

Solar & Wind Capacity Contribution with Storage Outlook

Effective Load Carrying Capability Methodology & Results

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Agenda

- Introduction
- Effective Load Carrying Capability (ELCC) Methodology
- Idaho Power System Needs
- Results



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IRP Relevance



Megawatt (MW) Rated
Effective Forced Outage
Rates (EFOR)
Costs



MW Rated
Contribution to Peak
Costs

Introduction

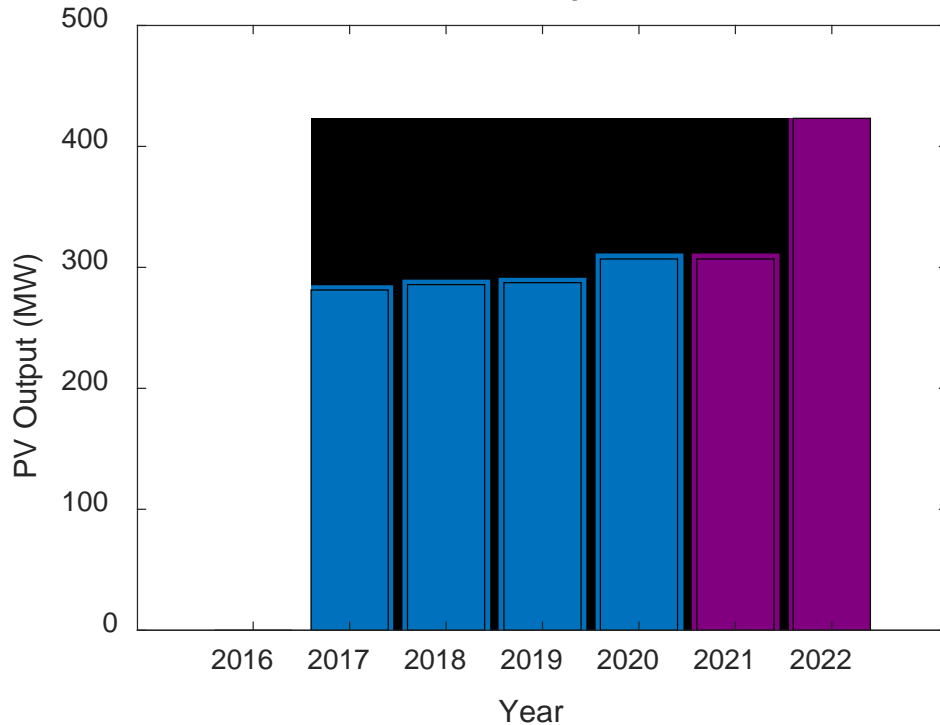
- This presentation describes the methodology used to calculate the contribution to peak of different Variable Energy Resources (VER).
- Preliminary results are shown for informational purposes.



Variable Energy Resources



Peak PV Output



Resource	Installed MW
Solar	316.75 MW
Wind	727.92 MW

Idaho Power's Clean Energy Goal



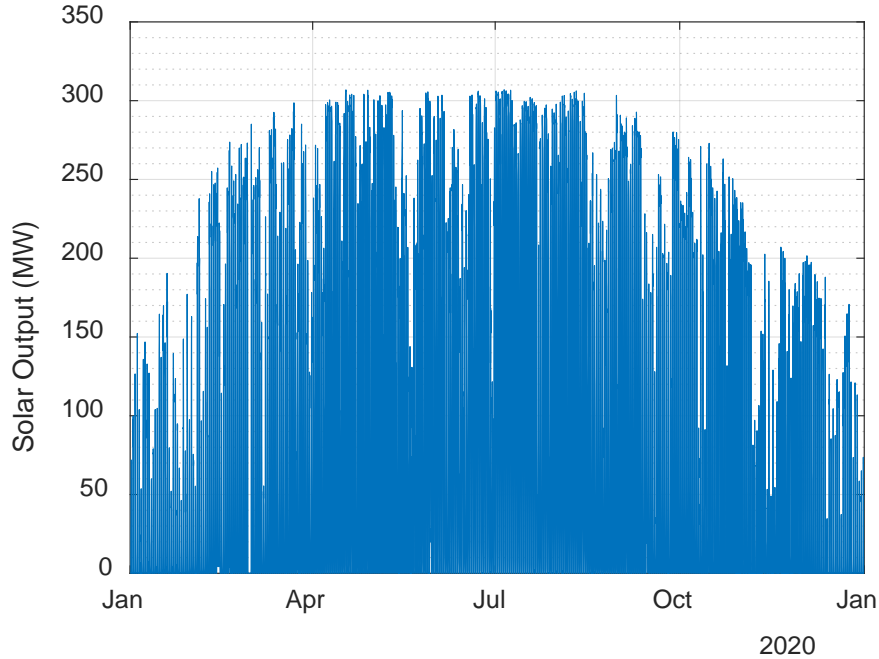
Providing
100% clean energy by 2045.

Clean today. **Cleaner tomorrow.**[®]

