lecture 8 - HARDWARE DESIGN IS NOT DEAD!

This lecture, we wanted to take a step back, **and think a little about** *why what we are doing here is important.* **To help you find** future directions for your work,
AND INSPIRE YOU TO MAKE THE WORLD A BETTER PLACE!

UHHH NOUN CEMENTS

- **lab sections + layout DRs are tomorrow and thursday!**
  - **can come to n>1 lab section, but be there for at least your lab section**
- **Will be sending emails to fix ya'll's registration - don't make us have to fail you**
- **track 2 write-ups due Friday 5pm over email!**

- ***pizza + good vibes in lobby 13 7pm wednesday!***

why should we care about hardware in a world that’s becoming increasingly driven by software?

Registrar's Office

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Statistics & Reports

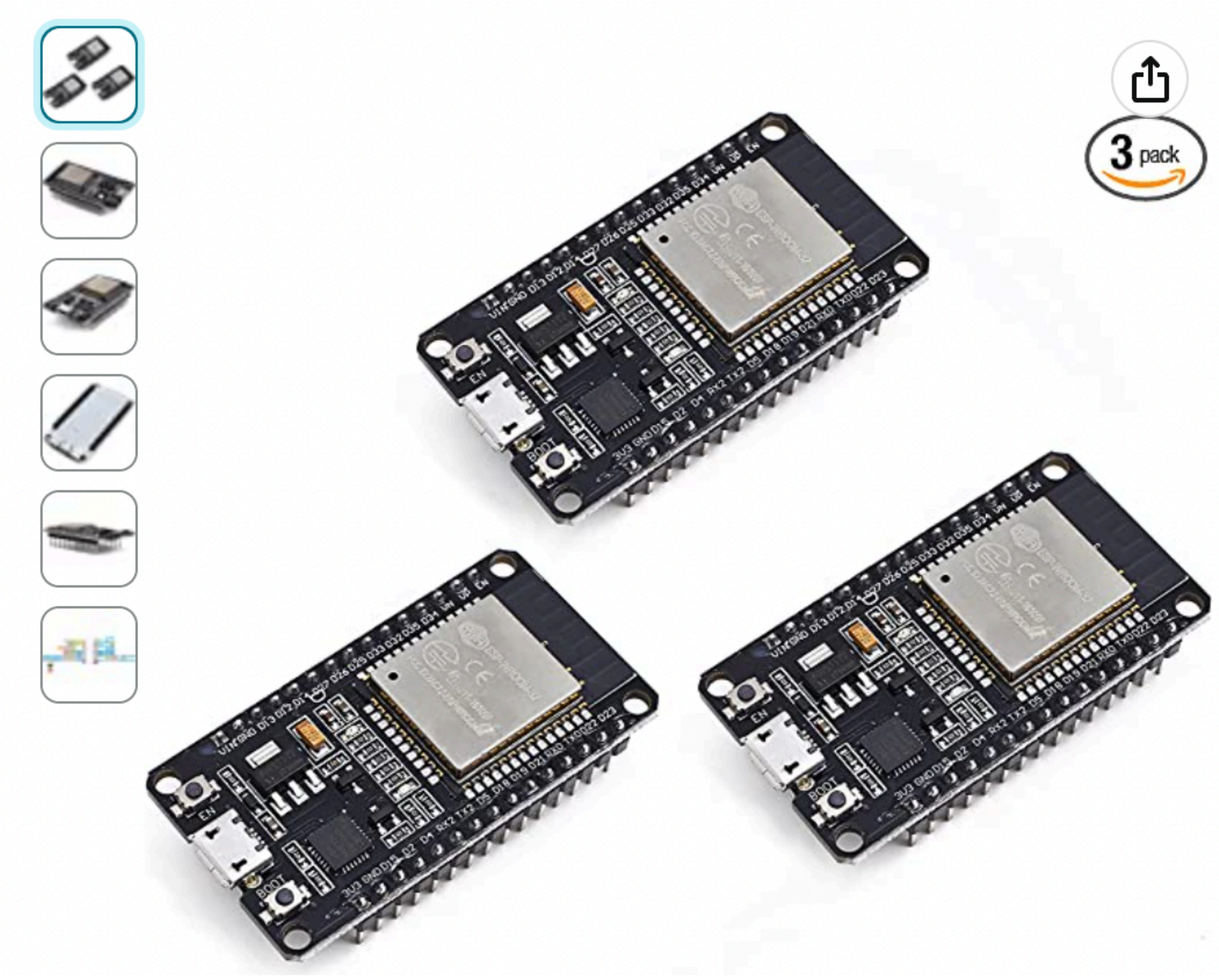
STATISTICS & REPORTS

Undergraduate majors count

Prior Years
2022-2023 ▾

Electrical Science and Engineering, VI-1	40	6	46
Electrical Engineering and Computer Science, VI-2	333	21	354
Computer Science and Engineering, VI-3	774	49	823
Artificial Intelligence and Decision Making, VI-4	37	-	37
Computer Science and Molecular Biology, VI-7*	32	0.5	32.5
Computation and Cognition, VI-9*	85.5	2	87.5
Computer Science, Economics and Data Science, VI-14*	51	11	62

don’t even need a PCB



Teyleten Robot ESP32S ESP32 ESP-WROOM-32 Development Board 2.4GHz Dual-Core WiFi +Bluetooth 2 Function Microcontroller for Arduino (ESP32 30P, 3PCS)

Brand: Teyleten Robot

370 ratings | 45 answered questions

Amazon's Choice for "esp32 development board"

-10% $17.88

List Price: ~~$19.88~~

prime One-Day

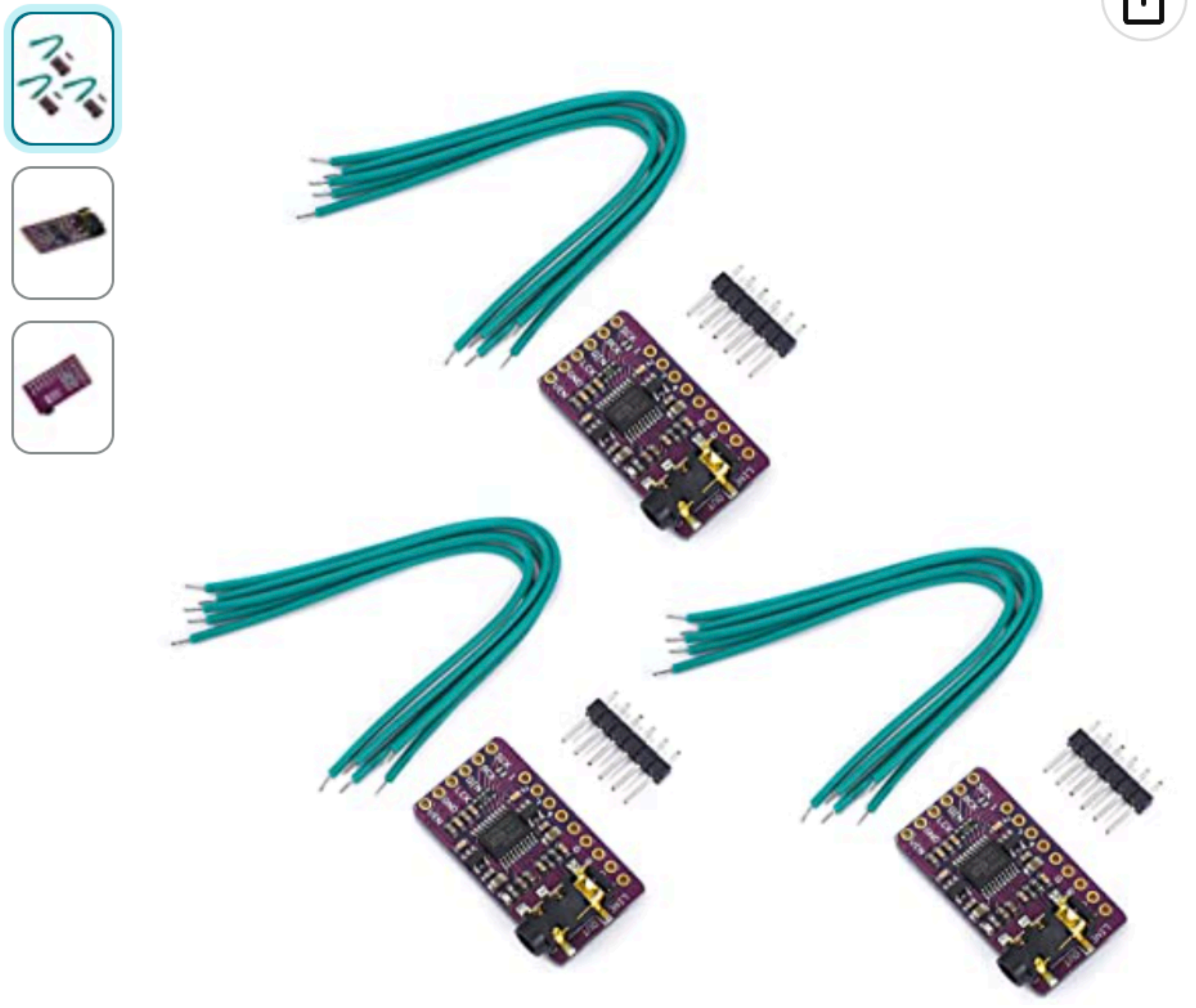
FREE Returns

Get a $100 Gift Card: Pay $0.00 ~~$17.88~~ upon approval for the Amazon Prime Rewards Visa Card. No annual fee.

Eligible for amazonsmile donation.

Size: **ESP32 30P**

don't even need a PCB



Teyleten Robot PCM5102 PCM5102A AUX Stereo Digital Audio DAC Decoder Board Module Voice Module Player Module Digital-to-Analog Converter IIS I2S for Arduino Raspberry Pi (3PCS)

Brand: Teyleten Robot

★★★★★ 7 ratings

$16.88 ($5.63 / Item)

prime One-Day

FREE Returns

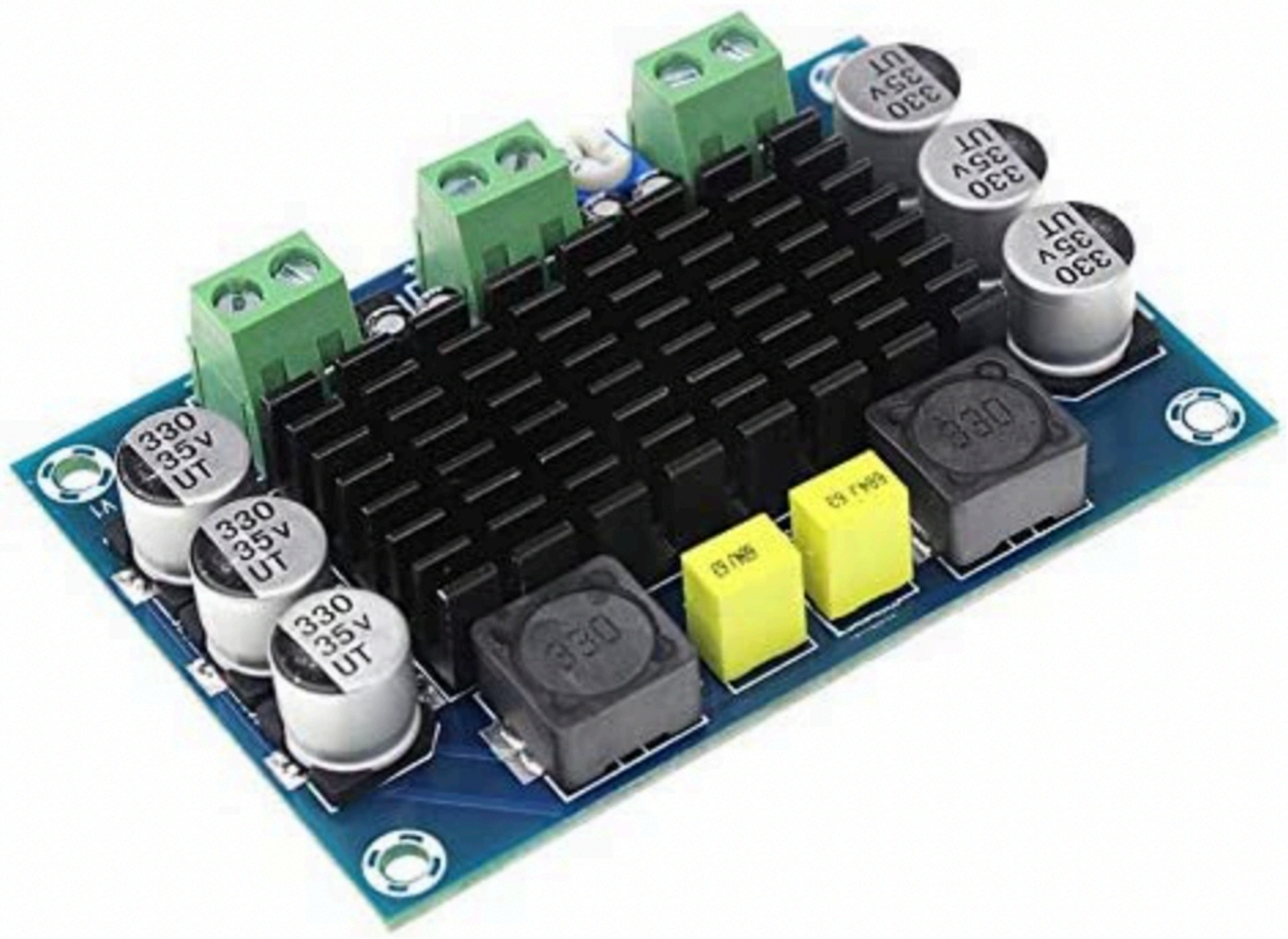
Get a $100 Gift Card: Pay $0.00 ~~$16.88~~ upon approval for the Amazon Prime Rewards Visa Card. No annual fee.

