3SO Assignment for Systems Class
CU Renewable Energy System

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Stakeholder Analysis

Introduction

CU's energy infrastructure and renewable energy system is complex and involves a diverse group of stakeholders. Because decisionmaking around renewable energy at CU is dominated by power dynamics, we chose to group the stakeholders by sector, values, and influence, as portrayed in Table 1. However, there are other important characteristics of each stakeholder that aren't captured in the table, and we've decided to explore those in more detail in this section.

Sector	Stakeholder	What's at stake?	Influence
Higher Education	*University Administration*	· Alumni support · Federal funding · University image · Public relations · Status/position within university	· High level of influence · Top-down decisionmaking controls most university functions and infrastructure investment High influence over relationships within and outside CU
	Environmental Center	· Mission fulfillment · CU's STARS rating · Student accountability · CU's reputation	· Low-medium level of influence · Lack influence in administrative decisionmaking on renewable energy
Public	*City of Boulder*	·City climate and renewable goals ·Matching CU with Boulder's public image	· Low influence over university adoption of renewables · Potential for collaboration in city utility municipalization
Private	*Xcel Energy*	·Financial security ·CU's role as a large customer	· High level of influence · Monopoly over CU's electricity
	3rd Party Financing and Solar Contractors	· Business from CU as an electricity customer	· Medium level of influence · Submit RFP's for campus solar projects, and set electricity rate-structures
Civil Society	*Students*	· Tuition costs ·CU representing student green values	· Low influence for individual students · Student activist groups have a higher level of influence, and can impact decisionmaking through non-traditional venues
	Clean Energy Now!	·Environmental values ·CU adopting renewable energy goals	· Medium-high level of influence (during their active years) · Today, the group no longer exists

Table 1: Stakeholder Motivation and Influence in CU Renewable Energy System

Stakeholder Context

Student Body

- In general, CU's student body has indicated strong preferences for sustainability on campus. When surveyed, 95% of students say that it's important for CU Boulder to have a strong commitment to environmental sustainability, and 92% say they personally want to be sustainable.[1] We can say with confidence that environmental conscientiousness is certainly a part of student culture at CU.
- Yet it's not clear that students are necessarily financially committed to renewable energy. Clean Energy Now!'s campaign in 2001 saw success in securing a $1 per semester tuition hike, which students selected by referendum in a 5 to 1 vote. However, rising tuition is a real concern for many students today, and large infrastructure projects like CU's new Athletic Center and the Euclid Parking Garage construction have resulted in significant student fee hikes. While a $1 per semester increase was palatable in 2001, it only resulted sourcing 2,000 MWh from wind per year (CU currently uses roughly 130,000 MWh annually).[2]
- If future efforts to source a large portfolio of renewables demanded a significant hike in student fees, we're not sure there's evidence that the student body would be on board.

Xcel Energy

- Xcel Energy's role in CU's renewable energy system is fairly straightforward. They dictate what energy resources are available for the school to buy (though their decisionmaking on new electricity generation is ultimately at the mercy of the Public Utilities Commision). Xcel also has a primarily financial bottom line, since they're beholden to their shareholders.
- It's worth noting that CU is a major customer of Xcel, and so Xcel has a stake in preserving a strong and functioning relationship with the University. CU has shown willingness to work with Xcel, as indicated by their recent deal with the City of Boulder to retain electricity purchasing choice in the event that the city municipalizes (see "Strategies" section for more details).

City of Boulder

- The City of Boulder has set ambitious climate goals, including a commitment to 100% renewable energy by 2030. It's clear that the residents of Boulder have strong environmental values, and may even prioritize those over economic bottom lines (as shown by residents' repeated support for municipalization).[3] Since CU represents roughly 5% of the city's electricity load, there's an incentive for the City to increase renewable energy within CU's portfolio.
- However, the City lacks authority over CU's decisionmaking process, and therefore is unable to participate meaningfully in CU's conversation around renewable energy. There has been some collaboration between the City and CU in the past, and there is certainly room for more collaborative efforts going forwards, especially in the context of renewable goals.

Environmental Center

- In the past, CU's Environmental Center has played a large role in the adoption of renewables on campus, by helping to orchestrate the 2001 student campaign for wind power. Today, the ECenter continues to push for renewable adoption on campus, and is leading the effort towards a Platinum-level STARS rating (under Dave Newport's leadership).
- The ECenter works to represent student environmental values and can be a loud voice advocating for renewables, but our interviews suggested that administrative top-down decisionmaking doesn't always incorporate ECenter input. In certain campus sustainability sectors, such as green infrastructure, the ECenter has had massive success in swaying administrative decisions. However, it appears to be a more difficult task when it comes to renewable

[1] Marianne Moulton Martin. In-class lecture on March 2nd, 2017.
[2] CU Environmental Center. (2017). Campus Energy Usage.
[3] Burness, A. (2016). Plurality of voters backs Boulder municipalization — but support has waned, Daily Camera poll finds. *Daily Camera.*

development. One limiting factor is the lack of a robust cost-benefit analysis for future renewable deployment (see "Strategies" section below for more details).

