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by

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Cover photos: *Top left: Milford 2 solar farm, Beaver County. Top right: Longwall mining machine at the now-closed Deer Creek coal mine. Bottom left: Pumpjack in the Aneth oil field, Utah's largest producing oil field, San Juan County. Bottom right: Huntington Power Plant.*

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During the 2021 Utah State Legislative Session, the Natural Resources, Agriculture, and Environmental Quality Appropriations Subcommittee secured funding for a new study on the economic contributions of Utah's energy and mining industries. The Utah Geological Survey, in partnership with the Utah Office of Energy Development, commissioned the Department of Applied Economics at Utah State University to perform the study and generate the following written report.

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THE ECONOMIC CONTRIBUTION OF UTAH'S ENERGY AND MINING INDUSTRIES

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EXECUTIVE SUMMARY

Utah's abundant energy and mineral resources are used to heat homes, drive industry, and keep the lights on. Effectively managing these energy and mineral resources and their associated supply chains requires knowledge of their economic value and how they currently contribute to Utah's economy. This report calculates the total economic contribution of Utah's energy and mining industries for 2019 and 2020. Each industry makes substantial contributions to Utah's gross domestic product, employment, and tax base. Table 1 displays each industry's economic contribution to Utah's economy.

Collectively, these industries contributed over 10% to Utah's total Gross Domestic Product (GDP), supported over 6% of its jobs, and contributed 20% to state tax revenue. Not only do these industries produce sizable economic value, they also create high-paying jobs. Average wages for the energy and mining industries were calculated to be $22,415 (45%) and $13,652 (28%) above the overall state average wage, respectively. These results are displayed in figure 1.

Table 1. *Summary of the Contributions of Energy and Mining Industries to Utah's Economy in 2019.*

Sector	Category	Total Contribution from Sector	% of Utah's Total Economy
Energy	State GDP	$12.1 billion	6.3%
	Jobs	74,200 jobs	3.3%
	State Tax Revenue	$1.5 billion	14.4%
Mining	State GDP	$7.7 billion	4.0%
	Jobs	56,700 jobs	2.7%
	State Tax Revenue	$0.6 billion	5.6%

Note: Energy sector includes crude oil, natural gas, and other associated industries; mining sector includes coal mining, metal mining, non-metal mining, and associated industries; results for GDP, jobs, and tax revenue are the sum of direct, indirect, and induced effects; results for 2019 reported, as 2020 was an anomalous year due to covid.

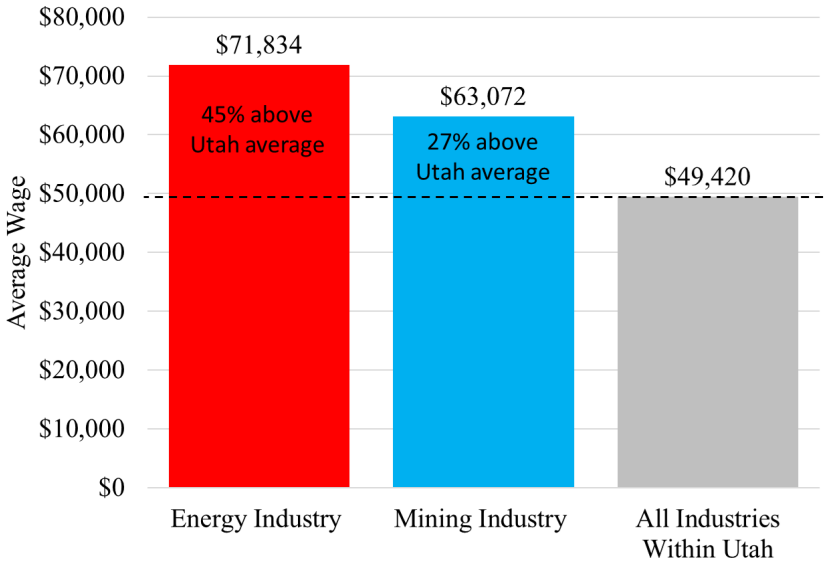

Figure 1. *Average Wages for the Energy and Mining Industries Compared to the Overall State Average.*

INTRODUCTION

Utah's energy and mining industries are an important part of Utah's economy. In 2021, the Utah legislature requested a study to determine the economic contribution of Utah's energy and mining industries. The resultant study quantified their contributions to Utah's gross domestic product (GDP), employment, worker earnings, state tax revenue, and total economic output. This report also explores contributions at a sectoral level (e.g., coal mining, power generation, etc.). Finally, economic contributions for energy and mining industries from 2019 and 2020 were both analyzed to better understand what impacts, if any, the SARS-COVID-19 pandemic and associated supply chain disruptions, changes in policy, and employment had on these industries.

For the purposes of this report, Utah's energy industry includes extraction of crude oil and natural gas, as well as their supporting sectors, all power generation, and downstream value-added sectors. Utah's mineral sector includes all coal mining, metal mining, non-metal mining, as well as supporting and value-added industries. This report examines the impacts of each sector (table 2) and includes detailed descriptions of which sectors get included from each industry and what activities/products define each sector. The sectors included from each industry were determined by the authors to effectively establish the value of each sector. The sector definitions and their associated data are defined in the North American Industry Classification System (NAICS) database. This report uses the NAICS convention for categorization in the analysis since most of the data used in this study originates from this database. Table 2 highlights that energy and mineral materials are part of a much larger supply chain and each of the following sectors makes their own unique contribution to state output, GDP, employment, employee compensation, and state tax revenue. For a detailed explanation of each sector see Appendix A.

The economic contribution of Utah's energy and mining industries is the estimated value of each industry's production level at a given point in time (IMPLAN, 2022a, 2022b). Watson et al. (2007) defined economic contribution as "... the gross change in economic activity associated with an industry, event, or policy in an existing regional economy..." Contribution analysis is the method used to investigate how the current state of energy and mining industries support other related businesses and sectors in Utah's economy (IMPLAN, 2022a).

Data and Methods

The contribution of the energy and mining industries to Utah's economy was calculated using economic multipliers from a 2019 model of the region's economy. This model was created with the impact analysis for planning (IMPLAN) Input-Output/Social Accounting Matrix (see Appendices B and C for a detailed discussion of the methods and multipliers used to estimate economic contribution and the data used in IMPLAN, respectively). IMPLAN is an economic impact assessment platform based on an Input-Output model (Leontief, 1936, 1941; Miller and Blair, 2009) and Social Accounting Matrix (Stone and Brown, 1962; Holland and Wyeth, 1993), which is maintained by the IMPLAN company (https://implan.com/). French (2018) stated that "... IMPLAN is a software that combines data from a set of extensive databases, economic factors, multipliers, and demographic statistics and allows a user to gain insight into an industry's contributions to a region, quantify the impact of a shock to an economy, examine the effects of a new or existing business, model the impacts of expected growth or changes, or study any other event specific to the economy of a particular region and how it will be impacted…"

The economic contribution of Utah's energy and mining industries as determined through IMPLAN is reported in terms of contributions to the economy including output, employment, earnings, and value-added (State GDP), defined as:

- **Output** is the value of production by industry in a calendar year including the sum of annual revenue and inventory change.
- **Employment** is a measure of jobs; the number of full-time/part-time jobs.
- **Earnings** indicates employment compensation in value-added which includes salary disbursements, employer wage contributions from pension and insurance funds and for government social insurance, and income of the self-employed.
- **Value-added** (State GDP) includes employment compensation (earnings), proprietor income (PI), indirect business tax (IBT), and other property income.

Economic Contributions of Energy and Mining Industries in Utah

The entire economic contribution the energy and mineral industries collectively make to Utah's economy was calculated for 2019, based on the analyses of the IMPLAN sectors in table 2. The most recent data available in the IMPLAN database is for 2020, which was thought to be an anomalous year due to COVID-19 and supply chain disruptions, so 2019 data was also analyzed as a closer approximation to a more "normal" year. Later in the report, comparisons are made between 2019 and 2020 contributions and a more detailed analysis of 2020 data can be found in Appendix D.

Utah's energy and mining industries in 2019 created a significant contribution to the state economy (table 3). Taken together these two industries accounted for 6.0% of total employment, 10.3% of state GDP, and 20.0% of tax revenue. In addition, jobs tied to these industries on average pay better than other jobs within the state. The energy industry ac-

Table 2. *Categorization of Energy and Mining Industries Using NAICS.*

	Sector	Sector Definitions and NAICS Codes
Energy Industry	Oil & gas extraction	2111 – oil and gas extraction
	Oil & gas support	213111 – drilling oil and gas wells
		213112 – support activities for oil and gas operations
	Power generation	2211 – power generation (fossil fuel and renewables), transmission, and distribution
	Natural gas distribution	2212 – natural gas distribution
	Construction related to energy	237120 – oil and gas pipeline construction
		237130 – power and communication line construction
	Petroleum refinery	324110 – petroleum refineries
	Oil & gas manufacturing	32412 – asphalt
	Petroleum wholesale	4247 – petrol products merchant wholesalers
	Gas retail	4471 – gasoline stations
	Pipeline	486 – crude oil, natural gas pipeline
Mining Industry	Coal mining	2121 – coal mining
	Metal mining	2122 – metal ore, iron, gold, silver, and others
	Nonmetal mining	2123 – nonmetallic mineral mining and quarrying
	Mining support	213113 – support activities for coal mining
		213114 – support activities for metal mining
		213115 – support activities for nonmetal mining
	Nonmetal manufacturing	327 – clay, glass, cement, lime, other
	Metal manufacturing	331 – iron and steel, aluminum, foundries
		332 – forging, fabricated metal
	Mineral wholesale	4235 – coal, mineral, ore, metal wholesalers

Note: Coal is both mined and used to generate electricity. This classification counts coal mining and its support within the mining industry, but power generated from coal gets counted within the energy industry.

counts for 3.3% of all state jobs but produces 5.2% of all state worker earnings. The mining industry accounts for 2.7% of all state jobs but produces 3.5% of all state worker earnings. Another takeaway from table 3 is that the energy industry pays a disproportionate share of taxes relative to its GDP; while only contributing 6.3% of the state's GDP, it pays 14.4% of total taxes. The energy industry is thus a critical tax base for the state.

Additional detail on energy and mining's economic contributions to Utah is provided by breaking down the total economic contribution by sector (table 4). The energy and mining industries generate the largest economic contributions farther down the supply chain. Roughly 58% of the entire GDP of the energy industry was generated within the refinery and power generation sectors. The intuition is similar within the mining sector where just over 53% of that industry's GDP contribution came from the metal manufacturing and non-metal manufacturing sectors. Having a well-established supply chain that adds value to energy and mineral products is every bit as important economically as the primary production.

Separating the energy and mining industries' contributions into direct, indirect, and induced effects helps pinpoint where a sector's value is created and how integrated it is with the rest of the economy. A sector that creates most of its contribution through direct effects is fairly insulated from other parts of the economy. A sector that produces most of its value through indirect or induced effects has more ties to other economic segments. Changes in market conditions, business decisions, or policies affecting a given sector will have impacts that are easier to predict if that sector's contribution is concentrated in one place (direct effect), than if that sector influences other areas of the economy (indirect and induced effects) (figures 2–5).

Direct, indirect, and induced effects all have a similar overall contribution to Utah's employment. However, the importance of each effect varies across sectors. The direct effect in energy construction drives almost 59% of the total employment contribution. In power generation, direct effect contributes less than 22% of the total employment contribution. This difference highlights the advantages of breaking down sectors by effect type. Some sectors may seem relatively unimportant for employment if only measured with the easier-to-observe direct effect but become more important when one quantifies their contribution to state employment through indirect and induced channels (figure 3).

