

PROJECT FINAL REPORT

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Name of the scientific representative of the project's co-ordinator, Title and Organisation:

Kostas Anagnostopoulos, Head of the Development Project Studies Department, Centre for Renewable Energy Sources and Saving (CRES)

Tel: +30 210 6607434,300

Fax: +30 210 6603301

E-mail: kanagnost@cres.gr

Project website address: www.ressol-medbuild.eu

4.1 Final publishable summary report

A. Executive Summary

The RESSOL-MEDBUILD project has contributed significantly towards the enhancement of the capacities of two Mediterranean organisations, the National Energy Research Center (NERC) of Jordan and the Lebanese Association for Energy Saving & for Environment (ALMEE) in order to engage in high quality research, implement research projects and provide scientific services in the fields of solar thermal and PV technologies and energy modeling and planning. The capacity build was provided by the Centre for Renewable Energy Sources (CRES) and the Fraunhofer Institute for Solar Energy Systems (ISE) to the Mediterranean organisations. The project has improved scientific knowledge through secondments and training, recruit researchers, enhance equipment, create partnerships and disseminate at EU, Mediterranean, national and international level. The capacity building has resulted in enhancing the capacity of the Mediterranean partners in making research, and network, diffuse information and provide scientific services.

B. Summary description of project context and objectives

The project aimed at enhancing the scientific and research capacity as well as the human resources and infrastructure of the National Energy Research Centre (NERC) of Jordan and the Lebanese Association for Energy Saving & for Environment (ALMEE), by providing capacity building derived from the efforts of the Centre for Renewable Energy Sources and Saving (CRES) and Fraunhofer Institute for Solar Energy Systems (ISE).

NERC and ALMEE need to speed up their pace in order to improve their research capacities and respond to the challenges of their countries regarding energy supply and demand issues. The resolution of this problem is the capacity building activities from the EU partners to the Mediterranean partners. The capacity building focused on the following research fields:

- **Field 1:** The technological integration of solar thermal (heating and cooling) and PV technologies (grid-connected and stand-alone) in buildings.
- **Field 2:** Simulation models and optimization of solar heating and cooling systems and PV technologies into building operations.
- **Field 3:** Energy modeling and decision support regarding the energy planning in municipal and regional scale.

The project objectives were the following:

- Organisation of trans-national two-way secondments for the researchers of the NERC and ALMEE to be trained and engage in research projects in the facilities of the CRES and Fraunhofer ISE.
- Organisation of training sessions for the NERC and ALMEE in the facilities of the CRES and Fraunhofer ISE.
- Recruitment of experienced, high-level research staff as well as young researchers with high academic credentials by NERC and ALMEE.
- Acquisition of equipment and software by NERC and ALMEE to facilitate their research goals.
- Participation in research consortia and preparation of research project proposals.
- Cooperation with research centres, public and private sector in international RTD projects.
- Creation of partnerships with international research institutions, the public and private sector to make project proposals.
- Create an e-Observatory to monitor research in PVs, solar thermal systems and energy planning.
- Organisation of international conferences and national workshops.
- Communication of knowledge and experience in the respective scientific fields through electronic means.
- Participation in international conferences, workshops, information days, etc.
- Dissemination of scientific knowledge and information through academic publications, information material, studies.

C. Description of the main S&T results

In this section, project main S&T results are described per Work Package as follows:

WP1: Reinforcing expertise and know-how

The scientific knowledge and research experience of NERC and ALMEE were enhanced through the implementation of trans-national two-way secondments for researchers of the Mediterranean partners to be trained and engaged in research projects in the facilities of the EU partners.

In particular, 9 high quality 1/2month secondments were implemented in Greece and Germany. During these secondments 13 researchers from ALMEE and NERC (7 from ALMEE and 6 from NERC) were trained and actively participated in research projects in the following fields:

- Indoor & outdoor testing of PV modules according to standard procedures
- Designing & sizing of off-grid and on-grid PV systems
- Building Matlab/Simulink models for building integrated PV system components
- Validation of Matlab/Simulink models using solar data available for Jordan and feedback from real PV systems already installed
- Application of TRNSYS software in modelling, simulating and designing solar water heaters, and solar space heating and cooling systems in buildings
- Simulation of medium and large scale solar thermal systems with T-SOL software
- Development and testing of a mobile monitoring system for solar thermal systems
- Energy policy analysis using planning tools - Demand forecasting
- Development and application of energy models in energy policy planning

Furthermore, 5-days training sessions were organized for the Mediterranean partners in the facilities of the EU partners. 25 researchers from ALMEE (14) and NERC (11) were trained in 17 training sessions that were carried out in CRES (8) and Fraunhofer ISE (9) facilities. Researchers were trained in the following subjects:

- PV materials technology and concentrated PVs
- Sizing and optimization methodologies for on-grid and off-grid PV systems - Modelling and simulation of PV systems
- PV system technology, BIPV, performance simulation
- PV inverter state of the art, topologies and performance testing
- Smart grids - Microgrids - ICT and control strategies
- T-SOL software package: use and data analysis
- TRNSYS review – Systems' optimization and control procedures

- Introduction to solar cooling technologies, design, dimensioning, monitoring and data evaluation
- Solar collector performance tests according to European standards
- Adsorption materials and heat exchanger research
- Energy planning and usage of energy models -Optimisation methodologies for energy planning

WP2: Elevate Human Resources

The enhancement of the research capabilities of ALMEE have also been achieved through the recruitment of a senior and experienced researcher that has established excellent research records on the respective research fields. Dr. Adnan Jouni was selected and recruited by ALMEE on January 2011 as senior researcher.

Dr. Jouni is an engineer with a PhD in industrial engineering specialized in the fields of RE and EE. During his long experience (1987-2002) as engineer in research, development and technology transfer at Hautes Etudes d'Ingénieur he has carried out more than 80 contracts and projects for European and international companies. He has served twice as an advisor to the Lebanese Minister of Energy and Water and worked as Local Back Stopper for UNDP in the creation of the National Energy Conservation Center in Lebanon. He has also actively participated in the adoption and implementation of the Thermal Standard for Buildings in Lebanon.

Since January 2011 and in the frame of RESSOL-MEDBUILD project Dr. Jouni has been actively involved in the implementation of the Work Packages 2, 3, 4 and 5 of the project, while his work has been continually monitored and assessed by the President of ALMEE Dr. Said Chehab during project duration on the basis of the following activity categories:

- Guidance of existing and young researchers in the respective research fields and equipment and software utilization (WP 2,3)
- Contribution to the implementation of research projects and activities (WP 4)
- Networking with national and international stakeholders (WP 4)
- Contribution to the envisioning and formulation of a strategy and an action plan for the expansion and enhancement of the research activities of ALMEE to new markets. (WP 4,5)
- Submission of competitive project proposals and the participation in project consortiums, in order to strengthen ALMEE's financial resources and ensure resources for ALMEE staff after the end of the project. (WP 4)

Additionally, the project team has proceeded to the identification of young promising researchers with good performance to their post graduate studies and high academic background in the respective scientific fields. In particular, 4 young researchers were recruited to the ALMEE research team in the framework of the project, while NERC's research team has been strengthened with the addition of 3 young researchers.

