MEIC

MONTANA'S ENERGY TRANSITION

A FIVE PART SERIES FROM MEIC

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INTRODRUCTION

Climate change is the greatest challenge of our time, driven by unprecedented atmospheric concentrations of carbon dioxide (CO_2) and other greenhouse gases as a result of human activities since the Industrial Revolution. Access to abundant fossil fuel energy has made modern technological development possible, but there are dire consequences to this energy consumption. Addressing the climate crisis does not mean shutting off the power, but it does mean a complete overhaul of the energy systems that modern societies and institutions are built upon.

As a net energy exporter positioned with disproportional access to untapped fossil fuel reserves, Montana is a key actor in the fight against climate change. This is not just about deploying clean energy infrastructure; this is a transformation of the entire energy system. Decarbonizing Montana's energy systems is no doubt a transition of great proportion, but it can and must be done to avert the greatest impacts of the climate crisis. Engineers and regulators must abandon antiquated practices, facing the possibilities of this new energy age with open minds. Montanans can lead the charge.

Of Montana’s energy-related CO_2 emissions, nearly 45% come from electric power generation, followed by nearly 30% from transportation, over 15% from industrial processes, and the remaining 10% from commercial and residential heating and cooking. Nationally, about 75% of all anthropogenic greenhouse gas emissions (CO_2, methane, nitrous oxide, hydrofluorocarbons, etc.) result from combusting fossil fuels for energy, including over 90% of the U.S.’s total CO_2 emissions. All sources of greenhouse gas emissions must be curtailed but, as the largest contributor, energy presents the greatest opportunity to lessen anthropogenic emissions.

Decarbonizing Montana's energy system will require a highly coordinated effort and the concurrent achievement of several interrelated transformations. To meet energy demand cleanly, energy electrification, demand-side management, and electricity decarbonization are all necessary. Expanding transmission infrastructure and implementing power sharing across the West will also be essential to reliably connect clean energy production to consumers. The Federal Inflation Reduction Act and the Infrastructure Investment and Jobs Act (IIJA) have opened substantial federal funding avenues for Montana to facilitate these transformations.

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PART ONE: ENERGY ELECTRIFICATION

Electricity can be sourced through both carbon-intense and carbon-free means, but carbon-based liquid and gas fuels such as methane and petroleum inherently release CO2 upon combustion. Viable options for generating clean electricity exist today, so all energy uses must be electrified to rapidly decarbonize the Montana energy system. Electrification targets three general areas: Residential & Commercial Heating, Transportation, and Industry.

Residential & Commercial Heating

Gas is often used in commercial and residential buildings for space heating, water heating, and cooking. Heat pumps are an extremely efficient alternative that can electrify both space- and water-heating needs, while electric induction stoves are an excellent solution to most efficiently replace gas in cooking applications.

Heat pump technology can be deployed to recycle thermal energy between neighboring buildings ("clean energy districts") by using the ground and other available "sinks" as thermal batteries. Montana State University (MSU) has pioneered this technology in the state, deploying several energy districts that connect campus regions with ground-source heat pumps. MSU faculty have also been involved in retraining oil and gas drilling operators across the state to drill boreholes for ground-source heat pumps.

Industry

Across the U.S., industries such as cement production and steel manufacturing burn fossil fuels on-site to achieve extremely high temperatures for their processes. Alongside power generation and petroleum refineries, cement production and associated processes are among the largest point sources of greenhouse gas pollution in Montana. Industrial cement production and lime manufacturing at three sites across the state are collectively responsible for nearly one million metric tons of CO2 equivalent emissions annually (2% of total state emissions). Aluminum production is another industry using direct fossil fuel heat, but Montana's only aluminum smelter closed in 2009. Electrifying these industries is a challenge, but Antora Energy is developing solid-carbon batteries that can be charged with clean electricity for just these industrial heating applications. (Chemical processes in industrial manufacturing, such as cement clinker calcination, emit greenhouse gases not associated with energy use. These must be addressed separately.)

Transportation

Electrifying transportation is a hot topic these days as car manufacturers roll out growing electric vehicle fleets. This electrification eliminates the need for petroleum-based fuels used in combustion engines.

