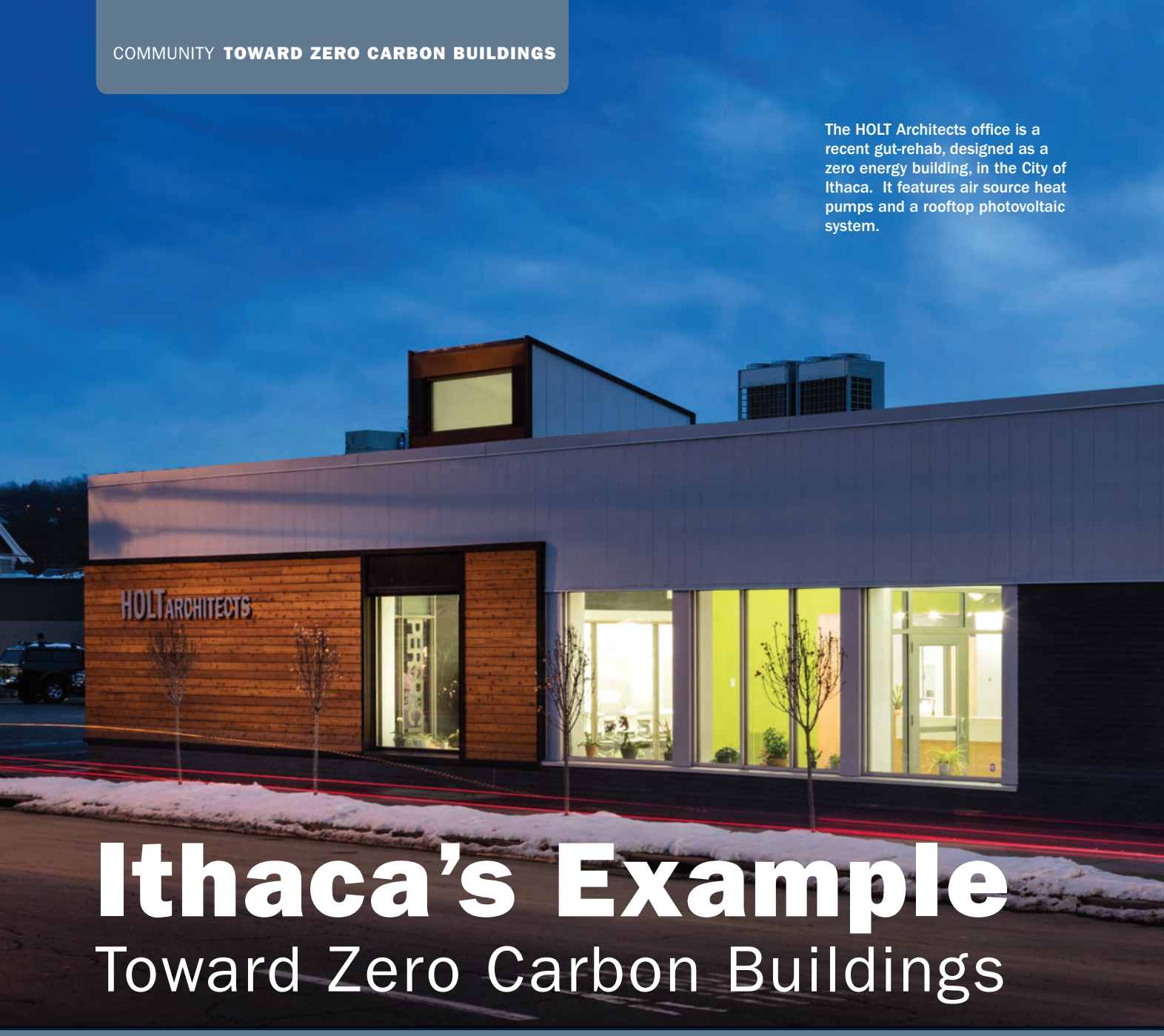


The HOLT Architects office is a recent gut-rehab, designed as a zero energy building, in the City of Ithaca. It features air source heat pumps and a rooftop photovoltaic system.

Ithaca's Example
Toward Zero Carbon Buildings

BY IAN M. SHAPIRO, P.E.; NICK GOLDSMITH

PHOTO: HOLT ARCHITECTS, PHOTOGRAPHY BY REVETTE STUDIO

IMAGINE AN ENERGY CODE that measurably reduces energy use and carbon emissions in new buildings, without increasing construction cost. Imagine an energy code with a simple point system: six points and you pass. Imagine an energy code that does not require energy modeling. Imagine an energy code that broadly follows the goals of Architecture 2030, taking us to zero carbon buildings that are free of fossil fuels by 2030.

