

callux

Field Test of Residential Fuel Cells

Background, Activities and Lessons learnt

20 February 2013 | Ene.field Consortium Meeting | Berlin
Alexander Dauensteiner

Background



Former Federal Minister Tiefensee and representatives of participating companies kicked off the project at the Federal Ministry of Transport, Building and Urban Affairs on 23 September 2008.

Project goals

Preparation for launch of natural gas-driven fuel cell heating appliances

- Demonstrate technical maturity, support further improvements to ensure marketable products
- Develop supply chains by winning binding orders for large quantities
- Enhance product profile on the market
- Continue work on concepts for supply structure integration
- Support (further) training of market partners
- Validate requirements from customers and the market
- Promote the creation of added value in Germany



callux project partners

Energy suppliers:

EnBW, E.ON Ruhrgas, EWE ENERGIE,
MVV Energie, VNG

- have been installing and operating fuel cell heating appliances for years;
- have jointly gathered experience from installation and operation of more than 250 fuel cell heating appliances.



HEXIS



callux project partners

Manufacturers:

Baxi Innotech, Hexis, Vaillant

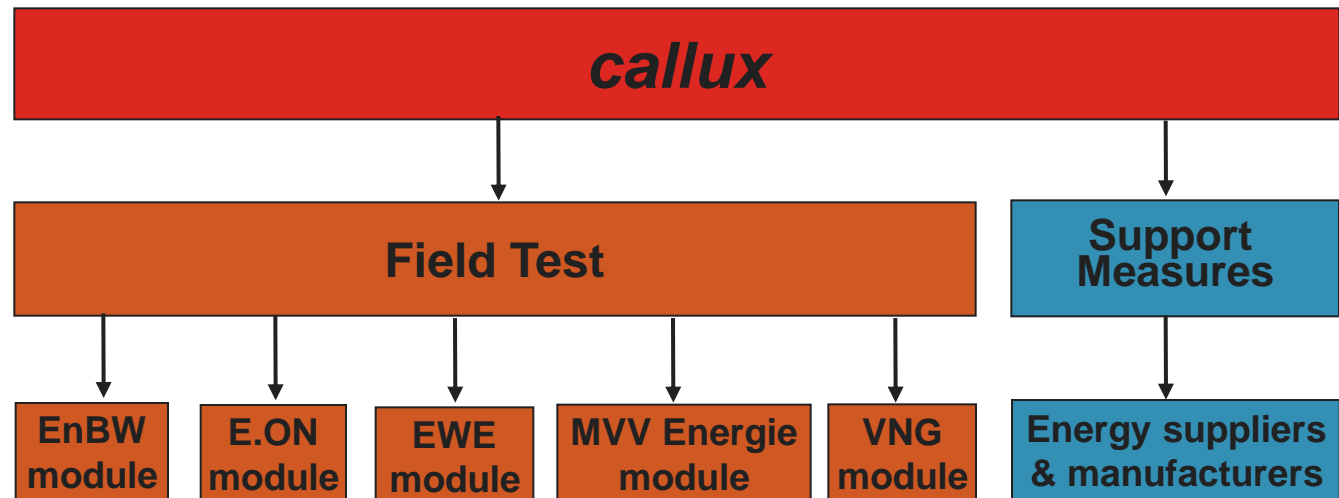
- are experts in Germany for the development of fuel cell heating appliances;
- use PEM and SOFC technology (1 kWe);
- have many years of experience operating far more than 250 appliances.

Project coordinator

Centre for Solar Energy and Hydrogen Research (ZSW)

- has comprehensive experience with the handling and implementation of funded projects.

Project structure



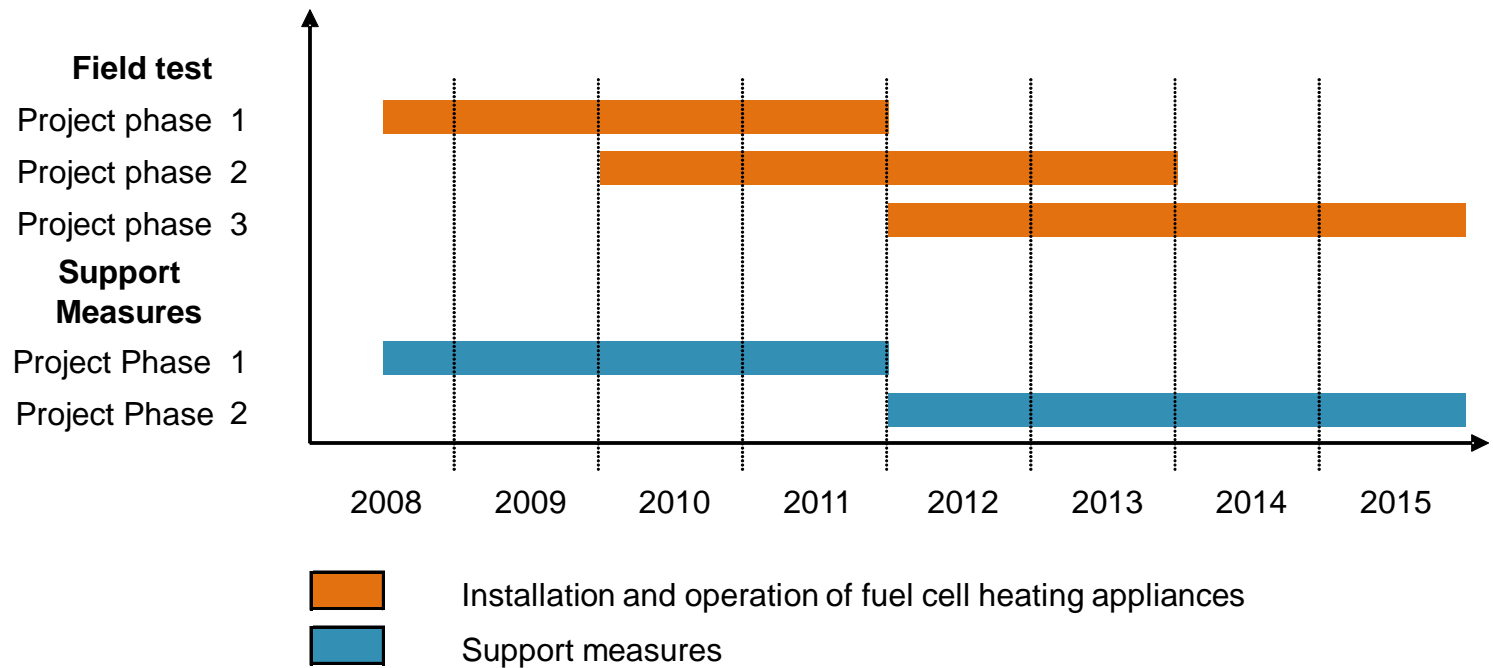
Separate organisational structures have been set up for the joint *Field Test* and *Support Measures* projects.

Field test

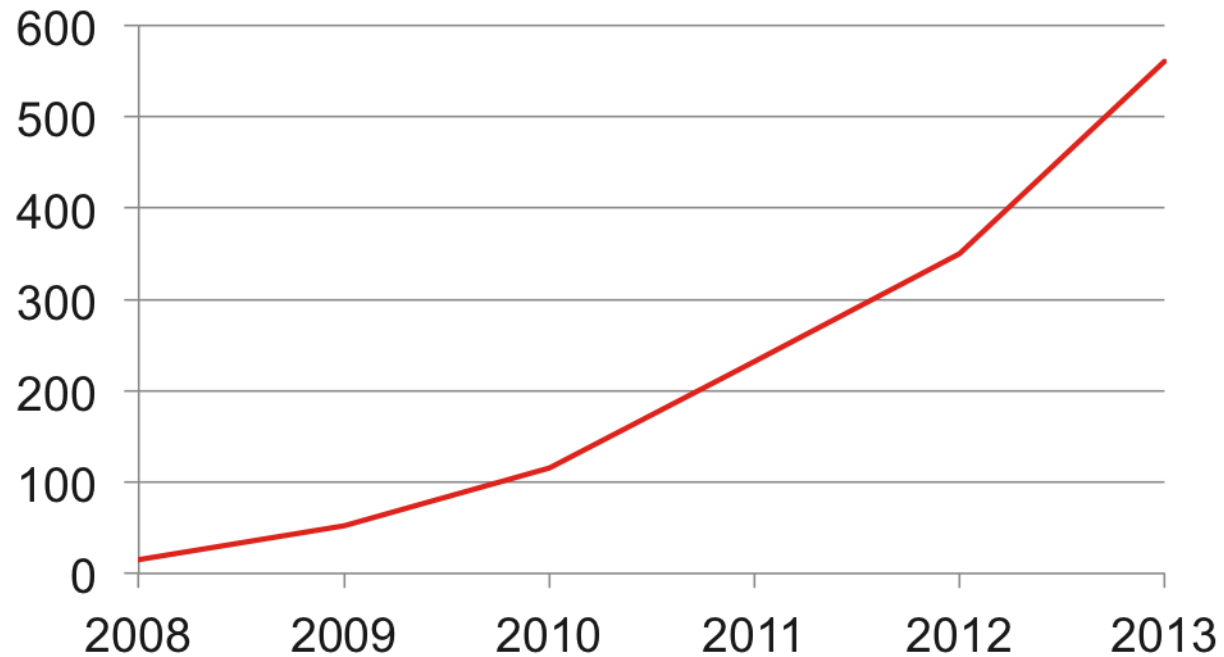
- The field test is being carried out primarily at residential users in selected regions of Germany.
- The energy suppliers buy, install and operate the fuel cell heating appliances independently of each other.
- The field test consists of three phases; a final assessment report has to be prepared for each phase.
- Specific target values have been specified for the field test, which are identical for all manufacturers.



