Supplementary Information

Decarbonizing the US power system presents diverse challenges and opportunities in the changing employment landscape

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1 ReEDS Standard Scenarios

Figures S1 and S2 show the snapshots of the capacities and generations, respectively, of the start and end of the model planning horizon (2022-2050). These data from from the 2021 Standard Scenarios [1]. Figure S3 represents the emission outcomes of those scenarios.

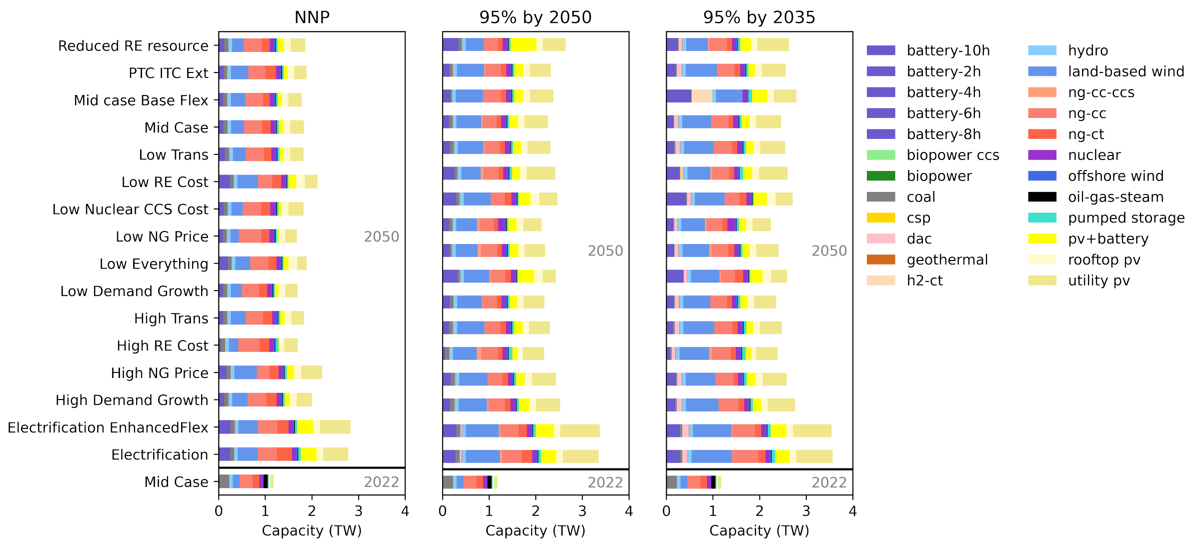

Fig. S1: The capacities of different power technologies in the US in 2022 and 2050 across the ReEDS Standard Scenario outputs. Data source: [1].

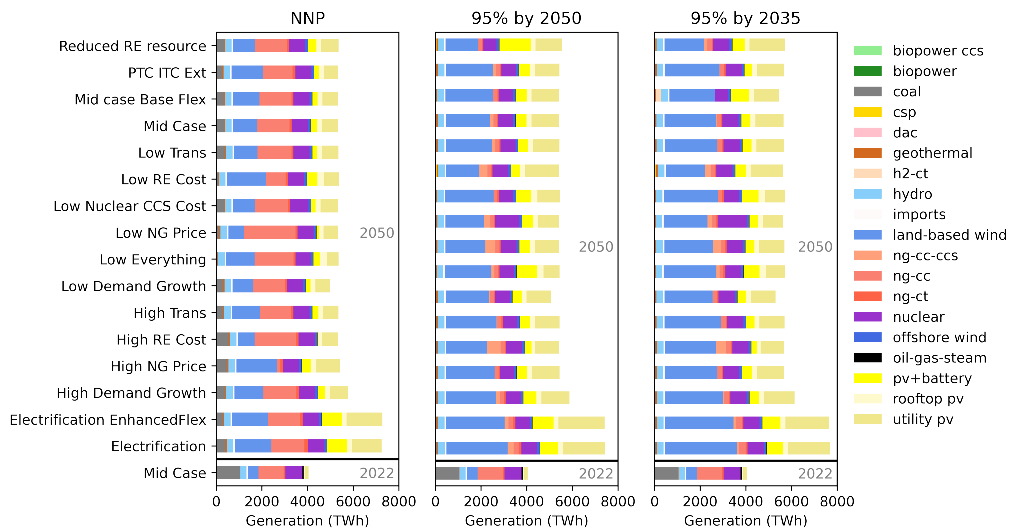

Fig. S2: The electricity generation of different power technologies in the US in 2022 and 2050 across the ReEDS Standard Scenario outputs. Data source: [1].

Table S1 shows the lifetime and construction time assumption in the ReEDS model Documentation [2]. Since the 15-year lifetime of batteries is shorter than the planning horizon of this work (2022-2050), those built before 2036 were rebuilt after the lifetime if their capacity was needed. The construction time for DAC is assumed to be 2 years based on ClimeWorks data [3].

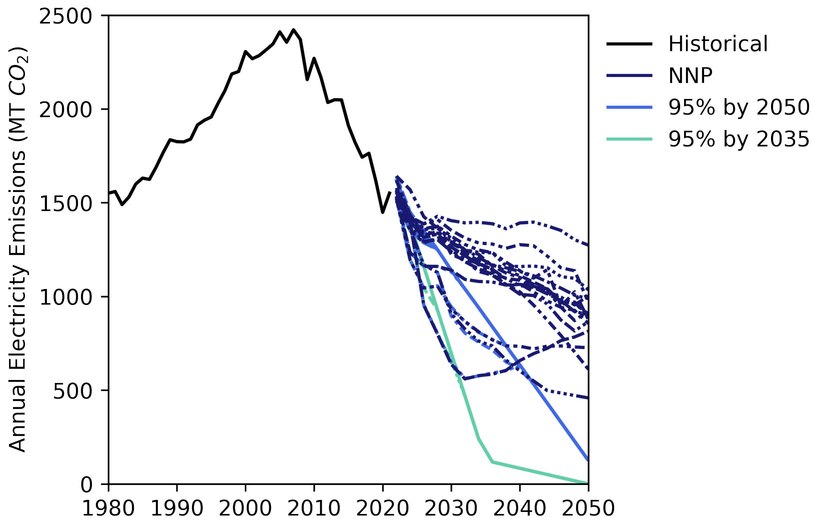

Fig. S3: The electricity sector emission scenarios in the US in 2022 and 2050 across the ReEDS Standard Scenario outputs. Data source: [1].

Table S1: Lifetime and construction time assumptions of technologies in the ReEDS model. The values in the parentheses show the lifetimes for units larger than 100MW. The time unit is year. Data Source: [2]

Technology	Lifetime	Construction Time
Land-based wind	30	3
Offshore wind	30	3
Solar PV	30	1
Concentrating Solar Power	30	3
Geothermal	30	4
Hydropower	100	3
Biopower	50	4
Marine hydrokinetic	20	3
Battery	15	1
Natural gas combustion turbine	50	3
Natural gas combined cycle and CCS	60	3
Coal, all technologies, including cofired	65 (75)	6
Oil-gas-steam (OGS)	50 (75)	6
Nuclear	80	6

2 Original JEDI Models

The suite of JEDI models used in this analysis includes biopower, coal, concentrated solar power (csp), geothermal, hydropower, land-based wind, natural gas combined cycle (ng-cc), offshore wind, photovoltaics (both rooftop and utility), and transmission. The generation and capacity expansion of the power technologies were from the ReEDS Standard Scenario Viewer [1]. The transmission line data is from the assumptions in the ReEDS model Documentation [2]. The model versions used can be found in Table S2.

Table S2: Original JEDI models used for ReEDS technologies and their respective versions.

Technology	JEDI Model
biopower	01d-jedi-biopower-model-rel-b12-23-16
coal	01d-jedi-coal-model-rel-c12-23-16
csp	01d-jedi-csp-trough-model-rel-csp12-23-16
geothermal	01d-jedi-geothermal-model-rel-gt12-23-16
hydro	01d-jedi-chydro-model-rel-ch12-23-16
land-based wind	01d-jedi-land-based-wind-model-rel-w6-28-19
ng-cc	01d-jedi-ngas-model_rel-ng4-17-17
offshore wind	01d-jedi-offshore-wind-model-rel-osw10-24-17
rooftop pv	01D_JEDI_PV_Model_rel._PV05.20.21
utility pv	01D_JEDI_PV_Model_rel._PV05.20.21
transmission	01d-jedi-transmission-line-model_rel-tl12-23-16

Based on the Energy Information Administration's Form 860 [4], the nameplate capacities of the existing generator fleet can vary across different states (Figures S4 and S5). The nameplate capacity of technology could determine the job implications, especially in the construction, installation, and fixed O&M components. The effect of the economy of scale could result in lower job creation per unit of capacity with a larger generator. The output of the ReEDS model, however, does not specify the detailed capacity information of the new builds. For the simplicity of calculation, we assume a uniform generator nameplate capacity for each technology in each state. This uniform name capacity is based on the lower quartile, median, and upper quartile of the existing fleet built after 1990 (the past 30 years). For those without an existing fleet, the nameplate capacity was assumed to be the median of the existing national fleet. Note that some of the largest facilities were excluded as outliers in the statistical analysis. These include,

- a battery facility in CA (250MW)
- a geothermal facility in CA (1163MW)
- hydropower facilities in WA (6809MW – Grand Coulee Dam, 2456.2MW – Boundary Dam, and 1250MW), TN (1713.6MW - Raccoon Mountain pumped hydro), VA (2862MW - Bath County pumped hydro), NY (2429.1MW - Robert Moses Niagara dam), OR (2160MW - John Day Dam), and MI (1978.8MW - Ludington pumped hy-

dro)

- Oil gas steam in NY (1803.6MW - Oswego Harbor Power) and MA (1165MW - Canal)
- Solar PV in CA (585.9MW - Topaz Solar Farm)

Figures S6 and S7 below show the CIM and O&M job creation of each JEDI model in each state. The nameplate capacities evaluated include the three orders of magnitude from the lowest capacity currently installed, and from there, three data points linearly spaced until the largest capacity currently installed. The capacity factors for combustion-based technologies were assumed to be 100%.

Natural gas combined cycle, coal, and photovoltaics showed the smallest job creation dependency on nameplate capacity. The former two also showed the most variations in the capacities of the existing technology fleet. Biopower, hydro, land-based wind, and geothermal showed the most variations in the lower capacity range and plateaus towards larger capacities. Concentrated solar showed continuously increasing productivity in larger capacities.

