Low Temperature Solid Oxide Fuel Cells for micro-CHP Applications (256694)

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HyGear Fuel Cell Systems

The LOTUS consortium

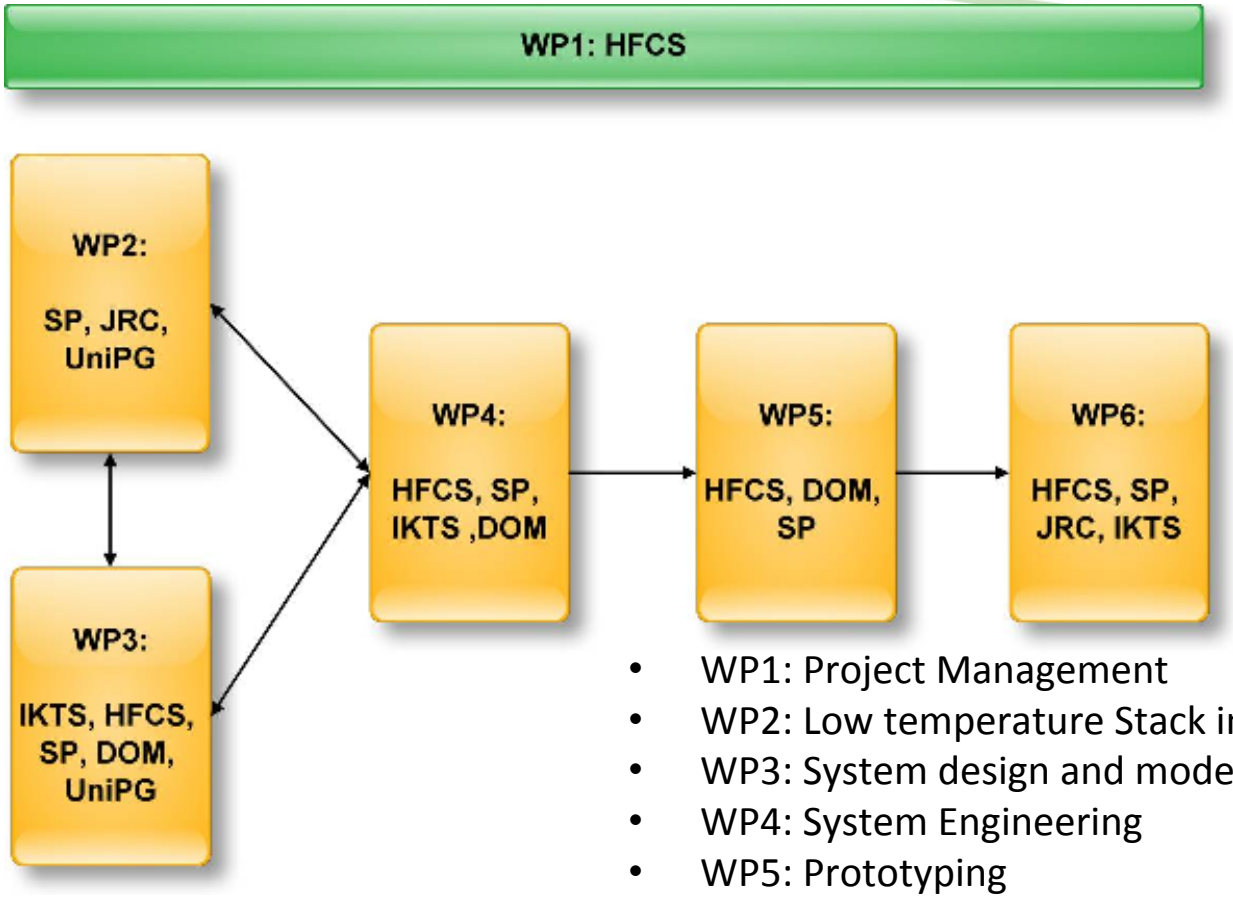
LOTUS is:

the development, construction and testing of a μCHP system based on low temperature SOFC stack technology

Partner	Main task in Project
• HyGear Fuel Cell systems (NL)	Coordinator, system design and construction
• SOFCPower (I)	SOFC stack development
• Frauenhofer Institut für Keramische Technologien und Systeme (D)	System modeling
• Domel (Slo)	Gas- Air system development
• University of Perugia (I)	User profile input, SOFC single cell testing
• European Commission/ JRC (B)	SOFC stack testing, test harmonization

