Faculty of Electrical Engineering

WARSAW UNIVERSITY OF TECHNOLOGY

www.ee.pw.edu.pl

100 years

Electrification of land, air, and water means of transportation

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This presentation was made by a human :)

Electrify everything!

„If we truly want to get to net-zero emissions, (…) We have to focus on (…) **electrifying all of our end uses** and powering them with emissions-free electricity from **nuclear*** or **renewables**."

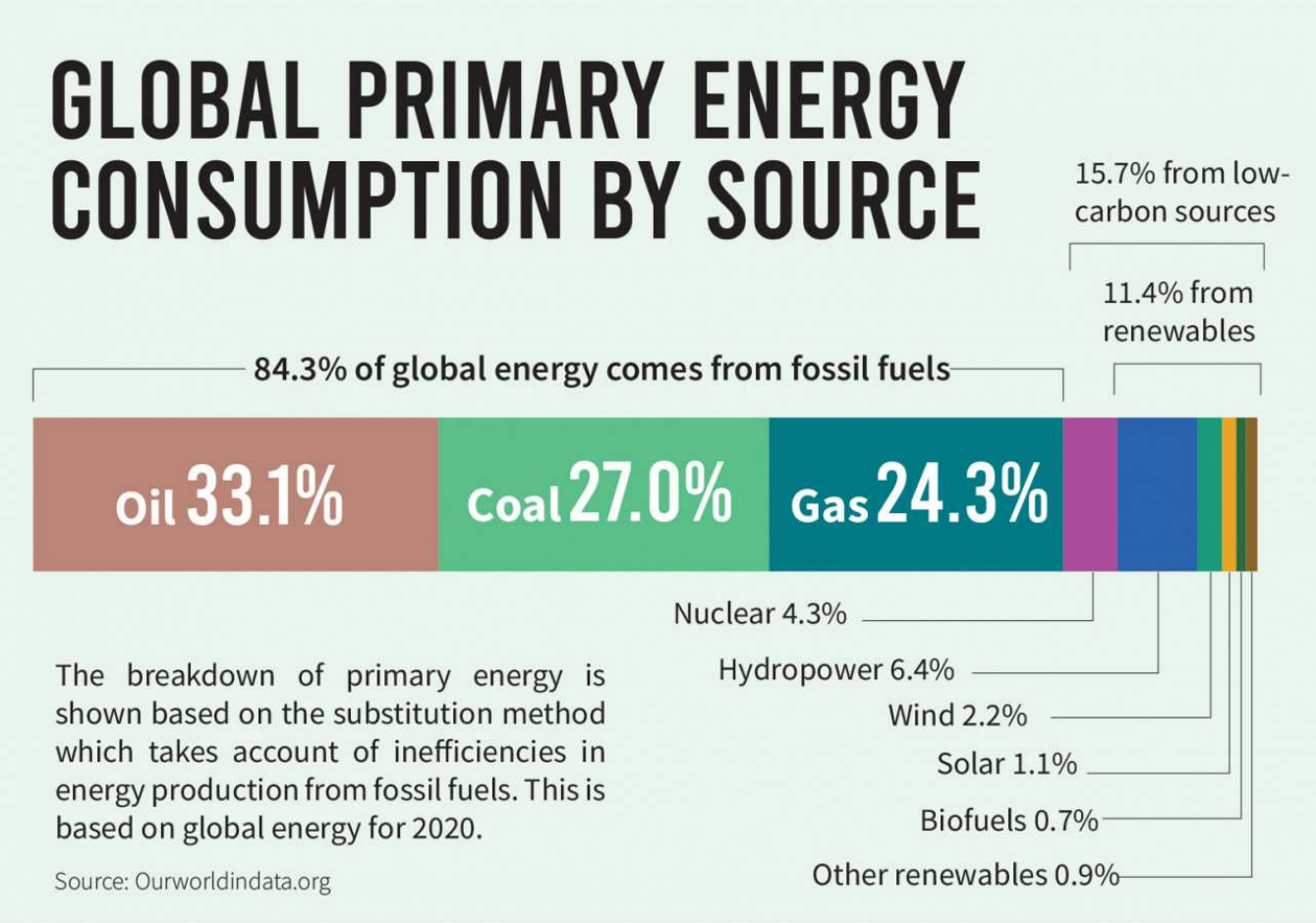
Saul Griffith, the founder of Instructables.com

Source: Flaticon.com

*fission now and fusion in the future – Fingers crossed, ITER!

https://www.washingtonpost.com/politics/2022/03/17/why-we-need-electrify-everything-according-saul-griffith/
https://www.iter.org/ (International Thermonuclear Experimental Reactor)
https://www.audible.co.uk/pd/Electrify-Audiobook/B09KSVWP7W

Renewables are replacing fossil fuels? In 2000 fossil fuels contributed 86.1% to the mix.



