Course PM ME2086, autumn 2023

Global Energy Markets and Systems in Transition

Period 2, HT 2023, 6.0 credits

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Table of contents

Introduction

Welcome to the course ME2086 “Global Energy Markets and Systems in Transition”!

The course is held by the Division of Sustainability, Industrial Dynamics and Entrepreneurship (SIDE), at the Department of Industrial Economics and Management (INDEK). The course is aimed at students who are interested in how energy systems and energy markets function and who are interested in understanding the economic, social, political, climatological and technical implications of these energy systems. The course takes into account a range of current transitions in the energy markets and systems, such as an increasing share of renewable energy installed at increasingly lower prices, transformations towards carbon neutrality to mitigate climate change in various sectors such as power generation, transportation and industries, and the goal of providing modern energy access to billions of people across the world.

The course design and structure aim to give course participants the best possible conditions for active learning. This includes lecture material, online lectures, workshops, seminar activities, including group case solving, where you can apply your knowledge. There is a group work, based on a seminar, and an individual home exam. With this course structure we aim to summarize your course experience, as well as distribute workload during the course. Course literature offers suggested readings and statistical sources, which can also be used for the home exam.

Teaching will be held either in class on KTH Campus or through Zoom – see schedule in this course PM. All detailed information regarding the course content, schedule, deadlines, readings, submissions and other related issues can be found in this course PM.

If you have any questions or inquiries, please contact the course coordinator Dr Petter Johansson at petter.johansson@indek.kth.se (please write “ME2086” in the subject).

All updates will be reported in class and in Canvas (see home page and announcements)

Course content

The course treats the functioning of global energy systems. The course will deal with the relationship between the structure of the technical systems and their respective economic boundary conditions (market, pricing etc.), as well as the function and transformation of energy markets.

The course contains a series of lectures with an in-depth review and analysis of conditions and driving forces behind the transformation of the intertwined global energy system from the following perspectives:

- Socio-technical
- Economic
- Political
- Institutional
- Climatological

The course also offers insights into theories, concepts and tools from industrial dynamics to analyse global energy markets and technical changes in energy systems. These theories, concepts and tools will be applied in the group work and the home exam.

Learning outcomes

On completion of the course the students should be able to:

- Analyse the structure of the global energy system
- Critically discuss the mechanisms that drive systems transitions in relation to global energy markets and their implications

- Evaluate theoretical concepts and current research from the field of industrial dynamics for managing technological and industrial change processes in relation to global energy markets
- Write an analysis related to industrial and technological change and independently discuss problem formulations and their solutions to tackle complex change in global energy markets
- Present results and conclusions based on a scientific investigation for different types of audiences

Guest lectures

We have invited guest lecturers who will talk about relevant topics in the energy field. This is a great opportunity to discover more about key energy issues, thus guest lectures are mandatory.

Literature and course material

Textbooks:

Urban, F., 2019. Energy and Development. Routledge, Oxon.

> This textbook is available as an e-book in the KTH library. It can also be purchased online at Amazon, Adlibris, Bokus, or ordered at book stores in paperback, hardback or e-book versions. It can also be ordered directly from the publishers: https://www.routledge.com/Energy-and- Development/Urban/p/book/9781138485969

Blomkvist, P. & Johansson, P., 2016. A Dynamic Mind – Perspectives on Industrial Dynamics in Honour of Staffan Laestadius. KTH, Stockholm.

> This textbook is available to download online and can be found here: http://mdh.diva-portal.org/smash/get/diva2:1251714/FULLTEXT01.pdf

There will also be articles, papers, reports and website for you to read and look through, see course schedule below for details.

Passing the course

To pass the course you should attend the guest lectures, submit workshop tasks, attend and participate actively in the seminar, pass your home exam and the group work.

If any mandatory elements are missed, alternative assignments will be given before the student can pass. This usually consists of writing an essay of 500 words about the literature and the lecture slides if guest lectures have been missed. If an entire group misses to participate in either of the two seminar slots, then that group will not get a final grade for SEM1.

