A Business Vision for Utah's Energy Future

Compendium

SALT LAKE EST. 1887 CHAMBER
UTAH'S BUSINESS LEADER

Prepared by the Salt Lake Chamber

October 6, 2022

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Note: This Data Compendium provides supplementary data, definitions, and focus group summaries for the companion report, "A Business Vision for Utah's Energy Future." This companion report can be accessed on the Salt Lake Chamber or Kem C. Gardner Policy Institute website.

Terms Used in this Report

Anaerobic Digestion An anaerobic digester facilitates biological processes in which bacteria break down organic matter (e.g., animal manure, wastewater bio solids, and food waste) in the absence of oxygen. Combining multiple organic materials in one digester is a practice called co-digestion. Anaerobic digester outputs are biogas and digestate. Digestate finds application as either fertilizer or ground cover.

Base Load Energy Minimum amount of electric power delivered or required over a given period at a steady rate. See *Figure 1: Sample Daily Load Curve* on page 2.

Battery-electric Vehicle A vehicle solely powered by batteries charged by plugging the vehicle into an external electric power source.

British Thermal Unit Quantity of heat required to raise the temperature of one pound of liquid water by one degree Fahrenheit.

Carbon Intensity The weight of carbon dioxide equivalent emitted per unit of energy released. Typical units for this measurement are grams of carbon dioxide equivalent per megajoule of energy produced.

Community Property Assessed Clean Energy (C-PACE) Financing tool administered by the Utah Governor's Office of Energy Development enabling businesses to implement energy efficiency and renewable energy measures on either new or existing commercial properties.

Dispatchability Ability of a given power source to increase and decrease output quickly on demand.

Energy Transition A shift in energy production and consumption of fossil-based energies (oil, natural gas and coal) to renewable energies (wind, hydro, solar and battery storage).

Energy Efficient Dwellings Homes designed to conserve and reduce energy use. Features may include: 1) insulated windows and doors, 2) water heaters without tanks, 3) Energy Star certified appliances, 4) energy-efficient lighting, 5) moisture control and ventilation, 6) smart tech appliances, 7) sustainable construction materials, 8) alternative energy solutions such as solar panels.

Environmental Social Governance (ESG) A set of corporate performance evaluation criteria assessing the robustness of a company's governance mechanisms and its ability to manage its environmental and social impacts.

Electrolysis A pathway producing green hydrogen using electricity generated from renewable energy sources such as wind or solar to split water into hydrogen and oxygen.

Feedstock creation process:

$$2\,H_2O + \text{electric current} \longrightarrow 2\,H_2 + O_2$$

Geothermal Power Electricity generated by hydrothermal resources having both water (hydro) and heat (thermal). Geothermal power plants require high-temperature (300°F to 700°F) hydrothermal resources generated by either dry steam wells or hot water wells. Drilling wells into the earth and piping either steam or hot water to the surface powers a turbine that generates electricity.

Hydrogen A fuel with no carbon footprint serves as transportation fuel for vehicles. Electricity generation plants utilize hydrogen as a replacement fuel for coal and natural gas. Feedstocks shown in Table 1 produce hydrogen by chemical processes.

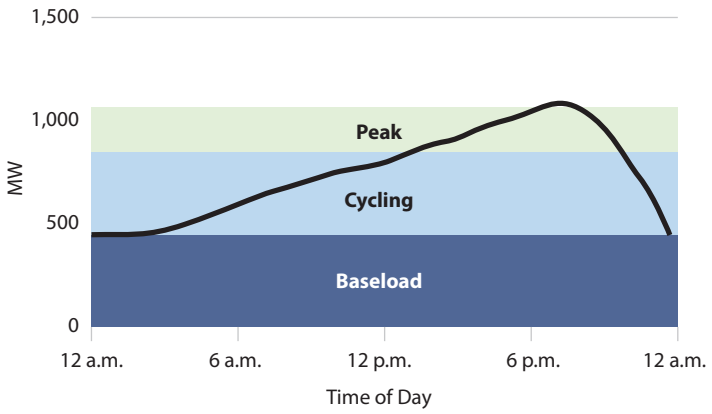
Table 1: Hydrogen Feedstocks

Feedstock	Process	End Product
Water	Electrolysis	Green Hydrogen
Fossil Fuels	Steam Reforming with carbon sequestration	Blue Hydrogen
Fossil Fuels	Steam Reforming with no carbon sequestration	Gray Hydrogen
Coal	Gasification	Brown Hydrogen

Source: S&P Global Market Intelligence

Hydroelectric Power Energy created by water in motion, such as water flowing over a waterfall, to generate electricity. Most hydroelectricity is produced at large dams built by the federal government; many of the largest hydropower dams are in the western United States.

Figure 1: Sample Daily Load Curve



Source: RBN Energy

Intermittent Energy Renewable energy sources such as wind power and solar power are not dispatchable due to their fluctuating nature. Solar fluctuates because of the day-night cycle while wind fluctuates because of unpredictable meteorological conditions.

Load Curve Indicates electricity usage at any hour of the day (Figure 1).

- *Baseload capacity* (gold-shaded area) meets daily demand around the clock at the off-peak level. Reliability and low variable costs are criteria for generation of baseload capacity. Options include nuclear, coal, and natural gas fired electricity generation.
- *Cycling capacity* (blue-shaded area) ramps up and down during the day as demand fluctuates. Cycling capacity is flexible to ramp up or down rapidly. Options include natural gas combined–cycle electricity generation.
- *Peak capacity* (green-shaded area) runs when electricity demand exceeds the cycling level. The most expensive units generate peak plant electricity. Options include liquefied natural gas and heating oil electricity generation.

Plug-in Hybrid Vehicle A vehicle with a battery pack that may either be recharged by an external electric power source or by an on-board engine-powered generator.

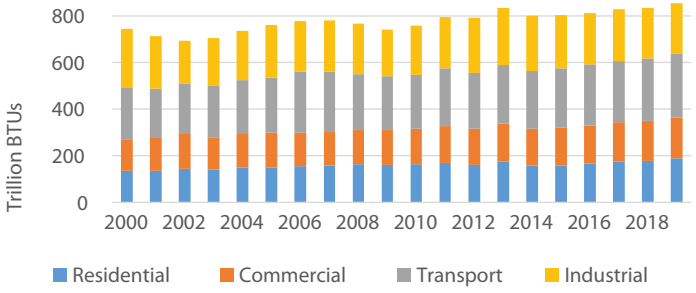
Renewable Natural Gas (RNG) Biogas upgraded to replace fossil natural gas to generate electricity or fuel vehicles. Biogas sources include municipal solid waste landfills, wastewater treatment plants, livestock farms, and organic waste management operations including anaerobic digesters.

Weatherization Reduces energy costs for households by increasing home energy efficiency of homes. Methods include insulation and air sealing; heating, ventilation, and air conditioning systems; and appliances.

Data Tables and Figures

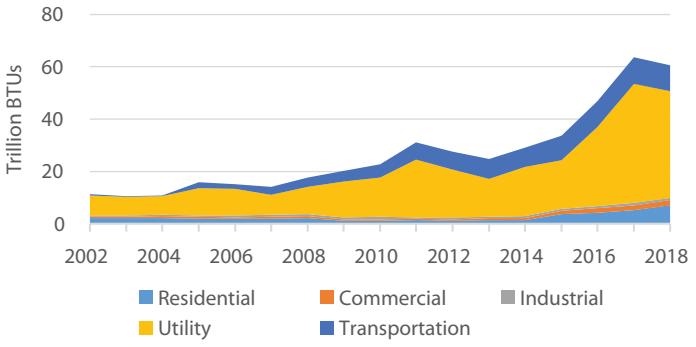
Energy Trends

Figure 2: Utah Energy Consumption by End Use



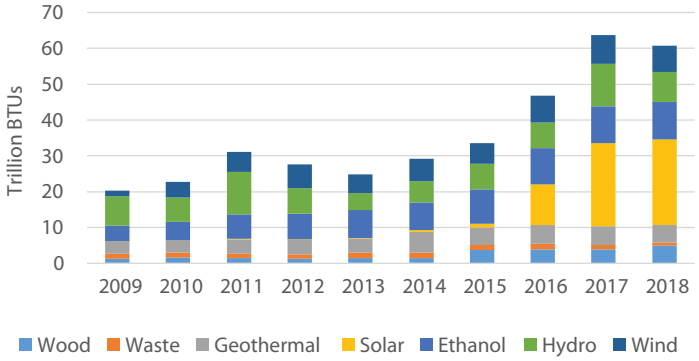
Source: U.S. Energy Information Administration

Figure 3: Utah's Renewable Energy Growth by End Use (Trillion BTUs)



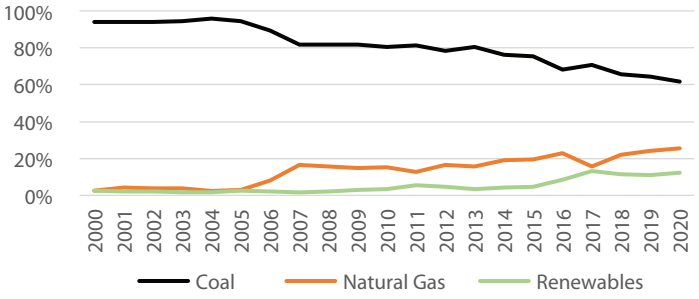
Source: Utah Geological Survey

Figure 4: Utah's Renewable Energy Growth by Source (Trillion BTUs)



Source: Utah Geological Survey

Figure 5: Utah Electricity Generation by Energy Source



Source: Utah Geological Survey

Table 2: Utah Industrial Energy Usage by County (2016)

