Energy Task Force

The University of New Hampshire
2017 Annual Report

Prepared by the

University of New Hampshire

Sustainability Institute

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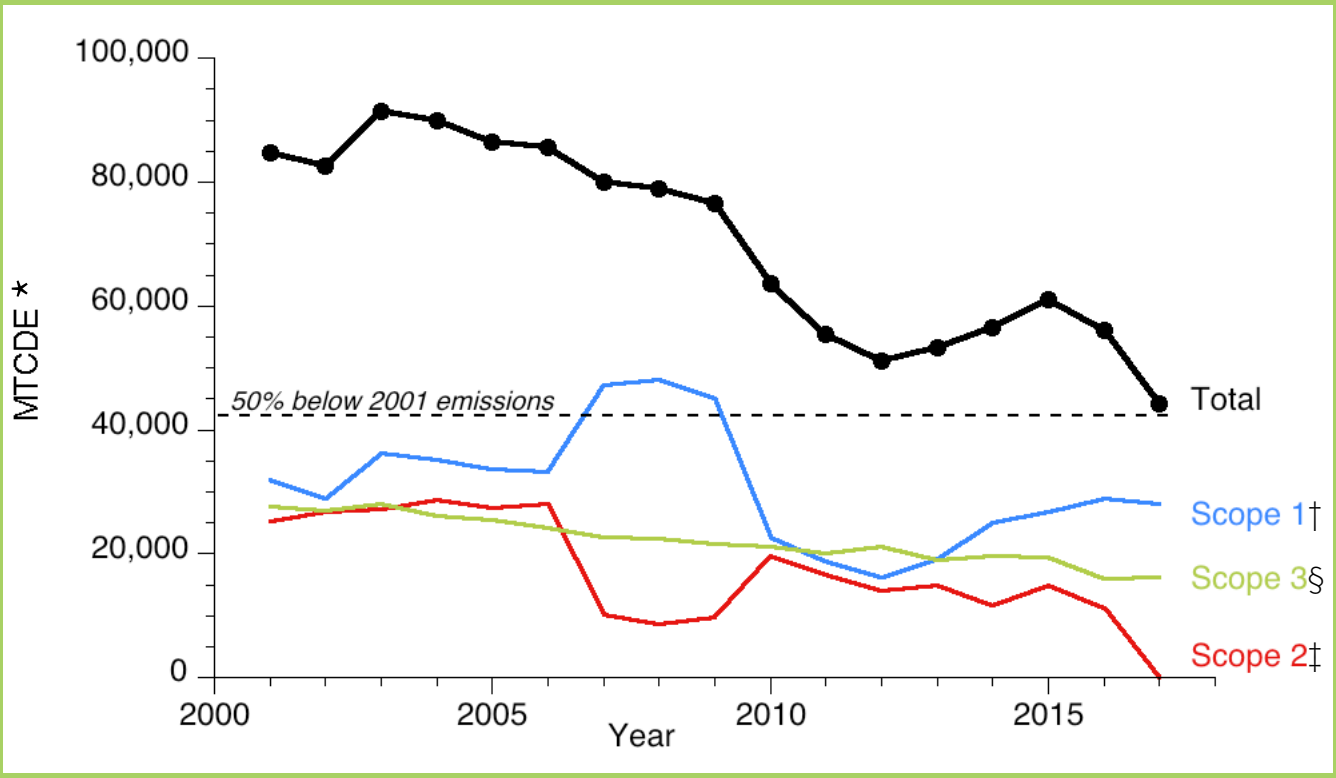
UNH Sustainability Institute

