



LIFE ENVIRONMENT

**SUSTAINABLE CONSTRUCTION
IN PUBLIC AND PRIVATE
WORKS THROUGH IPP
APPROACH**

LIFE05 ENV/GR/000235

Layman's Report

Athens 2008

Project Summary

SUSCON is expected to be the catalyst for Greek and Cypriot construction industries, public authorities and other stakeholders to get familiar with environmental aspects of construction, evaluate the environmental performance of specific works, promote more environmentally friendly products and services and introduce environmental benchmarking in the construction sector. For this reason, a strong partnership among universities, construction industries, technical consultants and associations has been established. More specifically, the National Technical University of Athens and the University of Cyprus have contributed to conducting the Life Cycle Assessment (LCA) methodology and the development of ecodesign criteria in a quite complicated sector, the two leading construction industries from Greece and Cyprus (EDRASIS-PSALLIDAS and CYBARCO) can provide the practical expertise in construction, EPTA as technical consultant can provide the experience from drafting tender documents for construction works on behalf of public authorities and finally ETEK representing all the engineers in Cyprus have a significant role to play towards sustainable construction.

Project Methodology and Objectives

The main objective of SUSCON project was the adoption and application of "sustainable construction" concept in the practices of construction industries, engineering and consulting companies which draft technical specification of civil works, public authorities which issue technical tenders, suppliers of construction materials and other stakeholders involved in this field. More analytically, the objectives of the project included:

- Establishment of an Advisory Board in Greece and one in Cyprus from different related stakeholders
- Assessment of the environmental impacts from construction activities in Greece & Cyprus
- Implementation of the Life Cycle Analysis methodology in two categories (potentially civil works and buildings)
- Assessment of all the ecodesign issues towards the ecodesign of a construction & Development of ecodesign criteria
- Production of a software tool for estimating the eco-friendly percentage of construction works
- Evaluation of the environmental performance of the participating companies
- Creation of an online database for the construction industry
- Raising environmental awareness of construction industries & motivation towards sustainable construction
- Wide dissemination of the project's results to national and European stakeholders

The project partners were the following organizations:

From Greece: NATIONAL TECHNICAL UNIVERSITY OF ATHENS, EDRAIS-PSALLIDAS, EPTA Ltd.

From Cyprus: UNIVERSITY OF CYPRUS, CYBARCO Plc., SCIENTIFIC AND TECHNICAL CHAMBER OF CYPRUS (acronym ETEK)



Project Actions and Results

Task 1. Task management and reporting to the EC

1. Timely and efficient co-ordination of the project tasks
2. Financial and technical management of the project
3. Regular reporting of the technical progress and the financial situation of the project to the EC
4. Monitoring and Evaluation of the project

Task 2. Analysis and Documentation of the Construction Sector in Greece, Cyprus & EU level

1. Identification of all activities of the construction sector in Greece, Cyprus
2. Collection and analysis of national data
3. Assessment of the environmental impacts from each sector

Task 3. LCA in two construction activities

1. Selection of two categories from the construction activities
2. Collection of data for the creation of a Life Cycle Inventory for the two categories (potentially civil works and public buildings)
3. Implementation of the Life Cycle Analysis methodology

Task 4. Development of ecodesign criteria

1. Assessment of all the ecodesign issues towards the ecodesign of a construction
2. Development of ecodesign criteria

Task 5. Application of eco-design criteria in construction

1. Assessment of the eco-design criteria used in the construction works by the two participating companies
2. Production of a software tool for estimating the eco-friendly percentage of construction works
3. Application of the tool to the participating companies
4. Distribution of the tool to all public and private stakeholders
5. Drafting national institutional arrangements

Task 6. Online Database for the Construction Industry

1. Creation of an online database for the construction industry
2. Provision of environmental information about construction to Greek, Cypriot and other EU stakeholders
3. Raising environmental awareness of construction industries

Task 7. Dissemination

1. Dissemination of the project results to national and European stakeholders
2. Motivation of Greek and Cypriot construction industry to move towards sustainable construction
3. Information to stakeholders about sustainable construction
- 4.

All SUSCON deliverables and achievements are available at www.uest.gr/suscon.

Main SUSCON Achievements

1. Life Cycle Assessment

The Life Cycle Assessment of an Office Building has been implemented. The object of the study was the environmental performance of an office building built in Athens, Greece. The modelling of the system and the impact assessment has been done with the use of the "GaBi 4" software. The software system GaBi is a tool for the modelling of life-cycle-balances.

