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INVESTMENT PROPOSAL
PIG FARMING BIOGAS PLANT
BANAT ROMANIA

Feasibility study for the investment in a biogas plant in connection with pig farming in the newly EU Country Romania, Region of Timis, Banat

A Master Thesis submitted for the degree of
"Master of Science"

supervised by

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Pörtschach am Wörthersee, February 2008

Affidavit

I, **Mag. Hermann Wieser,** hereby declare

1. that I am the sole author of the present Master Thesis, “INVESTMENT PROPOSAL PIG FARMING BIOGAS PLANT BANAT, ROMANIA - Feasibility study for the investment in a biogas plant in connection with pig farming in the new EU Accession Country Romania, Region of Timis, Banat", 86 pages, bound, and that I have not used any source or tool other than those referenced or any other illicit aid or tool, and
2. that I have not prior to this date submitted this Master Thesis as an examination paper in any form in Austria or abroad.

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Date Signature

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Introduction

As a recent member of the European Union, Romania faces new competitive challenges in all sectors of its economy while implementing new member requirements for improving the social, environmental and economic conditions within the country. Romania has elaborated the National Strategic Plan (PNS) and the National Program for Rural Development (PNDR) for the period 2007-2013 to advance sustainable development. The valorisation of renewable energy resources is an important topic in all these development plans. The government is currently also developing a national Energy Policy of Romania for 2007-2020.

Before the political changes in the year 1989, Romania was one of the largest producers of pig meat in Europe. During the transition period from 1989 until the Accession of Romania to the European Union in 2007 the industrial pig production decreased dramatically and is only now on the way to up and up.

Within the Accession of Romania the pig farmers are obliged to adopt the environmental and health regulations of the European Union. The main environmental impact in the case of pig farms is related to animal manure management. The application of biogas technology as a closed cycle by using pig manure as input material might have an important contribution to the improvement of the environmental impact of industrial pig farming.

Beside the assessment of environmental issues, the Master Thesis should provide a clear answer on the economic efficiency and profitability of a potential project taking the present market conditions, renewable energy tariff system and legal aspects in consideration.

In order to provide transparent and valuable results the parameters for a potential project shall be demonstrated on the example of an industrial pig farm in the size of 8.160 fattening places in combination with a biogas plant. As location for the investment the region of Timis in the Romanian Banat - which was an intensive pig production area in former times – shall be selected as model region.

At the same time with the technological and commercial concept the Master Thesis should highlight potential subsidies within the new European Union Structural Fund Programs 2007 – 2013 and the introduction of the “Green Certificate” market mechanism for the production of green energy.

The main methods of approach in order to gain reliable results in the study report have been personal visits of the project region and collection of data form local authorities and companies active in the field of pig production with the aim of implementation of biogas technology. Desk research and internet research of available up-to-date literature, studies and articles as well as discussions with suppliers of biogas technology in terms of the specification, dimensioning and technical process concept of an agricultural biogas plant project.

Furthermore to make us of the presentations and lessons provided by the lectures of the Master of Science Program Renewable Energy in Central and Eastern Europe.

Executive Summary

Romania as new European Union Accession country with around 14,7 million hectare agricultural land and 6,4 million ha forest offers promising resources for the generation of renewable energy. According to the Romanian Governmental Decision 1535/2003 approving the national strategy for the revaluation of renewable energy sources the potential for the production of renewable energy from biomass is estimated for 318 PJ annually.

Specially the Timis County in the so called Romanian Banat area, the target region for the present investment proposal, is on the first place in Romania regarding the total agricultural surface and arable land and offers excellent conditions for industrial pig production and generation of renewable energy within a closed cycle. Before the political changes in 1989 the Banat was European-wide known as important region for extensive pig farming having COMTIM as major production company.

This historical denotation and the favourable agricultural economics might have been the determining factors for Smithfield, the world largest and US-based producer and processor of pig meat, to invest in the Romanian agribusiness. The company's goal is to create the leading pork company in Romania and to prepare it to be a major player in the European market.

The economic target of Smithfield is to produce around two million pigs annually by assisting the investment in around 120 standard "wean to finish" farms. Such a farm is designed for an animal housing capacity of 8.160 fattening places and a production of approximately 16.000 pigs per year. The implementation of this farms and the fattening of pigs will be outsourced to individual farmers based on a long-term delivery contract.

Especially pig manure from industrial pig farming like the Smithfield "wean to finish" farms offers a tremendous substrate potential for the application of biogas technology. The output of pig manure of one "wean to finish" farm is 44.000 kg/day and 16.060 tons/year. The biogas yield of pig manure 20-35 m^3 per ton substrate is slightly higher than for cow manure and contains with 60 – 70 vol.% a significant higher average methan content.

The present study report offers a comparison of four different investment proposals whereas CASE B - assuming the processing of the manure of four standard “wean to finish” farms located next to each other - delivered the comparable best financial results. The main reason for this outcome is, that the investment cost of biogas plants processing manure only are lower than for biogas plants applying co-fermentation. This result is inasmuch noticeable as the application of co-fermentation and especially corn silage as co-fermentation substrate in generally accelerates the production of biogas.

Related to environmental issues of industrial pig farming the Council Directive 96/91/EG on Integrated Pollution Prevention and Control (IPPC Directive), determines, that facilities with intensive pig livestock have to make provisions against environmental pollution, particularly by using the “Best Available Techniques” (BAT). European Union organisations of BAT-related work stated in their recommendation the anaerobic treatment (methane fermentation) in a biogas plant as BAT for industrial pig farming.

Even Romania requested a transition period of seven years, until 2014 for the application of the IPPC Directive, local authorities in extensive areas of animal production might regulate the use of BAT by official notification before. The implementation of BAT can thereby contribute to the Kyoto targets by preventing uncontrolled emissions of methan (CH_4) and laughing gas (N_2O) during manure storage by sealed process of fermentation in biogas plants and using methan for generating electricity and thermal power.

Within the Accession of Romania to the European Union in 2007 the financing instruments in the framework of the EU Structural Fund Program have been implemented. For the investment in a biogas plant and depending on the capacity and capital expenditure, two subsidy programs can alternatively be taken into consideration. The Fond for Agriculture and Rural Development (FEADR) offers up to 50% subsidy (grant financing) of the eligible expenditure with a maximum EUR 1,5 mio.. The Sectoral Operational Program – Increase of Economic Competitiveness (SOP-IEC), sub measure Valorisation of Renewable Energy Sources provides, depening on the size of the beneficiary company, between 50% and 70% subsidy of the eligible expenditure with a maximum of EUR 10 mio. per

project and company. Both subsidy programs are most suitable for the intention of an investor to realise one of the proposed project cases within this study report.

As incentive system to promote renewable energy production Romania has adopted the mandatory quota system combined with the trade system with minimum and maximum price limits set up by ANRE for the Green Certificates. Between 2005 and 2010, the mandatory quotas for E-RES the electricity suppliers have to comply with are set up by law each year.

The minimum and maximum prices of a green certificate were traded between EUR 102,2 RON/GC (EUR 28,--) and 153,3 RON/GC (EUR 42,--) in 2007. Currently, a new government ordinance is in preparation which will increase the Green Certificate price up to EUR 60,0/GC by mid of year 2008. For the evaluation of the economic efficiency of the four project cases in this study the value of EUR 60,0/GC was taken into consideration which comes on top of the regular energy price with a value of EUR 40,0/MWh.

The Chapter IV in the present study provides a comprehensive overview on the renewable energy promotion system in Romania, the authorities involved in E-RES promotion system and their function, the necessary steps for starting a project, the legal framework as well as energy and environmental laws.

Finally, the Master Thesis report determines that the investment in a biogas plant in combination with industrial pig farming complies with the principal of sustainable generation of green electricity from biomass within a closed cycle. In consideration of the prevailing market conditions and subsidy programs in Romania, the investment in a biogas plant in combination with industrial pig farming is a profitable business. Beside the economic issue, the implementation of a biogas plant, in the sense of “best available technology” for anaerobic treatment (methane treatment) of pig manure, contributes to the solution of sensible environmental and health impacts of industrial pig farming.

CHAPTER I

Project framework conditions

1. Agricultural and renewable energy potential of Romania and in the Region of Timis, Banat

Potential biomass is regionally distributed over Romania and characterized by a twofold regional distribution; about 90 percent of fuel wood and 55 percent of wood waste is found in the Carpathians and Subcarpathians. Large amounts of small-sized wood is obtained in wood industry, but utilization of this wood for energy purposes is insufficient due to difficulties related to gathering, processing and transportation. Studies show that these wood wastes are economically viable resources. About 54 percent of agricultural wastes are found in the South Plain and Moldavia. About 52 percent of biogas is found in the South Plain and the Western Plains. [1]

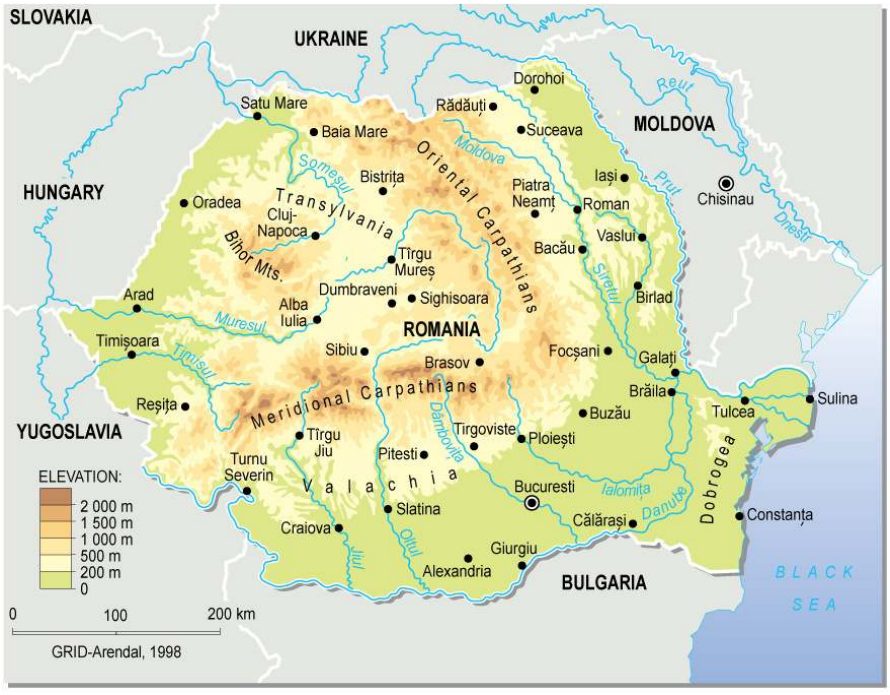


Figure 1. Topographic map of Romania, http://maps.grida.no/go/graphic/romania_topographic_map

[1] EBRD European Bank for Reconstruction and Development, Renewable Development Initiative, www.ebrd.renewables.com

When referring the use of renewable energy in Romania, one actually speaks of hydropower, as the other sources are poorly represented. A small number of wind, solar, biomass and geothermal projects have been implemented in the country, most of them successfully, but the rate of new investments in this sector is quite low. Such projects include the use of wood waste for heat and hot water supply in five small cities, the use of geothermal energy for district heating, a demonstration PV project in the capital city, solar panels for heating and hot water supply in two cities, and two wind turbines connected to the grid. The share of RES in total primary energy consumption is said to have been 10,1% in 2000 and targets are set for 2010 (11%) and 2015 (11,2%) in the national strategy for the revaluation of RES.

The Romanian government has set a target for electricity production alone from RES of 33% by 2010; this includes large hydropower plants also. The table below shows the RES potential which can be harnessed at any time. There is actually no action plan to establish that this potential will be revaluated in a specific timeframe.[2]

Source	Annual potential	Equivalent energy savings (PJ)	Application
Solar energy - thermal - photovoltaics	 60 PJ 1,200 GWh	 60 4.32	 Thermal energy Electricity
Wind energy	23,000 GWh	82.8	Electricity
Hydro energy Of which in 780 HPPs < 10 MW	40,000 GWh 6,000 GWh	21.6[3]	Electricity
Biomass	318 PJ	318	Thermal energy
Geothermal energy	7 PJ	7	Thermal energy

Table 1. Romanian Governmental Decision 1535/2003 approving the national strategy for the revaluation of renewable energy sources

[2] Romanian, Country analysis, barriers for the development of renewable energy sources, report Agreenet in cooperation with Hnuti DUHA

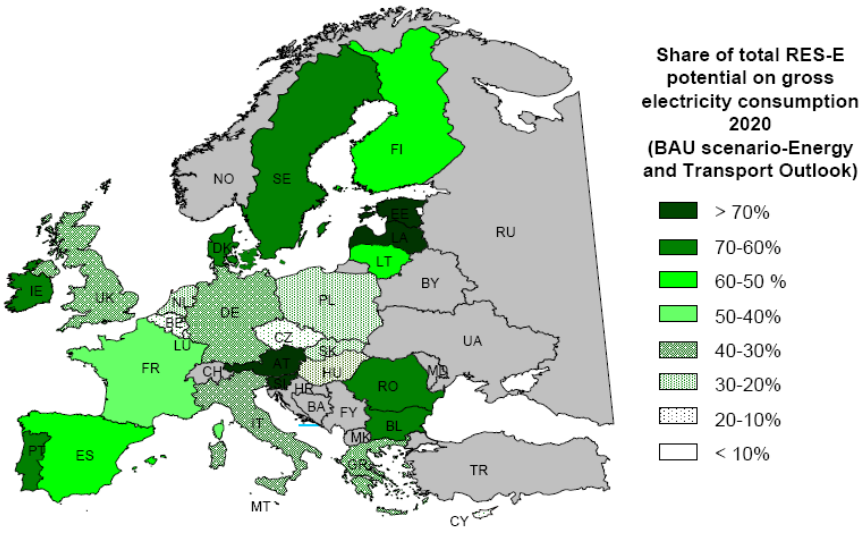


Figure 2. Introduction on Renewable Energy; R. Haas, L. Kranzl, G. Resch, L. Weissensteiner (EEG, TU-Wien)

The figures in the above BAU (business-as-usual) scenario Energy and Transport outlook are confirming a mid-term realisable potential for Renewable Energies for Romania in the range of 60 – 70% for “green” electrical energy in comparison with the other European Union Member States. The same scenario is valid for production of thermal heat from renewables.

1.2. Agricultural potential of Timis County

The total agricultural surface of Timis County is 702.170 ha, out of which 532.860 ha represent arable land, pastures of 126.152 ha, grass land 29.503 ha, vineyards of 4.314 ha, orchards of 9.258 ha. Timis County is on the first place in Romania regarding the total agricultural surface and arable land.

Almost all agricultural land, pastures, grass lands, orchards and other are private properties, wile forests and related lands are to be juridical regulated by application of Law no.1/2000. The main and representative crops for Timis County, the surfaces occupied by those and average yields per hectare are as following:

Crop	Cultivated surface	Average yield	Total Production
	ha	Kg/ha	tone
Wheat	130.483	3.320	433.223
Barley	28.724	3.079	88.454
Corn	152.826	3.999	611.159
Sun Flower	51.793	2.068	107.117

Table 2: The agricultural potential of Timis County, Prof. Dr. Ioana Ionel, NETBIOCOF workshop, Timisoara, June 2006

As regards animal breeding sector, the situation is as follows:

Animals	head
Pigs	425.401
Cattle	64.158
Sheep and goats	358.960
Horses	17.495

Table 3: The agricultural potential of Timis County, Prof. Dr. Ioana Ionel, NETBIOCOF workshop, Timisoara, June 2006

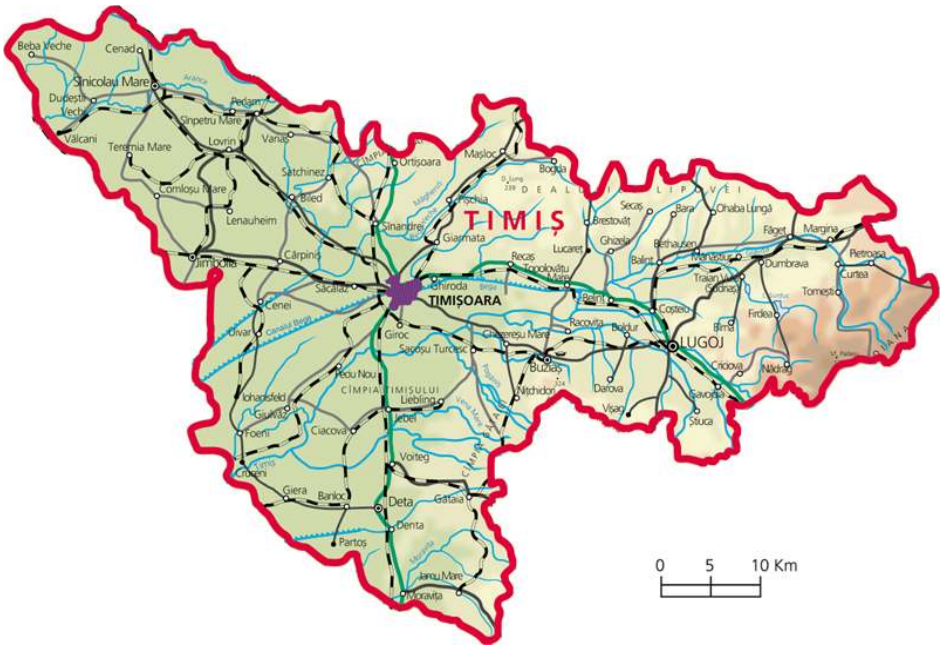


Figure 3. Map of Timis County:
http://www.celendo.ro/images/intern/1JudetulTimisBanat.jpg

1.3. Environmental impacts related to industrial pig farming

In this chapter the main environmental issues of industrial pig farming are given taking into consideration that animal waste, in this case pig manure, can also be used to produce green electricity and thermal heat as well as fertiliser within a closed cycle by the application of biogas technology. This chapter will also try to provide answers to the question to what extent the application of biogas technology is able to reduce greenhouse gas emissions of industrial pig farming and thereby contributes to reduce the environmental. Especially in the region of Banat investors are facing additional requirements of environmental authorities and public awareness.

One of the major issues investors in industrial pig farming are facing are related to the fulfilment of regulations in context with the EU Council Directive 96/91/EG on Integrated Pollution Prevention and Control (IPPC Directive) and several other national and local licensing requirements and orders.