Project timeline



Planned fuel cell heating appliances (cumulative number of installations)



Up to 560 fuel cell heating appliances are to be installed as part of the *callux* field test by the end of 2013 and to be operated in some cases until 2015.

Project financing

EnBW

BAXI INNOTECH

e-on | Ruhrgas

HEXIS

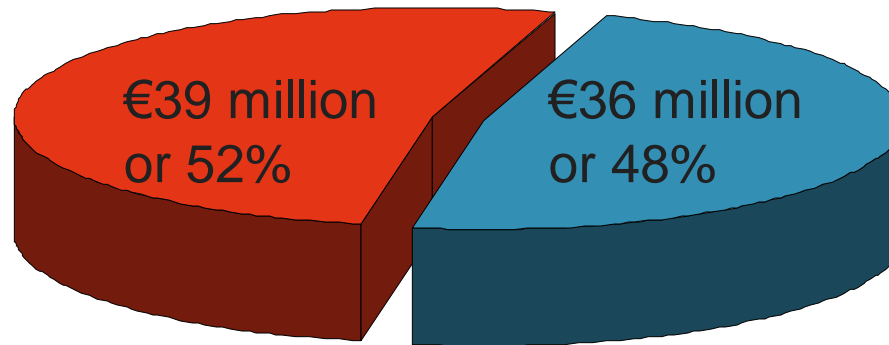
EWE

Vaillant

MVV Energie

SW

Verbundnetz Gas AG



Gefördert durch:



aufgrund eines Beschlusses des Deutschen Bundestages



NOW
Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie

■ Contributed by project partners

■ Subsidies

If implemented as planned, *callux* will have a total investment volume of approx. €75 million, of which €39 million will be contributed by the project partners.

Regional focus

Current projects at
www.callux.net

The size of a house on the map indicates how many projects are being implemented at a location.



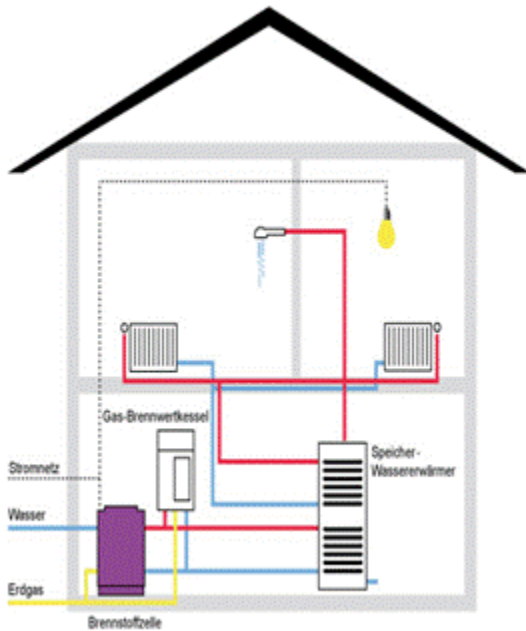
Selection of test sites

Residential fuel cell heating appliances

- suitable for use in single- and multi-family homes;
- replace existing heating systems;
- are very energy-saving and have low emissions.

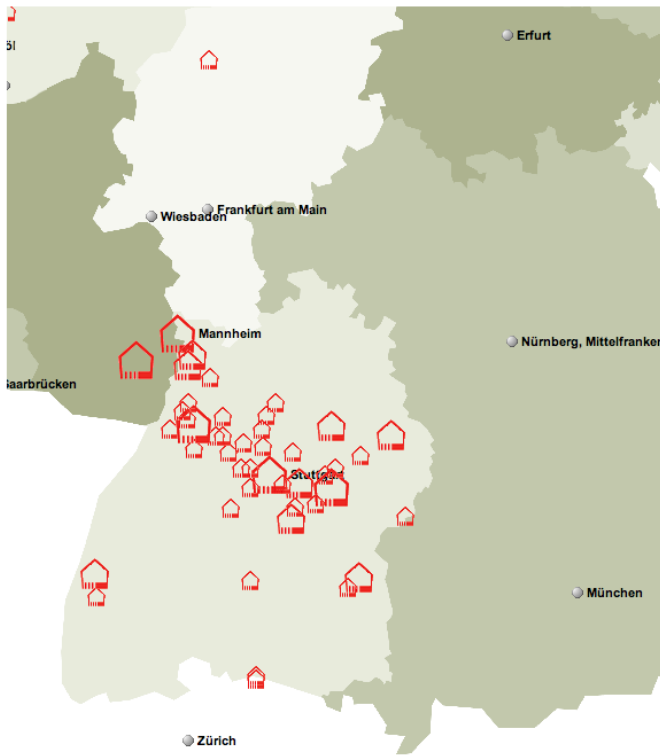
Preconditions for operation are

- a minimum heat requirement of the building (space heating, hot water production);
- connection to natural gas and electricity grids.



Graphic: www.initiative-brennstoffzelle.de

Example projects



Example projects



Single-family home in Ötisheim
(Baden-Württemberg)



Day-care facility in Oberderdingen
(Baden-Württemberg)

Example projects



Single-family home in Mannheim
(Baden-Württemberg)



Single-family home in Müncheberg
(Brandenburg)

Example projects



Single-family home in Westoverledingen
(Lower Saxony)



Single-family home in Oldenburg
(Lower Saxony)

Support measures

Work package 1: market partners

- Develop a training module to establish a specific qualification for the trades involved

Work package 2: market research

- Analyse requirement profiles and market entry barriers

Work package 3: infrastructure

- Develop a standardised interface for communication between fuel cell heating appliances and energy management systems

