4TU. Energy

Powering Impact

4TU.Energy Impact Review 2022-2026 and Looking Ahead

TU Delft Delft University of Technology

TU/e Eindhoven University of Technology

University of Twente.

Wageningen University & Research

4TU.

Contents
Powering Impact 2022-2026

Photo cover: shutterstock

What We Built Together

This document reflects on how 4TU.Energy has evolved between 2022 and 2026. Guided by our mission "Accelerating the energy transition through connecting and strengthening research and education" and our specific 4C goals Connect, Collaborate, Coordinate, Create, we deliver impact in four themes:

From Ideas to Large-Scale Consortia

We provide a centralised support for collaborative energy research across the four TUs. Through targeted seed funding, we lowered the threshold for inter-university collaboration and accelerated the formation of competitive research consortia. This approach proved highly effective: seed-supported networks contributed to the successful €16.5 million NWO-LSRI grant for the UTOPYS consortium. By enabling early-stage alignment and consortium building, 4TU.Energy strengthened the Dutch position in large-scale European energy research.

From Expertise to a Connected Energy Ecosystem

We connect and leverage the expertise in the field of energy in the Netherlands by strengthening connections with external partners. By partnering with initiatives such as the GroenvermogenNL Ideation Lab, we help translate academic knowledge into societal and market-oriented trajectories. Rather than operating as isolated institutions, the four TUs increasingly act as an energy knowledge ecosystem - amplifying visibility, strengthening valorisation pathways, and reinforcing the Netherlands' competitiveness in energy innovation.

From Individual Researchers to a Visible, Vibrant Community

We create the environment where energy researchers are connected and provided with opportunities to foster collaboration. Our recurring flagship events - the annual Community Day and the 2-day PhD Course have become breeding grounds for new collaborations, funding applications and thematic alignment.
In parallel, our growing online presence, including the "Meet Our Energizer" series, has strengthened community identity and increased visibility.

From Education to Coordinated Energy Talent Development

We play the coordination role for energy education programmes within the four TUs, developing opportunities for tomorrow's engineer. Through initiatives such as the 4TU.Responsible Sustainability Challenge and support for the MSc Sustainable Energy Technology programme, we foster interdisciplinary learning environments that bridge technology, systems thinking and societal impact. The development of the 4TU.Energy Research Map and Curriculum Overview further strengthens transparency and accessibility, providing students, educators and external stakeholders with a structured overview of 4TU energy expertise, enabling more strategic collaboration and talent development.

In this document, we also take the opportunity to highlight energetic researchers, our boards, and collaborative teams, whose contributions have been instrumental in our achievements. To conclude, we outline our renewed strategy for 2027–2030, building on the foundation laid during this period.

4TU.RSC

4TU.Responsible Sustainability Challenge 2022-2025

TUDelft
TU/e
UNIVERSITY OF TWENTE.
WAGENINGEN
4TU.

Collaborate
Coordinate
Create
Connect

4C GOALS

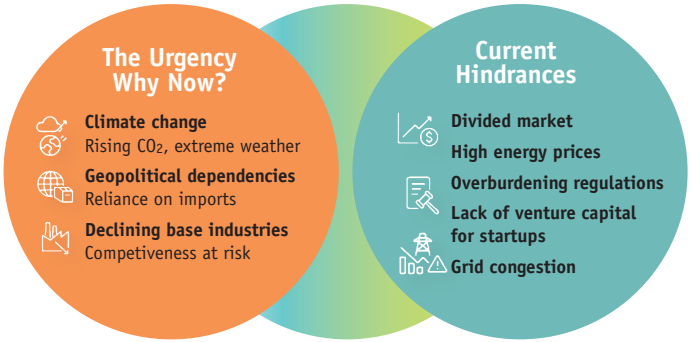
Future of Energy
Business Course

4TU.Energy
calls for funding
A collaboration across Dutch universities
For Rapid Research & Community Buildir

GroenvermogenNL
Ideation Lab
Green Energy

"Meet our Energizers"

Towards a Carbon-Neutral Future



The urgency and current hindrances of the energy transition

The EU faces a widening competitiveness gap in energy, threatening industrial resilience and climate goals. Structural challenges, such as price volatility, fragmented markets, infrastructure bottlenecks, and regulatory barriers, demand a comprehensive response.

While the Draghi report (2024) analyses the scale of this issue and prioritises actions, 4TU.Energy focuses on practical ways to decarbonise energy sources. Research areas encompass storage of resources, such as hydrogen, CO2 and natural gas, and decarbonising industrial processes with the long-term aim of transitioning to green gases or electrification.

For electricity, investments in grid upgrades and standardised components are essential. Flexibility through demand response, storage and locational pricing will reduce costs and curtailment.

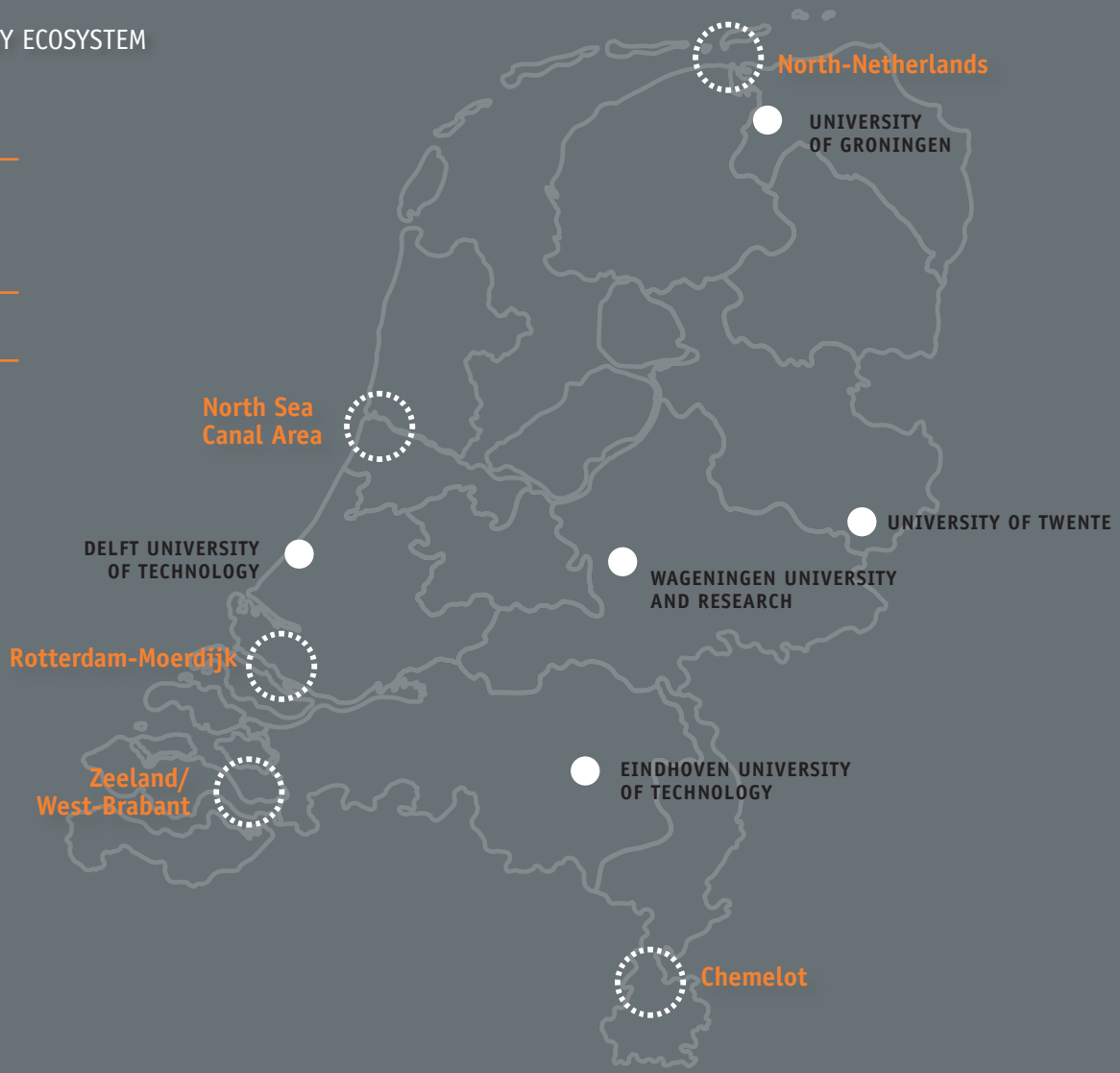
Innovation is pivotal to regaining competitiveness and reaching carbon neutrality. The Draghi report recommends prioritising action in the research and development of batteries, hydrogen, AI-driven grids and fusion, supported by robust data governance and cybersecurity measures. Social equity is equally important, and targeted support for households and Small and Medium-sized Enterprises (SMEs) is needed to mitigate the risk of energy poverty and ensure energy access.

