

Austrian Energy Agency

The Implementing Agreement on Advanced Fuel Cells - Focus: Fuel Cells for Stationary Applications

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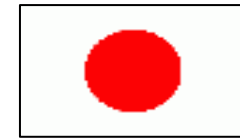
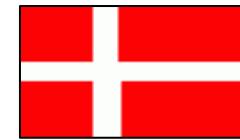
Contents

- Introduction to the AFC programme
- Activities of Task XIX/25: Stationary applications
- Analysis of the Austrian economic framework for the introduction of fuel cell/micro CHP systems
- Summary

Aims, scope & participation

- Aims to advance knowledge in the field of (advanced) fuel cells
- Task shared R&D + info exchange
- Covers technologies and applications for:
 - Polymer Fuel Cells (PEFC)
 - Solid Oxide Fuel Cells (SOFC)
 - Molten Carbonate Fuel Cells (MCFC)
- 19 participating countries
- Present period: 2009 – 2013
- Website: <http://www.ieafuelcell.com/>

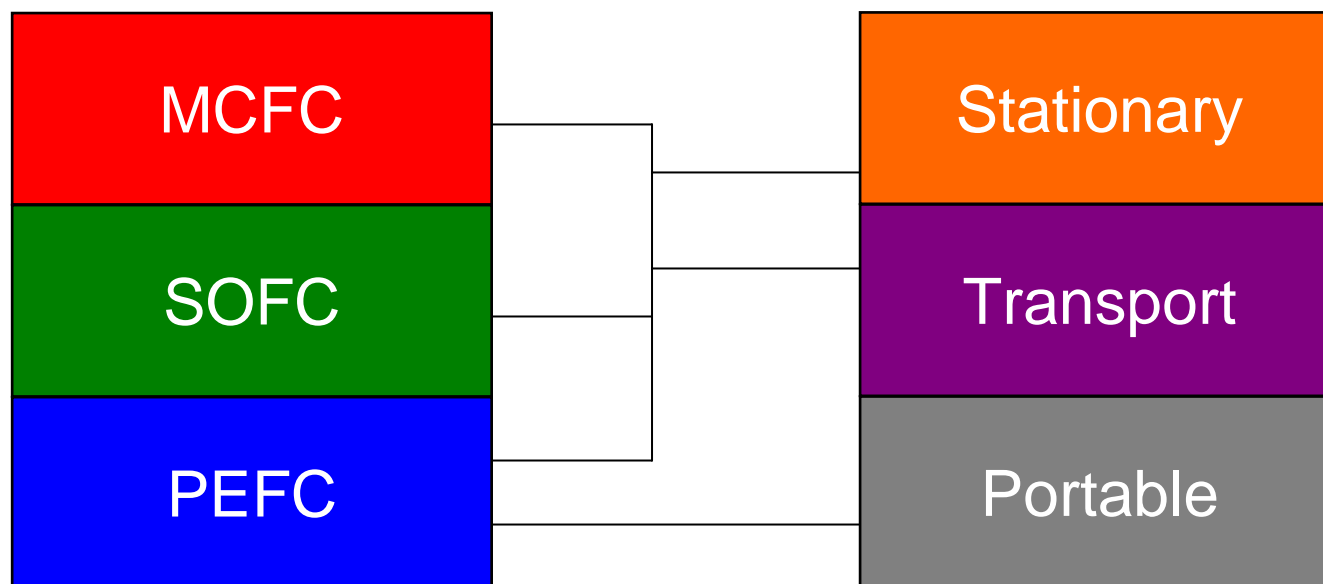
Participating countries



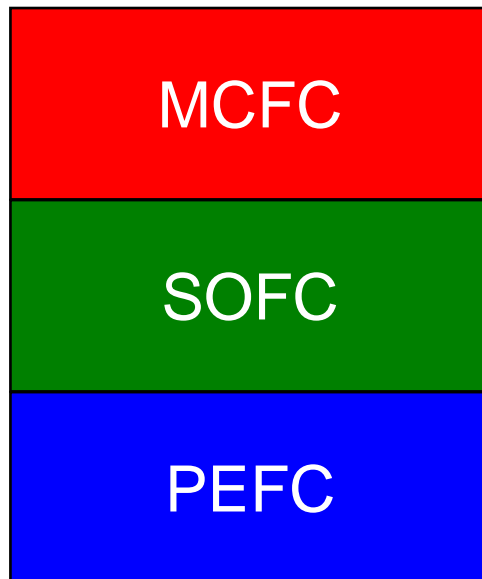
Annex structure

Technology annexes

Application annexes



IEA AFC programme 2009-2013



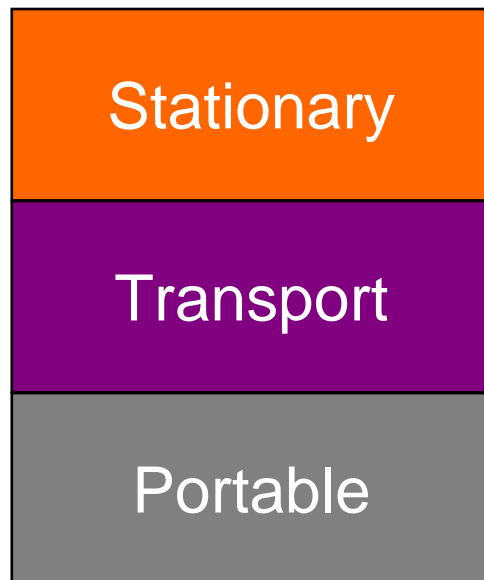
R&D activities

- Materials development (all)
- Component development (all)
- Stack/system modelling (PEFC, SOFC)
- Biomass fuelling (MCFC)

Demonstration activities

- Exchange of experience (MCFC, SOFC)

