Carleton’s utility plan is part of a 10-year planning progression.
The charge.
Key objectives:

1. Replace the *aging and outdated* central plant facilities, campus steam distribution network and controls

2. Provide for *future loads* as envisioned in the Facility Master Plan

3. Reduce our *operating costs and carbon emissions* significantly and permanently
Little campus on the prairie.
First building constructed in the 1910 campus master plan
We are now planning for the next 100 years.
We are always asking:

- How much should we invest now to save long term?
- What technology investments will serve us well into the future?

Expanding the steam tunnels

Installing a wind turbine (2011)
Build off of existing plans.
How can we incorporate the goals of prior strategic plans into the utility planning process?
We believe colleges and universities must exercise leadership in their communities and throughout society by modeling ways to minimize global warming emissions, and by providing the knowledge and the educated graduates to achieve climate neutrality.”

- ACUPCC Excerpt

Carleton signed in 2007
2011 Climate Action Plan

2011 CAP: carbon reduction strategies

GREENHOUSE GAS MANAGEMENT

DEMAND FOR ENERGY
- People, Practices, and Politics
  - Green Building Standards
  - Behavior Change Initiatives
  - Space Utilization
  - Land Management Policies/Practices
- Physical Systems and Technologies
  - Energy Conservation Measures
  - Green IT
  - Metering and Monitoring
  - Campus Transportation

SUPPLY OF ENERGY
- Supply Efficiency
  - Central Combined Heat and Power (CHP)
  - Building Level Combined Heat and Power (CHP)
  - Building Chilled Water Upgrades
  - Central Chilled Water Upgrades
  - Steam Line Upgrades
- Substitute Fuels
  - Biomass
  - Wind
  - Municipal Solid Waste
  - Landfill Gas (Direct Connection)
  - Landfill Gas (Methane Flaring)
  - Small-scale Nuclear
  - Animal Waste to Energy
  - Used Oil
- Building Level Renewables
  - Geothermal
  - Solar Domestic Hot Water
  - Solar Photovoltaic
  - Solar Thermal
  - Renewable Energy Credits (RECs)

MARKET/THIRD PARTY PURCHASES
- Market/Third Party Purchases
  - Renewable Energy Credits (RECs)

OTHER
- Transportation
  - Business Travel
  - Improved Commuting
- Waste Management
  - Source Reduction
  - Waste Diversion
  - Campus Vehicles
  - Composting
- Offsets
  - Land/Forest Management
  - Other Carbon Offsets
  - Avoided Travel
    - Inter-campus Connectivity

Legend:
- Included in plan, quantified
- Included in plan, not quantified
- Not included in plan, quantified
- Not evaluated
- Future technology to watch
2011 CAP: carbon reduction strategies

Strategies that are complete and ongoing.

GREENHOUSE GAS MANAGEMENT

DEMAND FOR ENERGY
- People, Practices, and Politics
  - Green Building Standards
  - Behavior Change Initiatives
  - Space Utilization
  - Land Management Policies/Practices
- Physical Systems and Technologies
  - Energy Conservation Measures
  - Green IT
  - Metering and Monitoring
  - Campus Transportation

SUPPLY OF ENERGY
- Supply Efficiency
  - Central Combined Heat and Power (CHP)
- Substitute Fuels
  - Biomass
  - Renewable Energy Credit (RECs)
- Building Level Renewables
  - Wind
  - Solar Domestic Hot Water
  - Solar Photovoltaic
  - Solar Thermal
  - Municipal Solid Waste
  - Landfill Gas (Direct Connection)
  - Landfill Gas (Methane Flaring)
- Market/Third Party Purchases
  - Renewable Energy
- Other
  - Transportation
  - Waste Management
  - Offsets
    - Land/Forest Management
    - Other Carbon Offsets

OTHER
- Business Travel
- Improved Commuting
- Waste Diversion
  - Campus Vehicles
  - Composting
- Public Transportation Options
- Avoided Travel
- Inter-campus Connectivity

Included in plan, quantified
Included in plan, not quantified
Not included in plan, quantified
Not evaluated
Future technology to watch
2011 CAP: carbon reduction strategies

What are the utility planning opportunities?
2012 Strategic Plan: six “critical next steps”

What are the utility planning opportunities?

