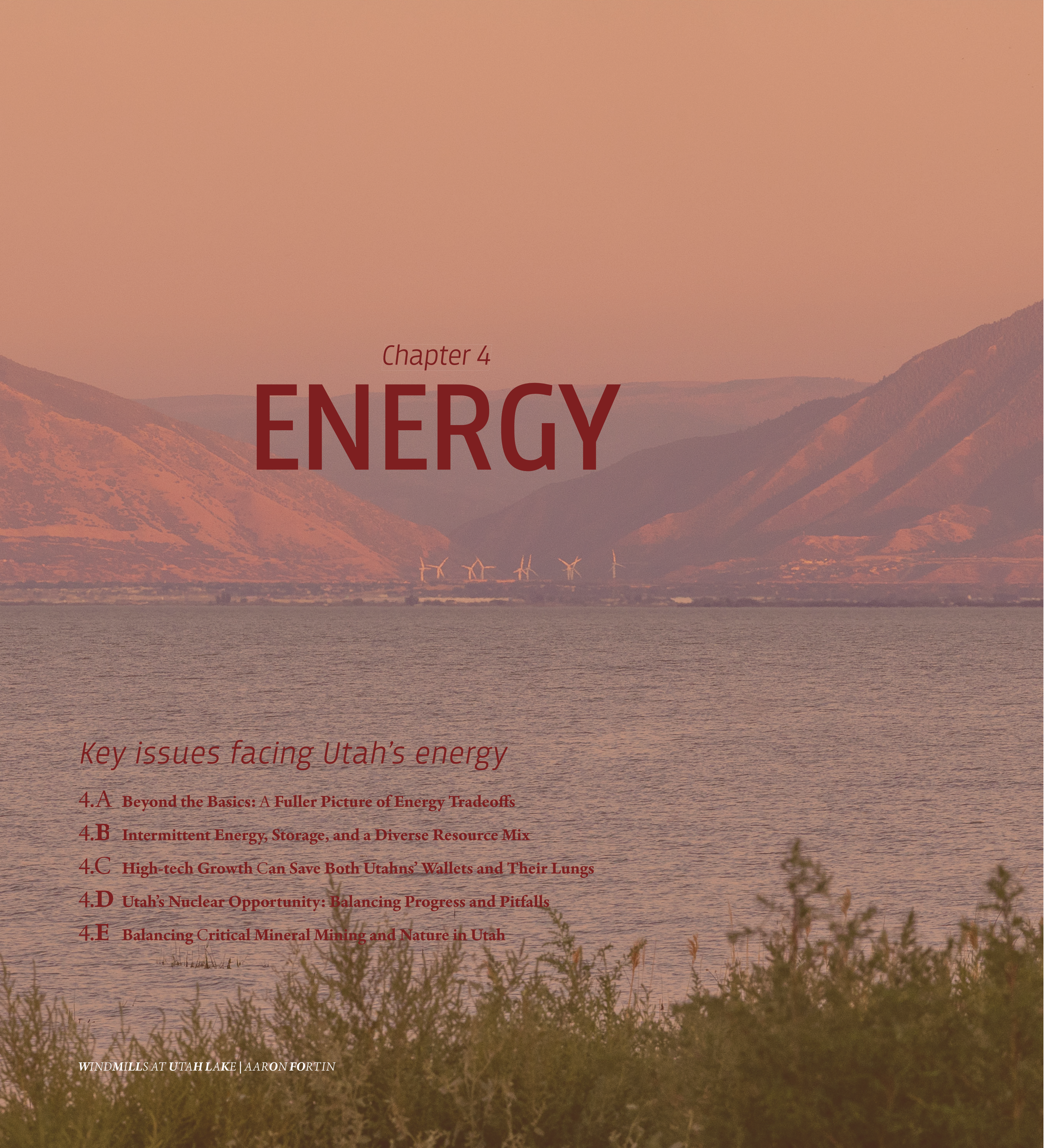


Chapter 4

ENERGY

Key issues facing Utah's energy

WINDMILLS AT UTAH LAKE | AARON FORTIN

Chapter Introduction

BRIAN STEED

Utah's Operation Gigawatt initiative aims to add a gigawatt of new power through nuclear, geothermal, and complementary technologies. This is not only a response to rapid population growth and rising energy demand, but also a chance to re-imagine the role of natural resources in powering Utah's future. Energy expansion on this scale will require careful consideration of land, water, mineral, and air resources—each a vital piece of the state's prosperity.

Water availability will be a defining factor of energy development. Some forms of new generation, particularly nuclear, depend on secure and predictable water supplies. Land and mineral resources also come into play. Expanding geothermal and nuclear capacity depends on critical minerals, many of which lie under Utah's federally managed lands. Air quality in Utah may see future opportunities. Transitioning toward lower-emission energy sources offers the potential to improve air conditions along the Wasatch Front and in energy-producing regions.

Finally, communities themselves are central to the success of Operation Gigawatt. Large energy projects are often sited in rural areas, where they bring both opportunities and disruptions. Utah has a chance to design its energy future in ways that provide lasting benefits to local communities—through infrastructure, jobs, and water resilience—ensuring that the gains are broadly shared.

In this way, Operation Gigawatt is a test of whether Utah can integrate energy expansion with natural resource stewardship, aligning innovation with conservation, and achieving the kinds of "win-wins" that will define a resilient future.

