

AMMA 2025

The 35th SIAR International Congress of Automotive and Transport Engineering
AUTOMOTIVE MOBILITY, MANAGEMENT AND AUTOMATION

23-25 October 2025, Cluj-Napoca, Romania

Artificial Intelligence in Energy and Mobility

Perspectives and Research Frontiers

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JUST STREETS

MOBILITY JUSTICE FOR ALL:
FRAMING SAFER, HEALTHIER
AND HAPPIER STREETS.

Energy Transition Research Center

EnTReC





(2015 - ongoing)



**Laboratorul de Cercetare
în METODE NUMERICE
NUMERICAL METHODS
Research Laboratory**

Technical University of Cluj-Napoca

(2010 – 2015)





MISSION

EnTReC mission is to significantly contribute through evidenced based research to the energy transition in the energy sector, industry, buildings and local communities, in a sustainable approach focused on development, testing and replication of innovative instruments, energy and digital technologies.



TEAM MEMBERS

+ 10 YEARS OF EXPERIENCE

in

+ 30 INTERNATIONAL PROJECTS

with

+ 60 TEAM MEMBERS

from

10 RESEARCH GROUPS

within

8 FACULTIES

RESEARCH TEAMS

*Energy Transition
Group*

*Distributed System
Research Group*

*Electromechanics
Systems Research
Group*

*Electric Mobility
Applied Research
Group*

*Termotechnics
Group*

*Lighting Electrical
Laboratory Group*

*Process and
Energy Systems
Engineering Group*

*Civil Engineering
Group*

*Renewable
Energies Research
Group*

*Environmental
Engineering Group*

MEET OUR TEAM

We are described by **the passion and the enthusiasm** for what we do, supported by our skills and held results that with each new experience we develop and harness at a personal level for the **University's and the Community's Interest**.



We prove **courage in development** by undertaking performance **in energy related fields** through applied scientific research and a permanent open eye for new opportunities that could be transposed in scientific knowledge or feasible and efficient solutions for the industry.



AREA OF EXPERTISE

AREAS of EXPERTISE

Research center expertise and activities are concentrated on **multidisciplinary research** through the joint effort of several research groups

*Energy Efficiency
in Buildings &
Industry*

RES Integration

Smart Grid

*Energy Islands &
Communities*

Energy Storage

*Power flow
Optimisation*

nZEB adoption

Electric mobility

Waste to Energy

*Energy Culture
and Consumer
Behaviour*

*Energy Analytics
& Numerical
Tools*

*Energy Profiling
and Forecasting*

*IOT and
Blockchain
technology*

*Big Data
Analytics*

*Cognitive and
Artificial
Intelligence*

*Electromagnetic
Fields*

*Electromagnetic
Compatibility*





Project Title: hOListic Green Airport (OLGA)

Time: 60 months (1st of October 2021 – 1st October 2026)

Project value: 24.991.644 Euro

Project Link: <https://www.olga-project.eu/>



Project Title: Renewable Energy-based Positive Homes (RENplushOMES)

Time: 2023-2026

Project value: 5 999 983 EUR

Project Link: <https://renplushomes.eu/>



Project Title: Smart Grid-Efficient Interactive Buildings (EVELIXIA)

Time: 2023-2027

Project value: 10 320 789 EUR

Project Link: <https://www.evelixia-project.eu/>



Project Title: EnTRAINER - Energy Transition Audits Towards Decarbonization

Time: 36 months (December 2022 – November 2025)

Project value: 1,842,112 EUR

Project Link: <https://entrainer-project.eu/>



Project Title: Sun coupled innovative Heat pumps

Time: 60 months (1st October 2018 – 30th September 2023)

Project value: 11.604.927 EURO

Project Link: <https://sunhorizon-project.eu/>





Project Title: Meeting the energy professionals' skills (MEnS)

Time: 36 months (1st of March 2015 – 31st of August 2017)

Project value: 1.478.160 euro

Project Link: <https://cordis.europa.eu/project/id/649773>



DR-BOB

Project Title: Demand Response in Block of Buildings (DR-BOB)

Time: 36 months (1st of March 2016 – 31st of August 2019)

Project value: 5.136.769 euro

Project Link: <https://cordis.europa.eu/project/id/696114>



Project title: REnewableCOGeneration and storage techNologiesIntegraTion for energy autONomous buildings (RE-COGNITION)

Time: 36 months (1st of April 2019 – 30 of March 2022)

Project value: 4.990.000 €

Project Link: <https://re-cognition-project.eu/>



Project title: A holistic framework for Empowering SME's capacity to increase their energy efficiency, (SMEmpower Efficiency)

Time: 36 months (1st of April 2019 – 30 of March 2022)

Project value: 1.990.000 €

Project Link: <https://smempower.com/>



Project Title: Generate Energy efficient Acting and Results at Small & medium enterprises (Gear@SME)

Time: 30 months (1st of September 2020 – 28th of February 2023)

Project value: 1 993 227 €

Project Link: <https://www.gearatsme.eu/>



Project Title: NetZeroCities Cluj-Napoca - 2023 – 2024 National Competence Centre and solutions for the development of Climate Neutral and Smart Cities

Time: 48 months (2023-2027)

Project value: 500.000 EURO

Cod SMIS: 156386



Project Title: Design and development of an Energy Efficiency Management and Control System with cost-effective solutions for residential and educational buildings

Time: 20 months (May 2022 – December 2023)

Project Link: <https://eeagrants.org/archive/2014-2021/projects/RO-ENERGY-0067>

Project Title: GREENER - 2023 – 2024

Supporting increased knowledge on renewable energy and energy efficiency in Alba Iulia

Time: 12 months (2023-2024)

Project value: 210.196 EUR



Project Title: ENERGEIA - 2023 – 2024

Empowering Energy Efficiency Awareness through a Holistic Educational Approach

Time: 12 months (2023-2024)

Project value: 199,987 EURO

Project Link: <https://www.linkedin.com/company/energeia-project-2023/about/>



Project Title: Positive EneRgy diStrictS driven by ciTizens

Time: 29 months (March 2024 - December 2026)

Project value: 195.960 EUR

Project Link: <https://entrec.utcluj.ro/positive-energy-districts-driven-by-citizens/>



Project Title: Fostering the implementation of shallow geothermal hybrid heating and cooling systems in the Danube Region – GeoHeCo

Time: 29 months (January 2024 – June 2026)

Project value: 2.481.000 EUR

Project Link: <https://entrec.utcluj.ro/danube-geoheco/>



Project Title: Building local partnerships for reducing the fossil energy demand of district heating systems in the Danube region – Reheateast

Time: 29 months (January 2024 – June 2026)

Project value: 2.214.691 EUR

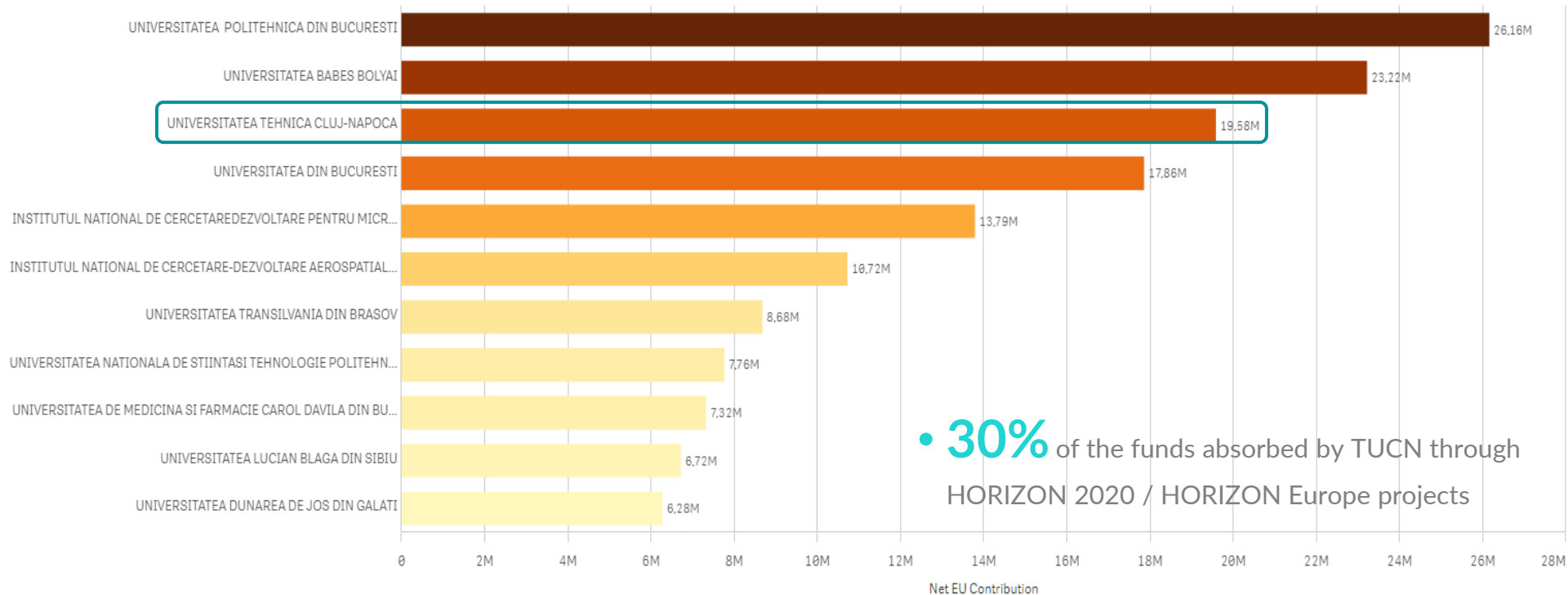
Project Link: <https://interreg-danube.eu/projects/reheateast>



