CCEI

Cleaner and more cost effective industry in Macedonia

Fuel switch to vine prunings in Kavadarci

Pre-feasibility study for pilot project in Dobri Daskalov high school

Developed under the project "MAK-09/006 Cleaner and more cost effective industry in Macedonia" funded by the Norwegian Government and implemented by Norsk Energi and Centre for Climate Change

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Extract:

The Norwegian Ministry of Foreign Affairs is funding the program MAK-06/009 Cleaner and more cost effective industry in Macedonia (CCEI), implemented by Norsk Energi and Centre for Climate Change. For more information about the program see www.ccei.org.mk. This pre-feasibility study is developed under the framework of the program in order to support the transition to a low carbon society in Macedonia.

The aim of the pilot project described in this pre-feasibility study is to replace fossil-fuel based heating with heating based on biomass waste from vine pruning in in a public school in Municipality of Kavadarci, and this way assess the potential of a wider use of waste biomass generated by the wine industry, for heating purposes. It is estimated that the volume of biomass generated in the pruning season in Kavadarci, which today is treated as waste, is suffient to cover the heating demand in all publich buildings in the municipality.

The total investment for the pilot project is estimated to 58 000 euro, including cost of establishing a system for collecting and preparing vine pruning for combustion. The project has a pay-back period is 6,5 years, and will result in annual greenhouse gas emission amouting to 90 ton CO_2e/yr.

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Contents

1. Executive summary

The aim of this pilot project is to replace fossil-fuel based heat with biomass based heat in in a public school in Municipality of Kavadarci, and this way assess the feasibility of a wider use of waste biomass generated by the wine industry, for heating purposes. The project will reduce the heating costs for the school, while reducing CO_2 emissions, as well as contributing to better conditions for grape producers in the region of Kavardarci.

The main scope of work is to install biomass boiler with a filtration system in the school. The boiler will be additional in the already established heating system in the school, and when in operation enable reduced load or replacement of one of the existing oil boilers Contracted vine growers will provide grape residues sticks as a bio fuel, and handle the process of storing, drying, chopping and supplying the biomass to the end-user..

2. Project background

2.1. Brief introduction to the programme CCEI

The idea for developing the Pilot Project “Replacement of fossil fuels with vine branches for heating Secondary School “Dobri Daskalov” is based on the pre-feasibility study “Replacement fossil fuels with grape residues in Municipality of Kavadarci” prepared by Center for Climate Change and in the frame of the project for “Building Local Expertise in Climate Project Development”. In continuation of Norsk Energi activities in Macedonia it was set up a project “Cleaner and More Cost Effective Industry in Macedonia”- CCEI, where as a part of Energy efficiency component was included this project. The project CCEI is granted by Norwegian Ministry of Foreign Affairs for period from 2009-2010. The project is implemented by Consortium consisting of Norsk Energi, Centre for Climate Change with support from Mechanical Faculty in Skopje. Main aim of the CCEI project is identifying energy efficiency measures in industry sector, reducing GHG emissions and contributing to a more cost effective industry in Macedonia. Project has 3 components, Energy Efficiency, Environmental Management and Student Exchange, the energy efficienty component is providing technical assistant to the industry sector in identifying energy efficiency measures and preparing needed documentation for financing.

The main objective of this pilot project is to partly replace the fossil fuel (oil) with biomass collected during pruning season of vine. To achieve this we are going to replace an old boiler from the school Dobri Daskalov with a new bio-boiler, and purchase a wood chopping machine that can produce woodchips from the vine residuals.

2.2. Introduction to the project

With this project we are going to increase the public awareness of the local government and the grape growers about the potential usage of waste biomass for heating. The project will facilitate reducing heating costs, and as well providing a potential new income of the grape growers. The project is also assisting farmers to comply with environmental legislation which today forbids the waste biomass to be burned in the fields. The project will also result in reduction of CO_2 to the atmosphere.

Secondary School “Dobri Daskalov” will be supplied with chopped and dried biomass pruned from grape vines growing in the village Palikura, near the town of Kavadarci.

Each winter the grape vine owners have to prune the grape vine and this process produces each year 35 tons of biomass residues in the selected area around Kavadarci. The normal practice is it to collect this residue in piles, and burn it in open air when the weather gets warmer. Within the planned project, the biomass, which today is treated as waste, is intended to be used as energy source for heating the school. The main grape producer in the selected area is AD Kozuvcanka, which owns 17 hectares of grape yards. To facilitate easy logistics, the project will first start working with AD Kozuvcanka for the supply of biomass to the school and in later stage, additional grape growers can be included. The grape growers will be contracted for usage of the woodchopper and production of the woodchips.

3. Experiences with biomass energy utilisation

3.1. Review of studies for biomass utilisation for energy purposes in MK

Research work on available biomass waste as energy source in Macedonia and on possibilities for its effective utilization dates from the early 80-ies. In the framework of the study “Biogas Production in SR Macedonia”[1] a short survey is given of the waste combustible materials in a few of enterprises in the country. Initial experience in biogas production from animal farming, particularly from pig farms, is presented.

