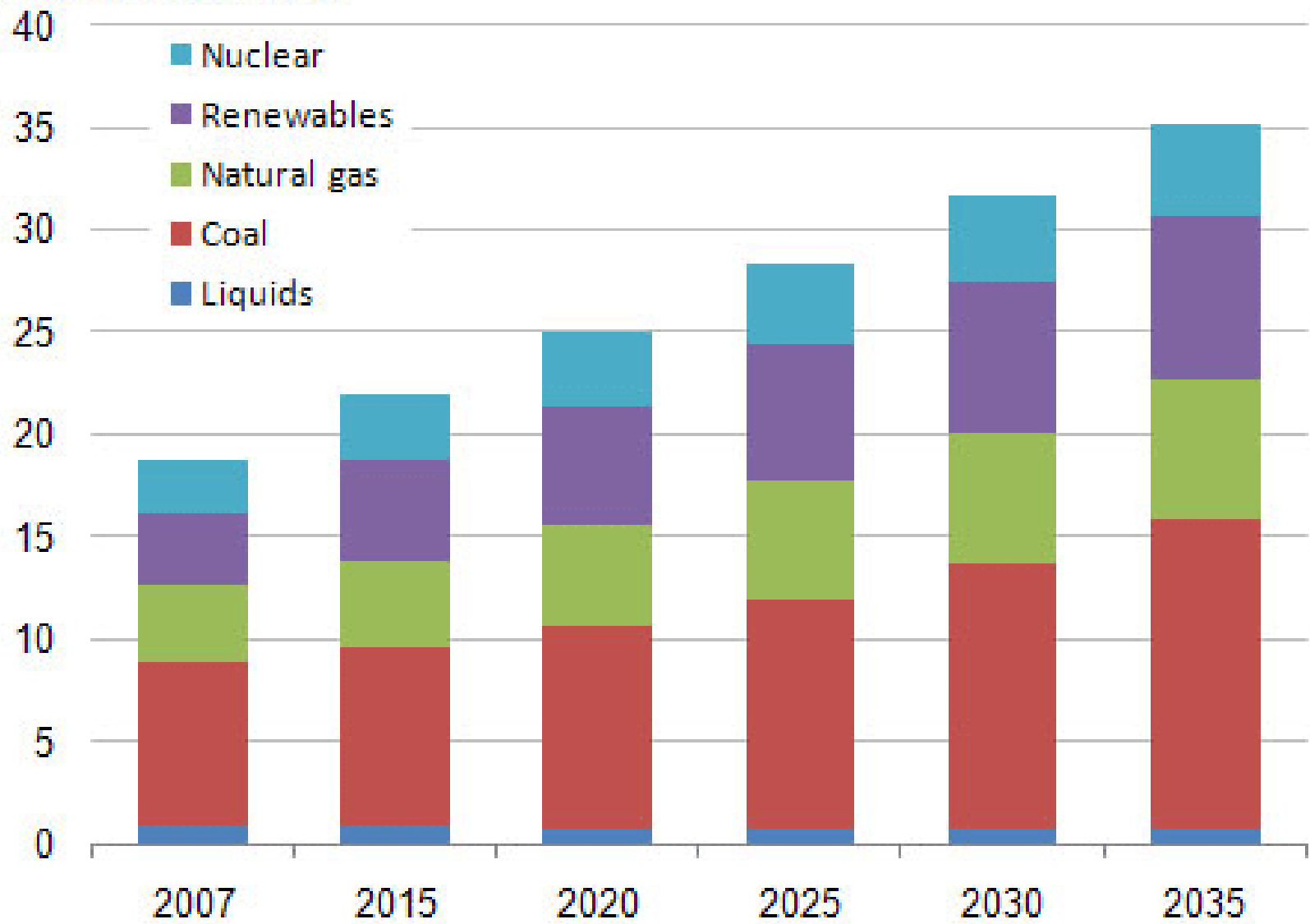


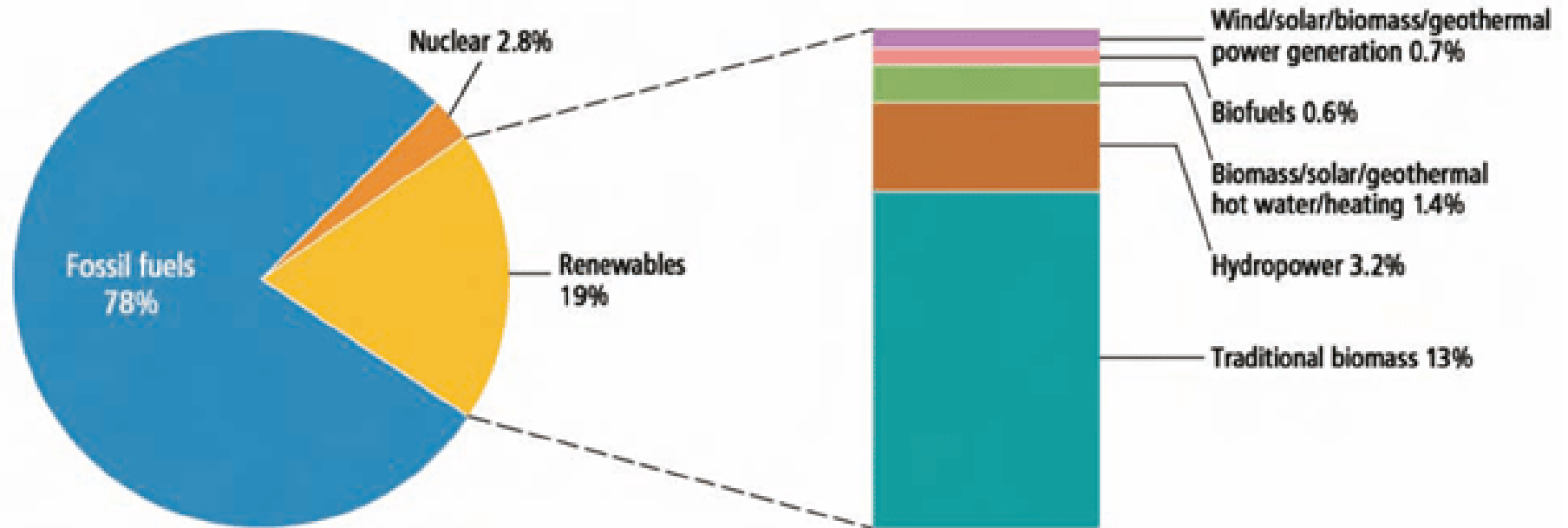
# Hybrid Renewable Energy Systems: Design and Performance

towards EU target for nearly zero  
energy buildings from 2020

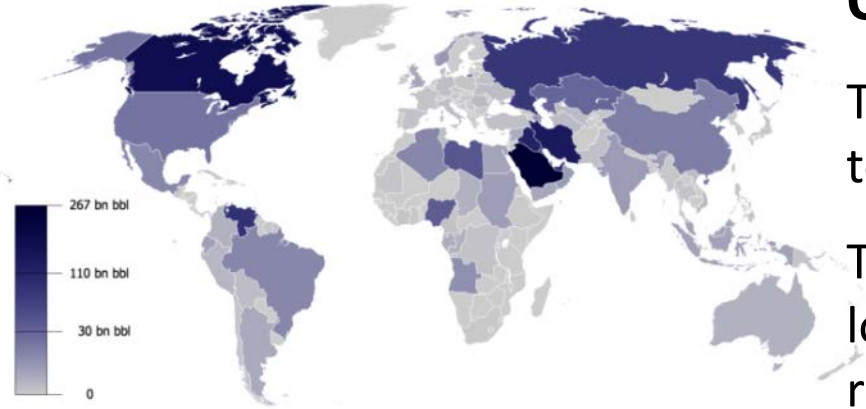




# Renewable Energy Share of Global Final Energy Consumption 2008



# Global Energy Problem



## Oil:

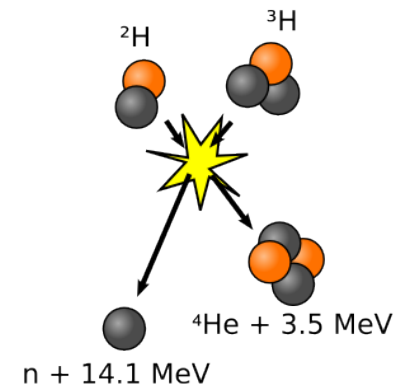
The price for a barrel of oil is 4 times higher to the price before the crisis of 70's

The discovering rate of new oil sources is lower than the oil consumption rate. This results to global energy and economical problems

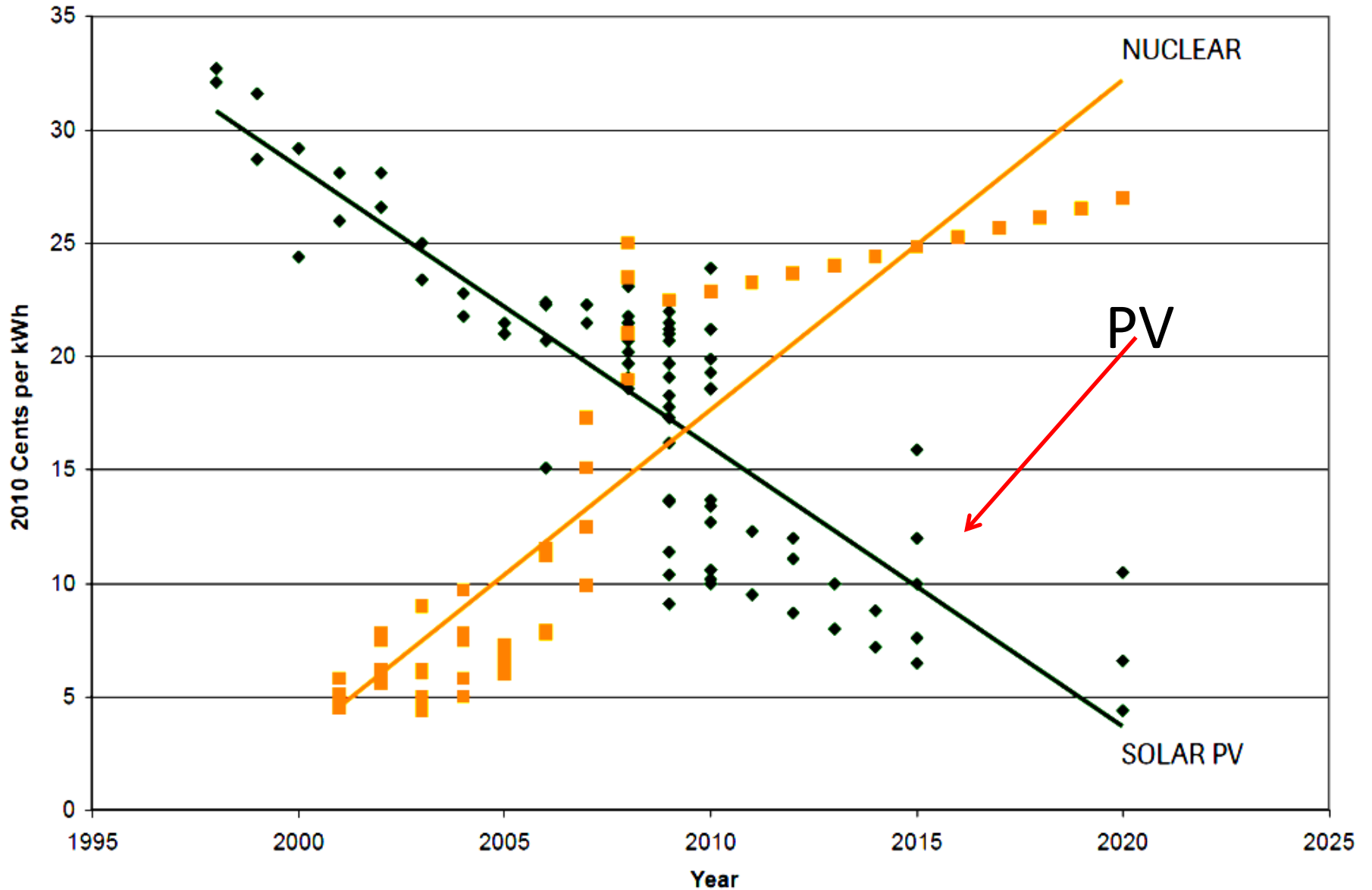
## Nuclear Energy

Nuclear fission reactors have problems with safety and disposal of radioactive waste

Nuclear fusion is not yet controlled. It is expected to be controlled after 30 years.



