



# Using Hydro and Energy Storage for Resiliency in Puerto Rico

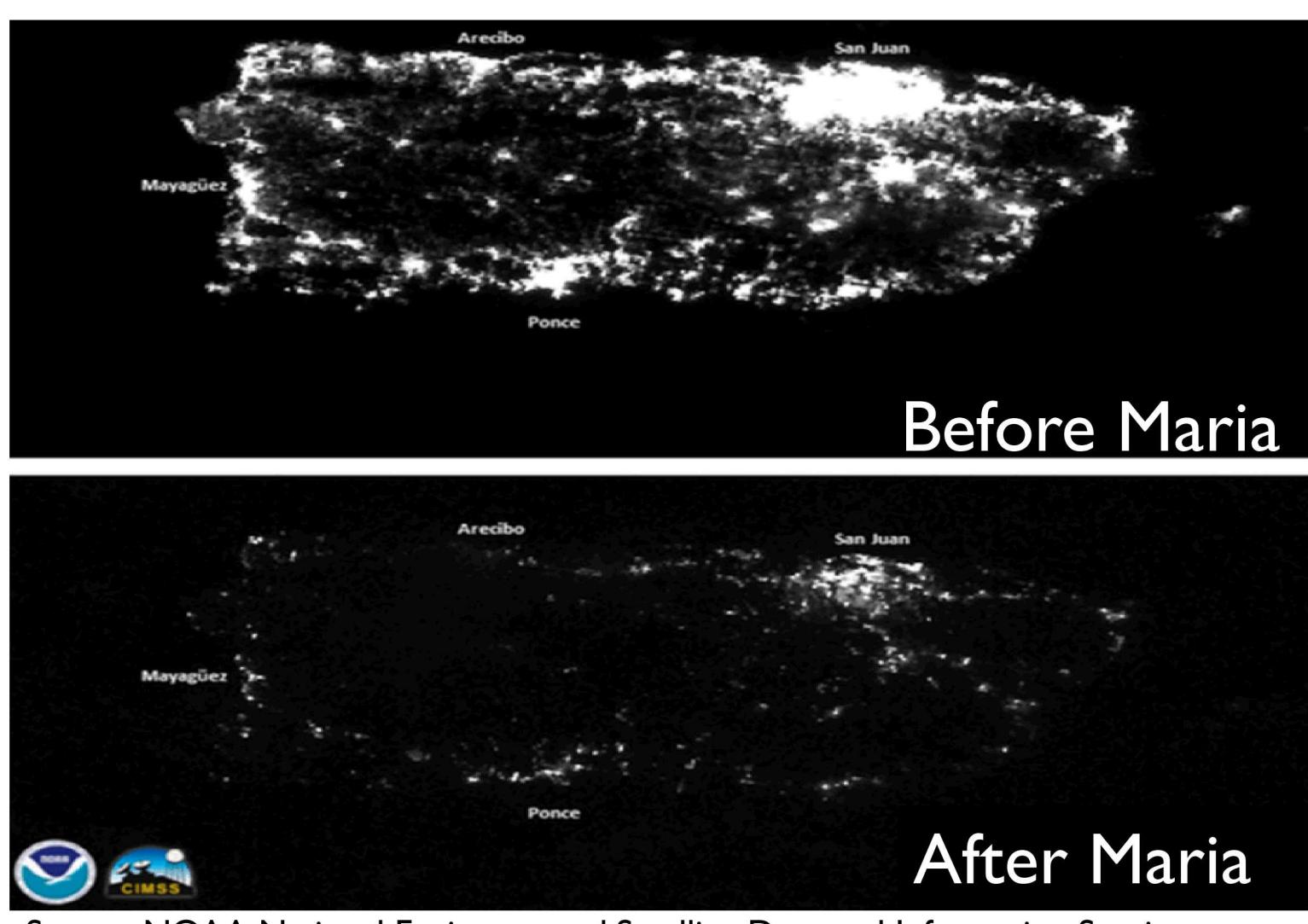
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Municipality	Population (2010)	Area (mi <sup>2</sup> )
Utuado	33,149	115
Jayuya	16,642	39.4
Ciales	18,782	66.5
Morovis	32,610	38.7
Orocovis	23,423	71.1
Villalba	26,073	37.7
Barranquitas	30,318	33.2
<b>Totals</b>	<b>180,997</b>	<b>401.6</b>



## Abstract:

Municipalities in the interior of Puerto Rico went *months* without power after hurricane Maria. This work focuses on using energy storage and existing hydroelectric facilities to create an independent mountain region minigrid that would require no transmission ties to PREPA baseload generation assets. An optimization minimized energy storage and PV requirements as a function of hydroelectric capacity factor. The results show that hydro and energy storage can be used cooperatively to increase resilience and vastly reduce future capacity investments.



