



FutureGas WP2

November
2019

WORK IN WP2

Main activities in WP2

Work Finalized

➔ Report 2.0 Gases in the scope of the project FUTUREGAS (with WP1) Report delivered end of 2016. Updated early 2017.

Jean Schweitzer, DGC, Torben Kvist, DGC, Jesper Bruun, Energinet. Revision February 2017.

Focus: The document describes the scope of the gas types for the project FutureGas. Both the type of gases and the variation of key parameters are defined to make clear the boundaries of the work, especially in WP1 and WP2. Too wide boundaries will make the study less accurate and, so, less conclusive. On the other hand, too narrow boundaries may not cover the future gases that we will have in the grid! It is, therefore, important to use as a basis realistic scenarios for the development of gas quality. To that end we have used two existing studies reflecting the state of the art for gas quality development on the EU market. The proposed scope for gases presented in this document was elaborated with the decisions taken during a workshop on 14 June 2016. Five scenarios are proposed:

- Scenario 1 = Natural gas H with future harmonized Wobbe
- Scenario 2 = Natural gas H with 10% H₂
- Scenario 3 = 100% H₂ (or NG + more than 10% H₂)
- Scenario 4 = Not upgraded biogas (e.g. 60% CH₄)
- Scenario 5 = Not upgraded syngas

➔ Report 2.1 Danish natural gas utilisation today. Mapping of the Danish natural gas utilisation and evolution. Report delivered early 2017. Updated November 2019.

Jean Schweitzer, DGC (overall), Lars Jørgensen, DGC (industry), Jan de Wit, DGC (power production), Negar Sadegh, DTU (domestic gas technologies), with review and contributions from HMN, Frauke Wiese, DTU, Jesper Bruun, Energinet, Mannes Wolters, TU Delft, Jan Jensen, DGC.

Focus: The WP2 objective is to clarify how well the gas applications and utilisations are able to accommodate the gases that are expected to be in the future gas grid. The specific work in task 2.1 is to establish a map of the present gas utilisation with a "gas quality perspective". In other

words, we intend to show how gas is used, how much is used and by whom. This is done by looking at application families with a similar function and expected to react in a similar way to gas quality changes. The work and conclusions from this report will be used further in the FutureGas project, especially for the modelling work. The report is therefore providing details on the various segments of utilisation and information on expected developments for each of those segments based on the market drivers that are known today. The overall context for gas at a 2050 horizon is not known, but many projections seem to indicate that:

- Gas consumption in 2050 will be about half of what we have today.
- Only a few per cent of the gas distributed will be natural gas.

The investigation has as far as possible taken this context into account when making the projection work (mapping of gas utilisation in the future). The work is essentially based on a segmentation done in 2009 with the database from the Danish natural gas distribution companies. The existing data have been updated and completed, and a work of sub-segmentation was executed for segments like power production and industry. The data have been processed further in order to fulfil the requirements and needs of the project and especially the modelling of industrial use of gas. As a result, the report presents a realistic view of the present gas appliance population in Denmark. The population is organized in segments of technologies assuming that for a given segment the impact of gas quality will be similar.

The use of gases is organised in 4 main groups:

- Industry
- Domestic and commercial
- Power production
- Transportation sector

These groups are further divided into sub-groups (segments), and for each the number of appliances installed, their average capacity and gas consumption are established.

Finally, the report gives some trends for the market evolution after 2015.

➔ **Report 2.2 Impact of gas quality on appliances (and utilisations). Report delivered mid-2017. Updated November 2019.**

Jean Schweitzer, DGC, Jesper Bruun, Energinet, Negar Sadegh, DTU, Lars Jørgensen, DGC, Jan de Wit, DGC, with review and contributions from Mannes Wolters, TU Delft.

Focus: The integration of new gases in the gas grid and the development of the LNG market may bring new challenges to the population of appliances (using gas) already installed and to the new ones as well. This report gives a detailed analysis of the actual knowledge on how the different segments of utilisation are impacted by the possible gas quality variations. The report is based on existing literature gathered worldwide. Gas quality is a topic that is discussed on all continents, as the diversification of supply is increasing almost everywhere. Many investigations have been carried out in the EU in parallel to still ongoing discussions on gas quality harmonisation. However, the issue is complex, and the number of gas appliances is huge (about 200 million small domestic and commercial appliances have been installed in the EU), some of them being very specific or unique (e.g. customised applications for the industry). One of the main parameters used for the gas interchangeability is the Wobbe Index. Most gas applications are able to operate safely and efficiently within a given Wobbe Index band. Today's challenge is that in general, LNGs have high Wobbe Index and upgraded biogas has low Wobbe Index. An ideal situation would be to have a very broad range covering both cases. But in practice, this may lead to safety or operational issues with some applications.

