

# 1. Intro Class

**Sustainable Software Engineering**  
**CS4575**



**Luís Cruz**  
**[L.Cruz@tudelft.nl](mailto:L.Cruz@tudelft.nl)**

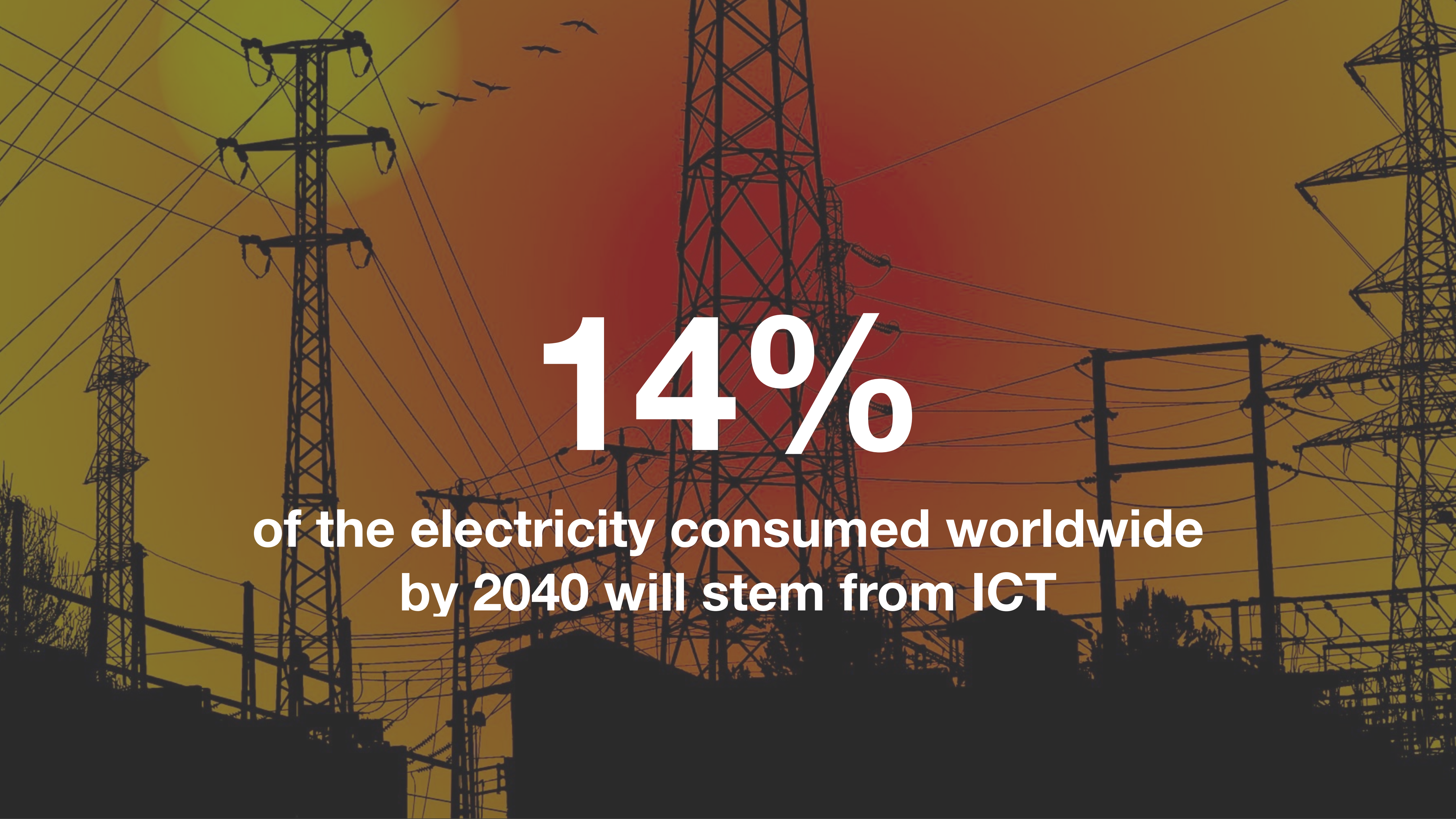


**Carolin Brandt**  
**[C.E.Brandt@tudelft.nl](mailto:C.E.Brandt@tudelft.nl)**



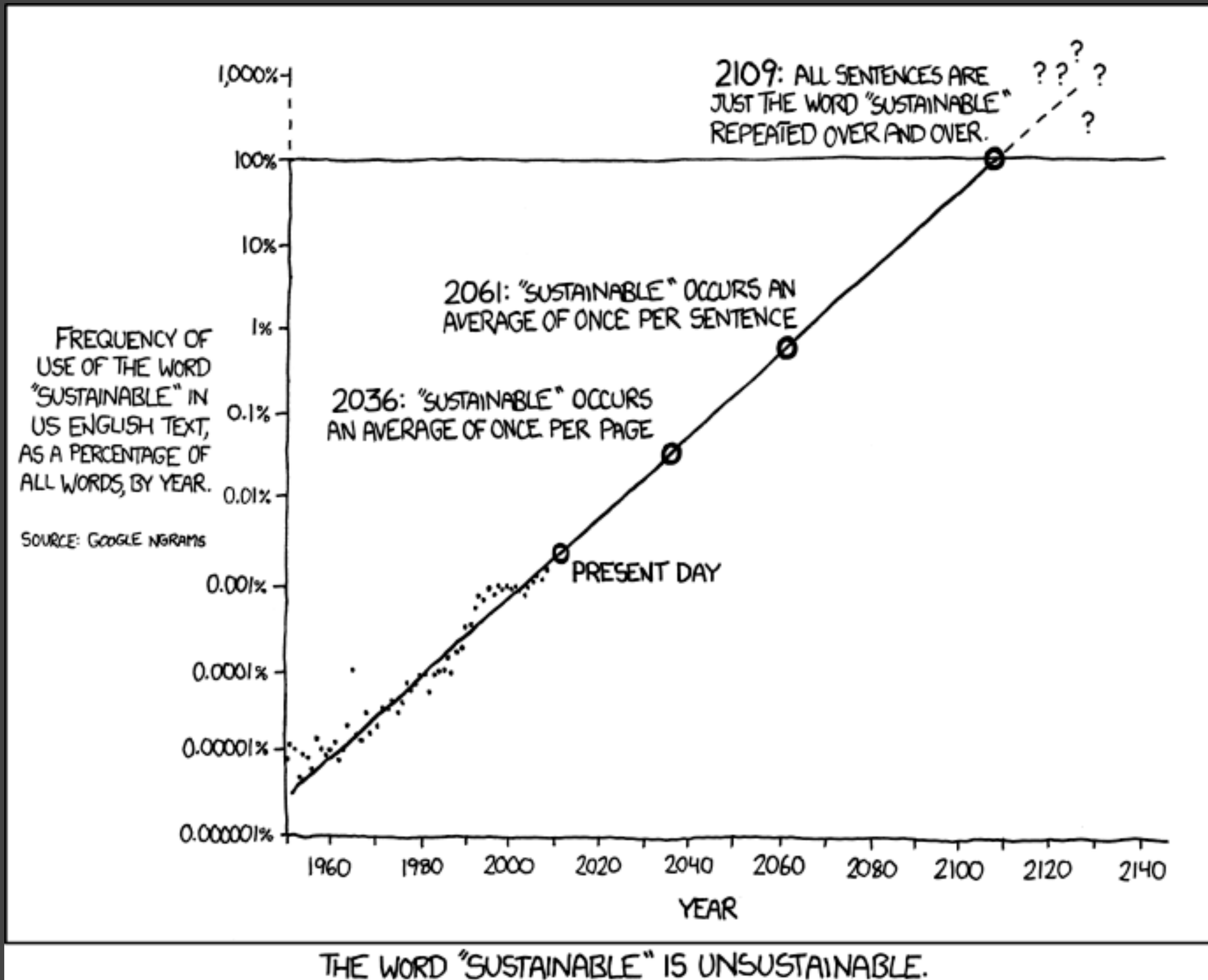
**Enrique Barba Roque**  
**[E.BarbaRoque@tudelft.nl](mailto:E.BarbaRoque@tudelft.nl)**