- Associated partner: Vaillant (D)

Work packages



- WP1: Project Management
- WP2: Low temperature Stack implementation
- WP3: System design and modeling
- WP4: System Engineering
- WP5: Prototyping
- WP6: System test and validation

Planning and Status

WP1
Task 1.1: R&D Management
Task 1.2: Dissemination and communication Management
Task 1.3: Administrative Management

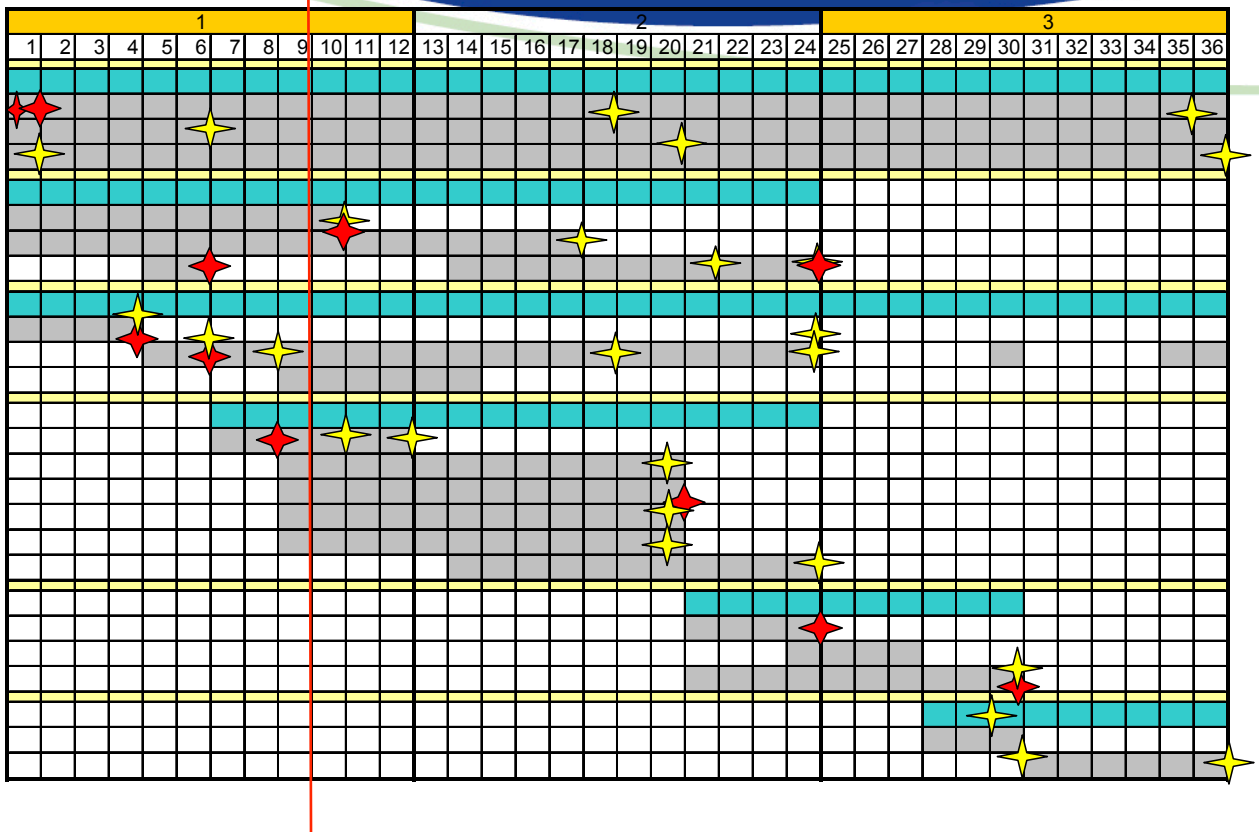
WP2
Task 2.1 Development single cells
Task 2.2. Develop Short Stack
Task 2.3. Develop and test stacks to 1 kWe

WP3
Task 3.1 SRD development
Task 3.2 System modeling
Task 3.3 Control logic development

