

# Decarbonising Energy in Europe

CSEI Report 2019 – 2023

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# DECARBONISING ENERGY IN EUROPE

*CSEI Report 2019 – 2023*

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# PREFACE

*Since its creation in 2019, the Copenhagen School of Energy Infrastructure (CSEI) has evolved as a major voice within research in energy economics and European policy debate in the framework of a fully decarbonised energy infrastructure in Europe. This report accounts for the activities and achievements of the European Research Centre at the Department of Economics at Copenhagen Business School (CBS).*

With the establishment of the Copenhagen School of Energy Infrastructure (CSEI) as a European Research Centre in 2019, Copenhagen Business School made a major step towards becoming a leading voice in the debate around future European energy infrastructure and green transition following an idea by the European Commission.

CSEI today has a unique profile both as a research centre where excellent state-of-the-art research is conducted and as an important platform for stakeholders to engage in an informed energy policy debate.

In its first four years of activities, CSEI has published more than 90 publications, arranged more than 20 events with over 500 participants, set up cooperations with more than 60 actors in the field and – last, but not least – has emerged as an important advisor to the European Commission and the energy sector.

This would not have been possible without the commitment of our founding partners that have generously supported us in the first 5-year framework. We deeply thank our partners not only for their contribution to making this centre a reality but also for the dialogue, debates, and inputs along the way. The cooperation with our partners is a cornerstone for our work – access and cooperation with the sector enables relevant research and direct impact.

Soon after the founding of CSEI, we all experienced major challenges: The corona-pandemic from 2020-2022 made events and discussion in person impossible. The invasion of Ukraine by Russia in 2022 and the following gas and electricity crises made clear that well-known concepts and experiences – especially regarding energy prices and markets – must be reconsidered in the context of societal and political pressure. The focus on these challenges – along with the current climate crisis – has made our field of expertise even more crucial. The eco-

nomic framework is essential to ensure not only a fair and just green transition of the sector but also security of supply for all citizens.

CSEI covers more than the role of a pure research centre. At the core of our activities also stands the education of our students. With the lack of a skilled labour force in the energy sector, conveying a thorough education in the economics of energy to our students has become even more important. CSEI has introduced a minor in Energy Economics and Policy, which more than 300 students have joined since its creation – all of them possible candidates for jobs in the energy sector.

CSEI's role as an impartial platform for debate is key to our work. To ensure the societal impact of our research, we have actively established strong networks within the sector, including regulators, companies, and policy makers. CSEI is a member of the Energy Infrastructure Forum, that is held annually in Copenhagen. The European Commission with the Directorate General for Energy is an essential partner for us. The close and frank dialogue with the Commission, our partners and our network create the ground for CSEI's success.

We look forward to developing this success in the coming years – together with our partners, collaborators, friends, and stakeholders.

**Tooraj Jamasb**  
Director



**Philipp A. Ostrowicz**  
Coordinator



## PREFACE BY THE EU COMMISSIONER FOR ENERGY

Our Union, as we know it, is experiencing a crisis more difficult than we have seen for a long time. Whilst war is raging at our doorstep sending global energy markets into turmoil, we need policy choices that keep us on the path to climate neutrality by mid-century while safeguarding the security of our energy supply. Meanwhile, the affordability for our households and the competitiveness of our industry, which have been hit the hardest in the past year, must remain at the top of our agenda.

These manifold challenges we face require collaborative approaches to policymaking and pooling in expertise from all actors. This is where the Copenhagen School of Energy Infrastructure comes in. Established as a research centre within the Copenhagen Business School four years ago, the school has gradually developed into a supportive platform informing policymaking with a robust economic angle at the heart of energy systems, technology and regulation that enables a swift energy transition.

Infrastructure plays a pivotal role in delivering the European Green Deal and the REPowerEU objectives cost-effectively. Whilst striving towards independence from Russian fossil fuel imports, we are steadily developing a homegrown renewable energies based system. We have laid down the rules for future-proof infrastructure that is optimised, efficient and integrated between carriers so as to enable tomorrow's climate neutral energy system rethinking our fuel supply, our demand patterns, our energy networks and our energy trade relations.

The revised trans-European energy networks regulation, our single European energy infrastructure planning instrument, builds on the robustness of the Ten-Year Network Development Plan to deliver a fit-for purpose Union list of Projects of Common Interest (PCI list). The future lists will support offshore wind scale-up, further electrification, the development of a hydrogen backbone and the smartening of our grids.

Through their economic research lens, the Copenhagen School of Energy Infrastructure is looking closely at how to create and exploit new synergies in the planning of different energy networks and further integrate it with other sectors, such as transport, heating, and industry. The work by the school thus far has helped to identify

cross-sectoral linkages that impact the way we design, plan and implement cross-border infrastructure in Europe to the benefit of society overall.

On the no-regret path to diversify away from sources and supplies of energies used as a weapon against the European Union and its citizens, we must team up and improve our tools and approaches. CSEI's research will help guide our search for sustainable ways to radically overhaul European infrastructure in a socially just and fair way, while strengthening our competitiveness and the EU's position as leader in the global fight against climate change.

**Kadri Simson**

European Commissioner  
for Energy



## PREFACE BY CBS' PRESIDENT

When the proposal to establish a research centre within the field of energy economics was presented by the European Commission in 2016, Copenhagen Business School did not hesitate to take up this challenge. After an innovative and thorough process of fundraising, CSEI was established in 2019 as a European Research Centre at the Department of Economics with donations by major European and Danish companies from the energy sector.

The generous donations by the major donors made it possible for CBS to employ an excellent Endowed Professor together with a research team to carry out independent research at CBS on topics like economic regulation, the economics of the energy system, market design, business models, public acceptance, and many others. More than 90 publications since 2019 demonstrate the high level of research activity at the centre.

At the same time, it is a great pleasure to see that CSEI also already makes an important contribution to CBS' educational programs – the establishment of a minor in Energy Economics in our largest Master of Science-Program is one of the milestones with regard to CBS' impact on business life and society. With our candidates, CBS helps business life and industry to solve important societal challenges.

With its new strategy adopted in 2020, CBS has stressed the importance to help transform society with business by tackling challenges with curiosity, creative new ideas and collaborative engagement. One of the strategic areas that has been highlighted is the green transition, which is of strategic and central value for CBS. With its strong cooperation with the energy sector and the European Commission, CSEI will no doubt be a major player here at CBS – the energy sector is key to reach the target of full decarbonization and to tackle the climate crisis.

In addition, CSEI has already attracted further external funding for research projects, that will for example contribute to tackling the structure of future European energy infrastructure, the digitalization of the energy sector, the integration of decentralised energy production – to name just a few projects. CSEI's research is carried out at highest international standards and shapes societal impact at the same time.

For me, it is important to point out, that the basis for CSEI is the cooperation between the centre and its stakehold-

ers. Let me thank, once more, the donors, which have made it possible to establish CSEI as a European energy research centre in Copenhagen.

But also, let me thank the people behind CSEI, the director Tooraj Jamasb, who has been appointed in 2019, Philipp A. Ostrowicz, who has worked hard to bring this centre from idea to reality, and the researchers at the centre, who contribute every day to tackle the huge challenge of climate change.

I am looking forward to many more years for CSEI at Copenhagen Business School.

**Nikolaj Malchow-Møller**

CBS' President



## PREFACE ON BEHALF OF THE PARTNERS BY TRANSNETBW

The set-up of the Copenhagen School of Energy Infrastructure in 2019 was not only timely, but also the next logical step: to us, who have gathered here today, it has always been clear that there is no way around adequate energy infrastructure if Europe is to achieve its ambitious energy and climate policy objectives. The CSEI has ever since its set-up been closing a gap by providing crucial research, advising policy makers, and providing a discussion forum for the relevant stakeholders.

Today, it is clearer than ever that the implementation of the energy transition is not moving along fast enough. If anything, it would have to be sped up significantly to adequately address the current challenges related to climate change and supply security. In this context, we are faced as much with a mix of 'new' and 'old' challenges as we are with a set of opportunities that are opening up to us. Just to mention a few:

We must think European and move from a national perspective towards pan-European solutions, in order to cope with the uncertainties of the future power system, while ensuring the most cost-efficient development of energy infrastructure.

The national and European network development plans, such as the Ten-Year Network Development Plan (TYNDP) of ENTSO-E, are a key instrument for the coordinated approach to long-term electricity system planning, connecting borders, sectors, and regions. That being said, the methodologies and output of the network development should be subject to constant review and improvement.

