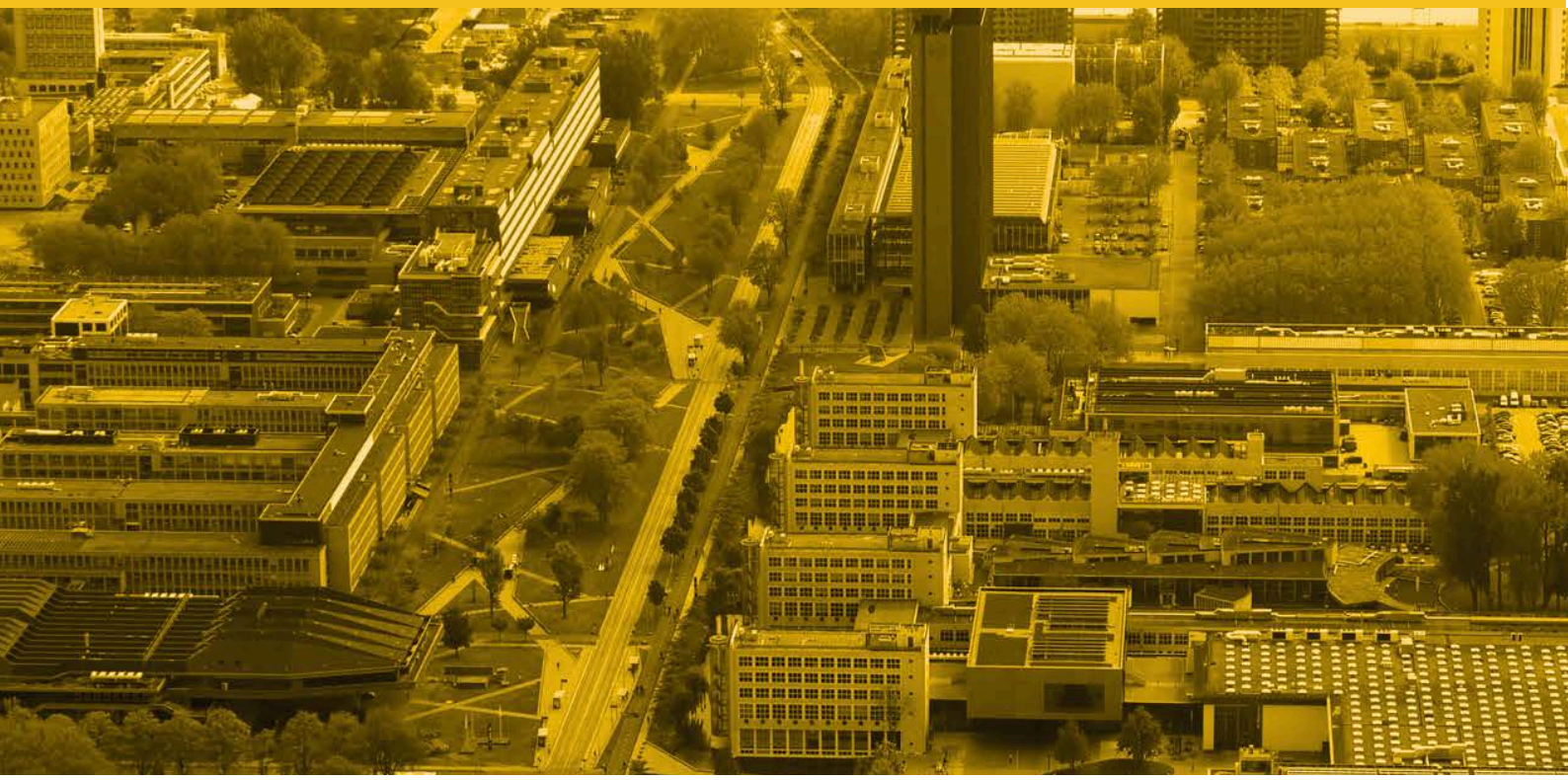
Supporting a rapid, just and equitable transition
to a carbon-free built environment

TU DELFT URBAN ENERGY INSTITUTE



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In cooperation with

THE GREEN VILLAGE

AMS Amsterdam Institute for Advanced Metropolitan Solutions

"Supporting a rapid, just and equitable transition to a carbon-free built environment."

