Identification of the Possible Field of Application and Potentials of the Dual Fuel Technology – Summary Report

Identification of the Possible Field of Application and Potentials of the Dual Fuel Technology for Increasing Efficiency and Cost Effectiveness of CHP-Units with Experimental Verification of the Benefits of Using a Pilot Plant in Practical Operation

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Motivation / Starting position

With regard to the development goals for power generation by combined heat and power and the rising fuel prices it is becoming ever more important to increase the electricity yield of CHP plants. One possible approach is offered by dual fuel technology. Here a gaseous fuel is ignited and combusted by the injection a small amount of liquid fuel. Dual fuel engines can achieve a high electric efficiency based on their design and offer maximum flexibility regarding the choice of fuel and the mode of operation.

Object of the research project

The goal of the research project was to identify the potential advantages of the dual fuel technology compared to spark-ignited gas engines for CHP applications and to evaluate these advantages using a pilot plant. The focus was on CHP plants with a rated electrical power of 50 kW to 1 MW. These kinds of plants are well suited for supplying heat to public facilities, such as hospitals or swimming pools, and municipal and industrial small district heating systems. At the beginning of the project no dual fuel power units that run on natural gas in the investigated power range were available on the market. Dual fuel units capable of operating on the natural gas grid were the sole interest of the project, because on the one side natural gas is where the largest growth is predicted[1] and on the other side dual fuel technology has already established itself on the market for lean gases, such as biogas or wood gas. The company Burkhardt GmbH, a medium-sized manufacturer of CHP plants in the electric power range of 150 kW to 300 kW, could be gained as an industrial partner for the project. Among other products Burkhardt GmbH develops and sells dual fuel CHP plants based on diesel engines.

During the first phase of the project the available data regarding the existing CHP plants in Germany was obtained and today's market share of the dual fuel technology was analysed in order to assess the potential for expanding the dual fuel technologies field of application to natural gas applications. Dual fuel engines are currently mostly used for biogas applications. Following this assessment, the economic and ecological potential was compared to the current state of technology using a model calculation based on an existing dual fuel CHP unit manufactured by project partner Burkhardt GmbH.

During the second phase of the project a pilot dual duel CHP plant was set up and brought into service with the help of project partner Burkhardt GmbH to verify the results of the model calculation experimentally. With the pilot plant practical experience was gained over a period of 10,000 hours of operation. The goal was to verify the predicted advantages in efficiency as well as the economic and ecological benefits in practical operation. Also the suitability for daily use was to be evaluated. The

[1] Source: Arbeitsgemeinschaft: Deutsches Zentrum für Luft- und Raumfahrt (DLR), Fraunhofer Institut für Windenergie und Energiesystemtechnik (IWES), Ingenieurbüro für neue Energien (IFNE): Langfristszenarien und Strategien für den Ausbau der erneuerbaren Energien in Deutschland bei Berücksichtigung der Entwicklung in Europa und global – Schlussbericht; 2012

emphasis of the experiments was on the behaviour of the combustion and the exhaust emissions of the CHP plant, the calculation of the degree of efficiency during practical operation and the monitoring of the operational behaviour of the pilot plant over a period of at least 12 months.

Conclusion

To estimate the economic potential of the dual fuel technology model calculations (full cost accounting and sensitivity analysis) were performed for various scenarios. On the basis of the results of these calculations it is possible to say that dual fuel CHP plants are an interesting solution when the electric efficiency plays a significant role. This is the case when fuel costs and/or the electricity credit are high. From an ecological point of view neither particular advantages nor disadvantages could be determined regarding primary energy savings and CO_2 emissions in comparison to spark-ignited gas engines.

Based on the experimental results the predicted advantages in efficiency could be confirmed for the dual fuel technology. The pilot plant reached an electrical efficiency of up to 42.5 % and a total efficiency of over 80 % while operating under realistic test conditions. The levels of exhaust-gas emissions before the catalytic converter are high, which will require exhaust gas after-treatment in order to comply with the relevant emission regulations. This applies to the nitrous oxide emissions in particular, because of the particular combustion process based on diesel engines.

The operational behaviour of the pilot plant proved to be trouble-free. Apart from the downtime for regular service work and modifications for experiments no major outages occurred during the period of 10,000 hours of operation. Based on the results of the continuous-operation tests the predicted cost effectiveness could be confirmed.

In comparison to the current state of technology at the beginning of the project in the year 2012, the high electric efficiency of the dual fuel technology is currently no more the unique feature it once was. In the meantime (year 2014) spark-ignited gas CHP plants with comparable degrees of efficiency are increasingly being introduced to the market. It is to be expected that the dual fuel technology will be used for especially for niche applications, where highly efficient units with maximum flexibility regarding fuel choice and operation mode are required.