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Labor Trends in Nuclear Energy and Developmental Obstacles in Nuclear Energy

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Abstract

The idiosyncrasies that exist in the United States independent system operator's structure poses many unique challenges to wholesale energy markets. The array of energy production solutions is one of these challenges to understanding energy markets. Numerous tools have been used to measure the quantitative complexity of energy markets. Few tools and indices exist to track macroeconomic fluctuations in US employment and wage for United States relative to the cost of energy delivery. In modelling the derived labor demand for energy employment, we should be better able to explain markets and allow for predictions in fluctuations in the labor market. This research looks to answer questions such as: How volatile is the nuclear energy labor market? What trends exist in employment? How do changes in wage equate to the increase in variable and indirect costs for nuclear energy plants?

Acknowledgements

I would like to thank Joseph Duggan my advisor. He has seen to it that I was able to complete my thesis through a global pandemic and has remained eager to discuss my research and has enabled me to further explore energy markets. I would also like to thank Dr. Nancy Haskell, Dr. Tony Caporale and Dr. Jia Wang for their inputs on my thesis topic. I would like to thank all economic faculty members and my fellow students. All of you have endowed me with knowledge and enabled me to affirm my passion and dedicate my work to something much greater. Lastly, I would like to thank my family. There is no feasible way I could have achieved what I have achieved without you all. Your support and attestation have enabled me to become something that I could have only ever imagined. I love you all for that. Thank you.

University *of* Dayton

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Introduction

The organization of energy markets varies across the globe, and, even within the United States across geographic region. The structure of energy markets is under much social scrutiny, particularly given extreme weather conditions as well as growing concerns over carbon emissions and political reforms and proposed legislation in the form of green energy. Two goals that are being implemented by the US government are, first the goal of being carbon free by 2035 as well as the second achieving net zero emission by 2050 (McKinsey 2021). Renewable energy in its current capacity cannot produce the current needs of the American people or an industrial nation (Menyah, Wolde-Rufael 2010). For this reason and this reason alone an intermediary form of energy that can satiate residential and industrial demand that utilizes no carbon emissions and long-range energy transmission is required. The solution to this proposed quandary is Nuclear Energy. While nuclear energy creates spent nuclear waste this paper looks to examine the benefit that nuclear creates relative to this cost. Nuclear energy seems to be the way out of a carbon emitting energy production process and the problems in its development as well as its employment remain the very obstacles of its large-scale deployment and implementation.

While it is certain that renewable energy means generate fewer negative externalities than do fossil fuels (Pearce 2001), the current means of energy consumption needs, and total energy capacity cannot be met by strictly renewable energy sources (Menyah, Wolde-Rufael 2010). Thus, one can come to realize that a pairing of renewable and non-renewable energy sources is utilized in our modern society to meet the current consumption needs for both residential and commercial energy. Building out the capacity for not only the United States but for developing countries requires an energy source that minimizes externalities and carbon emissions to meet international and state centric measures will require an energy source that is incredibly powerful. For this reason, nuclear energy is this paper's proposed solution to meeting our capacity needs while also offsetting carbon emissions. This is no easy task to transition to nuclear energy. Nuclear energy projects have seen a societal hesitation of implementation: socially from political parties as well as bi-partisan actors in federal government concerned over the threat that nuclear poses to the nation as a whole in the context of war and terrorism.

In the context of carbon emissions, renewable energy means of production such as solar, hydroelectric, wind, geothermal and biomass minimize carbon emission indirectly (Bose 2010). The prior mentioned forms of energy generation appropriately allocate the resources needed to support residential and commercial sectors. Rather than paying for inputs to generate energy processes, the input for renewables is the natural landscape. These renewable generation means do not directly generation carbon emissions. Examples of this are the abundance of natural light in places like Arizona that capture the light of the sun for solar energy and the sprawling planes of Texas that capture the power of wind to generate electricity for homes (EIA 2021). They do, however, still have indirect emissions in the form of maintenance, and construction from emissions in infrastructure; pouring concrete or fabricating materials for end use (Stoft 2002).

Nuclear energy as a source of energy has the most capacity with the least amount of production materials of all energy sources (Brook 2014). Nuclear energy commands twenty percent of the U.S. energy production with just 59 nuclear powerplants operating in the U. S. (Department of Energy 2020). Comparing this to the 241 coal-fire powerplants in the U. S. that supply only 23% energy production, one can see the production capacity of nuclear energy (Department of Energy 2020). Nuclear energy has faced much stigmatization over the last century with disasters and meltdowns that resulted in closures of differing geographic regions across the globe. Germany for example used to be the international leader alongside France and the United States boasting 17 operational powerplants in 2011, now in 2022 it has one nuclear reactor that will be closed by the end of the year (World Nuclear News, 2022). The storage and distribution of radioactive waste requires safe and responsible storage by the country that has utilized nuclear energy as a source of energy. Financing nuclear energy remains a barrier to its implementation from the increased safety measures to long term storage of waste, nuclear energy lacks the capital investment that non-renewable capital projects receive (Barkatullah & Ahmad, 2017).

While an increased social emphasis on renewable energy and reducing household carbon emissions, has pushed some homeowners to become “pro-sumer” economic actors, equipping their homes with solar panels or make use of geothermal technologies to heat homes lowering reliance on renewable energy sources (Almenning et al., 2019). “pro-sumers” are homeowners that retrofit their homes with solar or geothermal energy appliances that enable the household to both produce and consume their own electricity. This lacks the scalability of reducing carbon emissions for developing countries and means of production. Solar panels and, geothermal home energy utilize either a heat pump that heats your home with thermal energy from your home reducing your dependency on gas and electric heating elements or capturing solar energy from the sun with solar panels (Barbier, 2002). While this notably reduces reliance on residential fossil fuel consumption it does not reduce the total scale at which households rely on fossil fuels to power appliances and heat homes.

In response to market-based solutions to both prices and per household carbon production, nuclear energy models externalities of production on the firm or state producing the energy in the form of financial responsibility for nuclear waste. Comparable to a coal fire plant or natural gas plant where externalities can inadvertently be externalized to surrounding communities or states. Nuclear energy bears the externality of the construction of infrastructure in the form of concrete and metal fabrication. As well as in the form of routine maintenance for power plants as a carbon emission alongside its energy production. With adequate investing strategies and implementing subsidization, producers can lower the price to that which is lower than non-renewable energy sources (Menyah & Wolde-Rufael, 2010).

Sources of Cost Overrun in Nuclear Power Plant Construction Call for a New Approach to Engineering Design, written originally for engineering related fields, notes an important hurdle to financing nuclear energy. This article found a disparity between actual and predicted costs of labor in nuclear energy development the article examines. Author, Eash-Gates coins the term “soft costs”, a form of observed increased costs in labor during the construction of the plant that exceeds the projected construction cost by the developing firm. The World Nuclear Association serves as a thorough repository of information on economic components of nuclear energy, infrastructural cost, material sourcing, maintenance, as well as the decommissioning of a reactor. Eash-Gates’ observations of continued high budget nuclear construction is not a theory that they alone hold. Nancy Stauffer of MIT’s Energy Initiative notes similar under projections of cost across the past three decades particularly in the United State. The miscalculation of infrastructural project costs while not uncommon can have serious implications for such commodities and their prices which can often be passed down to consumers or affect the lifetime financial stability of a plant.

The increased cost of nuclear energy infrastructure relative to all other forms of energy creation make it another obstacle for not only developed nations but those without substantial capital to invest in this clean energy source. From a financial perspective, if nuclear powerplants often go over budget and continue to be the most expensive and complex power plants to build, it can be rationally deduced that nuclear energy has not been more widely deployed. This thread of nuclear energy developmental and infrastructural costs was explored further, with a focus on labor trends and employment as a form of derived demand for the production of nuclear energy. Utilizing the theory of derived demand for product markets, the product of nuclear energy production is declining across the United States, which is in turn decreasing the demand for nuclear energy related labor. While it seems the trend in employment in nuclear energy is downward, the correlation of pricing and employment is not determined easily.

If we are to understand the problems of nuclear energy production in the United States, we must further understand the energy market trends and employment for states specifically as well as the country as a whole. Coal and Natural Gas fired power plants are the two most common forms of energy production followed closely by nuclear energy (EIA 2021). For this reason, the energy sources of coal and natural gas will be examined alongside nuclear energy to better understand market trends, pricing and employment. Energy generation for total end use at the national level is respectively 20% Coal, 39% Gas, 19% Nuclear and 20% Renewable energy displayed below in *Figure 1* with the exact percentages of renewable being displayed below *Figure 1* in *Figure 2*. Notably over the past two decades the national level has seen a supplementing of coal generation with natural gas generation. This is reflected in the 50% increase in natural gas consumption from 2000 to 2020 in the total consumption of natural gas. This can be seen in *Figure 3* as the consumption of coal has declined by 45% from 2000 to 2020. Thus, we can conclude that the total decrease in coal consumption has been offset and the total generation capacity for the US has increased in the same period by 5.3% since 2000.