Table 3. *Total Economic Contribution of Energy and Mining Industries to Utah's Economy in 2019.*

Sector	Category	Total Contribution from Sector	% of Utah's Total Economy
Energy	State GDP	$12.1 billion	6.3%
	Jobs	74,200 jobs	3.3%
	Earnings	$5.3 billion	5.2%
	State Tax Revenue	$1.5 billion	14.4%
	Output	$31.6 billion	8.6%
Mining	State GDP	$7.7 billion	4.0%
	Jobs	56,700 jobs	2.7%
	Earnings	$3.6 billion	3.5%
	State Tax Revenue	$0.6 billion	5.6%
	Output	$17.6 billion	4.8%

Table 4. *Total Contribution of Utah Energy and Mining Industries by Sector in 2019.*

Energy and Mining Industry	Output ($ million)	State GDP ($ million)	Earnings ($ million)	Employment (jobs)	State Tax Revenue ($ million)
Energy	**31,636**	**12,049**	**5330**	**74,199**	**1536**
Oil and gas extraction	2263	898	485	7807	145
Oil and gas support	1645	756	466	7784	77
Power generation	8872	3924	1436	15,474	636
Gas distribution	1429	737	337	4023	78
Construction related to energy	3110	1883	1017	17,033	108
Refinery	12,543	3083	1159	15,515	364
Oil and gas manufacturing	1079	352	180	2472	32
Wholesale-petroleum	57	46	7	99	32
Retail-gas	398	212	130	3007	37
Pipeline	240	154	116	987	27
Mining	**17,556**	**7743**	**3575**	**56,681**	**595**
Coal mining	1368	749	234	3896	53
Metal mining	1950	916	364	6042	83
Nonmetal mining	1113	576	219	4018	49
Mining support	1130	469	271	4032	56
Nonmetal manufacturing	3615	1585	859	13,775	109
Metal manufacturing	6661	2552	1083	16,295	159
Wholesale-mineral	1722	895	546	8625	86
All Energy and Mining	**49,192**	**19,792**	**8905**	**130,880**	**2131**

Note: Contribution is the sum of direct, indirect, and induced effects; numbers in Table 4 are rounded. Additionally, care should be taken interpreting the output metrics. Output is the value of an industry's production, that is, the sum of sales to final users in the economy and sales to other industries (intermediate inputs). As pointed out in Clouse (2020) and Watson and others (2015), IMPACT analysis at times double counts sectoral output because it adds outputs from various industries where one industry's direct output effect may be another industry's indirect output effect. For instance, crude oil output within the oil and gas extraction industry gets counted as direct effect for output. If this crude oil gets used as an input in a refinery, then it also gets counted as an indirect effect within the refinery industry. This double counting also affects employment metrics since employment numbers are calculated from output data. Although a valuable metric, output and employment should not be taken by themselves but should be compared to other metrics like state GDP (or value added) that accounts for costs and avoids the pitfall of double counting. Earnings and tax revenue are also calculated using GDP data.

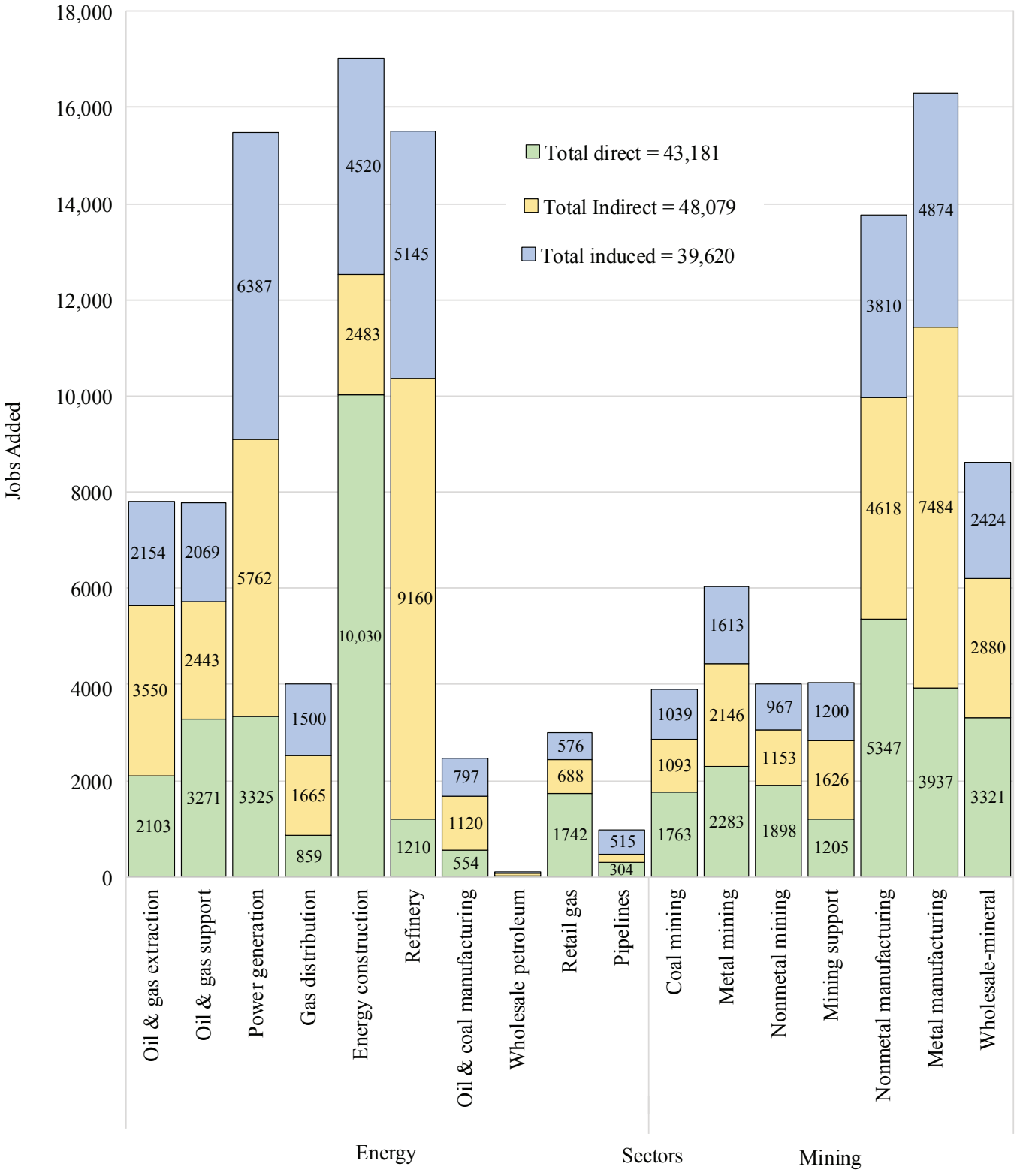

Figure 2. *Energy and Mining Employment Contributions in 2019 [Unit: No. jobs]*

Dividing labor income (figure 3) by employment (figure 2) yields some valuable insights. Across all energy and mining sectors the average income per worker was approximately $86,010 for direct contributions, $68,991 for indirect contributions, and $47,299 for induced contributions. The contributions most directly aligned with the energy and mining industries yielded the highest paying jobs. Also, the energy sector paid workers $71,834 on average and the mining sector paid workers $63,072 on average, when including and averaging direct, indirect, and induced effects. Utah's average wage in 2019 was $49,420 (Bureau of Labor Statistics, 2020). Both industries paid more than the average state wage. The average energy industry wage was 45% higher than the average state wage and the average mining wage was 27% higher than the state average wage.

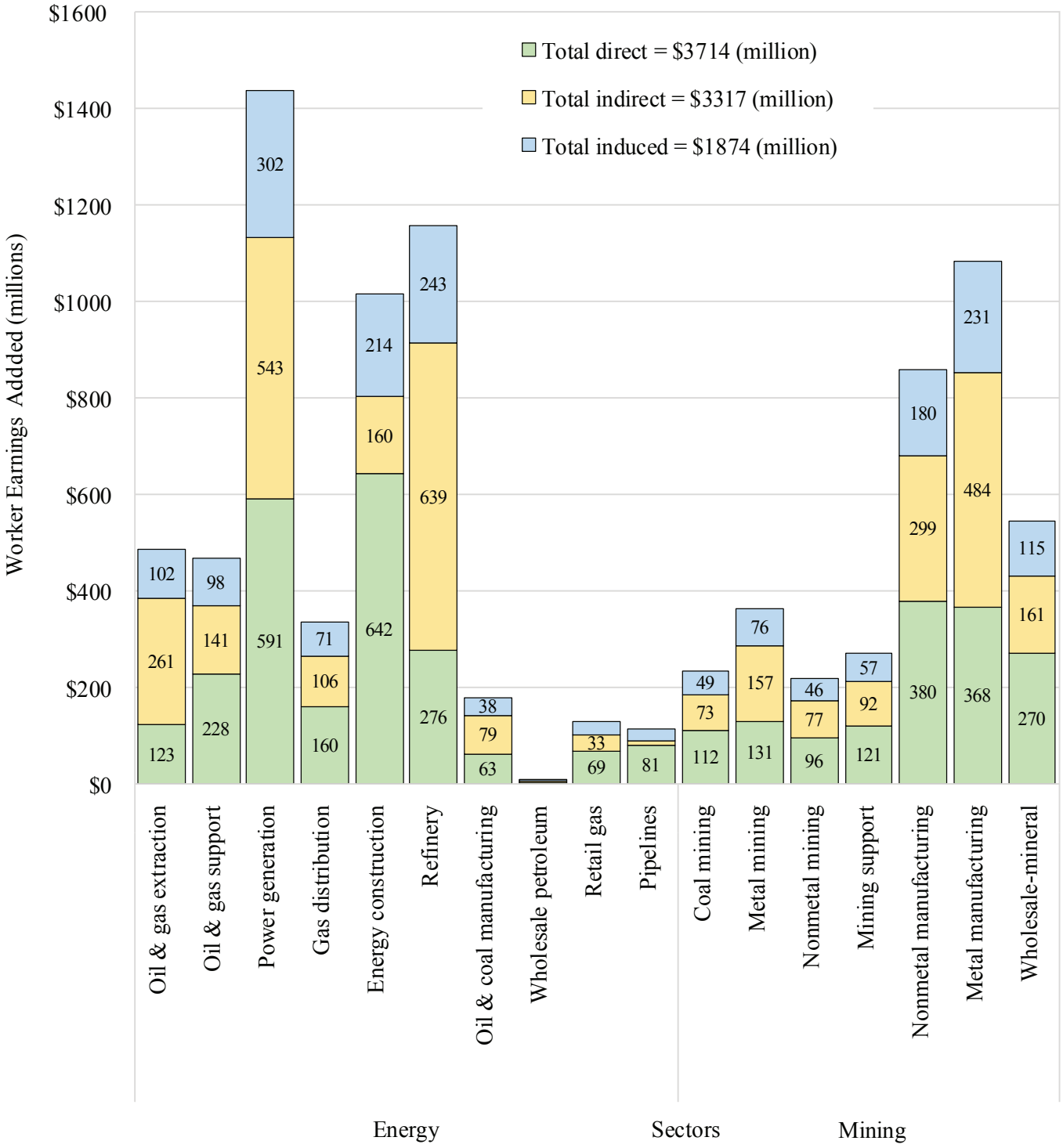

Figure 3. *Energy and Mining-related Labor Income (Wages) in 2019.*

When considering value added aspects of a sector, direct contributions have the largest effect for the energy and mining industries. Dividing GDP by sector (figure 4) by workers per sector (figure 2) shows that Utah's energy and mining industries are productive on a per worker basis. Utah's energy industry added an average value of $162,388 and the mining industry added an average of $136,607 per worker. Average state GDP per worker in 2019 was $120,109 (Bureau of Economic Analysis (BEA) 2021; St. Louis Federal Reserve, 2022). Additionally, the highest contribution to GDP and GDP per worker comes from activities most closely related to energy and mining (direct effects). Direct effects across both industries averaged to a value added per worker of $228,758. The value added from indirect effects and induced effects was $131,721 and $90,384 per worker, respectively.

Output is similar to GDP but has a slightly different interpretation. GDP measures value added whereas output measures total value. Thus, output will always be larger than GDP as it does not subtract the value of inputs. It also means that sectors farther down the supply chain will typically have higher values. The benefit to output is that it provides a clear picture as to how much revenue a given sector produces. This is helpful because it gives a scale to each sector. Figure 5 has a similar takeaway to figure 4. While all effects matter for output, the most important aspect of the energy economy in Utah is the direct effect. Refineries, power generation and metal manufacturing were the sectors with the largest contribution to state output.

