Radar Project
Raising Awareness on renewable energy
Developing Agro-energetic chain models

WORKING PAPER
Illustrating the models of agro-energetic chains and their respective feasibility Studies
Radar Project
Raising Awareness on renewable energy
Developing Agro-energetic chain models

WORKING PAPER
Illustrating the models of agro-energetic chains and their respective feasibility Studies
Lead Partner:
Marche Region – Agriculture, Forestry, Fishery Unit
Cristina Martellini, Andrea Bordoni
Andrea.bordoni@regione.marche.it

Management:
Sviluppo Marche Spa
Territory and Rural Development Area
Lucia Catalani, Vanessa Conigli, Elena Montironi
rdpolicies@svimspa.it

Text edited by:
Polytechnic University of Marche Region

Product Realized with the contribution of:
Marche Region – Agriculture, Forestry, Fishery Unit (IT), Sviluppo Marche SpA (IT), Marches Energy Agency - MEA (UK), Development Agency North – DAN (HR), Riga Managers School - RMS (LV), Tallinn University of Technology - TUT (EE), Setomaa Valdade Liit – MTU (EE), Energy Agency for South East Sweden (SE), Regional Energy Agency of Plovdiv (BG) and the Agriculture University of Plovdiv (BG)

Layout and Setting:
ekn comunicazione | www.ekn.it

Printed by:
arti grafiche pesaresi
05. Introduction

06. Feasibility Studies methodology

09. Feasibility Studies: overview in each RADAR project partner country
  10. Feasibility study. ESTONIA
  15. Feasibility study. LATVIA
  20. Feasibility study. UNITED KINGDON
  25. Feasibility study. ITALY
  30. Feasibility study. CROATIA
  34. Feasibility study. SWEDEN
  38. Feasibility study. BULGARIA

43. Set of Indicators evaluate efficacy and efficiency of Feasibility Studies and comparison results

47. Conclusions
   Conclusions
Raising awareness on renewable energy in Rural communities for sustainable Energy created in the pilot area thanks to the RADAR project, was the main goal of many activities towards administration, responsible for local energy planning, and towards all key actor of the agro energy field. The main output subsequently at this “stone activities” is represented by feasibility study that each partner country has developed on the basis of agro-energy chain model developed with respective Local SEC.

The realization of the feasibility study has been possible thanks to the large informations collected during both the analysis than mapping phases of the Pilot Area. Above the informations about kind and distribution of local biomass, energetic consumption of each local sectors collected during the phase WP II° of the RADAR project have been fundamental for the choice and dimensioning of the energetic chain.

On the basis of agro-energetic chain model, the feasibility study has analyzed with helping by local SEC. As consequence, the part of report summarizes a synthesis of each feasibility study developed by each partner. More in particular the feasibility study describes the assessment of a conversion of biomass analyzed during the respective agro-energetic chain.

There are several questions which typically come up around the idea of converting to energy by biomass. The effect of biomass uses on the environmental condition is typically one of these questions of Fuel supply with sustainable criteria is typically another concern in the discussion of using of biomass during the analysis of agro-energetic chain.

Very important questions to ask are: “What does the fuel supply look for two feasibility projects? How many facilities can this supply sustain?” and therefore “Which to measure the efficiency and effectiveness of the Agro-Energetic Chain Model chosen?”.

Shortly, some kit of indicators is selected in order to estimate the effectiveness of the Agro-energetic chain chosen. More in particular, not only economic indicators as: value or yield of the Investment and respective Payback time or energetic production are considered, but the environmental and social indicators as: number of created job and Avoided of greenhouses gas are also taken in consideration.
Introduction

The methodology of Format of the Feasibility Study described by chapters and sub-items hereinafter is well known tool applied to context of this project. On the basis of the Format of the Feasibility Study for Agro-Energetic Chain Model and using data from previous work packages such as Pilot Area Description, Mapping of Pilot Area and Agro-Energetic Chain Model will be developed in Pilot Area each partner selected one more applicable chain and drew up Feasibility Study.

An indicator to evaluate efficacy and efficiency of Feasibility Studies to evaluate the efficiency and effectiveness of the Agro-Energetic Chain Model were produced and was added to Feasibility Study report. The draft of Feasibility Study by the SEC members was submitted and to this process other stakeholders in region who provided suggestions to the draft was involved.

The Feasibility Study consists of the following chapters and items that described little-bit detail below. Each partner used available him analytical tool (financial calculation program) and main outputs are: NPV, IRR and discounted payback time.

1 Context analysis and project objectives

1.1. Short description of project and definition of project objectives

Short description of the project (agro-energetic chain model) and a clear statement of the project’s objectives is an essential step in order to understand if the investment has social and economical value. The broad question any investment appraisal should answer is “what are the net benefits that can be attained by the project in its socio-economic environment?” The benefits considered should not be just physical indicators (kW or MWh) but socio-economic variables that are quantitatively measurable. The project objectives should be logically connected to the investment.

1.2. Socio-economic context

The first step of the project appraisal aims to understand the social, economic and institutional context in which the project will be implemented. In fact, the possibility of achieving credible forecasts of benefits and costs often relies on the accuracy in the assessment of the macro-economic and social conditions of the region. In this regard, an obvious recommendation is to check that the assumptions made, for instance on GDP or demographic growth, are consistent with data provided in the corresponding agro-energetic chain model.

2 Feasibility and option analysis

The present section provides an overview of the main features of a good project option selection. This process aims at providing evidence that the project choice can actually be implemented and is the best option of all feasible alternatives.

2.1. Option identification

Once the socio-economic context and the potential demand for the project output have been analyzed, then the next step consists of identifying the range of options that can ensure the achievement of the
objectives of the project. Some typical examples of many options are:
- Heat from RES, technologies considered for energy generation projects, local subjects (items),
- Electricity and heat from RES, technologies considered for energy generation projects, local and regional subjects,
- Biogas from waste and energy crops, the location of a production plant in area A nearer to the end markets, versus area B, nearer to the suppliers.

The basic approach of any investment appraisal aims to compare the situations with and without the project. To select the best option, it is helpful to describe a baseline scenario. This will usually be a forecast of the future without the project, i.e. the “business as usual” (BAU) forecast.

In general, when dealing with options, pricing policy is often a decision variable – and will have an impact on the performance of the investment, not least through influencing demand. Thus, the relationship between each option and the assumptions on tariffs, or other prices, should be explored. The combinations of locations, investment expenditures, operating costs, pricing policies, etc., may amount to a large number of feasible alternatives, but usually only some of them are promising and worth detailed appraisal.

### 2.2. Feasibility analysis

Feasibility analysis aims to identify the potential constraints and related solutions with respect to technical, economic, regulatory and managerial aspects. A distinction between binding constraints (e.g. lack of human capital, geographical features) and soft constraints (e.g. specific tariff regulations) may be stressed, because some of the latter can be removed by suitable policy reforms. This aspect underlines the importance and the need for coordination between national/regional policies and projects. A project is feasible when its design meets technical, legal, financial and other constraints relevant to the nation, region or specific site. Feasibility is a general requirement for any project and should be checked carefully. Moreover, as mentioned, several project options may be feasible.

Typical feasibility reports for major infrastructures should include information on:
- Demand analysis,
- Available technology,
- The production plan (including the utilization rate of the infrastructure),
- Personnel requirements,
- The project’s scale, location, physical inputs, timing and implementation, phases of expansion and financial planning,
- Environmental aspects.

### 2.3. Option selection

EU Regulations require the proposer to provide the results of feasibility and option analysis. The main result of such analysis is to identify the most promising option on which detailed CBA should be carried out. Sometimes this selection process is managed as part of the preparation on an operational programme or master plan.

### 3 Financial analysis

The main purpose of the financial analysis is to use the project cash flow forecasts to calculate suitable net return indicators. A particular emphasis is placed on two financial indicators: the Financial Net Present Value (FNPV) or NPV and the Financial Internal Rate of Return (FIRR) or IRR, respectively in terms of return on the investment cost.

The different definitions of net cash flows for the calculation of the project performance indicators can be used. The methodology would be used in this Format for the determination of the financial return is the Discounted Cash Flow (DCF) approach. The financial analysis should be carried out through subsequent, interlinked, accounts:
- Total investment costs,
- Total operating costs and revenues,
- Financial return on investment cost: NPV and IRR,
- Sources of financing,
- Financial sustainability,
- Available at option - financial return on the national capital: FNPV and FIRR.
3.1. Total investment costs
The first logical step in the financial analysis is the estimation of how large the total investment cost will be. The investment outlays can be planned for several initial years and some non-routine maintenance or replacement costs in more distant years. Thus we need to define a time horizon. By time horizon, we mean the maximum number of years for which forecasts are provided. Forecasts regarding the future of the project should be formulated for a period appropriate to its economically useful life and long enough to encompass its likely mid-to-long term impact. For the majority of infrastructures and energy economy the time horizon is at least 20 years; for productive investments, and again indicatively, it is about 10 years. Nevertheless, the time horizon should not be so long as to exceed the economically useful life of the project.

3.2 Operating costs
The operating costs comprise all the data on the disbursements foreseen for the purchase of goods and services, which are not of an investment nature since they are consumed within each accounting period.

3.3. Financial return on investment
Having collected the data on investment costs, operating costs and revenues, the next logical step in the financial analysis is the evaluation of the financial return on investment. The indicators needed for testing the project’s financial performance are: the financial net present value of the project (NPV), and - the financial internal rate of return (IRR).

3.4. Sources of financing
The fourth step in financial analysis is the identification of the different sources of financing in order to calculate the total financial resources of the project. Within the framework of EU co-financed projects, the main sources of financing are: community assistance (the EU grant), national public contribution (grants or capital subsidies at central, regional and local government level), national private capital (i.e. private equity under a PPP), other resources (e.g. EIB loans, loans from other lenders).

3.5. Financial sustainability
Having determined the investment costs, the operating revenues and costs and the sources of finance, it is now possible and helpful to determine the project’s financial sustainability. A project is financially sustainable when it does not incur the risk of running out of cash in the future. The crucial issue here is the timing of cash proceeds and payments. Project promoters should show how over the project time horizon, sources of financing (including revenues and any kind of cash transfers) will consistently match disbursements year-by-year. Sustainability occurs if the net flow of cumulated generated cash flow is positive for all the years considered.

4 Economic analysis
The economic analysis appraises the project’s contribution to the economic welfare of the region or country. It is made on behalf of the whole of society instead of just the owners of the infrastructure, as in the financial analysis. The key concept is the use of accounting shadow prices, based on the social opportunity cost, instead of observed distorted prices. Observed prices of inputs and outputs may not mirror their social value (i.e. their social opportunity cost) because some markets are socially inefficient or do not exist at all. Examples are monopoly or oligopoly markets, where the price includes a mark-up over marginal costs; trade barriers, where the consumer pays more than he/she could elsewhere (in some cases energy market).

5 Risk Assessment
Critical factors like investment costs and length of cycle, energy demand dynamics, dynamics of incentive regimes etc. have to be considered. Main variables could be affect to the results of project, such as forecast of economical growth
rate, sales price of energy will be generated, finan-
cial values for the energy generated by renewable 
resourced, dynamics of critical inputs cost (fuel, 
labor etc). All described here and any more risks 
would be assessed taken into consideration.

Feasibility studies: overview in each 
RADAR project partner country

This paragraph contains a brief description of the agro-energetic chains 
and their Feasibility studies of each country.
For each Feasibility Study following aspects will be high lightened:

1. Short description of selected object – Chain Model
2. Definition of project objectives
3. Socio-economic context
4. Overview of the main features of a good project option selection
5. Results of feasibility analysis
6. Results of Financial analysis
7. Sources of financing
8. Risks of the project implementation
FEASIBILITY STUDY. ESTONIA

1. Short description of selected object – Chain Model

Estonian Pilot Area represents the territory of five rural municipalities (parishes) in South-East Estonia – so called Setumaa or Seto (Figure 1). There are Meremäe, Mkitamäe, Misso and Värksa parishes which belong to Seto cultural heritage area. Vastseliina parish is additional part that we view as a pilot area because of similarity in natural, cultural and economical aspects.

For realization of Estonian agro-energetic chain model on the base of converting waste to biogas and energy swinery farm of Kimeko Ltd was selected. Local resources like swinery manure and herbaceous biomass (green silage) harvested from Kimeko fields and supplied by other local farmers will be taken into use. Digested biogas and transformed by this heat and electricity will be used locally such as digesting residues. All agro-energetic chain will be elaborated by local initiative and operated by local actors.

2. Definition of project objectives

Idea of current project is to build up biogas agro-energetic chain which would use local resources like agricultural waste (manure) and herbaceous biomass (green silage) supplied by local farmers. The main activity of the project is plan to built biogas plat, combined heat and power station (CHP) and greenhouses (additional) will be realized in Kimeko farm in Meremäe parish. Power will be sold to national grid and heat could be used for heating greenhouses. Digestion material will be used as fertilizer for herbaceous biomass fields surrounding Kimeko farm. Aim is to operate all chain by local producers. True there is other farm, called Nopri that has some interest in biogas in the same area, but Kimeko farm has higher biogas potential and we have stayed with this choice.