# Solar-Nuclear Kilowatt-Hour Cost Comparison



◆ Solar PV    ■ Nuclear    — Solar Trendline    — Nuclear Trendline

# European Targets for 2020

- 20% energy by Renewable Energy Sources
- 20% reduction of CO<sub>2</sub> emission relative to 1990
- 20% energy saving to all sectors
- use of biofuels by 10% to transportation

• From 2020 all new buildings should be:

**nZEB (nearly Zero Energy Buildings)**

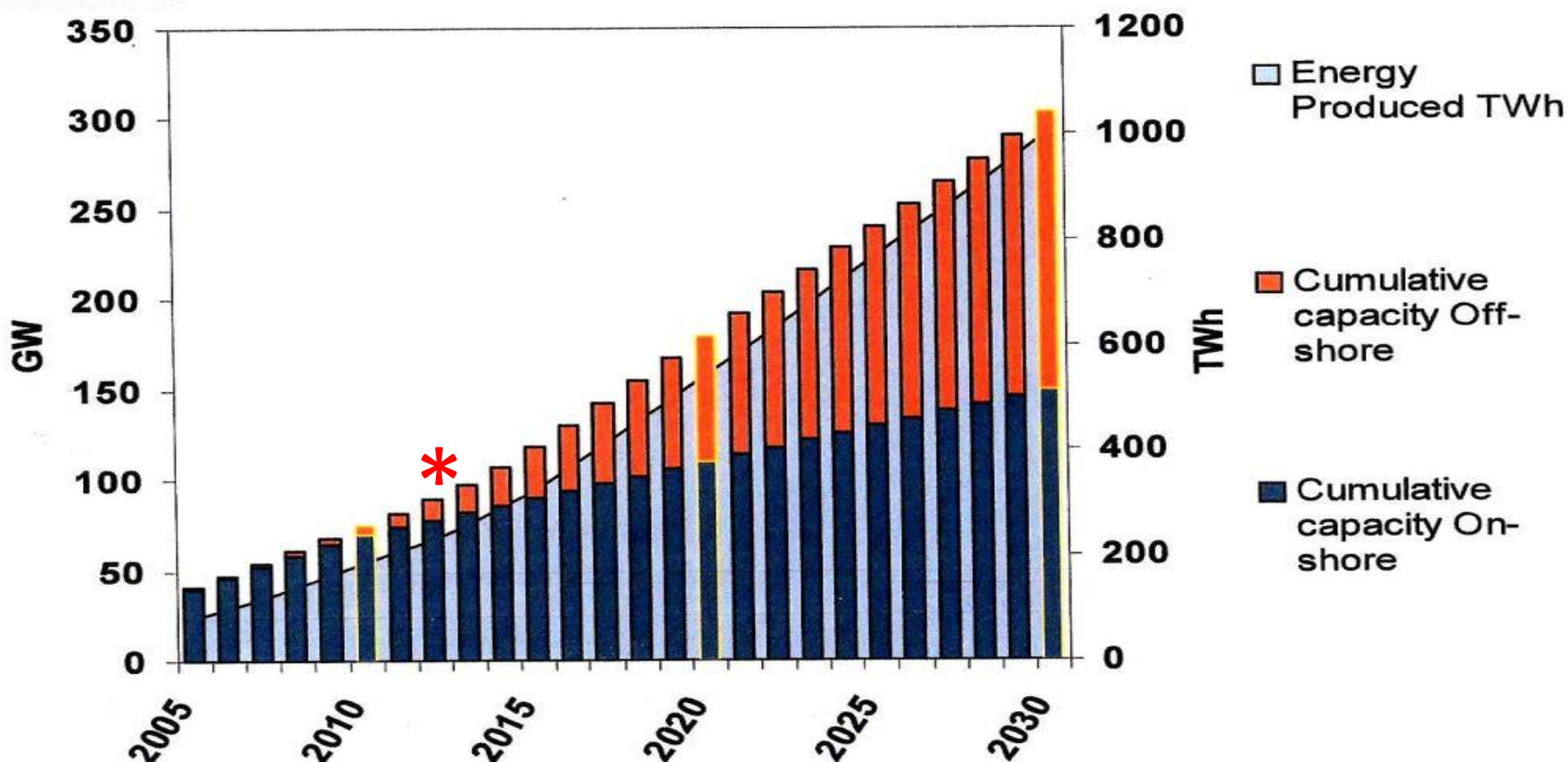


## Wind Energy



# Wind Turbines

Greece: 2.000 MW, Europe: 94.000 MW





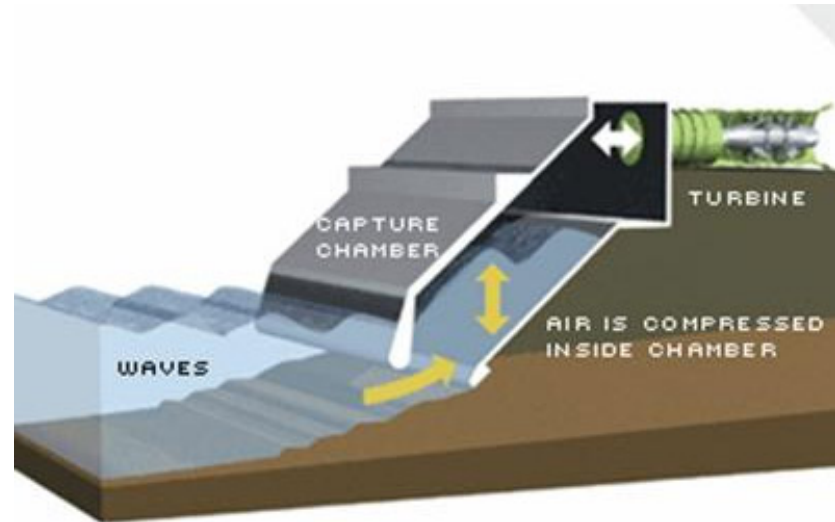
## Wind Park on Panahaikon mountain, Patras