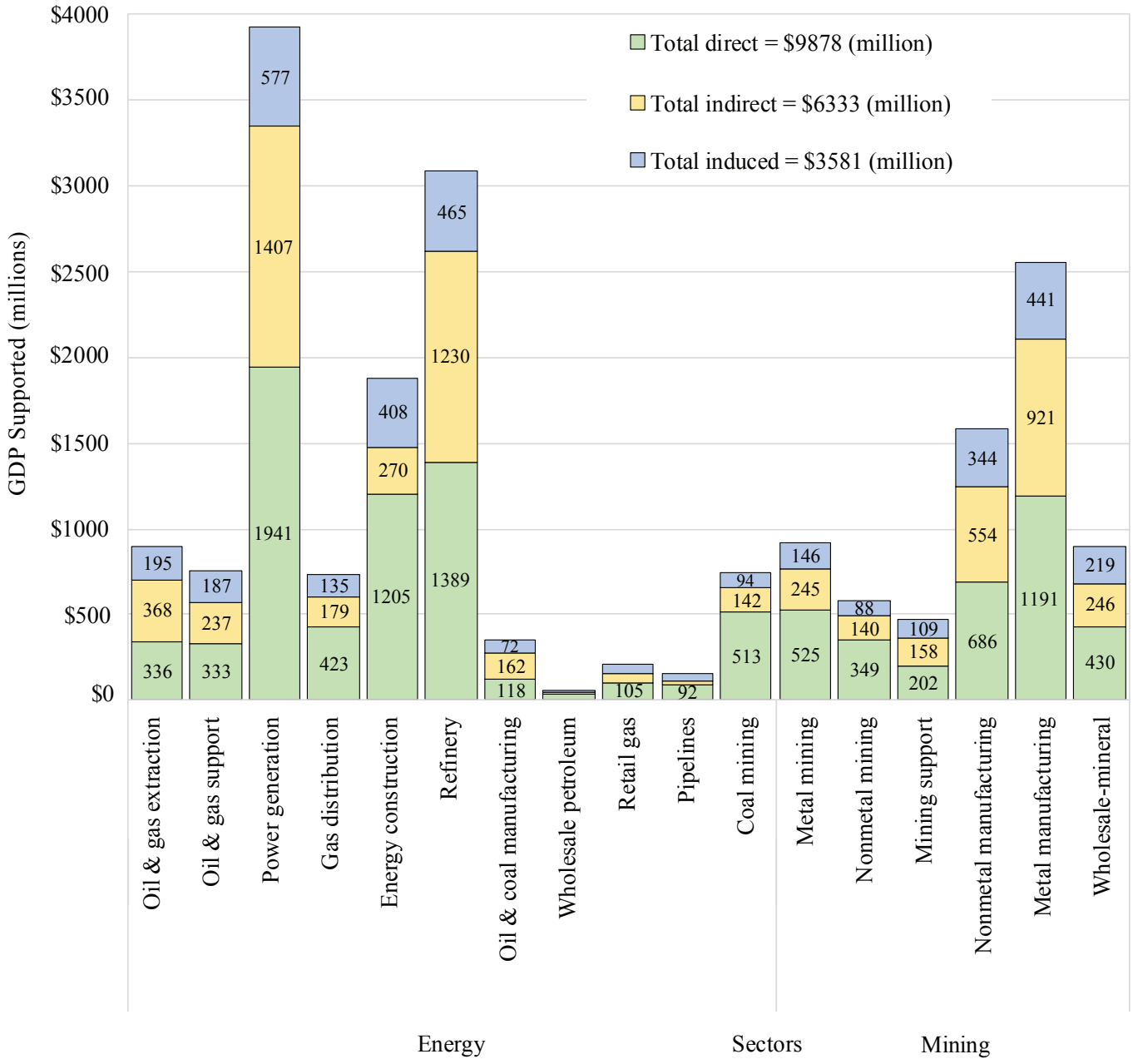

Figure 4. *Energy and Mining Contribution to State GDP in 2019.*

Initial spending from direct impacts can often have a spillover effect into indirect and induced impacts. In other words, $1 of output generated in direct activity may catalyze a regional economy to produce $2 of total output. Table 5 shows the normalized economic contribution "multipliers" of Utah's energy and mining industries. A multiplier is calculated as:

(Direct + Indirect + Induced effects)/Direct effect

This report uses three types of multipliers: output, employment, and income. An output multiplier is the total output generated in the Utah economy as a result of one dollar of direct output. An employment multiplier captures the impact on employment (number of jobs) when the corresponding sector hires one more employee. An income multiplier describes the total labor income generated as a result of one dollar of direct labor income (Clouse, 2022). For example, the output

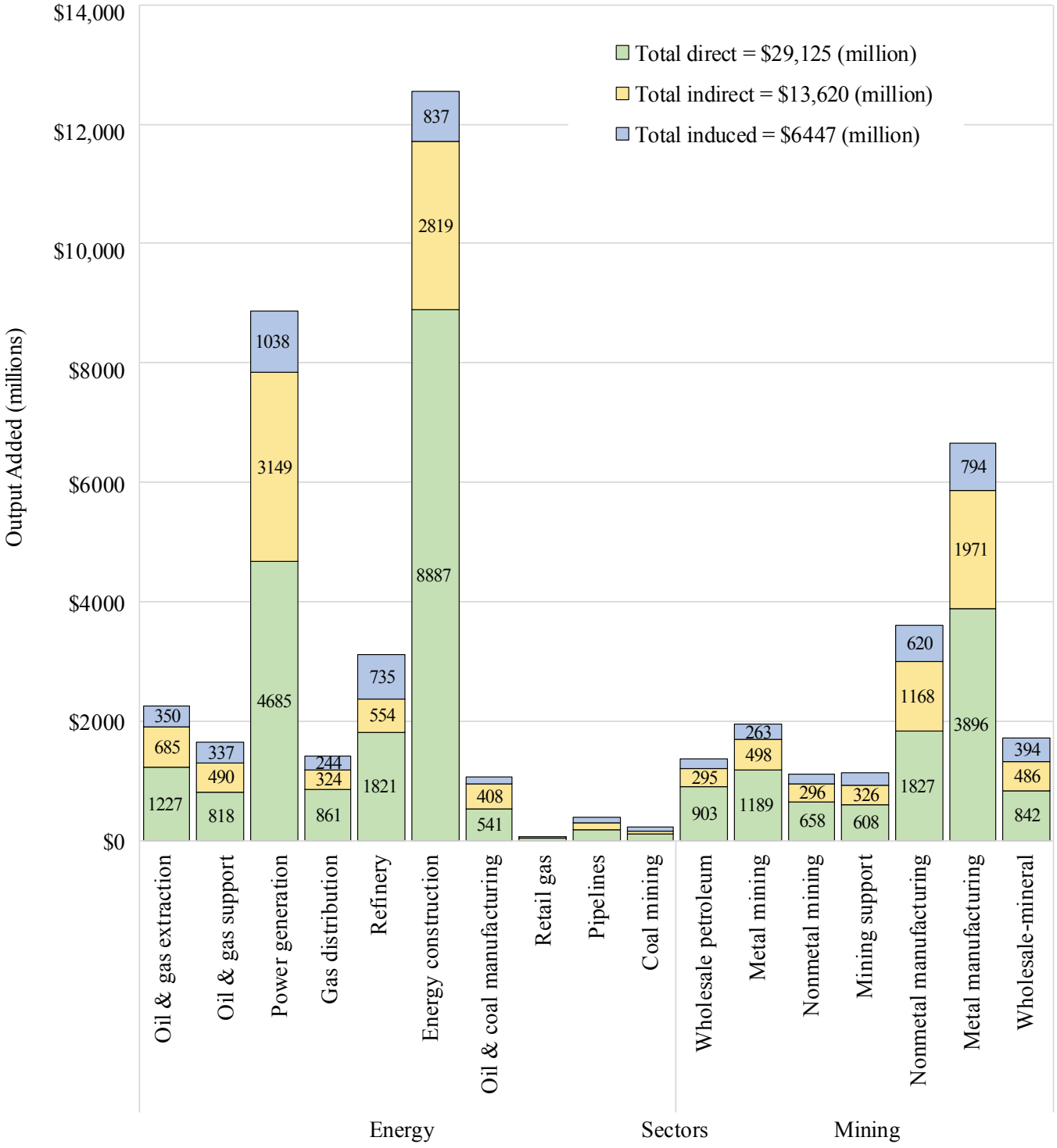

Figure 5. *Energy and Mining-related Economic Output in 2019.*

Table 5. *Normalized Contribution of Utah's Energy and Mining Industries in 2019.*

Mining and Energy Industry	Output Multiplier	Employment Multiplier	Income Multiplier
Energy	**1.65**	**3.17**	**2.39**
Oil and gas extraction	1.84	3.71	3.96
Oil and gas support	2.01	2.38	2.05
Power generation	1.89	4.65	2.43
Gas distribution	1.66	4.68	2.11
Construction related to energy	1.71	1.70	1.58
Refinery	1.41	4.19	12.82
Oil and gas manufacturing	1.99	4.46	2.87
Wholesale-petroleum	1.25	3.45	2.26
Retail-gas	2.08	1.73	1.88
Pipeline	1.92	3.24	1.43
Mining	**1.74**	**2.87**	**2.42**
Coal mining	1.51	2.21	2.09
Metal mining	1.64	2.65	2.78
Nonmetal mining	1.69	2.12	2.28
Mining support	1.86	3.34	2.23
Nonmetal manufacturing	1.98	2.58	2.26
Metal manufacturing	1.71	4.14	2.95
Wholesale-mineral	2.00	2.55	2.02
All Energy and Mining	**1.69**	**3.03**	**2.40**

Note: Normalized contribution of Utah energy and mining industries or multipliers = *(direct + indirect + induced effects)/direct effect*, numbers may not add up due to rounding.

multiplier for the oil and gas extraction sector for 2019 is calculated to be 1.84, which means that $1 of direct output from the oil and gas extraction stimulates the Utah economy and generates $1.84 of total output. Appendix B includes more discussion about multipliers.

Among the 17 energy and mining sectors highlighted in table 5, retail gas has the largest output multiplier of 2.08. In case of the employment multiplier, gas distribution has the largest value of 4.68 jobs per direct hire. Finally, the largest multiplier for income occurs at petroleum refineries and is 12.82. These multipliers matter because they show to what degree each sector is tied to other businesses within the economy. For instance, every $1 in worker income lost due to a refinery shutdown would cost Utah's economy a total of $12.82 worth of worker wages.

The energy and mining industries also contribute to local and state tax revenue (table 6). In total, tax contribution to local and State governments from Utah's energy and mining industries in 2019 was $2.1 billion[1].

The most notable takeaway from table 6 is the relative importance of utilities for generating state tax revenue. Despite producing less than 33% of the energy industries' GDP, the utility sector generates over 41% of all energy industry tax contributions.

COMPARISONS BETWEEN 2019 AND 2020

This report focuses on what occurred in Utah's economy in 2019 because 2020 was likely an anomalous year due to economic disruptions caused by the SARS-COVID-19 pandemic and the corresponding supply chain bottlenecks and reduced economic activity that resulted[2]. However, comparing economic contributions across the two years yields important insights as it highlights how sectors may be affected by future economic disruptions and identifies possible time lags in different industries. Table 7 highlights the changes in each sector that occurred between 2019 and 2020.

[1] Social Insurance taxes (Social Ins Tax), or payroll taxes, are paid under employee compensation. TOPI represents taxes on production and imports and includes 1) sales tax, 2) property tax, 3) motor vehicle license, 4) severance tax, and 5) other taxes. Personal tax has a sub-category such as 1) income tax, 2) fines and fees, 3) motor vehicle license, 4) property taxes, and 5) other tax (fishing/hunting). These tax categories are the sum of direct, indirect, and induced contributions from energy and mining to each category, not the entirety of each category itself.

[2] Appendix D contains all 2020 tables and figures.