The Challenge

Institutions at all scales are setting ambitious GHG and energy targets to address the global climate crisis. The IPCC is urging governments and institutions to set policies that will ensure that global temperatures do not rise above 1.5 degrees. The European Commission has set a target to achieve net zero GHG emissions by 2050 and efforts are underway to set ambitious GHG reduction targets for 2030 and beyond. The Dutch government has set a target to reduce greenhouse gas (GHG) emissions by 49% below 1990 levels by 2030 and to achieve a climate-neutral built environment by 2050.

In this leaflet, we present the major research challenges that need to be addressed to achieve the energy transition. In nearly all faculties of TU Delft, relevant research of high quality is being carried out, from in-depth technical research via integrated approaches connecting all expertise to assessment methods needed for decision making. The social innovation aspect is part of the research portfolio as well.

The research challenges are categorised along seven intertwined themes, covering the building, neighbourhood, district and city scales, and involving multiple disciplines. Examples of ongoing projects at TU Delft demonstrate our track record in this research field.

Urban Energy Institute TU Delft

Founded in 2018, the Urban Energy Institute at TU Delft is a multi-disciplinary platform of researchers and experts with widespread knowledge on the urban energy transition.

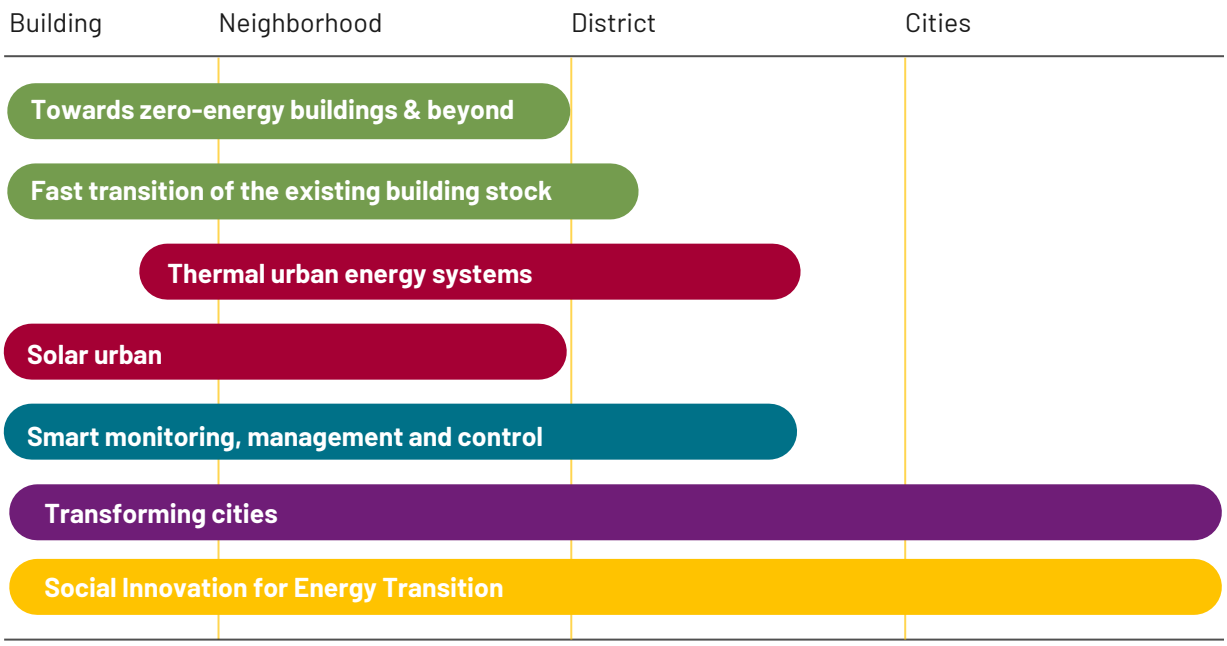
Institutions worldwide are setting ambitious GHG and energy targets to address the global climate crisis. The European Commission and the Dutch government have set targets to achieve net zero GHG emissions by 2050 and to reduce emissions by 49% below 1990 levels by 2030, respectively. The Urban Energy Institute at TU Delft aims to exceed national and international targets by aiming for a 90% reduction in GHGs over 1990 levels by 2035.