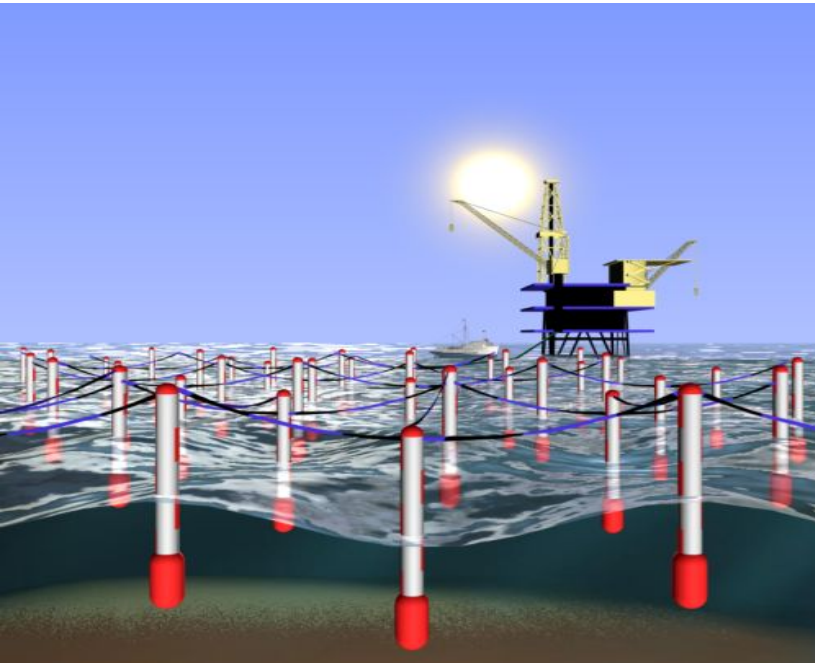


# HYDRO ENERGY

## HYDRO-ELECTRIC STATIONS



## Wave Energy



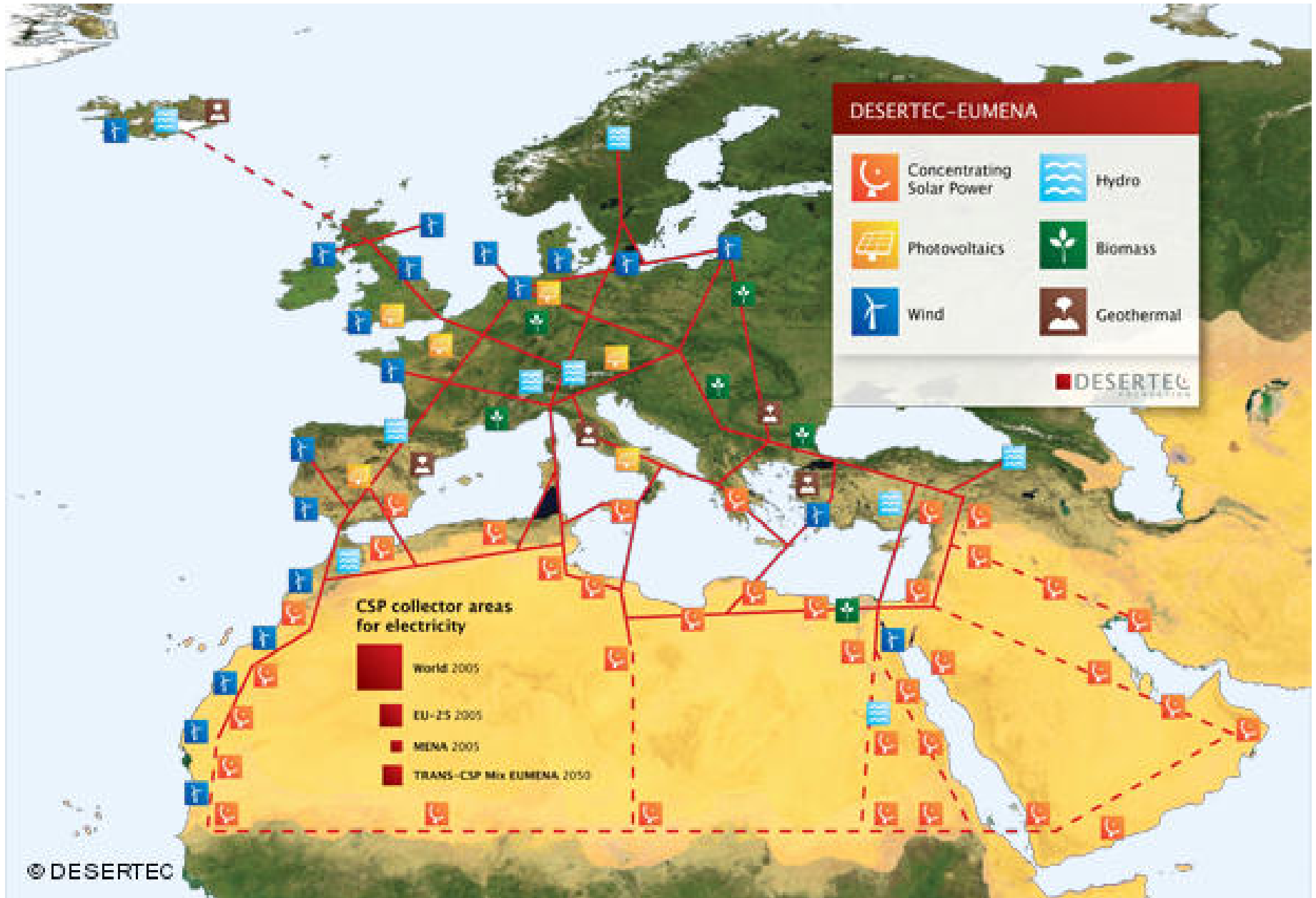


Tidal Energy

# NORTH EUROPE RES NET



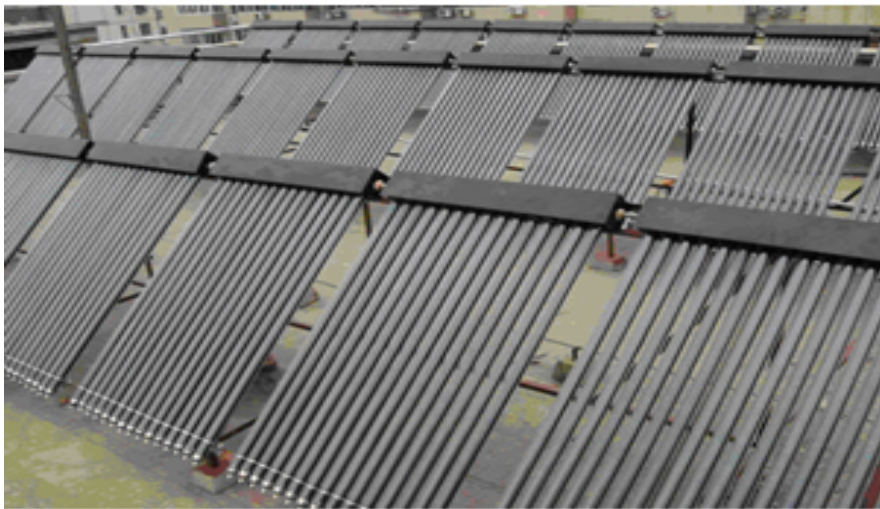
# SOUTH EUROPE RES NET



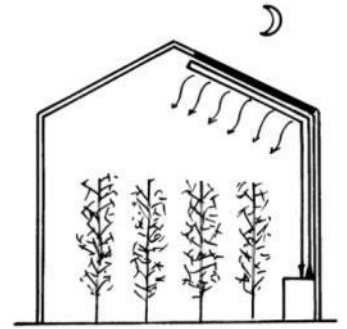
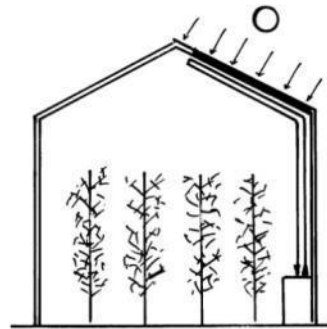
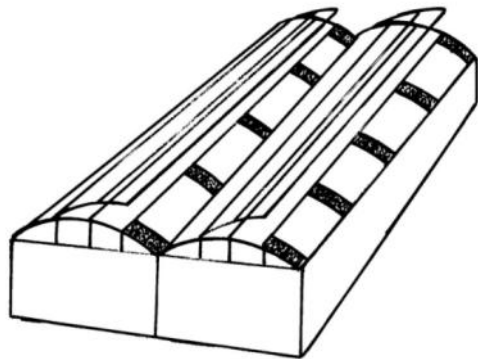
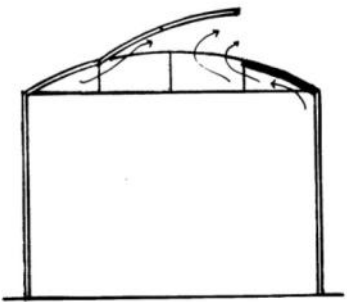
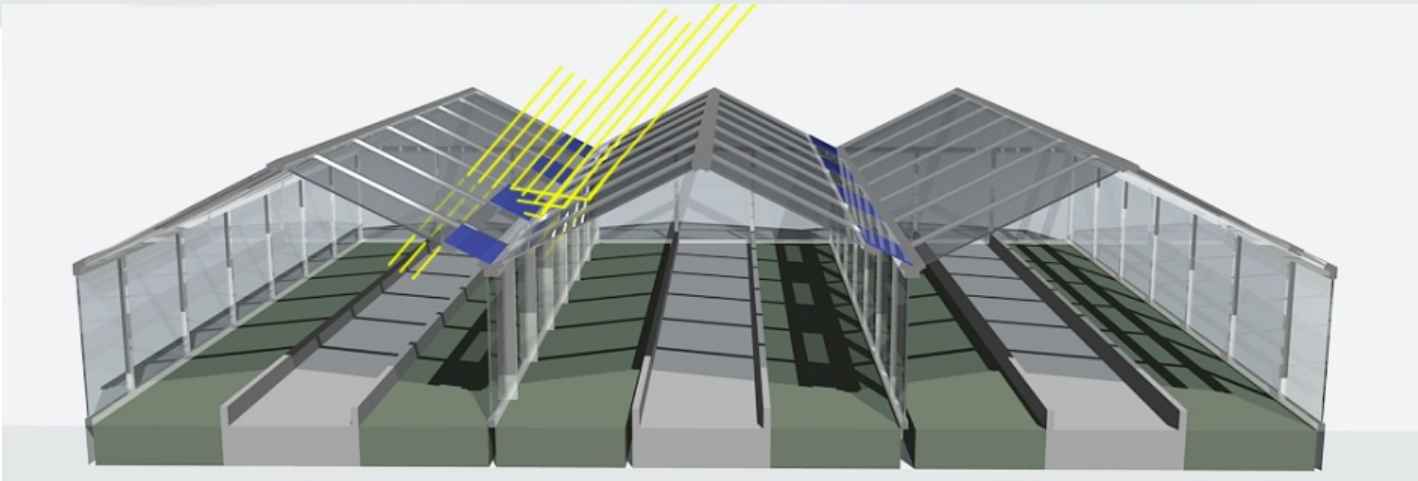
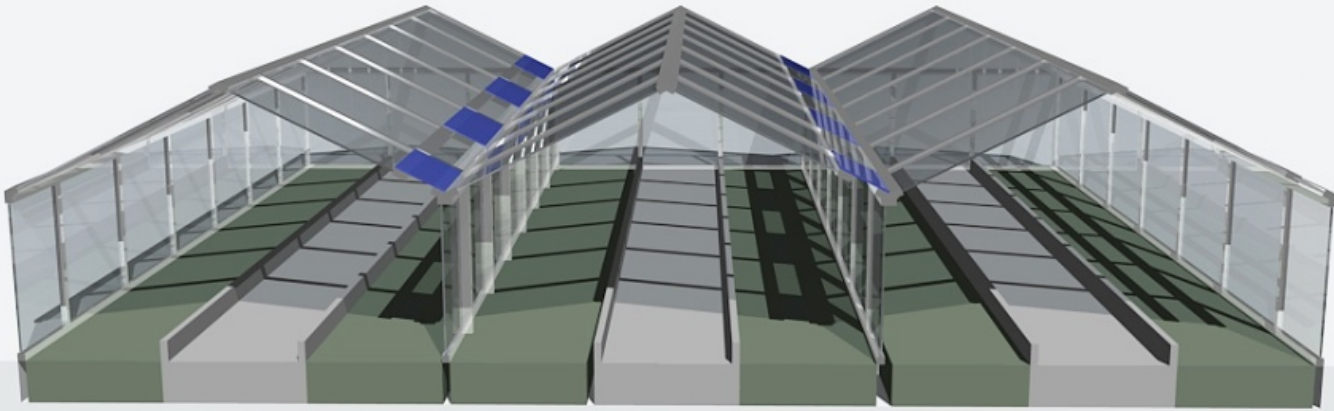
## Energy share per sector

