"ENERGY POLICY IN CYPRUS"

by

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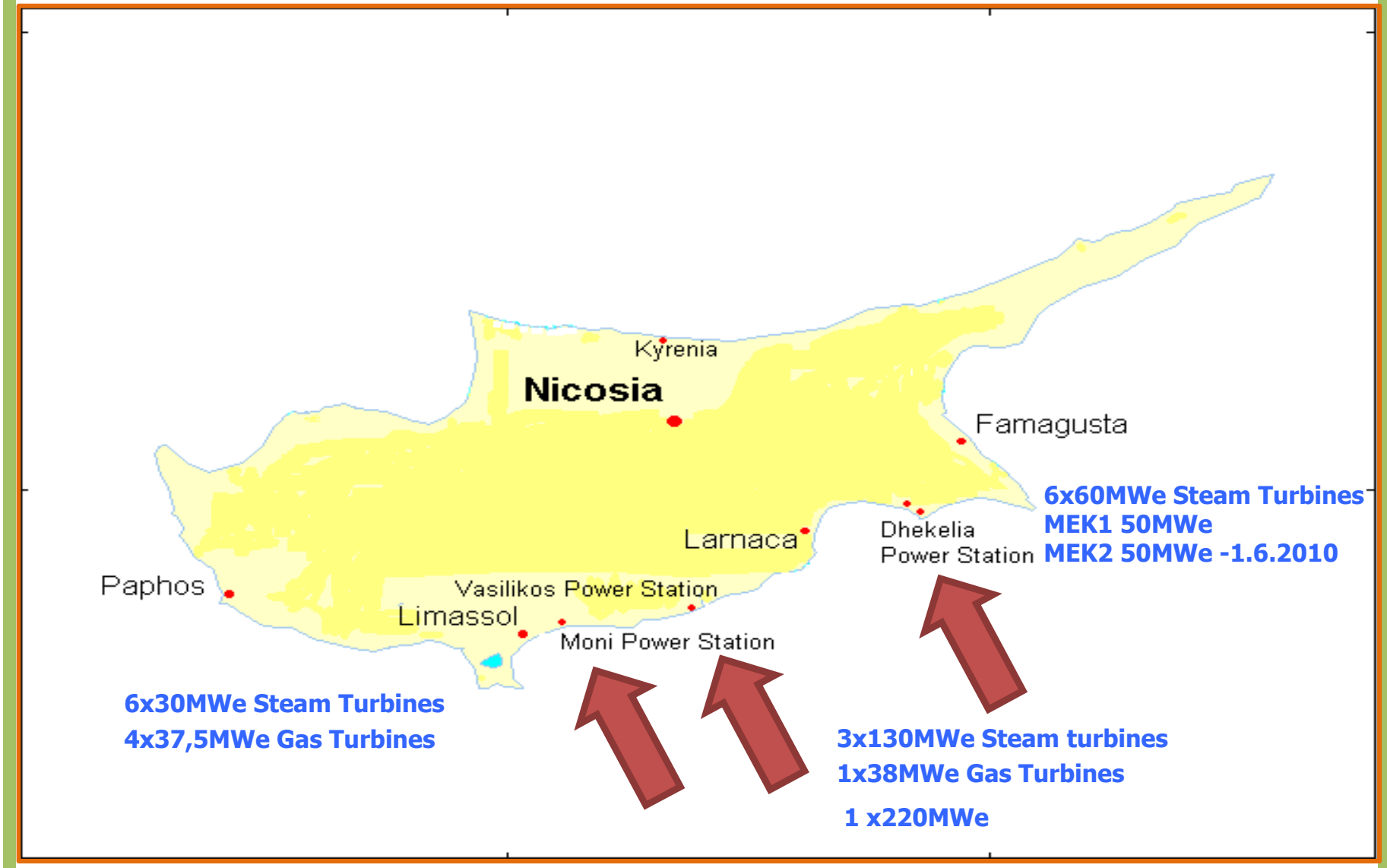
INTRODUCTION – THE FACTS

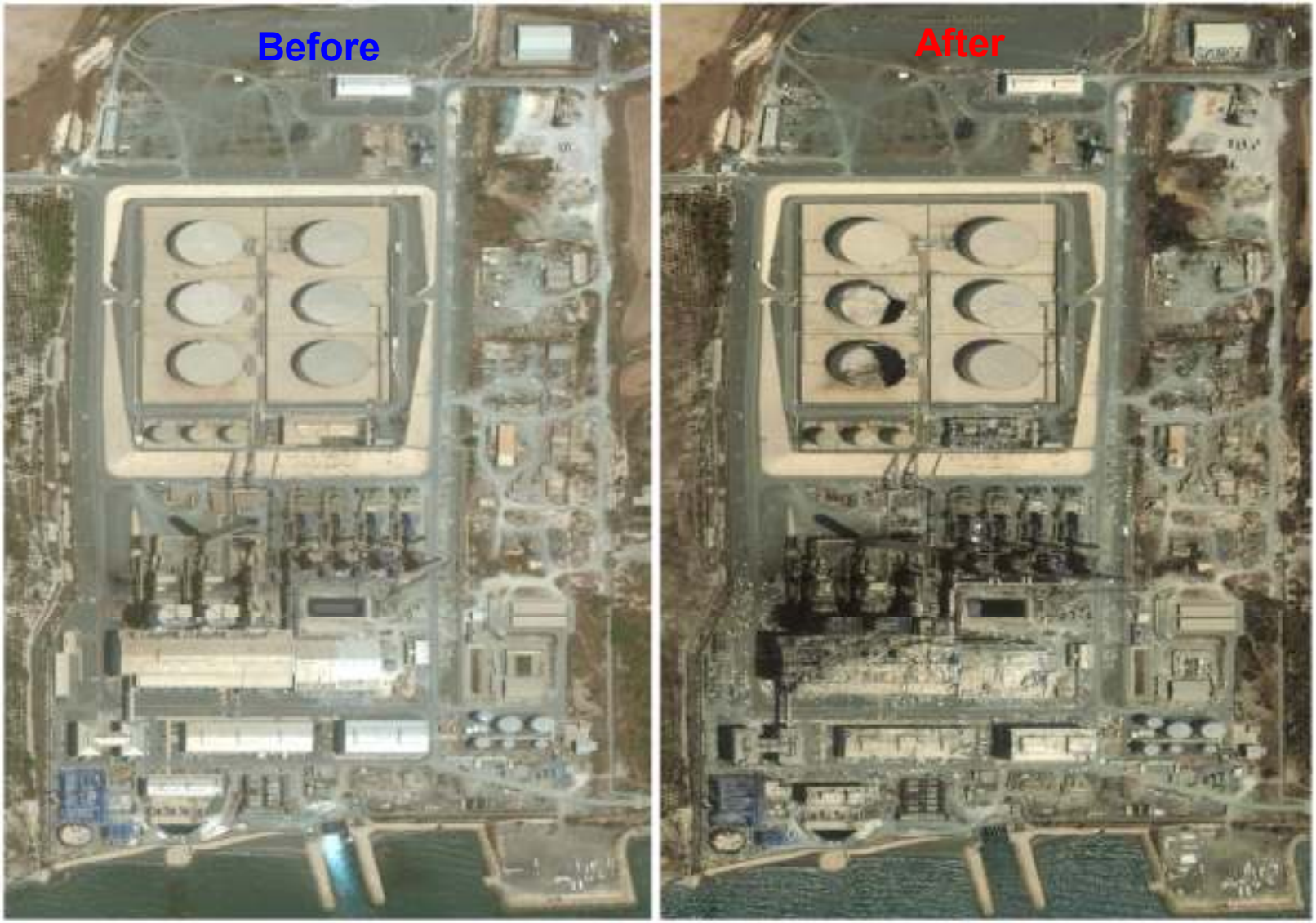
11th of July 2011

- **"Evangelos Florakis" Naval Base Explosion [Dead: 13, Wounded: 65]**
- **Vasilikos Power Plant (VPP) extensively damaged and non-operational**
- **Loss of 793MW from country's installed power capacity, about 53% of total power (1,646MW). Deficit of 400MW in relation to expected maximum summer demand**

Power Production System (Pre July 11th 2011 events)



Photos of Vasilikos Power Station



Building Roof of Units 1, 2 and 3
(Shot taken from height of approx. 50m)

