FINAL ACTIVITY REPORT

Collective Research Project

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Acronym: GREENERGY

Title: ENERGY OPTIMISATION IN EUROPEAN GREENHOUSES

Project coordinator: PANHELLENIC CONFEDERATION OF UNIONS OF AGRICULTURAL COOPERATIVES (PASEGES)

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Publishable Executive Summary

The main aim of the **Greenergy** project is to contribute to the reduction of the energy consumption in greenhouses and enable greenhouse growers to remain competitive in the European market by optimising equipment and operating procedures to decrease production costs and initiating the European Quality Standard for efficient use of energy in greenhouses.

At present, more than 30 % of vegetables and fruits consumed in Europe are produced in greenhouses. Including eastern european markets, EU will become the biggest consumer and supplier of greenhouse products in the world. Regarding the structure of the sector, more than 90% of European greenhouse growers are SMEs. There are more than 70,000 SME greenhouse growers in the Europe e.g. The Netherlands (more than 10000 SMEs), Denmark (1000 SMEs), Spain (more than 5000 SMEs), Finland (around 1000 SMEs), UK (1200 SMEs), Estonia (2500 SMEs), Hungary (3000 SMEs). The sector employs directly more than 500,000 persons in Europe.

The key factor affecting European greenhouse growers is the cost of energy: European growers have to compete with external suppliers that have very low labour and production costs and are able to supply their products all year round. In Europe, it is estimated that in greenhouse production, operating costs represent around 78 % of the total costs chain, with energy consumption being the main factor affecting those expenses (up to a 50%). As labour and transport costs are expected to grow within the next few years enabling greenhouse products from outside the EU to have even more competitive prices with respect to European produce, it is evident the necessity of reducing the production costs of European products, which can mainly be achieved by reducing the costs related to energy consumption.

The problem of energy costs affects all the European production areas to a different extent:

- North-western Europe. Around 78% of the European horticulture produce comes from the north-western region of the continent. Producers of this region have the advantage of being located at short distance from the markets of high-densely populated areas. However, production costs in the area are significantly affected by high labour costs (which are not expected to

decrease), and high costs of heat and electricity due to a great consumption in spring, winter and autumn seasons. In the Northern European countries, energy costs account for more than 50% of the total production costs. Energy is mainly used for heating proposes, although it is also used to provide supplementary lighting (to enhance plant growth), to enrich with CO_2 and to control humidity.

- New EU Member. These countries bring further horticulture capacity to the EU. They have a similar climate to that of North-West of Europe, short distance to the main markets and very low labour cost having therefore an enormous potential for intensive agriculture. The main obstacle for Eastern European greenhouse growers is the use of energy systems with very low thermal and electrical efficiency, which increase the production costs and consequently the total chain costs. These growers normally use burners and hot water pipes in order to provide proper temperatures inside the greenhouse. These systems are not environmentally friendly and produce a large amount of emissions, which is a barrier for their owners to penetrate the European market after their integration in the Union due to the strict environmental legislation of the Community concerning emissions control.

- Southern Europe. Over the past fifteen years, the surface area covered by greenhouses in the South of Europe (especially in Spain) has increased enormously in comparison with a 13% growth experienced in the Dutch greenhouse sector. This development is based on mild weather conditions, which imply lower production costs. On the other hand the area has several disadvantages with respect to northern European countries, above all, the long distance to the main European markets which increases the final price of the products due to transportation costs. The sector is also affected negatively by climatic and technical factors. Firstly, summer temperatures are too high for production, and secondly the lack of heating in winter season decreases productivity and the quality of the products when the temperature falls below 12 ^{o}C. Therefore in southern countries it is necessary to extend the production season during the summer by reducing the temperature inside the greenhouse through efficient ventilation and cooling systems and to improve quality and productivity by means of supplementary heating in winter time.

Parallel to the pressure of external competitors, the European SME growers have to face an increasing public demand for environmental friendly production. Furthermore, according to the data published in the EEA Report, No 5/2008, 'Greenhouse emission trends and projections in Europe 2008' by the EEA, more than 80% of greenhouse emissions are energy related – that is, related to the production electricity and heat, road transportation, etc. "Greenhouse gas emissions per capita vary widely among European countries, with an EU-27 average of 10.4 tonnes carbon-dioxide equivalent per capita." The European Union has already addressed these social concerns by approving the Kyoto Protocol through Council Decision 2002/358/EC and with measures currently in place is trying to cut down the emissions of greenhouse gases and contribute to energy efficiency.

The EU is committed to achieve at least a 20 % reduction of its greenhouse gas emissions by 2020 compared to 1990 and is ready to reduce emissions by as much as 30 % under a new global climate change agreement when other developed countries make comparable efforts. To accomplish this target, the Community is issuing a series of environmental policies and measures to bring significant emission reductions from base year.

Many possibilities and solutions to reduce energy use in greenhouse horticulture are known, although many of them are not yet used by the SME growers. In the last few years some European countries like The Netherlands and Denmark have focused several research activities to increase the energy efficiency in the glasshouse industry and have achieved some partial success. However the results of such research activities have not been transferred into the practical procedures for application by the greenhouse SMEs at national or European level. This is due, partly to high investment costs but also due to a lack of knowledge and the inability to access to practical information experienced by the growers. For example, a case study in the tomato production process shows that current production costs of tomato is about 60 Cent€/kg of which 20 Cent€/kg represent energy costs. With an optimization in the greenhouse energy system, the energy cost can be reduced to 10 Cent€/kg. For an average tomato grower (5000 m^2 greenhouse area and 44kg/m^2 average annual tomato yield) this reduction of energy cost is equivalent to 10-20 € Cent/kg which means 10-20.000 € annual cost reduction.

Through Greenergy, it is proposed an integrated and more proactive approach to the problem of energy costs and greenhouse gas emissions in the intensive horticulture sector considering environmental constraints. The participating IAGs and core SMEs firstly will gain know-how on energy auditing and optimisation, and then they will transfer the acquired knowledge to their greenhouse SME members. The project aim of GREENERGY is to reduce the energy consumption in existing greenhouses by 20 - 40 % through small changes in configuration and operating procedures. The projects' results show us that a successful outcome of the project will produce a reduction of production costs in the sector up to 30%.

RESULTS:

- **Energy Auditing Software** tool
- **Investment Decision** tool
- **European Quality standards** (EQS) for efficient use of the energy in greenhouses
- **Transfer of knowledge** and skills from the RTDs to the Associations (IAGs) and core Small and Medium Enterprises (core SMEs)
- Core **SMEs & IAGs partners trained** on the software use
- Software **user's manuals**
- **Training material** prepared as study cases modelling actual greenhouses to be used for the training of IAGs associates
- **Dissemination of results: IAGs training of several SMEs associates** (North East Europe, North West Europe, South East Europe and South West Europe)
- **Property rights** management plan
- European Quality Standards proposed **labelling**

Project Execution

Summary Description of the Project's Objectives

The aim of the GREENERGY project was to investigate the greenhouse energy requirements for different areas in Europe. A tool for auditing energy efficiency in greenhouses, a set of technical improvements measures and a guideline for the optimisation of energy consumption in European greenhouses was degigned to be developed and tested in several case studies taking into account current and upcoming European environmental legislation.

More specifically, the short-term project objectives of the Greenergy project were:

- Review of the situation of European greenhouses in terms of energy consumption in the different climatic areas and definition of technical improvements in the form of low and medium investment measures.
- Creation of a user-friendly optimisation guideline to assist greenhouse growers in the improvement of their greenhouse energy systems through the application of best practice procedures including the technical improvements described above.
- Creation of an Energy auditing and investment decision tool to help the growers determine the profitability of the medium cost technical improvements.
- Development of an energy auditing software tool to assess the efficiency of energy use in greenhouses installations by benchmarking the actual energy consumption of the greenhouse against the consumption of an optimized reference greenhouse simulated by the program with real meteorological data.
- To propose the European Quality Standards for efficient use of energy in greenhouses based in the auditing tool described above offering European greenhouse growers the possibility to reduce energy consumption in greenhouses measurably up to 20 – 40%/
- Development of training material and transfer of know-how to the IAG partners to enable them to transfer it to their SME associates.
- Dissemination of the project outcomes among the relevant stakeholders through the Internet, publications in relevant sectorial journals, presentations in conferences and fairs, etc.

The overall long-term objectives were:

- To improve the energy systems of existing greenhouses in order to achieve a more efficient use of the energy that complies with the environmental legislation in the different European producing areas.
- To propose, initiate and implement the European Quality Standards for efficient use of energy in greenhouses.
- To increase the general knowledge of the SMEs to increase the ability to complete in the European and global market leading to noticeable reductions in greenhouse production costs:
    - By 20 - 30% for reasons of reduced energy consumption, more efficient use of fossil energies and increased application renewable energies (biogas, solar energy, etc.)
    - By additional 10 – 20% by implementation of standardization and benchmarking instruments leading to more efficient production structure.
- To achieve an economically sustainable and environmentally friendly greenhouse horticulture production.

The project's objectives were planned to be accomplished via five main actions:

1) Information compilation and proposed technical measures: All the members of the consortium except the core SME group, was foreseen to gather information on environmental regulations affecting greenhouse energy supply systems at national and European level. The RTDs on the other hand were responsible for the elaboration of a short report analysing the effects of this regulations in the sector. In addition, a compilation integrating the different energy supply systems employed in Europe has planned to be performed. The different systems in use were planned to be compared and then the issue of a set of recommendations for preferable technologies. All the energy supply systems were to be evaluated in order to identify and categorise the critical points that have a major influence on energy efficiency. A set of measures to improve the efficiency in those points would be the outcome of this action.
2) Initiation of European Quality Standards for efficient energy use in greenhouses and the Energy Auditing Software Tool: The boundaries and categories for the European Quality Standards of energy efficiency in greenhouses integrating existing environmental standards and Community regulations would be defined by the RTD partners. The main indicator to assess the compliance of a greenhouse with the EQS would be a

measurement of the deviation of its actual energy consumption from the theoretical minimum energy input to a greenhouse constructed and operated under best practises procedures of application in the sector. With this purpose, a software tool based on Process Integration Techniques would be developed. The software would include a user-friendly graphical interface (GUI) specially designed to be used by greenhouse growers.

3) Guideline for technical improvement measures and investment decision tool: A guideline for the optimisation of the energy critical points in greenhouses would be elaborated with the information and proposed measures from the first main action, by the RTD partners. The IAG partners would provide feedback in order to make the guideline easily accessible to their SME members. This manual would be structured as a troubleshooting guideline in order to achieve both ease of use and comprehensiveness. The set of measures proposed in the guideline would be divided in two different categories, low investment and medium investment optimisations measures. An evaluation procedure to assist the growers in deciding whether these last higher investment measures are economically valuable would also be included in the quideline.
4) Training of the IAG partners and of the SME partners by the RTD partners in in order to provide them with the highest possible competence in assessing the compliance with the EQS and the practical usage of the technical improvement guideline so that they can transfer the know-how and provide advise to their SME members at a later stage. The participating IAG and core SME partners would provide their feedback along the course of their training. Once the software and the guideline have been optimised, the IAGs would complete the knowledge transfer strategy and adapt the training material. The know-how transfer strategy would be tested with a group of SME partners from each IAG through several workshops. These SMEs would apply their new acquired knowledge to their own greenhouses. The ability of the growers to assess the performance of their greenhouses and propose measures for optimisation would be evaluated by the RTD and IAG partners. From the results obtained, the know-how strategy would be evaluated and modified if necessary. The training materials (handbooks, brochures, spread sheets, presentations video, etc) would be translated in all languages of the involved countries.
5) Dissemination: The appropriate measures related to property rights and future management of the future EQS for efficient use of energy in greenhouses would be undertaken.. Furthermore, several dissemination measures such as the creation of a project website or the publication of project outcomes would be

carried out here; also in co-operation with third parties like CEAF consortium and EurepGAP representatives.

Contractors involved

The consortium of GREENERGY intended to cover all different tasks and objectives of the proposal. For this purpose horticulture and greenhouse grower associations (PAS, DEG, HDC, KPL, HFV, EHA, COE, CONF and TGA), which are aware of general situation of European horticulture and especially utilisation of energy in their members greenhouses in their related countries have been involved to the consortium of this project. Additionally, several greenhouse grower (as end-user, HO, PAE, SKI, AN, MAR and HKO) provided a practical and closer view to the specific cases and opportunity to practical evaluation of the theoretical results of the whole project. On the other hand, research institutes (TTZ, VTT, WU, UPT, KVL, EAU, UAL) fulfilled the technical and scientific tasks of project under scientific and experimental support of horticultural energy experts (AGC, FEC and BL) with high experience in greenhouse energy systems. Thus, all the relevant sectors were represented: horticulture association and research institute with high experience in horticulture field and greenhouse energy systems get together to deliver valuable results for the greenhouse grower SME´s. The distribution of partners involved in the project consortium which covered almost all the regions of Europe.

The group of IAGs (PAS, DEG, HDC, KPL, HFV, EHA, COE, CONF and TGA) in the consortium comprised the most important greenhouse growers and greenhouse energy system expert SMEs. The IAGs participated in both the research stage and in the dissemination phase of the GREENERGY. During the research period, their task waS to cooperate with the RTDs in compiling information, in the initiation European Quality Standard (EQS) and in the elaboration of the energy optimisation guideline. The IAGs were also responsible partners for the dissemination of the project as they would contact their members in order to spread the initiated EQS and optimisation guideline. On the other hand IAGs also established contact with other association and were in charge of keeping updated the results.

As mentioned before, SME core groups in the consortium of GREENERGY can be divided in two groups:

- The greenhouse growers (HO, PAE, SKI, MAR, AN, and HKO) provided direct information to the RTDs in order to make it possible to perform the required evaluation about the current situation. Scientific results of the project (EQS initiation and optimisation guideline elaboration) tested practically by some of greenhouse growers and necessary feedback was provided in order to match the result of project with the needs of growers practically.

- Greenhouse energy system experts (AGC, FEC and BL) supported the RTD partners to compile and analysis of information, evaluation of the results and adjust it based on the field test results in order to make it practical and user friendly as much as possible based on their long experience in this field. These SMEs participated in the dissemination phase by informing their customer about the developed standards and optimisation guideline.

The consortium comprised eight RTDs (TTZ, KVL, VTT, WU, UPT, EAU, UAL and HU) with wide range of knowledge in horticulture, energy systems for horticulture and in the environmental sector. The RTD performers compiled the information with the support of greenhouse growers and IAG groups. RTD performers initiated a practical EQS for the greenhouse energy systems and created an optimisation guideline for European greenhouse energy systems. The also produced support materials and trained the IAGs in the implementation of EQS and optimisation guideline.

The members of the consortium represent 12 countries; Greece, Denmark, United Kingdom, Finland, Hungary, Estonia, Italy, Spain, Germany, Romania, Denmark and The Netherlands.

A short profile of the different organisations involved in this project can be found in the project webpage under www.greenergy-project.com.

The overall project management is responsibility of the Project Coordinator, which is PASEGES (www.paseges.gr), Contact Person: Mr. Ioannis TSIFOROS, email: gm@paseges.gr).

Work Performed

The **first work package** comprised the definition of the legal framework in which greenhouse energy supply systems were included, the evaluation of the technologies for greenhouse energy supply in use in Europe and the proposal of a set of improvements to these technologies.

The legal constrains which have direct or indirect implications for greenhouse energy supply system at national level varied among the twelve (12) countries that participated in the project. The legislative framework in each country was directly connected with the degree of the development of greenhouse cultivations and the energy needs. North European countries where the energy needs seemed to be increased for greenhouse cultivations have established laws and regulations in order to encourage not only greenhouse producers but investments as well. On the other hand, South European countries due to the warmer climatic conditions have not established such a large number of laws and regulations. As far as the European directives are concerned it resulted that most of them have been transferred into national legislation, while the EU regulations were binding them entirety and were directly applicable in all Member States.

The appropriate information was integrated into two main categories, national and European directives. Within each category and for each, the following items were specified:

- Directive or regulation title and number;
- Application: current or to enter into force in the near future;
- Type of energy supply systems / equipment affected or potentially affected by the regulation analysed;
- Parameters regulated

The analysis of the legislative framework presented some forty six (46) pieces of EU legislation, most of which have been adopted in the last 15 years and have been integrated entirely or partially in some cases to the national legislative framework (e.g. The Netherlands have been integrated 75% of the EU legislation to the national legislation framework). At this analysis all the IAG and the RTD partners participated and provided all the information needed for the achievement of this first objective. The work carried out in this task was as scheduled and as planned at the beginning of the project.