The mission of the Urban Energy Institute is to support a rapid, just and equitable transition to a carbon-free built environment.

We do this by:

- Producing and sharing essential knowledge through research
- Providing a platform for knowledge-sharing and collaboration among experts

The TU Delft Urban Energy Institute is one of the 4 energy pillars of the TU Delft Energy Initiative.



Theme 1: Towards zero-energy buildings & beyond

Future-proof buildings and neighbourhoods

Goals

- New buildings that go beyond energy neutrality consider circularity and are comfortable and healthy.
- Existing buildings that are equipped with affordable future-proof solutions enabling connection to sustainable energy supply

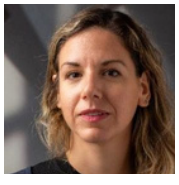
Challenges

- Buildings designed for the local climate, providing thermal, visual and acoustical comfort (bioclimatic design).
- High-performance materials and components take into account embodied energy and circular use.
- Technologies for feasible renovation solutions that enable sustainable energy supply and a fast renovation process.
- New approaches for assessing and integrating the ambitions on different aspects of the energy transition.

Scale

Building | Neighborhood | District | Cities

Theme Lead

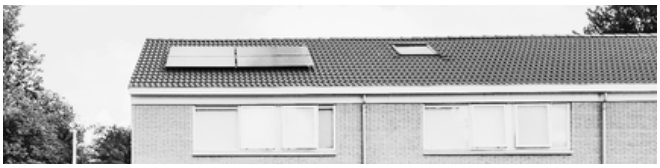


Thaleia Konstantinou
Assistant Professor
Department of Architectural Engineering and Technology

Project Examples

Smart Urban Isle

This project explores the possibilities of neighbourhoods to become 'Smart Urban Isles': areas – possibly around a public building – where energy is generated, exchanged and stored to locally balance supply and demand as much as possible.



DeZONNET

To achieve the climate agreement goals, good solutions are needed that make it possible to switch existing buildings and neighborhoods off natural gas and make them more sustainable. The solar heating network is one of these solutions. Does the idea work as well in practice as previously conceived, is it affordable for the average resident of the Netherlands and how does the resident experience the system?

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Theme 2: Fast transition of the existing building stock

Delivering 200,000 high-performance renovations per year

Goals

- Building owners commission the renovation of their buildings themselves.
- A construction sector that has the capacity (in size and quality) to deliver renovations on a large scale.
- Affordable renovations.
- Guaranteed performance of renovation solutions in terms of energy, comfort and operations.

Challenges

- Industrialisation and standardisation of the building process.
- Nudging and incentivising building owners to create demand.
- Continuous monitoring of building performance.
- Evidence-based policies to incentivise innovations.
- Development and supply of innovative business and fi nancing models

Scale

Building | Neighborhood | District | Cities

Theme Lead

Erwin Mlecnik
Assistant Professor
Department of Management in the Built Environment
Section Housing

Project Examples

CondoReno

The CondoReno project is a multi-year, multi-stakeholder project focused on creating and replicating Integrated Home Renovation Services (IHRS) in Flanders and the Netherlands for achieving label A renovations with condominium associations.

Future Factory

The Future Factory consortium consists of experienced parties who realize that the scale envisaged entails an enormous innovation task. The goal of this consortium is to develop a Future Factory that can deliver 25,000 renovations annually by 2025, fitting 40% of homes in the Netherlands. The renovation propositions are available to both private owners and landlords through delivery and sales channels tailored to them.

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Theme 3: Thermal urban energy systems

Deliver heat, in the right place, at the right time and at the right temperature

Goals

- Technology in place to deliver heat efficiently to all parties in the urban environment
- Reliable and predictable thermal heating systems, enabled by robust business models
- Integrated solutions connecting distributed and centralized sources, and on-demand storage facilities

Challenges

- Better predictions of geothermal source and storage performance
- Development of high-efficiency, low-noise and low-cost heat pumps
- Governance of heat and electricity infrastructure, such as underground management and optimisation
- Balancing heat demand and supply over the year
- Integration of renewable sources of different scales into district heating networks

Scale

Building | Neighborhood | District | Cities

Theme Lead

Phil Vardon
Professor of Energy Geomechanics, Faculty of Civil Engineering and Geosciences

Project Examples

WarmingUP

In the WarmingUP collective, we develop applicable knowledge with thirty-eight participants , so that collective heating systems are reliable, sustainable and affordable for the heat transition. Collective heating systems in combination with sustainable sources form an important link in the solution to achieve the objectives of the Climate Agreement and reduce CO 2 emissions.