County	Construction	Agriculture	Manufacturing	Mining	Memo: MM BTU's
Beaver	2%	8%	2%	88%	1,436,217
Box Elder	4%	5%	90%	1%	8,550,846
Cache	12%	9%	78%	1%	7,519,252
Carbon	3%	3%	8%	86%	2,797,089
Daggett	17%	83%			21,317
Davis	7%	1%	90%	1%	20,998,555
Duchesne	5%	7%	1%	87%	4,640,483
Emery	5%	17%	0%	78%	932,960
Garfield	13%	33%	1%	53%	235,959
Grand	6%	2%	58%	34%	1,431,019
Iron	5%	2%	91%	2%	7,783,611
Juab	6%	12%	21%	61%	780,919
Kane	5%	4%	1%	90%	1,401,499
Millard	1%	4%	88%	7%	5,796,098
Morgan	10%	8%	79%	3%	1,381,650
Piute	7%	93%			41,465
Rich	33%	53%		14%	77,614
Salt Lake	8%	0%	54%	38%	77,411,463
San Juan	2%	7%	17%	75%	3,021,991
Sanpete	10%	23%	64%	4%	1,385,184
Sevier	13%	32%	15%	40%	729,027
Summit	28%	10%	34%	28%	1,652,987
Tooele	1%	1%	75%	22%	13,773,287
Uintah	2%	2%	0%	95%	11,510,144
Utah	15%	5%	75%	5%	17,376,227
Wasatch	64%	4%	23%	9%	411,361
Washington	65%	9%	13%	13%	1,730,631
Wayne	28%	50%	13%	9%	119,811
Weber	13%	4%	48%	35%	9,821,142
State Percentages	8%	3%	58%	31%	100%
Memo: MM BTU totals by sector	16,444,302	5,764,679	119,723,527	62,837,303	204,769,811

Notes: Shaded energy totals signify highest county energy usage. Thirteen Utah counties have highest energy utilization in manufacturing, ten in mining, four in agriculture, and two in construction.
Source: National Renewable Energy Laboratory; Dr. Colin McMillan

State Comparisons

Table 3: 2019 Energy Consumption Per Capita, Selected States (MMBTUs)

	Cumulative Totals		Residential		Commercial		Industrial		Transportation	
1	AZ	213	NV	56	AZ	48	AZ	31	AZ	77
2	NV	251	AZ	57	NV	50	NV	56	CO	80
3	UT	267	UT	59	ID	52	UT	68	UT	85
4	CO	274	NM	63	CO	52	CO	75	NV	89
5	ID	315	CO	66	UT	55	ID	94	ID	93
6	NM	351	ID	77	NM	62	NM	116	NM	110
7	WY	934	WY	93	WY	99	WY	542	WY	200

Source: U.S. Energy Information Administration

Table 4: 2018 Carbon Dioxide Emissions Per Capita, Selected States (CO2 tons)

	Cumulative Totals		Commercial		Electric Power		Residential		Industrial		Transportation	
1	ID	8.9	AZ	0.4	ID	0.7	AZ	0.31	AZ	0.06	AZ	5.12
2	NV	12.2	CO	0.7	NV	4.4	NV	0.79	NV	0.12	CO	5.34
3	AZ	12.3	NV	0.8	CO	5.9	ID	1.00	ID	0.19	UT	5.87
4	CO	13.6	ID	0.8	AZ	6.4	NM	1.03	UT	0.22	NV	6.06
5	UT	17.1	NM	0.8	NM	8.7	UT	1.21	CO	0.23	ID	6.16
6	NM	18.4	UT	0.9	UT	8.9	CO	1.39	NM	0.36	NM	7.40
7	WY	89.4	WY	1.7	WY	70.2	WY	1.64	WY	2.28	WY	13.56

Source: U.S. Energy Information Administration

Table 5: Western States' Electricity Feedstocks, 2020

	COAL	RENEWABLES	NATURAL GAS	PETROLEUM	NUCLEAR	TOTAL	Memo: Carbon Intensity (lbs. CO2 per kWh)
Idaho	0%	76%	24%	0%	0%	100%	0.22
Nevada	5%	29%	66%	0%	0%	100%	0.71
Arizona	13%	12%	46%	0%	29%	100%	0.70
New Mexico	38%	27%	35%	0%	0%	100%	1.15
Colorado	36%	31%	34%	0%	0%	100%	1.09
Utah	61%	13%	26%	0%	0%	100%	1.59
Wyoming	79%	16%	4%	0%	0%	100%	1.79

Note: Carbon intensity emissions factors for coal are 2.21 lbs. CO2 per kWh, natural gas 0.91, and petroleum 2.13
Source: U.S. Energy Information Administration

Table 6. Reliability Metrics of Electricity Distribution in Western States (2019-2020)

State	2019		2020	
	Average Outage Duration (Customer Average Interruption Duration Index in hours)	Rank	Average Outage Duration (Customer Average Interruption Duration Index in hours)	Rank
Arizona	1.6	1	1.5	1
California	7.8	11	4.1	9
Colorado	2.8	8	2.2	3
Idaho	2.2	5	3.4	8
Montana	2.1	4	3.3	6
Nevada	1.8	2	1.7	2
New Mexico	2.3	6	2.4	4
Oregon	3.7	9	4.5	10
Utah	2.4	7	7.3	11
Washington	4.3	10	3.3	7
Wyoming	1.8	3	2.6	5

Footnote: A 5.7 magnitude earthquake with 50 aftershocks on March 18, 2020 in Salt Lake Valley caused power outages along the Wasatch Front due to damaged power lines. Utah's outage duration in 2020 when excluding major events averages just 1.9 hours.
Source: Energy Information Administration, Electric Power Annual, Table 11.3

Table 7: Auto Manufacturers Commit to Electric Vehicles – Timeline to 100% EV production

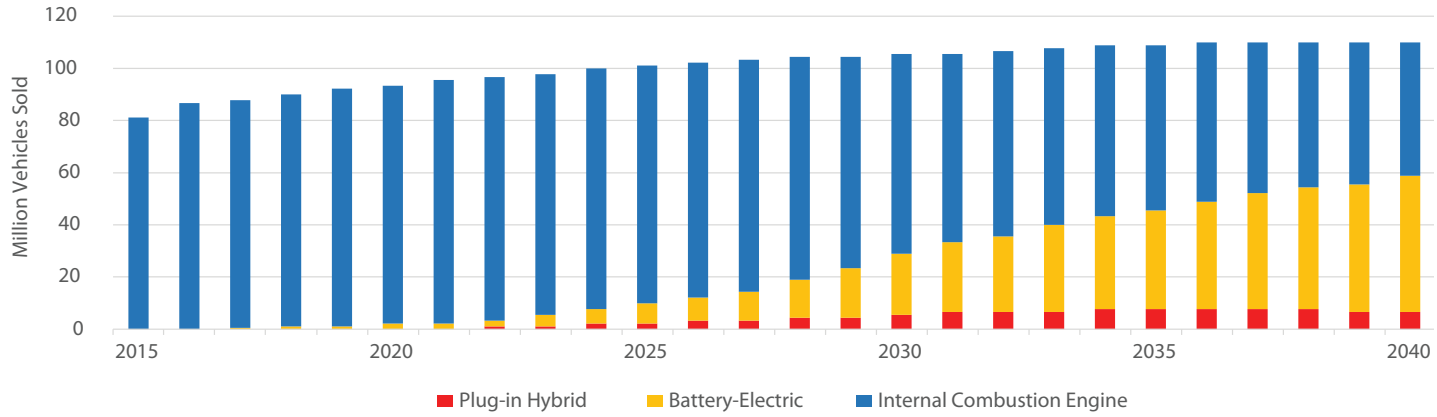
Manufacturer	Year
Jaguar	2025
Cadillac	2030
Lexus	2030

Manufacturer	Year
Mercedes	2030
Mini	2030
Volvo	2030

Manufacturer	Year
Ford*	2030
Audi	2033
General Motors	2035

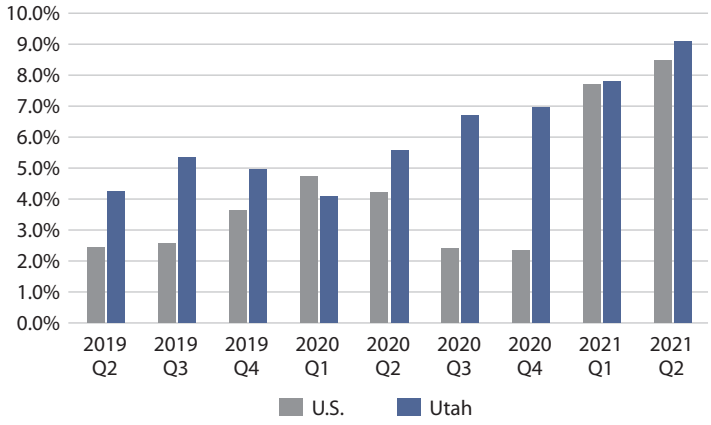
* Ford manufactures 100% EVs in Europe.
Source: Gear Patrol

Figure 6: Projected Global Sales of Vehicles, 2015–2040



Source: The Economist

Figure 7: Utahns Embrace Clean Technology (Percentage New Sales of EV/Hybrids in Passenger Car/Lt. Truck Class)