Wide research titled ”Biomass as a Fuel – Possibilities and Limitations” is conducted in the middle 80-ies in the former Yugoslavia under the coordination of the Institute ”Boris Kidric” Vinca[2], concerned with a complex utilization of biomass as raw material and as energy source.

Important results that have arisen from the scientific investigations in the field of biomass utilization as energy source in the former Yugoslavia are sublimed in the publication” Biomass Combustion for Energy Purposes”[3].

One of the relevant data sources concerning the agriculture sector in Macedonia is Agriculture Sector Study, Macedonia”, a project completed by Senter, Utreht, The Netherlands, in 1999[4]. Although the main purpose of this study was to make an assessment concerning the conditions of the agriculture in the country and to give proposals for improvement of the co-operation between The Netherlands and Macedonia in this sector and in separate sub-sectors, the results can be also used to draw conclusions regarding the available biomass waste.

Within bilateral co-operation between Macedonia and the Netherlands, company Haskoning, at the beginning of 2001 prepared”Biomass Availability Study for Macedonia”. The objective of the study was to find out the types and quantity of biomass available in Macedonia, the sectors in which is available and the price. Three sectors were analyzed: forestry, wood processing and agriculture. In the agriculture sector various types of biomass are produced, such as wine branches, fruit tree branches and rice chips. From the energy point of view, it seems that the most interesting is utilization of wine branches as potential fuel. The total theoretical and practical annual availability

[1] Jankovska S., Kociska L.: Proizvodstvo na biogas vo SRM, Termotehnika, No 1-2, Beograd, 1985
[2] (IBK-ITE-504, Vinca, March 1985)
[3] – N. Ninic, S. Oka, Yugoslav Society of Thermal Engineers, Naučna knjiga Publ., Belgrade, 1992 [3].
[4] Agriculture Sector Study, Macedonia, Senter, PSO98/MA/1/3, Utreht, The Netherlands, 1999

of biomass waste in the sectors forestry, wood processing and agriculture is shown in the Table 1[5].

Table 1. Theoretical and practical availability of biomass waste from the sectors forestry, wood processing and agriculture

SECTOR	THEORETICAL AVAILABILITY (ton/year)		PRACTICAL AVAILABILITY (ton/year)	
1) Forestry	100,000		50,000	
2) Wood processing	45,000		15,000	
3) Agriculture	436,000		55,000	
▪ Vine branches		81,000		50,000
▪ Straw		334,000		0
▪ Rice chips		4,000		500
▪ Fruit tree branches		17,000		4,500
Total	581,000		120,000	

In Kavadarci region theoretical availability is around 35,000 ton/year and practical around 20,000 ton/year

3.2. Some practical experiences in Macedonia and other EU countries

In Germany one small factory that's produces handmade products have implemented new heating system using the woodchips residuals to fuel 100kW KWB-Austria biomass boiler for heating 2,500 m2 working area. The total investment was 50,000 euro including the boiler, woodchip bunker, and chipping machine. The replaced boiler had an annual consumption of 25 ton light oil boiler, amounting to 12,500 euro in fuel cost. The new biomass boiler has anannual consumption of 250m3 biomass, at the cost of 2750 euro. The annual fuel cost saving paid back the investment in 5 years.

Another successful experience is from Redondo, Alentejo in the southern part of Portugal. In this area there is only two or three really cold months for which heating is needed. Like Kavadarci, Redondo is a wine-producing area, generating 510 tonnes of pruned vine twigs per year. The Municipality of Redondo decided to use this to heat an elementary sc elementary school hosting 190 student.The school was equipped it with a centralised space heating system designed to burn vine twig bundles. Vine twigs are collected in the vineyards using a special hay bailing machine and are packed in bundles of 0.5 m diameter and 1 m in length. This activity is supported by the municipality; whom in turn reduce their heating costs.. One hectare of vineyard produces approximately one tonne of vine twigs. Once dried, to a humidity of 15%, the net calorific value of the vine twigs is near 4 kWh/kg, which is equivalent to about 400 litres of fuel oil. The heating system relies on water storage and, therefore, takes up the peak heating during the combustion of the vine twig bundles, thus enhancing its efficiency and autonomy. The total investment cost for the heating system amounted to € 31 517, of which 70% was supported by the Valoren Programme of the European Commission. The gross investment payback time, without financial support, was 5.5 years. Compared

[5] Energy and Environment in Macedonian Industry: Business Development for Boiler Manufacturer WK CRONE B.V., Inception Report, Senter/Haskoning, PSO99/MA/2/2, Utreht, 2000

to the previous situation where space heating was provided by electric radiators using 114 550 kWh/year, the new system gives annual energy savings valued at € 1 900.

