Intelligent Energy Europe

Transfer of experience for the development of solar thermal products

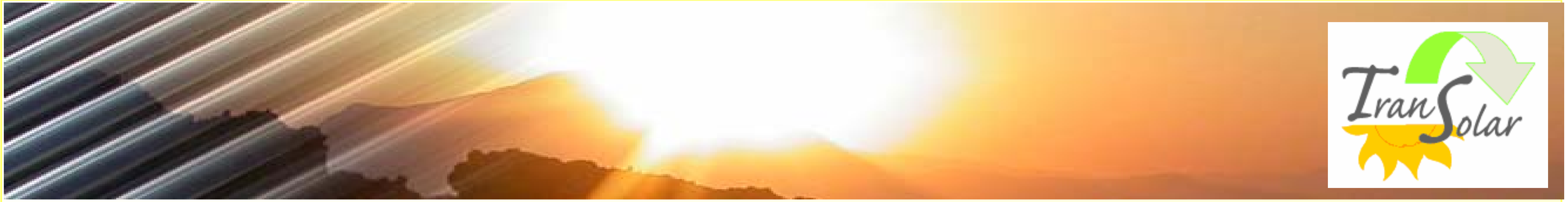
Specific Information Package

Hungary

Intelligent Energy Europe

Topics

- NEW DEVELOPED SOLAR THERMAL SYSTEMS FOR HEATING AND COOLING (CRES)
- INTRODUCTION OF THE HUNGARIAN SOLAR COMBS (HUNGARIAN BUILDING ASSOCIATION)
- ESTIMATION OF THE SOLAR COMBS’ LIFE-TIME (BUDAPEST UNIVERSITY OF TECHNOLOGY AND ECONOMICS)
- THE HUNGARIAN SUPPORTING POLICY FOR THE RENEWABLE ENERGIES (JOZSEF BANFI)
- SOLAR THERMAL HEATING SYSTEMS IN EUROPEAN UNION (CRES)



New developed solar thermal systems for heating and cooling

Budapest, 16th April 2009

Tsekouras Panagiotis
Mech. Engineer NTUA
Centre for Renewable Energy Sources
Solar Thermal Dept.

Intelligent Energy Europe

ΚΑΠΕ CRES

Overview

- Solar Thermal Systems
- Solar Collectors
- Solar Cooling Technologies
- HIGH COMBI, Best Practice

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- Solar Collectors
- Solar Cooling Technologies
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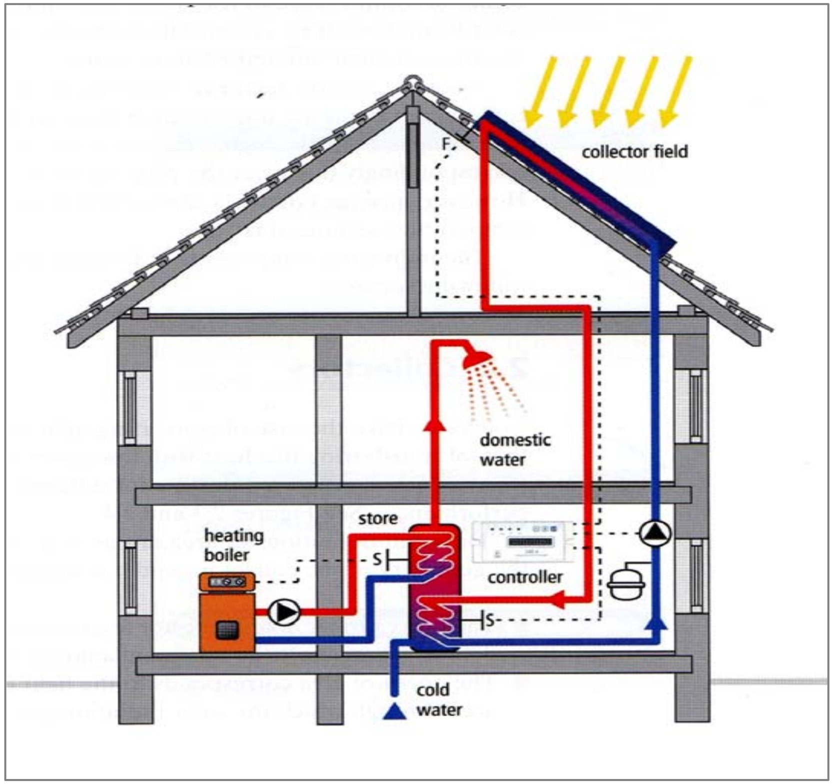
Domestic Hot Water Systems

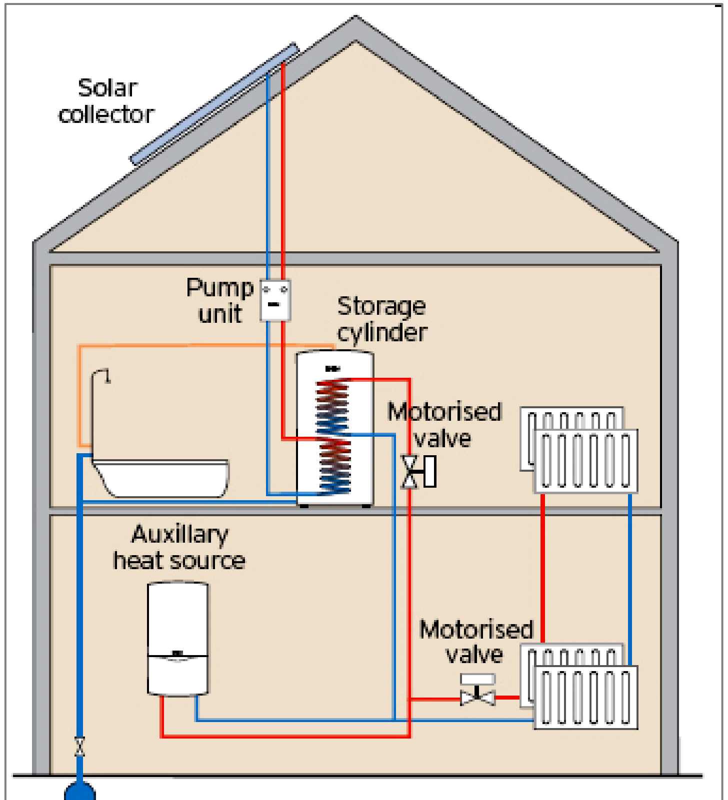
✓ **DHW** × Space Heating × Space Cooling



Central Sustem for DHW

Solar Combi Systems

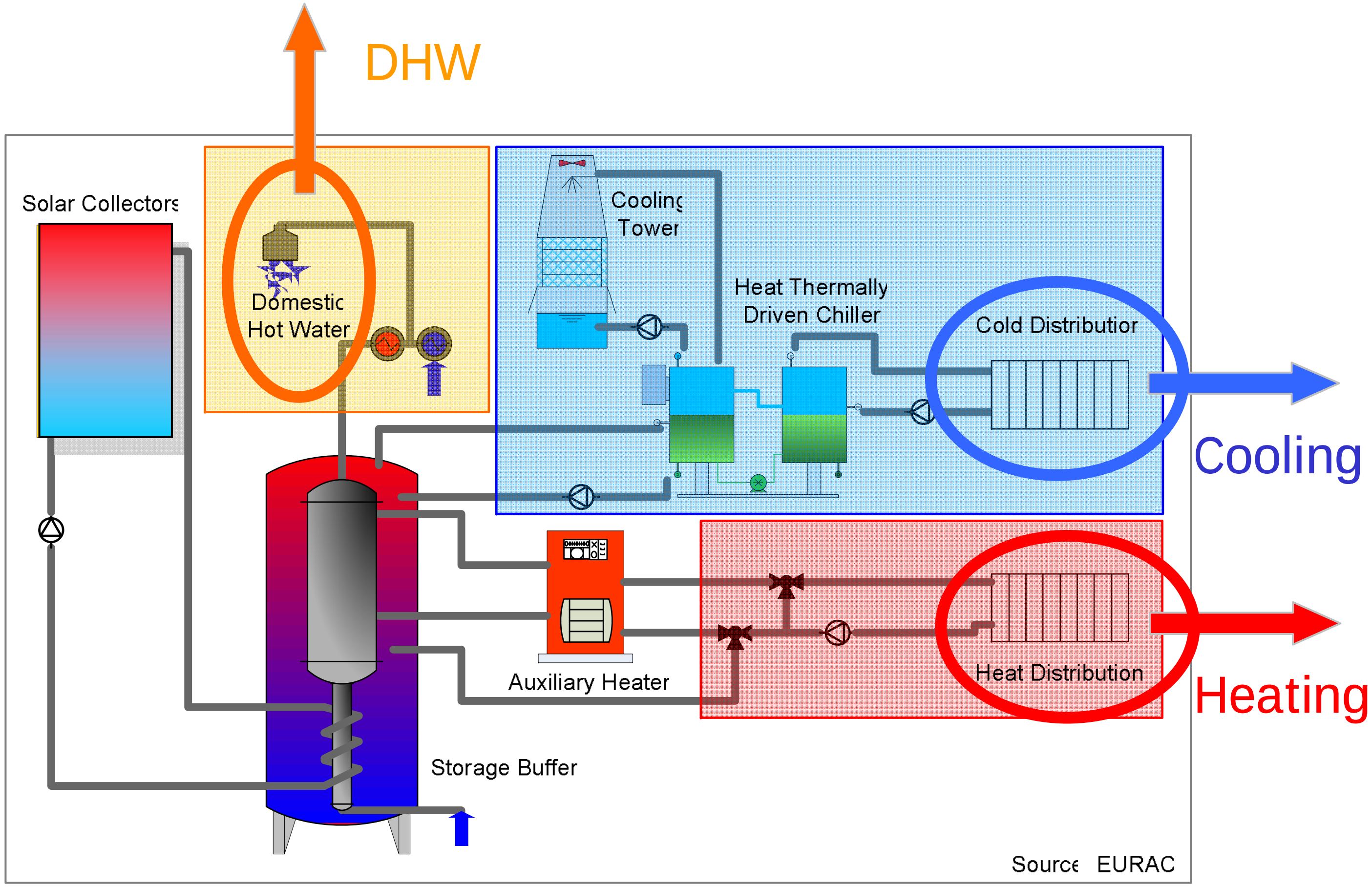
✓ **DHW** ✓ **Space Heating** × Space Cooling



A typical solar installation and heating system

Solar Combi plus Systems

✓ **DHW** ✓ **Space Heating** ✓ **Space Cooling**

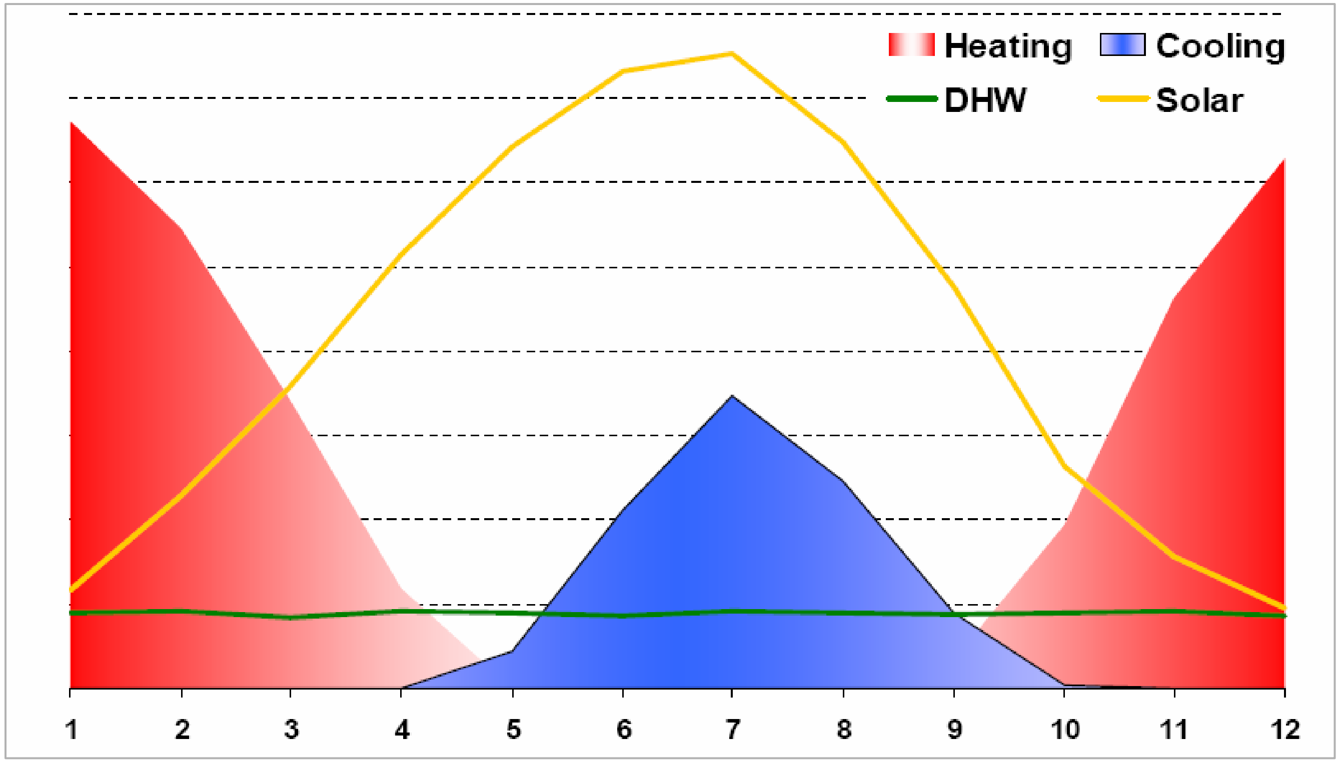


KAΠE CRES

TranSolar

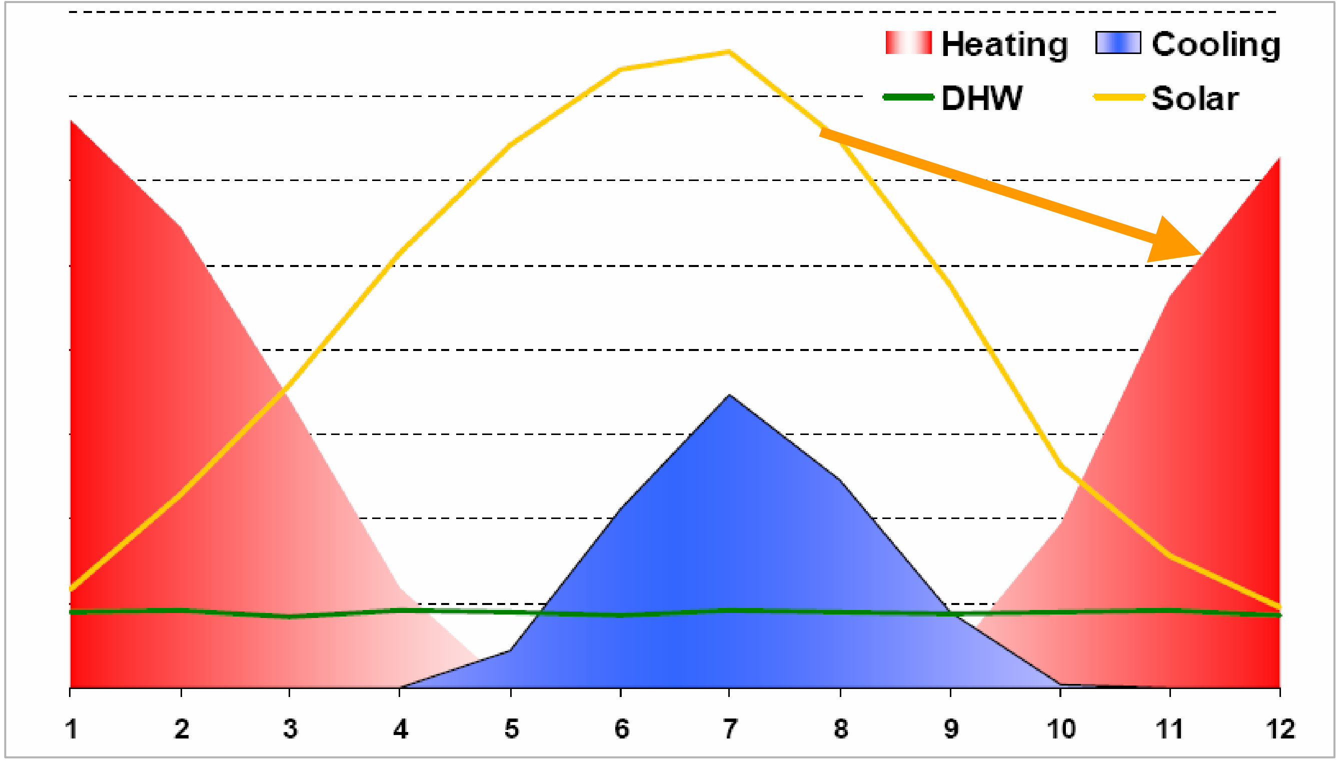
Loads vs Solar Radiation

- ✓ **Coincidence of solar gains and cooling loads**
- ✓ **Reduction of electric peak loads**
- ✓ **Better utilization of solar energy throughout the year**
- ✗ **Mismatch of Solar Radiation and Heating Load**



Energy Storage

- ✓ Exploit Better Solar Energy
- ✓ Raise Solar Fraction
- ✗ Increase initial cost
- ✗ Extra space required



Overview

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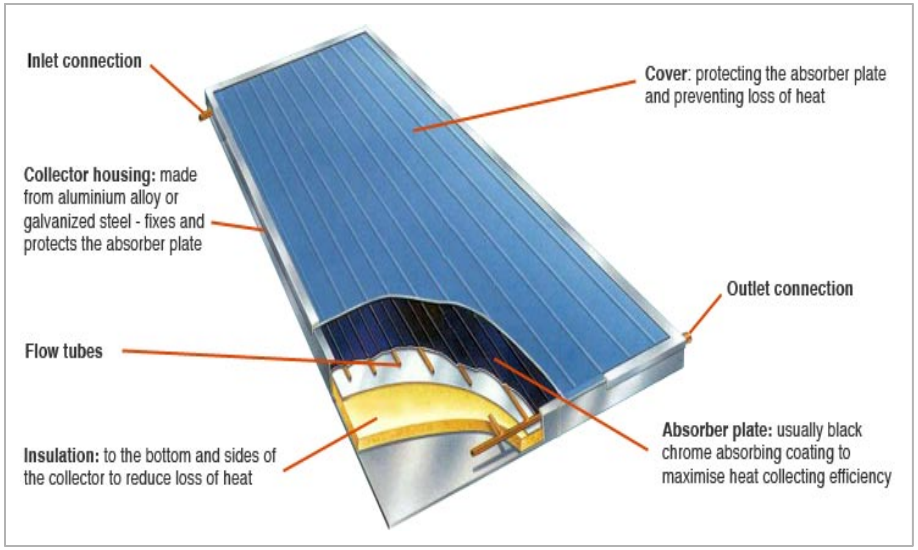
Flat Plate Collectors

Properties

- Middle cost: more expensive than unglazed, but cheaper than vacuum
- Higher operation temperature
- Thermal insulation on back & edges
- Fragile, heavier: 20-32 kg/m^2
- Absorber: black paint or spectral-selective coating
- Spectral-selective coating: conversion of short-wave solar radiation into heat (light absorption capacity) is optimized
- Absorption rate: 90-95%, emission rate 5-15%

Applications

- DHW Preparation
- Space heating
- Solar air conditioning

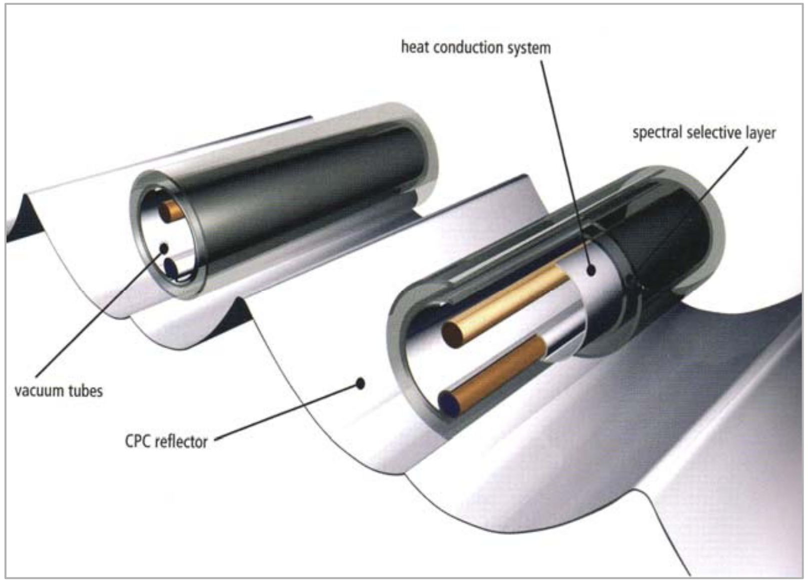


Source: Wagner & Co ESTIF

Vacuum Collectors

Properties

- High cost
- Minimal convection thermal losses (tube pressure < 10^{-5} bar)
- Low radiation losses
- High efficiency, even with low radiation
- Low weight
- Average annual efficiency 45-50% (with 1000kWh/m^2 irradiation, the energy yield is 450-500kWh/m^2a
- Stagnation temperature: 200-350^{0}C



Applications

- Solar air conditioning
- Industrial applications (steam generation)

Overview

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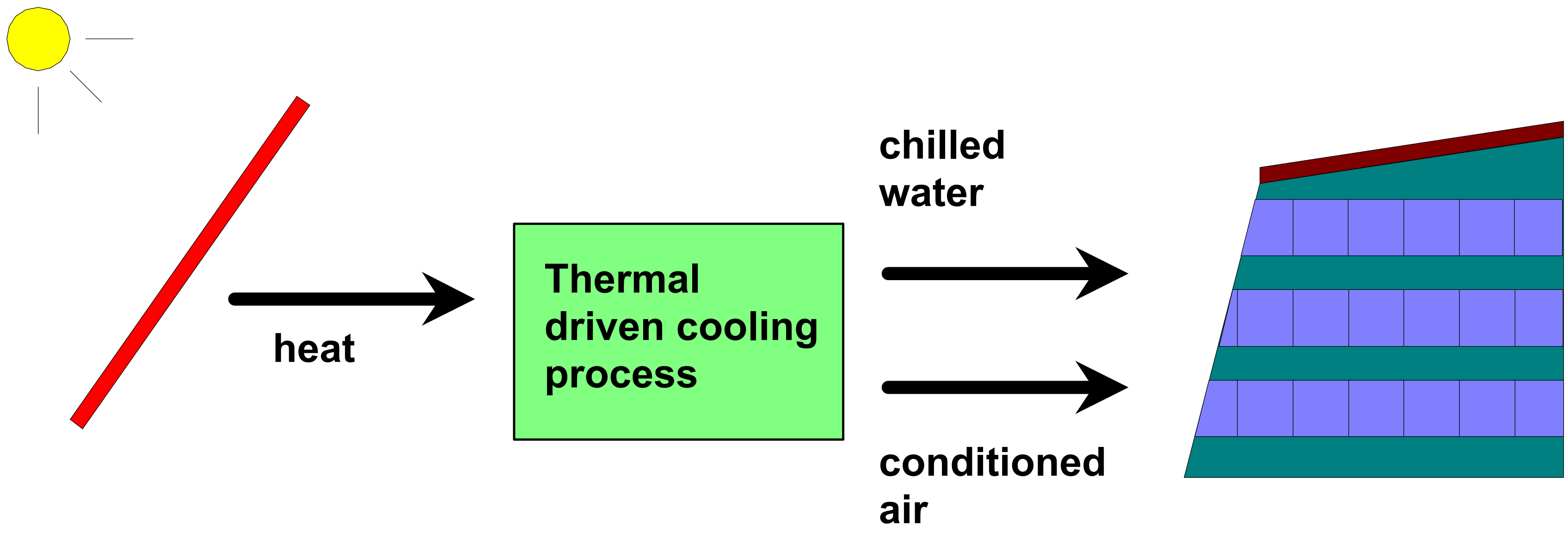
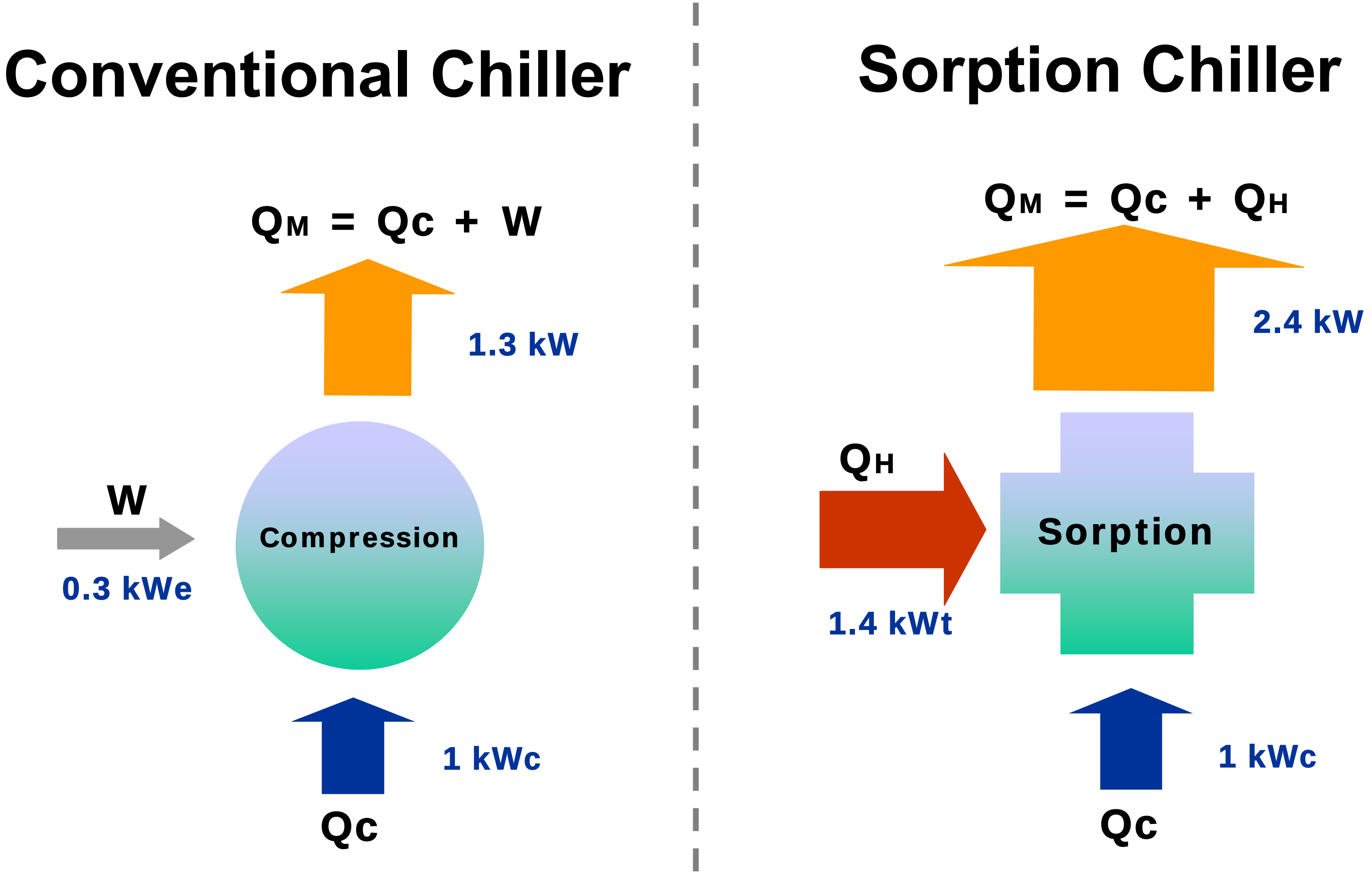
Basic Concept