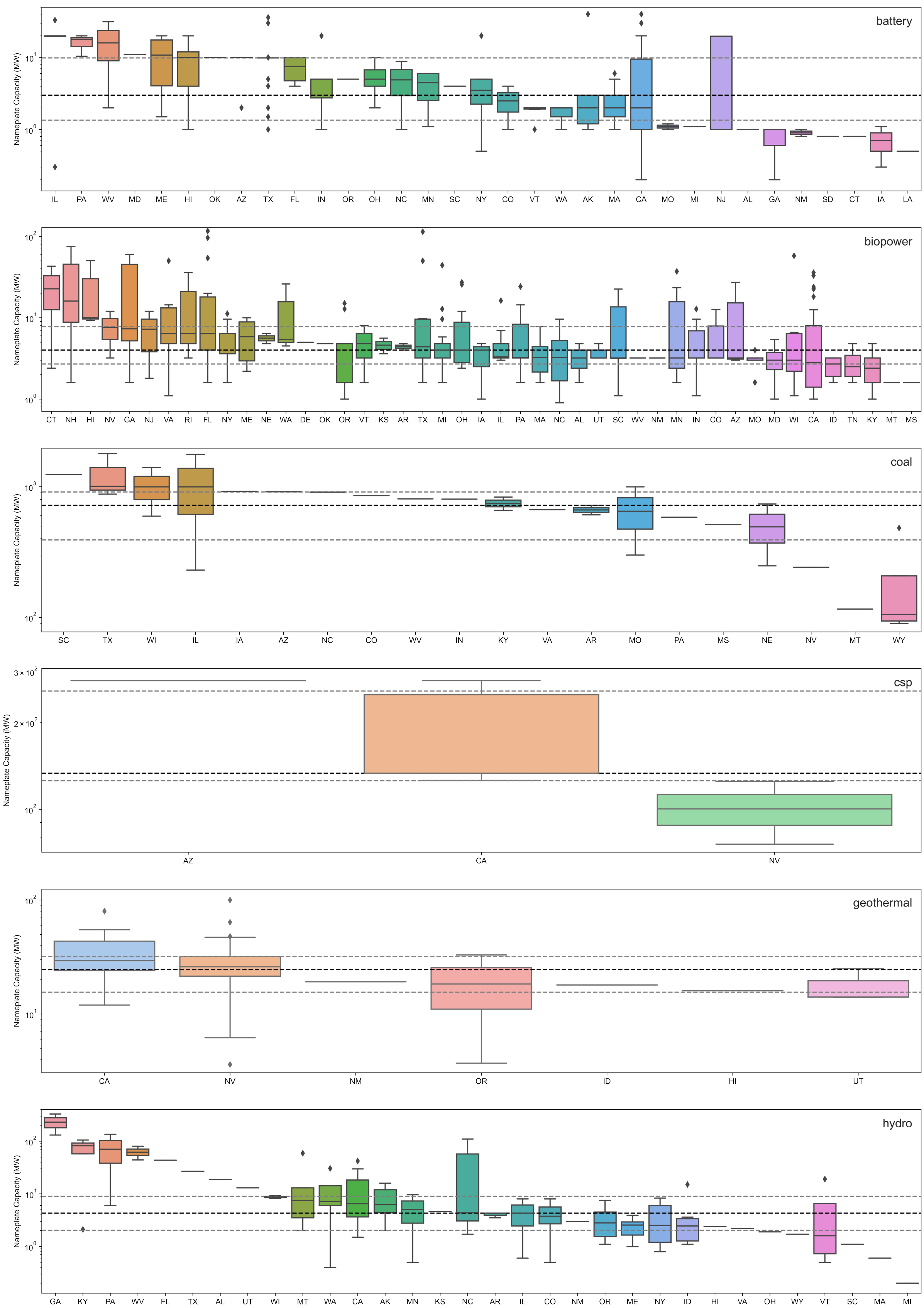

Fig. S4: The nameplate capacities of the existing fleet of battery, biopower, coal, concentrated solar, geothermal, and hydro in each state with an existing fleet. The box plots show the median and the interquartile range of the dataset. The dashed lines represent that information at the national level. Data source: [4].

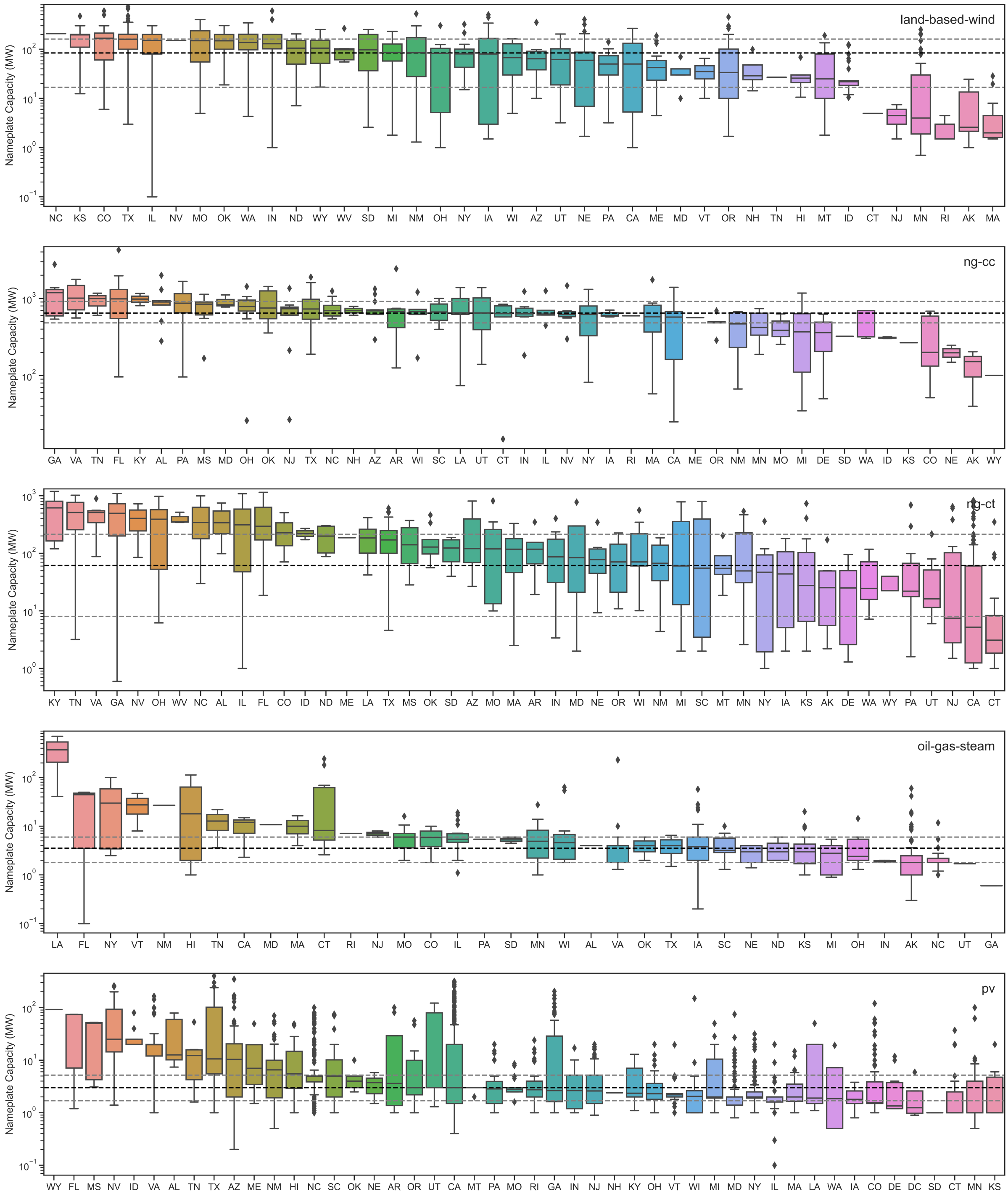

Fig. S5: The nameplate capacities of the existing fleet of land-based wind, natural gas combined cycle, natural gas combustion turbine, oil gas steam turbine, and photovoltaics in each state. The box plots show the median and the interquartile range of the dataset. The dashed lines represent that information at the national level. Data source: [4].

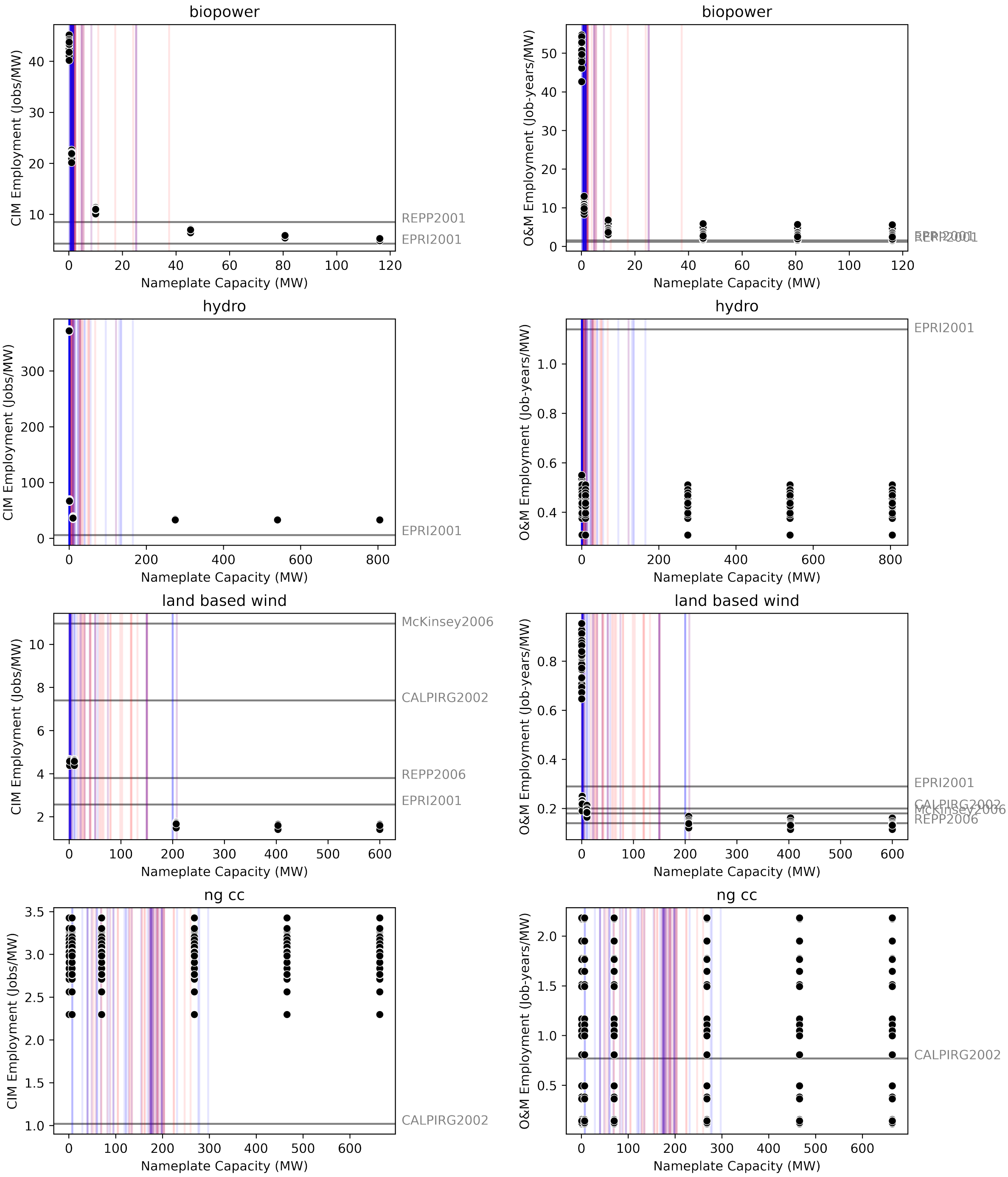

Fig. S6: The CIM and O&M employment output from the JEDI models for biopower, hydro, land-based wind, and natural gas combined cycle. The vertical lines represent the median (red) and mode (blue) of the 50 state-level capacity data. The horizontal lines represent the job creation data in the literature [5].