Location of the project: Meremäe village and Obinitsa village in Meremäe Parish. Developer is agricultural company Kimeko Ltd, the owner of pig breeding farm and lands for growing herbaceous biomass in Meremäe (Figures 1).
For building and running biogas plant will be set up new company which would belong to Kimeko Ltd, other local farmers and landowners, some energy companies and financial investors.

3. Socio-economic context

In our Pilot Area electrical energy is not yet produced. All power energy consumed in Setumaa is produced and distributed by Estonian national power company Estonian Energy Ltd. This company also owns transmission grids. In Estonia most power (95%) is produced from oil-shale, 3% from natural gas and 2% from different renewable resources (wind, hydro, biogas etc). Today one biogas station with cogeneration unit is running on agricultural waste (manure from pig breeding farm and sewage sludge) in Saare County (on the Western island called Saaremaa). There is biogas station in the capital of Estonia Tallinn using city sludge for biogas production and one on landfill using Tallinn garbage. Also several biogas plat studies have been done and projects are under development. In case of success this project would be a big step towards increasing the use of renewable energy in Estonia and even more important it would give more positive experience in production and use of biogas. Until today production and use of biogas from manure and green biomass has been not so efficient in Estonia and entrepreneurs are very careful investing in this business. Also it could bring interest in cooperation in this field of biogas with Russia and Latvia. All these changes could recover business environment in Setumaa. Knowing that this area is interesting in cultural way it has a chance to be also extremely interesting in the use of modern renewable energy sources.

In case of building biogas plant biogas chain will consist of three main links:
1. The growing and stocking of raw material (herbaceous biomass in the form of silage and manure),
2. Harvesting and transportation of raw material and digestion waste,
3. Conversion of raw material into energy (heat and electricity) and fertilizer.

4. Overview of the main features of a good project option selection

To improve the situation with biomass supply these measures should be introduced:
• Better planning of the balance of the biomass demand and supply possibilities,
• More efficient use of the traditional biomass resources - first of all wood waste in all stages of wood processing,
• Introduction of new sorts of biomass (herbaceous biomass, residues from food processing, bio-fraction of municipal solid waste etc.).

5. Results of feasibility analysis

Option identification

For pilot area three main options to build up local renewable energy – bio energy – chain were under observation:

1. Harvesting and chopping brushwood of small value for wood industry. Wood chips could be sold for boiler houses in Põlva and Võru County,
2. Producing pellets from agricultural residues as straw, reed and energy crops. All these resources are available in region. Potential production could be sold to local consumers or exported,
3. Anaerobic digestion of manure and herbaceous biomass. Biogas station has to be built at one of cattle breeding or pig breeding farm. There are two large scale farms in pilot area.

Local communities and R_SEC decided to develop last option. This one is a great challenge for area. On the base of biogas station is possible to solve some local problems, mainly environmental connected of waste management (odor of pig manure, contamination of soil etc). Biogas is only energy source rather simple to produce and to use as fuel for heat and electricity in cogeneration unit (CHP). Nowadays we have good reliable technology and equipment from different producers for biogas plant and CHP. Total value and impact to pilot area of the biogas chain is probably enormous. Other opportunities could be considered along with the change of individual heating boilers to modern ones working on wood and grass pellets. But the
implementation of modern technologies in the individual house holdings is limited with the limited access to the financial resources – especially now, in the time of crisis. What will happen if such scenario will not be implemented? In this case the Kimeko farm has to find another way for waste (manure) management and they can grow energy crops on their grasslands and sell raw material for fuel manufacturing or energy companies. Gained profits they can use in company enlargement, but opportunity to process waste and crops to energy and to get more profit will be lost. This scenario “to-do-nothing” takes away opportunity to implement profitable waste management and energy generation system and to develop backward region and create some jobs.

Feasibility analysis
Kimeko farm has been operating 7 years and there are 8 employees. Farm is receiving 13,000 pigs during a year and are breeding them from 25 kg to 110 kg (every 4 month 3,250 new pigs and grown ones are being sold to slaughterhouse). Kimeko Ltd is planning to have 14,000 pigs more 7 km away in Obinitsa village. Farm has land part of which 140 ha could be used for growing energy plants for silage and in addition 210 ha would be rented (in the future 200 ha more could be rented). This land is situated within 7 km from planned biogas plant. By the year 2011 there should be also 100 milk cows. Produced electrical energy would be sold with the higher price of 7.4 Euro cents to national grid, produced heat would be used for biogas plant (up to 30%) in greenhouses that would be built by Kimeko Ltd., which would bring extra business to the farm and the whole parish would have extra jobs or to heating system which would provide with heat houses around 2 km away.

Main sources of biogas are manure from Kimeko pig breeding farm, one in Meremäe village and new one in Obinitsa village, 7 km from Meremäe and herbaceous biomass supplied by local farmers including Kimeko (landowners). Biomass will be supplied from agricultural lands (energy crops like maize, reed canary grass or galega) and from semi-natural grasslands. Location of the planned biogas plant would be in Meremäe village near piggery. If biogas plant was built in Obinitsa it could provide with heat that district. Very important pre-condition for project implementation is availability to use heat that is generated from CHP. Developer has foreseen to build greenhouses for vegetable production. Not far 2 km from planned biogas production. For fermentation mesophilic process (35 – 37°C) is chosen as more suitable for Estonian conditions. The substrate stays in storage approximately 24-28 days and use on an average 0% of produced heat for heating fermentation tank. In such way heat production will partly decrease just in winter time while greenhouses needs are the biggest. Therefore one additional heating device (probably woodchip boiler) for greenhouses is needed.

Option selection
In our project we have chosen last option with bioenergy chain based on manure and silage digesting. Pig and cow manure and silage (from energy crops, which will come from Kimeko Ltd. farm land and from neighboring land) will be used in biogas plant to produce heat and electricity in CHP, with 0.844 MW electrical and 0.854 MW thermal capacities. Heat will be used by biogas plant itself around 30% per year and the rest 70% to greenhouses or central heating system.

For fermentation mesophilic process (35 – 37°C) is chosen as more suitable for Estonian conditions. The substrate stays in storage approximately 24-28 days and use on an average 30% of produced heat for heating fermentation tank. In such way heat production will partly decrease just in winter time while greenhouses needs are the biggest. Therefore one additional heating device (probably woodchip boiler) for greenhouses is needed.

Data about estimated biogas, power and heat production are given in Table 1. Developed conception of feasibility study are chosen by analyzing geographic, climatic and economic conditions with assumption that renewable energy policy of Estonia stimulate to get use renewable natural resources incl. biomass. Complicated economical situation and decreasing of GDP of Estonia could not change this policy. Situation on labor market is favorable for project because the number of unemployment is high, people need jobs. Using biogas we would avoid methane emission and avoid 7 225 t CO₂/a. (Table 1.)
6. Results of Financial analysis

Total investment cost of biogas plant and CHP with design and construction works was estimated here **2 600 000 EUR**.

Biomass cost and its transportation cost is calculated with price 18 EUR/t for galega. For transport we will use truck that contains 0 t of manure. Carriage of 0 t of manure per distance 1 km is 1. EUR (total driving distance is 14 km, because machine has to bring manure and go back). Transportation of manure from Meremäe village is free of charge because this farm situated next to planned biogas plant and feeding of manure to digestion tanks can be organized by pipelines.

Total annual operating costs was calculated here **408 495 EUR**. Investment lifetime 1 year is estimated, power production is assumed the same each year, 6 752 MWh and produced heat for sale 4 782 MWh each year. Next we observe the main case then project will get State grant 50% from investments cost. Results can see in the Table 2. Additional conditions of calculations - bank loan for 12 years, interest rate 8.15%, estimated inflation 3%. (Table 2.)

7. Sources of financing

The biogas plant and cogeneration unit in Meremäe village (in Kimeko Farm) will be financed from principal sources of financing – own capital, borrowed capital and State (or EU) grant.

Beside of these would be taken into account national private capital (i.e. private equity under a PPP (public private partnership) and other resources as money from investments companies in the future when the project will reach to investigation phase.

8. Risks of the project implementation

Some principal risks for the project have been selected, which reflect the changes in NPV and IRR values. These are changes in price of electricity, in-

<table>
<thead>
<tr>
<th>Price of Electricity</th>
<th>IRR</th>
<th>NPV</th>
<th>Discounted pay-back period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Euro cent/kWh</td>
<td>%</td>
<td>EEK/MEUR</td>
<td>years</td>
</tr>
<tr>
<td>7.4</td>
<td>8.5</td>
<td>3 988 397/0.255</td>
<td>10</td>
</tr>
<tr>
<td>8.5</td>
<td>16.8</td>
<td>14 758 105/1.135</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 2. Results of economical calculations (50% State grant, 30% bank loan, 20% own capital)
interest rate, lifetime of loan and share of state grant in total investments cost. Calculations show that a 26% decreasing of interest rate (what is possible in the nearest future) and shortening of loan lifetime by 2 years causes approximately 12% decrease IRR of the project and 76% increase NPV of the project. Decrease in electrify price make the project more profitable in terms of both, IRR and NPV and payback time will become shorter by one year. Naturally, increases in operating expenses make the project less profitable.

Other calculations show that by half decrease of state grant (from 50% to 25%) will demand major share of bank loan and own capital. If the lifetime of bank loan is 10 years, interest rate is 6%, estimated inflation is 3% as in previous case the project don’t become profitable at all.

If total investments are 40 MEEK (2.6 MEUR) then 10 MEEK state grant, 0 MEEK bank loan and 10 MEEK own capital are calculated.

The risk assessment indicate that the major risks of the project appear to be changes in electricity price and in share of state grant of total investments cost. Revenues and the required amount of investments are essential too. Risks of a lesser extent are changes in the discount rate and operating expenses. However, it has to emphasize that sudden change of all factors (risks) and arising barriers can have mortal effects on the overall profitability of the project.
FEASIBILITY STUDY. LATVIA

1. Short description of selected object – Chain Model

The current feasibility studies consider the setting of combined heat and power station (CHP) working on biogas which may be received from agricultural energetic cultures (for example corn) and organic waste from cattle in Viļāni Rural Area at the base of one of the two biggest agro-industrial / zootchnical farms in the Pilot Area - Joint stock company “Viļānu selekcijas and izmēģinājumu stacija” (Viļāni Selection and Research Station) with cattle population of 600 cows. JSC “Viļāni Selection and Research Station” (VSRS) is located in Vilani civil parish, Rezekne district. VASS covers the area of 1105 ha. The staff of the station constitutes 85 person. The company was established in 1956 as a state farm “Viļāni”, transferring Osupe Flax Cultivation Station from Galeni civil parish, “Preili district”. In 1958 a collective farm “Vienota saime” was joined to a state farm “Viļāni” and in 1969 the company was enlarged adjoining a collective farm “Narodnaja pobeda”. As the result of privatization in 1990s the state farm was reorganized as a joint-stock company “Viļāni Selection and Research Station”. The main spheres of activities of VSRS are the cultivation of grain, potatoes and flax cultivation for seeds, dairy cattle-breeding, agro technique services, a hotel and a cafe “Pie Kaupra”. Since 1997 JSC “Viļāni Selection and Research Station” has been organizing agricultural exhibitions in cooperation with Latvia University of Agriculture, colleges, agricultural selection stations and farms.

2. Definition of project objectives

The economic potential of VSRS and its favorable geographic location allows cost-effective implementation of the project of setting combined heat and power station (CHP) working on biogas. The project is considered as a pilot one for the region as a prospective example of rational use of local bio-energetic resources and implementation of local agro-energetic chain model. Here comes some of the important parameters of Viļāni Selection and Research Station: total sowing area - 1115 ha, int. al., crops (winter crops and spring crops) - 458 ha, corn - 149 ha, potatoes - 15 ha, flax - 31 ha, cultivated pasture - 163 ha, grassland for cutting - 299 ha, Cattle population – 600 cows.
3. Socio-economic context

The region of Vilani has one of the lowest indicators of economic development in Latvia and certainly needs a consequent policy of overcoming the current state. The level of unemployment in the region is about 18% which provides for pessimistic public frame of mind and creates a considerable burden for local social budget. The task of creating new working places takes an absolute priority. Following a decrease of demand on agricultural products and especially because of low prices on milk products the population migrates to the town of Vilani hoping to find another occupation there. To prevent mass departure of active population outward of Latvia the local authorities along with dealing with urgent social items need to facilitate the development of local small and medium enterprises. The most prospective areas of business could be considered the following: processing of food products, wood-processing, collection and processing of residential waste, small repair services of different home appliances. RUE and RES projects could be considered as very important for the general strategic development of the region. Such projects as for example renovation of heat and electricity systems in Vilani may provide a fresh impulse for development of entrepreneurial activity. It’s important to mention that only few months ago the regional reform took place in Latvia. This reform has provided fundamental changes in the life of rural areas in Latvia. Thus the membership of local municipals decreased almost 5 times (!), respectively the new administrative units became considerably larger in comparison with the previous ones. New management of these administrative units is revising regional development plans including their energy development. During this period new ideas on the introduction of contemporary technologies (also in the area of energy production) have more chances to be approved by local administration and receive corresponding financial support. Summarizing this chapter it’s important to mention that current situation in Latvia is rather favorable for developing of biogas co-generation projects in Latvia. Creation of cogeneration working on biogas as a secure and sustainable energy source in Vilani region (which hasn’t got a connection to gas main lines and is highly dependent from the imported from other regions sources of thermic energy – mainly wood) will play a significant role in the improving of