1. Intro to Sustainable SE
2. Intro to the course



**14%**

**of the electricity consumed worldwide  
by 2040 will stem from ICT**



THE WORD "SUSTAINABLE" IS UNSUSTAINABLE.

# Buzz words

- Eco-friendly
- Climate change, action, adaption
- Energy efficiency
- Environmental-responsible
- Carbon-neutral; Climate-neutral; Net zero
- Carbon-offsetting
- Carbon-free
- Clean technology
- E-waste



What is **Sustainable  
Software Engineering**?

<https://www.menti.com/uns9d89kzn>

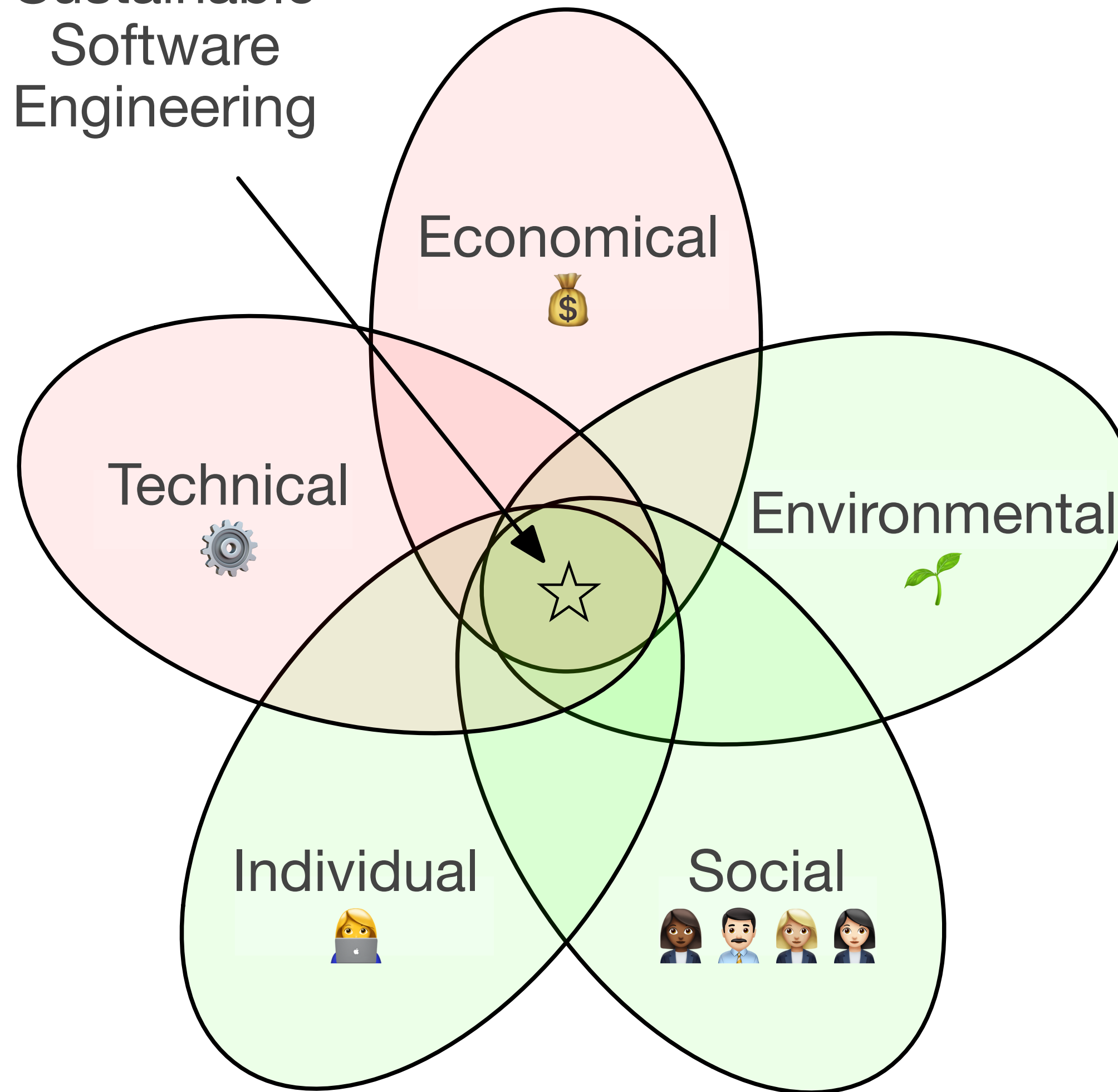




# Sustainable Software Engineering is...

*...the discipline that studies the process of creating software systems that are able to create value in the long term without hindering its surrounding environment.*

# Sustainable Software Engineering





# Economical

- Focused on **assets**, **capital** and **added value** (wealth creation, prosperity, profitability, capital investment, income, etc.)
  - Nr of customers
  - Man-day-rate estimate
  - Next round of funding
  - Meet requirements in the contract



# Technical

- Longevity of information, systems, and infrastructure and their adequate evolution with changing surrounding conditions.
- Examples:
  - **Technical Debt**
  - Does it scale?
  - Software testing
  - **Bus-factor**
  - Data integrity
  - Innovation
  - ...

```
    this._config.interval =  
  }  
  
  var transitionDuration =  
    $(activeElement).one(Util.  
      $(nextElement).removeCl  
      $(activeElement).remove  
      _this4._isSliding = fal  
      setTimeout(function ()  
        return $(_this4._elem  
      }, 0);  
    }).emulateTransitionEnd(t  
  } else {  
    $(activeElement).removeCl  
    $(nextElement).addClass(C
```

# Individual

- **Well-being of the individuals** in an organisation.  
**Note** that it also includes how well individuals interact with each other within the org.
- Examples:
  - mental and physical **well-being**
  - **self-respect**
  - **education/skills**
  - **career development**
  - ...



# Social

- concerned with **societal communities** (groups of people, organisations) and the factors that erode **trust in society**.
- Examples:
  - **Social equity**
  - **Justice**
  - **Employment**
  - **Democracy**
  - ...
- Also includes compliance with policies and regulations



# Environmental Sustainability

- the branch of Software Engineering that studies the *development of software that has **minimal impact in our planet** throughout its **whole lifecycle**.*
- Looking at software at different levels:
  - Developing, Using, Serving, ...
- Also includes **e-waste**.
- Almost identical to **Green Software**. (?)



