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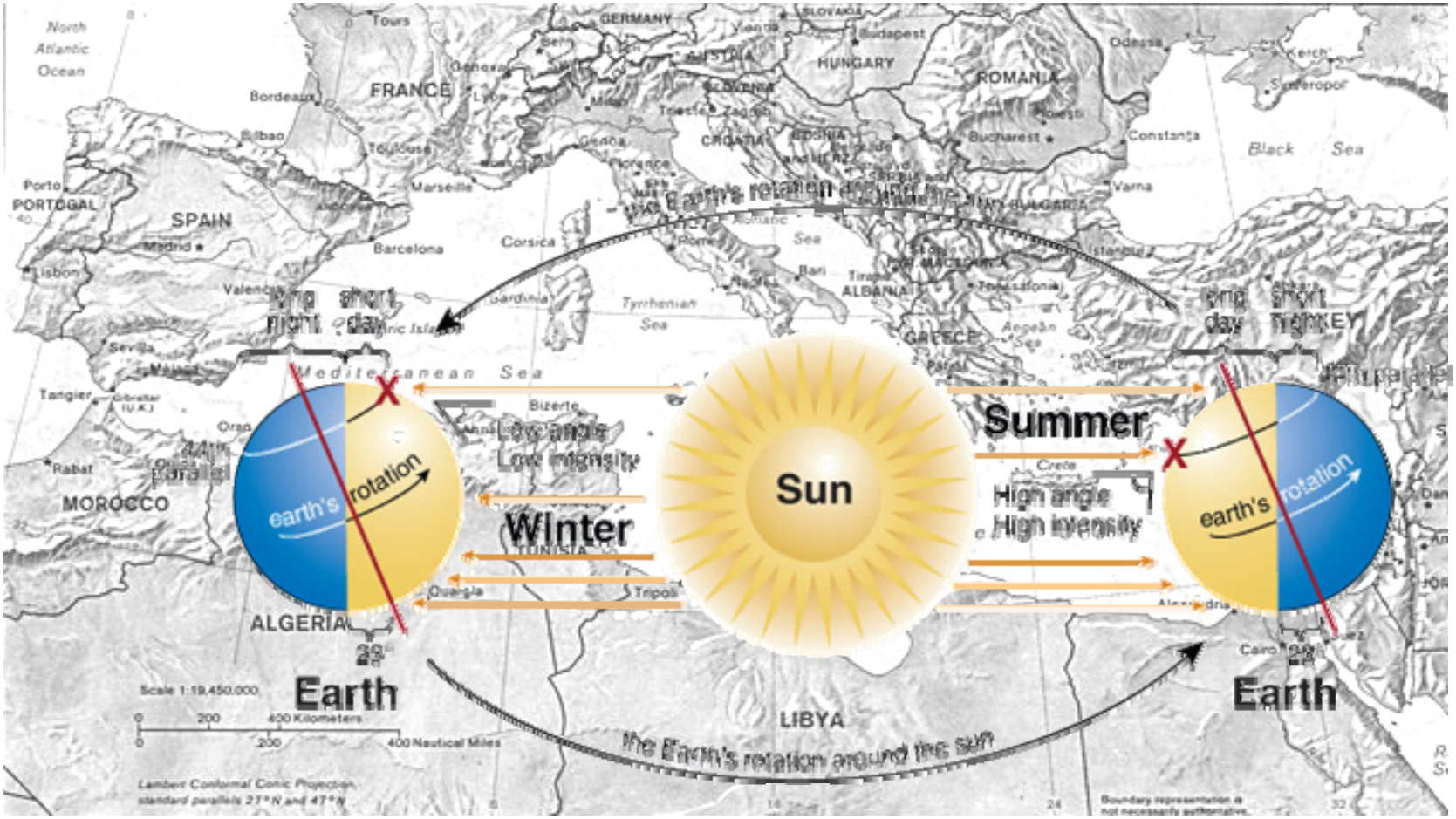
FP6-2002-INCO-MPC/SSA-2

Integration of solar technologies into buildings in Mediterranean communities



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Greece

Located in the south-eastern Europe (between 34° and 42° parallel N), on the Southern end of the Balkan Peninsula.

Bordered:

- **on the north with Albania, the Former Yugoslav Republic of Macedonia and Bulgaria**
- **to the west by the Ionian sea**
- **to the south by the Mediterranean sea**
- **to the east by the Aegean sea.**

The country consists of a large mainland at the southern end of the Balkans; the Peloponnesus peninsula and numerous islands (around 3,000). About 80% of Greece consists of mountains and hills, thus making Greece one of the most mountainous countries of Europe.

- **Total area: 131,957 sq. km**
- **Population: 11,170,957 (estimate 2007)**
- **Growth rate: 0.18%.**
- **Capital: Athens (population: 3,361,806)**

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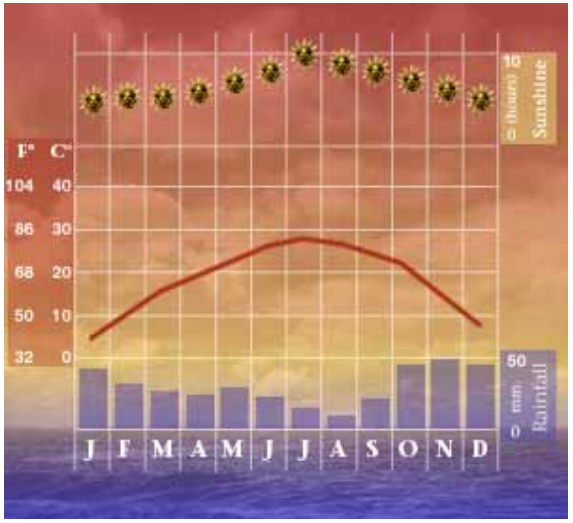
Climate(1)

The climate in Greece is typical of the Mediterranean climate:

- ✓ **mild and rainy winters**
- ✓ **relatively warm and dry summers**
- ✓ **generally, extended periods of sunshine throughout most of the year.**



A great variety of climate subtypes, always within the Mediterranean climate frame, are encountered in several regions of Greece. This is due to the influence of topography (great mountain chains along the central part and other mountainous bodies) and on the air masses coming from the moisture sources of the central Mediterranean Sea.