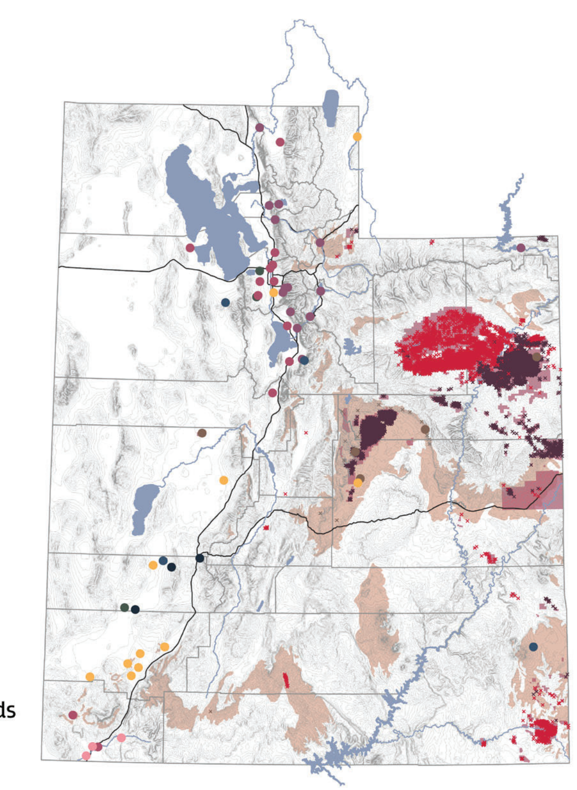


Figure 4.1.1 Utah's Energy Assets

Power Production Facilities
- Biomass
- Coal Fired
- Geothermal
- Hydroelectric
- Natural Gas Fired
- Oil Fired
- Solar Farm
- Wind Farm

Active Mines
- Oil Well
- Gas Well
- Coal Mine

Deposit Areas
- Utah Oil and Gas Fields
- Coal Deposit Areas

Map Created by Kori Ann Kurtzeborn, Data from Office of Energy Development

WINDMILLS AT UTAH LAKE | AARON FORTIN

Beyond the Basics: A Fuller Picture of Energy Tradeoffs

STEPHANIE FROHMAN, ANNA MCENTIRE, & PHILLIP FERNBERG

While cost, reliability, and emissions often dominate the debate, policymakers must also weigh social, environmental, and system design factors that shape the true impacts of Utah's energy choices.

Utah's Operation Gigawatt has set an ambitious goal: doubling the state's electricity production by 2035. Meeting this target requires a careful balancing act among diverse generation sources, each carrying unique environmental and economic tradeoffs. In the short term, coal and natural gas remain reliable baseload resources, but they produce air pollution and consume water. Solar and wind are inexpensive and clean but are land intensive and require battery storage to balance intermittency. Looking ahead to longer term options, geothermal provides the promise of lower-emission baseload power but only where geologic conditions allow, requiring significant transmission investment. Nuclear offers carbon-free baseload capacity, but poses challenges in cost, permitting and development timeline, potential water use, and radioactive waste disposal.

Operation Gigawatt aims to provide electricity that is clean, affordable, reliable and secure. To succeed, policymakers must weigh not only economics, baseload capability, and air pollution but also a wide array of additional considerations regarding land use impacts, water demands, transmission requirements, grid balancing, and public acceptance. Additionally, since power demand varies throughout the day and throughout the year, they must consider both "always on" sources and dispatchable sources that can be turned off and on quickly and affordably to meet peak demands.

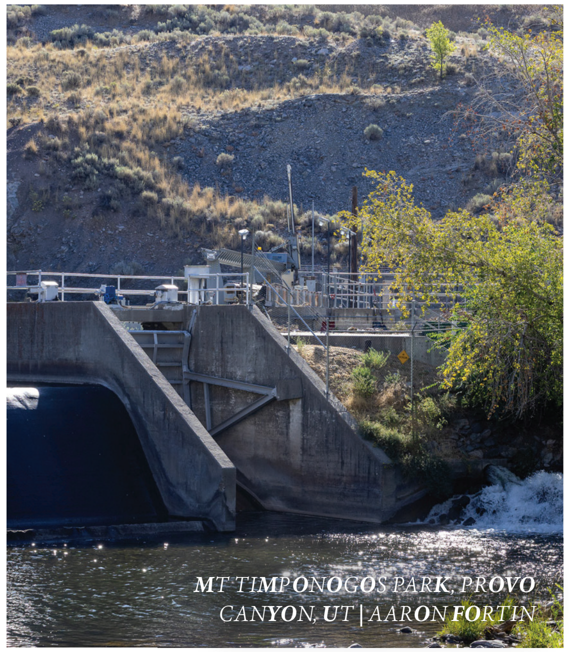
As a starting point for deeper evaluation, Figure 1.A.1 provides a simplified comparison across the six major electricity modalities most likely to be developed at utility scale in Utah over the next decade. At Utah State University, researchers are working with students to expand and validate this model, developing a one-stop, easy-to-understand matrix that policymakers can use to compare electricity options holistically. The goal is not to prescribe one path, but to clarify tradeoffs so that energy planning aligns with Utah's growth, environmental limits, and long-term prosperity.