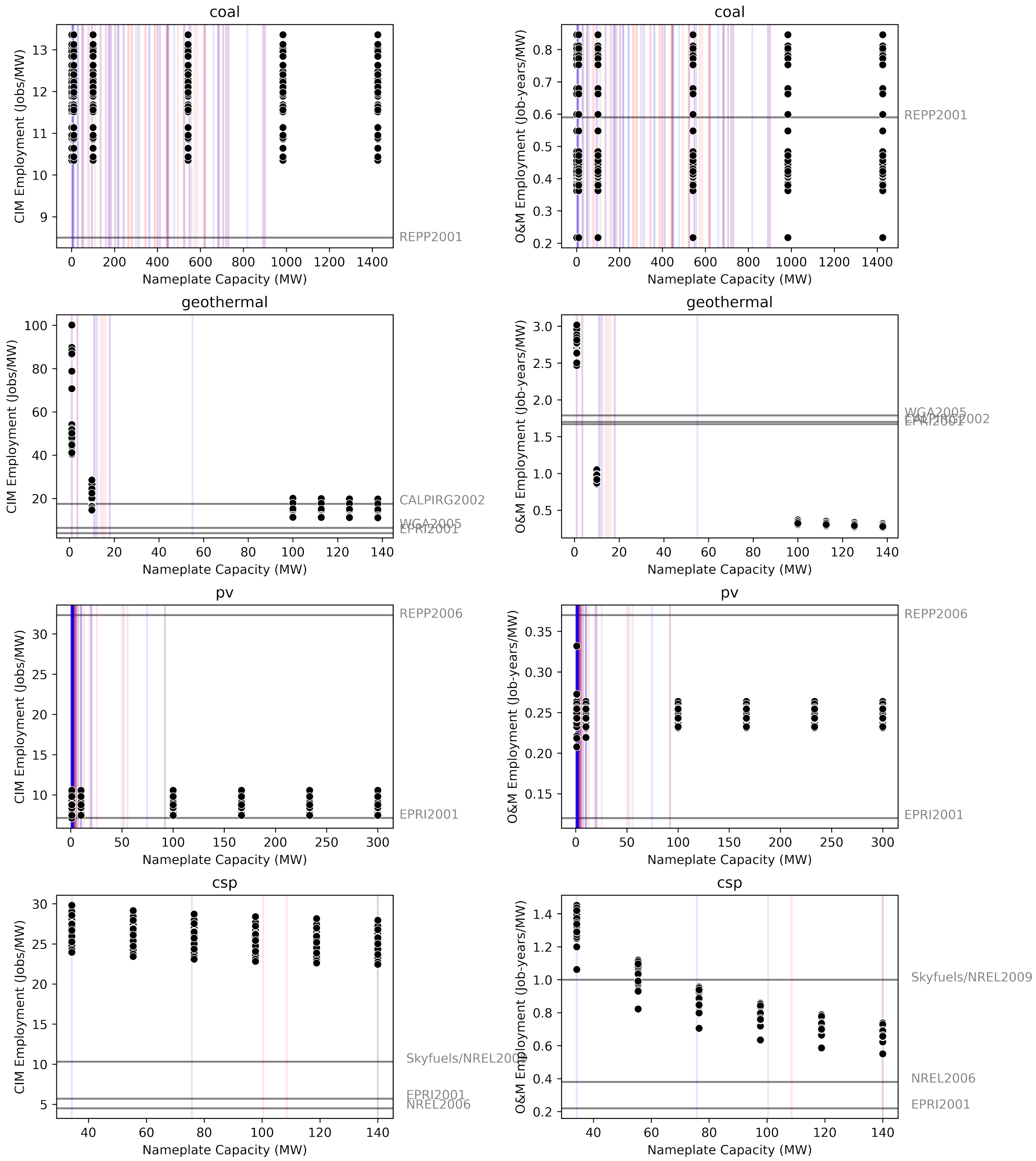

Fig. S7: The CIM and O&M employment output from the JEDI models for coal, geothermal, photovoltaics (utility), and concentrated solar. The vertical lines represent the median (red) and mode (blue) of the 50 state-level capacity data. The horizontal lines represent the job creation data in the literature [5].

3 Modified JEDI Models

The technologies modified include nuclear, oil-gas-steam, natural gas combined cycle with carbon capture (ng-cc-ccs), bioenergy with carbon capture (bio-ccs), batteries, photovoltaic battery (PV battery), pumped storage, hydrogen, and direct air capture (dac). Specific model modifications and corresponding assumptions can be found below.

3.1 Nuclear

The Institute for Sustainable Futures' Calculating Global Energy Sector Jobs report [6] was commonly cited for the employment impacts of nuclear technologies. It is less relevant for this study because its data were sourced from studies in the UK, South Korea, Switzerland, and France. Compiling data from Bechtel Power Corporation, Nuclear Energy Institute, and Dominion Energy, Kenley et al. conducted an employment impact analysis for achieving the "50000 MWe production goal" in the US [7]. This study assumed that all equipment requirements were fulfilled by US suppliers. The Nuclear Energy Institute's employment report on the Millstone Power Station in Connecticut was used as sectoral employment multipliers for this analysis [8].

Alternatively, the coal JEDI model was used due to the similarity in producing steam to power turbine generators. The overall supply chain assumptions for the power generation facilities were assumed to follow the coal model, although constructing a nuclear power plant may require more jobs in higher-skilled sectors, e.g., engineering, and professional services. The default capacity, capital costs, and non-fuel operational costs (Tables S3-S5) were based on the 2156W Advanced Nuclear (Case 11) in the EIA Capital Cost and Performance Characteristic Estimates for Utility Scale Electric Power Generating Technologies 2020 report ("EIA Technology Report") [9]. The cost of uranium was based on the EIA 2020 Annual Energy Outlook [10] and was assumed to not be produced locally in any state [11].

Table S3: Project descriptive data for the modified nuclear JEDI model.

Project Descriptive Data	
Project Size - Nameplate Capacity (MW)	2156
Plant Construction Cost ($/kW)	$ 6,041.00
Fixed Operations and Maintenance Cost ($/kW)	$ 121.64
Variable Operations and Maintenance Cost ($/MWh)	$ 2.37
Money Value (Dollar Year)	2019

While there is no significant magnitude difference between the options, the analytical method (Connecticut) results in more jobs in Miscellaneous Services. Both options were included in the analysis to address the uncertainties.

Table S4: Annual operating and maintenance costs for the modified nuclear JEDI model.

Fixed Costs	**Cost Per kW**
Labor	$ 13.80
Materials	$ 67.26
Services	$ 40.58
Fixed Subtotal	$ 121.64
Variable Costs	**Cost Per MWh**
Ash/sludge disposal	$ 0.17
Water	$ 1.81
Catalysts & chemicals	$ 0.39
Variable Subtotal	$ 2.37
Fuel Cost	$ 7.75

Table S5: Construction costs for the modified nuclear JEDI model.

Facility and Equipment	
Power Generation	$ 788,320,000.00
General facilities	$ 1,675,180,000.00
Plant Equipment	$ 4,631,380,000.00
Facility and Equipment Subtotal	$ 7,094,880,000.00
Labor	
Construction Labor	$ 1,778,647,000.00
Project management	$ 93,613,000.00
Labor Subtotal	$ 1,872,260,000.00
Construction Subtotal	$ 8,967,140,000.00
Other Costs	
Engineering, Procurement, Construction Management	$ 896,714,000.00
Land	$ 1,800,000.00
Grid intertie	$ 2,520,000.00
Owner costs	$ 1,972,771,000.00
Legal and Advisory	$ 1,184,095,000.00
Other Subtotal	$ 4,057,900,000.00
Total	$ 13,025,040,000.00

3.2 Oil-gas-steam

The general cost data for oil-gas-steam was assumed to resemble the coal JEDI model. The cost of fuel was calculated as the average of distilled fuel oil and residual fuel oil [10]. The local share of oil was based on the historical crude oil production at the state level (Table 14, Production of Crude Oil by PAD District and State) [12]. Due to the small percentage (¡1%) of oil consumed for power generation [13] in the US, any state that produced more than 100 thousand barrels in 2020 was assumed to provide 100% of the fuel locally. Otherwise, the local share was assumed to be zero. The heat rate of oil as power generating fuel is calculated from data provided by the EIA [14, 15],

$$HeatRate_{heatingoil} = \frac{137381Btu}{1gallon} \times \frac{1gallon}{12.76kWh} = 10767\frac{Btu}{kWh} \tag{1}$$

3.3 NG-CC-CCS

The NGCC-CCS model is built as a modified version of the natural gas JEDI model. The capital and non-fuel operational cost data are based on the 430MW Combustion Turbine H Class, Combined-Cycle Single Shaft with 90% CO_2 Capture (Case 9, EIA Technology Report) [9]. The post-combustion CO_2 is assumed to be captured with an amine-based sorbent. The cost for the additional CCS facilities was added under the category of "power generation" facilities. The additional fixed O&M cost (13.50 $/kW) of this technology compared to the one without CCS (Case 8, EIA Technology Report) was attributed to the "fixed payment portion of a long-term service agreement for the carbon capture system equipment". The additional variable O&M cost (3.29 $/kWh) was attributed to the cost of amine sorbents. Details of the costs can be found in Tables S6, S7, and S8.

Table S6: System descriptive data for the modified NG-CC-CCS JEDI model.

System Descriptive Data	
Project Size - Nameplate Capacity (MW)	377
Heat Rate (Btu per kWh)	7124
Construction Period (Months)	30
Plant Construction Cost ($/KW)	$ 2,481.00
Fixed Operations and Maintenance Cost ($/kW)	$ 27.60
Variable Operations and Maintenance Cost ($/MWh)	$ 5.84
Money Value (Dollar Year)	2020

Table S7: Annual operating and maintenance costs for the modified NG-CC-CCS JEDI model.