Built sector	40%
Industry/agriculture	30%
Transportation	30%

# Application of solar thermal to industry/agriculture



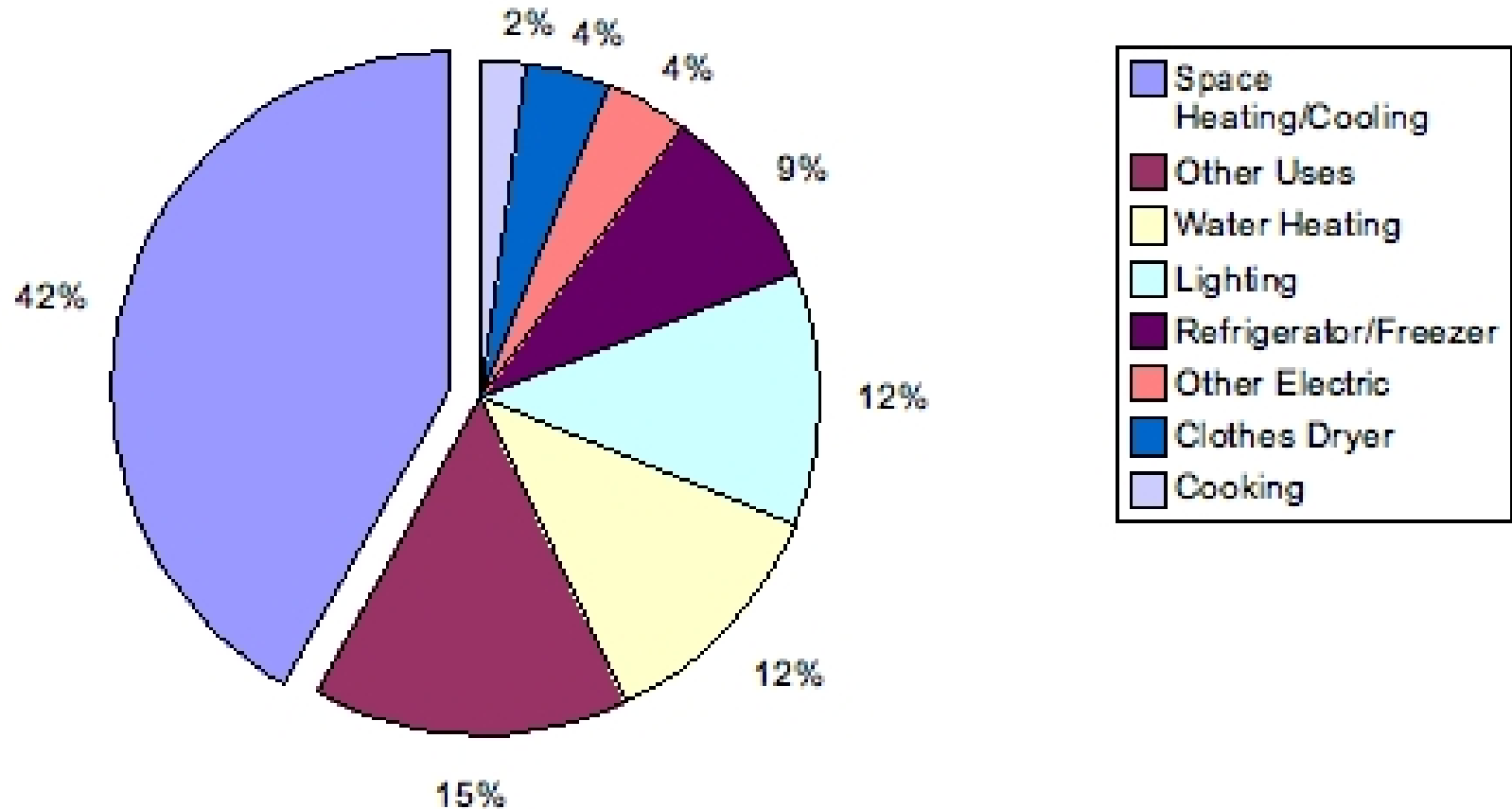






# Distribution of energy demand in buildings

Energy Information Administration, Annual Energy Outlook 2004



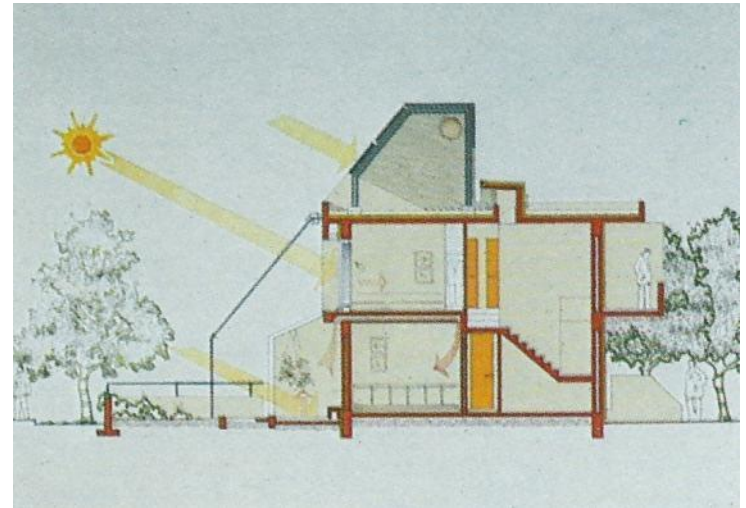
# Bioclimatic Architecture

- Natural lighting and ventilation
- Solar gain and shading
- Passive heating and cooling

Target for 2020: 20% energy saving in buildings

Use of Renewable Energy Sources

Green facades, roofs and balconies





# Solar Energy systems for domestic use

Solar thermosiphonic systems,  
Integrated Collector Storage systems,  
Central Solar Thermal systems

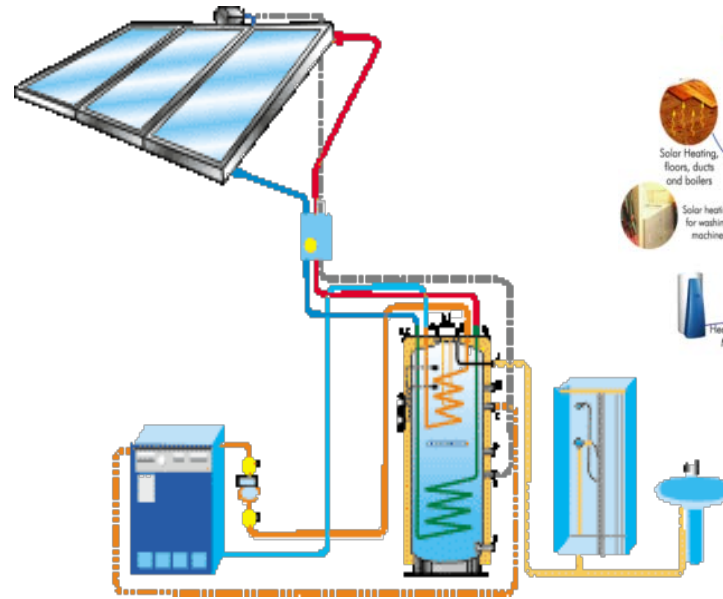
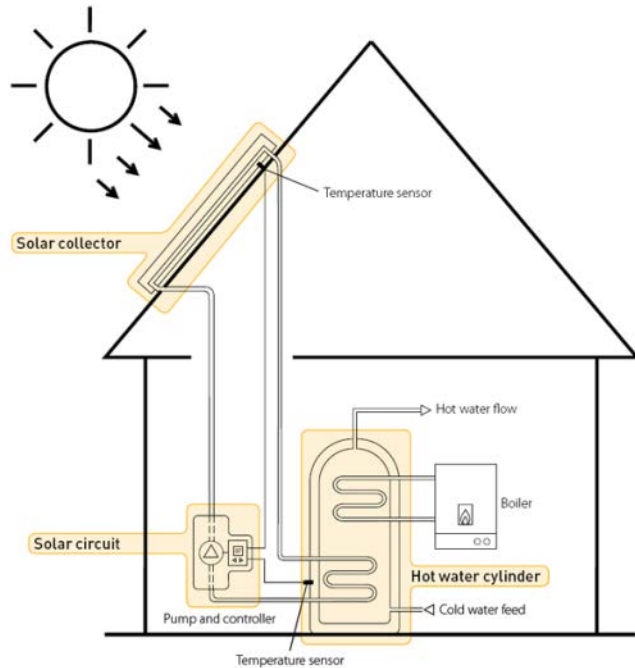




# Solar Thermal Collectors for domestic hot water and space heating

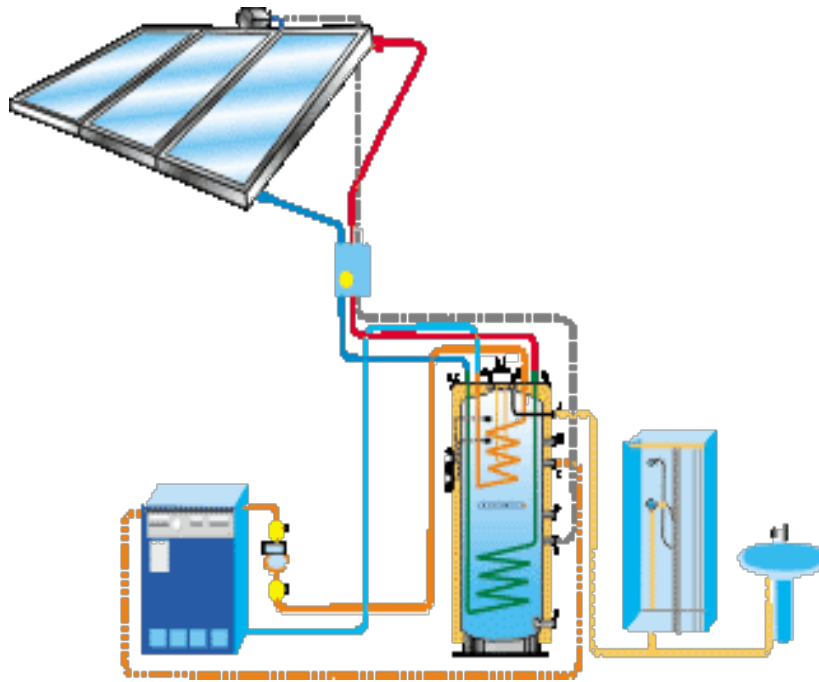
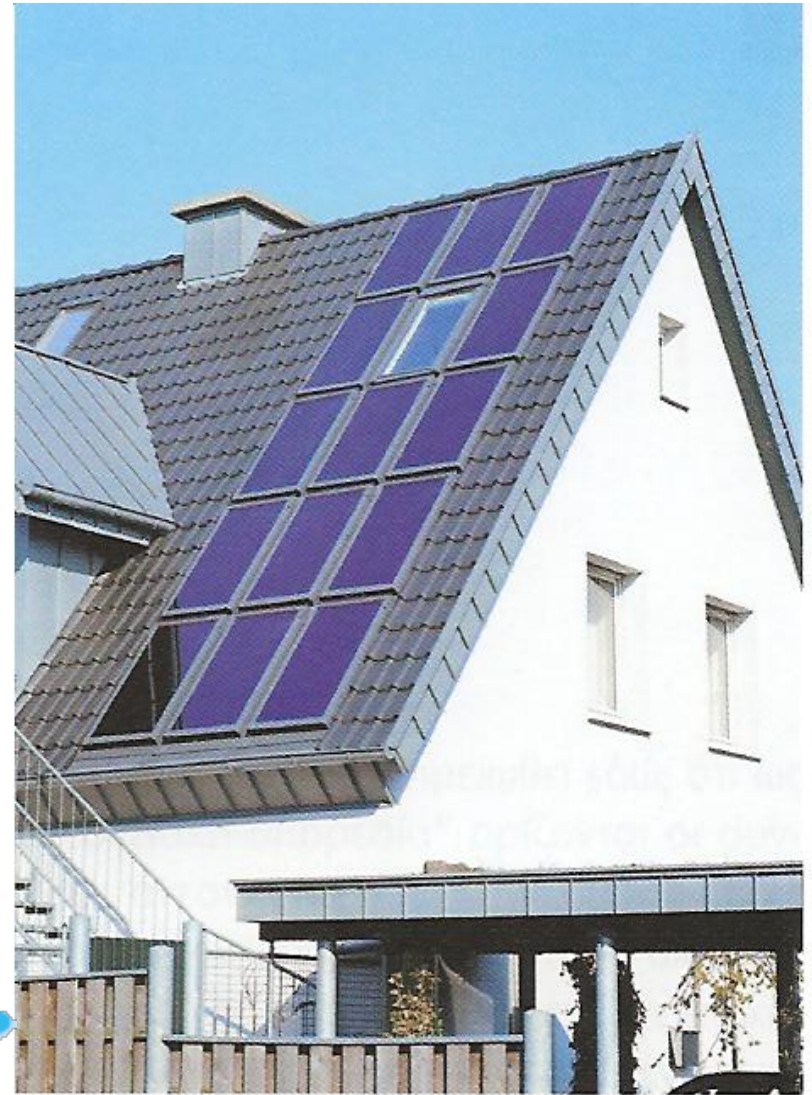
Systems of 4-6 m<sup>2</sup> and 200-300 liters water storage for DHW.

