Hy-flex etiquette for this course

- [https://columbiauniversity.zoom.us/j/99574533101?pwd=ZUc2MiNjQTvBaG9DZEZaS1BQTwEDQ09](https://columbiauniversity.zoom.us/j/99574533101?pwd=ZUc2MiNjQTvBaG9DZEZaS1BQTwEDQ09) (meeting ID: 995 745 33101; passwd: SPS2021)
- Ensure that under participants, your are shown with your name
- **Remote students**: Video ON strongly encouraged
  - To speak up, temporarily unmute yourself anytime during the lecture (with a question/comment, etc.), using e.g., the spacebar
  - You do NOT have to wait for me to call on anyone
  - Quickly say your first name whenever you say something
- **In-classroom students**:
  - You will be audible and visible on the instructor’s zoom channel
  - In addition, log into Zoom BUT for now, keep speaker, mic, and video off
- Optional: To improve audio quality
  - Use your phone to dial in: (646) 876-9923; after password, enter your personal participant ID as shown to you in Zoom:
- Chat disabled … “raise hand” enabled but simply speaking-up is preferred
- **Additional “channel” for participation (all students, especially a-sync)**
  - “Async participation” discussion group on Canvas
- **Pitches (after short break – stay in zoom during break)**
  - Each student doing a pitch will share their screen
  - You will still be held to the 5-min rule, however, we will "stop the clock" in case there are any technical glitches at the start of or during your pitch
  - Q&A will be done as well
- Make sure your zoom version stays current ([https://zoom.us/download](https://zoom.us/download))
Goals of today’s session

- For those who are shopping
  - What this class is all about, flavor, assignments, grading

- For those who will stay
  - Actually getting us started, first homework, logistics, introduce you to the TA, etc.

- Please ask questions and raise any concerns you have about the course
  - Nature of assignments
  - Grading
  - Pre-requisites
  - Etc.

…”the idea is to give you as much info as possible to plan your spring 2021 curriculum…"
How to participate in class

- I am a fan of lively in-class debate and will encourage it as much as possible
  - Whenever you have a question or comment, feel free to “barge” right in and speak up
    - Use spacebar as a “temporary unmute” whenever you want to speak up
      - Quickly mention your first name
    - No need to raise hand
      - TAs (but not instructor) will monitor raised virtual hands and alert instructor
    - “Plan B”: Post question to chat

- How to use chat
  - Post a question which TAs will then relay to instructor
  - Instructor will not monitor chat (neither during nor after class)
  - If you would like to post something for everyone to read (fellow students and instructor), then please use the Canvas “a-sync participation” discussion board instead
Movie clip: Biochar
http://www.youtube.com/watch?v=jFdJB50K4A8
History and origins of this class
From “Industrial Ecology” in the Engineering School to “Theory & Practice of LCA” in SPS

- Past classes defined “Industrial Ecology” as:
  - *The design or re-design of processes and products with full knowledge of their environmental impacts*
  - *Industrial Ecology can best be understood as a set of tools to measure sustainable development*

- Overarching goal: Really about studying material cycles
  - At the levels of global to country to consumer products
  - … and their impacts on the environment

- LCA evolved as the pre-eminent thought process and accounting method to achieve that goal … and to find ways to reduce the impacts

- More in the next lecture
Recommended books (optional)

- No textbook is required for this class
- Students will be provided with relevant excerpts from the following standard textbooks on LCA and on Industrial Ecology (which also offer additional, optional reading on various related topics):

  **Books on LCA**
  - “LCA handbook” from University of Leiden
    - Very comprehensive but “classic” amongst LCA specialists and teachers
  - … and some (but not many!) others

  **Early ideas & frameworks of Industrial Ecology**
  - R. Socolow et al. (ed.): Industrial Ecology and Global Change (1994) [Cambridge University Press]

  **Actual textbooks on Industrial Ecology**
Throughout this class, you will see how some of “Industrial Ecology’s” original goals can be quantitatively measured and achieved through LCA … and how LCA is also a very pragmatic “accounting” tool suitable for businesses

