Sustainable Management of Wastes and Wastewater

Proposal Acronym: **SUMAWA**
Priority 3 – NMP
Identifier: **[FP6-2002-NMP-1]**
NMP research area(s):
NMP-2002-3.4.3.2-1 Radical changes in the "basic materials" industry (excluding steel) for cleaner, safer and more eco-efficient production
NMP-2002-3.4.3.2-2 Sustainable waste management and hazard reduction in production, storage and manufacturing
SUSTDEV-1.2.5 New and advanced concepts in renewable energy technologies – Biomass

Research topics:
IP SUMAWA is a multidisciplinary proposal addressing several topics.
A centre of gravity is 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.**
Other relevant topics are 3.4.3.2-2 Sustainable waste management and hazard reduction in production, storage and manufacturing *in the research area 3.4.3.2 Systems research and hazard control,* **New and user-friendly production equipment and technologies**, and their incorporation into the factory of the future *in the research area 3.4.3.1 Development of new processes and flexible, intelligent manufacturing systems* and **Energy from bio-residues and energy crops** (innovative, low emission waste-to-energy and crop-to-energy concepts and technology development) *in 6.1.3.2.3 Renewable energy technologies in area 6.1.3.2. Research activities having an impact in the medium and longer term.*

Type of Instrument: **Integrated Projects (IP)**

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B 1 Confidential proposal summary

Water, soil, minerals and biomass 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.

The SUMAWA Integrated Project (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 challenges of this IP are to create and implement a "breakthrough" model for management of waste and wastewater in both the short and long term, and integrate social, economic and environmental dimensions. This model will be a new applicable knowledge to support transformation of industry.

To meet these challenges the IP SUMAWA will 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 waste and wastewater bioconversion processes in Europe which currently is underestimated and fragmented.

This IP will contribute to international efforts to mitigate against adverse trends in global change. The research expertise of the partners includes biological and biochemical process, logistics, energy, plant nutrients, cultivation, sanitation, transportation, process control, environmental and health aspects, waste and wastewater treatment as well as microbiology, design, engineering and construction.

One key objective is to contribute to the creation of a stronger scientific base orientated to-wards knowledge-based, more environment-friendly approaches essential for research and development in other topics in FP6. Results from SUMAWA are of direct relevance and importance for most of the seven thematic priorities in the first block of FP6 activities.

The activities under IP SUMAWA 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), environment, energy, transport, 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.

The overall management structure will contain "Co-ordinator" (with co-workers), "Management board" where all partners will be presented, "Board for Communication and Training", "Scientific board" and "Technical board".

B 2 Relevance to the objectives

Renewable organic material (ROM) is 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 main objective of this IP is to make the **efficient biological transformation** of ROM - from municipal and industrial waste, residues from agriculture, horticulture, forestry, green areas, and from fuel crops - **a mainstream "biomass-to-energy-and-fertilisers" conversion technology**.

We propose that by "radical changes and innovations" in the management of waste and wastewater treatment, 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** will be developed.

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 synthetic chemicals and fossil fuels will be uncovered.

Central to this IP will be the development and testing of mobile research facilities dealing with "Integrated Waste and Wastewater Management". 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 SUMAWA will give the essential input for manufacturing novel equipment, for creating new infrastructure adjusted for the "production of tomorrow" and building novel, economic viable systems.

IP SUMAWA will illustrate the potential for the elaboration of a clear roadmap for planners and manufacturers working on future waste and wastewater management. This is important for increased efficiency in recycling of elements (plant nutrients), in recovery of renewable energy (bioenergy) bound in ROM 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 waste and chemicals, on carbon sequestration and on minimising of pollution.

Results from SUMAWA 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 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 at the horizon 2010.

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 candidate countries. An international dimension and holistic perspective is central to our philosophy, and has been included. Furthermore, IP SUMAWA will co-ordinate activities that evidently respond to EU IPPC (Integrated Pollution Prevention and Control) directive furthermore, with the aim to enhance the quality of decision making IP SUMAWA 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.

To achieve the objectives with this IP, activities will be needed to integrate the diverse range of skills. When these skills are integrated joint research activities and extension of results will be undertaken. The integration activities will include:

* Workshops and courses to update all partners on the state of the art of the individual scientific fields;

* Information about resources available in the network e.g. ongoing research projects, technical equipment, accredited labs, field experiments, data;

* Identification of knowledge gaps and establishment of shared databases and shared websites;

In this Integrated Project enthusiastic researchers will develop and test the knowledge based concept SUMAWA and break the barriers that exist between self-evident essential knowledge and implementation of it (See Fig.1 in B 4)

The overall structure of IP SUMAWA is built on scientific and technical excellence and contains
A) experts on

- biological processes in bioconversion, plants, animals, microorganisms, substrates and soils for cultivation of crops, biological processes in water systems et,
- chemical process
- design
- construction
- process control
- logistics
- transportation
- energy
- plant nutrients supply
- environmental and health aspects
- waste treatment
- wastewater treatment
- sanitation
- irrigation
- social impacts
- economic impacts

B) engineers
C) manufacturers
D) householders

B 3 Potential impact

Impact on Europe

There is a widely acknowledged need throughout Europe to enhance the manufacture and use of more sustainable treatment 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 **renewable organic material** (ROM) in Municipal Solid Waste (MSW) together with human excreta (HE). This annual production of ROM contains plant nutrients NPK (nitrogen, phosphorus and potash) to the value of approximately 3.8 billion euros, and at least 825 TWh of bioenergy.

To these figures must be added the greater amount of NPK and bioenergy hidden in ROM 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 in more sustainable systems**.