IEA AFC programme 2009-2013



Demonstration activities

- Exchange of demonstration experience
- System studies

Commercialisation activities

- Market & cost studies
- Well-to-wheel studies

Supporting activities

- Support to codes & standards authorities

In collaboration with other IEA Agreements including Hydrogen and Hybrid & Electric Vehicles

Austria's participation in the IEA AFC



- since Autumn 2004
- ExCo representation:
 - Austrian Energy Agency and
 - Fuel Cell Laboratory/TU Graz
- Participation in the following Annexes:
 - Annex XIX/25 - Stationary applications: Austrian Energy Agency
 - Annex XVI/22 - PEFC: Fuel Cell Laboratory/TU Graz
 - Annex XXI/27 - Portable applications: Fuel Cell Laboratory/TU Graz
- End of term report: 2004 - 2008
- Websites
 - National: http://www.energyagency.at/projekte/iea_afc07-09.htm

Introduction to Task 25 (former Task XIX): Stationary applications

- Main **objective** is to better understand how stationary fuel cell systems may be deployed in energy systems
- Subtask structure is as follows:
 - **Subtask 1: Small Stationary Fuel Cells**
Subtask leader; Ulf Birnbaum FZJ, Germany
 - **Subtask 2: Fuels for Fuel Cells**
Subtask leader: ENEA, Italy and Adwin Martens, WaterstofNet, Belgium (hydrogen)
 - **Subtask 3: Fuel cell plant components**
Subtask leader: Rolf Rosenberg, VTT, Finland
 - **Subtask 4: Analyzing design, operating and control strategies for stationary fuel cells systems**
Subtask leader: Whitney Collela, Sandia NL. USA
 - **Subtask 5: Follow up of demonstrations projects**
Subtask leader: Stephan Renz, Switzerland
 - **Subtask 6: Market status**
Subtask leader: Bengt Ridell, Grontmij, Sweden

Focus and Motivation of AEA activities within Task 25

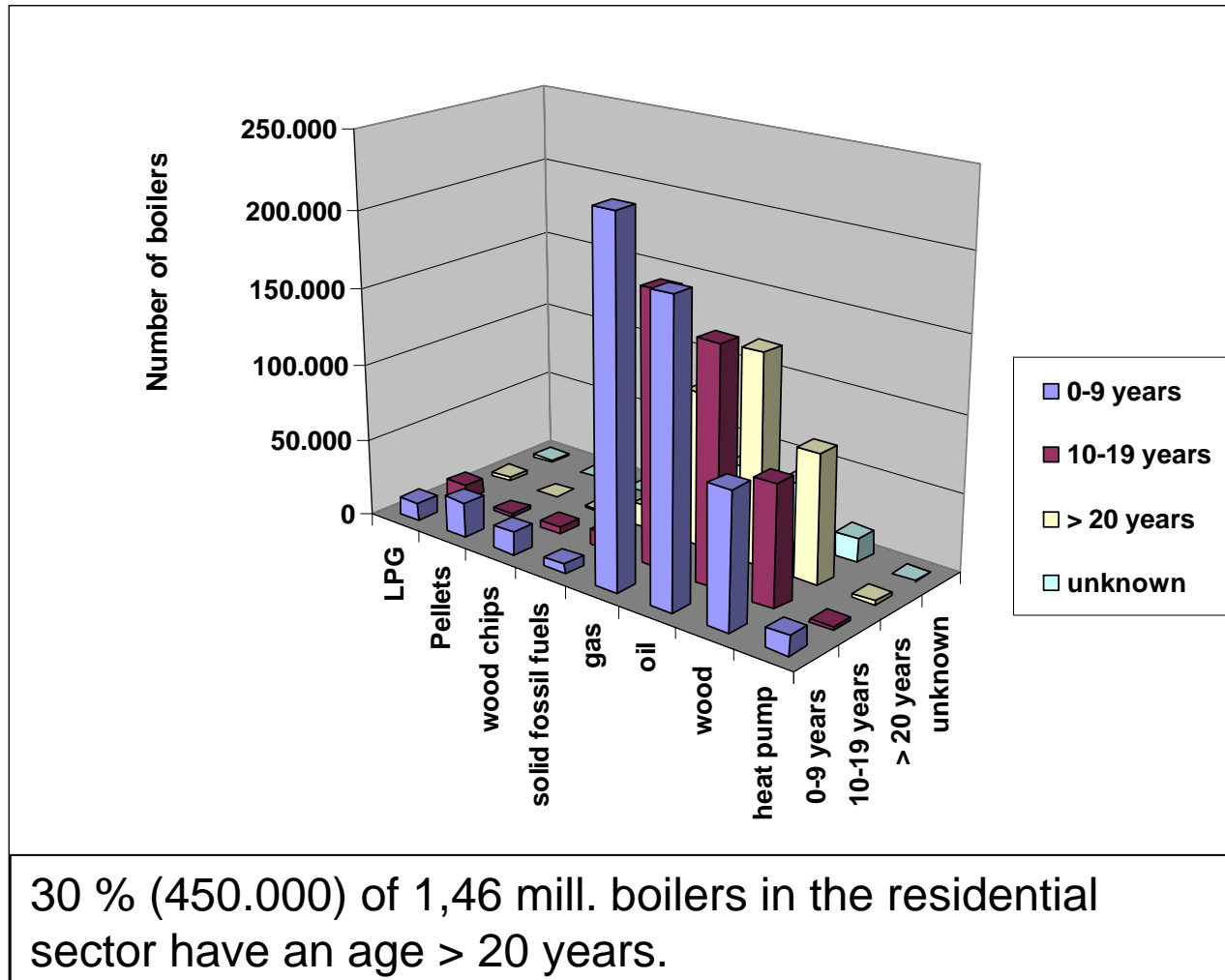
■ Focus

- Analysis of the techno-economic framework for the deployment of fuel cells/micro CHPs in Austria
- Identification of niche markets and of market segments for the deployment of fuel cells/micro CHPs in Austria (residential sector, applications in the industrial and commercial sectors)
- SWOT-Analysis for the market introduction of fuel cells/micro CHPs (incl. market transformation efforts)

