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NREL
Transforming ENERGY



Pacific Northwest
NATIONAL LABORATORY

South Asia Group for Energy

**Pathways to Resilient Energy Futures:
Innovations and Strategies**

October 21, 2024

11:30 AM to 1:00 PM



Call to Order

Meredydd Evans

Team Lead

Pacific Northwest National Laboratory



Agenda

- Welcome Remarks
- Special Address
- Setting the Stage: Innovations and Strategies for Resilient Energy Futures
- Panel Discussion: Pathways to Resilient Energy Futures
- Closing Remarks





Welcome Remarks

Naren Chanmugam

Environment and Resilience Office Director

USAID Nepal





Special Address

Shri Alok Ji

Rajasthan Energy Ministry Department

India



Setting the Stage: Innovations and Strategies for Resilient Energy Futures

Adarsh Nagarajan

Manager

National Renewable Energy Laboratory

Meredydd Evans

Team Lead

Pacific Northwest National Laboratory



The South Asia Group for Energy (SAGE)

Objectives

1. Implement research, analysis, and capacity building activities focused on the South Asia energy sector
2. Equip USAID partner governments with critical information and consultation, enabling strategic investments along South Asia's path to self-reliance
3. Facilitate access to technical expertise within U.S. Department of Energy (DOE) Labs, U.S. Government, and private sector partners.

Mechanisms for activities

- Direct technical assistance to public institutions
- Enabling engagement with U.S. public and private sector
- Direct research collaborations

Learn more about SAGE:



www.sarepenergy.net/sage



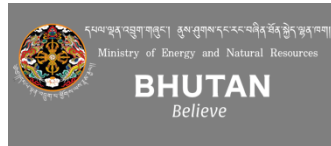
Supporting Clean Energy Transitions Across South Asia

Government Agencies



CENTRAL ELECTROCHEMICAL RESEARCH INSTITUTE

Bureau of Indian Standards
The National Standards Body of India



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National Center for Hydrology and Meteorology
Royal Government of Bhutan



NGO and Private Sector



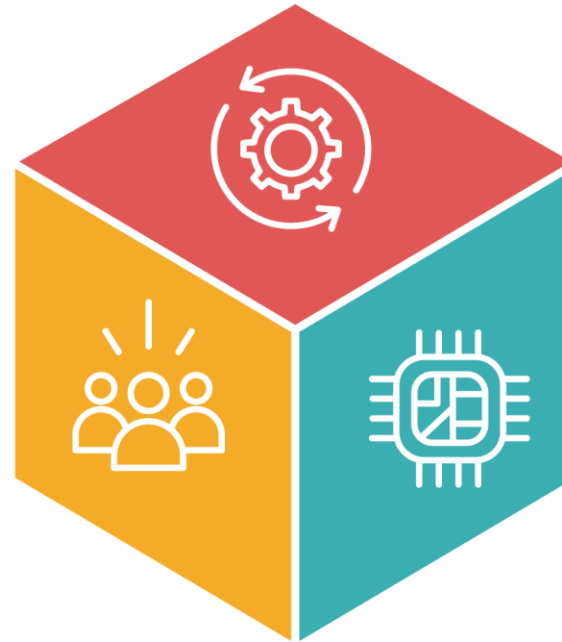
Pathways to Resilient Energy Futures: Innovations and Strategies

Strategies

Develop sustainable strategies to strengthen resilience against challenges such as climate change

Collaboration

Facilitate cross-sector collaboration to promote dialogue between key stakeholders



Innovations

Showcase cutting-edge innovations by highlighting recent advancements in energy sector

Informing Decisions on the Road to a Resilient and Reliable 100% Renewable Future

Present



Future



A 100% clean energy system can improve resilience in many ways, including:

Reduced environmental impact

Decentralized power

Diverse power supplies

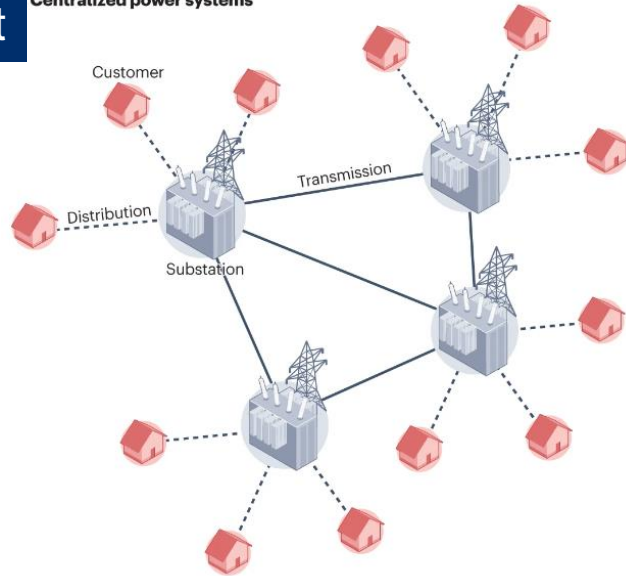
Improved air quality

Local control

Enhancing Grid Resilience Through Technology Integration

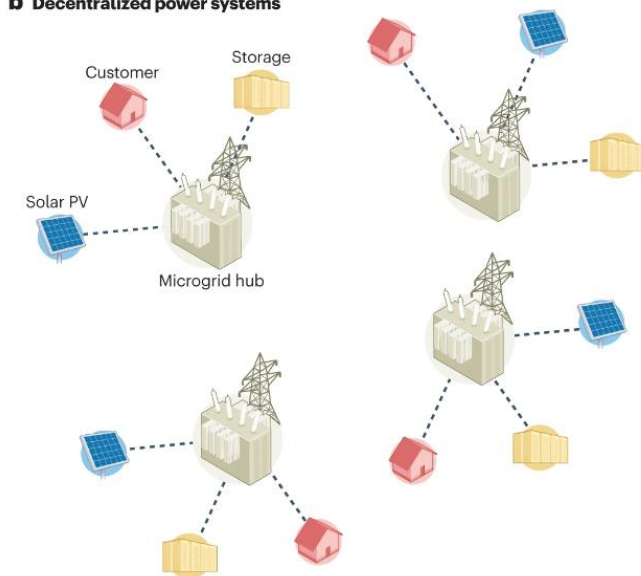
Present

Centralized power systems



Future

Decentralized power systems



Hardware technology integration

Grid forming inverters

Long-duration energy storage

Blackstart

Microgrids

Biofuels

Hydrogen technologies

Strategic analysis integration

Resilience informed grid planning

Just transition

Investment prioritization

Economics

Workforce

Social burden

Energy burden



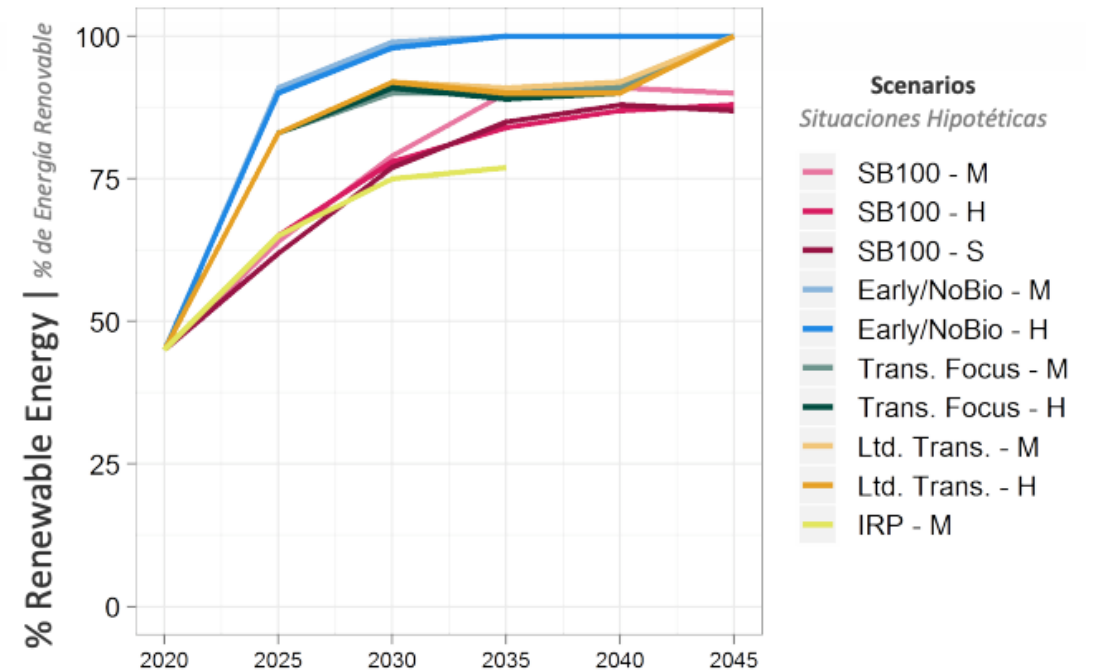
NREL has partnered with and supported **more than 3,000** communities, tribes, jurisdictions, utilities, and businesses for **energy transitions** planning, technical assistance, capacity building, workforce development, and more.