4. Technical and financial-economic aspects of the pilot project

Quantity and availability of grape residuals in the Kavadarci region

The potential area of vine grapes fields in municipality of Kavadarci is about 16,000 hectares. Under the assumption that from one hectare of vine grapes can be collected approximately 1.5 tons of grape pruning residuals, in the municipality of Kavadarci can be produced 28,000 tons of residuals annually. Considerable part of this amount is not easily available, because of various reasons.

The grapes fields under consideration

The fields under consideration in this case are located in the village of Palikura, about 11 km from the school (Figure 1). There are in total 17 hectares of vineyards that are owned by the company Kozuvcanka and 15 hectares owned by private vine growers. Potential residuals that can be collected in this region are about 48 tons. The storage place is going to be located on the property of Kozuvcanka with maximum capacity of 300 m^3.

Selection of pilot project

By screening of several public buildings in the municipality of Kavadarci including primary schools, kinder gardens and one secondary school, it was decided by the project team that the most appropriate place to implement the project was secondary school “Dobri Daskalov”. The school has one boiler on wood with capacity of 300 kW and other two light oil boilers of 225 kW each. The plan is to replace the wood-fired boiler with a new biomass boiler with the same capacity of 300 kW. The wood boiler is in very bad condition, and there is no possibility for any kind of adaptation. The boiler last time was used 15 years ago. The other two boilers (on light oil), which are in use today, were produced in 1959 and they are at the end of their life cycle. They also have to be replaced as soon as possible.

Next to the boiler room there is a space with an area of about 50 m^2 and 4 meters height that can be used for storage of the residuals. The entrance is accessible. For replacement of the old boiler there has to be a special dissemble process, because the dimensions of the openings of the room are not large enough to take the boiler outside as a whole object.

