SOFT-PACT
(278804)

Andrew Thomas
E.ON Technologies (Ratcliffe) Ltd
www.soft-pact.eu

PROJECT OVERVIEW

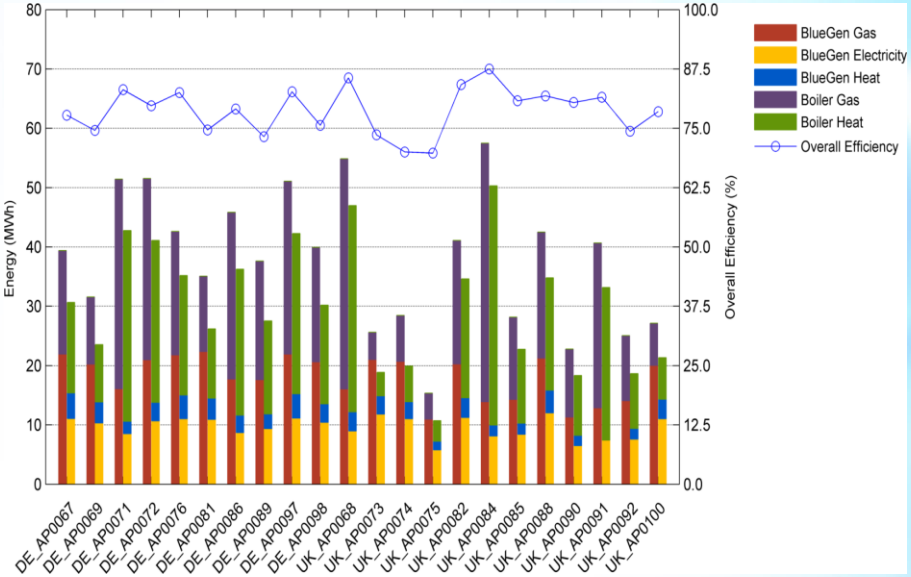
- Solid Oxide Fuel Cell micro-CHP Field Trials
- Call topic: SP1-JTI-FCH.2010.3.5 -Field demonstration of stationary fuel cell systems
- Start date: July 2011, End date: Oct 2015
- Budget: €10.3M
- FCH JU contribution: €3.95M
- Consortium: e·on ideal Ceramic Fuel Cells HOMA
- Overall purpose of project:
- European demonstration of fuel cell microCHP systems
- Stage of implementation (100% - Completed)

PROJECT TARGETS AND ACHIEVEMENTS

Programme objective/target	Project objective/target	Project achievements to-date	Expected final achievement
MAIP 2008-13			
FC system life time (h) >5,000	FC system life time (h) >10,000	At end of project: **12,792 hours** Given its degrade rate expected to reach **27,118 hours**	
AIP 2010: SPI-JTI-FCH-2010.3.5			
Deployment of fuel cells with Trial 10	Deployment of fuel cells with Trial Up to 100	39 BlueGen Pathfinder Systems 26 Integrated Fuel Cell Appliances (SIFC) **Total: 65 Fuel Cell Systems**	
FC system Electrical efficiency (%) (HHV) >40	FC system Electrical efficiency (%) (HHV) >40	**From 56% to 42% (HHV)** **From 61.5% to 46.0% (LHV)** **Over lifetime**	
Cost Reduction (€/kWe) €5000/kWe	25% Reduction on BlueGen Costs	**Achieved: 25% BlueGen Cost Reduction** via Reengineering components & supply chain enhancements	

PROJECT TARGETS AND ACHIEVEMENTS

- Project Achievements
  - The mean overall system efficiency of the SIFC units was 79.0% for UK and 78.3% for German sites utilising newly designed IP for low grade waste heat recovery Due to higher temperatures in heating system.

