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**Paper
Title:**

**Quantification of Capacity Credit of Additional
Photovoltaics Installations on the Island of Crete**

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LEPS

Outline

- A brief description of the Cretan Power System
- Additional PV capacity considered
- Methodology applied
- Evaluation of the results

Cretan Power System

- Three **power stations** in three different locations, with total capacity of 824.8MW:
 - Linoperamata : 279.1 MW
 - Xylokamara : 334.5 MW
 - Atherinolakos : 211.2 MW

- **Wind parks** along the grid with nominal power of 200.3 MW

- **Photovoltaic parks** with rated power of 98.67 MW

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Additional PV capacity

- Currently 100 MW installed PV capacity, 7% annual penetration reaching 10% of the peak demand
- 20MW additional PV capacity limit (Regulatory Authority of Energy of Greece) as an island network
- Increase by 20% of existing PV capacity
- Via legislative framework of “Net metering” and “Virtual Net Metering” with increased interest from public authorities

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Methodology



Probabilistic techniques based on actual data from the power system of Crete (for the last three years: 2016, 2017, 2018)

□ Three independent probability density functions (pdfs):

- $P_{Load}(mo,hr)$
- $P_{Wind}(mo,hr)$
- $P_{pV}(mo,hr)$

□ Derivation of the expected thermal generation probability density function via convolution:

- $P_{Th_units}(mo,hr) = P_{Load}(mo,hr) - P_{Wind}(mo,hr) - P_{pV}(mo,hr)$

Reliability and Forced Outage Rate (**FOR**):

- Thermal units availability:

$$p_i + q_i = 1, q_i = \text{FOR}$$

- Reliability indices:

- Expected Energy Not Supplied (**EENS**)
- Loss of Load Expectation (**LOLE**)

- New index: **LWLOLE** (Load with LOLE > 0.1 sec, 99.99999% period studied)

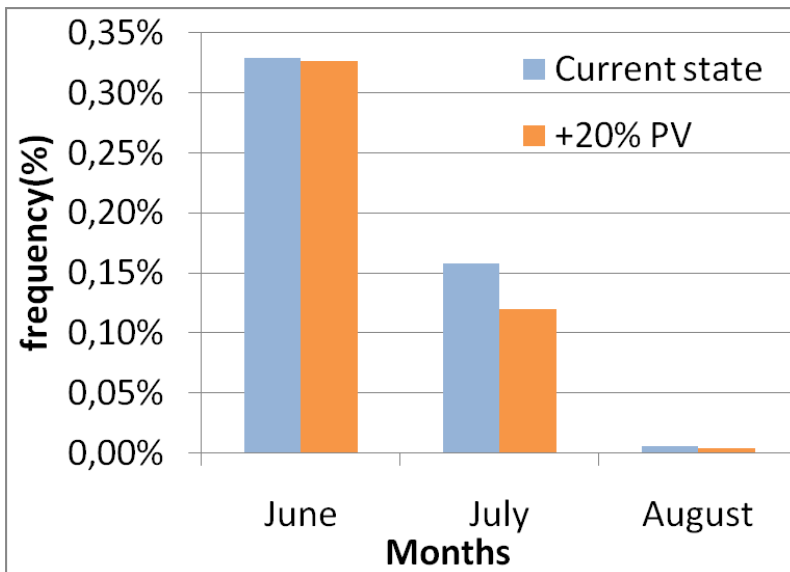
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Results

- -24.23% in thermal units load > 600MW in July
- Capacity credit: 7.5 MW

Expectation of the demand to be met by thermal units to exceed 600MW



Maximum load to be met by thermal units (MW)

