



LIFE Project Number

**LIFE03 ENV/GR/205**

**TECHNICAL FINAL REPORT**

Reporting period: 1.12.2003 – 31.8.2006

Reporting Date

**30/11/2006**

LIFE PROJECT NAME

**Promotion and implementation of systems for the  
production of high quality compost from biodegradable  
household waste separated at source**

**Data Project**

<b>Project location</b>	Municipalities of: Kifissia, Acharnes, Nea Halkidona, Attica, Greece
<b>Project start date:</b>	01/12/2003
<b>Project end date:</b>	28/02/2006 (approved extension to 31/08/2006)
<b>Total Project duration (in months)</b>	27 months (33 months after approved extension for 6 months)
<b>Total budget</b>	1.131.470€
<b>EC contribution:</b>	565.735 €
<b>(%) of total costs</b>	50
<b>(%) of eligible costs</b>	50

**Data Beneficiary**

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## 1. List of Contents

2. List of i. key-words and ii. abbreviations	3
3. Executive Summary	4
4. Introduction	8
5. LIFE-project framework	10
6. Description of the applied technology	19
7. Technical progress, results and deliverables	26
8. Dissemination activities and deliverables	46
9. Evaluation and Conclusions	53
10. After – LIFE communication plan	64
11. Actual project realisation against the baseline implementation plan	65
12. Comments on financial report	65
13. Appendices Deliverable C.2: Analytical design of the prototype system Deliverable F.1: Recording and solving of problems that were arisen during the pilot application of the program Deliverable F.2: Methodology and results for the evaluation of the household composting process and the quality of the compost that was produced during the pilot application of the program Deliverable F.3: Development of guidelines for the implementation of the program at large scale/ Preliminary cost – benefit analysis Deliverable F.4: Report on site visits to Austria Deliverable H.1: Information on meetings among the partners (managerial meetings) Layman’s Report in English Layman’s Report in Greek	67

**2. List of i. key-words and ii. abbreviations**

**i.** Key words: biodegradable household waste, compost, home composting, collection and composting at source, waste management, environment, Attica region, Greece.

**ii.** Abbreviations:

NTUA: National Technical University of Athens

UEST: Unit of Environmental Science and Technology

EU: European Union

EC: European Commission

ME: Ministry of Environment, Regional Planning and Public Works

ACMAR: Association of Communities and Municipalities of the Attica Region

ALAGT: Association of Local Authorities of Greater Thessaloniki Area

ERS: Ecological Recycling Society

### **3. Executive Summary**

The LIFE project: “COMWASTE – Promotion and implementation of systems for the production of high quality compost from biodegradable household waste separated at source - LIFE03 ENV/GR/205” deals with the use of an specifically designed and constructed prototype system at pilot scale application, in order to demonstrate and document the feasibility of the simultaneous separate collection and composting of the household biodegradable organic waste at source. The beneficiary/coordinator of the project is the National Technical University of Athens (NTUA) while the Municipalities of Kifissia, Acharnes and Nea Halkidona of Attica Region are the partners of the project. This is the first attempt in Greece to establish such a system for simultaneous separation /composting at source and it will be the basis for full – scale introduction in other Municipalities and Communities in the country and EU. The design and development of the new prototype system includes all state – of – the – art notions and ideas with respect to technological and scientific aspects.

The final technical report presents initially an introduction to the subject of the project (composting of biodegradable organic waste in general, and composting of household organic waste after separate collection at source, in specific). Then, the COMWASTE project framework is presented. The project consists of eight tasks, six of which are related to its technical development, one task refers to the dissemination/training activities and one task includes all managerial and coordinating activities.

In addition, the technology that was developed and applied through the project is described analytically, In particular, the methodology and the procedures that were applied for the implementation of the project, the means that were used for carrying out the technical activities of the project as well as analytical description of the features and the operation of the innovative prototype household composting system are given.

Moreover, the technical progress of the project is presented and evaluated in detail, and the results that were obtained are given. The technical development of the project included the following individual steps:

- A complete recording and analysis of the legislative European and national framework related to the management of solid waste
- Determination and assessment of the quantitative and qualitative characteristics of the household waste generated in the Attica region in general, and in the three Municipalities – partners specifically
- Recording and assessment of the existing practices, systems and plants applied for the management of household waste in the Attica region
- Identification, recording and assessment of the special characteristics and habits of the households in the Attica region. The result was the acquirement of a clear and representative picture of the existing conditions that prevail in the households in the area under study in order to design and develop an innovative system for the simultaneous separate collection/composting of the biodegradable waste at the source that would be tailored to the special characteristics and needs of the people that would be selected to participate in the pilot application.
- Recording, extensive analysis and assessment of success stories (management schemes and plants) that focus on the collection and utilization of the organic fraction of waste at source. In particular, all the programs and systems (pilot and large scale applications), as well as their technical details were recorded, aiming at the acquisition of a complete and up-to-date picture with regard to their application (problems that are faced during the implementation, ways of

elimination of these problems, conditions of application, degree of participation of the citizens, results from their application etc.).

- Recording of the available composting systems (compost bins) that are used for the utilization of the biodegradable organic fraction of waste at source were recorded. In particular, an analytical description of the operation of these systems as well as of their technical characteristics/features was carried out, with the aim to obtain a representative and complete view concerning their use (advantages and disadvantages, conditions and restrictions of application, quality of product, categories of solid waste that can be treated, treatment time period, operation mode, etc.).
- Once the extensive analysis of all applied systems and techniques related to composting in household was completed, an evaluation was carried out aiming to determine the most suitable and efficient systems (33 systems were evaluated). The evaluation of the systems was carried out via the development and application of a multi-criteria method of analysis which was based on a wide range of criteria that were numerically weighed (weighting factors) according to their importance (degree of importance). Through the analysis of the results obtained from the comparative evaluation via the multi-criteria method, conclusions were drawn concerning the effectiveness of the available systems. These conclusions were used as a preliminary basis for the development of the proposed system.
- Then the prototype household composting system was designed, developed, tested and manufactured taking into account:
  - The lab testing of the operation and the efficiency of three alternative household composting systems that are available in the market
  - The experience of the working group of the NTUA in the composting process
  - The results from the thorough lab testing of the performance of the individual components of the prototype system
  - The results of the re-examination of the functions of the prototype system, as a whole, in order to make sure that the required performance has been achieved
- Afterwards, 100 pieces of the prototype system with high operational functions and high performance were manufactured. 90 composting systems were installed in the 90 selected households (30 in each Municipality). Also 8 more systems were installed in the households of 8 members of the NTUA scientific team and 2 systems were installed in the Laboratory of Environmental Science and Technology of NTUA. The installation of the systems at the household was carried out by the members of the NTUA working group in collaboration with the members of the working groups of the three Municipalities/partners. The householders were provided with the prototype system as well as with additives that are used for the best development of the process and the for the improvement of the quality of the end-product. These extra materials were zeolite (Greek clinoptilolite, mature compost and sawdust.
- Specially organized training modules (for the representatives of the Municipalities and the participating households) have taken place in order to assist people in separating/composting the biodegradable waste at home. For this purpose:
  - Special training modules were organized by the three partners where, where members of the working group of the NTUA explain in details, the functions and the use of the prototype system. These training modules took place at the premises of the three Municipalities (three modules of 8-12 householders were held in each Municipality). Special adhesive informative material was prepared by

NTUA and distributed to the householders that are participating in the individual training modules.

- Printed material was prepared by NTUA and distributed in collaboration with the three Municipalities/partners to the participants of the three workshops–awareness events that took place in the three Municipalities. This material contains information about the composting procedure, the prototype system and the program in general.

- Additional training was given by the working group of NTUA and the partners, to the householders during the implementation phase (installation of the prototype system at each household). The members of the beneficiary explained analytically the use of the system and demonstrated its operation to the householders in practice (training of the householders on site).

- The implementation of the programme lasted for a sufficient time in order that the householders become familiar with the activity of the separation and composting of the biodegradable waste at their households and consider it as a daily common practice. The householders separated and composted the biodegradable waste as trained, using the prototype equipment with which they have been provided. The working groups of the NTUA and the partners were in constant communication with the householders participating in the program (visits at the selected households on a regular basis, frequent phone communication, at least once a week) in order to overcome potential difficulties and malfunctions. In addition, the householders were provided with a telephone number, where they could get all required information by the working group of NTUA. Further explanations and directions were given to some householders at the beginning, when the system was installed. Also, in few cases, additional instructions were given to some householders during the operation of the system in order to improve the performance of the system (e.g. elimination of the odors). Overall, the implementation of the program ran smoothly and the cooperation of the householders with the members of the individual working groups was continuous and efficient.
- Additionally, appropriate questionnaire (a clear and easy to be filled in form) was developed and distributed to the householders that participated in the implementation of the program in order to complete it regularly with their observations about the operation of the system. Also, during the visits that took place by the working groups to the households, additional observations and comments were recorded, after interviews that were contacted with the householders.
- Moreover, compost samples from all the participated households as well as from the composting systems that operated at the premises of the NTUA were collected and analysed properly at the lab of the NTUA in order to determine the quantitative and qualitative characteristics of the product and assess its quality level.
- Then, the implementation of the program was evaluated through:
  - i. the analysis and the assessment of the content of the filled in questionnaires that were distributed to the householders as well as though the observations and remarks obtained by the working groups during their visits to the households.
  - ii. the analysis and the evaluation of the results that were obtained by carrying out appropriate measurements and analyses for the determination of the qualitative and quantitative characteristics of the compost samples that were taken during the implementation of the program

iii. identification of the problems that arisen during the implementation of the program (problems related to the interest of the people involved, to the time needed for the development of the composting process, use of the system according to the instructions that were given to the householders etc.) and presentation of the solutions that were provided in order to overcome these problems.

According to the content of the questionnaires, some problems were determined mainly during the first stages of the implementation program (first composting cycle) due to the fact that the householders were not fully familiar with the use of the prototype composting system. The direct and on time response of the members of the working groups in combination with the high level of collaboration of the householders led to the quick and efficient elimination of each problem.

Also, the individual and the overall results of the laboratory analyses of the compost indicated that the compost is of a high quality level (as it was confirmed by the values of the quantitative and qualitative characteristics and the non presence of phytotoxicity) and it fulfills the legislative quality standards for its safe use.

- Finally, a framework of guidelines and specifications were developed for the implementation of the program in larger scale and potential incentives that may promote its successful implementation were given. Also, a preliminary cost-benefit analysis was carried out, through which, the viability of the implementation of the program in large scale is ascertained. In particular: i. all the examined alternative scenarios are viable, ii. the viability of all the alternative scenarios provides the Local Authorities with the ability to select the management scheme that fits better to their needs, iii. for all the alternative management schemes, the potential benefit increases in correspondence with served population. Nevertheless, the Municipalities with low population as well as the Communities also benefit from the application of the household composting system, improving their economic balance, iv. for Municipalities with relative high population (e.g Municipality of Acharnes) the application of the system is still viable even in the cases when the biodegradable household waste fraction is not diverted completely from the mixed municipal waste (the citizens do not separate at source the entire quantity of this waste stream)

In addition, details on the site visits that were carried out for the purposes of the project are provided.

Furthermore, analytical information related to the dissemination and training activities that were implemented as well as their output are presented.

Specific focus is given to the overall evaluation of the project as well as on the conclusions obtained through its implementation. The main parameters from this evaluation are presented synoptically, below:

- The technical development of the project (six technical tasks) was carried out successfully and in accordance to the proposal of the project, qualitatively and quantitatively. All the individual targets that were set per task were achieved and the outcomes and the deliverables, that were foreseen in the proposal, were obtained adequately.
- Concerning the management of the project, everything proceeded smoothly and the collaboration between the NTUA (Beneficiary) and the three Municipalities

(partners) was efficient and productive. The project was developed according to the initial proposal and no modifications (technical, financial, project – organisation) were made.

- The reproducibility and the application of the prototype system in large scale is well – documented.
- A significant number of benefits are obtained via the implementation of the project (direct/quantitative environmental benefits, positive impacts on environmentally significant issues or policy areas, long-term/qualitative environmental benefits, long-term sustainability, long-term/qualitative economic benefits, long-term/qualitative social benefits) which are point out in the report.
- The outcome of the project has a great impact to all the actors involved in the field of the generation and management of the household solid waste
- The content and the outcome of the COMWASTE project are characterized by a high level of innovation at national and international level

In addition, the after-LIFE plan to continue and expand the dissemination and the communication of the results and the outcome of the COMWASTE project via the development of several actions is described, analytically.

Finally, the actual project realization against the baseline implementation plan is given in the form of a Gantt – chart, while comments on the costs that were incurred through the project are provided.

#### **4. Introduction**

The successful diversion of biodegradable organic waste from landfill relies on the separation of this waste stream at the source. Whilst the biodegradable organic fraction can be extracted from mixed waste, this is laborious and tedious and in many cases leads to the recovery of biodegradable organic material of a low quality (due to the presence of impurities). Separation at source offers the opportunity of a high quality clean feedstock for composting and the prospect of an uncontaminated product. A clean waste collected via separate collection at source is more likely to meet compost quality standards and be suitable for use, leading to environmental benefits. Separation of biodegradable waste at source also facilitates the promotion of home composting or composting within local communities or development of central composting systems for more communities. This management route has two major advantages: i. the environmental impacts of transport and handling of organic waste are avoided ii. the compost product could be used by the householders, realizing environmental benefits from the substitution of the use of other market products (e.g. synthetic fertilizers). Additionally, separating their own waste stream will raise the awareness of householders regarding waste generation and help develop a sense of responsibility for their waste.

More generally, composting as a technology is adaptable and suitable for treating wastes in a variety of socio-economic and geographical locations. Despite the range of treatment technologies from simple/conventional home composting schemes to centralized systems, both the technology and the associated collection systems can be implemented relatively simply and inexpensively. The most important barriers to composting household waste are: i. to achieve suitable separation of organic waste ii. to match demand with supply of compost in a competitive market iii. to ensure appropriate quality and health standards for compost.

Through the COMWASTE project, all the aforementioned issues are confronted by developing and implementing an innovative system for the composting of the separately collected organic household waste (kitchen waste) at the source and utilising for the production of a stabilised useful end product. This system was implemented at three



Municipalities of the Attica Region of Greece (Municipality of Acharnes, Kifissia and Nea Halkidona). It is characterised by flexibility, convenience in use and capability to treat small quantities of waste in a short time period, at households. The specific means for the design, construction and operation of the system were set after thorough examination of all the alternative available technologies/systems, by performing laboratory research and experiments and according to the needs and characteristics of the households under concern.

This is the first attempt in Greece to establish such system for simultaneous separation /composting at source and it will be the basis for full – scale introduction in other Municipalities and Communities in the country and EU. The design and development of the new prototype system includes all state – of – the – art notions and ideas with respect to technological and scientific aspects.

In particular, the actions and means involved for the development of the project were:

- **Recording and assessment of data concerning** i. European and national legislative framework covering biodegradable household waste ii. qualitative and quantitative characteristics of the household waste in Attica Region iii. management practices and systems implemented in the area under examination iv. special characteristics/habits of households in the three Municipalities that participated in the project.
- **Identification and analysis of success stories** concerning best practices on separate collection and composting at source and alternative technologies/systems
- **Design and development of the prototype system** taking into account the existing state-of-the-art technologies, the characteristics and special needs of the households involved as well as the results of an extensive lab work that was developed specifically for this purpose.
- **Organization of the implementation of the programme** through i. information campaign to the public ii. selection of target households iii. construction and thorough testing of the prototype system iv. installation of the system at the households, v. training of people involved with the use of the system, on its use vi. identification of the potential applications and further use of the stabilised product
- **Implementation of the programme and organisation of raising awareness events**
- **Evaluation of the results obtained from the implementation of the program – Suggestions for full scale introduction of the system**, through:  
i. evaluation of the participation level of the people involved ii. evaluation of the quantitative and qualitative characteristics of the compost produced at households iii. identification of the problems arising during the implementation iv. identification of potential incentives that may promote the successful implementation of the system v. development of guidelines and specifications for the implementation of the program on a larger scale v. carrying out of a preliminary cost-benefit analysis for the full scale implementation of the program (examination of its viability).
- **Dissemination of the project content, progress and results**
- **Management of the project and reporting to the EC**

The main expected results – objectives from the implementation of the project are:

- The residents of the participating Municipalities: i. possess a high level of environmental awareness and a sense of responsibility for their waste ii. were trained on the separate collection and composting of organic wastes
- The overall household waste quantity that must be transferred to landfill sites will be decreased
- The environmental impacts and cost of waste transport and handling will be minimised
- The waste recovery, recycling and reuse are promoted
- The principles of waste prevention and minimisation are enhanced
- The problem of finding markets for the stabilised product will be solved, (the end-product is uncontaminated since a high quality “clean” feedstock is used for composting)
- The project serves as a pilot for introducing the scheme on a larger scale, since it is characterised by high reproduction potential and demonstrative character.

## **5. LIFE-project framework**

The COMWASTE project consists of eight tasks. Six tasks are related to the technical development of the project, one task refers to the dissemination/training activities and finally one task includes all managerial and coordinating activities. The duration of the project was 33 months, after approved extension for 6 months that was given by the EC.

In particular:

### **Task 1: Assessment of the Existing Situation**

This task consists of four subtasks:

**Subtask 1.1:** Analysis of the European and National Legislative Framework related to the biodegradable household waste so as to obtain a clear picture of the requirements, the activities, the actions and the constraints that are related to this field.

**Subtask 1.2:** Determination and assessment of quantitative and qualitative data of the biodegradable household waste in Attica region.

**Subtask 1.3:** Identification and evaluation of the existing practices, systems and plants for the management of household waste in the Attica region, which is the area under examination.

**Subtask 1.4:** Identification and assessment of the specific characteristics and habits of households in the Attica region and especially in the three Municipalities that participate in the project.

### **Task 2: Identification and analysis of success stories in relation to the management of biodegradable household waste at source**

This task consists of two subtasks:

**Subtask 2.1:** Analysis of success stories on separate collection and composting at source.

**Subtask 2.2:** Evaluation of the alternative technologies used and the systems related to the management of biodegradable household waste applied at European level.

### **Task 3: Design and development of an appropriate prototype system for the collection and composting at source**

This task consists of two subtasks:

**Subtask 3.1:** Design of the appropriate prototype system for the simultaneous collection/composting at the source, after thorough examination of all the alternative

state-of-the-art technologies and according to the needs and characteristics of the households under concern

**Subtask 3.2:** Development of the prototype system (technical characteristics and specifications)

#### **Task 4: Organization of the implementation of the programme**

Task 4 consists of five subtasks:

**Subtask 4.1:** Development of an information campaign in the Municipalities under concern.

**Subtask 4.2:** Selection of the households that will participate in the programme.

**Subtask 4.3:** Construction and testing of the system

**Subtask 4.4:** Installation of the system in the selected households

**Subtask 4.5:** Training of the people involved on the use of the system according to its operational and technical specifications

#### **Task 5: Implementation of the Programme**

This Task includes the following:

**Subtask 5.1:** Implementation of the programme for a sufficient length of time in order that both the householders and the representatives of the Municipalities become familiar with the activity of the separation and composting of the biodegradable household waste and consider it as a daily common practice. The householders separate and compost the biodegradable waste as trained in Subtask 4.5, using the prototype equipment with which they were provided. Also, compost samples are taken and analysed in order to determine its quality characteristics and its suitability for use.