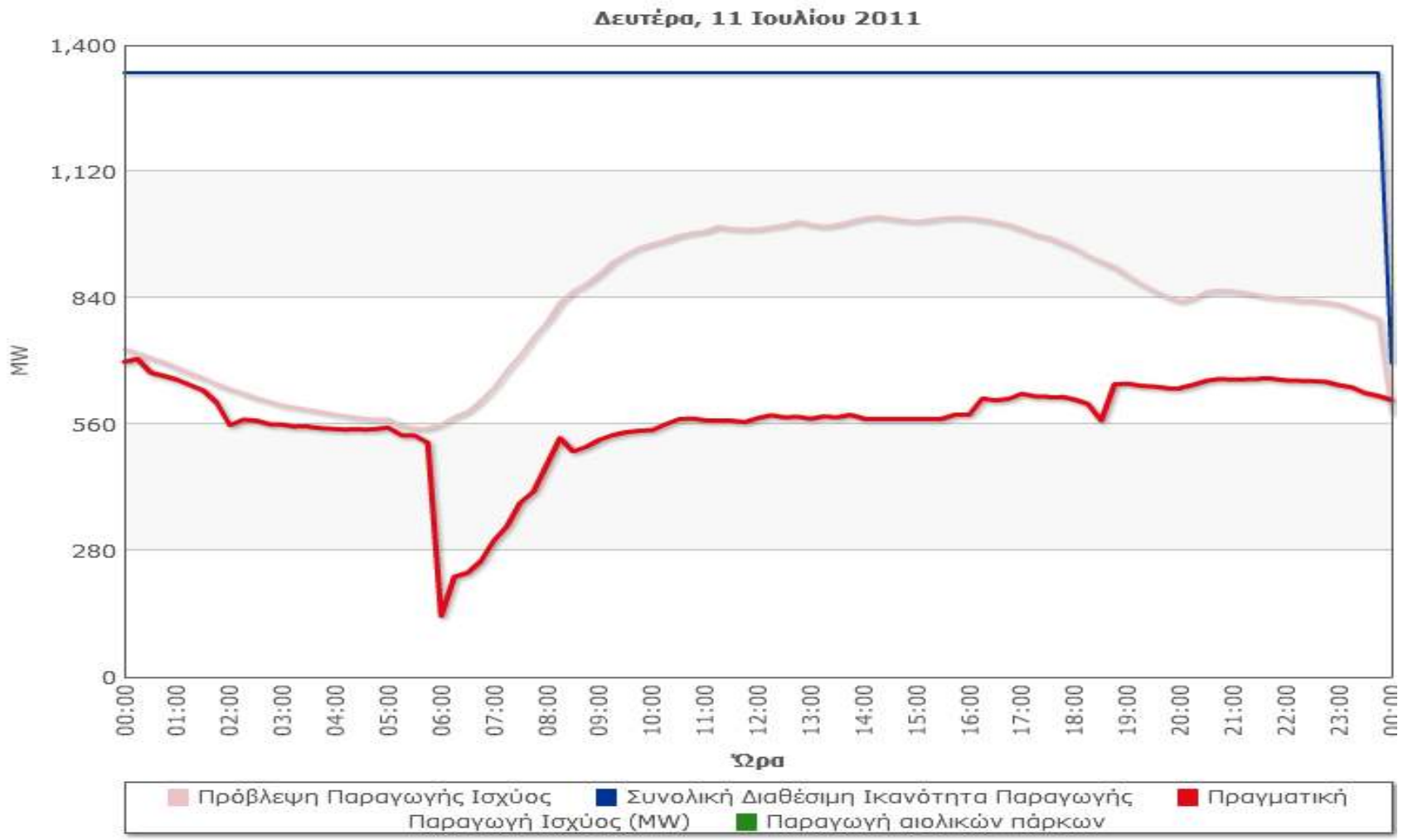
PRELIMINARY IMPACT EVALUATION-4:
Production System Losses

#	Power Plant	Capacity(MW)	Nominal Installed Capacity (MW)	Available Capacity Production (MW)
1	Vasilikos Power Plan	3 x 130 MW Steam Turbines 390 MW	793MW Non operational	0MW 53% of total power production capacity non operational
		1 x 38 MW Gas Turbines 38 MW		
		1x 220MW Combined Cycle Unit (CCGT) 1x145MW Combined Cycle Unit (CCGT)		
2	Dekelia Power Plant	6 x 60 MW Steam Turbines 360 MW	460MW	460MW
		2x50MW ICE		
3	Moni Power Plant	6 x 30 MW Steam Turbines 180 MW 1 x 20 MW Steam Turbines 20MW	350MW	229MW
		4 x 37,5 MW Gas Turbines 150 MW		
4	Autoproducers		26MW	26MW
5	Independent producers from RES, (not considered as contributing to the production capacity)	82MW (Wind Farm)	82MW	~10MW
			1691MW	725MW

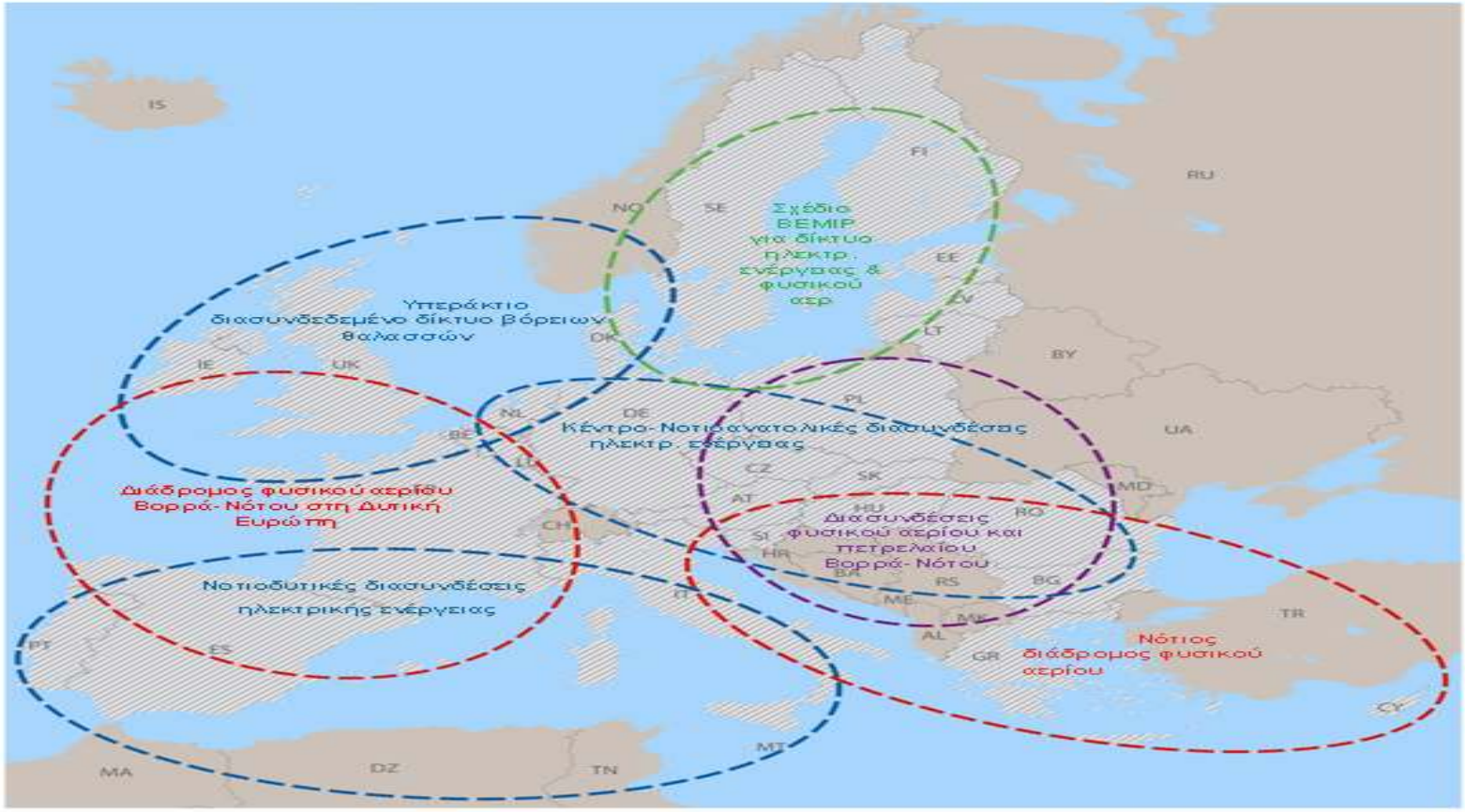
PRELIMINARY IMPACT EVALUATION-4
Initial Repair Cost and Economic Impact (EU Experts)

Unit/Activity Parameter	Best Case Scenario €M	Base Scenario €M	Worst Case Scenario €M
Direct Losses (repair cost) VPP repair cost	330	400	700
Indirect Losses Income loss from VPP Increase in insurance premiums Operational Expenses	 600 20 300	 600 20 300	 600 20 300
Total Losses	1250	1320	1620

ENERGY CRISIS MANAGEMENT-1
Production Profile: Day 1 (July 11th 2011)