Using the present knowledge the bioenergy in ROM can be transformed biologically with following results:

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

In concept SUMAWA will increase and utilisation of raw material improved, **using technical improvements and newly created knowledge efficiency of bioconversion.** Unfortunately, a great amount of water, chemicals and energy from fossil sources are used today for getting rid of ROM from all above mentioned sources.

Economic benefits of the SUMAWA concept are:

* Lower total costs for waste and wastewater treatment;

* Lower costs for collection and transportation of waste and wastewater;

* Profit from biogas;

* Profit from biofertilisers.

By expanding the agricultural possibilities of biofertilisers, produced from ROM in solid and liquid urban waste in localised bioconversion plants, several million € could be saved annually in Europe. These savings would come from:

* Reduced collection and transportation costs;

* Increased yields of cultivated crops;

* Reduced use of fossil-based fertiliser, pesticides, and herbicides;

* Water savings;

* Energy savings.

Beyond the 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 discharge. The processing of renewable organic material in waste is carried out 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.

Social impacts of the concept SUMAWA include:

* Novel technology, with the possibility creating new employment.

* User friendly, good working milieu and thus high acceptance of the system;

* Inhabitants satisfaction through being part of an ecologically sustainable system suitable for all societies;

* Holistic approach with a significant impact on the global environment;

Ecological impacts of the concept SUMAWA

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 waste management, and for the sustainable production of food, feed, fibre and fuel, is obvious. Therefore, in the concept SUMAWA we want to use **ROM from waste and use it efficiently as a raw material in novel closed systems for**

* The recovery of renewable energy as methane in biogas;

* The production of soil amendments/biofertilisers that contain energy, plant nutrients, and beneficial microorganisms;

* The protection of the environment as each yearly addition will increase the carbon sequestering abilities of soils.

Our Holistic Philosophy/Vision

There is lack of a holistic view of plant nutrients, and bioenergy flows through different spheres of human activity. Some examples:

- In conventional approaches to waste management and waste water treatment which uses substantial amounts of fossil energy to get rid of ROMs. These ROMs contain plant nutrients and energy from the sun, bound in biochemical compounds that could give positive effects on cultivated soils.

- 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.

Many partners in IP SUMAWA feel responsibility 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 ROM, 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.

"Because soil organic matter decline is a crosscutting issue which is affecting other areas such as soil fertility and soil erosion, it is extremely difficult to estimate its cost." (on page 11 in *"***Towards a Thematic Strategy for Soil Protection"**
http://eionet.eu.int/Topic_Areas/Terrestrial_Environment/SoilProtection.pdf)

The great challenge facing us is to efficiently reuse both the nutrient elements, and the energy bound in ROM. It is not possible to recover all plant nutrients, or all bioenergy hidden in ROM as inevitably some losses occur during processing. A smaller amount of synthetic fertilisers still have to be used in order to compensate for the loss of nutrient elements. Their role is to optimise the delivery of plant nutrients for achieving maximum yields.

So it may be said that we need a system which will be ecologically favourable, economically profitable, environmentally friendly, holistic, and resource efficient. No small feat, but not impossible if we consider the research and technology already available today and possibilities for re-engineering and improving the human waste processing system.

The impact on training and education

Result from SUMAWA activities will be presented for during joint training courses and workshops and on electronic communication networks.
Researcher, engineers, staff and student will have possibilities to attend seminars, courses, workshops and also can visit other partners for shorter or longer collaboration. We want to establish database for all involved partners. Documents of broader interest will be published on Internet.

* The production of soil amendments/biofertilisers that contain energy, plant nutrients, and beneficial microorganisms;

* The protection of the environment as each yearly addition will increase the carbon sequestering abilities of soils.

Our Holistic Device

There is lack of a holistic view of plant nutrients, and bioenergy flows through different spheres of human activity. Some examples:

- Sector dealing with conventional waste management and waste water treatment is used a lot of fossil energy to get rid of ROM's, which contain plant nutrients and energy from the sun, bound in biochemical compounds that could give positive effects on cultivated soils.

- 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.

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The impact of training and education

Result from SUMAWA activities will be presented for during joint training courses and workshops and on electronic communication networks. , mobility of personnel, joint studies, establishment of shared databases, shared websites, international graduate school

B 4 Scientific and Technological excellence

One of the main objectives of this IP is the development of applications to tackle and solve the complex environmental problems and increasing demand of energy we are faced with today. Our approach is to make **efficient biological transformation** of the renewable organic material (ROM) **a mainstream "biomass-to-energy-and-fertilisers" conversion technology**. We aim to create novel, effective and efficient bioconversion systems, in order for the majority of the energy and elements from the ROM in waste to be reused in sustainable way.

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 have sustainable or unsustainable management of renewable material.