**Subtask 5.2:** Organisation of raising awareness events

#### **Task 6: Evaluation of the results from the implementation of the programme/Suggestions for full - scale introduction of the system**

Task 6 consists of four individual subtasks:

**Subtask 6.1:** Evaluation of the participation of the people involved as well as the quantitative and qualitative characteristics of the product

**Subtask 6.2:** Identification and analysis of problems encountered during the implementation – Development of solutions in order to overcome the problems encountered

**Subtask 6.3:** Identification of the potential incentives that may promote the successful implementation of the system

**Subtask 6.4:** Development of guidelines and technical specifications for the implementation of the program on a larger scale

#### **Task 7: Dissemination of the project results**

This task runs continuously during the whole period of the development of the project. It includes the dissemination of the results of the project, as well as the training activities.

#### **Task 8: Management and reporting to the European Commission**

This task covers the whole time period of the project and includes (a) the effective management of the project and fulfilment of the activities included, on time (Subtask 8.1) and (b) the preparation and submission of reports to the EC (progress reports, interim and final technical and financial reports) (Subtask 8.2).

The Beneficiary and coordinator of the project is the NTUA, while Anaptyxiaki Kifissias, Municipality of Acharnes and Municipality of Nea Halkidona are the partners of the project. NTUA is the scientific responsible for all the Tasks concerning the technical development of the project (Tasks 1 – 6) as well as being responsible for the Dissemination/Training and Management Tasks (Task 7 and 8, respectively). The three partners are involved in all Tasks while their main contribution is concentrated on Subtask 1.2 (Determination and assessment of the quantitative and qualitative characteristics of the household waste in Attica Region), Subtask 1.3 (Identification and evaluation of the existing urban waste management practices in Attica Region), Subtask 1.4 (Identification and assessment of the special characteristics of the households in the three Municipalities), Task 4 (Organisation of the implementation program) Task 5 (Implementation of the program), Subtask 6.1 (Evaluation of the participation of the people involved in the pilot program) Subtask 6.2 (Identification and analysis of problems encountered during the implementation – Development of solutions), Subtask 6.4 (Development of guidelines for the implementation of the programme on a larger scale), Task 7 (Dissemination and training activities) and Task 8 (Management).

In the following Tables, analytical information is given related to the role and the responsibilities of the personnel of the beneficiary and the partner that participated in the implementation of the project.

#### NTUA

Name	Role and responsibilities
M. Loizidou	Coordination of the activities of all Tasks – Supervision of their implementation – Scientific and managerial responsible of the project – Overall coordinator of the project
K. Haralambous	<p>Analyzed the legislative material with regard to the management of solid waste, assessed the data concerning household waste generation and management practices in the Municipalities and Communities of the Attica Region, supervised the analyses and measurements carried out for the characterization of the household waste generated in the three Municipalities as well as the procedures for the distribution of the questionnaire to the householders of the three Municipalities.</p> <p>Analysed and evaluated the data concerning success stories and best practices in the field of separate collection and composting of organic waste at source, which collected by the other members of the working group.</p> <p>Analysed and evaluated the collected data concerning alternative systems for separate collection and composting of waste at source, developed the multi-criteria analysis method, set the groups of criteria and weight factors per criterion, applied the multi-criteria analysis and evaluated the results. Also, developed the guidelines for the design of the system according to the results of the analysis</p> <p>Involved in the preparation of material for the information campaign, the selection of the households that participate in the programme and the preparation of training printed material.</p> <p>Supervised the activities concerning the lab testing of the system and participated in the training courses. Participated in the dissemination activities of the project.</p> <p>Participated in the implementation of the pilot program – Supervised the 9 working groups that were established for the pilot implementation in the three Municipalities – Evaluated of the implementation of the pilot program – Supervised the lab analyses of the household compost – Participated in the development of the guidelines for the large scale application of the program.</p> <p>Participated in the management activities – Preparation of reports</p>

A. Papadopoulos	<p>Analyzed the legislative material with regard to the management of solid waste, assessed the data concerning household waste generation and management practices in the Municipalities and Communities of the Attica Region, supervised the analyses and measurements carried out for the characterization of the household waste generated in the three Municipalities and developed as well as the procedures for the distribution of the questionnaire to the householders of the three Municipalities.</p> <p>Collected, through primary recording, the data concerning success stories and best practices in the field of separate collection and composting of organic waste at source, analysed and evaluated the collected data.</p> <p>Analysed and evaluated the collected data concerning alternative systems for separate collection and composting of waste at source, developed the multi-criteria analysis method, set the groups of criteria and weight factors per criterion, applied the multi-criteria analysis and evaluated the results. He developed the guidelines for the design of the system according to the results of the analysis</p> <p>Involved in the preparation of material for the information campaign, the selection of the households that participate in the programme and the preparation of training printed material.</p> <p>Supervised the activities concerning the lab testing of the system.</p> <p>Participated in the dissemination and training activities of the project.</p> <p>Participated in the implementation of the pilot program – Supervised the 9 working groups that were established for the pilot implementation in the three Municipalities – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost – Participated in the development of the guidelines for the large scale application of the program as well as in the development of the preliminary cost-benefit analysis.</p> <p>Participated in the management activities – Preparation of reports</p>
K. Moustakas	<p>Collected the necessary data concerning the European and national legislative framework with regard to the management of solid waste as well as the primary data concerning household waste generation and management in the Municipalities and Communities of the Attica Region.</p> <p>Participated in carrying out of the lab analyses and measurements for the characterization of the household waste generated in the three Municipalities and in the distribution of the questionnaire and had contacts with the householders.</p> <p>Collected, through primary recording, the data concerning success stories and best practices in the field of separate collection and composting of organic waste at source, analysed and evaluated the collected data.</p> <p>Collected primary data concerning alternative systems for separate collection and composting of waste at the source and participated in the development and application of the multi-criteria analysis.</p> <p>Involved in the preparation of material for the information campaign and the training courses as well as in the lab testing of the system.</p> <p>Participated in the dissemination activities of the project and prepared informative material.</p> <p>Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost – Participated in the development of the guidelines for the large scale application of the program as well as in the development of the preliminary cost-benefit analysis.</p> <p>Participation in the management activities – Preparation of reports</p>
S. Liappa	<p>Collected the necessary data concerning the European and national legislative framework with regard to the management of solid waste.</p> <p>Participated in the collection of the primary data concerning household waste generation and management in the Municipalities and Communities of the Attica Region.</p> <p>Participated in carrying out of the lab analyses and measurements for the characterization of the household waste generated in the three Municipalities, distributed the questionnaire and had contacts with the householders.</p> <p>Collected, through primary recording, data concerning success stories and best practices in the field of separate collection and composting of organic waste at the source</p> <p>Collected primary data concerning alternative systems for separate collection and composting of waste at the source and participated in the development and application of the multi-criteria analysis.</p>

D. Vassilakopoulos	<p>Collected the necessary data concerning the European and national legislative framework with regard to the management of solid waste.</p> <p>Participated in the collection of the primary data concerning household waste generation and management in the Municipalities and Communities of the Attica Region as well as in carrying out of the lab analyses and measurements for the characterization of the household waste generated in the three Municipalities.</p> <p>Distributed the questionnaire and had contacts with the householders.</p> <p>Collected, through primary recording, data concerning success stories and best practices in the field of separate collection and composting of organic waste at the source</p> <p>Collected primary data concerning alternative systems for separate collection and composting of waste at the source and participated in the development and application of the multi-criteria analysis.</p>
E. Doulami	<p>Collected the necessary data concerning the European and national legislative framework with regard to the management of solid waste.</p> <p>Participated in the collection of the primary data concerning household waste generation and management in the Municipalities and Communities of the Attica Region.</p> <p>Participated in carrying out of the lab analyses and measurements for the characterization of the household waste generated in the three Municipalities.</p> <p>Distributed the questionnaire and had contacts with the householders.</p> <p>Collected, through primary recording, the data concerning success stories and best practices in the field of separate collection and composting of organic waste at source.</p> <p>Collected primary data concerning alternative systems for separate collection and composting of waste at the source and participated in the development and application of the multi-criteria analysis.</p> <p>Participation in the preparation of training printed material, in the lab tasting of the system as well as in the training courses</p> <p>Participated in the dissemination and training activities of the project, prepared and distributed informative material and participated in the development of the project website.</p> <p>Participated in the implementation of the pilot program - Carried out of lab analyses of the household compost – Participated in the development of the guidelines for the large scale application of the program.</p>
E. Poulla	<p>Collected the necessary data concerning the European and national legislative framework with regard to the management of solid waste. Participated in the collection of the primary data concerning household waste generation and management in the Municipalities and Communities of the Attica Region. Participated in carrying out of the lab analyses and measurements for the characterization of the household waste generated in the three Municipalities, distributed the questionnaire and had contacts with the householders.</p> <p>Participated in the preparation of training printed material and in the lab tasting of the system.</p> <p>Participated in the implementation of the pilot program - Carried out of lab analyses of the household compost</p>
I. Glekas	<p>Collected data concerning the European and national legislative framework with regard to the management of solid waste as well as the primary data concerning household waste generation and management in the Municipalities and Communities of the Attica Region. Participated in carrying out of the lab analyses and measurements for the characterization of the household waste generated in the three Municipalities. Distributed the questionnaire and had contacts with the householders.</p> <p>Collected, through primary recording, the data concerning success stories and best practices in the field of separate collection and composting of organic waste at source, analysed and evaluated the collected data.</p> <p>Participated in the dissemination activities of the project, in the design and lab tasting of the system – Participation in the preparation of the reports.</p>

D. Glekas	<p>Collected the necessary data concerning the European and national legislative framework with regard to the management of solid waste as well as the primary data concerning household waste generation and management in the Municipalities and Communities of the Attica Region. Participated in carrying out of the lab analyses and measurements for the characterization of the household waste generated in the three Municipalities, distributed the questionnaire and had contacts with the householders.</p> <p>Collected, through primary recording, the data concerning success stories and best practices in the field of separate collection and composting of organic waste at source, analysed and evaluated the collected data.</p> <p>Participated in the dissemination activities of the project, in the design and lab tasting of the system. Participation in the preparation of the reports</p>
C. Michalopoulos	<p>Collected data concerning the legislative framework with regard to the management of solid waste, household waste generation and management practices in the Attica Region. Collected, through primary recording, data concerning success stories and best practices in the field of separate collection and composting of organic waste at the source.</p> <p>Involved in the design of the system, in the lab testing of the system and participated in the training courses.</p> <p>Participated in the implementation of the pilot program - Carried out of lab analyses of the household compost</p>
K. Loizou	<p>Collected data concerning the legislative framework with regard to the management of solid waste, household waste generation and management practices in the Attica Region</p> <p>Collected, through primary recording, the data concerning success stories and best practices in the field of separate collection and composting of organic waste at source, analysed and evaluated the collected data.</p> <p>Involved in the design as well as in the lab testing of the system</p>
E. Salta	Participated in the preparation and distribution of the questionnaire and they have contacts with the householders
A. Sgourovassilaki	<p>Participated in the preparation and distribution of the questionnaire and they have contacts with the householders.</p> <p>Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost</p>
M. Naoum	<p>Collected, through primary recording, the data concerning success stories and best practices in the field of separate collection and composting of organic waste at source, analysed and evaluated the collected data.</p> <p>Participated in the disseminating activities of the project, in the preparation and distribution of informative material.</p>
A. Lekkas	<p>Collected, through primary recording, the data concerning success stories and best practices in the field of separate collection and composting of organic waste at source, analysed and evaluated the collected data.</p> <p>Involved in the development and application of the multi-criteria analysis</p> <p>Participated in the implementation of the pilot program - Carried out of lab analyses of the household compost</p>
B. Kanouta	<p>Collected primary data concerning alternative systems for separate collection and composting of waste at the source and participated in the development and application of the multi-criteria analysis.</p> <p>Participated in the preparation of training printed material and in the lab tasting of the system.</p>
A. Mentzis	<p>Participated in the collection of data concerning alternative systems, the development and application of the multi criteria analysis, as well as in the design and testing of the system. Participated in the preparation of the reports.</p> <p>Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost – Participated in the development of the guidelines for the large scale application of the program as well as in the development of the preliminary cost-benefit analysis.</p>

E. Mantzourani	Participated in the collection of primary data concerning alternative systems for separate collection and composting of waste at source. Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost – Participated in the development of the guidelines for the large scale application of the program as well as in the development of the preliminary cost-benefit analysis.
D. Farmakis	Participated in the collection of primary data concerning alternative systems for separate collection and composting of waste at source. Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost – Participated in the development of the guidelines for the large scale application of the program as well as in the development of the preliminary cost-benefit analysis.
F. Kourmoussis	Involved in the preparation of material for the information campaign and the training courses as well as in the lab testing of the system. Participated in the dissemination activities of the project in the preparation and distribution of informative material and in the development of the project website.
P. Karlis	Participation in the preparation of training printed material, in the lab tasting of the system as well as in the training courses. Participated in the dissemination activities of the project in the preparation and distribution of informative material and in the development of the project website.
N. Naoum	Participated in the dissemination and training activities of the project as well as in the preparation and distribution of informative material.
S. Malamis	Participated in the dissemination and training activities of the project. Also, participated in the preparation and distribution of informative material and in the updating of the project website. Participated in the preparation of the reports. Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost – Participated in the development of the guidelines for the large scale application of the program as well as in the development of the preliminary cost-benefit analysis.
A. Kokkalis	Participated in the pilot implementation of the program
N. Diamantis	Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost
D. Malamis	Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost
K. Naoum	Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost
G. Xydis	Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost
M. Stylianos	Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost
K. Xapeshis	Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost
V. Inglezakis	Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost
E. Sgourou	Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost
M. Margaritis	Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost



D. Poulla	Participated in the implementation of the pilot program – Evaluated of the implementation of the pilot program – Carried out of lab analyses of the household compost
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### **Municipality of Nea Halkidona**

V. Papaeuthimiou I. Lardis	<p>Visited the households in the Municipality, had interviews with the householders and distributed and filled in the questionnaires</p> <p>Provided suggestions and opinions concerning the special characteristics of the prototype system (collaboration with the working group of NTUA and the other two partners).</p> <p>Responsible for the organisation and implementation of the information campaign in their Municipality, the selection of households in their Municipality, the arrangements for the installation of the prototype system in the selected households as well as for the organisation of the training courses</p> <p>Supervised the procedures for the installation of the systems at the households</p> <p>Participated in the implementation of the pilot program at their Municipality --</p> <p>Supervised the working group of their Municipality that was established for the pilot application – Participated in the evaluation of the pilot program.</p> <p>Coordination of the activities carried out by their Municipality</p>
E. Litsa A. Kokolatou G. Gaitanos E. Kolovou A. Tsiantis S. Galanopoulou A. Ntegiannakis P. Leutakis	<p>Visited the households in the Municipality, had interviews with the householders and distributed and filled in the questionnaires</p> <p>Provided suggestions and opinions concerning the special characteristics of the prototype system (collaboration with the working group of NTUA and the other two partners).</p> <p>Participated in the organisation and implementation of the information campaign in their Municipality, the selection of households in their Municipality, the arrangements for the installation of the prototype system in the selected households as well as in the organisation of the training courses</p> <p>Distributed of informative material to the citizens of their Municipality and other Municipalities in the Attica Region.</p> <p>Participated in the procedures for the installation of the systems at the households</p> <p>Participated in the implementation of the pilot program at their Municipality --</p> <p>Collected of compost samples that were transferred to the lab for chemical analyses.</p> <p>Also, Mr Leutakis participated in the development of the preliminary cost – benefit analysis for his Municipality.</p>

### **Municipality of Acharnes**

I. Kada E. Avramidou A. Katara	<p>Visited the households in their Municipality, had interviews with the householders and distributed and filled in the questionnaires</p> <p>Provided suggestions and opinions concerning the special characteristics of the prototype system (collaboration with the working group of NTUA and the other two partners).</p> <p>Responsible for the organisation and implementation of the information campaign in their Municipality, the selection of households in their Municipality, the arrangements for the installation of the prototype system in the selected households as well as for the organisation of the training courses.</p> <p>Supervised the procedures for the installation of the systems at the households</p> <p>Participated in the implementation of the pilot program at their Municipality --</p> <p>Supervised the working group of their Municipality that was established for the pilot application. Participated in the evaluation of the pilot program.</p> <p>Coordination of the activities carried out by their Municipality</p>
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N. Georgakopoulos D. Tzanos N. Rafailidis P. Ramantani I. Gakis F. Milonas D. Markoutsaki A. Ntougourtoglou P. Zomas E. Lamrakaki D. Tzanos	<p>Visited the households in their Municipality, had interviews with the householders and distributed and filled in the questionnaires.</p> <p>Provided suggestions and opinions concerning the special characteristics of the prototype system (collaboration with the working group of NTUA and the other two partners).</p> <p>Participated in the organisation and implementation of the information campaign in their Municipality, the selection of households in their Municipality, the arrangements for the installation of the prototype system in the selected households as well as in the organisation of the training courses</p> <p>Distributed of informative material to the citizens of their Municipality and other Municipalities in the Attica Region.</p> <p>Participated in the procedures for the installation of the systems at the households</p> <p>Participated in the implementation of the pilot program at their Municipality --</p> <p>Collected of compost samples that were transferred to the lab for chemical analyses.</p> <p>Also, D. Markoutsaki and A. Ntougourtoglou participated in the development of the preliminary cost – benefit analysis for their Municipality.</p>
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### **Anaptyxiaki Kifissias**

A. Korrogiannaki E. Agrogianni	<p>Visited the households in their Municipality , had interviews with the householders and distributed and filled in the questionnaires</p> <p>Provided suggestions and opinions concerning the special characteristics of the prototype system (collaboration with the working group of NTUA and the other two partners).</p> <p>Responsible for the organisation and implementation of the information campaign in their Municipality, the selection of households in their Municipality, the arrangements for the installation of the prototype system in the selected households as well as for the organisation of the training courses.</p> <p>Supervised the procedures for the installation of the systems at the households</p> <p>Participated in the implementation of the pilot program at their Municipality --</p> <p>Supervised the working group of their Municipality that was established for the pilot application. Participated in the evaluation of the pilot program.</p> <p>Coordination of the activities carried out by their Municipality</p>
A. Aggelidou A. Varela G. Giannakopoulou V. Grammatikou M. Latsou G. Leontaridis S. Mprinias S. Moraiti G. Papanastasiou P. Zoukou	<p>Visited the households in their Municipality, had interviews with the householders and distributed and filled in the questionnaires</p> <p>Provided suggestions and opinions concerning the special characteristics of the prototype system (collaboration with the working group of NTUA and the other two partners).</p> <p>Participated in the organisation and implementation of the information campaign in their Municipality, the selection of households in their Municipality, the arrangements for the installation of the prototype system in the selected households as well as in the organisation of the training courses</p> <p>Distributed of informative material to the citizens of their Municipality and other Municipalities in the Attica Region.</p> <p>Participated in the procedures for the installation of the systems at the households</p> <p>Participated in the implementation of the pilot program at their Municipality --</p> <p>Collected of compost samples that were transferred to the lab for chemical analyses.</p> <p>Also, V. Grammatikou and M. Latsou participated in the development of the preliminary cost – benefit analysis for their Municipality.</p>

## **6. Description of the applied technology**

The project focuses on the design, development and installation of a prototype system in households for the simultaneous separation and composting of the biodegradable organic fraction of urban waste at source. The household organic materials that could be separated/composted by the system are residues of food from the kitchen such as bread, cereals, fruits, vegetables, residues of garden work such as leafs, grass, herbs, etc. The technology that was applied for the implementation of the project included the following:

## **Techniques and methods for the analysis and comparative evaluation of the alternative composting practices and systems**

Prior to the design and the construction of the prototype system, all the available methods, techniques and systems used for household composting are described and analyzed:

- Composting in open provision of piles on the ground or in the interior of artificial cavities
- Composting piles in the interior of artificial fencing
- Composting piles inside closed baskets (Static Composting baskets, Turned or reversed composting baskets, Composting baskets with mechanic stirrer and Complex baskets of automated provisions)

After the extensive analysis of all applied systems and techniques related to composting, an evaluation was carried out aiming in the determination of the most suitable and efficient systems (33 systems were evaluated). The evaluation of the systems was carried out via the development and application of a multi-criteria method of analysis which is based on a wide range of criteria that are numerically weighed (factors of gravity) according to their importance (degree of importance). These criteria are divided into three main categories (groups of criteria) that also are numerically weighed: Technological criteria, Environmental criteria and Economic criteria. Through analysis of the results obtained from the comparative evaluation via multi-criteria method, conclusions concerning the effectiveness of the available systems were extracted. These conclusions were used as a preliminary basis for the development of the proposed system.