Any completion assignment should be uploaded to Canvas – see Canvas for more information.

Workshops

There will be two workshops as part of the course. The aim of the workshops is to get a better understanding of the subject matter and the content of the lectures. One of the workshops will be done completely in class and will be based on calculating electricity prices under specific conditions. For both of those workshops you will be asked to prepare a task in advance in small groups and to present it at the workshop. Please do your homework by reading the course literature and preparing the assignments in advance so that you can benefit the most from the workshops. Upload your preparations to Canvas before the workshops – see Canvas for deadline.

Examination

The course is examined through a written take-home exam (INL1) and seminar assignments/project work (SEM1). The focus is on the ability to critically analyse and discuss the consequences of technical and industrial processes related to global energy markets and systems in transition and their implications from an environmental, economic, political, social and ethical perspectives. The students need to independently formulate and define problems to tackle complex processes of change by means of data from various types of sources.

- SEM1 - Seminar, 3.0, grading scale: A, B, C, D, E, FX, F
- INL1 – Home exam (Inlämningsuppgift) 3.0, grading scale: A, B, C, D, E, FX, F

The final grade is composed to 50% of the SEM1 grade and to 50% of the INL1 grade according to the following grading schedule:

		SEM1	50%			
		A	**B**	**C**	**D**	**E**
INL1	**A**	A	A	B	C	D
50%	**B**	A	B	B	C	D
	C	B	B	C	C	D
	D	C	C	C	D	E
	E	D	D	D	E	E

Seminar and group work (SEM1)

The assignment consists of two parts: writing a group report of up to 5,000 words and presenting your work at the seminar. Groups will be made of about 4-5 students, depending on the size of the class. The assignment that should be explored in the seminar and the report this year is located at the interface of global energy markets, technological development, systems' transitions, energy finance, industrial dynamics, energy justice and geo-politics for energy security.

The seminar is a key element of the course, as it involves presenting your group work. Thus, participation is mandatory, and the students will be given grades (A-Fx) based on everyone's attendance, oral presentation and written submission of their group work. See schedule below for seminar dates.

You will be divided into two seminar panels, to keep a manageable seminar size enabling everyone to participate. You will be asked to present your group work, to actively participate in the seminar discussions and to take into account the comments you receive for the final group work report. The report should be submitted on Canvas as a pdf document. See Canvas for final deadline.

Home exam (INL1)

The home exam is the end point of your individual study. It will be graded A-Fx. The home exam should be submitted on Canvas as a docx, doc or pdf document – see Canvas for deadlines. The home exam will be made available at Canvas.

The home exam is an open book exam. Any kind of information can be used, such as journal articles, books, papers, reports, policy documents, data bases, websites etc.

More information about the home exam will be given towards the end of the course.

Intended learning outcomes and alignment with examination

After completing the course, students are intended to be able to:

• Analyse the structure of the global energy system (Examined by INL1)

• Critically discuss the mechanisms that drive systems transitions in relation to global energy markets and their implications (Examined by SEM1 & INL1)

• Evaluate theoretical concepts and current research from the field of industrial dynamics for managing technological and industrial change processes in relation to global energy markets (Examined by SEM1 & INL1)

• Write an analysis related to industrial and technological change and independently discuss problem formulations and their solutions to tackle complex change in global energy markets (Examined by SEM1 & INL1)

• Present results and conclusions based on a scientific investigation for different types of audiences (Examined by SEM1)

Grading

High distinction of publishable quality: A

- Potentially publishable after minor amendment and/or improvement to presentation
- Ability to plan, organise and execute independently a research project to the highest standards
- Clearly demonstrates creativity, originality, and independence of thought in research design
- Ability to assemble information from different sources to produce highly organised and original arguments
- Ability to evaluate critically existing methodologies and suggest new approaches to current research or professional practice
- Ability to analyse data critically to the highest professional and academic standard
- Ability to evaluate published or publicly presented work critically to the highest professional standards
- Highest standards of competence, written expression, and presentation