WP3: Advance research facilities

The goal of Work Package 3 “Advanced Research Facilities” was to create the necessary technological infrastructure for the Mediterranean partners in order to conduct innovative research activities, to improve research and services and support all interested stakeholders in their activities in the fields of energy efficiency, solar technologies and energy planning.

In a first step, the project team has worked in close collaboration, in order to identify the needs of the MED partners in terms of new research equipment and software as well as to determine desirable and appropriate technical characteristics for this equipment and software. Then ALMEE and NERC proceeded with the purchase of the identified equipment and software after a market survey.

A short description of the acquired equipment and software as well as of its use and the main results throughout project duration are provided below.

❖ *Equipment acquired by ALMEE*

- a) **I-V curve tracer** for PV panels and arrays (including pyranometer, c-Si solar radiation sensor and temperature sensors).
- b) **Power grid simulator** to be able to evaluate the performance and safety characteristics of inverters.
- c) **Digital temperature meter** for measuring ambient, surface and liquid temperatures.
- d) **Thermal camera** for building thermal property analysis.
- e) **Mobile equipment** for the evaluation of solar thermal system performance:
 - o Radiation sensor (Pyranometer)
 - o Clip-on temperature sensors
 - o Clip-on volume flow sensors
 - o Mobile data acquisition system
 - o Wind sensor
 - o Monitoring software
- f) **Laptops:** Two laptops for the installation of software and for the possibility to present software and simulation results to interested stakeholders.

❖ *Software acquired by ALMEE*

- a) **PVSOL Expert** (10 student licenses). PVSOL is a dynamic simulation program with 3D visualization and detailed shade analysis for PV systems.
- b) **TRNSYS** (10 educational licenses). TRNSYS is a complete and extensible simulation environment for the transient simulation of thermal systems including multi-zone buildings.

- c) **TSOL Expert** (10 student licenses): TSOL is a complete simulation program that allows to visually design and simulate solar thermal systems of different categories: domestic hot water, process heating, air collectors, space-heating, swimming pools and buffer tank systems.
- d) **TRANSOL 3.1** (10 student licenses): TRANSOL is a predictive tool for thermal performance of hot water systems and solar air conditioning for the individual, collective and tertiary applications.
- e) **METEONORM Database** (10 student licenses): METEONORM is a Global Meteorological Database for Engineers, Planners and Education.

❖ *Equipment acquired by NERC*

- a) **CMP 6 Pyranometer:** It has a double glass dome construction to protect the thermopile from external influences and has improved performance due to the increased thermal mass.
- b) **CMP 11 Pyranometer:** uses a different detector design with temperature compensation. It is a step up in performance from CMP 6 and particularly suitable for upgrading meteorological networks.
- c) **Handheld Solar Irradiance Meter:** it is used by PV engineers and the technicians in testing and maintenance of PV systems at field.
- d) **Data logger:** LOGBOX SD data logger combines a low power data acquisition system with high measurement accuracy in a compact weather-proof enclosure.
- e) The **Pathfinder for Solar Shading Analysis Device** is used for obtaining an accurate solar site analysis that should be made by combining the site-specific shading data of the device with the published global weather data.
- f) **Portable TDS, pH and conductivity meter:** it is used for water quality measurements for the solar thermal working liquid.
- g) **Laser distance meter.** This instrument is used for measuring the dimension of solar collector, storage tank and the roof.
- h) **DC and AC (3-phase) Power Analyzer.** The power quality analyzer is a portable analyzer for measuring electrical network parameters. It is a digital measuring instrument that takes samples of voltage waves and current values with a specific TMP averaged time.
- i) **Photovoltaic Curve Tracer - cetis PV-CTF1 IV-curve Tracer.** IV-Curve Tracer for outdoor field measurements of solar modules and strings. IV-Curve Tracer is used for testing the PV modules and PV arrays up to 100 kWp.
- j) **Propylene glycol Refractometer.** It is used for measuring propylene glycol percentages in the solar thermal system hydraulics to read the concentration of the glycol to water ratio to check the condition of the heat transfer of the fluid and to predict if maintenance is necessary or not.

- k) **Thermal imager (infrared camera).** Thermal imagers discover anomalies and weak spots in solar collector quickly and without physical impact or damage.
- l) **Ultrasonic flowmeter.** It measures flow from outside plastic, metal or concrete-lined pipes non-intrusively, so there is no pressure drop, leaks or contamination.
- m) **Precision digital function generator.** The Precision Function Generator is a versatile signal source which combines several functions into one unit: waveform generation, pulse generation (through variable symmetry), and frequency sweep. Additionally, the instrument provides a built-in frequency counter.
- n) **2 Laptops:** They are used in remote logging measurements and in long term monitoring for the installed PV systems.
- o) **Laser Printer:** The colour Laser Printer is also used by the members of PV Division to print-out, scan and copy documents.

❖ *Software acquired by NERC*

- a) **TSOL Expert 4.5** “Simulation Program for Experts of Thermal Solar Heating Systems” (10 educational licenses). TSOL is a dynamic simulation program for the planning and professional design of solar thermal systems.
- b) **TRNSYS 17.1** ,TRaNsient SYstem Simulation program (10 educational licenses). Since TRNSYS is a detailed simulation program, this software was selected for building and solar thermal analysis, through building up the components of an existing system in order to modifying each component until reaching an optimal thermal design.
- c) **PVSyst Software:** It is a detailed software used for sizing the photovoltaic system and components on hourly based simulations for stand-alone and grid-connected projects.
- d) **METEONORM database:** METEONORM is a comprehensive climatological database for solar energy applications.

❖ *Use of equipment and software and results for ALMEE*

In line with ALMEE research strategy and the help of RESSOL-MEDBUILD project several research activities were launched:

- a) **PV Systems:** Research in PV domain has begun at the Lebanese University (Faculty of Engineering) under the supervision of Dr. Imad Mougharbel; the research team, composed of young researchers (RE Master students & students at the Faculty of Engineering) use the set of PV equipment and PV*SOL software allocated by RESSOL-MEDBUILD project.

- b) **Optimal Solution for the Connectivity of PV systems on a scheduled availability of the grid.** The grid is not available all the time and a daily scheduled program of electricity shortage is applied in some developing countries like Lebanon. In such situations, renewable energy systems connected to the grid cannot be an effective solution. Although net metering or feed forward connectivity is allowed, still the grid outage program prevents its use in an efficient way. For this reason, a new control algorithm for photovoltaic systems connected to a grid with scheduled outage provides to the consumer the maximum benefit of connectivity.
- c) **Simulation of a Hybrid Renewable Energy System in Rural Regions.** This topic presents the design of a hybrid renewable energy system applied for energy generation in rural regions. The system is simulated. It consists of a set of photovoltaic panels, a wind farm, a pumped water storage / generation station and it is designated to supply residential and industrial loads. Equipment and software secured by RESSOL-MEDBUILD project allowed researchers to realize tests and simulations in order to have the necessary data and characteristics about the solar radiation and the different PV systems and their interaction with the Lebanese network electricity supply. The objective is to find the optimal configuration for each case or situation.

