VERY SMALL- & SMALL- CHP SYSTEMS IN BUILDINGS IN HELLAS

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Exec. Comm. COGEN EUROPE

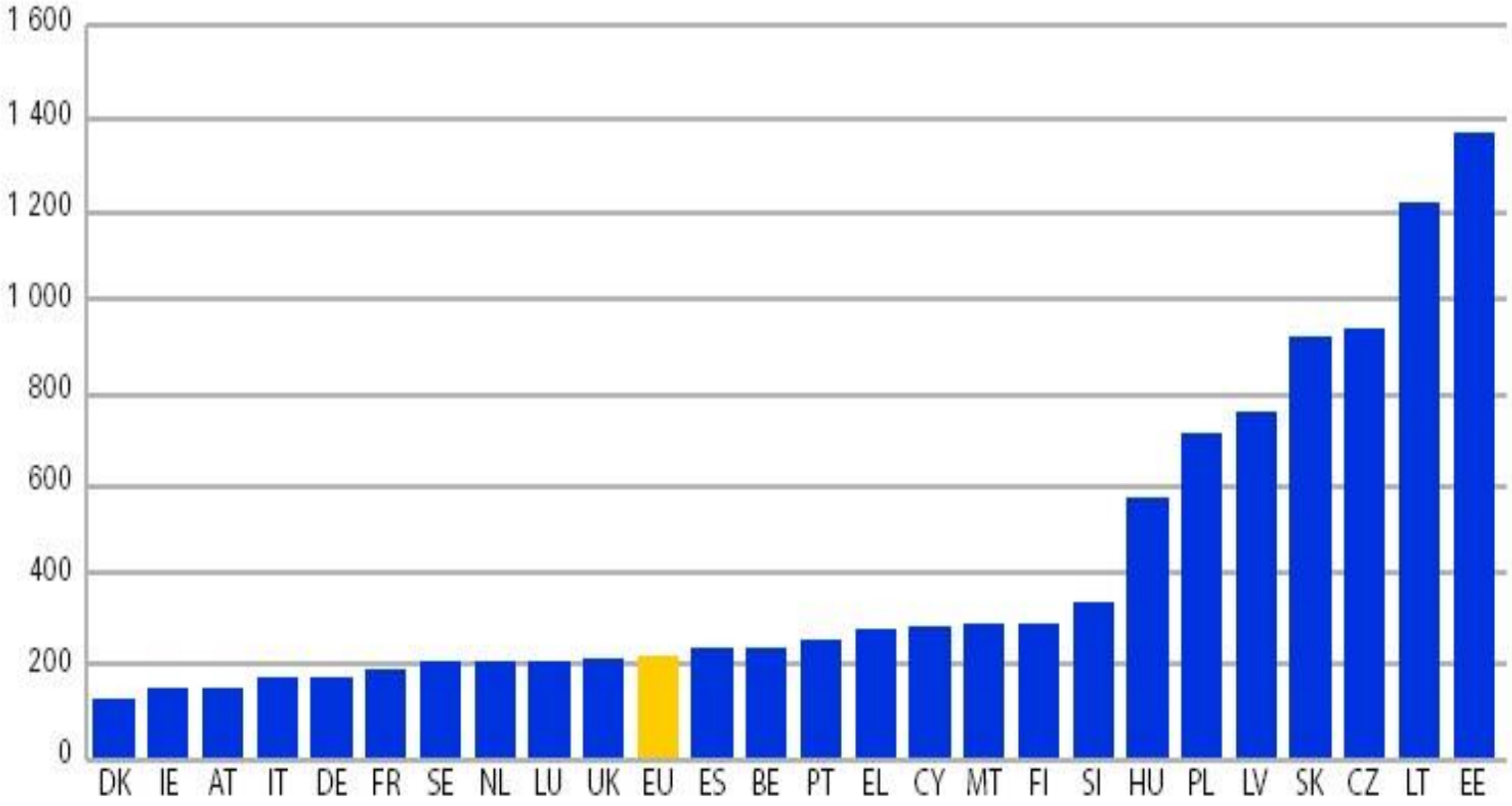
ASHRAE HELLENIC CHAPTER – TEE

"ENERGY & BUILDING"

