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Energy Demand and Economic Growth: Public Opinion and Mutual Exclusivity

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Abstract

The world is currently undergoing an energy transition from primarily fossil fuels to cleaner energy. The developing world is becoming more advanced, spawning relentless economic growth and an increase in energy consumption. Energy demand and economic growth are inextricably linked which poses a paradoxical question about future economic growth during a period of energy transition. Unfortunately, the transition requires large upfront costs with no guaranteed net benefit. A multitude of studies depict the impact of education, party identification, and age on how individuals perceive alternative energy. This study shows that views on governmental spending and party membership have a paradoxical relationship with the development of new energy sources. Republican individuals who support liberal economic views tend to be less supportive of the energy transition compared to their liberal or conservatively economic counterparts. This study posits that non-republicans, regardless of their views on the economy, are indistinguishable from fiscally conservative Republicans. The complexity between funding the energy transition and partisanship suggest that an individual's perspective depends on their willingness to promote clean energy over other economic programs.

Keywords

Energy, Economics, Public Opinion

Disciplines

Environmental Policy | Environmental Studies | Oil, Gas, and Energy | Political Science

Comments

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Energy demand and economic growth have long been axiomatically and inextricably linked. All production requires work. Therefore, all production requires energy input and there must be some limitation on the substitution of other factors of production so energy is always an essential factor to produce goods or services (Stern, 1997). While capital, labor, and even natural resources are reproducible factors of production, energy and matter are non-reproducible (Stern, 1997). Energy vectors, such as fuel or electricity, must be captured from the environment with implied environmental disruption (Stern, 1997). This is especially relevant as, according to the second law of thermodynamics, useful energy cannot be recycled. As economies grow, energy demand increases; if energy is constrained, GDP growth is also restrained. It has been the case since the Industrial Revolution, if not before. The interconnection of environmental and economic issues is imperative to understanding the difference in opinion regarding a transition in energy sources to cleaner fuel. Without understanding an individual's background and why they are against an energy transition, governmental agents cannot craft meaningful policy that leads to a sustainable future.

In the 1800s, the fuel of choice was biomass, such as logs from fallen trees. Even as the United States and Europe began to industrialize in the latter half of the century, biomass was central to economic growth (Palm, Ellegård, 2017). Biomass, writ large, is highly inefficient as a fuel source as almost all of its embodied energy is lost in its burning. Yet biomass was efficient enough to promote growth, albeit at about 1% a year from 1850-1900 (Stern, 1997).

From 1900-1950- when horses were replaced by cars, ice boxes, by refrigerators; oil lamps to electric lighting, etc.- energy demand nearly doubled (Gross, 2020). With this increase

in energy demand, GDP skyrocketed. In the US, GDP in 1950 was nearly double that of 1900. Biomass was deemed inefficient and the age of fossil fuels was born (Stern, 1997).

The 20th century's acceptance of petroleum and its derivatives sent production and consumption into overdrive. While fossil fuels lose 40-70% of their energy when burned, this was a large improvement when compared to the nearly 100% loss when burning biomass (Gross, 2020). Global energy demand has only risen since the mid 20th century as more countries become developed. China alone helped push global GDP increases to 3.7% annually since 2000, with energy demand increasing exponentially (Stern, 1997).

Royal Dutch Shell, BP, and other major European based oil companies launched various cost cutting measures in anticipation of the latest transition-away from oil and gas to renewable options such as wind or solar in late September 2020 (Bousso). BP and Shell declared that they are cutting the production of oil and gas by 40% and eliminating about 9,000 workers each. Within 10 years, BP will have developed 50 gigawatts of renewable energy, up from 2.5 gigawatts today, and will have 70,000 electric vehicle stations, up from 7,500. BP will also increase investment in biofuels, hydrogen and carbon capture and storage—a technology that pulls carbon dioxide from smokestacks or directly from the air. These measures, of cutting jobs and the prospects of an energy transition, are leading to a sense of unease among consumers.

During each energy transition were periods of uncertainty and doubt. The speed at which the transition occurs is of utmost importance, and is especially critical now. The mainstream literature poses that "phases" are one reason for this delay. Grubler (2012) suggests that major European energy transitions since 1800 all went through phases of having a core or innovation center, where that innovation began, moving upward to early adopters (what he called the rim) to, lastly, the late adopters, which he classified as the periphery. He posits that it took 96-160

years to transition from pre-industrial biomass to coal and 47-69 years to transition from coal to oil and electricity. Grubler (2012) also notes that there was tension between early and late adopters.