PHOTO: LEARN@ECOVILLAGE ITHACA

The Sustainable Living Center at EcoVillage in the Town of Ithaca has an overall window-to-wall ratio of 16%, which is sufficient for residents' comfort as its south-facing façade has a significant number of windows.

We are trying to accomplish all this and more with a proposed energy code for the Town of Ithaca and the City of Ithaca, N.Y. Ithaca is a college town located in Tompkins County, in the beautiful Finger Lakes Region of upstate New York. The City of Ithaca and the Town of Ithaca have a combined population of a little more than 50,000 people; about 30,000 of these are students of Cornell University and Ithaca College. Downtown Ithaca—the vibrant and creative urban core located in the City—and the surrounding combination of urban, suburban, and rural areas that makes up the Town, are both undergoing a significant building boom. The area is already a hub of progressive green building activity, with many LEED-certified buildings and a growing number of zero energy buildings. The recent growth of heat pump installations has been exponential, and there is strong local opposition to adding fossil fuel infrastructure. The area was a center of resistance against New York State for fracking, resulting in a de facto six-year statewide fracking ban, that then led to a permanent ban in 2014.

Our Town and City

The Town and the City of Ithaca, like Tompkins County and New York State, have goals of reducing greenhouse gas emissions 80% by 2050. To achieve this goal, energy use in buildings, responsible for nearly three quarters of the City's carbon footprint, is a crucial sector to address. Given the building boom that Ithaca is experiencing, the municipalities realize it is a crucial time to address the energy efficiency of new construction.

In 2016, the City of Ithaca was awarded a grant to study green building policies with the Town of Ithaca. The project team conducted a comprehensive study of Ithaca's existing and future building stock; available green building standards/systems for new construction; and the potential economic, social, and environmental impacts of policies that incentivize or mandate those standards/systems. The Ithaca Green Building Policy Final Project Report, completed in April 2018, provides background and results of the study and makes policy recommendations for energy efficiency requirements and related incentives to substantially reduce carbon emissions in all new buildings, while emphasizing and supporting affordability.

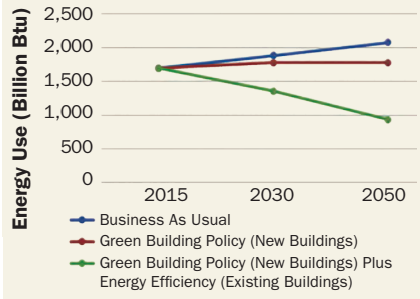
Table 1 DIFFERENT APPROACHES TO REDUCING ENERGY USE IN NEW BUILDINGS

	Approach	Examples	Market Penetration
8 Carrot	Incentivize	Tax Credits, Rebates	12% Penetration for Energy Star Homes, 2% Penetration for Solar
7	Recognize	Energy Star, LEED, Architecture 2030/District 2030	2% to 3% for LEED
6	Encourage	Bulk Purchasing, Solarize, HeatSmart, Model Behavior by Targeting Net-Zero for New City and Town Buildings	Solarize and HeatSmart Have So Far Seen Market Penetration Below 1%
5	Finance	PACE, Performance Contracting, Other	PACE Financing Less Than 1% Penetration
4	Support	Training (Contractors, Building Operators, Building Code Officials, Others), Cooperative Extension Navigators	
3	Advocate	Websites, Green Building Tour, Discourage Fossil Fuels	
2	Pressure	Require Energy Score to Be Shown on Listings, Benchmarking	
1 Stick	Require	Code Requirements, Ordinances	U.S. DOE Estimates 80% to 90% Compliance

Projections and an Important Conclusion

One finding of the study is that without any intervention, energy use will continue to grow, as the City and Town grow. For example, *Figure 1* shows a "business as usual" scenario for the City, with continued growth in energy use. With a green building policy targeting new construction, the growth in energy use can at least be halted ("Green Building Policy [New Buildings]" scenario), if new buildings are zero carbon buildings. Energy use and carbon emissions cannot be reduced without also addressing existing buildings ("Green Building Policy [New Buildings] Plus Energy Efficiency [Existing Buildings]" scenario), but options to address existing buildings were not included in the study.