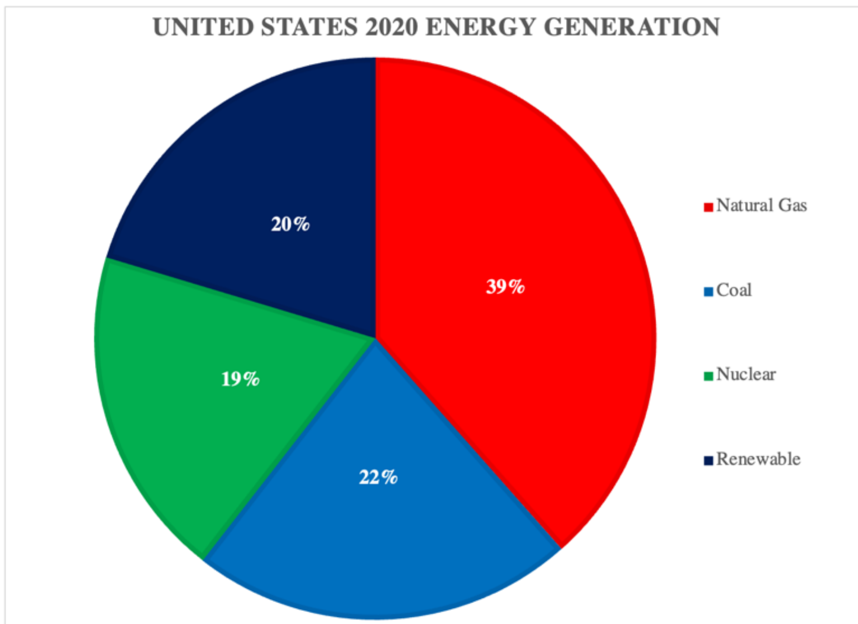

Figure 1, United States 2020 Energy Generation by Sector (Energy Information Administration, State Energy Database)

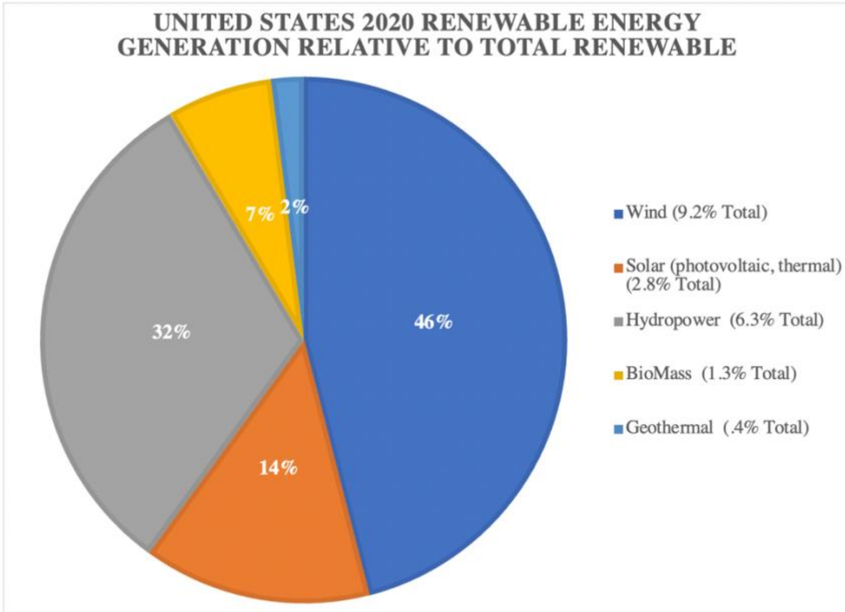

Figure 2, United States 2020 Energy Generation by Renewable Energy Sector Delineation (Energy Information Administration, State Energy Database)

Figure 2 above showcases the renewable energy sector in the United States. Of the United States total energy generation seen in *Figure 2,* 100% of generation is renewable energy and is compared relative to other forms of renewable energy to sum to 100% of total renewable. The metric of renewable energy is comprised of five sectors by the EIA, Wind, Solar, Hydropower, Biomass and Geothermal. 9.2% of the total energy generation in United States in 2020 was from Wind generation and accounts for 46% of the total US renewable energy production. 6.3 % of the total energy generation in United States in 2020 was from Hydropower generation and accounts for 32% of the total US renewable energy production. Lastly the most notable 2.3 % of the total energy generation in United States in 2020 was from Solar (photovoltaic and thermal) generation and accounts for 14% of the total US renewable energy production. Renewable energy consumption has seen the largest increase in energy adoption boasting a 149.2% in total renewable energy production in the past two decades (EIA 2020). To place this metric in perspective natural gas has only increased its total generation by 49% with respect to the last year (EIA 2020). However, the total amount of renewable energy is still only three quarters of the generation capacity at 20% of total energy generation of non-renewables combined 61% as of April 2022 (EIA 2022).

Data

Individual state data for sector employment and wage was derived from the Bureau of Labor Services Quarterly Census of Employment and Wages (QCEW). The Utility Sector NCAIS code of 22100 was used to determine total sector employment and annual wage variables that provided the basic labor supply schedule of utility sector employees. The QCEW has data with every state examined reporting data annually from 2001 to 2020 consistently, these data were the most specific energy sector employment that could be utilized in a time series regression to compare prior years, price and consumption to determine the wage and employment of private sector employees. While Nuclear sector employment data exists, state level reporting for nuclear technician and, nuclear engineer for numerous years are missing making the time series difficult to regress. The Energy Information Administration, State Energy Data Systems Data Set has every state and territory in the United States energy consumption by source total and unit price by energy source. QCEW data was then paired with SEDS data with each corresponding year. Five number summaries of the national average and state employment data is available in the Appendix in the later of this paper. QCEW and SEDS data was then imported into Stata and checked for errors. Stata was then used to lag variables of consumption by source and energy unit source price, once for a one-year period lag and subsequently again for a two-year lag. A natural log transformation was applied to every variable in every model excluding year to create a double logged model for ease of interpretation regarding units and coefficients. This model construction was done for each state to determine the predictive and statistical relevance.

Results

The United States has one of the most unique means of energy diversification and production as a geographic region that spans time zones and varying climates. While strong winds in Colorado, California and Texas spin turbines to create wind power, the coal from the Wyoming Powder River Basin fuels 40% of domestic coal fire power plants in aggregate US (EIA 2019). The increase in adoption of natural gas in the past decade comes domestically from states such as Pennsylvania and Texas (EIA 2021). This diaspora of energy generation showcases the wide array of natural resource endowments that have shaped our country's development and employment. Energy generation is dependent directly upon the demand by consumers for end use energy production. This demand for energy in turn creates a utilities sector in the form of induced demand. The demand for energy in the form of generation can directly be correlated to the amount of labor required to build infrastructure, maintain generation and, spur innovation in the form of investment in energy generation. The later of these, investment in energy production correlated to induced demand, will be explicitly explored at the state and national level.

United States

National trends in energy generation are concentrated in three areas of generation that produce a quantitative majority of the Energy generation for total end use at the 20% Coal, 39% Natural gas and, 19% Nuclear account for 78% of total energy production in just three forms of energy production (SEDS 2021). The aggregate energy generation is reflected on *Figure 1*. National trends in further adoption of natural gas from 2008 onward have seen an increase in consumption but a decrease in price on the aggregate from 2008 to 2020, a roughly 50% increase over the 12-year period seen below in *Figure 3* (SEDS 2021). At this same time the price of natural gas rose at the national level from 2000 to 2008 by 57% (SEDS 2021). This increase in price was followed by a downward trend in the price of gas from 2008 onward with increases in the price of natural gas in years 2012, 2013 and 2016 seen in *Figure 4* (SEDS 2021). Increases in the price of natural gas in years 2012, 2013 and, 2016 do not exceed year over year percentage changes of 20% (SEDS 2021). While natural gas has seen further expansion in generation and consumption in the past decade, Coal has seen a stark decreases in generation, demand, and consumption. Factors absent of price are believed to contribute to the shift away from coal. In consulting *Figure 4* one can see that the price of coal has marginally increased year over year from 2000 to 2013 (SEDS 2021). This minimal variation on price can be attributed to the total generation of coal being constant or not varying in the proceeding years.