University Administration

- Ultimately, the university administration is the dominant stakeholder in CU's renewable energy system. CU's administrators have to balance alumni and endowment interests as well as the interests of current students when making financial decisions. Any decisions that incur extra costs must be justified to these other stakeholders.
- While the University has worked to cultivate an image of sustainability, we're not sure that the administration currently views renewable development as a priority. Some evidence suggests that fossil fuel interests play a role in administrative decisionmaking. University President Bruce Benson has professional ties to the fossil fuel industry, after founding the Benson Mining Group before taking on his position at CU.[4] In 2015, the Board of Regents voted against divesting CU's substantial investment pool from the fossil fuel sector.[5]
- Overall, the administration seems to care more about its economic bottom line than meeting significant renewable goals.

Strategies

Introduction

The movement towards renewable energy at the University of Colorado was largely successful between the years of 2000-2005. The RE campaign was driven by motivated student activists and received campus wide support from not only the student body, but also through the involvement and dedication of the staff at the CU Environmental Center. Initially, student activists utilized an extensive grassroots campaign that consisted of outreach, education, and public engagement. In addition, the student activists "venue shopped," by going around the student government and pushing for a referendum, which eventually proved successful. This referendum gave the University the ability to increase student fees by $1 per semester for the next four years, in order to buy the output of a wind-turbine. Yet following this success, the student activist group that spearheaded the renewable energy campaign dissolved, and much of the forward movement of the renewable energy campaign crumbled along with it. Because the students hadn't solidified a plan for future renewable installments, the decisionmaking arena on renewable energy became largely dominated by CU administration. Today, although significant system inertia remains, we've identified some of the key strategies going forward.

Market Factors

- Renewable Energy Credits (RECs) have allowed CU to purchase renewable energy without having to actually generate renewable power on site. The WindSource program has been in effect since 2004, in which CU pays Xcel to provide a certain percentage of CU's electricity from wind energy. Yet at this point in 2017, Xcel has a large amount of new wind generation that they are installing at cost.
- In this sense, Xcel is charging CU extra money for what is already on the grid system. In addition, bottom-up policies like the City of Boulder's aggressive renewable targets fail to capture the reality of national energy markets. Grids are regional, and emissions reductions made inside Boulder or CU may only push impacts outside of Boulder's jurisdiction.

Property Rights

- Property rights are not a concern in the realm of CU's renewable energy. CU owns its property and has decisionmaking authority over its infrastructure and land development.

Legal & Regulatory Interventions

- Municipalization of Boulder's utility may cause price volatility within the system. CU has bypassed this with an agreement with the city to preserve power purchasing choice in the event of municipalization. If the city municipalizes its energy system, it may cause power costs to rise within the city, and CU can just continue to buy power from Xcel.

[4] University of Colorado. (2017). CU President Bruce D. Benson.

[5] Kuta, S. (2015). CU regents say no to to fossil-fuel investment. *Daily Camera.*

- This undermines the City's commitment to 100% renewable, as CU Boulder represents about 5% of the city's electricity load demand and Xcel's portfolio is still dominated by fossil fuel-based generation. In addition, Xcel doesn't have a binding commitment to develop renewables beyond its Renewable Portfolio Standard requirement of 30% renewable by 2020, which it expects to reach early.

Infrastructure Plans

- CU's Chief Architect has preached consistency within the buildings on campus. A requirement for the same red roofs on all buildings has thwarted some efforts to place solar panels atop buildings. The solar panels near SEEC were planned as a result of land development limitations - the area was unable to be zoned for a building because of it's location in the floodplain, and the area was repurposed for a solar array.
- Solar panel visibility has become increasingly more acceptable on campus, but it hasn't always been this way. In addition, sunk cost in on-campus combined natural gas plants prohibits rapid deployment of renewables on campus until they break even on investment costs and/or these plants are taken offline.
- Open space within Boulder's urban growth boundary is scarce, which limits CU's access to undeveloped land. On the open land that it does own, it's possible that CU will continue direct funding toward new housing for the growing student population instead of building ground-mounted solar farms. This may limit new on-campus renewable energy options to rooftop solar installations and covered parking canopies.

Collaborative Processes

- On-campus decisionmaking is inherently non-collaborative because of University power dynamics. There are likely efforts between CU and the City, as well as between CU and Xcel to collaborate on energy planning, but it is unclear how successful those have been.
- Collaborative partnerships between CU students and the administration are limited by student turnover. Student efforts have been more focused on specific projects rather than the organization of an enduring movement that can be passed down from one class to the next.

