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4.1 Final publishable summary report

1. An executive summary

The main objective of the SENERES project was setting up the Sustainable Energy Research and Development Centre SENERES, devoted to supporting a development of efficient low-carbon energy technologies, namely energy generation from biomass, clean coal technologies and fuel cells.

The SENERES Centre was established on the basis of the cooperation of the most advanced units of the Institute of Power Engineering, engaged in the research concerning energy thermal conversion and solid oxide fuel cells - Thermal Processes Department; Fuel Cells Laboratory; Ceramics Department CEREL. Energy Research Integration Centre CENERG performs the role of SENERES secretariat, providing support for the management, organization and realization of project's activities. The key to success of the program is combining existing tools with new possibilities. Cooperation with the leading research centres in Europe unquestionably reinforces the research potential of the SENERES project:
ECN Petten, The Netherlands; TU Delft, The Netherlands; University of Cambridge, UK; CIRCE, Zaragoza, Spain; KTH, Stockholm, Sweden; IFK USTUTT, Stuttgart, Germany; CNR-ISTEC, Faenza, Italy.

The objectives of the project are divided into Work Packages,

- WP1 - The exchange of know-how and experience by two-way secondments, organisation of short- and medium-term visits in SENERES and in partner's institutions;
- WP2 - The reinforcing SENERES's research staff by recruitment of experienced researchers by launching dedicated calls and permanent invitations;
- WP3 - Modernization of infrastructure and purchase of special equipment for opening new opportunities for experimental research;
- WP4 - Organization of 3 thematic workshops and 6 scientific seminars to facilitate knowledge transfer on national, regional and European level. Participation of the SENERES's research staff at international conferences and short training events. Organisation of an intensive course/specific training on protection and management of Intellectual Property in the SENERES's research field;
- WP5 - Dissemination and promotion of SENERES activities as well as the project results for increasing SENERES's visibility in the EU and other countries;
- WP6 - Coordination of all project activities including progress of scientific, technical and budgetary Work Packages realization, communication with the EC, organizing meetings with the project Strategic partners, preparing periodical reports and final report.

The outcomes of SENERES project are presented in the form of Deliverables which constitute to Work Packages.

2. A summary description of project context and objectives (not exceeding 4 pages).

The main context of the project is to reinforce the existing research and development potential of the IEn's Thermal Engineering Division and Ceramics Department CEREL and establish on its basis Sustainably Energy Research and Development Centre SENERES. The SENERES Centre establishment will be a continuation of the activities started by Centre of Excellence CENERG in 2002 and will become the next important step of development of the IEn's units research potential.

The CENERG establishment was vitally important for the Thermal Engineering Division for many reasons described below. The project enabled to strengthen links between energy research institutes in Central Europe accession countries. CENERG has created the platform for exchange of knowledge and experiences in the energy area between partners from the Region. Moreover owing to the CENERG's activities many new links with the experienced EU research institutes and centres have been also established. Those links have been very helpful in the development of scientific cooperation in numerous EU projects. IEn's Thermal Engineering Division research groups become partners of many FP5, FP6 and FP7 research, demonstration, coordination and supporting projects. The IEn's participation in EU projects has opened new research areas in the Division's activities (such as biomass gasification, fuel cells, etc).

The realization of the SENERES project have deeply accelerated the IEn's Thermal Engineering Division development and began the new phase of IEn's energy research. After finishing of the project financial support by the Commission the SENERES Centre will continue its activity and will be subsequently extended and developed. Building the SENERES Centre strong position in the Region and developing new research fields should imply new requirements.

The main objectives of SENERES project were:

1. to reinforce and develop research and demonstration potential of the most advanced, experienced and promising parts of the Institute of Power Engineering (IEn, Warsaw, Poland): the Thermal Engineering Division providing research in the area of thermal conversion of energy and development of high efficient low-carbon energy technologies and the Ceramics Department CEREL in Boguchwala specialised investigation of ceramic membranes for oxygen separation and fuel cells
2. to establish on the basis of above two units the Sustainable Energy Research and Development Centre SENERES focused on the advanced sustainable energy generation: energy generation from biomass, clean coal technologies and fuel cells

In the frames of the project activities the human resources of the above units will be supported and mobilized by cooperation with seven knowledgeable and experienced partnering organisations – leading energy research centres in Europe: ECN and TU Delft (Netherland), University of Cambridge (UK), CIRCE (Spain), KTH (Sweden), USTUTT-IFK (Germany) and CNR-ISTEC (Italy). The material resources gaps of the new SENERES Centre will be filled in during the project realisation.

The realization of the above goals:

- support realization of European SET Plan for clean, efficient and low emission energy technologies development and to brings together the research capacities of the major European energy research centres,

- integrate the new SENERES Centre and the Institute of Power Engineering as a whole to European Research Area (ERA) and will improve participation of the SENERES's research groups in FP7 and next framework programmes,
- support transformation of energy system in Poland and in Central Europe based on fossil fuels into sustainable one.

The achievement of the above strategic objectives is fully feasible. It will be achieved thanks to:

- large research potential of the IEn's Thermal Engineering Division and Ceramics Department; the existing weakness will be overcome and knowledge gaps will be filled in during the project SENERES realization,
- strong position in Poland of the Institute of Power Engineering as the largest energy research institute in the country and in particular of the IEn's Thermal Processing Division as the most experienced research centre in Poland in the area of biomass and coal combustion and gasification and fuel cells,
- existing significant knowledge, experience, staff and half-industrial equipment of the Thermal Processing Division which would give basis for investigation of new energy technologies
- broad experience of Thermal Engineering Division's research groups in the realization of many FP5, FP6, FP7, RFCS and national projects,
- active participation in various European initiatives (Institute of Power Engineering is the only Polish member of the EERA Executive Committee),
- the SENERES and Institute's willingness for new research areas development,
- numerous links with similar research centres in Central Europe Region,
- experience of the existing Centre of Excellence CENERG within the Thermal Engineering Division of the Institute which will coordinate SENERES project activities.

