NORTH CAROLINA
PUBLIC STAFF
UTILITIES COMMISSION

December 20, 2019

Ms. Kimberley A. Campbell, Chief Clerk
North Carolina Utilities Commission
4325 Mail Service Center
Raleigh, North Carolina 27699-4300

Re: Docket No. EMP-105, Sub 0 - Application for CPCN for 70MW Solar Facility Located at Leisure Road near Academy Road in Laurinburg. NC in Scotland County

Dear Ms. Campbell:

In connection with the above-referenced docket, the Public Staff wishes to provide the Commission and the parties the attached Public Staff Late-Filed Exhibit No. 1, which is the presentation given by NREL on its Carbon-free Resource Integration Report on the Duke System[1] given to the Carbon Stakeholder Group hosted by the NC Department of Environmental Quality at the Nicholas Institute on December 11, 2019. This late-filed exhibit was requested by Commissioner Brown-Bland on December 19, 2019, during the evidentiary hearing of the above-referenced matter.

By copy of this letter, I am forwarding a copy to all parties of record by electronic delivery.

Sincerely,

/s/ Layla Cummings
Staff Attorney
layla.cummings@psncuc.nc.gov

Attachment

[1] A reference on page 2 of the presentation states that it is an analysis of the Duke Energy Carolinas service territory. The Public Staff has confirmed that the analysis provided in the presentation applies to both the Duke Energy Progress and Duke Energy Carolinas service territories.

Carbon-free resource integration study

Bri-Mathias Hodge

Scott Haase

National Renewable Energy Laboratory (NREL)

Scope of work – Phase 1

Net Load Analysis

- Analyzed the impacts of integrating differing amounts of new solar photovoltaic (PV) power into Duke Energy's Carolinas service territory, comparing estimated hourly solar, wind, load, and system minimum generation time series for 12 different scenarios

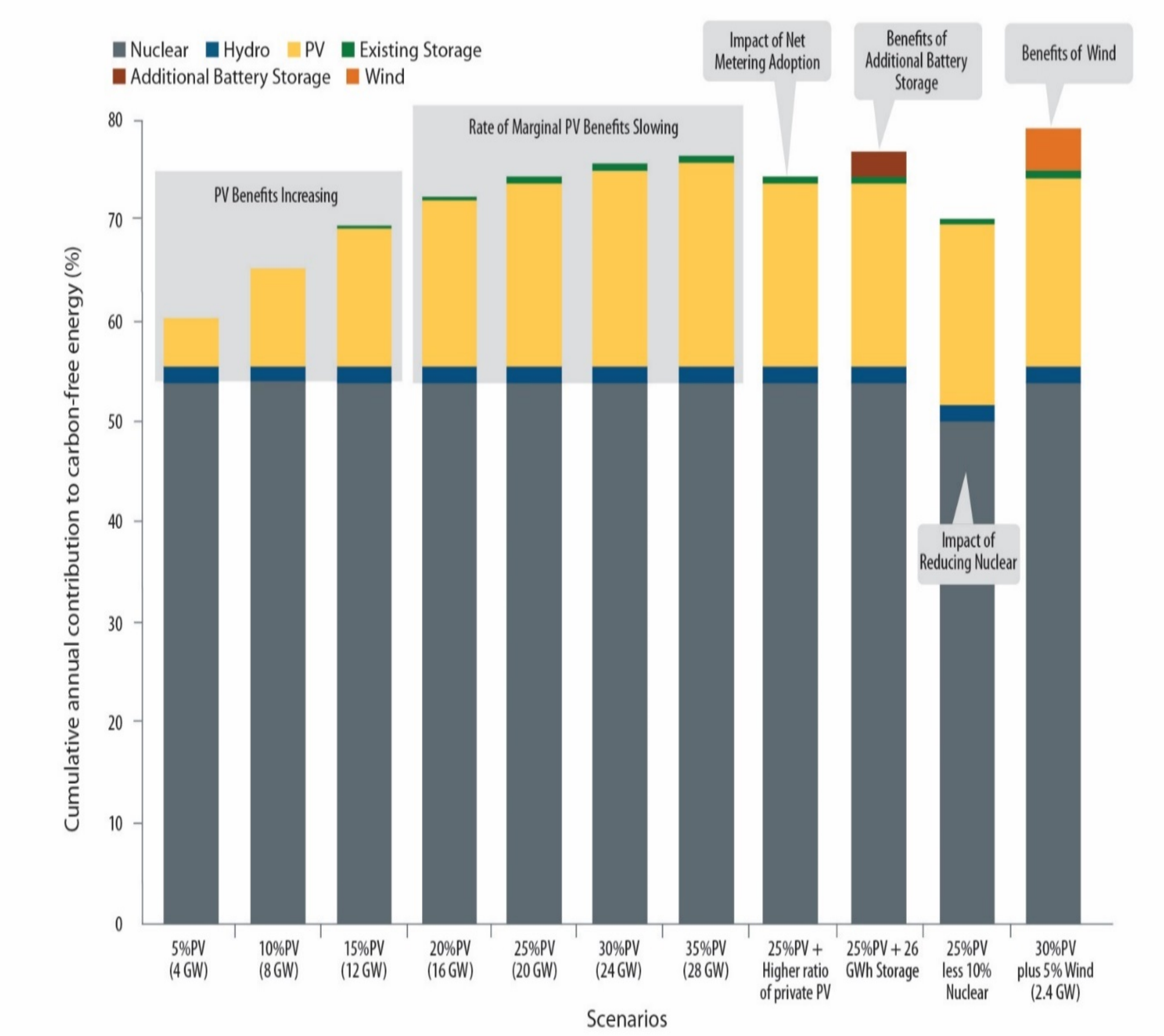
Phase 1 Scope

- Quantified the amount of carbon-free electricity
- Estimated curtailment, ramping, and system flexibility limits
- Evaluated shifts in daily and seasonal net load timing, supply and demand challenges

Phase 1 Did Not Consider

- Unit commitment and economic dispatch
- System stability analysis, e.g. voltage/frequency/transient analysis
- Cost or transmission impacts

Summary of scenarios



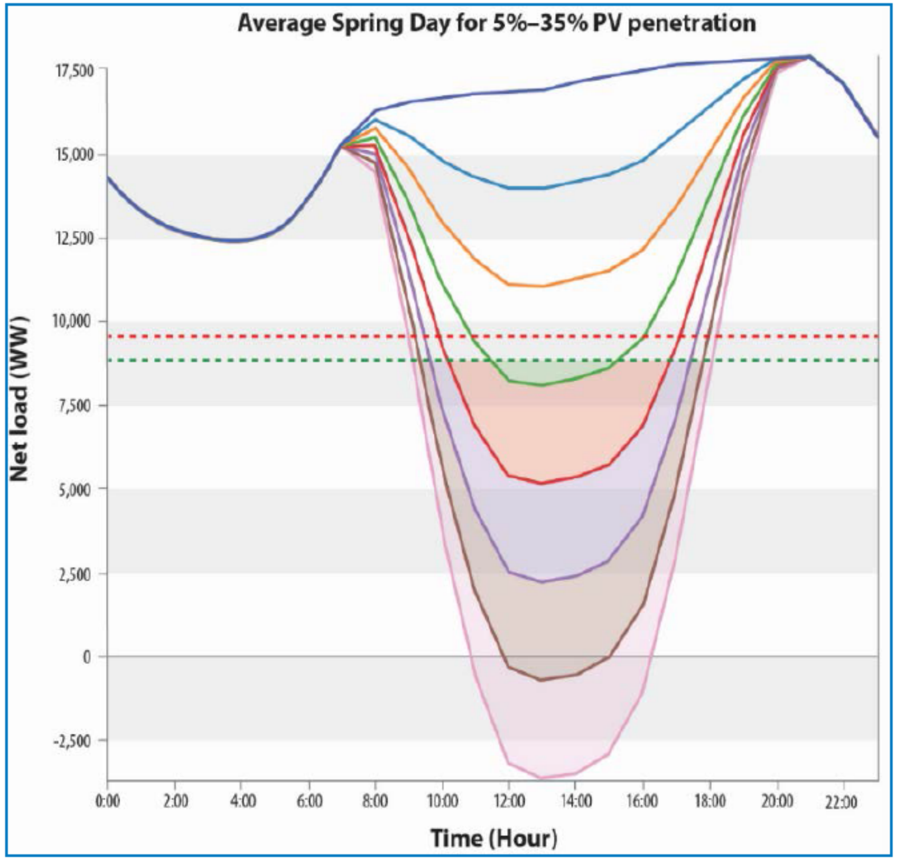
Key Findings:

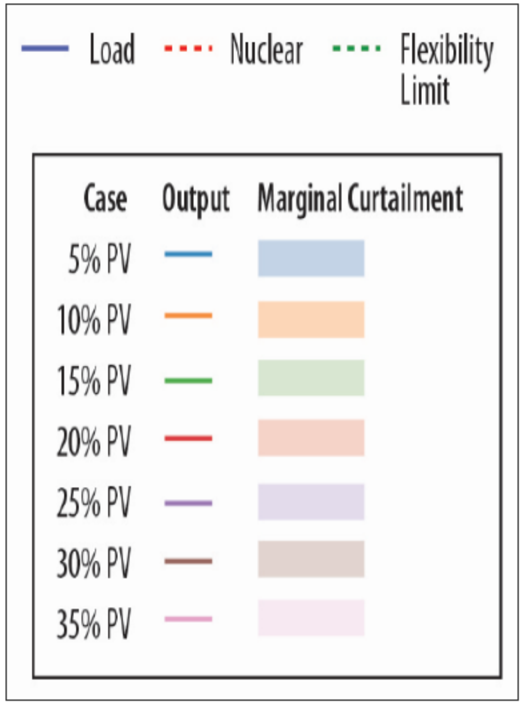
- Net load analysis highlights challenges and opportunities with integrating solar PV
- Average annual % of load met by carbon-free generation ranges from 60-79%
- Nuclear remains greatest contributor to carbon-free energy
- Above 15% solar PV, required curtailment grows
- The highest share of carbon-free generation is achieved by the scenario with the most resource diversity.
- Solar power curtailment is greater under separate balancing authorities