4. Overview of the main features of a good project option selection

The regional structural reform leads to expansion of municipal responsibility to both the urban and rural territory. And now each municipality tries to increase the efficiency of use of energetic resources and provides very rational and even egoistic energetic policy. The pilot region is characterized with rather low speeds of wind (which is understandable as the region is far from the costal line) and absence of access to main gas lines. In these conditions the main source of heat energy is wood chips. Most of them are imported from other regions of Latvia. Fossil fuel in the form of coal and fuel oil (black oil) is produced in a limited amount and increase is not planned. There is a deposit of peat in the region which may cover 10 – 15% of annual consumption of heat energy. The most popular technology is a direct digestion of biomass (mainly cut wood) in the individual houses of rural area and this situation will remain the same in the nearest years as soon as rural individual houses are located rather far from each other and centralized provision of heat energy is not possible in such conditions. Other opportunities could be considered along with the change of individual heating boilers to modern ones working on wood and peat pellets. But the implementation of modern technologies in the individual house holdings is limited with the limited access to the financial resources – again especially now, in the time of crisis. One of the option how to overcome this difficulties is introduction of private-public-partnership scheme. Along with such scheme the local municipality could sign a long-term agreement with a private company which would install the whole new system of heat supply in the town of Vilani using its own resources. There are a number of proposals from differ-
ent companies of such a partnership. According to this scheme the town would collect the payments for heating from users and repay the credit to the company-contractor. The town of Vilani does not accept this scheme as soon as the municipality will receive only the most problematic function - collection of payments of heating. In these conditions the most realistic in the nearest time in the pilot region of Vilani seems to be the introduction of a network consisting of small (up to 1 MW) biogas combined heat and power (CHP) stations on the base of existing relatively large farms. As a raw material they may use cattle manure and silage of different energetic crops. The efficiency of such stations in Latvia is not researched, so local farmers are not ready to invest in them even with the support of the Structural funds. As mentioned above the most prospective model of the energetic development of the pilot region is the creation of a network of CHP stations working on biogas which may be received from agricultural energetic cultures and organic waste (manure) from cattle.

5. Results of feasibility analysis

The Biogas plant will be built at the base of JSC “Vilani Selection and Research Station” (VSRS) which possesses all necessary pre-conditions for implementation of such a project.

VSRS has got milk production from 600 cows and agricultural land in the radial distance up to 15 km. Transportation of raw material at the distance up to 15 km could be considered as cost-effective. As additional source of raw materials cow manure from another big cattle farm – “Latgale Cattle Breeding Station” (LCBS) – could be used. This station is situated at 10 km distance from VSRS. At present all manure from LCBS is used for fertilizing of agricultural land belonging to LCBS. According to preliminary agreement cow manure from LCBS could be sold for biogas production purposes for the price no less than 4.5 EUR per ton plus transportation. LCBS might be also interested to buy digestate as fertilizer exists in Latvia, so managers of local farms don’t believe in theoretical data and require experiential confirmation of its quality. VSRS does possess enough land both for feeding of its cows and for cultivation of green mass with subsequent co-fermentation. For this purposes VSRS can make available 200 hectares out of its total 1,115 hectares. Percentage of methane in biogas is 53 % on average and could vary depending on the quality of silage and consistence of cow manure. It is possible to increase methane percentage up to 53 – 68 % diversifying the consistence of cow feeds.

Very important pre-condition for project implementation is availability of residential houses (the district of Jaunvilani) situated at a distance of no more than 1 km from the location of future biogas plant and co-generation station. These residential houses will use all heat produced by CHP station in winter – for heating and part of the heat in summer – to produce hot water. Other alternatives of centralized heating in Jaunvilani are rather problematic as soon as it is situated at a distance of 5 km from the nearest heating line and it isn’t cost-effective to build a separate heating line to this district. The rest heat produced by CHP station in summer will be used at the auxiliary business unit – a dryer of chips which will then (in winter) be used as a raw material at the existing boilers in Vilani.

The most important administrative pre-condition of the project implementation is getting quota permission from the Ministry of Economics of Latvia. Without this quota it will be not realistic to implement the project at all because only those entrepreneurs who receive quota would be able to sell electricity produced on the fixed price which is considerably higher than the price of conventional electricity. Next important administrative pre-condition is whether the project will get a 50 % co-financing from European Structural funds. Such program of support for biomass co-generation plants is currently open. So well-prepared and timely submitted projects will have a good chance to get this support. Otherwise the essential changes in the terms of project implementation would be introduced. Regular operation and maintenance of CHP station will be supported with long-term contract
with procurer of the whole complete of equipment including guarantee on the exploitation of equipment. One of the possible procurers of CHP station could be the company “UPB ENERGY LATVIA”. The station provided by this company is successfully functioning in Vecauce as well as in the central hospital of the city of Liepaja. Also the company has got very positive reputation carefully following all contract obligations and providing 24-hour maintenance service to its customers. Producing of thermal energy for local needs are decreasing also quantity of CO₂ emissions thanks to that for the supply of necessary raw materials are necessary transportation services by total scale are lesser than transportation services for fuel supply. In result of process obtained digestate are used for fertilization of local fields. Thanks to its effective operation will increase productivity of cultivated crop, facilitating less consumption of energy for the same amount of cultivated crop. Wherewith facilitating decrease of CO₂ emissions. Very important is ecology aspect of people. Equipments, which operates with large efficiency (and demonstrates cautious attitude to environment) inspires people to other activities, which are cautious regarding the environment.

6. Results of Financial analysis

The financial analysis of the project has taken in consideration some assumptions as:
- electro energy rate is around110 LVL/MWh,
- heat energy rate is around 42 LVL/MWht,
- green mass is around 25 LVL/t,
- manure (animal waste) is around 4,5 LVL/t;
- planned rate of increase considering inflation is considered of the 6%.

The financial analysis shows the FNPV and FIRR in terms of return on the investment cost – FNPV (C) and FIRR(C). It is expected that the project is to generate 18.06% return on investment and the NPV is 689 292 Ls. The discount rate applied for the calculations is based on the weighted average cost of capital.

WACC Calculation

The WACC Calculation (Weighted Average Cost of Capital Calculations) has been calculated in order to determine the cost of capital in Latvia, the Riga Stock Exchange Index average return on investment from 1998 to 2008 was calculated. The calculation is based on the information obtained from www.rfb.lv and is based on DJ RSE and OMX index values. The WACC Calculation is around 8.60%.

The Terminal Value of the Project

Since the equipment in the project is expected to last beyond 5 years, in this case 7 years (12 years in total) the terminal value is calculated, which is later applied in the calculation of FNPV and FIRR in terms of return on the investment cost (FNPV(c) and FIRR (c))as well as return on national capital (FNPV(K) and FIRR(K)).

Payback period

The project’s payback period according to the calculations is expected to 6,15 years. Thus, it is expected that the project will generate positive net cash flow in the year of 2016. For the calculation purposes it was assumed that the net cash flow in 2015 and 2016 will continue to grow at a steady rate of 9% as it’s so from the year 2010 to 2014.

7. Sources of financing

The cogeneration station in “Vilani town” will be financed from 3 principal sources of financing – own capital (400,000 Ls), borrowed capital and an EU grant. In 2009, 1,600,000 Ls at a rate of 10% are to be borrowed so as to finance the building and installation costs of the project. In 2010 the EU Grant worth 1 million last will be obtained and immediately the amount will be paid back to the bank as a principal amount. (Table 1.)
Four principal risks for the project have been selected, which reflect the greatest changes in FNPV and FRR values. These are changes in operating expenses, required investment for the project, the discount. If there is a 10% of changing in operating expenses irrespective of its direction causes approximately a 1% change in the project’s FRR/C and a 1.5% change in the project’s FRR/K. Decreases in operating expenses make the project more profitable in terms of both, FRR and NPV. Similarly, increases in operating expenses make the project less profitable. While a 10% of decreasing in the project’s required investment sum causes around a 4% change in the project’s FRR/C and a 2% change in the project’s FRR/K. Decreases in required investment amount make the project more profitable in terms of both, FRR and NPV. Likewise, increases in required investment amount make the project less profitable. Regarding to the change in revenues, a 10% increase or decrease in the project’s revenue stream causes around a 2.5% change in the project’s FRR/C and a 4% change in the project’s FRR/K. Decreases in the revenues make the project less profitable in terms of both, FRR and NPV. Increases in the revenues, in turn, makes the project more profitable.

In conclusion, the risks of the analysis indicates that the major risks of the project appear to be changes in revenues and the required amount of investment. Risks of a lesser extent are changes in operating expenses and the discount rate. However, it seems worthwhile to emphasize that sudden changes at a breakneck pace in all mentioned factors can have grave effects on the overall profitability of the project.
FEASIBILITY STUDY. UNITED KINGDOM

1. Short description of selected object – Chain Model

The ‘Sustainable Energy Community’ most developed in the UK pilot area has been a group wishing to develop a farm-based anaerobic digester in Cleobury Mortimer, South Shropshire. The proposed location of the plant not only has good access to a baseline quantity of feedstock (dairy slurry) for the plant but could also realistically supply the heat production envisaged from the plant to the site itself and several other large hear users neighboring it. Anaerobic Digestion of the farm waste available on site alone is not sufficient to produce commercially viable quantities of biogas, however, a number of sources of domestic and commercial food wastes (from catering and food processing industry) have been identified through this study. Neighboring farms within a small radius (e.g. no more than 3km) may be able to supplement the quantity of farm waste available (mainly as farm yard manure from beef cattle operations and poultry litter). Encouraging neighboring farmers to contribute may be difficult due to bio-security concerns, the changes in operation required and significant additional costs of transporting farm waste to the site. Whilst a reciprocal arrangement recognizing the potential added nutritional value (and quantity) of the digestate available at the end of the anaerobic digestion process may be possible and encourage neighboring farmers to contribute this added value is as yet unknown.

2. Definition of project objectives

The main objective of the RADAR project is to identify a source of renewable energy using local (farm and forestry based) resources and an appropriate technology to utilize this. This will have the subsequent benefits of mitigating the CO2 emissions arising from the local and global consumption of energy. Given the RADAR project’s objectives this is specifically concerned with maximizing the use of any ‘residues’ from local agricultural and forestry activity although non bio-energy technologies may well be appropriate also. In the context of the UK pilot area located in South Shropshire the most community support for the project was received in the town of Cleobury Mortimer. Given its large rural hinterland predominated by mixed-farming an anaerobic digester based on a large dairy farm adjacent to the town has been chosen as the most appropriate project to take forward. A pilot area of some 400km² was chosen for the project encompassing various ‘wards’ of the former South Shropshire and Bridgnorth districts as shown below:
Data was collated for the entire project area through an exercise termed ‘Description of the Pilot Area’. This looked at:

- Energy demand: the total demand for mains gas and electricity as well as LPG and heating oil for use in buildings in the area.
- Resources for the potential generation of energy from agricultural and forestry residues in the pilot area.

A key aim of this project is to move from theory to practice and so a suitable individual scheme in the pilot area had to be chosen to enable an even more localized study of an supply chain either drawing on resources from the whole area to serve particular premises or concentrating on one localized major scheme. Ideas for this included:

- Wood chip supply for a number (say 12) of large (i.e. over 40,000kWh per annum) heat users throughout the pilot area.
- Briquette manufacture taking waste wood from small timber processors across the pilot area and beyond for use in heating their own workshops and for sale to users of solid fuel.
- A large (2MW+) biomass power (& heat) station located at the best location within the pilot area.
- A farm-based anaerobic digestion plant co-digesting other waste from commercial and domestic sources providing heat to a localized network of users and electrical power for export.

The latter was chosen as the ‘definitive’ model as this had the most community backing from members of the community in Cleobury Mortimer in the South East of the pilot area. In addition a reasonable amount of background work on such a scheme had already been carried out including a ‘Low Carbon Communities’ pilot project by the County Council as part of their Local Area Agreement to reduce CO₂ emissions.

3. Socio-economic context

The benefit of generating energy from local resources on the local economy is twofold:

- It will reduce the expenditure on bought-in energy leaving the local economy.
- It will act as a new source of income to the direct stakeholders in the local community.

At the same time it is envisaged that considering energy resources in this localized context will stimulate further activity to reduce energy consumption amongst local residents as their awareness of energy issues increases. Given that the plant will need to take in food waste from local food processing industry and commercial catering outlets it will also ensure the local recycling of waste, possibly reducing waste disposal costs to local businesses, and avoidance of methane emissions from landfill. Again, this may improve awareness of waste issues amongst local businesses.

4. Overview of the main features of a good project option selection

In particular its work with 50 businesses in the town has led to 22 low energy lighting ‘makeovers’ and 10 significant energy efficiency or renewable energy projects (including an 11kW wind turbine and numerous solar hot water installations) being implemented in the town making a total saving of some 50 tones of CO₂ and around £10,000 in energy costs per annum. Representatives of many of these businesses are now heavily involved in taking the RADAR feasibility study forward. This recent activity was further inspired by a presentation on the similarly sized town of Gusing in Austria, which is entirely heated and powered by a renewable energy CHP station, and the presence of another local scheme to encourage share offers in significant local renewable energy installations to be issued in order to raise capital and give the community some
of the financial benefits of the installation.

