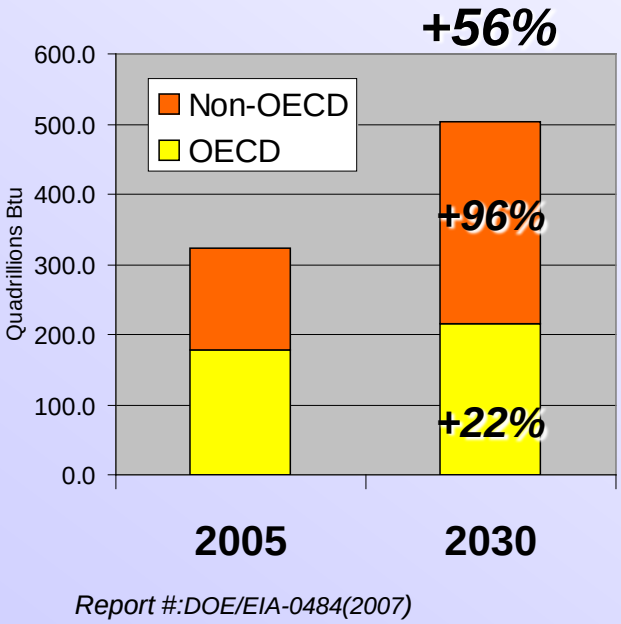
# Distributed (co)generation, ready to go?

*Alberto Ravagni*

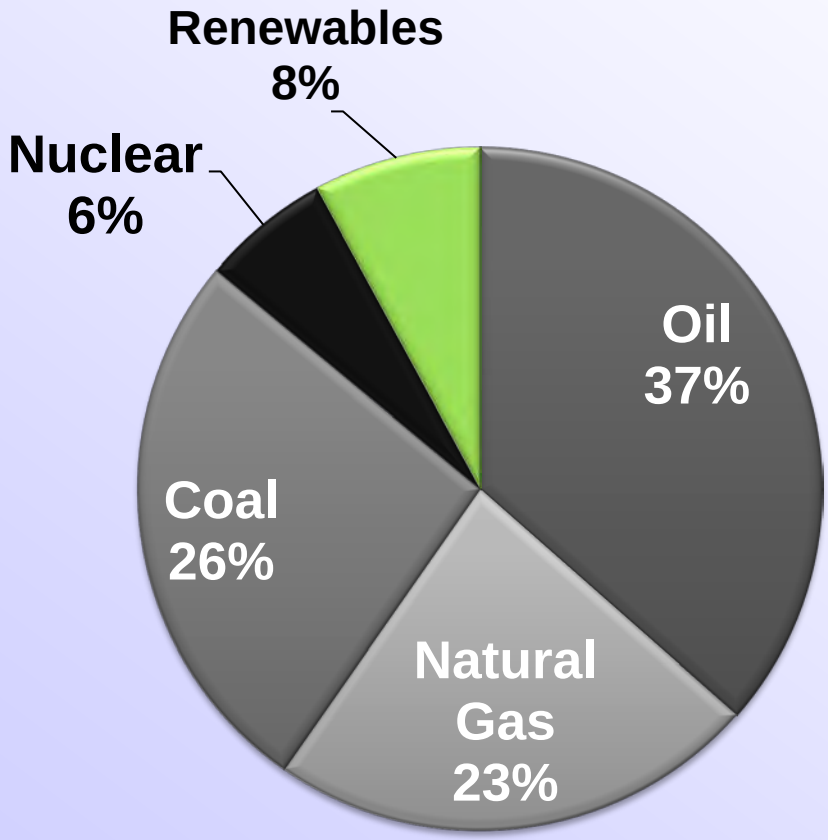
# The future of energy: why are we concerned?




