

*Supplementary Material*

# **Life-Cycle Carbon Emissions and Energy Return on Investment for 80% Domestic Renewable Electricity with Battery Storage in California (U.S.A.)**

**Marco Raugei <sup>1,2,3,\*</sup>, Alessio Peluso <sup>1</sup>, Enrica Leccisi <sup>2</sup> and Vasilis Fthenakis <sup>2</sup>**

<sup>1</sup> School of Engineering, Computing and Mathematics, Oxford Brookes University, Wheatley, Oxford OX33 1HX, UK; apeluso@brookes.ac.uk (A.P.)

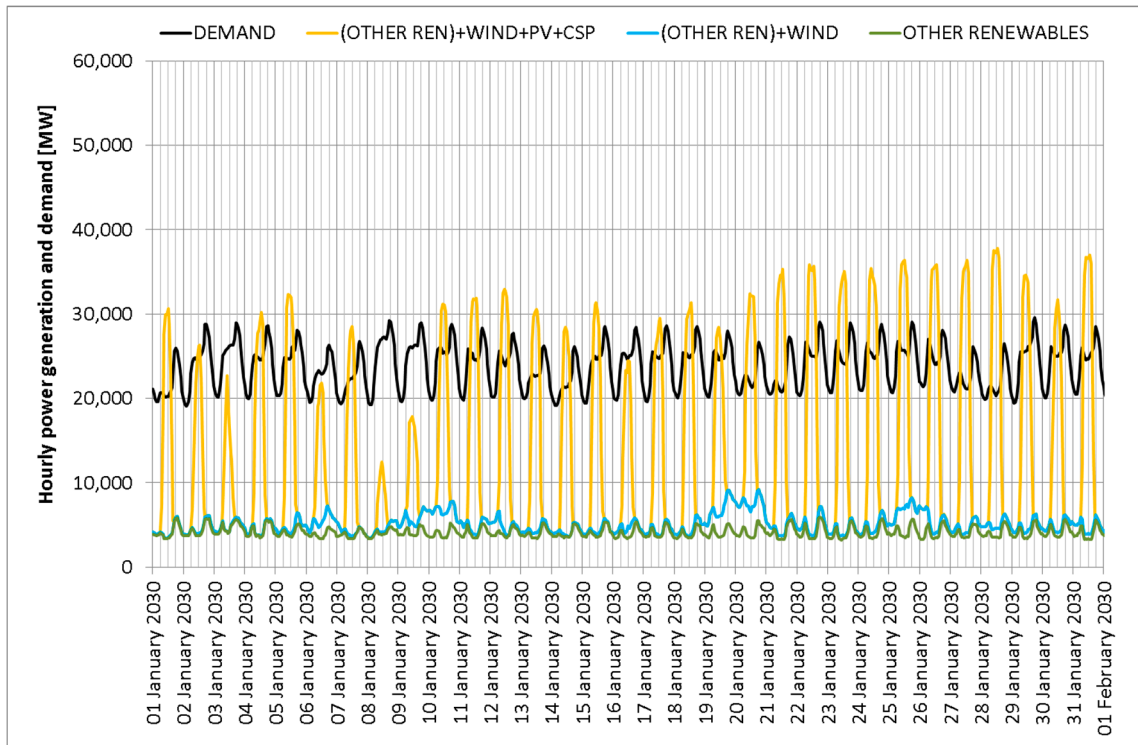
<sup>2</sup> Center for Life Cycle Assessment, Columbia University, New York, NY 10027, USA; el2828@columbia.edu (E.L.); vmf5@columbia.edu (V.F.)

<sup>3</sup> The Faraday Institution, Didcot, OX11 0RA, UK

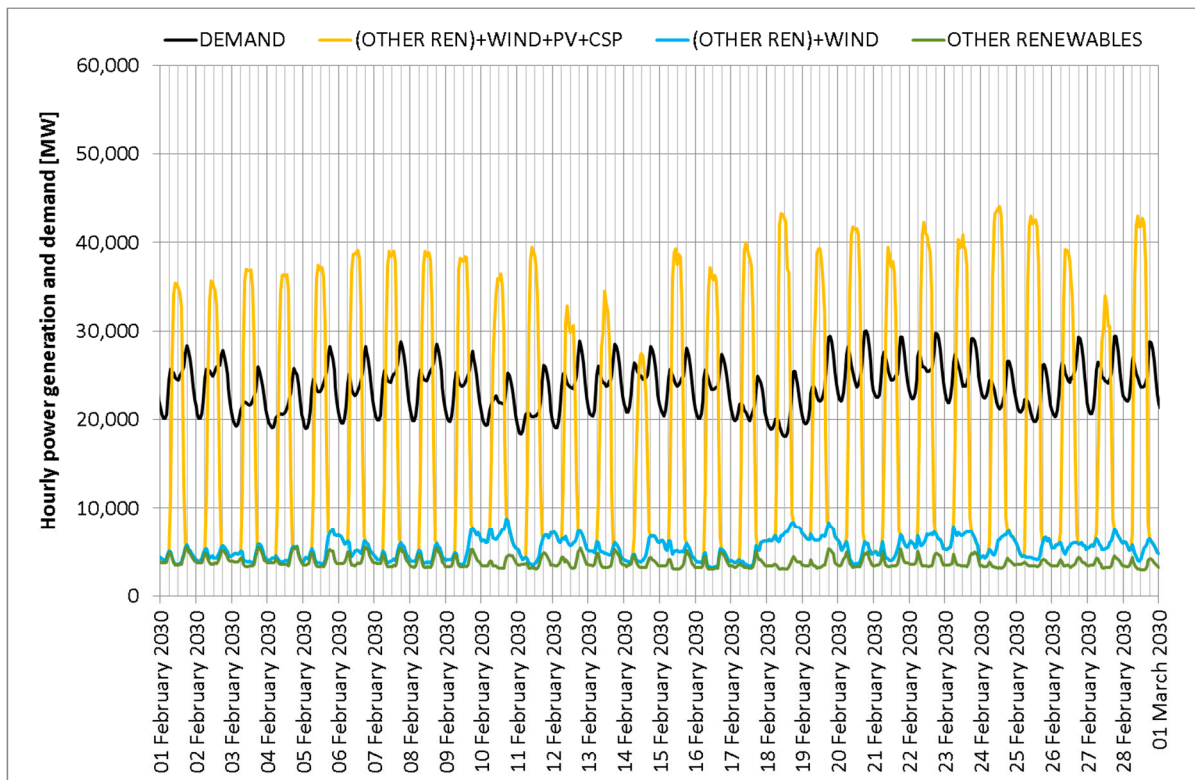
\* Correspondence: marco.raugei@brookes.ac.uk

