SET-PLAN IMPLEMENTATION

The Steering Group of the SET-Plan in its last meeting on October 28th, 2010 agreed to speed-up the execution of activities of the Implementation Plans (IPs) of the European Industrial Initiatives (EIIs). It was decided to collectively identify the possibilities for launching joint actions between Member States and/or Member States and the European Commission.

The mapping exercise carried out through this questionnaire builds upon this decision of the Steering Group. It aims to identify topics for leveraging best ongoing efforts with complementary joint actions, as prioritized by the Implementation Plans. In this phase the mapping will focus on projects and activities with a total budget higher than 1 M€.

We trust that you also consider the success of this exercise important for the immediate implementation of the SET-Plan.

MAPPING OF PROJECTS, ACTIVITIES, RESOURCES AND INVESTMENTS

To which EII(s) is your project, activity, resource or investment relevant? (multiple choices are possible)

<table>
<thead>
<tr>
<th>WIND</th>
<th>SOLAR</th>
<th>GRIDS</th>
<th>CCS</th>
<th>NUCLEAR</th>
<th>BIOENERGY</th>
<th>FCs &amp; H2</th>
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A. PROJECTS AND ACTIVITIES

GENERAL INFORMATION

<table>
<thead>
<tr>
<th>Name of project:</th>
<th>SofcPower 2007-2011 “Tutkimuksella demonstrointiin”</th>
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<tbody>
<tr>
<td>Acronym:</td>
<td>SofcPower</td>
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<tr>
<td>Location:</td>
<td>Applicable only for demo/pilot project; enter specific location(s) and Member State(s)</td>
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</tbody>
</table>
Project partners:
List project partners; name coordinator first. For European & international projects mention the country affiliation of each partner

VTT Technical Research Centre of Finland, Lappeenranta University of Technology, Aalto University, Wärtsilä Finland Oy, Gasum Oy, Fortum Oyj, ABB Oy, Ecocat Oy, Joroisten Kunta, Vaasan Sähkö, Bigman Oy, Raucell Oy, AS Elcogen

Project website:

Contact details:
Name, affiliation and contact details of the project coordinator

Matias Halinen
VTT Technical Research Centre of Finland
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Start date: 1.1.2007

Duration: 60

SHORT PROJECT DESCRIPTION
Provide a short abstract of max. 100 words
Primary target for the SofcPower –project is to proceed towards demonstration and commercialization of the complete SOFC systems with the aid of research activities. In the project, new technology is created and developed to provide solutions for industrial enterprises in order to support development work on SOFC-based power plants. Results of the project can be utilized by companies that aim to create business activities as SOFC systems integrators, component manufacturers, fuel suppliers or SOFC system end-users.

PROJECT GOALS & OBJECTIVES

Goals:
Indicate main qualitative goals

1) Development and demonstration of a grid-connected, thermally-self-sustaining SOFC system which utilizes anode recirculation loop.
2) Development and validation of critical BoP – components for the above mentioned SOFC system
3) Development and validation of simulation and modelling tools for SOFC systems design and control
4) Development and demonstration of high efficiency scalable power conversion equipment for fuel cell systems
5) Development and demonstration of a warm (~300°C) anode gas recirculation blower
6) Assessment of the required quality of fuel
## Alternatives for SOFCs

7) Assessment of legislative and safety issues related to demonstration of SOFC systems in the fields.

## Objectives:
*Indicate quantitative objectives (similar to KPIs of the IPs of the EII). Also indicate intermediate milestones where applicable.*

| 1) Validated and working prototypes of balance-of-plant components for demo unit |
| 2) Construction and testing of a 10 kW SOFC demonstration unit |
| 3) Long term experiment of the 10 kW SOFC demonstration unit |
| 4) Validated modelling tools for SOFC system design and control |
| 5) Validated and working prototype of the power conversion equipment |
| 6) Validated and working prototype of the anode gas recirculation blower |
| 7) Report on required quality of fuel for SOFC applications |
| 8) Handbook for SOFC system demonstration |

## Performance of the Project

### Assumed state-of-the-art:
*Describe quantitatively the state-of-the-art that the project objectives are based upon.*

The state-of-the-art SOFC power generation systems are not mature enough to compete with conventional systems in the existing markets. The long-term durability, performance and reliability of SOFC stacks and Balance-of-Plant components are not well established, and due to the absence of mass-market production the availability of some SOFC specific system components (e.g., stacks, anode gas blowers, fuel processing equipment) is poor and/or the prices are high. Additionally, it is beneficial to increase the SOFC stack power class from <3kW to 10-20 kW, in order to make construction of SOFC system in the power range of several hundred of kW feasible. So far, no systems have been demonstrated that utilize these larger sized planar type SOFC stacks.

### Achievements so far:
*If intermediate results are available, please indicate the current achievements (qualitative and/or quantitative).*

Main achievements so far include:
1) Development and validation of system components and solutions in actual SOFC system conditions (burner, anode gas recirculation and fuel processing equipment, control system, heat exchangers, power
2) Construction and testing of a SOFC demonstration unit with a single 10 kW power class stack (planar type, developed by Versa Power Systems)
3) -1500 hours uninterrupted operation with the SOFC demonstration unit (grid-connected, thermally-self sustained, operated with anode gas recycled alone)
4) Working prototype of the anode gas recycle blower
4) Validated modelling tools for SOFC systems dimensioning and process layout simulations

Potential risks include:
- SOFC stack technology is not mature enough with respect to degradation and performance for commercial systems.
- Complexity of SOFC systems and absence of mass-market production inhibits commercialization of the systems in mid-term time frame.
- Further optimization of the SOFC system mechanical construction is required to decrease thermal losses and increase efficiency to achieve the competitive edge over conventional power generation systems.