ATHENS 13th October 2012

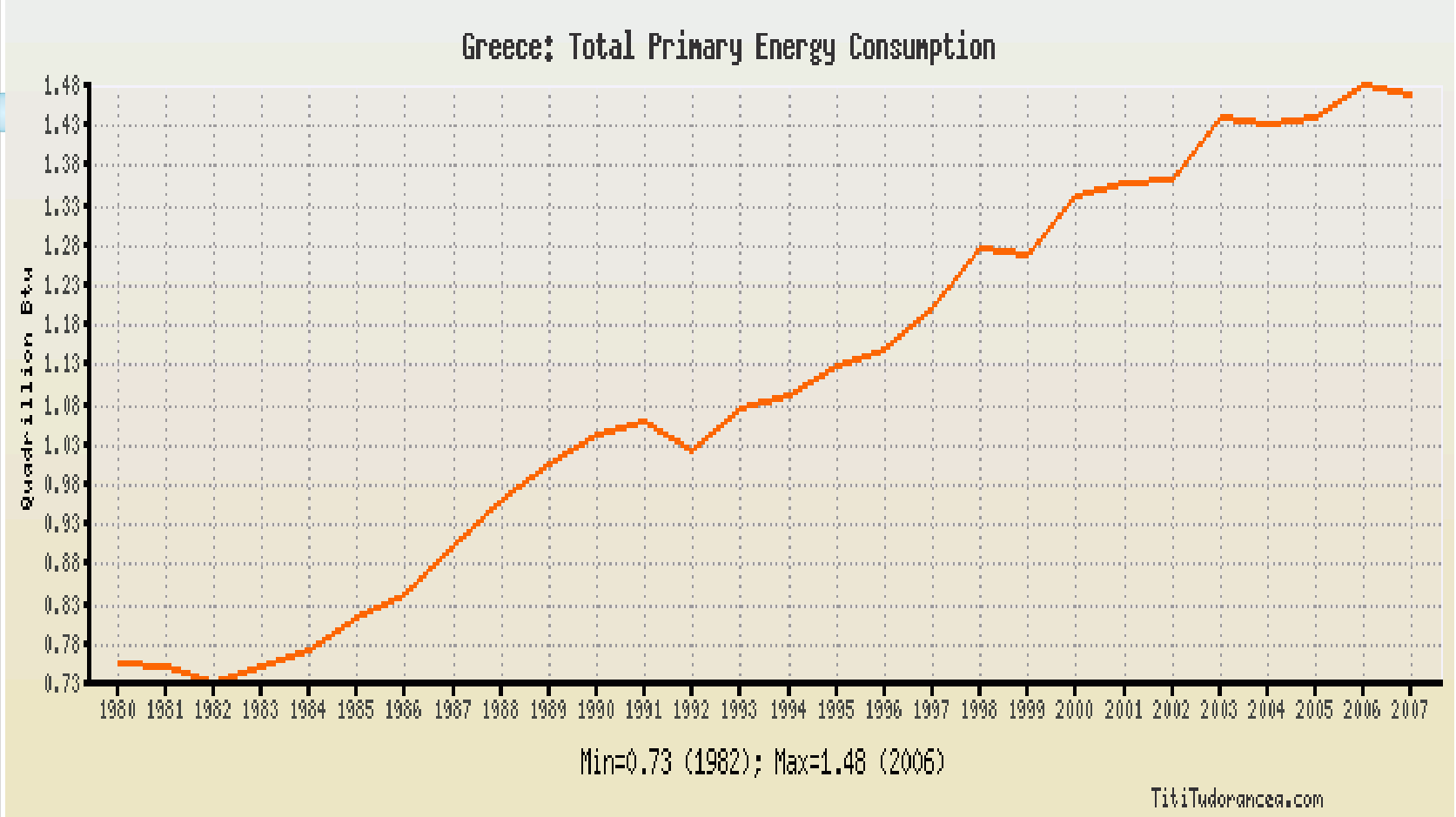
EU-25 Energy Intensity

Figure 2. Energy intensity in 2003 (in toe/million EUR of GDP at 1995 market prices) in EU-25



Source: *Enerdata (calculations based on Eurostat data).*

Greece: total primary energy consumption



- More than doubled in the last 25 years
- Slight decrease in recent years, due to the economic crisis
- Energy consumption in the tertiary and residential sectors are high (+40%)
- Industrial energy consumption is declining the past years

But what really applies...