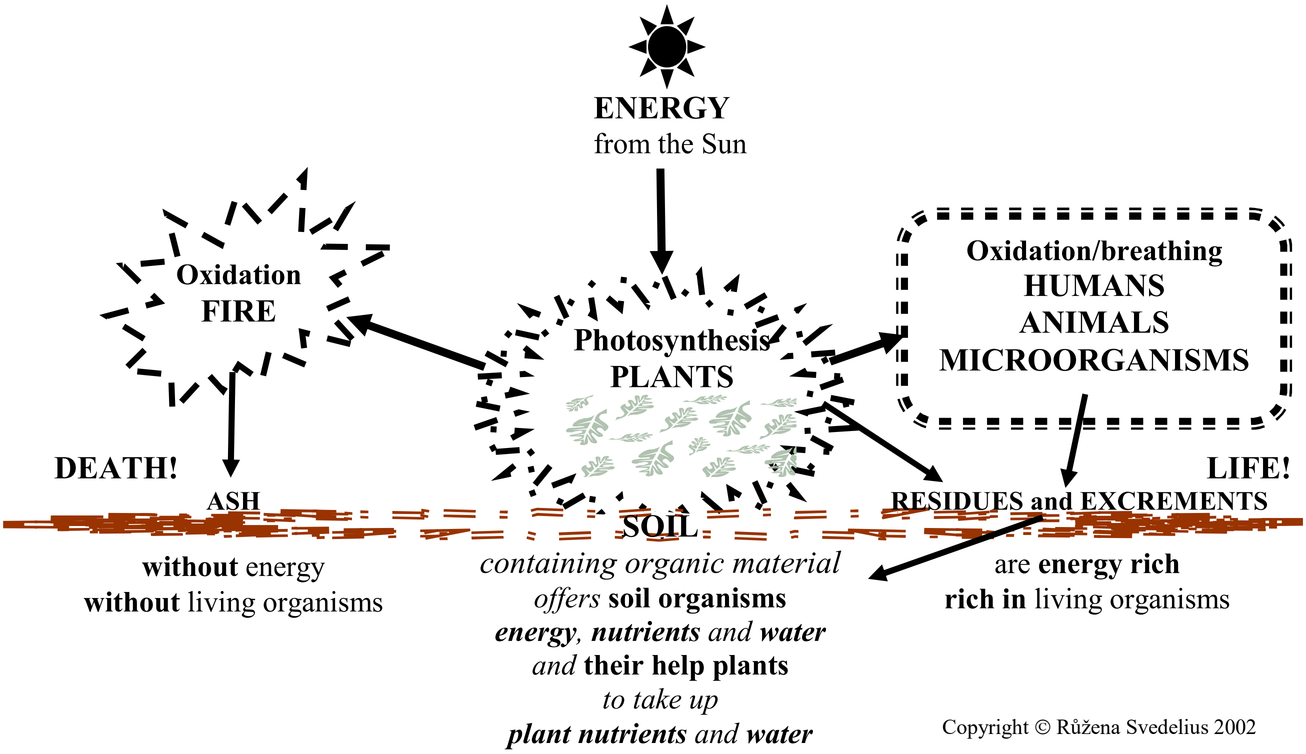

Figure 1. Comparison between oxidation in burning and oxidation in living organisms

During the bioconversion process ROM is upgraded to valuable products. ROM 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 we need both facilities and recipes. Therefore in this IP we want to use expertise, skilfulness and competence of all partners to build up new knowledge necessary for sustainable solutions.

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

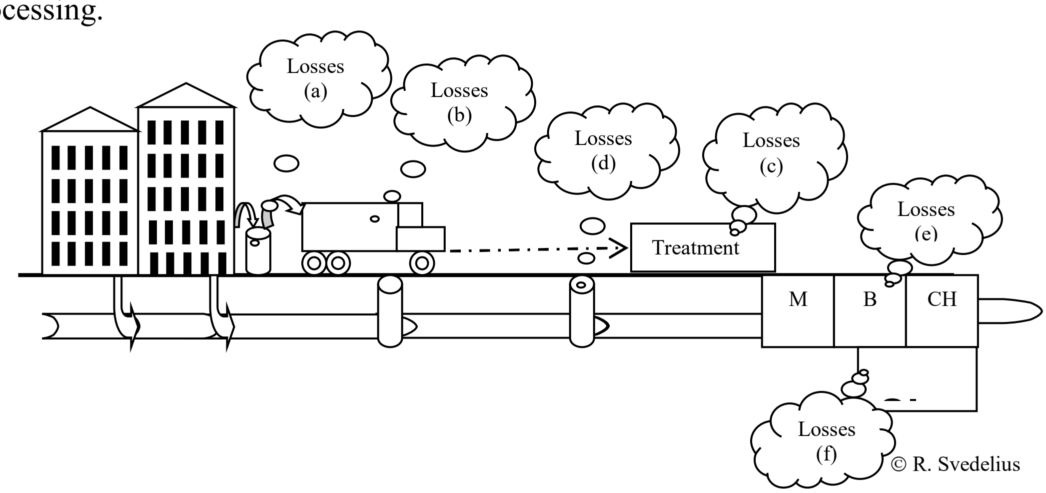

Figure 2: Present waste and wastewater "by end of pipe" management in open and centralised systems.

Losses of energy and plant nutrients appear:

When renewable organic material in solid waste is collected in dust bins (a), transported (b) and treated (c) in incineration plants, on landfills, in central composting plants and in biogas plants using rotting methods; or

When liquid waste (human excreta) is diluted, transported in sewage system (d) and treated 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 all polluting systems.

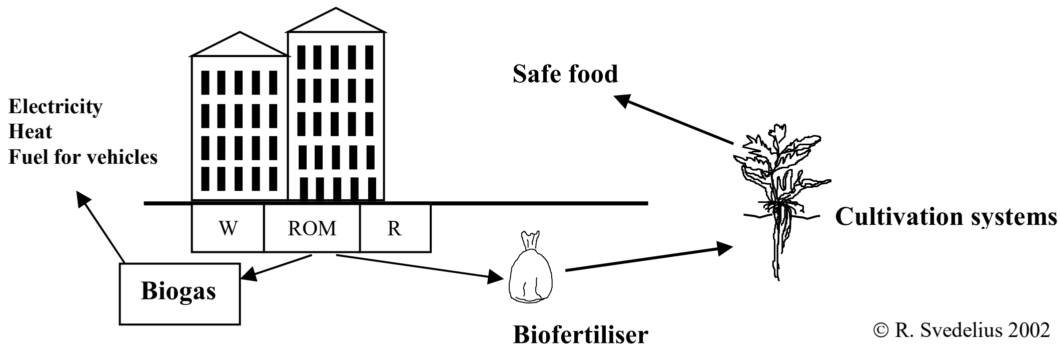

Figure 3: Future integrated waste and wastewater "at source" management in closed localised systems.