Systems of 10-20 m<sup>2</sup> and 500-1000 liters water storage for DHW and contribution to space heating





## Solar Thermal collector Systems

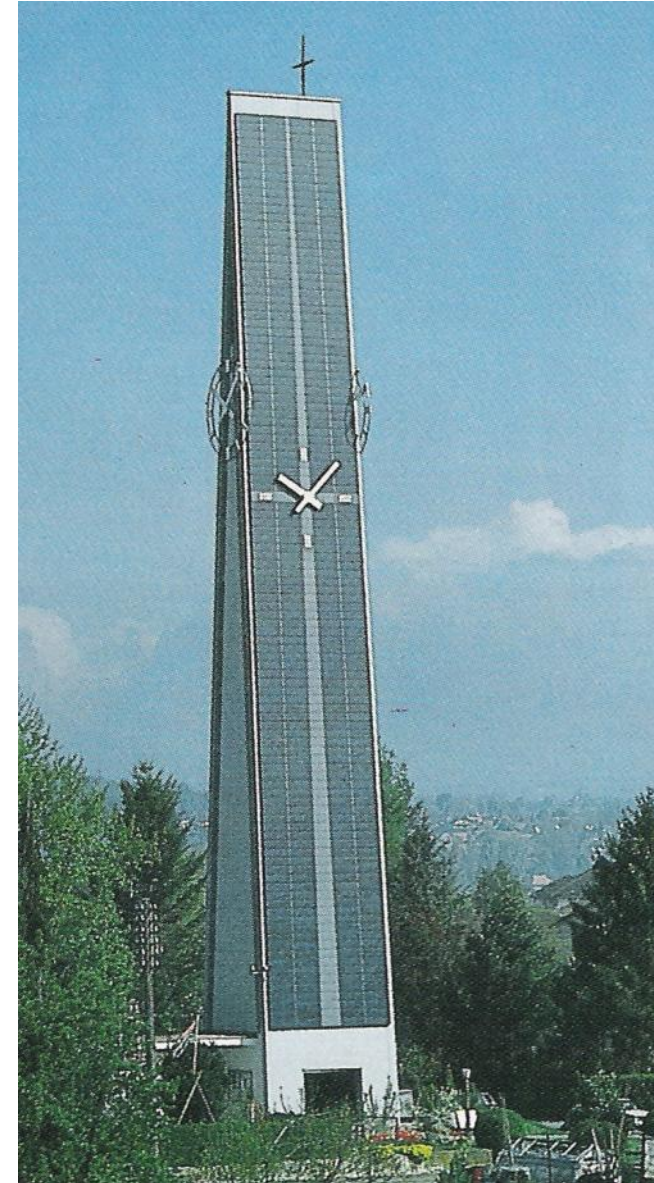
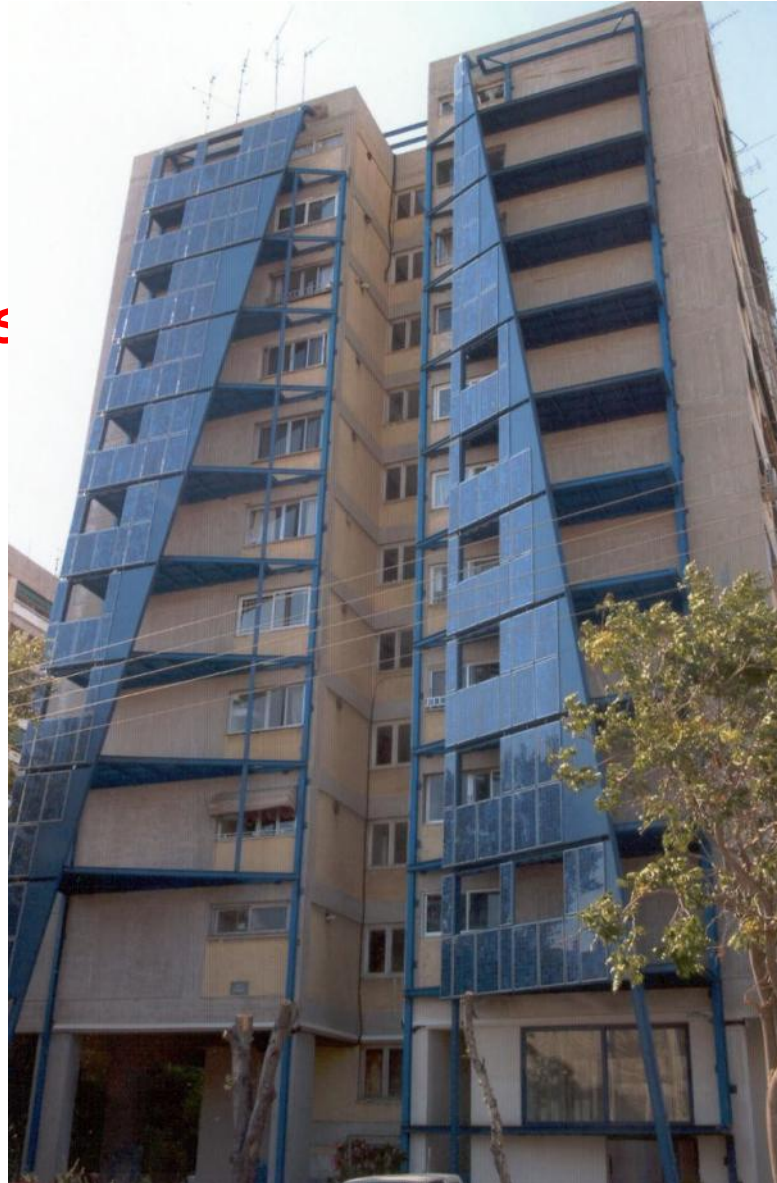