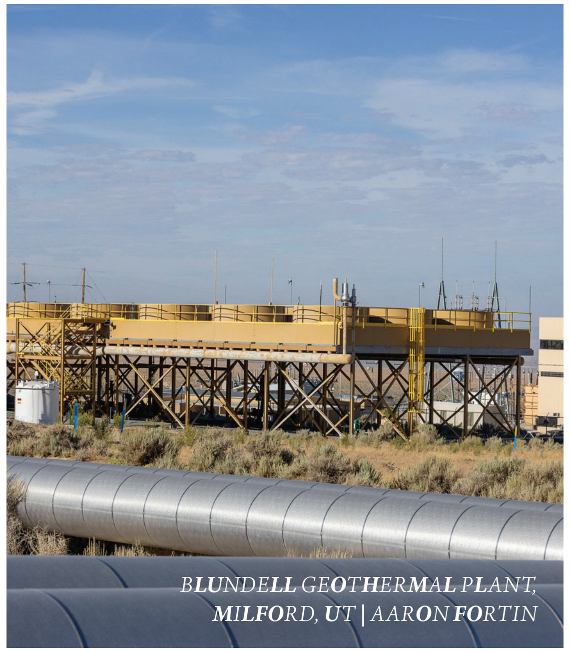
"The goal is not to prescribe one path, but to clarify tradeoffs so that energy planning aligns with Utah's growth, environmental limits, and long-term prosperity."

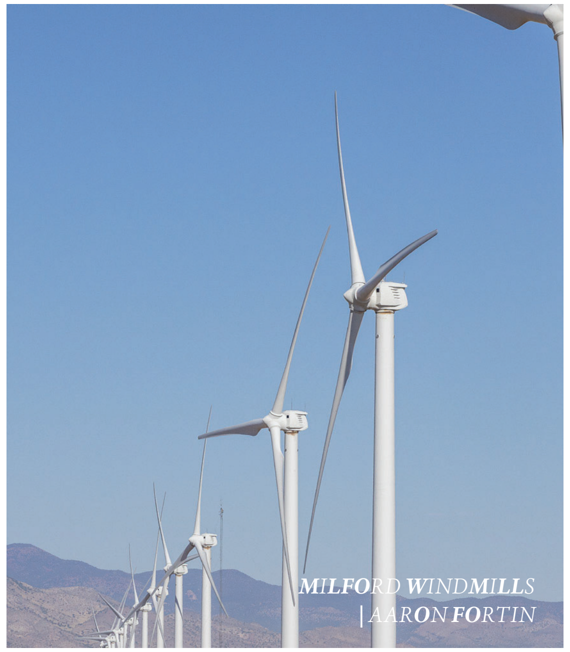
Figure 4.A.1 Electricity Generation Tradeoffs

	Development Cost	Baseload Capable	Dispatchable	Air Pollution	Water Demand	Land Use
Coal	Medium-High	Yes	Medium	Medium-High	High	Medium
Natural Gas	Medium	Yes	High	Medium	Medium	Medium
Wind	Low-Medium	No	With Battery	Very Low	Very Low	High
Solar (PV)	Low-Medium	No	With Battery	Very Low	Very Low	High
Geothermal	Medium-High	Yes	Medium	Very Low	Low-Medium	Medium
Nuclear	High	Yes	Medium	Very Low	Medium-High	Medium-Low

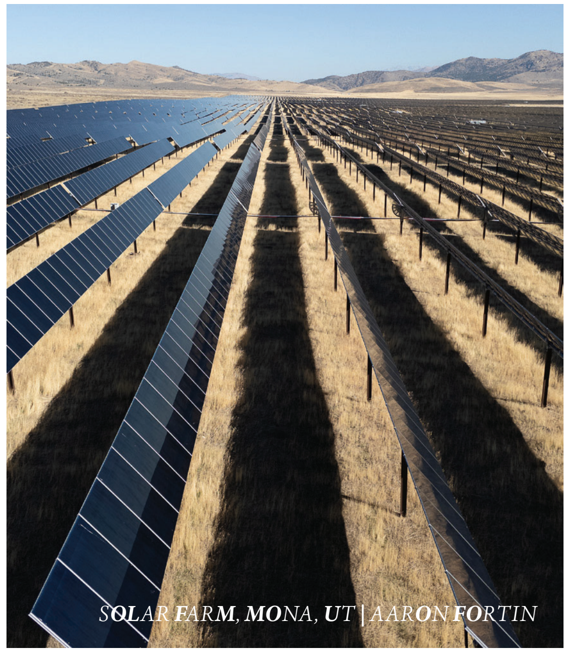
While all thermoelectric sources can be dispatchable, some are more costly and have more environmental impacts when operated at lower efficiency.


MT TIMPANOGOS PARK, PROVO CANYON, UT | AARON FORTIN


BLUNDELL GEOTHERMAL PLANT, MILFORD, UT | AARON FORTIN


MILFORD WINDMILLS | AARON FORTIN


URANIUM AT UTAH CORE RESEARCH CENTER, SLC, UT | AARON FORTIN


SOLAR FARM, MONA, UT | AARON FORTIN

Intermittent Energy, Storage, and a Diverse Resource Mix

TIM KOWALCHIK

Only a diverse mix of energy generation will effectively meet Utah's needs. Intermittent resource plus storage are insufficient alone.

Terms to Know:

Intermittent energy generation: Energy produced only when resources like sun or wind are available.

Peaking energy generation: Power plants run briefly to meet highest electricity demands.

