Resource Counting for Preferred Resources

NP Energy on behalf of the **Natural Resources Defense Council**

NP ENERGY

Disclaimer

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Presentation Overview

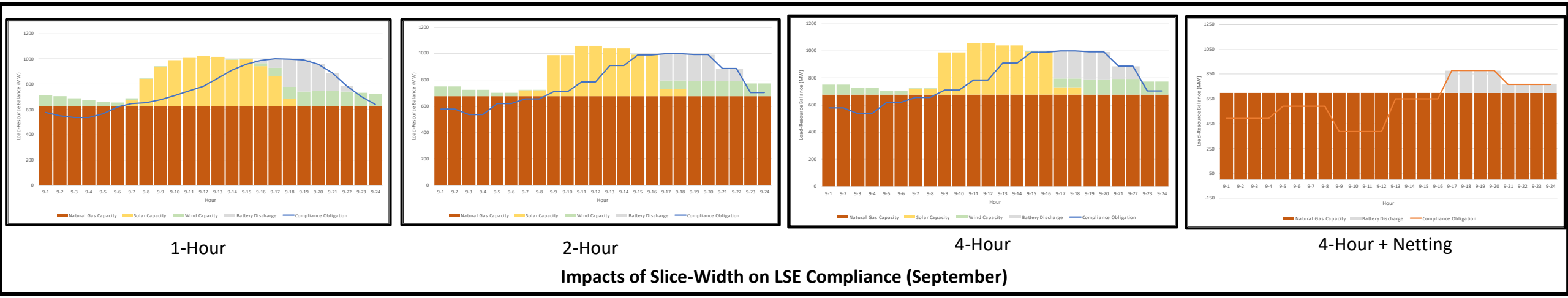
- **Presentation Segments:**
  - Resource Counting: An Hourly Exercise
  - Resource-Specific Exceedance Process and Benefits

- **Key Takeaways:**
  - Resource counting and structural design are inextricably linked
  - Hourly accounting improves reliability precision, reduces barriers for preferred resources, and reduces compliance costs for LSEs
  - Resource-specific exceedance aligns LSE and developer incentives with reliability
  - Resource-specific exceedance and hourly counting are technically and administratively manageable

Resource Counting: An Hourly Exercise

Resource Counting Is Inextricably Linked to Structural Design

Slice Width – 1-, 2-, or 4-Hour Slices



1-Hour | 2-Hour | 4-Hour | 4-Hour + Netting

Impacts of Slice-Width on LSE Compliance (September)

Slice-width has an outsized impact on resource counting.

Should slice width align with the hourly variability and limitations of preferred resources (solar, wind, storage, DR, EE)?

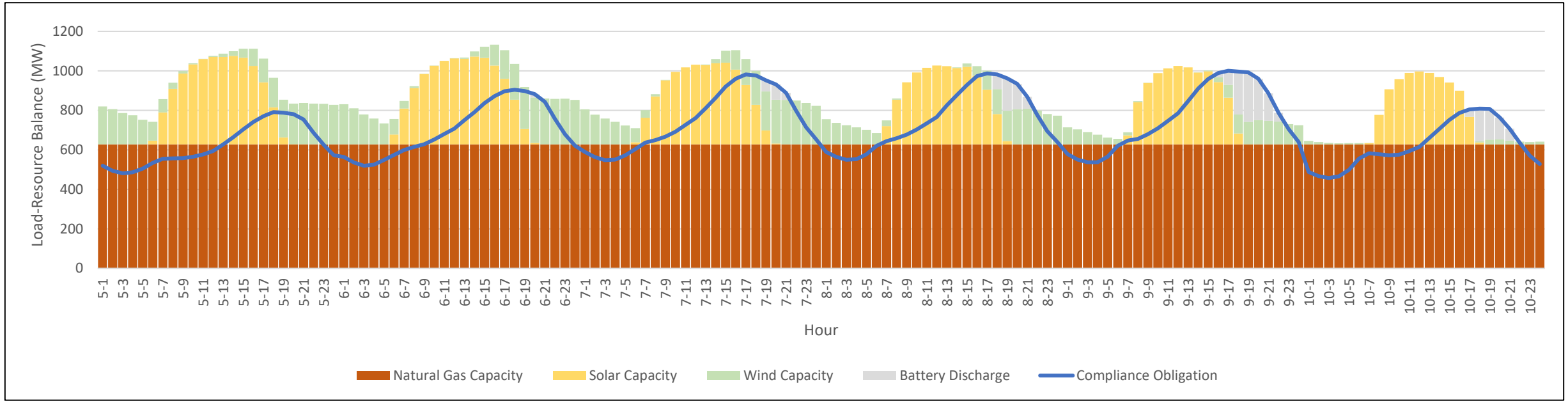
How do Slices Impact an LSE's RA Portfolio?

A Compliance Thought Exercise.

- *LSE A* wants to minimize natural gas in its RA portfolio. Showing a natural gas resource as RA:
  - Is expensive (+portfolio cost)
  - Diverts funds from alternative investments (-renewables and storage)
  - Increases the likelihood the shown resource operates (+emissions)

- LSE A has the following preferred resource portfolio to show:
  - 1000MW Peak Compliance Obligation
  - 500 MW Solar PV
  - 400 MW Wind
  - 250MW / 1000MWh Storage

1-Hour / 24-Slice (May-October)



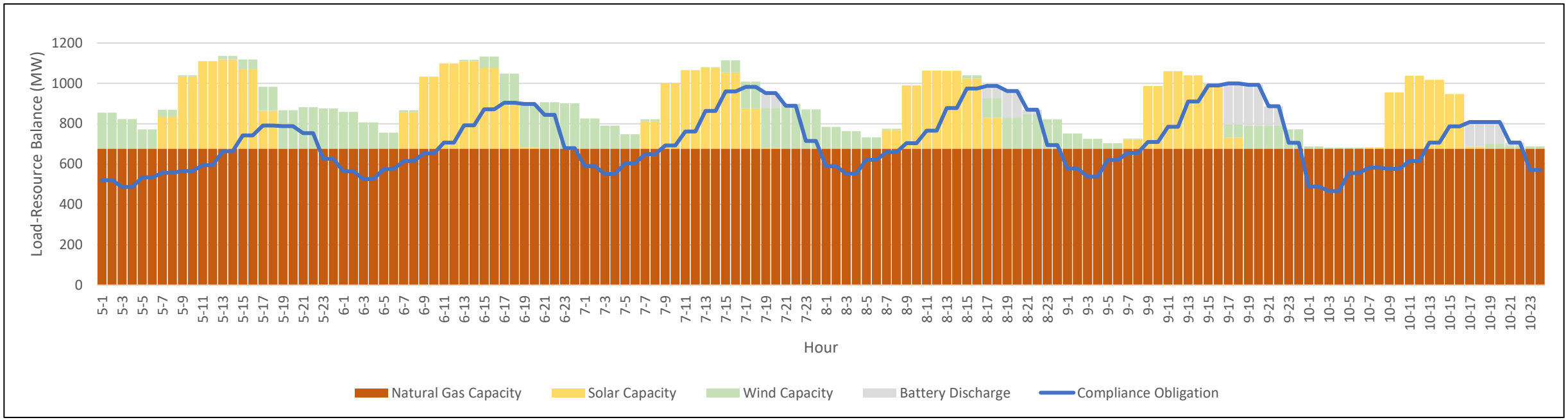
With hourly accounting, LSE A needs to "top up" its preferred resource portfolio with **628MW** of 24/7 resources.

LSE A's preferred resource portfolio provides the equivalent to **372MW** of its RA obligation.