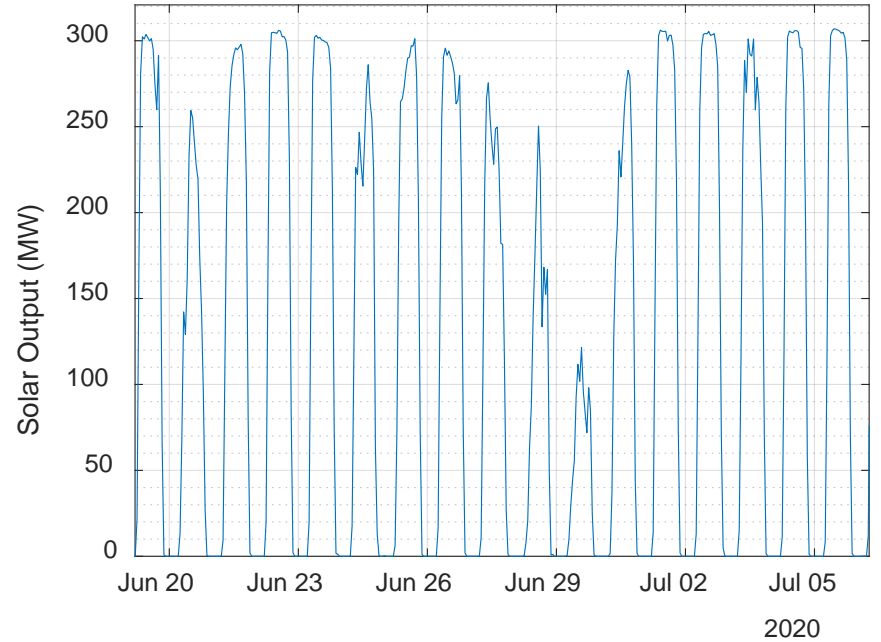
Variable Energy Resources



Solar Hourly Output



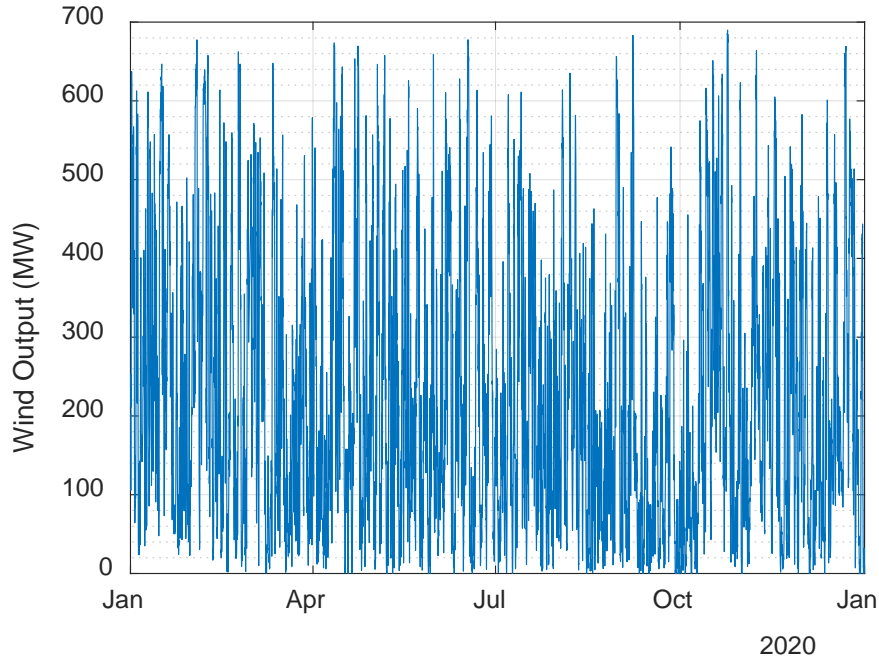
Solar Hourly Output



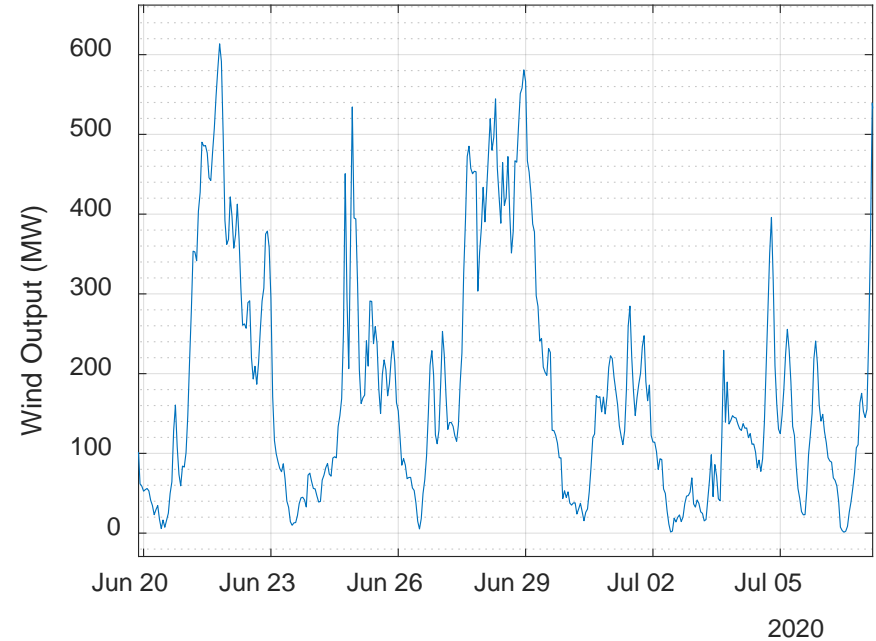
Variable Energy Resources



Wind Hourly Output



Wind Hourly Output





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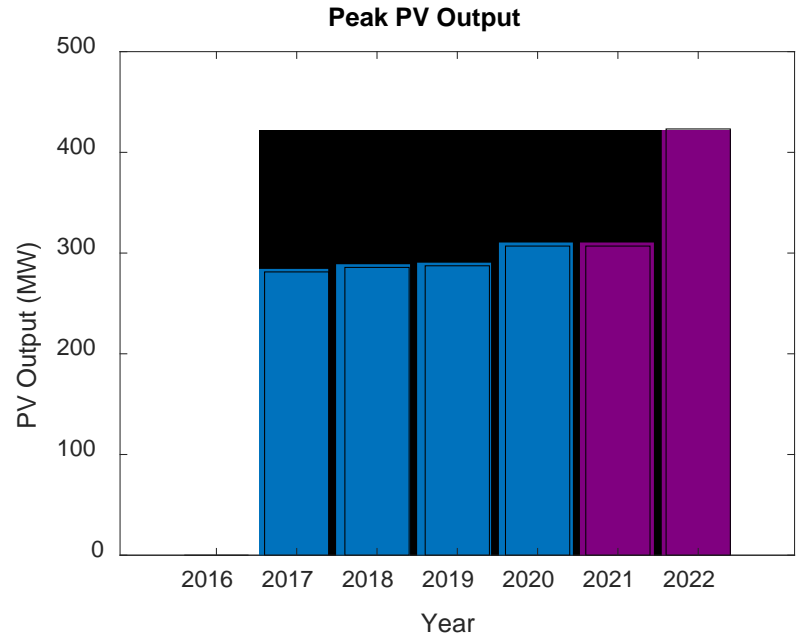
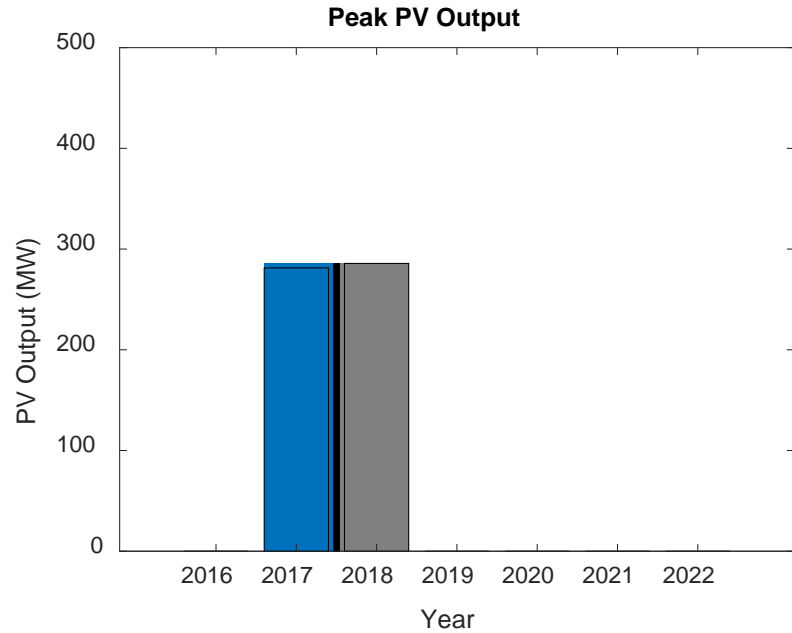
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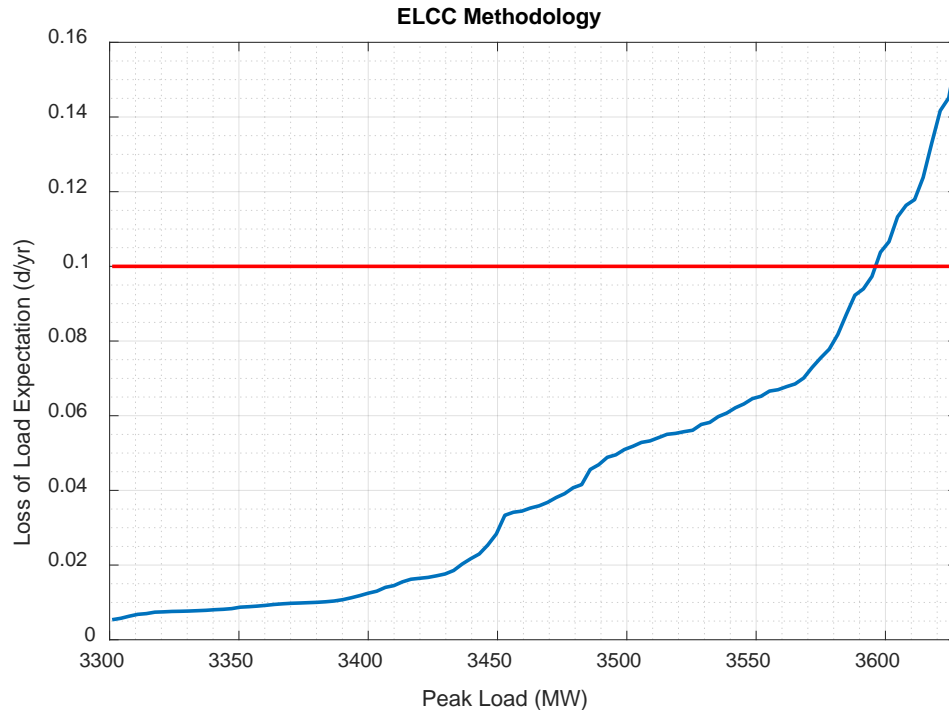
Contribution to Peak (Capacity Value) Concept

- The capacity value of variable generation is its ability to reliably meet demand during **high-risk hours**.
- Capacity value is measured either in terms of physical capacity (kilowatt [kW], MW, or gigawatt [GW]) or the fraction of the power plant's nameplate capacity (%).

2021 IRP Methodology Change



ELCC Methodology



- ELCC provides a way to assess the capacity value of a resource that is tied to the loss of load probability concept.
- ELCC can be defined as the equivalent perfect capacity needed to improve the reliability on the system by the same amount as a particular generator.

ELCC Challenges



- Performance data
 - Difficult to obtain future resource data
- Historical data
 - Solar came online in 2017
- Data Intensive
 - Time consuming

Reliability Definitions

LOLE: the expected number of days per time period for which the available generation capacity is insufficient to serve the demand at least once per day

$$LOLE = \sum_{d=1}^D \max_{i=1}^H (LOLP_i)$$

LOLH: the expected number of hours per time period when a system's hourly demand is projected to exceed the generating capacity

$$LOLH = \sum_{i=1}^H LOLP_i$$

Reliability Definitions (Continued)

LOLP: the probability of system peak or hourly demand exceeding the available generating capacity during a given period

$$LOLP = P_i(G_i - L_i)$$

Generation available at hour "i"

Net load at hour "i"

LOLP: Generation

- Generator Data
 - Monthly Capacity
 - Effective Forced Outage Rate (EFOR)



Capacity Out	Capacity Available	Individual Probability
0	15	$(0.97)^3 = 0.9126$

LOLP: Generation

- Generator Data
 - Monthly Capacity
 - Effective Forced Outage Rate (EFOR)



