Greenhouse Gas Emission Reduction Goals at Public Institutions: The Case of a Land-Grant University

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ABSTRACT

Aims: We apply several theories to the problem of greenhouse gas emission and energy consumption reduction goals at large public institutions. We discuss the history of the movement for reduced greenhouse gas emissions at universities and introduce a case university. We test our case university's energy consumption for evidence of reductions.
Methodology: We develop two base OLS model for on-campus energy consumption. We build time series elements into the models to test for statistically significant reductions in monthly energy consumption.
Results: We do not find evidence for reduced energy consumption at the case university over the twelve year time period (n=146).
Conclusion: Several theoretical problems make reducing energy consumption or greenhouse gas emissions at large public institutions particularly challenging. The case university we analyzed has failed to make meaningful energy consumption reductions despite setting ambitious goals.

1. INTRODUCTION

There is much political debate about the appropriate response to climate change. Although there is broad scientific consensus that anthropogenic climate change is occurring, there is little agreement on the best way to reduce Greenhouse Gas (GHG) emissions—the principle cause of anthropogenic climate change. In particular, public and private universities in the United States have faced increasingly vocal pressure to craft emission-reduction policies, to move toward carbon neutrality and to do so with deliberate speed.

Implementing meaningful policy is fraught with theoretical challenges. Public Choice theory demonstrates the difficulty of implementing beneficial policies that span multiple politicians' tenure. Principal-Agent theory introduces another problem for universities. Although reduced energy consumption may be optimal and desirable for the principal (the university or its facilities department), active energy consumption is a decentralized process undertaken by a host of agents (professors, students, staff and researchers) with little incentive to incur immediate personal costs in pursuit of the principal's long-term goal. Finally, goal-setting theory in the management literature has repeatedly found that vague goals are ineffective in changing behavior. As there is not currently a consensus on how to measure an organization's carbon footprint; the goal of reducing or eliminating that footprint is necessarily vague.

There are multiple methods for determining a product's carbon footprint. These approaches fall along a continuum, from a life-cycle assessment or cradle-to-grave approach to determining a product's footprint, to methods that only track a product's first order impacts. The bulk of these tools are designed for consumer products (see Finkbeiner [1] for a review of advances in carbon footprinting). Given the nature of a university's primary product (education), the majority of these tools are inappropriate.More directly related, a collection of sustainability groups supported by the World Bank has established a standard tool for calculating GHG emissions at the community level (the Global Protocol for Community-Scale GHG emissions).Additionally, there are some

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university-specific tools, such as the National Wildlife Federation's State of the Campus Environment, Higher Education 21's Sustainability Indicators, the Clean Air Cool Planet Campus Carbon Calculator and a dozen others [2].The difficulty with measurement has been well documented, and the interested reader can review and compare a multitude of tools.

Our case university's initial inventory of GHG emissions follows intuition, that the primary GHG-emission producing inputs to education are on-campus energy use and student, professor, and faculty travel. On campus electricity and natural gas use are the top two contributors to the university's GHG emissions, and our analysis includes only them.Broadly, there are two ways a university can reduce the carbon footprint of its on-campus energy consumption. The first is transitioning from traditional carbon-intensive electricity sources to less carbon-intensive alternative sources. The second is to reduce net consumption through changes in practices or infrastructure.We choose to model on-campus energy consumption for the following reasons. First, the data for energy consumption are much more reliable than the calculations of GHG emissions. Second, it may be the case that reducing energy consumption is preferable to transitioning to less GHG intensive energy sources when considering costs and the carbon lifecycle burden of the transition. Analysis of the relative costs of the multiple approaches to GHG reductions can inform the prioritization of such methods based on their effective reductions versus their costs. Such a discussion lies outside the scope of this paper. Finally, USU purchases its electricity and natural gas from third parties. Although the university is one of the larger purchasers of electricity in its city and carries a certain political weight, other parties are responsible for the composition of the energy portfolio available to USU.

Because data for travel and commuting are less reliable than data for on campus energy use, our analysis focuses on how on-campus energy consumption has changed. Data are available and reliable for on-campus consumption and the university can exert more control over on-campus energy use than over student and faculty travel.

In this paper, we sketch each the theories detailed above in the context of energy consumption reduction goal-setting in a large organization, using the specific case of the university. We then examine the recent history of GHG emission reduction efforts at universities. Next, we focus our analysis on a land-grant university in the western United States, propose a basic method for evaluating the effectiveness of energy consumption reduction policies, and apply this method to the university's energy consumption over a twelve-year time series. Finally, we discuss the external validity of our results compared to other universities and public institutions.

1.1 Theory Applications

In the following, we apply three areas of theory to the problem of energy consumption reductions at public institutions, using the specific example of energy consumption reduction at a university. Public choice theory, principal-agent theory, and goal-setting theory each indicate unique problems for GHG emission reduction goals at public institutions structured like universities.

