Human activities, in particular transport, are partially responsible for the problems associated with the greenhouse effect, and therefore global warming.

A key short-term action consists in increasing the use of alternative fuels to reduce greenhouse gas emissions. More generally, the Biogasmax objective is to develop alternative and affordable means of transport with a global policy of improving the management and use of waste and urban transportation.

In terms of its needs for energy, the European Union is increasingly dependent on imported fossil fuel. This complex situation leads to significant ecological and economical risks for society, as:

- The demand for energy is constantly increasing,
- Oil products come from politically unstable regions,
- Oil prices are rising,
- Resources are limited,
- Greenhouse gases emitted by fossil fuels through combustion contribute to climate change.

The European Commission is seeking to solve these issues through a series of initiatives, including many that focus on the transport industry, which is almost fully dependent on oil. In this context, it has launched a call for projects that focus on biofuels (Biofuel Cities).

Fossil fuel combustion (petrol, diesel, kerosene, gas,...) emits more than three billion tons of CO₂ in the atmosphere each year. Biogas used as fuel (biomethane) can eliminate smog in the atmosphere and significantly reduce noise pollution. The most environmentally harmful compounds (particles, non-methane hydrocarbons) are absent when biomethane is used. For example, using biomethane as a fuel in buses leads to a reduction of 95% in particles, 99% in sulfur compounds and 70% in nitrogen oxide, as compared to diesel buses.

The European Biogasmax project creates a network of biogas-related demonstrations on the European territory with the aim of sharing experiences in terms of best practices in managing urban transportation.
From waste to clean fuel

**Biogas production is a natural process**

Biogas is produced by the degradation of organic matter in the absence of oxygen (anaerobic digestion). This degradation, also referred to as methanization, occurs in natural areas like swamps or in controlled areas like landfill containing organic waste. Methanization can be artificially controlled by fermenting sewage sludge, industrial or agricultural crops.

**Efficient reduction of greenhouse gases**

Biomethane is produced from biomass, is therefore a renewable energy resource and does not contribute to the greenhouse effect. The use of landfill or waste for biogas production can even result in a reduction of CO₂ emissions as methane leakage is prevented (the effect of which, as a greenhouse gas, is 23 times greater than carbon dioxide).

**Biomethane has a very wide range of biomass feedstock**

Biomethane can be produced via two different processes – digestion and thermal gasification. Digestion is an anaerobic process where bacteria convert degradable organic matter into methane and carbon dioxide. The feedstock is sewage sludge, household, industrial and agricultural waste. Biogas may also be produced from various agricultural energy crops. The thermal gasification technique allows even wastewood from forests or agriculture to be used to produce biomethane. Biogas requires upgrading to a high level of methane concentration – biomethane – to be used in cars or to be injected into the natural gas grid. Compared to other alternative fuels, biomethane benefits from the extensive availability of biomass feedstock sources.

**Sustainable waste treatment and agriculture**

Production of biogas from waste may be a key to a more sustainable waste treatment system. Residual digestion-based products may be used in agriculture as fertilizer. Nutrients such as nitrogen, phosphor and potassium are circulated back into the soil.

**Biomethane – an energy efficient fuel**

A German* study has shown that a biomethane-fueled car runs three times the distance of a car fueled with bio-diesel produced from one hectare of arable land. The distance is 50% longer when compared to ethanol. EUROCAR/JRC/CONCAWE’s well-to-wheel analysis indicates that methane-based hybrid engines provide greater energy efficiency than gasoline and diesel engines.

**Biomethane can reduce dependence on oil and secure energy supply**

The conditions for a successful introduction of biomethane for vehicles in Europe are excellent:

- A great potential exists for biomass from urban areas, agriculture and forests.
- The natural gas grid in Europe is very broad.
- There are more than 2,000 filling stations for natural gas vehicles.
- The market for biomethane is very extensive – 600,000 cars, buses and trucks run on natural gas.

* FNR (Fachagentur Nachwachsende Rohstoffe) and BEE (Bundesverbandes Emeuerbare Energie)

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From biogas to biomethane

**The successive steps: waste – biogas – biomethane – fuel, prevent emissions into the atmosphere and allow for organic waste to be treated in a natural cycle.**

- **Gas grid**
  - Direct injection into natural gas grids.
  - High in octane, biomethane is used as a substitute fuel and may be used to power vehicles.