- A systems view of the interactions between industrial and ecological systems
- The study of material and energy flows and transformations
- A multidisciplinary approach
- An orientation toward the future
- A change from linear (open) processes to cyclical (closed) processes, so the waste from one industry is used as an input for another
- An effort to reduce the industrial systems’ environmental impacts on ecological systems
- An emphasis on harmoniously integrating industrial activity into ecological systems
- The idea of making industrial systems emulate more efficient and sustainable natural systems
- The identification and comparison of industrial and natural systems hierarchies, which indicate areas of potential study and action
- Study of anthrobiogeochemical flows
Additional reading (see Canvas | Files: "Additional Materials")
Homework assignment: HW1

- **Part 1**
  
  Choose (and cite) any one of the many possible definitions of “Sustainability”
  - Can be current or old … good or bad … comprehensive or narrow … “left” or “right”
  - Does not have to be one you agree with … but must be one that is documented somewhere
  - 100 words maximum *(add the word count to your HW)*
  - If your definition is not about “Sustainability” but rather “sustainable process”, “sustainable product”, or “sustainable development”, etc., that is fine (but make it clear in your title)

- **Part 2**
  
  Write 6 succinct bullets or short paragraphs to critically evaluate the definition you chose in part 1
  - 3 strengths about the definition
  - 3 weaknesses about the definition
  - 300 word maximum (for all 6 together) *(add your word count to your HW)*

- **Part 3 (optional)**
  
  Expectations for the class, what do you hope to learn, what should be covered (or not…) etc.
  (TAs will consolidate and relay to instructor)

- **Due Thursday 21 Jan 2021 at 4.10pm** *(pdf, with word counts given, → Canvas/Assignments)*
  - Please note Canvas will stop accepting submissions at 4.10pm
Three content pillars of this course

**THEORY**
Industrial Ecology and Life Cycle Assessment (LCA)

**PRACTICE**
Sustainability management and innovation in business

**COMMUNICATION**
Student discussions, breakout groups, and presentations
Movie clip: Diet coke commercial
https://www.youtube.com/watch?v=еРf5gGvau4A
Often, answers from LCA are relatively straightforward, but the actions companies want or can take are much more complicated.
Course objectives
What will you get out of it?

▪ Know concepts and philosophy of LCA, both in theory and practice
  – What is it, what are the basic steps?
  – What are the disadvantages and pitfalls?
  – How do companies use it, and with what challenges?

▪ Know how to do a “carbon footprint” for a product
  (and most other LCAs as well)

▪ Know how to read, interpret, and critically evaluate product LCAs
  (and companies’ sustainability claims around them)

▪ Have been exposed to a large number of environmental issues,
  possible remedies, and how to quantify these

▪ Be trained as a “system’s thinker”
## Semester preview (tbc)

<table>
<thead>
<tr>
<th>Session</th>
<th>Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Thursday, January 14, 2021</td>
<td>Introduction and logistics</td>
</tr>
<tr>
<td>2</td>
<td>Thursday, January 21, 2021</td>
<td>IE history and taking stands</td>
</tr>
<tr>
<td>3</td>
<td>Thursday, January 28, 2021</td>
<td>LCA: Introduction &amp; history</td>
</tr>
<tr>
<td>4</td>
<td>Thursday, February 4, 2021</td>
<td>LCA: Basic steps - example carbon footprint</td>
</tr>
<tr>
<td>5</td>
<td>Thursday, February 11, 2021</td>
<td>LCA: GHG emission factors</td>
</tr>
<tr>
<td>6</td>
<td>Thursday, February 18, 2021</td>
<td>LCA: LCA thorny issues</td>
</tr>
<tr>
<td>7</td>
<td>Thursday, February 25, 2021</td>
<td>LCA: Final deep dives and new developments</td>
</tr>
<tr>
<td></td>
<td>Thursday, March 4, 2021</td>
<td><strong>No class - spring recess</strong></td>
</tr>
<tr>
<td>8</td>
<td>Thursday, March 11, 2021</td>
<td>LCA then and now: Case studies</td>
</tr>
<tr>
<td>9</td>
<td>Thursday, March 18, 2021</td>
<td>Personal transportation &amp; electric cars</td>
</tr>
<tr>
<td>10</td>
<td>Thursday, March 25, 2021</td>
<td>From product to system</td>
</tr>
<tr>
<td>11</td>
<td>Thursday, April 1, 2021</td>
<td>Lessons learned &amp; course wrap-up</td>
</tr>
<tr>
<td>12</td>
<td>Thursday, April 8, 2021</td>
<td>Students' presentations and discussion of final projects (1/2)</td>
</tr>
<tr>
<td>13</td>
<td>Thursday, April 15, 2021</td>
<td>Students' presentations and discussion of final projects (2/2)</td>
</tr>
</tbody>
</table>