Efforts to Educate & Motivate

- Efforts to educate citizens and consumers of CU about energy have been narrow in nature. It is unlikely that students are aware that coal and natural gas meet the bulk of CU's energy demand, or how small of a role renewables actually play in the energy portfolio.
- CU students tend to pride themselves in the identity of CU's sustainability, but in the case of renewable energy, it might be superficial. CU hasn't seen student activism on renewable energy in recent years, but an education campaign may have large potential to galvanize student action.

Business Opportunities

- We believe CU needs a solid cost benefit analysis to understand the potential, or lack thereof, of what financial impact more renewable investment would have on the University. With continued technological advancement, cost will influence future renewable deployment (see 'technology' section).
- Our interviewees suggest it is possible that investment in other green efforts like infrastructure upgrades and energy efficiency may produce a greater return on investment than renewables in terms of overall emission reductions.

Finance Outcomes

- The financial bottom line is the main concern of the University. Our research suggests that CU cares most about cheap energy, and not whether the power being produced is clean or renewable. We haven't had clear answers on how much influence oil and gas has had on University decisionmaking. CU's President Benson has a notoriously extensive history of involvement with oil and gas development.
- CU's Board of Regents has declined to divest stock portfolios away from fossil fuel interests. In the realm of financially viable energy investments, wind and solar have reached grid parity faster than any models in the past 10 years have predicted. If the University decides to push toward renewables, they may be able to save money with cheap wind and solar in the long run.

Protests

- Today, there are no protests, boycotts or acts of sabotage (unlike past student activism with Clean Energy Now!). Interviewees had mixed reactions about the viability of student efforts today.

Media

- Renewable energy has been an issue of low salience in the media. CU's outreach efforts around renewables could be regarded as greenwashing, and this has contributed to a lack of real energy literacy about CU's energy portfolio.

Technology

- We expect that battery technology innovation will continue to bring renewable costs down and reduce the inherent intermittency issues with solar and wind. Advances in battery technology could also increase campus resilience and energy independence in the case of natural disasters and brownouts.
- Advances in solar panel efficiency and durability will also influence the future of CU's renewable portfolio. Many of the Panasonic solar panels installed prior to 2011 are now out of commission. These projects are owned by third-party developers, so CU has no financial incentive to fix any of the malfunctioning solar panels. In fact, CU is saving money on its energy bill by replacing the PPA-agreed solar rate with cheaper electricity from Xcel.
- Solar panel efficiency degrades by 1% each year. As CU's on-campus solar installation starts to age, energy productivity will also decrease, which will reduce the amount of Renewable Energy generation in CU's portfolio. It is unclear whether the University plans to replace these panels with renewed PPA's once the 25 year contracts have expired.
- Widespread adoption of electric vehicles and shifting demand for more electric household devices could drive the growth of renewables, increasing their value in an emissions reduction context.