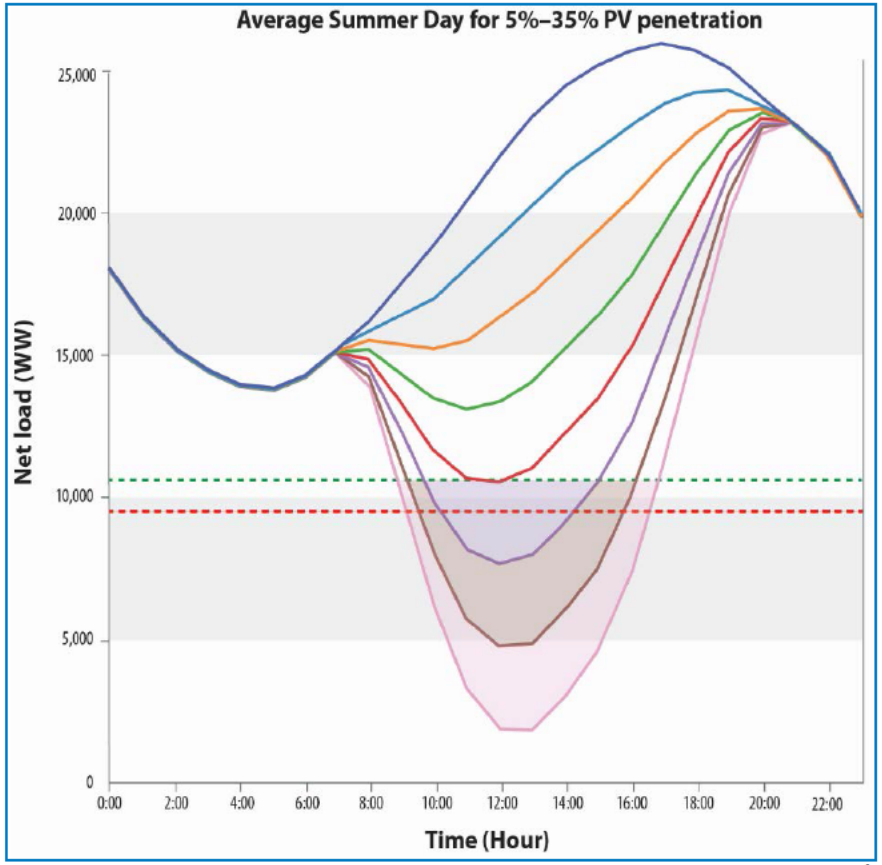
Scenarios

Scenarios 1-7: 5%-35% Solar Energy Penetration

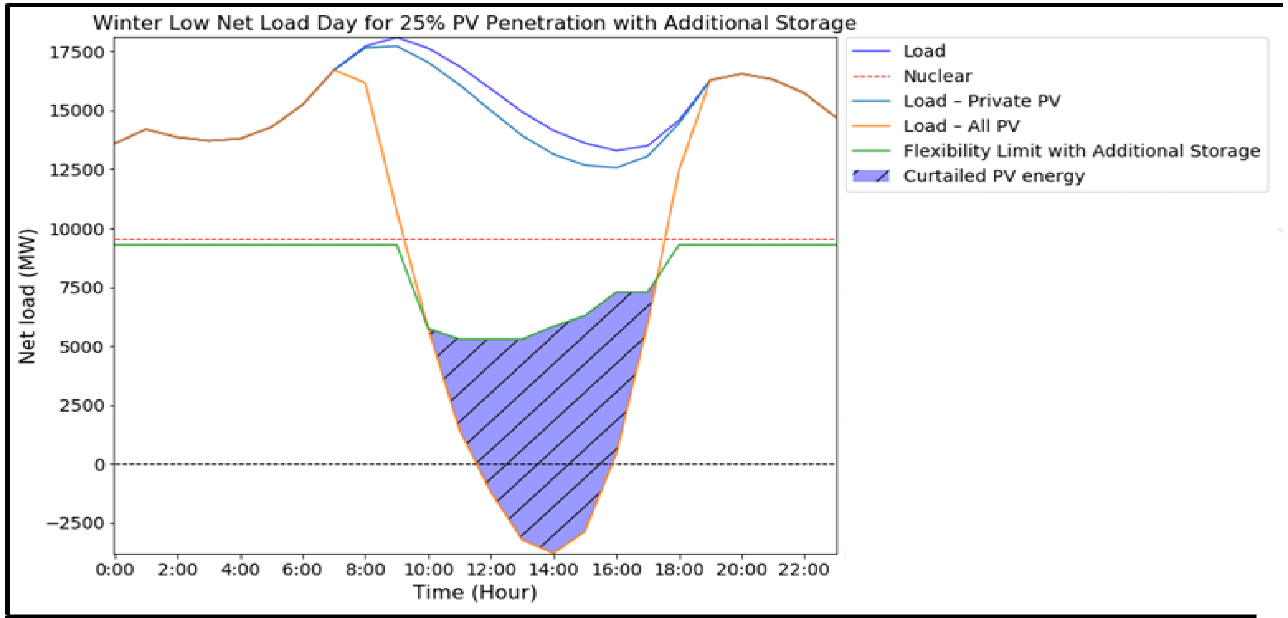
PV penetration (%)	5	10	15	20	25	30	35
PV capacity (MW)	4,109	8,219	12,328	16,438	20,547	24,656	28,766
Average Percentage Curtailed Energy, %	0	1	8	17	27	35	42
Marginal Curtailment, %	-	2.2	21.4	46.3	64.6	76.7	83.2
Load met by zero-carbon generation, %	60.4	65.5	69.7	72.5	74.4	75.6	76.5

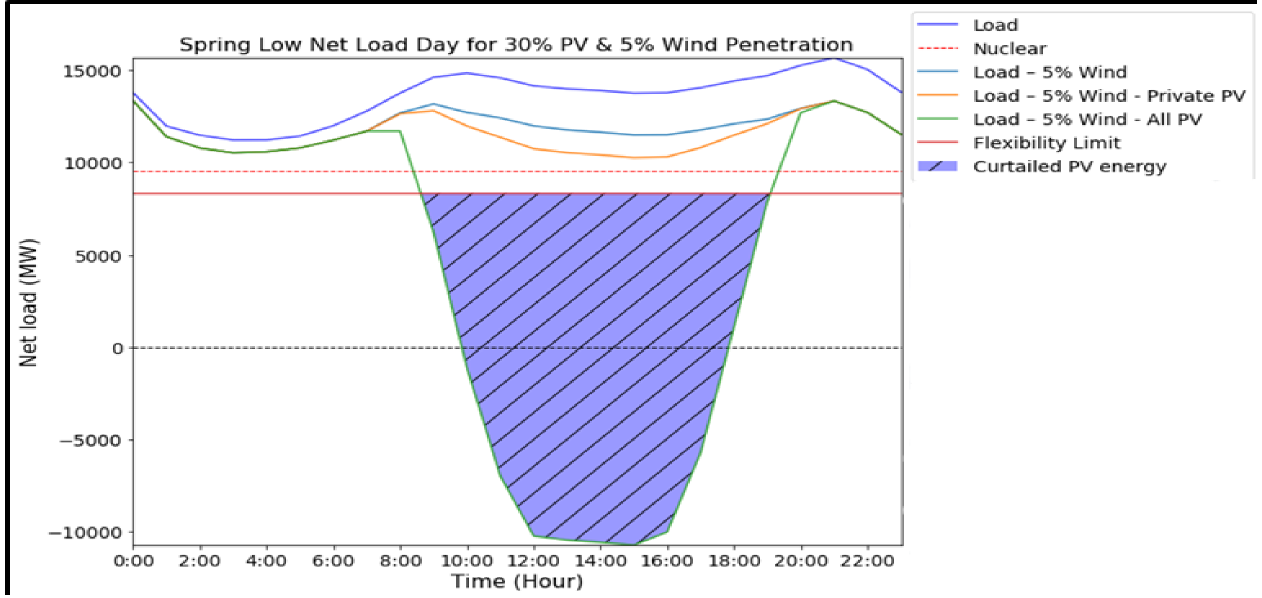






Storage, nuclear and wind scenarios





Key Findings:

Storage deployment (26,000 MWh)*

- Solar curtailment reduces from 27% to 15%
- Zero-carbon contribution rises from 76% to 78%