Phasing out the combustion engine does not stop at the single-occupancy vehicle. Additional progress can be realized toward addressing the climate crisis through expanded access to public transportation such as electric buses and electric passenger rail. The Big Sky Passenger Rail Authority was recently established to advocate for the revival of abandoned rail service in the state, particularly across southern Montana. Federal funding is explicitly set aside in the IIJA to improve passenger rail in the U.S. Freight and cargo shipping vehicles must also be electrified.

PART TWO: DECARBONIZING ENERGY

Upgrading to Renewables

To truly decarbonize Montana's energy system, fossil fuel power plants must be thoughtfully retired and replaced with renewable electricity generation. Then, as electrification eliminates direct fossil fuel combustion for energy, the electricity we consume will contain no direct greenhouse gas emissions. The longer utilities wait to decarbonize generation portfolios, the more financial risk they will incur with fossil fuel assets. Securitization, enabled by a bill from the 2021 Montana Legislature, offers a viable financing mechanism for utilities to refinance debt on stranded generation assets, easing the economic impact of shuttering fossil fuel plants. Unfortunately, the financial burden faced by utilities and ultimately passed on to ratepayers will only increase the longer utilities drag out this transition.

Where fossil fuel plants are retired, it is important to invest in the affected communities. Recently, the state legislatures of Colorado and Michigan created the "Just Transition Office" and the "Office of Worker & Community Economic Transition," respectively. A similar office could be created within the Montana Department of Labor and Industry to guide the economic and community transitions in fossil fuel-dependent communities across the state. Already, the Colstrip Impacts Foundation offers grants for economic development, workforce retraining, and community adaptation in the Colstrip community.

Puget Sound Energy has invested $10 million into this fund, and Avista Energy has donated $3 million for transition. The other Colstrip owners have not invested in community transition. This funding, along with $4.7 million in federal dollars from the Partnership for Opportunity and Workforce and Economic Revitalization (POWER) Initiative to retrain affected workers, remains largely untouched by the Colstrip community.

Replacing fossil fuel generation infrastructure requires a monumental buildout of renewable generation infrastructure and associated grid integration technologies. Montana's greatest renewable energy potential is in our untapped wind resource, and the state also has extensive opportunity to build out both distributed rooftop and utility-scale solar. In 2022, wind and solar produced more electricity for NorthWestern Energy customers than NorthWestern's share of the Colstrip power plant, and current buildout of these renewable resources has only scratched the surface of what is possible. Additionally, existing dams can be upgraded to increase their generation capacity, such as the recent upgrades at the Ryan Dam near Great Falls. Unlike coal and methane gas generation plants whose operations can be scaled to follow demand variations, renewables are dependent on the real-time availability of wind, solar, and hydrological processes (though dams provide relatively stable electricity supply). Integrating this renewable-powered grid with short- and long-term energy storage solutions such as electric batteries and pumped hydro (elevating water to store energy using the potential energy of gravity) can capture energy when it is available, ensuring electricity is reliably dispatched when Montanans need it.

In addition to utility-scale renewable electricity generation, the clean electricity grid of the near future will integrate numerous decentralized components and advanced technologies for optimal functionality. At the grid level, operators must accept the end of a decades-old large-scale centralized generation asset paradigm. It is completely feasible to reliably run the electric grid on variable renewable resources, but it will require new practices and more advanced systems. A major example of this shift is the idea of grid "inertia," where the mass of large spinning turbines at centralized power plants provide stability to the grid. These resources are "grid forming," because they establish the voltage and frequency of oscillating electricity on the grid, while variable renewables are traditionally "grid following," dependent on a pre-established voltage and frequency to seamlessly feed electricity into the grid. However, grid-forming inverters are an available technology that enable reliable control of low-inertia power systems based solely on renewables. This technology is already well-integrated into isolated island grids such as on the Hawaiian islands.

Distributed energy resources (DERs) such as rooftop solar can further contribute to energy supply, while also bolstering efficiencies on the grid. When electricity is generated near where it is consumed, transmission losses associated with transporting electricity long distances are virtually eliminated. DERs are devices that consume or produce electricity, potentially also encompassing electric vehicles, smart thermostats, and home batteries. Innovations such as Virtual Power Plants (VPPs), as piloted in several applications across the country, can harness DERs to turn the conventional electricity grid on its head through this more flexible and resilient electricity supply. VPPs rely on decentralized DERs, utilizing a network of batteries (such as residential electric vehicles and battery walls) to store electricity when it is abundant. Advanced software and control systems then dispatch electricity when and where it is needed.