1.4. Environmental impact of the industry

In intensive livestock the key environmental aspect is that the animals metabolise feed and excrete nearly all the nutrients via manure. In the production of pigs for slaughter the process of nitrogen consumption, utilisation and losses is well understood and is shown in the figure below:

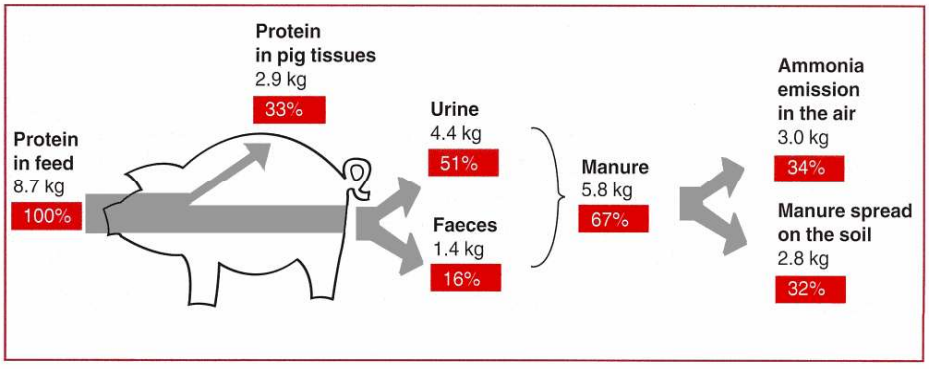


Figure 4. Consumption, utilisation and losses of protein in the production of a pig of 108 kg, IPPC Reference Document on BAT for intensive rearing of poultry and pigs, EU Commission 2003

Intensive livestock farming coincides with high animal densities and this density can be considered as a rough indicator of the amount of animal manure produced by the livestock. A high density might suggest that the mineral supply available from the animal manure might exceed the requirements of the agricultural area for growing crops or maintaining grassland.

Data on the concentration of livestock production at a regional level are considered to be a good indication of whether a region might have potential environmental problems. This is clearly illustrated in the figure below, which shows problems such as: acidification (NH_3, SO_2, NO_x), eutrophication (N, P), local disturbance (odour, noise) and diffuse spreading of heavy metals and pesticides.

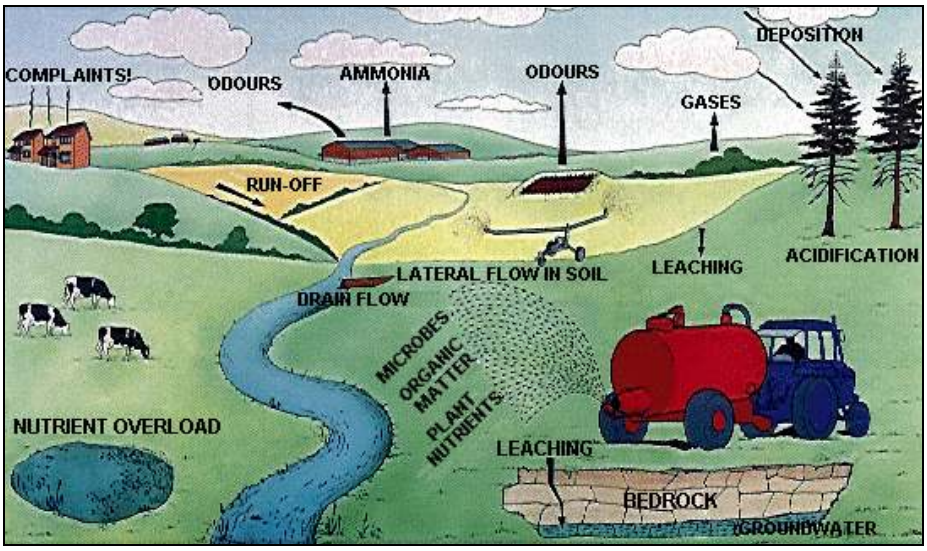


Figure 5. Illustration of environmental aspects related to intensive livestock farming; IPPC Reference Document on BAT for intensive rearing of poultry and pigs, EU Commission 2003

According to a report issued by Terra Mileniul III's[3] in September 2006 the main environmental impact in the case of pig farms is related to animal waste management.

[3] TERRA Milenium III; Industrial pig farms and their environmental impact; Case study September 2006; The mission of TERRA Milenium III is to develop ecological programs in order to raise public awareness regarding the effects of climate change and to promote programmes for sustainable development at national, regional and global level.

Pig waste contains a significant amount of nitrogen that evaporates into the air as ammonia (a highly reactive and biologically available form of nitrogen) and falls back to the land and water bodies when it rains. A small portion of it is lost as nitrous oxide (N_2O) which is the most damaging greenhouse gas that depletes the ozone layer - it is 320 times more damaging than carbon dioxide. Atmospheric nitrogen deposition, though beneficial to the extent that it may be easily absorbed as fertilizer if it falls (with rain) on a crop, can actually cause more harm than good to the environment. It can destroy natural habitats, trigger algal blooms that rob the water of oxygen and changes in population species.

1.5. Context with Council Directive 96/91/EG on Integrated Pollution Prevention and Control (IPPC Directive) [4]

Council Directive 96/91/EG of 24 September 1996 on Integrated Pollution Prevention and Control (IPPC Directive), determines that facilities with intensive pig and poultry livestock management within the scope of the directive (> 40,000 poultry places, **> 2,000 fattening pig places** and > 750 breeding pig places) have to make provisions against environmental pollution, particularly by using the "**Best Available Techniques" (BAT)**.

Romania opened this chapter in the first half of 2002 and requested a transition period of seven years, until 2014 for the Council Directive No 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources.

The BAT relate to the entire chain of animal production processes, from basic farm operations (type of housing, manure removal, ventilation) and feeding (feed storage, processing, rationing and delivery) all the way to the storage, treatment and field application of farm-produced manure.

Apart from obtainable emission levels, including those relating to airborne odours, ammonia and dust, emissions into water and soil, efficient utilisation of energy and raw materials, as well as type and quantity of residual waste materials produced, are also decisive criteria for BAT establishment. The term "*techniques*" (as the last word in BAT) is furthermore also - and particularly so - intended to comprise the way and

[4] Umweltforschungsplan des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit; Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. (KTBL); Darmstadt; Forschungsbericht 360 08 001; UBA-FB 000284

manner of how an animal farming unit is managed (with specific regard to its maintenance and operation) in addition to considering its underlying technologies.
The term "*available*" (in Best Available Technologies) assumes that a specific technology can be put to economically efficient use by a given sector under technically acceptable conditions. Starting from that assumption necessitates the availability of relevant economic data. The BAT are also meant to provide a basis for extrapolating emission tolerance limits which, in turn, become part of permit procedures' supervisory functions. But inasmuch as animal farm production units are concerned, this requirement does, however, come under the proviso of practical applicability.

Organisation of BAT-related work

To help with elaborating Best Available Technologies, the EU Commission has established pursuant to art. 16, sec. 2 of the IPPC Directive an information exchange process among EU member states. The IPPC Bureau at the Seville, Spain-based institute for Prospective Technological Studies has been assigned the task of co-ordinating such information sharing. The IPPC bureau serves as a collection centre of all relevant information from individual member states, where such input is subsequently processed and a proposal for the respective BAT reference sheet (BREF document) is elaborated in co-ordination with the international TWG-ILF (Technical Working Group on Intensive Livestock Farming).

The German Environmental Agency (UBA) serves as a centre for co-ordinating the German activities. The KTBL has been assigned the task of preparing the German proposal for the BAT "Intensive Livestock Farming" reference document. The proposal was co-ordinated with the national consensus (or harmonisation) group “Intensive Livestock Farming” (nTAG) that has been constituted as part of the UBA and the KTBL working group “BAT in Intensive Livestock Farming” The present report summarises the German proposal for BAT in intensive pig and poultry farming according to the requirements laid down in the IPPC Directive.

1.6. Available techniques that have been identified as BAT and emerging techniques in pig production

PIG HOUSING
a) BAT for pig fattening
Fully slatted floor, small group (10-15 animals), forced ventilation
Fully slatted floor, large group (> 24 animals), forced ventilation
Kennel housing, slatted floor in roaming area, natural ventilation, outdoor climate
b) Emerging techniques for pig fattening
Partly slatted floor, solid concrete floor in centre, cambered and heated (forced ventilation)
Sloped-floor/straw-flow system with covering (natural ventilation, outdoor climate)
STORAGE OF SOLID AND LIQUID MANURE
a) BAT
Solid manure
Slab for dung storage (foundation slab of water-impermeable concrete) with fluid manure pit
Liquid manure
Above-ground tower silo with covering (artificial straw floating crust at least) and leak identification (only in ground water protection areas)
Underground silo with covering (artificial straw floating crust at least) and leak identification
TREATMENT OF MANURE (SLURRY)
a) BAT
Anaerobic treatment (methane fermentation) in a biogas plant
b) Emerging techniques: NONE
APPLICATION OF MANURE
a) BAT liquid manure
Broadcast distribution on cropland without growth in combination with direct working liquid
a) BAT solid manure
Manure spreader with two or four vertically arranged distributor shafts and spreaders
b) Emerging techniques
Drag shoe, slitting disk and liquid manure injector

Table 4. Umweltforschungsplan des Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit; Kuratorium für Technik und Bauwesen in der Landwirtschaft e.V. (KTBL)

Agriculture can contribute to the Kyoto targets by preventing uncontrolled emission of methan (CH4) and laughing gas (N2O) during manure storage by sealed process of fermentation in biogas plants and using the CH4 for generating electricity and heat (Amon et al., 2001). The reduction of emissions and the substitution of fossil energy sources by biogas are considered as very cost efficient possibility of achieving the targets (Neubarth und Kaltschmitt, 2000, 398; Nielsen and Hjort-Gregersen, 2002, 4 and Nill et. Al., 2003, 43).[5]

[5] Wirtschaftlichkeit von Biogasanlagen, University of Natural Resources and Applied Life Sciences, Vienna, Dissertation Dipl.-Ing. Christoph Walla, 2006

Chapter II

Technical project description

2. 1. Principal of generating energy from biomass within integrated farming

The principal of generating energy from biomass by the application of biogas production within integrated farming is based on the production of three products: Electricity, thermal power and fertilizer. Manure by itself or mixed with corn silage is specially suited for the utilization in a biogas plant. This raw materials produced by integrated animal and crop production is degraded in special fermenters to produce biogas. Biogas is composed mostly of methane and carbon dioxide.

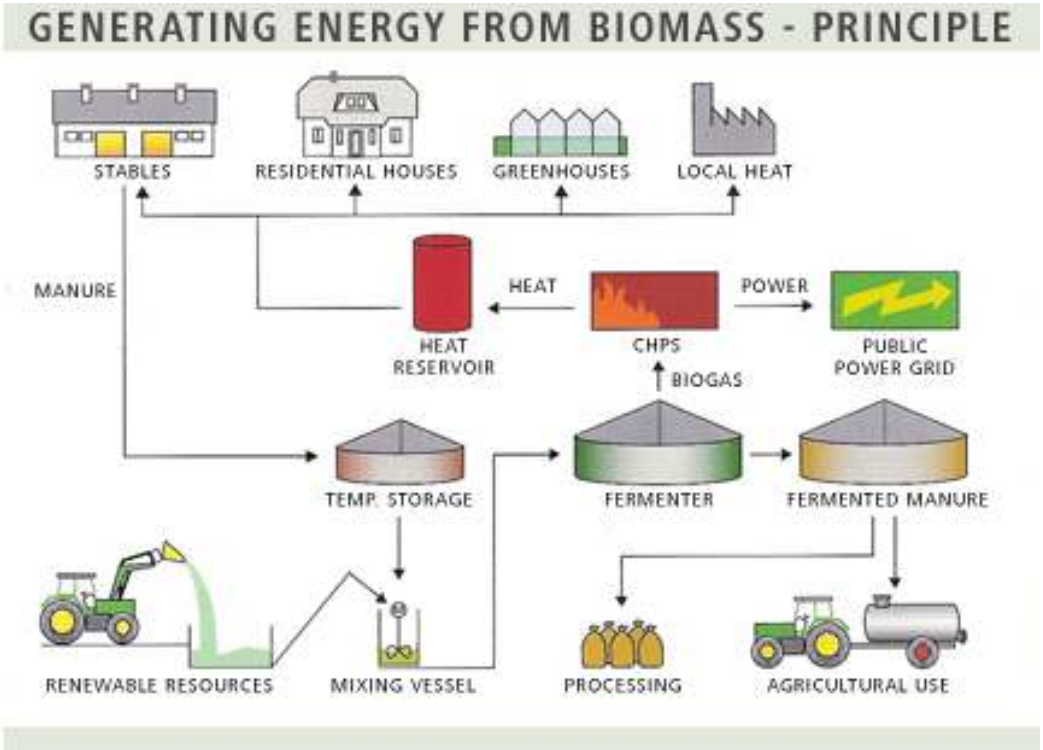


Figure 6. NAWARO BioEnergie AG, Servicebereich, Downloads, www.nawaro.de

In the cogeneration plant the biogas gained through fermentation is combusted to produce electricity and thermal heat. The electricity is contracted with the relevant power distribution companies and fed into existing electric power grids. The accounting is organized according to the renewable energy promotion system in Romania based on obligatory quota's and the price for Green Certificates.
Moreover, because the by-products of biogas generation are recycled, all material cycles are closed – the by-products that remain after fermentation are used to produce fertilizer and thus return to the biosphere.

2.1.1. Environmental sound and reliable

Biomass as a resource for generating energy has numerous advantages. Producing energy for biogas reduces consumption of limited resources and is high reliable. Energy generated from biogas is CO_2-neutral. The amount of CO_2 released during combustion of biogas equals the CO_2-consumption of the energy crops during cultivation.

Bioenergy therefore makes a significant contribution to combating global warming and preventing climate change from greenhouse gases and is an indispensable element – together with water, wind, and solar power – of today's renewable energy mix.

In contrast to photovoltaic and wind energy, biomass from regional resources has a further important advantage: industrial-scale use of biomass guarantees a high level of reliability in electricity feed-in. Whereas wind and sunshine are available only intermittently, biogas can be produced and employed in decentralized, controlled, and continuous production processes.

A key critical argument often heard against renewable energy sources – the supposed unreliability of supply – does not apply to biogas. Electric power generated in biogas plant can be fed into the grid as what is called "baseload" electricity, that is, power that reliably secures the constant, minimum customer demand for electricity. [6]

[6] NAWARO Bioenergie AG, Servicebereich, Downloads, www.nawaro.de

2.1.2. The biogas and cogeneration plant

The wet fermentation is further, also with the technology proposed in this project proposal, the only applied technology for biogas production from organic materials. As basic substrate manure and in addition energy crops are brought into the fermenters. In this project proposal corn silage will be used but also silage from other arable field crops might be applied as input material.

On the one hand also these substrates contribute to a increased gas production, on the other hand, the supply costs are higher contrary to co-substrates like slaughterhouse waste, biogenic waste or sewage.

The energy recovery of the produced fermentation gas in practice solely takes place in cogeneration plants producing electricity and thermal heat. The electricity will be fed into the existing grids according to the Romanian renewable energy promotion system. After the own use of thermal heat for the fermenters the energy can be used in the pig production facilities by partly replacing the use propane gas or can be sold to different thermal heat users like DHN (district heating networks), green houses, factories and other local heat consumers nearby the biogas plant.

2.2. Basic key figures for the evaluation of the investment proposal

The following key figures gathered from several information sources and study reports as well as dissertations are the basis for the evaluation of the four different investment cases in the next sections.

2.2.1. Biogas yield of pig manure and other different substrates

The biogas yield is not only depending on the substrate but also on the in each case prevailing framework conditions (e.g. plant operating method, temperature, hydraulic retention time). There from yields to some extent deviate substantially.

In the below figure the gas yield per ton substrate input for different substrates are shown (calculated gas yields by substance of contents of proteins, fats and carbohydrates). Pig manure offers 30 m^3 biogas per ton substrate FW (fresh weight).

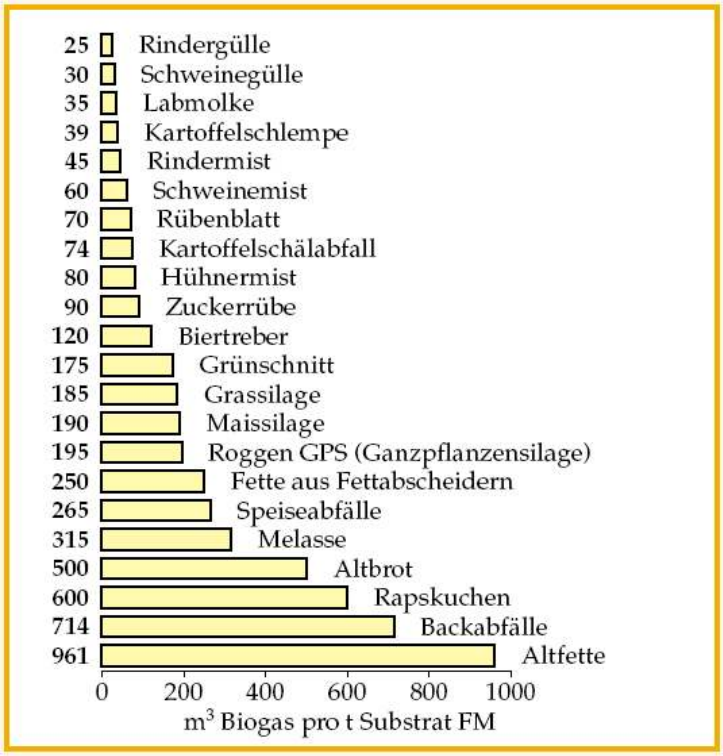


Fig 7: Source: Biogas yield of different substrates; Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany; www.bio-energie.de

2.2.2. Key figures for the calculation of livestock units (LU)

PIGS	LU/animal
Piglets up to 12 kg	0,01
Piglets > 12 kg up to 20 kg	0,02
Piglets > 20 kg up to 45 kg	0,06
Fattening pigs	**0,16**
Breeding sows	0,33

Table 5. Source: KTBL-Taschenbuch Landwirtschaft; VDI-Richtlinie; Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany; www.bio-energie.de

2.2.3. Key figures for biogas production

	Standard values
1 LU	6,6 – 35 t manure/year
1 LU	200 – 700 m^3 biogas/year
1 t manure	20 – 35 m^3 biogas
1 ha corn silage	approx. 8.000 – 10.000 m^3 biogas
1 t corn silage	180 – 230 m^3 biogas
1 LU	0,15 – 0,20 kW installed capacity
1 m^3 biogas	5,0 – 7,5 kWh_{total}
1 m^3 biogas	1,5 – 3 kWh_{el}
Efficiency CHP_{el}	30 – 40%
Efficiency CHP_{th}	40 – 60%
Efficiency CHP_{total}	85 %

Table 6. Source: nach Mitterlehner (2000), FNR; Handreichung Biogasgewinnung und -nutzung; Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany; www.bio-energie.de

2.2.4. Description of selected animal substrates with focus on pig manure[7]

Taking the German statistics of animal husbandry as a general basis it is evident that especially in the pig and cattle production a tremendous substrate potential exists which can be used in biogas plants. In particular due to the increasing sizes of the animal farms and the extended environmental requirements alternative applications for the use of animal substrates must be developed. The nutrient contents of different animal substrates can be taken from table 7.

The biogas yield of pig manure 20-35 m^3 per ton substrate is slightly higher than for cow manure (see table 8). In addition to that, gas from pig manure contains significant higher average methane content than cow manure. This is due to the fact that the stomach of a cow works similar to a biogas plant with the effect that the manure already was pre-fermented.