- **Upgrading**
  - Controlled methanization allows for digestion-based gas to be used as an energy base for the production of heat, electricity and fuel.

- **Heat**

- **Biogas Energy**

- **Co-generation of electricity**

- **Compost/fertilizer**
  - The process generates added-value products, for example, compost and fertilizer.

- **Fuel**

- **Principal sources of biogas**
  - House waste
  - Landfill
  - Agricultural crops
The objective of the BIOGASMAX project is to address urban challenges related to air and water pollution, as well as waste management.

To this end, it uses a virtuous cycle in which biogas is produced from various types of urban waste that must be managed.

During the process, BIOGASMAX focuses on monitoring the economic and environmental impact in order to produce fuel for transport that does not harm the environment.

The research and development projects carried out in the context of BIOGASMAX are closely tied to the following four main fields of technological activities:

- **Production** of biogas from various types of waste;
- **Upgrading** of biogas to a high-quality fuel;
- **Distribution** for transport and injection into natural gas grids;
- **Use in vehicles** to increase the number of biomethane-fueled vehicles.

### Content of demonstration projects

<table>
<thead>
<tr>
<th>City/Location</th>
<th>Production</th>
<th>Upgrading</th>
<th>Distribution</th>
<th>Use in vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Urban Community of Lille (FR)</strong></td>
<td>- Organic waste - Sewage</td>
<td>- Gas scrubber - Pressure Swing Adsorption</td>
<td>- Filling on-site - Snap-body transport - Biogas highway</td>
<td>- Waste collection - Service fleets - Buses</td>
</tr>
<tr>
<td><strong>Stockholm (SE)</strong></td>
<td>- Restaurant waste - Sewage - Biodegradable</td>
<td>- Organic composting/drying</td>
<td>- Direct supply filling stations - Biogas highway - Grid injection</td>
<td>- Taxi and delivery - Airport buses - Clean Driver Network</td>
</tr>
<tr>
<td><strong>Poland (Toruń and Zielona Gora)</strong></td>
<td>- Sewage</td>
<td>- Gas scrubber</td>
<td>- Filling stations - Storage tanks</td>
<td>- Waste collection - Service vehicles - Municipal fleets</td>
</tr>
</tbody>
</table>

**Anaerobic digestion** is the degradation of organic matter in an oxygen-free environment. It can be applied to most municipal waste streams and supports biogas production.

**Use in vehicles**

Biomethane may be used in all forms of vehicles with spark ignition and compression ignition engines designed to run on a combination of diesel and methane.

**Distribution**

Biomethane may be used in natural gas grids (injection) or filling stations.

**Upgrading**

Biogas is concentrated and cleaned in order to produce a gaseous fuel (biomethane) for vehicles with characteristics similar to those of natural gas.

**Production**

The waste spends approximately three weeks in the digester where methanization separates it into two parts:
- A solid part (digester sludge)
- A gaseous part (biogas).
Role of Biogasmax partners

The Biogasmax project includes 25 public and private partners in Europe responsible for specific tasks.

- Four countries participate in projects to demonstrate the technological and economic viability of biogas production from waste: France, Italy, Poland and Sweden.
- Four partners have quantified objectives under the Biogasmax project: Göteborg, Lille, Rome and Stockholm.
- Four partners have horizontal responsibilities:
  - LMCU (France) for project management and communication,
  - ISET (Germany) for advanced technologies in upgrading biogas,
  - University of Stuttgart (Germany) for the evaluation of the Biogasmax project,
  - ENGVA (The Netherlands) for knowledge transfer.

The Biogasmax project is divided into eight Work Packages:

WP1: project management
WP2: biogas production
WP3: upgrading
WP4: distribution
WP5: use in vehicles
WP6: evaluation
WP7: transferability studies
WP8: communication and dissemination

Quantified objectives

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<tr>
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<tbody>
<tr>
<td>Lille (FR)</td>
<td>Organic Recovery Center: Raw biogas production of 7.3 million Nm³/year.</td>
</tr>
<tr>
<td>Göteborg (SE)</td>
<td>- Refurbish a pilot plant to produce 3.6 to 4 million Nm³/year of raw biogas annually, of which at least 0.28 million Nm³/year will be upgraded to biogas fuel (for 10 buses). - Demonstrate that it is possible to increase biogas production by at least 10% in the existing plant.</td>
</tr>
<tr>
<td>Stockholm (SE)</td>
<td>- A new anaerobic unit will be added to the existing composting plant in Maccarese to produce 10,000,000 Nm³ of raw biogas.</td>
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<td>Rome (IT)</td>
<td>- Demonstrate and use of 30 light duty biogas vehicles in the service fleet, i.e. company-owned cars used by employees. - Demonstration and use of 10 heavy duty waste collecting biogas vehicles. - Local incentives to promote 100 light duty biogas service vehicles, i.e. company-owned cars used by employees.</td>
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Upgrading

