Briefing to the Faculty Senate

"Options for Achieving a Carbon Neutral Campus by 2035"

Robert Howarth
The David R. Atkinson Professor of Ecology & Environmental Biology
and
Edwin A. Cowen
Professor of Civil and Environmental Engineering and the Kathy Dwyer Marble and Curt Marble Faculty Director for Energy, David R. Atkinson Center for a Sustainable Future

On behalf of the Senior Leaders Climate Action Group (SLCAG)

9 November 2016

Pursuing a Carbon Neutral Future

Campus community has embraced and remains committed to the goal of reaching carbon neutrality by 2035.

- Climate Action Plan published in 2009; Updated 2013.
- Acceleration Working Group Report published 2014.
- In March 2016, Provost Kotlikoff charged the Senior Leaders Climate Action Group with analyzing viable options for the Ithaca campus to meet that goal.
- “Options for Achieving Carbon Neutrality by 2035” is not a defined plan of action, but rather a thorough review of feasible options and associated costs.

How is this report different?

- Updated financial analysis

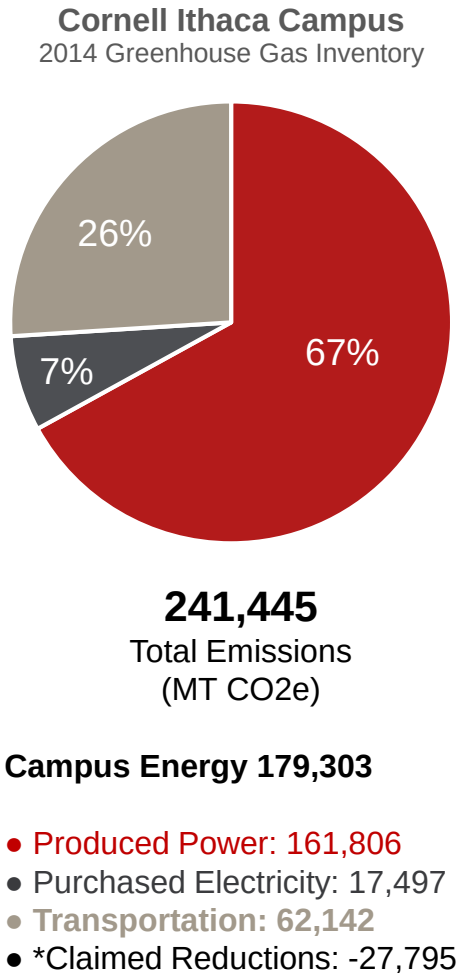
- Identifies new tools for valuing projects:
  - The social cost of carbon
  - Introducing the quadruple bottom line
  - Estimating the impact of upstream natural gas leakage

Cornell's Carbon Footprint

Campus energy needs account for nearly two-thirds of Cornell's carbon dioxide footprint.

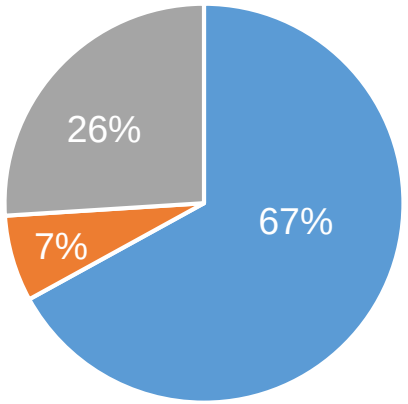
Size of the Problem:

- 179,303 metric tons of CO2e
  (energy produced + purchased from grid)
- 62,142 metric tons of CO2e (transportation)
- **241,445 metric tons of CO2e (total)**
  (213,650 after -27,795 claimed reductions)



2014 Ithaca Campus Greenhouse Gas Inventory, Impact of Using Natural Gas

Baseline Inventory

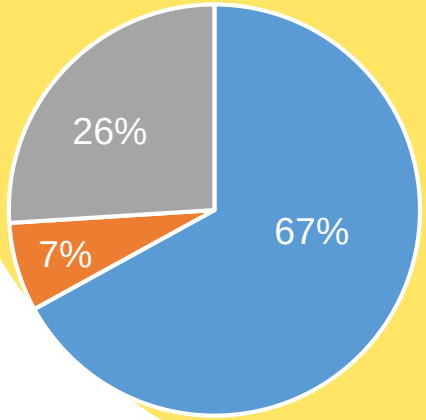


241,445
Total Emissions
(MT CO2e)

Campus Energy 179,303

- Produced Power: 161,806
- Purchased Electricity: 17,497
- **Transportation: 62,142**

Accounting for Methane Leakage



821,445
Total Emissions
(MT CO2e)

Campus Energy 179,303

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

Carbon Footprint Challenges

- Designing a heating system that can handle the high energy demand of a research institution, and extreme weather conditions of Ithaca, NY.
- Current low cost of fossil fuels makes it difficult to justify renewable energy projects based simply on a return-on-investment analysis.
- Reducing the energy demand of campus buildings; increasing the number of high-performance buildings.