Priority corridors for electricity, natural gas and oil



Φυσικό αέριο

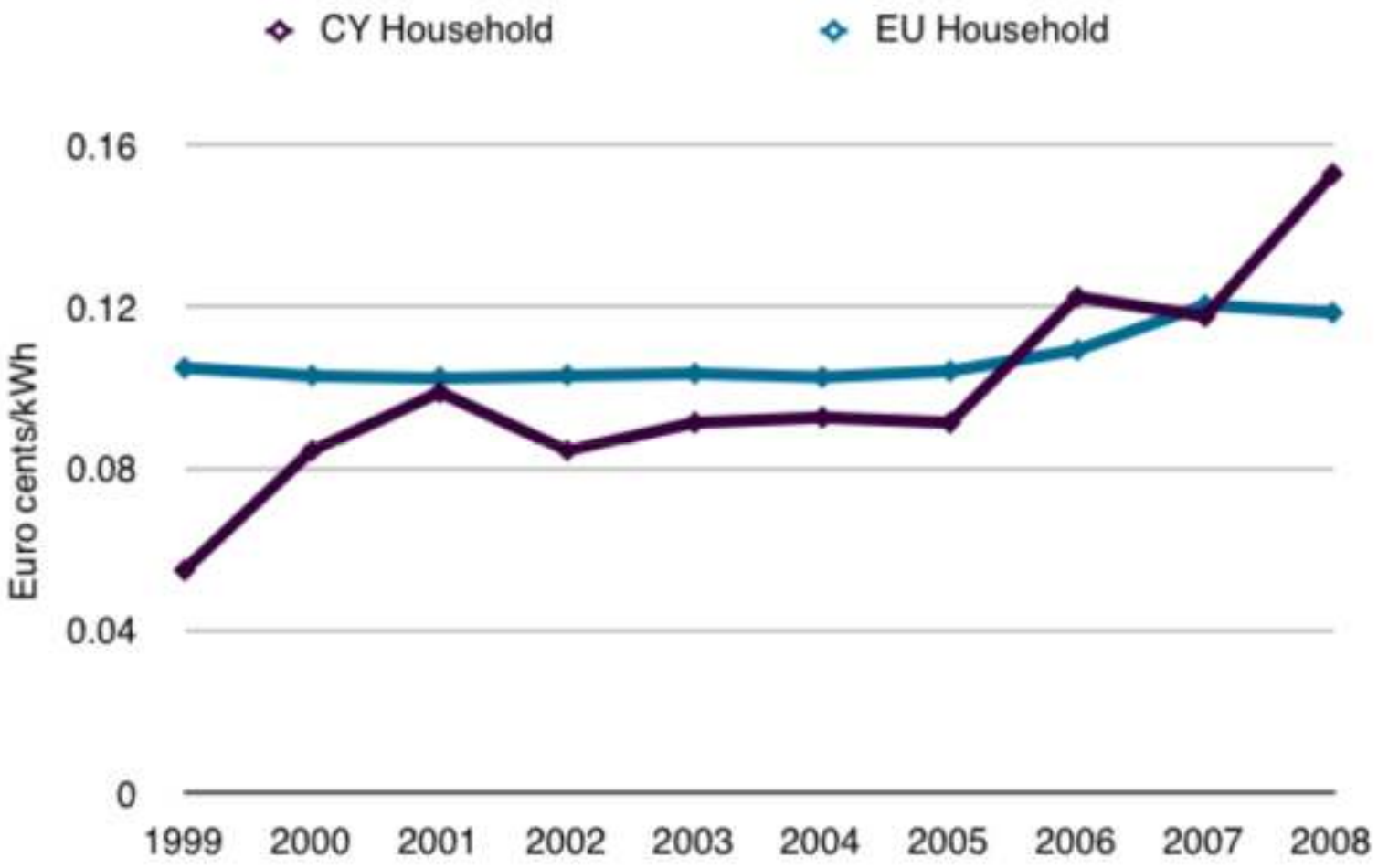
Ηλεκτρική ενέργεια

Ηλεκτρική ενέργεια και φυσικό αέριο

Πετρέλαιο και φυσικό αέριο

Ευφυή διασυνδεδεμένα δίκτυα ηλεκτρ. ενέργειας στην ΕΕ

Electricity Prices (CY vs EU Household)



ENERGY CHALLENGES FOR CYPRUS

- **Short term (current-2020)**
  - **Hydrocarbon extraction**
  - **Import and use of Natural Gas**
  - **Integrated planning of RES use**

- **Medium Term (2020-2030)**
  - **Transition to low carbon energy mix**

- **Long Term (2040-2050)**
  - **Transition to hydrogen economy**

The lowest economic cost (to the Cypriot consumer) must be ensured.

RES technologies considered:

- Wind (135 MW)
- PVs (9 MW)
- CSP with 6 hours thermal storage (x)
- Biomass (8 MW)

- Total RES ⇨ 152 MW

Applications in the Framework of NER 300 Program

Solar Thermal Stations:
4 Applications (176,26 MW) και 1 EAC Application in the past (50 MW)