1.1.1 Public Choice Theory

Climate change presents a difficult political problem. Energy consumption reduction agents (in our case, University Presidents) must incur immediate costs in pursuit of a long-term goal. Gersbach [3] provided a theoretical framework for politicians pushed to "undertake socially desirable long-term projects" in order to satisfy their constituency and win votes" (157). The model spans two political terms, and Gersbach demonstrates that rational politicians will not incur the costs of socially beneficial policies if their discount rate is insufficiently high or if re-election is uncertain. Rather than implement the desired policy, these politicians "opt for inefficient short-term projects or stick to the status quo" (157).

In the context of the university, the problem is even more difficult to solve than in the Gersbach model. University presidents' terms seldom span multiple decades. The timeline for

implementation of GHG reduction goals is generally at least a decade, and carbon neutrality goals are frequently set a half-century in the future. The accrual of costs for GHG emission reduction policies may span a half-dozen university presidents' tenure. Further, the constituency lacks the political consensus that exists in the Gersbach model, which assumes that the public has a strong preference for the policy. Given these challenges, we expect university presidents to pay lip service to GHG emissions or energy consumption reduction while avoiding policies that incur significant short-term costs.

Some energy consumption policies may result in financial savings for a university or public institution. If this were the case, we may find parties more willing to incur the costs of retrofitting or other approaches to energy consumption reduction; the problems presented in the Gersbach model do not apply as the benefits of cost-savings begin accruing immediately even if the payback period spans multiple tenures. Basic economic theory predicts that agents would adopt cost efficient methods of reducing energy consumption absent commitment to a GHG emission reduction goal as long as the net present value of benefits exceed the opportunity cost of the required capital improvements. As these methods become available (or as an administrator becomes aware of them), theory predicts their adoption. If this trend of technology discovery and adoption holds, we would anticipate a consistent downward trend in energy use intensity.

1.1.2 Principal-Agent Theory

Gillingham, Newell, and Palmer [4] provide a review of the problems facing energy consumption reduction policies. In their framework, they consider potential market and "behavioral" failures regarding investments in energy efficiency. Market failures occur when consumers of electricity fail to account for environmental externalities or lack information, leading them to underinvest in energy efficient devices or overconsume. Behavioral economics explains behavioral failures and has demonstrated cases where an individual's behavior is inconsistent with energy cost minimization. In the context of energy consumption, there is a persistent bias against capital investment in energy efficient devices.

Principal-Agent problems can exacerbate the problem. Levinson and Niemann [5] compare electricity use among tenants whose electricity bills are included in their rental contracts to those who pay their own utility bills. As expected, tenants who are insulated from the cost of their electricity consumption consume significantly greater amounts of energy than those who bear the cost directly.

There are also problems with the salience of electrical bills. Consumers use electricity to produce a variety of energy goods (heating, refrigeration, television, etc.), but the amount of electricity used as an input in each of these energy goods is aggregated into a monthly or bi-monthly bill, making it difficult for consumers to accurately understand the marginal cost of a particular energy good. Froehlich [6] suggests that new data and intelligently designed human-computer interactions can improve the timeliness and salience of reports to consumers, but currently even consumers who directly bear the costs of their energy consumption lack salient information.

At a university, most electricity consumers (students, faculty, and staff) are insulated from the costs of their goods. Facilities departments have the ability to invest in more energy efficient capital, but are able to exert little control over the use of energy by the direct consumers. This principal-agent problem, where the facilities managers are the principals and consumers are the agents, presents a serious challenge to energy consumption reduction efforts. Effective policies must target individual behavior, but the standard toolkit for consumption reduction policies (e.g. Pigouvian consumption taxes) is ineffective given the principal-agent problem present at the university.

1.1.3 Goal-Setting Theory

The final major issue facing GHG emission reduction policies at universities is described by goal-setting theory. Locke and Latham [7] provide a review of the major findings of goal-setting theory. Challenging and specific goals "lead to greater effort and/or persistence than do moderately

difficult, easy, or vague goals" (265). GHG emission reduction goals a necessarily vauge, especially the goal of carbon neutrality. The term "carbon footprint" comes from the term "ecological footprint", which refers to the study of how the flow of energy and resources from areas that supply them to areas that demand them constrains nature [8][9]. Politicians, producers, consumers, and even investment companies have adopted "carbon footprint" as a buzzword [10], and have exploited it for public relations and financial purposes [11]. Meanwhile, the scientific community has not agreed on a general definition or means of measurement for a "carbon footprint" [11][12]. Goal-setting theory suggests that the broad goal of reducing an institution's carbon footprint must be composed of more specific, better defined, and measurable goals in order to effectively change behavior. Otherwise, the goal remains vague and inefficient. Our analysis of public choice theory in 1.1.1 suggests that university administrators will favor vague goals, which are the least likely to effectually influence behavior at the university.

With the above theoretical problems facing energy consumption reduction efforts at universities, we anticipate that policies will be ineffective at reducing consumption unless policy makers successfully address the goal-setting and principal-agent problems. These issues are compounded by the fact that it is not in administrators' interest to find real solutions, as illustrated in 1.1.1 and 1.1.2.

