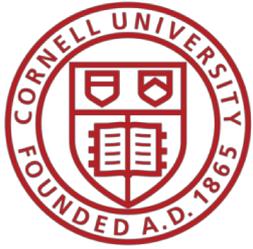


Cornell University

Quadruple Bottom Line

*Embedding a Sustainability Evaluation Framework
across business level decision making*

*AASHE Conference, San Antonio
October 2017*

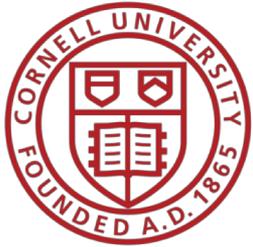


Materials

[sustainablecampus.cornell.edu/initiatives/
quadruple-bottom-line](https://sustainablecampus.cornell.edu/initiatives/quadruple-bottom-line)

or

climateaction.cornell.edu
Left Hand Navigation



About

Quadruple Bottom Line (QBL) Analysis uses mission-aligned sustainability impact areas to strengthen carbon reduction project assessment. Often single-bottom, financial, or non-rigorous 'reputational' factors, drive decision making. QBL uses a metrics framework to assess projects across four impacts areas: People, Prosperity, Planet, and Purpose. How does a solution meet the needs of People on campus, in the community and in the world? Does it enhance campus & community Prosperity now, and in the future? Will it support a sustainable Planet? Does it help the campus fulfill its academic mission and Purpose? By creating this assessment process which combines qualitative and quantitative analysis with strong financial tools for appropriately valuing carbon, upstream fuel-source emissions, and future risk, QBL can be used to assess and compare campus climate solutions at the operational and unit level.

This workshop will focus on how to develop financial and QBL impact analysis tools for valuing climate neutrality solutions. Using tools developed by a team of senior administrators, campus financial stewards, sustainability officers, and facilities engineers at Cornell University for a 2016 report which compared 10 carbon-neutral solutions for meeting campus energy needs, participants will unpack developing criteria for project evaluation, how to develop consensus with decision-makers, and specific applications of the quadruple bottom line framework.

Presenter

Sarah Brylinsky, Cornell University

Andrew Germain, Cornell University

Pursuing a Carbon Neutral Future

“Meeting our goal by 2035 will require creativity and investment. The report will help inform our decisions *in the context of Cornell’s need to advance its academic mission* – which is to offer an excellent, cost-effective education for our students – while creating knowledge that advances society and serves the citizens of New York state and the world. Working to eliminate our carbon footprint will advance these goals.”

– Michael Kotlikoff, Provost



Idea Evolution

- Original goal in 2008 Climate Action Plan: Triple Bottom Line Training for all Managers
- 2009: Management Academy Training on Natural Step 2 Bottom Lines launched
- Spring 2016: Goal becomes an opportunity to strengthen from “training” to actually creating and embedding a framework into decision making
- Fall 2016: Framework piloted for high level project decision making
- Spring 2017: Five pilots launched using new framework
- Today: Framework and Tools exist, integrating into core business decision making



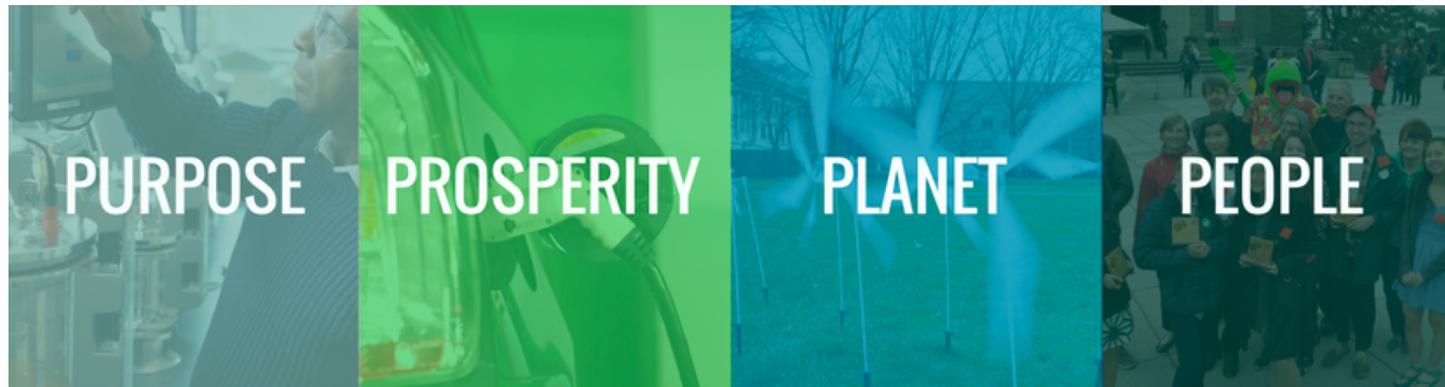
Why Create Embedded Framework?

THE NEW UPSON HALL



Quadruple Bottom Line

The traditional measure of project viability for the campus is based on a single, financial bottom line. A method more in line with sustainable decision making for an educational university considers four impact areas:



Purpose

Does the solution help Cornell fulfill its academic **purpose**?

Prosperity

Does it enhance overall **prosperity** for the campus and our region?

Planet

Does it support a sustainable **planet**?

People

Does it meet the needs of **people** on campus, in the community, and in the world?