Eligible for amazonsmile donation.

- The DAC Module provides a super affordable high-quality DAC for the Raspberry Pi.Since it's digital audio, it sounds really good, much better than the onboard analog audio. The stereo jack comes soldered onto the board already.
- Line out stereo jack;pHAT format board;Uses the PCM5102A DAC to work with the Raspberry Pi I2S interface

don’t even need a PCB

‹ Back to results



Click image to open expanded view

HiLetgo 2pcs TPA3116 100W Audio Amplifier Board DC 12V 24V TPA3116DA Mono Channel Digital Audio Amplifier Board High Power AMP Module

Visit the HiLetgo Store

69 ratings | 6 answered questions

$14.49

prime One-Day

FREE Returns

Get a $100 Gift Card: Pay $0.00 ~~$14.49~~ upon approval for the Amazon Prime Rewards Visa Card. No annual fee.

Eligible for amazonsmile donation.

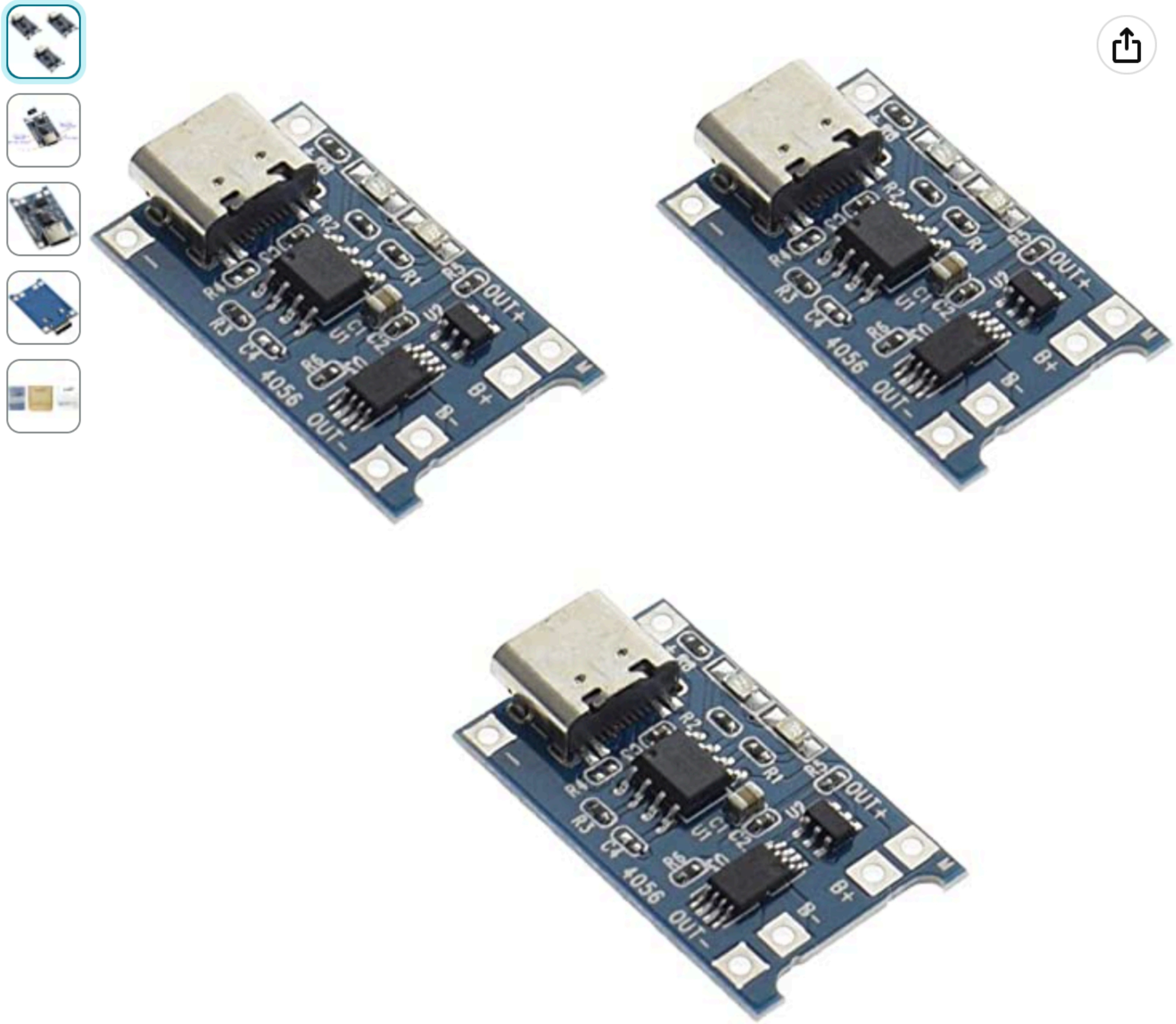
Voltage	24 Volts
Manufacturer	HiLetgo
Brand	HiLetgo
Number of Channels	1

About this item

- TPA3116 100W Power Amplifier Board
- DC 12V 24V TPA3116DA Mono Channel Digital Stereo Audio Amplifier

Report incorrect product information.

don’t even need a PCB



HiLetgo 3pcs TP4056 Type-c USB 5V 1A 18650 Lithium Battery Charger Module Charging Board with Dual Protection Functions

Visit the HiLetgo Store

171 ratings | 12 answered questions

$5.99

prime One-Day

FREE Returns

Get a $100 Gift Card: Pay $0.00 ~~$5.99~~ upon approval for the Amazon Prime Rewards Visa Card. No annual fee.

Eligible for amazonsmile donation.

Brand	HiLetgo
Color	Green
Input Voltage	5 Volts

About this item

- Input interface: Type-c USB.
- Battery overcharge lifting voltage: 4.00 V
- Battery: over-current protection current 3 A
- Maximum charging current output: 1000 ma
- Light state: no load the light not bright, red light for recharging, is full of green light.

Report incorrect product information.

THE ART AND SCIENCE of PCB DESIGN

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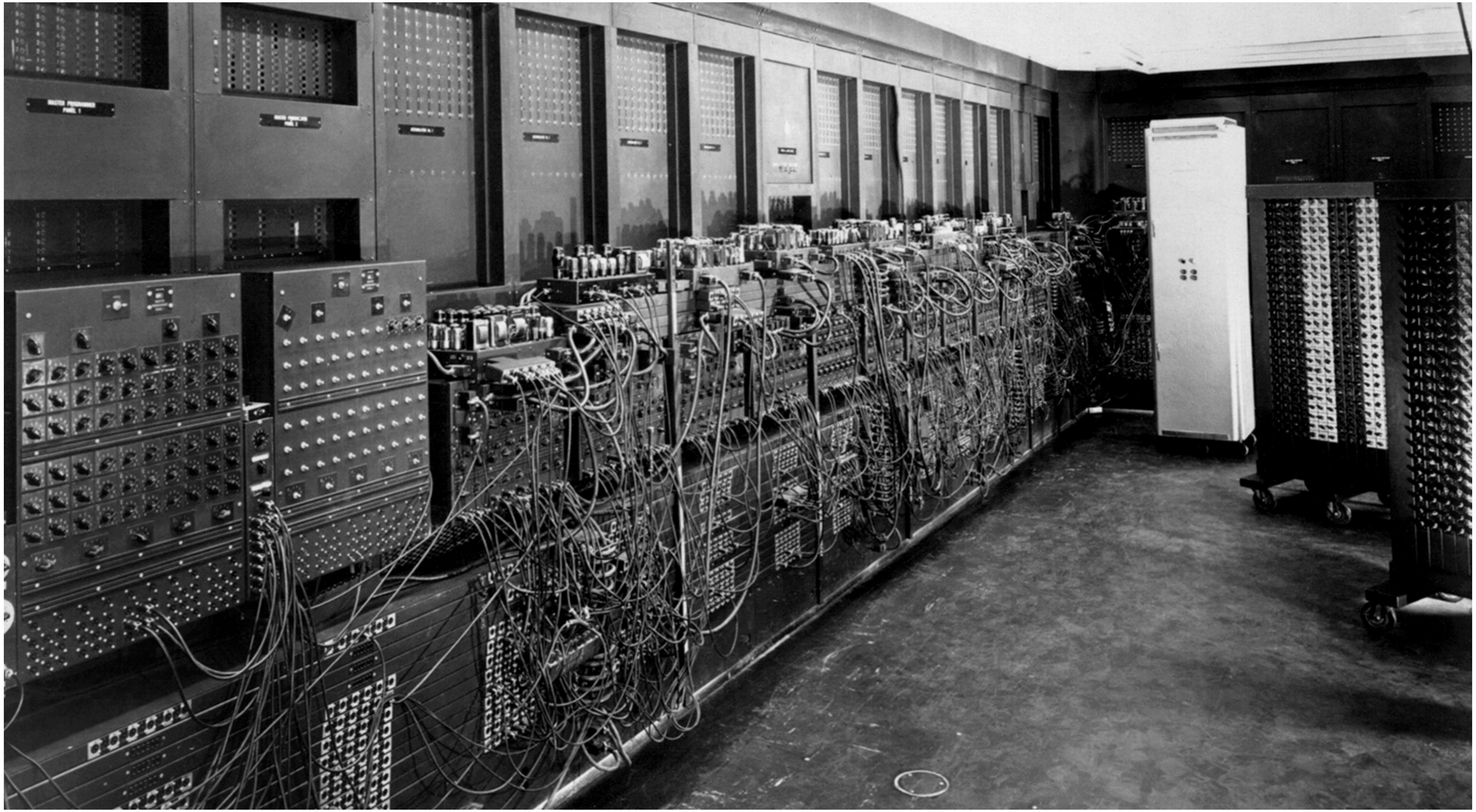
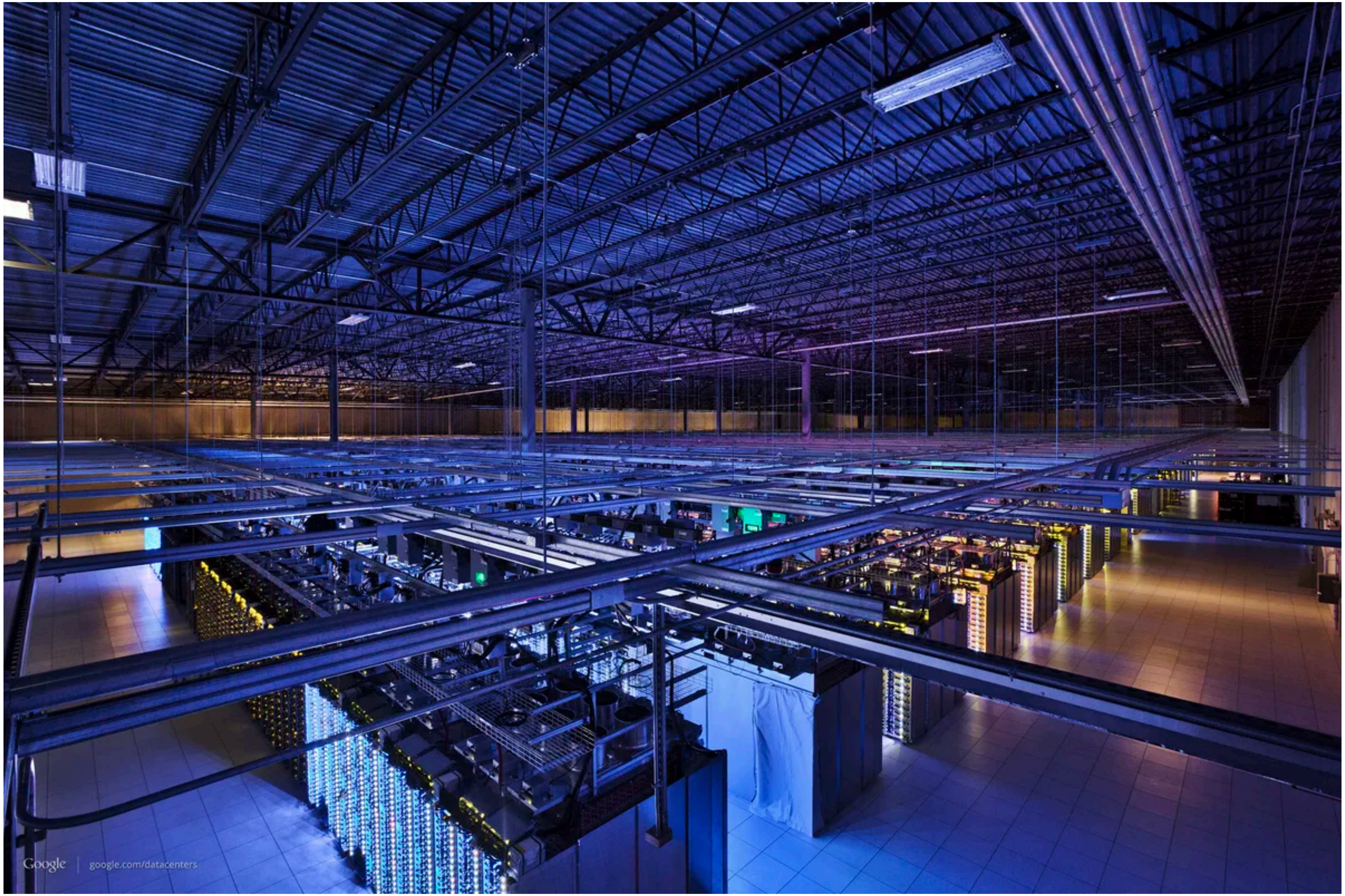



digital
pdp11



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Photograph is taken
Amazon S3
Photo is uploaded to an S3 Bucket
Lambda is triggered
AWS Lambda
Lambda runs image resizing code
Photo is resized into web, mobile, and tablet sizes

THE ART AND SCIENCE OF PCB DESIGN

don’t even need a PC~~B~~

in summary

- *hardware is a commodity*
  - *both in terms of circuit components and computers themselves*

in summary

- *hardware is a commodity*
  - *both in terms of circuit components and computers themselves*

- *do we keep EEs around just to keep the wheels turning?*

yes!

