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UK-ISES 50-YEAR CELEBRATION
Celebrating 50 years of advances in solar energy utilisation

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"Greece and SE Europe in the New Solar Landscape"

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INSTITUTE OF ENERGY
FOR SOUTH EAST EUROPE

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Greece and SE Europe in the New Solar Landscape

- Today Greece is playing a leading role in the solar transformation not only of the country itself but also of the rest of SE Europe. The countries in the region include those in the Balkan peninsula but also Turkey, Israel, Cyprus and the East Mediterranean in general
- A real solar revolution has been quietly taking place over the past 20 years or so with applications accelerating over the last 5 years
- Interest in solar energy by households and industry was compounded by the growing awareness of the role of Renewable Energy Sources (RES) as part of the overall effort in tackling climate change

Greece and SE Europe in the New Solar landscape - SWH

- Back in the 70's and 80's the predominant solar application concerned solar water heating and related applications and as a result we saw the rise of a vibrant solar industry in Cyprus and Israel to start with, followed by Greece.
- The early introduction of ASHRAE based standards and the mandatory laboratory testing of new collector models, lead to the establishment of a reliable and forward looking solar industry.
- The use of solar water heating systems spread fast in most countries in the region with Greece emerging as clear winner with more than 1.8 million domestic and business applications, corresponding to 5.5 million sq.m, including hotels, schools, hospitals, industrial plants etc. (2023 data)
- The rest of the region boasts as many as 8.0 million sq metres of solar collector area.
- A noteworthy achievement is the emergence of Greece as a net exporter of locally manufactured solar water heating systems, exporting some 60% of its annual production to a large group of countries all over SE Europe but also to Africa and the Middle East.

Source: Solar Heat Europe

Solar Waters Heaters in Greece

The Greek Solar Collector Market 2005 – 2023 (m^2)

European Solar Thermal - Market Overview 2023

Solar thermal in volume, in Europe, by market segment
(Source: Solar Heat Europe)

Buildings
Large scale

96%
of solar thermal volume
is installed on buildings

Distribution of the newly installed capacity by collector type in 2022 - Europe
Source: IEA Solar Heating and Cooling Programme - Solar Heat Worldwide

Evacuated tube collector 27.6%
Unglazed water collector 0.3%
Air collector 0.2%
Flat plate collector 71.9%

Europe: EU27, Albania, North Macedonia, Norway, Russia, Switzerland, Turkey, United Kingdom

1) The relation between collector area and capacity is $1m^2 = 0.7kW_{th}$ (kilowatt-thermal)
2) Capacity "in operation" refers to the solar thermal capacity built in the past and deemed to be still in use. Solar Heat Europe/ESTIF assumes a 20 year product life for all systems installed since 1990. Most products today would last considerably longer, but they often cease to be used earlier, e.g. because the building was demolished, or there has been a change of building use.
3) The figures shown here relate to Metropolitan France (mainland). As a reference, in 2022 the newly installed capacity in overseas departments is estimated to be around 60 MW_{th} (86 000 m^2).

Country	Use of Solar thermal per capita	Cumulative Installed Capacity in Operation (MW_{th})	Annual evolution Total Installed Capacity 2023/2022	New installed capacity in 2023 (in m^2)	New installed capacity in 2023 (MW_{th})	Annual Evolution New Installed Capacity
AT		2 471	-4%	38 711	27	-20%
BE		504	1%	13 000	9	-30%
BG*		156	4%	13 800	10	-25%
HR		208	3%	12 473	9	-8%
CY		701	4%	66 740	47	-10%
CZ*		468	2%	22 472	16	-12%
DK*		1 249	-1%	2 451	2	-8%
EE*		17	5%	1 354	1	-5%
FI*		58	8%	7 360	5	-8%
FR		2 009	3%	114 669	80	8%
DE		13 285	-2%	376 000	263	-47%
GR		4 024	6%	469 280	328	12%
HU*		263	2%	12 880	9	-8%
IE*		292	0%	1 027	1	-8%
IT		3 829	3%	232 728	163	-31%
LV*		31	3%	1 564	1	-8%
LT*		20	6%	1 698	1	-3%
LU*		54	3%	3 387	2	-8%
MT*		35	-3%	1 238	1	-7%
NL		454	2%	43 360	30	3%
PL		2 427	3%	130 800	92	-38%
PT		985	2%	41 659	29	-37%
RO*		196	5%	15 577	11	-8%
SK*		153	5%	15 456	11	-8%
SI		93	0%	1 269	1	-14%
ES		3 089	1%	128 357	90	-7%
SE		174	-6%	4 600	3	-8%
CH		1 076	0%	23 708	17	-28%
UK		494	-1%	15 394	11	69%
EU27 + CH + UK		**40 816**	**0.6%**	**1 813 012**	**1 269**	**-22.7%**

0 kW$_{th}$ per 1000 capita 800

* Solar Heat Europe estimations
+ Based on the EurObserv'ER "Solar thermal and CSP Barometer" (2022).