3. A description of the main S&T results/foregrounds (not exceeding 25 pages)

The S&T objectives of the project have been defined taking into consideration the main EU and Polish challenges for economy and energy sector which require relevant research and development:

- Climate changes and requirements of CO2 reduction. The EU has committed to reduce its greenhouse emission by 20% by and 60-80% by 2050. New energy technologies have to be developed to achieve the ambitious goals.
- Polish energy sector is coal dependent in 93% and has not been yet restructured. The main reason is the structure of primary energy resources available in Poland, in which the coal share equals to 98%. In future Polish energy sector has to reduce emissions of pollutants and has to adopt it to EU requirements. Subsequent substitution of conventional coal technologies by new near zero emission energy technologies should take place with an assistance of the Institute.
- Enlargement of the EU and in particular Polish accession in 2004 has opened new challenges for the Institute as the main energy research centre in Poland. Contribution to EU SET Plan has become the main objectives for the Institute's activities.

The general priorities for the energy research at the IEn's Thermal Engineering Division are the following:

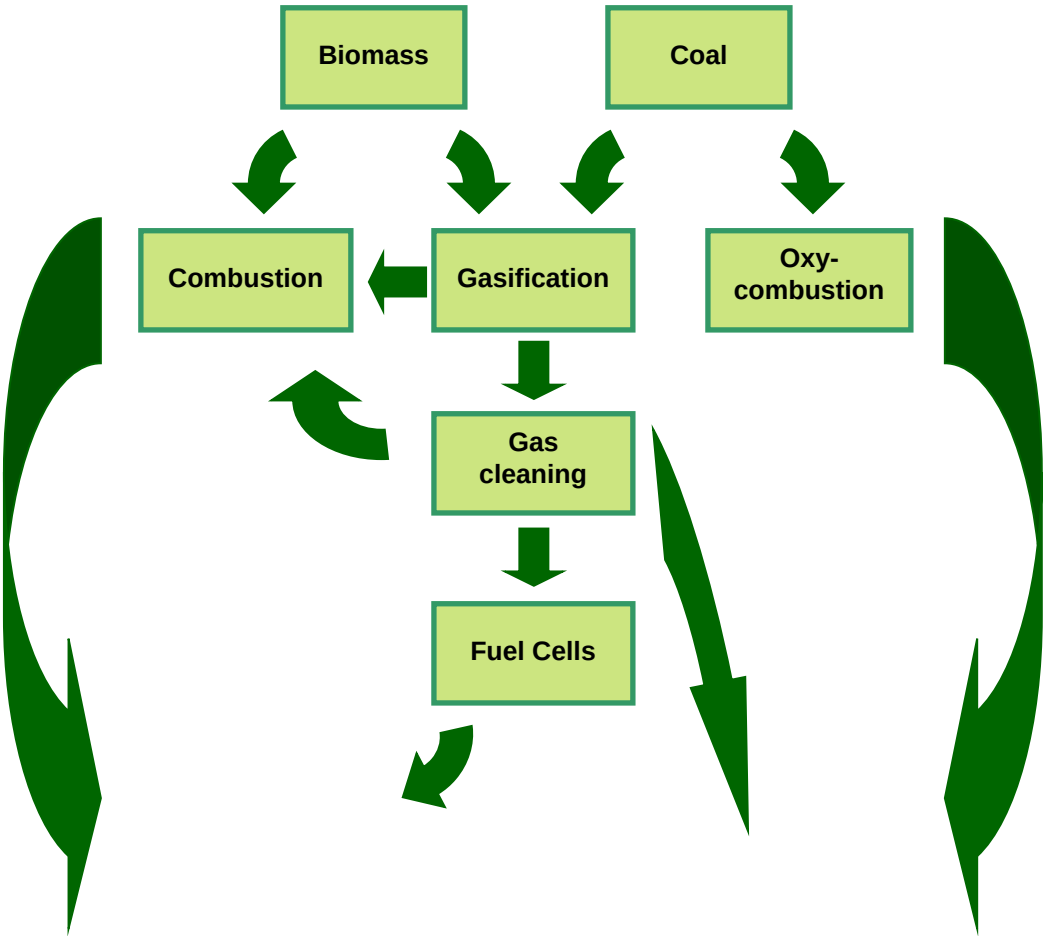
- adapting current energy system based on fossil fuels into sustainable system based on a diverse mix of energy sources, in particular wider implementation of renewable energy sources,

- answering for pressing challenges of climate changes by developing low emission energy generation technologies,
- transferring old technologies of energy generation based on coal combustion to clean coal technologies,
- developing fuel cells technologies as an inherently clean technologies of energy generation,
- looking for new concepts for future energy technologies.

In the period 2001-2008 the Division (supported by the EU and national projects) has begun the development of several new energy research areas consistent in the above mentioned domains in accordance with EU and Polish political and economy needs and strategy. The selected areas are the alternative energy technologies and tools that promise transformation of current energy system into more sustainable one:

- Energy generation from biomass – combustion, coal co-firing, gasification technologies for electricity and heat production (also cogeneration).
- Clean coal technologies (CCT) – technologies with improved efficiency of coal output, processing and recycling as well as with reduced negative environmental impact (in particular CO2 emission). CCT cover for instance coal combustion and gasification with near zero CO2 emission and flue-gas cleaning.
- Fuel cells (FC) – as intrinsically clean technologies of energy electro-chemical conversion. Fuel cells generally use hydrogen as a fuel but other fuels as natural gas, methanol and cola can also be applied.

