Smart solution for NZEB

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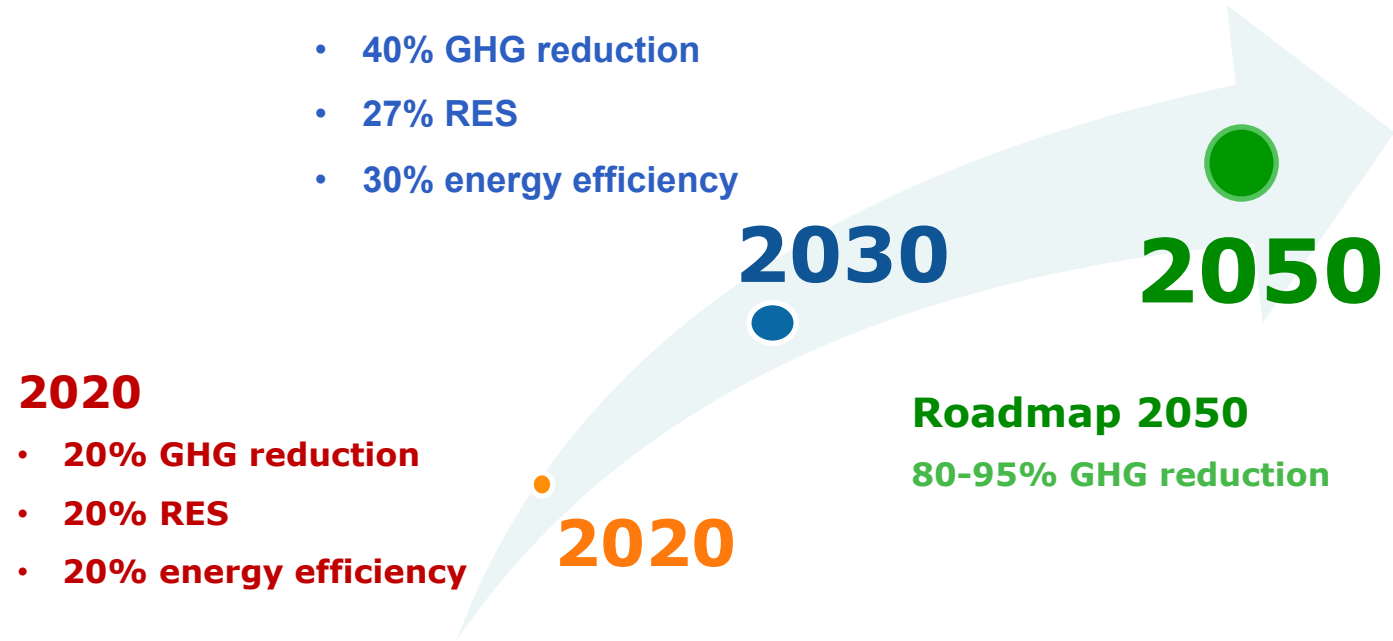
The vision (within the process of leading change, J Cotter, 2005)

Going beyond the features of the existing model:

- end-user centrality
- social inclusion: etics and development
- energy, environmental, economic, social policies
- environmental cost

Recast of EED, EPBD, RESD

De-carbonization of energy (according to Energy Union pillars)



SEN (Italy: 2017-2030)

-40 % GHG; 30% EE; 27% RES

This means a minimum developing rate in (2015-2030) compared to what realized in (2010-2015), according to a 50% renewable electricity of overall end consumptions.

Furthermore, heat renewable (geothermal, bioenergies, solar, heat pumps) has to double what done in (2010-2015).

Role of Buildings /1

- Even in Italy H&C is responsible of 50% of overall consumptions with more than 70% by imported gas
- RES penetration is less than other sectors (20%)
- The defined RES percentage of NZEB (50%) may be reached only in a coherent standard frame related to the specificity of the Country (i.e.: importance of summer cooling loads)

Role of Buildings /2

Furthermore, in order to match those goals:

- Existing buildings renovation from a present value of 0,5-1,2% sqm per year must arrive to 2%
- not-ETS sector may include, according to the existing emission level, a deep renovation moving from today 15-25% consumption rduction towards future 60-80% (Integrated Deep Renovation, i.e. connection with anti-seismic improving)

Role of Buildings /3

Main topic:

- The climate finance: innovative business models for EE to force the bridge between finance and actual economy (long-term tools)
- Effective information of the prosumers (domestic sector)
- Big data management, i.e. EE in ultra-large band design

How to approach nZEB policy

- A multidisciplinary approach
- A GD scenario (smart grid for electricity, heat and gas coupled with coherent storages)
- Supporting the update of digital systems (Virtual Power Plant VPP, ICT applied to energy, ultra-large band connection, smart DSO)
- The role of R&D

NZEBnet
Collaborative platform for the development and the implementation of NZEB

An Research Program of National Interest (PRIN)
http://www.iwebyou.it/nzeb/

NZEBnet

La piattaforma collaborativa per lo sviluppo
e l'implementazione degli edifici a energia quasi zero

Informazioni e servizi | Le università | Le collaborazioni | Contatti

Perchè il progetto?

Why the project

Finalità della ricerca

Scopri >

TASK FORCE #1 (Labs Roma1 e Roma2)

Smart energy systems: a reference cellar for energy communities; EMS

TASK FORCE #2 (Labs UniCassino e UniCagliari)

ex-ante and post-retrofit of existing buildings monitoring and auditing.