Capacity Out	Capacity Available	Individual Probability
0	15	$(0.97)^3 = 0.9126$
5	10	$3(0.03)(0.97)^2 = 0.08468$

LOLP: Generation

- Generator Data
 - Monthly Capacity
 - Effective Forced Outage Rate (EFOR)



Capacity Out	Capacity Available	Individual Probability
0	15	$(0.97)^3 = 0.9126$
5	10	$3(0.03)(0.97)^2 = 0.08468$
10	5	$3(0.03)^2(0.97) = 0.002619$

LOLP: Generation

- Generator Data
 - Monthly Capacity
 - Effective Forced Outage Rate (EFOR)



Capacity Out	Capacity Available	Individual Probability
0	15	$(0.97)^3 = 0.9126$
5	10	$3(0.03)(0.97)^2 = 0.08468$
10	5	$3(0.03)^2(0.97) = 0.002619$
15	0	$(0.03)^3 = 0.000027$

LOLP: Generation

- Generator Data
 - Monthly Capacity
 - Effective Forced Outage Rate (EFOR)



Capacity Out	Capacity Available	Individual Probability	Cumulative Probability
0	15	$(0.97)^3 = 0.9126$	1.000000
5	10	$3(0.03)(0.97)^2 = 0.08468$	0.087299
10	5	$3(0.03)^2(0.97) = 0.002619$	0.002646
15	0	$(0.03)^3 = 0.000027$	0.000027

Hydro



Run of River



Hourly Output

Hydro w/ Storage



Monthly Capacity
EFOR

Generation EFORs



Hydro: **0.6% - 3.6%**

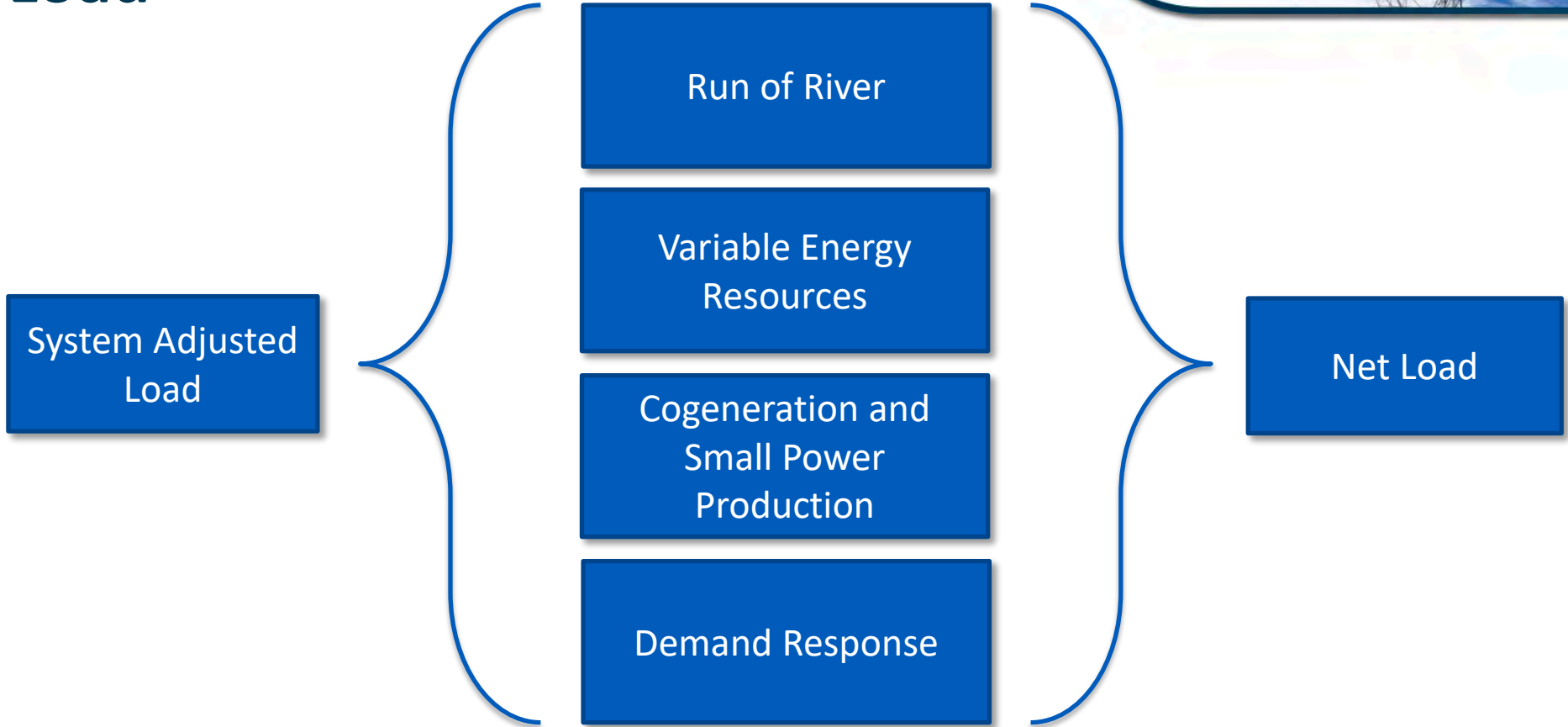
Combined Cycle Gas Turbines (CCGT): **2.0%**

Simple Cycle Gas Turbines (SCGT): **4.4% - 7.3%**

Coal: **6.3% - 9.1%**

Market Purchases: **0.1% - 2.6%**

Load



System Adjusted Load

Run of River

Variable Energy Resources

Cogeneration and Small Power Production

Demand Response

Net Load

Loss of Load Probability (LOLP)