Then, three household composting systems available in the market were provided in order to examine their operational functions and performance, under actual conditions, using organic waste from the households of the three Municipalities that are participating in the project. The examination of each composting system was developed by applying the procedures referring to their operational and technical characteristics (e.g. quantity of waste, treatment time period, mixing and aeration conditions) through four experimental cycles. During each experimental cycle, all the data related to the operational performance of the systems was recorded and after the completion of the experimental procedure, samples of the product were collected and subjected to laboratory measurements and analyses in order to determine their quantitative and qualitative characteristics. The parameters that were examined for each sample are: pH, Organic Matter, Total Organic Carbon, Humic substances and C/N ratio.

According to i. the observations that were recorded during the operation of the systems and ii. the results obtained from the characterization of the end products process, the overall performance of the systems was determined and evaluated.

## **Design, development, manufacture and installation of the prototype systems**

Then, taking into consideration: i. the results obtained from the lab testing of the three systems ii. the overall evaluation of the performance of the three systems and iii. the most effective technical and operational characteristics of the other systems that were examined through the application of the multi-criteria analysis and based on the experience of the working team on the development, control and optimization of the composting process, the first version of the components of the prototype system were manufactured and tested.

After the completion of the lab testing of the individual components of the prototype system, the first pieces of the entire system were manufactured and their functions were

re-examined in order to ensure that the required performance has been achieved. By completing this re-examination, the technical characteristics of the entire system were finalized and the 100 pieces of the prototype system were produced and installed as follows: 90 composting systems were installed in the 90 selected households (30 in each Municipality), 8 systems were installed in the households of 8 members of the NTUA scientific team and 2 systems were located in the Environmental Science and Technology Laboratory.

### **Training of the householders**

Specially organized training modules (for the representatives of the Municipalities and the participating households) have taken place so as to assist people in separating/composting the biodegradable waste at home. For this purpose, information and training material has been distributed to the participants of the training sessions. Additional training was given to the people that participated in the programme, during the installation of the system at each household. Also, the working groups (NTUA and Municipalities) were in constant communication with the householders participating in the program (visits at the selected households, frequent phone communication) in order to overcome potential difficulties and malfunctions.

### **Evaluation of the implementation of the pilot programme**

Then, the implementation of the program was evaluated through:

- i. distribution of monitoring questionnaires which the participants have to complete regularly, and also at the end of the period of the pilot implementation.
- ii. visits by the members of the working groups to the households participating in the program, on a regular basis and discussions with the householders.
- iii. identification of the problems arisen during the implementation of the collection/composting scheme at source.
- iv. evaluation of the quantitative and qualitative characteristics of the compost that was produced using the prototype systems. The parameters that were examined for each sample, using standard methods, were: Moisture content, pH, organic content (% Corg), nitrogen content (% N), carbon/nitrogen ratio (C/N), trace metals (Na, K, Ca, Mg, Cr, Cu, Zn, Pb, Ni) and phytotoxicity.

Based on the overall evaluation of the pilot implementation of the program, guidelines and specifications for its implementation at a larger scale were developed. Also, potential incentives that may promote the successful implementation of the system were provided. The main features and operational functions (technical specifications) of the prototype household composting system are given below:

### **Details on the operation of the prototype system**

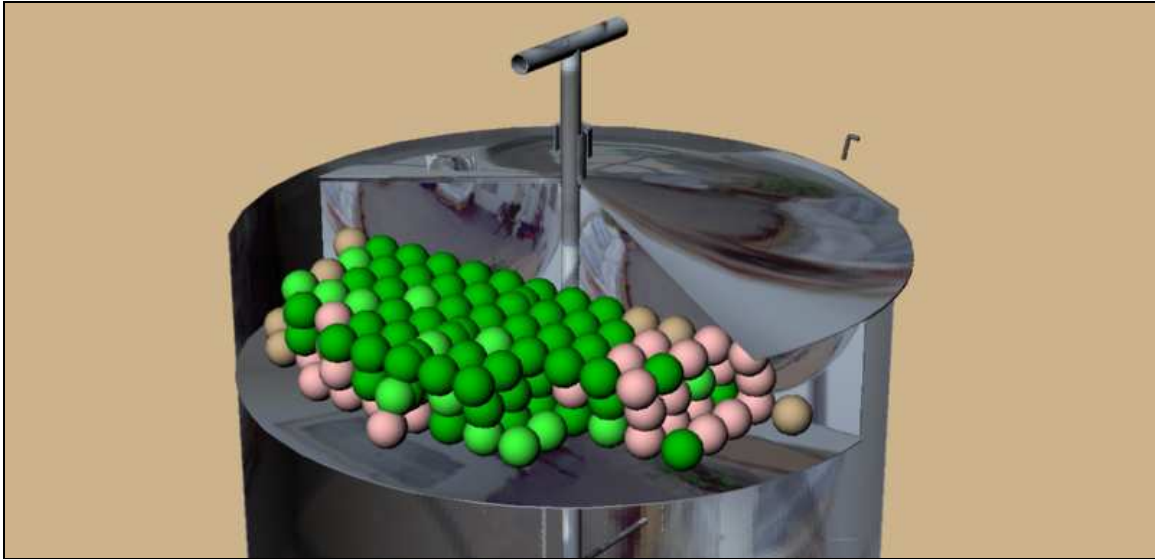
#### **Operation mode of the system**

The prototype system is based on the mechanical mixing/stirring of household organic materials that are fed on a continuous basis through vertical flow. It consists of four individual, segregated, successive compartments, as follows:

- Feeding compartment
- Composting process compartment
- Compartment for the collection and removal of compost
- Compartment for the collection and removal of leachate

#### **Feeding compartment**

The capacity of the feeding semi-cylindrical compartment is 9.615 liters. The feeding of the organic wastes is achieved through the manual movement of its rotating cap.



After inserting the organic wastes into the feeding compartment the rotating cap is closed manually, isolating the content from the external environment.

The average quantity of biodegradable organics generated by a typical household (four persons) is estimated to be 2 kg or 1,6 liter. As a result, the capacity of the feeding compartment is adequate for the storage and mixing of organics that are generated within a time period up to four days. For the optimum operation of the system, it is suggested that the feeding compartment must be emptied every two days.

The transfer of the organics from the feeding to the composting compartment is accomplished via manual rotation of the diaphragms of the mixing/stirring shaft (rotation up to  $180^\circ$ ), as illustrated in the following figure.



### Composting process compartment

The capacity of the composting cylindrical compartment is 66 liters and it receives organic household waste on a continuous basis. The pile of the organics in the compartment comprises of layers of organics with different level of degradation, as

presented in the following figure (the lower layers are related to degraded or/and partially degraded organics while the upper ones include the new input of organics).



The aeration of the substrate in the composting compartment is achieved by manual stirring. According to the design of the system, the organic material is stirred when new material is entered from the feeding to the composting compartment.

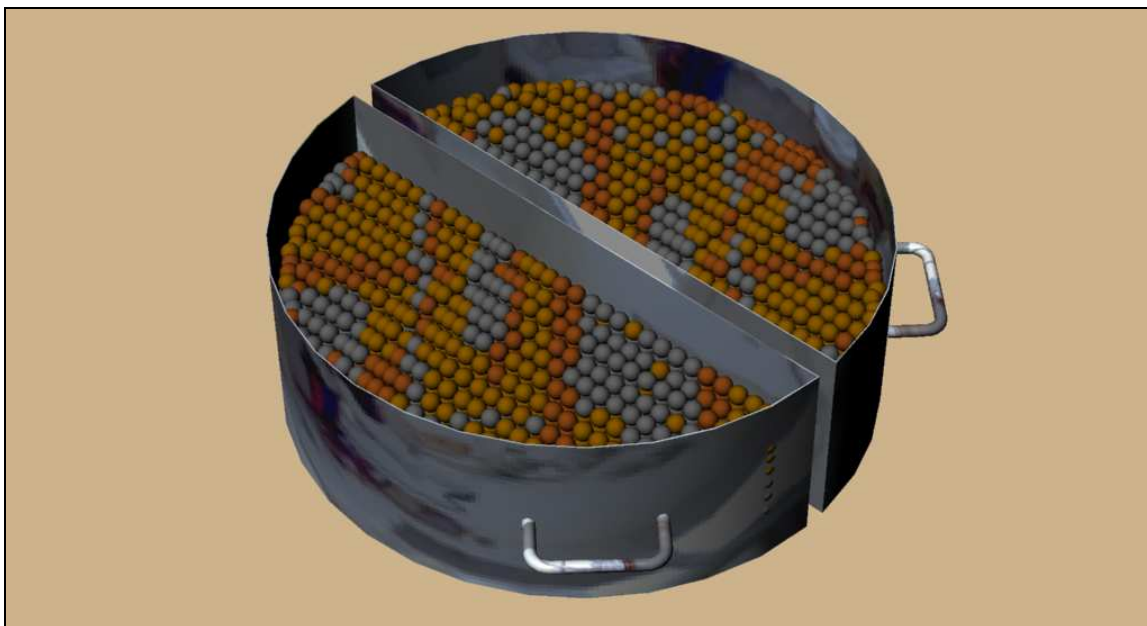
The favorable temperature conditions (mesophilic and thermophilic composting phases) are developed when the volume of the organic material in the composting compartment is about 24 liters (a volume of organics that are generated by a typical household within two weeks).

The moisture content of the organics that is subjected to composting sustains between 55 to 60%, w/w of fresh material, a level that is favorable for the development of the process. This, is achieved by using specific additives such as sawdust together with the biodegradable organics. Additionally, the use of sawdust facilitates the aeration of the compost pile.

#### Compartment for the collection and removal of compost

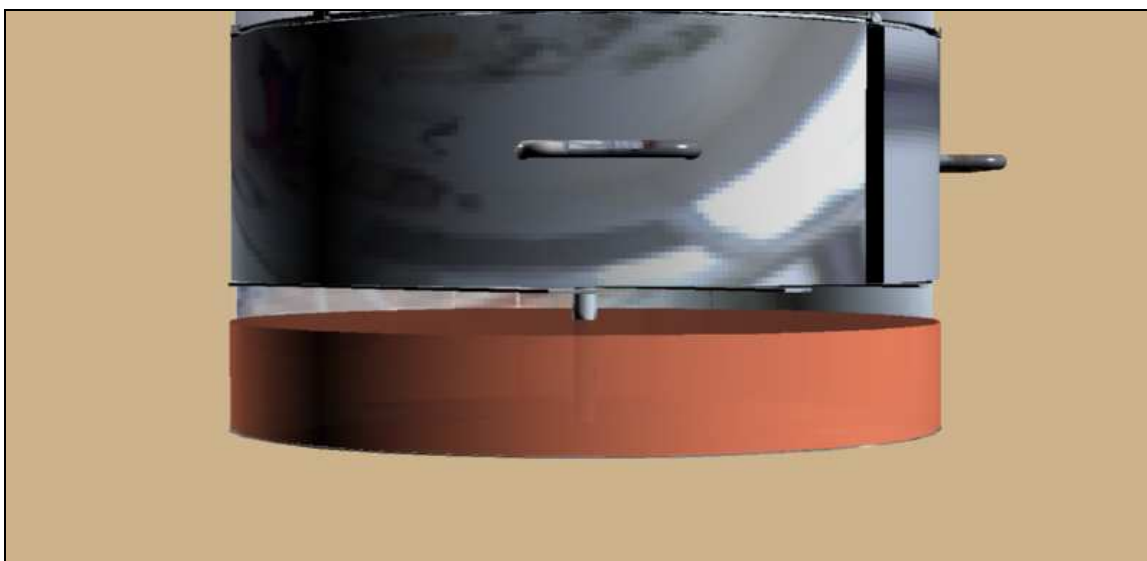
During the rotational movement of the stirrer, new fresh material enters into the core of the process while the lower shaft mixes the composted organic particles upwards of the separation grate. During the mixing, the composted organic particles pass through the grate grid and they accumulate in two compost receptors.

Each one of the two semi-cylindrical receptors has a capacity of 14.735 liters (total volume of collected compost up to 29.47 liters) and consequently, are filled after continuous operation of the system for a time period of 55 to 65 days. Nevertheless, it is suggested to be empty every month. The compost receptors are detached manually, using the specific hatches of the cylindrical jacket and the compost is removed.



#### Compartment for the collection and removal of leachates

The compartment for the collection of the leachates that are generated during the composting process, is the lowest part of the system and its capacity is 19.283 liters. The leachates from the composting compartment enter into the leachate compartment via gravity, initially through the grate to the compost compartment and then through vents that are incorporated to the compost compartment.



Special attention is given to odors control, by using specific additive (natural zeolite of Greek origin) in the process. Also, mature compost and sawdust are added to the composting compartment in order to facilitate the development of the process.

The prototype system has significant comparative advantages, compared to the other available household composting systems, since it has the following unique characteristics:

- Separate feeding system: Minimization of odours from the composting compartment during feeding of fresh organic material, simplified and fluent feeding procedure
- Composting compartment (reactor vessel) that is isolated from the feeding system: avoidance of mixing of fresh organic material with the composted

material, the procedures of insertion of fresh organic material and the collection of composted material do not affect the composting procedures.

- Collection of the compost on a continuous basis
- Collection of leachate
- Agitation system without contacting waste with compost
- Use of specific additives and in particular, i. clinoptilolite - a natural zeolite of Greek origin - that assists to the control of odor and the improvement of the quality of the composted product, ii. mature compost and sawdust for the improvement and the acceleration of the process development .
- The composting system operates on a continuous basis (continuous feeding of new organics in parallel with continuous removal of composting product).



**The prototype household composting system**



**Compartment for the collection of leachates**



**Compartment for the collection of compost**





**Feeding of kitchen waste through the rotation of the feeding compartment cap**



**Collection of compost**



**Removal and use of compost**



## **7. Technical progress, Results and Deliverables**

### **General**

The project was realised in an appropriate pilot scale in order to demonstrate and document the feasibility of separate collection and composting at source and more specifically in the households. The technical development of the project was materialised through the implementation of six tasks, as described analytically in the following text:

### **Task 1: Assessment of the Existing Situation**

This task consists of four subtasks, details of which are given below.

In **Subtask 1.1**, a complete recording and analysis of the legislative framework related to the management of solid waste was carried out, which includes the objectives, the principles, the requirements and the restrictions that condition the individual stages of the activities of the management of solid waste, at national and EC level.

The analysis of the national and EC legislation is focused on those provisions that concern the management of urban, non-hazardous waste and particularly of the biodegradable fraction of these waste, which constitutes the waste stream under examination through the COMWASTE project.

The EC legislation concerning the management of urban waste includes Directives, Regulations, Decisions and Resolutions (Indicatively: Directive 75/442/EC on solid waste, Resolution 97/311/EC on EC waste management policy, Directive 99/412/EC on

waste sanitary landfilling, Directive 2000/72/EC on waste incineration, Decision 2000/532/EC on establishment of the Waste Catalogue, Decision on the questionnaire related to the application of the provisions of the Landfill Directive in the member states, Regulation 2002/2150/EC on waste statistics, Decision 2003/33/EC for the determination of criteria and procedures for landfilling of waste, Directive 94/62/EC on packaging wastes etc.) These legislative provisions either are in effect as such, or constitute replacements, revisions or completions (amendments) of previous relevant statutes. Apart from the existing European legislative framework, provisions regarding the management of solid waste, which are under development, are also recorded and analyzed completely. These provisions concern consultations and proposals of directives or regulations, aiming at the revision of certain older statutes and the coverage of potential future requirements and restrictions regarding to the management of solid waste.

National (Greek) legislation includes laws and Joint Ministerial Decisions. These provisions in their existing form are harmonized with relevant Community legislative provisions and also describe measures, terms and conditions that govern the practices of the management of solid waste.

In addition, the Community and national legislative framework that concern the management of solid, non-hazardous, waste are presented in appropriate tables. For each legislative provision, information is given related to the year coming into force and the object that it examines. Moreover, the Community legislative provisions and the corresponding national ones that have been drawn up are presented.

Meetings with the competent authorities in Greece have been arranged in order to fully understand and analyse the legislation and in order to be able at a later stage to establish a system that will satisfy the targets set by the existing legislation in relation to the management of this special waste stream. Specifically, meetings were arranged between the working team of NTUA and representatives from the Ministry of Environment, Regional Planning and Public Works, ACMAR and ALAGT. All the relevant authorities have been cooperated and there is a great concern on their part to design and develop appropriate systems that will facilitate the enforcement of the relevant legislation.

The activities of subtask 1.1 were carried out by the working team of the NTUA.

All the data and information related to the development of subtask 1.1 are included in Deliverable A.1 that was submitted to the EC with the first progress report.

**Subtask 1.2** referred to the determination and assessment of the quantitative and qualitative data of the household waste generated in the Attica region in general and in the three Municipalities – partners specifically. A review of all relevant existing studies concerning the household waste was carried out while contacts have been made with the representatives from each municipality and community of Attica region and visits took place in order to retrieve all the information required. The data collected, completely reflects the existing situation related to the urban waste that is generated in the most populated Prefecture of the country, and are the result of the primary recording of data, since those available from the competent authorities are either not updated or incomplete. The result of this activity was the determination of the potential overall biodegradable quantities in the region that can be utilized and the assessment of their quality in order to be able to design a suitable system for the separate collection/composting of organics at source. Also, measurements and analyses of the household waste generated in the three Municipalities – partners took place and the data acquired have been verified. Specifically:

- The quantities of waste that are generated in each Municipality and Community of the Attica Prefecture (92 Municipalities and 30 Communities) have been recorded.

- The quantity of waste produced per inhabitant, per day, for each Municipality and Community was determined, aiming at the establishment of the tendencies of change of this quantity during time and with regard to the particular characteristics of each region.
- The qualitative and quantitative characteristics of the waste generated in the three Municipalities that participated in the program were recorded and analyzed by carrying out measurements and analyses.

NTUA was responsible for the implementation of this subtask, while the working groups of the three Municipalities - partners provided data concerning the household waste generated in their Municipality and participated in the collection of the primary data (through visits and contacts) from other Municipalities and Communities in the Attica Region. Also, the three partners provided the necessary household waste samples for carrying out the appropriate measurements and analyses by NTUA.