TASK FORCE #3 (Labs IUAV e UNICAL-Cosenza)

The envelope, innovative materials (PCM)

TASK FORCE #4 (Labs UniSA e UniCassino)

IEQ and its monitoring and control

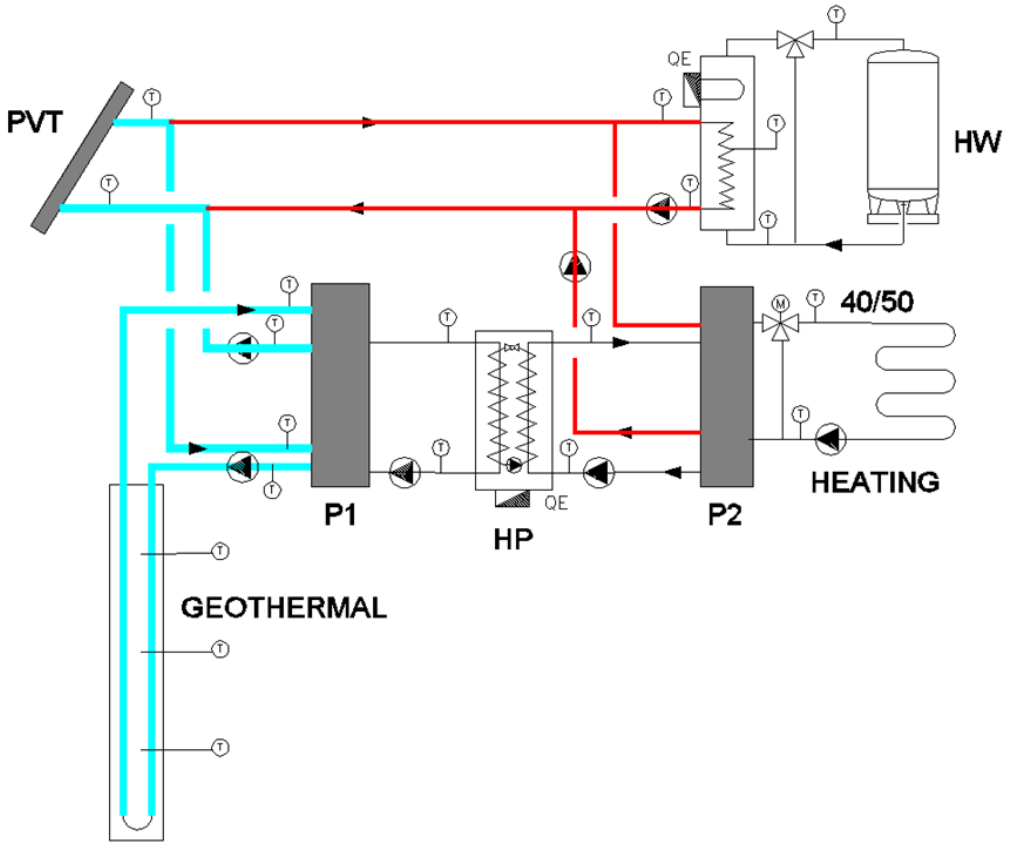
TASK FORCE #5 (Labs PoliTO e Roma3)

Cost Optimality in energy auditing for existing buildings: and interactions between energy/enviromental and economic analyses. Choice of EEM

TASK FORCE #6 (Labs PoliMI e UniTrento)

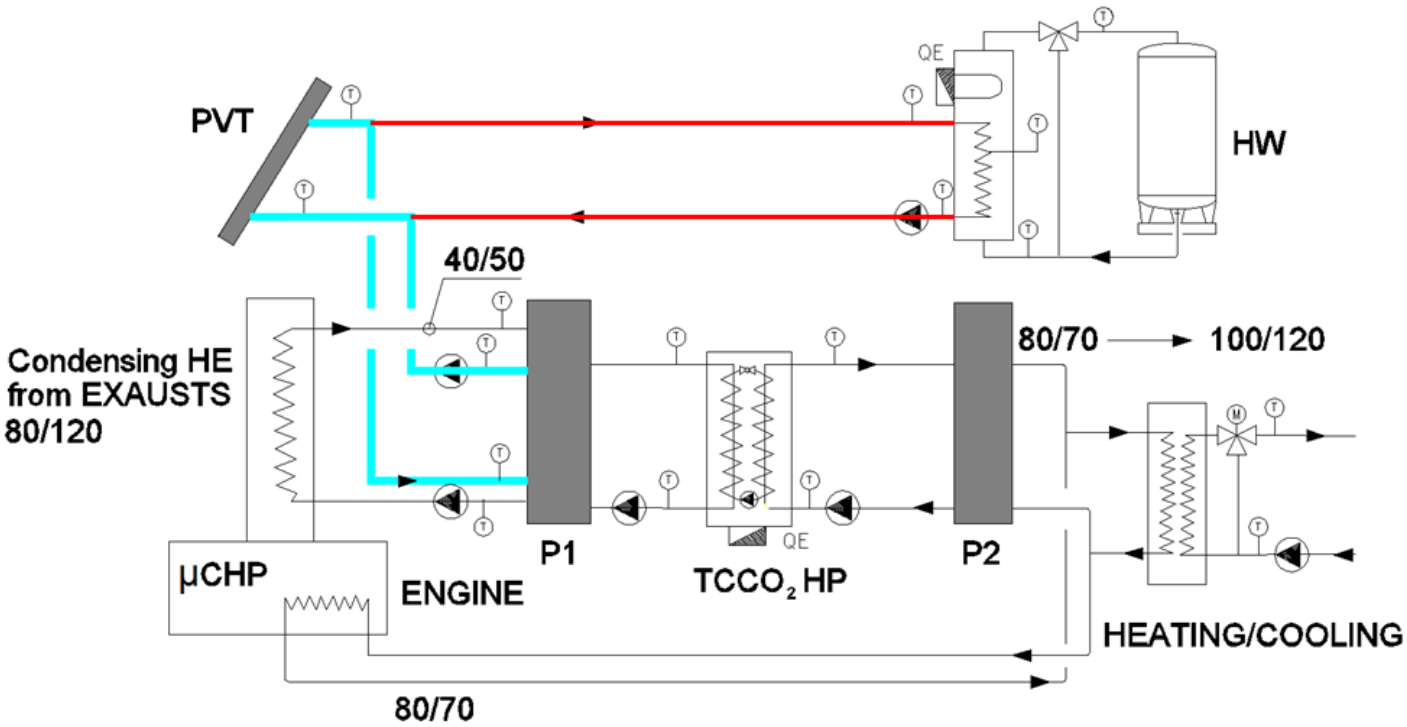
Dynamic simulation for energy auditing in existing buildings

