D2Service

Design of 2 Technologies and Applications to Service

Programme Review Days 2019

Brussels, 19-20 November 2019

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PROJECT OVERIVEW

- **Call year: 2014**
- **Call topic:** Significant improvement of installation and service for fuel cell systems by Design-to-Service
- **Project dates:** 01/09/2015 – 31/03/2020
- **% stage of implementation 01/11/2019:** 85%
- **Total project budget:** 3 636 797.50 **€**
- **FCH JU max. contribution:** 2 953 790.75 **€**
- **Other financial contribution:** 683 006.75 **€**
- **Partners:** SOLIDpower, Ballard Power Systems Europe, Bosal Emission Control Systems, Energy Partner, The hydrogen and fuel cell center ZBT GmbH, DLR Institute of Networked Energy Systems

PROJECT SUMMARY

D2Service - Design of 2 Technologies and Applications to Service

The project aims at simplifying both residential and commercial fuel cell systems for easy, fast and safe system service and maintenance.

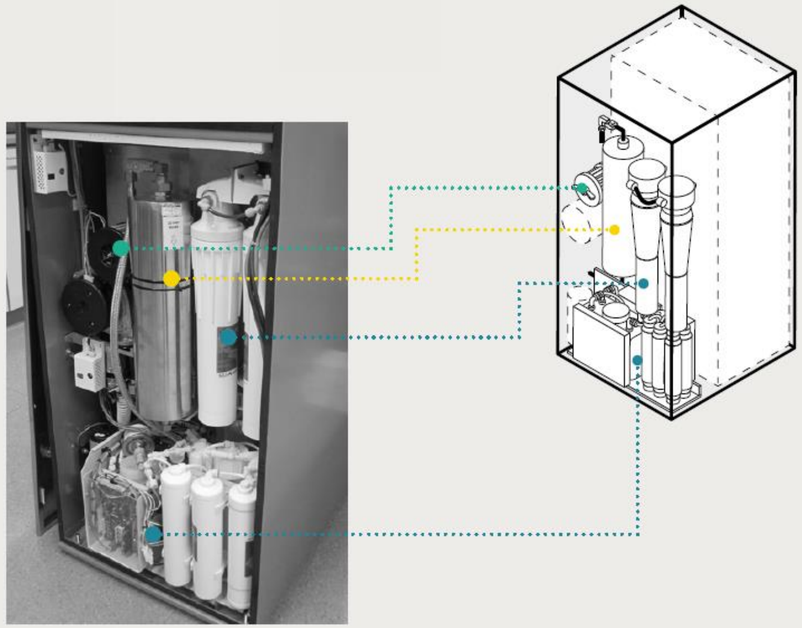
- 2 Technologies: SOFC and PEMFC
- 2 Applications: micro-CHP and back-up power systems

- 2 Manufacturers: SOLIDpower (IT) and Ballard (DK)
- 1 Component provider: Bosal (BE)
- 1 Energy service provider: Energy Partner (IT)
- 2 Research institutes: ZBT (DE) and DLR (DE)

PROJECT SUMMARY

D2Service - Activities

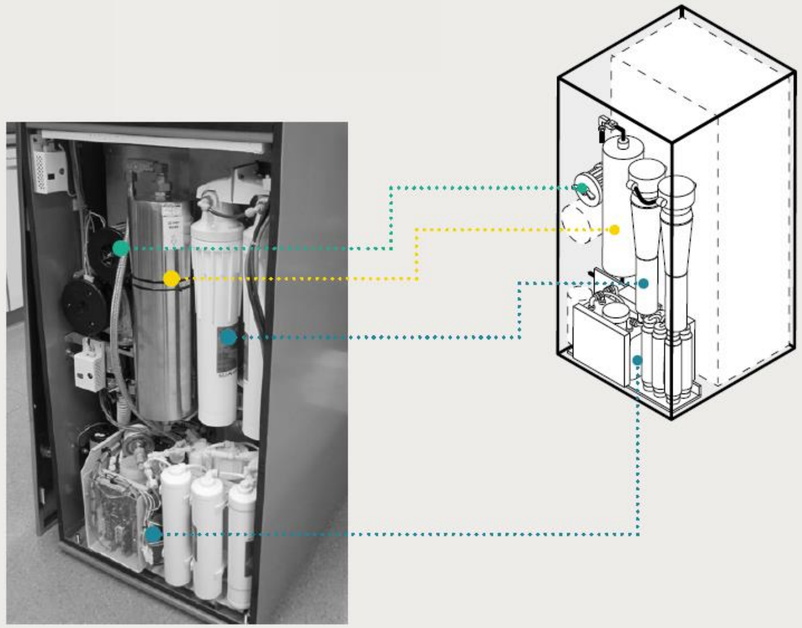
- Micro-CHP system design improvements
- Component lifetime improvements
- Remote monitoring and diagnostic tool developments
- Guidelines for easily understandable service manuals
- Laboratory tests
- Field trial