The data and information concerning the development of subtask 1.2 are analytically presented in Deliverable A.2 that was submitted to the EC with the first progress report.

**Subtask 1.3** dealt with the identification and evaluation of the existing practices and systems and plants applied for the management of household waste in the Attica region, which is the area under examination. All relevant studies and past research have been examined. In addition, meetings with the local authorities have been organised and the current status with respect to the management of urban waste was thoroughly examined. Also, the existing problems and constraints have been identified. The authorities were very cooperative since they consider the management of biodegradable waste as a priority for their municipalities in order to make the whole waste management system more flexible, effective and environmentally sustainable. More specifically, after primary search, collection, recording and assessment of data, are presented:

- Quantitative data per Municipality and Community that dispose their waste to the sanitary landfill located in the area of Ano Liosia.
- Quantitative data per Municipality and Community that transfer their waste to semi – controlled or uncontrolled disposal sites
- Existing stations for transfer of waste as well as the Municipalities and Communities that are served by them
- Existing programs for recovery and recycling of materials from municipal waste in Attica region (recycling program of the Association of Communities and Municipalities of the Attica Region, Greek Company of Recycling, Ecological Recycling Society and individual Municipalities)
- Mechanic recycling and composting plant located near the sanitary landfill in the area of Ano Liosia.

NTUA was responsible for the implementation of this Subtask, while the working groups of the three Municipalities - partners provided data concerning the household waste management practices applied in their Municipality and participated in the collection of primary data through visits and contacts with representatives from other Municipalities and Communities in the Attica Region.

All the data and information related to the development of subtask 1.3 are extensively presented in Deliverable A.3 that was submitted to the EC with the first progress report.

**Subtask 1.4** included the identification, recording and assessment of the specific characteristics and habits of the households in the Attica region. This data was gathered through selected visits to households, interviews with the householders and filling in of

questionnaires that were prepared specifically for this purpose. It has been noticed that people were interested in collaborate with the working group of the project and therefore provided correct and representative information. The result of this subtask was to obtain a clear and representative picture of the existing conditions that prevail in the households in the area under study in order to design and develop an innovative system for the simultaneous separate collection/composting of the biodegradable waste at source that would be tailored to the specific characteristics and needs of the people that would be selected to participate in the pilot application. The questionnaire that was distributed to the householders was submitted to the EC with the first progress report as Deliverable A.4.

The three Municipalities - partners were actively involved in the implementation of this subtask, under the scientific/technical supervision of the NTUA, since they were responsible for the distribution and completion of the questionnaires developed by the NTUA. Approximately, 200 questionnaires were distributed and filled in by the householders in each of the three Municipalities that participate in the project. The evaluation of the content of the filled questionnaires was carried out by the NTUA in collaboration with the three partners.

Overall, Task 1 was implemented according to the approved proposal, starting on 1.12.2003 and ending on 29.2.2004, as indicated in Gantt-chart.

## **Task 2: Identification and analysis of success stories in relation to the management of biodegradable household waste at source**

This task consisted of two subtasks, aiming at the achievement of a clear, representative and up-to-date picture related to the schemes, systems and technologies that are applied at European level for the management of the biodegradable household waste at source. In particular:

**Subtask 2.1** referred to the recording, extensive analysis and assessment of success stories (management schemes and plants) that focus on the collection and utilization of the organic fraction of waste at source.

All the programs and systems (pilot and large scale applications), as well as their technical details were recorded, aiming at the acquisition of a complete and up-to-date picture with regard to their application (problems that are faced during the implementation, ways of elimination of these problems, conditions of application, degree of participation of the citizens, results from their application etc.).

In **Subtask 2.2** all the available composting systems (compost bins) that are used for the utilization of the biodegradable organic fraction of waste at source were recorded. A description of the operation of these systems as well as of their technical characteristics/features was carried out, with the aim to obtain a representative and complete view concerning their use (advantages and disadvantages, conditions and restrictions of application, quality of product, categories of solid waste that can be treated, treatment time period, operation mode, etc.).

The necessary data for the implementation of subtasks 2.1 and 2.2 was obtained through extensive literature review, search in the Internet, review of relevant projects which were carried out in the framework of European and other programmes as well as via contacts with experts from all over Europe, USA and Canada and with operators of relevant systems and schemes. The collected data and information were evaluated by the working group of the NTUA. All the data and information have been included in the Deliverables

B.1 and B.2 (Deliverables of Subtask 2.1 and 2.2, respectively), of the first progress report.

It must be mentioned that additional information related to the descriptions and analysis of best practices (success stories) were obtained during the site visits in Spain and Portugal (28<sup>th</sup> of February – 5<sup>th</sup> of March 2005). The purpose of these trips was to acquire the knowledge and exchange experience in the operation of systems applied successfully for the separation at source and stabilisation of the biodegradable organic fraction of household waste (conditions and restrictions of their application, quality of the end product, categories of solid waste that can be treated, problems that have been arisen during the operation of the systems, ways to overcome these problems, ways and means for increasing the public interest, etc.). Two representatives of the NTUA, the Municipality of Acharnes, the Municipality of Nea Halkidona and the Anaptyxiaki Kifissias as well as one collaborator of the NTUA – coordinator of the three partners participated in these site visits. More specifically, the participants were:

1. Prof. Maria Loizidou – Chemical Engineer, Professor of NTUA, Scientific Responsible of the project
2. Ioannis Lekkas – Engineer
3. Eleni Douлами – Chemical Engineer, PhD candidate, member of the Unit of Environmental Chemistry and Technology of NTUA
4. Ioanna Kada – Civil engineer, Vice Mayor of the Technical Service of the Municipality of Acharnes
5. Anastasia Katara - Expert in finance, Municipality Consultant of the Municipality of Acharnes, ex President of the Municipal Service of Development
6. Virginia Papaefthimiou – Director of the Municipality of Nea Halkidona
7. Elli Litsa – Civil Engineer at the Technical Service of the Municipality of Nea Halkidona
8. Anna Korogiannaki – President of Anaptyxiaki Kifissias (site visits to Spain)
9. Pinelopi Katsianou – Civil Engineer of Anaptyxiaki Kifissias (site visits to Spain)

Furthermore, Dr. Valaora Georgia, member of the LIFE – Environment monitoring team in Greece, participated in the site visits to Spain.

The first visit was held on the 1<sup>st</sup> of March 2005 in Barcelona. Specifically the places that the Greek working groups visited were: Ecoparc Montaca II, Sorting Plant, Composting Plant and Controlled Disposal Site. On the 2<sup>nd</sup> of March the Greek working groups visited in Tarragona the following: Comarcal Council of Reus, Town Council of Cambrils and Botarell Composting Plant. Finally, the Greek team visited Porto's waste treatment installations on the 4<sup>th</sup> of March 2005 and in particular: Composting Plant, Sorting Plant, Incineration Plant and Sanitary Landfill.

The main conclusions obtained from the site visits described above, are:

- The public opinion was favourable before the publicity campaigns but the campaigns themselves have also helped in the success of the schemes (high effectiveness of the dissemination campaigns)
- There has been will by the Authorities involved to implement the schemes and coordinate with the Municipalities
- The local Authorities (Municipalities) are involved actively in the implementation of the management schemes
- The citizens, who have adopted the separation at the source as a common practice, separate the compostable organics at the source.

- The effective operation of the composting plants and the production of a high quality end product are based mainly on the proper separation of the biodegradable fraction of the household waste at the source.
- The schemes had some initial difficulties including technical constraints but these were overcome as the required experience was gained through the implementation.

The full report concerning the site visits to Spain and Portugal is attached as Appendix 1 of the interim technical report (it is re-numbered as B.3 in the final report).

Task 2 was developed according to the time – schedule of the approved proposal, starting on 1.3.2004 and ending on 31.5.2004, as indicated in Gantt-chart.

### **Task 3: Design and development of an appropriate prototype system for the collection and composting at source**

This Task was divided into two individual subtasks, as described analytically, below:

**Subtask 3.1** included the recording, analysis and evaluation of all the alternative composting systems and practices. In particular, all the available methods, techniques and systems used for composting were described and analysed:

- Composting in open provision of piles on the ground or in the interior of artificial cavities
- Composting piles in the interior of artificial fencing
- Composting piles inside closed baskets:
  - Static composting baskets
  - Turned or reversed composting baskets
  - Composting baskets with mechanic stirrer
  - Complex baskets of automated provisions

Once the extensive analysis of all applied systems and techniques related to composting in household was completed, an evaluation was carried out aiming at the determination of the most suitable and efficient systems (33 systems were evaluated).

The evaluation of the systems was carried out via the development and application of a multi-criteria method of analysis which was based on a wide range of criteria that were numerically weighed (weighting factors) according to their importance (degree of importance). These criteria were divided into three main categories (groups of criteria) that were also numerically weighed:

- Technological criteria
- Environmental criteria
- Economic criteria.

Through the analysis of the results obtained from the comparative evaluation via the multi-criteria method, conclusions were drawn concerning the effectiveness of the available systems. These conclusions were used as a preliminary basis for the development of the proposed system.

All the data and information related to this subtask (description of the multi-criteria method that was developed and applied and the results that were obtained) are included in Deliverable C.1 that was submitted to the EC with the interim technical report.

**Subtask 3.2** referred to the development of the prototype system. In particular:

Three household composting systems available in the market were provided in order to examine their operational functions and their performance, under actual conditions, using organic waste from the households of the three Municipalities that were participating in the project. The examination of each composting system was developed by applying the procedures referring to their operational and technical characteristics (e.g. quantity of waste, treatment time period, mixing and aeration conditions) through four experimental cycles. During each experimental cycle, all data related to the operational performance of the systems was recorded and once the experimental procedure was completed, product samples were collected and subjected to laboratory measurements and analyses in order to determine their quantitative and qualitative characteristics. The parameters that were examined for each sample were: pH, Organic Matter, Total Organic Carbon, Humic substances and C/N ratio.

According to (i) the observations that were recorded during the operation of the systems and (ii) the results obtained from the characterization of the end product process, the overall performance of the systems was determined and evaluated.

Then, through the consideration of:

- (i) the results obtained from the lab testing of the three systems
- (ii) the overall evaluation of the performance of the three systems
- (iii) the most effective technical and operational characteristics of the other systems that were examined through the application of the multi-criteria analysis

and based on the experience of the working team on the development, control and optimization of the composting process, the first version of the components of the prototype system were manufactured and tested. In the revised Deliverable C.2 that is re-submitted to the EC with the final technical report, analytical data and information concerning the following issues are given:

- The lab testing of the operation and the efficiency of three alternative household composting systems that are available in the market
- The lab testing of the individual components of the prototype system
- The technical and operational characteristics of the individual components of the prototype system
- Dimensions of the components and manufacturing material
- Operational functions of the components in the framework of the operation of the entire prototype system (from the feeding stage to the stage of collection of the end product)
- Economical data concerning the cost for the manufacturing of the prototype system as well as for its operation.
- Analytical technical specifications of the prototype system (full engineering design) on which the manufacturing of the 100 pieces was based.
- Evaluation of the performance of the prototype system in relation to the performance of the other available household composting systems (determination of the improvements that were incorporated) and identification of its unique characteristics, such as:
  - ✓ Separate feeding system

- ✓ Reactor vessel isolated from the feeding system
- ✓ Collection of the mature compost on a continuous basis
- ✓ Collection of leachate
- ✓ Agitation system without contacting waste on compost
- ✓ Odour control system using specific additives
- ✓ Operation of the entire system on a continuous basis

Also, in March 2005, the scientific responsible of the project traveled to Sofia and had a meeting with the working group of Dr M. Zlateva. Regarding this trip, the following are remarked: When the design of the prototype system for composting at home was completed, we were informed that another system had just been developed in Bulgaria by the working team of Dr. Zlateva. As a result, this trip to Sofia was made so as to meet the members of the working team of Dr. Zlateva and see the system that had been developed in case some of our ideas were incorporated in that system. In fact, the Bulgarian system was characterized by less advanced technology and mainly is designed to be placed in the garden not near the kitchen, so the design of the NTUA was considered superior. We had discussions on home composting and still we collaborate in order to promote our system for kitchen waste.

The activities related to the implementation of subtasks 3.1 and 3.2 were carried out by the working group of the NTUA. Finally, Task 3 was implemented according to the approved proposal, starting on 1.6.2004 and ending on 31.1.2005.

#### **Task 4: Organization of the implementation programme**

Task 4 consisted of five individual subtasks, as described below:

**Subtask 4.1** referred to the information campaign set up in the Municipalities under concern. This publicity campaign involved direct mailing to householders as well as visits to the households. Also, it included workshops organized in the three Municipalities, presentations and articles in newspapers and the radio. The outcome of these activities was an increase of the environmental awareness of the residents of the three Municipalities as well their willingness to participate in the programme. Printed material was prepared and delivered in the framework of the three workshops that were held during October and November 2005. Analytical details and information about the information campaign set up in the three Municipalities is presented in the Dissemination Task (Section 8 of the final technical report).

**Subtask 4.2** included the selection of the households that would participate in the program. The procedure was developed in such a way in order to ensure that representative households with respect to the persons that live at them, the age of the individuals, the hours that they spend at home, their consumption patterns, their standard of living etc. would participate.

In **Subtask 4.3**, the system that was designed and developed during Task 3, was procured and properly tested. The construction of the entire prototype system included individual steps, as described below:

- (i) Manufacturing of the first version of the components of the system, according to the specifications, as determined after carrying out the laboratory tests of the three systems and taking into consideration the most effective individual characteristics/features of the other systems that are available in the market



- (ii) Thorough testing of the performance of the individual components of the prototype system
- (iii) Suggestions for improvement of the performance of the individual components of the system
- (iv) Manufacturing of the first pieces of the entire prototype system according to the suggestions for improvement of the performance of its individual components
- (v) Re-examination of the functions of the prototype system, as a whole, in order to make sure that the required performance has been achieved
- (vi) Production of 100 pieces of the prototype system with high operational functions and high performance.

In particular, the first two pieces of the entire prototype system were delivered in July 2005 and tested properly in the lab by the working group of the NTUA. During the testing of the two pieces of the prototype system, all data and observations related to their operational performance was recorded. The testing/re-examination of the functions of the prototype system, as a whole was necessary in order to make sure that the required performance has been achieved.

In **Subtask 4.4**, the prototype composting systems were installed in the selected households (December 2005). More specifically, 90 composting systems have been installed in the 90 selected households (30 in each Municipality). Also 8 more systems were installed in the households of 8 members of the NTUA scientific team and 2 systems were installed in the Laboratory of Environmental Science and Technology of NTUA. The installation of these 10 systems was decided in order to obtain a clearer and more direct view concerning the use of the system and the potential problems that may arise. The installation of the systems at the household was carried out by the members of the NTUA working group in collaboration with the members of the working groups of the three Municipalities/partners. The householders were provided with the prototype system as well as with additives that are used for the best development of the process. These extra materials were: i. zeolite (Greek clinoptilolite) for odor control and for the improvement of the quality characteristics of the final product, ii. mature compost in order to support the starting of the process and iii. sawdust for improving the quality characteristics of the raw material (increase of the carbon that is available for the development of the biochemical actions by the microorganisms as well as optimization of the aeration conditions of the material that is subjected to composting). Also the additives are needed for the moisture control since the composting process can be best developed when the moisture content ranges from 55 – 60%.

**Subtask 4.5** focuses on the training of the people involved, on the use of the system according to its operational and technical specifications. Especially organized training modules (for the representatives of the Municipalities and the participating households) have taken place in order to assist people in separating/composting the biodegradable waste at home. For this purpose:

- Special training modules were organized by the three partners where, where members of the working group of the NTUA explain in details, the functions and the use of the prototype system. These training modules took place at the premises of the three Municipalities (three modules of 8-12 householders were held in each Municipality). Special adhesive informative material was prepared by NTUA and distributed to the householders that are participating in the individual training modules.

- Printed material was prepared by NTUA and distributed in collaboration with the three Municipalities/partners to the participants of the three workshops–awareness events that took place in the three Municipalities. This material contains information about the composting procedure, the prototype system and the program in general.
- Additional training was given by the working group of NTUA, to the householders during the installation of the prototype system at each household. In particular, 9 individual teams were formed in order to serve 10 households each. Each team consists of 2-3 members of the beneficiary and 1-2 members of the partners. The members of the beneficiary explained analytically the use of the system and demonstrated its operation to the householders in practice (training of the householders on site).

NTUA was the overall responsible for the implementation of Task 4, while the working groups of three partners were involved in the household selection, in carrying out appropriate arrangements for the installation of the systems as well as in the organization of the information campaign and the training courses. Additionally, the Municipalities provided the tracks for the transfer and installation of the composting systems.

#### Problems encountered

According to the approved proposal, the activities of Subtask 4.3 was planned to be completed before 30.4.2005, but a short delay was observed for its on time completion, due to the following reasons:

- (i) the procedures for the finalization of the detailed technical characteristics of the system was time-consuming, since thorough market search for the selection of the most appropriate manufacturer was required and a significant number of contacts and meetings with the manufacturers took place in order to finalize the details of the technical specifications of the system
- (ii) the manufacturing of the system had to be supported by additional laboratory tests and trials in order to re-examine its function and achieve the highest possible performance level.
- (iii) It was estimated that the required amount of money needed for starting the production of the prototype systems would be available two months after the submission of the interim report (end of May 2005)

As a result, a two-month extension of the duration of this Task was requested on 18.7.2005 by the Beneficiary. Unfortunately, the market search for the selection of the most appropriate manufacturer and the contacts and meetings with the manufacturers that took place were extremely time-consuming. This, led to delay in carrying out the additional laboratory tests and trials which were necessary in order to finally examine the function of the prototype system and achieve the higher level of its performance. Consequently, this led to a delay in the manufacturing of the system. Under these conditions, a six-month extension of this Task was requested by the Beneficiary on 27.10.2005 and was given by the EC.

The problems faced during task 4 (organization of the implementation of the program) concerning the construction of the system were dealt and since the time extension was given by the EC, the project ran smoothly.

The actual realization of Task 4 against the new approved implementation plan is presented in the Gantt-chart.

#### **Task 5: Implementation of the Programme**

Task 5 consisted of two subtasks, as described below:

**Subtask 5.1** referred to the implementation of the programme (started on 1.11.2005 instead of 01.04.2005 after the extension given by the EU, as described previously) and it lasted for a sufficient time (until 31.08.2006) in order that the householders become familiar with the activity of the separation and composting of the biodegradable waste at their households and consider it as a daily common practice. The householders separated and composted the biodegradable waste as trained in Subtask 4.5, using the prototype equipment with which has been provided.

As mentioned in Subtask 4.4, 90 composting systems were installed in the selected households (30 households at each of the three Municipalities). Also 8 more systems were installed at the households of 8 members of the NTUA scientific team and 2 systems were installed in the laboratory of the working group of the NTUA. The householders were provided with the prototype system as well as with additives that were used for the efficient development of the process. In particular, the householders fed the system with the appropriate biodegradable waste generated at their kitchen together with Greek zeolite of a specific proportion and dose in order to eliminate the odor and improve the quality characteristics of the final product. Moreover, a low quantity of mature compost is added to the system in order to support the composting process as well as a specific quantity of sawdust for improving the quality characteristics of the household waste (in order to increase the carbon that was available for the development of the biochemical actions in the composting compartment by the microorganisms as well to optimize the aeration conditions and the moisture content of the material that was subjected to composting). These additives were provided by the NTUA. The product obtained was temporarily stored by the householders in appropriate biodegradable bags that were provided by the three Municipalities. The bags had the capacity to store the quantity of compost that produced during a period of three months for each household.