HP dual source

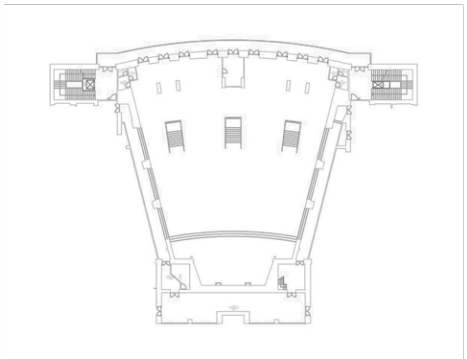


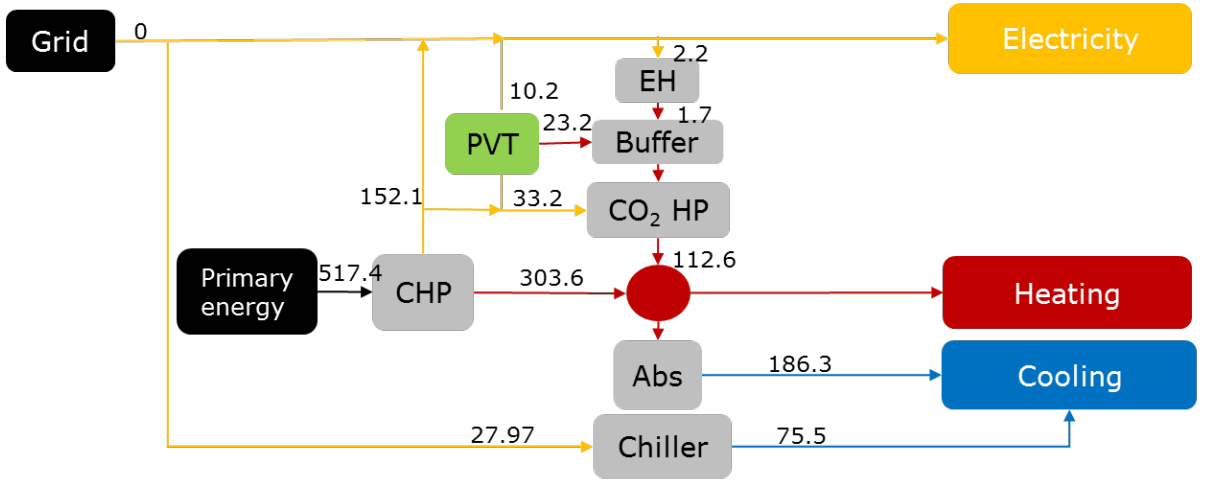
PVT + geothermal as heat (renewable) source of a water-water heat pump

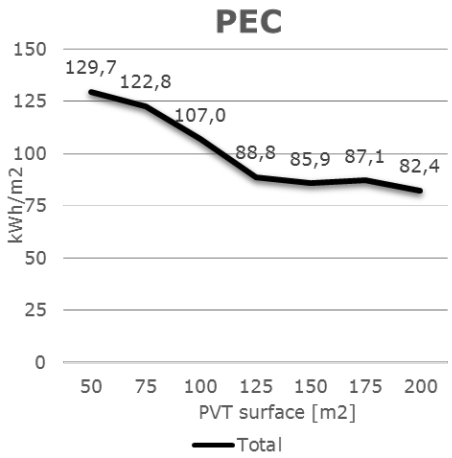
HP-TCCO$_2$

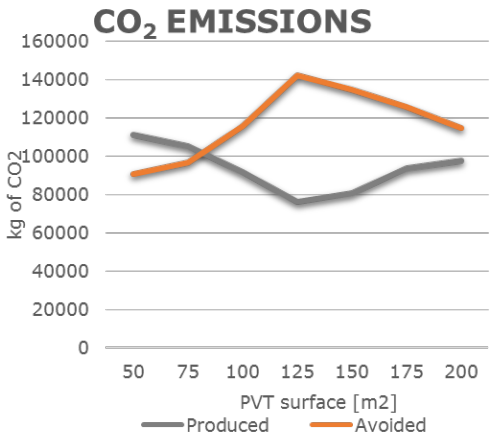


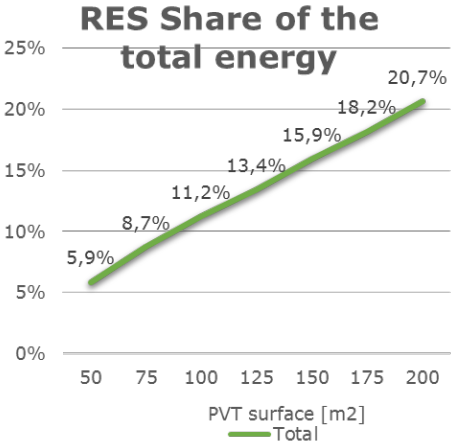
PVT + uCHP as heat (renewable) source of a TCCO2 heat pump

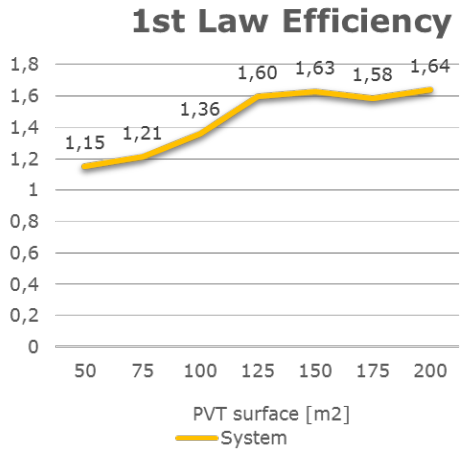



Grid
0
Electricity
2.2
EH
10.2
PVT
23.2
1.7
Buffer
152.1
33.2
CO_2 HP
Primary energy
517.4
CHP
303.6
112.6
Heating
Abs
186.3
Cooling
27.97
Chiller
75.5