QBL Pilot in the Options Report

Detailed technical analysis of feasible options for reaching carbon neutrality by 2035 for heat & power

climateaction.cornell.edu

Options for Achieving a Carbon Neutral Campus by 2035

Analysis of Solutions

Cornell University Senior Leaders Climate Action Working Group
September 2016



Cornell University

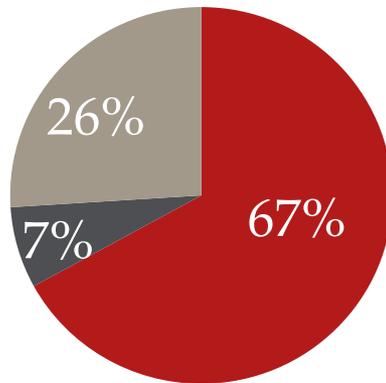
- Updated financial analysis of options to reach neutrality for campus energy
- New tools for valuing projects:
 - Estimating the impact of upstream natural gas leakage
 - The social cost of carbon
 - Introducing the quadruple bottom line



Tools for Valuing Projects:

Greenhouse Gas Inventory - Impact of Using Natural Gas

Baseline Inventory
Ithaca Campus, 2014



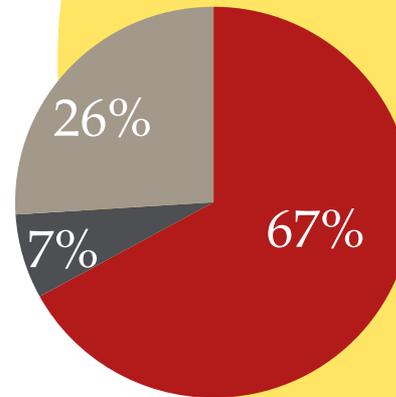
241,445

Total Emissions
(MT CO₂e)

Campus Energy 179,303

- Produced Power: 161,806
 - Purchased Electricity: 17,497
 - Transportation: 62,142
- (Claimed Reductions: -27,795)*

Accounting for
Methane Leakage



821,445

Total Emissions
(MT CO₂e)

Campus Energy 179,303

- Produced Power: 161,806
- Purchased Electricity: 17,497
- Transportation: 62,142
- Methane Leakage: **580,000**

Tools for Valuing Projects

Social cost of carbon

- A calculation of the economic toll of the impacts of climate change.
- The report applies an average charge of \$58 per metric ton of CO₂e emissions to offsets for all direct emissions in all financial scenarios, and to the methane leakage models described in the report.

Social Cost of CO₂, 2015-2050^a (in 2007 Dollars per metric ton CO₂)				
Source: Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (May 2013, Revised July 2015)				
Discount Rate and Statistic				
Year	5% Average	3% Average	2.5% Average	3% 95th percentile
2015	\$11	\$36	\$56	\$105
2020	\$12	\$42	\$62	\$123
2025	\$14	\$46	\$68	\$138
2030	\$16	\$50	\$73	\$152
2035	\$18	\$55	\$78	\$168
2040	\$21	\$60	\$84	\$183
2045	\$23	\$64	\$89	\$197
2050	\$26	\$69	\$95	\$212

^a The SC-CO₂ values are dollar-year and emissions-year specific.



Quadruple Bottom Line



Cornell University

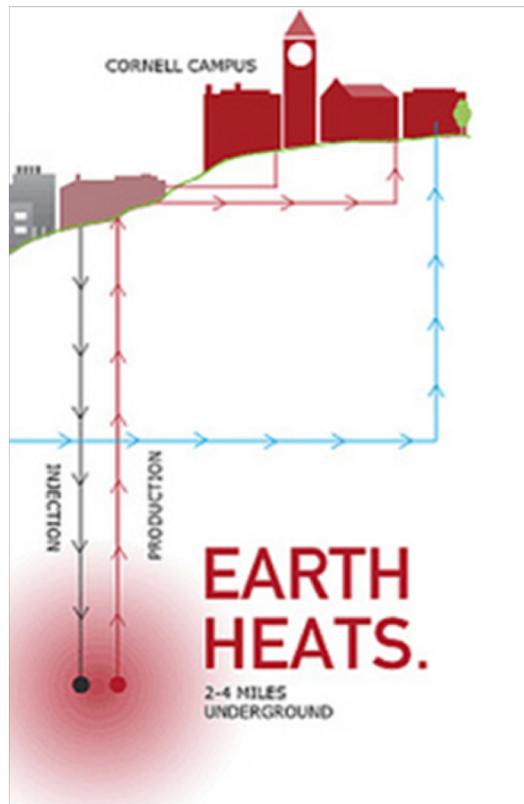
People · Prosperity · Planet · Purpose

We apply the following questions to our project evaluation:

- does the solution help Cornell fulfill its academic mission and **purpose**?
- does it meet the needs of **people** on campus, in the community, and in the world?
- will it enhance overall **prosperity** for the campus and our region?
- does it support a sustainable **planet**?