Figure 1 PROJECTED BUILDING ENERGY USE, CITY OF ITHACA



An important conclusion of the study is that while there are many approaches to reducing energy and carbon emissions in new buildings, such as incentives, recognition and other forms of encouragement, deep market penetration may only be possible with mandates, such as an energy code (*Table 1*). Therefore, we directed our main attention to a mandate through the development of firm requirements for all new buildings. However, we believe that it is nonetheless helpful to use a balanced approach during a transition to high-performance building approaches, supplementing the mandated component with other "softer" support mechanisms. We have proposed an incentive package to facilitate compliance

and to promote early adoption of best practices.

As the recommendations were developed, we strived to create a policy that was FAIR: flexible, affordable, impactful and reachable. Flexible means any developer should be able to build the project they want to. Affordability is a significant issue in Ithaca, as it is in many places. A primary goal of the project was to identify ways in which carbon emissions could be reduced without increasing construction costs. By impactful we mean that the policy must reduce energy use and GHG emissions substantially. Finally, we strove to create a reachable policy: one that is achievable without excessive additional burden placed on developers or the municipal code staff tasked with enforcing the policy.

Our Overall Approach

We settled on an approach based on energy-efficiency requirements for all new buildings—in other words, a local energy code. New York State allows local energy codes, providing they are more stringent than state requirements. The scope of the proposed requirement covers all new buildings, larger new additions, and gut rehabs. Larger new additions can either comply on their own, or in combination with the original building, or if the entire building with the new addition emits less carbon than the original building.

Flexibility is achieved by offering both a Whole Building compliance path and a separate point-based Easy Path. Compliance with the New York State Energy Conservation Construction Code is a prerequisite.

The Whole Building Path itself offers a variety of recognized approaches, each at a high level of energy efficiency, including LEED (minimum of 17 energy credits), Passive House, HERS (maximum score of 40), and

Table 2 ITHACA GREEN BUILDING POLICY: EASY PATH POINT SYSTEM. BUILDINGS MUST ACHIEVE SIX POINTS (FROM ANY CATEGORY)

Category	Improvement	Points	Details
Efficient Electrification			
EE1	Heat Pumps for Space Heating	2 to 4	2 Points (Commercial) or 3 Points (Residential) for Air Source Heat Pumps. 3 points (Commercial) or 4 Points (Residential) for Ground Source Heat Pumps
EE2	Heat Pumps for Domestic Hot Water	1	1 Point for Water Heating Systems That Use Heat Pumps (Residential)
EE3	Electric Stove and Ventless Heat Pump Clothes Dryer	1	1 Point Total for Electric Stoves and Ventless Heat Pump Clothes Dryers (Residential) Requires EE1 as Prerequisite, and No Fossil Fuels in the Building
Affordability Improvements			
AI1	Smaller Building/ Room Size (Residential/ Hotel)	1 to 2	1 Point for Building/Room Size 15% Smaller Than Reference Size 2 Points for Building/Room Size 30% Smaller Than Reference Size
AI2	Heating Systems in Heated Space	1	1 Point for Placing Heating/Cooling Systems and Distribution Inside Actively Heated and Finished Spaces
AI3	Efficient Building Shape	1	1 Point if Exterior Surface Area Divided by Gross Floor Area is Less Than Maximum Value Provided in Table 3
AI4	Right-Lighting	1	1 Point for Reducing Over-Lighting and Other Lighting Improvements (Commercial)
AI5	Modest Windows With Views and Natural Light	1	1 Point for Overall Window-to-Wall Ratio Less Than 20% (Windows in Individual Spaces May Exceed 20%)
Renewable Energy			
RE1	Renewable Energy (Non-Biomass) Systems	1 to 3	Electric Systems: (On-Site or Remote): 1 Point per 1.2 kwh/ft^2/yr Renewable Energy Capacity (Residential) or per 2.4kwh/ft^2/yr (Commercial) Thermal Systems: 1 Point per 4.0 kBtu/ft^2/yr Renewable Energy Capacity (Residential) or Per 8.0 kBtu/ft^2/yr (Commercial)
RE2	Renewable Energy Biomass	3 to 4	3 Points (Commercial) or 4 Points (Residential) for Approved Biomass Space Heating Systems
Other Points			
OP1	Development Density	1	1 Point for Density of More Than 7 Dwelling Units per Acre
OP2	Walkability	1	1 Point if the Property is on the Walkability Map
OP3	Adaptive Reuse	1	1 Point for Substantial Re-Purpose of Existing Building
OP4	Meet NY Stretch Code	1	1 Point for Complying With NY Stretch Energy Code
OP5	Custom Energy Improvement	1 to 2	1 Point for Each 1.2 kwh/ft^2/yr (Residential) or 2.4 kwh/ft^2/yr (Commercial) Reduction in Energy Use Prerequisite: No Fossil Fuels. 2 Points Maximum