PEC
150
125
100
75
50
25
0
kWh/m2
129,7
122,8
107,0
88,8
85,9
87,1
82,4
50 75 100 125 150 175 200
PVT surface [m2]
Total

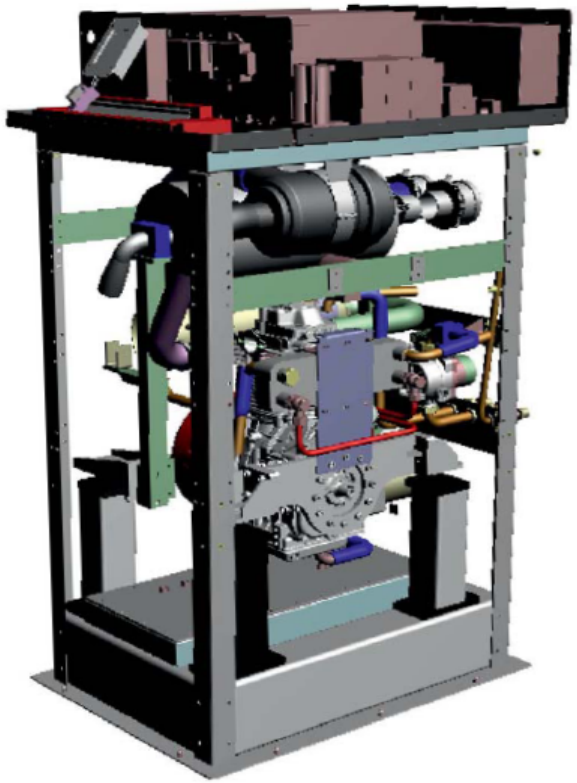

CO_2 EMISSIONS
160000
140000
120000
100000
80000
60000
40000
20000
0
kg of CO2
50 75 100 125 150 175 200
PVT surface [m2]
Produced
Avoided


RES Share of the total energy
25%
20%
15%
10%
5%
0%
5,9%
8,7%
11,2%
13,4%
15,9%
18,2%
20,7%
50 75 100 125 150 175 200
PVT surface [m2]
Total


1st Law Efficiency
1,8
1,6
1,4
1,2
1
0,8
0,6
0,4
0,2
0
1,15
1,21
1,36
1,60
1,63
1,58
1,64
50 75 100 125 150 175 200
PVT surface [m2]
System

Domestic ICE μCHP (5 kWe, 12 kWt)

μe=26%, μt=78%



Numerical model of a micro gas turbine fuelled with H_2NG blends and comparison with experimental data

SAPIENZA UNIVERSITÀ DI ROMA

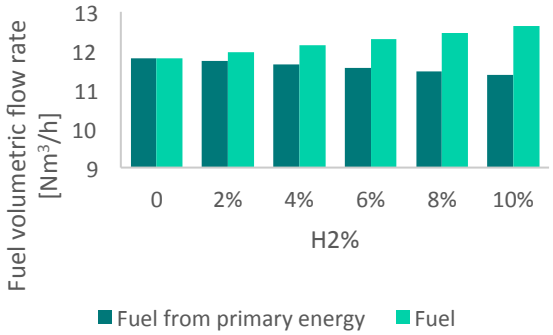
H_2 volumetric fraction added to the natural gas is not taken into account as primary energy

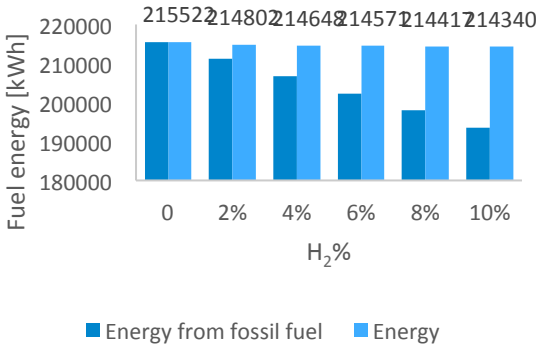
32% reduction of fossil fuel consumption with H_2 content equal to 10%

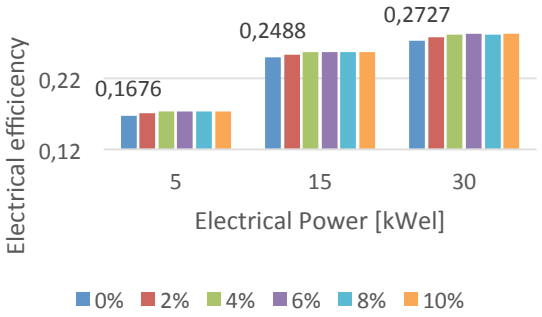
Energy from fossil fuel reduction with H_2 enrichment of natural gas

Overall fuel energy reduction due to slight increase of electrical and heat recovery efficiency