At second part of the first work package the IAGs in co-operation with the RTD performers performed a review of the current technologies involved in the supply of energy to greenhouses, analyzing at the same time indirect technical or operational aspects that affect the energy consumption in greenhouses. In order for this task to be carried out the RTD and the IAG partners from the same geographical areas collaborated. At this point we must point out the significance of the SMEs since they contributed to this phase by introducing their actual energy systems to the consortium.

The first step of the energy analysis of the core SME was the data collection and the analysis of their overall situation in the greenhouse growing as well as technical and operational aspects affecting the energy consumption. A questionnaire was prepared and send to all project partners.

The second step of identification energy consumption was to deepen consumption analysis from the annual energy level to the monthly, weekly and hourly level. However, some of the core greenhouses have not initially been equipped with devices needed in heat energy measuring at short term periods. In order to collect also hourly based measurements for the project they have taken measures to install relevant devices. The data for these collections would be obtained later during the Greenergy project.

In order to achieve the above the SMEs provided data regarding their current status of energy consumption and energy related technologies and solutions. The SMEs were asked to fill in a questionnaire, the main topics of which were the following:

- Statistical data of greenhouse growing
- Energy used in the greenhouses
- General description of the importance of different elements in the country/business
- Structure efficiency of greenhouse
- Glazing materials used in greenhouses
- Supplementary heat insulation, windbreak, etc.
- Shading/cooling/ventilation systems
- Supplementary lighting for growing purpose
- Advanced energy management system

- Space utilization
- Primary energy used
- More about energy plants in greenhouses
- More about electricity system
- Mechanical chillers for cooling of growth spaces

The conclusions of this task can be summarized as follows:
Energy data and information on energy related technologies of core greenhouses have been collected and analysed as far as possible. It is clear that not all the data was available. Here we present data from Finland (HKO and HO) and Germany (PAE and SKI).

- The total primary energy used (excluding electricity) ranges from 212 MWh for 1806 m^2 (SKI) to 6513 MWh for 15052 m^2 (HKO).
- The total electricity consumption is 14193 MWh for HKO, 9.53 MWh for PAE and 5.26 MWh for SKI.
- HKO consumes 404 kWh/m^2, HO 186 kWh/m^2, PAE 17.5 kWh/m^2 and SKI 48 kWh/m^2 for heating and CO_2 production.
- For electricity the values are HKO 914 kWh/m^2, PAE 7.17 kWh/m^2 and SKI 1.93 kWh/m^2.
- The energy source for heating differs between these SME's. For HKO 80% is from waste heat while 20% is from propane. For HO 100% is from natural gas. In Germany PAE uses 100% natural gas while SKI uses 100% light fuel oil.

In addition, the second step of the first work package examined the following three aspects:

1. "Energy supply systems and energy consuming equipment review"
2. "Indirect factors affecting the energy consumption
3. "Identification of energy critical points and performance indictors in the energy systems"

The outcome of the above topics comprised the deliverable 3 "Energy systems in their European Greenhouse Sector and their critical points". In this report the first two topics have been combined into 4 sections. Partners WU and VTT considered this necessary because of the amount of overlap between these two topics. The third topic has been included by TTZ in order to provide the basis for the future analysis of the energy critical points.

The main aspects that have been examined are the following:

- Basics in greenhouse growing
  - Climate and weather (energy balance, the solar resource, extra-terrestrial solar radiation characteristics, ground level solar radiation characteristics)
  - Energy critical points on climate and weather
  - Measurement of solar irradiance (global solar irradiance-pyranometers, direct normal solar irradiance-pyrheliometers, diffuse irradiance, other measurements)
  - Solar radiation data basis (typical meteorological year data sets, clearness index, European and worldwide solar radiation data bases)
  - Some data regarding climate and weather in the participant countries
  - Greenhouse growing (distribution of greenhouse cultivation, energy consumption)
  - Greenhouse structures (main structure types and materials)
  - Detailed description of structures (wide-span greenhouse, venlo-type, tunnel greenhouse, pitched roof greenhouse, arch-shaped roof greenhouse, inflated-double plastic film greenhouse, parral-type of greenhouse structure in Spain, low plastic tunnels)
  - Energy critical points on greenhouse structures
- Constructions and equipment related to energy consumption
  - Lay-out of the greenhouses (free-standing greenhouses, multi-bay, gutter connected or ridge and furrow greenhouses, influence of structural design, influence of location, influence of interior greenhouse components and systems)
  - Covering materials or glazing (transmission of radiation through glazings, glass, structured sheets, film plastic, polystyrene pellets, influence of weathering on glazing, influence of condensation on the glazing, glazing and insulation)
  - Ventilation (natural ventilation, mechanical ventilation using fans, retractable roof greenhouses, air circulation, automatic vent openers)
  - Cooling (evaporative cooling, cooling tower, misting/fogging systems, pan and fan cooling)
  - Supplementary arrangements – shading, screens and insulation (internal shading system, external shading, supplementary insulation, insulation of greenhouse, foundation insulation, energy screens, windbreaks)

  - Other points (greenhouse age)
  - Energy critical factors/points (opening and connections, ventilation and air circulation, forced cooling, insulation and covering material)
- Energy conversion and distribution systems
  - Energy conversion (fuels used in energy conversion, boilers, unit heaters, heat pumps, cogeneration of heat and power)
  - Heat distribution systems (central heating system with water-filled pipes, air heating, in-floor heating, bench heating, condenser)
  - Electrical systems (growing under artificial light)
  - Heat storage
  - Other energy systems (CO_2 fertilization, energy cluster projects in horticulture in The Netherlands)
  - Energy critical factors/points (boilers and unit heaters, cogeneration of heat and power, heat distribution systems, electrical systems, cooling systems, storages, CO_2 fertilization)
- Energy control and management systems
  - Control and management environment
  - Control alternatives (manual versus automatic control, open loop versus closed loop control systems, characteristics of control systems, control modes, feedforward and cascade control, digital control system, adaptive and self-tuning control, multi-layer and multi-level control systems)
  - Energy critical factors/points
- Indicators

The next step was Repercussions of energy critical points and performance indictors in the energy systems (recapitulation from the first reporting period). To generate a general overview of the repercussion that future environmental legislation would have in the sector of protected horticulture throughout Europe given the current state of the technology, the TTZ, with the support of the other partners in the consortium, generated a very simple to use database, which summarised the effect of each regulation in different areas.

The database was developed using the programme Microsoft Access®, which is a very common tool. This was done in order to assure the usability of this tool by the majority of people.

[This database can be found in the Annexes, of this report. It is also free for download on the Greenergy project website (www.greenergy-project.com). Also in the Annex II is a manual explaining how to use the database (file: "GREENERGY Regulations Database - Manual.pdf")]

The Microsoft Access database (see figure 1) consisted of 3 tables, 11 queries and 1 form.

Fig. 1 - General content of a Microsoft database file.

The tables in this database were:

- Regulations List: list of the total number of regulations (296)
- Legend: List of categories and their codes
- Regulations and codes: Regulations and their applicable codes

The queries were named by country and contained the national regulation and its codes arranged by category codes.

The form was called "Environmental Legislation".
The Fields in the "Regulations and codes" table were as it follows:

- **Code:** A unique number identifying each regulation
- **Regulation:** Name of the regulation
- **Application:** Present or future implementation: Current (C) / Future (F)
- **Date:** Implementation date
- **Apply:** category code(s) applying the regulation
- **Affects:** General description of the regulation
- **Parameters:** Parameters being regulated
- **Notes:** Other comments
- **Country:** Concerning country

Following is a table showing the different categories in which the regulations were divided, together with their respective abbreviation.

Abbreviation	Name
AP	Gas emissions (Air pollutants)
BR	Building Regulations
C	Cooling
CHPS	Combined heat and power stations
DH	Dehumidifiers
EEP	Electrical energy production
EIA	Environmental impact assessment
ES	Energy Supply
ESE	Energy saving and efficiency
ET	Emergent technologies
FF	Fossil fuels
FFS	Fossil Fuel storage
FS	Financial subsidies
GGE	Greenhouse gas emissions
H	Heating
IPPC	Integrated pollution prevention control
QIS	Quality and industrial security
RE	Renewable energies
TEPE	Taxation of Energy products and electricity
WM	Water and Waste management

Table 1: - Categories assigned to regulations

Following is a screen shot of the database, showing an example for a search on legislations in the EU for “energy saving and efficiency”.

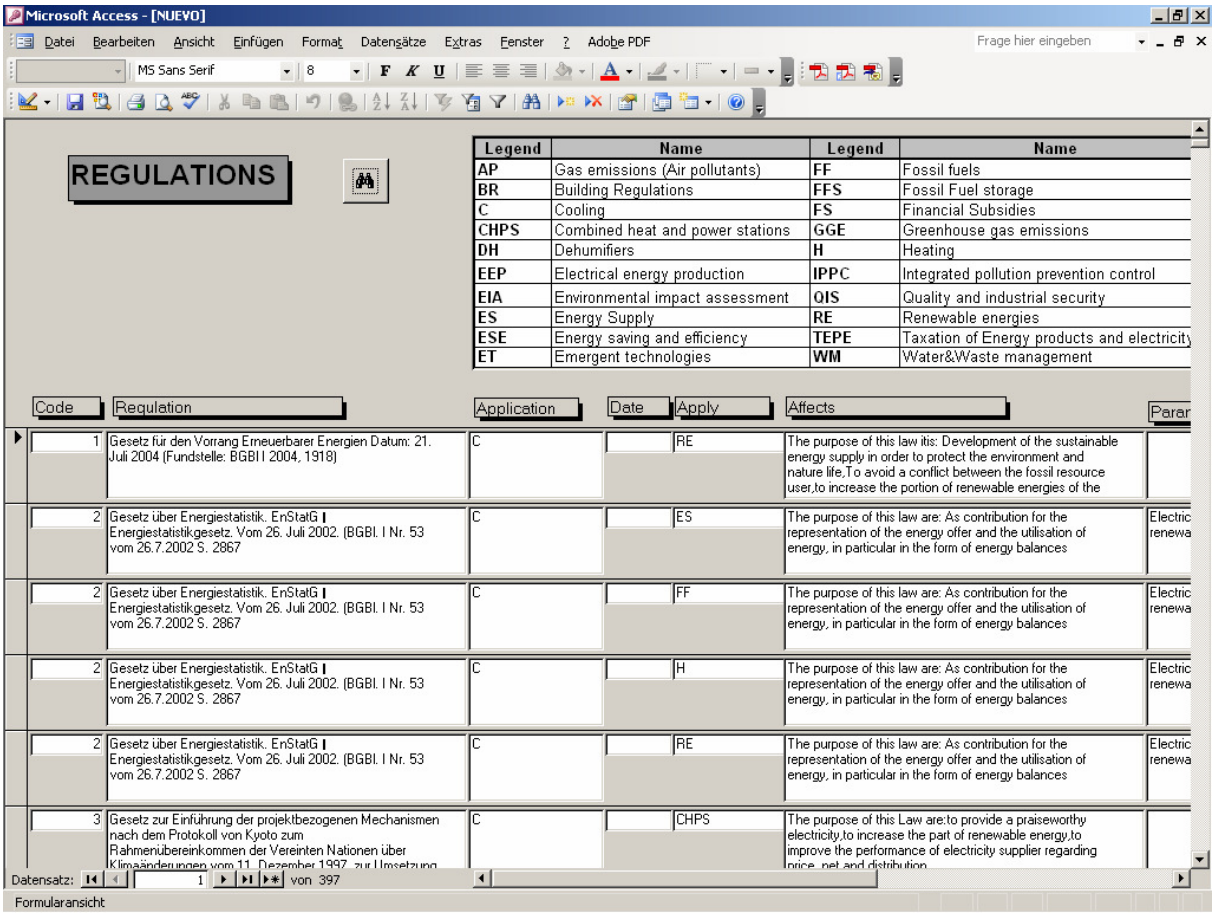


Fig. 2 – Example list for energy saving and efficiency related legislation in the EU.

The aim of the last step of this work package was the definition of the measures for technical improvements and the application of best practices procedures. More specifically, the RTD with input from the SME core partners BL and AGC would propose several sets of measures in order to improve the energy efficiency of greenhouses taking into consideration the first results of the energy cadastres elaborated in previous step and possible legal repercussions identified in the previous work.

During the meeting in Athens a discussion took part between the partners regarding the ideas of compilation of datasheets. In June EAU was designing the datasheets according the greenhouse energy critical points described in deliverable D3, and it was sent to all partners. In August the collected data from partners was summarized in one data file and presentation for the first year progress meeting was prepared. In

September EAU collected some additional data for this work and they summarized the data.

In the meeting that took place in UK in September 2006, EAU presented all the critical points and measures that they have collected from all the partners and all the partners discussed the first results of compiled datasheets. The next step of their work was to divide them between 4 geographical areas (North East Europe, North West Europe, South East Europe and South Europe).

Finally, during October and November Estonian University of Life Sciences, as the Task Leader, collected some additional data and finally they summarized all the data and prepared deliverable 4.

At the end all the data was summarized and divided between the following geographical areas:

NEE – North East Europe: Finland, Estonia

NEW – North West Europe: Denmark, Germany, The Netherlands, United Kingdom

SEE – South East Europe: Hungary, Romania

SE – South Europe: Greece, Italy, Spain

In the tables that all the above mentioned data is presented there is given the percentage of the estimated energy save for most of the improvement measures. These figures are estimations based on previous research and in some cases on personal experience. Therefore energy saving value can only be a guideline as it will depend on the original situation. General improvement measures and best practices procedures are varied from the geographical region and the technological level of greenhouses.

At the **second work package** the European Quality Standards for efficient use of energy in greenhouses would be defined and a software tool to assess its compliance had to be developed.

The wide variability of factors influencing the use of energy in a greenhouse, such as climatic conditions, types of crop and seasonal requirements, technical greenhouse configurations, etc, maked it impossible to establish useful comparisons between different systems or to evaluate precisely whether a greenhouse uses the generated heat and/or electrical energy in an efficient way or not. Therefore the energy standards should be based on a reference optimum greenhouse for each location and size. Thus, the assessment of compliance with the standard would consist on benchmarking the performance of a certain greenhouse in terms of kWh of heat and/or electrical energy consumed per kg of product (kWh per standardized 10 cm pot in case of ornamentals production) against the performance of the theoretical standard greenhouse built and operated under the best practice procedures proposed in the previous work package. The percentage of deviation between both systems would be used as a comparison parameter to assess the compliance with the energy efficiency quality standards. With the purpose of presenting a reasonable optimum greenhouse model in each case, the ratio performance/installation costs of the theoretical greenhouse would be taken into account. The compliance with the EQS would be categorized differently depending on the degree of deviation with respect to the standard system.

To ease the task of benchmarking process, a software tool based on Process Integration Techniques would be developed. This system would be capable of calculating the energy consumption of a theoretical optimized greenhouse given its location and surface area. The system would also integrate the constraints derived from the current regulations affecting the sector and those ones coming into force environmental in a near future.

The first step of this work package was the Definition of the European Quality Standards for efficient use of the energy in greenhouses. The RTD performers UAL, EAU, KVL and UH and the IAG partners, with the input from BL, AGC and the greenhouse growers, would define the range of application of the standards establishing the adequate modifications to integrate the costs of equipment and materials in the calculation of the reference greenhouse. Partners BL, VTT, EAU, UAL and TTZ summarized the defined data in a draft for European Quality Standards. These European Quality Standards for efficient use of energy in greenhouse horticulture may represent a key factor for further pre-normative research activities to be performed later in the project.

All the partners that were involved in this task contributed to the needs and inputs of this task. The Hungarian National Fruit and Vegetable Council with the input from the greenhouses growers defined the range of application of the standards establishing the adequate modifications in order to integrate the costs of equipment and materials in the calculation of the reference greenhouse.

The Estonian Horticulture Association gathered all the information needed in cooperation with EAU and delivered it together to the task leader. The General Confederation of Italian Agriculture prepared a report with a series of recommended or obligatory measurements and in addition integrated the report with the regulations and laws in Italy regarding the European Quality Standards for efficient use of energy in greenhouses. COE worked very closely with UAL, collected data concerning the energy input in greenhouses from companies associated to COE and also facilitated contacts. The associated to COE companies were visited and asked for technical details concerning their production.

The RTD partners provided HKO a checking list and HKO based on this list made an assessment of different energy saving alternatives. Furthermore HKO had discussions with VTT on the items of efficient energy potential and saving percentages possible to gain in the Northern Region of Europe. UoC collected data for European Quality Standards for Zone B (Northwest Europe).