Table 3 EFFICIENT BUILDING SHAPE REQUIREMENTS

Gross Floor Area (ft^2)	Maximum (Wall+Roof)/ Floor Area Ratio	Gross Floor Area (ft^2)	Maximum (Wall+Roof)/ Floor Area Ratio	Gross Floor Area (ft^2)	Maximum (Wall+Roof)/ Floor Area Ratio
100–199	4.7	1,500–1,599	2.1	10,000–14,999	1.05
200–299	3.9	1,600–1,699	2.1	15,000–19,999	0.94
300–399	3.5	1,700–1,799	2.0	20,000–29,999	0.84
400–499	3.2	1,800–1,899	2.0	30,000–39,999	0.75
500–599	3.0	1,900–1,999	2.0	40,000–49,999	0.68
600–699	2.8	2,000–2,499	1.9	50,000–59,999	0.64
700–799	2.7	2,500–2,999	1.7	60,000–69,999	0.61
800–899	2.7	3,000–3,999	1.6	70,000–79,999	0.58
900–999	2.6	4,000–4,999	1.5	80,000–89,999	0.55
1,000–1,099	2.5	5,000–5,999	1.4	90,000–99,999	0.53
1,100–1,199	2.4	6,000–6,999	1.3	100,000–199,999	0.46
1,200–1,299	2.3	7,000–7,999	1.2	200,000–299,999	0.39
1,300–1,399	2.2	8,000–8,999	1.2	300,000–399,999	0.35
1,400–1,499	2.2	9,000–9,999	1.1	> 400,000	0.33

the National Green Building Standard certification (minimum of 80 points). The Whole Building compliance path allows developers maximum flexibility. The Whole Building approach might also be more attractive for developers who are already comfortable with one of these high-performance building standards/programs.

The Easy Path focuses on electrification, affordability, and renewable energy. Points are earned for various improvements, and six points are required to pass. The rest of this article focuses on the Easy Path, which is summarized in *Table 2*. This summary does not include important clarifying details, which are available in the full Green Building Policy report.

Easy Path Explored

A primary goal of the project was to identify ways in which carbon emissions could be reduced without increasing construction costs. We carefully examined building improvements that reduce energy use and that also either reduce construction costs or are roughly cost-neutral. Some of these are self-evident, and some might be viewed as unusual. They include efficient building shape, right-lighting (not over-lighting), smaller window-to-wall ratio while maintaining good views, modestly smaller buildings, and other cost-efficient improvements.

For example, one point is obtained for efficient building shapes,

This new-construction single-family home in the City passes the Green Building Policy thanks to its compact shape, small size, low window-to-wall ratio, heat pumps, and location within a dense area.

PHOTO: STREAM COLLABORATIVE

specifically if the ratio of a building's exterior surface to its gross floor area is less than the values provided in *Table 3*. An efficient building shape reduces the area of the exterior envelope, through which heat is lost and gained, relative to the useful floor area of the building, while also reducing construction costs.

Another point is obtained if a building has less than 20% overall window-to-wall ratio (WWR), which, again, reduces construction costs. Windows in individual regularly occupied spaces may exceed the 20% WWR. In this manner, the generally accepted green building standard of 20% for views in regularly occupied spaces (for example, in the BREEAM sustainability assessment method and the WELL system) can be met, while still meeting the requirement of WWR less than 20% for the whole building.

For residential buildings (single-family and multifamily) and hotels, up to two points may be obtained if the buildings are modestly smaller than a baseline. The baseline for hotels is 330 square feet per room. The baselines for residential buildings are shown in *Table 4*. One point is obtained if the floor area is 15% smaller than the baseline, and two points if the area is 30% smaller. The baseline floor area for single-family buildings can be recognized from the EPA Energy Star requirements for certified homes.

For multifamily buildings, building size includes only in-unit space, not common areas.