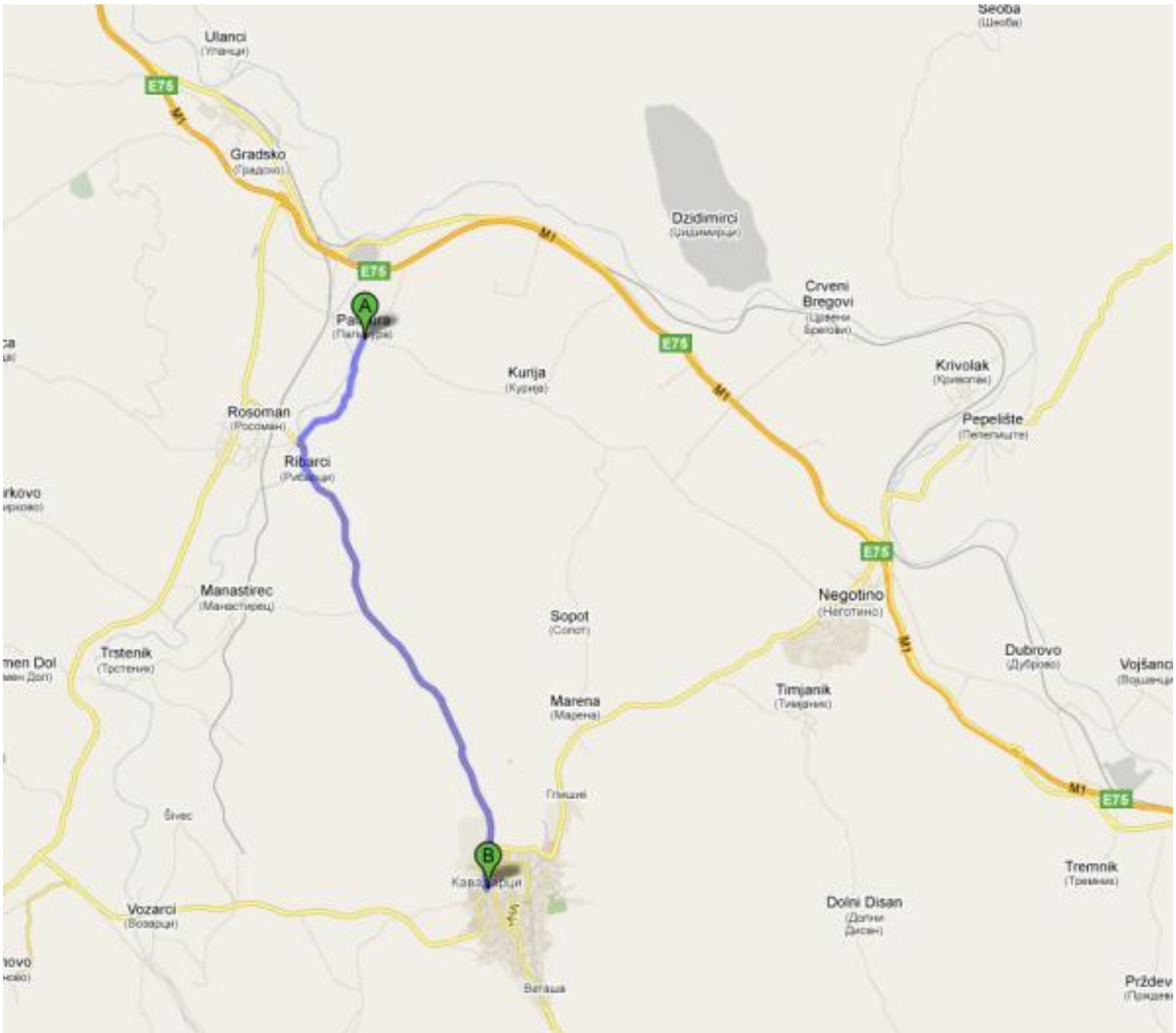

Figure 1. Map of the project

Figure 2. Location where storage place is planned, owned by Kozuvcanka

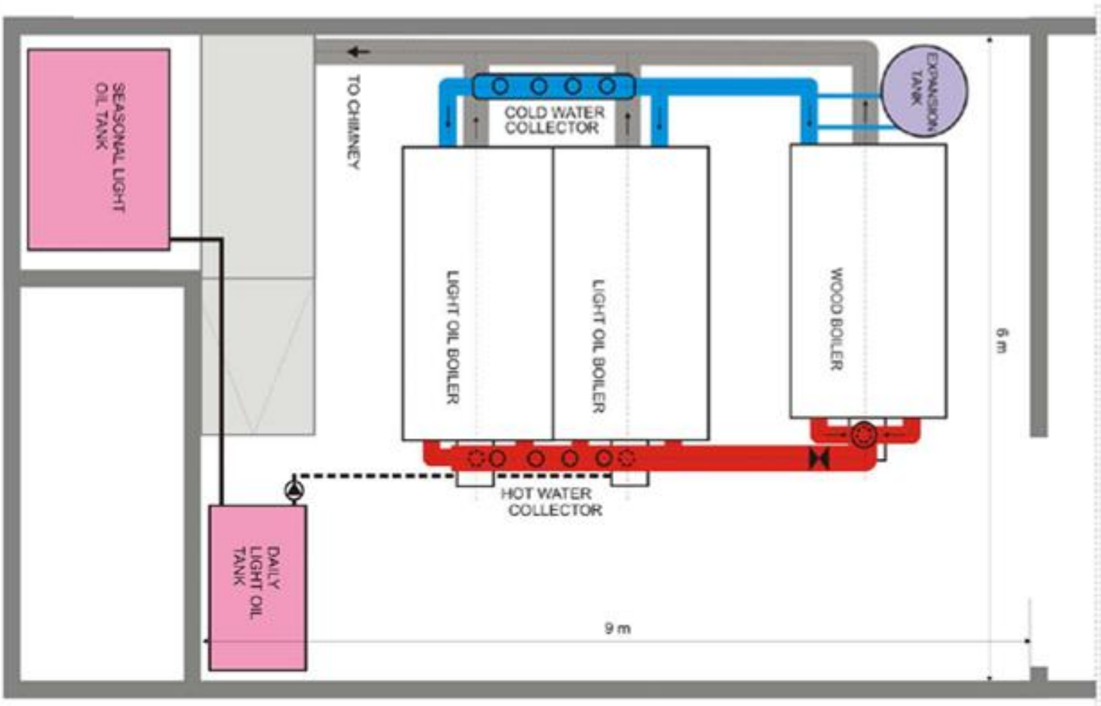

Figure 3 Boiler room in the secondary school Dobri Daskalov

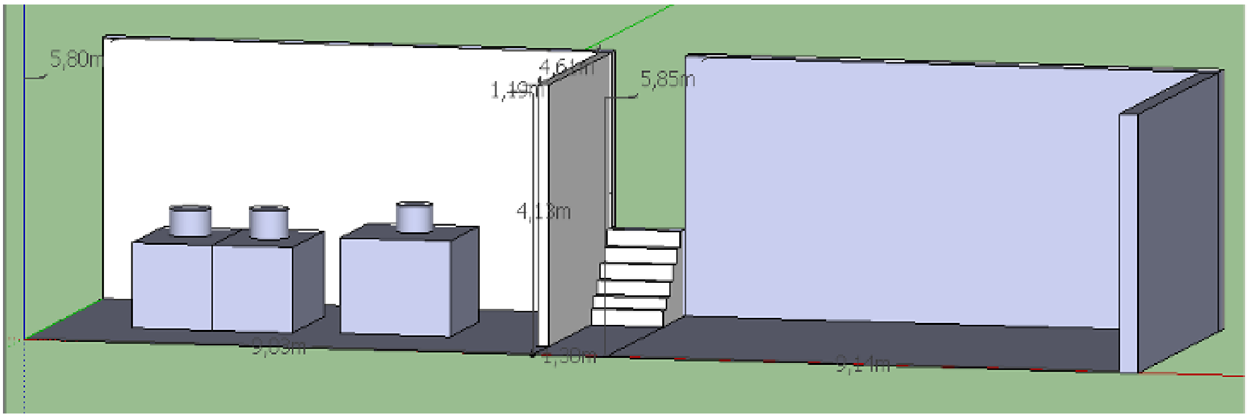

Figure 4. Boiler room and the storage place in the school Dobri Daskalov

Figure 5. The wood-fired boiler from year 1959 which has not been in operation the last 15 year. This boiler needs to be demounted to make place for the new bio boiler. In the rear end are the two oil fired boilers today supplying the school with heat