Until now two papers were finished using the results of this topic:

No	Publication title	Journal / conference	Authors	Organisations	Type of publication
1	Optimal Solution for the Connectivity of PV systems on a Scheduled Availability of the Grid	Engineering Diploma thesis REDEC 2012	Imad Mougharbel, Ahmad Mikkawi, Hassan Ghazal	ALMEE / RESSOL-MEDBUILD / LU	Conference publication
2	Simulation of a Hybrid Renewable Energy System in Rural Regions	IECON 2012	Imad Mougharbel, Hussein Saleh, Semaan Georges	ALMEE / RESSOL-MEDBUILD / LU / NDU	Conference publication

- d) **Energy Efficiency Building code:** The equipment & software allocated by the project and especially Meteonorm, T*SOL & the solar monitoring equipment helped ALMEE employees to introduce the Thermal Standard Building in a more accurate manner. For example, the Thermal Standard Building for Lebanon (TSBL) is now regularly taught to engineers and architects at the Lebanese University; at research level, TSBL uses the concept of the Net Zero Energy Building in Lebanon and two related papers are in preparation for 2013:

No	Publication title	Journal / conference	Authors	Organisations of authors	Type of publication
3	Introduction of renewable energy requirements in the Lebanese Energy Efficiency Building Code	ENERGY and BUILDING Journal	Adel Mourtada, Adnan Jouni	ALMEE / RESSOL-MEDBUILD	Paper
4	Climate change and Building sector in the Mediterranean: Lebanon Case study	ENERGY and BUILDING Journal	Adel Mourtada, Adnan Jouni	ALMEE / RESSOL-MEDBUILD	Paper

- e) **Solar Heating systems:** The objective of this activity is to optimize the installation of solar water heating systems according to demand profile, building type or climate conditions. This activity takes place at the ALMEE / NDU Unit (Notre Dame University) with the necessary testing equipment and software. A first result of this research topic was already presented by Adnan Jouni and Leila Kantar:

No	Publication title	Journal / conference	Authors	Organisations of authors	Type of publication
5	Optimization of SWH systems according to climatic & utilization conditions for Lebanon	EMR 2012 International Conference June 2012 Malaga Spain	A. Jouni L. Kantar	ALMEE / RESSOL-MEDBUILD	Conference publication

- f) **Net Zero Energy Buildings or Positive Energy Buildings concept in Lebanon:** ALMEE's research task is to study the possibility to apply this concept in Lebanon. An important part of this research will be based on the use of available software. Under the supervision of Adnan Jouni, an initial work is already carried out using the available RESSOL-MEDBUILD equipment and software and especially the mobile thermal equipment installed at NDU and Meteonorm, T*SOL and PV*SOL software. First results were already achieved in the framework of the RE Master Thesis & presented at REDEC 2012 Conference. Tarek Samarji continues his research work as a PhD student financed by ALMEE and in collaboration with the University of Lille (France):

No	Publication title	Journal / conference	Authors	Organisations of authors	Type of publication
6	Positive energy building in Lebanon: concept design and realization, energy management by TRNSYS software simulation	RE Master thesis REDEC 2012	Tarek Samarji, A. Mourtada, A. Jouni,	ALMEE / RESSOL-MEDBUILD / LU / NDU	Conference publication

❖ *Use of equipment and software and results for NERC*

- a) **CMP 6 Pyranometer:** This measuring instrument is used for field measurements at solar heating systems and PV arrays.

This instrument in addition to the CMP 11 Pyranometer data logger was used in calibrating similar instruments at Jordan University for one of the master thesis students. This pyranometer was also used in one of the studies carried out for a food factory (Nabil Foods) in Amman.

- b) **Pathfinder for Solar Shading Analysis Device:** This device was used in some site evaluations in PV intended installations in Amman. It was also used at Nabil's Factory to assess the effect of shading on the overall performance of the solar thermal system.
- c) **Portable TDS, pH and conductivity meter:** This device was used in testing the quality of glycol in a solar thermal systems at Al-jubeiha in Amman.

- d) **Laser distance meter:** This instrument is used for measuring the dimension of solar collector, storage tank and the roof. Moreover, it is useful to use the laser meter for measuring the distances between the collector arrays. This device was used in site evaluation for one of the Concentrating Solar Power (CSP) sites in the southern part of Jordan at Alfujeij area. Also it was used at Nabil's Food Factory to evaluate the accurate distances between solar collectors arrays.
- e) **DC and AC (3-phase) Power Analyzer:** This device was extensively used in energy saving studies in many sites. A complete detailed energy audit study was carried out for the premises of the Royal Scientific Society (RSS) in Amman. This device was the key player in all electrical energy measurement in the buildings.
- f) **TSOL Expert 4.5:** The software was used for designing the thermal performance of a biscuit manufacturing plant in Amman and for calculating the benefit of utilizing the solar energy in Process Heating Purpose for this factory.

This software was used in several studies that covered a) performance of solar thermal system in process heating, b) simulating the effect of various parameters on stagnation temperature in large scale solar thermal systems and c) Solar Heated Biogas Digester (SHBD).
- g) **TRNSYS 17.1:** The software was used to evaluate solar assisted space heating system at solar house in Amman. The building (Solar House) is located at Royal Scientific Society (RSS) in Amman Region-Jordan.
- h) **PVSyst Software:** PVsyst was used in simulation model to be used by PV designers to optimize the sizes of PV generator and battery bank according to available tilted solar irradiances and ambient temperatures. The simulation model using PVSyst was verified with real data from the site.
- i) **METEONORM software,** This software was used for generating hourly weather data of many cities in Jordan such as Amman, Aqaba, Ghor, Irbid, Maan and Zarqa. These hourly data were used in TRNSYS and PVsyst software.

❖ **WP4: Enabling international and national research and cooperation**

Identification of research priorities and exploitation plan

The project team has identified the research priorities of the Mediterranean organizations as regards their participation in EU, international and national research projects in the respective scientific fields and formulate their research strategy. Furthermore, an integral part of the work consisted of an exploitation plan that was carried out in order to create and realize a strategy for the effective exploitation of the research project results for ALMEE and NERC. The plan included a market analysis for the solar thermal and PV technologies in Lebanon and Jordan, the target groups that can be addressed for being the receivers of research and services and the necessary actions for ALMEE and NERC to penetrate the market, commercialize the research results and provide services to the target groups.

More specifically, the research strategy and exploitation plan for ALMEE and NERC is described in 3 deliverables (D 4.1) for each organization that were drafted throughout project duration. A brief description of the content of these reports is given below:

ALMEE

The first version of the Research Strategy and Action Plans for ALMEE focused on a market analysis of the solar thermal and PV technologies in Lebanon, the target groups that can be addressed for being the receivers of the research products and services and the necessary actions for ALMEE to penetrate the market, commercialize the research results and provide services. The research team found and analyzed the barriers that hinder the wide spreading and adoption of solar technologies, suggested a set of solutions to overcome these barriers and defined two strategic research directions for ALMEE: a) solar technologies (thermal & PVs) and b) energy planning.

