We are pleased to share fresh insights from the Energy Systems and Climate Analysis (ESCA) team. ESCA researchers have published work addressing gaps in future climate data, evaluating capabilities of gridded climate datasets, consolidating key information of GHG accounting for electric companies, discussing the role of net-zero targets, and evaluating opportunities for climate policy to address health and equity concerns. We are thrilled to announce one of ESCA's models for analyzing U.S. energy systems, US-REGEN, has been publicly released with an open-source license. Code and documentation now available on GitHub.

For more of our research head to ESCA's website.

Visit our interactive webpage to learn more about ESCA's history of cutting-edge climate change and decarbonization research.

Open-source US-REGEN launch

EPRI's Regional Economy, Greenhouse Gas, and Energy (REGEN) model is going open-source with a release of the U.S. version, now available on GitHub. REGEN combines an electric sector capacity expansion and a fuels supply model with buildings, transport, and industry end-use models, used for technology assessments, policy analysis, informing

company strategy, and evaluating decarbonization pathways. Access the electricity and fuels model in GitHub or view documentation.

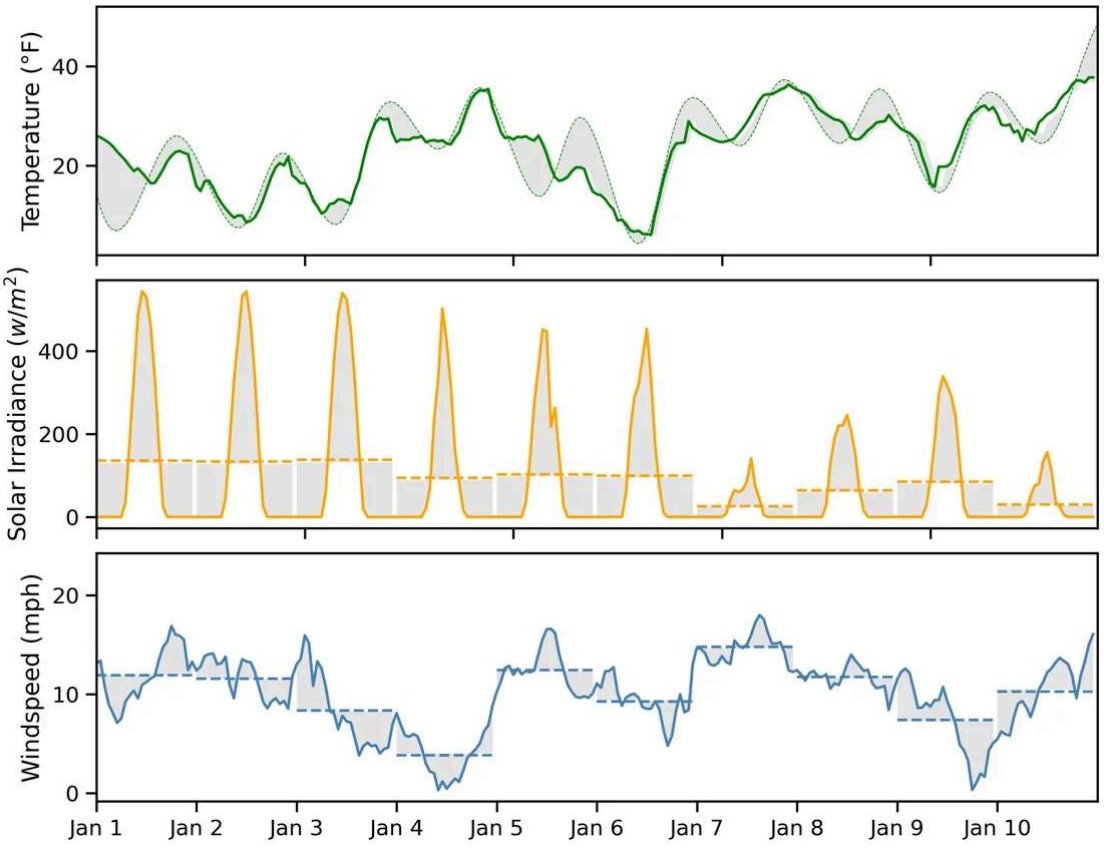
ACCESS MODEL

DOCUMENTATION

For more information, contact John Bistline or Geoff Blanford.