4TU.Energy focuses on innovation and competitiveness through research and education, and on creating critical mass within the energy ecosystem to accelerate the energy transition.

4TU.Energy's contribution on driving Europe's competitiveness

4TU.ENERGY'S NATIONAL ENERGY ECOSYSTEM AND COLLABORATIVE REACH

- **4TU+**
  100+ Research Groups
  1000+ Researchers
- **6 Industry Clusters**



The national energy ecosystem comprises both academia and industry clusters.

4TU+ stands for the four TUs and the University of Groningen, totaling over 100 research groups and 1,000 researchers.

The sixth industry cluster is dispersed across the Netherlands.

Funded Projects: Driving Impact in the Energy Transition

Our seed funding programmes enabled rapid research development and community activities for 4TU staff, with each funded project involving at least two technical universities. This highly cost-effective instrument strengthened inter-university collaboration and accelerated the development of follow-up grant proposals and larger consortia.

Here are some highlights.

UTOPYS Consortium Secures €16.5 Million LSRI Grant - 2025

The Netherlands leads in developing complex, green energy systems. To sustain this position, the NWO's Large-Scale Research Infrastructure (LSRI) programme awarded €16.5 million to the UTOPYS project - *Understanding Large and cOmplex Power sYstems*, a collaboration among eight universities and SURF (national collaborative ICT organisation for education and research). 4TU.Energy and 4TU.NIRICT contributed by providing seed grants to foster inter-university partnerships, strengthening the application.

Over the next decade, UTOPYS will deliver groundbreaking insights into managing complex energy systems, benefiting urban climate, water, and transport infrastructures. This grant will enhance the safety, resilience, and security of Europe's future energy networks.

Hackathon & Workshop: Energy Transition in Buildings - 2025

As the energy transition accelerates, buildings and cities demand innovative, efficient solutions. This two-day event brought together researchers, students, industry experts, and municipal representatives to explore intelligent integration of building energy supply and demand. The 4TU.Energy Transition in Buildings event served as a collaborative platform, bridging academia, industry, and municipalities. It highlighted both the challenges and opportunities in accelerating sustainable energy solutions for buildings and neighbourhoods.

"We particularly would like to thank 4TU.Energy and 4TU.NIRICT for their joint Community Funding grant of last year which has been extremely helpful. It enabled us to bring together the eight universities and SURF to work together on this grand proposal. It brought a team of outstanding interdisciplinary researchers together to tackle the groundbreaking scientific challenges in the energy systems."

Lily Li - Managing Director, PowerWeb Institute, TU Delft

Symposium: Energy Transition in Horticulture – 2024

Horticulture – including greenhouse and vertical farming – is critical for food production but highly energy-intensive. Transitioning this sector requires collective action beyond research. To drive progress, 4TU.Energy funded a two-day symposium, uniting academia, industry, government, policymakers, and growers. The goal: joint innovation to reduce energy use and advance climate-smart horticulture.

In the appendix 'Funded Project Impact Table' a comprehensive list of funded projects is provided.

Amplifying Societal Reach Through Strategic Partnerships

We create critical mass within the energy ecosystem to accelerate the energy transition. We connect and leverage the expertise in the field of energy in the Netherlands and beyond.

The Future of Energy Business Course with Deloitte Educating the Next Generation of Energy Leaders

By combining the academic strength of the 4TU.Energy with Deloitte's expertise in business and consultancy, the Future of Energy Business course brings together 4TU Bachelor and Master students, industry trainees, researchers, and industry experts to develop future-oriented solutions for real-world energy challenges. Each autumn since 2022, there are 5 half-day workshops over a period of 5 weeks. This course offers motivated students and young professionals a unique learning environment with a business perspective on the energy transition. The course targets energy-interested 3rd-year bachelor and master students across all faculties from four technical universities (4TU) in the Netherlands (Trainees from companies across the energy sectors and students from RUG joined since 2025).

Future of Energy Business Course - 2025

Participants work in interdisciplinary teams on concrete challenges related to the energy transition, guided by facilitators from both academia (4TU.Energy researchers) and industry (Deloitte topics experts). The course attracted on average 100 applications, with 40 students enrolled annually.

Showcasing Dutch Innovation in Energy and Health Technology in Brussels

15 October 2025 - The "4TU on the Stage - Challenges in Energy and Health Technology" hosted at the Permanent Representation of the Netherlands to the EU, brought together EU policymakers, scientists, and innovation leaders to explore how Dutch universities can contribute to Europe's clean energy transition and strategic autonomy.

Representing 4TU.Energy, Harry Bitter (Wageningen University and Research) showcased how we drive impactful solutions. Zofia Lukszo (TU Delft) presented on the socio-technical challenges of the energy transition, emphasizing the need for integrated systems thinking.

Jimmy Faria-Albanese (University of Twente) discussed long-term energy storage through ammonia, while Donatella Zappalá (TU Delft) shared insights on holistic wind energy innovation. Maja Rücker (TU Eindhoven) explored materials for sustainable energy and the role of education in closing the innovation gap.


4TU on the Stage in Brussels

Tackling Grid Congestion with Dutch Distribution System Operators

The first edition of the Matching Symposium organised by 4TU.Energy and Distribution System Operators (DSO) in the Netherlands, such as Enexis Netbeheer, Alliander and Stedin, will take place on 2 June 2026 and has been in preparation since autumn 2025. During this interactive event, participants will explore shared challenges, exchange insights, and identify opportunities for collaboration across research and practice, focusing on the topics of “Grid Congestion & Infrastructure”; “Flexibility in the Energy System” and “Energy Hubs”.

The symposium aims to strengthen connections, stimulate new partnerships, and support matchmaking around ongoing and future DSO-related initiatives. We aim to develop this activity into a DSO Ideation Hub from 2027 and onward.

Innovation Sprouts at the GroenvermogenNL Ideation Lab

4TU.Energy takes part in a five-month entrepreneurial programme co-organised by the 4TU.Federation and GroenvermogenNL. This initiative brings together entrepreneurial researchers and students across universities and institutes to explore the market and societal potential of research. In December 2025, 81 students applied for the programme. Of these, 36 were selected to progress to the next stage and were given access to 14 valorisation cases under the supervision of researchers from eight institutions. There are two more editions following the current edition, running up to the year of 2028.