Earth Source Heat

Earth Source Heat (ESH)	Supports Cornell Mission (Purpose)	Supports Cornell Finances (Prosperity)	Supports Community Goals (People)	Supports Environmental Needs (Planet)
Average	4.29	2.29	3.57	4.29
Standard Deviation	0.76	1.38	1.13	0.76

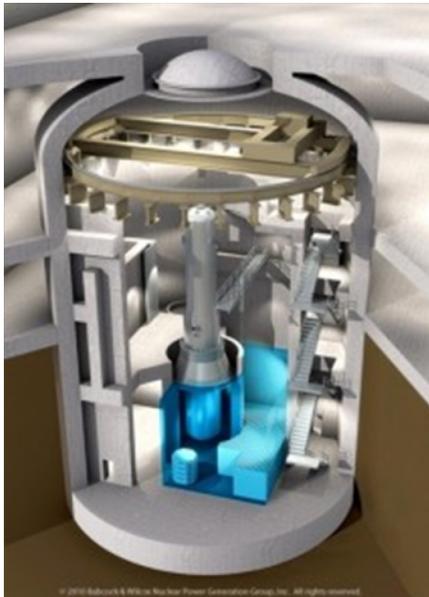


ESH Note Comments

- Great research and demonstration project; moves us towards C neutrality if successful, and C neutrality alone is important to our missions of being the Green Ivy
- Here and in all of the following technologies, I assume continued use of fossil fuels puts Cornell at risk, due to increasing volatility and the eventual likelihood of a carbon fee or tax. I rank ESH higher than other items due to higher chance of external funding.
- C neutrality, without long-term traffic, and zero emissions.
- Need to discuss that all of these options as presented do not include the methane leakage and what that does to relative costs vs BAU. It would be helpful in the discussion to show table 8.1 (or maybe convert it to a graph?). It depends how we go about it – if we can get significant external capital funds, it is also low opex. It would be helpful in the discussion to show the BAU parity table 7.19 from CNCEAR and graphed cap/op ex.
- I have the sense that the community gets that we need a non-combustion solution for heating and need to start addressing heat not just electric, lowest impact on surrounding land, visual etc.
- This is dead on mission – particularly ACSF – Applied research leading to translational solutions to move the needle toward sustainability. Not sure why staff reviewed this lower than B/ESH
- The risks are obvious – cost overruns, stop gates, etc. But this is a huge hedge against fossil fuel costs and/or carbon taxes if successfully implemented. Hard to say today how big those future risks are but they are appreciable and I considered going with a 3.
- Seems to hit your definition dead on. Addresses GHG brilliantly, scalable and could lead to business infrastructure being established locally, minimizes land, traffic and air pollution
- Does it all – only downside is extreme cost of building so many well-pairs
- Will do this option only if we can get OPM: Other people's money. Private investment and state and federal R&D funding.
- Technical unknowns / implementation time
- High cost uncertainty
- Requires convert to hot water

Small Modular Nuclear Reactor

Small Modular Nuclear Reactor (SMR)	Supports Cornell Mission (Purpose)	Supports Cornell Finances (Prosperity)	Supports Community Goals (People)	Supports Environmental Needs (Planet)
Average	1.67	2.11	1.78	2.89
Standard Deviation	1.00	1.05	0.97	1.05
Member Draft Score				
Member Final Score				



SMR Notes

- Would undercut the image of Green Ivy, in the eyes of many
- Reasonable cost..... but are cost estimates real??? Waste disposal?
- Fear about nuclear....
- C neutral, but environmental damage from mining of fuels, and waste disposal problem.
- The opex in the info packet seems too low based on Josh's input at our meeting? We did not include potential insurance premiums – that might be something to consider for any of these options that we move forward.
- Seems unlikely to attract external funding based on having had nuc engineering program and a reactor that was decommissioned
- Note Katherine McCommas' survey <https://es.fs.cornell.edu:8448/Sustain/cap/Shared%20Documents/2007-McComasCarbonNeutralSurveyReport.pdf> of Cornell undergrads this was by far the lowest rated. FYI her community survey did not include nuclear <https://es.fs.cornell.edu:8448/Sustain/cap/Shared%20Documents/2009%20CAPCommunityAttitudesSummaryReport.pdf>
- The waste issue makes this a concern
- Tremendous potential for delays and extra costs. These do not currently exist so if we bet on them it may never happen
- Community wants zero GHG – they have not really thought about this and there will be a vocal no nukes crowd but plenty of supporters. It is a viable solution to move off fossil fuels and one of the very few for heat.
- If waste risks can be dealt with this moves way up.
- Lots of research in this area. Sixty-three university just won major federal grant.
- Per Los Alamos: .07-.11/kwhr
- Maintain steam system
- Full GHG reduction / 5-7 yr. implementation time

Quadruple Bottom Line Project Analysis



Cornell University

Options for a Climate Neutral Campus by 2035
Cornell University 2016

Heating & Powering Solutions

Purpose
 Prosperity
 People
 Planet

QBL Analysis

	Purpose	Prosperity	People	Planet
Earth Source Heat + WWS + Biomass Gasification	Green	Yellow	Yellow	Green
Earth Source Heat + WWS	Green	Yellow	Yellow	Green
Air Source Heat Pumps + WWS	Yellow	Red	Yellow	Green
Ground Source Heat Pumps + WWS	Green	Red	Yellow	Green
Nuclear	Red	Red	Red	Yellow
Business as Usual + Carbon Offsets	Yellow	Red	Red	Red

Options Report: Final Analysis



Cornell University

(AEC = Annual Cost + Capital Cost spread over 30 years)