Due to the rise in energy demand, and the waning of fossil fuels, the global energy supply is currently undergoing a transition from primarily fossil fuels to cleaner, more renewable forms of energy such as solar or wind power. The discussion of the energy transition and how it is received by the general public is imperative to understanding why there is division among citizens compared to economists and scientists. To ensure a smooth transition and craft proper policies, it is essential to understand the background and rationale of those who oppose such an energy transition.

The current energy transition, and fear surrounding a paradigm shift in energy technology, raises a number of questions related to public support for such a program:

- *How do the two ideals of governmental spending and environmental protection influence an individual's support for an energy transition?*

- *What other factors influence whether an individual is likely to support or refute an environmental issue such as the shift to renewable energy?*

- *Are these factors of influence specific to one political party in the United States?*

Uncertainty of Economic Viability

In the early stages of policy adoption, there is oftentimes high uncertainty. Renewable energy is often overlooked because the extraction methods involve new entrants and initially

high costs (Steg, et al). After costly failures in nuclear and fossil technologies, such as nuclear fusion, synthetic fuels, and 'clean coal', the public is oftentimes wary about expenses and (Dufour, 2018).

In some cases, incumbents underestimated the disruption that new technologies would pose to their business models, such that they choose not to expend their political capital on fighting these new entrants. This helps explain why "regime resistance" (Hess, 2014; Hess, 2016) tended to lag the initial policy enactment, especially in the US where renewable policies are simply "layered" onto existing policy (Laird, 2016). Resistance is seen most clearly when looking at solar PV and corn ethanol which was initially seen as a small-scale, grassroots industry with little potential to displace petroleum (Dufour). As these industries outgrew their grassroots inception and began receiving subsidies, however, incumbents began resisting policies and to expend more effort in lobbying and lawsuits. The increase in lobbying and lawsuits, in turn, led to greater political pushback against transitioning energy sources (Hess, 2014).

In other cases, however, policymakers overestimated the ability of a new technological innovation to bring commercial success, or underestimated the costs (Stokes, 2015). Prematurely enacting overambitious mandates for technological development again leads to pushback and public opposition, as these policies are ultimately scaled back (Stokes, 2015; Hess, 2016; Laird, 2016).

Applying Institutional Theory to Energy Policy

The analysis of and policy implementation for a low-carbon energy transition requires an understanding of many idiosyncratic attributes of society. Key elements of a society's adaptive efficiency are its ability to learn and its capacity for collective action. Both these attributes are shaped by the prevailing institutions. Social learning is best perceived when societies engage in

open, transparent and participatory policy-making processes, and by a wide range of social and professional networks (Parsons and Clark, 1995; Nilsson and Swartling, 2009; Dedeurwaerdere, 2010; Reed et al., 2010). Collective action requires trust and social capital to allow a society to come together to address certain collective action problems; or, in terms of transaction cost economics, trust lowers the transaction costs of solving collective action problems.

A number of studies drew upon institutionalism to explain phenomena in the energy sector. The earliest applied rational choice theories to regulating newly liberalized public utilities, such as energy and telecommunications (Joskow, 1991; Levy and Spiller, 1994; Stern and Holder, 1999). More contemporary research has examined the role of institutionalism in the varying nature of and consequences of energy sector reform in the former communist countries of Central and Eastern Europe and the Former Soviet Union (Von Hirschhausen and Waelde, 2000; Kalyuzhnova and Nygaard, 2008; Locatelli and Rossiaud, 2011) as well as various energy sectors: electricity (Hauteclocque and Pereze, 2011), the role of national oil companies (Boscheck, 2007), natural gas (Ruester, and Neumann, 2009), urban transport (Brette et al. 2014), and technological innovation (Mokyr, 2002), as well as to individual industry governance challenges in specific countries (Vicchini, 2007).

In the United States, there are four broad patterns that illuminate the conceptual and theoretical development, as well as the politics, of renewable energy policymaking (Stokes and Warshaw, 2017). Policymakers and industry incumbents oftentimes underestimate new energy technologies. Omnibus legislation tends to provide key political incentives for the growth of the renewable energy sector. Once enacted, supportive policies are often sustained through incremental extensions, despite moments of retrenchment due to expiring provisions. Finally, as low-carbon energy technologies mature and begin threatening incumbent fossil fuel industries,

they become more politically contentious as they draw governmental funds from their competition.

