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Heatwaves and power peaks: Analyzing Croatia's record electricity consumption in July 2024

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INTRODUCTION

In July 2024, an intense and prolonged heatwave hit Southern Europe, including Croatia. Daytime temperatures consistently exceeded 30 °C, which, coupled to the peaking tourist season, caused unprecedented energy demand for cooling and air-conditioning. As consequence, new record high power loads were set on several occasions during July 2024. The overall maximum power load of 3381 MW was recorded at 19:30 on July 17, 2024, as shown in figure 1. All available base load capacities (nuclear, thermal and hydro) were online in an attempt to meet the increasing demand. However, as much as 50% of the power load had to be imported as the domestic power plants could not meet the entire demand.

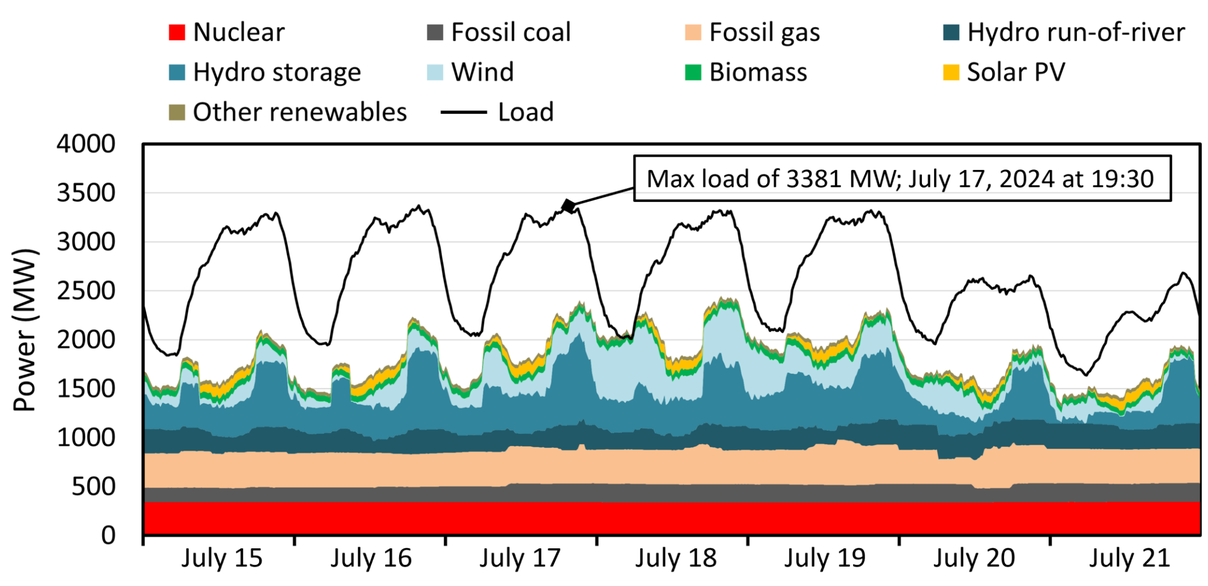

Figure 1. Net electricity generation in Croatia during July 15-21, 2024

Large electricity imports cause price spikes in the evening hours of hot summer days. Data from the Croatian power exchange (CROPEX) reveal that the price of electricity usually oscillates between 50 and 100 €/MWh, but it can go up several times between 18:00 and 23:00 in the summer months, as shown in figure 2.