1.2 GHG Emission Reduction Efforts in Higher Education: Overview

The organized movement for Sustainability in Higher Education (SHE) began in the 1980s with Anthony Cortese [13]. Cortese began pushing sustainable practices at Tufts University by integrating environmental practices in 170 courses. This translated into a collective push for sustainable practices in higher education culminating with the Talloires Declaration in 1990. The Talloires Declaration was an agreement by university leaders to mobilize resources, promote sustainability, and encourage other universities to join their cause [14]. However, a lack of funding has lead most universities to either ignore it, attempt to implement the principles and fail, or to only incorporate "umbrella principles" in their internal policies while ignoring the specific goals of the Declaration (206).

Growing from the logic of Talloires, the American Colleges & University Presidents' Climate Commitment (ACUPCC) was created in 2006. The ACUPCC provides a framework in which universities can build their sustainability plans. It requires universities to complete an emissions inventory, set a date by which to become climate neutral, take immediate short-term actions and make sustainability a part of their curriculum [15]. Between its creation and Spring 2011 the ACUPCC had received pledges from 468 schools, putting almost 25% of American college students in the Presidents' Climate Commitment [16].

Congress provided additional support to university sustainability programs in 2008 with the authorization of a 'University Sustainability Program', competitive grants offered to universities to "develop, implement and evaluate sustainability curricula, practices and academic programs" (4) [17]. Additionally, the Energy Independence and Security Act of 2007 provided one-time funding for renewable energy projects at all levels of education (4). Currently, there are over one dozen higher education associations working towards significant advances in sustainable practices on campus (4).

The "success" of sustainability programs at universities is variable and frequently ill-defined, consistent with the theoretical discussion above. For example, the Los Angeles California Community College District hired Larry Eisenberg to oversee a $5.7 billion dollar taxpayer-funded program designed to supply all nine colleges in the district with completely green energy, with a surplus that could be sold [18]. Unfortunately, Eisenberg's plan was based on unavailable technology, the costs were too high to implement this plan, local weather didn't permit his designs and the tax credits he proposed utilizing to defray the costs were not available for these public institutions (2-6). Additionally, if the school were to run purely on green energy, windmills, solar panels and other sources would have to have been placed in every possible location (1). Once

the community college board caught wind of Eisenberg's plan he had spent nearly 10 million dollars in taxpayer money (1). Ultimately, the program was a source of embarrassment and wasted funds.

Other colleges and universities agree that there is a need to pursue more environmentally friendly and sustainable practices, but are not willing to risk large-scale embarrassment or failure like that in Los Angeles. Despite these concerns, some schools understand that this switch comes at a cost. For example, the Ivy Plus Sustainability Working Group was formed in 2007 in order to reduce greenhouse gas emissions on campus [19]. All of these schools have set reasonable emission reduction goals. For example, Yale University has chosen instead to cut their emissions by 43 percent by 2020, levels that exceed those prescribed by the Kyoto protocol. Harvard University has chosen to cut Green House Gas Emissions by 30 percent by 2016. Only two have gone as far as to promise the currently unattainable goal of zero emissions by 2050.

1.2.1 Energy Use Reduction Efforts and Sustainability at Utah State University (USU)

Although many factors contribute to a university's greenhouse gas emissions, energy consumption from campus operations has the most significant impact on the environment [20]. Table one presents USU's carbon footprint inventory. Given energy consumption's position as the primary contributor to GHG emissions (accounting for a combined 45% of USU's emissions) and the fact that data are both available and reliable for on-campus energy use, we focus our analysis on energy use reductions at USU rather than the broader portfolio of GHG sources.

Table 1: USU GHG Emissions by Source

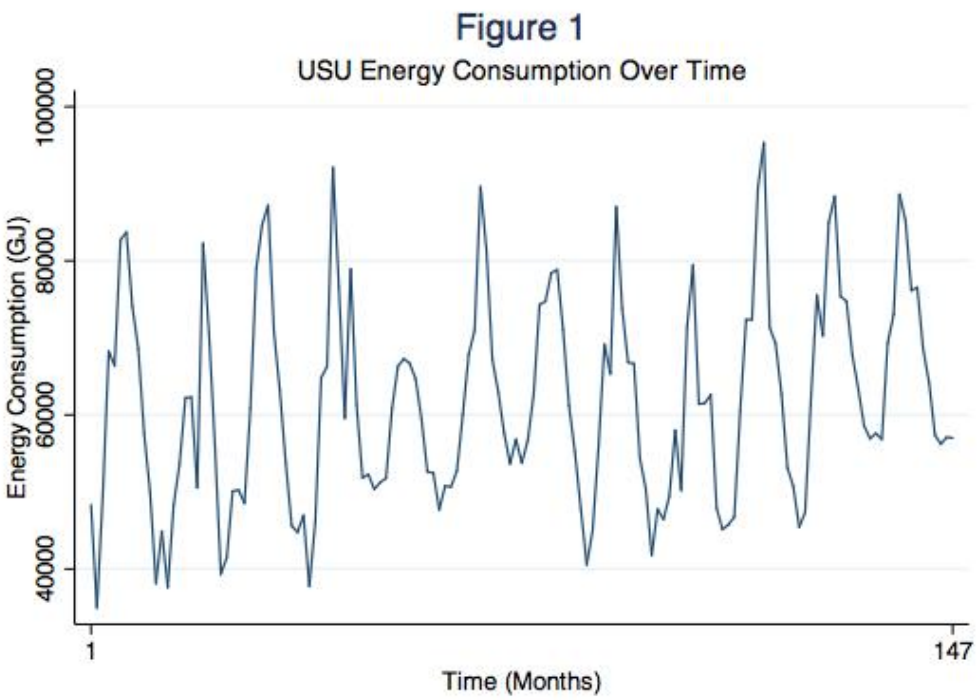
Purchased Electricity	22%
Natural Gas	23%
Student Commuters	17%
Air Travel	17%
Faculty/Staff Commuters	10%
University Fleet	3%
Co-Gen Electric	3%
Solid Waste	3%
Agriculture Total	2%
Refrigeration	0%