A. The internal combustion engine will stay with us probably longer than for one decade. E-fuels will let us electrify at least some parts of the energy chain.

Siemens Energy + Porsche

Maersk, MAN ES, Amonia: methanol/ammonia-powered ships

https://www.youtube.com/watch?v=P2RmJVbOnq4

https://amogy.co/

https://www.man-es.com/discover/two-stroke-ammonia-engine

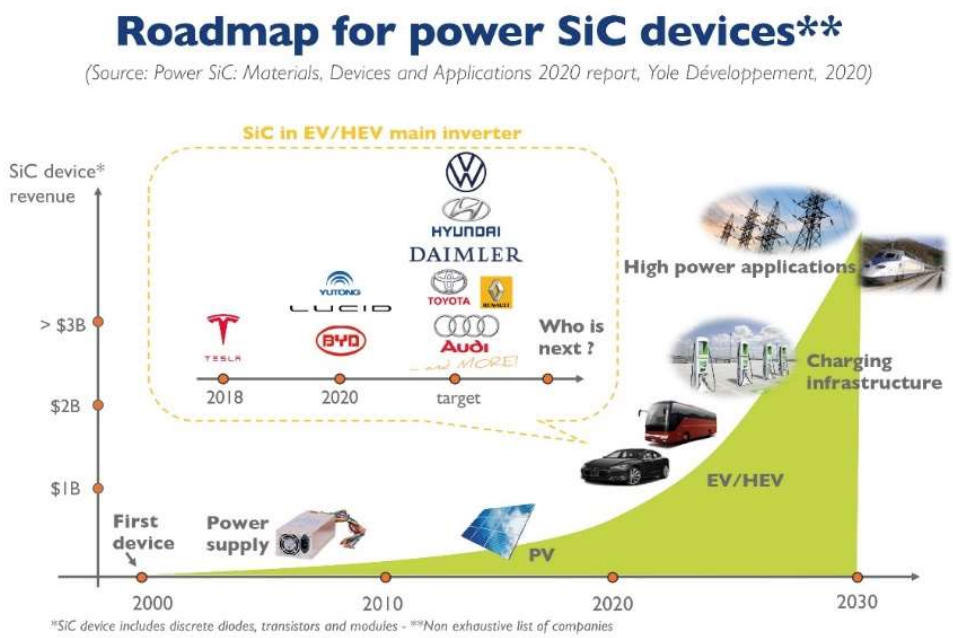
B. Standardization of 1+ MW charging connectors