Fixed Costs	**Cost Per KW**
Labor	$ 5.90
Materials	$ 0.85
Services	$ 20.85
Fixed Subtotal	$ 27.60
Variable Costs	**Cost Per MWh**
Routine Turbine Maintenance	$ 2.15
Water	$ 0.13
Catalysts & chemicals	$ 3.55
Variable Subtotal	$ 5.84

Table S8: Construction costs for the modified NG-CC-CCS JEDI model.

Facility and Equipment	
Power Generation	$ 565,306,000.00
General facilities	$ 31,000,000.00
Plant Equipment	$ 28,000,000.00
Subtotal	$ 624,306,000.00
Labor and Management	
Project management (construction and owner's)	$ 55,002,000.00
Subtotal	$ 55,002,000.00
Construction Subtotal	$ 679,308,000.00
Other Costs	
Engineering/Design	$ 90,000,000.00
Construction insurance	$ 85,024,000.00
Land	$ 1,800,000.00
Permitting Fees	$ 71,431,000.00
Grid intertie	$ 7,700,000.00
Other Subtotal	$ 255,955,000.00
Subtotal All Costs (without sales tax)	$ 935,263,000.00
Sales Tax (Materials & Equipment Purchases)	$ 26,845,000.00
Total Project Cost	$ 962,108,000.00

3.4 Bioenergy-CCS

The bioenergy model was used to create the bioenergy-CCS model. There's limited cost and performance information on a bioenergy-CCS unit with a high capture rate. This work uses data from the Techno-economic Cycle Analysis of Bio-Energy with Carbon Capture and Storage (BECCS) Baseline report developed by NETL, which uses the Cansolv amine-based flue gas carbon capture technology [16]. The additional cost of a CCS unit is added to the bioenergy JEDI model with a unit of 650MW. The cost of a CCS unit is calculated from the net of the facility with CCS (PA3) and the facility without CCS (PN3). While the NETL report currently only provides cost data for bioenergy generation with a mixed feedstock, the PA3 and PN3 facilities are the ones with the highest biomass composition. Tables S9, S10, and S11 show the cost data used in the final bioenergy-CCS model.

Table S9: System descriptive data for the modified bioenergy-CCS JEDI model.

System Descriptive Data	
Project Size (MW)	650
Heat Rate (Btu/kWh)	16759
Money Value (Dollar Year)	2018

Table S10: Construction cost for the modified bioenergy-CCS JEDI model.

Facility and Equipment	
Plant Equipment	
Feedstock Handling and Preparation	$ 65,632,000.00
Steam Turbine and Auxiliaries	$ 191,676,000.00
Boiler and Air Quality Control	$ 804,821,000.00
General Facilities	$ 269,781,000.00
Equipment Subtotal	$ 1,331,910,000.00
Labor	
Construction Labor	$ 157,413,000.00
Labor Subtotal	$ 157,413,000.00
Construction Subtotal	$ 1,489,323,000.00
Other Costs	
Balance of Plant	$ 118,490,000.00
Construction Insurance	$ 265,497,000.00
Permitting, Legal, Commissioning and Development	$ 484,765,000.00
Other Subtotal	$ 868,753,000.00
Total	$ 2,358,076,000.00

3.5 Batteries and PV-battery

The photovoltaic JEDI model was assumed to be a close fit for the batteries and PV-battery modifications due to the modular nature of manufacturing and the automated operational

Table S11: Annual operating and maintenance cost for the modified bioenergy-CCS JEDI model.

Fixed Costs	**Per kW**
Labor	
Plant Management	$ 1.82
Administration	$ 3.59
Equipment/Parts	$ 12.00
Insurance	$ 44.60
Fixed Subtotal	$ 62.01
Variable Costs	**Per MWh**
Labor	
Operators	$ 0.33
Fuel Handlers	$ 0.05
Maintenance Staff	$ 0.25
Labor Subtotal	$ 0.63
Maintenance Materials	$ 0.92
Variable Subtotal	$ 1.55
Consumables Costs	
Chemicals	$ 0.44
Water	$ 0.05
Solids/Ash Disposal	$ 0.18
Ammonia	$ 0.36
Consumables Subtotal	$ 1.03
Subtotal O&M costs	
Feedstock Cost	$ 40.77

processes. While the battery industry has followed the cost reduction trajectory of the photovoltaics industry, the former can be more difficult due to its more complex material composition compared to the more widely available silicon [17]. This may also require higher-skilled labor in sectors such as chemicals. The capital and non-fuel operational costs of the PV battery were based on the reported values for the 150 MWAC Solar Photovoltaic with Battery Energy Storage System (Case 25, EIA Technology Report) [9]. Those costs for the batteries were based on the Lithium-ion LFP (Appendix 1, pg 87) data in the Pacific Northwest National Laboratory's (PNNL) 2020 Grid Energy Storage Technology Cost and Performance Assessment report [18]. Details of these values can be found in Tables S12, S13, and S14.

3.6 Hydrogen

The hydrogen JEDI model was modified from the natural gas model. Given the potential of converting natural gas power plants into hydrogen facilities, the majority of the model set up remains the same and the efficiency is based on the Hydrogen Power Generation – Challenges

Table S12: Project descriptive data for the modified battery (2h, 4h, 6h, 8h, and 10h) and PV-battery JEDI models.

Project Descriptive Data	**2h**	**4h**	**6h**	**8h**	**10h**	**PV**
System Application	Utility	Utility	Utility	Utility	Utility	Utility
Total Project Size - DC Nameplate Capacity (kW)	10000	10000	10000	10000	10000	150000
Base Installed System Cost ($/kWDC)	$ 922.00	$ 1,643.00	$ 2,355.00	$ 3,063.00	$ 3,767.00	$ 1,755.00
Annual Direct Operations and Maintenance Cost ($/kW)	$ 12.50	$ 24.55	$ 36.58	$ 48.60	$ 60.61	$ 32.17
Money Value (Dollar Year)	2020	2020	2020	2020	2020	2019

and Prospects for 100% Hydrogen Gas Turbines report for the UK CCS Research Centre [19]. The heat rate of hydrogen was based on the GE Hydrogen for Power Generation report [20]. The cost of hydrogen in the US is based on the DOE Cost of Electrolytic Hydrogen Production with Existing Technology report [21]. Table S15 shows the modifications.

3.7 Direct Air Capture

Given the lack of at-scale DAC plant data, cost information from Carbon Engineering's report [22] is in the structure of a natural gas JEDI model. This assumes that the economic structure of a developed carbon dioxide supply chain may be similar to the natural gas supply chain. The early plant (41MW) costs are used instead of the Nth plant, so the employment impact is much overestimated. The 2-year construction time is rounded from the 15-month build time of the ClimeWorks Orca plant [3]. Tables S16 and S17 show the assumptions made to the JEDI model.

Table S13: Intallation costs (Cost per kW) of for the modified battery (2h, 4h, 6h, 8h, and 10h) and PV-battery JEDI models.

Materials & Equipment	**2h**	**4h**	**6h**	**8h**	**10h**	**PV**
Mounting (rails, clamps, fittings, etc.)	$ 86.00	$ 160.00	$ 234.00	$ 312.00	$ 380.00	$ 359.91
Modules	$ 352.00	$ 696.00	$ 1,032.00	$ 1,368.00	$ 1,700.00	$ 481.00
Electrical (wire, connectors, breakers, etc.)	$ 81.00	$ 81.00	$ 81.00	$ 81.00	$ 81.00	$ 605.94
Inverter	$ 104.00	$ 188.00	$ 270.00	$ 352.00	$ 430.00	$ 96.39
Subtotal	$ 623.00	$ 1,125.00	$ 1,617.00	$ 2,113.00	$ 2,591.00	$ 1,543.25
Labor						
Installation	$ 25.00	$ 25.00	$ 25.00	$ 25.00	$ 25.00	$ 28.01
Subtotal	$ 25.00	$ 25.00	$ 25.00	$ 25.00	$ 25.00	$ 28.01
Total	$ 648.00	$ 1,150.00	$ 1,642.00	$ 2,138.00	$ 2,616.00	$ 1,571.26
Other Costs						
Permitting, Fees, and Taxes	$ 124.00	$ 224.00	$ 324.00	$ 424.00	$ 520.00	$ 54.51
Other Costs	$ -	$ -	$ -	$ -	$ -	$ 45.79
Business Overhead	$ 150.00	$ 268.00	$ 390.00	$ 504.00	$ 620.00	$ 83.58
Subtotal	$ 274.00	$ 492.00	$ 714.00	$ 928.00	$ 1,140.00	$ 183.89
Subtotal	$ 922.00	$ 1,642.00	$ 2,356.00	$ 3,066.00	$ 3,756.00	$ 1,755.15
Total	$ 922.00	$ 1,642.00	$ 2,356.00	$ 3,066.00	$ 3,756.00	$ 1,755.15

Table S14: Annual operating and maintenance costs (Cost Per kW)in the modified battery (2h, 4h, 6h, 8h, and 10h) and PV-battery JEDI models.

Labor	**2h**	**4h**	**6h**	**8h**	**10h**	**PV**
Technicians	$ 2.24	$ 4.03	$ 5.80	$ 7.56	$ 9.31	$ 11.07
Subtotal	$ 2.24	$ 4.03	$ 5.80	$ 7.56	$ 9.31	$ 11.07
Materials and Services						
Materials & Equipment	$ 10.25	$ 20.50	$ 30.75	$ 41.00	$ 51.25	$ 20.21
Services	$ 0.01	$ 0.02	$ 0.03	$ 0.04	$ 0.05	$ 0.89
Subtotal	$ 12.50	$ 24.55	$ 36.58	$ 48.60	$ 60.61	$ 32.17
Total	$ 12.50	$ 24.55	$ 36.58	$ 48.60	$ 60.61	$ 32.17

Table S15: Technology and economic data for the modified hydrogen model.

System Descriptive Data	
Project Size - Nameplate Capacity (MW)	2200
Heat Rate (Btu per kWh)	5686.9
Cost of Fuel ($/mmbtu)	$ 52.77
Money Value (Dollar Year)	2020

Table S16: Construction costs for the modified DAC model.

Facility and Equipment	
Power Generation	$ 385,440,000.00
General facilities	$ 151,900,000.00
Plant Equipment	$ 153,600,000.00
Subtotal	$ 690,940,000.00
Labor and Management	
Construction Labor	$ 6,700,000.00
Project management (contruction and owner's)	$ 44,250,000.00
Construction Utilities	$ 44,250,000.00
Subtotal	$ 95,200,000.00
Construction Subtotal	$ 786,140,000.00
Other Costs	
Engineering/Design	$ 135,200,000.00
Construction insurance	$ 157,200,000.00
Land	$ 24,100,000.00
Permitting Fees	$ 24,100,000.00
Other Subtotal	$ 340,600,000.00
Subtotal All Costs (without sales tax)	$ 1,126,740,000.00
Sales Tax (Materials & Equipment Purchases)	$ 27,307,000.00
Total Project Cost	$ 1,154,047,000.00

Table S17: Annual operating and maintenance costs for the modified DAC model.

