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MIT Faculty Newsletter

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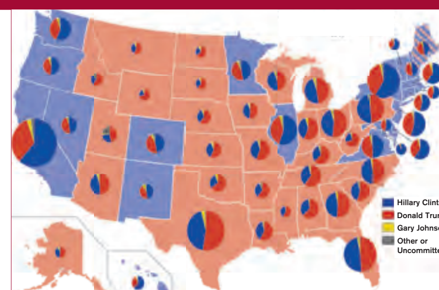
in this issue we offer responses to the recent Presidential election (Editorial and "A Message From MIT Faculty," below, and "On Gracious Professionalism," page 4); "Skoltech – A Personal and Professional Journey," page 8; and "Evolution of Schools, Departments, and Centers at MIT," page 14.



2016 Presidential Election By Vote Distribution

A Message From MIT Faculty Affirming Our Shared Values

THE PRESIDENT-ELECT HAS appointed individuals to positions of power who have endorsed racism, misogyny and religious bigotry, and denied the widespread scientific consensus on climate change. Regardless of our political views, these endorsements violate principles at the core of MIT's mission. At this time, it is important to reaffirm the values we hold in common.

We, the undersigned faculty at MIT, thus affirm the following principles:

- We unconditionally reject every form of bigotry, discrimination, hateful rhetoric, and hateful action, whether directed towards one's race, gender, gender identity, sexual orientation, religion, national origin, disability, citizenship, political views, socioeconomic status, veteran status, or immigration status.

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Can A University Become Carbon Neutral?

Timothy Gutowski

THIS IS THE QUESTION we took up as a class project in 2.83/2.813 for the spring term 2016. We looked at the climate action plans of 22 colleges and universities in the U.S. (and four more in Europe), including 10 who signed the American College and University Presidents Climate Commitment (ACUPCC) and claimed they would be carbon neutral by 2016. The short answer to this question is a conditional yes. Of the 10 first movers, five are, or soon will be, carbon neutral; however, the solutions they use are not scalable, or have other issues, and the schools are arguably only able to achieve carbon neutrality because of their unique circumstances. Having said that, we should give them credit for their accomplishments.

The successful schools (all from the Northeast) are generally small, mostly

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Editorial

Resisting Anti-Science Stances of the New Administration

U.S. PRESIDENTS HAVE HAD a history of enthusiastic and constructive engagement with science and technology. Notable among them have been Washington and Jefferson, Lincoln, Roosevelt, Kennedy, Jimmy Carter, and Barack Obama. In fact, the growth and health of the U.S. economy post World War II was the product, in large part, of the far sighted and generous public investments made through the National Science Foundation, National Institutes of Health, NASA, NOAA, and the Department of Energy, in computer science, materials science, telecommunications, biomedical research, environmental and geophysical programs, and many other disciplines.

President-elect Trump has nominated as a leading member of his cabinet an individual who dismisses the scientific

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liberal arts colleges in rural settings in states with below average carbon intensity electric grids (Vermont, Maine, and New York). They all appear to have a strong environmental identity and started on their carbon-neutral path as soon as the ACUPCC was signed (2007), or slightly before. They all appear to have sufficient, to significant resources including land as well as money. The most practiced solutions were, approximately in order of prominence: 1) burning wood, 2) buying carbon credits, 3) claiming sequestration from owned forests, and 4) burning syngas from cow manure. Everyone practiced some level of energy efficiency, but it was the four actions listed above that appeared to make the difference.

For larger universities with engineering and science laboratories, or with medical schools, the task is much more difficult. Second Nature, the group that is tracking the progress of the 679 signers of the ACUPCC agreement, provides data showing that "industrial-strength" universities such as MIT are about four times more carbon intensive per full-time enrollment (FTE) than the baccalaureate colleges (28 metric tons of CO_2equivalent per FTE versus 7tCO_2e/FTE). MIT currently stands at about 20tCO_2e/FTE, but our accounting is ongoing with potentially important pieces still missing (for example, institute travel, procurement, and waste).

Our acknowledgment of the success of the five schools is conditional, because each of the methods used to obtain their carbon neutral goal has some level of controversy that needs comment.

Wood burning is often assumed to be approximately carbon neutral over the long term, and can be feasible for a school if pollution is addressed, the demand is modest to reduce truck deliveries, and supply is available. Even so, wider use of wood has several issues: it is limited in supply, land intense, and would compete with cropland and affect food prices if developed on a large scale. In other words, it is not scaleable. Nevertheless, for these small applications, and from a carbon emissions point of view, burning wood cleanly is still better than using fossil fuels. It is worth noting that there are some sophisticated new technologies for burning wood including a 2MW combined heat and power biomass gasification unit at the University of British Columbia. It is also worth noting that there are remaining issues concerning the effect of harvesting on Net Primary Productivity for the decades immediately after the harvest.

The free market approach of paying someone else to reduce their emissions and claiming the credit, i.e., buying carbon credits, could be an efficient way to address this problem. The idea is to direct resources to the best opportunities. We found that four out of the five successful schools used some level of carbon credits to obtain their goal.