The second version of the Research Strategy and Action Plans for ALMEE defined the overall objectives, specific targets and key actions to deliver these objectives of promoting solar technologies and energy planning by scientific research means. Universities were identified as ALMEE's most involved partners. In the frame of RESSOL-MEDBUILD project and with the recent acquisition by ALMEE of research equipment and software, another dimension has been given to ALMEE's research activities. Researchers have more resources at their disposal in order to implement more testing and more simulations with better conditions and results. Furthermore, the large number of scientific events planned and executed by ALMEE's team in order to present ideas and research results of the RESSOL-MEDBUILD project, especially those related to universities and research centers, have already had a positive impact on the volume and quality of research activities. In this regard ALMEE has come into agreement with some of its research partners and signed an MOU (Memorandum Of Understanding) for close collaboration in research and educational activities.

The third version details the 2 previous versions and describes the concrete actions for ALMEE plus foreseen actions to reach the research objectives. The last part of the report describes the point of view of ALMEE team about the national energy planning adopted by the government and the different gaps and problems that prevent the adoption of specific action plan measures. A set of proposals was also provided by ALMEE with concrete measures, where the Research Strategy and Action Plans play a significant role in removing different types of barriers that prevent the adoption of renewable energy in Lebanon. In particular ALMEE suggested a scenario of transition and a break with the past. Supplying sustainable and competitive renewable energy should be primordial to Lebanon's new energy policy.

NERC

In the first version of the Research Strategy and Action Plans for NERC a market analysis for the sectors of solar thermal and PV technologies in Jordan with particular focus on local solar industry was conducted. Main policy, technical, market and social barriers towards the development of these two sectors were identified and recommendations for barriers' removal were given. In light of these findings the principal directions for NERC's PV Division research strategy were developed.

The 2nd and 3rd versions of Research Strategy and Action Plans for NERC summarized the scientific experience gained during the secondments, training sessions and workshops that NERC staff had in the framework of the RESSOL-MEDBUILD project. Then an action plan to explore gained knowledge and infrastructure that was set up under WP3 was developed. The action plan included a) targeted cooperation with other organizations, b) targeted projects and project proposals and c) planned services. In brief, NERC is seeking to provide their services and consultation to local commercial buildings, industries and the public sector through cooperation with local universities, the royal scientific society, the Ministry of Energy and industrial chambers in Jordan. NERC has also participated in big projects funded by the EU, such as the WECSP project in cooperation with CRES and Fraunhofer, and also submitted several project proposals as shown in the next paragraph. Among the planned services that will be provided by NERC are a) carrying out training courses for engineers in the field of solar water heating, b) preparing the 1st draft of the Energy Efficiency Action Plan for Jordan and c) establishing a standardization, certification and quality assurance body for solar water thermal collectors.

Networking and creation of research partnerships

During project implementation several contacts by the project team were made primarily towards the objective of facilitating the procedures for project proposal making of NERC and ALMEE. These contacts resulted in a network of collaborating organisations and ALMEE, NERC, CRES and Fraunhofer ISE cooperated with them in making project proposals or working with them in projects. These organisations are additional to the organisations CRES and Fraunhofer ISE cooperate regularly and can be mobilised to participate in project proposals or projects.

More specifically, RESSOL-MEDBUILD project has assisted through networking the Mediterranean project partners in the submission of 16 project proposals: 12 for NERC and 4 for ALMEE. Moreover, during project implementation NERC has actively participated in the implementation of 17 projects and ALMEE in 8 projects.

In the framework of the above proposals and projects the Mediterranean project partners have collaborated with over 100 different organizations, research institutes and private companies from Europe and the MENA region.

As far as projects are concerned, the Renewable Energy Laboratory and the Renewable Energy Master Program developed by ALMEE in the framework of the RESSOL-MEDBUILD project are described in more detail below:

❖ **Renewable Energy Laboratory**

The Renewable Energy Laboratory (REL) is an inter-departmental Laboratory located in the Lebanese Engineering School at El-Hadath Campus. Its activities are dedicated to enhance and promote renewable energy and energy efficiency research and development (R&D).

This new laboratory operates as new branch of the existing RIT¹ (Recherches et Innovations Technologiques) laboratory, which will in this way extend its activities to the field of RE.

ALMEE and RESSOL MEDBUILD team had an important role in the creation of this entity and their actual and future role is essential to the success of REL. In particular, ALMEE has contributed the following equipment and software to the lab:

- ✓ I-V curve tracer for PV panels and arrays
- ✓ Power grid simulator to be able to evaluate the performance and safety characteristics of inverters
- ✓ Digital temperature meter for measuring ambient, surface and liquid temperature
- ✓ PV*SOL Expert & TRNSYS software

Professor Imad Mougharbel is the head of the RIT laboratory. An MOU is signed between RIT and ALMEE describing their collaboration in the framework of the new REL laboratory. The equipment will remain in ALMEE's ownership, nevertheless the equipment will be at the disposal of REL's and ALMEE's research teams. This collaboration aims at strengthening research cooperation between ALMEE and the Lebanese University by implementing common research projects in the field of renewable energy. All work published in the framework of this collaboration will acknowledge the contribution of the RESSOL-MEDBUILD project.

REL's mission and strategy are focused on advancing the LU's and national energy goals. The laboratory's scientists and researchers support critical market objectives to accelerate research from scientific innovations to market-viable alternative energy solutions. At the core of this strategic direction are REL's research and technology development competencies. These areas span from understanding renewable resources for energy, to the conversion of these resources to renewable electricity, heat and fuels, and ultimately to the use of renewable electricity and fuels in homes, commercial buildings, and vehicles. The laboratory thereby directly contributes to Lebanon's goal for finding new renewable ways to power homes, businesses, and cars.

¹ <http://ulfg.ul.edu.lb/RITCH%20WEB/RITCH%20Web%20Pages.htm>

REL's focused R&D capabilities are positioned to advance national energy goals by developing innovations to change the way Lebanese power their homes and businesses, and fuel their cars. Its R&D capabilities allow it to develop and advance renewable energy and energy efficiency technologies more effectively through the full R&D life-cycle—from basic scientific research through applied research and engineering, to testing, scale-up, and demonstration. REL's main R&D areas of expertise are: Solar, Wind, hydraulic, bio-fuel.

A main part of the Lab's mission is the transfer of REL-developed technologies to renewable energy markets. REL's team will support laboratory scientists and engineers in the successful and practical application of their expertise and the technologies they develop. A group of scientists and researchers in the domain of renewable energies and its related fields are member of the REL's team and play an important role to the success of its several missions.

This laboratory is now in operation and a number young researchers started already their activities. Two publications have already been made regarding the simulation of a hybrid RE system for rural regions and the investigation of the optimal solution for the connectivity of PV systems on a scheduled availability of the grid.

❖ **Renewable Energy Master Programme**

- ✓ A common program: Lebanese University & Saint Joseph University
- ✓ In cooperation with French Research Institutions
- ✓ With the support of French Embassy in Beirut

Scientific and Educational Objectives

Students who chose this Master Programme will acquire expertise in the field of renewable energy, enabling them to design and implement systems for the generation, conversion and distribution of energy from renewable energy sources and develop relevant projects.