Bordallo II

# Green Software

- **Sustainability** and energy **efficiency**.
- Building **energy-efficient software** is important also from a **technical sustainability** POV.
- Smartphones, smart wearables, IoT devices, etc. run on **limited power resources**.
  - Developing software to these devices require energy-efficiency testing and improvement.
- It also leads to environmental sustainability (e.g., less battery cycles)
- Important for **UX** (e.g., no need to walk around with power banks)





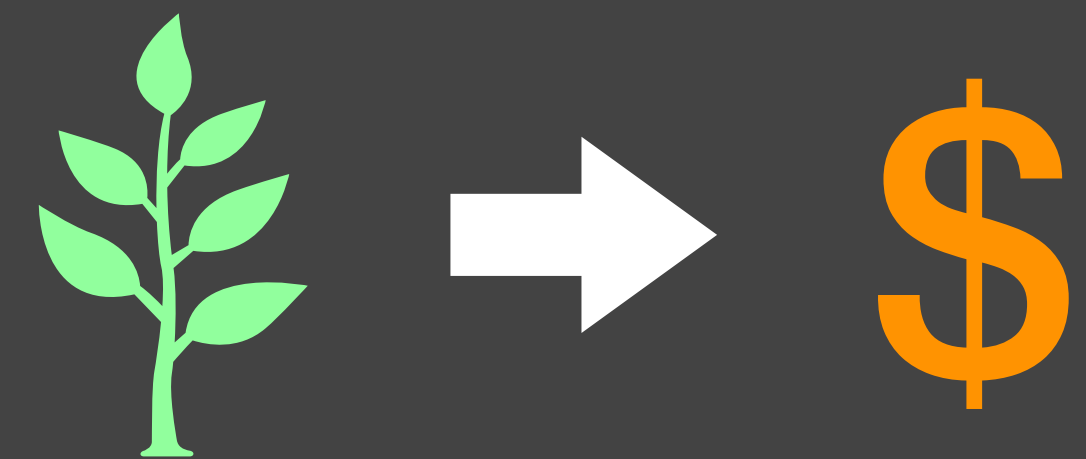
What is the **sustainability dimension** you are most interested in?



<https://www.menti.com/uns9d89kzn>

# Economical sustainability tops the environment

- In general, a software project will not survive if it's not economical sustainable
- Yet, a project can survive even if it is not environmental sustainable
- **The mindset is changing!**
  - Software consumers have started to worry about the **climate impact of their behaviour as users.**
  - Being environmentally sustainable is now an important competitive factor
- Marketing teams are already using all eco-friendly labels. Technical teams are not there yet, though.
  - **It's easier said than done!**





# Green Washing

- Deceptively use marketing techniques to claim being eco-friendly.
- Opting for **green-coloured designs**.
  - Red/orange is usually **perceived as tasty**.
  - Green is **perceived as eco-friendly**.
- The VW case. (?)



# The VW scandal

## Greenwashing

- Used software to **cheat on vehicle emissions tests**.
- The vehicle's software **could detect** whether they were being **tested**, **changing the performance** accordingly to improve results.
- Affected **11M cars** worldwide, 8M in Europe.



**How can we drive sustainability  
in the SE industry?**

# Green Procurement

- Customers decide on providers that **share their values**
- This is currently the **main trigger** reason why organisations worry about Sustainability and Green Software.
- Examples of green procurement:
  - Customers that only buy green **services/products**
  - Companies that only use green **providers**
  - **Developers** that only work for green companies
- Green procurement makes environmental sustainability essential for economical sustainability.



# Sustainability via compliance

- EU wants to be **carbon neutral** by 2030
- This also affects the **ICT sector**. Estimated to impact **14% of the global carbon footprint** by 2040.
- Some initiatives are already being negotiated.
  - Extending the smartphone lifetime to **7 years**.
  - **Right-to-repair** movement. <https://repair.eu>
  - Making IT services relying on clean energy more accessible (e.g., less taxes).