Another huge benefit of renewable electricity generation is that it does not require fuel; while coal and methane gas plants consume constant fuel supplies (constantly polluting) to maintain operations, renewables simply require initial construction then natural processes maintain steady power generation. Therefore, not only does the energy transition eliminate the costs of fuels (passed to ratepayers), but this transition enables additional load reduction by eliminating the energy needed for fossil fuel extraction, processing, and transportation.

Transitioning our massively interconnected electric system that spans the entire continental U.S. and can never be shut "off" poses real challenges along the way as we move from the established system to the end-state fully-renewable system. Realistically, this process will unfold over the next several decades, with the intention of fully decarbonizing the energy system as soon as possible. How rapidly we can accomplish this transition is constrained by real technological deployment and project implementation bottlenecks, but there are ample opportunities for acceleration. It is therefore imperative that we get to work. Both the current and end states are viable from a functional standpoint, so the real challenge of the energy transition isn't designing that final state, but ensuring functionality and reliability throughout the mid-transition.

PART THREE: DEMAND SIDE MANAGEMENT

Efficiencies

With all else held equal, electrifying energy in Montana could lead to dramatically increased electric loads throughout the energy system. Add to that the projected increase of data centers and cryptocurrency mining operations, and the electrical grid could be strained beyond its designed limits. Whether or not these growing loads are warranted is a different discussion, but the truth of the matter is that today's build-out rate of carbon-free energy resources may not keep up with current load growth projections. It is therefore essential to pursue DSM and efficiency measures to ensure demand does not exceed generation capacity and to prevent an overbuild of expensive, unnecessary generation infrastructure. Efficiencies seek to achieve the same functional output with a lower energy input, while demand response programs are designed to encourage consumers to alter their level and pattern of electricity use based on the overall load in the system at a given time.

Efficiencies can most accessibly be achieved in homes and businesses by replacing outdated household appliances. At scale, adopting better building energy efficiency codes at the municipal, state, and federal government levels is a long-term solution for implementing deep-rooted efficiencies. Efficiency overlaps with electrification (discussed in Montana's Energy Transition Part 1) in a number of areas, such as installing highly efficient electric heat pumps and induction stoves.

However, the opportunities for efficiency upgrades extend to all electric appliances and beyond. Consider the highest energy guzzlers such as washers and dryers, refrigerators, dishwashers, microwaves, and any other appliances cluttering countertops and cabinets. Newer, highly efficient appliances often improve user experience while using less energy. LED lighting is another accessible efficiency upgrade, greatly mitigating the energy consumption of incandescent and fluorescent bulbs. Energy Star is a nationally recognized certification that can help identify energy-efficient home appliances.

Efficiency can be realized indirectly as well by minimizing the amount of energy a building loses to the surrounding environment. Ensuring proper insulation can passively hold living and working spaces at a comfortable temperature, reducing energy consumption for heating and cooling dramatically and saving money in the process. Replacing old windows with highly insulative multi-pane windows and ensuring that all exterior doors adequately seal with their frames are a couple of great places to start. The federal Inflation Reduction Act (IRA) includes ample rebates and incentives for building energy efficiency improvements, so don't miss out!

At a more macro level, containing urban sprawl for more walkable and bikeable cities can reduce the energy needed for transportation. Electric vehicles are great, but it is also necessary to move away from car-centric development to reduce energy needs and improve quality of life.

Where electric transportation is still necessary, single occupancy vehicles can be limited through the implementation of comprehensive public transportation systems, such as integrating electric bus fleets with electric passenger rail both within and between urban centers.