2.2.5. Nutrient content of different animal substrates

Substrate	DS (%)	oDS (% DS)	N	NH_4	P_2O_5 (% DS)	K_2O	Mg
Cow manure	8-11	75-82	2,6-6,7	1-4	0,5-3,3	5,5-10	0,3-0,7
Pig manure	**ca. 7**	**75-86**	**6-18**	**3-17**	**2-10**	**3-7,5**	**0,6-1,5**
Cow dung	ca. 25	68-76	1,1-3,4	0,22-2	1-1,5	2-5	1,3
Pig dung	20-25	75-80	2,6-5,2	0,9-1,8	2,3-2,8	2,5-3	
Chicken dung	ca. 32	63-80	5,4	0,39			

Table 7. Source: Handreichung Biogasgewinnung und -nutzung; Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany; www.bio-energie.de

2.2.6. Gas yield and methane content of different animal substrates

Substrate	Biogas yield		CH4 content
	(m3/t substrate)	(m3/t oDS)	(Vol.-%)
Cow manure	20-30	200-500	60
Pig manure	**20-35**	**300-700**	**60-70**
Cow dung	40-50	210-300	60
Pig dung	55-65	270-450	60
Chicken dung	70-90	250-450	60

Table 8. Source: Handreichung Biogasgewinnung und -nutzung; Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany; www.bio-energie.de

2.3. Investment costs

Results of a survey conducted in Austria indicate a distinct decrease of investment costs per unit as the size increases. Various reasons are responsible for the deviation of the investment costs for plants of similar capacity. The contribution of the owners, purchasing in cooperation, precise planning, site and construction of the plants, the distance between the biogas plant, the stable and the farm house, the availability of farm buildings and the technical equipment of the plant concerning stirrers, pumps, controlling devices are some of the examples mentioned in the survey (WALLA and SCHNEEBERGER, 2003, s.p.).

[7] Source: Handreichung Biogasgewinnung und – nutzung; Fachagentur Nachwachsende Rohstoffe e.V. (FNR), Germany; www.bio-energie.de

In Austria the plant operator is responsible for the establishment of a transformer station and the reinforcement of the grid (BGBl. I Nr. 149/2002). [8]

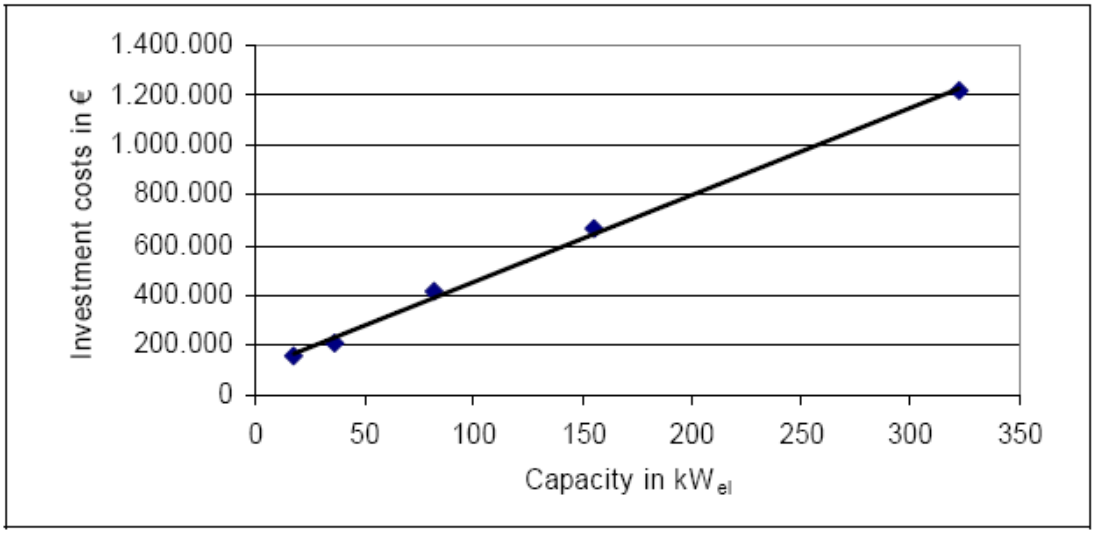


Fig 8. Wirtschaftlichkeit von Biogasanlagen, University of Natural Resources and Applied Life Sciences, Vienna, Dissertation Dipl.-Ing. Christoph Walla, 2006

2.4. Planning and constructing period

According to a survey in Austria of 34 biogas plants built since 2000 the planning period lasted between 9 months (old plants) and 14 months (new plants), on average one year. The construction period lasted 10 months on average, no difference within the two groups was found. The shortest planning and construction period was half a year, the longest more than three years. Most biogas plants were planned by specialized planners in co-operation with the farmers. Only a few plants were planned by experts or local civil engineers. The construction was mainly done by local enterprises, supported by craftsmen and the owners. Two biogas plants were handed over as turn key facilities and seven small plants were constructed by the farmers themselves.

2.5. Labour requirement

The labour requirement does not differ according to the date of implementation. Differences were found regarding the feedstock. Biogas plants using exclusively

[8] Wirtschaftlichkeit von Biogasanlagen, University of Natural Resources and Applied Life Sciences, Vienna, Dissertation Dipl.-Ing. Christoph Walla, 2006

slurry and manure require on average 1.1 hours per day, the data vary between 0.35 and 1.75 hours per day. The biogas plants fermenting energy crops needed on average 1.25 hours per day, varying between 0.5 and 2 hours per day. Biogas plants using organic waste reported the highest average labour requirement (1.7 hours per day), the dispersion is highest too (between 0.5 and 5.3 hours per day). The large dispersion results from the different degree of impurity of waste and the technical equipment for conditioning. Biogas plants with complex automatic control systems need less labour than those without. [9]

2.6. Motives for investment in biogas plants

According to a survey in Austria conducted in year 2006 in average more than three motives out of the possibilities were selected by the respondents. The majority stated the "improvement of manure" as one of the motives (see figure below). All organic farmers indicated this motive. Other motives were the possibility to produce the own energy demand and to "diversify" the farm income. The operators of new biogas plants stated the motives "diversification" and "odour reduction" more often than the operators of old plants. The motive "changes of the farm organisation" was mainly named by organic farmers. Some of the farmers built the biogas plant in combination with shed investments.

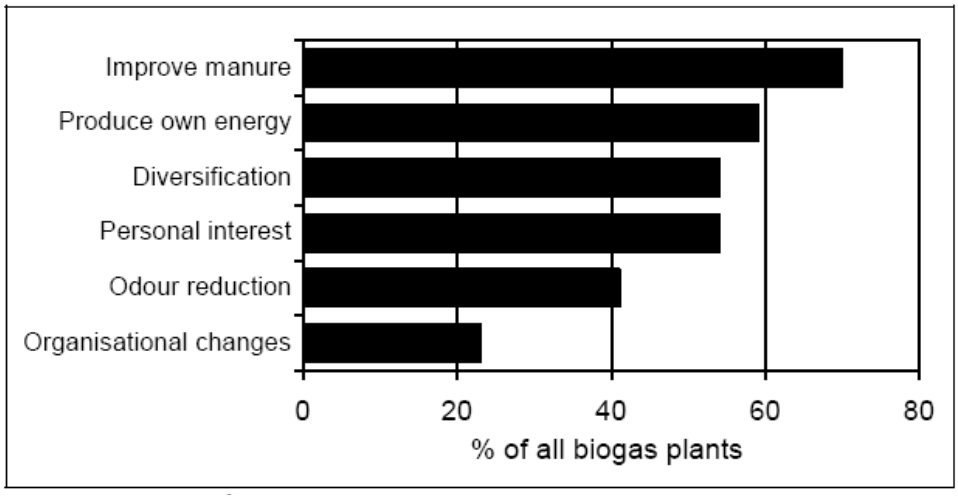


Figure 9. Wirtschaftlichkeit von Biogasanlagen, University of Natural Resources and Applied Life Sciences, Vienna, Dissertation Dipl.-Ing. Christoph Walla, 2006

[9] Wirtschaftlichkeit von Biogasanlagen, University of Natural Resources and Applied Life Sciences, Vienna, Dissertation Dipl.-Ing. Christoph Walla, 2006

2.7. Smithfield's investment targets in Romania

Smithfield as one of the most important investors in the Romanian agribusiness and in industrial pig farming entered the Romanian market in 2004, first with the acquisition of Agrotorvis, followed by the acquisition of Comtim Group. Together these acquisitions reunified much of the former Comtim's meat processing complex based in Romania's Timis County in Banat.

"Our goal is to create the leading pork company in Romania and to prepare it to be a major player in the European market when Romania joins the European Union in 2007. Romania is at the centre of our European strategy. Primarily because of Romania's wealth of natural resources and its strategic location, but also because of the availability of a capable workforce to support intensive development of the agricultural industry, Smithfield predicts that Romania will become Europe's leading food producer in the years ahead**"**, stated Michael Cole, Vice President of Smithfield Foods, Inc. in the United States.
Noul Comtim currently employs 989 people. By 2011, it expects to employ another 1,700 people and record annual sales of over USD 420 million. To date, Noul Comtim has 10 farms with 16,000 sows producing 260,000 hogs annually. The company plans to expand its sow herd to 100,000 over the next six years in order to produce two million pigs annually.

In Romania, Smithfield's goals are to produce high-quality pork applying strict quality controls and technologies aimed at maintaining the highest standards for our products. Through our vertically integrated operations, we exercise control over the production process from "farm to fork". We will be cooperating with local grain producers and other suppliers, entering into long-term relationships with independent farmers and fostering economic growth of the agricultural areas in Timis, Arad and Bihor counties.[10]

Within the vertical integrated operations Smithfield intends to cooperate with local farmers offering them to produce fattening pigs according to their standard "wean to finish" farm model with a housing capacity of 8.160 pigs.

[10] Smithfield Prod SRL, 300523 Timisoara, company information published on the website www.smithfield.ro

In the present Master Thesis study report this standard farm model will be the basis for the evaluation of a technical and economical solution for the application of biogas technology.

2.7.1. Smithfield standard “wean to finish” farms

The Smithfield standard “wean to finish” (fattening) farm consists of four buildings in which the piglets supplied by Smithfield breeding farms will be fed up in groups from 7 to 110 kg per head. Attached to the farms two manure tanks each with a capacity fo 5.000 m^3 are installed. By implementation of a biogas plant the existing manure tanks remain as final storage for the processed manure.

Fig 10. Layout plan of Smithfield standard “wean to finish” farm provided by Smithfield company

The main production figures are shown in the table below:

Housing capacity	8.160 pigs / cycle
Number of cycles	2,0 cycles / year
Pigs in farm / year – max. capacity	16.320 pigs / year
Pig production / year (considering 2% losses)	16.000 pigs/year
Pig manure per day	44.000 kg
Pig manure per year	16.060 tons

Table 9. Specification of Smithfield standard “wean to finish” farm provided by Smithfield company

2.8. Agricultural biogas plant investment cases

According to the investment plans of Smithfield to produce around two million pigs annually the investment in around 120 standard “wean to finish” farms will be necessary. This farms will be built in the traditionally so called Banat area in the regions of Arad, Bihor and mainly Timis. Due to the fact that the investment will be done by individual farmers as co-operation partners of Smithfield the locations of the “wean to finish” farms will be spread over the Banat area.

In some cases the “wean to finish” farms will more or less “stand alone” with many kilometres distance to other farms but, in some cases, the farms will be located nearby to each other. This assumptive situation shall offer the possibility to transport manure with trucks or even pipelines to a major biogas plant to the most centralised farm. In the present investment proposal it is assumed that 4 “wean to finish” farms are located next to each other.

Furthermore, taking into consideration that some of the farmers also might be active in extensive crop production, the issue of co-fermentation will be also considered in the investment proposal by using corn silage as input material. As a standard size 200 ha agricultural land are destined for the cultivation of corn silage.

The present investment proposal makes notice of the above mentioned conditions and therefore provides a comparison of following four different investment cases:

Case A:	Processing the pig manure only of a **single “wean to finish” farm**
Case B:	Processing the pig manure of **4 “wean to finish” farms** located near-by
Case C:	Processing the pig manure of a **single “wean to finish” farm** with **co-fermentation of 200 ha corn silage**
Case D:	Processing the pig manure of **4 “wean to finish” farms** located near-by with **co-fermentation of 200 ha corn silage**

2.8.1. Overview on comparison of investment cases

In order to compare the four investment cases in terms of main indicators like pig manure input and output, application of corn silage as co-fermentation material, size

of combined heat and power plant (CHP), green electricity and thermal power production, the software program of BIOGAS SYSTEMTECHNIK GmbH was applied.[11] The evaluation of the economic efficiency was assessed by the application of "profit and loss statement" method and the financial rations "return on investment" (ROI) and "pay-off period" (amortisation).

INPUT	**Case A**	**Case B**	**Case C**	**Case D**
Pig manure				
Number of fattening places	8.000	32.000	8.000	32.000
kg/day	44.000	176.000	44.000	176.000
tons/year	16.060	64.240	16.060	64.240
m3/day	44	176	44	176
m3/year	16.060	64.240	16.060	64.240
Renewables - corn silage				
Area under cultivation in ha	0	0	200	200
kg/day	0	0	24.658	24.658
tons/year	0	0	9.000	9.000
m3/day	0	0	33	33
m3/year	0	0	12.000	12.000
Total input				
kg/day	44.000	176.000	68.658	200.658
tons/year	16.060	64.240	25.060	73.240
m3/day	44	176	77	209
m3/year	16.060	64.240	28.060	76.240
Output (endsubstrate)				
tons/year	15.500	62.000	22.100	73.200
fertilizer for surface in ha (170 kg/ha/yr)	390	1.560	550	1.730
CHP PLANT DIMENSION	**70 kWel**	**280 kWel**	**535 kWel**	**738 kWel**
Green electric power				
kWh/day	1.359	5.436	10.683	14.760
kWh/year	496.008	1.984.033	3.899.216	5.387.240
Thermal power				
kWh/day	1.941	7.765	15.261	21.085
kWh/year	708.583	2.834.333	5.570.308	7.696.058
Own consumption for plant and building kWh/year *25%*	177.146	708.583	1.392.577	1.924.015
Thermal power for pig production or sale	531.437	2.125.750	4.177.731	5.772.044
Financial data				
Return on investment	5,23	**11,78**	6,23	7,03
Pay-off period (amortisation)	5,91	**4,18**	5,48	5,28

Table 10. Results of the economic evaluation of the analysed four investment cases

[11] Application of MS Excel software program, BIOGAS SYSTEMTECHNIK GmbH, A-3380 Pöchlarn

As result the agricultural biogas plant CASE B assuming the processing of the manure of four standard “wean to finish” farms located next to each other delivered the comparable best financial results. The main reason for this outcome is, that the investment cost of biogas plants processing manure only are lower than for biogas plants applying co-fermentation. This result is inasmuch noticeable as the application of co-fermentation and especially corn silage as co-fermentation substrate accelerates the production of biogas.

The table below shows the impact of corn silage on the productivity of a biogas plant. By the use of marginal quantities of substrate the energy production increases disproportionately.

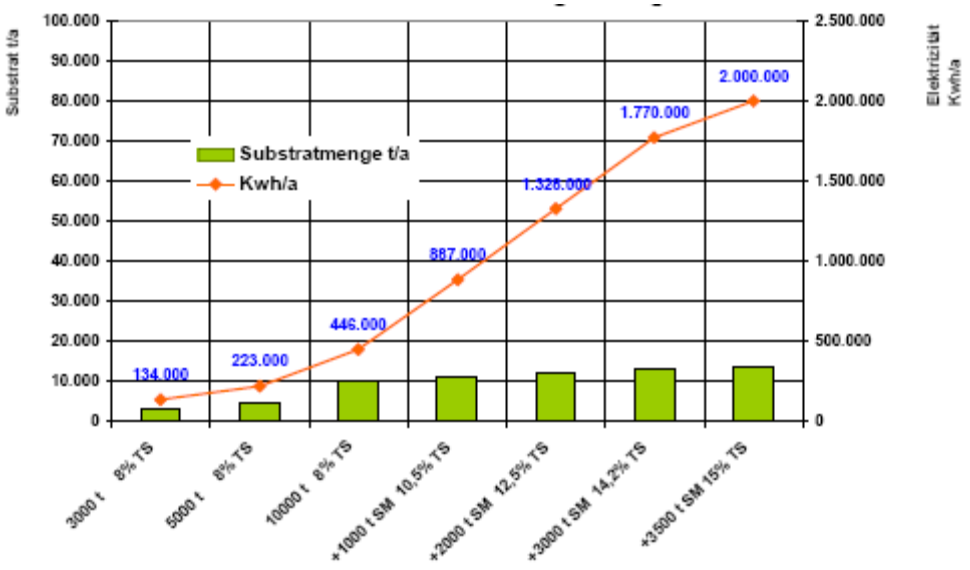


Figure 11. Mais als Energiepflanze für die Biogasproduktion, Dr. Friedrich Jäger, KWS MAIS GmbH, Fachberatung Mais, Seminar 3. März 2004, AG Nachwachsende Rohstoffe in der Gesellschaft für Pflanzenbauwissenschaften e.V.

As a matter of form it must be mentioned at this stage that, before taking a final decision for the investment in one of the calculated agricultural biogas investment cases, a more detailed feasibility study with determination of actual investment for a certain location shall be conducted. The findings of the present study proposal shall only be treated as first recommendation to proceed in the project considerations.

2.8.2. Comparison of agricultural biogas plant cases

The following drawings demonstrate the agricultural biogas plant process for the assessment of the four different investment cases by showing the main figures like input materials, output of final substrate, capacity of combined heat and power plant (CHP unit) as well as the production of green electricity and thermal power.

In the value for thermal power already 25% of the output were deducted for the own consumption of the biogas plant and the buildings. The remaining thermal energy shall be used in the “wean to finish” farm buildings as substitution of propane gas. In the CASES B and D the value of EUR 1,00 per ton as costs for the transportation of manure was estimated.

Furthermore, before taking a final project decision a technical clarification must be conducted related to the issue, if for investment CASE B, processing the manure of four “wean to finish” farms without co-fermentation, a second digester is essential. If not, this fact will notably reduce the investment costs.