■ Motivation

- Heat market is characterised by an old boiler stock in Austria
- EBPD - Energy Performance of Buildings Directive
 - Article 6: MS shall ensure that – before construction starts – the technical, environmental and economic feasibility of high-efficiency alternative systems is considered and taken into account (incl. CHP solutions)
 - Article 8: ... advice for operators of inefficient boilers for adequate replacements and/or alternative solutions
- Market introduction of boilers and micro CHPs received major attention by Austrian Bund/Länder authorities
- First subsidy schemes for micro CHPs are already in place

Boiler stock in Austria



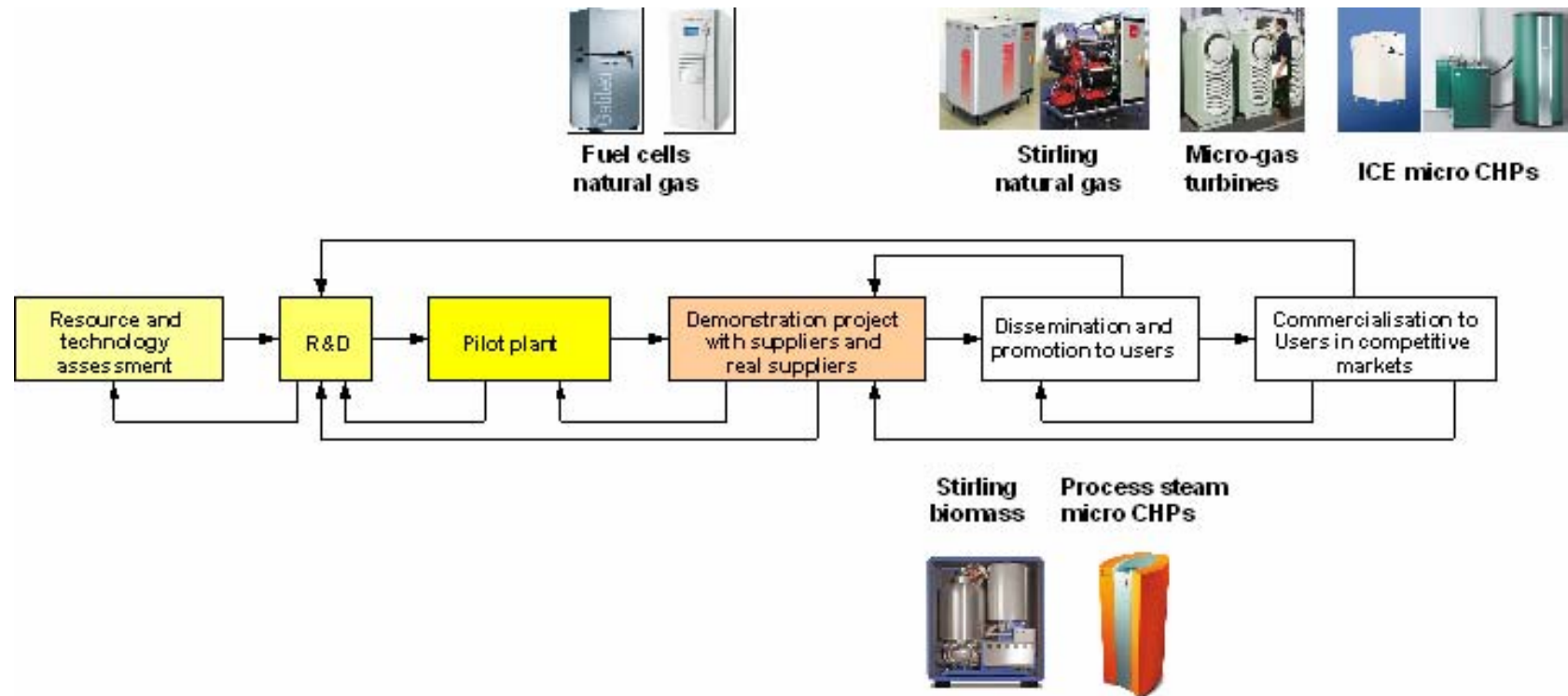
Fuel cells/micro CHPs: State of the art in Europe

	Baxi Innotech: Gamma 1.0	Hexis AG: Galileo N	CFCL: Blue Gen
Fuel cell type	LT-PEM	SOFC	SOFC
Electrical output	1 kW (mod. 30 %)	1 kW	2 kW
Thermal output	1,7 kW	2,5 kW	0,3 – 1 kW
Aux. Burner	3,5 -15 or 3,5 -20 kW	4 – 20 kW	Not specified
Electrical efficiency	32 % (Hi)	25 - 30 % (Hi) (goal: > 30 %)	60 % @ 1,5 kWel (Hi)
Total efficiency	96 % (Hi)	> 90 (Hi)	Ca. 85 % (Hi)
Fuel	Gas	Gas	Gas
Market implementation	34 systems in Callux project, commercial by 2013 ?	30 systems in Callux project, commercial by 2013 ?	Demo projects with German utilities announced, commercial by ?