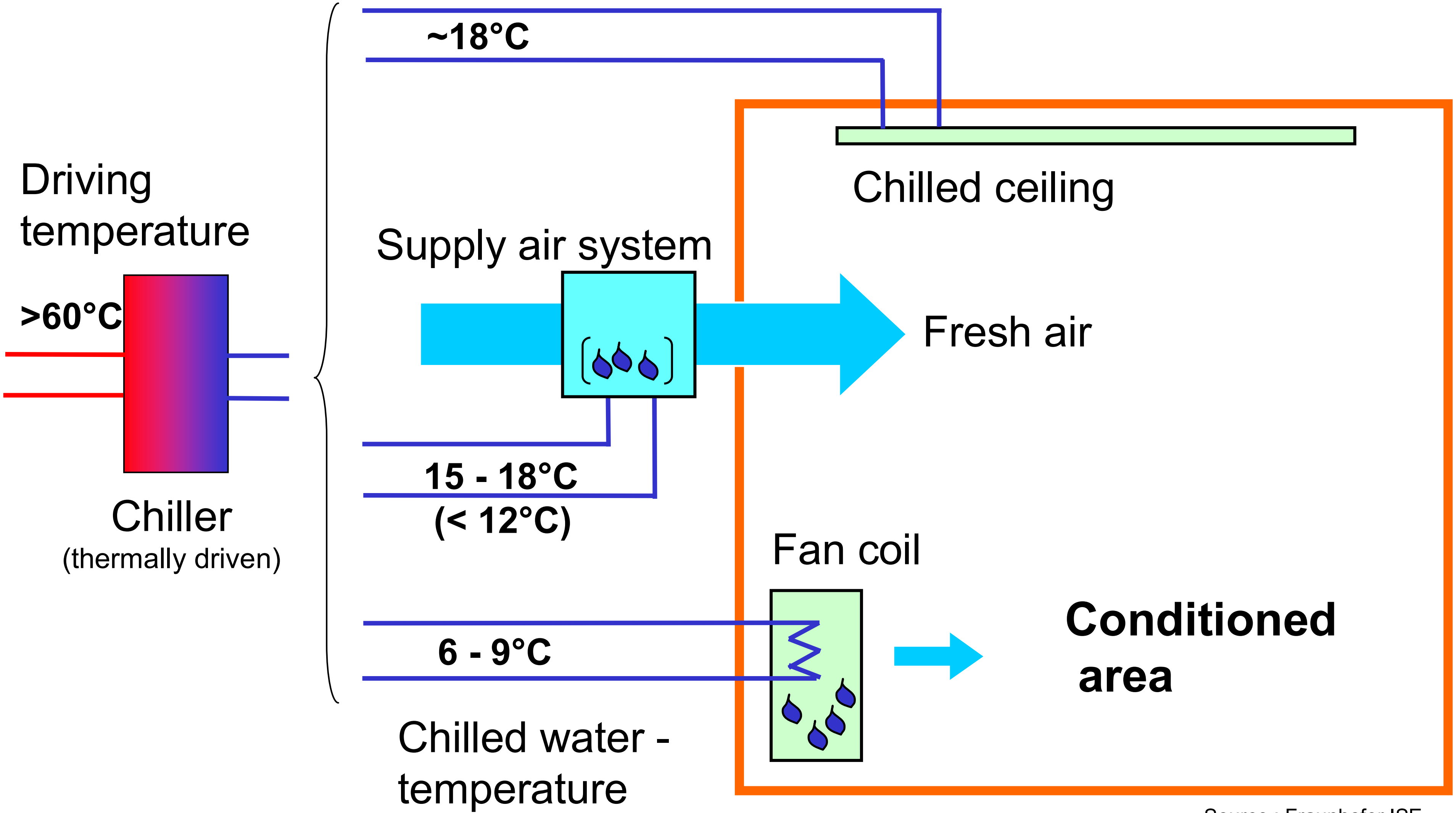
Principle of Operation



Cooling Technologies

Method	Closed cycle		Open cycle	
Refrigereant cycle	Closed refrigerant cycle		Refrigerant (water) is in contact to the atmosphere	
Principle	Chilled water		Dehumidification of air and evaporative cooling	
Phase of sorbent	solid	liquid	solid	liquid
				
Typical material pairs	water - silica gel	water - lithium bromide ammonia - water	water - silica gel, water - lithium chloride	water - calcium chloride, water - lithium chloride
Market available technology	Adsorption chiller	Absorption chiller	Desiccant cooling	Close to market introduction
Typical cooling capacity (kW cold)	50 – 430 kW	15 kW – 5 MW	20 kW – 350 kW (per module)	
Typical COP	0.5 – 0.7	0.6 – 0.75 (single effect)	0.5 – >1	> 1
Driving temperature	60 – 90 °C	80 – 110 °C	45 – 95 °C	45 – 70 °C
Solar collectors	Vacuum tubes, flat plate collectors	Vacuum tubes	Flat plate collectors, solar air collectors	Flat plate collectors, solar air collectors

Closed Cycle Systems

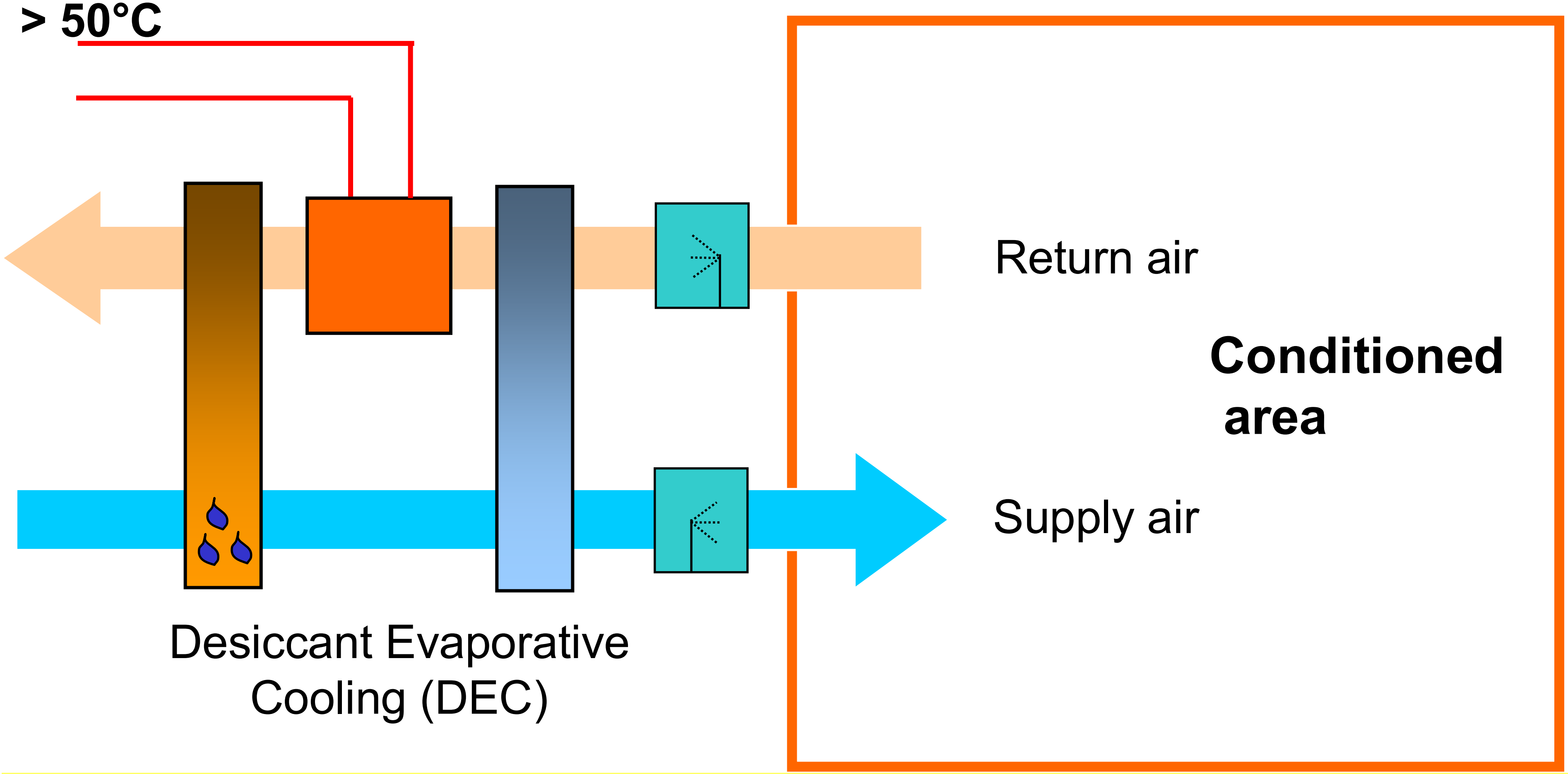


Source : Fraunhofer ISE

Open Cycle Systems

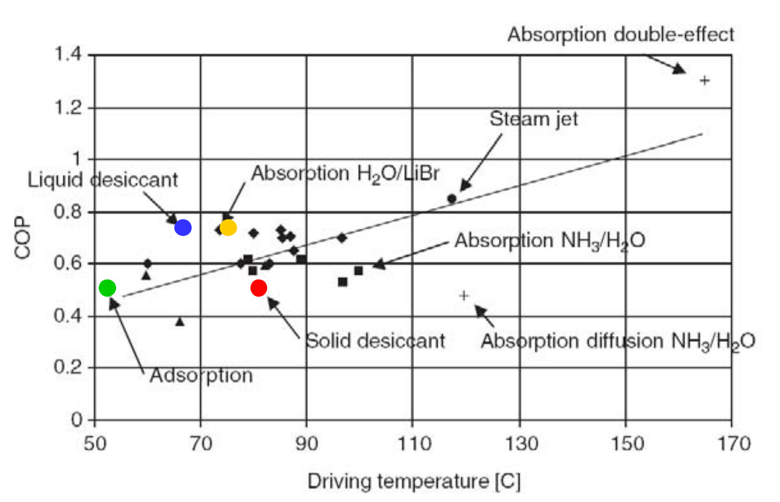
Driving temperature

> 50°C



Desiccant Evaporative Cooling (DEC)

Comparison



Efficiency – Operational temperature, 2007

Open systems

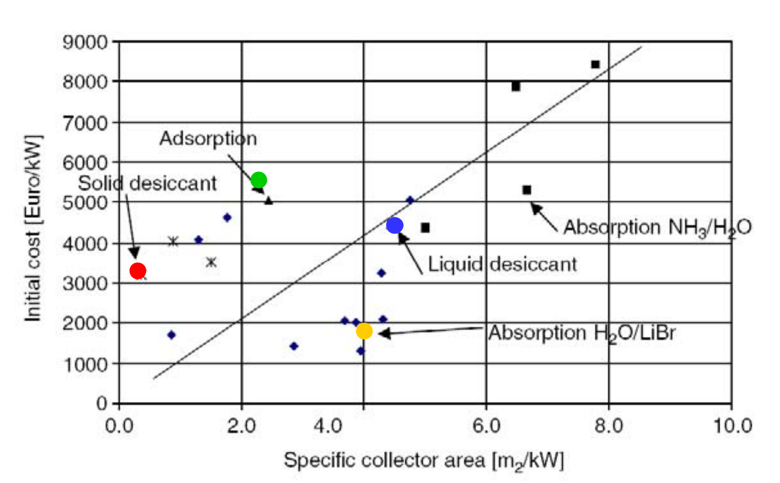
Liquid DEC: T = 60C, COP = 0.7

Solid DEC: T = 80C, COP = 0.5

Closed systems

Absorption: T = 75C, COP = 0.7

Adsorption: T = 55C, COP = 0.5



Initial cost – Collector area needed, 2007.

Open systems

Liquid DEC: 4500 €/kW, 5 m^2/kW

Solid DEC: 3500 €/kW, 0.5 m^2/kW

Closed systems

Absorption: 2000 €/kW, 4 m^2/kW

Adsorption: 5500 €/kW, 2.5 m^2/kW

Source : CA Balaras, G Grossman, HM Henning, *Solar Air-Conditioning in Europe - an overview*, Renewable Energy & Sustainable Energy Reviews, 11, 2007, 299-314

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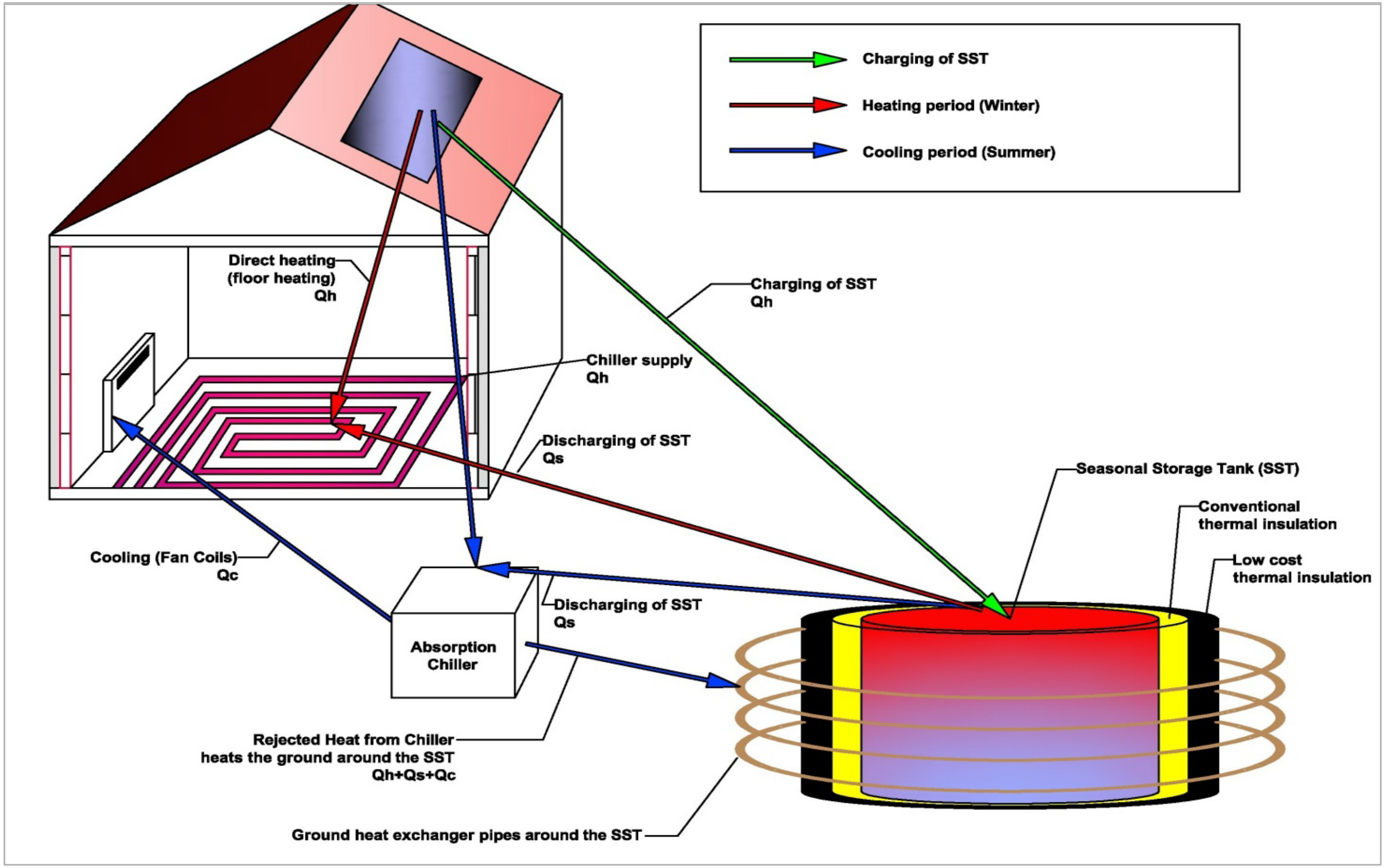
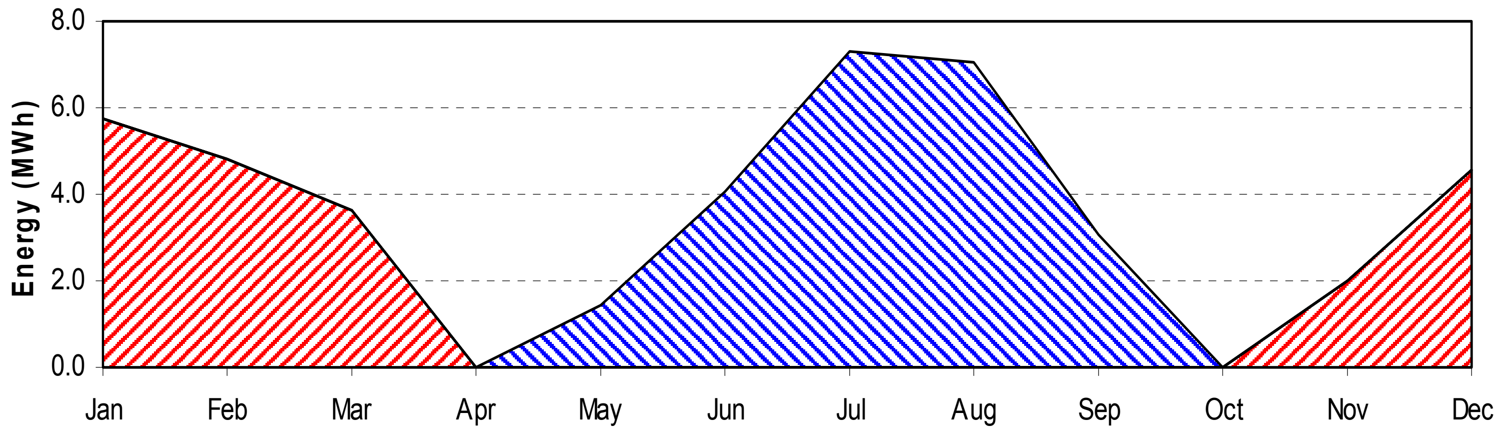
The Greek plant, **HIGH COMBI** ***Concept***



The Greek plant, ***End User Data***

CRES Offices, Athens

Building Data	
Area	545 m^2
Heating Load (max)	51 KW
Heating Energy Demand	22 MWh
Cooling Load (max)	45 KW
Cooling Energy Demand	18 MWh
DHW Demand	-
Heating / Cooling Distribution System	Fan Coils



Building Energy Demands, Heating / Cooling

The Greek plant, ***Solar System***

Energy System Data

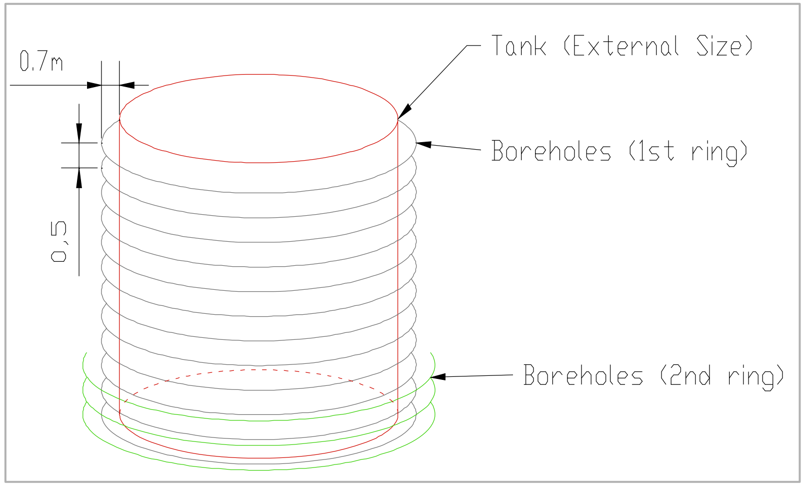
	Type	Unit
Collectors	Flat Plate	120 m^2
Primary Circuit Fluid	Mixture of propylene glycol and water	30 %
Chiller	Absorption	35 kW
Heat Rejection	GHE & Cooling Tower	
Storage	Buried Cylindrical Tank	180 m^3
Heating supply/ return Temperature	Fan Coils	45 / 40 ^oC
Cooling supply/ return Temperature	Fan Coils	7 / 12 ^oC
Back up System	Heat Pump	50 KW

Estimated Solar Fraction ~ 95%

The Greek plant, ***Storage System***

Innovative Seasonal Storage

	Type	Unit
Storage	Cylinder	180 m^3
Position	Underground (T_{ground} ~ 15^{o}C)	1 *m*
Restrictions	High Water Level	8 *m*
Structure	Steel & Concrete	
Insulation	Polyurethane & Chipped Tyres	0,4 *W/(m² K)*
Heat Rejection	Horizontal Ground Heat Exchangers	402 m *(1st loop)* 463 m *(2nd loop)*
Ground	Clay/ Silt , dry	0,5 *W/(m K)*



Information

www.highcombi.eu

- Further information
- Progress
- Contacts
- Deliverables / Reports
- News

Thank you for your attention!