Thus the weather in Greece varies from the dry climate of Attiki (Athens' greater area) and East Greece in general, to the wet climate of Northern and Western Greece.

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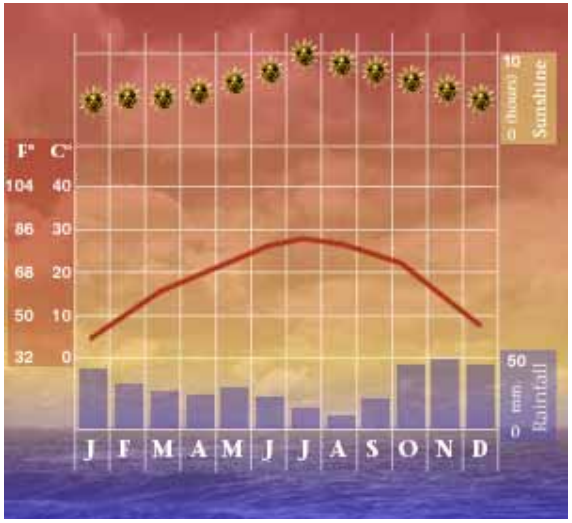
Climate(2)

In climatological terms, the year can be broadly subdivided into two main seasons:

- the cold and rainy period lasting from mid-October until the end of March
- the warm and dry season lasting from April until September.



During the first period the coldest months are January and February, with, a mean minimum temperature ranging, on average, between 5 - 10ºC near the coasts and 0 – 5 ºC over the mainland, with lower values (generally below freezing) over the northern part of the country. The winter is milder in the Aegean and Ionian Islands compared to Northern and Eastern mainland Greece.

The warmest period occurs during the last ten days of July and the first ten days of August, when the mean maximum temperature lies between 29.0 and 35.0 degrees Celsius.

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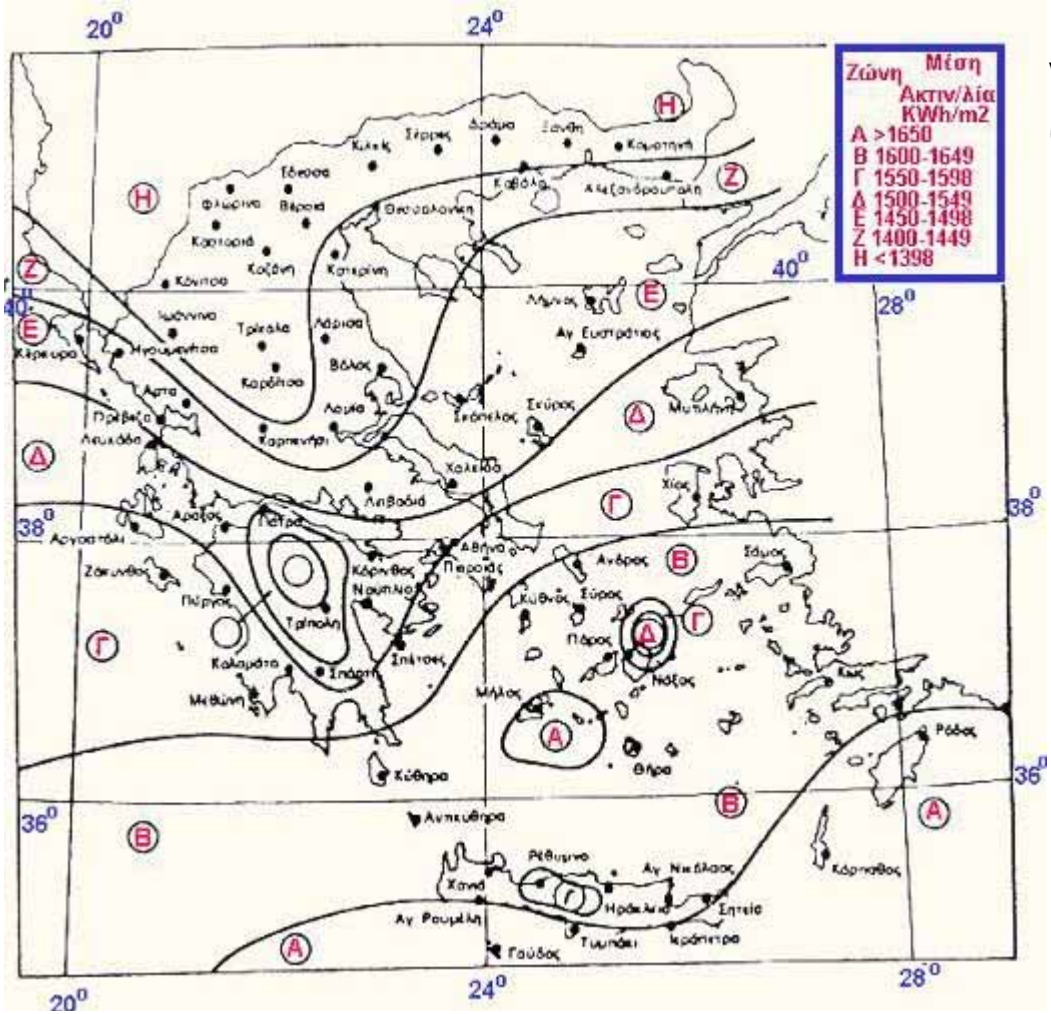
Solar Radiation Intensity