EUROPE,

LET'S

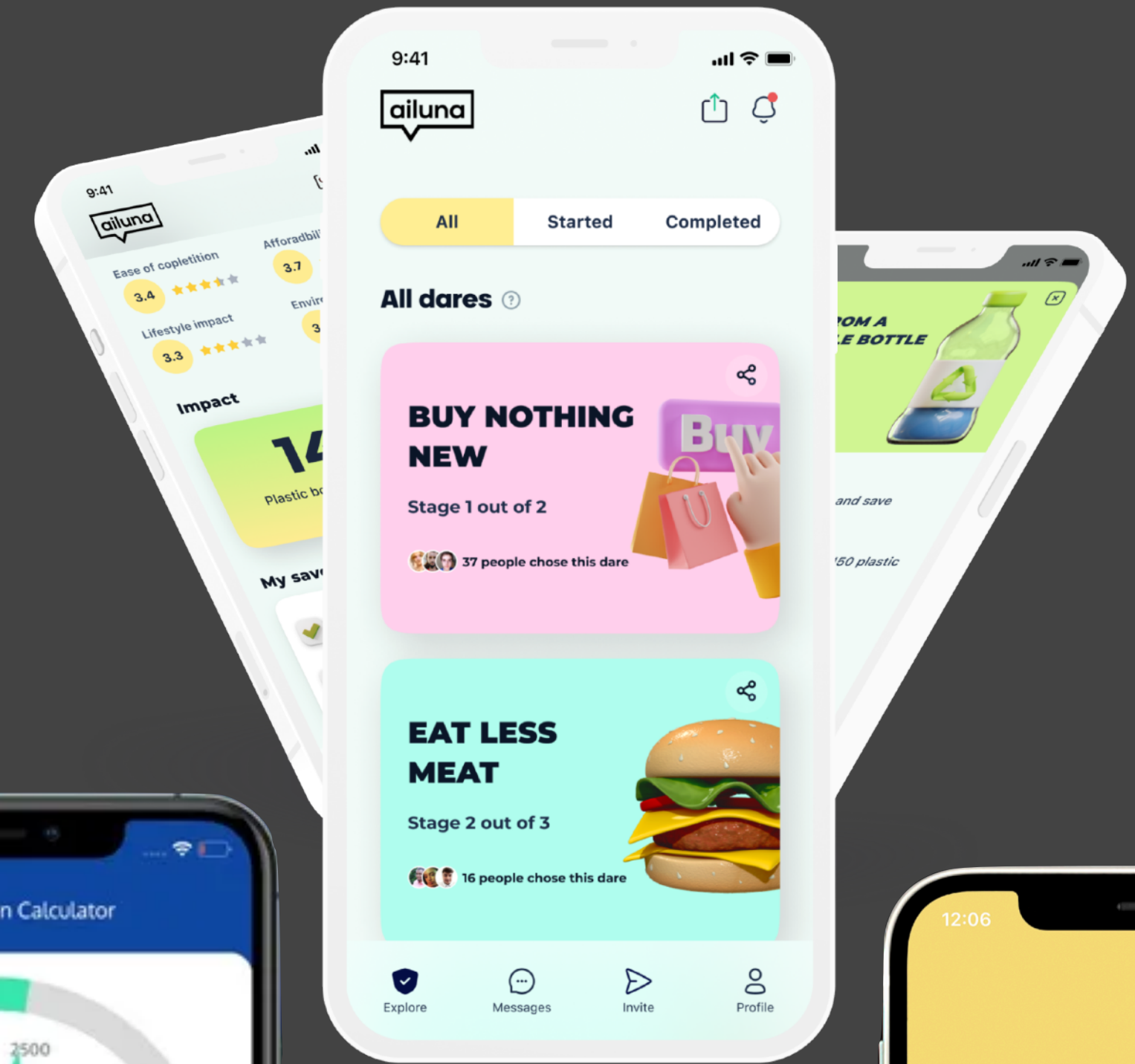
REUSE

REFURBISH

REPAIR

# Software for Sustainability

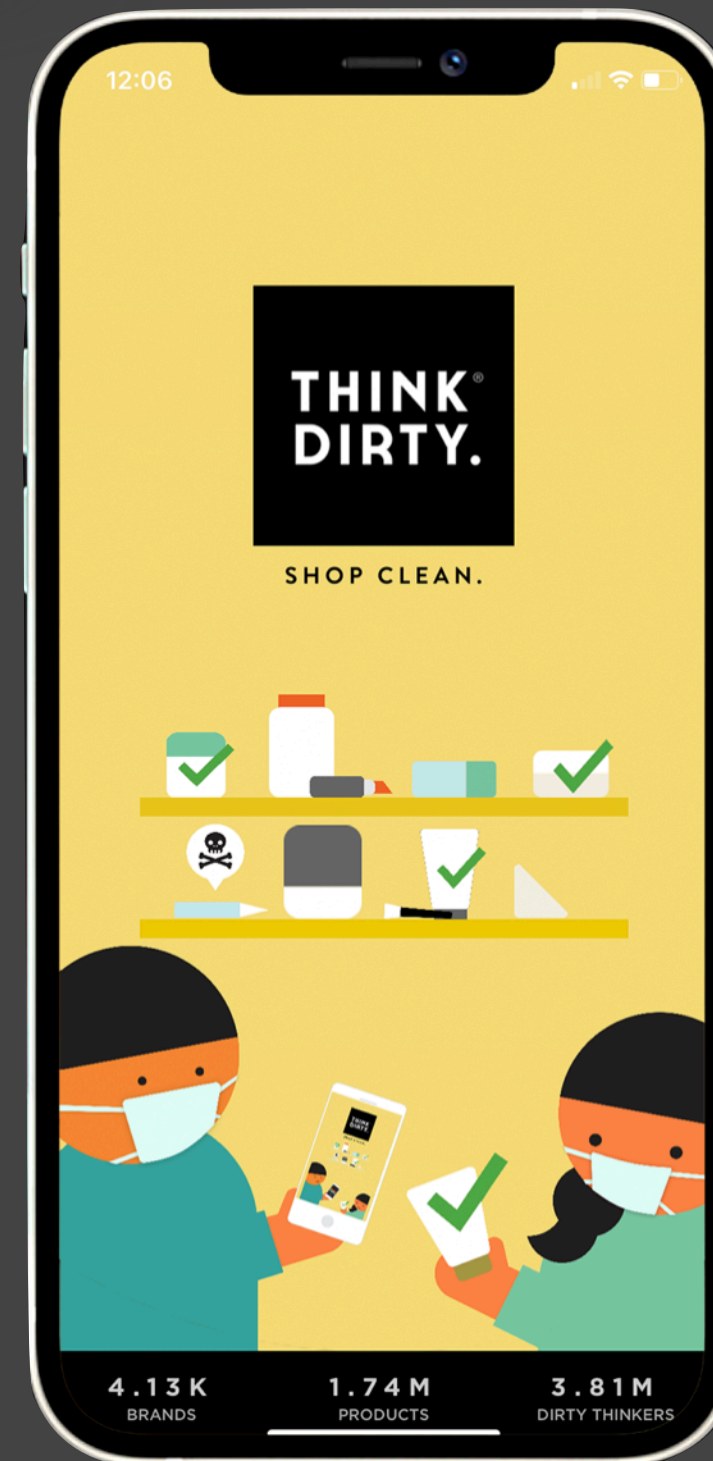
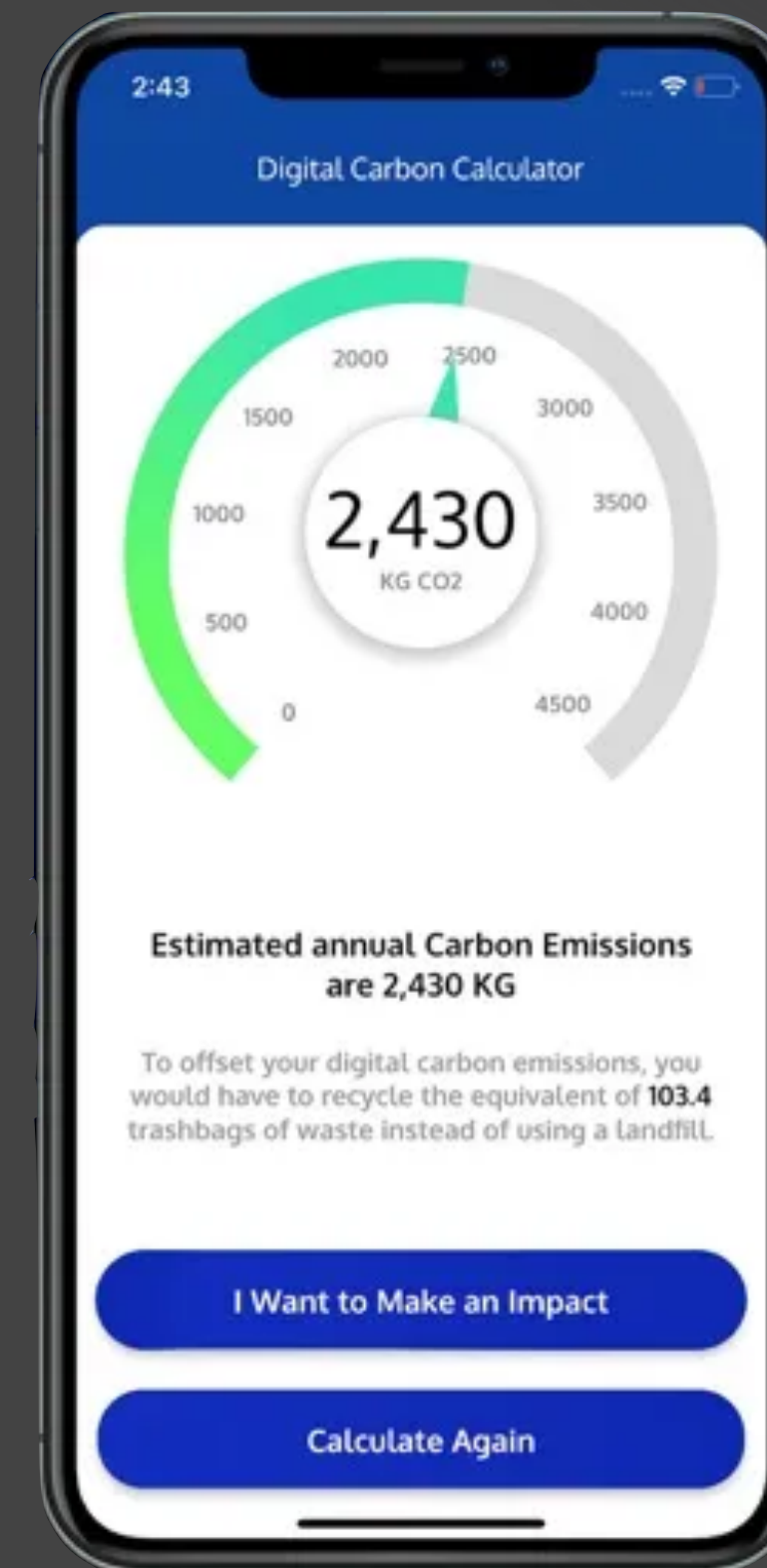
- We are not covering it in this course.