**The agro-energetic chain resource and Urban wastes**

Resources from agricultural activity for potential Anaerobic Digestion had been specifically identified in the pilot area description and are represented by 160,000 tonnes of slurry from dairy cattle, farmyard manure from intensive beef cattle and litter from housed poultry may be available per annum in the 400 km² pilot area. This could result in the production of approximately 28.65 GWh per annum Gross Energy if aerobically digested. However, if a proportion of this were to be utilized economically it is likely that facilities would need to be highly concentrated to a few (approximately 10) locations. One of these, it is proposed, is the dairy farm at Mawley Town Farm, Cleobury Mortimer. Although the farm itself can supply a significant quantity of feedstock this is deemed insufficient to base a technically and financially viable plant upon due to the relatively low gas yield available from these feedstock. A recent study on The Development of SME Commercial Waste Projects in Shropshire and Telford & Wrekin commissioned by WRAP and Shropshire & Telford Local Authorities directly identified the likely quantities of catering waste in Cleobury Mortimer and to the neighboring towns of Tenbury Wells. The total potential available commercial catering waste was therefore calculated as some 1,022.4 tonnes per annum Bewdley and Kidderminster. Significant primary research and use of local knowledge was required in order to estimate the annual potential quantities of bio-degradable waste in the area. Although this is mainly commercial waste there is one local district engaged in segregating food waste; Wychavon District Council. If the proposed AD plant could offer a more financially attractive route to disposal then a proportion of this waste may become available to it. No other district authorities currently have plans to collect segregated food waste from households. A number of other potential local sources of food waste were identified by the SEC including Kerry Foods Jam Factory in Burford which currently disposes of approximately 1,820 tonnes of liquid waste containing 10-20% sugars. A final figure of some 28,500 tonnes of waste per annum suitable for anaerobic digestion was identified from within a 10 mile radius (plus Wychavon). The SEC were consulted for their consensus as to what proportion of this waste may be realistically captured. It’s essential that the feasibility study should be based on an anaerobic digester facility of no more than 10,000 tonnes per annum (mixed farm and food waste) in capacity.

**Optimal Utilization of Biogas**

An early proposal for the project involved the possibility of supplying biogas to end user appliances. However, this has never been achieved in Europe and would require significant technical hurdles to be overcome. Given the value of renewable electricity, outlined below, this was not investigated any further.

**Electricity Generation Potential**

The UK Government recently proposed some very generous tariff rates payable on the generation of renewable electricity. For CHPAD it is proposed that every unit generated will attract a ‘feed in tariff’ of 11.5p (10 euro cents at today’s exchange rate). In addition a payment of 5p/kWh is proposed for every unit that is exported. Given that the site will mainly be exporting electricity if the gas is to be utilized through a CHP generator then an income of over £300,000 per annum could be expected from a plant based on the feedstock outlined above; plus there will be an income for the ‘waste’ heat.

**Heat utilization – quantity**

Despite the heat being of lower value than electricity it is, nonetheless, likely to be essential to the financial viability of the plant. However, the proposed plant would be estimated to produce some 2,000,000 kWh of heat energy per annum and so there is significant excess. If neighbouring heat users can be brought into a district heating scheme buying their heat at a guaranteed rate of 6p/kWh (output) for the next 20 years then the difference to the annual income in utilizing all of the excess heat and utilizing none of it is around £98,721 per annum. In reality there is sufficient localized demand to utilize 93% of the heat generated and so potential income is almost maximized.
Waste Gate Fees
In the UK the cost of disposing of waste to land-fill is now set at some £58 per tonne and this is set to rise significantly as more and more waste is required to be diverted from land fill. Therefore, a charge of anything less than this is commercially attractive to a business wishing to dispose of waste. A gate fee of £50 per tonne could therefore be applied to the potential incoming food waste in order to calculate total income (a cost of collection has been factored into operating costs).

5. Results of feasibility analysis
In theory the study has identified the potential for a plant with a capacity of some 21,000 tonnes per annum although it is likely that there are many more viable sources locally. The community consider that a realistic capture rate to base a plant size and business plan on may be just 60% of this potential which would still be sufficient to provide the identified heat requirements; it is on this basis that the feasibility study has been carried out. It is estimated that this would have a build cost of some €2 million and operating cost of €290,000 per annum with income of €620,000; this is largely dependent on the proposed new feed-in tariff of 11.5p/kWh for CHP AD and generation tariff of 5p/kWh which are proposed to be paid for 20 years. For CHP AD it is proposed that every unit generated. Given that the site will mainly be exporting electricity if the gas is to be utilized through a CHP generator then an income of over £300,000 per annum could be expected from a plant based on the feedstocks outlined above; plus there will be an income for the ‘waste’ heat. This is based on the use of a Jenbacher biogas engine with a thermal efficiency of 43.5% and electrical generation efficiency of 40.5%. If heat alone were to be utilized the same plant could only yield a maximum income of around £225,000. It is clearly, therefore, a more rational use of the resource to utilize the gas through CHP. The proposed plant will of course result in the displacement of both heating fuels and the use of electricity from the national grid which has direct CO2 savings from the avoidance of combusting fuels for heat power generation respectively. However, more significant than these CO2 savings are the capture of methane emissions and their conversion to CO2 through the anaerobic digestion process and burning of the biogas in a CHP engine to generate the heat and power. The co-digested food waste would also emit methane over time if disposed of to landfill or through composting. Although this may be captured/reduced in either of these processes this very much depends whether the alternative disposal route would have measures to mitigate this and there would inevitably be some fugitive emissions. It’s estimated a Net CO2 emission avoided about 5752 GHG/y

6. Results of Financial analysis
Based on the plant size and potential incomes outlined above the following capital and operating costs were used for a financial model of the plant (over 20 years). It should be noted that, although hopefully within the right order of magnitude, these have been assumed purely as a financial ‘scenario’ for the purposes of this feasibility study exercise and will require much more detailed specification for building up a business case. Many of these figures have been calculated through information available from other RADAR partners developing bio-digestion projects, most notably Talinn University of Technology. The total capital cost is estimated around 1,989,000 €, while the operative cost is estimated around 9,945 €/y. The NPV & IRR Analysis shows that, if the discount rate of 6% being applied the plant would have the discounted cash-flow with a total NPV and IRR after 20 year of around: NPV of €1,732,358 and IRR of 15.4% before the impact of any potential capital grants are considered.

7. Sources of financing
In addition planning permission and Environment Agency enforced regulations have been investigated. As the UK Government recently unveiled its
‘Implementation Plan for Anaerobic Digestion’ it is reasonably likely that Regional Development Agencies will identify specific grant funding streams for the installation of anaerobic digesters (principally through the Rural Development Programme for England). However, at present it is unknown as to how these may interact with the proposed feed in tariffs as far as remaining below the ‘de minimus’ state aid threshold (i.e., no more than €500,000 over a 3 year period) is concerned. However, it does seem likely that some level of grant funding may be attainable. The next stage is to work up a fully costed business plan in order to attract the necessary bank loan for the outstanding finance required. This is required in order to work up the community share offer and so can be supported (in terms of further professional fees) by that scheme.

8. **Risks of the project implementation**

One of the main risks in the plant going ahead at all is the need to comply with a whole raft of regulation. However, the need to comply with these regulations should result in the risks the regulation is designed to avoid being mitigated over the lifetime of the project. The main regulations concerned are:
- Development Control (Planning Permission)
- Waste Disposal (Environmental Protection)
- Animal By-Products (Health Protection)

**Sensitivity analysis - Feedstock Supply**

The main risk to the operation and financial viability of the plant over the 20 year period is the ability to continue to capture the quantities and types of feedstock envisaged in the modelling that the income is based on (and assume that an income or at least no cost can be attributed to disposing of these feed stocks. The discounted cash flow included above assumes a gate fee or fertilizer sale value can be charged for the lifetime of the project. Sensitivity analysis shows that 10% less (commercial) feedstock per annum would result in an IRR of 9.4% (5% less than optimal) and NPV of just €576,990 (just 33% of optimal) and so the potential impact is significant. The greatest risk to the estimated income of the proposed plant is the ability to capture the feedstock identified and any costs of doing so as they are from a large number of sources and competing (cheaper) disposal routes may become available. However, at present this in itself could present itself as an income stream for the plant as a ‘gate fee’ (i.e. less than landfill tax) per ton may be chargeable.
FEASIBILITY STUDY. ITALY

1. Short description of selected object – Chain Model

The Univpm as partner of the RADAR Project “Raising awareness on renewable energy Developing Agro-Energetic chain models” studies the viability of using wood as an energy source to heat public buildings in the Pilot Area “AltaVellesina” inside of the Marche Region (Italy). On the basis of agro-energetic chain model, the bi-polar system has granted by local SEC. As consequence, the report summarizes the preliminary assessments realized for the installation of biomass cogeneration systems (electric and energy production) for two different areas. As selected objects of the feasibility study, an assessment of a conversion to biomass heating at the “Citta della degli Studi - Campus of Fabriano” and the realization of a heating district in the industrial area of “Mergo” are taken in consideration. If all buildings involved in the facilities studied here will be heated with biomass heating systems, it would require a total of 10,000 – 11,000 tons of wood chips per year. Assuming that a wood-chip system can replace more or less 90% of the annual heating load, biomass fuels would replace more of 500,000 m³ of natural gas, equivalent at more of 400 TOE. The municipalities inside of the pilot area are planning the harvesting of forestal wood with effective economic conditions for near future. From a programmatic perspective, there are numerous opportunities to make a state-wide effort to convert schools, municipal buildings and other facilities to biomass, well within the amount of biomass potentially available for use. Among the schools, with consumption less than 15,000 m³ of natural gas per year may be good candidates for semi-automated wood-chip systems. Among the facilities studied, those using natural gas for space heating had a better potential for savings when natural gas consumption was more than 25,000 m³ of natural gas per year.

2. Definition of project objectives

The agro-energetic chain model of the Italian pilot area is represented by wood-energy chain. The analysis of biomass supply of the pilot area evidences as the wood biomass comes mainly from the agricultural field in the east zone, and from the forest field in the west zone. On the basis of localization and characterization of the local biomass, the SEC has also caught up the decision of to consider two different biomass power plant installation (Bi-polar model chain) in order to valorise the kind of biomass deriving by fore-
stal and agricultural local sectors. This chosen is in agreement with the agro-energetic chain model and it also valorises the social, environmental and economic aspects, which are typical of the local area. The objective is to conserve, protect, improve and develop the natural resources for the citizens of Pilot Area of the Marche Region assisted by farmers associations which provides private land owners with the technical assistance to conserve and manage their forests and agricultural lands. The aim of the work is to assess the feasibility conditions for the projects of the Campus in Fabriano and of public buildings in Mergo.

3. Socio-economic context

UNIVPM evaluated the sites and collected the data necessary to conduct these studies in order to assess the biomass fuel availability and pricing for the projects taking in consideration the social environmental and economical benefits that could be produced. The pilot area is strongly characterized by a forestal and agricultural sector very leading, in spite the haverage age of the famers is very in advance. Nevertheless, the activities started in the renewable energy sector thanks to Radar Project, can create a several socio and economical benefits as Energetic authonomy of Public administrations, economic and Energy savings, local resources usage allows new kind of social cohesion, Involvement of local key actors related to biomass production guarantees stable revenues, new job opportunities along the energy chain context, reduction in the fossil fuels dependence.

4. Overview of the main features of a good project option selection

The agro-energetic chain chosen is wood – energy on the basis of territorial analysis carried out on the Pilot Area. Different places have been taken in consideration before highlighting two feasibility conditions: the first represented by Mergo’s municipality where agricultural wood is used as chip for heating district and electricity production; the second analysis is represented from Fabriano’s municipality where the pellet made by Local SRF (Local Short Rotation Forestry) or chips from forestal residues can be used as biomass for heating district of the campus.

Options Identification

Each feasibility study (Mergo and Fabriano’s Projects) foresees to identify a kind to options that are represented more in details from kind of fit biomass for heating with fit technology connected. For this reasons a several options about them have been identified and explained as: Biomass heating Overview and Biomass technology Overview.

5. Results of feasibility analysis

Results of the feasibility analysis of Mergo’s municipality

The Mergo’s municipality foresees to realization of heating district for a couple of manufacturing firms placed in the industrial area of the same municipality, with a maximum distance around 500 m between them. The project also foresees the electricity production transferable to the national grid.