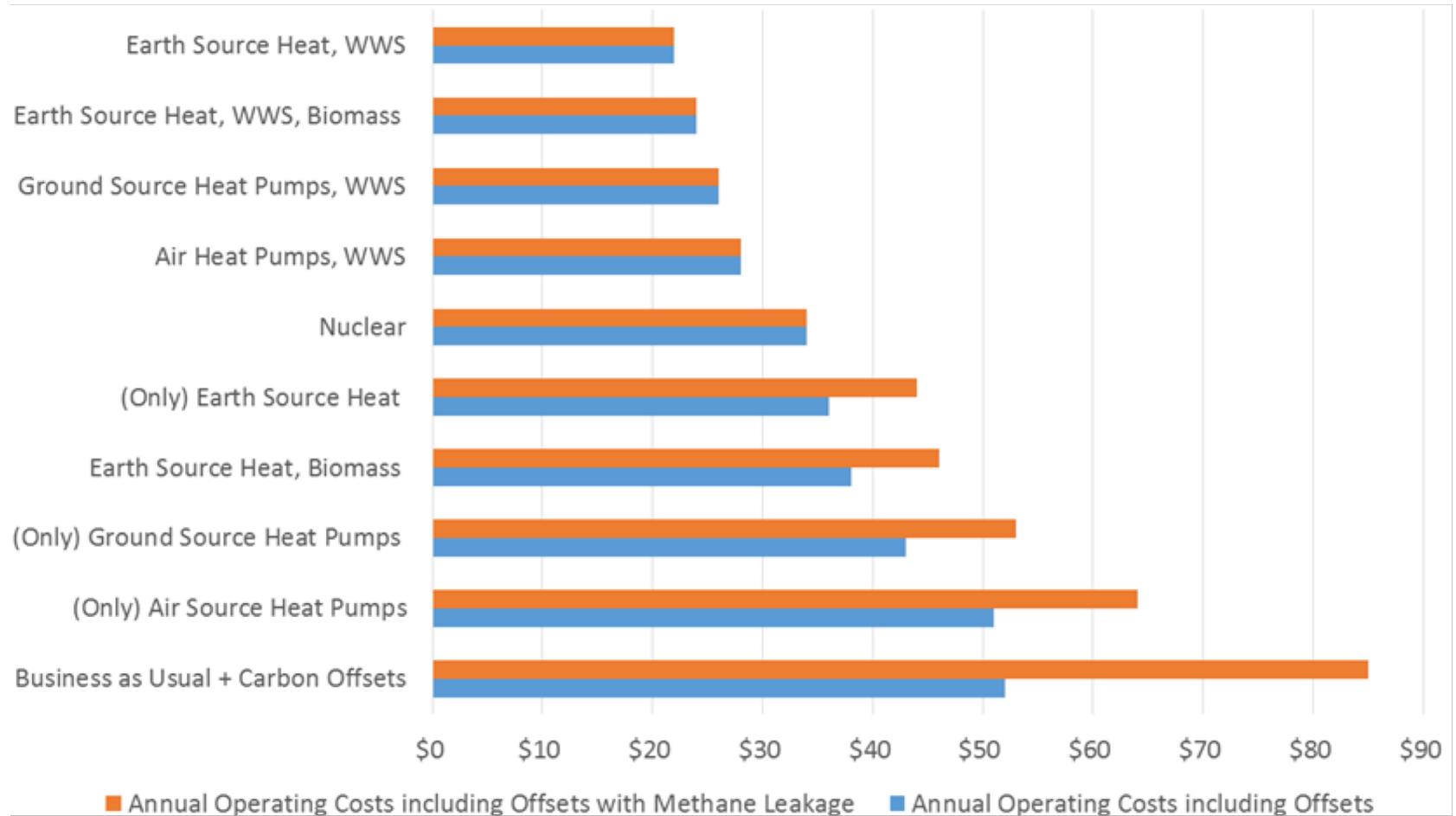
Up-Front Capital Cost	Annualized Capital Cost	Annual Operating Cost	Annual Offsets Cost	Annual Equivalent Cost	Accounting for Methane Leakage		QBL Analysis			
					Annual Offsets Cost	Annual Equivalent Cost	Purpose	Prosperity	People	Planet