And that's all we do. Good night folks.

climate change

climate change

- *electric vehicles*

climate change

- *electric vehicles*
    - *25% global energy consumption goes to transport*

climate change

- *electric vehicles*

climate change

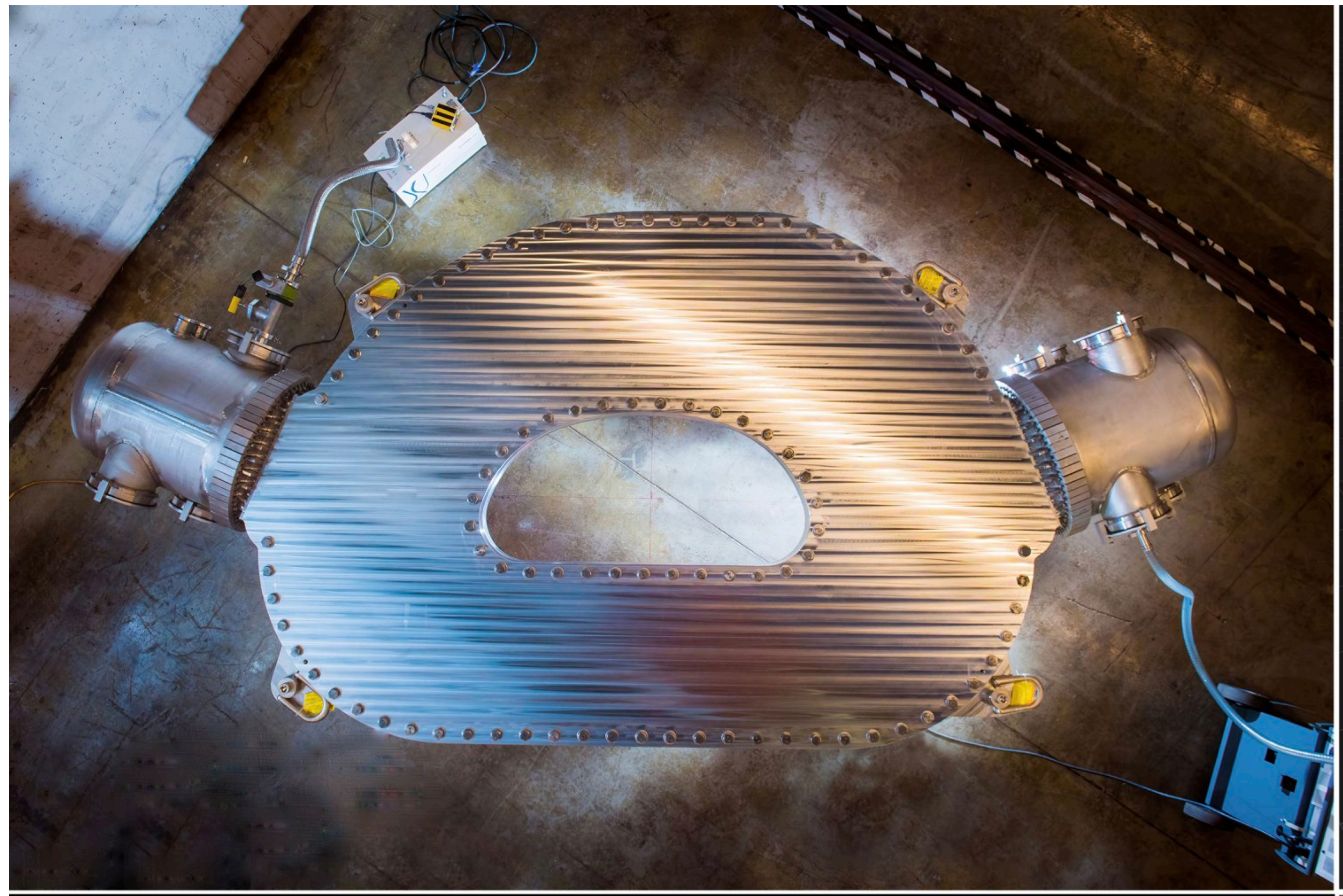
- *electric vehicles*
- *hydrogen energy systems*

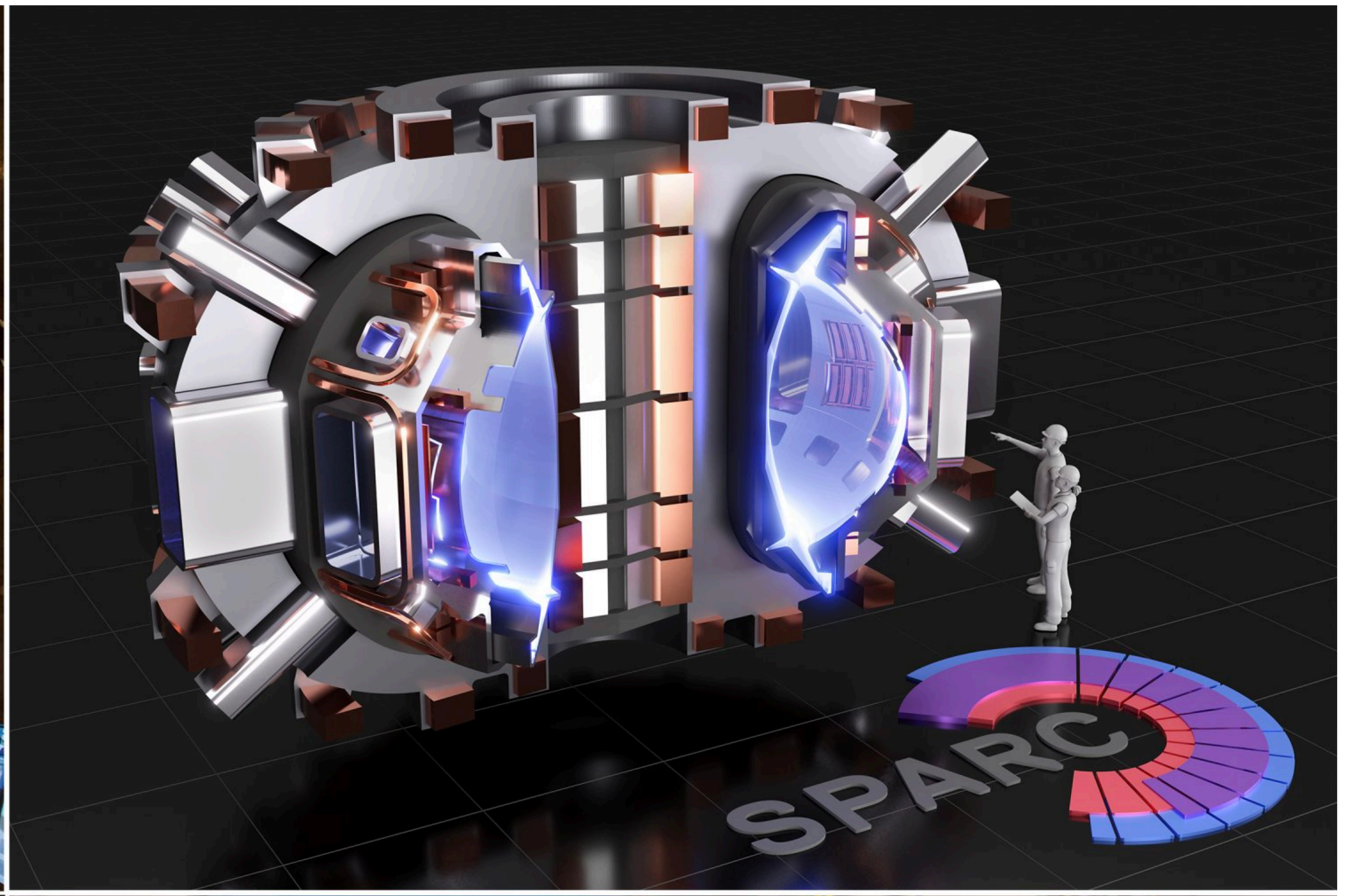
climate change

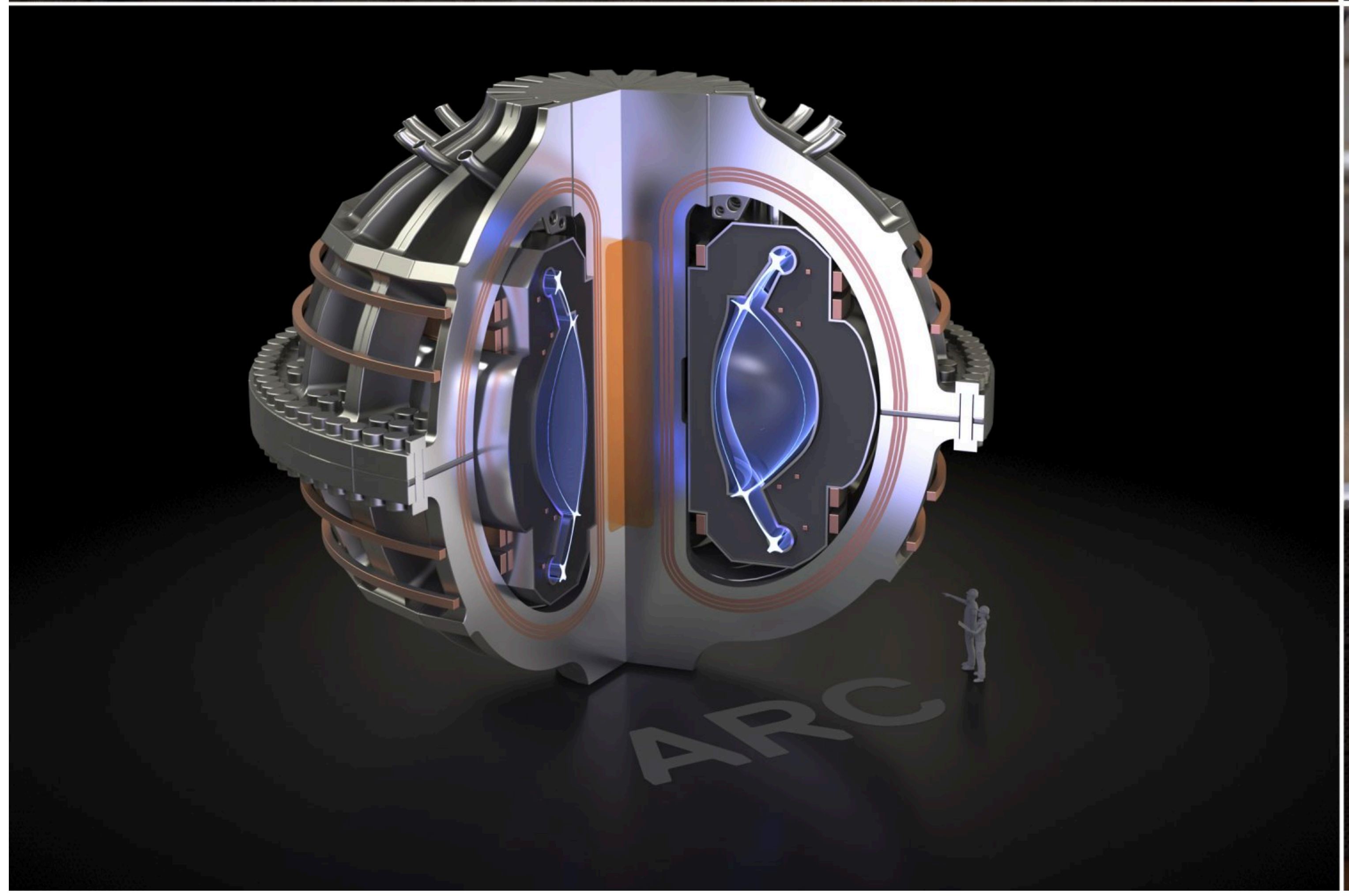
- *electric vehicles*
- *hydrogen energy systems*
- *developing power grids*