Majority of the new fields have grown out from common roots – experiences in investigations of fossil fuels combustion. The above three technologies will create internally consistent research area of SENERES Centre. The relationship between the above areas are presented in the Fig. 4.



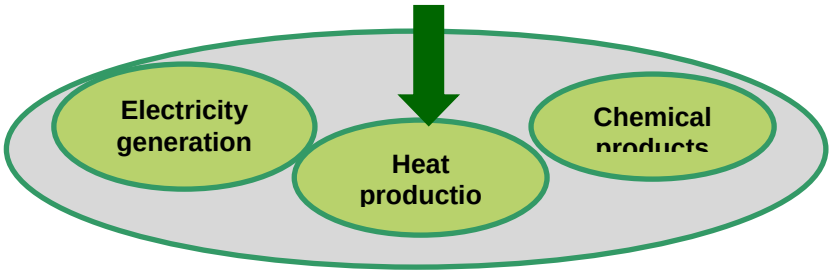


Fig. 4. The research area of Sustainable Energy Research and Development Centre SENERES

The above motioned areas have various perspectives of demonstration: short-to-medium-term (biomass, clean coal technologies) and long-term (fuel cells). The different approaches are necessary for each area: technologies with a short-to-medium- term perspectives require rather demonstration actions with research component, technologies with a long- term perspectives need research for technology development acceleration and subsequent demonstration.

The main S&T objective of the project is to support the development of IEn's Thermal Engineering Division and Ceramics Department CEREL selected research areas by applying the existing knowledge, experience, research staff and infrastructure and the knowledge and experience of the most advanced energy research centres in EU Member States. The future SENERES's activities should be focused on sustainable energy technologies to assist transformation of Polish and Central European conventional energy system into environmental friendly, effective and based on renewable energy sources one.

The realisation of S&T objectives of the project correspond to relevant project Work Packages (WP). All details of tasks realisation have been fully presented in relevant deliverables uploaded in the European Commission's Participant Portal.

1. Exchange of know-how and experience (WP1)

Two-way secondments of research staff between SENERES and leading research centres in EU Member States have been realized. The researchers invited to SENERES have given lectures, seminars and shared knowledge during research performed in SENERES. The researchers helped in better research management and they advised in research equipment upgrading. Researchers from SENERES, in order to improve their knowledge and experience, participated in research carried out in partners' institutions. The results of the visits have been presented during internal and external seminars, as well as in reports, gathered in annual deliverables D 1.1, D 1.2, D 1.3.

	Visits summary (months)	
	Planned	Performed
In IEn	31.9	18.43
In partners institutions	35	43.27
Total	66.9	61.7

The following researchers have taken part in two-way secondments:

Task 1.1. ECN, Petten, The Netherlands
Visits in IEn:
Dr Mariusz Cieplik, prof. Jaap Kiel, dr Christian van der Meijden, dr Lydia Fryda, dr Rian Visser, dr Jan Pels, dr Luc Rabou, dr Paul de Wild
Visits in ECN:
Janina Ilmurzyńska, Ewa Marek, Krzysztof Strug

Task 1.2. TU Delft, The Netherlands
Visits in IEn:
Dr P.V. Aravind, Theo Woudstra, Botta Giula, Fan Liyuan, Fernandes Alvaro, Liu Ming, Eva Promes, Tabish Asif Nadeem, Thallam Thattai Aditya,
Visits in TU Delft:
Dr Jakub Kupecki, dr Agnieszka Jakubiak, dr Janusz Jewulski, dr Michał Struzik, Marek Stefański, Katarzyna Wawryniuk, Marcin Błesznowski

Task 1.3. Cambridge University, UK
Visits in IEn:
Prof. Bartłomiej Głowacki, Rumen Tomov, Simon Hopkins, dr Vasilka Tsaneva
Visits in Cambridge
Dr Mariusz Krauz, Szymon Obrębowski, Agnieszka Szudarska

Task 1.4. CIRCE, Zaragoza, Spain
Visits in IEn:
Dr Luis M. Romero, MSc Eng. Pilar Lisbona, dr Luis I. Diez, S. Espatolero
Visits in CIRCE:
Krzysztof Jagiełło, Maria Kaska, dr Aneta Świercz

Task 1.5. KTH, Stockholm, Sweden
Visits in IEn:
Prof. Włodzimierz Błasiak, prof. Weihong Yang, Mohsen Saffari Pour, Karthik Ramakrishnan, Mersedeh Ghadamgahi, Abdul Hye, Pelle Mellin, Chunguang Zhou, Duleeka Sandamali Gunarathne
Visits in KTH:
Karol Białobłocki, dr Andrzej Sławiński

Task 1.6. IFK, Stuttgard, Germany
Visits in IEn:
Dipl.-Ing. Jörg Maier, Gosia Stein-Brzozowska, Collins Ndibe
Visits in IFK
Dr Robert Lewtak, Beata Glot, dr Aleksandra Milewska, dr Jarosław Hercog, dr Paweł Bocian, Grzegorz Nehring

Task 1.7. CNR-ISTEC, Faenza, Italy
Visits in IEn:
Dr Carmen Galassi, David Gardini
Visits in CIRCE:
Dr Magdalena Gromada, Agata Tłuczek, dr Ryszard Kluczkowski, Michał Kawalec

All in all, the realisation of WP1 can be described as successful. Ambitious plans from the kick-off meeting – to realise all possible secondments – have been confronted with the reality of researcher's daily obligations and overload of work e.g. while preparing proposals, publications and fulfilling academic tasks. The pre-scheduled plan has been discussed and if necessary slightly modified in order to obtain the highest quality of knowledge exchange between all partners. All modifications in visits plan have been consulted with project partners and confirmed by project officer, Ralitsa Atanasova. All discussions have taken place during SENERES Steering Committee Meetings and emails exchange if necessary. Secondments have been realized throughout three years of the project duration. During the final SC meeting all project partners have been underlining the great importance and profits from SENERES secondments.

