Beyond the Bill: Broad Behavior Change in Yale's Carbon Charge Pilot Project

A senior essay in the department of Environmental Studies

source: carbon.yale.edu

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Table of Contents

Tables

Figures

Photos

Glossary of Acronyms

CO_2: Carbon dioxide
COP 21: Conference of the Parties
CPLC: Carbon Pricing Leadership Coalition
GHG: greenhouse gas
IPCC: Intergovernmental Panel on Climate Change
LEED: Leadership in Energy and Environmental Design
MIT: The Massachusetts Institute of Technology
PCCCSC: Pierson College Carbon Charge Steering Committee
UNFCCC: United Nations Framework Convention on Climate Change

Abstract

From December 2015 to May 2016, Yale implemented an internal carbon price through its Carbon Charge Project pilot. Though carbon pricing programs had already existed in the public and private sector, Yale was the first university to use this type of financial tool to reduce greenhouse gas emissions. Yale undertook the project to provide decision makers with incentives for reducing emissions in buildings across campus, but also as a way to engage students, faculty and staff in energy reduction efforts. Because only a few individuals throughout the university are responsible for paying energy bills, however, the financial incentive of a carbon charge only impacts a small portion of people at Yale. To overcome this challenge, this study investigates how a carbon charge might be leveraged to engage the broader campus community in energy abatement efforts. To that end, this study identifies and evaluates a list of factors that enable pro-environmental behavior. Qualitative data were collected from semi-structured interviews with pilot participants to identify what factors motivated them during the Carbon Charge Project pilot. These findings were synthesized with quantitative data from a survey disseminated to students, faculty and staff across the university asking what factors might motivate them to engage in energy reduction efforts. This study concludes that people at Yale are most motivated to reduce their energy because of an internal concern for the environment, but would be willing to further reduce their consumption if they received decentralized economic incentives, if they received more feedback on their energy use at Yale, and if energy reduction efforts enabled more collaboration. Carbon pricing efforts in other contexts can use these findings from the Yale Carbon Charge Project to devise the most effective methods for engaging behavior change among their own communities of energy consumers.

I. Introduction

In the winter of 2015, Tanya Wiedeking, an operations manager for Pierson College, a residential building at Yale University, was told that her building had to reduce its energy usage. If Pierson reduced its energy consumption by 1% compared to its average consumption during the last three spring semesters, nothing would happen. However, if the building failed to reduce its consumption by that much, or even increased its consumption that season, Wiedeking would incur a fee proportional to the amount by which the building had missed its goal. On the contrary, if the building not only met but *exceeded* the 1% energy reduction goal, Wiedeking would receive a rebate proportional to the amount by which the building surpassed the goal.

Figure 1: The economic stakes facing Pierson College under the Yale Carbon Charge Project pilot

source: carbon.yale.edu

Pierson College faced these economic stakes as one of 20 buildings on campus that participated in Yale's Carbon Charge Project pilot. The project used an economic tool called "carbon pricing" that incentivizes energy abatement by making people pay for the carbon emissions that result from their energy consumption. Carbon pricing is one of many strategies being deployed worldwide to address the rising threat of climate change. The objective of these policies is to use price signals to link energy consumption in buildings to the larger societal

impacts of climate change.[1] Targeting buildings specifically is an effective strategy for tackling climate change as residential and commercial buildings are the largest source of CO_2 emissions in the U.S., responsible for almost 40% of CO_2 emissions.[2] Thus, carbon pricing has become an increasingly popular climate change abatement strategy in both the public and private sector. Amid this landscape, Yale joined the ranks of governments and private companies as the first university to put a price on its carbon emissions.

Yale's first attempt at an internal carbon charge took the form of a pilot project that ran between December 2015 and May 2016.[3] When Yale's Carbon Charge Task Force first recommended that the university adopt a carbon charge as part of the university's sustainability efforts, the group identified three main benefits of the project. First, the project would provide primary decision makers (individuals like Wiedeking who oversee budgets and operations in buildings) with appropriate incentives to orchestrate emissions reductions in their buildings. Second, the project would provide "decentralized incentives" to engage secondary decision makers (the students, faculty and staff whose actions impact the overall energy consumption in their buildings) in energy abatement activities. And third, the project would serve the broader purpose of expanding Yale's role as a pioneer in research, teaching, and policy design to cope with climate change.[4]

Figure 2: Decision makers in buildings under the Carbon Charge Project at Yale

- **Primary decision makers:** Those who oversee budgets and operations in buildings; includes individuals designated with responsibility for the carbon charge in pilot buildings
- **Secondary decision makers:** The remaining students, faculty and staff who do not make decisions on operations or budgets in their buildings, but whose actions impact energy consumption on campus

[1] Lisa Ryan et al. "Energy Efficiency Policy and Carbon Pricing," *International Energy Agency*, (2011)
[2] "Buildings and Climate Change," *U.S. Green Building Council, a*ccessed April 1, 2016, http://www.eesi.org/files/climate.pdf
[3] The Presidential Carbon Charge Task Force, "Report to the President and Provost of Yale University: Findings and Recommendations on a Carbon-Charge Program at Yale." *Yale Carbon Charge Project,* (2015)
[4] Ibid.

Table 1: Three advantages of implementing a carbon charge at Yale articulated in the Task Force report recommending Yale adopt the charge[5]

1	Provide appropriate incentives for decision makers to reduce emissions from carbon-intensive activities
2	Focus policies on carbon pricing as a superior tool for providing decentralized incentives and thereby engage students, faculty, and staff
3	Serve the broader purpose of expanding Yale's role as a pioneer in research, teaching, and policy design to cope with climate change.

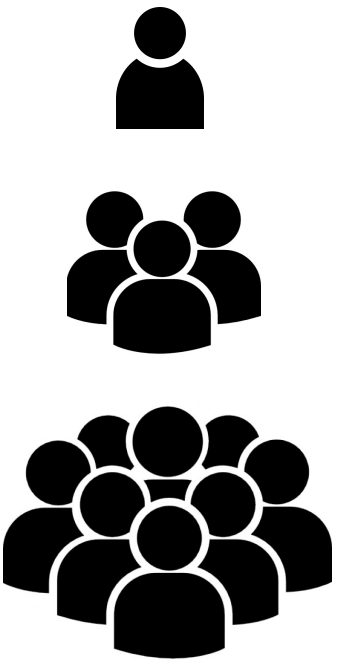
The first two benefits describe how the carbon charge would enable energy abatement on Yale's campus, via either individual behavior change (actions like shutting off the lights or powering down one's computer) or building-level behavior change (changes in building policy, like decreasing a building's operating hours).[6] In Pierson's experience with the carbon charge, both of these benefits proved true, and abatement occurred at both the individual level and the building level.

At the beginning of the project, Wiedeking (the primary decision maker) began identifying ways that her building could reduce its energy consumption. Rather than trying to work in isolation, Wiedeking assembled the "Pierson College Carbon Charge Steering Committee" (PCCCSC), a group of students (secondary decision makers) that convened to brainstorm ways to address energy consumption in the college. To have the maximum impact, the group was especially keen to find ways to reduce energy that would involve the entire student population inhabiting the building. To that end, they created a checklist that every student's "suite" needed to complete before leaving for break (a building-level policy). This checklist instructed students to take energy-saving actions like turning radiators down and unplugging appliances (individual actions).

[5] Directly quoted from The Presidential Carbon Charge Task Force, "Report to the President and Provost of Yale University"
[6] "Yale University's Carbon Charge: Preliminary Results from Learning by Doing." *Yale Carbon Charge Project,* (2016)

By the end of the semester, the efforts of Wiedeking, the PCCCSC, and the other individuals residing in Pierson paid off. Pierson Collage surpassed its 1% goal, reducing its energy so much that the building received a $3,300 rebate to spend on the student activities of their choosing.[7]

Figure 4: Decentralized behavior change under the carbon charge in Pierson College



Tanya Wiedeking | Primary decision maker

After learning about the charge, Wiedeking assembled the PCCCSC to bridge the gap between primary and secondary decision makers

PCCCSC | Primary and secondary decision makers

Primary decision maker collaborated with small group of secondary decision makers to craft building-level policy

Pierson residents | Secondary decision makers

This building-level policy change (the checklist) spurred individual behavioral change (turning down radiators and unplugging appliances) among a broader community of secondary decision makers

In sum, Pierson's experience with the Carbon Charge involved a primary decision maker (Wiedeking) collaborating with secondary decision makers (the PCCCSC) in the crafting of a building-level policy (the checklist) that requested individual behavioral change (turning down radiators and unplugging appliances) among an even broader set of secondary decision makers occupying the building (student residents). All in all, Pierson's was a story of truly decentralized energy abatement activities.

[7] Wiedeking, Tanya, Personal interview. December 13, 2016.

However, the carbon charge did not produce decentralized behavioral change in every building. When implementing the pilot, the Carbon Charge Task Force only designated one decision maker in each building (the "designee") with formal responsibility for the carbon charge in their building.[8] The designee was the only one who would technically see the costs of the charge, meaning that the financial incentive on its own did not directly involve all individuals in the building. Instead, it was up to each designee to engage the secondary decision makers in their building to participate in energy reduction efforts. Wiedeking may have taken the initiative to bridge this gap on her own accord, but this would not necessarily occur organically everywhere throughout the pilot. Further, even when primary decision makers bridged this gap, secondary decision makers may not have felt motivated to join the efforts without themselves feeling the financial pressure. Thus, the design of Yale's Carbon Charge does not incentivize behavior change among a broad range of individuals through the financial tool on its own.

In some buildings, the primary decision maker worked on their own to achieve energy reduction, and in other buildings, the incentive of a carbon charge was not enough to even influence this primary decision maker to pursue energy reduction strategies. If a central goal of the project was to "engage students, faculty and staff," Yale's carbon charge should first engage the primary decision maker in each building, but also the wider group of secondary decision makers that regularly use the buildings.[9]

After a successful pilot, Yale now moves forward to university-wide implementation of the carbon charge. The plan is to provide a primary decision maker in every building throughout the university with a new energy bill that officially integrates a carbon charge into their

[8] "Yale University's Carbon Charge: Preliminary Results from Learning by Doing." *Yale Carbon Charge Project*
[9] "Report to the President and Provost of Yale University: Findings and Recommendations on a Carbon-Charge Program at Yale." *The Presidential Carbon Charge Task Force.*

building's budget.[10] Under this design, the program continues to focus on engaging the primary decision maker, with less attention on how to broaden the program to involve secondary decision makers. In so doing, Yale misses an opportunity to better engage a wider swath of important campus actors in its sustainability endeavors.

To refocus the project around its goal of engaging individuals throughout the university in energy abatement, it is important to understand why individuals who were highly-active in energy reduction during the pilot were so engaged. Conversely, it is useful to know why people who were more apathetic to the pilot may have felt that way, and what approach would have motivated people who may not have been involved in the project. Understanding the best way to foster broad behavior change can shed light on how Yale's Carbon Charge, and carbon pricing efforts in other contexts, may enable a wider reach of individuals to become more deeply engaged with energy reduction efforts in their buildings. To that end, this paper will explore the research question: what factors influence behavior change under a campus energy reduction program among individual students, faculty and staff at Yale?

This essay will situate Yale's Carbon Charge Project within the context of similar emission reduction efforts in the public sector, the private sector, and at universities. Next, the essay discusses broader literature on how to engage people to reduce energy consumption in a variety of contexts to distill out a list of engagement factors relevant to this investigation. With this background in place, this paper then presents its research methods, comprising interviews and a survey with individuals at Yale. The paper concludes by presenting the results from the interviews and surveys in light of the relevant engagement factors identified, followed by discussion, conclusions and recommendations based on these results.

[10] Casey Pickett, e-mail message to Carbon Charge Project Manager, February 20, 2017

II. Literature Review

The Current State of Carbon Pricing

In their 2014 Synthesis Report, the Intergovernmental Panel on Climate Chance (IPCC) concluded that human influence on climate change is clear, with anthropogenic GHG emissions at their highest rates in history.[11] The impacts of climate change have been widespread, including increases in extreme weather events, risks to human health, and threats to biodiversity.[12] Recognizing this mounting problem, nations worldwide have begun seeking solutions. 189 countries whose cumulative emissions make up 96% of global GHG emissions agreed to reduce their emissions at the 21st Conference of the Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC) in Paris in 2015.[13] One key instrument nations will use to meet their emission reduction targets is carbon pricing, with roughly 100 of the nations at COP 21 planning to use some form of a carbon pricing policy.[14]

Simply put, carbon pricing refers to any policy that applies an explicit price on a unit of greenhouse gas emissions.[15] These policies are intended to internalize the environmental, social, and economic costs of climate change (referred to as "externalities"), thus incentivizing GHG emissions reductions.[16] Within this broad definition, though, the design and context of such policies can vary considerably. The commitments made at COP 21 involve public policies that put a price on emissions at a governmental level, but carbon pricing programs also exist in the

[11] Intergovernmental Panel on Climate Change. "Climate Change 2014: Synthesis Report," (2014)
[12] Ibid.
[13] World Bank. "States and Trends of Carbon Pricing 2016," World Bank, Washington, D.C.
[14] Ibid.
[15] Ibid.
[16] UN Global Compact Caring for Climate Initiative, "Executive Guide to Carbon Pricing Leadership," (2015)

private sector and now at the institutional level with Yale as the first university to put a price on its carbon emissions.[17]

The concept of pricing carbon originated in economic theory from the early 20th century, when Pigou discussed the notion of internalizing externalities.[18] However, carbon pricing did not begin in practice until the early 1990s when Finland, Norway, Sweden and Denmark enacted the first carbon pricing legislation.[19] Momentum behind such efforts has grown rapidly, as the quantity of global emissions covered by a carbon price has tripled in the past ten years.[20] Now, about 40 national jurisdictions and more than 20 city, state and regional jurisdictions price their carbon, corresponding to roughly 7 gigatons of CO_2, or about 13% of GHG emissions globally. This growth will likely continue, with China planning to implement an emissions trading scheme in late 2017, which would increase the proportion of global emissions covered by carbon pricing policies from 13% to between 20-25%.[21]

This momentum in the public sector is matched by a trend of companies voluntarily putting a price on their own carbon emissions in the private sector. In the short period since 2014, the number of companies using an internal carbon price has more than tripled, up to 517 in 2016 from 150 two years prior.[22] This number will continue to grow to more than 1,200 by 2018, as hundreds of companies across industries have reported their intentions to begin pricing their carbon within the next two years.[23] Many companies begin pricing their carbon in accordance with existing policies or in anticipation of impending government policies that might impose a

[17] In each of these contexts, there are numerous options for the design of these policies, and for the price charged per ton of CO_2. An exploration of these nuances in design, however, is outside of the scope of this paper.
[18] Pigou, A.C., "Wealth and Welfare," London: Macmillan, (1912)
[19] Kennedy, Kevin, Obeiter, Michael and Kaufman, Noah, "Putting a Price on Carbon: A Handbook for U.S. Policymakers." *World Resources Institute*, (2015)
[20] Carbon Disclosure Project, "Putting a price on risk: Carbon pricing in the corporate world," (2015)
[21] World Bank, "States and Trends of Carbon Pricing 2016"
[22] Carbon Disclosure Project, "Global corporate use of carbon pricing," (2014)
[23] Ibid.

price on carbon emissions in the future. In fact, of the 1,200 companies that either currently price their emissions or intend to do so in the next few years, 83% have their headquarters in countries that already mandate carbon pricing, or that are scheduled to implement such mandates soon. Thus, as policy development in the public sector continues, efforts in the private sector and the academic sector will become increasingly relevant.[24]

To harness this energy, groups across sectors joined forces at COP 21 in November 2015 by forming the Carbon Pricing Leadership Coalition (CPLC), a partnership between more than 200 governments, businesses and civil society organizations coordinated by the World Bank and the International Monetary Fund to unite on the common goal of advancing carbon pricing efforts.[25] Within months of its formation, Yale became the first educational institution to join the CPLC in March 2016. In so doing, Yale became the first university to deploy a carbon pricing scheme.[26]

Before Yale's Carbon Charge Project, other universities had certainly made strides in campus energy reduction through other efforts. One effort comparable to Yale's program was UC Berkeley's Energy Incentive Program.[27] In this program, departments across Berkeley's campus received incentive payments if they reduced their energy use relative to their average emissions.[28] Beyond Berkeley, universities around the country had deployed similar strategies to try to discourage energy use on campuses. Many efforts involved small-scale events or competitions encouraging student buildings to compete with one another to achieve the most energy savings. Other university efforts were larger in scale, involving implementing renewable

[24] Carbon Disclosure Project, "Embedding a Carbon Price into Business Strategy," (2016)
[25] Carbon Pricing Leadership Coalition, "Official Launch Event and World Plan," (2015)
[26] "Yale becomes first university to join Global Carbon Pricing Leadership Coalition," *Yale News,* March 15, 2016. http://news.yale.edu/2016/03/15/yale-becomes-first-university-join-global-carbon-pricing-leadership-coalition
[27] In fact, Yale's Carbon Charge Task Force drew from the design of Berkeley's program when crafting its own pilot. The Presidential Carbon Charge Task Force, "Report to the President and Provost of Yale University"
[28] "Campus Energy Savings Bring $870k Back to Teaching & Research," *Berkeley Sustainability*

energy technologies or undertaking building remodels and retrofits.[29] But among the myriad approaches to encouraging energy reduction across campuses nationwide, Yale's approach was the first to set an outright price penalty on buildings for their emissions.

