Proposal summary page

Proposal full title: **Carbon and Nitrogen in Systems for Energy from Solid and Liquid**
Proposal acronym: **CANIBSER**

(A part of the proposal that was send in March 2003 to Brussels, EU:s 6FP)

Strategic objectives are:

- to reduce present environmental, economic and social problems concerning pollution of air and water, soil degradation, waste management, use of synthetic chemicals and fossil fuels, unemployment and poverty, by development and implementation of novel, economic viable concept "SOLIWA" dealing with "Integrated Waste and Wastewater Management" in order to increase use of renewables (biodegradable materials) in efficient, clean and sustainable way;
- to make results easily available for researchers, students, planners, designers, architects, politicians, manufacturers, decision makers and for the public.

Proposal abstract
We propose a system based on radical changes and innovations in the management of renewables. Using combined aerobic and anaerobic operating systems which are high-rate, simple to operate and have reliable performance, the new knowledge necessary for creating the appropriate technology for biotechnology-based processes for efficient use of energy bound in renewables will be developed. This will lead to enhanced carbon and nitrogen capture, storage and use, and in consequence the negative impact on regional and global climate change will be reduced.

The technology refers to a system of *liquid and solid renewables*, directed both to small and large-scale users both in urban and rural areas, for the production of carbon and energy rich biogas and carbon and energy rich biofertilisers that at the same time contain most of the nitrogen from the raw renewables. The use of biogas and biofertilisers will avoid the use of correspondent quantities of fossil energy sources. By developing and using a mobile line approach, the system will be adjusted to local needs and following commercialisation will then become marketable.

The importance of energy-rich carbon compounds in biofertilisers on cultivated soils are in these days under valued. A key element of this IP will be to carry out C and N life-cycle analysis, which will include the impact on CO_2 sequestration and soil fertility, together with plant nutrients and beneficial microorganisms. Further, novel sustainable solutions that reduce present environmental and social problems concerning pollution of water and air, soil degradation, waste management, and the use of fossil resources and synthetic chemicals will be uncovered.

Facilities using advanced technology adjusted to microorganisms are needed to make bioconversion of the renewables from municipalities, industries, agriculture, horticulture, forestry, green areas, and from fuel crops a clean mainstream *renewables-to-energy-and-fertilisers* conversion technology.

B.1 Scientific and technological objectives of the project and state of the art

Carbon sequestration in terrestrial ecosystems can be defined as the net removal of CO_2 from the atmosphere into long-lived pools of carbon. Therefore is important to develop and implement direct solutions to the underlying problem of large CO_2 releases from human activities. One of our challenges is determining how to optimise waste management practices to enhance C sequestration in the Europe. We want to enhance carbon and nitrogen capture, storage and use that will mitigate the negative impact on regional and global climate and to detect and describe processes**,** associated with greenhouse gas emissions and atmospheric pollutants from novel efficient bioconversion processes, transport and cultivation systems, and to improve prediction and assessment of their global and regional impacts and evaluate mitigation options.

Renewable organic materials (renewables) from municipal and industrial waste, residues from agriculture, horticulture, forestry, green areas, and from fuel crops are a vitally important biological resource, and can be considered to be the most important "basic material" for humans, being used for food, feed, fibre and fuel. The objective of this IP is to make the efficient biological transformation a mainstream "renewables-to-energy-and-fertilisers" conversion technology.

IP will operate in the field of science, research and innovation, and will explore new and emerging scientific and technological areas on the border biology and technology. The challenge of this IP is to create and implement a "breakthrough" model for bioconversion of renewables to biogas and biofertilisers, demonstrate alternative ways for capture, storage and use of carbon and nitrogen, and integrate social, economic and environmental dimensions. This model will be a new applicable knowledge to develop concepts, strategies and tools for sustainable management of renewables and to support transformation of industry.

Renewables are scarce and precious resources that must be carefully managed. Improved knowledge of basic biological processes will going to play an increasingly important role in numerous key areas of scientific and technological progress associated with the effective utilisation of physical and biological resources. To meet these challenges the IP bring together researchers from various countries and with a range of expertise and ambition to develop modern research in a global environment. The objectives of activity in this IP are to improve integration and co-ordination of research on bioconversion processes in Europe which currently is underestimated and fragmented and do not support holistic view on carbon and nitrogen elements.

The technology to be developed and tested refers to a system of liquid and solid renewables, directed both to small and large-scale users in urban and rural areas, for the production of carbon and energy rich biogas and carbon and energy rich biofertilisers that at the same time contain most of the nitrogen from the raw renewables. We propose that by radical changes and innovations in the management of renewables in waste and wastewater, where combined aerobic and anaerobic operating systems are high-rate, simple to operate and have reliable performance, the new knowledge, necessary for creating the appropriate technology for **biotechnology-based processes,** for the production of energy rich methane in biogas and energy rich biofertilisers, will be developed. The biogas will be used locally as fuel in vehicles, for heating, cooling and electric power in urban and rural areas. By using mobile line local conditions will be tested and the line need little improvement to become marketable.

Furthermore, novel **sustainable solutions** that reduce present environmental and social problems concerning soil degradation, pollution of water and air, waste management, and the use of fossil energy sources and synthetic chemicals will be uncovered. This IP will contribute to international efforts to mitigate against adverse trends in global change. One key objective is to contribute to the creation of a stronger scientific base orientated towards knowledge-based, more environment-friendly approaches essential for research and development in other topics in FP6. Results from CANIBSER are of direct relevance and importance for most of the seven thematic priorities in the first block of FP6 activities.