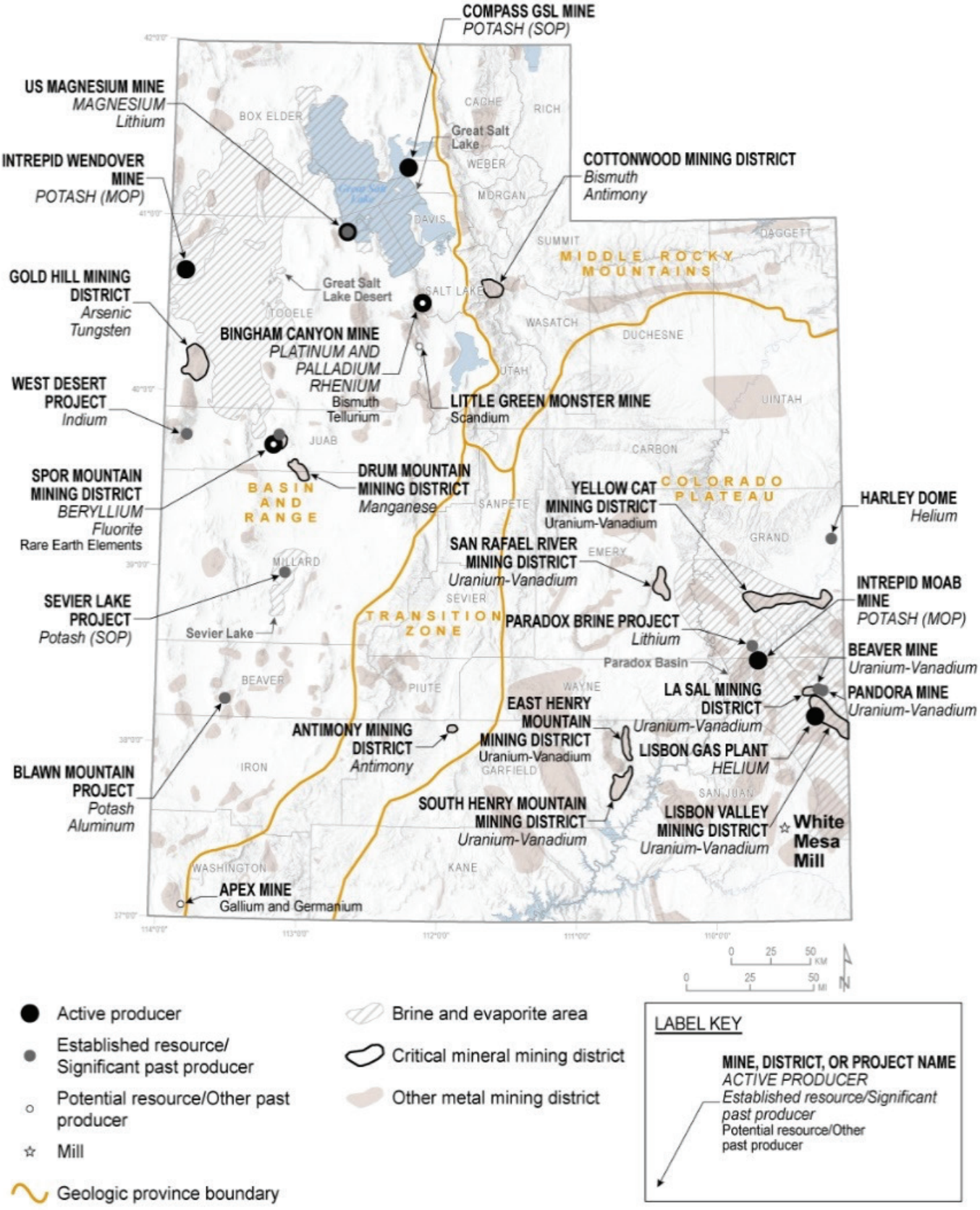
Source: Cox Automotive Quarterly Light-Vehicle sales reports, Utah State Tax Commission - New Motor Vehicle Sales

Table 8: Low-Emission and Zero-Emission Vehicle States

State	Model Year Vehicle			Share of U.S. New Light Vehicle Sales
	Criteria Pollutants Regulation	Green House Gas Regulation	Zero-Emission Vehicle (ZEV)	
California	1992	2009	1990	11.0%
New York	1993	2009	1993	6.1%
Massachusetts	1995	2009	1995	2.1%
Vermont	2000	2009	2000	0.3%
Maine	2001	2009	2001	0.4%
Pennsylvania	2001	2009		3.9%
Connecticut	2008	2009	2008	1.0%
Rhode Island	2008	2009	2008	0.3%
Washington	2009	2009	2021	1.7%
Oregon	2009	2009	2009	1.0%
New Jersey	2009	2009	2009	3.5%
Maryland	2011	2011	2011	1.9%
Delaware	2014	2014	2027	0.3%
Colorado	2022	2022	2023	1.5%
Minnesota	2025	2025	2025	1.5%
Nevada	2025	2025	2025	0.8%
Virginia	2025	2025	2025	2.3%
Total:				39.6%

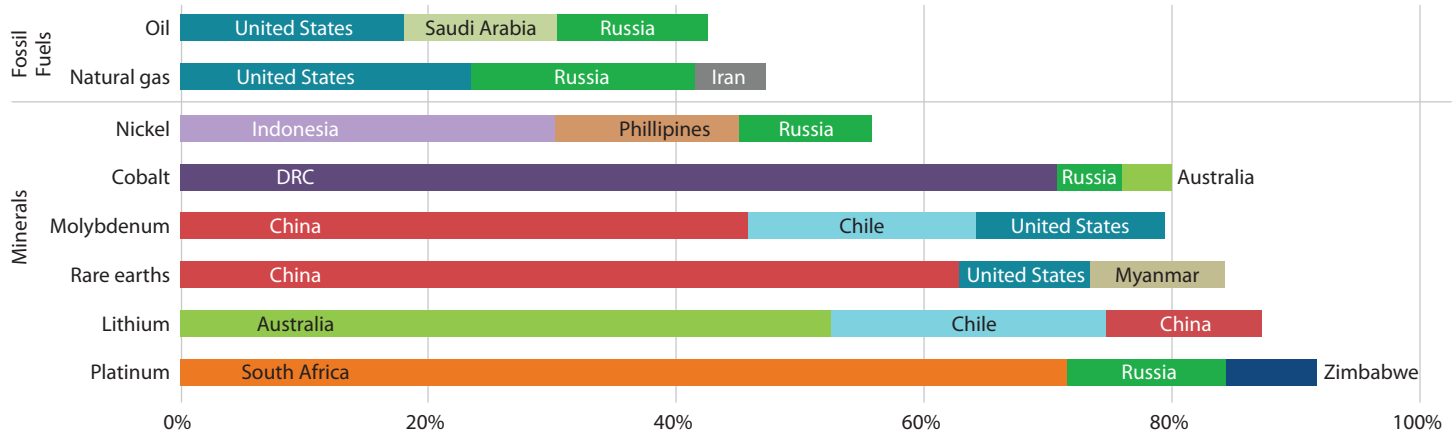
Footnote 1: Model Year Effective date.
Source: California Air Resources Board

Figure 8: Utah's Mining Districts



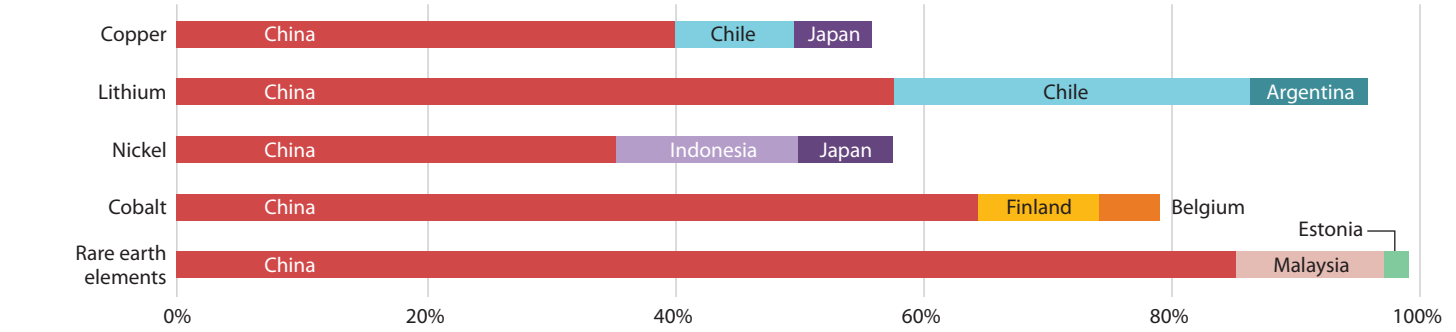
Source: Utah Geological Survey

Figure 9: Share of Top Three Producing Countries in Total Production for Selected Resources and Minerals, 2019



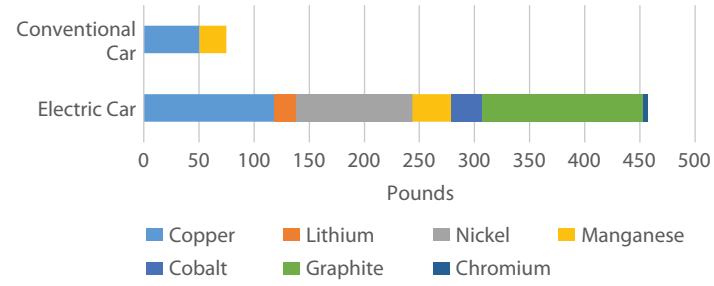
Source: International Energy Agency

Figure 10: Share of Top Three Producing Countries in Total Processing of Selected Minerals, 2019



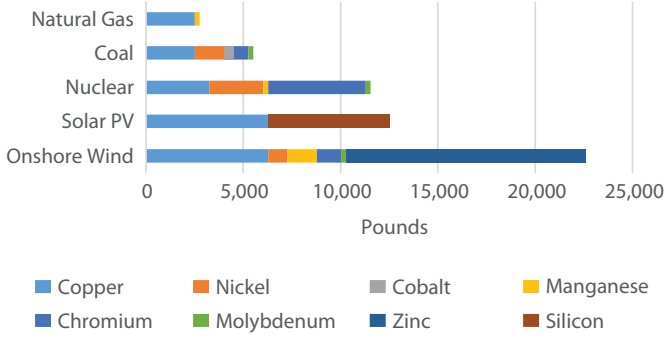
Source: International Energy Agency

Figure 11: Mineral Weight in Transport Vehicles, 2021 (pounds per vehicle)