The 9 individual working teams of the NTUA were in constant communication with the householders participating in the program (visits at the selected households on a weekly basis, frequent phone communication, at least once a week) in order to overcome potential difficulties and malfunctions. In addition, the householders were provided with a telephone number, where they could get all required information by the working group of NTUA.

Further explanations and directions were given to some householders at the beginning, when the system was installed. Also, in few cases, additional instructions were given to some householders during the operation of the system in order to improve the performance of the system (e.g. elimination of the odors). Overall, the implementation of the program ran smoothly and the cooperation of the householders with the members of the individual working groups was continuous and efficient.

Appropriate questionnaire (a clear and easy to be filled in form) was developed and distributed to the householders that participated in the implementation of the program in order to complete it regularly with their observations about the operation of the system. The content of the questionnaire which is attached as deliverable E.1 of the final report, is given synoptically, below:

#### Macroscopic observations and remarks on the process

- Presence of insects
- Presence of worms
- Odor emissions
- Production of compost (quantity, texture, etc.)
- Generation of leachate (quantity, presence of odor, etc.)

#### Technical observations and remarks on the operation of the system

- Clogging of the tap at the compartment of leachate collection
- Way and convenience of rotating of the shaft of the system
- Quantity of material in the composting compartment
- Leakages of liquids
- Condition of the blades and flaps of the system

#### Measurements (carried out by the members of the NTUA working teams)

- Moisture of the material
- Temperature in the composting compartment
- Ambient temperature
- Oxygen content in the composting compartment
- Quantity of leachate that has been generated

Also, during the visits that took place by the working groups to the households, additional observations and comments were recorded, after interviews that were contacted with the householders.

Additionally, compost samples from all the participated households as well as from the composting systems that operated at the premises of the NTUA were collected and analysed properly at the lab of the NTUA in order to determine the quantitative and qualitative characteristics of the product and assess its quality level. In particular, 270 compost samples were collected and analysed from the 90 composting bins that were located at the households of the three Municipalities (30 samples per composting cycle \* 3 composting cycles for each one of the 3 Municipalities). In addition, more than 120 compost samples were collected and analysed from the 8 composting systems that were installed at the households of the members of the NTUA working group and the 2 systems that were operating at the laboratory of the Unit of Environmental Science and Technology of the NTUA.

The analysis of the compost samples included the determination of the following parameters: Moisture content, pH, organic content (% Corg), nitrogen content (% N), carbon/nitrogen ratio (C/N), trace metals (Na, K, Ca, Mg, Cr, Cu, Zn, Pb, Ni) and phytotoxicity.

NTUA has the overall responsibility for the implementation of Task 5, but it was in close collaboration with the working groups of the three partners which are responsible for the use of the systems at their Municipalities.

It must be noted that the operation of the prototype systems by the householders and the working group of the NTUA took place under different conditions concerning the raw material and the additives. In particular, there are variations in the quality of the kitchen waste that are inserted into the system as well as in the quantities of the additives. Through this procedure, the alternative scenarios related to the operation and the efficiency of the system were examined, aiming at the optimization of the system under actual conditions.

Dr Katerina Raftopoulou (member of the external LIFE monitoring team) was invited to visit some of the households where the systems were installed. These visits were held during February 2006.

Subtask 5.2 included the organisation of raising awareness events. In particular, three workshops – awareness events were organised at the three Municipalities that participated in the project before the installation of the prototype systems at the households while, during the implementation of the program, visits to the premises of the NTUA took place during which, citizens from many areas of the Attica Region had the opportunity to be informed about the COMWASTE project and the prototype system and they obtained hands on experience on the operation of the system in practice (details are given below at point 8, Dissemination Task).

The actual realization of Task 5 against the new approved implementation plan is presented in the Gantt-chart.

### **Task 6: Evaluation of the results of the implementation – suggestions for full - scale introduction of the System**

Task 6 started on 01.01.06 instead of 01.07.05 after the extension of the programme given by the EC and lasted until 31.8.2006. It consisted of four individual subtasks, as described analytically, below:

**Subtask 6.1** referred to the evaluation of the implementation program. This was achieved:

i. through the analysis and the assessment of the content of the filled in questionnaires that were distributed to the householders as well as through the observations and remarks obtained by the working groups during their visits to the households. (Deliverable F.1 that is submitted with the final technical report). The problems were determined mainly during the first stages of the implementation of the program (first composting cycle) due to the fact that the householders were not fully familiar with the use of the prototype composting system. The direct and on time response of the members of the working groups in combination with the high level of collaboration of the householders led to the quick and efficient elimination of each problem.

ii. through the analysis and the evaluation of the results that were obtained by carrying out appropriate measurements and analyses for the determination of the qualitative and quantitative characteristics of the compost samples that were taken during the implementation of the program (Deliverable F.2 that is submitted with the final technical report). In particular, measurements and analyses were carried out for the determination of:

- the composition (qualitative and quantitative) of the organic kitchen waste that are used as a substrate for the household composting (determination of the parameters: moisture content, total carbon - % C<sub>org</sub> total organic matter - % OM , total nitrogen - %N και C/N ratio)
- the main operational parameters of the household composting process (temperature, oxygen and moisture)
- the quality of the compost that was produced using the composters that were located at the household of the three Municipalities (determination of the parameters: moisture content, % C<sub>org</sub> , pH, %N, C/N, Na, Mg, Ca, K, Cu, Cr, Ni, Zn, Pb and phytotoxicity)
- the quality of the compost that was produced using the composters that are installed in the laboratory of the Unit of Environmental Science and Technology (determination of the same set of parameters as in the case of the compost that was produced in the households. Additionally, alternative combinations regarding the type and the quantity of additives were examined such as individual use of Greek

zeolite (dosage of 5% and 10% w/w), sawdust (dosage of 5% and 10% w/w), mature compost (dosage of 5% and 10% w/w) and their combinations.

According to the results that were obtained, the following could be noted synoptically:

- Regarding the organic kitchen waste, the results shown that the majority of them are considered as appropriate for use as composting substrate. Nevertheless, some of them have C/N ratio lower than the optimum one. As a result, when these type of waste are used, it is suggested to be used together with materials of higher carbon content.
- Concerning the main operational parameters of the household composting process, the results indicated that the temperature which is developed in the copmoters is adequate. Initially, relatively low temperature values are observed which increase during the development of the process, reaching values that are favourable for supporting the composting as well as for elimination of the pathogen microorganisms that may be developed. In addition, in some cases, the moisture content was increased and a small quantity of sawdust was added in order to adjust it at the optimum level. Finally, the oxygen content was efficient for the development and continuation of the favourable aerobic conditions of the process.
- The quality of the compost that was produced in the households is high and in accordance to the quality standards that are set for its use. Only in few cases (in the first cycle of the pilot implementation) the quality of the compost was not quite good due to operational problems that were observed during the development of the process (some householders were not familiar with the use of the composter). With the assistance of the members of the working groups, the operational problems were solved and the compost that further produced was of a high quality.
- Regarding the compost that was produced using the composters that are located in the Laboratory, the results shown that by using additives (zeolite, sawdust and mature compost) the quality of the product is improved further and the process become more efficient. In addition, from the overall results that were obtained it is concluded that the optimum combination of additives is 5% zeolite, 5% sawdust and 5% mature compost, since it leads to the optimization of the process and the production of high quality compost (the best results were obtained with the use of the minimum quantities of additives, in combination).

**Subtask 6.2** included the identification of the problems that arisen during the implementation of the program (problems related to the interest of the people involved, to the time needed for the development of the composting process, use of the system according to the instructions that were given to the householders etc.) as well as presentation of the solutions that were provided in order to overcome these problems. The outcome of subtask 6.2 is included in Deliverable F.1 that is submitted with the final technical report. The main problems that were determined were: presence of odour, difficulty of rotation of the shaft, clogging of the tap of the collection of the leachate, generation of quite high quantities of leachate, clogging of vents of the internal grate, and the presence of insects.

The problems were determined mainly during the first stages of the implementation program (first composting cycle) due to the fact that the householders were not fully familiar with the use of the prototype composting system. The direct and on time

response of the members of the working groups, in combination with the high level of collaboration of the householders led to the quick and efficient elimination of each problem.

**Subtask 6.3** included the identification of the potential incentives that may promote the successful implementation of the program in large scale. The outcome of this subtask is incorporated in Deliverable F.3 that is submitted with the final technical report. The main potential incentives that are proposed, includes the following: percentage reduction of the municipal rate that are paid by the citizens according to the quantity of compost that will produce, access and use of the municipal installations (place of athletic exercise, gums etc.) for free, attendance to cultural and other activities that are organised by the Municipality for free, use of the municipal means of transport for free, reduction in the ticket price for entrance into the municipal cinemas.

Finally, during **subtask 6.4** a technical report was prepared in which a framework of guidelines and specifications are recorded for the implementation of the program at larger scale. This report is attached to final technical report as Deliverable F.3 that is submitted with the final report and it includes the development of suggestions and guidelines for the application of the prototype household composting system at larger scale, as presented synoptically, below:

- I. Amendment of national legislative provisions related to the existing procedures that are applied for the determination of the fee which is paid by the Municipalities for the final disposal of municipal solid waste. At present, this fee is fixed for each Municipality and independent from the quantities of waste that are disposed to landfills.
- II. Procedures for informing the Local Authorities about i. the household composting system ii. the benefits that will be gained by the incorporation of the system in the existing local schemes for the management of the household wastes.
- III. Procedures, means, organizational structure and content of a campaign for informing of the citizens about the household composting as well as for their training on the use of the household composting system.
- IV. Procedures for the exploitation of the existing experience of actors and networks that are involved in the field
- V. Alternative management schemes that could be developed and applied for the utilization of the household compost
- VI. Expansion of the household composting system in order to include areas with specific geo-morphological characteristics (settlements and Communities that are located away from the Municipality in which they belong or/and they are located at mountainous areas).

Additionally, specific incentives which could be provided to the citizens are given, aiming at the further promotion of the application of the system at large scale.

Finally, a preliminary cost-benefit analysis was developed related to the application of the household composting system at large scale (by examining alternative scenarios for the management/utilization of the household compost as well as alternative populations that could be served). In particular, the following four alternative scenarios were examined for full implementation in the three Municipalities - partners:

Scenario 1: Collection and exclusive use of the compost by the Municipal Authorities in municipal gardens, playfields etc.

Scenario 2: Exclusive use of the compost by the householders

Scenario 3: Use a portion of the compost by the householders (in the cases when the households have private gardens and yards) and collection and use of the remaining quantity by the Municipal Authorities

Scenario 4: Collection and exclusive utilization of the compost by the Municipal Authorities (promotion through the market to the end users)

It must be noted that the populations of the three Municipalities (Municipality of Kifissia: 44.000, Municipality of Acharnes: 76.000, Municipality of Nea Chalkidona: 10.000) are representative for the majority of the populations of the Greek Municipalities.

In the following Tables, the outcome of the preliminary cost – benefit analysis is summarized.

**Summarized presentation of the results of the preliminary cost – benefit analysis for the Municipality of Kifissia**

<b>Scenario</b>	<b>Annual cost (€)</b>	<b>Annual income(€)</b>	<b>Annual benefit(€)</b>
Scenario 1: Collection and exclusive use of the compost by the Municipal Authorities in municipal gardens, playfields etc.	751.630	1.848.000	1.096.370
Scenario 2: Exclusive use of the compost by the householders	596.750	1.848.000	1.251.250
Scenario 3: Use a portion of the compost by the householders (in the cases when the households have private gardens and yards) and collection and use of the remaining quantity by the Municipal Authorities	674.190	1.848.000	1.173.810
Scenario 4a: Collection and exclusive utilization of the compost by the Municipal Authorities (promotion through the market to the end users) (100% of the quantity that is produced)	906.630	2.640.000	1.733.370
Scenario 4b: Collection and exclusive utilization of the compost by the Municipal Authorities (promotion through the market to the end users) (50% of the quantity that is produced)	829.190	2.244.000	1.414.810

**Summarized presentation of the results of the preliminary cost – benefit analysis for the Municipality of Acharnes**



<b>Scenario</b>	<b>Annual cost (€)</b>	<b>Annual income(€)</b>	<b>Annual benefit(€)</b>
Scenario 1: Collection and exclusive use of the compost by the Municipal Authorities in municipal gardens, playfields etc.	1.298.270	3.248.000	1.949.730
Scenario 2: Exclusive use of the compost by the householders	1.030.750	3.248.000	2.217.250
Scenario 3: Use a portion of the compost by the householders (in the cases when the households have private gardens and yards) and collection and use of the remaining quantity by the Municipal Authorities	1.164.150	3.248.000	2.083.850
Scenario 4a: Collection and exclusive utilization of the compost by the Municipal Authorities (promotion through the market to the end users) (100% of the quantity that is produced)	1.503.870	4.616.000	3.112.130
Scenario 4b: Collection and exclusive utilization of the compost by the Municipal Authorities (promotion through the market to the end users) (50% of the quantity that is produced)	1.370.110	3.932.000	2.561.890

**Summarized presentation of the results of the preliminary cost – benefit analysis for the Municipality of Nea Chalkidona**

<b>Scenario</b>	<b>Annual cost (€)</b>	<b>Annual income(€)</b>	<b>Annual benefit(€)</b>
Scenario 1: Collection and exclusive use of the compost by the Municipal Authorities in municipal gardens, playfields etc.	170.825	616.000	445.175
Scenario 2: Exclusive use of the compost by the householders	135.625	616.000	480.375
Scenario 3: Use a portion of the compost by the householders (in the cases when the households have private gardens and yards) and collection and use of the remaining quantity by the Municipal Authorities	153.225	616.000	462.775
Scenario 4a: Collection and exclusive utilization of the compost by the Municipal Authorities (promotion through the market to the end users) (100% of the quantity that is produced)	293.025	796.000	502.975
Scenario 4b: Collection and exclusive utilization of the compost by the Municipal Authorities (promotion through the market to the end users) (50% of the quantity that is produced)	275.425	706.000	430.575

The main outcomes of this analysis are:

- i. all the alternative scenarios are viable
- ii. the viability of all the alternative scenarios provides the Local Authorities with the ability to select the management scheme that fits better to their needs.
- iii. for all the alternative management schemes, the potential benefit increases in correspondence with served population (Municipalities of a high population presents higher potential benefits). Nevertheless, the Municipalities with low population as well as the Communities also benefit from the application of the household composting system, improving their economic balance.
- iv. The application of the system at large scale remains viable even in the case when the quantitative benefit that refers to the fee that is paid by the Municipalities for the final disposal of their waste is not taken into account in the cost-benefit analysis. At present, this fee is fixed for each Municipality and independent from the quantities of waste that are disposed to landfills.
- v. For Municipalities with relative high population (e.g Municipality of Acharnes) the application of the system is still viable even in the cases when the biodegradable household waste fraction is not diverted completely from the mixed municipal waste (the citizens do not separate at source the entire quantity of this waste stream)

Additionally, in the cost-benefit analysis, a significant number of non quantitative non measurable) benefits that could be obtained by the application of the system at large scale is given. Indicatively:

- contribution to the achievement of the quantitative national targets concerning the diversion of the biodegradable organics from landfilling
- raising of the environmental awareness of the public – Increasing of the sensitization of the citizens on environmental issues – placing of good environmental practices among the daily activities of the householders
- reduction of the nuisance that occurs during the collection and transfer of the municipal solid waste (decrease of the number of vehicle routes for the collection of the municipal solid waste and their transfer to sanitary landfill)
- lower burden of the landfill sites, in terms of quantity and polluting load, due to the reduction of the amount of municipal solid waste that are disposed, fact that results in the increasing of their operation life cycle
- generation of leachates at landfill sites with reduced organic load due to the decrease of the organics that are disposed
- reduction in the air emissions from landfills in qualitative and quantitative terms (concentrations of carbon dioxide, methane, VOCs, etc.)
- production of a product with added value that could be used for landscaping or for agricultural purposes such as soil fertilizer, soil improvement and soil conditioner (through improving the soil structure, porosity and density, increasing infiltration and permeability, reducing runoff and erosion, improving water holding capacity, reducing water loss and leaching in sandy soils, supplying macro and micronutrients, controlling of soil-borne pathogens, improving of cation exchange capacity of soils, increasing the ability to hold nutrients for plant use, supplying of beneficial micro-organisms to soil and growth media, improving/stabilizing soil pH and providing the potential to bind and degrade some pollutants of the soil.
- avoidance of using synthetic fertilizers for agricultural purposes
- The application of the practice of the separation of organics at source offers the opportunity of a high-quality “clean” feedstock for composting and the prospect of an uncontaminated end-product, compared to the organic material derived from central mechanical sorting plants)

- The separate collection and simultaneous composting of the kitchen waste fraction by the householders facilitates a reduction in the frequency that is required for the collection of the residual household waste fraction. This is especially important consideration in Southern European and other Mediterranean countries where the climatic conditions demand more frequent collection of easily degraded wastes.

As far as the site visits are concerned, instead of the trips to England and France that had been initially planned to be held during Task 2, a trip to Austria took place from 6<sup>th</sup> to 8<sup>th</sup> of April 2006, during Task 6. This change aimed in the better implementation of the project, taking into consideration the following: The purpose of the initial planned trips was to obtain information related to success stories of the composting systems, activity that had already been completed successfully. As a result, more trips for this purpose were not necessary. On the contrary, trip at the last stage of the project supported the purposes of Task 6 during which, the guidelines for the implementation of the program in large scale were developed. Through extended search, the members of the NTUA working group concluded that the Austrian waste management - composting schemes could provide useful information related to this subject.

The persons from the National Technical University of Athens and the three Greek Municipalities which participated in this trip were:

Konstantinos Moustakas –NTUA  
 Anna Korogiannaki –Anaptyxiaki Kifisias  
 Eleni Agrogianni - Anaptyxiaki Kifisias  
 Anastasia Katara – Municipality of Acharnes  
 Anastasios Vrettos - Municipality of Acharnes  
 Andreas Tsiantis – Municipality of Nea Halkidona  
 Konstantinos Plessas - Municipality of Nea Halkidona

As mentioned above, during this trip, a significant number of information was gathered which was very useful for the implementation of the last stage of the COMWASTE project and in particular, the materialization of Task 6. More specific:

- Information was gained and experience was exchanged on the way through which the Municipal Association for Waste Management of the Tulln Region of Austria (GVA TULLN) has organized its program for the collection and management of household waste in the area and how the Association has set its organizational structures in order to carry out its activities. These information was of a great importance for the COMWASTE project since they were used as an input for the development of the framework of specifications for the implementation of the household composting program in a large scale application (Task 6)
- Information was received on the incentives that are being provided to the citizens in order to increase their participation level in the activities of recovery of materials from the household waste (evaluation of the efficiency of these incentives in practice). This outcome was very important for the purposes of the COMWASTE project since one of the deliverables of the Task 6 of the project is the setting of incentives that assist to the promotion of the implementation of the program in larger scale.
- Information was get and experience was exchanged on the way that the Association develops its communication strategy. This outcome was considered as a useful input for setting up the after – LIFE communication and dissemination plan for the COMWASTE project.