CONTENTS

I. KEY FINDINGS

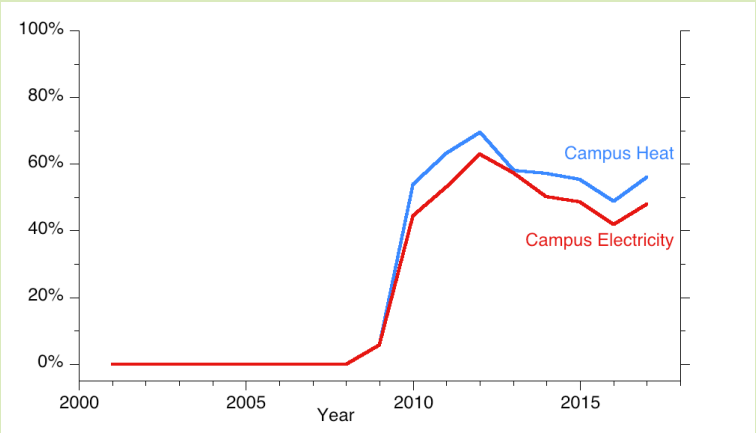
2017 was a watershed year for UNH and our commitment to renewable energy. Our greenhouse gas footprint is down 51% from the 2001 baseline and our electricity is now 100% powered by renewables. Here are some additional figures on our progress.

UNH'S TOTAL CARBON FOOTPRINT



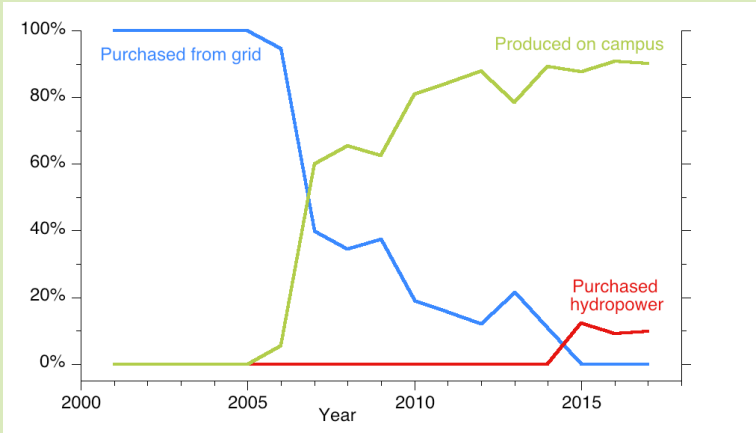
UNH's greenhouse gas footprint is DOWN 48% from 2001.

ECOLINE POWERING & HEATING CAMPUS



EcoLine produces half of UNH's heat & electricty.

COMMITTING TO RENEWABLE ELECTRICITY



100% of UNH's electricity is powered by renewable energy.

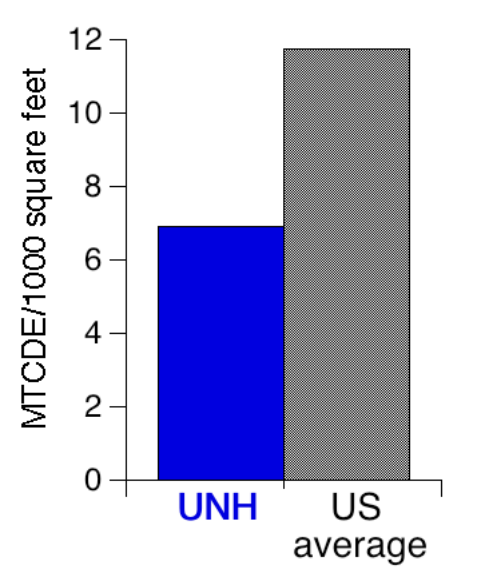
★ *MTCDE is metric tons carbon dioxide equivalent & is a weighted measure of all relevant greenhouse gases (CO2, CH4 and N20)*

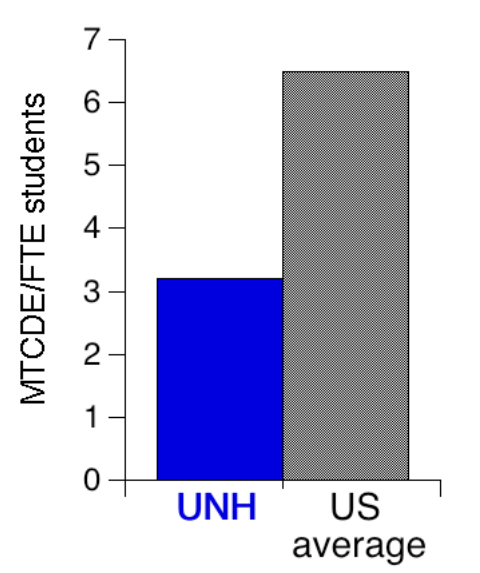
† *Scope 1 – direct emissions from UNH facilities*