Source: International Energy Agency

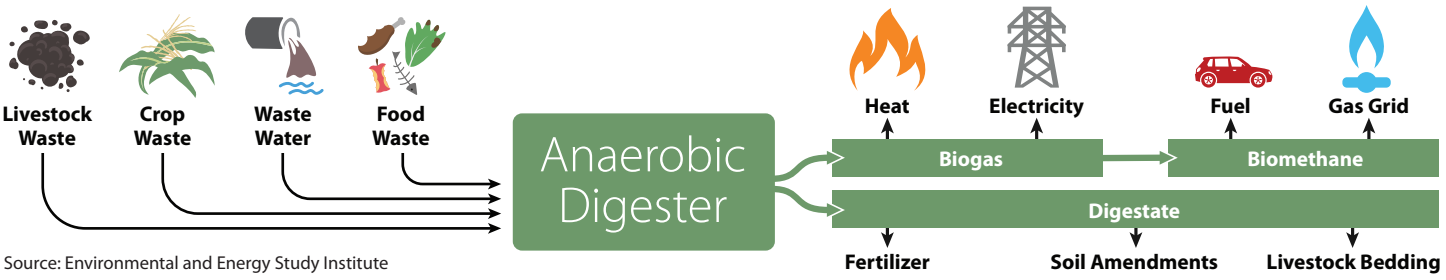
Figure 12: Mineral Weight in Power Generation Plants, 2021 (pounds per megawatt)



Source: International Energy Agency

Renewable Natural Gas

Figure 13: Anaerobic Digester



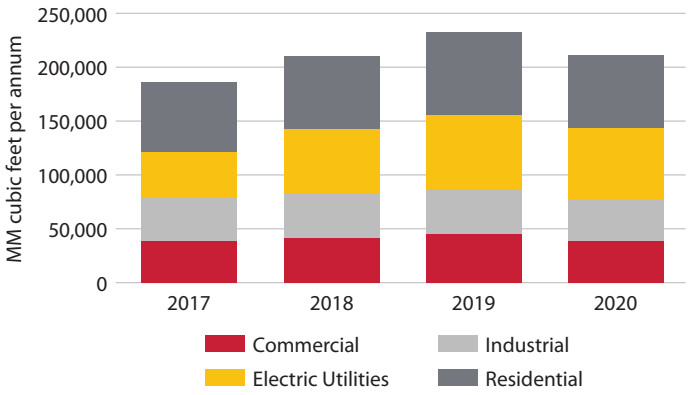
Source: Environmental and Energy Study Institute

Table 9: Utah Feedstocks for Renewable Natural Gas

Source		Annual RNG Feedstocks	Potential Renewable Natural Gas (billion cubic feet/yr)	Range of Feedstock Carbon Intensity (g CO_2e/MJ)
Animal Manure	Swine – 1MM	1.2MM tons manure	3.7	**-525 to -150**
	Cows – 95,000	2.6MM tons manure		
Landfill Gas	8 landfills	2.6 billion ft^3 biogas	1.0	**40 to 80**
Wastewater	2 facilities	92,000 gallons sludge	0.7	**10 to 40**
Food Waste	Wasatch RR	1MM ton food waste	2.7	**-25 to 0**
Total Utah RNG Production			**8.1**	
Utah Natural Gas Demand in 2020			**211.6**	

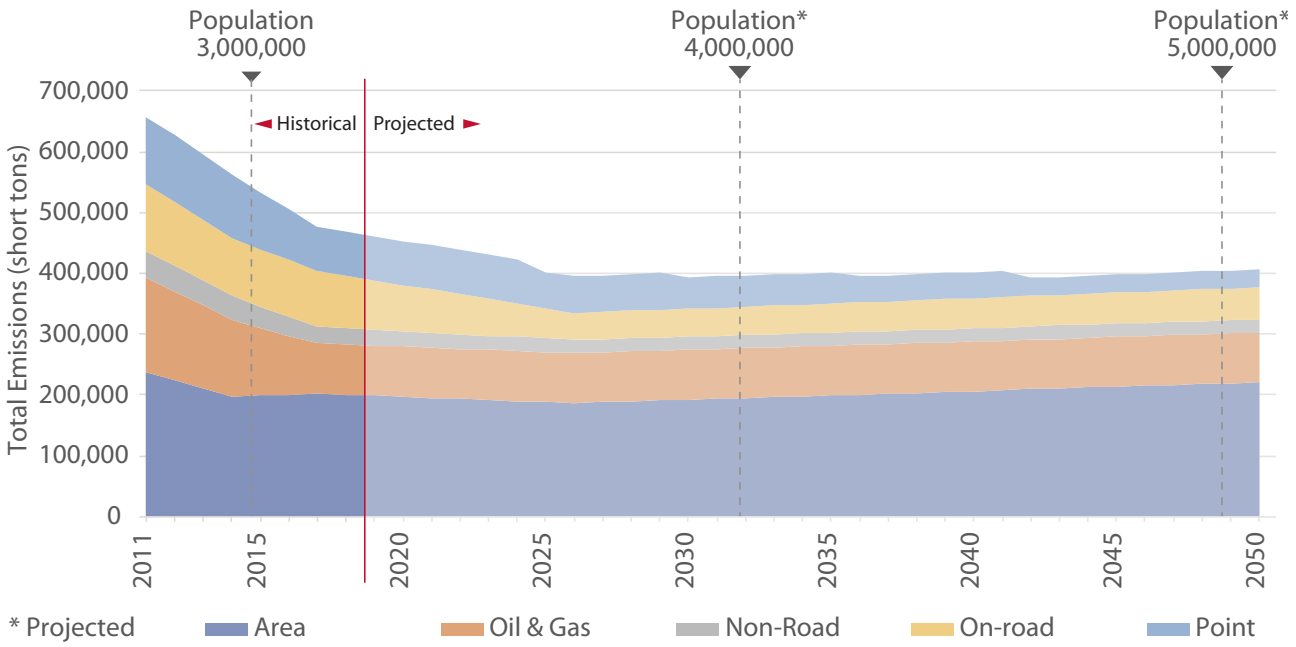
Source: American Biogas Council, Utah Geological Survey, World Resources Institute, Utah State Agricultural Review

Figure 14: Utah Natural Gas Consumption, 2017-2020



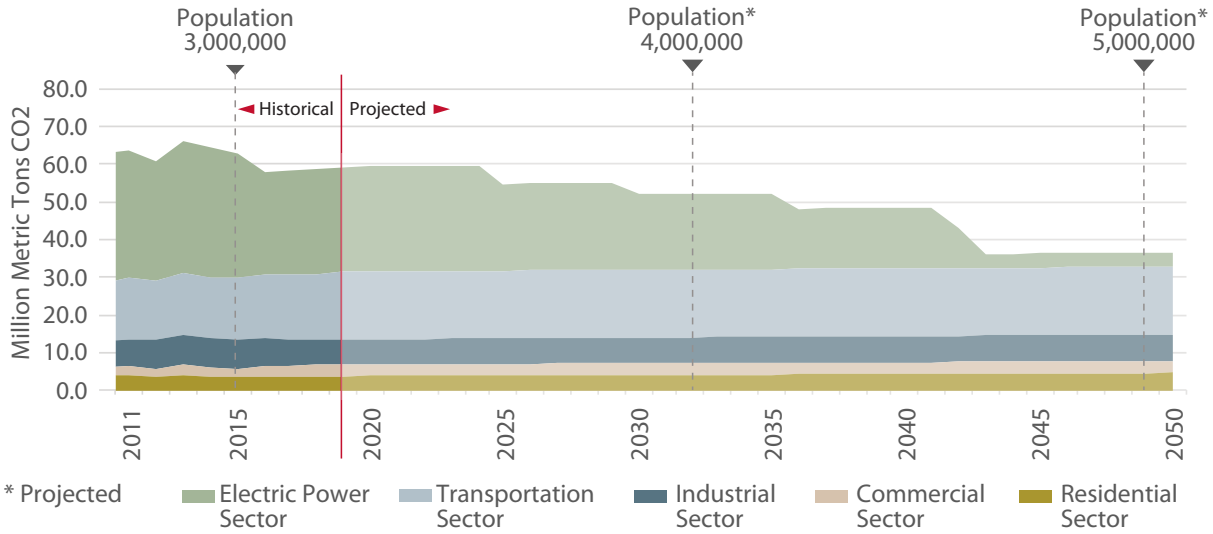
Source: Utah Geological Survey, Consumption of Natural Gas in Utah

Figure 15: Utah's Air Emissions Baseline for Criteria Air Pollutants



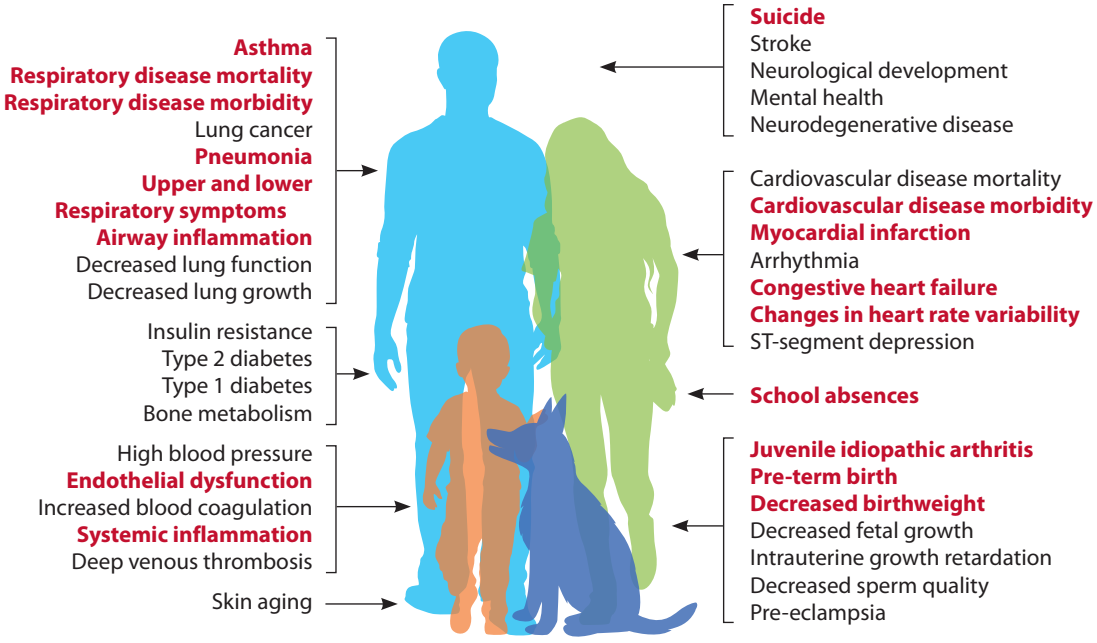
Note: Area sources include stationary source fuel combustion, service stations, painting operations, solvent use, waste management, and light industrial, and a wide range of citizen activities such as lawn maintenance, gas and charcoal barbecues, and home heating. Point sources are localized, large, stationary sources of air emissions such as factories, power plants, foundries, refineries, and chemical plants. Baselines account for potential scenario dates for the notional closures of Bonanza (2030), Huntington (2036), and Hunter (2042) power plants.
Source: Utah Department of Environmental Quality, and Kem C. Gardner Policy Institute