Losses of energy and plant nutrients are minimised when concept "SOLIWA" is used.

(W) Grey water is treated in "Bio H2O".

(ROM) Renewable organic material from solid and liquid waste is by microorganisms transformed to biogas and biofertilisers in "G&G-System".

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

The other important objective of this IP is to link the technological applications with 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.

Present high-tech centralised systems for treatment of solid waste and wastewater offer great public comfort but are expensive and do not offer efficient protection of the environment.
Municipal solid waste is composed mainly of organic matter i.e. from plants and animals. The organic fraction of waste is a renewable source of energy that ends up mostly in incineration plants and on landfills A small amount is processed by outdated composting and rotting methods. Plant nutrients should be returned back to cultivation systems.
Wastewater produced in households and industries 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. 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 "SOLIWA"

- 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,
- is a revolutionary achievement never before realised by conventional waste and wastewater technologies,
- 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 develop and implement "SOLIWA".

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, is one of the common objectives of this IP. The concept SOLIWA can be used as model.

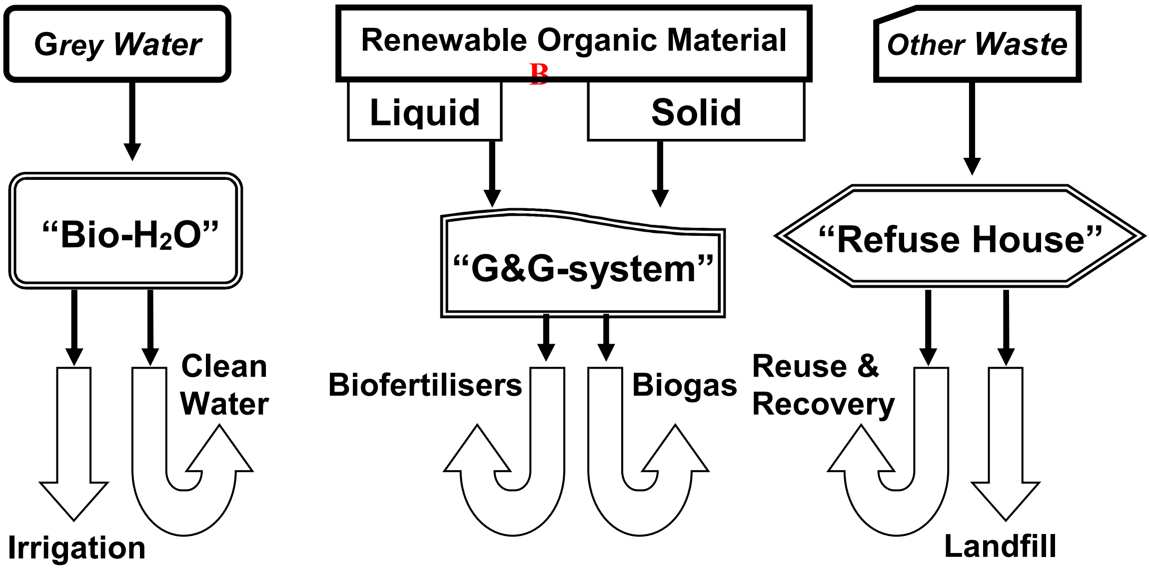

Figure 4: Concept SOLIWA for the integrated waste and wastewater "at source" management of solid and liquid waste/residues in closed localised system.

Description of SOLIVA

"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"

An efficient batch system for bioconversion of ROM into biogas and biofertilisers. Raw materials for bioconversion are taken from renewable organic solid[1] and liquid[2] waste from households, from central markets, from the food and feed industry, slaughterhouses as well as from forestry, agri- and horticulture. Fuel 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 connected to a bio filters. The contents of the bio filters 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.

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[1] 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)!*

[2] 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!*

Combined aerobic and anaerobic bioconversion in the “G&G-System” (Fig. 3 and 4) is microbial transformation in the model **biomass-to-energy-and-biofertilisers.**

IP will follow this concept and make it transparent for users, manufactures and planners in whole Europe.

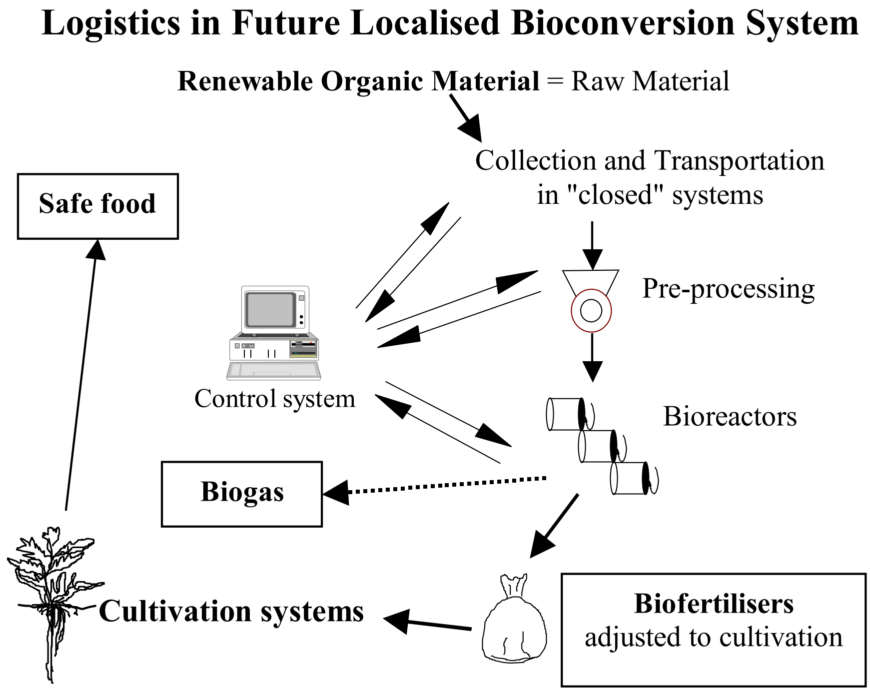


Figure 5: Flows in a modern system for bioconversion of renewable organic material in waste that is called “G&G-System” (Gas & Gödsel=Fertiliser) © R. Svedelius 2002.