Distribution of yearly mean solar radiation intensity, on horizontal plane

varies considerably and depends on:

- ✓ **time period of the year:**

  Mean daily value in Summer:

  7 kwh/m²

  Mean daily value in Winter:

  2 kwh/m²

- ✓ **geographical position**
- ✓ **elevation (increasing by 7 W/m² per100m)**

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Economy

Greece has a mixed capitalistic economy with a large public sector accounting for approx. 40% of GDP and with a per capita GDP at least 75% of the leading euro-zone economies. The greek economy has improved in recent years due to the tight policy before and after EU's single currency. The economic improvement from 1990 to 2000 is a budget deficit below 1% of GDP and an inflation which fell from 20% to 3.1%. Nevertheless, the reconstruction of the economy and the reduction of unemployment (11.3%) are the major challenges of the country

Although Greece is an agricultural country,

- ✓ **20 % of the workforce is employed in agriculture**
- ✓ **59 % of the workforce is employed in the sector of services**
- ✓ **21 % in the sector of industry and construction**

The agricultural contribution to the economy is only of 15 %.
The industry which contributes the most to the economy is the tourism industry and the shipping

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Economy

GDP official exchange rate	: 223.8 billion $	(2006 est.)
GDP growth rate	: 4.2%	(2006 est.)
GDP per capita	: 24,000 $	(2006 est.)
Inflation rate	: 3.3%	(2006 est.)

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Building stock data

Total number of buildings	3.990.970
Domestic	2.755.570
Hotels	22.830
Industrial	31.422
Educational	16.804
Commercial and offices	111.097
Hospitals	1.961

National Statistical Service, inventory 2000

Total number of buildings	: 3.990.970
Built before 1980	: 2.770.215

✓ **Residential buildings represent approx.70% of the total building stock in Greece**

✓ **30% of the residential building stock is concentrated in urban and 18 % semi-urban areas**

✓ **Construction rate**

The most intense construction work was in the 1960s - 19% of the total building stock (~70%)

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Building stock data

2000-2004: increase in construction permits - 18%.

From the registered permits: 50-54% corresponds to new buildings

13-17% corresponds to extensions

✓ Renovation rate

Most of the renovation projects are not recorded, as permit processes are costly and time consuming. data is not available on the type of renovation actions.

The recorded percentage of renovation projects (to the total no of permits for new buildings as well as renovations) was 4,5%, 4,7%, and 5,5% for the years 1997, 1998, and 1999 respectively.

However, a new construction market is growing during the last years in Greece. Due to building stock ageing and refurbishment needs, an increasing number of construction enterprises focus their activities on building renovation projects and this particular market segment is growing fast. For the period 2000-2004, from the registered permits, a percentage of 8 – 10% corresponds to renovation projects.

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Common building practice

✓ Type of construction

reinforced concrete structure with brick walls

✓ Insulation

Insulation regulations enforced in 1979. Since than:

- beams and columns: insulated externally
- exterior walls: made of double brick construction with insulation in between
- roofs: either flat with insulation placed above concrete slab or pitched with tiles placed above a wooden or concrete structure with internal insulation

Old buildings (built before 1980) are uninsulated and represent approximately 80 % of the building stock.

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Common building practice

✓ Heating systems

- Either central or non central, using mainly fuel oil.
- Buildings constructed before 1990: central heating systems based on diesel fired boilers are being used in the vast majority of buildings
- Buildings constructed after 1990: use diesel or natural gas fired boilers

✓ Cooling systems

- RAC units, being installed at ever increasing rates
- Very few older buildings utilize water cooled central systems.
- In building of the tertiary sector heat pumps (air to water or VRV systems) are also used for cooling. These buildings do not employ boilers, in order to avoid the extra complication of two different systems

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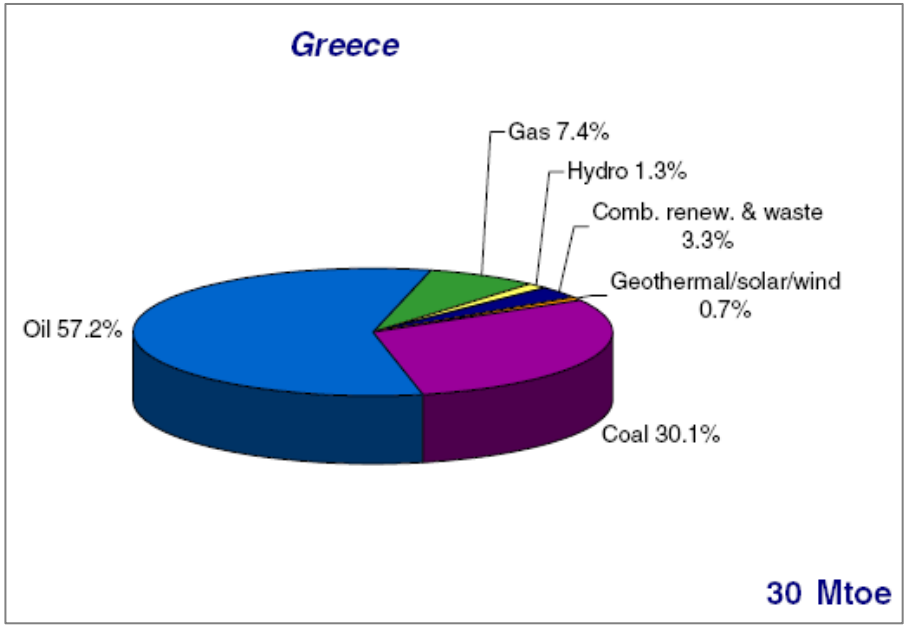
Energy data