We expect outcomes such as a validated follow-up trajectory towards spin-out, a license or pilot, further research, or preparations for grant applications.

Building Community with Annual Flagship Events

Since 2023, our 4TU.Energy Community Day in spring and our 4TU.Energy PhD Course in autumn have been designed and organised as our flagship events. They bring together researchers, PhD candidates, teachers, and external partners from all four TUs, ensuring balanced representation and fostering active participation and meaningful collaboration.

Annual 4TU.Energy Community Day

The 4TU.Energy Community Day serves as a platform for researchers to expand their professional network and seek inspiration from their peers. Each year, the Energy Community Day addresses a specific theme.

Year	Theme	Participants	Pitches	Posters
2023	**Boost Our Collaboration**	40	20	4
2024	**Energy Landscape and Funding Opportunities**	50+	4	17
2025	**Energy & Materials Transition - One and the Same Problem?**	70+	17	25
2026	**Educating the Energy Transition: From Schools to Societal Impact**	80+		

Annual 4TU.Energy Community Day: themes and participation

The 2024 programme adopted a slightly different format, hosting 4 pitches and 3 break-out sessions with special-interest topics. The Community Day in 2025 welcomed participants from the University of Groningen, Sharif University, DIFFER and BigCircle Ventures.

On 21 May 2026, we will combine our 4TU.Energy Community Day with the 20 years' celebration of the 4TU MSc programme Sustainable Energy Technology, attracting more than 80 participants.

Over time, we observe a strong link between participation in the 4TU.Energy Community Day and applications for 4TU.Energy funding. This suggests that face-to-face meetings stimulate the development of collaborative activities and the exploration of novel research ideas.

Annual 4TU.Energy PhD Course

The annual PhD course aims to enable knowledge transfer and build the capacity of young researchers to learn from and to reflect on timely energy topics. In addition, we stimulate PhD students to analyse energy transition from the lens of other research areas and build their own peer network through the two days event. Each year, we can facilitate over 40 PhD candidates in this course.

From Pitch Training to Life-Long Communication Skills

To enhance the communication skills and research dissemination capacity of PhD candidates, we organise Pitch Training sessions led by external professionals prior to the PhD Course. Every year, approximately 30 PhD candidates divided in 3 sessions learn pitch skills and receive the personal feedback, enabling them to further develop their communication skills. The participants always evaluate these training sessions positively.

Substantiating "Sustainability, Systems and Societal aspects in Energy Transition"

Looking back at the PhD courses held so far, we can see that participants gain a broad perspective on the energy transition through the events. In evaluations, participants positively mention a variety of technical and societal topics, such as hydrogen, congestion and infrastructure. Participants also recognised the need for multidisciplinary collaboration to address the complexities of the energy transition, with many willing to recommend the course to their peers.

Lecture topics for each year's course edition are available in the appendix, as well as a full overview of organised activities in the period 2022-2026.

Meet Our Energizers!

Personal Stories Connect

Since 2023, we have featured 12 researchers and experts, each bringing a unique perspective to the energy transition. The series has not only given the science behind energy research a human touch but also demonstrated the real-world challenges and passions driving innovation.

Eli Shirazi, Assistant Professor in the Advanced Manufacturing, Sustainable Products, and Energy Systems at University of Twente: "My work aims to make our energy systems smarter and more efficient. Modern energy systems handle more diverse generation and load types with different dynamics and characteristics compared to traditional systems. In my work, I model these components to optimize the flows within the energy system."

Eli's story was published in September 2024, she went on to co-organise the first Women in PV event in Jaarbeurs Utrecht, May 2025.

Annemiek Bles, senior advisor at Enexis; she shared her story when she was the Programme Manager Energy at Brainport Development: "We just completed a feasibility study, with several companies, on a regional hydrogen network. If the large manufacturers are going to electrify their gas consumption, grid congestion will be an even bigger problem. Because many processes are not easy to electrify, like high-temperature heat on gas, we explore the possibilities of hydrogen to move towards a renewable energy source for these types of processes."

By fostering a sense of community among energy researchers, sharing their personal motivations, challenges, and achievements, we provide visibility and recognition for their work, helping them expand their networks and opportunities.

Building an Online Community

The "Meet our Energizer!" series has played a major role in growing our online presence and engaging a wider audience. Since launching our LinkedIn page in February 2023, the series has consistently drawn the highest engagement and has facilitated an online community.

In just three years, our LinkedIn community has grown from 0 to 2,346 followers (on 9 March 2026), reflecting our collaborative efforts to grow our community.

Charting Disciplines in the Field of Energy

Fostering talent: 4TU.Responsible Sustainability Challenge

The 4TU.Responsible Sustainability Challenge (4TU.RSC) was a 15 ECTS honours programme for motivated 4TU master students developed in 2021 in collaboration with other 4TU.Networks: 4TU.High-Tech Materials and 4TU.Ethics and Technology. The 4TU.RSC was designed to foster creative, transdisciplinary problem-solving in sustainable technology, focusing on energy, materials, and ethics aligning with the EU Green Deal.

Results from the students' work ranged from concrete technological solutions to analyses that drove further conversation within the companies that were involved. Challenges were offered by ProRail, KLM, Twence, Heliostrome, Quantum Energy and Engineering, Alliander-AI Lab and NMI. In total 34 students participated in the 4TU.RSC during the tracks of 2022-2025.

The programme was highly evaluated by the participants. From its beginning to final project, the organisation of the 4TU.RSC demonstrated an iterative evolution for everyone involved. Rooted in a Challenge-Based Learning approach, the programme bridged theory and real-world sustainability challenges, strengthened academia–industry interaction, and delivered a transformative educational experience with tangible societal impact. Read more details in our report *"4TU.Responsible Sustainability Challenge - An organisational perspective on a 4TU. MSc honours programme 2022-2025"*, published in September 2025 on our website.

See the concrete results on page 13.

TRACK YEAR	COMPANY	STUDENTS INVOLVED	CASE
2022-2023	KLM	5	Disposal programme of end-of-life vehicles
2022-2023	ProRail	5	Partial electrification railroads in the Netherlands
		10	
2023-2024	Heliostrome	3	Analysis of business case to develop software for solar irrigation systems
2023-2024	Quantum Energy & Engineering	5	Life cycle assessment of a clean biomass cooking stove
2023-2024	Twence	4	Integrating battery energy storage in a solar park
		12	
2024-2025	Alliander-AI Lab	2	Local energy recommendation simulation
2024-2025	Quantum Energy & Engineering	5	Development of a materials selection tool for the Brava stove
2024-2025	NMI	5	Development a sustainable assessment framework for electric vehicle charging stations
		12	

4TU.Energy's Research Map

The energy transition involves a change in the way we convert, distribute, transport, and consume energy. Therefore, the 4TU.Energy community has a broad orientation to energy. We have charted a "Research Map" depicting the many disciplines, fields, and applications that together make up the 4TU.Energy community. See page 15.

Since the first edition in March 2023, we have expanded the Research Map to include 13 main research domains and an impressive 99 sub-topics, all of which are areas of active research for energy experts who are willing to collaborate through 4TU.Energy. The full document with topics and experts list is available on our website > Research.

4TU.Energy's Curriculum Overview

The Curriculum Overview highlights the major courses on both master level and bachelor level related to energy, offered by the four TUs. Each university's curriculum has its own strengths to address various aspects of energy studies, including sustainable energy technologies and environmental impact assessment. See page 16.

Until February 2026, the 4TU.Energy Curriculum Overview has included 119 courses, among which 42 BSc major courses, 77 MSc major courses. The complete list with course details in hyperlinks is available on our website > Education.