The report summarises today's situation. At the moment, Wobbe variations of $\pm 5\%$ seem to offer a good compromise for the vast majority of applications. Technical developments also offer possibilities to extend the range in the future. A specific report will be prepared to discuss those technologies, but this report is already introducing the mitigation solutions segment by segment.

Hydrogen may to some extent be injected in the grid, but it presents a challenge for a number of applications. The advantages of injecting 10% H₂ or so (what is believed today to be possible for a number of applications) have to be compared to the cost of it (infrastructure to make this possible, solving the issues for the applications that cannot cope with it).

After release of the report in June 2017, we have contacted some known EU combustion experts in order to get feedback on the report. The report 2.2 was updated in 2018, and some of the results were presented during a gas harmonisation-stakeholder meeting in Brussels early 2018. The results were also discussed in detail with EU JRC (Joint Research Centre)

➔ **Report 2.3.1 Laboratory tests. Design of the test. Draft delivered May 2018.**

Negar Sadegh, DTU, Jean Schweitzer, DGC

Focus: In the framework of the FutureGas project, task 3 of the WP2 is dedicated to laboratory tests. The test program includes the evaluation of gas quality mitigation solution in support of task 4 of WP2. The report describes a test protocol for condensing boilers equipped with combustion controls. The technology is already used in several boilers on the market and could become a standard in the future. The objective of the tests is to verify the performances of the combustion controls with various gases including gases with very low Wobbe, gases with very high Wobbe and gases with hydrogen.

➔ **Report 2.3.2 Laboratory tests. Results. Report delivered Nov. 2018.**

"Self-regulated gas boilers able to cope with gas quality variation

State of the art and performances". Report, October 2018. Jean Schweitzer, DGC; Negar Sadegh, DGC-DTU; Stéphane Carpentier, CRIGEN; Patrick Milin, CRIGEN; Nourreddine Mostefaoui, CETIAT, Petra Nitschke-Kowsky, E.ON; Olivier Thibaut, GAS.BE

Focus: The testing in WP2 is dedicated to the evaluation of the combustion control systems that are designed to help the gas appliances to burn safely and efficiently natural gas of varying quality (composition). The tests were executed early 2018. This work is also subject to collaboration with 4 international gas testing laboratories. In addition, tests are also carried out to check the influence of gas quality on start-stop emissions of unburned hydrocarbons on boilers. The tests have shown that appliances equipped with combustion controls (here based on flame ionisation) are able to maintain an air/gas ratio of appliances in a way that safety, efficiency and emissions are maintained close to nominal conditions, despite very large variations of gas quality covering band L and H of Europeans gas qualities! Hydrogen, however, is not detected by the ionisation, and, therefore, the control system cannot be used for H₂/natural gas mix. The system is rather simple and low-cost, and it is already installed on several commercial boilers on the market. Most probably the system can also be installed on other gas appliances and would simplify the EU market of gas appliance if widely used.

➔ **2.3.3 Execution of tests. CH₄ emissions**

Tests in laboratory have also been executed on unburned hydrocarbon / CH₄ emissions of domestic gas boilers. The tests are confirming that the emissions are occurring during the start and stop phases of the burners. As a result, the start-stop frequency of the burner is a fundamental parameter. The start-stop frequency of installed boilers is presently investigated in the framework of a DGC project. The gas quality also impacts the CH₄ emissions.

➔ **2.4 Investigation of existing and upcoming solutions to broaden gas quality variations (sensors, etc.).**

A large number of reference documents, studies, technologies, etc. have been gathered and analysed.

For small installations the literature work and testing were made together with 4 other laboratories and an extended report was issued (see 2.3.2).

For larger applications a note was prepared: "Mitigation measures to gas quality variations in the process and power industry" June 2018 - Henrik Iskov, DGC

A report "WP2 Gas Quality Requirement Task 4 Solutions to equip sensitive appliances Jean Schweitzer, Nov. 2019" was issued as main deliverable for this task.