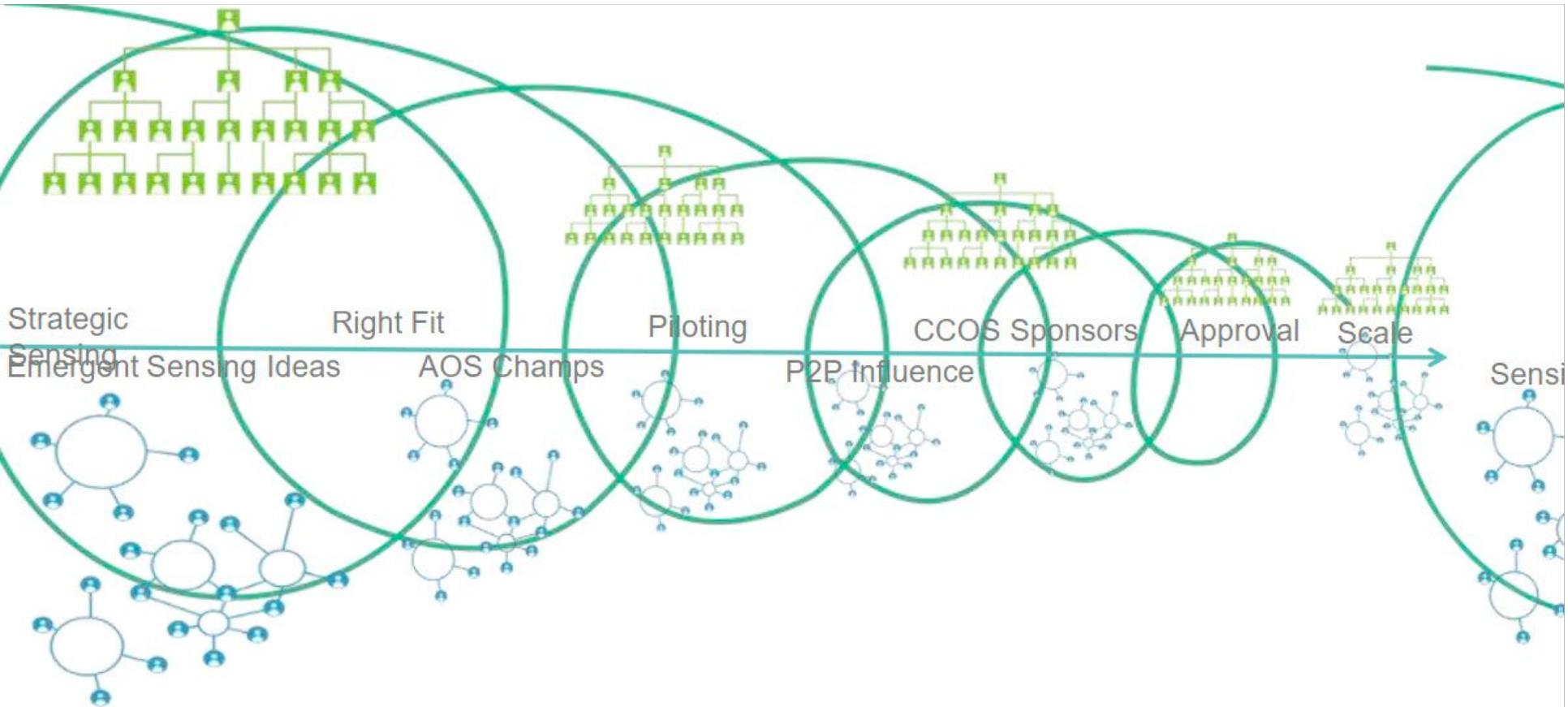
Business as Usual (for comparison, not a solution)					\$42								
<i>Heating & Powering Solutions</i>	1.	Earth Source Heat, WWS, Biomass	\$700	\$47	\$24	-	\$71	-	\$71	●	●	●	●
	2.	Earth Source Heat, WWS	\$730	\$50	\$22	-	\$72	-	\$72	●	●	●	●
	3.	Air Heat Pumps, WWS	\$930	\$62	\$28	-	\$90	-	\$90	●	●	●	●
<i>No offsets needed</i>	4.	Ground Source Heat Pumps, WWS	\$920	\$55	\$26	-	\$81	-	\$81	●	●	●	●
	5.	Nuclear	\$700	\$42	\$34	-	\$76	-	\$76	●	●	●	●
<i>All offsets needed</i>	6.	Business as Usual + Carbon Offsets	-	-	\$42	\$10	\$52	\$43	\$85	●	●	●	●



Annual Operating Costs

Technical Solutions Reviewed for the Report





"Phases in Healthy Idea Flow" by [Leith Sharo](#) is licensed for open sharing and adapting under Creative Commons [CC BY-AS 4.0](#)



*Incorporating the Quadruple Bottom Line
into the Project Approval Process*



So... when do we talk about this?
Andrew Germain

Life Cycle of a Project



Cornell University

Capital Planning & Prioritization

Scope Development

Identification & Support

Capital Plan Review



Review & Study

Approved Capital Plan

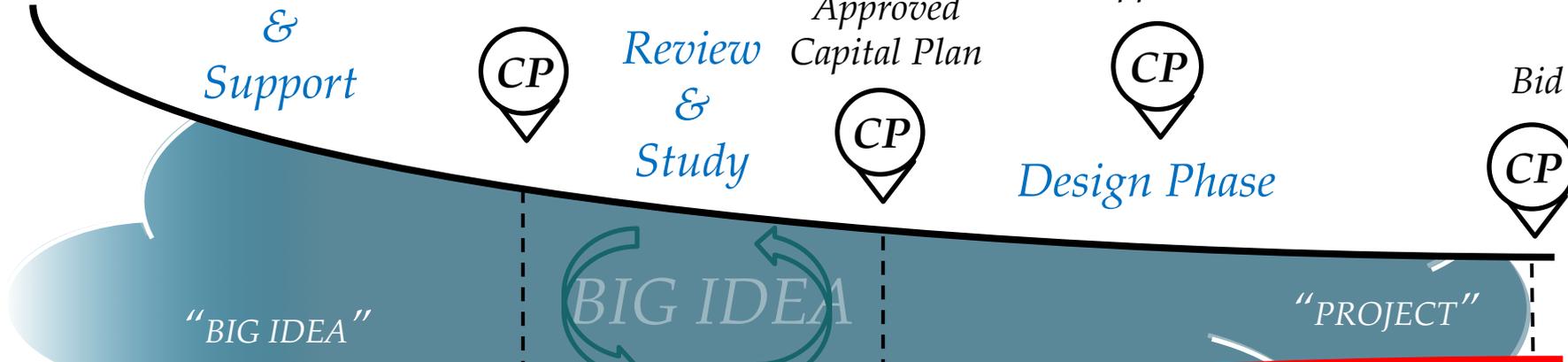


Design Approval



Design Phase

Bid



Threshold Criteria

Prioritization Criteria

Project Requirements

Budget Development

TIME

Capital Planning & Prioritization

Threshold Criteria

- *Conformance with the Campus Master Plan*
- *Process & Voice*



Prioritization Criteria

- *Academic Mission*
- *Cornell character/identity*
- *Def Maint & Regulatory Compliance*
- *Life on Campus*
- *Building Functionality and Site Use*