2.8.3. CASE A

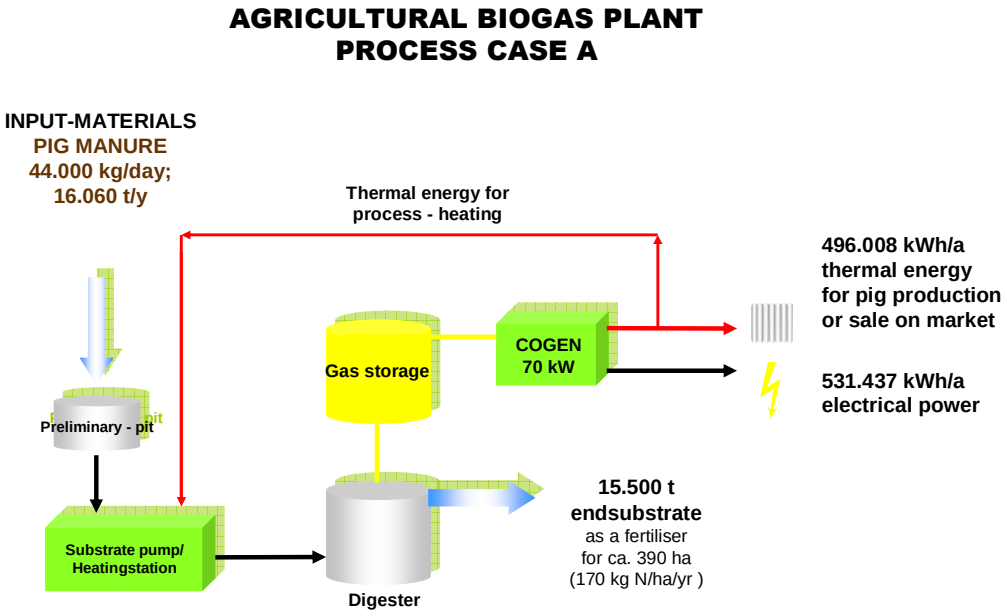


Figure 12: Biogas plant process concept developed in cooperation with company etaone energy, 7311 Neckenmarkt, Austria

2.8.4. CASE B

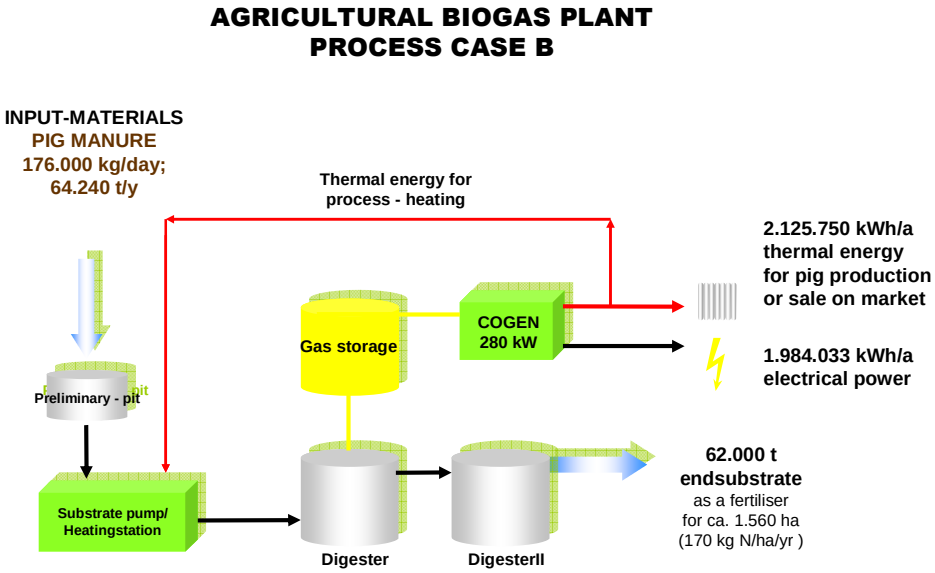


Figure 13: Biogas plant process concept developed in cooperation with company etaone energy, 7311 Neckenmarkt, Austria

2.8.5. CASE C

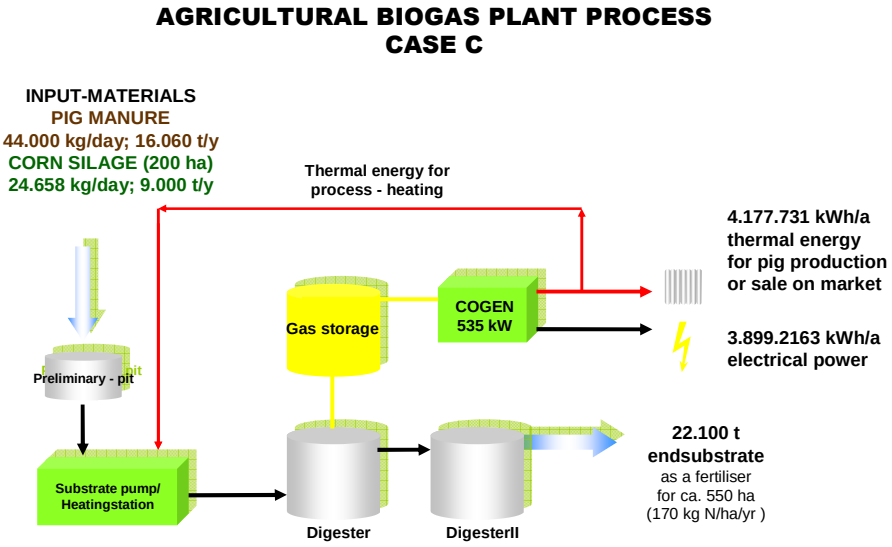


Figure 14: Biogas plant process concept developed in cooperation with company etaone energy, 7311 Neckenmarkt, Austria

2.8.6. CASE D

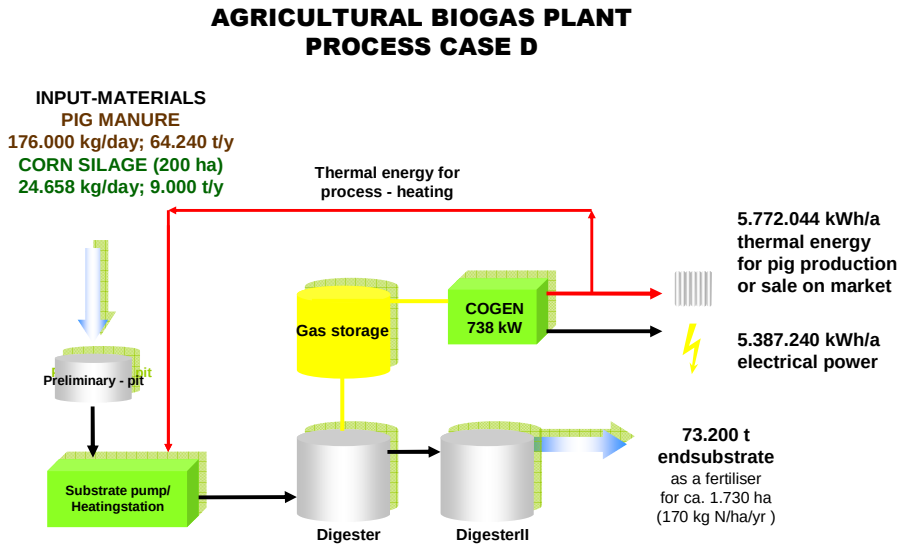


Figure 15: Biogas plant process concept developed in cooperation with company etaone energy, 7311 Neckenmarkt, Austria

In order to provide an accurate overview on the study results and for the reason of simplification, only the investment CASE B, selected because of the comparable more favourable financial results, will be described in more detail in the following sectors. Further detailed information and financial analysis for the investment CASES A, C and D can be gathered from the appendix.

2.9. Evaluation of economic efficiency

The evaluation of the economic efficiency is based on the following financial assumptions:

Equity capital	10% of total investment
Credit	40% of total investment
Subsidies	50% according to EU Structural Fund 2007 - 2013
Interest rate	8 %
Green Certificate price	6 €cent/kWh
Regular energy price	4 €cent/kWh; yearly increase 4%
Thermal energy price	2 €cent/kWh; yearly increase 4%
Corn silage	20 € / t
Transport of manure	1 € / t; case B and D
Labour cost production	€ 0,5 – 2,5 per day according to plant type
Service and maintenance	2% of total investment
Insurance	1% of total investment
Depreciation	25 years for building; 7 years for machinery
Return on investment	= (Profit after tax ÷ total investment) x 100
Pay-off period (amortisation)	= Total investment ÷ (depreciation + avg. profit after tax)

Table 11. All data due to a desk research and personal interviews on the spot in Romania conducted by the author of the study report

2.10. Investment cost

Investment cost		EUR	*Depcreciation time period*	*Depcreciation per year in EUR*
Technical equipment		90.000	7	12.857
Gas engine		250.000	7	35.714
Building/concrete		150.000	25	6.000
Design & Engineering		80.000	7	11.429
Installation		250.000	7	35.714
Infrastructure		20.000	0	
Total investment cost		**840.000**		**101.714**
Financing structure				
Equity	10%	84.000		
Subsidies	50%	420.000		
Credit	40%	336.000		
Total finance	100%	**840.000**		
Parameters for credit				
Years	10			
Interest rate	8%			
Amount of annuity		**50.074**		

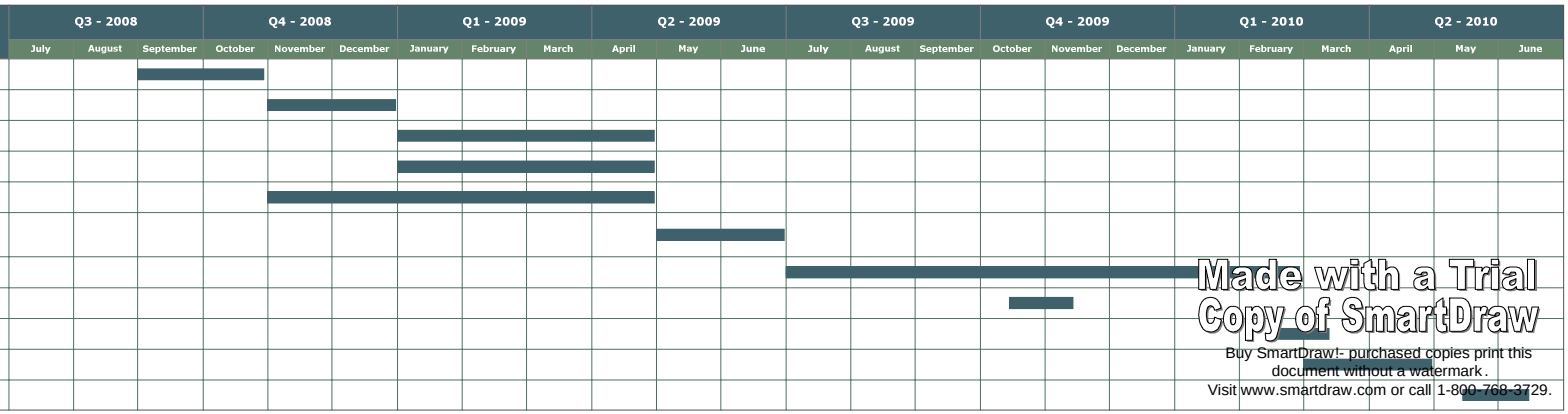
2.11. Profit and loss statement

Engine power	**280 KW_{el}**		**Year 1**		**Year 2**		**Year 3**		**Year 4**		**Year 5**	
Total investment in EUR	**840.000**		**TEUR**		**TEUR**		**TEUR**		**TEUR**		**TEUR**	
Operating hours	***7.800h***											
Sales revenues		EUR/kWh		EUR/kWh		EUR/kWh		EUR/kWh		EUR/kWh		
Green Certificate	1.980.000	0,060	118.800	0,060	118.800	0,060	118.800	0,060	118.800	0,060	118.800	0,0%
Regular energy price	1.980.000	0,040	79.200	0,042	82.368	0,043	85.663	0,045	89.089	0,047	92.653	4,0%
Thermal power for sale or own use in pig farm	2.100.000	0,020	42.000	0,021	43.680	0,022	45.427	0,022	47.244	0,023	49.134	4,0%
Final substrate	0	0,000	0	0,000	0	0,000	0	0,000	0	0,000	0	0,0%
Total revenue			**240.000**		**244.848**		**249.890**		**255.134**		**260.587**	
Cost of inputs		EUR/t										
Manure	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,0%
Corn silage	0	20,00	0	20,00	0	20,00	0	20,00	0	20,00	0	0,0%
Transport manure	64.240	1,00	64.240	1,00	64.240	1,00	64.240	1,00	64.240	1,00	64.240	0,0%
Other operating expenses	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,0%
Total cost of inputs			**64.240**		**64.240**		**64.240**		**64.240**		**64.240**	
Production cost												
Labour cost production 1 h/day; € 10,--/h			3.650		3.650		3.650		3.650		3.650	0,0%
Management			15.000		15.000		15.000		15.000		15.000	0,0%
Service and Maintenance (2% of investment)			16.800		16.800		16.800		16.800		16.800	0,0%
Lease of land and building			0		0		0		0		0	0,0%
Administration and office expenses			1.000		1.000		1.000		1.000		1.000	0,0%
Total production cost			**36.450**		**36.450**		**36.450**		**36.450**		**36.450**	
Other operating expenses												
Insurance (1% of investment)	0		8.400		8.400		8.400		8.400		8.400	
Other expensens	0		0		0		0		0		0	
Total operating expenses			**8.400**		**8.400**		**8.400**		**8.400**		**8.400**	
Total cost			**109.090**		**109.090**		**109.090**		**109.090**		**109.090**	
Depreciation	0		101.714		101.714		101.714		101.714		101.714	
EBIT			**130.910**		**135.758**		**140.800**		**146.044**		**151.497**	
Credit period in years	10											
Interrest rate		8%	26.880		25.024		23.021		20.856		18.519	
Profit/Loss before tax			**104.030**		**110.734**		**117.779**		**125.187**		**132.978**	
Tax		16%	16.645		17.717		18.845		20.030		21.276	
Profit/Loss after tax			**87.385**		**93.016**		**98.935**		**105.157**		**111.702**	
Cash-Flow												
Profit/Loss after tax			87.385		93.016		98.935		105.157		111.702	
Depreciation			101.714		101.714		101.714		101.714		101.714	
Cash-Flow			**189.099**		**194.730**		**200.649**		**206.872**		**213.416**	
Return on investment			10,40		11,07		**11,78**		12,52		13,30	
Pay-off period			**4,18**									

2.12. Project implementation plan

Agricultural Biogas Plant Implementation Plan

Number	Task	Start	End	Duration
1	Feasibilty Study	9/1/2008	10/30/2008	43
2	Planning and Engineering	11/1/2008	12/31/2008	42
3	Authorisations and Endorsement	1/1/2009	4/30/2009	85
4	Preparation of EU-Subsidy application and submission to Competent Autority	1/1/2009	4/30/2009	85
5	Clarification of project financing	11/1/2008	4/30/2009	128
6	Project approval by Competent Authority and signing of financing agreement	5/1/2009	6/30/2009	42
7	Start with project implementation - construction phase	7/1/2009	2/27/2010	173
8	First payment of EU subsidies	10/15/2009	11/14/2009	22
9	Second payment of EU subsidies	2/15/2010	3/13/2010	20
10	Initial operation	3/1/2010	4/30/2010	44
11	Last payment of EU subsidies	5/15/2010	6/15/2010	21



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CHAPTER III

Subsidies within the European Structural Fund Program 2007 -2013

3.1. European Fund for Agriculture and Rural development 2007 – 2013 (FEADR)

Objectives of the measure

- Community support granted by this measure has the following objectives:
- Modernizing and restructuring the agricultural holdings aiming at increasing their competitiveness through a better use of the production factors;
- Introduction of new technologies and innovations, aiming to improve the quality and the organic production;
- Production diversification with the use of renewable energy;
- Observance of the Community standards regarding cross-compliance.

Type of the beneficiaries

Agricultural producers – authorised natural persons, authorised family associations and legal entities, settled up according to the legislation in force.

Description of the requirements and targets with regard to the improvement of the overall performance of the agricultural holdings

The projects concerning the improvement of the overall performance of the agricultural holdings shall be supported by the measure, as:

- Introduction of new technological investments and improvement of existing tangible assets
- Introduction of new products, processes and technological systems
- Improving horizontal cooperation with the processing and manufacturing sectors
- Protection of the environment, including reducing of harmful emissions and waste
- Increasing implementation of renewable natural resources and improving the effectiveness of used resources

- Improving the occupational safety
- Improving the hygienic, veterinarian, phyto-sanitary, ecological and other production requirement
- Improving the quality of the agricultural products

Type of investments (tangible-intangible)

Support will be provided for tangible and intangible investments.

Tangible and intangible investments (indicative list):

- Construction, modernization and purchase of buildings and other estate property used for the agricultural production at farm level, including the those used for the environment protection
- New buildings and/or modernization of agricultural road infrastructure (internal roads or access roads), including utilities needed for the project
- New buildings and/or modernization of diary cow farms which fit with the milk quota European system
- New buildings and/or modernization of greenhouses, including heating systems and irrigation installations, utilities complying with environment conditions
- Purchase of new tractors, harvesting machines, machinery, installations, equipments and accessories, specialized equipments and software
- Purchase of new specialized transport vehicles needed for the project (e.g. manure transport truck)
- Purchase of high-genetic value animals only for the restoration of farms affected by natural disasters
- Purchase of land for administration and production purposes, for a value which cannot exceed 10% of the eligible value of the project
- Investments for the production and use of renewable energy
- General costs of the project consisting in: fees of architects, engineers and consultants, feasibility studies, certification taxes, acquisition of patent rights and licences

Support intensities

Non-refundable public support consists in:

- 80 % Community contribution
- 20 % national contribution

The public support covered by this measure shall amount between 50% -75% of the eligible value of the project and may be differ, as follows:

- 50 % of the eligible value of the investment for agricultural producers
- 55 % of the eligible value of the investment for agricultural producers from mountain areas and natural handicap areas other than mountain areas
- 60 % of the eligible value of the investment for young farmers
- 65 % of investment costs approved for young farmers from mountain areas and natural handicap areas other than mountain areas
- 100 % for the restoration of the productive potential affected by natural calamities

Financing

Indicative budget per measures of the RDP.

- Total cost: 1,218,628,000 EUR
- Public expenditure: 609,314,000 EUR
- The maximum ceiling for non-refundable public support is of 1,000,000 EUR/project.
- The maximum ceiling for non-refundable public support for a project that includes as well investments for the generation of renewable energy is of 1,500,000 EUR/project.

3.2. Sectoral Operational Program – Increase of Economic Competitiveness

Within the Structural Fund Program of the European Union 2007 – 2013, currently in the implementation phase and most probably operative in mid of year 2008, special measures for the promotion of the renewable energy sector are drawn-up in the SOP-IEC “Sectoral Operational Program – Increase of Economic Competitiveness.

Thereby the investment in a agricultural biogas plant shall be co-financed under the measure IV. 4.2. KEY AREAS OF INTERVENTION 4.2. VALORISATION OF RENEWALBE ENERGY SOURCES.

Description

Romania has an important exploitable potential of RES (hydro 40,000 GWh/year – out of which 6,000 GWh/year for micro hydro, wind – 23,000 GWh/year, solar thermal - 60 PJ/year and solar photovoltaics – 1,200 GWh/year, biomass - $318x10^6$ GJ/year and geothermal resources – $7x10^6$ GJ/year), distributed in different parts of the country.

The renewable energy resources have an important energy potential and their availability degree is higher than that of the traditional fuels in certain areas. Their use should be made on the basis of three important premises: accessibility, availability and acceptability.

The technical potential of renewable energy resources represents about 30% of the total primary energy supply reported in 2002. While there are significant hydro resources available and the hydro resources were valorised on a large scale, a big part of the generation capacities in this field are outdated and need to be upgraded.

Except hydro resources, the major potential contributors are the biomass, wind power, solar thermal and geothermal resources. Until now, the valorisation of these types of renewable resources has been at an early stage of development.
Therefore, greater use could be made of wind, solar, biomass and biofuels, geothermal resources, while continuing the valorisation of the hydro resources, which have the advantage of producing competitively priced energy.