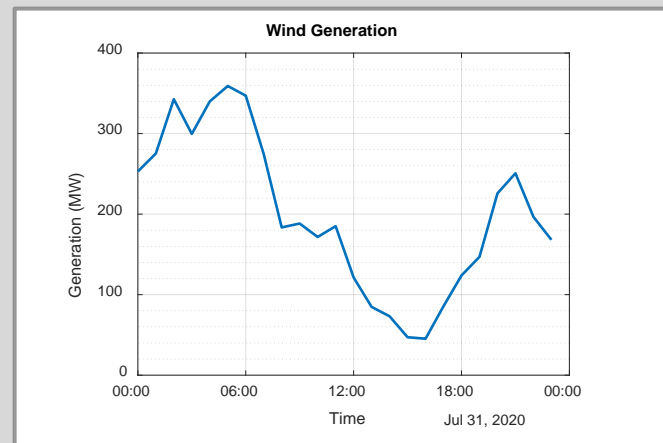
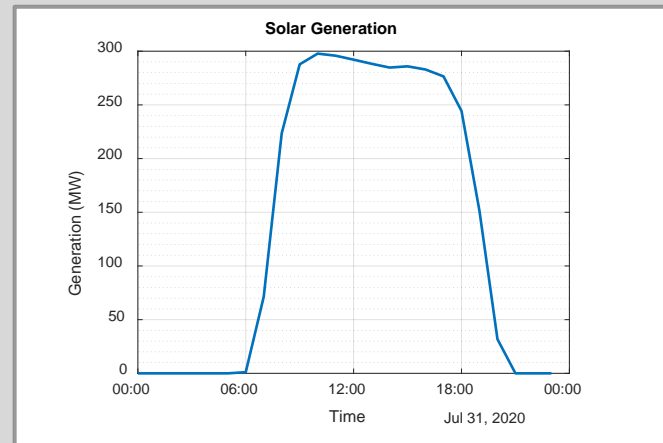
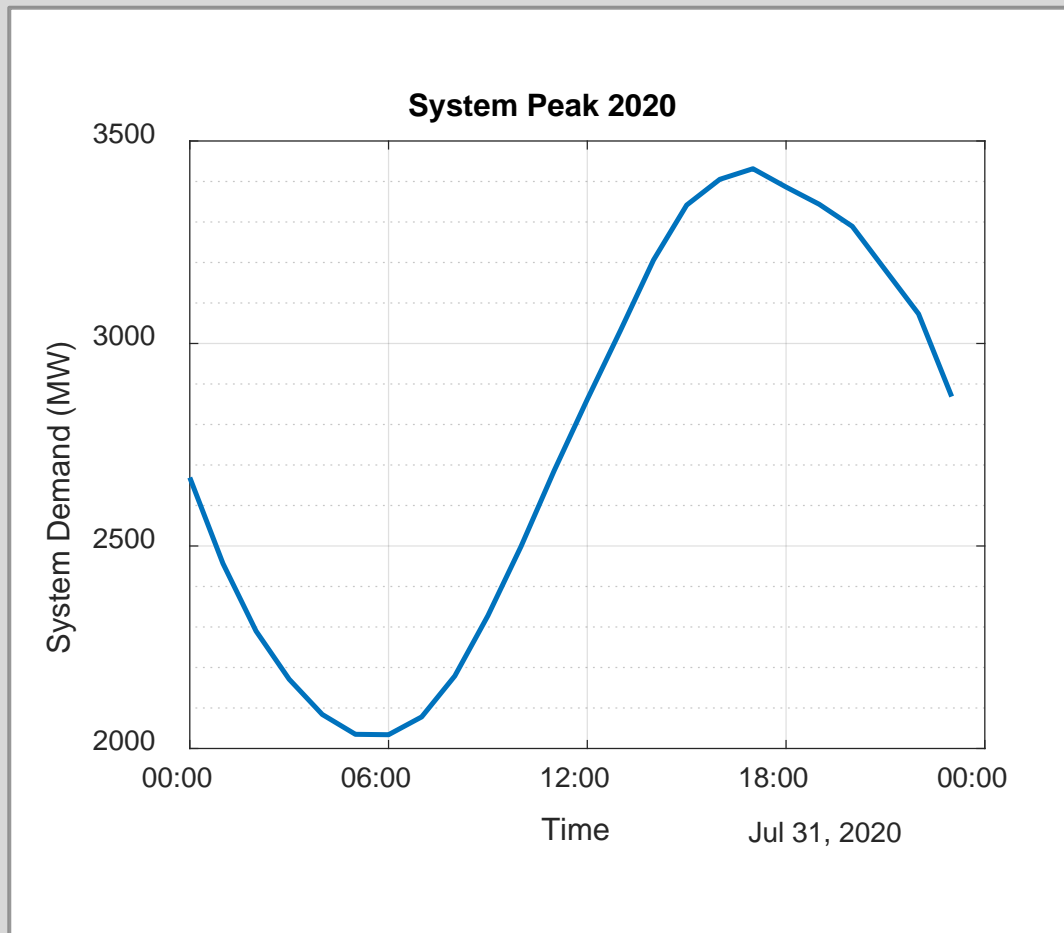
- The probability of system peak or hourly demand exceeding the available generating capacity during a given period