Source: NOAA National Environmental Satellite, Data, and Information Service (NESDIS)

## Future Study:

- Use a hydro **rehab cost estimate** to improve resource optimization
- Improve **hydro model** to include reservoir dynamics
- Improve **load profile** using historic load data for the specific municipalities
- Improve **solar profile** to reflect municipalities-specific differences
- Integrate ReNCAT to modify load profile to reflect load criticality

**Acknowledgements:** Funding provided by US DOE Energy Storage Program managed by Dr. Imre Gyuk of the DOE Office of Electricity Delivery and Energy Reliability.

Current plans call for PV + ES, but the total cost of new capacity can be significantly reduced by using existing hydroelectric facilities.

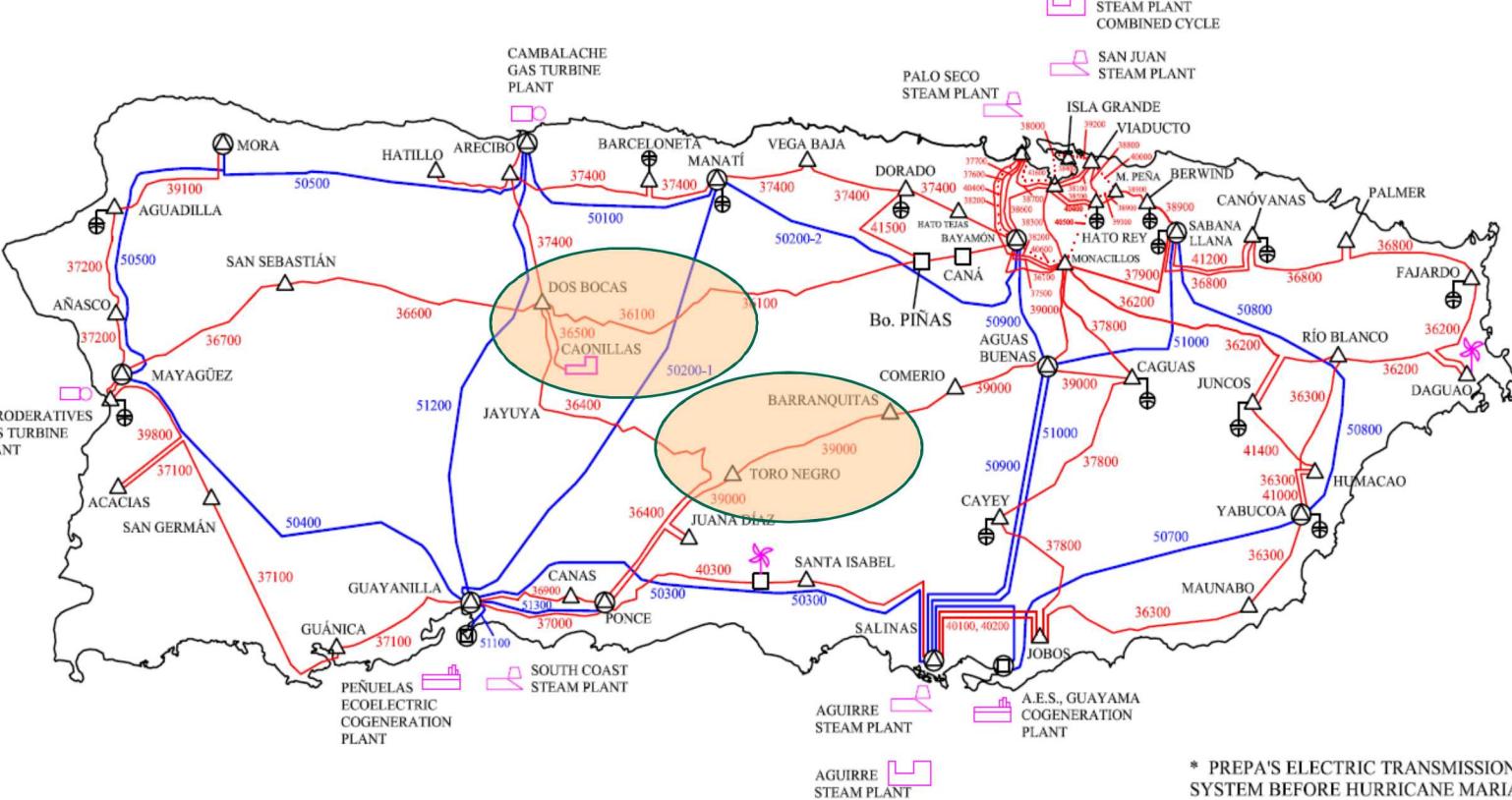
**North Central:** Includes the cities of Ciales, Morovis, Utuado, and Jayuya