Case Study: LA100 Study Points to No-Regrets Options Toward 100% Renewables

The LA100 study informs the city, LADWP, and stakeholders on pathways to achieve 100% renewable energy.



- In all scenarios, wind and solar meet 69%– 87% of future electricity demand.
- The pathways diverge going from 90% to 100% renewables.
- The last 10% is crucial for ensuring reliability during periods of low wind and solar output, high demand, and unexpected events like transmission outages.



Collaboration in South Asia

Energy storage



Battery Operational Optimization

Long duration energy storage

- Sodium-ion technology
- Redox-flow technology

Inverter-based resources



Control center of the future

Grid forming inverters

- #### Concentrated loads
- Hydrogen hubs
 - Data centers

Future clean-energy technologies



Off-shore wind

Hydrogen

Geothermal

Incubation



Decarbonization and Resilience in Energy Systems

Meredydd Evans

October 21, 2024

South Asia Group for Energy

Round Table: Pathways to Resilience Energy Futures: Innovations and strategies

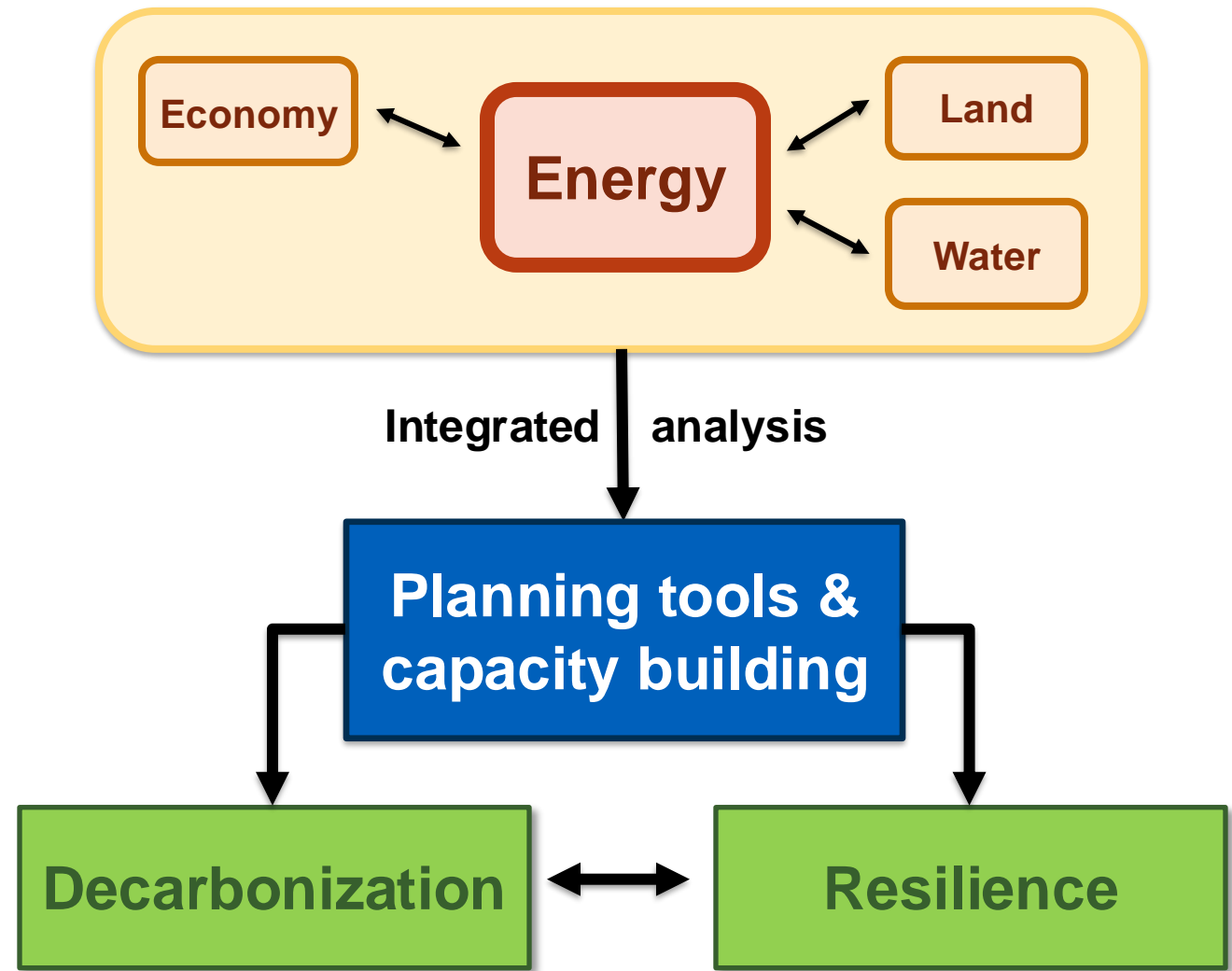


Meredydd Evans, Dan Broman, Siddarth Durga,
Rachel Hoesly, Taryn Waite, Maridee Weber

