Beyond Solar: Other Renewable Energy and Thermal & Energy Storage Strategies
Better Buildings Alliance

RENEWABLES INTEGRATION

- Strategic use of renewables
- Building load flexibility
- Grid coordination
- Provide resources, information, and guidance on these topics to building owners and managers

https://betterbuildingsinitiative.energy.gov/alliance/technology-solution/renewables-integration
Renewables Integration – Team Players

Technical Team Lead:

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Join us! | Better Buildings Alliance Renewables Integration Team
Buildings-to-Grid Working Group

**FOCUS AREAS:**
- Strategic integration of renewables
- Energy storage
- Building load flexibility
- Grid coordination

- Bimonthly, 1-hour conference calls
- Kick-off meeting in early August
- Also looking for participants for two studies:
  - **Portfolio analysis:** understand potential for load flexibility (optimized demand management)
  - **Field study:** implementing building load flexibility solutions

Interested? Email us!
Rois Langner: Rois.Langner@NREL.gov
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Today’s Presenters

Bard College
- Daniel Smith
  - Energy Manager
  - Bard College

Joel Herm
- CEO
- Current Hydro, LLC

Rick Burgess
- VP, Facilities and Campus Services
- Cornell University
Beyond Solar: Other Renewable Energy and Thermal & Energy Storage

Micro Hydro for Macro Impact

July 11th, 2019

Daniel Smith
Energy Manager

Joel Herm
Founder

Bard College

CURRENT HYDRO
BARD COLLEGE  At a glance...

NY Mid-Hudson Valley Region:
- 4-year private college
- Founded 1860 as St. Stephen’s College (renamed Bard in 1943)
- ~900 acres of fields and forested land bordering the Hudson River
- ~165 buildings / 1.26M ft²

Population:
- Students 1,800 (+200 grad)
- Faculty 290 FTE
- Staff 690 FTE
BARD COLLEGE  At a glance...
Highlights: Sustainability & Climate

• American College & University Presidents' Climate Commitment (ACUPCC)
  • Signatory in January 2009
  • Committed to achieving carbon-neutrality by 2035
Highlights: Sustainability & Climate
Highlights: Sustainability & Climate
Highlights: Energy Efficiency

**Geothermal**

- Early adopter; default system for new construction since 1990’s
- 40% of total building area
- **Low EUI:** 96.5 kBTu/ft²
Highlights: Energy Efficiency

Lighting Upgrades

- 2013... interior (mix of new fluorescent & LED) ... transitioning to all LED
- 2015... exterior (all street, parking, path & building)
- >1 million kWh reduction; stabilized demand
Highlights: Energy Efficiency

Other Energy Projects

- Whole-building insulation, windows, airsealing, etc.
- Controls/automation upgrades
- Capital equipment (oil → propane)
Highlights: Renewables

On-site Solar
Highlights: Renewables

On-site Solar
Highlights: Renewables

Renewable Mix

- Supply contract = 10% renewable mix
- RECS = 10%
- On-site Solar = 1.5%
- Off-site Hydro = 1.5% (Wallkill, NY)
- Community Solar = 1.5% (in-progress)

TOTAL = 24.5%
Highlights: Renewables

On-site Wind?

= not feasible
(we’re in a valley)
A Historic Opportunity...

Montgomery Place
• Acquired in January, 2016

• 300 acres, historic manor, outbuildings, gardens, etc.

• Working farm & orchard

AND... two functional dams
A Historic Opportunity...

How can we utilize these new resources?

Upper Sawkill Dam
- Former irrigation reservoir & pump house for farm/orchard

Lower Sawkill Dam
- Early 1920’s, 30kW AC turbine to electrify the estate (in use thru 1965 until connected to local utility)
Upper Sawkill Dam
Lower Sawkill Dam
A Historic Opportunity...
New York State: Energy & Climate Goals

June 20th, 2019: Gov. Andrew Cuomo announces...

NY Green New Deal:
- 100% emissions-free electricity by 2040
- Currently most aggressive timetable in world.
New York State: Energy & Climate Goals

2015 Energy to Lead Competition: $1M Award

“Micro Hydro for Macro Impact”
• Use local dams to develop micro-hydropower.
• Include the launch of a public, interactive website dedicated to micro-hydropower.
Can microhydro have a macro impact?