2. Recruitment by SENERES of incoming experienced researchers (WP2)
The special mechanism for attracting experienced researchers have been created. The calls for experienced researchers to develop their research carrier in SENERES have been launched. The relevant announcements have been published on the specialized websites and in the branch publications.

All experienced researchers have successfully realized their plans when working in SENERES with regards to Work Programs that have been prepared at the beginning of their employment in the Institute of Power Engineering. After the end of SENERES project some researchers will continue working in the Institute and others will cooperate with the Institute after changing their place of employment.

Dr Izabela Stefanowicz-Pęta
Jan Pieter Ouweltjes
Dr Piotr Płaza
Dr Rui Antunez

Dr Marcin Siedlecki

SENERES plan for employment has been performed successfully with minor modifications connected with the division of number of months and number of researchers employed. In general, the total sum of employment duration is the same as planned at the beginning of the project. All modifications have been consulted with the project officer, Ms Ralitsa Atasanova.

Name of the researcher	Former place of work	Duration (months)
Dr Marcin Siedlecki	TU Delft, The Netherlands	24
Dr Izabela Stefanowicz-Pięta	University of Waterloo, Canada	24
Jan Pieter Ouweltjes	ECN, The Netherlands	22
Dr Piotr Płaza	TU Delft, The Netherlands	10
Dr Rui Antunez	Instituto Politécnico de Setúbal, Portugal	10
Total		90

Below there are some selected scientific results of experienced researchers activities:
Dr Marcin Siedlecki:
The research work performed during two years of employment at the Institute of Power Engineering (IEn) within the scope of the SENERES project was mainly focussed on the following activities:
a) further development of biomass gasification at pilot scale (800 kWth)
b) development of a gas cleaning line for gas engine application
c) improvement of gas analysis and the development of on-line diagnostics
d) work on process optimization and control
e) waste (RDF) gasification experiments (150 kWth test rig)

Dr Izabela Stefanowicz-Pięta:

The activity within SENERES project was mostly related to develop clean technologies for energy generation, especially fuel cells technologies, combustion and oxy-combustion technologies. Some part of the performed work was dedicated new materials, catalyst and processes development. Catalyst can be applied to power generation sector both to enhance process performance including application of modified fuels and alternative fuels as well as to minimize its negative environmental and health impact, i.e. Selective Catalytic Reduction (SCR) of NOx and simultaneous NOX, SOx and particulates (PM) removal.
The idea of work within the whole recruitment period based on a combined approach of catalysts, process and reactor design and optimization through variable catalyst loading and recuperative energy designs.

Dr Rui Antunez:
Cell performance is one of the key factors in determining the electrical efficiency of the DC-SOFC stack and the overall power system. However, the least understood area within the cell is the anode electrochemical oxidation carbon mechanism. A fundamental understanding of the anode electrochemical oxidation of carbon and transport phenomena is critical in order to direct future efforts. Concepts for optimizing anode performance by correlating structural surface properties and carbonaceous fuel properties with electrochemical performance have been carried out. The work was divided into three work areas.
I - Evaluation of performance of DC-SOFC cell as function operational parameters
The experiments have been focused on testing and the evaluation of the cell performance as function of carbonaceous fuel preparation, interconnector, anode aids and mode of operation. The EIS technique and I-V curves coupled with GC measurements have been used as standard method of characterization of the cell performance.
II- Developing a model of DC-SOFC operation
Several models have been developed to fit the experimental I-t data from batch mode operation as methodology to understand the mechanism the electrochemical oxidation of carbon on direct contact with Ni-YSZ cermet anodes. A physicochemical model has been developed to predict DC-SOFC performance.
III - Design of a DC-SOCF stack (10 W) 27
The design of a DC-Stack (10W) has been realized under the frame of the project – Konsorcjum WOP – "Badania przemysłowe – określenie barier komercjalizacji" (Direct Carbon Fuel Cells consortium stage III – "Industry research – definition of commercialization barriers").

Jan Pieter Ouweltjes:
Contribution to solid oxide single cell development (design, manufacture, testing, operation).
Contribution to solid oxide fuel cell stack development (design, manufacture, planning, literature review, patent search)

Dr Piotr Plaza:
To undertake day to day research activity within the overall research programme of the SENERES Centre (Sustainable Energy Research and Development Centre, IEn) in the field of energy generation of biomass and clean coal technologies. The work programme was related and adjusted to the three currently ongoing projects running at the Institute of Power Engineering:
- FLOX COAL-II Project (funded by the European Commission RFCS programme, expected end date 30/06/2014). This project aimed to develop a scale-up methodology and simulation tools which are required for the implementation of pulverized-coal flameless oxidation (PC-FLOX) burners in