**Solar Thermal collector Systems**





# Photovoltaics on buildings

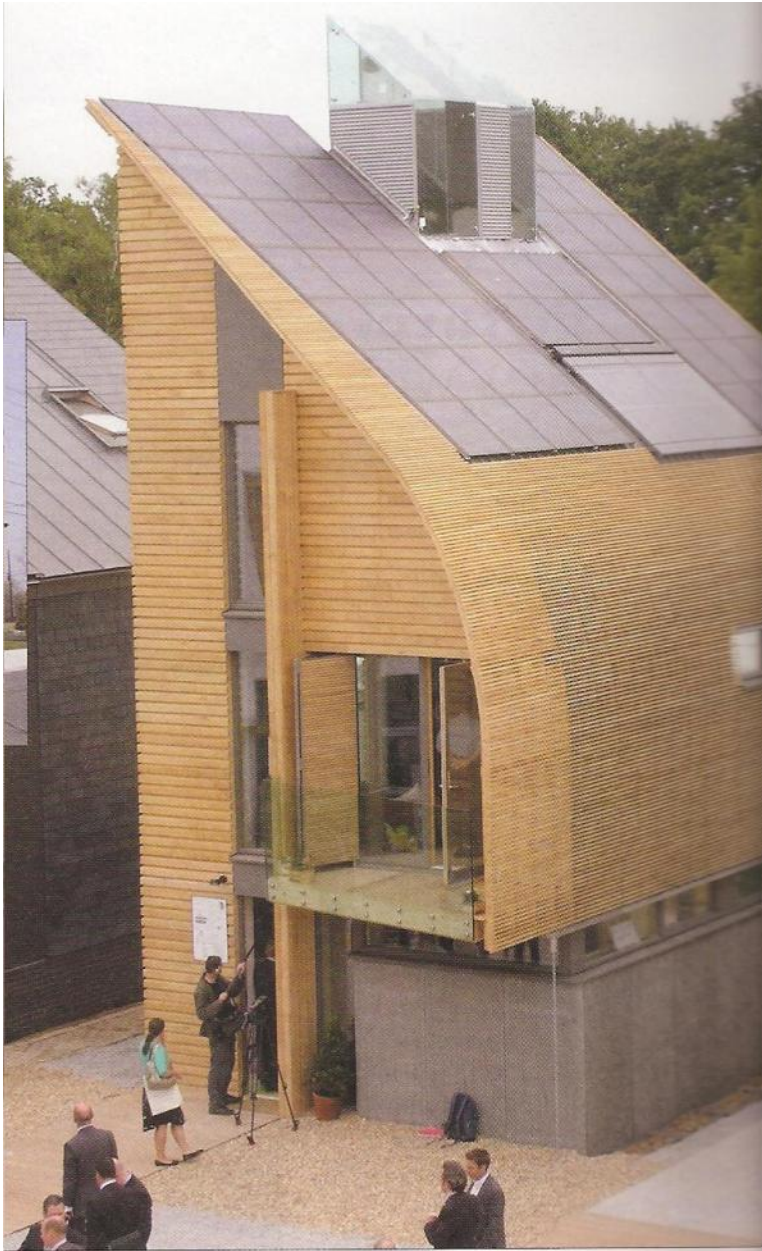


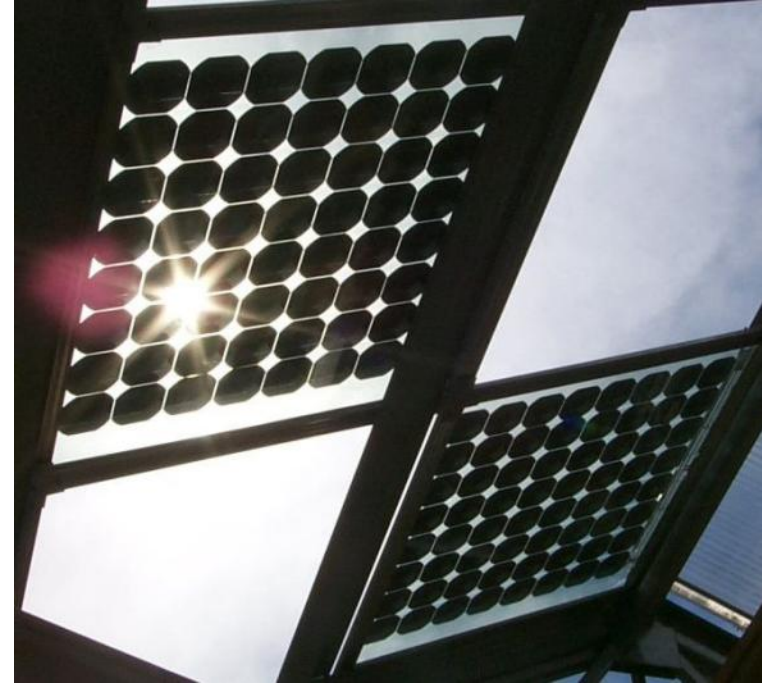


# Photovoltaics

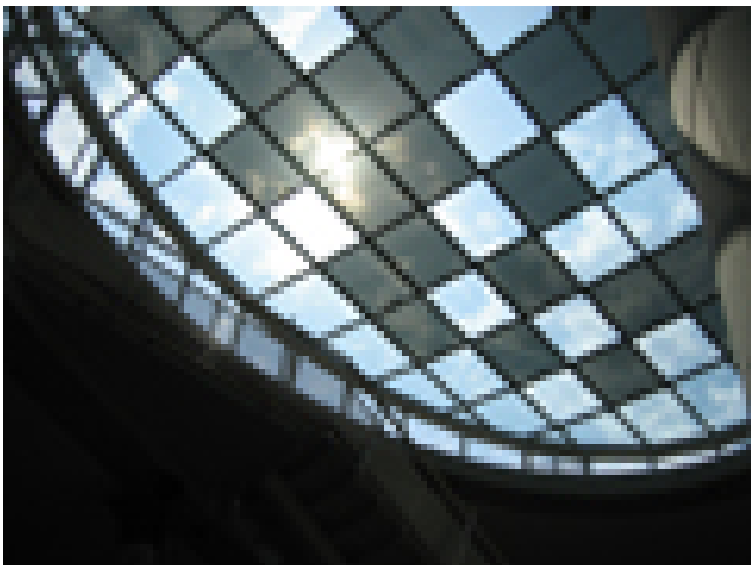


# Photovoltaics on buildings

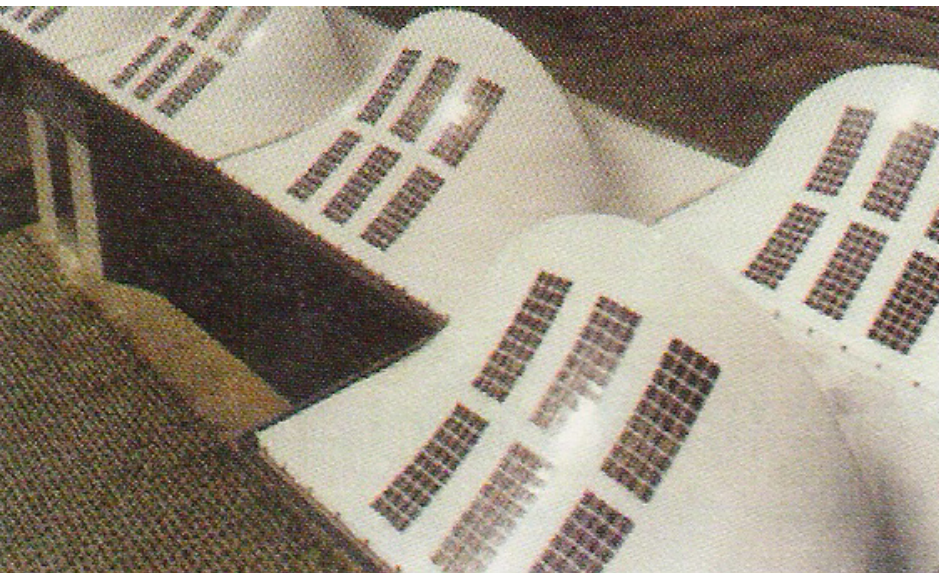




**Photovoltaics**



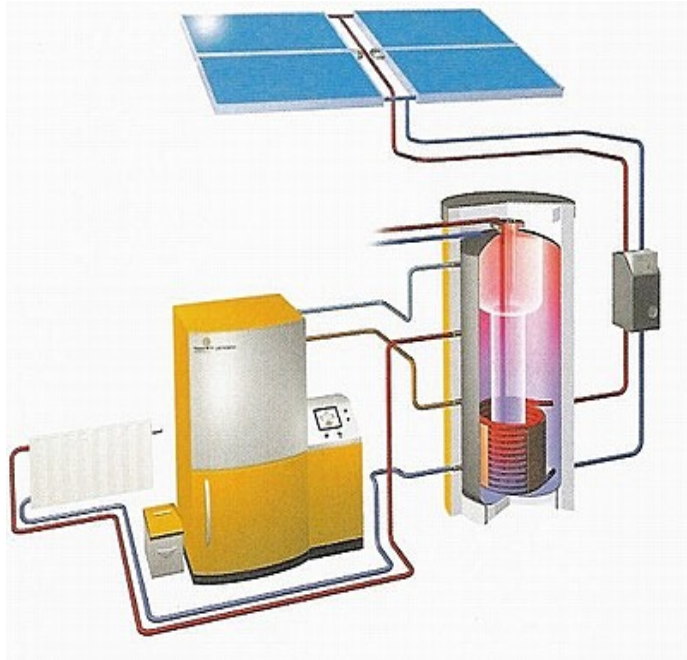
# Interesting integration of curved photovoltaics





# Biomass and Geothermal energy

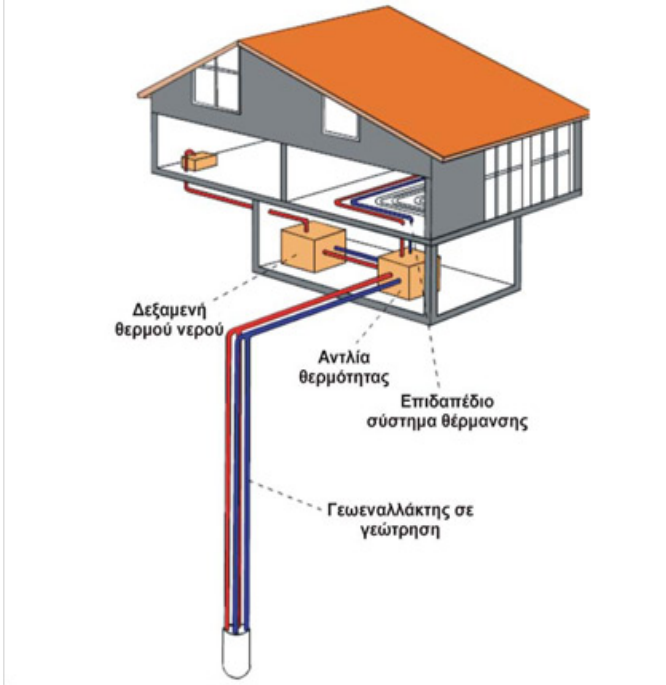
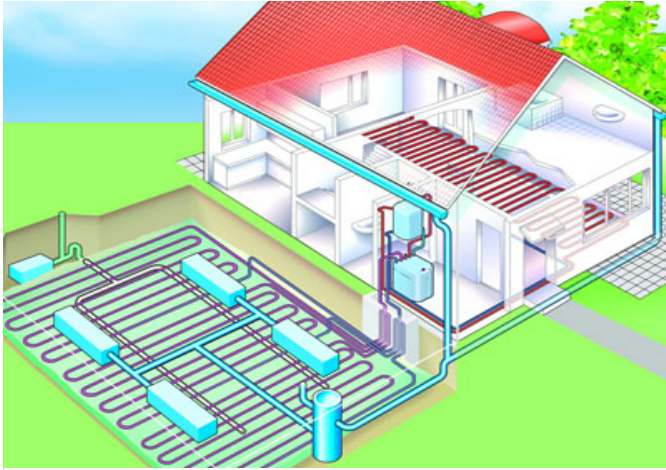
Biomass (wood, pellets, biofuels) and Geothermal Energy (geothermal heat pumps, plants) are alternative technologies that will be applied more next years



In addition, small wind turbines can be also used if a satisfactory wind potential exists



