

Faculty of Science and Engineering

Profile report: Energy and Industry Network Dynamics
Netwerkdynamiek van Energie en Industrie

- Discipline: Energy Systems and Industrial Ecology
- Level: tenure-track Assistant professor
- Fte: Full time (1,0)

1. Scientific discipline

Energy systems and industrial ecology seeks to “understand the emergent behavior of complex integrated human/natural systems.” (B. Allenby). Their material and energy flows, system configuration and performance are analyzed. Technology change and system innovation are investigated.

2. Vacancy

This position is opened by the Board of the Faculty (as part of the start-up package of Prof. Dijkema, letter (JK/gl/14/00015a) and will be embedded in the Energy and Sustainability Research Institute Groningen (ESRIG), base unit Energy and Environmental Sciences (IVEM). The position falls within the framework of ‘Career Paths in Science 3’ (‘Bèta’s in Banen 3’). Please see link for [criteria and conditions](#).

3. Selection committee (BAC)

Prof. dr. H. A.J. Meijer, director of ESRIG (Chair)
Dr. ir. S. Nonhebel, vice-director Master Program Energy and Environmental Sciences
Prof. dr. A.P.C. Faaij, IVEM, ESRIG
Prof. M.A. Herber, ESRIG
Prof. dr .ir .J.C. Wortmann, Faculty of Economics and Business
Prof. dr. L. Tavasszy, TNO / Delft University of Technology
M. Sc. student EES

advisors:

M.H. J. Renker (HR)
dr. Christopher B. Davis, IVEM, ESRIG

4. Research area

Core of the area of research is "Energy and Industry *Network Dynamics*" to assess and explore the transition to a low-carbon society, the bio-based and circular economy.

Electricity, gas, water, food and information reach us via networks; products and services result from a network of industrial processes that loosely connects agricultural land use, the extraction and use of fossil resources, minerals and metals, and emissions to the environment. Increasing our understanding of such networks, their development and how to shape them is key to achieve more sustainable systems.

Modelling energy and industry systems as dynamic networks is a rapidly growing area and at the frontier of interdisciplinary energy systems science and industrial ecology, where scientists from different (system) disciplines meet and collaborate. It builds on and links to network theory, modelling, data science and complexity.

One challenge in modelling and analysis is to relate current systems performance and organization (markets, regulation) to long-term development and dynamics of system configuration and performance. The energy transition, for example, unfolds over decades as the electricity grid accommodates renewables, which involves the realization of new components (nodes and edges).

A second challenge is to understand and relate local and global development to underpin technology and system development. Industrial Ecology concentrates on closing material cycles and improving system efficiency at local scale via dedicated facilities. How does this affect development, transformation and system innovation?

A third challenge is to model and analyse energy and industrial systems as multi-dimensional multi-level networks – connected and integrated by material/energy flows, information and contracts. This requires to bring network analysis to a next level and is expected to yield novel insights on the dynamics of system change and transition.

A fourth challenge is to develop and use network models connected, informed by or enriched with domain-specific models (such as load-flow models of electricity grids). Beyond electricity, development and use of such hybrid models represents tremendous opportunities and new challenges in research.

5. Embedding: institute (and base unit)

The Energy and Environmental Science group (IVEM) is an interdisciplinary research group within the Energy and Sustainability Research Institute Groningen (ESRIG). This institute comprises of 6 groups (“base units”) with a total of some 80 staff. These groups are Ocean Ecosystems (oceanic carbon cycle, biomimetics), Centre for Isotope Research (atmospheric greenhouse gases, radiocarbon), Combustion Technology (detailed combustion studies in flames), Geoenergy (CCS and geothermy), the Science and Society Group (research into the relation between science and society), and IVEM, with energy transition, analysis and modelling of energy and resource systems as its focus areas. Research at IVEM is done to assess and explore the energy transition, bio based systems and circular economy. Major research lines involve the modelling of the development and evolution of energy systems, energy transition and bio-based economy and the water-energy-food nexus.

By opening this position it is specifically recognized that in IVEM there is not only research on energy systems, but also on the adoption and advancement of theory, methods and techniques of modelling, at the interface of energy and industrial systems science, modelling and data science.

