Dynamical Systems at DTU Compute

Turning mathematical insight into real-world solutions

Credit: Gemini

Many of the challenges we face as a society involve systems that change over time. Energy networks must balance supply and demand, cities need to manage growing mobility needs, and digital infrastructures process enormous amounts of data every second. These systems are complex, interconnected, and often affected by uncertainty and human behaviour.

At the Section for Dynamical Systems (DynSys) at DTU Compute, we develop mathematical models and data-driven methods to better understand how such systems behave and how they can be improved.

Our research combines strong scientific foundations with a clear focus on real-world relevance.

This allows us to move efficiently from ideas and models to solutions that can be tested, demonstrated, and used in practice.

What sets the section apart is how closely our research is connected to application. From the very beginning, we design models with implementation and validation in mind. This means we can move quickly from fundamental research to real-world use, ensuring that our work stays grounded in reality and delivers value to value to society.

By turning mathematical insight into real-world solutions in energy systems, smart cities, and beyond, we help shape a more sustainable and digitally enabled future.

Making sense of complex systems

At the core of our research is the study of **dynamical systems** in mathematical descriptions of how systems evolve over time. These systems may behave in predictable ways, or they may be influenced by uncertainty, randomness, and incomplete information.

We work with a broad set of tools, including:

- time series analysis and forecasting
- mathematical models that capture uncertainty
- methods for estimating unknown system parameters
- optimization and control techniques
- approaches for understanding and managing risk

Together, these tools help us simplify complex phenomena without losing what really matters.

Importantly, our models are built to work with real data and real constraints. This makes it possible to test ideas, learn from observations, and refine solutions as new information becomes available.

Our goal is not only to understand systems better, but also to support better decision-making, especially in situations where trade-offs are unavoidable and uncertainty cannot be ignored.

Contact

Razgar Ebrahimy
Head of Section,
Senior Researcher
DTU Compute
raze@dtu.dk

www.compute.dtu.dk/sections/dynsys

January 2026

DTU

Technical University of Denmark

Supporting the Green Transition through energy systems research

Energy systems are changing rapidly as renewable sources like wind and solar become increasingly important. While this transition is essential for sustainability, it also makes energy systems more variable and complex.

At DynSys, we develop models that help make sense of these changes. Our research includes:

- forecasting renewable energy production and energy demand
  analysing electricity prices and market behaviour
- developing methods for controlling district heating and integrated energy systems
- studying flexibility and stability in modern energy networks
- demand side flexibility

Because our models are closely linked to real data and real operational conditions, they can be applied directly in collaboration with industry and public partners. This allows us to test strategies, explore future scenarios, and demonstrate solutions that support a reliable and sustainable energy system.

Smart cities: understanding energy, mobility and urban data

Cities bring together energy systems, buildings, transport, and digital infrastructure in a tightly connected environment. Decisions in one part of the city often affect many others – for example, how buildings use energy influences both indoor comfort and overall energy demand, while mobility patterns shape congestion, emissions, and quality of life.

At DynSys, **Smart Cities** research focuses on understanding and improving these interactions through mathematical models and data-driven methods that can be applied directly in real urban settings.

Our work supports cities in using digitalization to become more sustainable, efficient, and resilient:

- Urban energy systems and indoor climate
- Mobility and traffic dynamics
- **Urban sensing and data integration**
- Integrated urban modelling

A key strength of this work is the **short path from modelling to application**. Models are typically developed with real data and practical use in mind and are often applied immediately in scenario analysis, decision-support tools, or pilot studies.

This allows cities and partners to test ideas, compare alternatives, and demonstrate solutions under realistic conditions.

Throughout our smart cities research, we place strong emphasis on **interoperability**. Digital tools, data sources, and models must be able to work together across sectors and administrative boundaries.

By designing methods that bridge energy systems, buildings, mobility, and data infrastructures, we help cities make better, more coordinated decisions.

Digitalization with purpose

Digitalization plays an important role across all our research areas. By creating mathematical and computational models that mirror real systems, we help turn data into insight and insight into action.

Sustainability is a common thread in this work. Whether we are studying energy systems or urban mobility, our aim is to support solutions that are efficient, resilient, and aligned with long-term societal goals. By working across the full spectrum from theory and modelling to application and demonstration we are able to create impact while keeping our research firmly rooted in scientific excellence.

Education, collaboration, and real-world engagement

Our research is closely connected to education at DTU Compute. Students learn not only advanced mathematical methods, but also how these methods are used to address real societal challenges. This prepares them to work confidently at the interface between theory and practice.

Collaboration is a natural part of our work. We engage with industry, municipalities, and researchers from other disciplines to ensure our methods are relevant and our results can be applied beyond academia. These partnerships also bring new perspectives and challenges that help shape our research.