Yale's project generated a significant amount of publicity and attention, with its efforts covered in news outlets like the Huffington Post.[30] Other institutions took note, and a number of universities have begun to follow Yale's lead. The Massachusetts Institute of Technology (MIT) became the second university to join the CPLC in May 2016, followed by The George Washington University in November 2016.[31,32] Though neither institution has yet implemented a carbon price on their campus, MIT's president has said he is exploring how MIT might one day do that.[33] Other universities outside the CPLC have also explored the concept of pricing their carbon emissions, with universities like Duke, Vassar and Swarthmore studying Yale's example.[34,35,36] The success of Yale's project even led Vassar and Swarthmore to implement carbon pricing policies on their own campuses.[37,38] With all of this momentum occurring at this very moment, the study of carbon pricing at universities is timely and relevant.

While the economic literature discussing the economics of carbon pricing is wide and deep, a thorough discussion on the particulars of these economic analyses is outside of the scope of this paper. What *is* relevant is that the consensus of economists is that carbon pricing is an

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[29] Massachusetts Executive Office of Energy and Environmental Affairs. "Campus Sustainability Best Practices." *Leading by Example Program*, (2008)
[30] Milikowsky, Jennifer and Laemel, Ryan. "Piloting a Price on Carbon: How World Universities Can Join in Taking the Lead." *The Huffington Post*
[31] MIT News Office, "MIT joins Carbon Pricing Leadership Coalition," *MIT News*
[32] Environment and Energy Management Institute, "EEEMI Establishes Partnership with the World Bank on the Carbon Pricing Leadership Coalition," *The George Washington University*, November 20, 2016.
[33] MIT News Office, "MIT joins Carbon Pricing Leadership Coalition"
[34] Duke University. "Developing Departmental Energy Reports and a Carbon Pricing Program for Duke University (2016-2017)."
[35] Hall, A. et al. "Internal Carbon Accounting at a Small Liberal Arts College," *Vassar College,* (2015)
[36] Swarthmore College Office of Sustainability. "Swarthmore Carbon Charge Initiative." *Swarthmore College*
[37] Vassar College Committee on Sustainability and the Office of Sustainability. "Climate Action Plan, July 2016"
[38] "Swarthmore Implements Carbon Charge for Current Budget Year." *Swarthmore College News & Events, August 4, 2016*

economically efficient way to reduce emissions.[39,40] On one hand, carbon prices can incentivize a transition away from fossil fuels for energy production, moving instead to lower-carbon sources like renewables that are more economically-favorable under a carbon price.[41] On the other hand, carbon prices can also incentivize energy conservation within buildings by raising energy prices and making energy consumption more expensive[42,43,44] Thus, when compared to emission abatement policies like performance standards that only target production, carbon pricing policies have emerged as distinctly favorable policy tools for abating climate-warming emissions, as they target both the production *and* the consumption of energy.[45]

Drawbacks, however, do exist. A major hindrance of carbon pricing and other environmental policies is the "value-action gap." This gap is a phenomenon that scholars have identified to explain the discrepancy between the way people value environmentally-favorable behavior, and their willingness to act in accordance with those values.[46,47] The gap can be explained by the "complex interactions of psychological, social and environmental factors" that produce behavior.[48]

This study seeks to identify all of these factors that might prevent behavior change under a carbon pricing scheme. Conversely, though, it seeks to understand what factors might enable

[39] Kennedy, Kevin, Obeiter, Michael and Kaufman, Noah, "Putting a Price on Carbon"
[40] Nordhaus, William D., "To Tax or Not to Tax: Alternative Approaches to Slowing Global Warming," *Review of Environmental Economics and Policy* 1, no. 1 (2007): 26-44
[41]Kaufman, Noah, Obeiter, Michael and Krause, Eleanor. "Putting a Price on Carbon: Reducing Emissions," *World Resources Institute,* (2016)
[42] Ibid.
[43] Martin, R., L. de Preux, and U. Wagner. 2011. "The Impacts of the Climate Change Levy on Manufacturing: Evidence from Microdata." NBER Working Paper No. 17446.
[44] Neenan, Bernard and Eom, Jiyong. "Price Elasticity of Demand for Electricity: A Primer and Synthesis," *Electric Power Research Institute*, (2007)
[45] Kaufman, Noah, Obeiter, Michael and Krause, Eleanor, "Putting a Price on Carbon: Reducing Emissions"
[46] Blake, J., "Overcoming the 'value-action gap' in environmental policy: tensions between national policy and local experience," *Local Environment* 4, no. 3, (1999): 257-278
[47] Whitmarsh, Lorraine, Seyfang, Gill and O'Neill, Saffron, "Public engagement with carbon and climate change: To what extent is the public 'carbon capable'?" *Global Environmental Change* 21 (2011): 56-65
[48] Ockwell, David, Whitmarsh, Lorraine and O'Neill, Saffron. "Reorienting Climate Change Communication for Effective Mitigation." *Science Communication* 30, no. 3 (2009): 305-327

behavior change in such a context. A carbon charge is designed around one main factor – the price signal – but other factors may also be at play. Thus, this study seeks to compile an exhaustive list of factors, including both barriers and enablers, that might influence behavior change under a carbon pricing scheme. To that end, this study reviews literature on factors influencing pro-environmental behavior.

Factors Influencing Behavior Change

First, it is necessary to define this idea of "factors." For this analysis, a factor is "anything that actively contributes to the production of a result."[49] Thus, a factor could be any driving force that might affect the way in which an individual engages with a carbon charge or other energy reduction efforts more broadly.

Much of the literature studying what contributes to energy reduction or environmental behavior uses this approach of identifying and evaluating a number of distinct factors or variables that might influence behavior. In their paper "Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior?", Kollmuss and Agyeman describe the most influential frameworks for studying pro-environmental behavior.[50] Based on their analysis of these different approaches, Kollmuss and Agyeman propose a new model that synthesizes the factors and insights common to prior models into a single, new model (Table 2).

[49] The definition of a "factor" from Merriam-Webster
[50] Kollmuss, Anja and Agyeman, Julian. "Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior?" *Environmental Education Research* 8, no. 3, (2002): 239-260

Table 2: Factors influencing pro-environmental behavior from Kollmuss & Agyeman's model of pro-environmental behavior[51]

External Factors	Internal Factors
• Institutional • Economic • Social & Cultural	• Motivation • Values • Environmental Attitudes • Environmental Involvement • Environmental Knowledge • Environmental Awareness • Locus of Control • Responsibility & Priorities

These models make the distinction between "external factors" and "internal factors" because each category of factor influences behavior change in different ways. External factors may be easier to leverage as they can be altered at the level of the building or policy, instead of at the level of the individual. However, in their "motivation crowding theory," Frey & Jegen warn that "external intervention may reduce individuals' intrinsic incentives to act."[52] Thus, environmental behavior results from a balance between both types of factors.

In an attempt to trace how all of these factors might interplay, Kollmuss and Agyeman consolidated a model of pathways to environmental action from a number of distinct models (Figure 4). The two introduce this model with the caveat that creating a model incorporating every factor that influences environmental behavior "might neither be feasible nor useful," but that such models simply work as helpful "visual aides in clarifying and categorizing factors."[53] The key point that this model communicates is that no single factor directly leads to environmental behavior. Rather, the pathway to pro-environmental behavior is influenced by a

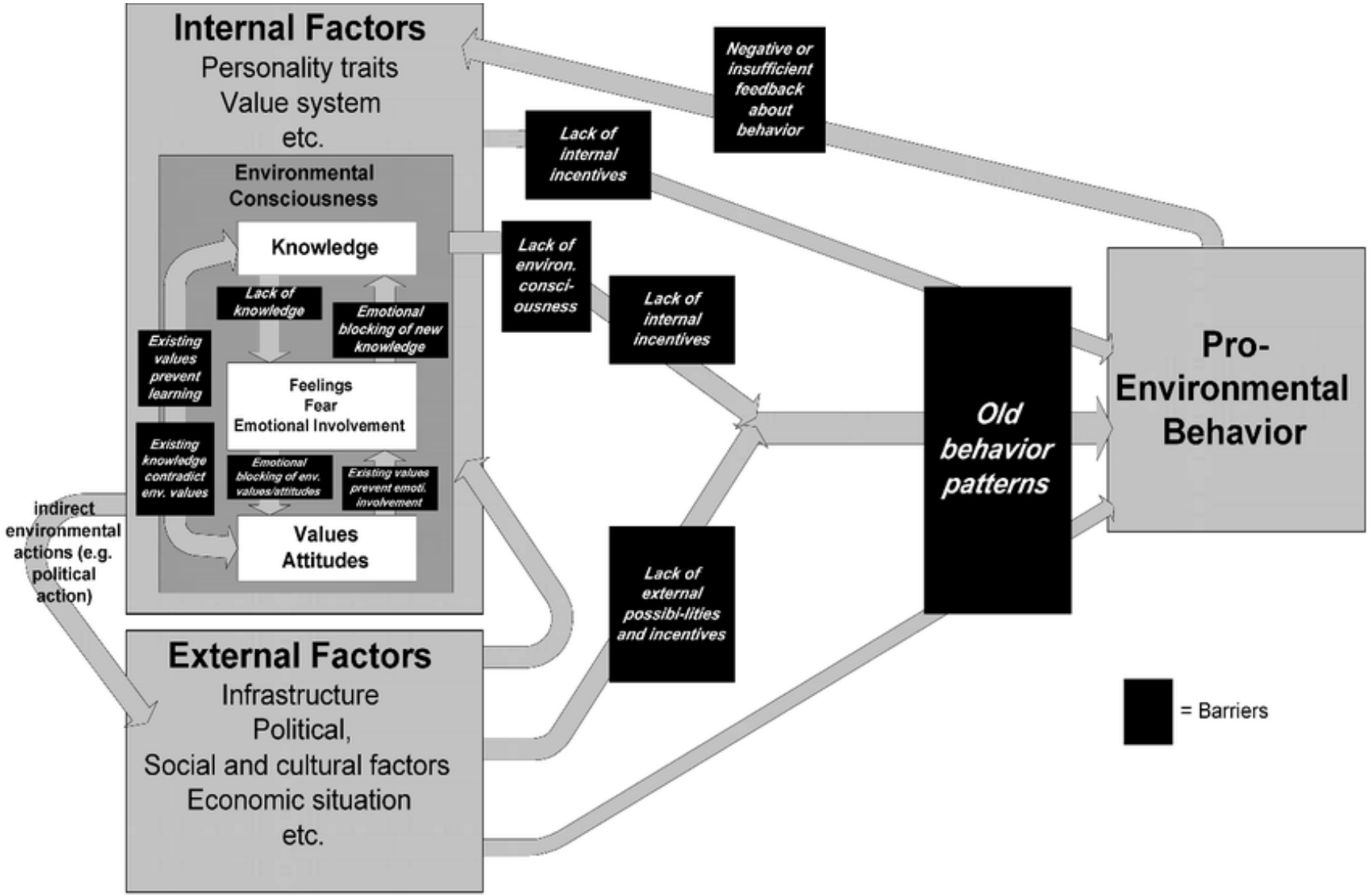
[51] Their original model also included a brief discussion of demographic factors, including gender and education. Though these factors may influence environmental behavior, this study omits this category because they are highly immutable, and accommodating for such factors risks being too political

[52] Frey, B.S. and Jegen, R, "Motivation crowding theory: A survey of empirical evidence," *Zurich: Institute for Empirical Research in Economics, University of Zurich*, (2000)

[53] Kollmuss, Anja and Agyeman, Julian, "Mind the Gap"

number of different enabling factors (in gray and white) and barriers (in black), that eventually may or may not lead to pro-environmental behavior, depending on the pathway followed and the strength of each factor present.

Figure 5: Kollmuss & Agyeman's model of pro-environmental behavior



This research seeks to review Kollmuss & Agyeman's model of factors of engagement, and the underlying literature that influenced their model, to generate a list of factors that would influence behavior change in the Carbon Charge Project at Yale. However, Kollmuss & Agyeman's model draws from studies of emissions reduction programs in contexts distinct from Yale's carbon charge. To make up for any gaps that result from applying their model to Yale's context, this analysis uses Kollmuss and Agyeman's factors as a baseline, but supplements their list with factors identified in literature on energy reduction in contexts similar to Yale, including other forms of university emissions reduction programs and carbon pricing programs in the private sector. Using this list of factors, this study seeks to analyze the presence of, and interaction between, all of these factors to predict how people might participate in a carbon pricing program.

External Factors

The first external factor that Kollmuss and Agyeman discuss is the influence of **institutional** factors, which they use to refer to aspects of the building or organization where sustainability engagement will be taking place. Specifically, they state that many sustainable behaviors require necessary infrastructure to enable them. They cite, for instance, the importance of having recycling infrastructure to encourage the green behavior of recycling. In the case of energy reduction, then, the "necessary infrastructure" could refer to technology like control panels that allow people to adjust their energy consumption.