Introduction of the Hungarian solar thermal collector market

- Very good climate conditions
- Great lag
- Unpredictable financial support policy
- Confusing collector supply
- Long payback period

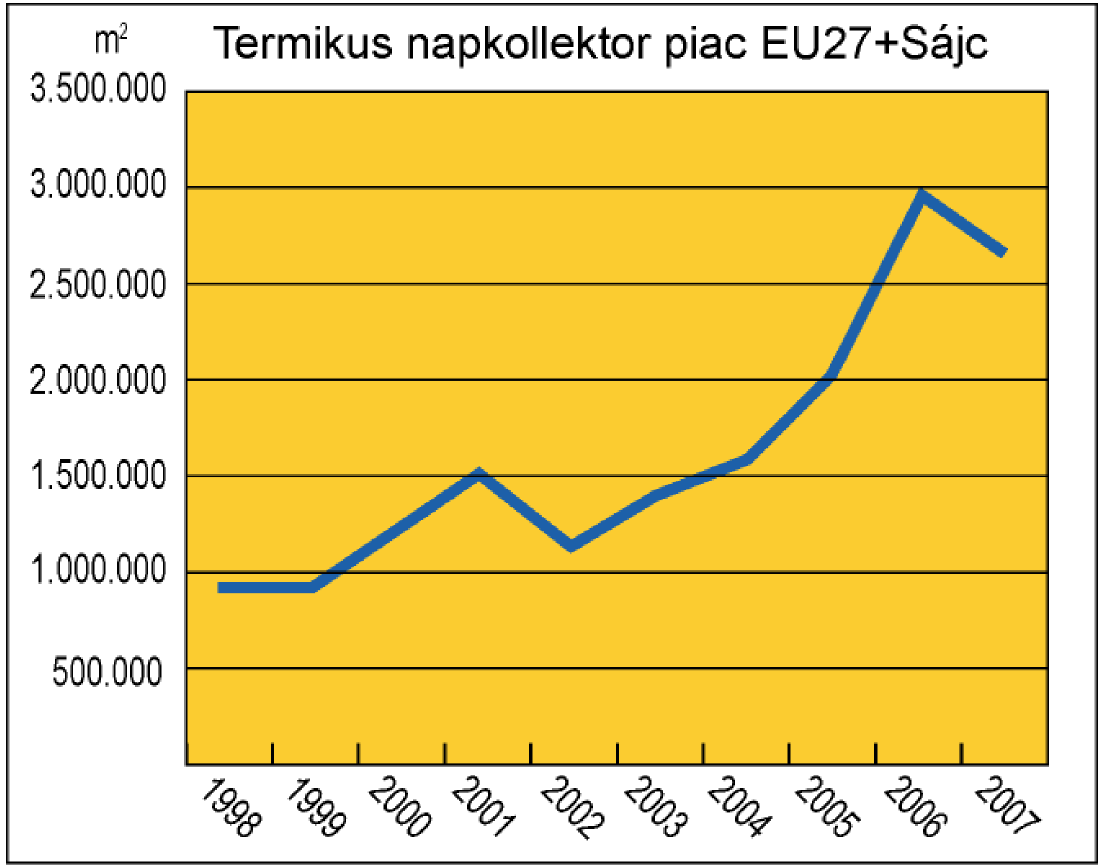
Pál Varga

NAPLOPÓ KFT. Napenergia-hasznosítás

International overview

ESTIF
European Solar Thermal Industry Federation

www.estif.org



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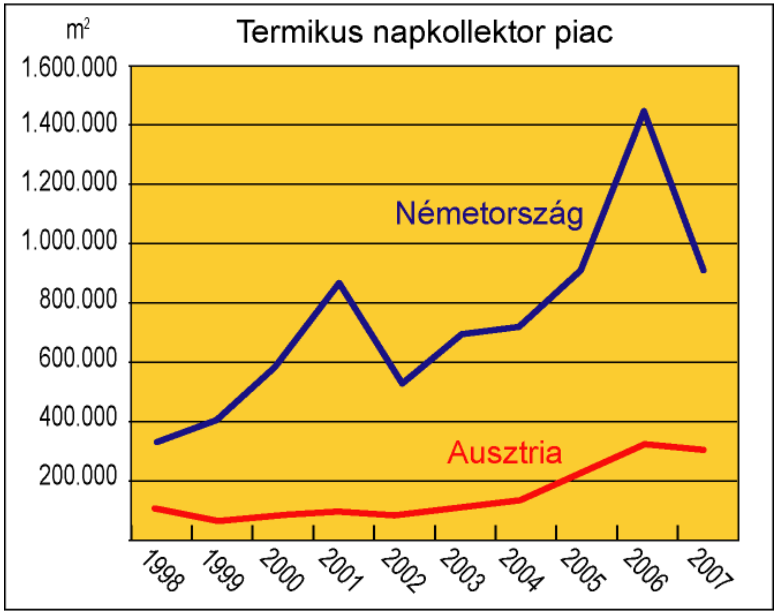
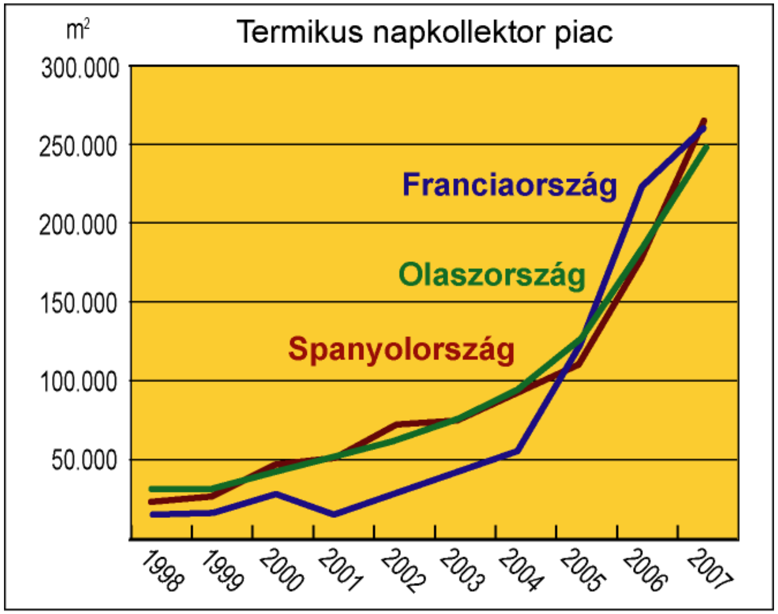
International overview

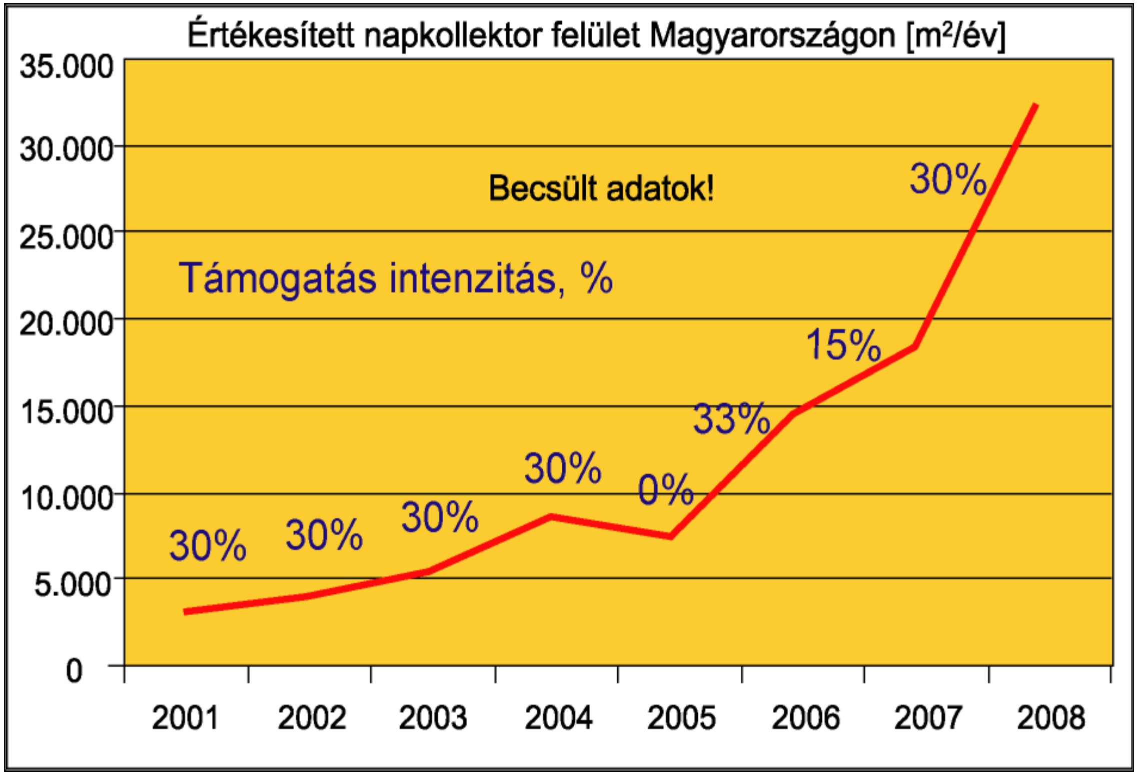
ESTIF

European Solar Thermal Industry Federation



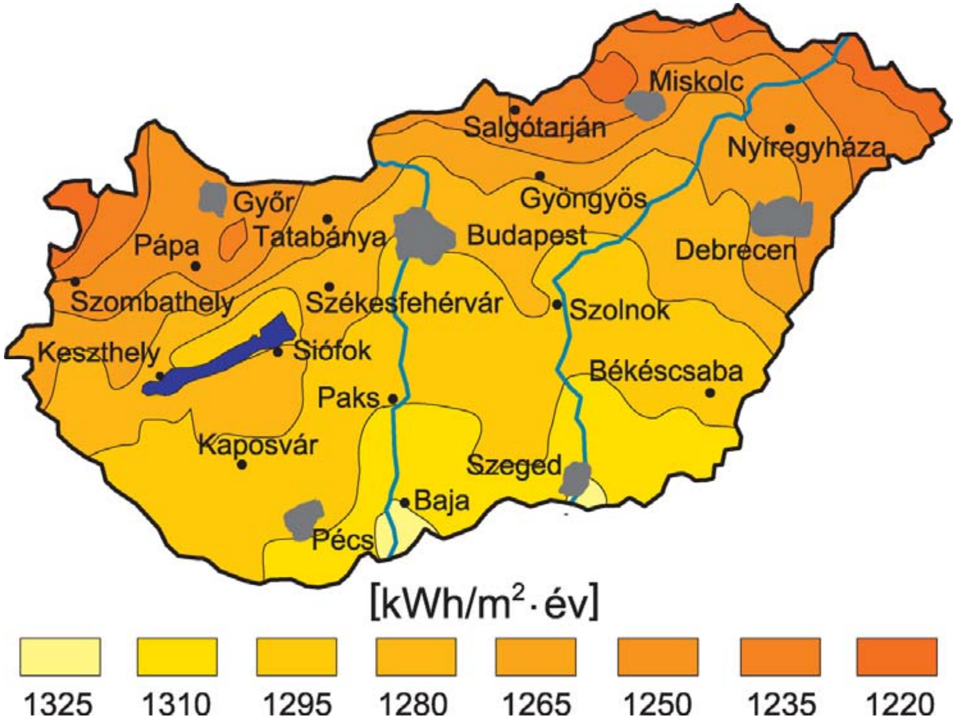


Current situation in Hungary



Year	2004	2005	2006	2007	2008	2009
% of financial support:	30%	0%	1/3	15%	30%	?
Max. financial support, thousand HUF	500.- (250)	0.-	300.-	265.-	1.200.-	?
NEP financial frame, million HUF	?	0	?	~800.-	3.200.-	1.300.-

Climate conditions in Hungary



Global solar radiation on horizontal surfaces in Hungary

The biggest difference: 8%

The whole country area is good for utilization of solar energy!

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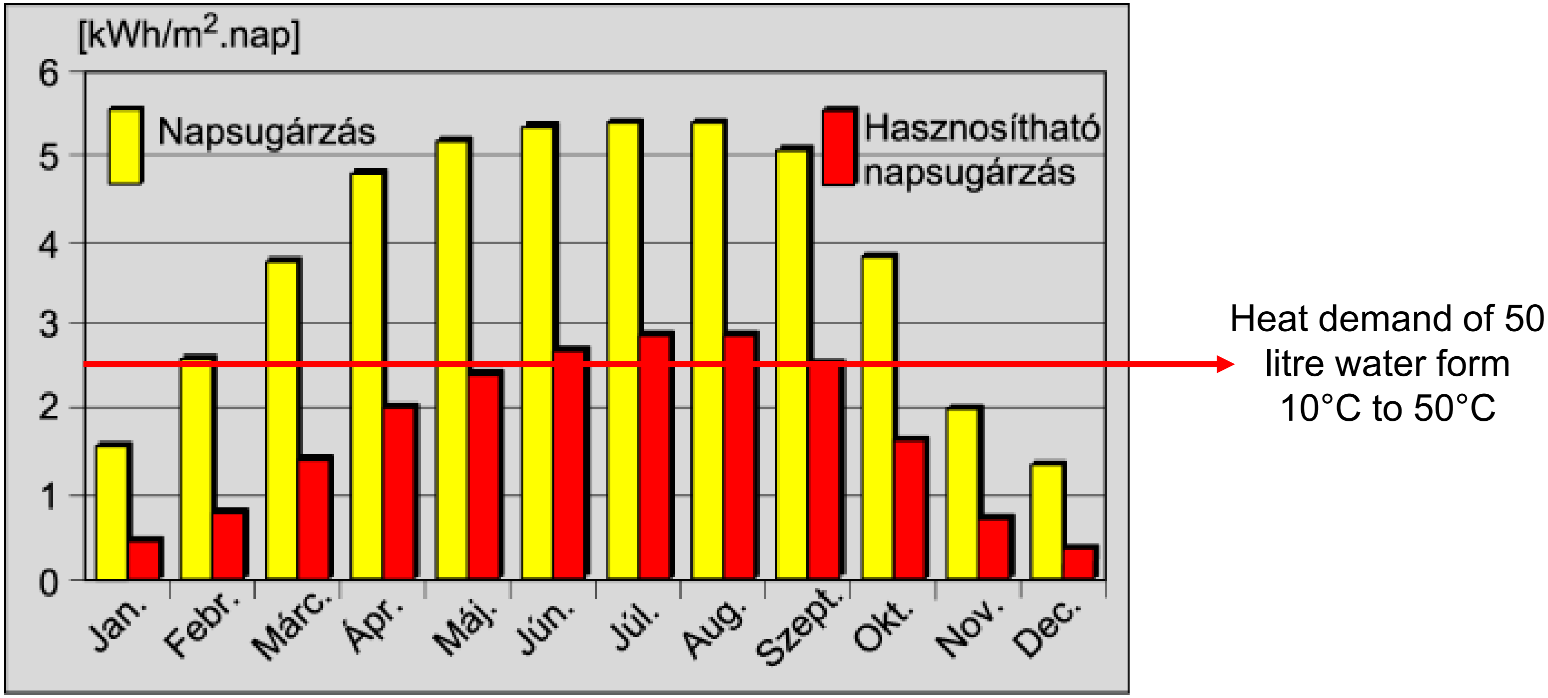
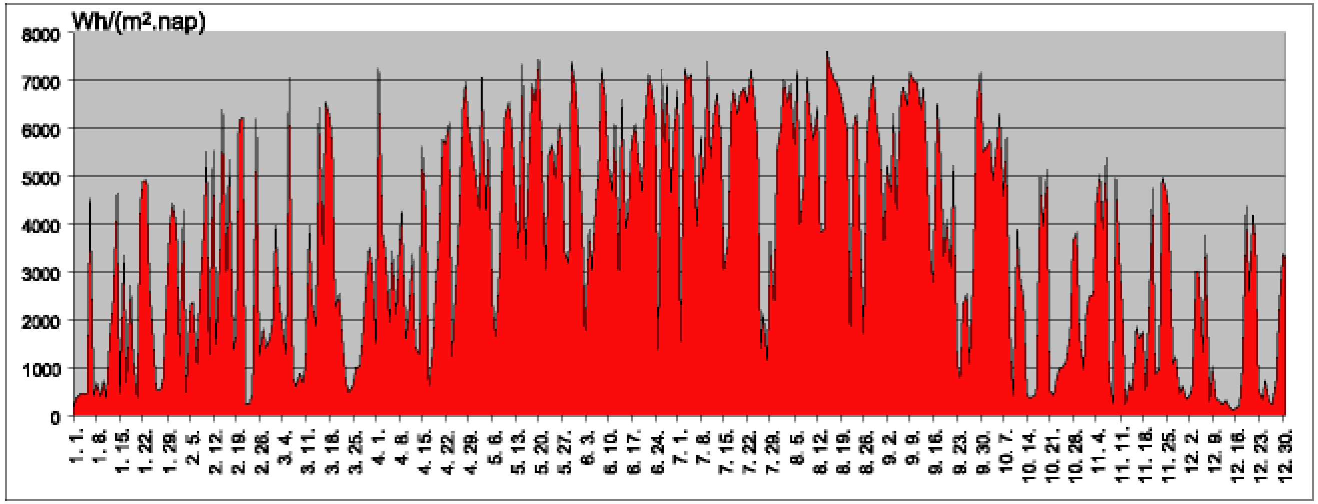
Climate conditions in Hungary



Solar radiation on surface siting to South, gradient 45° and usable solar radiation with solar collector per month in Hungary

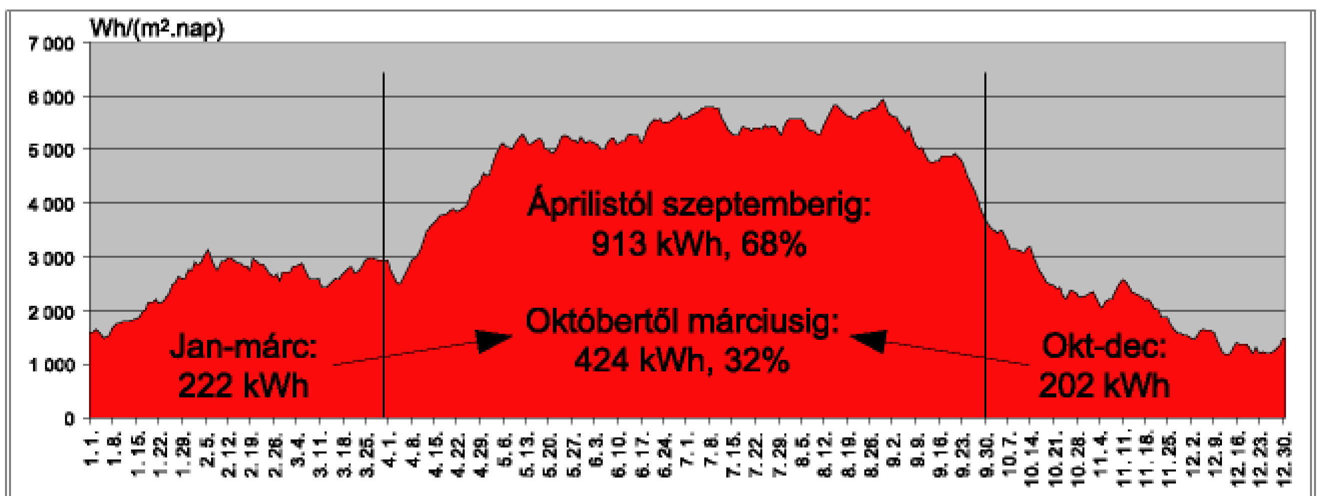
Solar radiation:	**~1300-1400 kWh/(m^2.year)**
Usable solar radiation:	**~500-600 kWh/(m^2.year)**

Climate conditions in Hungary



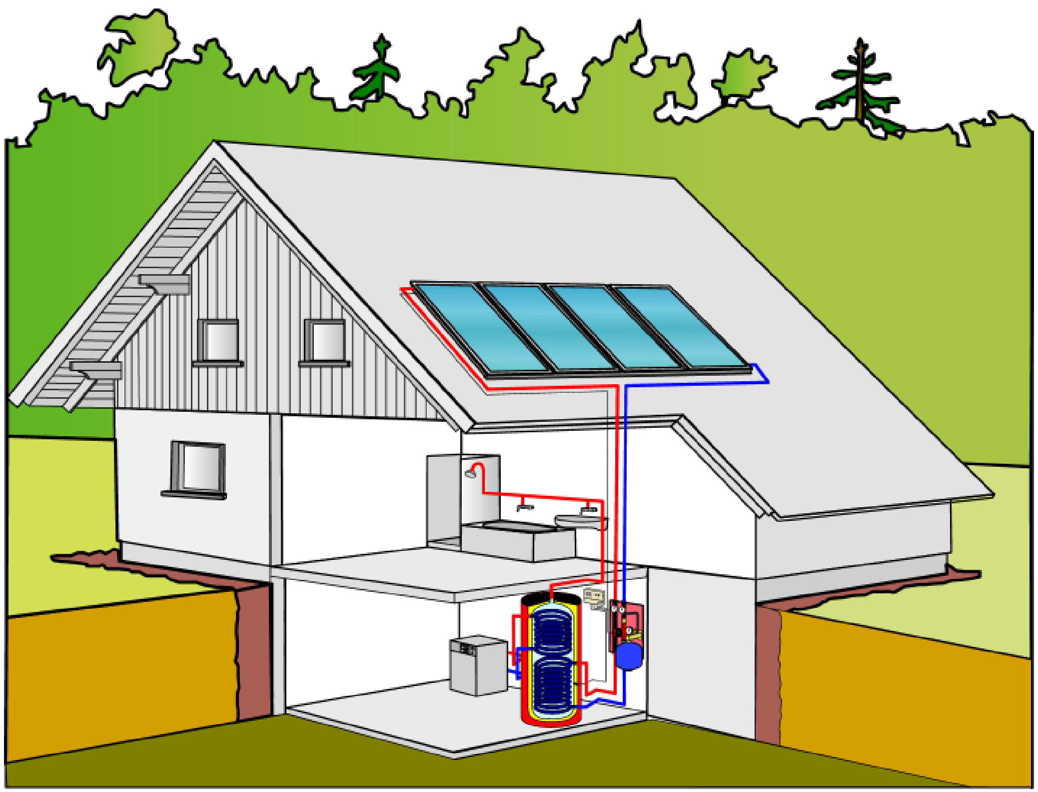
2004 évi napsugárzás napi adatokkal

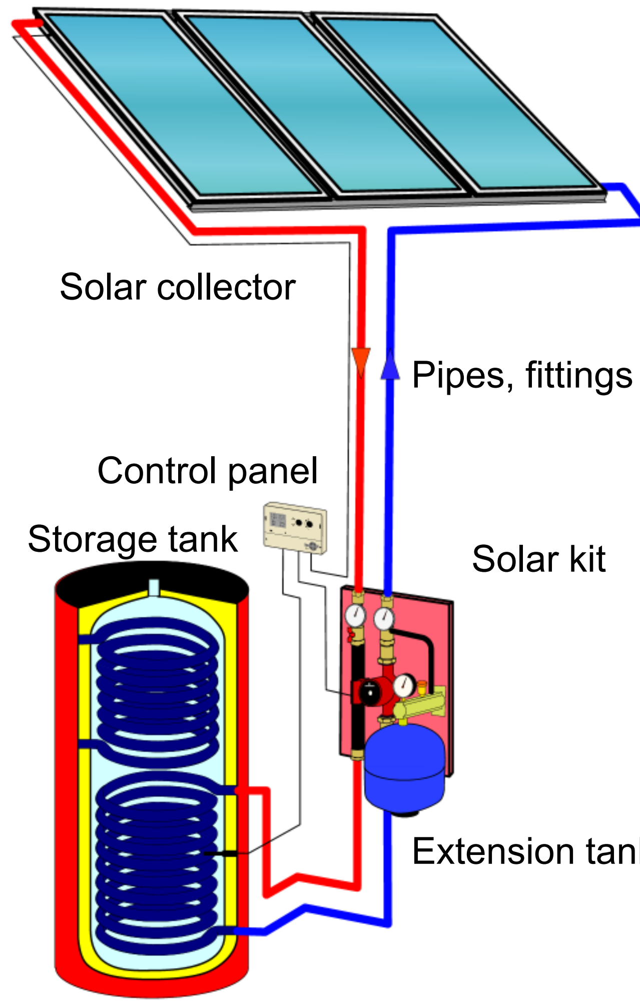
www.naplopo.hu



2004 évi napsugárzás 30 napos átlagértékekkel

Tipical system in Hungary



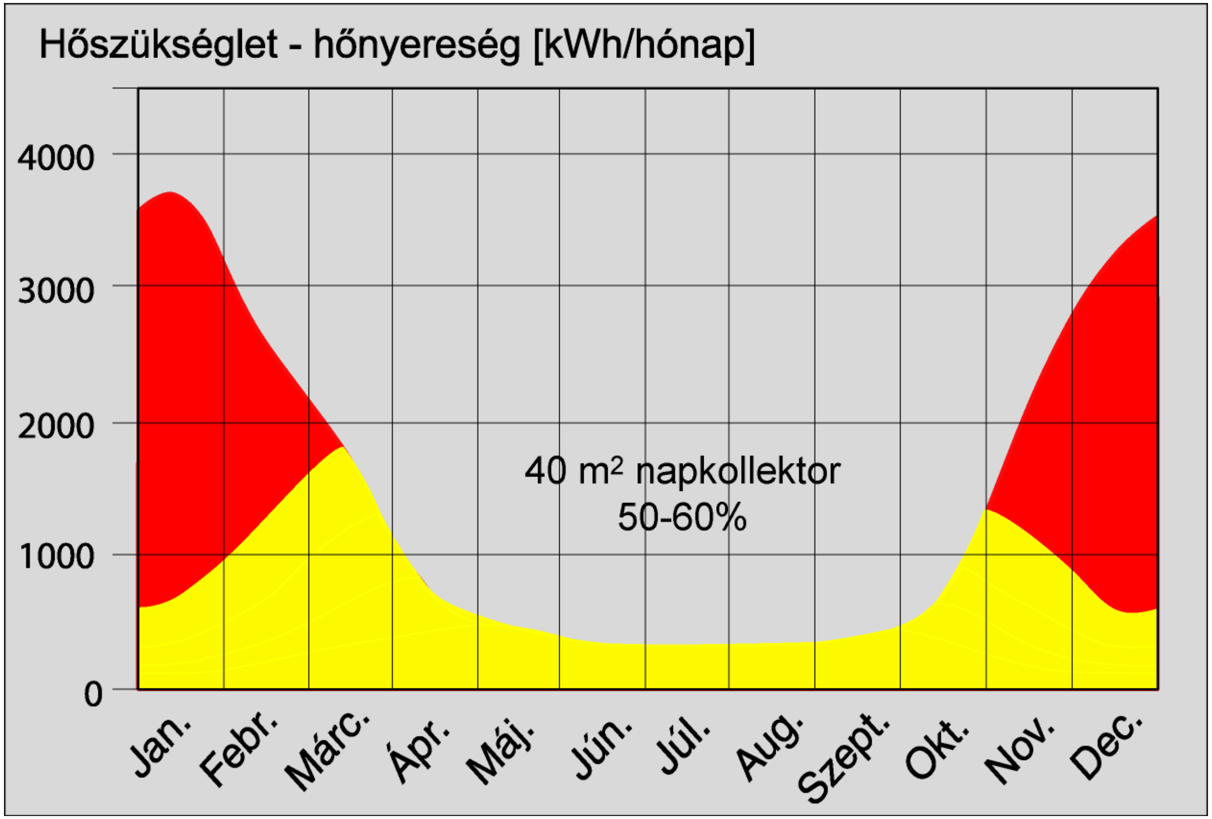


What is the solar thermal system used for?


Hot water


Space heating


Swimming pool heating



Rate of heat demand of the building and usable solar energy

Dilemma in Hungary: which collector should be used?

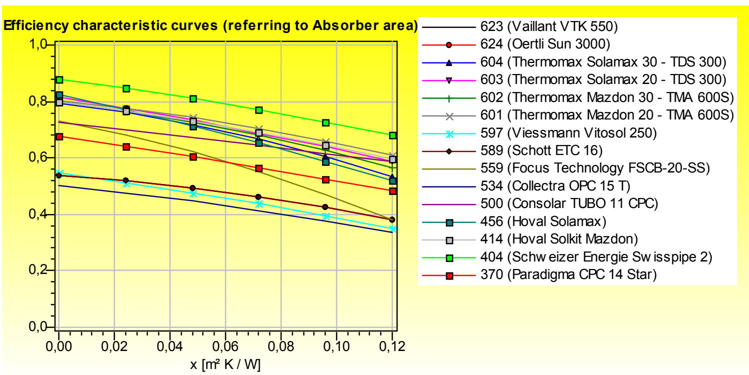
?

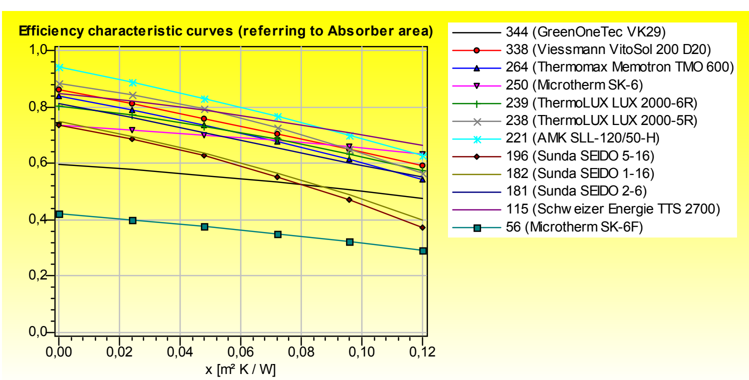
Flat plate collector or vaacum tube collector

?