TUCN IMPACT



Top organisations



• **30%** of the funds absorbed by TUCN through
HORIZON 2020 / HORIZON Europe projects

EU - PARTNERS

EU - PARTNERS



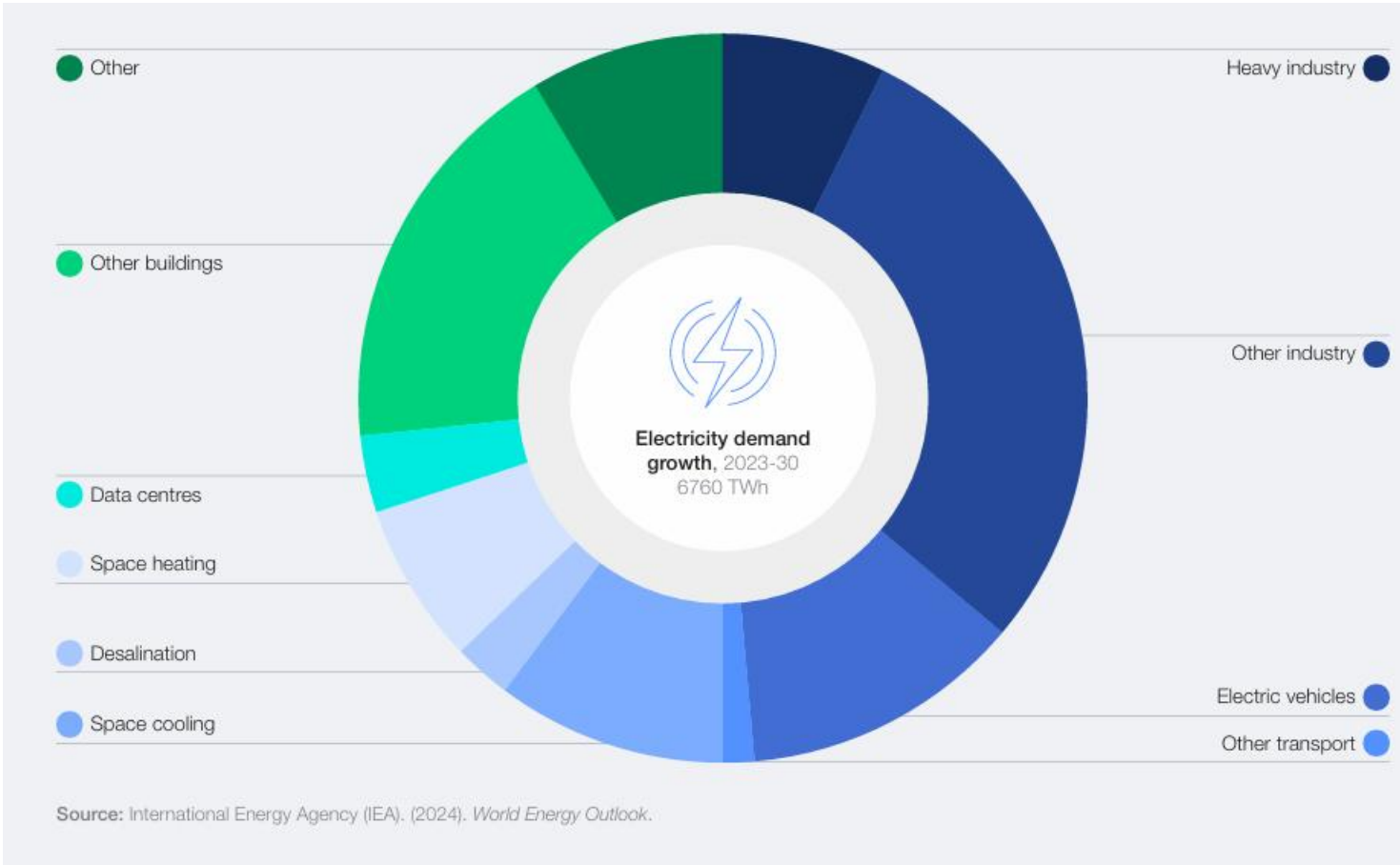
EU - PARTNERS



Artificial Intelligence in Energy and Mobility

Perspectives and Research Frontiers

Electricity demand growth by end use in the Stated Policies Scenario (STEPS) 2023-2030



Does AI represent a true technological revolution?

- AI is the most hyped and best financed economic sector of the moment
- **November 2022:** OpenAI's ChatGPT launch – the first advanced conversational assistant based on a large language model (GPT3.5) - under the promise that most human activities will be drastically improved by an upcoming boom in AI application.
- The holy grail of the race: **Artificial General Intelligence (AGI)** When? “Soon! 3-5 years away, possibly sooner!” The recently launched GPT-5 was deemed to pass the benchmark, but the reception has turned out to be rather reserved.

Source: FES Conference 2025 – Dr. Radu Dudău - invited talk

The AI race

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'Absolutely immense': the companies on the hook for the \$3tn AI building boom

Private capital joins Big Tech in seeking to capture rewards from historic expansion of data centres



Tabby Kinder in San Francisco
Published AUG 14 2025



Melissa Heikkilä and Tim Bradshaw in London and Cristina
Francisco

Published AUG 15 2025

as Nvidia maintain their investor support © FT montage/Bloomberg/Getty Images

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US tech stocks drop as AI uncertainty knocks chip groups

Marvell Technology and Nvidia shares slip after earnings disappoint investors



Wall Street's S&P 500 fell 0.6%, its biggest one-day drop since the start of August © Getty Images

George Steer and Aiden Reiter in New York and Michael Acton in San Francisco

Published AUG 29 2025 | Updated AUG 29 2025, 23:21

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X

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Finance & economics | Revolutionary road

What if the AI stockmarket blows up?

We find that the potential cost has risen alarmingly high



Saved



Share



Summary

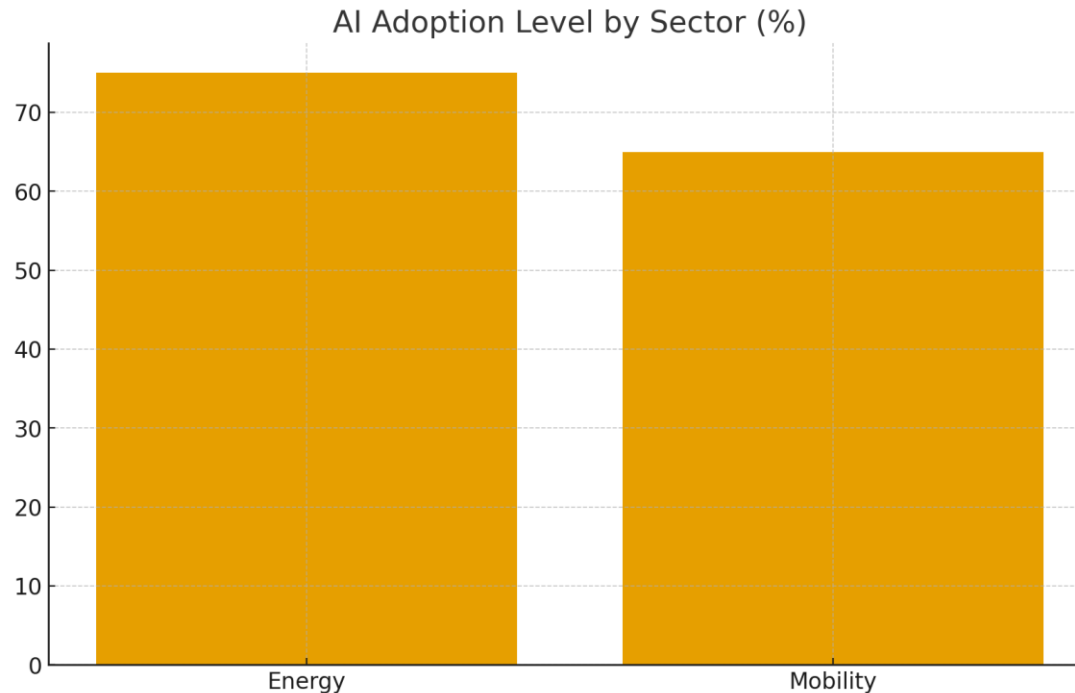
Source: FES Conference 2025 – Dr. Radu Dudău - invited talk

Sep 7th 2025 | 8 min read

- The **dominating AI narrative is powerful**: AI applications in the military are growing (to the point of redefining military might), as well as uses in industry, medicine (pharma), etc.