Source: Climate Action Plan

USU is a large public research institution located in Logan Utah with a Spring 2011 total enrollment of 25,767 and a just under 2000 employees. Created in 1888 as Utah's land grant institution, questions of public interest have long been central to the school's mission and focus. In recent years exploration of alternative energy generation has become increasingly important. Since the university's founding in 1888, at least one engineer in the facilities department has been devoted to monitoring issues related to energy consumption [21]. USU's major projects aimed at decreasing energy use include a chilled water plant, a natural gas co-generation plant, and a campus wide conversion to energy efficient light bulbs and light sensors [21]. Installed in 2003, the chilled water plant cools air with generators, which is then pumped into buildings across campus to control the temperature more efficiently than the previous method. In 2004, Facilities installed a co-generation unit, which burns natural gas and turns it into electricity; energy that would normally be considered excess and wasted is used to heat or cool buildings [21].

Figure 1 presents USU's energy consumption from July 1998 to September 2010. There is clear seasonality in the consumption. The peaks occur in the months of December and January, by far the most energy intensive for USU. Weather along Utah's Wasatch Front is classified as humid continental-hot summer, with average winter temperatures below freezing and summer

temperatures about 77° F (25° C) [22]. The seasonality in Utah's weather is clearly reflected in the consumption of energy at USU. USU has two sources of energy: purchased electricity from Logan City and natural gas. Currently, Logan City's energy comes mostly from coal-burning power plants (see Table 2). Although Logan City does not have plans to reduce the GHG emission intensity of their portfolio, efforts by the City to do so would cause reductions in USU's emissions even without on-campus consumption reductions. According to interviews with USU staff, the commitment to carbon neutrality depends, in part, on improvements in technology and the option to purchase less carbon-intensive energy than is currently available through Logan City.



The University leadership's commitment to sustainability began when President Stanford Cazier signed the Talloires Declaration in 1991. President George Emert renewed this commitment in 1993 [23]. Despite this, as of 2003, USU had "made only what could be termed as sluggish progress of implementing in theory or practice the tenets of the Talloires Declaration" [24](9). Many peer institutions had surpassed Utah State as "models of campus greening for the higher education community." (9). AggieEcology pushed for significant changes to USU's Sustainability Projects, but little was done until the Presidency of Stan Albrecht. On January 22, 2007 President Albrecht signed the American College and University Presidents' Climate Commitment. The ACUPCC set the goals of carbon neutrality and increased student education. As part of this pledge President Albrecht set the goal of a carbon neutral campus by 2050. Utah State is also a member of the Association for the Advancement of Sustainability in Higher Education. Since the signing of the ACUPCC there has been a push to change University curriculum to include sustainable education, although it has met some resistance. In 2010 Utah State produced the Climate Action Plan, an illustration of where Utah State is on their path to a sustainable campus. The document claims that since 1990 USU has seen a 20% increase in student population with only a 1% increase in energy growth [23].

Table 2: Logan City Sources of Electricity

Hydro (Logan River)	6%
Natural Gas Turbines (Local)	1%
Other/All in Pool	2%
Pool	2%
PPM Wind	1%
CRSP (Glenn Canyon)	16%
Deseret (Coal)	23%
Nebo (Coal)	7%
Hunter (Coal)	18%
IPP (Coal)	24%

Source: Logan City

Our analysis focuses on a slightly different question: have the various declarations by University Administrators and actions taken on campus actively reduced energy consumption on campus?

2. DATA AND METHODS

2.1 Data

Energy consumption data were gathered from USU Facilities. These data were collected aggregated at the month level for both natural gas and purchased electricity consumption. The dataset begins in July 1998 and ends in September of 2010. We also collected the university's active square footage from USU facilities over the same time period. Student registration data were collected from the USU Office of the Registrar. Data on heating and cooling degree days (a proxy for the energy demand required to heat or cool a building given the weather) were collected from the Utah Climate Center. Heating and cooling degree days are also seasonal in nature. These data (presented in Figure 2) show that the winters have significantly higher energy demands than summers in Logan's climate. We combine heating and cooling degree days to form our control variable energy use days. Note that there are separate axes for cooling and heating degree days, with higher energy demand during the cold season, operationalized as heating degree days.