Support measures

Work package 4: communication

- Ensure comprehensive and mutual communication between the project partners

Work package 5: scientific support

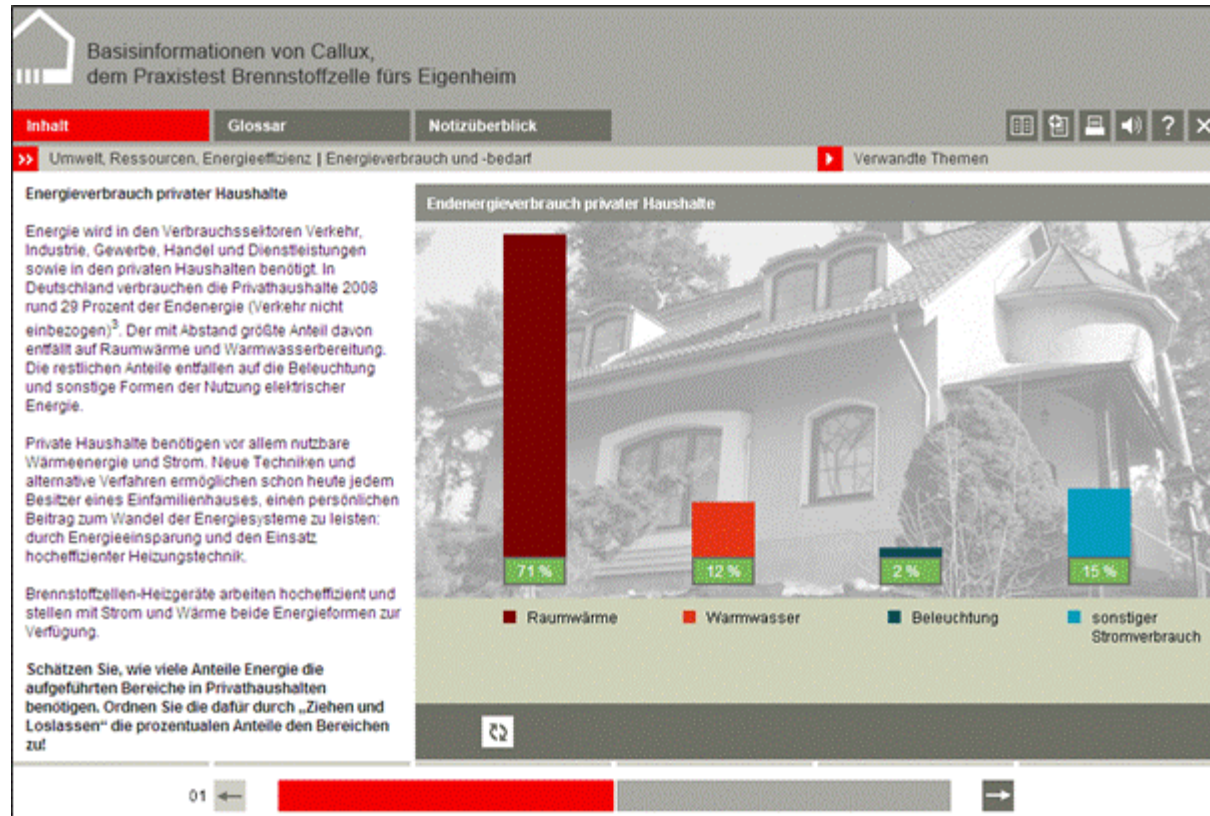
- Investigate common scientific questions affecting test implementation and evaluation

Work package 6: project coordination

- ZSW as the project coordinator to provide support to the project partners

Examples of support measures

Work package 1: market partners



Fuel cell heating appliance information programme

Examples of support measures

Work package 1: market partners



Basisinformationen von Callux, dem Praxistest Brennstoffzelle fürs Eigenheim

Inhalt Glossar Notizüberblick

>> Rahmenbedingungen für den Markterfolg | Gesamtgesellschaftliche Betrachtung

Themenübersicht

In diesem Kapitel werden folgende Themen behandelt:

Programmseiten

1. Themenübersicht
2. Ungewisse Gewissheiten
3. Zur Energiewende beitragen
4. Die nächste Zukunft der Energieversorgung
5. Technischer Impuls für wirtschaftliche und soziale Innovationen in Deutschland

Mit der Seitennavigation im unteren Bildschirmbereich können Sie bequem per Klick die Themenbereiche ansteuern.

Mittelschwere Wärme mit 6-10 kWh Heizleistung

14.000
12.000
10.000
8.000
6.000
4.000
2.000
0

2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017

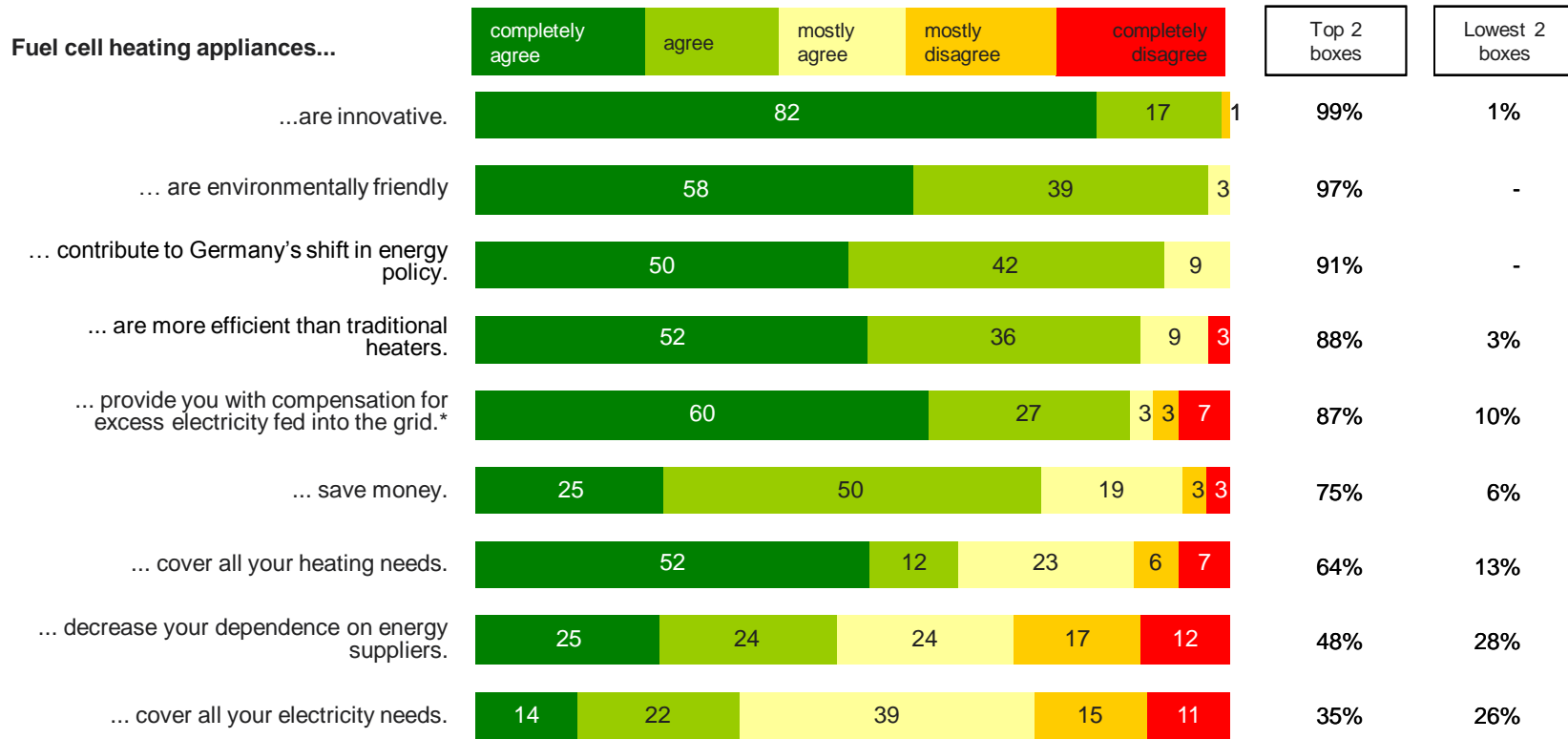
Kohle / Turf Erne Ertrag Kernenergie
 Wasserd Abgasenergie Propanol / Aprop

Fuel cell heating appliance information programme

Examples of support measures

Work package 2: market research

Fuel cell heating appliances are innovative, environmentally friendly, support new technologies, help you save