**The search engine that  
plants trees.**

**149,905,173**

Trees planted by Ecosia users



# Carbon-free giants

- **Google, Microsoft, Meta/Facebook** want to be **carbon free by 2030**
  - **Carbon free** is different from **carbon neutral**
  - Green IT experts are needed to meet these goals



Register

Sign In

# AI drives 48% increase in Google emissions

3 July 2024

Share Save

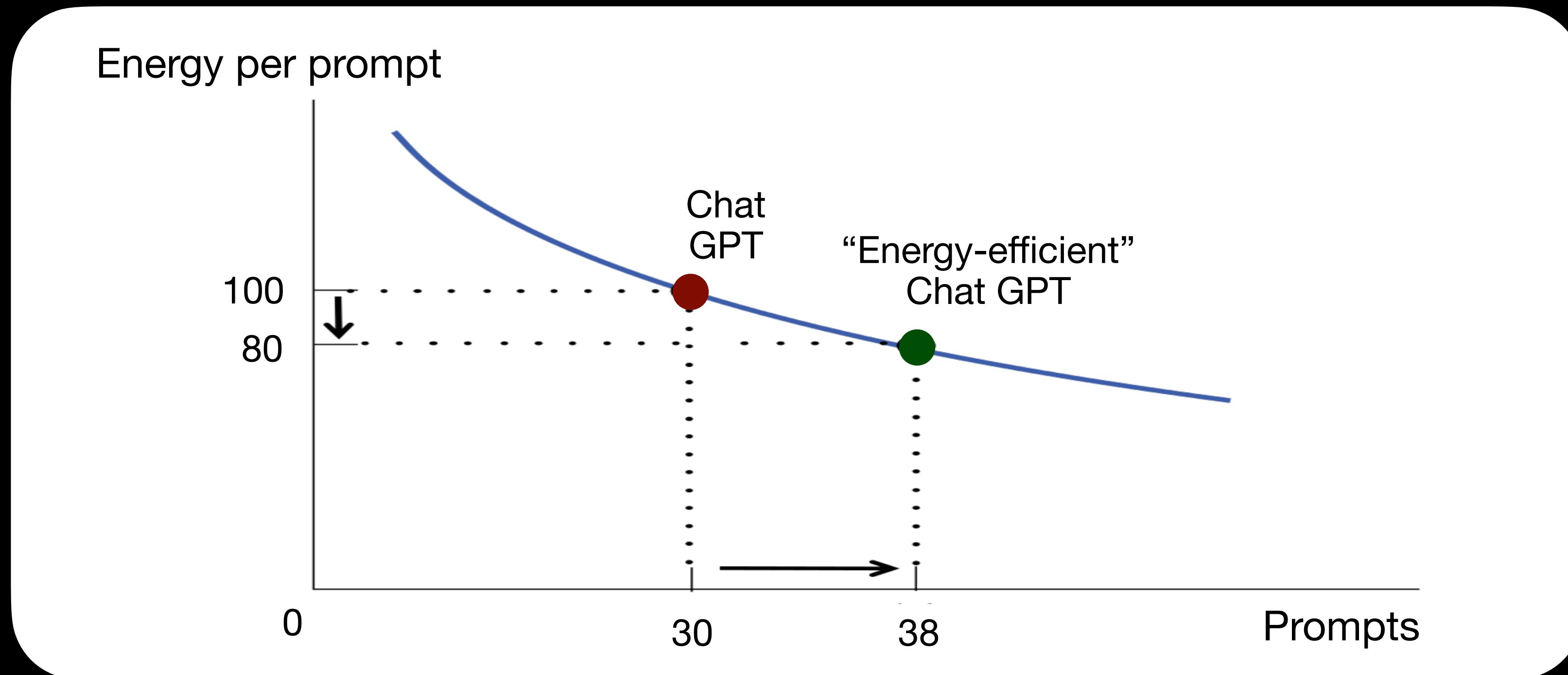
**Imran Rahman-Jones**  
Technology reporter





# Rebound effect\*

- Energy consumption **decreases** ↓↓ but demand also **increases** ↑↑.



- \*a.k.a. **Jevons Paradox** in economics; **Downs–Thomson** paradox in mobility.

# Is sustainability an ethical issue?

- Climate change is more likely to affect **the poorest** countries.
  - Less financial resources to adapt
  - Climate-impact does not necessarily affect polluting countries.
- Poorest countries have contributed less to the climate change.
- We need to figure out how to **do more using less** resources.



# Morality ≠ Moralising

- We should not use climate action as a **shaming weapon**
- Climate action should be agnostic of political views, ideology, social status, etc.
- We need **everyone** to take action!



# Why?

- Throughout your career you might:
  - Design/maintain/contract data centers
  - Set up **operations/devops**
  - Develop **AI for IoT** devices
  - Be the next **CEO/CTO** of a software company
- Sustainability can be your **main role**:
  - Green Software Developer
  - Sustainability Consultant
  - Green Advocate
  - Founder of a **Green Tech startup** (B2B?)



