EGATEC2015
European Gas Technology Conference

GERG

Young Researcher's Prize

Nov 25, 2015

OVGW
ÖSTERREICHISCHE VEREINIGUNG FÜR DAS GAS- UND WASSERFACH

marcogaz
TECHNICAL ASSOCIATION OF THE EUROPEAN NATURAL GAS INDUSTRY

GERG
groupe européen de recherches gazières
the european gas research group

EGATEC2015
European Gas Technology Conference

Romain Bonabe de Rougé

A comparison of integration solutions for a gas Stirling micro-cogeneration system in residential buildings

GERG
Young Researcher‘s Prize

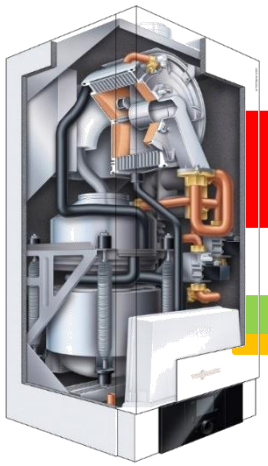
OVGW
ÖSTERREICHISCHE VEREINIGUNG FÜR DAS GAS- UND WASSERFACH

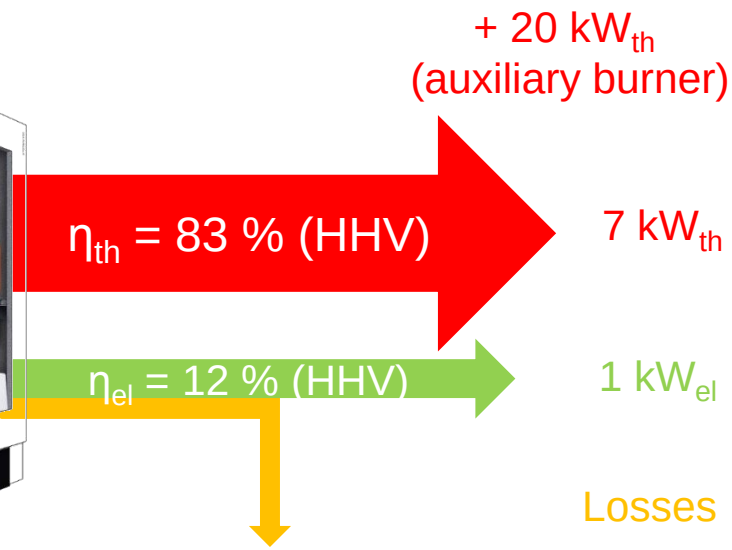
marcogaz
TECHNICAL ASSOCIATION OF THE EUROPEAN NATURAL GAS INDUSTRY

GERG
groupe européen de recherches gazières
the european gas research group

Context and objectives

- Context
  - Residential households
  - How cogeneration solutions can **reduce primary energy (PE) consumption**
  - How does it contribute to smart energy management at urban scale?
- Market emerging technology
  - Micro-Combined Heat and Power units (µCHP) – **Stirling Engine**
  - Generating electricity with high PE efficiency
  - Water tank for heat storage
- Objectives
  - Does **hydraulic configuration** influence the performance of µCHP?
  - Comparison of energy and technical performances through simulations