Diversification of renewable energy sources is needed, taking into account that different types of renewable resources are available for use and that the energy production from different types of renewable resources varies in different periods of the year, depending on the weather conditions.

This way, the operations will contribute to the achievement until 2010 of the national target of 33% for the share of electricity produced from RES in the gross electricity consumption, according to the Government Decision no. 443/2003 regarding the valorisation of renewable energy sources for electricity generation and the National Strategy on RES valorisation approved by Government Decision no. 1535/2003.

The valorisation of renewable energy sources can also favour the introduction into the economic system of some isolated areas by providing the basis for development of economic activities.
Investment in RES will favour the development of local resources in various locations in Romania and will contribute to the reduction of dependency on energy imports, while at the same time contributing to the technological progress and creating new job opportunities on local labour market.

Using clean renewable energy is environmental friendly and reduces emissions of carbon dioxide and other greenhouse gases.

These actions are in line with the European guidelines**:** Energy for the future: renewable energy sources **-** White Paper laying down a Community strategy and action plan; Commission Green Paper of 20 November 1996 on renewable energy sources ; Cohesion Policy in Support of Growth and Jobs: Community Strategic Guidelines, 2007-2013"**;** Directive 2001/77/EC and the Lisbon Strategy**.**

Objectives

The key aim is to increase the use of renewable energy. The envisaged objective is to contribute to the following national target: 33% share of electricity produced from renewable energy resources in the gross national electricity consumption by 2010.

The proposed operation has the following objectives:

- to reduce the dependence of primary energy resources (mainly fossil fuels) imports,
- to diversify the available energy resources,
- the new envisaged production capacities in different zones of the country will lead to the increase of employment and, simultaneously, will diversify the offer on the labour market,
- the business environment will be diversified by attracting private companies (both from our country and from abroad) and the central and local public authorities in the process of capitalization of RES,
- the investments in the field of renewable resources will offer the possibility of manufacturing, transfer and trading of modern products and technologies in this field,
- the valorisation of the local renewable energy sources will lead to a greater reduction of the possible emissions resulting from the process of fossil fuel combustion and to the environment conservation.

Operations

Investments in upgrading and building new power and heating production capacities by valorisation of renewable energy sources: wind, hydro, solar, biomass, geothermal and other.

Grant size

Maximum value of the grant (Euro)	250,000-10,000,000 (except major projects)
Maximum size of grant to total eligible cost (%)	70% for small enterprises* 60% for medium-sized enterprises* 50% for large enterprises* 95% for public authorities[1]
Minimum contribution of the applicant	30% for small enterprises* 40% for medium-sized enterprises* 50% for large enterprises* 5% for public authorities?[2]
Community contribution to the support granted (%)	100% (for economic operators)
National public contribution to the support granted (%)	0 (for economic operators)

[1]for Bucharest: 60%/50%/40%
[2]for Bucharest: 40%,/50%/60%

Project eligibility and selection criteria

Applicant eligibility criteria

- The applicant should be an economic operator registered according to the valid national standard regulations or a public administration body
- The applicant is not under bankruptcy or clearance state or is not involved in civil, penal or administrative procedures which might affect the project co-financing
- The applicant should prove that he has fulfilled his commitment concerning the social insurance or any other taxes to the national/local budget, and if necessary, the payment obligations regarding rescheduling, according to the legislation in force
- The applicant assumes full responsibility that he is not the beneficiary of another non-reimbursable financing program for the submitted project
- The applicant should prove that he has project management experience in the implementation of investment projects

- The applicant should prove that he has financial, technical and human resources necessary for project implementation
- The applicant should prove the availability of co-financing
- The applicant should be directly responsible for the preparation and implementation of the project and he does not act as an intermediary
- The applicant should prove that he has all agreements, approvals and authorizations required by the Romanian legislation in force for works related to the implementation of the project or he is in the process of obtaining them. The applicant has the obligation to obtain them until the starting deadline of the project implementation as it is set up in the co-financing contract
- The applicant should prove that he has necessary resources (financing, material and human) in order to ensure the operation and maintaining of the investment at least during the standard economic life-time
- The applicant (economic operator) should make the evidence of an operational profit in the last two years

Project eligibility criteria

- The project makes a contribution to the accomplishment of one of the objectives of the key area of intervention of Priority Axis 4 from the Sectoral Operational Programme "Increase of Economic Competitiveness";
- The project should be implemented during the period 2007-2013, in Romania.
- The project should have an approved feasibility study, including environment impact study, cost-benefit analysis, elaborated according to the Romanian regulations in force.

Selection criteria

- The technical project should be realized according to the standards and technical regulations in force.
- The project co-financing rate from own sources of the applicant has to be as large as possible and it has to be proved based on documents at the data of application.
- The proportion between the expected results and the estimated costs (financing technological and additional benefits) should be positive.
- The investment costs should not exceed the market value at the submission date of the application;
- The investment has a positive impact upon the environment in the area in which the investment is performed.
- Location of the project implementation and/or the importance for the economic development of the community should be stated.
- The impact of the project from economic and social point of view should be positive as well. Projects implemented in disadvantaged areas and having a positive effect upon the labour market should have priority.

- The project should be performed based on new equipments and mature technologies.
- The time for recovering of the investment (years) should be as short as possible (maximum 50% of the economic life-time of the main equipments).

Specific selection criteria

- The cost of the kW installed.
- The location in which the project is going to be realised should be mentioned. (The locations having a high pollution degree and/or in which conventional energy resources are not available should be preferred).
- The number of users which are beneficiaries of the realized/modernized producing capacity
- The number of new work places created

Chapter IV

The renewable energy promotion system in Romania

4.1. EU Directive 2001/77/EC

The directive 2001/77/EC of the European Parliament and the Council on the promotion of electricity produced from renewable energy sources in the internal electricity market represents the first step of European Union in complying with the Kyoto targets of reducing the greenhouse gases. Romania was one of the first EU candidate countries transposing the Directive 2001/77/EC provisions into its own legislation (see GD no. 443/2003). Its indicative target for 2010 was fixed at 30%, representing the share of E-RES in the gross national electricity consumption.

E-RES produced from **wind**, **solar**, **biomass** energy as well as electricity produced from **hydro power** units with installed power **less than 10MW**, put in to function or refurbished starting with 2004 may benefit from the promotion system.

Romania has adopted the **mandatory quota system** combined with the **trade system** with minimum and maximum price limits set up by ANRE for the **green certificates**. Between 2005 and 2010, the mandatory quota for E-RES the electricity suppliers have to comply with are set up by law each year:

Mandatory quota applied to electricity suppliers (%)	Year
0.7	2005
2.22	2006
3.74	2007
5.26	2008
6.78	2009
8.3	2010-2012

Table 12. Table available on the website of OPCOM – Green certificate market operator (www.opcom.ro)

The minimum and maximum prices of a green certificate were traded between EUR **102,2 RON/GC (EUR 28,--)** and **153,3 RON/GC (EUR 42,--)** in 2007. Currently a new government ordinance is in preparation which will increase the Green Certificate price up to **EUR 60,0/GC** by mid of year 2008.

Figure 16. Graphic available on the website of OPCOM – Green certificate market operator (www.opcom.ro)

The electricity suppliers demonstrate the compliance with the quota system by number of green certificates they buy each year. This number has to be equal to the mandatory quota value multiplied by supplied electricity quantity. In case the supplier do not comply with the annual mandatory quota, they will pay to TSO (Transport and System Operator - Transelectrica) the maximum trade value of green certificates they were unable to buy. This value is set up by ANRE regulation.

4.2. Authorities involved in the E-RES promotion system and their functions

ANRE – Romanian Energy Regulatory Authority (www.anre.ro)

- Publishes primary and secondary legislation dedicated to E-RES
- Monitoring the development and functioning of the green certificate market

TRANSELECTRICA – Transport and System Operator (www.transelectrica.ro)

- Issue on monthly basis the green certificates
- Inform on monthly basis the E-RES producers, ANRE and the green certificate market operator about the producers receiving the GC and their hierarchy
- Involve and collect the monay from the electricity suppliers not complying with their mandatory quota

OPCOM – Green certificate market operator (www.opcom.ro)

- Publish annual prognosis of national offer and demand of green certificates
- Register the bilateral contracts and the information concerning the transaction between the E-RES producers and the electricity suppliers
- Create the GC Register and keep it up-to-date
- Register the participants to the green certificate market
- Ensure the proper functioning of the green certificate market
- Publish on monthly basis the cumulated demand and offer of green certificates from the beginning of the year
- Send a three-month report to ANRE regarding the evolution of the green certificate market

4.3. Distribution Operators

- Send to TSO on monthly basis the E-RES quantities supplied in the network by the producers connected to their area

4.4. Necessary steps for starting-up a E-RES project

Following steps are necessary for starting-up a generation capacity based on E-RES , trading the E-RES and benefiting from E-RES promotion system:

- Obtaining the authorisation and approvals needed for building-up the generation capacity
- Building up the generation capacity
- Obtaining the generation licence
- Obtaining the qualification certificate for the electricity priority production

- Registration at the Electricity Market Operator (OPCOM) for selling E-RES on the DAM (Day Ahead Market)
- Registration at TSO (TRANSELECTRICA) for obtaining the certificates
- Registration at the Green Certificate Market Operator (OPCOM) for participating on the centralised market of the green certificates

The E-RES producer may sell the E-RES on the electricity market, as any other electricity producer, obtaining the market price. For covering the entire generation cost and for obtaining a reasonable profit, the producer receives a green certificate for each MWh of electricity supplied in the electricity network. This green certificate may be traded within the price limits set by ANRE. The E-RES producer may sell the E-RES within a bilateral contracts, to electricity suppliers or eligible consumers, at negotiated prices.

4.5. Legal framework

4.5.1. Authorities

The following authorities are involved in RES:

Public administration

Ministry of Economy and Commerce

The Ministry of Economy and Commerce (MEC) (according to the Government Decision no. 738/2003 establishing its organising and functioning) is responsible, inter alia, for drawing up the national energy strategy regarding to the energy sector evolution, such as power and thermal energy, hydroelectric and nuclear power, oil, natural gas, mineral resources, mine-geology fields.

Romanian Agency for Energy Conservation (ARCE)

ARCE is in charge of promoting energy efficiency at the national level. Responsibilities include energy efficiency policy making and programme implementation. ARCE (according to the GD no. 941/2002 establishing its structure and function) has legal personality, functioning, operational and financial autonomy being under the subordination of the Ministry of Economy and Commerce. ARCE is financed from extra budgetary funds and allocation of funds from the state budget.

ARCE has 8 regional offices (in Bucharest, Brasov, Cluj, Constanta, Galati, Iasi Suceava and Timisoara), which can cover all the country.

The National Electricity and Heat Regulatory

ANRE, established according to the Law no.99/2000, is organised as an independent public legal person of national interest under the Prime Minister co-ordination. ANRE operates as per its own organisation and functioning regulation approved through government decision. Its mission is to create and implement fair and independent regulations to ensure an efficient, transparent and stable functioning of the electricity and heat sector and market while protecting the interests of consumers and investors.

ANRE issues, sets up and monitors mandatory regulations to be implemented at national level with a view to ensuring the proper functioning of the electricity sector and market in terms of efficiency, competition, transparency and consumer protection.

Green Certificates Market Operator OPCOM

OPCOM is a legal person which assures Green Certificates trading and determines the prices on the Centralised Green Certificates Market, performing the functions established by the Regulation for organising and functioning of the Green Certificates Market (Order no. 15 / 2005 issued by ANRE).

National Regulatory Authority in Natural Gas Sector (ANRGN)

ANRGN (according to the GO no. 41/2000 approved by Law no. 791/2001) is a public institution and legal person, which elaborates, applies and monitors the regulation system necessary for the natural gas sector and market function on efficiency, safety, competition, transparency and consumers and environment protection terms.

Ministry of Agriculture, Forests, Water and Environment (MAPAM)

The Ministry of Agriculture, Forests, Waters and Environment (MAPAM) is responsible for the development of the general environmental policy and specific legislation related to water management and environmental protection. It is also the Implementing Authority for the projects financed through the ISPA – Environmental Programme. Responsibility for the implementation of the environmental policy at local level lies with local authorities.

The Inter-ministerial Committee for the co-ordination of environmental field integration into sectoral policies and strategies at the national level was set up with the aim of developing a unitary environmental policy. Its members are representatives of all ministries who analyse and approve all environmental policies, strategies and legislation, having an important role in promoting and updating the National Environmental Action Plan and assessing the progress of the National Programme for the Adoption of the Acquis.

In order to adopt the EU institutional structures, two objectives have been set, namely the establishment of 8 Regional Agencies for Environmental Protection and of the National Agency for Environmental Protection

4.5.2. Energy related organisations

Romanian Energy Policy Association

APER is an independent professional organisation (NGO, non-profit), established under EC SYNERGY programme. APER provides energy information and knowledge to decision makers and experts with respect to energy policy development and analysis, acts as an independent forum for exchange of experience & opinions, and supports business development in the energy & environment fields.

The Romanian Association for Energy Efficiency

SOCER is a technical and non-governmental association, with juridical personality, a professional body and a non-profit organisation focusing on the efficient use of energy. Its activity is widely unfolded in Romania and Republic of Moldova and it is oriented to help the Local and Regional Authorities, the state and private companies from all economic fields, public institutions and natural persons.

By its initiatives, SOCER is sustaining the Romanian Agency for Energy Conservation (ARCE), the governmental body for the energy efficiency matters.

ALGEPEM Iasi (Local Agency for Efficient Management of Energy & Environment Problems)

The activities of ALGEPEM Iasi are coordinated by a Management Board which includes Managers of all Local Public Services Companies (Electricity, Gas, Transportation etc) and specialists/consultants in the field of energy and environment. The objectives of the agency include promoting energy efficiency on

local level, realising an Energetic Master-plan for the city of Iasi, modernising of the heating system; promoting new and renewable energy sources; organising special events - e.g.: "In town without my car" , etc.

ENERO - Centre for Promotion of Clean and Efficient Energy in Romania

ENERO is a non-governmental, non-profit R&D organisation active in the energy field. The ENERO team brings together highly experienced experts in the energy field, including economics and legislation, with wide experience in the management of the international complex projects and in consulting activities.

The objectives of ENERO are to develop the efficient and clean use of energy, renewable energy sources and to support new and innovative energy technologies, to promote the alignment to the European Union acquis in the energy field.

Since 2000, ENERO was selected as member of the European OPET Network co-ordinated by DG TREN, covering energy efficiency and renewable fields, at national level.

The Romanian "Energy Cities" Network

OER is a non-governmental organisation, gathering 38 members, important municipalities interested in improving the energy efficiency in public services (district heating, public lighting, water and gas supply, waste collection and storage, local transportation, etc.) and in promoting renewable energy and environmental protection.

Institute for Studies and Power Engineering (ISPE)

ISPE, founded in 1949, is a Consulting & Engineering Company 100% private. ISPE developed, through its projects, practically all the National Power System, from the generation up to the transmission and distribution systems for heat and power. The ISPE's medium and long-term development goals follow closely the Romanian strategy for EU integration, adoption and application of EU acquis. The transition to a sustainable energy future, in the Eastern and Central Europe, is reflected within ISPE's strategy by implementing, through its projects, cleaner technologies and imposing the use of energy resources in an environmental friendly manner.

ASA Holding SA

ASA Holding is an engineering company involved in the fields of energy and environment. ASA actively promotes energy solutions for the reduction of environmental pollution and fossil fuel consumption.

The fields of business are:

- Passive Houses
- Design Services for new / retrofitted Power Plants
- Steam/Hot Water Industrial Facility
- Turn-key Projects
- Cogeneration Projects (CHP)
- Environmental services

ICPE - Research Institute for Electrical Engineering New Energy Sources Laboratory

ICPE is participating in the 5th Framework Programme, the Specific Programme on Energy, Environment and Sustainable Development (EESD). ICPE is an electrical engineering company. Following the oil crisis, the activity in renewable energy has been initiated in ICPE. Business areas are:

- Photovoltaic energy
- Wind energy
- Hybrid systems

4.6. Energy related funds and programs

The Romanian Energy Efficiency Fund (FREE)

Established (Law no. 287/2002) as an institution of public interest having its own legal personality, independence and financial autonomy and headquartered in Bucharest. The Fund's purpose is the management of financial resources received by Romania from the Global Environmental Facility (GEF) through the International Bank for Reconstruction and Development (IBRD). According to the Grant Agreement signed between the Romanian Government and IBRD and ratified through Emergency Ordinance no. 188/2002.

Special Fund for Energy System Development (SFESD)

Established by Government Decision no. 29/1994. This fund can be used for achieving the energy conservation projects. The manager of SFESD is the Ministry of Industry and Resources (MIR) through the Romanian Agency for Energy Conservation (RAEC).

The Environmental State Fund

The Environmental Fund is a financial and economic tool, aiming to support the development of the projects comprised within the National Environmental Action Plan in conformity with the environmental norms and standards in force and envisages, as a main objective, the necessary investments for the adoption of the Aquis Communautaire. The institutional framework for the Environmental Fund is established by the Environmental Fund Administration, a legal public utility body, under the authority of the Ministry of Agriculture, Forests, Waters and Environment (MAPAM).

4.7. Energy laws

The legal framework of the production of renewable energy is constituted in the following primary and secondary legislation:

Primary legislation on RES

- Electricity Law no. 318/2003
- GD no. 1535/2003 regarding the approval of the strategy of use the renewable energy sources
- GD no. 443/2003 regarding the promotion of electricity produced from renewable energy sources
- GD no. 1429/2004 regarding the approval of the regulation of guarantee the origin of electricity produced from renewable energy sources
- GD no. 1892/2004 regarding the system for promotion of electricity produces from renewable energy sources

Secondary legislation on RES

The regulation of organisation and functioning of the green certificate market, approved by ANRE Order no. 15/2005
The methodology of fixing the minimum and maximum values of the green certificates on the market, approved by ANRE Order no. 19/2005
ANRE Order no. 20/2005 regarding the approval of minimum and maximum values of green certificates

Other useful information regarding E-RES

Information on electricity prices on DAM (day ahead market) my be found on the OPCOM website (www.opcom.ro)

4.8. Environmental laws

The main Romanian legislation concerning environmental aspects of biomass utilisation: Law no. 137/1995 on environmental protection, Law no. 107/1996 on water protection, Forestry Code approved by Law no. 26/1996 Ordinance Ministry of Waters, Forests and Environment Protection. no. 462/1993 on evaluation of pollutant emission, Ordinance Ministry of Waters, Forests and Environment Protection. No. 125/1996 on regulation procedure for economical and social activities having environmental impact.

Chapter V

Conclusions

Romania as newly European Union country with around 14,7 million hectare agricultural land and 6,4 million ha forest offers promising resources for the generation of renewable energy. Specially the Timis County in the so called Romanian Banat area, the target region for the present investment proposal, is on the first place in Romania regarding the total agricultural surface and arable land and offers excellent conditions for industrial pig production and generation of renewable energy.

The results of the present Master Thesis study report confirm, in consideration of the prevailing market conditions and subsidy programs in Romania, the technical and economical feasibility for an investment in a biogas plant in combination with industrial pig farming.