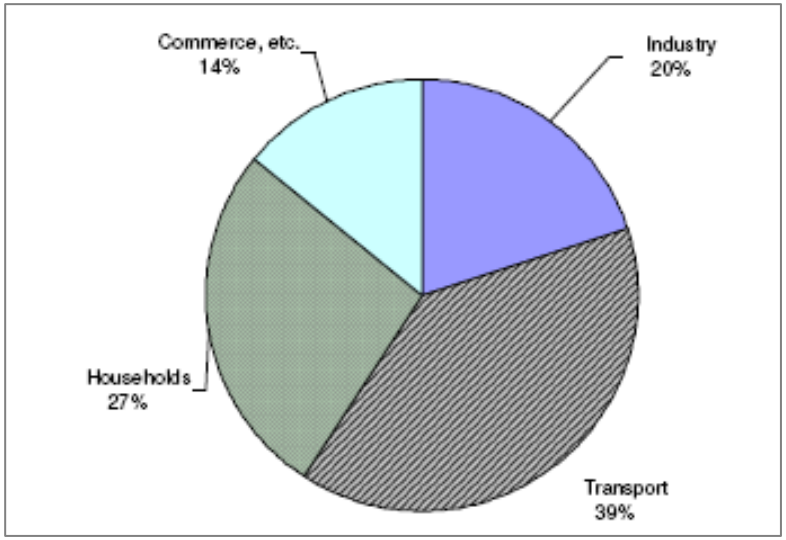
Since 1990 final energy consumption has increased by 39%

All sectors, but especially households and commerce, have followed similar growth rates



2004 Share of Total Primary Energy Supply

2004 Final Energy Consumption by Sector



Transport is the most energy-consuming sector (above EU-27 average of 31%)

Households and industry exhibit a total share of 47% in final energy consumption

Oil dominates in terms of types of energy consumed, followed by electricity

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Energy data

Energy consumption by end use

Regarding the domestic, the improving standards of living resulted in continuously increasing levels of energy consumption

Domestic sector

	2000	2001	2002	2003	2004
Electricity consumption					
Mtoe	1,222	1,25	1,29316	1,414	1,449
Final consumption					
Mtoe	4,50597	4,65961	4,89224	5,459	5,361

Electricity consumption for space heating					
Mtoe	0,202341	0,207169	0,220395	0,24038	0,22889
Final consumption for space heating					
Mtoe	3,188419	3,301778	3,502341	3,941595	3,829323

Electricity consumption for water heating					
Mtoe	0,101989	0,104423	0,097135	0,10605	0,112547
Final consumption for water heating					
Mtoe	0,223737	0,230714	0,22577	0,244118	0,22827

Energy data

Energy demand for cooling, lighting and office equipment in the tertiary sector is also increasing

Energy consumption by end use

Tertiary sector

	2000	2001	2002	2003	2004
Final consumption of the tertiary sector					
Mtoe	1,3069	1,4656	1,540411	1,657	1,769
Electricity consumption of the tertiary sector					
Mtoe	1,054	1,1378	1,206483	1,288	1,363

Source: D-base ODYSEE, Energy Efficiency Indicators, 2006

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Supporting policies - Legislative and Financial mechanisms

- **The 'Regulation for Thermal Insulation' imposed in 1979, sets limitations to heat losses (by setting limits to k values) of the building envelope, varying by climate zone and F/V ratios.**

- **By amendment of the General Building Code, since 2000, incentives are provided for the application of passive solar systems onto the building shell. Such incentives foresee exclusion of the area of the energy systems within the building factors and volume coefficients.**

- **Moreover, in the General Building Code (1985), an exception was provided to the limitations posed with respect to the maximum allowable height of buildings, in case a solar water-heating installation was included.**

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Supporting policies - Legislative and Financial mechanisms

- In 1984-1986 the Hellenic State supported a successful advertising campaign. This campaign, combined with the introduction of the VAT process in the Hellenic taxation system (due to the consumers' expectations this change created a major increase in the durable product market), by the end of 1986 boosted the annual sales of glazed solar collectors up to 185.000 m^2. Low interest loans and tax credits were also available during this period

- The campaign of 84-86, as well a new one performed in cooperation with the Public Power Corporation in 1995, resulted in a considerable penetration of solar systems in the residential sector

- To promote the application of central solar systems in the tertiary and the industrial sector, which is still low, the Operational Programme for Energy (1996-2000) supported a significant number of solar systems in Hotels and Industry by financing up to 50% of the capital cost

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Supporting policies - Legislative and Financial mechanisms

- **Following official adoption of the Action Plan "Energy 2001" by the Hellenic Government, significant tax incentives for (domestic) RES installations and systems were introduced by Law 2364/1995: up to 75 % of the total cost for the purchase and installation of domestic RES appliances and systems could be deducted from the taxable income of natural persons. It is estimated that the tax deduction of Law 2364/1995 could reduce the cost of domestic RES systems (e.g. of solar heaters) by up to 30 %**