**Heads up:** Group papers will due **Thu April 22nd at 11.59pm**
## Typical schedule

<table>
<thead>
<tr>
<th>Time</th>
<th>Agenda</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.10 – 5.20</td>
<td>Main lecture</td>
</tr>
<tr>
<td>5.20 – 5.30</td>
<td>Break</td>
</tr>
<tr>
<td>5.30 - 6.00</td>
<td>Students' pitch presentations (~4 per session)</td>
</tr>
</tbody>
</table>
## Grading and class logistics

### Grading

- **Home work:** 40%*
  - Announced in each session
  - Due on Canvas | Assignments, usually within 1 week
  - Sometimes aided by Canvas discussions
  - **SimaPro license will be available**

- **5 min. pitch presentation:** 10%
  - One per student, live in class

- **Group project & paper:** 35%
  - Groups of 6 students max.
  - Details tba over coming weeks

- **Class participation:** 15%
  - "Monitored" by instructor and TAs
  - Additional participation on Canvas discussion “Async Participation” (for async students, but available to all)

* There will be ~7 HWs; all count 4% towards the final grade, except HW4, which will count 12%

### Policies and Etiquette

- Tas give raw scores for assignments according to instructor’s rubric, instructor checks these, but only instructor gives an actual grade

- There is **no** standard late policy
  - Default rule: HWs not submitted by deadline receive an F
  - … unless extension was obtained from instructor prior to deadline
  - … or in cases of "force majeure"

- **Attendance**
  - Expectation is that most students will attend all classes
  - … but emphasis is on overall participation throughout the semester (see participation grade), therefore exceptions not a problem
  - If you cannot attend a particular class, heads-up emails to me or the TAs are appreciated but not mandatory
How Canvas is used in this course

- “Files” has a folder for each week’s session
  - Readings will be posted ~5 days ahead of the respective session
  - Lecture slides (as pdf) will be posted on Thursdays 1-2 hours ahead of each lecture
    - As an alternative way to follow along (instead of watching the screen share)
    - To make notes on during class

- Assignments
  - Slides with instructions (same as in lecture slides)
  - Submit assignment
  - Review grade once posted

- Discussion groups
  - A-sync participation: This discussion board is intended to provide all students - whether you attend in person, online, or a-synchronously (i.e. watching the zoom recordings) - with an additional, separate channel for participation: by asking questions, posting comments, etc. I will follow the discussion and provide occasional answers etc. - but I may also just leave it to students to answer each other and engage in discussion, just like in in the classroom. Participation will be graded and will be a portion of your final grade. The grade will be for your COMBINED participation, whether live in class or whether via this discussion board. In other words, if you usually participate live in class, there is no need to also contribute to the discussion board (but you can!). However, if you are not a friend of live participation through zoom, if you participate a-synchronously (or you just “couldn’t get a word in” during the last live session), then you can use this channel to participate.
Responsibilities of the 2 TAs