The partner UAL summarized a draft for the European Quality Standards which was delivered to the European Commission and also it was presented to the meeting in Brussels. In addition, during the meeting the partners decided that they will make an effort to gather more information and during summer UAL compiled all the contributions and submitted the final version of the Definition of the European Quality Standards for efficient use of the energy in greenhouses.

The last step of this work package consists of the following five topics:

- Reference greenhouse specifications
- Core calculation module design and development
- Graphical User interface design and development
- Usability tests
- User’s manual

Regarding the first two topics the main points and the methodology of work that was followed can be described as follows. After attentive discussion and consideration, it was decided to definitely change the work of the above two topics. The definition of the reference greenhouse was not anymore necessary since there is no reference greenhouse for the different regions in Europe. Even within one country like The Netherlands or Denmark, the greenhouses vary a lot such that it is impossible to define on reference greenhouse for a region.

The core calculation module has been developed closely by UH and UoC and included apart from an initial meeting of Northern Europe partners after the end of 1st year meeting in the UK in September 2006 two technical meetings (totalling 5 days) at UH in April and June 2006 and a technical meeting at UPT (2 days) also in April 2006. At the first meeting in the UK in September 2006 the requirements of the core calculation module were discussed. It was decided that the calculations would need to be made on an hourly basis and that climate data on an hourly basis for each partner country would also be required. A software specification document that described the proposed method and an overview of the calculus and how the software may be structured was written by UH in October 2006 and circulated between TTZ, UoC and WU for comment. It introduced the concept of the 'Greenhouse Builder' that would allow the grower to construct their own greenhouse and then make alterations to the structural materials and set-points etc then compare the energy consumption with their original structure, a 'what if' comparison. This was in response to the concerns expressed by the IAG's at the meeting in Athens in May 2006 that the formulation of a reference greenhouse would be difficult due to the regional variation in growing methods. A calculation of the impact on crop yield was also to be included. A revised version of the document was completed in November 2006 and formed the basis for the document that contains Deliverables 6, 7 and 8.

The Energy Auditing Tool (EAT) was improved in both usability and accuracy with a further nine upgrades produced during year 3 in response to requests from consortium partners as part of the testing and the training of IAGs and SMEs. It included improvements to the calculus, the adaptation of the code to function on all Regional language settings within Windows, the addition of further crop models, further greenhouse structural types and additional facilities for the user to input their own data. Additional output screens to display data graphically were also added. The version 1.10 of the EAT was then tested again using the greenhouse profiles representative of actual greenhouses (created by the partner WU for subtask 6.4).

The calculus consisted of the development and combining of several models for example solar interception, crop transpiration, crop growth etc. It was done largely in tandem with the development of the energy auditing tool since each individual calculation sequence for each component of the tool was tested and validated by UoC using MATLAB® as each part was incorporated. Once UH and UoC were satisfied with the output of a particular component a subsequent model was then incorporated and tested and validated in the same way. The combined output of all models running in conjunction with eachother was then tested and compared with actual greenhouse energy consumption data. As the tool was constructed it became evident further models than originally foreseen would require incorporation into the software in order to increase the accuracy of the output. This has now been undertaken. An Excel spreadsheet that contained headings for the required thermal and light transmission properties for greenhouse materials and a request for hourly climate data was sent by UH to the RTD partners. Obtaining climate data on an hourly basis was not possible for all partner countries either because it did not exist at this level of detail or because the costs were too high.

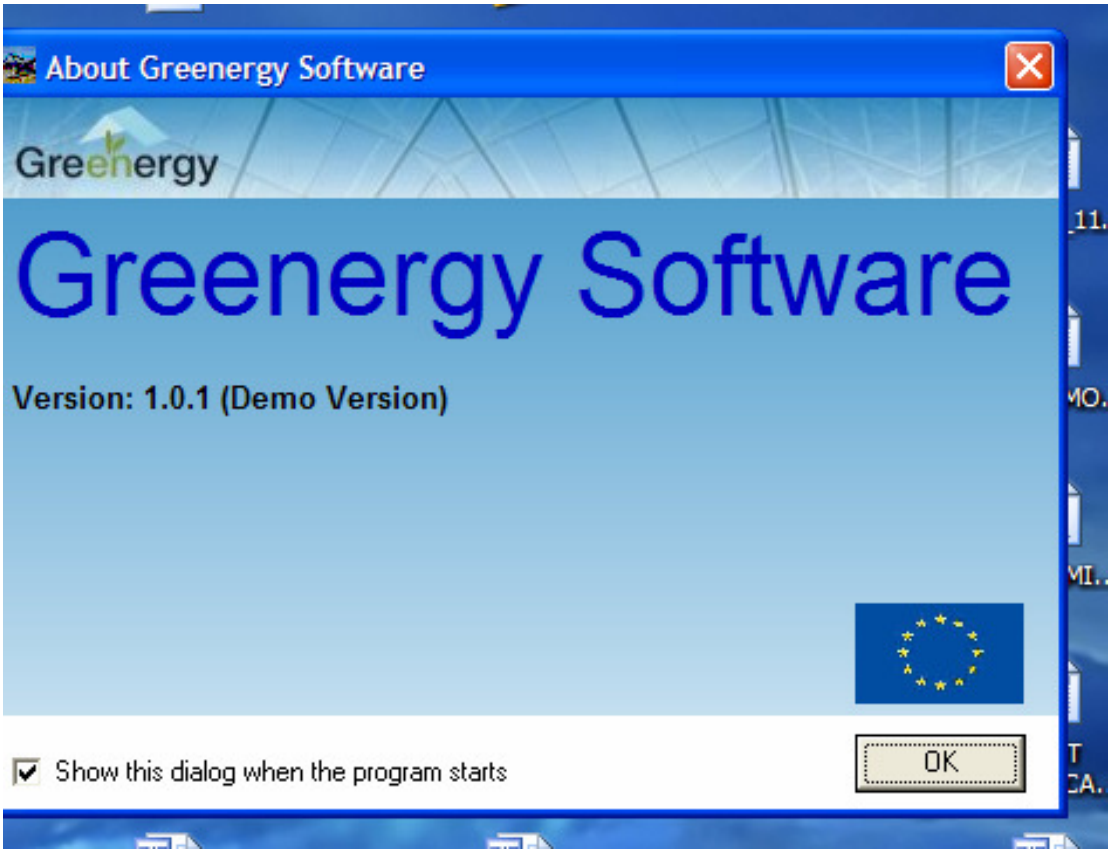
Regarding the Graphical User interface design and development the graphical user interface has been constructed to allow the user to make adjustments to their greenhouse as described previously and save their 'greenhouse profile' within the software so that they do not have to construct a new greenhouse each time the software is used. Output may be displayed graphically either hourly, daily or monthly. A table displays the energy consumption values and light transmissivity properties of the structure in sequence alongside the energy consumption of other greenhouse profiles. The user can compare the figures directly and rank the output values from lowest to highest and vice-versa. A summary of the properties of each greenhouse construction and its energy consumption is displayed on the 'start up' screen. An update facility has been constructed on the UH (AERU) website that will allow the user to download any upgrades to the software as they are made available.

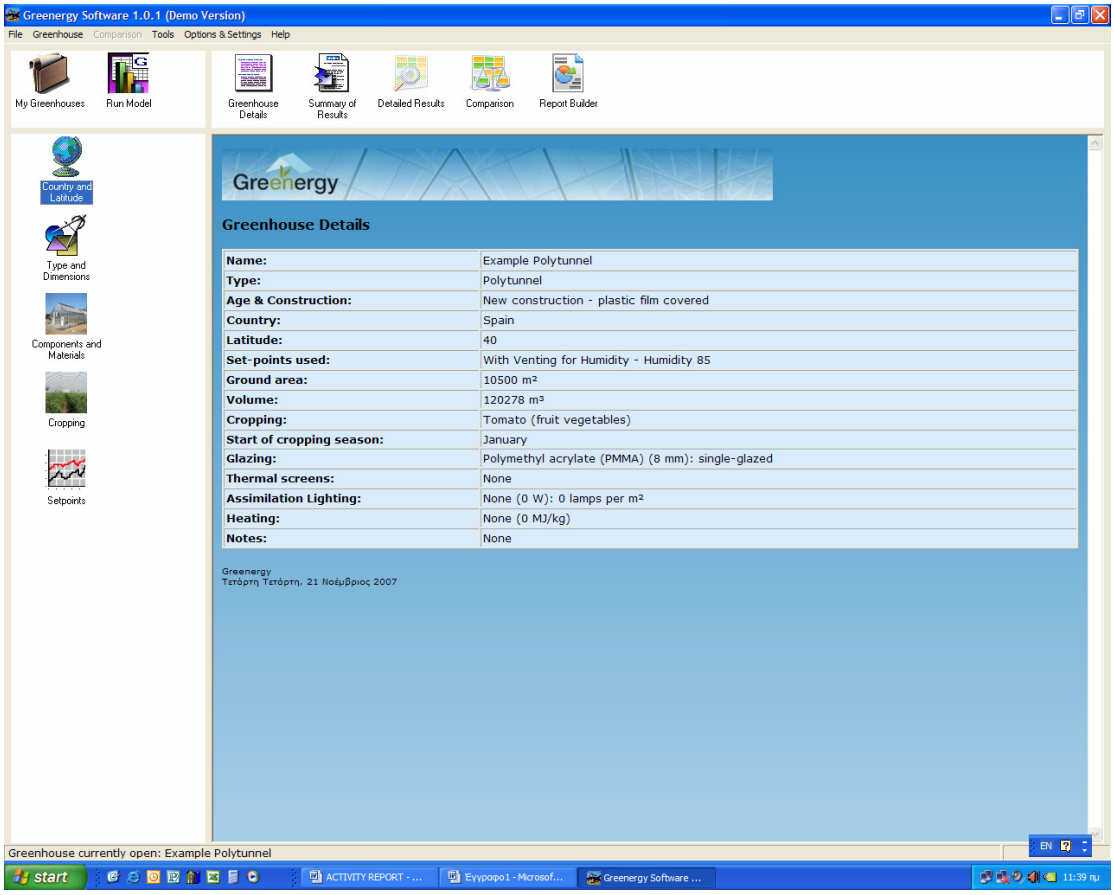
As far as the Usability Tests is concerned, the Energy Auditing Software Tool firstly tested by SKI, with the support of TTZ and UH. And after incorporating necessary improvements, it tested also at HO, AGC, FEC, PAE and AN in order to investigate different conditions. To assess its user friendliness, a questionnaire was elaborated

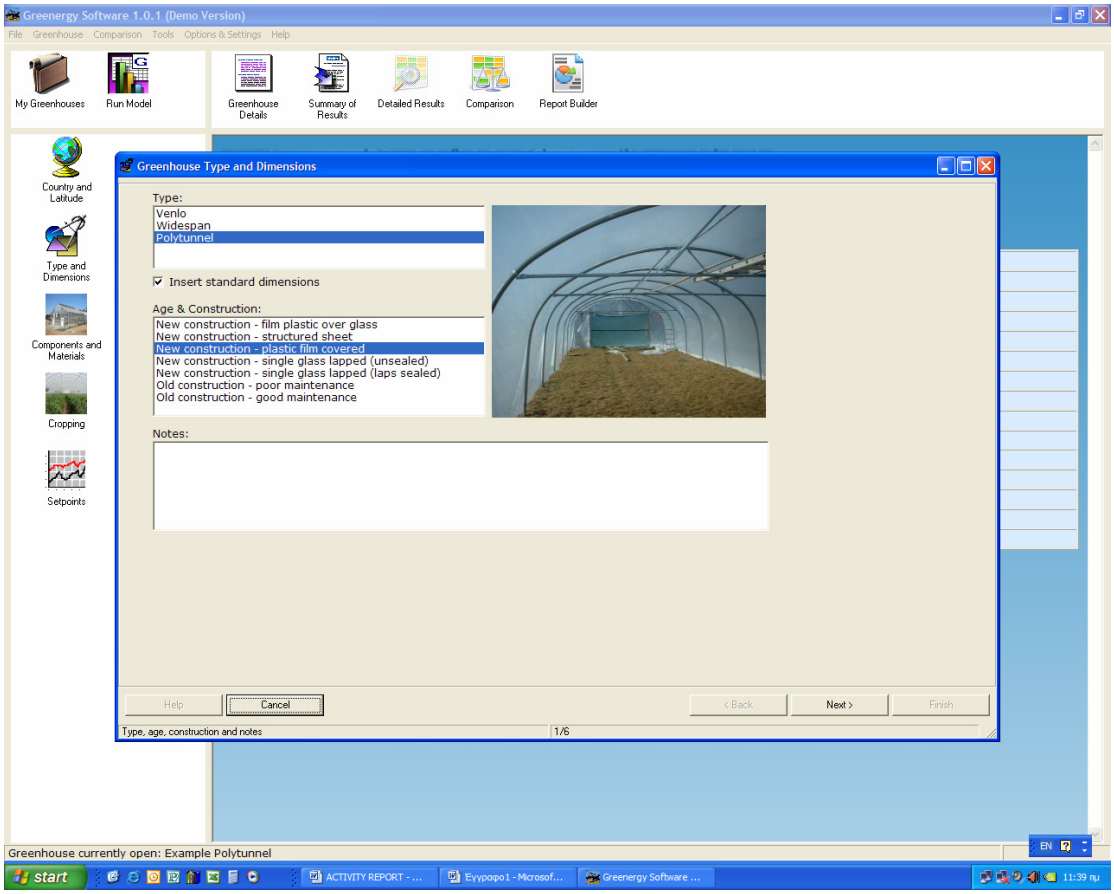
by TTZ and distributed to the partners to complete it and the results are included in the deliverable 10.

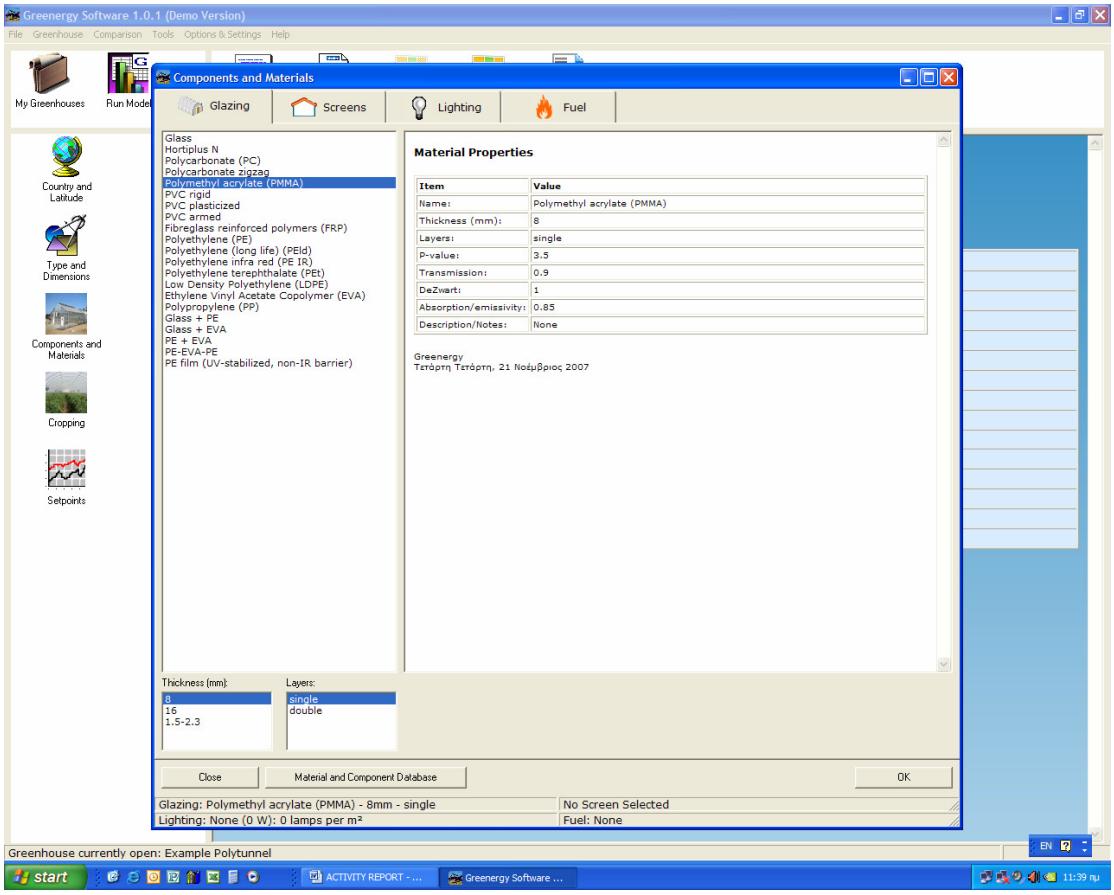
For the User's manual, the partner TTZ elaborated and distributed to the partners the User's manual for the Energy Auditing Tool in February and also during the 30-th month meeting in Wageningen.