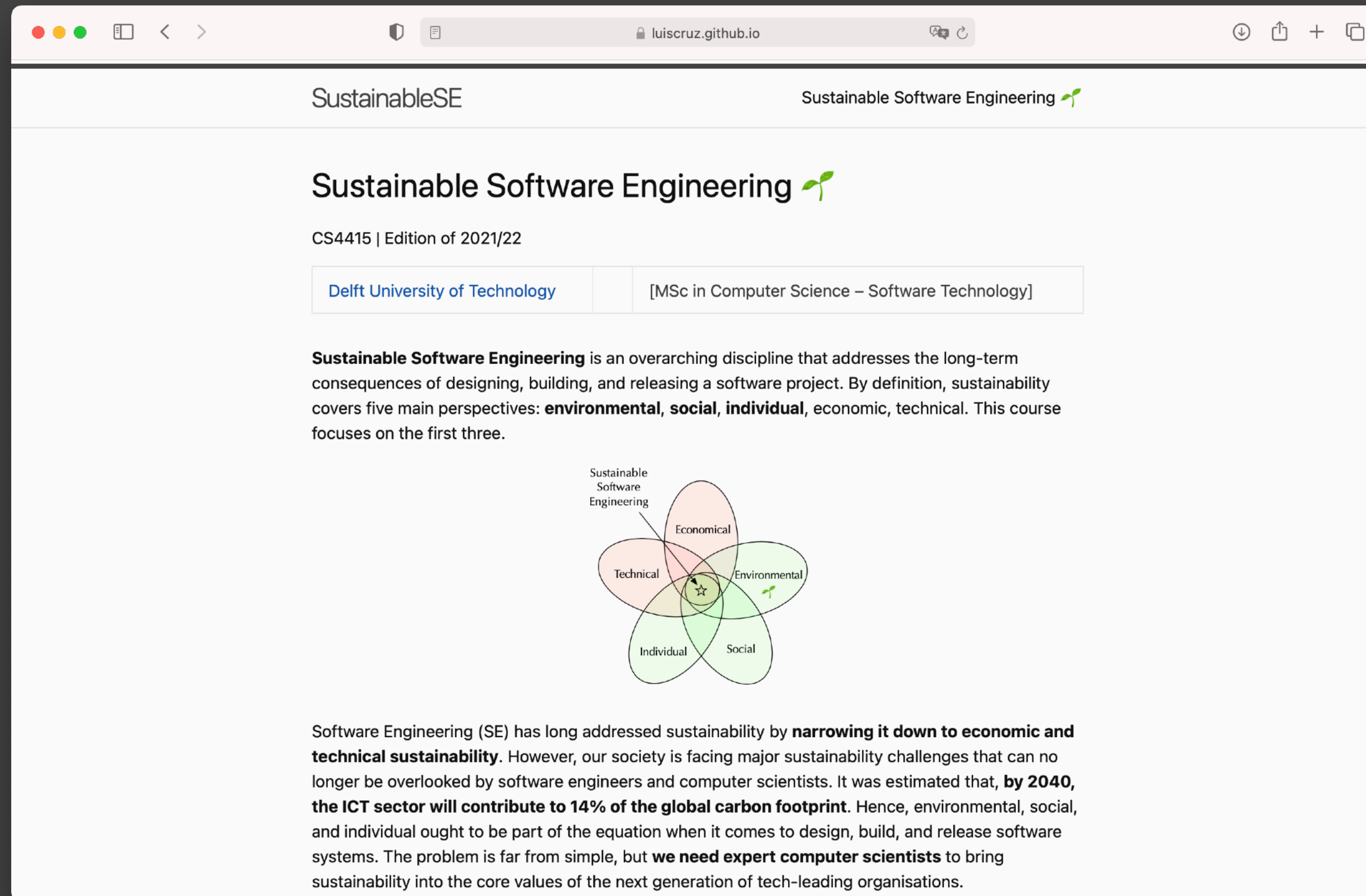
# Format of classes

- **In-person.**
- Collegerama recordings.
- Lectures and Labs.
- Guest lectures.
- Steering meetings (after week 5, new schedule)

# Format of classes

- There's no exam in this course. It's more important that we learn how to discuss this topic and come up with new ideas than learning all the theory. **Critical thinking over checkboxes.**
- Mix of content and discussion
- Ultimately, the lectures aim to give you food for thought and the necessary knowledge to excel in Project 2. (We will talk about it later)

# Content of the course 🖱️



The screenshot shows a web browser window with the URL `luisacruz.github.io`. The page title is "SustainableSE" and the subtitle is "Sustainable Software Engineering 🌱". The main heading is "Sustainable Software Engineering 🌱". Below the heading, it says "CS4415 | Edition of 2021/22". There are two buttons: "Delft University of Technology" and "[MSc in Computer Science – Software Technology]". A paragraph defines Sustainable Software Engineering as an overarching discipline addressing long-term consequences of software projects, covering five perspectives: environmental, social, individual, economic, and technical. A diagram shows five overlapping circles labeled "Economic", "Environmental", "Social", "Individual", and "Technical", with "Sustainable Software Engineering" at the center. A final paragraph discusses the ICT sector's carbon footprint and the need for expert computer scientists.

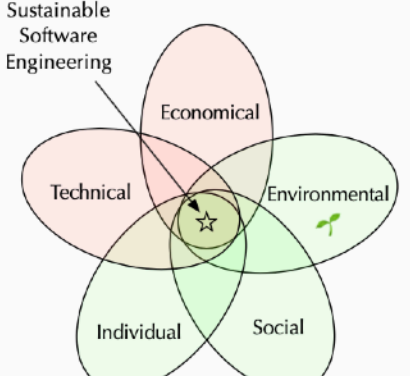
SustainableSE Sustainable Software Engineering 🌱

