, the harvest of the biomass for energy – be it bales of straw from cereal, from corn, be it corncobs, be it sunflower shells or trees – the transport, the storage, and the equipment to feed the biomass into the boiler have to be planned and realized as one supply chain to minimize cost. The logistics to bring the biomass from the field to the boiler in an efficient and cheap way is more challenging than just letting the gas flow into the boiler.

RECOMMENDATION 1:

- Set up a working group comprising farmers, experts for agricultural mechanization, researchers from the universities, experts from the Toplanas and companies producing boilers to organize the supply for the first bigger installations.
- Try to start demonstration projects based on long term contracts between the producer and the user of the biomass to secure supply for different supply chains like straw bales, corncobs, wood chips from short rotation forests and try to develop all supply sources with a big potential.
- Adapt the legislation in such a way, that a) the state owned forests offer 10 years contracts for the supply of biomass installations with wood, wood residues or wood chips and b) up to 100.000 ha of land unused for agriculture can be rented for at least 25 years to plant and manage short rotation forests as basis for the supply of biomass installations.
- Help to create a market by supporting the installation of biomass plants and thus creating buyers of biomass and
- to support with government grants the construction of storage facilities in privately operated biomass market places.

9.2 HEAT

The heat sector plays an important role in the energy system of Vojvodina.

The contribution of biomass to heat should be strongly increased by using different concepts and measures. In a first phase the substitution of fossil heating systems by biomass shall be pursued, in a second phase also the replacement of existing old biomass installations by new biomass heating systems shall be aimed at to improve the air quality.

The actions to support biomass to heat should address all types of heat consumers. Table 17 gives an overview about these different types of heat consumers in a society.

TABLE 17: OVERVIEW ABOUT HEAT CONSUMERS AND HEATING SYSTEMS BASED ON BIOMASS

Nr	Type of heat consumer	Biomass technology, typical size in kW	Biomass feedstock	Organizational structure
1	Single house	Biomass stove, biomass boiler 10 – 30 kW	Fire wood, corn cobs Pellets from wood or straw	Private solution
2	Large family dwellings	Pellet boilers, wood chip boilers, 50 -150 kW	Wood chips, pellets or briquettes, from wood or straw	Private solution Heat contracting
3	Public buildings – schools, offices buildings, hospitals	100 – 500 kW	Wood chips, pellets or briquettes from wood or straw	Public solutions, heat contracting Heat companies
4	Farms, production companies, service sector	50 – 1.000 kW	Wood chips, pellets or briquettes from wood or straw, straw bales, heat from biogas	Private solutions
5	Industry	1.000 – 30.000 kW	Straw bales, wood chips, wood residues, heat from biogas	Company solutions
6	District heating plants	1.000 – 80.000 kW	Straw bales, wood chips, wood residues, other residuals	Municipalities, private companies, they cover all types of consumers

Source: WBA

The change of the heating systems in a country from fossil to renewable energy takes a long time, requires a lot of investment and needs various activities. These activities comprise general measures and specific actions directed toward the different types of consumers.

These general activities are mentioned first:

• Awareness building, information

The education of the public, of the consumers, about the advantages of a renewable heat supply is needed. Information leaflets have to be prepared about the advantages of renewable heat such as: domestic supply, creation of new jobs in the region, reducing the cost of heating, avoidance of CO_2 emissions in connection with the growing problem of climate change, security of supply and also information about the technical options. Normally such informative meetings should be organized in collaboration with the municipality.

• Training of installers and technicians

Experience shows that installers and plumbers have a big influence on the decision of consumers concerning the heat system. It is important to win the plumbers supporter for renewable heat and to train them how to install biomass heating systems and how to warrant a reliable heat supply.

• State testing programs for the quality of the boilers concerning emissions, efficiency, functionality

In this connection it is important that the boilers that are being sold comply with the state rules on efficient and clean combustion with low emissions of particulates, high efficiency and a good reliability. It is important that the clients using biomass heating systems are content and recommend these systems to their friends and neighbors.

• Programs to secure the supply of biomass from agriculture and forestry

A close cooperation between the energy department and the forest and agricultural administration including the farmers and forest owners is necessary to build up a reliable and cost competitive supply of biomass. This supply issue concerns straw pellets and briquettes, straw bales from cereals and corn, sun flower shells, fire wood, wood chips, wood residuals, saw dust, bark etc.

• Extension units and consultant units

The setup of a public consultant unit that advices farmers and small entrepreneurs and helps them to develop projects usually in the size between 100 and 300 kW for consumers described in table 17 as types 2, 3, 4. Such a unit is essential to develop the concept of heat contracting on a private commercial basis that can be offered for consumer type 2 and 3 as described in table 17.

These more general activities have to be supplemented by specific actions for the different consumer groups.

• Financial grants for consumers type 1-4 as defined in table 17

The switch to a new heating system based on biomass is rather expensive in terms of needed investment although the feed stock cost are lower than using fossil fuels. This investment cost can be a burden for the change of the system.

Hence it is recommended to introduce a program that offers investment grants to help consumers that intend to install biomass heating system. This program should be offered to all consumers' type 1 -4: single houses, houses with several apartments, public buildings, farms.

Such a support program should follow certain rules to be successful such as:

The program should be well conceived and last for several years. It should be stable and not changed during the period. The program has to be adapted to the financial means available. The size of the support, 50% of the investment cost, has to be in line with the available means. A set of requirements concerning the performance of the device, the efficiency shall be defined as prerequisite to get the support of the government.

• Heat contracting or neighbor heating

As it is called in some countries this means that a small private company constructs and operates a biomass heating system for public buildings or several private houses in a size between 70 – 250 kW with only a very short distribution grid. In many cases the company rents the basement as location for the boiler, adapts the place to store the feedstock and operates the system selling the heat to the client. These projects have normally a good economic performance. The proposed support unit should help to set up such programs, they also should get a government grant for the construction in the size of 40 -50%.

• Specific programs for the industry:

Industrial production companies use heat frequently throughout the year. Hence they offer the opportunity to install efficient combined heat and power solutions based on biomass. Whereas heating plants only reach around 2500 – 3500 full operation hours per year the industry can reach 8000 hours and more. This reduces strongly the capital cost per MWh generated heat or electricity. For companies using natural gas it should be profitable to switch to a biomass heating or CHP solutions. Feasibility studies should analyze these possibilities more in detail. Especially the food related industry such as sugar mills, dairies, and slaughter houses offer interesting investment possibilities.

It is proposed that the government or other public funds co-finance feasibility studies for projects.

• District heating

Toplanas are an important sector of the energy system in Vojvodina as was shown in chapter 5. The conversion of district plants from natural gas to biomass poses different questions such as:

<u>1. heating plant only or combined heat and power plants</u>

According to the principles of WBA to use biomass in an efficient way a cogeneration plant should only be considered if the heat coming along with the electricity production can be used all over the year. If this is not the case a CHP solution should be excluded, because of the losses of heat and the low efficiency. Other considerations in this context are explained in the chapter 9.3 on electricity.

2. The future price of the heat for the consumers – government support

The price the consumers pay for the heat depends on different parameters such as:

A. The cost of the feedstock

B. The cost of combustion – the conversion of primary energy to heat

C. The cost of the distribution of the heat including the losses in the grid

D. General management costs including a profit margin.

There is no difference in the costs c) and d) between Toplanas using natural gas or biomass. Differences are in the cost element a) feedstock and b) cost of combustion. As was explained in chapter 6 the feedstock cost of biomass is lower than of natural gas, and the cost of combustion is higher. The cost of combustion can be reduced by government grants to the investment.