LSE A Obligation + Portfolio

- 1000MW Peak
- 500MW Solar
- 400MW Wind
- 250MW/1000MWh Storage
- **628MW Gas**

2-Hour / 12-Slice (May-October)



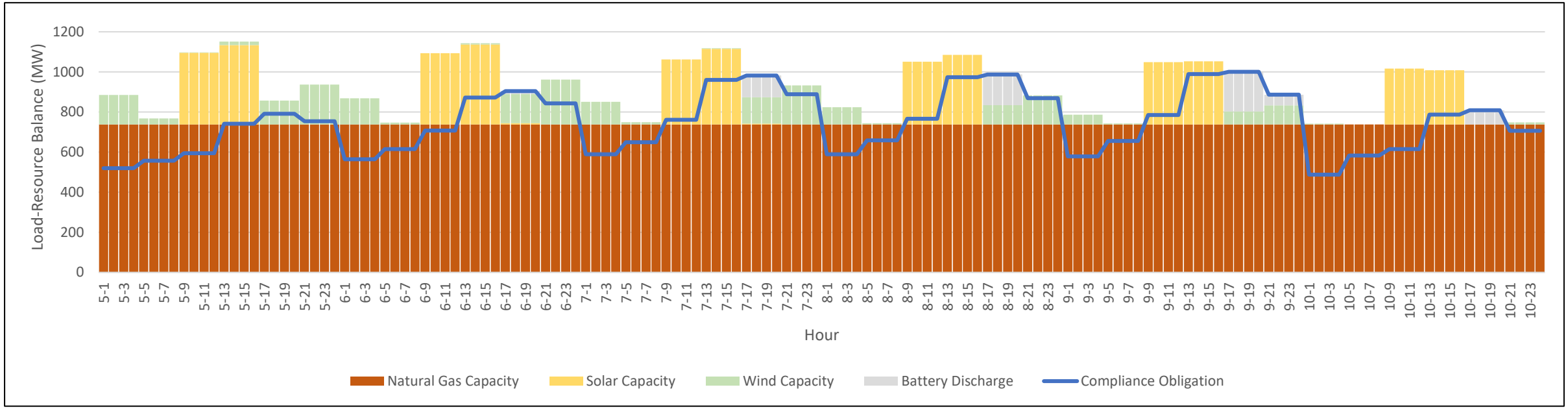
With two-hour slices, LSE A needs to "top up" its preferred resource portfolio with **676MW** of 24/7 resources (+**48MW** from 1-hour).

LSE A's preferred resource portfolio provides the equivalent to **324MW** of its RA obligation (-**48MW** from 1-hour)

LSE A Obligation + Portfolio

- 1000MW Peak
- 500MW Solar
- 400MW Wind
- 250MW/1000MWh Storage
- **676MW Gas**

4-Hour / 6-Slice (May-October)



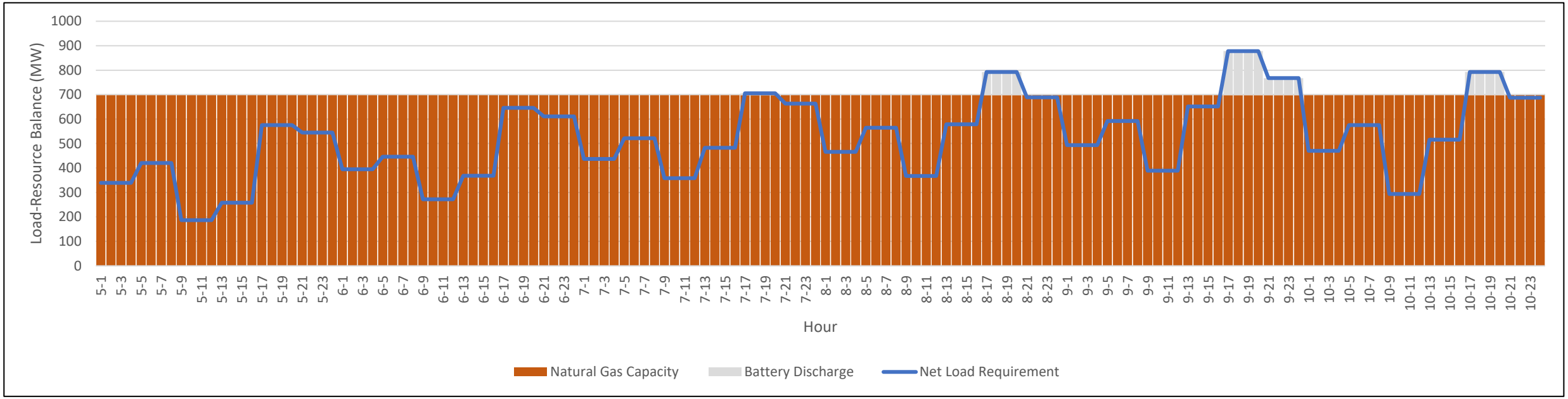
With four-hour slices, LSE A needs to "top up" its preferred resource portfolio with **737MW** of 24/7 resources (+**109MW** from 1-hour).

LSE A's preferred resource portfolio provides the equivalent to **263MW** of its RA obligation (**-109MW** from 1-hour)

LSE A Obligation + Portfolio

- 1000MW Peak
- 500MW Solar
- 400MW Wind
- 250MW/1000MWh Storage
- **682MW Gas**

What if We Net? 4-Hour Plus Netting



With four-hour slices ***and netting***, LSE A needs to "top up" its preferred resource portfolio with **698MW** of 24/7 resources (+**70MW** from 1-hour).

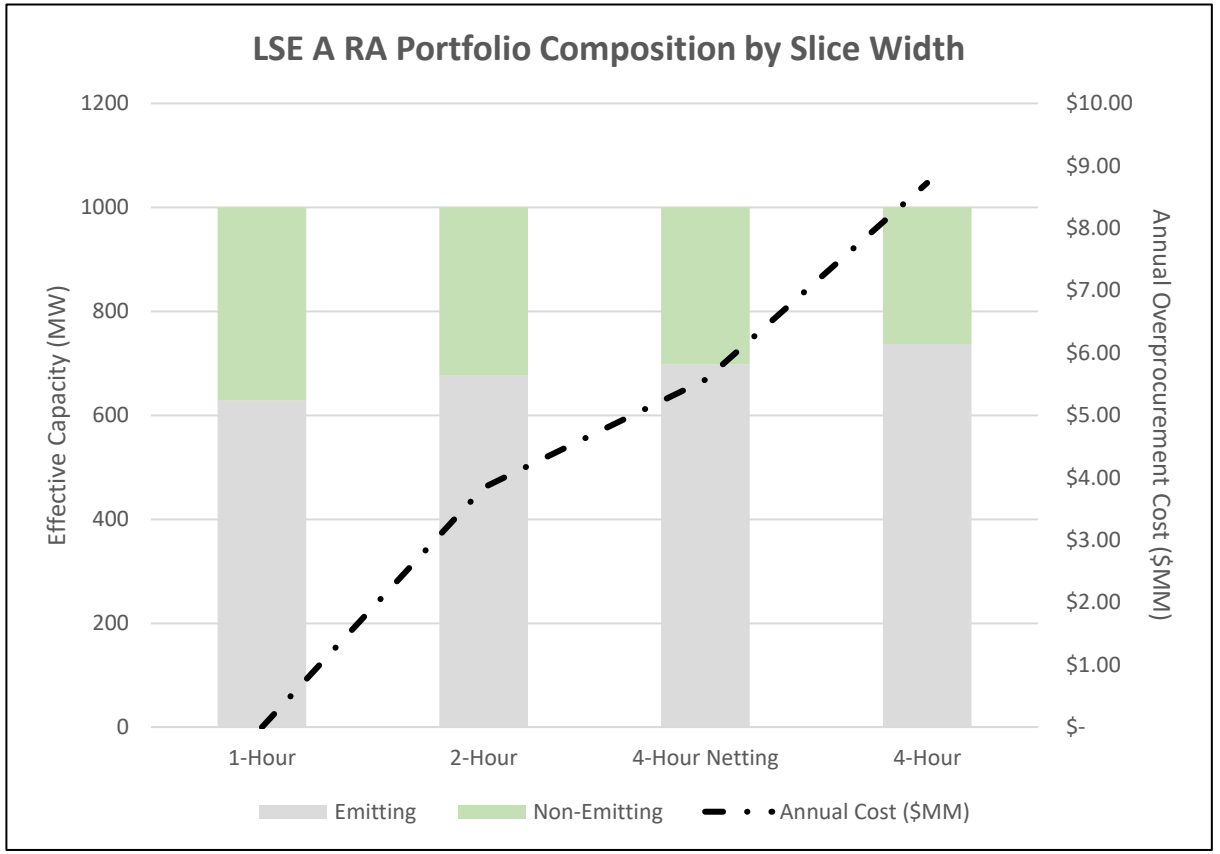
LSE A's preferred resource portfolio provides the equivalent to **302MW** of its RA obligation (**-70MW** from 1-hour)