The proposed range of local experiments will make results easily available for researchers, students, planners, designers, architects, politicians, manufacturers, decision makers and for the public, and thus will enhance their implementation. Results from IP CANIBSER will give the essential input for manufacturing novel equipment, for creating new infrastructure adjusted for the "production of tomorrow" and for building novel, economic viable systems.

IP CANIBSER will illustrate the potential for the elaboration of a clear roadmap for planners and manufacturers working on future bioconversion systems and methods in waste and wastewater management. This is important for increased efficiency in utilisation of carbon and nitrogen in processes of recovery of renewable energy (bioenergy), in recycling of elements (plant nutrients) bound in renewables and the support of "safer" cultivation systems by using well designed biofertilisers that will have positive effects on "food safety", on life-cycle safety, on minimisation of man made chemicals, on carbon sequestration and on minimising of pollution.

Our efforts are based on the most elementary processes. There is known that oxidative processes in organisms are necessary for life and that oxidative processes in fire are dangerous for living creatures. In both cases transformation of energy from one form to several forms occurs. Figure 1 symbolise these processes and shows what kind of impact on cultivated soils and recycling have sustainable or unsustainable management of renewables.

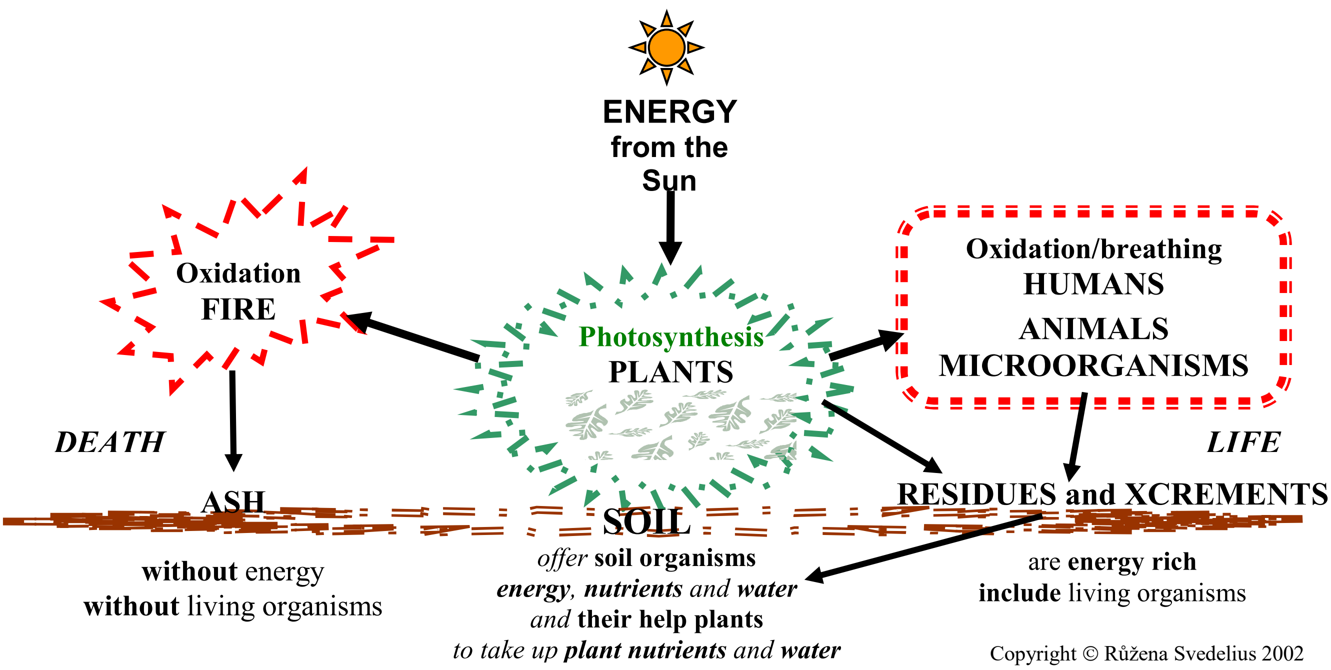

Figure 1. Comparison between oxidation in burning where all C and N compounds are disappearing to the air and oxidation in living organisms reusing C and N compounds.

To realise the importance of the main objective of our IP, figures 2 and 3 briefly compare present and possible future systems for reusing carbon and nitrogen from waste and wastewater in housing areas. By using outdated methods for waste management in present systems (Fig. 2) the carbon is lost and nitrogen do seldom return to cultivation systems. Losses of elements pollute the environment and negatively affect human health. This is the international state-of-the-art. In most countries are used these polluting and costly methods to get rid of the renewables instead of utilising them as raw material for processing.