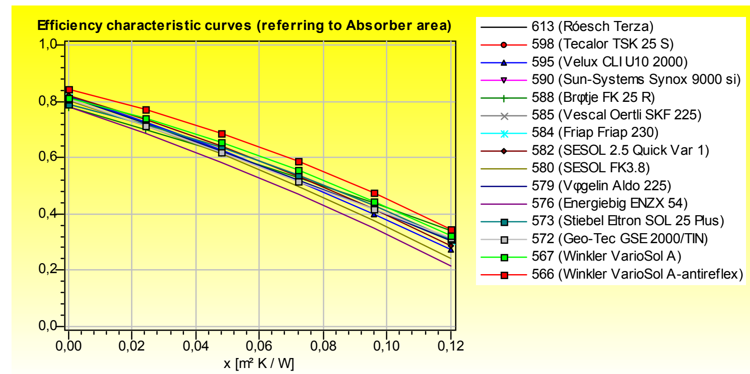
Dilemma in Hungary: which collector should be used?

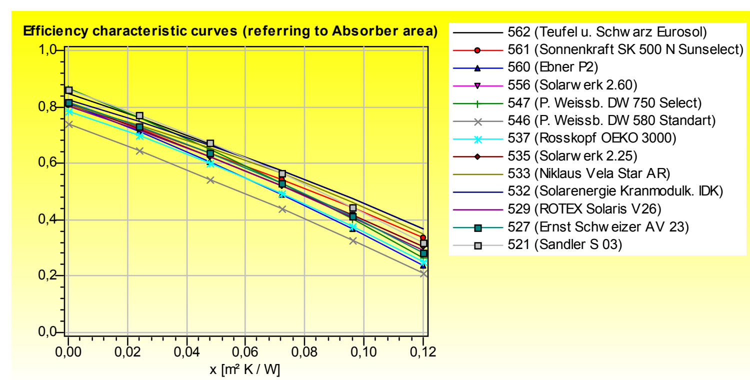
Vaacum tube collectors





Falt plate collectors





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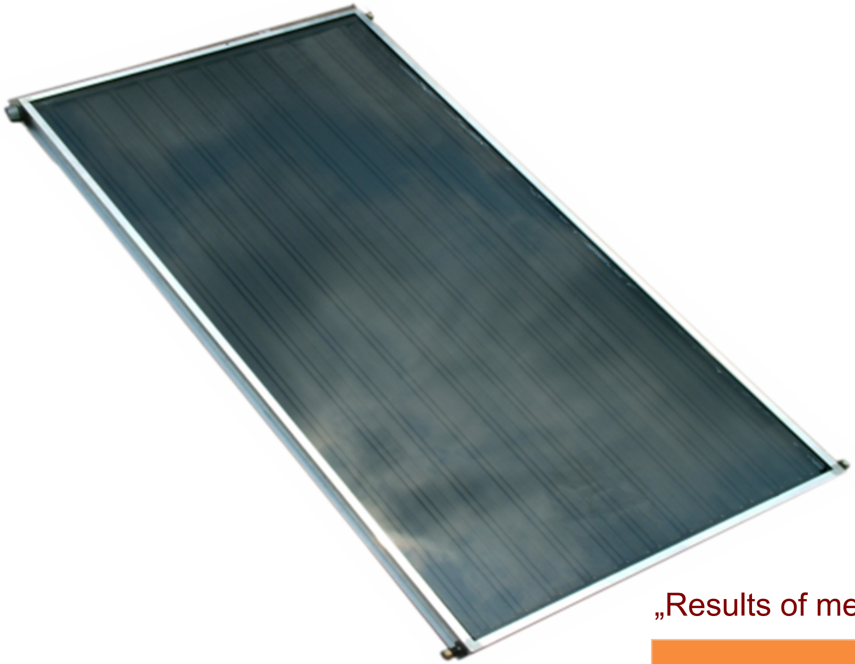
Confusing collector supply in Hungary



Technical parameters:

- Performance: 0-2400 W = 1318 W/m²
- Max. pressure: 4 bar
- Size: 1,00 x 2,00 x 0,06 m
- Active surface: 1,82 m²
- Volume: 1,7 litre
- Weight: 38,6 kg
- Max. temperature: 180ºC

Efficiency: (1318 W / 1000 W)·100 = 132%

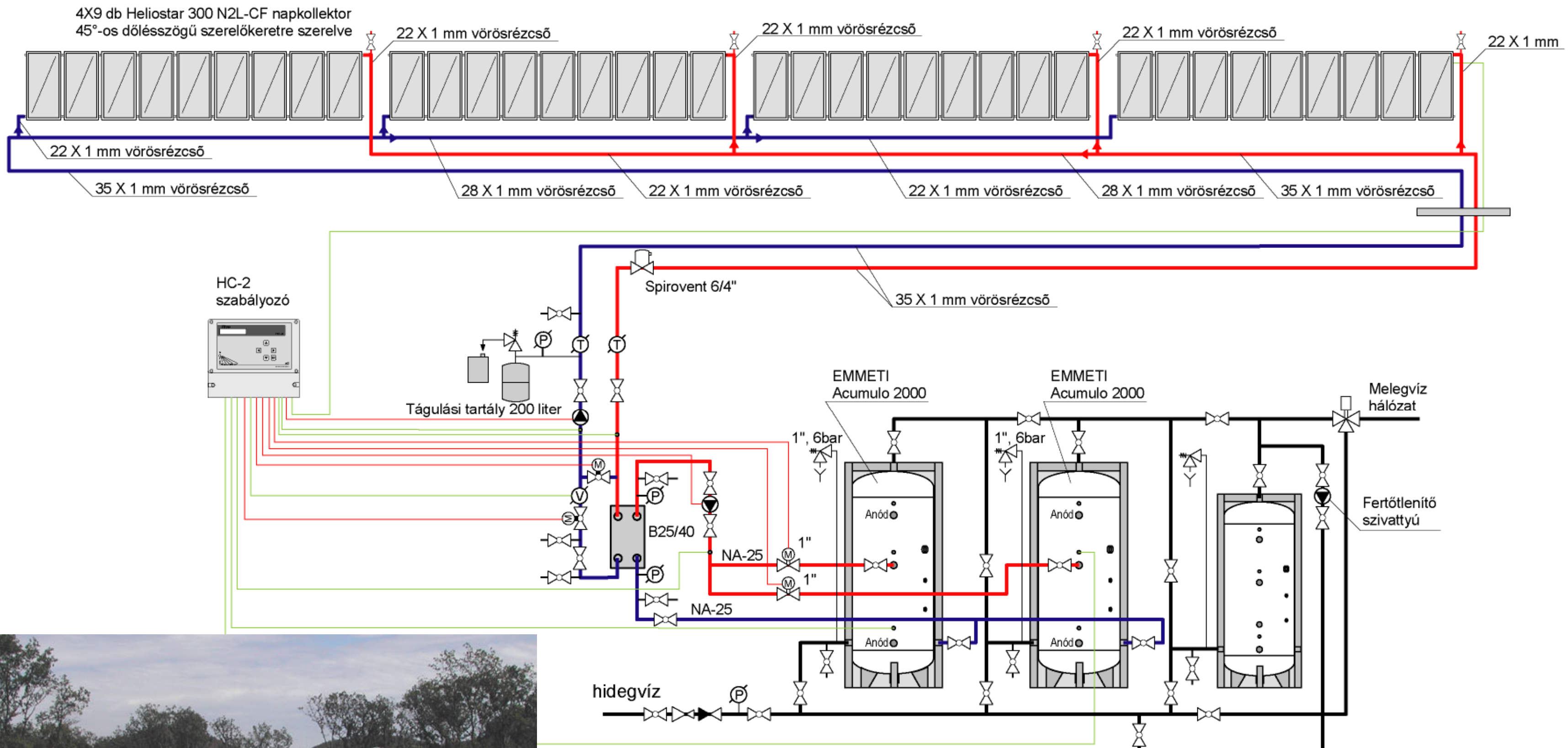
„Results of measures"

Time (s)	Temp. Ext. (°C)	Light Ext. (klux)	Light ALU (klux)	ALU Visszavert %	Light CON (klux)	CON Visszavert %	CON-hoz viszonyított ALU hatékonyság
0	24,87	138,21	32,54	23,54%	38,75	28,03%	119,09%
1	24,87	138,21	32,54	23,54%	38,75	28,03%	119,09%
2	24,89	138,21	32,54	23,54%	38,75	28,03%	119,09%
3	24,92	138,21	32,54	23,54%	38,75	28,03%	119,09%
4	24,95	138,21	32,54	23,54%	38,75	28,03%	119,09%
5	24,97	138,21	32,54	23,54%	38,75	28,03%	119,09%
6	25,00	138,21	32,54	23,54%	38,75	28,03%	119,09%
7	25,00	138,21	32,54	23,54%	38,75	28,03%	119,09%
8	25,00	138,21	32,54	23,54%	38,75	28,03%	119,09%
9	25,00	138,21	32,54	23,54%	38,75	28,03%	119,09%

Source:

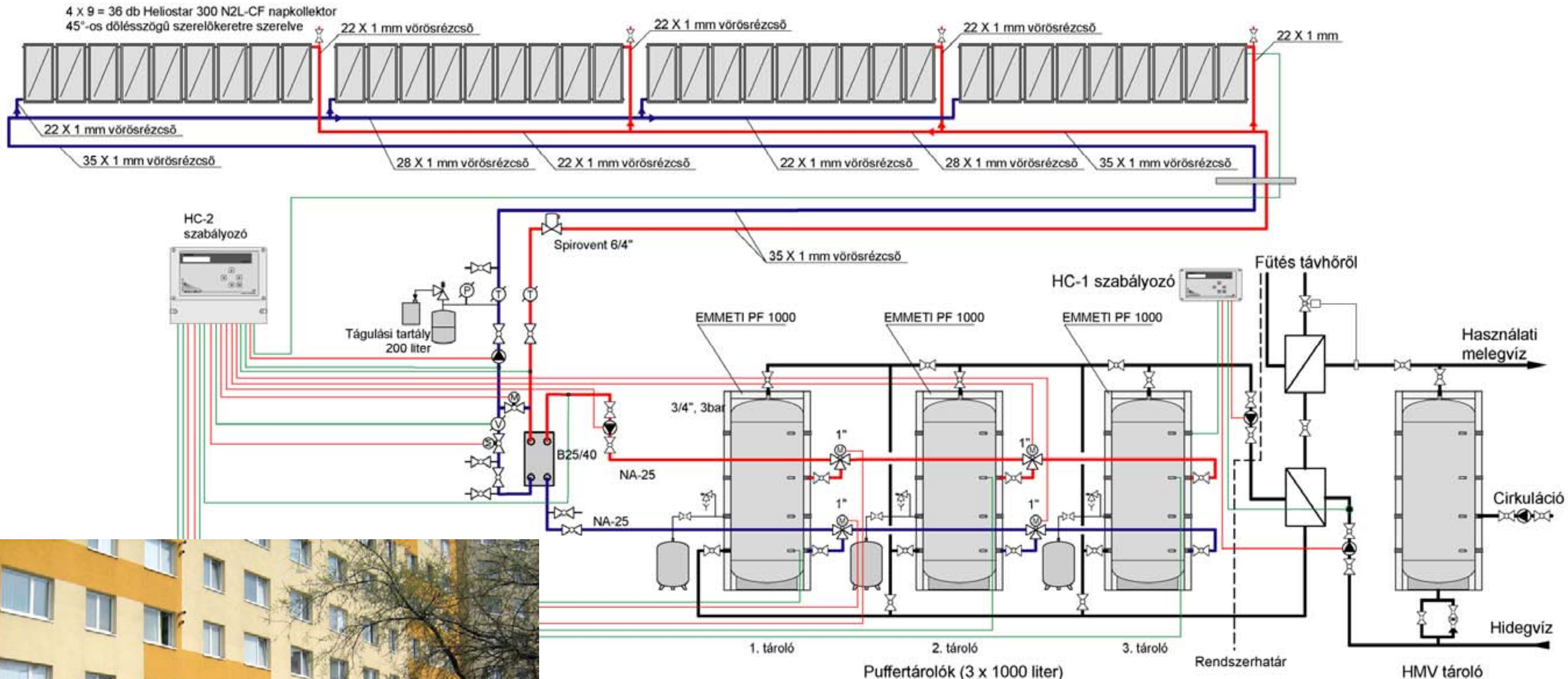
www.solarkollektor.hu

Examples for bigger solar thermal systems in Hungary



Budaörs

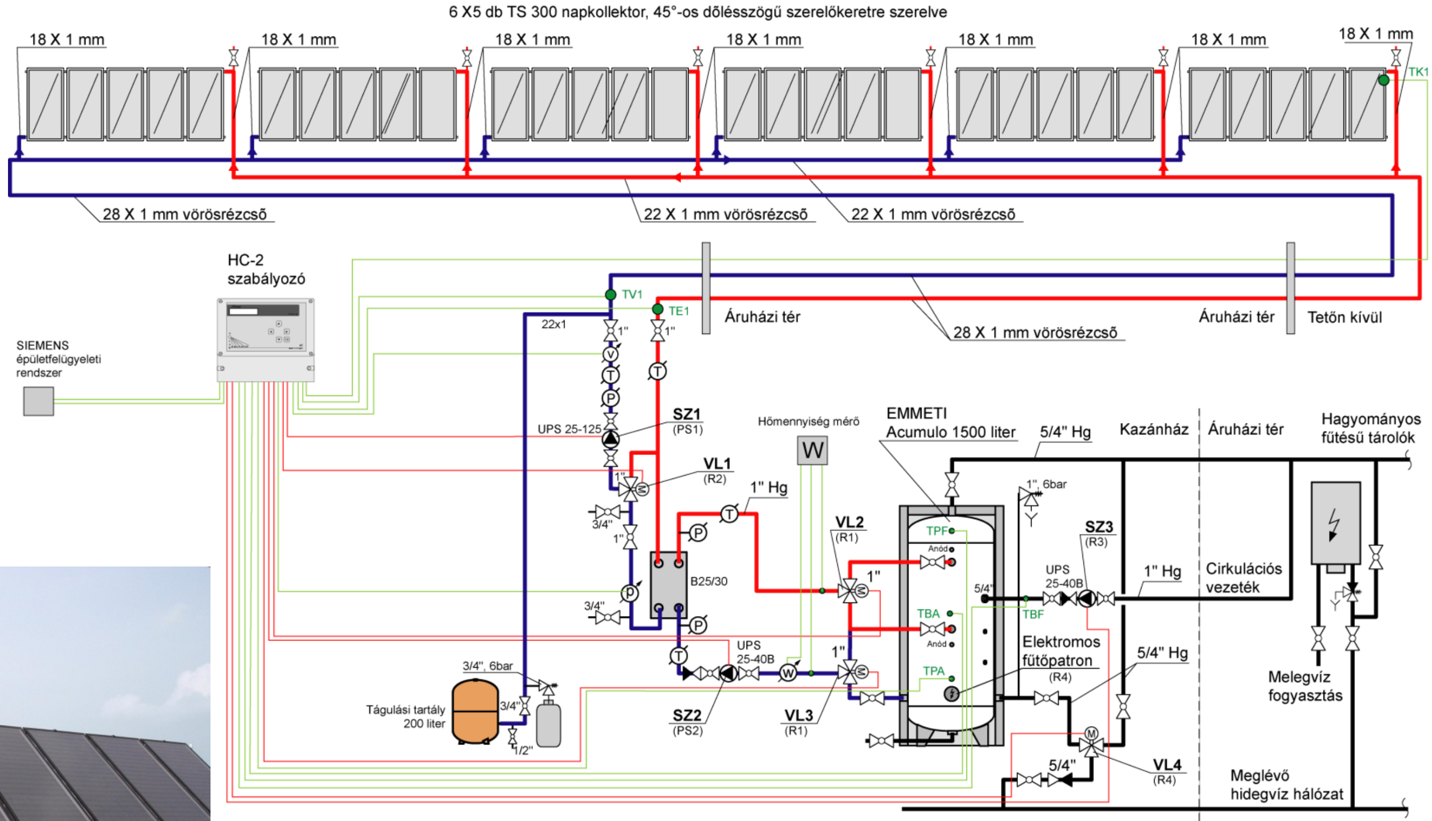
Examples for bigger solar thermal systems in Hungary



Dunaújváros, Solanova building

Intelligent Energy Europe

Examples for bigger solar thermal systems in Hungary



Tesco department store, Érd

Solar thermal systems' economic calculation

Electricity

Lakossági villamos energia díjak (Ft/kWh)								
		Energia díj	Rendszer-használati díj	VET 147. §-a alapján fizetendő pénzeszközök	Energia adó	Nettó végfelhasználói díj	ÁFA (20 %)	Bruttó végfelhasználói díj
A1 kedvezményes		20,59	13,772	0,335	-	**34,7**	6,94	**41,64**
A1 normál árszabás		21,90	13,772	0,335	-	**36,01**	7,2	**43,21**
A2 árszabás	csúcsidőszak	26,14	13,772	0,335	-	**40,25**	8,05	**48,3**
	völgyidőszak	16,14	13,772	0,335	-	**30,25**	6,05	**36,3**
B árszabás		13,71	6,922	0,335	-	**20,97**	4,19	**25,16**

Natural gas

3,113 HUF/MJ + 20% VAT= 3,74 HUF/MJ = 13,45 HUF/kWh = (127 HUF/m^3)

System efficiency: 70%

Price of natural gas corrected with system efficiency:

13,45 HUF/kWh / 0,7 = 19,27 HUF/kWh

Solar thermal systems’ economic calculation

szolarhu dvja5.lnk

Family house,

6m² collector, investment brutto 150.000 HUF/m²

Energy source	Electricity		Natural gas
	„A” Public general	„B” Public lower	
Solar thermal system’s investment cost (K)	150.000.-HUF/m2		
Energy saving by solar thermal system (Qk)	600 kWh/m2		
Energy price (Pe)	43,21 HUF/kWh	25,16 HUF/kWh	19,27 HUF/kWh
Yearly energy saving with 1 m² solar collector (Mev = Qk x Pe)	25.926 HUF/y	15.096 HUF/y	11.562 HUF/y
Simlified bayback time (K/Mév): (Mev = Qk x Pe)	5,8 year	9,9 year	12,9 year

Gróf Gyula

Napkollektorok Energetikai értékelése

Energy assessment of the solar collectors

Energetikai értékelés
Energy Assessment

- Mit értünk ez alatt? What does it mean?

=

Technikai + Gazdasági

Technical + Economical

Szempontrendszer

Point of view

$\Rightarrow$ **Optimum**

Kihez szól?   Who is the listener?

- Felhasználók (nem szakmai közönség)
- Users (non specialists)
- Szakmai közönség (specialists):

  Tervezők (Designers)

  Installációs szakemberek

  Fejlesztők (Developers)

  . . .

Technikai szempontok:

(Technical aspects)

- Funkcionális megfelelőség (functions)
- Termodinamikai megfelelőség (thermodynamics)
- Élettartam (life cycle)
- Környezeti hatások (environmental impacts)
- …

Szabványosított minősítési eljárások!

(standards)

SRCC STANDARD 100-08

TEST METHODS AND MINIMUM STANDARDS FOR CERTIFYING SOLAR COLLECTORS

February 2008

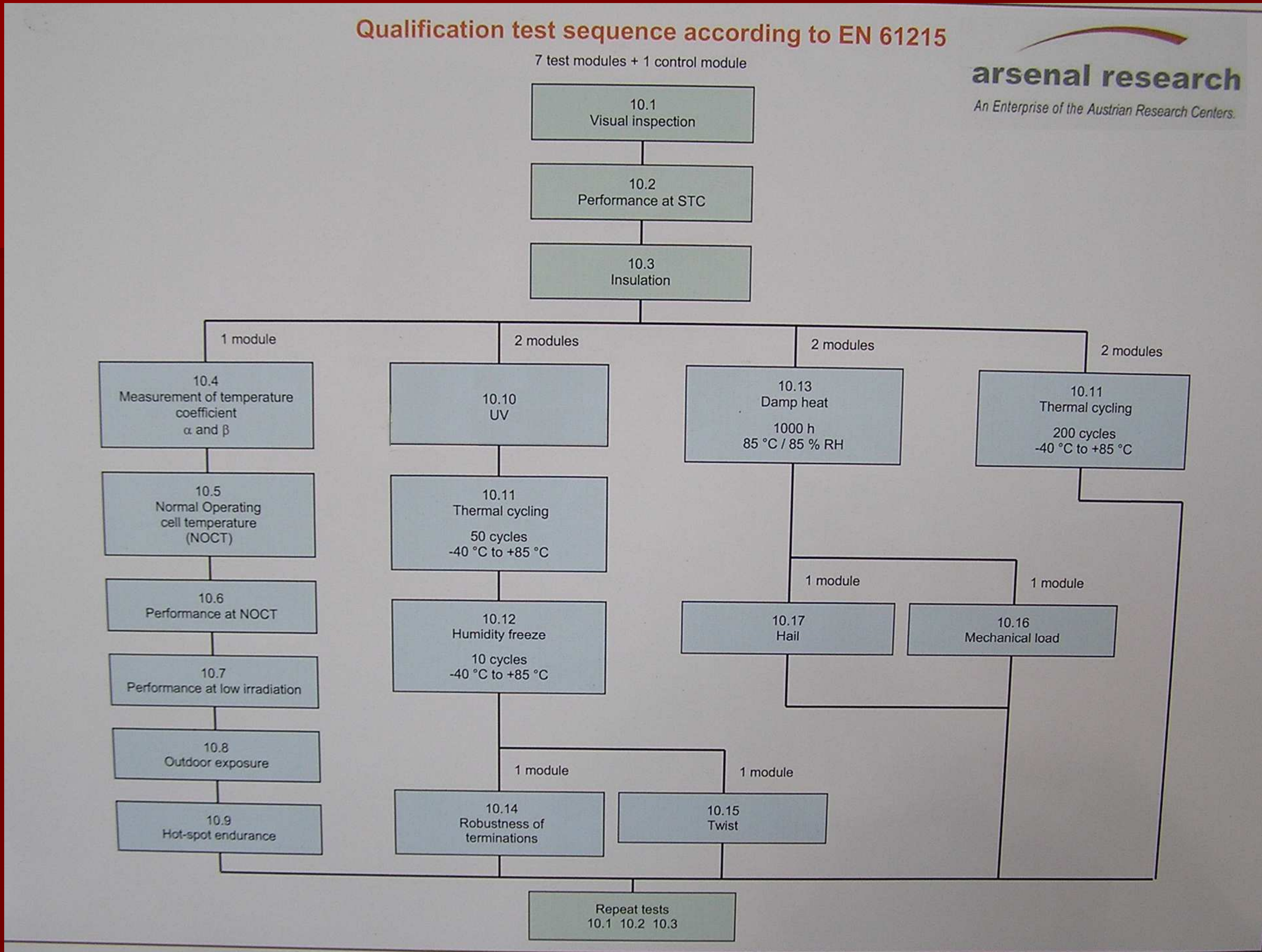
INTERNATIONAL STANDARD

IEC 61215

Second edition 2005-04

Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval

Reference number IEC 61215:2005(E)

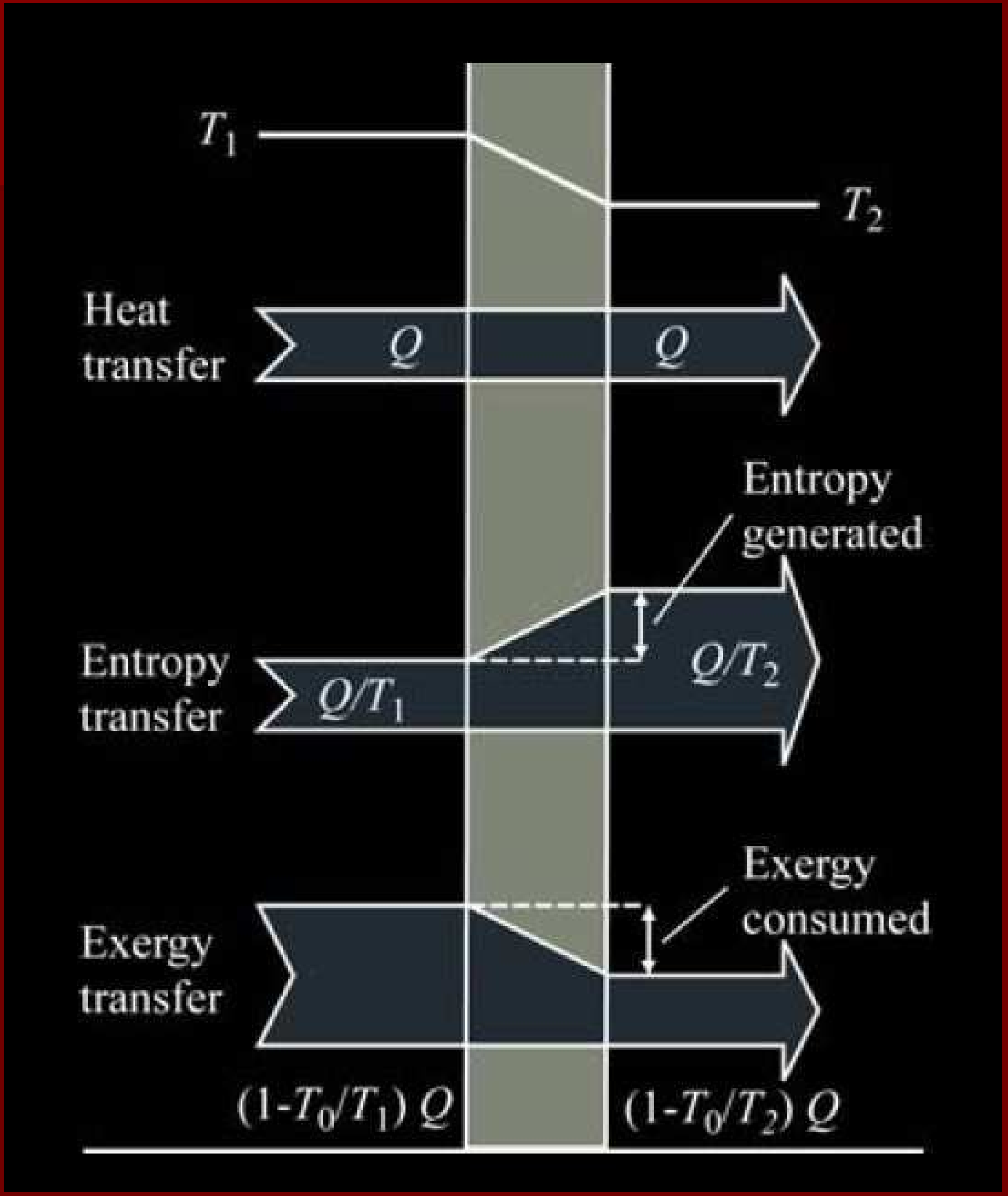

Qualification test sequence according to EN 61215
7 test modules + 1 control module
arsenal research
An Enterprise of the Austrian Research Centers.
10.1 Visual inspection
10.2 Performance at STC
10.3 Insulation
1 module
2 modules
2 modules
2 modules
10.4 Measurement of temperature coefficient α and β
10.5 Normal Operating cell temperature (NOCT)
10.6 Performance at NOCT
10.7 Performance at low irradiation
10.8 Outdoor exposure
10.9 Hot-spot endurance
10.10 UV
10.11 Thermal cycling 50 cycles -40 °C to +85 °C
10.12 Humidity freeze 10 cycles -40 °C to +85 °C
1 module
1 module
10.14 Robustness of terminations
10.15 Twist
10.13 Damp heat 1000 h 85 °C / 85 % RH
1 module
1 module
10.17 Hail
10.16 Mechanical load
10.11 Thermal cycling 200 cycles -40 °C to +85 °C
Repeat tests 10.1 10.2 10.3