- How **economically productive** has the AI industry proven to be so far?
 - Microsoft, Alphabet, Amazon and Meta plan to spend more than \$300bn in 2025.
 - Gartner: up to \$475bn will be invested in AI DCs this year – up 42% on 2024.
 - McKinsey: \$5.2tn of investment in data centres would be required by 2030.

- AI as a catalyst for the digital and green transition
- Accelerates efficiency, flexibility, and sustainability
- Key focus: predictive intelligence and system optimization



A Review on AI Algorithms for Energy Management in E-Mobility Services

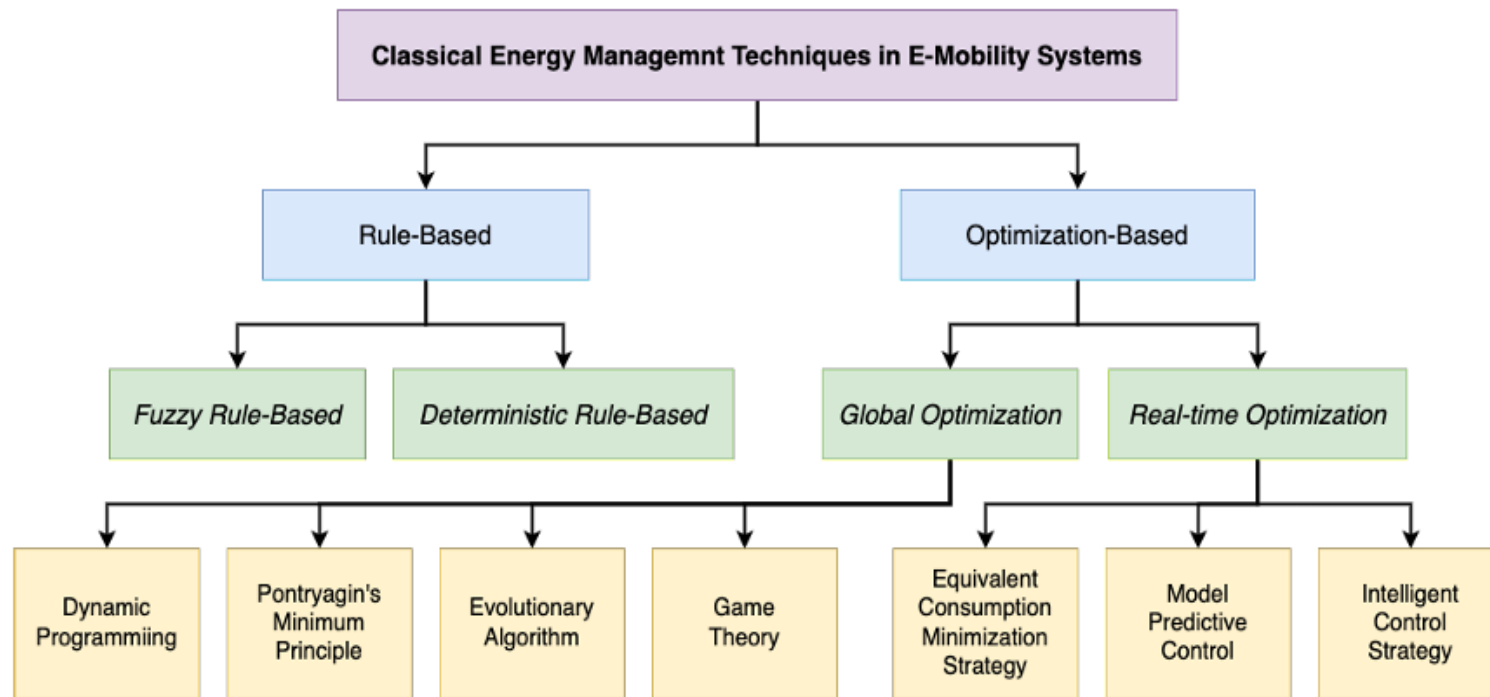
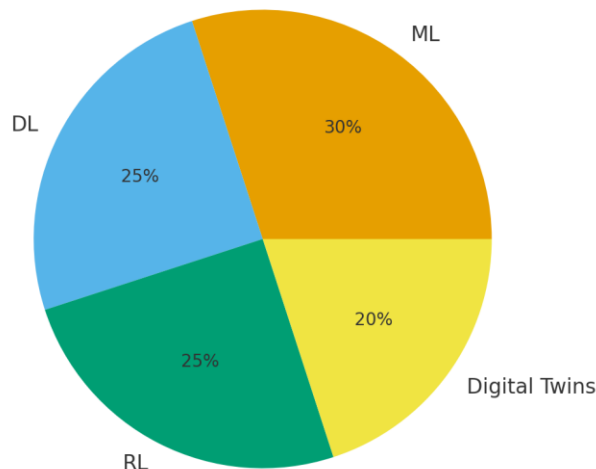


Fig. 1. Hierarchical categorization of classical EMS.

AI Paradigms

- Machine Learning – forecasting and anomaly detection
- Deep Learning – pattern recognition and vision systems
- Reinforcement Learning – adaptive decision-making
- Digital Twins – simulation and optimization tools

AI Techniques in Energy & Mobility Research



The current AI growth model: Large Language Model scaling

The LLM scaling law: *The bigger the model and the more data it sees, the better it performs – up to a point.*

Three factors

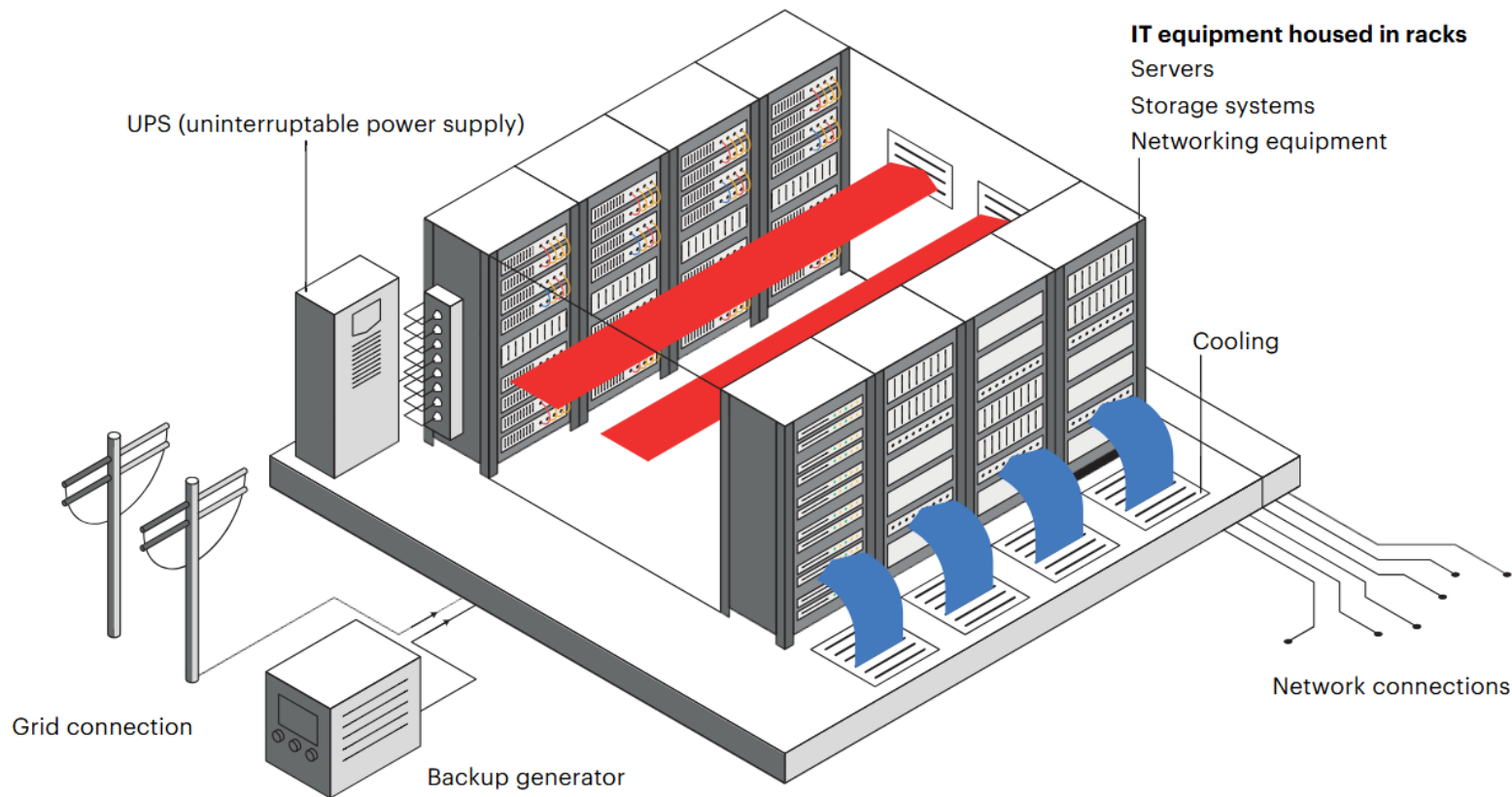
- Number of parameters (trainable weights) - model size
- Total computational resources (size of the AI data center) used for training
- Amount of training data