The generation of green electricity and thermal heat from manure by using the methane originate of industrial pig farming manure by the sealed process of fermentation in biogas plants within a closed cycle is a sustainable concept and delivers, beside renewable energy, a valuable and odorless fertiliser. An agricultural biogas plant, in addition to economical aspects, can contribute to the Kyoto targets by preventing uncontrolled emissions of methane (CH^4) and laughing gas (N^2O).

Related to environmental issues in regions with extensive animal production, the implementation of a biogas plant, in the sense of “best available technology” for anaerobic treatment (methane treatment) of pig manure, contributes to the solution of sensible environmental and health impacts of industrial pig farming.

In consideration of the present trend in the western European countries to implement co-fermentation technology as state of the art technology, the outcome of the study is inasmuch noticeable, as the fermentation of large quantities of pig manure provides competitive commercial results. This aspect might be of importance in the future particularly when the prices for co-fermentation substrates - like the primarily used corn silage - will increase as this is the case at present.

Chapter VI

Alternative investment cases

6.1. Investment cost CASE A

Investment cost		EUR	*Depcreciation time period*	*Depcreciation per year in EUR*
Technical equipment		70.000	7	10.000
Gas engine		130.000	7	18.571
Building/concrete		80.000	25	3.200
Design & Engineering		40.000	7	5.714
Installation		40.000	7	5.714
Infrastructure		10.000	0	
Total investment cost		**370.000**		**43.200**
Financing structure				
equity	10%	37.000		
subsidies	50%	185.000		
credit	40%	148.000		
Total finance	100%	**370.000**		
Parameters for credit				
years	10			
interest rate	8%			
Amount of annuity		**22.056**		

6.1.1. Profit and loss statement CASE A

Engine power 70 kW	**70 KW_{el}**		**Year 1**		**Year 2**		**Year 3**		**Year 4**		**Year 5**	
Total investment in EUR	**370.000**		**TEUR**		**TEUR**		**TEUR**		**TEUR**		**TEUR**	
Operating hours	***7.800h***											
Sales revenues		EUR/kWh		EUR/kWh		EUR/kWh		EUR/kWh		EUR/kWh		
Green Certificate	490.000	0,060	29.400	0,060	29.400	0,060	29.400	0,060	29.400	0,060	29.400	0,0%
Regular energy price	490.000	0,040	19.600	0,042	20.384	0,043	21.199	0,045	22.047	0,047	22.929	4,0%
Thermal power for sale or own use in pig farm	531.000	0,020	10.620	0,021	11.045	0,022	11.487	0,022	11.946	0,023	12.424	4,0%
Final substrate	0	0,000	0	0,000	0	0,000	0	0,000	0	0,000	0	0,0%
Total revenue			**59.620**		**60.829**		**62.086**		**63.393**		**64.753**	
Cost of inputs		EUR/t										
Manure	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,0%
Corn silage	0	20,00	0	20,00	0	20,00	0	20,00	0	20,00	0	0,0%
Transport	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,0%
Total cost of inputs			**0**		**0**		**0**		**0**		**0**	
Production cost												
Labour cost production 0,5 h/day; € 10,--/h			1.825		1.825		1.825		1.825		1.825	0,0%
Management			15.000		15.000		15.000		15.000		15.000	0,0%
Service and Maintenance (2% of investment)			7.400		7.400		7.400		7.400		7.400	0,0%
Lease of land and building			0		0		0		0		0	0,0%
Administration and office expenses			1.000		1.000		1.000		1.000		1.000	0,0%
Total production cost			**25.225**		**25.225**		**25.225**		**25.225**		**25.225**	
Other operating expenses												
Expenses for procurement and distribution			0		0		0		0		0	
Insurance (1% of investment)			3.700		3.700		3.700		3.700		3.700	
Other expensens			0		0		0		0		0	
Total operating expenses			**3.700**		**3.700**		**3.700**		**3.700**		**3.700**	
Total cost			**28.925**		**28.925**		**28.925**		**28.925**		**28.925**	
Depreciation			43.200		43.200		43.200		43.200		43.200	
EBIT			**30.695**		**31.904**		**33.161**		**34.468**		**35.828**	
Credit period in years	10											
Interrest rate		8%	11.840		11.023		10.140		9.187		8.157	
Profit/Loss before tax			**18.855**		**20.881**		**23.021**		**25.282**		**27.671**	
Tax		16%	3.017		3.341		3.683		4.045		4.427	
Profit/Loss after tax			**15.838**		**17.540**		**19.338**		**21.237**		**23.244**	
Cash-Flow												
Profit/Loss after tax			15.838		17.540		19.338		21.237		23.244	
Depreciation			43.200		43.200		43.200		43.200		43.200	
Cash-Flow			**59.038**		**60.740**		**62.538**		**64.437**		**66.444**	
Return on investment			4,28		4,74		**5,23**		5,74		6,28	
Pay-off period (amortisation)			**5,91**									

6.2. Investment cost CASE C

Investment cost		EUR	*Depcreciation time period*	*Depcreciation per year in EUR*
Technical equipment		150.000	7	21.429
Gas engine		360.000	7	51.429
Building/concrete		300.000	25	12.000
Design & Engineering		200.000	7	28.571
Installation		1.000.000	7	142.857
Infrastructure		130.000	0	
Total investment cost		**2.140.000**		**256.286**
Financing structure				
equity	10%	214.000		
subsidies	50%	1.070.000		
credit	40%	856.000		
Total finance	100%	**2.140.000**		
Parameters for credit				
years	10			
interest rate	8%			
Amount of annuity		**127.569**		

6.2.1. Profit and loss statement CASE C

Engine power	**535 KW_{el}**		**Year 1**		**Year 2**		**Year 3**		**Year 4**		**Year 5**	
Total investment in EUR	2.140.000		**TEUR**		**TEUR**		**TEUR**		**TEUR**		**TEUR**	
Operating hours	***7.800h***											
Sales revenues		EUR/kWh		EUR/kWh		EUR/kWh		EUR/kWh		EUR/kWh		
Green Certificate	3.900.000	0,060	234.000	0,060	234.000	0,060	234.000	0,060	234.000	0,060	234.000	0,0%
Regular energy price	4.100.000	0,040	164.000	0,042	170.560	0,043	177.382	0,045	184.478	0,047	191.857	4,0%
Thermal power for sale or own use in pig farm	4.100.000	0,020	82.000	0,021	85.280	0,022	88.691	0,022	92.239	0,023	95.928	4,0%
Final substrate	0	0,000	0	0,000	0	0,000	0	0,000	0	0,000	0	0,0%
Total revenue			**480.000**		**489.840**		**500.074**		**510.717**		**521.785**	
Cost of inputs		EUR/t										
Manure	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,0%
Corn silage	9.000	20,00	180.000	20,00	180.000	20,00	180.000	20,00	180.000	20,00	180.000	0,0%
Transport	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,0%
Total cost of inputs			**180.000**		**180.000**		**180.000**		**180.000**		**180.000**	
Production cost												
Labour cost production 1,5 h/day; € 10,--/h			5.475		5.475		5.475		5.475		5.475	0,0%
Management			30.000		30.000		30.000		30.000		30.000	0,0%
Service and Maintenance (2% of investment)			42.800		42.800		42.800		42.800		42.800	0,0%
Lease of land and building			0		0		0		0		0	0,0%
Administration and office expenses			3.000		3.000		3.000		3.000		3.000	0,0%
Total production cost			**81.275**		**81.275**		**81.275**		**81.275**		**81.275**	
Other operating expenses												
Expenses for procurement and distribution	0		0		0		0		0		0	
Insurance (1% of investment)	0		21.400		21.400		21.400		21.400		21.400	
Total operating expenses			**21.400**		**21.400**		**21.400**		**21.400**		**21.400**	
Total cost			**282.675**		**282.675**		**282.675**		**282.675**		**282.675**	
Depreciation	0		256.286		256.286		256.286		256.286		256.286	
EBIT			**197.325**		**207.165**		**217.399**		**228.042**		**239.110**	
Credit period in years	10											
Interrest rate		8%	68.480		63.753		58.648		53.134		47.179	
Profit/Loss before tax			**128.845**		**143.412**		**158.751**		**174.908**		**191.931**	
Tax		16%	20.615		22.946		25.400		27.985		30.709	
Profit/Loss after tax			**108.230**		**120.466**		**133.351**		**146.922**		**161.222**	
Cash-Flow												
Profit/Loss after tax			108.230		120.466		133.351		146.922		161.222	
Depreciation			256.286		256.286		256.286		256.286		256.286	
Cash-Flow			**364.516**		**376.752**		**389.637**		**403.208**		**417.508**	
Return on investment			5,06		5,63		**6,23**		6,87		7,53	
Pay-off period (amortisation)			**5,48**									

6.3. Investment cost CASE D

Investment cost		EUR	*Depcreciation time period*	*Depcreciation per year in EUR*
Technical equipment		190.000	7	27.143
Gas engine		420.000	7	60.000
Building/concrete		500.000	25	20.000
Design & Engineering		350.000	7	50.000
Installation		1.357.000	7	193.857
Infrastructure		135.000	0	
Total investment cost		**2.952.000**		**351.000**
Financing structure				
Equity	10%	295.200		
Subsidies	50%	1.476.000		
Credit	40%	1.180.800		
Total finance	100%	**2.952.000**		
Parameters for credit				
Years	10			
Interest rate	8%			
Amount of annuity		**175.974**		

6.3.1. Profit and loss statement CASE D

Engine power	**738 KW_{el}**		**Year 1**		**Year 2**		**Year 3**		**Year 4**		**Year 5**	
Total investment in EUR	**2.952.000**		**TEUR**		**TEUR**		**TEUR**		**TEUR**		**TEUR**	
Operating hours	***7.800h***											
Sales revenues		EUR/kWh		EUR/kWh		EUR/kWh		EUR/kWh		EUR/kWh		
Green Certificate	5.380.000	0,060	322.800	0,060	322.800	0,060	322.800	0,060	322.800	0,060	322.800	0,0%
Regular energy price	5.700.000	0,040	228.000	0,042	237.120	0,043	246.605	0,045	256.469	0,047	266.728	4,0%
Thermal power for sale or own use in pig farm	5.700.000	0,020	114.000	0,021	118.560	0,022	123.302	0,022	128.234	0,023	133.364	4,0%
Final substrate	0	0,000	0	0,000	0	0,000	0	0,000	0	0,000	0	0,0%
Total revenue			**664.800**		**678.480**		**692.707**		**707.503**		**722.892**	
Cost of inputs		EUR/t										
Manure	0	0,00	0	0,00	0	0,00	0	0,00	0	0,00	0	0,0%
Corn silage	9.000	20,00	180.000	20,00	180.000	20,00	180.000	20,00	180.000	20,00	180.000	0,0%
Transport manure	64.240	1,00	64.240	1,00	64.240	1,00	64.240	1,00	64.240	1,00	64.240	0,0%
Total cost of inputs			**244.240**		**244.240**		**244.240**		**244.240**		**244.240**	
Production cost												
Labour cost production 2,5 h/day; € 10,--/h			9.125		9.125		9.125		9.125		9.125	0,0%
Management			20.000		20.000		20.000		20.000		20.000	0,0%
Service and Maintenance (2% of investment)			59.040		59.040		59.040		59.040		59.040	0,0%
Lease of land and building			0		0		0		0		0	0,0%
Administration and office expenses			3.000		3.000		3.000		3.000		3.000	0,0%
Total production cost			**91.165**		**91.165**		**91.165**		**91.165**		**91.165**	
Other operating expenses												
Expenses for procurement and distribution	0		0		0		0		0		0	
Insurance (1% of investment)	0		29.520		29.520		29.520		29.520		29.520	
Other expensens	0		0		0		0		0		0	
Total operating expenses			**29.520**		**29.520**		**29.520**		**29.520**		**29.520**	
Total cost			**364.925**		**364.925**		**364.925**		**364.925**		**364.925**	
Depreciation	0		351.000		351.000		351.000		351.000		351.000	
EBIT			**299.875**		**313.555**		**327.782**		**342.578**		**357.967**	
Credit period in years	10											
Interrest rate		8%	94.464		87.943		80.901		73.295		65.081	
Profit/Loss before tax			**205.411**		**225.612**		**246.881**		**269.284**		**292.886**	
Tax		16%	32.866		36.098		39.501		43.085		46.862	
Profit/Loss after tax			**172.545**		**189.514**		**207.380**		**226.198**		**246.024**	
Cash-Flow												
Profit/Loss after tax			172.545		189.514		207.380		226.198		246.024	
Depreciation			351.000		351.000		351.000		351.000		351.000	
Cash-Flow			**523.545**		**540.514**		**558.380**		**577.198**		**597.024**	
Return on investment			5,85		6,42		**7,03**		7,66		8,33	
Pay-off period (amortisation)			**5,28**									

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Chapter VIII

Annex

8. Overview on the Romanian Energy Market

Electricity market – Structure of power sector

In the year 2000, the former national electricity company CONEL reorganised and therefore dissolved. The following commercial companies were established.

- **TRANSELECTRICA S.A.** , the National Power Grid Company for the transport of electrical energy - electric transmission, electric market management, and foreign electric system interconnection.
- **TERMOELECTRICA S.A.,** Commercial Company for Electricity and Heat Generation for the production of electrical and thermal energy - electricity generation from thermal power plants, district heating, and related fuel supplies.
- **HIDROELECTRICA S.A.,** Commercial Company for Electricity Generation for the production and delivery of hydroelectric power.
- **ELECTRICA S.A.,** Commercial Company for Electricity Distribution and Supply.
- **NUCLEARELECTRICA S.A.** (SNN SA), fully state owned company which carries out as its main mission the production of nuclear power, of nuclear fuel and the project development at the Cernavoda Nuclear Power Plant site.

Status of deregulation

The mission of The National Electricity and Heat Regulatory - ANRE, responsible for issuing licences for the unbundled Romanian market, is outlined in "Regulatory White paper for Sustaining the Liberalisation & Privatisation Processes in the Electricity and Heat Sector). Price liberalisation was started in 1997. As far as the Implementation of the Electricity Directive is concerned, an Emergency Ordinance (1998) lays out the measures to be introduced for liberalisation of the Romanian electricity market.

Opening of the market

In the electricity sector, following a Government Decision in January 2002, market openness was increased to 33%, with licensed suppliers and eligible customers defined by the regulatory authority. In practice, the contracts signed between licensed suppliers and eligible customers amount to around 8% of the market.

Requirements:

- Consumption threshold: 40 GWh
- Creditworthiness
- Absence of debts to former national company CONEL

Access to the network

Regulated Third Party Access will be used. The likely model for tariff regulation is a combined price cap and rate-of-return system. ANRE has chosen a nodal transmission tariff system.

Regulator

The National Electricity and Heat Regulatory - ANRE

Competition in generation

ANRE issues authorisations for new generation capacity and for the rehabilitation of existing plants for companies with headquarters or secondary head offices in Romania. Licences are awarded subject to the accomplishment of a feasibility study, an environmental impact assessment and a financial assessment.

Tariff setting

The National Electricity and Heat Regulatory - ANRE is responsible for regulating prices and tariffs in monopolistic activities (transmission and distribution). Until the market operator is established, ANRE is also responsible for the generation sector.

Oil and gas market

Oil: Structure and Status of Deregulation

PETROM SA, the former National Oil Company, is the biggest company is the largest oil and gas company. PETROM is an integrated enterprise, comprising two refineries and two petrochemical units. 51% of PETROM are owned by OMV, the Austrian oil company.

- **Rompetrol** is a private company specialized in external trade
- **Conpet**: the oil pipeline company
- **Petrotrans**: distributes and markets oil and oil products

The petroleum products market is open to competition; seven out of the eight operating refineries were privatised. Distribution is also highly competitive, containing a diversity of large foreign and Romanian private companies.

Gas: Structure and Status of Deregulation

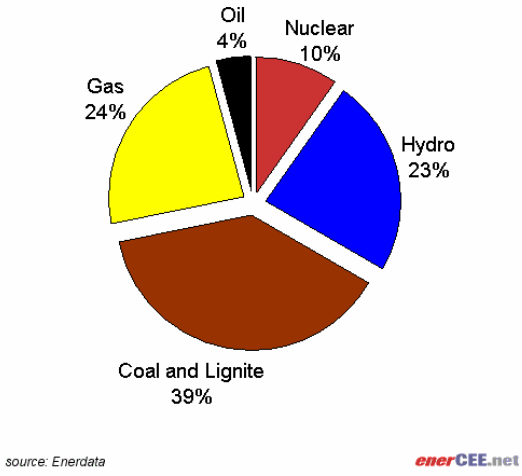
ROMGAZ. S.A S.N.G.N. has as main activities exploration, production and underground storage. After the restructuring Romgaz is open for foreign investment. Transgaz SN is in charge of transport of locally produced gas. Southern Distrigaz and Northern Distrigaz , together with Petrom and private distributors are being restructured in order to be privatised.

In the gas sector, the rate of market opening was increased from 10% to 25%, and the regulatory authority has selected 45 eligible customers. As with the electricity sector, gas prices have been adjusted to reflect production costs, they are now indexed with the US dollar, and the president of the National Gas Regulatory Authority (ANRGN) is appointed by the Prime Minister.

Coal and lignit market

The National Lignite Company Oltenia (CNLO) has a production capacity of about 31 Million t per year, while Romania's domestic consumption is estimated at 23-27 Miliont t per year. RAL, RACP and RAH are coal producing companies; RAL and RACP controlling most lignite mines, RAH being responsible for hard coal mines and some lignite mines.

8.1. Structure of Energy Production



Electricity production in Romania according to energy sources, 2003

Electricity grid

Romania has an extensive interconnected power transmission and distribution network with an overall length of about 600,000 km, and a total transformer capacity of about 172,000 MVA. The national grid operates on 750 kV, 400 kV, and 220 kV for transmission and 20 kV, 10 kV, 6 kV, 1 kV and 0.4 kV for distribution.

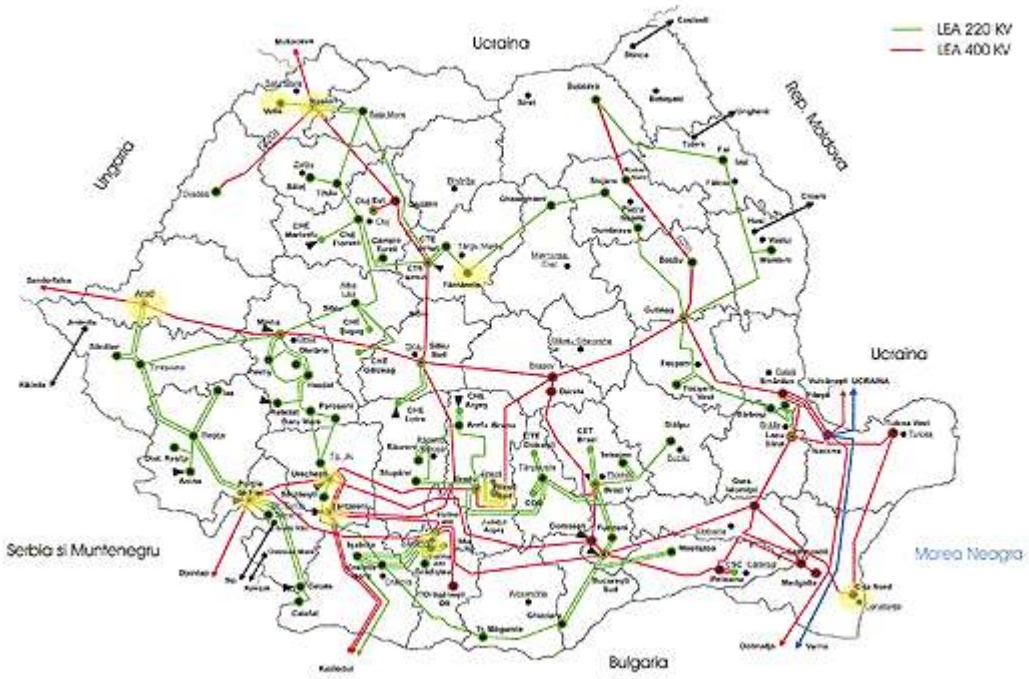
Transelectrica (Romania) is member of UCTE and observer in CENTREL. As a limited member of the Interconnected Power System-Central Dispatching Organization, Romania has strong interconnections with Ukraine and Bulgaria, substantial interconnections with the former Yugoslavia, and weaker links to the Republic of Moldavia and Hungary.