➔ **2.5 Analysis of future potentials with focus on gas use in the industrial sector.**

For this task, we have been working with the IGU (International Gas Union) in order to gather international experience on the impact of gas quality on industrial applications. A report was prepared: "Impact of gas quality on utilization. Impact on: Industrial use (processes and power production), Mobility (vehicles, ships, etc.), Domestic use". Prepared by: Alice Vatin, ENGIE, Jean Schweitzer, DGC, and Aksel Hauge Pedersen, Ørsted (DONG Energy). It was officially released for the WGC 2018 in Washington June 2018, and this document is the main source for the deliverable

➔ **2.5.1 Catalogue of industrial utilisations.**

There is one other deliverable for task 5:

➔ **2.5.2 Linking the catalogue with applications in Denmark & Overall conclusions.**

Linking the catalogue with applications in Denmark was extensively done in 2.1.2. and resulted in a report:

Report of future potentials on gas use in industry. Overall conclusions. Delivered May 2018. *Jan de Wit, DGC, Lars Jørgensen, DGC.* Industry and power production are significant user segments for European & Danish gas sales. The reports discuss the prospects for both sectors in view of gas quality change and context around the gas utilisations in general.

Conference Proceedings

Two papers have been submitted as conference proceedings. One of the conference papers was presented at the International Gas Union Research Conference – Rio 2017, Brazil (IGRC 2017). Another paper was presented at the WGC (World Gas Conference) in Washington, June 2018.

IGRC2017: European Knowledge Sharing on the Influence of Natural Gas Quality on Gas Utilization.

J. Schweitzer, DGC, N. Sadegh, DTU, J. Lana, Enagás, S.A., U. Klaas, DVGW

Focus: The paper focuses on the work done in collaboration with EU gas industry partners to gather facts and figures on the impact of gas quality variation on appliances. Together with MARCOGAZ we have launched an initiative among its members to identify, collect and analyse results of current and past investigations related to the influence of natural gas quality on gas applications. This initiative includes the identification of research projects and solutions/technologies on how to deal with the variation in gas quality and its possible impact on the safety, efficiency and emissions of the applications. The paper brings preliminary results that subsequently have been implemented in the report 2.2.

WGC2018 : World Wide Study of Impact of Gas Quality Variations on Appliances (and Utilisations)

J. Schweitzer, DGC

Focus: In line with report 2.2 and the IGRC paper, this paper brings a final overview of the present knowledge about gas quality impact worldwide. It will include input from the EU as well as from USA and Asia. The audience of WGC (and specifically the audience for the dedicated session on gas quality) will be used to call for further identification of studies and knowledge that have not yet been found by the FutureGas WP2 team.

EGATEC 2019: Self-regulated gas boilers able to cope with gas quality variation. State of the art and performances.

J. Schweitzer, DGC

Focus: In line with report 2.3.2, this paper presents the investigation carried out and positive results obtained.

IGRC2020: CH₄ emissions from gas boilers.

J. Schweitzer, DGC

Focus: The paper will deliver the main findings of the work carried out on this topic (see 2.3.3).

Other Presentations

A large number of presentations have been given at different workshops, meetings, etc. Among others:

- **“Gas quality” GasAkademin, Sweden 2017**
Jean Schweitzer, DGC, Negar Sadegh, DTU
- **“FUTUREGAS WP2 Gas Quality Requirements for End-Use. Status.” Meeting of the DK gas industry, Hørsholm, September 2017.**
Jean Schweitzer, DGC
- **“FUTUREGAS WP2 Impact of gas quality on appliances (and utilisations)” MARCOGAZ meeting. Study group GAS QUALITY. Presented at several meetings in Brussels in 2018.**
Jean Schweitzer, DGC
- **“FUTUREGAS WP2 Impact of gas quality on appliances (and utilisations)”. Presented at CEN Sector Forum Gas. Working Group. Gas Quality study. Brussels 23 march 2018.**
Jean Schweitzer, DGC
- **“Gas quality” GasAkademin, Malmö. Sweden 2018**
Jean Schweitzer, DGC

INFORMATION

Jean Schweitzer, DGC (jsc@dgc.dk)