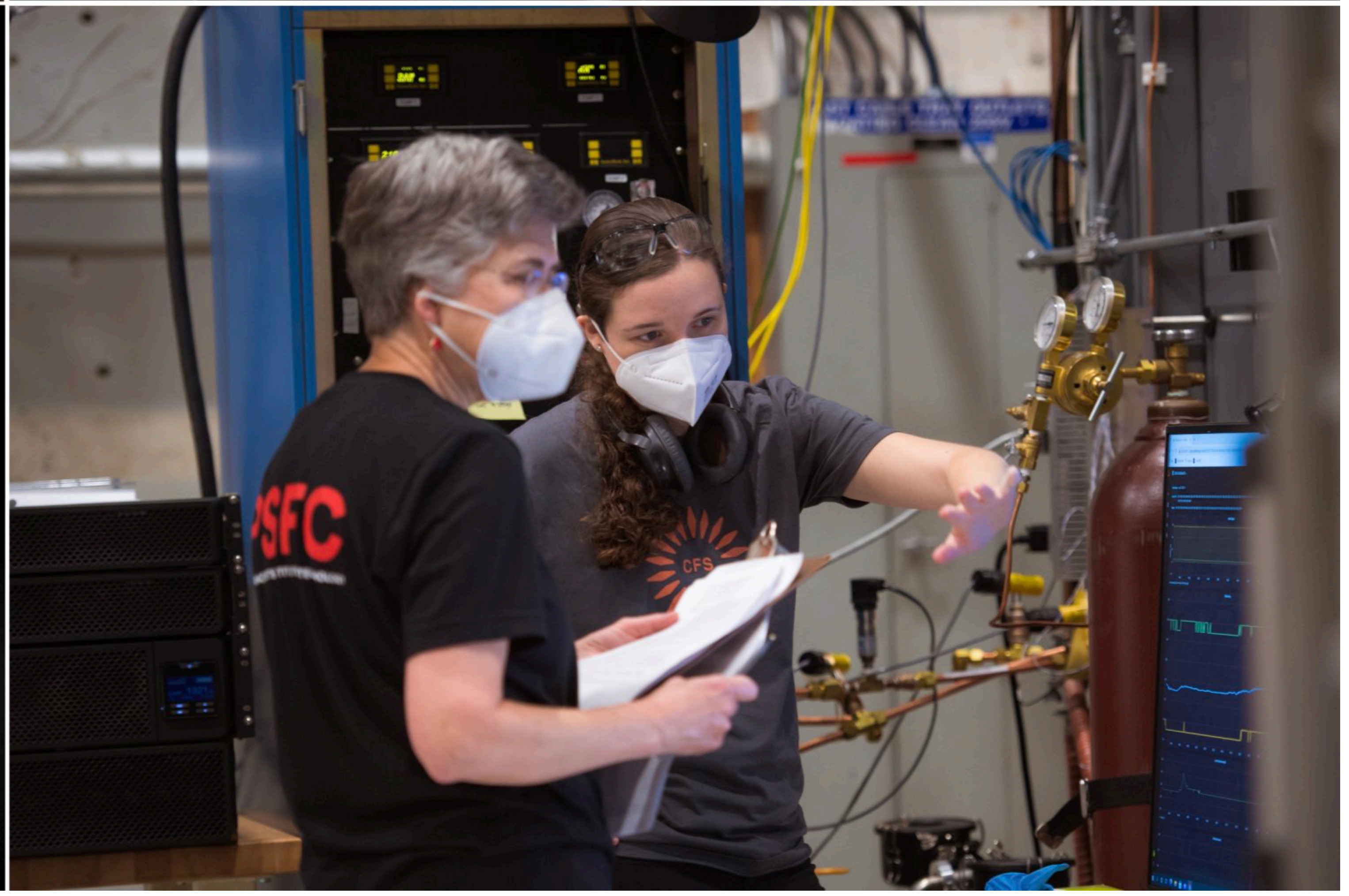
climate change

- *electric vehicles*
- *hydrogen energy systems*
- *developing power grids*
- *fusion energy*







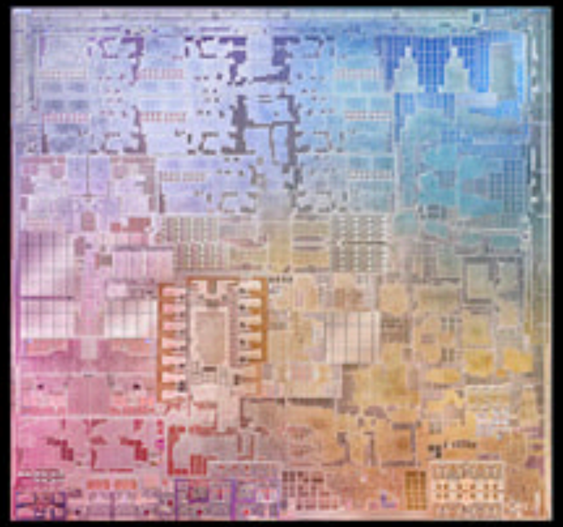


climate change

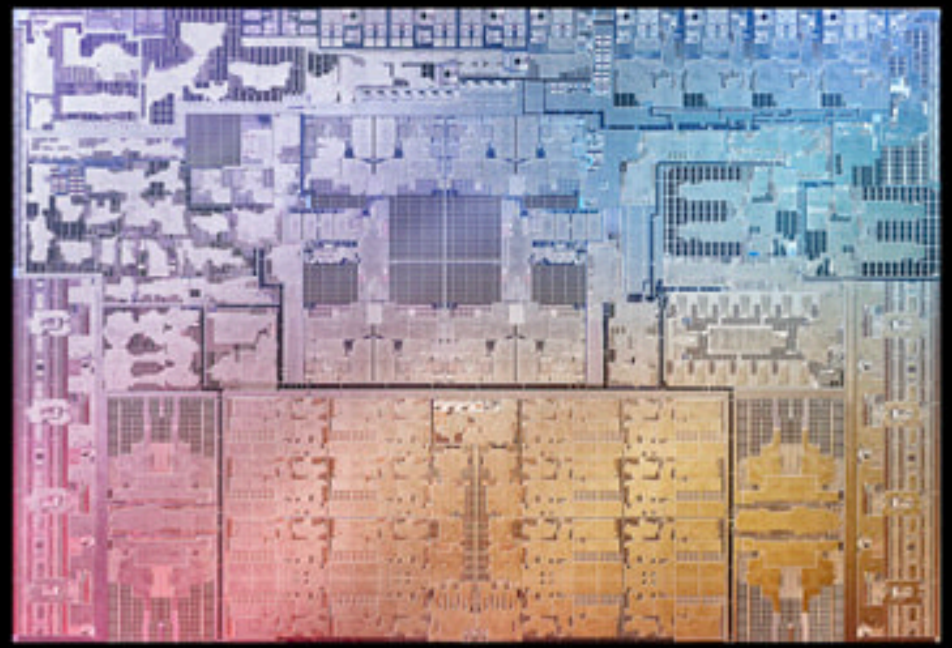
- *electric vehicles*
- *hydrogen energy systems*
- *developing power grids*
- *fusion energy*
- *computing itself*

climate change

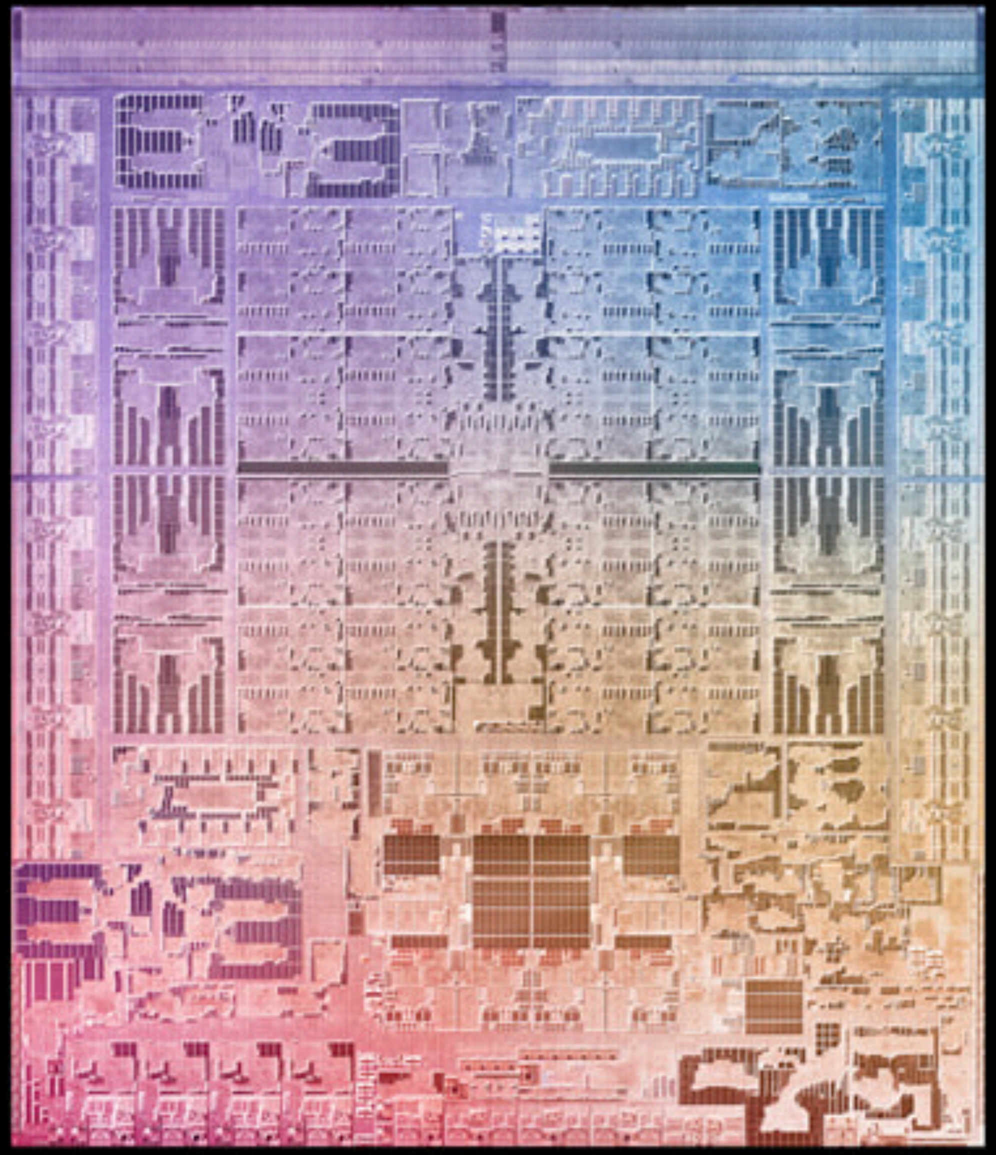
- *electric vehicles*
- *hydrogen energy systems*
- *developing power grids*
- *fusion energy*
- *computing itself*
  - *10% of the world's power goes to computers*