$$LOLP = P_i(G_i - L_i)$$

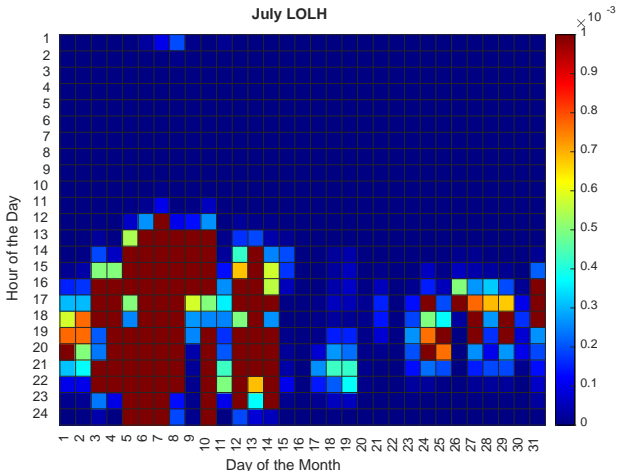


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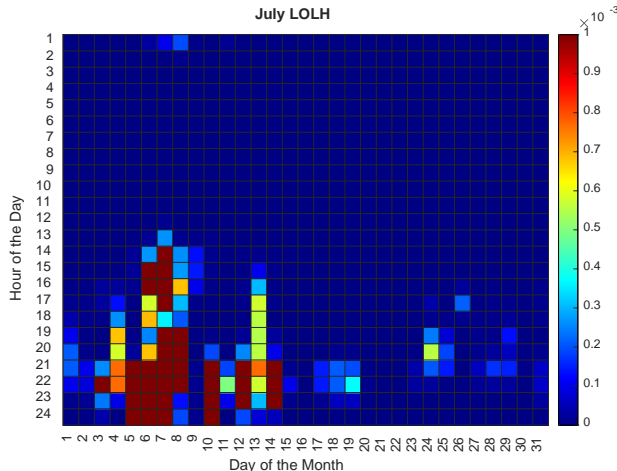
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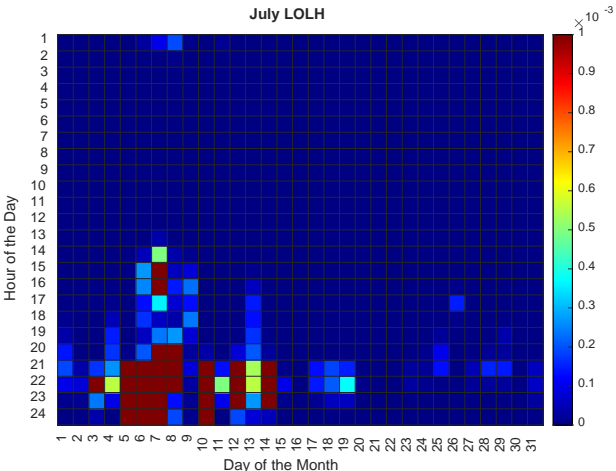
Idaho Power System Needs