## Sustainable Software Engineering 🌱

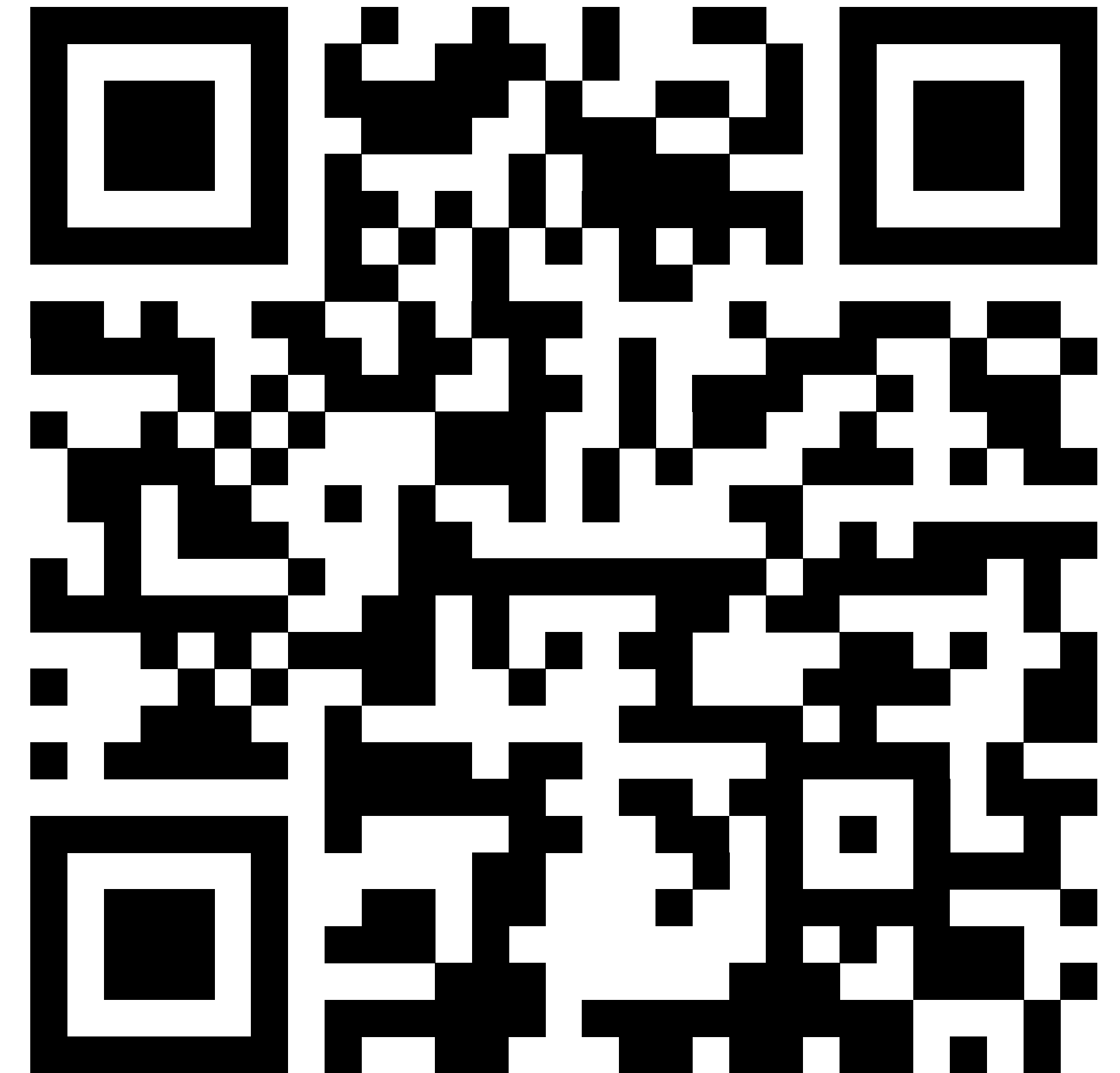
CS4415 | Edition of 2021/22

Delft University of Technology [MSc in Computer Science – Software Technology]

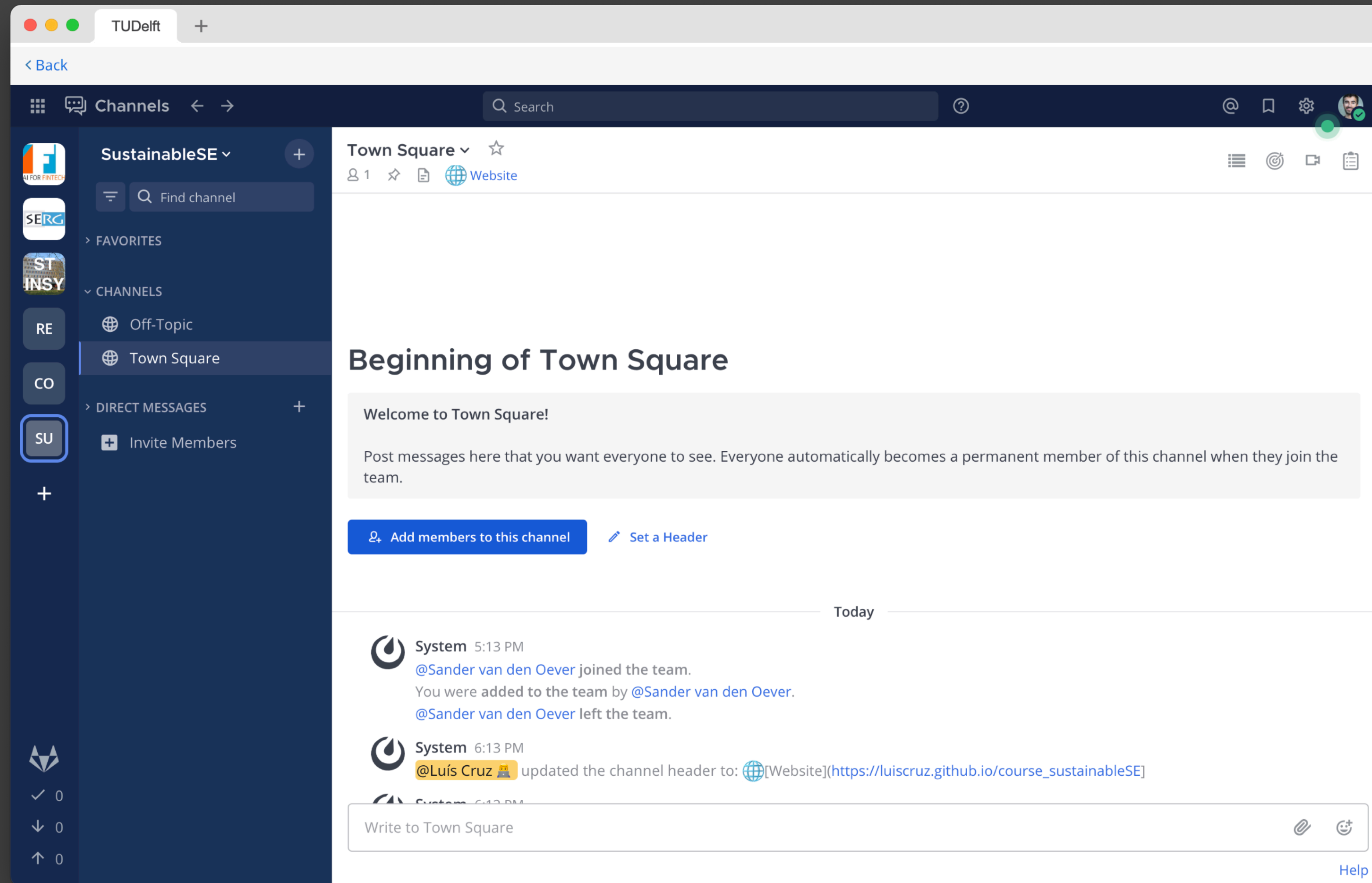
**Sustainable Software Engineering** is an overarching discipline that addresses the long-term consequences of designing, building, and releasing a software project. By definition, sustainability covers five main perspectives: **environmental, social, individual**, economic, technical. This course focuses on the first three.



Software Engineering (SE) has long addressed sustainability by **narrowing it down to economic and technical sustainability**. However, our society is facing major sustainability challenges that can no longer be overlooked by software engineers and computer scientists. It was estimated that, **by 2040, the ICT sector will contribute to 14% of the global carbon footprint**. Hence, environmental, social, and individual ought to be part of the equation when it comes to design, build, and release software systems. The problem is far from simple, but **we need expert computer scientists** to bring sustainability into the core values of the next generation of tech-leading organisations.



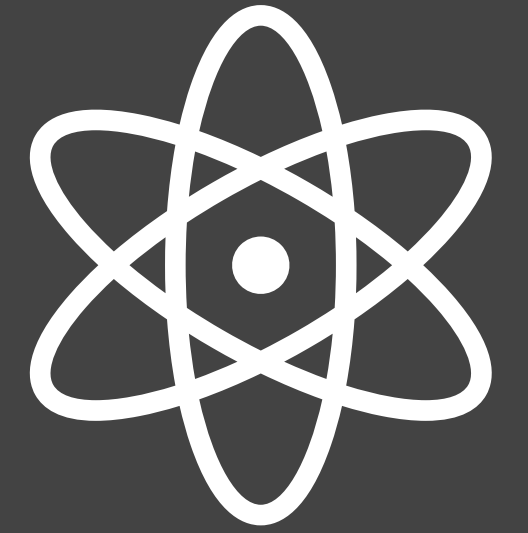
[https://luisacruz.github.io/course\\_sustainableSE/](https://luisacruz.github.io/course_sustainableSE/)