A goal of this biomass action plan should be to decrease the cost of heating for the clients of Toplanas.

RECOMMENDATION 2:

• It is recommended that in a first step a small number of DH plants should switch from natural gas to biomass heating systems alone and that the government provides financial support to lower the CAPEX (Capital Expenditure) of biomass boilers to a level similar to gas fired boilers. This government support should be in the size of 50% of the total CAPEX for the first demonstration projects for the biomass boiler including the systems for handling of the biomass into the boiler.

• It also recommended to encourage the industry, especially the food industry, to switch from fossil fuels to biomass.

• It is also recommended to encourage smaller heat consumers as defined in table 17 under category 1-4 by offering governments grants for the investment of modern biomass boilers.

9.3 ELECTRICITY

Electricity plays a crucial role in each society. The technologies for the generation of electricity are changing over time. At the beginning, decades ago, electricity was mainly produced in hydropower stations. Today the generation of electricity using fossil fuels is dominant worldwide.

The CO_2 emissions are one of the problems of fossil driven electricity generation: one kWh electricity produced with coal causes emissions in the size of 1kg CO_2, using oil 0,65 kg CO_2 and using gas 0,45 kg CO_2. Another problem is the low overall efficiency of many power plants.

Since 2000 a new global development is emerging: the dynamic growth of renewable electricity, especially wind, photovoltaics, concentrated solar power, also hydropower in regions with available potential. The big advantage of these technologies: they don't have feedstock costs, only CAPEX. As soon as the installations are put in operation they produce electricity with minimum marginal cost. Worldwide, also generation of electricity from biomass is growing. Biomass has the big advantage in delivering electricity with high reliability independent on the blowing of the wind or the shining of the sun.

A modern concept for the deployment of electricity from biomass and biogas has to bear in mind these new trends in the generation of renewable electricity.

The technologies to produce electricity from solid biomass or biogas are well established. The cost of production are higher than the market price and sometimes higher than the cost of electricity from wind and photovoltaics. The concept of Feed in Tariffs (FiTs) proved to be successful to overcome this gap.

In converting biomass/biogas to electricity a share of 15 – 37% of the primary energy is transformed to electricity depending upon the technology, the rest is heat.

If the FITs are high enough it is profitable for the companies to produce only electricity and just waste the heat. Obviously somebody has to pay for these losses and for the gap between the FITs and the market price. This is normally the consumer of electricity. Hence, the concept of FITs has a microeconomic and a macroeconomic dimension. High FITs without restrictions are incentives for companies producing electricity but they might cause considerable losses of energy and problems for the society if the burden to pay for the FiT increases. This can be observed in many European countries and should be considered in Vojvodina. The background is explained in detail in chapter 7.

Based on the arguments above the following recommendations are presented:

RECOMMENDATION 3:
• Solid Biomass to electricity shall be developed but only in projects where a big share of the heat can be used all over the year.
• FiTs for solid biomass projects shall only be granted, if the efficiency in the conversion biomass to final energy (heat and electricity) is above 65%. The national rules should be adapted in this sense.
For biogas see chapter on biogas!

RECOMMENDATION 4:
• The burden for the consumer to finance the FITs shall be limited.
• The extent of limitation is a political decision. The basis for such a decision is an analysis of the relation between the production of renewable electricity and the additional cost for the consumers.

These restrictions might be surprising in a biomass action plan. But experience shows that in the longer run biomass is only well accepted if it lowers the cost to the consumers or if it delivers specific advantages to the system such as the reliability of the generation of electricity that justifies higher cost.

Wind, photovoltaics and to a lesser extent hydropower will play the dominating role in the future deployment of renewable electricity on the international stage. As an example the concept for the development of renewable electricity in Austria is proposed by the Austrian Association for Renewable Energy, see table 18.

TABLE 18: ADDITIONAL GENERATION OF ELECTRICITY FROM RENEWABLES IN AUSTRIA AS PROPOSED BY THE AUSTRIAN ASSOCIATION FOR RENEWABLE ENERGY

	Additional generation 2012 – 2020, GWh	Total generation proposed for 2020, GWh
Photovoltaic	+6.400	6.800
Hydro	+6.000	48.000
Wind	+5.500	8.000
Biomass/Biogas	+2.100	6.500
Geothermal	+1.000	1.000
Fossil generation	- 20.000	0
Total	**+1.000**	**70.300**

Source: 2013 stromgipfel. 2020 100% Sauberer Strom für Alle – eine reale Vision. Wien.
2013 www.erneuerbare-energie.at;www.pvaustria.a;.www.igwindkraft.at;www.biomasseverband.at

As can be seen, 85% of the additional generation of electricity is supposed to come from photovoltaics, Hydro and Wind. According to this concept 100% of the generation shall be renewable in 2020. This might be possible in Austria due to the already high share of electricity from hydro! Yet it has to be added that the targets in the official NREAP are much smaller than these proposals coming from the Austrian Association for renewable energies!

9.4 BIOFUELS FOR TRANSPORT

The European position on transport fuels is controversial. In 2009 a mandatory target of 10% biofuels in transport for 2020 was defined. Later the commission came up with a reduced target of 5%; but this was not endorsed by the Parliament and the Council. In spring 2014 a new target of 7% was proposed. In June 2014 the original target of 10% is still legitimate.

Ethanol and biodiesel are the leading biofuels worldwide. They are called 1G fuels (first generation fuels). Especially in the USA and in Brazil many efforts are made to produce ethanol form cellulose, so called 2G fuels (second generation fuels). But also biogas, upgraded to bio-methane produced from MSW (municipal solid waste) is used as renewable transport fuel.

In the discussion on food or fuel it is often ignored that 1G biofuels are a kind of byproduct of the protein production, because all crops used for 1G fuels in Europe also deliver protein. In terms of quantity the protein production and the fuel production are of equal importance. If the 1G fuel production is reduced and land is set aside also the protein production for food and feed is reduced. WBA is of the opinion that 1G fuels will continue to grow in the future.

Ethanol and biodiesel are well traded products. They are a part of the transport fuel market. In all European countries the programs for biofuels are national programs supported by the national legislation. Mandatory blending rules and tax exemptions are the instruments to promote the production and consumption of biofuels. A regional program concerning liquid biofuels for transport can only be part of the national biofuel policy. The situation is different for bio-methane. Several regions and cities in Europe demonstrate that local solutions for bio-methane as transport fuel are possible.

In a first step the production of 1PJ of biofuels is recommended; this corresponds to about 33 million liter, partly ethanol and partly biodiesel. Corn, cereals, canola and soybeans can be used. The needed area for this quantity is in the size of 16.000 ha land. A blending share of 10% would require a production of 2.6 PJ biofuels.

RECOMMENDATION 5:
It is recommended that the biofuel policy should be developed on national level. In accordance with the national targets the production of biofuels should be developed in those regions where the crops for the biofuel production are cultivated.

RECOMMENDATION 6:
Biofuels will become more important in the future – of both 1G and 2G. In a first step the 10% target for biofuels should be realized and at the same time the global development in biofuel production closely observed. In addition, specific activities might be set to increase the use of biodiesel in agriculture.

RECOMMENDATION 6A:
Biogas upgraded to bio-methane as transport fuel for public transportation should be developed as a pilot project in one or two of the biggest cities of Vojvodina. The feedstock could be MSW. Such a program requires the full support of the city council. A feasibility study using the experience of other cities would be the first step to realize such a program.