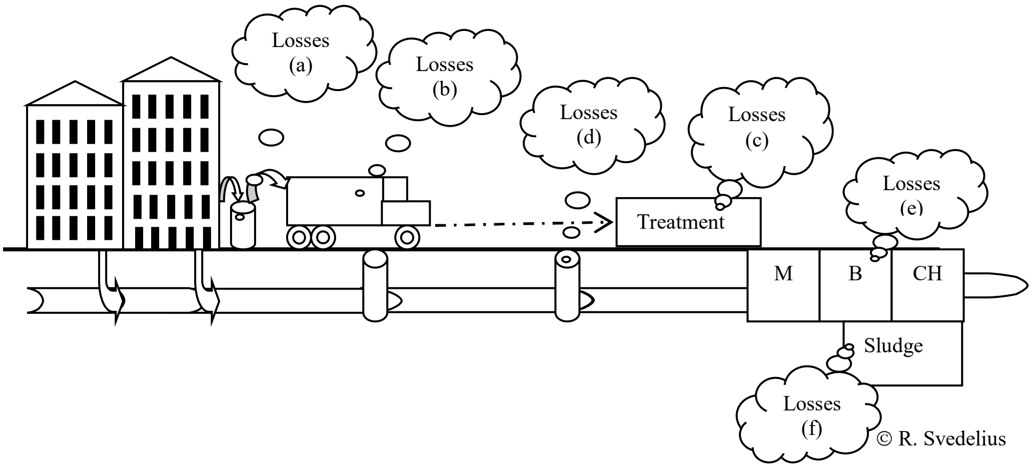

Figure 2: Present waste and wastewater “by end of pipe” management in open and centralised systems.

Losses of energy (as CO_2 and heat) and plant nutrients (mostly nitrogen an sulphur compounds) appear:

When renewables in solid waste are collected in dust bins (a), transported (b), and treated (c) in incineration plants, on landfills, in central composting plants and in biogas plants using old rotting methods;

When liquid renewables (in human excreta) are diluted, transported in sewage system (d) and treated by expensive methods mechanically, biologically(e) and chemically in wastewater treatment plants, and when sewage sludge (f) of doubtful quality can not be used on cultivated soils.

Some of the losses are pollutants transported across international boundaries.

Costs for construction and operating are huge. Most of the above-described management is principally based on old-fashioned systems, which cause environmental damage and are a health hazard.

Sustainable waste and wastewater systems are possible only by radical changes of facilities, methods and management. More knowledge and clear examples of novel concepts (Fig. 2) are required to change old fashion thinking and step by step phase out the polluting systems.

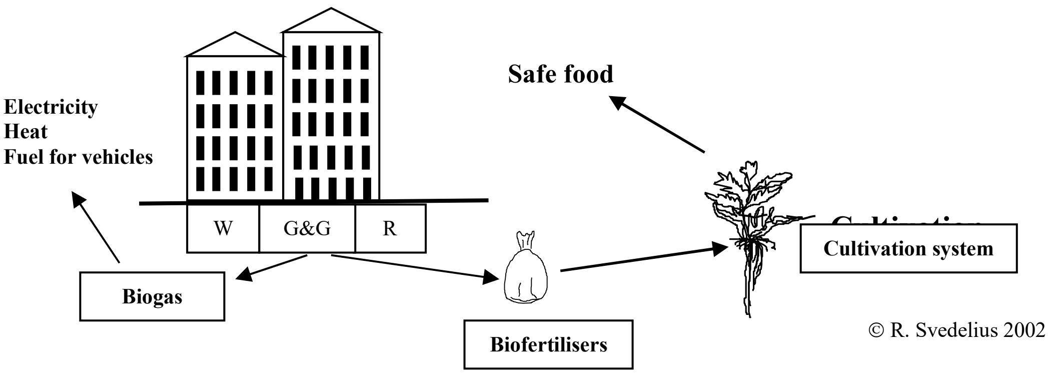

Figure 3: Future integrated management of carbon and nitrogen in waste and wastewater “at source” in closed localised systems. Losses of energy and plant nutrients are minimised when concept for sustainable management of solid and liquid waste “SOLIWA” is used.

(W) Grey water is treated in “Bio H2O”.

(G&G) Renewables from solid and liquid waste is by microorganisms transformed to biogas and biofertilisers in “G&G-System” (Gas & Gögsel/fertiliser-System).

(R) Mixed waste of inorganic and non-renewable materials such as glass, plastics, metal and toxic waste are sorted in ”Refuse House” and then handled by specialists for reuse, recovery, destruction or burying on landfills.

B.2 Relevance to the objectives of this Priority Thematic Area

In order to achieve our objectives and contribute to an advancement of sustainable development, the research actions tackle cross-cutting issues, which address several topics within the area "Sustainable development, global change and ecosystems", Sub-Priority 1.1.6.3 GLOBAL CHANGE AND ECOSYSTEMS. The centre of gravidity is on the issue number 1: "Impact and mechanisms of greenhouse gas emissions and atmospheric pollutants on climate, ozone depletion and carbon sinks".

The Six Environment Action Programme identifies four environmental areas to be tackled for improvements: (1) Climate Change; (2) Nature and Biodiversity; (3) Environment and Health and quality of life; (4) Natural Resources and Waste (Brussels, 24.1.2001
COM (2001) 31 final 2001/0029 (COD)

IP CANIBSER is going to establish bottom up action. By improvements of methods and technology in management of "Natural Resources and Waste" we are going to reach progress in the others above mentioned areas.

Unsustainable technologies cause environmental degradation and climatic change. The sustainable systems require specific technological development of innovative and cost-effective mitigation technologies by improvement of existing methods and technologies that can be adapted to specific conditions of both developed and developing countries. In the experimental mobile line we want to generate new knowledge on impact and mechanisms of greenhouse gas emissions and atmospheric pollutants on climate and on carbon sinks.