Courtesy: Baxi, Sulzer & CFCL

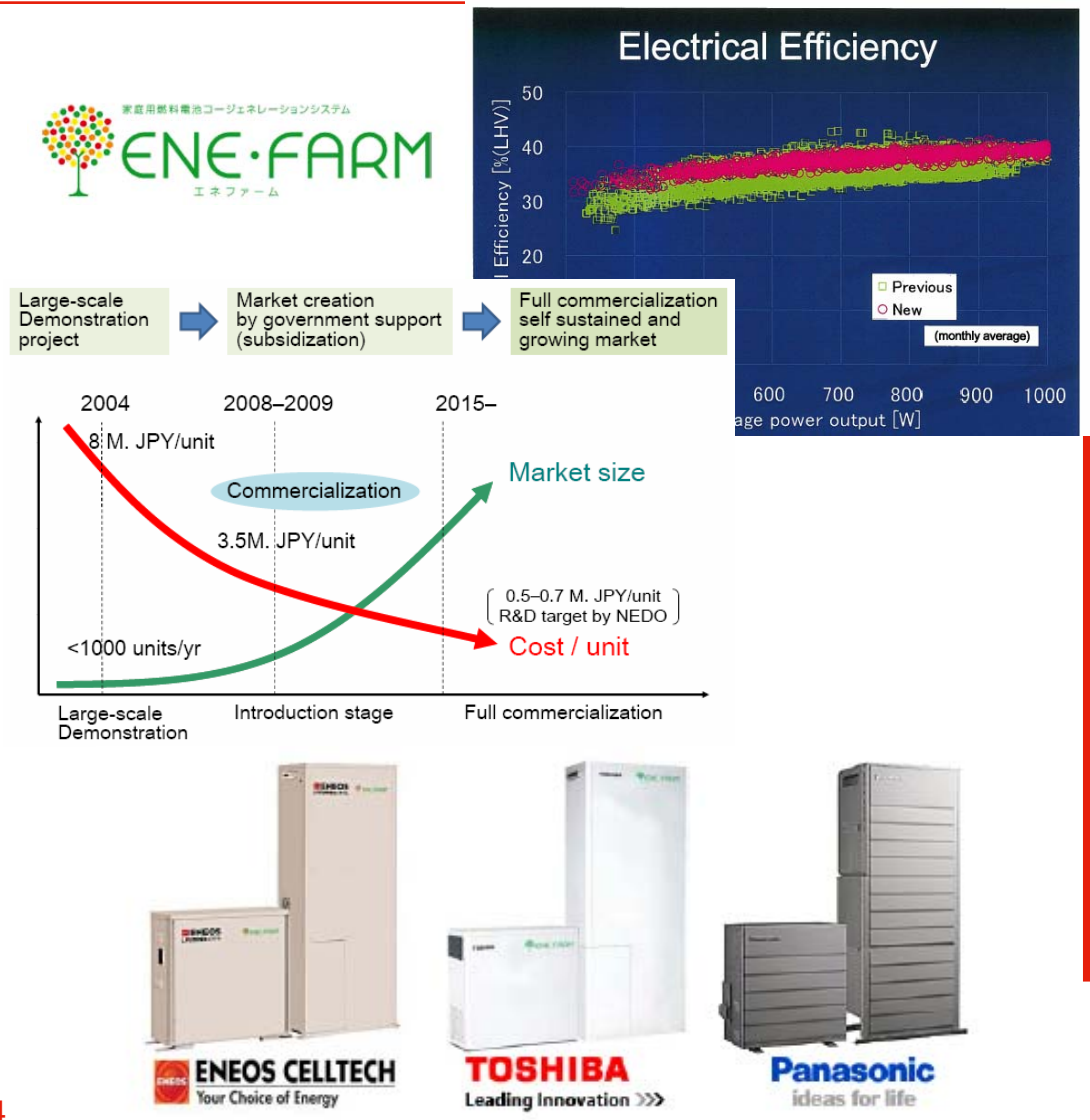
Micro CHP technology portfolio: from R&D to competitive markets



- Fuel cell systems are still in the early phase of product commercialisation for competitive markets

Commercialization of residential fuel cells in Japan

- Residential fuel cell systems
 - 0.7–1.0 kW PEFC + heat recovery (CHP)
 - Three manufactures
 - Subsidization program initiated
- 1/2 of users' costs (system + installation) up to 1.4M JPY
- 1,500 units installed (as of Sep. 2009)
- + 3,307 in 2004 to 2008
- SOFC demonstration project incl. 5 projects (0,7 kWel) shows electr. eff. > 40 % (Hi)
- 1 € = 107,4 Yen
1 Mio Yen = 9.345,8 €

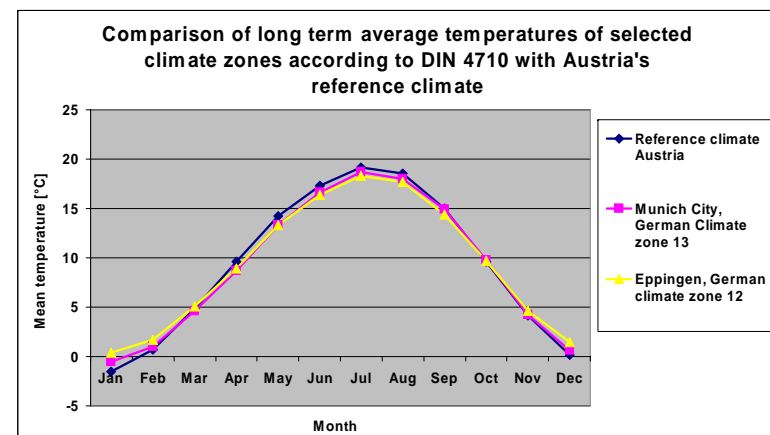
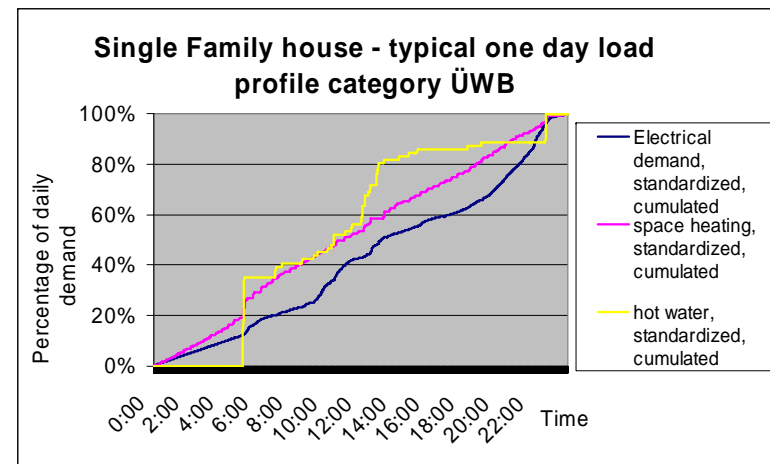


