A COMBINATION OF FRESNEL TECHNOLOGY AND NEXT-GENERATION SOLAR PVT SYSTEM WITH PHASE- CHANGE MATERIAL AND TEG MODULES: FLPVT

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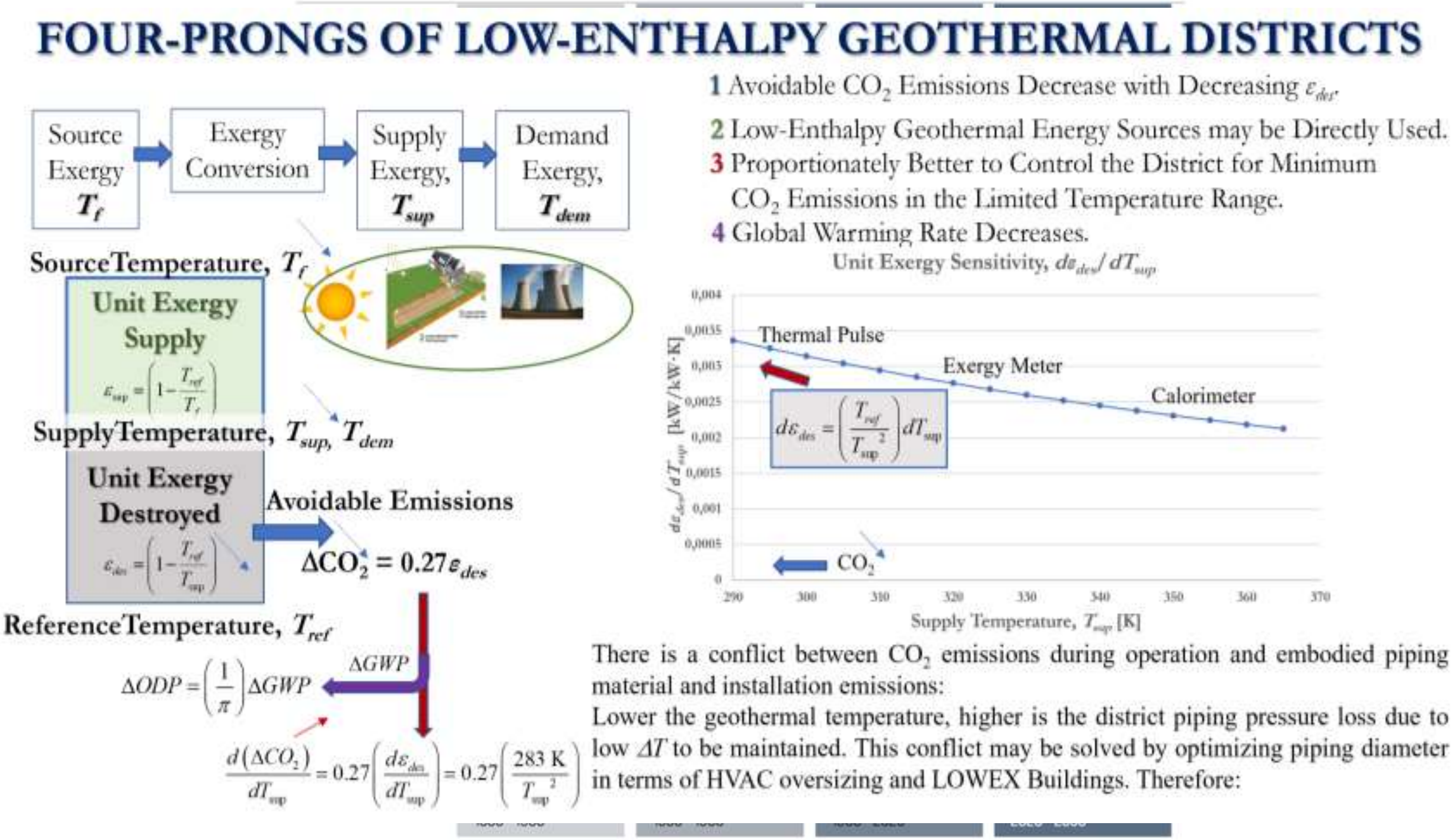
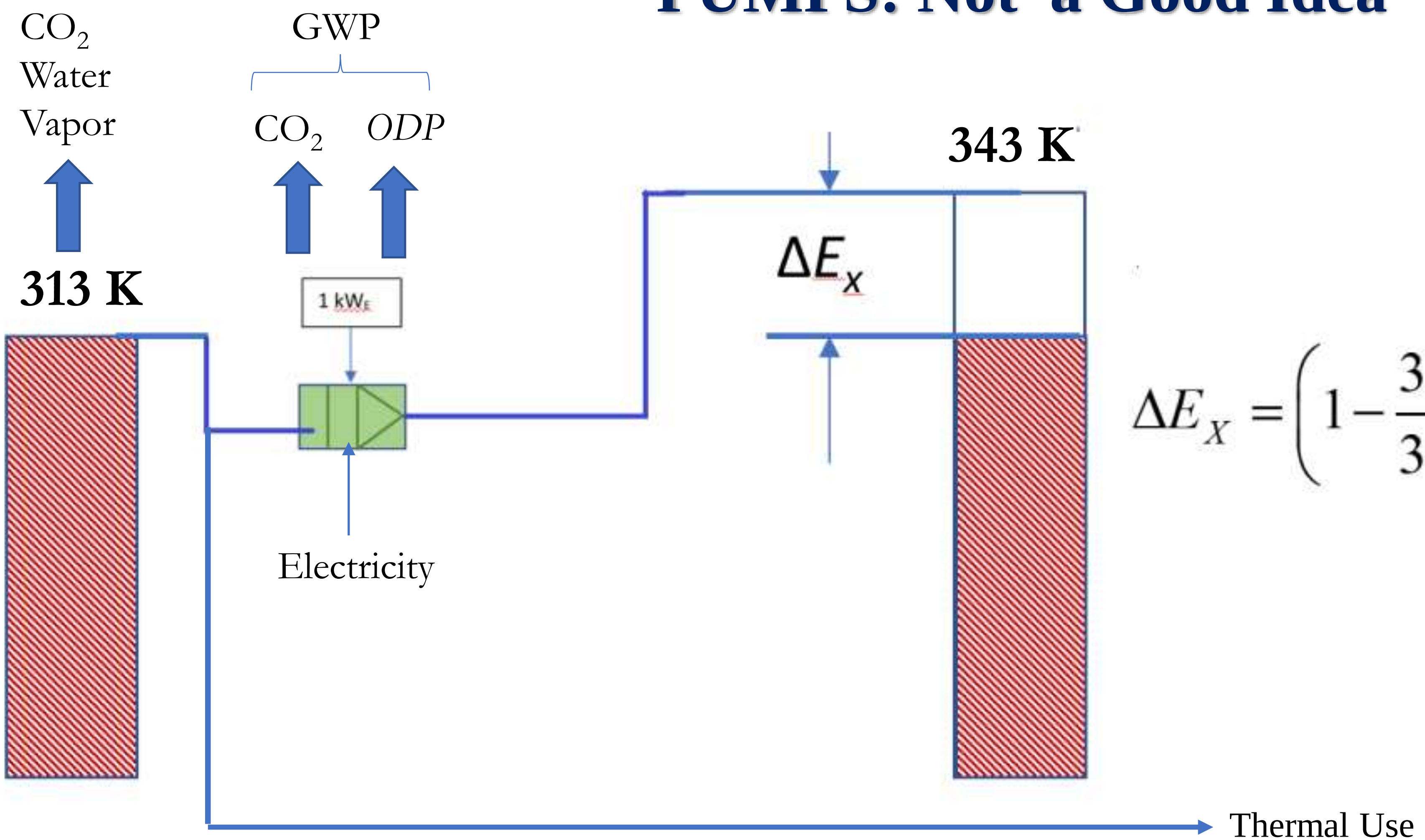
LOW TEMPERATURE DISTRICT ENERGY SYSTEMS