The life cycle of the office building comprises of the following stages:

1. Raw material extraction
2. Components manufacture
3. Components transportation
4. Construction of the office building
5. Use and Maintenance stage
6. Demolition - Final Disposal/Recycle/Waste Management stage

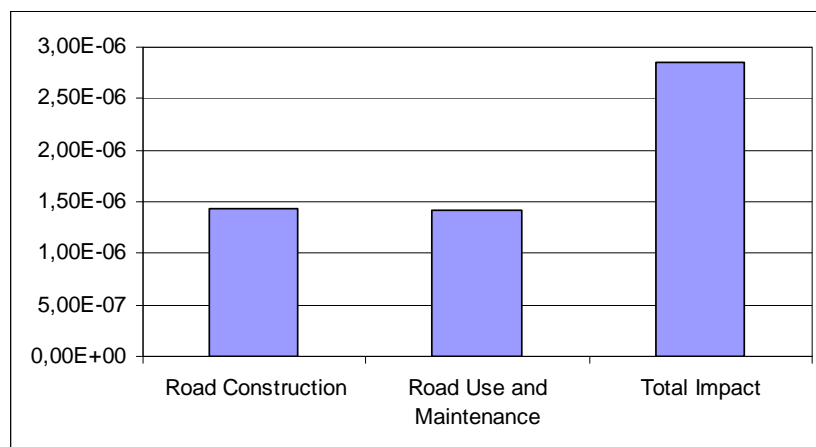
According to the LCA study, life cycle distribution of energy consumption and environmental impacts are concentrated in the use and renovation phase of the office building. The results showed that, for the use phase, the environmental impacts accounted for more than 92% of the total inventoried environmental burdens. Global warming potential is the environmental impact with the larger contribution to the total environmental score of the life cycle. Global warming potential contributes 78.77% to the total environmental score.

A Life Cycle Assessment of a typical part of a Road in Cyprus was implemented in order to measure its environmental performance of 1km of road in Cyprus. The modelling of the system and the impact assessment has been done once again by using the "GaBi 4" software. The software system GaBi is a tool for the modelling of life-cycle-balances. The life cycle of the road consists of three distinct phases; construction, use and end-of-life.

The life cycle of the road was divided into 5 major subsystems:

1. Raw material production
2. Raw material transportation
3. Construction of the road
4. Use and Maintenance stage
5. Demolition - Final Disposal/Recycle/Waste Management stage

The LCA study showed that the environmental impacts of the road life cycle are almost equally distributed among the construction and the use and maintenance phase of the road. The construction stage contributes by 51% to the total environmental score and the use phase by 49%.



2. Software Tool for Estimating the Eco-friendly Percentage of Construction Works

The Software Tool is a stand-alone application for Windows deployed under the dot Net Framework. It includes a click-once setup file which installs the application into the user's personal computer.

The Software is designed in a way that it can be easily adapted to the specific environmental and socioeconomic status of the area in which the assessed building or construction occurs. The evaluator can define the significance of each assessment parameter in relevance to the local or national conditions and the specific environmental or economic goals which have been set. The tool is a decision making tool that can assist the evaluator grossly estimate the performance of a construction.

The assessment is based on two main axes: (1) the Environmental and (2) the Economic. The Environmental axis is divided into five (5) main environmental issues which implicate Natural Resources (Land, Energy, Material and Water Resources) and Health & Safety which enters the sphere of Social Performance of a building. Economic Performance is defined by five (5) main parameters as well, which include the contribution to the Local Economy, the Efficiency, the Adaptability, the Operational Costs and the Capital Costs.

How the Tool works:

The software is divided into nine steps / tabs. Each tab / step has its goal. These nine tabs / steps are described below:

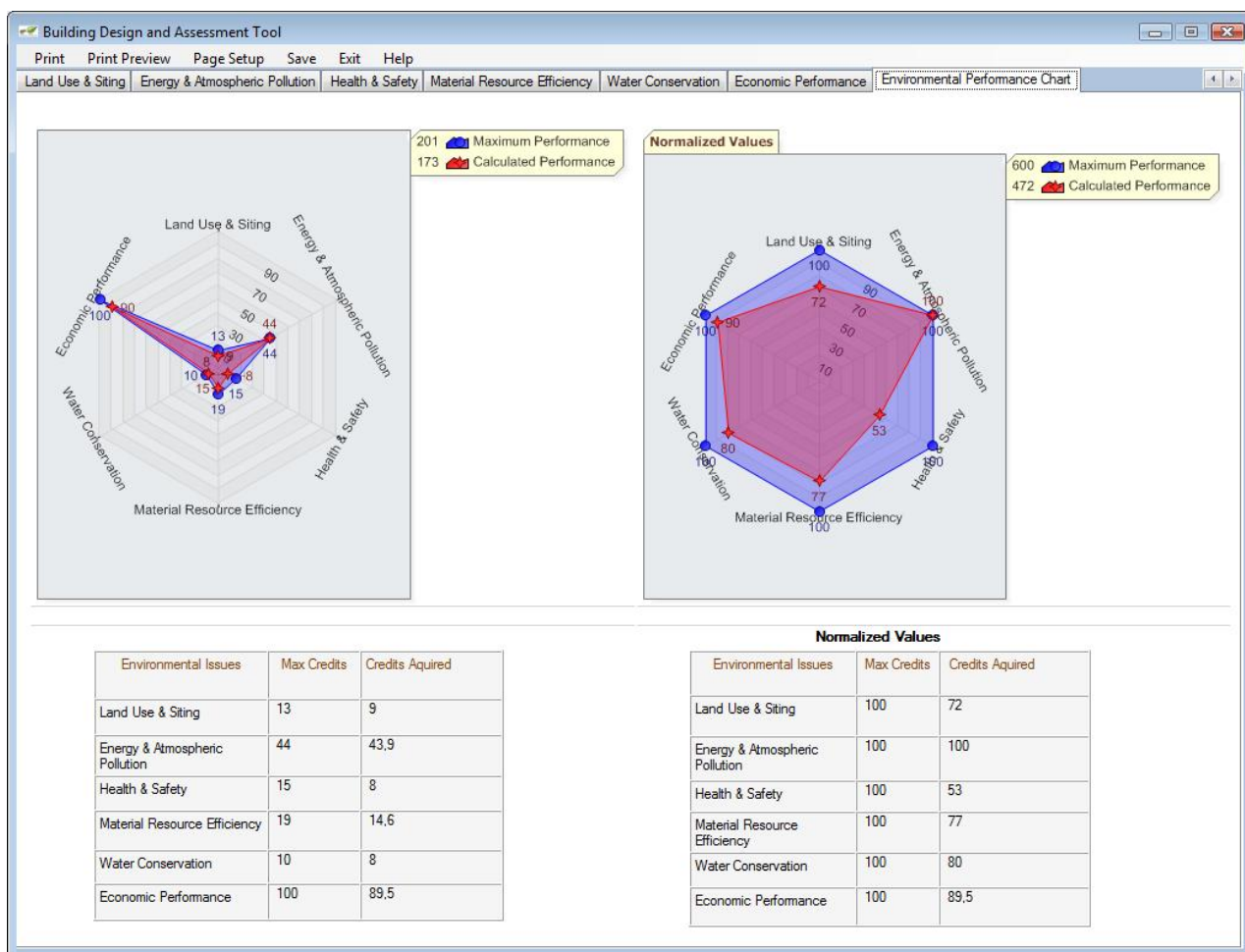
- Tab1→Building Assessment Tool
- Tab2→Ecodesign Criteria Group
- Tab3→Land Use & Sitting
- Tab4→Energy & Atmospheric Pollution
- Tab5→Health & Safety
- Tab6→Material Resource Efficiency
- Tab7→Water Conservation
- Tab8→Economic Performance
- Tab9→Environmental Performance Chart

Tab1 informs the user about the purpose of the software. By following each tab / step the user can successfully create the environmental performance chart, which is the desired main output from this tool. In Tab2 "Ecodesign Criteria Groups" the evaluator, based on the potential Spatial Extent, Duration and Intensity of the effect, assigns weight to each environmental performance parameter. The scores of the groups are summed assigning a percentage (weight) to each one. Most of the main categories of criteria were divided into more groups, to whom the evaluator must also assign weight based on their participation level in the main group. Participation level can, for example, be defined based on the goals set or the consumption levels for the energy group.

Criteria Group	Sub-Group	Weight
Land Use & Sitting		13%
Energy & Atmospheric pollution	Site Design and Building Orientation	8
	Building Envelope	12
	Foundation Systems	5
	Lighting	15
	Mechanical Heating_Cooling Systems	20
	Water Heating	15
	Renewable Energy	10
	Air Pollution	15
Health & Safety	Indoor Air Quality	75
	Thermal, Visual and Acoustic Comfort	25
Material Resource Efficiency	Reduce quantity of material and waste generation	16
	Renewable materials	0
	Locally acquired and produced materials	33
	Recycled content materials	17
	Reuse materials	17
	Recycle materials during construction/demolition	17
Water Conservation	Reduce water quantity	25
	Water management	25
	Wastewater recycling/reuse	25
	Rainwater harvest	25

In Tab3 "Land Use & Siting", the evaluator assigns weight to the fundamental environmental criteria which consists this group. The weighting is conducted in the same way as described previously for the main groups. The percentage that is calculated for each criteria represents the maximum score that the criteria can achieve (the same applies for the main criteria groups and sub groups). In Tab4, Tab5, Tab6 and Tab7 ", the evaluator assigns weight to the environmental criteria which consists this group. Tab8 "Economic Performance" evaluates the economic performance of a construction.