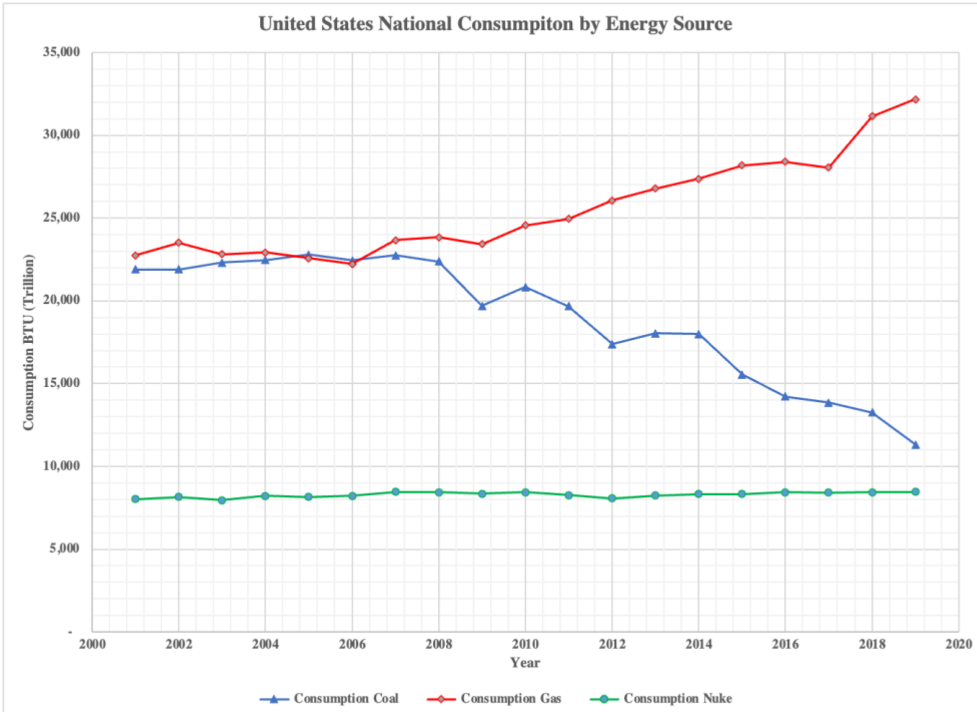

Figure 3, United States Consumption by Energy Source (Energy Information Administration, State Energy Database)

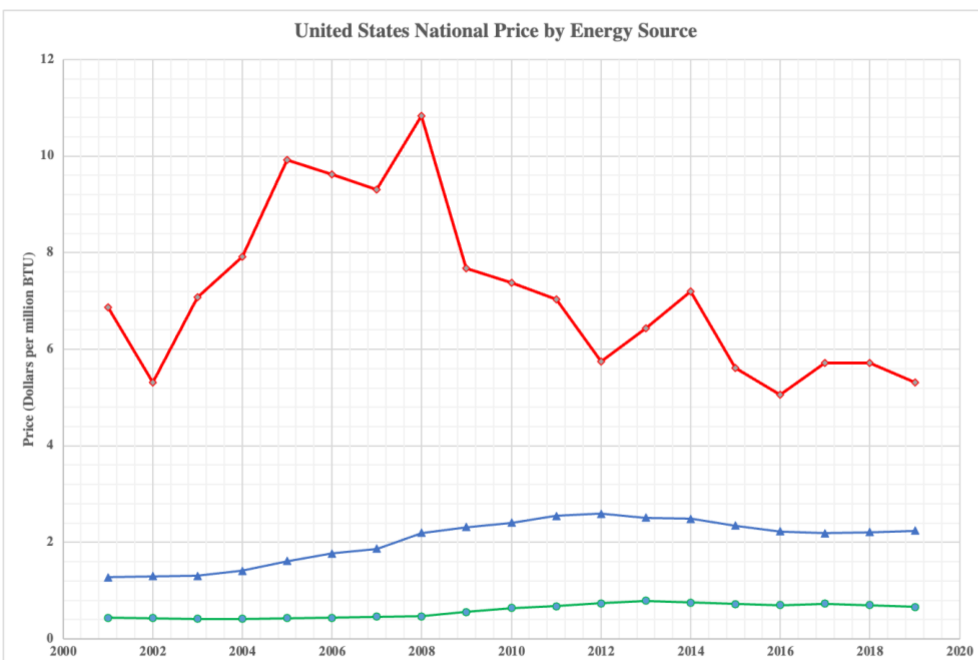

Figure 4, United States National Price by Energy Source (Energy Information Administration, State Energy Database)

Table 1, Double Log One & Two Period Lag of National US Energy Consumption Regression (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

Double Log One & Two Period Lag US National Energy Consumption Regression							
Utility Worker Wage	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
Consumption Coal	0.293	0.416	0.71	0.503	-0.69	1.276	
Consumption Gas	0.964	0.495	1.95	0.093	-0.207	2.136	*
Consumption Nuclear	0.785	1.008	0.78	0.461	-1.598	3.169	
One Period Consumption Coal	0.085	0.321	0.27	0.798	-0.674	0.845	
One Period Consumption Gas	0.484	0.707	0.69	0.515	-1.187	2.155	
One Period Consumption Nuclear	1.035	1.145	0.9	0.396	-1.672	3.743	
Two Period Consumption Coal	0.115	0.308	0.37	0.72	-0.614	0.844	
Two Period Consumption Gas	0.664	0.62	1.07	0.32	-0.803	2.131	
Two Period Consumption Nuclear	1.321	1.288	1.03	0.339	-1.724	4.366	
Constant	-43.202	20.482	-2.11	0.073	-91.635	5.231	*
Mean dependent var	11.407	SD dependent var	0.15				
R-squared	0.952	Number of obs	17				
F-test	15.377	Prob > F	0.001				
Akaike crit. (AIC)	-48.963	Bayesian crit. (BIC)	-40.63				
*** p<.01, ** p<.05, * p<.1							

A double log one and two period lag for consumption of energy sources model in the United States pictured above as *Table 1* allows us to better understand the national trends in consumption of the three most utilized energy sources in regard to the effect these variables have on Private Utility Sector Annual Wages. Specifically for the United States the consumption of natural gas remains the only statistically significant variable. The significance of gas in this model is for every 1% increases in the consumption of natural gas we can expect a .96% increase in the annual wage of a utility sector employee at the .093 p-level. In regards the model for consumption there exists a positive trend between the coefficients that while they lack statistical significance suggest that on the aggregate as consumption increase in this period wages of utility sector employees will in turn increase. While these increases are marginal, with a lack of statistical significance, they still suggest that as our consumption increase the total wages of private utility sector employee's will increase. There exist little trends that can still attribute positive and negative on our utility worker wage which does not necessarily incorporate all utility workers or those that contribute to the infrastructure of nuclear power plants. This model alongside other models posed later show that varying limitations given the lack of reporting on data specific to broad term and employment of utility workers.

Pictured below is a double log consumption and price model of energy sources in the United States by energy generation source. *Table 2* enables us to interpret energy sources in regard to the effect these variables have on private utility sector annual wages. We see strong significance in the consumption of coal with a coefficient of -.424 at the p-level of .001. This contrasts with the trends we see in the consumption of coal over the past two decades. Coal consumption has decreased year over year from 2008 onward except for 2009 and 2012 which saw slight increases in consumption but were dwarfed by coal's aggregate decrease in consumption over the past 14-year period. The negative coefficient of -.424 would suggest that as our consumption of coal increase by 1% we would expect a .424% decrease in the annual wage of utility sector employees. We can also observe slight significance at the .1 p-level with a positive coefficient of .937 in the consumption of nuclear energy. This would suggest that an increase of 1% in the consumption of nuclear energy would lead to .937% increase in the wage of a private utility sector employee.

Table 2 also enables us to interpret energy price in regard to the effect these sources have on private utility sector annual wages. We see minimal significance in the price of coal with a coefficient of .148 at the p-level of .09. This would lead us to derive that a 1% increase in the price of coal would increase the annual wage of our utility sector employee by .148%. We also see significance in the price of gas with a coefficient of .169 at the p-level of .01. This would equate to a .169% increase in the utility worker wage from a 1% increase in the price of gas. The positive coefficients we see in our model in regards to price showcase that increases in price of energy allow for surplus to be shared by utility workers and firms from increases in price of or directly compensate our workers over time as prices increase.