Table 6. *Tax Contribution of Utah Energy and Mining Industries in 2019. [$ millions]*

Sector	Dividends	Social Ins Tax	TOPI	Personal Tax	Corporate Profits Tax	Row sum
Energy	**3.4**	**12.2**	**1309.2**	**168.3**	**42.6**	**1535.7**
Oil and gas extraction	0.2	1.2	126.2	15.2	2.2	144.9
Oil and gas support	0.1	1.2	58.8	14.6	1.8	76.5
Power generation	1.2	3.1	571.5	45.5	15.0	636.3
Gas distribution	0.2	0.8	63.7	10.7	2.7	78.0
Energy construction	0.5	2.2	66.2	32.2	6.5	107.6
Refinery	1.0	2.8	311.2	36.4	12.8	364.3
Oil and gas manufacturing	0.1	0.5	24.3	5.6	1.2	31.7
Wholesale-petroleum	0.0	0.0	32.1	0.2	0.0	32.3
Retail-gas	0.0	0.3	31.8	4.1	0.4	36.6
Pipeline	0.0	0.2	23.4	3.7	0.1	27.4
Mining	**2.4**	**9.3**	**441.7**	**111.6**	**29.9**	**595.0**
Coal mining	0.3	0.6	41.2	7.3	3.8	53.2
Metal mining	0.3	1.0	66.7	11.3	3.9	83.3
Nonmetal mining	0.2	0.7	39.2	6.7	2.6	49.4
Mining support	0.1	0.7	45.6	8.5	1.2	56.0
Nonmetal manufacturing	0.4	2.2	74.0	26.8	5.2	108.7
Metal manufacturing	0.9	2.8	110.0	33.8	11.0	158.6
Wholesale-mineral	0.2	1.3	65.0	17.2	2.2	85.9
All Energy & Mining	**5.8**	**21.6**	**1750.9**	**279.9**	**72.6**	**2130.8**

Note: Numbers may not add up due to rounding.

Table 7. *Comparison of the Contribution of Energy and Mining Industries Between 2019 and 2020.*

Sector	Category	Total Contribution 2019	Total Contribution 2020	% change
Energy	State GDP	$12.1 billion	$11.0 billion	-9.1%
	Jobs	74,200 jobs	58,700 jobs	-20.9%
	Earnings	$5.3 billion	$4.7 billion	-12.2%
	State Tax Revenue	$1.5 billion	$1.2 billion	-22.1%
Mining	State GDP	$7.7 billion	$8.3 billion	+7.8%
	Jobs	56,700 jobs	50,100 jobs	-11.6%
	Earnings	$3.6 billion	$3.4 billion	-4.7%
	State Tax Revenue	$0.6 billion	$0.4 billion	-35.0%

Table 7 highlights several key ideas. The first is that the energy industry was hard hit by COVID-19. The pandemic contributed to reductions in energy demand which led to price drops for both crude oil and natural gas in the second half of 2020. Crude oil was particularly hard hit, where a barrel of West Texas Intermediary (WTI) crude oil fell from an average monthly price of $60/barrel in December of 2019 to $17 per barrel in April of 2020 (Energy Information Administration (EIA), 2022). These low energy prices made the industry less profitable which led to layoffs and reduced state tax revenue. The mining industry fared comparatively better over this time period. While many mining subsectors important to the state such as copper, molybdenum, and phosphate experienced price dips in mid-2020, the dips were modest, and their prices strongly rebounded to end the year higher than they started[3]. However, total job contribution within the mining sector decreased by 11.6%, worker earnings dropped 4.7%, and tax contributions shrank by 35.0%. Table 8 breaks down these changes between 2019 and 2020 by sector for GDP and employment.

Although 2020 represented an overall economic contraction from 2019 across the energy and mining industries collectively, the effects were uneven across sectors. For the energy industry, economic output fared generally better for sectors farther down the supply chain. Value added increased for oil and gas manufacturing, pipelines, and utilities, due in part to

[3] One notable exception to this trend occurred in coal which ended 2020 at a lower price than it started.

Table 8. *Change in Contribution of Energy and Mining Sectors Between 2019 and 2020.*

Mining and Energy Industry	Value added 2019 [$ million]	Value added 2020 [$ million]	% change in value added	Employment 2019 [jobs]	Employment 2020 [jobs]	% change in jobs
Energy	**12,049**	**10,947**	**-9.1%**	**74,199**	**58,713**	**-20.9%**
Oil and gas extraction	898	642	-28.5%	7807	6703	-14.1%
Oil and gas support	756	528	-30.2%	7784	6051	-22.3%
Power generation	3924	4271	8.8%	15,474	15,093	-2.5%
Gas distribution	737	596	-19.1%	4023	2981	-25.9%
Construction related to energy	1883	1236	-34.4%	17,033	9871	-42.0%
Refinery	3083	2755	-10.6%	15,515	11,072	-28.6%
Oil and gas manufacturing	352	492	39.8%	2472	2552	3.2%
Wholesale-petroleum	46	45	-2.2%	99	109	10.1%
Retail-gas	212	199	-6.1%	3007	2997	-0.3%
Pipeline	154	181	17.5%	987	1287	30.4%
Mining	**7743**	**8343**	**7.7%**	**56,681**	**50,117**	**-11.6%**
Coal mining	749	897	19.8%	3896	3401	-12.7%
Metal mining	916	1386	51.3%	6042	6441	6.6%
Nonmetal mining	576	833	44.6%	4018	4434	10.4%
Mining support	469	355	-24.3%	4032	3604	-10.6%
Nonmetal manufacturing	1585	1586	0.1%	13,775	12,589	-8.6%
Metal manufacturing	2552	2709	6.2%	16,295	14,090	-13.5%
Wholesale mineral	895	577	-35.5%	8625	5557	-35.6%
All Energy and Mining	**19,792**	**19,290**	**-2.5%**	**130,880**	**108,830**	**-16.8%**

lower costs of raw materials. On the other side of the supply chain, output fell over 25% for oil and gas extraction, oil and gas support, and construction related to energy. Conversely, most sectors of the mining industry experienced sizable increases in GDP for 2020. Jobs in both industries were harmed at higher percentages than output. Employment related to the energy construction, refinery, and gas distribution sectors were particularly hard hit within the energy industry. While employment within the mining industry faired generally better overall compared to the energy industry, it experienced a large loss in the wholesale mineral sector for employment.

CONCLUSIONS

This report produces three key takeaways about Utah's energy and mining industries:

1) They create sizable contributions to state output, GDP, job creation, worker wages, and taxes. In 2019 the energy industry contributed approximately $12.1 billion to state GDP (6.3%), 74,200 to state employment (3.3%), and $1.5 billion to state tax revenue (14.4%). The mining industry contributed $7.7 billion GDP (4.0%), 56,700 jobs (2.7%), and $0.6 billion to state tax revenue (5.5%) that same year.

2) These industries support jobs with above average incomes for the workers they employ. Average yearly wages for jobs in the energy industry were $22,414 (45%) higher than the average yearly wage in the state. Average annual wages for jobs within the mining industry were $13,652 (27%) higher than the average yearly wage in the state.

3) Employment in these industries was sensitive to the supply chain disruptions and changes in consumption habits influenced by the beginning of the COVID-19 pandemic. The job contribution within the energy sector decreased 20.9% between 2019 and 2020. Job contribution within the mining sector fell 11.6% over that same time.

REFERENCES

Clouse, C., 2020, Output, Value Added and Double-Counting, Available Online: https://support.implan.com/hc/en-us/articles/360025171053-Output-Value-Added-Double-Counting, accessed on September 13, 2022.

Clouse, C.,2022, Multipliers, Available Online: https://support.implan.com/hc/en-us/articles/360037178313-Multipliers, accessed on June 2, 2022.

Deller, S.,2019, The Contribution of Agriculture to the Wisconsin Economy—An Update for 2017, University of Wisconsin Extension, Available Online: https://economicdevelopment.extension.wisc.edu/files/2019/08/Contribution-of-Ag-to-WI-Econ-4-Update.pdf, accessed on May 27, 2022.

Energy Information Administration. (2022b). *Cushing OK WTI Spot Price FOB*. Retrieved 10/27/2022 from https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RWTC&f=M.

French, T.,2018, What is IMPLAN, Available Online: https://blog.implan.com/what-is-implan, accessed on May 27, 2022.

Gale, L., and Kim, M-K., 2021, Economic Contribution of Utah Green Industry, Report prepared for Utah Nursery and Landscape Association (UNLA) and Utah Department of Agriculture and Food (UDAF), Applied Economics, Utah State University February 2021 (27 pages).

Henderson, H., and Evans, G., 2017, Single and Multiple Industry Economic Contribution Analysis Using IMPLAN: Research Bulletin FO468, Forest and Wildlife Research Center, Mississippi State University, Available Online: https://www.fwrc.msstate.edu/pubs/implan_2017.pdf, accessed on May 27, 2022.

Holland, D., and Wyeth, P., 1993, SAM Multipliers—Their Decomposition, Interpretation and Relationship to Input-Output Multipliers: Research Bulletin XB1027, Washington State University (46 pages).

IMPLAN, 2022a, IMPLAN Pro—Considerations of Industry Contribution, Available Online: https://support.implan.com/hc/en-us/articles/115002801513-IMPLAN-Pro-Considerations-of-Industry-Contribution-Analysis, accessed on May 27, 2022.

IMPLAN, 2022b, IMPLAN Pro—Multi-Industry Contribution Analysis, Available Online: https://support.implan.com/hc/en-us/articles/115009542247-IMPLAN-Pro-Multi-Industry-Contribution-Analysis, accessed on May 27, 2022.

IMPLAN, 2022c, IMPLAN Data Source, Available Online: https://support.implan.com/hc/en-us/articles/115009674448-IMPLAN-Data-Sources, accessed on July 21, 2022.

Leontief, W., 1936, Quantitative Input and Output Relations in the Economic System of the United States: Review of Economics and Statistics 18: 105–125. Volume 18 number 3 and pages 105 to 125.

Leontief, W., 1941, The structure of American economy 1919–1929, Cambridge, Massachusetts: Harvard University Press.

Miler, R.E., and Blair, P.D., 2009, Input-Output Analysis—Foundations and Extensions: Cambridge University Press.

Mulkey, D., and Hodges, A., 2004, Using IMPLAN to Assess Local Economic Impacts, Available Online: https://meridian.allenpress.com/jfwm/article-supplement/203506/pdf/10_3996_122011-jfwm-069_s4/, accessed on July 21, 2022.

Parajuli, R., Henderson, E., Tanger, S., Joshi, O., and Dahal, R., 2018, Economic Contribution Analysis of the Forest-Product Industry—A Comparison of the Two Methods for Multisector Contribution Analysis Using IMPLAN: Journal of Forestry v. 116 no. 6, p. 513–519.

St. Louis Federal Reserve, 2022, Gross Domestic Product—All Industry Total in Utah, Available Online: https://fred.stlouisfed.org/series/UTNGSP, accessed July 21, 2022.

Stone, R., and Brown, A., 1962, A Computable Model for Economic Growth: Cambridge Growth Project, England.

U.S. Bureau of Economic Analysis, 2021, GDP and Personal Income, Available Online: https://apps.bea.gov/iTable/iTable.cfm?reqid=70&step=30&isuri=1&year_end=-1&acrdn=4&classification=naics&state=0&yearbegin=-1&unit_of_measure=levels&major_area=0&area=12000&year=2019&tableid=31&category=431&area_type=0&statistic=1004#reqid=70&step=30&isuri=1&year_end=-1&acrdn=4&classification=naics&state=0&yearbegin=-1&unit_of_measure=levels&major_area=0&area=12000&year=2019&tableid=31&category=431&area_type=0&statistic=1004, accessed September 14, 2022.

U.S. Bureau of Labor Statistics, 2020, May 2019 State Occupational Employment and Wage Estimates Utah, Available Online: https://www.bls.gov/oes/2019/may/oes_ut.htm, accessed July 20, 2022.

Watson, P., Cooke, S., Kay, D., and Alward, G., 2015, A Method for Improving Economic Contribution Studies for Regional Analysis: Journal of Regional Analysis & Policy, v. 45, no. 1, p. 1–15.