Nuclear

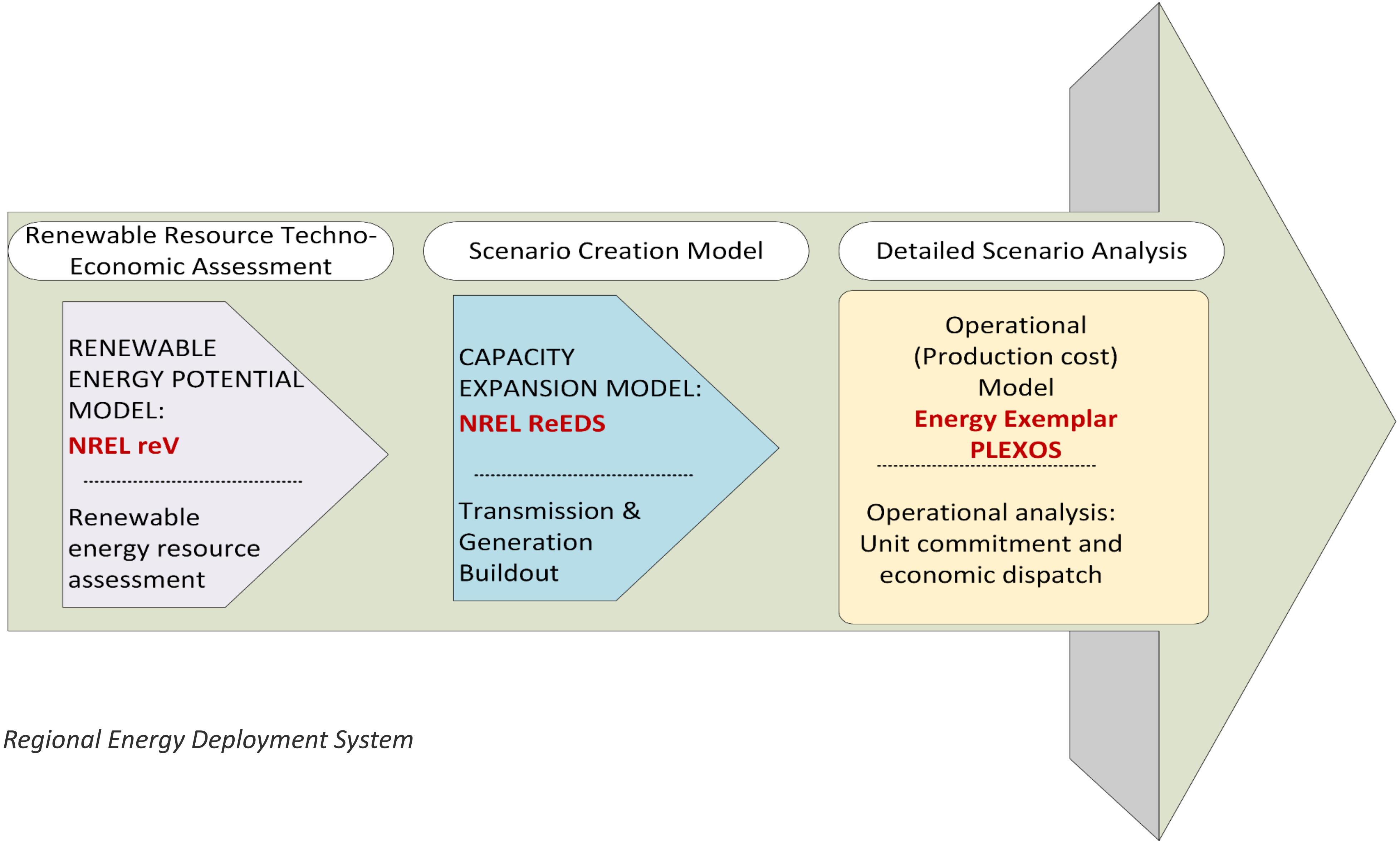
- The nuclear retirement scenario reduces the solar curtailment from 27% to 22%, but also reduces carbon-free generation from 74% to 70%

Wind

- Carbon free generation increases from 77% to 79% with 5% wind + 30% solar, as opposed to 35% solar case due to reduced curtailment

**Estimated cost for 26,000 MWh of storage based on current market prices is approximately $8-12 Billion*

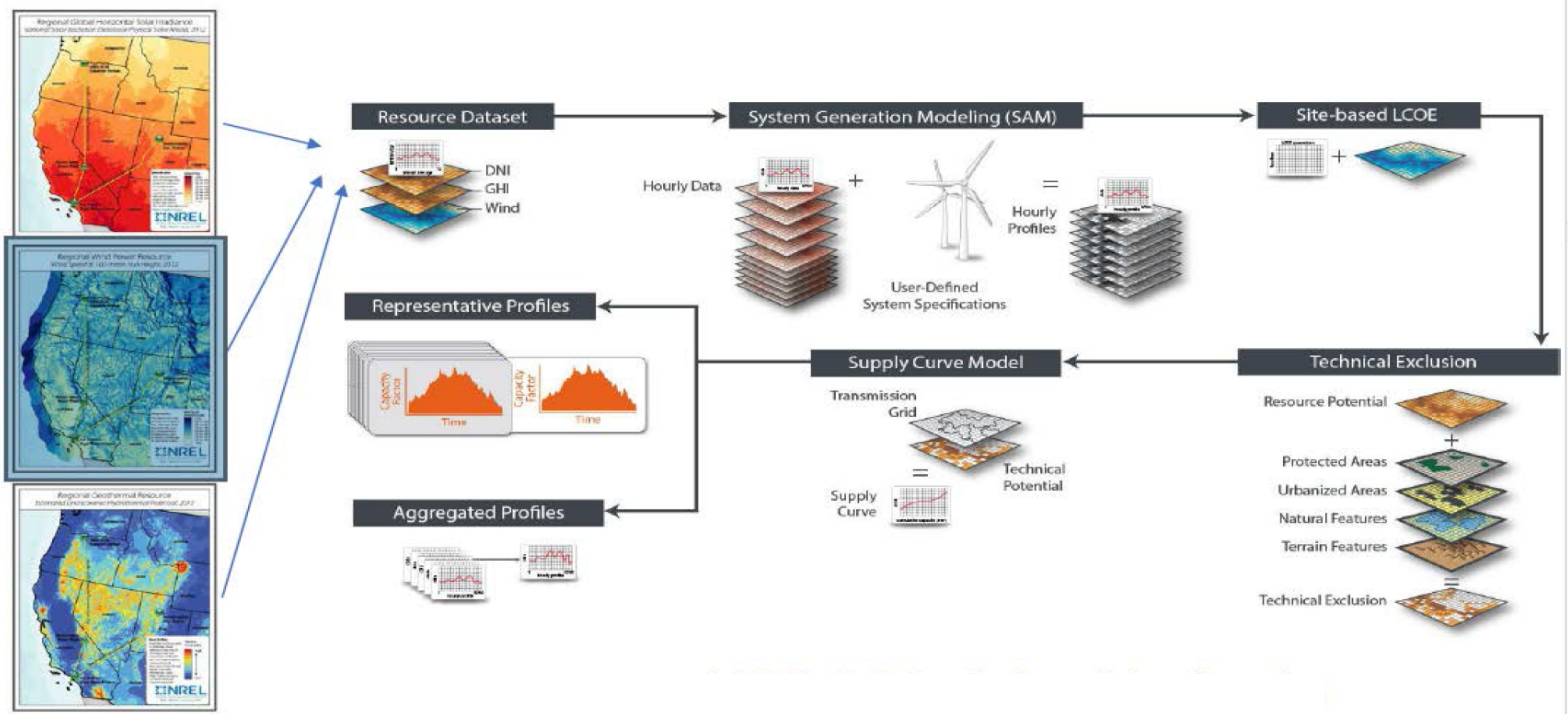
Carbon-Free Resource Integration Study – Phase 2



**ReEDS: Regional Energy Deployment System*

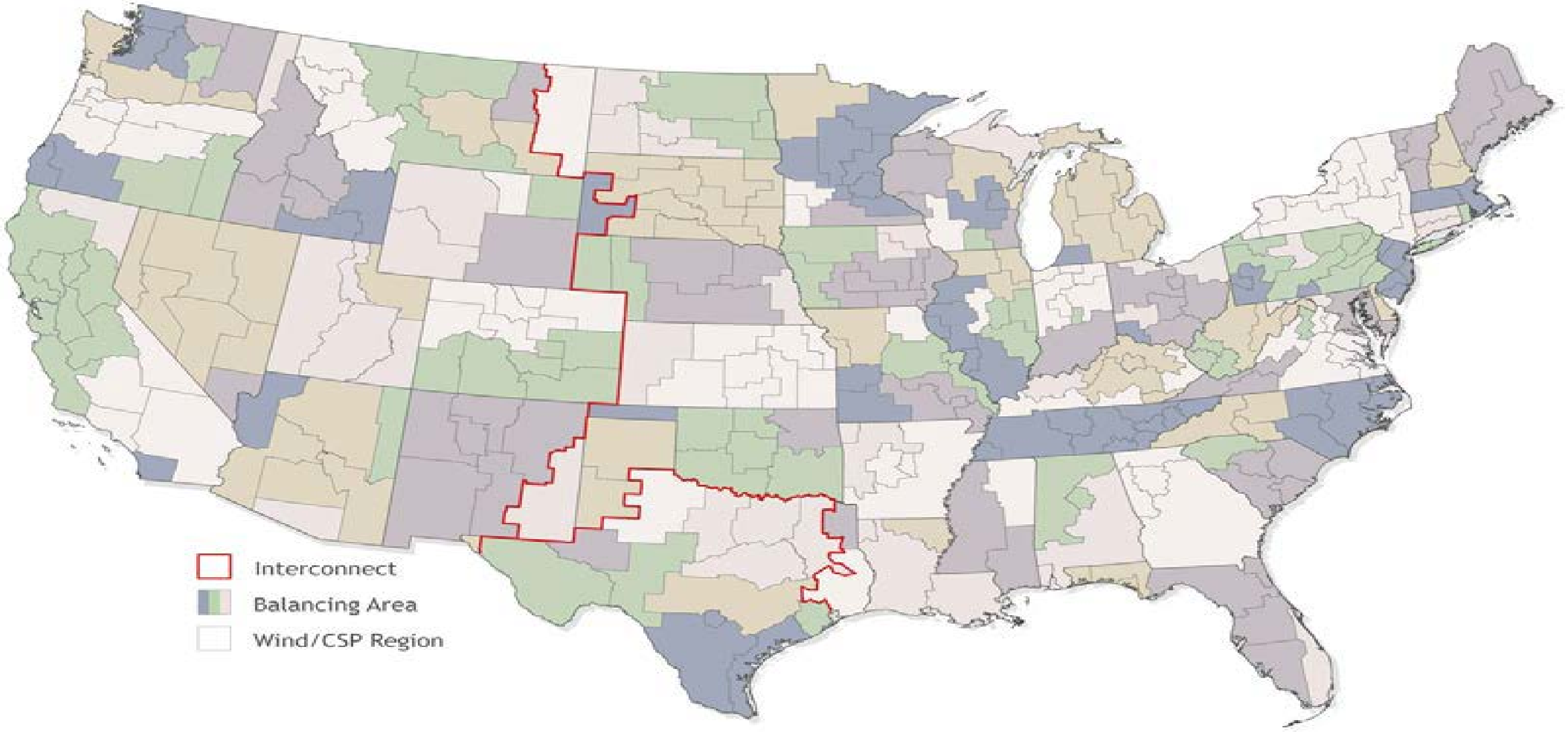
Renewable Energy Potential Model – NREL reV

- Resource Assessment (Geospatial data science modeling)



Capacity Expansion Model – NREL ReEDS

- ReEDS includes 3 interconnections, 134 model BAs, and 356 Wind and CSP resource regions
- Transmission and generation buildout
- Scenario creation model
- Optimal investment pathways