utility plants. The work included: i) Implementation of the NOx –reduced CFD sub-models for Flameless Pulverized Coal Combustion into FLUENT code and models 29 validation in a Pilot-Scale IFK Furnace -0.5MWth (Task 3.5-3.6), ii) Investigation of the retrofit concept of a tangentially fired boiler equipped with FLOX-COAL burners (Task 5.2), iii) Feasibility study of a flameless coal combustion large scale burner (40 MWth) operated under oxy-fired conditions (Task 5.5).
- DUO-BIO Project (nationally funded by NCBiR, started on 01/01/2014). The project aims to develop the concept of a low emission pulverized slag tap boiler fired with agricultural biomass. The activities include experimental characterization and modeling of biomass ash melting behaviour under reducing atmosphere conditions with regard to slag-tap firing systems. The use of various experimental tests have been conducted (or is planned) e.g. the slag viscosity measurements as well as the ash deposition trials performed at the lab-scale deposition rig and 0.5 MWth semi-technical scale pulverized fuel furnace (owned by IEn) under various combustion conditions. The data delivered from the experimental tests are aimed to support the development of a reliable ash deposition CFD sub-model valid for slag-tap pulverised boilers fired with biomass.
- RELCOM Project (funded by the European Commission FP7) – Assistance in planning and performing experimental ash deposition trials by IEn at PF 20 MWth oxy-coal fired boiler in CIUDEN.

3. Acquisition, development, maintenance or upgrading of research equipment (WP3)
The evaluation of existing equipment by invited cooperating experienced researchers was provided. The equipment modernization and upgrading in particular fields have been realized to reinforce SENERES's potential. The following research equipment has been purchased:

Position	Apparatus name	Explanation
1	Black body calibration system	Realised
2	Elliptical Radiometer	Not planned to buy
3	Installation for biomass preparing	Realised
4	Digital coal ash fusibility furnace	Realised
5	Elementary analyzer for oxygen content	Realised
6	Moisture analyzer	Realised
7	TGA analyzer	Realised. Sum of positions 4, 5, 7
8	FID analyzer	Not planned to buy
9	Analyzer ULTRANAMAT 23	Realised
10	Titralab	Realised
11	Installation for testing LPG burners	Realised
12	Physisorption and density analyser	Realised
13	High dynamic range photo camera	Realised
14	NI Developer Suit	Realised
15	High performance computer cluster	Realised
16	Matlab with toolbox	Realised
17	Laser cutting system	Realised
18	Electrochemical impedance spectroscopy system	Realised
19	Installation for measuring of the waste-gases purity	Realised

4. Workshops, seminars and participation in conferences (WP4)
3 thematic international workshops have been organized to facilitate knowledge transfer on national, regional and European level. The workshops' subjects were relevant to three areas

covered by SENERES. The workshops subjects included groups of the areas and attracted participants from Poland, Central Europe Region and other EU countries.

	Title	**Date**
First workshop	Energy generation from biomass and clean coal technologies – combustion and gasification problems	May 15-16, 2012
Second workshop	Clean coal technologies with CO2 capture – gasification and oxy-combustion technologies	May 13-14, 2013
Third workshop	3rd International Symposium on Solid Oxide Fuel Cells for Next Generation Power Plants: Gasifier - SOFC systems	June, 2, 2014

Moreover, 6 scientific seminars have been organised:

	Title	**Date**
1st Seminar	Enabling Technologies for Superconductivity Applications: Hydrogen technologies, Publications and Patents	27th of July 2012
2nd Seminar	Reduction of CO2 and NOx emission in energy generation from biomass and coal"	11th of July 2013
3rd Seminar	Materials, processes and fuels for Solid Oxide Fuel Cells	6th of February 2013
4th Seminar	SOFC optimisation and small CHP installations on the basis of SOFC	30th of October 2013
5th Seminar	Biomass, clean coal technologies and SOFC – next steps in technologies development	27th of January 2014
6th Seminar	Biomass gasification – the use of low calorific gas	12-13th of May 2014

Additionally an active participation of the SENERES's research staff in international conferences and short training events. It aimed at the participation in events relevant to activities of SENERES's Research Groups - energy generation from biomass, clean coal technologies and fuel cells – as well as management team. During these conferences SENERES's researchers have

presented the SENERES centre and results of research activities. In total, 20 conference and training participations have been organized.

Name of international event	Date	Country	City	Name of SENERES researcher
Power Gen International	8-14.12.2012	USA	Orlando	Jakub Kupecki
6th International Conference on Application of Biomas	29-31.03.2012	Germany	Stuttgart	Krzysztof Strug
6th International Conference on Application of Biomas	29-31.03.2012	Germany	Stuttgart	Karol Białobłocki
37th International Technical Conference on Clean Coa	3-7.06.2012	USA	Clearwater	Aleksandra Milewska
9th European Confernece in Coal Research and its ap	9-13.09.2012	UK	Notthingam	Robert Lewtak
Międzynarodowe seminarium dot. Zgazowania	17-19.10.2012	Sweden	Sztokholm	Marcin Siedlecki
17th IFRF Member Conference (International Flame R	10-14.06.2012	France	Maffliers	Jarosław Hercog
FDFC 2013	16-18.04.2013	Germany	Karlsruhe	Mariusz Krauz
FDFC 2013	16-18.04.2013	Germany	Karlsruhe	JP Ouweltjes
Introduction to gROMOS / Optimisation and Model Val	24.02-02.03.2013	UK	London	Jakub Kupecki
SOFC advanced training workshop	30.04.2013-4.05.2013	Netherlands	Petten, Eindhoven	Marcin Błesznowski
SOFC advanced training workshop	30.04.2013-4.05.2013	Netherlands	Petten, Eindhoven	Janusz Jewulski
Fuel Cell Seminar and Exposition 2013	20.10.2013 - 24.10.2013	USA	Columbus, OH	Jakub Kupecki
PieroLunghi Conference and Exhibition EFC 2013	9-13.12.2013	Italy	Rome	Marek Skrzypkiewicz
PieroLunghi Conference and Exhibition EFC 2013	9-13.12.2013	Italy	Rome	Michał Struzik
US National Combustion Meeting	19-22.05.2013	USA	Park City (UT)	Robert Lewtak
European Biomass Conference and Exhibition 2013	3-7.06.2013	Denmark	Kopenhagen	Marcin Siedlecki
European Biomass Conference and Exhibition 2013	3-7.06.2013	Denmark	Kopenhagen	Marek Stefański
International Seminar on Gasification	16-18.10.2013	Sweden	Malmo	Karol Białobłocki
Energy sector in Poland - potential and cooperation po	8-10.12.2013	Turkey	Ankara	Tomasz Golec
Energy sector in Poland - potential and cooperation po	8-10.12.2013	Turkey	Ankara	Bartosz Świątkowski
Fuel Cells 2014 Science and Technology	2-5.04.2014	Netherlands	Amsterdam	Rui Antunes
8th Symposium on Group Five Compounds	24-27.06.2014	Spain	Malaga	Izabela Pięta
Nordic Biogas Conference 2014	28-30.08.2014	Island	Reykjavík	Karol Białobłocki
NI Week 2014	4-7.08.2014	USA	Austin	Marek Stefański
WIRE Conference 2014	12-13.06.2014	Greece	Athens	Maria Kaska
WIRE Conference 2014	12-13.06.2014	Greece	Athens	Aneta Świercz