Inhabitants are involved in activities where they are dependent upon decision-makers that are influenced by lobbyists serving the present unsustainable out-of-date systems.

We want to make results available for planners and for applications. The novel systems and methods decrease environmental damage and let people know that management of waste and wastewater can be without direct or indirect negative impact on food and health, both now and in the future.

Our scientific objectives are

* To maximise the utilisation of energy and elements (plant nutrients) from **renewable organic material** (ROM) in solid and liquid waste and in fuel crops when producing biogas and biofertilisers (Fig. 4). The experimental equipment for bioconversion will be situated in mobile modules. That will increase possibility to test material and energy flows at many different localities. For example in housing areas, university campus, on farms, nearby industries or at tourist centres.

* To investigate the survival of plant, animal and human **pathogens and weeds,** during various methods of bioconversion of high solid substrate in batch bioreactors with modern control systems (Fig. 4).

* To study factors affecting the highest yield and lowest emissions/pollution from bioconversion and thus affecting **hygienic aspects** (Fig. 4). Hygienic safety should be the minimum in legislation for the handling of synthetic chemicals, waste, wastewater and fertilisers. All these materials have impact on soil, food, health and environment, and on **quality of life** of humans.

* To investigate the **function** of "Integrated Waste and Wastewater Management" according to concept SOLIWA (Fig. 4). Mobile facilities, including combined aerobic and anaerobic operating systems, that are high-rate, simple to operate and have reliable performance are needed to make biological transformation of the ROM transparent and a useful tool for education, workshops and seminars. "Learning by doing" methods have the best impact on **training and education** activities and in long term on the improvement and development of new skills and expertise.

* To **evaluate the economic, environmental and social impacts** of "Integrated Waste and Wastewater Management" on sustainable development when – compare present systems with concept SOLIWA (Fig. 2 and 3). In spatial planning, among others, are involved planners, politicians, architects and economists. They are to a greater extent responsible for the development of the whole society. Results from evaluation of all impacts will **influence** their **understanding** and their decisions that control economy, environment, and people's health and well-being both in urban and rural areas.

The suggested concept "SOLIWA" is only one of possibilities to achieve sustainability in waste and wastewater management. Let's open the discussion on holistic solutions. Modernisation of infrastructure, systems and method need several smart solutions that are outcome from combination of knowledge and technicians skilfulness. We pay for the food, for drinking water, for the waste and wastewater management and we have right to ask for environmentally safe products and services.

Technological objectives of this IP are

* To design and construct several mobile **RTD facilities** that include all three parts of concept "SOLIWA". Facilities for biological treatment of grey water "Bio H_2O"or water with similar impurities have to be chosen with regard to local needs.
Mixtures of renewable organic material (ROM) will be converted by microorganisms in a series of bioreactors in the "G&G-System". There will be carried out improvements on equipment and methods for increasing efficiency of the system. At the same time materials from local sources and impact on local and global environment will be studied.
Materials that are not suitable for bioconversion will be sorted and preserved in the "Refuse House" before transported for reuse, to recycling or to landfills.
All mobile facilities will be connected by Intranet and impacts on economic, environmental and social dimension will be documented and evaluated. Mobile facilities can be easily moved to various sources of ROM for adjustment to local conditions and for testing best logistics.

* To design and test novel equipment for the collection, transportation, pre-processing and processing of ROM. Energy-rich microbial metabolite methane in biogas and biofertilisers of a high and reproducible quality can be produced effectively only when basic requirements of

the microorganisms are satisfied. The **radical innovations in treatment methods** expect development of novel equipment. For example for optimal utilisation of energy and nutrients in human excreta and for better hygiene during transport and treatment novel toilets have to be designed, tested and manufactured. Other products for every day use have to be adjusted to the modern systems for treatment of waste and wastewater. For example biodegradable packages without additives that disturbs bioconversion have to be created.

* To improve the system for separation, collection, pre-processing and equipment for aerobic and anaerobic **bioconversion, storage and utilisation of products** (biogas and biofertilisers) by innovation or re-engineering or technology transfer. The novel systems will include sub-systems, which are subjected to economically and ecologically efficient, long-term environmentally sound waste management. The system can be modified to meet the local needs and can be implemented in all countries.

* To create experiments where various substrates (mixtures of several ROM) are processed under **controlled conditions,** and where several variables can be modified during processing. Various additives and in different ways bioconversion stimulating amendments have to be studied.

* To **test and improve equipment** for biogas and biofertilisers including storage, distribution and usage. Computers, robots, control system and many other types of equipment are necessary to make localised facilities, including bioconversion systems with combined aerobic and anaerobic treatment, high-rate, simple to operate with reliable performance.

* To treat grey water and water containing similar impurities by biological methods in well designed facilities.

There are still technical limitations caused mostly by misunderstanding of information given by biologists and technicians. Doing research together in IP where the common objectives are clear will be a breakthrough in new applicable knowledge.

Most of innovations are made on the border between various specialities or areas of expertise. Therefore closed collaboration between researchers and engineers is one of the most important tasks in this IP. Also collaboration between partners, exchange of information, material, facilities, researchers, teachers and students will be strong supported.

RTD facilities will be open for all interested. We want to invite whole society to participate in dialogue. There are tremendous possibilities to get input of ideas from interested visitors and to explain our efforts and reach social acceptant.