Fixed Costs	**Per KW**
Labor	$ 63.71
Materials	$ 9.23
Services	$ 79.40
Fixed Subtotal	$ 152.35
Variable Costs	**Per MWh**
Routine Turbine Maintenance	$ 45.24
Water	$ 2.77
Catalysts & chemicals	$ 5.54
Variable Subtotal	$ 53.55
Fuel Cost	$ 44.13

4 Industrial Crosswalks

Table S18: Industry crosswalk between the O*NET industry categories based on the North American Industry Classification System (NAICS) and the 14 JEDI industry sectors.

JEDI Index	JEDI Industries	NAICS Industries
1	Agriculture	Agriculture_Forestry_Fishing_and_Hunting
2	Mining	Mining_Quarrying_and_Oil_and_Gas_Extraction
3	Construction	Construction
4	Manufacturing	Manufacturing
8	TCPU	Utilities
8	TCPU	Transportation_and_Warehousing
8	TCPU	Information
9	Wholesale Trade	Wholesale_Trade
10	Retail Trade	Retail_Trade
11	FIRE	Finance_and_Insurance
11	FIRE	Real_Estate_and_Rental_and_Leasing
12	Misc. Services	Administrative_and_Support_Services
12	Misc. Services	Educational_Services
12	Misc. Services	Health_Care_and_Social_Assistance
12	Misc. Services	Arts_Entertainment_and_Recreation
12	Misc. Services	Accommodation_and_Food_Services
12	Misc. Services	Other_Services_Except_Public_Administration_
13	Professional Services	Professional_Scientific_and_Technical_Services
13	Professional Services	Management_of_Companies_and_Enterprises
14	Government	

Table S19: Industry crosswalk between the Census industry categories and the 14 JEDI industry sectors.

JEDI Index	JEDI Industries	Census Index	Census
1	Agriculture	3	Agriculture, forestry, fishing and hunting
2	Mining	4	Mining, quarrying, and oil and gas extraction
3	Construction	5	Construction
4	Manufacturing	6	Manufacturing
5	Fabricated Metals	6	Manufacturing
6	Machinery	6	Manufacturing
7	Electrical Equipment	6	Manufacturing
8	TCPU	9	Transportation and warehousing, and utilities:
8	TCPU	12	Information
9	Wholesale Trade	7	Wholesale trade
10	Retail Trade	8	Retail trade
11	FIRE	13	Finance and insurance, and real estate and rental and leasing:
12	Misc. Services	20	Educational services, and health care and social assistance:
12	Misc. Services	23	Arts, entertainment, and recreation, and accommodation and food services:
12	Misc. Services	26	Other services, except public administration
13	Professional Services	16	Professional, scientific, and management, and administrative and waste management services:
14	Government	27	Public Administration

Table S20: Industry crosswalk between the 22 industry sectors in the JEDI photovoltaics module and the 14 main JEDI industry sectors.

PV Industry	PV Index	JEDI Industry
Ag, Forestry, Fish & Hunting	1	Agriculture
Mining	2	Mining
Construction	3	Construction
Construction/Installations - Non Residential	4	Construction
Construction/Installation Residential	5	Construction
Manufacturing	6	Manufacturing
Fabricated Metals	7	Fabricated Metals
Machinery	8	Machinery
Electrical Equip	9	Electrical Equipment
Battery Manufacturing	10	Electrical Equipment
Energy Wire Manufacturing	11	Electrical Equipment
Wholesale Trade	12	Wholesale Trade
Retail trade	13	Retail Trade
TCPU	14	TCPU
Insurance and Real Estate	15	FIRE
Finance	16	FIRE
Other Professional Services	17	Professional Services
Office Services	18	Professional Services
Architectural and Engineering Services	19	Professional Services
Other services	20	Misc. Services
Government	21	Government
Semiconductor (solar cell/module) manufacturing	22	Electrical Equipment

Table S21: Industry crosswalk between the Bureau of Labor Statistics (BLS) industry categories and the 14 JEDI industry sectors.

JEDI Index	JEDI Industries	BLS Industries
1	Agriculture	Agriculture, forestry, fishing, and hunting
2	Mining	Mining, quarrying, and oil and gas extraction
3	Construction	Construction
4	Manufacturing	Nonmetallic mineral products manufacturing
4	Manufacturing	Transportation equipment manufacturing
4	Manufacturing	Wood products manufacturing
4	Manufacturing	Furniture and related product manufacturing
4	Manufacturing	Miscellaneous manufacturing
4	Manufacturing	Nondurable goods manufacturing
5	Fabricated Metals	Primary metals and fabricated metal products manufacturing
6	Machinery	Machinery manufacturing
7	Electrical Equipment	Computers and electronic products manufacturing
7	Electrical Equipment	Electrical equipment and appliances manufacturing
8	TCPU	Transportation and utilities
8	TCPU	Information
9	Wholesale Trade	Wholesale trade
10	Retail Trade	Retail trade
11	FIRE	Financial activities
12	Misc. Services	Education and health services
12	Misc. Services	Leisure and hospitality
12	Misc. Services	Other services
13	Professional Services	Professional and business services
14	Government	Public Administration

5 Local Share of Fuels

5.1 Coal and natural gas

The local shares (Figure S10) of natural gas and coal in each state are calculated from historical ratios of consumption and production data (Figures S8 and S9) from the Energy Information Administration.

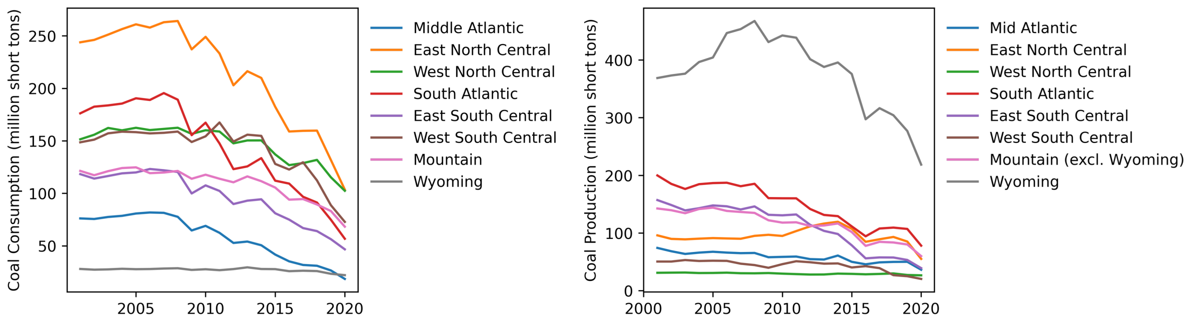

Fig. S8: The historical consumption (left) and production (right) of coal across several regions from 2001 to 2020. Wyoming was the largest producer of coal in the United States. Data source: [23].

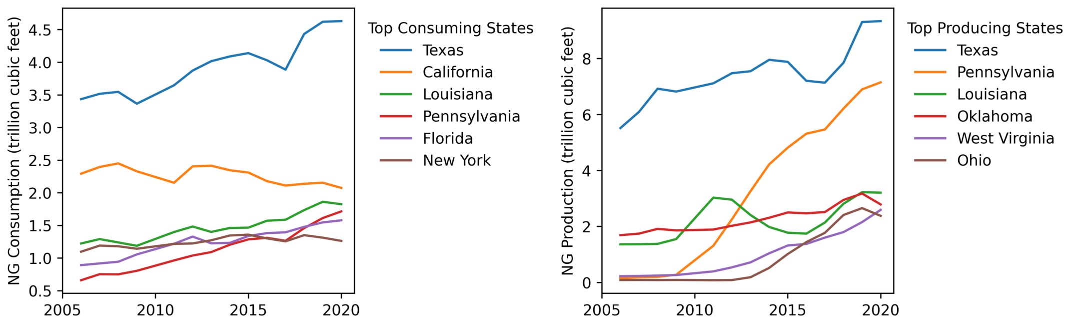

Fig. S9: The historical consumption (left) and production (right) of natural gas across the top consuming and producing states from 2001 to 2020. Texas is the top producing and consuming state in the United States. Data source: [24], Table 2. Natural Gas Production, Transmission, and Consumption by State.

For the share of fuels not produced locally, the supplier states were estimated based on the US Census Commodity Flow Survey [25]. For example, if a state produces 30% of its coal consumption locally, the remaining 70% is attributed to jobs in supplier states in the ratio of its historical coal imports. Figures S11 and S12 below show the flows of coal (15 – Coal) and natural gas (19 - Other coal and petroleum products, not elsewhere classified) in 2017 respectively.

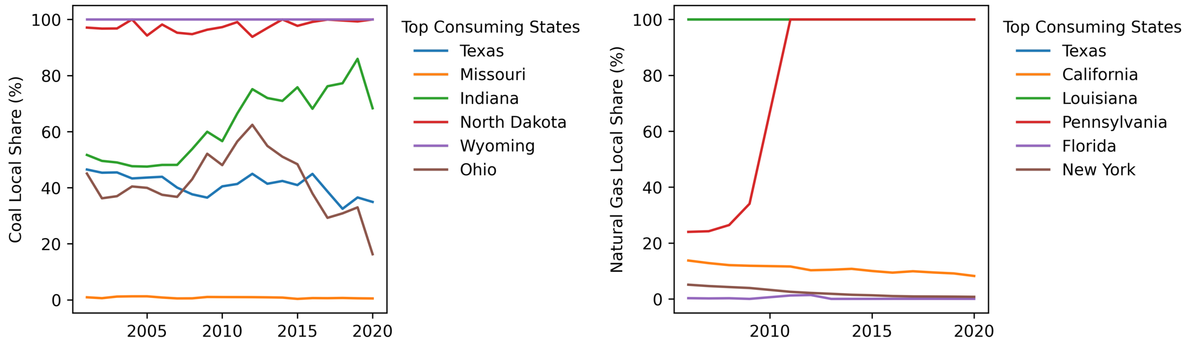

Fig. S10: The historical local shares of coal (left) and natural gas (right) in the top 6 consuming states in 2020. If the state outproduced its consumption, the local share was assumed to be 100%. If the state did not produce the fuel, the local share was zero. Otherwise, the local share was estimated to be the percentage of consumption in production in 2020. Data source: own calculations.