*Report #:DOE/EIA-0484(2007)*

- Security of supply
- Economical competitivity
- Environmental impact

# Renewables are a solution, however they cannot represent the ONLY solution

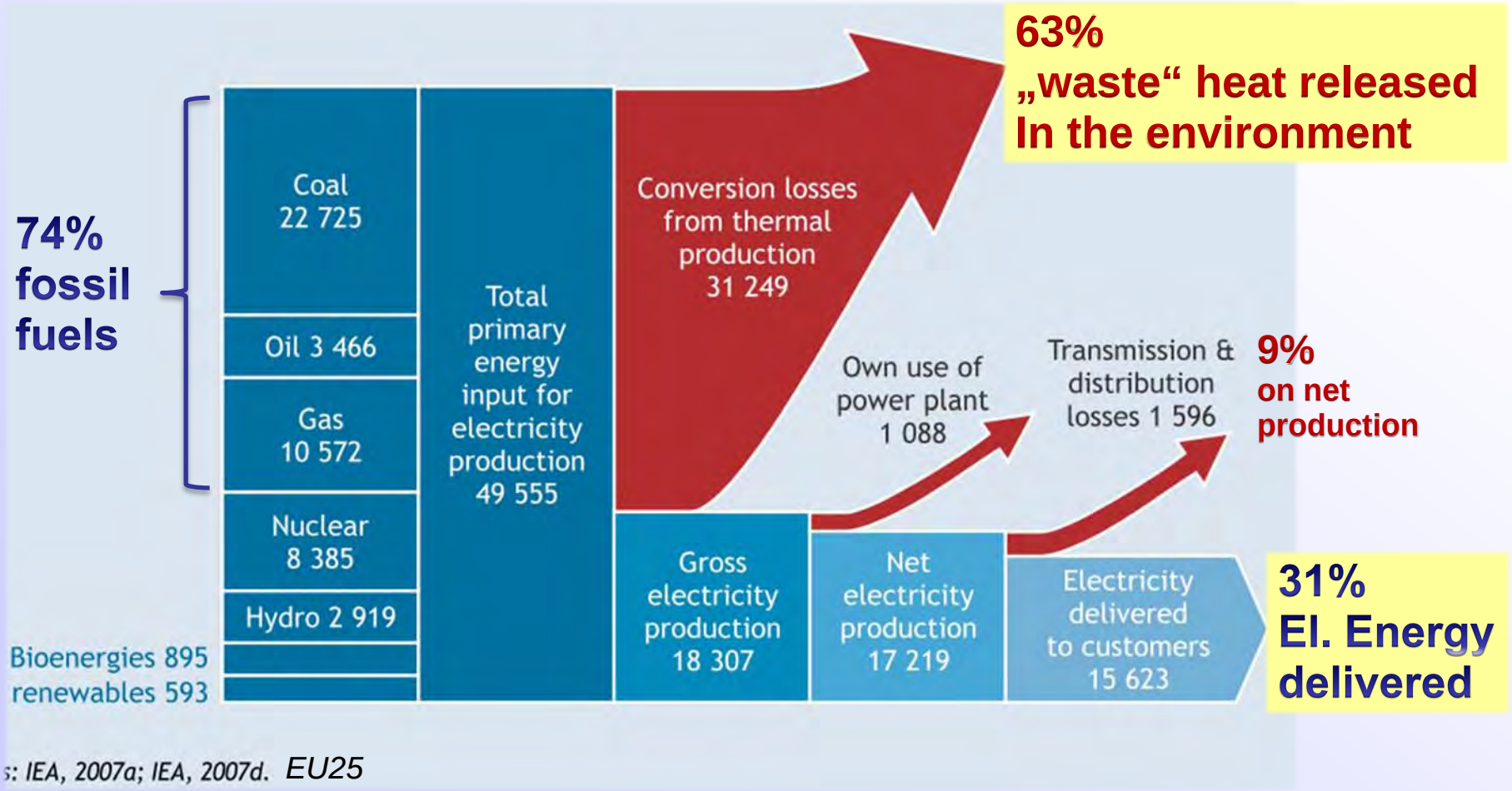



Increasing the **efficiency** in using current energy sources must deliver a major part of the necessary change



*Report #:DOE/EIA-0484(2007)*

# Efficiency in electricity production: where are we today?




Average el.efficiency of fossil fuelled power plants: **35-37%**
Best gas turbine (GTCC): ca. **55%**

•**Why can't we use the heat?**

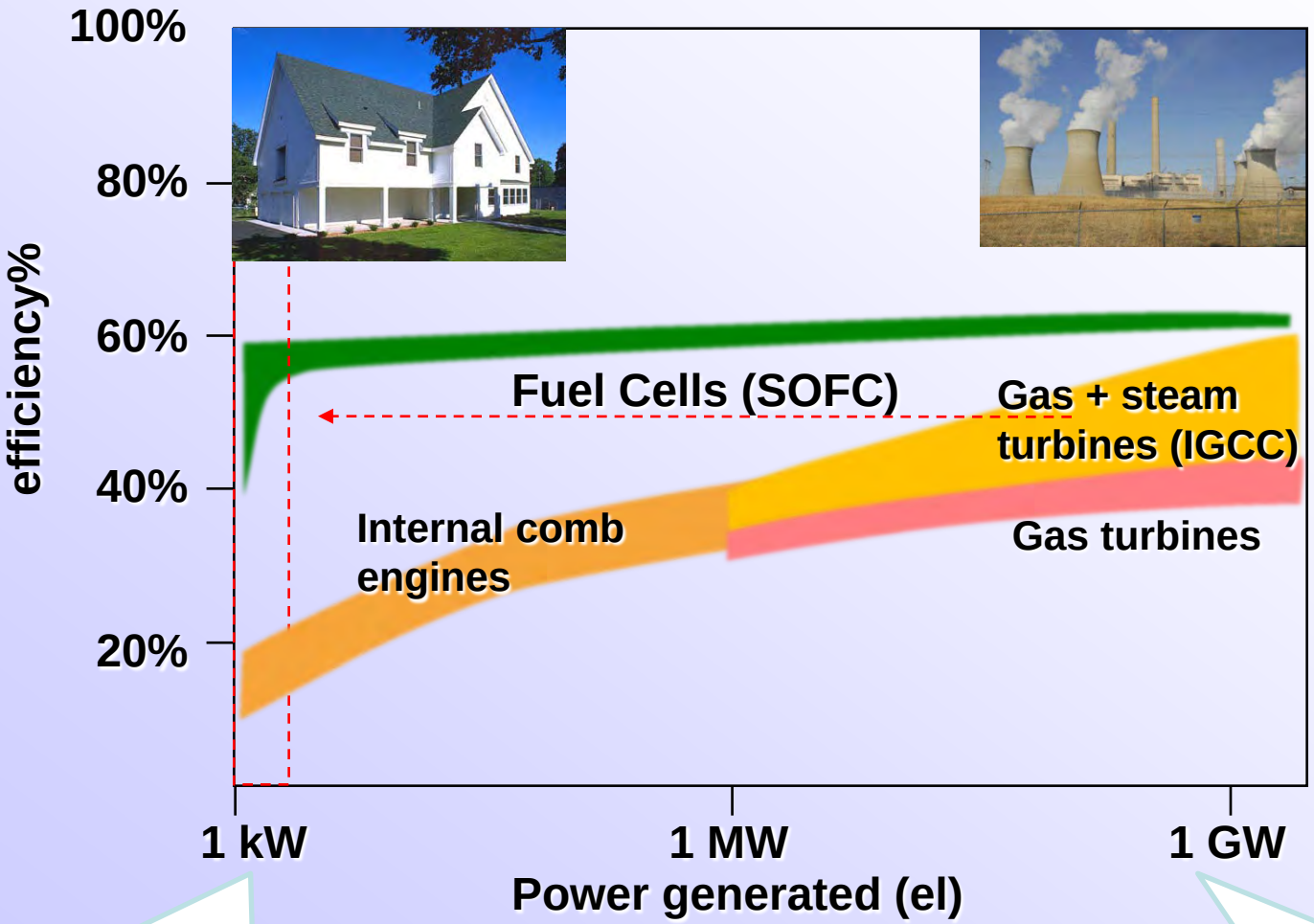
**Because heat is difficult to transport**

•**Why do we produce electricity far from where the heat is needed?**

(„distributed HEAT" a.k.a. „boiler" is quite popular...)