4DE and Beyond:Solar to the Rescue
CSP, PV or PVT?



LOW ENTHALPY HEAT: TEMPERATURE PEAKING WITH HEAT PUMPS: Not a Good Idea



COP

$$\Delta E_X = \left(1 - \frac{313K}{343K}\right) = 0.09x5 = 0.45 << 1$$

Even *COP* is 5 in this example this peaking system is not rational. *COP* must be at least 11.
This may be possible by using multiply cascaded heat pumps, each having incremental temperature riseat a substantial investment cost. This approach may be optimized on economical grounds.

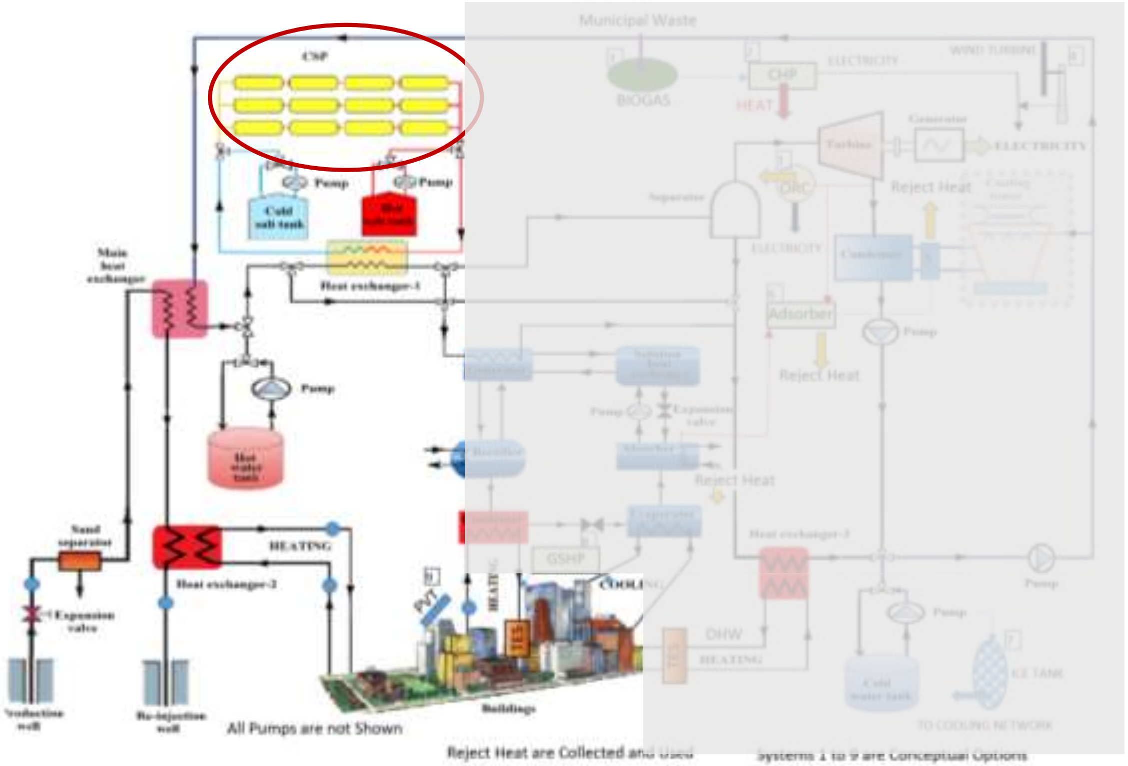
SOLAR CSP or PV
Electricity or Temperature Peaking