Decarbonization and Resilience

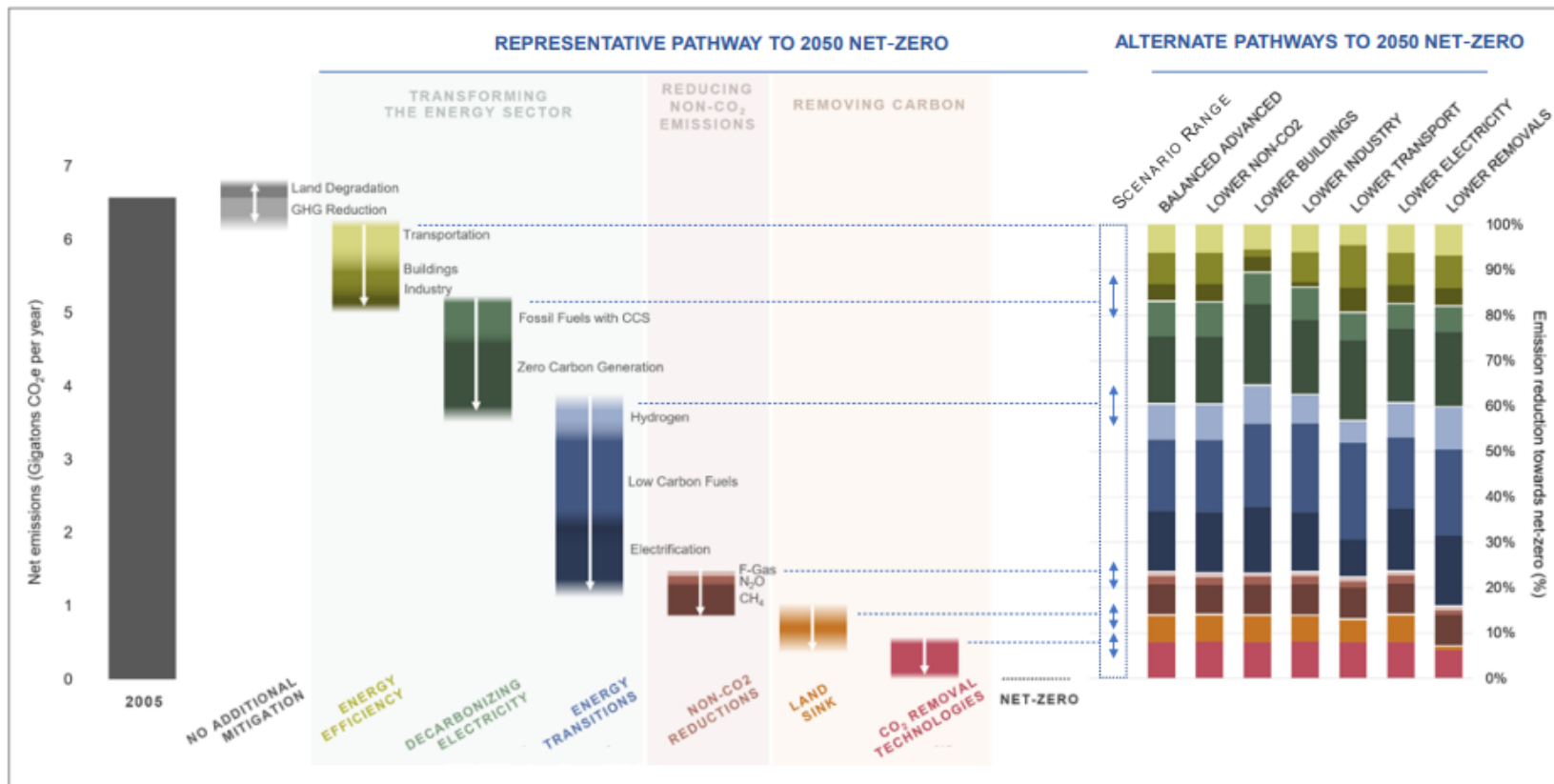
Overview

- Analysis for Decarbonization Planning
 - US Long-term Strategy
 - SAGE: Sustainable Growth Working Group
- Resilient Decarbonized Power Analysis
 - US Hydropower Assessment
 - Bhutan Regional Analysis
- Co-benefits of System Analysis



The U.S. Long Term Strategy

- PNNL conducted the analysis for the U.S. LTS, which the White House released in 2021. Included integrated assessment and resilience analysis.
- Assessed costs and benefits of multiple options and pathways.