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<td>Lille (FR)</td>
<td>Organic Recovery Center: One storage unit with two horizontal tanks for the optimized refueling of 100 buses.</td>
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<td>Göteborg (SE)</td>
<td>- Gas quantity: 6,500,000 Nm³/year - Quality: 11.0 kWh/Nm³</td>
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**THE UNIVERSITY OF STUTTGART**
assesses the actions undertaken by Biogasmax partners with the aid of a management tool that has been successfully applied in other European projects.

**ENGVA** (European Natural Gas Vehicle Association) is a driving force in the implementation of transfer opportunities to other European cities.

**ISET** (Institut für Solare Energieversorgungstechnik, e.V.), together with Nova Energie, will work on emerging technologies to be used for the optimal production and concentration of biogas.

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**University of Stuttgart Evaluation**

The Department of Life Cycle Engineering (LBP, University of Stuttgart) brings exceptional experience to the development and practical application of life cycle methodologies. The Department of Life Cycle Engineering activities began in 1989 at the Institute for Polymer Testing and Polymer Science (IPT). Due to internal structural changes at the University of Stuttgart, the entire LCE Department changed at the beginning of 2006 and became the Chair of Building Physics.

The department has the scientific background in the LCE approach, which comprises economic, technical, environmental and social criteria in terms of supporting decision-making processes. The research engineers at LBP's Life Cycle Engineering Department have more than 150 person-years of outstanding experience in developing Life Cycle related methodologies, software (Galbi) and databases. The development of practical methodologies and software is conducted in close cooperation with industry, leading to scientific-based sophisticated solutions, which are widely used in industry and research. LBP and its cooperation partner, PE International, form together the world's largest working group of LCA experts and are among the world market leaders in LCA software and databases. LBP conducts joint activities with PE International in developing the professional LCA Software System and Galbi databases for Life Cycle Engineering (www.galbi-software.com). Galbi is one of the leading software tools for LCA and LCE worldwide and the database has been specifically praised for its quality and volume.

**CONTRIBUTION TO THE BIOGASMIX PROJECT**

Within the BIOGASMIX Integrated project, the Life Cycle Engineering Department (LBP) conducts Life Cycle (LCA) tools and databases. LBP conducts joint activities with PE International in developing the professional LCA Software System and Galbi databases for Life Cycle Engineering (www.galbi-software.com). Galbi is one of the leading software tools for LCA and LCE worldwide and the database has been specifically praised for its quality and volume.

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**ENGVA Transferability Study**

The European Natural Gas Vehicle Association (ENGVA) was created in January 1994 by a group of 63 member companies from 17 countries. These included natural gas utilities, NGV equipment and vehicle suppliers, as well as environmentalists and individuals.

ENGVA’s mission is to develop a sustainable and profitable market for natural gas vehicles (NGV) throughout Europe by creating a favorable political and economic environment that encourages the development of NGV technology, as well as a European fueling infrastructure. ENGVA supports the direct use of natural gas-to-hydrogen and the long-term use of hydrogen as a vehicle fuel.

ENGVA provides a leadership role within the growing NGV industry, but also serves its members to ensure their needs for market development, technology growth, and natural gas fueling are fulfilled.

**CONTRIBUTION TO THE BIOGASMIX PROJECT**

Within the BIOGASMIX project, ENGVA leads Work Package 7, which is the analysis of the decision criteria that cause decision-makers to implement – or not – biomethane as a vehicle fuel in their community, municipality or region. Through research, the energy, ecological, economic, social and political aspects of biomethane implementation are outlined. The decision makers will provide feedback on the biomethane decision – from the biomethane pathway to biomethane business – illustrated by practical examples. ENGVA will also contribute to the further dissemination of this information with four two-day training sessions to be held in different European locations.

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**ISET: Institut für Solare Energieversorgungstechnik Emerging Technologies**

The Institut für Solare Energieversorgungstechnik e.V. (ISET) in Hanau is engaged in application-oriented research and development of renewable energy generation and distribution. This includes the area of Energetic Use of Biomass.