### Approximate peak loads:

Ciales: 6 MW  
Morovis: 9 MW  
Utuado: 15 MW  
Jayuya: 8 MW  
38 MW

### Generation:

Caonillas 1: 18 MW  
Dos Bocas: 15 MW  
Caonillas 2: 4 MW  
37 MW



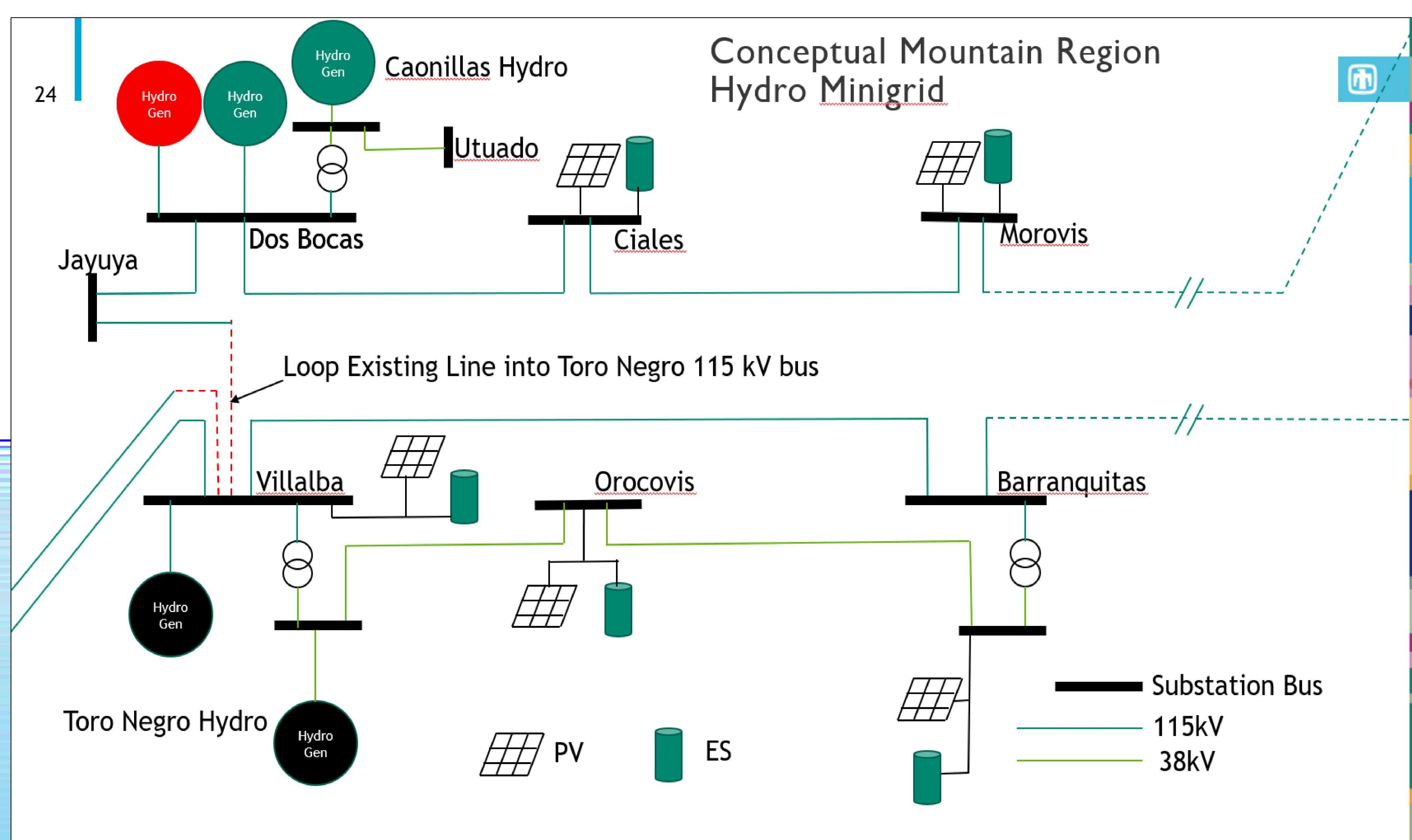
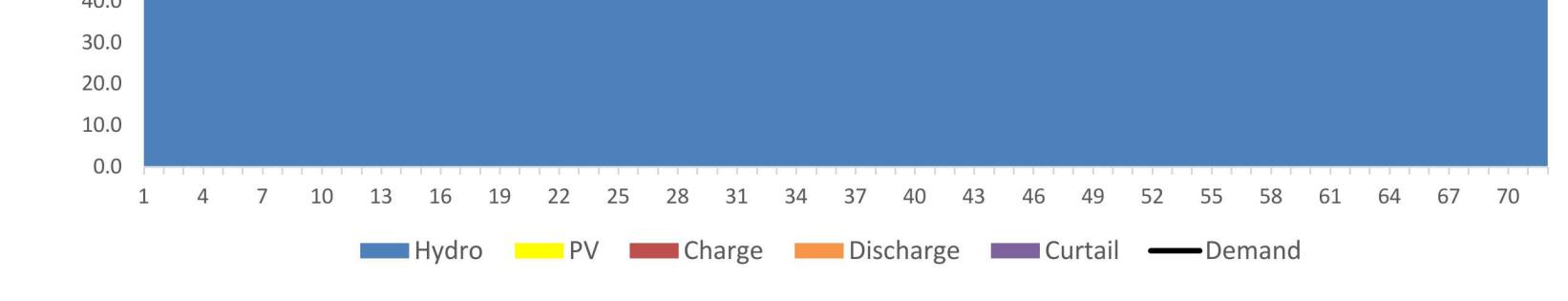