PROJECT SUMMARY

D2Service - Activities

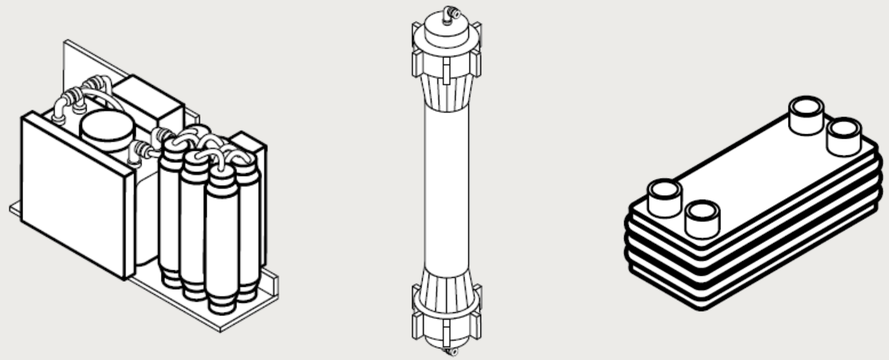
- **Micro-CHP system design improvements**
  - Layout and component position
  - Component complexity
  - On-site replacement of hot BoP and Stack
  - Hydraulic and electric connections
- Component lifetime improvements
- Remote monitoring and diagnostic tool developments
- Guidelines for easily understandable service manuals
- Laboratory tests
- Field trial



PROJECT SUMMARY

D2Service - Activities

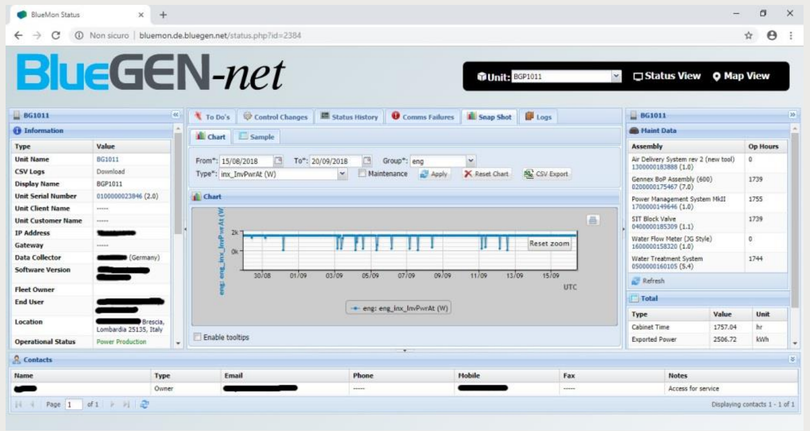
- Micro-CHP system design improvements
- **Component lifetime improvements**
  - Water clean-up optimization
  - Lifetime hydrodesulphurisation
  - Heat exchanger coating to prevent chromium evaporation
- Remote monitoring and diagnostic tool developments
- Guidelines for easily understandable service manuals
- Laboratory tests
- Field trial



PROJECT SUMMARY

D2Service - Activities

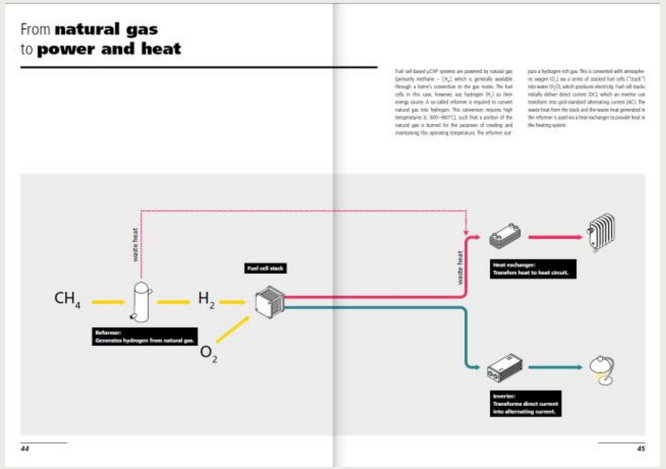
- Micro-CHP system design improvements
- Component lifetime improvements
- **Remote monitoring and diagnostic tool developments**
  - Improvement of remote monitoring tools
  - Estimation of remaining of life of fuel cell systems
- Guidelines for easily understandable service manuals
- Laboratory tests
- Field trial

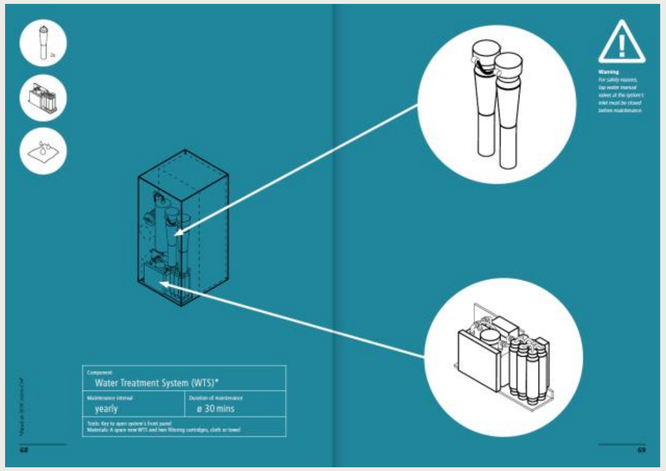


PROJECT SUMMARY

D2Service - Activities

- Micro-CHP system design improvements
- Component lifetime improvements
- Remote monitoring and diagnostic tool developments
- **Guidelines for easily understandable service manuals**
  - Enabling non-specialised technicians to perform service tasks
- Laboratory tests
- Field trial