We need to better understand and analyse the situations with adequacy risks in order to define the mandatorily coordinated EU steps. Which incentives and penalties are needed in order to prevent a fallback on national solutions in an emergency case?

Permit granting and public acceptance remain complex, slow, and a source for significant delays across most infrastructure categories and across Europe. The problems are multi-layered which is why there is no silver bullet that will provide for a simple solution. The expansion of infrastructure must, overall, be better communicated to the society.

As we phase out conventional (fossil fuel-based) generation from the power system, we not only need to replace "capacities" but also "capabilities", such as flexibility,

voltage control, frequency control, and black-start capability. This issue is multi-angled. It is as much about innovation and technology as it is about economics and market design. "How can flexibility be incentivised?"; "how can the potential of flexibilities be activated" and "what additional costs are associated with this?" are just some of the central questions we see.

The construction of Europe's Internal Energy Market has been challenging. However, the past year has also shown how much welfare is at stake and can be destroyed when energy prices rise above certain levels. I therefore believe, the European Commission is right in their assessment to review, with high priority, certain aspects of the market design. This, however, should not be done hastily but carefully thought through.

To put it in a nutshell, we are currently living through exceptional circumstances. Yet, even in 'normal' times – if such a thing has ever existed in the energy sector – there is an awful lot of sophisticated analysis to be conducted. I am therefore pleased that we can count on the CSEI to contribute to this research. I am pleased to see that, over the past three years, the CSEI has been adding competence across a range of fields, which is also reflected in its output.

I'd therefore like to express my sincere congratulations and I am very proud that TransnetBW has been given the opportunity to support and contribute actively to the CSEI's work. I would like to take this opportunity to reemphasise our commitment to the School and I am looking forward to future research projects and exchanges.

Dear Tooraj, dear Philipp, dear Klaus-Dieter Borchardt, congratulations, not only on the anniversary, but also on having founded the CSEI as a school closing some important research gaps which have existed so far in Europe.

Well done and all the best for the future.

**Michael Jesberger**  
TransnetBW  
Executive Board





# CSEI FROM 2019 TO 2023

*The Copenhagen School of Energy Infrastructure is a European Research Centre for independent research in energy economics, regulation, and policy analysis. CSEI strives to generate and disseminate original knowledge, promote debate, and support education on energy systems, markets, and infrastructure to foster green energy transition and decarbonisation of the European Union and globally.*

## MAIN ACHIEVEMENTS

In 2023 the Copenhagen School of Energy Infrastructure (CSEI) is an independent research centre at Copenhagen Business School (CBS) with a team of 14 faculty and staff embedded at CBS' Department of Economics. The centre has published more than 90 scientific papers since 2019, established a minor in Energy Economics and Policy in CBS's largest study programme MSc in Economics and Business Administration, and is a prominent and renowned actor within the policy debate on the future European energy infrastructure with a strong network to research institutions, governments, and the energy sector.

The main achievements are based on the three essential pillars of CSEI: research, education, and dissemination and impact. This following presents a brief overview of these main achievements – described in detail later in this report.

### Research

From 2019 to 2023, CSEI has published more than 90 scientific papers and established the CSEI Policy Brief series that is essential to disseminate research content to a broader public sphere including policy makers and actors from industry. The research conducted at CSEI is freely accessible and contributes to the discussions in the energy sector. As the impact for stakeholders, policy makers and the general public based on CSEI's research is essential, the research strategy focusses on several key research topics highly relevant for the sector.

In addition to centre activities within our research team's main research areas, CSEI has ventured into several

research projects. These projects are based around research areas of strategic importance, and have expanded CSEI's research portfolio. Projects on digitalisation of the energy sector, hydrogen, and public acceptance are just a few examples. From 2022 to 2023 CSEI has assessed the methodology for the TYNDP process in a research project funded by the European Commission and in dialogue with the relevant stakeholders including ENTSO-E, ENTSO-G, and ACER among others. The findings will be included in the revision of the TYNDP methodology in the future.



*Inauguration of CSEI Honorary Professor Klaus-Dieter Borchartdt at CBS, November 2022.*

## Education

In discussions with stakeholders it became clear that the energy sector lacks skilled labour force: Not only in the field of engineering but also within energy economics. When CSEI was established in 2019, Copenhagen Business School (CBS) has had no educational programme directed to the energy sector. Therefore, CSEI introduced a minor in CBS' largest Master study programme in Energy Economics and Policy to foster knowledge on the economics of the energy sector among CBS' university graduates. Since its establishment, the minor and CSEI courses have attracted more than 300 students and is steadily growing. With this, CSEI is actively supporting the sector by educating young talents and creating essential impact on the labour market.



*Visiting Professor Anne Neumann giving a guest lecture on gas storage in the energy crisis at CBS, September 2023.*

## Dissemination and impact

To create impact with its research, CSEI has actively engaged in dissemination and outreach activities. From the start, CSEI has been a member of the EU Commission's Energy Infrastructure Forum in Copenhagen which CSEI is continuously contributing to. The EU Commission has been actively engaged in CSEI. The director of unit C4 holds the co-chair of the CSEI Advisory Board and in 2023 CSEI has met bilaterally in Copenhagen with the EU-Commissioner for Energy, Kadri Simson, to discuss challenges and future activities. Regular CSEI workshops for the partners including the Commission are a core activity of the centre and allow direct discussions on current challenges.

The current IPCC 2023 report mentions six different CSEI publications, when discussing energy system integration, R&D, efficiency, and peer-to-peer trade. CSEI is also continuously active in several fora and events to disseminate current research.

*“TransnetBW welcomes the Copenhagen School of Energy Infrastructure (CSEI) conducting research on the European energy infrastructure from an economic policy point-of-view. We especially appreciate the practical oriented CSEI research scope, not limiting its activities to theoretical research. In order to achieve pragmatical results, CSEI regularly brings the relevant stakeholders together, such as the European Commission, manufacturers, industry, and grid operators from the electricity, gas and hydrogen sector. The successful, efficient integration of enormous amounts of volatile renewables, often far away from the load centres, can only succeed if academics, policy makers and industry work together on feasible solutions. For this reason, TransnetBW considers the exchanges promoted by CSEI, based on its relevant research, as an important possibility of dialogue. TransnetBW has greatly appreciated the cooperation in the last years, and we look forward to further fruitful exchanges as a CSEI partner.”*

**TransnetBW**

## CREATION OF CSEI

The Copenhagen School of Energy Infrastructure (CSEI) is created as a European research centre at Copenhagen Business School (CBS). The centre acts also as an independent and neutral platform to bring together different stakeholders from the energy sector to engage in the debate around current challenges.

### The idea

In 2016 the European Commission initiated the idea to create a research centre in Copenhagen that might focus on the future of European energy infrastructure from an economic point of view, and CBS did not hesitate to take up this challenge. The European Commission had just created the Copenhagen Energy Infrastructure Forum in 2015 and it became clear that policy relevant research on the economics of a fully decarbonized energy infrastructure would be essential.

At that time, CBS had a large research group with internationally renowned scholars in the field of sustainability, which had been a research focus at CBS for many years. Despite having several scholars who worked on the economics of transitioning to a green industry, a distinct research group within energy economics had not been established. Also, in its educational programmes, the topic of the energy sector transformation was not present in a significant sense.

Therefore, the endeavour of creating a European research centre based on an idea by the European Commission seemed appealing to the Senior Management of CBS and the process to found and establish such a centre was set in motion. The idea was presented to the public for the first time in 2016 at the second Energy Infrastructure Forum in Copenhagen by CBS' Dean of Research. A process to raise funds from the sector was initiated in cooperation with the Danish TSO Energinet. On this occasion it was decided to call the centre "Co-

penhagen School of Energy Infrastructure" inspired by the "Florence School of Regulation".

The aim was clear: To create a truly European research centre with a renowned professor in the front, generate excellent research in the area of energy economics and enable close cooperation with a broad base in the sector. The fundraising programme entailed a five-year-partnership to establish the centre – all contributions by the sector were to be given as donations to make sure that CSEI would be able to conduct the much needed fully independent research.

### Dialogue with the energy sector

In 2017 and 2018 the dialogue with the sector was intensified and seven partners accepted to be major donors to establish CSEI. The partner group consists of Copenhagen Infrastructure Partners (CIP), a fund management company specialized in offering tailor-made investments in energy infrastructure assets globally, the German gas TSO GASCADE, a partnership of three European electricity TSOs including Tennet, Statnett and Energinet, the French gas TSO GRTgaz, the Rambøll Foundation that is behind the Rambøll consulting company, the European gas DSO association GD4S from eight European countries, Siemens A/S and the German electricity TSO TransnetBW.