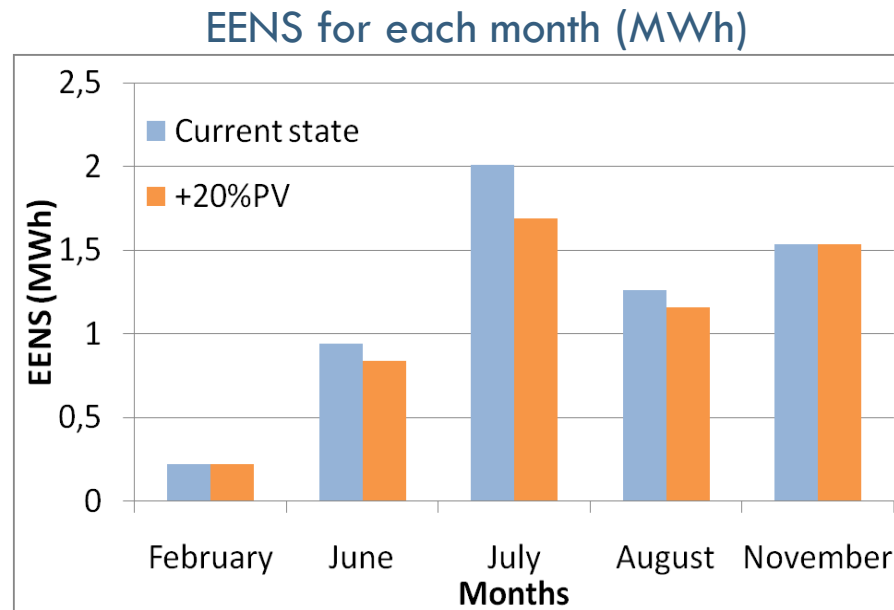
Months	Current state	+20% PV	Hour
June	610	610	20:00-22:00
July	630	622,5	14:00-15:00
August	610	602,5	13:00-14:00

Results



EENS:

- -15.93% in July, -0.19% in November
- 1.54 MWh in November (low capacity of the available thermal units)

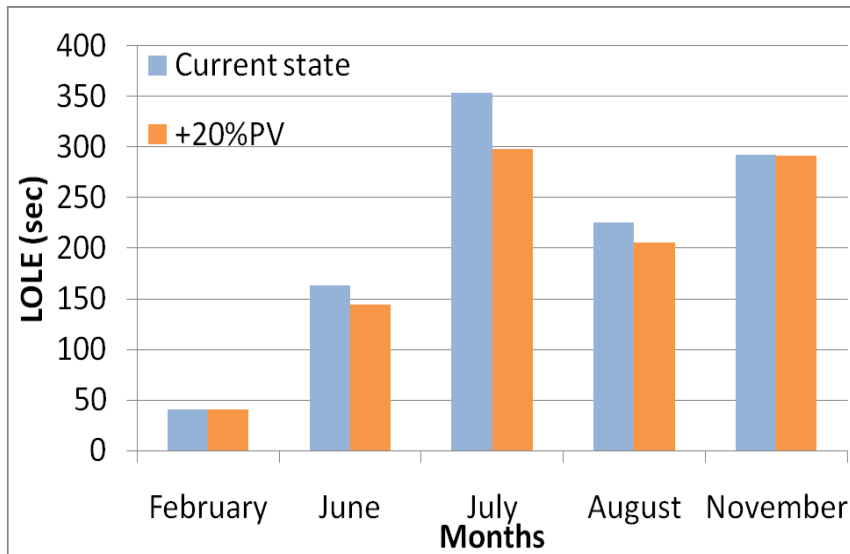


Results

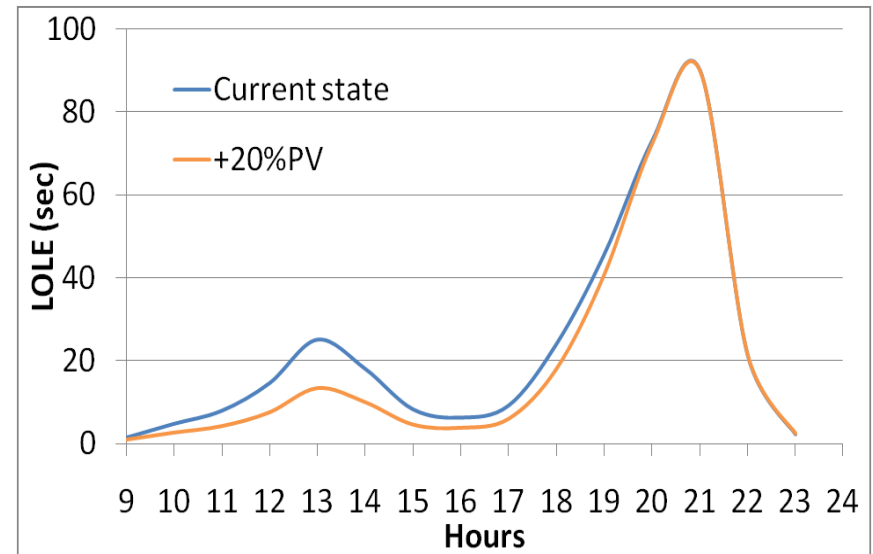
LOLE:

- Sum of LOLE/month: -15.71% in July, -0.25% in November
- July: >45% reduction in LOLE during 12:00 - 15:00