The **RTD approach** is multidisciplinary and contains both fundamental and applied research. As researchers and technicians come from various countries and do not have the same resources for doing experiments is it important to test research methods on different levels. Valuable improvements can be made by enthusiastic and creative staff.

Most of the participants find EoI SUMAWA worth effort and therefore we started to communicate without previous personally meeting. Our scientific experiences tell us that we can open new “doors” to better understanding our co-workers microorganisms and their needs. With increased precision in processing and with modern logistics we receive many positive effects.

The plan for the dissemination of knowledge and the exploitation of results.
The use of modern telecommunications to spread and share information, through shared databases and websites, papers, seminars, conferences, lessons, workshops, electronic communication networks, meetings, discussions with scientists, contact with manufacturers and the public.

Implementation of concept "SOLIWA" with focus on renewable organic material in waste management 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, trans boundary air pollution, water stress, soil degradation, waste, biodiversity, human health, urban areas, coastal and marine areas.

Our detailed implementation plan is on the way. We are very new colleagues and time was too short to decide details. In general participants accepted suggestions made in EoI last June presented below.

The stages of implementation and the results expected in each one of them

- Research and technical improvements of biological treatment of ROM – both equipment and methods. Resulting in efficient processing, minimising pollution, in products of high quality, in increased employment and increased social acceptance.

- Research and technical improvement of collection, transportation and pre-treatment of ROM in solid waste, and human excreta is needed to improve logistics and minimise emissions that are polluting losses. Novel systems have to be constructed to improve the environmental impact with regard to emissions, noise and vibrations from present vehicles used for the collection of solid waste, and emissions from the unsustainable sewage systems. Designers, manufactures and planners will use results from the technical improvements.

- Biogas is a renewable energy source, and investigations have to be made on its integration in the energy system, including storage, distribution and use. Results will lead to improvements of infrastructure. Vulnerability of society will decrease.

- Biofertilisers are fresh materials containing living organisms, and thus investigations have to be made on the quality and BAT, including storage, distribution and land application. This is important for measurements, and efforts with an aim to improving the savings and efficiency of the system.

- Effects of biofertilisers on the soils biological, chemical and physical properties need to be followed-up and evaluated. In addition the soils capture and sequestration of CO2. Results can be used as feedback information, for the improvements of equipment and methods in the system as a whole.

The main lines and timetable

Stage I.

1. Build several mobile RTD plants including alternative wastewater treatment "Bio-H2O", equipment for "Bioconversion" and "Refuse House". Design various models of source separation of waste and human excreta. Create suitable equipment for collection, transportation and pre-processing. Manufacture different prototypes of bioreactors. Design storage system for biogas and biofertilisers. Check BAT for use of biogas, improve equipment for application of biofertilisers, and provide cultivation tests for evaluation of quality of biofertilisers. To build mobile RTD plants and make improvements will take 2 years.

2. Provide research, investigations, studies and evaluations (including feed-back) to develop best management practices (BMPs) to reduce the risk. That will go on at the same time and will continue 3 more years.
3. Training and information will go on during all 5 years.

Stage II.

1. When mobile RTD plants are well adapted to local needs, full-scale plants can replace them. Full-scale plants can start after approximately four years, and require several years of continuous evaluation and feedback, in order to make improvements to equipment and methods.

2. Investigations, studies and evaluations will continue as well as research and training. It is estimated that it will take totally 8 to10 years to reach satisfactory results.

B 5 Description of the consortium

The key person's experience

1. AS-M: Dr. Ruzena Svedelius has research experience in bioconversion of renewable organic material carried out in bioreactors and cultivation experiments. Her fields of interest are recycling of plant nutrients, soil fertility, energy flows and environmental issues.

2. IFA-Tulln: Dr. Johann Fritz is experienced for several years in determination of biodegradability and ecotoxicity of xenobiotica and anthropogenic materials in soil and aquatic ecosystems.

3. EURES-IC: Ing. Francesco Bellomonte has experience in wastewater reuse in agriculture.

4. DAAPV: Prof. Maurizio Borin, agronomist of Agricultural Ecology, is experienced in agriculture/environment relationships, with particular regard to water pollution control and re-use of organic waste as fertilizers.

5. unibait: Prof. Leonardo Mancini has experience in studies on horticultural and floricultural cultivation in open field and protected areas, and in evaluation of soil properties.

6. ICRM-CNR: Dr. Francesco Secundo has research experience in enzymes extraction, immobilization and applications. His research activity has dealt with purification, characterization and application of enzymes to organic synthesis.

7. WASTE: Mr. Gert De Bruijne is ecological Sanitation Specialist, on decentralised sanitation projects, sustainable integrated land and water management, involving various stakeholders.

8. ISA: Prof. Elisabeth Duarte is experienced for many years in anaerobic digestion technology of manure and organic wastes, food industry wastewater treatment processes and efficient re-use of water in industry.

9. Prof. Dr. Juan Manuel Arroyo Sanz is university professor of agronomy and environmental sciences and has research experience in fertilization, irrigation and environmental indicators.

10. HiK: Prof. William Hogland has more than 25 years of experience of waste and water management with focus on local treatment and biological decomposition processes.

11. aeroba: Mr. Johan Sundgren has experience in building biogas and composting plants and his company is interested in innovation of bioconversion processes.

12. SLU: Dr. Guy Svedelius has research experience in testing of survival of plant pathogenic fungi during bioconversion of organic material from household waste and in cultivation tests where biofertilisers were used.

13. UOP: Dr Robert Parkinson has research experience in soil nutrient dynamics in agro-ecosystems, including efficient re-use of human and animal bio-solids within crop production systems, and environmental fate of nutrients in soil/plant/environment systems.