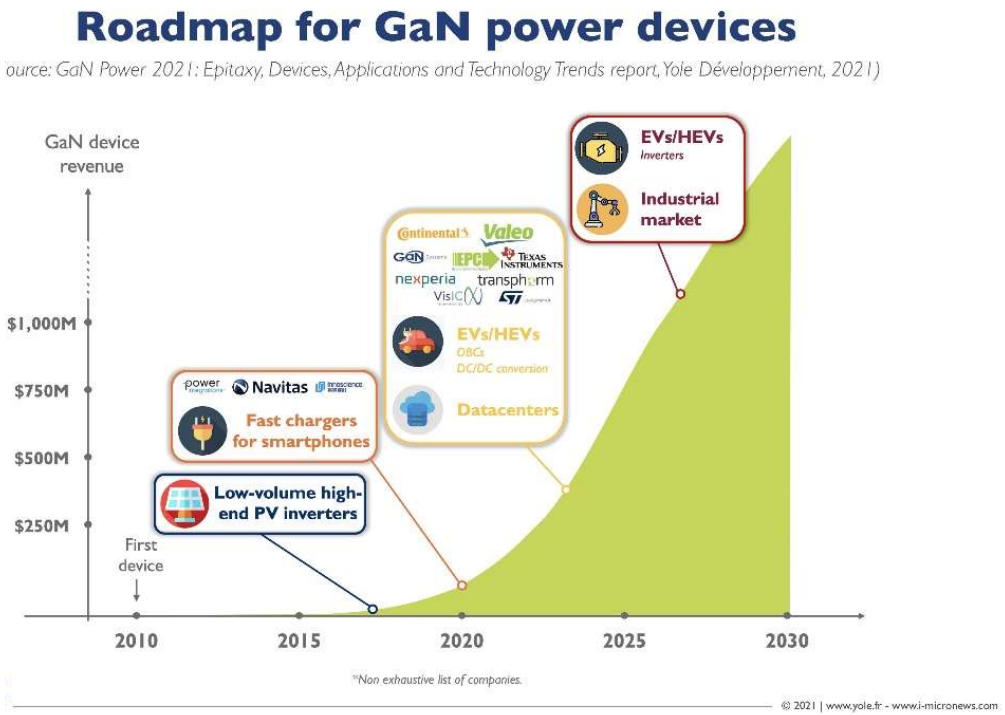
Tesla Megacharger

Megawatt Charging System

Nxu Energy

C. SiC and GaN semiconductor devices



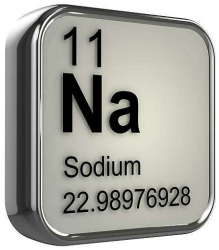


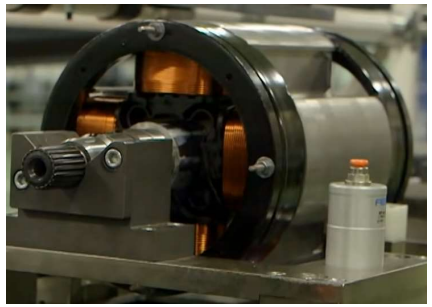
70% of SiC power devices produced is consumed by the automotive industry.

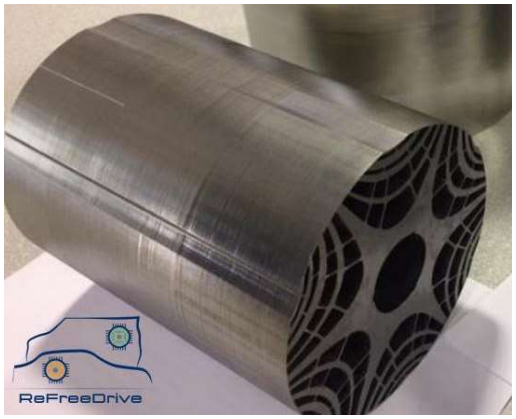
D. REE-free drivetrain

Why is it so important? Let's look at the household level.

- BYD and sodium-ion batteries
- Sodium batteries for electric bikes in India
- IPMSM as current workhorses of the electromobility – reluctance machines as the future?
- SSB



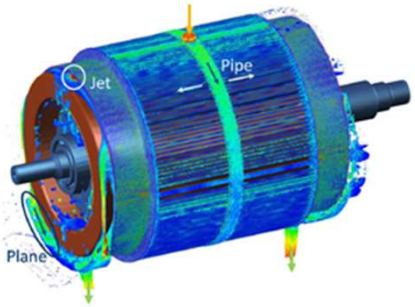




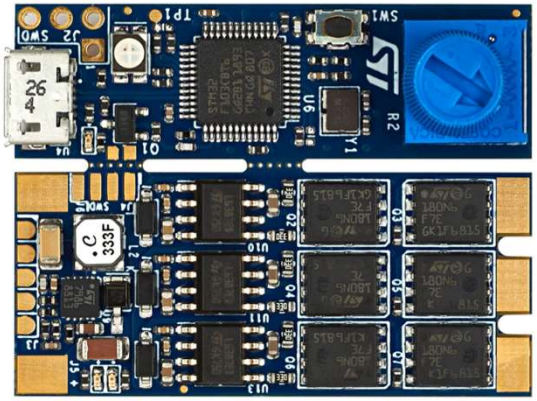
Neodymium-free. Cobalt-free. The post lithium-era.