Watson, P., Wilson, J., Thilmany, D., and Winter, W., 2007 Determining Economic Contributions and Impacts—What is the difference and why do we care? Journal of Regional Analysis and Policy v. 37, no. 2 p. 140–146.

APPENDICES

APPENDIX A

Details on North American Industry Classification System (NAICS) Sectors

Table A1. *Details on NAICS Sectors for Energy Industry.*

Sector	NAICS Code	Definition of Sector on NAICS Website	Source
Oil and gas extraction	2111	Crude petroleum extraction and natural gas extraction	https://www.naics.com/naics-code-description/?code=2111
Oil and gas support	213111	This U.S. industry comprises establishments primarily engaged in drilling oil and gas wells for others on a contract or fee basis. This industry includes contractors that specialize in spudding in, drilling in, redrilling, and directional drilling.	https://www.naics.com/naics-code-description/?code=213111#:~:text=213111%20%2D%20Drilling%20Oil%20and%20Gas%20Wells
	213112	This U.S. industry comprises establishments primarily engaged in performing support activities on a contract or fee basis for oil and gas operations (except site preparation and related construction activities). Services included are exploration (except geophysical surveying and mapping); excavating slush pits and cellars, well surveying; running, cutting, and pulling casings, tubes, and rods; cementing wells, shooting wells; perforating well casings; acidizing and chemically treating wells; and cleaning out, bailing, and swabbing wells.	https://www.naics.com/naics-code-description/?code=213112#:~:text=213112%20%2D%20Support%20Activities%20for%20Oil%20and%20Gas%20Operations&text=This%20U.S.%20industry%20comprises%20establishments,preparation%20and%20related%20construction%20activities).
Power generation	2211	This industry group comprises establishments primarily engaged in generating, transmitting, and/or distributing electric power. Establishments in this industry group may perform one or more of the following activities: (1) operate generation facilities that produce electric energy; (2) operate transmission systems that convey the electricity from the generation facility to the distribution system; and (3) operate distribution systems that convey electric power received from the generation facility or the transmission system to the final consumer.	https://www.naics.com/naics-code-description/?code=2211
Gas distribution	2212	This industry comprises: (1) establishments primarily engaged in operating gas distribution systems (e.g., mains, meters); (2) establishments known as gas marketers that buy gas from the well and sell it to a distribution system; (3) establishments known as gas brokers or agents that arrange the sale of gas over gas distribution systems operated by others; and (4) establishments primarily engaged in transmitting and distributing gas to final consumers.	https://www.naics.com/naics-code-description/?code=2212
Construction related to energy	237120	This industry comprises establishments primarily engaged in the construction of oil and gas lines, mains, refineries, and storage tanks. The work performed may include new work, reconstruction, rehabilitation, and repairs. Specialty trade contractors are included in this industry if they are engaged in activities primarily related to oil and gas pipeline and related structures construction. All structures (including buildings) that are integral parts of oil and gas networks (e.g., storage tanks, pumping stations, and refineries) are included in this industry.	https://www.naics.com/naics-code-description/?code=237120
	237130	This industry comprises establishments primarily engaged in the construction of power lines and towers, power plants, and radio, television, and telecommunications transmitting/receiving towers. The work performed may include new work, reconstruction, rehabilitation, and repairs. Specialty trade contractors are included in this industry if they are engaged in activities primarily related to power and communication line and related structures construction. All structures (including buildings) that are integral parts of power and communication networks (e.g., transmitting towers, substations, and power plants) are included.	https://www.naics.com/naics-code-description/?code=237130#:~:text=237130%20%2D%20Power%20and%20Communication%20Line%20and%20Related%20Structures%20Construction
Petroleum refinery	324110	This industry comprises establishments primarily engaged in refining crude petroleum into refined petroleum. Petroleum refining involves one or more of the following activities: (1) fractionation; (2) straight distillation of crude oil; and (3) cracking.	https://www.naics.com/naics-code-description/?code=324110

Table A1 continued. *Details on NAICS Sectors for Energy Industry.*

Sector	NAICS Code	Definition of Sector on NAICS Website	Source
Oil & gas manufacturing	32412	This industry comprises establishments primarily engaged in (1) manufacturing asphalt and tar paving mixtures and blocks and roofing cements and coatings from purchased asphaltic materials and/or (2) saturating purchased mats and felts with asphalt or tar from purchased asphaltic materials.	https://www.naics.com/naics-code-description/?code=32412
Petroleum wholesale	4247	This industry group comprises establishments primarily engaged in the merchant wholesale distribution of petroleum and petroleum products, including liquefied petroleum gas.	https://www.naics.com/naics-code-description/?code=4247#:~:text=4247%20%2D%20Petroleum%20and%20Petroleum%20Products%20Merchant%20Wholesalers&text=This%20industry%20group%20comprises%20establishments,products%2C%20including%20liquefied%20petroleum%20gas.
Gas retail	4471	Gasoline stations with convenience stores and other gasoline stations	https://www.naics.com/naics-code-description/?code=4471
Pipeline	486	Industries in the Pipeline Transportation subsector use transmission pipelines to transport products, such as crude oil, natural gas, refined petroleum products, and slurry. Industries are identified based on the products transported (i.e., pipeline transportation of crude oil, natural gas, refined petroleum products, and other products). The Pipeline Transportation of Natural Gas industry includes the storage of natural gas because the storage is usually done by the pipeline establishment and because a pipeline is inherently a network in which all the nodes are interdependent.	https://siccode.com/naics-code/486/pipeline-transportation#:~:text=NAICS%20Code%20486%20Description&text=The%20Pipeline%20Transportation%20of%20Natural,all%20the%20nodes%20are%20interdependent

Table A2. *Details on NAICS Sector for Mining Industry.*

Sector	NAICS Code	Definition of Sector on NAICS Website	Source
Coal mining	2121	Bituminous coal and lignite surface mining, bituminous coal underground mining and anthracite mining	https://www.naics.com/naics-code-description/?code=2121#:~:text=NAICS%20Codes%20that%20fall%20under,Codes
Metal mining	2122	This industry group comprises establishments primarily engaged in developing mine sites or mining metallic minerals, and establishments primarily engaged in ore dressing and beneficiating (i.e., preparing) operations, such as crushing, grinding, washing, drying, sintering, concentrating, calcining, and leaching. Beneficiating may be performed at mills operated in conjunction with the mines served or at mills, such as custom mills, operated separately.	https://www.naics.com/naics-code-description/?code=2122#:~:text=2122%20%2D%20Metal%20Ore%20Mining&text=Beneficiating%20may%20be%20performed%20at,as%20custom%20mills%2C%20operated%20separately.
Nonmetal mining	2123	This industry group comprises establishments primarily engaged in developing mine sites, or in mining or quarrying nonmetallic minerals (except fuels). Also included are certain well and brine operations, and preparation plants primarily engaged in beneficiating (e.g., crushing, grinding, washing, and concentrating) nonmetallic minerals.	https://www.naics.com/naics-code-description/?code=2123#:~:text=2123%20%2D%20Nonmetallic%20Mineral%20Mining%20and%20Quarrying&text=This%20industry%20group%20comprises%20establishments,nonmetallic%20minerals%20(except%20fuels).
Mining support	213113	This U.S. industry comprises establishments primarily engaged in providing support activities for coal mining (except site preparation and related construction activities) on a contract or fee basis. Exploration for coal is included in this industry. Exploration includes traditional prospecting methods, such as taking core samples and making geological observations at prospective sites.	https://www.naics.com/naics-code-description/?code=213113#:~:text=213113%20%2D%20Support%20Activities%20for%20Coal%20Mining
	213114	This U.S. industry comprises establishments primarily engaged in providing support activities (except site preparation and related construction activities) on a contract or fee basis for the mining and quarrying of metallic minerals and for the extraction of metal ores. Exploration for these minerals is included in this industry. Exploration (except geophysical surveying and mapping services) includes traditional prospecting methods, such as taking core samples and making geological observations at prospective sites.	https://www.naics.com/naics-code-description/?v=2017&code=213114
	213115	This U.S. industry comprises establishments primarily engaged in providing support activities, on a contract or fee basis, for the mining and quarrying of nonmetallic minerals (except fuel) and for the extraction of nonmetallic minerals (except site preparation and related construction activities). Exploration for these minerals is included in this industry. Exploration (except geophysical surveying and mapping services) includes traditional prospecting methods, such as taking core samples and making geological observations at prospective sites.	https://www.naics.com/naics-code-description/?v=2017&code=213115
Nonmetal manufacturing	327	The Nonmetallic Mineral Product Manufacturing subsector transforms mined or quarried nonmetallic minerals, such as sand, gravel, stone, clay, and refractory materials, into products for intermediate or final consumption. Processes used include grinding, mixing, cutting, shaping, and honing. Heat often is used in the process and chemicals are frequently mixed to change the composition, purity, and chemical properties for the intended product. For example, glass is produced by heating silica sand to the melting point (sometimes combined with cullet or recycled glass) and then drawn, floated, or blow molded to the desired shape or thickness. Refractory materials are heated and then formed into bricks or other shapes for use in industrial applications.	https://www.naics.com/naics-code-description/?code=327

Table A2 continued. *Details on NAICS Sector for Mining Industry.*

Sector	NAICS Code	Definition of Sector on NAICS Website	Source
Metal manufacturing	331	Industries in the Primary Metal Manufacturing subsector smelt and/or refine ferrous and nonferrous metals from ore, pig or scrap, using electrometallurgical and other process metallurgical techniques. Establishments in this subsector also manufacture metal alloys and superalloys by introducing other chemical elements to pure metals. The output of smelting and refining, usually in ingot form, is used in rolling, drawing, and extruding operations to make sheet, strip, bar, rod, or wire, and in molten form to make castings and other basic metal products.	https://www.naics.com/naics-code-description/?code=331
	332	Industries in the Fabricated Metal Product Manufacturing subsector transform metal into intermediate or end products, other than machinery, computers and electronics, and metal furniture, or treat metals and metal formed products fabricated elsewhere. Important fabricated metal processes are forging, stamping, bending, forming, and machining, used to shape individual pieces of metal; and other processes, such as welding and assembling, used to join separate parts together. Establishments in this subsector may use one of these processes or a combination of these processes.	https://www.naics.com/naics-code-description/?code=332#:~:text=332%20%2D%20Fabricated%20Metal%20Product%20Manufacturing&text=Industries%20in%20the%20Fabricated%20Metal,metal%20formed%20products%20fabricated%20elsewhere.
Mineral wholesale	4235	This industry group comprises establishments primarily engaged in the merchant wholesale distribution of products of the primary metals industries (including metal service centers) and coal, coke, metal ores, and/or nonmetallic minerals (except precious and semiprecious stones and minerals used in construction)	https://www.naics.com/naics-code-description/?code=4235#:~:text=4235%20%2D%20Metal%20and%20Mineral%20(except%20Petroleum)%20Merchant%20Wholesalers

APPENDIX B

Input-Output Modeling and Economic Contribution

This section explains how to estimate the economic contribution of the energy and mining industries to the Utah economy using Input-Output (IO) modeling. Most of the discussions in the appendix are primarily based on Deller (2019), Henderson and Evans (2017), and Parajuli and others (2018). The structure of the discussion is following Gale and Kim (2022) closely.

Utah Input-Output Model

The Input-Output (IO) table in figure B1 is constructed using the 2020 IMPLAN database for Utah. Industries are highly aggregated to six sectors for illustration purposes, that is, 1) agriculture and forestry (*agForest*), 2) mining industry (*mining*), 3) manufacturing (*mnfct*), 4) utility (*utility*), 5) trade (*trade*) and 6) finance, insurance, real estate, education, and other services (*FIRES*).

A central concept of IO modeling is the interrelationship between the producing sectors of the region, the consuming sectors (e.g., households), and the rest of the world (i.e., regional imports and exports). In the IO table in figure B1, it is possible to read across the industry row to determine total commodity demand. That is, each row accounts for the sales by the industry named at its left to the industries identified across the top of the table and to the final consumers listed in the right-hand section of the row. It is composed of commodities consumed by activities in production (intermediate demand) (the box labeled A activities), household consumption, other demand (= government consumption and investment), and exports. The sum of a row is the total output or total sales of an industry. For example, sales by the mining industry are shown in row two of figure B1 as the total output worth $5,374 million. $1,205 million is sold to the *mnfct* (which processes it for further sale), $122 million is sold to *utility* industry, and $2,861 million is sold outside of Utah. Household consumption is $20 million. Within the mining industry itself, $102 million is sold.