Kollektor értékelés termodinamikai lehetőségei:

- Hőmérséklet szemlélet
- Energia szemlélet
- Entrópia szemlélet
- Exergia szemlélet

Cél: meghatározni az energia átalakítás
hatékonyságát
veszteségeket (mennyiség, minőség)
utalni a gazdaságosságra

Characterization of the heat transport:



Temperature method

- optimal temperature for getting power from a heat source -

$f(T_f, T_h)$ characteristic function of heat source

$g(T_h, T_o)$ function of use of energy

$$\frac{\partial\left[f(T_f T_h)\cdot g(T_h, T_o)\right]}{\partial T_h} = 0 \rightarrow T_{h\max}$$

$$P_{\max} = f(T_f T_{h\max})\cdot g(T_{h\max}, T_o)$$

Problem: knowledge of the characteristic function

Case of radiation

$$f\left(T,T_h\right)=C\cdot\left[T_f^4-T_h^4\right] \qquad g(T_h,T_O)=1-\frac{T_O}{T_h}$$

$$T_{h\max}=\sqrt[5]{\frac{T_O}{4}\left[T_f^4+3\cdot T_{h\max}^4\right]}$$

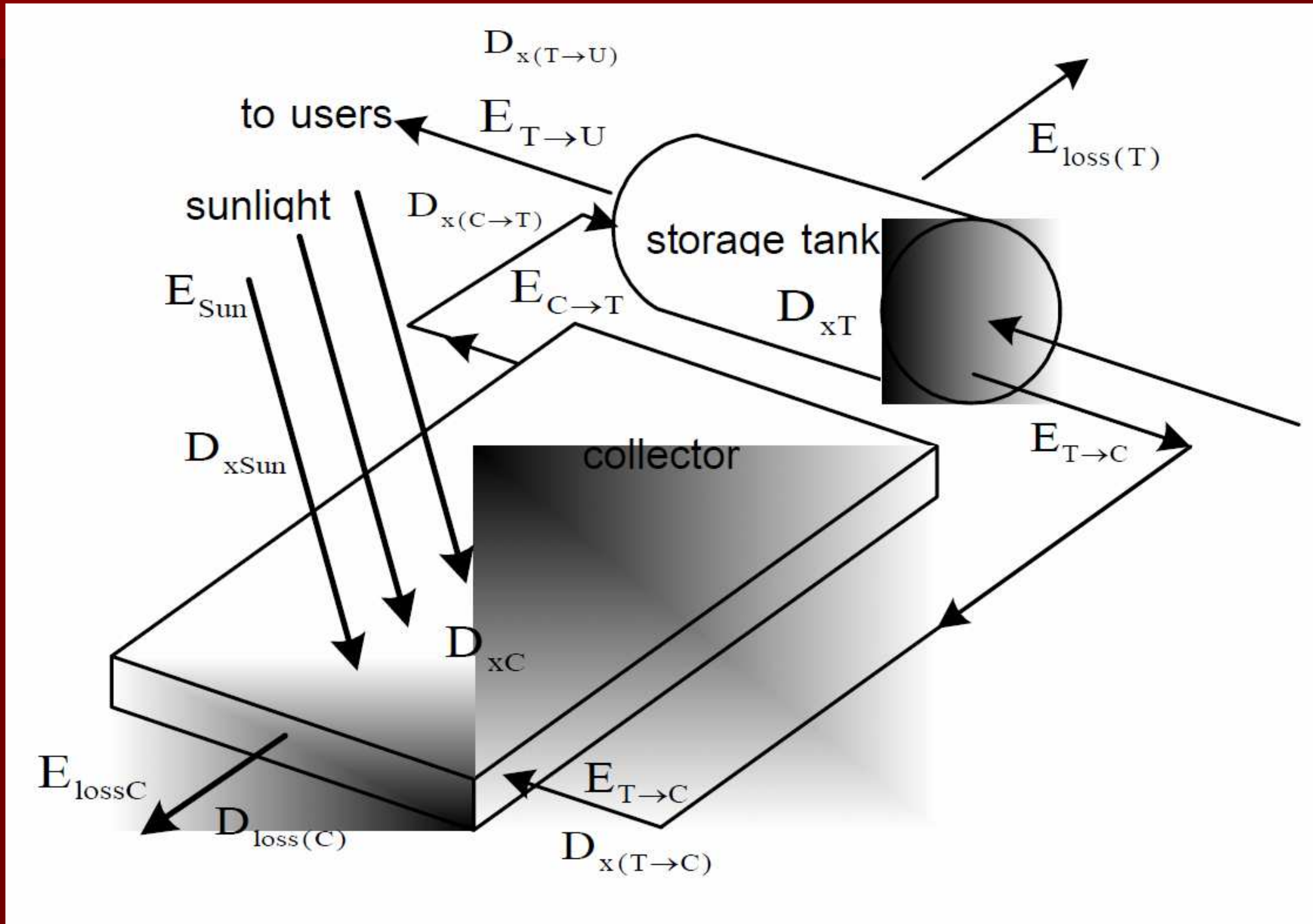
Case of convection or conduction:

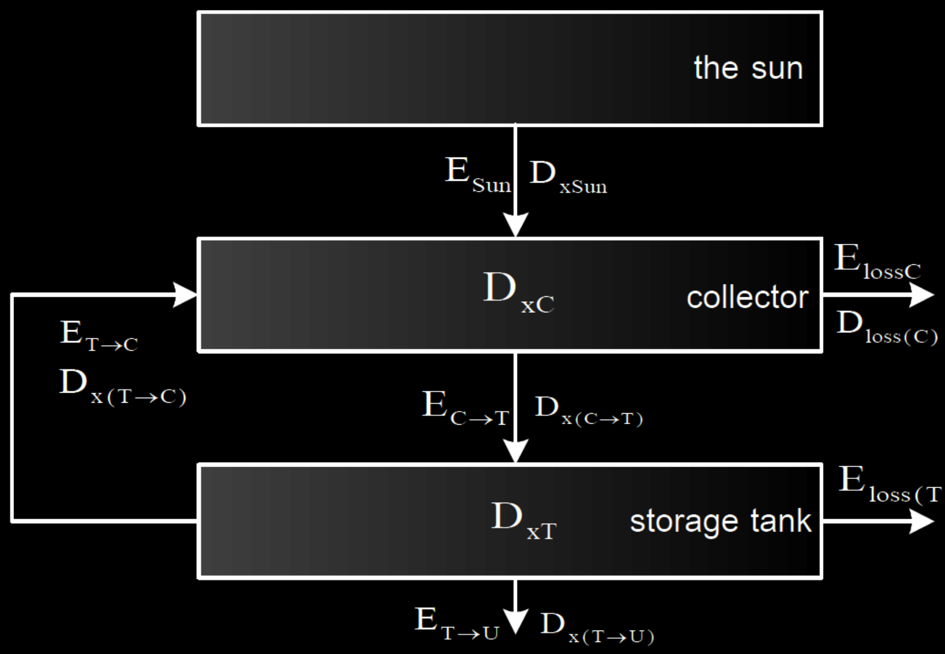
$$f\left(T,T_h\right)=C\cdot\left[T_f-T_h\right] \qquad g(T_h,T_O)=1-\frac{T_O}{T_h}$$

$$T_{h\max}=\sqrt{\left[T_f\cdot T_O\right]}$$

Energy method - Energia szemlélet

- application of the energy conservation -





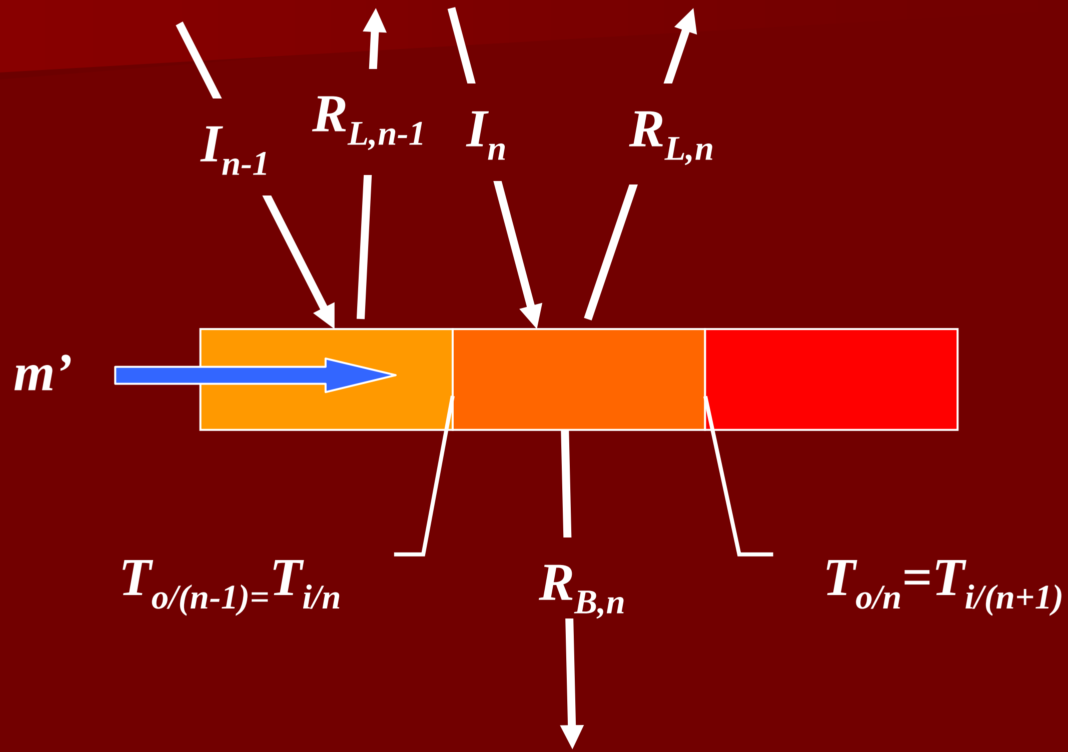
Energy balance equations in this model are :

at collector : $E_{Sun} + E_{T\rightarrow C} = E_{lossC} + E_{C\rightarrow T}$

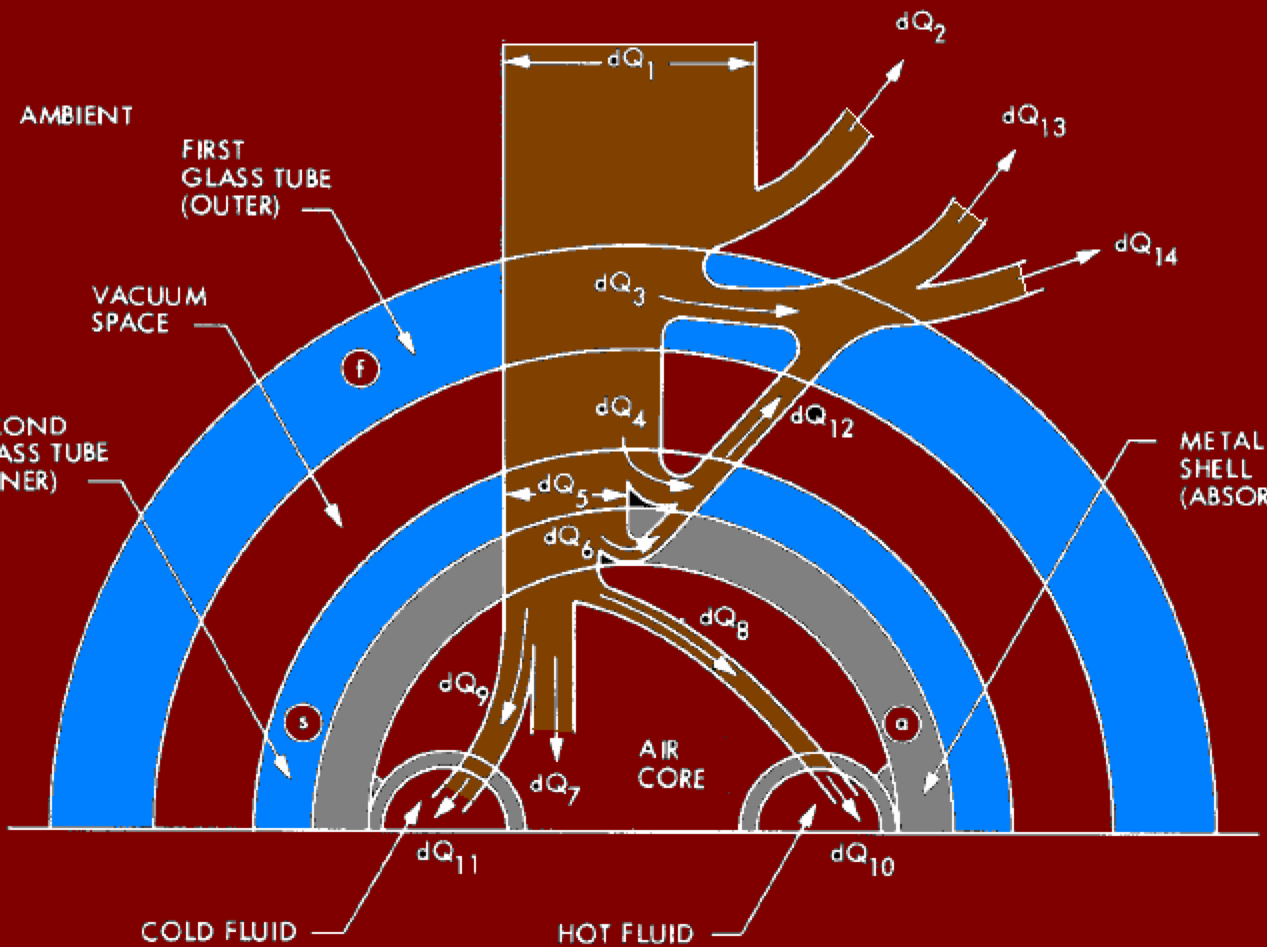
where E_{Sun} is power from sun (input power)(W) , $E_{T\rightarrow C}$ is power from storage tank to collector associated with water recycle(W) , E_{lossC} is power losses due to imperfectly thermal insulation in collector (W) , $E_{C\rightarrow T}$ is power from collector to storage tank(W)

at storage tank : $E_{C\rightarrow T} = E_{loss(T)} + E_{T\rightarrow U} + E_{T\rightarrow C}$

Energy balance in „Cell" level:

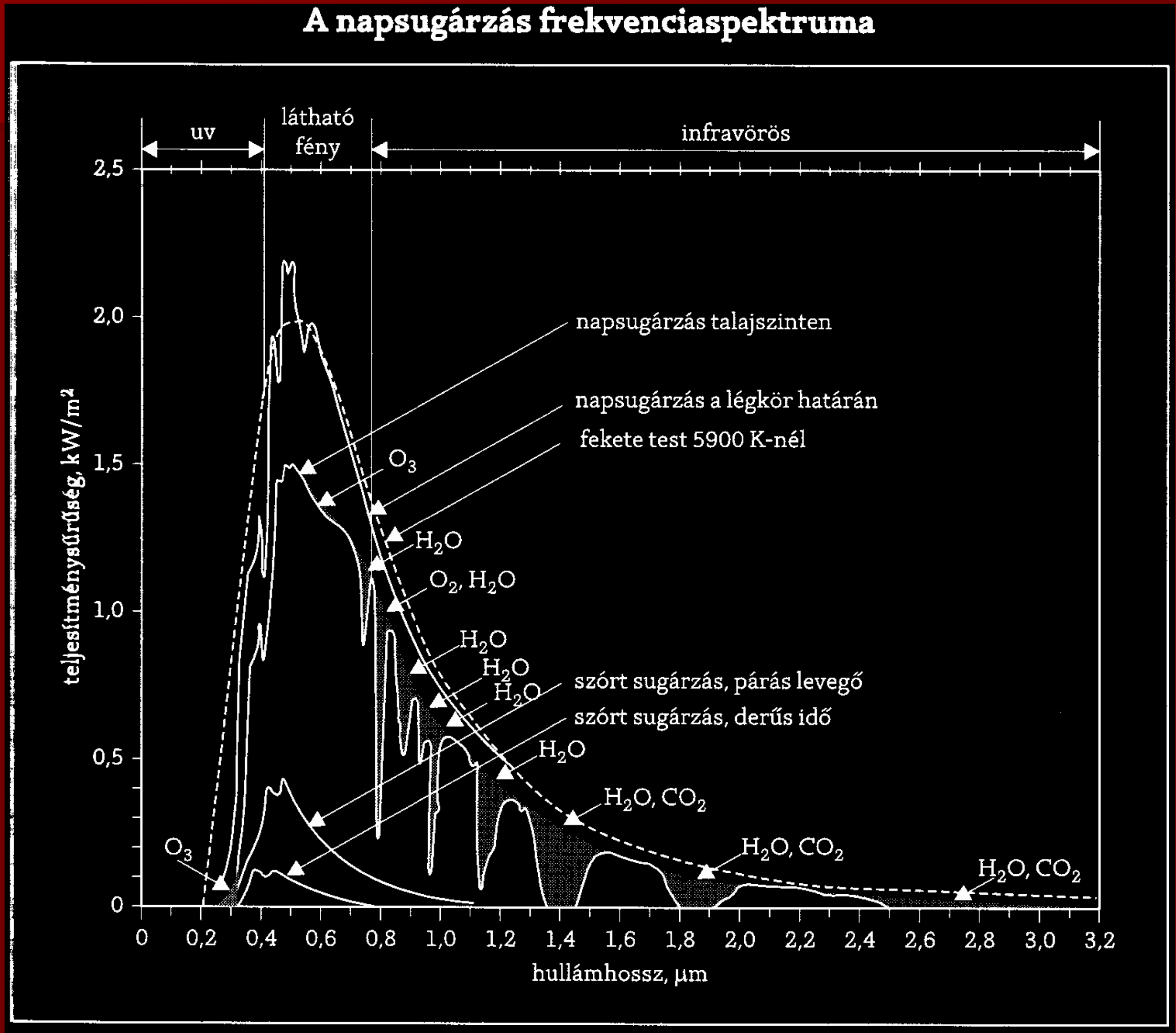


Energy balance:

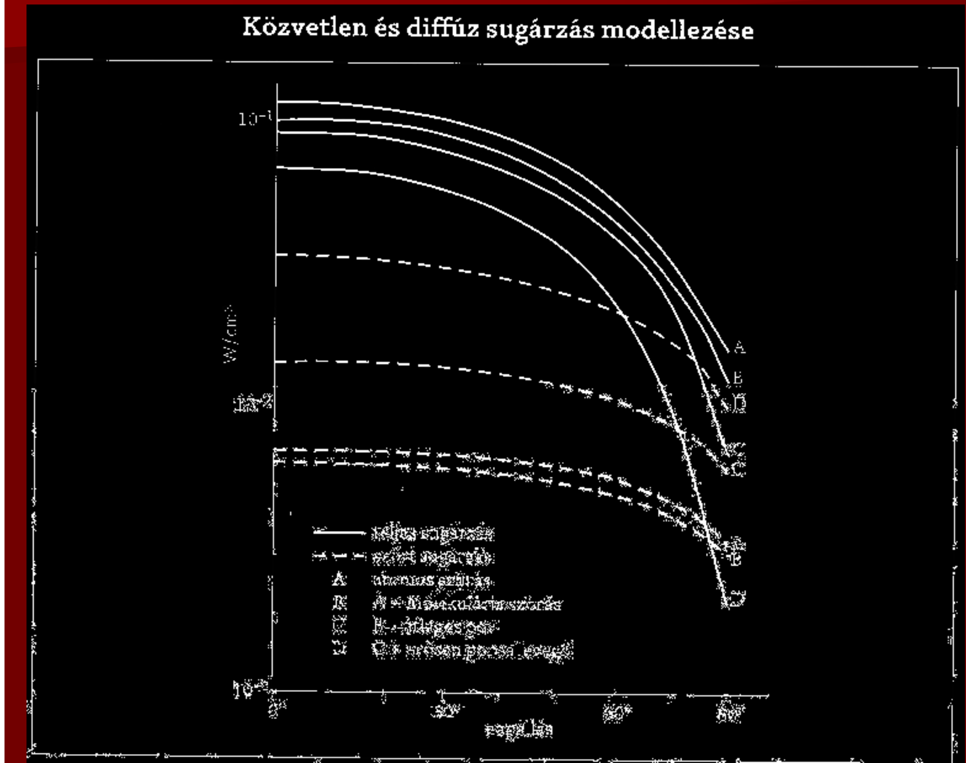


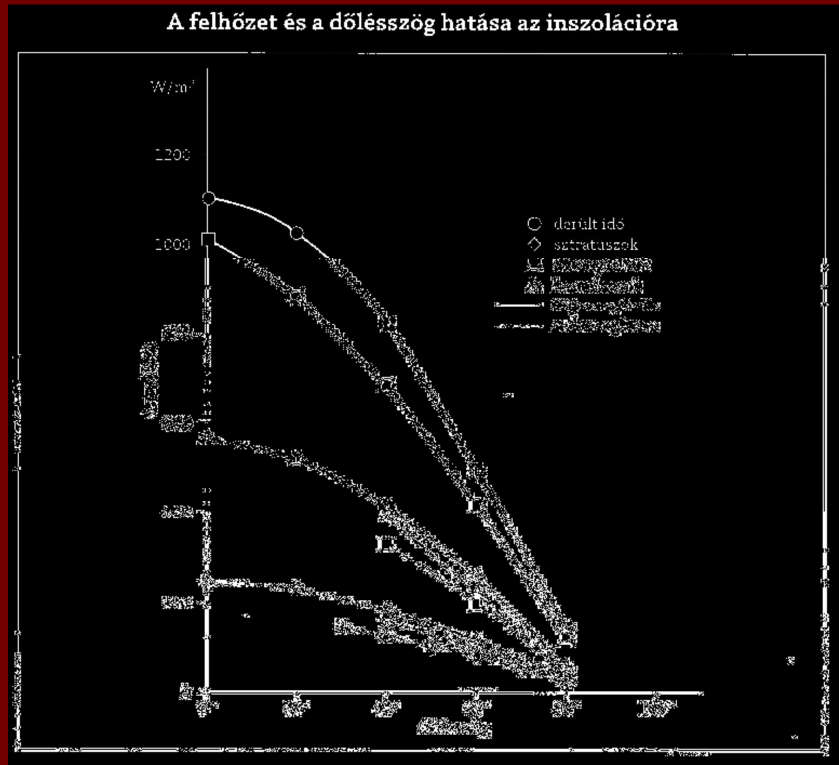
Sankey diagram for a twin tubular collector

Input data (1):


A napsugárzás frekvenciaspektruma
uv
látható fény
infravörös
napsugárzás talajszinten
napsugárzás a légkör határán
fekete test 5900 K-nél
O_3
H_2O
O_2, H_2O
H_2O
H_2O
H_2O
szórt sugárzás, párás levegő
szórt sugárzás, derűs idő
H_2O
H_2O, CO_2
H_2O, CO_2
H_2O, CO_2
O_3
teljesítménysűrűség, kW/m²
2,5
2,0
1,5
1,0
0,5
0
0 0,2 0,4 0,6 0,8 1,0 1,2 1,4 1,6 1,8 2,0 2,2 2,4 2,6 2,8 3,0 3,2
hullámhossz, μm

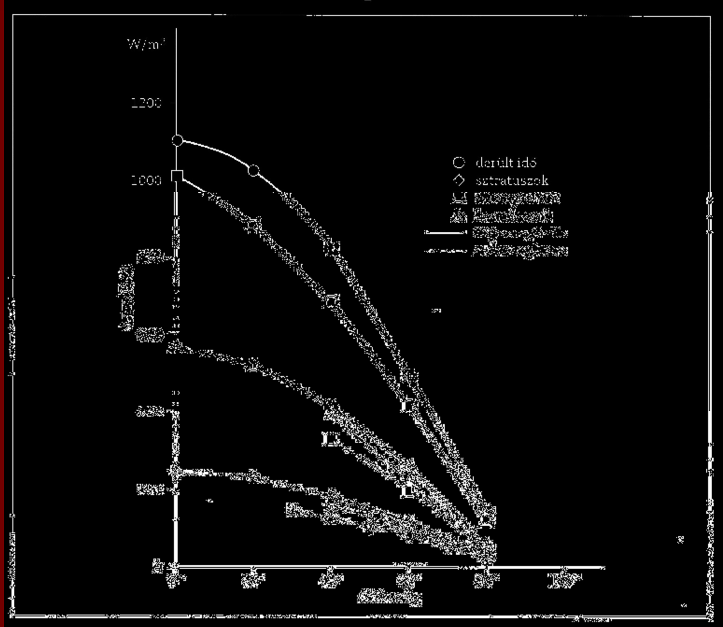
Input data (2):