Finally, an intensive course/specific training on protection and management of Intellectual Property in the field of energy generation from biomass, clean coal technologies and fuel cells has been realised.

2-3.04.2012 - SENERES training on protection and management of Intellectual Property in the field of new energy technologies

5.06.2013 - IP protection and management in energy research – comercialisation processes in IEn

The participation in the intensive training on protection and management of Intellectual Property in the SENERES's research field provided thoughtful insights into many aspects which were of participants' interest. SENERES scientists are actively involved in research in many fields, what is followed by the necessity of knowledge of Intellectual Property rights. SENERES workshop strengthened an innovative understanding and applications of IP with reference to EU's policy and main goals. As a justification of positive impact of SENERES actions undertaken in IPR context the Agreement of Collaboration between InnoCo Ltd (Luk Palmen – IPR expert, speaker at SENERES 2nd Workshop) and Thermal Processes Department (biggest IEn department) has been established. It foresees to monitor and support commercialization scenarios and evaluate the industrial value of research and inventions.

In order to increase the visibility of SENERES project and disseminate results of the research conducted in areas of Biomass, Clean Coal technologies and Fuel Cells, researchers articles publications in prestigious scientific national and international energy related journals and presentations of SENERES's research and demonstration results during international events was foreseen. Researchers have been encouraged to be active by project coordinator and research teams. There have been several possibilities to publish their presentations during the realisation of all Work Packages of the project.
During the period of project duration over 100 articles were published in well-known scientific magazines and conference materials. Moreover, around 90 presentations have been delivered by SENERES researchers. All detailed results are presented in D 5.8 (Publications and presentations).

4. The potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and exploitation of results (not exceeding 10 pages).

Better integration of SENERES and IEn as whole in the European Research Area

The European Research Area (ERA) is the central part of the EU Lisbon Strategy for growth and knowledge economy building in Europe. It foresees reinforcing researchers mobility, knowledge sharing, developing strong links between research partners around the Europe and optimization of national and European research potential among others.

The SENERES project actions have improved the integration in ERA through:

- reinforcing collaboration between SENERES and 7 research entities from 5 countries to learn from entities that are more experienced in defined fields and possess the knowledge how to better realize research (issues of research management and documentation will be very important). The collaboration have been realized in WP1-WP5 and WP6;
- facilitating flow of competent researchers that support knowledge exchange and help to avoid duplication of research efforts. Exchange of know-how and experience in the frames of actions undertaken in WP1 supports solution of the existing problems concerning knowledge fragmentation, multiple non-aligned research strategies and sub-critical capacities that remain a prevailing characteristic of the EU research. Recruitment of experienced researchers foreseen in WP2 opened new opportunities for researchers from all Europe to work in SENERES;
- building of new competences in not yet well recognized fields (for instance hydrogen and fuel cells and future emerging energy technologies) in WP1-WP4;
- stimulating researchers' creativity by sharing new ideas during personal discussions, seminars, workshops and conferences realized in WP1 and WP4;
- reinforcing researchers mobility by supporting significant number of short-, medium and long- term visits and trainings in all cooperating research centres. Totally 89,35 person/months of two way secondments realized in WP1 is a significant input to ERA building in the area of researchers mobility;
- better exploiting of existing and new acquired research infrastructure by opening it for researchers from cooperating institutions in the frames of WP1 research exchange. The equipment maintenance and upgrading is realised in WP3,
- better laboratory equipment selection in the frames of acquisition planed in WP3 owing to advices of SENERES's Steering Committee and experienced Strategic Partners. Less cost and the highest quality of new energy technology infrastructure thanks to multinational approach have been a significant benefit;
- building future knowledge–based society by active promotion and dissemination of research results in developed areas by dedicated website, newsletter and other actions foreseen in WP5. The effective communication channels that give the public a large access to scientific knowledge have been created. Society have a more accessible chance to get knowledge of new energy technologies;
- reinforcing knowledge especially concerning environmental friendly European energy system by developing of the most promising energy technologies based on renewable energy sources (in particular biomass), clean coal technologies and fuel cells. Seminar and workshops organized during the project realization helped to avoid some pitfalls in the transformation pathway of current energy system into a sustainable one. It concerns all WPs;
- reinforcing potential of SENERES and all cooperating partners in FP7 applications and implementation

All SENERES's actions have been organized in a coherent way in accordance with accepted Action Plan to make the integration fully competent and effective.