The results of this software tool are presented in a spider chart of six (6) axes: 5 environmental performance axes and the axis of economic performance. Two such charts are presented: one presenting the absolute figures of performance and a second one presenting the normalized performance figures.



These two environmental charts are the main outputs from this software tool. Within the framework of the SUSCON project the software tool was applied for two buildings in Greece and two building in Cyprus.

3. Hellenic Business Awards for the Environment Competition

In Greece, the sustainable construction competition has been succeeded to get integrated in the Hellenic Business Awards for the Environment, which is organized by the Greek Association of Environmental Protection Companies (PA.S.E.P.PE). The effort of the Greek partners to combine the two competitions focused on ensuring a wider publicity for the SUSCON initiative and establishing a permanent award category in the Greek Awards for the

Environment, called "Sustainable Construction". The construction project sub-categories included in the competition are: Building and Road construction. The SUSCON initiative attracted the interest of the European Commission DG for Environment. For this reason a

meeting was organized in September 2007 by DG for Environment in order to discuss the possible introduction of sustainable construction in the European Business Awards for the Environment (EBAE).

4. Greek Sustainable Construction Awards Competition

In the framework of "SUSCON" project the Sustainable Construction Awards Competition was organized under the auspices of the National Technical University of Athens. The purpose of these awards was to allow Greek organizations either public or private sectors to enhance their environmental performance in the construction area.



The first prize was awarded to the company named "MELETITIKI" for the office building "MELETITIKI". The building is located in a three buildings zone around a court entrance which consists of a small scale lake and old olive oil trees.



The second prize was awarded to the "PROMITHEAS PYRFOROS" building, which was designed and constructed by "SOL ENERGY HELLAS" in collaboration with "DEMOKRITOS", ARISTOTLE UNIVERSITY OF THESSALONIKI, and NTUA. The building is fully energy independent, solar and geothermic energy and abolishes non environmentally friendly energy forms.uses



The Special prize was awarded to Mr. Konstantinides for the country house at Makrikapa Messapias located at Evia island. The building is a demodernization of an old watermill, constructed at 1880. During the reconstruction of the building the preservation of the old style and the original design was the first priority.

5. Sustainable Construction Competition in Cyprus

The Sustainable Construction Competition in Cyprus was organised by the Cypriot partners; Laboratories of Environmental Engineering and Building Materials of the University of Cyprus (UCY), the Scientific and Technical Chamber of Cyprus (ETEK) and Cybarco Plc. The organisation of the competition aimed to give public organisations and companies the opportunity to promote their environmental practices in the construction sector and to further motivate the application of such practices.

The project categories included in the competition were: A. Building and B. Infrastructure works. The criteria dimensions for the *Sustainable Building Award* were: Environment Dimension, Energy Dimension, Social Dimension, Economic Dimension and Unified Design Dimension. Criteria dimensions for the *Sustainable Infrastructure Work Award* included: Environment Dimension, Energy Dimension, Social Dimension, Economic Dimension, Aesthetics and Setting Dimension and Innovation Dimension.

The competition commencement was announced on November 1, 2007 and an extended submission deadline was given until 31 January 2008. The Prize Award Ceremony took place on June 3, 2008. Officials from three Ministries of Cyprus gave welcome speeches and gave the awards to the competition winners. Following the wide dissemination of the competition through the media, newsletters, posters and leaflets, a representative sample of a number of works was submitted; four (4) works for category A' and four (4) works for category B'). Based on the relevant assessment sheets completed by the Assessment Committee Members the competition results were as follows:

- For *Category A (Buildings)*, the second award was awarded to the proposal A1- Electricity Authority of Cyprus Office Building.



- For *Category B (Infrastructure works)*, proposal B1- Upgrading of Platres-Prodromos Roadworks and proposal B2- Upgrading of the Limassol By-Pass Agios Athanasios Roundabout were awarded the second competition prize.



- B4-Upgrading of Kalopanagiotis village centre was awarded the third prize.



The final awards included: a monetary prize (provided by sponsors), a symbolic award, a participation certificate - diploma to all the actors involved in each awarded proposal and promotion, via the internet, the media and publication of articles in relevant magazines and newsletters. More information about the awarded projects can be found at www.uest.gr/suscon.