**Supplementary Material contains:**

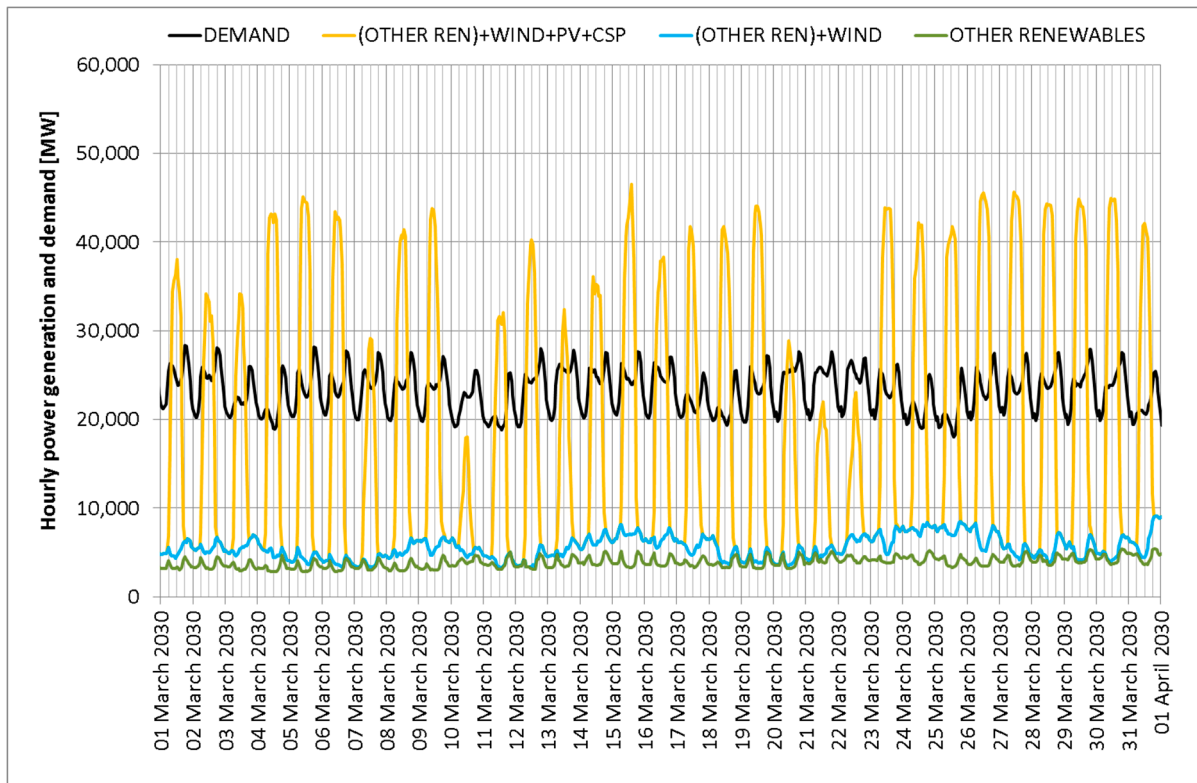
- 1) Complete projected hourly electricity generation and demand profiles for the entire year 2030, broken down by month (Figures S1 – S12).**
- 2) Sensitivity analysis on the % VRE curtailment, resulting from alternative nuclear and storage deployment hypotheses in 2030 (Table S1 and Figure S13).**