No Solar

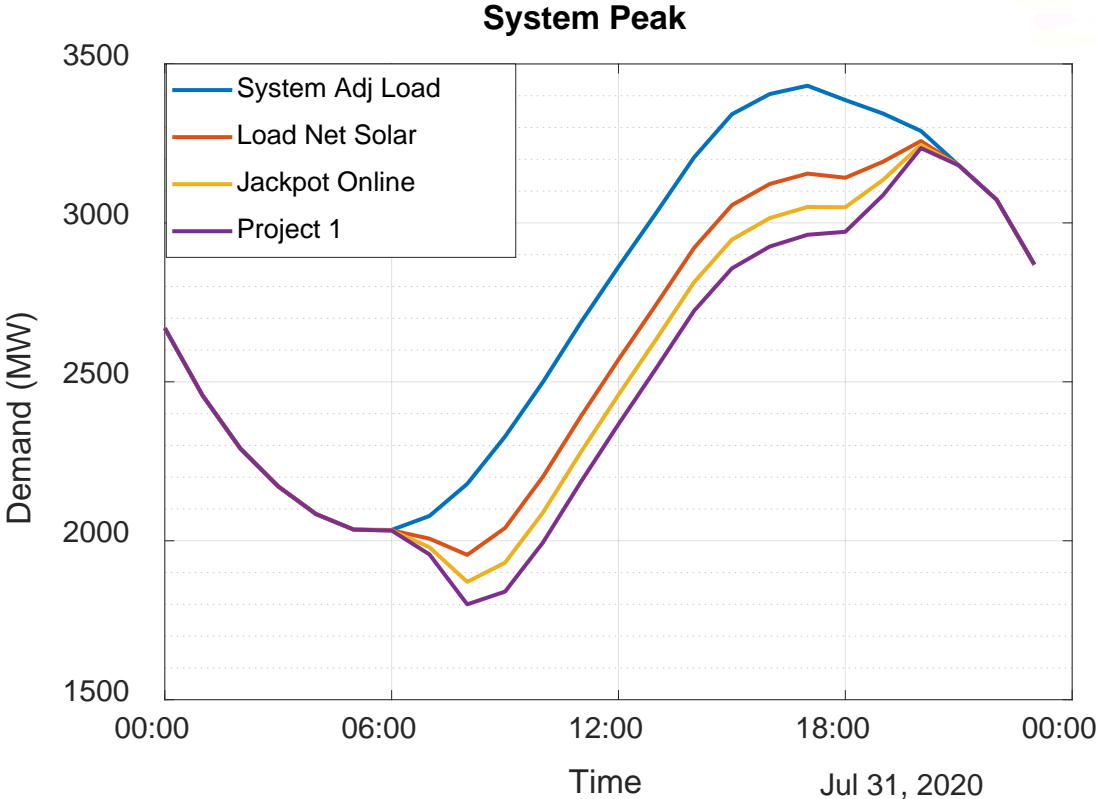


Solar



Future Solar

IPC System Needs

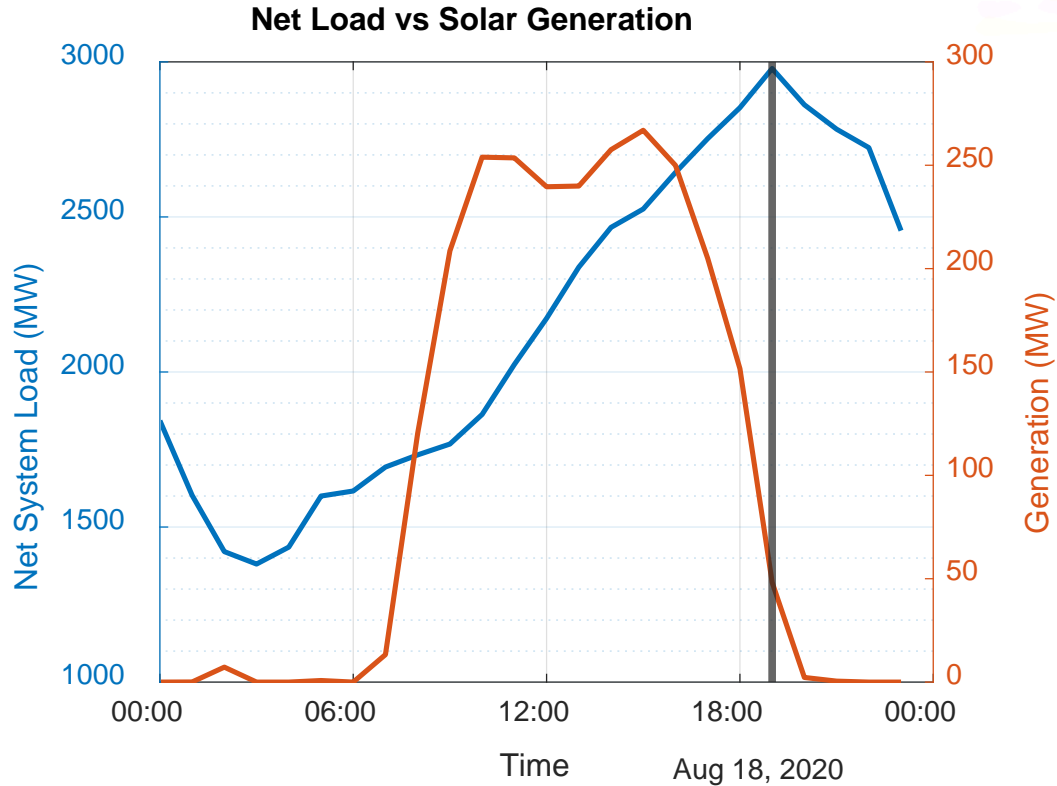


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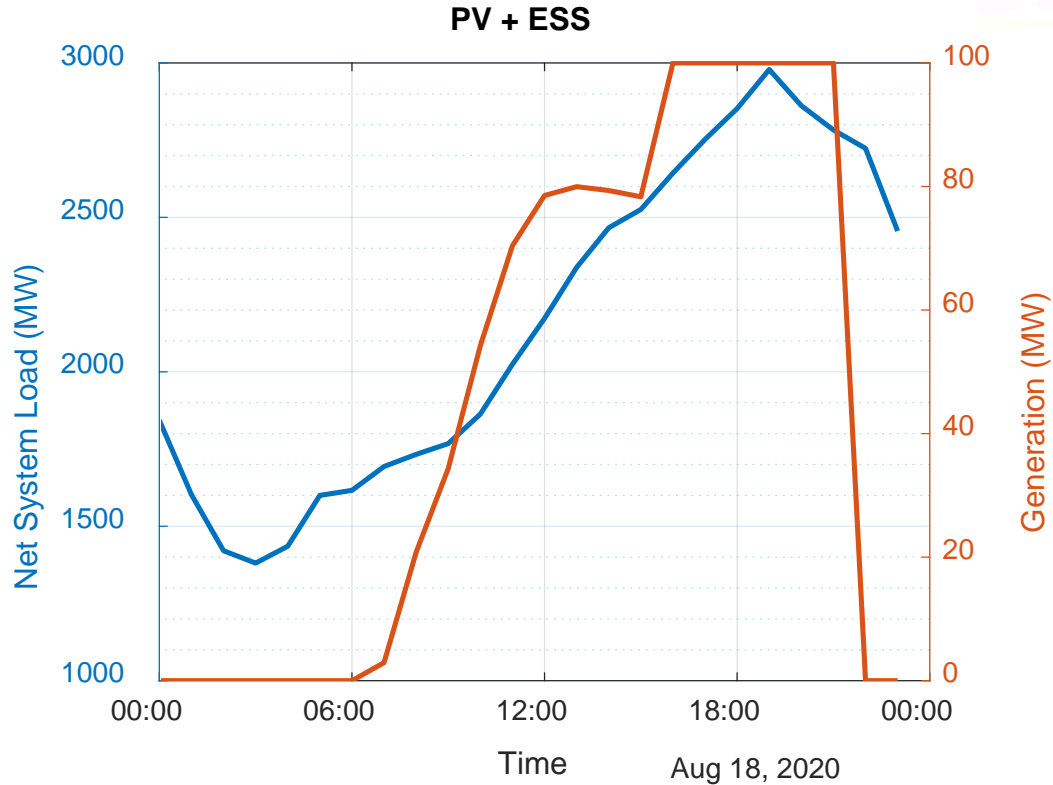


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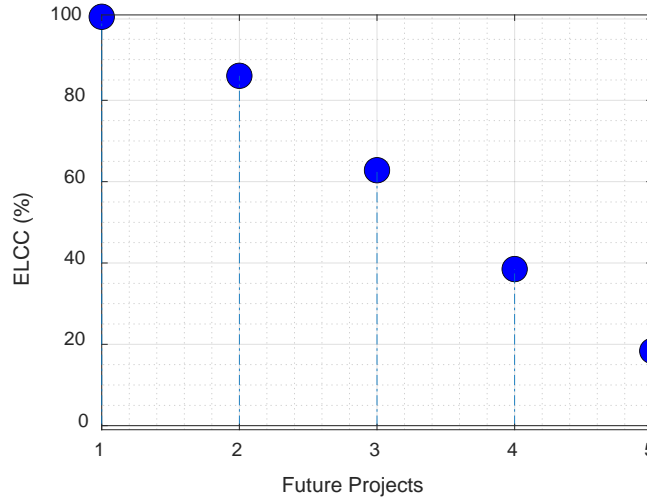
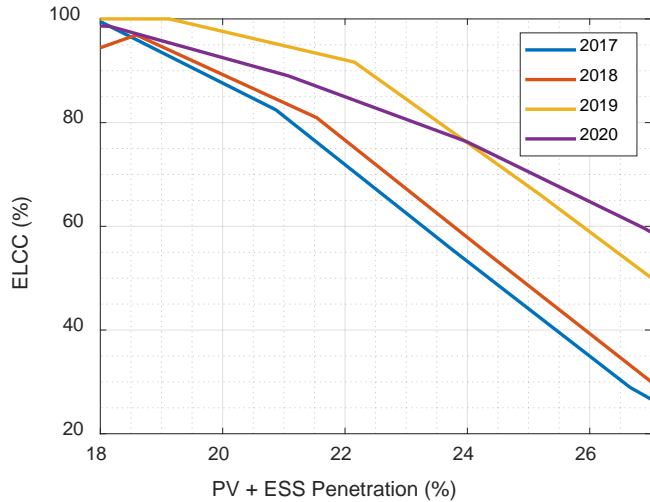
Solar ELCC Results