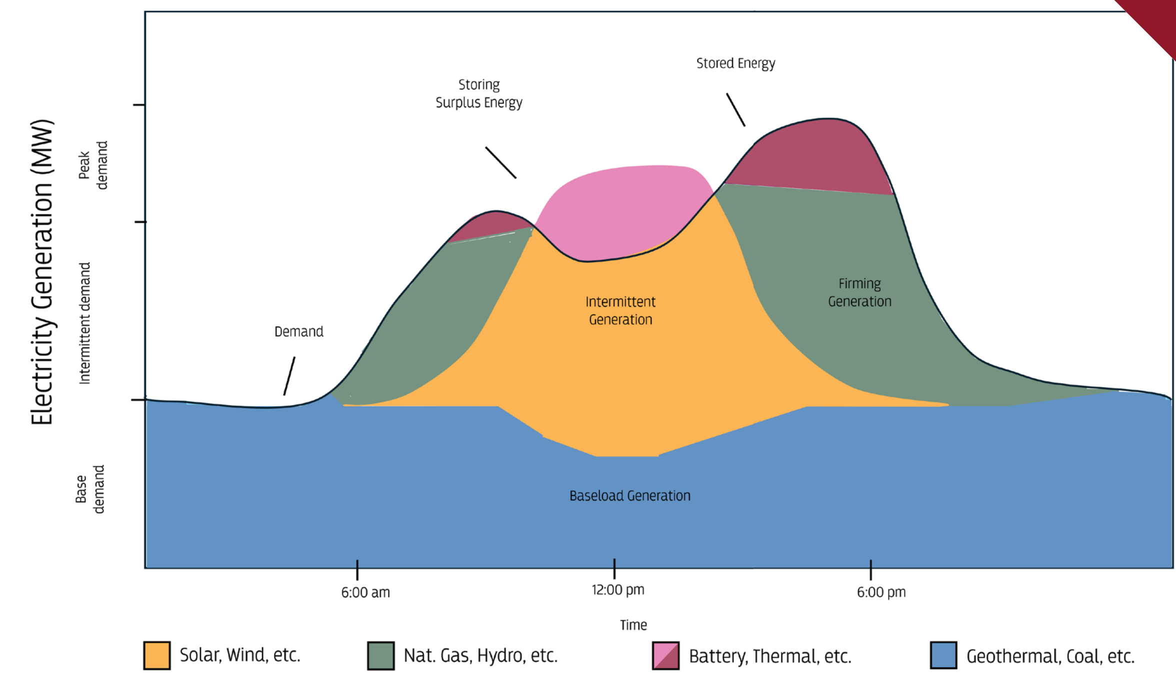
Baseload energy generation: Power plants that run continuously to supply steady electricity.

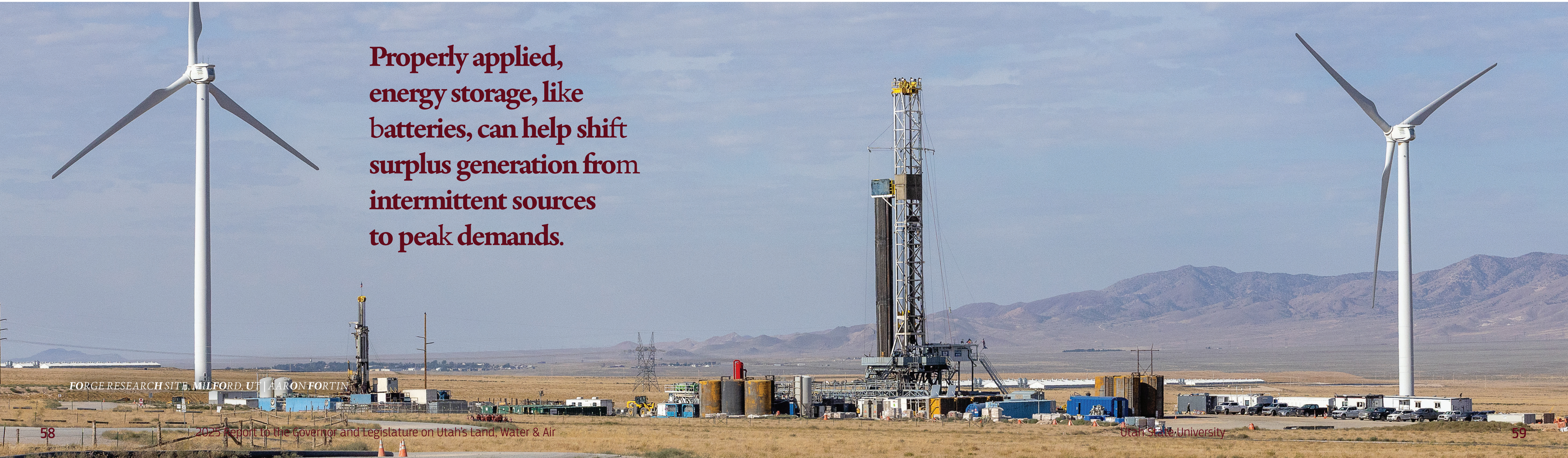
Intermittent electricity resources, such as solar and wind, are essential to Utah's growing energy portfolio but present unique challenges when considering their contribution to system-wide capacity. Unlike on-demand generation, their output is tied to variable conditions like sunlight availability or wind speed that cannot be controlled to match demand. This means a solar plant rated at 200 megawatts of capacity may only deliver a fraction of that during peak evening hours. Demand won't wait for morning or sunshine. The entire grid must match demand and generation to operate and must be planned around the greatest predicted demand. The inherent variability of intermittent resources reduces the certainty that installed capacity translates to useable electricity during peak demand.

When properly applied, energy storage, like batteries, can help shift surplus generation from intermittent sources to peak demands. However, implementing storage at the scale required to meaningfully offset intermittency and provide reliability is technically challenging and capital-intensive. Current battery technologies, while rapidly improving, face limitations in duration, lifecycle, and material availability. Long-duration storage options, such as pumped hydro or advanced thermal systems, have their own challenges. This is further complicated by the electricity market, which rewards short duration storage, not long-term reliability.