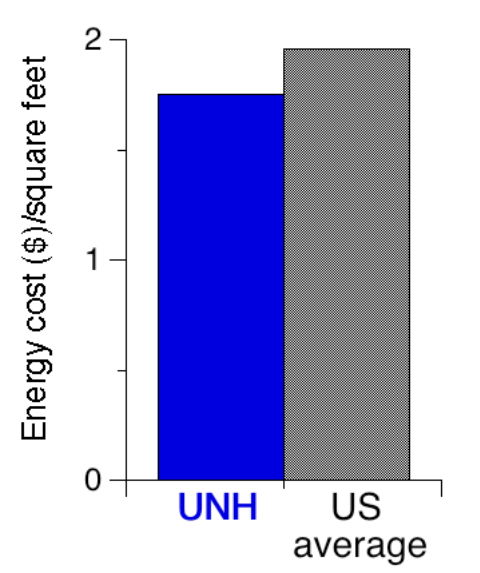
‡ *Scope 2 – emissions from purchased electricity*

§ *Scope 3 – selected indirect emissions (i.e. commuting and business travel)*

HOW WE COMPARE NATIONALLY







UNH's emissions and costs are lower than national averages.

PROGRESS TOWARD EMISSION REDUCTION GOALS BY SOURCE

BUILDING ENERGY

In 2017: 57% total emissions

From 2001: ↓ 52%

We've been able to reduce our building energy emissions thanks to our cogeneration plant, EcoLine, renewable power purchases, and continued efficiency efforts.

FLEET TRANSPORTATION

In 2017: 4% total emissions

From 2001: ↓ 23%

Our transportation emissions have decreased thanks to our move toward alternative fuel buses and other fleet vehicles — including bikes!

COMMUTING

In 2017: 21% total emissions

From 2001: ↓ 44%

We've reduced our commuting emissions thanks to agressive transportation demand management. What is transportation demand management? Find out more.

FINANCED AIR TRAVEL

In 2017: 14% total emissions

From 2001: ↓ 39%

Our air travel emissions are down thanks to our community reducing work-related trips & efficiency gains by airlines.

II. 2017 ACCOMPLISHMENTS

ETF leadership foundation for STARS Platinum and Sierra Club "Cool Schools" ranking

The achievement of AASHE STARS "Platinum", and the designation by Sierra Club of UNH as the second "coolest school" were important sustainability benchmarks for UNH in AY18, and the work of the ETF was vital in securing that ranking. Top scores for renewable energy, greenhouse gas management and reduction, and low-carbon fleet vehicles were all vital components of the STARS profile, as were the coordination and planning , advocacy and outreach, and student and faculty engagement functions provided by the Energy Task Force.

New building and equipment investments are saving energy and money, reducing fossil fuel dependence

Construction is underway on the new Northwest Heating Plant. This district heat plant will provide hot water to serve 5 area buildings. The centerpiece of this project is a new biomass boiler. This boiler, rated at 2.5 MMBtu of heat output, will be fired using semi-dry woodchips. The plant will burn about 750 tons of woodchips per year, reducing the natural gas use of the plant by 85-90%. This project was partially funded with a $300,000 grant from the NH PUC.

A new back-pressure steam turbine was installed at Rudman Hall in 2017. Rudman Hall is served by high pressure steam from our central plant. Some of this steam is used for process needs in the building, but much of it is throttled through a pressure reducing valves (PRVs) which creates low pressure steam for heating and cooling the building. These PRVs vent the excess energy to the atmosphere. This project installed a new back-pressure steam turbine in parallel with the pressure reducing station. The steam is now sent through the turbine to make up to 75 kW of electricity with the excess steam energy. This project is expected to create up to 500,000 kwh of electricity per year. It was funded by a $200,000 grant from the NH PUC and by the revolving EEF.