Solar + Storage ELCC Results

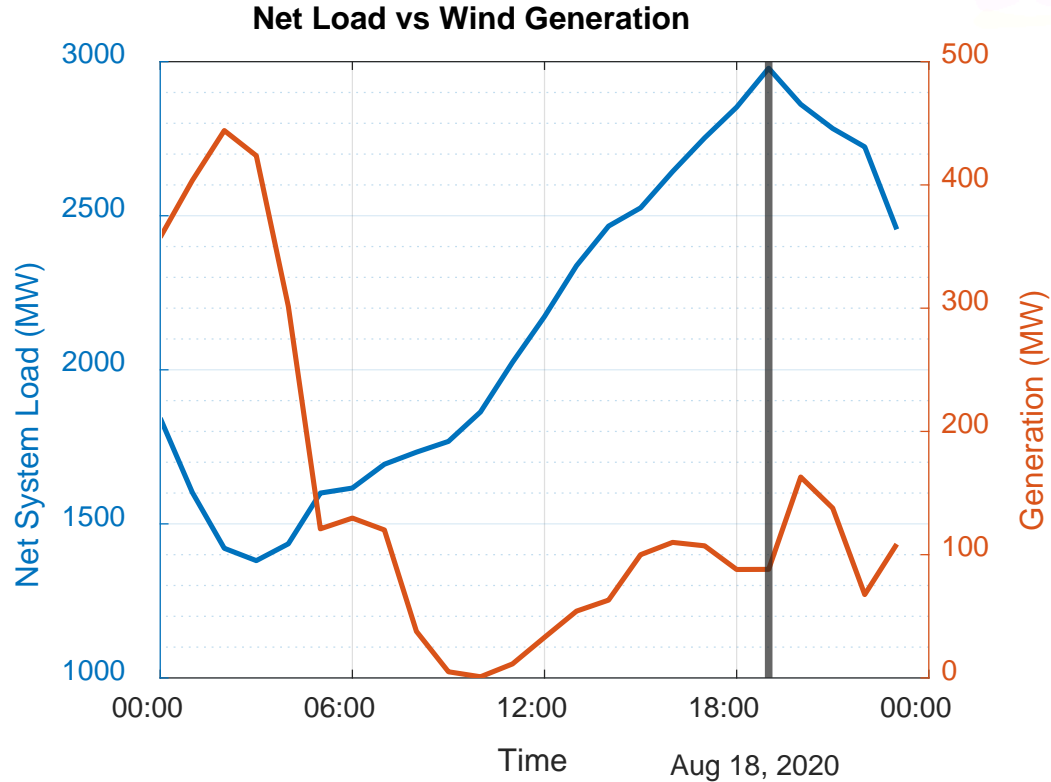


Solar + Storage ELCC Results

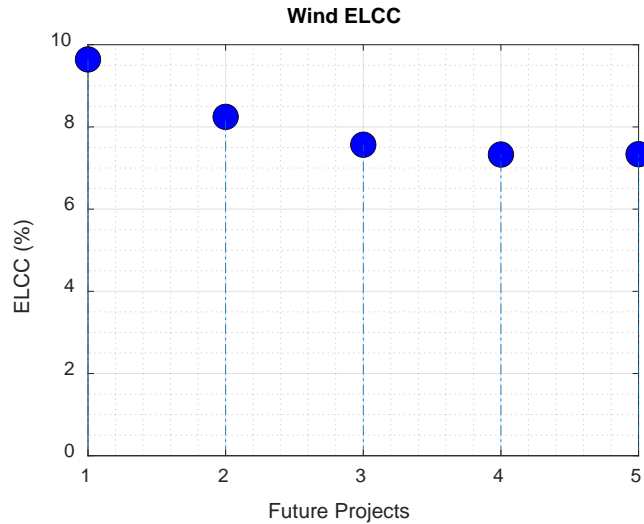
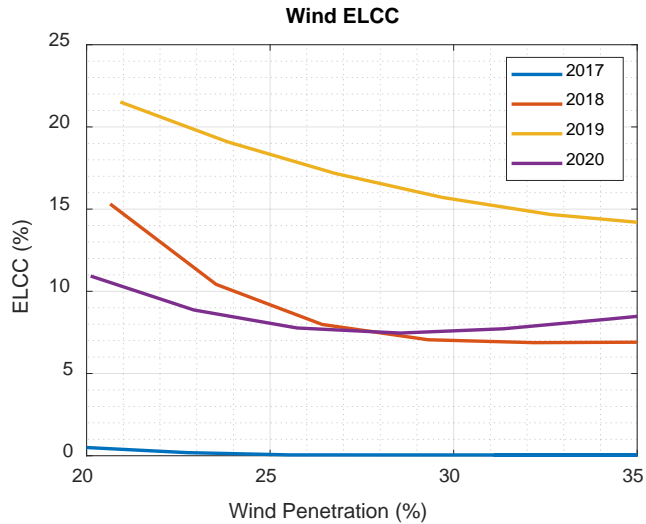


Projects (100 MW)	ELCC (%)
1	100.00
2	TBD
3	TBD
4	TBD
5	TBD

Wind ELCC Results



Wind ELCC Results



Projects (100 MW)	ELCC (%)
1	9.64
2	8.24
3	7.56
4	7.32
5	7.30



Thank you!

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