9.5 SPECIFIC ISSUES BIOGAS, PELLETS, SHORT ROTATION COPPICES

BIOGAS

“Biogas” is produced by anaerobic fermentation of different forms of organic matter. It is composed mainly of methane (CH_4) and CO_2. One cubic meter biogas contains about 65% CH_4 and has an energy content of 5-6kWh. The feedstock for biogas comes from agriculture or the waste economy. Typical feedstock for biogas production:

Agriculture: Manure, residues of crop production (straw), energy crops like corn, grass,

Waste economy: Landfills, sewage sludge, the organic fraction of the waste from households and the food industry. Biogas is typically a decentralized energy option involving many rather small-scale entrepreneurs.

Different arguments can be brought forward in favor of biogas:

Biogas can be produced from feedstock without economic value like manure, waste and therefore broadens the offer of raw material for renewable energy generation.

In addition, under anaerobic conditions organic material like manure and landfills produce and release CH_4, a greenhouse gas much more dangerous than CO_2. By using this material in biogas plants the greenhouse gas emissions are reduced in a double way: no emissions to atmosphere of CH_4 and reduced emissions of CO_2 by replacing fossil fuels with biogas. This double advantage justifies the rather high cost of biogas production that is a consequence of the high CAPEX.

A biogas plant on a farm has different elements such as the liquid manure store, storage space for energy crops, the reception area, the digester, the gas storage and the combined heat and power (CHP) unit with grid connection for the electricity and a connection to the heat user.

A general problem of the biogas sector is the high costs of investment. The costs are the higher the lower the energy content per ton of feedstock, because using a low energy feed stock requires bigger storage capacities of fermenters.

One ton manure has an energy content of around 130 kWh, one ton corn silage more than 1.000 kWh, one ton glycerin – a byproduct of the biodiesel production - more than 6.000 kWh. This explains why corn is the main feedstock for many biogas plants in Central Europe and why the combination of biogas plants with biodiesel plants makes sense.

4.7 million m³ biogas are needed to supply a gas engine generator of 1 MWel output for one year producing 8 GWh electricity per year.

This corresponds to an input material coming from as example:

- 9 500 milking cows or
- 60 000 pigs or
- 450 ha maize.

The global potential of biogas is huge; estimations show that biogas could cover around 5% of the global primary energy supply or one quarter of the present consumption of natural gas.

Currently the biogas production is at the beginning with the exception of a few countries like Germany; globally only a tiny part of the potential is used. Reasons for the slow deployment of biogas are: lack of information about the possibilities of biogas, lack of trained labor force, high capital cost for the set up of commercial plants, insufficient and unreliable government support policies and the competition of natural gas being a cheap alternative in some parts of the world.

BIOGAS IN EUROPE

In 2010 the biogas production reached 455 PJ in Europe. The biggest part of it was used for electricity generation – around 30 000 GWh (108 PJ) electricity were generated- and 11 200 GWh heat (40 PJ). The installed capacity for the generation of electricity is in the size of 4 000 MW. More than 10 000 Biogas plants are operating, with more than 7000 on agricultural farms. Leading in biogas production is Germany with a share of more than 50% of the total production in Europe. The biogas potential of EU 27 is estimated with 2 800PJ, with about 75 % coming from agriculture and 25% from the waste sector, and about 20% of this potential is used currently. 177 biogas plants in 2012 were producing biomethane and injecting about 70.000Nm³/h into the gas grid.

VOJVODINA

Also Vojvodina has a remarkable potential for the production of biogas. It is estimated that 1.7 PJ based could be produced using manure, 0.8 PJ based on MSW, and in addition residues from agriculture like straw, biomass from landscape cleaning and waste from the food industry, the sewage sector can added as well as biomass from energy crops. This adds up to an estimated total potential of 6- 8 PJ.

At present 4 installations are operating with an installed electrical capacity of 4 MW producing approximately 18 Mio. M³ biogas (ca 0.4PJ) corresponding to 30 GWh electricity if operating all over the year.

In developing the biogas sector several aspects should be considered:

Cost of feedstock: in the case of MSW (municipal solid waste), food industry waste, landfills and sewage sludge or manure there are no costs or even negative feedstock costs.

In the case of material from landscape cleaning, straw or other byproducts collecting and sometimes processing cost may occur.

In the case of energy crops like maize opportunity cost occur for the alternative use of these crops and these costs depend mainly on the price level of the agricultural commodities.

Cost of investment and FITs: As mentioned the cost of investment is lowest for high energy feedstock like fats residues, oils or maize. They are highest for manure. If FITs are granted only, if a minimum quantity of manure is used, they have to be higher to offset the high investment costs. In general it is more reasonable to have tariffs that really cover the costs, even if the number or installations remains small. Experience shows if the FITs are too low biogas installations might end up in bankruptcy.

THE USE OF BIOGAS:

1. Biogas can be used at the place of production to generate electricity and heat.
2. Biogas can be upgraded, compressed and then injected into the gas grid and then used like

natural gas for heat, electricity, the industry or as transport fuel.

3. Biogas can be transported in a biogas pipeline as biogas to a gas engine near a heat consumer (industry, district heating grid) and used in a gas engine to generate electricity and heat.

4. In many countries including India and China many very small biogas installation are in use to produce biogas for cooking.

THE DEVELOPMENT OF BIOGAS

Biogas from urban waste streams: Municipal Solid Waste (MSW), waste of the food industry:

A first priority should be the use of waste streams because of the low or negative feedstock cost. In workshops with municipalities, organized by a government agency, project ideas should be developed and then feasibility studies performed. Feed in tariffs can be the main support instrument for these biogas plants.

Also the use of the biogas should be diversified: One way is the generation of electricity and the use of the heat for district heating or for industry.

Another option would be upgrading and compressing the biogas to use it as transport fuel or inject it into the gas grid. For this kind of demonstration projects a specific support system has to be installed that covers the higher cost of the upgraded biogas as compared to natural gas. One way would be to set a feed in price for bio-methane injected into the gas grid. Another way could be to sell the blend of biogas and natural gas as partly green gas to consumers that are willing to pay a higher price for the share of renewable biogas. As an example this concept is implemented in Vorarlberg, Austria where a blend “gas 20” – natural gas with 20% biogas –is sold to consumers at a higher price.

Biogas on farms – biogas from agriculture: Agriculture offers different feedstock for biomass. The cheapest feedstock is manure; only on big animal farms is enough manures available to build a cost- effective biogas plant. Yet, biogas plants using only manure tend to be an exception. The rule is a combination of manure and other feedstock like maize, glycerin, other organic waste.

In some cases it might be necessary to build a biogas pipeline to a village and operate the gas engine in the village to deliver the heat into the heating grid or to another heat consumer. The government should grant some financial support to the construction of such a biogas pipeline.

Also biogas installations on farms offer the opportunity to upgrade the biogas and deliver it into the gas grid.

Some rules of thumb can be calculated: A biogas plant supplying a gas engine with 1 MW el delivers 8 GWh electricity and 8 GWh heat per year. If the feedstock comes as 1/3 from manure and 2/3 from energy crops such a plant needs

Manure from 3.200 cows or 20.000 pigs and 290 ha maize in average. The annual support for the FITs is in the size of 800.000 Euro.

RECOMMENDATION BIOGAS 7:

- Biogas to electricity shall be developed but only in projects where a big share of the heat can be used all over the year.
- FITs for biogas plants shall only be granted if more than 50% of the energy, sold as electricity expressed in GWh is also sold as heat on the basis of a heat contract that guarantees a heat price in the size of 30 Euro/MWh.
- In addition FITs for biogas shall only be granted if about 30% of the energy in the feedstock comes from manure or waste of the food processing industry, slaughter houses or biofuel industry.
- Also legal rules shall be prepared that allow the injection of upgraded biogas (biomethane) into the gas grid and use it at places where the heat can be sold. For such projects FITs shall be granted as well as financial support for the upgrading or the building of biogas pipelines to places were the heat and electricity can be used.