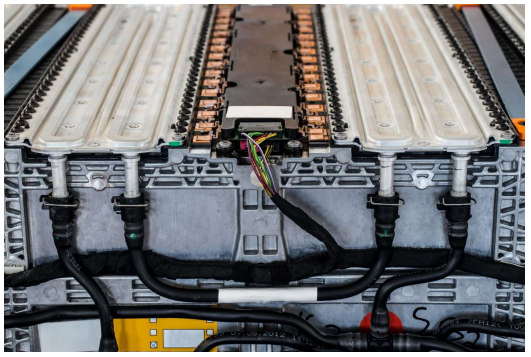
E. Packaging and thermal management

45 A, 22.2 V (6S), 13 x 28.5 mm



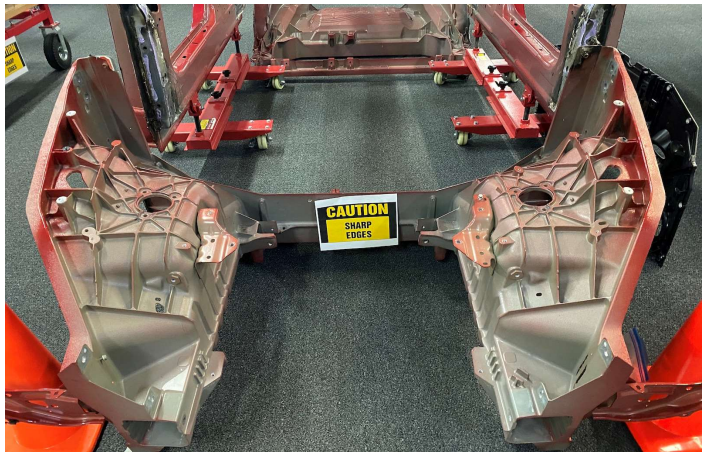
Computational fluid dynamics (CFD)





Battery immersion cooling

F. 9000-t giga press (giga casting)



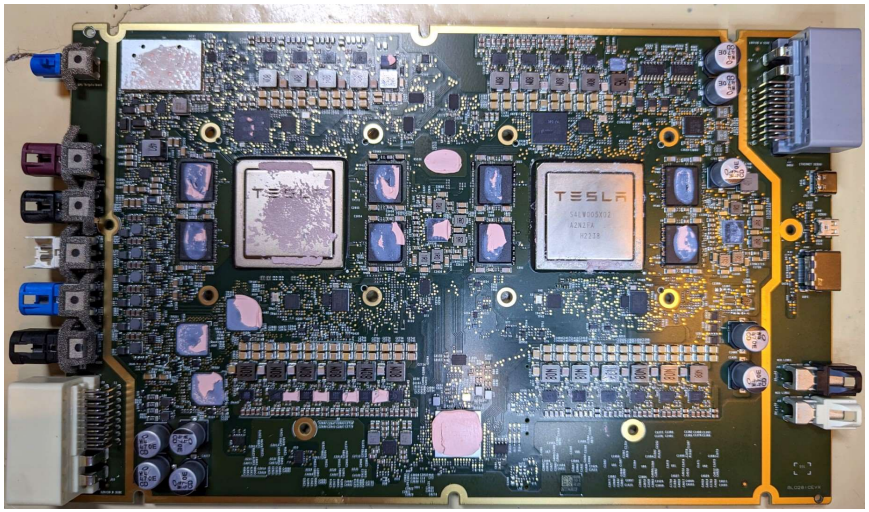
Source:
https://www.torquenews.com/11826/first-tesla-gen-3-platform-be-cast-1-piece-will-be-china-compact-car-suggests-giga-press-supplier
https://www.lightmetalage.com/news/industry-news/automotive/the-impact-of-giga-castings-on-car-manufacturing-and-aluminum-content/

G. Reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle

- Second-life EV batteries
- Car refactory
- Right to Repair
- Recycling of not only nickel and cobalt

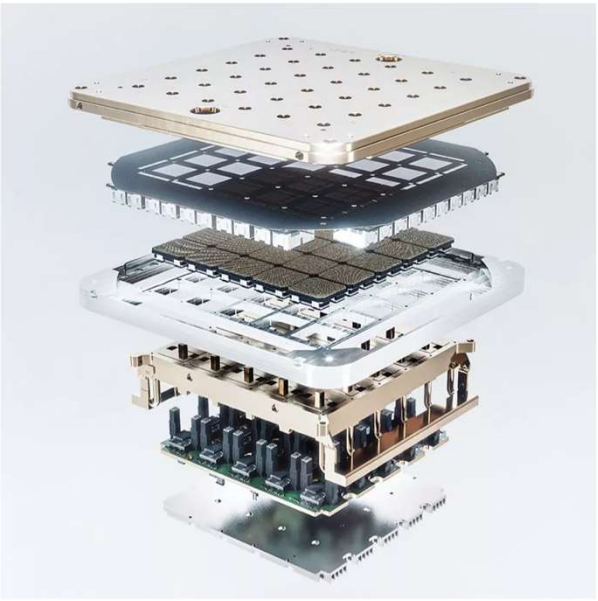
https://www.bloomberg.com/features/2023-china-ev-graveyards/

H. Autopilot, IoT, smart city and smart grid



Highly wanted exemplary competencies:

- embedded systems
- software development
- machine learning
- cloud computing
- edge computing



Jack Clark
@jackclarkSF

https://openai.com/
https://www.anthropic.com/

A mental model I have of AI is it was roughly ~linear progress from 1960s-2010, then exponential 2010-2020s, then has started to display 'compounding exponential' properties in 2021/22 onwards. In other words, next few years will yield progress that intuitively feels nuts.