Analysis of the specific Austrian framework



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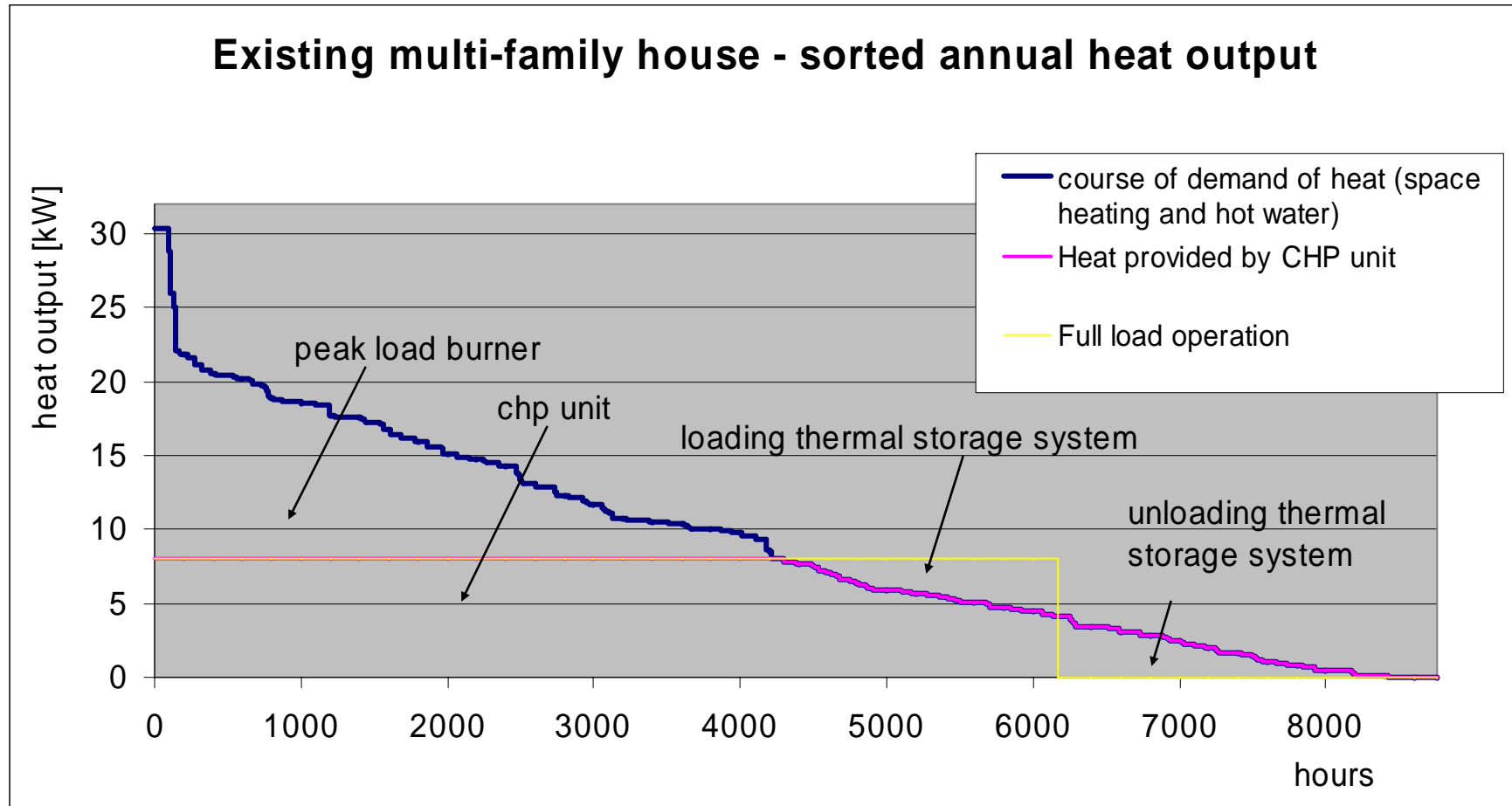
- Parallel to the EU and international developments the framework of the implementation of fuel cell/micro CHPs was analysed for Austria
- Five model cases (building categories) reflecting typical Austrian buildings were selected:
 - single family houses: new & existing
 - multi family houses: new & existing
 - small office building: refurbished
- The specifications of Austrian model cases are based on Statistic Austria data sets
- Specific Austrian reference climate conditions were defined
- Typical load profiles following VDI 4655 were used
- Due to missing fuel cell demonstrators in Austria state-of-the-art micro CHP systems were used for the analysis
- Analysis in the last period (2004 – 2008) focused to the commercial/tourism sectors; five fuel cell demonstrators were tested by Austrian utility companies



Five model cases (building categories)