Total Solar Thermal:
5 Applications, 226, 26 MW

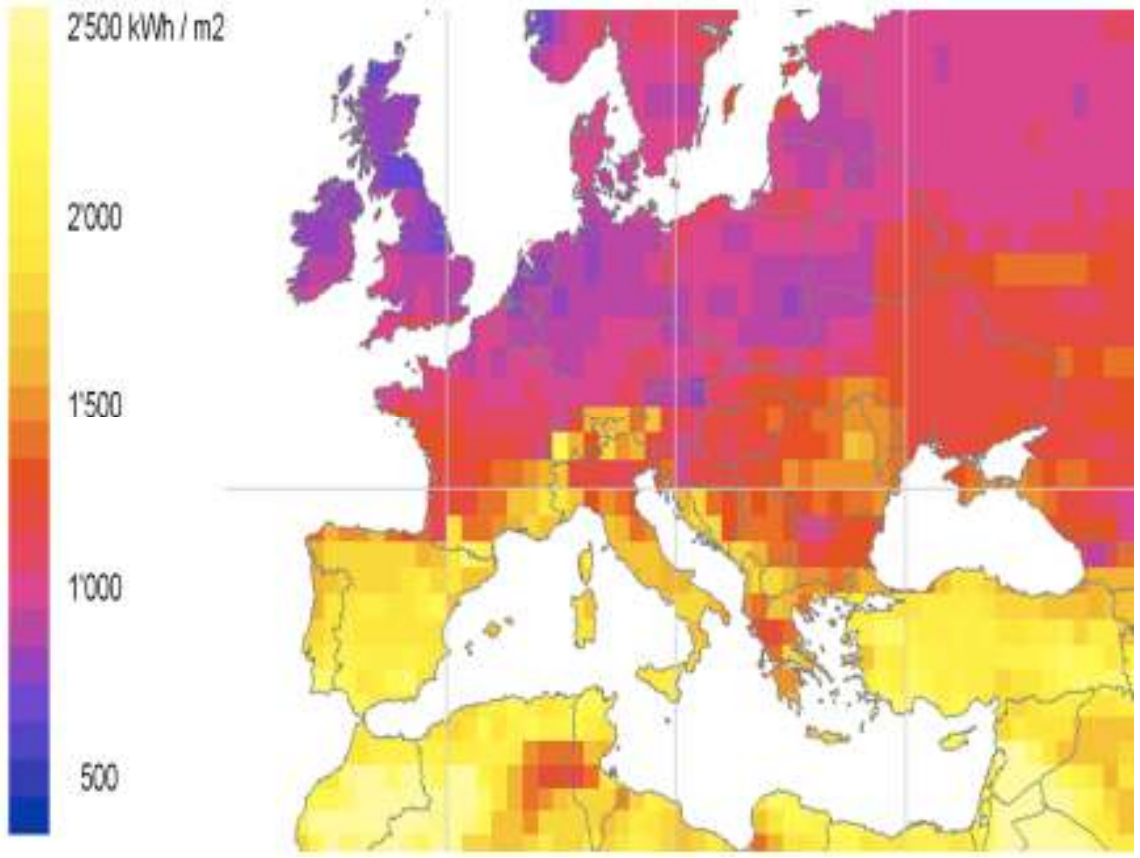
Solar Parks:
4 Applications, 90MW

Offshore Wind Farm:
1 Application, 54 MW

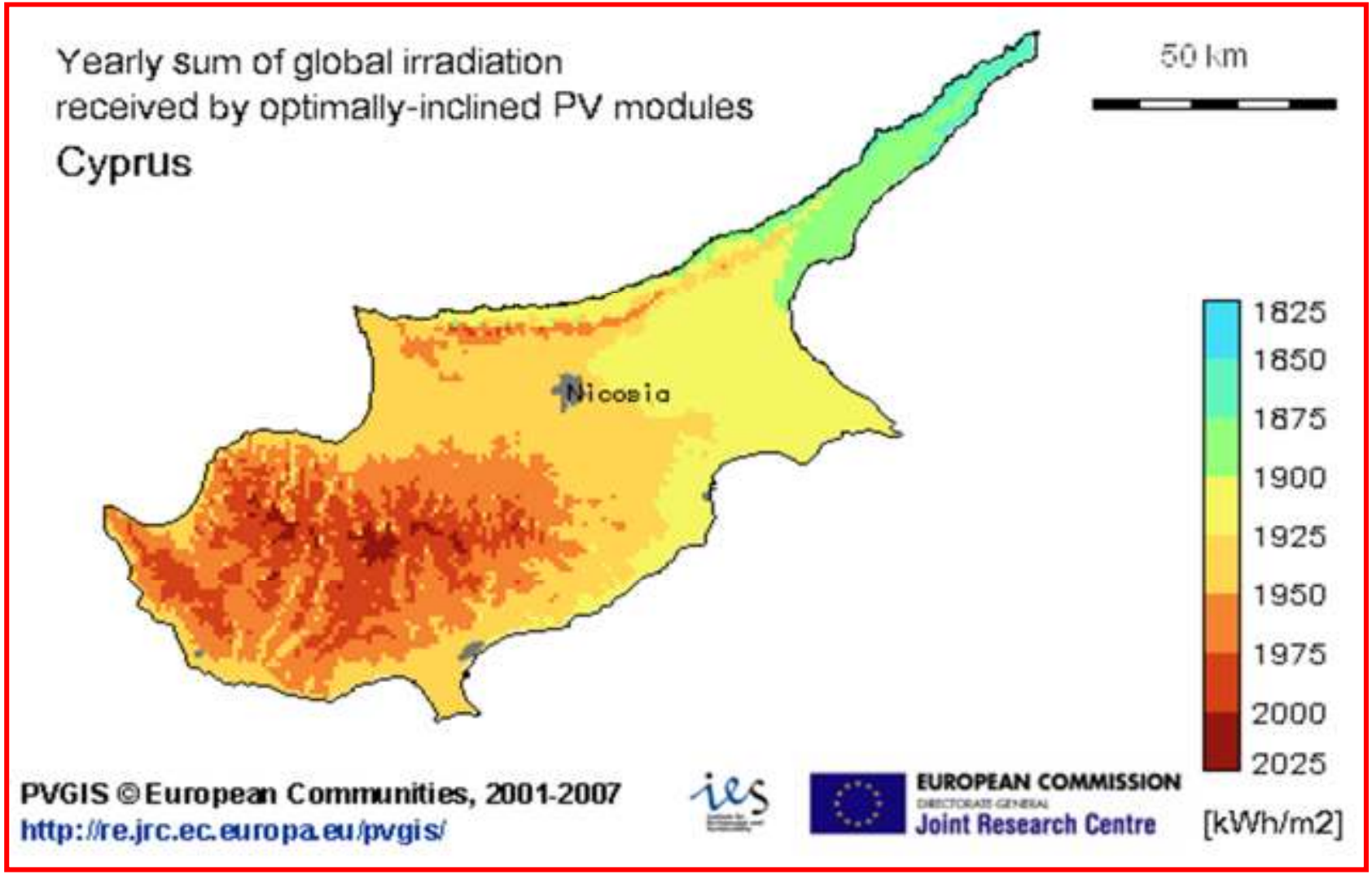
Potential

Solar irradiation in Cyprus is one of the highest in Europe - Proof of the enormous prospect and potential of this technology in Cyprus

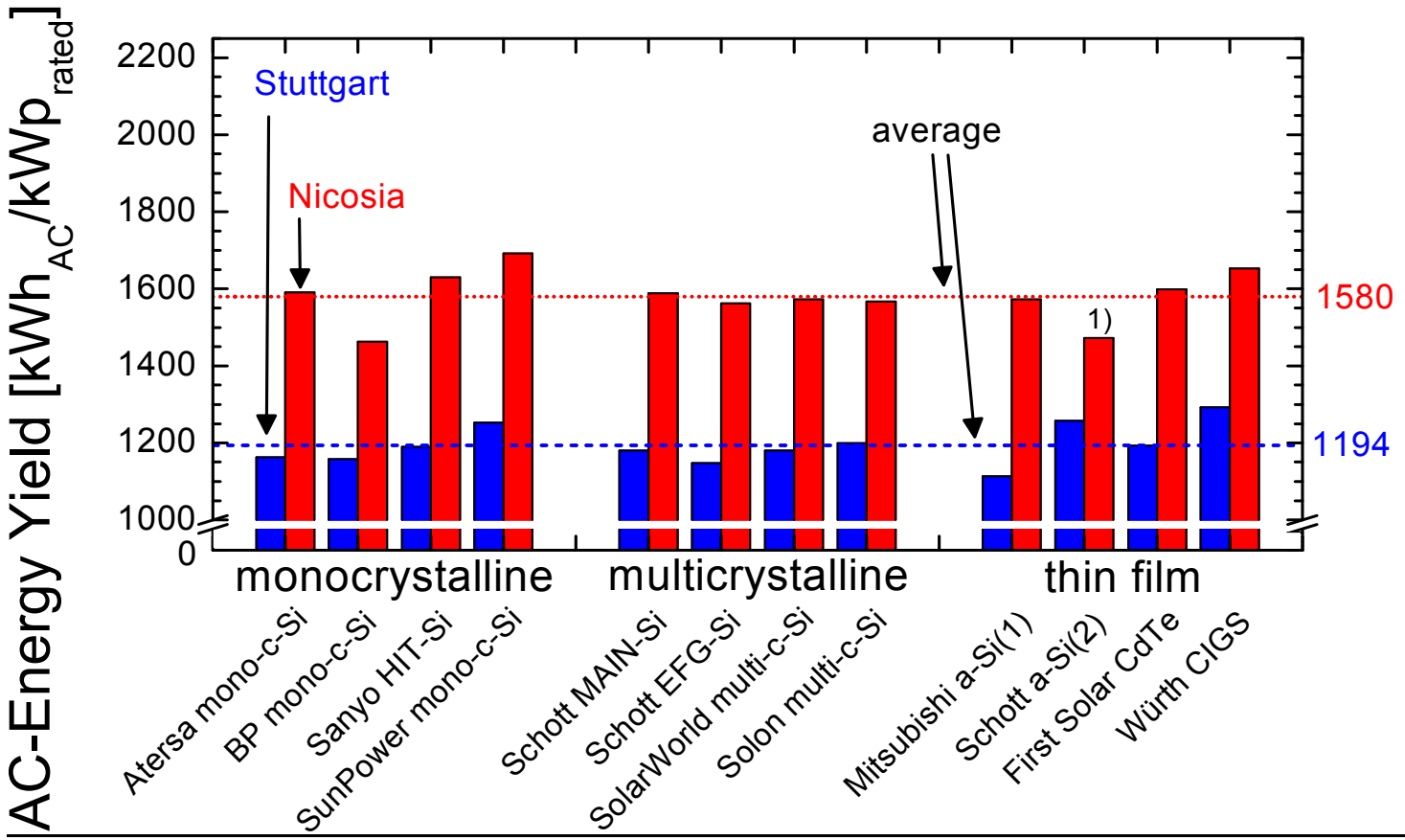
Urgent requirement towards more sustainable sources of energy.



Solar Potential in Cyprus



AC Energy Yield Comparison: Stuttgart and Nicosia



Location	Solar irradiation [kWh/m^2]		AC Energy Yield [kWh/kWp]	
	Year 1	Year 2	Year 1	Year 2
POA	1997	2050	1580	1609
tracker	2532	2606	2039	2052
POA (Germany)	1460	1306	1194	1066

Solar Thermal Electricity Power Production Plant in the area of Acrotiri Limassol – Description of Proposed Project

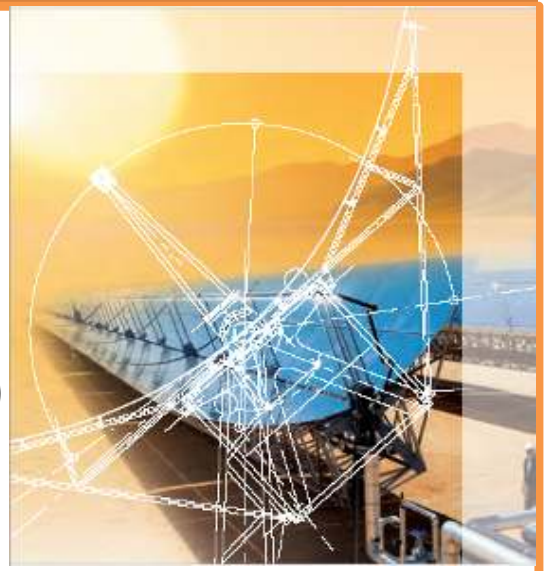
Total installed electric power: **50 MW**

Thermal storage **7.5 hours**

Estimated production energy output: **149 GWh/yr**

Parabolic mirrors: **624 (**length 148,50 m and width 5,77 m)

Site Area: **3,300,000 m2**



55% of which will be used for the proposed project **1,804,032 m2**

The Solar Thermal Station production will be channeled in the existing electricity grid with the construction of a closed type substation (GIS).

The new substation will be connected to the Colossi substation with an underground cable.