The category of factors they next discuss is **economic factors**. Kollmuss and Agyeman conclude that economic incentives generally play a mixed role in encouraging pro-environmental behavior. On one hand, economic incentives can influence people to behave sustainably, but on the other hand, people's actions cannot be predicted solely through economic analysis. This

phenomenon is known as "bounded rationality," stating that consumers often will not perform the necessary calculations to determine the most cost-effective behavior that would lead them to energy efficiency actions.[54] An additional shortcoming of economic factors is the "split incentive problem," which states that within the same building, the individuals that make infrastructural investment decisions, those that pay energy bills, and those that consume energy are sometimes all different people, meaning they have different incentives and motivations for making decisions. [55] Because of these shortcomings, some researchers go as far as to say that rewards or penalties as "some of the least effective techniques in fostering movement towards 'greener' behavior."[56]

The final external factor that Kollmuss and Agyeman include in their model is that of **social and cultural factors**. In research on why people adopt green electricity, Ozaki concludes that "strong social norms are needed" because "people show their sense of membership by taking up activities that are regarded as a norm within the group they belong to."[57] In line with this assertion, insights drawn from Microsoft's Carbon Price – which has been used as a model for such programs in the private sector – discuss the importance of a building culture that encourages buy-in to such energy reduction efforts. When crafting their program, Microsoft highlighted the importance of involving all of its business units in the design process in order to "maximize long-term organizational commitment."[58] At a university, especially, including a social component in energy reduction efforts is quite important. In energy reduction competitions at six universities in British Columbia, researchers found that "participants were motivated by

[54] Kennedy et al., "Putting a price on carbon"
[55] Lisa Ryan et al., "Energy Efficiency Policy and Carbon Pricing"
[56] Temminck, Elisha, Mearns, Kathryn and Fruhen, Laura, "Motivating Employees towards Sustainable Behavior," *Business Strategy and the Environment* 24, (2015): 402-412
[57] Ozaki, Ritsuko, "Adopting Sustainable Innovation: What Makes Consumers Sign up to Green Electricity?" *Business Strategy and the Environment* 20, (2011): 1-17
[58] DiCaprio, Tamara, "The Microsoft carbon fee: theory & practice," (2013)

the actions and stories of their friends and did not pay attention to the actions or competition scores of strangers," indicating that getting people plugged in on energy reduction might be highly social.[59]

This example from the university in British Columbia brings up the factors of **competition,** a category that was absent from Kollmuss & Agyeman's list but that has often been invoked at universities to get students to pay attention to their energy consumption.[60] Even beyond universities, though, competition can be a motivating factor. OPower, for instance, is a company that has found that households are motivated to reduce their energy use when they receive energy bills pitting themselves against their neighbors in terms of who is saving the most energy.[61]

Finally, Kollmuss & Agyeman include environmental knowledge and awareness in their list of *internal* factors (see section below), but they do not acknowledge the potential external influence of access to **information** about energy consumption to supplement such internal environmental knowledge. Much of the underlying literature they drew from, however, recognizes the effect such information can have. Blake, for instance, cited a lack of information as a barrier to environmental action.[62] Further, Microsoft suggested that appropriate information should be made available both at the beginning and throughout a carbon pricing program, in the form of frequent progress updates.[63] It is important to note, however, that information by itself

[59] Senbel, Maged, Ngo, Victor Douglas and Blair, Erik. "Social mobilization of climate change: University students conserving energy through multiple pathways for peer engagement" *Journal of Environmental Psychology* 38, (2014): 84-93
[60] Ibid.
[61] Laskey, Alex and Kavazovic, Ogi, "OPower: Energy efficiency through behavioral science and technology," *XRDS* 17, no. 4, (2010): 47-51
[62] Blake, J., "Overcoming the 'value-action gap' in environmental policy"
[63] DiCaprio, Tamara. "The Microsoft carbon fee: theory & practice"

may be limited. According to Eden, the widely-criticized "information-deficit model" wrongly assumes that environmental education on its own will propel the public into action.[64]

Internal Factors

These main "external factors" are complemented by "internal factors" inherent to the individual participants in an emissions reduction project. The first internal factor that Kollmuss and Agyeman discuss is **motivation,** which can refer to either larger, guiding principles or immediate, intense desires.[65] Next, they bring up **values** as a factor, in terms of where environmentalism ranks among the value sets of individuals. Similarly, they identify **environmental attitudes** ("enduring positive or negative feelings" about environmental issues) and **emotional involvement** ("the extent to which we have an affective relationship to the natural world") as other internal factors.[66] Because of the similarity of these four factors, I consolidate them all into one and refer to them simply as **concern for the environment**. Though often thought to be essential to pro-environmental behavior, Kollmuss and Agyeman's review of the literature concludes that concern for environmental issues has a varying, often small, impact on such behavior. Ozaki reached the same conclusion in his study, explaining how "people are capable of being contradictory or hypocritical."[67] Thus, a stated concern for the environment will not necessarily predict environmental actions.

Similarly, Kollmuss and Agyeman next list environmental knowledge and environmental awareness as two separate factors that I refer to simply as **environmental knowledge**. While information as an external factor refers to something mutable, knowledge as an internal factor refers to the baseline knowledge of individuals about energy consumption and environmental

[64] Eden, S. "Public participation in environmental policy: considering scientific, counter-scientific and non-scientfic contribution." *Public Understanding of Science* 5, (1996): 183-203
[65] Moisander, J., "Motivation for Ecologically Oriented Consumer Behavior," *The European Science Foundation* (1998)
[66] Kollmuss, Anja and Agyeman, Julian, "Mind the Gap"
[67] Ozaki, Ritsuko, "Adopting Sustainable Innovation"

issues. Again because of criticisms of the information-deficit model, they state that "most researchers agree that only a small fraction of pro-environmental behavior can be directly linked to environmental knowledge and environmental awareness."[68]

Next, locus of **control** is a factor that refers to "an individual's perception of whether he or she has the ability to bring about change through his or her own behavior," with a strong internal locus of control referring to a feeling that one can affect change.[69] Blake acknowledges how people often will not act pro-environmentally out of a feeling that they cannot influence the situation, meaning a weak locus of control around energy abatement would discourage engagement with energy reduction.[70]

The last internal factor the two incorporate into their model is **responsibility and priorities**, asserting that pro-environmental behavior should align with peoples' priorities. This study separates out responsibility as an external factor rather than an internal one, as the designers of Yale's Carbon Charge Project could choose who would have responsibility for the charge in their building, meaning responsibility was a factor mutable to change.

The final list of factors this thesis will study are consolidated below, in Table 3.

[68] Kollmuss, Anja and Agyeman, Julian, "Mind the Gap"
[69] Ibid.
[70] Blake, J., "Overcoming the 'value-action gap' in environmental policy"

Table 3: Factors tested in this analysis compared to factors from Kollmuss & Agyeman

Factors identified in Kollmuss & Agyeman		Factors tested in this analysis*	
External Factors	Internal Factors	External Factors	Internal Factors
• Institutional • Economic • Social & Cultural norms	• Motivation • Values • Environmental Attitudes • Environmental Involvement • Environmental Knowledge • Environmental Awareness • Locus of Control • Responsibility & Priorities	• Institutional • Economic • Social & Cultural norms • **Information** • **Competition** • **Responsibility**	• Concern for the Environment (Motivation, Values, Environmental Attitudes + Environmental Involvement) • Environmental Knowledge (Environmental Knowledge + Environmental Awareness) • Locus of Control • Priorities

*Note that factors in boldface type are additions from literature outside of Kollmuss & Agyeman

Summary & Conclusions of Literature Review

Given the momentum behind the development and spread of carbon pricing programs in the public and private sector, research on Yale's project is timely and relevant. By being the first university to deploy a carbon pricing project, Yale paves the way for other universities and similarly sized companies to learn from their experience and emulate their practices. Thus, lessons learned from Yale's project will be relevant for carbon pricing efforts in both the academic and private sector, because of the similar size, scope and challenges that both an educational institution and a large company might face. Because of the nascence of Yale's project, this research will be the first to address the question of how an internal carbon price influences behavior change among individuals in a university. More broadly, though, this research contributes to knowledge about which factors motivate people to abate their energy generally, not necessarily within the specific context of a carbon pricing program.

III. Methodology

Research Methods

Examining the experiences of the various participants in Yale's Carbon Charge Project pilot, this study evaluated factors that influence individuals at a university to participate in energy reduction efforts on buildings across campus. This analysis hinged around the general hypothesis of my research, stated below:

Hypothesis: Factors beyond the financial incentive of a price signal motivate individuals to participate in energy reduction efforts under the Carbon Charge Project at Yale.

Having distilled out a list of "factors" from the literature, this study evaluated each factor and its influence on behavior change using a mixed-methods approach that drew from two primary sources of data: (1) responses from semi-structured interviews with pilot participants and (2) results of an online survey disseminated to students, faculty and staff at Yale (Table 4). Mixed methods research yields more completeness of data, and has become the norm in many disciplines in the social sciences.[71] Generally speaking, the interviews yielded insights on what factors would enable or prevent primary decision makers from changing building-level energy consumption behavior under the Carbon Charge Project specifically. Meanwhile, the survey yielded insights on what factors would enable secondary decision makers to change their individual consumption behavior in the context of a more general energy reduction program.

Table 4: Data source and type of behavior evaluated

Data Source	Decision Maker Evaluated	Behavior Change Evaluated
Interview	Primary	Building-level
Survey	Secondary	Individual-level

[71] Pidgeon, Nick et al,. "Creating a national citizen engagement process for energy policy," *Proceedings of the National Academy of Sciences* 111, no. 4, (2014): 13606-13613

The Context: An Overview of Yale University

Photo 1: Harkness Tower at Yale University sticks out from the skyline of New Haven, Connecticut. The Carbon Charge Project studied here took place on Yale's campus. Source: Yale University LinkedIn

The Carbon Charge Project pilot took place at Yale University, a private American research university established in 1701 in New Haven, Connecticut.[72] There are more than 300 buildings across the university's campus serving more than 12,000 students studying at Yale's undergraduate, graduate and professional schools, and nearly 15,000 staff and faculty working in different departments throughout campus.[73] To accommodate the assorted functions of a university, buildings on Yale's campus include residential buildings, offices, research laboratories, athletic facilities, museums and more.

Naturally, these buildings have diverse energy needs and costs, as a small office building consumes far less energy than a large laboratory with energy-intensive equipment. Buildings at Yale differ further from one another in terms of how they budget their energy costs. They can be separated into two categories from a budgetary standpoint: self-support and central-support.[74] Self-support buildings are those that pay their own energy bills, and thus are likely already tuned into their energy costs, because such costs have a direct impact on their budgets. However, about

[72] "About Yale" *Yale University*. Accessed April 3, 2017. https://www.yale.edu/about-yale
[73] "Yale Facts," *Yale University*, Accessed April 3, 2017, https://www.yale.edu/about-yale/yale-facts
[74] The Presidential Carbon Charge Task Force, "Report to the President and Provost of Yale University"

90% of energy spending at the university falls under the second category of central-support, meaning these units do not pay their own energy bills and thus do not face the financial consequences of their energy consumption.

The Carbon Charge Project at Yale

On Earth Day 2014, Yale Professors William Nordhaus and Daniel Esty convened students, faculty and staff from across the university in a "teach in" aimed to discuss how to best tackle climate change. Nearly one year later to the day, one of the ideas tossed around during that Earth Day Summit came to fruition, when President Salovey announced that Yale would launch a pilot program for a university carbon charge.[75] This campus-wide email sent out April 20, 2015 made Yale the first institution to attempt to mitigate its emissions in this way, using an unprecedented model for a carbon price in a university setting.[76]

The Carbon Charge Project at Yale would place a price on the CO_2 emissions from buildings and operations on the university's campus. However, before rolling out this program across the entire university, Yale announced that it would first attempt the program during a pilot phase that would test four different policy approaches, called "treatment groups" (Figure 6 & Table 5). In this pilot, 20 different buildings throughout campus were subject to a charge of $40 per ton of CO_2.[77] This charge applied to direct GHG emissions (Scope 1), and indirect emissions resultant from energy generation the buildings consume (Scope 2). The 20 buildings chosen to participate in the pilot were studied to determine their "baseline" energy consumption based on historic consumption data from the past three years. They were then separated into five

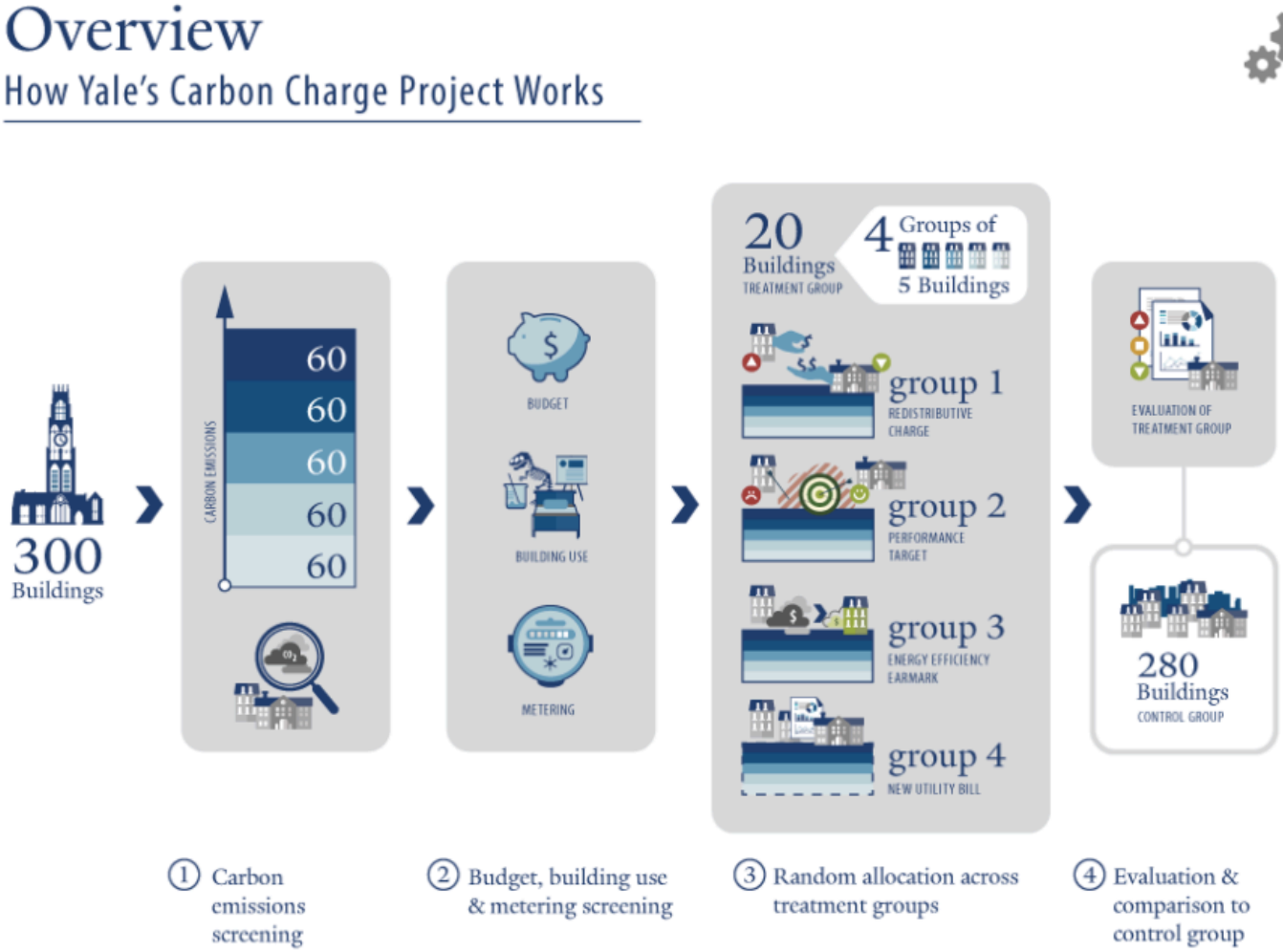
[75] Jennifer Milikowsky, Memo for Climate Change and Clean Energy course with Daniel Esty.
[76] "Project Overview," *Yale Carbon Charge Project.* Accessed April 1, 2017. http://carbon.yale.edu/project-overview
[77] $40 is considered the "social cost" of carbon by the federal government. "Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis," *Interagency Working Group on Social Cost of Carbon, United States Government* (2013)

categories based on their energy consumption data, with the most energy-intensive buildings in one group, and the smallest consumers of energy in another. The 20 buildings were divided among the four treatment groups, with five buildings in each group – one from each category of energy consumption needs. Though each treatment group differed slightly, each intended to draw attention to a building's carbon emissions through the use of a price signal that would be felt by buildings regardless of if they were central- or self-support from a budgetary standpoint.[78]

Scheme 1 ("information") simply involved providing an informational report on the energy consumption, carbon emissions, and associated costs to the key decision makers in each building. This scheme sought to test the effect of information alone, absent a financial incentive.[79] Scheme 2 ("target") assigned each building the goal of reducing its emissions by 1% from its historic baseline. If the building missed the goal, it would incur a charge, but if it surpassed the goal, it would receive a rebate. Scheme 3 ("redistribution") compared the energy performance of all five buildings at the end of the pilot to their historic baselines to determine how much each building changed from its baseline. The buildings in the group with the greatest energy reduction relative to their baselines would receive a rebate, and those in the group with the least energy reduction would incur a charge. Finally, scheme 4 ("investment") charged each building $40 monthly for each ton of CO_2 emitted. At the end of the fiscal year, buildings would receive a full refund for this charge, with 20% of the money earmarked for energy efficiency programs. Finally, the remaining 280 buildings on Yale's campus served as the control group to test whether the carbon charge schemes actually led to emissions reductions.[80] With this format in place, the first phase of the pilot began December 2015 and lasted until May 2016.[81]