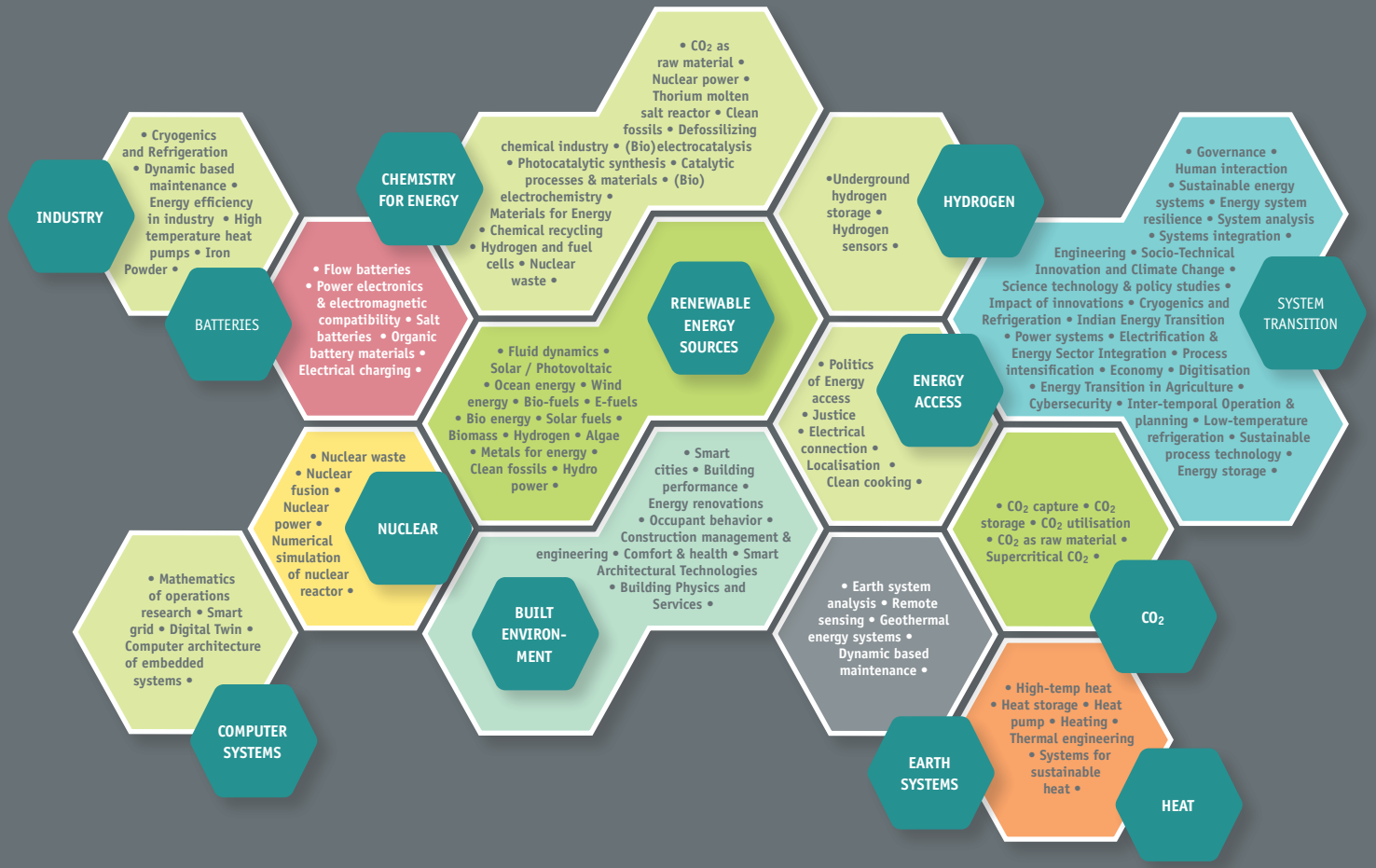
Both the Research Map and the Curriculum Overview serve as widely used entry points for researchers, students, teachers, and external stakeholders and benefit them with a comprehensive understanding of energy-related challenges and solutions. Additionally, these overviews provide the starting points for collaboration and course-settings within the 4TU context.

MSc Programme Sustainable Energy Technology 20 years in 2026

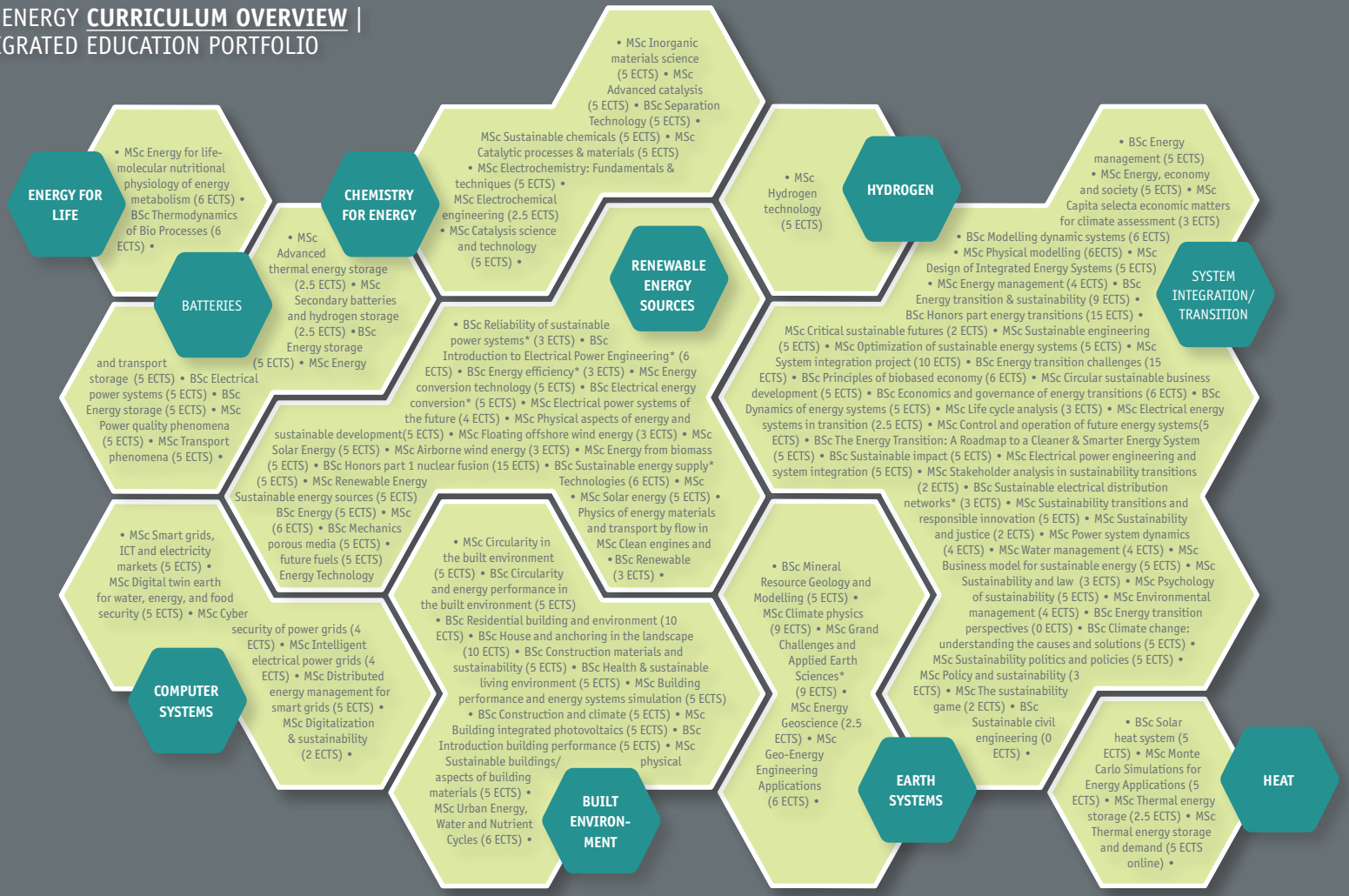
The MSc Sustainable Energy Technology (MSc SET) programmes of TU Delft, TU Eindhoven, and the University of Twente have been running for 20 years. They are proud to organise a unique joint event on 21 May 2026 bringing together students, academics, and industry leaders to celebrate the 4th lustrum of these programmes and discuss the future of sustainable energy.