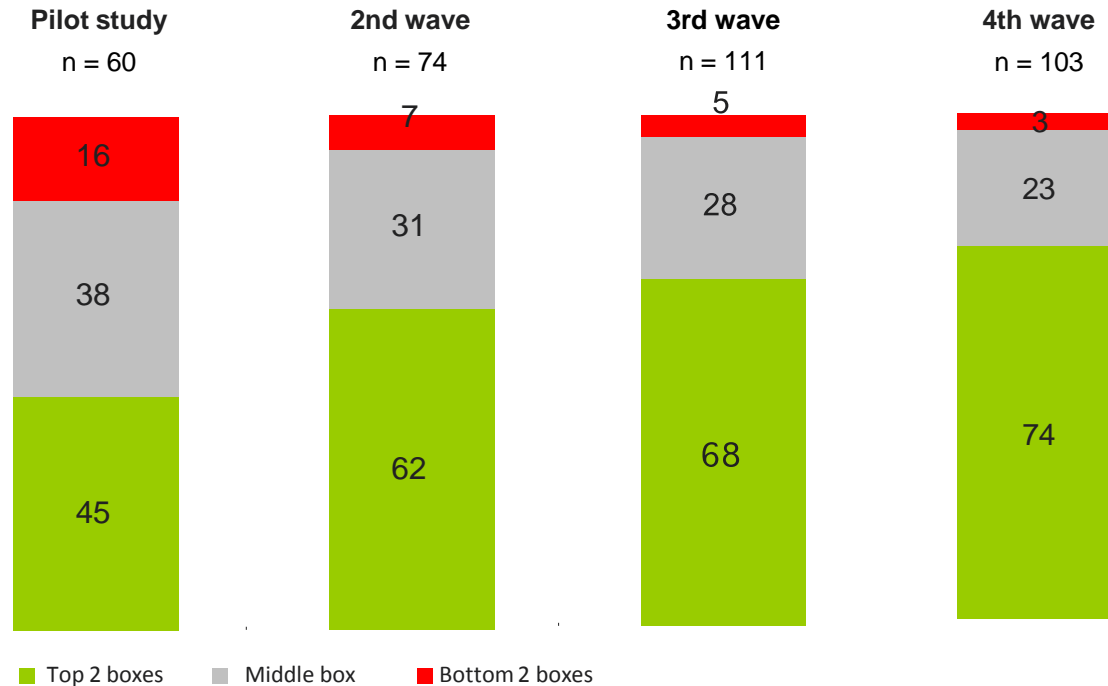


Survey of *callux* field test customers in May 2012, figures in %

Examples of support measures

Work package 2: market research

Three quarters of users extremely satisfied



Now some general questions about your experiences with the fuel cell heating appliance.
How satisfied are you with the fuel cell heating appliance?

Survey of *callux* field test customers between January 2011 and May 2012, **figures in %**

Examples of support measures

Work package 3: infrastructure

The *callux* box: objective

- The *callux* box is the standardised interface for communicating with the fuel cell, and makes scheduled automation a possibility.
- Standardising the interface will make it possible to operate a number of system types from different manufacturers.
- The development is based on IEC 61850-7-420 (*Communication networks and systems for power utility automation*)
- Integrated information management will reduce development costs over the long term and reduce potential errors when transmitting measurement values.



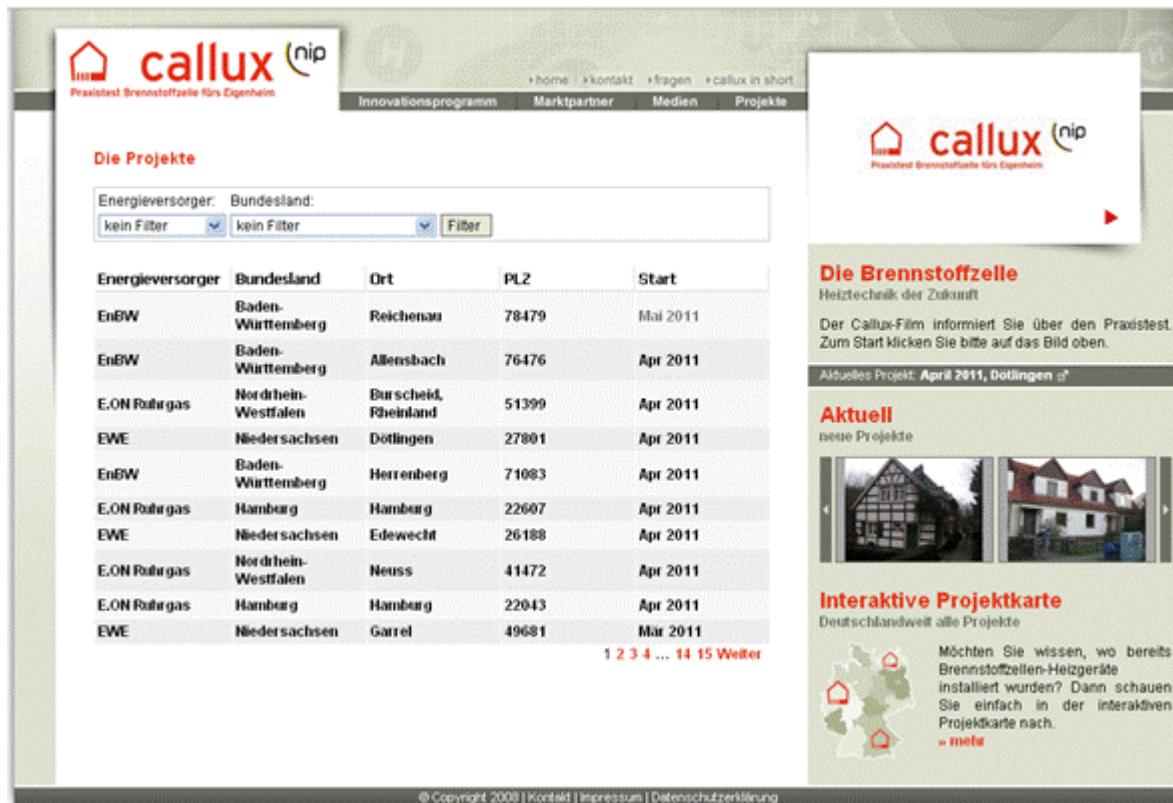
Examples of support measures Work package 3: infrastructure

The *callux* box's interfaces and connections



Examples of support measures

Work package 4: communication



The screenshot shows the website interface for 'callux (nip) Praxistest Brennstoffzelle fürs Eigenheim'. It features a navigation menu with 'home', 'kontakt', 'fragen', and 'callux in short'. Below the menu, there are sections for 'Die Projekte' (Projects) and 'Die Brennstoffzelle' (The Fuel Cell). The 'Die Projekte' section includes a filter table and a main project list table. The 'Die Brennstoffzelle' section contains a description and a gallery of project photos. At the bottom, there is an 'Interaktive Projektkarte' (Interactive Project Map) and a copyright notice.

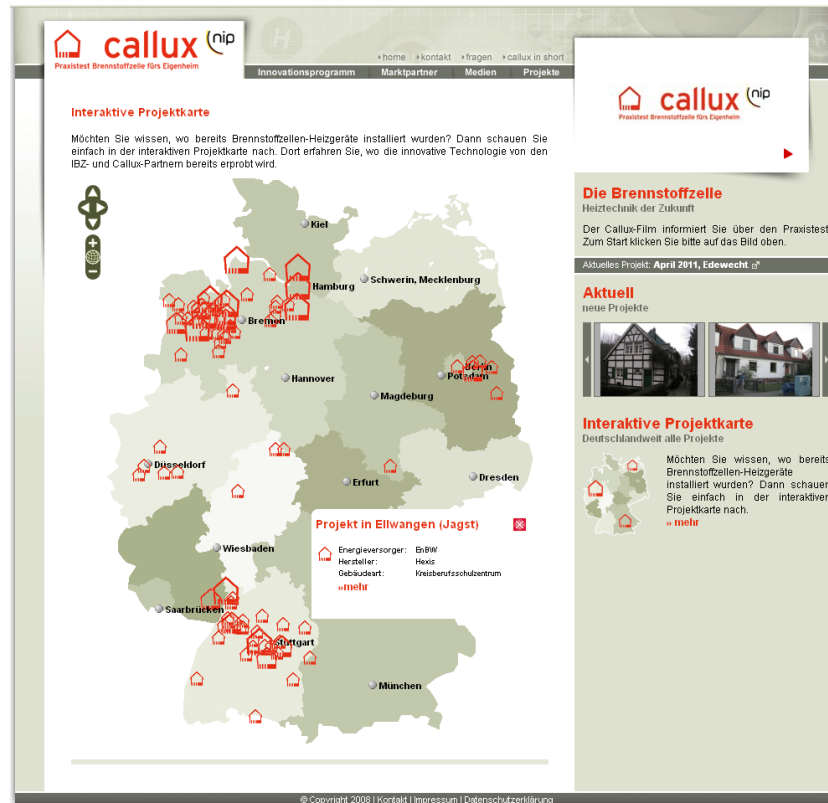
Energieversorger	Bundesland	Ort	PLZ	Start
EnBW	Baden-Württemberg	Reichenau	78479	Mai 2011
EnBW	Baden-Württemberg	Allensbach	76476	Apr 2011
E.ON Ruhrgas	Nordrhein-Westfalen	Burscheid, Rheinland	51399	Apr 2011
EWE	Niedersachsen	Dötlingen	27801	Apr 2011
EnBW	Baden-Württemberg	Herrenberg	71083	Apr 2011
E.ON Ruhrgas	Hamburg	Hamburg	22607	Apr 2011
EWE	Niedersachsen	Edewecht	26188	Apr 2011
E.ON Ruhrgas	Nordrhein-Westfalen	Neuss	41472	Apr 2011
E.ON Ruhrgas	Hamburg	Hamburg	22043	Apr 2011
EWE	Niedersachsen	Garrel	49681	Mär 2011

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www.callux.net on the Internet with project database

Examples of support measures

Work package 4: communication



Interactive project map at www.callux.net

Examples of support measures Work package 4: communication



callux (nip)
Praxistest Brennstoffzelle fürs Eigenheim
Das Projekt zur Modernisierung von Heizungsanlagen
mit Brennstoffzellen-Heizgeräten

2008 startete das Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS) gemeinsam mit Partnern aus der Wirtschaft den Bundesweit größten Praxistest von Brennstoffzellen-Heizgeräten fürs Eigenheim namens Callux, im Rahmen des Nationalen Innovationsprogramms Wasserstoff und Brennstoffzellentechnologie, das von der NGW koordiniert wird. Investiert die Industrie gemeinsam mit dem BMVBS eine Milliarde Euro, um den Einsatz der innovativen Technologie voranzutreiben.