Upgrading SENERES's RTD capacity and capability

The SENERES project reinforced research potential of SENERES in all below described categories.

- Human potential – number of SENERES's new researchers have been increased and serve as an important factor in reinforcing human resources of SENERES. About 90 person/months totally of two way secondments realized in WP1 have been a significant contribution to the human development.
- Improvement of research management – SENERES's Strategic Partners' experience in research management have been applied for better IEn's research organization, structuring, controlling and documentation. SENERES project helped to overcome the existing problems, such as weak cooperation between IEn's units. The above mentioned activities are included in WP1.
- Improvement of research carried out by SENERES – significant improvement of the quality of the research performed by SENERES has been a result of implementation all measures foreseen in the project Action Plan (WP1-WP5). It has been observed in:
  - widening knowledge and experience of SENERES's research staff,
  - upgrading of infrastructure and research equipment,
  - development of new research areas,
  - facilitation and demonstration of advanced technologies owing to elaborated system of IEn and industry cooperation,
  - delivering research at the leading word's standards.
- Upgrading of research equipment – modernization of the infrastructure and purchase of special equipment foreseen in WP3 unlocked, reinforced and developed SENERES's potential and highly increased the Institute's opportunity to contribute in key EU technology challenges for the next 10 years. High-quality research infrastructure enabled to conduct more advanced research.
- Increased SENERES's market potential - SENERES enabled to interact routinely with the world of business as well as to engage in durable public/private partnerships. The improved SENERES's promotion foreseen in WP5 facilitated the cooperation with industry and SMEs.

Contribution to regional economic and social development

Despite the substantial results of economy reforms, the countries of Central Europe Region still differ considerably from EU-15 countries in various aspects of economy - for example they represent lower level of industrial development and quality of life. However economy growth of the above mentioned Region is quite significant what implies the increase of energy demand.

The energy sector plays an essential role in each country economy. As countries of Central Europe have recently become EU Members States they should adjust their energy sector to the EU strategy requirements of environmental protection in particular in the context of climate changes. The reduction of negative impact regarding energy generation and security of energy supply are the main priorities for the EU energy sector. The major EU targets are formulated in the EU SET Plan:

- to reduce its greenhouse emission by 20% by 2020 and 60-80% by 2050,
- to increase share of renewable energy sources by 20% by 2020,
- to increase energy effectives by 20% by 2020.

Thus the countries in the Region, where energy system is fossil fuel based, should transform their energy system into a more sustainable one and simultaneously secure energy supply. Only the development of new energy technologies would make it realistic to achieve ambitious goals. The development of alternative energy sources and transformation of the existing old technologies into clean technologies have to be accelerated.

The SENERES project contributed to regional economic and social development through:

- development of the most promising energy technologies
  - energy generation from biomass as renewable energy source - renewable energy sources, other than hydro power, play a small role in the countries of Central Europe Region. Only utilization of wood, wood waste and agricultural biomass would have a significant importance for energy generation,
  - clean coal technologies - energy sector in Central Europe countries is 70% based on coal resources. 93% of energy in Poland – the largest country in the Region - is generated in the coal based power plants. It is necessary to support transformation of the exiting old technologies of energy conversion form coal into clean technologies,
  - fuel cells – as the most promising intrinsically clean technologies with longer perspective of broad market implementation,

Subsequent substitution of conventional coal technologies by new near zero emission energy technologies will help to make the regions' energy sector less dependent on coal. The above mentioned contribution has been a key action of the project concerning all WPs;

- integration of the research in energy sector in the Region in concordance with European Union energy priorities. The existing links with Central Europe energy centers as a result of Center of Excellence CENERG's activities (SENERES project coordinator) in the frames of FP5 project will be exploited. SENERES will become a platform of knowledge transfer which should be beneficial for all interested research institutions. The researchers from the region will gain an access to other specialist knowledge and S&T capacities in the rest of Europe and the world, notably through researchers' mobility, knowledge sharing and development of virtual networks and 'communities'. Upgrading SENERES's R&D potential will contribute to the development of research and innovation capacities in the Region. The most talented researchers will be encouraged to enter research careers in the Region. Industry of the Region might be incited to invest more in European research - contributing to the EU objective to devote 3% of GDP for research and strongly contribute to the creation of sustainable growth and jobs what is a central pillar of the EU 'Lisbon Strategy'. This integration will be realized mainly in WP4 and WP5.

Improvement of the SENERES's potential to participate in FP7 projects

The participation of Central Europe Convergence Region countries in FP7 is appreciable low. For example in the first two calls of the Theme Energy Cooperation Programme FP7-ENERGY-2007-1-RTD and FP7-ENERGY-2007-2-TREN only 12 projects (12.77% by 94 submitted) with Polish partners are financed. The number of partners from the Region and the Region success rate

in the financed projects in the above two calls is extremely low, for instance: Poland (14 partners in financed projects, 10.07%, success rate), Czech Republic (4 partners, 7.69%), Slovakia (3 partners, 6%), Hungary (11 partners, 13,75%), Romania (6 partners, 4,88%). There is a lack of energy research project coordinators for the Region. IEn is one of the few partners from the Region represented in FP7 projects in the energy area.