A diverse generation mix is a healthy generation mix. To meet the growing demand of the future, integrating storage alongside healthy proportions of intermittent, peaking, and baseload generation will be essential. Doing so will require careful planning, diverse technologies, and accompanying transmission investment to ensure that generation is always ready to meet demand.

Figure 4.B.1 Daily Energy Production and Allocation Example





Properly applied, energy storage, like batteries, can help shift surplus generation from intermittent sources to peak demands.

FORGE RESEARCH SITE, MILFORD, UT | AARON FORTIN

High-Tech Growth Can Save Both Utahns' Wallets and their Lungs

PHILLIP FERNBERG

Customized utility contracts can allow data centers flexible energy options for on-site production systems. The state needs strategies to advance Utah's tech credentials without compounding existing air quality concerns.

> *Terms to Know:*
> **Tiered Pricing:** Charging different rates for different usage levels to encourage conservation.

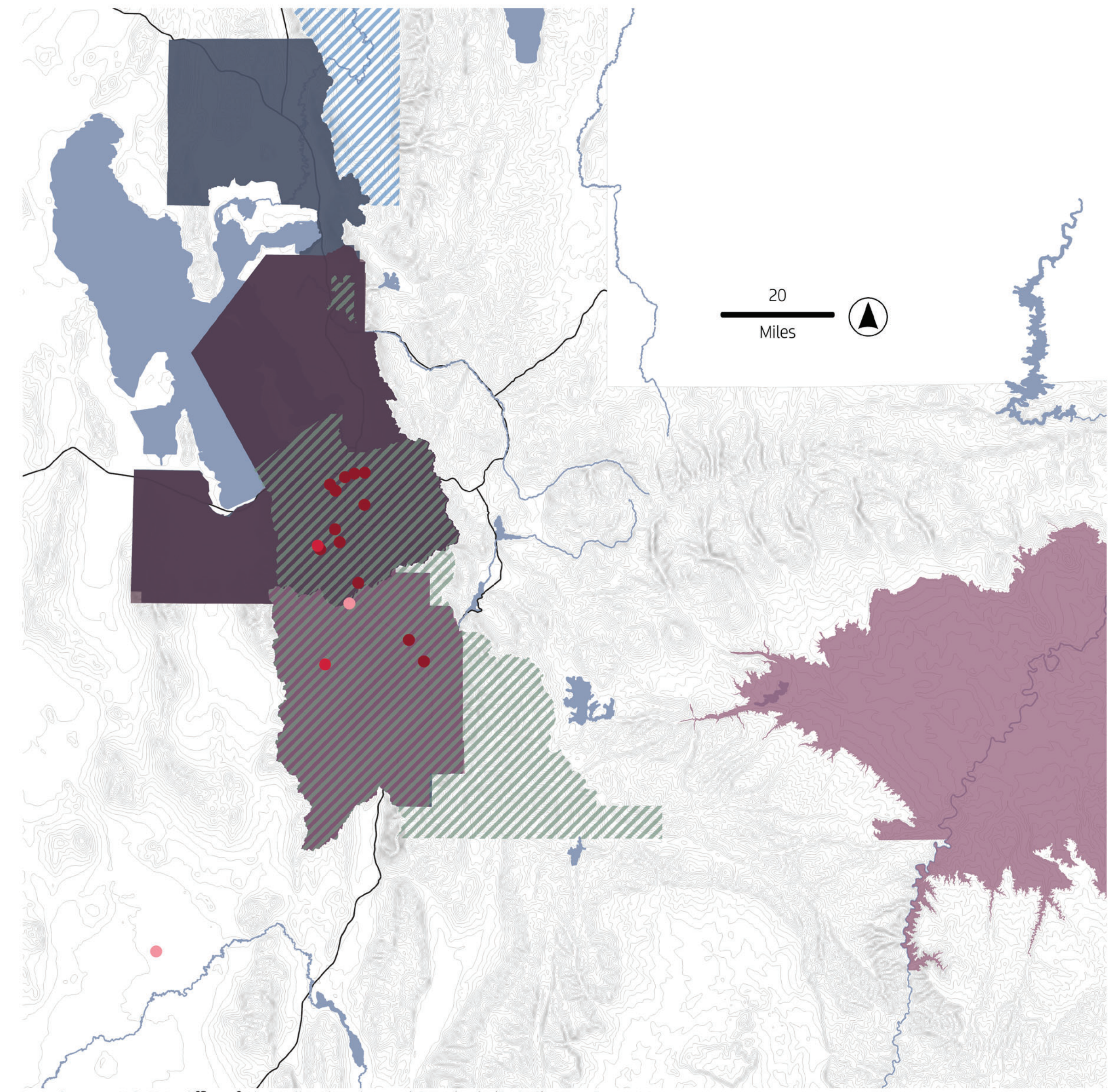
Rapid increases in demand for digital services pose a pressing energy challenge: how to feed the appetite of data centers and other industrial behemoths without leaving ordinary households and small businesses to foot the bill. Senate Bill 132 aims to address this challenge by allowing industrial-scale customers to be supplied through bespoke utility contracts, customer-owned generation tied to the grid, or closed private on-site systems. The bill is deliberately flexible and resource-neutral, meaning firms may choose renewables, traditional fuels like natural gas, or emerging technologies, provided they carry the full cost of their power.