The biomass supply will be represented by agricultural residual wood of olive pruning and popular wood from SRF produced by local farmers and managed by most important Agronomic Company. Paralllely, good informations and strong inputs have arrived by Municipality of Mergo for the developing of the feasibility analysis indicating the fit local place where manufacturing firms are working. The heating place is represented by Industrial area of Mergo with a several small and medium
enterprises are located. In particular, the heating district will be used by complex of manufacturing firms working chimneys for kitchens and laboratories in area interested of around 150,000 m² where the place to heat is around 32,500 m² organized in two industrial building. The heating will be used in order to produce only hot-water heating and not heat for production activities with a heating-district network of 500 m. The industrial area of Mergo’s municipality appears to be a good site for the installation of a centralized fully automated wood-chip heating system only after the heating systems at the industrial buildings are connected. The technology advised for this kind of project is therefore a wood chip boiler with a mobil grid with steam turbine - alternator, for electricity production. The power installing of the power plant has been calculated on the basis both of potential biomass available, than choosing of the public administrators and potential heating demand by industrial district of the Mergo’s municipality. In this case the total power installing in cogeneration system is around 2,2 MWₚ and 0,5 MWₑ with a biomass demand around 8,510 t/y which around 500 t of biomass could come from pruning activities of the agricultural sector while others 8,000 tons per year from poplar wood by short rotation forestry. In this case, the electric power installing is around 500 kWₑ with a time-working of the power plant for 8,000 hours/y and electricity production of around 4,000 MWhₑ/y. It has also supposed the total electricity will be directly given to the national grid thanks to a favourable payment conditions by certification system. (GV – Green Certificate for electricity production by agricultural biomass power plant). In according to the GWP evaluation, the CO₂ equivalent avoided will be done by the CO₂ emissions deriving from gas combustion avoided from industrial buildings complex of the Mergo’s municipality and corresponding to CH₄ not burned (Nm³/y ) 529,626; GWP avoided (t CO₂ avoided/y) 980; TOE avoided (t/y) 430. Results of the feasibility analysis of Fabriano’s municipality

The Fabriano’s Municipality in collaboration with the same County of Ancona where it’s placed, foresee to realize a heating district by Biomass using for a complex of school buildings which would represent the School Campus called “Cittadella degli studi di Fabriano”, building up an high quality study centre available to local citizens.

The feasibility study proposed in this section foresees to realize a heating district for the first complex of school buildings for a total heating area of 4,200 m² with a heating district of around 300 m linear meter. The project also foresees the electricity production transferable to the national grid. The biomass supply will be represented from two options: the first foresees that biomass supply will be represented by wood of Short Rotation forestry derived from local farmers and managed by company “AGO Energy” who will foresee to the local pellet production; the second alternative foresees that biomass supply will be represented by chip forestal wood derived from local forestal consortium. Parallely, not good informations and strong inputs are arrived by Municipality of Fabriano and forestal consortium connected, due both to the less competitive price of the forestal chip than to the guarantee lacking about biomass availability for all time life of the power plant. For this reason, the role played both by Biomass supply activity of the Apiro municipality than the pellet local production made by a energy company “AGO Energy” seems to be the only good occasions and alternative options for the future of this project. The heating place is represented by Campus area of the local Fabriano’s district with a several school
buildings are located. In particular, the heating district will be used by a complex of school buildings of around 17,000 m² where the heating place is around 5,200 m² organized in two big school buildings. The heating will be used in order to produce only hot-water and heating space with a network of heating district of 500 linear meter and with a power plant place near to first school building. An area for storing pellet and wood chip will be also planned. The Fabriano’s school campus appears to be a good site for the installation of a centralized fully automated wood (pellet/chip) heating system only after the heating systems at the school buildings are connected. In this case the total power installing in cogeneration system is around 611 kWt and 141 kWe with a biomass demand around 2.670 t/y of forestal chips or 1.600 t/y of agro-pellet by Short Rotation forestry. At last point but not less least, the substitution of the gas consumption with biomass means less dependence by fossil fuel use that in other words could be translated as less consumption of TOE - Tons Oil Equivalent and estimated as: CH₄ not burned (Nm³/y) 68,896 ; GWP avoided (t CO₂ avoided/y)128 ; TOE avoided (t/y) 57.

6. Results of Financial analysis and Sources of financing

Results of Financial analysis of the Mergo’s Project and sources of financing

Several advantages could arrive to the whole pilot area at industrial, public administrations and agricultural sectors. Infact a fully automated wood-chip heating system to the industrial area of Mergo would decreases the annual heating budget at the facility by about 14%, a economic savings of more than 44,575 €/y in the first year of operation for local industrial sector in the Pilot Area. More in detail all cash inflows/outflows have been calculated and the financial indexes are taken in consideration, as: NPV – “Net Present Value”, IRR – “Internal Rate of Return”, ROI – “Return of Investment”, PBP – “Regular Payback Period”, DPT – “Discounted Payback Time”. At twentieth year NPV would be over 3 million €, with 5% of Interest rate of banking loan taken as assumption, while the IRR and ROI would be 20,93% and 1,42 respectively. While if the inflation rate is assumed around 3% the DPT would be 5,6 years, not so far away from PBP value that is 4,3 years. Paralllely, these types of the CHP projects are most important in the region where are planned, therefore a several local regional fundings can be inquired but not going over the 40% of the investment cost of the project if the GC - “Green Certificates” are considered as incentive system for the electricity selling to the national grid. As consequence the second scenery has been assumed which the regional funding of around 40% of the investment cost of the project is considered. In this case the NPV is less twice greater than the first alternative with a value around 6 million € and the investment cost should be return only after 2 year.

Results of Financial analysis of the Fabriano’s project and sources of financing

Several advantages could arrive to the whole pilot area in particular for school managers and Ancona’s County involved, for public administrations and agricultural sectors. Infact a fully automated pellet combined and/or wood-chips heating system to the campus area of Fabriano would decreases the annual heating budget at the facility by about 57% and 65% respectively, with a economic saving of more than 5,000 €/y in the case of pellet is chosen as fuel, or .000 €/y of economic saving in the case of wood-chip is used as alternative fuel during the first year of operation for local school buildings of Fabriano district. If the forestal wood-chip is considered as principal fuel. At twentieth year NPV of savings would be over 310,000€, with 5% of Interest rate of banking loan taken as assumption, while the IRR and ROI would be 10,94% and 0,41 respectively. While if the inflation rate is assumed around 3% the DPT would be 8 years, not so far away from PBP value that is 6,5 years. Parallely, these types of the CHP projects are most important in the region where are planned, therefore a several local regional funding can be inquired but not going over the 40% of the investment cost of the project if the GC - “Green Certificates” are considered as incentive system for the electricity selling to the national grid. As consequence the sec-
ond scenery has been assumed which the regional funding of around 40% of the investment cost is considered. In this case the NPV is less twice greater than the first alternative with a value around 1 million € and the investment cost should be return only after 3-4 years.

7. Risks of the project implementation

Risk Analysis of the Mergo’s Plan
The Mergo’s Plan has a good conditions to be realized due both to the stable biomass cost (60 €/t) than to the high chance to obtain part of regional fundings. If the some condition will change in the short time the prevision of the feasibility will be change. In the worse conditions, if the cost of biomass will be greater of the 110 €/t, only the allowable public fundings (up to 40% of the investment cost) will allow the feasibility of the project (Worse Scenario). Reducing the price of the biomass up to 86 €/t, the feasibility condition of the project could be also improved without regional fundings. This value of the biomass cost represents the acceptable level of the risk beyond which would be better not to exceed (Limit Scenario). Fortunately, the price of the biomass cost is lowest then acceptable limit cost, therefore the Risk level can be also considered lower. If the regional fundings will be available up to 40%, the investment cost is strongly advised and the risk could be considered to the minimum level (Real Scenario).

Risk Analysis of the Fabriano’s Plan
The risk assessment of the Fabriano project presents a complex analysis due in part to the alternative to use different wood fuels: wood-chip or pellet considered as options during the planning of the project. The financial analysis shows how to use the pellet is more expensive then use of the wood chip, despite the use of pellet could be a more practical solution for a small power plant like that one of Fabriano’s project. If pellet is considered as solution of the project, the economic indicators show how the feasibility analysis is already to the limit therefore the real conditions would coincide to the acceptable level of the risk. Risk conditions are different if the wood chip is considered as principal fuel of the power plant. The respective financial analysis shows as wide side of risk could be present. The range of the price about biomass cost is very short if compared with the price of the same wood chip of the Mergo’s Project. It can decrease the acceptable level of risk which is due to the different size of the Power plant therefore to different investment cost and operating condition on the total investment cost. In this case the limit cost of the biomass can arrive up to 68 € and public regional fundings are advised as incentive if the project want to be realized with a lower risk side.

Conclusion
In any case the financial analysis shows as the feasibility study proposed could be a positive occasion for the local area, and the virtuos cycle of the renewable energy use could be strengthened. This last statement would be confirmed from a strengthening of the “Agricultural Income”. Infact, the advantages of this virtuos cycle are not directed toward industrial and public administration but also the agricultural sector as said before. The biomass production derived from this last sector represents a “key role” for all renewable chain. The virtuos cycle will be primed if the agricultural farmers involved in the system will have a more stable incomes. In this case the biomass production step would produces a total agricultural income around 560.000 €/year for 9.500 tons/y of biomass sold. Other energetic benefits could weight upon on whole local area are large: the percentage of the renewable energy could be added by the total project to energy balance of pilot area is around 89% with an cost energy saving of around 80.000 €/y and a quantity of avoided greenhouse gases of around 1.000 t/y.
FEASIBILITY STUDY. CROATIA

1. Short description of selected object – Chain Model

The type of Agro-Energetic Chain Model that will be realized in the RADAR Project Pilot Area in Croatia is the **Wood-cellulosic heat and electricity chain**. Wood-cellulosic heat and electricity chain is the agro-energetic system that produces thermal and electrical power from locally available, renewable energy sources. A primary material sources used in the Chain is biomass from local forests and wood processing industry. Biomass resources will be collected and transported to the biomass power generation facility which is a plant where electrical and thermal power is produced from biomass. Main technological concept which is involved in the energetic utilization of biomass is using it as a fuel for stationary CHPs to produce both electricity and heat. The use of biomass as a fuel for cogeneration (combined heat and power, CHP) to produce electricity and heat is the most common implementation. Electrical energy produced is fed to the grid and thermal energy produced is distributed among the different end users who belong to the Industrial, Agricultural, Tertiary, Domestic and Civil Sector.

2. Definition of project objectives

The main project objective is to build a CHP plant which will produce electrical and thermal energy. The final local users will be many households which will use electrical energy from a public grid and one municipality building, one primary school and one school sports hall all of which will use the thermal energy produced. General project objectives are energy costs savings, decentralized energy production, implementation of innovative, clean and environmentally friendly technology, production of high quality wood products, high standard working conditions, sustainable family business tradition, development of Kircek Ltd. company and development of **Municipality of Ljubescica**.

3. Socio-economic context

Socio-economic objectives of the project are reduction in fossil fuels dependence, change in the mix of energy sources, e.g. increasing the share of renewable sources in the energy balance – with a view to achieving the international, European and national objectives of reducing greenhouse gas emissions, energy production diversification and security of supply, development of renewable energy resourc-
es sector in Croatia, reduction of energy imports through substitution by local or renewable energy sources to answer the increased energy production which will cover a growing energy demand, economic and energy savings, significant decrease of energy sector environmental impact, high energy and environmental efficiency, creation of new jobs in the rural and urban area, new green and brown field investments in the rural areas, areas of special government care, coastline and islands and rural development.

Potential demand for project outputs – electrical and thermal energy, exists among the different end users who belong to the Industrial, Tertiary, Domestic and Public Sector. The final local users are many households which use electrical energy from a public grid and one municipality building, one primary school and one school sports hall all of which use the thermal energy produced.

4. Overview of the main features of a good project option selection

On the basis of the RADAR Project Pilot Area description and mapping, the final agro-energetic chain model was chosen and it is the Wood-cellulosic heat and electricity chain. The concerned Chain uses biomass as a renewable source of energy. Climatic conventions (Kyoto and Buenos Aires) and the European Union White paper demand a substantial increase in the use of biomass, which can be achieved only if new applications for the use of biomass are developed, like electric power generation or production of synthesis gas from biomass. Gasification seems to have the greatest potential in the Pilot Area, offering great flexibility and high electrical as well as high overall efficiencies.

5. Results of feasibility analysis

Option identification

CHP power plant project will be realized on the premises of the Kircek Ltd. private company, situated in the Municipality of Ljubeštica, Varaždinska County in Croatia. Kircek Ltd. is a producer of solid wood panels and has a constant heat energy demand during production process. Company plans to enlarge its wood drying capacities and will therefore invest in the new and innovative CHP power plant which will produce both electrical and thermal energy.

The quantity of energy produced will be enough to satisfy both the annual energy demand of the Kircek Ltd. company and energy demand of the few public buildings in the Municipality of Ljubeštica. The CHP's are containerised, reliable, fully automatic units comprising: gasification reactor, chute, gas cooler, heat exchangers, scrubber, gas engine, exhaust system, emergency flare and control system. Approximately 52% of available energy is converted to heat and 25% to electricity.

The rest of the energy is lost in the process and cannot be recovered. Combined heat and power plant uses an innovative process of power production which is based on steam gasification. Biomass is gasified in a dual fluidised bed reactor. The producer gas (i.e. wood biogas) is cooled, cleaned and used in a gas engine to produce electricity and heat. Electrical energy produced in the CHP power plant will be fed to the grid and thermal energy produced will be distributed among the different end users who belong to the Industrial, Tertiary, Domestic and Public Sector.

The final local users of the energy produced will be many households which will use electrical energy from a public grid and one household, one enterprise, one municipality building, one primary school and one school sports hall all of which will use thermal energy produced in the CHP power plant. The following picture shows the localization of the CHP power plant, grid connections for the electrical energy produced and the heat end consumers. CHP power plant will be localized in the Municipality of Ljubeštica. Total heat energy demand of the planned number of end consumers in the Municipality of Ljubeštica – a municipality building, a primary school and a school sports hall is 350 MWh.
Feasibility analysis

The chosen technology solution is the most coherent one with the requirements of this project. Technology solution was chosen based on the efficiency and quality criterion. Seven people will be employed (and educated accordingly) directly in the Kircek Ltd. – CHP plant operator, to operate the plant. Another ten people will be employed to fulfill the personnel need of the Agro-energetic Chain.