Load Reduction and Shifting

While efficiency improvements can reduce overall energy consumption, utilities can also pursue DSM through pricing structures that disincentivize expensive electricity use during peak demand periods. Utilities often build capacity infrastructure to meet the most extreme energy needs, but electricity demand varies dramatically both throughout a given day and throughout a given year. For example, a daily peak in demand is experienced in the late afternoon, while seasonal winter and summer demand peaks are experienced on the coldest and hottest days of the year. Instead of building excessive costly infrastructure that only runs to keep the lights on during infrequent extreme peaks and sits dormant the rest of the year, load shifting redistributes these peaks while load reduction shaves down these peaks for a smoother and lower demand curve. From a utility perspective, load shifting can look like time-of-use tariffs or real-time pricing, for which customers face higher electricity rates during peak periods, incentivizing a shift of non-essential consumption habits away from these peaks. Under these structures, smart appliances such as water heaters or electric vehicle chargers could be programmed to respond to utility data, kicking in when electricity prices are at their lowest (generally overnight). Utilities can also implement load reduction by offering curtailment services to non-essential, heavy-use customers such as a cryptocurrency mining operation or industrial manufacturing facility that agree to shut off or dial back their operations during seasonal load-peaking events

PART FOUR: EXPANDING TRANSMISSION

Transmission as a Bottleneck

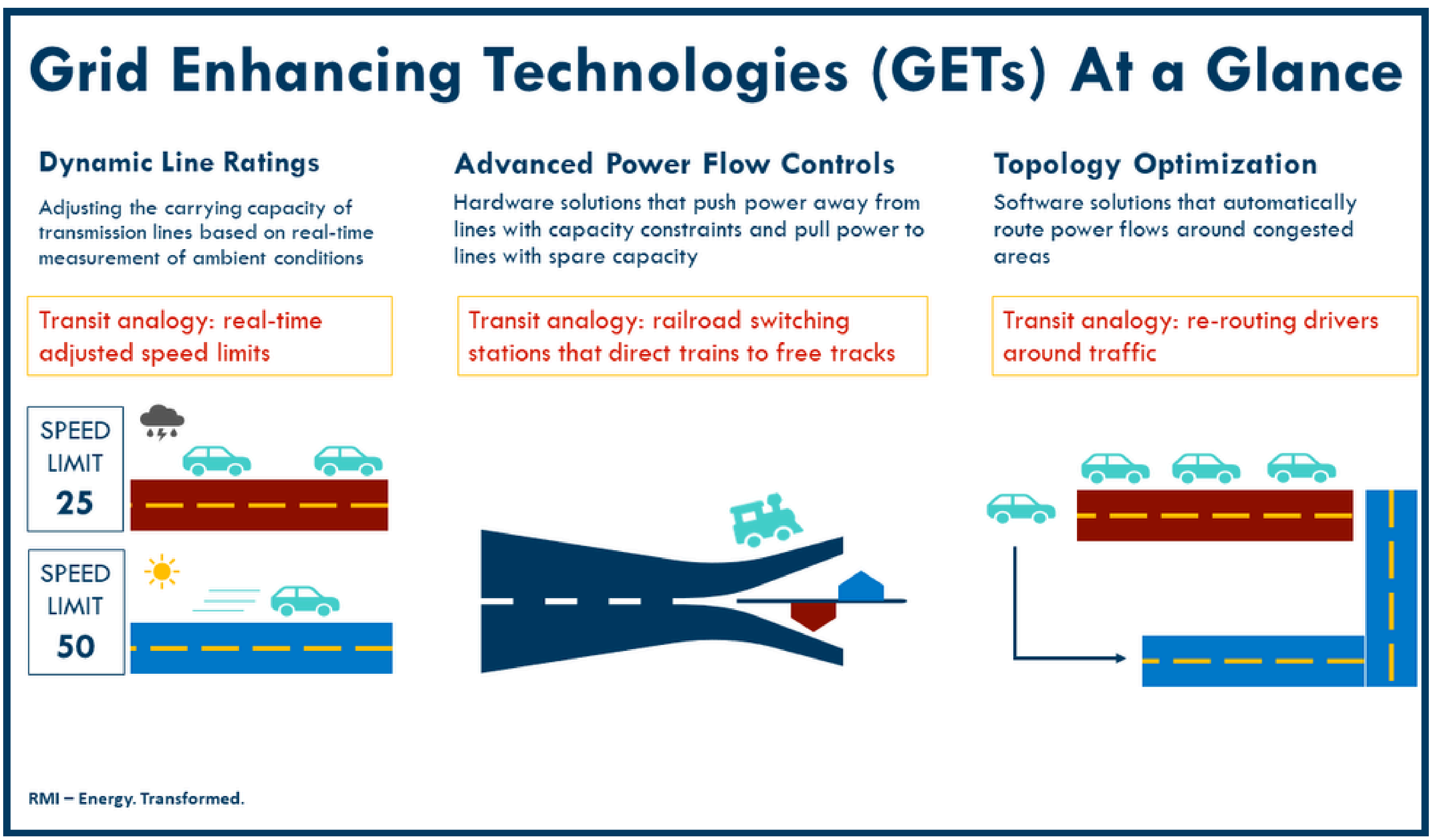
Transmission is currently the greatest bottleneck to the energy transition. While developers race to build wind, solar, and energy storage resources, progress is impeded by an antiquated electric transmission system desperately needing upgrades and expansion. In fact, the amount of renewable electricity capacity waiting to connect to the U.S. electric grid is equal to about twice the total installed electric generation capacity in the U.S. at the end of 2023. According to a recent expert report, "[m]ore than 12,400 MW of new generating resources have applied to [connect to NorthWestern Energy's transmission system]. 6,700 MW of these are under construction or in the final stages of the approval process ... and have planned in-service dates before 2027."