SHIFFT

Space and water heating represent a large fraction of overall energy consumption across the EU Member States and around one-third of carbon emissions. Dependence on fossil fuels has made the heat sector hard to decarbonise in at least three of the four Member States in the 2 Seas region. The main objective of the SHIFFT project is to stimulate the adoption of low-carbon heating technologies in existing buildings.

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Theme 4: Solar urban

Utilisation of solar energy everywhere

Goals

- Multifunctional solar cells integrated in building elements, urban surfaces and the landscape
- Smart combination of custom shapes, bendability, colour, transparency, shading tolerance and heat usage
- Circular and efficient materials and components

Challenges

- Modelling of design and energy yield of urban/architectural integrated PV systems
- PV solutions for architectural heritage, domotics, e-mobility and heat management
- Photovoltaic (PV) solar energy fully integrated in building elements such as walls, bricks, pavements, coatings, roofing and acoustic screens

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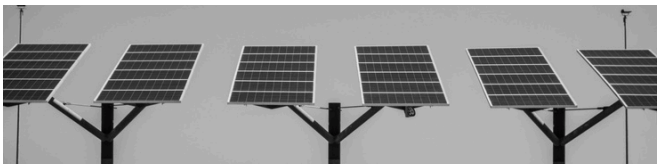
Theme Lead

Rudi Santbergen
Assistant Professor, Photovoltaic Multiscale Modelling, Delft University of Technology

Project Examples

Colour-coated Solar Panels for the Built Environment

TU Delft has developed a coating for solar panels that reflects a specific part of the light spectrum. The coating can be used to achieve desired properties, like panel colouring and limited panel heating. The use of this coating makes it possible to integrate solar cells invisibly or aesthetically in the built environment without compromising on efficiency.



Reconfigurable PV Modules

The electrical performance of urban solar PV systems is often affected by partial shading. Our team works on reconfigurable modules that can adapt their inner electrical interconnections according to the shading conditions, and maximize the electrical power output. Our work is focused on developing and measuring the performance of shade-tolerant systems.

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Theme 5: Smart monitoring, management and control

Give brains to urban energy systems

Goals

- Energy systems with maximum efficiency under all circumstances
- Consumers participation in the energy transition through smart home appliances and smart grids
- Smart and ethical use of data for demand/supply match and system optimisation

Challenges

- Self-learning and self-optimising energy management systems
- Advanced energy diagnosis systems
- Multi-objective optimisation: energy, comfort, air quality and costs
- Big data for a better understanding of occupant behaviour and energy rebound
- Big data for real-time performance assessment

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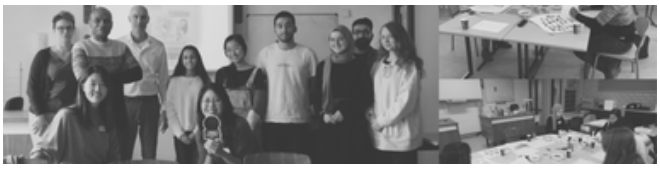
Building | Neighborhood | District | Cities

Theme Lead

Tamas Keviczky
Professor, Delft Center for Systems and Control

Project Examples



ENERGE

With the ageing of the existing post-primary school building stock, there is a need for low-cost solutions that enable long-term resource efficiency in schools and reduced greenhouse gas emissions (GHG). ENERGE addresses this need using targeted physical interventions that combine a data-enabled platform and building sensors with behavioural and social studies.

Brains 4 Buildings

Brains 4 Buildings is a multi-year, multi-stakeholder program focused on developing methods to harness big data from smart meters, building management systems and the Internet of Things devices, to reduce energy consumption, increase comfort, respond flexibly to user behaviour and local energy supply and demand, and save on installation maintenance costs.