The planned CHP plant will have an electrical output of 900 kWel and thermal output of 1,570 kWt. A total efficiency of CHP power plant will be around 77%. Electricity produced by biomass gasification combined cycle is considered to be a renewable energy and attracts state subsidies.

Total yearly wood chips quantity needed for the CHP plant amounts to approx. 8,000 tons/annum (approx. 7,700 m³/a) with humidity content around 35%. One lorry full of wood chips (approx. 88 tons) will transport biomass approx. eight times a month (two times a week) from Hrvatske šume Ltd. material storage to Kircek Ltd. CHP plant. That will save the costs of biomass transportation, reduce traffic congestion and environmental impacts caused by CO₂ emissions from lorries. Biomass will be transported from material storages of company Hrvatske šume Ltd. to Kircek Ltd. CHP plant from the distances within a radius of ca. 40 kilometres. Relative time for biomass to be transported from material storage to the CHP plant is around 1 hour and transport cost within a radius of 40 kilometres amounts to 19,23 EUR/t. The total supply cost of biomass DDP Kircek Ltd. (Delivered duty paid) amounts to 50,00 EUR/t.

Environmental aspects of the project are favorable. The process doesn't contribute to the increase of atmospheric carbon dioxide concentrations because the gas is not released directly into the atmosphere and the carbon dioxide comes from an organic source with a short carbon cycle. The CO₂ biomass combustion balance is null – no fossil fuels are burned, and production waste (wood biomass) is used to power the plant.

6. Results of Financial analysis

Total investment cost of the Project amounts to 4,741,800,00 EUR. Investment includes the following costs: the cost of project planning, documentation preparation, permits, project management, training and commissioning; the cost of combined heat and power plant facility; the cost of land purchase and the cost of construction of production hall and a warehouse; the cost of heat pipeline construction (2 kilometers); the cost of operational capital; the Total annual expenses of the Project include expenses for raw material (wood chips) and other material costs, maintenance costs, employee costs, depreciation and loan interest. In the first year of operation, total annual expenses of the Project are calculated to 768,858,16 EUR.

The Investment lifetime of the project is 15 years. Prices for the first year of Project’s operation are calculated on the basis of the prices in the year 2009. In the following years of project’s operation, prices and financial calculations will be made on the basis of consumer prices index in Croatia for the year 2008, which amounted to 2,9 %. It is also assumed that the inflation rate in Croatia for the year 2010 will amount to 2,9 %. Total revenues of the project
include the sale of electrical energy produced and value of thermal energy (heat) used for heating one municipality building, one primary school and one school sports hall all of which will use thermal energy produced in the CHP power plant. In the first year of operation, total annual revenues of the project are calculated to 1.225.500,00 EUR.

A planned annual electrical energy production of the CHP power plant will be over 6.750 MWh. Total annual electrical energy produced and sold to the grid will be around 6.750.000 kWh. A Feed-In-Tariff, calculated for the year 2009 according to the Croatian Tariff system for electricity production from Renewable Energy Resources and Cogeneration – biomass resources (wood chips), amounts to 0,18 EUR/kWh. According to the stated parameters it can be calculated that the Total annual electrical energy sales revenues amount to 1.215.000,00 EUR.

A planned annual thermal energy production of the CHP power plant will be 11.777 MWh. The most of the thermal energy produced, around 97%, will be used in the wood production process, for the purpose of wood drying, in the Kircek Ltd. company. Around 350 MWh of thermal energy produced will be sold for the purpose of heating one municipality building, one primary school and one school sports hall. A Heat Tariff is calculated for the year 2009 according to the Croatian Heat Tariff system for thermal energy production, which amounts to 0,03 EUR/kWh. According to the stated parameters it can be calculated that the Total annual thermal energy sales revenues amount to 10.500,00 EUR.

The main results of the Project's financial analysis are Internal rate of return (IRR), Net present value (NPV) and Discounted payback period. Interest rate (IR) taken for the calculations amounts to 4%. Internal rate of return (IRR) amounts to 16,18%, Net present value (NPV) amounts to 5.057.481,00 EUR and Discounted payback period is 7 years.

8. Risks of the project implementation

The main risks of the Project's implementation are major changes in the feed-in-tariff system (the price for electrical energy produced), changes in the price for thermal energy produced, changes in the bank loan interest rate and operational costs changes.

The above mentioned changes would positively or negatively affect Internal rate of return, Net present value, Investment's payback time and Investment's discounted payback time.

7. Sources of financing

The Project will be financed from the 3 main sources of financing – private capital, bank loan and EU grant. Kircek Ltd. company, a solid wood panel producer, will finance 10% of the Project's total investment cost with it's private capital. Bank loan with 4% annual interest rate will be received from the Croatian Bank for Reconstruction and Development. A EU grant for the rest of 50% of the Project’s total investment cost will be received from the WeBSEDFF, a EBRD’s Western Balkans Sustainable Energy Direct Financing Facility.

There are also other sources of financing and financing options available at the beginning of the investment or in the near future. Some of them are Croatian Environmental Protection and Energy Efficiency Fund which approves the interest rate subsidy, Third Party Financing through ESCO companies, Public-private partnerships, commercial bank loans and European Commission's IPARD Programme (Instrument for Pre-Accession Assistance in Rural Development 2007-2013.).
Sweden

FEASIBILITY STUDY. SWEDEN

1. Short description of selected object – Chain Model

In Södra Ljunga, a few kilometers south of Ljungby, the first district heating owned and operated by farmers in the region will be located. The district heating, a network consisting of about 1100 metre pipes, will combust wood chips purchased from local entrepreneurs of the surrounding forests, within a range of maximal 100 km. Three farmers and one builder, founders of the Södra Ljunga Bioenergi AB, will handle the whole biomass chain from the primary product in the forest to the delivery of heat to the customers: a local school, a parish home, six apartments and four one-family houses. The plant will have a lot of advantages: it will be CO₂ neutral; it will guarantee regional development and will reduce and centralize emissions of particles. The heating costs for the customers will be about half the price compared to heating oil. The customers are binding themselves for 15 years. The ashes, which are rich in nourishments, will be mixed with the manure and spread on the fields.

2. Definition of project objectives

The objectives of the feasibility study can be summarize in the table as below.

<table>
<thead>
<tr>
<th>Supply biomass</th>
<th>Technology Type: Harvesting, chipping, transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity:</td>
<td>about 500 m³/år</td>
</tr>
<tr>
<td>Localization: 5 to 100 km from the plant</td>
<td></td>
</tr>
<tr>
<td>Supply cost:</td>
<td>between 47 and 160 €/Srm (7 Srm are about 1 tonne)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Storage/processing biomass</th>
<th>Technology: mobile wood chipper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Localization: forest/plant site</td>
<td></td>
</tr>
<tr>
<td>Processing costs:</td>
<td>between 47 and 160 €/Srm (7 Srm are about 1 tonne), same entrepreneur who is doing all steps of the chain</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Transport biomass</th>
<th>Type of transport: truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance:</td>
<td>5 – 100 km</td>
</tr>
<tr>
<td>Costs of Transport:</td>
<td>between 47 and 160 €/Srm (7 Srm are about 1 tonne), same entrepreneur who is doing all steps of the chain</td>
</tr>
</tbody>
</table>
3. **Socio-economic context**

The plant will have a lot of advantages: it will be CO\(_2\) neutral; it will guarantee regional development and will reduce and centralize emissions of particles. The project contributes to increase the attractiveness of the village and the region and will increase competitiveness. Furthermore, the local produced heat creates independence from fossil fuels therewith fosters regional development and contributes to the reduced climate gas emissions.

4. **Overview of the main features of a good project option selection**

Once the socio-economic context and the potential demand for the project output have been analyzed, then the next step consists of identifying the range of options that can ensure the achievement of the objectives of the project.

Some typical options examples considered are:

- Heat from RES, technologies considered for energy generation projects, local subjects;
- Electricity and heat from RES, technologies considered for energy generation projects, local and regional subjects;
- Different peak-load arrangements for energy supply;
- Energy efficiency improvements rather than the construction of new power plants or boiler houses;
- Solar energy transforming solutions.

5. **Results of feasibility analysis**

**Option identification**

The village was in need for a new heating system. Old oil boilers had to be exchanged. Thus the decision was to research the possibilities for a district heating system. The next step was the identification of the fuel. Two fuels where considered: oat or wood chips. Because prices for oat were rising oat was out of the question and the company decided to use wood chips as fuel.
Feasibility analysis:

Harvesting and extraction
Many harvesting systems for biomass for energy are available today. The extraction of wood fuel can be performed as a single product or as a part of an integrated harvesting system. The choice of a suitable system depends on the type of material to be extracted as well as felling type (final felling or early thinning). In extraction systems where the residue is chipped in the forest, the chips are loaded into containers and road-transported either to the terminal or directly to the consumer. The method of loading the biomass into the vehicle can affect the compaction of the load. Tipping the chips from a chipper bin or loading shovel will be looser than chips blown from a discharge fan into the chip van. The condition of the chipping device and the type of material affect the quality of the produced chips. Comminution using sharp knives produces better quality chips than grinders or shredders. A material such as stem wood could be comminuted into chips with homogeneous particle size and good quality while logging residues and small trees often produce chips with long pieces or high percentage of fine particles. Chipping frozen wood also leads to high contents of fines especially if the knives are in poor condition. The moisture content of the biomass also plays a significant role in the comminution process. Wood fuel with a high percentage of fines or extremely large pieces of wood affects the process of feeding the fuel to the burner as well as the combustion process itself, therefore a good quality fuel should be homogeneous with respect to particle size distribution.

Transport characteristics
The transport of wood fuel is one of the important and most expensive phases in the chain between biomass extraction and combustion. The various forms of biomass necessitate different designs of vehicle, which also depend on the type of road, local transport regulations and the distance of transportation. There is also an increasing concern for the machine specifications as to ground impact and economics as well as environmental aspects such as emissions. The choice of transport system mainly depends on the biomass form, which, in turn, depends on the harvesting system operating on the site and the end use of the biomass. One of the common problems encountered during the transport of forest residues is the difficulty in achieving the maximal load capacity of the vehicle. This is the main reason behind the high costs of transport. The cost of transporting chips, which is considerably lower than for unchipped fuel, is around 20-25 % of the total cost at the end-user. The payload weight was increased from 18 to 23.9 tonnes when it was compacted using a large crane thus saving 20 % of haulage cost. If such handling is introduced it is important to delay the bundling until the green parts have fallen off the fuel fraction in order to avoid ash-and slagging problem during the combustion phase. Wood chips are usually transported by road in containers. A rig carrying three containers, each with a volume of 40 m³, is often used. The normal payload is approximately 33 tonnes. Chips transported between terminal and heating plant are loaded into the containers using a wheel loader.

Storage characteristics
There are many factors concerning the properties of raw biomass that play a significant role during the storage phase. The main factor in storage is the initial moisture content of the material. Moisture content higher than 15 % (green weight basis) is sufficient for the establishment of microbial growth. The type of the material, stem wood, whole tree chips, bark, straw, young plants etc. is another major factor which determines the availability of nutrients for the growth of these microbes and, consequently, the extent of fuel degradation. The particle size distribution of the material is also an important factor which could affect the storage of raw material. Wood chips, produced through the cutting and trimming of undried timber at the sawmill, can be used for pulping as well as for energy production. It has a basic density of about 410 kg/m³ and moisture content of 50-55 %.

Demand for energy: Household heat demand
Generally speaking, the demand for heating with households customers is composed by two com-
ponents – a climatic factor and a social demand. The total demand for heat energy is just above 12,000 kWh/year on average, an amount of energy that must be supplied either by aid of a domestic boiler or by an energy supply system. Peak values are during the period Dec.-Feb. and are typically about 2000 kWh/month while the lowest values are found during June-August and may be down at about 10-20 % of the peak values. The electricity demand is 23 % other total on average, peaking at 58 % in July because of the low heating demand.

6. Results of Financial analysis

The main purpose of the financial analysis is to use the project cash flow forecasts to calculate suitable net return indicators. A particular emphasis is placed on two financial indicators: the Financial Net Present Value (FNPV) or NPV and the Financial Internal Rate of Return (FIRR) or IRR, respectively in terms of return on the investment cost, FNPV(C) and FIRR(C), and return on national capital, FNPV(K) and FIRR(K). The different definitions of net cash flows for the calculation of the project performance indicators has been used. The methodology used for the determination of the financial return is the Discounted Cash Flow (DCF) approach.

7. Sources of financing

The fourth step in financial analysis has been the identification of the different sources of financing in order to calculate the total financial resources of the project. Within the framework of EU co-financed projects, as: community assistance (the EU grant); national public contribution (grants or capital subsidies at central, regional and local government level); national private capital (i.e. private equity under a PPP; other resources (e.g. EIB loans, loans from other lenders). It is important to ensure that the project, even if assisted by EU co-financing, does not risk lacking of cash.