1:24 am · 12 Feb 2023 · **673K** Views

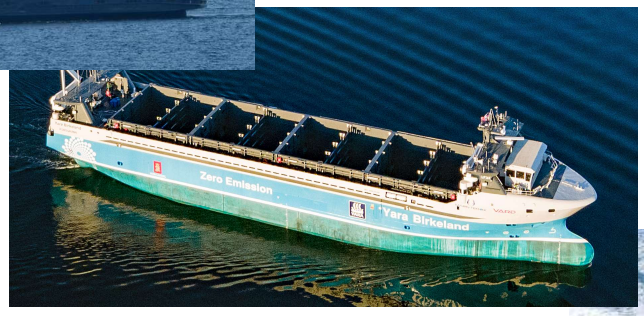
I. Heavy/construction equipment electrification

J. Batteries and fuel cells in the air

Aviation Alice:
9 passengers, 2 crew members, ca. 500 km range

Regional air travel a la Embraer 145: 50 passengers, ca. 3000 km range – hydrogen/methanol/ammonia (turbofan or fuel cell)

K. Batteries in maritime transport



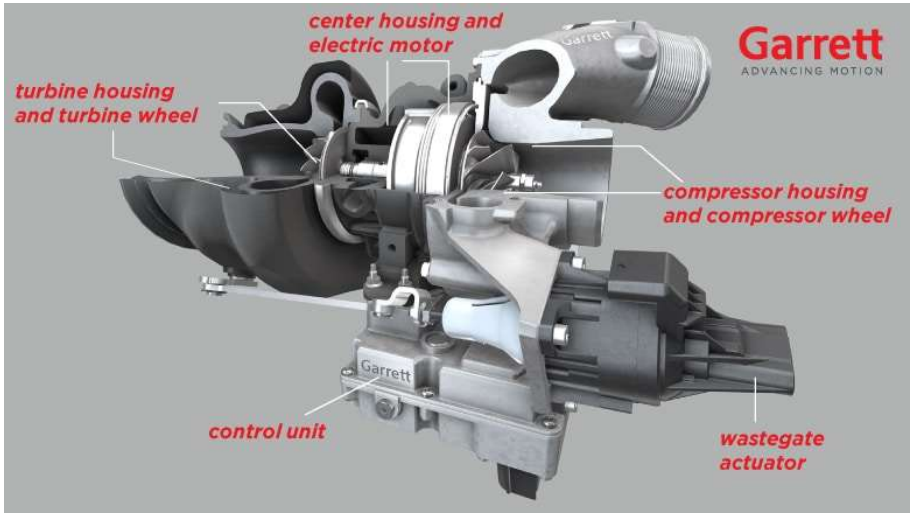
Ferries: Ellen, Basto Electric, NZK Pont 100, 101, 102, 103 and 104, Penguin Refresh, Medstraum.

Container ship: Yara Birkeland (30 nmi range).

Yachts: Silent Yachts, Sialia Yachts with AMPROS, Candela.

Submarines go lithium-ion.