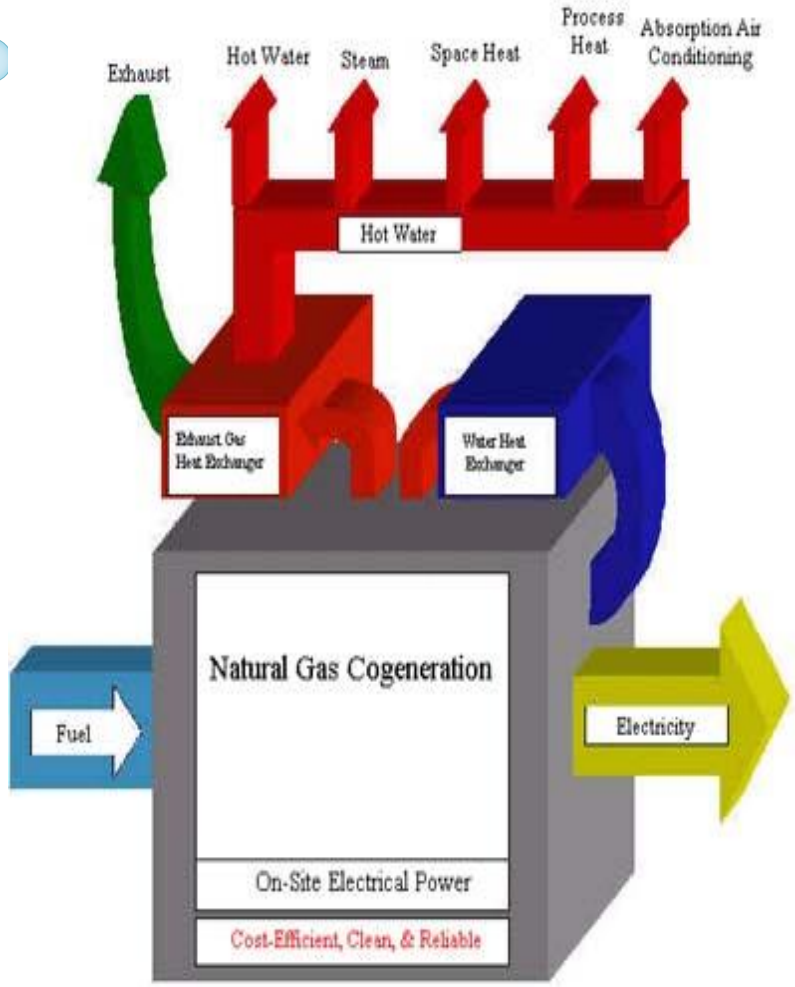
- The Greek economy is in a recession for the last 4 years, at least, causing political and social instability
- The energy market has still many distortions
- There is no reliable energy strategic framework for the next coming years,
- The promotion of RES with current guaranteed prices, FiT, are not based on "real" energy prices,
- Many energy players from the entire energy spectrum are operating in an opportunist attitude, with no strategy and plan,
- HACHP considers that CHP is a reliable energy efficient technology, as

  - many obstacles in the field of CHP were withdrawn,

  - the guaranteed prices (FiT) are satisfactory for the co-producers who use natural gas, but still there are issues that prevent the implementation of major investment, by using CHP.

So we need to integrate to our energy system: RES and CHP – Energy efficiency

What is Cogeneration of Heat & Power



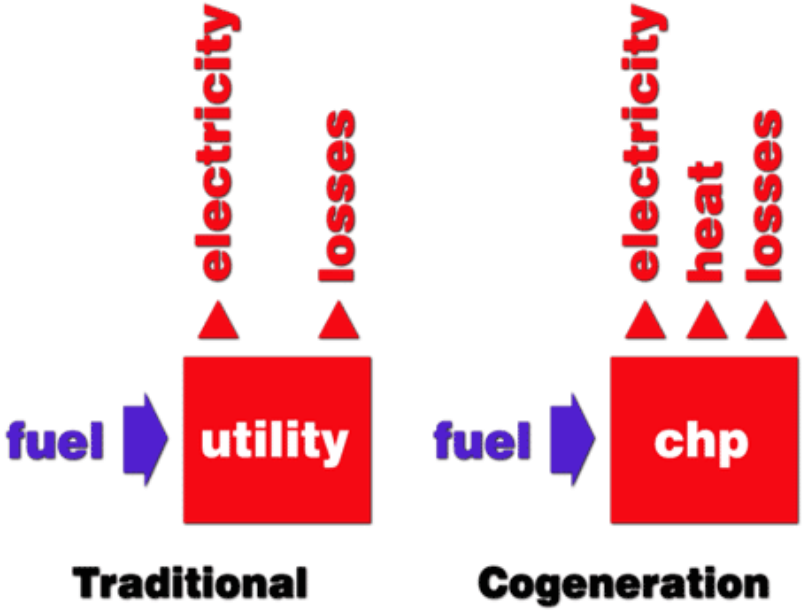
Cogeneration of Heat & Power- CHP is the simultaneous production of electricity and useful heat in one process.