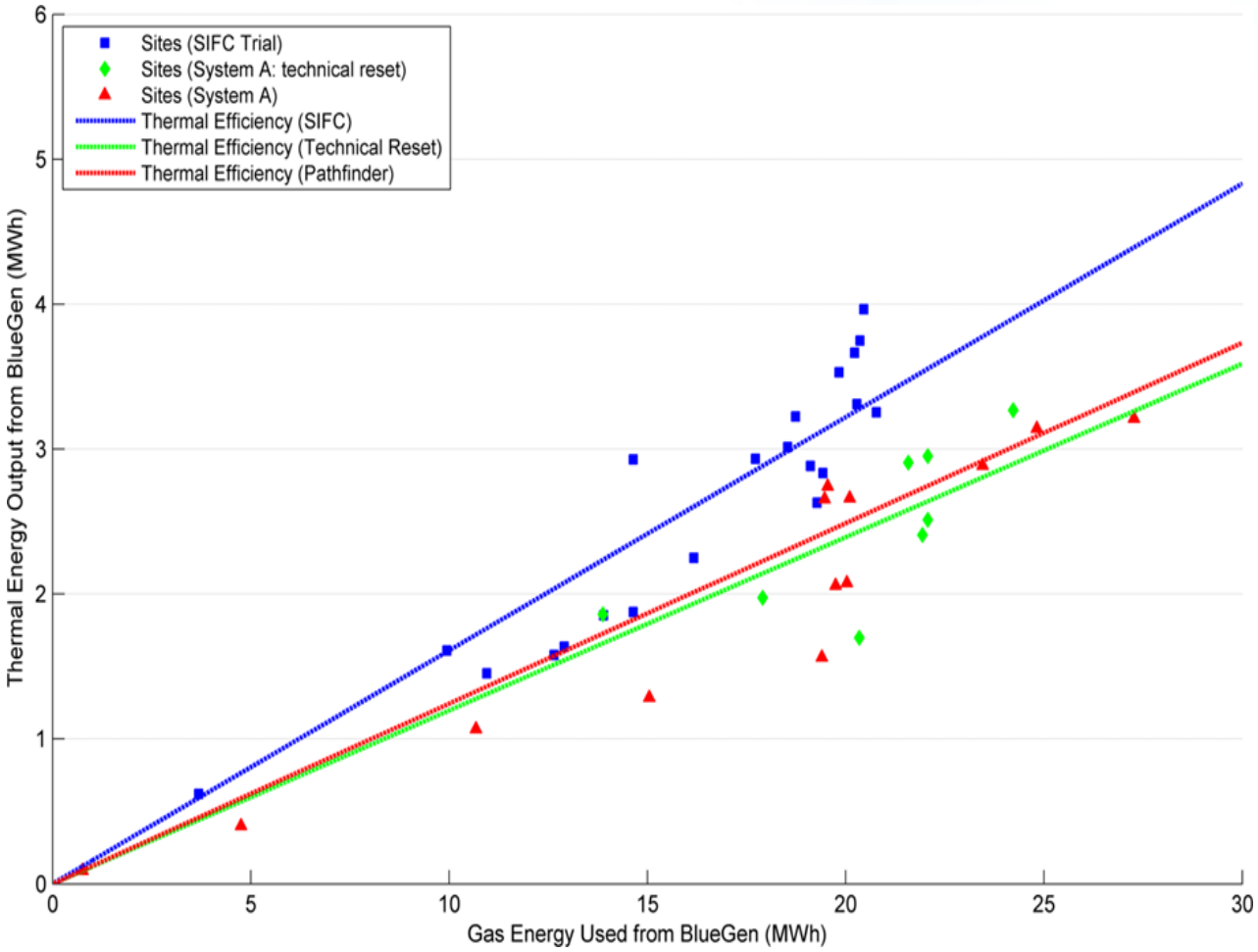


  - Reduced, but effective monitoring devised for the SIFC system generated resulted in 24 Gigabytes of data to be analysed consisting of 588 million data points.
  - The Integrated Fuel Cell (SIFC) system deployments in two very different EU regions (UK and German) provided sufficient insights during the trial period to determine the performance and effectiveness of the system compared to a modular system:

An integrated Fuel Cell system is more efficient than modular!

PROJECT TARGETS AND ACHIEVEMENTS

Fuel Cell Integrated System is shown to be Optimum Configuration



The gradient in this figure represents the average thermal efficiency across these units:
16.1% for the SIFC trial,
12.0% for the System A technical reset trial and
12.5% for the original System A trial.
With approx 4 percentage point's greater thermal efficiency than the BlueGen Pathfinder System A trials, the SIFC design is clearly making better use of the waste heat from the BlueGen, and thus increasing its overall efficiency

A scatter plot shows the total gas energy used versus the total thermal energy output from the SIFC, Modular BlueGen Pathfinder System A Field Trials and Modular BlueGen System A (Pathfinder Technical Reset) Field Trials

RISKS AND MITIGATION

- **Specification of Integrated Fuel Cell (IFC) Appliance**
  - Target: Milestone Missed
  - Nature of bottleneck and risks to project:
    - Schedule Delay, due perfecting design to meet requirements based on BlueGen Pathfinder field trial data and technology integration and performance requirements (four design iterations undertaken, resulting in new IP)
  - Remedial action taken:
    - Extend project to allow more time for prototyping, testing and build of integrated systems for field trial
  - Nature of revision of original targets
    - Post Specification IFC work packages to run over to 2014 and 2015 as required.
    - Deployment quantities of SIFC reduced to remain in Budget.