PELLETS

Pellets are cylindrical particles produced by compressing wood or agricultural biomass. They are homogeneous, easy to transport and trade and have a relatively high energy content (4.8 kWh/kg).

Within international trading in biomass especially the wood pellet market has experienced a large growth worldwide in recent years. The global production was 18,5 million tons in 2012. (Source: WBA Global bioenergy Statistics 2014, Stockholm, 2014). The market growth in the first decade of this century was 20% per year.

In the European Union the production and consumption of pellets is booming. In 2012 more than 10 million tons of pellets were consumed. An average market growth of 5 -10% per year in the coming years is expected. Nearly 20% of the pellets were imported from abroad. The raw material for pellets consists of saw dust, and other byproducts of wood industry and, to a small extent, round wood.

Europe is a leading producer and consumer of pellets. The pellets are used in three different markets:

- Pellets in bags for pellet stoves.
- Pellets loose, transported in trucks for pellet boilers in the residential area and in larger quantities for the small industry and the service sector.
- Pellets for power plants using pellets instead of coal or for co firing to comply with CO2 reduction targets.

In Europe around 50% of the pellets sold on the market go to power plants and 50% to residential or industrial users. In central Europe residential consumers paid a price between 225 and 270 Euro per ton during the year 2013, the utilities buying several 100.000 tons of pellets pay around 130 – 150 Euro/ton. Strict quality standards exist. The EN plus certification of pellets for small boilers is a kind of prerequisite to enter the market.

There is only little experience producing and using agricultural pellets. Agricultural biomass and agricultural pellets have a higher mineral content than wood pellets, the combustion is more complicated, the ash content higher. The pellet boilers in use in Europe are not designed to use agropellets; therefore there is barely a market for agropellets in central and Western Europe.

VOJVODINA

The pellets market in Vojvodina is at the beginning. One rather big pellet plants exists producing pellets from maize straw. Wood pellets are barely in use.

Vojvodina could supply several different raw materials for pellet production: The forest industry offers a rather small potential for wood pellets, and the agricultural sector offers a much bigger potential for agro pellets. Due to their specific properties, agropellets are better suited for bigger boilers above 100 kW but they can also be used in smaller boilers if these are built for this kind of feedstock.

The development of a market for agropellets in Vojvodina and outside is a prerequisite for the development of the agropellets industry in Vojvodina. The key action for market development is the availability and the installation of boilers tested and approved for the combustion of agro pellets. Such boilers can be imported but in the longer run boiler production in the region should be supported.

Small consumers in family houses are not seen as the main market in the future, rather bigger boilers between 50 and 500kW in heat contracting projects, hotels or other bigger heat consumers. District heat plants and big industrial heat users will rather take straw bales or wood chips because they are cheaper than pellets.

Also the export of pellets might be an interesting business field.

RECOMMENDATION PELLETS 8:
Increased Information and training about the advantages of pellet heating systems, financial support to install pellets boilers, incentives to increase the production of pellets and initiatives to develop a pellet boiler industry in Vojvodina producing boilers designed and approved by state authorities for the use of agro-pellets.

SHORT ROTATION COPPICES (SRC)

Short rotation coppice crops are trees like poplar or willows grown as energy crops. They are planted in high density and harvested every two to 8 years and are used mainly for energy generation but also for paper and pulp production.

It can be estimated that average harvestable yields of poplars from SRC in temperate regions of Central Europe range between 10 and 12 dry ton per ha and year.

In introducing SRC in a region it has to be distinguished between the research phase and the commercial phase. The research phase concerns the breeding, the correct choice of species and locations for the establishment of energy plantations, experiments on many parameters such as the preparation of the soil, planting density, fertilizer use, weed control, the harvest technology and the end use.

The commercial phase should rely on the results of the research work. A commercial project has to take into account the whole chain such as: site and species selection, legal contracts for 25 – 30 years concerning the land, planting, weed control, fertilizer application etc. The harvesting technology, transport, storage and use as feedstock in a biomass boiler have to be harmonized and planned as one comprehensive supply chain. Commercial planting of SRC should start after a contract for several years with the end user exists, in which prices, moisture content, harvesting time are defined.

The cost of primary energy in SRC is generally higher than using by-products of agriculture. But the feedstock of SRC will be needed in the future as soon as the deployment of biomass heating and cogeneration installations is advancing rapidly. Therefore the scientific and experimental work on SRC should be pushed forward now as basis for commercial projects in a few years. In the longer run 50 000 ha or more SRC might be needed if a big share of fossil fuels should be replaced by biomass.

RECOMMENDATION 9:
Intensify the research work on SRC as the basis for the future establishment of commercial plantations in connection with heating or cogeneration plants.

Preparing of corn swathe before baling in Region of Sombor. Photo: Hermann Wieser

10. STRAW AS FEEDSTOCK: ECONOMIC AND LOGISTICAL CONSIDERATIONS

Straw from cereals and canola as well as cornstalk from maize are abundant resources in Vojvodina. Sometimes the complexities of this feedstock are overlooked. This chapter presents some details to avoid mistakes. Concerning straw as feedstock the experience in Europe shows at least three problem areas:

- The combustion of straw
- The reliability of the supply of the feedstock at contracted prices
- The influence of unforeseen events: drought, floods

The combustion of straw is more difficult than the combustion of wood because straw has a higher content of minerals and a lower melting point of ash than wood. The combustion chamber of a straw boiler has to be designed in a specific way to avoid problems of corrosion or lagging that can be caused by these minerals. There are a few companies around that are able to manage these problems. In Europe, Denmark has the best experience in the combustion of straw. At this point it only should be mentioned that the selection of the boiler for the combustion of straw has to be done carefully to avoid problems later.

Drought and floods can strongly reduce the supply of straw. Companies using straw have to consider these risks and prepare alternative solutions like additional storage or alternative supply chains.

10.1 STRAW LOGISTICS

As long as there is no well-established biomass market the supply issue has to be tackled by the company using the straw. A few remarks help to illustrate the challenges:

BALING

Straw for heating plants is harvested in bales. Different types of balers are in use. They deliver:

- Small cubic bales with a weight of 20 – 40 kg
- Round bales with a weight around 260 - 330kg
- Big cubic bales with a weight around 450 – 550kg.

The weight depends upon the type of straw, the type of the baling machine and the moisture content.

LOADING – INTERMEDIATE STORAGE – UNLOADING

The storage of the straw can be made at intermediate storage places near the field where the straw was harvested or at the power plant. Bigger plants usually only keep bales for a few days or weeks at the plant, most of the straw is stored outside at intermediate places.

Therefore the following steps have to be performed: loading – transport to the intermediate storage – unloading. Depending on the size of the bales these steps can be made by hand, by tractors with loading equipment or by special machines constructed to handle big bales.

LOADING - TRANSPORT – UNLOADING - FEEDING INTO THE COMBUSTION CHAMBER

The next part of the logistic chain is the transport to the boiler house. This requires again different steps: loading – transport- unloading-feeding into the combustion chamber of the boiler.

The transport can be done by tractors with trailers or special trucks. Big power plants use cubic bales of about 500kg. Cubic bales allow better use of the space available on a truck. This is important because bigger plants might use the straw from a supply circle with a radius up to 100km around the plant. They use special trucks that transport up to18tons straw. Small plants might use all other types of bales and organize the transport accordingly.