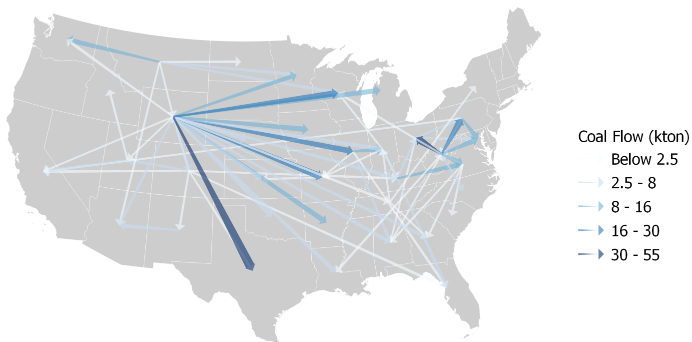

Fig. S11: The flow of coal across US states.

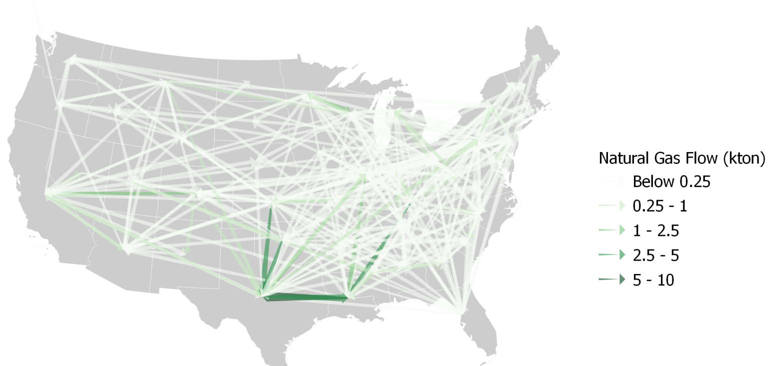

Fig. S12: The flow of natural gas across US states.

5.2 Biomass feedstock

The NREL Biopower Atlas [26] was used to extract the state- and county-level feedstock production (Figure S14) estimate data from the 2016 billion-ton study [27]. The study provided data on the resource availabilities (tonne per year) of several different biopower feedstocks including barley straw, sorghum, and corn stover. The Higher Heating Values (HHV) of feedstocks are based on the Biopower Technical Assessment Table A3-4 Ultimate Analysis Data for Selected Solid Fuels and Biomass Materials [28]. The power generation ability of a feedstock was calculated as follows,

$$Generation[kWh] = \frac{Production_{feedstock}[lb] \cdot HHV_{feedstock}[\frac{Btu}{lb}]}{HeatRate[\frac{Btu}{kWh}]} \tag{2}$$

where the heat rate was 14000 Btu/kWh (based on the JEDI model).

In the ReEDS Mid Case Standard Scenario, the calculated usages of biopower feedstocks generally took up less than 10% of the total amounts produced by each state (Figure S13 - right). Thus, the local shares of the biopower generators were assumed to be 100% across all states. Although this assumption neglects the dynamic merit order mechanism of the market, it simplifies the analysis before more accurate local share data becomes available.

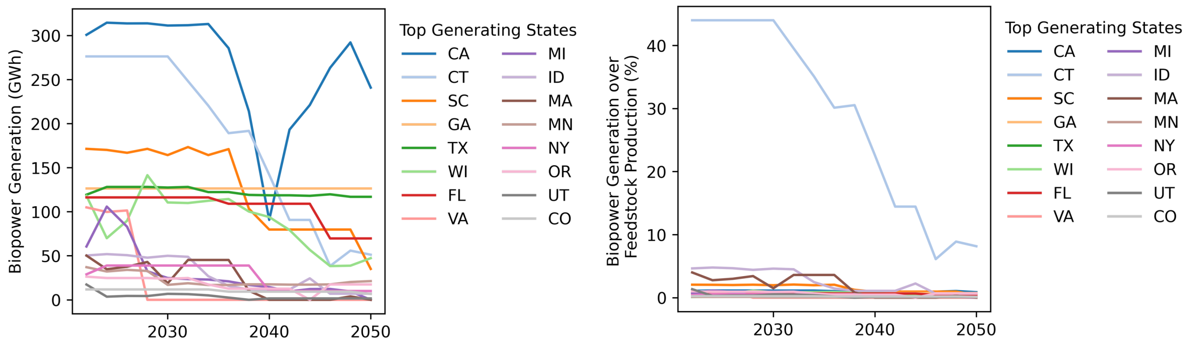

Fig. S13: Biopower generation (left) and the percentage of generation over the state's total biopower feedstock production (right) using the ReEDS Mid Case Standard Scenario. (Data source: [29] and own calculations)

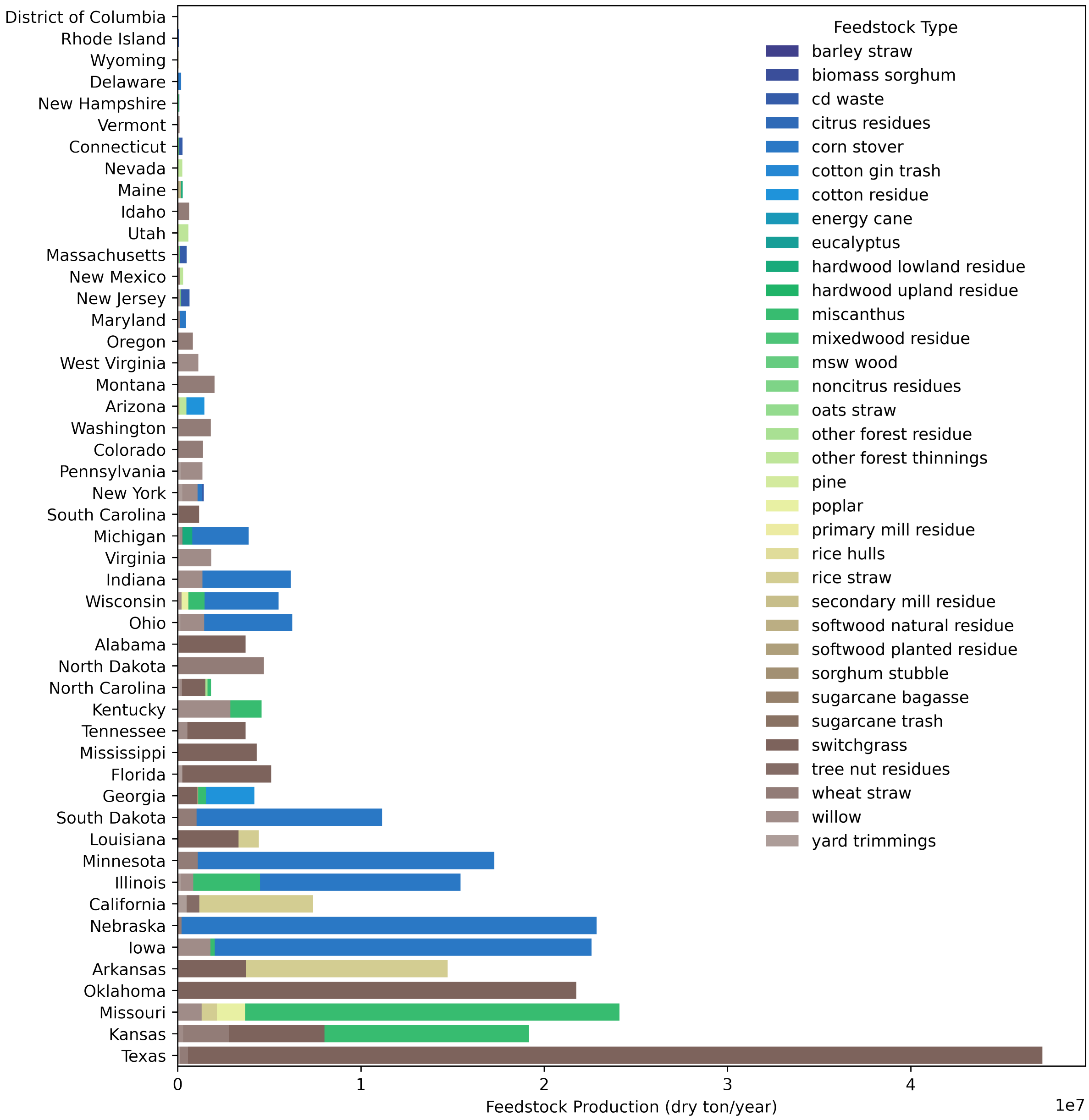

Fig. S14: Biopower feedstock production by feedstock type and state.

6 Demographic Databases

6.1 Gender composition

Figure S15 shows the national gender composition of 14 JEDI sectors. TCPU stands for Transportation, Communications, and Public Utilities. FIRE stands for Finance, Insurance, and Real Estate. Miscellaneous services include sectors such as education, healthcare, and the arts. The industrial crosswalk from Census sectors to JEDI sectors is in Table S19. Figures S16 and S17 are state-level data in 2010 and 2020 respectively.

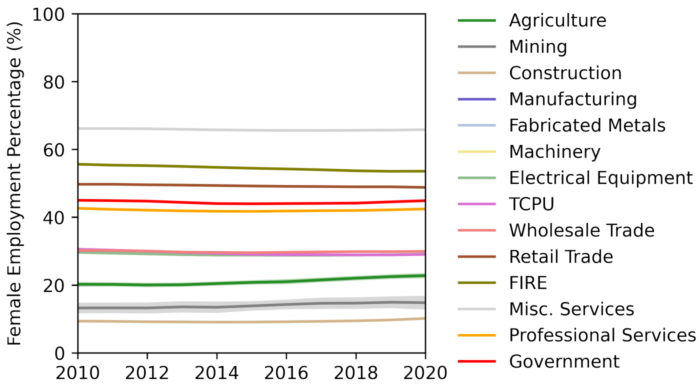

Fig. S15: Trends of US national female employment percentage from 2010 to 2020 across 14 JEDI industry sectors. Data source: [30].

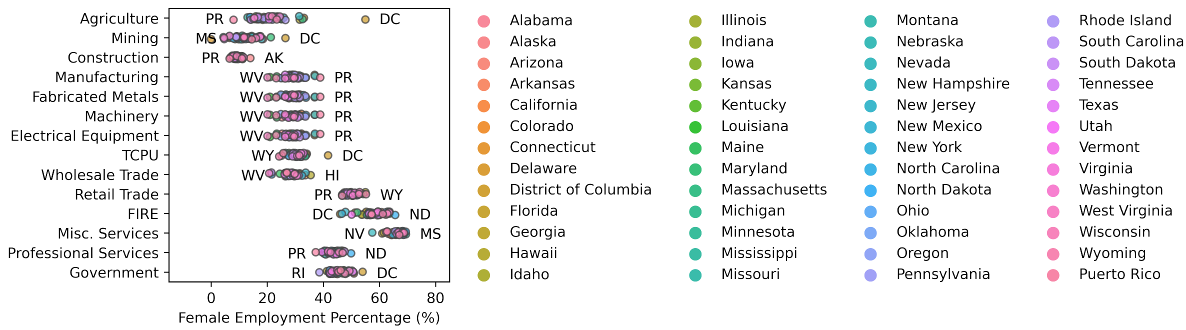

Fig. S16: Female employment percentage in 2010 across 14 JEDI industry sectors and 52 states. The states with the maximum and minimum percentages of each industry sector are denoted. Data source: [30].