LSE A Obligation + Portfolio

- 1000MW Peak
- 500MW Solar
- 400MW Wind
- 250MW/1000MWh Storage
- **698MW Gas**

Identical Portfolio + Simplification = More Gas

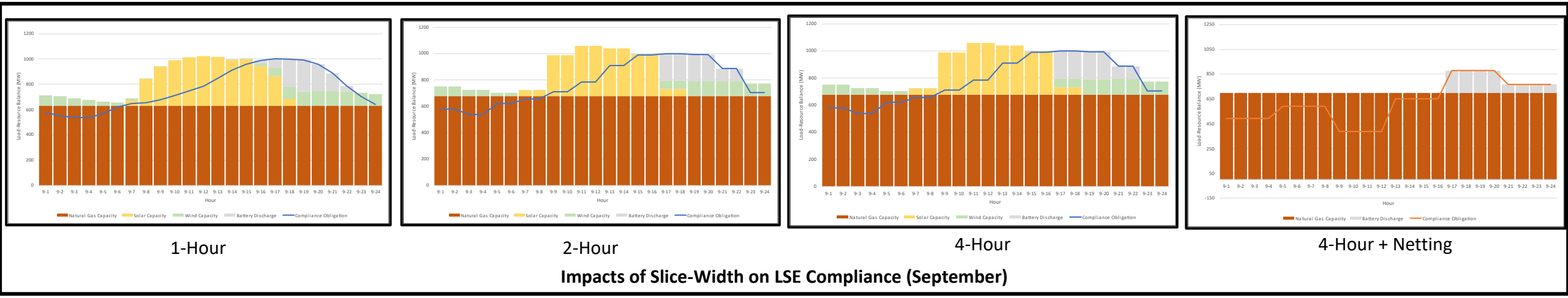
- **Multi-Hour Slices: More Gas, More Cost, More Emissions, More Non-Compliance**
  - Unnecessary gas showings have meaningful ratepayer costs and transfer wealth from ratepayers to generators
  - Higher gas RA costs divert limited LSE funds from developing new-build renewables and storage and lower cost-benefit of investments
  - Unnecessary gas showings may delay viable retirements or mothballing
  - Higher requirements may result in non-compliance despite technical sufficiency



	1-Hour	2-Hour	4-Hour Net	4-Hour
Non-Emitting (Equiv MW)	372	324	302	263
Emitting (MW)	628	676	698	737
Add'l Cost ($MM/Year)	$ -	$ 3.84	$ 5.57	$ 8.73

Additional cost assumes $6.66/kW-Month for marginal gas resources.

Recap: Slice Width Must be One Hour



1-Hour | 2-Hour | 4-Hour | 4-Hour + Netting

Impacts of Slice-Width on LSE Compliance (September)

Slice-width has an outsized impact on resource counting.

Slice width should align with the hourly variability and limitations of emerging preferred resources (solar, wind, storage, DR, efficiency).

Resource Counting Structure: Policy Considerations

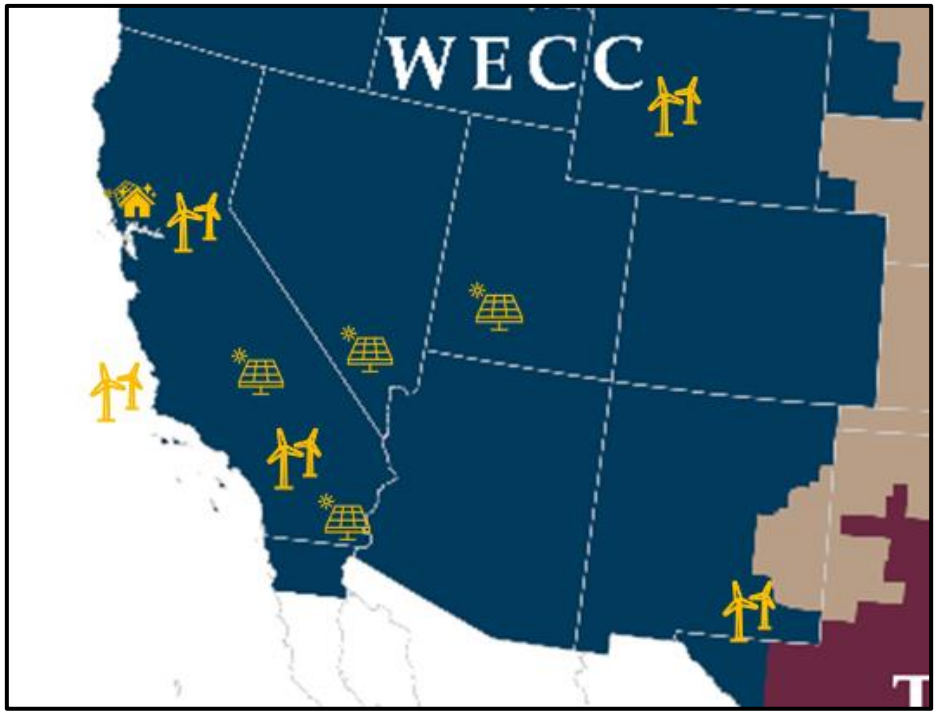
- **Hourly Accounting**
  - Facilitates replacement of gas RA with preferred resource RA
  - Could avoid several thousands MW of unnecessary gas RA showings per year
  - Requires matrix math
- **Multi-Hour Accounting**
  - Reduces the ability of preferred resources to count for RA
  - Requires unnecessary showings beyond what's technically necessary
  - Requires slightly less matrix math

Policy Consideration: *Is avoiding matrix math worth $4-9 million in annual excess RA procurement for a mid-sized LSE?*

Resource-Specific Exceedance

Rationale and Process for Resource-Specific Exceedance Profiles

Renewable Resources Across the WECC



Each of these resources has a unique production profile.