Natalie Freeman  nf2501@columbia.edu
Amira Maryana  am5244@columbia.edu

- Assist students with assignments (and pitch)
  - Please email Amira and Natalie with requests for assistance (always email both)
  - They will respond by email or meet you during their office hours, whichever works best for everyone (TA office hours and the zoom link will be posted on Canvas)
  - Look out for occasional Canvas announcements in case of FAQs on some assignments

- Score and provide feedback on HWs (but Prof. Meinrenken will give grades)
  - Amira: HWs 1, 4, 7
  - Rina: HWs 2, 3, 5, 6

- One or both TAs will always attend class
  - Likely: Natalie in classroom and Amira via Zoom
  - Score pitch presentations
  - Help instructor keep track of participation
  - Both TAs will be zoom co-host

- Logistics and scheduling support for
  - Pitch presentations: Amira
  - Group projects (who is in which group, which topic, and when do they present: Tba
### Pitch presentations – Recommending something *based on* LCA-type evaluation

#### Required content (5 min. maximum)

- Introduce yourself and title of pitch
- **Part 1: Problem you are addressing**
  - What is it called?
  - What are its basic mechanics?
  - How big is it (give a figure and unit)?
  - Why and how exactly “unsustainable”?
  - Does NOT have to be GHG emissions
- **Part 2: Solution you are suggesting**
  - What are its basic mechanics?
  - Quantify potential alleviation of the figure in part 1 and explain calculation(s)
  - List at least 1 important **assumption or estimate** you made in the calculation(s)
  - Which possibly important effects were outside the **boundaries** of your analysis and therefore disregarded?
  - How do you propose to ensure or at least promote adoption of your solution?
- **Part 3: Summary**

#### Form & logistics

- **Sources**
  - Cite all major statements (source is either someone else or your own calculation)
  - Rule of thumb: 1 source per bullet point
  - Use footnotes, inline citations, or “…” [number]” with separate bibliography slide
- 5 min. maximum (we will cut you off)
- Practice
  - Memorize key phrases (first 10 sec.!!)
- Powerpoint very much *not* required ... try to make it memorable; props?
- 2 min Q&A per presentation
  - Try to keep your answers brief ... and thus answer more questions
- After your pitch, submit your notes, slides, pictures, bibliography (whichever) as a single file into Canvas | Assignments
Sample "Pitch presentation" (1 of 3)

- My name is ... I am a ...

- **Title:** Gasoline-powered hybrid vehicles in the US and their alleviation potential for global (fossil) carbon emissions

---

### Part 1: Problem

- Each year, combusting the world's fossil fuels emits 7 billion tons of carbon (or 26 billion tons CO2) [2006; source]

- In the absence of "carbon capture", i.e. ..., the thus emitted CO2 further contributes to global warming (in the case of CO2 by absorbing the infrared radiation being scattered back from the Earth's surface and thus reducing its re-radiation back into space)

- Estimates by Socolow et al. [source] indicate that 7*25=175 gigatons of carbon avoided cumulatively over 50 years would keep the atmospheric CO2 conc. at or below 560ppm, i.e. below a doubling of pre-industrial levels, and climate models [source] further indicate that this would keep the global warming at or below 2 degrees centigrade

- In 2006, all US passenger vehicles consumed 75 billion gallons of gasoline annually [source]
  - Life Cycle Assessment: EF of 2.915 kg CO2e per liter of gasoline [source]
  - Thus, 75 billion gallons in US correspond to 3.2% of **global** annual CO2e emissions
Sample "Pitch presentation" (2 of 3)

### Part 2:

- **Solution**
  - In 2006, the average consumption of US passenger cars was 22.5 miles per gallon.
  - Commercially available, gasoline-driven hybrids such as the Toyota Prius or Chevy Volt offer ~45 miles per gallon (at comparable size and performance).
  - Main mechanism by which hybrids are more fuel efficient (i.e. more miles per chemical energy in onboard fuel): (i) regenerative breaking (ii) rpm sweetspot of ICE [source]