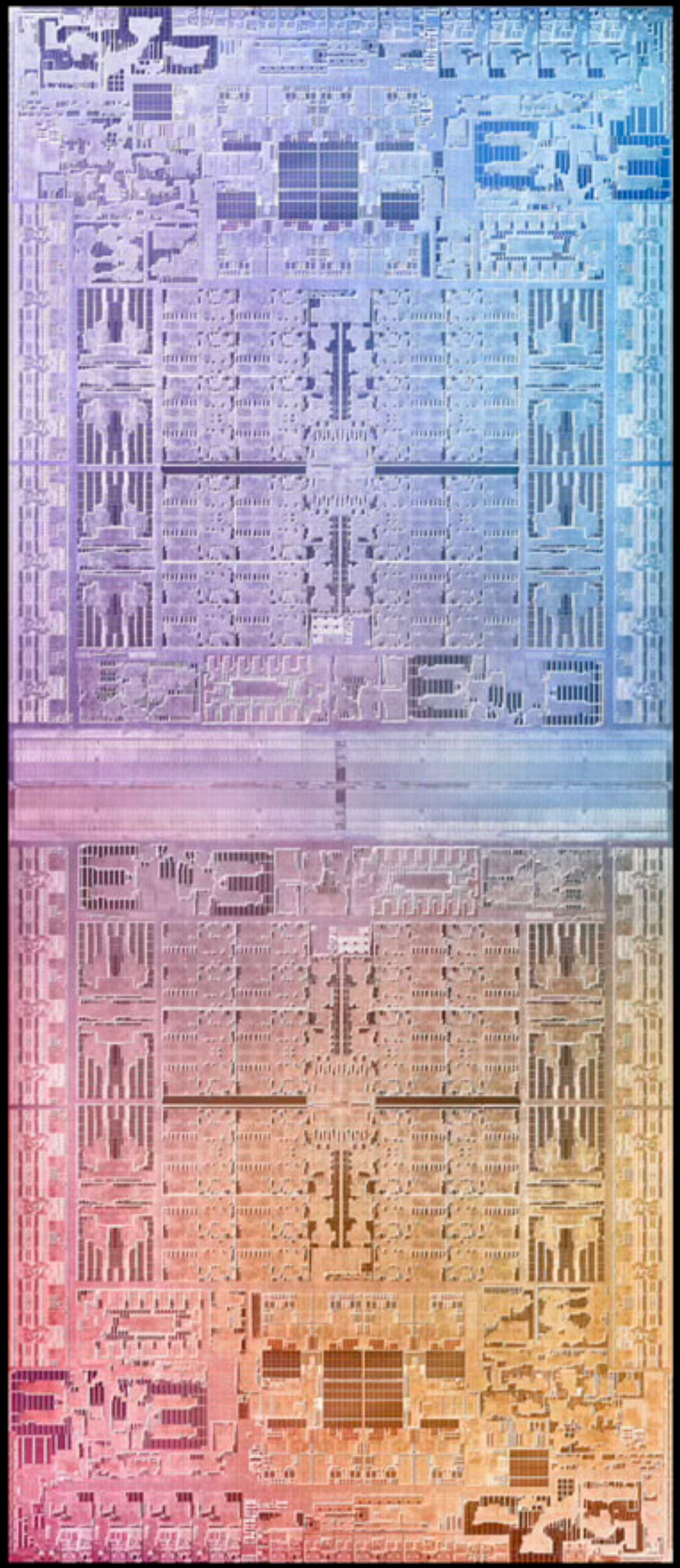
M1



M1 Pro



M1 Max



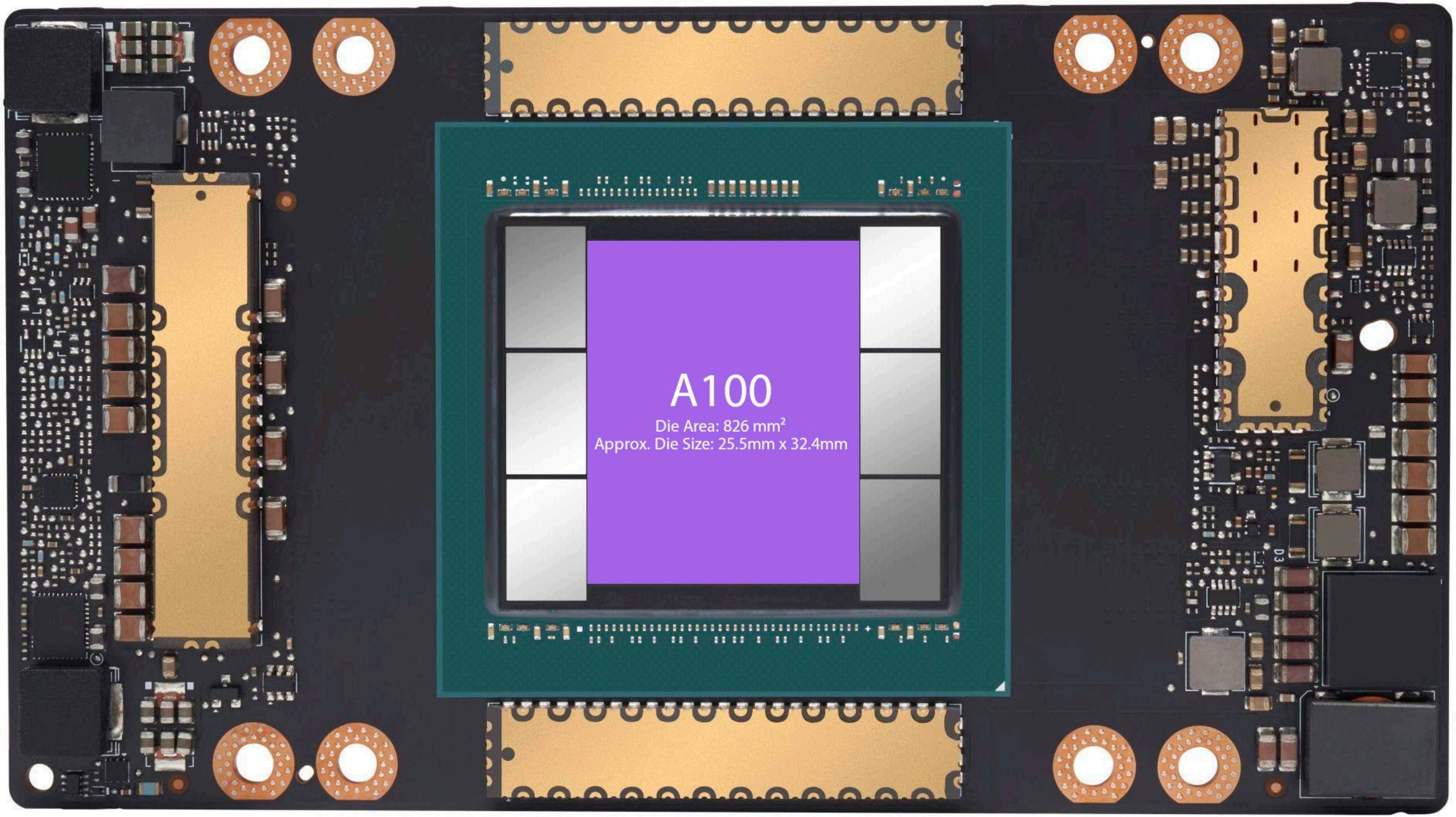
M1 Ultra

- *ARM, not x86!*

M1 | M1 Pro | M1 Max | M1 Ultra

climate change

- *electric vehicles*
- *hydrogen energy systems*
- *developing power grids*
- *fusion energy*
- *computing itself*
    - *10% of the world's power goes to computers*
    - *ARM's got wayyy better power efficiency*
    - *starting to work it's way into datacenter*



 Die Size Analysis Conducted by Lambda Labs, Inc. - https://lambdalabs.com


NVIDIA
NVIDIA
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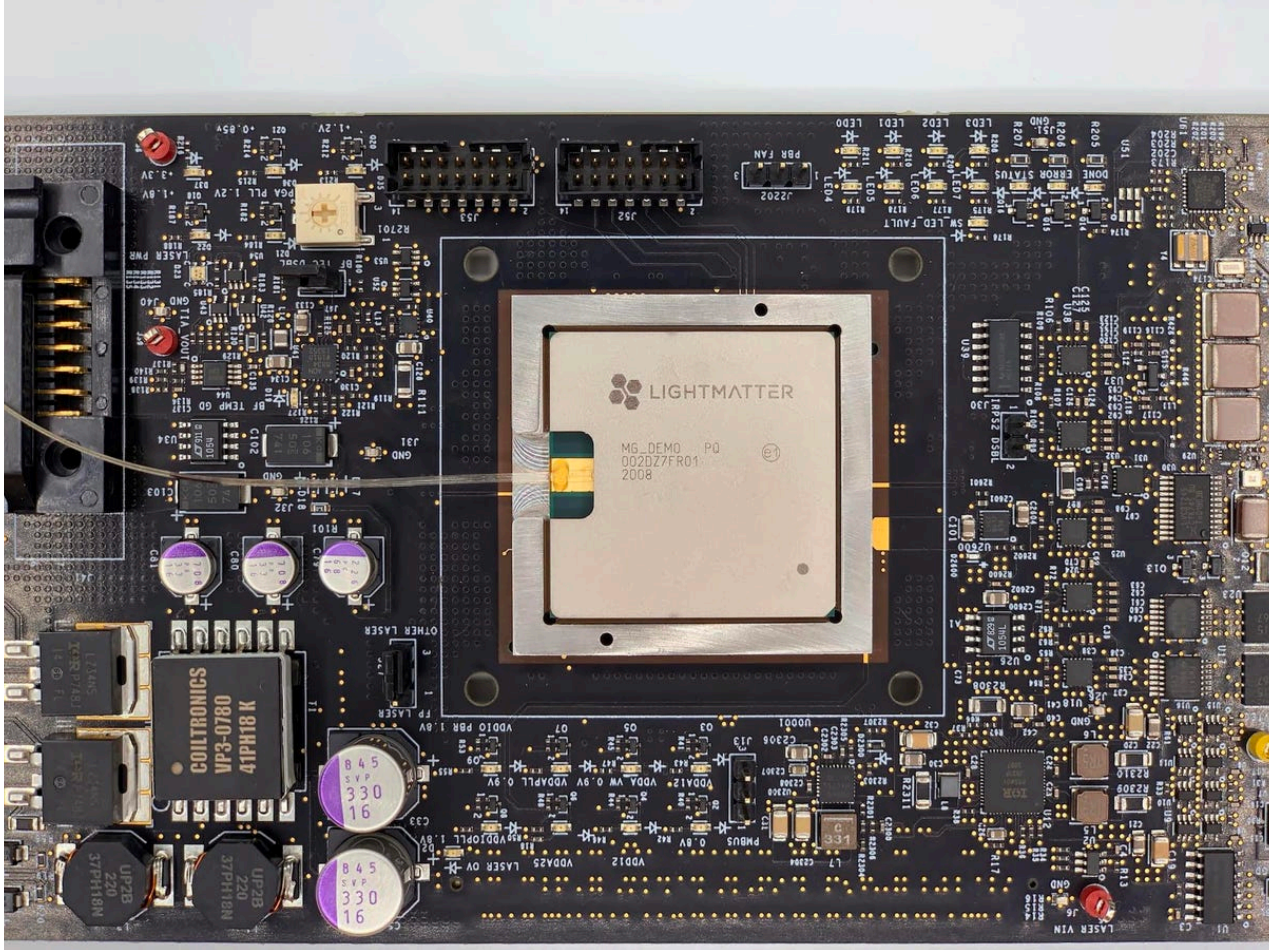
NVIDIA



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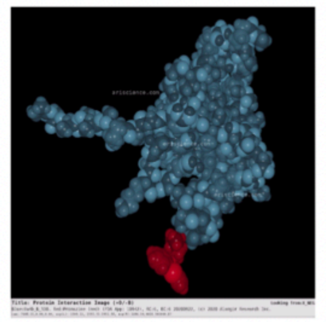
IBM Q
System One

more pandemics

COVID-19 HPC Consortium | Who We Are | Collaborations | Projects | News & Press | Blog

← Back to all projects

SARSCOV2/COVID19 protein interruption search with existing active compounds using quasi-quantum simulation



Completed project

Abstract

COVID-19 is a highly transmissible disease caused by Severe Acute Respiratory Syndrome coronavirus 2 (SARSCoV2). Although vaccine development is critical, it is also a lengthy process. To this end ARIScience has developed a state-of-the art molecular simulation software to identify whether existing FDA-approved drug active compounds may interrupt SARSCoV2 proteins. This quasi quantum simulation software autonomously disassembles SARS-CoV-2 proteins, identifies target areas on the protein, and then identifies drug compounds with highest potential for interruption. If an existing drug compound, or cocktail of compounds, can be discovered to affect the speed, formation, and activity of different parts of multiple viral proteins, a multi-pronged attack strategy to slow down COVID-19 can be developed, which in turn can help save civilian lives in the U.S. ARI can currently simulate 1213 drugs and have already completed simulations against 5 SARS-CoV-2 proteins. Preliminary simulation results are confidentially attached to this request pending subsequent validation steps of our overall research.

PI

Joy Alamgir
ARIScience

Therapeutics

Drug repurposing

Results (3)

27 May 2021 Results available

Final report

occupational injuries

the case for hardware

- *if you want to solve big existential problems, hardware's for you*

the case for hardware

- *if you want to solve big existential problems, hardware's for you*

- *and even if you don't:*
  - *understanding hardware lets you write better software.*
  - *understanding underlying first principles lets you design better things.*
    - *debugging ensures that you learn <3*

  - *it's kinda just really fun*

the case for hardware

UN SDGS

the Suitable Development Goals **+ their** *translation* **to** hardware design.