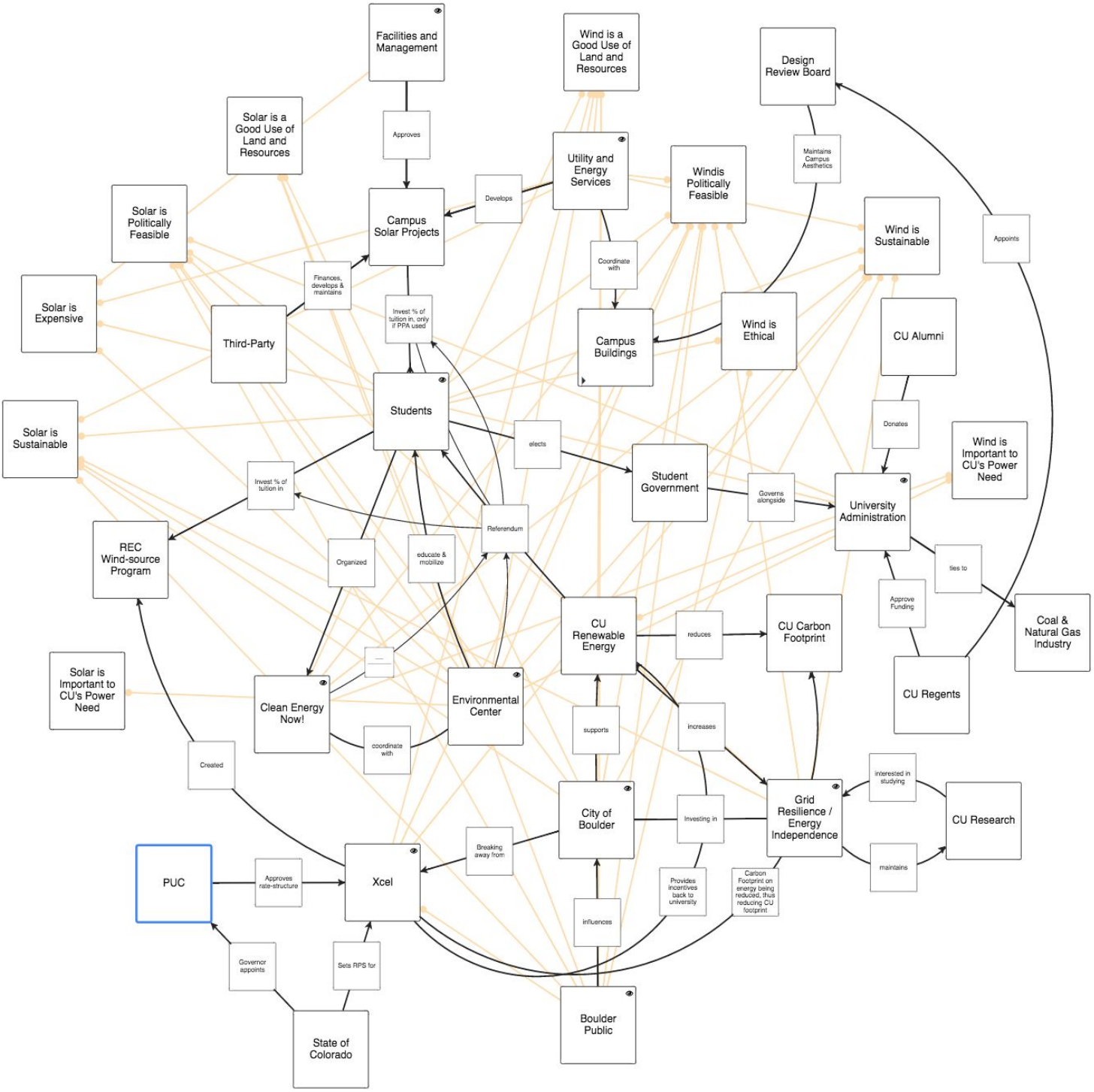
Systems

Renewable energy is inherently a complex system. It encompasses a variety of actors, stakeholders, and influencers - compounded with highly politicized perspectives that may alter the level of influence actors have in this system. The Meta-Map below illustrates the system participants and indicates not only the relationships between elements of the system, but how these relationships may have the ability to influence the perspective of each stakeholder. **Please see page 7 for Systems Meta Map.**

Map Context

- The **factors/components** that are impacted by the system depend on the change being sought by the participating stakeholder. In the case of the wind power campaign in 2001, the students became the **leverage point** (a la Meadows) necessary to mobilize the issue through student government, as there was a lack of will through the administration. However, this was a new movement at the time and an unconventional request - one that now includes many more **stakeholders** and **components** in 2017 (which is why the Cabrera's meta-mapping exercise helps make sense of the complex system). Arguably, stakeholder authority and influence has changed, and the map on page 7 reflects a more sophisticated system that is difficult to alter through student support.
- For now, many of the causal pathways and interdependence reside with university administrative operations and Xcel. As a large client, the university has mechanisms by which to negotiate with Xcel, and certainly within their current offerings and services. However, the results of ongoing negotiations could make the City of Boulder a pathway to renewables that does not currently exist in Xcel's portfolio - or so the city asserts. The current energy regulatory structure would need to **shift** to create a hard reset on this dynamic.
- Policy intervention through political means seems heavy-handed in terms of renewable energy on campus. Instead of providing methods of implementing change, policies have the potential to exacerbate political tensions on an issue. Assertions and demands that come through messaging campaigns have the ability to stifle long-term progress on this issue. For example, requests for arbitrary and aggressive metrics to advance renewable energy on campus **without** financial analysis and buy-in from administration stakeholders appears to **detract** from any meaningful strategic planning that could improve renewable options and access for the university.

CU Renewable Energy System Meta Map



Map Context (Continued)

- Much of the **flow of information** within the system depends on the the position of the stakeholders. Those who are entitled to contractual information between Xcel and the university, including Utilities and Energy Services, Design Review Board, Facilities and Management, and other administrative operations have access to the most useful information for negotiating how renewable energy can be be built into the system. Stakeholders **outside** of this contractual relationship are dependent on public disclosure requirements of the university and the energy utilization dashboard.
- Universities and utilities are some of the largest organizations in America, and therefore, often the **slowest to change**. Xcel oversees thousands of MW of energy generation from coal and natural gas-fired plants. These power plants each represent 25-50 years of capital investment. Xcel's PUC-regulated business model sets the rate-structure, making it extremely difficult to abandon productive coal-firing plants in favor of new Renewable Energy installation. Even with rapidly decreasing solar and wind costs, it is difficult for a utility to justify turning off an existing coal plant **without significant government support**. With many new NG-fired power plants coming online in 2017, it will take decades before we can retire all of our coal-plants. The "fastest" variable on our map is represented by CU students, who cycle out of the system every four years. As demonstrated by the RE student initiative, it's difficult to sustain momentum from one student class to the next without focusing on the **administration and maintenance of the organization**. The RE student-led initiative was focused on a specific issue rather than the bigger problem. Without an emphasis on the bigger-picture, it's difficult to pass down the torch from one generation of students to the next.
- There are several points of **political leverage and authority** in this system that may greatly influence **outcomes**. The Board of Regents' authority over the Design Review Board and major administrative decisions permits them to exert a strong amount of control on widespread policy changes within the university system. his relates to some of the issues with power dynamics that Wyborn and Cleland discuss in their article about Critical Systems Thinking methodology, where a group can be excluded from decisionmaking due to inequality. Being an elected board, the regents are also a reflection of the will of Colorado voters, which includes many of those in the student body. The negotiations between the City of Boulder and Xcel will also potentially split the utility's influence on the university - potentially giving the university negotiating power that does not exist in a one-utility system.