- **Alleviation**
  - In 20 years, all vehicles could be replaced [source; based on average vehicle life time and "turnover " in the market]
  - This would halve the contrib. of US passenger vehicles to global (fossil) CO2 emissions, from 3.2% to 1.6% of global total CO2 from all fossil fuel combustion

- **Key assumption**
  - Hybrids, despite their higher price, could be phased-in at equal pace as "current" cars with conventional internal combustion engines

- **Boundary**
  - Batteries and possible generators in the cars cause additional life cycle CO2e emissions that are NOT yet included (however studies have shown that these can be significant [source])

- **Adoption scenario and incentives**
  - Higher purchasing price of hybrids offset by lower cost at pump; alternative of electric vehicles much more disadvantageous because of high battery cost and range anxiety
Part 3: Summary

- In 2006, in the US passenger vehicles consumed 75 billion gallons of gasoline
  - These 75 billion gallons annually in US correspond to 3.2% of global annual CO2 emissions

- If in 20 years all US cars could be replaced with gasoline driven hybrid cars, this would cut the contribution of US passenger vehicles to global (fossil) CO2 emissions in about half
  - Assuming: All other things being equal

- Lastly, re. feasibility of adoption rates: Incremental sticker price of hybrids over conventional ICE cars would be made up for cost savings at the pump
Examples of past pitch presentations – *pitches will start on 21 Jan 2021*

<table>
<thead>
<tr>
<th>Paper vs. plastic</th>
<th>Sustainable beer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free energy efficiency measures</td>
<td>China's One Child Policy</td>
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<tr>
<td>Hybrid cars</td>
<td>Solar trash compactors</td>
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<tr>
<td>Green roofs</td>
<td>Waterless compacting toilets</td>
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<tr>
<td>&quot;No mow zones&quot; to curb emissions</td>
<td>Commercial jets vs. propeller aircrafts</td>
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<tr>
<td>Subway trash and recycling</td>
<td>Life cycle of ethanol</td>
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<tr>
<td>Nuclear power</td>
<td>Paper receipts vs. e-receipts</td>
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<tr>
<td>Wave energy for Hawaii</td>
<td>Print media vs. e-readers</td>
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<tr>
<td>Meat-free Mondays</td>
<td>CO2 reductions without cap-and-trade</td>
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<tr>
<td>PV in Japan, CO2 reductions</td>
<td>CO2 capture and storage: Sleipner field</td>
</tr>
<tr>
<td>Stairs vs. elevator</td>
<td>Vertical farming</td>
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<tr>
<td>Renewable potential in New York State</td>
<td>Guinea pig manure as energy source for P</td>
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<tr>
<td>Energy use of prisoners</td>
<td>Env. impact of U.S. coin production</td>
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<tr>
<td>Hydroponics and urban farming</td>
<td>Concrete, Calera technology</td>
</tr>
<tr>
<td>Sustainable road materials</td>
<td>Tobacco vs. sunflower production in Tanzania</td>
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<tr>
<td>WTE carbon footprint</td>
<td>Cats vs. dogs</td>
</tr>
<tr>
<td>Reusable vs. disposable cups</td>
<td>NYC shared bicycles</td>
</tr>
<tr>
<td>Natural fertilizers from human waste</td>
<td>Amazon frustration free packaging</td>
</tr>
<tr>
<td>NYC &quot;cool roofs&quot; (painted white)</td>
<td>PV on building walls</td>
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<tr>
<td>Pharmaceutical industry: US vs. Canada</td>
<td>Green burials</td>
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<tr>
<td>Styrofoam from mushrooms</td>
<td>Insinkerators</td>
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<tr>
<td>Offshore wind and high-voltage DC</td>
<td>Alternative fertilizers</td>
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<tr>
<td>Emissions from truck idling</td>
<td>Drip irrigation</td>
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<tr>
<td>Underwater kite energy for Chile</td>
<td>Biochar</td>
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<tr>
<td>&quot;Vampire energy&quot;: plugged appliances</td>
<td>Bioplastics</td>
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