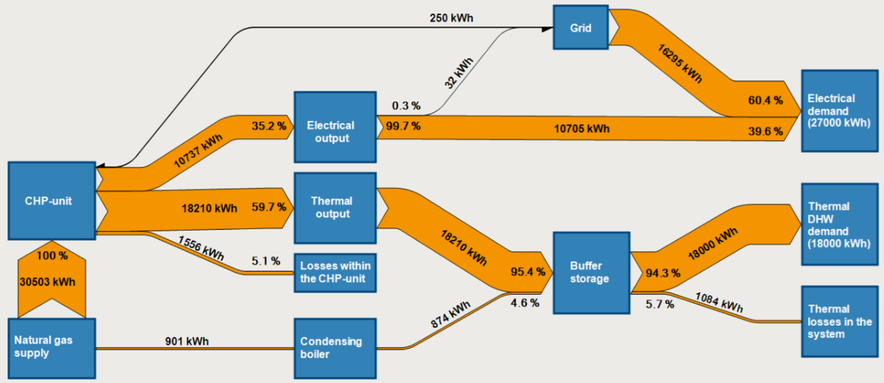




PROJECT SUMMARY

D2Service - Activities

- Micro-CHP system design improvements
- Component lifetime improvements
- Remote monitoring and diagnostic tool developments
- Guidelines for easily understandable service manuals
- **Laboratory tests**
  - Benchmark testing of micro-CHP systems
  - Long-term test of hydrodesulphurisation
- Field trial



PROJECT SUMMARY

D2Service - Activities

- Micro-CHP system design improvements
- Component lifetime improvements
- Remote monitoring and diagnostic tool developments
- Guidelines for easily understandable service manuals
- Laboratory tests
- **Field trial**
  - 4 SOFC micro-CHP systems installed at selected sites
  - 2 PEMFC back-up power units installed at telco provider facilities

Project Progress – KPIs for SOFC micro-CHP

Start value	Achievement to-date	Project Target
8h		<4h
4/a		<1/a
120h		<48h

- Service time / presence time of maintenance technician ca. 4h
- Service interval ca. 1/a
- Total down time for servicing depending on task 0 – 72 h

% stage of implementation is the % of project *duration* (months) elapsed on 01/11/2019

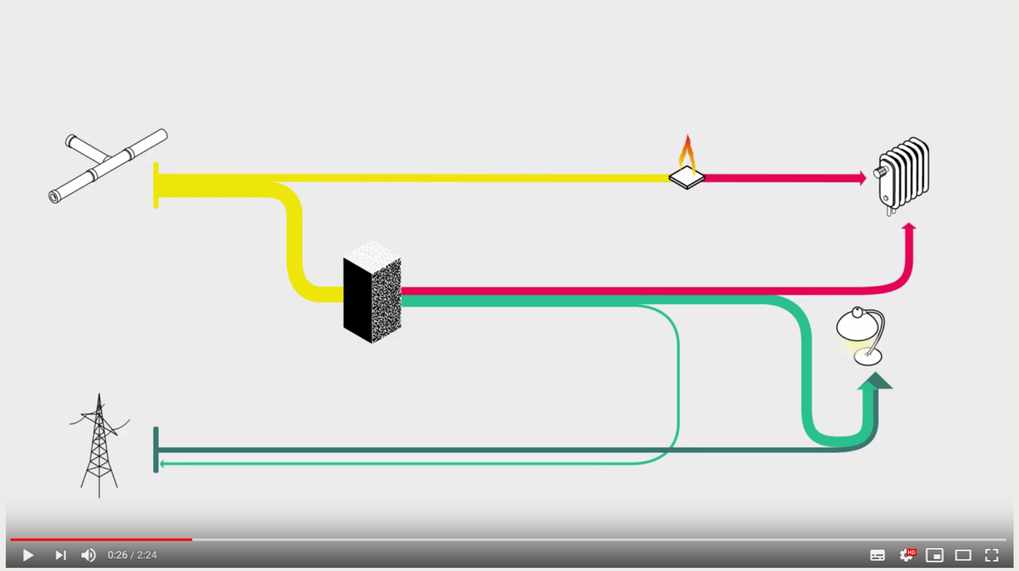
Risks and Challenges

- **Changing market environment and products:**
  - Withdrawal British Gas
  - Changes in manufacturers product strategies

- **Field trial installations:**
  - Technology partially new for authorities, grid providers etc.