Our research will
- develop new methods, equipment, facilities and system adjusted to the biological base
- place emphasis on by man controlled bio-geochemical processes and feed backs of potential significance for the climate system.
- concentrate on carbon and nitrogen cycle, atmospheric pollutants and their regional impacts, and mitigation strategies
- focus on integrating observations, process studies and modelling of the budgets of carbon and nitrogen to better quantify the biospheric carbon and nitrogen sources and sinks for terrestrial ecosystems
- tackle effects of human induced disturbances of ecosystems and their impact on the carbon and nitrogen cycle
- predict Global integration of terrestrial carbon and nitrogen sources and sinks and exchanges between the reservoirs
- quantify the European carbon balance from local ecosystem to regional and continental scale to support the implementation of sinks in the Kyoto Protocol and verify the effective CO_2 reduction in the atmosphere.
- include assessment how external parameters such as changing waste, wastewater and land management affect the European carbon balance and future projections of the carbon cycle.
- establish collaboration with international programmes such as the International Geosphere and Biosphere programme (IGBP).

Results from IP CANIBSER will have impact on other topics in
- "Water cycle, including soil-related aspects" (when efficient bioconversion have impact on water quality and availability, on mitigation technologies and on

developing flexible adaptation strategies to change, in order to decrease vulnerabilities);

- “Biodiversity and ecosystems” (develop a better understanding of terrestrial biodiversity and of ecosystem functioning for example increase the knowledge of the influence of biodiversity in cultivated soils on biological control of plant pathogens and thus reduction of use of pesticides, the function of biodiversity and the consequences of changes in biodiversity in cultivated soils by observing, monitoring, surveying and forecasting of physical, biological and chemical parameters in various cultivated soil ecosystems);
- “Mechanisms of desertification and natural disasters” (the development of innovative soft ecologically-based techniques and soil conservation measures and technologies for the prevention and mitigation of land degradation when increased use of biofertilisers are necessary for maintaining and restoring soil and land quality, and ecosystem health and can prevent desertification);
- “Strategies for sustainable land management, including coastal zones, agricultural land and forests” taking into account the effects of rural development, land-use, agriculture and forestry by efficient bioconversion of renewables.

Results from CANIBSER will by new knowledge support “knowledge-based multifunctional systems” such as

- operational forecasting and modelling including global climatic change observation systems
- data-base on rural development practices, policies and other data usable for modelling and future land-use management decisions and can be a tool for long-term sustainability of soil status and productivity
- development of a European capacity for Global Monitoring of Environment and Security (GMES).

IP CANIBSER will have also impact on the topics in area Nanotechnologies and nanoscience, knowledge based multifunctional materials, and new production processes and devices on the topic 3.4.3.2-1 Radical changes in the “basic materials” industry (excluding steel) for cleaner, safer and more eco-efficient production by supporting the “production of tomorrow” and the development of sustainable solutions that do not harm ‘people and planet’ for the whole life cycle of products, equipment and infrastructures.

Socio-economic implications and especially public attitudes will be considered. Research activities in IP CANIBSER will generate option development and decision making tools: methodologies, models and tools for integrating interrelated processes, including socio-economic driving forces and feed-backs, for integrated management. The evaluation of the socio-economic benefits obtained from bioconversion systems will make available socio-economic impact from short-term events and long-term changes.

IP CANIBSER will, to the extent possible, incorporate the findings of past programmes related to carbon and nitrogen capture or, in the case of on-going programmes, work in close partnership with them in order to avoid duplication and optimise the overall benefit.

B.3 Potential impact

There is a widely acknowledged need throughout Europe to enhance the manufacture and use of more sustainable systems based on knowledge of biological processes.

There were at the 1st January 2002, exactly 376 461 772 inhabitants in EU. These inhabitants are responsible for the total production of about 753 000 tonnes per day of renewables in Municipal Solid Waste (MSW) together with renewables in wastewater (human excreta). This annual production of renewables contains at least 825 TWh of bioenergy and plant nutrients NPK (nitrogen, phosphorus and potash) to the value of approximately 3.8 billion euros.

To these figures can be added the greater amount of bioenergy and NPK in renewables from industrial waste and in residues from agriculture, horticulture, forestry and green areas, and from fuel crops that can be, by modernised processes of bioconversion, used as raw material in more sustainable systems. Using the present knowledge the bioenergy in renewables can be transformed biologically with following results:

1. About ⅓ **recovered as biogas;**
2. About ½ bound **in biofertilisers**
   a) in the remaining structures from renewables and
   b) in microorganisms while both include element important as plant nutrients.

In IP CANIBSER utilisation of raw material by using technical improvements and newly created knowledge on efficient bioconversion will increase. Unfortunately, a great amount of water, chemicals and energy from fossil sources are used today for getting rid of renewables from all above mentioned sources.

Economic benefits
* Profit from biogas;
* Profit from biofertilisers.
* Lower total costs for waste and wastewater treatment;
* Lower costs for construction of infrastructure (without sewage system);
* Lower costs for collection and transportation of waste and wastewater;
* Lower costs for production of artificial fertilisers and other agrochemicals.

By expanding the agricultural possibilities of biofertilisers, produced from renewables in solid and liquid urban waste in localised bioconversion plants, several million € could be saved annually in Europe. These savings would come from:
* Reduced use of fossil-based fertiliser, pesticides, and herbicides;
* Energy savings;
* Reduced collection and transportation costs;
* Increased yields of cultivated crops;
* Water savings.