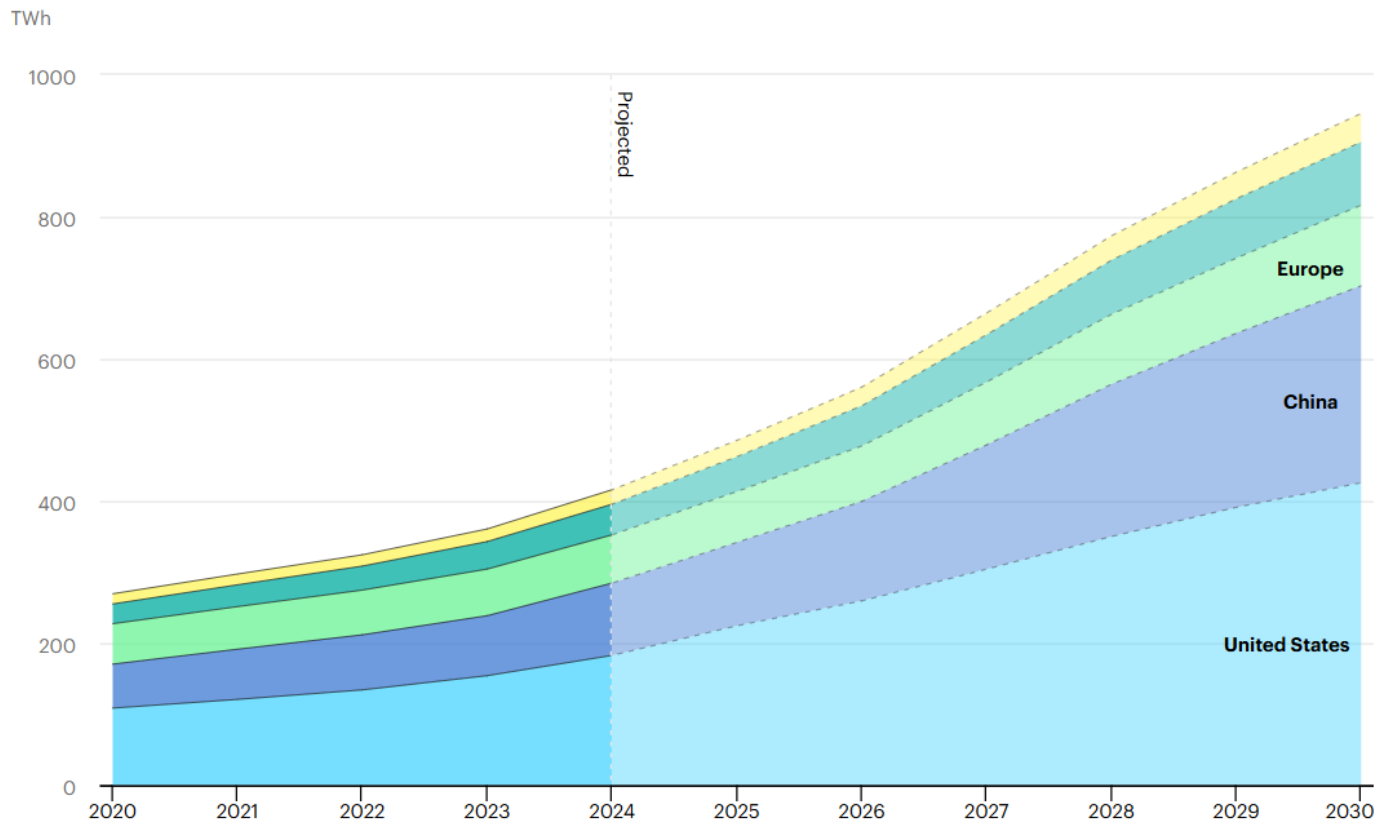
AI Data Centers energy demand

For lack of public data, estimates for the amount of power DCs use vary widely.

- IEA (2025): energy usage is likely to climb from 415 TWh in 2024 to about **1,000 TWh by 2030** and **1,300 TWh in 2035**. New AI DCs will have to use whatever energy so supply is available.
- AI DCs contain **servers** equipped with CPUs and GPUs (ca. 60% of electricity consumption), **storage** systems (ca. 5% of consumption); **networking** equipment (i.e. switches, routers, load balancers – about 5%); **cooling and environmental control** equipment, regulating temperature and humidity – from 7 to 30% of electricity demand – according to IEA data. **Uninterruptible power systems (UPS)**, batteries and back up generators are meant to keep the DC supplied during power outages.
- Racks of computers running Nvidia's GPUs consume **at least 10x as much power as regular web servers**, and give off so much heat that AC is not enough to cool them. While traditional DCs allocate 5-10 kW per rack, at present they support racks that consume 120-150 kW.

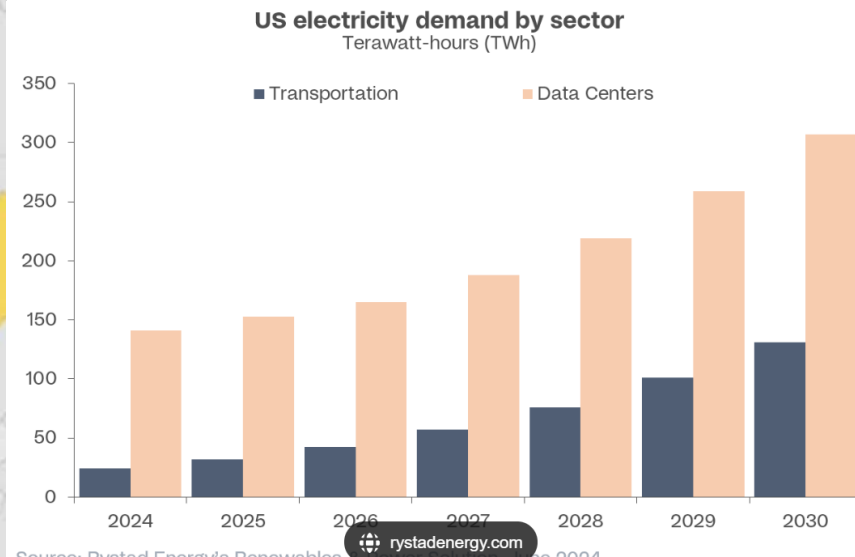
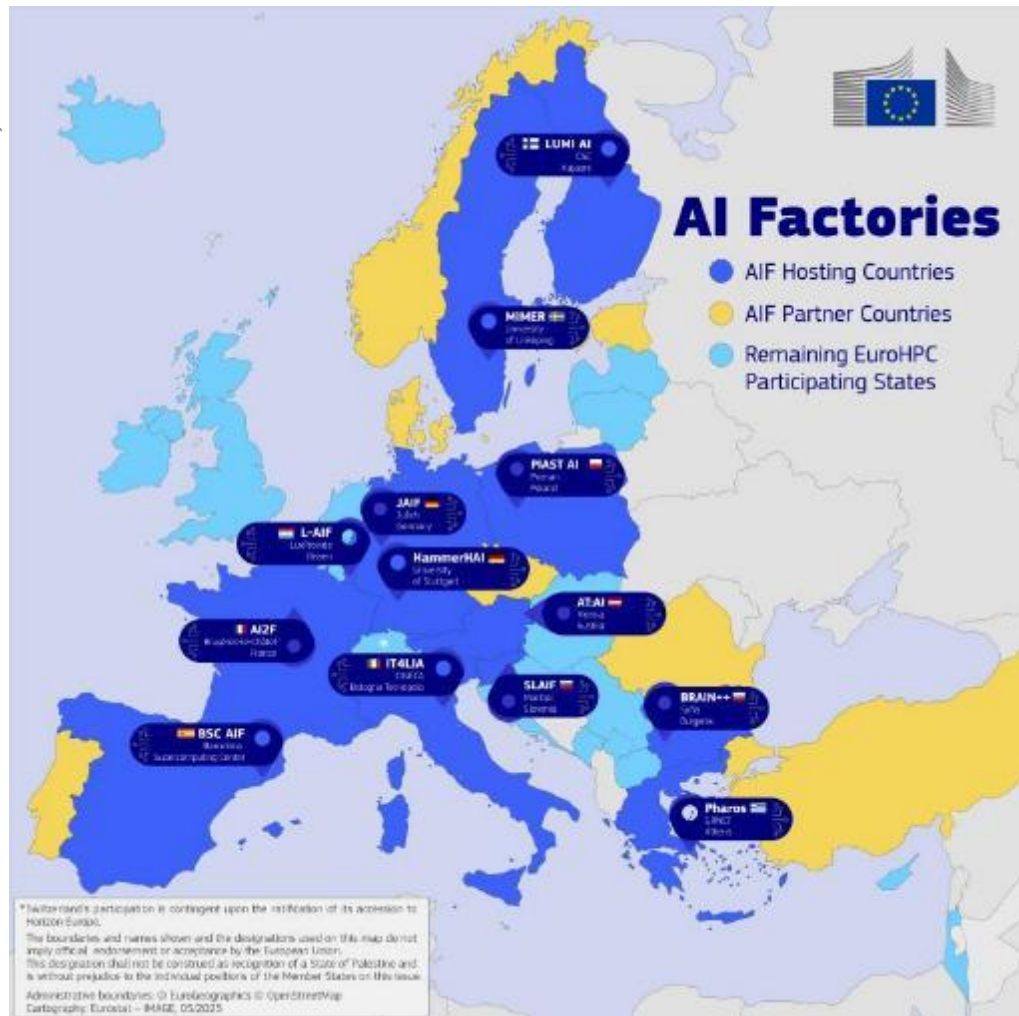
Source: FES Conference 2025 – Dr. Radu Dudău - invited talk