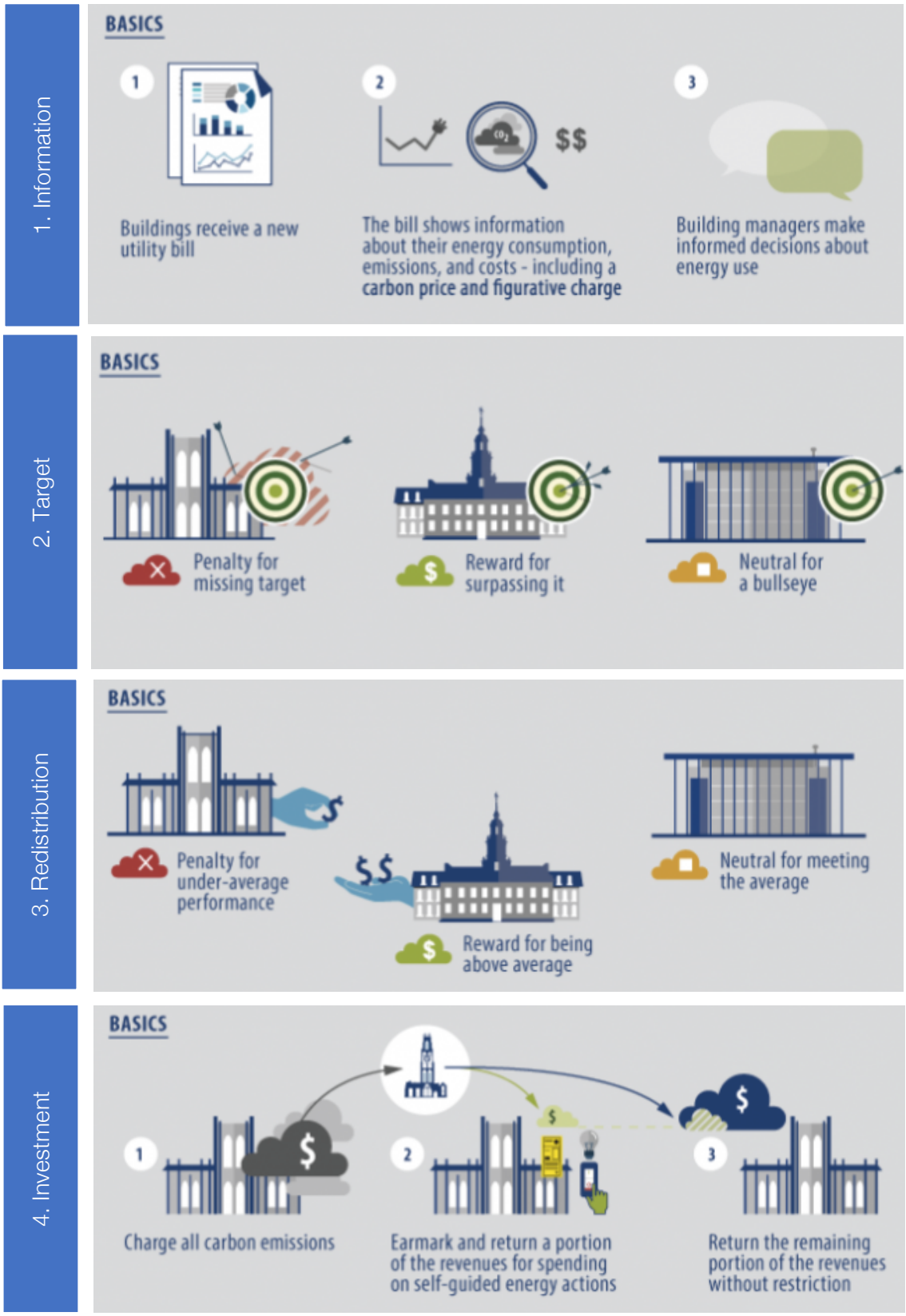
[78] The Presidential Carbon Charge Task Force, "Report to the President and Provost of Yale University"
[79] Yale University's Carbon Charge: Preliminary Results from Learning by Doing." *Yale Carbon Charge Project*
[80] Yale University's Carbon Charge: Preliminary Results from Learning by Doing," *Yale Carbon Charge Project*
[81] Ibid.

Figure 6: Overview of Yale's Carbon Charge Project



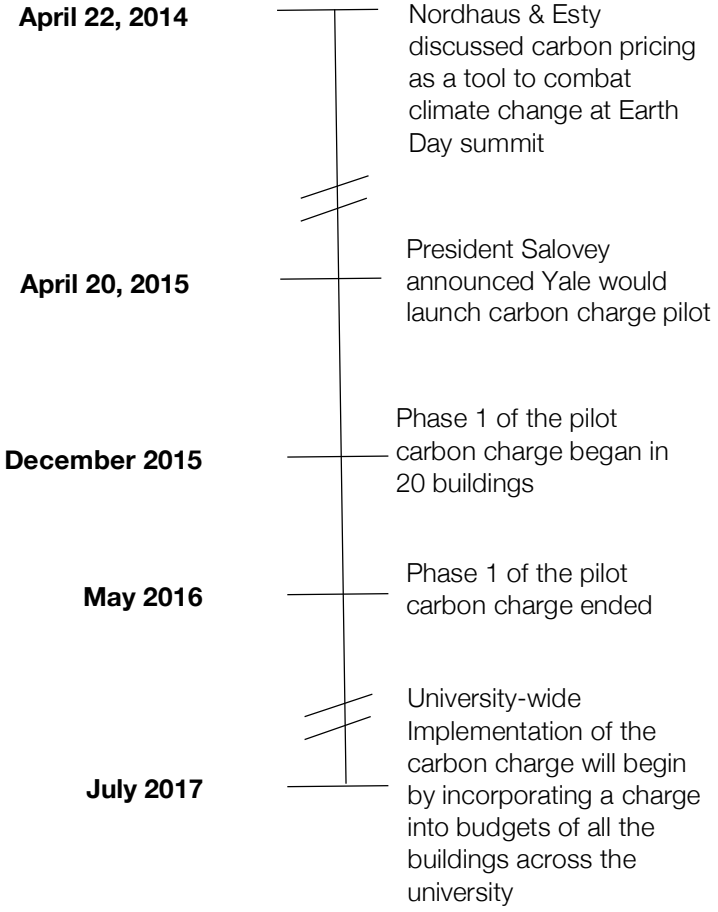
source: carbon.yale.edu
Note: Treatment group category labels and numbers in this figure do not match categories used in this paper and in the October 2016 report, "Yale University's Carbon Charge: Preliminary Results from Learning by Doing." In this diagram, "group 1" refers to scheme 3, "group 3" refers to scheme 4, and "group 4" refers to scheme 1. Thus, this diagram should not be used for reference throughout this paper, but just as a visual explanation of the project organization.

Table 5: Treatment groups from Carbon Charge Project pilot[82]



After the pilot demonstrated that Yale could feasibly implement a carbon charge, the task force recommended the university expand the charge at a larger scale, incorporating more buildings.[83] Rather than repeat the pilot process, though, Yale chose to pursue official university-wide implementation of the carbon charge. Starting July 1, 2017, Yale will formally incorporate the carbon charge into the budgets of all buildings across campus. This research, however, focuses on the pilot project that ran between December 2015 and May 2016.

Figure 7: Timeline of Yale's Carbon Charge Project



[82] "Yale Carbon Charge Project," *Yale University.* Accessed April 3, 2017. http://carbon.yale.edu/
[83] "Yale University's Carbon Charge: Preliminary Results from Learning by Doing," *Yale Carbon Charge Project*

Data Collection

(1) Semi-structured Interviews

I conducted semi-structured interviews with 13 individuals who had participated in the Carbon Charge Project pilot, including designees responsible for the charge in 11 of the 20 buildings involved in the pilot, plus two individuals who collaborated extensively with the designee in two of these buildings. Thus, I primarily interviewed individuals considered "primary decision makers" at Yale. For a detailed description of the interview format and for a full list of interview questions, refer to section (a) of the Appendix.

The purpose of this component of the research was to hear in-depth reflections about how the pilot fostered energy abatement efforts at the building level, and what could have been done better to encourage this engagement. After compiling these reflections, I coded each response to correspond to one of the factors from my list of factors tested.

The interviews were useful to understand what each individual found engaging or frustrating about the project in their own words, which allowed for more precise conclusions than the survey. Nonetheless, the interview results do face shortcomings that are important to address. First, interviewees were asked to remember details about a project that happened over six months before, meaning they could potentially suffer from recall bias. Further, when designing the pilot, the Carbon Charge Task Force identified individuals in each of the 20 buildings who would be inclined to take the lead on this project.[84] Thus, in many cases the conclusions reflect the opinions of people who were more likely to engage with energy reduction efforts than the average individual on Yale's campus. Having acknowledged these shortcomings, the survey was designed to make up for these weaknesses.

[84] "Yale University's Carbon Charge: Preliminary Results from Learning by Doing," *Yale Carbon Charge Project*

(2) Online Survey

To supplement the interview results, I conducted an online survey designed to gauge how students, staff and faculty consume energy in buildings at Yale. While the interviews provide depth, the survey provides breadth by reaching a larger sample size. The survey did not target people who were involved with the Carbon Charge Project specifically, but instead targeted a broad population of "secondary decision makers." The survey sought to identify what types of factors they identified as potentially most motivating to get them to pay attention to energy reduction in the building they spend the most time in at Yale, and conversely, what they identified as presenting the biggest barriers to changing their energy consumption behavior. For a detailed description of survey distribution and format, refer to appendix (b).

Though these results cannot draw conclusions related directly to the pilot project, they can provide data to cross-reference with the conclusions from the interviews to add statistical significance to these conclusions and make up for their limitations. Nonetheless, the survey has drawbacks of its own. Any survey runs the risk of response bias where respondents give answers that are not in line with how they would act in practice. To try to minimize the impact of that bias, I designed the survey with attention to phrasing and question order, and I shuffled the order of response options when possible. Finally, the survey asked about energy reduction efforts in general terms, not specific to the Carbon Charge Project due to a broad lack of familiarity with the project across campus. Thus, there are limitations to applying this data to the Carbon Charge Project, specifically.

IV. Results & Discussion

Interview Results & Discussion

Collaboration

Pierson College was a model of decentralized energy reduction during the Carbon Charge Project pilot, with Wiedeking coordinating energy abatement initiatives that spread from the high level of building policy down to the low level of individual student residents. Pierson's story was not an exception, though. A number of other designees I spoke to were similarly motivated to organize wide-reaching strategies to abate their buildings' emissions during the course of the pilot. Their stories highlight ways in which a carbon charge can promote broad behavior change at both the building level and the individual level in buildings in a university community (Table 13: Condensed Interview Highlights, appendix (a)).

Though pilot designees like Wiedeking comprised primary decision makers with the authority to make many high-level changes to their building's energy consumption, rarely did they effect change entirely on their own. At a minimum, the designee collaborated with another key primary decision maker with knowledge and authority to make many infrastructural changes to address energy consumption (often the facilities manager for the building). In other cases, the designee collaborated with a wider group of individuals in the building to identify opportunities for energy abatement. Sometimes the designee assembled groups similar to the PCCCSC in Pierson. Other times, these sustainability-oriented groups already existed in buildings, and the designee simply needed to connect with them to collaborate on energy abatement.[85]

[85] In the Laboratory of Epidemiology and Public Health (LEPH), Allie Squeglia worked with the School of Public Health Sustainability Committee; in 32 Edgewood, Jonathan Rohner engaged the School of Art's environmentally-conscious students; and in Kroon Hall, the Environmental Stewardship Committee took on the Charge.

Collaboration sometimes spread beyond the internal communities of the buildings themselves. In Betts House, Ted Wittenstein enlisted the help of an outside student group from the Office of Sustainability to identify recommendations for energy improvements in his building. Moreover, many of the designees from different buildings in the pilot convened periodically to reflect on their experiences and share best practices. Even in treatment group 3, which technically pitted buildings against one another, designees were more interested in working together than competing against one another. Although collaboration took on different forms in different buildings, none of the primary decision makers interviewed had particular success under the carbon charge when they tried to work entirely on their own.

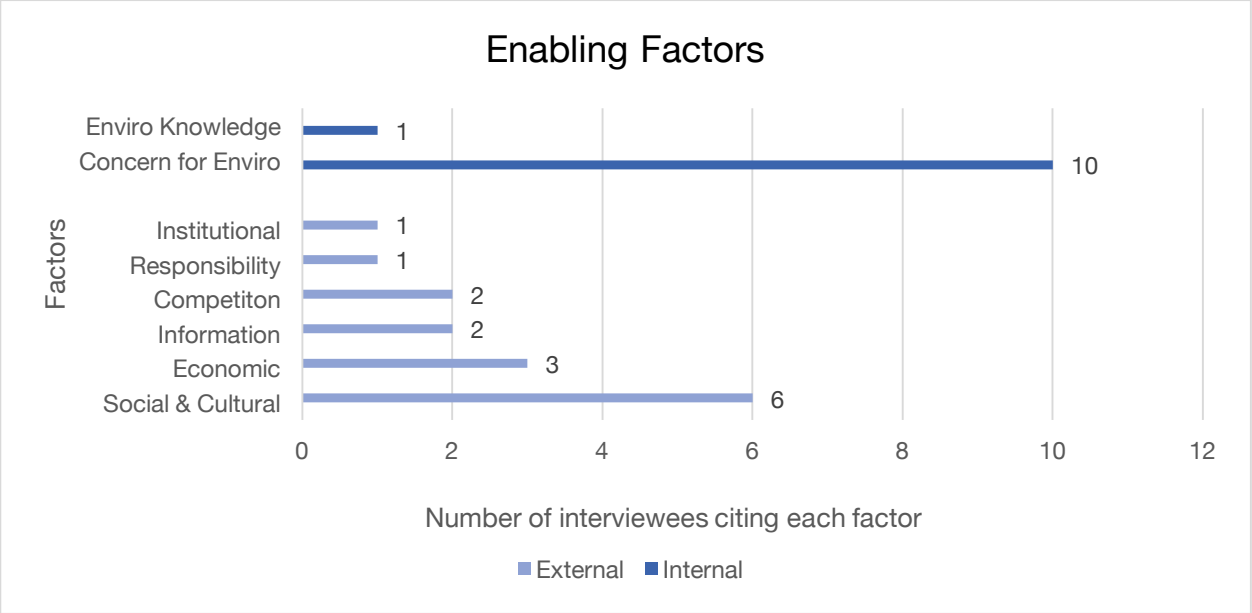
Efforts Undertaken

Starting from the top, the first place most primary decision makers looked for opportunities to reduce their building's energy consumption was at the level of building policy. One of the most common strategies pursued was replacing inefficient incandescent lightbulbs with LED bulbs. Beyond this popular strategy, designees also addressed energy usage centrally by changing the set points for thermostats, reducing water temperature centrally, turning off unnecessary air handlers, and ensuring unoccupied areas weren't lit or heated.

These tactics changed the energy consumption behavior of the building as a whole, but other strategies involved changing consumption behavior down at the level of the individual. Similar to Tanya's building-wide energy saving checklist, other designees crafted ways to influence individual behavior in their buildings. These strategies included encouraging people to turn space heaters off; asking people to get rid of energy-sucking appliances like mini fridges, coffee pots, and personal printers; and putting up posters throughout their building encouraging sustainable behaviors.

Enabling Factors

Figure 8: Factors listed as enablers by each interviewee



When asked why they were motivated to implement such decentralized strategies for energy abatement, the one reason cited by the greatest number designees was their personal **concern for the environment,** an internal enabling factor that is a starting point for environmental action in many models of pro-environmental behavior.[86,87,88] Though environmental concern is a key starting point for many of these pathways to action, it on its own is insufficient to drive action.[89] In fact, designees I spoke to who were largely disengaged during the pilot also talked about how they cared for the environment and thought the carbon charge was a worthwhile cause, but these sentiments did not bring about significant change.

[86] Kollmuss, Anja and Agyeman, Julian, "Mind the Gap"
[87] Blake, J., "Overcoming the 'value-action gap' in environmental policy"
[88] Fietkau, H.-J. and Kessel, H. "Umweltlernen: Veraenderungsmoeglichkeite n des Umweltbewusstseins," *Modell-Erfahrungen*, (1981)
[89] Kollmuss, Anja and Agyeman, Julian, "Mind the Gap"

The next most-cited factor was some sort of **social** component of the project. Whether it was through engaging other individuals in their building or other designees in the pilot, many people discussed how opportunities for collaboration were particularly motivating to them. Bill Cronan, for instance, said he was motivated to cut his building's energy costs when he met with other designees and felt that they were his "comrades."[90] In fact, the only time a social component was described in a negative light was when designees felt like there were not *enough* opportunities for collaboration. Though the buildings in each treatment group would meet once every month or so to discuss their experiences, Cyndi Erickson said she had wanted more occasions for experience sharing, specifically with buildings with similar energy needs to hers.[91] Cronan and Wiedeking voiced similar frustrations with the lack of social networks around the charge, expressing interest in knowing who at the university had relevant energy expertise or could be used as resources to them.[92]

The next factor mentioned most in interviews was the **economic incentive** of the carbon charge. Wiedeking, whose building ultimately received a $3,300 rebate under the charge, said that having this financial incentive was "helpful" for communicating the project throughout her building "because it's so tangible."[93] It is important to note, however, that the financial incentive alone was not what motivated her. In fact, she talked about how the social aspect of bringing individuals together for a central focus was more impactful for her. This was not unique to Wiedeking. Only a minority of the designees interviewed mentioned the economic incentive as motivating to them (3 of 13 interviewed), and only one said it was the most motivating part of the project, despite this being the central tenant of the Carbon Charge Project.