Figure 6. Storage place 50 m^2 **Figure 7.** The corridor to the boiler room

– The process of making the vine residuals, transport and production price.

a. *Pruning of vine grapes.* From one vine grape plant there are residual branches of approx. 1kg. Pruning is done after New Year when the weather is cold (Jan-Feb)

b. And the residuals can be left on the ground from 2-4 weeks. Depends of the weather conditions the humidity of the residuals can be lowered form 50 to 35%

c. *Collecting of the branches*. The tractor with harrow is collecting the branches to the end of the row (collecting point) and usually they burn the branches. Our objective is instead of burning them on this spot chop it and place the residuals in trailer for further transport.

d. *Chipping of branches*. The machine for chipping is tractor mounted and it can be easily moved. For this operation there is need of two workers. They will operate and load the machine with branches. The chops from the machine are poured directly in to the tractor trailer. They are all tractor powered and mounted so easily so the wood chipper can be moved from place to place. The capacity of these machines is from 1 to 4 tons per hour.

e. *Storage place.* The residuals have to be transported to the main storage place, with the volume of approx. 300 m3. This storage place will be provided by the company Kozuvcanka vineyard and in the school. The storage place has to be open and dry and with access for loading the chips-residuals.

f. *Transport of the chip-residuals*. The first transport is internal transport from the end of the one row to another row and to the main storage place if it is on vineyard property. Or transport, form tractor trailer directly to truck and place the residuals in the school storage. Trucks have capacity from 15-20m3. Tractor trailer have capacity of 3-4m3.

g. *Loading the residuals* from the tractor trailer to the main storage place.

- Economic analysis of manufacturing costs of residuals production (Methodology: production cost, storage cost, drying cost, transportation cost, overall cost of raw material delivered to the pellet plant). Table 2

a. The first activity pruning of vine grapes and the second collecting of the sticks-residuals is done by the vine growers every year so it is not calculated as a cost in our project.

b. The third activity is chipping the sticks with the wood chipper machine. For this activity there has to be 2 workers, 2 tractors, 1 trailer and 1 wood chipper. This activity takes place where usually the vine growers will burn the sticks. For 35 hectares vineyards, working hours for the 2 workers are total 280, 1 hour labour is 2, 5 euro, and total for this activity is 700 euro. The fuel consumption for this activity is 350 litres of diesel, with the price of 0.8 euro total is 344 euro.

c. Transport of the residuals. Firstly there is an internal transport from one row to another end row where the residuals are chipped, and also to the main storage place. For internal transport there are total 25 working hours. From on place of chipping to storage place there is a distance of approximately 500 meters. In 1 hectare the trailer has to go 2 times if the capacity is 3m3 and distance of 2 km. In our case for 35 hectares it will go 80 times and total distance 40 km, with average speed of 4km/h it will take 20 hours. Here we have 2 workers and with additional time total is 25 hours. The fuel consumption is 80 litres of diesel with the price 0, 8 totals is 64 euro.

d. External transport with truck. For total amount of 300m3 of residuals to be transported to the school we need 40 trucks loads with capacity of 15m3. The price for the service for average distance of 10km is 15 euro per truck. For this transport service total amount is 600 euro.

e. Storage place of the residuals. In our case the storage place must be at least 300 m3. That place has to be at least 200m2. The renting price for this kind of storage place is 0,5 euro per square meter. Also additional drying of the residuals with turning over the bio-mass is 200 euro. Total amount for rent and additional drying is 1400 euro.

f. Loading and unloading the residuals. For this activity approx. for 1 hectare is 1 hour, in our case 120 hours or 300 euro.

Total for all activities in the primary phase is **2644 euro**. When we calculated per m3 it is**, 15,2 euro or per ton 50 euro.**

Table 2

Vineyards hectares	35	Residuals ton.	52,5	Residuals vol. (m3)	173,25	Replace Oil (t)	17,5

Labor	**hours**	**euro/h**	**total**	**Fuel (lit)**	**euro/lit**	**total**
Chopping	140	2,5	350	350	0,8	280
Transport	50	2,5	125	80	0,8	64
Unloading	40	2,5	100			
Drying	50	2,5	125			
Total	280		700			344

Necessary thermal capacity and other issues for the pilot plant

a. The biomass boiler location will be in the school "Dobri Daskalov" in Kavadarci.

b. The present boiler is wood fuelled with capacity of 300kw, from the year 1959 and also there are 2 more boilers with light oil fuel from the same year of production

c. The objective is to replace the wood boiler with same capacity of biomass boiler, and usage as a supplemental to the existing installation.