# Geothermal Heat Pumps







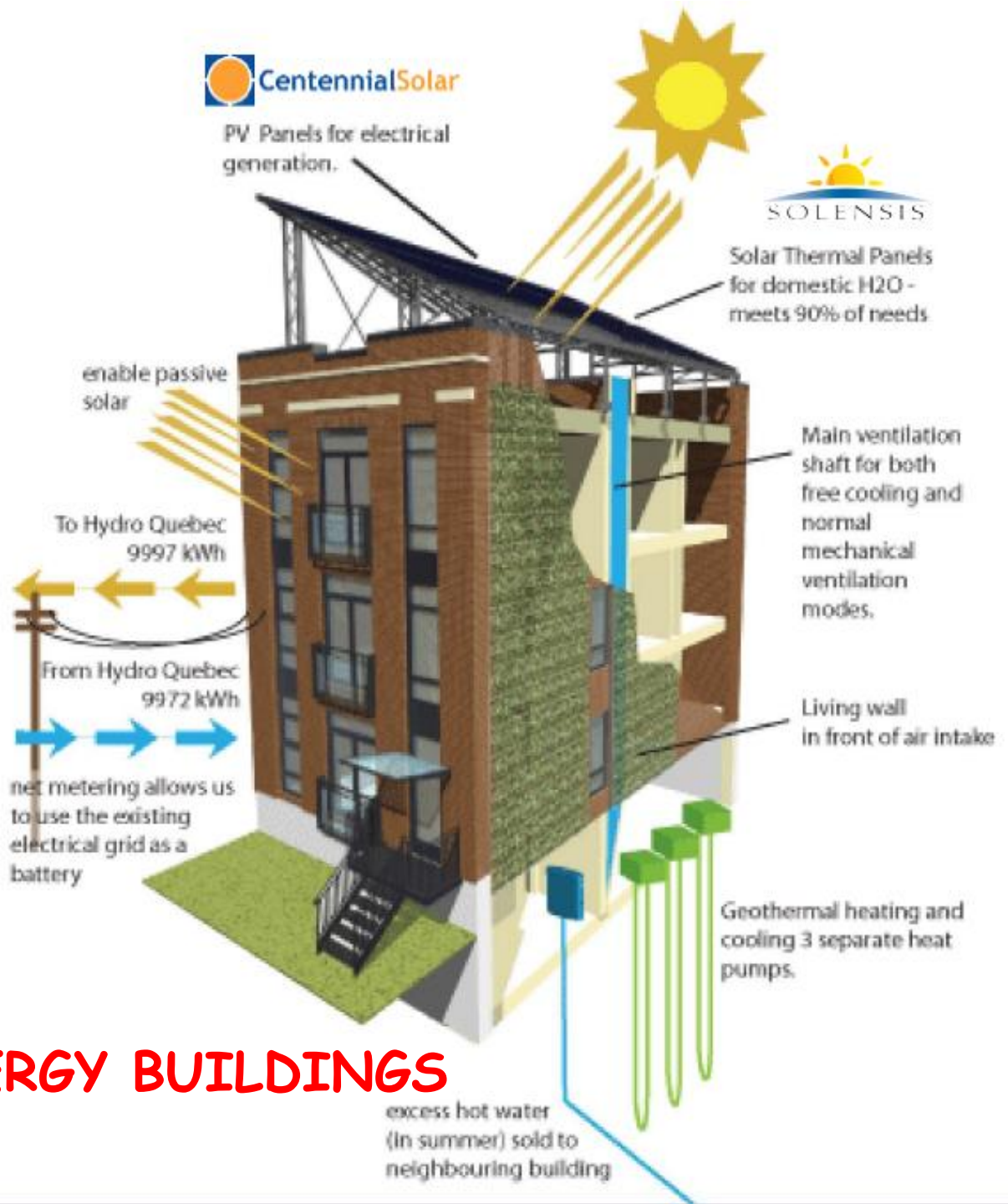
Building integration of wind turbines





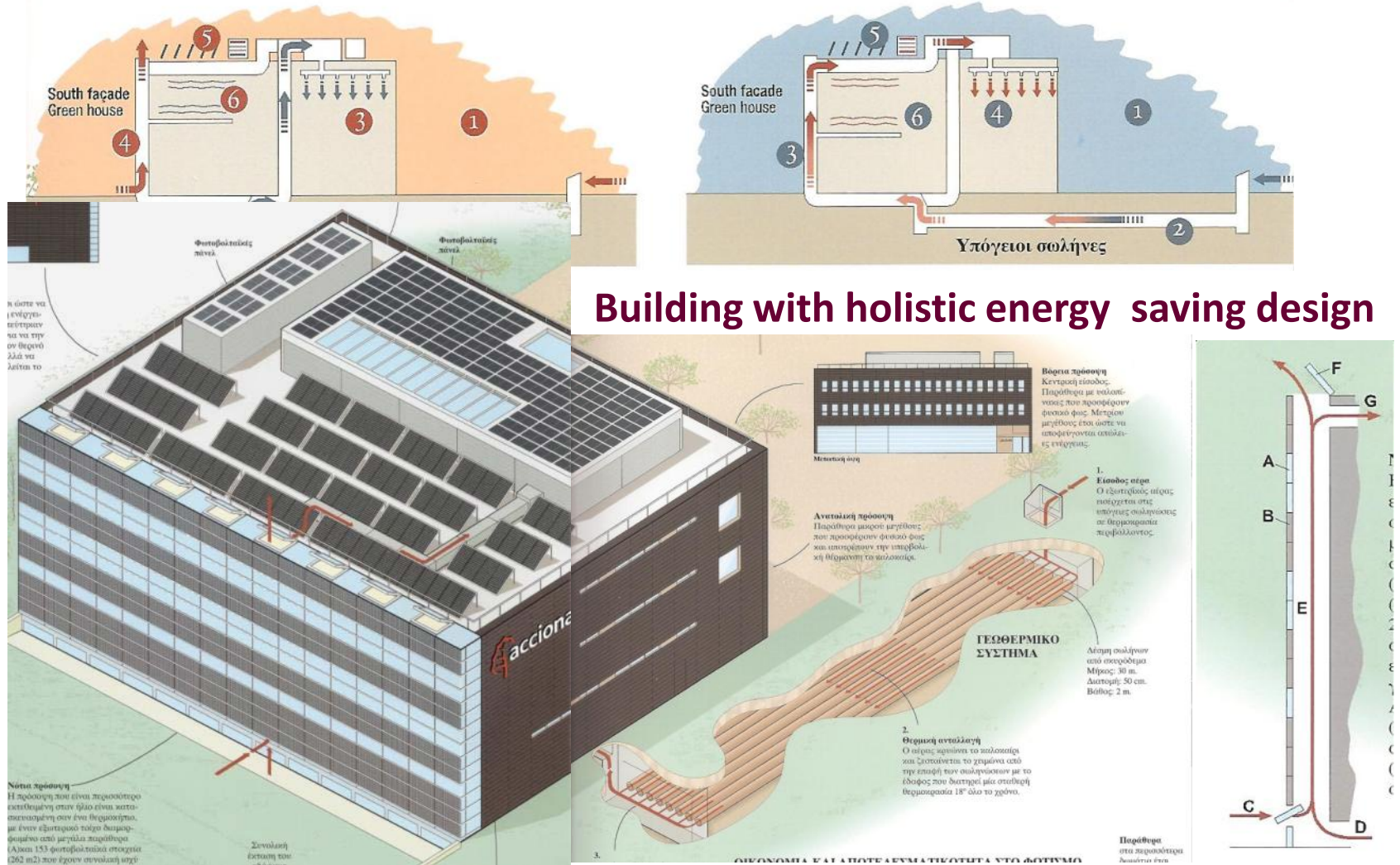


Le Soleil,  
The net zero  
energy triplex,  
Montreal

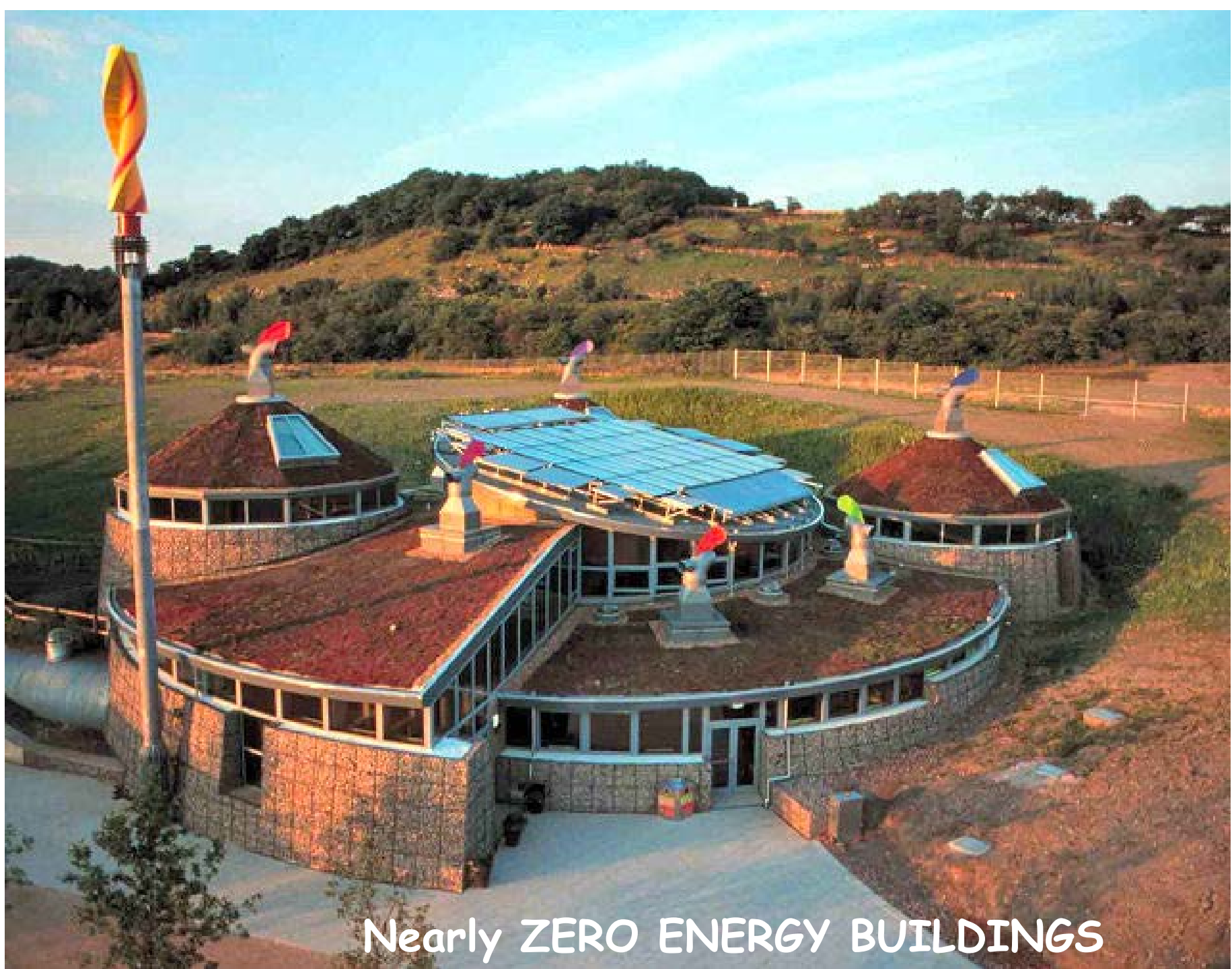


## Nearly ZERO ENERGY BUILDINGS

# Example of nearly zero energy building "Acciona Building"



**Bioclimatic energy saving (52%), Photovoltaics (21.4 kW), Solar thermal collectors (156 m<sup>2</sup>), Biofuel (5000 l/y), Geothermal heat pumps (30 m length, 2 m depth)**