Source: Solar Heat Europe

The SE European Region Defined

Core countries

- Albania
- Bosnia and Herzegovina
- Bulgaria
- Croatia
- Cyprus
- Greece
- Hungary
- Israel
- Kosovo
- Montenegro
- North Macedonia
- Romania
- Serbia
- Slovenia
- Turkey

Peripheral countries

- Austria
- Egypt
- Italy
- Lebanon
- Moldova
- Slovakia
- Syria
- Ukraine

Total Installed Collector Area (m^2) in Operation in SE Europe, 2022

Country	Water collectors (m^2)			Air collectors (m^2)		Total (m^2)
	unglazed	FPC	ETC	Unglazed	glazed	
Albania		315,223	14,262			329,485
Bulgaria		214,938	5,850			220,788
Croatia		275,393	13,308			288,701
Cyprus	2,213	859,430	23,567			885,210
Greece		5,399,200	22,800			5,422,000
Hungary	18,300	293,749	79,850	3,418	2,300	397,617
North Macedonia		81,907	63,129		32	145,068
Romania	340	150,479	114,590	800		266,209
Slovenia		128,000	23,670		10	151,680
Türkiye		16,395,608	10,950,989	15,815		27,362,412

European Solar Thermal - Market Overview 2023: Residential and Tertiary Buildings

The solution: Providing hot water and heat directly from the sun's energy with Solar Thermal

11 million rooftops in Europe are equipped with solar thermal & thermal storage

Total installed capacity in Europe (mainland): **41 GW_{th}**

That's **58 million m²** of collectors

Newly installed capacity in 2023: **+ 1.27 GW_{th}**

- 22.7 % of newly installed capacity vs 2022
+ 0.6% of increase of the **total** installed capacity
An increase of + 1.8 million m²

All is relative – Varying countries dynamics in Europe in 2023 vs 2022:

UK + 70%
+ 15 394 new m²
A new market in growth

GR + 12%*
+ 469 280 new m²
Constant supportive scheme for renovation

FR + 8%*
+ 114 669 new m²
"Ma Prime Rénove" ongoing financing support scheme for various clean heat options notably solar thermal

NL + 3%*
+ 43 360 new m²
Supportive schemes include Sustainable Energy Incentive Measure (SDE++) for large scale projects and Sustainable Energy Investment Subsidy (ISDE) for buildings

DE - 47%
+ 367 000 new m²
An unfortunate counter effect of the Heating Law (requiring 65% RES heat supplies), with increases of sales of heat pumps and... gas boilers

* estimations

Solar Photovoltaic Thermal (PVT):

Total installed capacity in Europe:

1.01 million m²

= 64% of all PVT installed worldwide

FR	DE	NL
616 551 m²	162 549 m²	127 303 m²

2023 vs 2022:
Spain: + 34% (+ 7 382 m²)
Belgium: + 20% (+ 1 018 m²)
Germany: - 20%

Lighthouse projects delivered in 2023:
The British Library, Central London: 617 m²
Olympic Swimming Club, Barcelona: 2 082 m²

Countries with the largest Solar Thermal installed capacity (in operation):

DE **13 285** MW_{th}
GR **4 204** MW_{th}
IT **3 829** MW_{th}
ES **3 089** MW_{th}
AT **2 471** MW_{th}

Source: Solar Heat Europe

Greece and SE Europe in the New Solar Landscape – Solar Buildings

- In SE Europe, and Greece in particular we have some succesful examples of solar heated and cooled building. There is a long tradition in Greece and other Mediterranean countries of climate adapted vernacular architecture
- However, solar heated and cooled building applications have not really taken off
- The problem lies in the fact that such applications normally involve solar passive techniques (today known as bioclimatic), and these mostly apply to new buildings. In addition, they require proper training by architects and engineers and a willingness by clients to try new systems and pay the added cost (3% - 6% of total construction budget)
- As a result, bioclimatic type buildings count only few thousand in the whole region. However, as energy costs rise there is now a trend to consider bioclimatic applications in connection with building conversion and renovation projects. So, a new chapter in solar applications is about to begin.