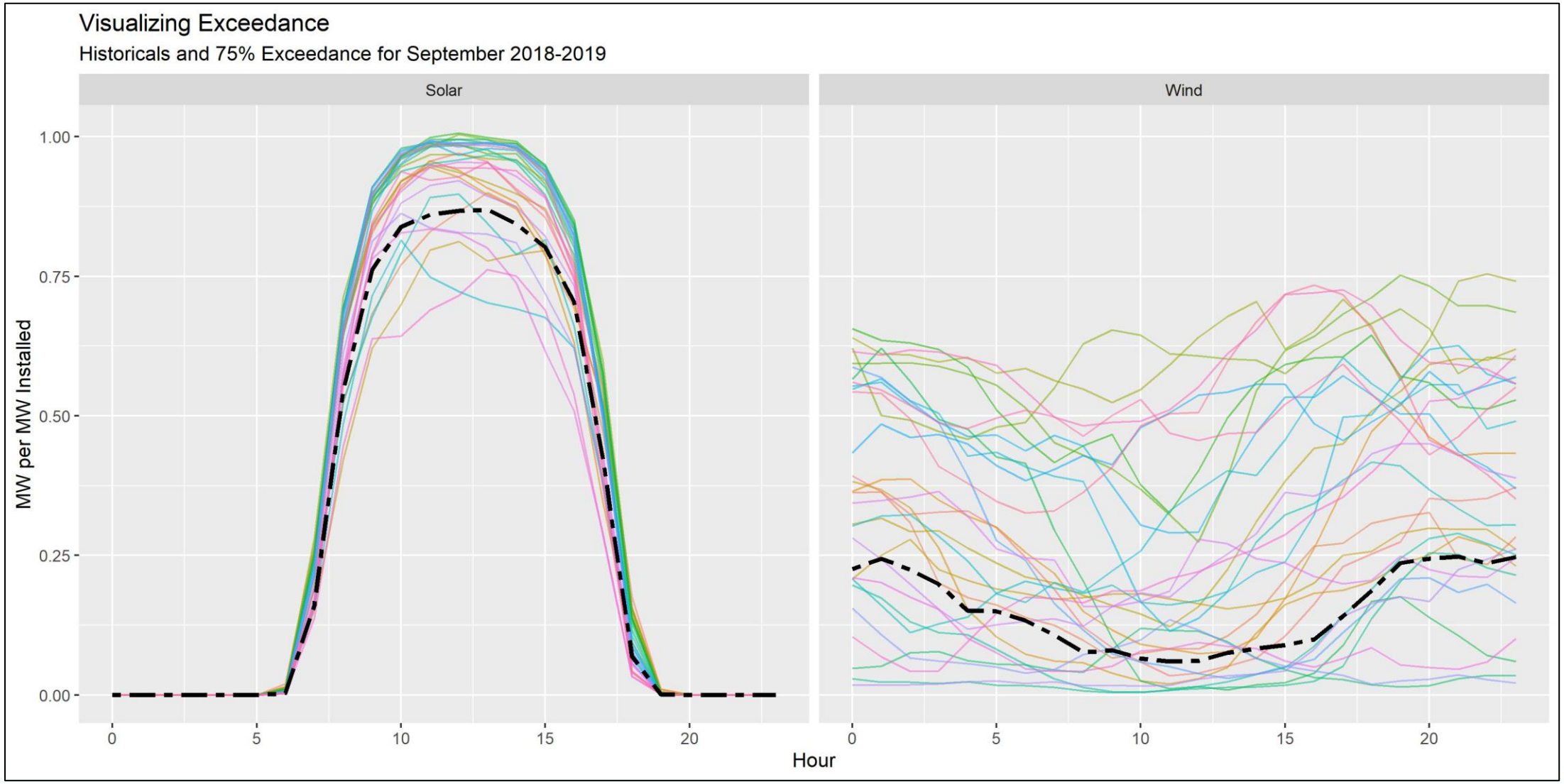
Should RA value recognize beneficial locations, technologies, and other developer / LSE investment choices?

Resource-Specific Exceedance: Rationale

- Resource-specific exceedance:
  - Aligns LSE and developer incentives with reliability needs
  - Is mathematically and administratively simple
  - Reduces “errors-by-simplification” in reliability planning

The following slides walk through how LSEs, developers, and/or CPUC staff could determine exceedance values for individual resources.

Refresher: What is Exceedance?



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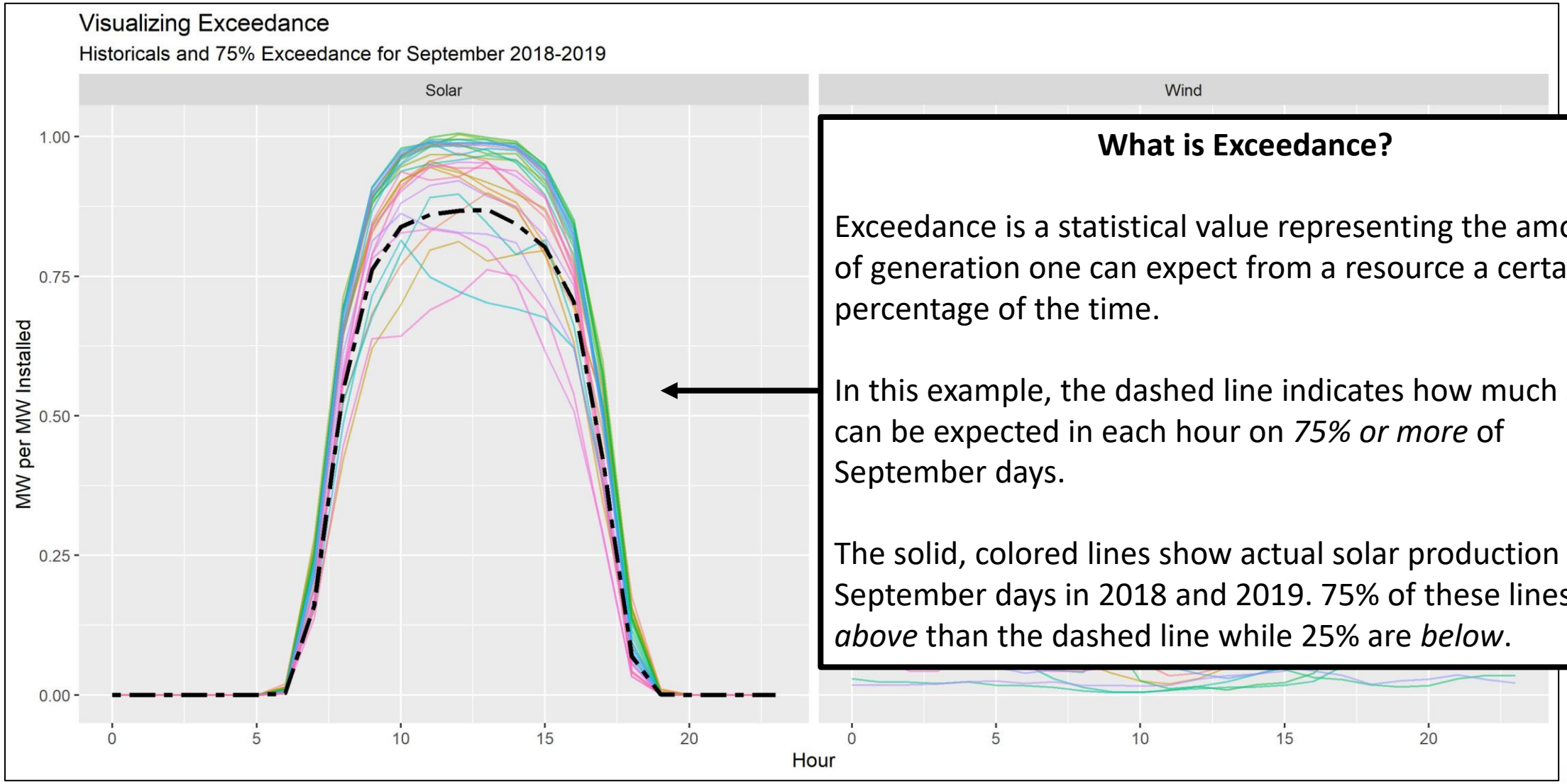