Hydro on ~33% of New York dams will meet electrical needs of 80,000 NY homes
A quick path to a low-carbon future
Our great-great grandparents had good ideas
Reinventing small-scale hydro
Fish are stakeholders too
A turbine for (almost) any site

The Gravitational Vortex turbine is recent addition to a 3,000 year-old power toolkit.
Streamlining the hydro permit process
Hydro plays well with others
Can microhydro have a macro impact?

Hydro on ~33% of New York dams will meet heating and cooling needs of 250,000 Passive Houses
Passive house - Active hydro
Thank you!

Any Questions?

Joel Herm
Founder

Bard College
Daniel Smith
Energy Manager
Earth Source Heat: Innovative Transformation of Geothermal Systems

Rick Burgess, Vice President of Facilities and Campus Services
Cornell University

Broad Commitment to Sustainability

“I accept and endorse the Faculty Senate’s recommendation that we seek a more aggressive reduction in the use of fossil fuels that could bring us to carbon neutrality by 2035.

Cornell President David Skorton, February 2014
• Over 2300 acres
• 16 million gross square feet
• 35 MWe electric peak; 90MWth heating peak; 90MWth cooling peak
Legacy of Sustainability
Lake Source Cooling
Positive Impact
Lake Source Cooling and Peaking Chillers

Metric Tons of CO₂E

AVOIDED CARBON
11,000+

Annual carbon savings
LSC, Chillers, ECI, PPA

LSC ONLINE 2000

BUSINESS AS USUAL
CLIMATE ACTION PLAN

OUR STRATEGY

AVOID
Avoid carbon-intensive activities

REDUCE
Reduce energy demand with aggressive energy conservation and engagement programs

REPLACE
Replace fossil fuels with low-carbon renewable energy

OFFSET
Offset what remains with actions connected to our mission

ENGAGEMENT PROGRAMS ARE THE KEY TO AVOID / REDUCE
Every member of the campus must help eliminate redundancy and waste as we invest in new technologies
Inefficient Space

Increased Efficiency

FREE SPACE
Building energy standards reduce EUI 20%
Positive Impact
Combined Heat and Power

AVOIDED CARBON
TO DATE
1.5 million
Metric Tons of CO$_2$E
Opportunities to offer programs that promote the use of electric heat pumps [for heating] may arise ....  
**Electrification of these end-uses will likely have a significant impact on peak demand and could increase winter electric usage to the point where the system peak shifts from the summer to the winter.**  

Source: ConEd Electric Long-Range Plan 2019-2038 (*emphasis ours*)
\sim \approx 250,000 \text{ MWh}_{th}

(Total Annual Campus Heating Demand)

\sim \approx 80,000 \text{ MWh}_{e}

(Electrified Heat with Heat Pumps)

400 acres
300 football fields
Abundant Subsurface Heat Supply

Target Zone of the Cornell Study
U.S. Geothermal Resources

Temperatures at 5.5 km

Blackwell et al., 2011
CORNELL

Cornell Heat Exchange Facility

*Diagram not to scale*
CAMPUS CONVERSION TO HOT WATER FROM STEAM

- **Central Campus**
  - Existing Steam Loop
  - New Central Steam-to-hot water heat exchangers (backup to ESH)

- **East Campus**
  - New Hot Water Loop
  - Buildings
  - Earth Source Heat Exchanger

*Diagram not to scale*
**DISCOVERY/DESIGN**

- Subsurface imaging
- Drill single test borehole
- **Goal:** Gain insights into subsurface and requirements for deployment

**DEMONSTRATE**

- Create functioning well-pair
- Connect to district heating system
- **Goal:** Demonstrate viability; develop partnerships for full deployment

**DEPLOY**

- Expand to other State sites with existing district heating system
- **Goal:** Multiple well-sets across the state to reduce electric demand for heat
Reported District Heating Systems in NYS
(International District Energy Association graphic)
Preliminary Economic Results of US Department of Energy Study for Earth Source Heat at Cornell

- Cost for supplying campus today: $5.50 to 6.10 per MMBtu
- Cost with a future “full cascading” system: $3.10 per MMBtu

Compare that to Natural Gas: $\sim$8.00 per MMBtu (per U.S. Energy Information Agency; commercial rate)
Cornell Carbon Neutral District Energy
Current and Planned
Thank You

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