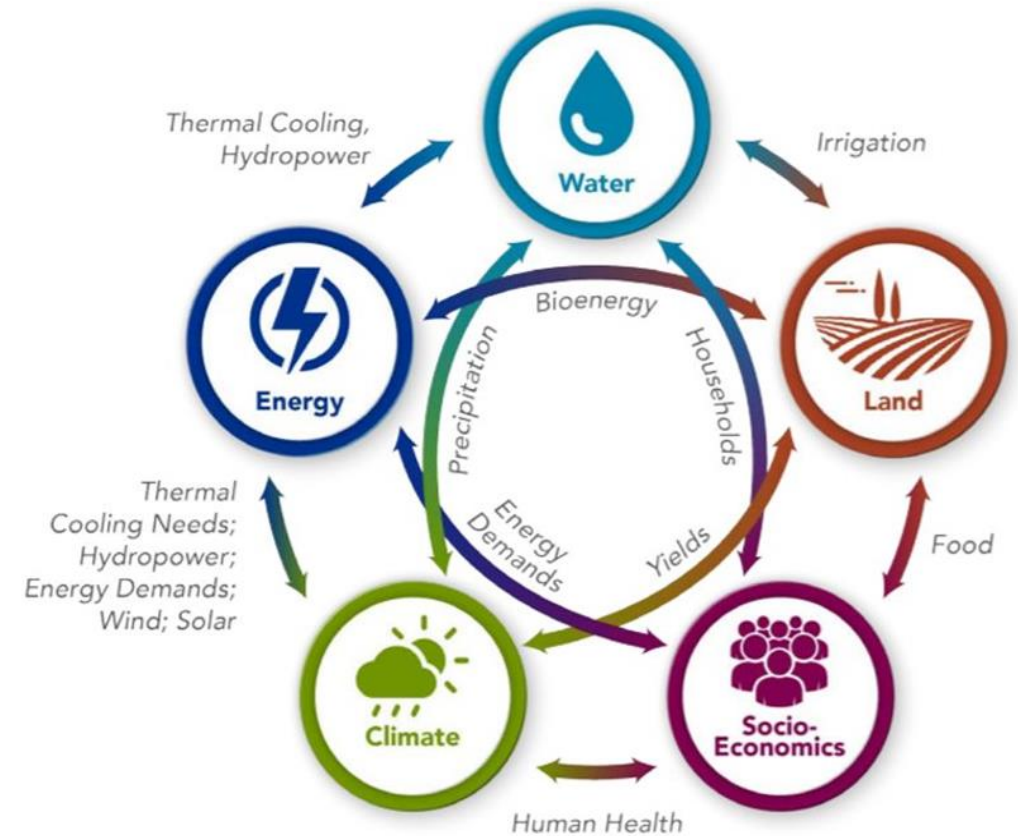
Sustainable Growth Working Group



- PNNL is working directly with NITI Aayog on integrated assessment modeling of India's energy system to provide insights to the Government of India (GOI) for India's **National Energy Policy, Nationally Determined Contribution and Long-Term Strategy.**
- Recognizing the importance of energy modeling to India's future energy and environmental decision making, NITI Aayog and USAID convened the **Indian Climate and Energy Modeling Forum** to help the GOI with their net-zero planning.



