ENERGY AND ENVIRONMENT PRAXIS LAB

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Abstract
Energy is central to civilization on Earth, and the demand for it is always increasing. Many of the challenges facing society today arise from our reliance upon non-renewable energy resources—resources that support economic growth and societal innovation while contributing to civil unrest and environmental degradation. We spent a semester exploring the science, engineering, policy, environmental consequences, economics, and sociopolitical complexities of energy systems. It is clear to us that fossil fuels must be replaced with renewable energy sources, but so far there is no renewable source that can feasibly be scaled to produce the output needed. In the United States and other industrial nations, there is energy hidden in every detail of our lives. Large-scale, systemic changes are needed, but they can only be accomplished with the support of the public. As a group of students who care about sustainability, we were shocked by just how much we *didn't* know before stepping into this course. That means the general public is likely to know even less. We designed our project around education—hoping to convey the importance of informed energy consumption in a non-trivial, positive, and exciting way that will produce tangible results.

Problem
To address the local issues that we face regarding Salt Lake City's energy infrastructure, we first formulated a problem statement that served as a basis for the projects we created: Communities are unaware of how their activities and choices link to energy systems and thus do not know what to do to reduce energy use.

Introduction
The problem of fossil-fuel energy system dependence was so complex we had trouble deciding on one overarching solution. After careful brainstorming and research, we decided the problem would be best addressed through a variety of smaller projects, all gathered under the umbrella of the larger Salt Lake Public Library Partnership. The public library would help us maximize the impact of our projects, diffusing our proposed solutions to the local public body. The five projects themselves, outlined below, provide a mix of immediate and long-term solutions.

Salt Lake City Public Library Partnership - LED Retrofit
The Salt Lake City Public Library (SLCPL) System lies on both sides of the energy efficiency spectrum. Their newest buildings, Glendale and Marmalade, are on the front edge of sustainable design while many of their older buildings are in need of improvement. Without any current staff hired to manage energy- and sustainability-related issues, the library was happy to partner with us. We worked with their community outreach coordinator and their facilities manager to learn about what they felt the libraries needed, and where we could have the most impact.

After assessing the need and efficacy of possible projects, we have decided to use a grant given to us by Rocky Mountain Power to replace light bulbs in the Sprague Branch with high-efficiency LED light bulbs. We hope this will be the first in a series of steps to improve the energy efficiency of the Sprague Branch, which is nearly 100 years old. It is estimated the retrofit will save 46,000 Kilowatt Hours and $3,500 per year for the library. For reference, 46,000 kWh could power an average American home for 4 years or a laptop computer running 24/7 for 86 years.

Energy Star Portfolios

Data driven decision-making is a key aspect in all effective energy management systems. For this to be possible, energy managers must have the ability to track energy data and interpret trends. This allows them to identify inefficiencies and to distribute their budget in a way that provides the greatest reduction in energy cost and environmental impact.

The process of looking at energy trends and making comparisons between different buildings or time periods is commonly referred to as *benchmarking*. There are many software packages on the market that provide benchmarking capabilities. Energy Star Portfolio Manager (developed by the EPA) is a free option that gives building managers performance scores, trends, and reports based on meter data. We created Energy Star Portfolios for all 8 of the SLCPL branches and linked them to their electricity meters. This will provide the library with a basis on which they can continue to expand their energy management practices to increase energy efficiency and energy savings.

Energy Dashboard

Demand side management (DSM) is a meaningful tool for managing energy systems. It involves motivating consumers to reduce energy use through financial incentives, education, behavioral changes, etc. Due to the complexity of existing energy infrastructure and difficulties with large-scale renewable implementation, DSM will be an important part of future energy solutions. For DSM to be effective, consumers must have the ability to view and interact with real-time energy data. This data, which is usually not open to the public, must be easy to interpret.

In response to the lack of available data, we are installing an interactive energy dashboard in the Glendale Library. The dashboard will be accessible to the public and will display tangible information related to the library's solar production, geothermal heat pump production, energy consumption, and general information related to energy efficiency. Our goal is to connect the public to energy data and information in a way that inspires behavioral change and participation in the movement towards a more sustainable energy infrastructure.

There is currently a campus and statewide effort being put forth to create a common platform on which energy dashboards are designed and integrated into public spaces. We are collaborating

with students, faculty, and professionals around the valley so that our work with the library contributes to this campus/statewide platform.

Education

As part of our effort to inform the public about energy systems, we developed three education modules to present as part of the Glendale Library's after school programming. These hands-on lessons, all relating to sustainable energy in some way, were meant to motivate future generations to be aware of energy issues and to realize the potential for jobs in these areas.