Table 2, Double Log National US Energy Consumption and Price Regression (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

Double Log US National Energy Consumption & Price Regression							
Utility Worker Wage	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
Consumption Coal	-0.424	0.099	-4.3	0.001	-0.639	-0.209	***
Consumption Gas	0.261	0.211	1.24	0.24	-0.199	0.721	
Consumption Nuclear	0.937	0.47	1.99	0.07	-0.088	1.962	*
Price Coal	0.148	0.081	1.83	0.092	-0.028	0.324	*
Price Gas	0.169	0.055	3.06	0.01	0.048	0.289	***
Price Nuclear	0.166	0.099	1.67	0.12	-0.05	0.382	
Constant	4.113	4.471	0.92	0.376	-5.628	13.854	
Mean dependent var	11.375	SD dependent var	0.17				
R-squared	0.988	Number of obs	19				
F-test	164.583	Prob > F	0				
Akaike crit. (AIC)	-84.4	Bayesian crit. (BIC)	-77.788				
*** p<.01, ** p<.05, * p<.1							

California

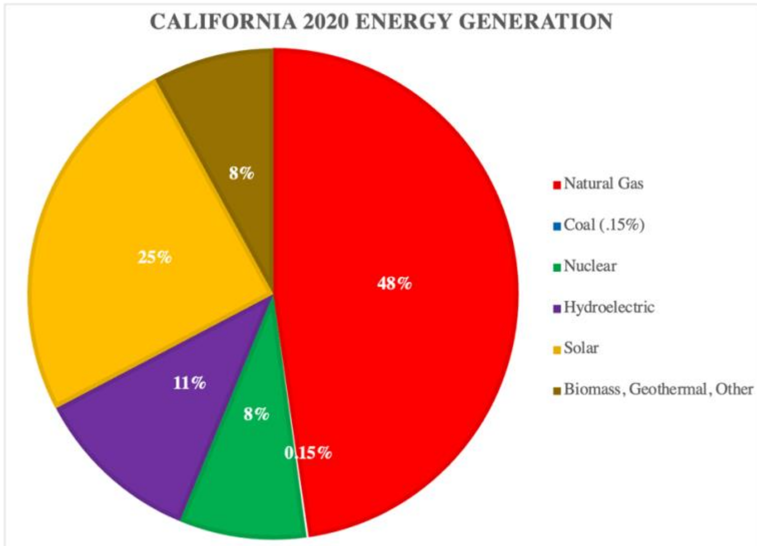

Figure 5, California 2020 Energy Generation by Sector (Energy Information Administration, State Energy Database)

The most populous state in the country of the United States is California. California ranks fourth in energy consumption. While California is the most populous state, its total end use energy consumption is not the highest nationally, this honor is reserved for Texas. California has the most diversified means of energy production of any state (EIA 2022). This is in part due to legislation being passed in California in 2006, "[the] Global Warming Solutions Act" which limited coal reliance by phasing out the transmission of electricity derived from coal as well as its production (CAISO 2007). This legislation paired with a varying climate by which California spans nearly the entire west coast of the United States creates diverse needs for the state in the form of generation and delivery. This clean energy legislation to reduce coal production and transportation affects not only California but neighboring states such as New Mexico which supplied previously supplied California with energy (CAISO 2018). Operating within both the California Independent System Operator as well as transmitting across the Southwest System operator. This policy introduced in 2006 limits the production of coal only to supplement non-renewable generation with natural gas and increase its reliance in the preceding decades on natural gas (EIA 2020).

Figure 5 displays the energy generation for total end use at the state level for California in 2020. California has the following annual averages of generation .15% Coal, 48% Natural Gas, 8% Nuclear, 11% Hydroelectric, 25% Solar, and 8% Biomass, Geothermal, and other (SEDS 2020). Other encompasses all other forms of generation not accounted for in biomass or geothermal. Following national trends Coal has decreased over the past decade and has in turn been supplemented by natural gas generation. California with its bright coastline and clear skies dwarfs the national average of 2.8% total energy generation at the national level, with its 25% production at the state level (SEDS 2020). California again deviates from the National averages in regards to nuclear power generation producing only one third the national average (SEDS 2020).

Table 3 utilizes data gathered from the state of California on state pricing, consumption, and total employment regarding the effect these variables have on private utility sector annual wages. We see strong significance in the consumption of coal with a coefficient of -.422 at the p-level of .004. Coal consumption has decreased from the state of California to a minute .15% of total generation in 2020. The negative coefficient of -.422 would suggest that as our consumption of coal increases by 1% we would expect a .422% decrease in the annual wage of utility sector employees in California. This is rather interesting that the statistical significance in a state where coal consumption makes up such a small percentage of total energy. We can also observe slight significance at the .1 p-level with a negative coefficient of -.493 in the consumption of natural gas. This would suggest that an increase of 1% in the consumption of natural gas would lead to .493% decrease in the wage of a private utility sector employee in the state. Total consumption can also observe moderate significance at the .016 p-level with a positive coefficient of 1.164. The total consumption variable accounts for the total consumption of all energy sources for the year; non-renewable and renewable. This would suggest that an increase of 1% in the consumption of total energy would lead to 1.164% increase in the wage of a private utility sector employee. This can likewise be attributed to the diverse nature of California's energy consumption that is encompassed in the total calculation more so than it is captured in the large three factors of generation that are less prominent in California.

Table 3, Double Log California US Energy Consumption, Price and Employment Regression (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

Double Log California Energy Consumption & Price Regression							
Utility Worker Wage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Utility Worker State Employment	0.31	0.492	0.63	0.545	-0.804	1.423	
Consumption Coal	-0.422	0.111	-3.82	0.004	-0.672	-0.172	***
Consumption Gas	-0.493	0.25	-1.97	0.08	-1.059	0.072	*
Consumption Nuclear	-0.001	0.075	-0.01	0.994	-0.17	0.169	
Consumption Total	1.164	0.393	2.96	0.016	0.275	2.052	**
Price Coal	0.127	0.132	0.96	0.361	-0.171	0.425	
Price Gas	-0.029	0.093	-0.31	0.766	-0.24	0.182	
Price Nuclear	-0.081	0.178	-0.45	0.662	-0.484	0.323	
Price Total	0.342	0.138	2.49	0.035	0.031	0.653	**
Constant	2.033	5.929	0.34	0.74	-11.381	15.446	
Mean dependent var		11.516	SD dependent var			0.216	
R-squared		0.993	Number of obs			19	
F-test		134.715	Prob > F			0	
Akaike crit. (AIC)		-78.697	Bayesian crit. (BIC)			-69.253	
**** p<.01, ** p<.05, * p<.1*							

Table 3 also enables us to interpret energy prices and the affect these sources have on private utility sector annual wages. We see moderate significance in the price of total energy for the state with a coefficient of .342 at the p-level of .035. The price total variable accounts for the aggregate price of all energy sources for the year; non-renewable and renewable. This would lead us to derive that a 1% increase in the price of total energy would increase the annual wage of our utility sector employee by .342% in California. These negative coefficients we see in our model in regard to coal and nuclear consumption are seen in states with low generation of coal and high generation of nuclear which is not necessarily true in the context of California. California has minute generations of coal .01% of the state's total generation, comparing this to the national average of 20% (SEDS 2021). California also lags behind the National average in its nuclear generation a moderate amount of 8% nuclear energy generation relative to the state total for the state of California, relative to the average national of 19% nuclear energy generation relative to the national generation (SEDS 2021).

Table 4, Double Log One Period Lag of California Energy Consumption Regression (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

Double Log One Period Lag California Energy Consumption Regression							
Utility Worker Wage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Consumption Coal	-0.624	0.233	-2.68	0.021	-1.137	-0.111	**
Consumption Gas	1.442	0.772	1.87	0.088	-0.256	3.141	*
Consumption Nuclear	0.401	0.198	2.03	0.068	-0.034	0.836	*
One Period Lagged Consumption Coal	-0.436	0.287	-1.52	0.158	-1.068	0.197	
One Period Lagged Consumption Gas	-1.064	0.592	-1.8	0.1	-2.368	0.24	*
One Period Lagged Consumption Nuclear	0.048	0.171	0.28	0.784	-0.329	0.425	
Constant	10.239	5.426	1.89	0.086	-1.703	22.182	*
Mean dependent var	11.537	SD dependent var	0.201				
R-squared	0.922	Number of obs	18				
F-test	21.598	Prob > F	0				
Akaike crit. (AIC)	-39.533	Bayesian crit. (BIC)	-33.301				
**** p<.01, ** p<.05, * p<.1*							

Table 4 utilizes data gathered from the state of California on state pricing and consumption regarding the effect these variables have on private utility sector annual wages. This model has significance in the consumption of gas with a positive coefficient of 1.442 at the p-level of .08. This corresponds with the trends we see in the consumption of Gas over the past decades at the national level with increases in natural gas consumption. The positive coefficient of 1.442 would suggest that as our consumption of gas increases by 1% we would expect a 1.422% increase in the annual wage of utility sector employees in the state. We can also observe slight significance at the .1 p-level with a negative coefficient of -1.064 in the one period lagged consumption of natural gas. This would

suggest that an increase of 1% in the consumption of natural gas in last year's natural gas consumption would lead to -1.064% decrease in the wage of a private utility sector employee in California. Nuclear energy can also observe minimal significance at the .1 p-level with a positive coefficient of .401. This would suggest that an increase of 1% in the consumption of total energy would lead to .401% increase in the wage of a private utility sector employee in California. Statistical significance even at the minimal level is often not seen in nuclear energy. Coefficients for nuclear energy in California remain not statistically significant something we have seen in out other regressions of other state and national models specifically for consumption.