Greece and SE Europe in the New Solar Landscape – Solar Buildings

Source: Tombazis and Associates Architects

Greece and SE Europe in the New Solar Landscape - Photovoltaics

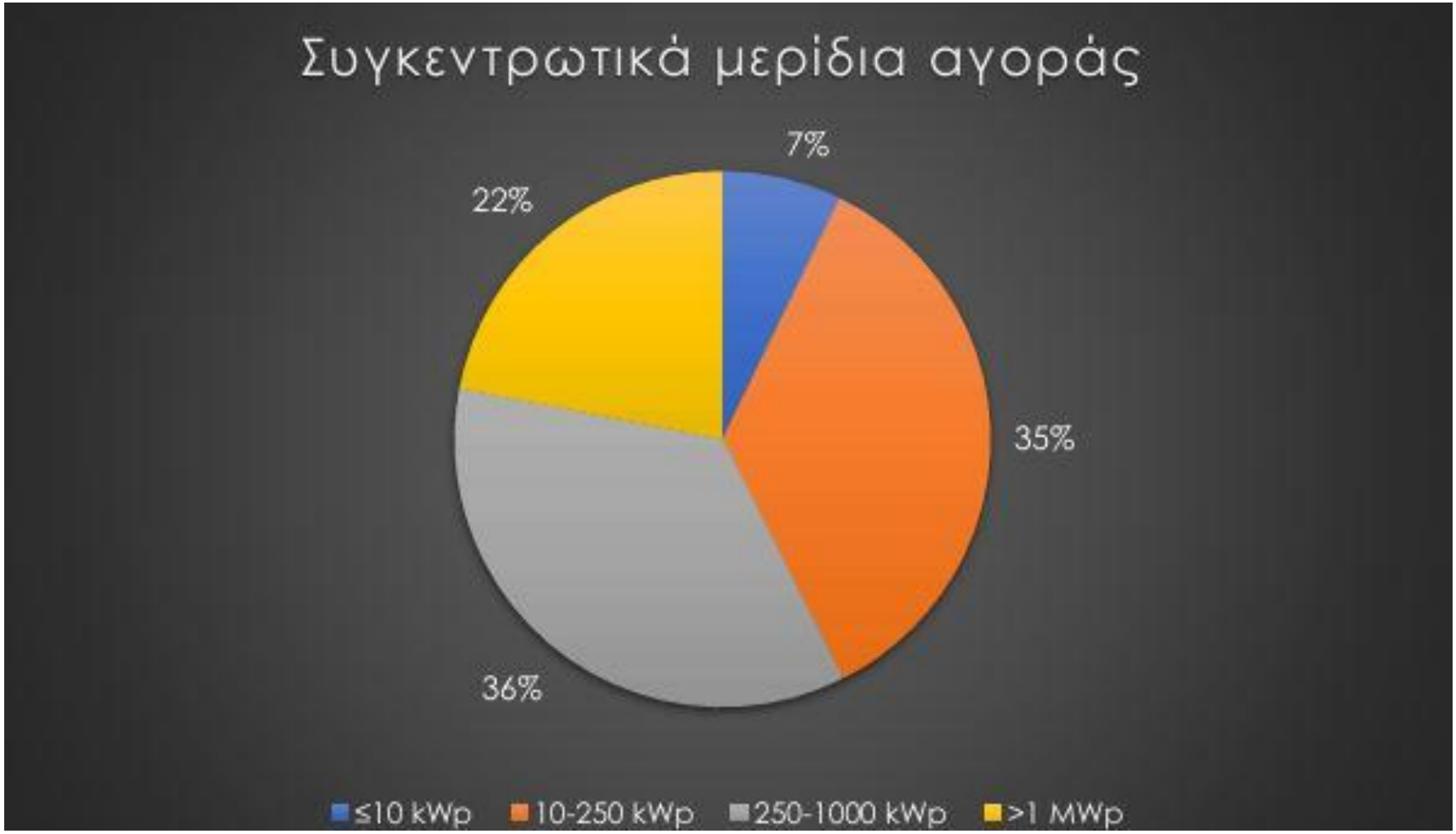
- The rise of photovoltaics came much later into the scene although pilot applications at specialized level (eg lighthouses, telecom installations) and at remote household level appeared as early as 1980. The real impetus came after 2006 following bold policy messures by the then government in Greece, which were soon followed by other countries in the region
- A combination of feed in tariffs and government backed soft loans supported the first wave of auto producers, which few years later was followed by the introduction of auctions for PV and Wind. By 2016 /2017 conditions had matured for the construction of several multi MW photovoltaic projects first in Greece and shortly afterward in the other countries in the region
- The rise of photovoltaic and RES applications in Greece and the other countries in the SEE has been phenomenal, to say the least, over the last 5 years. With more than 8.0 GW of PV installations by the end of 2024, 5.5% of which involve house photovoltaics, and 5.5 GW of wind
- Greece is emerging a clear winner in the region (surpassed only by Türkiye which strictly speaking is not part of the European scene) Excluding Türkiye the total RES installed capacity in SEE currently exceeds 50 GW, (including large hydros), of which 35% is to be found in Greece.
- With more than 45% average yearly contribution of RES in the electricity generation mix (including hydros), Greece is ranking very high in European terms concerning the contribution of renewables for power generation