Assessment of the quantity of biomass needed, storage, drying, (eventually) production of pellets

a. The annual oil consumption of the school is 35 tons, we want to reduce the oil consumption up to 10 tons. Therefore we need bio mass of 75 tons or 300m^3. In the first phase we are going to start with 40 tons biomass.

b. Storage place in the school min. 30m^2

c. Storage place on vineyards in Kozuvcanka 150m^2 approx. (300m^3)

Chipping machines

a. Wood chipper 6' China 1500 euro capacity 1 ton/h
b. Wood chipper PZ-140, Italy 11000 euro 4 ton/h
c. Wood chipper Junkari HJ 4M, Finland 3100 euro 3 ton/h

They are all tractor powered and mounted easily, so the wood chipper can be moved from place to place. The capacity of these machines is from 1 to 3 tons per hour.

Bio Boilers

a. Bio-mass boiler, Herz Bio Boiler-Austria, 300kw, 57.790 euro with automatic system. Without automatic system 47.000 euro (not recommended).

b. Bio-mass boiler SURI KU 300-Serbia, capacity 300kw, Fuel (wood residuals, pellets..), working temperature 110 C, Working pressure 3,5 bar, weight 1650kg. Price 9200euro + VAT, FOB

c. Bio-mass boiler Erato SU 300- Bulgaria, capacity 300kw, Fuel (wood residuals dimension 15x15mm), Price 19,000 euro

d. Bio-mass boiler Termo-Klima RM 01 300kw-Bosnia, capacity 300kw, Fuel (wood bundles with dimension 800x400x400mm), Price 18,364 euro

Table 3

Calculation Pilot Project Dobri Daskalov (in euros)							
Year	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Income (Oil cost)	13.659	13.659	13.659	13.659	13.659	13.659	13.659
Expenses	58.134	5.011	5.011	5.011	5.311	5.011	5.011
Revenue	-44.475	-35.828	-27.180	-18.533	-10.185	-1.538	7.110
Expenses							
Wood chipper	3.100	50	50	50	50	50	50
Bio Boiler	47.790	717	717	717	717	717	717
Labor Bio-Boiler	1.600	1.600	1.600	1.600	1.600	1.600	1.600
Reconstruction	3.000	0	0	0	300	0	0
Labor	700	700	700	700	700	700	700
Fuel (tractor)	344	344	344	344	344	344	344
Rent (storage)	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Transport (truck)	600	600	600	600	600	600	600

In the Table 3 there is a calculation for collection of residuals from vineyard of 35 hectares, and using the bio boiler with manual refilling of fuel. The revenue is based on how much oil will be replaced with the residuals. With this calculation on the year 7 the project is going profitable.

5. Boiler plant preliminary design considerations

- Bio-mass boiler, **Herz Bio Boiler-Austria**, 300kw, 57.790 euro with automatic system. This boiler can also be purchased without automatic system for 47.000 euro , but this is not recommended.

Table 4

No.	Description	Unit	Amount	Unit price in EUR	Total price in EUR
1	HERZ Biomatic 300 KW	Piece	1.00	32,232.20	32,232.20
2	Cyclone for Biomatic 300 KW	Piece	1.00	4,338.24	4,338.24
3	Reversible set (pump, mix-valve)	Piece	1.00	1,367.21	1,367.21
4	Automatic switcher for other boiler	Piece	1.00	136.01	136.01
5	Unit for monitoring without a modem	Piece	1.00	343.57	343.57
6	Modem	Piece	1.00	113.34	113.34
7	Floor acoustic insulation of boiler	Piece	1.00	136.71	136.71
8	Floor acoustic insulation sector for ash	Piece	1.00	43.92	43.92
9	Floor acoustic insulation transport system	Piece	1.00	74.38	74.38

10	Assembly and mounting of the boiler , transport system and all equipment	Piece	1.00	4,680.50	4,680.50
11	Star-up of the boiler and training of the user	Piece	1.00	1,031.55	1,031.55
12	Agitator for transport system (400V) f 4m	Piece	1.00	5,309.46	5,309.46
13	Extension of the transport conveyor	Piece	1.00	1,990.60	1,990.60
14	Water tank V= 10 000 Lit.	Piece	1.00	4,640.02	4,640.02
15	Insulation for Water tank V= 10 000 Lit.	Piece	1.00	1,352.72	1,352.72
Total			**57,790.44 EUR**		

Boiler automatic equipment is around 10.000 euro and the amortisation is 5% annually. Also the risk of mail functioning is high due the previous experience from the boiler in v.Chashka Veles, it is estimated that the risk is 4%. For amortisation and risk total annual cost is 9% or 900 euro.