Carbon Footprint Benefits

- Advancement of Cornell's academic and land-grant mission; become a model for reducing fossil fuel use for the state and the world.
- Reduced financial exposure to increasingly unstable energy markets, compliance regulations, and potential changes in carbon policy.
- Demonstrate enhanced geothermal energy, possibly establishing a new industry in upstate New York.
- New revenue streams from external fundraising and energy conservation savings.

Solutions for Today: Recommendations

Community Engagement

- Further utilize the Think Big, Live Green campaign to educate and engage the campus community.
- Ensure all students graduate with a basic literacy of climate change.

Build High-Performance Buildings

- Modify capital projects approval processes to incorporate the quadruple bottom line in long term building maintenance and planning.
- Expand the Energy Conservation Initiative and Continuous Recommissioning Program to further drive down the energy use of existing buildings through increased investment in both, and extending the payback period required for energy conservation projects.

Increase Electric Vehicle Capacity

- Prioritize development of infrastructure to support a campus fleet of clean-fuel vehicles and replace the existing fleet accordingly.

Solutions for Today: Recommendations

Community Engagement

- Further utilize the Think Big, Live Green campaign to educate and engage the campus community.
- **Ensure all students graduate with a basic literacy of climate change.**

Build High-Performance Buildings

- Modify capital projects approval processes to incorporate the quadruple bottom line in long term building maintenance and planning.
- Expand the Energy Conservation Initiative and Continuous Recommissioning Program to further drive down the energy use of existing buildings through increased investment in both, and extending the payback period required for energy conservation projects.

Increase Electric Vehicle Capacity

- Prioritize development of infrastructure to support a campus fleet of clean-fuel vehicles and replace the existing fleet accordingly.