The first module was on insulation. This project consisted of building insulators out of assorted materials (paper, bubble wrap, aluminum foil, cotton balls, etc.) to keep a small block of ice frozen when placed in front of a heater. The students compared how their ice cube melted to one with no insulation, noticing how much of a difference proper insulation makes. We presented a short lesson during the building of the insulators, connecting energy efficiency to air quality—something they see in everyday life.

The second presentation was on solar power. The children built solar stills to purify salt water, demonstrating the power of the sun. The students responded well to this project, asking questions about how the sun works, and why solar power is even possible. We tied this project to the solar panels on the roof of the library, so that the students could get a sense of sustainability in action. The final project was about wind power. They used kits to build functional miniature turbines, giving them a hands-on look at alternative energy.

We are leaving these kits and lesson plans with the Glendale Library so they can continue to incorporate energy education into their after school programming.

Game

With each of our other projects directed towards enabling change and educating people about *how* they can reduce energy consumption and make sustainable choices, we were interested in finding a way to convey just how complex and multi-faceted energy systems really are. Since it's not feasible to expect everyone to read all the materials we did, we wanted to make this information accessible without requiring a directed passion and commitment to time-intensive research. We decided that a board game would be the best platform to educate in an intuitive and fun way, so we designed ReSource. ReSource divides the players up into countries, and requires them to race against a carbon-clock to switch their energy sources from carbon-based to carbon-neutral. The game is meant to give a realistic picture of the complexities of energy systems and convey why transitioning is so difficult yet necessary.

Conclusion

By the end of the year we successfully taught students about sustainability principles, leaving a wealth of educational materials with the Glendale library to continue the tradition. In addition to

this, we completed energy star portfolios for the library system branches to support the future growth of the libraries energy management system.

By the end of the summer we will print ReSource, an educational board game, and test its efficacy with the campus community as well as with students who frequent Glendale Library. The Sprague library branch will be updated with energy efficient LED technology, saving 46,000 Kilowatt Hours per year. Also to be completed by the end of the summer, the energy dashboard will be installed to display information relevant to the Glendale Libraries energy production and consumption.

Overall, we believe this selection of projects will unobtrusively educate students and adults on the importance of everyday choices about energy use and the link to destructive climate change. When efficient technologies are prominently displayed and encouraged, those exposed to them will be more receptive to these technologies. People are also more likely to make behavioral changes if the necessity of reducing energy use and switching to cleaner energy is made clear. In addition, our Sprague retrofit project will reduce energy demands instantaneously, reducing the ecological footprint of the libraries energy consumption.

Throughout this course, we gained a thorough understanding of the complexities that surround our global energy infrastructures. While large-scale infrastructure changes will certainly need to be a part of the success of sustainable systems, the involvement of consumers in the energy decisions that are being made will be an integral part in creating a system that supports the health of the environment and everything within. If consumers are to play an active role in this process, then they need to be educated on the topic of energy systems. Our projects were formulated to support this education and inspire people to assume a more active role as energy consumers.

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Attachments

Class Presentation Script

PART 1: INTRO, SCOPE, COMPLEXITY

Michael: Energy. The demand for energy is central to civilization; it's vital in our everyday lives.

Rebecca: In this course we explored the science, engineering, policy, environmental consequences, economics, and sociopolitical complexities of energy systems.

Enzo: Through the Fall Semester, we read, watched, and talked A LOT.

Stuart: The Bruntland Report, the Energy Outlook, the Cost of Coal, Sustainable Energy Without the Hot Air

Caroline: Geofuels, Clean Coal, Fracking, Shale Gas

Kaden: The Keystone Pipeline, the IPCC, Chernobyl and Fukushima

Daniel: A Global Boom in Hydropower Dam Construction, Technology Roadmap for Solar Photovoltaics, Utilization of Geothermal, Alternatives

Sasha: Wind, Baseloads, Biofuels, the Structure of Systems, and Clean Energy Solutions.

Sam: We were assigned *hundreds* of pages each week.

Michael: We began by watching The Switch Energy Project

Rebecca: "Every energy resource— fossil, nuclear and renewable— is undergoing profound changes. And overall, we're gradually shifting from coal and oil to the energies of tomorrow."

Enzo: We heard from faculty who are energy experts in Geology, Sociology, Engineering, Communications, Sustainability; from Utah Clean Energy and the Utah Coal Industry.

Stuart: Our thirst for energy is intertwined with economic growth, societal innovation, civil unrest and environmental degradation. Our planet is warming.