**Efficiency ! (& cost)**

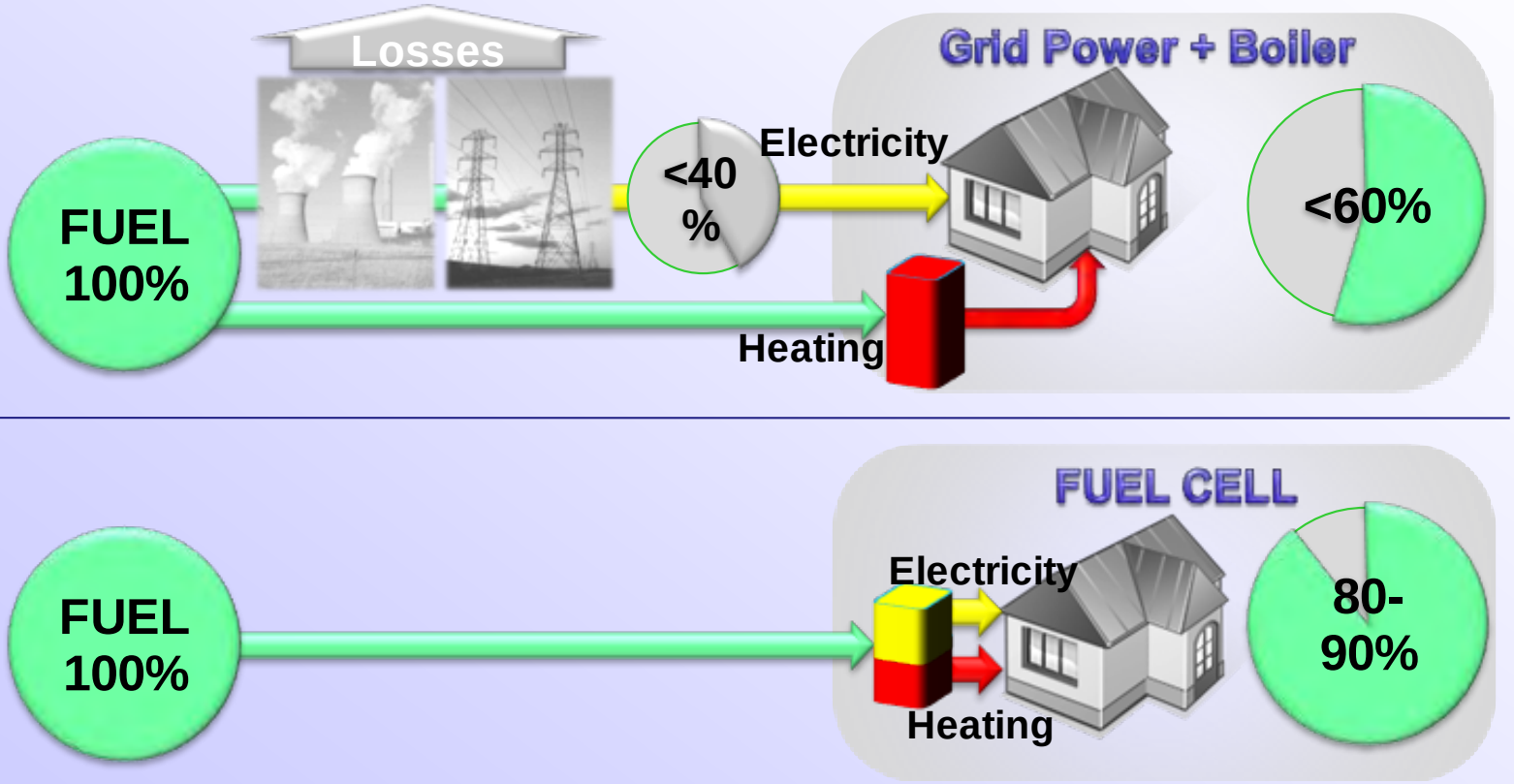
# Efficiency Advantge of Fuel Cells



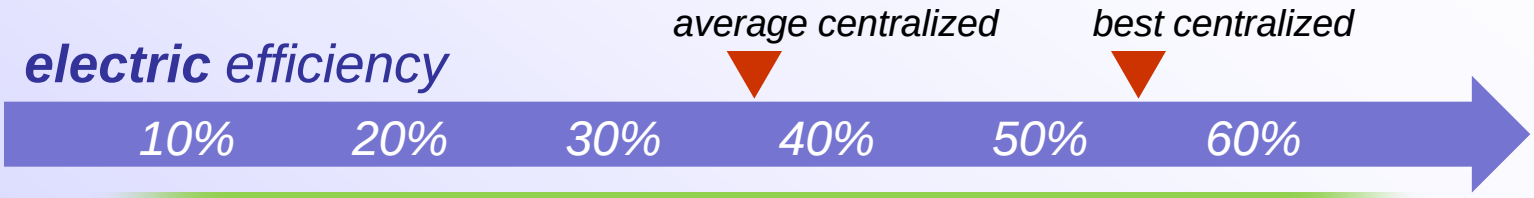

- kW size
- ~1000 €/kW
- X1000 € investment

- GW size
- ~1000 €/kW
- bn€ investment

# Fuel cells enable distributed generation and co-generation



# El Efficiencies required for Distributed Generation and Co-Generation




**Cogeneration**

Total (heat*+power) efficiency of >80-90%
is achievable also at low electrical efficiency

***Existing buildings***

***New buildings***

Distributed
**Generation**

Distributed Generation range
When electric efficiency is
higher that centralized generation

**"high temperature heat" can be used for cooling / air conditining*

Development activities on fuel cells are ongoing for a long time…

When will they deliver?

Now

# Ten jears later…
# a disruptive technology realizes ist potential

| 1999: Generation I | | 2009: Generation II |
|---|---|---|
| **ESC Electrolyte Supported Cells** | | **ASC Anode Supported Cells** |
| *50-100 µm Electrolyte* | • higher energy density | *5-10 µm Electrolyte* |
| *900°-1000°C* | • **lower temperatures** | *750°C* |
| *0.1-0.2 W/cm²* | • **improved materials** | *0.4-0.5 W/cm³* |

| | | |
|---|---|---|
| Energy density (active area) | **>1 MW/m3** | *0.4 W/cm3 x 3 layers/cm ➔1.2 W/cm3 ➔ 1.2 MW/m3* |
| Electric efficiency (@ 2-5 kW power) | **60%** | |
| Material costs stack | **100 €/kW** | *Verbindliche Lieferantenangebote für 50 MW/J Produktion* |
| Investement cost/kW | **1000 €/kW** | *e.g. verwendeter Stähle: GEN I:100€ / Kg ➔ GEN II: 5€ / Kg* |
| Continuous operation, 10% degradation *…still running…* | **17‘000 h** | *Dauerversuch Forschungszentrum Jülich* |

# A key element
# for the distributed generation is available.

- **Generating electricity** in small 2-5kW units is (at least) as efficient as in centralized power plant.
- With the local utilisation of the heat the total efficiency „jumps" over 80-90% **(Co-generation)**
- The investment costs are comparable with best turbine technology (ICGT),… or with the price difference between conventional and condensing boilers.
- The demonstration are proceeding successfully, the first companies are ready to enter the m-CHP market.