Communications Activities

- Project website **www.project-d2service.eu**
- Project video
- Project presentations at conferences and industrial fairs
- Distribution of Manual Design Guidelines (project-d2service.eu/documents)



Exploitation Plan/Expected Impact

Exploitation

- System and component design improvements
- Service procedure improvements
- Service manual improvements
- Installation and service procedure improvements
- Reduced service costs
- Technology and experience transfer to new micro-CHP and back-up power models
- Development of new business models including micro-CHP systems

Impact

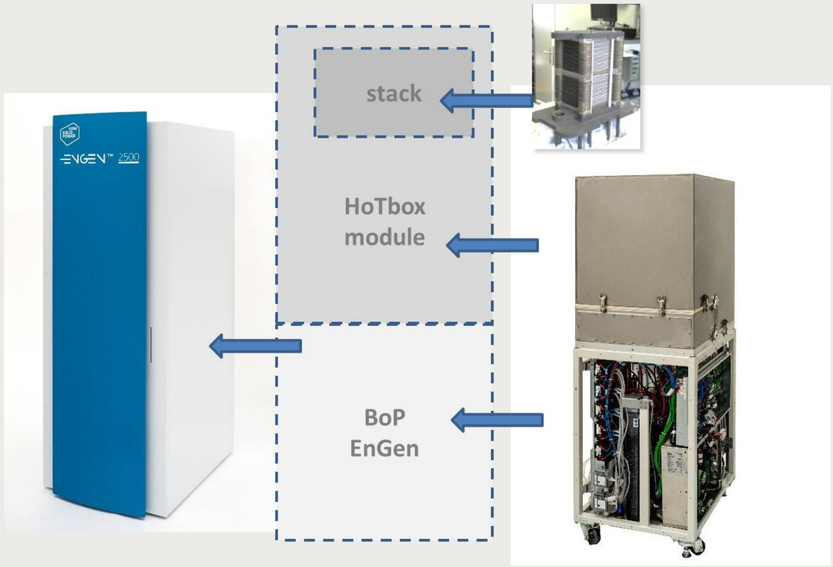
- Fuel cell-based micro-CHP and back-up power products are more readily available with lower cost of operation
- Spread of technology is enhanced by facilitating installation and service by local non-specialised technicians
- Possible higher market penetration yields improved efficiency in energy production and lower emissions than conventional energy production

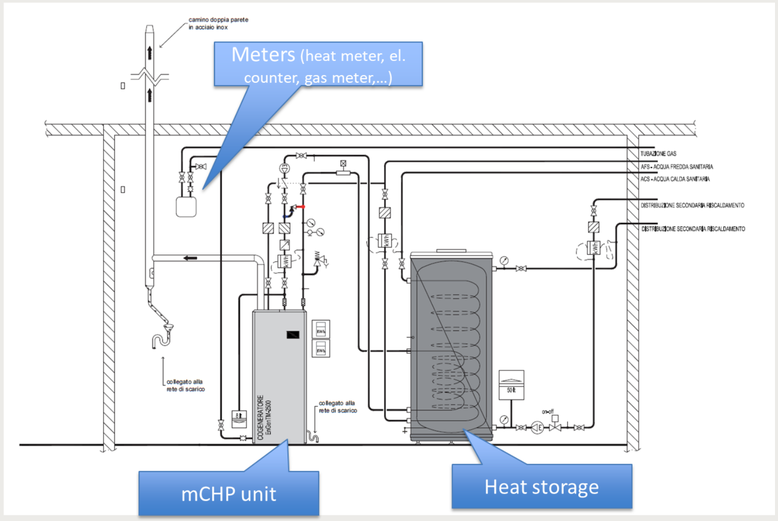
SOLIDpower activities in D2Service

- **ene.field and Crisalide projects**: EnGEN2500 (gamma)
  - limited serviceability
  - cold compartment devices surrounded by pipes and wires
  - access and replacement difficult, time consuming
  - Service strong impact on TCO

- **Annual Service:**
  - Replacement of consumables, e.g. filtering media
  - easy and fast consumables replacement
  - single operator

- **Periodical service:**
  - stack
  - minimal stacks size & weight -> on-site replacement





Service costs analysis – KPIs

- **KPIs selection**

KPI – annual service	Unit
Service cost/unit	euro
Material cost/unit	euro
Labour cost/unit	euro
N.of operators/unit	number
Service complexity Index	points

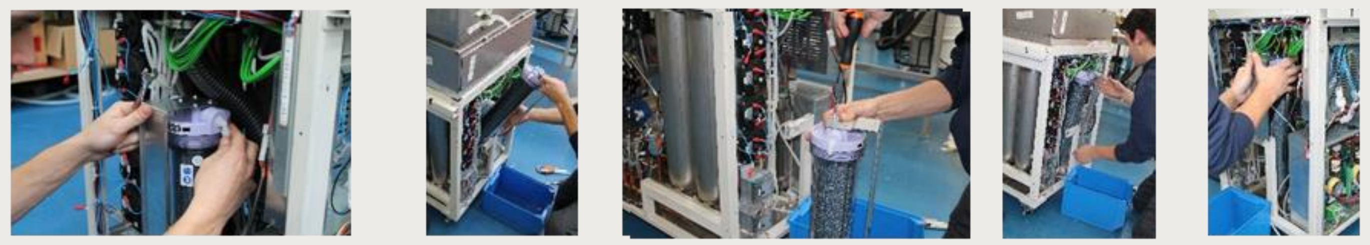
It includes:
- Availability for handling
- Availability for sight
- Availability for tooling
- Risk of damage
- Risk of loose some components
- Risk to make mistake
- Ergonomics