RISKS AND MITIGATION (2)

- **Deploy Integrated Fuel Cell (SIFC) Appliances in Germany, UK and Netherlands**
  - Target: Milestone Missed
  - Nature of bottleneck and risks to project:
    - Complexity of development, build and testing of integrated system
    - Challenges with small quantity supply chain, prices changes
    - Deployment challenges, loss of in house installers, Budget shortfall risk; Remedial action taken:
      - Parallel prototype and field trial build processes
      - Parallel multi region deployment
      - Tendered for new installers and retrained
      - Ongoing technical in field issues – 10 Tech Bulletins Issued
  - Nature of revision of original targets
    - Field Trial to run to July 2015 to obtain valid seasonal data
    - Deployed Units reduced further to accommodate budget shortfall and provide budget for ongoing fleet stabilisation due to technical issues

SYNERGIES WITH OTHER PROJECTS AND INITIATIVES

- Overview of support received via national programmes or other agencies:
  - None
- Extent to which project builds on previous FCH JU/EU-funded projects:
  - Utilises FC-Hyguide Project Member to produce the BlueGen LCA Report
- Description of any partnerships, joint activities formed with other FCH JU/EU projects:
  - Discussions with ene.field on Project Management and monitoring assistance
- Interactions with any international-level projects or initiatives:
  - None

HORIZONTAL ACTIVITIES

- Training activities organised by the project:
  - Training of Installation Organisations: E.ON Microgen Support Services, Forrest (UK), Lindorfer (Germany), UW Huismeester (Netherlands)
  - Training delivered to E.ON and Ideal technical group increasing awareness of Fuel Cell technology as applied to the heating / energy industries.
- Project work in safety, regulations, codes, standards, general public awareness:
  - The BlueGen became fully compliant as the project started and has verified CE, PAS67 (or equivalent) and G83/1 connection certificates
  - BlueGen became G83/2 grid compliant during 2014
  - Ideal worked with the BSI to cover the safety testing of the integrated fuel cell.
  - Integrated FC mCHP appliance obtained interim CE approval from independent approvals test house – Kiwa GASTEC.
  - BlueGen featured in Channel 4 Future Homes TV series and UK Gov DECC AIM C4 Low Carbon New Build Demonstrator

DISSEMINATION ACTIVITIES

- Conferences, workshops organised/attended by project (with presentation)
  - We sponsored the 8th International FC Conference, NEC UK
  - Members of the consortium have shown the BlueGen at EOCBuild, Greenbuild, All Energy and CIH Conference.
  - A BlueGen was shown in a TV show 'Future Family' on UK's Channel 4 resulting in 300+ enquires. Case studies have been created by CFCL and placed on the bluegen.info website.
  - Having trained the only installation team in the UK, we installed a BlueGen into the AIMC4 – UK Government's DECC demonstration of a low carbon house with Crest Nicholson promoting the technology to house builders.
  - In Europe, we have had the BlueGen at ISH, Hanover fairs and others and promoted the technology in local press in Hamburg and Heinsberg and with all the E.ON regional units and share holders.
- Lobbying
  - Lobbying continues in all regions but already there was in 2013 a UK FIT increase and a 250M Euro capital subsidy in NWR of Germany.

DISSEMINATION ACTIVITIES (2)

- Publications, patents arising out of project and its results
  - Numerous coverage on social media, forums and websites
  - An article for the Professional Engineering magazine which was published in November 2013 by Ideal Heating's Adrian Waddington.
  - Patent search on unique thermal store design, as undertaken within SOFT PACT project, is currently being undertaken by independent Patent Attorney.

EXPLOITATION PLAN/EXPECTED IMPACT

- What has your project changed in the panorama of FCH technology development and/or commericalisation?
  - Identification of real world support and maintenance issues that will effect the long term sales propositions and payback models
  - Cost reduction activities performed during the project have lowered the commercial cost of the BlueGen by 25%
  - Improved integrated system's joint reliability through the development of custom electronic control PCB eliminating costly control PLC's, custom manifolds applied to water & gas systems reduced the overall cost and size of the appliance
  - Data created from monitoring the SIFC demonstrator field test units provides a 'real life' database of that will drive the specification of such supporting applications.
  - The development work to optimise the performance of these systems has been completed and provides a ready made specification for an industrialised appliance.