6.2 Age distribution

Figure S18 shows the age distribution across JEDI sectors nationally. The variations by industry sector can be large. For example, nearly 20% of the agriculture workforce is 65 years and older, while the compositions in the other sectors are less than 10%. Figure S19 shows the age distribution across states. The variations across the states are roughly at 5%. The industrial crosswalk from BLS to JEDI sectors is in Table S21.

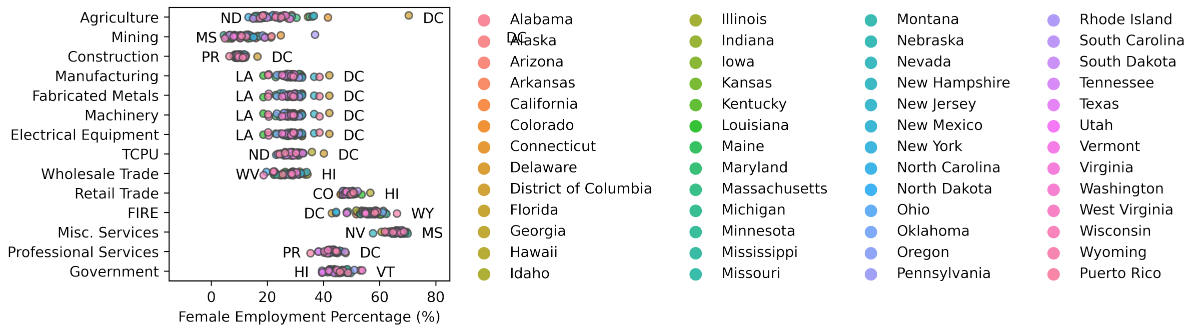

Fig. S17: Female employment percentage in 2020 across 14 JEDI industry sectors and 52 states. The states with the maximum and minimum percentages of each industry sector are denoted. Data source: [30].

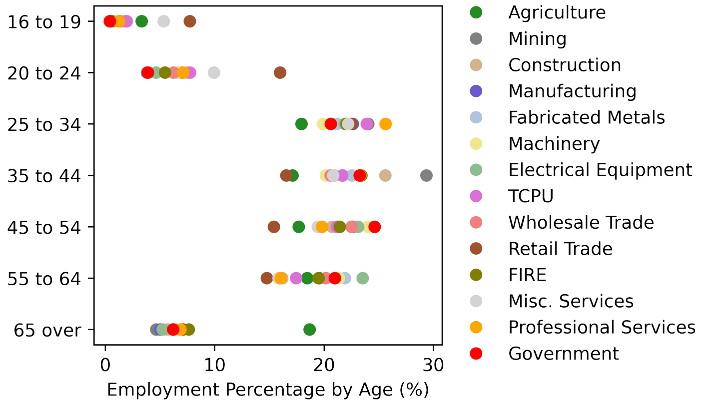

Fig. S18: Employment distribution by age group in 2021 across 14 JEDI industry sectors. Data source: [31] and own calculations.

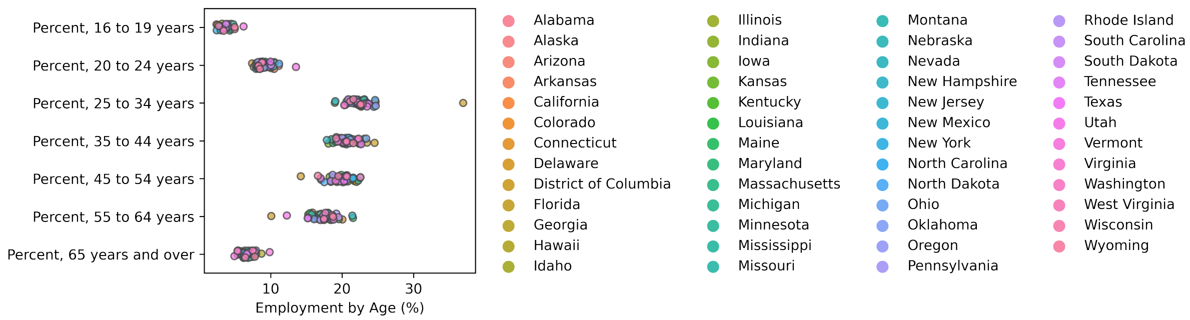

Fig. S19: Employment distribution by age group in 2019 across 52 states. Data source: [32].

6.3 Job Zones

Figures S20 and S21 show the Job Zone compositions in the 48 continental states across JEDI sectors. The industrial crosswalk from BLS to JEDI sectors used here are in Table S21.

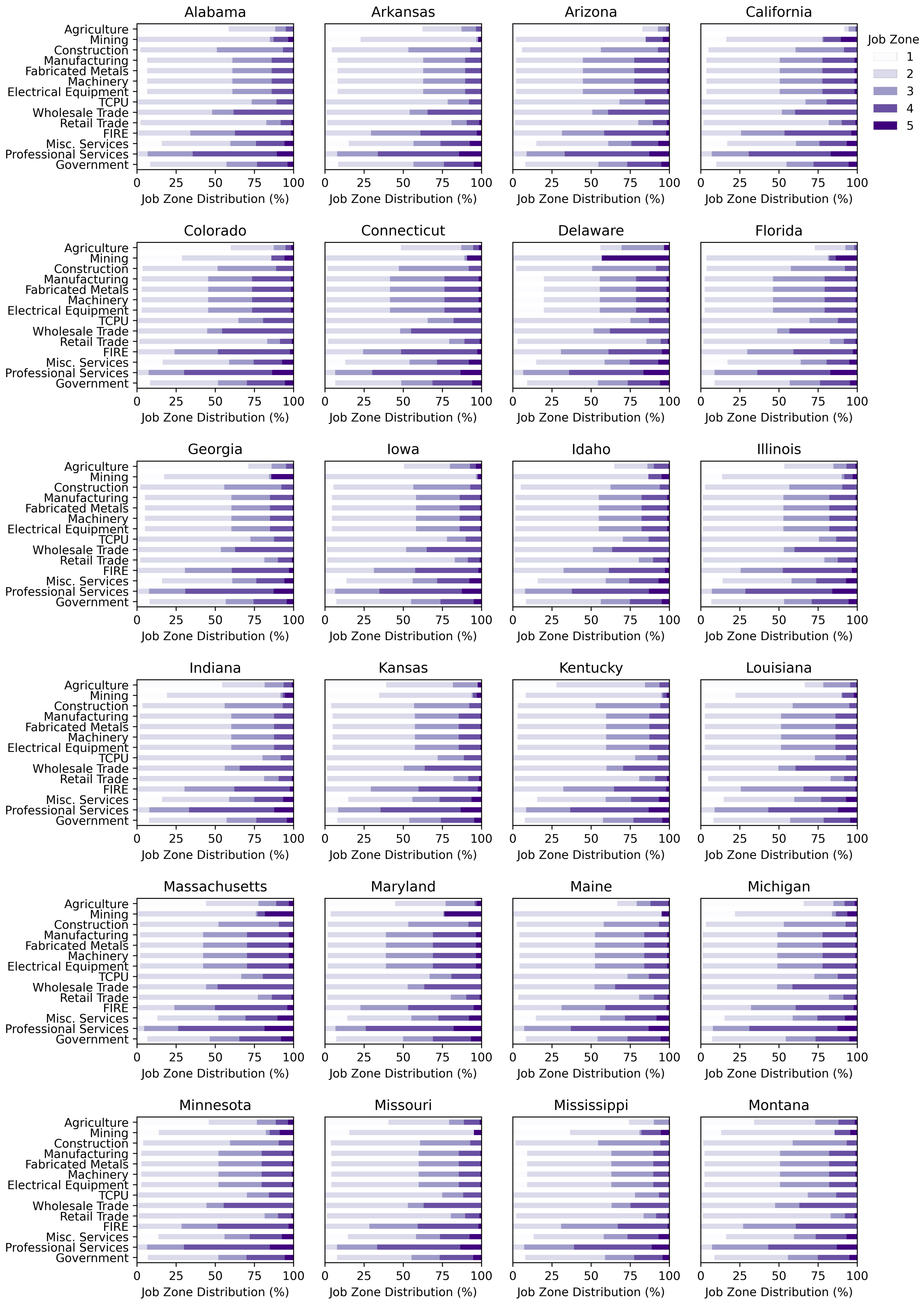

Fig. S20: The compositions of 14 JEDI industry sectors by occupation Job Zones in US States (1 of 2). Data source: [33, 34], and own calculations.