Sustainable Growth Working Group



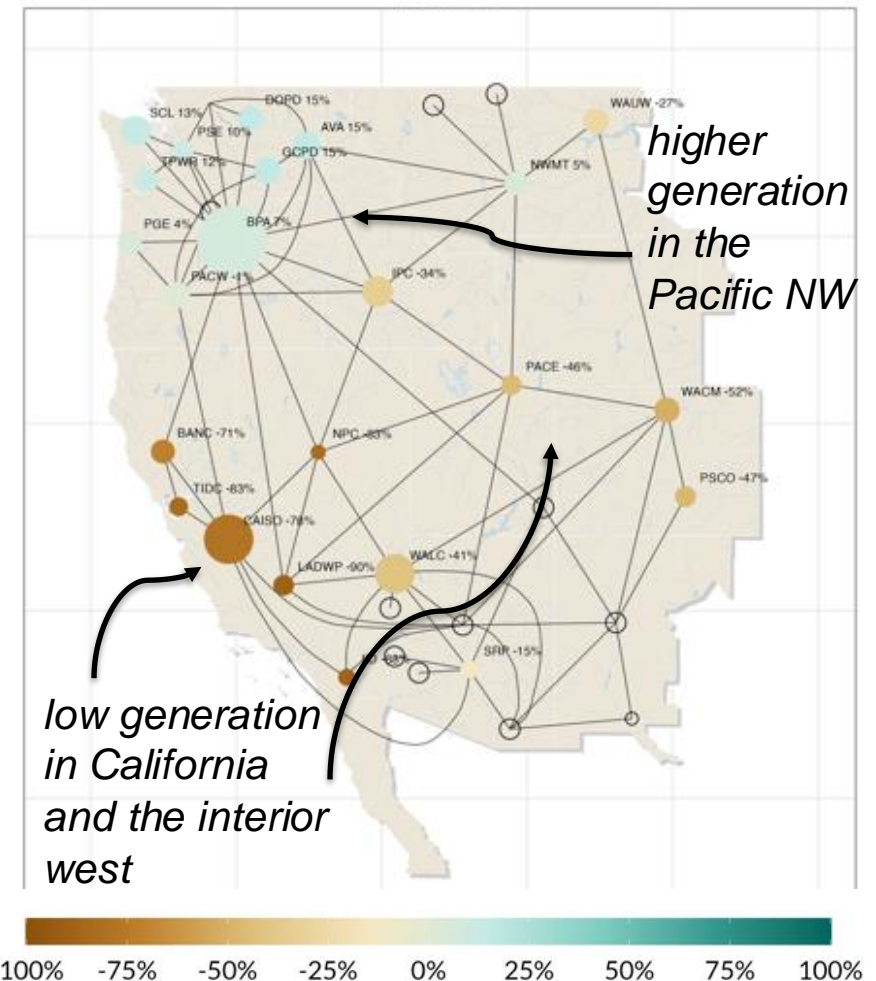
SGWG analysis has supported the development of resilient energy policy:

- Conducted analysis used to design India's Energy Policy.
- Built modeling capacity of multiple institutions to strengthen policy making focused on energy resilience and clean development
- Enhanced energy data for decision making (Energy Dashboards 2.0).