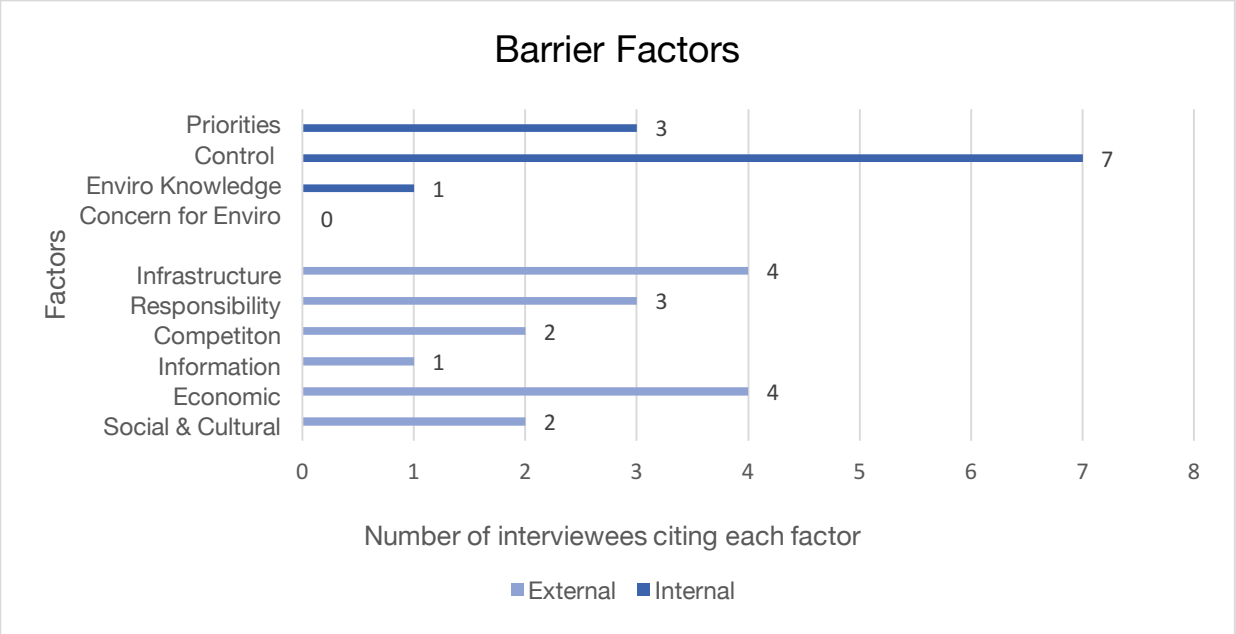
[90] Cronan, Bill, Personal interview. December 12, 2016
[91] Erickson, Cyndi, Personal Interview, January 23, 2016
[92] Wiedeking, Tanya, Personal Interview, December 13, 2016 and Cronan, Bill, Personal Interview, December 12, 2016
[93] Wiedeking, Tanya, Personal Interview, December 13, 2016

Though the budgetary impact of the carbon charge was motivating to certain designees, others discussed how a corollary benefit of the charge was that it allowed them to see detailed **information** about their building's energy costs that they had never seen previously. Squeglia, for instance, said that simply seeing her building's spend information was "absolutely" motivating for her and other people in her building. "To see that you're spending $1.6 million on energy consumption, […] you think 'Oh my god, there has to be ways to improve that.'"[94]

In fact, two of the buildings whose designees I interviewed were in the treatment group that *only* received this informational report without any financial consequences for their energy consumption (scheme 1, "information"). Nonetheless, both were just as engaged with the project as the designees facing actual charges in their budgets. Thus, simply communicating energy costs to individuals who had never seen their building's energy bills might be just as motivating as assigning a carbon price explicitly.

Analysis of barrier factors:

Figure 9: Factors listed as "barriers" by each interviewee



[94] Squeglia, Allie, Personal Interview, December 4, 2016

Though the majority of individuals interviewed felt motivated to engage with the project in one way or another, certain factors undeniably still frustrated individuals, in some cases preventing them from engaging with the project altogether. The factor cited as a barrier by the greatest number of interviewees was **control**, or in this case, a lack thereof. Squeglia described the frustration of not having control. "You're trying, you're communicating, you're getting people on board, and you're not seeing any results."[95]

In most cases, interviewees attributed this lack of control to the fact that Yale's facilities department manages many decisions regarding energy systems in the buildings, but they do not operate in the buildings they manage. Thus, there is a disconnect between those that make many energy infrastructure decisions and those that face the carbon charge in their buildings. To overcome this issue, a number of designees said they had wanted more involvement from facilities. Cronan opined that involvement from facilities would be crucial because they understand the technology available and have the expertise to think holistically, making long-term decisions about how best to improve energy consumption in buildings.[96] Wells went as far as to say that without involvement from facilities, "the carbon charge is just a metric; it doesn't address the problems."[97]

Involving facilities with energy reduction efforts under the carbon charge would not be so straightforward, though. Though they may have the funds and the expertise, they lack the manpower and the capital sufficient to advise on and invest in efficiency projects in every building on campus.[98] Though there are issues with trying to rely too heavily on facilities, what

[95] Squeglia, Allie, Personal Interview, December 4, 2016
[96] Cronan, Bill, Personal Interview, December 12, 2016
[97] Wells, Sue, Personal Interview, December 13, 2016
[98] Wittenstein, Ted, Personal Interview, January 27, 2017

can be gleaned from this finding is that the unequal distribution of control, with so much power in the hands of central facilities, is hindering.

One way that power lies in the hands of central facilities is in their control over finances for energy investment. Thus, though the financial incentive of the charge meant the category of "economic factors" was motivating for many people, this factor also presented certain frustrations for other designees. A number of interviewees felt hindered by a lack of access to finances for their ideas that would have helped them reduce their building's energy impact. Discepolo described how he and his colleagues would brainstorm ways to improve the building's carbon footprint, such as changing lightbulbs to LEDs, but there wouldn't be the necessary capital behind it. "The frustration really just lies in you getting so excited about [making] all these changes, but you eventually are trying to do all this with no real funding."[99] To remedy this lack of funds, Allie Squeglia said that she had wished her building had been allocated a certain amount of money to reinvest in energy efficiency projects, which was actually the case for buildings in a different treatment group (scheme four, "investment").

The desire for funds to invest in larger-scale capital projects is understandable, as numerous interviewees discussed how the physical attributes of their buildings prohibited significant energy reductions (**institutional factors**). Often, these frustrations were due to the fact that many buildings on Yale's campus are quite old and thus do not operate very efficiently from an energy use standpoint. For instance, 30 Hillhouse is a late-1800s building with old windows that leak a lot of heat, and the Peabody Museum is a building that is nearly 100-years old, with antiquated heating systems.[100] On the flipside, opportunities for energy efficiency improvement tend to be more obvious in older buildings, whereas for efficient buildings like the

[99] Discepolo, Kevin, Personal Interview, January 23, 2017
[100] White, Tim and Boardman, Rich, Personal Interview, January 27, 2017

LEED platinum[101] Kroon Hall, opportunities for improving energy consumption in the building are less obvious. In yet other buildings, energy efficiency was hindered by the particular energy needs of the building. The Peabody museum, for one, has a specific set of needs for heating and lighting because of the importance of artefact preservation, while LEPH, a lab building, has a high demand for energy because the machines necessary for research cannot be turned off or down in any way.[102,103]

Clearly, buildings at Yale are diverse in terms of age, energy needs, and energy efficiency. Thus, the factor of "infrastructure" is a rather cumbersome hurdle that cannot be easily addressed by a singular standardized carbon charge. One way to go about this would be to foster more opportunities for experience sharing among similar buildings, as Cyndi Erickson suggested, and to provide more building-specific information about approaches to reducing energy.

The next factor mentioned as a barrier during many of the interviews was **responsibility.** Similar to the issue of control, a number of individuals did not appreciate bearing responsibility for the actions of other people. Gygi Jennings, for instance, criticized how the carbon charge imposes an "onus of responsibility for people's behavior."[104] The way the carbon charge is currently designed, with one designee with all the responsibility, might then be excessively burdensome, and responsibility should be decentralized among secondary decision makers in some way.

Finally, a factor that might be engaging in a traditional market that was seen as a barrier at Yale was **competition.** Wells said it didn't "make sense" to make it a competition, because the

[101] LEED refers to Leadership in Energy and Environmental Design
[102] Squeglia, Allie, Personal Interview, December 4, 2016
[103] White, Tim and Boardman, Rich. Personal Interview, January 27, 2017
[104] Jennings, Gygi. Personal Interview. January 31, 2017

carbon charge should instead allow for sharing of best practices. Similarly, Rohner described the competitive element as in conflict with the culture of support at Yale. "We want to make sure we are doing collectively the best for Yale," he said. "And that's why we work here – it's such a great culture."[105] Thus, it seems that overall, emphasizing this as a competition for a body like a university that is its own community does not make sense, and might be more prohibitive than enabling.

Because the majority of people interviewed were quite actively-engaged with energy abatement efforts in their building, the previous conclusions reflect a combination of factors that motivated and frustrated individuals who managed to implement energy abatement in their buildings. It is useful to contrast these conclusions with insights from the buildings that were less engaged with the project to determine what prevented them from taking significant action. Michael Hoepp of the Yale Physician's Building, who regretted not being as engaged with the project as he would have liked, attributed his disengagement to an issue of **priorities**, as his schedule prevented him from attending the group meetings on the carbon charge, and a lack of **knowledge** of energy issues. Timing is more of an issue of chance, and no project can really be designed to avoid scheduling conflicts entirely. However, Hoepp's mention of his lack of knowledge confirms the positive role that more information can have, in contrast with Eden's criticisms of the information deficit model.[106]

[105] Rohner, Jonathan, Personal Interview, December 14, 2016
[106] Eden, S. "Public participation in environmental policy"

Survey Results & Discussion

Current energy consumption behaviors at Yale

Table 6: Reason for paying attention to energy consumption in primary building occupied at Yale (aggregate responses)

Question: "Why do you pay attention to your energy consumption in this building at Yale? (Rate the influence of each reason from 1 to 5, with 1 being "not true for me" and 5 being "very true for me")"

	1	2	3	4	5
I want to save energy for financial reasons	**38.03%**	19.67%	18.03%	13.77%	10.49%
I care about the environmental impact of my building	2.62%	6.56%	16.39%	33.77%	**40.66%**
I care about my own environmental impact	0.33%	0.66%	11.48%	32.79%	**54.75%**

Energy awareness is already the norm at Yale, with 82% of survey respondents saying they attempt to reduce their energy consumption in the buildings they occupy on campus. For these 82% of respondents who indicated that they already pay attention to their energy consumption in this building at Yale, care for their own environmental impact and for the environmental impact of their building were the most motivating, with each being rated as a "5" by 54.75% and 40.66% of respondents, respectively (Table 6). This suggests that the internal factor of **concern for the environment** is what currently motivates people to pay attention to their energy consumption. The presence of an internal concern for the environment indicates a receptiveness to these types of efforts, which could be tapped into further if it was bolstered by leveraging other external motivating factors. Saving energy for **financial reasons**, however, was much less influential, with 38.03% of respondents saying it was "not true" for them (Table 6).

This statistic highlights the fact that secondary decision makers in buildings who don't see energy costs tend not to be concerned with the financial impact of their consumption.

Table 7: Reason for paying attention to energy consumption in primary building occupied at Yale (responses broken down by population type)

Question: "Why do you pay attention to your energy consumption in this building at Yale? (Rate the influence of each reason from 1 to 5, with 1 being "not true for me" and 5 being "very true for me")"

Student

	1	2	3	4	5
I want to save energy for financial reasons	**46.05%**	22.81%	11.84%	12.72%	6.58%
I care about the environmental impact of my building	2.63%	7.89%	19.30%	35.09%	35.09%
I care about my own environmental impact	0.00%	0.88%	13.16%	32.02%	53.95%

Faculty & Staff

	1	2	3	4	5
I want to save energy for financial reasons	**13.51%**	10.81%	37.84%	17.57%	20.27%
I care about the environmental impact of my building	1.35%	2.70%	8.11%	31.08%	56.76%
I care about my own environmental impact	1.35%	0.00%	5.41%	35.14%	58.11%

When broken down by population type, the trends generally followed this, though a desire to save energy for **financial reasons** was slightly more influential for staff and faculty (only 13.51% of faculty & staff together rated this as a "1" in terms of level of influence) than it

was for students (46.05% rated this as a "1" in terms of level of influence) (Table 7). This likely indicates that there is more of a feeling of responsibility for building finances among staff and faculty than among students.

Figure 10: Attempt to reduce energy consumption in buildings on campus

Question: "Do you ever attempt to reduce your energy consumption in this building at Yale?"

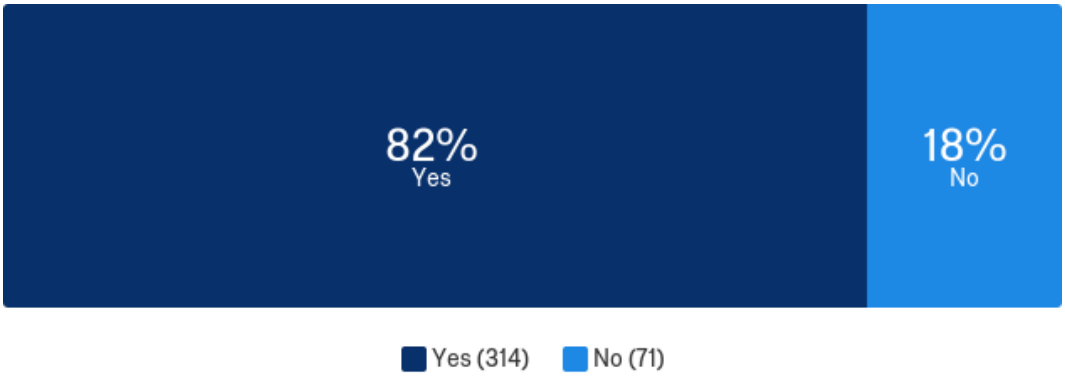
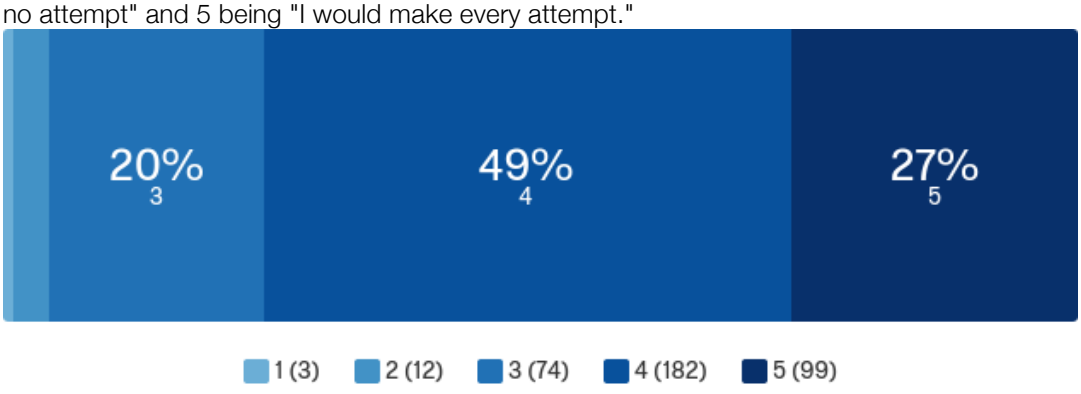


Figure 11: Willingness to participate in energy reduction efforts

Question: "If your building were trying to reduce its energy consumption, would you try to reduce your energy use? Rate the likelihood that you would try cutting your energy use from 1 to 5, with 1 being "I would make no attempt" and 5 being "I would make every attempt."