Examples of Solar Photovoltaics Installations in Greece

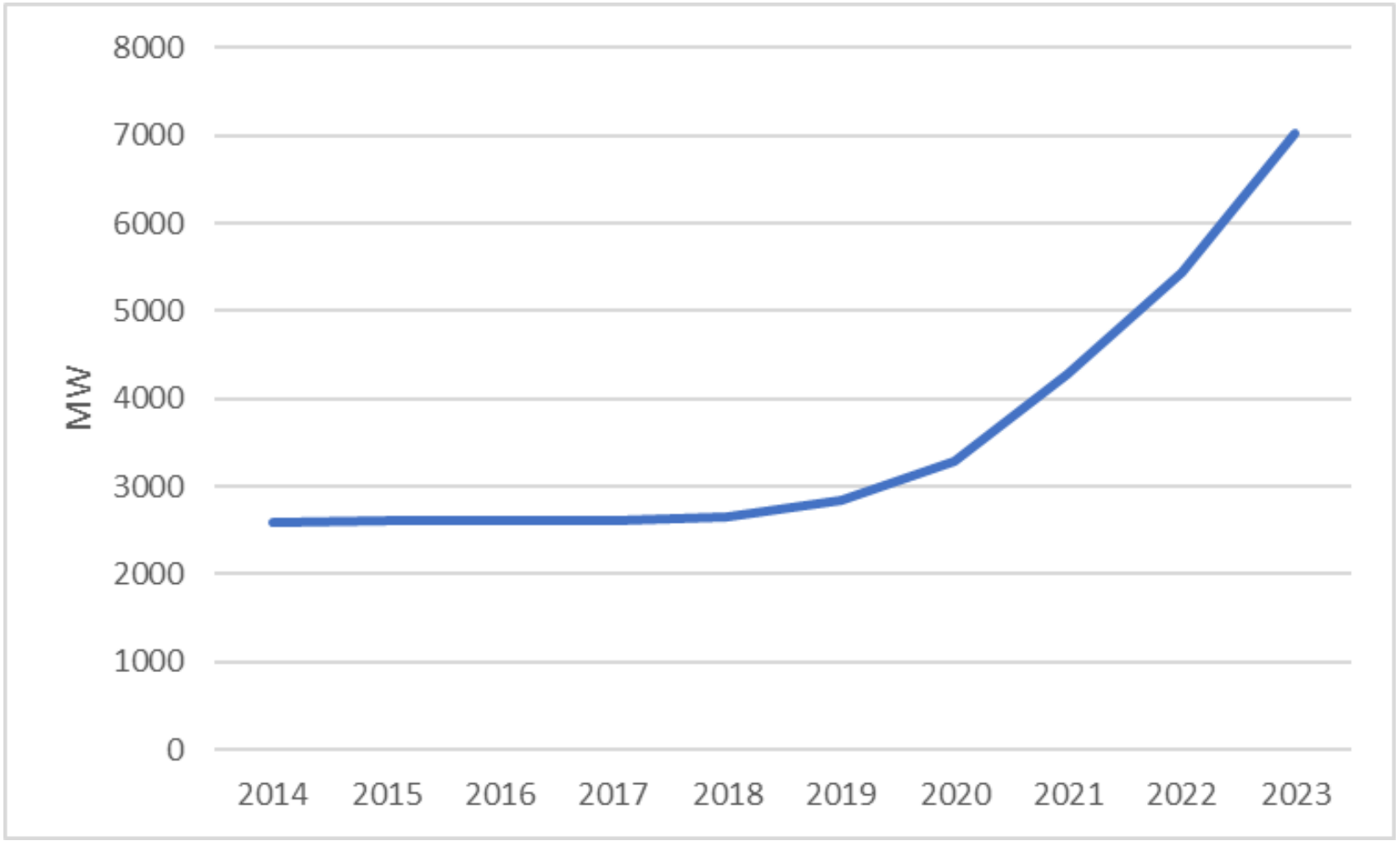
The Greek Solar PV Market (2010 – 2022)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Ετήσια συνδεδεμένη ισχύς	152	426	912	1.043	17	10	6	13	43	161	459	838	1.340
Συνολική συνδεδεμένη ισχύς	199	625	1.537	2.579	2.596	2.607	2.612	2.625	2.668	2.829	3.288	4.126	5.466

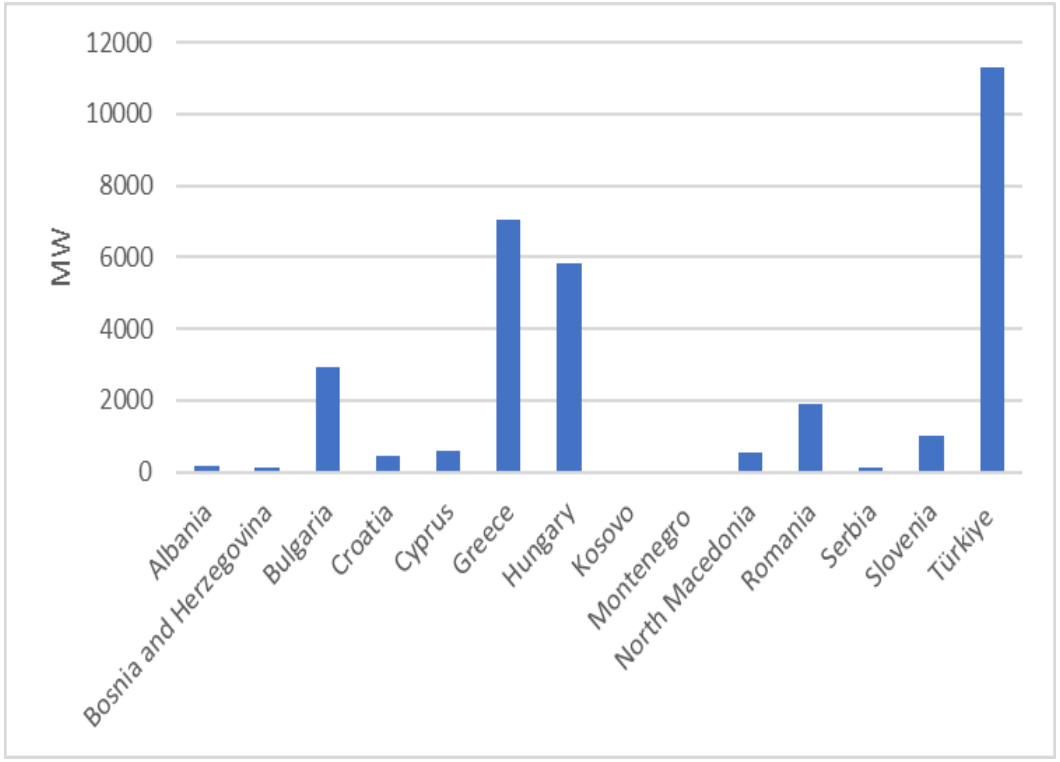
Greek Solar PV Market: Capacity Distribution