The free market approach of paying someone else to reduce their emissions and claiming the credit, i.e., buying carbon credits, could be an efficient way to address this problem. The idea is to direct resources to the best opportunities. We found that four out of the five successful schools used some level of carbon credits to obtain their goal. Note that for a small school with relatively low emissions, say 4tCO_2e/FTE (a real case), one can appear to solve the problem by buying low cost carbon credits at about \$10/tCO_2e with a resulting cost of \$40 per student per year. The chief challenges to this solution are related to risk and a potential moral hazard. That is, the effectiveness of some schemes can be hard to confirm, and potentially could lead to mischief. Morally, the Harvard philosopher Michael Sandel has argued that "turning pollution into a commodity to be bought and sold removes the moral stigma that is properly associated with it . . . [and] may undermine the sense of shared responsibility that increased global cooperation requires." These problems aside, if you follow this path, it requires an ongoing payment until you actually do get your carbon emissions down. For MIT, buying high quality carbon credits at \$20/tCO_2e (to reduce risk and ensure effectiveness) and assuming that full accounting puts us at 25 tons CO_2 per FTE would cost \$500 per student or a yearly total cost of \$5.5 million.

Several schools with large tracts of forested land are claiming carbon credits for increasing carbon sequestration on those lands. Although the protocols are still being worked out, the general idea is that by using improved forestry practices, one can manage a tract of land to increase the stored carbon (usually in the standing trees) over some considerable length of time, i.e., 40 to 100 years. If you have enough land, you can even sell these credits and make a profit, as at least one school said they are doing. If MIT were to try to engage in this practice, we would find ourselves at a noticeable disadvantage. Our campus land area of 68 hectares (ha) is about an order of magnitude smaller than our fellow industrial-strength university campuses. We found several examples of this carbon credit method. One was provided by the California Air Resource Board (ARB) with claims of an improvement potential of 1.56 tC/ha/yr (over 100 years) for forest in California (Willits Woods in Mendocino County). Using this number, MIT would need the land area equivalent of about 500 of our current campuses to sequester our 200,000 metric tons of CO_2 equivalent per year. That is, we would need to find

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this land and develop it over 100 years. (This scheme does raise some questions that need more discussion.)

Finally, two schools (both in Vermont) claimed to have developed a scheme to use syngas produced from cow manure. This plan requires, among other things, investment in a bio-digestor, infrastructure to transport the gas to the school (a pipeline is preferable) and, of course, a sufficient supply of cow manure. This struck us as one of the more creative solutions. Unfortunately, we learned from one school that the current low price of natural gas has made such an investment questionable, resulting in a delay and causing that school to develop alternative options.

In comparison to the smaller schools, the bigger technical universities, with more in common with MIT, have, understandably, much higher emissions and more modest percent reductions. As mentioned earlier, the larger technical universities have roughly four times the carbon emissions per student compared to the smaller undergraduate institutions. In addition, the larger schools we studied have roughly 10 times the students (~20,000 versus ~2,000) hence the emissions from the larger universities are roughly 40 times larger (e. g., 200,000 tCO_2e versus 5,000 tCO_2). Changes in CO_2 emissions from these universities, over roughly the same length of time as the smaller institutions, ~9 years, range from an increase of 6%, to a decrease of 32%, with an average decrease of 9%. While this appears to be a much more modest reduction than the smaller first movers, in terms of absolute reductions, it is actually larger. That is 9% of 200,000 is more than three times the total emissions previously emitted by our prototypical small carbon neutral college (~5,000 tCO_2e). Hence, only looking at relative reductions could be misleading. Furthermore, using percent reduction in carbon emissions as the metric to judge improvement has an additional disadvantage in that it can favor late movers, for example those who only recently have converted from coal to natural gas for their power plant. In fact, this is part of the explanation behind the 32% decrease mentioned above. If you remove the power plant conversion from their data, we estimate the improvement is about 22%. For your information, MIT is not at all a late mover. MIT switched from coal to oil in 1935 and from oil to natural gas in 1995.

We found that the improvement strategies at the larger schools were somewhat different than those employed by the successful first movers. There was little mention of wood burning boilers, forest sequestration, and biogas from cow manure. There was a strong emphasis on energy efficiency, as with the small schools, and alternative renewable energy sources.

We found that the improvement strategies at the larger schools were somewhat different than those employed by the successful first movers. There was little mention of wood burning boilers, forest sequestration, and biogas from cow manure. There was a strong emphasis on energy efficiency, as with the small schools, and alternative renewable energy sources. These renewable energy sources included photovoltaic panels, land-based wind turbines, small geothermal applications, small hydroelectric installations, and even water exchanges from deep lakes for building cooling. The general theme was to look for local opportunities and exploit them. And again, having a large land footprint is very helpful to accommodate these alternative land intensive energy sources. For those who do not have sufficient area to accommodate these projects, they could support their development at remote sites, and could possibly qualify for carbon credits. (More on this later.)