Service costs analysis – KPIs evaluation and ranking

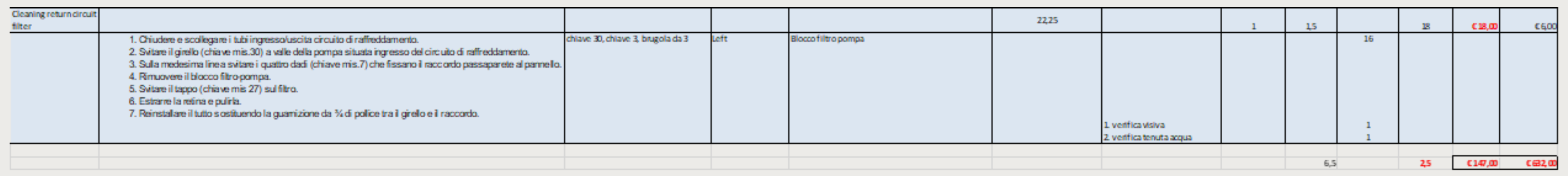
KPIs List

Yearly Maintenance													
									Time			Cost	
Operation	*Descriptio*	*Tools*	*Side*	*Components to be*	*Complexity of operation*	*QC of operation*	*# operato*	*hr man*	*Estimation*	*Measured*	*Meas. Cu*	*labor*	*raw materials*
									[hours]	*[min]*	*[min]*		
Cleaning return circuit filter					0		1		1,5		18	€ 0,00	€ 6,00
Desulphurizer					0		1		2,5		24	€ 0,00	€ 323,00
Cover removal and remounitng					0		1		0,5		30	€ 0,00	
Cover removal and remounitng					0		2		0,5		21	€ 0,00	
Water deionizer					0		1		1		15	€ 0,00	€ 152,00
Deionized water filter					0		1		0,5		18	€ 0,00	€38,00
BoP panel removal					0		1				13	€ 0,00	
BoP panel remounting					0		1				24	€ 0,00	
Cathodic air filter					0		1		0,5		3	€ 0,00	€55,00
External air filter					0		1		0,5		2	€ 0,00	€58,00
								0	2,5		2,5	€ 0,00	€ 632,00