Callux-Projektpartner:

- EnBW
- E.ON Ruhrgas
- EWE
- MVV Energie
- Verbundnetz Gas AG
- BAXI INNOTECH
- HEXIS
- Vaillant
- CSW

praxistest
Neuigkeiten von CALLUX
dem Praxistest Brennstoffzelle fürs Eigenheim
Ausgabe 2 | Jahrgang 2011

Herausforderungen für das Handwerk

Brennstoffzellen-Heizgeräte erwecken auf den ersten Blick Strom und Wärme. Damit stellen sie besondere Anforderungen an die Installateure, den Bereich und die Wartung der Anlagen.

Die Redaktion spricht mit Prof. Dr. Peter Hoyer über die verschiedenen Herausforderungen, die sich für das Handwerk und die Techniker im Praxistest Callux stellen.

Präzise Arbeit bei E.ON Ruhrgas

HERR SPROGG, WAS IST BEI DER INSTALLATION VON BRENNSTOFFZELLEN-HEIZGERÄTEN ANDERS ALS BEI HERKÖMLICHEN ANLAGEN?

Grundsätzlich muss der Installateur von Handwerker des Brennstoffzellen-Heizgeräts geschult sein. Für die Lieferung stellt er aufgrund des erheblichen Höhen-Anforderungsbereichs ein Aufzugsgerät erforderlich. Die Mindesthöhe vor Ort übersteigt sich von zwei Personen bewältigen. Dies vor Ort die eingebaute Gasanlage, die für die Kraft-Wärme-Kopplung geeignet sind, für die Abfallentsorgung zu erfassen, sind gegebenenfalls zwei Gasanschlüsse notwendig sowie zwei Gasleitungen.

Für den elektrischen Anschluss ist die VDE-Norm VDE 0100-710 „Eigentümerversorgungssysteme am Niederspannungsnetz“ zu beachten. Der Heizanschluss ist 1 Phase/16 A/230V AC mit ausreichender Abschirmung und zusätzlichem PE-Anschluss vorzusehen. Ferner muss ein geeigneter Stromzähler zur Messung des eingesparten Stroms im öffentlichen Stromnetz installiert werden. Je nach Einsatzort des Brennstoffzellen-Heizgeräts ist zudem ein zur

Alles geregelt bei VNI:

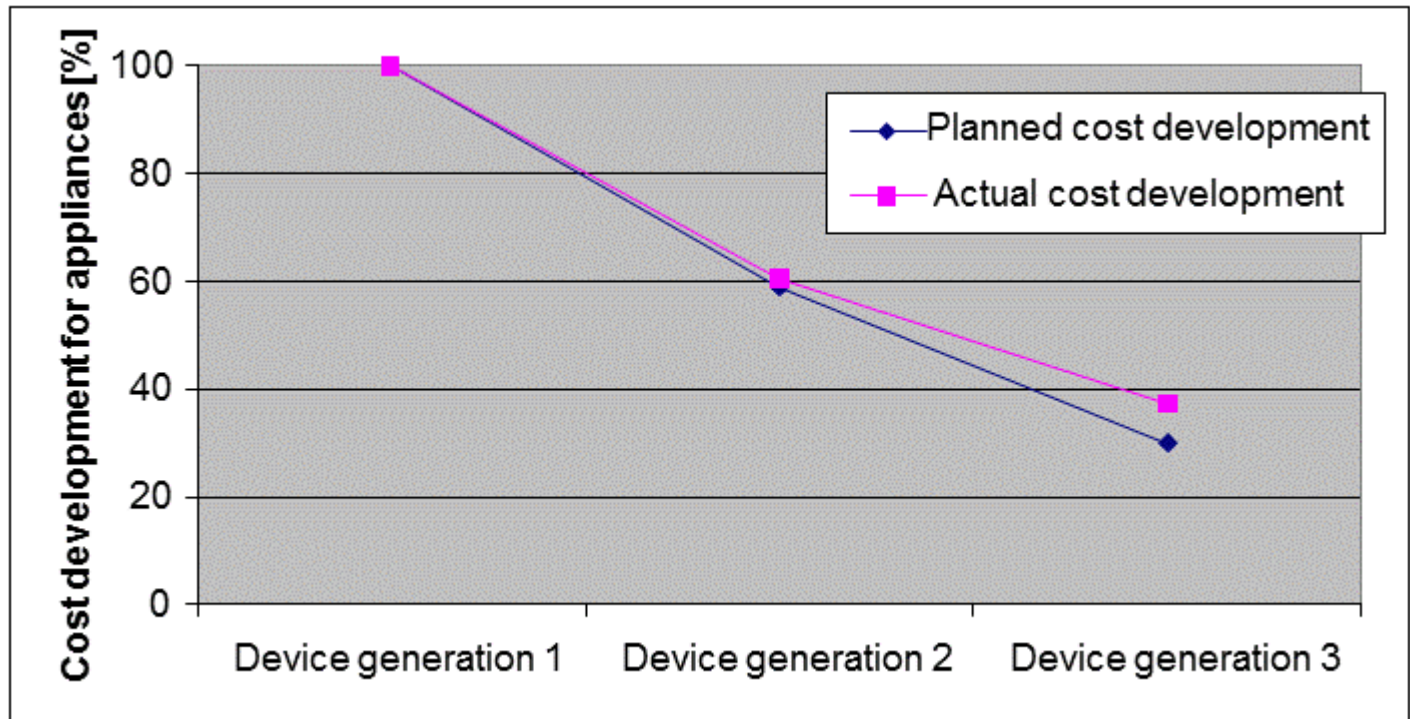
HERR DÜSINKEL, IST DIE EINSTELLUNG BEZÜGLICH DER REGELUNG DER ANLAGE ANDERS, WENN ES UM DIE INTEGRATION INS BESTEHENDE HEIZSYSTEM GEHT?

Die installatorische Einbindung von Brennstoffzellen-Heizgeräten in Anlagen im Gebäudebestand oder bestehende Anlagenkonzepte ist ebenso einfach wie man es von den bei am Markt befindlichen Systemen kennt. Ähnlich wie bei den Brennstoffzellen-Heizgeräten befinden sich an Brennstoffzellen-Heizgeräten Anschlüsse für die hydraulische sowie elektrische Einbindung. Mit der Einbindung bzw. Installation eines zentralen Speichers kann man im Bereich der Heizenergieerzeugung den Verbrauch senken. Das führt zu besseren Nutzungswerten für die Stromerzeugung. Einzig die elektrische Anbindung ist etwas komplexer, da die Brennstoffzellen-Heizgeräte auch Strom in das öffentliche Netz einspeisen. Das wird aber durch die Überlagerung von zusätzlicher Mess- und Regeltechnik in einem Schaltkreis erledigt.