Data center electricity consumption by region, Base Case, 2020-2030

IEA. Licence: CC BY 4.0



Key Applications of AI in Energy



- **Modernizing the Energy Grid:** AI is crucial for improving the reliability and efficiency of the aging energy grid. It helps in predictive maintenance, load forecasting, and managing the integration of renewable energy sources. AI-powered tools can anticipate disruptions caused by extreme weather or cyber threats, ensuring a stable power supply.
- **Enhancing Energy Efficiency:** AI technologies are being used to optimize energy consumption in buildings, transportation, and industrial processes. For instance, AI-driven control systems can adjust energy use in real-time, significantly reducing waste and costs.
- **Accelerating Energy Innovation:** AI accelerates the development of new energy technologies, such as advanced solar panels and next-generation batteries. It aids in material discovery, optimizing manufacturing processes, and reducing the time and costs associated with bringing new technologies to market.
- **Optimizing Renewable Energy Production:** AI is instrumental in maximizing the efficiency of renewable energy sources. It analyzes complex datasets, such as weather patterns and energy prices, to determine optimal locations for renewable installations and improve operational efficiency.
- **Reducing Carbon Emissions:** AI applications in clean energy can lead to significant reductions in carbon emissions. For example, AI can optimize factory processes, leading to energy savings of up to 50% compared to traditional methods.
- **Improving Safety and Monitoring:** In sectors like nuclear energy, AI enhances safety by monitoring plant operations and predicting maintenance needs, thus reducing human error and improving overall safety.

Challenges and Future Directions

Boston Consulting Group

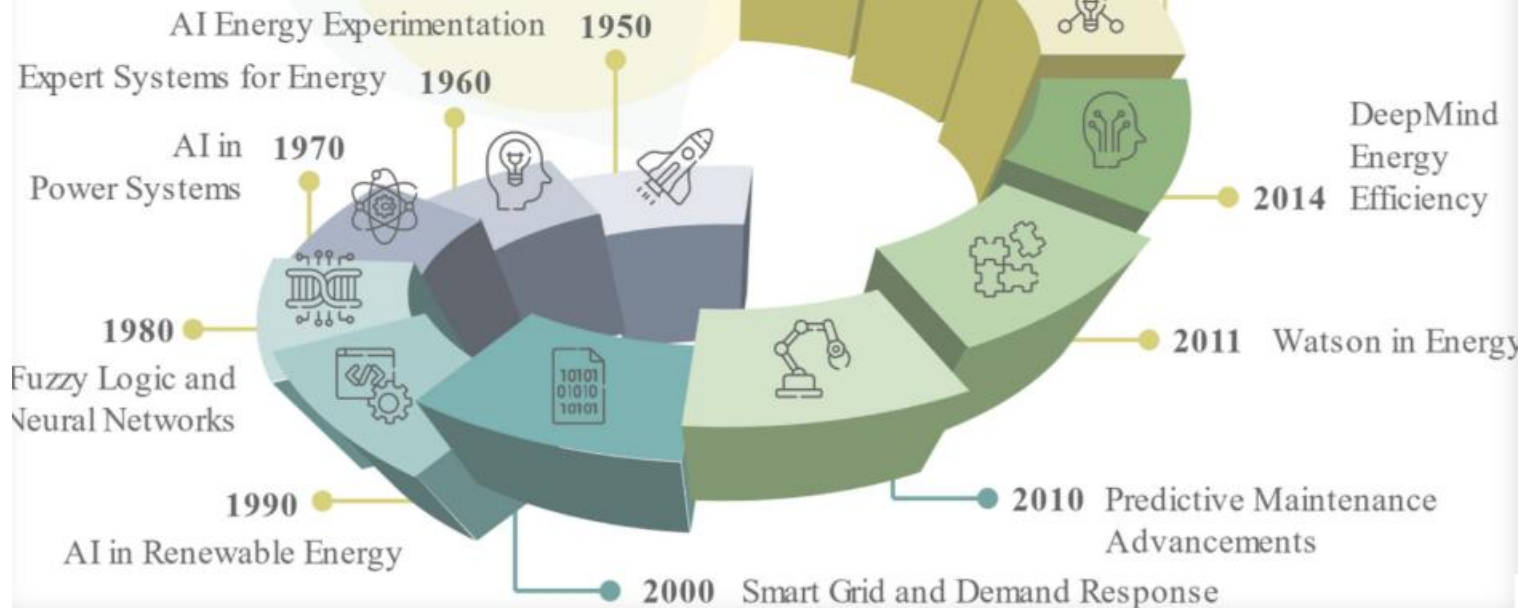
- Despite the potential of AI in the energy sector, many companies face challenges in implementation. A survey indicated that while many energy leaders expect quick results from AI, a significant number are dissatisfied with their progress.
 - This highlights the need for strategic planning and investment in AI technologies to realize their full potential.

Yale University

- As AI continues to evolve, its integration into energy systems will be crucial for achieving sustainability goals and meeting the growing global energy demand. The focus will be on creating value through AI applications that enhance operational efficiency, reduce costs, and support the transition to a cleaner energy future.
- In summary, AI is not just a tool but a necessity for transforming the energy sector, driving innovation, and ensuring a sustainable energy future.



**1957 to 1974
Flourished
Period**



Key Applications of AI in Mobility

AI is **revolutionizing mobility** by transforming transportation in several key areas:

- **Autonomous Vehicles:** AI enables cars to operate without human intervention, using sensors and machine learning to analyze environments and make real-time decisions.
- **Traffic Management:** AI technologies help optimize traffic flows and improve the efficiency of transportation systems, addressing long-standing challenges in mobility.
- **Data Utilization:** AI algorithms leverage large datasets generated by sensors and communication devices to enhance transportation effectiveness and efficiency across various modes, including rail and aviation.
- **Competitive Advantage:** Machine learning is becoming a foundational technology in automotive and mobility sectors, providing significant competitive advantages for companies that effectively implement it.

Overall, AI is set to **play a crucial role in shaping the future of mobility**, making it more efficient and responsive to user needs.