From the rather high baseline of 82% of individuals at Yale already attempting to reduce their energy consumption (Figure 10), many respondents indicated a willingness to embrace more energy conservation than they already do. On a scale from 1 to 5, with 5 being a

willingness to "make every effort" to reduce their energy as a part of such an effort, 96% of respondents said they would be at least a 3, with 76% of respondents identifying as either a 4 or 5 (Figure 11). Thus, energy abatement fits in with the **priorities** and internal **values** of individuals at Yale.

Table 8: Reason for <u>not</u> paying attention to energy consumption in primary building occupied at Yale

Question: "Why don't you pay attention to your energy consumption in this building at Yale? (Rate the influence of each reason from 1 to 5, with 1 being "not true for me" and 5 being "very true for me")

	1	2	3	4	5
I don't have time to worry about it	27.50%	25.00%	26.25%	13.75%	7.50%
I'm not responsible for energy use in my building	25.00%	17.50%	15.00%	18.75%	23.75%
It is too difficult to reduce my energy use	37.50%	26.25%	20.00%	11.25%	5.00%
I don't know how to reduce my energy use	26.25%	21.25%	16.25%	17.50%	18.75%
It might negatively impact my level of comfort	41.25%	21.25%	15.00%	16.25%	6.25%
It's not something I particularly care about	31.25%	30.00%	18.75%	13.75%	6.25%
My actions won't make a difference	33.75%	25.00%	8.75%	18.75%	13.75%
I don't receive feedback about my energy consumption	11.25%	1.25%	13.75%	27.50%	**46.25%**

On the other hand, for individuals who say they currently *don't* pay attention to their energy consumption at Yale, the most influential reason cited (receiving a "5" on a scale from 1

to 5) was the fact that they don't receive **feedback** on their energy consumption (46.25% of respondents) (Table 8). In fact, Kollmuss & Agyeman's model cites "negative or insufficient feedback about behavior" as one of the barriers preventing pro-environmental behavior (Figure 5).[107] In Fietkau & Kessel's model that influenced Kollmuss & Agyeman, the two discuss that people need to receive feedback reinforcing their pro-environmental behavior in order to continue it.[108] Thus, this is a barrier that should be addressed in the design of a Carbon Charge at Yale.

How to motivate more energy abatement at Yale

Given that there is a willingness to engage with energy reduction efforts on campus at Yale, the question is how? Specifically, which factors could be leveraged to get more people to engage with a carbon charge? The survey sought to find that out by asking "What would motivate you to reduce your energy consumption in this building at Yale? (Rate each factor)."

[107] Kollmuss, Anja and Agyeman, Julian, "Mind the Gap"
[108] Fietkau, H.-J. and Kessel, H. "Umweltlernen: Veraenderungsmoeglichkeite n des Umweltbewusstseins

Table 9: Factors that would motivate energy reduction in primary building occupied at Yale (Aggregate responses, ordered by which response was rated as having "considerable impact" by most respondents)

Question: "What would motivate you to reduce your energy consumption in this building at Yale? (Rate each factor)"

	No impact	Slight impact	Moderate impact	Considerable impact
If I personally received a financial incentive for reducing energy	9.68%	14.78%	20.43%	**55.11%**
If it were easier to adjust my energy consumption	4.84%	12.10%	33.87%	**49.19%**
If I had more control over energy consumption	4.85%	10.78%	37.20%	**47.17%**
If I had more information about how to reduce my energy use	6.43%	16.35%	33.24%	**43.97%**
If I had more information about my energy consumption	5.11%	15.86%	35.22%	**43.82%**
If my personal energy use were publicly displayed	13.94%	17.69%	24.66%	43.70%
If my building as a whole received a financial incentive for reducing energy	11.56%	20.97%	28.76%	38.71%
If I received frequent updates about my energy consumption	8.85%	23.86%	29.22%	38.07%
If my peers were also trying to reduce their energy	7.26%	22.04%	34.14%	36.56%
If my building's energy use were publicly displayed	9.92%	21.72%	35.12%	33.24%
If I felt like my efforts would be supported by others in my building	9.92%	21.98%	34.85%	33.24%
If I was competing with someone to reduce more energy	19.89%	25.54%	29.03%	25.54%
If I received some non-financial reward	13.48%	26.68%	35.04%	24.80%
If there was pressure from someone with authority in the building to do so	12.06%	29.49%	39.14%	19.30%
If I had more time to worry about it	20.43%	31.99%	29.03%	18.55%
If it had come up when I first started spending time in the building	24.80%	30.46%	28.84%	15.90%

The variable that most people said would be most impactful was receiving a personal **financial incentive** for reducing energy (55.11% of respondents) (Table 9). In theory, this would confirm the influence of the price signal of the carbon charge. In practice, however, its role is different. The way the carbon charge is currently designed, the financial incentive is not

distributed equally throughout the building, and certainly not at the level of secondary decision makers. Unless the financial incentive were restructured to be more decentralized (which is currently not the plan), the financial incentive cannot have this influence. Because of how many respondents cited a financial incentive as potentially motivating, perhaps Yale should pursue ways to decentralize the charge by giving building occupants more access to the revenue generated, or giving them partial financial responsibility for the costs incurred. For instance, a number of students wrote in the "suggestions" section of the survey that energy use could be decentralized by making it a variable cost for students, rather than a lump-sum part of their tuition.

The option of next greatest impact for the most people was ease of adjustment of infrastructure (**institutional**), as 49.19% of individuals indicated a desire for it to be "easier" to adjust their energy consumption. Similarly, the next most cited answer was a desire for more **control** over energy consumption, from 47.17% of respondents. It makes sense that secondary decision makers would feel discouraged by how difficult it is to adjust their consumption as many buildings at Yale are spaces shared by dozens, sometimes hundreds, of occupants whose individual energy impact is not naturally adjustable. This is one of the inherent shortcomings of energy efficiency efforts in shared spaces. One potential way to address this shortcoming is by installing more easily-adjustable energy controls in shared spaces.

The next two factors most cited as having considerable impact are "if I had more **information** about how to reduce my energy use" with 43.97% and "if I had more **information** about my energy consumption" with 43.82%. This statistic indicates a broad desire for more feedback on energy consumption throughout the Yale population – not only on their energy usage performance, but also on how to improve said performance. A number of respondents

wrote in the suggestions section that they would feel more motivated to reduce their energy if they had more information about what their current consumption was. For instance, one student suggested that Yale "make energy-use metrics available; I have no access to any energy consumption information, so there's no way to gauge how much of an impact any energy-reduction efforts would have." Other students wrote that this information could be broken out at the level of individual suites in residential buildings, for instance, so there would be more of a sense of responsibility over consumption behavior. Similarly, other respondents thought posting real-time consumption information in public spaces would give people more of a sense of responsibility for their impacts in those spaces.

The factors that were cited as less influential by respondents also offer interesting insights. For instance, the fact that a "competitive" aspect ranked toward the bottom of the list of factors, only rated as "considerably impactful" by 25.54% of respondents, is interesting given the emphasis there has been thus far on energy reduction competition campaigns in university and private sector contexts, and the fact that scheme 3 ("redistribution) of the Carbon Charge tested the impact of a competitive element. This suggests that despite the historical reliance on competition to motivate energy reduction, this may not be the best way to induce individual behavior change.

Table 10: Factors (other than energy costs) that would motivate energy reduction in primary building occupied at Yale (Broken down by population type, ordered by which response was rated as having "considerable impact" by most respondents)

Question: "What (other than energy costs) would motivate you to reduce your energy consumption in this building at Yale? (Rate each factor)"

Students

	No impact	Slight impact	Moderate impact	Considerable impact
If I personally received a financial incentive for reducing energy	6.83%	13.99%	18.77%	**60.41%**
If it were easier to adjust my energy consumption	3.41%	13.31%	34.13%	49.15%
If my personal energy use were publicly displayed	10.58%	16.38%	24.23%	48.81%
If I had more control over energy consumption	4.79%	11.30%	36.99%	46.92%
If I had more information about my energy consumption	3.75%	17.06%	36.52%	42.66%
If I had more information about how to reduce my energy use	5.46%	17.75%	34.81%	41.98%
If my building as a whole received a financial incentive for reducing energy	10.24%	20.14%	29.35%	40.27%
If I received frequent updates about my energy consumption	8.19%	23.89%	29.35%	38.57%
If my peers were also trying to reduce their energy	6.48%	21.50%	35.15%	36.86%
If my building's energy use were publicly displayed	8.53%	20.48%	36.52%	34.47%
If I felt like my efforts would be supported by others in my building	9.90%	22.87%	37.20%	30.03%
If I was competing with someone to reduce more energy	15.70%	25.26%	31.06%	27.99%
If I received some non-financial reward	10.58%	25.60%	36.86%	26.96%
If I had more time to worry about it	17.75%	32.76%	29.35%	20.14%
If there was pressure from someone with authority in the building to do so	9.90%	31.40%	39.93%	18.77%
If it had come up when I first started spending time in the building	20.14%	32.42%	30.38%	17.06%

Faculty & Staff

	No impact	Slight impact	Moderate impact	Considerable impact
If I had more information about how to reduce my energy use	10.39%	10.39%	27.27%	51.95%
If it were easier to adjust my energy consumption	9.21%	7.89%	32.89%	50.00%
If I had more control over energy consumption	5.26%	9.21%	36.84%	48.68%

If I had more information about my energy consumption	9.21%	11.84%	31.58%	47.37%
If I felt like my efforts would be supported by others in my building	9.09%	18.18%	25.97%	46.75%
If my peers were also trying to reduce their energy	9.21%	22.37%	31.58%	36.84%
If I received frequent updates about my energy consumption	10.39%	23.38%	29.87%	36.36%
If I personally received a financial incentive for reducing energy	19.74%	18.42%	26.32%	**35.53%**
If my building as a whole received a financial incentive for reducing energy	15.79%	22.37%	27.63%	34.21%
If my building's energy use were publicly displayed	14.29%	24.68%	31.17%	29.87%
If my personal energy use were publicly displayed	25.97%	23.38%	25.97%	24.68%
If there was pressure from someone with authority in the building to do so	18.18%	22.08%	37.66%	22.08%
If I received some non-financial reward	24.00%	30.67%	28.00%	17.33%
If I was competing with someone to reduce more energy	34.21%	27.63%	21.05%	17.11%
If I had more time to worry about it	30.26%	28.95%	27.63%	13.16%
If it had come up when I first started spending time in the building	42.67%	21.33%	24.00%	12.00%

When breaking up the data by population (students in one group, and faculty & staff in another) many of the most influential factors mentioned above were ranked with equal importance by both populations. Thus, despite distinctions in responsibilities and relationships to buildings among these populations, conclusions about the influence of the factors cited above can apply to the entire Yale population represented. However, the most interesting distinction in responses when broken up this way is attitude toward the financial incentive. Receiving a personal financial incentive for energy reduction was the factor cited as having "considerable impact" by the greatest quantity of students, at 60.41% (Table 10). On the contrary, only 35.53% of staff and faculty said a personal financial incentive would have "considerable impact" (Table 10). Perhaps, then, redesigning the carbon charge to be decentralized would be more important in student buildings like residence halls, but less so in staff and faculty-centric buildings.

V. Conclusions & Recommendations

As carbon pricing becomes an increasingly relevant policy to address the threats of climate change, Yale's trailblazing move to expand its carbon price university-wide deserves praise. Nevertheless, the project could have an even broader impact if Yale restructured the carbon charge in a number of ways. Though the economic incentive of a carbon price is undeniably motivating, this study found that other factors also motivate energy abatement among individuals throughout the university. This aligns with the research of Stern et al. suggesting that what is more important for reducing emissions than the financial incentive itself is ensuring that the incentives are deployed "in ways that address the nonfinancial barriers to action, which may have equal or greater effect than money."[109] Thus, as Yale rolls out its carbon charge across the university, it should properly address the factors identified as barriers in this study, and leverage the factors identified as enablers in order to promote broad engagement with energy reduction efforts, as the charge initially set out to do. These key factors are consolidated below (Table 11), and discussed in detail to identify specific recommendations for Yale's Carbon Charge Project and other carbon pricing efforts in similar contexts.

[109] Stern et al. "Design Principles for Carbon Emissions Reduction Programs," *Environmental Science & Technology Viewpoint* 44 (2010): 4847-4848

Table 11: Conclusions & Recommendations

Key Conclusions & Recommendations
Factors beyond the financial incentive of a price signal motivate individuals to participate in energy reduction efforts under the Carbon Charge Project at Yale
Internal Factors • **Concern for the Environment:** A predisposed sympathy for environmental causes is an important precursor to energy abatement
External Factors • **Economic Incentive:** Because of its ambiguous role, the economic incentive should be deemphasized, decentralized and restructured to enable investments in energy efficiency efforts • **Information:** Counter to criticisms of the information-deficit model, improved information and feedback on energy consumption would motivate energy abatement efforts • **Responsibility:** The project places excessive responsibility on the project designee, and ownership of the charge should instead be spread among various stakeholders in each building • **Social:** Collaboration internally (within buildings) and externally (with other relevant stakeholders) was especially motivating. The project should create social networks to foster this collaboration. • **Competition:** Competition was perceived largely as antithetical to Yale's culture of collaboration, and should not be promoted in similarly communal contexts • **Institutional:** Infrastructural constraints were especially prohibitive, but there is less opportunity for intervention in this realm

More than any other single factor, both interviewees and survey respondents cited their **concern for the environment** as what motivated them to abate their energy in buildings at Yale. This mentality is an important precursor to environmental action, indicating that the success of similar efforts elsewhere might hinge on their populations having a predisposed sympathy for environmental causes. However, since environmental concern is an internal factor inherent to the individual, it cannot be easily addressed in the project design of a carbon price.

Nevertheless, this study did identify a number of external factors impacting how individuals consume energy at Yale that could be addressed by the Carbon Charge Project design. As the project stands, the carbon charge will rely heavily on the **economic** incentive of the carbon price by focusing on incorporating it into building budgets campus-wide. The role of this incentive in motivating behavior change, though, is ambiguous. The way the carbon charge is currently structured, it only has financial consequence for a small number of primary decision

makers in buildings. Ironically, these primary decision makers who faced the economic consequences of the charge tended to cite other factors as more motivating to them than the prospect of the financial consequences of the charge.

Undeniably, the cornerstone of a carbon charge is this economic tool. The nature of the price signal, though, could be redesigned. Interestingly, it was these secondary decision makers who are not responsible for energy costs in their buildings that cited financial incentives as the factor that would most motivate them to reduce their consumption. To tap into this desire, Yale should explore ways to decentralize the financial impacts of the carbon charge so they are felt by individuals throughout the buildings. Pricing structures to enable this should be explored in greater depth.

Another frustration with the charge was that its financial impact was not great enough to enable infrastructural investments that would have real impact on energy consumption in buildings. One way to overcome this hurdle would be to reconsider pursuing a carbon charge structured more like scheme 4 ("investment"), which would provide buildings with more capital to pursue projects of greater impact.

When pilot designees did discuss the financial side of the project, they tended to discuss how motivating it was to see their building's energy costs for the first time. Perhaps, then, in contrast with the criticisms of the information-deficit model, **information** is a factor that the project could be better leveraging. In fact, the survey results corroborated this desire, as many respondents answered that receiving more feedback about their consumption would motivate them most to pay more attention to their energy usage. To address this desire, Yale should make energy consumption information available to all inhabitants in a building. This feedback should be coupled with educational materials on strategies to improve said consumption, as survey

respondents also answered that they wished for more information about how to improve consumption in their building.

Another drawback of the project is the fact that it designates one individual with full **responsibility** for overseeing the charge in their building. On one hand, some designees lamented this responsibility as excessively burdensome to them. On the other hand, numerous designees discussed how motivating it was to *relieve* that burden by collaborating with other people on their building's energy reduction efforts. Collaboration took two forms during the pilot. First, designees collaborated internally with other individuals in their building to come up with energy abatement strategies. Because of the positive role of this internal collaboration, the project should require that each building have its own steering committee with ownership for the charge, rather than placing responsibility in the hands of one, single individual. Second, designees collaborated externally with other designees to share best practices, and with other central groups with relevant expertise (such as the facilities department and the Office of Sustainability's student group). Thus, the project should design a sort of social network that establishing connections between key groups and stakeholders through periodic meetings or one-off communications.