"One of the Netherlands' unique strengths is the strong collaboration between Dutch universities in education and research, as evidenced by networks such as 4TU.Energy. In many countries, students do not have the opportunity to attend courses or engage in research collaborations that are supported across institutes. The 4TU.Energy Research Map and Curriculum Overview make it easy for students and researchers alike to develop their own learning and research trajectories."

Maja Rücker - Assistant Professor in the Energy Technology group within the Department of Mechanical Engineering at TU Eindhoven


INDUSTRY
• Cryogenics and Refrigeration • Dynamic based maintenance • Energy efficiency in industry • High temperature heat pumps • Iron Powder •
BATTERIES
• Flow batteries • Power electronics & electromagnetic compatibility • Salt batteries • Organic battery materials • Electrical charging •
CHEMISTRY FOR ENERGY
• CO_2 as raw material • Nuclear power • Thorium molten salt reactor • Clean fossils • Defossilizing chemical industry • (Bio)electrocatalysis • Photocatalytic synthesis • Catalytic processes & materials • (Bio) electrochemistry • Materials for Energy • Chemical recycling • Hydrogen and fuel cells • Nuclear waste •
RENEWABLE ENERGY SOURCES
• Fluid dynamics • Solar / Photovoltaic • Ocean energy • Wind energy • Bio-fuels • E-fuels • Bio energy • Solar fuels • Biomass • Hydrogen • Algae • Metals for energy • Clean fossils • Hydro power •
•Underground hydrogen storage • Hydrogen sensors •
HYDROGEN
• Governance • Human interaction • Sustainable energy systems • Energy system resilience • System analysis • Systems integration • Engineering • Socio-Technical Innovation and Climate Change • Science technology & policy studies • Impact of innovations • Cryogenics and Refrigeration • Indian Energy Transition • Power systems • Electrification & Energy Sector Integration • Process intensification • Economy • Digitisation • Energy Transition in Agriculture • Cybersecurity • Inter-temporal Operation & planning • Low-temperature refrigeration • Sustainable process technology • Energy storage •
SYSTEM TRANSITION
• Politics of Energy access • Justice • Electrical connection • Localisation • Clean cooking •
ENERGY ACCESS
• Nuclear waste • Nuclear fusion • Nuclear power • Numerical simulation of nuclear reactor •
NUCLEAR
• Smart cities • Building performance • Energy renovations • Occupant behavior • Construction management & engineering • Comfort & health • Smart Architectural Technologies • Building Physics and Services •
BUILT ENVIRON-MENT
• CO_2 capture • CO_2 storage • CO_2 utilisation • CO_2 as raw material • Supercritical CO_2 •
CO_2
• Mathematics of operations research • Smart grid • Digital Twin • Computer architecture of embedded systems •
COMPUTER SYSTEMS
• Earth system analysis • Remote sensing • Geothermal energy systems • Dynamic based maintenance •
EARTH SYSTEMS
• High-temp heat • Heat storage • Heat pump • Heating • Thermal engineering • Systems for sustainable heat •
HEAT

4TU.ENERGY **CURRICULUM OVERVIEW** | INTEGRATED EDUCATION PORTFOLIO



COMMITTED TEAMS AT 4TU.ENERGY

Our organisational structure is aimed at strengthening interuniversity collaboration. Therefore, we have four boards or teams, each member committed to drawing in expertise and partnerships to support our mission.

ROLE	NAME	AFFILIATION
Board	Fred van Keulen	TU Delft
	Mark Bentum	TU/e
	Bart Koopman	UT
	(vacancy)	WUR
Management Team	Kamel Hooman	TU Delft
	David Smeulders (Scientific Director)	TU/e
	Mina Shahi	UT
	Harry Bitter	WUR
Young board	Francesco Lombardi	TU Delft
	Maja Rücker	TU/e
	Amirhoushang (Amir) Mahmoudi	UT
	Akbar Asadi Tashvigh	WUR
Advisory board	Maaike Damen	TU Delft
	Diana van der Sloot	TU/e
	Elham (Eli) Shirazi	UT
	Annemiek ter Heijne	WUR
Coordinator	Sha Lou	TU/e
Communication advisor	Nienke D. Nijenhuis	Freelance

Outreach to the Global South Through the 4TU.Alliance on Energy Access

Additionally, through the 4TU.Alliance on Energy Access, we are scaling up our efforts to support the global energy transition, and connect with the Dutch Ministry of Foreign Affairs, private sector and NGOs.

In 2023, researchers from the four TUs established the 4TU.Alliance on Energy Access. This alliance aims to connect researchers and create a collaborative organisation embedded in 4TU.Energy. The organisation's single goal is to share knowledge and raise awareness of the urgent need for energy access in both the Global South and the Global North, thereby contributing to the energy transition.

Access to clean electricity and clean cooking methods lies at the heart of the 4TU.Alliance on Energy Access. This mission is closely linked to Sustainable Development Goal (SDG) 7. As the 2030 deadline for achieving the SDGs approaches, the Alliance's work is both urgent and strategic. This involves taking stock of the current situation. The outcome is a truly multidisciplinary approach to energy access in the Global South, incorporating input from the Dutch government via the Ministry of Foreign Affairs' NL Energy Compact, and from the Netherlands Enterprise Agency (RVO).

Involved researchers

TU Delft	Nihit Goyal, Luis Cutz
TU Eindhoven	Henny Romijn, Jonas Van der Straeten, Diego Quan Reyes
University of Twente	Jelena Popovic, Niek Moonen, Amalia Suryani, Maarten Appelman, Ilman Sulaeman
Wageningen University and Research	Nowella Anyango-van Zwieten

"People in the Global South depend on biomass for cooking and that's becoming increasingly scarce and, by extension, increasingly expensive. Wood quality is decreasing due to deforestation and the price of charcoal is going up."