Outcomes

Introduction

The CU energy problem brings together many different stakeholders, each of which has their own value system and list of priorities. These values include things like economy, sustainability, resilience, and culture. Values define perspective, which informs the desired outcome of any decision or strategy. Strategies that succeed in connecting with these stakeholder values have the highest potential for adoption. Therefore, the most promising strategies for change will produce outcomes that satisfy the highest number of influential stakeholders. By identifying overlaps in stakeholder value systems and articulating the relationship between proposed strategy and desired outcome, we can generate stakeholder support and move toward action.

Stakeholder Outcomes

<u>University Administration</u>

- Active student body: upholding mission/values of the university
- Low energy bill: cheap long-term power contracts
- Grid resilient / Energy independence in case of blackout - back-up energy generation and storage to support expensive research activity
- Emergency response: providing a safe space for students in the case of disaster
- Establishing CU as a leader in technology and future energy systems - providing opportunities for hands-on study
- Financially solvent business model - continued growth in student enrollment

- ❖ Attracting talented students to boost university ranking and ultimately, alumni funding
- ❖ Fostering relationship between CU and the City of Boulder - potential for collaboration in energy generation and procurement
- ❖ Great PR - Image (or facade) of caring about transitioning to renewables (Greenwashing)
- ❖ Students feeling supported by the University and the fact that they cared about renewables / sustainability

Environmental Center

- ❖ Publicity and access to CU funding
- ❖ Collaboration and working closely with activist students who support their environmental mission
- ❖ Helping to aid in the development of outside partnerships
- ❖ Moving towards implicit goals regarding renewables

City of Boulder

- ❖ Publicity: Boulder is associated closely with the University
- ❖ Aligning energy consumption with Boulder's Climate Commitment (100% Renewable Energy by 2030)
- ❖ Integrating CU's renewable energy portfolio into City-wide energy mix
- ❖ Using CU's technological expertise to design a path toward 100% RE
- ❖ Showing that the University was in line with Boulder's mentality and general populace on where they stand regarding renewables
- ❖ CU is included in Boulder's renewable goals, which requires CU to be part of reaching the goals for the community at large

Xcel Energy

- ❖ Keeping customers happy - provide cheap and reliable energy
- ❖ Using pricing signals to incentivize a predictable electricity demand management strategy
- ❖ Maintaining regional monopoly and market share - includes not losing CU to Boulder Municipal Utility and avoiding domino effects in Xcel's 8-state territory
- ❖ Complying with Colorado's "Clean Air Clean Jobs Act," which mandates the decommission of 900 MW of coal-based power generation
- ❖ Satisfying Colorado's RPS, which requires that 30% of total energy is generated from renewables by 2020, and 3% from distributed energy resources
- ❖ Transitioning to a new utility business model that incorporates RE, energy storage, and distributed energy generation

CU Students

- ❖ Feeling like they were part of something bigger and working towards a large goal
- ❖ Experiencing grassroots activism
- ❖ Upholding the perceived value proposition and sustainability goals of the University
- ❖ Accessing renewable energy systems and technology for research purposes

Clean Energy Now!

- ❖ Organized and succeeded in accomplishing a grassroot activism campaign
- ❖ Inspired the student body
- ❖ Enacted change at a community level

Specific Outcomes

- ❖ Installation of large-scale solar PV in recent years: 2.8 GW / 130 GW = **2.15% of total energy consumption at maximum output**

CU-Boulder On-Campus Solar Installations			
Location	**Year**	**Power (kW)**	**Energy (kWh/year)**
Indoor Practice Facility	2016	850	1,056,653
Grounds and Recycling	2016	11	15,755
Coors Event Center 2	2013	290	320,000
Research Park Solar Farm (SEEC)	2012	500	850,000
Bear Creek Car-Port	2011	100	141,422
Center for Community	2011	98	140,000
Institute for Behavioral Science	2011	10	13,000
CINC	2010	102	135,102
Coors Event Center 1	2009	88	115,375
CU Wolf Law	2009	12	15,643
Chancellor's Residence	2008	6	8,700
UMC	2004	7	10,150
Total Solar Installation	**2017**	**2,074**	**2,821,800**
Total Energy Consumption	**2017**	**--**	**130,000,000**