Közvetlen és diffúz sugárzás modellezése
A
B

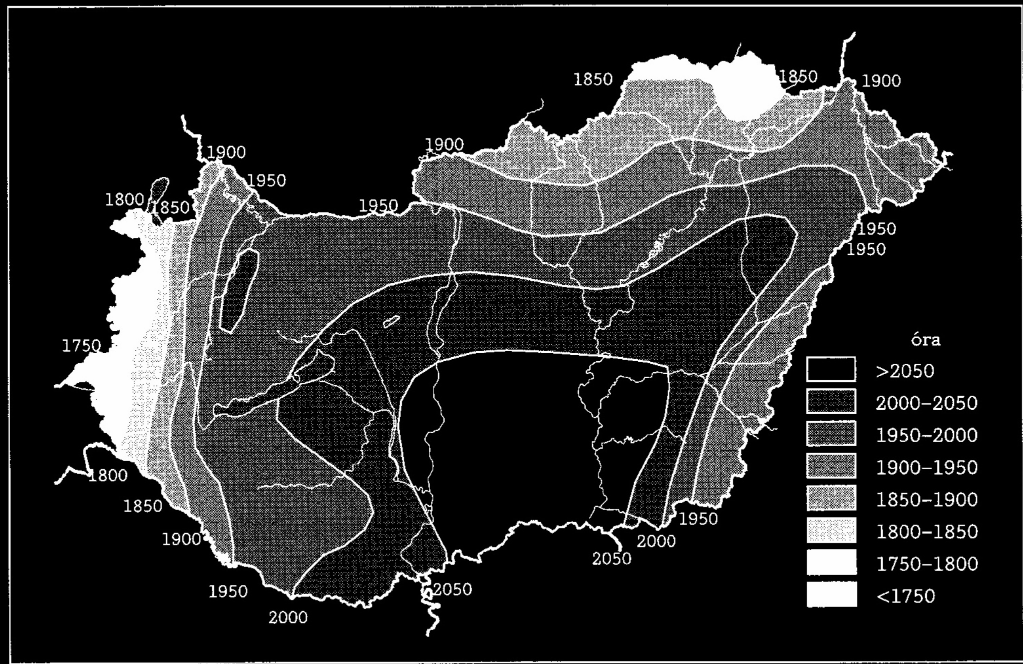

A felhőzet és a dőlésszög hatása az inszolációra
W/m²
1200
1000
derült idő
sztratuszok

Input data(3):

A felhőzet és a dőlésszög hatása az inszolációra



A napsütéstartam évi összegének területi megoszlása Magyarországon

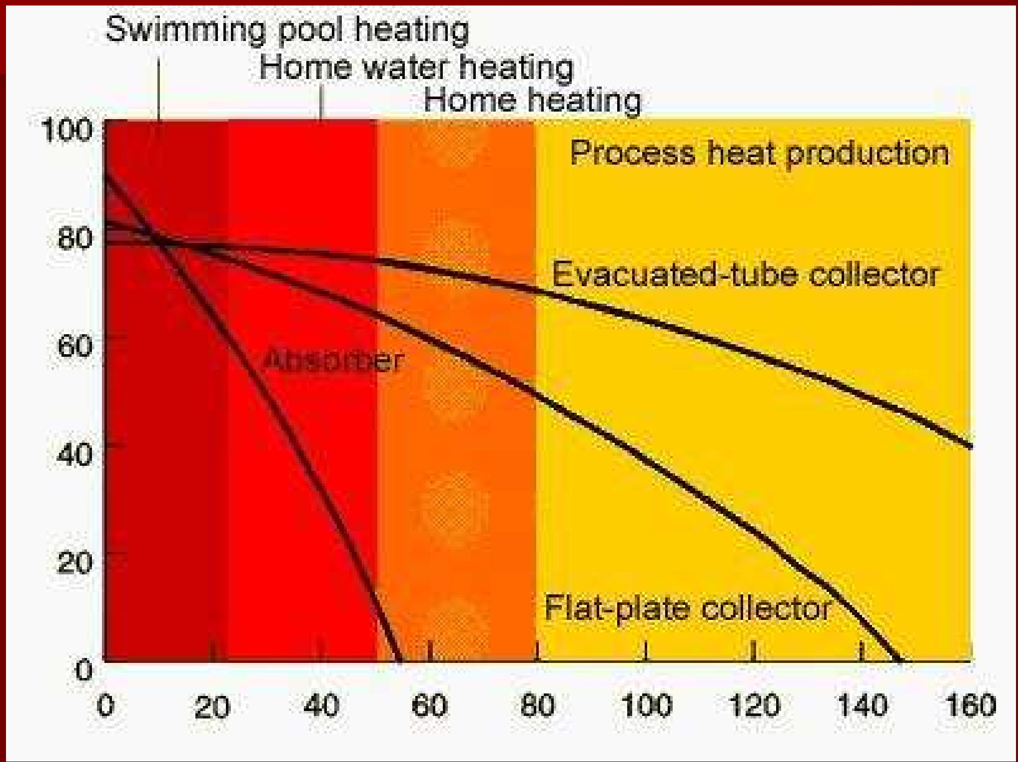


6. táblázat

Napos órák havi és évi átlaga

		Hónapok												Éves átlag
		I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	
napos órák időtartama	Budapest	55	84	137	182	230	248	274	255	197	156	67	48	1933
	Pécs	68	91	146	187	237	259	293	268	206	165	82	59	2061
energia, MJ/m^2	Budapest	111	177	330	438	598	630	650	570	421	270	121	88	4406
	Pécs	120	187	340	476	615	640	660	580	410	270	132	94	4524

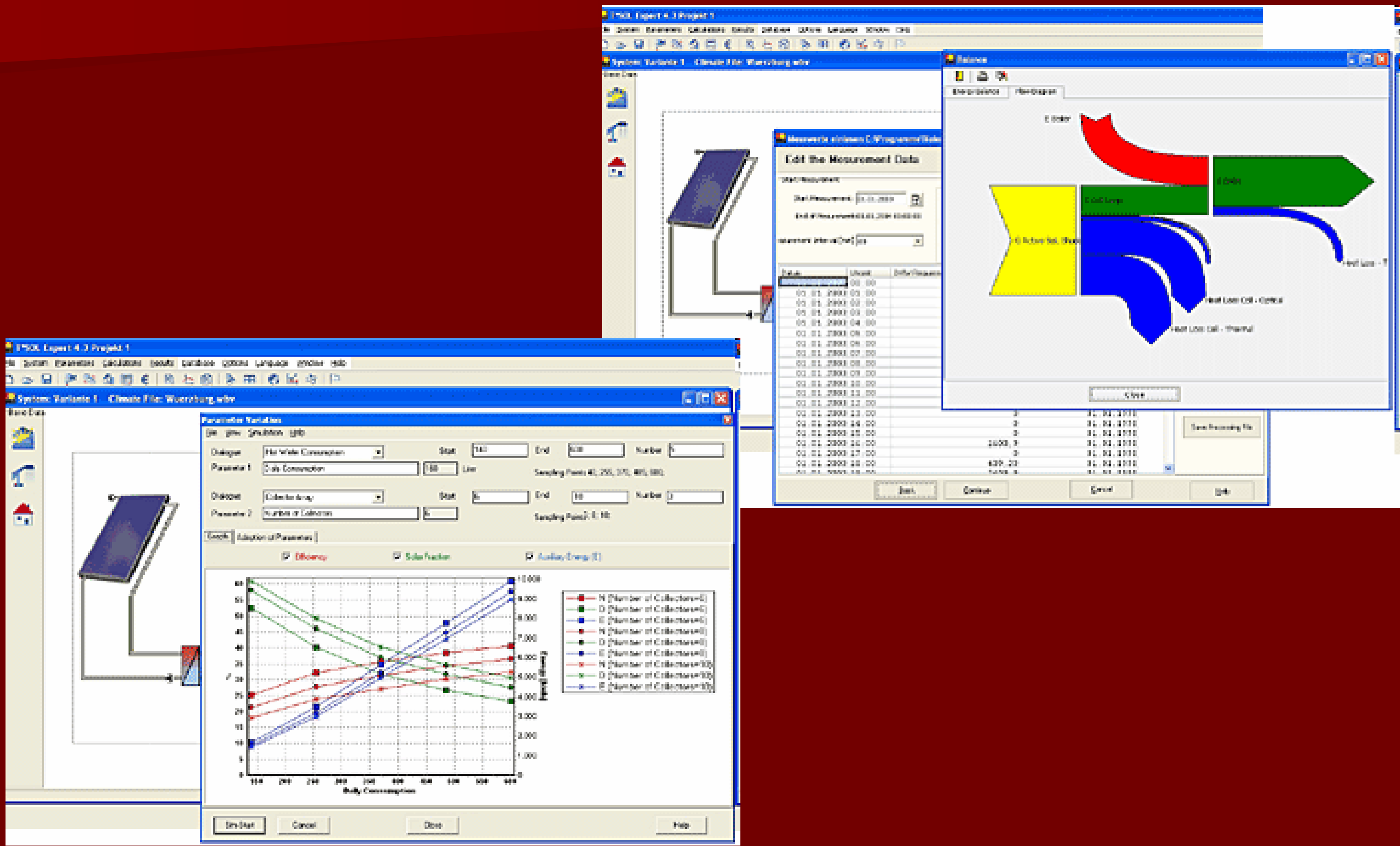
General energy efficiency



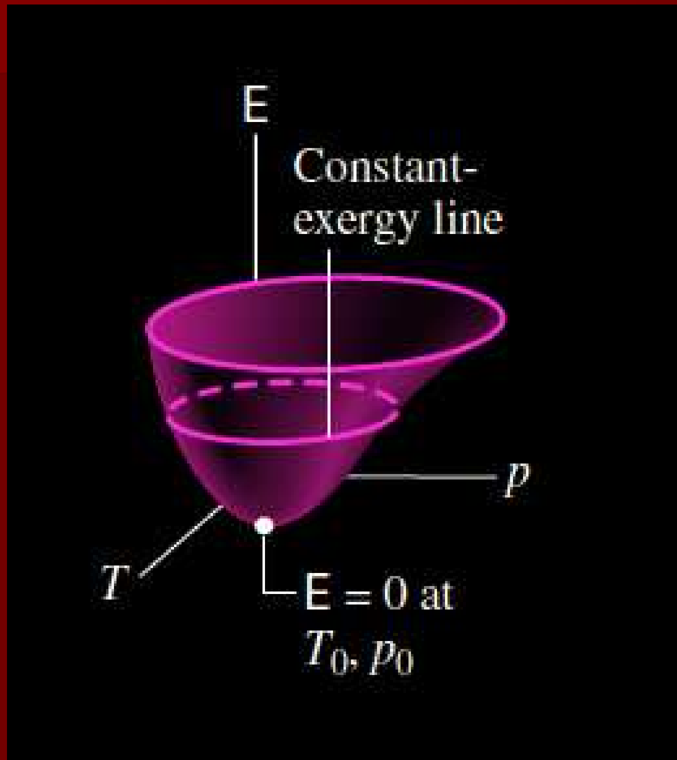
$$\eta = \eta_0 - a_1 X - I \cdot a_2 X^2$$

$$\eta_t = \frac{\int_{time} \dot{W}(\tau) \cdot \Delta T(\tau) \cdot d\tau}{\int_{time} A_I \cdot I(\tau) \cdot d\tau}$$

Simulation softwares



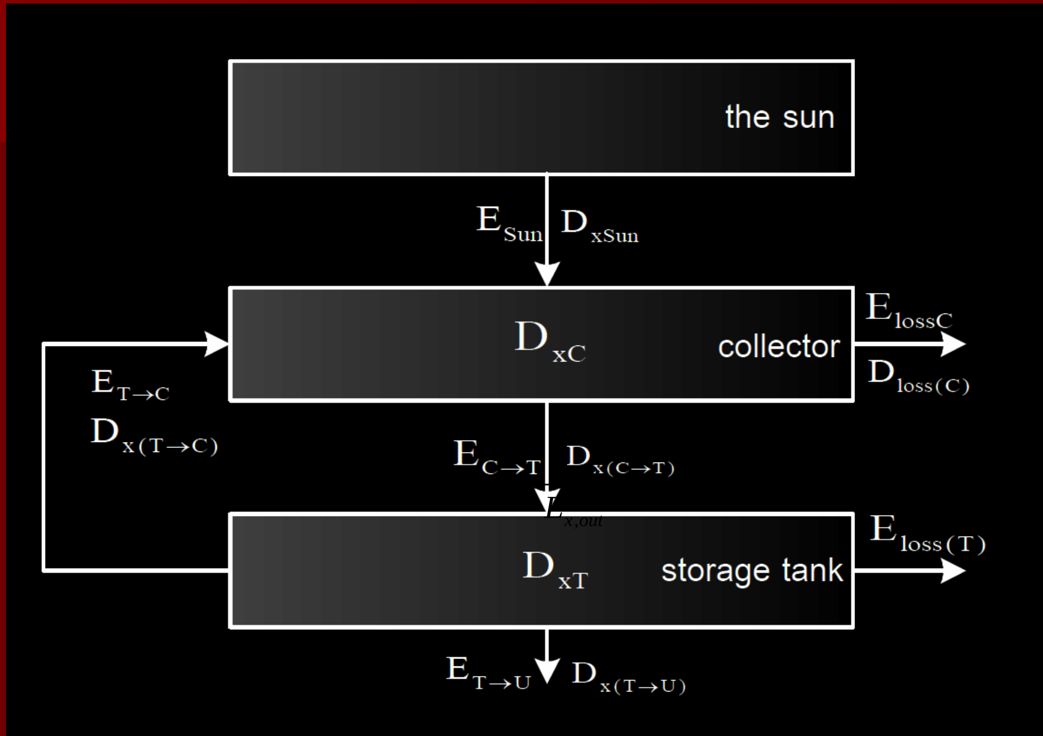
Exergy method:
- Calculating the usable part of energy -



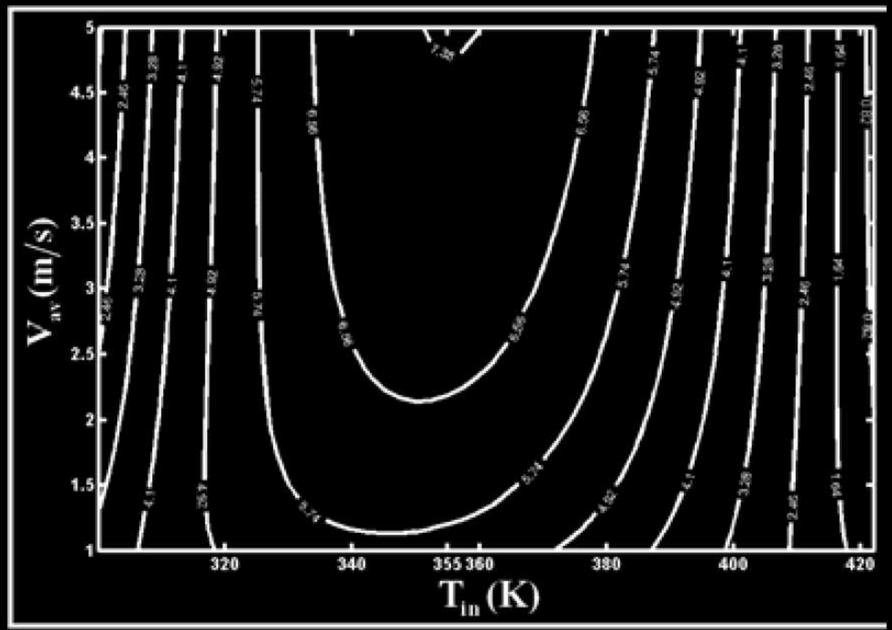
$$e = [(u + V^2/2 + gz) - u_0] + p_0(v - v_0) - T_0(s - s_0)$$

$$\begin{bmatrix} \textit{exergy}\text{ transfer} \\ \text{accompanying heat} \end{bmatrix} = \int_1^2 \left(1 - \frac{T_0}{T_b}\right) \delta Q$$

Exergy flow:



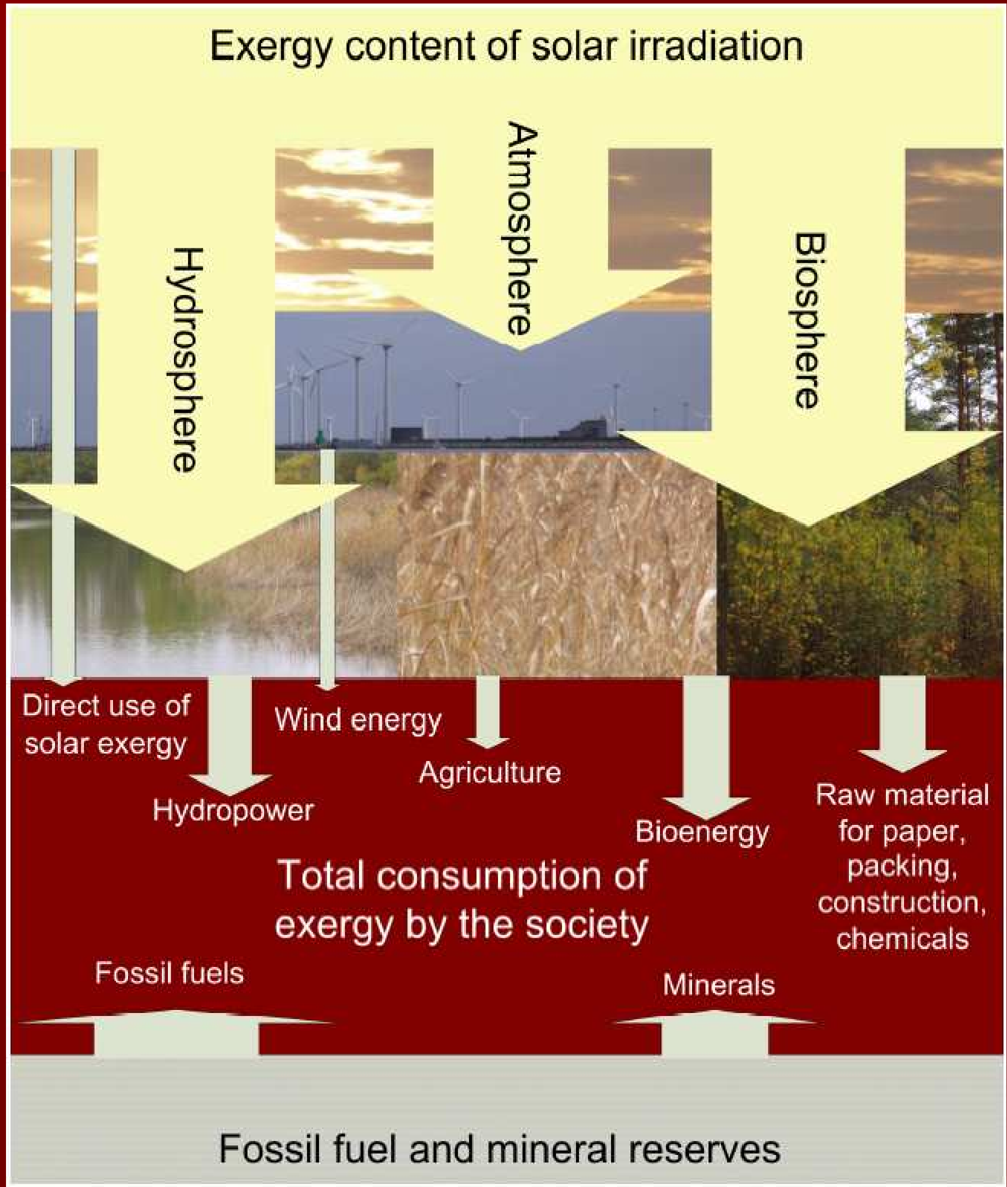
the sun
E_{Sun}
D_{xSun}
D_{xC}
collector
E_{lossC}
$D_{loss(C)}$
$E_{T \to C}$
$D_{x(T \to C)}$
$E_{C \to T}$
$D_{x(C \to T)}$
D_{xT}
storage tank
$E_{loss(T)}$
$E_{T \to U}$
$D_{x(T \to U)}$



Exergy efficiency contour according to average air velocity and fluid inlet

$$\eta_E = 1 - \left\{ \left(1-\eta_o\right) + \frac{\eta_o T_a \left(1/T_p - 1/T_s\right)}{\left(1 - T_a/T_s\right)} + \frac{U_l (T_p - T_a)\left(1 - T_a/T_p\right)}{I_T\left(1 - T_a/T_s\right)} + \frac{\dot{m}\Delta P T_a}{\rho T_m I_T A_p \left(1 - T_a/T_s\right)} + \frac{\eta_{th} T_a \left(1/T_m - 1/T_p\right)}{\left(1 - T_a/T_s\right)} \right\}$$

„Think about destroying exergy during using energy"



The *performance of a solar heating system* depends on

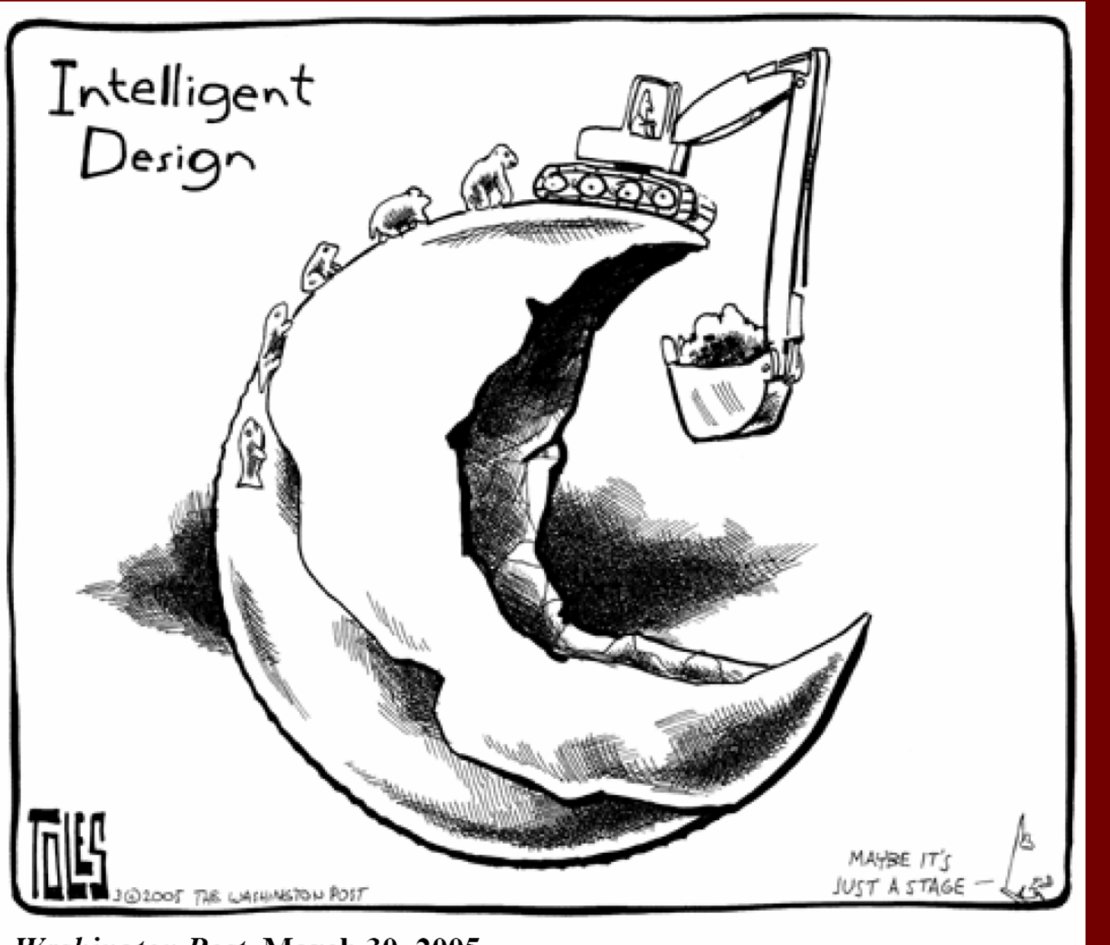
- ✓ the local climatic conditions

- ✓ the collector area and type

  the overall annual performance of a solar system is technically limited by the amount of energy that can be collected during the winter time. Improvements in collector design can also have a significant effect on the overall system performance.