Summary of the Standard Scenarios

Non-Policy Scenarios

Fuel Cost
- High Oil & Gas Resource (AEO 2018)
- Low Oil & Gas Resource (AEO 2018)

Demand
- Low Demand
- High Demand
- Vehicle Electrification

Other
- Extended Cost Recovery
- Climate Change Impacts
- Reduced RE Resource
- Transmission Expansion Barriers
- Restricted Cooling Water

Mid-case
- Reference or Mid-level Assumptions

Technology Cost
- Low RE Cost
- High RE Cost
- Low Wind Cost
- Low PV Cost
- Low Geo Cost
- Low CSP Cost
- Low Hydro Cost
- Low Offshore Wind Cost
- Nuclear Breakthrough
- Low Battery Cost
- High Battery Cost

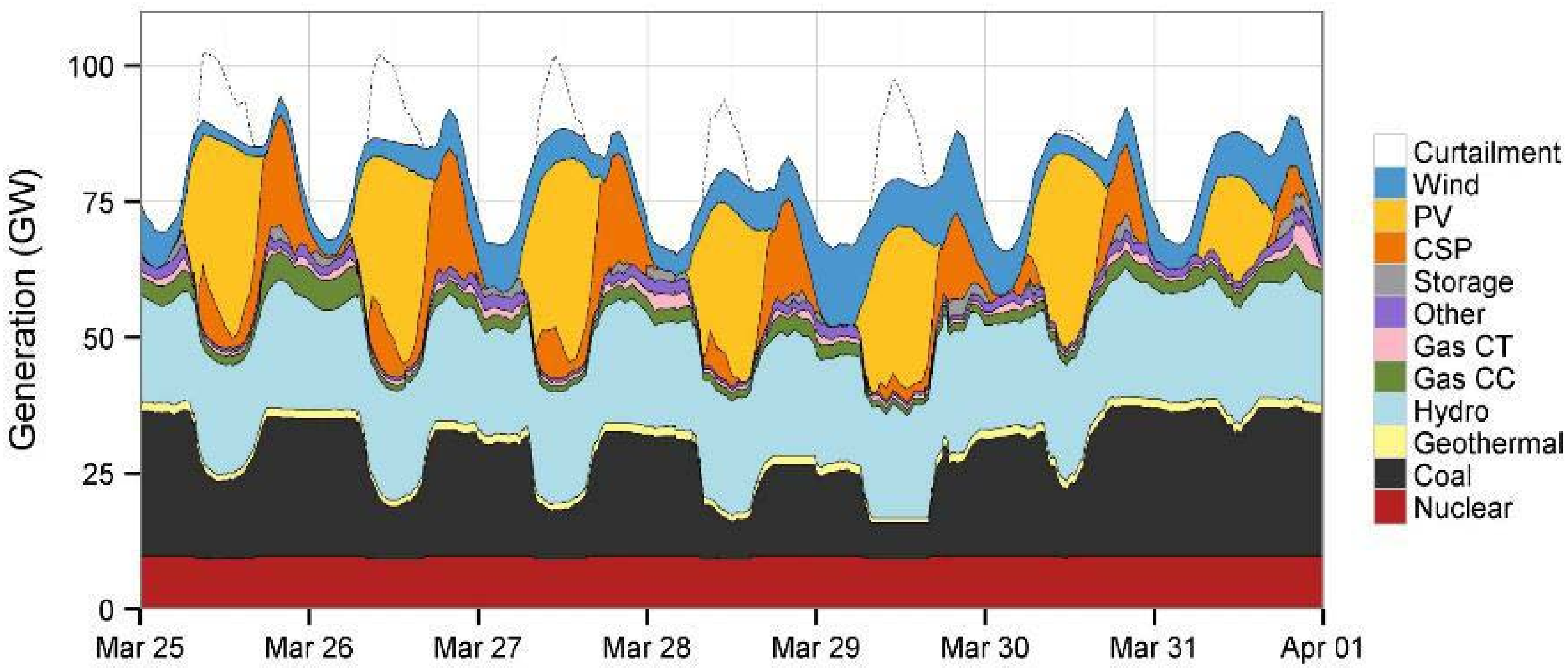
Combinations
- Low/High NG Price with
  - Low/High RE Cost
  - Low/High Geo Cost
  - Low/High CSP Cost
  - Low/High Hydro Cost
  - Low/High Offshore Wind Cost

Retirements
- 80 Year Nuclear
- 60 Year Nuclear
- Accelerated Nuclear Retirement
- Accelerated Retirements
- Extended Lifetimes

Policy
- National 80% RPS by 2050
- 83% CO_2 Reduction by 2050
- ITC & PTC Extension to 2030

Operational (Production cost) Model – Energy Exemplar PLEXOS

- Detailed scenario analysis from NREL ReEDS simulations
- Optimizes unit commitment and economic dispatch up to 5-minute resolution
- Minimizes the cost of power system operations

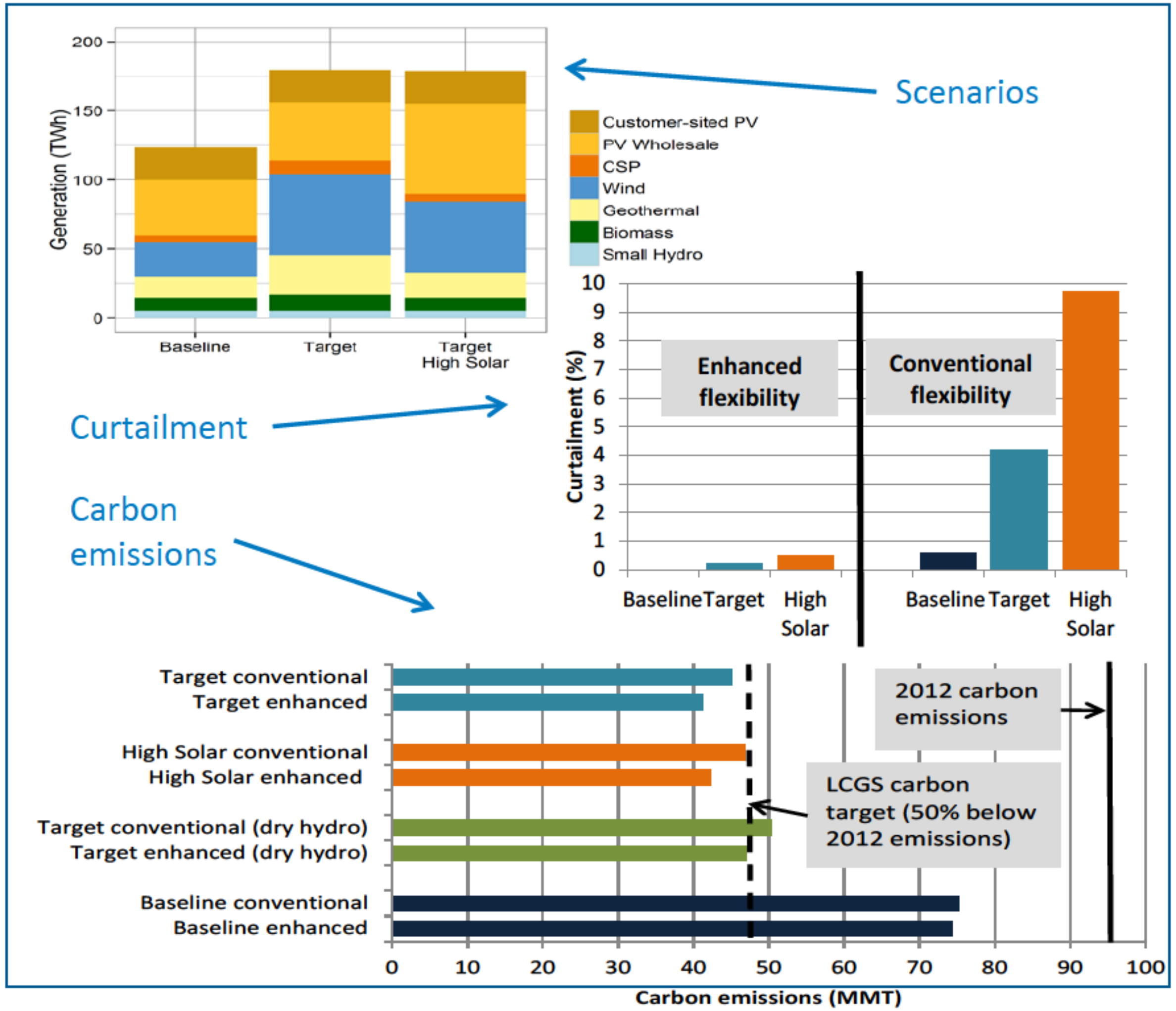


NREL Transforming ENERGY

Relevant National Studies to Inform North Carolina's Process

California Low Carbon Grid Study

Contact: gregory.brinkman@nrel.gov



Brinkman, G., et al. (2016). *Low Carbon Grid Study: Analysis of a 50% Emission Reduction in California*, NREL/TP-6A20-64884. Golden, CO: National Renewable Energy Laboratory.

Methodology: Use PLEXOS to analyze the grid impacts of scenarios that achieve a 50% carbon emissions reductions from California's electric sector by 2030, through energy efficiency, renewable energy, and grid flexibility.

Key Findings:

- The modeling results indicate that achieving 50% emissions reductions below 2012 levels is possible by 2030 with relatively limited curtailment (less than 1%) if institutional frameworks are flexible.
- Less flexible institutional frameworks and a less diverse generation portfolio could cause higher curtailment (up to 10%), operational costs (up to $800 million/yr higher), and carbon emissions (up to 14% higher).
  - Enhanced flexibility scenarios assume better regional coordination, more storage, and fewer restrictions on local generation and ancillary service provisions.

Companion Reports:

- GE Energy found that mitigation options exist to help maintain grid reliability, but more work is needed.
- JBS Energy found that the additional revenue requirement of achieving the 50% carbon reduction would be most likely be less than 1%, but could vary between -3% and +6%.