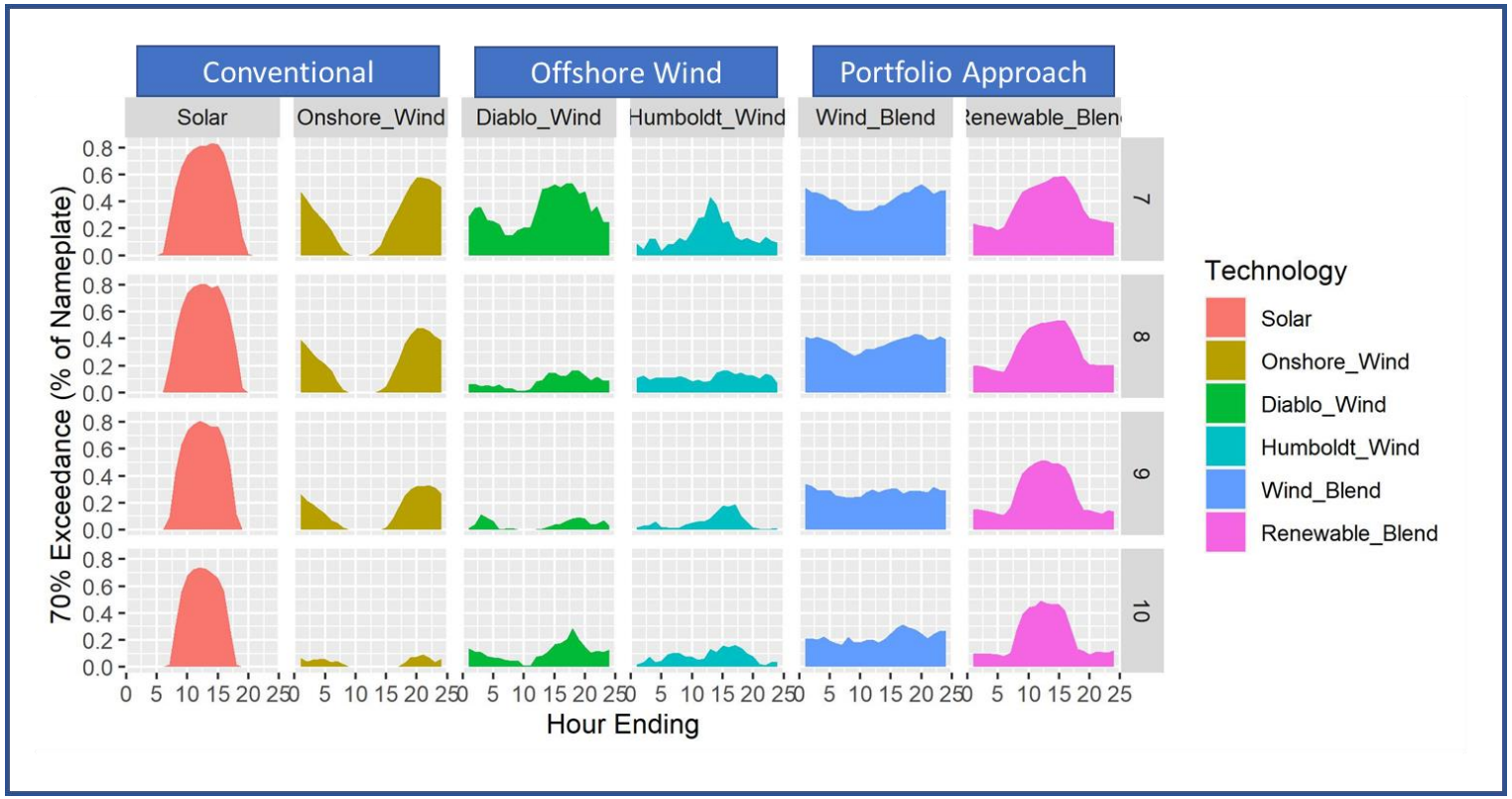
What is Exceedance?

Exceedance is a statistical value representing the amount of generation one can expect from a resource a certain percentage of the time.

In this example, the dashed line indicates how much solar can be expected in each hour on *75% or more* of September days.

The solid, colored lines show actual solar production on September days in 2018 and 2019. 75% of these lines are *above* than the dashed line while 25% are *below*.

Blended Portfolio: "Diversity Benefit"



"The wind is always blowing somewhere." Looking at exceedance on a blended portfolio basis can provide substantial "diversity benefits" when considering the different profiles across wind regions, on-shore / off-shore, etc.

- Wind Blend = 33% Onshore, 33% Diablo Offshore, 33% Humboldt Offshore
- Renewable Blend = 50% Solar, 25% Onshore Wind, 12.5% Diablo, 12.5% Humboldt Offshore

Note: Illustrative only; IRP Clean System Power profiles used for lack of historical data.

Resource-Specific Exceedance: Easy as 1-2-3

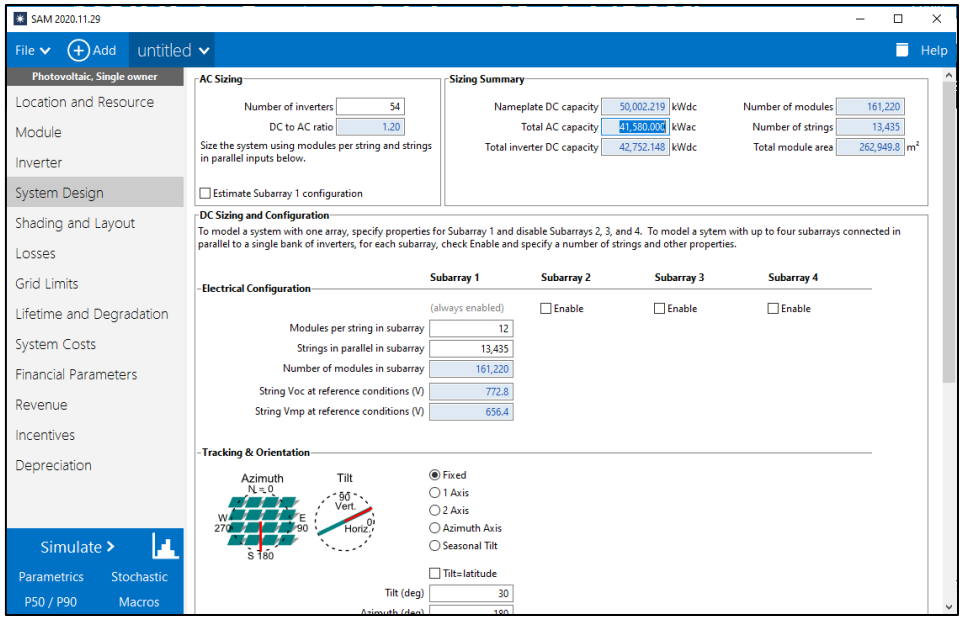
- Step 1: Source Data
  - > 1-3 Years of Operation: Historical Production
  - Pre-COD and < 1-3 Years of Operation: Modeled Production

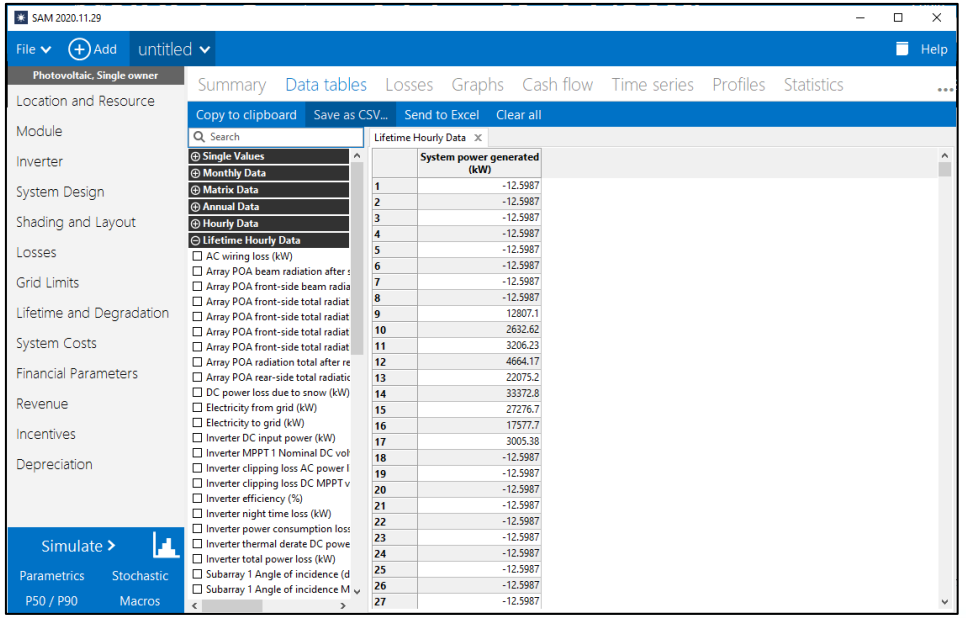
- Step 2: Execute Exceedance Analysis
  - Load Data into Statistical Software
  - Process Exceedance Function
  - Return Data to Compliance Worksheet