Project Requirements

- *Sustainability*
- *Process & Voice*
- *Positive Spillovers & Externalities*
- *Community Engagement, Integration, and Grant Opportunities*
- *Innovation*

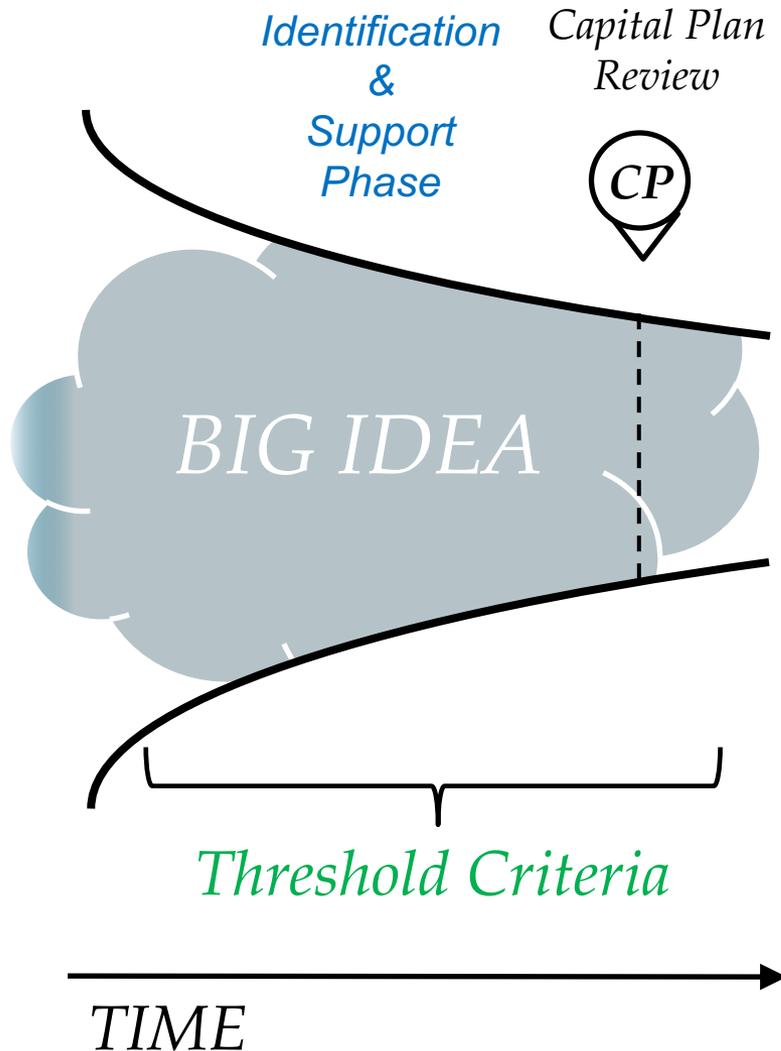




Where Does QBL Best Fit?



Cornell University



Threshold Criteria

- *Conformance with the Campus Master Plan*
- *(Quadruple Bottom Line)*
- *Process & Voice*



Where does QBL Best Fit?