LA100: The Los Angeles 100% Renewable Energy Study

LADWP

$6 billion annual budget

9,400 employees

4 million residents

Advisory Group

Diverse energy backgrounds

Quarterly meetings

Integrated Electricity Modeling

Full range power system modeling

Integrated transmission and distribution analysis

Environmental Analysis

Air quality

Environmental Impact

Economic Analysis

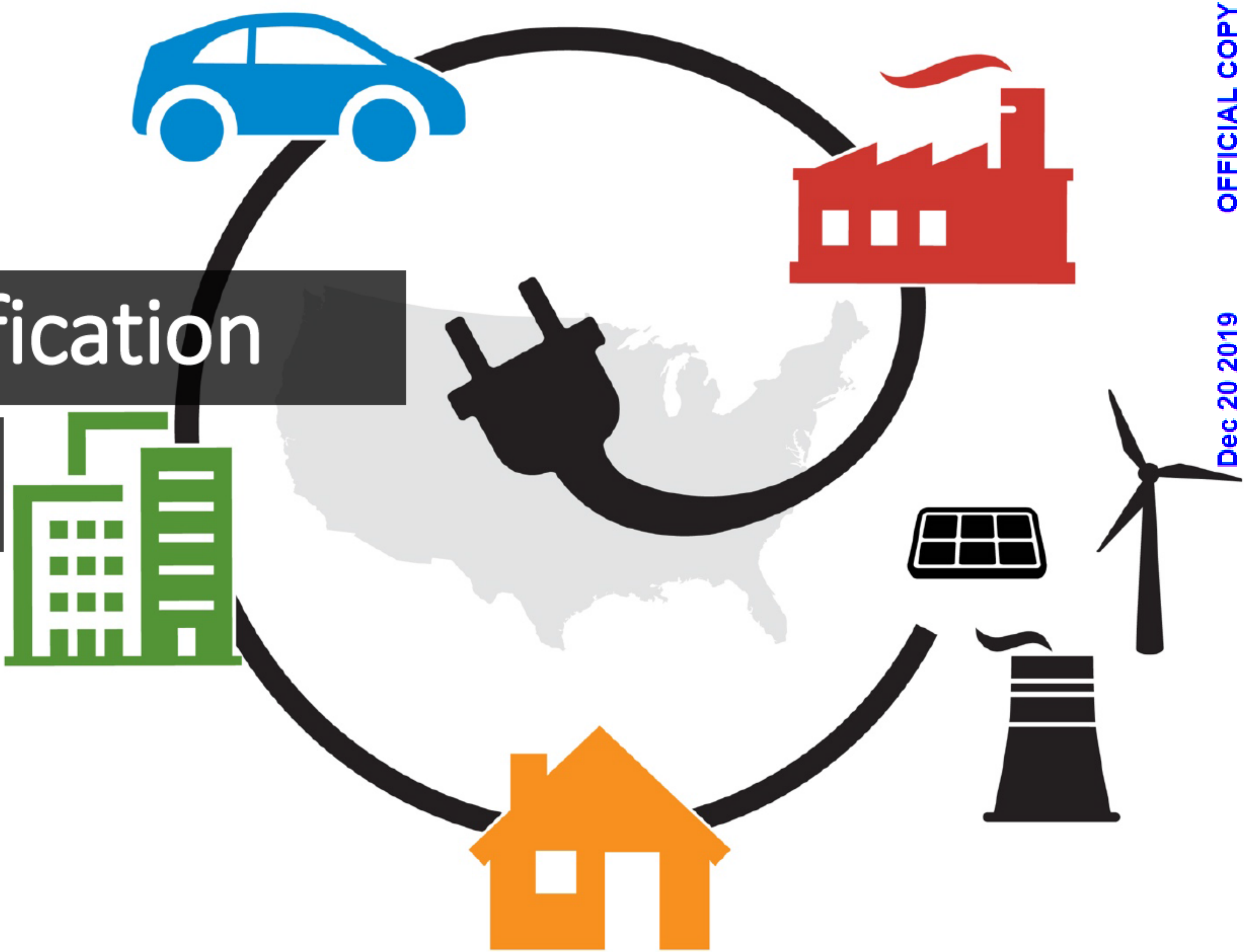
Workforce needs

Economic development

LA100 Study Objectives

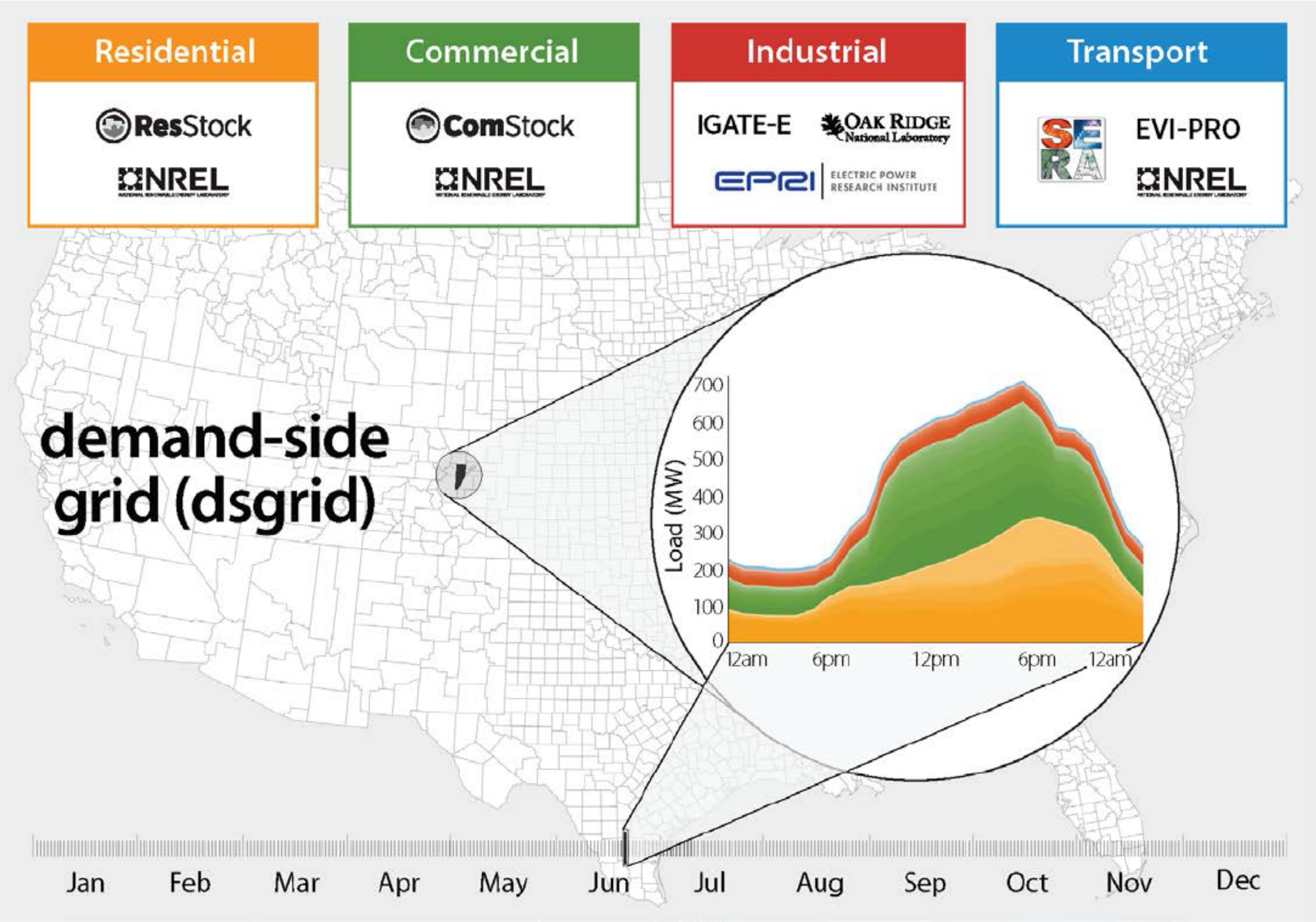
- What are the **pathways and costs** to achieve 100% RE while maintaining the current high degree of reliability?
- What is the **impact** on the environment?
- How might the **economy** respond to such a change?
- How can **environmental justice** communities be part of the solution?