Because of the appreciation for these opportunities for collaboration, designees discussed **competition** as antithetical to the culture of support and collaboration they so appreciated about Yale. This conclusion was corroborated by the low number of survey respondents citing competition as motivating. This finding is particularly interesting as many university energy abatement efforts have thus far relied on creating a sort of competition. Thus, a carbon charge that pits groups against one another should not be pursued in these sorts of communities.

Finally, a key barrier identified as preventing energy abatement was the **institutional** factor of building infrastructure. In the interviews, designees discussed how energy needs and certain elements of their building infrastructure prevented certain abatement activities. Similarly, survey respondents cited a lack of control over their building infrastructure as prohibitive to them adopting energy efficiency efforts. Because of the nature of how energy is consumed in spaces shared by hundreds of people, and because of the vast diversity in infrastructure among buildings at Yale, the Carbon Charge Project is not well-poised to address this barrier. One potential solution would be to install infrastructure that enables easier energy adjustment, such as smart thermostats or controllable panels. However, the costs of such moves would likely outweigh the benefits. Thus, the project should focus on leveraging the other factors previously mentioned as enablers to overcome this barrier and lead to the broad energy abatement the charge sought to inspire.

These conclusions are based on Yale University, specifically, but have applicability to other university campuses and private company campuses with similar building makeups, financial systems and cultures. As momentum continues to increase around these smaller-scale carbon prices, and more universities and companies follow Yale's lead, similar institutions can incorporate these recommendations and test these conclusions in contexts distinct from Yale.

Carbon pricing efforts at universities are only just beginning. As momentum behind such efforts continues to increase, now is the time to influence their design and harness their potential to provoke truly decentralized energy abatement efforts.

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VIII. Appendix

(a) Interview format

Interview Methods

I conducted semi-structured interviews with 13 people who had been a part of the first phase of the carbon charge pilot in some capacity (Table 12). Interviews were semi-structured in that I asked interviewees approximately the same questions regarding the same topics, but could stray from the interview structure based on the flow of conversation. I conducted most interviews in person, with one over the phone and one over email, on the campus of Yale University in New Haven, CT between 12/4/2016 and 1/31/2017. All but the one interview conducted over email lasted between 30 and 60 minutes, and I recorded and transcribed all but the email and phone interview. Interview questions were reviewed by the Human Subjects Committee, HSC #1611018660.

Table 12: List of interviewees by building

Interviewee	Building	Building Scheme	Building Quintile*
Cyndi Erickson	Berkeley College	1	1
Kevin Discepolo	Gilder Boathouse	1	3
Allie Squeglia	LEPH	2	1
Tanya Wiedeking	Pierson College	2	2
Jonathon Rohner	32 Edgewood	2	3
Sue Maher	30 Hillhouse	2	4
Michael Hoepp	Yale Physician's Building	3	1
Tim White and Richard Boardman**	Peabody	3	2
Bill Cronan & Ted Wittenstein**	Betts House	3	3
Sue Wells	Kroon Hall	3	4
Gygi Jennings	Weir Hall	3	5

*As mentioned in IV. The Carbon Charge at Yale, Building Quintiles were broken down by amount of energy consumed in each building, with quintile 1 containing the biggest consumers of energy in each scheme, and quintile 5 containing the smallest consumers of energy.

** All interviewees were the designees for the pilot in each building, except for these two individuals, who were simply highly actively collaborating with the designee during the pilot

I solicited their participation via email using the following introductory message:

"I am conducting interviews to try to learn about people's experiences with the Carbon Charge Project. The research will be used in my senior thesis for the Environmental Studies major at Yale, and will help inform university carbon charge efforts going forward. If you agree to be interviewed, you will be entered into a raffle for a $50 Amazon gift card. The interview should take between 15 and 30 minutes, but you are welcome to cut it off at any point if necessary. Are

you comfortable being quoted by name? Finally, I'd like to remind you that being in the study is voluntary, and you can decide you no longer want to participate in the study at any time."

I wanted to provide a financial incentive for participation in the interview (entry into a raffle for a $50 Amazon gift card) to improve the participation rate and to improve the quality of the interviewee responses.

Interview Questions

Though interviews were semi-structured, the questions I used as a baseline were as follows:

1. Tell me about your position at Yale.
2. Tell me about your building at Yale:
3. How much control do you have over energy use in your building?
4. How much control do you have over your fellow building users' energy use?
5. How much access to finances / budget do you have for energy projects?
6. How did you first learn about the carbon charge project?
7. What was your first impression of the carbon charge at Yale?
8. How did you engage with the carbon charge throughout the pilot?
9. Why was that your role? Who were you reporting to/who reported to you?
10. What motivated you to be involved? Or, what deterred you from being involved?
11. Did you create plans to execute action?
12. Did you actually execute anything?
13. Have the efforts continued this year?
14. What is your impression of the carbon charge now?
15. Would you participate again if you had the choice? Why or why not?
16. If you had to participate in the carbon charge project again, would you do anything differently?
17. What advice would you give to someone else just starting out with the Carbon Charge project?

Interview Results

Table 13: Condensed Interview Highlights

Interviewee(s)	Actions	Enablers	Barriers
Cyndi Erickson[110] • **Berkeley College** • **Group 1** • **Quintile 1**	• Emailed students about leaving buildings in efficient state before break	• **Concern for the environment**: All about environmental impact & desire to make change • **Information**: Informational reports	• **Economic incentive**: A lack of funds for certain projects • **Control:** Feeling of not having an impact at work • **Social & Cultural Norms**: Desire for more opportunities for experience sharing with similar buildings
Kevin Discepolo[111] • **Gilder Boathouse** • **Group 1** • **Quintile 3**	• Worked with facilities • Changed set points on thermostats • Replaced bulbs with LEDs • Ensuring unoccupied areas weren't lit or heated • Communicated best practices with coaches	• **Concern for the environment** • **Social & Cultural Norms**: Desire to help university efforts • **Competition**	• **Economic incentive**: Limitations of what they could do financially – not their money directly, so incentives didn't really work
Allie Squeglia[112] • **LEPH** • **Group 2** • **Quintile 1**	• Changed timing of air handlers • Engaged School of Public Health Sustainability Committee to collaborate • PR Campaign – signage, email and newsletter reminds	• **Concern for the environment** • **Information**: Seeing the energy costs for the first time was motivating	• **Infrastructure, Control**: Lack of control over infrastructure (architectural clause, lab building with intense energy needs) • **Economic incentive:** Lack of funds for infrastructural spend • **Priorities:** People's habits, reluctance to be "uncomfortable"
Tanya Wiedeking[113] • **Pierson College** • **Group 2** • **Quintile 2**	• Assembled PCCCSC • Disseminated checklist for rooms before recesses • Replaced incandescent bulbs with LEDs in some common areas • Reduced water temperature centrally	• **Social & Cultural Norms**: Opportunity to interact with other departments • **Economic incentive** • **Competition** • **Concern for the environment**	• **Economic incentive:** Lack of funds for certain projects (e.g. occupancy sensors) • **Control, Responsibility:** Lack of control over behavior of others
Jonathan Rohner[114] • **32 Edgewood** • **Group 2** • **Quintile 3**	• Engaged their environmentally-conscious students • Reprogrammed light schedule	• **Concern for the environment** • **Economic Incentive:** Connecting it to money motivated people	• **Social & Cultural norms**: Facilities and dean were disengaged • **Competition**: Having buildings compete didn't make sense

[110] Erickson, Cyndi, Personal Interview. January 23, 2017
[111] Discepolo, Kevin, Personal Interview, January 23, 2017
[112] Squeglia, Allie, Personal Interview, December 4, 2016
[113] Wiedeking, Tanya, Personal Interview, December 13, 2016.
[114] Rohner, Jonathan, Personal Interview, December 14, 2016

Sue Maher[115] • **30 Hillhouse** • **Group 2** • **Quintile 4**	• Sent out an email to remind people to turn lights out	• **Concern for the environment**: Thinks it's a worthwhile focus for the university	• **Control:** Nothing she could change • **Infrastructure:** Needed capital investments in larger areas (windows)
Michael Hoepp[116] • **Yale Physicians Building** • **Group 3** • **Quintile 1**	• N/A	• **Concern for environment:** Supported the project because thinks energy conservation is a serious issue	• **Priorities:** Schedule did not allow him to attend meeting • **Environmental knowledge:** "Not an expert in energy conservation"
Tim White & Rich Boardman[117] • **Peabody Museum** • **Group 3** • **Quintile 2**	• Turned off small air handler • Looked for areas to upgrade to LEDs • Asked people to get rid of mini fridges, personal coffee pots and personal printers	• **Concern for the environment** • **Social & Cultural Norms:** Presence of Green Team**;** engaging with the people organizing the project	• I**nfrastructure**: Old building; preservation of artefacts takes precedence • **Control, Responsibility:** Being penalized for something out of your control
Bill Cronan[118] **& Ted Wittenstein**[119] • **Betts House** • **Group 3** • **Quintile 5**	• Told operations manager to brainstorm proposals • Changed LEDs, added some motion sensors • Engaged student group to give recommendations • Changed temperature settings • Went around and asked people to turn space heaters off • Ensured unoccupied areas were not being heated or lit unnecessarily	• **Economic Incentive:** Most motivating; had money at disposal • **Responsibility**: Being given responsibility motivated; had personal investment in the project • **Social & Cultural Norms**: Being on a team was motivating • **Infrastructure**: Building had low-hanging fruit	• **Control:** Facilities has control**;** separation between building head/occupiers and finance guy
Sue Wells[120] • **Kroon Hall** • **Group 3** • **Quintile 4**	• School of Forestry Environmental Stewardship Committee took this on – one very active student took a deep look at complex energy systems of Kroon	• **Social & Cultural Norms:** Environmental Stewardship Committee already in place • **Concern for the environment, environmental knowledge**	• **Infrastructure**: Complex • **Information**: Report too confusing • **Control**: Held accountable for things out of their control • **Competition**: Competitive aspect didn't make sense
Gygi Jennings[121] • **Weir Hall** • **Group 3** • **Quintile 5**	• Formed sustainability group • Collaborated with facilities • Sent out weekly green facts and challenges • Put up posters • Replaced incandescent bulbs with LEDs	• **Concern for the environment** • **Social & Cultural norms:** Student enthusiasm	• **Priorities**: schedule gets too busy as the semester wears on; people lose stamina • **Responsibility**: Frustrated with responsibility for other peoples' behavior

*All of these buildings but Kroon Hall were central-support, with Kroon being self-support

[115] Maher, Sue, Personal Interview, January 27, 2017
[116] Hoepp, Michael, Personal Interview, January 24, 2017
[117] White, Tim and Boardman, Rich, Personal Interview, January 27, 2017
[118] Cronan, Bill, Personal Interview, December 12, 2016
[119] Wittenstein, Ted, Personal Interview, January 27, 2017
[120] Wells, Sue, Personal Interview, December 13, 2016
[121] Jennings, Gygi, Personal Interview, January 31, 2017

(b) Survey Format

I distributed the survey as an online Qualtrics form. I sent the form using an anonymous link that placed a cookie on respondents' web browsers after they complete the survey to prevent them from taking the survey multiple times, though not with guaranteed success.[122] . In order to participate in the survey, an individual needed to confirm their Yale affiliation by providing a valid "@yale.edu" email address, ensuring that the results would not be flawed by participant bias from individuals outside of the university. The questions were reviewed by Seth Rosenthal from the Yale Program on Climate Change Communications, a research group at Yale with expertise on surveying and studying public opinion on climate change, and by the Human Subjects Committee, HSC #1611018660.

To recruit undergraduate student responses, I posted the survey in Facebook groups restricted to students at Yale University broken down by graduation Year (Class of 2017, 2018, 2019 and 2020). Next, I solicited responses from the student body of one residential college at Yale.[123] I posted the survey in Facebook groups affiliated with this college and distributed it to email lists of all undergraduate students affiliated with the college. To recruit graduate students, faculty and staff, I contacted a top administrator (often either the registrar or lead administrator, though titles varied by department) in each department at Yale whose department name begins with the letters A (African American Studies) – H (Humanities).[124] Though many departments did not respond to my inquiry to send out the survey, and some may have sent it out without notifying me. Nonetheless, those that did forward it to the staff, faculty and graduate students in their department were African American Studies, Anthropology, Applied Physics, Cell Biology, Comparative Literature, Experimental Pathology, French, German, Global Affairs and History. Finally, I distributed the survey via the Yale Office of Sustainability Weekly Newsletter, an email list made up of students, staff and faculty members who sign up for the weekly communications.

To incentivize responses and yield a higher response rate, I promised respondents the opportunity to enter their email into a raffle for a $50 Amazon gift card. [125] Further, this incentive was also intended improve the quality of my data itself. Several studies have found that survey participants that receive financial incentives are less likely to give "bad answers" (e.g. "I don't know), and are more likely to give lengthier responses in comment sections.[126] The survey remained open for two weeks from Jan. 30, 2017 to Feb. 13, 2017. In the end the survey received 408 responses. However, because of the networks I have access to, being an undergraduate student, 262 were from undergraduates, while only 50 were from graduate students, 65 from staff members, 20 from faculty members and 4 categorized as "other."

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[122] Respondents can circumvent this preventative method by either using a different web browser or by clearing their cookies. However, as the gift card raffle entry was a separate Google Form that collected names and emails, meaning double entry would be easily detectable, there wasn't much incentive for individuals to fill out the Qualtrics survey itself more than once, meaning this was not a significant concern. CITE and add to bibliography https://www.qualtrics.com/support/survey-platform/survey-module/survey-options/survey-protection/

[123] Undergraduate students are divided into 12 residential colleges that they affiliate with throughout their four years at Yale. Residential colleges are designed to be microcosms of the Yale community, populated by students of diverse backgrounds and academic interests. Thus, each residential college is intended to be representative of Yale College as a whole.

[124] "Departments and Programs." *Yale University*. Accessed April 4, 2017. https://www.yale.edu/academics/departments-programs

[125] National Business Research Institute. "Survey Incentives: Response Rates and Data Quality."

[126] National Business Research Institute. "Survey Incentives: Response Rates and Data Quality."

I sent the survey out to respondents with the following message soliciting their participation:

"This survey is intended to learn about people's experiences with the Carbon Charge Project. The research will be used in my senior thesis for the Environmental Studies major at Yale, and will help inform university carbon charge efforts going forward. The survey should take approximately 5 minutes. Upon completion of the survey, you may enter your email address to be considered for a raffle of a $50 Amazon gift card. Your answers will remain anonymous, unless you are willing to be contacted for follow up and choose to leave your name."

The question list inputted into the Qualtrics survey are as follows:

Questions

This survey is intended to learn about people's experiences with energy use and carbon emissions on Yale's campus. The research will be used in Sarah Brandt's senior thesis for the Environmental Studies major at Yale, and will help inform university energy reduction efforts going forward. The survey should take approximately 10 minutes. Your answers will remain anonymous, unless you choose to leave your name to be contacted for follow up. Upon completion of the survey, you may enter your Yale email address to be considered for a raffle of two $50 Amazon gift cards. In order to do so, you will be redirected to a different form that is completely independent from this survey, and thus the email address you enter for the raffle will not be connected to your survey answers. This survey has been reviewed by the Human Subjects Committee, HSC# 1611018660.

Which best describes your role at Yale?
- ❍ Student
- ❍ Faculty
- ❍ Staff
- ❍ Other

Which department do you primarily work in?

Are you an undergraduate student or a graduate student?
- ❍ Undergraduate
- ❍ Graduate

What graduate or professional program are you in?
- ❍ Graduate School of Arts & Sciences
- ❍ School of Architecture
- ❍ School of Art
- ❍ Divinity School
- ❍ School of Drama
- ❍ School of Engineering & Applied Science
- ❍ School of Forestry & Environmental Studies
- ❍ Law School
- ❍ School of Management
- ❍ School of Medicine
- ❍ School of Music
- ❍ School of Nursing
- ❍ School of Public Health
- ❍ Other

If other, please describe your graduate/professional program below

Does the focus of your studies have anything to do with energy or the environment?
- ❍ Yes
- ❍ No

What is your intended major?[127]

Do you live on or off campus?
- ❍ On campus
- ❍ Off campus

What is your anticipated year of graduation from Yale?
- ❍ 2017
- ❍ 2018
- ❍ 2019
- ❍ 2020
- ❍ Other

What is your estimated graduation year?