ISET supports the following essential project objectives:

- The use of biomass in new energy conversion technologies, such as micro gas turbines or fuel cells.
- The optimization of the interaction between biomass generation and converter units.
- Measurement processes and sensory analyses for the optimized operational control of biomass systems.
- Standardization and modularization of systems using biomass.
- The integration of biomass systems into power supply structures (gas, electricity and heat).
- Demand-oriented biomass production to cover real-time load profiles.
- The development of biomethane-led ‘micro-gas grids’.
- The use of biomass in hybrid systems to replace diesel.

The ‘Energetic Use of Biomass’ Division is looking at the optimization of the systems’ technology for the entire process chain related to the use of biomass to produce energy. The objective of the division’s projects is to exploit the present potential and opportunities in this area of technology and open up new perspectives.

An experimental center in Hanau is approximately 350 m² in size and various process chains for the energetic use of biomass have been put in place. These include various portable systems to prepare feedstock, digestion and gas purification with integrated measurement data compilation and computer-aided control components. To optimize operations, the parameter specifications are compiled and evaluated online. For further analyses, adjacent labs are available where special biological, chemical and physical parameters can be studied.

**CONTRIBUTION TO THE BIOGASMIX PROJECT**

Within BIOGASMIX, ISET, together with NOVA, will be responsible for monitoring, evaluating and exchanging experiences with regard to biogas plant construction, as well as biogas upgrading facilities. ISET will demonstrate the applicability of the different biogas upgrading systems and will provide practical advice related to the implementation and operations of the upgrading units to be built within Biogasmix.
Region of Göteborg
Biogas fuel market breakthrough

Issues and choices
Biogas West is a regional cooperation project in western Sweden for the implementation of biogas as a vehicle fuel. The activity is led by Business Region Göteborg and involves more than 25 stakeholders representing municipalities in the western region, organizations, authorities and companies. Among the participants are Göteborg Energi, Fordonsgas Sverige and the Municipality of Falköping, all partners in the Biogasmax project. The purpose is to develop a new environmental sound industry that stimulates market development for the production, distribution and use of biogas as vehicle fuel. This will contribute to creating job opportunities and less greenhouse gases. In addition, it solves waste problems and stimulates the production of eco-fertilizers.

The entire public/private system is involved in the project, which contributes to strong political support that can change financial conditions and provide a long-term perspective, as commitments are needed as well as a holistic view.

In Biogas West, the Green Gas principle is applied: this is a concept that covers the use of renewable biogas and fossil natural gas. This unique concept may be applied to all filling stations already connected to the natural gas grid. A customer may fill a vehicle with methane gas at a filling station, then the corresponding amount of biomethane is injected into the natural gas grid. In order for biogas to become a complementary fuel in the strategies of Sweden and Europe, this concept is necessary.

Previous experience
The main tasks for 2004-2006 have been to:
• Increase biogas production
• Use of agricultural substrates as feedstock for biogas production
• Improve distribution
• Initiate information efforts for new fuel stations

As of December 2005, the result was 126 GWh of green gas (natural gas and biogas) has replaced 14.5 million liters of petrol. This means that emissions of greenhouse gases from vehicles in West Sweden have decreased by 17,000 tons/year.

The project goal for 2006 is to dispose of 35 fueling stations, 7,000 gas vehicles and increase production to 120 GWh of biogas.

Territory vision
The vision and concrete goal for 2010, which somewhat coincides with the Biogasmax project period, are to:
• Contribute to the region’s environmental goals by decreasing emissions of harmful substances and greenhouse gases.
• Develop a new industry, which includes market and technical development, export opportunities and new job positions.
• Become the leading region in Sweden, with an international perspective.

The specific accountable goals are:
• 16,000 gas vehicles, including 300 buses and 200 “heavy duty and distribution vehicles”
• 65 fueling stations, including 6 fueling stations for buses,
• 300 GWh of green gas, i.e. 180 GWh of biogas and 120 GWh of natural gas,
• Reduction of CO2 emissions by 50,000 tons per year.

The vision for 2020 consists in Biogas West contributing to:
• Sustainable economic growth in the region that generates new jobs and export opportunities.
• Opportunities for companies.
• Biogas being injected in the natural gas grid and replacing 30 % of fossil fuels.
• The infrastructure for biogas achieving the same level for gas vehicles as for conventional vehicles.
• Increased public transport that is driven by locally produced biogas.
• The creation of a large international biogas network.
• A decrease in greenhouse gases.