Beyond the energetic and financial savings made by use of biofertilisers instead of synthetic agrochemicals, there lies a multitude of environmental benefits such as:
- The decrease of emissions that in turn decreases peoples' exposure to unhealthy conditions during collection, through transportation and treatment of renewables in waste with outdated methods of composting and rotting, on landfills, at incineration plants, and/or wastewater treatment plants.
- Improving the physical, chemical and biological properties of cultivated soils in the long-term, thereby resulting in reduced soil erosion, increasing crop yields and improving their quality. In addition to a higher resistance of cultivated crops to weeds, parasites and disease,

the more effective use of biofertilisers will reduce harmful agricultural run-off by cutting the use of fossil-based pesticides, herbicides and fertilisers. There will be further conservation of water by increasing the water holding capacity of the soil, and therefore decreasing percolation, evaporation and runoff of plant nutrients and increased sequestration of carbon.

Ecological impacts
Environmental aspects which have, or can have a significant direct and *indirect* effect on the environment include:
* Reduction in air pollution;
* Reduction in the negative impact on water and cultivated soil, its fertility and productivity;
* Better quality food, which affects human health.

The European Environment Agency presented an overview in 'Official Publications of the European Communities (1998)' of the state of the environment in Europe and the main areas requiring action at national or international level. Only "waste" and "soil degradation" showed little or no change in the state of the environment, and little development of policies or unfavourable development for the state of the environment.

The requirement of new strategies for sustainable recovery of energy from renewables in waste and wastewater, and for the sustainable production of food, feed, fibre and fuel, is obvious. Therefore, we want to use renewables efficiently as a raw material in novel closed systems for

- The recovery of renewable energy as methane in biogas;
- The production of to cultivation system tailored biofertilisers that contain energy, plant nutrients, and beneficial microorganisms;
- The protection of the environment as each yearly addition of energy rich structures in biofertilisers will increase the carbon sequestering abilities of soils.

The research to be developed is indeed based on the utilisation of "Mobile experimental lines", which are energy efficient, cost effective, and environmentally safe. The proposed technology offers an important health benefits i.e. an improved working environment and due to the completely closed system that minimise emissions (= polluting losses).

Social impacts
The project CANIBSER contributes to the EU social objectives as follows:

- New job opportunities - novel technology, education;
- Health benefits - user friendly, good working milieu, holistic approach with a significant impact on the global environment;
- Inhabitants satisfaction through being part of an ecologically sustainable system suitable for all societies and thus high acceptance of the system.

Because of the receptivity of the market, the realisation of the project may also stimulate an evolution of both the demand and the offer of innovative and environmental safe systems, and therefore the creation of direct and indirect new job opportunities. Indeed, a number of studies show that the development of decentralised systems dealing with bioconversion creates jobs.

Impact on energy system
Demand of better knowledge concerning processes of microbial transformation (bioconversion) is growing very fast all over the world, due to the growing renewable energy use expectations and, according to the major scientists, to the global climatic modifications. A new energy efficient technology has certainly a large potential specially where geographic and local conditions are appropriated. Technologies to transform biomass efficiently and safe

by microbial processes, that do not pollute the environment, can be widely implemented in mega cities as in the rural areas. These technologies will not only reduce CO_2 emissions and other pollutants but in most every case, such technologies will save enough money, now spent on fuel, to pay for their capital cost.

By supplying, 80 to 90 percent[1] of the useful energy in fuel can be put to beneficial use. The Intergovernmental Panel on Global Climate Change (IPCC) found that within the energy supply sector «an increase in efficiency of 1% would result in a 2.5% reduction in CO_2 emissions».[2] To put the possible benefit in perspective, the ESOLIRE project will reach at least 15 % efficiency increase compared to which of the standard systems. When biogas is used to supply heating in existing and new thermal distribution networks efficiencies can increase. CANIBSER consortium will refine the operation of such energy balanced systems.

The implications of biomass stem not just from its inherent efficiency, but also from its decentralised character. Because it is costly to transport energy and raw material over any distance, equipment for bioconversion of renewables must be located physically close to its user. A number of positive consequences flow from this fact: power tends to be generated close to the power consumer, reducing transmission losses, stray current, and the need for distribution equipment significantly. Plants for bioconversion tend to be built smaller, and owned and operated by smaller and more localised companies.

Energy from bioconversion is suitable for a wide range of applications, and effectively displaces the combustion of carbon-based fuels, with all their environmental implications.

Our Holistic Philosophy/Vision

There is lack of a holistic view of bioenergy and flow of elements through different spheres of human activity. Some examples:

- In conventional approaches to waste management and waste water treatment uses substantial amounts of fossil energy to get rid of energy and elements from renewables. These renewables contain energy from the sun and elements bound in biochemical compounds that could give energy rich methane in biogas and positive effects on cultivated soils. Instead cause these processes emission with negative impact on the climat.

- In conventional cultivation systems, with a goal to maintain/increase crop yields for the production of food, feed, fibre and fuel, unfortunately, to make up for the deficiency of plant nutrients, the cultivation factors are optimised by using agrochemicals made from fossil sources.

- Here a third sector pursued their goal through an effective marketing strategy. The production of agrochemicals uses plenty of energy, mostly from fossil sources and pollutes the environment. In addition the transportation methods used are a polluting factor.