Tom Düstroski ist Kundenbetreuer bei der Firma Borg GmbH in Bad Kreuznach. Er hat für VNI in der Stadt Bad Kreuznach ein Gerät im Betrieb genommen. Bild: VNI

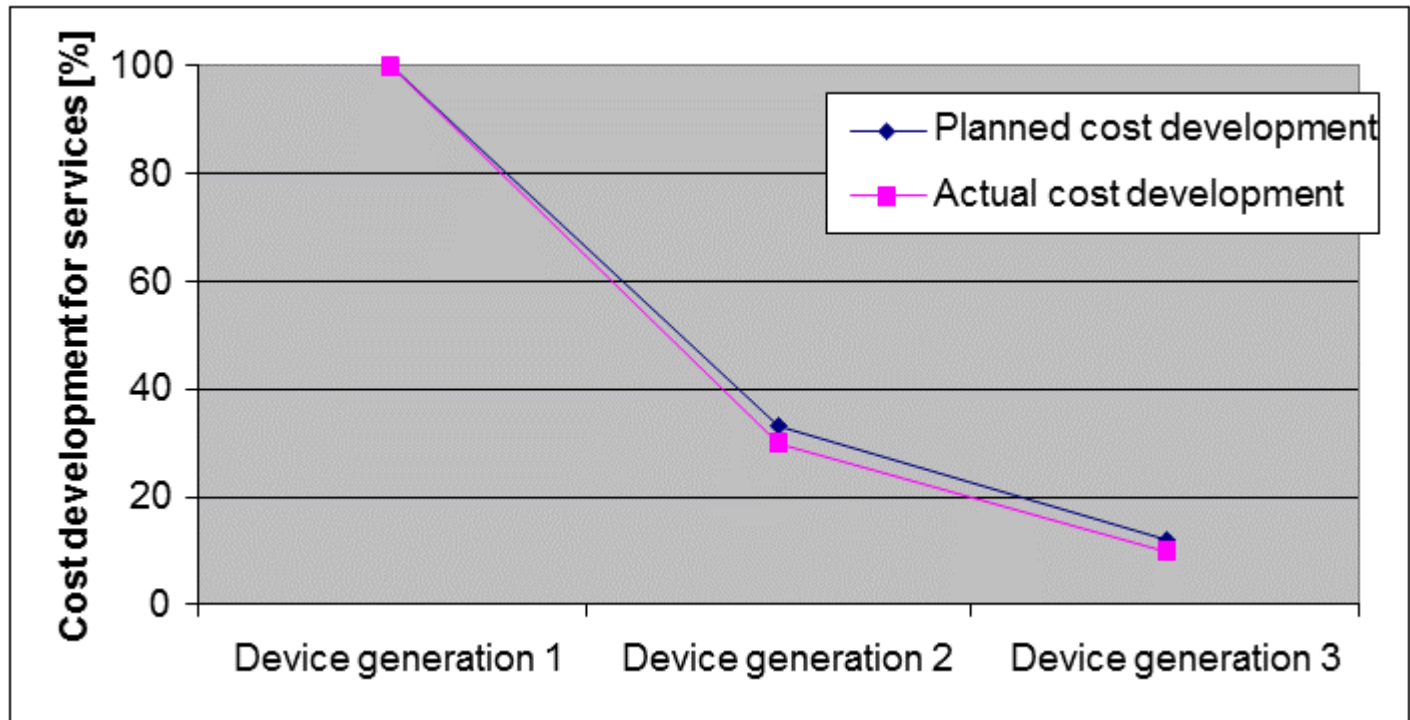
Newsletter covering questions revolving around *callux* field test

Cost trend for fuel cell heating appliances (averages for all manufacturers)



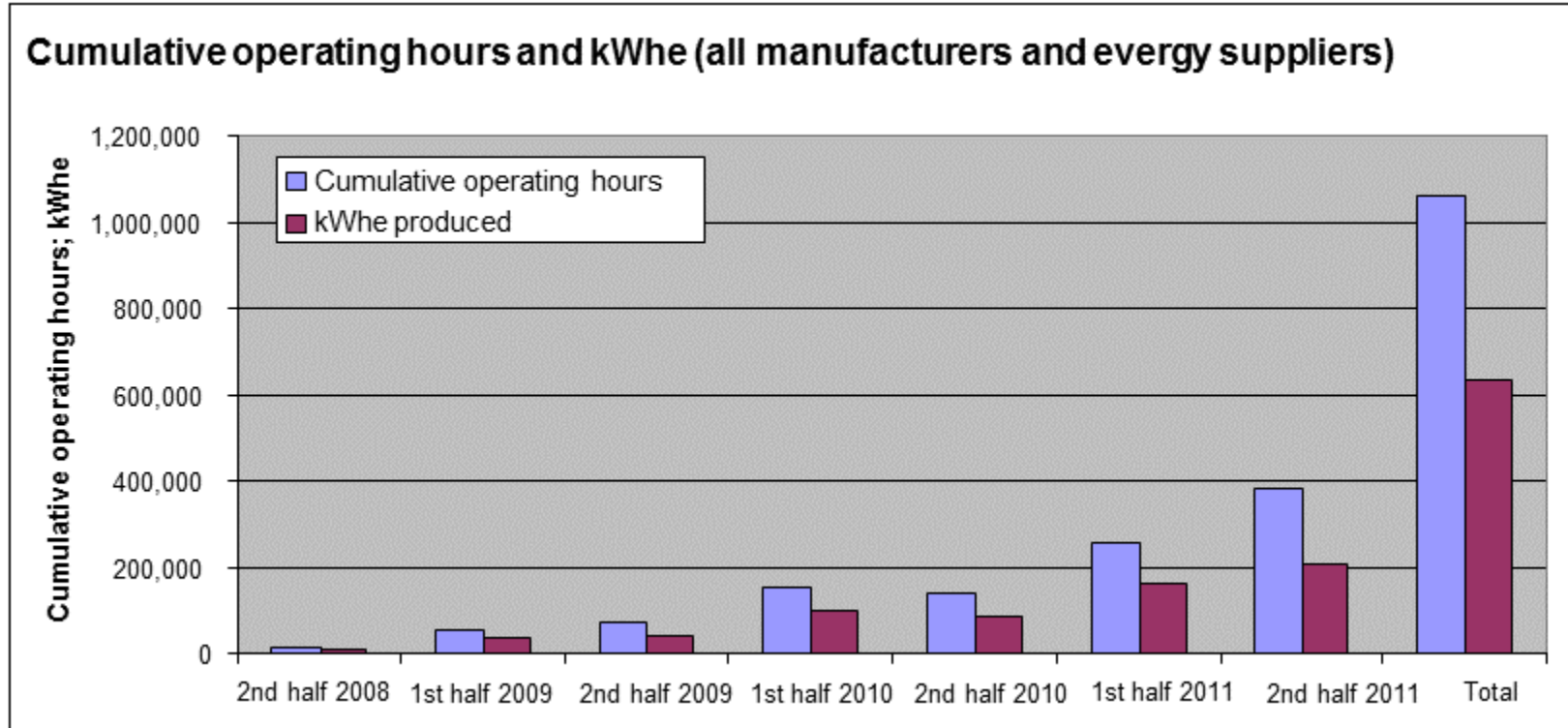
→Appliance costs were reduced by around 60% over the course of the project.

Cost trend for servicing/replacement parts (averages for all manufacturers)



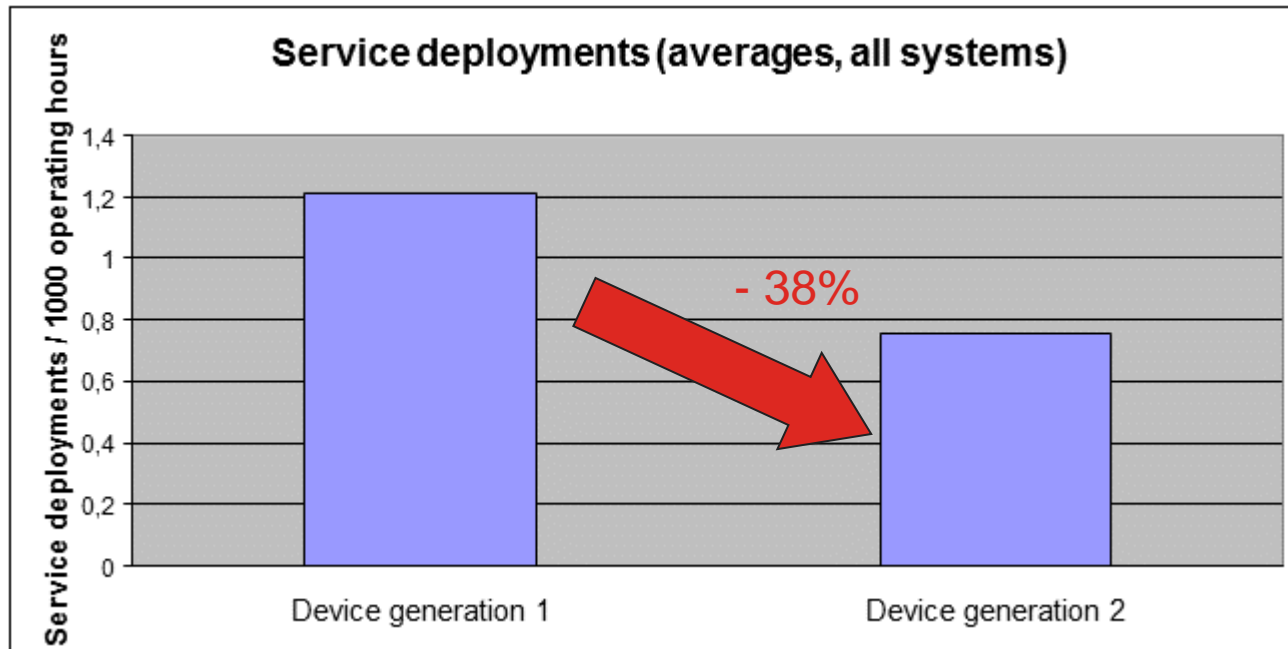
→ Costs for appliance servicing and replacement parts were reduced by around 90% over the course of the project.