Figure 16: Utah's Carbon Dioxide Emissions Baseline



Note: Baselines account for potential scenario dates for the notional closures of Bonanza (2030), Huntington (2036), and Hunter (2042) power plants.
Source: U.S. Energy Information Administration (EIA) based on the combustion of fossil fuel (historical), and Kem C. Gardner Policy Institute (projected)

Figure 17: Health Effects of Air Emissions and Pollutants
Utah-based health studies highlighted in red



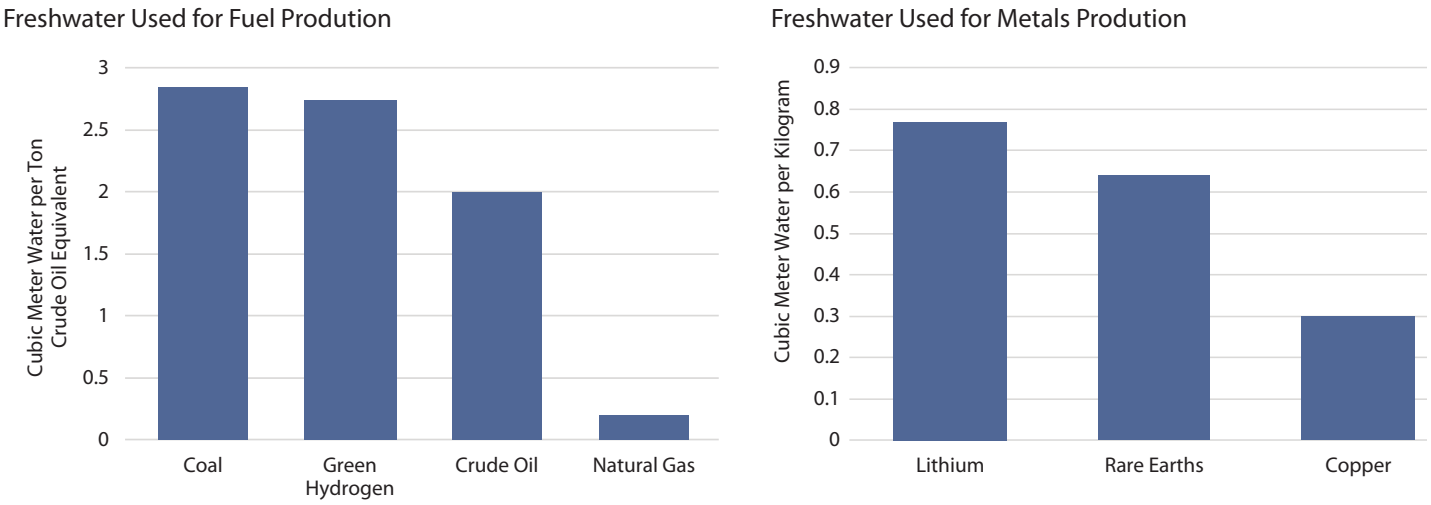
Source: Adapted from Thurston et al., 2017: Utah health studies included in additional reference list.

Table 10: Severe Weather Events Affecting Utah from 1980–2021 (in 2021 constant dollars)

Severe Weather Event	Events	Events/Year	% Frequency	Total Costs	Percent of Total Costs
Drought	11	0.3	46%	$250–$500 million	14.3%
Flooding	1	0.0	4%	$1.0–$2.0 billion	45.1%
Freeze	1	0.0	4%	$5–$100 million	0.4%
Severe Storm	1	0.0	4%	$5–$100 million	0.8%
Tropical Cyclone	--	--	--	--	--
Wildfire	10	0.2	42%	$1.0–$2.0 billion	39.4%
Winter Storm	--	--	--	--	--
All Events	24	0.6	100.0%	$2.3–$4.7 billion	100.0%

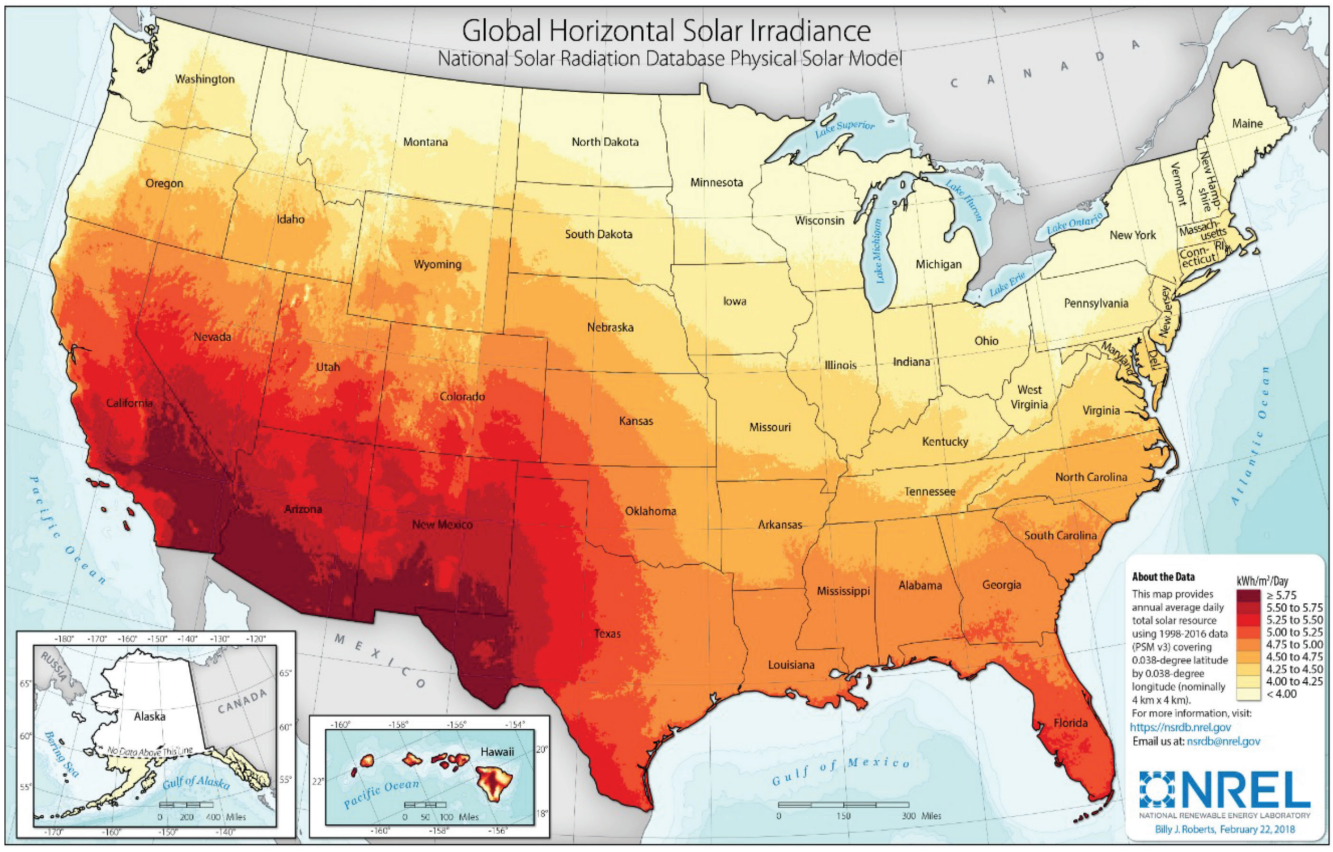
Source: National Oceanic and Atmospheric Administration, Billion-Dollar Weather and Climate Events

Figure 18: Freshwater Used for Fuels and Metals Production



Source: International Energy Agency, Reducing the Impact of Extractive Industries on Groundwater Resources; Gutteridge, Haskins, Davey (GHD), Water for Hydrogen.