- Discussion took place on the economic aspects of the program which is being implemented in the area by the Municipal Association. The result of this discussion assisted to the development of the preliminary techno-economic study for the implementation of the household composting system in a large scale (deliverable of Task 6 of the project).
- On sight picture related to the way that the citizens separate their organic household waste at source, was obtained.
- Discussion took place between the Greek participants and the Austrian citizens on issues that are related to the participation of the last ones in the recycling program which is being implemented by the Municipal Association (in order to gather information, on a first hand basis, about the level of: i. the easiness in order to participate in such a program, ii. the collaboration with the personnel of the Association, iii. the gratification of their participation in the program iv. the time that is needed in order to separate their household waste etc. The outcome was very important for the development of the framework of specifications for the implementation of the household composting program in a large scale application (Task 6)
- Discussion took place on the legal and technical premises for the application of composting practices (household composting and composting at central installations) with representatives of the consortium “Biogas & Compost”. From the discussion it was arisen that the household composting is a competitive and efficient alternative practice for the management of the household biodegradable organics which presents a high level of applicability.

The report concerning the site visits to Austria is attached as Deliverable F.4. of the final technical report.

The actual realization of Task 6 against the new approved implementation plan is presented in the Gantt-chart.

Synoptically, Table 1 presents information related to the deliverables that were prepared during the implementation of the six technical tasks of the COMWASTE project.

**Table 1: List of deliverables prepared during the technical development of the project**

<b>Task</b>	<b>Title and content of deliverable</b>	<b>Date of delivery</b>
Task 1	<b>Deliverable A.1:</b> Report that refers to the recording and analysis of the legislative framework regarding the management of household waste	29.2.2004 (with the 1 <sup>st</sup> progress report)
	<b>Deliverable A.2:</b> Report related to the determination and assessment of the quantitative and qualitative data of the household waste generated in the Attica Region	29.2.2004 (with the 1 <sup>st</sup> progress report)
	<b>Deliverable A.3:</b> Report deals with the identification and evaluation of the existing practices and systems and plants applied for the management of household waste in the Attica region	29.2.2004 (with the 1 <sup>st</sup> progress report)
	<b>Deliverable A.4:</b> The questionnaire that was distributed to the householders in order to identify their special characteristics and habits	29.2.2004 (with the 1 <sup>st</sup> progress report)

Task 2	<p><b>Deliverable B.1:</b> Technical report that refers to the analysis and assessment of success stories that focus on the collection and utilization of the organic fraction of waste at source.</p> <p><b>Deliverable B.2:</b> Technical report related to the recording and description of the available composting systems that are used for the utilization of the biodegradable organic</p> <p><b>Deliverable B.3:</b> Report includes information on the site visits to Spain and Portugal</p>	<p>1.5.2004 (with the 1<sup>st</sup> progress report)</p> <p>31.5.2004 (with the 1<sup>st</sup> progress report)</p> <p>10.3.2005 (with the interim report)</p>
Task 3	<p><b>Deliverable C.1:</b> Technical report refers to the recording, analysis and evaluation of all the alternative household composting systems and practices</p> <p><b>Deliverable C.2:</b> Technical report that includes information on the lab testing of the systems as well as technical and financial description of the prototype system (accompanied with analytical technical specifications -full engineering design)</p>	<p>31.1.2005 (with the interim report)</p> <p>31.1.2005 (with the interim report)</p> <p>27.10.2005 (revised)</p> <p>30.11.2006 (with the final technical report)</p>
Task 4	Information and training material, advertisements (they are included in the Deliverables of Task 7- Dissemination and training activities, Table 2 of the final technical report)	With the 3 <sup>rd</sup> progress report
Task 5	<p><b>Deliverable E.1:</b> Monitoring questionnaire distributed to the householders during the implementation of the program</p> <p>Information leaflets and material of raising awareness events (they are included in the Deliverables of Task 7- Dissemination and training activities, Table 2 of the final technical report)</p>	1.11.2005 (with the final technical report)

Task 6	<b>Deliverable F.1:</b> Report that includes the analysis and the assessment of the content of the filled in questionnaires and the observations and remarks obtained by the working groups, identification of the problems that arisen and presentation of the solutions that were given.	30.11.2006 (with the final technical report)
	<b>Deliverable F.2:</b> Technical report presents the analysis and the evaluation of the results that were obtained from carrying out measurements and analyses for the determination of the qualitative and quantitative characteristics of the compost samples	30.11.2006 (with the final technical report)
	<b>Deliverable F.3:</b> Technical report that presents a framework of guidelines and specifications for the implementation of the program in larger scale (including the identification of the potential incentives that may promote its successful implementation as well as a preliminary cost-benefit analysis)	30.11.2006 (with the final technical report)
	<b>Deliverable F.4:</b> Report includes information on the site visits to Austria	10.4.2006 (with the final technical report)

## 8. Dissemination activities and deliverables

### 8.1 Dissemination Plan (summary)

The dissemination plan of the project included the following activities:

- Publications in scientific/technical journals and conferences
- Leaflets and brochures distributed in all actors involved in the field of household waste management
- Training courses for the householders that participate in the programme as well as for the representatives of the Municipalities – partners of the project
- Information campaign for the householders
- Development and updating of a website describing the project
- Advertisements for the promotion and the dissemination of the project
- Preparation and distribution of informative printed material
- Personal meetings of the working groups with those interested in being informed on the project
- Organisation of a Conference in Athens

### 8.2 Activities implemented and output

Regarding the project dissemination, several efforts have been made with remarkable results during the entire implementation of the project. In particular:

A meeting between the staff of NTUA and representatives from the Greek Ministry of Environment, Regional Planning and Public Works (A. Issaakidis, S. Kollanou, K. Dontas) has been arranged (12.12.2003) in order to inform the ME about the project and to find useful information, especially concerning the legislation field. From the meeting it was concluded that the outcome of the programme is in accordance to the national plan for waste management and, furthermore, it contributes to the direction of achieving the national targets concerning the recovery of the biodegradable organic fraction from the urban solid waste.

Moreover, meetings took place (18.12.2003, 20.4.2004, 5.11.2004, 10.1.2005) between the staff of NTUA and representatives from the Association of Communities and Municipalities of the Attica Region - ACMAR (E. Kapetanios, N. Karavassilis), with the purpose to retrieve information concerning the waste of each municipality and community of Attica region and to inform ACMAR about the project progress. From the meetings it was concluded that the project is useful for the implementation of the management schemes in the Attica region. Also, the representatives of the ACMAR intended to support the effort for the development of the programme in other Municipalities of the Attica region.

In addition, a meeting was held (12.2.2004) between NTUA staff and representatives from the Association of Local Authorities of Greater Thessaloniki Area –ALAGT (C. Mparmpounakis, G. Savvidis). From the meeting it was concluded that the programme could be implemented, in a pilot scale, in Municipalities of the area of Thessaloniki.

Meetings took place between NTUA staff and representatives of the Ecological Recycling Society – ERS (ECO.RE.C.) (N.Chrisogelos, F.Kirkitsos) on 16<sup>th</sup> December 2003 and the Hellenic Solid Waste Management Association –HSWMA (national member of the International Solid Waste Association - ISWA) (K. Komilis, K. Lazaridou) on 18<sup>th</sup> December 2003 in order to inform them about the project and to retrieve useful information, concerning the quality of the waste that is produced by the Greek urban households and also information relevant to the field of the design of the composting unit.

Finally, contacts were made and meetings were arranged between NTUA staff and representatives from many Municipalities and Communities of Attica region, aiming at disseminating the project content and collecting information on waste. Also, in order to inform all the municipalities and the communities of Attica region about the program, phone calls were made and e-mails, mail and faxes were sent. It must be mentioned that many Municipalities and Communities have shown great interest for the project and expressed their willingness to get informed on the results when the project is completed.

Additionally, the following dissemination material was prepared and distributed:

1. Two sets of informative printed material were prepared by the NTUA, one in English (submitted to the EC with the first progress report) and one in Greek (submitted to the EC with the second progress report). 500 copies of this dissemination material were distributed to members of Greek and Cypriot Universities, Research Centres and Institutes (Greece: Department of Environmental Engineering of the School of Mechanical Engineering of the Aristotelian University of Thessaloniki, Department of Applied Physics of the National and Kapodistrian University of Athens, Department of Environmental Engineering of Technical University of Crete, Department of Production Engineering and Management of Technical University of Crete, Department of Environmental Engineering of Democretian University of Thrace, Department of Environment of the School of Environment of the Aegean University, Department of Agriculture production of the Agriculture University of Athens, Department of Agronomics of Aristotelian University of Thessaloniki, National Agricultural Research Foundation, Research Department of the ACMAR, Hellenic Non Profit Association of Management of Solid Waste, Cyprus: Department of Civil and Environmental Engineering of the Polytechnic School of the University of Cyprus, Department of Environmental Management and Agricultural Department of Cyprus University of

Technology, Water Development Department of the Ministry of Agriculture, Natural Resources and Environment, Agriculture Department of the Ministry of Agriculture, Natural Resources and Environment, Agricultural Research Institute) as well as to European and international ones (Department of Food Science of University of Leeds – UK, Department of Agrotechnology and Food Sciences of Wageningen Universiteit – The Netherlands, School of Food Biosciences of University of Reading – UK, Earth Engineering Center of Columbia University – USA, Department of Civil and Environmental Engineering of Imperial College – UK, Agriculture Research Service of United States Department of Agriculture, Department of Land, Air and Water Resources of University of California – USA, Department of Soil Science and Chemistry of Czech University of Prague – Czech Republic, Technical University of Sofia, Technical University of Istanbul). The distribution of this printed material was done through e-mail, postal service and FAX as well as during individual meetings (during the entire implementation of the project).

2. Furthermore, 3000 copies of a short version of the program in Greek were prepared by the NTUA (it was submitted with the second progress report) and distributed to Municipalities, NGOs, companies involved in the management of solid waste and habitants of the three Municipalities participated in the project (distribution during the entire time period of the project).

3. Publication of an article in the Greek newspaper “Ethnos tis Kyriakis” published on 16/10/05 (an analytical article about the programme and the prototype system).

4. Publication of an article in the local newspaper of the Municipality of Acharnes “I Elpida” published on 01/12/05 (an analytical article about the programme and details about the workshop-awareness event held at the Municipality of Acharnes).

5. Publication of an article in the local newspaper of the Municipality of Acharnes “Nei Stohi” published on 01/12/05 (an analytical article about the program and details about the workshop-awareness event organized at the Municipality of Acharnes).

6. Preparation of invitation – informative material by the Municipality of Acharnes in collaboration with NTUA. This material was distributed by the Municipality in the framework of the workshop – awareness event held on 28.11.05, to the citizens of the Municipality, through mailing and door-to-door to the householders (more than 1000 copies) .

7. Preparation of a leaflet by NTUA that was distributed to the citizens of the three Municipalities in collaboration with the partners. The leaflet contains information about composting procedure and the prototype composting system (5000 copies) .

8. Preparation of printed material by NTUA that was distributed in collaboration with the three Municipalities – partners to the participants of the three workshops– awareness events. This material contains information about the composting procedure, the prototype system and the program in general (750 copies).

9. Organisation of three workshops – awareness events at the three Municipalities that are participating in the project (details are given below)

10. Preparation of special adhesive informative material by NTUA that was distributed, in collaboration with the three Municipalities – partners, to the householders that are participating in the implementation of the programme. The purpose of this adhesive material is to assist the householders to separate waste and it can be on the fridge or on the composter. The material was distributed during the special individual training modules that were organized by the three partners, where members of the working group of the NTUA explain in details, the functions and the using of the prototype system. These training modules took place at the premises of the three Municipalities (three modules of 8-12 householders were held in each Municipality) (200 copies)



11. Preparation of printed material, containing information about the programme, by NTUA that was distributed to the participants of the LIFE programme meeting held at NTUA on the 24<sup>th</sup> of November 2005.
12. Preparation of invitation – informative material by the Municipality of Nea Halkidona in collaboration with NTUA. This material was distributed by the Municipality to the citizens of the Municipality, through mailing and door-to-door to the householders in the framework of the workshop – awareness event held on 31.10.05 (500 copies).
13. Publication of an article in the Greek local monthly newspaper of the Municipality of Nea Halkidona “Anazitisi agoras”, published on November 2005 (an article containing information about the programme and the workshop - awareness event held in Nea Halkidona).
14. Preparation of an invitation by Anaptyxiaki Kifissias for the workshop – awareness event held in Kifissia on 3.10.2005. The invitation was prepared and distributed to the citizens of the Municipality of Kifissia by Anaptyxiaki Kifissias through mailing and door-to-door to the householders (750 copies).
15. Preparation of invitation cockades by Anaptyxiaki Kifissias in collaboration with NTUA that were distributed to the citizens of the Municipality of Kifissia during the workshop – awareness event held in Kifisia on 3.10.2005 (200 pieces)
16. Preparation of printed informative material by NTUA that was distributed by the Municipality of Kifissia during the workshop – awareness event held in Kifissia on 3.10.2005 (200 copies).
17. Preparation of information and training material by NTUA that was distributed, in collaboration with the three Municipalities, to the participants of the training sessions (more than 500 copies, in total).
18. Preparation of posters by NTUA that were set up at the premises of NTUA and at the three Municipalities - partners, aiming at the dissemination of the project (20 posters).
19. Preparation of 3 posters by the Municipality of Acharnes, in collaboration with NTUA, that were set up at the premises of NTUA and at the Municipality of Acharnes disseminating the program and announcing the workshop-awareness event at the Municipality on 28.11.2005.

The dissemination and training material described at points 3 to 19 was submitted to the EC with the 3<sup>rd</sup> progress report.

Also, an interview on the radio was held, during which Prof. Maria Loizidou explained the separation of waste, the composting process and gave details about the programme. (Metropolitan Radio Station of the Municipality of Athens, 22.10.2005).

Moreover, for the dissemination of the programme the following activities have taken place:

- Undergraduate and postgraduate students as well as citizens from several Municipalities of the Attica region have visited the laboratory of NTUA (at hoc visits), where they were informed about the COMWASTE project and the prototype system and they obtained hands on experience on the operation of the system. Since December 2005 and up to the end of the project (August 2006), more than 250 undergraduate and postgraduate students were informed through special information sessions and more than 80 citizens were informed, individually.
- Contacts were made with the company Compost Hellas located at Kefaliona Island that is involved in the production and selling of compost. Compost Hellas was fully informed about COMWASTE project and a meeting with representatives of the company took place in April 2006, in order to exchange experience about the

promotion of the household compost to the end users, in the framework of the possible implementation of the programme in a large scale.

- A meeting with representatives of the Ecological Recycling Society was held on 10<sup>th</sup> of April 2006 during which, discussions were made on the COMWASTE project and its outcome as well as how the home composting using the prototype system can be promoted after the LIFE project completed.
- The members of the NTUA team visited on regular basis the households in order to obtain a clear view of the implementation of the program, to help the householders to use the system efficiently and to solve any problems arisen (November 2005 till today).
- The members of NTUA team were in contact via phone calls, e-mails and faxes with the householders in order to help the householders to use the system efficiently and give answers to their questions concerning the composting process and the use of the prototype system (November 2005 till today).

Details about the three workshops – awareness events:

**Workshop – Awareness event held in the Municipality of Kifissia on the 3<sup>rd</sup> of October 2005**

The workshop – awareness event was organised by the Anaptyxiaki Kifissias, while NTUA was the technical/scientific responsible for its implementation. The scientific responsible, Prof. Maria Loizidou presented the project (activities, outcome, expected results etc.) while Dr. Evaggelos Kapetanios (Director of the Research Department of the Association of the Communities and Municipalities of Attica Region – ACMAR) explained the composting process. On behalf of the Municipality of Kifissia, the President of Anaptyxiaki Kifissias, Mrs Anna Korogiannaki, made the introduction to the workshop, while the Mayor of the Municipality, Mr Nikolaos Chiotakis, presented in detail the existing situation concerning the practices that are applied for the management of solid waste generated at the Municipality. Furthermore, Mr Giannis Razis (General Director of the Hellenic Company of Development – Recycling) made a speech about the recycling of packaging materials. Finally a member of the Club for the Protection of Kifissia gave a speech concerning the activities that are developed for the protection of the environment at the Municipality.

**Workshop – Awareness event held in Municipality of Nea Halkidona on the 31<sup>st</sup> of October 2005**

The workshop – awareness event was organised by the Municipality of Nea Halkidona, while NTUA was the technical/scientific responsible for its implementation. In the framework of this workshop – awareness event, on behalf of NTUA, Prof. Maria Loizidou presented the project (activities, outcome, expected results etc.) while Mrs Eleni Doulami explained in detail the composting process. On behalf of the Municipality of Nea Halkidona, the Vice President of the Community Centre of the Municipality, Mrs Evaggelia Tsilikouna, made the introduction to the workshop, while the Mayor of the Municipality, Mr Nikos Papamikroulis, presented in detail the existing situation concerning the practices that are applied for the management of solid waste generated at the Municipality.

**Workshop – Awareness event held in Municipality of Acharnes on the 28<sup>th</sup> November 2005**

The workshop – awareness event was organised by the Municipality of Acharnes, while NTUA was the technical/scientific responsible for its implementation. In the framework of this workshop – awareness event, Prof. Maria Loizidou on behalf of NTUA, presented

the project (activities, outcome, expected results etc.) while Mrs Eleni Doulami explained the composting process. On behalf of the Municipality of Acharnes, the Vice Mayor of the Municipality, Mrs Ioanna Kada, made the introduction to the workshop, while the Mayor of the Municipality, Mr P.Striftos, explained in detail the existing situation concerning the practices that are applied for the management of solid waste at the Municipality. Additionally, Mr. Thanassis Katsigiannis (President of the Environment Commission of the Greek Parliament) made a speech explaining the existing situation in Greece in general, and more specifically in the Attica Region, concerning the environmental policy and the practices that are applied/planned for the management of solid-municipal waste.

The presentations made by Prof. Maria Loizidou and Mrs. Eleni Doulami in the framework of the workshops – awareness events can be downloaded from our site.

The three awareness events – workshops (in Kifisia on 3rd of October 2005, Nea Halkidona on 31st of October 2005 and in Acharnes on 28th of November 2005) were held very successfully. All three workshops were well - attended (150 participants in Kifisia, 80 in Nea Halkidona and 250 in Acharnes) and all the interested parties (public/householders, representatives of the Local Authorities, representatives of the Greek Parliament, media) showed interest in the project. It must be mentioned that the level of participation in the three awareness events – workshops was very high and proportional to the population of each municipality.

Finally, a website including information about the project was developed (<http://www.uest.gr/comwaste>). This site contains analytical data related to the implementation and the results of the project as well as information on the prototype household composting system.

The dissemination and training activities were carried out according to the dissemination plan with one modification and in particular: Instead of the materialization of a conference where the project's content and outcome would be presented, an extensive dissemination campaign took place at the stand that set up by the NTUA at the exhibition which was organized by the Committee of Environment of the Hellenic Parliament and the Municipality of Athens (Sintagma Square, Athens) from 3<sup>rd</sup> to 5<sup>th</sup> of June 2006 (from 9.00 a.m. until 9.00 p.m, each day) in the framework of the World Day of Environment. During this 3-day event, the personnel of the NTUA distributed dissemination material (more than 5.000 of a set of dissemination material), they had discussions with the public related to the COMWASTE project and additionally, the working group of the project demonstrated in practice the use and the operation of the household composting system to the people that visited the stand (four household composting systems were available for the demonstration). The number of people that visited the stand of the NTUA and were informed about the use of the prototype system exceeded 5000, a number that is extremely higher than the number of people that would have attended the conference which initially it was foreseen to be held.