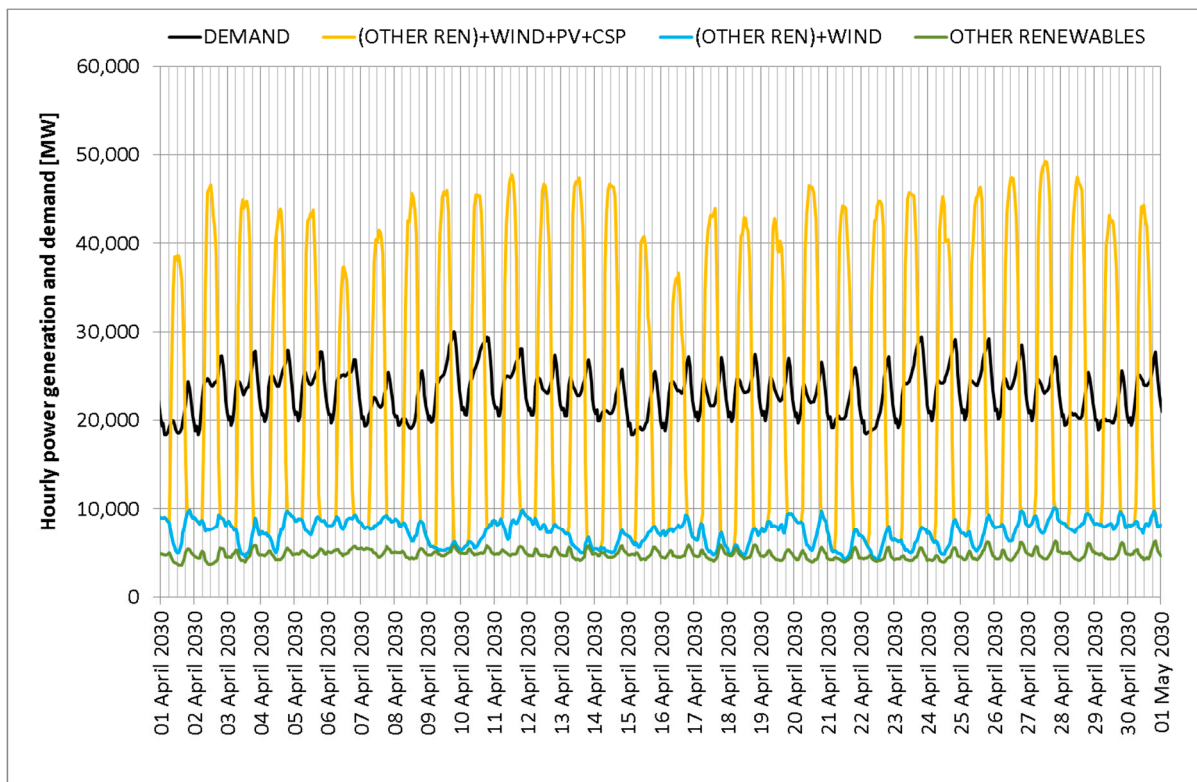
**Figure S1.** Projected CAISO gross power generation and demand profiles for the month of January 2030. (“Other renewables” = Geothermal + Biomass + Biogas + Hydro)



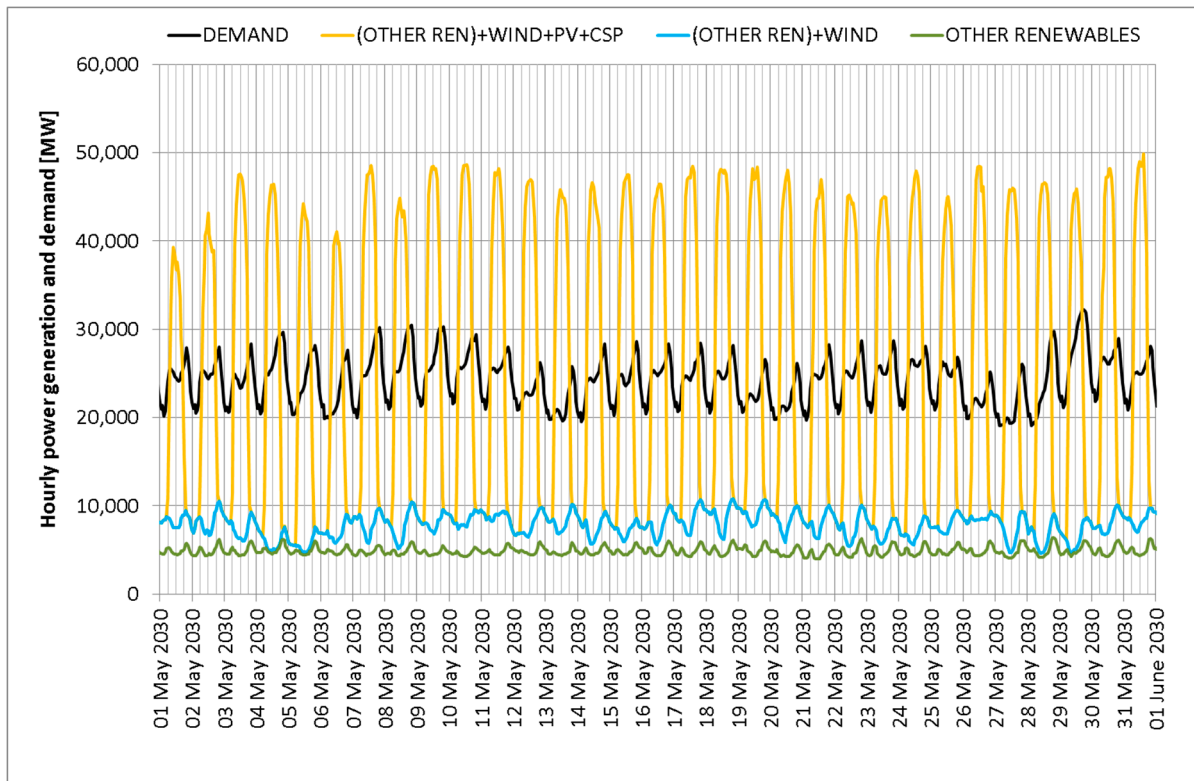
**Figure S2.** Projected CAISO gross power generation and demand profiles for the month of February 2030. (“Other renewables” = Geothermal + Biomass + Biogas + Hydro)