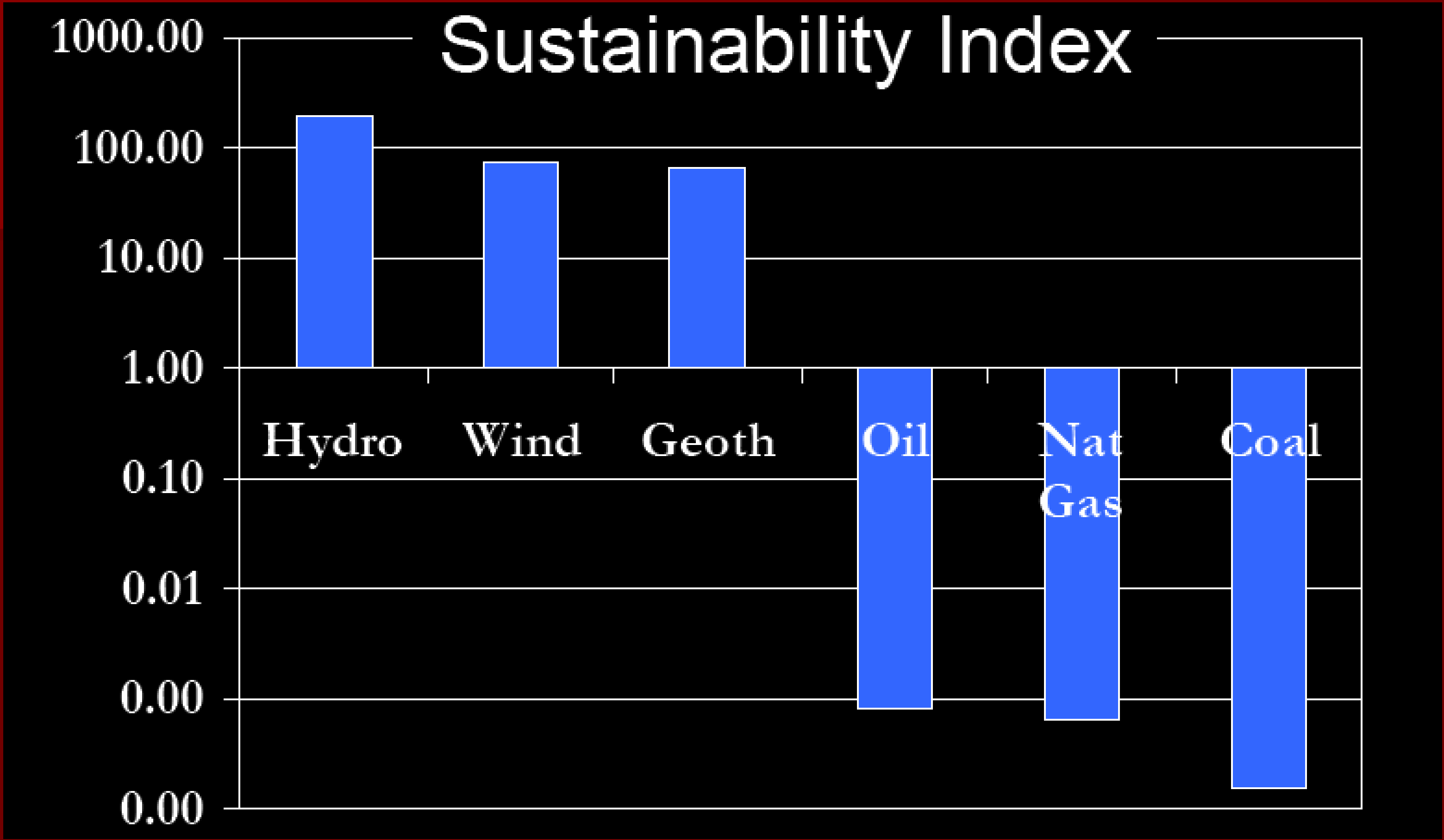
- ✓ the temperature levels

  the *delivery temperature* and the *cold water supply temperature*.



Washington Post, **March 30, 2005**

Thank you for attention!



Sustainability Index = <u>Return on Exergetic Investment</u> / Environmental load

$$\text{Sustainability Index} = \frac{\text{Return on Exergetic Investment}}{\text{Environmental load}}$$

Intelligent Energy Europe

Supporting policy of Hungary in the field of renewable energy sources

József Bánfi
Energetics expert

Retrospection

The importance of renewable energy sources (renewables) was recognised in the seventies (firs oil crisis 1973). The first step was taken in Hungary in this time. It was a long but not too successful period. There were hardly any governmental financial support.

The Széchenyi-terv (2001-2002) and the Act 2001/CX on electricity winded up the progress.

Széchenyi-terv: grant

VET: compulsory takeover, supported price (KÁP), green certificate

KIOP (2004-2006) EU and national source: grant

KEOP (2007-2013) EU and national source: grant

Financial support for the residential sector:

Széchenyi-terv (2001-2002)

NEP (National Energy Efficiency Programme)

grant + special loan (2004-2006, 2008)

Results

- Széchenyi-terv: number of supported projects: 196 (residential)
  total support: 143,7 M HUF
- KIOP-1.7. renewable number of supported projects : 22
  new capacity: 21,8 MW

- KEOP-4. (Környezet és Energia Operatív Program) 2007-2013

  - Source: 75 % EU, 25 % national, energy efficiency **41,4 Mrd HUF**
    renewables **68,5 Mrd HUF**

- KEOP-2007-2008 total for renewables **13,26 Mrd HUF**
  no. of applications - submitted: 122
  - approved: 26
  - under decision: 38

Intelligent Energy Europe

Current situation

- KEOP-2009-4.2.0/B – Utilization of renewables for local heating and cooling demands
- KEOP-2009-4.4.0 – Production of heat, electricity and bio methan with cogeneration based on renewables
- KEOP-2009-5.2.0/B – Third party financing (Development of buildings with the combination of renewables)
- KEOP-2009-5.3.0/B Development of buildings with the combination of renewables

KEOP-2009-4.2.0/B – Utilization of renewables for local heating and cooling demands

- Total fund for 2009-2010: **6 Mrd HUF**
- Possible applicants: companies, governmental organizations, non for profit organizations

Excluded: agricultural organizations

Industrial restriction: EC founding agreement Annex I.

steal industry
ship industry
coal mining
synthetic-industry activities
fishing
transportation
export linked activities

Territorial restriction: Central Hungarian region (KMR)

Supported activities

1. Solar energy utilization
2. Biomass utilization
   - 2.1. Solid or liquid biomass direct utilization for heat production
   - 2.2. Solid or liquid biomass proces for (solid, liquid, gas) energy source and utilization and selling for own heat demand
3. Building and extending systems based on biogas or landfill gas from solid or liquid biomass
4. Geothermic energy utilization
5. Heat pumps deployment
6. Renewables utilization for cooling
7. Combination of renewables
8. District heating with renewables

Other requirements

- Smallest project size **10 M HUF.**
- Percentage of financial support **10 – 70 %** - a (in some cases 100%).
- Financial support: **min. 1 M HUF, max. 1 Mrd HUF**
- The financial support depends: - in which region to invest
  - legal status of the applicant
  - size of the project
- Over 206 M HUF financial deficit calculation must be provided for profit making projects.
- Co financing must be approved by official documents
- Sustaining requirements after project closure **5 years,** in case of SME **3 years.**
- IRR between 0 – 15 %

KEOP-2009-4.4.0 – Production of heat, electricity and bio methane with cogeneration based on renewables

- Total fund for 2009-2010: **10 Mrd HUF**
- Possible applicants: companies, governmental organizations, non for profit organizations

  Excluded: agricultural organizations

  Industrial restriction: EC founding agreement Annex I.

  steal industry
  ship industry
  coal mining
  synthetic-industry activities
  fishing
  transportation
  export linked activities

  Territorial restriction: Central Hungarian region (KMR)

Supported activities 1

1. Solar energy based electricity production
   a) Photovoltaic systems connected to the grid
   b) Autonomous photovoltaic systems
2. Biomass utilization for electricity or cogeneration production
   a) Solid or liquid biomass direct utilization for cogeneration. New, cogeneration system utilizing solid biomass on high efficiency, small scale (below 20 MW).
   b) Solid or liquid biomass indirect utilization (for example: ethanol) for energy source and electricity production or cogeneration
3. Hydro energy: building, reconstruction of hydro power plants under 5 MW
   a) Rreconstruction of hydro power plants (not in use)
   b) Extension of current hydro power plants.
   c) New hydro power plants.

Supported activities 2.

4. Biogas production and utilization

a) Agricultural product or by-product, animal by-product based production of biogas for cogeneration or electricity production

b) Biogas from waste water for cogeneration or electricity production or connection to the natural gas pipe

c) Landfill gas utilization for cogeneration or electricity production or connection to the natural gas pipelines

d) Reconstruction of agricultural product or by-product, animal by-product based production of biogas and connection to the natural gas pipelines

e) New agricultural product or by-product, animal by-product based production of biogas and connection to the natural gas pipelines

Supported activities 3.

5. Geothermal energy utilization

a) Cascad (Kaszkád) system based cogeneration

b) Electricity production

6. Wind energy utilization

a) Wind power plant connected to grid (<50 kW) and construction of their connection to the grid

b) Wind power plant not connected to the grid and their connection to the consumer, electricity storage systems

7. Combination of renewables

Restriction

Biomass utilization cannot be supported in the following cases:

Solid biomass plants which do not fall under the requirements of Act 2007/LXXXIV.

Fossil power plants (coal, natural gas, etc.) conversion to co-fiering

Logistical systems, buildings, equipments, machineries for biomass buying, storing without biomass utilization

More than 20 MW capacity in case of biomass combustion plan.

Other requirements

- Smallest project size **10 M HUF.**
- Percentage of financial support **10 – 70 %** - a (in some cases 100%).
- Financial support: **min. 1 M HUF, max. 1 Mrd HUF**
- The financial support depends: - in which region to invest
  - legal status of the applicant
  - size of the project
- Over 206 M HUF financial deficit calculation must be provided for profit making projects.
- Co financing must be approved by official documents
- Sustaining requirements after project closure **5 years,** in case of SME **3 years.**
- IRR between 0 – 15 %

Feasibility study (FS)

Proposals are based on the feasibility studies.
The layout and content is defined by the relevant guidelines.
Content depends on the project: - size of the project
- legal status of the applicant

Based on the above the following FS are available:

- FS Profit making + max financial support calc. (> 260 M HUF)
- FS Simplified + IRR calculation (< 100 M HUF)
- MT Normal + IRR calculation (any other)

Most of the proposals are rejected because of the non adequate feasibility studies!

Horizontal requirements

The requirments of EU grants is the implementation of equal opportnity and sustainalbe development (horizontal requirements)

Every project must fulfill the entitlement and evaluation criterions!

Goals of equal opportunity:
- equality between woman and man
- gypsis
- disabled people

Goals of sustainable development:
- social fairness
- better life quality
- sustainable utilization of natural resources
- Reservation enviroment

For more information go the the guidelines.

Selection criterions

Method of selection: scoring.

Entitlement criterions:
- for the applicant
- for the project
- for the project's financial part
- for licensing requirements
- for the overall requirements.

Technical criterions :
- organization of the project
- fulfilling the aim of the call
- implementation of environmental and horizontal requirements

Exclusion: in case of certain selection criterions, which gained 0 points the proposal cannot be supported

Collaborator organization’s roles – Közreműködő szervezet (KSZ)

Roles of the Collaborator organization (Energia Központ Nonprofit Kft.):

- Administrative activities of the proposals
- Evaluation of application, preparation of decision
- Control and monitoring visit (interim, final)
- Administration and control of financial reports
- Follow up activities and monitoring of projects

Steps of the proposal process:

- Receiving
- Formal check, approval and competition of documents
- Reception
- Evaluation of the content
- Preparation of decision
- Decision making
- Signature of grant agreement
- Financial control and transfer
- Monitoring (reports)

Decision process

Receiving (receiving criterions) – KSz

Formal check, approval and competition of documents (entitlement and completeness) – KSz

Reception (or rejection) – KSz

Evaluation of the content - KSz (support<50 M HUF → one, otherwise two evaluator)

Preparation of decision, proposal for support– Evaluators Committee

Decision – leader of Környezetvédelmi Programok Irányító Hatóság

Signature of grant agreement

Financial support for the residential sector (NEP)

Currently it is not available

NEP – 2008 – 1,2,3,4 Raising energy efficiency

NEP – 2008 – 5 Enhancing the utilization of renewables

biomass, geothermic energy, heat pump systems, wind energy, solar thermal energy, photovoltaic systems, waste utilization for electricity or heat generation

The totla fund of NEP in 2008 was **3,1 Mrd HUF**

Number of application recieved 9000;

Distribution:

Energy efficiency ~ 6500,

renewables ~ 2500.

Supported projects: 6865.

Requirement of NEP-5

Type of support: grant

Percentage of support: 30% of the investment

Size of the support: max. 1,2 M HUF/flat

New flats as well as flats currently under construction can apply.

Restriction: houses build with prefabrication technology can apply in the instrument

What is expected in 2009?

- available fund decreases
- according to 7/2006. (V.24.) TNM. regulation the energy saving calcuation will be compulsory.

Thank you for your attention!

Budapest
16 April 2009

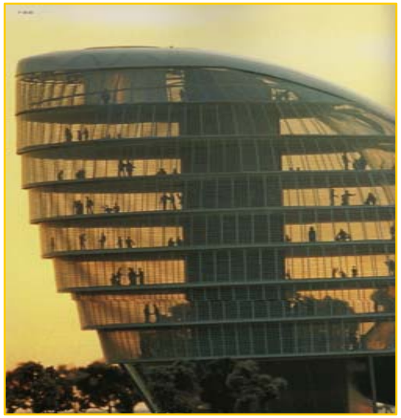
Solar thermal heating systems in European Union

Christodoulaki Rosie
MSc Environmental design & engineering
BSc Physics
Centre for Renewable Energy Sources – Solar Thermal dept.

КАПЕ
CRES

1. Primary energy demand

- **Energy consumption in commercial and residential buildings**:
  - 40% of Europe's energy bill.
  - 435 Mtoe in 2002.
- **Increased demand for air conditioning in buildings**:
  - Higher living and working standards
  - Adverse outdoor conditions in urban environments
  - Installed a/c has increased 5-fold in the last 20 years in Europe
  - Total a/c floor space: 30 million m^2 in 1980, over 150 million m^2 in 2000.
  - Annual energy use of room a/c was 6 TJ in 1990, estimated 160 TJ in 2010.
- **CO_2 emissions are expected to increase 20-fold from 1990 to 2010**, only in the EU



Solar thermal systems can help alleviate the problem!

Pool heating

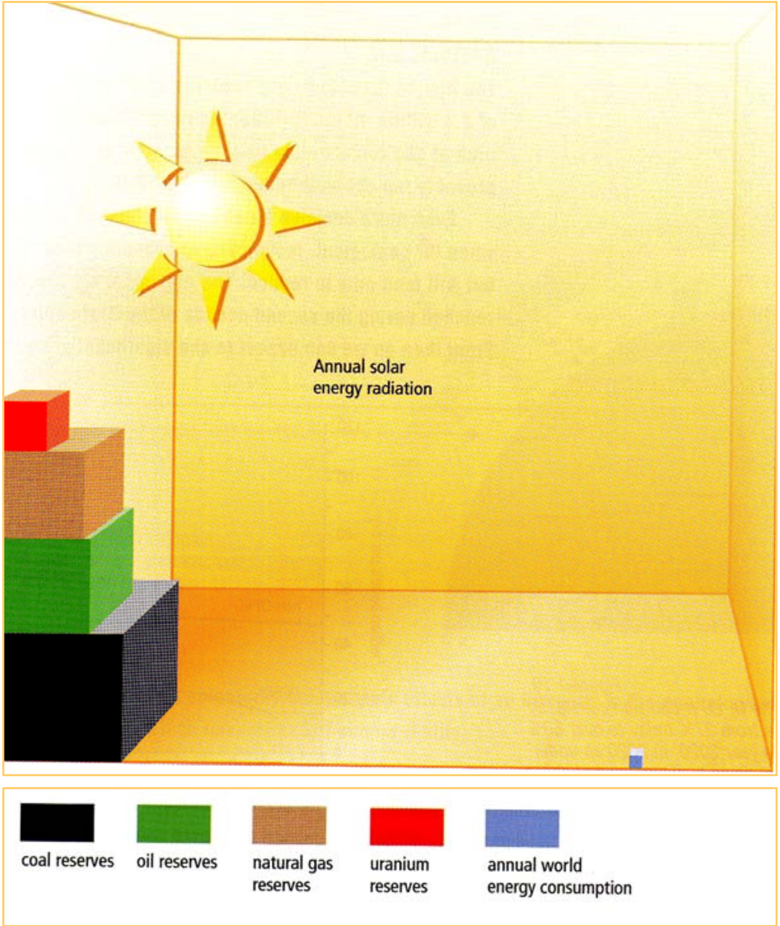
Domestic hot water

Space heating

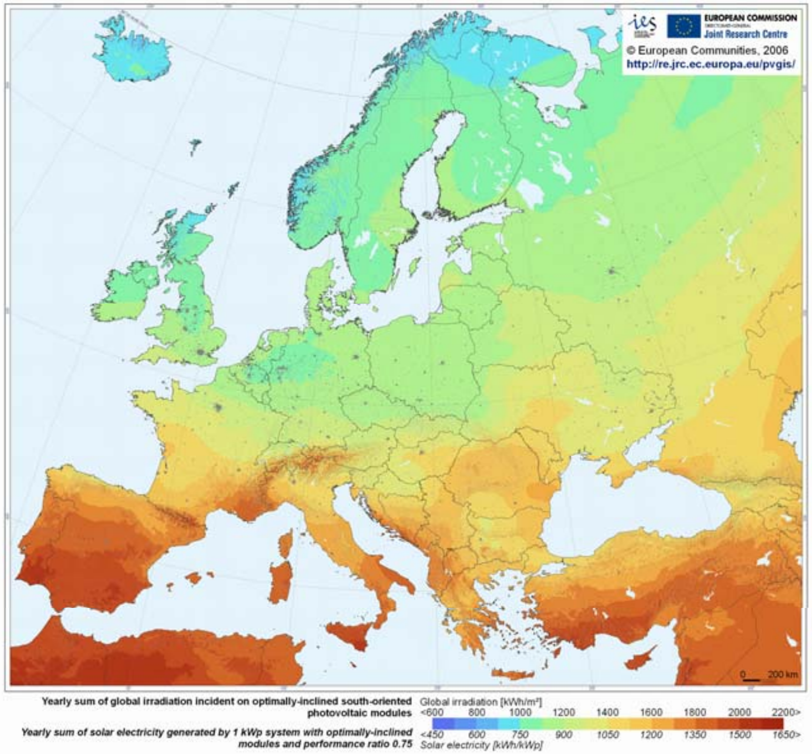
Space cooling

The solution : Solar Energy

- **Radiation** supply from sun carries a **5 billion year guarantee**
- Annually, **the sun provides $1.5*10^{18}$ kWh**, that is more than 10,000 times the energy that human race needs.

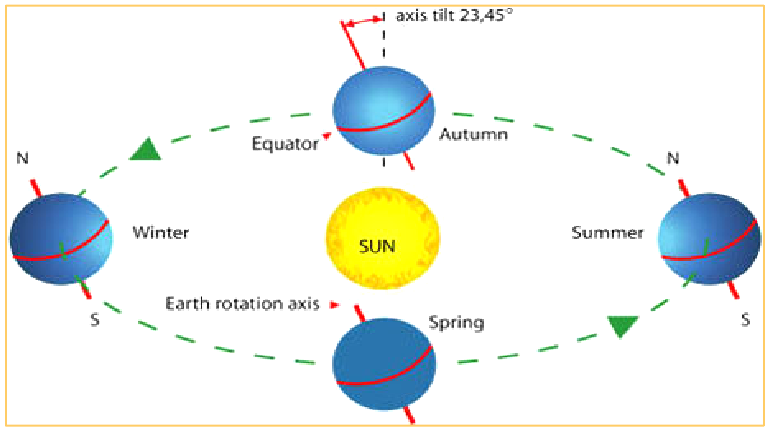


Source: *Planning & Installing Solar Thermal Systems: A guide for installers, architects & engineers*, EarthScan publications



Average annual solar irradiance is an important value for designing a solar plant. It depends on the geographical location, i.e. Saharan desert has 2.2 times higher radiation that Europe.

The **average solar irradiance is higher at lower latitudes**, since the rotation axis of the earth forms an angle of 23.45^0 with the perpendicular.



2. Solar Collectors Optimum Angle

Geographical location

- **Winter use**: geographical latitude of area + 15^0
- **Summer use**: geographical latitude of area - 15^0
- **Annual use**: collector angle = geographical latitude

RESULTS OF INCIDENT RADIATION ON COLLECTORS (FROM TSOL)
Place: Athens
Azimuth: 0

G Inclined, Specific[kWh/m²]
acording to collectors inclination (in degrees °)

From:	To:	0	10	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90
1/ 1/	1/ 2/	66	80	91	96	100	104	107	109	111	112	113	112	111	109	107	104	100
1/ 2/	1/ 3/	75	84	91	93	96	97	99	99	99	99	98	96	94	91	88	84	80
1/ 3/	1/ 4/	104	112	116	118	119	119	119	118	116	114	111	108	104	99	94	89	83
1/ 4/	1/ 5/	146	151	152	152	151	149	147	143	139	134	129	123	116	108	101	92	84
1/ 5/	1/ 6/	182	183	181	178	175	170	165	159	153	145	137	128	119	109	100	90	79
1/ 6/	1/ 7/	200	200	195	191	185	180	173	166	158	149	139	128	118	108	96	85	75
1/ 7/	1/ 8/	213	214	210	205	199	194	187	180	171	162	151	139	128	117	105	91	80
1/ 8/	1/ 9/	200	206	206	204	202	199	194	188	182	174	165	155	144	132	121	109	96
1/ 9/	1/10/	156	168	176	179	180	181	180	178	175	171	166	161	154	146	138	128	118
1/10/	1/11/	106	120	130	134	138	140	142	143	142	142	140	137	134	130	125	119	113
1/11/	1/12/	66	77	86	90	94	96	99	100	101	102	102	101	99	97	95	92	88
1/12/	1/ 1/	53	63	72	76	79	82	85	87	88	89	89	89	88	87	85	83	80
	Sum YEAR	**1567**	**1658**	**1706**	**1716**	**1718**	**1711**	**1697**	**1670**	**1635**	**1593**	**1540**	**1477**	**1409**	**1334**	**1252**	**1165**	**1075**
hotels season:1/4 to 1/11		**1203**	**1242**	**1250**	**1243**	**1230**	**1213**	**1188**	**1157**	**1120**	**1077**	**1027**	**971**	**913**	**850**	**784**	**714**	**645**
heating season: 1/11 to 1/4		**364**	**416**	**456**	**473**	**488**	**498**	**509**	**513**	**515**	**516**	**513**	**506**	**496**	**484**	**468**	**450**	**430**
"winter": 1/12 to 1/3		194	227	254	265	275	283	291	295	298	300	300	297	293	287	280	270	260

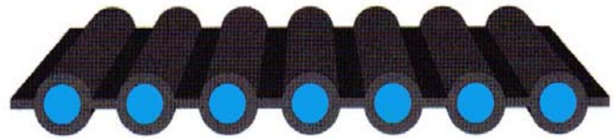
Unglazed collectors

Properties

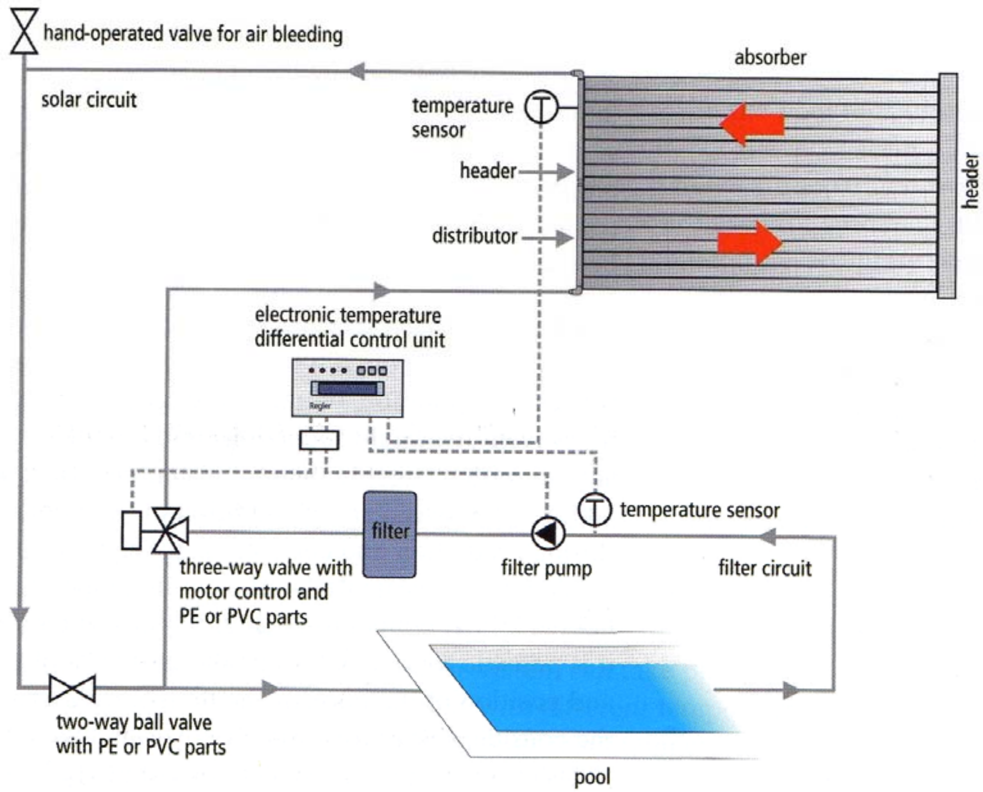
- No glazing, no insulation
- Low operation temperature
- Low cost, average payback time 1-5 years
- High thermal losses, low performance

Applications

- Pool heating only. Warm climates: to extend the swimming period from April-October.



unglazed collector, absorber



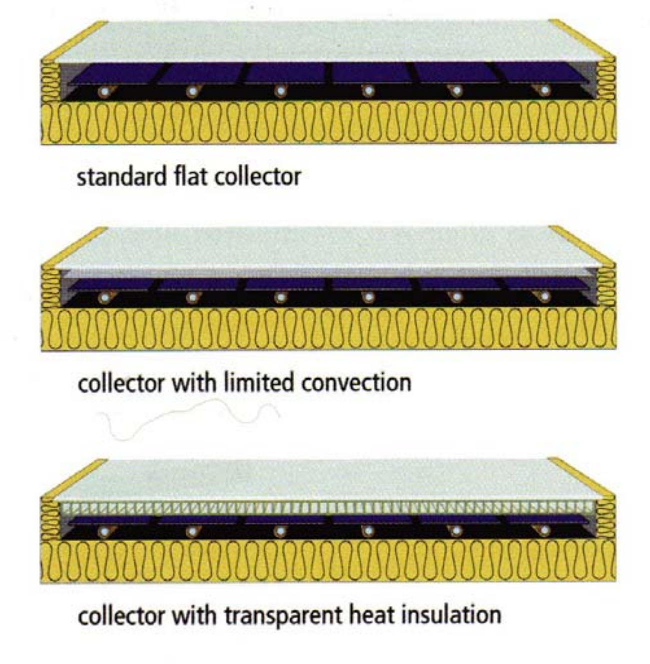
Flat plate collectors

Properties

- Middle cost: more expensive than unglazed, but cheaper than vacuum
- Higher operation temperature
- Thermal insulation on back & edges
- Fragile, heavier: 20-32 kg/m^2
- Transparent cover: black paint or spectral-selective coating (black chrome, black nickel, blue titanium)
- Spectral-selective coating: conversion of short-wave solar radiation into heat (light absorption capacity) is optimized, while thermal emissions are kept low. Absorption rate: 90-95%, emission rate 5-15%
- Stagnation temperature: 160-200^{0}C

Applications

- DHW
- Space heating
- Solar air conditioning (selective coating)



Collectors Comparison

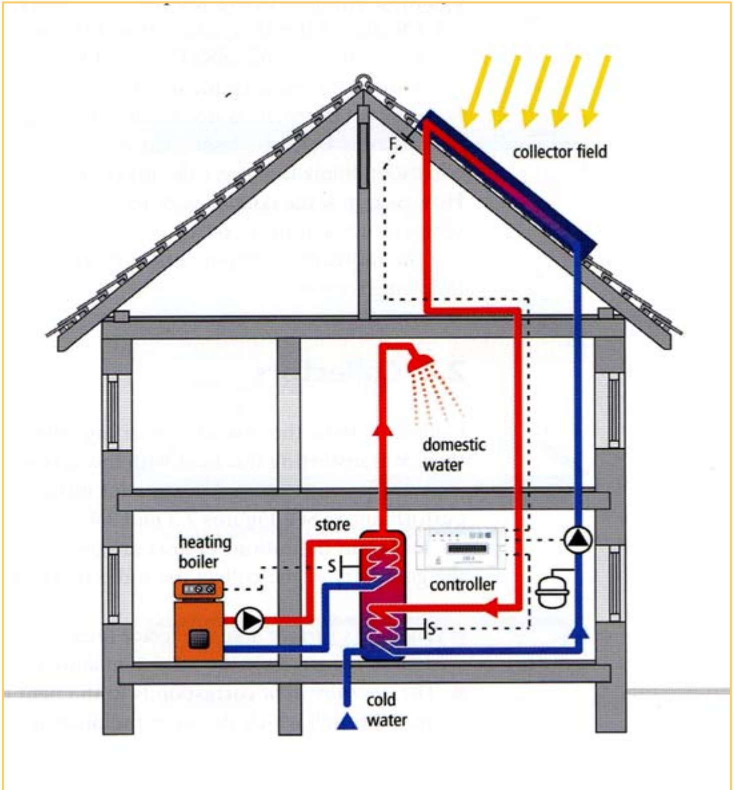
Collector type	Cost	Performance (kWh/m^2a)	Application
Unglazed	Low	300	Pool heating
Flat plate (black paint)	Middle	650	Pool heating, Hot water
Flat plate (selective coating)	Middle	700	Hot water, space heating, solar a/c

The solar collector converts the light that penetrates its glass into heat. The generated heat flows then to the hot water store.