The follow-up and utilization of the results is dependent on the activity of the industrial companies and their commitment to develop SOFC specific components or complete systems.

<table>
<thead>
<tr>
<th><strong>FUNDING &amp; BUDGET</strong></th>
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<tr>
<td><strong>Funding programme:</strong></td>
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<td>Give the name of funding programme</td>
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<tr>
<td><em>Tekes Fuel Cell Programme</em></td>
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<td><strong>Funding public entity:</strong></td>
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<tr>
<td>Indicate which public entity is in charge of manages the programme</td>
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<tr>
<td><em>Tekes, Finnish Funding Agency for Technology and Innovation</em></td>
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Total (public & private) project budget (€): ~ 11.3 M€
Public funding (€): ~ 9.6 M€
Total effort (person-months): 450

**DISSEMINATION OF PROJECT RESULTS**

Publications, presentations in conferences and workshops, and other dissemination means:
*Give highlights only*

Halinen, Matias; Saarinen, Jaakko; Rautanen, Markus; Pennanen, Jari; Kiviaho, Jari; Pastula, Michael; Machacek, Todd; Nuttall, Ben; Borglm, Brian, *SOFC Demonstration Unit with a 10 kW stack*, Oral presentation, Fuel Cell Seminar & Exposition, San Antonio, Texas, USA, 19 - 21 Oct. 2010. San Antonio, Texas (2010), 20 pp.


Klobut, Krzysztof; Vesanen, Teemu; Pykälä, Marja-Leena; Sipilä, Kari; Kiviaho, Jari; Rosenberg, Rolf, *Handbook of SOFC system in buildings. Legislation, standards and requirements*, VTT Tiedotteita - Research Notes : 2465, 2009. VTT, Espoo
TOWARDS COMMERCIALISATION

Indicate (new) products and/or services expected from the project. Are new business models required for commercialisation of the project results?

Highlight expected commercialisation benefits, e.g. patents, spin-offs, new products, business partnerships

Benefits of the project include:
- SOFC system integrators can improve the controllability, reliability and durability of their products
- BoP – component manufacturers and suppliers can establish additional revenue by introducing SOFC specific components, or by finding larger market area for their existing products.
- End-users and fuel suppliers can develop novel business models that utilize SOFC systems (distributed generation, utilization of lean biofuels)

Selected research results are published or presented in scientific journals or conferences. Several inventions have been made on more specific designs or methods that are currently assessed for IPR protection.

The participating industrial companies can unitize the results of the project in their own SOFC related R&D activities.

SYNERGIES WITH THE IMPLEMENTATION PLANS OF THE EUROPEAN INDUSTRIAL INITIATIVES – NETWORKING – KNOWLEDGE SHARING

Contribution to/Relevance with the IPs: To your opinion, to which activities of the IPs of the EIIs is this project related to? Indicate contributions / complements.

Please note that reference here is made to the activities of the IPs as published in http://setis.ec.europa.eu/activities/implementation-plans

The project is strongly related to Fuel Cells and Hydrogen Joint Technology Initiative. The project complements the ongoing SOFC R&D activities in the JTI. The SOFC systems specific know-how, research infrastructure and modelling tools developed in the SofcPower are utilized in the FHC-JTI projects.

Potential synergies with other projects and activities: Can you identify any other project(s) in your country, another MS or at European level that could be synergetic with this project?

ASSENT, CATION, GENIUS, DeSign, SOFC-Life

Networking: Would you be willing to share results with the projects identified above?

Indicate willingness to networking and also potential conditions

Public results can be shared in workshops and symposiums

Modelling tools developed at VTT in SofcPower -project are currently used in several EU-projects (ASSENT, CATION and GENIUS).
Knowledge sharing: Would the abovementioned Networking necessitate a formal knowledge sharing agreement? To your view would this be the preferred route?
Knowledge sharing agreements are necessary.

Future steps: Are there any follow-up activities considered after the completion of your project?
Is there a need to scale up activities in this topic at European level?
Follow-up project in national level is currently at planning stage
Research equipment, modelling tools and know-how has already been utilized in various past and present EU-projects.

### B. RESOURCES AND INVESTMENTS

**RESOURCES AND INVESTMENTS**

Describe in short any RD&D infrastructures that your project relies on. Are these available or do they need to be developed?

*R&D infrastructure at VTT include single cell and short stack test equipment, BoP component test equipment, fuel processing test equipment, 10 kW SOFC system demo unit, SOFC systems test equipment, and various analysis equipment for SOFC research (e.g. post-mortem, materials, gas analysis, thermal)*

If these are to be developed, what is the corresponding investment required? What is the allocated budget (€) for this investment in your project?

*Required investment to develop the infrastructure is several millions of euros, maintenance costs start from 300 k€/annually*

### OTHER INFORMATION

| Date: when the questionnaire was completed | 7.3.2011 |
| Information provider: Matias Halinen, VTT |  |
Thank you for your cooperation!