Each column in figure B1 reports payments (purchases or other inputs) made from the industry identified at the top of the column to the entities named at the left. Below the box labeled A, payments by the industry to employees, holders of capital, and indirect business taxes are found in box labeled V, value-added. Exogenous purchases are purchases from industries outside the region and are identified as import or categorized as other payments. The sum of the entries in each column represents the total purchases by the industry.

	Industry						Exogenous			
	agForest	mining	mnfct	utility	trade	FIRES	HH	Other	Export	Total
Industry	A									
agForest	99	0	1036	0	7	35	230	21	669	**2097**
mining	4	102	1205	122	4	59	20	999	2861	**5374**
mnfct	130	217	10980	17	817	3631	6101	18835	52982	**93711**
utility	11	48	538	1112	330	1207	1094	148	1100	**5589**
trade	181	299	9529	211	4285	4084	20031	1225	9590	**49435**
FIRES	183	1132	7464	543	11174	55113	67864	31600	36207	**211278**
Value-added	V									
EC	309	878	17846	565	16130	72563				
PI	347	1	2478	422	2273	6762				
Oth PI	433	1647	16369	1421	7013	46531				
IBT	-147	243	-731	420	2831	2102				
Exogenous										
Oth pymt	19	41	444	14	390	1928				
Import	529	767	26553	741	4181	17264				
	2097	**5374**	**93711**	**5589**	**49435**	**211278**				

Figure B1. *Aggregate Input-Output Table for Utah, 2020 [$ million]. agForestry = agriculture, forestry, hunting and mining; Manufacture = utilities, construction and manufacturing; FIRES= wholesale and retail trade, transportation, finance, insurance, real estate, education, and other services; EC = employee compensation (wage); PI = proprietors' income, Oth PI = other property type income; IBT = indirect business tax, taxes on production and imports; Oth pymt = Federal + State taxes or expenditure, and changes in capital and inventory additions/deletions, HH = Household consumption, Other = Government expenditure + changes in capital and inventory additions/deletions.*

Since profits, losses, depreciation (capital), taxes, etc., are recorded in the table, the total purchases and payments must equal to total sales or inputs equal to outputs. So, it is called "Input Output" table. For example, the purchases and payments of the *mining* industry are shown in column 2 of Figure B1, $0.5 million from *agForest*, $217 million from *mnfct*, $48 million from *utility*, $299 million from *trade*, and $1132 million from FIRES. There is the payment to labor (EC: employee compensation), $878 million, proprietors' income (PI), $1 million, and other property income, $1647 million. Utah *mining* industry imports from outside the state is $767 million. Notice that the total inputs, $5,374 million is the same as the total outputs identified in row 2. If the patterns of expenditures made by a sector are stated in terms of proportions, this means that the proportions of all inputs needed to produce one dollar of output in a given sector can be used to identify linear production relationships. This is accomplished by dividing the dollar value of inputs purchased from each sector by total expenditures. Or each transaction in a column is divided by the column sum. The resulting table is called the "direct requirements" table as in Figure B2.

	Industry					
	agForest	mining	mnfct	utility	trade	FIRES
Industry	A					
agForest	0.047	0.000	0.011	0.000	0.000	0.000
mining	0.002	0.019	0.013	0.022	0.000	0.000
mnfct	0.062	0.040	0.117	0.003	0.017	0.017
utility	0.005	0.009	0.006	0.199	0.007	0.006
trade	0.086	0.056	0.102	0.038	0.087	0.019
FIRES	0.087	0.211	0.080	0.097	0.226	0.261
Value-added	V					
EC	0.147	0.163	0.190	0.101	0.326	0.343
PI	0.165	0.000	0.026	0.076	0.046	0.032
Oth PI	0.207	0.306	0.175	0.254	0.142	0.220
IBT	-0.070	0.045	-0.008	0.075	0.057	0.010
Exogenous						
Oth pymt	0.009	0.008	0.005	0.003	0.008	0.009
Import	0.252	0.143	0.283	0.133	0.085	0.082
Sum	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**

Figure B2. *Direct Requirement Table. FIRES= wholesale and retail trade, transportation, finance, insurance, real estate, education, and other services; EC = employee compensation (wage); PI = proprietors' income, Oth PI = other property type income; IBT = indirect business tax, taxes on production and imports; Oth pymt = Federal + State taxes or expenditure, and changes in capital and inventory additions/deletions, HH = Household consumption, Other = Government expenditure + changes in capital and inventory additions/deletions.*

The direct requirements table can only be read down each column. Each cell represents the dollar amount of inputs required from the industry or other entity named at the left to produce one dollar's worth of output from the sector named at the top. The upper part of the table (box A) is often referred to as the "technical coefficients." In this example, for every dollar of sales by the *mining* industry, requires no output from *agForest*, 1.9 cents worth of additional output from itself, 4.0 cents of output from *mnfct*, 0.9 cents from *utility*, 5.6 cents from *trade*, and 21 cents from FIRES. 16.3 cents will be paid as the wage and 14.3 cents worth of inputs are imported for one dollar of output in the mining industry.

Economic Impact Analysis

An economic impact analysis (EIA) examines the effect of an event on the economy. The impact analysis reveals the ripple effect of new or foregone revenues from possible entry and exit of a particular firm or business within a sector or changes in exogenous final demand. The effects of the change on the other sectors can be predicted using Figure B2. For example, assume that export demand for the Utah *mining* industry increases by $1,000. From Figure B2, any new final demand for the *mining* industry will require purchases from the other sectors of the economy. The amounts shown in the second column are multiplied by the change in final demand to give the following figures: $0.09 (= 0.0009 x $1,000) from *agForest*, $19 (= 0.019 x $1,000) from *mining*, $40 (= 0.040 x $1,000) from *mnfct*, $9 (= 0.009 x $1,000) from *utility*, $56 (= 0.056 x $1,000) from *trade*, and $211 (= 0.211 x $1,000) from FIRES. These are called the (first round) indirect effects and, in this example, they amount to $334. The total impact on the economy is $1,334 (the initial change, $1,000 plus the total (first round) indirect effects, $334).

As Deller (2019) pointed out, the strength of IO modeling is that it does not stop at this point, but also measures the additional rounds of indirect effects of an increase in *mining* industry exports. In this example, *mining* industry increased purchases of *mnfct* goods by $40. To supply *mining* industry's new needs from *mnfct*, the *mnfct* sector must increase its production by $40 to accomplish this. Firms in *mnfct* sector must purchase additional inputs from the other regional sectors to produce this $40 of output. *agForest* and FIRES must purchase additional inputs as well. Continuing our $1,000 increase in export demand for the Utah *mining* industry(i.e., after many rounds of indirect changes), the total indirect effects are $1 in *agForest*, $20 in *mining*, $54 in *mnfct*, $15 in *utility*, $76 in *trade*, and $322 in FIRES. The total impact will be $1,000 (initial direct effect) plus $488 (indirect effect) or $1,488.

Typically, the result of the direct and indirect effects is presented as a "total requirements table," or the Leontief inverse table (figure B3). Each cell in Figure B3 indicates the dollar value of output from the sector named at the left that will be required in total (i.e., direct plus indirect) for a one dollar increase in final demand for the output from the sector named at the top of the column. For example, the element in the second row of the second column, 1.020, indicates the total dollar increase in output of *mining* industry that results from a $1 increase in final demand for *mining* products is $1.020 (for every dollar of direct *mining* output sales, there will be an additional 2.0 cents of economic activity as measured by industry sales). The element in third, fourth, fifth and sixth rows for *mining* sector column, 0.054, 0.015, 0.076, and 0.322 indicate that the total increase in *mnfct*, *utility*, *trade* and FIRES due to a dollar increase in the demand for *mining* industry are 5.4 cents and 1.5 cents, 7.6 cents, and 32.2, respectively.

	Industry					
	agForest	mining	mnfct	utility	trade	FIRES
agForest	1.050	0.001	0.013	0.000	0.001	0.001
mining	0.003	1.020	0.015	0.028	0.001	0.001
mnfct	0.079	0.054	1.140	0.011	0.028	0.027
utility	0.010	0.015	0.011	1.251	0.012	0.010
trade	0.112	0.076	0.133	0.059	1.106	0.033
FIRES	0.169	0.322	0.171	0.192	0.343	1.367
Sum	**1.424**	**1.488**	**1.484**	**1.540**	**1.490**	**1.439**

Figure B3. *Total Requirements Table (Leontief Inverse Table)*

Through the discussion of the total requirements table, the notion of external changes in final demand rippling throughout the economy was introduced. The total requirements table can be used to compute the total impact a change in final demand for one sector will have on the entire economy. Specifically, the sum of each column shows the total increase in regional output resulting from a $1 increase in final demand for the column heading sector. In the *mining* industry example, an increase of $1 in the demand will yield a total increase in regional output equal to $1.488. This number represents the initial dollar increase (direct effect) plus 48.8 cents (indirect effects). The column totals are often referred to as Type I output multipliers. If the initial change is $1,000 as in the above example, Type I effect is $1,488, which is the sum of $1000 and $488 indirect change.

The IO model and resulting (Type I) multipliers described up to this point present only part of the story. In this construction of the total requirements table and the resulting multipliers in figure B3, the production technology does not include labor (it is an open model in the terminology of IO modeling). In this case, the multiplier captures only the initial effect (initial change in final demand or the initial shock) and the impact of industry-to-industry sales. A more complete picture would include labor in the total requirements table. In the terminology of IO modeling, the model should be *closed* with respect to labor. If this is done, we have a different type of multiplier, specifically a Type II multiplier, which is composed of the initial and indirect effects as well as what is called the "induced effects." The Type II multiplier is a more comprehensive measure of economic impact because it captures industry to industry transactions (indirect) as well as the impact of labor spending income in the economy (induced effect).

Notice that, to meet the new outputs described above, each sector pays its workers. For example, *mining* industry pays 16.3 cents per dollar of (additional) output as reported in Figure B2. The $1,000 increase in *mining* industry results in $1,020 changes in output, and thus *mining* industry pays an additional $166 (= 0.163 x $1,020) as employee compensation. Similarly, *agForest*, *mnfct*, and FIRES sectors pay additional wages due to the new outputs. In the case of *mining* industry, the induced

effect is calculated to be $310 per dollar of change in exogenous demand. In other words, $1,000 increase in export in *mining* industry results in $310 induced output changes. All told, the total economic impact (sum of direct, indirect, and induced) is $1,789 (= direct, $1,000 + indirect $488 + induced $310). The Type II multiplier is calculated as 1.798.

Economic Contribution Analysis

While economic impact and contribution analyses are two different concepts with meaningful differences in regional economic analysis, both terms are used interchangeably, yielding confusion among practitioners (Watson et al., 2007; Henderson and Evans, 2017; Parajuli et al., 2018). The economic contribution analysis, for example, captures gross change in the region's existing economy (relative importance of an existing industry to an economy), whereas the impact analysis reveals the ripple effect of new activity (exogenous demand change) (Henderson and Evans, 2017; Parajuli and others, 2018; IMPLAN 2022a, 2022b). In other words, contribution analysis is about looking at how the current state of the sector supports other businesses in the local economy. Using the total production values to represent the sector's final demands in an IO model will overestimate the value of the sector of interest and its associated economic contribution to other sectors of the economy (Henderson and Evans, 2017).