The founding partners of CSEI agreed to a funding model that secured full independence of CSEI as a research centre within a Danish public university. All contributions by the partners were in the form of donations in a 5-year-framework without any expectation of quid pro quo by CSEI. This was to ensure impartiality as a cornerstone of CSEI's research and its credibility. All research conducted by CSEI is free and accessible without interference of third parties.

*“GASCADE joined CSEI as a founding partner in 2018. Being a German on- and offshore transmission system operator for hydrogen and natural gas we appreciate the scientific view and neutral economic analysis CSEI brings into ongoing debates on the European energy transition. CSEI actively facilitates the necessary dialogue between policy makers, researchers, and the industry on the challenges of a future sustainable energy infrastructure. For GASCADE the scientific engagement of CSEI in the field of offshore infrastructure for hydrogen in a European context is of special interest. It provides more economic knowledge regarding the potential of offshore hydrogen and helps relevant industry players to understand the scientific view on this topic. Therefore, we would like to thank Philipp Ostrowicz, Tooraj Jamasb and their highly professional team for the very good work and the inspiring insights.”*

**GASCADE**

## **CSEI is launched**

The opening on November 18th, 2019 marked the official launch of CSEI as a European Research Centre at the Department of Economics at Copenhagen Business School with opening remarks by Klaus-Dieter Borchardt, Deputy Director General, DG Energy, European Commission, the Danish minister for climate, energy and utilities Dan Jørgensen, the CEO of Energinet, Thomas Egebo, the CEO of GASCADE, Christoph von dem Bussche, Roar Amundsveen from the Norwegian Water Resources and Energy Directorate (NVE), and finally Prof. Jean-Michel Glachant, the Director of Florence School of Regulation (FSR).

In 2018 the work to substantiate the setup of the centre was initiated and it was decided to establish a CBS Endowed Professorship in Energy Economics at the Department of Economics. The recruitment process was conducted in accordance with CBS' policy on appointment without advertising. According to this policy, the president can appoint a search committee which examines the national and international professional “market” based on the job description and issues a statement to the president which contains a list of appropriate candidates.

The search committee consisted of four renowned scholars within the field: Prof. Catherine Waddams from Norwich Business School, University of East Anglia, Prof. Per Joakim Agrell from UC Louvain, Prof. Jean-Michel Glachant from Florence School of Regulation, Prof. Peter Bogetoft, Copenhagen Business School and the Head of Department, Prof. Lars Peter Østerdal. In a thorough process and in numerous meetings, the search committee discussed candidate lists, and in the end proposed one candidate to the rector and the respective CBS' committees.

At this time CSEI consisted of Prof. Tooraj Jamasb as the director and a small research team with one PhD, one Postdoc and a student assistant. The coordination of the centre continued to be in the hands of Philipp A. Ostrowicz who was in charge of the setup of the centre and the fundraising process in cooperation with Energinet.



*CSEI Dinner with Commissioner Kadri Simson, June 2023.*



## *CO<sub>2</sub> Lock-In by the Swedish art duo Bigert & Bergström*

In cooperation with the CBS student organisation CBS Art CSEI has supported an art exhibition of carbon dioxide molecules in metal with large foot shackles by the Swedish art duo Bigert & Bergström. Each of the cast-iron molecules weighs about 300 kilograms, which corresponds to the average person's carbon dioxide emissions for two weeks in the EU, according to the Swedish Environmental Protection Agency. The sculptures were inaugurated on Responsibility Day on September 1st by Mats Bigert from the art duo and has previously been exhibited at the Stockholm School of Economics. The scope for CSEI's involvement was to raise attention to the importance of CSEI's work regarding the green transition of the energy sector.



### **CSEI's growth and prosperity**

CSEI has been growing ever since its opening. Today, in 2023, the centre has 14 team members. CSEI has contributed to CBS study programmes and developed a minor in Energy Economics, several other courses, and has a stake in CBS' yearly Summer School. Regarding research, CSEI has attracted funding for more than ten research projects and published more than 90 scientific papers.

The current team of CSEI benefits from its interdisciplinarity. Economists and engineers work closely together on developing future concepts and solutions for the energy sector. With methods from both disciplines, CSEI is able to approach energy economics with a technology-informed mindset and discuss topics from different angles. Energy system analysis, productivity and efficiency analysis, and the toolbox that microeconomics and regulatory economics offer serve as the basis for most of CSEI's work and are enriched by the engineering backgrounds of CSEI's members.

At the core of CSEI is the dialogue with both the energy sector and the European Commission. Since 2021,

CSEI has been working on a research project on the Ten-Year-Network-Development-Plan (TYNDP). The project is funded by the European Commission and aims to lead to improvements of the methodology regarding the scenario building for the future European Energy Infrastructure. This project is carried out in close dialogue with DG Energy, the European regulator ACER, and the two TSO-entities ENTSO-E and ENTSO-G.

To make its research visible and accessible, CSEI has launched a series of Policy Briefs that provide insights into CSEI's current research in an easy-to-read version. Also, CSEI's research is mostly published open access – free and publicly available.

### **CSEI in the future**

The decarbonisation of the European energy sector remains challenging, security of supply has again become a major focus following the energy price crisis in 2021 and 2022. It is our clear expectation that CSEI will be growing in capacity and variety of activities in the years to come - with the energy sector and the European Commission as a strong supporter and dialogue partner.

## THE TEAM

The Copenhagen School of Energy Infrastructure (CSEI) is a European Research Center at the Department of Economics and Copenhagen Business School (CBS). The research center benefits from its interdisciplinarity with a team of researchers in junior and senior positions. Economists and engineers work closely together on developing future concepts and solutions for the energy sector. With methods from both disciplines, CSEI is able to approach energy economics with a technology-informed mindset and discuss topics from different angles. Energy system analysis, productivity and efficiency analysis, and the toolbox that microeconomics and regulatory economics offer serve as the basis for most of CSEI's work and are enriched by the engineering backgrounds of CSEI's members.



### Tooraj Jamasb

*Director and CBS Endowed Professor of Energy Economics*

Tooraj Jamasb is CBS Endowed Professor of Energy Economics and Director for Copenhagen School of Energy Infrastructure (CSEI). He has previously held posts as Chair in Energy Economics, Durham University; SIRE Chair in Energy Economics, Heriot-Watt University; and Senior Research Associate, University of Cambridge.

Tooraj is a Research Associate at Energy Policy Research Group (University of Cambridge); Centre for Energy and Environmental Policy Research (MIT); and Oviedo Efficiency Group (University of Oviedo). He is a member of the academic panel of the UK Energy Regulator Ofgem. He is a member of international advisory board of Energy Policy and Associate Editor of The Energy Journal and Energy Strategy Reviews Journals.

He has over 130 peer reviewed journal articles, books, and book chapters and is on the Stanford list of top 2% scientists worldwide (1% in energy, economics, and enabling and strategic technologies). He is co-editor of the inter-disciplinary books The Future of Electricity Demand: Customers, Citizens and Loads, 2011; Delivering a Low-Carbon Electricity System, 2008; and Future Electricity Technologies and Systems, 2006; all published by Cambridge University Press.

Tooraj has participated in various research and consulting projects for the Council of European Energy Regulators, European energy regulators, energy companies, Ofgem, Department of Energy and Climate Change (UK), and The World Bank.

## Philipp A. Ostrowicz

*Senior Research Advisor and Coordinator*



Philipp A. Ostrowicz is in charge of policy development, stakeholders, budget and cooperation for the centre. He has been working towards the establishment of CSEI since 2016 and has raised the funds for the creation of the centre.

Philipp holds a PhD from the University of Tübingen and has been engaged in university strategy and fundraising for many years. He also teaches within the field of German Studies at CBS. Before joining CBS, he held a position as Assistant Professor at the University of Tübingen and was a Project Manager for seven Danish and German Universities at the University of Southern Denmark.

He is member of the steering group of the Danish Centre for Energy Storage, represents CBS at the Danish Energy Cluster, is a member of the Advisory Board to TransnetBW's study Adequacy 2050, a member of the PRME Advisory Board at CBS and a Steering Group member of CBS Maritime.