Figure 19: Solar Potential in Utah



Source: National Renewable Energy Laboratory; https://www.nrel.gov/gis/solar-resource-maps.html

Figure 20: Ozone and Regional Haze in Utah

Utah's Statewide Air Emissions Challenges

Ozone (O_3)

- Invisible, odorless, tasteless gas
- Many naturally occurring & human-made sources
- NOx & VOCs can combine to form ozone
- Causes & worsens respiratory conditions
- Of concern statewide, especially Wasatch Front & Uintah Basin

Particulate Matter (PM2.5 & PM10)

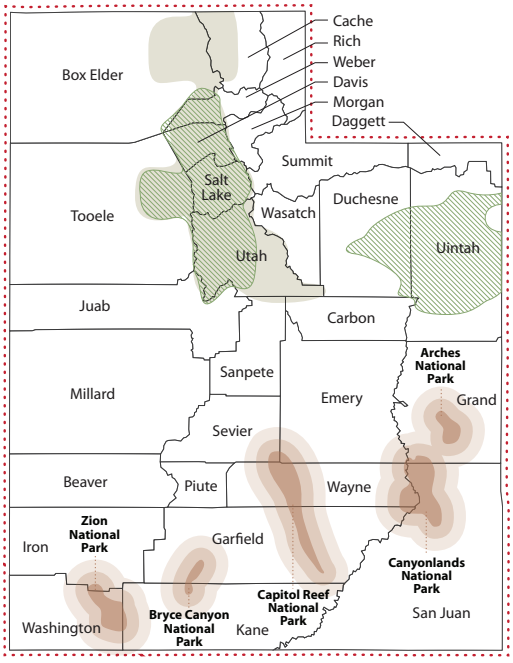
- Tiny particles, 10 micrometers or smaller
- From dust, smoke, soot, and atmospheric reactions
- Combinations of NOx, SO_2, VOCs and ammonia (NH_3) can create PM
- Causes & worsens respiratory conditions; worsens cardiovascular conditions
- Of concern statewide, especially Wasatch Front urban areas
- Contributing pollutants: Primary PM, NOx, VOCs, SO_2, and NH_3

Greenhouse Gases (GHGs)

- Group of gases including carbon dioxide (CO_2) & methane (CH_4)
- CO_2 from burning fossil fuels & other sources; is odorless & colorless
- Methane from oil & gas production, burning fossil fuels & other sources; is odorless & colorless
- Atmospheric build-up of GHGs warms Earth's surface, changing weather patterns & contributing to a wide range of health, environmental and economic impacts (see page 7)
- Of concern statewide

Regional Haze

- Regional haze concerns visual impacts of air pollution in and around Utah's five national parks
- Primary contributing pollutants are PM, NOx, SO_2 and VOCs
- Regional air quality issues affect Utah's tourism industry and local employment
- Of particular concern in the southern half of the state, especially near national parks



Source: Utah Department of Environmental Quality

Focus Group Summaries

Forty representatives from the Salt Lake Chamber business sectors plus five legislators and five university student leaders provided insights on how Utah businesses may position themselves during the energy transition. Table 11 lists employment totals and earning impacts for each sector.

Table 11: Salt Lake Chamber Business Sectors

Sectors	Direct Employment (Jobs)	Direct Earnings Impact ($B)
Food Retailers[1]	189,043	6.7
Health Care[2]	146,290	10.9
Finance/Banking[3]	138,597	8.0
Technology[4]	118,621	9.5
Hospitality/Tourism[5]	82,100	2.7
Transportation[6]	73,990	4.5
Energy[7]	38,514	1.9
Real Estate/Residential Construction[8]	29,004	1.7
Agriculture[9]	22,224	0.3

1. Utah Food and Ag Industries, Feedingtheeconomy.com
2. Bureau of Economic Analysis, 2020
3. Bureau of Economic Analysis, 2020
4. Utah's Tech Economy, 2019, Kem C. Gardner Policy Institute, Table 1 (employment), Table 1.18 (Direct Earnings Impact)
5. The State of Utah's Travel and Tourism Industry, 2022, Kem C. Gardner Policy Institute
6. Bureau of Economic Analysis, 2020
7. Economic Impacts of Utah's Energy Industry, 2017, Kem C. Gardner Policy Institute, Figures 1 and 2
8. Bureau of Labor Statistics, 3Q 2021 data for Real Estate Activities and Residential Construction activities
9. 2022 Economic Report to the Governor, Section 13 - Agriculture, p. 83

Table 12: Focus Group Themes on the Energy Transition

Focus Group	Government Directs Energy Transition by Incentives, not Regulations	Technology Facilitates Renewable Energy Development	Renewable Energy[1] Storage is Critical	Baseload Energies[2] Needed Until Energy Storage Develops	Utah Minerals[3] are Critical for EV Batteries	Carbon Tax Policy is Needed
Energy	x	x	x	x	x	x
Finance/Banking	x			x	x	
Real Estate/Construction	x	x				
Technology	x	x				
Transportation	x	x	x	x		
Health Care	x		x	x	x	
Hospitality/Tourism	x		x	x	x	
Agriculture and Food	x	x				
Legislator Group 1	x	x	x	x	x	x
Legislator Group 2	x	x	x			x
University Student Leaders	x			x		x
# Groups Mentioning Theme	11	7	6	7	5	4

1. Wind and solar are intermittent energies dependent on meteorological conditions; battery technology to hold energy from intermittent renewable energies evolves.
2. Baseload feedstocks including nuclear and natural gas dispatch electricity without intermittency.
3. Minerals needed to manufacture EV batteries include copper, lithium, nickel, manganese, and cobalt.

FOCUS GROUP 1: Energy and Minerals Sector

September 23, 2021

OVERVIEW

Energy Transition. The United States and energy companies are adept at technology innovation, renewable energy storage, and carbon capture, utilization, and storage (CCUS). Utah policymakers should focus on filling the technology innovation-to-commercialization gap.

Energy Policies. A border-adjusted, revenue neutral carbon tax will drive the energy transition to lower carbon fuels. Seventy minerals/rare earth elements are in an iPhone. Policymakers should incentivize extraction and refining of Utah's minerals.

The federal government should encourage green energy resources. However, in 1980, the federal government granted corn subsidies to farmers facilitating ethanol production; these subsidies have outlived their purpose.

Sustainability Practices.

- PacifiCorp will reduce its carbon footprint by 74% by 2030**.**
- US Magnesium built a new solar array to power its operations.
- Rio Tinto invests heavily in autonomous vehicles, drones, and artificial intelligence (AI) used in mining practices.

THEMES

An energy transition must be economy-wide and market driven. A transition driven by a carbon tax should be border-adjusted and revenue-neutral with emissions reductions measurable on a life-cycle basis.

Carbon-free power projects, renewable and nuclear, will stream by 2030. Energy storage is needed for renewable energies like wind and solar to cover base load demand. The business risk of an unstable power delivery system is overwhelming. Grid enhancement and security of transmission infrastructure is vital.

Technology innovation will facilitate the energy transition. The United States and the domestic energy companies have international superiority in technology advances.

National government should "push" the energy transition. Tax credits and tax incentives are key drivers of change.

National government needs a spokesperson to drive energy transition changes. Individual energy companies have discredited themselves in the past. A recognized national spokesperson (with the same stature as government epidemiologist Dr. Fauci) will explain the energy transition better than company spokespersons.

FOCUS GROUP 2: Banking

November 18, 2021

OVERVIEW

Energy Transition.

- Utah has developed renewable energy sources such as wind and solar. Bank clients face decisions about land use for either agriculture or renewable energy farms. Clients with a family succession plan often resist the offer to turn away from agriculture.
- Utah's mineral wealth (e.g., copper, lithium, rare earth elements) may prove as valuable as crude oil and natural gas.

Energy Policies.

- Swine and cow waste products create renewable natural gas, delivering a new revenue stream to Utah farms.
- Environment, Social, Governance (ESG) funds threaten the viability of coal and oil-and-gas companies. ESG funds drive a political agenda of the current Administration.
- Utility policies decreasing solar metering credits diminish financial returns on a homeowner's investment in renewable energy.
- The federal government should be energy technology-agnostic; *Solyndra* was a failed solar technology endorsed by the Obama Administration in 2009.

Sustainability Practices. New-build finance office buildings are more energy efficient. The Commercial Property Assessed Clean Energy (C-PACE) program of the Utah Office of Energy Development is a financing tool promoting energy efficiency in either new or existing commercial properties.

THEMES

Utah's energy sources should be base-load, i.e., capable of dispatch at all times. Until an effective energy storage technology is developed, renewable energies will have limited value.

Natural gas and nuclear should be utilized until the intermittency issue of renewable energies is resolved. Natural gas has a smaller carbon footprint than coal and is dispatchable.

Utility policies diminishing development of residential solar should be re-considered. Economic benefits enjoyed by early adopters of rooftop solar diminished when the Utah Public Service Commission lowered the export rate from 9.2¢/kWh to 5.9¢/kWh (summer) and 5.6¢/kWh (winter).

Environmental/Social/Governance (ESG) standards should not be a tool to defund oil-and-gas companies. Investment and pension funds such as Blackrock recently installed three environmentalist board members on ExxonMobil's Board of Directors.

Utah's mineral wealth may prove as valuable as its crude oil and natural gas. Lithium, copper, and rare earth elements will have increasing market value as demand for electric vehicle battery components increases.

Land prices in southern Utah will increase due to renewable energy development. Solar energy accounts for sixty percent of Utah's renewable energy. Utility-scale solar development is concentrated in southern Utah.

FOCUS GROUP 3: Real Estate and Construction

December 9, 2021

OVERVIEW

Energy Transition.

- Utah residential and commercial buildings will likely emit more pollutants than automobiles when Utah's population doubles by 2050.
- The electricity grid will move away from coal; buildings powered by electricity may outstrip buildings heated by natural gas.
- New home construction in Salt Lake City is about 25% more energy efficient than housing stock built pre-2006.

Energy Policies.

- Utah's culture features innovation but avoids regulation. Utah businesses possess ingenuity to resolve the Wasatch Front inversion problem by themselves.
- The homebuilding industry must resolve the "friction point" between regulatory mandates (sticks) and incentives (carrots).

Sustainability Practices. Homebuilders confront issues of sustainability versus affordability. Adding additional "green" features to a home may push some Utah families out of the housing market.

THEMES

Utah businesses possess ingenuity to resolve the Wasatch Front inversion problem by themselves.

Utah's real estate/construction sector should not wait for federal or state regulations but resolve the inversion problem themselves. Since buildings may overtake automobiles as the largest emissions source in Utah, energy efficient homes will resolve the Wasatch Front's inversion problem.