Caroline: World primary energy demand is projected to grow by 45 percent between 2006 and 2030.

Kaden: A doubling of urban populations.

Daniel: 90% of the energy demand growth is expected to come from rapidly growing nations, led by India and China.

Sasha: Don't these countries deserve the chance to elevate their middle classes?

Sam: The relationship between energy efficiency and total energy consumption is complicated, as the most efficient nations generally also have the highest consumption.

Michael: Energy consumption is intricately intertwined with economic growth.

Rebecca: Are we willing to place windmills and solar panels in our vistas and views? Will switching to renewables mean spreading the tendrils of technology to farmland, pastures, and preserves?

Enzo: Is it easier to tolerate an invisible intruder like CO2?

Stuart: Coal mines and oil fields produce the highest energy per volume materials known on earth.

Caroline: All this energy is converted for our needs, and spat out as invisible greenhouse gases that aren't even considered pollutants but are fundamentally changing our planet.

Kaden: How do we weigh the health of the environment against economic security?

Daniel: Renewables have major barriers keeping them as minority investments. Timing… Scale… Cost… Policy…and on top of this, a rising market for renewable energy is constantly being pushed back by the established industries of yesterday.

Sasha: Some of the renewable alternatives being embraced are barely making a dent, or may have unintended negative consequences.

Sam: On land that is already being utilized, production and use of corn grain ethanol releases 88% of the net greenhouse gas emissions of an energetically equivalent amount of gasoline.

Michael: 78% of our electricity is coming from coal in the year 2016? How does protecting an out-dated industry serve the interests of Utah residents?

Rebecca: I will tell you how. Demand. We are not protecting coal; it is protecting us— from the immediate financial burden of reducing a distant, disconnected ecological burden: Climate Change.

Enzo: The state of Utah is rich in natural energy resources. There is coal in the hills of Carbon County!

Stuart: The geoscience, engineering, and socioeconomic systems swirl together to create a mutual dependence.

Caroline: In the United States people living near coal-fired power plants are exposed to more radiation than people living near nuclear power plants. Is it worth trying to shift public opinion on nuclear power? No one wants it "in their backyard"

Kaden: Where will it go?

Daniel: I talked to a staunch environmentalist this weekend. She advocated for the immediate shutdown of all hydrocarbon fuel sources. (Knowing the imminent dangers of climate change,) I wondered: does she know that without these energy dense sources, *we wouldn't have power right now?* Economies would shut down. There would be food shortages. Many people would die.

Sasha: Energy is the building block of the life we all live.

Sam: There are trade-offs between social and environmental demands and complex connections between production and consumption.

Michael: But why would we lag behind other states on our energy and sustainability goals? Why would we invest so little in something that has the potential to define the next technological century?

Rebecca: Can you feel the shifting of risk?

Enzo: Try keeping a journal, as we did, tracking your energy use. There was so much— we failed.

Stuart: Considering the life cycle of all of it— direct and indirect.

Caroline: It can be overwhelming.

[pause]

PART 2: QUESTIONS—DEVELOPING OUR PROJECT

Kaden: If people from the general population— outside of the University— tried to read a lot of what we read in class, I don't know how much would get through; and it may be difficult for them to assess legitimacy.

Daniel: There seems to be an access barrier.

Sasha: Do individual actions make a difference?

Sam: Or do my decisions get lost in the buzz of my energy-hungry world?

Michael: I have trouble connecting my day-to-day activities to the larger picture.

Rebecca: Do people even know where their energy comes from?

Enzo: If they are aware, how can we motivate them to change behavior in a way that reduces demand?

Stuart: We use so much of it. All the time. A standard of living. Dependency, efficiency, and inequality

Caroline: Do we have options?

Kaden: How can we realize our options when they are made available?

Daniel: We live in a built environment— plugged in, fueled up, charging.

Sasha: How can we craft a realistic project, for us, within this complex, global-scale energy system?

Sam: How can we scale the benefits of renewable energy as it is introduced as an alternative to fossil fuels? Sustainability must become part of the analysis.

Michael: How can we help educate— economics, efficiency, feedbacks, adaptation?

Rebecca: Can we present energy efficiency as an immediate issue? Is it too late to consider our efforts "proactive?"

[pause]

Enzo: Efficiency and conservation are important, but if we don't pump the oil now are we just leaving more for someone else to use? Won't it all be pumped and burned?

Stuart: Look at National Forests! Why haven't we messed those up already, huh? People can eat their cake and have it too.