*Team photo taken at CSEI's workshop in August 2023.*

*From left to right, front: Jens Weibezahn, Alexandra Lüth, Tooraj Jamasb. Back: Manuel Llorca, Christopher Dirzka, Johannes Giehl, Christine Brandstätt, Philipp A. Ostrowicz.*

## Christine Brandstätt

*Assistant Professor*



Christine Brandstätt is an Assistant Professor with CSEI and a visiting fellow with the Oxford Institute for Energy Studies. Her main research interest is in network regulation, pricing, and market design. In her research, she analyses the interactions of different regulatory, market design, governance structures and policy options in energy systems. She previously held research positions at Fraunhofer IFAM, Jacobs University and Bremer Energie Institut. In these capacities, she has participated in and led research projects on flexible network users, smart grids, and the integration of renewable energy sources into energy systems.

She obtained her PhD in Energy Economics from Jacobs University Bremen and holds master's degrees from Kungliga Tekniska Högskolan in Stockholm, École des Mines in Nantes and Universidad Politécnica in Madrid within the Erasmus Mundus joint programme in Management and Engineering of Environment and Energy.

Christine currently teaches a master's level course on Energy Economics and Policy in CBS' Summer University and a course on Energy Markets, Competition, and Regulation. She has recently co-authored a book on *Electricity Distribution Networks in the Decentralisation Era* and published on strategic behaviour in redispatch markets. Looking both at the *international experience* and the *theoretical framework* the papers show that welfare-limiting strategic behaviour is largely linked to market power, which can be limited by adequate market design. Her earlier contributions discuss amongst others *curtailment agreements*, *locational network pricing* and *governance of distribution grids* as tools to integrate increasing shares of renewable electricity, especially at distribution level.



## Christopher Dirzka

*Postdoctoral Researcher*

Christopher Dirzka is a Postdoctoral Researcher with CSEI and CBS Maritime. The role involves bridging the gap between onshore energy markets and offshore operations with a particular focus on the clean energy transition. Besides, Christopher is seconded to the Mærsk Mc-Kinney Møller Centre for Zero Carbon Shipping, working on green corridors. Prior to joining CBS, Christopher pursued studies in International Business and Supply Chain Management.

In his research, Christopher studies spatial network designs, inter-organizational ties, and sustainable operations. Lately, the paper *Global shipping network dynamics during the COVID-19 pandemic's initial phases* and the subsequent co-authored book *Ocean container network dynamics during the COVID-19 pandemic* were published, addressing the impact on network structure by the pandemic. Currently, Christopher works on *Going outside the pastures: Transgression in alliances* (Nowinska, A., Schramm, H. J., and Dirzka, C. 2023), which analyses why organizations within formalized groups seek ties outside of the group and *Sailing as one or as many? Strategic multiplexity perspective and corporate social responsibility* (Dirzka, C., and Acciaro, M. 2022), which investigates the implications of multiplex ties on corporate social responsibility.



## Johannes Giehl

*Postdoctoral Researcher*



Johannes Giehl started as a Postdoc with CSEI in mid-2023. His research in energy system transformation focuses on renewable hydrogen and energy infrastructure development, energy economics and sector coupling business models. He investigates the operation and power-to-X business models of energy hubs as well as the impact of the regulatory framework and market development of renewable hydrogen. He studied at the Technische Universität Berlin and the Pontificia Universidad Católica de Chile and holds a B.Sc. and M.Sc. in industrial engineering. The focus of his master was on energy management and energy system modelling.

The research of his PhD project at the chair of Energy and Resource Management at the Technische Universität Berlin focused on the changes to the energy system and infrastructures due to the energy transition. He investigated the opportunity for new sector coupling business models of renewable hydrogen and the political, regulatory measures that promote them. His publications are primarily part of his dissertation project. The paper *Economic analysis of sector coupling business models: Application on green hydrogen use cases* focuses on hydrogen business models and the impact of the regulatory framework. His recent publication *Evaluation of hydrogen transportation networks - A case study on the German energy system* presents an approach to develop hydrogen networks candidates by converting the existing natural gas grid and evaluate the cost.



## Manuel Llorca

*Assistant Professor*

Manuel Llorca has been with CSEI since 2019 and is an Assistant Professor since August 2023. He was previously a Research Fellow at Durham University and Early Career Fellow at Durham Energy Institute. He holds a PhD and a master's degree in economics from the Universities of the Basque Country, Cantabria, and Oviedo. His research interests include economic performance, innovation, and regulation of energy networks, energy poverty, energy efficiency and rebound effects, energy sector reforms, and energy systems integration.

Manuel's research is aligned with current EU policy issues, such as the implementation of the energy efficiency first principle or the committal of the EU to tackle energy poverty and protect vulnerable consumers along the green transition. Manuel has given lectures in several bachelor and master courses on Environmental and Energy Economics at CBS. Moreover, he is the coordinator of the graduate *Minor in Energy Economics and Policy*. His most important publication is *A new approach to measuring the rebound effect associated to energy efficiency improvements: An application to the US residential energy demand*. This paper proposes a new methodology to study rebound effects and has been applied to analyse the phenomenon in diverse countries and sectors. Manuel's most recent publication is *Energy network innovation for green transition: Economic issues and regulatory options*, where alternative solutions to fostering innovation in energy networks in Europe are discussed.

## Alexandra Lüth

*Postdoctoral Researcher*



Alexandra Lüth is a Postdoc with CSEI. Her research focuses on energy economics, energy system analysis, and energy system modelling. Educated as an industrial engineer with a bachelor's and master's degree from TU Berlin, Germany, and a master's degree in Sustainable Energy Systems and Markets from NTNU, Alexandra takes her technical expertise to enrich the economic research. Prior to the Postdoc, Alexandra did her PhD at CSEI with a project focused on the economic aspects of sector coupling at sea as well as social, economic, and ecological aspects of decentralized energy technology. Alexandra teaches a course in Energy System Economics and Modelling and has in the past helped to develop and teach a bachelor course in Energy Economics.

In her relatively young research career, she has so far published mainly on the issue of local electricity markets and energy communities. The paper entitled *Local electricity market designs for peer-to-peer trading: The role of battery flexibility*, has received a lot of attention in recent years. It describes and discusses the patterns and role of batteries in energy communities and finds that they enable a relevant in local systems. Alexandra's recent work focuses more on energy system integration at sea with a recent paper publication *How to connect energy islands: Trade-offs between hydrogen and electricity infrastructure*, which discusses the integration of offshore energy generation into onshore systems.



## Kristoffer Rae

*Project Manager*

Project manager Kristoffer Rae is responsible for CSEI's daily administration, communication, and specific projects. He is a dual citizen of Denmark and the United States, has master's degrees in international relations from Aalborg University and the University of International Relations in Beijing, China. He has worked with building bridges between the Danish and African start up ecosystems, as well as spearheading cultural promotion for the Embassy of India.

Through his degrees and previous roles, he has developed an understanding of the unique challenges that face international projects and how to tackle them head on.

## Jens Weibezahn

*Assistant Professor*



Jens Weibezahn is an Assistant Professor and Marie Skłodowska-Curie Fellow with CSEI. He holds a PhD in Economics from Technische Universität Berlin and was a Research Associate at TUB's Workgroup for Infrastructure Policy (WIP), where he is now a Guest Researcher. Having studied at TU Berlin and the University of California, Berkeley, he has a background in industrial engineering and management with a concentration on energy and transportation infrastructure.

His research mainly focuses on flexibility options, sector integration, decentralization, and planning and market design in energy systems using – amongst other methods – open-source energy system models. Jens teaches the course Operationsanalyse (Operations Research) in the BSc HA(math.) program at CBS. His most-cited paper is *Two price zones for the German electricity market — Market implications and distributional effects*. This paper applies an electricity sector model with network representation to analyse the system implications and the distributional effects of introducing bidding zones in the German electricity system – a still ongoing discussion. Jens' most recent publication is *How flexible electrification can integrate fluctuating renewables*, where the potential role of flexible loads from heating, transportation, and industry – but also electrolyzers – for the integration of solar and wind in Europe are discussed.



## Klaus-Dieter Borchardt

*Honorary Professor*

Klaus-Dieter Borchardt has served the European Commission as leading civil servant for more than 25 years. As Director for Unit B from 2013-2018 and Deputy Director from 2019-2020, he established the Copenhagen Infrastructure Forum and has been the decisive person for the EU Commissioner's Miguel Arias Canete's proposal to establish Copenhagen School of Energy Infrastructure at CBS in 2016.

Dr. Borchardt has both the first and second degree in Law as well as a PhD in Law and is since 2001 teaching professor at the University of Würzburg in Germany. He has authored numerous articles related to law and the energy fields. Since his retirement last year, Klaus-Dieter Borchardt is active as Senior Advisor for Backer McKenzie and one of the leading figures in the field of energy advisory, where he is advising large companies from the energy sector.