14. ISSNP: Dr. Vesselin Koutev has an experience in the study of nitrogen transformations in soil cycle and organic fertilizers; nitrates and phosphorus pollution of surface and underground waters; laboratory, pot and field experiments testing of fertilizers quality. Fields of interests: soil fertility, soil pollution, fertilizing potential of organic wastes from agriculture.

15. TU Lodz: Dr L. Krzystek is an expert in bioprocess engineering, in particular in the field of environmental biotechnology (modelling of bioprocesses, treatment of organic fraction of solid MSW, inertization of landfills, bio-utilisation of cheese whey).

16. INCT: Dr. Grazyna Zakrzewska-Trznadel - her scientific interests concern membrane permeation processes, separation of liquids and gases, process engineering and environmental protection issues.

17. UPBTM: Dr. Eng. Andrei Sarbu has experience in chemical engineering, transfer phenomena and corresponding devices, polymers and biopolymers (synthesis, modification and uses), bioconversion kinetics, waste water treatment, immobilization of enzymes on polymers and chemical analysis.

18. TU-FEE: Dr. Daniel Lesinsky has experience in research on biodegradable plastics, waste management focused on packaging and bio-waste treatment and in activities focused on communal waste agenda with public environmental awareness reinforcement.

19. TUBITAK-MRC: Assoc. Prof. Erdem Gorgun is an environmental engineer with over 15 years experience in treatability studies on industrial wastewater, design of biological treatment system, improving the existing treatment plants, characterization and disposal of solid waste, wastewater reuse/recycle and biological nutrient (N & P) removal.

20. POLT JC: Dr. Eng. Jozef Cebula is an expert and senior scientist in Sanitary Engineering dealing with the study, designing and implementations of various technological and technological solutions of plants/regional plants, facilities, and equipments for separation, collection and processing of solid wastes and also of land treatment and irrigation, of removal of heavy metals and their influence on the potential value of biofertilisers and their final use with impact on the environment.

21. KMUTT: Dr. Soydoa Vinitnantharat has experience in environmental technology and environmental biotechnology since 1992. Her fields of specialization are biological treatment processes, adsorption technology, biologically activated carbon processes and waste utilization.

22. ECEERO: Prof. Lucian P. Georgescu has a very good expertise in research and research management for national and international environmental projects.

23. RSS: Dr. Bassam Hayek has experience in environmental assessment and management and has conducted and supervised research work on wastewater treatment.

24. ZHW: Dipl. Natw. ETH Vicente Carabias-Hütter involved in transdisciplinary projects from a holistic perspective, providing also competencies in risk management and governance as well as in the interfaces of environmental - social sciences and economy. He has investigated public acceptance and perception issues, social compatibility of processes, public participation not only in waste management but also in general related to the sustainable development of societies.

25. FK-DEU-TU: Prof. Dr. Fikret Kargi is expert on bioprocessing of wastes.

26. Forest Research: Dr. Gujjaiah Nanjaiah MAGESAN has expertise is in waste management and its impact on soil and water quality. He is currently the Secretary, soil physics, International Union of Soil Sciences.

27. UVM: Dr. Jan Venglovsky. Subsequently his research has focused on (i) the hygienization of animal wastes in agriculture, (ii) the use of secondary raw materials from the food and processing industry and (iii) the recycling of agricultural, municipal and industrial residues in agriculture.

Participation of SMEs with a significant role in the IP is presented in A2 forms.

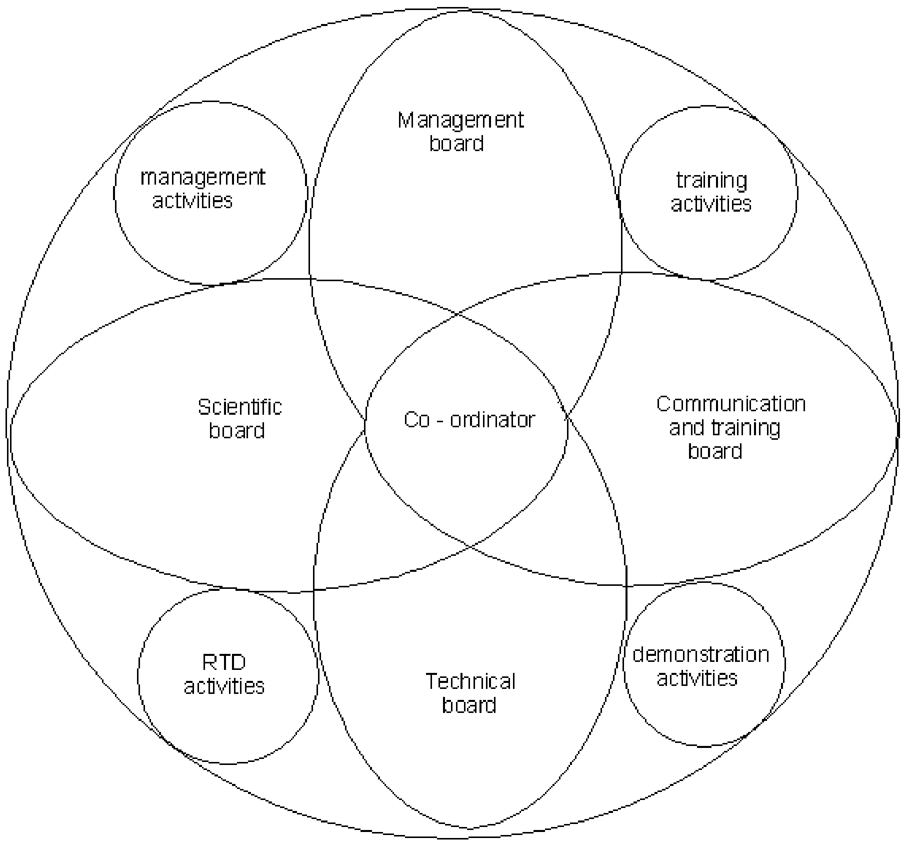
The partnership is explaining the complementarities of the expertise and the allocation of tasks.