Resilient Hydropower : U.S. Hydropower Assessment

- Examined the impact of climate change on hydropower across the U.S.
- Used SSP585 (high emission / growth pathway) with 1980-2019 as the baseline period and 2020-2059 as the future period
- Provides baseline national-scale assessment of climate impacts to hydropower that serve a broad range of stakeholders

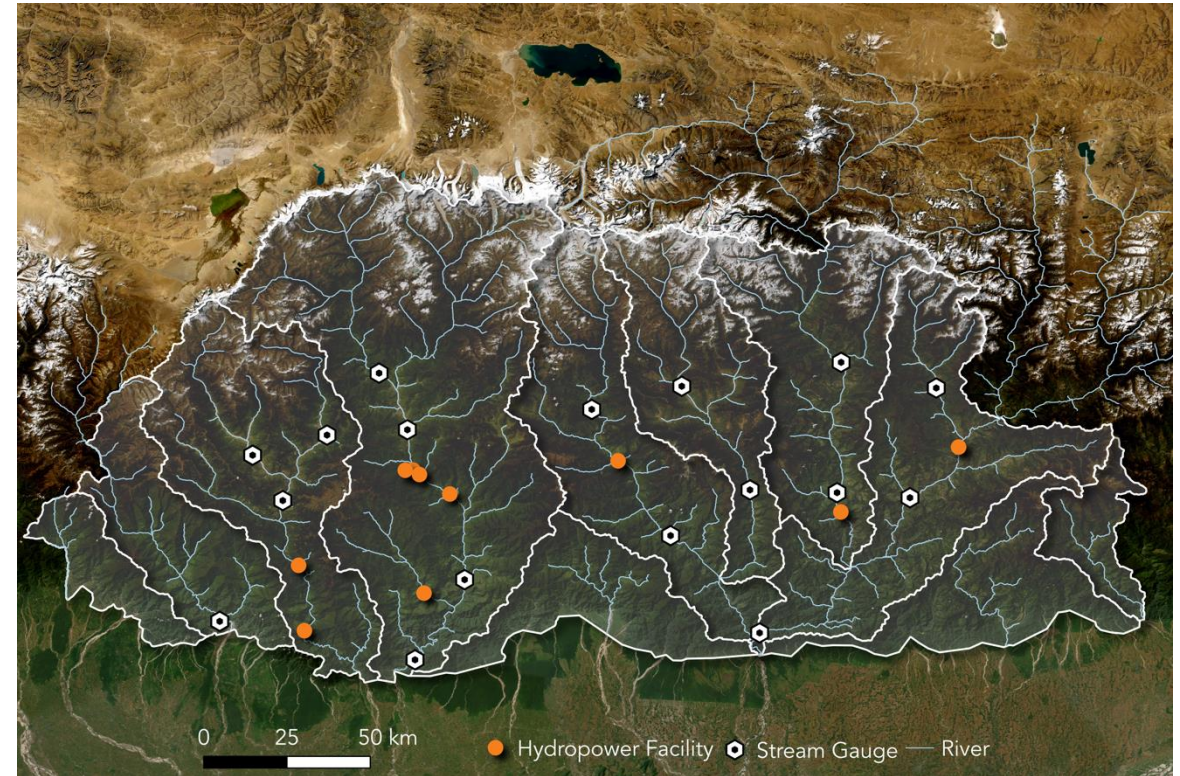
Western Interconnection



Change in annual generation during low future years which can support energy planners