Finally, the scientific content and the outcome of the project will be announced in conferences and it will be submitted for publication in international journals.

Table 2 presents synoptically, the information related to the items that were prepared during the implementation of the dissemination/training task of the COMWASTE project.

**Table 2: List of items prepared during the implementation of the Dissemination/training Task**

<b>Title and content</b>	<b>Date of delivery</b>
Informative printed material of the project in Greek	During the entire time period of the project (submitted with the 1 <sup>st</sup> progress report)
Informative printed material of the project in English	During the entire time period of the project (submitted with the 2 <sup>nd</sup> progress report)
Short version of the program in Greek	During the entire time period of the project (submitted with the 2 <sup>nd</sup> progress report)
An article published in the Greek newspaper “Ethnos tis Kyriakis” (an analytical article about the programme and the prototype system).	16.10.2005 (submitted with the 3 <sup>rd</sup> progress report)
An article published in the local newspaper of the Municipality of Acharnes “I Elpida” (an analytical article about the programme and details about the workshop-awareness event held at the Municipality of Acharnes).	1.12.2005 (submitted with the 3 <sup>rd</sup> progress report)
An article published in the local newspaper of the Municipality of Acharnes “Nei Stohi” (an analytical article about the program and details about the workshop-awareness event organized at the Municipality of Acharnes).	1.12.2005 (submitted with the 3 <sup>rd</sup> progress report)
Invitation – informative material that was distributed in the framework of the workshop – awareness event held on 28.11.05, at the Municipality of Acharnes	15.10.2005 – 27.11.2005 (submitted with the 3 <sup>rd</sup> progress report)
A leaflet by NTUA that was distributed to the citizens of the three Municipalities (it contains information about composting procedure and the prototype composting system).	October – November 2005 (submitted with the 3 <sup>rd</sup> progress report)
Printed material that was distributed to the participants of the three workshops– awareness events.	October – November 2005 (submitted with the 3 <sup>rd</sup> progress report)
Special adhesive informative material that was distributed to the householders that are participating in the implementation of the programme.	October 2005 (submitted with the 3 <sup>rd</sup> progress report)
Printed material, containing information about the programme that was distributed to the participants of the LIFE programme meeting held in NTUA	24.11.2005 (submitted with the 3 <sup>rd</sup> progress report)
Invitation – informative material that was distributed to the citizens of the Municipality of Nea Halkidona, in the framework of the workshop – awareness event held on 31.10.05.	October 2005 (submitted with the 3 <sup>rd</sup> progress report)
An article published in the Greek local monthly newspaper of the Municipality of Nea Halkidona “Anazitisi agoras”, (an article containing information about the programme and the workshop - awareness event held in Nea Halkidona).	November 2005 (submitted with the 3 <sup>rd</sup> progress report)

An invitation for the workshop – awareness event held in Kifissia on 3.10.2005.	September 2005 (submitted with the 3 <sup>rd</sup> progress report)
Invitation cockades that were distributed to the citizens of the Municipality of Kifissia during the workshop – awareness event held in Kifisia	3.10.2005 (submitted with the 3 <sup>rd</sup> progress report)
Printed informative material that was distributed during the workshop – awareness event held in Kifissia	3.10.2005 (submitted with the 3 <sup>rd</sup> progress report)
Information and training material that was distributed to the participants of the training sessions	October – November 2005 (submitted with the 3 <sup>rd</sup> progress report)
Posters that were set up at the premises of NTUA and at the three Municipalities - partners, aiming at the dissemination of the project	October – November 2005 (submitted with the 3 <sup>rd</sup> progress report)
Posters that were set up at the premises of NTUA and at the Municipality of Acharnes disseminating the program and announcing the workshop-awareness event at the Municipality on 28.11.2005.	October – November 2005 (submitted with the 3 <sup>rd</sup> progress report)

## **9. Evaluation and Conclusions**

### **Project implementation**

#### **a. The process**

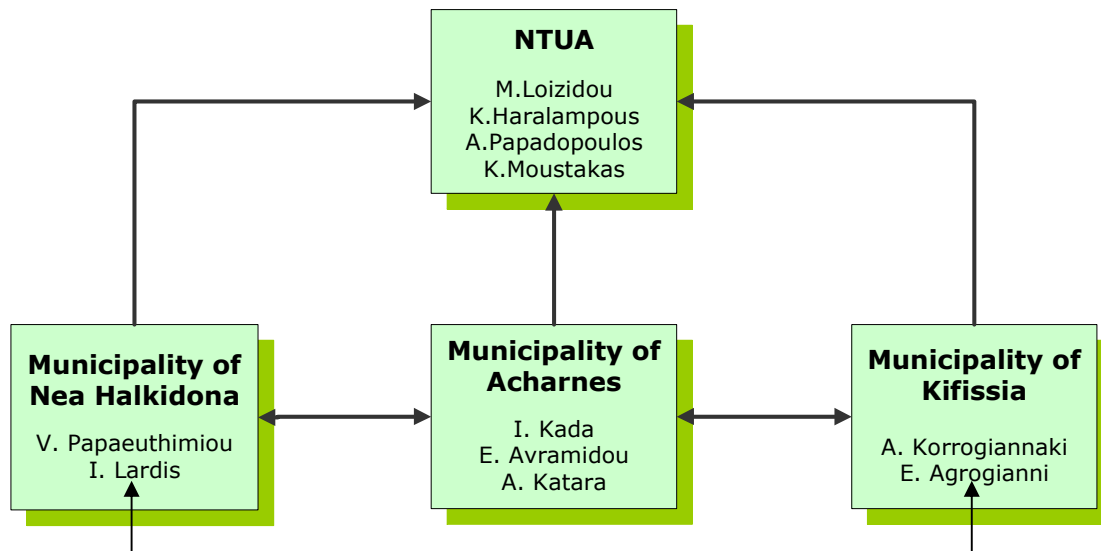
The technical development of the project was materialised through the implementation of six main technical tasks (each one with its individual subtasks). The six technical tasks were carried out successfully and in accordance to the proposal of the project, qualitatively and quantitatively. All the individual targets that were set per task, were achieved and the outcomes and the deliverables that were foreseen in the proposal, were obtained adequately.

#### **b. The project management, the problems encountered, the partnerships and their added value**

The management Task that covered the whole time period of the project and included (a) the effective management and coordination of the project and fulfilment of the activities, on time (b) the preparation and submission of the appropriate reports to the EC, was implemented successfully. Everything proceeded smoothly and the collaboration between the NTUA (Beneficiary) and the three Municipalities (partners) was efficient and productive. The project was developed according to the initial proposal and no modifications (technical, financial, project – organisation) were made.

During the entire period, several meetings were arranged between NTUA and municipal partner's staff, aiming at a good cooperation, management and dissemination of the project. No changes in the project's management structure have been made and everything proceeded as initially planned (Deliverable H.1: Information on the managerial meetings).

The project management organization chart of the project is presented below:



Finally, in order to fulfil the reporting obligations of the project, the following material have been prepared and delivered:

- First Progress Report: 31.05.2004
- Interim Technical and Financial Report: 31.03.2005
- Second Progress Report: 30.11.2005
- Technical material and additional information requested by the EC letter of 21.9.2005 (submitted on the 27<sup>th</sup> of October 2005).
- Third progress Report: 28.2.2006
- Final Technical and Financial Report: 30.11.2006

**c. Technical and commercial application (reproducibility, economic feasibility, limiting factors)**

The reproducibility and the application of the prototype system in large scale are feasible, since:

- The technology on which the development of the system is based, is well-documented.
- The manufacturing of the system was materialized using matrices and molds that were developed especially for this purpose, according to specific technical specifications and characteristics that were set. These matrices and molds are available for expanding the production line of the prototype system, fact that ensures its easy reproducibility.
- The prototype system was tested adequately during its manufacturing and in particular: i. during the construction and after the finalization of its individual components/compartments ii. during the construction and after the finalization (optimization) of the entire system.
- The prototype system was tested intensively in practice, for a sufficient time period, during its use by the householders.
- The cost for the manufacturing of the household composting system is quite low and competitive to the cost of other systems that are available in the market. Also, it must be mentioned that the cost per item is reduced as the number of items that are manufactured is increased. In particular, for the manufacture of more than 2000 items the cost per system is estimated to be 350€. Additionally, the operation cost of the system is extremely low since it includes only expenses for the provision of the additives (zeolite).
- The environmental benefits from the use of the system are considerable

Limiting factors for the application of the household composting system do not incur since:

- The use of the system by the householders is easy and simple
- The use of system is incorporated into the daily activities of the householders, easily (the householders place their kitchen waste in the system instead of placing them in the common bins used for the collection of the mixed household waste)
- The time needed for the use of the system daily is extremely low
- The dimensions and the volume of the system are small (similar ones to the dimensions of the most household devices), fact that allows its easy and unobstructed installation at the households.
- The response of the householders of the three Municipalities that participated in its pilot implementation as well as the intension of other citizens in the same and other Municipalities to be provided with the system were very high, fact that indicates the high level of its acceptance by the public.

#### **d. Comparison against the project-objectives**

All the individual objectives set through the project were achieved. In particular:

I. a complete, clear and representative picture of the existing situation related to the generation and management of the household wastes i. in the Attica region and ii. in the three Municipalities where the pilot project was implemented (characteristics and composition of the household waste, existing management practices), was obtained. Also, a thorough analysis of the corresponding national and European legislative framework was performed (principles, provisions, constrains, targets and obligations set in it) and the special characteristics/habits of the householders were identified and analysed. This outcome is of a great importance since it provides:

- i. a representative and cohesive view related to the household waste generated in the Municipalities and the Communities of the Attica Region generally, and in the three Municipalities that participated in the project specifically,
- ii. a clear picture concerning the efficiency of the existing household waste management practices
- iii. a well – documented identification about the potential degree of utilization (separate collection and composting) of the biodegradable fraction of the household waste in the Attica Region.

II. Knowledge and experience on scientifically sound and effective practices, systems and technologies on biodegradable household waste collection-composting at source was acquired (success stories at European and international level). In addition, the parameters and factors that affect the success of these schemes were identified. This outcome is very useful, since through it, it is documented that the practice of separate collection/composting of the biodegradable organic fraction of the household waste at source is a feasible option in respect to environment, technology, organisation, economics etc. Also, the know-how and experience on this practice is disseminated to the Municipalities involved in the project as well as to other Local Authorities.

III. A suitable and effective prototype system for the simultaneous separate collection and composting at source of the household biodegradable organics was designed, constructed and installed in selected households of the three Municipalities – partners of the project (pilot implementation). This prototype system was used for an adequate time period by

the householders who had been trained specifically on its use. The outcome is very important, since:

- i. it is the first application of such system (simultaneous collection/composting at source) in the country
- ii. the householders became familiar with the practice of separate collection/composting of their waste at source, placing this practice among their daily activities (common daily practice)
- iii. the environmental concern of the people was increased

IV. An evaluation of the results from the implementation of the pilot program was obtained and suggestions for the full-scale introduction of the prototype system was developed. The outcome is very significant since:

- i. the results of the implementation were analysed properly and adequately resulting to conclusions that are well-documented (documentation according to application in practice)
- ii. the problems that were identified during the pilot implementation were overcome on time and they will be used as a guide in order to avoid similar problems in further applications
- iii. the application was tested in practice and its viability was well - documented
- iv. the Local authorities were provided with a well-documented, in terms of technical and economic nature, tool for the application of the prototype systems in the households of their Community or Municipality.

Furthermore, all the overall objectives set through the implementation of the COMWASTE project were achieved. In particular:

- i. development of a prototype system for the simultaneous separation and composting of the biodegradable household waste at source, that is tailored to the needs and the specific characteristics of the densely inhabited area of the Attica Region and it is characterized by flexibility, convenience in use and capability to treat small quantities of waste in short time period.
- ii. Diversion of the organic matter of the household waste from the traditional disposal to landfills. It is estimated that a percentage up to 40% of the mixed municipal solid waste that refers to household organic waste will be utilized for the production of a useful end-product (compost) instead to be disposed at landfill sites. This fact leads to a significant number of environmental benefits, as presented analytically in the Section: Direct/Quantitative environmental benefits).
- iii. Contribution to meeting local recycling targets as set by the relevant EU legislation (e.g. Directive 99/31/EC) and the national strategy. According to this legislative framework, a percentage of (a) not later than five years after the date laid down in Article 18(1), biodegradable municipal waste going to landfills must be reduced to 75 % of the total amount (by weight) of biodegradable municipal waste produced in 1995 or the latest year before 1995 for which standardised Eurostat data is available (b) not later than eight years after the date laid down in Article 18(1), biodegradable municipal waste going to landfills must be reduced to 50 % of the total amount (by weight) of biodegradable municipal waste produced in 1995 or the latest year before 1995 for which standardised Eurostat data is available; (c) not later than 15 years after the date laid down in Article 18(1), biodegradable municipal waste going to landfills must be reduced to 35 % of the total amount (by weight) of biodegradable municipal waste produced in 1995 or the latest year before 1995 for which standardised Eurostat data is available.



iv. Provision of information related to the household composting to all the actors involved in the field, as described analytically in the Section: “Relevance for environmentally significant issues or policy areas”.

v. Increasing of the environmental awareness of the citizens (they take more ownership of efforts to protect the environment)

vi. Assistant to the local Authorities to introduce successful and cost-effective home composting and biodegradable waste-separation schemes in their localities, as described in detail, in the Section: “Relevance for environmentally significant issues or policy areas”.

#### **e. Effectiveness of dissemination activities**

As described analytically at Section 8.2, significant training and dissemination activities took place, that ran continuously during the whole period of the development of the project. The outcome of these activities was of a great importance since:

- the householders – participants in the implementation of the program were trained adequately and became familiar with the use of the prototype composting system
- other householders from the three Municipalities – partners of the project as well as householders from other Municipalities expressed their interest to be provided with a prototype system in order to use it for the separation and composting of the kitchen waste generated at their households
- representatives of other Local Authorities expressed their intent to organise similar programs at their Municipalities
- a vast number of undergraduate and postgraduate students, representatives of research Centers and institutes in Greece and internationally, citizens in Athens, other areas of the country and abroad was informed about the project.

#### **f. The future: continuation of the project + remaining threats**

##### **Analysis of long-term benefits**

##### **a. Environmental benefits**

##### **1. Direct/quantitative environmental benefits (e.g. reductions of emissions, energy or resource savings)**

- contribution to the achievement of the quantitative national targets concerning the diversion of the biodegradable organics from landfilling
- raising of the environmental awareness of the public – Increasing of the sensitization of the citizens on environmental issues – placing of good environmental practices among the daily activities of the householders
- reduction of the nuisance that occurs during the collection and transfer of the municipal solid waste (decrease of the number of vehicle routes for the collection of the municipal solid waste and their transfer to sanitary landfill)
- lower burden of the landfill sites, in terms of quantity and polluting load, due to the reduction of the amount of municipal solid waste that are disposed, fact that results in the increasing of their operation life cycle
- generation of leachates at landfill sites with reduced organic load due to the decrease of the organics that are disposed
- reduction in the air emissions from landfills in qualitative and quantitative terms (concentrations of carbon dioxide, methane, VOCs, etc.)
- production of a product with added value that could be used for landscaping or for agricultural purposes such as soil fertilizer, soil improvement and soil conditioner (through improving the soil structure, porosity and density, increasing infiltration and permeability, reducing runoff and erosion, improving water holding capacity, reducing water loss and leaching in sandy soils, supplying macro and

micronutrients, controlling of soil-borne pathogens, improving of cation exchange capacity of soils, increasing the ability to hold nutrients for plant use, supplying of beneficial micro-organisms to soil and growth media, improving/stabilizing soil pH and providing the potential to bind and degrade some pollutants of the soil.

- avoidance of using synthetic fertilizers for agricultural purposes
- The application of the practice of the separation of organics at source offers the opportunity of a high-quality “clean” feedstock for composting and the prospect of an uncontaminated end-product, compared to the organic material derived from central mechanical sorting plants)
- The separate collection and simultaneous composting of the kitchen waste fraction by the householders facilitates a reduction in the frequency that is required for the collection of the residual household waste fraction. This is especially important consideration in Southern European and other Mediterranean countries where the climatic conditions demand more frequent collection of easily degraded wastes.

**2. Relevance for environmentally significant issues or policy areas (e.g. industries/sectors with significant environmental impact, consistency with 6EAP or important environmental principles, relevance to the EU legislative framework (directives, policy development, etc.)**

The outcome of the project has a great impact to all the actors involved in the field of the generation and management of the household solid waste. In particular:

i. citizens/householders: Their environmental awareness is increased, they take more initiatives and make more efforts to protect the environment, they include the practice of simultaneous separation/composting of biodegradable household waste as a common daily activity, they produce a product with added value originated from the waste that they generate, they participate actively in material recycling schemes, they possess a sense of responsibility for their waste, etc.

ii. Local Authorities: They are provided with an effective tool in order to re-organize the existing practices that are applied for the management of the household wastes generated at their localities, which is based on the principles and the priorities of the European and national environmental policy and legislation. This, results in i) saving of money (from the reduction in costs for the collection and transfer of the mixed municipal wastes to the landfills as well as from the utilization of the compost that will be produced ii) limitation of the annoyance occurs during the collection and transfer of waste to the landfill sites iii) improvement of the entire environmental picture of the Municipality/Community.

iii. Private companies: Private companies that deal with the trading of products for agricultural applications could include the compost produced through household composting in the products that sell.

iv. Public Authorities/decision and policy makers: The application of the household separate collection/composting of the biodegradable organic wastes in large scale, will contribute to the achievement of the quantitative national targets concerning the diversion of the biodegradable organics from landfills. In addition, by incorporating this practice in the existing solid waste management schemes the principles and the priorities of the European and national environmental policy and legislation are enforced in reality providing tactile results.

Additionally, the COMWASTE project is consistent with the key environmental priorities of the 6EAP, and in particular with the thematic strategy on waste prevention and recycling, since it is based on the simultaneous separation and composting of the

biodegradable organic material contained in solid waste, fact that results in the transformation of waste to a useful end-product with added value.

Moreover, the project is relevant to the EU environmental Directives that deal directly or indirectly with the management of waste and in specific, the Directive 99/31/EC on sanitary landfill of wastes and the Directive 91/156/EU that amended Directive 75/442/EU on solid waste.

In particular:

- The objective of the Directive 99/31/EC is to prevent or reduce as far as possible the negative effects on the environment from the landfilling of waste, by introducing stringent technical requirements for waste and landfills. Also, the Directive sets specific quantitative targets that must be achieved by each member state in a specific time period concerning the reduction of the quantities of the biodegradable municipal waste that is transferred and disposed to landfills. The use of the prototype household composting systems will contribute significantly towards to this direction, since it is based on the utilization of the biodegradable household organic waste instead of its final disposal to landfills.
- According to the Directive 91/156/EU that amended Directive 75/442/EU, the member states must undertake actions for the management of solid waste in order to encourage:
  - (a) firstly, the prevention or reduction of waste production and its harmfulness, in particular by:
    - the development of clean technologies more sparing in their use of natural resources,
    - the technical development and marketing of products designed so as to make no contribution or to make the smallest possible contribution, by the nature of their manufacture, use or final disposal, to increasing the amount or harmfulness of waste and pollution hazards,
    - the development of appropriate techniques for the final disposal of dangerous substances contained in waste destined for recovery;
  - (b) secondly:
    - (i) the recovery of waste by means of recycling, re-use or reclamation or any other process with a view to extracting secondary raw materials, or
    - (ii) the use of waste as a source of energy.