Total Installed Capacity (MW) of Solar PV in Greece, 2014-2023



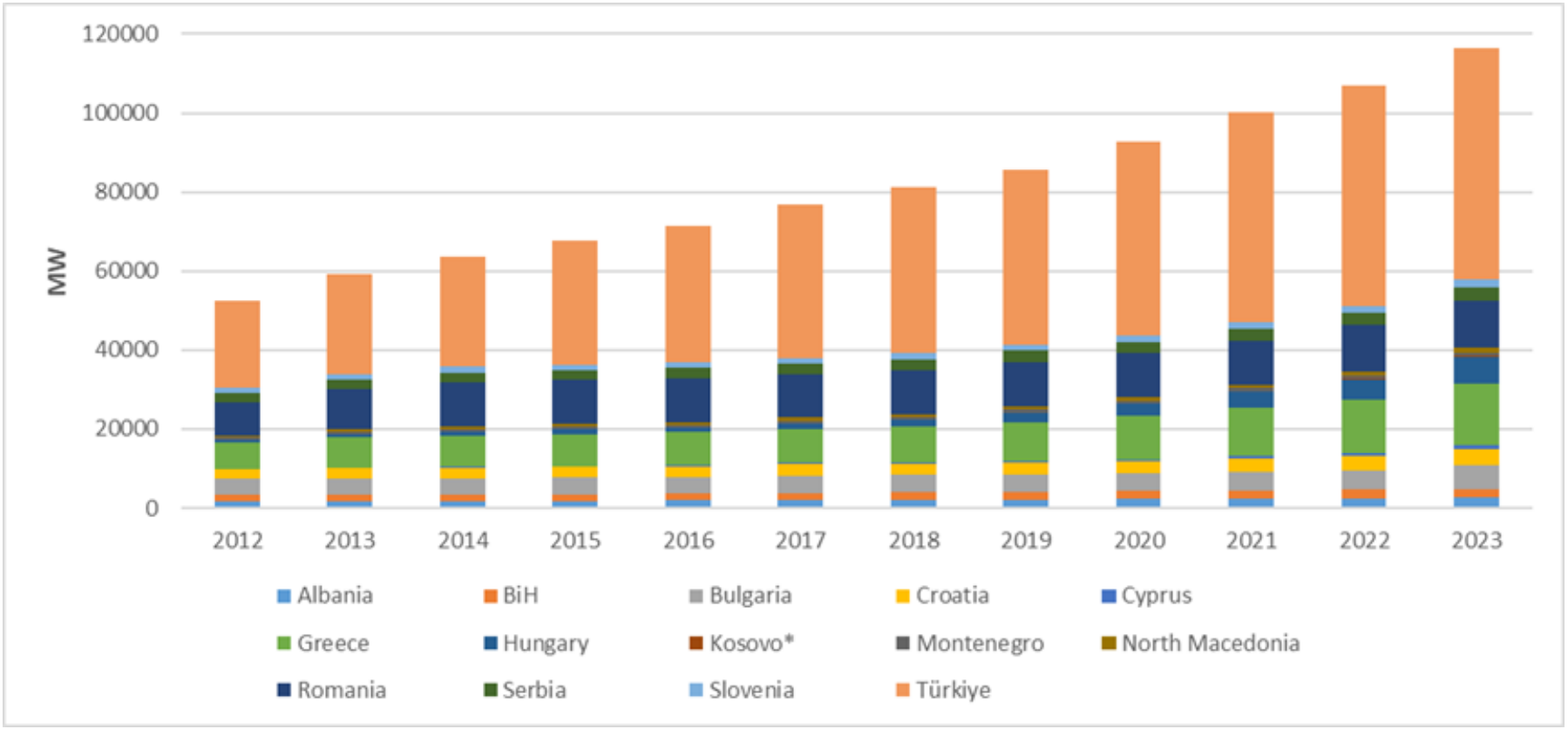
Total Installed Capacity (MW) of Solar PV in SE Europe, 2023



Country	Total Installed Capacity (MW) of Solar PV
Albania	163
Bosnia and Herzegovina	132
Bulgaria	2,937
Croatia	461
Cyprus	606
Greece	**7,030**
Hungary	5,835
Kosovo	20
Montenegro	42
North Macedonia	535
Romania	1,917
Serbia	137
Slovenia	1,034
Türkiye	11,293