	Residential buildings				Office building
	Existing single family home	New single family home	Existing multi – family home	New multi – family home	Refurbished office building
Building phase	1961-1981	2010	1961-1981	2010	1971, renovated
Gross-external area	150 m ²	150m ²	560m ²	560m ²	3.600m ²
Number of inhabitants / flats	3	3	6	6	-
Specific heat demand	219,0 kWh/m ² a	46,6 kWh/m ² a	130,2 kWh/m ² a	35,7 kWh/m ² a	40,8 kWh/m ² a
Specific domestic hot water demand	12,5 kWh/m ² a	12,5 kWh/m ² a	12,5 kWh/m ² a	12,5 kWh/m ² a	4,7 kWh/m ² a
Total heat demand	34.760 kWh/a	8.900 kWh/a	80.060 kWh/a	27.140 kWh/a	164.700 kWh/a
Demand of electrical energy	3.069 kWh/a	3.069 kWh/a	1.974 kWh/a /flat	1.974 kWh/a /flat	129.450 kWh/a
Standard heat load	14,0 kW	4,3 kW	37,3 kW	14,6 kW	103,0 kW

Planning and selection of micro CHP system: Example multi-family house (existing)



Market-ready CHP plants



Source: Senertec GmbH



Source: PowerPlus GmbH



Source: Energiezentrum NRW

	Dachs G 5.5	Ecopower e3.0	WhisperGen
	internal combustion engine	internal combustion engine	stirling engine
Rated Power			
Rated thermal power [kW]	12,5	4 - 8	7,5
Rated electrical power [kW]	5,5	1,3 - 3	1
Efficiency			
electrical [%]	27	25	12
thermal [%]	61	65	83
total [%]	88	90	95

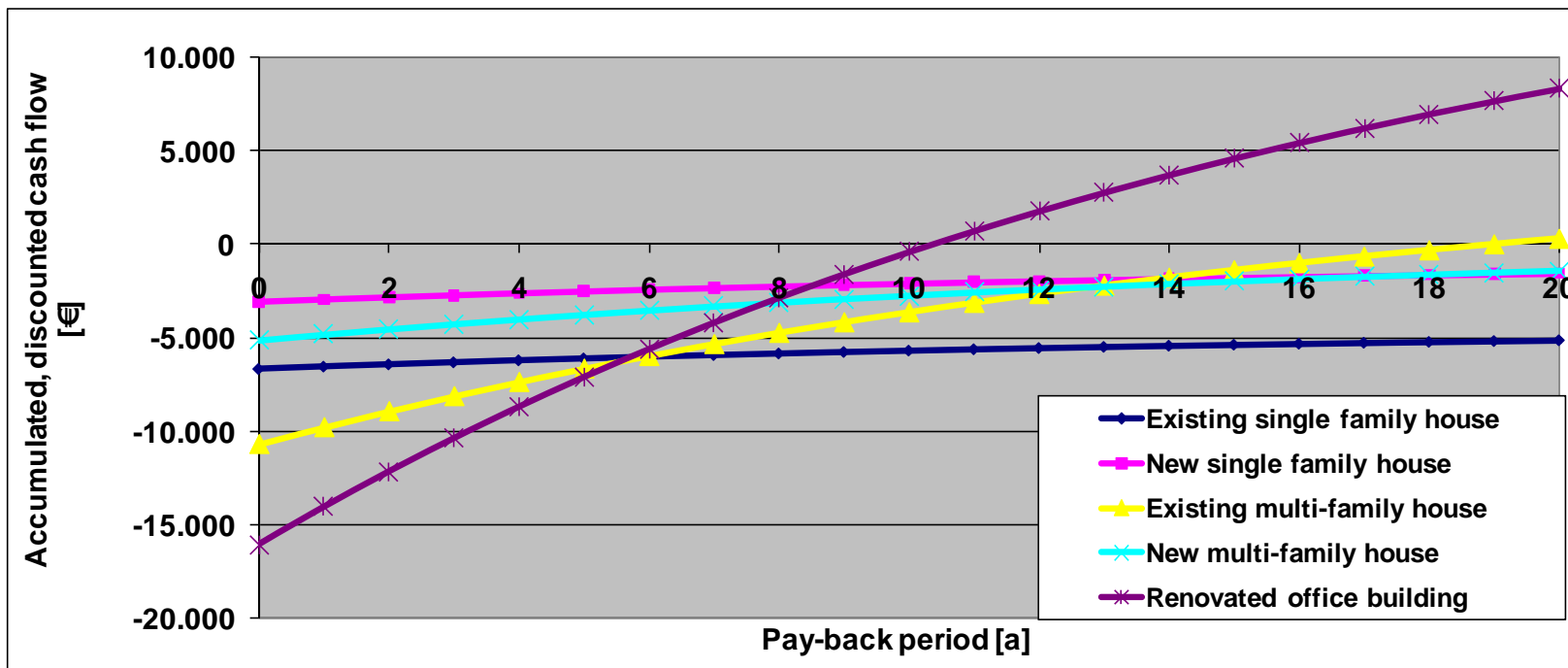
Investment costs

	Existing single family home	New single family home	Existing multi-family home	New multi-family home	Renovated office building
Micro CHP System	1 kWel/ 7,5 kWth	1 kWel/ 7,5 kWth	3 kWel/ 8 kWth	1 kWel/ 7,5 kWth	5,5 kWel/ 12,5 kWth
Costs micro CHP system [€]					
CHP unit	5693,40	5693,40	11886,20	5693,40	17840,82
Peak heating system, chimney, Installation	4700,00	1700,00	7080,00	6480,00	22412,34
	1548,90	1548,90	3457,24	2218,68	6986,99
Costs reference heating system [€]					
Gas condensing boiler	3600,00	3600,00	4200,00	3600,00	13295,45
Chimney	480,00	480,00	840,00	840,00	2659,09
Buffer	-	-	2040,00	2040,00	6457,79
Installation	720,00	720,00	1080,00	1080,00	3418,83

Pay back period of additional investment - taking account of annual discounted payments, feed-in tariff and investment incentive