The labour for refilling the boiler is one worker with 8 hours working time per day. The heating season is 5 months that means 800 working hours in total. The price per hour is 2 euro, for 5 months the cost for the labour is 1600 euro.

When we calculate the usage of amortisation for the 20 years and the cost of the labour the difference is 28.000 (automatic) – 32.000 (labour) = -4000 euro is additional cost if we use the labour vs. automatic.

It is recommended firstly to use the manual refuelling for the pilot project, for at least 5 winter seasons just for justification that the process is functioning and then the additional automatic equipment will be installed.

Automation vs. Labor Bio-Boiler 300KW							
Year	1	2	3	4	5	10	20
Automatic Equipment	10000	10900	11800	12700	13600	19000	28000
Labor	1600	3200	4800	6400	8000	16000	32000
Difference	8400	7700	7000	6300	5600	3000	-4000

Calculation for amortisation of the automatic equipment

Equipment	10000	
Amortization	5	%
Risk	4	%
Total annually	900	

Calculation for labour per winter season

Labor	
Working hours	800
Months	5
Euro per hour	2
Total annually	1600

- Bio-mass boiler SURI KU 300-Serbia, capacity 300kw, Fuel (wood residuals, pellets..), working temperature 110 C, Working pressure 3,5 bar, weight 1650kg. Price 9200euro + VAT, FOB
- Bio-mass boiler Erato SU 300- Bulgaria, capacity 300kw, Fuel (wood residuals dimension 15x15mm), Price 19,000 euro

- Bio-mass boiler Termo-Klima RM 01 300kw-Bosnia, capacity 300kw, Fuel (wood bundles with dimension 800x400x400mm), Price 18,364 euro
  Capacity: 300 KW,
  Usage level 82%
  Consumption: around 100 -120 KG/h ,
  Size of the burning place: 1900X1900X1690mm
  Size of the bundles 800X400X400 or F 1250X/1200 or 1500 or1750 mm
  Weight of the boiler: 5200 KG,
  Dimensions of the boiler: 3240X2200X2875
  Diameter of the chimney: F 405 mm
  Recommended water tank / SPAJHER/ : 15000 l

5.1. Fuel storage and local transport system

There are going to be two storage places one on the vineyards main (150 m2) and one in the school next to the boiler room (50m2). Transport system from the vineyards to the school will be organized in trucks owned by Kozuvcanka and contracted with the municipality.

5.2. Possible solution for installation of the bio boiler

Possible technical solution of installation of the biomass boiler and the equipment for local transportation of the biomass waste is presented in the following figure.

6. Financing

- The World Bank has a program issuing grant of 50% of the investment costs for energy efficiently projects (will require energy saving measures implemented also in school building). After the meeting with WB, the Municipality will possibly make another application for reconstruction of the school and implement the bio-boiler. **World Bank** is recommending for cheaper bio-boiler with semi automatic system and employment of one worker to operate. Engagement of the Municipality in co-financing 50% of the project for the reconstruction of the school Dobri Daskalov and possibly implementation of this bio boiler.
- GEF-SGP (Small Grants Programme in Macedonia) contributes with 14.500 euro for the wood chopping machine and for awareness raising/training of grape growers and local government. **GEF-SGP** is recommending for finding a local partner association where all the vine-growers involved in this project will be members. In Kavadarci there is one large association of vine growers “Agro Tikvesija”, but for the purpose of this projects it is recommended to create new local association. Saved money from reduced oil consumption will be invested in the local association or other green energy initiative.

- Norsk Energi will contribute 10.000 euro for technical assistance from Macedonian and Norwegian consultants, if the Municipality provides some of the investments funds via their budget, and signs cooperation agreement on the project implementation.
- Municipality of Kavadarci will contribute 10.000 euro for Bio-boiler equipment and in house contribution for management 6.000 euro. To be confirmed about the total contribution of the Municipality in the overall project that will be submitted in the next phase.

7. Management issues

- The wood chipper can be owned by Center for Climate Change but will be managed by local vine growers. The wood chipper will be financed with by SGP-GEF project. The chipper will be operated and maintained by Kozuvcanka. There has to be a contract for using/ownership of this machine with the municipality and local vine growers connected with the responsibility for delivery and price of the vine residuals per meter cubic or per ton.
- The owner of the whole GEF-Small Grants project is Center for Climate Change where Municipality of Kavadarci is partner and beneficiary. Municipality is responsible for the financing of the budget for heating in the schools and monitoring of the project in the next 5 years. The boiler will be operated possibly with employ from the school (new job position) that will has training for maintenance and operating by the producer company.