Different technologies exist for the feeding of the bales into the combustion chamber. Small plants might use a transport band loaded manually every five to ten hours. In this case only small bales can be used. Bigger bales can be moved with machines to the transport band. Yet this technique is not adequate for big heating plants using 100.000 tons of straw per year or more. They need 20 tons of straw or more per hour. These plants are equipped with automatic unloading stations that can unload a truck with a crane within a few minutes. The bales are moved to an automatic feeding installation able to feed a 500kg bale per minute into the combustion chamber.

DIFFERENCE BETWEEN CEREALS AND CORN STALK

Finally it should be mentioned that there are differences in collecting straw from cereals and corn stalks.

Cereals: normally the combine leaves the straw in rows that can be picked immediately by the balers.

Corn stalks: the harvesting method is different. A considerable part of the straw does not go through the combine. Therefore a tractor that is fitted with a kind of chipper follows behind the combine to chip the stalks, then another tractor with a rake has to form rows so that a baler can pick up the stalks to create the bales. The disadvantages: two additional working steps, and some stones or parts of the soil might be in the rows of corn stalk and in the bales.

THE INTEGRATED HARMONIZED SUPPLY CHAIN

This description demonstrates that supplying straw for a heating plant is not just about buying straw somewhere. The type of the balers, the size of the bales, the loading equipment, the installation at the boiler house to move the bales into the combustion chamber, all have to be harmonized and fully integrated to achieve an efficient supply of the feedstock. Bigger heating plants will have to secure investments in a fully integrated supply chain from the field to the boiler house to get a reliable and cost competitive feedstock.

CONTRACTS

A strong and fair partnership should be created between the heating plant and the farmers supplying the straw. Contracts for 10 years are desirable as basis for this cooperation. These contracts have also to specify the price of the straw. Several components define the price of the straw:

- The value of the straw as it is spread on the field after the harvest with the combine
- The cost of the manipulation to the intermediate storing place
- The transport to the gate of the boiler house

The value of the straw can be derived from the opportunity costs of the minerals and the organic matter. Leaving the straw on the field means buying less minerals. If the straw is taken off the farmer expects to get paid for the minerals and the organic matter. At the end supply and demand define the price of the straw. It can be expected that in an economy with an annual inflation also the value of the straw increases.

Also the costs of the manipulation and transport of the straw will change with inflation. The distance between the field from which the straw is delivered and the location of the plant influences the cost. The transport cost for a distance of 10 km is much lower than 80 km! Therefore a ten year contract should take care of these cost elements. One way is an index adapting the price of the straw regularly in accordance with the developments of the cost elements. Such a fair contract is the basis for a reliable supply of the feedstock over a period of years. As a consequence the price of the heat cannot remain stable and will have to be adjusted from time to time.

The different elements of the price of the straw have to be negotiated between the partners – the farmers and the heating plant. Based on different experiences in Europe a price of 45 Euro/ton straw with an energy content of 3900 kWh (14GJ) at the gate of the heating plant is assumed in the following calculations.

10.2 THE ECONOMICS OF A HEATING PLANT

In the case of a combined heat and power plant (CHP) the plant receives revenues for the sale of the electricity and the heat. The price of the electricity ranges between 114 to 136 Euro/MWH according the FiT. The price for the heat is much lower, it is assumed in the following calculations with 37 EUR/MWh. The question arises: can a heating plant operate profitably if it is not generating electricity, but only heat? WBA performed several calculations for different plant sizes to answer this question. The underlying assumptions for these calculations are as follows:

TABLE 19: BASIC ASSUMPTIONS TO THE CALCULATIONS

Price of feedstock at the plant gate	EUR/ton	45.00
Energy content of the feed stock	MWh/ton	3.9
Selling price of the heat at the plant gate	EUR/MWh	37.00
Operation time	Hours/year	3.200
Combustion efficiency	%	90

The calculation were made for three sizes of heating plants:

- Case 1: 2.7 MW
- Case 2: 12 MW
- Case 3: 22 MW

In all 3 cases a government grant of 50% of the investment cost is assumed and an equity of 5%. The following table offers the details:

TABLE 20: ECONOMIC RESULTS

	Unit	Case 1: 2,7 MW	Case 2: 12 MW	Case 3: 22 MW
Investment,	EUR	1.450.000	3.300.000	5.900.000
Equity	EUR	72.500	165.000	295.000
Grant	EUR	725.000	1.650.000	2.850.000
Loan	EUR	652.500	1.485.000	2.655.000
Heat output	MWh	8.640	38.400	70.400
Feedstock needed	tons	2.512	11.163	20.465
ROI	In %	8,2	21,3	22,2
Payback time	In years	12,4	4,7	4,5

Source: Calculation AGROPOWER; WBA

A BRIEF DISCUSSION OF THESE RESULTS

All three cases deliver satisfying results for an investor, the payback time ranges from 4,5 to 12,4 years. The financial results are the better the bigger the plant, because the specific cost of investment per MW installed capacity are decreasing as the boilers get bigger.

On the other hand the assumed operation time of 3.200 hours per year can only be achieved if the total capacity of the plants is higher and the peak demand is covered by an additional boiler that might be powered with natural gas or pellets. A detailed feasibility study would deliver the details. Also a rather high boiler efficiency of 90% is assumed. If the efficiency is lower more feedstock is needed.

In addition the price of straw and the selling price of the heat were assumed stable over time in calculating the ROI and the payback time. The results might change a little if an increasing price of straw and heat is calculated.

Summarizing: under these assumptions a competitive heat price can be offered with attractive results for an investor. Without the government grants this would not be possible.

Foil covered wheat straw storage in Region of Indija. Photo: Hermann Wieser

Heat distribution system at Toplana (District Heating Company) in Subotica. Photo: Hermann Wieser

11. FINANCIAL PLANNING AS BASIS FOR THE ACHIEVEMENT OF CLEAR TARGETS

In many European countries, the rules for the support of renewable energy have been changed frequently over the past years. This represents a big problem for investors, consumers and subsequently for the entire economy. In many cases it is the consequence of poor financial planning and/or of not being aware of the long-term consequences of different support programs. To avoid these problems in Vojvodina a long-term financial planning is needed based on an analysis of the different support schemes. On the basis of such planning specific and detailed targets shall be set and implemented.

11.1 BACKGROUND INFORMATION FOR FINANCIAL PLANNING

The transformation of the energy system requires additional money. In many European countries this money is provided for the electricity sector by the implementation of FITs- for the transformation of the heating sector, however, in many countries less funds are available. As a consequence the rather expensive electricity generation gets pushed and the heating sector overlooked.

The following example sheds light on this situation: Based on the NREAP for Serbia it can be concluded that by 2020 in Vojvodina 30 MW CHP plants, 10MW biogas plants, 150 MW windmills, installations for PV and landfills are foreseen which should generate about 630 GWh electricity (2,2PJ). Around 46 million Euro will be needed annually for the period of 12 years to bridge the gap between the FITs and the market price for the electricity generated by these installations. The total amount needed to finance the FiTs over 12 years would be 12x46 = 552 million Euro.

With this amount of 552 million Euro the construction of 4000 MW heating plants could be co-financed with government grants in the size of 50% of the investment cost. These heating plants would deliver around 11 TWh (40PJ) heat per year. Therefore, public money dedicated to construct biomass heating plants has a much higher impact on the final energy outcome than when used for FiTs. This is the lesson of this example!

In chapter 5 the present use of biomass was reported of about 6 PJ in Vojvodina. Based on the analysis of the biomass potential as presented in chapter 5, WBA proposes for 2020 to use additional 7PJ biomass for primary energy thus reaching 13 PJ. Bearing in mind the importance of the heat demand and the competitiveness of biomass in this market it is proposed that this 7 additional PJ are used as follows: additional 5,3PJ for heat, 0,7 PJ for electricity generation and 1 PJ for biofuels.