New Mexico

New Mexico is particularly interesting in regard to the implications, specifically the role the state has for nuclear. It has the world's second largest reserves of uranium, yet it produces no electricity in the form of nuclear energy (The Energy Council 2020). New Mexico generates an aggregate 78% of its energy generation from non-renewable resources. This is roughly 20% more non-renewable energy produced than the national average of 55% non-renewable. Much of this can be attributed to the fact that New Mexico does not produce nuclear energy and is not in the minority in this respect. Only 31 states have nuclear power plants, this leaves 29 states that produce no or minimal nuclear energy (EIA 2021). New Mexico accounts for 5% of the total Natural Gas production for the United States (EIA 2022). New Mexico is currently expanding renewables in the form of wind and geothermal, yet it still has minimal diversification from it large dependence on coal and natural gas (EIA 2021).

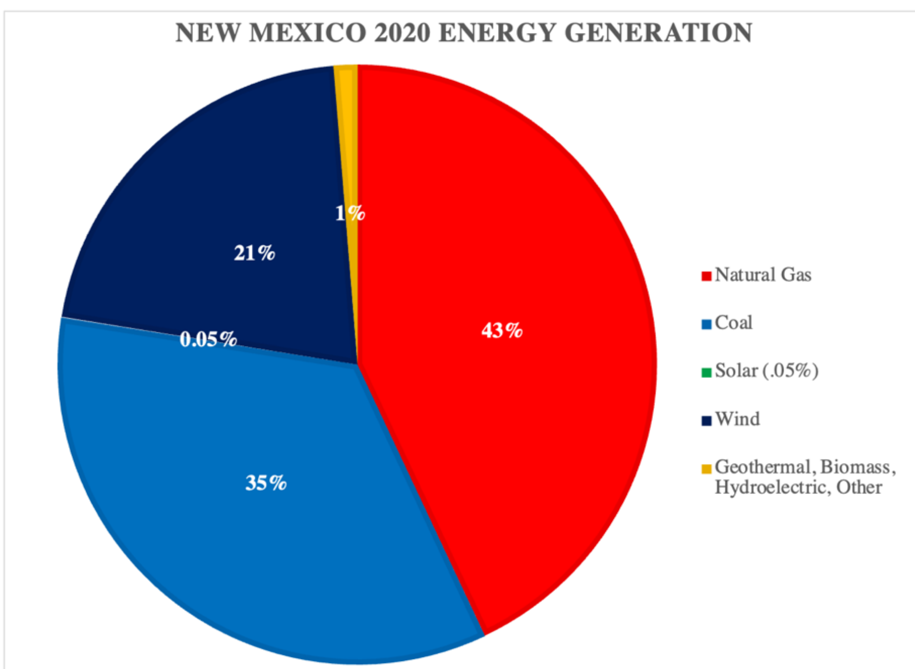

Figure 6, New Mexico 2020 Energy Generation by Sector (Energy Information Administration, State Energy Database)

Energy generation for total end use in New Mexico is respectively 35% Coal, 43% Gas, 0% Nuclear, 0.5% Solar and 1% Geothermal, Biomass and Hydroelectric, with energy visually displayed above in *Figure 6.* Natural Gas generation makes up a large part of New Mexico's production and has historically over the past two decades because of its natural gas reserves. Thus, we can conclude that the total decrease in coal consumption has been offset and the total generation capacity for the US has increased in the same period by 5.3% since 2000.

Table 5, Double Log One Period Lag of New Mexico Energy Consumption Regression (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

Double Log One Period Lag New Mexico Energy Consumption Regression							
Utility Worker Wage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Consumption Coal	-0.11	0.184	-0.6	0.56	-0.509	0.288	
Consumption Gas	1.476	0.536	2.76	0.016	0.319	2.634	**
One Period Lagged Consumption Coal	0.135	0.213	0.64	0.536	-0.324	0.594	
One Period Lagged Consumption Gas	0.172	0.502	0.34	0.737	-0.912	1.256	
Constant	1.91	4.217	0.45	0.658	-7.202	11.021	
Mean dependent var	11.143	SD dependent var	0.139				
R-squared	0.774	Number of obs	18				
F-test	11.129	Prob > F	0				
Akaike crit. (AIC)	-37.71	Bayesian crit. (BIC)	-33.258				
*** p<.01, ** p<.05, * p<.1							

Table 5 utilizes data gathered from the state of New Mexico on state consumption regarding the effect these variables have on private utility sector annual wages. We see moderate significance in the consumption of natural gas with a coefficient of 1.476 at the p-level of .016. The importance of natural gas for the state of New Mexico can be seen in

the statistical significance of the consumption of natural gas. The positive coefficient of 1.476 would suggest that as our consumption of gas increases by 1% we would expect a 1.476% increase in the annual wage of utility sector employees in New Mexico. Positive coefficients for natural gas and one period lag of natural gas emphasize the impact of the prior year's consumption on wages for utility workers in the state of New Mexico.

Table 6, Double Log One & Two Period Lag of New Mexico Energy Consumption Regression (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

Double Log One & Two Period Lag New Mexico Energy Consumption Regression							
Utility Worker Wage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Consumption Coal	-0.729	0.245	-2.97	0.014	-1.275	-0.183	**
Consumption Gas	-0.609	0.599	-1.02	0.333	-1.944	0.726	
One Period Lagged Consumption Coal	0.275	0.134	2.06	0.067	-0.023	0.573	*
One Period Lagged Consumption Gas	2.357	0.534	4.42	0.001	1.167	3.546	***
Two Period Lagged Consumption Coal	0.491	0.296	1.66	0.128	-0.169	1.152	
Two Period Lagged Consumption Gas	-0.594	0.337	-1.76	0.108	-1.345	0.156	
Constant	4.562	3.203	1.42	0.185	-2.574	11.698	
Mean dependent var	11.158	SD dependent var	0.128				
R-squared	0.935	Number of obs	17				
F-test	23.863	Prob > F	0				
Akaike crit. (AIC)	-55.18	Bayesian crit. (BIC)	-49.347				
*** p<.01, ** p<.05, * p<.1							

Table 6 utilizes data gathered from the state of New Mexico on state consumption regarding the effect these variables have on private utility sector annual wages. We see

strong significance in the one period lagged consumption of natural gas with a coefficient of 2.357 at the p-level of .001. This metric again emphasizes the importance of natural gas for the state of New Mexico. The positive coefficient of 2.357 suggests that as our consumption of gas increases by 1% in the prior year would expect a 2.357% increase in the annual wage of utility sector employees. We see moderate significance in the consumption of coal with a coefficient of -.729 at the p-level of .014. This negative coefficient seen in the consumption of coal is contrasted by a positive coefficient for a one period lag of coal consumption. This negative coefficient of -.729 would suggest that as our consumption of coal increase by 1% we would expect a .729% decrease in the annual wage of Utility Sector Employees. This is interesting in a state where coal remains the second most dependable means of energy generation.

Michigan

Michigan's state consumption metrics and percentages rival that of the United States as a whole. Energy generation for total end use at the national level for coal is 22%, Michigan produces 4% more relative to state total of 26% coal generation for Michigan relative to the state generation total. Generation at the national level for natural gas is 39%, Michigan produces 5% less relative to state total of 34% natural gas generation for Michigan relative to the state generation total. Generation at the national level for nuclear is 19%, Michigan produces 9% more relative to state total of 28% nuclear generation for Michigan relative to the state generation total. Generation at the national level for renewable means is 20%, Michigan produces 8% less relative to state total of 12% renewable generation for Michigan relative to the state generation total. While Michigan does not directly mimic the United States, Michigan's aggregate energy production closely reflects the United States energy aggregate production. Michigan is able to achieve 28% nuclear energy production with just three nuclear power plants operating less than a dozen reactors! Adoption of wind in 2011 that began in 2009 currently produces 5% of total energy for Michigan. Michigan also plans to decommission one of its nuclear reactors in late 2022 (EIA 2022).