8. Annual savings of light oil and reduction of CO_2

- Annual consumption of light oil per year in the school is 35 tons, with the project there is going to be reduction of the oil in the following year. For the first year our goal is to reduce the oil consumption by 30% and replace with the fuel from the vine residuals. And in the following years to increase the reduction by additional 5% each year till we reach 100% replaced oil fuel.
- The reduction of CO_2 that can be achieved after implementation of the pilot project, when the light oil will be replaced 100% with residue biomass, is 94 tons of CO_2 per year.

9. Identified project risks

9.1. Difficulties in project implementation

a. De-assembly of the old boiler, preparation the storage room in the school

   - An old large boiler will have to be de-assemblied and split in parts in order to make space for the new boiler. This may add to the cost of getting the boiler installed

b. The contract/price of the residuals for selling

- Prices for buy-out of the residuals between Kozuvcanka and Municipality. The price is calculated to be 50 euro per ton or 15,2 euro per m^3 , the price of wood at the moment is 83 euro per ton or 50 euro per m^3 .
- Contract between vine growers and Kozuvcanka for giving services with the machine

9.2. Barriers

Assessment of barriers and limiting factors to effective use of biomass waste as energy source is an important step in the overall activity for intensification of biomass utilization. Although biomass waste, in general, is recognized as a potential fuel for local heating systems within Macedonia, little is done on practical implementation level. However, certain activities should be initiated to operationally this potential in a sustainable manner. Various barriers and difficulties are preventing the operationalisation of the potential, namely: technical, organisational, economic, financial, institutional, policy, regulatory, information (public opinion), management etc.

9.2.1. Technical and organizational barriers

- Absence of precise estimation of available biomass.
- Practical availability and cost of biomass fuel.
- Collecting of biomass from different relatively small individual producers, transportation, drying and other preparatory works, briqueting, storage could be faced with both, technical and financial problems. In the case of the Kavadarci municipality huge barrier is non-existing organisational chain: collection of pruning residues, market for pruning residues, transportation to on-field storage space, transportation to the consumer, local storage.
- Fuel handling and combustion systems, as well as boilers and other equipment required are commercially available from many manufacturers. However, in general, the capacity and generating efficiency of biomass energy plants are considerably less than those of modern systems on oil or natural gas.
- Also, during the project activities, it became clear that there are very few or almost no experiences with direct use of vineyards pruning residuals for energy purposes in all the countries in the SE Europe region (Macedonia, Serbia, Bulgaria, Croatia, Bosnia-Herzegovina etc.).

9.2.2. Economic and financial barriers

- Biomass energy systems are characterized with much higher investment cost compared to other systems and, therefore, with longer payback period.
- Very limited investment capital is available; the risks related to investments in the proposed investment area are relatively unknown. Unfavorable financial condition of the population and the most of the enterprises and other subjects are additional barriers.

- Prices of equipment for biomass utilisation as energy resource: the price of boiler and auxiliary equipment is 2-4 times higher than for a boiler on light oil of the same capacity.

9.2.3. Institutional barriers

- One of the key barriers is inconsistent and unsupportive government policy and vulnerability of the country's economy due to internal and external shocks.
- Specialized energy departments are nearly non-existent at the municipal level. Republic of Macedonia is at the initial stage of privatizing energy services, e.g. electricity, heat and hot water, with, as a result, an unclear context for the proposed projects to be developed and implemented.

9.2.4. Policy and regulatory barriers

- No policy context/regulatory framework exist that facilitates the introduction and dissemination of commercially viable local heating systems, particularly on renewable energy sources, including biomass.

9.2.5. Public opinion, information barriers

- Limited reliable data on the availability and location of biomass waste exists at the level of detail required for developing investment plans.
- A clear distinction may not be made between modern effective biomass energy facilities and older polluting incinerator designs.

9.2.6. Management barriers

- Undeveloped market of biomass as fuel, except firewood. Lack of skills and experience with locally based management of energy technology systems.

Based on the previous analysis, as a priority for efficient use of biomass in energy production appears the necessity to create a biomass chain, meaning efficient gathering, previous preparation, transport, processing (cutting, chopping, briquetting or other methods for end use), storage, preparation for combustion etc. Also, stimulus to use alternative energy sources should be given with the new law regulations in the Republic of Macedonia, particularly in the field of energetics.

10. Conclusions, lessons learned, recommendations

There is enough quantity of vineyard pruning residues that can be used as an energy resource for heating purposes.

An appropriate fuel consumer is selected.

It is obvious that in the Republic of Macedonia and in the South-Eastern European countries there is not much experience when it comes to manufacturing of boilers and auxiliary equipment on specific types of biomass, such us vineyard pruning residues, but also in using this kind of waste biomass as fuel.

The prices of biomass boilers from regional manufacturers are much higher compared to boilers on fossil fuels of the same capacity.

There should be established an organisational chain for collection of pruning residues, transportation to on-field storage space, transportation to the consumer, local storage and other activities. Also, a market for waste biomass (in this case, pruning residues) should be established.

There are a few potential institutions, which have already expressed willingness to take part in financing the project.

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