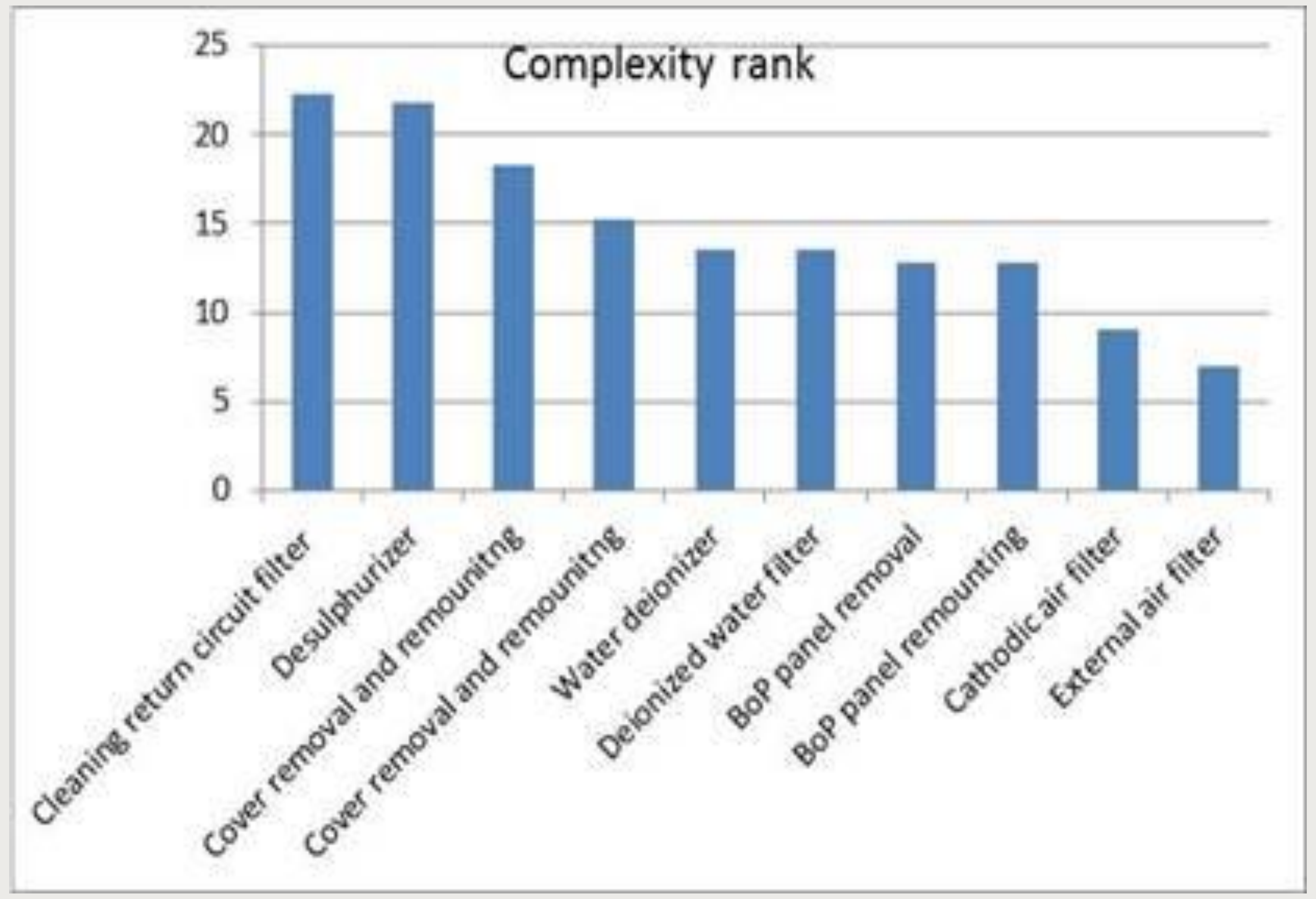
Service Operation Analysis

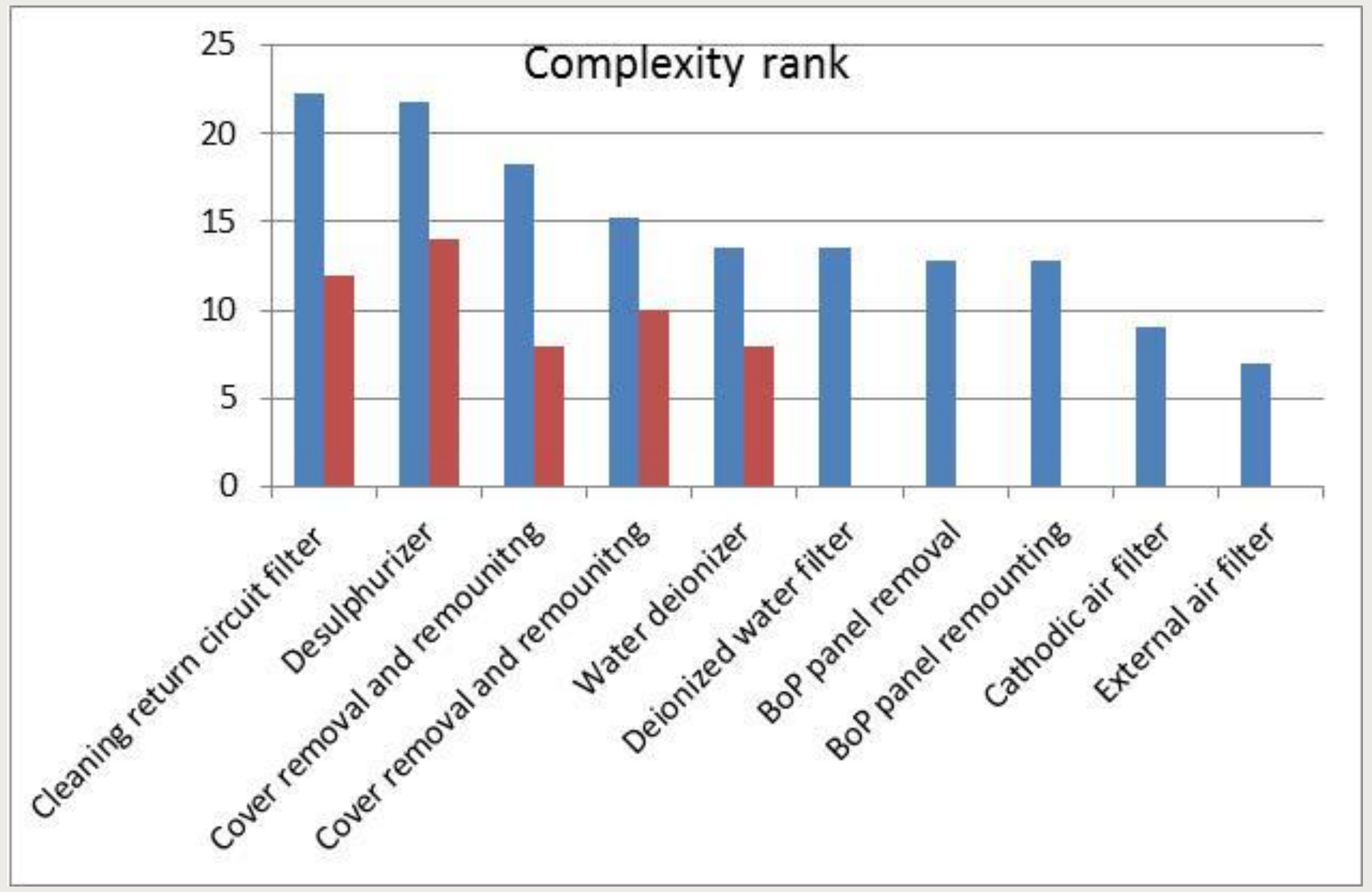


Service Operation Detailed Description



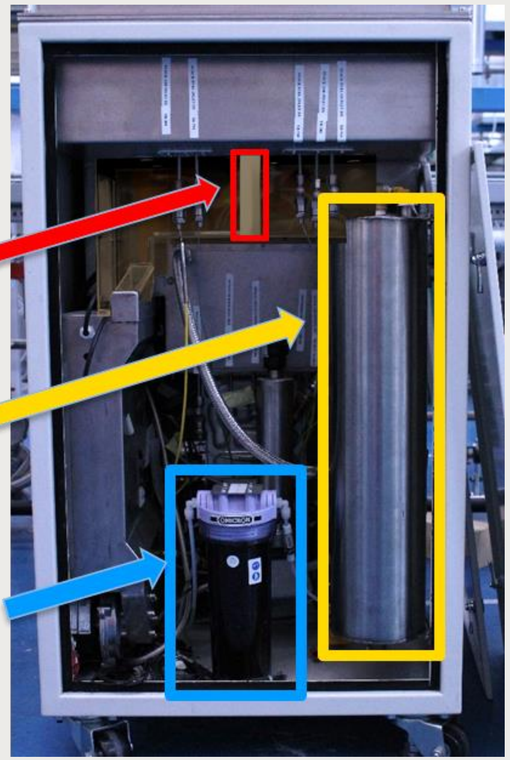
KPI optimization upon redesign



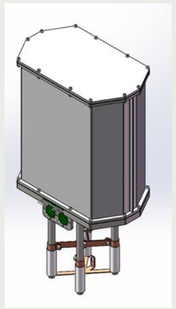


Outcome of improved serviceability on EnGen-2500

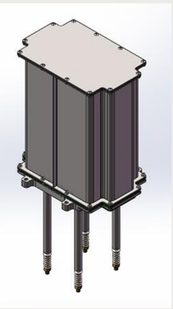