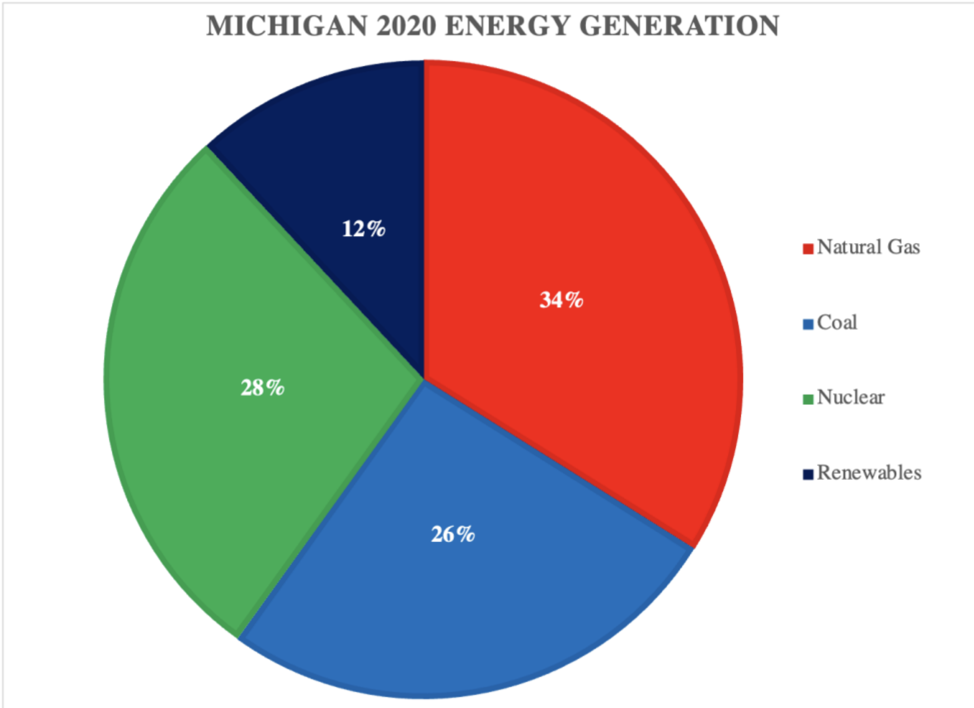

Figure 7, Michigan 2020 Energy Generation by Sector (Energy Information Administration, State Energy Database)

Figure 7 displays the energy generation for total end use at the state level for Michigan in 2020. Michigan has the following annual averages of generation 26% Coal generation, 34% Natural Gas generation, 28% Nuclear generation, and 12% Renewable generation. Renewable generation consisting predominantly of solar and wind for the state of Michigan. In line national trends consumption of coal has decreased over the past decade and has in turn been supplemented by natural gas generation and expanding nuclear energy in Michigan (EIA 2022). Just three nuclear powerplants fuel 28% of nuclear energy for the entire state of Michigan (EIA 2020). While Michigan has a strong nuclear power sector, it is decommissioning one of its three reactors and will likely lose 734 Mw of power from this plant being taken off the grid (EIA 2022).

Table 7, Double Log One Period Lag of Michigan Energy Consumption Regression (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

Double Log One Period Lag Michigan Energy Consumption Regression							
Utility Worker Wage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Consumption Coal	-0.517	0.176	-2.93	0.014	-0.905	-0.129	**
Consumption Gas	-0.363	0.359	-1.01	0.334	-1.154	0.427	
Consumption Nuclear	0.086	0.164	0.52	0.611	-0.275	0.447	
One Period Lagged Consumption Coal	-0.568	0.188	-3.02	0.012	-0.982	-0.155	**
One Period Lagged Consumption Gas	-0.666	0.354	-1.88	0.087	-1.445	0.114	*
One Period Lagged Consumption Nuclear	0.155	0.162	0.96	0.358	-0.201	0.512	
Constant	20.142	1.879	10.72	0	16.006	24.279	***
Mean dependent var	7.502	SD dependent var	0.188				
R-squared	0.945	Number of obs	18				
F-test	31.45	Prob > F	0				
Akaike crit. (AIC)	-48.339	Bayesian crit. (BIC)	-42.107				
*** p<.01, ** p<.05, * p<.1							

Table 7 utilizes data gathered from the state of Michigan on state consumption regarding the effect these variables have on private utility sector annual wages. We see moderate significance in the consumption of coal with a coefficient of -.517 at the p-level of .014. This negative coefficient of coal complements the negative trend in consumption in national models. The negative coefficient of -.517 would suggest that as our consumption of coal increases by 1% we would expect a .517% decrease in the annual wage of utility sector employees in Michigan. We further see moderate significance in the one period lagged consumption of coal with a coefficient of -.568 at the p-level of .012.

The negative coefficient of -.568 would suggest that as the prior year's consumption of coal increases by 1% we would expect a .568 % decrease in the annual wage of utility sector employees in the state. We can also observe slight significance at the .087 p-level with a negative coefficient of -.666 in the one period lagged consumption of natural gas. This would suggest that an increase of 1% in the prior year's consumption of natural gas would lead to .666% decrease in the wage of a private utility sector employees in Michigan.

Table 8, Double Log One & Two Period Lag of Michigan Energy Price Regression (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

Double Log One & Two Period Lag Michigan Energy Price Regression							
Utility Worker Wage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Price Coal	0.72	0.326	2.21	0.063	-0.052	1.491	*
Price Gas	-0.605	0.232	-2.61	0.035	-1.154	-0.057	**
Price Nuclear	-0.153	0.276	-0.56	0.596	-0.805	0.499	
One Period Lagged Price Coal	-0.276	0.43	-0.64	0.541	-1.292	0.74	
One Period Lagged Price Gas	0.285	0.308	0.92	0.386	-0.444	1.014	
One Period Lagged Price Nuclear	-0.165	0.362	-0.46	0.662	-1.022	0.692	
Two Period Lagged Price Coal	0.665	0.261	2.55	0.038	0.048	1.281	**
Two Period Lagged Price Gas	-0.22	0.268	-0.82	0.44	-0.854	0.415	
Two Period Lagged Price Nuclear	-0.282	0.354	-0.8	0.452	-1.12	0.556	
Constant	7.446	0.325	22.92	0	6.678	8.215	***
Mean dependent var	7.52	SD dependent var	0.177				
R-squared	0.944	Number of obs	17				
F-test	13.006	Prob > F	0.001				
Akaike crit. (AIC)	-40.516	Bayesian crit. (BIC)	-32.184				
*** *p<.01*, ** *p<.05*, * *p<.1*							

Table 8 utilizes data gathered from the state of Michigan on state price regarding the effect these variables have on private utility sector annual wages. We see strong

significance in the price of coal with a coefficient of .72 at the p-level of .063. This positive coefficient of the price of coal contradicts the negative trend in the price of coal in national models. The positive coefficient of .72 would suggest that as our price of coal increases by 1% we would expect a .72% increase in the annual wage of utility sector employees in Michigan. We see moderate significance in the price of gas with a coefficient of -.605 at the p-level of .035. The negative coefficient of -.605 would suggest that as our price of coal increases by 1% we would expect a .605% decrease in the annual wage of utility sector employees in the state. We further see moderate significance in the two-period lagged consumption of coal with a coefficient of .665 at the p-level of .038. The negative coefficient of .665 would suggest that as our two years prior consumption of coal increases by 1% we would expect a .665 % increase in the annual wage of utility sector employees in Michigan.

Texas

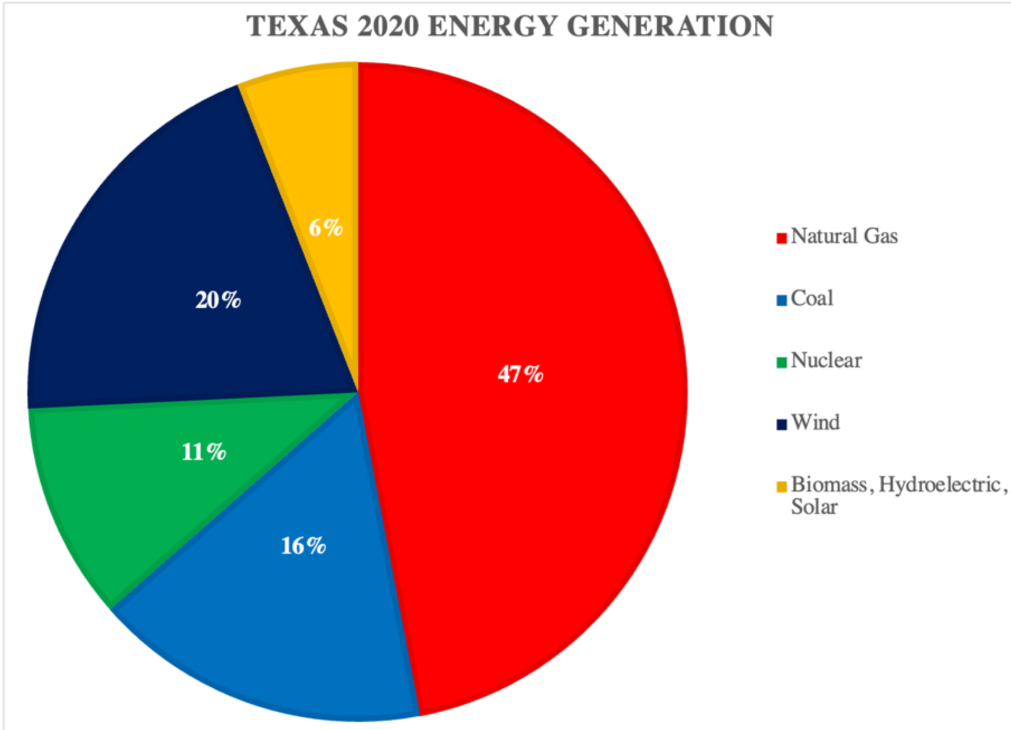

Figure 8, Texas 2020 Energy Generation by Sector (ERCOT, Grid and Market Conditions)

Figure 8 displays the energy generation for total end use at the state level for Texas in 2020. Texas has the following annual averages of generation 16% Coal generation, 47% Natural Gas generation, 11% Nuclear generation, 6% Hydroelectric, Solar, and Biomass generation and 20% Wind generation. Following national trends Coal has decreased over the past decade and has in turn been supplemented by natural gas generation and wind power (SEDS 2021).