There are very few companies worldwide who has developed this technology to an operating generator,

One of them is based here in the province of Trento

# SOFCpower: the first chapter of a success story



May 2007, acquisition of HTceramix S.A., & HoTbox™ technology

Jan 2008: pilot plant @ BIC Mezzolombardo (TN) operative

2009, signed agreement for mCHP development with MTS (world leader boiler)

INDUSTRIA 2015

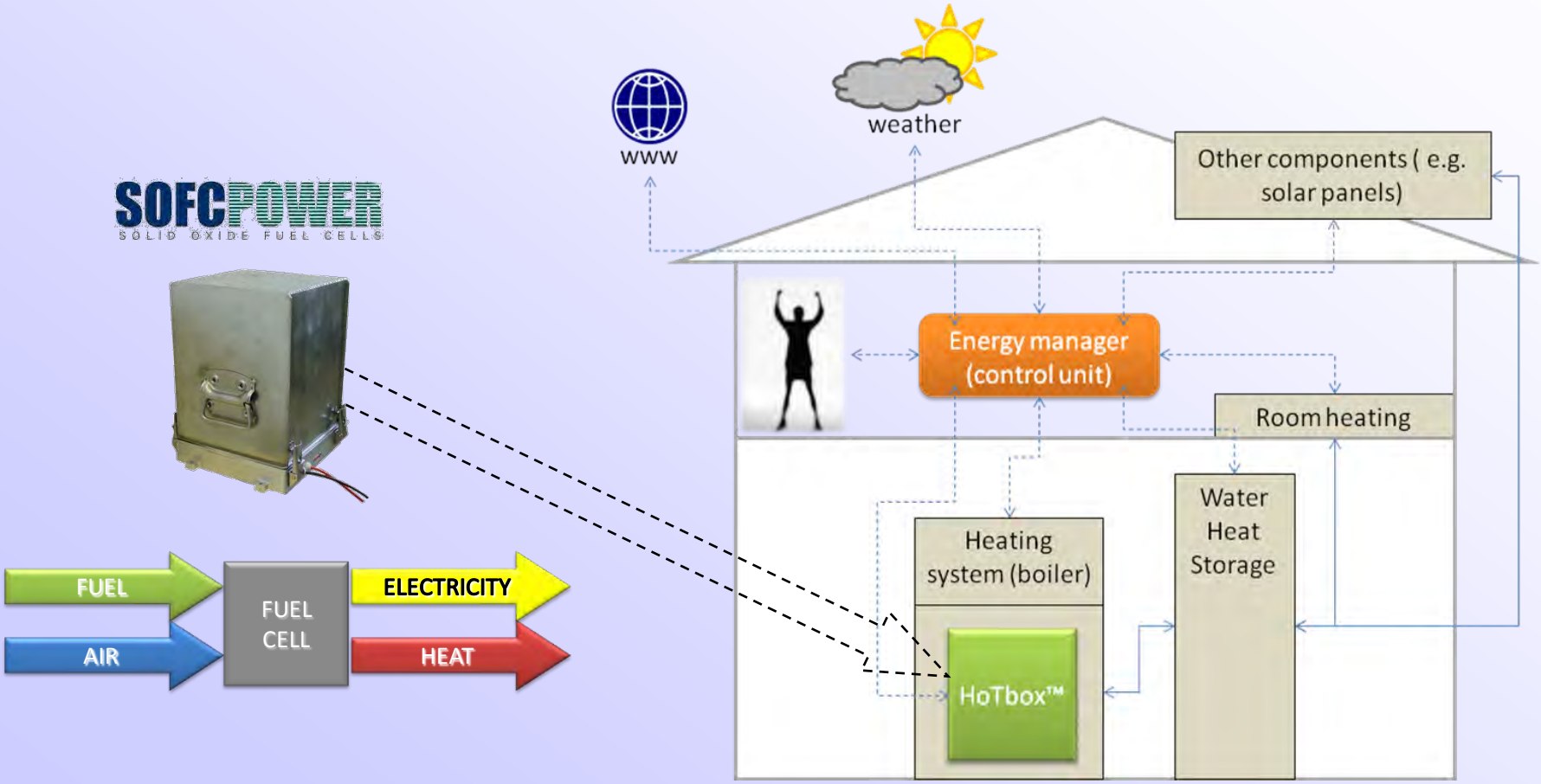
Nov 2006 start (up)

Germania · Francia · Olanda · Danimarca · Taiwan

Commissariat à l'Énergie Atomique · Consiglio Nazionale delle Ricerche

# The core product:

- Nat. gas fuelled generator of heat and : **HoTbox™**



A product alone is not enough.

Changes in the energy systems means the (r)evolution of a system and they need:

1. Proven and competitive technology,

2. Legislative and normative framework (RCS)

3. Involvement of all stakeholders

In order to increase the competitiveness of the Systems, the European Commission and the European Parliament have adopted a new approach:

**The JTI: Joint Technology Initiative**

# The European Fuel Cell & Hydrogen Joint Technology Initiative (JTI) .


## Fuel Cells and hydrogen for sustainability

# Five JTIs have been approved

| | | | | | |
|---|---|---|---|---|---|
| •Name | CLEANSKY | imi | New Energy World IG | niac | ARTEMIS |
| •Type | •Clean air transport | •Innovative medicines | •Fuel cells and hydrogen | •Nano electronics | •Embedded computing systems |
| •Public funding (EUR) | •1.6B | •1B | •0.47B | • 0.45B | •0.42B |
| •Start | •Feb 2008 | • Feb 2008 | •May 2008 | • Feb 2008 | •Feb 2008 |





www.fchindustry-jti.eu/

New Energy World IG
fuel cells & hydrogen for sustainability

# Strategic role of the JTI

- *The European Strategic Energy Technology (**SET**) Plan has **identified fuel cells as a key technology for Europe** for achieving a 20% reduction in greenhouse gas emissions; a 20% share of renewable energy sources in the energy mix; and a 20% reduction in primary energy use by 2020 ('20-20-20' target).*