Source: IRENA

Total Installed RES Capacity (MW) by Country in SE Europe, 2012-2023



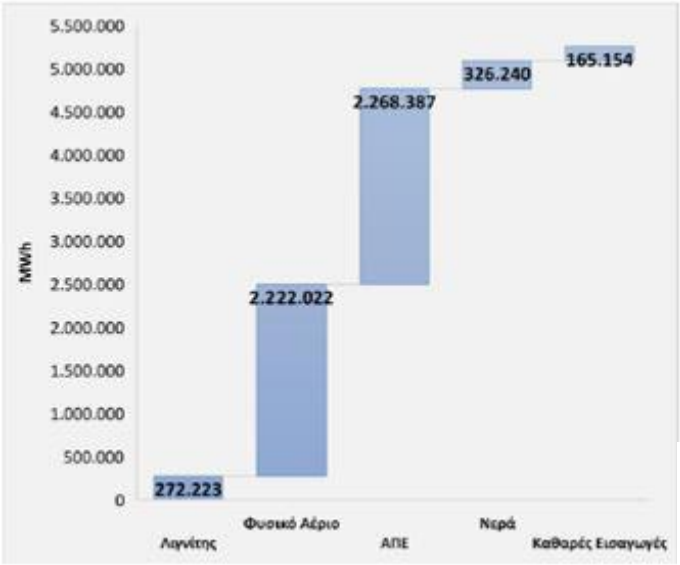
Source: IRENA

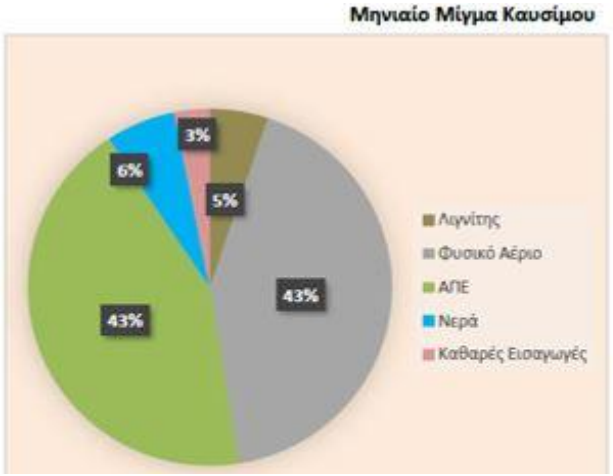
Renewable Electricity Generation Capacity (MW) in SE Europe, 2023

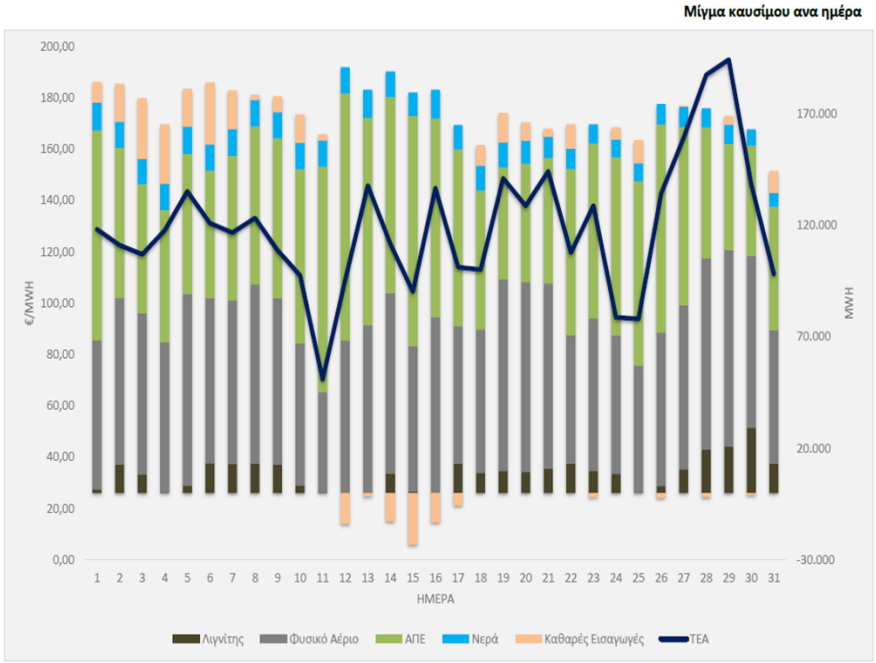
	Hydro	Wind	Solar	Bioenergy	Geothermal	Total
Albania	2493		163	1		**2657**
Bosnia and Herzegovina	2258	135	132	11		**2536**
Bulgaria	3390	702	2937	50		**7079**
Croatia	2206	1143	461	161	10	**3981**
Cyprus	3427	158	606	14		**4205**
Greece	3427	5220	7030	128		**15805**
Hungary	60	324	5835	534	3	**6756**
Kosovo	110	137	20			**267**
Montenegro	697	118	42			**857**
North Macedonia	696	110	535	14		**1355**
Romania	6666	3087	1917	185		**11855**
Serbia	3108	511	137	39		**3795**
Slovenia	1342	3	1034	96		**2475**
Türkiye	31779	11697	11293	2001	1691	**58461**
Total	**61659**	**23345**	**32142**	**3234**	**1704**	**122084**