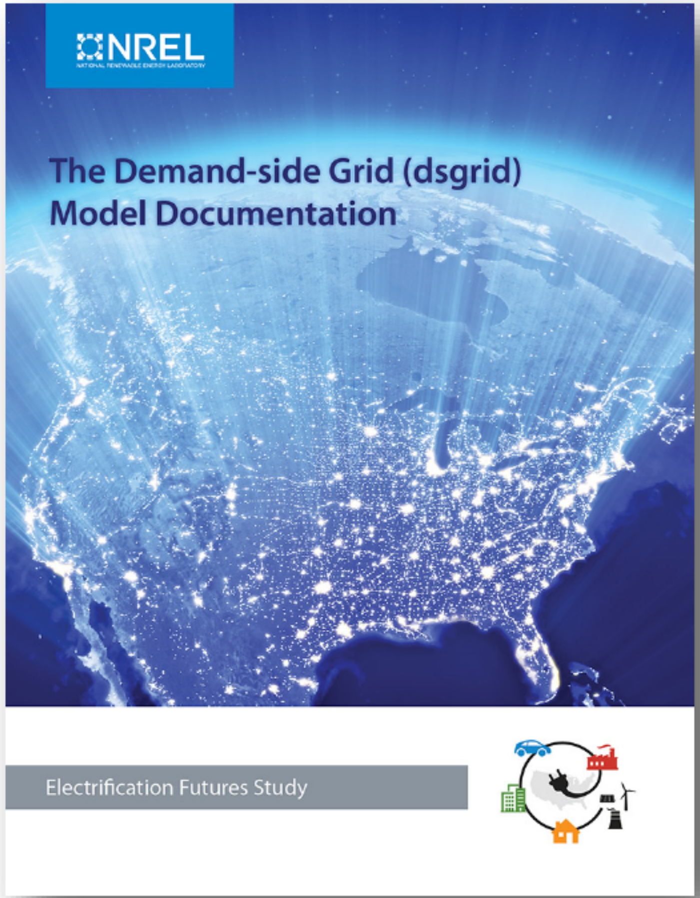
EFS: The Electrification Futures Study



nrel.gov/EFS

dsgrid: bottom-up engineering model to estimate hourly electricity consumption

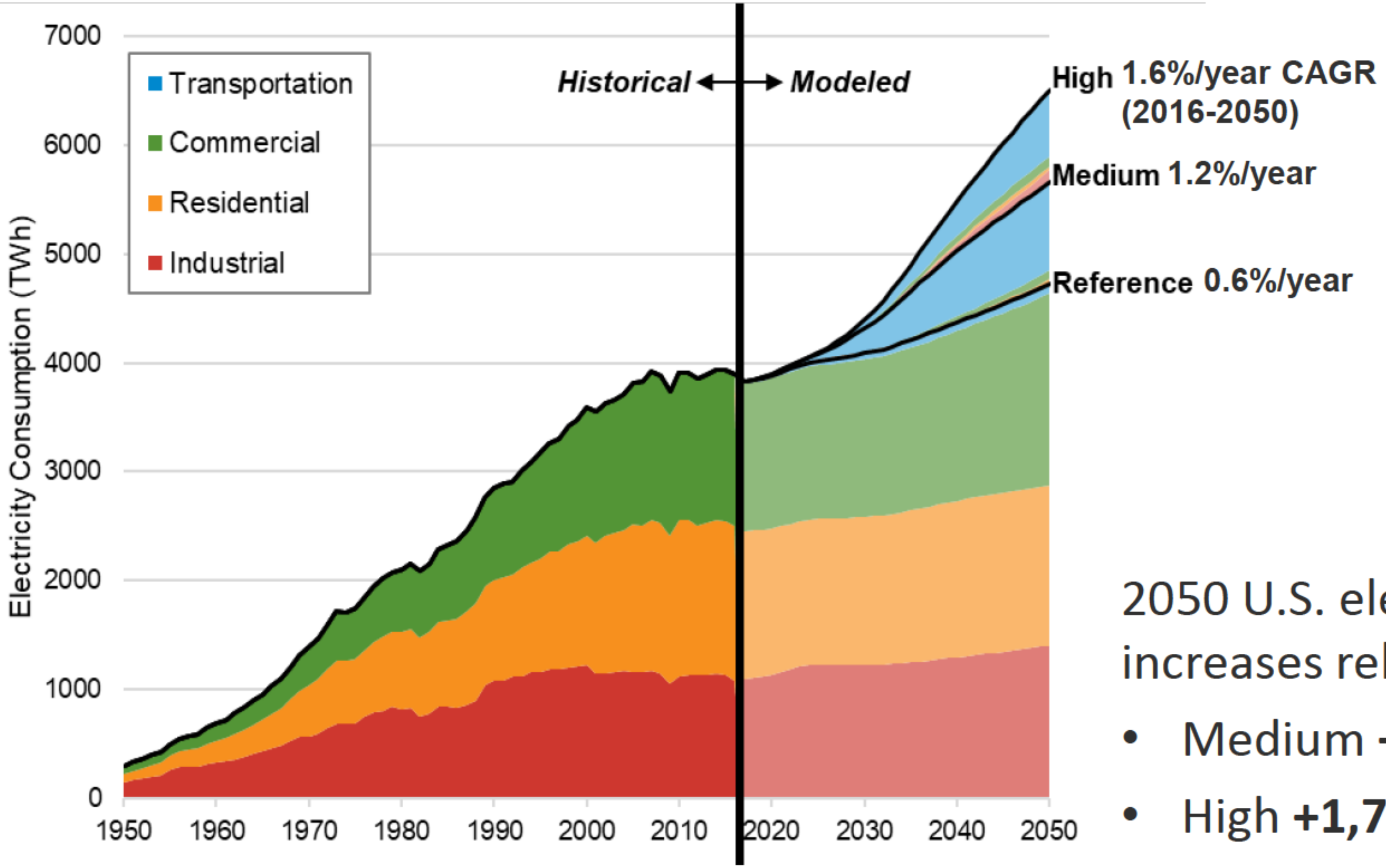


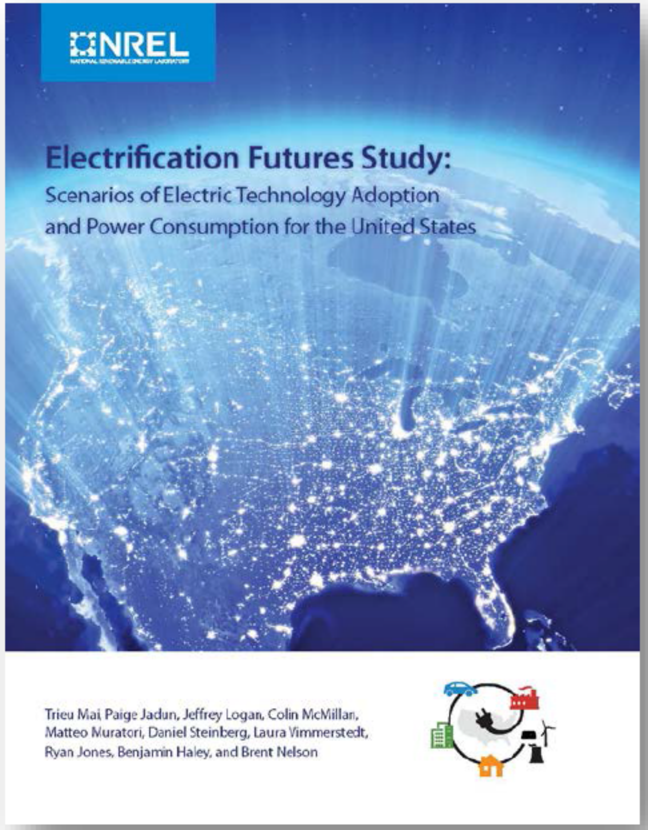


nrel.gov/docs/fy18osti/71492.pdf

nrel.gov/analysis/dsgrid.html

Demand-side adoption scenarios



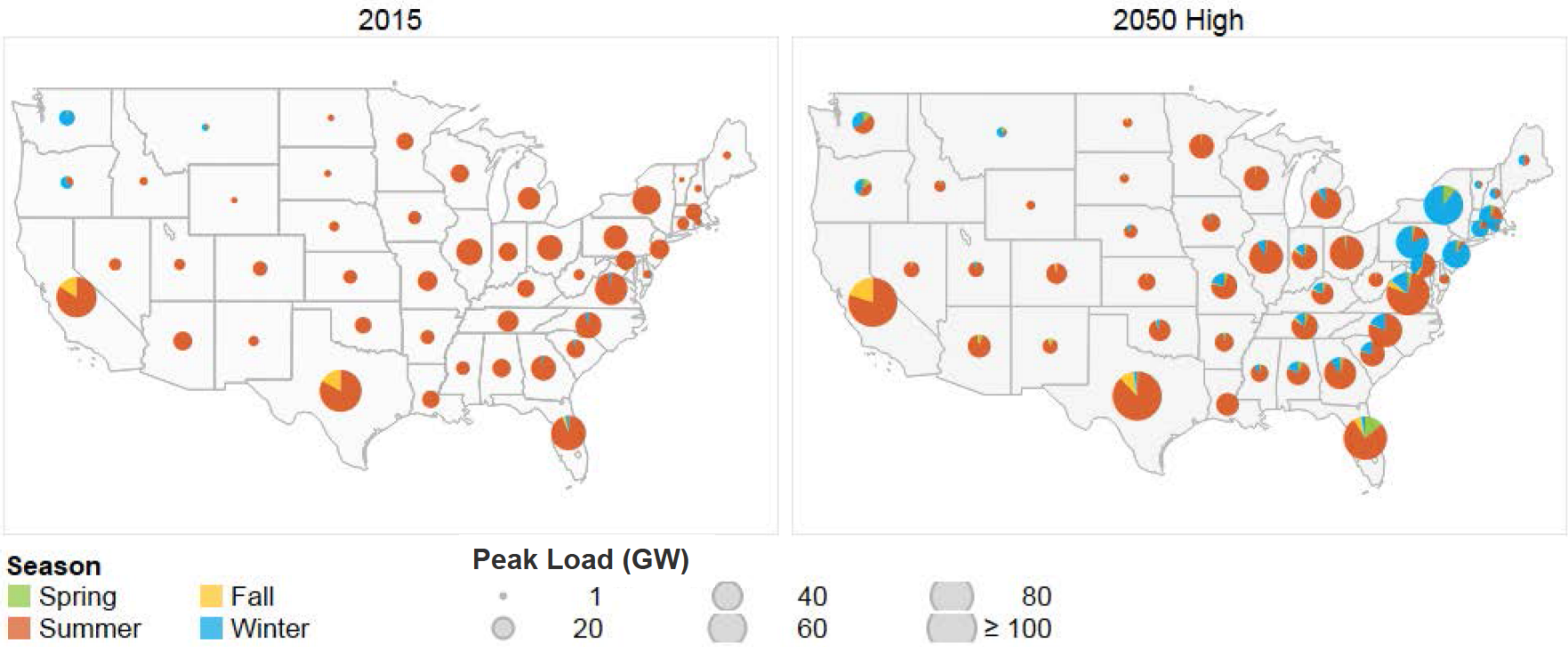


nrel.gov/docs/fy18osti/71500.pdf

2050 U.S. electricity consumption increases relative to Reference

- Medium **+932 TWh (20%)**
- High **+1,782 TWh (38%)**

Planning for electrification requires considering the impacts to annual consumption and <u>load shapes</u>



Note: Summer = June-August, Fall = September-November, Winter = December-February, Spring = March-May

Navajo Generating Station: Market Analysis

NAVAJO GENERATING STATION

& FEDERAL RESOURCE PLANNING

Volume 2: Update

NREL Transforming ENERGY

UTILITY DIVE Deep Dive Opinion Podcasts Library Events Jobs

Generation T&D Solar Storage Demand Response Distributed Energy Regs

BRIEF

Last GW of 2.25 GW coal-fired Navajo Generating Station expected to shut down any day now