In particular, this Master aims to educate students on:

1. Problems related to energy consumption worldwide, depletion of fossil fuels, global warming and air pollution
2. Various forms of renewable energy such as solar, wind, hydro, biomass, geothermal, tides and waves, by hydrogen fuel cells
3. Techniques of production, storage and use of energy
4. The different strategies of connectivity with the grid via dedicated electronic interfaces, and methods to optimize the energy flow through development of appropriate control laws.

It also aims to train:

1. Teachers and researchers
2. High-level officials in various administrations and public offices
3. Foreign researchers: because of the importance of the issues discussed, openness to foreign students in the Mediterranean basin can lead to synergy in favour of a more common approach for the use of the resource.

ALMEE members play an essential role in the successful implementation of this master as speakers and researchers. In particular, Said Shehab, Adel Mourtada and Adnan Jouni of ALMEE have been assigned teaching hours in this Master Programme in the subjects of energy efficiency and RE and EE project evaluation. Moreover, A. Jouni and A. Mourtada are supervising Master Thesis.

Creation and maintenance of an e-Observatory for research watch

e-Observatory is an online database that includes documents for the PV and solar thermal technologies and application in Jordan and Lebanon as well as documents for the energy planning of these two countries. These documents were developed by the experts of NERC and ALMEE, mainly, in the course of the RESSOL-MEDBUILD project and were published or presented in conferences and workshops. The uploaded documents have been categorized as follows:

1. Policy and legislative documents
2. Research projects
3. Scientific and informative material
4. Studies, publications



Figure 1. Screenshot from the e-observatory webpage

Access to the content of e-observatory is provided free to all interested visitors after they follow a simple online registration procedure. In this way access to e-observatory can be easily monitored and the list of registered visitors can be exploited by ALMEE and NERC for networking and dissemination purposes. Furthermore, this database can be used by both ALMEE and NERC as a reference for the RE and EE sectors in Lebanon and Jordan respectively.

Organisation of international conferences and national workshops

Two international conferences were organized by the project team in Jordan and Lebanon in the framework of the project. A brief description of conference objectives and results is provided below:

❖ *First International Conference on Solar energy for MENA region (INCOSOL) October 22-23, 2012 Amman – Jordan*

Under the auspices of His Royal Highness Prince El-Hassan Bin Talal and within the framework of the European project RESSOL MEDBUILD, the National Energy Research Center (NERC) in Jordan in collaboration with Zero Pollution, the Centre for Renewable Energy Sources and Saving (Greece) and the Fraunhofer Institute of Solar Energy (Germany) organized the International Conference on Solar energy for MENA region (INCOSOL) in Amman on 22-23 October 2012.

The objective of this conference was to address the most important issues in the MENA region with regard to solar thermal energy and solar photovoltaic. Solar energy is multifaceted and engages a broad range of people from variety of backgrounds. Energy supply is a daunting challenge to Jordan due to lack of indigenous energy resources. This conference addressed the various issues associated with all technologies and applications of solar energy in Jordan, the Middle East and around the world as well its relation to sustainability and conservation of resources. The conference supported approaches that promote solar energy by utilizing state-of-the-art technologies and environmentally friendly industrial solutions.

More than 39 scientific papers were selected by an international committee composed of researchers from NERC, CRES, Fraunhofer ISE, Karlsruher Institut für Technologie (KIT) and College of Engineering at Dhofar University. These articles cover all the topics of scientific research related to solar thermal applications and electricity generation (PV, CSP) of solar energy, single and hybrid applications, space heating and cooling applications and experimental and computational aspects.

The conference offered an excellent opportunity to get informed about latest developments and current projects and to exchange ideas with other experts from academia and industry to build partnerships, networking and drafting new project ideas. NERC has participated with two accepted papers in the fields of solar space heating and solar assisted biogas production. All conference material has been uploaded on the dedicated conference website <http://www.incosol2012.ressolmedbuild.eu/> and is available for downloading.

The conference was attended by 120 participants from universities, research institutes, private project development and investment companies, electricity companies, NGOs, local authorities, and international organizations from EU, MENA region and around the world.

❖ *International Conference on Renewable Energies for Developing Countries (REDEC 2012)*
November 28-29, 2012 Beirut – Lebanon

On 28-29 November 2012 the International Conference on Renewable Energies for Developing Countries (REDEC 2012) was successfully implemented in Beirut, Lebanon.

The conference's aim was to benefit from international experience and discuss innovative scientific solutions adapted to the developing countries situations. Researchers from local and foreign universities and research organizations suggested during this conference solutions for specific problems. Professionals found the opportunity to know about the most efficient way for investing in renewable energies in these countries. Case studies on successful solutions and on supporting programs were presented. The adaptation of laws and regulations was discussed for an easy penetration of renewable energies in developing countries.

The Organizing committee has started to implement the organizational issues for this conference since February 2012 and since that time the committee did successive meetings in order to pursue and evaluate the on-going process for achieving scheduled tasks. A peer review process was performed with the help of a skilled international technical committee and 80% of submitted papers were selected. The technical committee comprised researchers from the following organizations/institutes:

<i>IUT Versailles</i>	France	<i>Al-Manar University</i>	Lebanon
<i>Ecole Haute Etudes Ing.</i>	France	<i>United Arab Emirates University</i>	United Arab Emirates
<i>Universite de Picardie</i>	France	<i>Univ. of Sharjah</i>	United Arab Emirates
<i>UVHC (valenciennes)</i>	France	<i>Masdar Inst of Sc. & Tec.</i>	United Arab Emirates
<i>Universite de Toulouse</i>	France	<i>ESSTT</i>	Tunisia
<i>Inst Nat de l'Energ Solaire</i>	France	<i>ALCOR</i>	Tunisia
<i>Univsite du Havre</i>	France	<i>Sfax Natio. Sch. Eng.</i>	Tunisia
<i>Ecole des Mines</i>	France	<i>CRES</i>	Greece
<i>ENTPE</i>	France	<i>Fraunhofer ISE</i>	Germany
<i>IEEE</i>	Italy	<i>UQAR</i>	Canada
<i>ESCWA</i>	Lebanon	<i>ETS</i>	Canada
<i>ASHRAE</i>	Lebanon	<i>Hashemite Univ.</i>	Jordan
<i>St. Joseph Univ.</i>	Lebanon	<i>Ohio State Univ.</i>	USA
<i>Needs</i>	Lebanon		

ALMEE and its partners CRES and Fraunhofer ISE in the RESSOL-MEDBUILD European project, have covered all registration and logistic fees. IEEE-Lebanon Section has offered some of the financial aid. IEEE-IES accepted the technical support. Other sponsors like ESCWA (Economic and Social Commission for Western Asia) and the Lebanese Order of Engineers helped the consortium in the conference announcement process. Three important local Universities: The Lebanese University, St. Joseph University and Notre Dame University gave consortium the academic support for bringing this conference to a high scientific research standard.