EXPLOITATION PLAN/EXPECTED IMPACT (2)

- How will the project's results be exploited? When? By whom?
  - Development of what is currently the largest database of real-life operating data produced from extensive monitoring programme applied to demonstration field trial units will allow further modelling of the next generation of appliances, focus development for manufacturer and utility sales
- RTD projects:
  - What are the main results that go beyond international state-of-the art? Prolonged operational electrical efficiency above 42% during field trial, with System lifetime of 12,792 hours, predicted to reach 27,118 hours
  - What are the achievements that will allow progressing one step further to cost reductions and enhanced performance (efficiency, durability)? Real world operational issues allowing the true cost of ownership to be determined, Stack life and production cost improvements
  - How can the results from your project be taken on-board by industry? Real world Insights and learnings, re-engineering can remove costs, national training courses for the technology, will aid installation costs.

EXPLOITATION PLAN/EXPECTED IMPACT (3)

Demonstration projects:

- What are the next stages, after project ends to make commercial impact or achieve MAIP targets?
  - Heating System and Customer insights and learning will be utilised within other projects
  - Development of supporting cloud based application software utilising project learnings (e.g. smart phone APP's, Virtual Power Station, Pre-emptive Maintenance systems for heating products)
  - Given that fuel cells based systems are best suited to a situation where they can operate in continuous or base load then it will be interesting to consider how the addressable market would be influenced by significant reductions in the price of both the fuel cell and electrical energy storage moving forward.

EXPLOITATION PLAN/EXPECTED IMPACT (4)

Demonstration projects:

- What are the next stages, after project ends to make commercial impact or achieve MAIP targets?
  - Given the current volatility in energy markets, current low fuel prices and uncertainty over regulatory regimes (FIT) make it very difficult to make a strategic decision around new technologies such as fuel cells, particularly when there is a very competitive market in the domestic and SME heating market
  - The impact or the Energy Efficiency Labelling Directive may also make fuel cells more attractive as conventional boilers are no longer able to achieve the highest energy efficiency ratings.

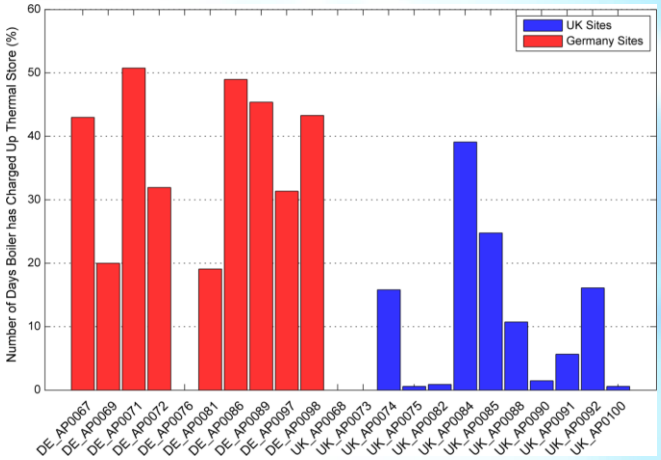
Cross-cutting:

  - Installation Skillsets go far beyond the current installation technicians skill levels and require focused training courses by national vocational associations as with other renewable / low carbon technologies.

SOFT-PACT

Project Learnings Summary

- Project Learnings
  - The performance of the monitored BlueGen Pathfinder systems provided invaluable data for the design of the integrated Fuel Cell system not only for system performance requirements but trialist usage statistics; therefore it has been a successful Pathfinder field trial achieving its objectives and deliverables



Number of days (in percentage) that the boiler has charged up the thermal store during the monitoring period to meet demand.

  - Meeting the challenges of performing a field trial on the prototype Integrated Fuel Cell has provided extensive insights and data, despite the deployment challenges, technology issues and delays.
  - Attempting to deploy in 4 countries highlighted by the original market opportunity report, so highlighted that connection regulations (Italy) and Gas Type Variations (Netherlands) can stop deployments or cause further development very quickly.

Project Learnings Summary (2)

- Project Learnings
  - Training installation technicians in both deployment regions allowed the building regulations and health and safety requirements to be determined but also highlighted the training and skills required for scaling to commercial deployments levels to be an ongoing challenge.
  - Trialists expect compact, easy to operate and interactive heating systems that are cost effective.
  - Installation companies expect easily installable, maintainable, heating systems that have demonstrable financial and environmental benefits
  - Inter-company knowledge transfer and prototyping of new complex integrated systems cannot be accelerated between design teams who use different methodologies and have both Tacit and Codified knowledge.