Within ESRIG, IVEM cooperates on analyzing bio-fractions in chains of products (Centre for Isotope research), in innovations in energy systems (Geo-Energy, Combustion Engineering), and in general with the Science and Society group (SSG). These lines of cooperation are steadily growing in intensity, while others are in development.

6. Local and (inter)national position

Energy and Sustainability, Data Science and Complexity are focus areas at the University of Groningen (UG), the Faculty of Science and Engineering (FSE) and in ESRIG. At the University of Groningen, FSE linkage is foreseen with Artificial Intelligence and Cognitive Engineering (ALICE), and with the Engineering and Technology institute Groningen (ENTEG). Analysis of energy and industry networks and dynamics provide natural links with other faculties, namely Economics and Business, Spatial and Social Sciences.

In the Energy Academy Europe (EAE) the UG collaborates with the Hanzehogeschool Groningen (University of Applied Sciences, offering professional education), provincial and municipal authorities and energy companies to establish a firm base for high-level interdisciplinary energy education and research. The work and position of the EAE will be beneficial to the present position, as modelling energy and industry network dynamics is required to combine information and knowledge from different disciplines, domains and sources in both research and teaching.

The position relates to but is also distinguished from a variety of groups / chairs established at Dutch Universities. In Eindhoven and Delft, groups focus on electricity networks. In Amsterdam, Delft and Nijmegen, more fundamental work is done on complex networks and system dynamics. In Leiden, attention is given to Multiregional Input/Output networks and dynamic Life-Cycle Assessment in the context of Industrial Ecology.

Internationally, the position is created to leverage our capabilities in the application of network theory and modelling dynamic systems in the domain of energy science, industrial ecology and bio-based systems. The domain of energy systems and industrial ecology poses questions that cannot be directly framed with currently available network theory. Evolving socio-technical systems can be modelled using System Dynamics, Agent-Based Modelling or Discrete Optimization. Positioned at the interface of networks, dynamics and complex systems modelling, applied to the Energy Systems and Industrial Ecology domain, we open up new avenues for theory development and new opportunities with modelling.

At the national level, IVEM is member of the national research school SENSE (Socio-Economic and Natural Sciences for the Environment), which brings together groups from Wageningen, Free University Amsterdam, Leiden and Utrecht.

The group has an extensive international network, including links with the Universities of Bremen, Lausanne, Yale, UCLA, Rutgers, Keio, and research institutes such as the International Institute for Applied Systems Analysis (IIASA) in Austria and the Wuppertal Institute in Germany.

7. Expected contributions to research

The candidate initiates and develops a competitive research programme around addressing “informing the energy transition, bio based and circular economy” at large, and through energy and industrial networks and dynamics in particular. Preferably, the programme interfaces with other research groups in ESRIG and other faculties of the UG, possibly via the Energy Academy Europe. The research programme should lead to publications in leading journals.

Obtaining substantial external funding for PhD projects is crucial. Supervision of PhD students is an important part of the research activities.

8. Expected contributions to teaching

The candidate will lecture in the teaching programmes within the faculty (Bachelor- and Master level), and contribute to Ph.D. student and post-graduate educational programs. In particular, it is expected the candidate will contribute to bachelor programmes with substantial energy-related elements, including the track "energy and sustainability" in physics and the university-wide minor programme People, Planet, Profit. At the Master level, the candidate will mainly be involved in the Energy and Environmental Science master programme. This includes the supervision of master students during their final research. He/she will supervise Ph.D. students and act as Ph.D. advisor (initially as “co-

promotor"). He/she will assume responsibility for the development of new course modules when appropriate.

9. Expected contributions to the organization

The candidate is expected to have an active interest and to provide a positive contribution to the management and organizational tasks of the institute. The candidate is an ambassador for ESRIG, and contributes to and leverages the university-wide "Energy" theme, and the Energy Academy Europe. At the level of the FSE, the candidate will contribute to the organization of the faculty, for example by participating in working groups and committees, in the fields of teaching, research and management. The candidate will participate in relevant national and international organizations.