As discussed in Henderson and Evans (2017), Parajuli and others (2018), and IMPLAN (2022a, 2022b), economic contribution analysis (ECA) uses the IO table as in impact analysis. The difference is that ECA estimates the direct and indirect effects of the sector *in situ*, that is, without assuming any external change in the final demands. Since the final demand remains unchanged, the analysis focuses on calculating a value that represents the direct contribution of a sector of the economy such that the sum of the total output is preserved. The contribution of an existing sector of the economy can be calculated with an adjustment factor that preserves the output values in the transactions table and the adjustment factor is the reciprocal of the sector's Type I multiplier. In the previous example, a Type I multiplier for the *mining* industry is 1.488. The direct contributions made by the *mining* industry are total output of the *mining* industry 1.448^{-1}, which is $3,612 million = $5,374 million/1.488. It is a value which fully preserves the transaction table's output value for *mining* industry.

APPENDIX C

IMPLAN and Data

This section explains IMPLAN data which are used to build the Utah Input-Output (IO) table based on Mulkey and Hodges (2004) and IMPLAN (2022c).

IMPLAN is an acronym for *Impact Analyses and Planning*. It is a computer software package that includes procedures for estimating local IO models and associated databases (Mulkey and Hodges, 2004). The IMPLAN system was initially created by the U.S. Forest Service in cooperation with the Federal Emergency Management Agency and the U.S. Department of the Interior's Bureau of Land Management to assist in land and resource management planning (Mulkey and Hodges, 2004). IMPLAN has been maintained by the IMPLAN company with exclusive rights. More information about the IMLPAN system is available at https://implan.com.

The IMPLAN Database: According to Mulkey and Hodges (2004), the economic data for the IMPLAN model comes from the system of national accounts for the United States based on data collected by the U.S. Department of Commerce, the U.S. Bureau of Labor Statistics, and other federal and state government agencies. Data is collected for industry sectors of the Utah economy corresponding to the North American Industry Classification System (NAICS). Data provided for each industry sector include outputs and inputs from other sectors, value added, employment, wages and business taxes paid, imports and exports, final demand by households and government, capital investment, business inventories, marketing margins, and inflation factors (deflators) (Mulkey and Hodges, 2004). National and Utah data are the basis for IMPLAN calculations of IO tables and multipliers for the Utah economy. IMPLAN processes and adjusts these data to build the IO table and Social Account Matrix for further analysis and to be consistent with economic theory suggested by Leontief (1936, 1941), which is described in Appendix B

Output: According to IMPLAN (2022c), output data mostly rely on the Bureau of Economic Analysis's (BEA) annual Industry Accounts and the Annual Survey Manufacturers. Retail data come from the U.S. Census Bureau's Annual Census of Retail Trade. Farm sector output estimates come from the United States Department of Agriculture's National Agricultural Statistics Service, Economic Research Service, and Census of Agriculture data sets. Output for the electricity generation, oil and gas extraction, and petroleum refining industries rely on Energy Information Administration (EIA) data. Other industries use information from other various surveys and censuses.

Employment and labor income: According to IMPLAN (2022c), employment and income (Employee Compensation [EC] and Proprietor Income [PI]) data come from BEA Regional Economic Accounts (REA), and Census of Employment and Wage (CEW).

Value added: According to IMPLAN (2022c), value added consists of EC, PI, Other Property Income (OPT) and Taxes on Production and Imports (TOPI). EC and PI come from the above sources; OPI and TOPI are based on BEA state-level GDP data.

APPENDIX D

Economic Contribution for 2020

Table D1. *Total Economic Contribution of Total Energy and Mining Industries to Utah's Economy in 2020.*

Economic Category	Total Contribution	% of State Total
Employment	108,832 jobs	5%
State GDP	$19.3 billion	10%
State Output	$41.7 billion	11%
Total Earnings	$8.1 billion	7%
State and Local Tax Revenue	$1.5 billion	11%

Table D2. *Total Economic Contribution of Energy and Mining Industries to Utah's Economy in 2020 by Sector.*

Sector	Category	Total Contribution from Sector	% of Utah's Total Economy
Energy	State GDP	$11.0 billion	6%
	Jobs	58,716 jobs	3%
	Earnings	$4.7 billion	4%
	State Tax Revenue	$1.1 billion	8%
Mining	State GDP	$8.3 billion	4%
	Jobs	50,116 jobs	2%
	Earnings	$3.4 billion	3%
	State Tax Revenue	$0.4 billion	3%

Table D3. *Contribution of Utah Energy and Mining Industries in 2020.*

Industry	Output [$ million]	Value added [$ million]	Earnings [$ million]	Employment [jobs]	State Tax Revenue [$ million]
Energy	**24,477**	**10,947**	**4681**	**58,713**	**1336**
Oil and gas extraction	1655	642	439	6703	126
Oil and gas support	1227	528	376	6051	42
Power generation	8479	4271	1637	15,093	562
Gas distribution	1036	596	281	2981	52
Construction related to energy	1958	1236	615	9871	21
Refinery	8190	2755	895	11,072	227
Oil and gas manufacturing	1141	492	191	2552	27
Wholesale-petroleum	57	45	7	109	30
Retail-gas	372	199	138	2997	24
Pipeline	361	181	101	1287	25
Mining	**17,208**	**8343**	**3410**	**50,117**	**336**
Coal mining	1434	897	233	3401	37
Metal mining	2379	1386	460	6441	65
Nonmetal mining	1412	833	301	4434	60
Mining support	937	355	250	3604	36
Nonmetal manufacturing	3376	1586	818	12,589	60
Metal manufacturing	6581	2709	989	14,090	94
Wholesale-mineral	1090	577	361	5557	41
All Energy and Mining	**41,685**	**19,290**	**8091**	**108,830**	**1472**

Note:

[1] Contribution is the sum of direct, indirect, and induced effects

[2] Numbers may not add up due to rounding

Table D4. *Tax Contribution of Utah Energy and Mining Industries in 2020 [$ million].*

Industry	Dividends	Social Ins Tax	TOPI[1]	Personal Tax	Corporate Profits Tax	Row sum
Energy	**3.41**	**0.46**	**978**	**124.2**	**29.95**	**1136**
Oil and gas extraction	0.05	0.05	114	11	0.45	126
Oil and gas support	0.08	0.04	31	10	0.68	42
Power generation	1.36	0.14	505	44	11.99	562
Gas distribution	0.18	0.03	42	8	1.55	52
Construction related to energy	0.41	0.06	1	16	3.58	21
Refinery	1.08	0.10	192	23	9.51	227
Oil and gas manufacturing	0.18	0.02	20	5	1.61	27
Wholesale-petroleum	0.00	0.00	30	0.2	0.03	30
Retail-gas	0.03	0.01	21	4	0.23	24
Pipeline	0.04	0.01	22	3	0.32	25
Mining	**3.04**	**0.38**	**256**	**90**	**26.83**	**377**
Coal mining	0.42	0.03	27	6	3.66	37
Metal mining	0.57	0.05	47	12	5.05	65
Nonmetal mining	0.32	0.03	33	8	2.86	44
Mining support	0.05	0.03	29	7	0.42	36
Nonmetal manufacturing	0.48	0.09	33	21	4.22	60
Metal manufacturing	1.08	0.11	57	26	9.56	94
Wholesale-mineral	0.12	0.04	30	10	1.06	41
All Energy and Mining	**6.45**	**0.84**	**1234**	**214**	**56.78**	**1513**

[1]TOPI represents taxes on production and imports and includes 1) sales tax, 2) property tax, 3) motor vehicle license, 4) severance tax, and 5) other taxes. Personal tax has a sub-category such as 1) income tax, 2) fines and fees, 3) motor vehicle license, 4) property taxes, and 5) other tax (fishing/hunting). These tax categories are the sum of direct, indirect, and induced contributions from energy and mining to each category, not the entirety of each category itself.

Table D5. *Normalized Contribution of Utah's Energy and Mining Industries in 2020.*

Industry	Output Multiplier	Employment Multiplier	Income Multiplier
Energy	**1.66**	**3.35**	**2.31**
Oil and gas extraction	2.11	3.90	4.07
Oil and gas support	2.08	2.45	2.11
Power generation	1.85	4.82	2.19
Gas distribution	1.66	4.57	1.89
Construction related to energy	1.65	1.76	1.64
Refinery	1.38	8.80	3.18
Oil and gas manufacturing	1.78	4.37	2.94
Wholesale-petroleum	1.27	3.31	2.31
Retail-gas	2.14	1.68	1.81
Pipeline	1.92	4.66	2.30
Mining	**1.64**	**2.89**	**2.35**
Coal mining	1.42	2.48	2.06
Metal mining	1.53	3.11	2.62
Nonmetal mining	1.59	2.42	2.07
Mining support	1.90	3.27	2.21
Nonmetal manufacturing	1.90	2.52	2.24
Metal manufacturing	1.55	3.73	2.76
Wholesale-mineral	2.00	2.02	2.55
All Energy and Mining	**1.65**	**3.12**	**2.33**