Market forces, not regulations, make Utah housing both energy efficient and affordable. Utah homebuilders preserve customer choice by allowing clients to choose if their home should have: 1) solar panels, 2) natural gas or electricity as a fuel-of-choice, and 3) an EV charging port. If a building code required these features, some Utah families would drop out of the housing market.

Although Utahns may not push for sustainability, they experience a nice fit when they live in a sustainable environment. A southern Utah community uses energy efficient practices such as extra r-factor insulation and "*localscaping*" with minimal water usage.

Homebuilders should face the challenge of changing Utah's reputation as a state with poor air quality. The real estate/construction sector should not wait for federal or state regulations but resolve the problem themselves. Energy efficiency, which decreases emissions, has made significant advances in Utah over the last 15 years.

FOCUS GROUP 4: Technology

January 11, 2022

OVERVIEW

Energy Transition. Technologies deployed and/or developed by participants include:

- Low carbon-intensity transportation fuels,
- Pilot-scale carbon dioxide utilization technology,
- Solar energy plus battery storage projects, and
- Pumped hydro storage projects.

Energy Policies. Participants acknowledged the range of state and national policies encouraging energy technology implementation.

- The U.S. Department of Energy Loans Program funds innovative energy projects and Tribal energy projects. The 45Q program offers tax credits for carbon sequestration.
- California's Low Carbon Fuel Standard (LCFS) provides credits to suppliers of lower carbon intensity fuels.

Sustainability Practices. Transportation and air quality are common priorities.

- One company sponsors a rideshare program and provides a bank of twenty free electric vehicle (EV) charging stations. This company also transports waste food from its employee cafeteria to the Wasatch Resource Recovery anaerobic digester in North Salt Lake for conversion into renewable natural gas (RNG) and compressed natural gas (CNG).
- Another company has solar panels on its buildings and covered parking generating eight MW's of electricity.

THEMES

Carrots, not sticks, are the preferred catalyst to drive the energy transition. Energy projects producing low-carbon transportation fuels such as hydrogen and renewable natural gas stand on their own economic vigor. Companies supplying these clean energy fuels require no government subsidies. However, clean energy consumers respond to carrots, such as tax credits for RNG and CNG, enabling an energy transition.

Companies developing new technology need assistance to cross a "valley of death" to advance from proof-of-concept to full-scale commercialization. A Utah company supplies carbon black to an automobile tire manufacturer. This carbon black derives from a patented process consuming carbon dioxide, otherwise released into the atmosphere. While a small laboratory produces sufficient carbon black to test proof of concept, facilities generating commercial volumes require much larger capital expenditure funding.

Tribal involvement in the energy transition is critical. Crude oil production in 2020 on tribal lands was 35% of Utah's total production, natural gas, 12%. Fossil fuel revenue streams fund tribes in the Uintah and Paradox Basins. Tribes in partnership with the Bureau of Indian Affairs administer 2.45 million acres of trust lands, 4.5% of Utah's land area. As fossil fuel demand diminishes, low-carbon energy projects such as green hydrogen and renewable energy projects may ensure tribal participation in the energy transition. The abundance of green resources on tribal lands may produce renewable energy, replacing revenues lost due to reductions in fossil fuel usage.

FOCUS GROUP 5: Transportation

January 12, 2022

OVERVIEW

Energy Transition.

- Sustainable aviation fuel is in its infancy with a blend of 97% aviation fuel plus 3% low carbon blend stocks such as plant-based oils, agricultural residues, and biogenic CO2 .
- Low carbon intensity fuel such as hydrogen now replaces diesel in train transport.
- Local energy generation ideally matches local energy demand. Equilibrium between generation and demand avoids energy storage costs as well as infrastructure transmission costs. Working with a Public Utility Commission is more effective when generation and utilization both occur locally.

Energy Policies.

- Section 111 of Federal Highway Code (FHC) currently prohibits state's ability to add access to, or exit from the Interstate Highway System. A work-around of Section 111 allowing more highway rest stops equipped with electric charging stations would facilitate a shift to electric vehicles (EV) from internal combustion engine (ICE) vehicles.
- More hydrogen storage capacity and hydrogen fuel cell access in the rail industry provides a counterbalance to trains powered by electricity.

Sustainability Practices. Bus fleets are ideally a mix of ICE vehicles and EVs because electric charging may not be viable during extreme weather periods. Fueling an ICE bus fleet with diesel is still possible during extreme weather.

THEMES

The aviation industry's energy transition will require more time than bus, train, or automobile transport.

- Lack of blend stocks for sustainable aviation fuels (SAF) limit the current SAF mix to 97% conventional aviation fuel, 3% low carbon blend stocks.
- Electric planes confront the weight problem of batteries 30 times heavier than aviation fuel for a comparable amount of energy stored. Cessna's eCaravan aircraft carries up to nine passengers and has a range of one hundred miles.
- While future battery technology may stretch range limits, battery-powered plane travel in the near term will have fewer passengers and limited flying range.

Collaborative work with public utility commissions is vital during the energy transition. Introduction of new energy sources (i.e., wind, solar, hydro) and new energy storage (i.e., battery, pump hydro) will be integral features of the transition. Working with local utilities is critical to optimize the infrastructure for generation, distribution, and utilization.

Crosscutting best practices add value in the transportation sector. Train fleets shifting from diesel to electric may productively apply lessons from bus fleets that made the same diesel-to-electric shift. Eliminating transportation silos allows sharing of best practices.

FOCUS GROUP 6: Health Care

January 28, 2022

OVERVIEW

Energy Transition. As energy shifts from fossil fuels to renewable energy, critical health care attributes include:

- *Reliability*. Patients depend upon medical devices such as pacemakers, respirators, ventilators, oxygen concentrators, and home dialysis units requiring periodic charging. At-risk patients depend upon energy for air conditioning in summer and heating in winter. Although renewable energies offer relief from particulate matter pollution, its intermittency decreases reliability of device charging. As a result, base load energies should remain in Utah's energy mix.
- *Cost*. Stable renewable energy costs ensure medical services remain within patient budgets. International supply chain delays have increased health care costs. Keeping supply chains, where possible, within the United States decreases delays. The global semi-conductor shortage delayed delivery of an ambulance to a local hospital.
- *Safety.* Energy safety drove Germany to exclude nuclear energy from its energy mix in 2011 after Japan's Fukushima disaster. Consumer safety of new energy resources is important.

Energy Policies. Individuals do not act in the interest of public health without incentives. Rooftop solar panels, electric vehicle purchases, and house weatherization to improve energy efficiency have grown due to incentives.

Sustainability Practices. Telehealth medical appointments increased during the COVID pandemic, providing more parity in caregiving. Other sustainable practices are gown-and-plastic glove recycling and hospital building energy efficiency measures.

THEMES

Shifting hospitals to population centers reduces automobile emissions.

- Building a University of Utah Health Care center in West Valley City would save 12 million commuter miles annually by eliminating travel to more distant hospitals. Reducing travel miles diminishes yearly carbon dioxide emissions by 5 thousand tons. This Health Care center complements existing services from Steward Healthcare, Granger Medical Clinic, MountainStar Healthcare, and Exodus Healthcare.
- Health care services are shifting to a local level. U of U Health maintains 5 hospitals and 12 community health centers. Hospital administrative jobs now shift to work-at-home status, freeing up 10% to 30% additional space in hospitals.

Renewable energies lower particulate matter emissions, resulting in fewer hospitalizations associated with poor air quality. Particulate matter pollution causes increased hospitalizations for people with heart disease, respiratory infections, chronic obstructive pulmonary disease (COPD), asthma, and stroke. Estimated costs of Utah air pollution are $0.75 - $3.00 billion annually, approximately 2 percent of Utah's GDP.

Healthcare is an integral part of Utah's economy.

- The University of Utah Health's patient care, training, and research generates 47,500 jobs (2.4% of all Utah jobs) and $3.9 billion in GDP (2.3% of Utah's GDP).
- Intermountain Healthcare's patient care generates over 30,000 jobs. These healthcare providers are Utah's largest employers, servicing Utah and areas of Idaho, Wyoming, and Nevada.

Focus Group 7: Hospitality and Tourism

February 16, 2022

OVERVIEW

Energy transition. Southern Utah counties have abundant solar and wind energy to drive a transition from carbon-intensive energies to renewable energies. However, renewable energy projects may spoil local view sheds. Examples include:

- A solar farm sited on Bears Ears National Monument acreage, and
- A windfarm near Monticello generating power from 27 turbines with 300-foot towers and 187-foot blades.

Energy Policies. Hospitality/Tourism sector profit margins have shrunk to the point that business owners rely upon state and national incentives to implement cleaner, alternative energy solutions. Hotel customers want electric vehicle (EV) charging stations; tour operators select hotels based on energy and recycling practices. However, hotel owners need clarity on capital expenditure funding sources for EV charging stations and associated maintenance costs.

Sustainability Practices. Focus group members provided four examples:

- A river rafting company purchased a recycling system for wastewater.
- A tourism office collaborated with county officials and a solar company to install solar panels on a visitor's center.
- The Salt Lake Convention Center installed solar panels, signaling its commitment to clean energies.
- State employees work from home on bad air quality days.

THEMES

Utah visitors demand sensitivity to the environment. Utah's five national parks (i.e., Arches, Bryce, Canyonlands, Capitol Reef, and Zion) drew 11.2 million visitors in 2021. The hospitality/tourism sector has an obligation to preserve the visitor experience. A focus group member observed, "When you invite people into your backyard, you are responsible".

Redistribution of visitors may help gateway cities to National Parks. Visitation to Arches and Canyonlands parks has overwhelmed Moab. Redirecting visitation to other Utah attractions allows gateway cities to preserve the "Utah Visitor Experience".