In addition to affordability, another major focus of the proposed policy is strategic electrification, to reduce the use of fossil fuels and associated carbon emissions. Electricity in upstate New York is already low in carbon emissions and is continuously becoming cleaner, with state goals of 70% renewably generated electricity by 2030 and 100% clean electricity by 2040. Several points are obtained for using heat pumps, with added points for ground source heat pumps. Additional points are available for electrification of domestic hot water and other loads such as stoves and clothes dryers. Heat pumps have already seen widespread adoption in the Ithaca area, with exponential recent growth. This growth in heat pump installations has been accompanied by reductions in installed cost. A recent local study found that air source heat pumps cost roughly the same as fossil fuel heating systems and are expected to drop below the cost of fossil fuel systems in the coming years. Ground source heat pumps are also competitive due to state and federal incentives, and competitive emerging

Table 4 RESIDENTIAL REFERENCE BUILDING SIZES

Bedrooms	Studio	1	2	3	4	5	6	7	8 or More
Floor Area (ft^2) Single Family	Not Applicable	1,000	1,600	2,200	2,800	3,400	4,000	4,600	+600 ft^2 per Additional Bedroom
Floor Area (ft^2) Multifamily	480	700	990	1,160	1,360	1,560	1,760	1,960	Not Applicable

design strategies. Due to our northern climate (DOE climate region 6), cold climate heat pumps are required to earn the points for air source heat pumps. An allowance is provided for limited electric resistance heat.

To allow flexibility not only in the Whole Building compliance path, but also in the Easy Path, custom improvements can be used to obtain up to two points, but only if the building does not use fossil fuels for building-related needs (heating, hot water, residential cooking, clothes drying).

One point will be earned if the building complies with the recently developed New York State stretch energy code.

While designing the Easy Path point-based approach, we asked several questions. Will the Easy Path measurably reduce carbon emissions? Will the energy code prevent "free riders" from taking advantage of the point system with improvements they were already planning to do? Would recently built high-performance buildings pass the point system? Would recent conventionally designed buildings fail? We put about 15 buildings through a stress test of the Easy Path point system. So far, the Easy Path approach has held up well to the stress test, as well as further pilot testing by local design professionals. Known high-performance buildings generally pass, known conventionally designed buildings fail, and where we know construction costs for specific buildings, those buildings that pass the Easy Path point system appear to be affordable.

PHOTO: DOWNTOWN ITHACA ALLIANCE STAFF PHOTO

The Commons is a pedestrian mall in the City where buildings would receive points for their location in a walkable, dense area, which reduces the need to drive.

The Easy Path approach is anticipated to work well as an overlay to the state energy code. And as the state energy code changes over time, the Easy Path's complementary emphasis on electrification, affordability, and renewables will contribute to lower energy use and carbon emissions, above and beyond the base requirements of the energy code. Carbon reduction of 40%-50% is projected using the Easy Path's six points.

Where We're Headed

The requirements are proposed to increase in stringency from six Easy Path points in 2019 to 12 points in 2025, with a corresponding increase in stringency for the Whole Building Path. Finally, in 2030, the policy will complete its arc with a requirement

PHOTO: TOWN OF ITHACA

Ithaca's well-known and loved Museum of the Earth has a photovoltaic system covering the roof of its new wing.

for zero carbon buildings that are free of fossil fuels. Exceptions will be allowed for fossil fuels such as industrial uses and commercial cooking, although strategies to minimize these uses are also being planned.

The policy recommendations also incorporate incentives to ease the transition to high-performance buildings. Buildings that meet the 2025 requirements or the 2030 requirements before they go into effect would be eligible for incentives. The Tompkins County Industrial Development Authority already has a highly progressive "enhanced energy" tax abatement associated with economic development, promoting energy reduction 40% less than the state energy code. The county also has a green building tax exemption. The policy proposes to leverage these incentives and possibly add others, such as allowing additional floor area, relief from parking requirements, and more.

Developing the Ithaca Green Building policy has not been without challenges. How should off-site renewable energy be handled? How should district energy systems be handled? How should combined heat and power be handled? At what pace should fossil fuels be increasingly discouraged and/or banned and, conversely, at what pace should electrification be encouraged? And how should the carbon emissions be estimated for electricity that comes from a typically diverse source fuel mix? How should buildings that have substantial non-building energy uses—such as labs, facilities with industrial processes, and buildings with commercial cooking or refrigeration—be treated? The proposed policy has draft language to address many of these issues. The remaining issues are still in discussion. Wherever possible, we tried to use generally accepted approaches that are being used in other high-performance building codes and standards/programs. We assume we have not accounted for all possibilities, and so will need to develop a process for interpretations and adjustments as we move forward.

The Ithaca Green Building Policy report, which includes the policy recommendations described above, was endorsed by both the Ithaca Town Board and the Ithaca City Common Council unanimously in May 2018. The code is currently being refined and drafted in legal language. Adoption is sought later in 2019. If the proposed requirements become law, Ithaca will place itself firmly on the path to a zero carbon future.

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