AI in Energy Systems

- Predictive maintenance and load forecasting
- Renewable integration and grid optimization
- Smart grids and autonomous control

AI in Mobility Systems

- Intelligent transport and connected vehicles
- Traffic prediction and fleet management
- AI for EV battery and charging optimization

Cross-Sector Synergies

- Vehicle-to-grid (V2G) integration using AI agents
- Coupled energy–mobility digital twins
- Shared data infrastructures and optimization layers

Drivers of AI Adoption

- Decarbonization – lower emissions and fossil fuel use
- Decentralization – microgrids and distributed energy resources
- Digitalization – IoT, data, and automation

Challenges and Ethical Aspects

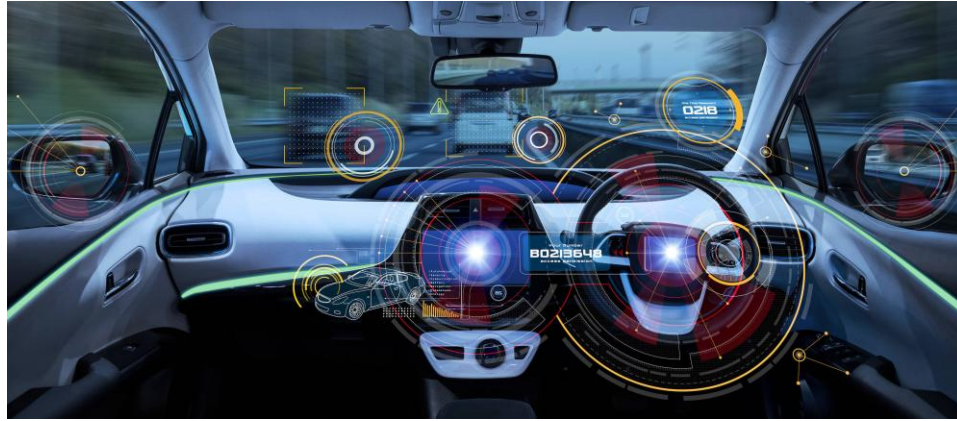
- Data interoperability and security
- Transparency and bias mitigation
- Regulation and accountability for AI systems

Research Directions and Opportunities

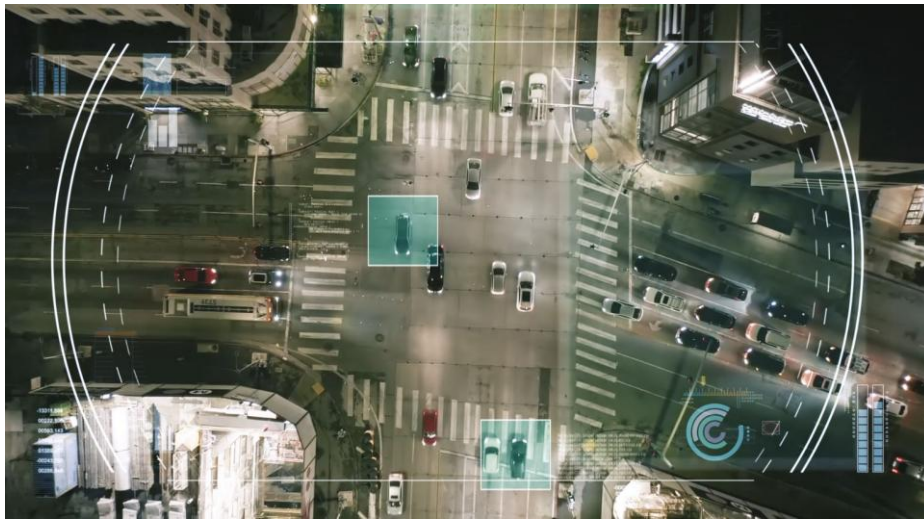
- Multimodal data fusion across sectors
- Edge AI and federated learning
- Sustainable, low-carbon AI models

Conclusions

- AI is central to energy and mobility transformations
- Synergistic integration fosters decarbonization and resilience
- Research must address ethics, interoperability, and sustainability



AI in Transportation: Revolutionizing Mobility



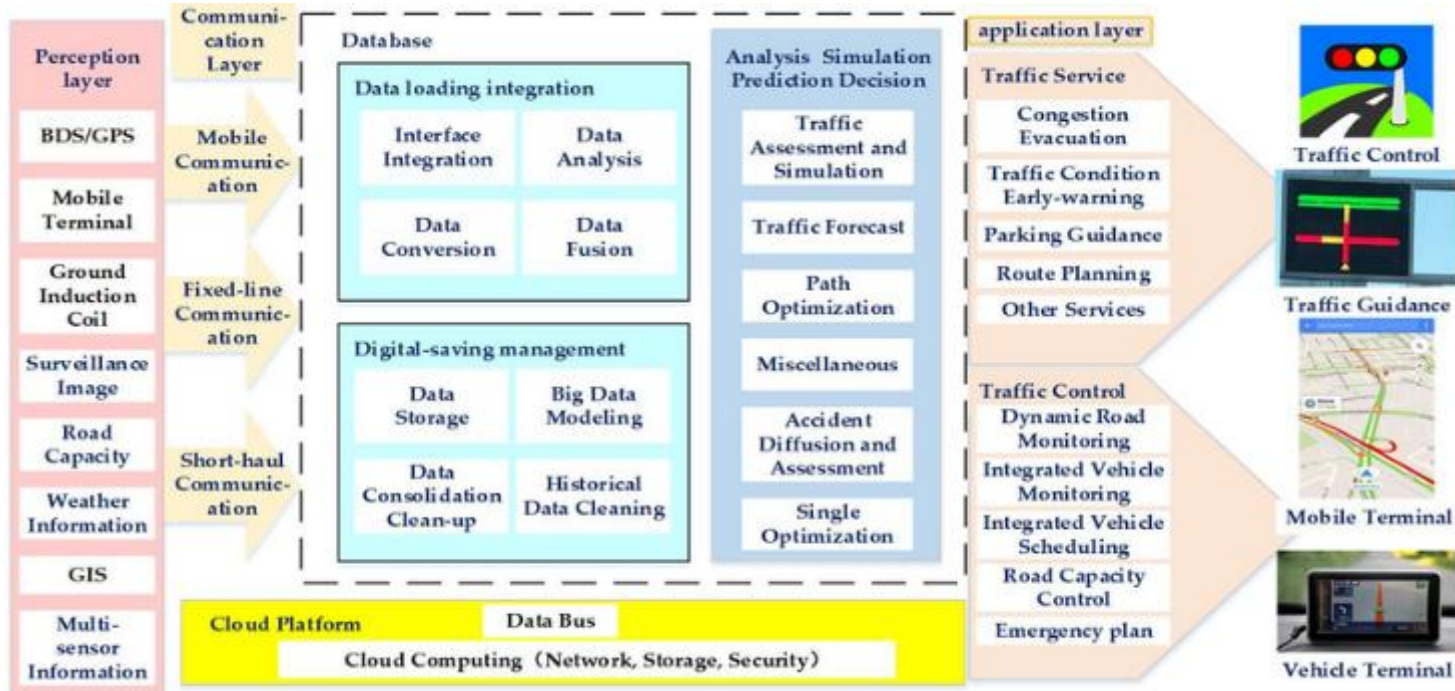
Case Study:

Waymo's Autonomous Fleet: Waymo, a subsidiary of Alphabet Inc., operates a fleet of fully autonomous vehicles in Phoenix, Arizona. These vehicles have logged millions of miles, demonstrating the potential of AI in reducing traffic accidents and improving urban mobility. The data collected from these journeys is used to improve the AI's decision-making capabilities, making the vehicles safer and more efficient over time.

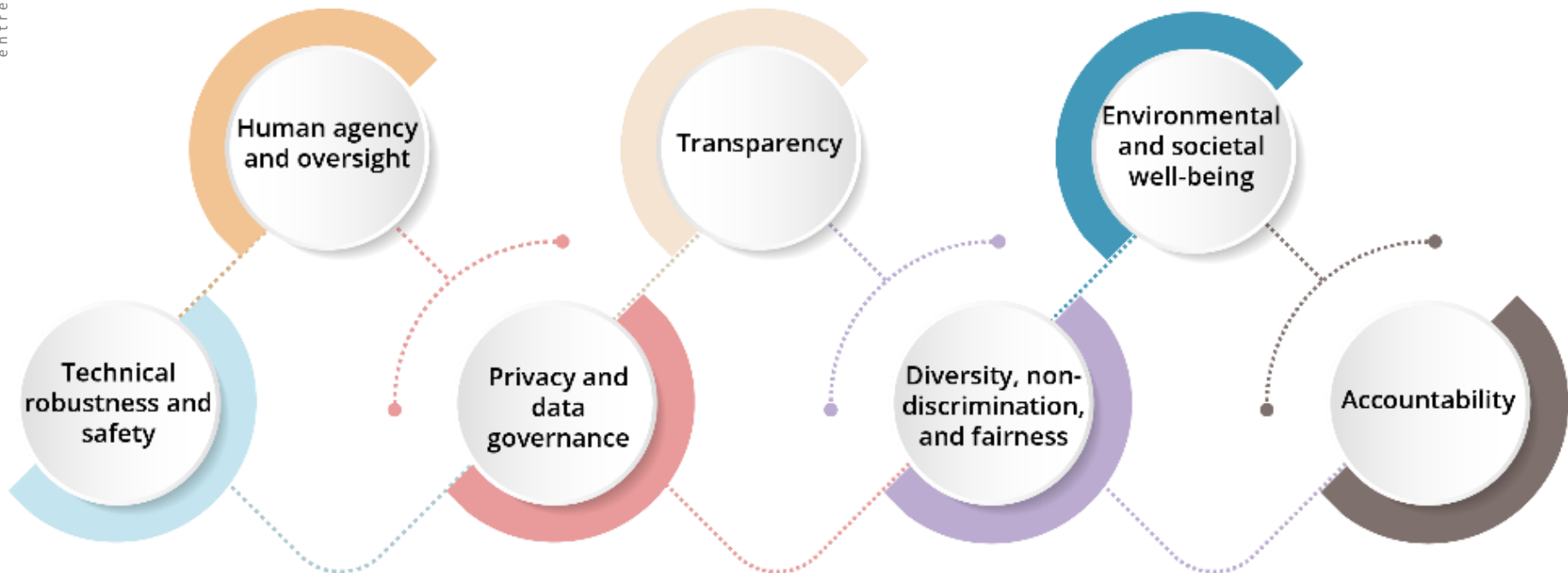


Case Study:

Singapore's Intelligent Transport System (ITS): Singapore's ITS uses AI to manage traffic in real time. The system analyzes data from traffic cameras and sensors to optimize traffic flow, reduce congestion, and enhance road safety. The AI can predict traffic patterns and adjust traffic signals accordingly, improving overall efficiency and reducing travel times for commuters.



Case Study: Ethical AI in Transportation



Deep Dive:

- **Machine Learning Algorithms:** Machine learning algorithms process vast amounts of sensor data to enable real-time decision-making in autonomous vehicles.
- **Sensor Fusion:** Autonomous vehicles rely on sensor fusion technology, which combines data from LiDAR, radar, and cameras, to create a comprehensive understanding of the vehicle's surroundings.
- **Computer Vision:** AI-driven computer vision systems analyze video feeds from traffic cameras to detect incidents and monitor traffic conditions.
- **Predictive Maintenance:** AI predicts maintenance needs for road infrastructure and public transportation systems, preventing breakdowns and ensuring safety.

Global Perspective

- **AI in transportation** is transforming mobility practices globally.
- Initiatives like AI-driven public transit projects aim to provide accessible and efficient transportation solutions to underserved populations, bridging mobility gaps worldwide.
- These projects demonstrate the potential of AI to improve transportation equity and sustainability.

First
TUCN Start-up

Renergia

Save energy
like no one else!



Forbes

decembrie 6, 2023, 1:28PM GMT+0200

Renergia, aplicația autohtonă care eficientizează consumul de energie, lansată la summit-ul COP28.

Startup-ul a atras deja o investiție de peste 300.000 de euro



84

INOVATIE DE PRODUS

Renergia - prima aplicație de sustenabilitate lansată în România, care eficientizează consumul de energie și reduce costurile factorilor la energie

Renergia este prima aplicație de sustenabilitate lansată în România, care eficientizează consumul de energie și reduce costurile factorilor la energie.

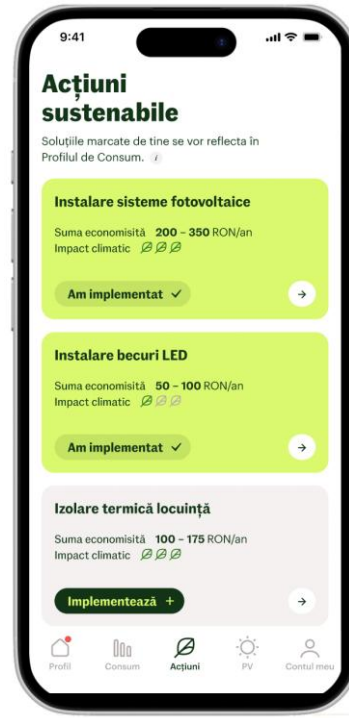
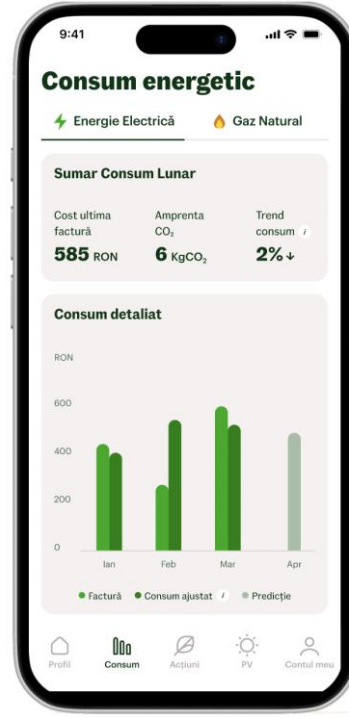
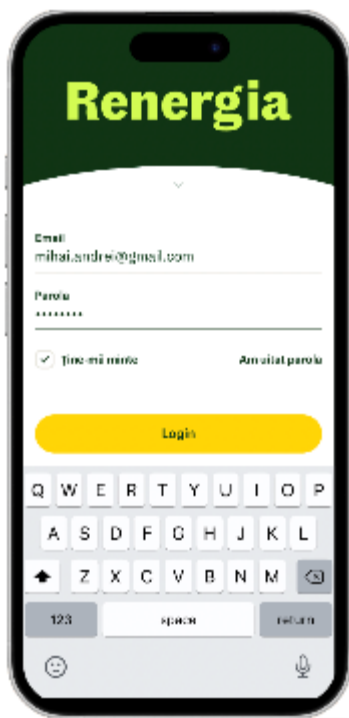
DESCRIEREA INOVATIEI:

Aplicația de monitorizare Renergia analizează consumul de energie la gospodărie și comercial și generează o estimare a costurilor lunare și anuale aferente și oferă date despre potențialul de economisire la energia electrică și termică. Analiza realizată de Renergia are la bază un algoritmi inovativ, ce îmbină conceptul de statistică și probabilitate cu algoritmi avansați, analiza de inteligență artificială.

Algoritmii propun Renergia o serie de recomandări pentru a reduce și să optimizeze costurile de energie și să reducă emisiile de carbon.

constituind astfel un instrument de măsură a impactului de mediu și a eficienței energetice. Renergia este o soluție inovativă care contribuie la reducerea emisiilor de carbon și la creșterea eficienței energetice.