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National policies related to the implementation of European energy and environmental targets

- **"Energy 2001" was further reinforced by the enactment of M.D. 21475/98, which incorporated the provisions of Council Directive 93/76/EC (EU Save Directive) for the stabilisation of CO_2 emissions and the efficient use of energy in buildings.**

  the M.D. 21475/98 specifically refers to:

  - active solar systems (ASS), such as hot water solar heaters and photovoltaic modules

  - other (non-specified) RES systems, which may convert renewable energy to electricity or thermal energy

- **In the frame of the implementation of the 'Energy Performance Building Directive 2002/91 of the EC and the Council', the 'Regulation for Thermal Insulation' is going to be replaced by the new 'Regulation on Energy Efficiency of Buildings' which sets as obligatory the energy design of all buildings, specific energy consumption limits (per climate zone), materials properties and performance and calculation methodologies for H/C/L.**

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Current status of solar energy technology applications

Regarding the use of solar systems:

- **99 % are small scale systems for domestic hot water**
- **0.75 % are large scale systems for hot water in the tertiary sector (hotels, hospitals and swimming pools)**
- **0.17 % (5,118 m^2) are large systems for hot water, air-conditioning and space heating in industry**

(Ref. EBHE)

- **About 20 % of Hellenic households use thermosiphoning solar systems for production of sanitary hot water**

  The majority (more than 95 %) of solar sanitary hot water systems installed in Greece regards compact thermosiphoning units, providing hot water to individual dwellings

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Current status of solar energy technology applications

- **Further to the wide application for domestic use, the second larger customer of Solar Thermal Systems in Greece is hotels and hospitals**

Over 100 hotel units in Hellas have large thermal solar systems for sanitary hot water production, swimming pool heating and solar air-conditioning

The market rises up to:

-28,820 m^2 for the large solar systems

-35,000 m^2 for the thermosyphoning type solar systems

Both parts share a 2.2 % of the total solar collector stock of Greece.

The average size of large solar system in hotels is 257 m^2, while the largest one is 2,783 m^2.

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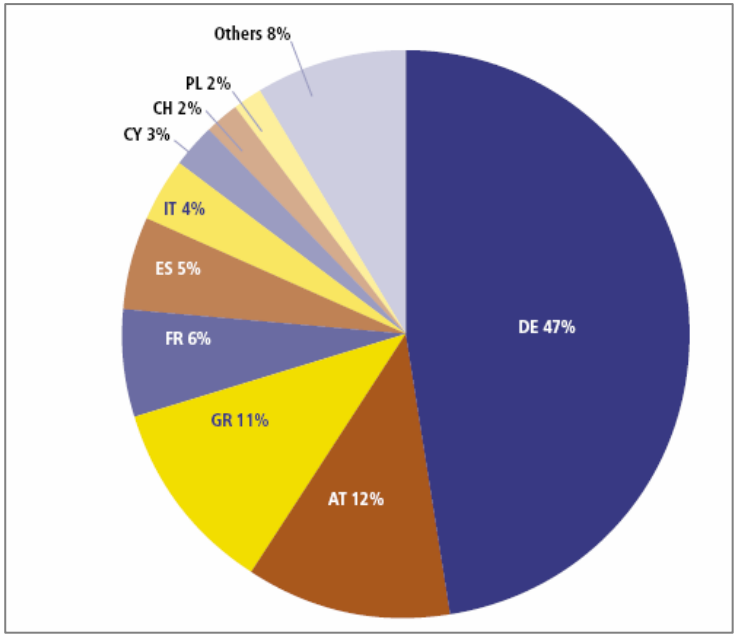
Current status of solar energy technology applications

Solar Thermal Capacity in Operation



The application of active solar systems in Greece started in mid 70s. The use of electric heaters in almost every Greek household, in combination with the oil crisis, and the rising price of electricity during this period, provided the background for the solar market to develop.