The participants based outside of the EU are important for exchange of knowledge and experience etc.

Consortium agreement will be signed later.

B 6 Description of the project management

General management and activities
Note: The circle represents the partners



The circle can describe best the equidistance between all partners, and between the partners, the coordinator and the boards. The boards will be in permanent contact keeping in the same time the closer contact with the specific activity. At the same time, the partners are linked by the conjunction of their fields of competence.

During the life of the project, the jobs for every partner can evolve:
- on horizontal plan, that means that the same partner can work on different field of competence for example biological kinetics may be studied at the same time with chemical kinetics, and the nutritive value of biofertilisers can be studied both from biological and chemical point of view;
- on vertical plan, the importance and the value of the work and results of one partner can make possible to situate him in one of the boards.

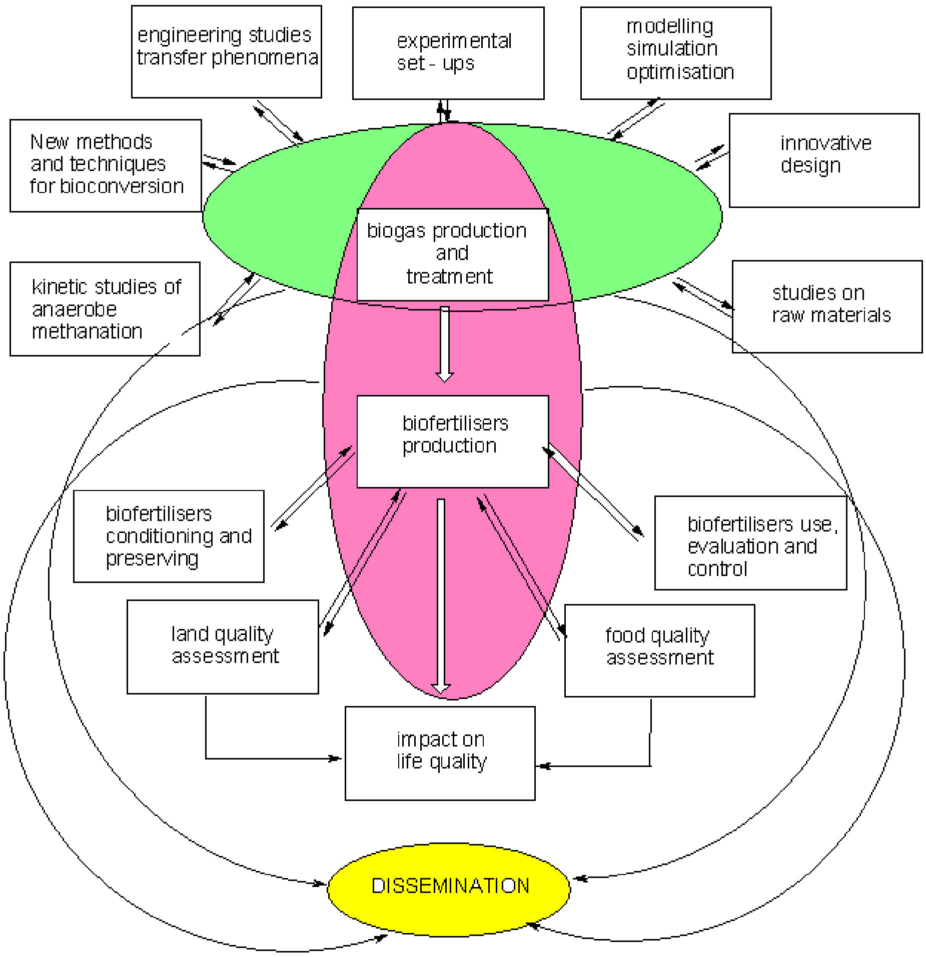
The project is characterized by a permanent feed-back. The technology and design will evolve depending on the concrete results, from the economic efficacy and environmental impact.

The multidisciplinary study will optimise the general process from: environmental, energetic, economic point of view. At the same time, the economic and social study will reflect if the research direction is good or not.

The convergence of these multiple factors will be studied in a several concrete cases. For example: In Galati, Romania, there is proposed an ISPA granted project on Municipal waste management. There is the most populated region from Romania (more that 700 000 inhabitants) and in the same time a very sensitive environmental region (the most sensitive hydrographical basin in Romania).

The most important part of this investment is building a several mobile plants for microbial conversion of renewable waste with production of biogas and biofertilisers.
The consortium from the project will be involved from the beginning at all the steps from the implementation of the novel system.

RTD organisation and management are presented in the figure below.



RTD organisation and management
rectangle = basic components
elipse = major steps

This project will require particular attention by the consortium to overall management and co-ordination issues.
Over and above the technical management of individual work packages, an appropriate management framework linking together all the project components and maintaining communications with the Commission will be needed.
Depending on the size and scope of a project, a specially constituted management team with dedicated staff covering a range of skills may need to be set up.

B 7 Project resources

Financial resources needed to carry out the project successfully are presented in enclosed *Financial Information (Integrated Project)*.

An IP **Project Effort Form** shows the person-months per partner associated with each activity that is briefly described.

Description of the experience of the all involved persons, equipment and all other resources will be presented at STAGE 2.

Should the agreement on Swiss participation in the 6th FP not be in force when the European Commission definitively decides to support the project, Swiss Partners (ZHW) will be funded by the Swiss Government.

B 8 Other issues

Statement

The IP SUMAWA will follow all ethical rules and women are very welcome to participate.