- Solar Steam from CSP occupies 7.6 acres per MW electricity installed.
- Solar PV occupies 4.4 acres per MW electricity installed.
- PVT3 is about 4.1 acres per MW electricity installed
- But CSP occupies slightly less land for annual GW-h power generation.

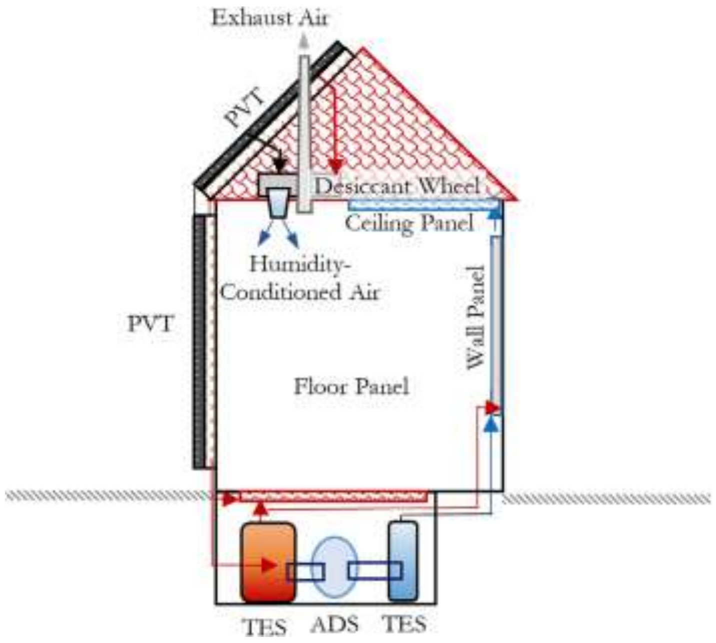
PARAMETER		CSP	PV	PVT3	COMMENTS
η_I	Power	0.35	0.17	0.20	CSP needs direct sunlight
	Heat	0.35	-	0.55	At 90^{o}C thermal output for CSP 323^{o}C for PVT3
ψ_R		0.73	0.68	0.75	Steam has *ODI*
Occupied Area		7.6	4.4	4.1	Acres per MW electricity installed.
E_x		0.409	0.16	0.258	Unit kW
ε_{des}		0.343	0.198	0.062	Destroyed exergy in the process
ΔCO_2		0.092	0.053	0.017	Kg CO_2/kW-h heat equivalent
η_{II}		**0.409/0.625 0.654**	**0.16/0.625 0.256**	**0.258/0.625 0.418**	**Unit kW**

- With steadily decreasing PV cell prices and higher efficiencies, especially with PVT systems it is more rational to generate electric power with PV panels and heat in spite of the above mixed conclusions, especially according to cost and direct sunlight requirement of CSP system disadvantages. Steam generation has also greenhouse effect due to cooling towers etc.
- Among above parameters, it seems that ΔCO_2 and ψ_R seem to be more decisive factors.
- Electricity then must be used as electricity rather than peaking the geothermal temperature.
- Low-temperature condenser heat must be used in low-temperature applications without peaking. Otherwise *COP* must be >8 if heat pumps are used for peaking. Also has *ODI*.
- In space heating of buildings, especially in low-temperature 4DE$^+$applications, Enover radiators may be used without oversizing penalty due to their unchanging pressure losses with oversizing.

DISTRICT ENERGY OR DISTRIBUTED ENERGY?