Prioritization Criteria

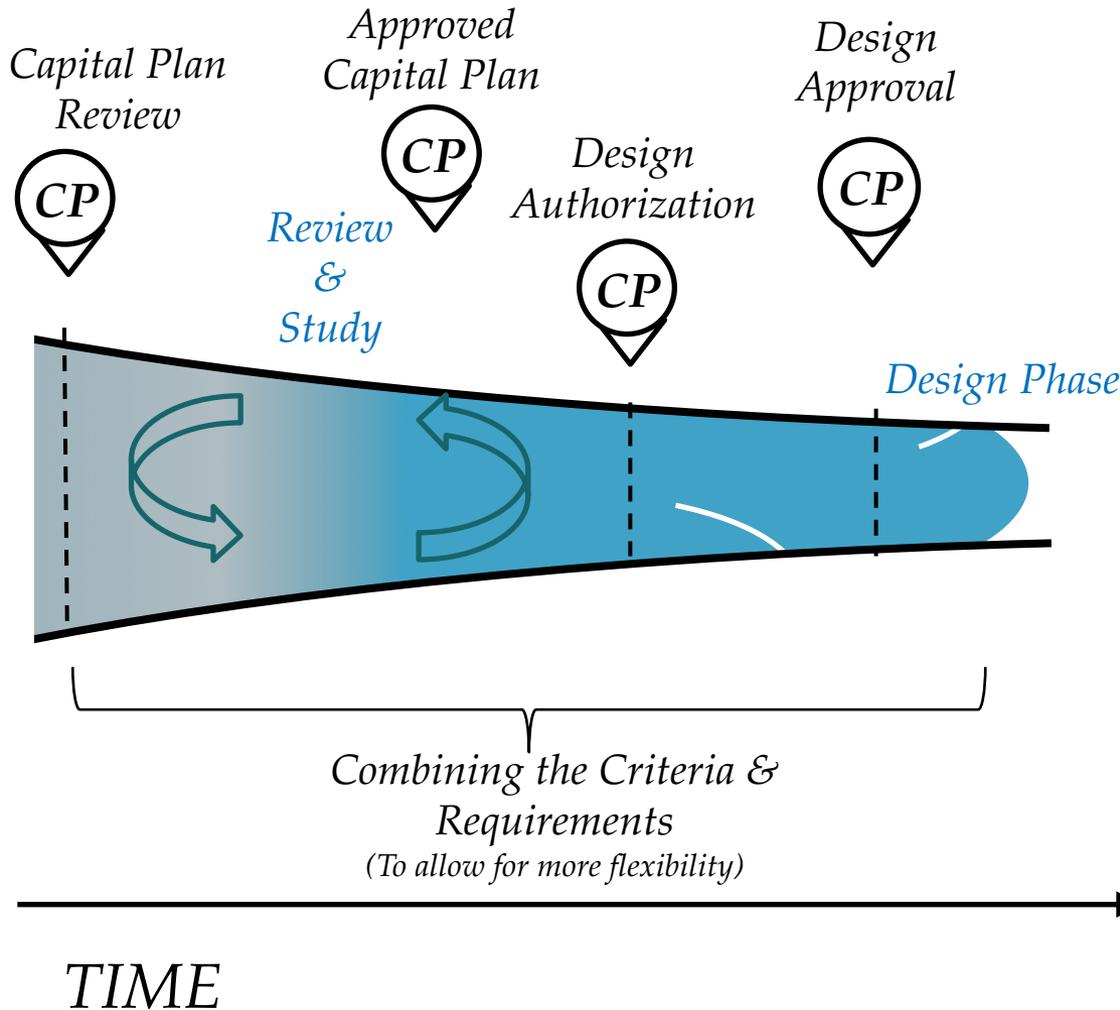
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Project Requirements

- Academic Mission
- Cornell character/identity
- Deferred Maint. & Compliance
- Life on Campus
- Building Functionality & Site Use

(Quadruple Bottom Line)

- Sustainability
- Process & Voice
- Positive Spillovers & Externalities
- Community Engagement, Integration, and Grant Opportunities
- Innovation



Basis of Design Document



Cornell University

Living Document:

- *Defines the Scope of the Project*
- *Documents Prioritization Process*
- *Records Decisions*

Threshold Criteria

Prioritization Criteria

Project Requirements





Sustainability Assessment Framework

Quadruple Bottom Line Tools

Sustainability Evaluation Framework

Purpose · People · Prosperity · Planet

Purpose

Does the solution help Cornell fulfill its mission and **purpose**?

- Mission Alignment
- Reputation
- Teaching
- Research
- Land Use
- Leadership

People

Does it meet the needs of **people** (campus, community, world?)

- Human Health
- Human Well-Being
- Community Character
- Regional Economic Impact
- Socialized Costs
- Work-Life Balance

Prosperity

Does it enhance overall **prosperity** for campus and region?

- Risk Mitigation
- Financial Security
- Short vs. Long-term Costs
- Job Opportunities
- Climate Risk

Planet

Does it support a sustainable **planet**?

- Environmental Quality
- Ecosystems
- Materials
- Climate Change
- Land Use

Which sub categories are applicable?

Level of detail and specific areas will differ

Sustainability Evaluation Framework

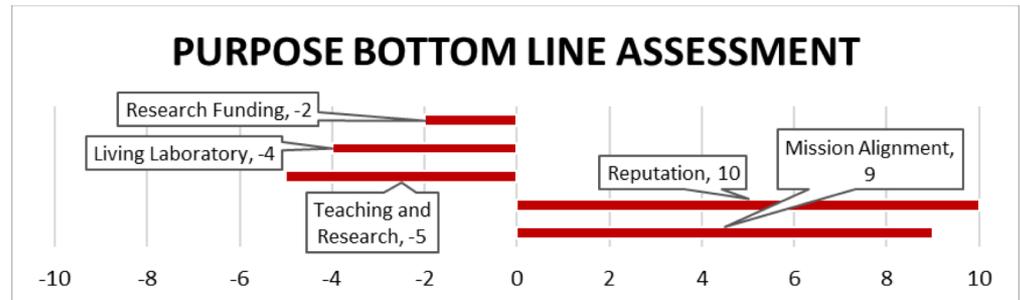
Step 1: Select sub categories to evaluate as appropriate for project



Step 2: Qualitative assessment of each sub category

What is the lifecycle impact of materials used in construction and upkeep?

Step 3: Assign a quantitative ranking to each sub-category and overall impact area



Sustainability Evaluation Framework

Worksheet Evaluation Tool



Cornell University

Sustainability Evaluation Framework Tool

Instructions: [Link: O&L Analysis Framework Worksheet](#)

1. Refine Impact Area or Assessment - Assess appropriate categories for impact assessment in each of the four quadrants.
2. Qualitative Assessment - Once impact areas have been refined, qualitative analysis in each area using guidance questions above or those created for specific project should be provided. Same impact area or content may be unknown.
3. Quantitative Assessment - Provide an assessment of the overall impact in each category. Overall positive benefit (maximum 10), neutral benefit, or detrimental carry (minimum -10).
4. Provide Final Impact Analysis - Final analysis should include both quantitative visualization and qualitative notes. Rationale should be provided for category chosen for impact area, if applicable.