WP4
Task 4.1 System design
Task 4.2 Develop De-Sulfurisation
Task 4.3 Develop heat exchangers
Task 4.4 Develop reactors
Task 4.5 Develop GAD
Task 4.6 Develop control strategy

WP5
Task 5.1 Procurement parts
Task 5.2 System assembly
Task 5.3 Build controls

WP6
Task 6.1 Factory acceptance test + fixes
Task 6.2 Test system



- System requirements are known, Proces flow diagrams are ready, SOFC materials are being tested.
- Started creating P&ID, hardware definition and control logic (start, steady state)

Deliverables

Del. No.	Deliverable name	WP No.	Nature	Dissemination level	Delivery date (proj. month)
D1.1	Kick off meeting	1	O	PP	1
D3.1	System requirement document (SRD), Hosting of SRD workshop (2 days)	3	R	RE	4
D1.2	Set up of website	1	O	PU	6
D3.2	Process window for steady state operation within the limits of SRD	3	R	RE	6
D3.3	Steady state process layout and model, technical basis Excel/DLL	3	O	RE	8
D4.1	P&ID of the CHP system (HFCS)	4	R	RE	10
D2.1	Report on single cells results (performance/ durability)	2	R	PP	10
D4.2	FMEA of the micro-CHP system	4	R	RE	12

All deliverables of the first year are reached on schedule.

milestones

Milestone number	Milestone name	Work package(s) involved	Expected date	Means of verification
1	Consortium Agreement in place	1	0	Signed agreement
2	First General Assembly	1	1	Minutes of meeting
3	SRD ready	2,3,4,5,6	4	Document
4	Select internal/external reforming	2,3,5	6	Decision documentation
5	Commonly agreed test protocol ready	2,6	6	Document
6	Select desulfurization strategy	2,5	8	Decision documentation
7	Selection of cell materials for stack operation at reduced temperatures	2	10	Decision documentation
8	Issue system BOM and component specs	2,3,6	20	Documents
9	Deliver 1kWe stack	2	24	Hardware with test report
10	All Hardware components in house	5	24	Documents (BoM)
11	Deliver LOTUS system for micro-CHP tests	2,3,4,6	30	Hardware with FAT report

Most milestones of the first year are reached on schedule.

Indicators (1)

1. Risk/technical success indicators
   - Electrical System efficiency from modeling: 43% (Target 45%)
   - Total System Efficiency from modeling: 63% (Target 80%)
     - Assumed heat loss in model 20%
     - ✓ Fix: get realistic heat loss and aux. power numbers
   - Stack temperature of 650°C with partial internal reforming is proven
   - Cost of the system is uncertain yet (too early in project)
   - Use off the shelf components: HFCS, Domel have systems in place to source components from known suppliers

Indicators (1)

2. Financial indicators
   - First input after 12 months
3. Exploitation indicators
   - Periodic meeting with Voice-of-Customer (Vaillant)
   - All customer demands still reached with current design
   - Too early in the project for business model development
4. Dissemination indicators
   - Lotus is represented at:
     - ✓ Workshop Series: Large Fuel Cell Systems Systems and Systems Components, Bruges, (B)
     - ✓ Symposium on SOFC integrated power plants at Delft (NL)
     - ✓ 2 abstracts accepted at EuropeanFuelCell Conference. December 14-16, 2011 in Rome (I)
   - Website: LOTUS-project.eu is online

Indicators (2)

5. Communication indicators
   - Website is online: not much technical information to share yet
   - Project intranet operational
6. Technical reporting indicators
   - Up to now 5/6 milestones reached as scheduled
   - 1/6 late due to more time needed to come to agreement with other (outside) LOTUS parties
   - 5/5 deliverables reached as scheduled
7. Gender indicators (♂, ♀)
   - IKTS: 50% ♀
   - HFCS: 33% ♀
   - UniPg: 25% ♀
   - Total: 20% ♀

Alignment to MAIP

MAIP Stationary Fuel Cell targets

1. Installed capacity 100MWe by 2015
2. Cost target uCHP €4000-5000 /kWe by 2015
3. Bridge gap between prototype and precommercial
4. Develop systems for real market conditions
5. Improve installation, operation and maintenance services
6. Increase component reliability
7. Connect to smart grids
8. Biogas & non-hydrocarbon usage
9. Harmonize testing and collaborate with JRC