HTTPS://SDGS.UN.ORG/GOALS

HTTPS://SDGS.UN.ORG/GOALS

Direct Impacts from Hardware DESIGN

HTTPS://SDGS.UN.ORG/GOALS

Direct Impacts from Hardware DESIGN

Indirect Impacts from Hardware Design

HTTPS://SDGS.UN.ORG/GOALS

Direct Impacts from Hardware DESIGN

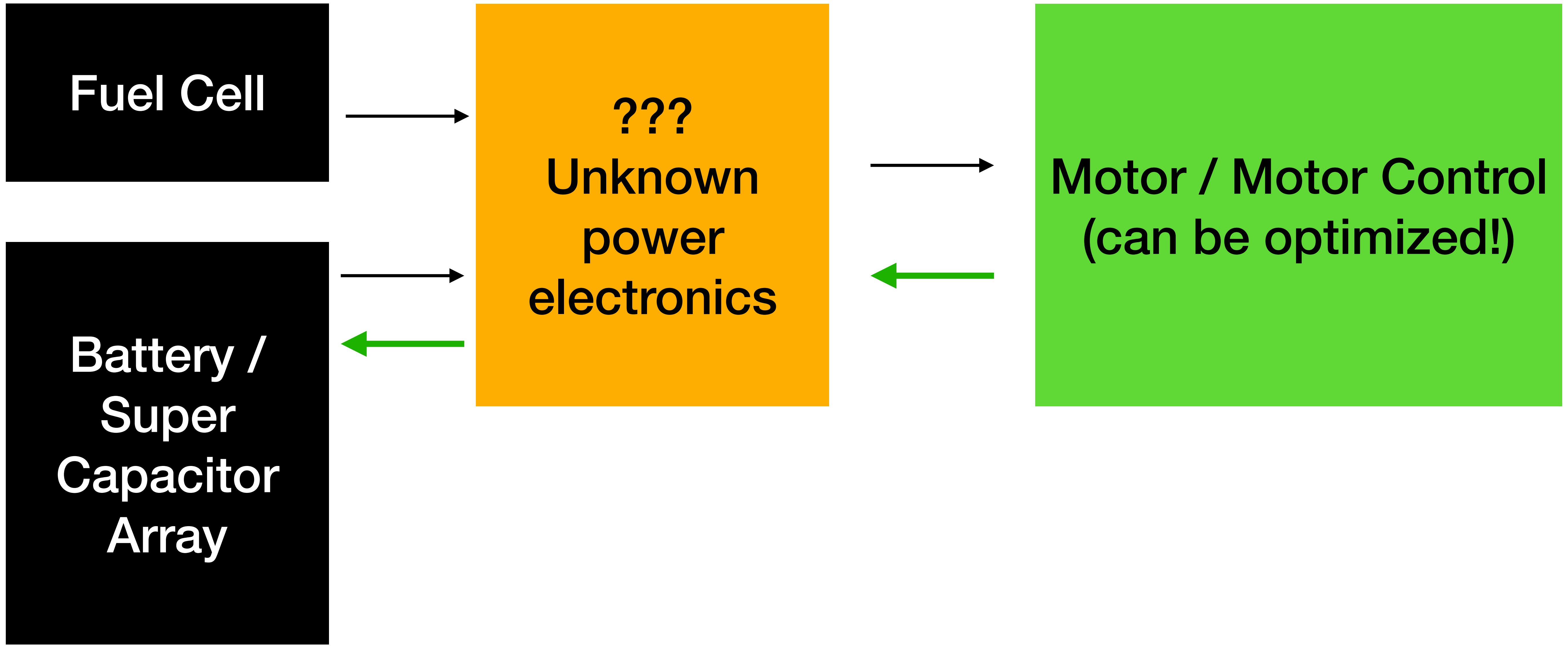
Indirect Impacts from Hardware Design

Less Direct Translation

CLEAN ENERGY

THE ART AND SCIENCE of PCB DESIGN

Hydrogen power is one of the possible futures of clean energy, required new and interesting power electronics, and optimized hardware design.



MIT EVT

Licence to Fab
EST. 2022
CAMBRIDGE, MA

[HTTPS://LICENCE-TO-FAB.GITHUB.IO/](https://licence-to-fab.github.io/)

@ MIT

CLEAN ENERGY

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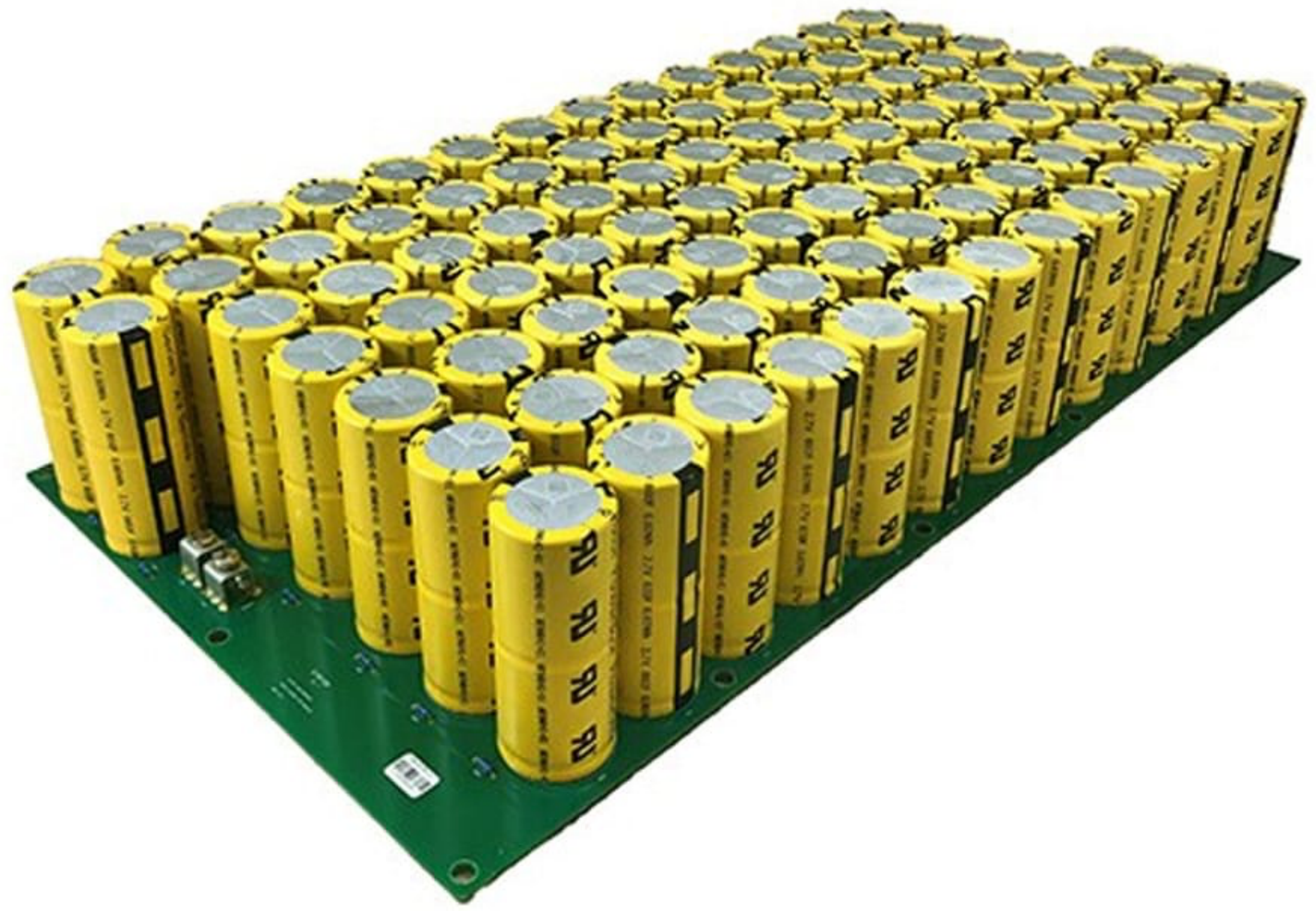
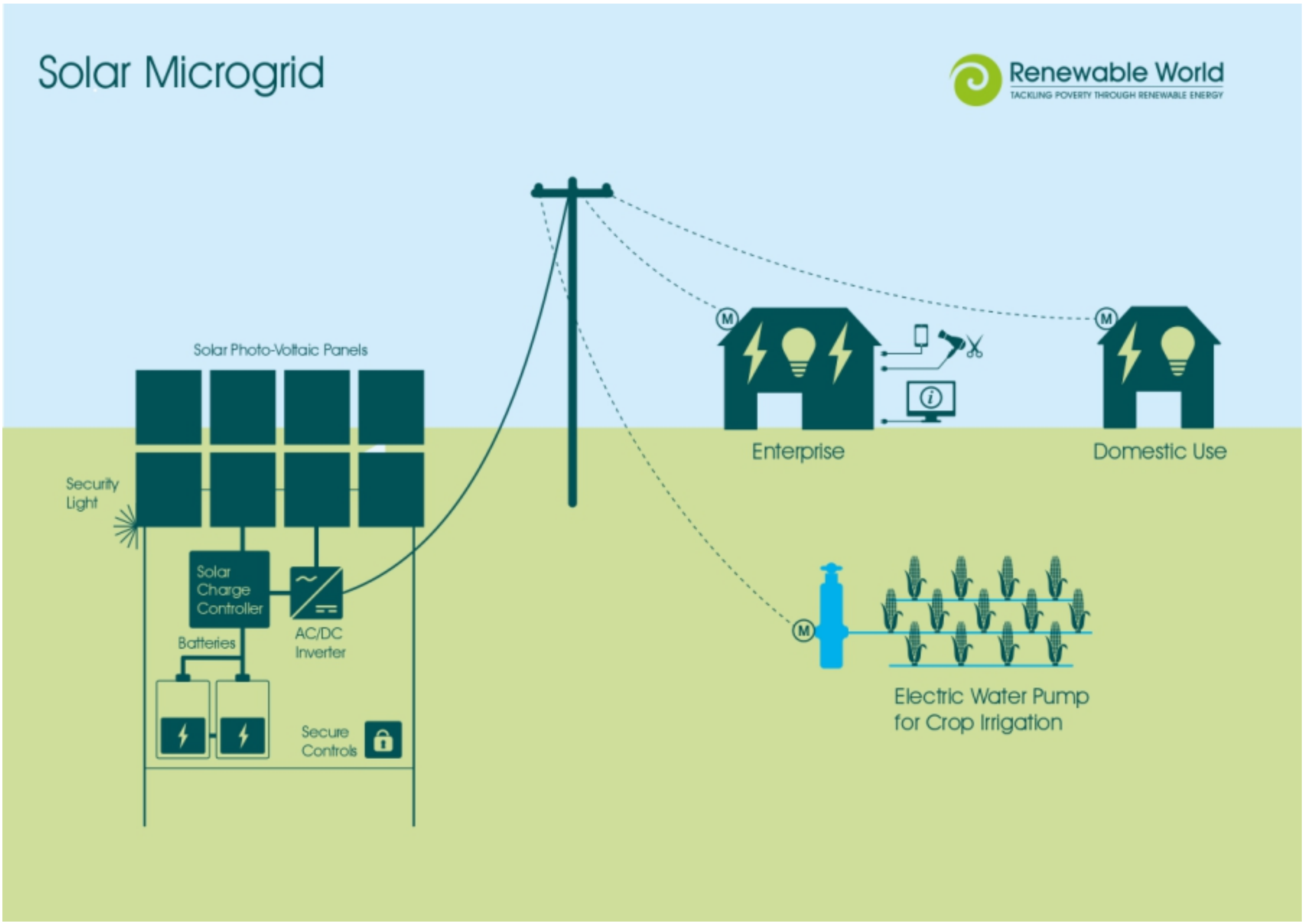


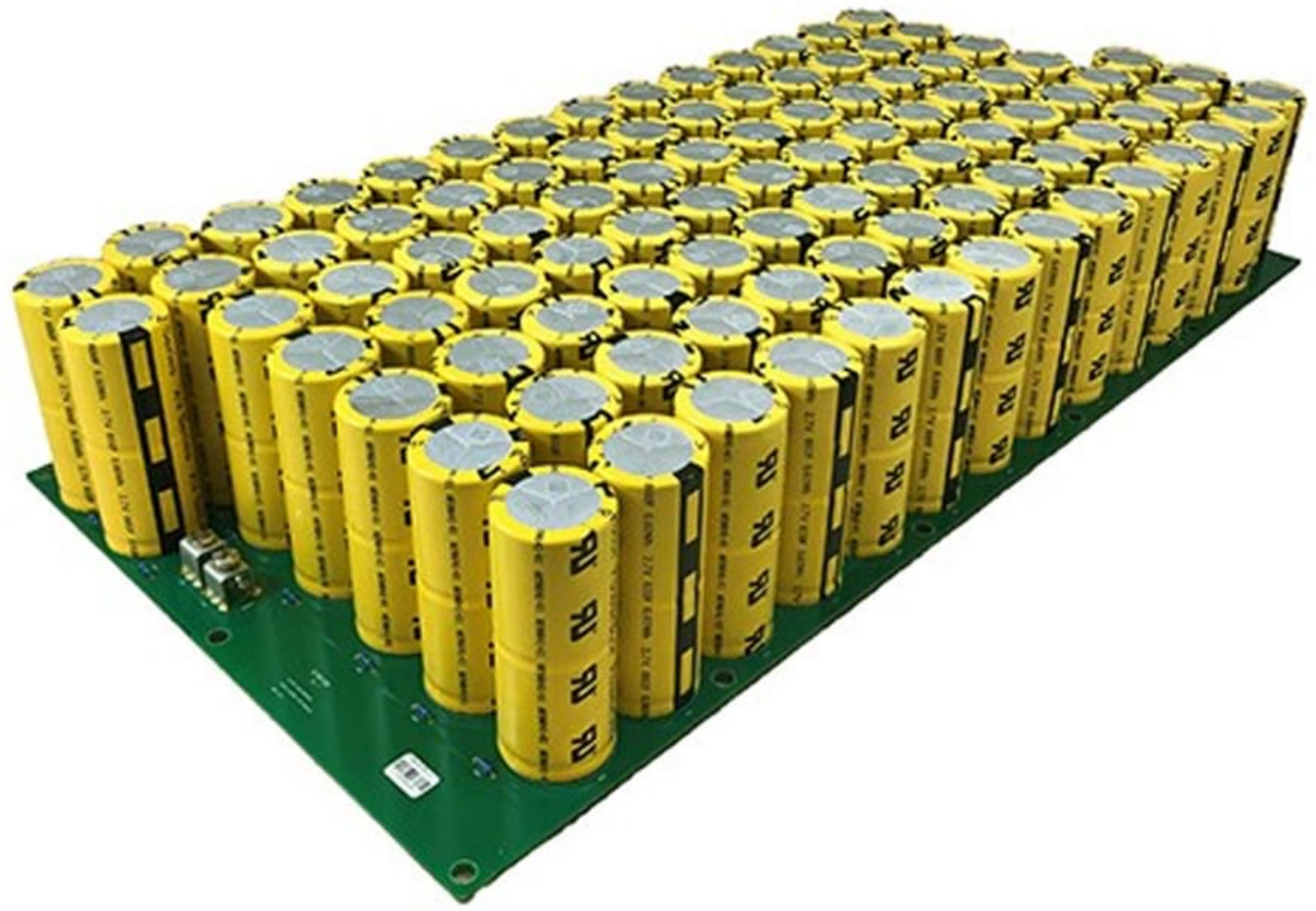
https://renewable-world.org/our-approach-to-renewable-energy/technologies/solar-microgrids/



Microgrids + local energy production can help developing and developed nations manage their energy consumption, and they require NEW technology like super capacitors which require advanced power electronics.