Table 9, Double Log One Period Lag of Texas Energy Consumption Regression (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

Double Log One Period Lagged Texas Energy Consumption Regression							
Utility Worker Wage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Consumption Coal	0.012	0.429	0.03	0.979	-0.934	0.957	
Consumption Gas	1.194	0.607	1.97	0.075	-0.142	2.529	*
Consumption Nuclear	1.367	0.745	1.84	0.093	-0.272	3.006	*
One Period Consumption Coal	0.208	0.53	0.39	0.702	-0.959	1.375	
One Period Consumption Gas	0.031	0.724	0.04	0.967	-1.563	1.625	
One Period Consumption Nuclear	1.542	0.665	2.32	0.041	0.078	3.006	**
Constant	-17.848	18.907	-0.94	0.365	-59.462	23.765	
Mean dependent var	11.425	SD dependent var	0.158				
R-squared	0.757	Number of obs	18				
F-test	5.723	Prob > F	0.006				
Akaike crit. (AIC)	-27.879	Bayesian crit. (BIC)	-21.647				
*** *p<.01*, ** *p<.05*, * *p<.1*							

Table 9 utilizes data gathered from the state of Texas on state consumption and the corresponding effect these variables have on private utility sector annual wages. We observe slight significance in the consumption of gas with a coefficient of 1.194 at the p-level of .075. This complements the trends we see for national natural gas consumption. The positive coefficient of 1.194 would suggest that as our consumption of coal increase by 1% we would expect a 1.194% increase in the annual wage of utility sector employees in Texas. We can also observe slight significance at the .093 p-level with a positive coefficient of 1.367 in the consumption of natural gas. This would suggest that an increase of 1% in the consumption of natural gas would lead to 1.367 % increase in the wage of a private utility sector employee in the state. One period lagged nuclear consumption can also observe moderate significance at the .041 p-level with a positive coefficient of 1.542.

This would suggest that an increase of 1% in the consumption of total energy would lead to 1.542% increase in the wage of a private utility sector employees in Texas.

Table 10, Double Log One & Two Period Lag of Texas Energy Consumption Regression (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

Double Log One & Two Period Lagged Texas Energy Consumption Regression							
Utility Worker Wage	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Consumption Coal	0.634	0.329	1.93	0.095	-0.144	1.412	*
Consumption Gas	1.765	0.5	3.53	0.01	0.584	2.947	***
Consumption Nuclear	1.838	0.545	3.37	0.012	0.55	3.127	**
One Lagged Period Consumption Coal	0.657	0.389	1.69	0.136	-0.264	1.577	
One Period Lagged Consumption Gas	0.849	0.65	1.3	0.233	-0.689	2.387	
One Period Lagged Consumption Nuclear	2.826	0.642	4.4	0.003	1.308	4.345	***
Two Period Lagged Consumption Coal	0.365	0.378	0.97	0.366	-0.529	1.26	
Two Period Lagged Consumption Gas	1.066	0.536	1.99	0.087	-0.201	2.333	*
Two Period Lagged Consumption Nuclear	1.214	0.507	2.39	0.048	0.014	2.414	**
Constant	-66.559	21.011	-3.17	0.016	-116.243	-16.876	**

Mean dependent var	11.439	SD dependent var	0.152	
R-squared	0.92	Number of obs	17	
F-test	9	Prob > F	0.004	
Akaike crit. (AIC)	-39.984	Bayesian crit. (BIC)	-31.652	

*** *p<.01*, ** *p<.05*, * *p<.1*

Table 10 utilizes data gathered from the state of Texas on state consumption and the corresponding effect these variables have on private utility sector annual wages in the state. We observe strong significance in the consumption of gas with a coefficient of 1.765 at the p-level of .01. This complements the trends we see for national natural gas consumption. The positive coefficient of 1.765 would suggest that as our consumption of gas increase by 1% we would expect a 1.765% increase in the annual wage of utility sector employees in the state. We can also observe strong significance at the .003 p-level with a positive coefficient of 2.826 in the one period lagged consumption of nuclear energy. This would suggest that an increase of 1% in the prior year in the consumption of nuclear energy would lead to 2.826% increase in the wage of a private utility sector employees in Texas. The deviation from national trends of minimal to slight significance in nuclear energy is very odd for Texas seeing as the total nuclear production is only 11% compared to the national average of 18%.

Conclusion

In analyzing the national data as well as state data in California, New Mexico, Michigan, and Texas multiple trends can be observed across states with little or no relation to national trends. At both the state and national level there exist negative coefficients on consumption variables for coal energy. This trend seen in *Tables 1, 2, 3, 4, 5, 6, 7, 8* of negative coefficient of coal correlates to the downward trend in the consumption over the past two decades that are likewise a part of this downward trend. Another trend seen in the data at the state level is a negative coefficient for natural gas consumption and gas consumption in the first period lagged variable of natural gas. This trend seen in *Tables 1, 3, 4, 5, 6, 7, 8* has the opposite coefficient sign than would be expected from the aggregate increase in adoption of natural gas relative to coal energy over the same period of 2000 to 2020. Lastly the largest national and state trend with little statistical significance is the positive coefficients for both nuclear price and nuclear consumption variables.

Reaching the goals of decarbonization requires us to explore divergent avenues of production and organization to truly meet this goal. Nuclear energy serves as a stark alternative to our current forms of energy production. As of Spring 2022, the United States operates 59 nuclear power plants with 88 reactors for residential and commercial use (EIA January Newsletter, 2022). The energy produced per nuclear plant exceeds that of any other form of energy. This can be seen through the approximate one gigawatt of power that a single nuclear reactor can produce. This translates to one large scale coal power plant producing 500 megawatts, and or one large scale gas fire plant producing 820 megawatts for non-renewables (Emerson 2020). In regard to renewables one solar farm with 1kw solar panels would require 250,000 panels to produce just a quarter of one nuclear reactors total generation. A single wind farm of 160 utility-scale Turbines would equate the one gigawatt that one reactor can produce (Siemens 2019). This is not cited to discourage the use of renewables, but rather it is cited to quantify our reliance on large scale energy production and consumption as Americans and the implication this has for the world as a whole.

On September 12, 2011, Angela Merkel signaled to the developed world that sovereign nations refused to embrace the future of energy production enforcing that all nuclear power plants in Germany were to be decommissioned by 2022 (The Economist 2021). This is not a decision that Merkel has made on her own but also has economic ramifications for the developed world and those still industrializing nations (World Nuclear News 2021). Nations that need raw inputs of labor, capital, and energy to fuel their means of production require an energy source that does not harm ones neighboring country or peer.

In an alternate view Germany could be signaling that is in not in need of such a large-scale power delivery system. This is to say that Germany no longer needs an industrial capacity for its nations energy. The argument could be made that Germany has filed its means of production with nuclear energy and sees to it that she does not need the capacity of nuclear energy, this is a hardly less relatable or rational reality that German has deployed. The idea that Germany is no longer in need of nuclear energy could not be farther from the truth. Germany sought to make the country less vulnerable to outside intervention in terms of nuclear power and it has done quite the opposite in recent months with its dependency on gas and oil from questionable countries. Regardless of Germany's intention, her choice to close all plants serves as an example to developing Asian and African Countries which seek to expand their residential and industrial energy sectors.

While the United States has seen minimal closures relative to Germany's full-scale desertion, numerous states have seen nuclear power reactors and subsequent plants decommissioned. States such as Ohio, New York and even California and have seen plants closed that provide the power of numerous plants that are required to be built in their place (DOE 2019). The lack of supplementation of new nuclear plants in place of old or determined nuclear plants can be seen in much of the western facing world. Where nuclear adoption is expanding is the developing world and where manufacturing for exports is expanding (World Nuclear Association 2021). Countries such as Brazil, China, India, Russia and United Arabs Emirates are all seeing expanses in their perspective nuclear energy sectors through new plant construction (World Nuclear Association 2022). One thing that can be said about the adoption of nuclear energy is that countries seek to adopt nuclear energy are expanding perspective production capacity as well as supplementing residential sectors from expanses in large scale capacity. From this understanding we can deduce that countries that are not adopting nuclear energy or are making little efforts to maintain the energy source are not expanding in production nor in population.

In summation the lack of expanse and maintenance in the nuclear energy sector alongside upward trends in utility sector wages have applied further pressure on the nuclear energy sector (SEDS 2021). This financial pressure alongside a lack of emphasis of nuclear as a means of reducing carbon emissions has left nuclear energy in a dissipated state of nuclear plant development. This lack of development has further been both hindered and culminated in nuclear meltdowns and concerns over the use of nuclear energy as a weapon in modern times. One truth remains in regard to nuclear energies adoption, countries expanding in both production or population are requiring of more energy and this energy must be derived from high-capacity source such as gas, nuclear or coal energy. If a state, country, or consortium of countries looks to meet both their nations needs and remain conservation minded in the handily if carbon emissions, nuclear energy remains the only option to satisfy these pertinent needs of production and expansion.