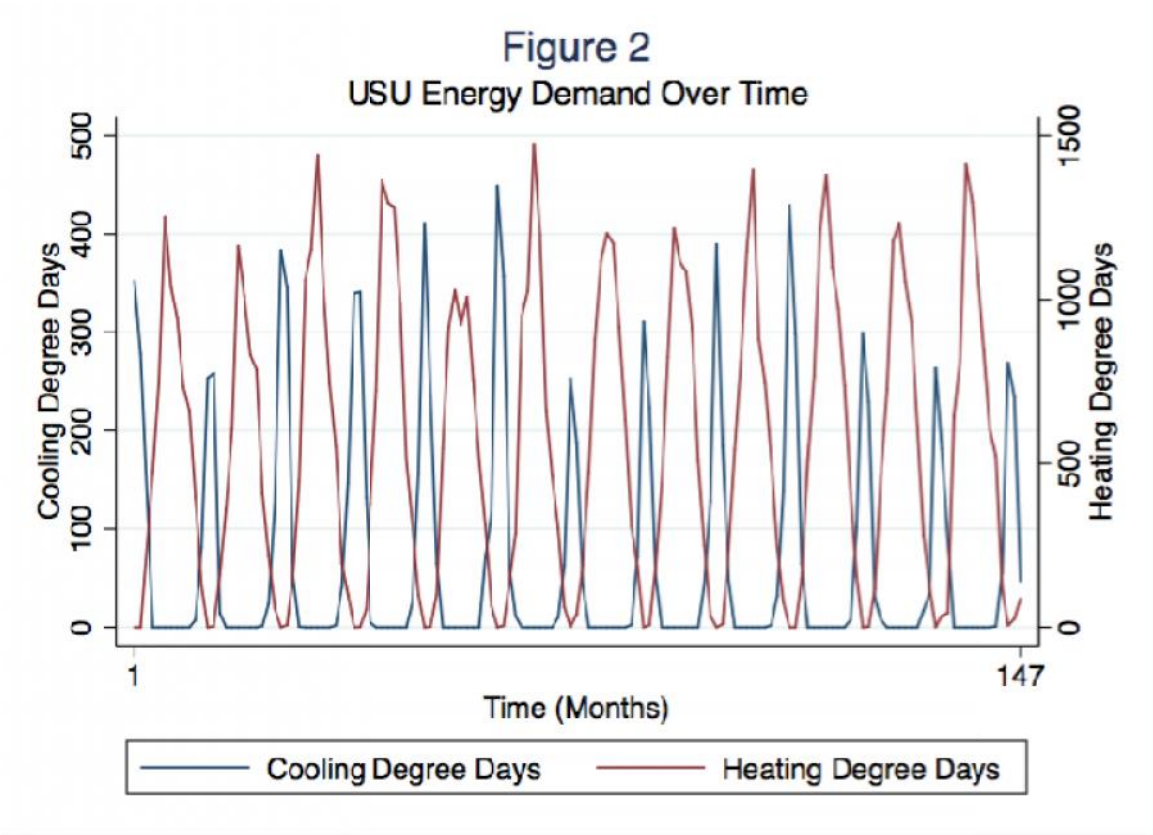
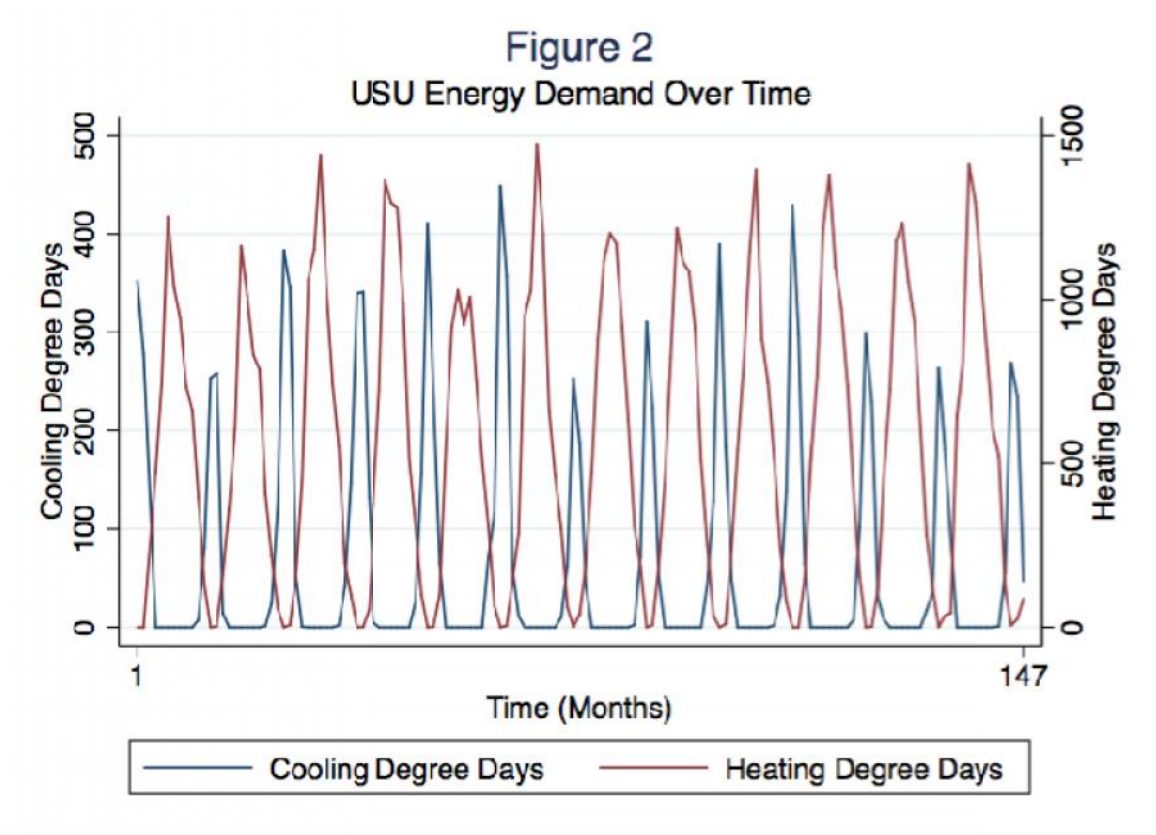