Fossil fuels should remain in the energy mix. Battery storage of electricity generated by renewable energies is not fully mature. A tour guide evaluated a small internal combustion engine (ICE) versus an electric motor. The ICE was preferred because electric motor battery weight was too heavy for a small river craft.

Increased battery usage brings challenges as well as opportunities to Utah. Solar panels and EV batteries require vigilant recycling at the end of their useful life because battery components are often corrosive. On the positive side, Utah's mining companies provide EV makers with copper, lithium, and rare earth elements. Forecasts of EVs on U.S. roads project an increase from 1 million in 2018 to 18.7 million in 2030.

Water is a "pain point" in southern Utah. Lack of water stopped some development projects in Utah's southern counties. Metering water usage leads to responsible utilization of a scarce resource. Poor air quality in southern Utah counties often results from wildfires in neighboring states.

Air quality is a "pain point" in northern Utah. Wintertime inversions along the Wasatch Front occur when a high-pressure system traps air in a valley bowl.

- The Utah Department of Environmental Quality provides an Air Quality Index (AQI). State employees work from home on bad air quality days, reducing the number of automobiles on highways.
- Media has unfairly labeled SLC as Smog Lake City.
- Snow pack levels concern both the Utah ski industry and Wasatch Front municipalities with water requirements.

FOCUS GROUP 8: Agriculture and Food

March 24, 2022

OVERVIEW

Energy transition. Farmers are "forward thinking" on embracing change that optimizes farm operations and improves profit margins.

Energy Policies. Incentives are preferable to regulations.

Sustainability Practices. Focus Group members provided four sustainability examples:

- The Utah Department of Agriculture and Food's *Grazing Improvement Program* helped ranchers in the Three Creeks region (Rich County) successfully petition the Bureau of Land Management (BLM) and the U.S. Forest Service (USFS) for a high density, short-duration grazing plan that improved health across the entire watershed.
- An environmentally friendly Juab County greenhouse tomato farm utilizes heat and carbon dioxide supplied by five natural gas fired boilers.
- Decreasing Utah snow pack levels challenge current water utilization rates. Optimization of Utah's agricultural irrigation practices promotes water conservation. Estimated water conservation is 9.1 billion gallons annually. The Utah State legislature approved funding ($70MM) supporting this initiative.
- Five anaerobic digesters in Utah divert animal manure from open lagoons to hooded lagoons, avoiding release of methane emissions into the atmosphere. Anaerobic digesters produce natural gas sold to utilities such as Dominion Energy, creating additional revenue streams for Utah farmers.

THEMES

Solar-powered submersible pumps deliver water to cattle grazing in southern Utah. Water distributes to cattle troughs via pipeline, sustaining an even distribution of grazing pressure for large herds of cattle. Pump mobility allows operations at multiple sites, facilitating diverse grazing patterns.

Agricultural profit margins are narrow but future technology may achieve savings. Planting and harvesting seasons typically require long hours for tractor and harvester operators. Driverless vehicle solutions may bring cost savings where labor shortages have challenged the industry.

Solar projects may diminish Utah's farm acreage. Utah is one of seven southwestern states with high-density solar potential. Solar sites on low-quality soil may be a good fit for solar projects, but tillable land should remain for agriculture. Solar sites on grazing land accommodate sheep and goats, but not cattle.

FOCUS GROUP 9: Legislators (Group 1)

March 9, 2022

OVERVIEW

Energy transition. Although Carbon County has benefited from Coal Country Strike Team (CCST) assistance to embrace other industries (i.e. tourism, Silicon Slopes back-office support), the 2022 Utah Legislature did not approve additional CCST funding.

Energy Policies. Incentivizing battery storage technology makes intermittent wind and solar energies a larger part of the Utah's energy mix.

Sustainability Practices. Utah State Government sustainability practices include:

1. Conversion of the transportation fleet to low carbon fuels
2. Adoption of building energy efficiency measures
3. Remote work on poor air quality days

THEMES

Energy security depends upon baseload energy and battery storage. Lower snowpack levels diminished hydropower, forcing the city of Bountiful to exercise its off-take rights to Intermountain Power Association (IPA) electricity. Baseload energy from natural gas is critical, as battery technology develops to store electricity generated by intermittent renewable energies.

Energy efficiency and renewable energy create jobs. Utah's third congressional district recently reported 7,000 solar jobs, the highest number of jobs in the nation's 435 districts.

An energy transition often leaves people behind. Germany set a high standard for re-training workers and granting pensions to coal industry workers as German coal production declined while solar and wind energies grew. Carbon County falls behind as it loses mineral lease money because of declining coal production.

Discussion of linkage between poor air quality and health needs improvement. Poor air quality damage causes asthma, airway inflammation, suicide, pre-term birth and decreased birthweight. However, many Utahns do not understand this causal relationship.

Incentives will facilitate the energy transition. A neighboring state proposed legislation offering double credits to people storing off-peak electricity generated by renewable energy for subsequent dispatch during peak hours.

Carbon border adjustments hold inefficient producers accountable for higher emissions. Adjusting the price of imported products to the amount of carbon dioxide (CO2) emissions created in their manufacture equalizes the cost of carbon between domestic products and imports. The carbon border adjustment (CBA) penalizes imports causing greater CO2 emissions than local products. A CBA would: 1) equalize the cost of carbon between domestic products and imports, 2) penalize production relocating to countries with relaxed climate objectives.

Current federal mining regulations impede timely development of Utah's mineral wealth. Electric vehicles and renewable energy power projects both require larger volumes of lithium, nickel, manganese, cobalt, graphite, and chromium than conventional (internal combustion engine) ICE vehicles and fossil fuel power plants. Federal regulations delay development of mineral resources.

FOCUS GROUP 10: Legislators (Group 2)

16 March 2022, 12:00–1:30 p.m.

OVERVIEW

Energy transition. Energy security and independence are key objectives.

Energy Policies. Incentives are preferable to regulations.

Sustainability Practices. Weber State University installed a solar farm, demonstrating community leadership.

THEMES

Utahns support energy transition. The Utah legislature passed HB411 (Community Renewable Energy Act - CREA) in the 2019 session. HB411 assists Utah communities achieve 100% electric energy from renewable sources. Communities will work with the utility, PacifiCorp, to establish the premium to the fossil fuel rate for electricity generated by renewables. Both PacifiCorp and the communities are motivated to establish a reasonable premium so CREA opt outs are minimized. Nevertheless, ratepayers retain flexibility to opt out and pay a fossil-fuel electricity rate instead of a renewable energy electricity rate.

Utahns want to know costs of an energy transition. HB411 provides ratepayers full visibility of electricity rates from renewable sources as well as fossil fuel sources. Likewise, a carbon tax provides full visibility of costs linked to negative externalities of carbon dioxide.

Energy security results from development of solar/ wind/ geothermal energies. Energy security is a priority in light of motor gasoline prices rising to $4 per gallon after the U.S. banned Russian energy imports. Both state and nation energy security is vital. As renewable energy sources grow, dependence on foreign nations for fossil fuel energy diminishes.

Innovation, not legislation, will drive the energy transition. Innovators creating battery storage for renewable energy-generated electricity is more effective than legislative mandates. The innovation process should be market driven.

A regional transmission organization (RTO) may lower Utah electricity costs. Pooling resources of western states to create new transmission infrastructure and optimize grid management may generate savings for RTO members. In addition, Utah potentially gains access to renewable energy electricity from other states. RTO governance favoring larger western states could be a drawback.

Renewable energy incentives improve air quality and conserve water resources; incentives are better than regulations. Public-private partnerships and free markets more effectively influence air quality and water than legislation.

FOCUS GROUP 11: College and University Students

May 6, 2022

OVERVIEW

Energy transition. Electric vehicles (EVs) do not solve environmental problems if a coal-fired power plant generates the EV charge. Both electricity generation and electricity utilization should be free of emissions.

Energy Policies. The federal government should not select technologies for the energy transition. The marketplace should select energy transition technologies without influence by federal subsidies.

Sustainability Practices. Students adapted the following sustainability practices to combat climate change.

- Three participants adopted vegan diets. Plant foods require less water to produce compared to animal products. Animal agriculture generates waste products emitting methane; by contrast, plant agriculture nourishes soil. Animal-based protein requires eight times more fossil-fuel energy than plant-based protein.
- Leave lights off, open windows in order to reduce household electricity consumption.
- Shop sustainably.
- No new clothing; recycle existing clothing.

THEMES

Homeowner incentives may reduce emissions by wood burning stoves. Cache Valley is susceptible to wintertime inversions. Efforts by Cache County jurisdictions to reduce particulate emissions from wood burning stoves have not been effective. Utah's Department of Environmental Quality (DEQ) conducts the *"Wood Stove and Fireplace Conversion Assistance Program"* for Box Elder, Cache, Davis, Salt Lake, and Weber Counties. Rebates up to $4,300 per household are available.

Low carbon energy sources such as nuclear and natural gas facilitate energy transition. Pending development of reliable renewable energy storage, utilization of low carbon energies such as nuclear and natural gas is a priority. Nuclear has no carbon footprint; natural gas has 40% of coal's carbon footprint.

Carbon Fee and Dividend programs reduce reliance on carbon intensive fuels. This program reduces greenhouse gas emissions by imposing a carbon tax on fossil fuel sales. Revenues generated by the carbon tax flow back to households by a monthly dividend. Steps in the program are:

1. A fee is levied on fuels at their entry point into the economy, such as a well, fuel pump, or port of entry. Carbon content of the fuel determines the fee.
2. Progressively increasing carbon fees provides consumers with steady, predictable price signals, incentivizing transition to low carbon energy sources and products.
3. Imports from nations lacking a carbon fee receive a border tax adjustment, boosting the import price.
4. Collected fees return to households as an energy dividend. Returning 100% of net fees results in a revenue-neutral carbon fee-and-dividend system.

201 South Main Street #2300
Salt Lake City, UT 84111
Phone: (801) 364-3631
Email: info@slchamber.com