Source: IRENA

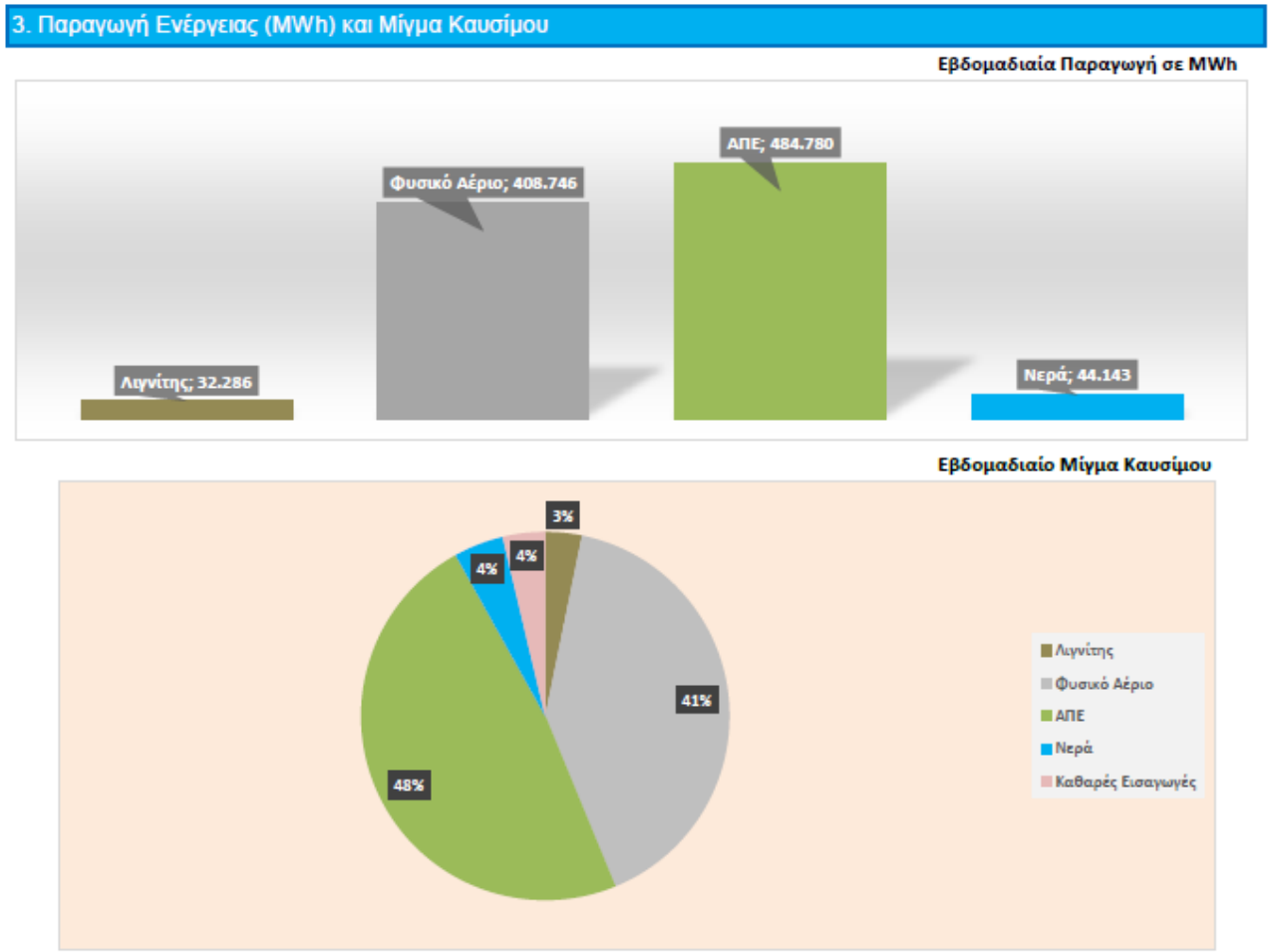
Power Generation Mix in Greece, August 2024