HTTPS://D-LAB.MIT.EDU/RESEARCH/ENERGY

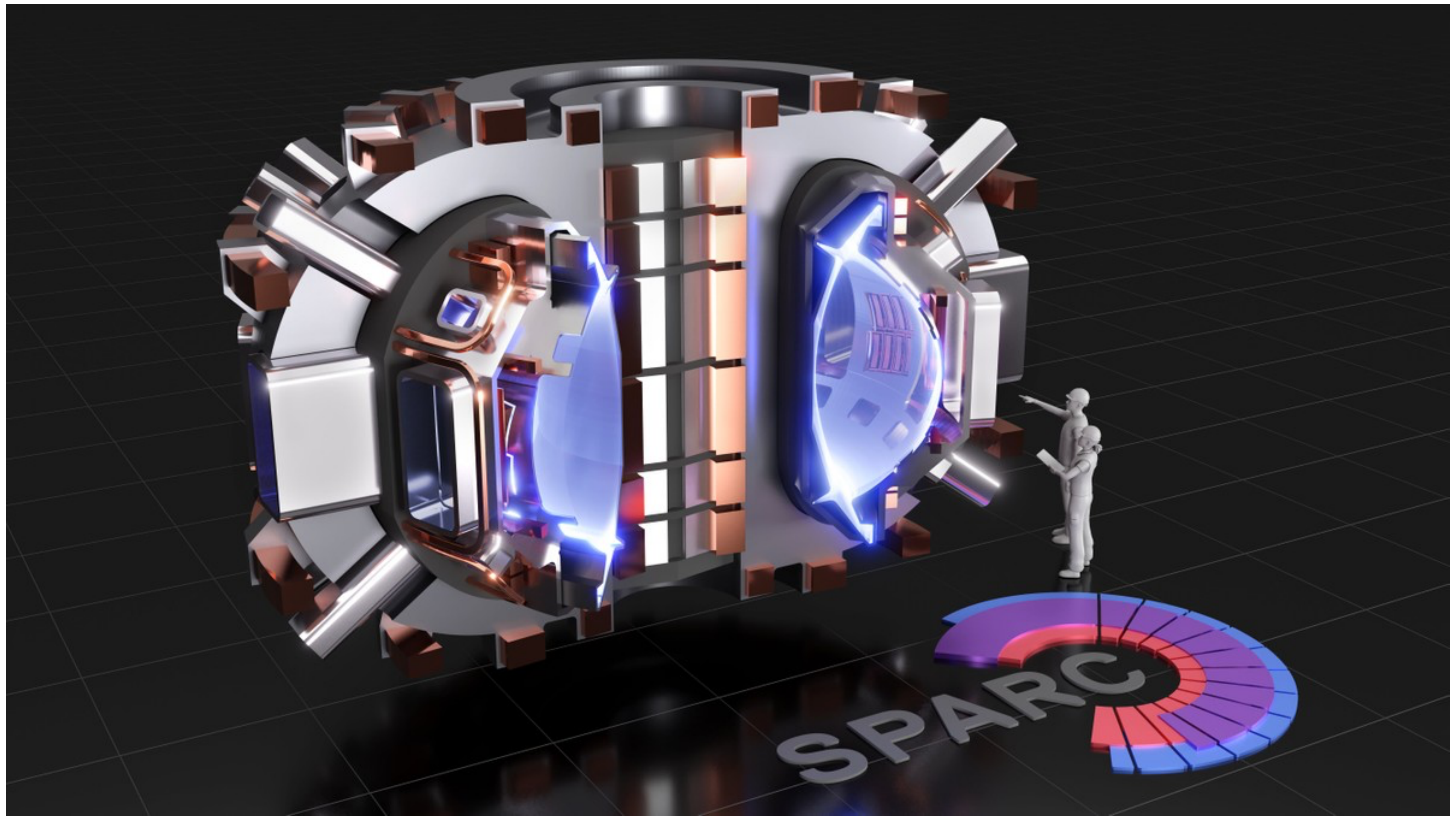
Clean Energy



Can't use a traditional Lithium Battery-Management System, needs circuitry that manages charge and discharge rate efficiently. Capable of super high currents but this could be a problem for many electrical systems. HUGE voltage swings on the output of these devices, how do we stabilize the voltage?

https://d-lab.mit.edu/research/energy

CLEAN ENERGY



https://cfs.energy/technology/sparc

Commonwealth Fusion Systems

HTTPS://CFS.ENERGY/

→

Nuclear Fusion requires advanced power supply design, magnetic design, energy capture, and so many other things!

Superconductors!
Superconducting magnets!

ZERO HUNGER

IronOx is using robots, controls, and electronics to make farming more sustainable. How do we deliver nutrients in precise quantities to plants without wasting energy? As in optimal plant production per unit energy, space, and water used!!!

—> this requires controls, instrumentation, robotics, sensing, etc. etc.

HTTPS://IRONOX.COM/SUSTAINABILITY/

ZERO HUNGER

THE ART AND SCIENCE of PCB DESIGN

Multispectral Image Sensing that allows farmers to predict crop yield, identify diseases, and etc.

**greatly reduces chances of crop failure with constant monitoring, can also help plan next year's field.

https://www.dji.com/p4-multispectral

https://ageagle.com/

https://www.pix4d.com/product/sequoia/

HEALTH + WELL BEING

THE ART AND SCIENCE OF PCB DESIGN

Helps deliver lifesaving drugs during the pandemic.

-GPS technology, advances in IMUs, motors and motor control, batteries, navigation and targeting.

HTTPS://WWW.FLYZIPLINE.COM/

HEALTH + WELL BEING

THE ART AND SCIENCE of PCB DESIGN

The Moving Ambulance:
Sissala Tricycle

Created with the communities of Sissala East District, Tumu Ghana and The Virtue Foundation Manufactured in Tumu Ghana.

1. **Ambulance Interior:** A removable patient stretcher, seats for nurse and family member, first aid kit, birthing kit, IV Drop, lighting, and window to the driver
2. **Window Coverings:** Leather panels cover the windows of the ambulance, allowing the passengers to modify the amount of ventilation coming in while keeping dust out.
3. **Custom Suspension:** Our suspension features a custom dual shock design, allowing for an extremely comfortable ride in any road conditions
4. **Ambulance Sirens:** Our Ghana made design works like a conventional ambulance with sirens and lights to signal to other vehicles.

→ Helps reduce pregnancy related deaths in rural Ghana.

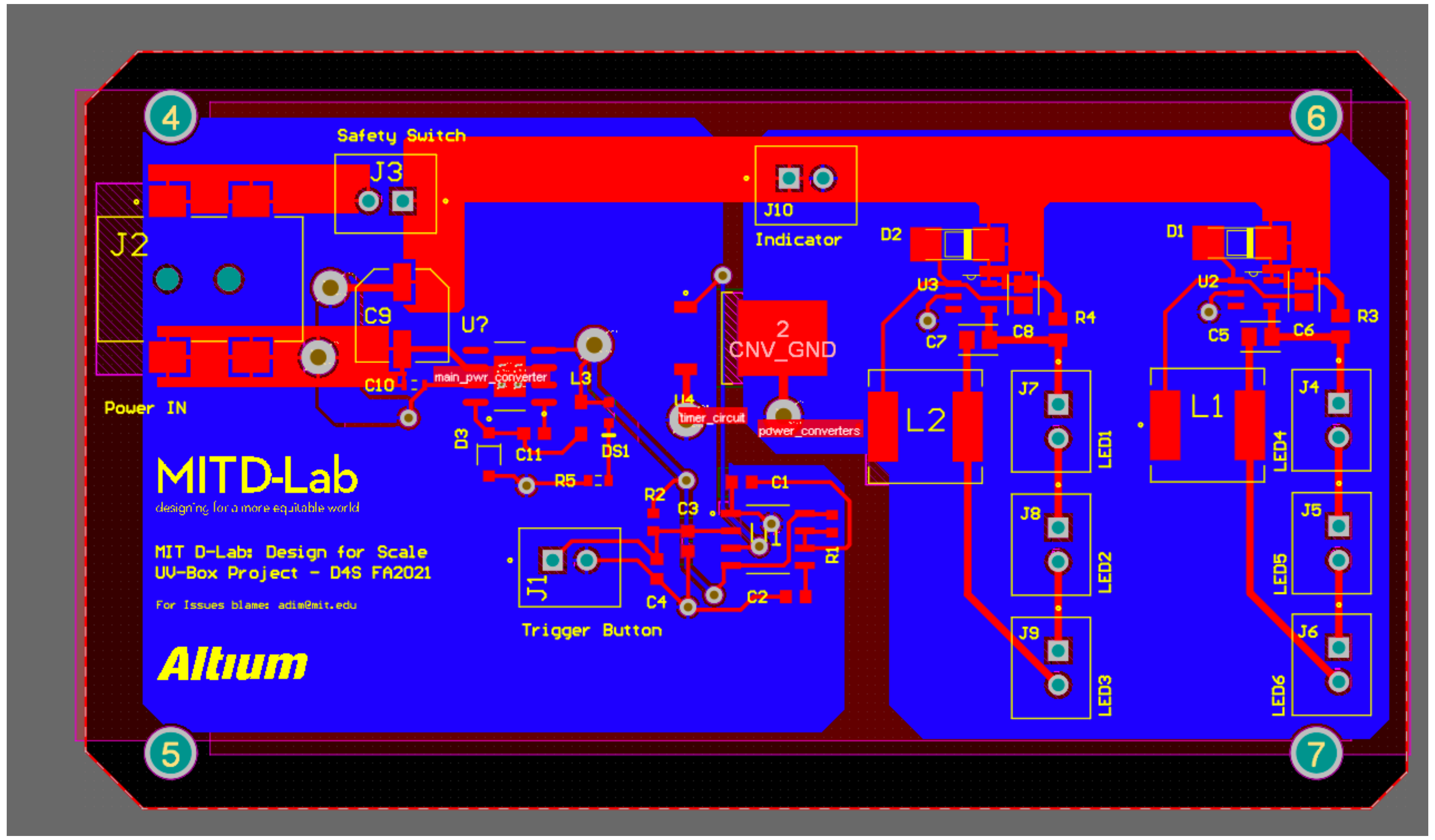
- sensor system on-board tracks ambulance use allowing the organization to deploy ambulances where they are most needed and to tailor the product to the needs of the local people.

HTTPS://WWW.MOVING.HEALTH/

THE ART AND SCIENCE OF PCB DESIGN

Don't have a good link, but INGESTIBLE flexible PCBs that go inside you for drug delivery, monitoring, etc. are becoming a thing too!

HEALTH + WELL BEING



LOW COST UV DISINFECTION!!!

- how do we sanitize in the developing world?
- low cost LED drivers? Low cost LEDs?