Renewable energy generation in a more connected grid can reliably meet energy demand in all conditions, complementing regional weather patterns to move energy from where it is available to where it is needed.

According to a recent study by the National Renewable Energy Lab, Montana boasts the second-highest wind energy potential and fourth-highest solar energy potential in the U.S. While these abundant energy sources represent the cheapest forms of electricity, they have yet to be tapped. A further impediment is Montana's monopoly utility which would rather pad its executives' and shareholders' pockets by investing in the most expensive fossil fuel infrastructure available than save customers money with clean and reliable energy; however, transmission poses a real constraint to fully developing this renewable potential. Luckily, many regional transmission planning processes are underway, including those spurred by the recent Federal Energy Regulatory Commission (FERC) Order 1920, which requires transmission operators to produce long-term transmission plans every five years. These plans cover necessary transmission system upgrades, with backstop guidance for how to allocate costs between various system users.

Decarbonizing Montana's energy system will not be possible without building out new transmission lines and upgrading existing transmission infrastructure locally, regionally, and nationally. Navigating challenges of cost allocation, permitting, and public support for new transmission builds is essential but could take up to a decade. In the meantime, upgrading existing transmission infrastructure can produce many of the same benefits at a fraction of the cost and time. For example, addressing existing transmission bottlenecks using high-performance wires (known as reconductoring) can allow more electricity to pass through a given line with limited to zero service interruption and a co-benefit of reduced wildfire risk. Furthermore, Grid Enhancing Technologies (GETs) can allow for better utilization of the entire transmission system. Grid upgrades such as reconductoring and GETs must be installed in the interim as developers navigate the obstacles to building new transmission infrastructure.

GETs are relatively cheap and easy to deploy, with the potential to increase the capacity of existing transmission lines by as much as 40%. They include digital technologies and advanced communication devices that monitor transmission lines, transformers, and substations to use these assets more efficiently based on real-time grid conditions. These technologies have been used in Europe for years, but utilities in the U.S. are only beginning to adopt them. GETs have recently drawn attention in numerous states, and Montana has the opportunity to join this movement. The three main GETs are Dynamic Line Ratings, Advanced Power Flow Controls, and Topology Optimization.



GETs: Dynamic Line Ratings

Currently, most transmission systems use high safety factors to limit electricity flow through the system based on the most extreme weather conditions the infrastructure might encounter seasonally or throughout its operating life. This avoids overloading the system with too much electricity in weather extremes where overheating may damage infrastructure or ignite wildfires from super-heated sagging lines. However, higher capacities can be achieved in most weather conditions if lines are monitored in real-time. Technology such as LiDAR imaging from transmission towers, in-line sensors, or data from nearby weather stations can monitor real-time line temperatures and forecast future temperatures so operators can maximize power flow throughout the system.

GETs: Advanced Power Flow Controls

Today's electricity grid is more rudimentary than many would think, with grid power flow controlled by manually flipping switches at stations and substations throughout the system. This control can be achieved remotely and more strategically by installing digital control devices at substations between generators and electric loads so operators can optimize power flow, ease overburdened circuits, and safely move more power when possible.