Figure 3 presents the other control variables, full- and part-time students and on campus square footage. Square footage on campus has increased consistently over time. Time and square footage are highly correlated, with a coefficient of 0.963. Enrollment at USU has remained relatively constant over time. Again, there is clear seasonality here. Fall enrollment is slightly higher than spring enrollment, with summer enrollment much lower than both spring and summer.



2.2 Methods

We use a variety of methods to search for evidence of decreased energy consumption at USU over the time period. First, we develop two baseor controlmodels for energy consumption at USUusing standard OLS regression. Second, we use basic time series analysis to modify each of these base models to test for statistically significant energy reductions. The OLS models are expanded with time variables and the use of two time-dependent dummy variables representing significant changes. There is wide agreement in the literature that climate is a large determinant of energy use [25][26][27]. Geoffrey et al. [25] recommend controlling for temperature and wind velocity data (1768). Sailor and Munoz [26] use “historical analysis of energy and climate data” to establish temperature at the determinate of energy consumption rates (992). They also find that wind speed is important in all states except Washington (997). As a proxy for climate they use heating and cooling days to indicate weather. Lam [27] found that cooling-degree days significantly affect electricity usage in Hong Kong. Given the available data, we use heating and cooling degree days as our proxy for climate. As climate is clearly seasonal, our second base model includes dummy variables for each month, using December as the reference month. Both models control for on-campus square footage and the student count. Table 3 presents the results of our base models.

Note that the models have equivalent explanatory power for on-campus energy production, explaining just over 76% of the variation in on-campus energy use. Our first basemodel estimates that an energy use day requires an additional 24 gigajoules of energy consumption. In our second model, all months have significantly lower energy requirements than December except January. The two base models’ estimates for the energy requirements of additional square footage arevery similar. The estimated sign of the effect of full- and part-time students changes signs between the base models, but is insignificant in the second base model. The number of students at USU

varies seasonally, so the inclusion of the monthly binary variables absorbed the positive effect of additional students on energy use estimated in Model 1.

Table 3: Base Regression Models

On-Campus Energy Consumption (GJ)						
	Model 1			Model 2		
Variables:	*Estimate*	*Std. Error*	*p-value*	*Estimate*	*Std. Error*	*p-value*
Campus Square Footage	2.34 E-2	5.05 E-3	0.000**	2.12 E-2	6.20 E-3	0.001**
Full- and Part-Time Students	0.56	0.127	0.000**	-0.456	0.589	0.44
Energy Use Days	24.62	1.78	0.000**			
January				-396	2807	0.89
February				-8099	2807	0.005**
March				-11031	2807	0.000**
April				-19857	2807	0.000**
May				-32334	7318	0.000**
June				-36649	7318	0.000**
July				-35858	7163	0.000**
August				-37734	7163	0.000**
September				-26450	2729	0.000**
October				-15065	2781	0.000**
November				-11899	2781	0.000**
	R Square:	0.763		R Square:	0.763	
	n:	146		n:	146	

*p<0.05 **p<0.01

Using the basemodels presented in Table 3, we use a variety of methods to search for evidence of reductions in on-campus energy consumption over the time period. The first method we use includes a time variable, counting from 1 to 147. The second and third methods to test for downward trends treat certain events as treatment: the launch of the university's cogeneration facility in late January 2004, and the signing of the ACUPCC by the university president in January 2007. These binary variables are 1 for observations after and 0 for observations prior to the events. We use these basic time series models to test for reductions. Statistically significant negative estimates would represent signs of measurable reductions in energy consumption on campus.