By 2020, market developments should lead to:
• 150 fueling stations in West Sweden,
• 100,000 gas vehicles on the roads in West Sweden,
• 1,500 GWh biogas production.

Contribution to the Biogasmax project
• Increased production of biogas in Göteborg, including techniques to reduce the methane slip from the production unit,
• Assessment of increased production of biogas in Falköping and study of the potential to distribute biogas production to farms and a central upgrading unit,
• Increased upgrading capacity in the Municipality of Falköping,
• Market activities to increase the number of vehicles,
• Using the experience and assessments of various techniques and methods to increase the amount and use of biomethane in West Sweden.
• Assist in exchanging the many years of experience in our region with other regions in Europe.
Lille Metropolitan area
Towards 100% clean public transportation by 2011

Issues and choices

The principle of separative collection and use of the organic portion of household waste was adopted in 1992. The treatment technology was not fully decided, however. Definition studies launched in 1995 over three sites and completed in 1998 led to the conclusion that the methanization process was viable from a technological, environmental and economic perspective in light of the amount to be treated. In parallel, this decision led to the implementation of an alternative waterway transport scheme for waste.

This waterway network was designed with the installation of two transfer centres to the north and south to receive the two portions of residual and organic waste and to transfer waste not treated on the site by boat.

Furthermore, the Lille Urban Area Mobility Plan provides for an increase in gas-fuelled urban buses; as a first step, in 2006, through the purchase of 100 additional vehicles, supplemented by 100 more as a second step. The entire public transportation fleet will therefore consist in clean vehicles.

In order to meet the objectives of the Mobility Plan and develop the fleet of clean gas buses, two new bus depots have therefore opened in Sequedin and Wattrelos fed with both biomethane and natural gas.

Previous experience

1990
- First experiments with selective waste collection.
- The Urban Community of Lille, in the context of its energy control policy, decided to recover the surplus of biogas produced by the digestion of the sewage sludge of the main waste water treatment plant. A pilot scrubbing unit was designed to produce biomethane.

From 1994
- Experiments with biomethane fuel production in the waste water treatment plant of Marquette, which produces fuel for four buses.

1999
- Decision to progressively, yet totally replace the diesel buses with natural gas and biomethane buses.

2003
- 70,000 tons of clean and dry waste and 60,000 tons of bio-waste are recycled.

2004
- Decision of the urban community Council to produce biomethane from the raw biogas generated by the digestion of household bio-waste.
- Decision to renovate the biomethane upgrading unit in the Marquette waste water treatment plant.

2005
- Construction of the Organic Recovery Centre in Sequedin to treat 100,000 tons of bio-waste per year.
- Construction of the natural gas/biomethane bus depot in Sequedin. 100 of the 150 buses will use the biomethane produced by the Organic Recovery Centre.

2007
- Operations start at the Organic Recovery Centre. Production of biomethane equivalent to 4 million liters of diesel per year.

Gas-powered buses: high level of profitability and performance

The commercial use of 127 gas-powered buses proved the reliability of the system and its economic competitiveness in relation to diesel after 16 million kms of use.

Territory vision

From waste management to urban transportation

Having experienced two centuries of intensive industrial activity, the Urban Area of Lille has undergone a deep restructuring and has experienced sustainable development as a cultural revolution and rebirth over more than ten years. The population of Lille is willing to recognize environmental needs and benefits. The sociological post-industrial mutation has been successful.

For more than 10 years, the Urban Community of Lille has implemented a biogas production approach that is now fully mature. The implementation of additional organic use fits into the continuity of the objective to be achieved over time: the implementation of selective collection and use of organic and energetic matter in incineration.

Increase in the production of biomethane

- Renovation of the Marquette pilot upgrading unit.
- Biomethane production studied on a new waste water treatment plant to become operational in 2013.
- Study of the production of biomethane with the digestion of non-easy biodegradable sewage sludge generated by the Grimonpont waste water treatment plant. The new gas-powered bus depot in Wattrelos could be fed with this biomethane.