Alignment to MAIP

- 100MW installed capacity
  - The LOTUS project will run from 2010-2013
  - Delivery of project is Proof-of-Concept prototype
  - No significant impact on installed (commercial) capacity

Alignment to MAIP

- Cost of € 4,000 - 5,000/kW
  - WP2: Reduction of SOFC temperature to 650C
    - Rational:
      - Use of less expensive materials
      - Longer life-time
    - Results:
      - Doubling power output at 650 C achieved
    - Next steps:
      - Build & Test larger cells and short-stacks

Alignment to MAIP

- Cost of € 4,000 - 5,000/kW
  - WP3: Use commercial available components
    - Rational:
      - Use of less expensive materials
      - Proven reliability and long life-time
    - Results:
      - Initial design work started on low-cost blower design based on commercial technology and manufacturability
    - Next steps:
      - Build & Test blower
      - Convert P&ID into BoP specifications
      - Contact suppliers

Alignment to MAIP

- Cost of € 4,000 - 5,000/kW
  - WP3: Simplify system design
    - Rational:
      - Less components lowers costs and increase reliability
      - Combining functions within same hardware
    - Results:
      - New design model made
      - Combining functions: e.g. 1 blower, 1 burner for start-up and peak burning
    - Next steps:
      - Convert P&ID into BoP specifications
      - Contact suppliers

Alignment to MAIP

- Bridge gap between prototype and precommercial
  - LOTUS will deliver a prototype unit
  - BUT, is based on Voice-of-customer demands and requirements
    - System Requirement Document finished
  - Input from Vaillant GmbH
  - Using user profiles North and South Europe
    - Vaillant GmbH
    - University of Perugia

Alignment to MAIP

- Bridge gap between prototype and precommercial
- Develop system for real market conditions
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Alignment to MAIP

- Improve Installation, operation and maintenance services
  - Use lessons-learned from FP5 EUVPP project
    - Input from Vaillant GmbH

  - WP3: Reduction of cost desulfurization
    - Technical solution
    - Service-solution
    - Results:
      - Evaluation of new non-toxic and non-flammable materials
      - Investigate service solution. Can we protect end-user from waste/recycle topic?
    - Next steps:
      - Keep evaluation both options
      - Decide on preferred option in Year2

Alignment to MAIP

- Connect to Smart grids
  - No Topic within LOTUS
  - Collaboration with Dutch SFN-project (Fuel Cell micro-grid development)
- Bio-Gas and non-hydrocarbon usage
  - No topic within LOTUS
  - Bio-Gas upgrading is product line of HyGear
- Collaboration with JRC
  - Harmonization of test procedures of cells, stacks and systems
  - Development of test procedures within WP2 & WP5

Cross cutting issues

- Training and Education within LOTUS
  - ➢ University of Perugia makes students familiar with fuel cells and their applications

- Safety, Regulations, Codes and Standards
  - ➢ System will be designed to meet CE criteria, which includes creation of a HAZOP document and a FMEA
  - ➢ Harmonization of testplans for single cells, stacks and systems

- Dissemination and public awareness
  - ➢ LOTUS website
  - ➢ Partners are taking part in many other international projects
  - ➢ Partners are members of many (inter)national organizations (IPHE, IEA HIA, EHA, etc)

Enhancing cooperation

- Technology transfer/collaborations
  - Vaillant GmbH. as associated partner provides input on the customer specifications
  - National collaborations in all partner countries on Fuel Cell Technology
  - Specific national collaboration on SOFC CHP:
    - Italy: Efeso
  - Interactions with other EU SOFC projects: (ADEL), DESIGN…
  - Technology improvement in HyGear, DOMEL, SOFCpower products
  - Component reliability improvements

Topic SP1-JTI-FCH.2009.3.5: Proof-of-concept fuel cell systems

- Development and construction of proof of concept fuel cell
- Show interaction with other devices required for delivering power, heat and cooling.
- Address the feasibility of proposed systems
- Assess system performance against required functional properties
- Increase in power density and/or efficiency over state-of-the-art generation
- Increased understanding of system level failure modes leading to more robust system designs
- Definition of requirements for fully integrated systems in the specific application(s)
- Maintenance and repair strategies necessary for introduction of robust and reliable systems