The electricity and transportation sectors are rarely, if ever, examined together. In electricity, the incumbent industries are utilities, coal, and natural gas, with recent entries such as solar and wind; in transportation, incumbents include oil and automobile companies, while new entrants include corn, ethanol, natural gas, and EV firms. Policymaking in these sectors tends to respond to different environmental and economic problems. Air quality, climate change, jobs, and electricity deregulation drove renewable electricity policy; foreign oil dependence, urban smog, rural development, and fuel additives' toxicity drove alternative fuels and vehicles policy (Stokes and Warshaw, 2017).

Energy Transition and Political Polarization

In comparing subsections of the energy transition, electricity and transportation, together, there are important similarities. Democrats typically initiated policy proposals, with few Republicans following suite. Policy tools are also similar: the federal government prefers "carrots", such as tax incentives or Research and Development funding, while states providing more regulatory "sticks" (Sherlock, 2011). Many well-educated conservative groups still strongly refute the necessity of an energy transition (McCright & Dunlap, 2011). Alcott (2011) argue that promoting the environment can negatively affect adoption of energy efficiency in the United States because of the political polarization surrounding environmental issues.

One method for bypassing the issue of polarization is focusing on the environmental benefits of energy-efficient methods. A 2010 North American advertising campaign for the Toyota Prius emphasized its environmental upside by telling viewers that "the world gets fewer smog-forming emissions" with a Prius, resulting in "harmony between man, nature, and

machine." Similarly, the ENERGY STAR website (jointly run by the United States Department of Energy and the Environmental Protection Agency) promotes energy-efficient products as providing ways for people to "save energy and fight climate change." Because these messages explicitly emphasize environmental benefits, they likely resonate well with individuals who value protecting the environment. However, this emphasis on the environment might detract from the appeal of energy efficiency among individuals who do not want to be associated with environmental concern.

The cause and debate over the legitimacy over climate change is one of the reasons why energy is undergoing such scrutiny (Alcott, 2011). Existing literature has studied consumer purchase behavior of energy-saving appliances and examined this issue from the perspective of consumer by focusing on consumers' own value systems and their perception of products (Tan et al., 2017). For example, Gaspar and Antunes (2011) found that consumers in the European market prioritize cost when purchasing energy-saving appliances, followed by quality and energy consumption. They also found that consumers with environment-friendly habit prefer energy-saving appliances (Gaspar and Antunes, 2011). Wang et al. (2017) discovered that environmental awareness, previous buying experiences, social relationships, age, and education levels substantially affect the willingness to purchase energy-saving appliances. Tan et al. (2017) conducted a survey of the Malaysian energy-saving appliance market and found that attitudes, perceived behavioral controls, and moral norm positively affect the willingness to purchase energy-saving appliances. Tensions are also building in relation to different approaches to building and subsidizing renewable energy plants, producing clean energy, and their implications for ecosystems, worker health, and communities, including utility-scale and community-scale facilities and distributed energy systems (Aanesen et al., 2012; Cowell et al., 2011).

Traditionally, these energy transitions are viewed in terms of energy source: wood, coal, oil, etc. However, these views are rather naïve. Transitions in fuel are often followed by widespread social, economic, and political transformations that must also be factored into assessments of energy change. Additionally, neither the fuel itself nor their associated technology and use determine the social and economic use that energy takes over time. The key choices involved in energy transitions are more related to the political, social, and economic ideals built in tandem with energy infrastructure as opposed to being between various fuel sources.

Causal Explanation and Hypotheses

While it may be economically advantageous in the long run, the energy transition means utilizing, and subsidizing, options beyond the cheapest form of energy. When looking at the macroeconomy and global trade, there is the risk of enabling the free-rider problem in which everyone benefits on the shoulders of the few. The tragedy of the commons presents a similar conundrum, it forces individuals to choose between economic gain or environmental protection.

The failures of past energy projects, such as such as nuclear fusion or ‘clean coal’, mean fiscally conservative respondents will be against governmental spending in the energy sector without a predefined positive outcome. The US Department of Energy estimates it will cost $65 billion to build, what is planned to be, the largest nuclear fusion project (Kramer, 2018). Without an accurate prediction of energy production to weigh against the immense cost, fiscally conservative individuals will be less likely to support any form of energy transition.