Caroline: Since we can't really stop energy use, we need to find ways to make the current emissions have less impact. We need to maximize the value of each kilowatt!

Kaden: It is clear to us that progress needs to involve an actively engaged public.

Daniel: So what are we going to do?

Sasha: Educate.

Sam: Invest in renewables.

Michael: Cut down on power use.

Rebecca: Make energy-saving behavioral changes.

Enzo: Create environmental art.

Stuart: Go viral.

Caroline: We can apply for SCIF Grants.

Kaden: Form community partnerships.

Daniel: Teach kids and the community about what we have learned.

Sasha: Make a movie about coal-based *mutated* zombies.

Sam: But really, what are we going to do?

[pause]

PART 3: A SOLUTION-OUR PROJECT

Michael: We know the problem: Communities are unaware of how their activities and choices link to energy systems and thus do not know what to do to reduce energy use.

Rebecca: Let's spark a conversation. Work with a public space.

Enzo: Addressing this problem will allow us to explore a number of QUESTIONS and propose a variety of ACTIONS to create SOLUTIONS to this PROBLEM.

Stuart: We will share what we have learned with our peers, with the public, with our neighbors and friends.

Caroline: We will explain our options and what we can do in our own spaces and homes to increase efficiency.

Kaden: The presentation of information needs to be simple. Easy to understand. Engaging.

Daniel: We don't want to trivialize it.

Sasha: We need to make it fun.

Sam: We want to address the positive aspects of energy efficiency. What can you gain by adjusting behavior?

Michael: Health, economic savings, community involvement.

Rebecca: We need hands-on, location-based, data-driven solutions.

Enzo: So we created our projects.

Stuart: A collection of actions and activities that collectively provide far-reaching attempts to infuse sustainable energy into our world.

Caroline: We wanted to work in a public space, to reach a large number of people, to reach the demographic of our community.

Kaden: We developed a partnership with the Salt Lake City Library System: to explore the energy use and efficiency of the public library buildings and find synergistic opportunities for education.

Daniel: The Salt Lake Library System lies on both sides of the energy efficiency spectrum. Their newest buildings, Glendale and Marmalade, are on the front edge of sustainable design while many of their older buildings are in need of improvement.

Sasha: We learned about energy benchmarking: an energy management practice that involves reviewing building performance and using trends to identify opportunities for improvement.

Sam: We created an Energy Star Portfolio for all 8 of their buildings, to help the library system track energy use and identify opportunities to increase efficiency.

Michael: We hosted multiple after-school lessons at the Glendale Library— teaching about concepts related to energy and efficiency, explaining some of the physical processes involved.

Rebecca: With these new hands-on lesson plans and supplies, the libraries can be a place that motivates future generations to be aware of energy issues and to realize the potential for jobs in these areas.

Enzo: With support from a SCIF grant, this summer we will be installing a touch screen dashboard into the Glendale Library. The dashboard will show people how the library is using energy in real time.

Stuart: We believe that an awareness of how their behavior and experiences are linked to energy use will motivate those who engage with the dashboard to take action.

Caroline: With a grant from Rocky Mountain Power and support from the Honors College, we are retrofitting the lighting in the Sprague Library. Updating to LED lights will save over 45,000 kWh per year, saving the library over $3,000 per year in energy costs.

Kaden: We created a board game, "ReSource", to allow players to sample the complexities of the overarching energy systems.

Daniel: Just enough so players— high-school kids and college students— can get a pseudo-realistic feel for what's going on, but still appreciate why transitioning might be so difficult.

Sasha: Sidelong exposure to the problem can build interest, and maybe make it solvable, if challenging.

Sam: My mom/dad would like to play this.

Michael: We can get it on the shelf of every library and dorm— reaching a population that can shape the energy portfolio of the future.

Rebecca: We believe the chosen solution set provides both immediate and long-term impacts.

Enzo: We need to take action now. Tangible projects, tangible results. Our library projects are a start, and our education materials will continue to generate conversation after the PRAXIS lab is over.

Stuart: No energy systems are without faults, but we are unanimous in our conviction that the security, well-being, and very survival of our species depends on such changes, now.

[pause]

Caroline: There was an important job to be done and Everybody was asked to do it.

Kaden: Everybody was sure Somebody would do it.

Daniel: Anybody could have done it, but Nobody did it.

Sasha: Somebody got angry about that, because it was Everybody's job.

Sam: Everybody thought Anybody could do it but Nobody realized that Everybody wouldn't do it.

Michael: It ended up that Everybody blamed Somebody when Nobody did what Anybody could have.

ALL: *Don't let this be us.*

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