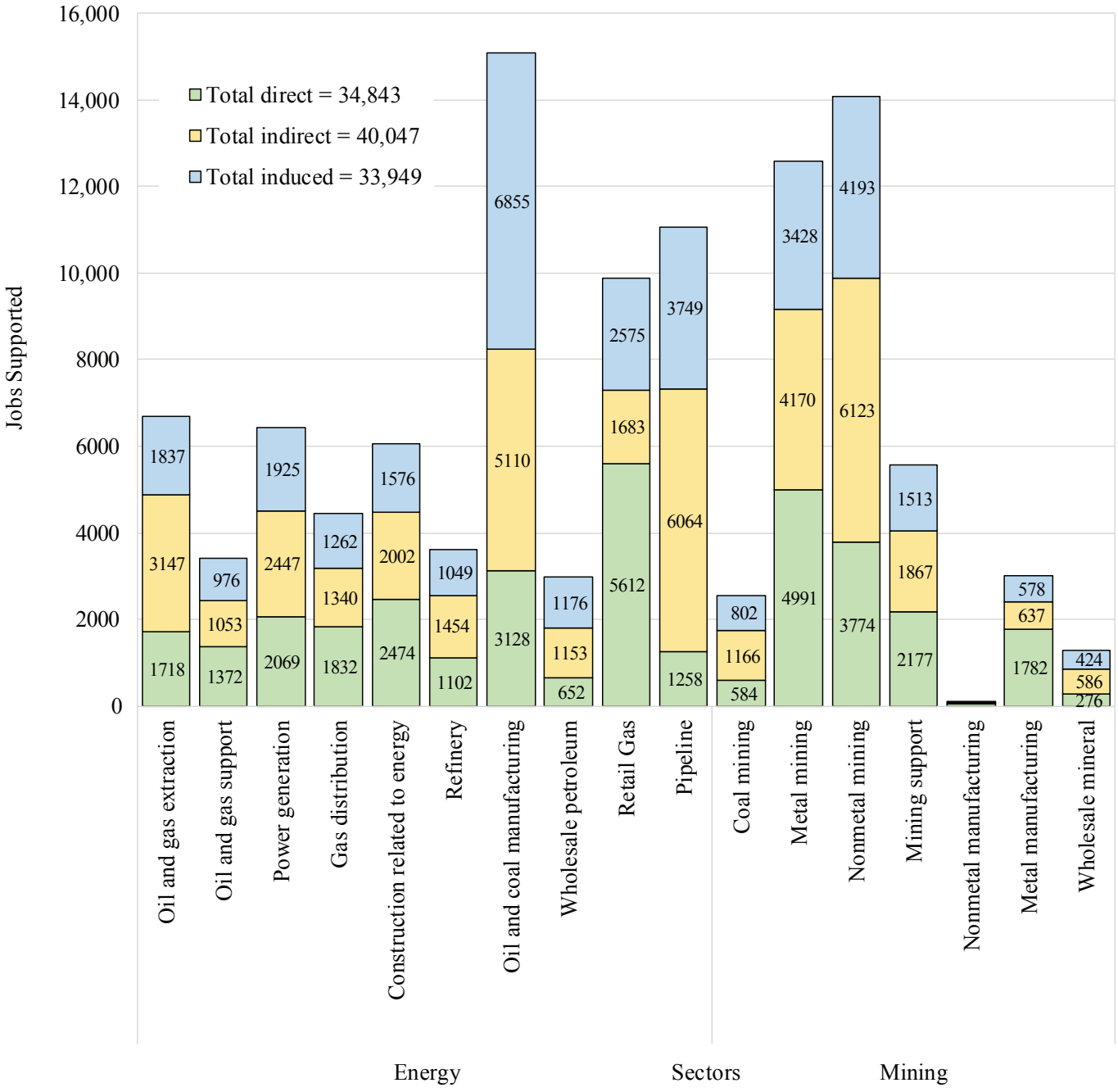

Figure D1. *Energy and Mining Employment Contributions in 2020.*

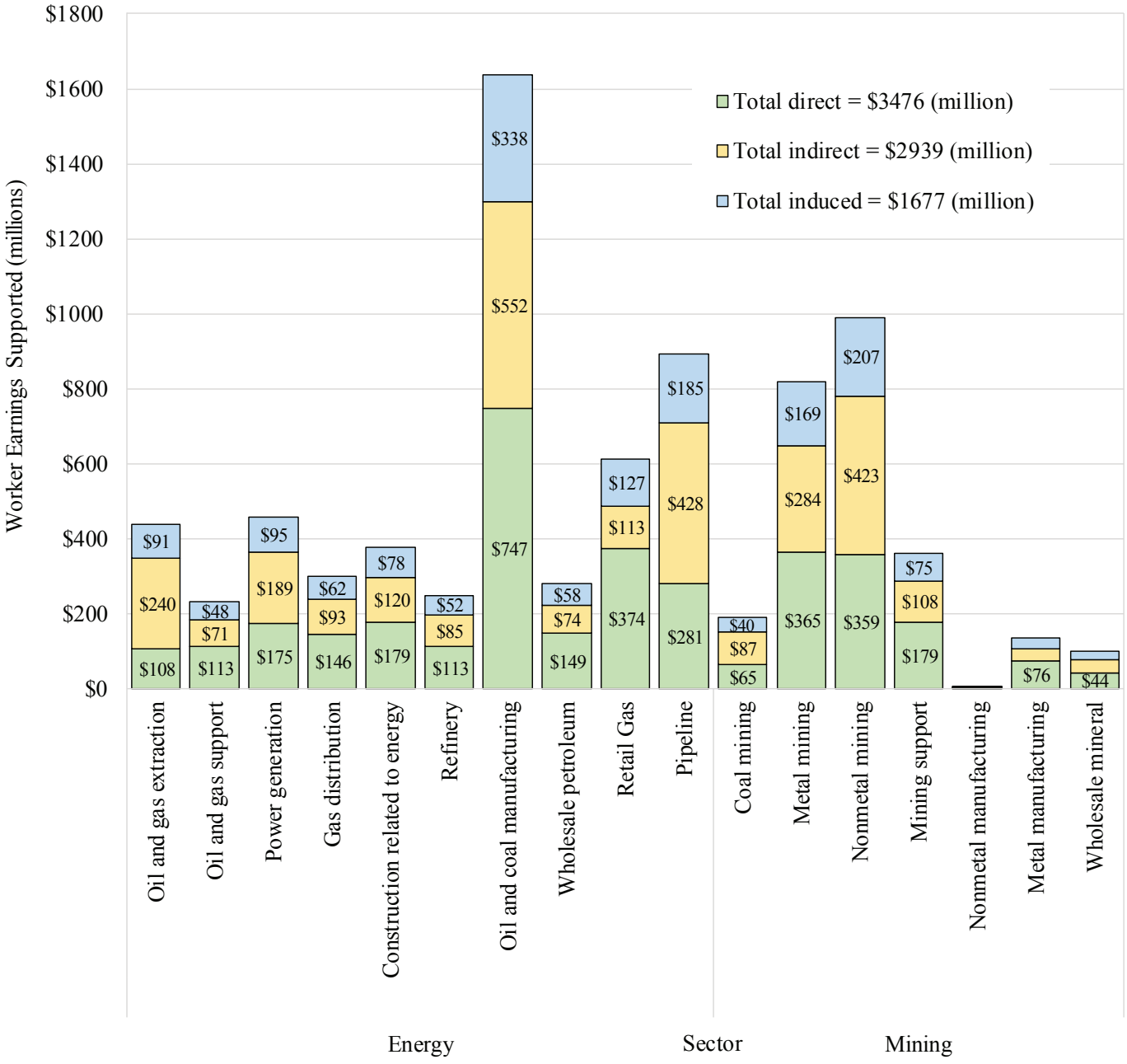

Figure D2. *Energy and Mining-related Labor Income (wages) in 2020.*

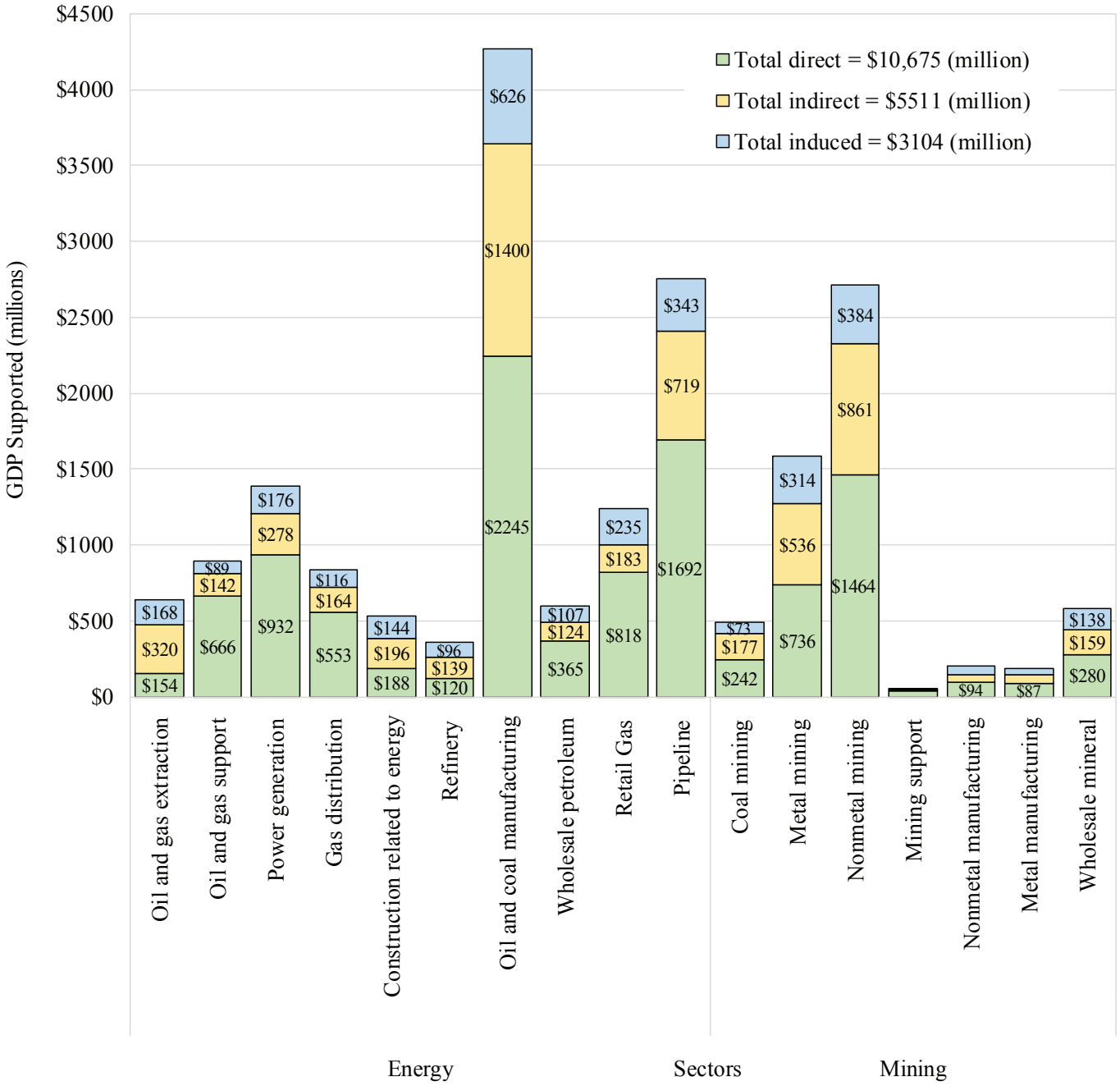

Figure D3. *Energy and Mining Contribution to State GDP in 2020.*

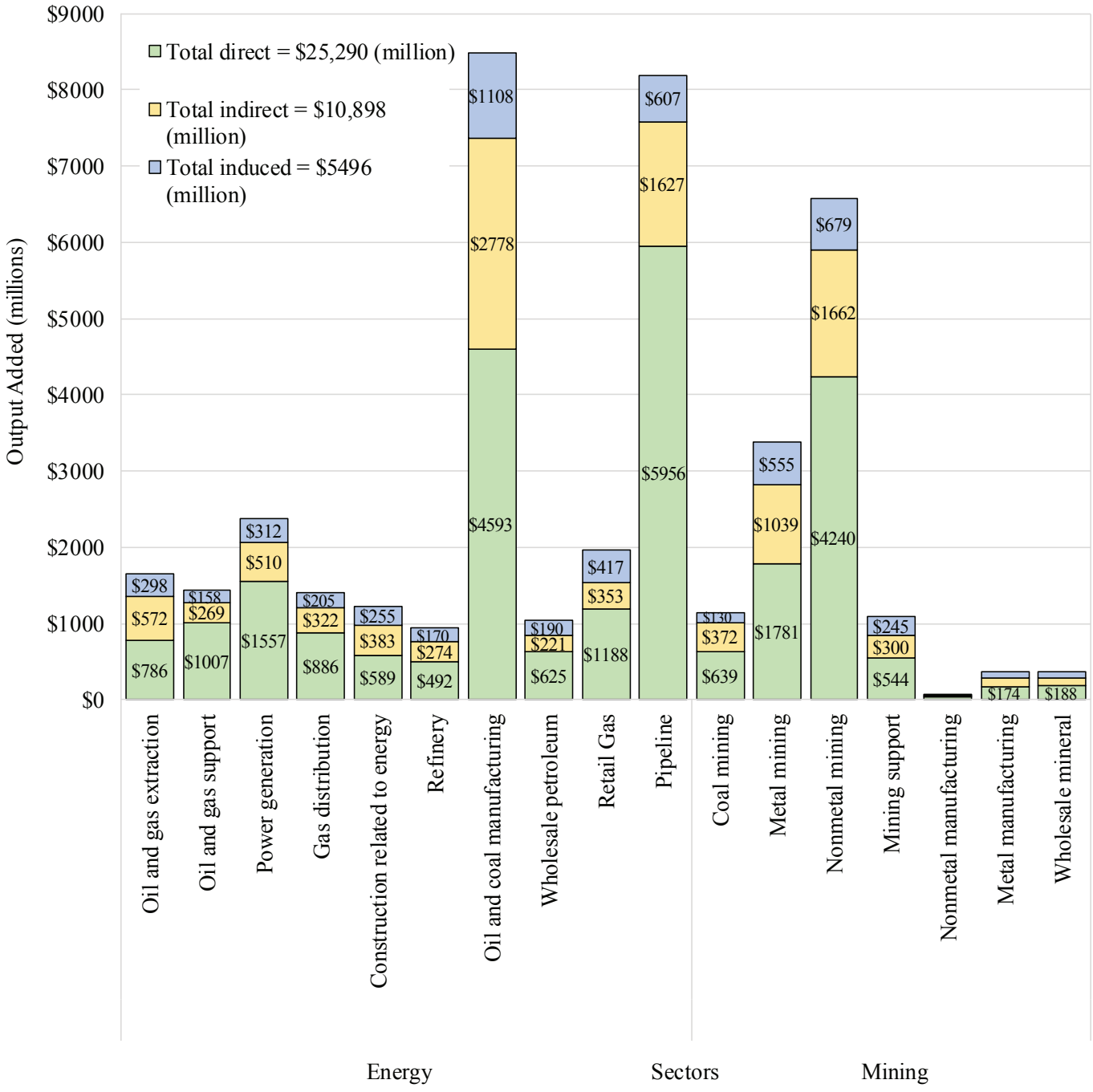

Figure D4. *Energy and Mining-related Economic Output in 2020.*