Movement toward the future with electric vehicle purchases, policy and charging infrastructure

During FY18, the ETF formally adopted an electric vehicle (EV) charging policy, which was subsequently adopted by the Transportation Policy Committee as well, to help guide the University's future efforts to develop EV charging infrastructure. The policy lays out EV infrastructure prioritization to accommodate UNH fleet and shared public access EVSE for commuters and visitors. The policy will direct future grant and direct investment plans.

In addition, UNH leased/purchased its first long-range EVs - five Nissan Leafs being operated by Facilities and Transportation Services. Level 1 and 2 charge stations were also installed to accommodate these vehicles

Finally, UNH is developing grant proposals for upcoming state and federal programs including the NH apportionment of VW settlement monies. UNH expects to propose expansion of UNH fleet and installation of Level 1 and 2 public access EVSE on campus.

Coordination with the Town of Durham to assess and enhance local climate resilience

While reducing emissions of greenhouse gas is critical for reducing the extent of human induced climate change, communities also need to prepare for the climate change that is already inevitable. To that end, UNH signed onto the 'Resilience Commitment" in 2015 as part of the Second Nature – President's Climate Leadership Commitment. (UNH signed onto the 'Carbon Commitment in 2007). The resilience commitment is focused on climate adaptation-specific goals, as well as building

community capacity to deal with a constantly changing climate and resulting extremes. Following a year of engagement among leaders from the Town of Durham and UNH faculty and staff, the initial campus-community resilience assessment, including initial indicators and current vulnerability was submitted in May 2018. (LINK) Over the coming year, ETF members will lead the next phase of this effort, which requires that UNH and the Town of Durham together develop a plan to increase and track the degree to which campus and community ecosystems, property, community members, governance structures and financial resources are resilient in the face of continued climate impacts.

Completion of a New Utility Master Plan

In 2017, UNH undertook a comprehensive Utilities Master Planning (UMP) effort. UNH consulted with RMF Engineering to develop a comprehensive master plan for all campus utilities, including the district heating system and high voltage electrical distribution. The plan provides a roadmap for us to strategically reinvest in our utilities infrastructure by upgrading old lines and equipment before it fails, while improving energy efficiency and reliability for the campus.

Advocacy for smart, sustainable energy policy in New Hampshire

The ETF helped UNH use its voice as an important stakeholder in energy policy discussions in New Hampshire in 2017 and 2018. In June, the Governor vetoed SB446 which had been passed by the legislature (with supporting testimony from ETF members.) This bill raised the cap for group net metering generation sites from 1 MW to 5 MW, which would have allowed us to self-generate all of our electricity through group net metering by utilizing our 4.6 MW turbine that exports energy to the grid—while potentially providing low-carbon energy to other University System of New Hampshire sites as well. The ETF supported the SB446 veto override effort and performed an analysis that showed that the bill could have an economic benefit of up to $1M for USNH. Unfortunately, the veto override came up 14 votes short of the necessary 2/3 majority in the house—but the ETF will continue to advocate for smart energy policy in New Hampshire.

"Passed the baton" on Zero Waste

For much of the early part of this decade, the Energy Task Force played a leading role in coordinating improved waste reduction and recycling efforts on campus, since waste reduction was included as part of WildCAP (the University's climate action plan.) Since the Zero Waste Task Force was initiated in 2017, the ETF has moved into more of a supporting role; its members continue to stay engaged and committed to initiatives to raise awareness, drive behavior change, and create a culture of "zero waste" for UNH.