- Future of on-campus Solar: Schematic plans to install an additional 8.5 MW of on-campus solar PV on flat-rooftops and parking structure canopies - RFP's submitted as of March, 2017
- Renewable Energy Credits (RECs): Purchase of wind RECs through Xcel's Windsource program - accounts for 5% of CU's annual energy consumption
- Wind purchase and CU-branding: 2000 of energy generated by (1) wind turbine with CU logo - marketing sustainability
- Carbon Offsets: 2012 Environmental Center purchases 8,000 metric tons of carbon offsets for all CU student government buildings
- Total RE Portfolio: CU was 30% Renewable as of 2015 including RECs and on-campus solar
  - 93% of CU's energy is supplied by Xcel's cumulative energy mix - 43% coal, 23% natural gas, 11% nuclear, 19% wind, 4% solar/biomass/hydro (23% RE)
  - Xcel continues to invest in renewable energy: CU % of RE is expected to increase to 42% by 2020 without University action
- Personnel changes / new hires: recent staffing changes in CU administration have revived interest in Renewable Energy
  - 2016: CU hires new Vice Chancellor of Infrastructure, David Kang - previously worked with the military on topics of sustainability and renewable energy integration
  - 2017: CU creates position of Chief Sustainability Officer to coordinate inter-departmental sustainability programs
- Organizational Chart Restructuring: Addressing department isolation and redundancies by combining resources in facilities management - simplifying distributed energy resource installation, O&M

- ➢ Inter-departmental Collaboration: Facilities Management to collaborate with CU transportation planners and combine funding for solar PV canopies over parking
- ➢ Aligning RE generation with campus architecture goals - all new buildings must be LEED Platinum, which requires a certain amount of RE integration

- ❖ Colorado Public University RE Fund: Current negotiations with other Colorado public universities to pool funding for the construction of an off-site wind farm and participate in statewide joint-PPA (2019 decision)
- ❖ REOpt program: collaboration with NREL on renewable energy options and feasibility studies for 100% RE scenario
- ❖ East Campus Resilience Plan - building the infrastructure to allow SEEC to operate as a micro-grid - research opportunities for energy independence and grid resilience

Outcome Indicators

There are a handful of outcome indicators that we have identified which would be useful to apply to the renewable energy system at the University of Colorado.

- ❖ *Global Reporting Initiative (GRI):* The GRI allows an organization to report publicly on its environmental, economic, and social impacts. This initiative could easily be tailored to a large public university such as CU, which is run and operated like a large business operation. In particular, the GRI offers a detailed reporting standard for energy consumption.
- ❖ *The Sustainability, Tracking, Assessment and Rating System (STARS):* STARS is a self-reporting rating framework for the higher education sector to increase their transparent and benchmark their sustainability performance. This initiative accommodates CU energy outcomes well due to its role in rating colleges and university sustainability performance in addition to its focus on tracking energy use.

Upstream, Direct, Downstream, and Enable Impacts Indicators

Source of Impacts	Type of Stakeholder	Indicators
Upstream	Stakeholders involved with the infrastructure, raw materials, and basic services upon which the product or event depend: Xcel, University Administration, City of Boulder	RPS, City of Boulder Climate Goals, GRI, STARS
Direct	Stakeholders engaged in and participating in making the project happen: Environmental Center, Clean Energy Now!	STARS, Environmental Center energy goals, CU Renewables Energy goals
Downstream and Use	Stakeholders involved in servicing, using, storing, distributing, cleaning, etc: CU Students, Staff and Facility, and General Public	Monitoring campus wide energy use (buildings, transportation), Tracking campus renewable energy use
Enabled Impacts	Stakeholder behavior and other impacts that change as the result of the product or event: No long term goal setting which caused a lack of motivation to continue to improve/expand renewable energy projects, Student engagement and pressure lessen which led to the dissolving of Clean Energy Now!	Tracking student participation and involvement in improve campus renewable energy use

Do established indicators exist to measure these outcomes?

- ❖ There are established indicators and measurements for energy usage and consumption by the University. The University displays their solar energy data in the form of Solar Production Dashboards on their website at http://www.colorado.edu/fmenergy/reporting

- For wind energy generation, outcome measurements are less explicit. It is unclear whether CU's investment in the Xcel Windsource program is actually promoting new wind development. The program was introduced in 1997 to subsidize the cost of clean energy when the technology was relatively immature. Now that wind energy has achieved grid parity with other types of energy generation (coal, natural gas), it is unclear whether the Windsource program is still necessary to support renewable energy development.
- There are currently no indicators that measure the direct impact of stakeholders in the CU energy picture. We don't have any mechanisms that monitor the influence of student initiatives in CU decisionmaking. Developing a metric that quantifies the impact of student engagement in campus sustainability would help to promote a more collaborative campus community.

Are indicators affordable, appropriate, sensitive, reliable, and linked to factors stakeholders can influence?