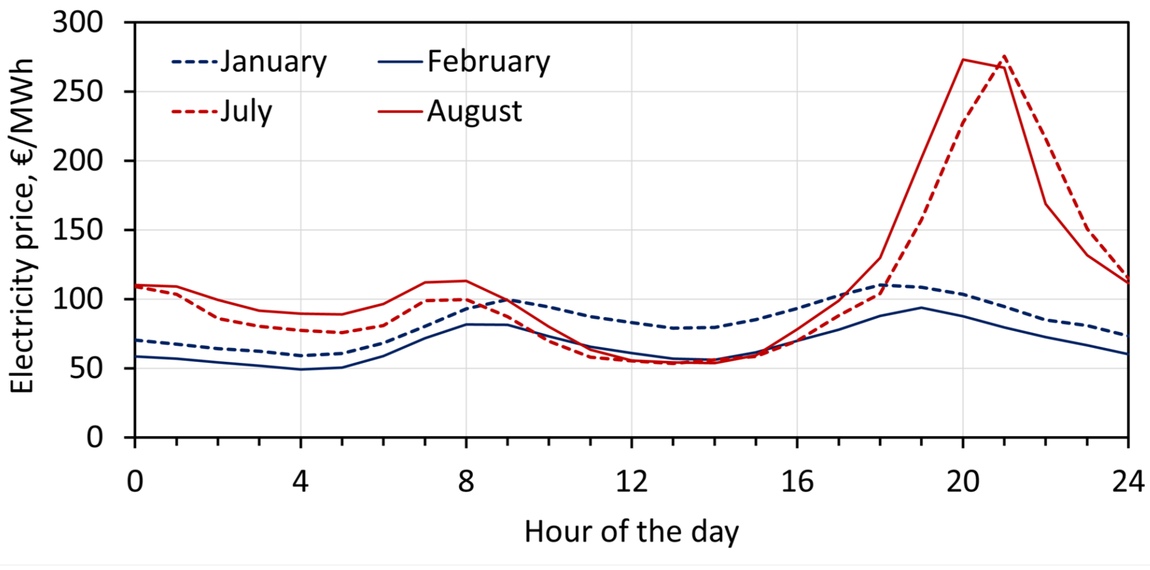

Figure 2. Average daily price of electricity in Croatia, a comparison between winter and summer months

ANALYSIS AND DISCUSSION

Over the past decade, Croatia has made decisive steps to expand renewable energy capacities. Wind energy will continue to grow, though at a slower pace than previously recorded. Currently, Croatia's wind power capacity is 1.15 GW (1,140 MW) and is projected to reach 1.5 GW by 2030. Solar PV started from a low base but is increasing quickly, as part of finding solutions for summer peak loads. In 2020, Croatia's solar PV capacity was only 100 MW, but increased investents and simplified policies pushed the solar PV up to 460 MW as of today. By 2030, projections estimate that the solar PV capacity in Croatia will reach about 1.4 GW, perhaps even surpass the wind capacity. Table 1 reports the annual electricity generation by energy sources in Croatia, across the period of 2017-2023.

Table 1. Annual electricity generation by energy sources in Croatia

Energy source | Year		2017	2018	2019	2020	2021	2022	2023
Electricity generation (GWh)	Hydro	5508	7785	5933	5810	7229	5574	8046
	Thermal	4667	3785	4416	4797	4688	5425	4979
	Nuclear	2984	2745	2766	3020	2709	2803	2666
	Wind	1204	1335	1467	1721	2062	2138	2531
	Biofuels	526	652	861	962	1083	1112	916
	Solar	79	75	83	96	149	152	340
	Geothermal	0	0	92	94	90	73	17
Import – export difference (GWh)		3970	2642	3367	1620	1252	1892	**– 1070**

Hydropower generation in Croatia fluctuates significantly, primarily due to variations in rainfall quantities and distribution throughout the year. A notable decline in hydropower generation was recorded in 2022 (5574 GWh), while a year later it increased by 30% (8046 GWh). In 2023, for the first time, Croatia switched from a position of electricity importer to a position of net exporter. However, this changed again in 2024, when the prolonged summer drought reduced the capacity factor of hydro power down to only 28%. This means that out of the total installed hydro capacity (2200 MW) only 600 MW was producing, as shown in Figure 1. Seasonal and annual fluctuations in renewable electricity generation will likely be even more accentuated in the future.