# Main JTI stakeholders

# Industry Grouping Members

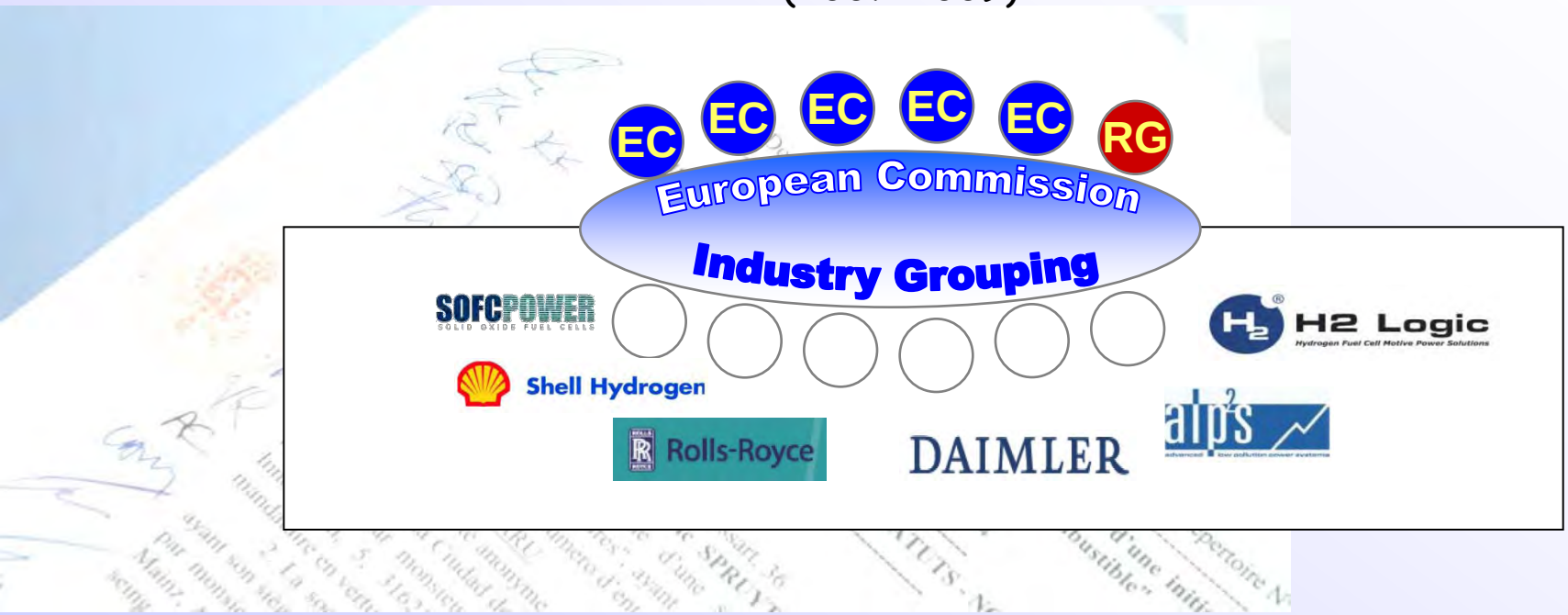
# Research Grouping Members

Total: 47 out of 57

215.505 M€
(47 participants)

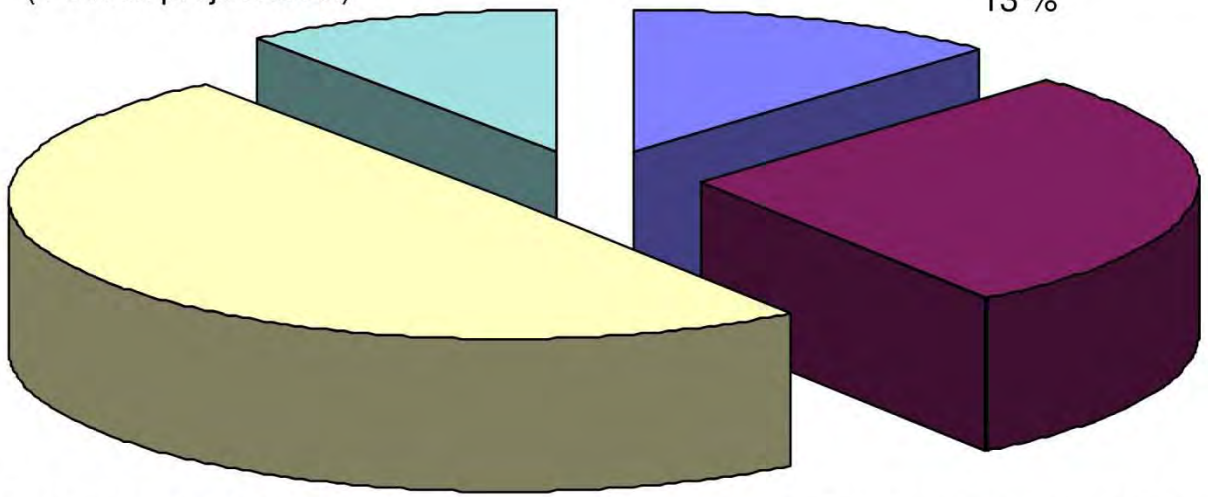
1838 persons
(47 participants)