Cogeneration solutions simply reduce waste, with only 10%-15% losses, compare that with the 55% or more using traditional generation methods and it is clear that cogeneration uses fuel more efficiently.

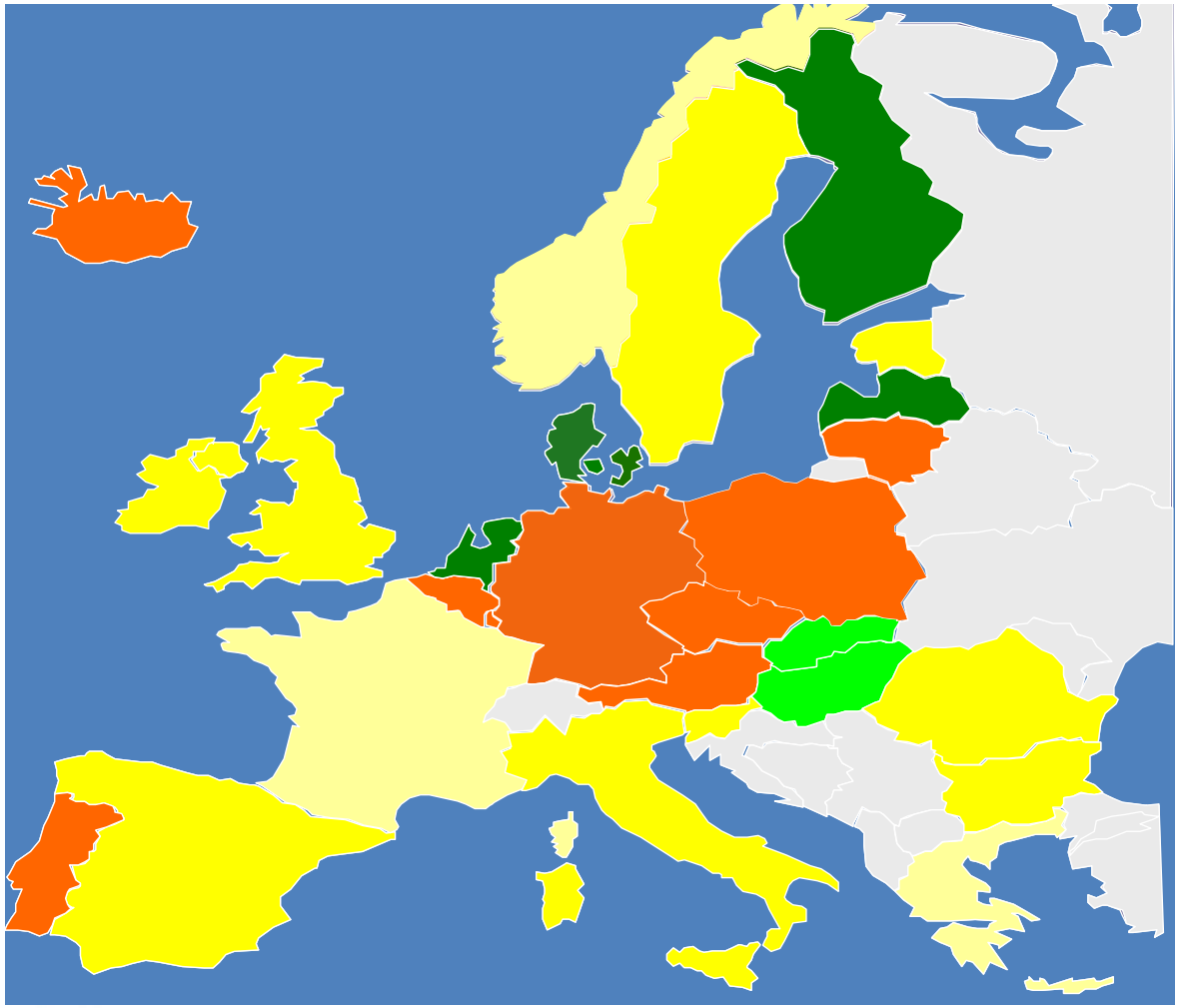
CHP is an Energy Efficient Technology – a Green Energy Challenge – as it is the most efficient way to use fuel.