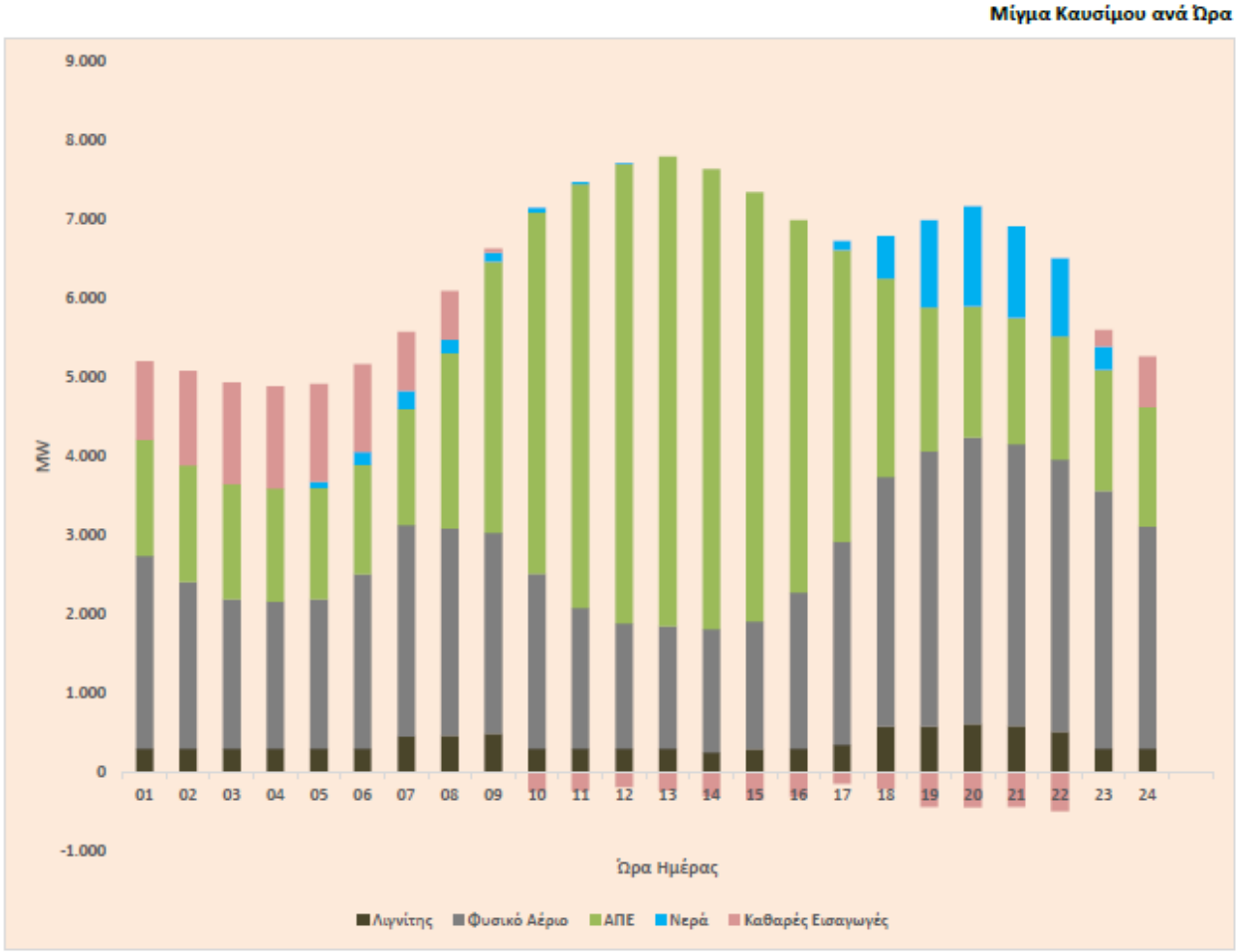




Power Generation Mix in Greece, Week 37, September 2024



Average Daily Power Generation Mix, Week 27, September 2024



The Kozani 203 MW PV Plant by HELLENiQ ENERGY

Major Solar PV Projects in Greece

Project	Location	Capacity (MW)	Company	Implementation Phase
Solar Power Plant of HELLENIC PETROLEUM Group	Kozani (Western Macedonia)	204.3	HELLENIC PETROLEUM Group	In operation (since 2022)
Solar project in the prefectural units	Larissa and Fthiotida	560	Lightsource bp	Under construction (since 2022)
PPC Ptolemaida Solar PV Park	Western Macedonia	550	PPC Renewables	Under construction (since 2023)
SENS LSG Greece Solar PV Park	Western Macedonia	480	LSG Building Solutions; Iqony Solar Energy Solutions	Permitting stage (since 2022)
PPC Renewable Amyntaio Solar PV Park	Western Macedonia	450	PPC Renewables	Permitting stage (since 2022)
Solar power portfolio	Western Macedonia, Thessaly and Central Greece	816	DEPA Commercial	Under development (since 2023)
RWE and PPC Greece Solar PV Park 2	Western Macedonia	940	RWE Renewables, PPC Renewables	Under development (since 2022)
RWE and PPC Greece Solar PV Park 1	Western Macedonia	1,060	RWE Renewables, PPC Renewables	Announced (since 2024)

Source: IENE

Greece and SE Europe in the New Solar Landscape

Concluding Remarks

- As we have seen in the previous table giant scale PV plants tend to dominate the market as we move towards a new level of maturity
- We have now reached a point, not only in Greece but in several other countries, whereby the further penetration of solar energy and other renewables will not be as easy, since we are already experiencing extensive power curtailments during peak hours as a result of electricity grid limitations (these range from 5% to 40% on daily basis)
- From now on the real challenge will be how to enhance further RES utilization in tandem with increased storage and upgraded electricity grid operation (eg extensive use of power electronics)
- As the global energy system will be gradually transforming into an all electric one over the next decades, the role of renewables and solar energy in particular, with its diverse applications, will be crucial. Greece, although a small country, is ready to take advantage and aspires to lead by example in the coming solar dawn

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