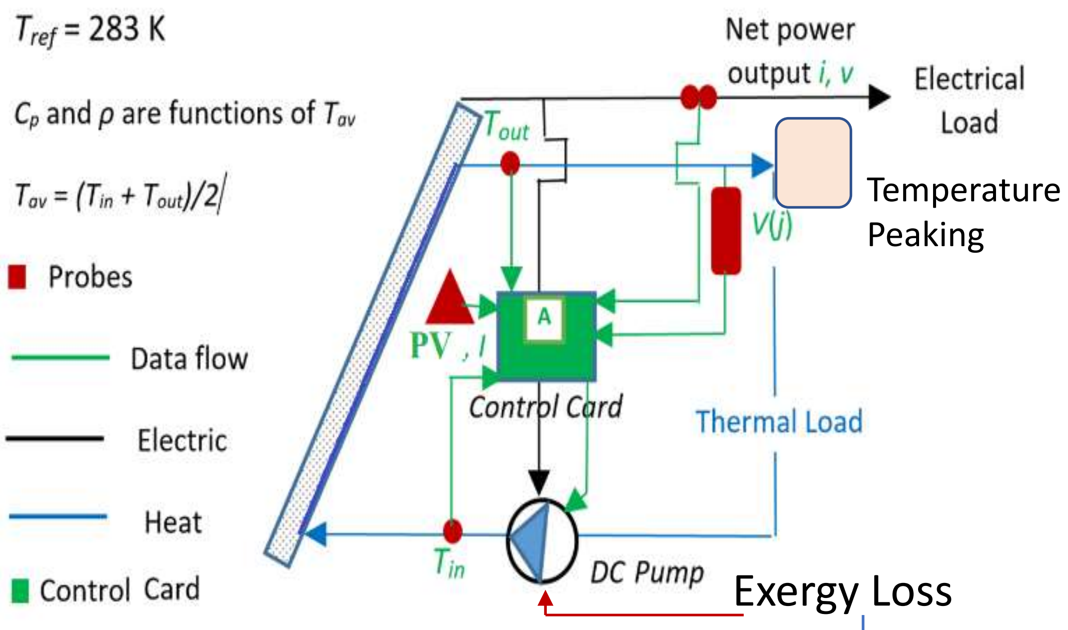


$$2L_{\max} < \frac{Q_D\left(1-\frac{T_{ret}}{T_{\sup}}\right)}{0.95\delta P_E}$$



İzmir Geothermal Upgrade for District Cooling: DANIDA Project Proposal, Yaşar University, Prof. N. Yıldırım et al.

WHAT HAPPENS IN FORCED CIRCULATION?



Exergy Loss

$$E_{XT} = 0.96iv + \rho V C_p \left(T_{out} - T_{in}\right)\left(1 - \frac{T_{in}}{T_{out}}\right) - E_{XP}$$

