July 5, 2019

To the Dartmouth College Community

We are three alumni who have led major scientific programs and research institutions dealing in part with forests as cause and cure of the climatic disruption. We have also been involved for decades in evaluating alternatives to fossil fuels in domestic and institutional settings.[1] We have read with interest and no little alarm that Dartmouth intends to replace its oil-fired steam heating system with a large wood-burning facility nominally in the interest of reducing institutional carbon emissions. While it is commendable to find ways to reduce the College's dependence on fossil fuels, the important goal is to reduce Dartmouth's net carbon dioxide (CO_2) emissions. Switching from oil to wood will increase the College's emissions substantially.

Shifting from steam to hot water will provide a modest saving in the need for primary heat. However, shifting from heating oil to wood to supply that energy will increase the college's carbon emissions substantially, worsening global warming and climatic disruption when dramatic emissions reductions are urgently needed to limit climate change.

The problems are several. First, the Intergovernmental Panel on Climate Change (IPCC) and many peer-reviewed studies show that wood generates significantly more CO_2 than the fuel oil it would replace, and even more than the natural gas used by Dartmouth's Mary Hitchcock Hospital. The carbon content of wood is about 30% higher per unit of primary energy than fuel oil and about 80% higher than natural gas. Second, the combustion efficiency of wood is less than that of modern oil and gas systems. Third, the wood supply chain requires substantial energy for harvest, transport, processing and drying prior to use, and for ash disposal.[2]

Therefore, the first impact of switching from oil to wood will be an *increase* in Dartmouth's carbon dioxide emissions, worsening climate change.

Of course, over time, the forests harvested to supply that wood may grow back, gradually removing CO2 from the atmosphere. That is the great hope underlying the use of bioenergy. However, and crucially, regrowth takes time and is not certain. In the northern forests that would supply the proposed plant, the time required to remove the excess CO_2 emitted from burning wood instead of oil is many decades at least, and possibly more than a century. This is true even under the optimistic assumptions that the harvested lands will remain forest and will not be converted to pasture, cropland, or development, and that the new growth in those forests will not suffer die-off from disease and insect damage, or burn in wildfire, all more likely as the world warms.

These dynamics mean that switching from oil to wood will worsen Dartmouth's contribution to climate change for decades, when the IPCC and scientists around the world agree that global emissions must fall dramatically by 2030, and essentially to zero by mid-century.[3]

The College's announcement states that only "waste wood" that would normally decay will be used, but it is difficult to verify that all such fuel is "waste-wood." In fact, removing wood, "waste" or not, deprives forests of the nutrients and soil carbon needed to ensure vigorous replacement growth. Northern New Hampshire, where a number of wood burning power plants are located, has a much-depleted forest in terms of carbon stocks than do southern NH forests. None of these wood burning plants has proven economically viable. Four have closed; two seek $75 million from the state legislature to remain open.

Furthermore, importing wood for fuel from other regions is in many instances proscribed to avoid spreading deadly tree diseases and pests such as the Emerald Ash Borer, now devastating ash in New England forests.

Wood generates a variety of public health harms over and above its harm to the climate. Wood smoke contains the most dangerous particulates of any fuel. Many regions have restricted wood burning for this reason. Winter temperature inversions in the Connecticut Valley capture fireplace and woodstove smoke now. The additional burden of smoke from a large wood-burning power plant could easily be enjoined by residents.

We urge you to avoid making a heavy investment in a mistaken assumption that a wood-fired heating plant will be of benefit to the College or the world.

Instead we urge a major effort in energy efficiency for the College's facilities. Efficiency is the fastest, cheapest, and safest way to meet people's need for warm buildings in winter and cool ones in summer. The increase in the up-front capital costs of highly efficient buildings, both new construction and retrofits, is very low (from roughly zero to a few percent), while their operating costs are far lower, often generating positive net present value while imposing little burden on cash flow.[4] Simultaneously, we urge a careful look at local potential solutions for heating and cooling, including air-and ground-source heat pump systems, powered by renewable energy from local sources including solar photovoltaics, wind, and water.

Yours truly,

George M. Woodwell '50, '96 (H), President Emeritus, Founder, Woods Hole Research Center, Woods Hole, MA

William Schlesinger '72, James B. Duke Professor of Biogeochemistry and Dean (Emeritus) Nicholas School of the Environment, Duke University

John D. Sterman '77, Jay W. Forrester Professor of Management, MIT, and Director, Sustainability Initiative, MIT Sloan School of Management

Notes and references:

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[1] Woodwell, George, *The Nature of a House*. Island Press. Additionally, J. Sterman lives in a 90 year-old house in Lexington MA that, after a deep energy retrofit with solar PV, generates approximately 50% more energy than it

uses year-over-year, with no fossil fuel. Woodwell enjoys similar efficiency with solar PV and no fossil fuel in a 70 year old house in southern Maine. Schlesinger designed and lives in a house in eastern Maine, powered by photovoltaics that generate twice as much energy as he uses each year.

[2] Sterman et al. 2018a, 2018b provide life-cycle analysis showing that wood energy worsens climate change for decades to centuries, even if the wood displaces coal, the most carbon intensive fuel, and includes analysis of forests in New England as well as the southern US. See: https://iopscience.iop.org/article/10.1088/1748-9326/aaa512 and https://iopscience.iop.org/article/10.1088/1748-9326/aaf354.

[3] See, e.g., Figueres et al. 2018, *Nature*: https://www.nature.com/articles/d41586-018-07585-6, and IPCC 2018, Global Warming of 1.5°C. https://www.ipcc.ch/sr15/.

[4] A post-audit showed that the MIT Sloan School of Management building, completed in 2010, uses about 70% less energy for heating and cooling, and about 40% less electric power, than a comparable code-compliant building, with an increase in up-front design and construction costs of approximately 0.25% of the project cost, because the higher costs of additional insulation, high-performance windows, efficient HVAC systems, etc. were nearly offset by savings due to the smaller HVAC system, electrical infrastructure, and steam and chilled water capacity enabled by the reduction in peak energy requirements. The project generated a net present value of nearly $10 million (on a roughly $140 million project) due to the savings from lower energy costs, with almost no impact on MIT's cash flow. See Lyneis, J. and J. Sterman 2016. How to Save a Leaky Ship: Capability Traps and the Failure of Win-Win Investments in Sustainability and Social Responsibility. *Academy of Management Discoveries* 2: 7-32.