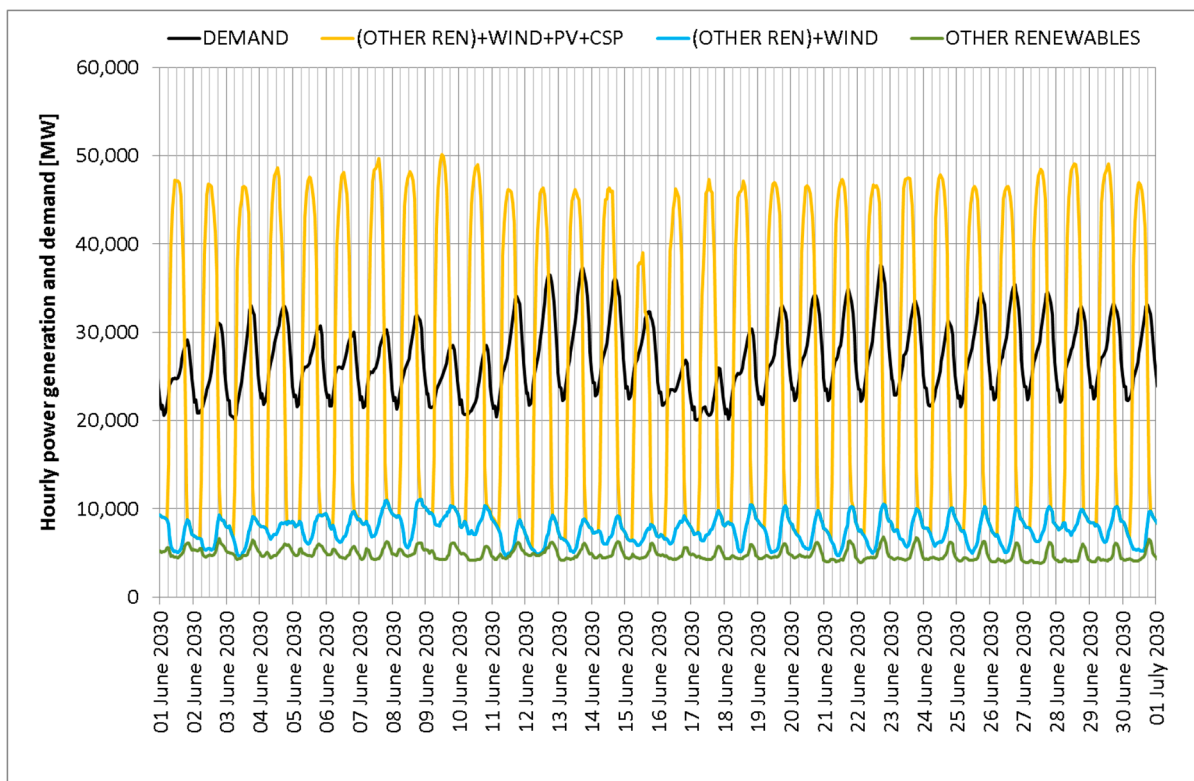
**Figure S3.** Projected CAISO gross power generation and demand profiles for the month of March 2030. (“Other renewables” = Geothermal + Biomass + Biogas + Hydro)



**Figure S4.** Projected CAISO gross power generation and demand profiles for the month of April 2030. (“Other renewables” = Geothermal + Biomass + Biogas + Hydro)