Yearly service parts can be replaced by opening the front panel



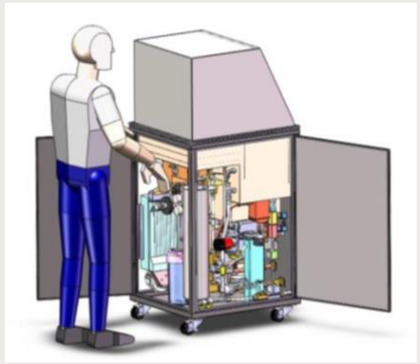
Stack size reduction



52% Weight Reduction
34% Volume
Reduction

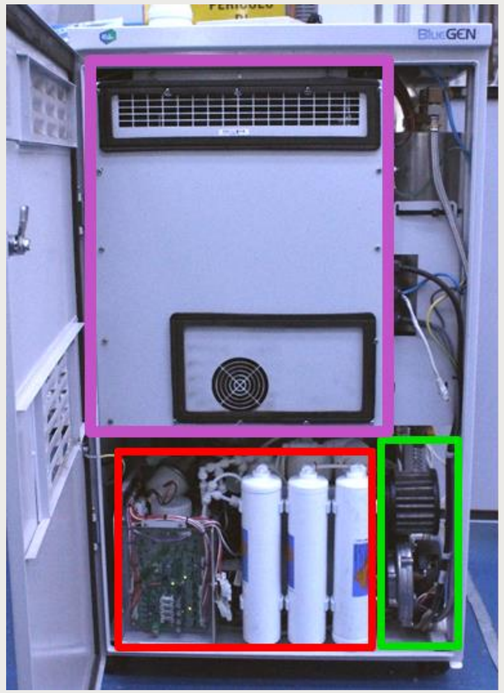


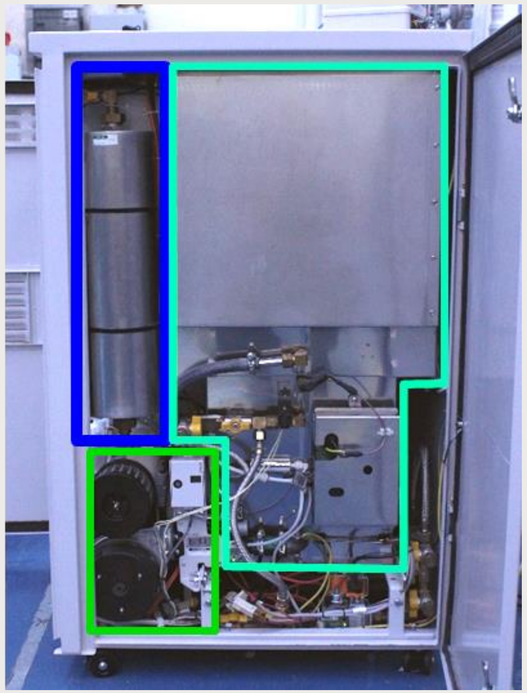
On-site stack replacement



Application of improved serviceability to BlueGen (1.5 kW unit)