Contribution to the Biogasmax project

Biogasmax is an opportunity for Lille to conduct multiple important projects:
- Production of 4 million m³ of biomethane at the Organic Recovery Centre,
- Biomethane injection project in the gas grid (partnership with Gaz de France),
- Optimization of waterway transportation of waste (with Cadet International),
- Partial conversion to natural gas / biomethane from household waste collection vehicles,
- Compost feasibility study (by ADEME).
ConVoco, a research and consulting company experienced in issues of sustainable transport and energy, is responsible for the transfer of knowledge related to the advanced use of biogas. The experience of other demonstration sites within the Biogasmax project will be used with the long-term objective of introducing the full well-to-wheel approach in Poland.

The main activities within the project are:

• The transfer of knowledge related to organizational, legal, economical and technical issues concerning the full biogas cycle in transport from France, Sweden, Italy and Switzerland to Poland,
• Working towards the use of biogas in urban transport and therefore creating showcases in Poland,
• Promoting biogas as vehicle fuel in Poland, with a focus on Torun (Central Poland) and Zielona Góra (Western Poland),
• Raising awareness and stimulating discussions on biogas in transport at national and local levels,
• Creating pathways for further use of biogas as a vehicle fuel in this region of Europe,
• Provide training, seminars and workshops to raise awareness on biogas in urban transport.

In light of the rural nature of vast areas surrounding cities and the existence of the national gas grid, there is a potential for biogas to take over a considerable slice of the general energy coverage, including vehicle propulsion.

ConVoco, a research and consulting company experienced in issues of sustainable transport and energy, is responsible for the transfer of knowledge related to the advanced use of biogas. The experience of other demonstration sites within the Biogasmax project could be used to promote the use of biogas in transport.

In Poland, waste water plants and landfills still burn off most of the biogas in flare stacks. If biogas is retrieved, it is usually used to produce electric and thermal energy.

In order to exploit the potential of biogas production in Poland and to create pathways for its use in transport, ConVoco, Biogaz Inwestor and the University of Zielona Góra work together to:

• Estimate production potential and develop strategies for biogas production and use,
• Benchmark available production technologies,
• Promote plants dedicated to biomass production,
• Lobby for the improvement of the legal framework and the introduction of pricing incentives,
• Prepare the introduction of the full well-to-wheel biogas cycle.

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Rome
A sustainable strategy

Issues and choices

The Municipality of Rome strongly promotes the use of alternative fuels in public and private fleets to comply with environmental standards and requirements, save energy and reduce dependence on oil. Since the early 90s, AMA, the Environmental Municipal Agency of Rome responsible for the integrated cycle of waste collection, transport, recycling and disposal, has experimented with the use of biomethane in a few waste collection Heavy Duty Vehicles (HDVs).

The sole biogas provider in Rome is the landfill and biogas plant of Malagrotta, owned by a private company. Waste, processed and subsequently landfilled, produces a considerable amount of biogas used mostly to fuel Malagrotta’s own electric power plant and partly to provide upgraded biogas to AMA waste collection vehicles.

As Malagrotta will soon be saturated and in order to secure the supply of biogas, Rome has adopted as a strategic priority the investigation of different integrated forms of waste management, the organic fraction of waste definitively being a key area of interest. In particular, AMA has identified one of the in-house municipal waste treatment plants (located in Maccarese, presently producing compost) as a source to self-supply the in-house demand for biomethane.

When realized, this vision will effectively complete the full biogas life cycle. Rome is therefore interested in studying the possibility of exploiting a portion of organic waste (65,000 tons/year) in a new anaerobic plant for biogas production, estimated at 10,000,000 Nmc of raw biogas (including 1,800,000 Nmc of biomethane). It would be used for energy and also for automotive traction.

The Malagrotta plant only performed a limited sorting of waste, which in turn produced highly contaminated gas. The upgrading process was consequently rather costly and ultimately produced a biomethane which required AMA to perform considerable engine maintenance.

Nevertheless, the biomethane experience has yielded satisfactory results in terms of technical knowledge accrued, data on emissions, fuel quality, and operation and maintenance issues.

Previous experience

AMA initiated the biogas experiment with some 10 HDVs, which were progressively increased to reach the current total of 25. MECO closely followed this experience and provided AMA’s vehicles with engines that were adjusted over time for biomethane use. Throughout the 10 years of operations, the quality of biomethane has remained the main challenge.

The Malagrotta plant only performed a limited sorting of waste, which in turn produced highly contaminated gas. The upgrading process was consequently rather costly and ultimately produced a biomethane which required AMA to perform considerable engine maintenance.