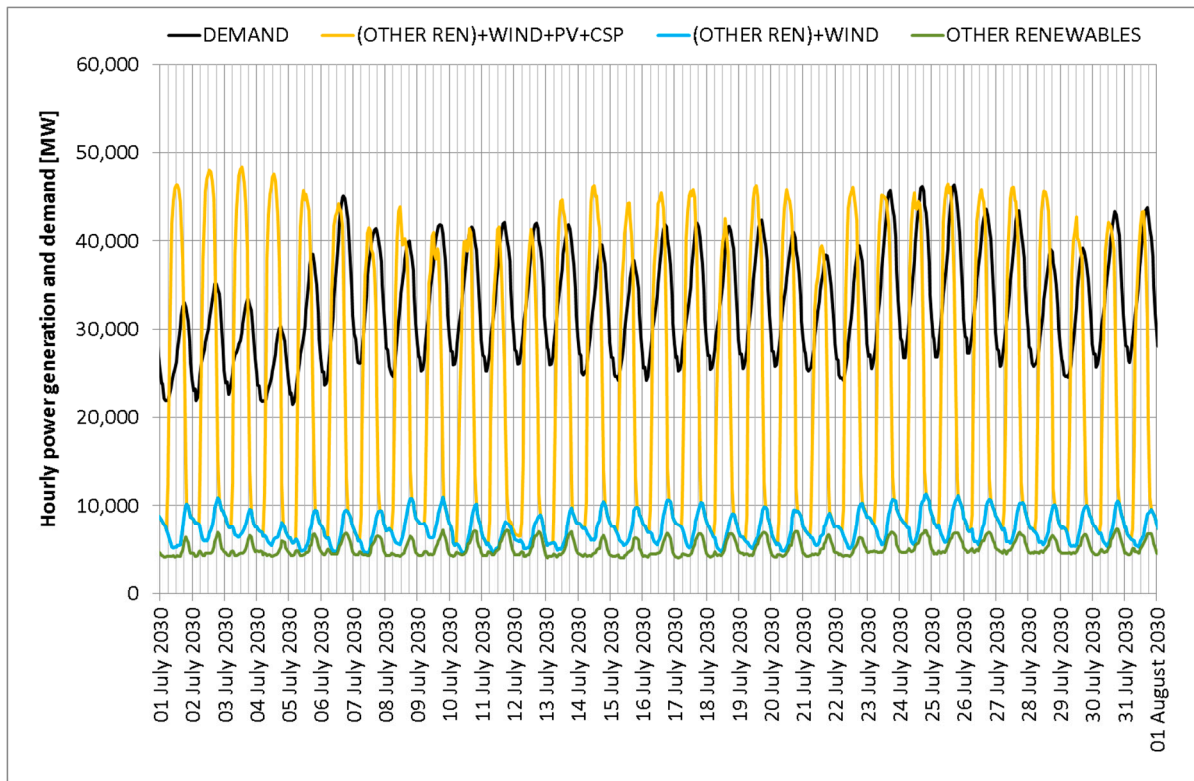


**Figure S5.** Projected CAISO gross power generation and demand profiles for the month of May 2030. (“Other renewables” = Geothermal + Biomass + Biogas + Hydro)

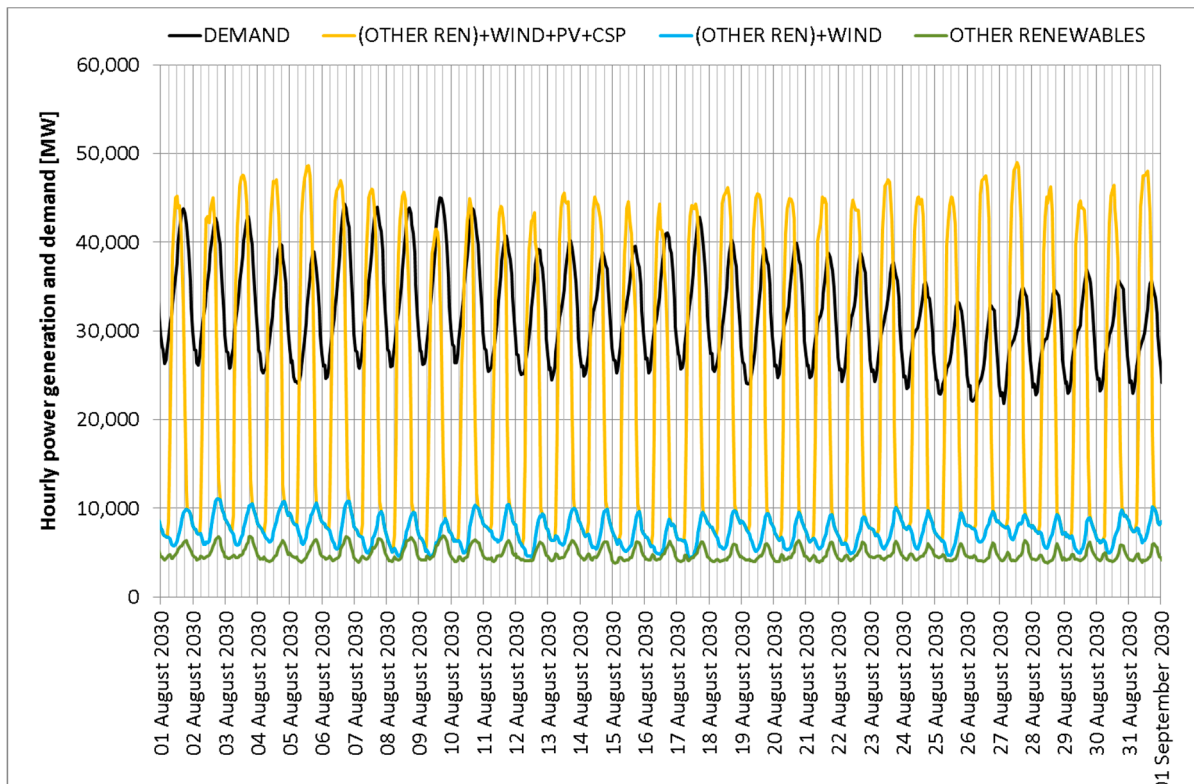


**Figure S6.** Projected CAISO gross power generation and demand profiles for the month of June 2030. (“Other renewables” = Geothermal + Biomass + Biogas + Hydro)