The result of this event was the submission of 80 papers from 24 different countries. Sixty five papers were selected to be orally presented and discussed. Unfortunately, few weeks before the conference date, some undesirable security events have occurred, therefore not all the authors of accepted papers came to Lebanon for presenting their works. Even though, 37 papers were presented and three keynote speakers from World Future Council Foundation, the Institute of the Mediterranean and the Fraunhofer Institute for Solar Energy Systems present the most important considerations for the penetration of renewable energy to developing countries. Finally, the great success of REDEC 2012 has encouraged the organizing committee to start thinking about REDEC 2014.

Papers presented at the REDEC conference will be included in IEEE Xplore data base. More information for the REDEC conference can be found on the dedicated conference website <http://www.redec2012.ressol-medbuild.eu>.

❖ *National Workshops*

In addition to the international conferences, seven national workshops have been organized and successfully implemented by the Mediterranean partners in Jordan and Lebanon during the course of the project. The objective of these was to train and inform municipalities, public administration and end-users of the solar technologies and their application in buildings. In addition, these workshops also dealt with energy efficiency and energy planning issues. Additional audience included design engineers, research institutions, universities and NGOs. A list of the implemented national workshops is provided below.

Date	Title	Type of audience	Size of audience	Organizing Institutions
NERC				
7 June 2010	<i>Renewable energy and energy efficiency Forum (within JIMEX 2010 Exhibition)</i>	<i>Ministry of Energy, energy policy makers, researchers, engineers, RE technology suppliers</i>	30	NERC
5 December 2011	<i>Energy efficiency and labelling in Jordan</i>	<i>Public institutions and engineers</i>	25	NERC, UNDP, MOP
27 March 2012	<i>Workshop on RESSOL-MEDBUILD project</i>	<i>Gov.institutions NGOs Private sector</i>	60	NERC/ Universities and research institutions

Date	Title	Type of audience	Size of audience	Organizing Institutions
ALMEE				
8 October 2010	<i>1-day national workshop as part of ALMEE's networking activities under the RESSOL-MEDBUILD project</i>	<i>Local researchers, Universities and engineers</i>	80	<i>ALMEE, Lebanese University, Saint Joseph University, CRES, NERC, Fraunhofer ISE</i>
11-12 January 2011	<i>2-day national workshop activities Eco construction & solar Invest in Med under RESSOL activities</i>	<i>Local researches, Universities, engineers and experts</i>	100	<i>ALMEE, Chamber of Commerce and Industry in Beirut</i>
8 July 2011	<i>The Lebanese Solar Master Plan</i>	<i>Energy Experts & Stakeholders</i>	25	<i>ALMEE- RESSOL-MEDBUILD, WWF</i>
29 October 2011	<i>Thermal insulation and renewable energy for buildings</i>	<i>Private & public institutions, SMEs, experts, researchers</i>	25	<i>COSV CLEAN ENERTEC/ ALMEE RESSOL-MEDBUILD</i>
15-16 March 2012	<i>Workshop for municipality members on energy efficiency, energy saving and renewable energy</i>	<i>Engineers, technicians, Municipal members</i>	30	<i>ALMEE, COSV, Municipalities</i>
8 November 2012	<i>Think globally act locally Workshop</i>	<i>NGO's members, experts, engineers</i>	25	<i>ALMEE, COSV</i>

D. Potential impact and main dissemination activities and exploitation of results

The aim of the RESSOL-MEDBUILD project was to enhance the scientific and research capacity as well as the human resources and infrastructure of two Mediterranean organizations, namely the National Energy Research Centre – NERC of Jordan and the Lebanese Association for Energy Saving & for Environment ALMEE. In the framework of this aim, project impact can be analysed in 4 axes:

❖ *Axis 1: Reinforcing expertise and know how*

25 researchers from NERC and ALMEE were trained at the facilities of CRES and Fraunhofer ISE in the scientific fields of PV and solar thermal technologies as well as energy policy analysis and planning. Furthermore, 13 researchers were actively engaged in research activities during the secondments that were implemented at the facilities of the EU research entities. In this way expertise and knowledge has been transferred from the EU institutes to their MED counterparts so that the later are more qualified to conduct applied research, be engaged in new research projects and work on new project proposals. Furthermore, they are strengthened in order to meet their role objectives in promoting and supporting the development of RE and EE sectors in Lebanon and Jordan.

❖ *Axis 2: Elevate human resources*

ALMEE's human resources were significantly elevated by the recruitment of the senior researcher Dr. A. Jouni. Dr. Adnan has proven experience of more than 25 years in the energy sector and particularly in the fields of RE and EE. He has significantly contributed towards the enhancement of ALMEE's scientific capacities by:

- o guiding and providing assistance to existing and young researchers in the respective research fields,
- o providing assistance in the acquisition and set up of new equipment and software,
- o contributing to the implementation of research projects and activities,
- o networking with national and international stakeholders,
- o contributing to the envisioning and formulation of a strategy and an action plan for the expansion and enhancement of the research activities of ALMEE to new markets,
- o submitting competitive project proposals and the participation on project consortiums.

Further to that, NERC and ALMEE were significantly strengthened by the recruitment of 7 new young researchers. These researchers will contribute to the Mediterranean partners' goals under the guidance of the existing and more experienced staff.

❖ *Axis 3: Advance research facilities*

ALMEE

In Lebanon, research in the field of solar energy remains very modest; lack of research resources and financial support, as well as lack of governmental action plans in this field, does not encourage the involvement of research centers and universities in solar energy research activities.

In this context, the role of RESSOL MEDBUILD project and especially the equipment and software were very important. The project helped ALMEE to speed up its pace in order to engage in high-level research and respond to the challenges of the country regarding energy supply and demand issues. The developed Sustainable Strategic Research Plan of ALMEE in deliverable D 4.1.v-2 has several key aims, one of which is to ‘Build up the research infrastructure to ensure that staff is better supported to undertake high quality research activities’. An improved research profile is seen as critical in securing ALMEE’s status and mission.

Research equipment and software allocated by the RESSOL-MEDBUILD project are important tools and play an essential role to achieve the research strategy objectives. It is certain that, in the frame of RESSOL-MEDBUILD project and with the recent acquisition by ALMEE of research equipment and software, another dimension has been given to ALMEE’s research activities. Researchers have more resources at their disposal in order to implement more testing and more simulations with better conditions and results. In this regard ALMEE has come into agreement with some of its research partners for close collaboration in research and educational activities.

In particular, the **Engineering school of the Lebanese University** has a research team in the field of PV systems but their resources were very limited. Thus, they were very interested in the project equipment and software which would enable them to work on a larger scale. They also had solar water heating equipment which was not operational due to lack of resources. ALMEE’s support provided them the possibility to update this equipment and carry out common research programs. Software calculations allow the validation of testing results and the optimization of different situations. So RESSOL-MEDBUILD equipment and software played an important role in the creation of the **Renewable Energy Laboratory (REL)**, an inter-departmental Laboratory located in the Lebanese Engineering School at El-Hadath Campus. Its activities are dedicated to enhance and promote renewable energy and energy efficiency research and development (R&D). This new laboratory operates as a new branch of the existing RIT (Recherches et Innovations Technologiques, <http://ulfg.ul.edu.lb/RIT>) laboratory, which will extend its activities to the field of RE. This new laboratory is now in operation and ALMEE and RIT research teams have already begun working on common research projects. Professor Imad Mougharbel is the head of the REL laboratory.

