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Enabling Clean Technologies

Peak Prediction Hedging for Saving More

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Outline

- **Background**
- **Spread Battery Capacity over Different Number of Hours**
- **Results**

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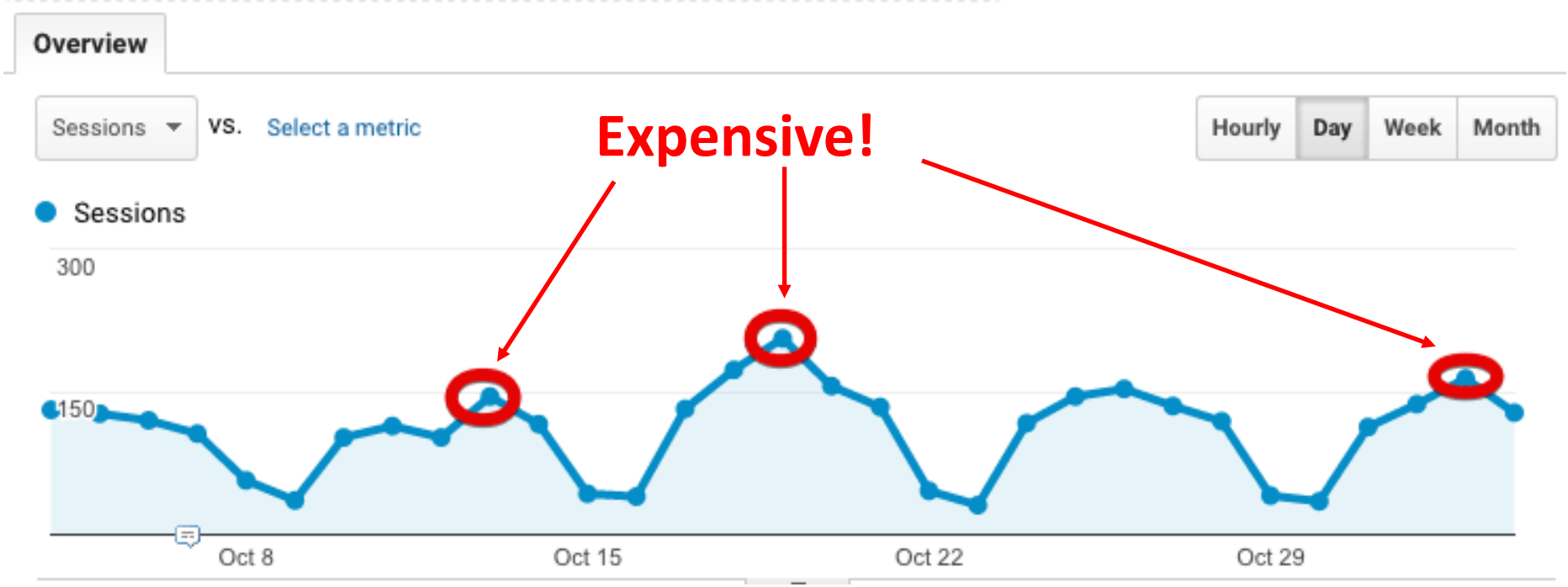
Background



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Background

How to save more on electricity bills?

- Enel X: System Peak Program
- Forecast the most likely peak hour.
- Discharge battery during predicted peak hour.

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Background

Error in forecasting

- Forecasted peak hour is 17:00:00-18:00:00
- Discharge battery from 17:00:00 to 19:00:00 (2-hour capacity)
- True peak hour is 20:00:00-21:00:00
- Have to consume expensive grid-power

Study a different discharging strategy to minimize the risk of wrong forecasts!