# The Governing Board of the JTI
(2007-2009)



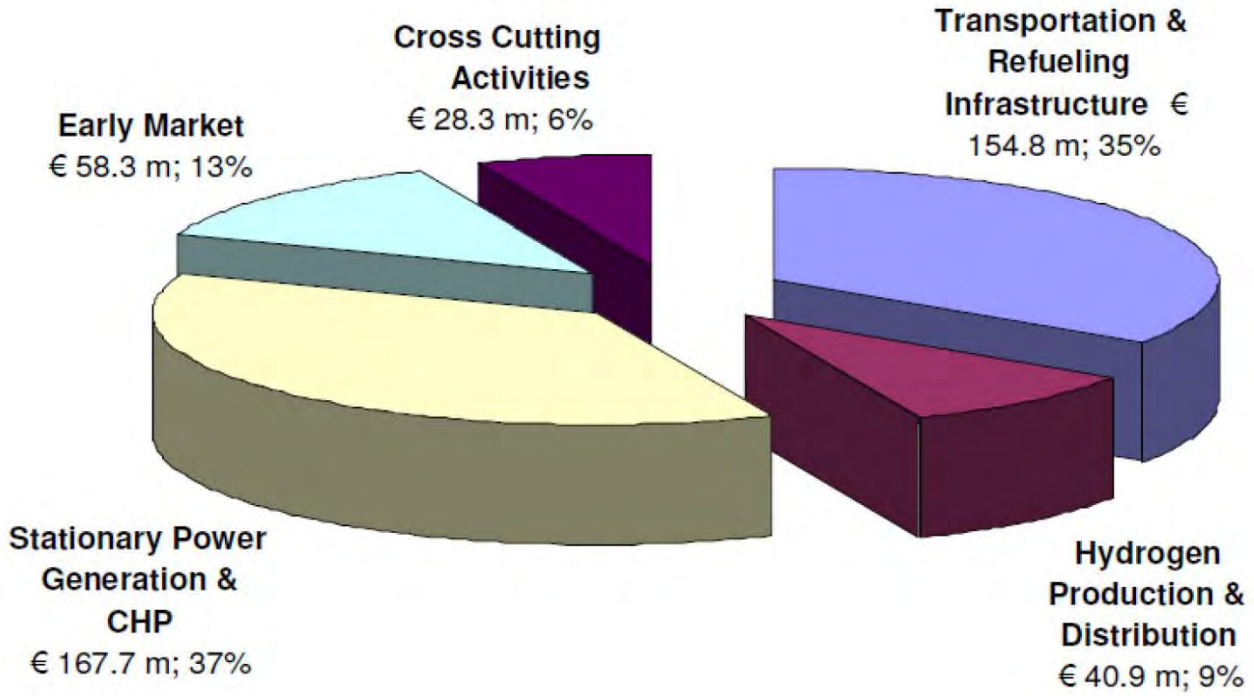

# € 1 billion public and private investment

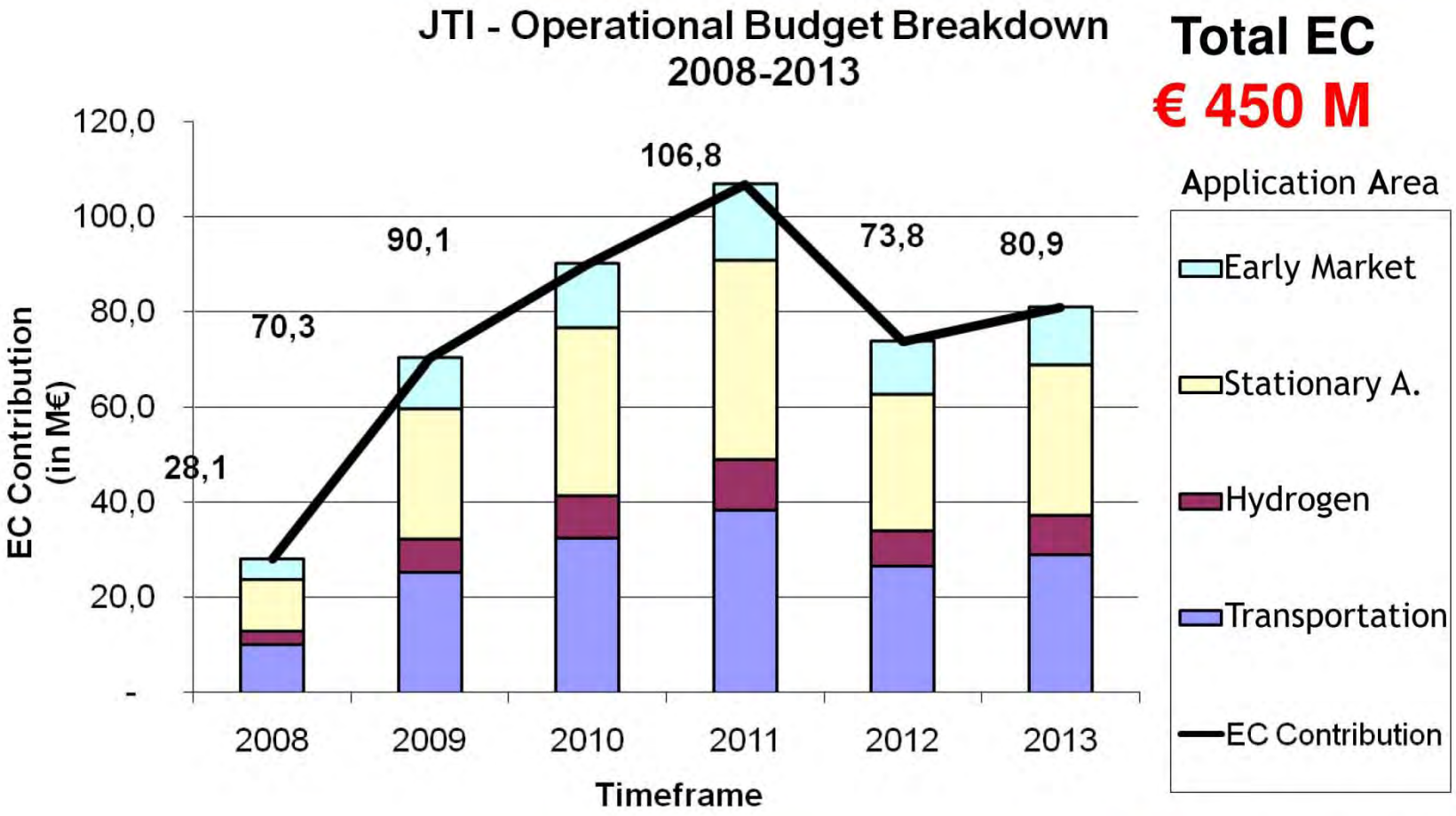
By Action Category



# € 1 billion public and private investment

By Application Area



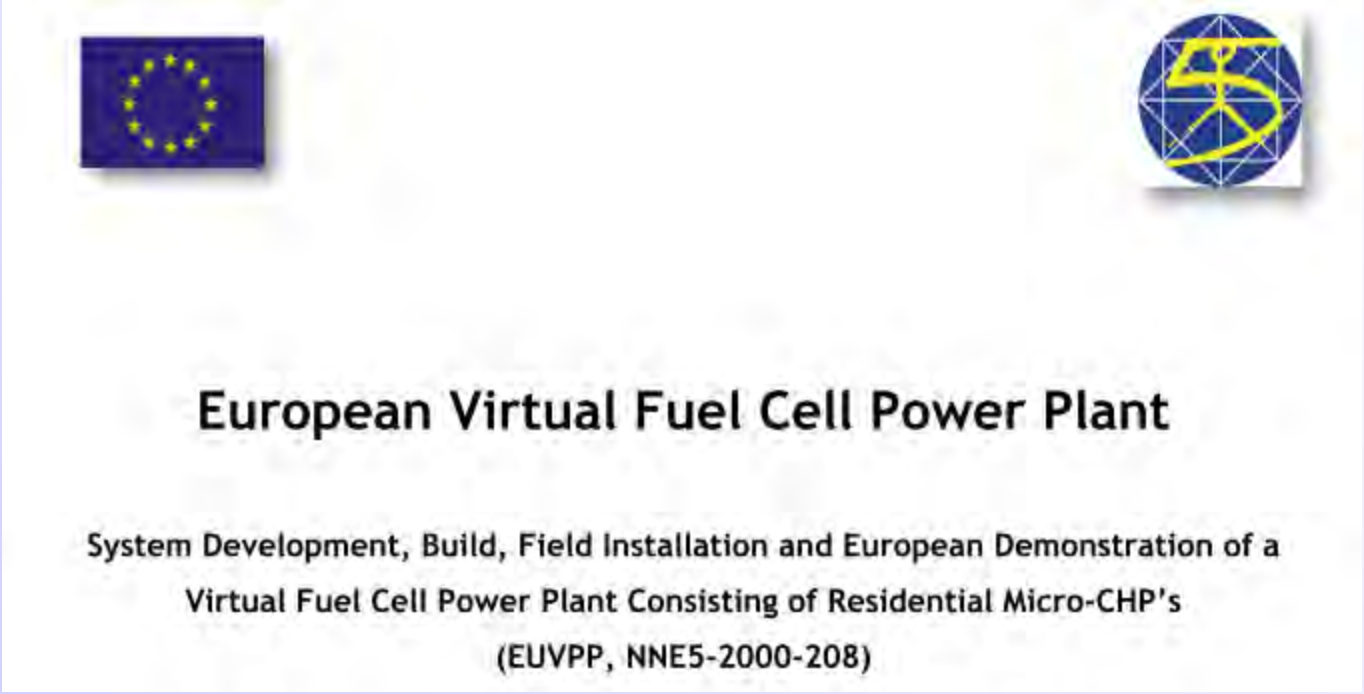

JTI - Operational Budget Breakdown
2008-2013
Total EC
€ 450 M
EC Contribution (in M€)
120,0
100,0
80,0
60,0
40,0
20,0
-
28,1