GETs: Topology Optimization

By incorporating a digitalized system-wide electricity grid model, specialized software can monitor and balance electricity flow throughout the system. Rather than a fallible human operator, this software mathematically determines and remotely programs optimal grid configurations in real time.

PART FIVE: ENERGY MARKETS

Lay of the Land

Regional energy markets are essential to a reliable and affordable electricity system. These markets also require investment in an electric transmission system that has largely been ignored for half a century. While transmission lines are the physical infrastructure that connects the grid system and delivers electricity from power plants to demand centers, energy markets dictate how these power transfers occur.

Electricity currently moves throughout the western electric grid based on a clunky and inefficient patchwork of individual transmission operators. A modernized and coordinated electricity market in the West will allow better interregional coordination for more optimal electricity generation and consumption by prioritizing electricity from more affordable power plants to boost the grid's reliability.

Other areas of the country already engage in coordinated energy trading systems within a larger geographic area than is covered by a single utility. These systems, generally termed independent system operators (ISOs) or regional transmission organizations (RTOs) don't exist in most of the West. There is a strong push to create such an entity in the Western U.S. to allow utilities to take advantage of the tremendous geographic and weather diversities, and use the best available electricity resources at any given time. A step in the right direction has been the formation of a rudimentary Western market called the Western Energy Imbalance Market (EIM). The EIM allows participating utilities to trade electricity with other utilities on a short-term basis (an hour ahead) to meet spikes in demand or to sell excess power. Since 2014, the EIM has grown to include 22 participants

The EIM helps western utilities trade electricity, but the current system is clunky and inefficient, causing exorbitant short-term energy prices during high-demand periods. NorthWestern Energy often construes high market prices as a reason to build more expensive generation infrastructure in Montana, when these prices really indicate the need for more advanced market systems and transmission upgrades. We need a larger organization that oversees the electric grid, expedites upgrades to an aging and inadequate transmission system, and ensures electricity is used more efficiently and affordably.

Regional Demands

Trading electricity across a greater geographic region boosts reliability and affordability by diversifying the available resources at a given time. While the wind doesn't always blow in a given location, it's almost guaranteed to be blowing somewhere else in the West. Instead of firing up an expensive in-state gas plant when the wind dies down, utilities can import cheaper renewable energy to meet that need. For example, the wind in Montana is most productive in winter months when coastal states have the highest demand for electricity, while the wind in Washington and Oregon is strongest during summer months when other states have a higher demand for electricity. Similarly, solar generation differs regionally depending on time of day and cloud cover, creating further opportunities for benefits in a connected region. In the January 2024 cold weather event in this region, it was solar electricity from the Southwest that kept the power on in the Northwest, thanks to trading enabled by the EIM. Sharing electricity resources across a greater area allows electricity to be used more efficiently and affordably.

Trading only an hour in advance is just the start, leaving room for further efficiencies and cost savings with longer trading horizons.

Utilities, regulators, and advocates across the West are working to improve the electricity trading system through the creation of a market to allow trade commitments a day in advance. Two competing markets are in development to meet this need, with the Extended Day Ahead Market (EDAM), operated by the same entity that operates the EIM, presenting the clearest path towards unifying the Western electric grid under a single market structure. A single, west-wide market structure would allow the most efficient and cost-effective trading of electricity resources.