The high correlation between square footage and time presents a problem for our first test model including the time trend. In this model, we adjust the response variable (energy use) to a newly created variable, energy use per campus square foot. The interpretation is slightly different. This model searches for evidence of a trend in energy use intensity on campus, not aggregate energy use as the base and other models. We transform our use variables from gigajoules to kilojoules for ease of interpreting the coefficient estimates. We prefer the aggregate response variable as the dependent variable in our other models as it is most directly related to the magnitude of carbon emissions resulting from energy use, but this alternative still represents a necessary condition for reducing energy consumption at USU absent reducing the University's square footage.

3. RESULTS AND ANALYSIS

3.1 Presentation of Results

Tables 4.1 and 4.2 present the results of our time series analysis. Table 4.1 uses the first base model, controlling for climate using the variable Energy Use Days from the Utah Climate Center. The first model's response variable has been transformed to correct for multicollinearity. In the second and third regressions, the control variables energy use days and full- and part-time students are all within one standard error of the original model's estimation. Campus square footage has changed but is no longer significant. Each of the three models uses a different method of detecting changes over time. In order to find evidence for energy use reductions (or energy intensity use reductions in the first model), the first estimate in each model should be negative and statistically significant. In each of the models, the estimate is positive and statistically significant.

Table 4.1: Time Series Analysis of Model 1

	On-Campus Energy Consumption (GJ)								
	Time Trend (KJ per sq. ft.)			Signing of ACUPCC			Launch of Cogeneration Facility		
Variables:	*Estimate*	*Std. Error*	*p-value*	*Estimate*	*Std. Error*	*p-value*	*Estimate*	*Std. Error*	*p-value*
Time	8.47	3.26	0.010**						
ACUPCC Signed				5046.74	1444.02	0.001**			
Cogeneration Facility							4269.32	2043.48	0.038*
Campus Square Footage				1.08 E-2	6.050 E-3	0.075	7.43 E-3	9.15 E-3	0.418
Full- and Part-Time Students	0.147	0.032	0.000**	0.60	0.123	0.000**	0.609	0.128	0.000**
Energy Use Days	6.0016	0.443	0.000**	24.35	1.72	0.000**	24.04	1.78	0.000**
	R Square:	0.759		R Square:	0.782		R Square:	0.770	
	n:	146		n:	146		n:	146	

*p<0.05 **p<0.01

The results presented in Table 4.2, using the other base model presented in Table 3 controlling for seasonality, has similar results. In the comparable models (the second and third), the estimates of the control variables are all within one standard error of the base model's estimate. In the second model, including a binary variable for the signing of the ACUPCC, we see a significant and positive estimate for the effect on energy use. The other models have statistically insignificant positive estimates.

Table 4.2: Time Series Analysis of Model 2

	On-Campus Energy Consumption (GJ)								
	Time Trend (KJ per sq. ft.)			Signing of ACUPCC			Launch of Cogeneration Facility		
Variables:	*Estimate*	*Std. Error*	*p-value*	*Estimate*	*Std. Error*	*p-value*	*Estimate*	*Std. Error*	*p-value*
Time	7.88	4.3	0.069						
ACUPCC Signed				4849	1581	0.003*			
Cogeneration Facility							3084.7	2781.29	0.269
Campus Square Footage				1.23 E-2	6.68 E-3	0.068	1.27 E-2	9.84 E-3	0.197
Full- and Part-Time Students	-0.019	0.157	0.902	0.103	0.6	0.864	9.39 E-2	0.77	0.903
January	-51	696	0.941	-30.15	2725	0.991	-293.3	2807	0.917
February	-1935	696	0.006**	-8137	2723	0.003**	-7996	2807	0.005**
March	-2680	695	0.000**	-11031	2723	0.000**	-10928	2807	0.000**
April	-4883	695	0.000**	-19896	2723	0.000**	-19755	2807	0.000**
May	-6973	1921	0.000**	-26310	7364	0.000**	-26271	9129	0.005**
June	-8044	1918	0.000**	-30625	7234	0.000**	-30586	9129	0.001**
July	-7779	1903	0.000**	-29672	7234	0.000**	-29624	9101	0.001**
August	-8273	1900	0.000**	-31549	7234	0.000**	-31500	9101	0.001**
September	-6545	676	0.000**	-26632	2647	0.000**	-26477	2727	0.000**
October	-3708	689	0.000**	-15065	2697	0.000**	-15065	2779	0.000**
November	-2920	689	0.000**	-11899	2697	0.000**	-11899	2779	0.000**
	R Square:	0.758		R Square:	0.779		R Square:	0.766	
	n:	147		n:	147		n:	147	

*p<0.05 **p<0.01

3.2 Analysis

In both of our models, we fail to find any evidence for reduced energy consumption on USU's campus over the time period. In the Model 1, each variable of interest has a statistically

significant positive estimate. In Model 2, the estimates are positive but only the signing of the ACUPCC had a statistically significant estimate. There are not any significant changes in the variables included in the base models.
Generating data to create a snapshot of energy consumption and the broader carbon footprint is one of the first steps of the process, so it may be that USU is still only taking the early step towards carbon neutrality of measurement. Reducing on-campus energy production is, it could be argued, a future step. This could explain why there is currently no evidence of on campus energy consumption reductions. Although this may be the case, our interviews with invested parties in the Facilities department never suggested that available means of energy reduction were awaiting implementation for some later phase of the broader policy goal. Rather, every indication was that Facilities pursued all obvious, available, and cost effective reductions as soon as feasible. Even these efforts fail to reverse the upward trend in energy consumption on campus. One could also argue that such commitments are symbolic, and should be evaluated as a symbol and not as policy. The criteria for evaluating a symbols' effectiveness seem even less well defined than carbon footprint reduction. Further, the ACUPCC insists that the commitment is more than symbolic.