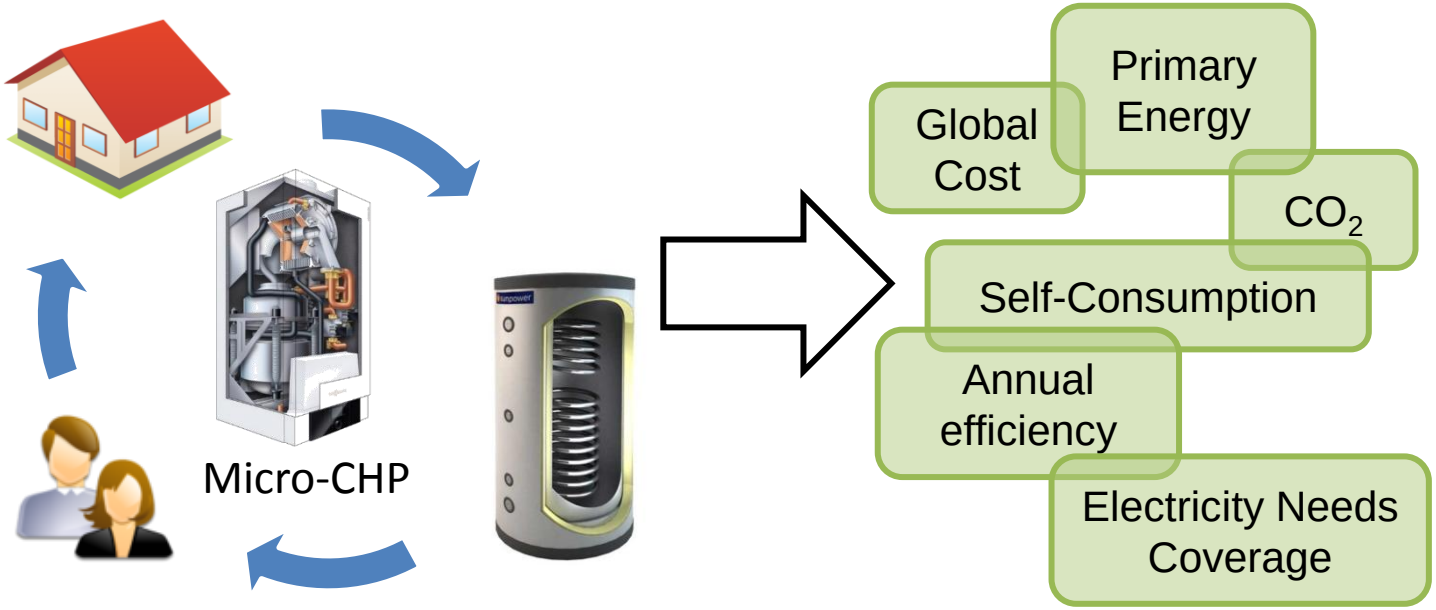




Approach

- Modeling
  - Modelica libraries to get dynamic HVAC systems models
  - Dynamic representations of thermal needs
  - Stochastical electrical consumption and occupancy profiles with 10 minutes timestep
- Evaluation
  - Primary Energy Consumption
  - Electricity Selfconsumption
  - Global Cost
  - ON/OFF cycles

Modeling

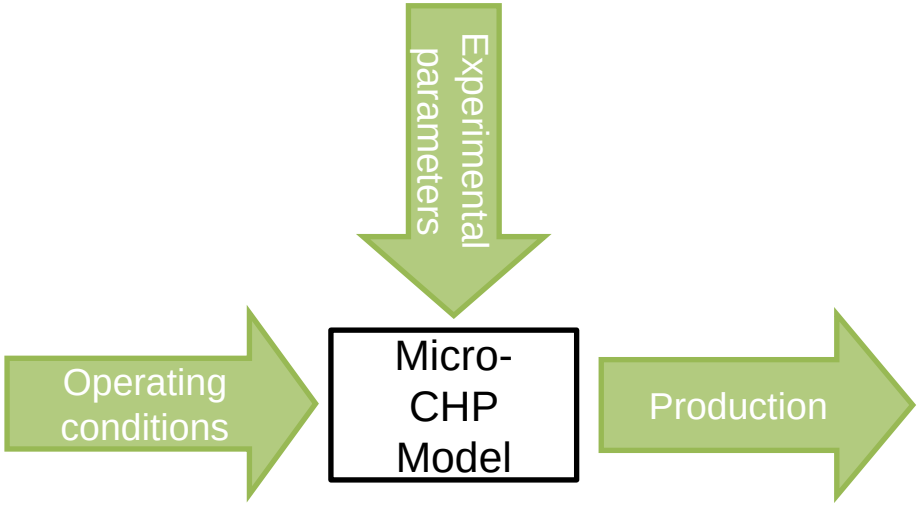


Evaluation

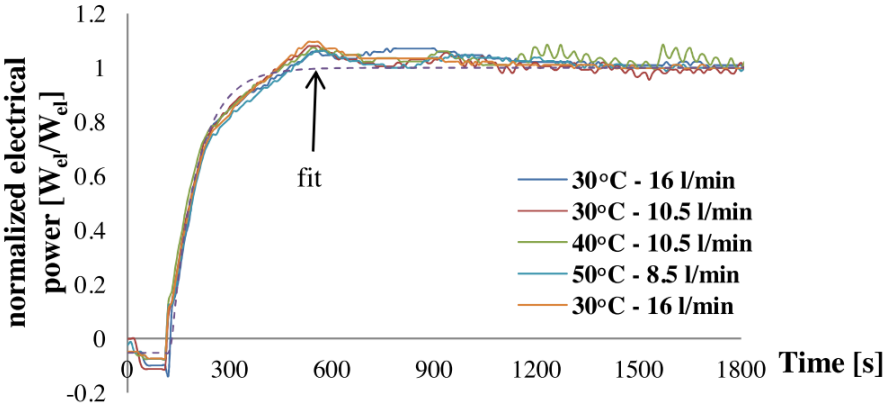
A semi-empirical model for Stirling Engine

EGATEC2015
European Gas Technology Conference

- **Grey-box model with dynamic** (start/stop) and steady-state equations
  - Based on **IEA Annex42**
  - **Reduced number of parameters** + first validation (Andlauer, 2011)
  - Calibration and validation from **experiments** (Bouvenot, 2014)
  - Implementation in Modelica environment (2015)