3,24% Increase of electrical efficiency with hydromethane @10% of H_2 by volume

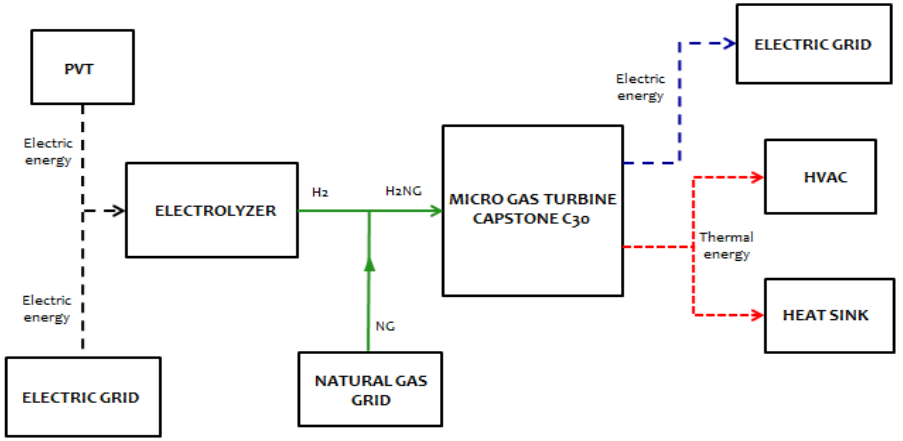


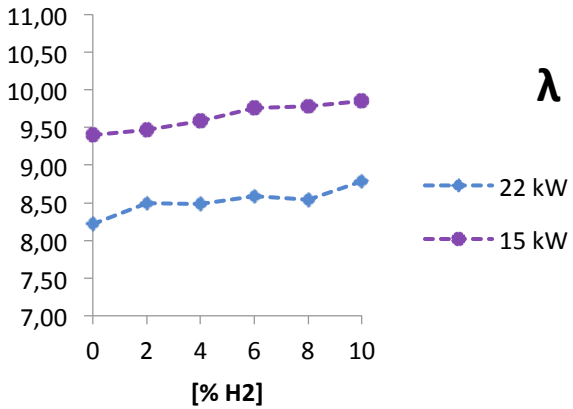




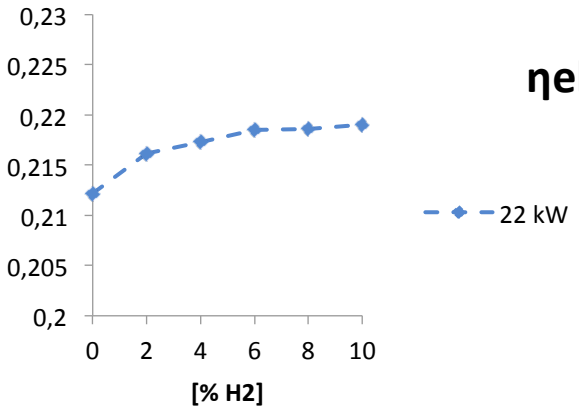
Experimental characterization of a micro gas turbine fuelled with H_2NG

- Results obtained by increasing hydrogen up to 10% vol. :
  - Relative equivalence ratio,λ, increase: 4% ÷ 7%
  - Maximum electrical efficiency increase: 0,00584
  - No drawbacks in the characteristic parameters of the MGT
  - CO_2 emissions reduction
  - Specific emissions lower than those resulting from separate heat and electricity production





λ



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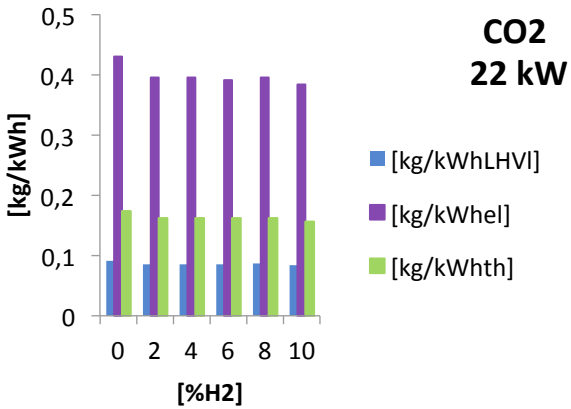
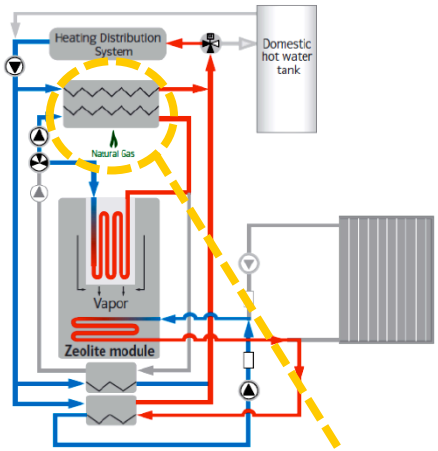
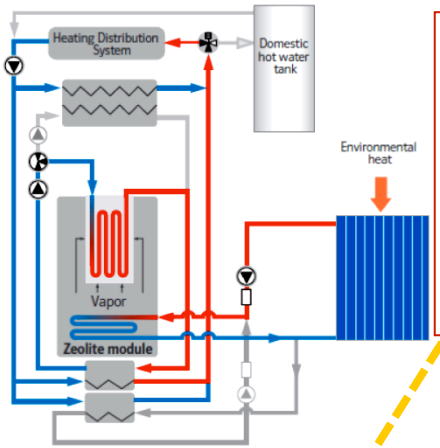