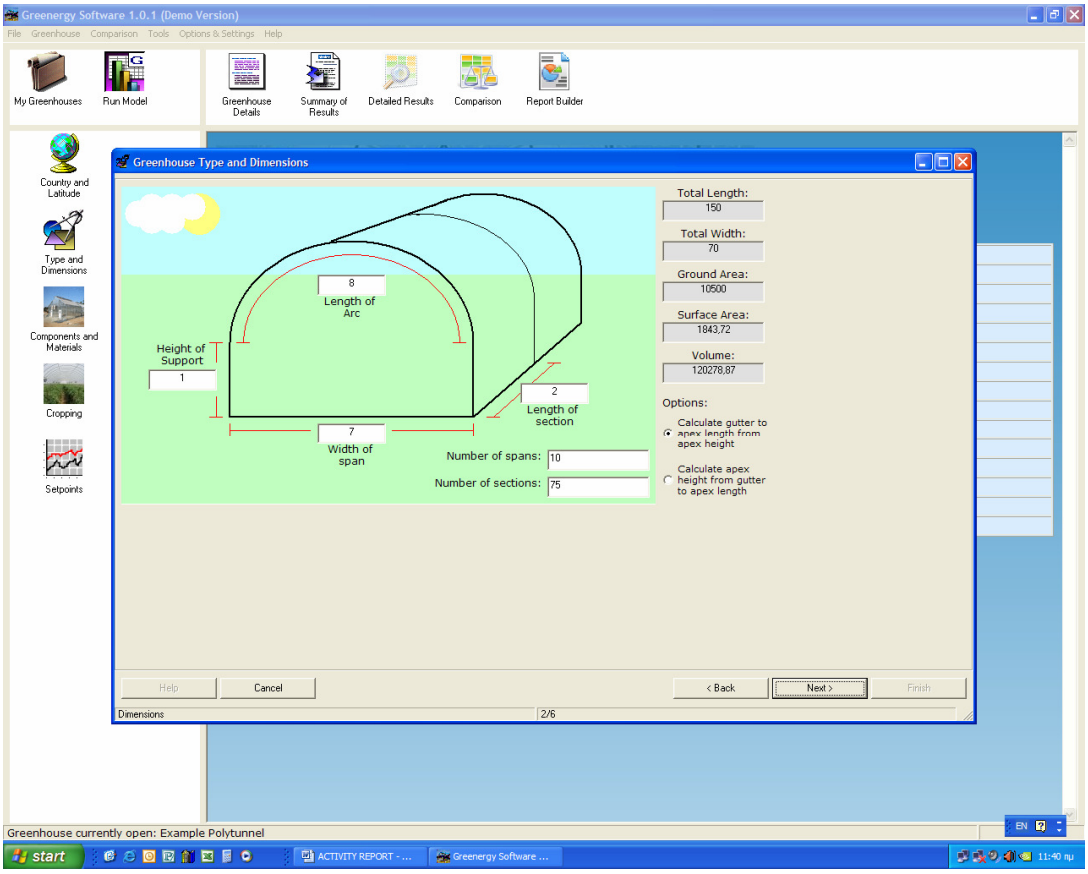
Screen shots of the Energy Auditing Software Tool

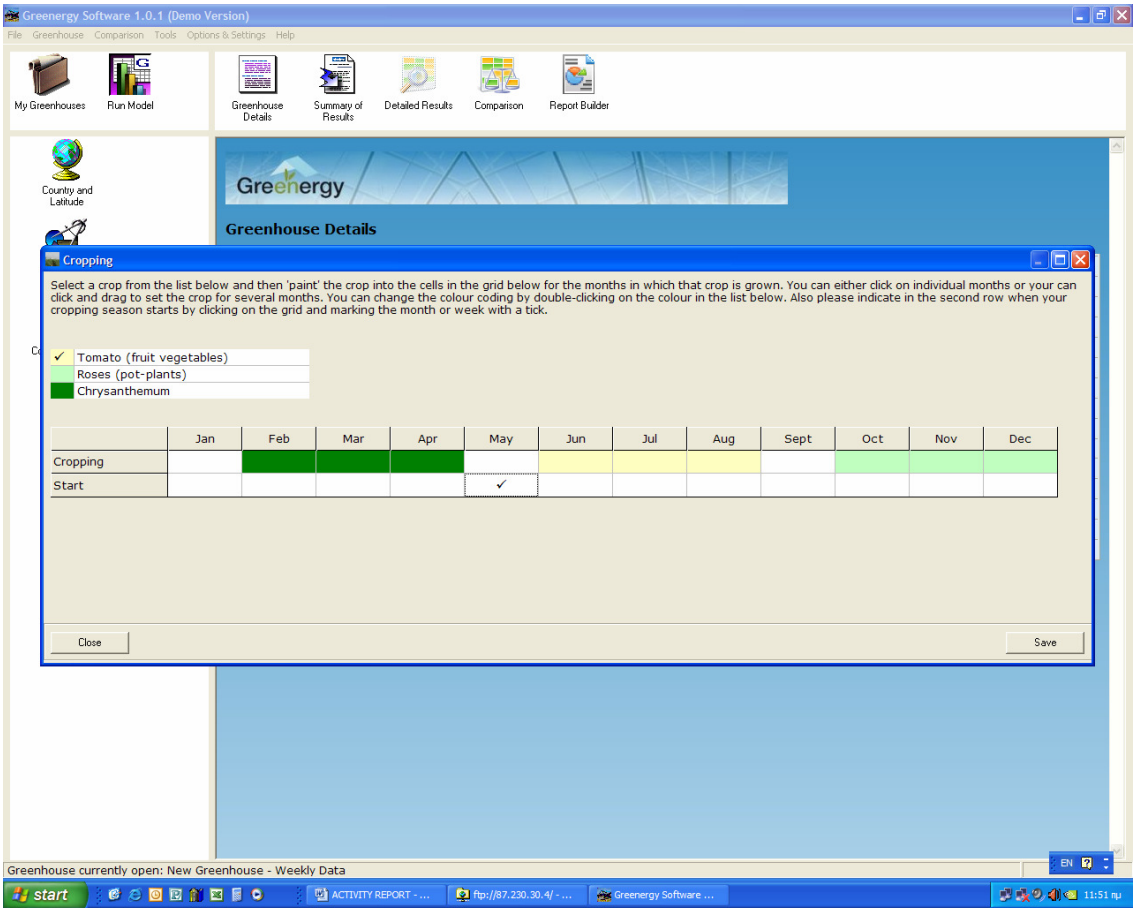



Greenergy Software 1.0.1 (Demo Version)
File Greenhouse Comparison Tools Options & Settings Help
My Greenhouses
Run Model
Greenhouse Details
Summary of Results
Detailed Results
Comparison
Report Builder
Country and Latitude
Type and Dimensions
Components and Materials
Cropping
Setpoints
Greenergy
Greenhouse Details
Name: Example Polytunnel
Type: Polytunnel
Age & Construction: New construction - plastic film covered
Country: Spain
Latitude: 40
Set-points used: With Venting for Humidity - Humidity 85
Ground area: 10500 m²
Volume: 120278 m³
Cropping: Tomato (fruit vegetables)
Start of cropping season: January
Glazing: Polymethyl acrylate (PMMA) (8 mm): single-glazed
Thermal screens: None
Assimilation Lighting: None (0 W): 0 lamps per m²
Heating: None (0 MJ/kg)
Notes: None
Greenergy
Τετάρτη Τετάρτη, 21 Νοέμβριος 2007
Greenhouse currently open: Example Polytunnel
start
ACTIVITY REPORT - ...
Greenergy Software ...
11:39 πμ

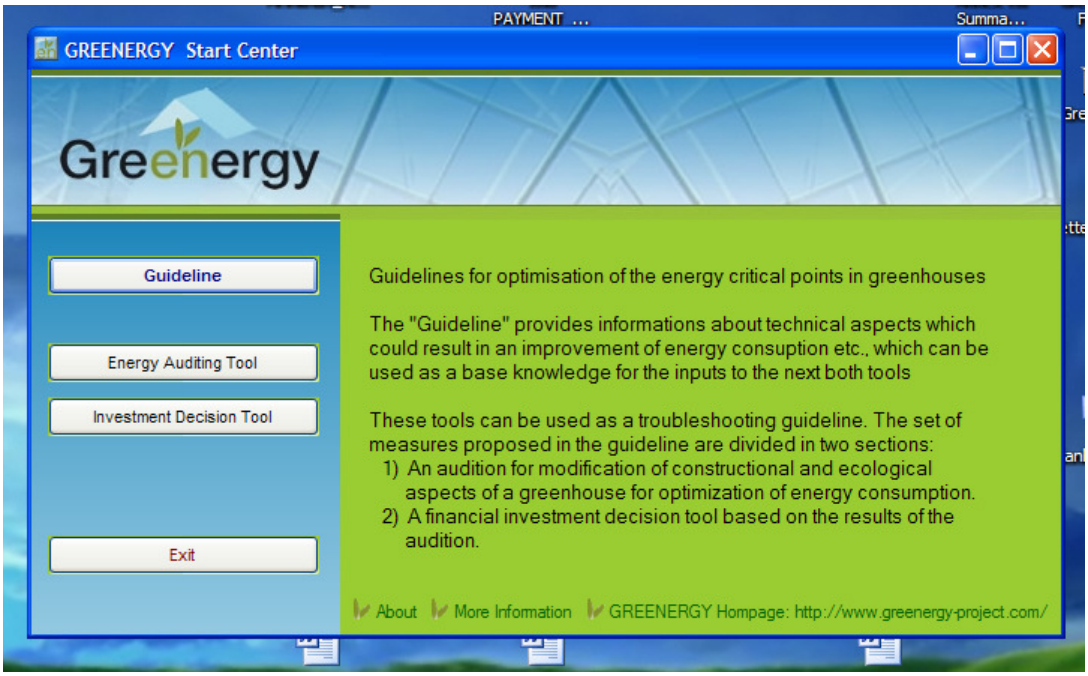

Greenergy Software 1.0.1 (Demo Version)
Greenhouse Type and Dimensions
Type:
Venlo
Widespan
Polytunnel
Insert standard dimensions
Age & Construction:
New construction - film plastic over glass
New construction - structured sheet
New construction - plastic film covered
New construction - single glass lapped (unsealed)
New construction - single glass lapped (laps sealed)
Old construction - poor maintenance
Old construction - good maintenance
Notes:
Help
Cancel
< Back
Next >
Finish
Type, age, construction and notes
1/6
Greenhouse currently open: Example Polytunnel

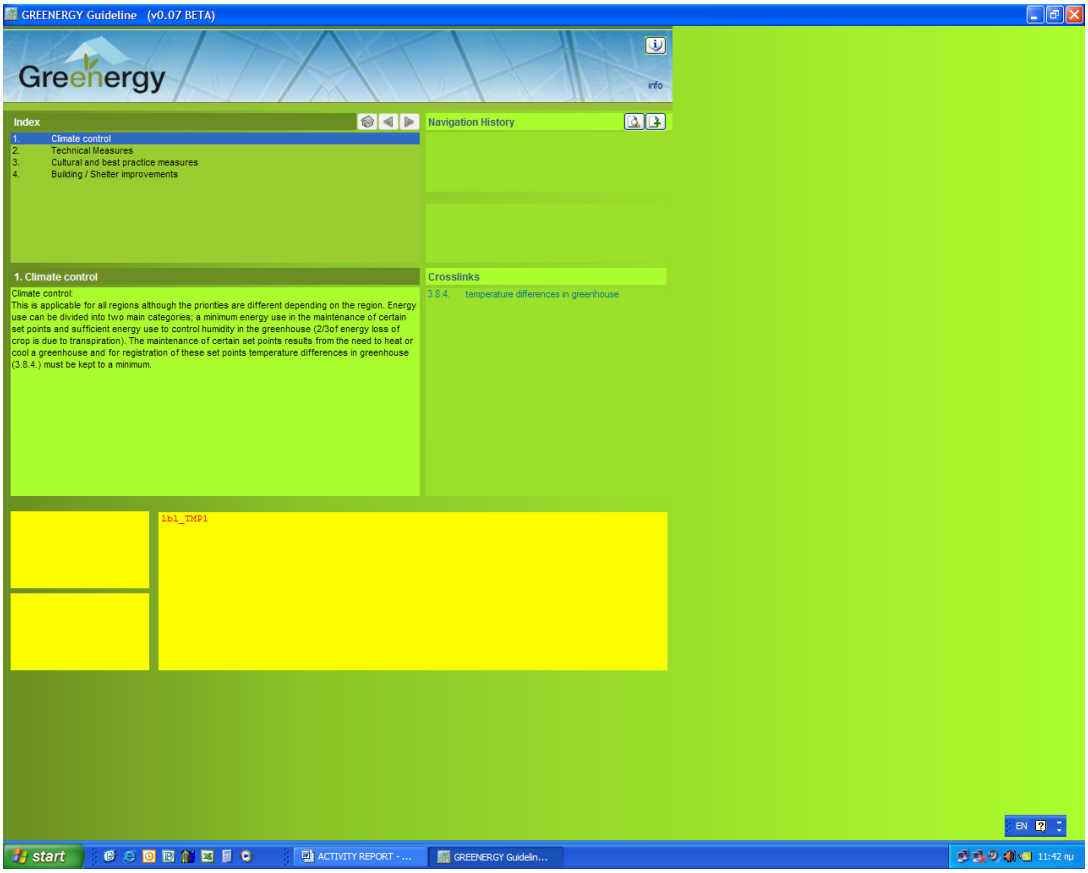

Greenergy Software 1.0.1 (Demo Version)
Components and Materials
Glazing
Screens
Lighting
Fuel
Material Properties
Item
Value
Name:
Polymethyl acrylate (PMMA)
Thickness (mm):
8
Layers:
single
P-value:
3.5
Transmission:
0.9
DeZwart:
1
Absorption/emissivity:
0.85
Description/Notes:
None
Close
Material and Component Database
OK
Greenhouse currently open: Example Polytunnel

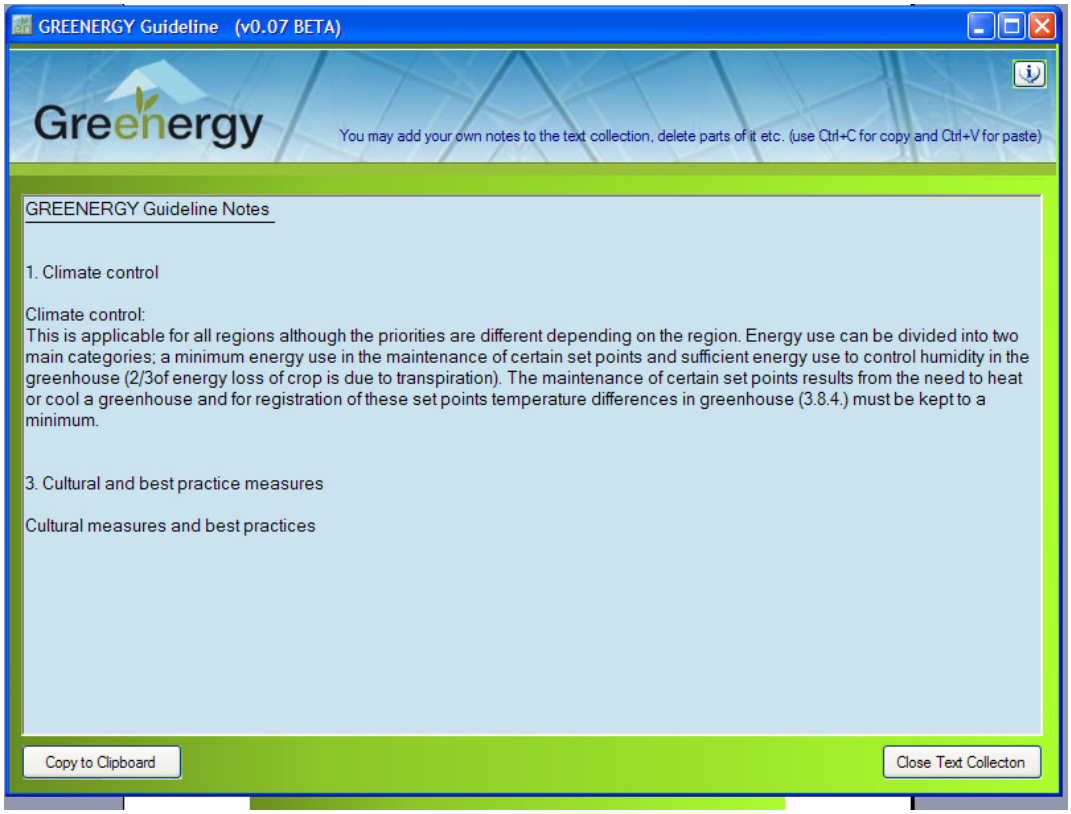

Greenergy Software 1.0.1 (Demo Version)
Greenhouse Type and Dimensions
Total Length:
150
Total Width:
70
Ground Area:
10500
Surface Area:
1843,72
Volume:
120278,87
Options:
Length of Arc
Height of Support
Length of section
Width of span
Number of spans:
Number of sections:
Help
Cancel
< Back
Next >
Finish
Dimensions
2/6
Greenhouse currently open: Example Polytunnel