To this end, the Organic Treatment Centre in Maccarese will operate as follows: the increased composting plant will use agricultural waste and selected organic waste (from hotels, restaurants, markets, cafeterias, etc.) to produce high quality compost; the new biogas plant will use organic waste from the household door-to-door selective collection, and the biomethane produced will mainly fuel vehicles circulating in neighborhoods close to the plant.

Territory vision

In order to ensure a balanced urban development and to minimize as much as possible the environmental impact caused by its activities (e.g. waste transport), AMA will envisage spatial integration of production and use in the existing plant, lay-out reallocation and the re-design of the waste collection services in accordance with logistic and technical problems related to biomethane/CNG captive fleet use.

Contribution to the Biogasmax project

The BIOGASMAX project represents a significant opportunity for Rome to gain access to updated information and start paving the way for the future expansion of biomethane production and use.

Rome also brings to the project specific characteristics that provide a good benchmark for the other demonstrations, mostly located in Northern countries. Namely:

- Mediterranean climatic conditions, with their adverse impact on biogas from the anaerobic plant;
- An extensive urban context, with related consequences in terms of waste collection, management and logistics issues.

Within the BIOGASMAX project, Rome will, in more detail:

- Compare the quality of biogas from the landfill site (Malagrotta) and a new anaerobic unit to be built in the Maccarese plant;
- Study the gas quality, process optimization, cost efficiency and emissions data that would result from different gas production and upgrading scenarios;
- Undertake procedures for the building of the production plant, the upgrading unit and the storage tank, according to the results provided by the research;
- Extend the existing biomethane/CNG waste collection fleet to include 55 additional HDVs (as part of a broader AMA clean vehicles strategy).
During Biogasmax, one overall objective is to create one interconnected regional biomethane market in eastern Sweden.

To be able to produce more biomethane, Stockholm needs sources other than the City’s own municipal wastewater sludge. The municipality-owned company, Stockholm Water, currently produces biomethane for Stockholm. Initially, the company will optimize production. This will be done in cooperation with Svensk Biogas. New sources for production can be provided by the agriculture sector. By using a mix of sludge, waste and crops, more gas can be produced. The Växtkraft company in Västerås has already attempted to mix feedstock and has achieved good results. This demonstration will serve as a basis for a regional scenario to be developed during the project.

A subproject, the Biogas Highway, has been designed. The Biogas Highway project aims at building biomethane filling stations in connection with highways E18 and E20. The purpose is to facilitate the use of biomethane vehicles between the western and eastern parts of Sweden. AGA Gas and Fordonsgas will finance the Biogas Highway, which will be completed in 2007.

### Contribution to the Biogasmax project

This is the only city in the project lacking pipeline supply of natural gas. Liquefied Natural Gas, LNG, is only used as a back-up. Stockholm therefore has a high profile gas fuel in terms of the reduction of greenhouse gases, but also higher vulnerability to disturbances in gas supply.

### Actions in Stockholm within Biogasmax include:

- Initiating cooperation to involve local producers in a regional biomethane market,
- Optimizing production and the introduction of new feedstock,
- Building new fueling stations, e.g. along highways,
- Expanding the use of biomethane vehicles in private as well as public companies,
- Testing and evaluating strategies and incentives to expand the use of clean vehicles and fuels,
- Developing targeted communication actions to promote the market breakthrough.
Biogasmax partners

Urban Community of Lille (FR)
Business Region Göteborg (SE)
Göteborg Energi (SE)
City of Stockholm (SE)
University of Stuttgart, LBP (DE)
European Natural Gas Vehicle Association
Institut für Solare Energieversorgungstechnik eV, ISET (DE)
TNO (NL)
Transport & Travel Research (UK)
Gaz de France (FR)
Nova Energie (CH)
ADEME (FR)
Esterra (FR)

Cadet International (FR)
City of Falköping (SE)
Fordonsgas Sverige (SE)
Stockholm Water Company (SE)
AGA Gas AB (SE)
Svensk Växkraft AB (SE)
Svensk Biogas AB (SE)
Azienda Municipale Ambiente, AMA (IT)
Istituto di Studi per l’Integrazione dei Sistemi, ISIS (IT)
University of Zielona Góra (PL)
Biogaz Inwestor (PL)
ConVoco (PL)
« Human beings are at the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature »

Rio Declaration, 1992