Credit: SRP

AUTHOR
Catherine Morehouse
@cmorehouse10

UPDATE: Nov. 19, 2019: *The Navajo Generating Station ended operations Nov. 18, majority owner Salt River Project (SRP) announced Monday.*

"A team of SRP employees and representatives of the Navajo Nation have

Markets and Policy Analysis at NREL

Kristen Ardani
Group Manager- Markets and Policy Analysis
Program Lead- Solar Analysis

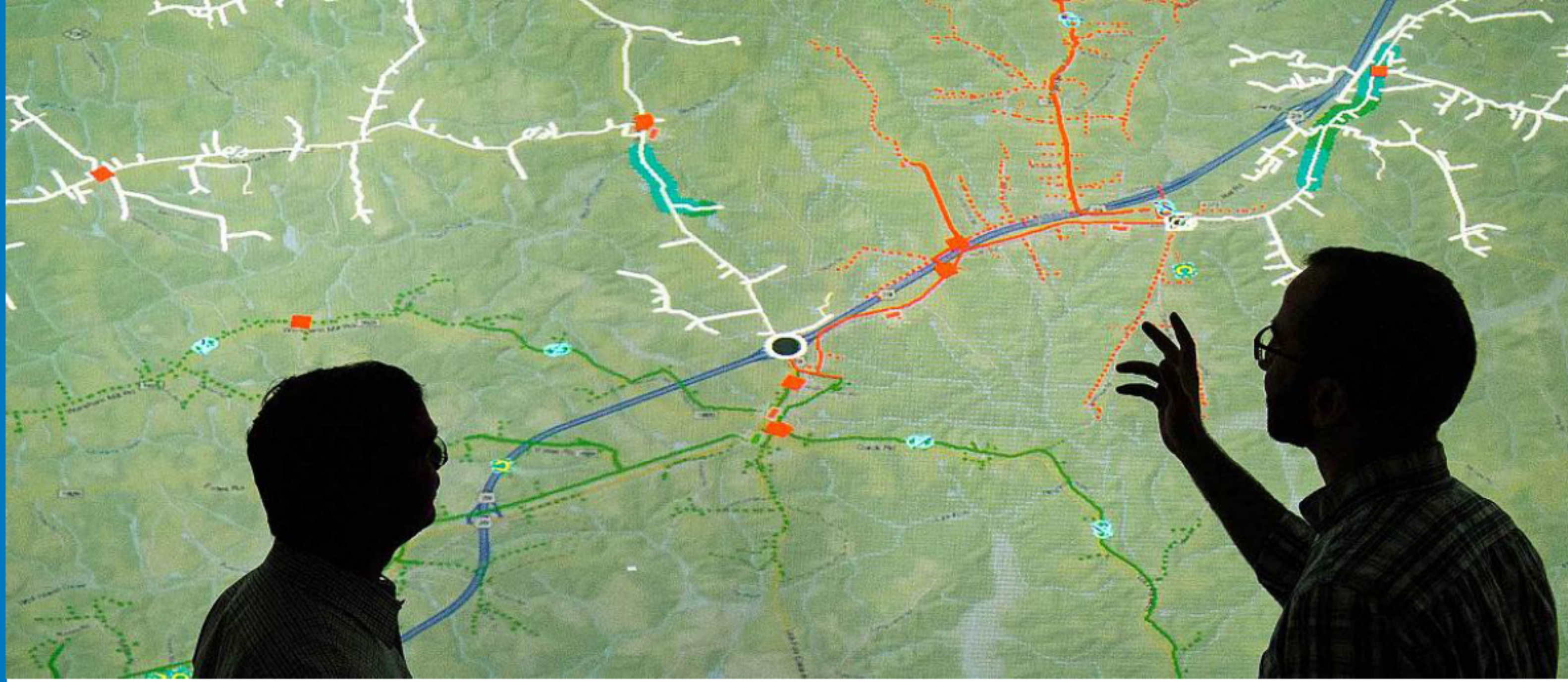
Markets and Policy Group

Who We Are

We're an interdisciplinary team of analysts who translate complex energy research and data into **objective, actionable market intelligence and policy analysis** for a variety of decision makers.

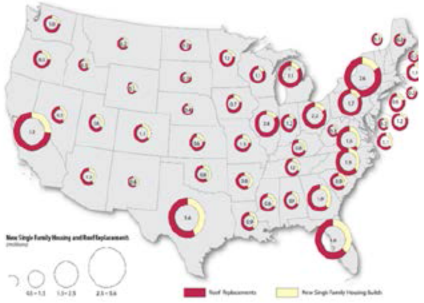
Markets and Policy Group Capabilities

We serve as a conduit, both inside and outside of NREL



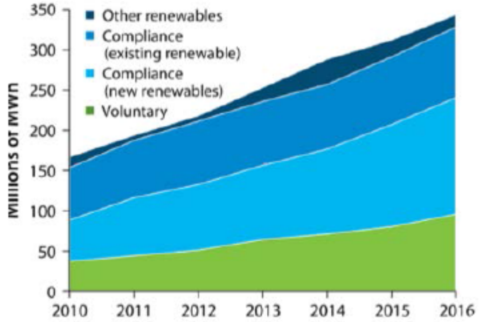
We **enable informed decision making** through a range of data analysis, research, and convening capabilities to provide stakeholders with the information they need to address key questions in a data-driven way.

NREL Markets and Policy Group
Informing Decision Making through Key Capabilities



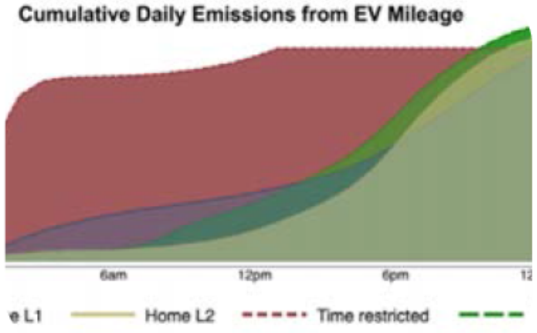
Market Assessments

Financial Analysis



Policy Impact Analysis

Legal and Regulatory Analysis



Data and Information Synthesis

Tool Development and Institutional Capacity Building

Example Questions

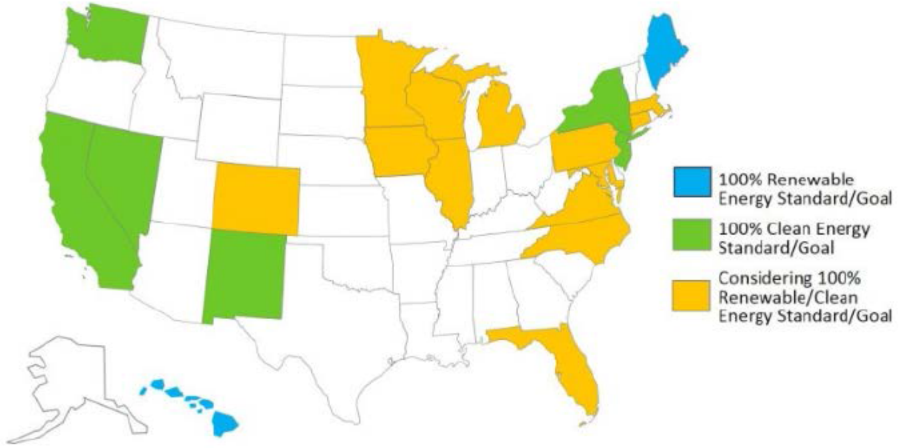
- How might certain policies and incentives affect renewable energy deployment in the State? (e.g. installed capacity, cost effectiveness)
- Are there interaction effects, or interdependencies, across certain policies if enacted? If so, what will the impact be on renewable energy deployment?

Policy Pathways Analysis

Technology Cost Analysis

Regulatory Options Analysis

100% Renewable or Clean Energy Standards/Goals



Eight states plus Washington DC, and Puerto Rico (not pictured here) have committed to 100% renewable or clean energy either through mandatory requirements or goals (California, Maine, and Nevada have established goals). At least 13 additional states are actively considering similar measures.

Analysis for Markets with High Renewable Energy and Energy Efficiency Goals

Rationale:
Increasing number of state and local governments are adopting aggressive renewable energy (RE) and energy efficiency (EE) targets

- As of August 2019, 8 states plus D.C., Puerto Rico, 145 cities, and 12 counties, made 100% clean energy commitments

Looking ahead: meeting city and state RE targets alone will require 21% increase in non-hydro RE by 2025

source: ACEE,LBNL,WRI

Analysis of State Level Actions and Commitments

Analysis of Different Policies on State Solar Markets

Key Questions Answered:

- What are the key market, financing, and policy drivers of residential solar technology deployment?
- Is there a connection between increasing PV market concentration and the emergence of third-party ownership (TPO) customer financing models?