CO2
22 kW

Hydrogen-driven Gas Heat Pump

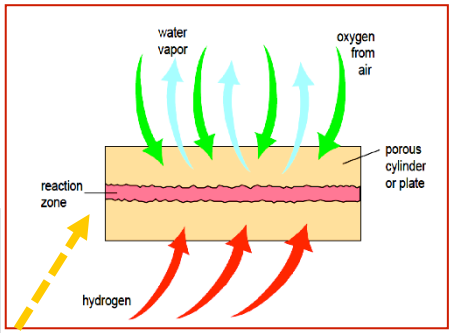


Desorption



Absorption

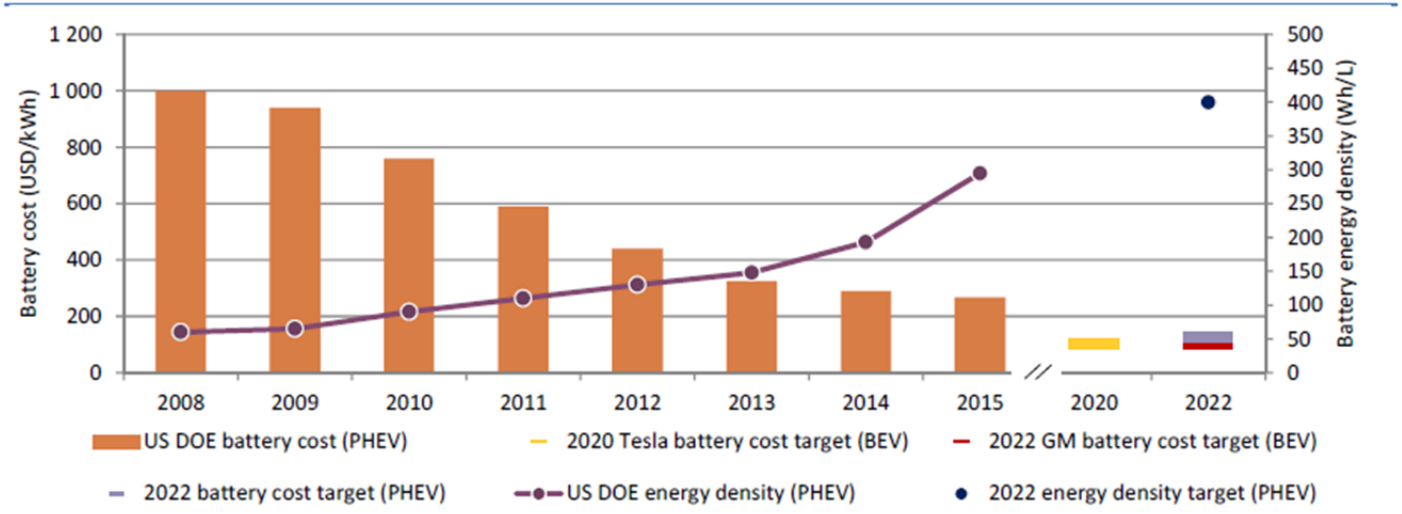
Burner modifications and substitution



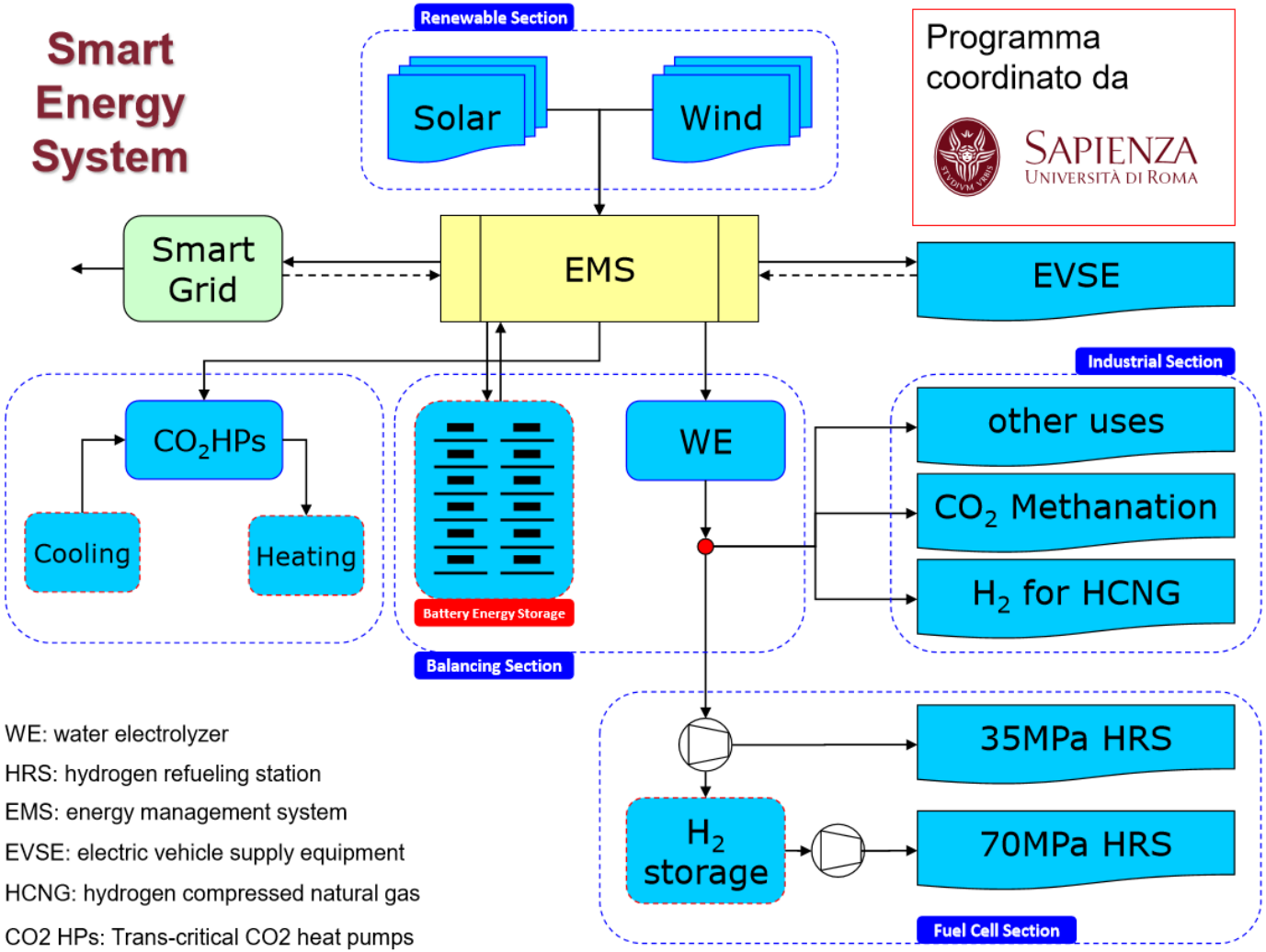
Schematic representation of catalytic burner

- Flameless combustion
- Low temperature combustion
- No nitrogen oxides
- No backfiring issues