8. Risks of the project implementation

- Cost of the research phase (meaning the prospecting phase for new deposits or research into new technological processes)
- Cost of the project realisation phase (site costs)
- Forecasts of growth rates
- Elasticity of electricity consumption
- Sales price dynamics for energy produced (or energy products)
- Financial values for the energy generated by RES
- Mix and dynamics of critical input costs (fuels, etc.)
FEASIBILITY STUDY, BULGARIA

1. Short description of selected object – Chain Model

European project RADAR is targeted to rising awareness of renewable energy, and developing agro-energetic chain models in chosen pilot areas of participating countries. The pilot area chosen for Bulgaria is the “Pazardjik Region”, situated in the South Central region of Bulgaria. On the basis of the data collected during the preparation of pilot area description and mapping of data base, the agro-energetic chain considered to be realized in the Bulgarian pilot area has been chosen to be the direct use of wood chips for heat production. This choice was made after a number of meetings and discussions with representatives of public authorities in the pilot area. This choice of agro-energetic chain aims first at establishment of a plant for producing fuel from renewable energy sources (RES) (European Parliament and Council Directive 2001/77/EC), namely biomass residues to supply selected public buildings in the “municipality of Panagurishte” - one of the 11 municipalities in the Pazardjik Region.

The objective of this agro-energetic chain model is to change the structure of energy sources used in the pilot area by increasing the share of wood residues in the energy balance. The fuel predominantly used for heating in the Pazardjik region presently is heating oil. Last year the price of heating oil was rising continually; moreover, its environmental impact is strongly negative. The substitution for oil of residual biomass will contribute to reducing heating costs and improving environmental conditions. Another economic advantage of the chosen agro-energetic model is the possibility for reduction of fossil fuels’ import through its substitution by locally produced wood residues. The sustainability and feasibility of an agro-energetic chain depends strongly on the availability of agricultural residues and agro-industrial wastes. Another aspect of the sustainability of biomass-for-energy chain is related to its ecological influence on the environment.

2. Definition of project objectives

Preliminary energy studies in the Pazardjik region (7 municipalities) have showed that the main share of the municipal energy expenses belongs to heating based on oil. An increase in the oil price makes it impossible to maintain a normal microclimate in public buildings (schools, hospitals, etc.). There is a huge need to find alternative solutions based on local resources. The analysis is aiming in creation
of pilot model for these objectives: reduction of energy expenses and CO₂ emissions at local level (pilot municipality of Panagurishte in the region) through substitution of oil fuel with wood chips wood residues for heating and hot water in the public buildings in parallel with implementation of energy savings measures in the entire region of Pazardjik (pilot area).

This choice has been made after a number of meetings and discussions with representatives of regional and local authorities in the region. An additional advantage of agro-energetic chain would be the cogeneration of electricity. The main obstacle to the technology of cogeneration is the fact that in Bulgarian pilot area the ratio between big towns and villages is approximately 1:3. This makes cogeneration ineffective because in summertime there are no consumers for generated heat. The feasibility study has been based on selected definite agro-energy model within RADAR project. The study covers both energy consumption studies and biomass potential studies both for region of Pazardjik and municipality of Panagurishte. The general aim of the feasibility study is to offer short-term help to the smaller municipalities not having the prospect of a natural gas supply in developing sustainable energy concepts. Besides the ecological effects of the substitution for fossil fuels with local resources, the reduction in energy costs for public buildings will make possible their renovation while maintaining living standards. The vision of the future investment project in municipality of Panagyurishte presumes introduction of complex measures for energy efficiency (MEE) and renewable energy sources for heating with priority the substitution of liquid fuels for heating with wood residues with using new combustion systems with efficiency higher than 85%.

3. Socio-economic context

One of the most aspect of the sustainability is related to social issues: the establishment of an agro-energetic chain should bring to the municipality the creation of new employment and an improvement in the living standard. The Bulgarian pilot area is abundant in forests – almost 54% of its territory is forested. The agricultural land in the region occupies 35% of the total area. The prevailing local biomass available under sustainable environmental conditions represents plant residues from the wood and timber industry and from agriculture. The utilization of forest and agricultural residues and waste, on the one hand, contributes to an improvement in environmental conditions, by increasing the opportunities job with decreasing the quantity of waste and hence the risk of contamination, and, on the other, by reducing the area of dunghills.

4. Overview of the main features of a good project option selection

Bulgarian pilot area is abundant with forests – almost 54% of its territory is afforested. The agricultural land in Pazardjik region takes 35%. The prevailing local biomass available under sustainable environmental conditions represents plant residues from wood timber and from agricultural activities. Sustainability and feasibility of agro-energetic chain depends strongly on the availability of agricultural/forest residues and agro/forest-industrial wastes. Another aspect of the sustainability of biomass-for-energy chain is related to its ecological influence on the environment. The utilization of forest and agricultural residues and waste contributes on one hand to improvement of environmental conditions. The region is characterized as having an industrial-agrarian economy, with the manufacturing production prevailing. Most of the public buildings in the region use heating oil for heating. The substitution of heating oil by wood residues is rather promising in view of economic conditions. In Pazardjik region there are seven municipalities that have not forthcoming perspective for gasification in close future. There mainly liquid fuels are used for heating. Municipality of Panagurishte has been chosen as pilot for the model of energy efficient substitution of imported liquid fuels with local renewable energy source - wood biomass.
Results of feasibility analysis

The municipality of Panagyurishte is located in the central part of the Sredna Gora Mountains, in Panagyurishte Valley down the River Luda Yana. The average altitude is 683 m. It occupies 59 891 ha. The average altitude is 683 m. Afforested area is 32 223 ha.

For the purposes of this study an area (the afforested area in the municipality of Panagurishte together with some neighbor forest area for the municipality of Strelcha) is studied for the assessment of biomass potential for application of agro-energy model.

The feasibility of selected agro-energetic model application is localized in the municipality of Panagyurishte. The available wood residues in the municipality are mainly of broad-leaved trees. The forests of governmental property represent 8% of the total afforested area in the municipality, 6.5% represent municipal property. Afforested area in the municipality is 6103 ha, annual growth 86. Estimated energy potential is 48 106 MWh (0.53 PJ). The wood residues produced are estimated at 33 794 dense cubic meters which is 7 times higher than the needs of public buildings in the municipality. At the first stage of the project a complex assessment of 9 public buildings in Panagyurishte is to be performed. For 4 of these buildings detailed energy efficiency studies are elaborated, for the remaining 5, more general ones. These activities are synchronized with the Energy Efficiency Act. They give only the measures for energy efficiency thermo modernization (roof, walls insulation and windows replacement) and do not consider fuel substitution, which is the basic element of the current feasibility study.

An expected result of project implementation is the reduction of CO₂ emissions by approximately 2 500 tons per year for the seven chosen municipalities. Other output of the project is the demonstration of economically advisable and accessible potential for energy production from wood residues from the timber industry in forests neighboring the municipality, and the residues from agricultural production are estimated at 34 000 tons totally. As a result of the detailed or preliminary energy audits, the measures for energy efficiency (MEE) will be developed in complex with the use of new bio-fuel, which is expected to bring at least 35% energy savings in the chosen public buildings.

As a result of the preliminary assessment of municipal energy expenses in Panagyurishte, it has been found that the main costs for energy needs in the public sector form the buildings heated with heating oil (hospital, schools, kindergartens, administrative building). The prices of this fuel rose significantly last year – heating oil costs 218 BGN/MWh, wood chips – 40 BGN/MWh. That is why it is almost impossible to maintain normal living conditions in the buildings. The substitution for heating oil of wood residues is rather promising in view of sustainable economic conditions.

On the basis of existing four detailed and five simplified energy audits of chosen 9 buildings (total area about 36 500 m²), the parameters of the measures of energy efficiency are estimated, as well as their contribution to the common saving and investment, and then the exact quantity of CO₂ emissions saved. An analysis and calculation of necessary investments for the realization of measures for energy efficiency, boiler substitution and chips production are performed.

Similar results on the heating costs will be obtained for 21 public buildings heated by oil in six other municipalities of the Pazardjik region (the total built-up area of 21 public buildings is about 42 000 m²). Table 6 presents a comparative assessment of the expenditure for substitution for heating oil fuel with chips in these 21 municipal buildings.

The energy consumption of heating oil in the public sector of Panagyurishte municipality for a group of nine buildings takes about 1 400 000 BGN. The replacement of oil old boilers with wood chips boilers will cost about 2,0 millions of BGN. The gross final savings of heating-oil replacement by wood would be about 1295 010 BGN per year. That means that the initial investment would be repaid in not more than two years. Regarding to ecological results, the expected reduction of gas emissions after the substitution of oil with wood chips is evaluated as the
replacement with 2.500 t wood chips for heating with respective emissions is around: SO\textsubscript{2} – 75 t/y, CO\textsubscript{2} – 100 t/y, NO\textsubscript{x} – 12.5 t/y.

6. Results of Financial analysis

The whole agro-energy chain (establishment of wood chips production factory for fuel supply, replacement of old boilers in nine selected public buildings in the municipality of Panagurishte, energy efficiency measures implementation) is subject of this analysis. In fact, the oil-based heat supply will be replaced in nine public buildings with an area of 36 000 m\textsuperscript{2} (total consumption of 567 t. oil or 6 520.5 MWh). The replacement will cover 14 oil-based boilers (5,4 MW total installed capacity) by 14 chips-based boilers in those nine public buildings. Wood chips production factory (2500 t/y) will be established. Changing fuel and replacement of the old boilers will be carried out in parallel with the implementation of energy efficiency measures.

Investments structure for changing the fuel

Including all the equipment for the production of 2500 t/y of the wood chip has been estimated around BGN 595,000; while the total operating cost for wood chips factory is estimated 100 630 BGN and respective revenues which are estimated 149 375 BGN/y.

Investment structure of the Energy Efficiency Measures (MEE) implementation in the public buildings

Taking in consideration the Investment and energy efficiency for all 9 public buildings. The first is estimated totally around 1,582,525 BGN while the total Energy saving around 622,730 BGN/y. the energy consumption for the total public buildings, before EEM is estimated near to 6,513 MWh/y while after EEM is 3,606 MWh/y. If the substitution of the 14 boiler is considered the total cost should be around BGN 2 000 000 with a total financial saving of BGN 672 280.

Financial return of investment

At a life of 10 years and discount rate of 7.8 % the different stages of the projects has been assessed. (Table 1.)

After the development of the economic analyses of the project, based on the financial return of investment results, the conclusion is that the project as a whole and its elements are economically very favorable, because:
- Net savings – BGN 1 444 385 -- are high enough to cover the real repayment of the credits in less than five years, which is the requirement of the National Fund for EE&RES;
- NPVQ values – 1,35 -show that for every invested leva the owner of the project will make a clear profit of 1,35 leva after the realization of the project; and
- The value of NPV=5 650 381 BGN of the project is higher than the primary investment

In addition, project implementation has:
- A social effect expressed in the number of new

<table>
<thead>
<tr>
<th>Projects stages</th>
<th>Investment BGN</th>
<th>Net saving BGN</th>
<th>PB year</th>
<th>PO year</th>
<th>IRR %</th>
<th>NPV</th>
<th>NPVQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Chips production</td>
<td>595 000</td>
<td>149 375</td>
<td>4.0</td>
<td>4.9</td>
<td>22</td>
<td>421 380</td>
<td>0.71</td>
</tr>
<tr>
<td>2. Change the oil to chips</td>
<td>2 000 000</td>
<td>672 280</td>
<td>3.0</td>
<td>3.5</td>
<td>31</td>
<td>2 574 338</td>
<td>1.29</td>
</tr>
<tr>
<td>3. EEM</td>
<td>1 582 525</td>
<td>622 730</td>
<td>2.5</td>
<td>2.9</td>
<td>38</td>
<td>2 654 664</td>
<td>1.68</td>
</tr>
<tr>
<td>4. Total for a hole project</td>
<td>4 177 525</td>
<td>1 444 385</td>
<td>2.9</td>
<td>3.4</td>
<td>33</td>
<td>5 650 381</td>
<td>1.35</td>
</tr>
</tbody>
</table>

Table 1. - Methodology used for calculation of EEM&RES is the software product ENSI “Financial calculations” – www.ensi.no
jobs created in the area - nine direct positions and 250 indirect ones;
- An environment effect expressed in a reduction of about 1 500 CO\textsubscript{2} equivalent.

7. **Sources of financing**

The main task for developing the biomass market is to compact the mechanisms for funding the end-user. Unfortunately, the state uses such mechanisms only for electricity production, and does almost nothing in the area of heat energy. A prior national policy and legislation are needed which would support and encourage the initiatives for biomass usage for heating. At this stage, there is only a RES law and the indicative goals on the national level.

The management of the structure funds is a characteristic example of the present situation from municipal point of view. The funding of EE&RES in the public sector – schools, kindergartens, hospitals, cultural and administrative buildings -is managed by five different ministries and a few more agencies. There is a lack of a mechanism supporting the implementation of an energy policy at local level. In fact that rural agricultural residues has also significant energy potential, but still the small and separate farms owned by small owners do not allow planning and management of the process on a larger scale.

8. **Risks of the project implementation**

The feasibility study in the municipality of Panagurishte shows that all possible elements of the wood-chips model are available. The following risk and project-sensibility factors are estimated:

**Availability and accessibility of wood biomass for heating of selected buildings (36 000 m\textsuperscript{2}).**

There are not any objective risks related to the amounts and prices of necessary feedstock. What is more, this local resource is the only alternative to fossil fuels for heating.