$- E_{XTP}$

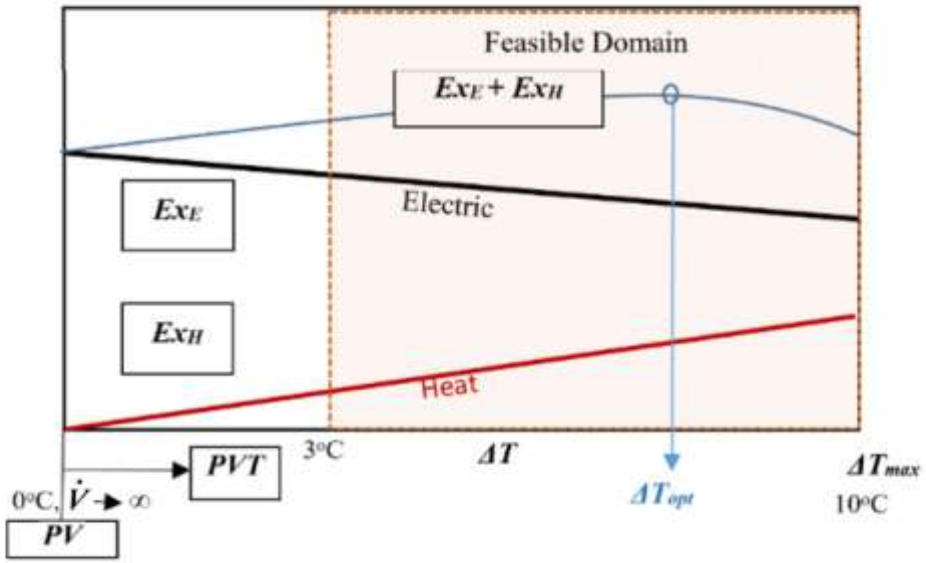
Power Heat

Exergy Gain, E_{XG}

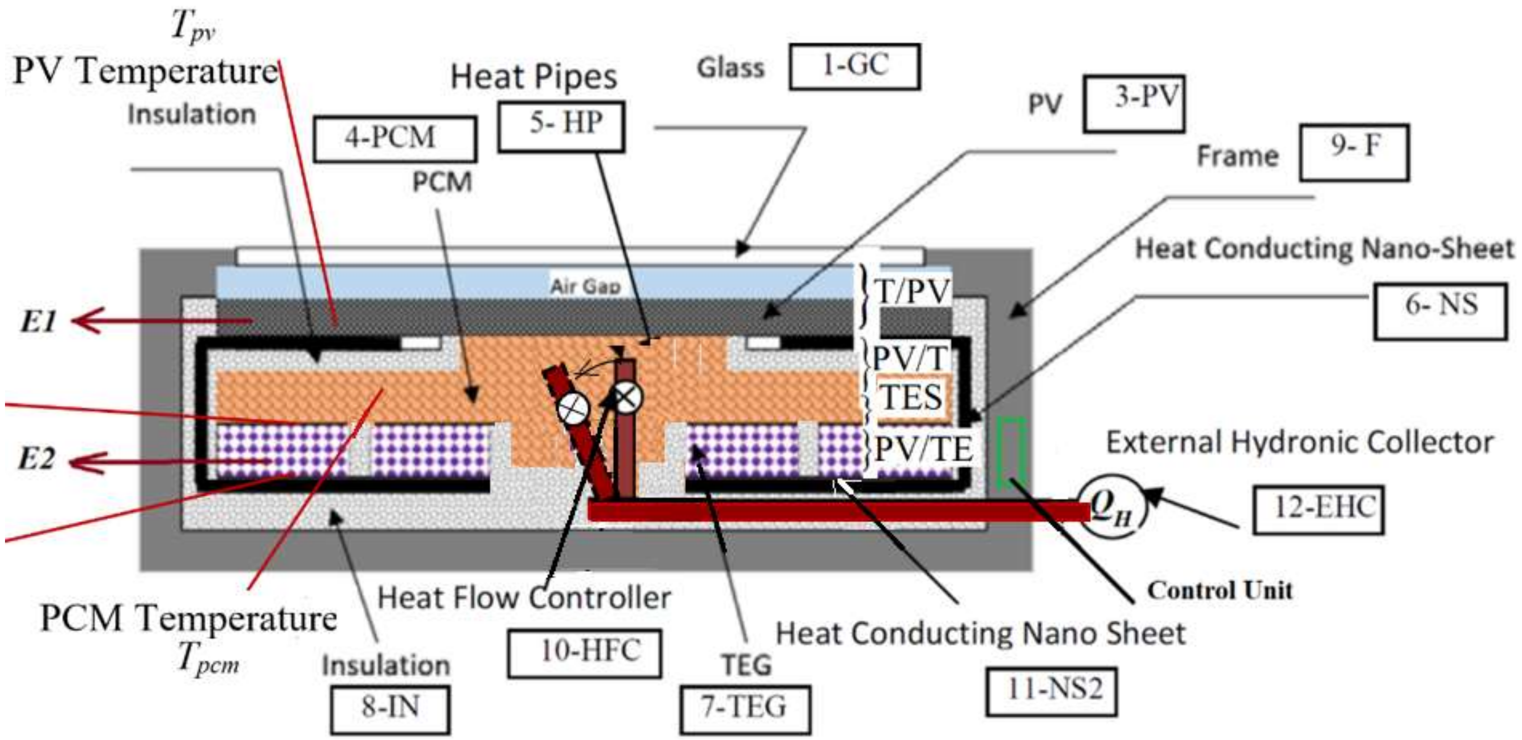
$E_{XG} < E_{XP}$

$E_{XT} < 0$

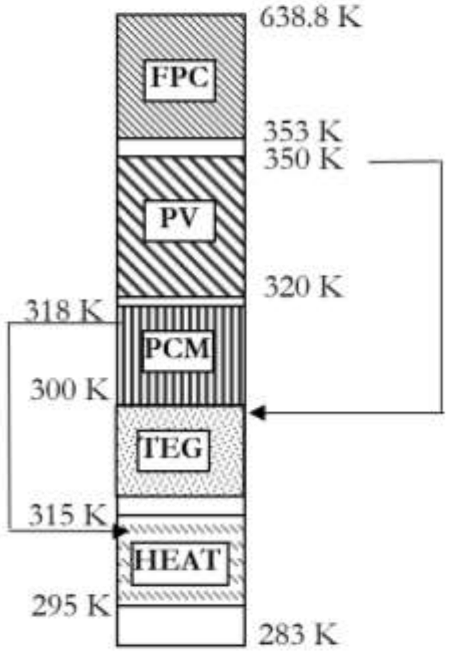
DILEMMA BETWEEN POWER AND HEAT



SOLAR PVT4^{+} SYSTEM