4. DISCUSSION

As of writing, the ACUPCC has 672 signatory institutions and many comparable declarations exist. Although the specifics of each program and declaration vary, they share the broad goal of reducing universities' carbon footprints and/or greenhouse gas emissions. We do not comment on the worthiness of this goal. Rather, we have highlighted some theoretical problems to such declarations and demonstrated a case where one land-grant university failed to translate commitment into meaningful energy consumption reduction.

By nature, case studies possibly lack external validity. Our results and analysis do not suggest the universal failure of energy consumption or GHG emission reduction programs. Rather, the case of Utah State University's program demonstrates that, consistent with the theoretical problems described in section 1.1, substantial reductions in energy use do not necessarily follow commitments to reduction. Whether this failure to translate the ACUPCC to energy consumption reduction at USU is exceptional or the rule requires cross-sectional analysis of numerous ACUPCC signatory institutions.

In 2012, the ACUPCC released a report detailing "the progress and promise" of the commitment. The report claimed that the signatories reduced their collective carbon footprint by 25%, although it is not disclosed to the reader how this reduction was calculated. The setup of the report suggests that at least some of the reductions in GHG emissions stem from changing the source of purchased energy from traditional to less carbon intensive alternative energies. These efforts reduce emissionsandmay be sufficient to achieve carbon neutrality. To reach neutrality, either the energy input has a life cycle carbon intensity of zero or consumed energy needs to be offset through some method.Many organizations interested in reducing their carbon footprints employ a combination of these divergent approaches of shifting the energy portfolio and reducing energy consumption. The ACUPCCreport includes numerous reports of energy consumption reductionefforts similarto those that have taken place at USU, such as implementing more energy efficient light bulbs. At least one relatively small campus claims to have nearly reached carbon neutrality with the installation of two 1.65 MV wind turbines and solar panels [28]. UC Irvine, a large state institution more comparable with USU, claims to have reduced energy consumption in its labs by 50%.

It may be the case that USU's failure to make meaningful reductions in on campus energy consumption is anomalous and that many institutions are making meaningful strides in reducing on campus energy consumption, as suggested by UC Irvine's claim. However, it is also possible that universities are over-representing the magnitude of their own GHG emission or energy consumption reductions. The phenomenon of self-enhancement is pervasive in the psychology

literature. Pfeffer and Fong [29] define self-enhancement as “the desire or observed reality of seeing oneself and by extension one’s actions, traits, and attitudes in the most positive light” (374) and provide a review of some of the demonstrated empirical manifestations of the phenomenon. The majority of this literature deals with individuals or group-level consequences of the phenomenon. We suggest evaluating universities’ stated progress towards their GHG emission or energy consumption reduction goals versus objective methods of tracing energy consumption reduction (such as our models for tests of energy consumption reduction) would test whether this individual level phenomenon translates to institutional over-reporting of progress.

GHG emission reduction goals are not unique to universities. Similarly, other public institutions with frameworks comparable to a university face a similar set of theoretical challenges. When considering the energy-use component of GHG emissions: those who make consumption decisions are rarely those responsible for managing and reducing energy use, chief administrator tenure is frequently shorter than the relevant GHG emission reduction goals, and achieving specificity in the goals can be difficult as well. The principal-agent problem is also applicable to firms, particularly large firms. Studying how firms monitor and control energy use in the context of the principal-agent problem may provide guidance for public administrators as they consider their own energy consumption goals.

Given the theoretical challenges to energy consumption reduction programs, identifying what has lead to successful programs and allowed other institutions to overcome these theoretical obstacles could inform programs at universities like USU whose efforts have failed to produce measurable reductions in energy consumption.

Abbreviations:

ACUPCC: America's College and University President's Climate Commitment
GHG: Greenhouse Gas
OLS: Ordinary Least-Squares
USU: Utah State University

Appendix: Correlation Table

	Energy Used (GJ)	*Energy Use Days*	*Campus Square Footage*	*Energy Use per Square Foot*	*Full and Part Time Students*	*Time*
Energy Used (GJ)	1					
Energy Use Days	0.8395	1				
Campus Square Footage	0.1581	-0.0045	1			
Energy Use per Square Foot	0.9916	0.8469	0.0322	1		
Full and Part Time Students	0.6205	0.5957	-0.1574	0.6434	1	
Time	0.1940	0.0077	0.9347	0.0765	-0.1574	1

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