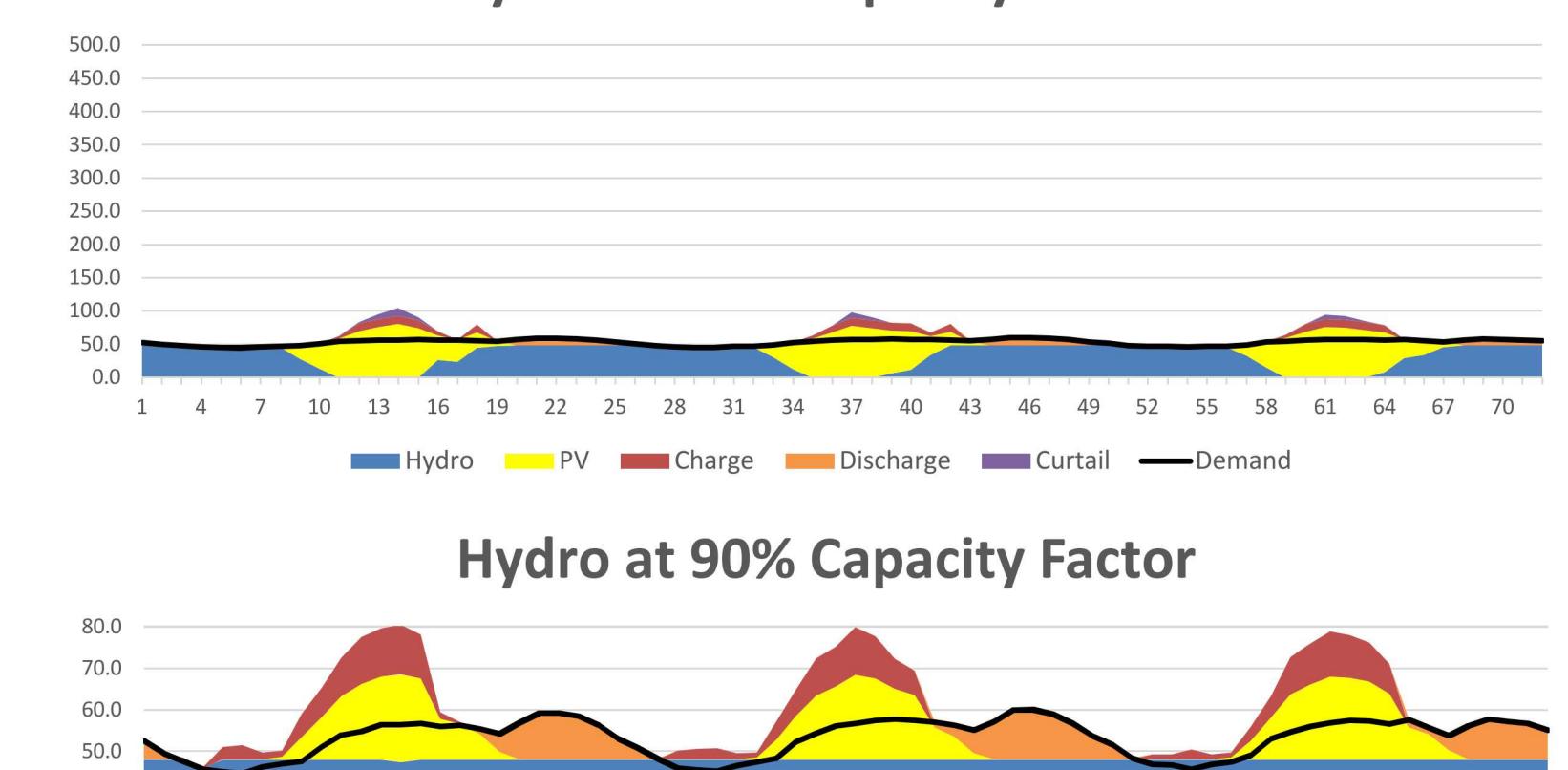
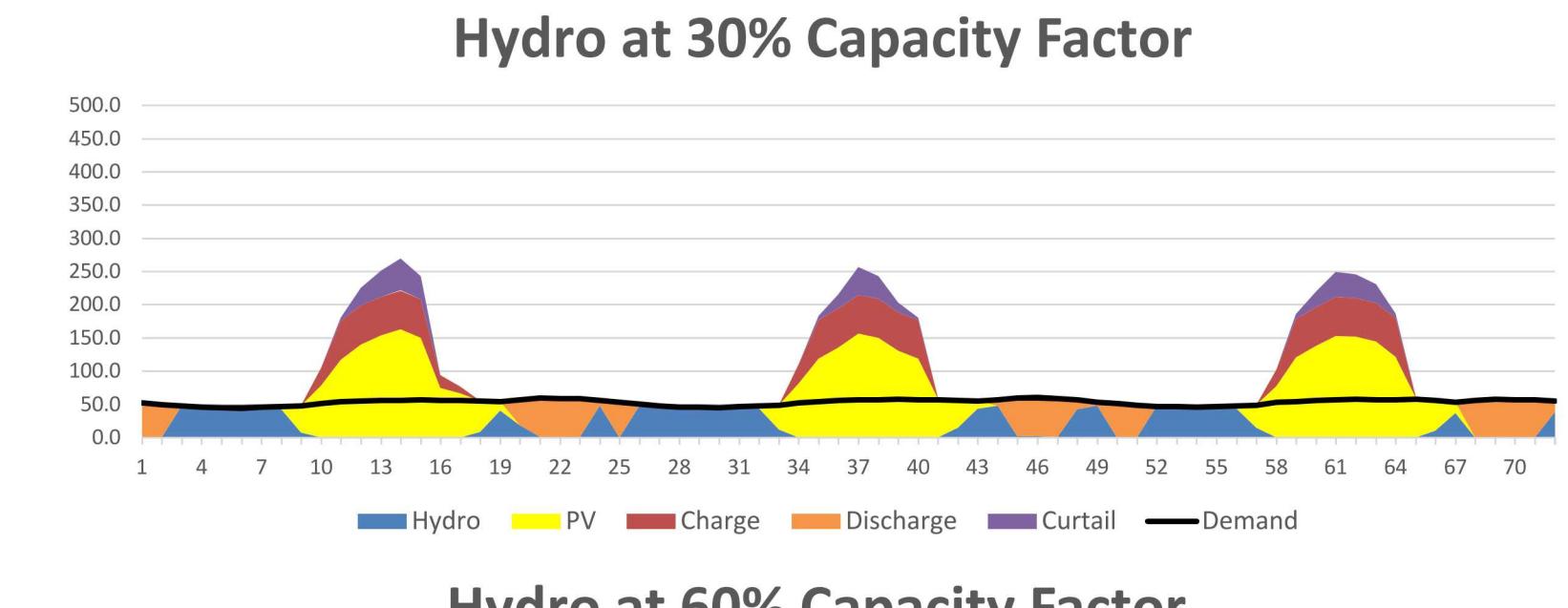
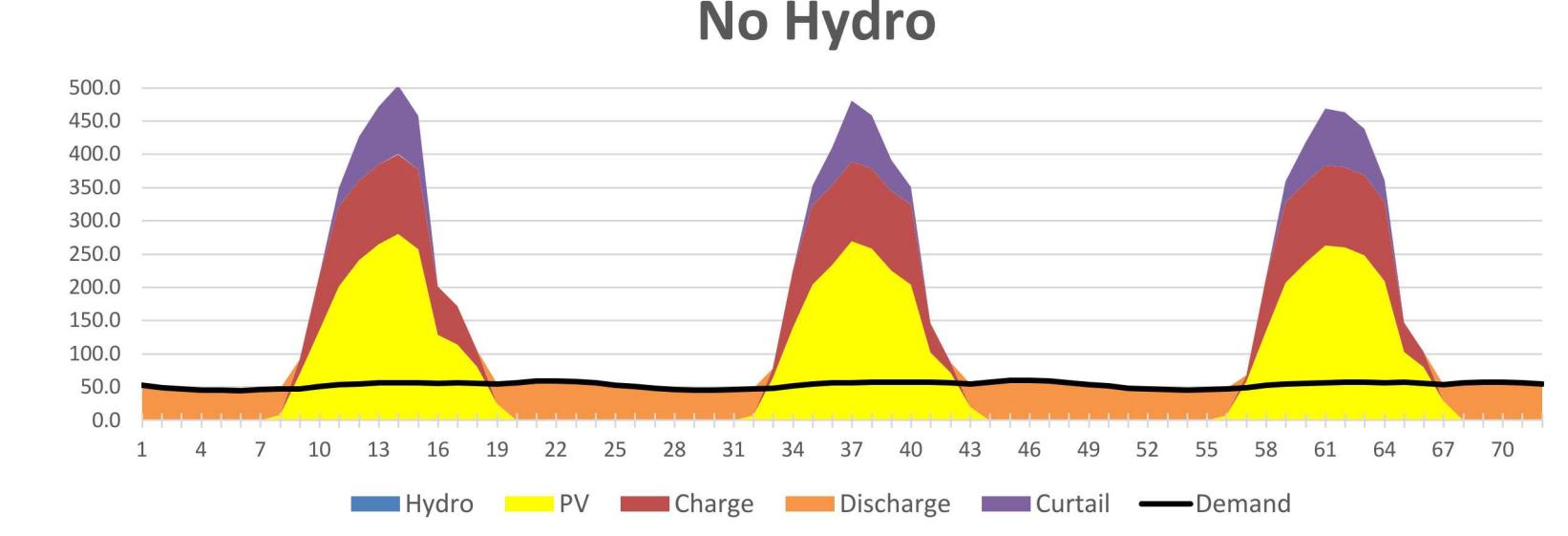