Cumulative operating data



→ Over 1 million hours of operation in the field were recorded and over 600,000 kWh of power produced by the end of 2011.

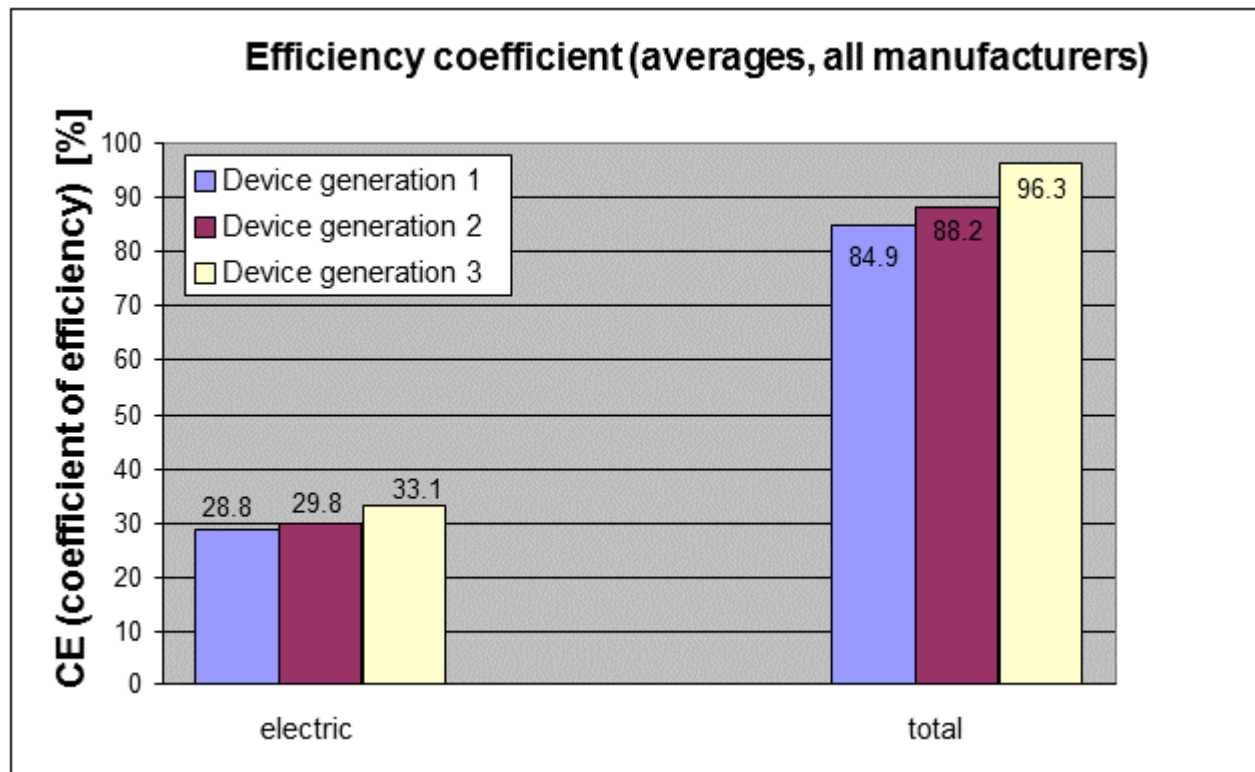
Appliance servicing



Time frame 08/2008 – 06/2011

→ The number of times that service personnel were deployed to fix faults was reduced considerably. The reliability of the main stack and reformer components was improved significantly, and the reliability of the system was increased to up to >97%.

Efficiency coefficient (CE test standard)



Based on net calorific value, NCV

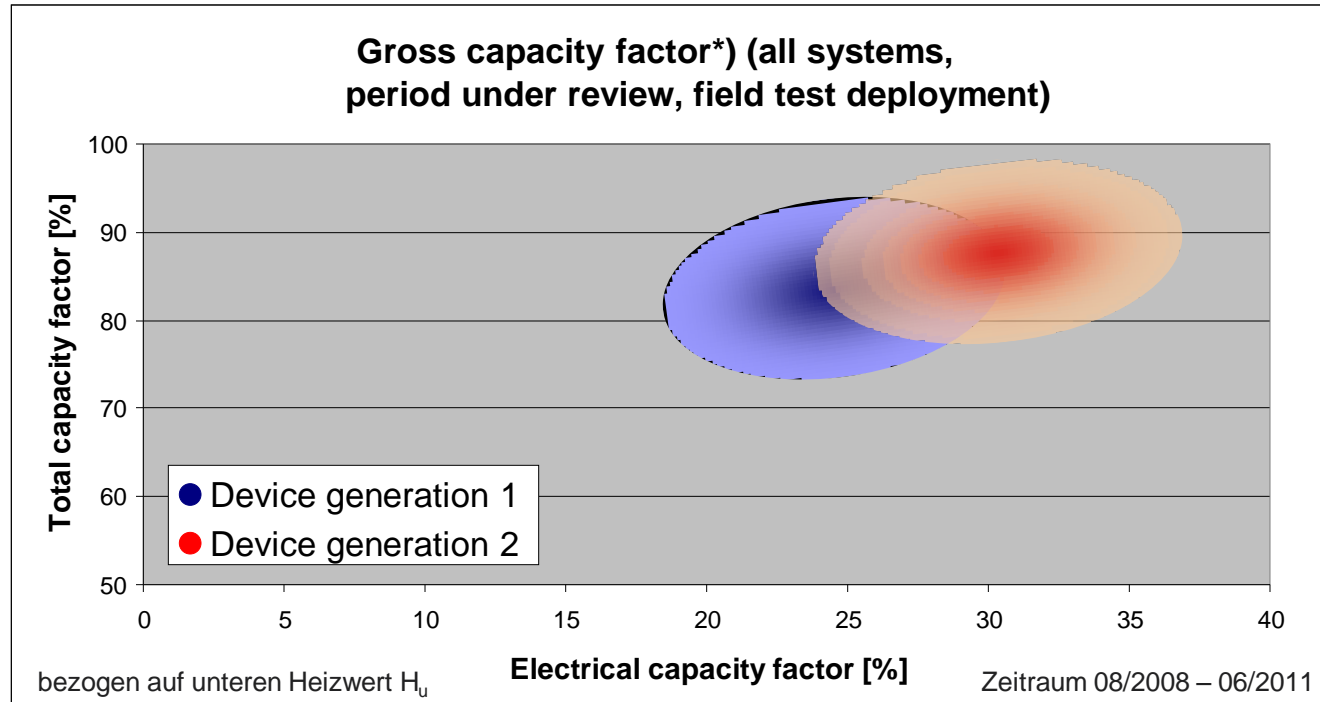
→ Efficiency was improved successively to electric efficiency >33% and overall efficiency >96%.

Capacity factor

*) Capacity factor ≠ efficiency!