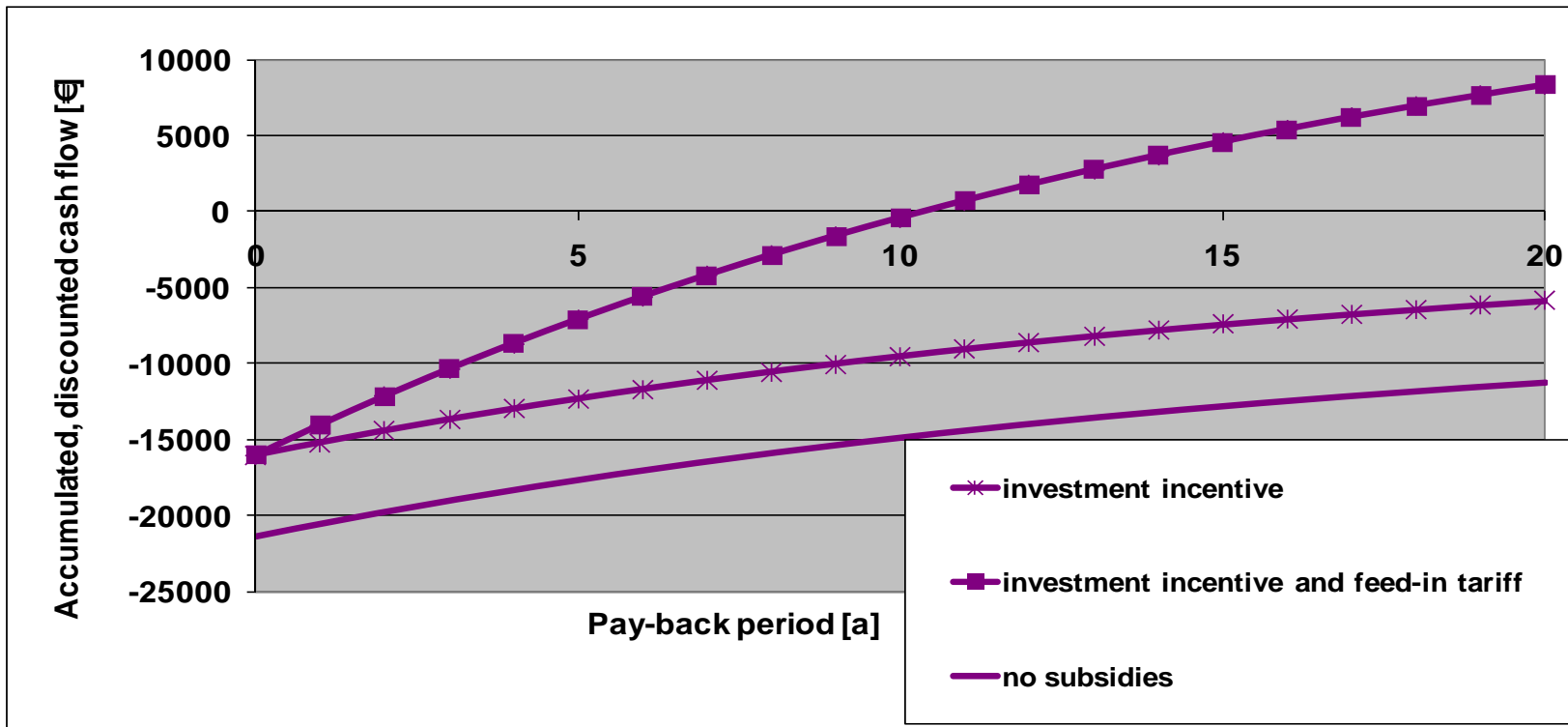


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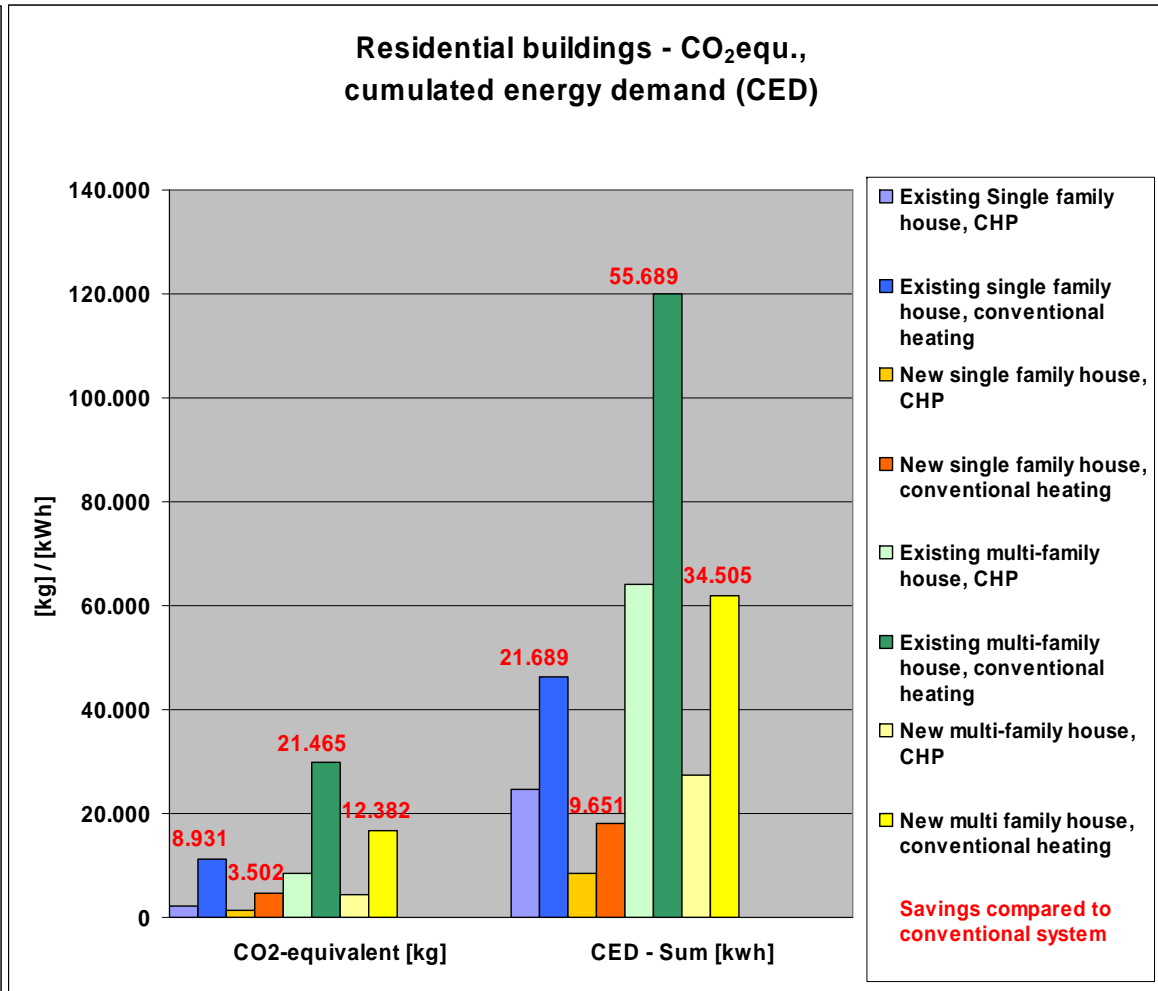
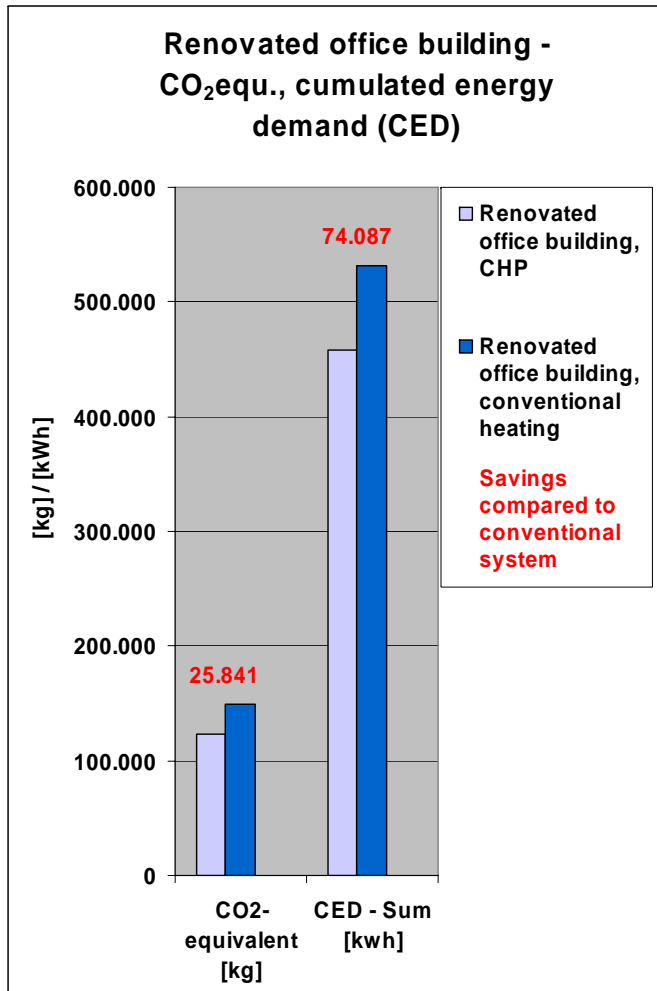
Investment incentive:	Feed-in tariff similar to German tariffs („KWK – Gesetz“):
25% of the Investment for the CHP system (incl. installation)	Self used: 5,11 [ct/kWh] Feed into grid: 10,30 [ct/kWh]

Pay back period of additional investment - effects of subsidies on pay-back period of assumed CHP unit in renovated office building



Investment incentive:	Feed-in tariff similar to German tariffs („KWK – Gesetz“):
25% of the Investment for the CHP system (incl. installation)	Self used: 5,11 [ct/kWh] Feed into grid: 10,30 [ct/kWh]

Analysis of CO₂eq. emissions and CED



Conclusions



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- Austrian IEA participation shows a positive picture concerning International co-operations and know-how transfer from and to Austria
- Results of International demonstration projects may be accessed and lessons were learned by the market introduction programmes of the leading industrialised countries (avoiding expensive national R&D demos)
- European stationary programmes show no clear picture concerning the advantages of fuel cells compared to alternative state-of-the-art CHP technologies (so far)
- Japanese stationary demonstrators in the residential sector outreach already existing micro-CHP systems based on ICE, stirling and micro turbine concerning electrical efficiency und justify public involvements in fuel cell technology. However, progress in cost reduction is still necessary to achieve commercial viability.
- The Austrian framework has to be significantly improved both by investment subsidies and(!) by feed-in tariffs (similar to the German „KWK Gesetz 2009“) in order to initiate investments in the micro CHP sector (missing level playing field)
- Acceptable economic conditions from an end-user perspective are to be found in multi-family houses (>> 6 flats), office buildings and in the commercial/tourism sectors (taking into account subsidy schemes both for the investment and feed-in tariffs) but not in single family houses.
- Emission reductions in all model cases have to be described as significant if fuel cells would be implemented in the residential sector (this also applies for primary energy savings!)

Thank you for your attention!



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AEA: <http://www.energyagency.at/energietechnologien/aktuelle-projekte/afc.html>

BMVIT/IEA: <http://www.nachhaltigwirtschaften.at/iea/index.html>

Pay-back period of additional investment – taking into account of annual discounted payments, without subsidies