Advantages of Cogeneration

- CHP is *more efficient* than separate generation of electricity and heat.
- Higher efficiency translates to *lower cost*.
- *Use of waste or byproduct fuel*, where available, further reduces cost.
- On-site electric generation *avoids distribution costs,* a significant component of grid electricity price.
- *Increased reliability and power quality* can also add significant value.



% of CHP on the total electricity production in Europe, for 2008



< 5% | 5-10% | 10-20% | 20-30% | >30%

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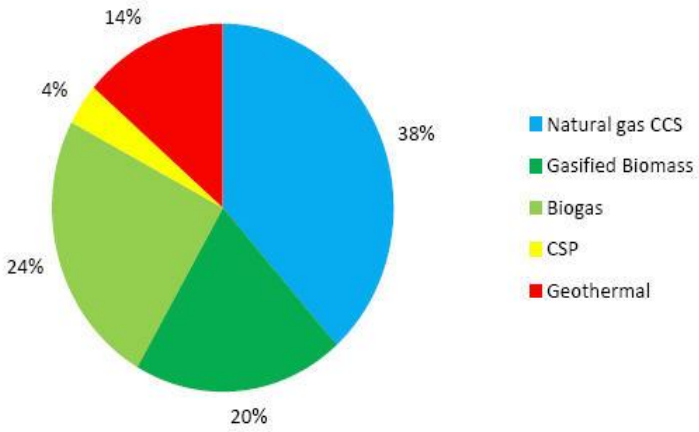

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www.hachp.gr

ΑΘΗΝΑ, ΔΕΚΕΜΒΡΙΟΣ 2011

Rates of primary energy CHP units for the EU27 in 2050

Basic Conclusion:

Cogeneration on 2050 will based on RES and on Biomass

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CHP in Greece today (1)

- The first CHP plant operated at a ceramics industry in Volos, in the early years of the 20th century.
- In the mid-70s, CHP spread to other heavy industries (refineries, steel, etc.).
- In the mid-'80s, many power plants of PPC became cogenerated stations, by supplying heating to the nearby cities. Overall, PPC is operating four district heating networks, in Greece.
- Also, at the same time, other high energy-intensity industries have introduced in their operation CHP units (e.g. paper industry, sugar, refineries, etc).
- During that period there was no legal framework for the operation of CHP.

CHP in Greece today (2)