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Theme 6: Transforming the cities

Robust, integrated local energy transition plans

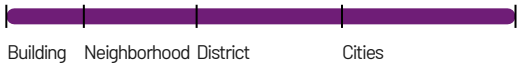
Goals

- Decision support for integrated energy solutions on the city, district and neighbourhood levels
- Local authorities to direct and facilitate the energy transition
- Empowerment of energy communities

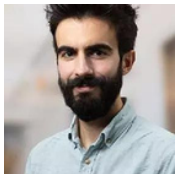
Challenges

- Integrated modelling of sustainable energy systems for neighbourhoods, districts and cities
- Approaches, methods and tools for the energy transition of cities
- New governance models for the energy transition in cities
- Interactive co-creative workshops methods to set energy visions and action agendas across Europe

Scale

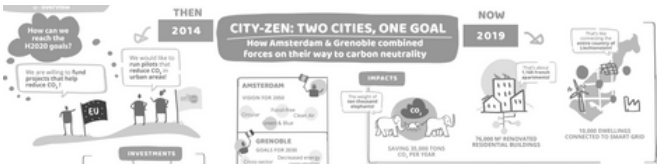


Theme Lead



Francesco Lombardi
Assistant Professor
Faculty of Technology, Policy and Management, Delft University of Technology

Project Examples



City-Zen

City-Zen built a methodology and tools for cities, industries and citizens to reach the 20-20-20 targets. 28 partners worked on 20 pilot projects, aiming for an annual saving of 59,000 tonnes of CO2. An integrated methodology was developed, as have roadmaps to sustainability for Grenoble and Amsterdam.

REScoop PLUS

Energy cooperatives are an important means to engage citizens in the energy transition. TU Delft provided expertise on the behavioural impact of the best practices on the cooperative members, and on behavioural changes due to the cooperative engagement with the energy cooperatives themselves.

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Social Innovation for Energy Transition

Goals

- To contextualize social innovation within the energy transition toward sustainability and distributed energy generation.
- To promote the use of social innovation as an analytical lens through which to view the socio-material intertwinement within energy transitions.

Challenges

- Community energy initiatives, its implications for society and impact
- New governance arrangements, policies and modes for inter-actor collaboration in the energy domain, in particular supporting grassroots movements
- New business models and institutional arrangements that support them in support of citizen-led action and projects in the energy transition
- New participative approaches like co-creation and co-production of energy transition policy
- Multi-actor behavioral change

Scale

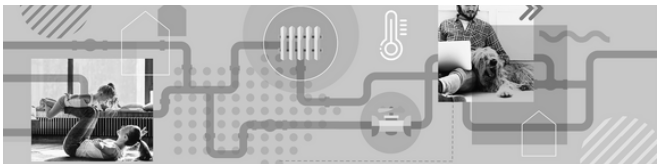
Theme Lead

Gerdien de Vries
Climate Psychology, Delft University of Technology

Project Examples

LANDMARC

LANDMARC (Land Use Based Mitigation for Resilient Climate Pathways) is a 4 year EU funded project that will enhance understanding of the realistic potential of land-based negative emission solutions in agriculture, forestry, and other land use sectors.



SHIFFT

SHIFFT is an INTERREG 2 Seas project that is stimulating the adoption of low-carbon heating in existing residential and community buildings. SHIFFT is helping to address this by installing measures in a number of pilot areas to demonstrate sustainable heating.

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Expertise at TU Delft

Faculty of Architecture and the Built Environment
Circular/carbon-neutral design and planning, building product innovation, architectural engineering, housing quality and process innovation, housing governance, housing systems.

Faculty of Technology Policy and Management
Governance, policy, energy systems, behaviour, social innovation.

Faculty of Civil Engineering and Geosciences
Shallow and deep geothermal energy systems, aquifer thermal energy storage.