6. EUpalinus Information Portal for Sustainable Construction



EUpalinus Information Portal for Sustainable Construction has been created so as to ensure to constructional and consulting companies, private companies of constructional materials, environmental institutions, public services and also all the consumers, easy and quick access in the informative material that interests them in the sector of Sustainable Construction. The contents of the EUpalinus database include the relevant legislation (environmental and energy issues, materials, eco-design) action plans and policies (energy efficiency plan and energy policy), material related to subsidies for sustainable practices (renewable energy, water saving devices etc.) as well as a number reports and links related to sustainable construction (e.g. construction and demolition waste management, green procurement, integrated products policy and case studies from the SUSCON project). In addition the search engines (EUpalinus Internal Search Engine and web search engine) are fully operational. The EUpalinus portal is available at www.uest.gr/eupalinus.

Environmental benefits of the Project

By promoting sustainable construction in Greece and Cyprus, which does not seem to be a common practice currently, the implicit scope of the SUSCON project is to minimize the environmental burden that derives from construction works and the entire life cycle of the materials used. A strong public demand for greener buildings and public works in general should be promoted and the importance of the use of renewable energy sources in buildings after their construction and during their lifetime should be highlighted, as well as the need for careful selection of the materials used in such works. The research has showed that a lot more can be done both in Greece and Cyprus resulting in savings and an overall environmental awareness and sensitivity.

SUSCON's core outcome is the development of ecodesign criteria with respect to some major environmental issues related to the construction sector:

- **Environmentally friendly construction materials:** As much as 50% of all materials extracted from the earth's crust are transformed into construction materials and products. Including energy in use, when installed in a building, they account for as much as 40% of all energy use. Moreover, these same materials when they enter the waste stream, account for some 50% of all waste generated prior to recovery.
- **Energy efficiency in buildings:** The construction, operation and subsequent demolition of built facilities accounts for about 40% of all energy end use and a similar percentage of greenhouse gas emissions.
- **Construction and demolition waste:** It constitutes the largest waste stream by weight in the European Union. Disposing of these waste materials is presenting increased difficulties in many parts of Europe. Increased emphasis needs to be placed on waste minimization and recycling.

The aspects linked to the creation, use and disposal of built facilities taken together constitute major environmental impacts. It is crucial to that that the built environment accounts for the largest share of greenhouse gas emissions (about 40%) in terms of energy end usage. Sustainable construction is also expected to facilitate the implementation of the European Directive related to the Energy Efficiency of buildings.

Measured by weight, construction and demolition activities also produce Europe's largest waste stream, most of which though, is recyclable and recommendation action should be taken regarding to construction and demolition waste according to the 6th EAP.

In addition, the potential for reducing greenhouse gas emissions in existing and new buildings is greater than that of any other sector and consequently represents the most significant target for reducing emissions in order to reach the targets laid down in the Kyoto Protocol.

Summarising SUSCON is the starting point for construction industries, public authorities and other stakeholders in Greece and Cyprus in order to get familiar with the environmental aspects of construction, evaluate the environmental performance of specific works, promote more environmentally friendly products and services and introduce environmental benchmarking in the construction sector.

Financial benefits of the Project

The financial savings from promoting sustainable practices in buildings could indicatively include the reduction of the electricity consumption in the cases where energy efficient lighting and IT equipment is used or water consumption by the use of water saving devices. Apart from sustainable consumption practices, bioclimatic architecture is by far considered the solution to the long term excessive energy consumption of buildings from the very initial design stage. In addition following the expansion of renewable energy sources market in both countries lower market prices will be achieved resulting in lower depreciation periods. Significant may also be the economic benefits the several subsidies provided for the introduction of sustainable practices (e.g. photovoltaics, solar water heaters, insulation systems and technologies, water reuse schemes etc.).

Transferability of the project

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

Conclusions

SUSCON project approaches many major issues relevant to energy saving, bioclimatic architecture, ecological criteria and the life cycle analysis in construction works. Furthermore, issues regarding the environmental impact during the construction and use phase of the buildings concluded that there is an immediate need for adopting sustainable construction principles construction works in Greece and Cyprus. In this framework, a software tool for the evaluation of the environmental performance of buildings was developed, based on the tools that already existed and using a more integrated combination of the criteria. This tool has been promoted to all competent authorities of Greece and Cyprus and more attempts will be made for the utilization of the tool at European and international level. Finally, the organization of the Sustainable Construction Competition in Greece and Cyprus constitutes an innovative initiative of significant importance in the framework of Sustainable Construction in Public and Private Works through IPP approach.