- Step 3: Add Resource and Exceedance to Compliance Worksheet
  - Add Exceedance Vector (288 Month-Hour Pairs) to Resource Profiles Tab
  - Align Resource and Exceedance Labels
  - Excel to Auto-Populate

Step 1: Source Data

- Process:
  - For existing resource (>3 year since COD), retrieve historical data
  - For planned / new resource (Pre-COD or <3 year since COD), generate modeled data
    - Add resource parameters to NREL's System Advisor Model
    - Load TMY for facility location
    - Simulate Hourly Production
  - Save as .csv file





Step 2: Process Exceedance

- Process:
  - Load the data into any statistical program (R, Python, Stata, SQL, etc etc)
  - Define the exceedance parameter
  - Group the data (month-hour pairs)
  - Execute a quantile function
  - Save as .csv

```
1  Historicals<-read.csv("Historical_Production.csv") #Load historical data
2
3  Exceedance_Parameter <- .75                        #Define exceedance parameter
4
5  Exceedance_Values<-Historicals%>%
6    group_by(Month, Hour, Resource)%>%               #Specify grouping
7    summarise(Exceedance = quantile(Production_MW,   #Process exceedance on data
8                                    probs =(1-Exceedance_Parameter)))
9
10 write.csv(Exceedance_Values, "Exceedance_Values.csv") #Return data to model
```

- Requires: Ten lines of code, four function calls, milliseconds of run time

Step 3: Add to Compliance Spreadsheet

- Process:
  - Load the exceedance .csv
  - Highlight column of month-hour exceedance pairs
  - Copy-paste to “Resource Profiles” tab in compliance worksheet
  - Label as “Solar Resource 1”, e.g.
  - Add “Solar Resource 1” to “Resources” tab
  - Pre-populated index-match function will add resources to slice compliance model

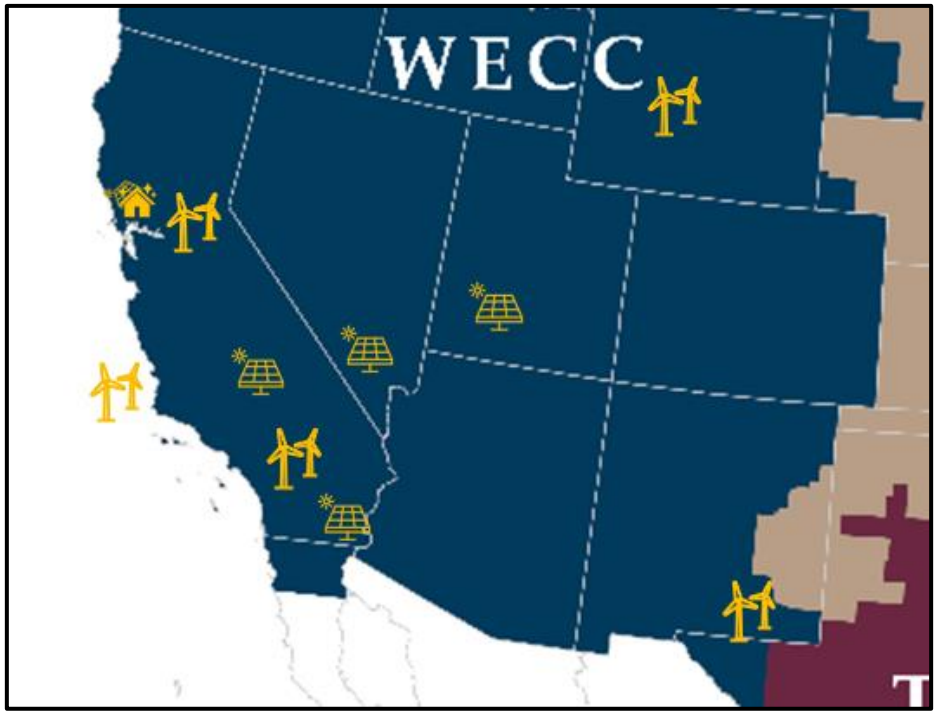
	A	B	C	D	E	F
1	Month	HE	Solar Resource 1	Solar Resource 2	Wind Resource 1	Wind Resource 2
2	1	1	0	0.254283788	0.512162906	0
3	1	2	0	0.178576851	0.518423119	0
4	1	3	0	0.113090638	0.700351924	0
5	1	4	0	0.066401483	0.81843301	0
6	1	5	0	0.043453705	0.790333112	0
7	1	6	0	0.034661454	0.746211783	0
8	1	7	0	0.016880881	0.684935956	0
9	1	8	0.028934387	0.002978505	0.529341072	0
10	1	9	0.35808335	0.011815367	0.446659555	0
11	1	10	0.581414056	0.06058915	0.527997176	0.003804124
12	1	11	0.667013003	0.120124425	0.330243542	0.002317431
13	1	12	0.688917608	0.154868372	0.125230419	0
14	1	13	0.683710248	0.162814613	0.042397189	0
15	1	14	0.669268889	0.150564643	0.102352769	0.003224665
16	1	15	0.62577088	0.137216584	0.162548628	0.0327772
17	1	16	0.523691165	0.131868308	0.217883202	0.027453746
18	1	17	0.196443673	0.167048828	0.230367684	0.008563077
19	1	18	0	0.23649745	0.324969258	0.004103341
20	1	19	0	0.290321508	0.253977901	0.01237802
21	1	20	0	0.30859638	0.430491698	0.010516512
22	1	21	0	0.296178854	0.729218643	0.008987361
23	1	22	0	0.274340185	1	0.002220353
24	1	23	0	0.265554661	1	0
25	1	24	0	0.248246402	1	0

Administrative Considerations and Oversight

- **Who Does the Analysis?**
  - **Option 1:** Developers / LSEs perform analysis and provide attestation to CPUC with resource parameters and outputs
  - **Option 2:** Developers / LSEs provide resource parameters to CPUC and CPUC staff executes analysis using NREL Python wrapper
  - ***Considerations:***
    - Option 1 requires developers and LSEs to confirm modeling seems consistent with reality, but may introduce "too many cooks" errors
    - Option 2 adds staff pressure on Energy Division but can be automated
    - Both approaches should involve benchmarking to use outliers to identify errors

- **Which Model(s) Should be Permitted?**
  - System Advisor Model is a free-to-use tool from NREL, well-vetted, and strong support community
  - Alternatives should be vetted with stakeholders – consistency and "realism" should guide vetting process, e.g. alignment of weather inputs and consideration of "bad days"