Sum of LOLE for each month (sec)



LOLE for each hour in July (sec)



Results

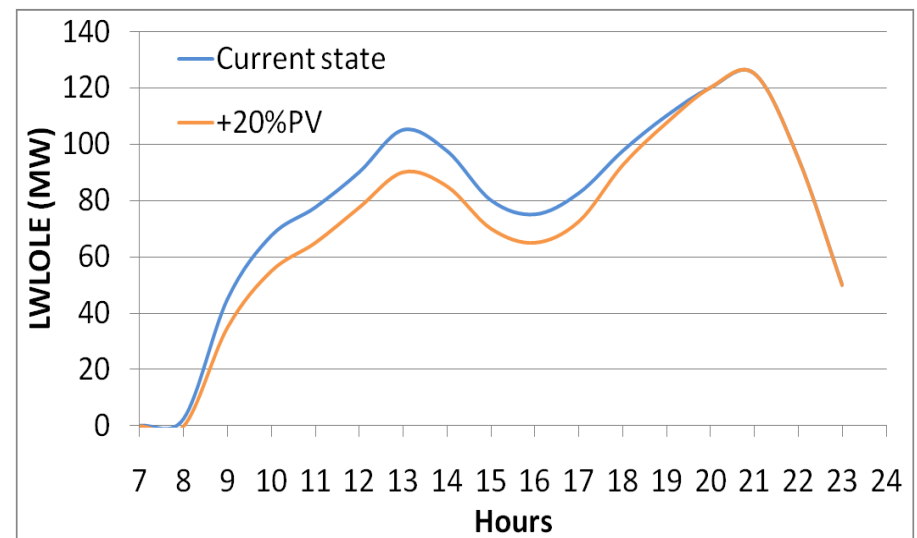
LWLOLE:

- LWLOLE in July: -15 MW during 13:00-14:00
- Max LWLOLE at night hours

Max LWLOLE for each month (MW)

Months	Max LWLOLE (MW)	Hour
February	90	19:00-20:00
June	115	20:00-22:00
July	125	21:00-22:00
August	125	20:00-21:00
November	110	18:00-19:00

LWLOLE for each hour in July (MW)



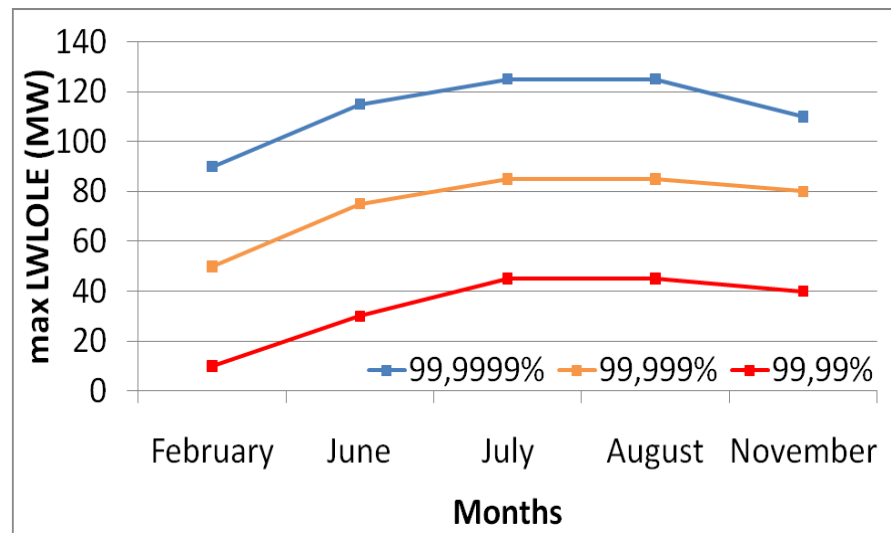
Results



Three alternative scenarios for generation adequacy limit:

- 99.9999% (LWLOLE > 0.1 sec)
- 99.999% (LWLOLE > 1 sec)
- 99.99% (LWLOLE > 10 sec)

Max LWLOLE (MW) for each month and generation adequacy scenario



Summary



This paper examines the impact of additional PV capacity on capacity credit and the generation system's reliability

The analysis showed that 20MW of PVs can offer:

- 7.5MW capacity credit (622.5MW peak, before: 630MW)

and also significant reduction in:

- EENS and LOLE (exceeds 15% in July)
- LWLOLE (22.2% in July)

Finally, if the additional PV capacity exceeds 50-60 MW, the peak demand will remain 610MW (night peak).

Thank you for your attention!