While the Democratic platforms opts to promote environmental protection, the energy transition, and fiscal freedoms at the expense of the economy, the Republican party oftentimes supports limited governmental spending in support of a growing economy. Investment in

environmentally conscientious infrastructure necessitates a large upfront cost for potentially unknown gains. Simply externalizing the costs of fossil fuels and other forms of energy allow for competitive pricing and a rise in GDP per capita. If Republicans support limited government spending, they will be unlikely to support an energy transition with expensive upfront costs and limited ROI. This cost could be one reason why the Republican party tends to avoid supporting issues like the energy transition.

In a comparison of individuals, I hypothesize that Republicans who support limited governmental spending will be less likely to support the energy transition when compared to Republicans who support increased governmental spending and non-Republicans. The dependent variable under scrutiny is natenrgy, which utilizes a 1 (too little) – 3 (too much) scale to compare respondents' feelings on developing alternative energy sources.

Research Design

To test my hypotheses, I focused on data from the General Social Survey dataset published in 2016. I analyzed this study, which tracks observations from 7,708 respondents, for its breadth and depth of information on environmental, political, and social based variables. The variable natenrgy, indicating respondent's feelings on the development of natural energy on a 1 (too little) – 3 (too much) scale was chosen as the dependent variable because it represents respondents' opinions on energy use and the ongoing global energy transition. The variable natenrgy was recoded to be on a 0 (Too much) – 1 (Too little) scale.

Variable Measurements

To operationalize natenrgy, I used the spend3 and partyid variables. The spend3 variable asked the respondents their opinion on governmental spending, on a scale of 1 (Economically Conservative) to 3 (Economically Liberal). The mean value of spend3 (mean=1.962513)

indicates a slight leaning towards economically conservative but is still relatively neutral. To further simplify the variable, I created a dummy variable, Econ_Con, which indicates the support for governmental spending. The variable Econ_Con was recoded on a 0 (Non-Conservative) – 1 (Conservative) scale. Both the median and the mode for the dummy variable were 0 indicating a liberal economic stance (Table 1). The mean value of the dummy variable is .4027356 which indicates a leaning towards economically liberal. The variable partyid asks respondents to list their political affiliation on an 8-point scale (0, Strong Democrat – 7, Strong Republican). The mean value for partyid is 2.89747 indicating a weak democrat. The median and mode values for partyid were Independent. The dummy variable Rep was crafted from partyid to simplify the connection between Republican (0, Non-Republican – 1, Republican), support for governmental spending, and views on alternative energy. The mean of the Rep variable is .3799785 indicating a non-Republican stance and the mode and median were both non-Republican.

The variables consci, educ, and age5 and were held at their respective means. The variable consci represents the respondents' feelings on confidence in the scientific community on a scale of 1 (a great deal) – 3 (hardly any). The mean response for consci was 1.642251 which indicates respondents having a great deal of confidence. The variable educ asked respondents the highest level of education attained with a mean answer of 13.73723 which correlates to some post high school education. The variable age5 asked respondents about their age with the mean falling in the 41-50 range.

Table 1: Descriptive Statistics of Variables					
	Variable name in dataset	Mean	Median	Mode	Observations
Support for Developing Alternative Energy Sources	Dummy variable using natenrgy (1-2)=Too Much (0) (3)=Too Little (1)	.9060676	Too Little	Too Little	7,367
Economic Liberalism	Dummy variable using spend3 (2-3)=Liberal (0) (1)=Conservative (1)	.4027356	Economically Liberal	Economically Liberal	1,974
Political Identification	Dummy variable using partyid (0/3)=Not Republican (0) (4/7)=Republican (1)	.3799785	Non-Republican	Non-Republican	7,432
Confidence in scientific community (1 Great deal – 3 Hardly any)	Consci	1.64527	Only some	Only some	5,032
Age	Age	48.90915	49	57	7,683
Education Level	educ	14.19654	Some post high school but no Bachelors degree	12th Grade	7,688

Model Estimation:

To test my hypotheses, I utilized the logistic regression model because of the interval nature of natenrgy, the dependent variable.