At **Saint Joseph University (USJ)**, researchers working in the field of PV and solar thermal technologies have expressed their interest in collaborating with ALMEE. Especially interesting for them is the opportunity to collaborate by using the available research equipment and software. Researchers at USJ have now the possibility to use the mobile thermal solar equipment as well as a set of software composed of T*SOL, PV*SOL, TRNSYS, METEONORM & TRANSOL.

At **Notre Dame University** there are also research teams interested in equipment, measurement tools and calculation software. In this regard, a new research unit in the domain of Renewable Energies was born, which is a direct output of RESSOL-MEDBUILD project. Research equipment is composed of a new solar water heater test bench completed by the addition of a mobile equipment for the evaluation of solar thermal systems, an infrared camera and a set of related software like T-SOL, TRNSYS, METEONORM provided by RESSOL-MEDBUILD project. The objective of this unit is to develop and optimize solar thermal systems in Lebanon according to different utilization scenarios and other constraints like available area and solar irradiation. Another objective is to offer test possibilities to ALMEE's industrial solar thermal partners to perform necessary tests with the available equipment. This unit is now in operation and ALMEE and NDU are already working on common research projects with some first research results in the field of solar thermal systems for buildings.

NERC

The National Energy Research Center (NERC) was established in Amman in 1998 for the purposes of research, development and training in the fields of renewable energy and efficient use of energy in different sectors in cooperation with local and international institutions. NERC has been responsible in implementing many projects in the field of renewable energy with local and international partnerships. The specific objectives for NERC is to create the necessary technological infrastructure for improving innovative research activities, to generate high-level research products and services and support all interested stakeholders to integrate solar thermal and PV technologies in buildings.

Many research studies at the National Energy Research Center were strongly supported by the use of the obtained measuring equipment and software. Also, many research students from local universities were assisted in their academic work using the available equipment and software. NERC's ability to perform thermo-physical measurements and corresponding analysis was greatly enhanced. This will be reflected on future research and development projects. On the basis of that NERC intends to:

- Enhance its capacity in research & application of solar energy
- Expand and enhance its consultation services to reach more beneficiaries (household sector, industrial sector for process heating, agriculture, etc.)
- Follow up market development on solar applications
- Establish solar energy database (long term goal). The data base shall include but is not limited to: solar map, existing solar projects, relevant data on solar applications & penetration rates as well as installed capacity, future planning and strategy for solar energy
- Provide training and capacity building to local manufacturers
- Cooperate with other relevant institutions for testing & certification of solar water heaters
- Conducting research on improvement of local manufactured solar water heaters
- Work with other relevant institutions on the proper implementation of the renewable energy law and the introduction of the necessary regulations (feed in tariff...etc)

❖ Axis 4: Enabling international and national research cooperation

First of all, the project has assisted both ALMEE and NERC in the development of concrete research strategies and an exploitation plans. Research priorities have been identified and research targets have been defined for both entities. The strategies proposed specific actions in order to achieve these targets. Furthermore, exploitation plans have been developed in order to exploit research results and services that will be produced/developed by NERC and ALMEE. In this way research activities of the Mediterranean partners will be channelled and become more focused, thus increasing efficiency and effectiveness of research efforts. In addition, the developed exploitation plans will identify additional financial resources for NERC and ALMEE that will help them on the one hand to secure their financial viability and on the other hand to further fund their research activities.

Moreover, throughout project lifetime the project consortium has worked towards contacting and developing research partnerships with a large number of research centers, institutes and organizations across Europe and MENA region. As a direct result of these networking activities, the Mediterranean partners have collaborated with more than 100 different organizations, research institutes and private companies from Europe and the MENA region in 25 projects and 16 project proposals during project lifetime. This pool of collaborating organizations will be used by ALMEE, and NERC in the future in making project proposals or collaborating with them in research projects.

CRES and ISE obtained two strategic partners in Lebanon and Jordan. Furthermore, they have expanded their network of cooperating organizations in Lebanon, Jordan and the region. This improved network provides CRES and ISE with a pool of partners for new research projects and opportunities.

Of particular importance is the establishment of the *Renewable Energy Laboratory* (REL), an inter-departmental laboratory located in the Lebanese Engineering School at El-Hadath Campus. Its activities are dedicated to enhance and promote RE and EE research and development. ALMEE and RESSOL MEDBUILD team had an important role in the creation of this entity and their actual and future role is essential to the success of the REL as already mentioned in the *Description of the Main S&T Results* section. In the framework of the operation of this laboratory ALMEE will continue to maintain a close research partnership with the Lebanese University and have the opportunity to be engaged in common research activities.

In parallel, the project team and ALMEE in particular, have played a crucial role towards the establishment of the *Renewable Energy Master Programme*. This Master is a common programme with the Lebanese University and the Saint Joseph University and has been developed and operates in cooperation with French research institutes and with the support of French Embassy in Beirut. The Master will advance the cooperation between ALMEE and the aforementioned Universities and be a strong educational and capacity building tool that will address a broad audience: teachers, researchers, high-level specialists in public administration, foreign researchers from other MENA region countries. ALMEE experts are delivering course and supervising Master Thesis.

An e-Observatory that is hosted in the project website has been created. Access to the content of e-observatory is provided free to all interested visitors after they follow a simple online registration procedure. In this way access to e-observatory can be easily monitored and the list of registered

visitors can be exploited by ALMEE and NERC for networking and dissemination purposes. Furthermore, this database can be used by both ALMEE and NERC as a reference for the RE and EE sectors in Lebanon and Jordan respectively.

Finally, two international conferences have been organized in the framework of the RESSOL-MEDBUILD project. These conferences offered an excellent opportunity for project partners to get informed about latest developments and current projects, to exchange ideas with other experts from academia and industry, to build up partnerships and to network and draft new project ideas. The great success of these conferences has encouraged the organizing committee to start thinking about establishing these conferences as recurring biennial international events.

Dissemination of project results

Project results were actively disseminated throughout project implementation according to a dissemination strategy that was continually updated.

 A dedicated project website has been created in the framework of the RESSOL-MEDBUILD project, which was a significant dissemination tool throughout project lifetime. In particular, the project website has contributed significantly to the dissemination and communication of the 2 international conferences that were organized by the project team, namely REDEC 2012 and INCOSOL 2012 in Lebanon and Jordan respectively. Two dedicated conference websites were created as subdomains to the main project site, where all conference info material was uploaded. Conference websites were efficiently used by the organizing committees in order to disseminate the events, inform participants on conference related issues (registration, accommodation, important dates, etc.) and finally present conference results.

In addition, the project website hosts e-Observatory. Furthermore, in the project website information is provided on the following:

- Project overview
- Project Work Packages
- Project partners
- Upcoming events on RE and EE in Lebanon and Jordan
- Directory of institutions, organizations, public bodies, private companies, etc. active in the fields of RE and EE in Lebanon and Jordan

A password protected partners' area, where project documents are uploaded.