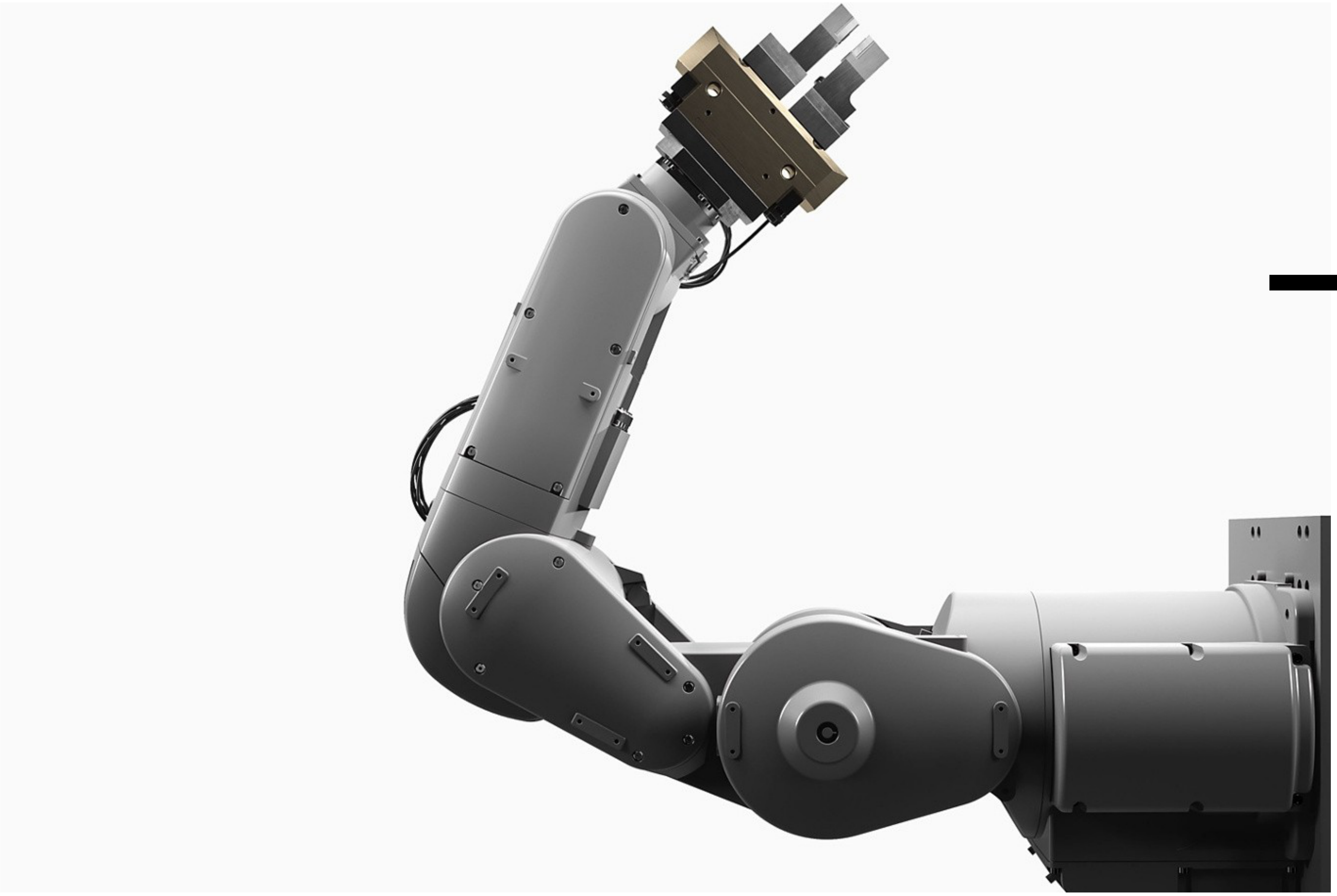
Sustainable
MANUFACTURING

Plastics pollution is a MASSIVE problem, over 90% of plastic waste does NOT get recycled according to nat geo.

—> using hardware design to solve plastic recycling! Heat, thermals, power systems, more!

HTTPS://PRECIOUSPLASTIC.COM/

Sustainable
MANUFACTURING



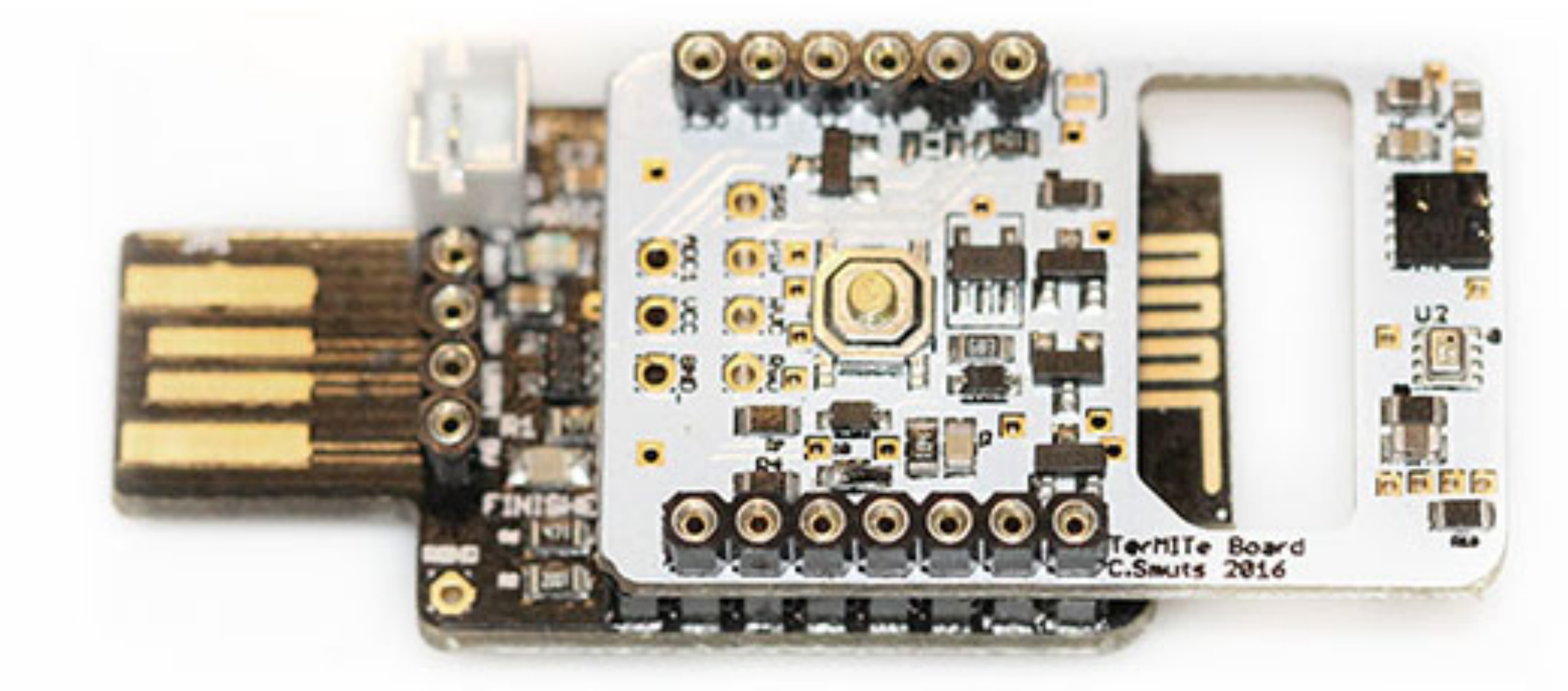
How do we design electronic systems so that AS MUCH OF THE SYSTEM can be recycle when we get to the product stage? How do we re-use components as much as possible to protect our planet.

Down to the RESISTOR LEVEL.

HTTPS://WWW.APPLE.COM/ENVIRONMENT/

Life Below Water + On Lab, Sustainable Cities, Etc.

THE ART AND SCIENCE OF PCB DESIGN



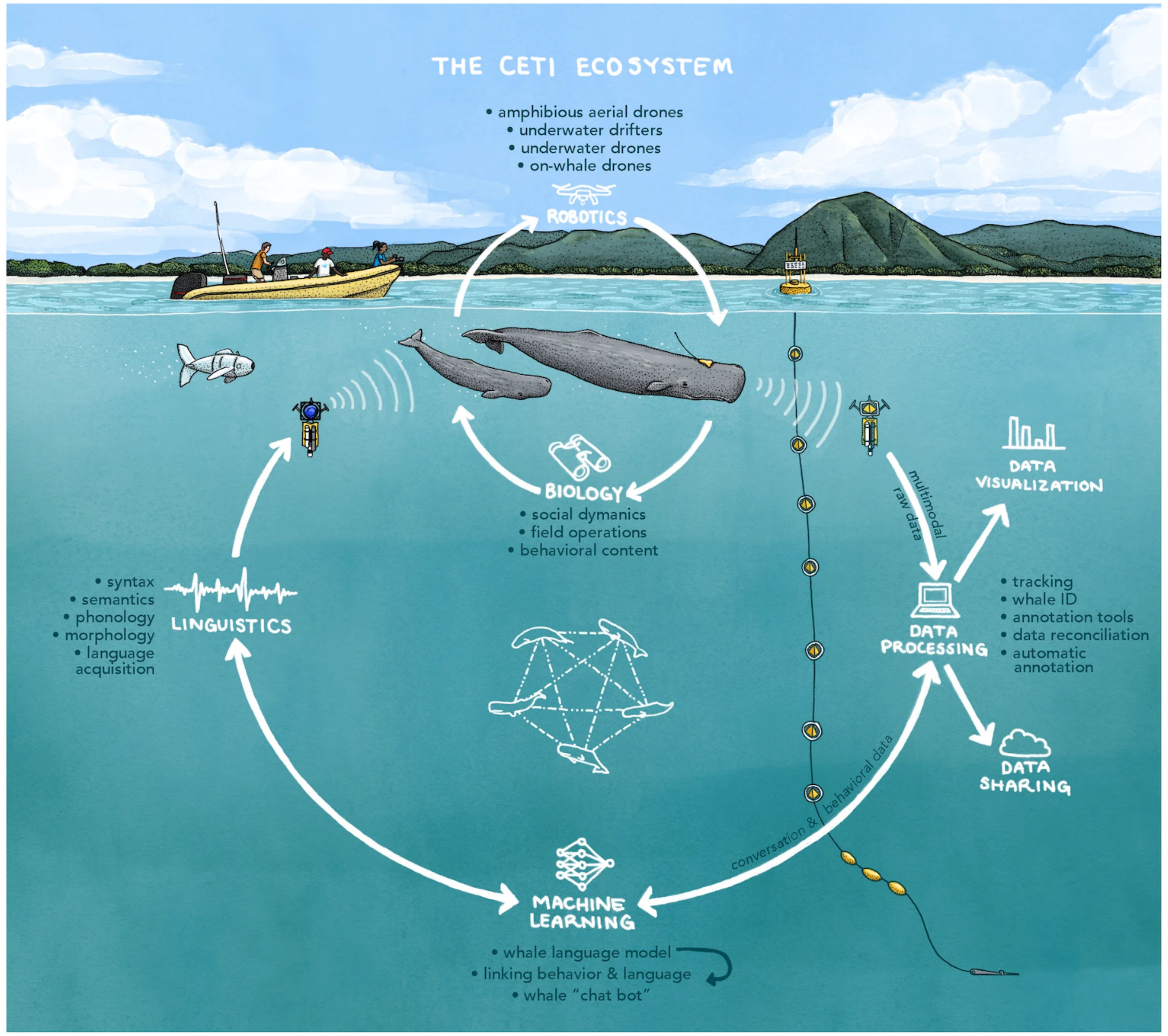
→

Getting data to make our cities more sustainable using IoT

- design of robust, small, low-power sensor and datalogging/transmission systems to install in our cities.

HTTPS://TERMITES.SYNTHETIC.SPACE/

Life Below Water + On Lab, Sustainable Cities, Etc.



→ Using acoustics + signal processing to get a better understanding of whales and how they behave for conservationists around the world.

[HTTPS://WYSS.HARVARD.EDU/NEWS/TALKING-WITH-WHALES/](https://wyss.harvard.edu/news/talking-with-whales/)

A Brief Story About My HS Chem Teacher…

(And why she's my Hero, and always will be…)

ETHICS FOR ENGINEERS

ETHICS FOR ENGINEERS

Do what you LOVE **+ don’t worry about how much you’re getting paid to start.**

ETHICS FOR ENGINEERS

Do what you LOVE **+ don't worry about how much you're getting paid to start.**

Work on things that ALIGN with your VALUES

ETHICS FOR ENGINEERS

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Work on things that ALIGN with your VALUES

Share your work with the world - open source, or teach!

Ethics for Engineers

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Work on things that ALIGN with your VALUES

Share your work with the world - open source, or teach!

Be kind + compassionate.

ETHICS FOR ENGINEERS

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Work on things that ALIGN with your VALUES

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BE KIND + COMPASSIONATE.

AN MAKE. A. POSITIVE DIFFERENCE.

CHECK THESE PEOPLE OUT:

MIT D-Lab
designing for a more equitable world

MIT SEVT

MIT MOTORSPORTS

MIT EVT

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CAMBRIDGE, MA

MIT Edgerton Center

classes we've enjoyed

- *6.002 - intro circuits*
- *6.131 - power electronics lab*
- *6.334 - graduate power electronics (v cute dog included)*
- *6.111 - digital systems lab*
- *6.832 - underactuated robotics*
- *6.800/843 - robotic manipulation*
- *8.03 - vibrations and waves*
- *8.223 - classical mechanics II*

- *6.SiP - silicon photonics*
- *6.900 - engineering for impact*

- *2.70 - FUNdaMENTALs of Precision Product Design*
- *2.14 - feedback controls*
- *2.12 - intro to robotics*
- *2.74 - bio-inspired robotics*
- *2.001/2.003/2.004 - intro MechE Classes*
- *2.007/2.008 - Design + Manufacturing*

- *2.678/2.679 - good electronics classes in MechE*
- *2.72 - Elements of Mechanical Design*
- *2.737 - Mechatronics*

THANK YOU FOR A GREAT CLASS <3

FREE DINNER + MUSIC! 7-9PM LOBBY 13 ON WEDNESDAY!! BRING YOUR FRIENDS!