1. Prepare students more robustly for fulfilling post-graduation lives and careers
2. Enhance our curriculum to improve liberal arts teaching and learning
3. Strengthen the socio-economic diversity of our student body
4. Maintain a self-sustaining economy with a growing endowment per student
5. Make focused investments in facilities that directly advance our mission
6. Embrace collaborative opportunities with other institutions to enhance our academic programs and save costs
With a focus on *replacement* and *renovation*, the 2014 Facilities Master Plan anticipates only *3% net growth* in total campus square footage over the next 20-30 years.
2014 Facilities Master Plan Priorities

*What are the utility planning opportunities?*

- Long-term precinct plan for the campus
- **Investment in science facilities**
- **Investment in music & public event facilities**
- Assess number, location, and size of needed classrooms
- Other needs incl. admissions and Academic Support Center
PRIORITY: Investment in music and event facilities

OPPORTUNITY: Skinner Chapel Upgrade

First low temperature (120 deg) hot water building.
PRIORITY: Investment in science facilities

OPPORTUNITY: New Science Complex

New geothermal satellite plant (East Energy Station)
The analysis.
Geothermal heating (to heat pump) High efficiency boiler load Simultaneous load (heat pump) Geothermal cooling (to heat pump)

Energy Profile: Existing Steam System

Carleton Heating & Cooling Load Profiles

Existing Energy Profile - Very Heating Dominant
Assessment of Existing Conditions

ASSETS

LIABILITIES
Integration with Other Campus Plans

Planned Renovation & Construction

- 0-5 years
- 5-10 years
- 10-15 years
- 15-20 years
Integration with Other Campus Plans

NEW SCIENCE ADDITION

- Located at center of campus
- Highest energy use intensity buildings
**Concept Phase Evaluation**

**Base Case**
Keep steam plant

**Alternative**
Transition to a hot water plant

- **Option B**
  100% Geothermal sized to meet winter heating load

- **Option C**
  Geothermal sized to meet summer cooling load

- **Option D**
  Geothermal sized to meet simultaneous heat/cool load

**Base Case w/ CHP**

**Option C w/ CHP**

**Option D w/ CHP**

CHP = Combined Heat and Power
Lower water temperature increases boiler efficiency and allows use of technologies like solar thermal, heat pumps and geothermal well fields.
Concept #2: Electricity as Green Energy

Upper Midwest
(Michigan, Minnesota, North Dakota, South Dakota, Wisconsin)

- Nuclear: 27%
- Wind: 13.7%
- Natural Gas: 14.8%
- Coal: 34.6%
- Other Renewable: 9.3%
  - Hydro: 7.3%
  - Biomass: 2.0%
- Other: 0.6%
- 50% Carbon-free Electricity

Xcel Energy Grid was 50% non-fossil fuels in 2015, and growing more so in the future
Concept #3: Storing and Repurposing Energy

Connecting the heating and cooling cycles allows them to share energy. Connecting to geothermal well fields stores energy like a thermal battery.
Geothermal testing on the Bald Spot (Summer 2016)

Carleton has very high conductivity, probably enhanced by high groundwater flow in the region.
Life Cycle Cost Analysis:
- Cost
- Carbon
- Energy

Sensitivity Analysis:
- Price of electricity
- Price of natural gas
- Price of bore field drilling
The plan.
Recommendations:

1. Transition from central steam to hot water distribution

2. Install a central geothermal heat pump
   - captures simultaneous heating and cooling energy
   - uses the earth’s mass as a thermal battery