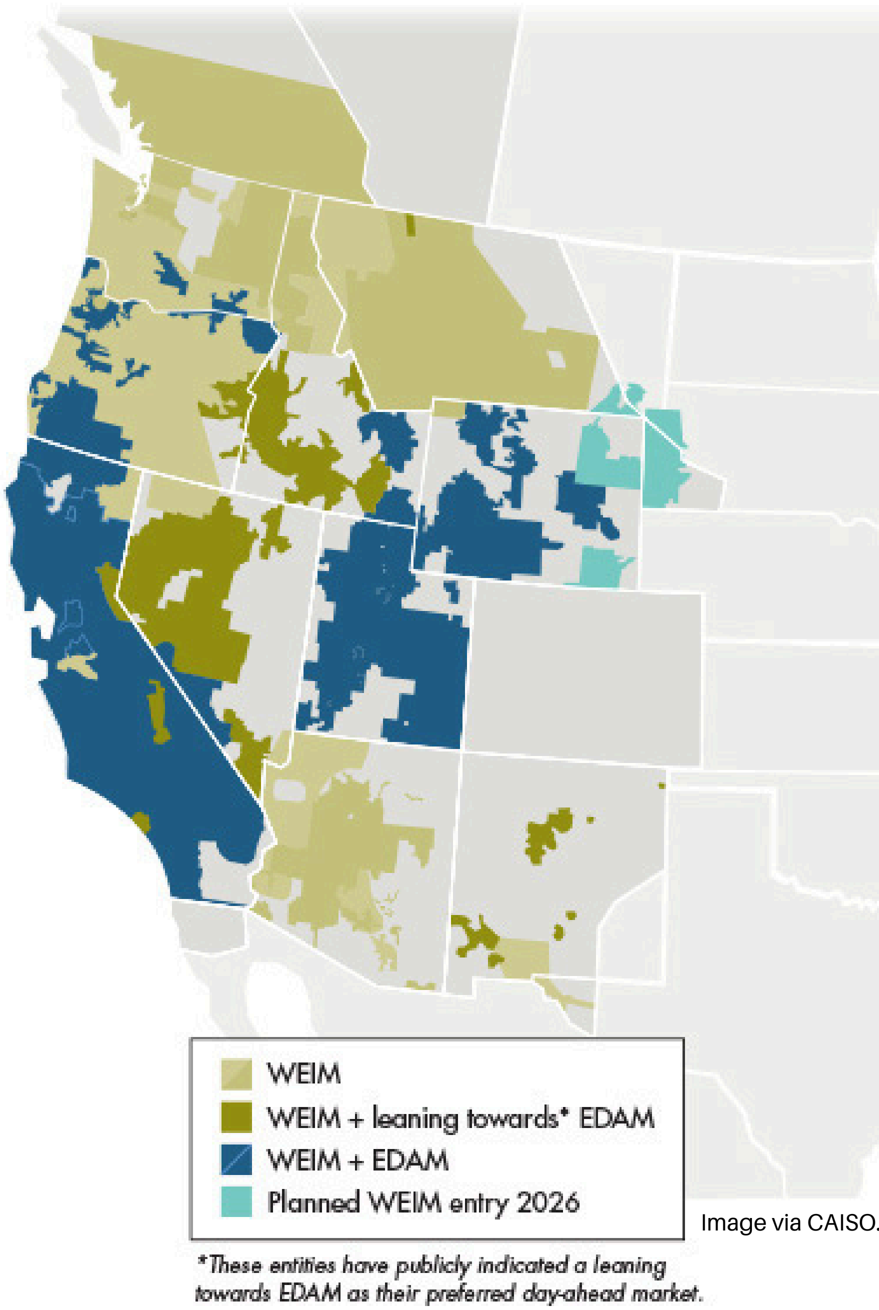


Image via CAISO.

EDAM has already been approved by the Federal Energy Regulatory Commission and will be onboarding participants by 2026. Many EIM participants have already committed to joining the EDAM. A more formally organized RTO would be the final market evolution in the West and would most optimally and cost-effectively coordinate power generation, transmission planning, and power sharing across the West. The formation of an RTO, something most of the country already has, is still many years away.

CLEAN ENERGY MYTHS AND MISCONCEPTIONS

Carbon Capture and Storage
Many fossil fuel proponents seek to protect their profits, pushing infeasible solutions such as carbon capture and storage (CCS) as a lifeline to expensive and polluting power plants. CCS is an expensive and unproven band-aid fix on climate pollution that ignores the real possibilities available in a rapidly shifting energy landscape. Atmospheric removal of CO2 may be necessary in the global push for net zero greenhouse gas emissions, but this is distinct from capture at a source such as a coal-fired power plant or gas processing facility. Removal decreases CO2 concentration in the atmosphere, while capture only partly reduces additional emissions into the atmosphere while that concentration continues to climb. Some drilling companies have been taking advantage of CCS tax incentives for use in enhanced oil recovery (EOR) schemes, wherein CO2 is captured or extracted from below ground and injected elsewhere into the ground to access additional oil for combustion. This Carbon Capture *Utilization* and Storage increases overall emissions, antithetical to climate action. The U.S. Department of Energy analyzed the potential use of CCS at the Colstrip Power Plant in 2018 and determined that it would cost $1.3 billion to reduce only 63% of the CO2 emissions from the two units that remain in operation while decreasing the plant’s energy output.

