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[2] The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

Executive summary

This report offers summary description of project context and objectives, description of the work performed with demo activities during both project periods and main results divided into work packages. Final project results, as well as their potential impact, were described. Consortium's plans for further dissemination and usage of foreground generated in the project were also stated.

Summary description of project context and objectives

Generation of solar thermal heat in mid-temperature ranging from 100°C up to 300°C is one with the highest market potential and can be combined with a whole series of power generation, industrial and home applications. The major disadvantage of existing solar thermal tubes for the above-mentioned temperature range is complex vacuum retention technology and subsequently the high product cost.

In order to make such technology available at acceptable price, the objective to develop the All Glass Mid Temperature Direct Flow Thermal Solar Vacuum Tube has been set up. Research and development activities that have been carried out within the European solar thermal and glass industries and laboratories resulted in new vacuum tubes technology named SOLEGLASS.

SOLEGLASS enables further development of solar collectors that stimulate implementation of enhanced and more efficient mid temperature solar thermal applications. The factors of SOLEGLASS successful market penetration are connected with the developed technology that ensures the reliable vacuum retention and tube efficiency, decreasing, at the same time, material cost of solar tube production (stainless steel vs. glass). The concept based on developed tube enabled a production of solar collectors for temperature range 100-160°C and collectors for temperature range 160-300°C at the commercially feasible level.

SOLEGLASS solar collectors aim to provide heat for industrial and home applications through a simplified technical and engineered solution to improve vacuum retention. The objective of the project has been to provide an all glass solar tube able to compensate high thermal dilations and would thus reduce vacuum and consequent thermal losses, which will make the technology more affordable than current solutions. For this purpose medium and high solar collector tubes, ranging from 100°C up to 300°C, have been designed based on the same engineering solution, which includes bellow shape ending on both side of the tube, to reduce and compensate thermal dilations. Therefore the outcome is twofold: on one hand and due to the lower expansion coefficient of the glass the dilations has been reduced, and on the other hand the all glass tube with the bellow shape ends has compensated for different dilations currently existing due to the use of different tube and diameter materials.

Innovative bellows have been made of glass in order to compensate for differential expansion between outer and inner glass tube and guarantee sustainable vacuum retention. Glass bellows have been developed and validated by means of research of structural behaviour of glass

bellow under static and dynamic (cyclic) load design and specification of glass bellows prototypes for both, mid and high temperature ranges.

Simulation tools were employed for the study of the different thermal, structural, hydrodynamic and optical behaviour of the system, to provide the optimum collectors and running parameters. Initial test were performed of the glass bellow tubes, for which the structural behaviour was proved under static and dynamic loads (EPFL) and also under high thermal and pressure conditions (EPFL and TWI). Results obtained from experimental tests and numerical simulations were compared. The models and designs were adjusted and calibrated based on the obtained results. In this sense several parameters have been varied with the aim to identify the most influencing factors and their applicable ranges. Based on this parametric study, the optimised SOLEGLASS prototype for both applications (SOLEGLASS-L and SOLEGLASS-H) has been specified. Final drawings were developed for the construction and integration of the prototypes. Two CPC units (one in Zagreb and another one in Skopje) and one CSP unit were produced and installed for testing purposes.

Description of the main S&T results/foregrounds

Project activities have been divided into 8 work packages (WPs), as well as into 4 Project results. WPs are structured of different project activities; six of which are oriented towards RTD and DEMO activities:

1. Glass bellows development and design
2. SOLEGLASS vacuum tube development and design
3. SOLEGLASS assembly technology process
4. Development of CPC heating/cooling collectors
5. Development of collector for CSP and industrial process heat application using SOLEGLASS
6. Technology testing, validation and demonstration

Two remaining WPs are dedicated to intellectual property rights, dissemination, exploitation and project management.

In this periodic report the main and most significant results and conclusions of the project were obtained. Two CPC collectors (up to 160°C) and one CSP collector (up to 250°C) were designed, constructed and installed at Novamina and Camel Solar's facilities. Experimental test was performed at real conditions in order to validate the technology.