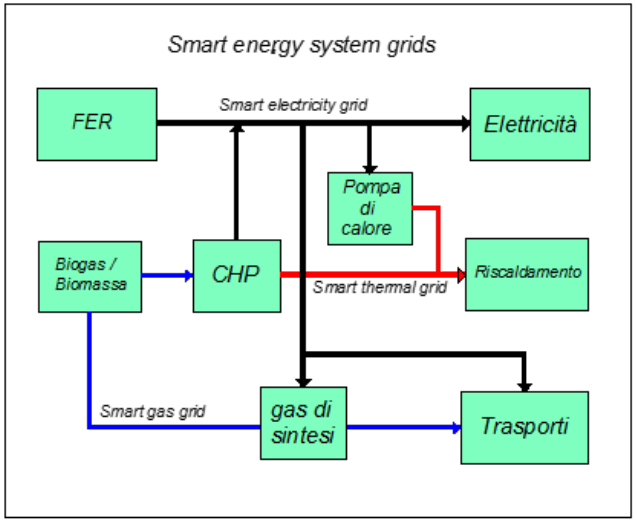
Bacteries costs/energy density

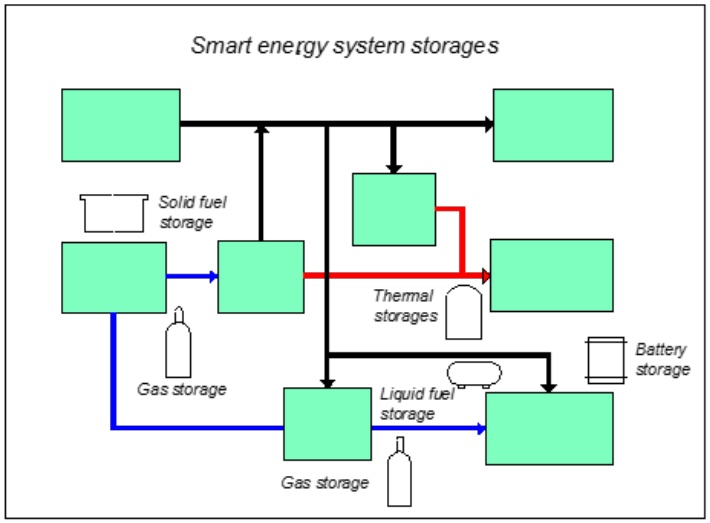


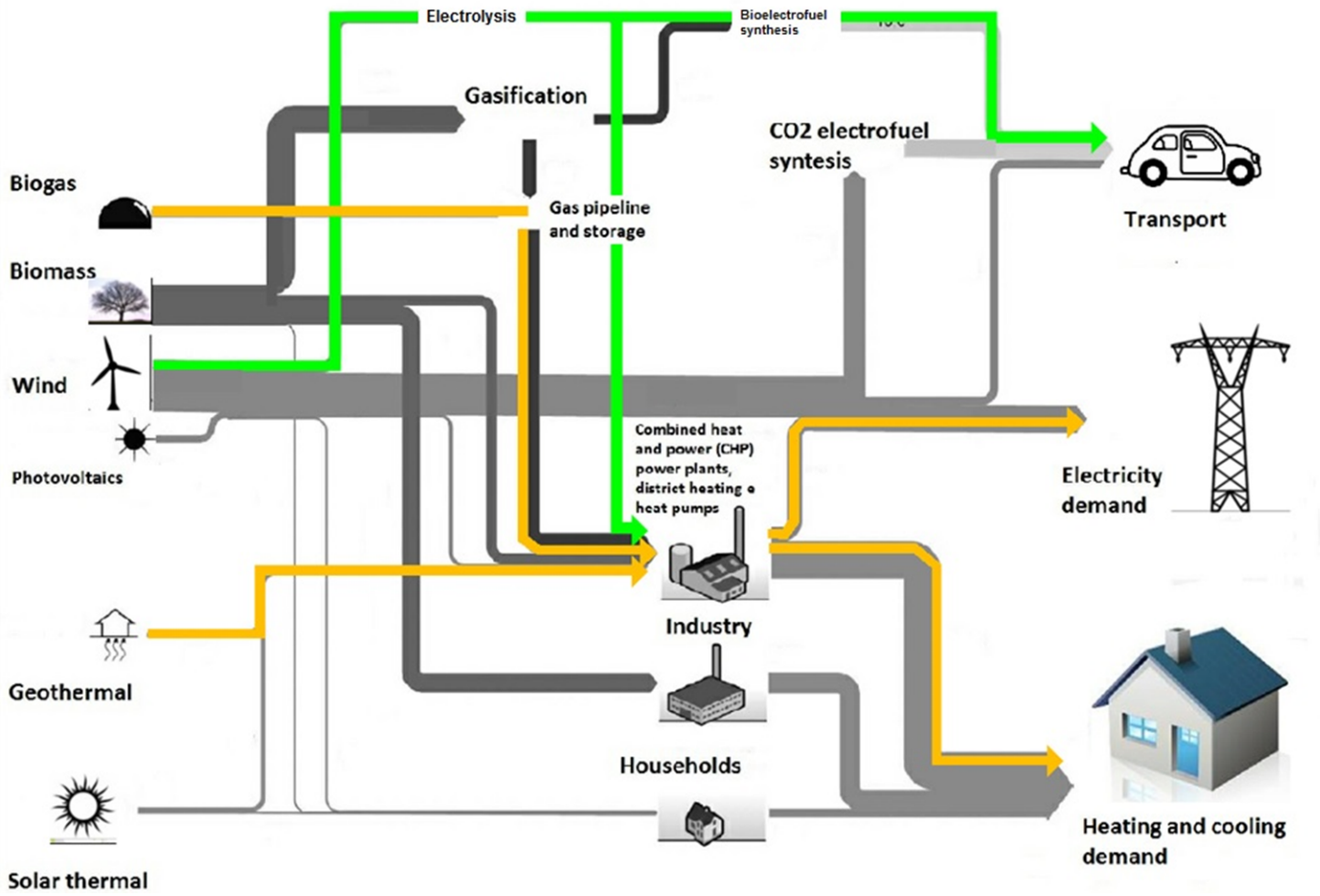
IEA,Global EV Outlook 2016

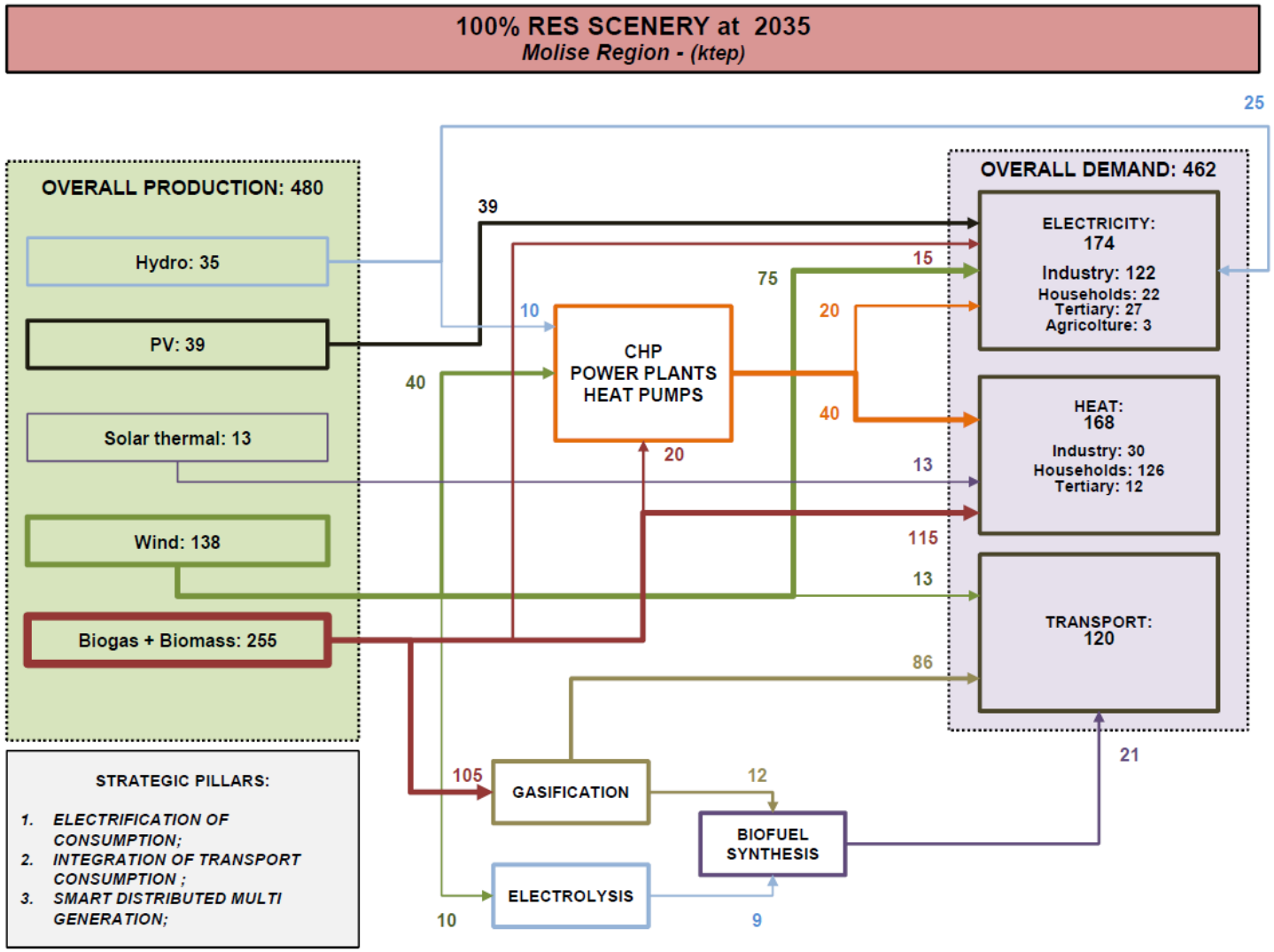

Smart Energy System
Renewable Section
Solar
Wind
Programma coordinato da
SAPIENZA UNIVERSITÀ DI ROMA
Smart Grid
EMS
EVSE
Industrial Section
CO_2HPs
Cooling
Heating
Battery Energy Storage
WE
other uses
CO_2 Methanation
H_2 for HCNG
Balancing Section
35MPa HRS
H_2 storage
70MPa HRS
Fuel Cell Section
WE: water electrolyzer
HRS: hydrogen refueling station
EMS: energy management system
EVSE: electric vehicle supply equipment
HCNG: hydrogen compressed natural gas
CO2 HPs: Trans-critical CO2 heat pumps

Towards the Smart Energy Systems (SES)






Electrolysis
Bioelectrofuel synthesis
Gasification
CO2 electrofuel syntesis
Biogas
Gas pipeline and storage
Transport
Biomass
Wind
Photovoltaics
Combined heat and power (CHP) power plants, district heating e heat pumps
Electricity demand
Industry
Geothermal
Households
Heating and cooling demand
Solar thermal


100% RES SCENERY at 2035
Molise Region - (ktep)
OVERALL PRODUCTION: 480
Hydro: 35
PV: 39
Solar thermal: 13
Wind: 138
Biogas + Biomass: 255
OVERALL DEMAND: 462
ELECTRICITY: 174
Industry: 122
Households: 22
Tertiary: 27
Agricolture: 3
HEAT: 168
Industry: 30
Households: 126
Tertiary: 12
TRANSPORT: 120
CHP POWER PLANTS HEAT PUMPS
GASIFICATION
BIOFUEL SYNTHESIS
ELECTROLYSIS
STRATEGIC PILLARS:
1. ELECTRIFICATION OF CONSUMPTION;
2. INTEGRATION OF TRANSPORT CONSUMPTION ;
3. SMART DISTRIBUTED MULTI GENERATION;
25
39
15
75
10
20
40
40
20
13
115
13
86
105
12
21
10
9

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