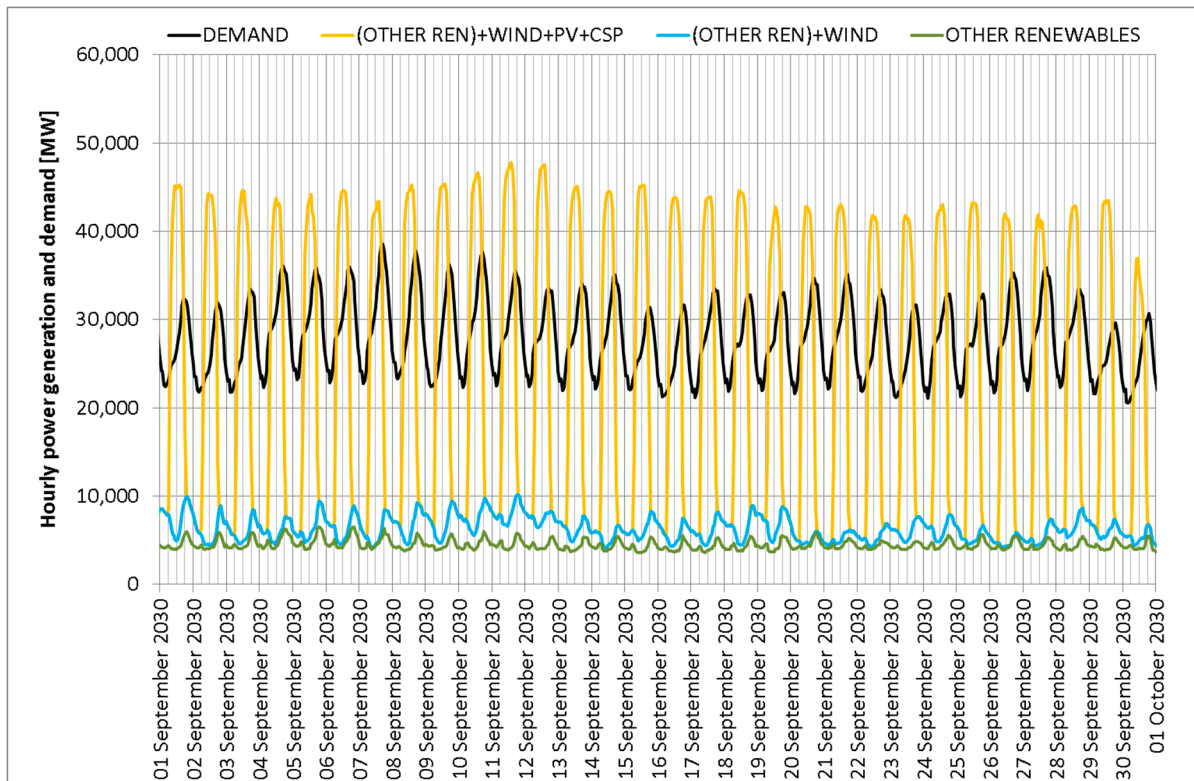




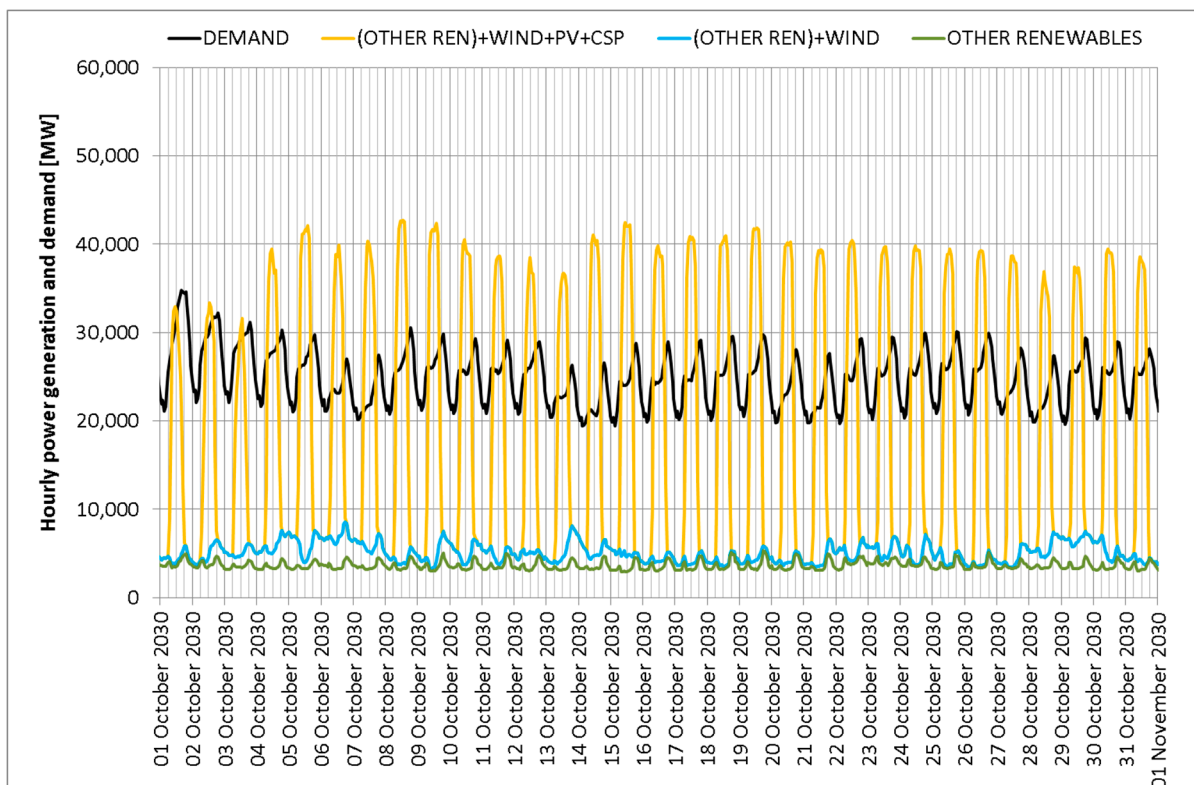
**Figure S7.** Projected CAISO gross power generation and demand profiles for the month of July 2030. (“Other renewables” = Geothermal + Biomass + Biogas + Hydro)