Screen shots from the Guidelines




GREENERGY Guideline (v0.07 BETA)
Greenergy
info
Index
1. Climate control
2. Technical Measures
3. Cultural and best practice measures
4. Building / Shelter improvements
Navigation History
1. Climate control
Climate control:
This is applicable for all regions although the priorities are different depending on the region. Energy use can be divided into two main categories; a minimum energy use in the maintenance of certain set points and sufficient energy use to control humidity in the greenhouse (2/3of energy loss of crop is due to transpiration). The maintenance of certain set points results from the need to heat or cool a greenhouse and for registration of these set points temperature differences in greenhouse (3.8.4.) must be kept to a minimum.
Crosslinks
3.8.4. temperature differences in greenhouse
lbl_TMP1
start
ACTIVITY REPORT - ...
GREENERGY Guidelin...
EN
11:42 πμ


GREENERGY Guideline (v0.07 BETA)
Greenergy
You may add your own notes to the text collection, delete parts of it etc. (use Ctrl+C for copy and Ctrl+V for paste)
GREENERGY Guideline Notes
1. Climate control
Climate control:
This is applicable for all regions although the priorities are different depending on the region. Energy use can be divided into two main categories; a minimum energy use in the maintenance of certain set points and sufficient energy use to control humidity in the greenhouse (2/3of energy loss of crop is due to transpiration). The maintenance of certain set points results from the need to heat or cool a greenhouse and for registration of these set points temperature differences in greenhouse (3.8.4.) must be kept to a minimum.
3. Cultural and best practice measures
Cultural measures and best practices
Copy to Clipboard
Close Text Collecton

The main aim of the **third work package** was the elaboration of a user friendly guideline in order to improve the energetic efficiency of the greenhouse energy systems.

The first step was the development of the guideline for optimization by developing the guideline structure and implementing the guideline. The RTDs elaborated the structure of the guideline, dividing it in subsections and these further on in technical elements. Due to the wide range of equipment and configurations found in the sector, the RTD partners might decide to include only the factors that have a major influence in the energy performance. In the analysis of each element, the user would be asked about working and maintenance parameters. For each question a set of possible prefixed replies will be proposed in order to delimit precisely the operational boundaries of the element analysed. These answers normally have the form of an interval of values among which the element is operated, paying special attention to the performance indicators that affected by the critical points identified in each element.

The guideline was implemented by the partner WU with the assistance of the partner TTZ, following the structure developed before in the development of the guideline structure. The IAG and the core SME partners collaborated in the development of the guideline by advising WU and TTZ on how the contents should be presented in order to achieve a good assimilation by the SME growers. Feedback from guideline application lead to improvements with respect to user friendliness and practicability.

The major user of the guideline would be the advisory services (IAGs). Based on the *Measures for Technical Improvement of the Energy Efficiency in the sector* and on the *Definition of the European Quality Standards for efficient use of the energy in greenhouses* a number of measures can be used to increase energy saving in greenhouses. The guideline made in order to improve existing greenhouses. The guideline can be used as a decision support tool for greenhouse energy saving and investments. The guideline is linked to the Energy Auditing Tool which focuses on the greenhouse structure and insulation and the Investment Decision Tool. The Energy Auditing Tool has been built up around the guideline to include many options on greenhouse structure, insulation and climate setpoints. This tool also includes energy efficiency.

The main aims are 1) to increase the energy use efficiency and 2) to calculate the investment.

The guideline structure was created and was filled with information taken from the *Measures for Technical Improvement of the energy efficiency in the sector* and further literature sources. The guideline was sent to the partners RTDs for commenting and for their inputs, the guideline was adjusted accordingly.

The following step was the Development of the Investment Decision Tool. This instrument would help the growers to analyze the economical feasibility of the measures proposed in the guideline that require a relatively significant investment. For this their specific feedback as well as the technological input from the IAGs was required. The tool would take several inputs from the user (energy costs, actual consumption of the equipment, cost of equipment and its installation, length of investment in years) to provide the rate of savings achievable from this investment. The system would also account for the costs of the analysis required to assess the actual efficiency of the element subject of evaluation.

The Investment Decision Tool is an application dedicated to the design and evaluation of optimal greenhouse structures by combining different types of commercial (not necessary) equipment. All of our structures can be easily customised to provide growers with the size, covering, heating, cooling and controls, creating the best possible environment for their crops. The software application uses modern IT implementation techniques in order to satisfy the demands of growers for optimal and low cost greenhouse design using a modified Net Present Value method. Using an investment decision tool seams pointless if the user does not understand its output. The result reading process is made simple and intuitive to the user by the investment decision tool through straight answers and warnings, as well as charts and reports.

The outcome is the development of a tool for evaluating possible investments concerning greenhouses in Europe based on the net present value that was tested. The three software applications: Guideline Optimisation, Energy Auditing Tool and Investment Decision Tool are linked together and can be used separately or as a combined tool.

The last step of the third work package was the test of the instruments developed. This Investment Decision Tool that has been developed tested by the RTD partners UH, TTZ, WU, UAL and EAU under the specific conditions of the involved growers and based on the regional working groups defined in the first work package. These groups were complemented by participating local SME growers. The partners evaluated the validity of the instruments developed and proposed the appropriate improvements in case it is necessary. Besides, it is possible that the SMEs and IAGs will identify further modifications to the software not identified during the testing to improve its usability although it is envisaged that these will be relatively minor. Subsequent modifications will be undertaken within the constraints of time and funding. In this way, UH presented in the last meeting in Bremerhaven, in August 2008, the results of the tests in version 1.10 of the EAT using the greenhouse profiles representative of actual greenhouses (created by the partner WU for subtask 6.4).

The *Auditing Software and Guidelines tested and Improved* outlines the improvements that have been made to the Energy Auditing Tool (EAT) in response to comments from GREENERGY consortium partners. It includes adjustment of the calculus to improve the accuracy of the simulations and improvements to the user interface and its overall usability.

The *Core SME greenhouse growers final energy consumption* describes the final energy consumption data of the SMEs greenhouses (provided by Wageningen University in Deliverable 10) as simulated by the final version of the Energy Auditing Tool (EAT). It then illustrates with an example the potential energy savings (per kg of marketable commodity) that may be made through the implementation of small changes in configuration and operating procedures. It also notes further modifications to the EAT in response to requests from partners during training (Deliverable 19).

The forth work package has as the main objective to provide the IAG partners with the skills and knowledge required to assess the compliance with the EQS “European Quality Standards for Energy Efficiency Greenhouses” and to optimise the energy consumption in greenhouses through the use of the guideline for technical improvement including the energy auditing software tool. This would enable the IAGs to train later their SME members.

The IAG and participating core SME partners will be trained by the RTDs in order to provide the IAGs with the highest possible competence in assessing the compliance

with the EQS and the practical usage of the technical improvement guideline and energy auditing tool. They can then transfer the know-how and provide advice to their SME members at a later stage. The participating IAGs and core SME partners will provide their feedback along the course of their training. Once the and guideline and software tool have been optimised, the IAGs will complete the knowledge transfer strategy and adapt the training material. The know-how transfer strategy will be tested with a group of SME partners from each IAG through several workshops. These SMEs will apply their newly acquired knowledge to their own greenhouses. The ability of the growers to assess the performance of their greenhouses and propose measures for optimisation will be evaluated by the RTD and IAG partners. From the results obtained, the know-how strategy will be evaluated and modified if necessary.

The training materials (handbooks, brochures, spread sheets, presentations video, etc) will be translated in all languages of the involved countries. After 19 months of project duration this training concept which is based on the results of the previous work packages will be critically reviewed and presented to the European Commission. The training plan is based on the transfer of skills from the RTD to the IAG and then to the SME partners.

The first step was the presentation of an updated training plan and the development of the training material. This was fulfilled with the submission of the Updated training plan (in month 19).

The next step was the preparation of the training material about the draft EQS and the use of the Energy Auditing Software Tool as well as the preparation of the training material for the training in the use of the guideline for technical improvement and the investment decision tool.

The training material for the workshops would comprise the following topics:

- The need for standardisation and benchmarking in the sector of protected horticulture.
- The aims and scope of the energy use standards and their assessment.
- Using the software tool to evaluate the energy consumption in greenhouses.

These training materials will be provided **in English** and include:

- Training handbooks (working booklets)

- Audiovisual training medium (CD-Rom or videotape) with explanations for application of the guidelines for technical improvement and investment decision tool
- Transparency films/power point files on CD for oral training presentations
- Training Excel spreadsheet for training on the application of the investment decision tool
- Explanatory brochures and posters
- Guidance to train SMEs

The training material about the draft-EQS and the use of the Energy Auditing Tool, and about the training material for the training in the use of the guideline for technical improvement and the Investment Decision Tool (subtask 10.3) prepared by WU and presented during the 30-month meeting and workshop which took place in Wageningen in month 30. The contents of the training material that were prepared are the following:

1. Guidance for the training of the SME
2. Energy Auditing Tool User manual
3. Start Centre and Guideline Optimisation Manual
4. Topics.dat
5. TopicsInfo.dat
6. Investment Decision Tool manual
7. European Quality Standards for Efficient Use of the Energy in Greenhouses - Handbook

8. Presentation 1: “Introduction of Training”
9. Presentation 2: “task 6_4”
10. Presentation 3: “NPV”

Exercises for the EAT:

11. Exercise 1 EAT Training version 2
12. Exercise 2 EAT Building own greenhouses

Exercises for the IDT

13. Explanation of IDT excel examples 1 and 2 of IDT_screen
14. Exercise 1 in excel for IDT_screen with total costs and revenues
15. Exercise 2 in excel of IDT_ screen without total costs and revenues

16. Exercise 3 IDT Training using excel examples.doc
17. Poster
18. Brochure

The third step was the training of the IAG partners; training on the draft EQS and the use of the energy auditing software tool, training on the use of the guideline for technical improvement and the investment decision tool and case studies.

For the above there have been foreseen that PAS with the support HDC and DEG would organise a workshop, in which the RTD performers TTZ, WU, EAU, UAL and UH (depending on the working group) will introduce to all the IAGs the information developed in previous step. This workshop would mainly focus on the use of the software tool to evaluate the consumption of energy in greenhouses and the compliance with the draft standards. Several practical examples would be introduced and evaluated.

In addition, the training involved on the use of the guideline for technical improvement would comprise two parts. The first one would consist of a workshop where the IAG and SME partners would learn how to use the guideline for optimisation to:

- Evaluate of the energy consumptions occasioned by different elements and equipment of greenhouses
- Propose of the adequate improvement measures.

In the second part, IAGs would be trained in the use of the Investment Decision Tool through several practical examples. The same RTD performers as in the previous steps would carry out these training measures.

Finally, the training of the IAGs would be completed by a practical part where the IAGs would have to use the knowledge acquired in the two previous levels, in direct application to the actual situation of the involved core SME growers. Here, the IAGs and SMEs assisted by at least one RTD partner of their working group (TTZ, VTT, WU, UAL, UH, EAU) would evaluate several real greenhouses (of their associates) and proposed all the possible measures for their energy optimisation. A financial analysis of the medium investment measures would also be carried out. The assessment would be evaluated by KPL supported by the involved RTD partners. KPL would introduce the results to the other IAGs who would as well provide them with the appropriate feedback.

PAS, with the contribution of WU organised a two-day workshop, after the planned 30-month meeting in Wageningen, to cover all the forenamed aims so as the IAGs to be trained. The first day of the workshop was mainly focused on the strategy and expected outcomes of the training activities as well as the use of the software tool to evaluate the consumption of energy in greenhouses and the compliance with the draft standards. In particular, IAGs trained on how to use the tools to evaluate of the energy consumptions occasioned by different elements and equipment of greenhouses started. The Energy Auditing Tool manual was presented and WU and TTZ gave examples on real greenhouses' cases and instructions how to build own greenhouses. Also, in direct application to the actual situation, various tests were applied in order to evaluate the energy consumption and optimization of the greenhouses of the involved core SMEs.

During, the second day of the training of the IAGs, the WU explained the logic behind the undertaking of an investment, how Investment decision Tool (IDT) calculates the Net Present Value (NPV) and the way two different investments can be compared by this tool. IDT manual's examples were represented and several practical examples introduced and evaluated as the participants applied the tool in real scenarios.

The training for the IAGs and core SMEs concluded by the distribution and completion of a questionnaire designed to assess the functions of the developed Energy Auditing Tool.

The third main aim of this forth work package was the SME training and the training strategy evaluation.

The IAGs would adapt and complete the training strategy and material produced by the RTDs to suit the characteristics of their member SMEs. For this work, a fluent communication between RTDs and IAGs was required. Once the training tools were completed, each IAG partner would carry out a training workshop with a group of their associates SMEs in their home countries. These ones would employ the acquired know-how to assess the energy performance of the real greenhouses analysed before by the IAGs and would propose the appropriate optimisation measures. These case studies would serve to evaluate the training strategy and redefine it in case it was necessary.

The RTDs TTZ, VTT, WU, EAU, UAL., UH, all the IAGs and SME partners would evaluate together the whole training strategy deployed in this work package. The partners would be asked to propose possible improvements to this strategy if appropriate. An evaluation report along with a recommendations annex would be elaborated to help the IAGs improve their training strategy.

IAGs, supported by PAS, have organised the know-how transfer strategy to their associates SMEs as follows:

a. Translated the training material in their native languages. The scientific language and the special jargon for the greenhouses and the horticulture cultivation used in many parts of this training material caused delays in the preparation of the translation of the training material.
b. Each IAG downloaded, installed and tested the developed software. In some cases, there were reported some problems during the installation of the tools but, a fluent and early communication of the problems occurred between RTDs and IAGs, mainly through the coordinator and subtask leader, PASEGES, lead to a smooth solution of the various issues.
c. Then, IAGs organised the training sessions in their home countries to correspond to the needs of their members associations (limited time) as it was high peak summer season for some plants (harvest and transfer to the market).
d. A questionnaire designed and distributed among the participants to get their feedback.

To complete this task, PAS compiled a report which comprises the results from the work was accomplished under this subtask. The report describes the IAGs' training strategy which was exercised and evaluated on several SME associates.

Parter DG undertake this subtask after the voluntary withdrawal of partner HDC. A questionnaire was made and sent to all the partners in GREENERGY. The questionnaire gave possibility to answer by "setting a mark" (as in Likert scale) or by giving comments and express views. The partners evaluated the whole training strategy deployed in this work package and gave their proposals on possible improvements to this strategy. An evaluation report (Deliverable 21) along with a recommendations annex was elaborated to help the IAGs improve their training strategy, which was also decided to include questions regarding Dissemination.

The questionnaire was divided in several parts:

- Dissemination of the tools developed
- Maintenance of the tools developed
- EAT, the Energy Auditing Tool
- IDT, the Investment Decision Tool
- EQS, the Energy Quality System
- The guidelines

The objectives of the fifth work package were the definition of the management of the EQS and the Technical Improvement Guideline, the definition of the process for granting the EQS and to establish the auditing bodies involved in such process and the establishment of the exploitation and dissemination routes for the results of the project.

Regarding the property rights management, the management of the project's outcomes had to define the plan of the measures that had to be taken in relation to the Intellectual Property Rights affecting the material produced in the project specially the optimisation guideline and the auditing software (usage fees, licenses, etc.).

As far as the updating schedule is concerned a permanent working panel would be constituted between the IAG partners in order to create a schedule for updating the technical improvement guideline.