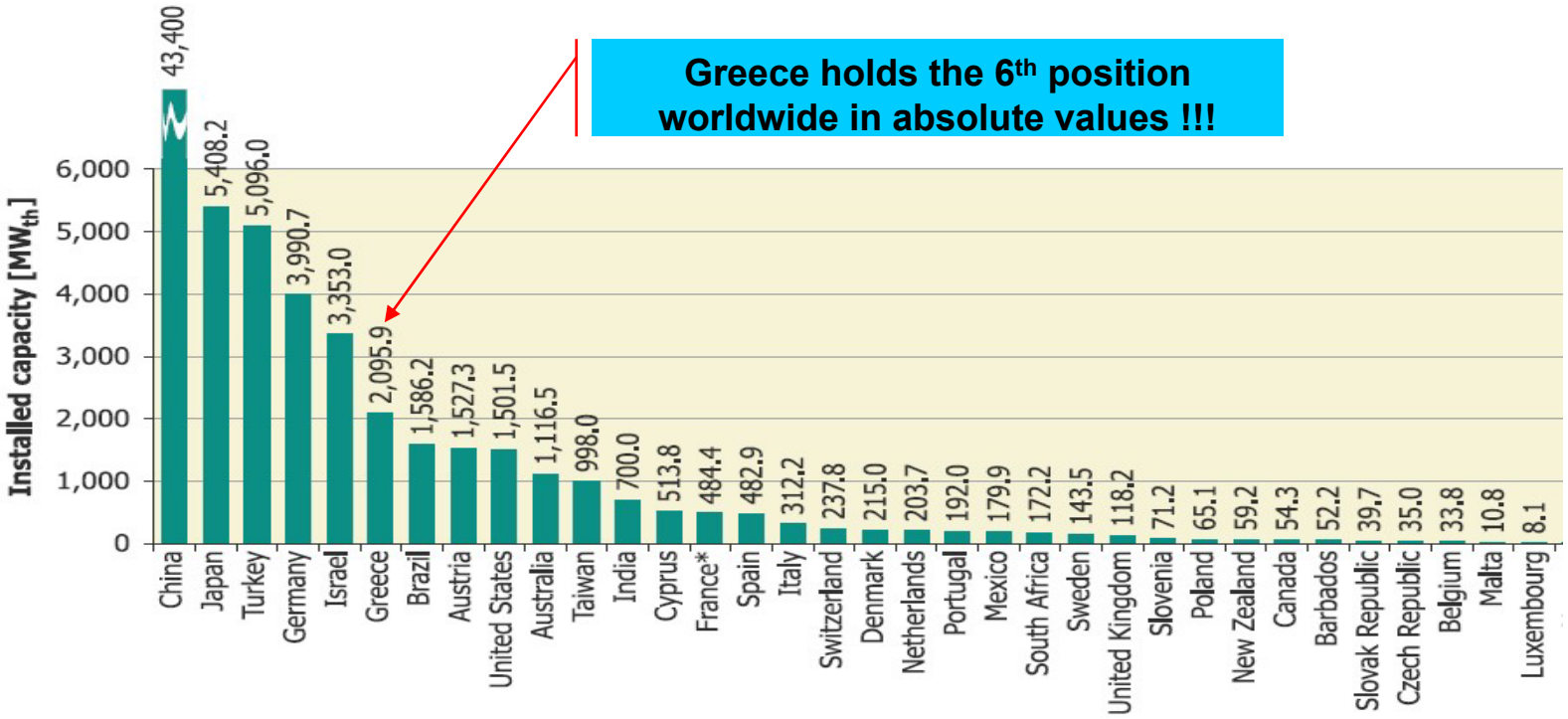
Source: ESTIF - European Solar Thermal Industry Federation, 2005

Since 1987 the market's growth rate has stabilised mainly because:

- **The financial constraints slowed down the rate of construction of new buildings**
- **The oil price started going down as the oil crisis ended**
- **The electricity tariffs remained low resulting in the decrease of the competitiveness of solar systems**

Current status of solar energy technology applications

- ## World-wide s-th installations (1)



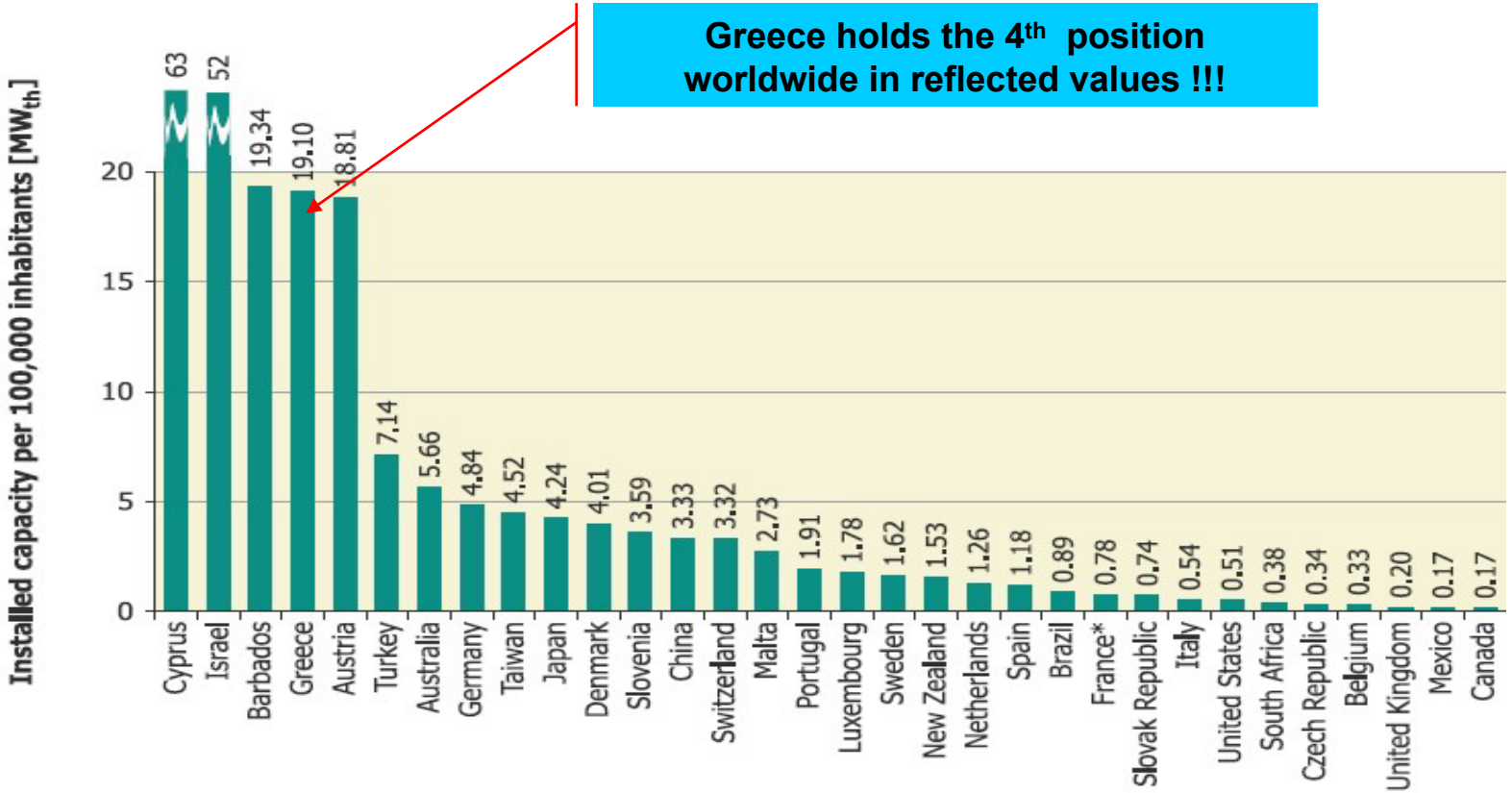
Installed capacity of flat & vacuum collectors