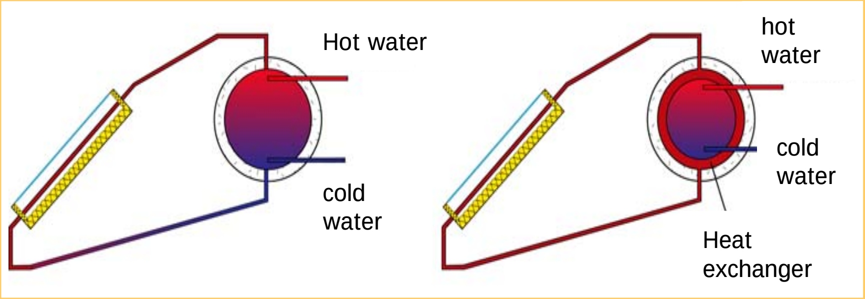
- **Thermosyphon**
No pumps, since gravity is used for liquid transport
- **Forced circulation**
Circulating pumps required, in Northern - Central Europe

- **Direct (drainback) system**
Direct circulation of domestic water through the collector, heat transfer medium: water. When the collector pump is switched off, the collector drains completely.
- **Indirect (filled) system**
Solar circuit is separate from domestic water circuit, heat transfer medium: water-glycol. The collector circuit is partially or completely filled.

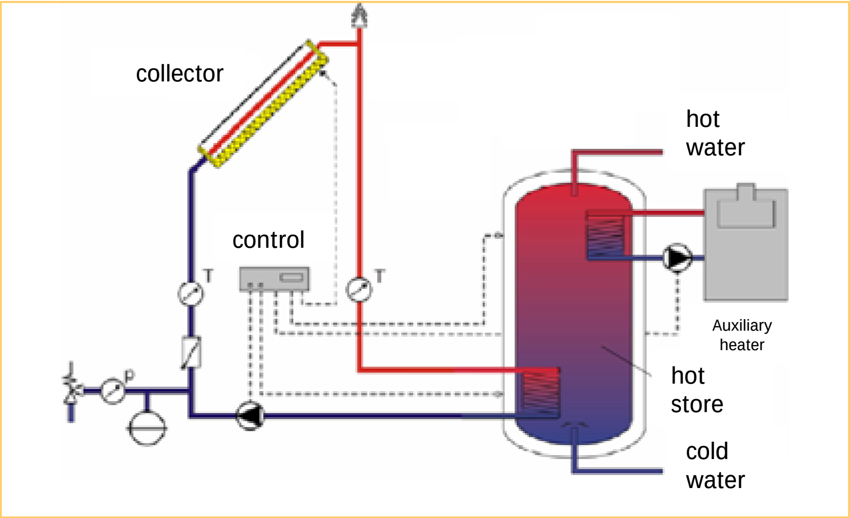
- **Open system**
Open container at the highest point of solar circuit, which absorbs the volumetric expansion of the liquid caused by T changes
- **Closed system**
Operate at high pressures (1.5-10 bar), which influences the $T_{evaporation}$ of the liquid.



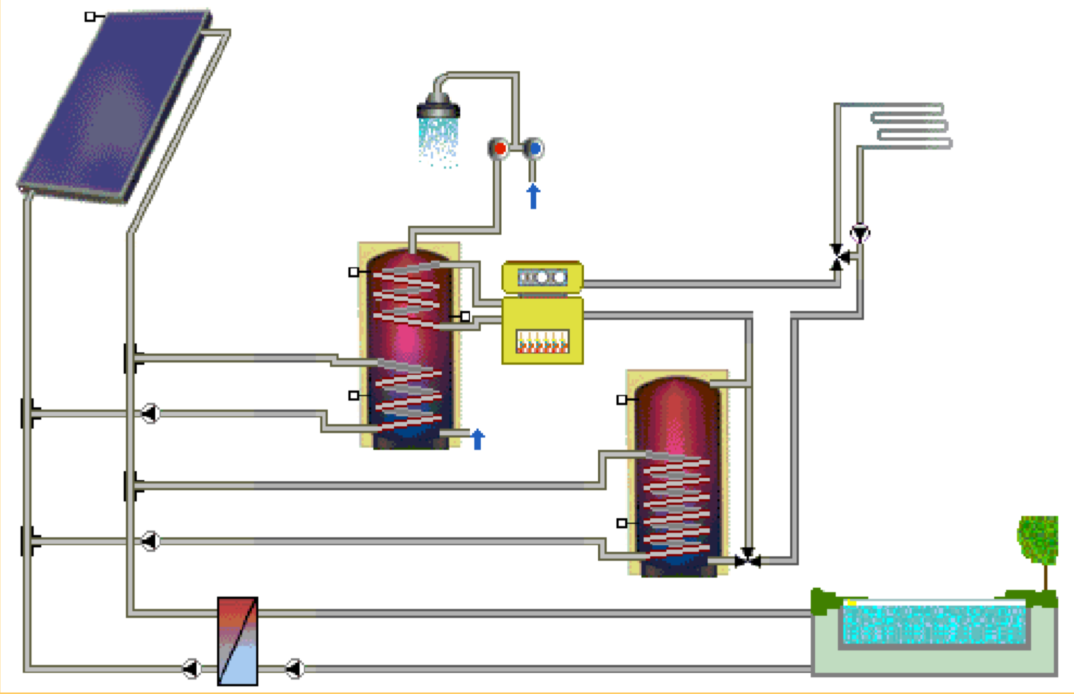
Thermosyphon direct Thermosyphon Indirect

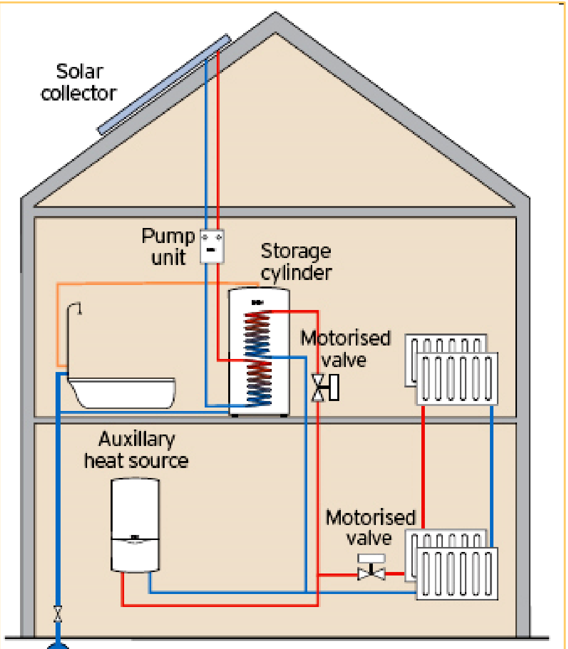


Forced circulation, indirect



Combi Systems





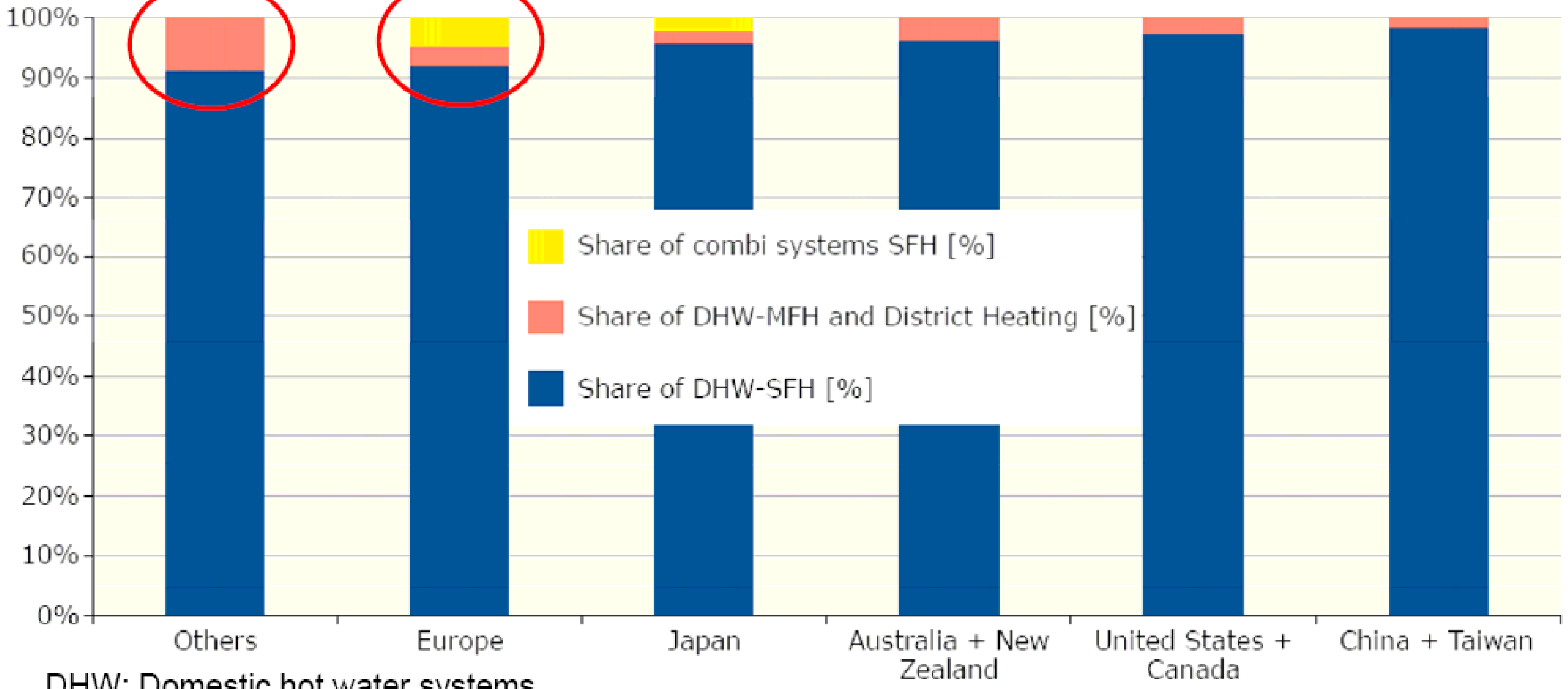
A typical solar installation and heating system

- Pool heating, hot water and space heating
- Integration into existing fan coil units
- High energy saving potential
- Required collectors: 20% of space for 40-50% covering
- 100% covering with solar collectors & biomass

Systems Cost

2008			
System	**Use**	**Cost (incl. installation)**	**Characteristics**
Pool heating	Pool heating	100 € /m² collector	Uncovered collectors, m² collector ≈ m² pool
Thermosyphon	Hot water	1,400 €	150 lt boiler, 2.5 m² flat plate collector
	Hot water	1,600 €	150 lt boiler, 2.5 m² selective flat plate
Combi	Hot water, Heating	500-750 € /m² collector	1000 lt boiler, 15 m² selective flat plate
	Professional: Pool heating, Hot water, heating & air-conditioning	400-650 € /m² collector	30.000 lt boiler, 500 m² selective flat plate

Distribution of solar thermal systems by application



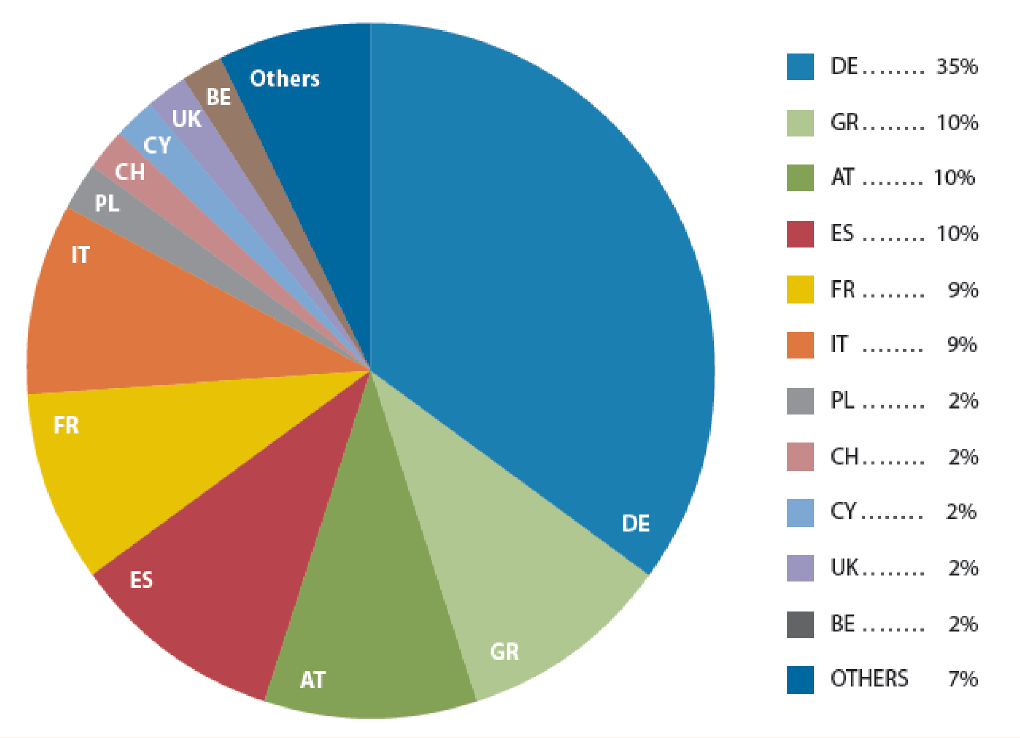
DHW: Domestic hot water systems
SFH: Single family houses
MFH Multi-family houses
Combisystems: Systems for DHW and space heating

Source: IEA-SHC, Solar Heat Worldwide Edition 2008, www.iea-shc.org

Others: Barbados, Brazil, India, Israel, Jordan, Mexico, Namibia, South Africa, Tunisia and Turkey

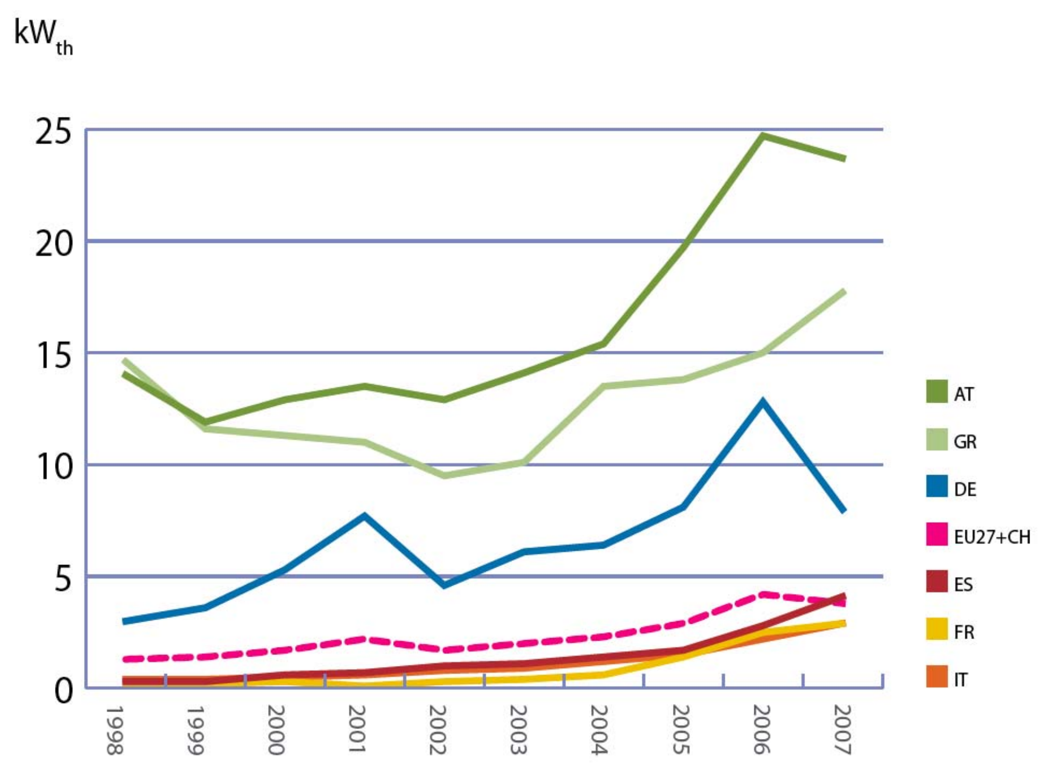
4. Solar Thermal Market in Europe, 2007

Breakdown per country, 2007



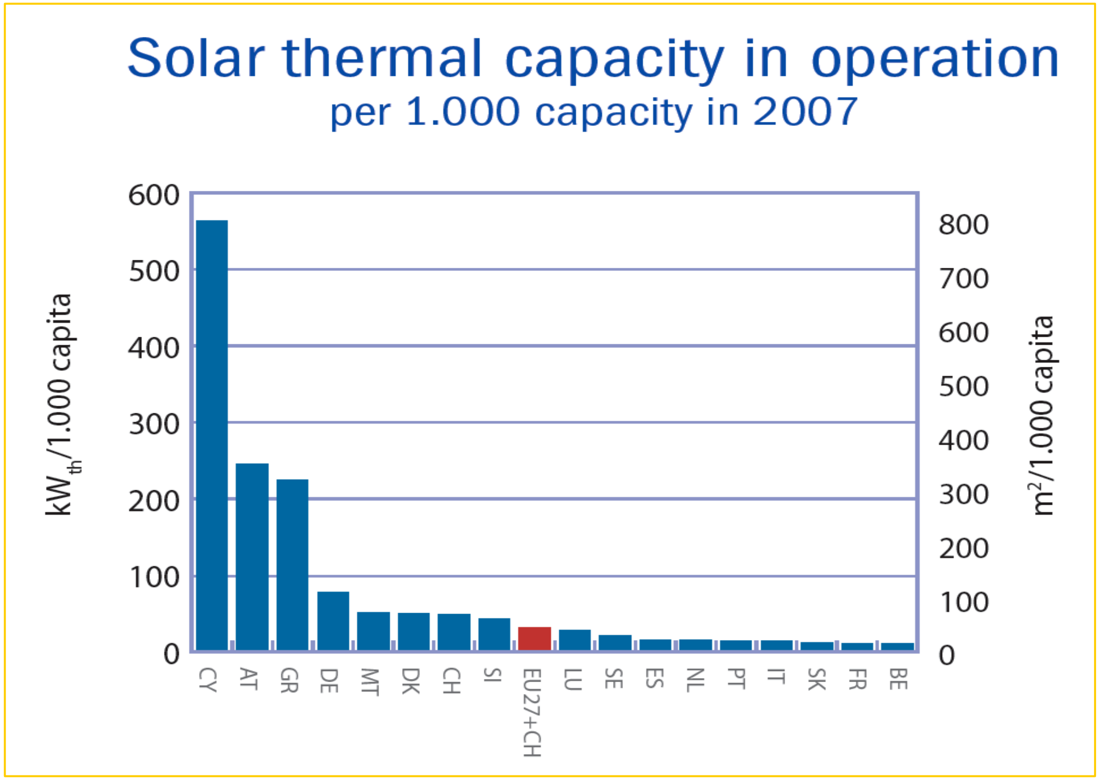
- Concentration in the European market is decreasing
- **5 countries account for ¾ of the total** – just a few years ago the same share was held by Germany, Austria and Greece only
- **Greece accounts for 9-10%** of European sales.

Newly Installed Capacity per Capita in Europe, 2007



- Big advance of **Austria: 23,7 kWth per 1.000 capita**, almost 3 times than Germany and more than 6 times than EU average (3,8 kWth per 1.000 capita)
- **Greece** has slowly and quietly increased its per capita market since 2002. Their **17,7 kWth per 1.000 capita** is 4,5 times as big as the Eu average.
- **France and Italy**: Strong growth in recent years, but only **2,9 kWth installed per 1.000 capita** each.

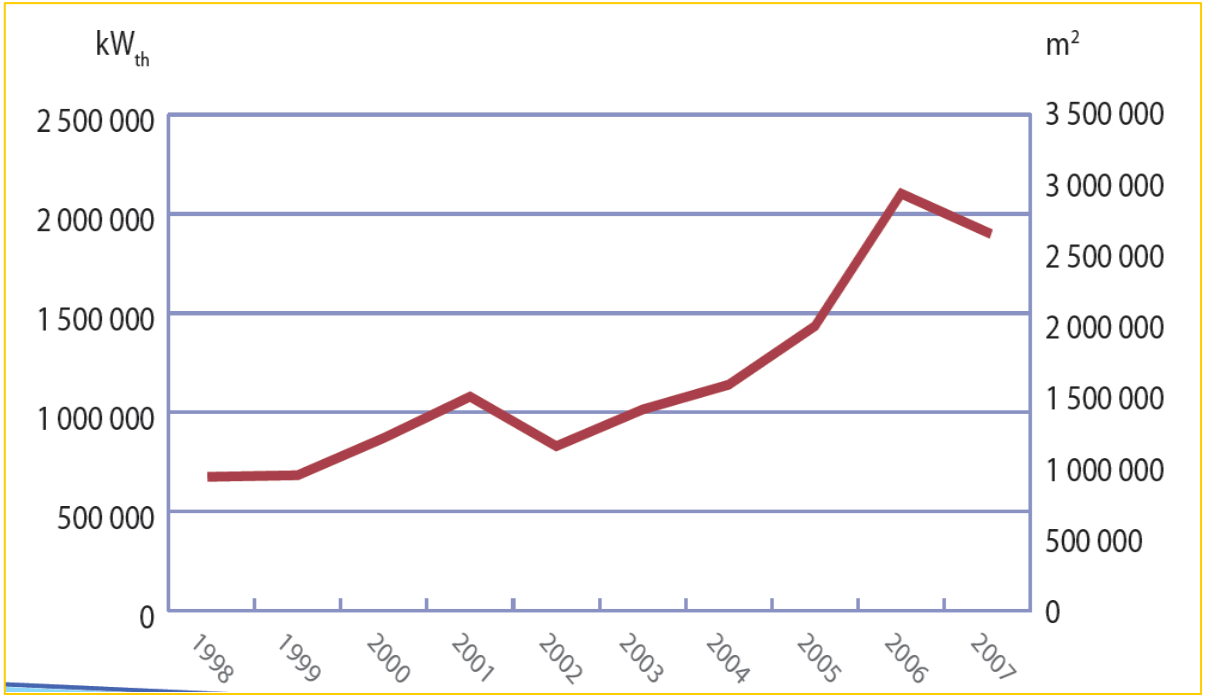
Solar Thermal Capacity in Operation, 2007



- **Cyprus is 1st: 562 kWth** in operation per 1.000 capita
- **Greece is 3rd**
- **EU average: 30,7 kWth** /1,000 capita.
- Austria shows the rest what is possible: 244 kWth/1.000 capita, 8 times the EU average

The figures relate to all installations built in the past and deemed to be still in operation (ESTIF assumes a life-time of 20 year for systems installed after 1989) and to today's size of the population.

Solar Collectors area in operation, 2007



- **2001: 12.3 million m²** glazed collectors in operation
  - 11,7% increase collector in operation
  - 13,6% increase new collector area
  - 1.6 million m^2 glazed collectors for pools
- **2007: 21.9 million m²** glazed collectors in operation

Conclusions/Remarks

- **Large market growth potential**

In Greece only 25% of the buildings are equipped with a solar thermal system (>90% of the owners are satisfied)

- **Seasonal storage**

For transferring the energy from low heating season to high heating season.

- **Solar Cooling**

Better utilization of solar energy throughout the year

Law modernization

solar thermal system project study compulsory for every large building

Financial incentives

to cover part of investment & construction costs

Thank you for your attention!

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