## International Affiliates

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Michael Pollitt (Professor of Business Economics, Cambridge Judge Business School), Carlo Cambini (Professor in Applied Economics, Polytechnic University of Turin), Rabindra Nepal (Associate Professor, University of Wollongong, Australia), Daniel Davi-Arderius (Associate Researcher, Chair of Energy Sustainability (IEB), University of Barcelona), Anupama Sen (Head of Policy Engagement, Smith School of Enterprise and the Environment at the University of Oxford), Christian von Hirschhausen (Professor for Economic and Infrastructure Policy at Technische Universität Berlin), Monica Giuletti (Professor of Microeconomics Loughborough Business School).

## Student Workers

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Student workers at CSEI have gone on to exciting institutions such as: Grantham Research Institute on Climate Change & the Environment, McKinsey & Company, Danish Institute for International Studies, Capgemini Invent, Heliac, and BIMCO.

Our current student workers are Peter George, Maria Hansen Eguiluz, Dana Hentschel, Frederik la Cour, and Pantelis Spanidis.

## Alumni

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Chenyan Lyu - University of Exeter

Ida Damsgaard - Rambøll

Nisan Gorgulu - World Bank

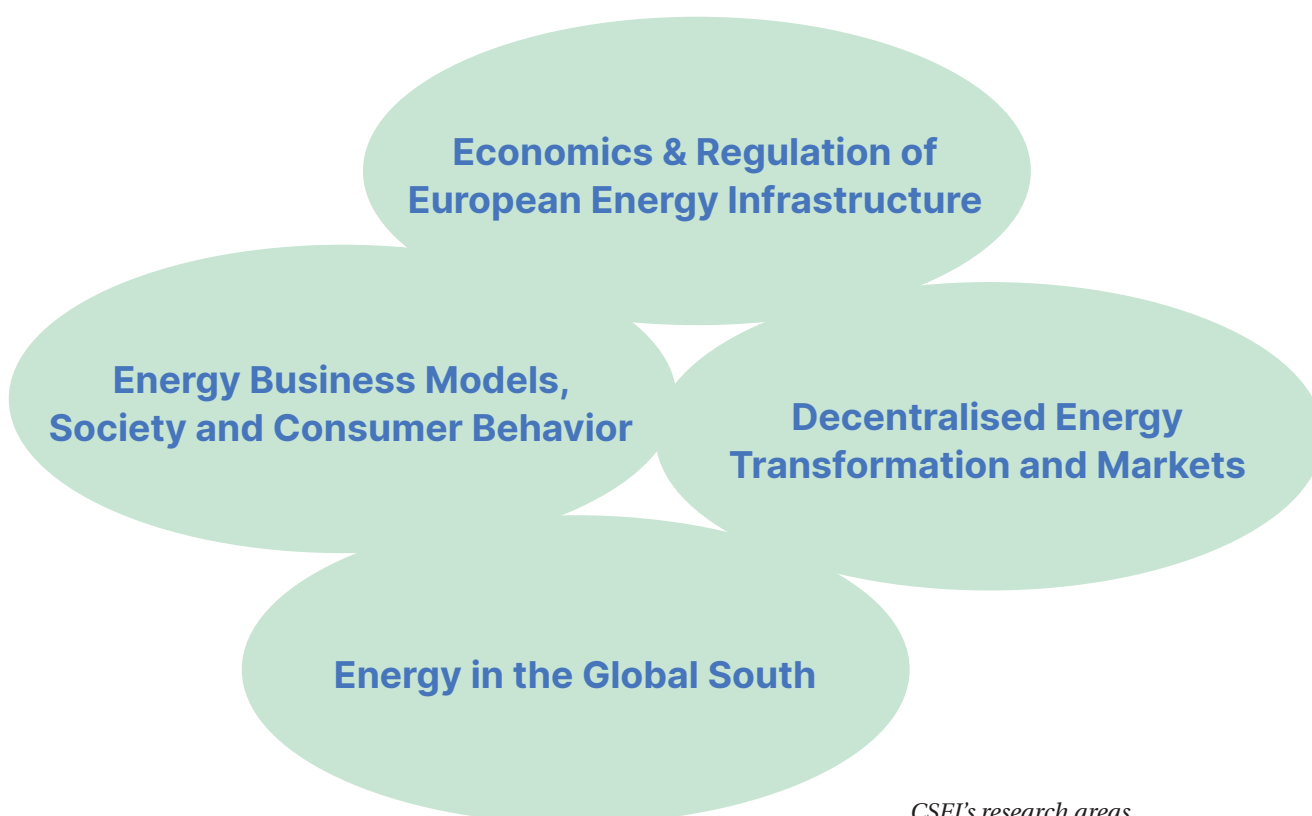
## Visiting Scholars

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Visiting fellows at CSEI include Prof. Ricardo Scarpa (Durham University), Prof. Parantap Basu (Durham University), Prof. Luis Orea (University of Oviedo), Tian Zhou, Beatriz Couto Ribeiro (TU Berlin), and Prof. Anne Neumann (NTNU).

# RESEARCH & IMPACT

*CSEI's research within the field of energy economics spans over a broad variety of topics – including economic regulation, business models, markets, consumer behaviour, and energy in the global south. CSEI has created four different research topic groups, coordinated by a CSEI specialist on the topic.*



## **Economics & Regulation of European Energy Infrastructure**

- Energy System Integration (ESI)
- Ten-Year Network Development Plan (TYNDP)
- Trans-European Energy Networks (TEN-E)
- Hydrogen infrastructure
- Power-to-X
- Energy islands

Energy infrastructure represents the backbone of the energy system and will play a crucial role to achieving the decarbonisation goals. The implementation of the

European Green Deal as a top priority and the strategies and policies that have followed, have a direct influence on network development and consequently on the future energy grid. Due to the challenges that these will pose to an increasing number of stakeholders, the Ten-Year Network Development Plan (TYNDP) will be under deep scrutiny. CSEI helps to improve the TYNDP process and other essential pillars (e.g., application of CBA and CBCA, identification of PCIs, revision of the TEN-E regulation) for the evolution of European energy infrastructure by offering an academic and economic perspective in the analysis of different aspects related to governance, regulation, organisation, and implementation.

## Energy Business Models, Society and Consumer Behavior

- Business models
- Digitalisation
- Energy poverty
- Consumer behaviour
- Public acceptance

As the energy system becomes increasingly integrated and complex, significant coordination is required. At the same time, this gives rise to innovative business models, changes in consumers' behaviour, and the redefinition of the roles and interactions between different actors in the sector. Digitalisation emerges as an enabler for this new setting and is expected to incentivise efficient behaviours and the materialisation of new business opportunities.

## Decentralised Energy Transformation and Markets

- Decentralised renewables development and integration
- Energy sharing in local networks
- Consumer Power Purchase Agreements (PPAs)
- Future electricity markets

Renewable energy technologies differ significantly from fossil power generation in sizing, siting, and variability. Smaller capacities are spread out over various places of the country and require a change in network infrastructure and operation as well as they may induce adjustments to the market design. While the characteristics differ, also the costs of technology for solar photovoltaics (PV) and batteries decreased over the past years and allowed not only large actors to generate power but also small entities such as single households or small firms. The combination of both opens new opportunities and need for research. CSEI participates in researching the development of decentralised energy generation and its implications.

*"Energinet wishes to extend our congratulations to the Copenhagen School of Energy Infrastructure (CSEI) for their achievements over the past five years. To succeed with the second phase of the green energy transition we must break away from conventional thinking and come up with new ideas and new solutions. In this regard, CSEI has been, and will be instrumental. Delivering high quality independent academic research, CSEI pushes our collective understanding and makes a valuable contribution in ensuring that we make the right and timely decisions necessary in our mission to decarbonise our planet. Infrastructure will be a key facilitator to reach the 2030 and 2050 targets. We therefore strongly support CSEI's research on how to optimize the role of infrastructure, exploiting the potential of sector coupling, while delivering on the three EU energy pillars.*

*Undoubtedly, one of CSEI's most significant achievements lies in fostering invaluable dialogues between and across industry, policymakers and academia. We urge CSEI to keep communicating and engaging!*

*Energinet wholeheartedly commends CSEI for its dedication, impact, and invaluable contributions to the energy transition. Here's to five years of excellence and to many more ahead. We look forward to continuing productive exchanges as a CSEI partner."*

**ENERGINET**

## Energy in the Global South

- Energy sector reform and development
- Electrification
- Institutions
- Social welfare
- Development

In recent decades, countries in the Global South have started reform programmes with the objective of intro-

ducing policies, regulations, and institutions, to increase the efficiency of their energy sectors and to promote social welfare and economic growth. Despite the relative success in fostering private sector participation and the creation of competitive markets, in general energy sector reforms have not yet delivered the promised goals. In general, the energy sector in the Global South is still characterised by high subsidies, investment constraints, low service quality and electrification rates, high technical and commercial losses, and capacity shortages, among other issues. In this context, global climate goals impose an additional burden to countries that are in need of focusing on their own energy and development issues.