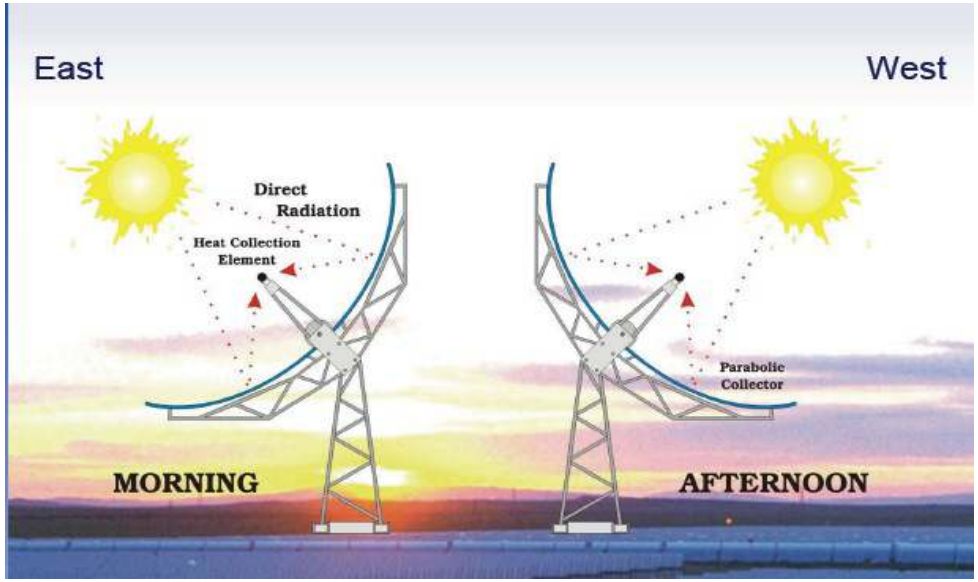
Cable routing through the existing road network.

Solar Thermal Station Description

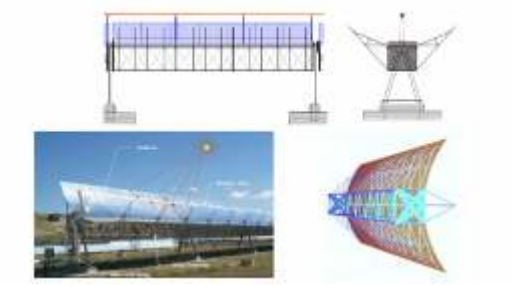
The mirrors concentrate solar rays in conductors running lengthwise, containing special fluid that is heated at 400°C.

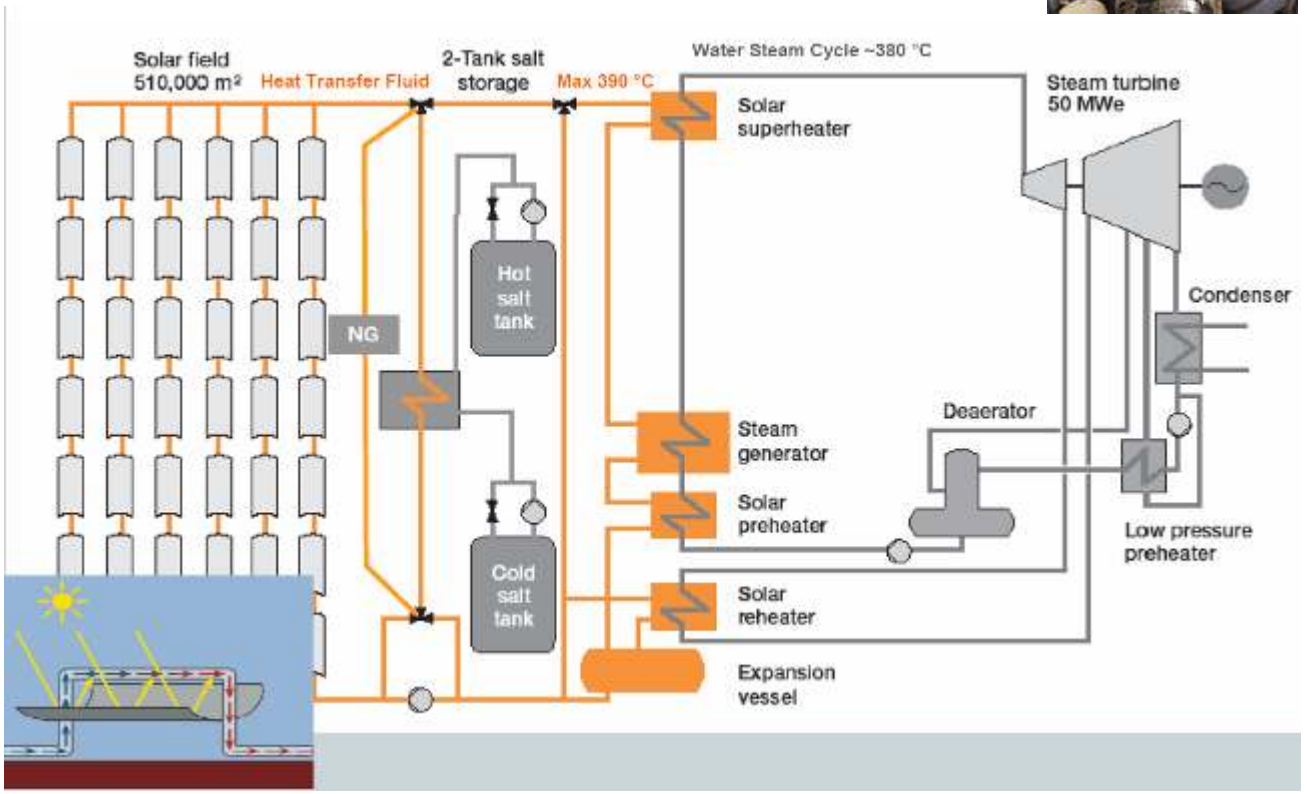
The special fluid is then transferred to the solar steam unit for steam production that is led to a steam turbine, which drives a generator to produce electricity.

The process is repeated as long as the sun is above the horizon with the use of the mirrors' special orientation mechanism, allowing the tracking of the sun until it sets.