- Measurement and indicators are affordable, appropriate, sensitive, and reliable. The ability to measure and quantify energy consumption and usage has evolved extensively over the last ten years, driven by increased big data and the accessibility of smart-grid technologies and the Internet of Things (IoT). In addition, data collection and the analytic capabilities have greatly enhanced the measurability of energy usage.

If new measures are needed, can they be developed in a timely way?

- Timing is relative when it comes to renewables. Future objectives for renewable energy use at the university will heavily influence whether the system can sustain change in a timely manner. Perspectives will also influence timing. As shown on the meta map, perspectives vary on feasibility of adopting these technologies. Furthermore, renewable energy contains a political element that could speed up or slow down adoption, depending on the makeup of the Board of Regents.
- Overall, campus renewable energy does not reside in an agile system. Limitations on sourcing, pricing, and political will requires a expectation of slow change and room for adoption. Of the pieces in this system, negotiations between The City of Boulder and Xcel on the future of local energy policy could have the ability to accelerate change in CU's energy policy - though not necessarily resulting in a growth of renewable energy adoption. Therefore, the university would be best suited viewing renewable energy implementation through the development of a long-term adoption plan that permits for regular reassessment and fluidity. Since some stakeholders in the system are susceptible to dramatic changes in perspective, any long-term plan needs to consider that the perspectives as read on this map are not firmly fixed as should be readdressed every 2-4 years.

Are the measures readily accessible (and relevant) to all stakeholders? Who does have access? Whose interests are reflected by the measures?

- Measures that could changes the university's adoption of renewables lies heavily in the hands of other actors in the system - particularly those who hold the position of energy contractor to the university. As Colorado is a regulatory system for energy sourcing, the university's ability to adopt measures to change the system reside with expensive on-site sourcing or Xcel. Additionally, influences outside this system's map regarding fuel markets and energy production federally could influence issues such as pricing and access that exist outside the immediate control those on this map.
- As this system depends on a contracts model, the most influential actors and those with access in measurements of change reside with the immediate contract participants - Xcel, CU Office of Facilities Management Energy, and potentially the City of Boulder should it obtain future contracts. Although student action initiated and propelled adoption of some wind energy sourcing, future initiatives will only be as effective as the market and CU's contract will allow. Similarly, these are the interests will be the most heavily reflected in any measure.

Who monitors and reports the indicators? What is the level of transparency? Is their accountability and enforcement? Are their issues regarding trust and commitment?

- The Office of Facilities Management Energy monitors and publicly discloses information on energy operations throughout the the CU Boulder Campus via an energy dashboard (http://www.colorado.edu/fmenergy/reporting.) While these dashboards are currently a mix of current and previous data, FME is in the process of developing a dashboard to illustrate real-time consumption and production metrics (http://www.colorado.edu/fmenergy/programs/intelligent-energy-management.)

- ❖ At the moment, information on energy use outside of the university's administration, regents, Xcel and any other contract-privy entities relies on such disclosure. Any concern that this information does not reflect actual data then becomes and issue of misleading the public. While not comprehensive, there is no indication that this is the case.

What ideas are triggered by looking at lists of indicators?

- ❖ CU Boulder should continue its efforts to onboard a real-time energy use dashboard. Not only will this provide a method of allowing third-parties to analyze and provide feedback on inefficiencies, but may also provide transparency in the generation of on-site renewables and the true costs/benefits involved in their employment.

Lessons Learned Page

Jess - I found this exercise beneficial in that it allowed me to delve deeply into emergence of the renewable energy system at the University of Colorado. That being said, this exercise also let me further explore how stakeholders, motivations, and complex relationships can ultimately dissolve what was a strong system, at one time, through various levers. The renewable energy system has evolved and emerged since 2000, but not in the way that I ultimately assumed it would. The lack of current strategic focus on renewables, the absence of activist students and student groups, and the low prioritization by University Administrators, has effectively silenced what was a momentous movement at the University. I find this truly applicable in regards to my Capstone Thesis, and have learned the importance of continuation plans, strategic future goals, and mapping out the path forward – even if I am not involved in the project in the future, reminiscent of Clean Energy Now!'s lack of go-forward strategy. I look forward to watching how this system continues to emerge, in tandem with the City of Boulder's renewable strategy and driven by a handful of motivated individuals who continue to prioritize renewable energy at the University management level.

Whitney - Defining a system is half the battle. While renewable energy is an enormous system, even within the context of campus operations, addressing this topic allowed me to better understand the influence systems thinking can have on scoping. Too often, we try to define scope through our own perspective. While using the full system's approach may be too comprehensive for many projects, merely going through the perspectives exercise gives us the ability to understand how heavily these perspectives matter, and how much influence they could have on changes to the system. Furthermore, this project improved my understanding of fluidity among perspectives. While I've had considerable exposure to perspectives-based policymaking, common practice often required us to align perspectives with individuals or entities - weighing their relevance by the power of these actors in the system. However, this project suggests that such an approach can ultimately cause us to ignore seemingly peripheral perspectives unless we thoroughly understand the scope of their existence in the system. Understanding that we can inadvertently narrow our understanding of a system by creating rules on how heavily perspectives matter has been an extremely valuable exercise for me.