When you are at Yale, do you spend most of your time in one single building or a variety of different buildings around campus?
- ❍ One building
- ❍ A variety of buildings

Regardless of your answer to the previous question, think about the Yale building you spend the most time in on campus. What kind of a building is that?
- ❍ Residential building
- ❍ Academic or office building
- ❍ Lab building
- ❍ Athletic building
- ❍ Other

If "other," please describe building briefly here

Think about the Yale building you spend the most time in on campus. What kind of a building is that? (if you are a student living on campus, this building is likely your residential college)
- ❍ Residential building
- ❍ Academic or office building
- ❍ Lab building
- ❍ Athletic building
- ❍ Other

If "other," please describe building briefly here

Please write the name of this Yale building you spend most of your time in below.

[127] A full list of undergraduate major options was provided, though not shown here

How many hours each week do you spend in that building?
- ❍ 0-5
- ❍ 5-10
- ❍ 10-20
- ❍ 20-40
- ❍ More than 40

What is your primary use for this building?
- ❍ Living space
- ❍ Studying/taking classes
- ❍ Office space/meetings
- ❍ Cooking/Cleaning
- ❍ Working/researching in a lab
- ❍ Other

Please briefly describe your primary use for that building below:

Think about this Yale building you spend most time in on campus when answering the following questions.

How long have you been spending time in this building at Yale?
- ❍ Less than 1 year
- ❍ 2-5 years
- ❍ 5-10 years
- ❍ More than 10 years

How much of a sense of belonging/community do you feel in this building? Rate between 1 and 5, with 1 being "none" and 5 being "a strong sense of community"
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5

Do you pay attention to your energy consumption in this building?
- ❍ Yes, all the time
- ❍ Yes, sometimes
- ❍ No

Why do you pay attention to your energy consumption in this building at Yale? (Rate the influence of each reason from 1 to 5, with 1 being "not true for me" and 5 being "very true for me")

	1	2	3	4	5
I want to save energy for financial reasons	❍	❍	❍	❍	❍
I care about the environmental impact of my building	❍	❍	❍	❍	❍
I care about my own environmental impact	❍	❍	❍	❍	❍

I am asked to by others in my building	❍	❍	❍	❍	❍

Why don't you pay attention to your energy consumption in this building at Yale? (Rate the influence of each reason from 1 to 5, with 1 being "not true for me" and 5 being "very true for me")

	1	2	3	4	5
I don't have time to worry about it	❍	❍	❍	❍	❍
I'm not responsible for energy use in my building	❍	❍	❍	❍	❍
It is too difficult to reduce my energy use	❍	❍	❍	❍	❍
I don't know how to reduce my energy use	❍	❍	❍	❍	❍
It might negatively impact my level of comfort	❍	❍	❍	❍	❍
It's not something I particularly care about	❍	❍	❍	❍	❍
My actions won't make a difference	❍	❍	❍	❍	❍
I don't receive feedback about my energy consumption	❍	❍	❍	❍	❍

Do you ever attempt to reduce your energy consumption in this building at Yale?

❍ Yes
❍ No

What action(s) do you take to reduce energy consumption in this building at Yale? (select all that apply)

❑ I turn lights off when not in use
❑ I use energy efficient lightbulbs (CFLs or LEDs)
❑ I adjust heating and cooling to minimize energy use
❑ I power down electronics and appliances when not in use
❑ I wash my laundry on a cold setting
❑ I use energy efficient appliances
❑ I ask facilities or other building professionals to take action
❑ I encourage peers in the building to reduce their energy consumption
❑ I make equipment purchasing decisions

- ❑ I make building energy system investment decisions (e.g. heating, ventilation, A/C, building information systems, etc.)
- ❑ I maintain and adjust building energy systems (e.g. heating, ventilation, A/C, building information systems, etc.)
- ❑ I set or influence incentives for other occupant behaviors
- ❑ None of the above

Do you take any other actions to reduce your energy use in that building that were not listed before? Please write them below:

Are you responsible for purchasing or investment decisions that influence energy use in your building?
- ❍ Yes
- ❍ No

How much control do you feel like you have over energy use in your building?
- ❍ None at all
- ❍ A little
- ❍ A moderate amount
- ❍ A lot
- ❍ I have complete control

How much do you think the energy efficiency of your building(s) can be improved?
- ❍ It can't be improved
- ❍ It can be improved, but cost of improvements will outweigh savings
- ❍ It can be improved in a way that saves money

Do you ever see the energy prices/bills for this building at Yale?
- ❍ Yes
- ❍ No

Are you aware of the following items?

	Yes	No
The introduction of the Yale Carbon Charge	❍	❍
How much energy my building uses per month	❍	❍
How my building's current energy use compares to historical use	❍	❍
My building's percent energy breakdown by steam, electricity, gas, and chilled water	❍	❍
How much carbon dioxide my building emits per month	❍	❍
Whether the amount above was more or less than my building's carbon dioxide emissions in the previous month	❍	❍
What my building's carbon charge is this month	❍	❍

If your building were trying to reduce its energy consumption, would you try to reduce your energy use? Rate the likelihood that you would try cutting your energy use from 1 to 5, with 1 being "I would make no attempt" and 5 being "I would make every attempt."

- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5

What (other than energy costs) would motivate you to reduce your energy consumption in this building at Yale? (Rate each factor)

	No impact	Slight impact	Moderate impact	Considerable impact
If my peers were also trying to reduce their energy	❍	❍	❍	❍
If there was pressure from someone with authority in the building to do so	❍	❍	❍	❍
If I had more control over energy consumption	❍	❍	❍	❍
If I had more time to worry about it	❍	❍	❍	❍
If I had more information about my energy consumption	❍	❍	❍	❍
If I personally received a financial incentive for reducing energy	❍	❍	❍	❍
If my building as a whole received a financial incentive for reducing energy	❍	❍	❍	❍
If I received some non-financial reward	❍	❍	❍	❍
If my personal energy use were publicly displayed	❍	❍	❍	❍
If my building's energy use were publicly displayed	❍	❍	❍	❍
If I was competing with someone to reduce more energy	❍	❍	❍	❍
If I received frequent updates	❍	❍	❍	❍

about my energy consumption				
If I felt like my efforts would be supported by others in my building	❍	❍	❍	❍
If it were easier to adjust my energy consumption	❍	❍	❍	❍
If it had come up when I first started spending time in the building	❍	❍	❍	❍
If I had more information about how to reduce my energy use	❍	❍	❍	❍

Did you know about the Carbon Charge Project at Yale (Spring 2016)?
- ❍ Yes
- ❍ No

Were you involved in the Carbon Charge pilot initiative in your building?
- ❍ Yes
- ❍ No

In what capacity were you involved in the Carbon Charge project?
- ❍ It was my job to oversee energy reduction
- ❍ I helped contribute to energy reduction efforts
- ❍ Other

If "other," please briefly describe your role in the Carbon Charge project:

How much would you say you care about environmental issues?
- ❍ Not at all
- ❍ A little
- ❍ A moderate amount
- ❍ A lot
- ❍ More than any other issue

How much would you say you know about energy consumption in buildings?
- ❍ Nothing at all
- ❍ A little
- ❍ A moderate amount
- ❍ A lot
- ❍ I am an expert on the topic

How much would you say you know about carbon emissions?
- ❍ Nothing at all
- ❍ A little
- ❍ A moderate amount

- ❍ A lot
- ❍ I am an expert on the topic

Do you have any ideas about how to get more students, staff and faculty to focus on energy conservation at Yale?

Other comments?

Would you be willing to be contacted for follow-up questions? (Note that this is separate from entry into the raffle for the Amazon gift card. At the end of the survey, you will be redirected to a different form where you may enter your email address into that raffle)
- ❍ Yes
- ❍ No

Name:

Email address:

Thank you for completing the survey! Press the next arrow to be redirected to a separate webpage, where you can enter your email address if you would like to be eligible for the $50 Amazon gift card raffle. Note that the email address you enter on that form will not be connected in any way to your answers on this survey, for purposes of anonymity.

Distribution

Table 14: Undergraduate student distribution channels

Group	Platform
Yale Class of 2017 Facebook Group	Facebook
Yale Class of 2018 Facebook Group	Facebook
Yale Class of 2019 Facebook Group	Facebook
Yale Class of 2020 Facebook Group	Facebook
Calhoun College Facebook Group	Facebook
All Calhoun College students	Email

Table 15: Graduate student, staff and faculty distribution channels (attempted), with bolded group names indicating those that confirmed to me that they distributed the survey*

Group	**# of individuals in group**
African American Studies	Unknown
African Studies	Unknown
American Studies	Unknown
Anesthesiology	Unknown
Anthropology	113
Applied Mathematics	Unknown
Applied Physics	49
Architecture	Unknown
Department of Astronomy	Unknown
Biological & Biomedical Sciences	Unknown
Cell Biology	~190
Classics	Unknown
Department of Comparative Literature	20
Comparative Medicine	Unknown
Computer Science	Unknown
Dermatology	Unknown
East Asian Languages & Literature	Unknown
Ecology & Evolutionary Biology	Unknown
Economics	Unknown
Environmental Health Sciences	Unknown
Experimental Pathology	Unknown
Film and Media Studies	Unknown
French	46
Geology & Geophysics	Unknown
Department of Germanic Languages & Literatures	Unknown
Global Affairs	16
History of Art	Unknown
History of Science and Medicine	13
Humanities	Unknown

*I reached out to the relevant administrator in each department listed here starting with the letter A – H, unless I was unable to find the contact information of the relevant administrator, as was the case with Biostatistics, for instance.
**It is possible that some registrars or administrators distributed my survey without confirming with me that they did.

Discussion of Representativeness of Survey Responses

Table 16: Survey response quantities by population type

Population	Responses	Population Size[128]	Percentage of Population
Undergraduate students	263	5,453	4.82%
Graduate students	50	6,859	0.73%
Staff	65	9,455	0.69%
Faculty	20	4,410	0.45%
Other	4	N/A	N/A
Total	**402**	**26,177**	**1.54%**

Figure 12: Breakdown of undergraduate student responses by graduating class

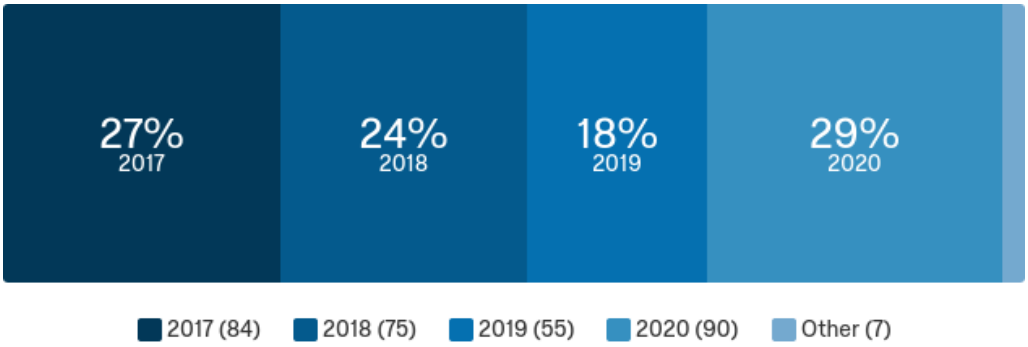

Table 17: Distribution of undergraduate student responses by major

Major	%	Count
Total	**100%**	**261**
Economics (B.A.)	8.81%	23
History (B.A.)	8.05%	21
Political Science (B.A.)	6.90%	18
Molecular, Cellular, and Developmental Biology (B.A. or B.S.)	6.90%	18
Computer Science (B.A. or B.S.)	6.13%	16
Undecided	4.21%	11
Psychology (B.A. or B.S.)	4.21%	11
Ecology and Evolutionary Biology (B.A. or B.S.)	3.83%	10
Biomedical Engineering (B.S.)	3.45%	9

[128] "Yale Facts." *Yale University*.

American Studies (B.A.)	3.07%	8
Ethics, Politics, and Economics (B.A.)	3.07%	8
Chemistry (B.A. or B.S.)	2.68%	7
Applied Mathematics (B.A. or B.S.)	2.68%	7
Global Affairs (B.A.)	2.30%	6
Environmental Studies (B.A. or B.S.)	2.30%	6
Sociology (B.A.)	2.30%	6

Figure 13: Undergraduate respondent living situation (on or off campus)

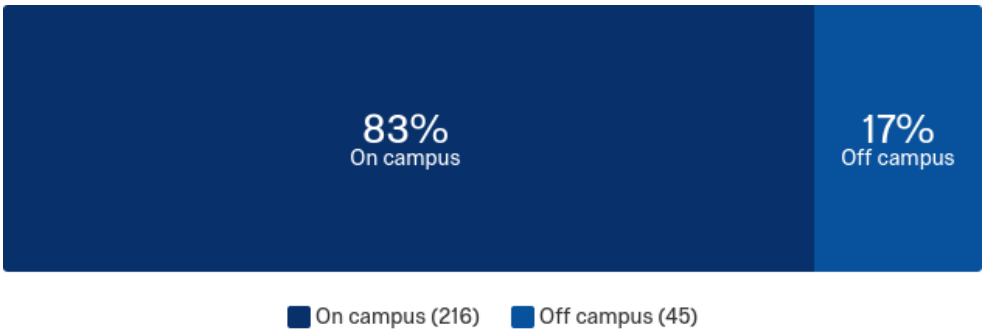

Table 18: Distribution of graduate student responses by program of study

Answer	%	Count
Total	**100%**	**50**
Graduate School of Arts & Sciences	82.00%	41
School of Management	6.00%	3
School of Forestry & Environmental Studies	4.00%	2
School of Engineering & Applied Science	2.00%	1
School of Architecture	2.00%	1
School of Medicine	2.00%	1
Divinity School	2.00%	1

As evidenced in Table 10, there was a clear skew toward undergraduate student responses, with 65% of the responses coming from undergraduates. These undergraduate student responses do, however, comprise a rather representative subset of that population. Broken down by anticipated year of graduation, responses are divided roughly evenly among the four class years (Figure 12), with the proportion of responses from each graduating class ranging between 18% and 29%. Further, the breakdown of undergraduate student responses by intended major seems to reflect the distribution across Yale college, as the three majors with the most survey responses are economics, history and political science, which are the three largest majors by degrees awarded in 2015/2016 (Table 17). [129] Finally, another indicator of the representativeness of undergraduate student data is in terms of living situation. 83% of undergraduate student respondents live on campus, which is in line with the statistic that 84% of Yale undergraduate students live on campus in university housing (Figure 13).[130] Given distribution of undergraduate student responses by graduation class, area of study, and living situation, the responses from undergraduates offer a representative sample size. Finally, there were 263 undergraduate student responses out of 5,453 undergraduate students at the university (Table 16)[131], meaning that using a 95% confidence level, the results are statistically significant for undergraduate responses with a margin of error of 5.9%.

As for graduate students, staff and faculty, their responses cannot be considered quite as representative of a proxy for those populations. Of the 29 departments contacted, only 6 confirmed that they sent my survey out (Table 15). As a result, the sample size for graduate students, staff and faculty was quite low, representing less than 1% of the university population

[129] Yale University Office of Institutional Research. "BA/BS Degrees Awarded by Major." (2016)
[130] "Yale Facts." *Yale University*.
[131] "Yale Facts." *Yale University*.

for each (Table 16). Graduate student respondents, for instance, were primarily in the Graduate School of Arts and Sciences (41 of 50 or 82%, Table 18), which is not reflective of the entire population of students studying in graduate and professional programs at Yale (only 41% of students in graduate or professional programs study in the Graduate School of Arts and Sciences[132]). Despite these shortcomings, these departments did, at least, represent a range in academic backgrounds, including disciplines like Comparative Literature, Cell Biology and Global Affairs.[133] Thus, though this data is not perhaps statistically significant or representative for graduate students, staff and faculty in isolation, the data did at least capture a range of areas of study and research.

[132] Yale University Office of Institutional Research. "Student Enrollment by School and Program." (2016)
[133] For a complete list of departments emailed, refer to appendix (b)