3. Install high efficiency condensing boilers to supplement the heat pump during peak heating demand

4. FUTURE PHASE: Invest in efficient and/or renewable electrical generation system(s)
KEY MESSAGE #1: The proposed utility plan diversifies our fuel mix and introduces much more flexibility to incorporate current and future technologies.
KEY MESSAGE #2: The proposed utility plan reduces both annual operating costs and carbon emissions.
KEY MESSAGE #3: The proposed utility plan keeps us on track with carbon reduction goals outlined in our 2011 Climate Action Plan.
KEY MESSAGE #4: The proposed utility plan breaks even in 15-20 years compared to the cost of maintaining the existing steam plant.
Project Cost Estimates

Phase 1: $24.1 M
- East Energy Station (in science)
- Geothermal well fields
- East side building mechanical modifications
- West side steam to hot water conversion

Phase 2: $12 M - 16 M
- West side building mechanical modifications
- West side steam to hot water conversion
- Facilities Building equipment, TURN OFF STEAM

Phase 3: $2 M - 4 M
- Electrical generation system (CHP or other)

TOTAL: $38 M - 44 M
Full steam ahead!
Student engagement and research opportunities tie the project to our core mission.

Carleton geology major and driller examining soil samples taken from a boring down to 520 ft. underground. Minnesota Geological Survey staff taking geophysical measurements with their mobile unit.
Fun facts are not only “fun”, they also generate campus pride and support for the project.
The project website is a one-stop-shop for project information.

Carleton College Utility Master Plan

The last time Carleton College made a major shift in its campus utilities was over 100 years ago with construction of the central plant in 1910. Before that, each individual building was heated by a coal furnace or fireplaces. Now the college is embarking on its utility plan for the next 100 years.

Our two wind turbines (installed in 2004 and 2011) have been a big help to our sustainability efforts, but we need to do more to reduce carbon emissions. Our Utility Master Plan furthers the concepts outlined in our 2011 Climate Action Plan which is the guiding document supporting our goal of making Carleton's campus carbon free by the year 2050. Our new utility system will utilize four forms of renewable energy - wind, solar photovoltaic, solar thermal, and geothermal - and is flexible enough to take advantage of future advancements in renewable energy technologies.

When all phases of the Utility Master Plan are complete, Carleton's plant emissions will be reduced by over 35 percent.

Progress

Bell Field: 95 of 95 horizontal bores complete

Mini Bald Spot: 77 of 77 vertical bores complete
...and progress updates.

**Week 17: Mini Bald Spot Drilling Complete**
Wednesday, October 4, 2017
A crew went up across the Mini Bald Spot at 7pm on Tuesday evening as drillers completed bore hole #17, the last hole on the field.
[Read more at "Week 17: Mini Bald Spot Drilling Complete"](

**Week 13: Sampling Bore Holes for the Geology Department**
Wednesday, September 6, 2017
The geology department is taking advantage of drilling on the Mini Bald Spot to get samples from 520 ft. below our campus.
[Read more at "Week 13: Sampling Bore Holes for the Geology Department"](

**Week 12: Bell Field Landscape Restoration**
Wednesday, August 30, 2017
[Read more at "Week 12: Bell Field Landscape Restoration"](

**Week 9: Bell Field and Mini Bald Spot Drilling Updates**
Tuesday, August 8, 2017
Bell Field drilling is almost complete.
[Read more at "Week 9: Bell Field and Mini Bald Spot Drilling Updates"](

**Week 8: Myers Hall Heating Conversion**
Thursday, August 3, 2017
Myers Hall undergoes heating conversion.
[Read more at "Week 8: Myers Hall Heating Conversion"]

[go.carleton.edu/geothermal](go.carleton.edu/geothermal)
Bell Field - 95 Horizontal Bores
Geothermal heating
(to heat pump)
High efficiency
boiler load
Simultaneous load (heat pump)
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High efficiency boiler load

Simultaneous load (heat pump)

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Mini Bald Spot - 77 Vertical Bores
Geothermal heating (to heat pump)

High efficiency boiler load

Simultaneous load (heat pump)

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Mini Bald Spot - 77 Vertical Bores
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New Science Building & East Energy Station
Questions?