Research Highlights

A Climate-Informed Approach to Create Hourly Future Weather Timeseries for Power System Planning



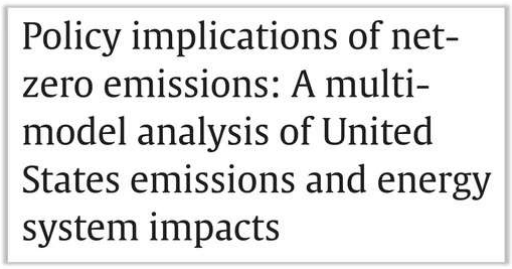
This work addressed the data gap regarding hourly weather timeseries for future climates by developing a monthly quantile delta mapping technique that preserves important, real-world characteristics from the historical record and adds the monthly climate change signal projected by climate models to historical weather data. This approach has many potential applications in the power sector, including for capacity expansion and production

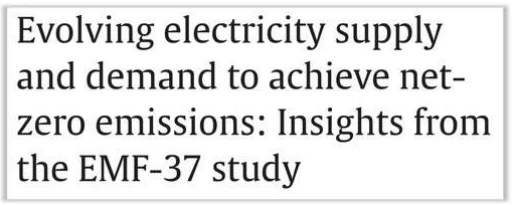
cost modeling where select hourly timeseries are used for complex optimizations or simulations, as well as for resource adequacy assessments that evaluate large samples of realizations to identify possible extremes for stress-testing a future year of interest.

READ ARTICLE

For more information reach out to Erik Smith.

Recent multi-model studies published in Energy and Climate Change





READ ARTICLE

READ ARTICLE

Authors, including ESCA's John Bistline and Geoff Blanford, investigate the potential policy implications of reaching economy-wide net-zero CO_2 emissions across the United States by 2050 using results from a multi-model comparison with 14 energy-economic models. Read the article to learn more about model results regarding impacts of IRA and net-zero policies, deployment of zero- and low-emitting resources, and potential impacts from carbon pricing on revenues and energy use.

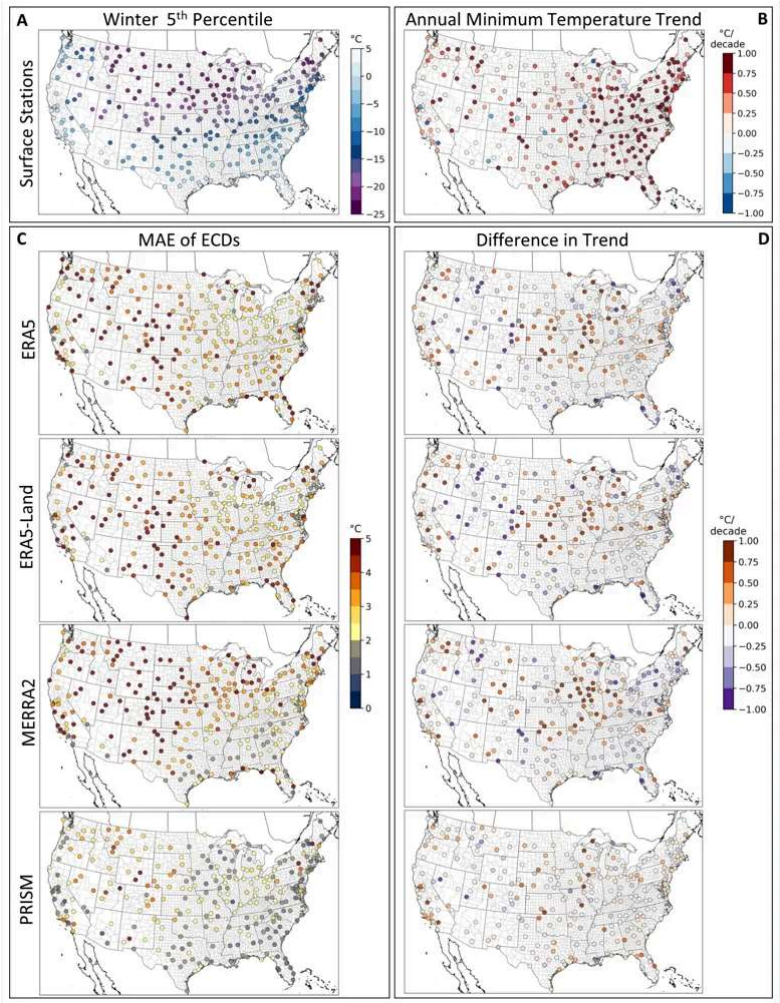
This paper explores the role of electricity in achieving economy-wide net-zero CO_2 emissions by 2050 in the United States and synthesizes the rich diversity of modeling approaches and results, highlighting differing views on how key drivers of

electricity demand and supply might evolve based on results from 17 models as part of the 37th Stanford Energy Modeling Forum (EMF-37). Read the article to learn more about how model results indicate electricity consistently emerges as central to achieving net-zero.

For more information reach out to John Bistline.