Recap: Resource-Specific Exceedance

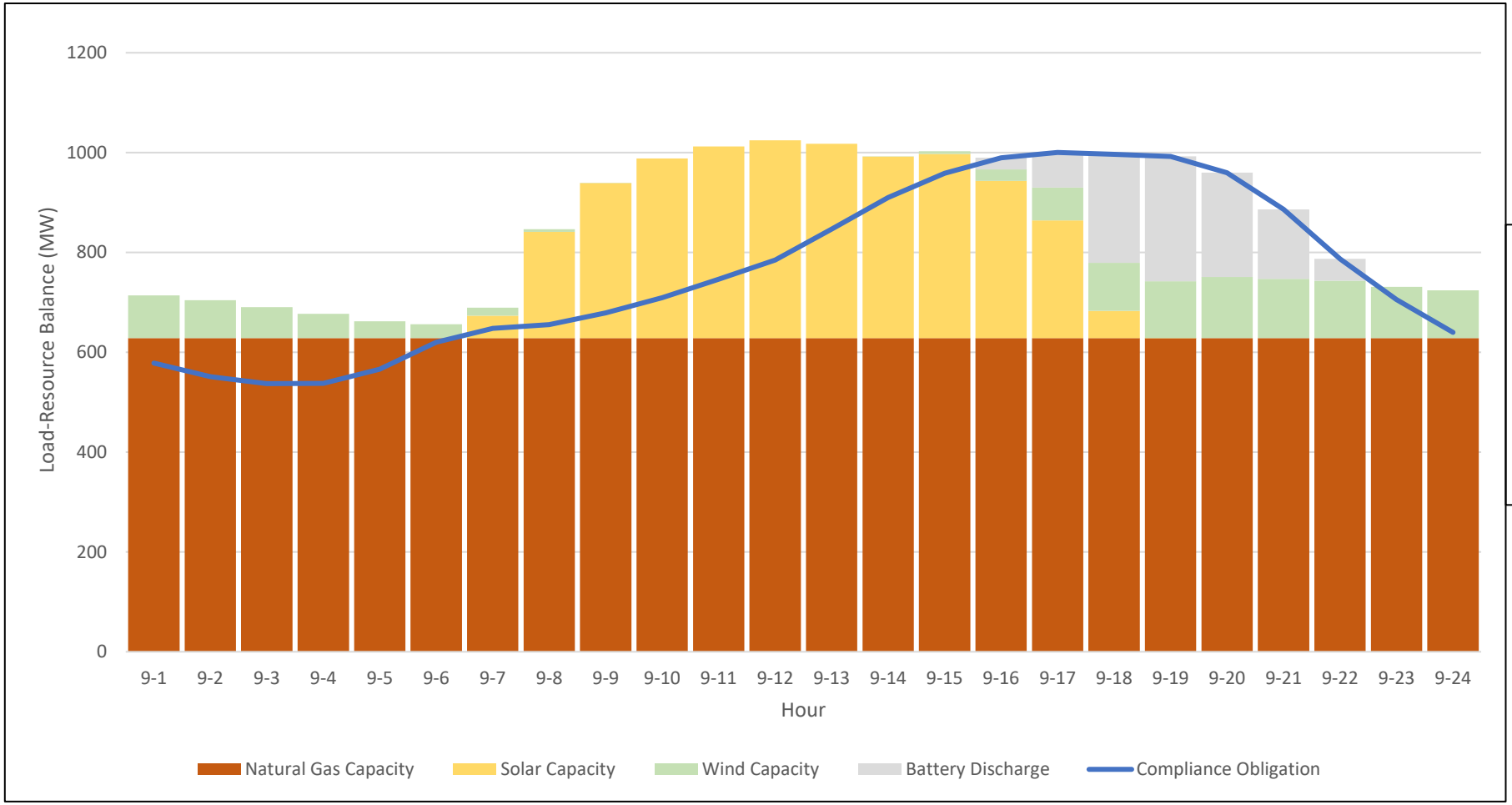


Each of these resources has a unique production profile.

RA value should recognize beneficial locations, technologies, and other developer and LSE investment choices.

Appendix: Hourly Counting in September

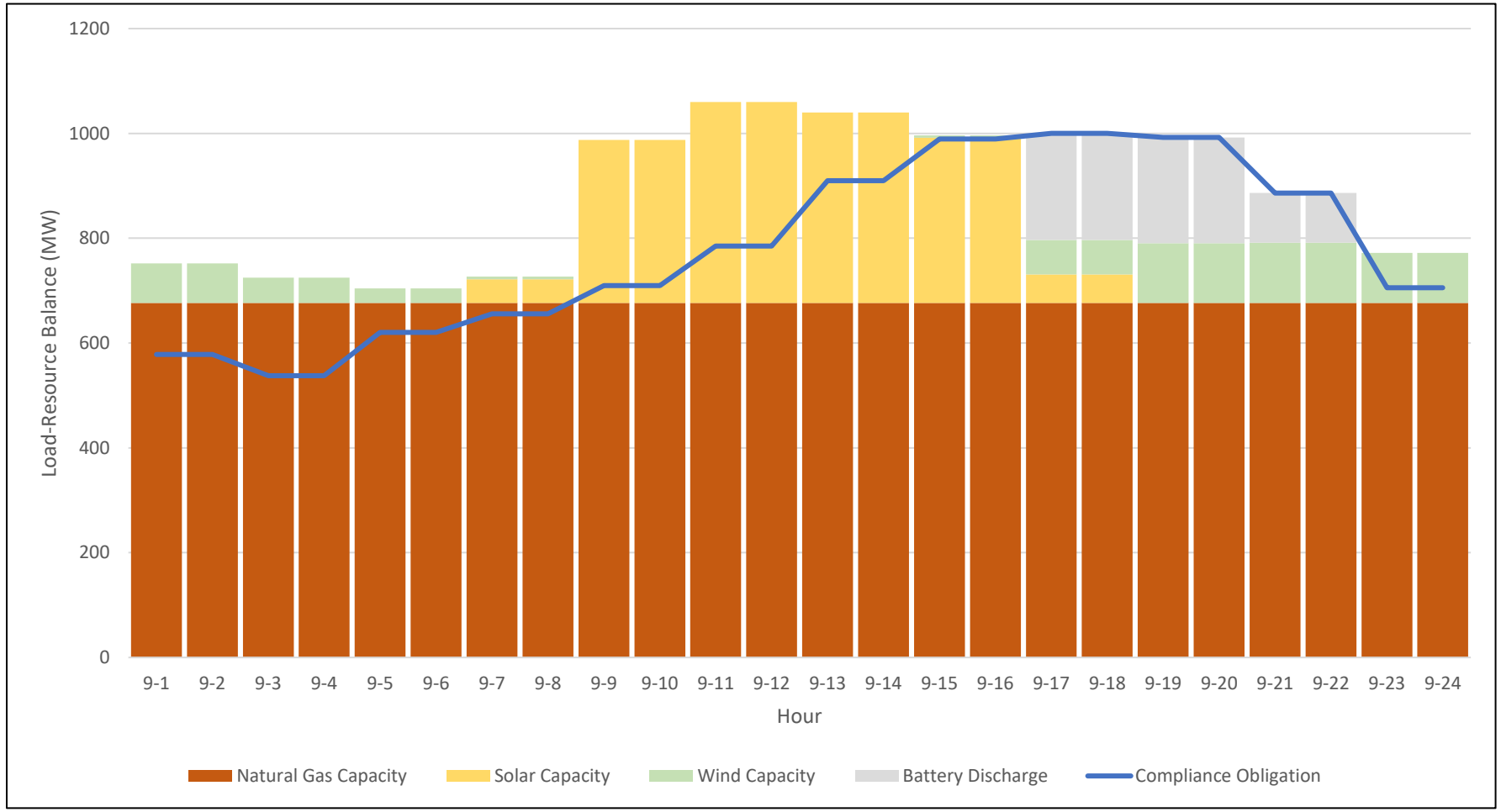
1-Hour / 24-Slice (September)



LSE A Obligation + Portfolio

- 1000MW Peak
- 500MW Solar
- 400MW Wind
- 250MW/1000MWh Storage
- **628MW Gas**

2-Hour / 12-Slice (September)