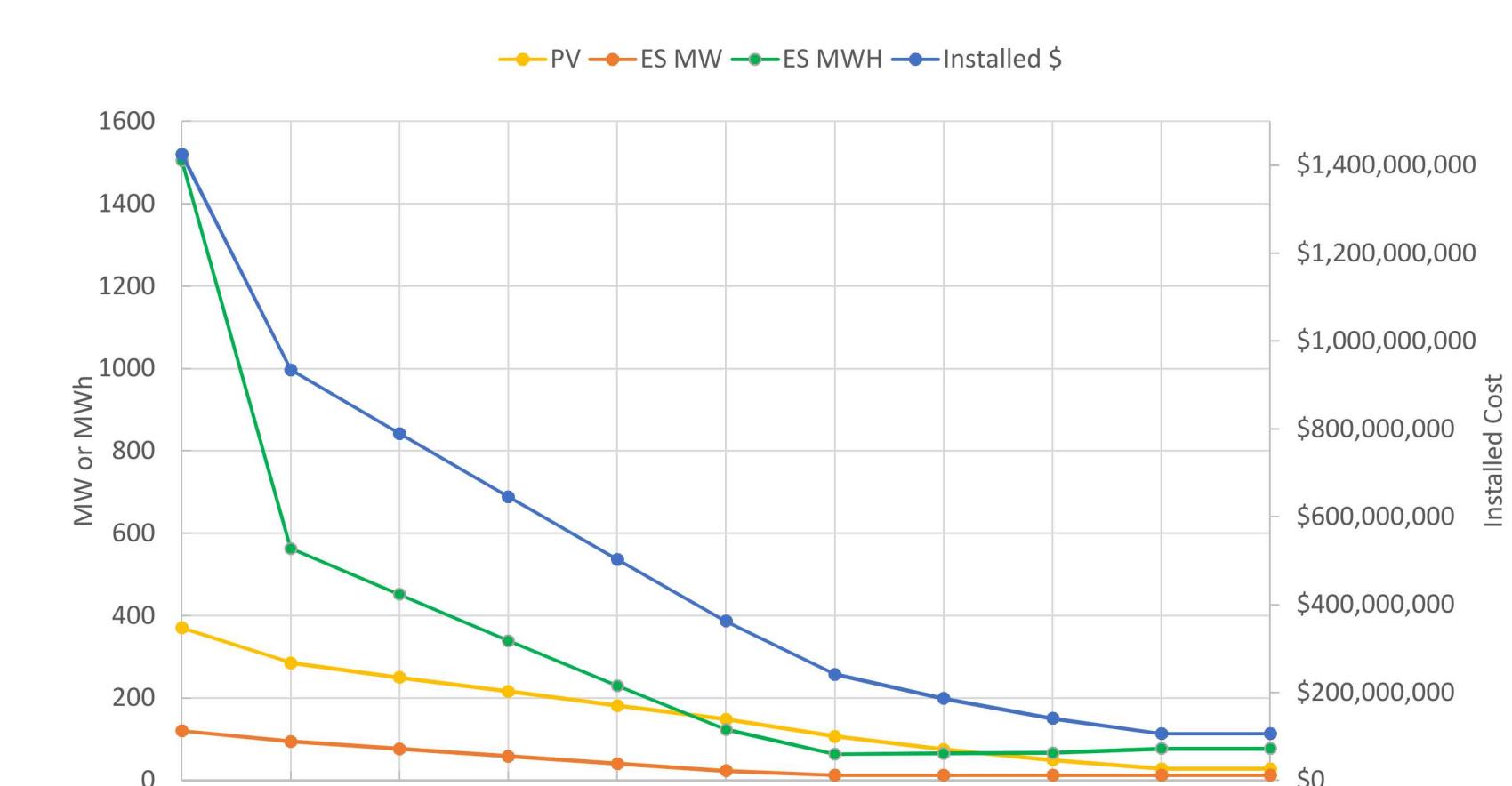
**South Central:** Includes the cities of Villalba, Orocovis, and Barranquitas