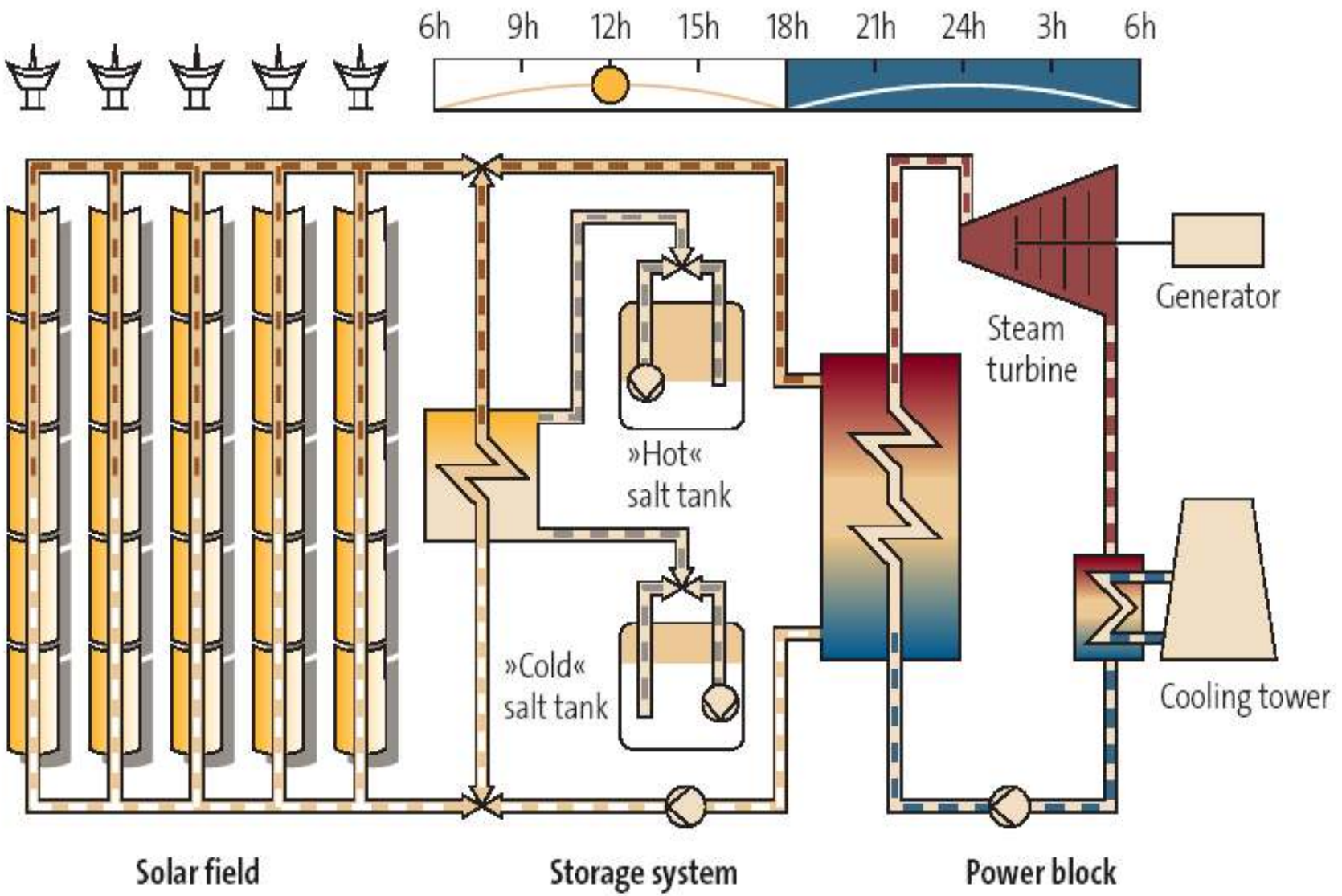


Solar Thermal Station Description

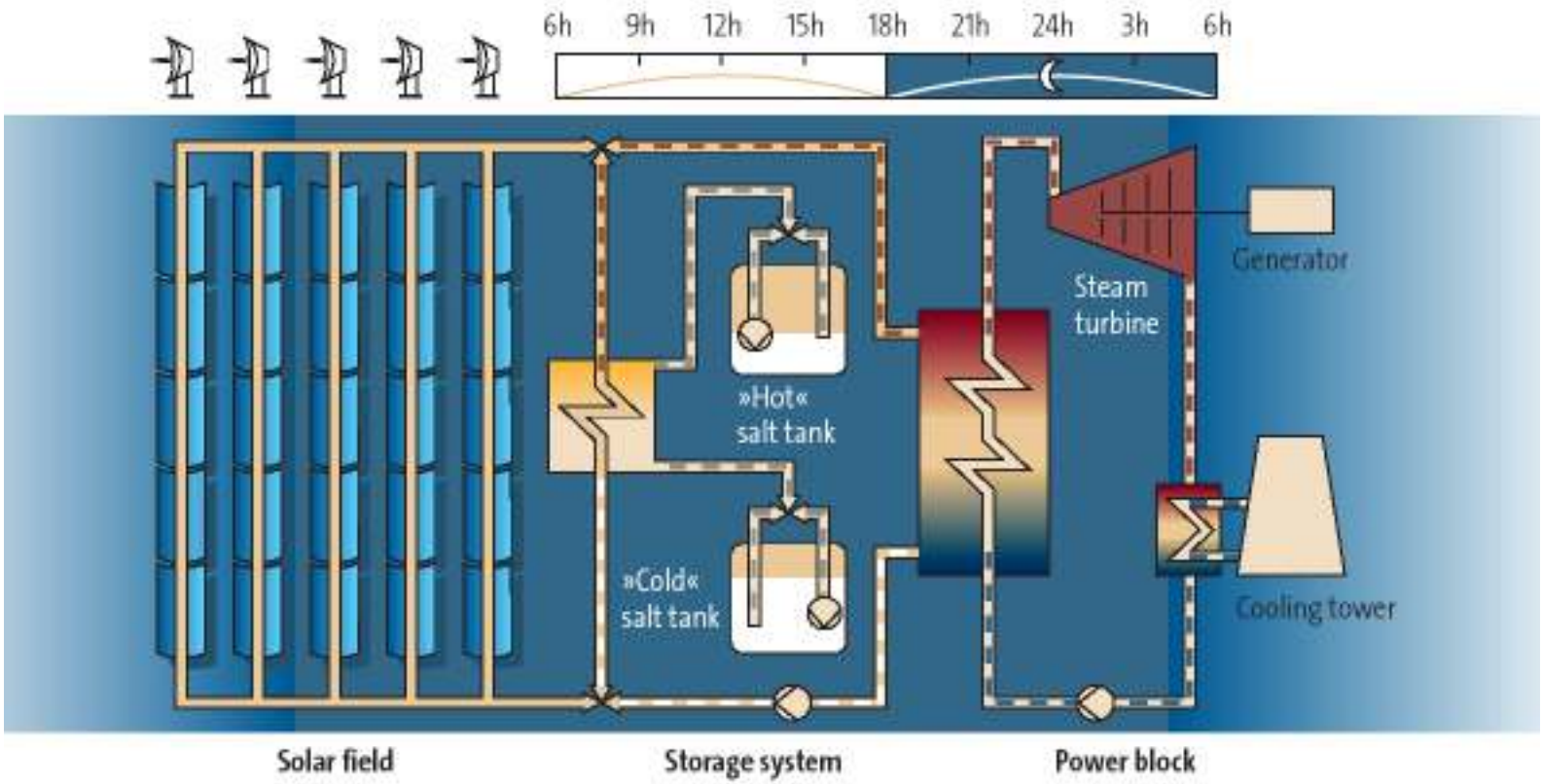




Solar Thermal Station Operation (daytime – sunshine)



Solar Thermal Station Operation (night time – cloudy)



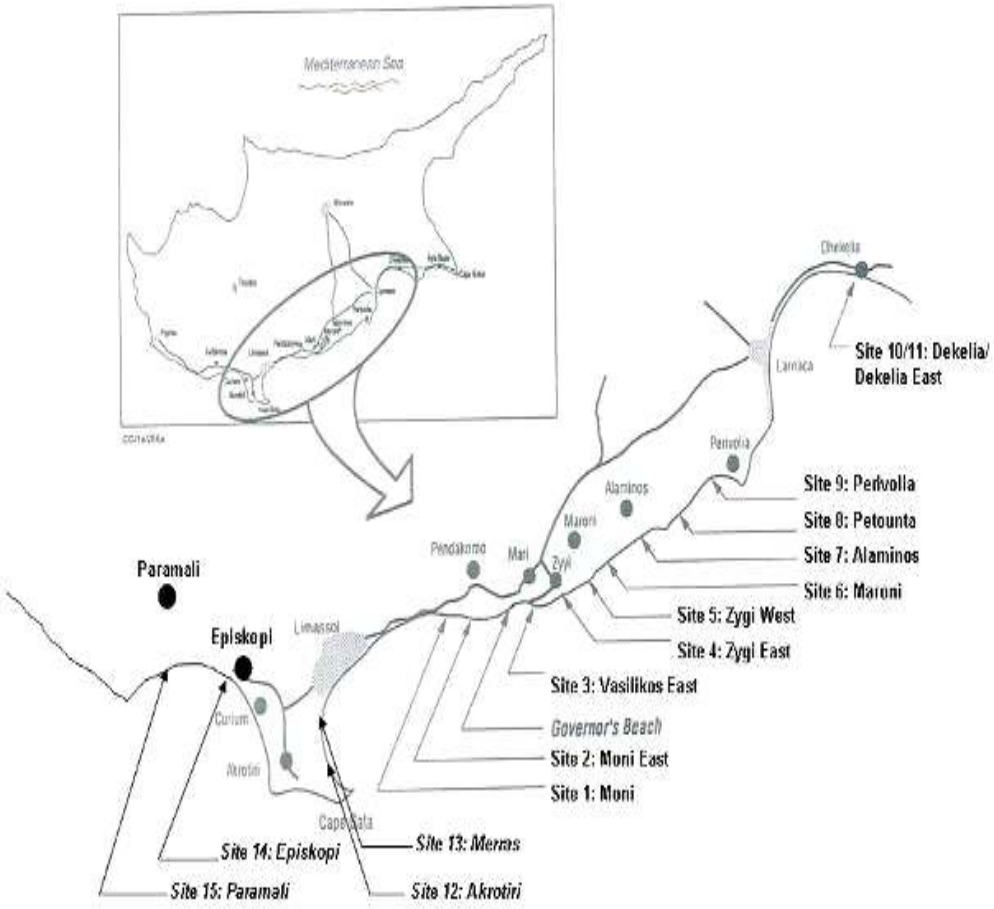
Location Choice

Criteria

a) Technological
Energy Storage
Cooling Water
Ground Area
Ground Inclination

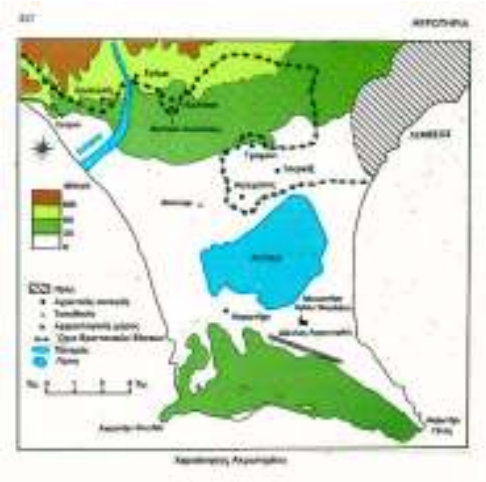
b) Natural Environment
Terrestrial Flora and Fauna
Marine Flora and Fauna
Soil Productivity
Fisheries
Aquatic Resources

c) Developed Environment
Land Uses
Cultural Heritage
Public Health
Landscape Aesthetics