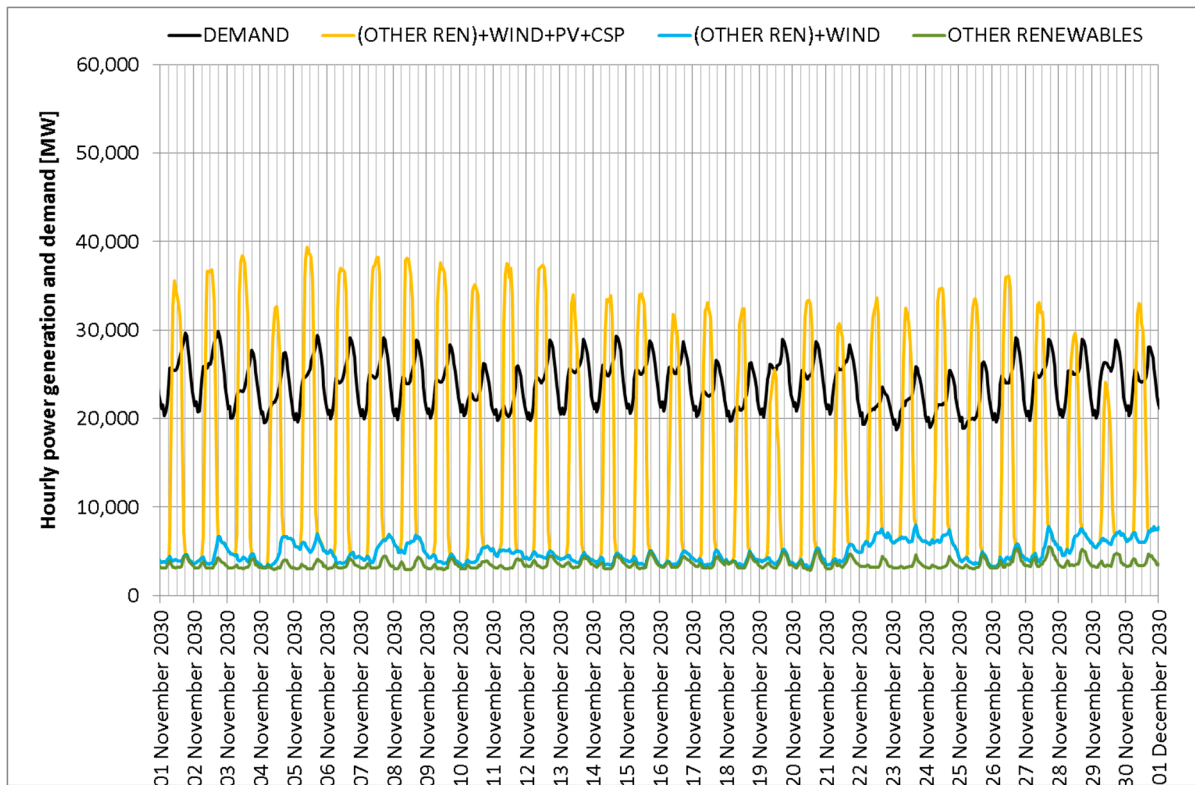
**Figure S8.** Projected CAISO gross power generation and demand profiles for the month of August 2030. (“Other renewables” = Geothermal + Biomass + Biogas + Hydro)



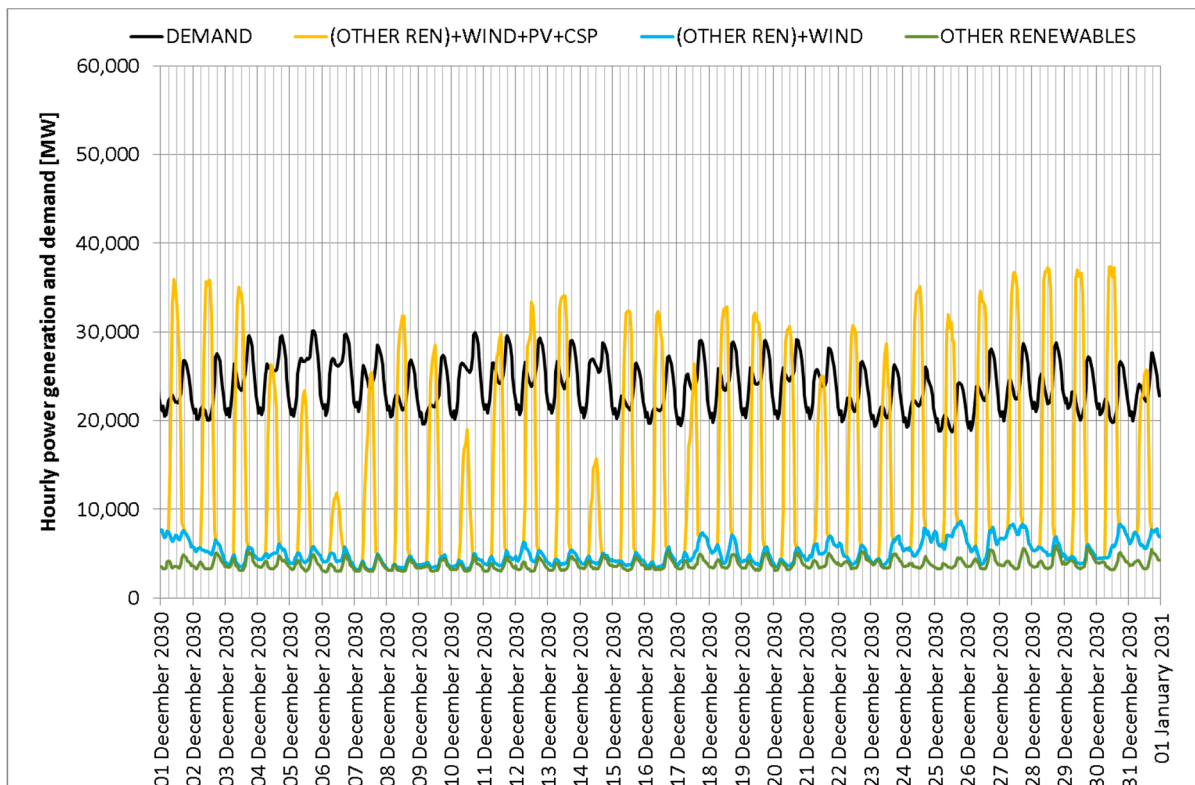
**Figure S9.** Projected CAISO gross power generation and demand profiles for the month of September 2030. (“Other renewables” = Geothermal + Biomass + Biogas + Hydro)