### Approximate peak loads:

Villalba: 10 MW  
Orocovis: 6 MW  
Barranquitas: 10 MW  
26 MW

### Generation:

Toro Negro 1: 9 MW  
Toro Negro 2: 2 MW  
11 MW

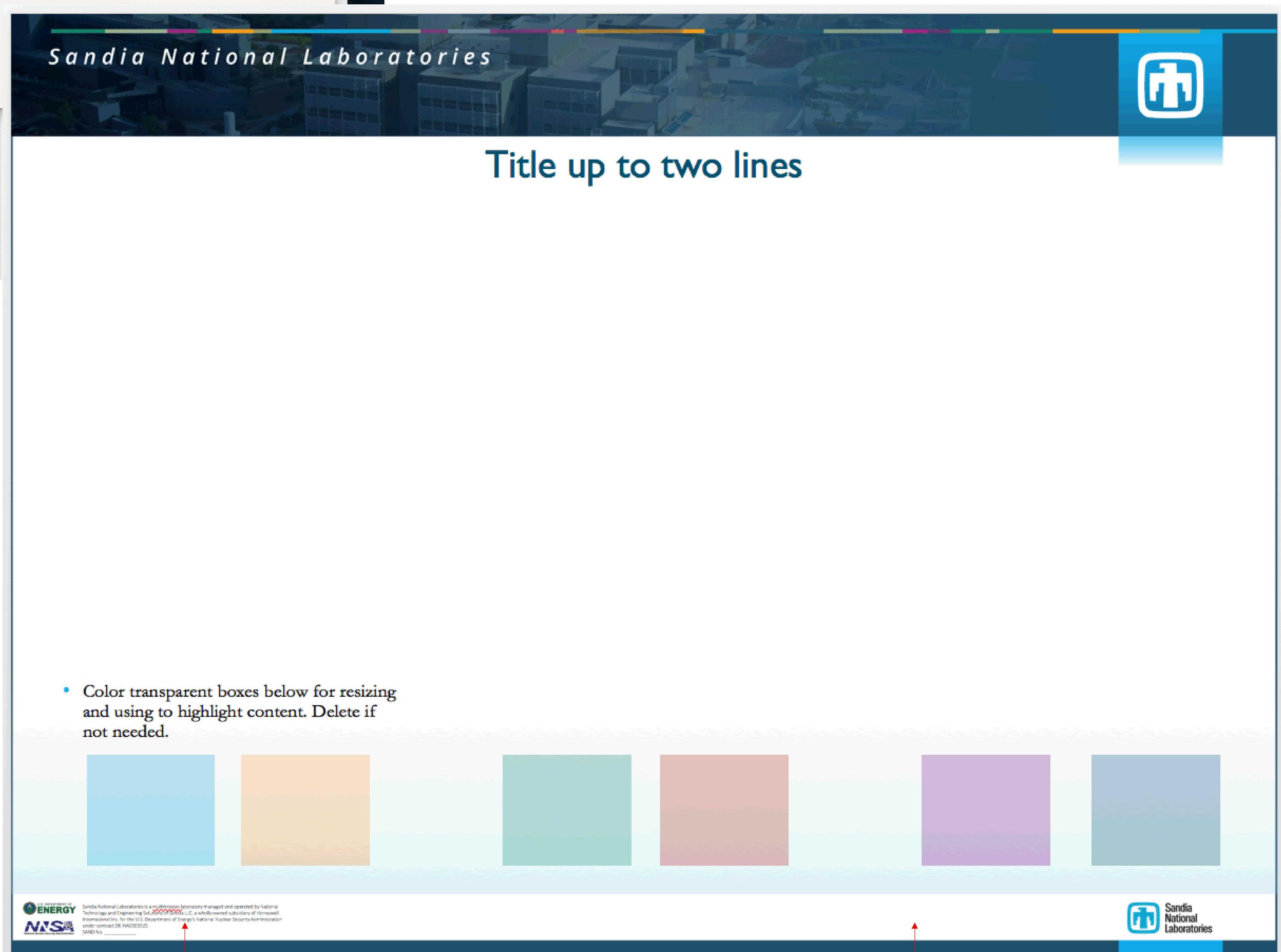
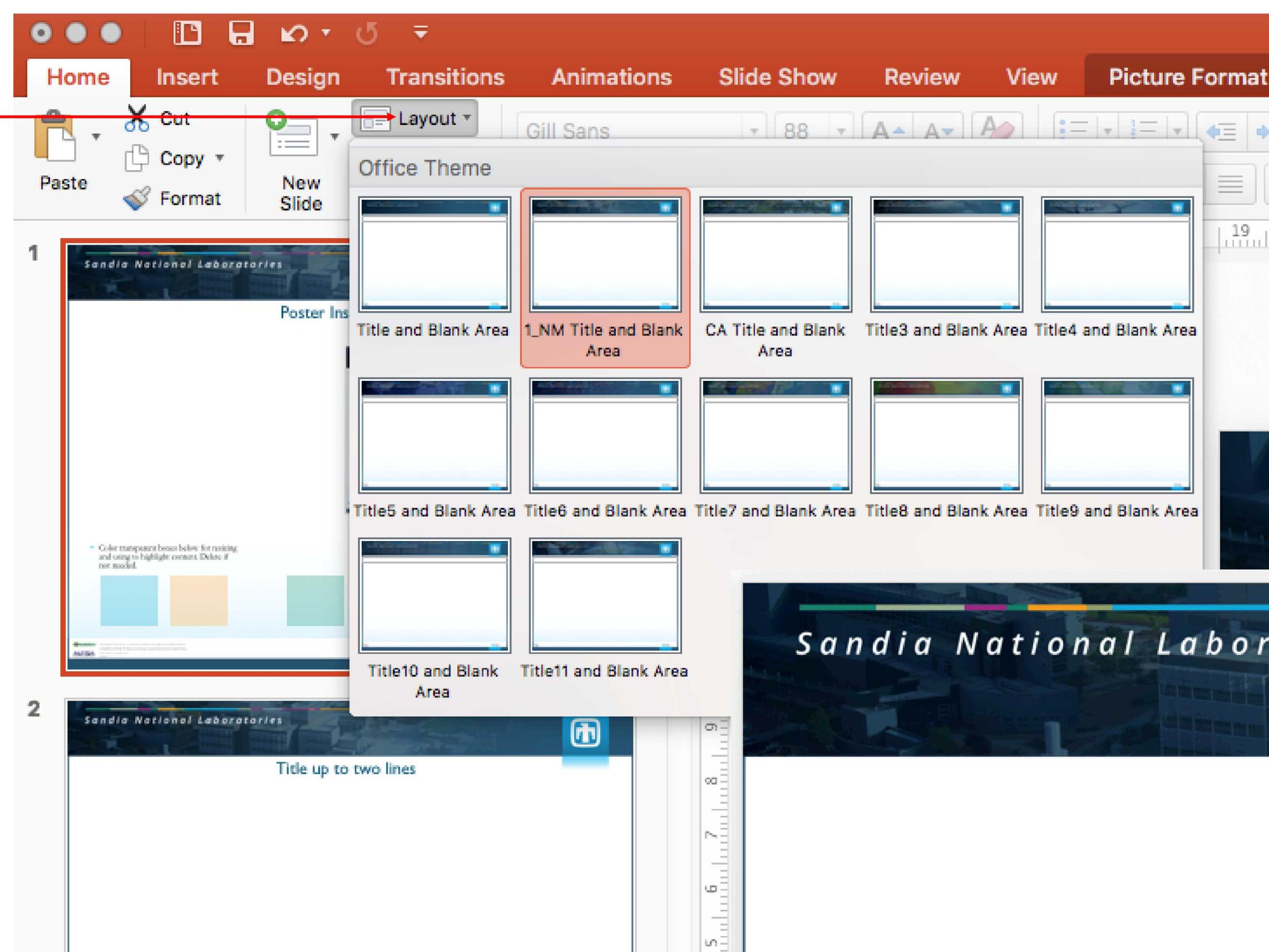




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