## RESEARCH PROJECTS

Between 2019 and 2023, CSEI has applied for 17 projects and has received funding for eight projects, with five projects still under review. The funding for these projects spans over a broad variety of sources, from Danish national funds, Nordic Energy Research funds to Horizon 2020 and funds directly from the European Commission. CSEI projects include:

**TYNDP 2020:** CSEI was commissioned by the European Commission to assess the TYNDP 2020 scenarios with a particular focus on the identification of methodological aspects and provide recommendations to improve these on the basis of energy economics research. The motivation was to assess the TYNDP scenarios and assist the policy framework with a view to inform the TYNDP 2020 as well as future development plans.

*Completed in April 2021.*

**STEERS** aimed to assess the methodology of the ten-year network development planning (TYNDP) against the state of knowledge on sector integration and system modelling. In order to support the European decarbonization targets energy network planning, i.e., the TYNDP process, needs to incorporate energy system integration and energy efficiency throughout. By proposing incremental and pragmatic changes the project aimed to contribute to a coherent TYNDP methodology that

supports the delivery of a smart and efficient integrated energy system.

*Completed in June 2023*

**NRGcitizens:** There is a mismatch between developed market designs and their feasibility in the current regulatory framework. The project NRGcitizen therefore addresses the following research questions: What are advantages and disadvantages of a decentralized energy transformation from a system perspective? How could organizational models be designed and what business models arise in energy communities? What are possible market designs for a 100% renewable energy transformation, integrating the heating and transportation sectors?

*Project period: 01/22 – 12/23*



*STEERS stakeholder workshop in Brussels, October 2022.*



**ENERforsk** is a network to connect energy researchers in Denmark (and neighbouring countries). Frequent and continuous exchange across institutions and research groups within the country shall facilitate collaboration and help bundle qualifications into multi-disciplinary clusters. The initiative has a focus on supporting junior researchers through quarterly workshops, offers one annual topical full-day workshop and hosts the annual “Sustainable Energy Day” Conference.

*Project period: 01/22 – 12/24*

**NordNET** focuses on the energy transition, transport modelling, energy market modelling, and the coupling thereof. It brings together world-class education and research groups from higher education institutions from Denmark, Finland, Norway, and Sweden working on these topics. The added value from the network is the interaction of topic experts leading to the creation of more knowledge valuable to all societies. The project team brings together interdisciplinary experience from energy sector modelling, energy system modelling, transport modelling, electrical engineering, and economics.

*Project period: 01/22 – 12/24*

**Nord\_H2ub** delivers insights into the characteristics of optimal production of hydrogen, ammonia, and other electrofuels, including cost and cost structures for production, storage, and transportation. It will also provide knowledge about demand side characteristics, such as volumes, locational distribution, and emissions.

*Project period: 09/23 – 08/26*

**EDDIE** creates a decentralized, distributed, open-source Data Space, aligned with directions of the work on the

Implementing Acts on Interoperability and other European activities. This European Distributed Data Infrastructure for Energy (EDDIE) lowers data integration costs drastically because the resulting EDDIE Framework lets energy service companies work and compete in a common European market. EDDIE’s vision is to make it cheap and easy for smart, data-based energy-related services to operate on a common European Energy Data Space.

*Project period: 01/23-12/25*

**INNO-CCUS** studies the factors deciding public acceptance and legitimacy in the placement of far-shore, near-shore, and on-shore CCUS and related infrastructure in Denmark. This analysis will be done through surveys, focus group interviews, data collection, and the estimation of acceptance and preference relations for diverse types of CCUS technologies.

*Project period: 01/23-12/25*



*Kick-off meeting for the EDDIE project in Vienna, March 2023.*

## SCIENTIFIC OUTPUT

Between 2019 and 2023, CSEI has published more than 90 scientific papers and created a Policy Brief series, that make scientific content available in an easy-to-read manner for the industry, policy makers, and the public at large. At the same time most of the current research is

reflected in CSEI’s Working Paper Series, that is accessible to everybody for free on our homepage.

At the end of this report there is a list of CSEI’s publications.



## EDUCATION

When CSEI was established in 2019, CBS had a strong track record and research environment in sustainability – but the energy side was lacking, despite some prominent researchers across the institution. To remedy this, CSEI established a new minor in CBS' largest Master Programme with three modules in order to strengthen CBS' profile in the field. With its new strategy from 2020, CBS emphasised its goal of becoming a leading player within green transition in general – with CSEI as one of the main pillars in education.

### Day time programmes

CSEI engages in undergraduate and graduate students' education. To attract and educate students in the basics in energy markets and regulation, the bachelor's elective "Sustainability and Business: Energy Markets, Competition, and Regulation" provides an overview of the sector, its regulation, and current policy challenges.

In the consecutive master's education, students across the Cand.merc. programme are offered a minor in "Energy Economics and Policy". This minor was developed by CSEI in 2020 and is run by CSEI faculty. The minor comprises a set of three courses, each with a different focus:

"Energy Economics, Markets, and Policy" is based upon microeconomic theory and introduces theories and models of energy markets, market regulation, and competition policy, with an emphasis on how these markets and their regulation are affected by globalisation and the need for sustainable energy development.

"The Energy Industry in Transition: Markets, Innovation, and Strategies" gives a deep insight into the energy industry from a business perspective, with an emphasis on innovation and business strategy. It builds on theories from business strategy, innovation, microeconomics, the economics and politics of regulation, and consumer behaviour, as they apply to concrete issues in the

energy industry.

"Energy System Economics and Modelling" introduces methods for modelling the energy system that are used by firms and policy makers for forecasting and for policy and scenario analysis. These methods are essentially optimisation models, but also econometric approaches and system dynamics simulation models are presented during the course. They are all part of the ongoing policy debate surrounding alternative energy technologies and future development paths.

Completing the minor will qualify students uniquely for specialist and management positions in the energy industry, broadly conceived as both energy producers, technology providers, regulators, and adjacent supplier networks. The minor is strongly based on theories and methods from microeconomics, business strategy and innovation, operations research, and system dynamics.

*"I decided to enrol in the Energy Economics and Policy summer course to learn how to apply my broad knowledge from my International Business and Politics studies to the energy sector. I really enjoyed the course and have learned many highly relevant concepts which I am now actively using in my student job in Market Development for Power-to-X."*

**Tara Dastmalchian**

Topsoe, Student Assistant  
MSc International Business and Politics

In addition, there are two elective courses for master's students: a course on "Advanced Topics in Energy and Environment" and a summer school in "Energy Economics and Policy". Whereas the first one discusses policy relevant issues around energy and environment based on recent developments and academic literature, the latter one educates students in the theoretical foundation of energy economics and applies the gained competencies to iterate and reflect on recent debates.

Since 2020 more than 300 students have participated in CSEI's courses and activities – with interest rising every year.

Besides the management and teaching in the reoccurring courses on energy related topics, CSEI has supervised many students for their business projects, bachelor's theses, and master's theses.

### Executive Education

In discussions with the energy sector, CSEI has identified a lack of executive education directed at the energy sector. Executives and employees at companies and organizations from all around the world lack competencies within the field. Therefore, a future central CSEI activity will be to develop executive education for professionals in the energy sector. Copenhagen Business School has a long-standing tradition of successful executive education programmes and short courses, which CSEI expects to venture in.

The first steps have already been made – from 2024 short courses for specific groups within the energy sector will be offered by CBS Executive. This test case will serve to further discuss possibilities to establish an executive programme at CBS in the field of energy economics.

### PhD Education

CSEI aims to engage in continuous education and thrives to train young academics. From 2019 to 2022, Alexandra Lüth and Chenyan Lyu were enrolled as PhD candidates with CSEI. They have both successfully completed and defended their PhD in Fall 2022.

In her PhD project, Chenyan Lyu explored the carbon market integration and risk sharing mechanism across markets, from developing carbon pilot markets in China, to global leading carbon markets in EU, US, and New Zealand. In an additional chapter, the impact of carbon price shocks on the volatility spillovers in integrated Nordic electricity markets is investigated.