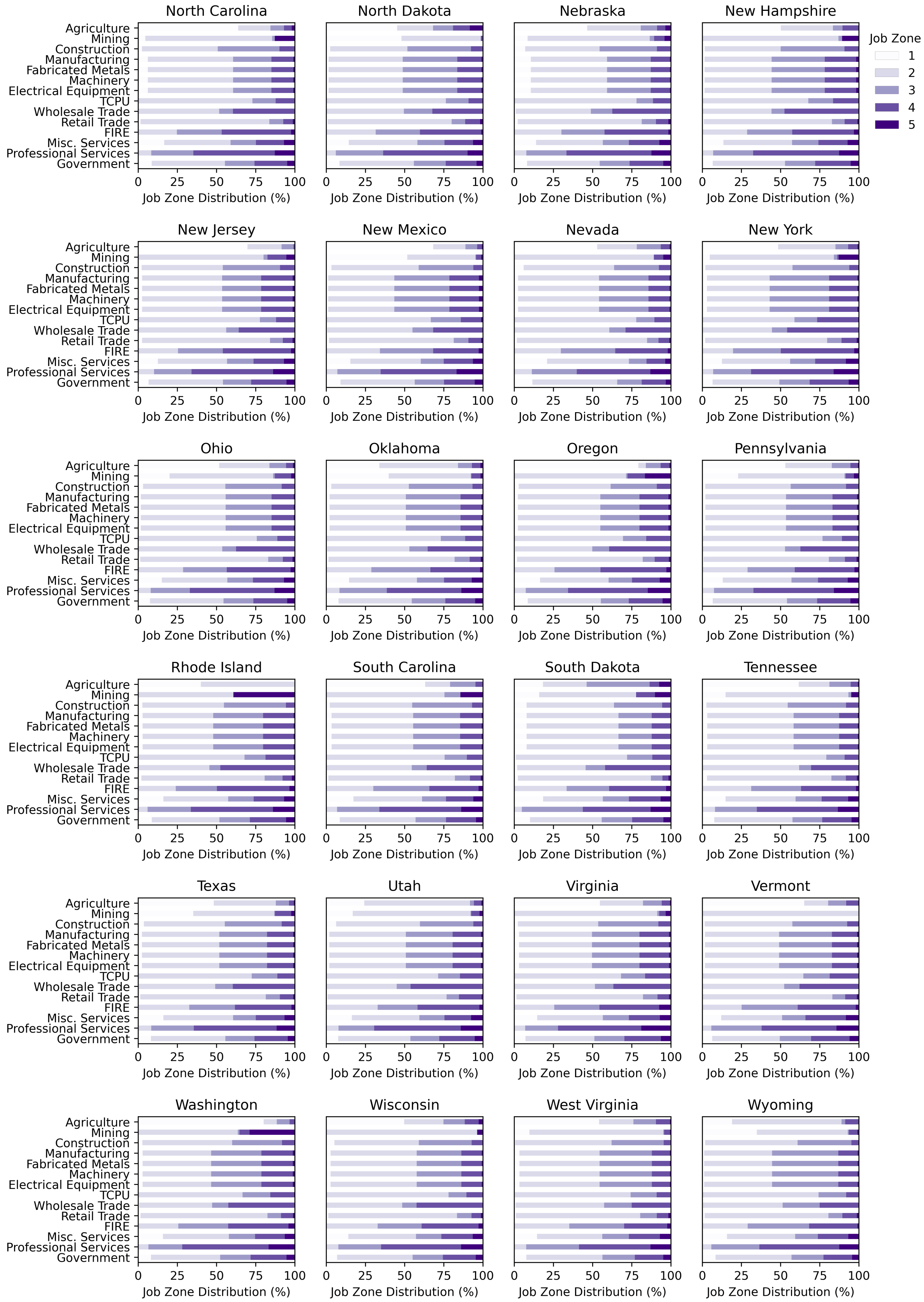

Fig. S21: The compositions of 14 JEDI industry sectors by occupation Job Zones in US States (2 of 2). Data source: [33, 34], and own calculations.

6.4 Racial composition

Figure S22 shows the racial composition across 14 JEDI sectors in 2021. The industry crosswarlk from BLS to JEDI sectors is in Table S21. Sectors employing more Asian Americans than the population average include Electrical Equipment, FIRE, Manufacturing, and Misc Services. The sector employing more Black or African Americans than the population average is Government. Sectors employing more Hispanic or Latinx Americans include Agriculture and Construction.

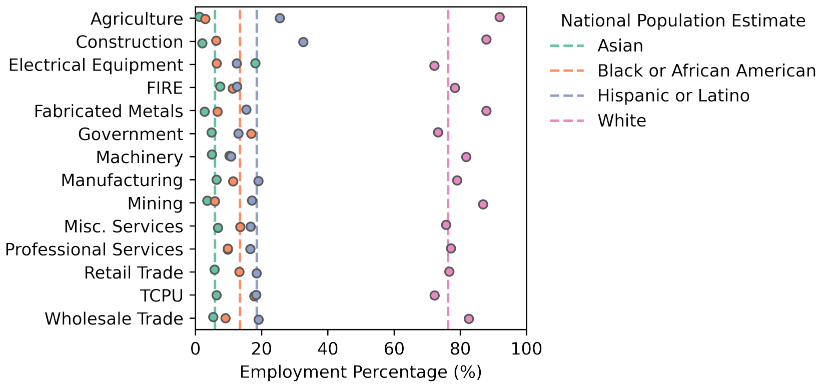

Fig. S22: National employment racial distribution in 2021 across 14 JEDI industry sectors. The dotted vertical lines represent the national population estimates. Data source: [35].

7 Modeled Employment Impacts

Figures S23 to S24 show the distributions of state-level employment change across all model runs by the NNP and 95% by 2050 emission trajectories. Employment change here indicates new opportunities created (positive) or reskilling needs (negative) in the 2040s compared to the size of the state-electricity workforce in 2020s. Some states show bimodal distributions with the mid-case scenario on the main peak and the high electrification scenario on the upper peak. Others show different distributions.

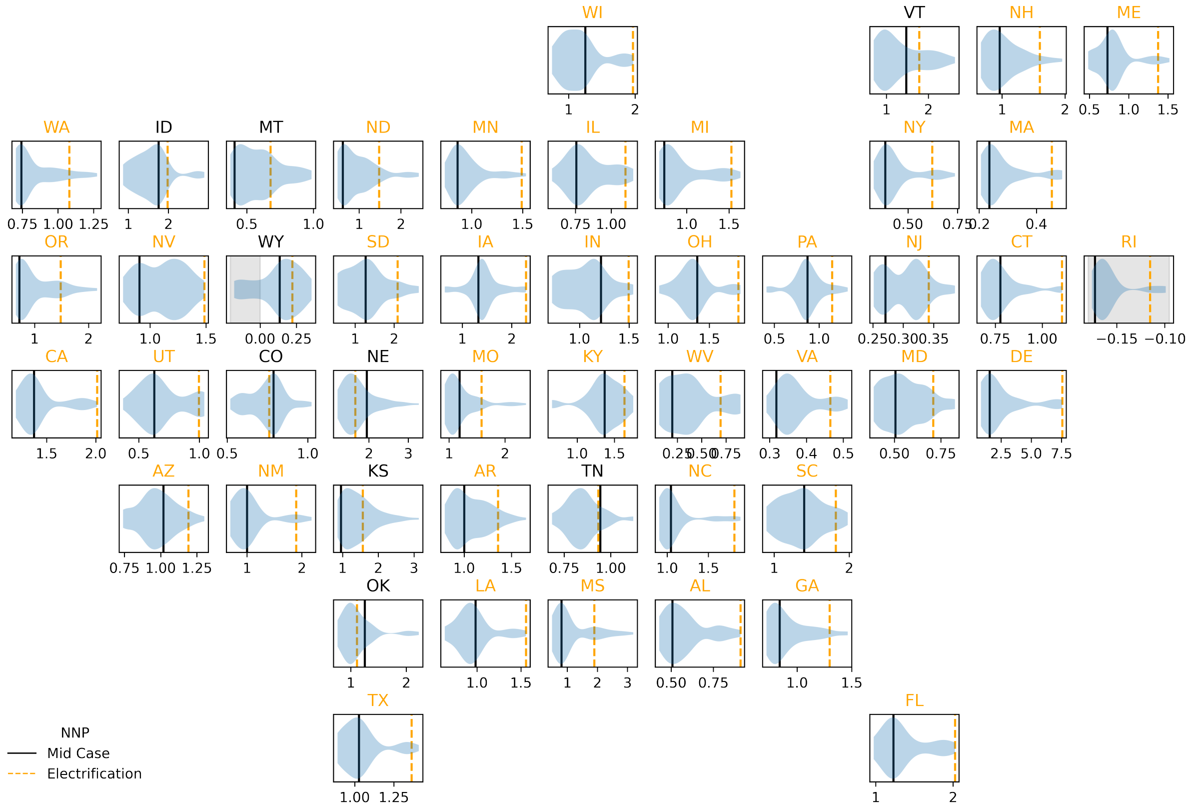

Fig. S23: Distribution of state-level employment change under the NNP emission trajectory. The black lines represent the mid-case system assumption and the orange dashed lines represent the high electrification assumption, both with the medium multiplier option. The state labels are marked orange if the electrification case is one standard deviation more than the mid-case line. The negative areas are shaded gray.

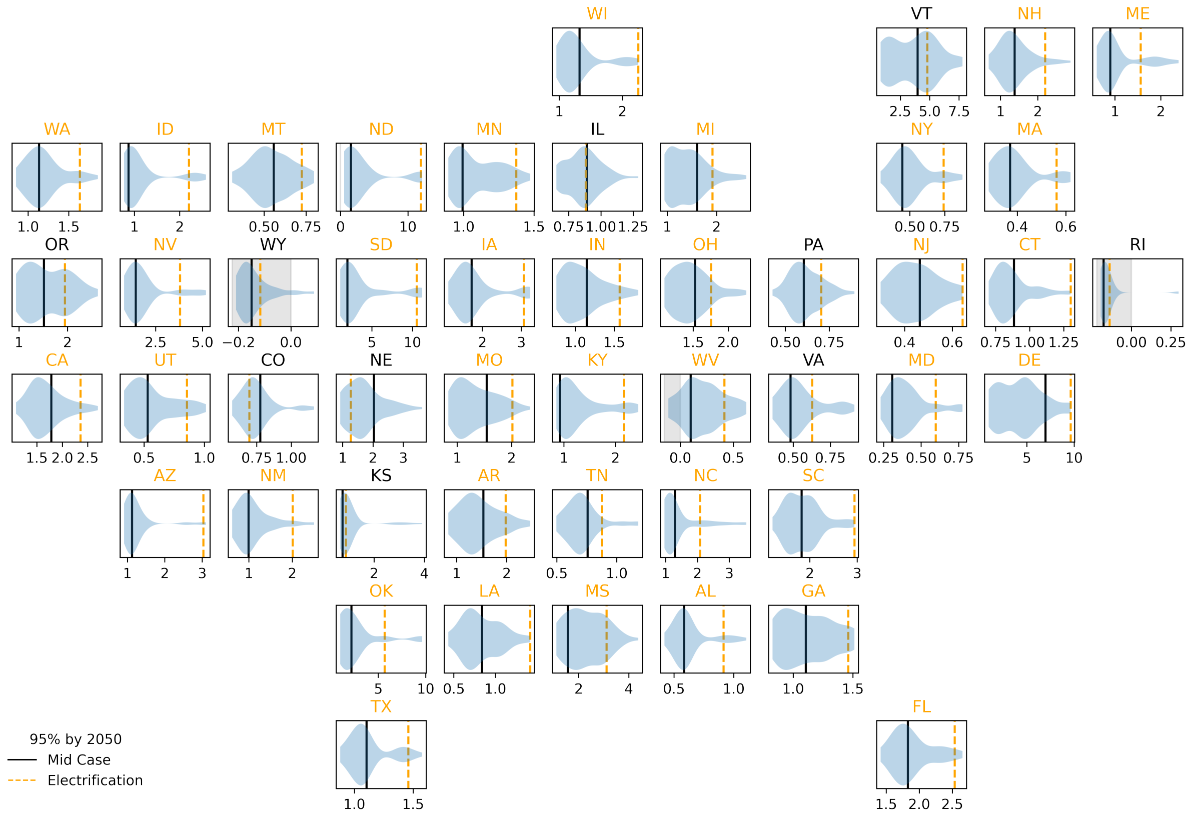

Fig. S24: Distribution of state-level employment change under the 95% by 2050 emission trajectory. The black lines represent the mid-case system assumption and the orange dashed lines represent the high electrification assumption, both with the medium multiplier option. The state labels are marked orange if the electrification case is one standard deviation more than the mid-case line. The negative areas are shaded gray.

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