The Project activities have been included in the following 4 results, which are RTD-oriented tasks:

1. All-glass bellows

2. Direct flow all glass vacuum tube

3. Solar Cooling/Heating collector

4. Solar CSP concentrator

Even though it was expected that Result 1 would be achieved within WP1, it has necessarily also been included in WP3, WP4 and WP5. Similarly, Result 3 is connected to WP1 and WP2

as collector design should be aligned with the glass tube system. This illustrates the complexity of the Project development.

In project period 2 the results that apply are 3 and 4 related to the development and testing of the CPC and CSP prototypes. Initially some studies were performed to design the required operating conditions and dimensioning each tube and the whole system.

Regarding the CPC collector (Result 3) two modules were developed with 7 tubes each and a specific compound parabolic reflector. For this purpose optical simulation for the reflector shape design was previously carried out. Some calculations were also performed (hydrodynamic, thermal and structural simulation) to obtain values such as the fluid temperature, pressure drop, required flow rate, etc. and thus obtain the final module dimensional parameters (nº of tubes/module, tube diameter, mirror dimensions, etc.) of the collector module. Manufacturing was carried out, comprising of tubes manufacturing (production, welding, annealing, coating deposition, etc) and experimental test was performed at Camel Solar and Novamina's facilities.

Potential impact and main dissemination activities and exploitation of results

SOLEGLASS considers replacement of critical glass-metal joints with thermal formed glass material. Thus a potential SOLEGLASS market penetration is expected that will take place due to the developed technology which will improve current vacuum retention systems. At the same time it is to decrease manufacturing costs, due to the reduction of complex elements and materials cost (glass instead of stainless steel). On the cost analysis performed some approximate values of production volumes and materials and processes cost were considered. It is believed that with an industrialization study it could be more accurately defined and a cheaper system could be finally designed.

SOLEGLASS as a final goal has the mission to bring solar energy to everyday use. The socio-economic impact (SEI) is focused mainly on the environmental impact. Thus it was evaluated in what extent the project would contribute to the reduction of maintenance cost, effectiveness of the final products, production cost and at the end value of the project the contribution to climate policy and decrease in CO_2 emissions. Due to less components used and materials employed (mainly glass) the product is more environmentally friendly also due to the disassembling during life cycle of the product. The focus is to make the collector available to the end user, and lastly the use of renewable energy.

SOLEGLASS solar thermal collectors will also contribute on the CO_2 emission reduction, defined by the European commission: "2030 framework for climate and energy policies". This policy aims to reduce greenhouse gas emissions by 40% below the 1990 level by 2030, for which Soleglass collectors will contribute. The initial idea and application of the project to provide solar water heating for domestic and industrial applications but in a following development and improvement of the system it could also be employed for the so-called solar cooling systems, in which the remaining heat is used air conditioning or integrated in a HVAC system.

As far as potential impact is concerned, the Consortium believes that the SOLEGLASS project will directly improve the competitiveness of the SME-AG members and the entire SME community, particularly in terms of energy costs savings and production capabilities and opportunities to penetrate worldwide markets. With particular flexibility in operation and with

minimized maintenance cost it represents a truly green, renewable energy solution product which will deliver a broad range of benefits.

In the first place, the technology beneficiaries (SME-AG and their Industry members) will benefit from the significantly lower energy costs (electrical power or fuel), lower emissions that will ultimately improve competitiveness of SME-AGs and create an attractive proposition for wider population of AG members, creating demand for this technology at discount prices.

The consortium has plans for further dissemination and usage of the foreground generated within the SOLEGLASS project:

- Plan is to implement more intense dissemination through consortium member organizations, especially SME members.
- At national and European level - in the framework of different National Initiatives and the on-going relevant European Initiatives;
- Through active participation of the SOLEGLASS members in the relevant events after the end of the Project
- Through further development of some tools and services created during the required upgrades of the Project: results to make the product feasible for the expected production process

Further exploitation of the SOLEGLASS will be managed by SME-AGs CCE, SERCOBE and CCIAAMI (with INNOVHUB as results owner) as well as SME partners CAMELSOLAR, EPSCO and EMERGO.

Address of the project public website and relevant contact details

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