That neutrality comes with tradeoffs. If new loads turn to low-emission sources, they could bolster northern Utah's tech sector without worsening existing air pollution problems. If they fall back on emitting sources like natural gas turbines, a more likely scenario in current conditions, the region's airshed could suffer. A cautionary example from Tennessee, where an AI data center's on-site turbines pushed up peak nitrogen dioxide concentration levels by 79% in areas immediately surrounding the data center, illustrates the scale of this risk. SB 132 insulates ratepayers but does not by itself safeguard the airshed.

Three strategies could close that gap. First, encourage traditionally fueled facilities to locate outside the Wasatch Front's national ambient air quality standard non-attainment zones and where dispersion lessens harm, perhaps using localized "good neighbor" provisions. Second, offer streamlined permitting or credits for low-emission mixes inside the valley. Third, consider tiered pricing that makes polluting generation more costly, with the premium reinvested in accelerating low or non-emitting technologies. Part 7 of the bill directing exploration of "large-load flexible tariffs" could be a vehicle for this. Whatever path they choose, Utahns should ensure SB 132 delivers economic growth without reversing progress on air quality.

An AI data center's on-site turbines pushed up peak nitrogen dioxide concentration levels by 79% in areas immediately surrounding the data center.

Figure 4.C.1 Existing and Planned Data Centers in Air Quality Nonattainment Areas



Data Sources: U.S. EPA - Office of Air Quality Planning and Standards (OAQPS); Data Center Map

Ozone Nonattainment Areas
- Nonattainment, Marginal
- Nonattainment, Moderate

PM2.5 Nonattainment Areas
- Maintenance
- Nonattainment, Serious

PM10 Nonattainment Areas
- Maintenance

Existing and Planned Data Centers
- Existing
- Planned
- Under Construction

Utah's Nuclear Opportunity: Balancing Progress & Pitfalls

STEPHANIE FROHMAN & TIM KOWALCHIK

Opportunity for nuclear energy development in Utah has become a central focus for Utah's energy security and economy. Understanding the challenges and opportunities for this industry will aid in responsible energy development.

Terms to Know:

Small modular reactor (SMR): Compact, factory-built nuclear power plant designed for flexible use.

Development and deployment of nuclear energy may become central to Utah's energy security and economy. But, like all forms of energy production, nuclear energy has its tradeoffs: nuclear facilities require immense upfront investment; cooling technology raises questions about water; the United States lacks a permanent solution for spent fuel; and public concerns linger over the legacy of Cold War-era nuclear projects. Modern nuclear energy advances aim to address these challenges by offering the following benefits:

- Factory manufacturing makes small modular reactors (SMRs) cheaper and faster to deploy.
- Advanced cooling systems and reactors are designed to reduce water use while improving human and environmental safety.
- Innovations in nuclear recycling are improving waste solutions.
- Modernizing regulatory frameworks can ensure rigorous safety and environmental standards while cutting down unnecessary delays and de-risking investments.

Demand for electricity is surging globally and interest in nuclear energy continues grows. In response, Utah is developing several advantages across the nuclear lifecycle. In particular:

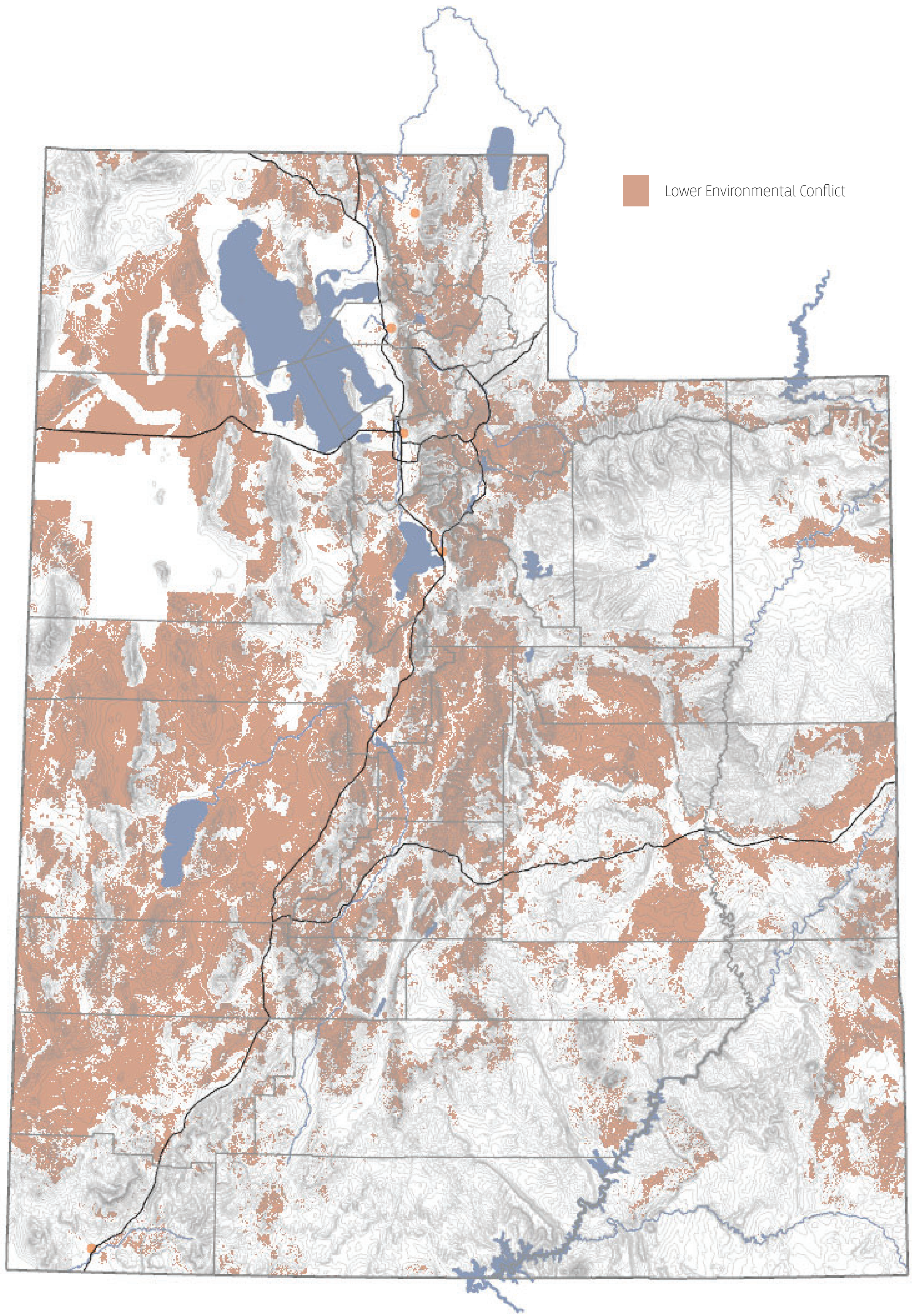
- Workforce & Research: Idaho National Lab, Hi Tech, and Utah's universities are laying the foundation to make Utah a nuclear workforce hub.
- Advanced Reactors: Utah has signed memos of understanding with TerraPower, NuCube, Valar, and Holtec to pursue siting of advanced reactors. Additionally, Utah's strong manufacturing sector and logistics capabilities make it attractive for advanced reactor and nuclear supply chain manufacturing.
- Fuel Fabrication: In West Valley, Nusano plans to produce High Assay, Low Enrichment Uranium (HALEU) fuel by 2029, vital for advanced reactors. Enrichment facility components are planned to be manufactured at Camp Williams.
- Raw Materials: Utah ranks #3 nationally in uranium production with active deposits in San Juan and Garfield counties. Energy Fuels restarted mining in 2024. Utah also has the nation's only operating uranium mill, White Mesa, with additional facilities pursuing permits.