[https://mattermost.tudelft.nl/signup\\_user\\_complete/?id=1nj9tk6usjf8xmsws8wpq3s5uy&md=link&sbr=su](https://mattermost.tudelft.nl/signup_user_complete/?id=1nj9tk6usjf8xmsws8wpq3s5uy&md=link&sbr=su)

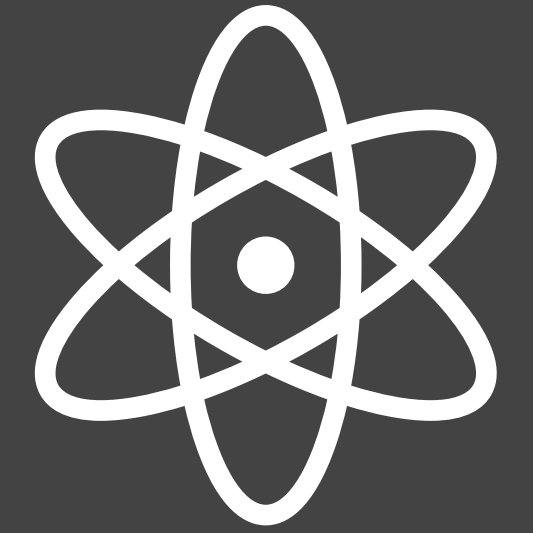


# Project 1



- **Goal:** Measure the energy consumption of software applications.
- **Approach:** energy measurement tools; use case testing.
- **Deliverable:** blog-style report (approx. 2500 words)
- **Deadline:** Week 3, Feb 28, 2025
- **Group size:** 4–5

# Project 2



- **Goal:** Create a solution/tool/technique that helps building green software. (You can come up with **your own idea** or choose one from a **list of suggestions**).
- **Approach:** open-source software development; literature review.
- **Deliverable:** library/tool/app; paper; presentation.
- **Two deadlines:**
  1. Paper and software: Week 8, April 4, 2025
  2. Presentation: Week 9, April 11, 2025
- **Group size:** 4–5

# Guest Lectures



**Nergis Tömen**

Computer Vision lab | TU Delft  
Week 4, Wed, Mar 5, 2025

# Community

## How to get involved?

# Green TU

- <https://www.tudelft.nl/sustainability/get-involved/greenttu>
- Student organisation at the TU Delft devoted to stimulating sustainability in **education**, **research**, **university operations** and **community engagement**.



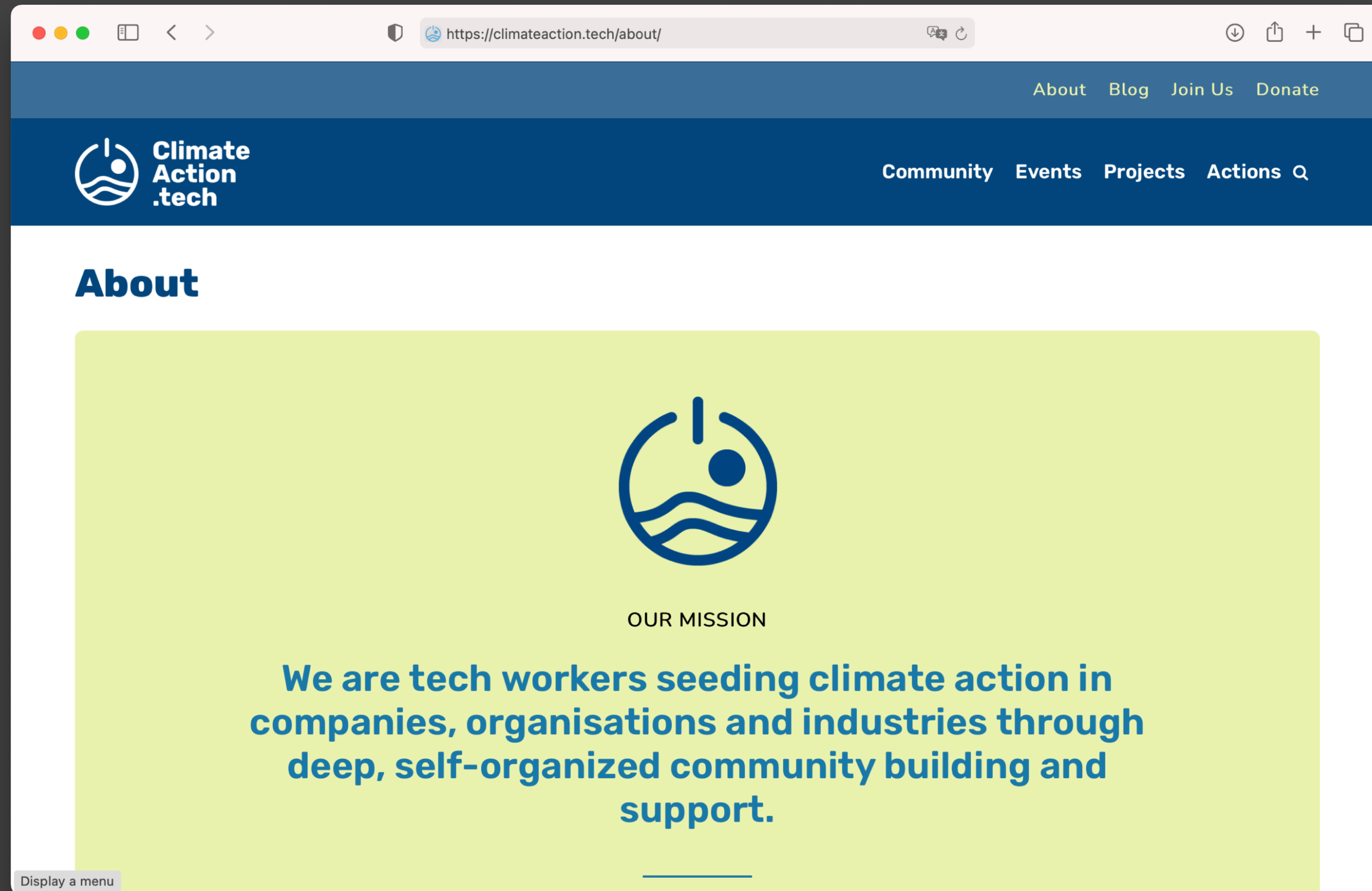
# ClimateAction.tech

- Great **community** for outreach
- Based on Slack
- Regular meetings, talks, social events
- You can join as a volunteer or simply to connect to other techies
- Also good to for **job hunting on green tech.**




**Climate  
Action  
.tech**

# ClimateAction.tech



# Branch magazine

- Stay **up-to-date** on sustainable tech
- **Creativity** booster
- **Carbon-aware** UI
- <https://branch.climateaction.tech> 





# This is the fourth edition



- Any feedback is welcome! **Email** or **DM!**



# 1. Intro Class

**Sustainable Software Engineering**  
**CS4575**



**Luís Cruz**  
**[L.Cruz@tudelft.nl](mailto:L.Cruz@tudelft.nl)**



**Carolin Brandt**  
**[C.E.Brandt@tudelft.nl](mailto:C.E.Brandt@tudelft.nl)**



**Enrique Barba Roque**  
**[E.BarbaRoque@tudelft.nl](mailto:E.BarbaRoque@tudelft.nl)**