L. E-turbo



Garrett E-Turbo – e technology for EU7?
6 kW, 150 000 rpm

Citroën Ami (electric vehicle)
6 kW, 5.5 kWh Li-ion

[31] Tesla AI Day 2021, https://www.youtube.com/watch?v=j0z4FweCy4M
[32] Tesla AI Day 2022, https://www.youtube.com/watch?v=ODSJsviD_SU
[33] SAE Levels of Driving Automation™ Refined for Clarity and International Audience, https://www.sae.org/blog/sae-j3016-update
[34] SANDY MUNRO: Tesla's FSD "Crap", Better Tech Available, https://www.youtube.com/watch?v=jPxQxgnlV1o
[35] Forget LiDAR: This Tech Will Make Autonomous Vehicles AFFORDABLE | Teledyne FLIR Thermal Fusion, https://www.youtube.com/watch?v=u3OGY_EINtE
[36] GRUPA WB, https://www.wbgroup.pl/
[37] Drone Delivery Was Supposed to be the Future. What Went Wrong?, https://www.youtube.com/watch?v=J-M98KLgaUU
[38] EHang, https://www.ehang.com/video/videolist?id=6
[39] Eviation Alice - electricity bursts into the sky, https://www.youtube.com/watch?v=mIU5VOfgzSc
[40] AI has started to display 'compounding exponential' progress, founder of ChatGPT rival claims, https://www.independent.co.uk/tech/ai-anthropic-chatgpt-artificial-intelligence-b2282110.html
[41] 2020 Hype Cycle for Connected and Smart Mobility, https://www.sae.org/news/2020/09/2020-hype-cycle-for-connected-vehicles-and-smart-mobility
[42] Software Defined Vehicle - this is not a hype, https://www.linkedin.com/pulse/software-defined-vehicle-hype-bernhard-kockoth
[43] Wschodzące technologie, które zmienią świat – Gartner Hype Cycle 2020, https://pl.linkedin.com/pulse/wschodz%C4%85ce-technologie-kt%C3%B3re-zmieni%C4%85-%C5%9Bwiat-gartner-hype-pawe%C5%82-flieger
[44] Citroën Ami (electric vehicle), https://en.wikipedia.org/wiki/Citro%C3%ABn_Ami_(electric_vehicle)
[45] Gartner, https://www.gartner.com/en
[46] Mercedes pokazał silnik, który wstrząsnął całą branżą motoryzacyjną. Analiza AMG M139L, https://www.youtube.com/watch?v=upnUAiwoHm4
[47] Award-Winning E-Turbo Technology, https://www.garrettmotion.com/electric-hybrid/garrett-e-turbo/
[48] MarineTraffic – ELLEN, https://www.marinetraffic.com/en/ais/details/ships/shipid:5535192/mmsi:219023531/imo:9805374/vessel:ELLEN
[63] The Role of Submarine Batteries in Undersea Warfare Technology, https://www.batterytechonline.com/materials/role-submarine-batteries-undersea-warfare-technology
[64] SIALIA, https://www.sialia-yachts.com/
[65] AMPROS, https://ampros.pl/
[66] Nissan to adopt North American Charging Standard (NACS) for Ariya and future EV models, https://usa.nissannews.com/en-US/releases/release-1b8d60744001bfa1e4ae234a43015313-nissan-to-adopt-north-american-charging-standard-nacs-for-ariya-and-future-ev-models
[67] BYD establishes joint venture to begin mass producing its nascent sodium-ion EV batteries, https://electrek.co/2023/06/12/byd-joint-venture-mass-producing-sodium-ion-ev-batteries/
[68] Sodium Batteries for Electric Bikes? Prof. Chandra | Battery Podcast, https://www.youtube.com/watch?v=vom2PhrxEzA
[69] Why we're not seeing solid-state batteries right now - Prof. Rupp | Battery Podcast, https://www.youtube.com/watch?v=lr7-PzSr5SU
[70] How LMFP and Sodium Ion Batteries will Change the Battery Market // 2023, 2025, and 2030, https://www.youtube.com/watch?v=iptLhpK6Cg0
[71] Joby Delivers First eVTOL Aircraft to Edwards Air Force Base Ahead of Schedule, https://www.jobyaviation.com/news/joby-delivers-first-evtol-edwards/
[72] Joby Aviation delivers electric air taxi to the US Air Force ahead of schedule, part of $131M contract, https://electrek.co/2023/09/25/joby-aviation-delivers-electric-air-taxi-us-air-force-ahead-of-schedule/
[73] Green NCAP, https://www.greenncap.com/
[74] BYD ATTO 3, https://www.greenncap.com/assessments/byd-atto-3-2023-0145/
[75] Will Chinese electric vehicles (EVs) win globally?, https://www.ubs.com/global/en/investment-bank/in-focus/2023/byd-teardown.html
[78] CANDELA, https://candela.com/
[79] Battery shortage shuttering Cami electric-vehicle plant until spring, https://lfpress.com/news/local-news/major-layoffs-at-cami-electric-vehicle-plant-amid-battery-shortage-source

All the sources are listed in
http://ufnalski.edu.pl/proceedings/sene2023/Ufnalski_SENE_komunikat_Electromobility.pdf - enjoy reading it!

Learn to electrify everything

Ponad dwóch kandydatów na miejsce.
Przyjęliśmy 26 studentów.

https://www.ee.pw.edu.pl/studia/kierunki-studiow/elektromobilnosc/
https://adek.pw.edu.pl/
https://www.youtube.com/watch?v=b2hmAKEQB4w

Thank you for your kind attention!