 ALMEE and NERC have issued a periodical guide/newsletter for analysing technological solutions and policy perspectives and include dissemination material. In particular, ALMEE has issued and disseminated the following newsletters:

- ❖ **'Energy and Economic impacts of Energy Efficiency Measures and the Thermal Standard of Buildings (2010) in Lebanon'** by A. Mourtada, S. Chehab, A. Jouni, A. Karaki, R. Khairallah and T. Matar, June 2011.

This newsletter presented the energy and economic analysis used to determine cost effective requirements levels to the thermal standard for buildings in Lebanon (TSBL2010) and the energy and socio-economic impacts of energy efficiency measures (EE) related to envelop and energy equipment of buildings.

- ❖ **‘Concrete analysis of energy facts in Lebanon with a perspective of promotion of renewable energy technologies’** by A. Mourtada, A. Jouni, T. Matar and S. Chehab, April 2012.

This newsletter presented a concrete analysis of energy facts in Lebanon with a perspective of promotion of RE technologies. The recommendations developed for an alternative energy efficiency policy will enable Lebanon to take control of its energy in the future, while contributing to global efforts to cut greenhouse gas emissions.

- ❖ **‘Assessment of financing mechanisms for EE & RE in buildings sector: the case of Lebanon’** by A. Mourtada, A. Jouni, T. Matar and S. Chehab, December 2012.

In this newsletter ALMEE focused on financial and economic measures, as the economic barriers are the most important. The incentive tools aim at removing two major economic constraints, namely: the low cost-effectiveness for the end consumer barrier and the initial investment cost barrier.

NERC has also issued and disseminated the following:

- ❖ **‘Sun Technologies for Mediterranean Buildings- Issue 1’**

This newsletter describes technologies for solar thermal collectors, renewable energy air-conditioning systems and the draft Jordanian Solar Energy Code, activities in which NERC has been actively involved.

- ❖ **‘Sun Technologies for Mediterranean Buildings- Issue 2’**

- ❖ **‘Sun Technologies for Mediterranean Buildings- Issue 3’**

These newsletters describe recent advances as well as research activities of NERC scientific team in the fields of solar thermal and PV technologies.

 As part of their dissemination activities, NERC and ALMEE organised or co-organized with partner institutions or organizations numerous events. These events disseminated the knowledge the experts of NERC and ALMEE gained in the secondments and training sessions in Greece and Germany. In addition, the Mediterranean project partners have participated in several events and disseminated gained knowledge. In total, NERC and ALMEE have actively participated in more than 60 international and national conferences, workshops, information days and networking events during project lifetime. A list of events organized or co-organized by ALMEE and NERC is provided in Table A.2 (Section 4.2).

 The knowledge gained by the experts of ALMEE and NERC from their participation in secondments and training sessions in CRES and Fraunhofer ISE was used as a basis for carrying out

high quality technical and scientific publications. ALMEE and NERC had 19 publications in refereed international conferences and workshops and 1 peer reviewed publication in international scientific journal. A list of publications is provided in Table A.1 (Section 4.2).

 In February 2012 CRES has developed a triptych A4 project leaflet. The leaflet contained information on project partners, objectives, and work structure. It also contained brief information on the 2 international conferences that eventually were implemented in Lebanon and Jordan, REDEC 2012 and INCOSOL 2012 respectively. The leaflet was printed in 2000 copies and distributed by project partners at the events that they organized. An electronic version of the leaflet has been distributed via email and posted on the project website.

At project end ALMEE drafted a final project e-brochure including project information and results. This electronic brochure was actively disseminated to project partners' mailing list.

 NERC has issued the Renewable Energy & Energy Efficiency Directory for the year 2011. This Annual Periodical Directory includes various articles on renewable energy including solar energy and energy efficiency. It also includes a data base and contact details for Renewable Energy & Energy Efficiency Suppliers and service providers. This Directory serves as a guidance tool for engineers, companies and any establishment who have the willingness to improve their energy efficiency and utilizing renewable energy at their facilities. The Directory has been uploaded on the website of the Network for Jordanian Industrial Sustainability (www.jordannetwork.net) targeting Jordan Industries.

E. Project website and contact details

A dedicated project website has been created in the framework of the RESSOL-MEDBUILD project, which was a significant dissemination tool throughout project lifetime. In particular, the project website has contributed significantly to the dissemination and communication of the 2 international conferences that were organized by the project team, namely REDEC 2012 and INCOSOL 2012 in Lebanon and Jordan respectively. Two dedicated conference websites were created as subdomains to the main project site, where all conference info material was uploaded. Conference websites were efficiently used by the organizing committees in order to disseminate the events, inform participants on conference related issues (registration, accommodation, important dates, etc.) and finally present conference results.

In addition, the project website hosts e-Observatory, which includes documents for the PV and solar thermal technologies and application in Jordan and Lebanon as well as documents for the energy planning of these two countries. Furthermore, in the project website information is provided on the following:

- Project overview
- Project Work Packages
- Project partners
- Upcoming events on RE and EE in Lebanon and Jordan
- Directory of institutions, organizations, public bodies, private companies, etc. active in the fields of RE and EE in Lebanon and Jordan
- A password protected partners' area, where project documents are uploaded.

The website address is: <http://www.ressol-medbuild.eu/>

❖ Project logo



List of project partners

Center for Renewable Energy Sources and Saving (CRES)



Contact Person

Dr. Anagnostopoulos Konstantinos
Address: 19th km Marathonos Ave, 19009,
Pikermi Attiki Greece
Tel: +302106607434,300
Fax: +302106603301
e-mail: kanagnost@cres.gr
Website: www.cres.gr

Fraunhofer-gesellschaft zur foerderung der angewandten Forschung e.v Fraunhofer-Institut für Solare Energiesysteme ISE



Contact Person

Christine Weber
Address : Heidenhofstraße 2, 79110
Freiburg, Germany
Tel: +49 (0) 7 61/ 45 88-56 24
Fax: +49 (0) 7 61/ 45 88-96 24
e-mail: christine.weber@ise.fraunhofer.de
Website: www.ise.fraunhofer.de

National Center for Research and Development Energy Research Program (NERC) of Jordan



Contact Person

Eng. Muhieddin Tawalbeh, Head of Rational Use of Energy & Solar Thermal Division
Address: P.O Box 1945 Al-Jubaiha 11941 Amman – Jordan
Amman - Ahmed Tarawneh Street, Campus of Royal Scientific Society
Tel. +962 6 5338042 Ext. 107
Fax. +962 6 5338043
e-mail. m.tawalbeh@nerc.gov.jo
Website: www.nerc.gov.jo

The Lebanese Association for Energy Saving & for Environment (ALMEE)



Contact Person

Tony Matar
Address: Furn el Chebbak, Mroueh building,
Beirut , Lebanon
Tel: 00 961 9215840
Fax: 00 961 9215840
e-mail: tmatar@dm.net.lb
Website: www.almee.org