The financial requirements of this program would be:

Heat: a total of 72 Mio Euro investment grants for 515 MW boiler capacity installed over 6 years 2015 -2020 (i.e. 12 million Euros per year)

Electricity: 90 GWh total electricity, annual support of the FiT about 9 Mio. Euro financed by the FiT system via a fee per kWh electricity defined by the federal government.

Biofuels for transport: 1PJ biofuels financed by tax exemptions and blending rules defined by the federal government

There are three options to finance the needed 12 Mio. Euro per year (72 Mio. Euro over 6 years) for the heat program:

1. The provincial budget allocates 12 million Euro per year for the program or
2. The government tries to get a part of the needed money from EU funds starting in 2016 and allocates only the residual in the budget.
3. The system of financing the FiT is adopted in such a way that the fee on the electricity consumption finances both, the transformation of the electricity supply as well as the heat system.

11.2 TARGETS FOR THE DEVELOPMENT OF BIOENERGY

Based on the explanation in the last chapter the following recommendations are presented:

RECOMMENDATION 10:
Set a target of additional 7PJ primary biomass for energy until 2022 with
Additional installed capacity of CHP and biogas: 8 MW
Additional new biomass boilers for heat 515 MW total capacity
Produced biofuels: 35 million litre/year
The decision about the financing of this program has to be made by the government.

Referring to the new goals defined in Brussels on a binding reduction of $C0_2$ emissions of 40% by 2030, and the UN targets on 36% renewables in the gross final energy consumption Vojvodina will need a coordinated policy to develop all renewables and bioenergy towards 2030. It is estimated that more than 50 PJ renewable energy as primary energy will be needed in Vojvodina until 2030 in combination with improved energy efficiency in order to reduce the $C0_2$ emissions accordingly and reach the UN target.

RECOMMENDATION 11:
It is recommended to develop a target for 2030 with 36 PJ contribution from biomass to the primary energy supply and to pursue a fast development of energies from wind and photovoltaics but also geothermal and hydropower.

Crop farm in Region of Kikinda. Photo: Hermann Wieser

12. SUPPORT MEASURES

At present Vojvodina has a well-operating energy system. As the data illustrates fossil fuels are the basis of this system. The share of renewables, including bioenergy is small. The increase of bioenergy means the reduction of fossil fuels. Such a transformation is a difficult, time consuming and complex process. It has to start in the minds of the people, the decision makers, the administration and then to be implemented in the form of concrete projects on the ground. Financial means are needed for this transformation, but also the institutional structure has to support this transformation.

12.1 FINANCIAL SUPPORT

The transformation of the energy system requires capital resources. This transformation includes not only the construction of a few big plants but of many small and medium sized installations too. The cost of the investments depends on the size, on the technology, and on the specific situation.

Loans, equity, foreign capital and government-grants are needed to finance these investments. In this context the following proposals are made:

- Toplanas. The legal conditions should allow that domestic and foreign private investors have the possibility to construct biomass heating plants and sell the heat to the Toplanas at a contracted price or to buy share of Toplanas and invest in the construction of biomass installations and the modernization of the system.
- Feasibility studies as prerequisite for the realization of projects should be financed or co- financed by national or foreign institutions.
- CHP plants shall be financed by equity and loans that can be repaid on the basis of FITs.
- Heating installations – boilers of all size - need a government grant as incentive to be more competitive with fossil fuel boilers. At the beginning the grants should account for 50% of the total costs occurred; later on this share should be reduced to 30-40%.The support should be financed according to the proposals in chapter 11.

12.2 THE CREATION OF A SUPPORT UNIT FOR BIOENERGY (AGENCY, ASSOCIATION FOR ADVICE, TRAINING, INFORMATION)

The construction, implementation and operation of renewable energy systems requires new skills, new knowledge, and new professional training in order to set up reliable well working systems. In addition renewable energy is basically a decentralized form of energy supply, which involves many stakeholders and producers like individuals, farmers, forest owners, municipalities, private investors – and many of these groups normally don't have a specific training or education in energy issues. Renewable energy involves many small and medium sized and a few big projects. International or national funding institutions like banks are mainly interested in large projects and overlook the many small opportunities for renewable energy. Therefore, it is the responsibility of the national or regional government to create a structure that supports and promotes local and regional entrepreneurs intending to implement renewable energy projects.

Another important aspect is the monitoring of the development, which involves the gathering of statistical data about new installed installations per year, the consumed biomass and the delivered final energy. A close cooperation of this statistical unit responsible for the data collection with the producing and trading companies that sell biomass equipment but also with the forest, agricultural, waste and energy sector is important, in order to document the annual progress of bioenergy.

Given the above in many European regions new institutions or associations were created. Some of them are serving as a kind of extension service helping private investors in order to successfully construct and operate biomass installations, organize the biomass supply or manage woody energy plantations. Yet, the working program differs region by region.

Typical activities for organization supporting bioenergy are: training programs about the basics of bioenergy and renewables:

- support and advice for individuals or small groups, that want to set up a biomass supply or renewable energy installation
- training of plumbers and chimney sweepers
- advice to municipalities and companies about questions related to renewable energy and energy efficiency
- general information about climate change, carbon emissions and the need for new carbon- neutral energy carriers
- organizing the exchange of ideas and experiences between the operators of small or medium-sized bioenergy installations
- permanent training and quality improvement
- developing projects
- awareness- raising by speeches at conferences and by the organization of meetings in communities (for instance with farmers).
- informing political decision makers about the needs of the bioenergy sector
- collecting data on bioenergy statistics

The creation of a specific support unit is very helpful in implementing a local biomass project. The realization of such a bioenergy project comprises several steps. This can be explained by describing the steps needed to realize a small 1000kW community heating project.

Step 1: the idea

Step 2: forming of a small project team

Step 3: collecting information such as a survey on the heating habits, the existing systems, the prices, the demand, the availability of biomass

Step 4: a pre-feasibility study, possible location, size of the projects, costs, financing

Step 5: information of the mayor, the community council, all possible stakeholders,

Step 6: forming of a legal entity, detailed feasibility study, business plan, finance plan, applying for a government grant

Step 7: information of the population, pre selling contracts for the heat,

Step 8: decision to realize the project, technical planning, call for orders,

Step 9: construction

Step 10: opening, delivering of the heat

The local entrepreneurs need the support of a regional service organization at least for steps 1 to 5 without the charging of a fee.

12.3 TESTING FACILITIES, EMISSIONS CONTROL

Newly installed biomass boilers must comply with all environmental rules on emission reduction and combustion efficiency as foreseen by the rules of the European Union. Financial support of the government should only be granted to these boilers that have been tested and received the certification. An agency or institute with the needed equipment should be in charge for this testing.

RECOMMENDATION 12:
The government of Vojvodina creates an agency or association with a small staff of experts to execute the above activities including monitoring and statistical reporting. In addition a technical unit has to be charged with the testing of new biomass equipment, especially boilers to secure the compliance with the European rules concerning particle emissions, efficiency, security issues.

13. PROPOSED PROJECTS

So far a series of recommendations has been presented to promote bioenergy in Vojvodina. In this chapter a few concrete proposals for projects are presented.

13.1 PILOT PROJECTS: BIOMASS FOR HEAT IN TOPLANAS

The use of biomass for heat in Toplanas should be a first priority. To get the development started three Toplanas of different size should be supported to install biomass boilers in this pilot phase.