Evaluating the ability of gridded climate datasets to capture temperature and precipitation trends and extremes

With an increasing number of regulations requiring entities to use local climate data in their planning, it's more important than ever to understand the strengths and limitations of data we use. While they have been shown to capture long-term statistics on global or regional levels, the ability of gridded climate datasets to capture trends and extreme events is not common knowledge. Four widely used gridded datasets, ERA5, ERA5-Land, MERRA-2, and PRISM, were assessed for their ability to capture extreme heat, extreme cold, and heavy precipitation events, as well as trends in annual maximum and minimum temperatures and total precipitation, over the contiguous US (CONUS). Read more in a new article featured in Scientific Reports.



READ ARTICLE

For more information reach out to Erik Smith.

Special Topics in Greenhouse Gas Emissions Accounting for Electric Companies and Combined Utilities

There is a growing need for electric companies and combined electric and natural gas utilities to conduct technically grounded greenhouse gas (GHG) emissions accounting and reporting. To help address this need, this compendium of briefing papers and Frequently Asked Questions explores some important GHG accounting challenges faced by electric utilities: (i) Accounting and reporting for electricity and natural gas transmission and distribution related emissions in scope 1, 2, and/or 3; (ii) Location- and market-based approaches to GHG accounting for scope 2 indirect emissions; (iii) GHG inventory base year recalculation methods and approaches; and (iv) Scope 3 insetting.

READ REPORT

For more information reach out to Adam Diamant.

Net-Zero Climate Targets are Not for Everyone

Net-zero climate targets are being discussed and even requested; however, there is very little scientific guidance for net-zero strategies for local decision-makers such as regions, cities, and corporations. This brief addresses this issue and, using available resources and illustrative analysis, generates foundational insights for more informed dialogue and development of local climate strategies and policies, which are critical for realistic, actionable solutions.

READ REPORT

For more information reach out to Steven Rose.

Seizing the policy opportunities for health- and equity-improving energy decisions

John Bistline contributed to this recently published article in One Earth exploring how federal policies, including the Inflation Reduction Act (IRA), offer a unique window of opportunity to promote health and equity goals through clean energy investments. Read to learn how authors conclude seizing these near-term opportunities could realize sizable synergies.

READ ARTICLE

For more information reach out to John Bistline.

ESCA in the news

Newsweek

Power Companies Get a Guide to Making the Grid Withstand Climate Impacts

ESCA principal technical leader Andrea Staid shared remarks with Newsweek in May 2025 regarding EPRI's recently launched Climate READi framework, which provides utility companies guidance on climate data, vulnerability assessments for assets and power systems, and a method for prioritizing needed investments in resilience. Read the full article for Andrea's insights on why power systems need climate informed approaches.

READ ARTICLE

Research Briefs

2-3 page summaries for quick insights

Integrated Resource Planning: Practical Realities

EPRI

Integrated Resource Planning

Generation Transitions: *Practical Realities*

Key Insights

- Rapid change is increasing the complexity of electric sector planning and exacerbating uncertainties and risks that challenge development of long-term investment strategies.
- Integrated resource planning is a continuous process for ensuring the adequacy and security of electricity supply while meeting company goals and objectives.
- IRPs are used to inform project execution development strategies, including near-term solicitations and procurements for new capacity, research and development needs, and preliminary engineering studies.
- IRPs do not address all of the actions, uncertainties, and risks involved in making investments and developing, operating, and maintaining new generation, storage, and other resources.
- Evolving modeling methods and tools, combined with enhanced project execution frameworks, can help advance understanding of risks and uncertainties and identify best practices for navigating challenges in moving from the resource planning phase through the implementation phase.

Overview

Data centers are driving rapid load growth, and innovation is occurring across the energy sector. Resilience is of rising concern, and significant increases in electricity consumption will be required in order to meet future targets for net-zero carbon emissions. These ongoing and anticipated developments imply both a substantial expansion in power generating capacity and an unprecedented transformation in energy networks across the remainder of this decade.

While the energy transition will vary greatly across companies and regions of the world, today's investment decisions will impact the timing and trajectory of progress toward mid-century targets, as well as the services received and rates paid by customers.

Integrated resource planning is a process commonly used by energy companies in the United States and globally to develop investment strategies over 20- to 30-year periods. Alternative scenarios are applied to evaluate existing assets and new generation, storage, and demand-side options and to identify flexible and robust portfolios for meeting long-term electricity needs and other objectives, including reliability and resilience standards, net-zero commitments, and environmental compliance obligations. The portfolios and strategies described in integrated resource plans (IRPs) are intended to define plausible pathways for meeting specific objectives across a range of future scenarios.

What Do Today's IRPs Tells Us About the Energy Future?