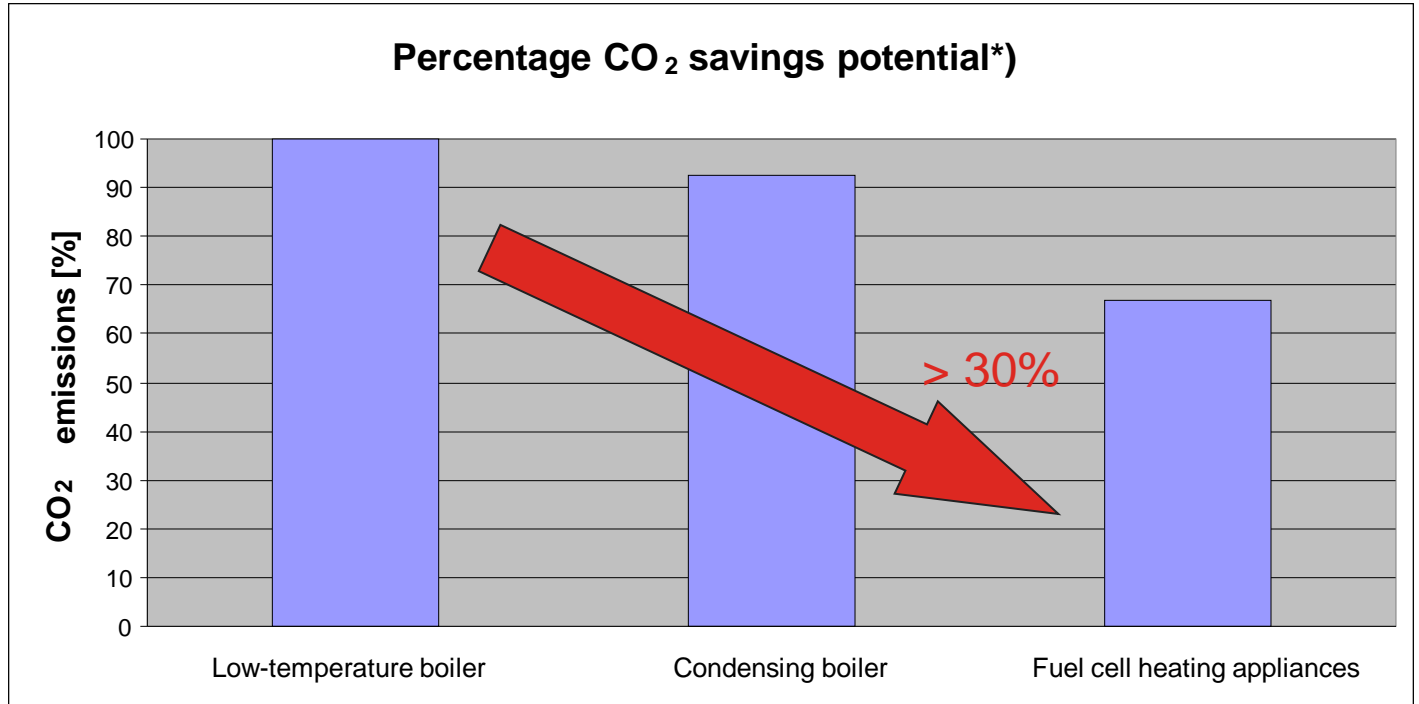
→ incl. all factors of real-world operation

- full capacity/partial load operation
- power consumption of additional heating device and external heating circuit control
- fluctuations flow/return temperature



→ The capacity factors of the systems were improved.
 The electrical capacity factor was >30% and total capacity factor was >95%.

CO₂ savings potential



*) Calculated according to residual power value method

→ The fuel cell heating devices continue the trend of modern gas technologies towards reduced CO₂ emissions.

Other advances in quality

- Significant reduction in appliance dimensions and weight (up to 50%)
- Pollutant and noise emissions demonstrably lower
- Increasingly easy to incorporate into existing building technology
- Significant reduction in maintenance
- Increased annual operating times due to modulation tailored to requirements
- Increased power to heat ratio
- Proven stack runtimes of approx. 10,000 hours in two-year field tests
- Stack degradation rates decreased further to < 0.2 % per 1000 hours

Baxi Innotech fuel cell heating appliance: GAMMA 1.0



CHP section

Type	low-temperature PEM fuel cell (70 ° C)
Output (e/th)	max. 1.0 kWe/1.8 kWth
Modulation range	approx. 100 – 30% PeN
Fuel	natural gas, biomethane
Electrical efficiency (NCV)	32%
Total CHP efficiency	> 91%

Integrated auxiliary heater

Type	condensing appliance
Output	3.5-15 kW or 3.5-20 kW
Efficiency	109% (η_N at 40/30 ° C)

Complete system

Total efficiency	> 97% (to EN 50465 with 60/40 ° C flow/return)
Dimensions (mm)	600 long x 600 wide x 1,600 high
Weight	approx. 200 kg
Housing	coated, fully enclosed
Natural gas pressure	20/25 mbar (EN 437)
Electrical connection	230 V/50 Hz
Operating mode	power-controlled, heat-controlled, energy manager-controlled; central control (virtual power plant)

Hexis fuel cell heating appliance: Galileo 1000 N



CHP section

Type	solid oxide fuel cell (SOFC)
Output (e/th)	1.0 kWe/2.0 kWth
Modulation range	100-50%
Fuel	natural gas, biomethane
Electrical efficiency (NCV)	> 30-35%
Total CHP efficiency	> 95% (at 40/30 ° C)

Integrated auxiliary heater

Type	condensing appliance
Output	4-20 kW
Efficiency	109% (η_N at 40/30 ° C)

Complete system

Total efficiency	> 95% (according to EN 50465 at 60/40 ° C flow/return)
Dimensions (mm)	580 long x 620 wide x 1,640 high
Weight	approx. 170 kg
Housing	coated, fully enclosed
Natural gas pressure	20-25 mbar (EN 437)
Electrical connection	230 V/50 Hz
Operating mode	heat-controlled, energy manager-controlled; remote control option

Vaillant fuel cell heating appliance

(Technical target values)



Type	solid oxide fuel cell (SOFC)
Output (e/th)	max. 1.0 kWe/2.0 kWth
Application	single-family home
Fuel	natural gas, biomethane
Electrical efficiency (NCV)	30%
Total CHP efficiency	80 – 85%

Appliance data

Dimensions (mm)	600 long x 625 wide x 986 high
Weight	approx. 150 kg
Housing	coated, fully enclosed
Natural gas pressure	20-25 mbar (EN 437)
Electrical connection	230 V/ 50 Hz
Operating mode	heat-controlled, energy manager-controlled; remote control option

External peak heater

Type	condensing appliance
Output	configuration as required by user
Efficiency	109% (η_N at 40/30 ° C)

Lessons learnt ... on selection of test sites

- Selection of sites has to be organised in close co-operation with the manufacturer (appliance requirements)
- Start as early as possible with pre-selection and selection
- A certain number of sites will not fit to requirements
- Take even care about minimum requirements (gas connection!)
- Take care to select a minimum number of very proper objects for dissemination and events

Lessons learnt ... on management of end-users

- End-users doesn't normally care about the test-conditions
- They expect first of all a reliable system with ideally 100% availability
- Loss of comfort (heat!) is out of any discussion!
- Define clearly what the end-user can expect and explain them carefully
- Contracts from utility with end-users recommended

Lessons learnt ... on contact with utilities

- Development and negotiation of contracts of manufacturers and utilities takes more time than anyone of us expects (in Callux up to 2 years!)
- Define clearly the responsibilities in the process
- Define the post-trial-scenario (what happens after the trial?)
- Define a start of the trial time (e.g. 4 weeks after delivery of the system).

Lessons learnt ... on data collection & monitoring

- You will never get data in that quality you want to have
 - Define responsibilities for the complete data monitoring chain
 - Sequence of definition is:
 1. Which results we wish to have?
 2. Which values do we need therefore?
 3. Which measurement equipment is necessary?
- NOT vice-versa!
- Approach of 10%/90% is the right one

Lessons learnt ... on dissemination activities

- We need to communicate in full professional way
- Without sufficient communication we will not achieve our targets!
- Callux has become a strong brand. Can we gain this for ene.field as well?
- Do not forget the policy! We need them on board by launching the products
- Try to get synergies with other Fuel Cell and Hydrogen activities in communication

Thank you.



Gefördert durch:



Bundesministerium
für Verkehr, Bau
und Stadtentwicklung



aufgrund eines Beschlusses
des Deutschen Bundestages



Nationale Organisation Wasserstoff- und Brennstoffzellentechnologie