Alexandra Lüth's PhD project discusses offshore energy hubs as a key milestone in the energy transition in the Nordic and Baltic region and for Western and Central Europe. The idea involves the construction of production and conversion hubs far out at sea, where the wind energy potential is high. Her thesis touches upon three interdisciplinary aspects of this concept. Summarised in three chapters, it provides insights into the risks and opportunities, system configuration and market design of offshore energy hubs.

Alexandra Lüth continues her research in offshore sector integration and hydrogen systems at CSEI. She started a project on power-to-x in collaboration with the Technical University of Denmark. Chenyan Lyu joined Heriot-Watt University in Scotland as a Postdoc after graduating and is now a research fellow at University of Exeter Business School in the UK.



*Alexandra Lüth's PhD defence, December 2022.*

# NETWORK & OUTREACH

*An important role for CSEI is to act as an impartial platform bringing together stakeholders from the sector including industry, policy makers, and society. The dissemination of CSEI's research is therefore an essential task for the centre – CSEI's outreach creates impact, which is central for all activities.*

## WORKSHOPS

A core activity for CSEI are the workshops with the Advisory Board and the European Commission conducted in conjunction with CSEI Advisory Board meetings. These take place at least three times a year. The workshops are organised on relevant topics to be discussed with leading scientists, practitioners and CSEI's researchers. Partners have the possibility to discuss relevant questions directly with speakers and in the plenum. Examples of these workshops include:

*2023 – Workshop on “Electricity Market Reform in Europe” in cooperation with Oxford Institute of Energy Studies (OIES)*

After a year of soaring wholesale electricity prices, many have come to blame electricity market design for translating gas price increases into electricity revenues through pay-as-clear pricing which determines the mar-

ket price paid to all generation sources, irrespective of their primary energy source. Consequently, the European Commission is now consulting on a range of reform options for the European electricity market. Beyond addressing the current energy crisis and short-term issues, the longer-term concern is that market design is not fit for deep penetration of renewable electricity, with either low price levels or uncertain changes in market design jeopardising the large-scale investments that are needed.

Speakers included: Richard Green (Imperial College London), Rahmat Poudineh (OIES), Sarah Keay-Bright (National Grid), Michael Pollitt (University of Cambridge), Klaus-Dieter Borchardt (CSEI/CBS), Malcolm Keay (OIES), Catharina Sikow (DG Ener), Morten Pindstrup (Energinet), David Robinson (OIES), Tooraj Jamasb (CSEI).



*Workshop on “Electricity Market Reform in Europe” in cooperation with Oxford Institute of Energy Studies (OIES) at Copenhagen Business School in May 2023.*

#### *2022 & 2023 - Sustained Conference*

In 2022, CSEI initiated the now annual Sustainable Energy Day (Sustained) as a platform for researchers, policymakers, and industry stakeholders to connect and discuss. Sustained is part of the Danish energy research network ENERforsk. The first edition in September 2022 was titled “Energy and the Sea” and covered the development of offshore energy hubs with talks by the Danish Energy Agency, the University of Oxford, Technical University of Denmark (DTU), Dartmouth College, Aqua Ventus, the WMU Malmö, and CSEI. In September 2023, the second edition under the title “Hydrogen Infrastructure & Regulation: Power to the Pipeline?!” with contributions from Technical University Berlin (TUB), European Hydrogen Backbone, Florence School of Regulation (FSR), DTU, ACER, Bellona, and ENTSOG hosted more than 80 energy professionals and students.

#### *2022 – Workshop on “Innovation in the Energy Sector: Current and Future Challenges”*

R&D and innovation (RDI) are prerequisites for a sustainable energy sector that cost-effectively achieves the decarbonisation targets. Prior to liberalisation, it was expected that competitive markets and private participation in the sector would become a major driver for innovation. However, despite the consensus on its pivotal role, innovation has not always been successfully promoted and especially in the case of regulated networks.

Sector coupling, decentralisation of the energy system, and the large deployment of renewable energy sources, among other technological challenges, pose questions that we will only be able to address via innovative solutions. Setting the right economic incentives will be paramount for the rise of new business models, efficient technologies, prioritisation of the ‘right’ investments and projects, and coordinating the different actors involved.

Speakers included: Gert Brunekreeft (Jacobs University Bremen), Christian Growitsch (Fraunhofer Centre for International Management and Knowledge Economy IMW), Renaldi Renaldi (Cranfield University), Karsten Krause (DG Energy).

#### *2021 – Workshop on “Offshore Renewables - Economic, Legal and Governance Aspects”*

Offshore renewables, energy islands and related technologies are envisioned to become key elements in the decarbonisation of the European energy system. The projects are large-scale and complex undertakings. While they rely on advanced technologies, they also require important non-technical solutions. This workshop discussed some key economic, legal, and governance dimensions related to the implementation of offshore renewable energy islands and infrastructure. These projects require a combination of conversion, storage, and delivery technologies.

Speakers included: Machiel Mulder (University of Groningen), Laurens de Vries (TU Delft), Raphael Heffron (Universite de Pau et des Pays de l'Adour), Anupama Sen (Smith School of Enterprise and the Environment, University of Oxford).

#### *2019 – Roundtable on Energy System Integration and Regulation – Challenges and Possibilities*

Speakers included: Roar Amundsveen (NVE), Jan Kostevc (ACER), Christian Growitsch (Fraunhofer Centre for International Management and Knowledge Economy IMW), Klaus-Dieter Borchardt (DG Energy), Jean-Michel Glachant (FSR).



*Visit of Middelgrund wind farm in Copenhagen with the NordNET consortium, June 2022.*



## NETWORKS & STRATEGIC PARTNERS

One important function of CSEI as a European research centre is to act as a platform to bring together scientists, policy makers, and industry on neutral grounds to discuss challenges and developments in the energy sector. The discussion is both conducted at the CSEI Workshops in connection with the CSEI Advisory Board meetings but also as a scientific discussion that fosters publications and dissemination of knowledge where CSEI partners play a major role in CSEI's cooperation with the sector.

Essential for this dialogue is the group of CSEI's funding partners that are engaged in the discussion and the support of CSEI. The relation with partners is bidirectional – CSEI disseminates new knowledge and research and discusses results and recommendations essential to the sector. The partners allow insights into the challenges and future developments of their organizations and give feedback on research important for researchers.

A principal cooperation partner for CSEI is the European Commission. The Directorate-General of Energy has been facilitating the setup of CSEI as a European Research Centre from the beginning. The European Commission is co-chairing CSEI's Advisory Board on director-level. This close cooperation with DG Energy enables a direct discussion on future challenges and possibilities.

CSEI has also created a strong network with major research institutions but also individual researchers boosting CSEI's research output and the discussion with the sector. The cooperation with the research community is manifested in

- i. structured research networks with CSEI as coordinator,
- ii. membership in research associations and clusters,
- iii. cooperation with relevant institutions,
- iv. cooperation with researchers, that have an affiliation with CSEI, and
- v. cooperation through concrete research projects.

### **Structured Research Networks coordinated by CSEI**

The NordNET network was created in 2022 and focuses on the energy transition, transport modelling, energy market modelling, and the coupling thereof. The network is funded by Nordic Energy Research and brings together world-class education and research groups from higher education institutions from Denmark, Finland, Norway, and Sweden working on these topics. The added value from the network is the interaction of topic experts leading to the creation of more knowledge valuable to all societies. Members include the Technical University of Denmark (DTU, Denmark), Lappeenranta-Lahti University of Technology (LUT, Finland), the Norwegian University of Science and Technology (NTNU, Norway), the Norwegian School of Economics (NHH, Norway), and Chalmers University of Technology (Sweden).

ENERforsk is funded by CBS' strategy funds and connects energy researchers in Denmark and neighbouring countries. Frequent and continuous exchange across institutions and research groups within the country shall facilitate collaboration and help bundle qualifications into multi-disciplinary clusters. The initiative focusses on supporting junior researchers through quarterly workshops, offers one annual topical full-day workshop and hosts the annual "Sustainable Energy Day" (SustainED) Conference.

### **Membership in research organisations and clusters**

CSEI is a member of the European Energy Research Alliance (EERA) constituting the largest low-carbon energy research community in Europe and a key player in the European Union's Strategic Energy Technology (SET) Plan. The alliance was established in 2008 by leading research institutes to expand and optimise EU energy research capabilities. Today it brings together more than 250 organisations from 30 countries.

With its membership in the International Association for Energy Economics (IAEE), an interdisciplinary forum for the exchange of ideas, experience and issues among professionals interested in the economic analysis of energy resources, CSEI strives to connect to major players of the research community within the field. The Association is based in the United States and includes members from over 100 nations.