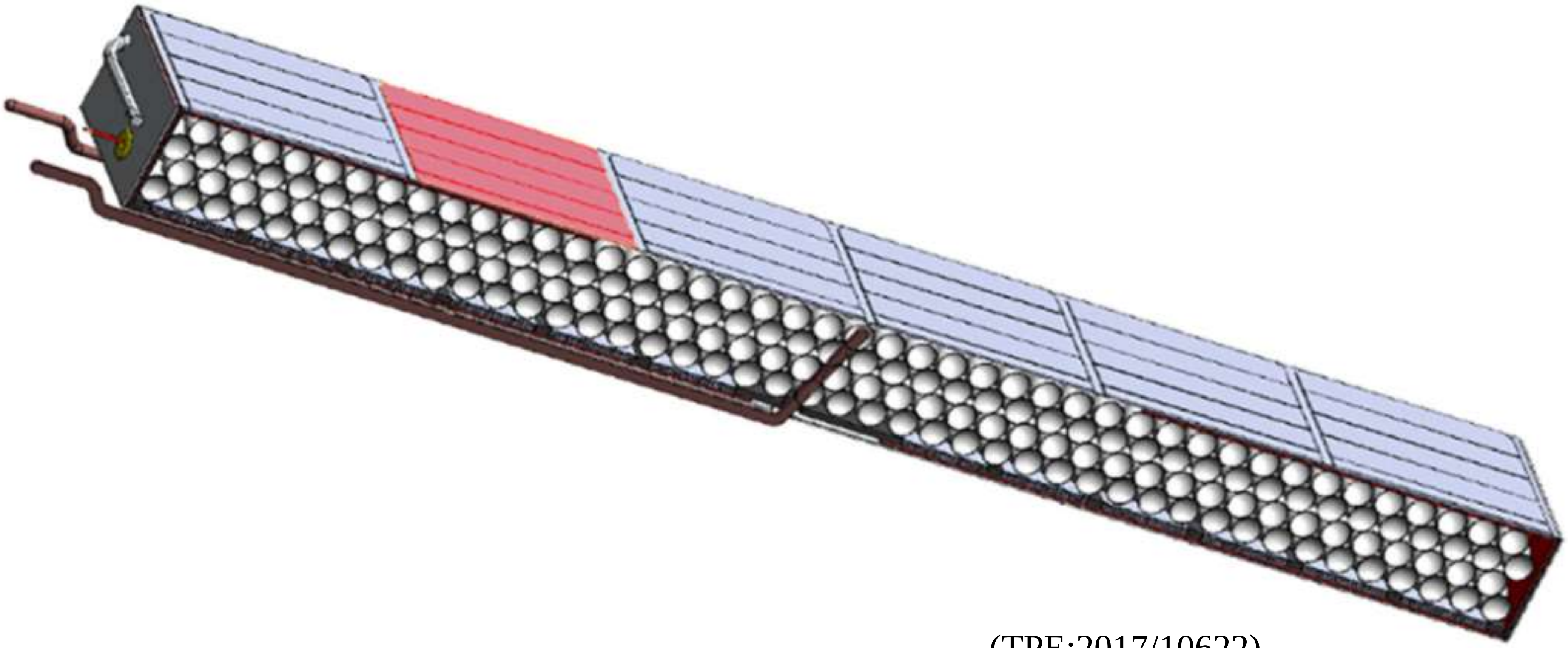


THERMODYNAMIC PERFORMANCE- 2ND LAW

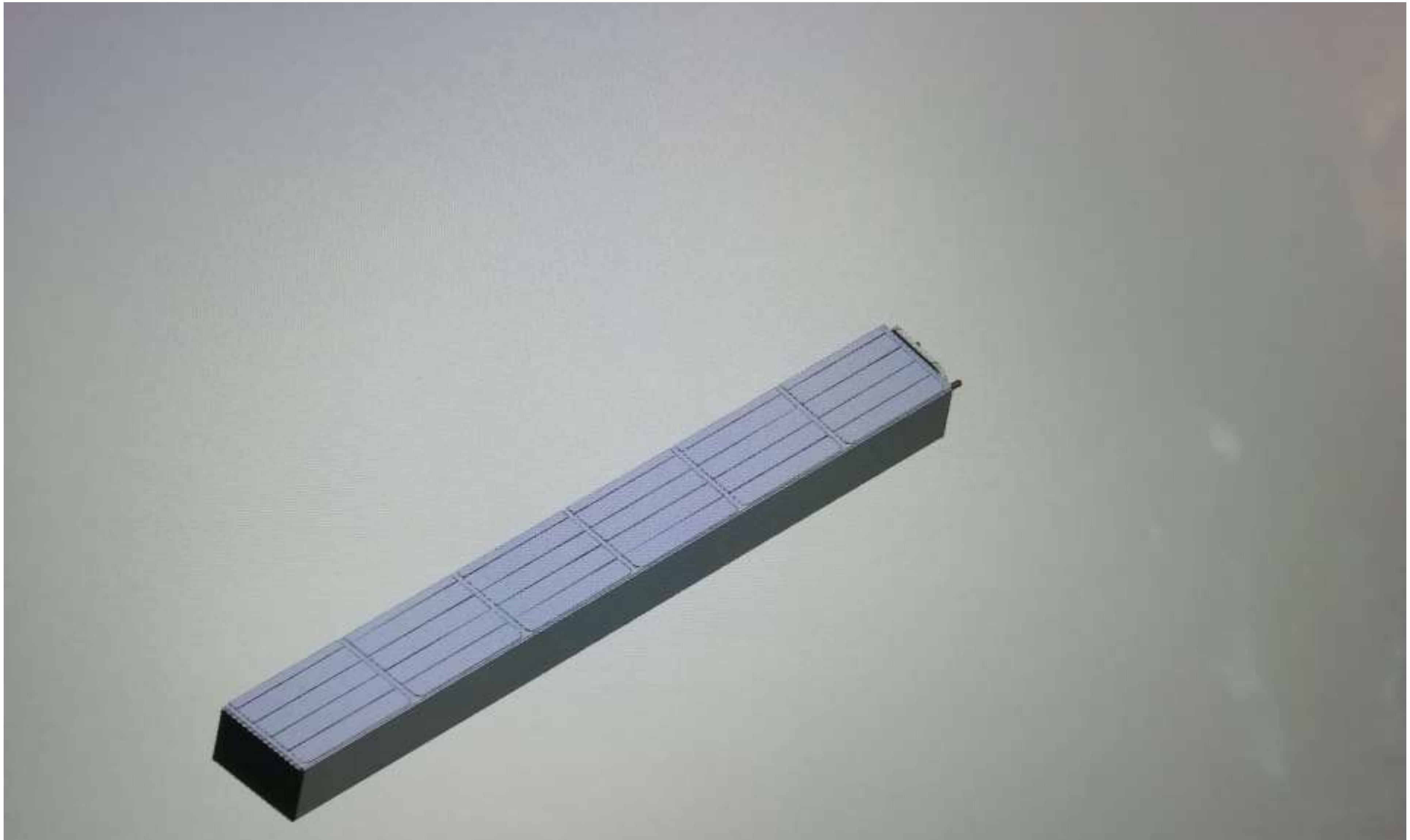


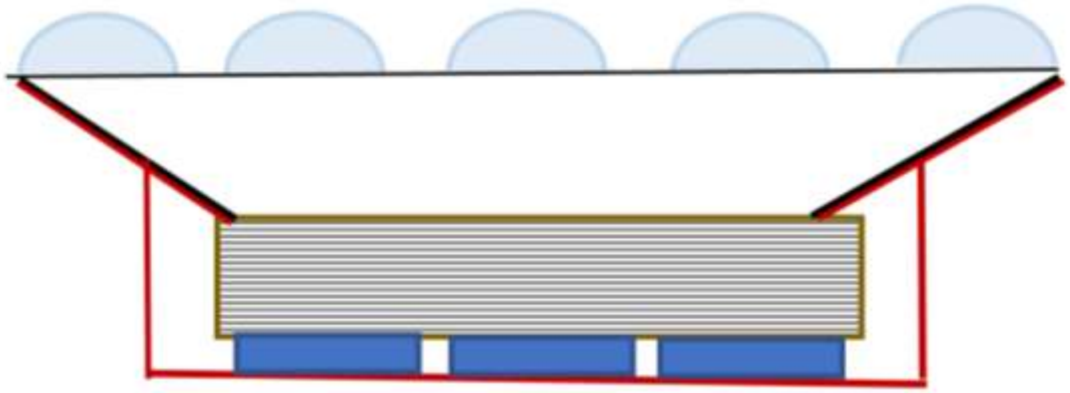
$$\psi_R = 1 - \frac{\sum \varepsilon_{des}}{\varepsilon_s} = 1 - \frac{\left(1-\frac{350\text{ K}}{353\text{ K}}\right) + \left(1-\frac{318\text{ K}}{320\text{ K}}\right) + \left(1-\frac{315\text{ K}}{318\text{ K}}\right) + \left(1-\frac{283\text{ K}}{295\text{ K}}\right)}{\left(1-\frac{283\text{ K}}{638.8\text{ K}}\right)} = 0.88$$