In response to the changing climate, increasing power loads and electricity prices, Croatia multiplied efforts to diversify and expand the renewable energy capacities. Although steadily increasing, the share of variable renewable energy (VRE) in the electricity mix is still low compared to other EU countries, as shown in figure 3. In 2023, wind contributed with 15% while solar PV with only 1.5% to the electricity mix in Croatia. The per capita electricity from wind and solar PV is 676 kWh in Croatia, about half the EU-27 average (1410 kWh per capita).

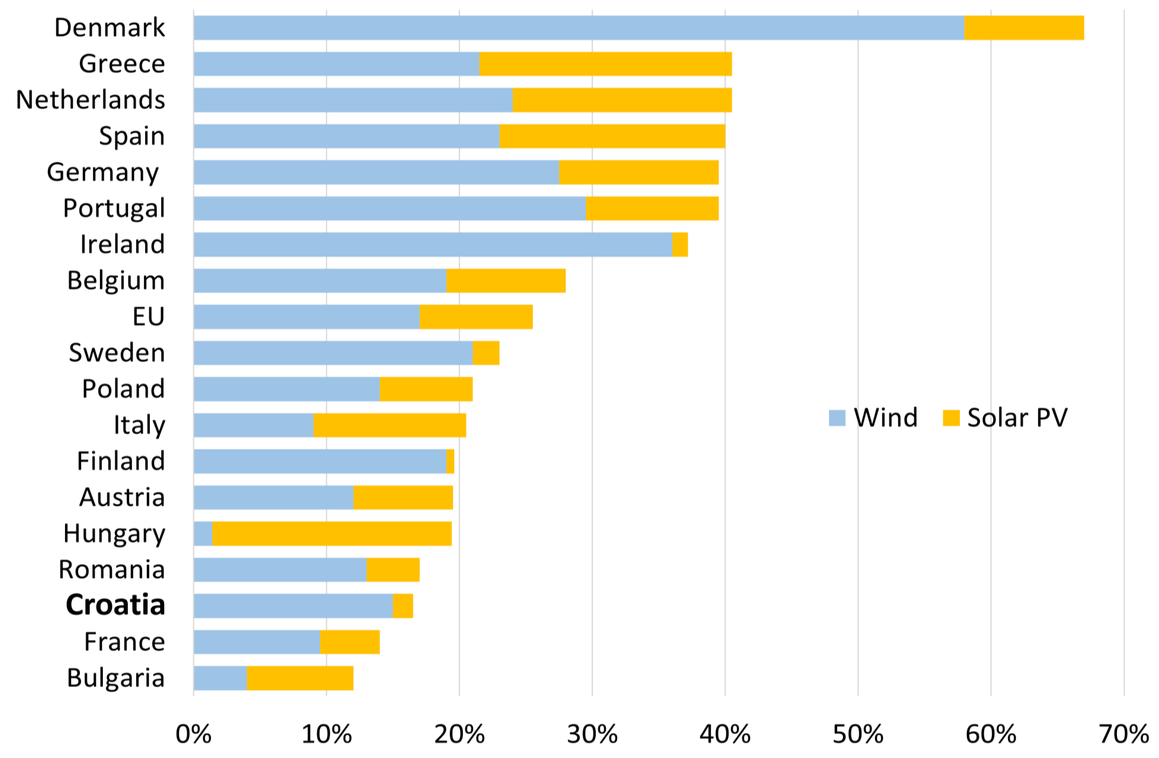

Figure 3. Share of wind and solar PV in the electricity generation of EU countries, data for 2023

CONCLUSION AND FUTURE WORK

Southern Europe and Croatia alike will continue to experience hotter summers. As the energy systems transition to a larger share of renewables, power grid flexibility will become crucial. Flexible power generation could be used to fill gaps in the renewable output. Pumped hydro and batteries could store excess renewable energy and release it during demand peaks. Demand response is another option, shifting electricity usage to periods when wind and solar generation are high could help adapt to their intermittent nature.