Proposed Project Location

- Private plot owned by the Limassol Bishopric
- Acrotiri Peninsula
- Adjacent to Acrotiri
- South West of the Acrotiri salt lake
- British Sovereign Bases
- North of Military Airport
- West of Acrotiri Forest
- Adjacent in the West with the Cyprus Environmental Research & Education Center and the Monastery of St. Nicholas of the Cats



INPUT PARAMETERS (ΠΕΙΡΑΜΑΤΙΚΟ ΦΩΤΟΒΟΛΤΑΙΚΟ ΠΑΡΚΟ ΠΚ)

Computer Aided PV Calculations (Excel interface version)

Project description — **UCY 10MW PV system**

Input parameters

Parameter	Unit	Value	Notes
Technical data			
Plant capacity	kW	10000	
Annual solar potential	kWh/m²	1970	28 degrees fixed angle
PV frame area	m²/kW	7.03	
PV efficiency	%	14.02	
Losses	%	18.20	Incl orientation and inclination losses
Capital data			
Specific capital cost	€/kW	1380.00	
Capital cost	€	13800000	
Plant life	years	20	
Equity	%	58	
Rate of return on equity	%	0.1	
Rate of return on borrowings before tax	%	6	
WACC	%	2.58	
Capital recovery factor	%	0.064620715	
Emissions data			
CO_2 indicator	g/kWh	800	
CO_2 ETS price	€/t	0	
O&M data			
Staff	€/year	20000	
Maintenance	€/year	69000	0.005 % of capital cost
Overheads	€/year	0	
Specific O&M cost	€/kW	8.9	
Other data			
Utility base tariff	€c/kWh	5.886	Connection at 132kV
Base fuel price	€/t	187.95	Based on RES policy
Actual fuel price	€/t	500.00	
Fuel adjusting index	€c/kWh/5€c/t	0.00132	Connection at 132kV
Utility purchase tariff	€/kWh	0.141241	
Annual income tax rate	%	10	

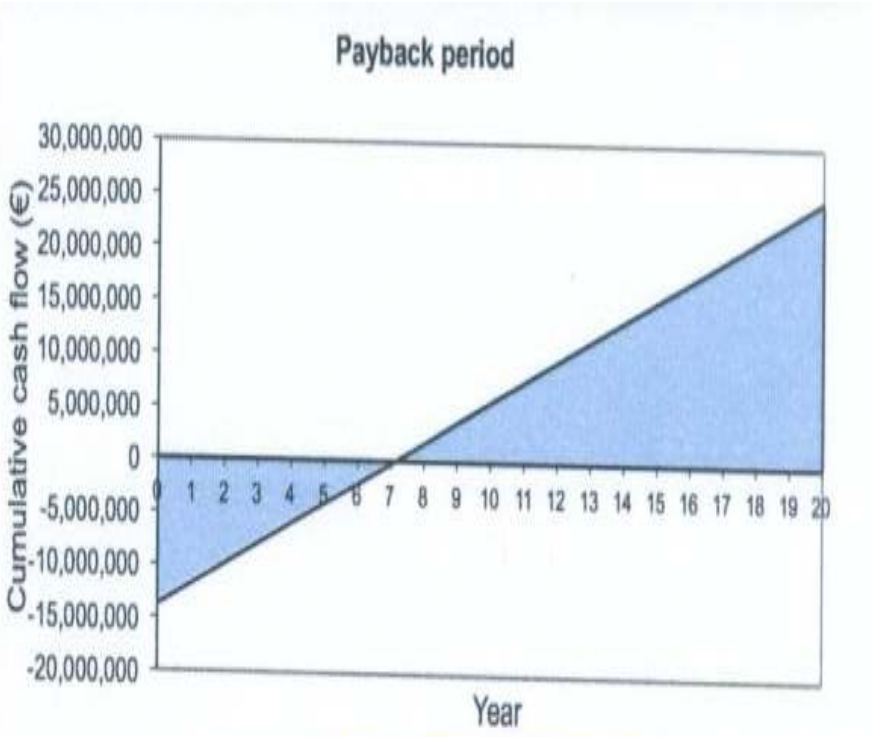
OUTPUT

Annual power generation	MWh	15882.65
Capacity factor	%	18.13
Annual CO_2 avoided emissions	t	12706
Annual barrels of crude oil not consumed	bbl	26380
Annual capital charge	€	-891766
Annual O&M charge	€	-89000
Annual CO_2 trading income	€	0
Annual electircity exported income	€	2243284
Capital charge	€/kWh	0.056147
O&M charge	€/kWh	0.005604
Total production cost	€/kWh	0.061751
CO_2 trading income	€/kWh	0.000000
Electircity exported income	€/kWh	0.141241
Production cost/benefit	€/kWh	0.079490

Benefit-accept project

CASHFLOW

Year	Annual (€)	Cumulative (€)
0	-13800000	-13800000
1	1938856	-11861144
2	1938856	-9922289
3	1938856	-7983433
4	1938856	-6044577
5	1938856	-4105722
6	1938856	-2166866
7	1938856	-228011
8	1938856	1710845
9	1938856	3649701
10	1938856	5588556
11	1938856	7527412
12	1938856	9466268
13	1938856	11405123
14	1938856	13343979
15	1938856	15282835
16	1938856	17221690
17	1938856	19160546
18	1938856	21099402
19	1938856	23038257
20	1938856	24977113