[1] Intergovernmental Panel on Climate Change (1996)
[2] Intergovernmental Panel on Climate Change (1996)

B.3.1 Contributions to standards

Partners in IP CANIBSER feel responsibility for more efficient use of renewables and for soil fertility and productivity. The soils content of organic material strongly affects food quality and human health. In the above examples, people have to pay for the disposal of organic compounds in renewables, which are then replaced by artificially produced inputs of newly paid energy. There is also the environmental damage caused as a result, in addition to the healthcare cost.

The activities under IP CANIBSER will highlight the importance of new Community policies. The outcome from this IP will be valuable knowledge for the support of European policies in waste and wastewater management, which is particularly relevant to the Common Agricultural Policy (CAP), energy, transport, environment, health, development aid, consumer protection and enterprise policy. The strength of the consortium is that it is composed of excellent scientists who are highly enthusiastic and open minded partners. Their specialities show good complementarily and provide an excellent base for cross-frontier cooperation.

So far, renewables (biodegradable materials) in waste has been regulated in order to reduce its negative consequences on the environment (Landfill Directive 99/31/EC). The Sewage Sludge Directive 86/278/EEC, the Organic Farming Regulation (EEC) No. 2092/91 and the eco-label for soil improvers and growing media (Commission Decision 2001/688/EC) are the EU instruments relevant to this waste stream. However, if properly regulated and managed, renewables may contribute towards effective resource management and sustainable development. Bioconversion (biological treatment) for producing biogas and biofertilisers has many already mentioned advantages. Outcomes from this project will be important input to new directives.

In this study on **sustainable energy and material recovery intensive system** we will:
1) Form sustainable, up-to date most effective bioconversion system, for microbial transformation of renewables to energy rich biogas and biofertilisers, as a pattern for EU countries and calculate and quantify the benefits from such system as a future standard in the Europe;
2) Use the results (best practices)as a valuable base to form synthesis - the **sustainable**, up-to date most effective **bioconversion system (SBS)**, calculate energy balance and quantify material savings by using the new system;
3) Analyse the present potential for implementation of the system in EU countries - define legislative, technological and economical tools, steps and standards necessary for successful implementation and enforcement. There will be defined the principles as a long-time basis for the improvement towards SBS as well as the measurable indicators to control and evaluate the improvement within the European Union.

B.4 Outline implementation plan

The overall structure of IP CANIBSER is built on scientific and technical excellence and contains experts on biological processes in bioconversion, plants, animals, microorganisms, substrates and soils for cultivation of crops, biological processes in water systems, etc; chemical process; energy transformation; plant nutrients supply; design; construction; process control; logistics; transportation; environmental and health aspects; waste treatment; wastewater treatment; sanitation; irrigation; social and economic impacts; engineers, manufacturers and householders.

This multidisciplinary proposal has been designed to create extensive synergy with other European, national or regional programmes in order to provide for the needs of both menmber and candidate countries. An international dimension and holistic perspective is central to our philosophy, and has been included. Furthermore, IP CANIBSER will co-ordinate activities that evidently respond to EU IPPC (Integrated Pollution Prevention and Control) directive and with the aim to enhance the quality of decision making IP CANIBSER will provide policy and decision-makers in the public and private sectors with relevant knowledge and data extracted from research carried out by the IP consortium.

During the bioconversion process raw material in renewables is upgraded with high precision to valuable products. Renewables from municipal and industrial waste, residues from agriculture, horticulture, forestry, green areas, from human and animal excreta and from fuel crops should be used as a raw material. The only problem is that there is luck of modern equipment and efficient methods. Like in cooking to be successful we need both facilities and recipes. Therefore in this IP we want to use expertise, skilfulness and competence of all partners to built up new knowledge necessary for advanced and sustainable solutions and link the technological applications with environmental, hygienic, sociological and economic aspects.

There is a growing demand for integrated decentralised sanitation systems providing opportunities to save and reuse resources. To arrive at an optimal decentralised sanitation and reuse system multidisciplinary approach is required. With the quality of life of future generations in mind, initial steps have to be made to make society realise the necessity for more sustainable environmental protection methods. As mentioned before the present high-tech centralised systems for treatment of solid waste and wastewater offer great public comfort but are expensive and do not offer either sustainable reuse of energy and elements or efficient protection of the environment.

Municipal solid waste is composed mainly of organic matter i.e. renewables from plants and animals. This renewable source of energy ends up mostly in incineration plants and on landfills. A small amount of renewables is processed by outdated composting and rotting methods. Plant nutrients should be returned back to cultivation systems.

Wastewater produced in households and industries that contains renewables is collected and transported to central treatment plants. Centralised urban sanitation systems are characterised by high investment costs and by high energy requirements during processing as well as by addition of several chemicals and huge amount of emissions. Conventional sludge treatment results in a large amount of poorly stabilised and significantly polluted sludge, which is not acceptable for cultivation of crops for food. This approach is far from sustainable as it results in the loss of useful resources and by the wastage of water.

In this IP we want to meet the needs of both present and future generations.
Our concept “CANIBSER”

- is a revolutionary achievement never before realised by conventional waste and wastewater technologies, producing biogas and to cultivation adjusted biofertilisers
- can improve agricultural productivity by improving soil fertility and reducing the impact of erosion,
- do not degrade the environment - is technically appropriate, economically viable and socially acceptable,

- creates employment and generates income through manufacturing, processing, distribution sectors and farming and contributes to overall national development,
- provides professional engineering solutions, automation and control systems for organic solid and liquid waste handling and treatment operations,
- gives example of possibilities for practical helps to developing countries and promotes development that provides long-term solutions to the fundamental problems of poverty and hunger.