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Spread Capacity over Different Number of Hours

Discharge in proportional to probabilities

- Forecasted probabilities of being the peak on some day:

  0.4, 0.2, 0.4

- Discharge the battery

  40%, 20%, 40%

  of the capacity

top_n_probs: number of forecasted probabilities to consider

Spread Capacity over Different Number of Hours

Algorithm Outline

Step 1

- Specify parameters top_n_peaks (number of peaks to consider in a season) and top_n_probs, i.e, top_n_peaks =**n**, top_n_probs=**k**
- Filter out the 365 peak hours in a season and keep the **n** highest peak hours
- For each selected peak hour, look at the **k** largest forecasted probabilities on that day

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Algorithm Outline

Step 1

Actual demand

Highest demand of the day

season_results

	adjusted_demand_MW	demand_MW	season	ts	rankings_per_day	rankings_per_season	forecast
5	20702.0	21168.0	2017-2018	2017-06-12 17:00:00	1.0	3.0	0.3025
6	20122.0	20536.0	2017-2018	2017-07-19 18:00:00	1.0	5.0	0.2125
7	21170.0	21786.0	2017-2018	2017-09-25 17:00:00	1.0	1.0	0.66
8	21039.0	21542.0	2017-2018	2017-09-26 17:00:00	1.0	2.0	0.72
9	20238.0	20906.0	2017-2018	2018-01-05 18:00:00	1.0	4.0	0.4675

Forecasted probability

4-th Highest demand of the season

Notations:
Season: from Apr. 30th to next year's Apr. 30th

Spread Capacity over Different Number of Hours

Algorithm Outline

Step 2

- Adjust the selected **k** probabilities to sum up to one
- The selected 3 probabilities are

  0.2, 0.1, 0.4

  Then the adjusted probabilities are

  0.2/(.2+0.1+0.4), 0.1/(.2+0.1+0.4), 0.4/(.2+0.1+0.4)

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Algorithm Outline

Step 2

season_adjusted

	ts	forecast	prob_rankings_per_day	is_true_peak	adjusted_prob	discharge_rate	season	top_n
1197	2017-06-12 17:00:00	0.3025	2.0	1	0.36	0.72	2017-2018	5
1198	2017-06-12 18:00:00	0.3125	1.0	0	0.38	0.76	2017-2018	5
1199	2017-06-12 19:00:00	0.215	3.0	0	0.26	0.52	2017-2018	5
1310	2017-07-19 17:00:00	0.515	1.0	0	0.5	1.0	2017-2018	5
1311	2017-07-19 18:00:00	0.2125	2.0	1	0.25	0.5	2017-2018	5
1312	2017-07-19 19:00:00	0.1625	3.0	0	0.25	0.5	2017-2018	5

Spread Capacity over Different Number of Hours

Algorithm Outline

Step 3

- Calculate the relative discharged energy
- Battery capacity is 2-hours long; maximum discharge per hour is 0.5 unit.
- If the adjusted probabilities are

  0.6, 0.1, 0.3

  then discharge 50%, 25%, 25% of the capacity.
- Relative discharge are **0.5/0.5=100%, 0.25/0.5=50%, 0.25/0.5=50%**

  Fully used!

Spread Capacity over Different Number of Hours

Algorithm Outline

Step 4

- Metric

  total energy successfully discharged / top_n_peaks

- More closer to 100%, better performance
- Evaluate our discharging strategy for top 1, top 5, top 10 and top 20 peaks in a season
- By varying the value of top_n_probs, study the changes in performance