Nearly ZERO ENERGY BUILDINGS

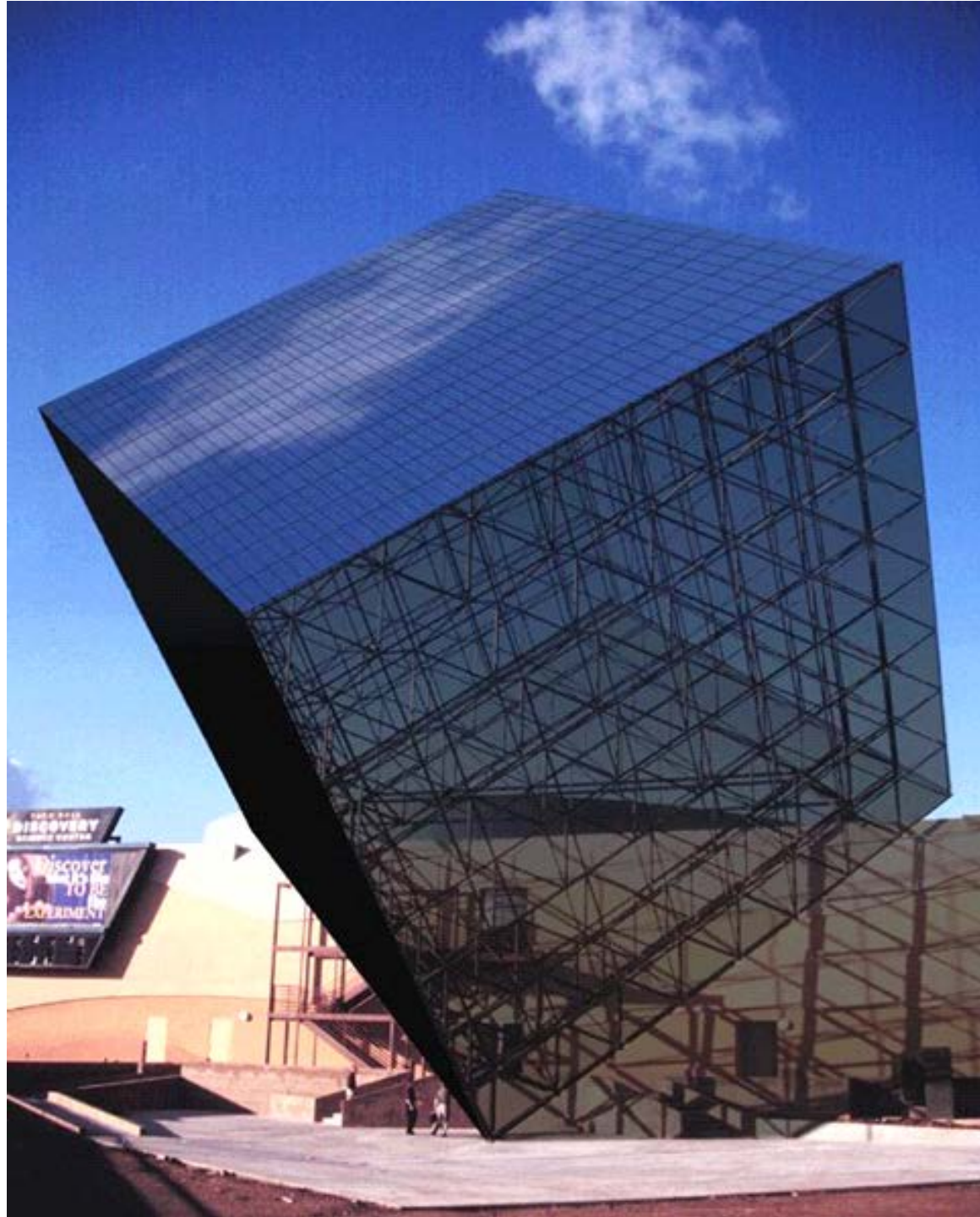
# Bahrain



## Solar sail



Solar cube



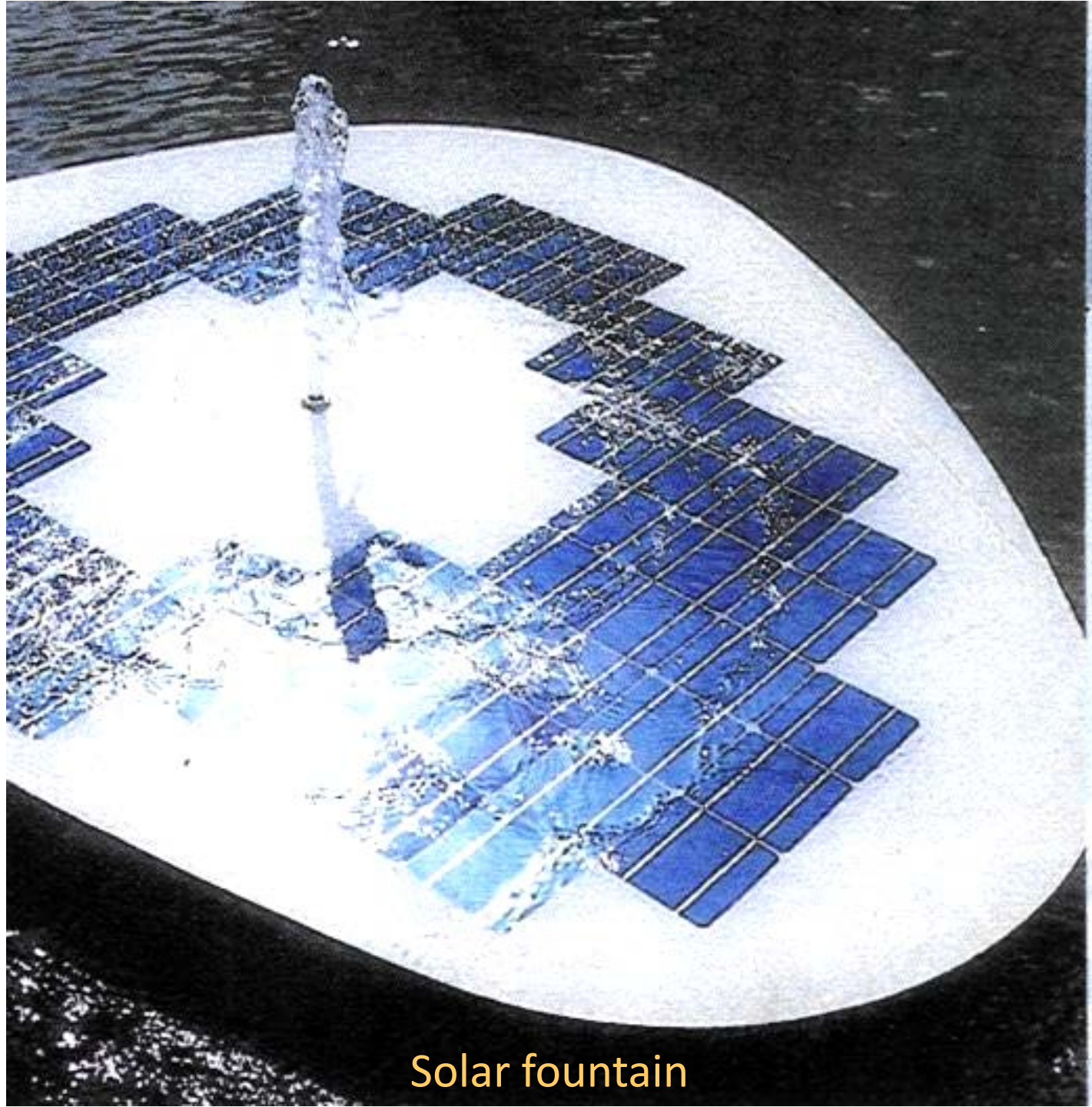




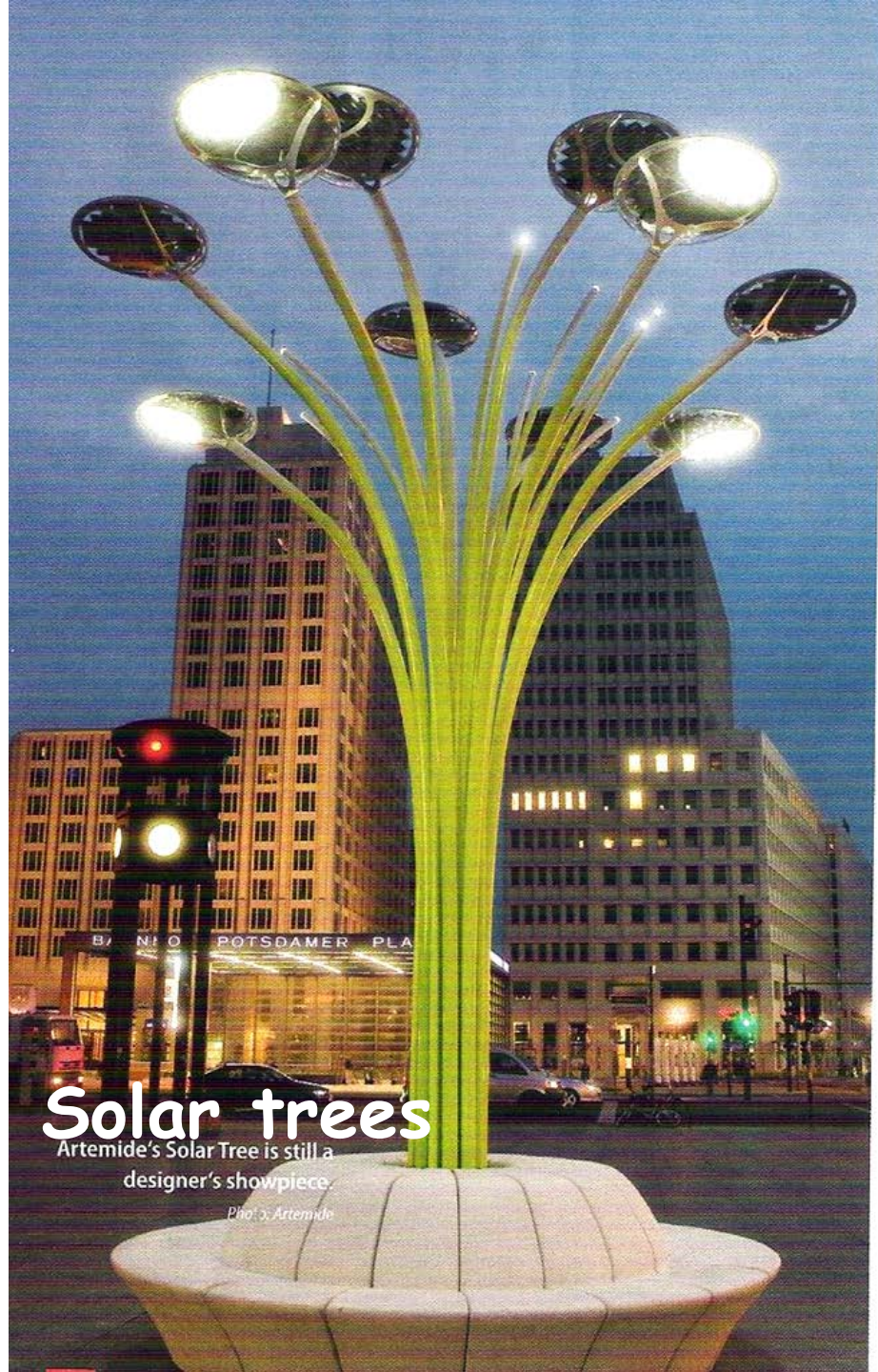
Solar flowers



Solar brain



Solar fountain

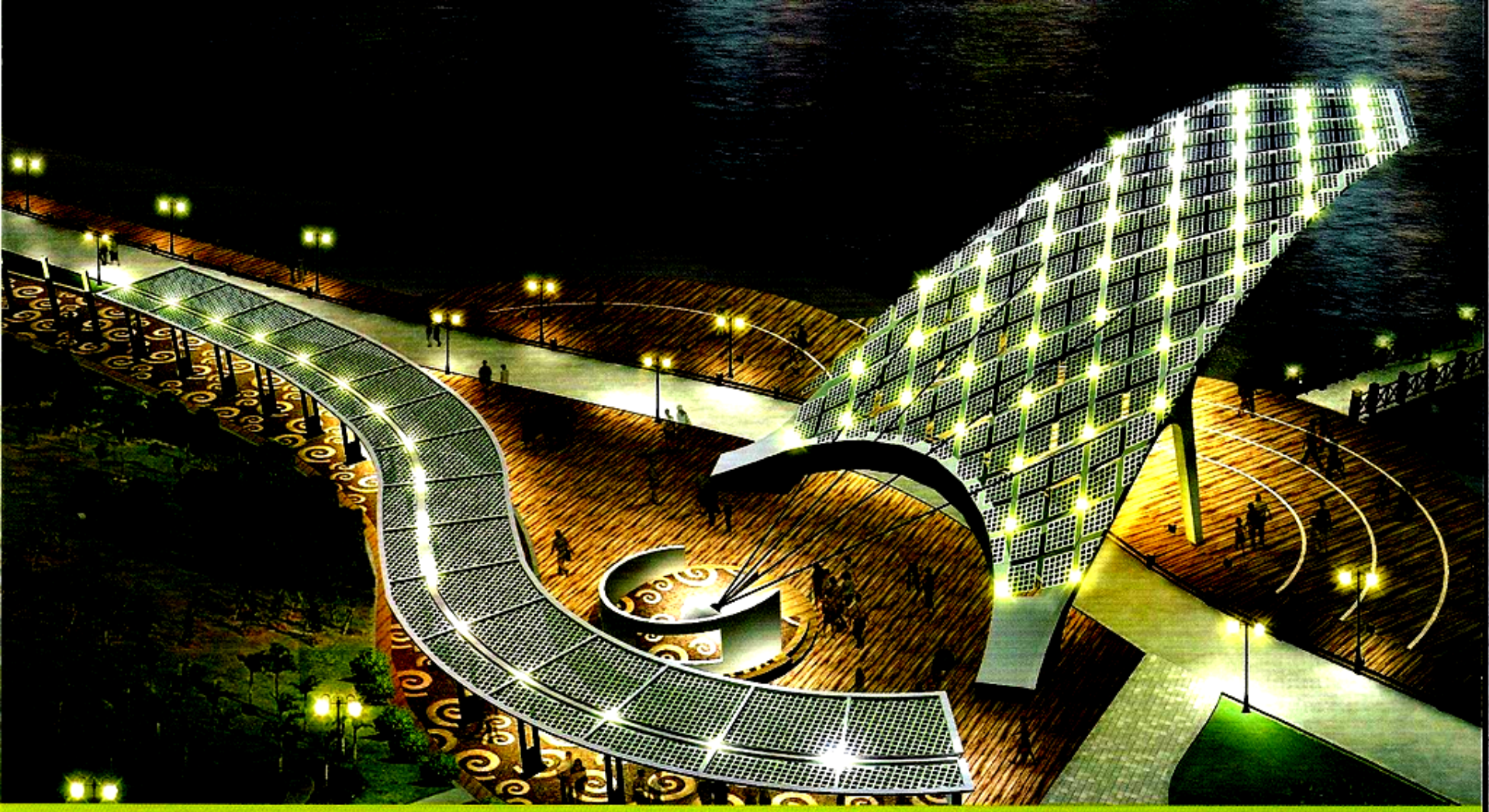


# Solar trees

Artemide's Solar Tree is still a designer's showpiece.

*Photo: Artemide*





Solar pergola



UPatras architectural design for cycladic island houses



Yiannis Tripanagnostopoulos  
[yantrip@physics.upatras.gr](mailto:yantrip@physics.upatras.gr)



*Thank you for your attention*  
*Ευχαριστώ για την προσοχή σας*