The Romanian grid operator, Transelectrica, is currently cooperating with the electric power systems of Greece and the former Yugoslavia (both UCPTE members) and is working to become more fully integrated into the UCPTE system.

The transmission network is interconnected with those of neighboring countries -- by 750 kV (4,000 MWe capacity), 400 kV (2,500 MWe capacity), and two 110 kV tie-lines with Ukraine; a 400 kV line with Hungary (currently operating at 220 kV, with a planned

capacity of 1,200 MWe); 750 kV (4,000 MWe capacity), 400 kV (2,500 MWe capacity), and 220 kV (260 MWe capacity) lines to Bulgaria; and one 400 kV (1,200 MWe capacity) and two 110 kV lines with Yugoslavia; and two 110 kV lines with Moldavia.

In 2001, Transelectrica received a $51.5 million loan from the European Bank for Reconstruction and Development (EBRD) to upgrade the Romanian transmission system and make it more compatible with the western European power network. Romania's electricity distribution companies are presently all state-owned, but this is likely to change soon.



Romanian electricity grid map

Oil and Natural Gas

Oil

Romania's crude oil reserves are estimated at 200 Mt. Oil production has been decreasing since 1997. (2001: 6 Mt) Oil imports have declined from 22 Mt in 1989 to 7 Mt today. The refining capacity has been reduced from 34 Mt in 1996 to 25 Mt today. With the opening of 15 oil and gas blocks for exploration in 1996, and the influx of western technology, Romanian reserves and production are expected to rise slightly in the coming years. The share of oil in primary energy consumption is 32%.

Gas

Romania's gas reserves are estimated at 335 Gm3. Gas imports have been decreasing rapidly since 1984. In 2001 10Gm3 were imported. The share of imports from Russia, via a pipeline through Ukraine, is increasing and now accounts for 20% of the country's consumption.

The share of gas in the country's primary energy consumption has dropped from 45% in 1990 to 35% in 2001.

Coal

Romania's reserves of coal and lignite are 800 Mt and 2.8 Gt, respectively. Most of these reserves are lignite and sub-bituminous coal, with the largest reserves located in the Jiu Valley. Less than 10% of the coal produced in Romania is bituminous. The share of coal and lignite in the country's primary energy consumption is 18%.

Renewable energy

In the 2002 regular report on Romania's progress towards accession to the EU, the EU commission comes to the conclusion that Romania does not devote the necessary resources to improving energy efficiency and to promoting renewal energy. The present efficiency of production means and networks is very poor, mainly due to a lack of investment. The Romanian Agency for Energy Conservation is in charge of promoting energy efficiency but has very limited financial and human resources - which is a demonstration of the low priority Romania gives to energy efficiency. This is particularly worrying, since the energy intensity of the economy is very high (estimated at around 8 times the EC average). Incentives for Renewable Energies and Funding The Law on the Efficient Use of Energy (see Law on the efficient use of energy) entered into force in 2002.

Hydropower

Current Status

The hydro-electric potential is estimated at 40 TWh, 12 TWh/a are developed: The 362 Hydroelectric power plants with an overall installed capacity of 6120 MW represent 27.9% of the overall installed capacity of the Romanian power system. Hydro Energy Resource Potential: The hydro-electric potential is estimated at 40 TWh. The opportunities for hydro development in Romania are very good. Around 5000 locations in Romania are favourable for small HPPs. However, there are no special incentives for the implementation of hydro projects.

Bioenergy

Current Status of Biomass Energy

Romania is covered by 40% of agricultural land and 27% of forest. The share of biomass in the total energy of the country was 10.94% in 1998. Currently, biomass is used only for heating purposes, direct burning for cooking and hot water preparation consuming the largest share. District heating systems are the most immediate and low-cost application. About 95% of the biomass currently used is firewood and agricultural waste, the rest is wood waste from industrial processes: The average installed capacity in sawmills is 3.3 MWth. Biogas has been used in the past to a larger amount. Today, the number of large pig and cattle units is decreasing. Two demonstrative biogas-projects were realised in 1999.

8.2. Biomass Energy Resources

Potential Biomass is regionally distributed over Romania. Fuel wood and wood waste is mostly found in the Carpathians and Subcarpathians, while agricultural waste is available in the South Plain and Moldavia, biogas in the South and Western plains.

In their Renewable Energy Resource Assessment for Romania, the EBRD estimates the South Plain region most promising for the utilisation of agricultural waste, and the Carpathian and Subcarpathian mountains as most promising for the development of district-heating plants from firewood and wood waste in a range of 1-6 MWth.

However, special incentives for the implementation of biomass projects are not in force, but under preparation within the Accession of Romania to the European Union.

Wind energy

Current Status of Wind Energy

There is only one demonstrating wind energy project in Romania (4 kW). Two demonstration projects with over 100 kW each, in the Semenic Mountains and at Black Sea offshore, are no longer in operation due to lack of funds. There is one current project (22 750 kW and 4 2 MW turbines at Constanta, Black Sea).

A country wide wind atlas was issued by the "Energy Research and Modernizing Institute" (ICEMENERG), in 1993. It indicates wind speeds of 4.5 - 11.5 m/s at 50m height in various areas, notably off-shore.

Wind Energy Resource Potential

Based on the available wind atlas, Romania has very good technical potential for wind energy development. Large areas with wind speeds over 11m/s are identified. Incentives would be the provisions of the Directive 77 and the National Strategy for Energy Development on Medium Term. Feed-in tariffs for autonomous small systems of 11-13 €cent/kWh are possible but not decided by law currently.

Solar energy

Current Status of Solar Energy

Starting 1979, a large scale program for various solar applications has been implemented: solar domestic hot water systems for hotels at the Black Sea, for apartment blocks, solar drying for agricultural products, solar cooling for fish preservation. However, due to poor quality, lack of maintenance and a stop of activities with the market reforming in 1990, only 10% of the installed 1 Mio m2 of collector area is still in operation. Currently, some demonstrative capacities, under 1 kW are installed.

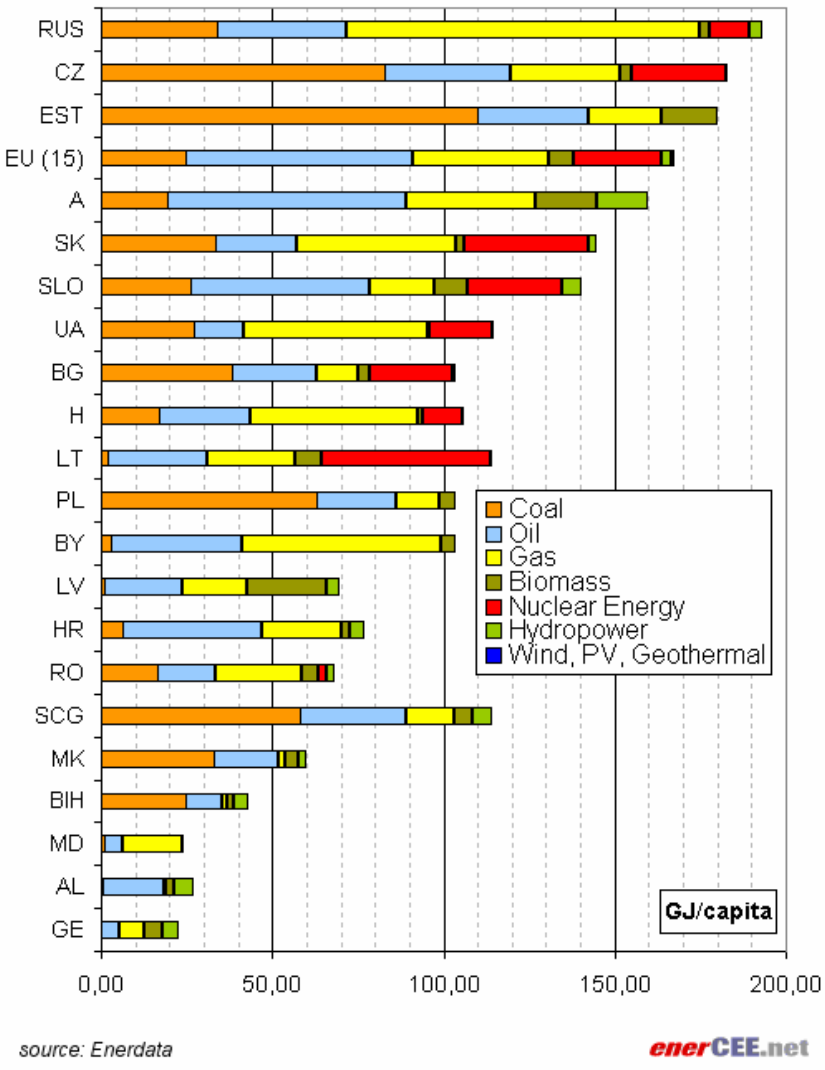
Solar Energy Resource Potential

The average solar radiation in Romania ranges from 1,100 to 1,300 kWh/m2 per year. A solar radiation map has been issued by the National Institute of Meteorology and Hydrology. There are good opportunities for solar energy development, and experiences from the past can be used. In the Renewable Energy Resource Assessment, the EBRD estimates domestic solar water heating for public buildings and hotels, passive solar systems, and stand alone systems for sites far from the grid, to be the most promising applications.

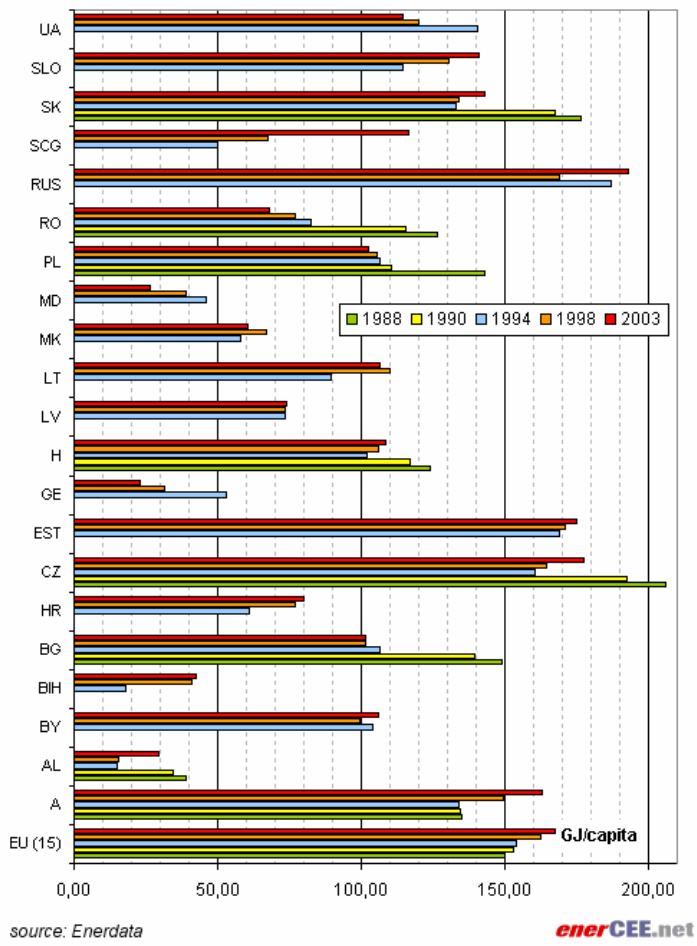
8.3. Energy services and demands

Romania has significant fossil fuel and hydroelectric resources: Romania has crude oil reserves of about 1.4 billion barrels, proven natural gas reserves estimated at 335 Gm3, estimated coal reserves of 3.98 billion short tons. Most of these reserves are lignite and sub-bituminous coal. The total hydroelectric power potential is about 40 TWh per year of which 12 TWh per year has already been developed. Domestic production supplies 70% of the primary energy demand.

Primary Energy Demand of Romania in 2003

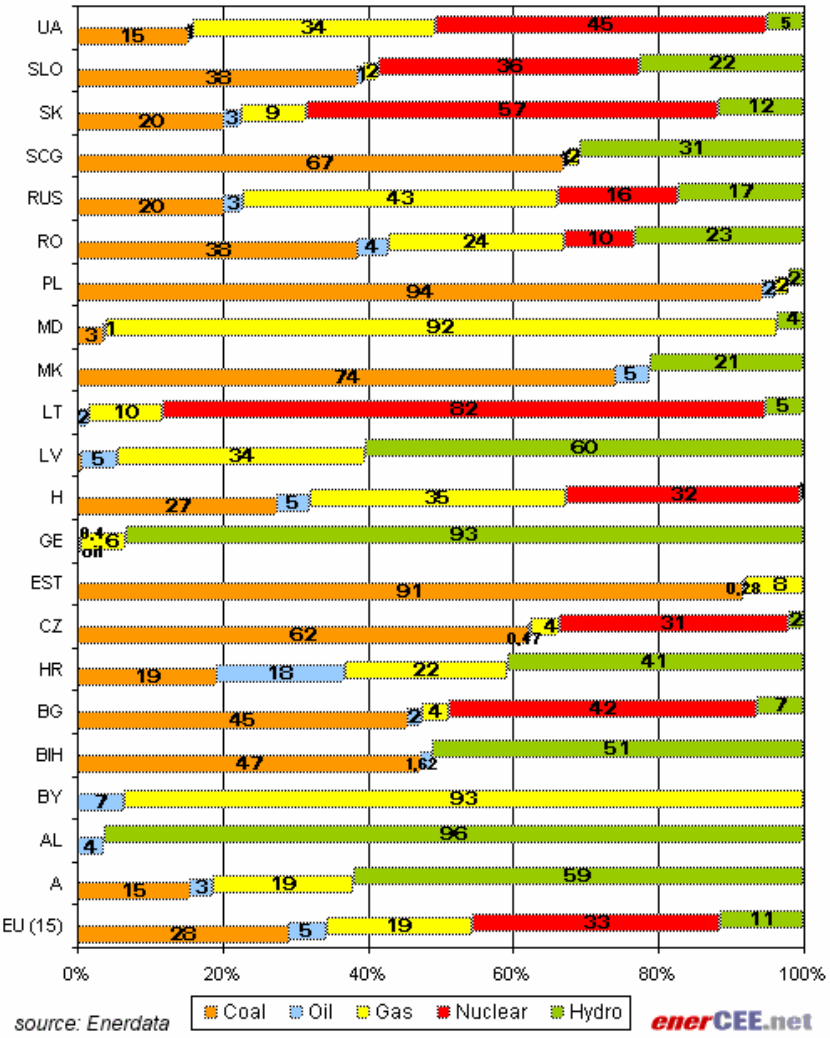


Development of Primary Energy Demand per Capita in Romania, as compared to the other countries in Central and Eastern Europe, the EU15 and Austria

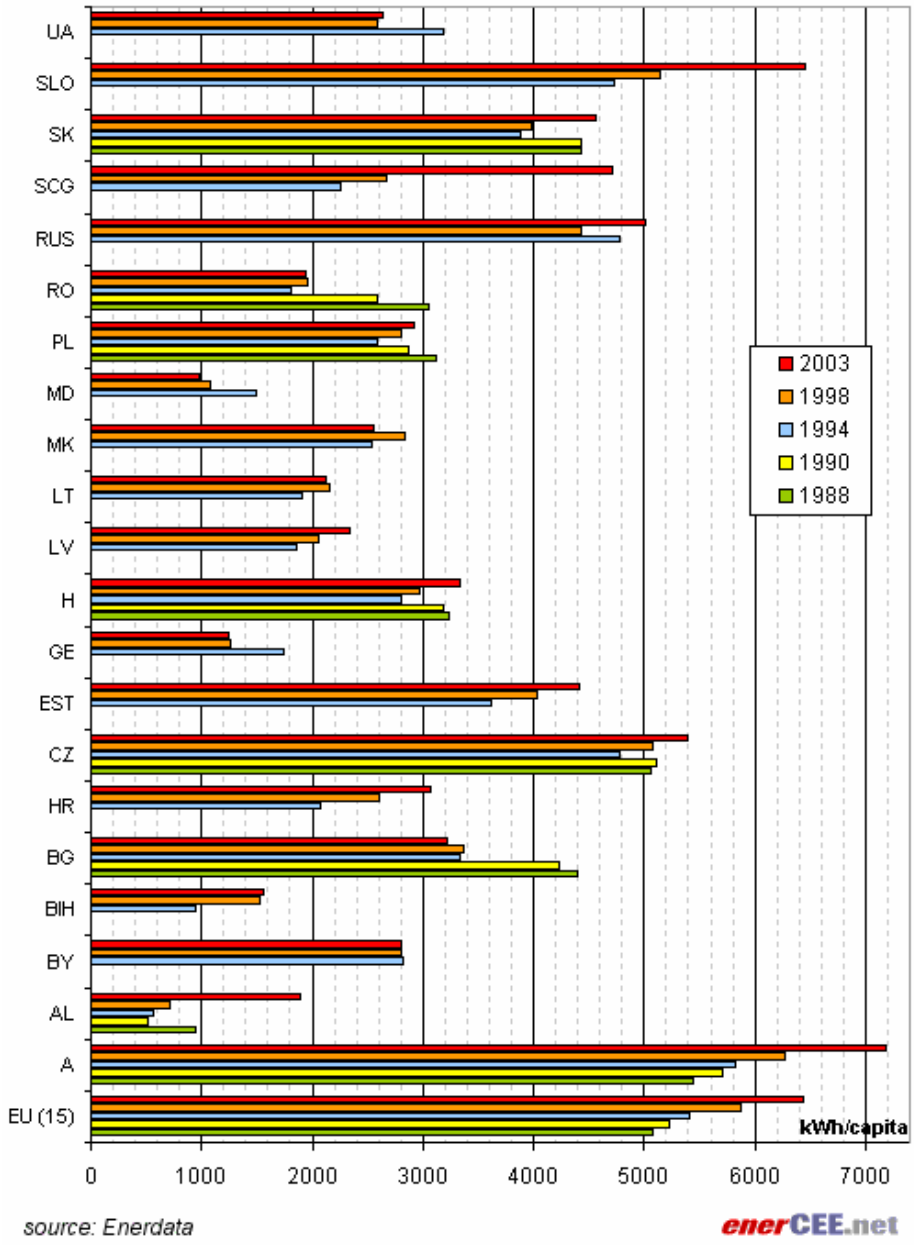


The decline of energy demand per capita is mainly due to the reduction of energy demand in industry. The trend of steadily rising primary energy demand, which is visible in the EU and Austria, can, in the countries shown in the figure, up to now only be seen in Slovenia, and, covertly, in Hungary and Slovak Republic.