### **Structured cooperation with institutions**

Already in 2020, CSEI has signed a cooperation agreement with German Fraunhofer Society's Cluster of Excellence for Integrated Energy Systems (CINES) that addresses the central technological and economic challenges of the energy transition. CSEI is cooperating with several Fraunhofer Institutes in different capacities.

In 2021, CSEI has initiated a structured cooperation with the Mærsk Mc-Kinney Møller Centre for Zero Carbon Shipping, which is a not-for-profit, independent research and development centre looking to accelerate the transition towards a net-zero future for the maritime industry. CSEI is seconding a postdoc to the centre and is contributing to various research projects to create synergies and joint publications.

The Florence School of Regulation (FSR) at the European University Institute (EUI) with its former director Jean-Michel Glachant has been a strong supporter for the establishment of CSEI. Today, CSEI is cooperating with FSR in research projects, educational and dissemination activities. FSR and CSEI have also cooperated for the EU Commission's Energy Infrastructure Forum.

A major player regarding the technological challenges of the energy transition is the Technical University of Denmark. They are a close cooperation partner for Copenhagen Business School in general but in national projects an important partner especially for CSEI.

As CSEI's director Tooraj Jamasb is Research Associate at the Energy Policy Research Group at the University of Cambridge, CSEI has strong ties to the University of Cambridge.

CSEI has established a dialogue with the European regulator ACER, who has contributed to several workshops and activities of CSEI. The relation with several regulators including ACER is essential for CSEI's work on economic regulation and the economic framework for the green transition in Europe. ACER is therefore a strong dialogue partner for CSEI.

As the national regulator, the Danish Utility Regulator (DUR) is an important partner for CSEI in national projects on, for example, energy islands, carbon capture, utilisation, and storage, and other topics. CSEI's director Tooraj Jamasb is the editor of the DUR Anthology series.

Through relations anchored in projects as well as bilateral cooperation, CSEI cooperates intensively with TU Berlin and NTNU in Trondheim.

### **Cooperation with individual researchers**

International cooperation with individual researchers from all over the world is key to CSEI's success. We always welcome international top researchers from the field to be our guest in Copenhagen and to be affiliated with CSEI.

Amongst our affiliates are Prof. Michael Pollitt (Cambridge Judge Business School), Prof. Carlo Cambini (Polytechnic University of Turin), Dr. Rabindra Nepal (University of Wollongong), Dr. Daniel Davi-Arderius (University of Barcelona), Dr. Anupama Sen (University of Oxford), Prof. Christian von Hirschhausen (TU Berlin) and Prof. Monica Giulietti (Loughborough University).

Visiting fellows at CSEI include Prof. Ricardo Scarpa (Durham University), Prof. Parantap Basu (Durham University), Prof. Luis Orea (University of Oviedo), Tian Zhou, Beatriz Couto Ribeiro (TU Berlin) and Prof. Anne Neumann (NTNU).

### **Cooperation through concrete research projects**

With its numerous research projects, CSEI cooperates internationally with other actors in the field of ener-

gy research. The cooperation within research projects includes more than 50 institutions, amongst them the Technical University of Denmark, Austrian Institute of Technology (Austria), Florence School of Regulation (Italy), University of Vienna (Austria), University of Applied Sciences Upper Austria (Austria), Lappeenranta-Lahti University of Technology (Finland), the Norwegian University of Science and Technology (Norway), the Norwegian School of Economics (Norway), and Chalmers University of Technology (Sweden), Aalborg University (Denmark).

### Outreach through media

Since 2019 CSEI has used several outlets to disseminate its work. CSEI's homepage [www.csei.eu](http://www.csei.eu) has been recently remodelled and hosts the CSEI Policy Brief Series and the CSEI Working Papers. Additionally, the CSEI Group account at LinkedIn and the Twitter (@cseicbs) account are used to communicate CSEI's work.

### CSEI cooperates with the Climate Club at CBS

CSEI has been active in cooperating with CBS' student association CBS Climate Club. The Climate Club wants



*Christine Brandstätt and Jens Weibezahn visited Florence School of Regulation in September/October 2023.*

to educate, inform, and enrich CBS students within environmentally sustainable business and show organizations that CBS students want to work in companies that prioritize sustainability. Their vision is to make CBS students front-runners of sustainable business management. We wish to connect students with sustainability through our three pillars: personal awareness, sustainable business, and greener campus. CSEI has been supporting the Climate Club and joined several of their events in order to promote CSEI's minor in energy economics and knowledge about our work.

*“Reflecting on it now, the minor in Energy proved to be a crucial milestone in my journey into the renewable energy sector. While my primary field of study was business, with only limited exposure to technical subjects like programming, the Energy minor introduced me to new and interesting perspectives. Not only did I choose to write my master's thesis in this area, but this newfound interest also prompted me to apply to several companies in the field. Ultimately, the knowledge I acquired through this minor played a central role in my success during job interviews and assessment days, leading me to get an exciting graduate position at Vestas.”*

**Hanne Boettcher**

*Vestas Germany, Graduated  
Minor in Energy Economics and Policy (2022)*

# FUTURE OUTLOOK & NEEDS

*In the beginning of 2023, CSEI has achieved the status of a successful European research centre and – at the same time – an influential advisor for the energy sector with a strong European focus and global outlook. Activities in research, education and dissemination are among the world-leading centres. Going forward, what are the likely challenges facing the energy sector and the need for research?*

In view of the recent disruptions due to high energy prices at the macro level and with the ongoing overhaul of energy policies to achieve climate goals and facilitate the energy transition, CSEI's research is set to focus on infrastructures, business models, decentralized systems and energy in society.

Firstly, CSEI will continue to contribute regarding the development of new energy infrastructure, such as offshore grids, ports, energy islands and carbon capture and storage. Applying energy systems modelling and regulatory theory, CSEI is in an excellent position to provide projections and policy recommendations for the efficient and swift development of vital infrastructures for the energy transition, especially across borders.

Secondly, CSEI will focus on innovative and sustainable business models in the energy sector, such as offshore renewables, the supply of hydrogen and its derivatives, digitalisation-driven innovations, and flexible electricity consumption. The centre's research is concerned with facilitating the regulatory framework, governance and

necessary market development as well as assessing the interaction with, participation, and acceptance by society at large.

Thirdly, the debate for an overhaul of market design has not been settled and will show momentum, also in view of decentralised energy systems and energy communities. CSEI will contribute with research on integrated and decentralized actors as well as on evolving governance models and transactional arrangements linked to new possibilities with digitalisation.

Lastly, with a perspective on energy concerns in Europe and beyond, social aspects, such as public acceptance, but also fuel poverty, and the nexus of energy, water and food will play an increasing role.

We hope to refine and sharpen the potential research areas through interactions with industry partners, policy makers, and other stakeholders.

CSEI's voice in the policy debate in Europe is strong and clear, where our research plays a pivotal role in shaping critical decisions and future directions in the energy sector. Since 2019 CSEI has contributed relevant insights regarding topical issues such as energy system integration, network planning, and energy islands.

The first four years of CSEI have been rather eventful. During this period, the energy industry, the wider energy-economic framework, and general energy policy experienced significant challenges. More recently, the changes brought about by the European Green Deal, the energy crisis and REPowerEU are crucial to relevant applied research in energy economics and policy.



*The CSEI team working at their annual strategic workshop, Snekersten in August 2023.*



CSEI's partner model, which is based on donations by partners from the field without a quid pro quo to ensure impartial research has been a successful basis for our work as a European centre at the Department of Economics at Copenhagen Business School (CBS), the largest business school in Europe.

To guarantee the continuation of this success and the sustainable development of CSEI, we strive to engage even stronger partnerships and dialogues with the industry. Formats such as the CSEI Workshop and the Sustainable Energy Day (SustainED) conference will be continued and developed further.

In education, CSEI will continue offering CBS graduates a sound understanding of the energy sector when entering the business world. In addition, CSEI intends to develop executive education including an executive programme, which can bring specialists from the sector together and equip them with the relevant knowledge to tackle current challenges.

But at the core of CSEI stands research – to foster new knowledge and insights the team needs to be developed and enlarged – including a structured approach on PhD education to secure that young scholars are educated and can contribute to the vast challenges within the field with new ideas and approaches.



*CSEI at the annual workshop, September 2023 in Helsingør.*

# LIST OF PUBLICATIONS

*From 2019 to 2023 CSEI has issued more than 90 scientific publications including a series of policy briefs. Included is a list with all publications that CSEI has published in cooperation with CSEI associates and authors from all around the world.*

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