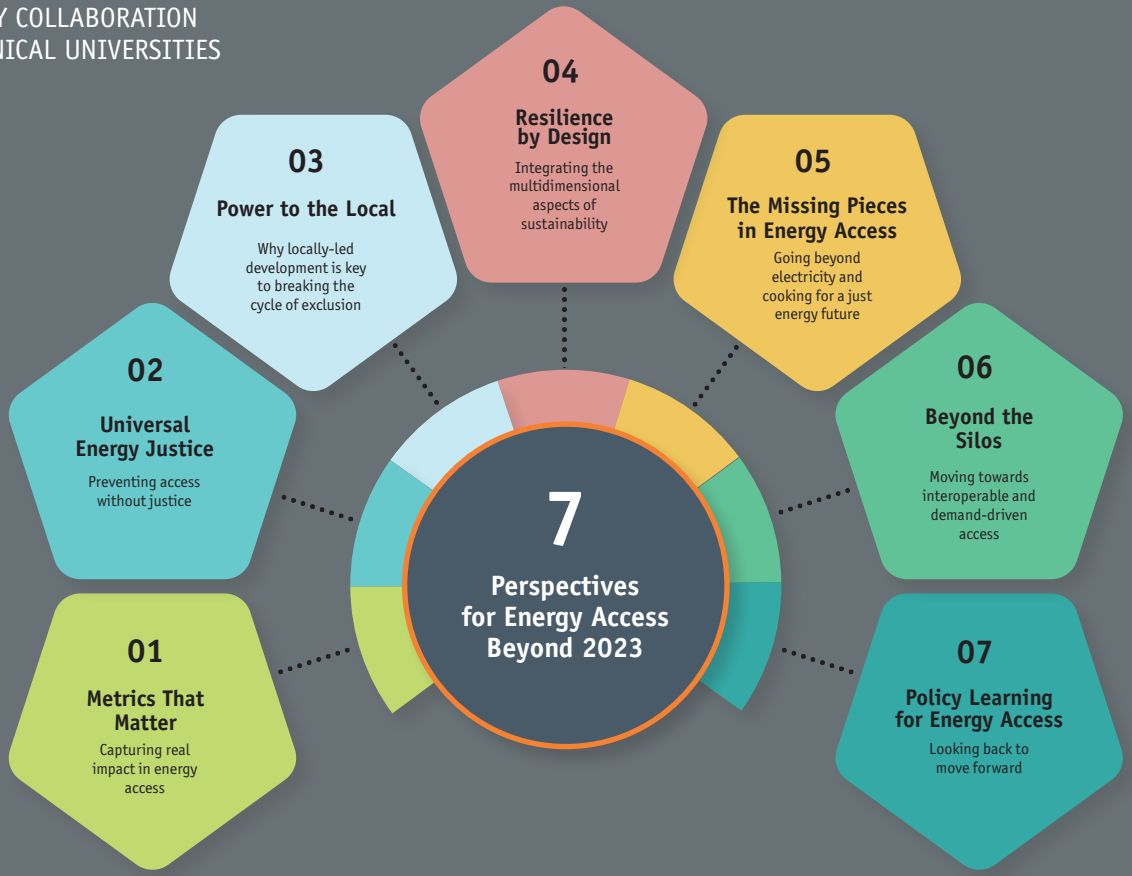
From Bridget Alcione Spoor's article for Cursor, April 2024

Henny Romijn (TU/e)

Kitchen for 50+ people at a rural college near Mpigi
Photo: Henny Romijn

PERSPECTIVES OF THE 4TU.ALLIANCE ON ENERGY ACCESS

AN INTERDISCIPLINARY COLLABORATION
OF THE 4 DUTCH TECHNICAL UNIVERSITIES



2027-2030 Strategy
Building a Competitive and Sustainable Energy Ecosystem

In a rapidly changing energy ecosystem where the Netherlands and the EU are striving to remain competitive, our mission to accelerate the energy transition continues to support these ambitions.

Therefore, we will continue our commitment to our current collaboration and activities, while strategically expanding our programmes into areas where ecosystem and critical mass are essential.

Our commitment is guided by the following underlying principles:

- Strengthen research portfolios though cross-institutional collaboration and large-scale consortia in energy technologies, grid integration and decarbonisation.
- Develop or support training programmes that prepare specialised talent for future energy systems. These programmes address the skills gap, particularly regarding digitalised energy systems, energy infrastructure, and climate technologies.
- Build networks between universities, industry, and EU funding bodies to drive cross-border research efforts.
- Facilitate innovation pipelines, industry partnerships, and incubation structures that translate research outcomes into scalable, real-world energy solutions.

From 2026 onward, an official collaboration with University of Groningen (RUG) is under discussion, most notably with the Zernike Institute for Advanced Materials (ZIAM), the Engineering and Technology institute Groningen (ENTEG) and the Groningen Engineering Centre (GEC).

This expansion strengthens the national North–West energy innovation axis and increases critical mass in materials, systems engineering, and industrial transition research.

Together we continue with our mission:

Accelerating the energy transition through connecting, representing and strengthening research and education

Scientific Impact

We aim to have a scientific impact on the following thematic clusters: 1) Grid Congestion, 2) Energy Hubs, and 3) Resilience.

Within these clusters, we will:

- Facilitate cross-disciplinary research that integrates technical, digital, economic and societal perspectives.
- Enable the formation of competitive, large-scale national and EU consortia.
- Contribute to long-term research programming aligned with Dutch and European strategic priorities.
- Strengthen the visibility and coherence of the Dutch energy research landscape.

By concentrating effort in these domains, 4TU.Energy supports systemic solutions rather than isolated technological advances.

"At 4TU.Energy, we bridge science and society by amplifying the impact of the 4TUs in the vital domain of the energy transition. We facilitate collaboration across disciplines, encourage cooperation within the 4TU network and with external partners, and strengthen visibility on national and European agendas."

David Smeulders - Scientific Director 4TU.Energy

Photo: Eneritz Murillo Luaces

Societal Impact

The energy transition requires coordination beyond academia. 4TU.Energy positions itself as a structural interface between research, industry and public stakeholders.

We will:

- Address pressing industry challenges - such as congestion, electrification and system integration - through structured academia–industry collaboration.
- Accelerate valorisation by connecting research outcomes to innovation programmes, pilot environments and policy agendas.
- Strengthen recognition of 4TU.Energy as the national coordination platform for energy transition knowledge, enhancing visibility, public engagement and European positioning.

In doing so, 4TU.Energy contributes not only to scientific excellence, but to the competitiveness, resilience and sustainability of the Dutch and European energy system.

Impact Pathway 4TU.Energy 2027-2030

Accelerating energy transition through connecting, representing and strengthening research and education

ACTIVITIES

Community & Talent Development

- Annual Energy Community Day
- Annual Two-Day PhD Course
- Annual Pre-Course Pitch Training

Strategic Thematic Focus

- Grid Congestion
- Energy Hubs
- Resilience

MECHANISMS

Scientific Strengthening

- Cross-disciplinary clustering
- National & EU consortia
- Long-term programming

Collaboration Platform

- Strengthen relations with 4TU.HTM and 4TU.RE
- Explore collaborations with 4TU.Impact, 4TU.Schools, 4TU.CEE, 4TU.Alumni
- Stay connected with DSOs, Deloitte, NL Energy Compact

IMPACT

Scientific Impact

- Strong 4TU.Energy identity
- Competitive large-scale proposals
- Integrated technical & societal view

Societal & Valorisation Impact

- Accelerated innovation
- Academia-industry collaboration
- Talent recruitment & skills alignment
- National coordination role

Strategic Communication & Visibility

LinkedIn & Website • Federation Channels • Thought Leadership • Policy & Industry Positioning