To capitalize on these advantages, Utah will need to recognize nuclear energy's challenges. Continued leadership should include innovating, building public trust, managing water demands, making strategic financial investments, and advocating for a safe, long-term waste storage solution.

To capitalize on these advantages, Utah will need to recognize nuclear energy's challenges and innovate through them.

PROPOSED DESIGN OF A SMALL MODULAR NUCLEAR REACTOR POWER PLANT | ROLLS-ROYCE SMR

Figure 4.E.1 Lower Conflict Areas Comprising 21% of Utah's Land



Partner Perspective

Balancing Critical Mineral Mining and Nature in Utah

MICHAEL CLIFFORD

Through planning and forethought, Utah can provide important supplies of critical minerals vital to energy generation and technology while avoiding environmental conflicts

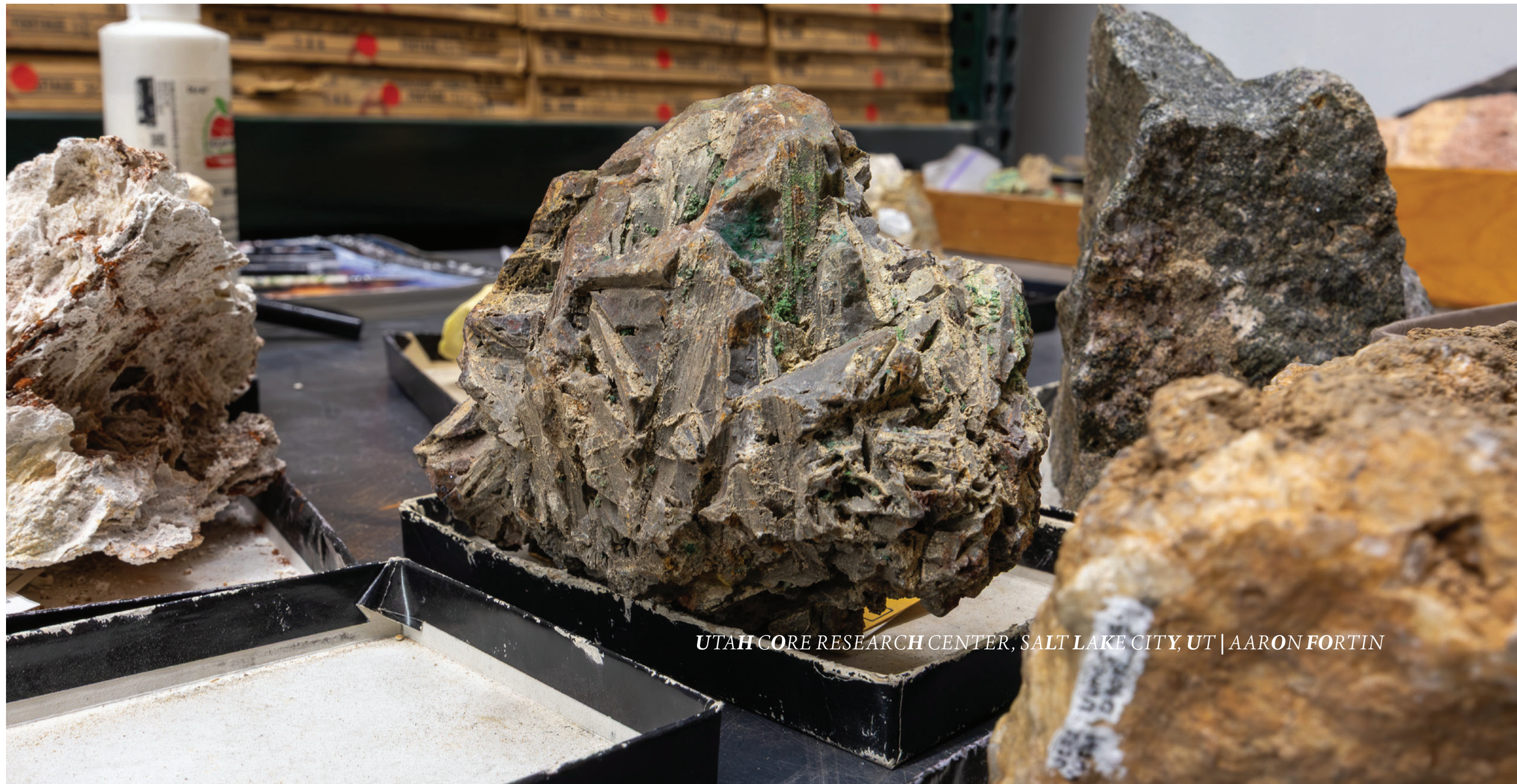
Terms to Know:

Critical minerals: Essential minerals needed for technology, energy, or defense with limited supply.

Critical minerals are used in energy and technology industries, helping to drive economic growth. Utah's diverse geology means it has a wealth of minerals. Responsible extraction and processing of minerals domestically reduces supply chain issues, reduces pollution, and brings economic benefits to local communities.

Mines can take decades to explore, permit, and build. By understanding the locations of high and low environmental conflict areas before exploration and permitting, unnecessary environmental impacts can be avoided, and the mine can be approved more quickly. Environmental conflict occurs in areas with high ecological, recreational, and tribal value. The Nature Conservancy's analysis of 59 critical minerals across six western states provides a broad view of where environmental conflict occurs along with mining impacts. The analysis identified over 17,000 square miles, or more than 21% of the state of Utah, as lower conflict lands overlapping with mineral resources. The analysis also identified geographic areas with high environmental conflict, including urban areas, endangered species habitat, tribal lands, and national parks. Mineral extraction on lower conflict lands should have reduced permitting hurdles and lower impacts on the environment.

Broad studies like this are just a starting point. Additional information such as field data, water availability, and consultation with local communities and tribes is necessary to identify conflict areas that cannot be identified using larger datasets. A key takeaway from the study is that with appropriate planning and consultation, Utah and other western states can provide domestic production of critical minerals while avoiding environmental conflicts.



UTAH CORE RESEARCH CENTER, SALT LAKE CITY, UT | AARON FORTIN

GLEN CANYON DAM | MICHELLE SMITH

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SPANISH FORK CANYON WINDMILLS | AARON FORTIN

Utah's ENERGY *in the news*

As we've tracked Utah and national news through 2025, we have compiled some of the key energy issues and topics that have appeared in media outlets this year.

1. OPERATION GIGAWATT

Governor Spencer Cox outlined a plan to double the state's power production within ten years as a path forward for Utah's energy future. The plan includes investing in "all of the above" forms of energy that are "reliable, affordable, secure and clean." Increasing transmission capacity, mining for critical minerals, investing in research, and developing workforce are also included in the energy plan. Geothermal and nuclear energy are specifically highlighted as emerging areas of focus.

2. UTAH'S NUCLEAR INDUSTRY

Utah officials have begun accelerating development for nuclear power. In April, Governor Cox signed a memo of understanding (MOU) with the governors of Idaho and Wyoming to collaborate on regional nuclear development. Additional MOUs have included an agreement with Idaho National Laboratory on research and workforce development, and agreements with TerraPower, NuCube, Valar and Holtec to pursue advanced reactor siting. Other agreements around fuel development and bills to support a nuclear energy ecosystem have also enhanced Utah's ability to become a national nuclear hub.

3. GEOTHERMAL ENERGY DEVELOPMENT

In October 2024, the Biden Administration signed an agreement to extend permits and funding for the FORGE geothermal energy project in Beaver County through 2028. In April, the BLM announced it was leasing 50,000 acres of public land in Beaver, Iron, and Sevier Counties for new geothermal projects. Congresswoman Celeste Maloy introduced legislation to speed up permitting for land leases to increase Utah's geothermal energy development.

4. SOLAR AND WIND ENERGY ROLLBACKS OF TAX SUBSIDIES

Federal policies on solar and wind energy changed dramatically through both legislative and executive action under the new administration. Congress passed legislation, effectively dismantling Inflation Reduction Act tax incentives on EVs, wind, and solar technologies and adding restrictions on foreign-supplied components. Senator John Curtis helped soften the language to phase out some programs over time rather than remove them immediately.

5. UINTA BASIN RAILWAY UPDATES

The U.S. Supreme Court unanimously ruled that the Uinta Basin Railway can proceed and that NEPA environmental review rules are more limited than opponents of the railway advocated. According to the ruling, NEPA rules are meant to inform but not stop agencies from making decisions on projects. The Uinta Basin Railway will connect northeastern Utah to national railways, creating opportunities to substantially increase oil production in Utah through partnerships with out-of-state refineries.

What's going on in Utah's land, water and air?

We publish a weekly email newsletter containing a roundup of stories in the media related to Utah's land, water, and air. This year, we shared nearly 2,000 stories, primarily from local media, with additional coverage from national outlets. Subscribe to our weekly email news roundup at: usu.edu/ilwa/newsletter.

WELLINGTON SOLAR FARM | AARON FORTIN

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