After tax IRR	12.78%	Profitable
NPV	€16,203,624	
Payback period in years	7.12	

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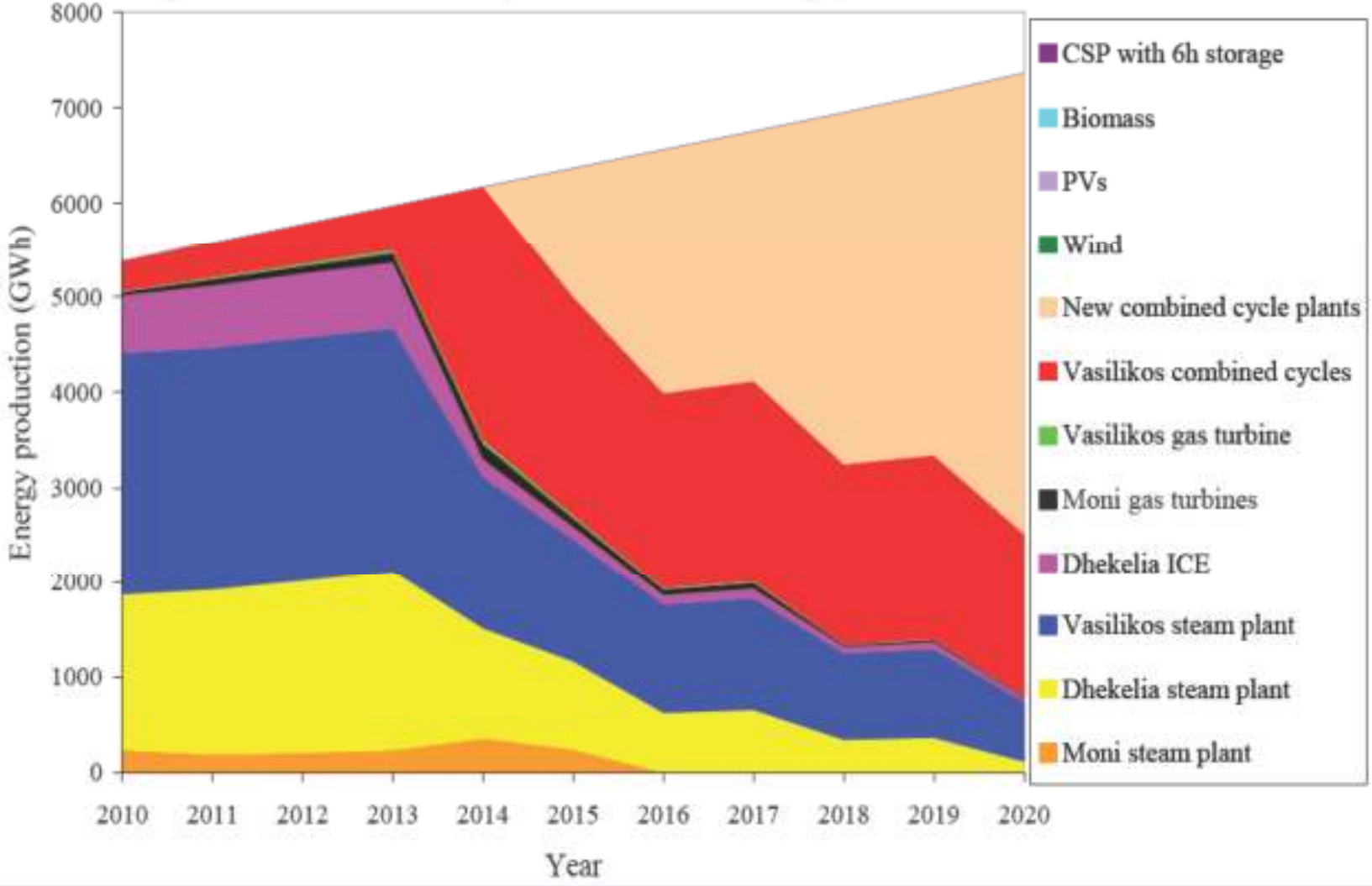
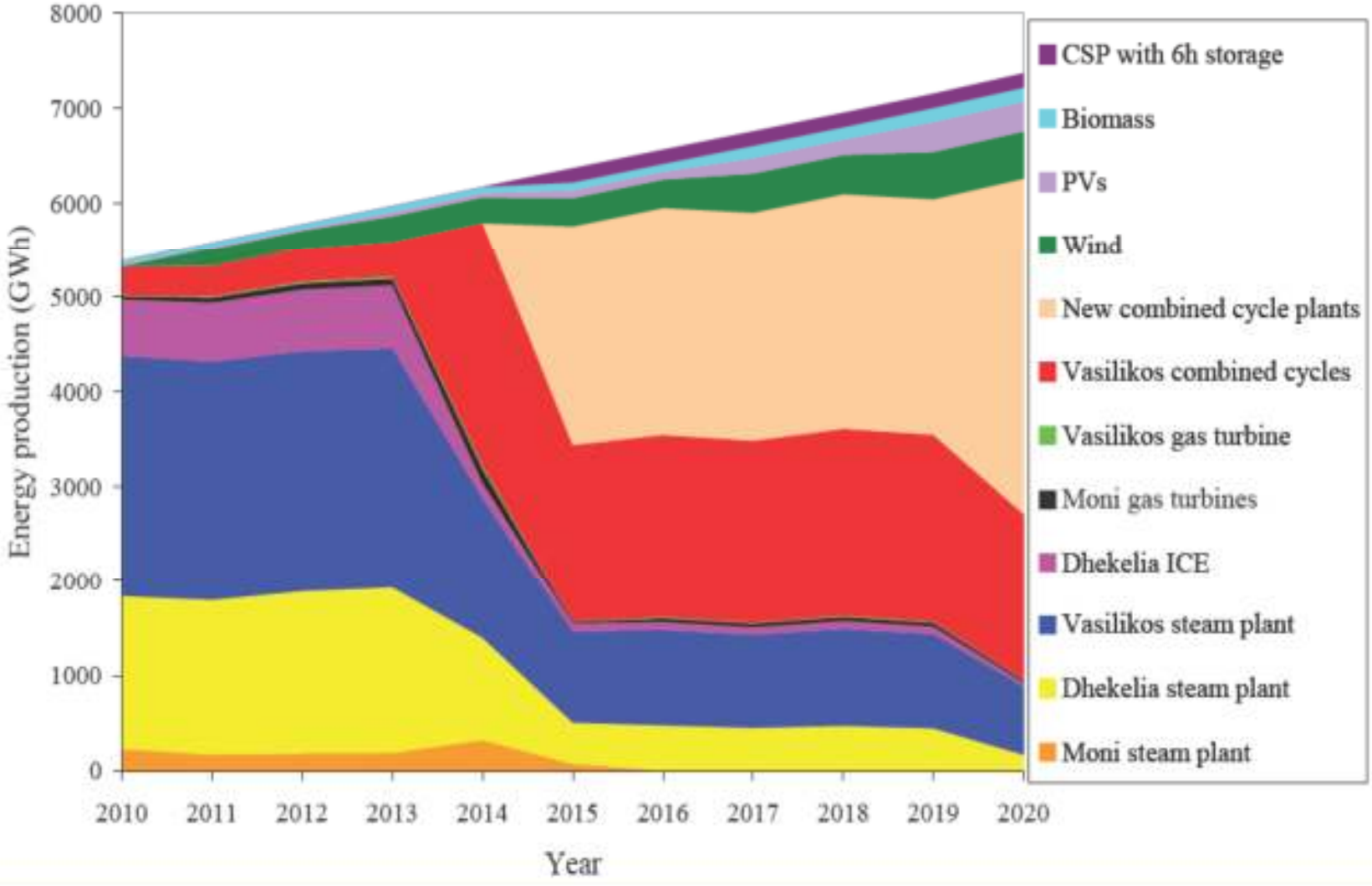
Cyprus RES action plan

Power generation system energy mix with BAU

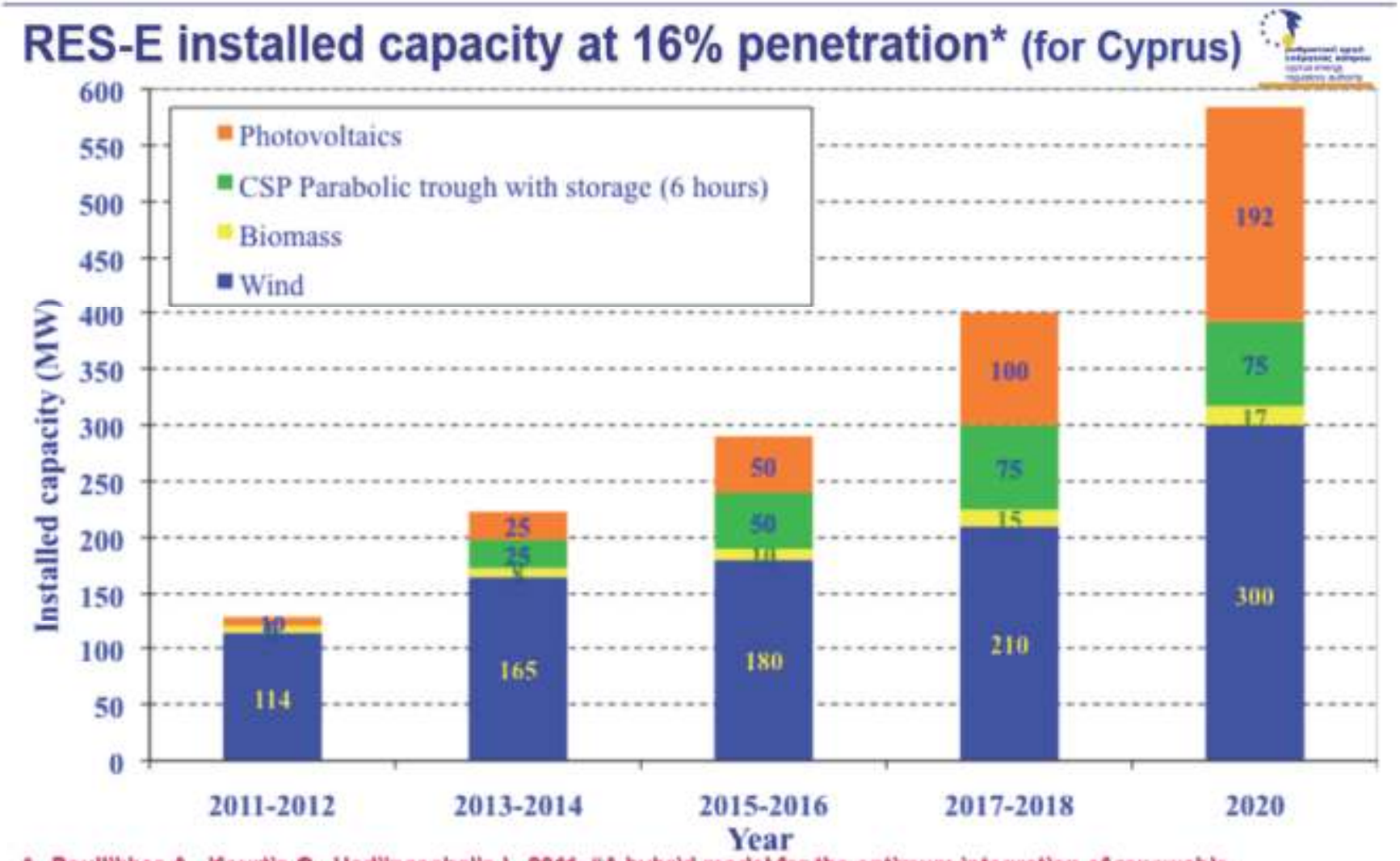


Cyprus RES action plan

Power generation system energy mix with 15% RES-E penetration



Cyprus RES action plan



* Poullikkas A., Kourtis G., Hadjipaschalis I., 2011, "A hybrid model for the optimum integration of renewable technologies in power generation systems", *Energy Policy*.

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REFERENCES

- Cyprus Energy Regulatory Authority - Mr. Georgios Shammas, President
- Electricity Authority of Cyprus - Dr Andreas Poullikkas, Research and Development Assistant Manager
- UCY Department of Electrical and Computer Engineering – Assistant Professor George Georgiou