1 m^2 collector corresponds to 0,7 kW_{th} installed capacity

Source: IEA, SHC: Solar Heat Worldwide, end 2004 (2006)

Current status of solar energy technology applications

- ## World-wide s-th installations (2)



Installed capacity of flat & vacuum collectors/population

1 m^2 collector corresponds to 0,7 kW_{th} installed capacity

Source: IEA, SHC: Solar Heat Worldwide, end 2004 (2006)

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Current status of solar energy technology applications

- 3 000 000 m^2 solar collectors
- 95% for domestic use (thermosiphoning)
- 90% of users satisfied
- Applied only to 25% of households
- Some central systems (hotels)
- A few space heating systems
- 3 solar cooling systems

Source: IEA, SHC: Solar Heat Worldwide, end 2004 (2006)

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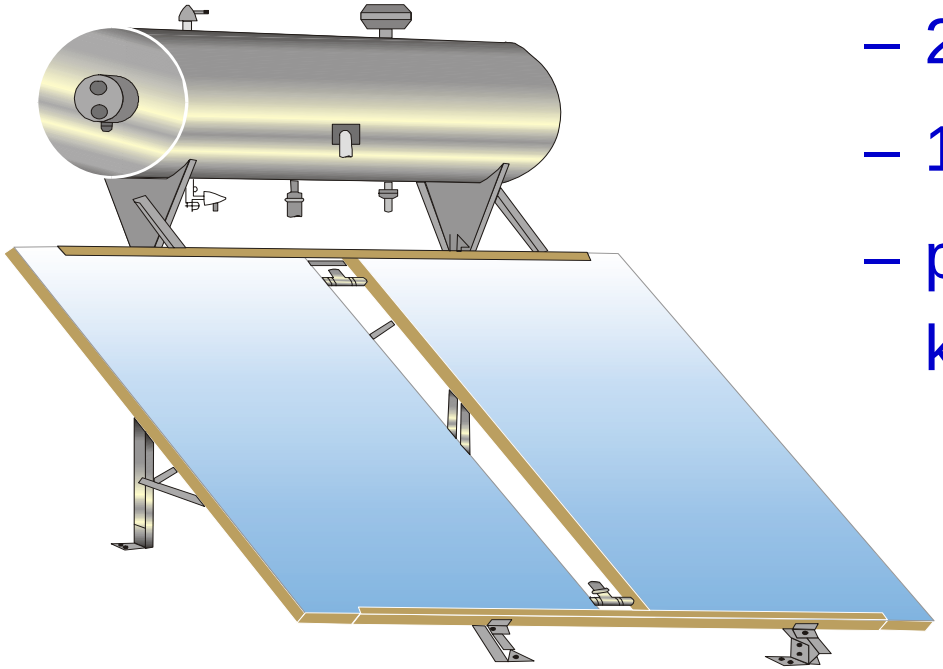
Current status of solar energy technology applications

- **Solar Water Heaters**



Typical system

- "family" system
- 2 – 4 m2 collector
- 100 - 300 litre tank
- production : 1200 –2400 kWh/year