III. STUDENT SPOTLIGHT

Through research, course projects, internships and participation in University initiatives, UNH students are experiencing the campus as a true living laboratory when it comes to energy and climate change. Here are a few highlights in terms of critical student contributions to UNH's energy and climate efforts:

Evaluating options to switch to renewables, store energy generated on site, and improve our messaging about energy conservation

For the past three summers, ETF members have helped mentor Sustainability Fellows in projects to improve UNH's energy profile. Renata Hegyi did the background research for the Northwest Heating Plant that resulted in a successful grant proposal from the PUC, as well as the necessary info to move forward with a contractor RFP, which together ensured the project was able to move forward. Renata is currently participating in a management rotational program at Con Edison, the electric, gas, and steam distribution utility of New York City. After she completes the program, she plans to continue to work on renewables integration and/or energy efficiency measures.

Jacky Kinson spent the summer of 2017 working with the UNH Energy & Utilities office as a Sustainability Fellow. She conducted a feasibility analysis of energy storage technologies to reduce energy costs, increase campus resiliency, and decrease Scope 2 emissions for the UNH Durham campus. Jacky Kinson completed her fellowship while pursuing a degree in chemical engineering (B.S.) with a concentration in energy at UNH and translated that into her current job with the International District Energy Association. Jacky's report can be found here.

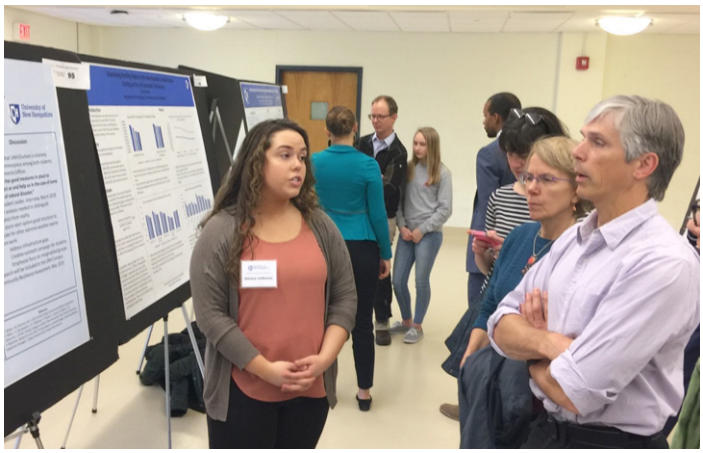
Developing tools for UNH and others to assess vehicle fuel efficiency

Joe Vero, an engineering major who graduated in the spring of 2018, served as a student member of the ETF during FY18, and worked with the Campus Planning office to update the Eco-Cat Calculator. This update significantly enhanced the comparison ability for EVs. The Calculator looks at the up-front, fuel and maintenance costs of different vehicles in a range of categories, to give users data about the "life-cycle costs—both financial and environmental, of different types of vehicles. The Eco-Cat Calculator is used to help guide purchasing decisions for UNH fleet vehicles, and has been made available to the broader community to use as well.

Understanding climate vulnerabilities and resilience at UNH and the broader Durham community

As Sustainability Fellows during the summer of 2017, Laurel Maley and Matthew L'Heureux helped develop the UNH/Durham community resilience plan framework and interviewed staff whose jobs and responsibilities are directly related to community resilience. Their report provides valuable insights regarding the range of campus resilience and vulnerability.

Four students collaborating on their Sustainability Dual Major Capstone project in the spring of 2018 added to this research by completing additional interviews, including interviews with UNH students. Their results, presented at the 2018 Undergraduate Research Conference, indicate that those interviewed feel the UNH/ Durham community is relatively resilient, especially with respect to snow storms and flooding. In addition, the main priorities of the students interviewed were addressing resilience among marginalized groups on campus and learning more about the emerging UNH resilience plan.



Finally, the 80 students in Professor Wake's Global Environmental Change Class (Fall 2017 semester) completed class research projects on a range of campus adaptation challenges ranging from large storms and emergency shelters, agriculture and forests, drought, flooding, financial impacts of snow days, increasing pollen and allergies, health and motivational impacts of more extreme heat days, invasive species, and water supply and demand. This research has already been integrated into UNHs resilience assessment and planning documents.