Results:

Support for decreasing governmental spending, Econ_Con, was shown to not have a statistically significant impact on the development of natural energy (Table 2). The dummy variable Republican was found to have statistical significance on the dependent variable, making the respondent less likely to support the development of natural energy with a coefficient of

-0.583 (P<0.01) (Table 2). The interaction between Republicans and support for decreasing governmental spending further decreased the likelihood that respondents would be in favor of developing alternative energy sources (P<0.01) (Table 2). The coefficient for the interaction variable is -0.990 (Table 2).

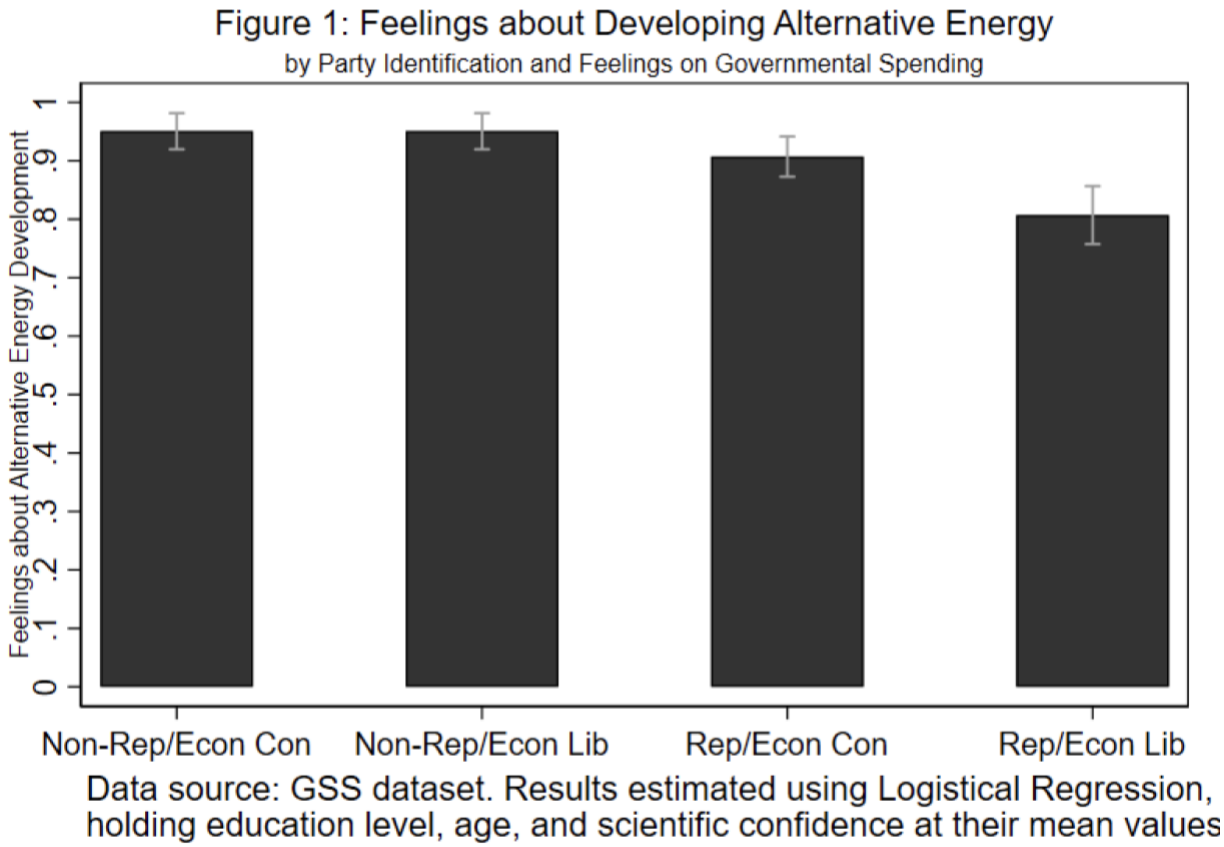
Table 2: Impacts on choice to support the development of alternative energy (1 Too Much – 100 Too Little)

Republican	-0.583**
	(0.295)
Economically Conservative	0.125
	(0.396)
Republican x Economically Conservative	-0.990**
	(0.465)
Confidence in Scientific Community	-0.557***
	(0.1666)
Highest Education Level	0.00429
	(0.0326)
Age	-0.0143**
	(0.00562)
Constant	4.441***
	(0.733)
Observations	1,188