The proposed labelling had foreseen that the IAG partners would create a set of labels to identify in the future the products produced in greenhouses whose energy performance has been audited and falls within the ranges established in the European Standards.

Regarding the Property Right Management the IAGs taking into consideration the conclusions of the comprehensive evaluation of the forth work package, which cover an appraisal of the project outcomes, proposals for their dissemination and the potential for their exploitation and sales, agreed on the plan of the measures to be taken in relation to the Intellectual Property Rights affecting the material produced. Of particular interest were the software outcomes, EAT (Energy Auditing Tool) and IDT

(Investment Decision Tool) and the EQS (Energy Quality Standard) with its accompanying labelling. As it was agreed, TGA with the support of DG will secure the performance of the decided measures.

For the updating Schedule the IAGs have been considering the importance of updating the technical improvement guidelines on a regular basis. They had proposed to add some links that could update the guidelines automatically but this is not an easy task according to the RTDs. It was agreed that the guidelines will be updated accordingly to correspond the demands of the end users.

At the Proposed EQS granting protocol, as Energy efficiency is a topic which can be found at every international standardization level, the consortium decided that the standards defined and which are proposed under the Greenergy project would fit better to complement previous standardization and to contribute to a sustainable use of energy in the European greenhouse production. Therefore, the subtasks leaders prepared a report - proposal with the Greenergy's standards with the scope to be incorporated within the GlobalGAP Standard, in the section that exists already auditing the energy efficiency and lies under the control points and compliance criteria for integrated farm assurance -all farm standard document.

Finally about labelling in order to identify in the future the products produced in greenhouses whose energy performance has been audited and falls within the ranges established in the proposed standards, HFV compiled a report which includes the set of three labels created under this subtask. The labels were designed in a 1-colour, a 2-colours, a 4-colours option (the less colour, the less printing cost) for the partners to choose the most suitable one.

The last objective of this work package was the development of a dissemination strategy for GREENERGY. This work package would ensure the dissemination of the project results by implementing this strategy, conduction of conferences, workshops, etc. Thus, the aim of this work package was to establish the exploitation and dissemination routes for the results of the project.

The following dissemination measures would be undertaken:

- Greenhouse auxiliary industry contacts: The IAGs would inform greenhouse equipment manufacturers and providers in their geographical regions about

the new standards with the aim of improving the advise and information on energy performance that greenhouse growers receive when purchasing new equipment.

- Project website: A project website would be created by TTZ comprising information about the European Standards for efficient use of the energy in greenhouses and information about the Assessment software tool. The results of the case studies performed would be presented in this web as well. The site would have a restricted access forum for non-members of the Greenergy consortium. This forum would contribute to achieve a fluid communication between the members. In particular, it would serve as a channel for the IAG to get technical assistance from the RTD partners when required. Several other forums would be created to registered members (associates members of IAGs) would be able to receive advise from other members or their corresponding IAGs on energy optimisation.

- EQS market promotion: The draft standards developed in the project would be made public to rise awareness in the consumers and stakeholders. The consortium would additionally contact other associations (done by the IAGs), research centres and universities related to the sector of protected agriculture (done by the RTDs) to rise their awareness on the draft standards proposed in this project and to receive their input. Then, the consortium would – via the co-ordinator- establish communication with the Technical Committee for Greenhouses of the European Committee for Standardization (CEN) to initiate the mechanisms to propose the draft developed in the project as European standards. In addition to the contacts to EurepGAP, the consortium would contact other relevant retail chains, retailers associations and distributors of greenhouse products to inform them about the Quality pre-Standards developed in the project. This measure would be the first step to transmit the energy standards concept to the customers, whose assimilation would set would set the future standards as a marketing tool.

- Further dissemination: The standards developed in the project would be further disseminated by all partners, initiated by TTZ and strongly supported by all IAGs and BL. They would present the project in fairs and congresses (such as HortiFair , GREENSYS or ExpoAGRO), as well as via publications in relevant magazines of the sector (such as FOLIAHORTICULTURAE, European Horticulture Journal, Acta Horticulturae etc.) .

The partners TTZ, PAS and TGA would provide specific information material to the co-ordinator of the CEAF project (Polish Academy of Sciences, see Appendix A3) to initiate further dissemination of GREENERGY results also via this platform. The participating growers would inform also their own specific customers about the advantages of implementing GREENERGY in greenhouse horticulture in order to create customer awareness about the benefits of GREENERGY application for the public end users.

The completion of the work described above has been implemented as follows:

Regarding the *Greenhouse auxiliary industry contacts* the IAGs communicated with greenhouse equipment manufacturers and providers in their geographical regions to present the outcomes of this project. Their utmost aim to achieve is to offer advices and information on energy performance when greenhouse growers purchase new equipment. A report with details of all the contacted people or companies was compiled by the TGA.

As far as the *Project Website* is concerned it has been developed (*www.greenergy-project.com*). It contains a restricted area for the project partners and the EC, a forum for registered users as a platform for communication and all the project relevant information. Moreover, on the Greenergy's website there are links to all partners' individual websites and vice versa in order to raise the awareness for this project. An area to download project information and reports which are not restricted to the consortium is also available in the website. The website is updated in a regular basis by TTZ to include all the newest information on the project.

Concerning *The European Quality Standards Market Promotion t*he consortium decided that this deliverable should be updated during the duration of the project, thus the final version will be delivered in the end of the project. The EQS for efficient use of the energy in greenhouses are being defined in parallel with the development of the Market Penetration Plan. Within this task, the draft standards under development in the project are aimed to be made public to raise awareness in the consumers and stakeholders sector. First of all, important associations, research centres and universities related to the sector of protected agriculture have been identified by the IAG and the RTD partners respectively. Once the draft of the standards is ready, the partners will contact those associations or research centres

(experts) that will check the draft proposed and will be asked to give their input, giving any further information, modifying or ruling out any aspect.

The main outcome of this subtask is the preparation of *Deliverable D27, Draft EQS market penetration plan,* by the partner BL, which main contents are:

Identification of associations:

- ✓ Contacts Related to the Sector of Protected Agriculture
- ✓ Potential End Users Contacts

Identification of research centres:

- ✓ Contacts Related to the Sector of Protected Agriculture

Other outcomes for this subtask were the following:

- ✓ Establishment of communication with the Technical Committee for Greenhouses of the European Committee for Standardisation (CEN) to propose the EQS as European standards
- ✓ Establishment of communication with the Spanish National member of CEN, the Normalisation and Standarisation Spanish Association (AENOR), that showed us their interest in our project and they were going to further contact us; therefore, it was not possible to go further on this issue by our side
- ✓ Establishment of communication with EurepGAP contact person for GREENERGY, Dr. Kristian Möller. He recommended us to attend the 9th GLOBALGAP (Global Partnership for Good Agricultural Practice) Conference which is going to take place in Cologne, Germany the 15th – 17th October 2008 (www.summit2008.org). No more information was provided by the EurepGAP representative

An extend description of the *Further Dissemination* follows.

According to the structure adopted for the project management, the IAG PAS, with the support of the TTZ, is the partner in charge of establishing the communication with the other associations and organism (authorities, groups, other entities; etc.) and for preparing the dissemination and exploitation plans for the project results.

The following table shows the past and future dissemination activities planned for the project GREENERGY:

Planned / actual dates	Type	Type of audience	Countries addressed	Size of audience	Partner responsible / involved
Several dates	Direct e-mailing (Circular letter)	AIGs members	Greece, Denmark, UK, Finland, Hungary, Estonia, Italy, Germany, Spain, Romania, Netherlands		PAS / IAGs
Several	EurepGAP	Consumers and stakeholders (Greenhouses)	International		TTZ / PAS / BL / all partners
Several	Press release (press)	Public in General	Germany	Media (press & magazines)	TTZ
Several	Press release (press)	Public in General	Greece	Media (press & magazines)	PAS
	Project website	General public	International		TTZ / All partners
Several	Links from partners websites	General public	All		The ones which have own web site

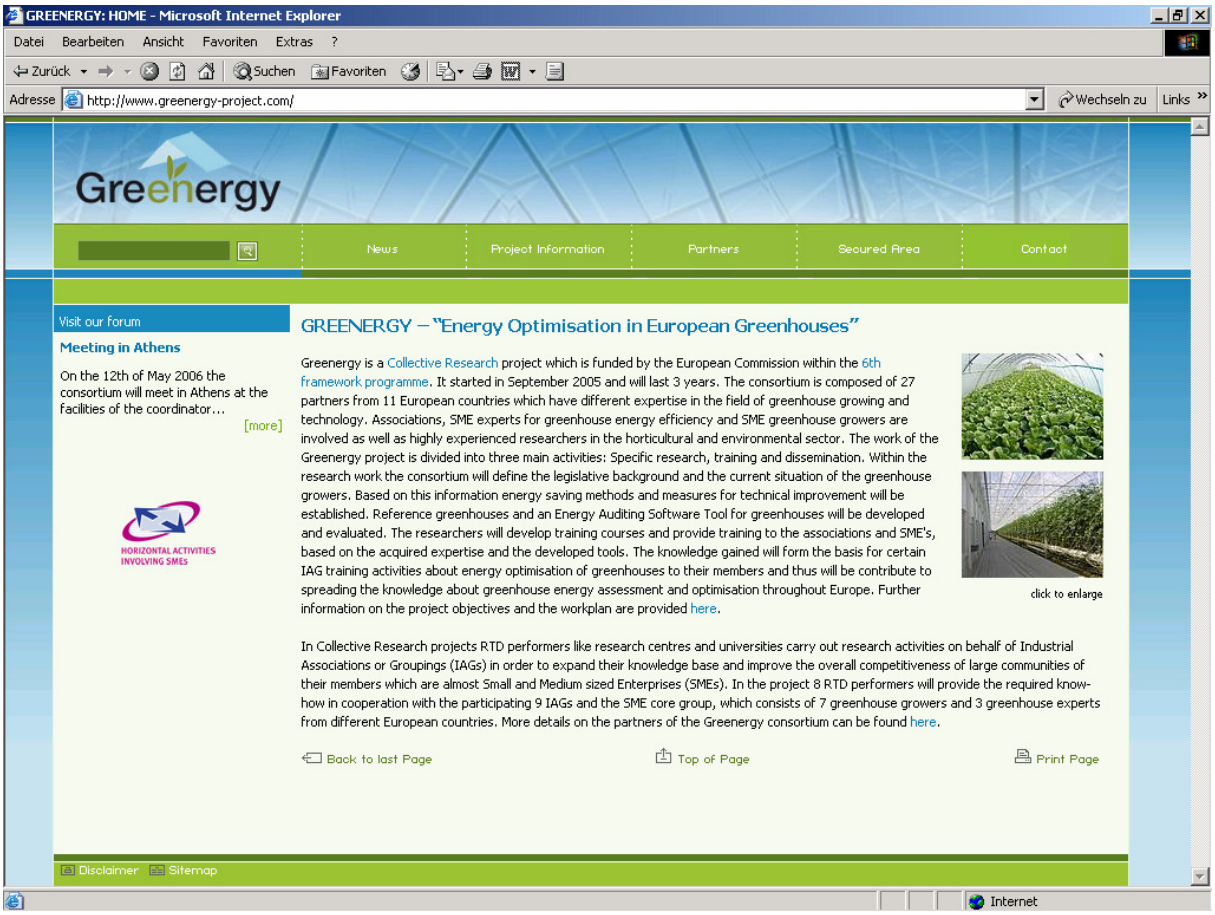
Several	Press release (press)	Public in General	UK	Media (press & magazines)	UH
Several	Press release (press)	Public in General	Netherlands	Media (press & magazines)	WU
Several	Presentation of GREENERGY in the official brochure of PASEGES	Public in General	Europe	More than 700,000 people	PAS
Several	Presentation of GREENERGY in the Annual Seminar of Presidents and General Managers of Unions of Agricultural Cooperatives	Members of PASEGES	Greece	More than 200 people	PAS
Several	Brochure about GREENERGY	Public in General	Greece		PAS
Several	CORDIS WEB page	Public in General	Europe		EU
Several	Fairs (Horti-Fair, ExpoAGRO, GREENSYS)	Public in General, Greenhouse management	International		TTZ / PAS
2007	Project	Public in	Denmark	Media,	KVL

	presentation	General, Greenhouse management		agricultural field	
2007	Project presentation	Public in General, Greenhouse management	Greece	Media, agricultural field	PAS
2007	Project Brochure	Public in general, greenhouse sector	International		TTZ / PAS
2008	Project Presentation	AGROTICA: Exhibition about agriculture in Greece	International	All the farmers from Greece and from other countries	PAS
2008	Project Presentation	Seminars organised by PASEGES	Greece	Farmers	PAS

Dissemination carried out

One of the most important means of sharing and disseminating the project's results with third parties is the project's webpage. The TTZ, supported by the rest of the consortium, has coordinated the setup of a webpage for GREENERGY: www.greenergy-project.com (Deliverable 26).

In this website, the visitors can find the latest news about the project, important project information, a description about the project partners, as well as the contact information to the coordinators of the project. In a password protected area the partners have access to the latest project reports, project meetings, etc., in order to support the consortium communication. Following a screen shot of the website already online:



The project website www.greenergy-project.com, was one of the main tools used for the wide dissemination of the project results, project follow-up and main events promotion. It contains the deliverables targeted to the public, articles related to the activities of the project, up-dated news and events, information of International

Conferences on greenhouses and other up-to-date information. Dissemination material was as well upload on the project website to the consortium members.

In addition, it must be commented that all the Associations in the GREENERGY consortium have already informed their members about the progress made in the development of the project through mailings and other usual communication methods used.

After the Kick of Meeting of the Greenergy project in Thessaloniki, Greece, PASEGES published a small article mainly about the goals of the project and the participants in a newspaper in Greece.

PASEGES has already published an article in the magazine that issues with the name “Agrotikos Synergatismos”, which is monthly and it is send to all the members of PASEGES, which are mainly farmers and unions of agricultural cooperatives.

In addition, PASEGES presented the Greenergy project in the Annual Seminar of Presidents and General Managers of Unions of Agricultural Cooperatives (more than 200 people) that took place in Loutraki, Greece (November 2006) *(See Annex 1).* The interest of the participants of this seminar was very high since PASEGES received many calls from owners of greenhouses from all over Greece that wanted more information about the progress of the project and the results of it.

Furthermore, PASEGES created a brochure regarding the GREENERGY project that is distributed in almost all the seminars and events that are organized *(See Annex 2).* In addition, PAS presented the GREENERGY project in its official brochure that has been issued in 3 languages (Greek, English and French) *(See Annex 3).*

Another important dissemination measure that PASEGES undertook is the constant presentation of the Greenergy’s project to the portal of PASEGES (www.paseges.gr) *(See Annex 3.1).*

During the last year of the Greenergy project PASEGES materialed the following dissemination activities:

- 6-20 February 2008: Presentation of the project during the “AGROTICA ’08: 22nd International Fair for Agricultural Machinery, Equipment & Supplies”, in Thessaloniki, Greece. Also Greenergy’s leaflets distributed there and

dissemination of the project's qualities through oral dissemination (personal contact). *(See Annex 3.2)*

- Greenergy's leaflets were translated in the Greek language and distributed to all seminars and fairs held for farmers from PASEGES.
- Periodic briefing on the progress of the Greenergy Project
- Sunday 10th of August 2008, presentation of the project, its aims and outcomes, during the weekly broadcast of the program "Peri gis o logos" (Talk about the Earth). *(See Annex 3.3)*
- 19th of August 2008: Article about the implementation of the Greenergy project uploaded at the website of PASEGES (www.paseges.gr) *(See Annex 3.4)*
- 29th of August 2008: Article about the Greenergy project and its philosophy to improve energy efficiency uploaded at the website of PASEGES (www.paseges.gr) *(See Annex 3.5)*
- In the issue September 2008 of the monthly magazine of PASEGES "Agrotikos Synergatismos" ("Farmers' Cooperation", with an approximate circulation of 10.000 copies) *(See Annex 3.6)*
- 15th of October 2008: 4 pages in the monthly magazine slip "Hellenic Earth" of the newspaper "Eleytheros tipos" (www.e-tipos.com) – available also from the webpage of the newspaper *(See Annex 3.7)*

The TTZ has done some press releases and has communicated with magazines specialized in the field for the publication of an article about the project and its results *(See Annex 4).*

Several dissemination activities were carried out by TTZ in three different dimensions during the last semester of the Greenergy project (Month 31 to Month 36). The first one deals with the knowledge component, which is the training and skills to use the software tools from the RTDs to the IAGs and SME consortium members. The second one was the media publication (within the consortium and to third parties or public in general) and the third one by electronic means through the use of the project website.