Neil - To me, learning about the lack of institutional backing for renewable energy at CU through the 3S0 analysis was eye opening. Our interviewees illuminated the fact that the administration has done a fairly effective job of greenwashing its electricity sector. CU's agreement with the city to preserve purchasing rights with Xcel in the event of municipalization truly highlights what little commitment the school has to renewables. Despite student efforts in the early 2000s, support for renewables never took off in a meaningful way and the steps that CU has taken to adopt renewables have been marginal (especially compared to progress made in other on-campus sectors—I think the sports sustainability program has been wildly successful, for example). As I've been thinking about ways to combat the institutional inertia (leverage points) in CU's renewable energy system, I've also been considering my approach towards the latter half of my Capstone Project with TNC. Our goal is to identify policies and practices that will leverage the most carbon sequestration in Colorado, while also considering feasibility. As I approach this section of the project, I'm tempted to map out stakeholders and strategies for each of the policy options we're looking at. I think it would help me identify which policies have the highest feasibility, and could be valuable in forcing me to consider external factors that I might normally miss.

Carly - Performing the 3SO analysis for the University of Colorado Boulder's renewable energy system was eye opening. Using the 3SO tool helped evaluate how various stakeholders respond to the challenges and opportunities of the system. One big insight for me , was how the University's public relations influenced student engagement and greenwashing. Before performing the 3SO analysis, I was under the impression that CU was a leader in supporting and generating renewable energy. I felt like I was constantly bombarded with posters, handouts, and other materials highlighting our efforts with pictures of solar panels and the 'go buffs' windmill. Once we performed the stakeholders analysis, I gained insight that CU actually wasn't performing as highly as I thought in renewable energy and my prior impression was due to the greenwashing of CU's sustainability PR campaign. This greenwashing places a great role in the decreasing amount of student engagement on CU renewable energy consumption as many students, like myself, believe CU is doing their part to source renewable energy. Increasing transparency, would improve student involvement and could establish grassroot efforts to improve the CU renewable energy consumption. Gaining this system perspective reiterates the importance of stakeholder influence in changing a system, affecting outcomes, and developing transparency. Taking the time to see beneath the surface level is a crucial takeaway that will help me be more successful in my capstone project and career path.

Matt - The 3SO process guided our group through a comprehensive analysis of the stakeholders, strategies, systems, and outcomes involved the CU Renewable Energy Student-led Initiatives. I found these four elements and the meta-map to be helpful tools for thinking about a situation and identifying key leverage points for change. Energy sourcing is a deeply complex issue for CU because it involves some of the most powerful and influential stakeholders in the state of Colorado. While these key stakeholders may not share the same values, the 3SO process enabled us to find overlaps in strategies for change. Our interviews were particularly helpful in brainstorming strategies and pinpointing overlaps toward feasible solutions. For example, while the University Administration, CU alumni, and Xcel may not prioritize Renewable Energy, they all have an interest in Grid Resilience, hedging against volatile natural gas prices, and maintaining a reputation of Sustainability on the CU-Boulder campus. While none of these strategies explicitly endorse Renewables, they each support the integration of Renewable Energy indirectly. These are the types of solutions that reveal themselves through Systems Thinking. My interview with CU's Energy Manager, Ellen Edwards, was particularly inspiring. She occupies an interesting vantage point in campus organization, at the nexus of energy, building management, and department politics. In our meeting, she expressed general disappointment in the student body because of their lack of engagement with the University Administration. Unlike our predecessors, the current generation of CU students are complacent and lack focused initiative. According to Ellen, we also lack a backbone. While student consensus seems to prioritize Renewable Energy, student groups aren't bold enough to confront the Administration and demand clean energy for a campus that we pay for. This project has inspired me to think about ways to reignite the Renewable Energy student movement from within the MENV program.

Morgan - While my understanding of renewable energy as a system is already extensive, I found the 3SO process informative of the ongoing system here on campus. Firstly, I found that there are many varying opinions and understandings of what is already going on at CU and how we should proceed in the future. Breaking down stakeholders, systems, strategies and outcomes was eye opening into the many interconnected nodes within a system like this. I was also interested to find that the sustainability platform that many CU students find themselves proud to stand upon is less sturdy than they may think. There has been a lot of greenwashing pushed onto students in this regard. A recent visit to Colorado State University unearthed to me that their sustainability efforts reach far beyond anything that has been done at CU. I appreciated the extensive research required by this project, to give each member of the group a deep and complex understanding of the renewable energy system from past to present. It gave me new motivation for the reasons I entered the renewable energy field in the first place. I want to raise awareness and educate, and help people understand their energy systems beyond paying their monthly utility bill. I think the average student would benefit greatly from reviewing the work that was done by Brugo's Angels on this project.