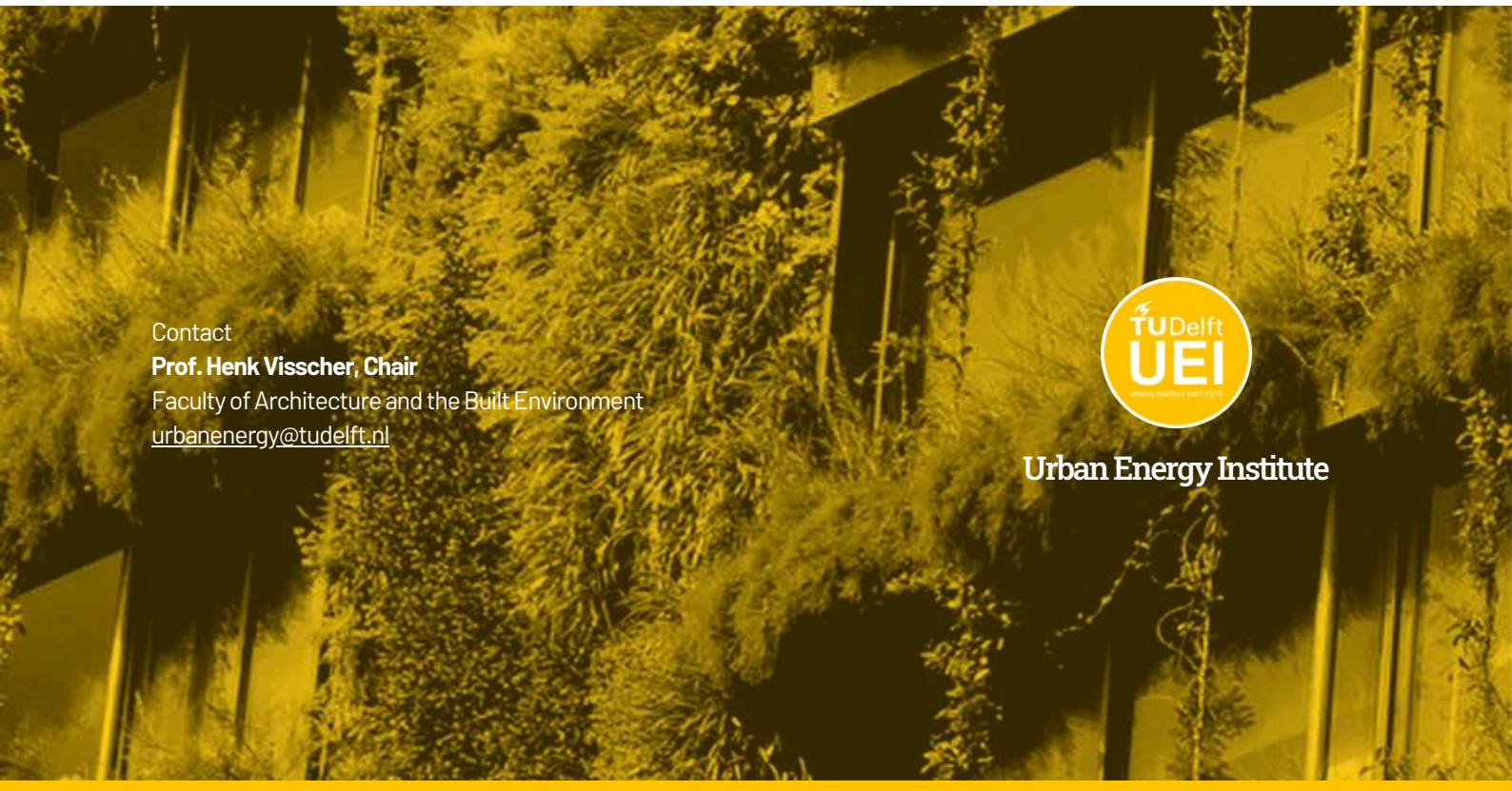
Faculty of Electrical Engineering, Mathematics and Computer Science
Solar cells and PV module manufacturing, smart module design, modelling of energy yield of PV systems, design of small-scale PV systems.

Faculty of Mechanical, Maritime and Materials Engineering
Systems and control, smart building and smart cities.

Faculty of Industrial Design Engineering
Design conceptualisation and communication.

The Green Village
Living-lab environment where universities and businesses can develop, test and demonstrate innovations with close involvement of the public and government.

TU Delft is academic partner of the **Amsterdam Institute for Advanced Metropolitan Solutions (AMS Institute).**



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