IV. COMING IN 2019

- **The new Thompson School Biomass plant: To provide more locally-sourced, efficient, renewable and resilient on-campus energy.**
- **Campus departmental bikes: UNH Facilities has worked with USNH to develop a pilot departmental bike program! This program will be expanded in FY 19. Contact Steve Pesci (862-4207).**
- **New Alternative Fuel Buses to be added to the Campus Fleet: UNH will purchase four full size CNG buses to be integrated into the WildCat Transit fleet this year. UNH has now made a commitment to end purchases of diesel engine transit buses.**
- **WildCAP Update: In 2019 we will begin preparing for another update to WildCAP, since we are on the verge of our interim "target" year, 2020. The WildCAP update will lay out a series of benchmarks to pave the way for meeting our ultimate goal of 80% reductions in UNH's carbon footprint by 2050.**

V. FREQUENTLY ASKED QUESTIONS

Running a college campus is complicated business and we know you have lots of questions. Here are some answers to questions we often hear from our community about energy.

WHEN WAS THE COMBINED HEAT & POWER PLANT INSTALLED AT UNH?

Our COGEN plant has been fully operational since 2006.

WHEN WAS THE ECOLINE PORJECT COMPLETED?

We've been piping repurposed landfill methane from the Turnkey landfill in Rochester since 2009.

IF UNH LOST POWER, HOW MUCH LIQUID FUEL DO WE HAVE STORED?

We have three days of backup fuel stored to operate the COGEN Plant.

WHY DOESN'T UNH HAVE MORE SOLAR?

Short answer: It's better for the climate and for UNH's bottom line to make other investments. The full story: It's complicated and here are the details.

HOW RESILIENT IS ELECTRICTY AT UNH TO WEATHER RELATED DISRUPTIONS?

Pretty resilient. Get the details here.

I'M A UNH STUDENT. HOW CAN I JOIN THE ENERGY TASK FORCE?

Interested in being a member of the Energy Task Force? Email us at sustainability@unh.edu

VI. APPENDICES

HOW RESILIENT IS THE ELECTRICTY SUPPLY AT UNH TO DISRUPTIONS?

Electricity is the lifeblood of modern society and its continuous flow is critical for resilient cities, business, industry, and university campuses. However, for those not involved in the production and distribution of electricity, the flow of electrons to power our modern society is often taken for granted.

Over the past three decades UNH has developed an efficient, renewable, and robust electrical system. The heart of the system is the generation of electricity and heat from a combined heat and power plant (aka co-generation plant) on the main Durham campus which uses processed landfill gas as its primary fuel source. This gas originates from the Waste Management landfill in Rochester, NH and is transported to UNH through a 12-mile pipeline known as EcoLine.

There are several redundant systems in place at UNH to keep the combined heat and power (CHP) plant up and running if there is a power outage or electrical grid disruption. In terms of fuel, the CHP plant can be run on processed landfill gas, natural gas, or liquid fuel (ultra-low sulfur diesel).

If there is power at the landfill in Rochester, the landfill gas is processed there and commonly blended with natural gas on the Durham campus so the gas mix consists of more than 75% methane. If there is a power outage at the landfill, the CHP plant needs to be operated on natural gas that is delivered via a utility pipeline directly to UNH. As long as the pressure in the directly connected natural gas line remains above 45 pounds per square inch (psi), the gas compressor can build the pressure up to 300 psi which is required at the turbine in the CHP plant. While the pressure in the natural gas line is commonly at 90 psi, it could drop below 45 psi during gas line maintenance (although this has not happened to date) or during extended power outages to utility owned compressor stations. In the rare event that natural gas is not available, 50,000 gallons of liquid fuel is stored on campus and will run the CHP plant for 2 to3 days; although the switchover to liquid fuel can take about two hours.

If for some reason the CHP plant is not operating, but the electrical grid is functional, UNH can import electricity from Eversource. UNH lies between two sub-stations (in Madbury and at Packers Falls) and the flow of electricity between those two substations is commonly reliable. If grid power is unavailable and power is lost to the facility entirely, the CHP's liquid fuel system is also delivered to a black start emergency generator that can bring the facility back online to power the equipment needed to start the plant.