Production of Electricity in 2003 according to energy sources in Romania, as compared to other countries in CEE, Austria and the EU 15, for 2003

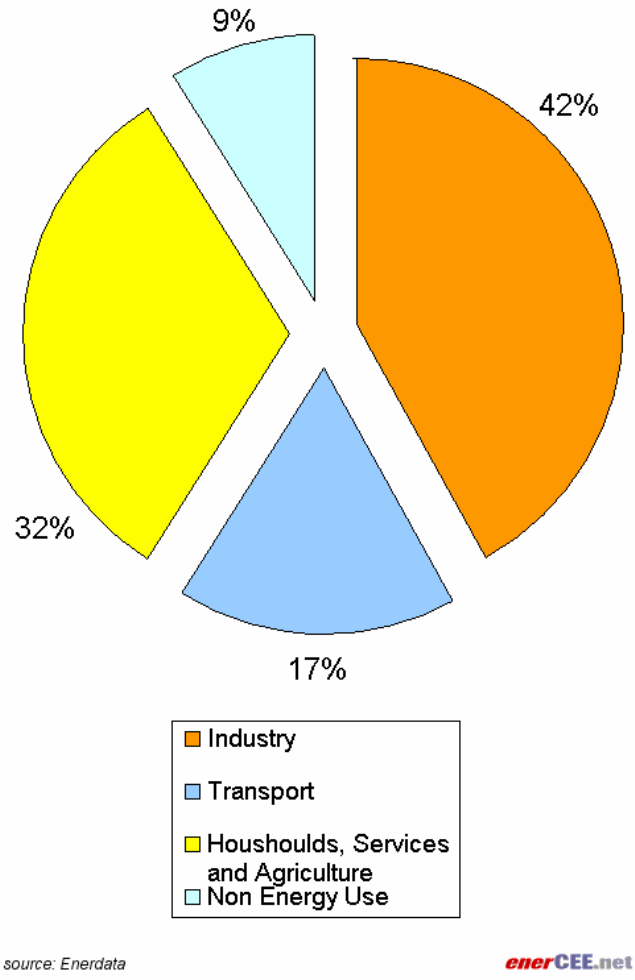


Per Capita Consumption of Electricity since 1988 in Romania, as compared to other countries in CEE, Austria and the EU 15



There is a trend visible in the EU, that the demand for electricity is increasing more quickly than the total demand for energy. From the countries of Central and Eastern Europe shown in the figure, so far only Slovenia shows this trend.

Final energy demand by sectors in Romania, 2003



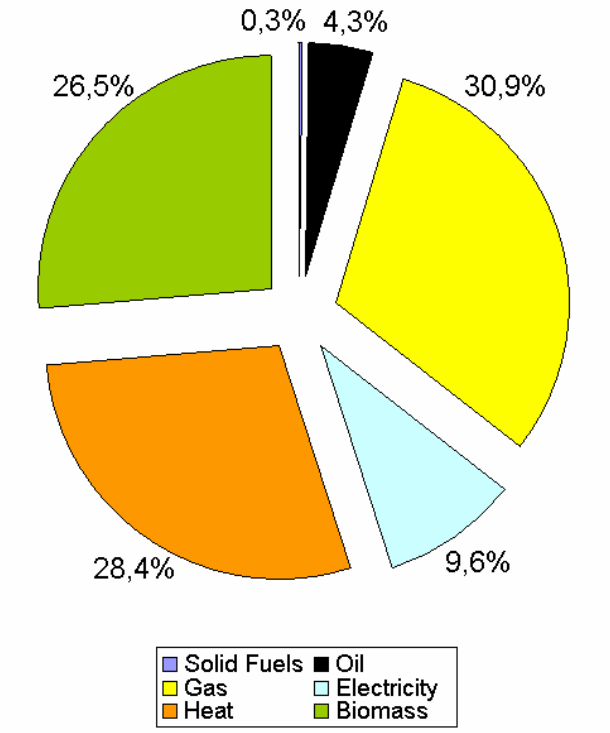
The primary energy consumption per capita is about 1.6 toe/ 67 GJ. The final energy consumption decreased sharply in the early 1990s, due to economic crisis and the changes in energy accounting methods. Since 1999 the consumption has stabilized at 24.5 Mtoe / 1,025,800 TJ.

Demand per sector

The final consumption by sectors is as follows:

Households and Services	**39 %**
Transport	**18 %**
Industry	**33 %**
Non Energy Uses	**10 %**

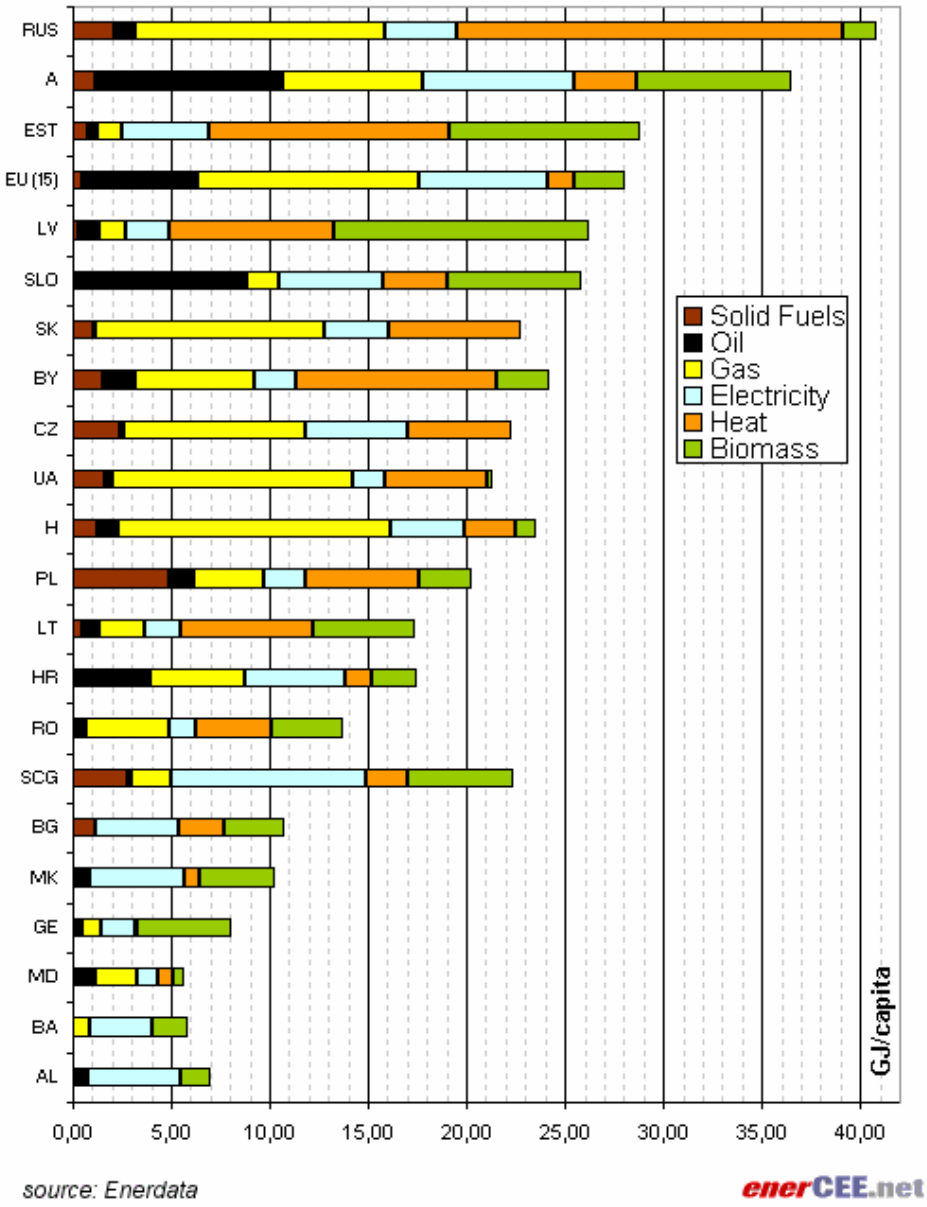
Final Energy Demand of the Residential Sector of Romania, 2003



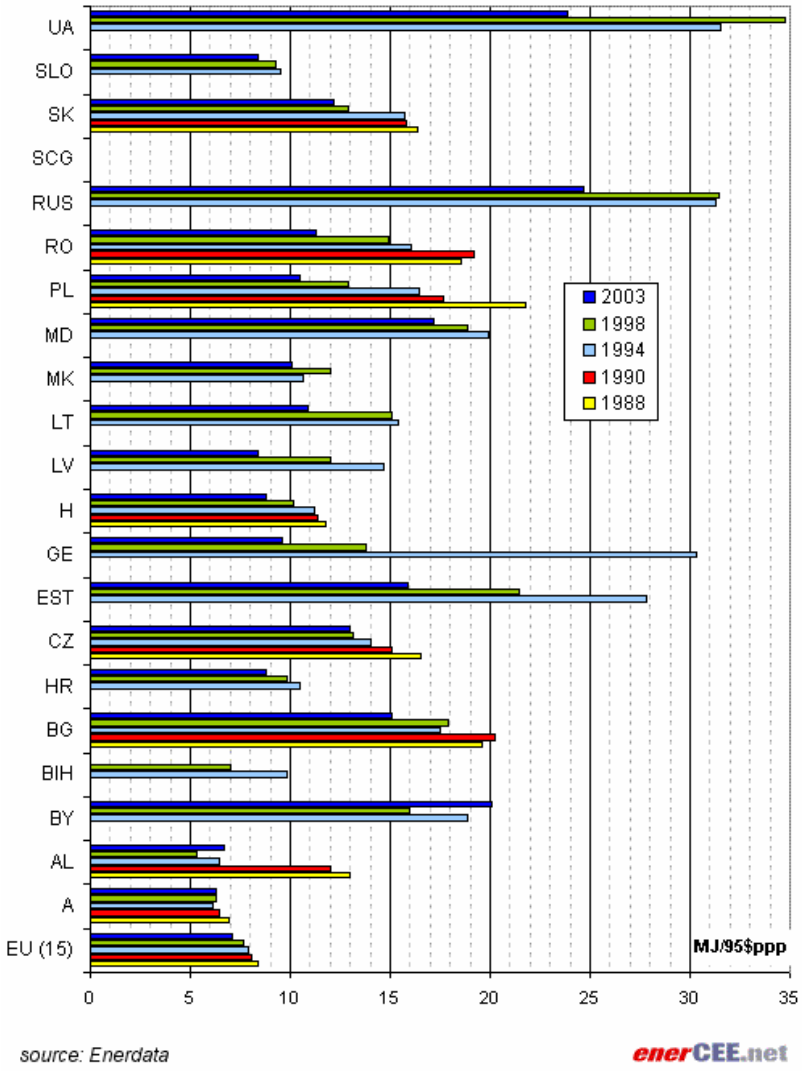
source: Enerdata

enerCEE.net

Final energy demand of the residential sector of Romania, as compared to that of other CEEC, Austria, and the EU 15, 2003

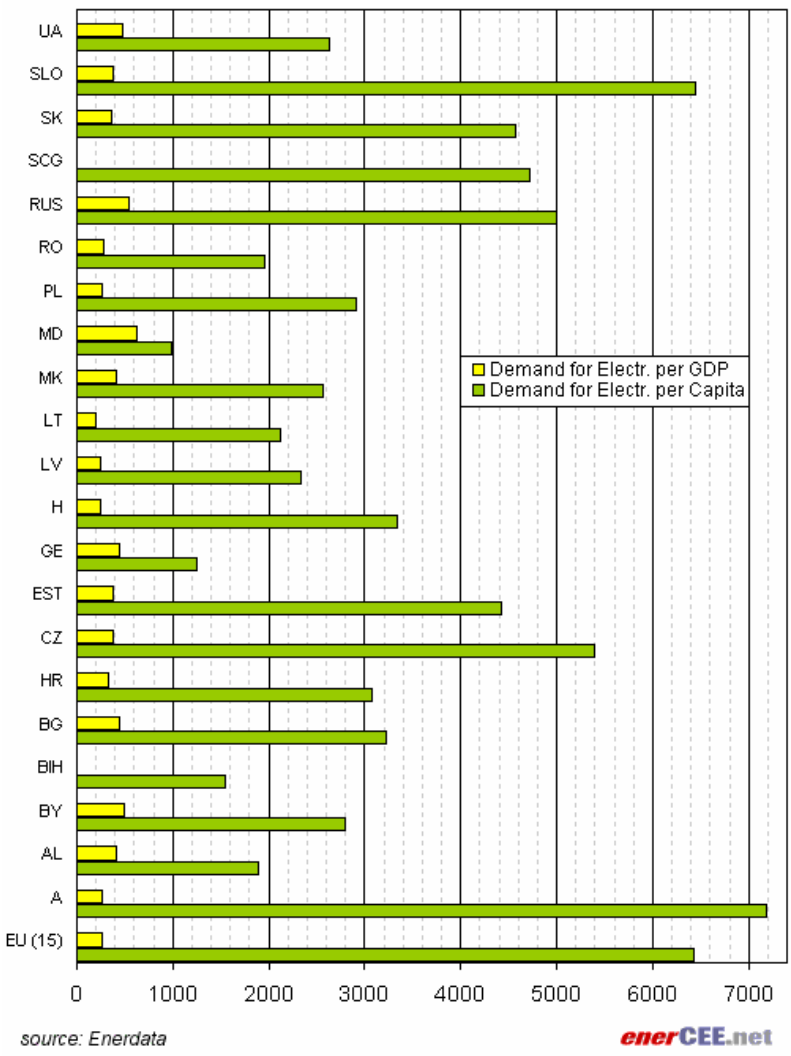


Primary Energy Intensity in MJ per GDP at purchase power parity for Romania, as compared to other countries of CEE, Austria and the EU 15, 2003



Primary energy intensity is an indicator to show how much energy is needed to produce one quantity of economic output. In 2001, the Romanian energy intensity was of 0.67 toe (28,052 MJ) per 1,000 USD. The energy intensity of the Romanian economy is very high (estimated at around 8 times the EC average).

Demand of Electricity per GDP (MWh/M$95) and per Capita (kWh/hab) for Romania, as compared to other CEEC, Austria and the European Union 15, 2003



The deviation of electricity demand per GDP of a country from that of Austria or the EU average indicates, how efficiently electricity is utilised in the respective economy in comparison to the EU or to Austria. If the electricity demand per GDP decreases - what can be expected for the future in CEE countries - more national income in the form of GDP will be produced with the same amount of electricity (the black bars in the figure will decrease in this case).

8.4. Potentials for RES

Biomass

Biomass is currently used only for heating. In year 1998 the production of biomass reached 126 PJ and contributed 11 percent to the total energy of the country. In 1999, the biomass production was of 118 PJ. The total market for biomass applications is very large but specific incentives will be needed in order for this potential to be realised.

Direct burning in the kilns, stoves for space heating, cooking and hot water preparation is about 95 percent of the biomass use. These furnaces have a nominal capacity between 0,8 kW to 4 kW and are hand stocked and with a average efficiency between 15 to 50 percent.

Burning in thermal plants to generate industrial steam and hot water in sawmills and in other industries equals about 5 percent of biomass usage. In sawmills, the average installed capacity is 3.3 MW and in other industries 4,7 MW.

The biomass sector in Romania is characterised in a twofold regional distribution.; about 90 percent of fuel wood and 55 percent of wood waste is found in the Carpathians and Subcarpathians. About 54 percent of agricultural waste are found in the South Plains and Moldova. About 52 percent of biogas is found in the South Plains and the Western Plains.

Large amounts of small-sized wood is obtained in wood industry, but utilisation of wood for energy purposes is insufficient due to difficulties related to gathering, processing and transportation. Studies show that these wood wastes are economically viable resources.

The following table Romanian Biomass Resource Data shows good opportunities for biomass development in Romania. Biomass applications can be grouped into the following main market segments:

Substitution of part of the fossil fuel in existing district heating schemes (wood chips)
Enhanced use of biomass as industrial fuels (wood chips and logs as industrial fuel for steam and hot water boilers) instead of oil.

Improved use of biomass for new DHN for small towns and villages near the resources, in the countryside, where the population has no access to central co-generation or gas supply. Uses of straw and other agricultural by-products in appropriate biomass boilers for heat supply of farms and small villages (in medium term).

The top priority is the use of biomass for thermal applications, substituting oil. Assuming an available biomass energy supply, DHN represent the most immediate an low-cost biomass application in Romania especially CHP plants, industrial co-generation and co-firing. The most promising regions for the agricultural waste utilisation could be the South Plain, especially the countries Braila, Ialomita, Calarasi, Giurgiu, Teleorman and the West Plain, especially the countries of Arad and Timisoara. In these counties the agricultural production is high, there are no own sources of fuel for heating and cooking.

In the Carpathian Mountains and Subcarpathians area where firewood and wood waste are available, there are opportunities to develop district-heating plants. The size of the boilers for district heating in the identified projects range from about 1 MW_{th} to 6 MW_{th}.

The expected and development of the wood industries will encourage the rehabilitation of existing boilers from the existing auto producer's thermal plants which account about 550 steam boilers, or the construction of new ones. The existing auto producer's thermal plants account 550 steam boilers. *(Source EBRD report)*

Romanian Biomass Resource Data

Biomass resource type	Total production	Production density
% of total land area covered by		
Forests	28%	
Shrublands, savanna and grassland	1%	
Cropland and crop/natural vegetation	69%	
Urban and built-up areas	1%	
Sparce or barren vegetation, snow/ice	0%	
Wetlands and water bodies	1%	
Total	100%	

Primary crop production, tonne	**(avg. 1999-2001, tonne)**	**(tonne/1.000 ha)**
Total primary crops	53.291.420	2.314
Top 10 primary crops		
Alfaalfa for Forage & Silage	7.846.000	341
Maize	7.777.600	338
Leguminous (misc.) Forage & Silage	6.316.667	274
Wheat	5.364.014	233
Grasses, Forage & Silage	4.678.167	203
Potatoes	3.742.300	162
Mixed grasses, legumes	2.949.367	128
Clover for Forage & Silage	2.704.367	117
Vegetables and roots, fodder	1.244.867	54
Grapes	1.170.786	51

Animal units, number	**(number)**	**(number/1.000 ha)**
Cattle	3.097.000	134
Poultry	69.312.000	3.009
Pigs	6.521.000	282
Equivalent animal units	6.398.000	278

Annual round wood production	**(1996-98, 1.000 m3)**	**(m3/ha)**
Total	12.476	542
Fuel	3.174	138
Industrial	9.302	404
Wood-based panels	390	17

Source: EBRD