Group 1: small Toplana:	installed biomass boiler between 1-3MW
Group 2: medium sized Toplana:	biomass boiler 5 – 10 MW
Group 3: bigger Toplana:	biomass boiler 20 – 30 MW

In these pilot projects 65 – 80% of the sold heat should be generated with biomass, the peak demand should be covered with natural gas. The biomass boiler should reach 3200 full load working hours per year. CHP solutions should be excluded in this demonstration phase with the exception of one project where the heat of the CHP plant can be used fully - winter and summer.

If the toplanas are selected according to this proposal, the following data can be expected.

TABLE 21: EXPECTED DATA OF THREE TOPLANAS SELECTED FOR THE DEMONSTRATION PHASE

	Heat sold now GWh	Proposed biomass boiler MW	Expected heat sold based on biomass, GWh	Straw needed Tons	Investment cost Euro [1)]
Small plant	9	2	6	1.800	
Medium sized	37	8	26	7.800	
Large plant	118	25	80	24.100	
Total	**164**	**35**	**112**	**33.700**	**9.600.000**

[1)] The investment cost for the project development, the boiler, the technical equipment, the building and machinery for straw logistics is assumed with 275.000 Euro/installed MW.

As table 21 shows, 112 GWh heat would be generated, 70% of the total heat sold now. The missing 30% should be generated as peak heat on the basis of natural gas or pellets. 33.700 tons of straw would be required, equivalent to the straw harvest from 11.200 ha cereals. The installed boiler capacity is assumed with 35 MW and the total cost of investment with 9,6 Mio. Euro. This investment should be financed as follows: 50% by equity and a loan and the other 50% by a government grant. The budget requirement to finance the grant would be in the size of 4,8 Mio. Euro.

The Toplanas selected for this demonstration phase should fulfil different criteria such as:

- At present natural gas as energy source
- A well-functioning distribution grid,
- Support of the project by the council of the municipality
- A comprehensive description of the project including the details of the existing and the planned heat supply, the planned location of the biomass plant, a first estimation of the investment cost, a description of the planned biomass supply including cost estimations.

On the basis of these criteria a public call should be published. In the call a grant of 50% for the investment into a biomass heating system (boiler, building, straw logistic) is offered.

Existing Toplanas but also private companies should get the chance to submit applications for the construction of a biomass heating system. Private companies can apply, if they have a contract of cooperation with one Toplana that fulfils the requirements.

In the application it also has to be explained, whether the straw heating plant shall be built at a new location at the outskirts of the city or within the existing heating plant. The straw supply for a heating plant of this size of 25 MW requires about 10 truckloads, each of 15 tons per working day. In the case of a CHP plant the requirement is much bigger.

After a review of the applications, the government selects three Toplanas for this demonstration phase.

As next step of this demonstration initiative the selected investor (Toplana or private company) has to deve-

Corn straw bale with field storage in the background. Photo: Hermann Wieser

lop a detailed feasibility study and a project development concept including a detailed technical concept, a detailed supply concept, contracts with the suppliers for several years, definition of the supply logistic, a binding declaration about the heating price at the gate of the plant and for the final consumers in cooperation or consultation with the operator of the distribution grid.

This development concept will be refunded as part of the project.

After this concept is presented to and approved by the government, the government and the private investor or the Toplana make a contract concerning the realisation of the project, the projected cost and the approved government grant and a time schedule for the realization.

13.2 BIOMASS HEAT CONTRACTING PROJECTS

Heat contracting is described in chapter 9.2. It is proposed to make a call for 10 demonstration projects of heat contracting. Given an average size of 200kW the total investment cost would be about 550.000 Euro and the required budget for a 50% grant 275.000 Mio Euro.

13.3 PILOT PROJECT BIOMETHANE FOR PUBLIC TRANSPORT IN NOVI SAD

It is proposed that Novi Sad starts a project to produce biogas from Municipal Solid Waste (MSW) and use this biogas in the form of biomethane as transport fuel for public busses in the city. A study tour to European cities using this kind of energy for the public transport should be the first step in starting this project.

13.4 BIOMASS FOR INDUSTRY

Within the "German Climate Technology Initiative – Development of a Sustainable Bioenergy Market in Serbia" studies on the use of biomass in the food industry have been realized. It is recommended that the government of Vojvodina cooperates with this German initiative in order to use the results of this study for bioenergy projects.

13.5 FURTHER PROPOSALS

In this action plan several recommendations were made concerning small scale heat uses, biofuels (recom. Nr. 5), electricity (recom. Nr. 3, 9) and biogas (recom. Nr 7). The priority should be put on 13.1 and 13.2 proposals and all other recommendations should follow according to the priorities of the government and the available funds.

14. TARGETS TOWARDS 2022, 2030 AND BUDGETS UNTIL 2022

In chapter 13.1 and 13.2 the priority demonstration projects were presented. The budget requirement is of the size of 5 Mio. Euro for these projects. As it takes time to select, plan and implement the projects the funds will be needed within a period of two years. Note however that this only holds true if the projects are pushed forward fast

As soon as the first results of the demonstration phase are available a general call for the implementation of heating projects of all sizes as described in chapter 9.2 should follow to achieve the proposed target of 13 PJ energy from biomass by 2020. The further development is indicated in table 22 but without financial calculations beyond 2022.

Based on the presented considerations and facts WBA proposes to set the following targets for the development of bioenergy in Vojvodina.

TABLE 22: TARGETS FOR BIOMASS AS PRIMARY ENERGY, PJ

	Unit	2013	2022	2030
Biomass	PJ	6	13	36
Share of biomass in total energy*	% of total energy	3,2	7	20

*Constant demand assumed

The targets can be reached if an integrated policy to mobilize the potential of biomass is realized. This involves for instance the increased use of by-products like straw and corn stalks, of manure and waste especially for biogas, wood from existing forests and planting up to 100.000ha new forests, of developing biofuels for transport.

TABLE 23: BIOMASS AS PRIMARY ENERGY, INDICATIVE TARGETS FOR HEAT, ELECTRICITY AND BIOFUELS UNTIL 2030

	Unit	2013	2022	2030
For heat	PJ	5,7	11	28,8
For electricity	Primary energy PJ (GWh)	0,3 (80)	1,0 (280)	4,2 (1.120)
	Electricity generated GWh (half solid biomass, half biogas)	28	90	380
For transport	PJ	-	1,0	3,0
Total	**PJ**	**6,0**	**13**	**36**

It is proposed that the promotion of the heating sector is based on financial grants to the investors in the size of 50% of the investment costs in the period until 2022, that the promotion of electricity is based on Feed in Tariffs and the promotion of biofuels by a combination of tax exemption and legal blending obligation. This has to be done on the federal level.

Heat assumptions: additional 5,3 PJ equals 1,47 TWh additional biomass for heat, 2860 hours per year fully used boilers, 514 MW new installations required, investment cost per MW of different sizes 275.000 Euro, total investment 142 Mio Euro, needed budget for six years 72 Mio. Euro, per year 12 Mio Euro.

It can be assumed that it will take two years to get the program fully operating. Based on these considerations the requirements for the budget are presented in table 24. Based on the experience of the first years the budget plan should be revised.

TABLE 24: ESTIMATED BUDGET REQUIREMENTS FOR THE ACTION PLAN MIO (EURO)

	Budget grants for heating	Budget for other activities	Total per year
Year 1	4	1	5
Year 2	12	1	13
Year 3	14	1	15
Year 4	14	1	15
Year 5	14	1	15
Year 6	14	1	15
Total	**72**	**5**	**77**

Table 24 delivers the budget data for the realization of the action plan until 2022. If the realization of the action plan starts at the beginning of 2016 it is estimated that in the first year the needed budget is in the size of 5 Mio. Euro. As the implementation of the program proceeds a higher support from the budget will be needed.