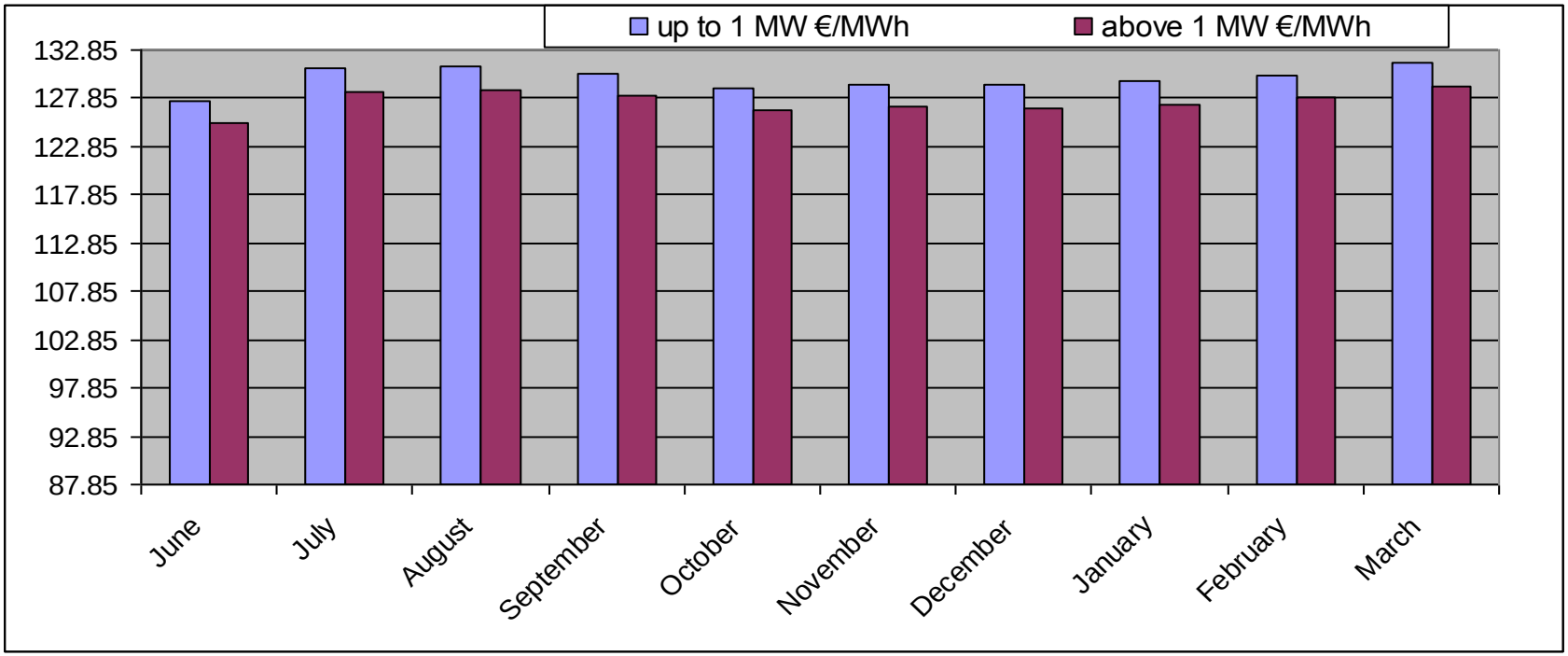
- In the mid-90, II & III CSF included CHP for grant, with a subsidy of 35-40% of the total investment.
- During this period, the guaranteed price for cogen. electricity was 60% of RES and cogen. electricity was at 2.4% of total electricity generation.
- During 2000, several new CHP units up to 2 MWe, with grants from CSFs, were installed.
- Today, in Serres, the first private District Heating System with four CHP units (16 MWe) is operating.
- For the last 4 years, two high-tech greenhouses of 100 acres each, in Drama and Alexandria, are using CHP with NG to cover their heating loads and to use their exhausts for supplying CO_2 for “extra” photosynthesis.
- The largest CHP unit in SE Europe, of combined cycle is located in AofG, of 121 MWe, waiting for the new Codes to start operation.

Legal framework for CHP

- In the mid-90, L.2244/94 introduces, for the first time, the concept of CHP.
- The L.3468/06 equates the guaranteed price for cogenerated electricity with those of RES.
- The L.3734/09 incorporates ED 2004/8/EC, giving emphasis on micro-and small-CHP, and on "useful heat".
- The MD 7/09 defines the methodology for calculating the cogenerated electricity.
- The L.3851/10 introduces the required equation to calculate the F-i-T from CHP, by using NG.
- The L.4001/11 prioritizes cogenerated electricity to the Network, regardless of their installed capacity (waiving 35 MW_e barrier).
- The Greek legislation is now in line with the European one.

F-i-T for CHP with NG

- Existing FiT for cogenerated electricity with all fuels, except natural gas, is equal to 87,85 € / MWh (same wind energy, etc)
- Special FiT for CHP, with NG, calculated from the equation 87,85 * NGC
- NGC = $\{1 + (NG_{price} - 26) / (100 * \eta_{el})\}$
- η_{el} = 0.33 for <1 MWe and 0.35 for>1 MWe
- The monthly price for the NG_{price} is announced by the Ministry of Environment, Energy and Climate Change.



High efficiency CHP systems in tertiary & domestic sector

- There is a notable increase of very small CHP installations, up to 50 kW_e, mostly in hotels, clinics, houses, etc.
- Also, there is an increase of CHP installations up to 1 MW_e.
- All Natural Gas companies support CHP installations.
- There are many difficulties for the connection to the grid of the very small CHP systems.
- Barriers:

  1 **Technical** (weather, energy connections)

  2 **Financial** (electricity/gas tariffs, etc)

  3 **Administrative** (licenses, codes).