70,3
90,1
106,8
73,8
80,9
2008
2009
2010
2011
2012
2013
Timeframe
Application Area
Early Market
Stationary A.
Hydrogen
Transportation
EC Contribution

It looks like all elements for implementation of distributed generation are ready…

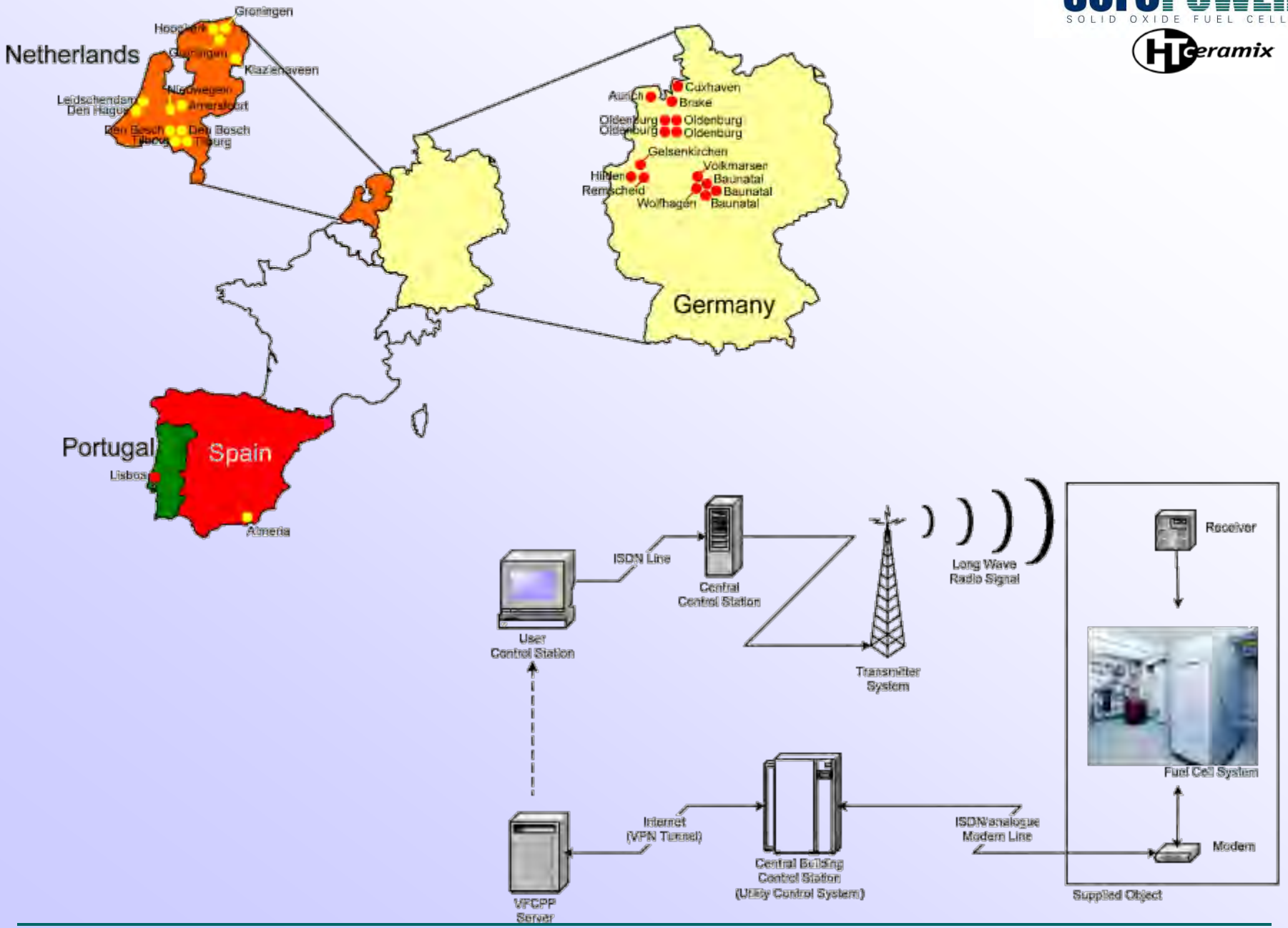
- ✓Technology,
- ✓System development approach at European level,
- ✓Evolution of legislation in supporting direction

…where is the virtual power plant?

