

SPECIAL TOPICS COURSE – FALL 2023 – OPEN TO ALL ENGINEERING STUDENTS

EECS 298-051 [1 credit-hour]

From 51 Billion to Zero:

Challenges and Opportunities in Reducing Greenhouse Gas Emissions

[Short Title: How to Reduce GHG Emissions]

Wednesday, 4:30-5:30pm. Room 1005 EECS Bldg.

Instructor: *Stéphane Lafortune* - EECS/ECE (stephane@umich.edu)

Summary: EECS 298-051, Fall 2023, will be a seminar-type course with presentations by the instructor and invited speakers. The goal of this course is two-fold. First, the understanding of how human activities, from electricity generation to transportation, construction, agriculture, and heating/cooling, contribute to the release of greenhouse gases (GHG) in the Earth's atmosphere. Second, the study of current and prospective engineering solutions for reducing and potentially eliminating GHG emissions, with several presentations by UM experts.

Description: The course will be organized according to the five sectors of human activity that contribute to the release of GHG in the Earth's atmosphere, in the amount of **51** Gigatons (or 51 Billion Tons) per **year** (pre-pandemic data). Using the terminology in the recent book by Bill Gates [Bill Gates, "How to avoid a climate disaster – The solutions we have and the breakthroughs we need," Knopf, 2021], these five sectors are:

- How We Plug In (27% worldwide - 28% in US);
- How We Get Around (16% worldwide - 29% in US);
- How We Make Things (31% worldwide – 24% in US);
- How We Grow Things (19% worldwide – 11% in US);
- How We Keep Cool and Stay Warm (7% worldwide – 8% in US).

[Worldwide and US data from Energy Breakthrough website.]

In order to reduce the number of 51 Gigatons to zero, or more precisely to *net-zero*, i.e., to the equivalent of zero once accounting for carbon removal or other offset measures, we need to understand how each of the above five sectors contributes to the total, both worldwide and in the US, what options currently exist for reducing these emissions, and what challenges and opportunities lie ahead. In particular, the course will discuss clean (i.e., GHG emission-free) electrification as a path to achieving significant reductions in GHG emissions. The discussion will be on current, near-term and medium-term engineering solutions that could be deployed and the reductions that they could achieve.

We will draw on the considerable expertise of UM faculty in each relevant sector; several faculty will make presentations during the course (live or pre-recorded). In particular, we will discuss: renewable energy (solar and wind), power grid, batteries, vehicular electrification, lighting, carbon capture and sequestration, and UM efforts on campus. [Syllabus on next page.]

Please join us!

Tentative syllabus:

Week 1: Course introduction: context, organization, schedule, readings and project, grading.

Week 2: Explaining the numbers. 51 billion tons of GHG emissions. US and worldwide data. Challenges and opportunities.

Weeks 3-4-5: Electricity generation and consumption. Solar and wind energy. Power grid. Storage.

Weeks 6-7: Transportation. Automobiles, trucks, trains, ships, and airplanes: status and challenges in each mode of transportation. Batteries.

Week 8: Buildings. Lighting, HVAC.

Week 9: Carbon capture and sequestration

Week 10: Agriculture and forestry.

Week 11: Nuclear energy; green hydrogen.

Week 12: UM sustainability efforts.

Week 13: Other topics, as time permits.

Week 14: Project presentations.

Grading: Based on class participation (attendance required) and short course project (preferably teams of 3) with brief oral presentation.