We found it difficult to assess the effectiveness of the various energy efficiency activities because the schools generally report their emissions at an aggregate level without sufficient detail to estimate these effects. However, the average energy use and carbon emissions per building area for some of these schools is far removed from current best practice, and it is reasonable to expect significant potential in this area. MIT has been working at this problem for some time with some success, but even so our current average energy use per floor area is about double best practice. It is worth pointing out that a major component of this high-energy use is our reliance on very high air exchange rates to ensure cleanliness and safety in our laboratories. And in addition, constant travel by people entering and leaving our buildings also leads to high air exchange rates. These are tough areas to address. We cannot compromise our standards for cleanliness, safety, and access, but could we meet them in alternative ways that reduce our air exchange rates with the outside? These problems need special attention if we are to be successful at reducing our building energy use.

Finally, there is the complication that successful universities are often growing. For the 11 universities for which we could gather building growth rates (in terms of floor area), we found a nominal average growth rate of about 3% per year. Yes, this is limited data, but it certainly rings true for us at MIT. A recent article in the *MIT News* suggests that our energy demand is expected to grow by 10% by 2030. Obviously, this significantly increases the challenge to become carbon neutral.

Part of MIT's challenge is that we have already made our move to natural gas cogeneration. There is no obvious renewable energy alternative that fits on campus and could meet all of our needs. Here in Massachusetts, the biggest opportunities for renewable energy are not on our campus. They are offshore wind and hydroelectric from Québec. These options are, of course, well known, and are the subject of a recent important initiative by the Massachusetts legislature. But these will take time to develop, so in the meantime what should we (MIT) do? What we know is that many people at MIT are working on this, with new studies and more efficiency improvements in the works. But, we appear to be committed to on-campus natural gas co-generation for the next 20 years with plans to increase our capacity from 1 to 2 new 22MW turbines. So what seems clear, is that some off-site activities (e.g., carbon off-sets, and/or working with the local grid, etc.) will be necessary.

In fact, while this article was being written, MIT announced participation in a large new solar farm in South Carolina. MIT will purchase solar power said to be equivalent to 40% of the Institute's current electricity use. This seems a significant move by MIT to take these steps in a relatively short time to address climate change. Those who have done this work on our behalf are to be congratulated. At the same time, it would be very helpful if more information about these carbon reduction claims could be made available to the wider MIT community. The article in the *MIT News* claims that MIT will "neutralize" 17% of its carbon emissions through the purchase of solar energy. But it is not immediately clear how our support for the development of this solar facility is going to neutralize our emissions. One needs to differentiate between renewable energy credits, and carbon offsets. In plain English, enabling low carbon growth and actually reducing real carbon emissions are two different things. Real reductions require that a real source of carbon emissions be attenuated or shut down. Presumably this is part of how the new energy will be integrated into the local grid, but nothing was said about this. More information about this arrangement would be welcomed so we can understand the basis for these claims.

I would like to personally thank the students who worked so closely with me on this class project, in particular, Samantha Houston, the teaching assistant, Patrick Callahan and Rachel Perlman, as well as, Sean Caetano, Tyler Capps, Wesley Cox, Aaron Downward, Amanda Hamlet, Matthew Hole, Patrick Linford, Jessica Press-Williams, Michael Sandford, James Slonaker, Prithivi Sundararaman, and Kevin Thomas.

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letters

Access MIT and Transit Commuter Benefits

To The Faculty Newsletter:

Re: "MIT Administration 'Walking the Talk' on Transit Commuter Benefits," by Frederick P. Salvucci, *MIT Faculty Newsletter*, Vol. XXIX, No. 1.

I INVARIABLY ENJOY READING your articles in the *Faculty Newsletter*. (I have appreciated your astute skepticism about plans for redevelopment near Kendall.)

This message is in reaction to your recent article about transit commuter benefits – not a response to the article, but a comment about the benefits themselves. It's great that MIT now fully subsidizes T passes. But to complete the picture, MIT should also work with the MBTA to decrease congestion and increase capacity. Travel between Central and Kendall Squares during morning rush hour is no fun; it's sometimes necessary to let a train or two go by before being able to board. The buses along Mass. Ave. are also crowded, and often delayed.

I write you in the hope that you'll be able to pass along a suggestion to someone who can make useful decisions. It's unfair to non-MIT Cantabridgians to encourage use of public transportation without also pitching in ease crowding. I believe that the MBTA is contemplating the purchase of new Red Line cars. Maybe MIT could figure out some clever design tweaks that would allow trains to hold more travellers, or to load/unload more quickly. Maybe MIT could subsidize salaries for train and bus drivers to allow more frequent service. Maybe MIT could develop safer signaling/braking systems that would allow trains in the subway tunnels at more frequent intervals. Or something else, t.b.d.

Please forward this message, or useful parts of it, as you see fit.

I look forward to your next FNL article.

Ken Pierce
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and Science