A summary of the above activities are: regular up-dates of the project web page, web release of the training meeting at WU in Holland, training workshops from RTDs to IAGs and core SMEs at Wageningen University, cases study uploading on the web

site, further workshops at Bremerhaven to core SMEs, printing and distribution by TTZ of 1.000 promotional flyers, posters printing and distribution to IAGs (pdf format for translation into their respective language), release of the final Greenergy meeting at Bremerhaven, scientific publications at the German magazine “Gemüsse” and a second one in cooperation with the Tech. Univ. of Timisoara (UPT) and newspaper publications in German media.

A second project brochure for promoting the project outcomes and successful implementation of the software tools was developed and distributed to the partners in English language. *(See Annex 5.1)*

A poster was designed additionally as support material to be translated by the partners and used during the IAGs training workshops of their associates*. (See Annex 5.2)*

The project brochure can be downloaded from the project website. Hard copies in all the languages of the consortium were printed. 1.000 brochures have been printed and distributed by TTZ to the partners and interested greenhouse growers on the area.

Additionally two posters were design in cooperation with partner BL from Spain. This dissemination material is intended to show the project outcomes and being used by all consortium partners on future dissemination activities. The two posters have been uploaded on the Greenergy website. *(See Annex 5.3 & 5.4)*

Information material was provided to the co-ordinator of the FP6 CEAF project. Contact was established to the coordinator Mrs. Bozena Podlaska to further disseminate the Greenergy results via this platform. The main aim was to introduce to them the project outcomes and project consortium members for potential future cooperation in related greenhouse initiatives. An invitation to a CEAF representative in September 2008 was extended to show the software tools and case studies.

TTZ presented technical publications of the project in the most relevant magazine for the sector. On the issue of October a paper was published in the magazine *GEMÜSSE*, one of the most important horticulture publications in Germany. Further on TTZ in cooperation with the Technical Univ. of Timisoara (UPT) public a paper at national level in Romania.

Finally several articles of the project results, development and final meeting were presented on the *NORDSEEZEITUNG* one of the most important news paper of northwest of Germany. *(See Annex 5.5)*

The dissemination activities carried out by TTZ on the last semester of the project are summarised in the following table:

Dates/location	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/ involved
February 2008	Release of 30th project meeting "Training	Consortium partners and public in general	EU	Estimated thousands	TTZ
March 2008	Training workshop	IAGs and SMEs	Consortium partners	Hundreds	RTDs
April 2008	Brochure	Greenhouse owners	Germany	1000	TTZ, PAE, SKL
May 2008	Up-date of official project webpage with	Consortium	Germany	Hundreds	TTZ
July 2008	Press release German newspaper Nordseezeitung	Public in general	Germany	Estimated Thousands	TTZ
July 2008	Release of Last project meeting at	Public in general, consortium members	EU	Estimated thousands	TTZ
September 2008	Press release German Newspaper Nordseezeitung	Public in general		Estimated Thousands	TTZ
September 2008	Up-date of official project webpage with	Partners and general public interested in Greenhouse technlogy	International	Estimated hundreds	TTZ
September 2008	CEAF FP6 project	FP6 project on horticulture and	International	Estimated Thousands	TTZ
October 2008	Scientific paper,	Product suppliers, Retailers, farmers,	Germany	Estimated hundreds	UPT
October 2008	Scientific paper University	University staff, students and public in	Romania	600	UPT

Additionally participation on fairs, symposia and conferences taking place on 2008 and 2009 are foreseen to be visited by all GREENERGY partners on the oncoming

year editions. In this way the results will receive widespread attention on global level and foremost at EU27 level.

The partner COEXPHAL attended several meetings of the Spanish horticultural sector where the project was presented. This concerns nation wide producer organizations (FEPEX-CCAE and FAECA), as well as organizations dedicated to the certification of quality standards (AENOR). Moreover, the Project was presented at a technical seminar for field technicians (29/03/2007). Finally, the Project was presented in various press releases, as well as in the COEXPHAL journal "Almeria en Verde" *(See annex 6).*

In addition partner COEXPHAL on the 25th of June 2008 made a leaflet for the training session for technicians of associated producer companies*.(See Annex 6.1)*

Publication in 'Almería en Verde' Nº 56, pp 22-23. - Translation of EAT Manual

In addition the partner University of Copenhagen, published an article in Hollendish *(See annex 7).*

The partner BL arranged the following press releases:

- Press release in the webpage of the Energetic Press release in the webpage of the Energetic, Environmental and Technical Research Centre (CIEMAT), Ministry of Innovation and Science, Spanish Government
- Press release in the REDCICLA webpage, devoted to recycling and other environmental issues
- Press release in the Andalucia Investiga webpage, a site property of the Andalusian Government which is devoted to research in the Andalusian Community
- Press release in the Innovatec forum, an innovation and technology Andalusian forum
- Publication of an article in the PHYTOMA journal, a specialised Spanish magazine distributed at national and European level related to vegetal healthiness (to be in December 2008 issue)

BL also prepared two Posters for the dissemination of the Project:

- Poster devoted to the EQS for efficient use of energy in greenhouses

- Poster devoted to the energy auditing tool and the investment decision tool

(See Annex 8)

Partners SKI and PAE organised meetings with other gardeners to introduced the developed software. Also, discussions with other horticultural enterprises about the aims of the project. Contribution to articles on newspapers.

In the Danish Grower Magazine “Gartner Tilende” there has been two articles about the tools developed in the GREENERGY Project. The first one was in “Gartner Tilende” nr. 2 2008 and was written in Danish and German. The issue was prented in a number of 5500 and 2500 were distributed in Germany. Another article was in “Gartner Tilende” nr. 7 2008 where partner DG talked about the tools and the training they received in The Netherlands. A third article has been published in September 2008 in an adition about energy and greenhouses. The announcement of the “workshop” in August has been carried out in “Gartner Tilende” nr. 14 2008. Also, DG organised 3 workshops, one for advisors and two for the growers.

The German *“Das Magazine fur Zierpflanzenbau”* published an article with photos of partner PAE and interview of Mr. G.Schories from TTZ. *(See Annex 8)*

Participation of partner AGC in the 3thInternacional Flora Expo 2007 in Amsterdam, Holland (9-12.10.2007) and Growtech Euroasia 2007 in Antalya, Turkey (06-09.12.2007)

FEC authored a technical article for HDC news. And an article about the project (Working in the Virtual Greenhouse) by Chris Plackett of FEC was commissioned and published in HDC News, June 2008. This publication goes to all commercial horticultural producers in the UK who were registered with HDC.

Information also disseminated during the whole period via FEC Services Website.

A scientific abstract was written and submitted as contribution to the ISHS conference GREENSYS2009 in Quebec City, Canada, hold in summer 2009.

Article by: Körner, O., Warner, D., Tzilivakis, J., Eveleens-Clark, B., Heuvelink, E., 2008. Decision support for optimising energy consumption in European greenhouses. Acta Horticulturae 801.

Article by: Körner, O., Rystedt, J., 2008. Investering i nybygning eller fornyelse af væksthuset? (Investing in new or renew existing greenhouses?). Gartner Tidende 2, 30-31.

Article by: Körner, O., Rystedt, J., 2008. Investering i nybygning eller fornyelse af væksthuset? (Investing in new or renew existing greenhouses?). Gartner Tidende 2, 30-31.

Article by: Körner, O., Eveleens, B., Heuvelink, E., 2007. Verhoging van energie efficiëntie in bestaande kassen (Increasing energy efficiency in existing greenhouses). Onder Glas 11, 56-57.

Article by: Körner, O., 2007. Beslutningsstøtte for højere energiudnyttelse i væksthuse (Decision support for higher energy use efficiency in greenhouses). Gartner Tidende 17, 20-21.

International Conference on Sustainable Greenhouse Systems, GREENSYS, Naples,Italy,October 2007, Poster G,
http://www.greensys2007.com/docs/opi_def.pdf

Presentation of the Greenergy project in the monthly Wageningen UR Greenhouse Horticulture Group Meeting, the Netherlands, January 2008

Presentations in the annual meetings of the ornamental growers in Denmark and in the annual MPS growers' Meeting, Denmark

Scientific bulletin of the "Politehnica" University of Timisoara, Romania, Transactions on mechanics, Tom 53 (67), ISSN 1224 - 6077,pp. 545-544, 2008

Investigation on Energy Savings Potential in pot plant greenhouses,
Gerhard SCHORIES, Leodegario LOPEZ, Hanyork von MAREES, Hubert PAETZ, Michael SADOWSKI, Ioana IONEL, Dumitru CEBRUCEAN

Bulletin of the “Politehnica” University of Timisoara, Romania, Transactions on mechanics, Tom 53 (67), ISSN 1224 - 6077, pp. 493-499, 2008, Alternative Fuels: The Energy of the future, Nicolae LONTIS, Ioana IONEL, Francisc POPESCU, Gelu PADURE

Experimental results concerning the CO2 combustion of biomass in a stationary fluidised bed pilot, with biogas support and CO2 capture, Ioana IONEL, Francisc POPESCU, Gavil Trif-Tordai, Dumitru CEBRUCEAN, Adrian CIOABLA,

The 15/th EU Bio Conference & Exhibition, June 2008, Valencia, Spain, ISBN 978-88-89407-58-1 4. Dumitru Cebrucean, Ioana Ionel, Tanase Panait, Al Savu, Novel technology of coal biomass co-combustion with CO2 capture,

International Conference on "Quality of life and environmental in the frame of E.U. sustainability", pp.43, 15-17.11.2007, Belgrade, Serbia, ISBN 978-86-82121-46-6 (proceedings), accepted for JEPE, 2008, Pp 45

Furthermore the partner UPT has proceeded with the following oral dissemination:

- CNMP conference (National Council of the Management of research projects), Moeciu, Romania, 4-6 December 2007, Oral Presentation “GREENERGY INVESTMENT DECISION TOOL”, presented by ovidiu Parvu to the more than over 100 Romanian participants, including Ministry representatives. The standards developed in the project have been also disseminated.
- Additionally, UPT has also contacted small private greenhouse users in Western part of Romania (Arad, Nadlag, Peciu Nou, Lipova, Oradea, Satu Mare, Brad, Cenad, etc.), to inform them about the project results and scopes accomplished so as to improve the advice and information on energy performance that is expected to be received when purchasing modern equipment. A close connection was performed with the local agricultural university that was involved in locally testing the tool that UPT developed.

PhD thesis:

1. Diana Silaghi, 2008 „CERCETĂRI TEORETICE ŞI EXPERIMENTALE PRIVIND POSIBILITĂȚILE DE VALORIFICARE A ENERGIEI SOLARE CA SURSĂ NEPOLUANTĂ” - (Translation in English - Theoretical and experimental research concerning the possibility of using solar potential as alternative energy source),

2. Laurentiu CALIN, Contributii la optimizarea sistemelor tehnologice de uscare a produselor cerealiere, Timisoara 2008 (Translation in English - Contributions towards the optimisation of the technology drying systems for agricultural cereals)

A paper in Estonian language "Kasvuhoonete energiamajanduse optimeerimine - GREENERGY" (The optimisation of energy use in greenhouses - GREENERGY) has been published in bulletin of forum of Estonian Horticulture (most important event for horticultural business sector in Estonia). For further dissemination in Estonia the Greenergy leaflets and posters have been developed and printed.

UAL presented the Greenergy project in two Workshops with assistance of the technical staff of the Spanish Ministry of Industry and students of the University of Almería and Engineers workings in the Almería greenhouses. They also have presented the standards for efficient use of the energy in greenhouses via publications in relevant magazines of the sector (Vida Rural and Phytoma).

3/4/2008 – The GREENERGY project and the main measures proposed in the European Quality Standards for efficient use of the energy in greenhouses were presented by Prof. D.L. Valera (UAL) in the Workshop “Jornadas sobre Ahorro Energético” organised in Madrid by the **Instituto para la Diversificacion y Ahorro de la Energía (IDEA)** of the Spahish Ministry of Industry, Truism and Commerce, [Document: **Workshop IDAE 2008 (Subtask 14.4).pdf**].

8/5/2008 – Presentation by the Prof. F.D. Molina-Aiz (UAL) of the application to a real greenhouse of some of the measures proposed in the European Quality Standards for efficient use of the energy in greenhouses in the Workshop “Curso de control climático 2008” organised in the University of Almería. [Document: **Workshop Climatic Control UAL (Subtask 14.4).pdf**].

November 2008 - The GREENERGY project and the main measures proposed in the European Quality Standards for efficient use of the energy in greenhouses were presented in a paper published in the monthly scientific Spanish magazine ‘Vida Rural’ [Documents: **Paper Vida Rural (Subtask 14.4).pdf**].

Valera D.L., Molina-Aiz F.D., Álvarez A.J., Peña A. y López A., 2007.- Avances en la mecanización de invernaderos para el ahorro del consumo energético. Vida Rural, **259**: 70-75. (ISSN: 1133-8938)

May 2008 – The GREENERGY project and some measures proposed in the European Quality Standards for efficient use of the energy in greenhouses were presented in a paper published in the monthly scientific Spanish magazine 'Phytoma' [Documents: **Paper Phytoma (Subtask 14.4).pdf**].

Valera D.L. y Molina-Aiz F.D., 2008.- Evolución tecnológica de los invernaderos. Phytoma, **199**: 47-55. (ISSN: 1131-8988)

June 2008 - Progress of the GREENERGY project was presented in a publication of the monthly magazine 'Almería en Verde', edited by COEXPHAL and distributed among its associates [Documents: **Paper Almeria en Verde (Subtask 14.4).pdf**].

COEXPHAL, 2008.- 'Greenergy': Optimizar el control de clima en invernaderos. Almeria en Verde, **56**: 22-23.

Moreover, in every opportunity, partners disseminated the project's qualities through oral dissemination (personal contact with single greenhouse growers).

Please find attached the Dissemination Material (articles, flyers, photos, presentations, magazines, announcements, dvd with a broadcast, etc.)

The "Philosophy" of the Dissemination Plan

To ensure an efficient and realistic knowledge and skills transfer, the training strategy was tested (in Task 11). For this purpose the IAG partner performed the training of a group of their SME associates through workshops. These last ones have been evaluated and provided feedback in order to improve the initial training strategy. Thus the training strategy was completely defined and the training process at European level took place through training courses to the relevant national IAGs. These training courses transferred the knowledge and skills down to regional and local associations

which are in charge of the final transfer to SMEs. Helpdesks at different levels along the training pathway were installed.

Greenergy aims to optimize the energy consumption of greenhouses all over Europe and to set the necessary foundations to establish in the near future the EQS for the efficient use of energy in greenhouses. Therefore, to accomplish these targets, the partners managed to achieve an effective dissemination of research activities and project outcomes. During the development phase, the consortium contacted other relevant stockholders, including greenhouse manufacturers, energy experts and other horticulture associations to obtain their support and possible input for the draft EQS. Additionally, the consortium contacted greenhouse manufacturers and equipment providers to inform them about the project results and scope so as to improve the advice and information on energy performance that greenhouse growers receive from them when purchasing equipment.

After termination of the project, the IAGs in the consortium established permanent contacts between them and other horticulture associations in order to manage the information and training materials resulting from the project activities paying special attention to the property rights affecting the energy optimization guideline and the energy assessment software. The Optimization guideline EQS up-dated. During the project and after its conclusion, the following dissemination routes will be followed:

- Setting up of a project web-site linkable from the IAGs own web-sites including a project newsletter
- Publication of information through a project brochure to relevant parts of the sector
- Publication in relevant magazines (e.g. *FOLIAHORTICULTURAE, Le lien horticole, La garance vogaeuse-Bultin, Acta Horticulturae, European Horticulture journal*)
- Presentation in sectorial conferences and trade fairs (e.g. Horti-Fair, ExpoAGRO, GREENSYS)
- Dissemination via the EC Specific Support Action CEAF

After the end of the project It is intended to present GREENERGY at least once a year on one of the related scientific conferences and to publish results in scientific magazines. Scientific papers for publication in relevant magazines or oral presentation in conferences will be at first presented to the European Commission.

Upon approval by the EC the IP Committee has to decide on the publication in unison, i.e. the IAGs and all the other participants have to agree in advance.

The relevant project results will be translated into the languages of the participating associations, i.e. English, Danish, Finish, Hungarian, Estonian, Italian, Spanish and Greek. Additional material for dissemination (Web page, leaflets and brochures, etc.) will be translated into the languages of all countries, represented by a project participant, i.e. English, Danish, Finish, Hungarian, Estonian, Italian, Spanish, Greek, Dutch, German and Romanian in order to achieve European wide announcement of the project.