Multi-scale Energy-Water Modeling in Bhutan

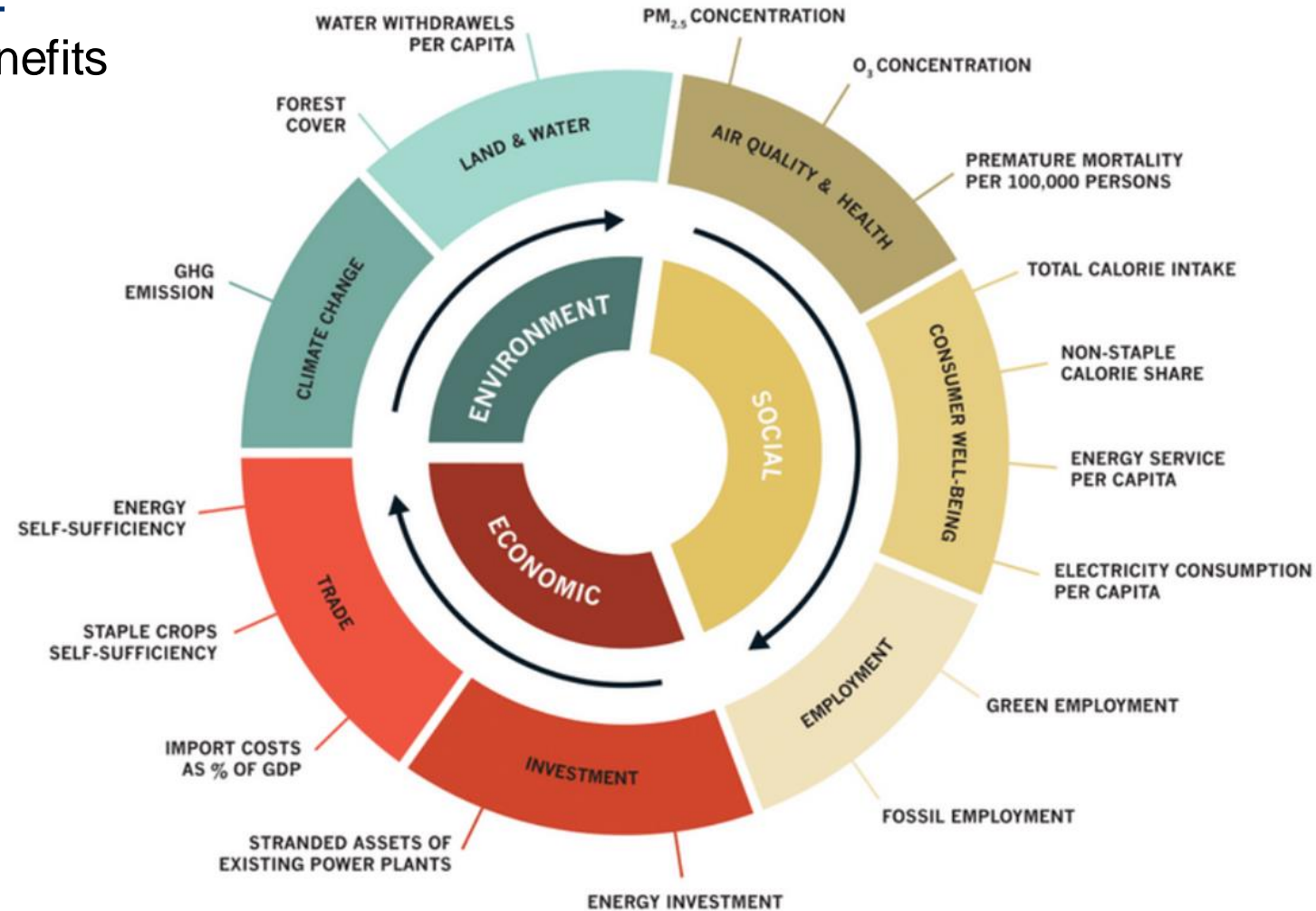
- Collaborating with National Center for Hydrology and Meteorology, Department of Energy, and Druk Green Power Corp.
- Developing fine scale hydrology models of all four major river basins to simulate hydrology and hydropower production with climate change
- Data support hydropower and energy planning in Bhutan; and provide future hydropower generation that can be used in system-wide integrated assessment modeling
- Training on hydrology and integrated energy modeling to develop capacity in Bhutan for continued use of these capabilities
- Coordination with integrated assessment modeling for consistency in climate scenarios and future hydropower generation projections



*This provides **national-scale capacity** and **datasets** on the climate impacts to **water** and **energy** that can support the needs of a diverse range of stakeholders*

Benefits of Taking a Multi-sector Approach

Understanding Co-benefits



Cui et al. 2022, Facilitate high-quality, sustainable growth through a low-carbon transition in the belt and road initiative countries, UMD, 2022
https://cgs.umd.edu/sites/default/files/2022-10/UMD-CGS-LowCarbonBRI-PolicyBrief-Oct2022-EN_1.pdf

Thank you

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Panel Discussion: Pathways to Resilient Energy Futures

**Vaibhav
Chaturvedi**

*Council on Energy,
Environment, and
Water*

**Karma
Dorji**

*Ministry of Energy
and Natural
Resources, Bhutan*

**Samitha
Midigaspe**

*Ceylon Electricity
Board*

**Amit
Tripathi**

*Coalition for
Disaster Resilient
Infrastructure*

**Ranju
Pandey**

*Nepal Electricity
Authority*

**Meredydd
Evans**

*Pacific Northwest
National
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Jal Desai

*National
Renewable Energy
Laboratory*



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Closing Remarks

Monali Zeya-Hazra

USAID India Mission



Thank you!



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