Original BlueGEN
openings on front and right side for service



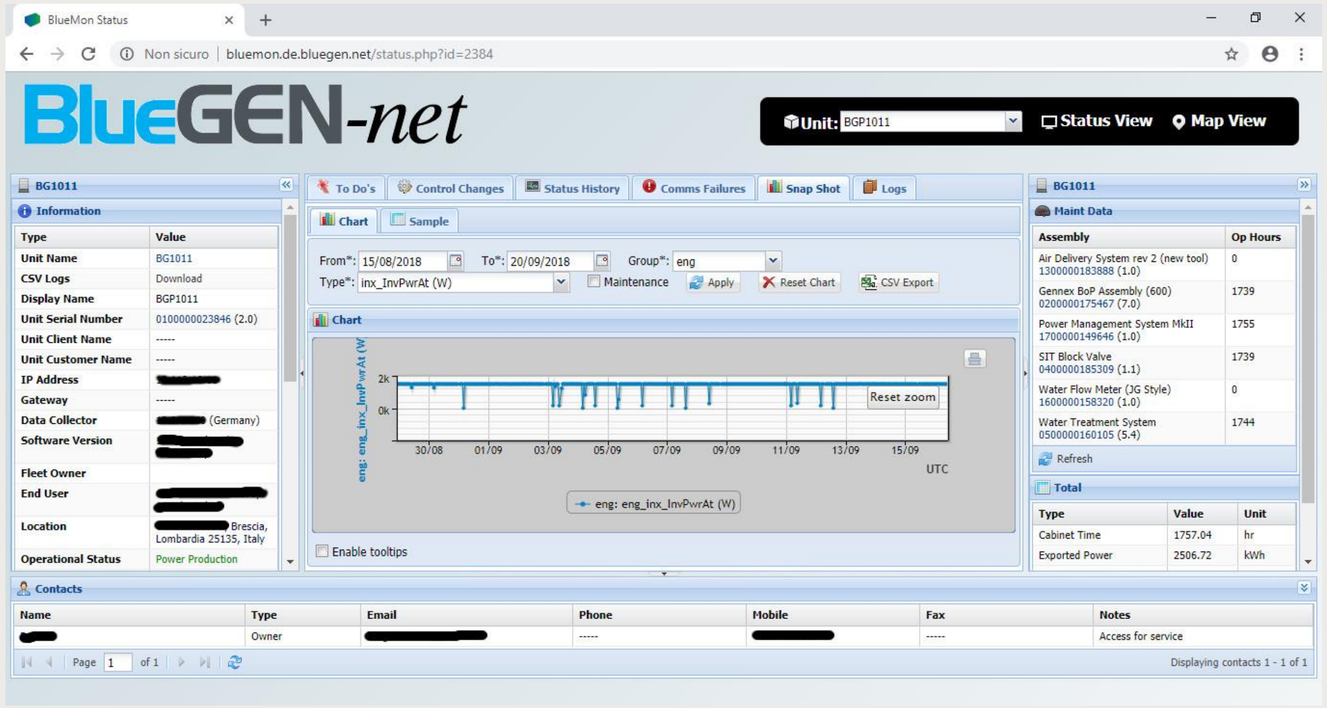


BG15
Single door opening for service

SOLIDpower monitoring tools

Monitoring tools

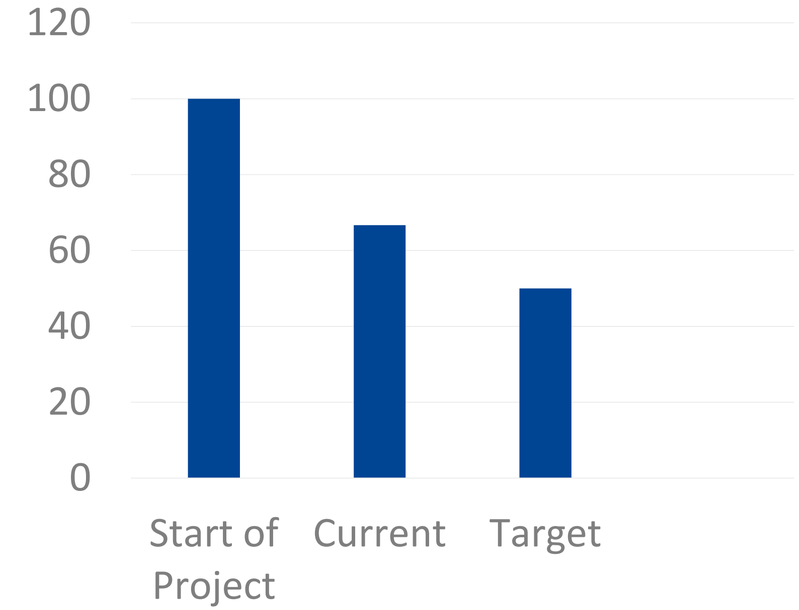
- know status of each system
- check alarms and warnings
- adjust operation parameters to prevent failures
- plan service intervention
- data gathering for improved understanding



SOLIDpower installations in D2Service

- Four BG15 installed in field tests in different locations in Italy, one at DLR facilities in Oldenburg
- used to test control software up-dates that reduced system degradation rate to very low values.
- improved serviceability: some tasks (air filter exchange) can be performed by the customer service manual and a minimal training.

Service Costs Trend



Learnings from Gen to Gen