Solutions for Tomorrow

Increasing Renewable Energy Supply

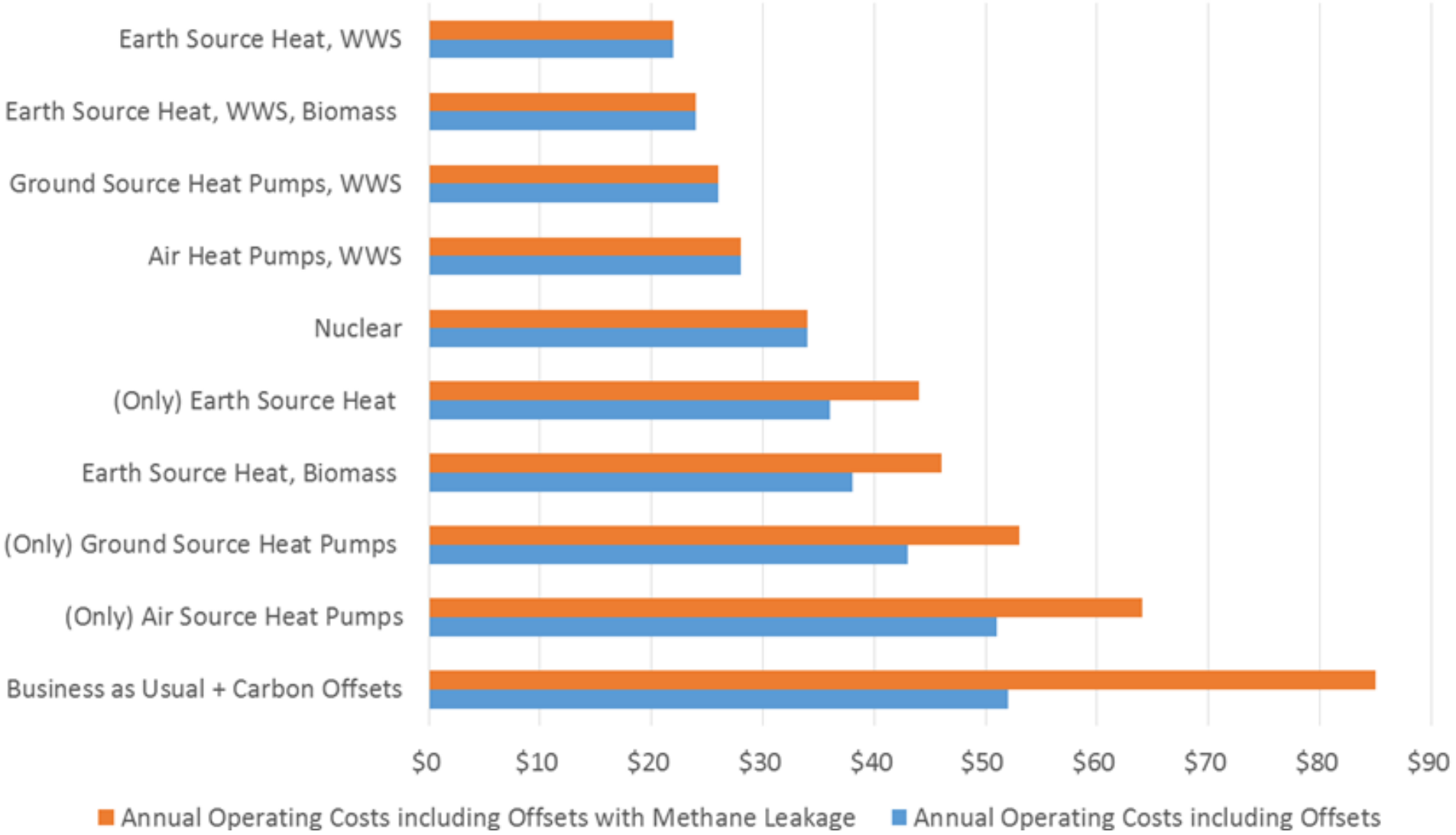
Solutions for Heating and Powering

1. Earth Source Heat Combined with Wind, Water, Solar and Biomass
2. Earth Source Heat Combined with Wind, Water and Solar
3. Ground Source Heat Pumps Combined with Wind, Water and Solar
4. Air Source Heat Pumps Combined with Wind, Water and Solar
5. Nuclear
6. Business as Usual, with Purchased Offsets

Solutions for Campus Energy Supply, Financial Details

			(AEC = Annual Cost + Capital Cost spread over 30 years)					Accounting for Methane Leakage		QBL Analysis			
			Up-Front Capital Cost	Annualized Capital Cost	Annual Operating Cost	Annual Offsets Cost	**Annual Equivalent Cost**	Annual Offsets Cost	**Annual Equivalent Cost**	Purpose	Prosperity	People	Planet
Business as Usual (for comparison, not a solution)			$42		$42								
Heating & Powering Solutions *No offsets needed*	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**	●	●	●	●
	4.	Ground Source Heat Pumps, WWS	$920	$55	$26	-	**$81**	-	**$81**	●	●	●	●
	5.	Nuclear	$700	$42	$34	-	**$76**	-	**$76**	●	●	●	●
All offsets needed	6.	Business as Usual + Carbon Offsets	-	-	$42	$10	**$52**	$43	**$85**	●	●	●	●
Heating Solutions *Offsets for Electricity*	7.	Earth Source Heat, Biomass	$430	$31	$36	$2	**$69**	$10	**$78**	●	●	●	●
	8.	(Only) Earth Source Heat	$470	$36	$34	$2	**$72**	$10	**$80**	●	●	●	●
	9.	(Only) Air Source Heat Pumps	$490	$28	$47	$4	**$79**	$17	**$92**	●	●	●	●
	10.	(Only) Ground Source Heat Pumps	$600	$34	$40	$3	**$77**	$13	**$87**	●	●	●	●

Annual Operating Costs of Solutions



Conclusions & Recommendations: Increasing Renewable Energy Supply

- Strive to meet or offset 100% of the expected annual campus electricity demand through cost-effective wind, water and solar projects.
- Pursue Earth Source Heat, as it is the most promising technology for heating the campus in our climate; greatest potential for outside funding.
- If Earth Source Heat is found not to be viable within five years, review options for utilizing ground source heat pumps.
- Continue to review other renewable options as technical and cost feasibilities change over time.

SLCAG Report for Carbon Neutrality endorsed by University Assembly (18-0-2 vote) on Nov 1, with charge to administration to report to the Assembly regarding progress toward carbon neutrality on an annual basis.

Questions and discussion:

- Balancing risks and opportunities (financial, ethical, reputational)
- Goal of climate literacy for all undergraduates (desirable? If so, how best achieved? Leadership for this and role of Faculty Senate)