**Technological and technical risks**

- The technology, equipment and organization of wood fuel (chips) is well-defined, and available on the market at acceptable prices that do not exceed 25% of the total amount of the project budget.
- The technology, equipment and organization of replacement boilers based on chips are available on the market. They cover the whole spectrum of installed capacities that are needed for the buildings, and good experience has been accumulated in individual buildings in the country.

The main difficulties are in the application of fuel production and wood chip boiler technologies derived from the need for discussing the subject of making guarantees to end-users (municipalities) on fuel purchases for periods of not less than 10 years. There is a need for coordinated actions between partners in the chain. This factor is at the moment the most risky for the project. There is a lack of experience and good practices of participation on the part of numerous different partners, as well as a good legal framework of such cooperation. Such approaches as a chain cluster and a public-private partnership, ESCO financing, etc. are rare practices in Bulgaria. It is evident that this is the main risk for implementation of the project.

**Conclusion**

Common efforts are needed – on the part of the state with its regulations and of entrepreneurs and financial institutions alike. Targeted regional and local information campaigns are vital for raising awareness among different actors to facilitate their cooperation in the field of biomass utilization and its promising application for heating of public and residential buildings.
Set of indicators to evaluate efficacy and efficiency of feasibility studies and comparison results

Introduction

The “kit of indicators” listed in this paper is foreseen within project with the aim to evaluate the efficacy and efficiency of Feasibility Studies that Partners have elaborated on the agro-energetic chain model chosen by each Rural SEC. The results obtained from Feasibility Studies of homologous chains will be compared through this “Kit of Indicators” in order to establish which model is the most efficient. Consequently, the less one will be modified.

The indicators listed below have been proposed and discussed by all Partners during the III SSTC Meeting, and they have been formalized by the WP 4. phase responsible.

Partners calculated the correct value of the indicators on the results obtained from the Feasibility Study and completed the table below, in order to allow the results comparison.

Selection and description of indicators

Three groups of indicators to evaluate efficacy and efficiency of feasibility studies and for its comparison in the form of table were elaborated (Table 1).

Environmental indicators - avoided greenhouse gases per year [tCO2ekv/y] (tons equivalent CO₂ that accounts different fuels, for biogas produced from slurry is higher than for wood) and total amount of avoided greenhouse gases per project lifetime [t/lifetime] – for instance 12 000 [t/15 y]. If somewhere was changed fuel - from oil to wood for instance – then avoided SO₂ and NOx were shown too per year and lifetime.

Social indicators - number of created jobs. If it was possible the number was divided into two parts – direct jobs and indirect jobs (place of work).

Economical indicators – turnover (income/revenue) per installed capacity [€/MW]. Here was used estimated turnover or revenue after put into operation the project on normal load, but at energy prices at 01.07.2009 in each country. Produced energy (power and heat or both) per installed capacity [MWh/MW]. It shows how efficiently project works. If boiler with high capacity produces small amount of heat it works inefficiently and gives less income. IRR and NPV are the indicators what were presented too.

Percentage of renewable energy added by the project to energy balance of each pilot area. It means how many percent will raise the share of renewables in the energy balance of each pilot area. For example before project it was 5% and after going into operation of new project it will rise to 10% - growth was 100% or two times. It shows the situation of renewable energy use and share of renewables in balance today and how much the project
will improve this situation tomorrow. Surely to start from low level is better to get high percentage, but if the share is small your project more needed.

Money (finances) stays in the region in year due to project implementation (realizing). It means that according to this investment we use more local biomass (biogas) resources, produce heat and power and we don't need to buy fuel (energy) from outside of pilot area.

Table 1. The indicators to evaluate efficacy and efficiency of feasibility studies

<table>
<thead>
<tr>
<th>Description of the Indicator</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENVIRONMENTAL INDICATORS</strong></td>
<td></td>
</tr>
<tr>
<td>Avoided greenhouse gases per year</td>
<td>tCO₂ekv/y</td>
</tr>
<tr>
<td>Total amount of avoided greenhouse gases per project lifetime</td>
<td>t/lifetime</td>
</tr>
<tr>
<td><strong>SOCIAL INDICATORS</strong></td>
<td></td>
</tr>
<tr>
<td>Number of created jobs</td>
<td></td>
</tr>
<tr>
<td>Direct jobs</td>
<td></td>
</tr>
<tr>
<td>Indirect jobs</td>
<td></td>
</tr>
<tr>
<td><strong>ECONOMICAL INDICATORS</strong></td>
<td></td>
</tr>
<tr>
<td>Turnover (income/revenue) per installed capacity</td>
<td>€/MW</td>
</tr>
<tr>
<td>Produced energy (power and heat or both) per installed capacity</td>
<td>MWh/MW</td>
</tr>
<tr>
<td>IRR</td>
<td>%</td>
</tr>
<tr>
<td>NPV</td>
<td>Euro</td>
</tr>
<tr>
<td>Percentage of renewable energy added by your project to energy balance of your pilot area.</td>
<td>%</td>
</tr>
<tr>
<td>Money remaining in the region in year thanks to the project implementation.</td>
<td>€/year</td>
</tr>
</tbody>
</table>

The results of comparison of project partners indicators
### Table 2. The comparison of technology and fuels

<table>
<thead>
<tr>
<th>Description of the indicator</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avoided greenhouse gases per year</td>
<td>tCO₂/y</td>
<td>1 053</td>
</tr>
<tr>
<td>Total amount of avoided greenhouse gases per project lifetime (15 years)</td>
<td>t/lifetime</td>
<td>16 680 - 22 160</td>
</tr>
<tr>
<td>Number of created jobs</td>
<td></td>
<td>Direct jobs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Indirect jobs</td>
</tr>
<tr>
<td>Turnover/revenue per installed capacity per year</td>
<td>€/MW</td>
<td>1 805 (el)</td>
</tr>
<tr>
<td>Benefit per installed capacity per year</td>
<td>€/kW</td>
<td></td>
</tr>
<tr>
<td>Produced energy per installed capacity</td>
<td>MWh/MW</td>
<td>8057</td>
</tr>
</tbody>
</table>
### Table 4. The summary of indicators

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Description of the Indicator</th>
<th>Partners total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENVIRONMENTAL INDICATORS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avoided greenhouse gases</td>
<td>tCO2eqv/y</td>
<td>22 623</td>
</tr>
<tr>
<td>per year</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total amount of avoided</td>
<td>t/lifetime</td>
<td>437 050</td>
</tr>
<tr>
<td>greenhouse gases per project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lifetime</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SOCIAL INDICATORS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of created jobs</td>
<td>Direct jobs</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Indirect jobs</td>
<td>301</td>
</tr>
<tr>
<td><strong>ECONOMICAL INDICATORS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turnover (income/revenue)</td>
<td>€/MW</td>
<td>Average 476 591.5</td>
</tr>
<tr>
<td>per installed capacity</td>
<td></td>
<td>5 643.3</td>
</tr>
<tr>
<td>Produced energy (power and</td>
<td>MWh/MW</td>
<td></td>
</tr>
<tr>
<td>heat or both) per installed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IRR</td>
<td>%</td>
<td>Average 20.34</td>
</tr>
<tr>
<td>NPV</td>
<td>M€</td>
<td>14.87</td>
</tr>
<tr>
<td>Percentage of renewable</td>
<td>%</td>
<td>Average 37.4</td>
</tr>
<tr>
<td>energy added by your project</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to energy balance of your</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pilot area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Money remaining in the</td>
<td>€/year</td>
<td>3.865</td>
</tr>
<tr>
<td>region in year thanks to the</td>
<td></td>
<td></td>
</tr>
<tr>
<td>project implementation.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The different agro-energetic chain model, wood-energy and biogas agro-energy chain has been selected by different European countries as best solution in order to analyse the feasibility conditions for a concrete realization.

On the basis of respective biomass potential analysis, partners as Italy, Croatia, Bulgaria and Sweden have preferred the wood – energy, while Estonia, Latvia, UK have oriented their chose toward the biogas chain.

Several conditions of planning, territorial management and different market develop a different results about feasibility study despite some countries has the same energetic – chain.

Regarding to the Wood energy, the gathering and transportation of biomass for chips production requires a high level of cooperation between the forest owners, amongst which the biggest is the state – it is the major owner of forests as example in Bulgaria.

This is an advantage which is supposed to give opportunities and good examples; unfortunately, it is one of the obstacles to biomass usage as well.

Still, in the commonly approved 10-years forestry plans, there are no economic indicators for the energy potential of the wood waste and mechanisms for its utilization.

The main barriers are connected to the lack of knowledge about the opportunities for wood residues utilization for energy needs, the lack of cooperation between the forest authorities, and the local authorities, as sometime it's verified in the Italy country but not in Sweden.

The biomass usage for energy purposes is an entirely new philosophy in Bulgarian and Croatia country, less in Italy and less than in Sweden, and that's why it requires a new way of thinking on the local level as well as on the national level.

For this reason the collaboration between partners and comparison of the results is a good tool and useful for all these countries where the new conception of the renewable sources is already bit unknown.

Moreover, the experience of the municipality of Bulgaria and Italy, showed that the decisions for realization of the different steps of an agro-energetic chain - the fuel production (chips) and the change of the heating boilers in public buildings - are inter-related, but also meet great barriers.

The actors, the businesses and the municipality cannot cooperate.

For instance, in the Bulgarian situation the public-private partnership (PPP) approach has already been discredited because of its application in illegal wood industry.

As a result, every decision can last for years despite the feasibility study shows as the economical/environmental conditions are very profitable.

In particular in Italy, where how the analysis of the potential investments developed shows as the feasibility studies proposed could be a positive occasion for the local area and in particular for final users and public sectors involved, so that the virtuos cycle of the renewable energy using could be strengthened if the regional fundings are available for local investments.

At least, this statement would be confirmed from a strengthening of the “Agricultural Income”.

Infact, the advantages of this virtuos cycle are not directed toward Industrial and public administrations but also the Forestal and Agricultural sectors as said before.

Conclusions
In this case the biomass production step would produces a total income for forestal and agricultural sectors of around 700,000 €/year both if wood from SRF is cultivated than if wood-chip is collected and sold as wood – chip biomass.

The biomass production derived from these last sectors represents a “key role” for all renewable chain.

The virtuous cycle will be primed if the agricultural farmers and forestal consortium involved in the system will have a more stable incomes. The same situation is also for Croatia countries and Sweden. In fact that rural agricultural residues has also significant energy potential, but still the small and separate farms owned by small owners do not allow planning and management of the process on a larger scale.

For a good developing of the total energy – chain and therefore for a good success of the feasibility study, the good management of the structure funds is necessary, some time as in Bulgarian country. It’s a characteristic example of the present situation from municipal point of view. The funding of EE&RES in the public sector – schools, kindergartens, hospitals, cultural and administrative buildings – is managed by five different ministries and a few more agencies.

There is a lack of a mechanism supporting the implementation of an energy policy at local level. Common efforts are needed – on the part of the state with its regulations and of entrepreneurs and financial institutions alike.

Targeted regional and local information campaigns are vital for raising awareness among different actors to facilitate their cooperation in the field of biomass utilization and its promising application for heating of public and residential buildings.

Different conditions is represented in the context of the UK pilot area located in South Shropshire, where the most community support for the project was received in the town of Cleobury Mortimer.

Given its large rural hinterland predominated by mixed-farming an anaerobic digester based on a large dairy farm adjacent to the town has been chosen as the most appropriate project to take forward.

This will have the subsequent benefits of mitigating the CO2 emissions arising from the local and global consumption of energy.

Given the RADAR project’s objectives this is specifically concerned with maximizing the use of any ‘residues’ from local agricultural and forestry activity although non bio-energy technologies may well be appropriate also.

Also in for the pilot region of Estonia this risk is not very high because is possible to hire consulting company in Estonia which possess long-term experience in management of various investment projects.

In case of approving the financial support from the Environmental Investment Fund (up to 50% of the total costs) the project could be implemented within 2 years.

In particular the risk analysis developed for the Estonia’s study indicates that the major risks of the project appear to be changes in electricity price and in share of state grant of total investments cost. Revenues and the required amount of investments are essential too. Risks of a lesser extent are changes in the discount rate and operating expenses.

However, it has to emphasize that sudden change of all factors (risks) and arising barriers can have mortal effects on the overall profitability of the project; while in the Latvia’s case, the analysis indicates that the major risks of the project appear to be changes in revenues and the required amount of investment.

Risks of a lesser extent are changes in operating expenses and the discount rate. However, it seems worthwhile to emphasize that sudden changes at a breakneck pace in mentioned factors can have grave effects on the overall profitability of the project.
I partner del progetto RADAR

Partners of RADAR project

REGIONE MARCHE
Agriculture Forestry and Fishery Unit
Marche Region - Italy

Svim
Sviluppo Marche - Italy

UNIVERSITÀ POLITECNICA DELLE MARCHE
Politecnical University of Marche Region - Italy

The Marches Energy Agency - UK

DAN
Development Agency North - Croatia

Riga Managers School - Latvia

TALLINNA TEHNIKAKÜLVKOOL
Tallinn University of Technology - Estonia

Union of Rural Municipalities of Selomaa

Energikonter Sydost
Energy Agency for South East - Sweden

Agriculture University of Plovdiv - Bulgaria

Energy Agency of Plovdiv - Bulgaria

Intelligent Energy Europe