Boiler house at Toplana (District Heating Company) in Subotica. Photo: Hermann Wieser

15. FINAL REMARKS

This paper is not a research program but a concept for the implementation of bioenergy projects. It follows the philosophy that economic considerations should play an important role in the drafting of such an action plan. In a region with an income lower than the European average those bioenergy options that should be pushed first are those that have the lowest cost and offer the biggest economic advantage for the society. More sophisticated technologies should be put forward if experience exists and the economic situation has improved. The proposed strategy requires a coordinated approach between the federal government of Serbia and the regional government of Vojvodina.

The developed strategy also follows the principle to convert as much as possible of the primary energy into final energy sold to consumers. Therefore a clear priority is given to the heating sector. Positive experiences in other European countries underline the accuracy of this strategy.

WBA has written this action plan in the first half of the year 2014. The purpose of this paper is to explain facts, relations and outcomes that come from certain actions, systems or expenditures and to develop proposals based on the experience observed in different countries. It has to be understood that things can change and WBA has no control over these changes and the way the plan is implemented. Hence WBA declares a disclaimer of liability.

The deployment of biomass to energy in Vojvodina has to be seen in the broader context of the global climate negotiations. An agreement of these negotiations that is aimed for at the UN conference in Paris in 2015 will, if attained, lead to the obligation to reduce the use of fossil fuels in the future. Sustainable and efficient used biomass will have to play an important role in this transformation. The recommendation in this Action Plan bear this global discussions in mind.

Finally it should be mentioned that the proposed strategy would create a strong positive impact on the regional economy of Vojvodina and Serbia. The deployment of biomass to energy not only means replacing imported fossil fuels but also building up a regional bioenergy economy. This also involves new companies producing the equipment needed for the implementation of the bioenergy chain. In this sense bioenergy can help develop a new flourishing sector of the regional economy.

ANNEX I: DEFAULT VALUES

Bioenergy Action Plan Vojvodina

The Action Plan contains various calculations to make the proposals more understandable.

The following default values are used in these calculations:

Market price electricity	Euro/Mwh	40
Average FiT for solid biomass	Euro/MWh	120
Average FiT for biogas	Euro/MWh	150
Annual hours with full capacity		
Wind electricity	hours	2.100
Toplanas heating boilers	hours	3.200
Small biomass boilers	hours	1.600
Industry biomass boilers	hours	7.800
CHP boilers, electricity generation	hours	7.800
Average over all boilers 4 MW topl.: 5MW small boilers: 1MW in industry	hours	2.860
Other values		
Electricity consumption Vojvodina	GWh	8.000
Investment cost per MW heating boiler, average over all sizes	Euro	275.000
Efficiency of heating boilers	%	85
El. Efficiency of biogas installation	%	37
El efficiency of solid biomass install.	%	26
Straw per ha	tons	3

ANNEX II: CALCULATION HEAT OR COMBINED HEAT & POWER (CHP)

The following calculation should help to better understand the choices decision makers have in developing bioenergy. It refers to chapter 7.

In table 25 detailed figures concerning option A (heat) and option B (CHP) are presented.

The investment cost for option B – CHP – are with 115 Mio. Euro much higher estimated than for the heat option. A subsidy of 50% is assumed for the heat boilers, which results in total of 37,5 million Euros

TABLE 25: ECONOMIC COMPARISON HEAT ALONE BOILERS VERSUS CHP BOILERS

	Heating option (A)	CHP option (B)
Fuel demand (straw) tons/year	230.000	230.000
Agric. Land use (3 tons straw/ha) ha	76.670	76.670
HEAT; installed power in MWth	**242**	**115**
Investment cost	75	120
Operation hour	3 800	3 800
Conversion efficiency % to heat	90	62
Heat output GWh	828	271
Heat price Euro/MWh	23	23
Grant for investment 50% Mio. Euro	37,5	-
ELECTRICITY, installed power MW	**-**	**30**
Operation hour	-	8000
Electricity output GWh	-	240
Market price electricity Euro/MWh		40
Feed in tariff Euro/MWh		120
Annual subsidy for FIT		19.2
Total final energy (heat and electricity) GWh (PJ)	828 (3PJ)	511(1.8PJ)
MACROECONOMIC COMPARISON		**19.2**
Investment cost	75	115
Grant/subsidies	37,5	-
Subsidy for feed in tariff for 12 years	-	230.4
Heat cost savings for the consumer/year Mio Euro (44-23 Euro/MWh) as compared to gas Over 12 years:	17,4 208,8	5,7 68,4

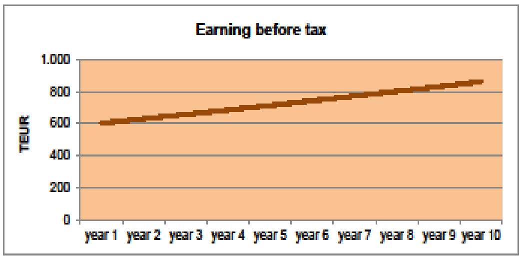
Source: WBA calculations

ANNEX III:
CALCULATION OF A HEATING PLANT WITH 12MW CAPACITY

Project overview

Country	Serbia
Project	Heating plant 12MW (Medium Toplana)

Investment	EUR	3.300.000
Equity	5%	165.000
Grant	50%	1.650.000
Credit	45%	1.485.000
Electricity installed capacity	MW_{el}	0
Operation time	hours/year	0
Electricity output	MWh	0
Green electricity price	EUR/MWh	138,45
Heat installed capacity	MW_{th}	12
Operation time	hours/year	3.200
Heat output	MWh	38.400
Heat price	EUR/MWh	37,00
Input materials	tons	11.163
ROI	in %	21,3
Payback time	in years	4,7



DATA INPUT					
Country: Serbia					
Project: Heating plant 12 MW (Medium Toplana)					
FINANCIAL DATA					
Investment		3.300.000		EUR	
Project development		120.000		EUR	
Buildings		280.000		EUR	
Machinery & Equipment		2.900.000		EUR	
Real estate		0		EUR	
EUR					
Equity		165.000		5,0%	
Grant		1.650.000		50,0%	
Loan		1.485.000		45,0%	
Loan repayment		10		years	
Loan interest		6,0%		%	
Depreciation (land / building)		25		years	
Depreciation (machinery)		15		years	
Tax		10,0%		%	
OPERATION COST					
Fuel	EUR /t		%		t / year
waste biogas	0,00		0,0%		0
straw	45,00		100,0%		11.163
wood / short rotation	0,00		0,0%		0
Power cost (consumption)		92,50		EUR / MWh	
Deposit cost (grate ash)		10,00		EUR / t	
Deposit cost (flue ash)		80,00		EUR / t	
EUR / person			persons		
Personal cost		15.000		2,0	
REVENUES					
EUR / MWh		%		MWh / year	
Heat sale	37,00		100,0%		38.400
EUR / MWh		%		MWh / year	
Internal power sale		0,0%		0	
External power sale	138,45		100,0%		0
TECHNICAL DATA					
Operational hours		3.200		hours	
Eff (el)					
Actual power production	0,000		MW		0%
Power production (no heat use)	0,000		MW		0%
Power production (full heat use)	0,000		MW		0%
Eff (th)					
Heat production (no drying)	12,000		MW		86%
Heat production (for sale)	12,000		MW		86%
Fuel demand (full operation)		13,953		MW	

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