Knowledge is a vital tool for development. Scientific and technological advances have brought unprecedented changes to every field of human activity - including waste and wastewater management, agriculture and food production. Radical changes of present methods must begin.

It is hoped that presented proposal will stimulate further research and constructive efforts to improve and implement concept "SOLIWA" that is described below. This concept can be used as model when building up the knowledge and technology for design and testing of the integrated system for future waste and wastewater "at source" management (Fig. 4), and the required facilities and methods.

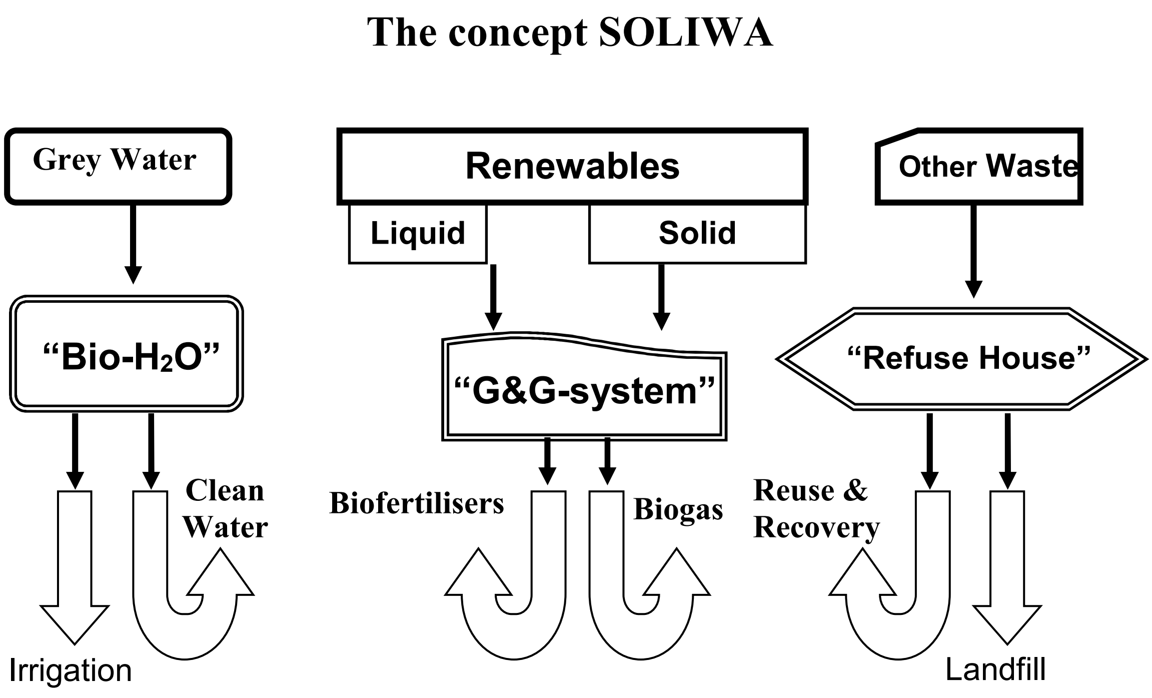

Figure 4: Concept SOLIWA for the integrated waste and wastewater "at source" management of "**Solid and Liquid Waste**" in closed system.

Description of SOLIWA

"Bio-H_2O"

Grey water is cleaned biologically. About 15 per cent less water will be polluted, as human excreta is collected in novel toilets. The cleaned grey water can be reused for irrigation or for other purposes.

"G&G-System" (Gas & Gödsel/Fertiliser-System)

An efficient batch system for bioconversion of renewables into biogas and biofertilisers. Raw materials for bioconversion are taken from renewable solid[3] and liquid[4] waste from households, central markets, the food and feed industry, slaughterhouses as well as from forestry, agri- and horticulture. Energy crops mixed with other materials can also be used.
A mixture with a high content of dry matter is treated in a three-step process of bioconversion. Firstly, aerobic, then anaerobic and finally aerobic transformation is carried out in a new kind of closed bioreactors BTF connected to a biofilters. The contents of the biofilters are reused in the process.
The biogas produced in the anaerobic step is converted into electricity and heat, used as fuel for vehicles, or both. Part of the electricity is used for equipment in the system.
Biofertilisers, adjusted for cultivation needs, contain energy rich organic structures, plant nutrients and beneficial microorganisms. Structures are important for soil organisms and as CO_2 sinks. The content and quality of biofertilisers can be modified with respect to needs of crops and the state of the soil.

”Refuse House”

Mixed waste of inorganic and non-renewable materials such as glass, plastic, metal and toxic waste are sorted, and then handled by specialists for reuse, recovery, destruction or burying on landfills.

Combined aerobic and anaerobic bioconversion in the “G&G-System” (Fig. 3, 4 and 5) stand for microbial transformation in the model **renewables-to-energy-and-biofertilisers.** IP will make this concept transparent for users, manufactures and planners in whole Europe.