Spread Capacity over Different Number of Hours

Algorithm Outline

Step 4

Metric

	Season	Top_n_peaks	Top_n_probs	HitRate(%)	Performance(%)	12	15	16	17	18	19	20
0	2016-2017	1	3	1/1(100.0%)	50.0	0/0	0/0	0/0	0/0	1/1(50.0%)	0/0	0/0
1	2018-2019	1	3	1/1(100.0%)	100.0	0/0	0/0	0/0	1/1(100.0%)	0/0	0/0	0/0
2	2019-2020	1	3	1/1(100.0%)	100.0	0/0	0/0	0/0	1/1(100.0%)	0/0	0/0	0/0
3	2017-2018	1	3	1/1(100.0%)	100.0	0/0	0/0	0/0	1/1(100.0%)	0/0	0/0	0/0
4	2016-2017	5	3	5/5(100.0%)	80.0	0/0	0/0	0/0	3/3(100.0%)	2/2(50.0%)	0/0	0/0
5	2018-2019	5	3	4/5(80.0%)	70.0	0/0	0/1	0/0	3/3(99.0%)	1/1(50.0%)	0/0	0/0
6	2019-2020	5	3	4/5(80.0%)	68.0	0/1	0/0	0/0	3/3(97.0%)	1/1(50.0%)	0/0	0/0
7	2017-2018	5	3	5/5(100.0%)	83.0	0/0	0/0	0/0	3/3(91.0%)	2/2(72.0%)	0/0	0/0

- **Hit rate x/y**

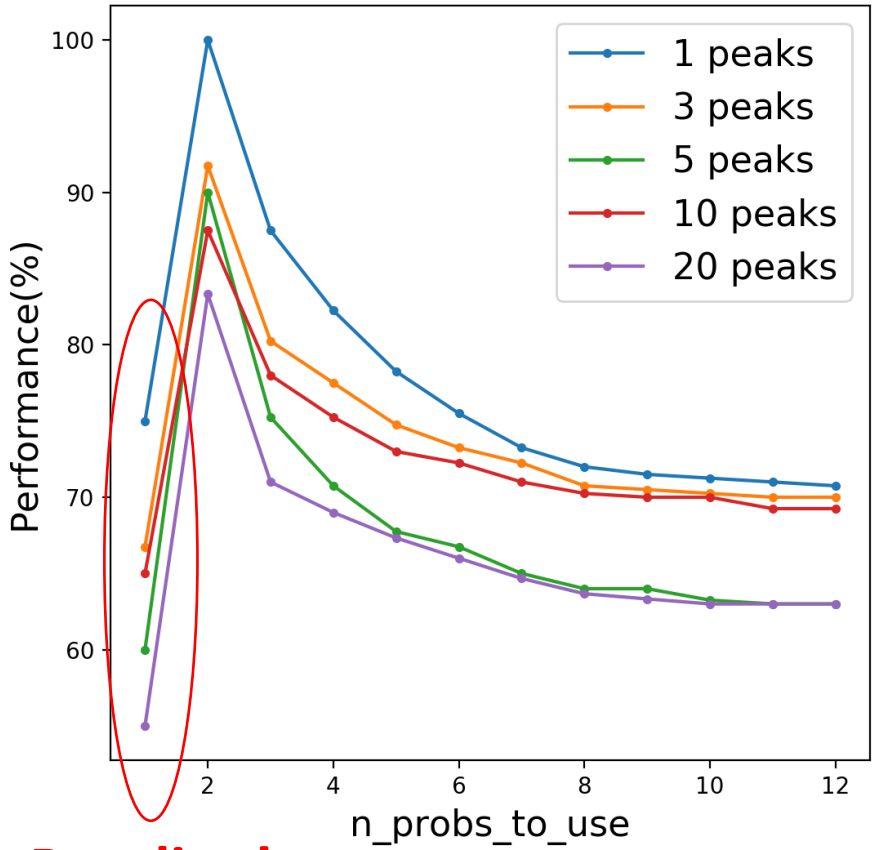
Successfully discharge x out of y peaks

- **17 x/y(p%)**

Successfully discharge x out of y peaks which appear at 17 and the averaged discharge is p%

Results

- **Baseline:** n_probs_to_use = 1
- **n_probs_to_use=2:** best performance for all top_n_peaks
- **n_probs_to_use>2:** except for top 1 peak, always better than baseline
- Spread capacity over more hours, **relative discharge decrease** in each hour



Baseline!

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Thank you!

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