The project improved SENERES's potential and opened new perspectives for the participation in FP7 projects through:

- creation of new innovative ideas during the project bilateral meetings, seminars, workshop (WP1, WP2, WP4),
- better recognition of European forms of cooperation by closer contacts with the most experienced energy research centres in Europe (WP1),
- extension of contacts with the energy research community (WP1),
- better recognition of procedures of project preparation thanks to the experience transfer from the project Strategic Partners (WP1),
- enlarging human potential (WP1, WP2),
- upgrading laboratory equipment and opening new opportunities for experimental research (WP3),
- improved knowledge concerning coordination of FP7 projects by the realization significant sized SENERES project (WP6),
- increased knowledge of current "state of the art" in particular field thanks to knowledge transfer foreseen in the project (WP1),
- better understanding of procedures for Intellectual Properties Right protection owing to expertise transferred in the frames of cooperation with the SENERES's Strategic Partners (WP1).

European approach, national support and impact indicators

All elements of impact presented in the sections 3.1.1–4. would be achieved only by European approach. All measures foreseen in SENERES's Action Plan require international collaboration:

- exchange of know-how and experience is obligatorily directed toward knowledge and experienced partner organization in EU Member States or Associated Countries (WP1),
- recruitment by SENERES of incoming experienced researchers particularly as a means of encouraging the return of nationals having left the country is inherently related to international activities (WP2),
- acquisition, development, maintenance and upgrading of SENERES's research equipment foreseen in WP3 will be carried out in accordance with the advices of the SENERES's Steering Committee to build high-quality research infrastructure on indeed European and world level,
- organization of workshops, seminars and participation in conferences (WP4),

- dissemination and promotional activities for improving SENERES's visibility in Europe (WP5).

Realization of the above activities only on national level is highly insufficient. However some elements of national support would be necessary. For instance:

- research performed during two-ways secondments in WP1 will be supported by national projects,
- some elements of upgrading of SENERES's research equipment foreseen in WP3 will be completed by own SENERES's resources,
- participation of representatives of national Ministry of Sciences and Higher Education and local authorities will be crucial for preserving SENERES's excellence and for contribution to national and regional development.

The main factors of the impact achievement have been:

- number of papers and articles concerning developed areas in international journals published by SENERES's researchers,
- number of new research projects financed on the European level,
- number of pilot installations for demonstration viability and feasibility of developed technologies.

Spreading excellence, exploiting results, disseminating knowledge

Dissemination and exploitation have been addressed by WP5 to ensure that the knowledge gained in the project is protected, disseminated and exploited to its full potential. The following tasks from Dissemination Plan have been realised:

- The project web-site (WP5) has been built up, describing the general public the scientific and technical content of the project, and its impact, in relation to present technologies, to the increase of efficiency in power generation from biomass, in a cost effective way; this section of the web-site have been periodically updated to include outlines of major results obtained. It also included all dissemination tools – video, newsletters, brochures etc. http://seneres.pl

- SENERES's periodic Newsletters (WP5) distributed to all interested partners – people and institutions interested, to keep them systematically aware about the newest activities and information (every 3 months). Uploaded on SENERES website, in Newsletters section – ready for immediate pdf download.

- Dissemination to the wider scientific and technological community of the project results will be by means of publication in international scientific journals and through presentations at international conferences (WP4). Particularly appropriate in the latter context were symposia held regularly on subjects of "Energy generation from biomass", "Clean coal technologies", "Fuel cells". Conferences and EU seminars organized by the Commission have been given priority.

- During the period of project duration over 100 articles were published in well-known scientific magazines and conference materials. Moreover, around 90 presentations have been delivered by SENERES researchers.

- 3 scientific workshops and 6 scientific seminars have been organized (WP4) by each thematic Research Group and special invitations to the institutions form the Central Europe Region have been prepared. The researchers from project partners' institution – the leading ones in Europe have been invited to give lectures. The aim of these workshops was to spread the knowledge gained during the SENERES project realization. Furthermore they enabled to show the infrastructure development and new technologies applied in SENERES during SENERES secondments. Detailed results are presented in D 4.1.

- Periodic reports have summarized the project progress Public authorities have been informed about SENERES development (WP5).

- Leaflets have been produced presenting objectives, activities, partnership etc. of SENERES. The section dedicated to research from the energy sectors make them informed about SENERES's activities and potential while the ones dedicated to people outside the energy sector explain the idea of the sustainable energy technologies. These leaflets together with CDs have been distributed during research related conferences, seminars, trade fairs and exhibitions, e.g: SET PLAN Conference in Dublin 7-8.05.2013, WIRE 2014 Conference in Athens, 12-13.06.2014

- There have been prepared downloadable pdf brochures concerning the current progress and activities of the Sustainable Energy Research and Development Centre. There have been produced 4 brochures: Biomass, CCT, Fuel Cells, Research results.

- SENERES Posters: The first SENERES Poster has been prepared and produced as a key dissemination tool and widely used during all workshops, seminars and conferences organised within SENERES activities. The second SENERES Poster has been prepared in the form of a leaflet, in order to meet demands of project partners and make it more effective for its users.

- Production of the factual video, has been prepared by IEn's CENERG-SENERES team and has been produced by an experienced film professionals (Studio Q). It brought a very appealing overview of the EU supported initiative and summarized main activities of SENERES actions. The film is available on the main website of SENERES: http://seneres.pl/home

- CDs have been produced by the middle and end of the project showing synthetically the project objectives, realization phase, future plans etc. These CDs together with leaflets have been distributed during research related conferences, seminars, trade fairs and exhibitions, e.g: SET PLAN Conference in Dublin 7-8.05.2013, WIRE 2014 Conference in Athens, 12-13.06.2014

5. **The address of the project public website, if applicable as well as relevant contact details**.

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Furthermore, project logo, diagrams or photographs illustrating and promoting the work of the project (including videos, etc…), as well as the list of all beneficiaries with the corresponding contact names can be submitted without any restriction.