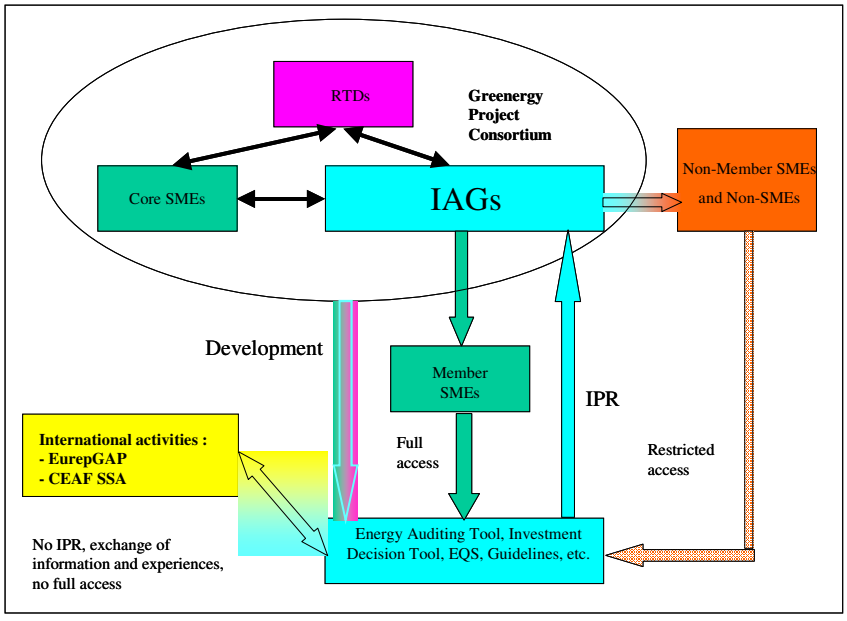
As a synergetic effect the GREENERGY project and regularly it's main achievements will be introduced to the Co-ordinator of the CEAF project (Polish Academy of Sciences) in order to initiate and support further dissemination also via the European initiative.

The idea and need for this Greenergy project was coming from British SME greenhouse growers which were pushing their associations to take an initiative. The growing international competition and high prices for energy (heating and lighting) are a fast growing problem. In the developing of the proposal the participating SME's (UK, Germany, Spain, Finland, Romania) have been contributing with specific definitions of their opportunities, needs and experiences. The combination of technology provider and end-users in this consortium created a win-win situation for both SME groups. The participation of SME's from many different EU and Candidate Countries created a broad European picture and a know-how exchange between Greenhouse farmers for different countries. Their practical input and opinion has also been absolutely necessary for the project performance and implementation of results. In cooperation with the IAG's and the RTD performers, the SME's participated in several specific WP's, bringing in practical knowledge and the basis for the urther testing and case studies.

All SMEs were strongly involved in dissemination of project results with a special emphasis on preparation of training material and contributing to training activities. The participating SME obtained practical knowledge on energy saving methods and technologies which is important for widespread convincement of other greenhouse farmers in their own organization and their region. They used this also for advertising and for creating awareness at their customers and finally at the greenhouse goods

consuming end-users. The involved greenhouse energy expert core group SMEs also contributed to further dissemination of the GREENERGY outcomes by introducing the benefits and advantages of the GREENERGY EQS and Energy Auditing tool to their customers which are again greenhouse growers and other (mainly regionally active) associations.

According to the regulations of Collective Research projects the participating IAGs retain the Intellectual property rights of GREENERGY. The intellectual property right management plan (graph 1) describes the access rights for different stakeholders. The IAG member SMEs have unlimited access to the project results and instrument, whereas non member SMEs and non SMEs as well as other third parties outside the consortium anly have restricted access (e.g. the public part of the web site, brochures, etc.). The SME and RTD consortium members do not receive any intellectual property rights. Representatives of those international activities the GREENERGY consortium collaborates during the course of the project (i.e. EurepGAP, CEAF SSA) also will not retain any intellectual property right, but may be involved also after project termination via advising and exchange of experience. They will also not have unlimited access to the documents and instruments.



Graph 1

(For further dissemination material please see the report "Plan for Using & Disseminating the Knowledge)

The **sixth** and last **work package** had to do with the *Project Management.* It has been considered advisable to divide the management tasks in two parts: General and administrative project management to be carried out by PAS, and scientific management (responsible TTZ), IP exploitation and dissemination management (responsible PAS), ethics, social and gender issues management (responsible PAS). The management activities to be undertaken during the project were as follows:

The detailed **management tasks** corresponding to PAS would be the following:

- General co-ordination and monitoring of the project progress (including milestones, deliverables, technical risks, deadlines, etc)
- Compilation of short monthly project updates from the WP leaders
- Legal, contractual and financial management (main contract, financial statements, supplementary final reports, audit certificates for each participant, etc.),
- Management of consortium agreement (incl. management of the Community financial contribution, the internal organisation of the consortium, intellectual property rights and exploitation assurance, settlement of internal disputes, etc.),
- Collection of the partners' documents and cost and other statements and forwarding thereof to the Commission,
- Reception of all payments made by the Commission to the consortium and its administration and distribution according to the work plan, the contract and the decisions made by the consortium,
- Communication with the partners and with the European Commission.
- Preparation of three periodic activity reports (for internal tracking of project progress. These will also be forwarded to the European Commission within 45 days after the end of the corresponding period).
- 3 additional 6-monthly progress reports forwarded to the EC (in months 7, 19 and 31)
- Preparation of all periodic management reports
- Preparation of supplementary reports established in the contract or in its annexes
- Mid-term Report together with Financial Statement (to the European Commission).
- Final Report together with Financial Statement (to the European Commission).

It was foreseen that PAS also organised the following general meetings with all partners during the project:

- **Kick-off-meeting** (an inaugural meeting would be held at the Coordinator's office in within the first month of the start of the project).
- **Research and progress meeting** every six months thereafter, a project review meeting would be alternately held, by agreement, in one of the participant's Associations (prioritaire) or RTDs.

The scientific management would be organised by TTZ, who would be responsible of ensuring the good communication and synergy of the RTD performers integrating the consortium over the whole course of the project.

The IP management Committee, led by PAS would undertake the following activities:

- identification of the results that may commercially be exploited and screening of the project results on possibilities for patenting;
- arrangement of the necessary agreements between the IAG partners about patenting and exploitation of project results
- distribution of the project results to all project partners coordinate of all relevant

The Ethics, social and gender issues management Committee review, audit and monitoring the social aspects involved in the activities of the consortium over the duration of project.

Scientific Management

The first period, as scientific manager of the project, TTZ has been supervising the work carried out by the rest of partners and has provided guideline to those ones who required it during the period concerned. In addition, TTZ has moderated the technical discussions carried out in the project meetings and has led several initiatives to redefine or clarify some aspects of the work which were not completely clear in the Technical Annex, among others, TTZ proposed the redefinition of the cost analysis to be implemented in the Investment Decision Tool as an energy savings analysis in order to make the tool more widely usable. TTZ also proposed to integrate the Investment Decission Tool as an add-on to the Auditing Software Tool in order to produce a more compact and versatile instrument for the potential SME users.

The second period, as scientific manager of the project, TTZ has been supervising the work carried out by the rest of partners and has provided guideline to those ones

who required it during the period concerned in this report. Additionally, TTZ has moderated technical discussions carried out at project meetings and has led several initiatives to redefine or clarify some aspects of the work which were not completely clear in the Technical Annex, among others.

The third period, strong collaboration and extra management work was done between TTZ and PAS as results of the withdrawal of the consortium member HDC in charge of the WP4. As scientific coordinator a close collaboration and communication between the core SMEs and IAGs allowed to gather and sent to UoC and HU updated consumption data to update, add and/or correct specific design parameters that the consortium partners required. With the data gathered and sent by the IAGs to HU (resulting from the training meeting sessions and further simulations from the IAGs) the greenhouse profiles were re-simulated in EAT 1.10 (final version of the software tool at the final meeting) and compared against actual energy consumption and output from the EAT 1.06 (D 16).

During the whole period, TTZ has been supervising the work carried out by the RTDs and provided guidelines and support when was asked to. TTZ moderated technical discussions during partners' meetings and gave solutions and guidance to some technical issues.

Management

During the first year of the project PASEGES tried to organise the work and the communication between the partners of the consortium. On the 6th and 7th of October 2005 PAS organised the Kick-off meeting in the Cooperative Centre of PASEGES in Thessaloniki where 30 delegated participated. At this first meeting the participants met and organised the work for the first six moths. Furthermore on the 12th of May 2006 PAS organised the 1st Progress meeting in Athens. The participation was again very high and the representatives of the partners referred to the work progress that had been achieved until that time and also to the way that the work for the next six months should be organised.

The first year of the project PAS communicated with all the partners through e-mails, mail, telephones and meetings. Especially PAS was in close contact with TTZ that is responsible for the scientific management.

The only difficulty that PAS faced was that partner VPO wanted to withdraw from the project and also the intention of partner KPL to have a reduce in his budget and in the work load that he had. In addition, we must refer to partner APS (SME UK) that it is very difficult to get in touch with him and he does not show any interest.

Generally speaking PAS is very pleased with the cooperation and the response of the partners of the consortium. Almost all of them show high interest for the project and have a frequently contact not only with PAS but also between them in order to organise the work in the best possible way.

During the second year of the project PASEGES tried to organise the work and the communication between the partners of the consortium. On the 11th and 12th of September 2006, PAS in close cooperation with Tomato Growers Association (TGA) organised the first Annual meeting in the *West Dean Conference Centre* at Chichester, United Kingdom. At this meeting (20 partners participated, many with more than one delegates) the progress of the ongoing tasks was discussed and the organizing of the fore coming tasks was discussed. In addition, visits to two nurseries were made. Furthermore, on the 2nd of March 2007, the 18th month meeting took place in Brussels. PASEGES also organised this meeting in cooperation with the executives of our office in Brussels. At this meeting a project review took place and also presentations of the fore coming tasks were made by the tasks leaders. Finally, PASEGES organised a technical meeting that took place at the University of Timisoara, Romania on the 13th and 14th of April 2007, were the Working Packages 2 and 3 were discussed and more specific the development of the assessment software tool and the Investment Decision tool.

The second year of the project PAS communicated with all the partners through e-mails, mail, telephone and meetings. Especially, PAS was in close contact with all the task leaders since many times the partners send their work via PAS. Finally, PAS was in close contact with TTZ that is responsible for the scientific management of the project.

The only difficulty that PAS faced during this period was that the IAGs HDC and KPL wanted to reduce their work load in the project, particularly in Research & Development activities; aspect that had then a direct influence reducing their budget. To compensate this reduction of work load, the other Associations assumed more

work, to assure the successful completion of the planned tasks. Also, the SME-partner APS withdraw from the project, so the remaining SMEs assumed the resources originally planned for APS to assure the normal development of the project tasks (also the partner VPO was replaced by the partner MAR; although this caused no deviation to the costs and person month budgeted).

A revised version of the Technical Annex of the project was submitted to the EU at the beginning of August 2007, containing these modifications.

Generally speaking PAS is very pleased with the cooperation and the response of the partners of the consortium. Almost all of them show high interest for the project and have a frequently contact not only with PAS but also between them in order to organise the work in the best possible way. Especially, at the last months of the second year many technical meetings took place between the RTD partners involved in the Working Packages 2 and 3 and decisions were taken for the development and the implementation of the project.

During the third period, PAS has supported the implementation of the Greenergy project in various aspects:

- general coordination and monitoring of the project progress (i.e. timely preparation of deliverables, follow-up of the accomplishment of the tasks, sending the deliverables to TTZ for updating the context of the website etc.)
- compilation and preparation of the assigned reports for the project's progress
- collection of the partners' documents and deliverables and dispatch them to the European Commission
- reception of the third payment made by the Commission to the consortium, administration and distribution of the amount to the partners according to the consortium agreement and the contract
- communication with the partners and the European Commission, settlement of any issue arose (updates in contractor's details, changes in legal names of the partners, i.e. KVL change to UoC, DEG change to DG, Estonian Agricultural University to Estonian University of Life Sciences, voluntary withdrawal of partner HDC from the consortium where its role was undertaken from partner DG, amendment of Consortium Agreement, submission of a revised version of the Technical Annex to correspond to this changes).

Unfortunately, PAS could not attend the 24th month meeting (September 2007) in Almeria, as it was necessary to support its members, the farmers who devastated badly due to catastrophic fires in summer 2007 in the region of Peloponnese (Greece).

In February 2008, PAS in close cooperation with WU and TTZ, the responsible of the scientific management of the project, organised the 30th month meeting in Wageningen, the Netherlands, where also the training of the IAGs and core SMEs partners on the developed tools took place. At this meeting, partners discussed about the progress of the ongoing tasks and the organization of the forthcoming ones.

In August 2008, PAS in close cooperation with TTZ organised the 36th month - final meeting in Bremerhaven, Germany, where partners reviewed all the tasks they accomplished and evaluated the outcomes of the project. Also, during this meeting, PAS asked the partners to pay special attention to the accurate completion of their C Forms and reminded them also that they had to submit an audit certificate for the last two periods of the project. Guidelines and responses to various questions on this issue were given by PAS then and later by e-mail and phone communication. Moreover, in the 26th of August, the IP management committee, led by PAS, assembled to discuss about further steps to be taken for the exploitation of the project's results.

Additionally, PAS submitted an audit certificate for the second (1 September 2006 to 31 August 2007) and third period (1 September 2007 to 31 August 2008) of the project as it is foreseen in the contract.

Generally speaking PAS is very pleased with the cooperation and the response of the partners of the consortium. Almost all of them show high interest for the project and its implementation and had a frequently contact not only with PAS but also between them in order to organise the work in the best possible way.

Throughout the tree years of the Greenergy Project, PASEGES submitted to the European Commission all the foreseen Reports:

- 6 months Management Report
- 12 months Progress / Management Report
- 18 months Progress / Management & Mid-term Review Report

- 24 months Progress / Management Report
- 30 months Management Report
- 36 months Progress / Management and Final Report

In addition, PASEGES has forwarded to the European Commission the minutes of all the meetings that were held as well as all the necessary documents for the changes that occurred in the consortium (withdrawals, enter of new partner, etc.)

Finally, PASEGES tried and collected all the financial Statements of the partners as well as their audit certificate.

The cooperation between PASEGES and the officers from the European Commission responsible for the Greenergy project was excellent and their help was valuable for us.

Annex

Annex
D1: Legal Overview Report
D2: Core SME greenhouse growers initial energy consumption data
D3: Energy systems in the European Greenhouse Sector and their critical points
D4: Measures for Technical improvement of the energy efficiency in the sector
D5: Definition of the European Quality Standards for efficient use of the energy in greenhouses
D 6/7/8: Reference Greenhouse Specifications / Core Calculation Module / Graphical User Interface Module (final version)
D 9: Energy Auditing Software Tool
D10: Software Usability test Report
D11: Software User's Manual
D12 /13: Guideline Structure & Complete Guideline for technical improvement measures D14: Completed Investment Decision Tool
D15: Auditing software and Guideline Tested and Improved
D16: Core SME greenhouse growers final energy consumption data
D17: Updated Training plan
D18: Training Material
D19: Trained IAGs and core SME partners:
D20: IAGs training Strategy exercised and evaluated on several SME associates
D21: Training Evaluation report and recommendations: Trained IAGs and core SME partners
D22: Property Right Management Plan
D23: EQS Auditing and future granting
D24: EQS Proposed Labelling
D25: Auxiliary industry contact report
D27: Draft EQS market penetration plan (final)
D28: Further Dissemination Plan

For the software and relative manuals please download:

http://www.greenergy-project.com →Secured Area
Username: pas_stavropoulou
Password: 53kjf

→ Software Download

Greenergy StartCenter v1.1 Setup (ZIP archive, incl. Guideline, EAT and IDT)	Filesize:	36 M

Energy Auditing Tool: Beta Version 1.1.3., Setup (MSI file)	Filesize:	9.7 M

Greenergy Software Setup Guideline

For installation and other notes regarding "Energy Auditing Tool" see Read Me.

Greenergy StartCenter & Guideline - User Manual (PDF document)	Filesize:	551 K
Energy Auditing Tool - User Manual (PDF document)	Filesize:	1.9 M
Investment Decision Tool - User Manual (PDF document)	Filesize:	2.9 M
Transfer of Investment Decision Tool databases (PDF document)	Filesize:	30 K