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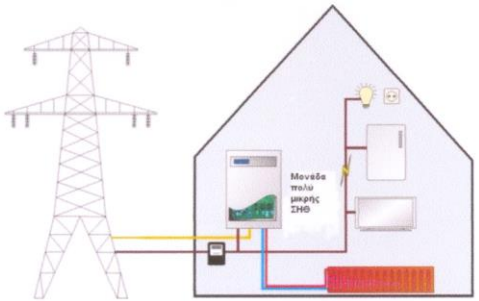


Α΄ έκδοση

Αθήνα, Απρίλιος 2012

Technical Directive 20701-5

titled ”CHP installations in Buildings”,

issued by TCG/ Greek Ministry of Energy, in April 2012.

BEST PRACTICES

of very small- & small- high efficiency

CHP units

to the domestic and to the tertiary sector

BEST PRACTICE:
CHP unit to the domestic sector

- City: Thessaloniki, Greece - HDD 1057 (16 ^{0}C)
- Building: 8 floors - 18 apartments
- Heating area: 1357 m^2

- **Before**:

  Oil boiler - capacity: 250 kW$_{th}$ - fuel consumption:14000 lt/yr
- **After**:

  very small CHP 4.5 kW$_{el}$ / 12 kW$_{th}$ – fuel: NG + NG boiler 58 kW$_{th}$ (stand-by) + 2 storage tanks x 1000 lt
- **Results** after a yearly operation:

  Consumption:12200 m^3 NG

  Production: 14500 kW$_e$, during winter period (2011-12)
- Initially, CHP unit covers thermal loads of apartments (and later of the domestic hot water)

Investment cost: 22000 €

Payback period: 4,5 years

BEST PRACTICE: High efficiency CHP unit to the tertiary sector

- ✓ **Installations in operation (7,231 MWe)**
  1. Maternity ‘MITERA’ 515 kWe
  2. I.IB.E.A.A. 700 kWe
  3. BRIGHT 300 kWe
  4. METROPOLITAN hospital 240 kWe
  5. Naval hospital of Athens 560 kWe
  6. University of Athens 2 x 1.358 kWe
  7. Doukas school 240 kWe
  8. Vivartia 2 x 980 kWe

Technical characteristics of high efficiency CHP installation maternity «Mitera»

- **INTERNAL COMBUSTION ENGINE, L36GLD, WAUKESHA**

  12 CYLINDER, DEVICE V, CUBISM 36 lt, COMPRESION RATIO 11:1,

  STROKE 165mm, CYLINDER DIAMETER 152mm

- **SYNCHRONOUS GENERATOR, LEROY SOMER, MTG 55**

  3-Ph, 400 V, 50 Hz, 0.8 p.f.

- **HOT WATER ABSORPTION COOLER,**

  LG ELECTRONICS, LWM-019

  LiBr , NOMINAL POWER 190RT

- **COOLING TOWER, KIMCO, MEX-400KL**

  OPEN TYPE, NOMINAL POWER 400RT

- **DESIGN-CONSTRUCTION:** HELIOSTAT

Energy balance high efficiency CHP-Trigeneration

Cooling
134 kW el
(133RT)

Electricity
515 kWel

Heating
933 kW

Domestic hot water
306 kW

Sensible Heat

Latent Heat

1.633 kW

Liners
380 kW

oil &
intercooler
142 kW

Operation of CHP unit

Data:

- COP water chiller: 3,5
- COP absorption chiller: 0,7
- Efficiency of conventional boiler: 80%
- LHV = 90% x HHV
- Operating hours: 5.000 p.a

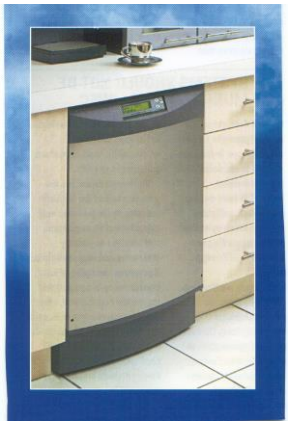
	Initial Study	Base Load Own consumption 700 hrs	Peak Load 2010	Base Load Producer 700 hrs
Electricity	**4.326 MWh**	**4.326 MWh**	**1.800 MWh**	**4.326 MWh**
Substitution of gas heating and domestic hot water	**2.500 MWh**	**2.500 MWh**	**2.500 MWh**	**2.500 MWh**
Substitution of electricity for cooling	**1.139 MWh**	**1.139 MWh**	**264 MWh**	**1.139 MWh**
Fuel	**13.720 MWh**	**13.720 MWh**	**5.709 MWh**	**13.720 MWh**