Methodology:

- Benchmark key market trends in residential PV from 2000 to 2016 using data set of more than 1 million residential systems

Findings:

- The emergence of the TPO model supported increasing market concentration
- At the state level, increasing market concentration is driven by increased TPO penetration (often lagging by one or two years in most states)

Relationship Between Third Party Ownership and PV Market Concentration, by State

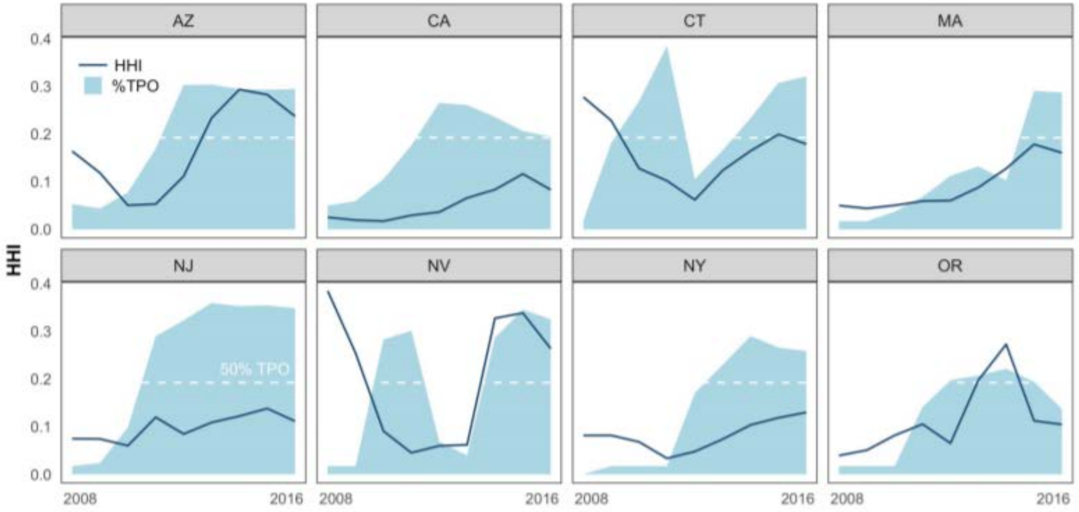


Figure 16. HHI and %TPO by state, 2008–2016

EV Charging and Integrating Renewables in Colorado

Key Questions Answered

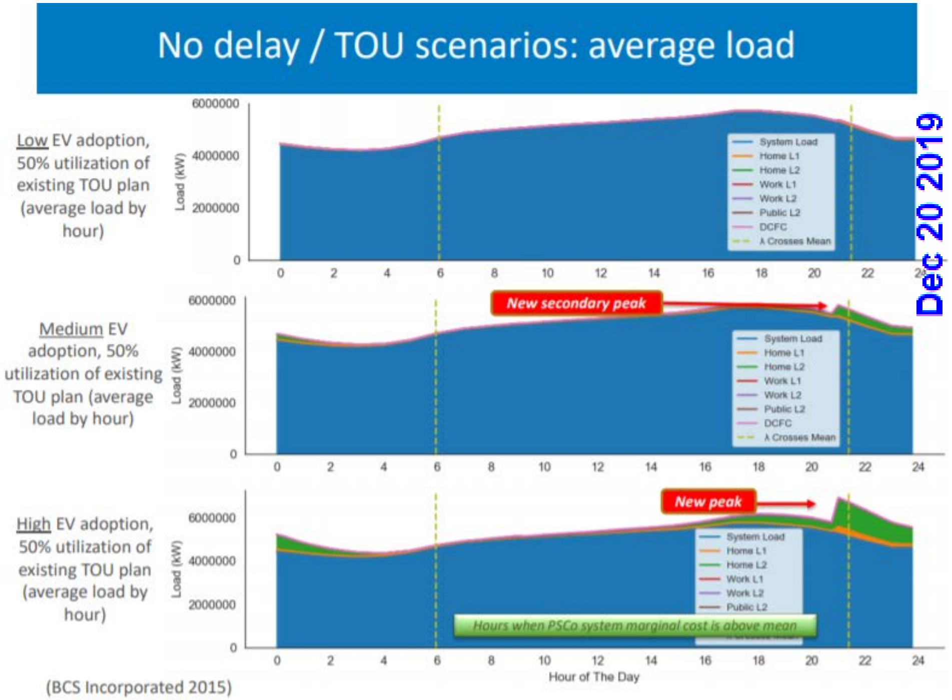
- What EV charging behaviors might systematically increase or decrease the utility's cost of service in Colorado?
- How would load profiles change if they reflected reasonably achievable behaviors that reduced the cost of service?

Methodology

- Create a bottom-up simulation to assess how the scale of EV adoption and various charging behaviors can change load patterns in the Public Service Company of Colorado (PSCo) balancing authority area

Findings

- Based on modeled results, residential charging presents the largest potential impact on system peak and the largest potential for load shifting.
- Well-designed time-of-use (TOU) rate structures can shift majority of EV charging load to times of low marginal cost of energy.



(BCS Incorporated 2015)

Equity, Affordability, and Access- Renewable Energy in Low to Moderate Income Communities

Key Questions Answered:

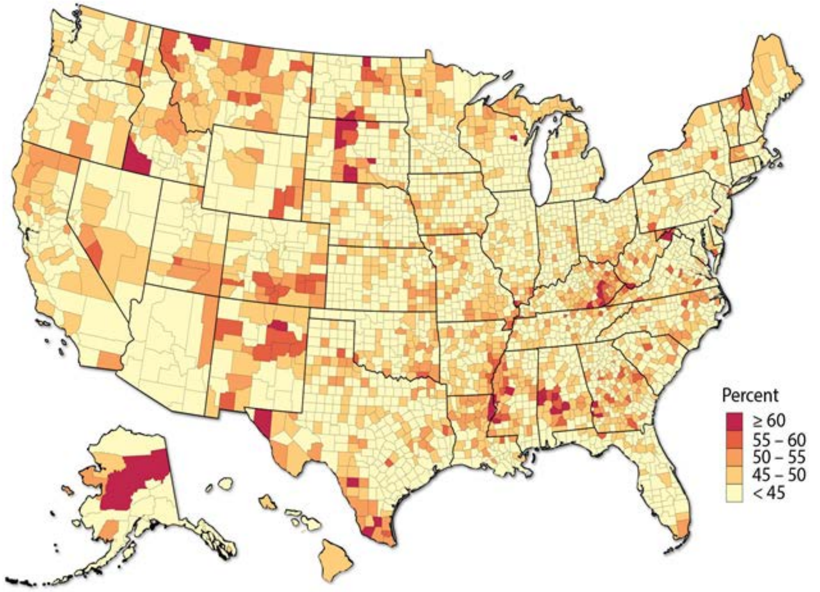
- How is rooftop solar potential distributed geographically, by income group, building type, and tenure of the building occupants?
- Are there certain strategies to scale up solar adoption among low-and-moderate income (LMI) communities across the U.S.?

Methodology:

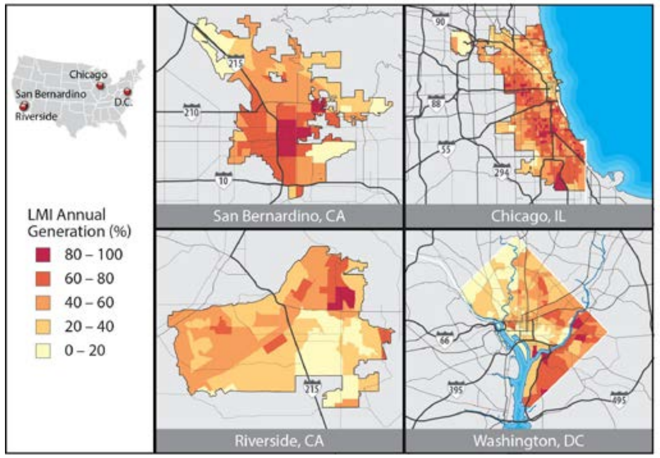
- Use LiDAR imagery combined with U.S. Census data sets to estimate the total usable rooftop area for LMI households nationally

Findings:

- There is substantial rooftop solar potential on LMI buildings (42% of U.S. total potential)
- Areas with relatively high LMI solar percentages include the Southeast (i.e., AL, AR, KY, LA, MS, and WV) and portions of the Midwest and Mountain West



County LMI rooftop technical potential as percent of total potential



LMI rooftop technical potential as percent of total potential in select cities

Low-Income Energy Affordability Data (LEAD) Tool

Key Questions Answered:

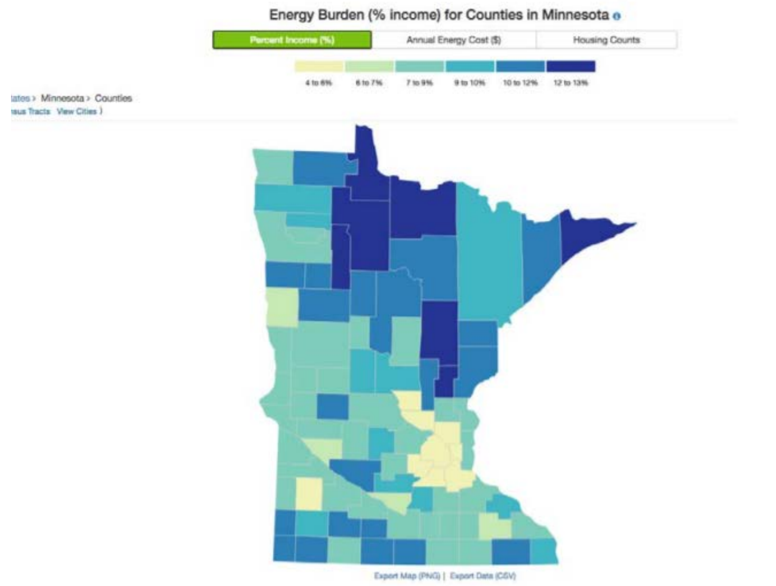
- What are the kay characteristics of low-income housing and energy use?
- What strategies may be best suited to serve LMI communities?

Methodology:

- Web-accessible, interactive platform that allows users to build national, state, city, or county profiles with estimated, locally specific low-income household energy characteristics.

Key Uses

- LMI energy policy and program planning, as it provides interactive state, county and city level worksheets with graphs and data including number of households at different income levels and numbers of homeowners versus renters
- Provides a breakdown based on fuel type, building type, and construction year. It also provides average monthly energy expenditures and energy burden



State choropleth map showing estimated average energy burden for all counties in Minnesota.

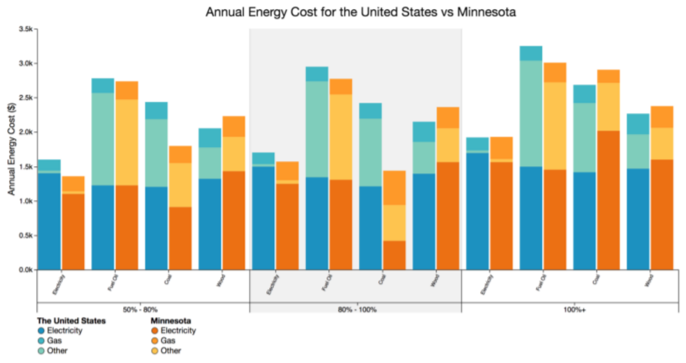


Figure 3: Estimated average annual energy costs for the U.S. (blue, left) and the state of Minnesota (orange, right) by housing unit primary heating fuel type and household income as a percent of area median income cohorts.