<u>Clean</u> Hydrogen
<u>CLEAN</u> hydrogen is likely to play a role in the energy transition, but it should only be used for the most challenging decarbonization sectors – think industrial and commercial applications such as cement production, shipping, aviation, and refineries (though alternatives should be fully considered). Producing hydrogen from water using electrolysis is an

incredibly energy-intensive process, placing additional load on an already overburdened energy system as we transition to meet current and future electricity demand cleanly. Hydrogen must be truly clean, with zero associated emissions throughout the fuel's value chain. "Green" hydrogen is the only clean form of hydrogen, produced using 100% renewable energy for the electrolysis of water. Other forms of hydrogen production that rely on fossil fuels, such as "blue" hydrogen (produced from fossil fuels where CO2 is captured and either stored or repurposed) will not be a part of a clean energy future. “Gold” hydrogen, extracted directly from naturally occurring reservoirs, should also be heavily scrutinized for associated methane and other greenhouse gases released from those reservoirs.

In October 2023, the Biden Administration announced $7 billion in awards to develop seven distinct “clean” hydrogen hubs across the US, including the Pacific Northwest and Heartland hubs. These hubs are intended to explore the use of hydrogen in different applications and using different quantities of clean hydrogen. The Pacific Northwest Hub includes a “node” in St. Regis, while the Heartland Hub may later expand into eastern Montana. The Pacific Northwest Hub intends to use green hydrogen from hydropower and other renewable energy sources, but the Heartland Hub is slated to include blue hydrogen. To truly guarantee hydrogen is 100% clean, experts have recommended that it must be electrolyzed using clean energy that is: (1) Newly built specifically for hydrogen production; (2) Delivered directly to the electrolysis facility; and (3) Matching the electrolyzer's power consumption in real-time. While carbon-free, special consideration should also be paid to the extensive water demands of green hydrogen production.

No Nuclear

Nuclear electricity generation will not be part of a rapid, affordable clean energy transition. This is the most expensive form of electricity production, relying on underperforming technologies that could not be deployed in time for their carbon reduction benefits to mitigate the impending climate crisis. When these plants have been built at all, projects exceed initial budgets by billions of dollars and are completed years behind schedule, if at all. In some cases, cost overruns have saddled ratepayers with decades of extraneous expenses for canceled projects that never produced electricity. Uranium mining is a highly polluting process that is disproportionately harmful to Indigenous communities. And with no national repository, highly radioactive spent nuclear waste is stored on-site in "short-term" storage and will likely stay there for hundreds or thousands of years, risking environmental contamination from geopolitical instabilities and natural disasters. With the economic challenges, environmental damages, and social injustices propagated by uranium extraction, there is a strong case against nuclear.

Nuclear weapons and nuclear energy programs are closely related, with shared technology, expertise, and funding (ratepayer and taxpayer subsidies). For example, both programs of U.S. government are housed within the Department of Energy. While the national fervor around nuclear rages on, last year's failed pilot project for NuScale Power's Small Modular Reactor (SMR) in Idaho Falls – the only SMR design licensed by the Nuclear Regulatory Commission – is yet another indicator that wasted investments into nuclear are directing funds away from where they can truly impact the energy transition.

MORE RESOURCES

MEIC will continue to share information about the energy transition.

- A webinar from MEIC: www.meic.org/webinar-recording-the-future-is-now
- Energy Star resources: www.energystar.gov/
- Big Sky Passenger Rail Authority:/www.bigskyrail.org/whoweare
- MSU "energy districts": www.montana.edu/news/18845
- Montana's energy-related emissions: www.eia.gov/environment/emissions/state/
- Emissions data: www.eia.gov/energyexplained/energy-and-the-environment/where-greenhouse-gases-come-from.php
- MSU retraining resources: https://www.montana.edu/news/21624/msu-researchers-help-pioneer-geothermal-technology-that-could-reduce-cost
- Grid-forming inverter controls: www.nrel.gov/grid/grid-forming-inverter-controls.html
- Upgrading existing dams: www.greatfallstribune.com/story/news/local/2017/03/23/million-ryan-dam-upgrade-complete/99558568/