**Figure S10.** Projected CAISO gross power generation and demand profiles for the month of October 2030. (“Other renewables” = Geothermal + Biomass + Biogas + Hydro)



**Figure S11.** Projected CAISO gross power generation and demand profiles for the month of November 2030. (“Other renewables” = Geothermal + Biomass + Biogas + Hydro)



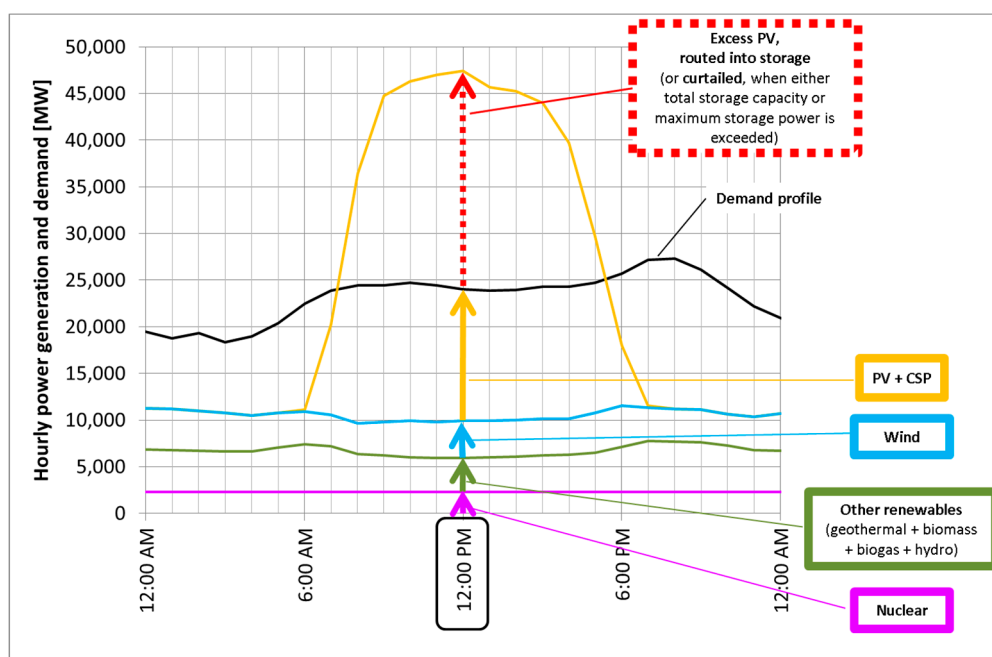
**Figure S12.** Projected CAISO gross power generation and demand profiles for the month of December 2030. (“Other renewables” = Geothermal + Biomass + Biogas + Hydro)

**Table S1.** Sensitivity analysis on the % VRE curtailment resulting from alternative nuclear and storage deployment hypotheses in 2030.

	<b>“Baseline” 2030 scenario</b>	<b>Alternative 2030 scenario 1</b>	<b>Alternative 2030 scenario 2</b>
Installed PV power [GW]	43.7	43.7	43.7
Installed storage capacity [GW]	26.2	26.2	26.2
Storage duration [h]	6	6	7.3
Nuclear output [TWh]	0	18.3	18.3
% of net renewable energy (RE <sup>1</sup> ) in domestic generation mix	80%	79%	80%
% of net variable renewable energy (VRE <sup>2</sup> ) in domestic generation mix	61%	60%	61%
% of VRE generation that is routed into storage	25%	27.6%	29.1%
% of VRE generation that is curtailed	2.8%	4.3%	2.8%

<sup>1</sup> RE includes: Geothermal, Biomass, Biogas, Hydro, Wind, PV, and CSP.

<sup>2</sup> VRE includes: Wind, PV, and CSP.



**Figure S13.** Projected hourly generation and demand profiles for the day of 2nd April 2030 in California – alternative scenarios 1 and 2 (compare with Figure 5 in main text).