The application of the household composting process that is promoted through the COMWASTE project is fully in accordance with the provisions and the priorities of this Directive (development of techniques for recovery and recycling of solid waste).

Finally, the know-how and the technology that were developed via the project are based on other fundamental European environmental principles and priorities such as the application of the three R management practices (Recovery, Reuse, Recycling), the development of waste management systems and schemes that promote the sustainable development etc.

## **b. Long-term sustainability**

**1. Long-term/qualitative environmental benefits (e.g. long term sustainable technology, from product to functional focus, from end-of-pipe to prevention; high visibility for environmental problems and/or solutions; spin-off effect in other environmental areas etc.)**

The technology that was developed and applied through the COMWASTE project is based on the simultaneous separation, biodegradation and stabilization of the household organic fraction, at source, using an appropriate prototype system that was designed and manufactured specifically for this purpose. The prototype system is characterized by a high level of sustainability since:

- it is based on the application of a treatment method (composting) that is time-tested successfully.
- it is based on a technology that promotes the sustainable management of waste (recovery of materials and transformation into a useful end-product which, additionally, could substitute the use of synthetic products)
- it uses a “clean” waste as feedstock for composting (organic fraction of household waste that is separated at source), fact that allows the production of an end-product of a high quality and, consequently, its unobstructed use (on the contrary, the biodegradable fraction that is extracted from mixed waste in central mechanical sorting plants may have impurities, fact that can result in the production of an end-product of a low quality with limited potential for use)
- it could be installed at any household without problems since its dimensions are similar to other household devices
- it is convenient in using (it operates similarly to a bin used for the placement of the mixed household waste)
- it has the capability to treat small quantities of organic wastes in a short time-period
- the cost for its manufacturing is low
- the cost for its operation and maintenance is low
- its use could be place among the daily activities of the householders, easily and smoothly.

Additionally, the application of such a system can lead to the limitation of significant environmental problems, giving tactile solutions, as described analytically at point f1a. Indicatively: reduction of the annoyance that occurs during the collection and transfer of the municipal solid waste, lower burden of the landfill sites, in terms of quantity and polluting load, due to the reduction of the amount of municipal solid waste that are disposed, increase of the operational time life of the landfills, reduced generation of leachates and reduced organic load in leachates due to the decrease of the organics that are disposed, reduction in the air emissions from landfills in qualitative and quantitative terms, production from waste of a product with added value which otherwise must be disposed at landfill sites etc.

Also, the use of the technology in large scale applications affects positively other environmental areas, since the end-product could be used for i. landscaping, ii. land restoration, iii. soil fertilizer and conditioner, substituting the use of synthetic fertilizers for agricultural purposes iv. deodorant mean at landfill sites.

Finally, the range of the feedstock of the system could be expanded in order to include other waste fractions such as green waste from private and municipal gardens, private yards, municipal parks, etc.

## **2. Long-term / qualitative economic benefits (e.g. long-term cost savings and/or business opportunities with new technology etc., regional development, cost reductions or revenues in other sectors)**

The application of the technology could result in cost savings in the sector of the municipal solid waste management since:

- The aggregated cost for the procurement, the operation and the maintenance of the prototype systems is quite lower than the respective cost which is required for the

construction and operation of a central mechanical recycling and composting plant.

- A product with high added value is produced, by transforming a waste into a useful end-product
- The quality of the compost produced by using the household composting systems is higher than the quality of the compost produced at central plants, fact that allows its easier use or/and forwarding to the corresponding market
- The cost for the collection and the transfer of the mixed waste to the landfill sites is reduced, as a result of the decrease of the number of the vehicle routes that are required for this purpose (lower quantity of waste must be collected and disposed). The reduction in this cost parameter is due to the reduction in the demands for personnel, fuel for the circulation of the vehicles and maintenance of the vehicles.
- The cost for the disposal of the mixed waste (disposal fees paid by the Municipalities to the operator of the landfill site) is reduced, since the level of this expense is proportional to the quantity of waste that are disposed.
- The lower burden of the landfill sites, in terms of quantity and polluting load, due to the reduction of the amount of municipal solid waste that are disposed, results in the increase of the operational time life of the landfills and consequently the decrease in the demands for space in order to construct new landfill sites.
- The reduction of the organic load content of the leachates generated at the landfill sites due to the decrease of the organic waste that are disposed as well as the reduction in air emissions from landfills in qualitative and quantitative terms results in the decrease in the operation and maintenance costs of the landfill anti-polluting systems.
  
- The potential substitution of the synthetic fertilizers used for agricultural purposes by compost leads to saving of cost for raw materials and energy.

Also, it must be mentioned that the European Operational Programme "Environment" for Greece involves Community support for all Greek regions within the Objective 1 framework (regions lagging behind in their development) and under Priority 5 "Quality of life" of the Community Support Framework (CSF) for Greece. According to the Priority 2 of this programme for Regional Development: Solid waste, the first objective is the creation of a waste policy with the aim of reducing the waste flows, to separate the different kinds of waste and to recycle them. This policy will contribute to the reduction of waste flows and to the protection of natural sites. The know-how and the outcome of the COMWASTE project is completely harmonized towards to this direction.

### **3. Long-term/qualitative social benefits (e.g. positive effects on employment, health, ethnic integration, equality and other socio-economic impact etc.)**

The project can lead to significant social and other relative benefits, such as:

The use of the prototype systems in large scale applications, covering high population areas will lead to the production of large quantities of household compost providing the opportunity for its trading. As a result, requirements for new jobs will be created since the need for increased number of employees who will work in the entire management scheme will be raised. These employees could be technicians, collectors of the composting product, drivers, engineers for the provision of technical support, agriculturists, etc.

The diversion of biodegradable organic fraction from the mixed household waste and the consequent reduction in the quantities and the polluting load of the waste that is disposed

to landfill will result in a decrease in the potential impacts that are occurred during the operation of the landfill sites to the environment and the public health. Also, the potential substitution of the synthetic fertilizers by compost will contribute to the conservation of the natural resources through the saving of raw materials and energy.

Also, as it is mentioned previously, the prototype composting system could be installed at any household and be used by any householder/citizen, regardless of his living and economic status, cultural and educational level, etc.

**c. Replicability, demonstration, transferability, cooperation**

**1. Transferability & Potential for Commercialisation, including cost-effectiveness compared to other solutions, benefits for users (e.g. improved health&labour conditions, less nuisance to others), drivers and obstacles for replicability/reproducibility, market conditions, pressure from the public, potential degree of geographical dispersion, specific target group information, high project visibility (eye-catchers), possibility in same and other sectors on local and EU level, etc.**

The project is characterized by a high level of transferability and potential for commercialisation, taking into consideration, the following:

A. The application of such a system in large scale applications presents a high level of viability, since:

i. the total cost for the procurement, operation and maintenance of the systems is significantly lower compared to other practices that are applied for the management of waste such as central mechanical sorting and composting plants, thermal treatment and sanitary landfilling of waste, as described at point b2.

ii. the cost for the entire management of the mixed household wastes is reduced significantly (reduction in costs for collection and transfer of mixed waste for final disposal, in demands for the operation of the anti-polluting systems at landfill sites, in final disposal fees, as described at point b2.

iii. the systems are based on a well-documented and reliable technology

iv. significant and tactile environmental benefits are obtained through the use of the systems, as described at point 1a.

v. the prototype systems are characterized by a high level of sustainability, as described at point b1

vi. the use of the systems in large scale applications can lead to significant social and other relative benefits, as described at point b3.

B. The application of the systems is based on the principles and the priorities of the European and national environmental legislation and policy, fact that facilitates its easier incorporation in the existing waste management schemes.

C. The incorporation of such systems in the local municipal waste management schemes will lead to limitation of the nuisance occurred during the collection and transportation of the mixed household wastes

D. The end-product is characterized by a high quality level, fact that allows its possible trading utilization through the development of the relative market

E. The technology that was developed through the project focuses on the solving of a common problem such is the generation of kitchen waste by the citizens and the prototype household composting system can be used by any householder in an easy and simple way. This fact ensures its possible application in large scale, covering big

populated areas and indicates the very high degree of geographical dispersion at local and national level.

F. The management of the biodegradable household waste is a widespread environmental problem, common in all the countries, fact which indicates that the prototype system could be used extensively in other European and international areas and countries.

G. The setting, planning-design and implementation of the project follows an integrated methodology that do not respond only to COMWASTE project but as a methodology could be implemented to a variety of topics of environmental concern such as the management of batteries and accumulators, small quantities of hazardous materials in household waste etc in Greece as well as at European and international level.

H. The project presents a high level of visibility since it leads to concrete, direct and tactile results that are evident by the people who use the prototype system (transformation of the household organic waste into a useful end-product, within a short time period).

#### **d. Innovation**

##### **1. Level of innovation on (inter)national level (including technology, processes, methods & tools, organisational & co-operational aspects)**

The content and the outcome of the COMWASTE project are characterized by a high level of innovation at national and international level, since:

i. The use of the system based on the separation and composting of the household biodegradable organic waste, at source which represents the new trend in the treatment of this type of household waste (until now, the biological treatment of the biodegradable organic material was, mainly, taking place at central plants after its pre-separation from the mixed household waste)

ii. The household composting applications are very limited at European and international level, while it is the first attempt in Greece to establish such as system for simultaneous collection.composting of kitchen waste at source

iii. The prototype system that was designed, manufactured and operated through the COMWASTE project has significant unique characteristics - advantages, compared to other similar systems that are available internationally, such as:

- Separate feeding system that minimizes the odours from the composting compartment during feeding of fresh organic material
- Simplified and fluent feeding procedure
- Composting compartment (reactor vessel) that is isolated from the feeding system, feature that leads to: i. the avoidance of mixing of fresh organic material with the composted material, ii. the procedures of insertion of fresh organic material and the collection of composted material do not affect the composting procedures.
- Provisions for the collection of leachate
- Agitate system without contacting waste on compost
- Using of specific additives that assist to the control and optimization of the composting process and the improvement of the quality of the composted product.
- The composting system operates on a continuous basis (continuous feeding of new organics in parallel with continuous collection and removal of composting product).

iv. The use of such a system by the householders activates the participation in a full level, fact that provides them with a high sensation of responsibility about their waste and furthermore it gives to them the ability to get involved in the management of their waste more effectively and dynamically

#### **10. After-LIFE Communication Plan**

As described analytically in Section 9, the project presents a high level of replicability and transferability. The after-LIFE plan to continue and expand the dissemination and the communication of the results and the outcome of the COMWASTE project includes several actions as described below:

The operation of the system at the 90 households is keeping on, and after the end of the project and it is foreseen to relocate some of them to other households in order to expand the use of the system (more citizens-householders use the system in practice). It must be noted that a great number of citizens from the three Municipalities and other Municipalities expressed their interest to install the system at their households.

The beneficiary (NTUA) in collaboration with the three partners – Municipalities plan to organise additional special events at the premises of each Municipality where citizens from the three Municipalities as well as from other areas will be invited to participate. The aim of these events will be to disseminate further the results of the implementation of the program.

Representatives from other Municipalities (e.g. Metropolitan Municipality of Athens, Municipality of P. Phaliron, Municipalities in Cyprus and Morocco), during contacts and meetings that had with the members of the working group of the beneficiary, expressed their interest to incorporate the use of the household composting system into their existing schemes applied for the management of the municipal solid waste at their localities. The working group of the beneficiary plan new meetings with the representatives of the Municipalities in order to make the appropriate arrangements (organisation of special events for the dissemination of the household composting and the prototype system, reproduction of the household composting bins as well as for the training of the householders) and speed up the procedures for the installations of the system at the households of these Municipalities

As mentioned at Section 8, contacts and meetings were made with the company Compost Hellas located at Kefaliona Island that is involved in the production and selling of compost. After extensive discussions about COMWASTE project and exchanging of experience on the promotion of the household compost to the end users, the beneficiary obtained a clear picture about the compost trading network in Greece and it plans to have contacts and meetings with all actors that participate in this network in order to make the necessary arrangements for the possible promotion of the compost that will be produced though the implementation of the programme in a large scale to the end users.

Also, the beneficiary in the framework of its activities, has close collaboration with Local Authorities (Municipalities and Communities), Prefecture and Peripheral Authorities and it plans to organise meetings with representatives of them in order to disseminate and promote the household composting system in the entire country.

Moreover, the beneficiary, in the framework of its close and constant collaboration with the ACMAR (the Authority that is responsible for the planning and implementation of municipal solid waste management schemes in the Attica Region), has contacts and



meetings with representatives of this Authority in order to examine the potential of incorporating the household composting system in the existing management programs that are applied (it must be noted that the ACMAR has already established recycling programs for paper, metals and other packaging waste materials in the Attica Region).

Additionally, the working group of the beneficiary has a constant contact with the representatives of the Ecological Recycling Society in order to promote the prototype home composting system to other areas, utilizing the collaboration that the Ecological Recycling Society have with many stakeholders.

Also, the COMWASTE outcome and the prototype system itself, are being and will be disseminated during the development of dissemination activities for other LIFE projects that are implemented by the beneficiary.

Finally, a section in the project website is included, where those who are interested in the prototype household composting system can get answers to frequently asked questions (FAQ) about the composting system in general, and its use specifically.

### 11. Actual project realization against the baseline implementation plan

The following Gantt - chart presents the actual project realisation against the approved by EC, implementation plan.

LIFE-03 ENV/GR/205		Promotion and implementation of systems for the production of high quality compost from biodegradable household waste separated at source															
Tasks/ Activities		2003				2004				2005				2006			
		1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T
Task 1	Baseline				.	.											
	actual				x	xx											
Task 2	Baseline				.	.											
	actual					x	xx										
Task 3	Baseline				.	.	.	.	.	.	.	.	.	.	.	.	.
	actual						x	xxx	xxx	x							
Task 4	Baseline				.	.	.	.	.	.	.	.	.	.	.	.	.
	Actual								x	xxx	xxx	xxx	xxx	xxx			
4.1	Baseline				.	.								.	.		
	Actual													xx			
4.2	Baseline				.	.								.	.		
	Actual									x							
4.3	Baseline				.	.								.	.		
	Actual													x			
4.4	Baseline				.	.								.	.		
	Actual													x			
4.5	Baseline				.	.								.	.		
	Actual													xx			
Task 5	Baseline				.	.	.	.	.	.	.	.	.	.	.	.	.
	Actual													xx	xxx	xxx	x
5.1	Baseline				.	.	.	.	.	.	.	.	.	.	.	.	.
	Actual													xx	xxx	xxx	x
5.2	Baseline				.	.								.	.		
	Actual													x			
Task 6	Baseline				.	.	.	.	.	.	.	.	.	.	.	.	.
	Actual													xxx	xxx	xx	
6.1	Baseline				.	.								.	.		
	Actual													xx			
6.2	Baseline				.	.	.	.	.	.	.	.	.	.	.	.	.
	Actual													x	xxx	xx	
6.3	Baseline				.	.								.	.		
	Actual													x	xxx	xx	
6.4	Baseline				.	.								.	.		
	Actual														x	xx	
Task 7	Baseline				.	.	.	.	.	.	.	.	.	.	.	.	.

Task 8	Actual				x	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xx	
	Baseline				.	...	...	...	...	...	...	...	...	...	...	..	
	Actual				x	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xx	

## 12. Comments on Financial Report

The following Table presents a consolidated picture of the costs incurred during the implementation of the project.

Categories of expenditure	Amount (€)
Personnel	846,154.16
Travel	27,852.75
Prototype equipment	100,000.00
Consumables	49,662.17
Other costs	6,000.00
Overheads	71,852.00
<b>TOTAL</b>	<b>1,101,521.08</b>

The project was implemented according to the proposal and no budget modifications were incurred. It must be mentioned that the expenses incurred, related to travel are lower than those in the initial budget breakdown, mainly due to the fact that a significant amount of money which it was foreseen to cover the travel costs of invited speakers and participants in the conference actually was not used, since the conference was not materialised. Instead of the materialization of a conference where the project's content and outcome would be presented, an extensive dissemination campaign took place at the stand that set up by the NTUA at the exhibition which was organized by the Committee of Environment of the Hellenic Parliament and the Municipality of Athens (Sintagma Square, Athens) from 3<sup>rd</sup> to 5<sup>th</sup> of June 2006 (from 9.00 a.m. until 9.00 p.m, each day) in the framework of the World Day of Environment. During this 3-day event, the personnel of the NTUA distributed dissemination material (more than 5.000 of a set of dissemination material), they had discussions with the public related to the COMWASTE project and additionally, the working group of the project demonstrated in practice the use and the operation of the household composting system to the people that visited the stand (four household composting systems were available for the demonstration). The number of people that visited the stand of the NTUA and were informed about the use of the prototype system exceeded 5000, a number that is extremely higher than the number of people that would have attended the conference which initially it was foreseen to be held.

## 13. Appendices

Deliverable C.2: Analytical design of the prototype system

Deliverable F.1: Recording and solving of problems that were arisen during the pilot application of the program

Deliverable F.2: Methodology and results for the evaluation of the household composting process and the quality of the compost that was produced during the pilot application of the program

Deliverable F.3: Development of guidelines for the implementation of the program at large scale/ Preliminary cost – benefit analysis

Deliverable F.4: Report on site visits to Austria

Deliverable H.1: Information on meetings among the partners (managerial meetings)

Layman's Report in English

Layman's Report in Greek





LIFE Project Number

**LIFE03 ENV/GR/205**

**FINANCIAL FINAL REPORT**

Reporting period: 1.12.2003 – 31.8.2006

Reporting Date

**30/11/2006**

LIFE PROJECT NAME

**Promotion and implementation of systems for the  
production of high quality compost from biodegradable  
household waste separated at source**

**Data Project**

<b>Project location</b>	Municipalities of: Kifissia, Acharnes, Nea Halkidona, Attica, Greece
<b>Project start date:</b>	01/12/2003
<b>Project end date:</b>	28/02/2006 (approved extension to 31/08/2006)
<b>Total Project duration (in months)</b>	27 months (33 months after approved extension for 6 months)
<b>Total budget</b>	1.131.470€
<b>EC contribution:</b>	565.735 €
<b>(%) of total costs</b>	50
<b>(%) of eligible costs</b>	50

**Data Beneficiary**

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<b>Project Website</b>	<a href="http://www.uest.gr/comwaste">www.uest.gr/comwaste</a>

## **A. CONTENTS**

External Auditor data  
Standard Statement of expenditures and income  
Beneficiary's Certificate  
Project Consolidated Statement of Expenditure  
Project Statement of Income  
LIFE Form 1 – Personnel Costs  
LIFE Form 2 – Travel Costs  
LIFE Form 3 – External Assistance  
LIFE Form 4.1 – Infrastructure  
LIFE Form 4.2 – Equipment  
LIFE Form 4.3 – Prototype  
LIFE Form 6 – Consumable Material  
LIFE Form 7 – Other Costs  
LIFE Form 8 – Overheads (part 1)  
LIFE Form 8 – Overheads (part 2)  
Check List for payment request

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