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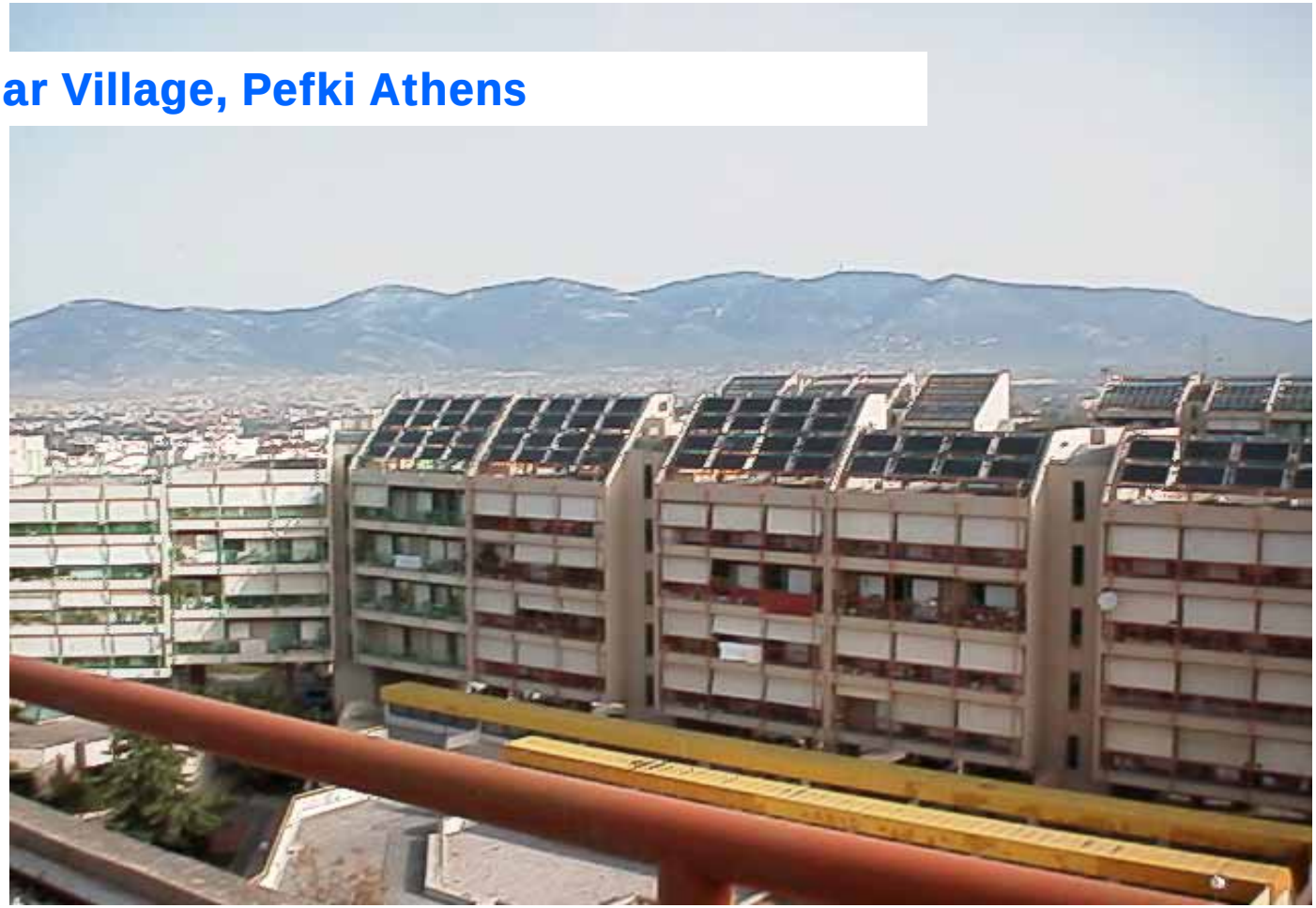
Applications of solar thermal systems

- **Solar Village, Pefki Athens**



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Applications of solar thermal systems

- Solar System in a Hotel in Crete

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Applications of solar thermal systems

- **Collaboration CRES-SOLE S.A. for combi in a house**

- **Collector field, 65 m²**
- **Integrated onto roof**
- **Conventional heating units (radiators)**

- **Cost: approximately 300 € /m²**
- **Storage tank: 2000 litres**
- **Installation: 2005**

Applications of solar thermal systems

- **Tyras S.A., Dairy, Trikala (2001)**

Use: Hot water for pre-heating of water entering the steam boiler (CIP - washing)

- Collector area: 1040 m^2 (selective flat plate) , 80 m^3 storage tanks
- 50% public subsidy (GSR contract) – O.P.E National
- Fuel replaced: Heavy oil

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Applications of solar thermal systems

- **Sarantis COSMETICS FACTORY in Aharnes, Greece**

- Application: Air-Conditioning of a Factory
- Technique: Adsorption
- Cooling Capacity: 700 kW
- Collector type: Flat plate
- Collector Area: 2700 m²
- Status: in operation since 1999

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Perspectives of solar energy technology applications

- More central systems
- Solar cooling and heating of spaces
- New improved components (T ↑)
- Reduced cost
- More specialists (designers, researchers, installers)

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Strengths, Weaknesses, Opportunities and Threats Analysis (SWOT) concerning the Hellenic Market

strengths	▪mature technology ▪economically reasonable ▪comfort for the consumer
weaknesses	▪need to train the plumbers or other installation personnel ▪inadequate international labelling ▪integration of STT in the architecture ▪low advertising budget ▪low environmental awareness in some regions
opportunities	▪high energy cost ▪on time penetration in new developing markets ▪STTs usually have positive social acceptance and more comfort for the consumer ▪EU environmental policy and subsidy Programmes ▪,joint ventures with new trade partners)
threats	▪seasonality ▪competition from countries with low labour cost ▪discredit due to bad previous examples ▪environmental sensitivity of the consumers

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Success stories - Lessons learned

The most important reasons of the success of Solar Thermal Systems :

- High solar radiation, climatic conditions and morphology of the country.
- Successful marketing campaigns.
- Legislative support and incentives at early stage.
- Broad dissemination of the technology (advertisements, information brochures, demonstration projects, etc.).
- Public acceptance.
- Continuous effort from the manufacturers for better and cheaper products.
- Easy access of solar thermal products.

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Barriers impeding building integrated solar technologies

Since 1987, the market has decreased due principally to:

- oil prices decrease after the end of the oil crisis
- reduced electricity tariffs, influenced by governmental social policy, have decreased the competitiveness of solar systems
- financial constraints slowed down the rate of new buildings construction
- removal of all existing incentives and the lack of support of solar systems in the future
- limited budget was available for promotion campaigns and development because the manufacturers suffered from sales decrease and lack of funds.

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Future opportunities and plans, most promising market niches

In order to achieve further penetration of solar thermal applications in the industrial and building sector Hellenic key players have to:

- Further advertise the products.
- Raise environmental awareness.
- Improve installation and product quality.
- Implement promotion campaigns to engineers, architects, installers
- Implement promotion campaigns for large systems
- Further penetrate solar systems in the public sector
- Continue subsidisation and incentives
- Introduce green taxes

Thank you for your attention