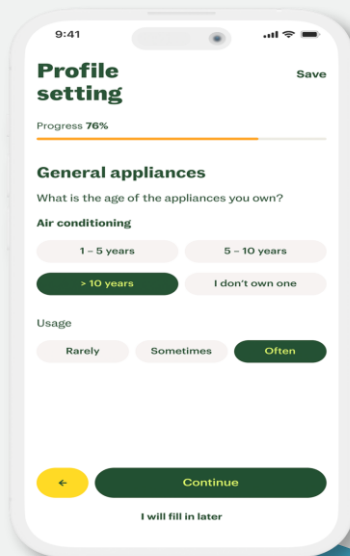
Google Play



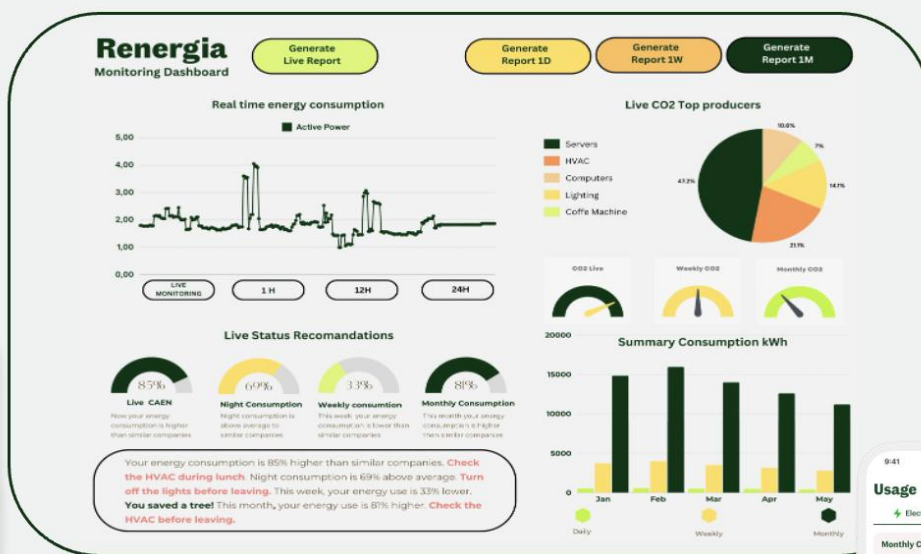
App Store



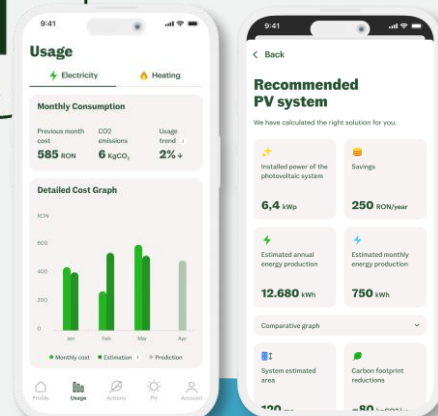
OUR PORTOFOLIO



**RENERGIA MOBILE APP
API INTEGRATION**



RENERGIA BOX REAL TIME MONITORING AUDIT

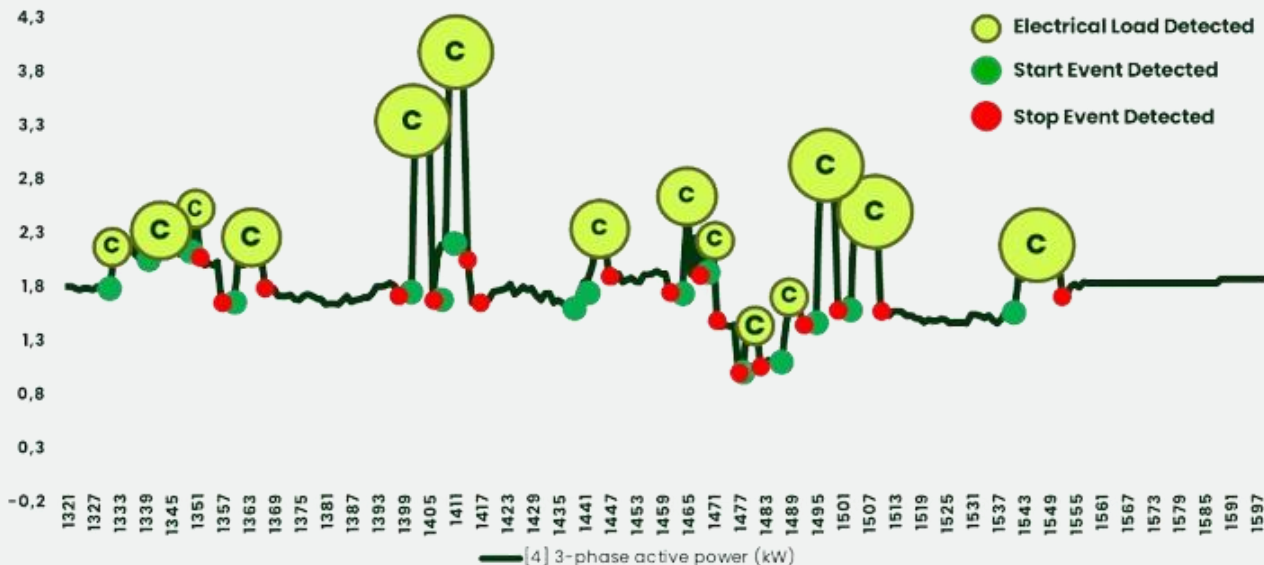


**RENERGIA MOBILE APP
ONE STOP SHOP**

Load Disaggregation Live Energy Audits

- Improved Customer Engagement

Personalized Feedback



- Enhanced Energy Efficiency

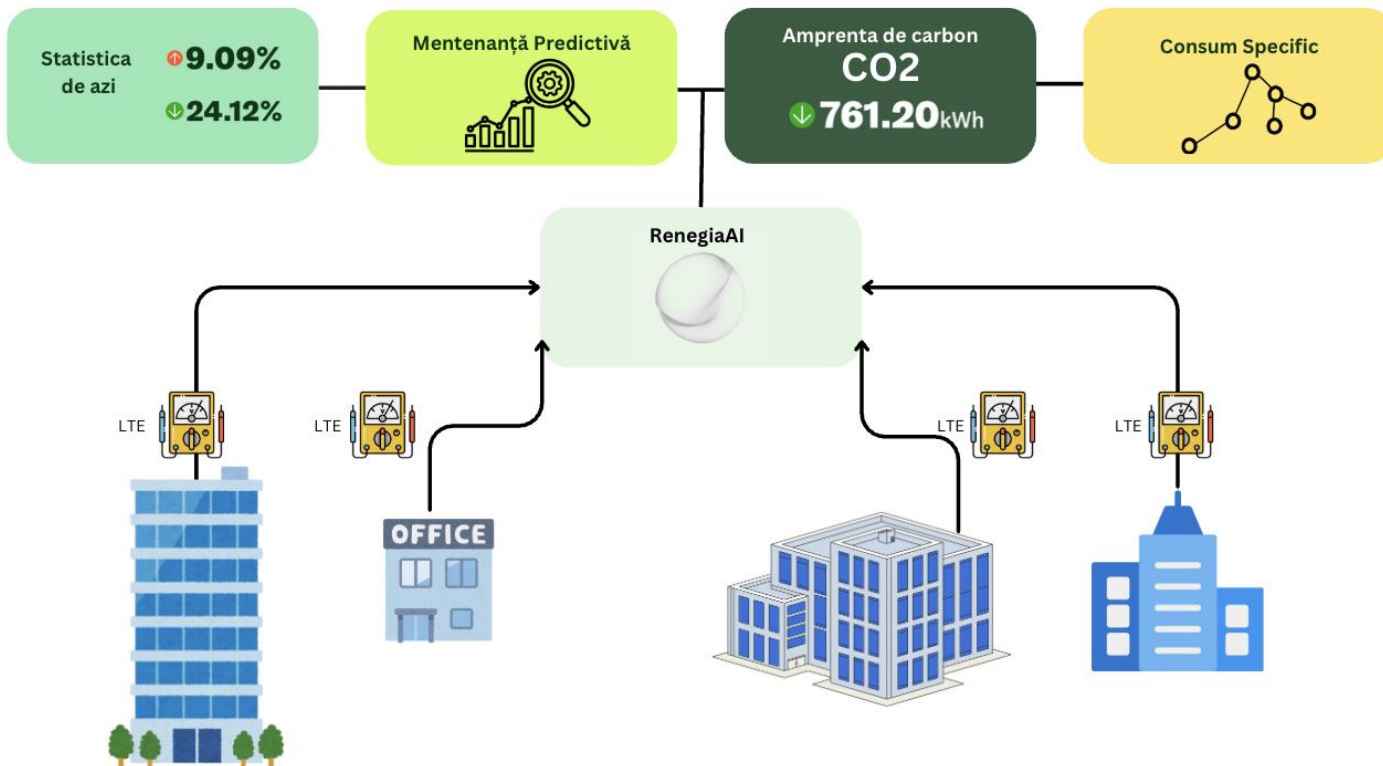
Automated Monthly Energy Audits

- ESG reporting
- CO2 Footprint Scope 2

What you cannot measure, you cannot improve

RENERGIA MONITORING PLATFORM

Renergia



Renergia

Save energy like no one else!

Google Play



App Store





AWARDS

Best European Energy Service Project - 2019

granted to Technical University of Cluj-Napoca & Cluj-Napoca City Municipality
by EU Commission in Brussels



Romanian Energy Award - 2015

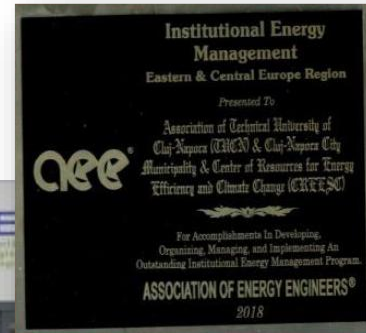


Gala Premiilor de Excelență în Energi
Romanian Energy Awards 2015



Institutional Energy Management Award - 2018

granted to Technical University of Cluj-Napoca & Cluj-Napoca City Municipality
by Association of Energy Engineers (AEE) - USA





Young Energy Trailblazer - Timea Farkas, European Sustainable Energy Week - 2022



Excellence prize and Pro Invent Medal – Young team EnTReC - 2023

Best Newcomer – 2024 Central European Startup Awards



Renergia

RENERGIA

10TH EDITION CENTRAL EUROPEAN WINNER OF
BEST NEWCOMER

Industry-University Collaboration Initiative Of The Year - 2025 ELECTRICA+RENERGIA+UTCN



Secure, clean and efficient energy

Alliance to save energy

Carbon reduction commitment EU 2030

Engineering sustainability

Building future

Adding value to energy

Behavioral energy efficiency

Living building lab

Inspiring success

Research recognized as world leading

Research 2 Market

Holistic approach

Sustainable building environment

Adress grand societal challanges

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