1. Refine Impact Areas

Impact Area	Impact Category	Relevance	Questions
Purpose	Mission Alignment		How does the project align with Cornell's educational and land grant mission?
Purpose	Regulation		How does it increase Cornell's reputation as a global institution addressing climate change and sustainability outcomes?
Purpose	Teaching and Research		Does it provide research, teaching opportunities? Is it aligned with existing programs?
Purpose	Teaching and Research	Living Laboratory	How does the project create living laboratory opportunities for students, faculty, and staff?
Purpose	Teaching and Research	Research Funding	Will it attract external, long-term research funding?
People	Leadership	Innovation	Is the solution a novel, scalable option to share with others? Does it help regional carbon reduction efforts?
People	Leadership	Skills/Ability	
People	Leadership	Regional Climate Goals	
People	Health & Well-Being	Quality of Life	Does it increase the quality of life for employees, students, or the surrounding community? Safety & security? Educational attainment? Equity? Happiness?
People	Health & Well-Being	Human Health	
People	Community Character	Visual Impact	Does it impact visual, infrastructural, social or community resources development?
Prosperity	Economic Impact	Job Creation	Does it create jobs? Long-term? Local base? Living wage?
Prosperity	Socialized Costs	Socialized Costs	Are there socialized costs or benefits associated with the project?
Prosperity	Risk Mitigation	Climate Change	How does the project mitigate factors such as uncertainties from research uncertainty, climate change, or other sustainability concerns?
Prosperity	Risk Mitigation	Resiliency	Does it increase Cornell's resiliency for the local economy?
Prosperity	Risk Mitigation	Longevity	What elements of the project will allow Cornell to plan for today and the future in an economically favorable way?
Prosperity	Financial Security	Financial Security	What are the financial costs, social and lifecycle costs? Does this project minimize life cycle costs?
Planet	Environmental Quality		Are there environmental and ecological benefits or risks related to land use, water, biodiversity, air quality or noise?
Planet	Ecosystem Services		What are the impacts on surrounding ecosystems/practices, e.g. production of food and water; recreation, i.e. control of climate and
Planet	Materials		What is the lifecycle impact of materials used in construction and operation?
Planet	Climate Change	Renewable Energy	
Planet	Climate Change	Energy Efficiency	
Planet	Climate Change	Carbon Emissions	How does this solution ensure that Cornell fulfills its commitment to sustainability and mitigating climate impact? Does it reduce the demand for fossil fuel and decrease the resiliency to loss or an energy energy supply?

2. Qualitative Analysis

3. Quantitative Assessment

Impact Area	Impact Category	Impact Relevance	Score (0 to 10)
Purpose	Mission Alignment	Mission Alignment	5
Purpose	Regulation	Regulation	5
Purpose	Teaching and Research	Teaching and Research	5
Purpose	Teaching and Research	Living Laboratory	5
Purpose	Teaching and Research	Research Funding	5
People	Leadership	Innovation	5
People	Leadership	Skills/Ability	5
People	Leadership	Regional Climate Goals	5
People	Health & Well-Being	Quality of Life	5
People	Health & Well-Being	Human Health	5
People	Community Character	Visual Impact	5
Prosperity	Economic Impact	Job Creation	5
Prosperity	Socialized Costs	Socialized Costs	5
Prosperity	Risk Mitigation	Climate Change	5
Prosperity	Risk Mitigation	Resiliency	5
Prosperity	Risk Mitigation	Longevity	5
Planet	Environmental Quality	Environmental Quality	5
Planet	Ecosystem Services	Ecosystem Services	5
Planet	Materials	Materials	5
Planet	Climate Change	Renewable Energy	5
Planet	Climate Change	Energy Efficiency	5
Planet	Climate Change	Carbon Emissions	5

PURPOSE BOTTOM LINE ASSESSMENT

PEOPLE BOTTOM LINE ASSESSMENT

PROSPERITY BOTTOM LINE ASSESSMENT

PLANET BOTTOM LINE ASSESSMENT

Sustainability Evaluation Framework



What could the framework help us do?

1. Systematically evaluate and document carbon neutrality and sustainability impacts (due diligence)
2. Ensure all sustainability needs are balanced and considered throughout the lifecycle of decision making in a project or process
3. Early identification of risks or previously unseen benefits to communicate to stakeholders
4. Embrace complex costs and benefits



Sustainability Evaluation Framework



Where could the framework be used?

1. To compare different projects, solutions, or products against each other
(Options Report, campus energy solutions)
2. At the beginning, middle, and end of project development to ensure tradeoffs or changes to one area do not drastically reduce benefits or add hidden costs to the University in another area
3. Flexibly. More comprehensive for larger projects, or scaled down for smaller projects. Most important to ensure the four impact areas are at least discussed and considered.



Sustainability Evaluation Framework



Questions under consideration...

- Not everyone is an expert in every area. Should all input be valued equally? How should non-expert feedback be integrated?
- QBL analysis often brings up questions we do not have the answers to. How do we address creating new ways of knowing, new areas of data, without becoming lost in a rabbit trail of “what if...”?
- Often easier to think of negative impacts rather than positive impacts
- Where should the framework be incorporated? At what level?





Cornell University

Thank You

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