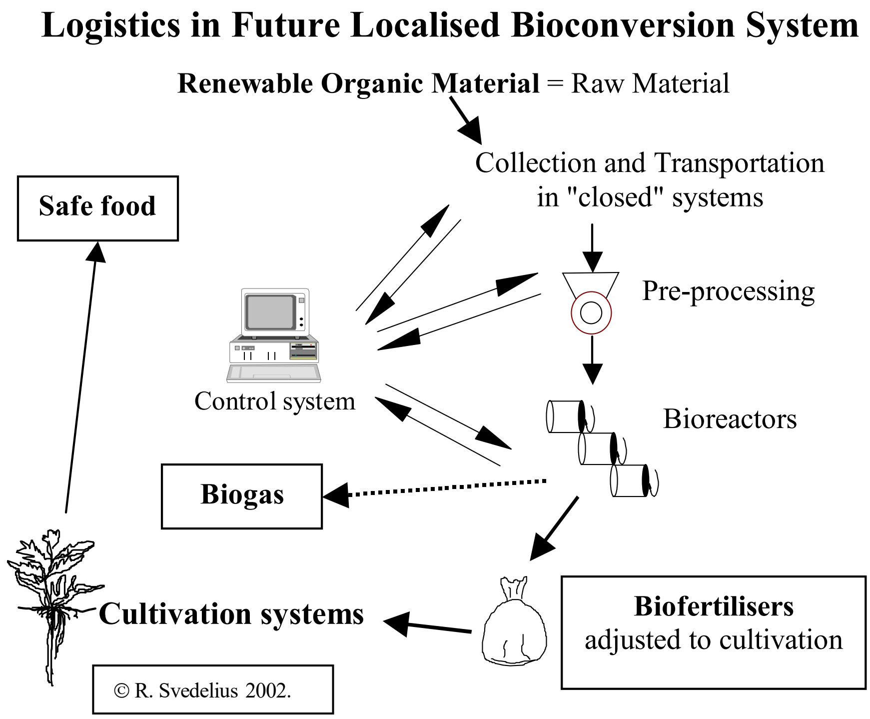

Figure 5: Flows in a modern system for bioconversion of renewables is called “G&G-System”.

Results from CANIBSER will support future cost-effective, high quality, fault-tolerant, eco-friendly and more flexible manufacturing systems for biogas and biofertilisers, including control systems and innovative automation by **integrating various innovative technological approaches.** We anticipate that the improvement of environmental technologies based on

[3] Solid organic wastes can be dry or wet. Examples of dry organic materials are: paper, paper packages, straw, wood and wooden residues, bark, dry leaves. Examples of wet organic materials are: food residues, grass clippings, weed plants and crop residues. In today’s Western Europe, household waste is being generated at a rate of over 1kg per person per day. *In Sweden 76 per cent are of organic origin (REFORSK, 1998)!*

[4] Liquid organic waste is both from human and animal excreta. Human excreta in developed countries averages 1.2 kg per person per day. *In Sweden, human excreta is diluted with 200 to 550 litres of wastewater per day!*

bio-processes will offer sound and human-friendly working conditions and safety aspects for prevention of accidents and diseases.

New design and engineering concepts used for effective development are important for a number of industrial sectors. These concepts will be created by the IP partners' scientific and engineering excellence, as well as the identification of best practices. Through planned collaboration between research and industry the industrial breakthroughs will accelerate and thus also hasten construction of knowledge-based industries.

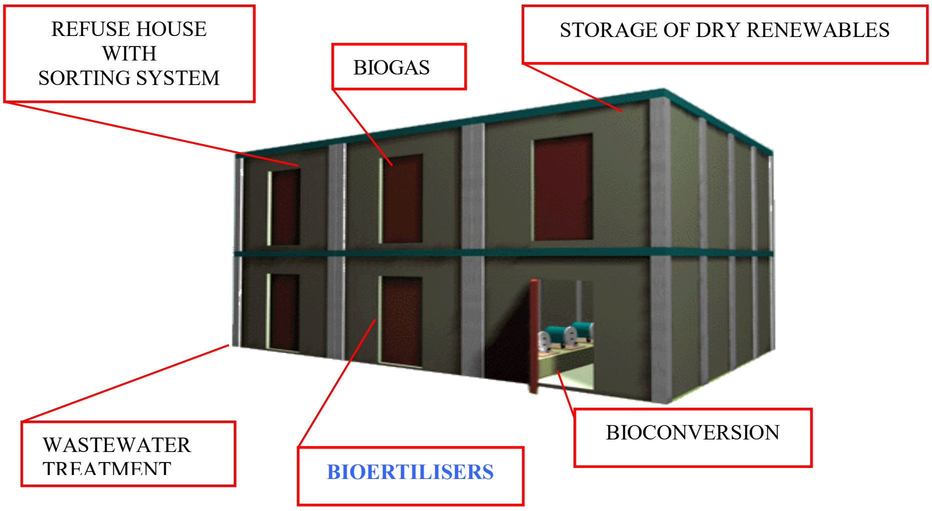

Figure 6.
Testing of concept SOLIWA can be carried out in mobile experimental/pilot plant for local integrated management of waste and wastewater that contains six modules.

Implementation of concept SOLIWA with focus on renewables will have great positive impact on all the most important environmental issues. These are described in EEA's *State & Outlook report on EU`s environment*: greenhouse gases and climate change, ozone depletion, hazardous substances, transboundary air pollution, water stress, soil degradation, waste, biodiversity, human health, urban areas, coastal and marine areas.