# Example:
## European Virtual Fuel Cells Power Plant




**2001-2005 !**


Netherlands
Groningen
Hoogkerk
Klazienaveen
Nieuwegein
Leidschendam
Den Haag
Amersfoort
Den Bosch
Tilburg
Cuxhaven
Brake
Oldenburg
Oldenburg
Oldenburg
Oldenburg
Gelsenkirchen
Volkmarsen
Hilden
Remscheid
Baunatal
Baunatal
Wolfhagen
Baunatal
Germany
Portugal
Spain
Lisboa
Almeria
ISDN Line
Central
Control Station
Long Wave
Radio Signal
User
Control Station
Transmitter
System
Receiver
Fuel Cell System
Modem
Internet
(VPN Tunnel)
Central Building
Control Station
(Utility Control System)
ISDN/analogue
Modem Line
VFCPP
Server
Supplied Object

# Conclusions:

Within the operation as a Virtual Fuel Cell Power Plant the capability to follow defined load profiles without relevant time delay has been successfully demonstrated

Important general outcome is that there is not one mayor technical hurdle or problem but several components within the whole system have to be optimized towards a reliable and cost effective system.

The project identified three major hurdles to be overcome in the development of a (fuel cell) product for the residential mass market:

1. *The **costs** must be reduced significantly to increase the technology's economic viability*
2. *The system must be **simplified** to improve reliability*
3. *The **temperature** of the heat output must be increased to become compatible with existing heating systems, and to give opportunities for tri-generation*

(see SOFC technology developments)...

# Everything set for the (r)evolution to distributed generation ?

- ✓ **Technology**
- ✓ **System-approach for evolution of the energy system**
  - ➢ **JTI at EU level**
  - ➢ **Local initiatives like „Crisalide" in Trento Province**
- ✓ **Virtual power plant:**
  - ➢ **From „connection" to „integration" ICT is key.**
- ✓ **The final factor: Entrepreneurship,or the**


**LET'S DO IT. Factor**

Thank You

# Back-up

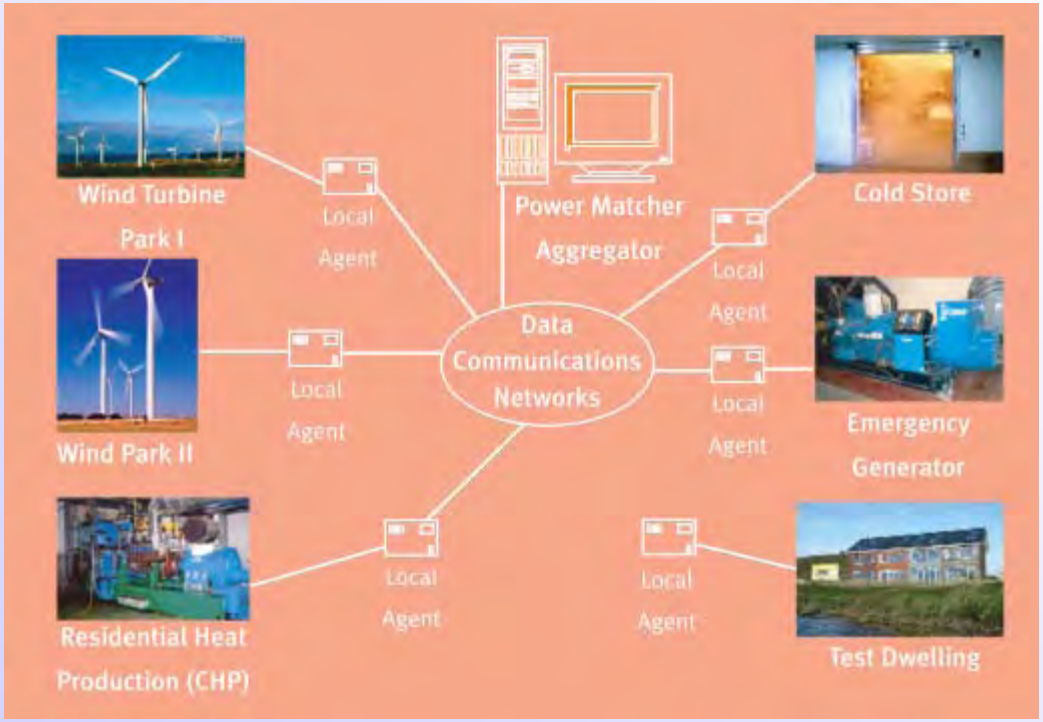
# Program Targets & Milestones

| | | |
|---|---|---|
| Hydrogen Production & Distribution | 2010 | • Appropriate hydrogen supply chain to match demonstration requirements |
| | 2015 | • 10 - 20 % of hydrogen demand, carbon free/lean<br>• Cost of delivered H2 at fuelling station < 5 €/kg - centralized and decentralised, excl. taxes |
| Stationary Power & CHP | 2010 | • 3 - 7MW electrical capacity installed for pre-commercial demonstration phase |
| | 2015 | • 100 MW electrical capacity installed<br>• Cost of 5 000 - 6 000 €/kW (Micro CHP FC) and 1,500 - 2,500€/kW for commercial/industrial units |
| Early Markets | 2010 | • 10 000 units in the market, thereof 6000 new sales |
| | 2015 | • 50 000 new units in the market |

# Program Targets & Milestones

| | | |
|---|---|---|
| Transportation & Infrastructure | 2010 | • Up to 10 road vehicles on 1 demo site and for demonstration on additional sites in Europe with re-fuelling capacity for up to 50 road vehicles<br>• Up to 20 buses on 3 sites with appropriate refuelling capacity |
| | 2015 | • Up to 500 road vehicles and 3 additional demo sites with 3 new refuelling stations<br>• Up to 500 buses on 10 EU sites with at least 7 new refuelling stations<br>• System cost of 100 €/kW, durability 5000h for car propulsion systems<br>• Ramp up scenario for European refuelling stations |

# Annex


Wind Turbine
Park I
Wind Park II
Residential Heat
Production (CHP)
Local
Agent
Local
Agent
Local
Agent
Local
Agent
Local
Agent
Local
Agent
Power Matcher
Aggregator
Data
Communications
Networks
Cold Store
Emergency
Generator
Test Dwelling