LSE A Obligation + Portfolio

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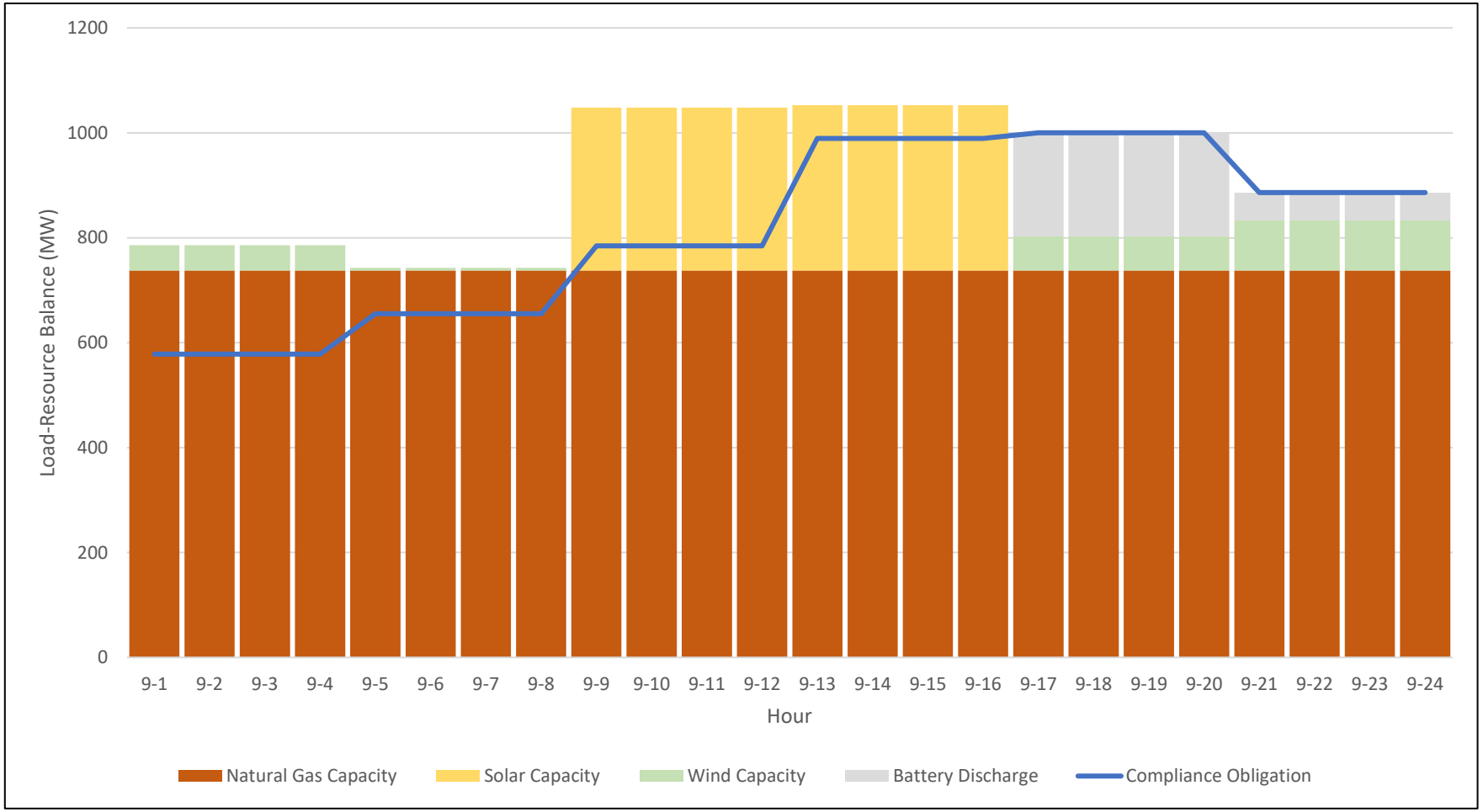
- 250MW/1000MWh Storage
- **676MW Gas**

4-Hour / 6-Slice (September)



LSE A Obligation + Portfolio

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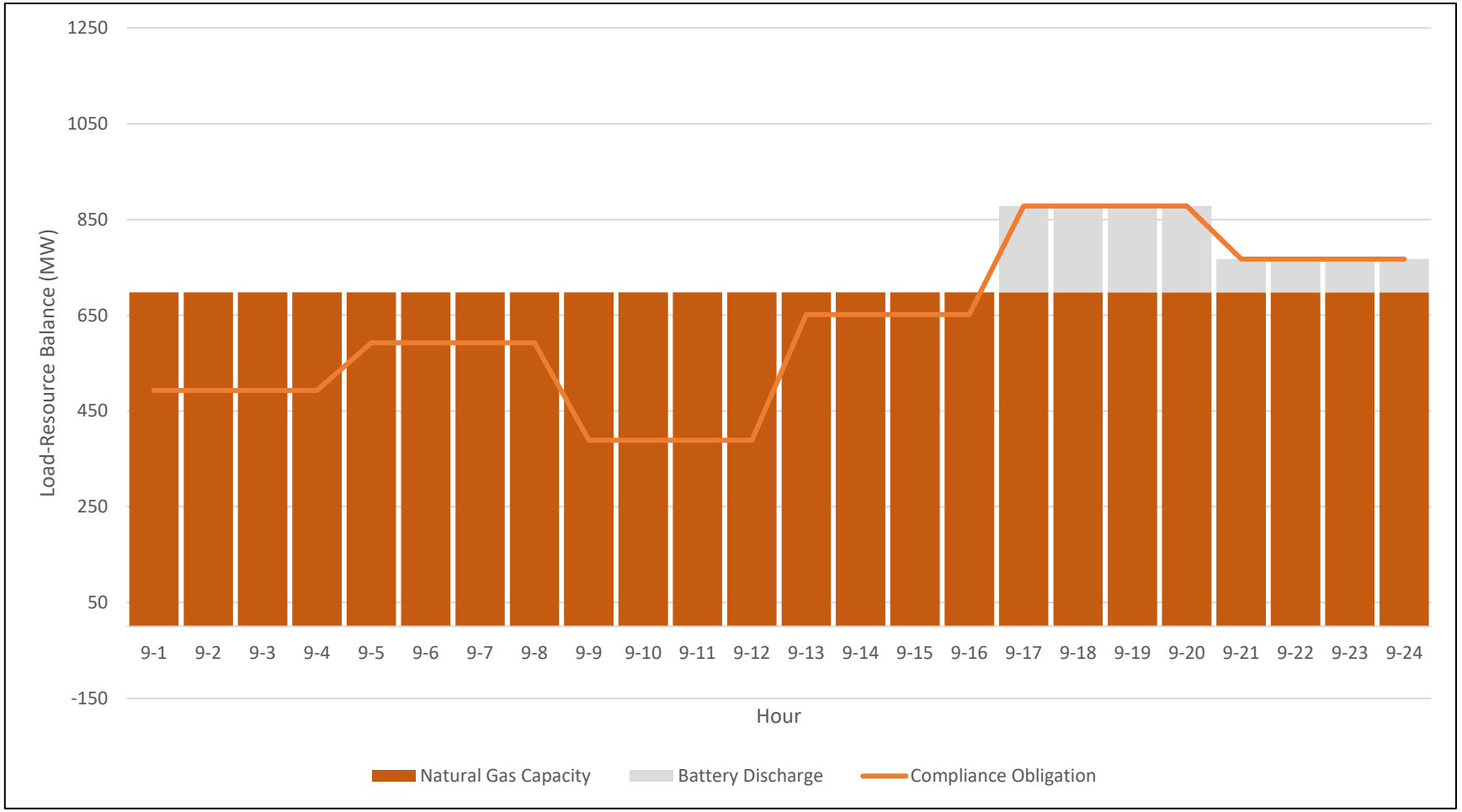
- 400MW Wind
- 250MW/1000MWh Storage
- **698MW Gas**

4-Hour / 6-Slice + Netting (September)



LSE A Obligation + Portfolio

- 1000MW Peak
- 500MW Solar
- 400MW Wind
- 250MW/1000MWh Storage
- **737MW Gas**

QUESTIONS AND DISCUSSION

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