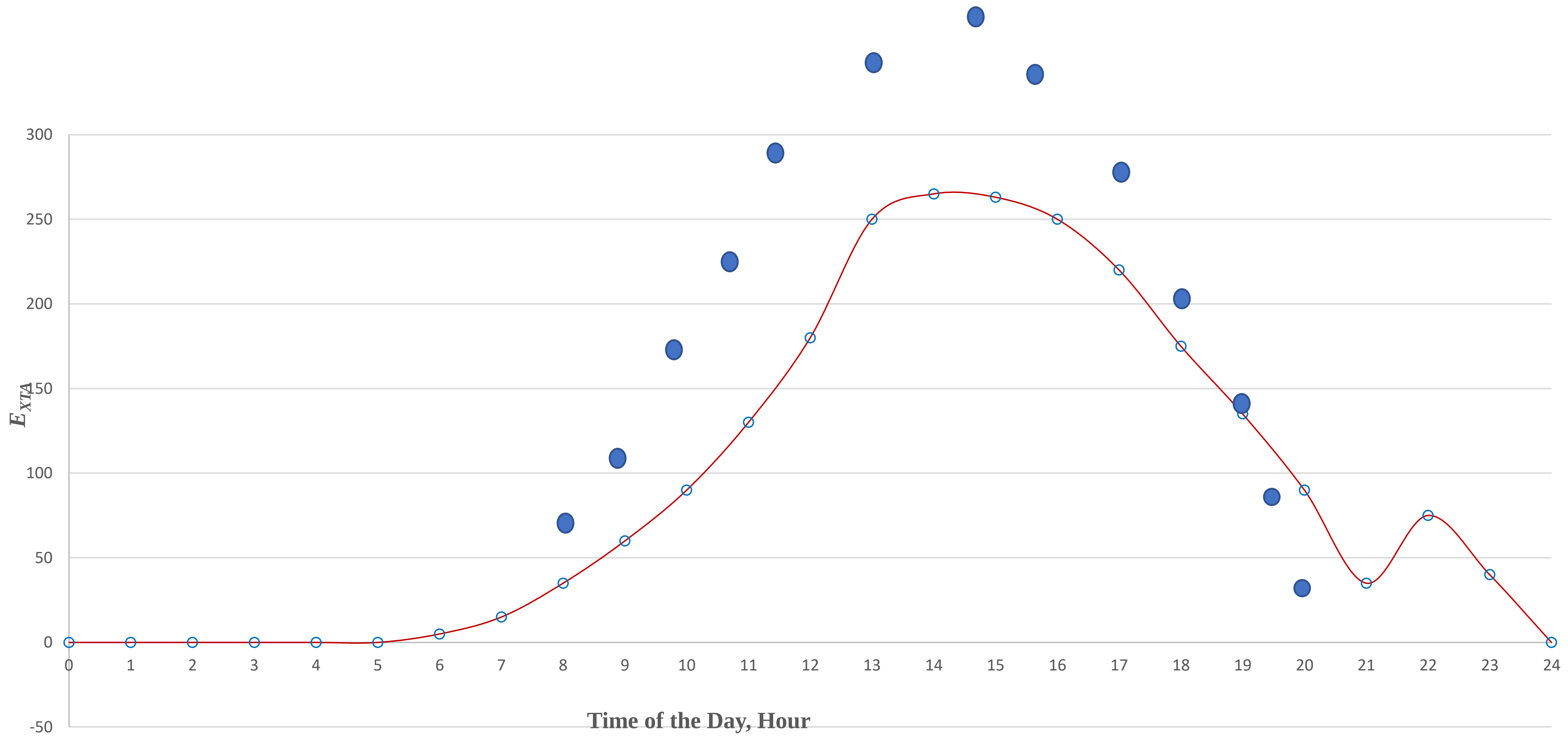
SOLAR PVT4^{+}CARTRIDGE



(TPE:2017/10622).



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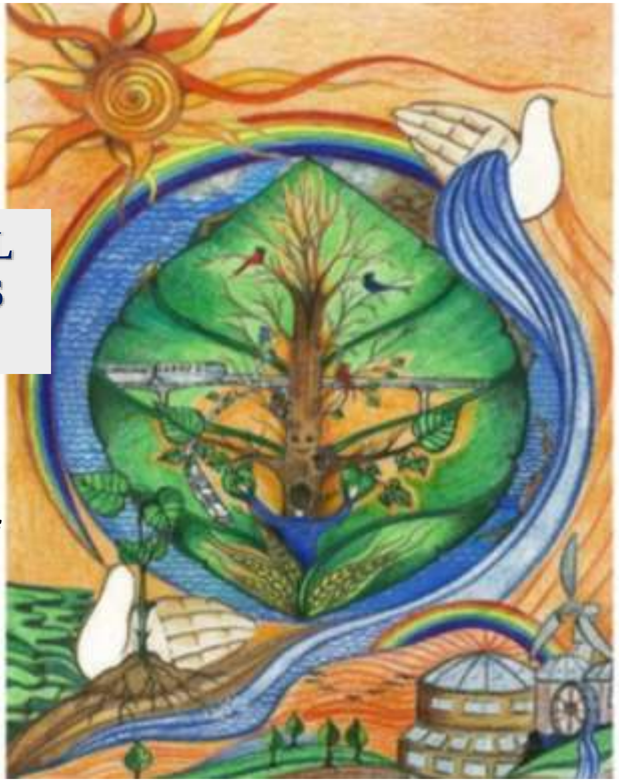
Time of the Day, Hour

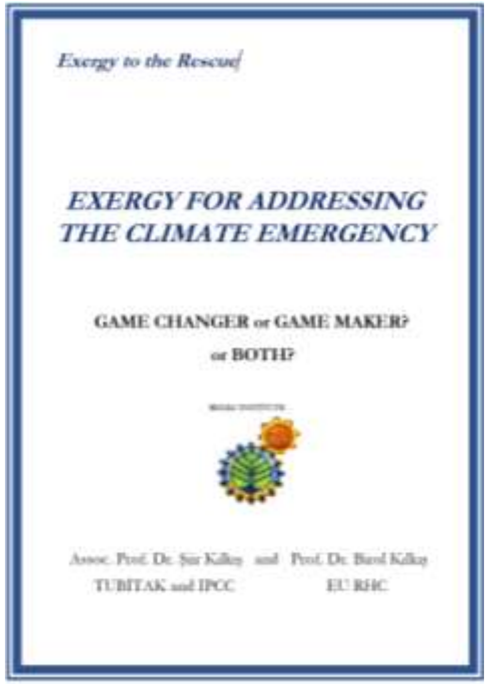
WHEN WE LEARN TO LIVE IN HARMONY WITH THE BOUNDS OF NATURE IN BALANCE,

THEN EXERGY WILL HAVE PROVIDED US THE SOLUTIONS.

Wisdom and Inventions for Solutions are Endless



Şan Kilkis, UNESCO Prize 2002



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