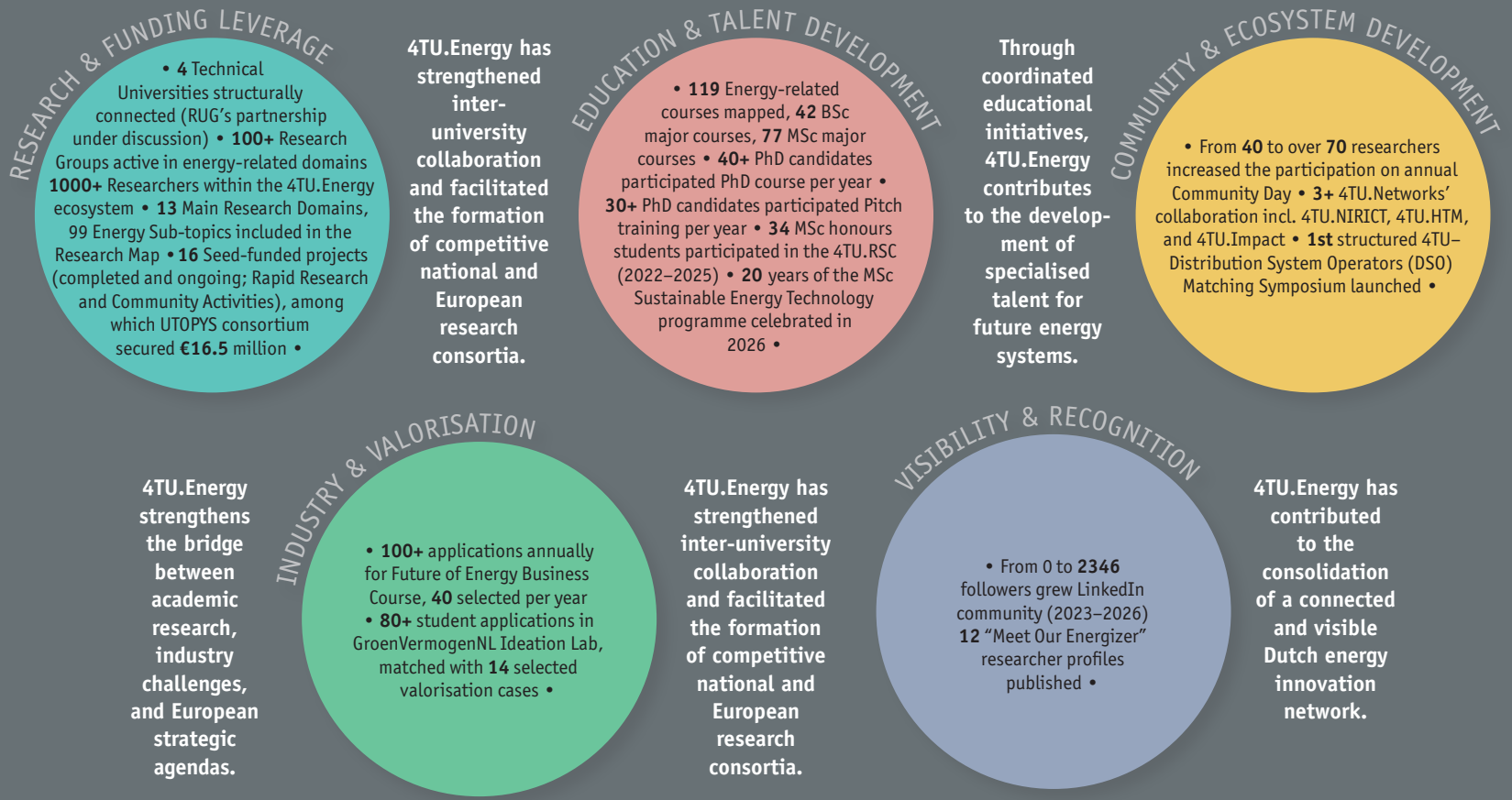
APPENDICES

APPENDIX 4TU.ENERGY FUNDED PROJECT IMPACT TABLE

END DATE	PROJECT TITLE	TYPE	PI	PARTNERS	KEY FOCUS	MAIN OUTCOMES / IMPACT
21-06-2024	**Microgel–MOF Sensor for Dissolved CO_2**	Rapid Research	H. Bazyar	TU Delft, TU/e	MOF–microgel integration for CO_2 sensing	Proof of principle AFM characterisation; custom experimental setup; joint publication and joint MSc project proposal
21-06-2024	**4TU Fair Battery Challenge**	Community Activity	Y. Tang	TU/e, UU, WUR	Connecting flow battery research and education	Cross-4TU collaboration; The battery kit developed and presented in the workshop has been used in our TU/e-ME education programme
21-06-2024	**3D-Printed Porous Electrodes for CO_2 Reduction**	Rapid Research	P. Taheri	TU Delft, UT	3D printing with functional coatings for CO_2 reduction	Proof of concept followed by PhD study, publication in preparation
03-11-2024	**Next-Generation Metal-Supported SOFCs**	Rapid Research	D. Giuntini	TU/e, Twente	Printable inks for SOFC anode structures	Groundwork for NWO-AES proposal; publications in preparation
30-01-2025	**Energy Transition in Horticulture Symposium**	Community Activity	C. Sun	WUR, TU/e	Energy challenges and solutions in horticulture	Consortium expansion; groundwork for NWO-OTP proposal; exchanges of students/staff initiated
31-11-2025	**Magnetic-Ionocaloric Heat Pump System**	Rapid Research	K. Rajamani	UT, TU Delft	Magneto-ionocaloric heat pump concept	Groundwork for Pathfinder proposal; content of student theses and designs
15-12-2025	**Energy Supply & Demand in Residential Buildings**	Community Activity	T. Zhu	UT, TU/e, TU Delft	Integrated building energy systems	Consortium growth; Groundwork for TKI PPS & EU CET preparation
30-12-2025	**Leveraging ICT for Energy Systems**	Joint Community Activity	P. Palensky	TU Delft, TU/e, UT, WUR	ICT–energy systems integration	UTOPYS funded (€16.5M); national consortium formed
30-12-2025	**Digital Twins of the Dutch Energy System**	Joint Community Activity	P. Vergara	TU Delft, TU/e, UT, WUR	National digital twin research agenda	TwinNL consortium; groundwork for NWO–TenneT proposal

APPENDIX PROJECTS THAT HAVE STARTED, NOT YET COMPLETED

EXPECTED END DATE	PROJECT TITLE	TYPE	PI	PARTNERS	MAIN OUTCOMES / IMPACT
11-2026	**AI-based decision support for cost-effective hydrogen production**	Joint Community Activity with 4TU.NIRICT	F. Khalighi	UT, TU Delft, TU/e	Support shared learning and collaboration
11-2026	**Quantum4EnergyNL: building a community for quantum computing in power and energy systems**	Joint Community Activity with 4TU.NIRICT	N. Paterakis	TU/e, TU Delft, UT, WUR	Connect researchers and co-create a shared national research agenda
11-2026	**Modelling Thermo-Chemically Active Granular Materials for Industrial Applications**	Rapid Research	T. Weinhart	UT, TU Delft	A critical step toward enabling industries to design energy-efficient and sustainable granular systems
11-2026	**Revolutionizing Nuclear Materials**	Rapid Research	F. Liu	UT, RUG, TU/e	Establish a foundation for a larger joint proposal
11-2026	**Multi-Source Energy Integration Framework**	Community Activity	G. Hu	TU/e, UT, WUR	Establish a foundation for future collaborative projects and funding applications with Dutch municipalities and energy utilities
12-2026	**Enhancing Nucleation in Salt Hydrate PCMs**	Rapid Research	S. Gaastra-Nedea	TU/e, TU Delft	The findings will inform the design of energy storage systems
12-2026	**PFAS free covalent organic frameworks**	Rapid Research	A.A. Tashvigh	WUR, UT	Explore a novel membrane concept