Appendix

A: State Summary Statistics

Table 11, United States Energy Descriptive Statistics (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

United States: Wage, Employment, Consumption, Price Descriptive Statistics					
Variable	Obs	Mean	Std. Dev.	Min	Max
Utility Worker Employment (Thousands)	20	557389.20	15060.32	543628.00	599899.00
Utility Worker Wage (Dollars)	20	89762.15	15794.90	65561.00	117180.00
Consumption of Coal (Million BTU)	19	18986.58	3755.73	11315.00	22793.00
Consumption of Gas (Million BTU)	19	25550.00	2983.76	22225.00	32170.00
Consumption of Nuclear (Million BTU)	19	8283.84	156.12	7960.00	8459.00
Consumption of Total (Million BTU)	19	98021.90	1994.64	93969.00	101162.00
Price of Coal (Per Million BTU)	19	2.04	0.46	1.28	2.59
Price of Gas (Per Million BTU)	19	7.14	1.72	5.06	10.83
Price of Nuclear (Per Million BTU)	19	0.59	0.14	0.42	0.79
Price of Total (Per Million BTU)	19	17.26	3.74	10.10	21.87

Table 12, New Mexico Energy Descriptive Statistics (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

New Mexico: Wage, Employment, Consumption, Price Descriptive Statistics					
Variable	Obs	Mean	Std. Dev.	Min	Max
Utility Worker Employment (Thousands)	20	4258.75	191.19	3939.00	4613.00
Utility Worker Wage (Dollars)	20	69868.25	10379.50	53570.00	87848.00
Consumption of Coal (Million BTU)	19	258.13	55.89	136.80	317.90
Consumption of Gas (Million BTU)	19	249.96	19.77	225.20	305.10
Consumption of Nuclear (Million BTU)	19	0.00	0.00	0.00	0.00
Consumption of Total (Million BTU)	19	678.25	21.95	644.50	735.60
Price of Coal (Per Million BTU)	19	2.01	0.55	1.42	3.77
Price of Gas (Per Million BTU)	19	6.22	1.81	3.02	9.51
Price of Nuclear (Per Million BTU)	19	0.00	0.00	0.00	0.00
Price of Total (Per Million BTU)	19	18.45	4.24	10.61	24.20

Table 13, Michigan Energy Descriptive Statistics (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

Michigan: Wage, Employment, Consumption, Price Descriptive Statistics					
Variable	Obs	Mean	Std. Dev.	Min	Max
Utility Worker Employment (Thousands)	20	20094.00	532.65	19134.00	20926.00
Utility Worker Wage (Dollars)	20	96049.50	19575.43	67367.00	130168.00
Consumption of Coal (Million BTU)	19	675.90	120.38	447.80	801.20
Consumption of Gas (Million BTU)	19	880.96	87.35	750.80	1054.40
Consumption of Nuclear (Million BTU)	19	313.80	28.01	228.50	344.20
Consumption of Total (Million BTU)	19	2940.49	166.20	2690.30	3215.20
Price of Coal (Per Million BTU)	19	2.20	0.57	1.32	3.09
Price of Gas (Per Million BTU)	19	7.59	1.79	5.02	10.69
Price of Nuclear (Per Million BTU)	19	0.60	0.15	0.40	0.80
Price of Total (Per Million BTU)	19	16.38	3.53	9.94	21.33

Table 14, Texas Energy Descriptive Statistics (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

Texas: Wage, Employment, Consumption, Price Descriptive Statistics					
Variable	Obs	Mean	Std. Dev.	Min	Max
Utility Worker Employment (Thousands)	19	48774.95	2135.42	44429.00	52656.00
Utility Worker Wage (Dollars)	19	91818.16	14337.52	68589.00	115194.00
Consumption of Coal (Million BTU)	19	1498.29	175.35	992.70	1695.20
Consumption of Gas (Million BTU)	19	4020.86	369.90	3481.10	4779.50
Consumption of Nuclear (Million BTU)	19	412.50	23.11	348.50	440.10
Consumption of Total (Million BTU)	19	12273.68	875.65	10884.40	14227.40
Price of Coal (Per Million BTU)	19	1.72	0.28	1.26	2.03
Price of Gas (Per Million BTU)	19	5.11	1.71	3.24	9.16
Price of Nuclear (Per Million BTU)	19	0.57	0.16	0.35	0.77
Price of Total (Per Million BTU)	19	15.22	3.92	7.96	21.71

Table 15, California Energy Descriptive Statistics (Energy Information Administration, State Energy Database & Bureau of Labor Services Quarterly Employment, and Wage Statistics)

California: Wage, Employment, Consumption, Price Descriptive Statistics					
Variable	Obs	Mean	Std. Dev.	Min	Max
Utility Worker Employment (Thousands)	19	57134.21	1453.22	54468.00	59705.00
Utility Worker Wage (Dollars)	19	102458.26	21427.84	68854.00	138608.00
Consumption of Coal (Million BTU)	19	51.86	15.57	30.90	70.00
Consumption of Gas (Million BTU)	19	2354.91	106.59	2191.00	2513.90
Consumption of Nuclear (Million BTU)	19	282.46	85.46	168.80	383.60
Consumption of Total (Million BTU)	19	7836.00	263.06	7453.80	8260.70
Price of Coal (Per Million BTU)	19	2.75	0.75	1.46	3.78
Price of Gas (Per Million BTU)	19	7.42	1.29	5.10	10.07
Price of Nuclear (Per Million BTU)	19	0.57	0.11	0.43	0.73
Price of Total (Per Million BTU)	19	20.42	4.38	12.07	25.63

B: Variables

Utility Worker Wage - Annual mean wage of private utility workers, state/national level annual average wage of private sector utility sector employees

Utility Worker Employment – Annual employment of private utility workers, state/national level annual employment of private sector utility sector employees

Price of Coal – Energy price in Dollars Per Million Btu of Coal per year at the state/national level

Price of Gas - Energy price in Dollars Per Million Btu of Natural Gas per year at the state/national level

Price of Nuclear - Energy price in Dollars Per Million Btu of Nuclear per year at the state/national level

Price of Total - Energy price in Dollars Per Million Btu of the state/national total energy unit per year at the state/national level

One Period Lagged Price Coal – One Period Lagged energy price in Dollars Per Million Btu of Coal per year at the state/national level

One Period Lagged Price Gas - One Period Lagged energy price in Dollars Per Million Btu of Natural Gas per year at the state/national level

One Period Lagged Price Nuclear - One Period Lagged energy price in Dollars Per Million Btu of Nuclear per year at the state/national level

One Period Lagged Price Total - One Period Lagged energy price in Dollars Per Million Btu of the state/national total energy unit per year at the state/national level

Two Period Lagged Price Coal – Two Period Lagged energy price in Dollars Per Million Btu of Coal per year at the state/national level

Two Period Lagged Price Gas - Two Period Lagged energy price in Dollars Per Million Btu of Natural Gas per year at the state/national level

Two Period Lagged Price Nuclear - Two Period Lagged energy price in Dollars Per Million Btu of Nuclear per year at the state/national level

Two Period Lagged Price Total - Two Period Lagged energy price in Dollars Per Million Btu of the state/national total energy unit per year at the state/national level

Consumption of Coal - Energy consumption Per Million Btu of Coal energy per year at the state/national level

Consumption of Gas - Energy consumption Per Million Btu of Gas energy per year at the state/national level

Consumption of Nuclear - Energy consumption Per Million Btu of Nuclear energy per year at the state/national level

Consumption of Total - Energy consumption Per Million Btu of all state/national energy consumption per year at the state/national level

One Period Lagged Consumption Coal – One period lagged energy consumption Per Million Btu of Coal energy per year at the state/national level

One Period Lagged Consumption Gas - One period lagged energy consumption Per Million Btu of Gas energy per year at the state/national level

One Period Lagged Consumption Nuclear - One period lagged energy consumption Per Million Btu of Nuclear energy per year at the state/national level

One Period Lagged Consumption Total - One period lagged energy consumption Per Million Btu of all state/national energy consumption per year at the state/national level

Two Period Lagged Consumption Coal – Two period lagged energy consumption Per Million Btu of Coal energy per year at the state/national level

Two Period Lagged Consumption Gas - Two period lagged energy consumption Per Million Btu of Gas energy per year at the state/national level

Two Period Lagged Consumption Nuclear - Two period lagged energy consumption Per Million Btu of Nuclear energy per year at the state/national level

Two Period Lagged Consumption Total - Two period lagged energy consumption Per Million Btu of all state/national energy consumption per year at the state/national level

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