Dependent Variable: 0 (Too Much) – 1 (Too Little).
Independent Variable 1: Political Identification (0 Non-Republican – 1 Republican). Independent
Variable 2: Economic Ideology (0 Liberal – 1 Conservative).
Confidence in Scientific Community (1 Great Deal – 3 Hardly Any). Results estimated using a logistic regression
model. Standard errors in parentheses. Data source: General Social Survey. *** p<0.01, ** p<0.05, * p<0.1

The mean choice of Republicans who are economically conservative are indistinguishable from that of Non-Republicans due to overlapping confidence intervals. Additionally, Republicans who are economically liberal have the lowest mean in relation to energy development. As such, we can reject the null hypothesis that there is no difference between the opinions on the development of alternative energy between Republicans who are

economically liberal and their peers. The information gleaned from this regression is consistent with the theory that political party, in part with governmental spending, impact how respondents view alternative energy.



Discussion:

The regression analysis presented shows a correlation between governmental spending and party identification on the development of alternative energy sources. Republicans who desire an increase in governmental spending, that is that they are economically liberal, are less likely to support energy development when compared to Republicans who are economically conservative or non-Republicans. This evidence confirms the argument that party and governmental spending plays a factor in determining action on the development of alternative energy, postulating an imperative explanation as to why people support energy development.

Individuals will support energy development if they are a non-Republican or a Republican who is economically conservative.

Previous literature has shown a plethora of rationales for why political identification and economic ideals cause friction in the energy transition. Since the 1970s, party identification has held the most influence on a given respondent's opinion on energy. Republican politicians and members of the general public are often less supportive of environmental legislation, including energy subsidization, and appear less concerned than their Democratic counterparts (Buttel and Flinn, 1976; McCright and Dunlap, 2011). Clean energy received support from both groups, although Democrats are more aggressive in their adoption of renewable energy than Republicans (Mayer and Smith, 2017). Republicans are more likely to endorse hydraulic fracturing and a lighter "regulatory regime" for energy development. Energy policies that encourage increased efficiency and decreased federal spending often receive bipartisan support and overall wind power is generally noncontroversial (Klick and Smith, 2010; Coley and Hess, 2012; Hess et al., 2015).

Political identities extend farther than simply just policy preferences. Even something as ostensibly private as household energy use are influenced by partisanship (Dietz et al., 2013; Gromet et al., 2013). As such, it appears that political ideology is salient beyond policy preferences – at least in the U.S., many individuals rely on political signaling for their understanding of what is empirically true in the world (Yeo et al, 2014).

That being said, both Republicans and Democrats support renewable energy and the ongoing energy transition. Ansolabehere and Konisky posit a simple explanation: there is a desire to utilize energy systems that simultaneously reduce environmental harms and economic costs (2014). Economically conservative Republicans have a multitude of motivations for

supporting alternative energy sources. As of 2018, the renewable energy sector provides nearly 800,000 jobs in the U.S., and more than 10 million jobs globally (IRENA, 2018), and is a catalyst for growing businesses, technological advances, and a strengthened economy. Additionally, alternative energy sources mitigate volatility in energy costs, decrease military costs of protecting foreign energy assets, and that it provides inexhaustible energy.

When asked to rank the importance of 16 different variables to transition to cleaner energy, Democrats stated that "reducing climate change" was the most important whereas Republicans demarcated it as the least important. Republicans tended to favor reducing energy costs and gaining energy from a limitless source as the most vital. However, both Republicans and Democrats rated "provide a better life for our children" and "reduce [air] [water] pollution" as among the most imperative reasons for a transition. To some extent, this may posit that Republicans and Democrats are not as polarized as the media portrays them to be although that has yet to be definitively tested. Further research could analyze why Republicans who are economically liberal are less likely to support an energy transition, which will help alleviate federal funds following the implementation of clean energy.

Seeing how political identity and economic ideals are central tenets on a range of issues related to energy production, distribution, and consumption, it is imperative that we develop an operational understanding of how both political identity, and feelings on governmental spending, impact decisions. Utilizing this information to further action on the energy transition, I suggest that future policy decisions take an approach that focuses on efficiency and decreasing federal spending. If energy policy, and the energy transition as a whole, can emphasize long term economic growth through the efficient use of federal funds, more respondents may support the transformation who may have been skeptical in the past.

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