RESEARCH & FUNDING LEVERAGE
• 4 Technical Universities structurally connected (RUG's partnership under discussion) • 100+ Research Groups active in energy-related domains 1000+ Researchers within the 4TU.Energy ecosystem • 13 Main Research Domains, 99 Energy Sub-topics included in the Research Map • 16 Seed-funded projects (completed and ongoing; Rapid Research and Community Activities), among which UTOPYS consortium secured €16.5 million •
4TU.Energy has strengthened inter-university collaboration and facilitated the formation of competitive national and European research consortia.
EDUCATION & TALENT DEVELOPMENT
• 119 Energy-related courses mapped, 42 BSc major courses, 77 MSc major courses • 40+ PhD candidates participated PhD course per year • 30+ PhD candidates participated Pitch training per year • 34 MSc honours students participated in the 4TU.RSC (2022–2025) • 20 years of the MSc Sustainable Energy Technology programme celebrated in 2026 •
Through coordinated educational initiatives, 4TU.Energy contributes to the development of specialised talent for future energy systems.
COMMUNITY & ECOSYSTEM DEVELOPMENT
• From 40 to over 70 researchers increased the participation on annual Community Day • 3+ 4TU.Networks' collaboration incl. 4TU.NIRICT, 4TU.HTM, and 4TU.Impact • 1st structured 4TU–Distribution System Operators (DSO) Matching Symposium launched •
4TU.Energy strengthens the bridge between academic research, industry challenges, and European strategic agendas.
INDUSTRY & VALORISATION
• 100+ applications annually for Future of Energy Business Course, 40 selected per year • 80+ student applications in GroenVermogenNL Ideation Lab, matched with 14 selected valorisation cases •
4TU.Energy has strengthened inter-university collaboration and facilitated the formation of competitive national and European research consortia.
VISIBILITY & RECOGNITION
• From 0 to 2346 followers grew LinkedIn community (2023–2026) 12 "Meet Our Energizer" researcher profiles published •
4TU.Energy has contributed to the consolidation of a connected and visible Dutch energy innovation network.

APPENDIX 4TU.ENERGY ACTIVITY OVERVIEW

	TIME	MILESTONE	ACHIEVEMENT
PHASE 1 INITIATION & POSITIONING	Nov 2022	**4TU.RSC pilot edition kick-off**	10 honours master's students involved with 2 companies challenges- KLM, ProRail
	Nov 2022	**Future of Energy Business Course 1st edition**	Deloitte co-organised with TU Delft, participants only from TU Delft
	Feb 2023	**LinkedIn account created**	Weekly post started; Until now 2325 followers
	Mar 2023	**4TU.Energy Research Map establishment**	7 categories 45 topics included
	Mar 2023	**Quarterly interview "Meet our Energizer" started**	Spotlight on early-stage researchers; until now 11 interviews delivered
	Mar 2023	**4TU.Energy Community Day pilot edition**	40 researchers from 4TU
PHASE 2 STRUCTURING & SCALING	Oct 2023	**4TU.Alliance on Energy Access joined 4TU.Energy**	An interdisciplinary collaboration of 4TU working on SDG7 and connected with Dutch energy access sector; regular working group meeting setup
	Nov 2023	**4TU.RSC second edition kick-off**	12 honors masters involved with 3 companies challenges-Heliostrome, Quantum, Twence
	Nov 2023	**Future of Energy Business Course 2nd edition**	4TU.Energy officially joined the organisation, participants from all 4 technical universities
	Nov 2023	**4TU.Energy 2-days-PhD course pilot edition**	40 4TU participants, 11 speakers from 4TU+TNO, Province North Brabant
	Feb 2024	**Joint call for funding with 4TU.NIRICT opened**	Until now 4 proposals on joint community activity were funded
	Apr 2024	**4TU.Energy Community Day - "Energy Landscape & Funding Opportunity"**	50 researchers from 4TU+RUG
	Jul 2024	**4TU.Energy Research Map update**	13 categories 85 topics included, with topic description & researchers list
	Nov 2024	**4TU.RSC third edition kick-off**	12 honors masters involved with 3 companies challenges-Alliander, Quantum, NMI
	Nov 2024	**Future of Energy Business Course 3rd edition**	Researcher from 4TU joined as facilitators teaming up with Deloitte facilitators
	Nov 2024	**4TU.Energy 2-days-PhD course**	55 4TU+RUG participants, 11 speakers from 4TU+Alliander, AMS institute, Stedin and Brainport Eindhoven
	Apr 2025	**4TU.Energy Community Day -"Energy & Materials Transition - One and the Same Problem?"**	Over 70 researchers, innovators, and experts from 4TU+ RUG, Sharif University, DIFFER, and BigCircle Ventures

APPENDIX 4TU.ENERGY ACTIVITY OVERVIEW

	TIME	MILESTONE	ACHIEVEMENT
PHASE 3 OUTREACH & MATURITY	May 2025	**Joint workshop with 4TU.HTM**	40 early-stage researchers in the joint community participated and connected via the theme "Energy Materials, Technologies and Sustainable Recycling Strategies"
	Sep 2025	**4TU.RSC end report**	Structured reflection and knowledge transferred
	Oct 2025	**Matching symposium 4TU-DSO programme committee installed**	The very first edition of bridging 4TU and DSO is planned on 2 June 2026
	Oct 2025	**Representing 4TU on the stage in Brussels for European policy visibility**	7 representatives connected with EU policymakers, scientists, and innovation leaders showcased how Dutch universities can contribute to Europe's clean energy transition and strategic autonomy.
	Nov 2025	**GroenvermogenNL Ideation Lab – Green Energy kick-off**	81 students applied, 30 research cases received, 15 cases selected
	Nov 2025	**Future of Energy Business Course**	Course also open to RUG and trainees from companies across the energy sectors
	Nov 2023	**4TU.Energy 2-days-PhD course**	40 4TU+RUG participants, 11 speakers from 4TU+Deloitte, AMS institute, Clingendael Institute, Stedin
	Dec 2025	**4TU Alliance on Energy Access delivered the seven perspectives on rethinking SDG7**	Three fundamental questions were addressed about the future of energy access

Key highlights

- **Growing engagement in flagship events**
  Flagship activities such as the 2-day PhD course (including pre-course pitch training) and the 4TU. Energy Community Day show sustained growth in both participation and organisational reach, expanding from internal 4TU engagement to include University of Groningen and increasing involvement from companies and external partners.
- **Strengthened internal and external collaboration**
  Joint activities intensified internally with 4TU.HTM, 4TU.NIRICT, and 4TU.Impact, and externally with academic partners, public organisations, and industry, including 4TU Alliance on Energy Access, Deloitte, and Distribution System Operators (DSOs).
- **Progressive scaling from pilot to mature programmes**
  Activities evolved from pilot editions to recurring, structurally embedded programmes with broader thematic scope, increased participant numbers, and clearer positioning within national and European energy ecosystems.

2023	2024	2025	2026
LECTURE TOPICS	**LECTURE TOPICS**	**LECTURE TOPICS**	
■ Systemic landscape approaches in the energy transition ■ Social tipping dynamics and societal change ■ Energy infrastructure & electricity network impacts ■ Solar–hydrogen systems and built environment integration ■ Industrial transformation and scaling ■ Regional governance perspectives ■ Interdisciplinarity in energy research	■ Energy system management ■ Socio-technical sustainability ■ Geothermal energy systems ■ Social & behavioral transition and energy policy ■ Innovation in chemistry and energy systems ■ Gas and electricity network strategy ■ Industry perspectives	■ Distribution network dilemmas ■ Design-driven approaches to energy transition ■ Chemical recycling & circularity ■ Energy storage in renewable systems ■ Participatory value and societal acceptance ■ Geopolitics of the energy transition ■ Spatial justice & participation ■ Business strategy perspectives ■ Geothermal innovation ■ Socially viable & resilient energy system design	TO BE ANNOUNCED

Colophon

Powering Impact

4TU.Energy Impact Review 2022-2026 and Looking Ahead

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