More than 90% of U.S. companies that file IRPs have carbon reduction objectives, including 55% with net-zero goals for future power supply. Reviewing recent IRPs collectively can provide insights on the direction of the future generation mix. As shown in Figures 1 and 2, IRPs filed between 2019-23 by companies across the U.S. generally show rapid near-term capacity expansion driven by demand growth due to electrification and data centers. (EPRI, 3002026243)

Collectively, an increase in installed capacity of more than 35% is projected through 2035 compared to 2020. Solar is by far the leading choice, followed by

Role of Carbon Management Technologies in U.S. Decarbonization Pathways

EPRI

ESCA Back Pocket Insights

KEY INSIGHTS

- Model results suggest that **carbon capture and storage can play key roles in emissions reductions**, but the extent and composition **depend on technological and policy uncertainties**.

- **Electricity demand increases significantly over time in all scenarios** due to data centers, electrification, and other loads. However, scenarios without CCS entail much higher demand due to electrolytic hydrogen.

- **Technology optionality enables affordability.** Carbon prices span $170-300 per ton CO_2 across most net-zero scenarios but can approach $1,000/tCO$_2$ in scenarios without CCS.

This brief is based on the report "LCRI Net-Zero 2050: Sensitivity Analysis and Updated Scenarios" published on epri.com

Role of Carbon Management Technologies in U.S. Economy-Wide Decarbonization Pathways

by Geoff Blanford and John Bistline

Analysis evaluates technology strategies for achieving economy-wide net-zero CO_2 emissions in the U.S. by 2050, including the role for carbon management.

Carbon management technologies could be important elements in achieving net-zero CO_2 emissions across the economy; however, technological and policy uncertainties make the extent of this role unclear. This analysis uses EPRI's REGEN model to investigate a range of technology sensitivities and recent developments, including evolving policy incentives and emerging trends in data center electricity use.

The analysis includes scenarios related to:

- Technology availability and cost assumptions for advanced nuclear, electrolysis, carbon capture and storage, and bioenergy
- Fuel price uncertainty
- Limited flexibility in how far individual sectors and regions are required to reduce direct emissions under an economy-wide target
- U.S. Inflation Reduction Act (IRA) incentives

More detail on scenario and analysis assumptions can be found here.

Model results suggest that carbon capture and storage (CCS) can play a key role in economy-wide decarbonization, but the **extent of deployment spans a wide range depending on policy and technology assumptions** (Fig. 1). Total capture rates range from 100-2,200 million metric tons of CO_2 annually across net-zero scenarios in 2050.

Sectoral CO_2 Reductions for Economy-Wide Decarbonization

EPRI
ESCA Back Pocket Insights

KEY INSIGHTS

- The potential for direct emissions reductions varies across sectors, and **strategies vary within each sector depending on technology costs and availability**.
- In general, the **buildings, industry, and fuels sectors achieve lower percentage reductions than the power and transport sectors**, reflecting their higher marginal abatement costs.
- Electrification and low-carbon fuels can substitute for conventional fuels to reduce emissions, but the **marginal costs can rise steeply for some end-uses**. This leads to carbon dioxide removal use to offset fossil fuel emissions, which can lower costs relative to direct reductions for some end-uses.

This brief is based on the report "LCRI Net-Zero 2050: Sensitivity Analysis and Updated Scenarios" published on epri.com

Sectoral CO_2 Reductions for Economy-Wide Decarbonization

by Geoff Blanford and John Bistline

Analysis evaluates technology strategies for achieving economy-wide net-zero CO_2 emissions in the U.S. by 2050.

Many companies, states, and countries are setting net-zero emissions goals; however, there are many uncertainties related to potential pathways and technology trade-offs to reach these targets. This analysis uses EPRI's REGEN model to investigate a range of technology sensitivities and recent developments, including evolving policy incentives and emerging trends in data center electricity use.

The analysis includes scenarios related to:

- Technology availability and cost assumptions for advanced nuclear, electrolysis, carbon capture and storage, and bioenergy
- Fuel price uncertainty
- Limited flexibility in how far individual sectors and regions are required to reduce direct emissions under an economy-wide target
- U.S. Inflation Reduction Act (IRA) incentives

More detail on scenario and analysis assumptions can be found here.

Achieving economy-wide net-zero goals requires deployment of low-carbon technologies across electric and non-electric sectors, including industry, fuels, buildings, and transportation. The **potential for direct emissions reductions varies across sectors**, and optimal strategies vary within each sector depending on technology costs and availability (Fig. 1).

Thank you for your continued interest in our work. If you have any questions please email eea@epri.com.

Best,

EPRI Energy Systems and Climate Analysis Group

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