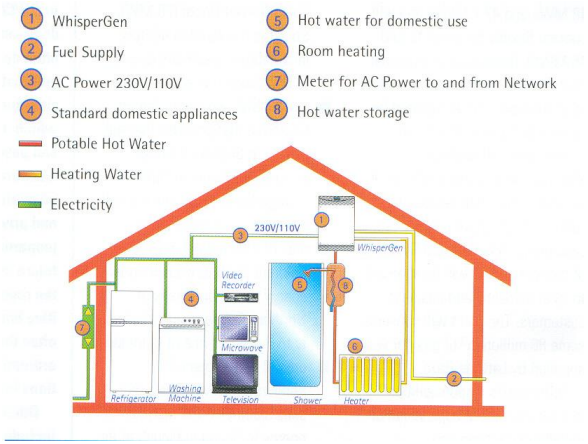
Maternity «MITERA»: CHP operation

- Investment cost : 600.000 €
- Electricity of Base: 88 €/MWhe, Peak: 120 €/MWhe, Producer: 142 €/MWhe, in *Feasibility study: 90 €/MWhe*
- Gas cost (CHP): 47,75 €/MWh – ave. 2011,
- Gas cost (other): 57,63 €/MWh – ave. 2011, in *Feasibility study: 27 €/MWh (CHP) – 38 €/MWh (other)*
- Maintenance cost: 15,00 €/MWh

	Initial Study	Base Load Own consumption 700 hrs	Peak Load 2010	Base Load Producer 700 hrs
Electricity	**389.340 €**	**380.688 €**	**216.000 €**	**614.292 €**
Substitution of gas heating and domestic hw	**95.000 €**	**144.075 €**	**144.075 €**	**144.075 €**
Substitution of electricity for cooling	**102.470 €**	**136.627 €**	**31.624 €**	**136.627 €**
Fuel	**-370.440 €**	**-655.130 €**	**-272.592 €**	**-655.130 €**
Maintenance	**-64.890 €**	**-64.890 €**	**-27.000 €**	**-64.890 €**
Annual savings	**151.480 €**	**-58.630 €**	**92.107 €**	**174.974 €**
Payback period	4 years		7 years	3 years

μCHP in Houses





House with swimming pool and μ CHP 4,5 kWe

Food industry – pasta – with μ CHP 10 kWe

A new Energy Efficiency Directive…

- The target of 20% energy savings in 2020 cannot be achieved with current data in EU.
- For this reason, the EU institutions as the Commission, the EU Parliament and the Council of 27, are in final negotiations for a new Directive, titled “Energy Efficiency Directive”
- On 12.9.2012, it passed from the European Parliament
- CHP and Energy Conservation are two key points for the new Directive, in order to promote faster the Energy Saving, in EU.

A new Energy Efficiency Directive…

The main changes the Directive brings to existing legislation are:

- Energy companies are requested to reduce their energy sales to industrial and household clients by at least 1.5% each year,
- A 3% renovation rate for public buildings which are "central government-owned and occupied"
- An obligation on each M-S to draw up a roadmap to make the entire buildings sector more energy efficient by 2050 (commercial, public and private households included).

The new Directive also includes additional measures on energy audits and energy management for large firms, cost-benefit analysis for the deployment of CHP and public procurement.

Conclusions

- Today, the cogenerated power in Europe corresponds to 11%, while in Greece is about 1.80% of total electricity production.
- The existing legal framework is sufficient to promote high efficiency CHP
- There are bureaucratic barriers, particularly in the interconnection of high efficiency CHP units, particularly of very small units, connected in the low voltage.
- Important barrier to CHP development is the so-called “spark-gap” – the price ratio between electricity and NG.
- There is a market for the development of very small- & small-CHP systems particularly in the tertiary and domestic sectors.
- But, because of the economic crisis, this is going to delay?..
- HACHP has declared 2012 “**Promotion Year for the very small CHP systems**”.

Thank you for your attention!
Any question?

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