In terms of operations, the CHP plant always has two operators at all times. If power is lost on campus for any reason, one of two on-call high voltage electricians need to assess what caused the system to fail and ensure that the problem has been addressed before the power is switched back on. There is a plan for rolling power outages with preference given to residence halls and dining halls. There are also some academic buildings that have backup electrical generation for critical systems.

Given the complexity of the overall system, it is just not possible to state with 100% certainty that the UNH electrical system will be operational during every weather disruption. However, the significant redundancies and local control make our electrical system very resilient.

WHY DOESN'T UNH HAVE MORE SOLAR ENERGY ON CAMPUS?

In 2006, UNH installed an 8 megawatt cogeneration turbine. Cogeneration means both heat and electricity are produced by the turbine. This is more efficient than a typical power plant, with an efficiency of about 75% compared to an average efficiency of 33% when electricity and heat are produced separately. This turbine initially used natural gas as its primary fuel source.

In 2009, the Ecoline project was completed. The Ecoline is a 12.7 mile pipeline that brings processed landfill gas (PLG) from the Waste Management landfill in Rochester to the campus. PLG is a renewable fuel generated by the decomposition of garbage at the landfill. Our cogeneration turbine now runs on a blend of 75% PLG and 25% natural gas. The turbine provides enough electricity to meet about 85-90% of our annual electric needs for the campus. Overall this results in 2/3 of our electricity being generated by PLG fuel.

Our interconnection agreement with the electric utility allows us to import supplemental electricity from the grid when needed, but does not allow us to export electricity. We ramp our turbine up or down to match the campus demand. Almost all residential and commercial solar generation sites in the state are net-metered or group net-metered. Net metering is an agreement that allows a generation site to export electricity to the grid when generation exceeds demand. The exported electricity is credited to the customer and used to offset the electricity that is used by the customer when demand exceeds generation (i.e. when the sun isn't shining). Since UNH is not allowed to net-meter, all electricity that we generate must be used when it is generated (or stored).

We produce up to 90% of our own electricity. We still purchase 10% of our electricity, so there is still a potential for our campus to support the installation of a PV array. Integrating a solar PV system presents challenges for our system. PV electric generation varies widely, producing a larger amount of electricity at certain times of the day and year and nothing at other times.

Since we are not permitted to net meter, the addition of a solar PV system means that all electricity must be consumed as it is generated. There would be some times of the year such as sunny afternoons in the summer when we may be able to run the turbine at peak output and absorb the solar PV output, depending on the size of the system. But there would be many more hours where we'd need to ramp down the turbine. So the solar electricity would be offsetting the renewably generated electricity rather than imported electricity from the grid. Ramping down the turbine presents a problem. The PLG from the landfill cannot be stored and must be used as it is drawn from the landfill. If we ramp down the turbine and are unable to use the full volume of PLG available at a given time, then we have to flare the gas. So rather than using this fuel productively in our turbine it would be burned directly to the atmosphere. And since we use the turbine for both electricity and heat, we'd potentially have to burn fuel in our boilers to make up for the lost heat output when the turbine was ramped down.

A solar PV system integrated with battery storage may help this situation somewhat, but would not entirely solve the issue. For a typical residential installation with solar PV and batteries, the batteries are charged during the day and discharged at night and on cloudy days. However, at UNH we are typically able to meet our electrical demand at night with the turbine so we aren't able to follow the charge/discharge patterns that battery storage is meant to provide. Plus, while battery storage technology is improving, it hasn't matured to the same level as solar PV technology. Battery storage is still quite expensive.

We will continue to look for good opportunities to introduce solar PV and energy storage to the campus in a way that will complement and enhance our current energy systems. We are currently contracted with three small hydro-electric dams located in New Hampshire through a group net-metering agreement. These agreements provide us with a local, renewable electric source for our imported power. The hydro-electric producers benefit through payments that are significantly higher than what they are able to earn by selling their power through the wholesale market, while we receive a discount compared to the retail rate. It's a win-win agreement that serves our current needs and provides us with the flexibility to expand our own renewable energy portfolio in the future.