Principle of grey-box modeling



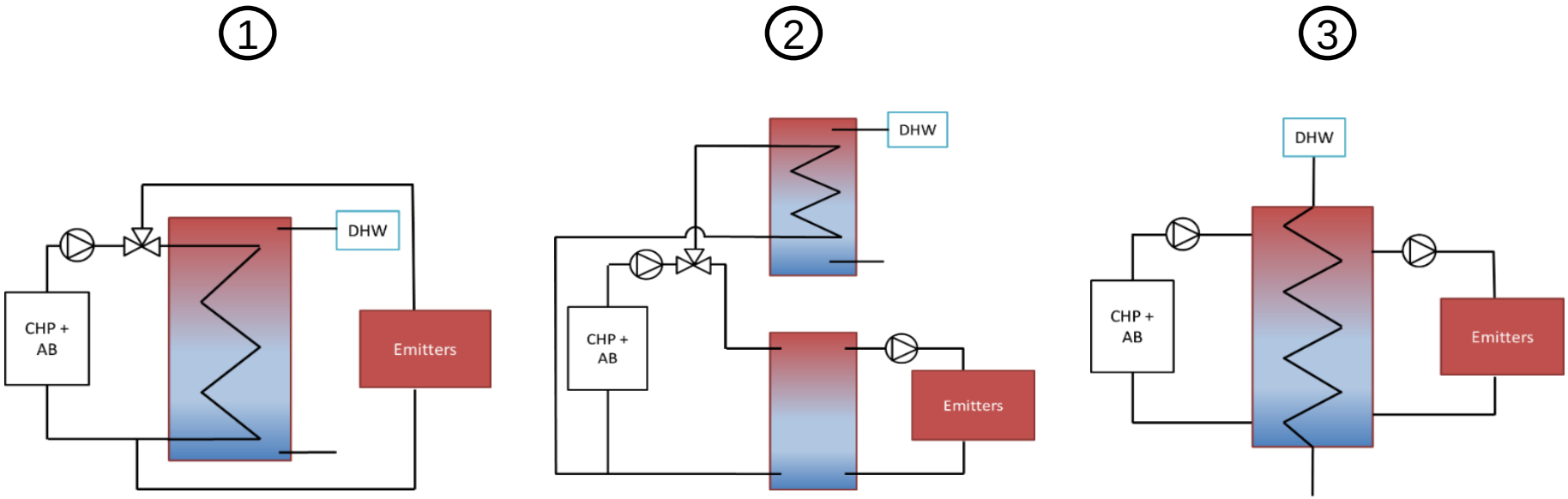
Experimental data from Bouvenot, 2014

OVGW ÖSTERREICHISCHE VEREINIGUNG FÜR DAS GAS- UND WASSERFACH
marcogaz TECHNICAL ASSOCIATION OF THE EUROPEAN NATURAL GAS INDUSTRY
GERG groupe européen de recherches gazières the european gas research group

Comparison of 3 possible integrations in a residential building

EGATEC2015
European Gas Technology Conference

- Schemes from manufacturers' recommendations

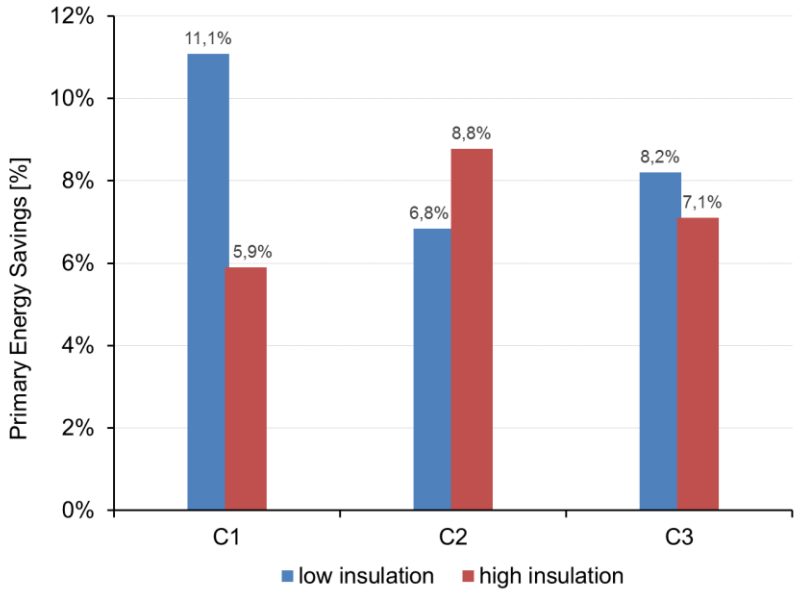


AB : Auxiliary Burner DHW : Domestic Hot Water

Example of results for 2 houses & perspectives

EGATEC2015
European Gas Technology Conference

- The best solution for primary energy savings is not the same according to the building



- Perspectives :
  - Evaluate more technologies
    → (fuel cells, micro-turbines, internal combustion engines)
  - Identify best sizing for other types of buildings
  - PhD defense planned end of 2017

Thank you for your kind attention