Distinction (potentially publishable): B

- Includes content that is original and potentially publishable after significant amendment and/or improved presentation
- Ability to plan, organise and execute independently a research project to a high standard
- Considerable evidence of creativity, originality and independence of thought in research design
- Ability to assemble information from different sources to produce well organized and original arguments
- Ability to analyse data critically and to a high standard
- Ability to evaluate published or publicly presented work critically and to a high standard
- High standards of competence, written expression and presentation

Merit: C

- Evidence of capability to undertake original research given appropriate guidance and support
- Flexibility of thought, and the ability to solve complex, though not entirely original research problems
- Evidence of some creativity, originality and independence of thought in research design
- Ability to evaluate published or publicly presented work and to analyse critically sources of literature and information
- Ability to analyse data critically
- Professional standard of competence, expression and written presentation

Pass: D

- Adequate knowledge and understanding of the relevant literature and other key sources of information
- Ability to construct coherent and relevant responses to research questions, though with few signs of originality
- Some ability to analyse critically sources of literature and information
- Ability to engage in research when provided with supervision and support
- A competent level of organisation and written expression
- Satisfactory degree of technical accuracy

Pass, with some reservations: E

- Some knowledge and understanding of the essential literature and other key sources of information, but arguments are either incomplete or not entirely coherent
- Limited grasp, or inadequate specification, of the research problem or topic
- Lacks clarity in written presentation
- Little or no evidence of originality
- Weak grasp of the relevant basic concepts and facts
- Poor formatting, style, presentation and referencing
- Work which is just enough for an acceptable professional standard

Fail on some or most indicators: Fx

- Fragmentary knowledge and understanding of the essential literature and other key sources of information
- Shows little or no grasp of a clear research problem or topic
- No evidence of independent or original thought
- No attempt to analyse data or present results in scientific manner
- Confused written presentation
- Inadequate formatting, style, presentation and referencing
- Work that is below an acceptable professional standard

If you get an Fx you will be asked to retry the examination. Retrying the examination will lead to a re-marking of your work, which can result in any marks between A and F.

Fail on almost all or all indicators: F

- A short submission with no knowledge and understanding of the literature or topic
- No independent thought or analysis
- Incoherent written presentation
- Wholly improper formatting, style, presentation and referencing

An F is basically a persistent non-submitting of your work and a non-passing of the course.

Examination adapted to students with special needs

The following applies for students with functional variations who have a statement from KTH's FUNKA unit on recommended support measures during examination:

- Support measure under code R (i.e. adjustments relating to space, time, and physical circumstances) are granted by the examiner

- Support measures under code P (i.e. pedagogical measures) are granted or rejected by the examiner after the examiner has been contacted by the student in accordance with KTH's rules. Normally, support measures under code P will be granted.

Seminar and group work instructions

The project theme for this year is 'Energy infrastructure projects and their links to global energy markets and systems in transition'.

Imagine you are a project developer for a large energy infrastructure project. *You should present your energy infrastructure project to a varied group of stakeholders, including government regulators and policy makers, investors, environmental and social rights groups and the wider public.*

Each group of students should choose one recent energy infrastructure project in a country / region of their choice and explore the following:

- Place the energy project into context: what type of energy infrastructure project is this, what type of technology is being used, size of the project, geographic location, companies involved
- What is the motivation behind building the energy project in relation to the necessity of the project for local / national / regional energy demand and supply (e.g. national energy security, increasing energy capacities to meet supply, reducing dependency from energy imports, phasing out fossil fuels)?
- How does the energy infrastructure project fit into an energy system in transition (e.g. move towards low carbon energy because of climate policy, changing energy costs etc.)?
- What are the energy economics implications of the project (e.g. project finance, profitability, financial competitiveness, grid parity, etc.)?
- How is the project being supported by industrial policy (e.g. to decarbonize the economy, to build up capacity for increased energy access, to strength a specific industrial sector)?
- What are the energy justice implications at distributive and procedural level (e.g. who owns the land / waterway where the project is being built, potential resettlements of local population, impact on employments and livelihoods of local population, compensation payments, dealing with hazardous waste and emissions, participatory approaches etc.)?
- What relevance does the project have for global energy markets (e.g. energy trading, prices, transboundary effects etc.)?
- What are the geopolitical and governance implications with regards to energy security (e.g. importance of the project for enabling security of energy supply, strategic decisions by political elite, energy trading with neighboring countries, bilateral / multilateral relationships between countries, transboundary issues etc.)?
- To which extent have local / national / regional / international policy, legislation and best practice been implemented, such as with regards to Environmental Impact Assessments (EIAs), mitigation plans etc.?
- What are the impacts of the project (energy-wise, environmental, economic, social, technical and political)?

The energy infrastructure projects could either have been built recently (time limit within the last ten years) or they could be under construction or in planning right now. Examples of energy infrastructure projects could include gas pipelines both on land and under sea, oil pipelines, hydraulic fracturing sites, coal mines, nuclear power plants, hydropower dams and reservoirs, wind farms, solar parks, bioenergy plants, geothermal plants, carbon capture and storage test plants, long-distance grid transmission lines, etc.

Some examples for inspiration: Nord Stream 2, Keystone XL Pipeline, Ajaokuta to Kano pipeline, fracking site in Lancashire, Three Georges Dam, Itaipu Dam, Grand Ethiopian Renaissance Dam, Sweden's largest solar PV park in Motala, Värtan CHP8 biomass plant, Walney offshore wind farm, Albatros / Hohe See offshore wind farm, Hinkley Point C nuclear plant, CCS test plant Lysekil, Südlink cross-national grid extensions etc.

You are free to use your own case studies within this field, according to your own interests.

The group work constitutes of maximum of 5,000 words report and a PowerPoint presentation at the seminar. Bibliography and appendices do not count towards the word limit.

Use references from the course, but also additional academic literature from research papers and books, news items, company information and data from databases (e.g. from the International Energy Agency https://www.iea.org/data-and-statistics, World Bank https://data.worldbank.org/)

Add graphs, figures and tables where appropriate.

Remember to reference correctly. Use the Harvard system for referencing. Submit your paper in Canvas and see your similarity index to avoid plagiarism.

Your group should present your work at the seminar, as well as participating in a short Q&A session. There is also a peer-review element: you should review the work of others before the seminar and provide a short commentary at the seminar.

A short summary of the energy infrastructure project of 2 pages and the PPT presentation should be handed in to another group for peer-review during the course prior to the seminar and the final report should be handed in towards the end of the course – see Canvas for deadlines.

Note that each student should write down their contribution to the report in the final report.

More information about the assignment will follow on Canvas.

Some data and useful websites to explore in your group project:

- Energy, environment and development statistics – World Bank: https://data.worldbank.org/

- Energy data and statistics - International Energy Agency IEA: https://www.iea.org/data-and-statistics

- World Energy Outlook 2023, IEA: https://www.iea.org/reports/world-energy-outlook-2023

- Fossil fuel subsidies, overview by IEA https://www.iea.org/weo/energysubsidies/

- Energy cost report. IRENA, 2022. Renewable Power Generation Costs in 2021. Read the highlights and the executive summary. https://www.irena.org/publications/2022/Jul/Renewable-Power-Generation-Costs-in-2021

- Renewable energy statistics. IRENA, 2022. https://www.irena.org/publications/2022/Jul/Renewable-Energy-Statistics-2022

- Statistical review of world energy. BP, 2023. https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy.html

- Energy charts - Fraunhofer ISE: https://energy-charts.info/?l=en&c=SE

- Energy in Sweden - facts and figures - Swedish Energy Agency (2022): https://www.energimyndigheten.se/en/facts-and-figures/publications/

- The Power Market - Nord Pool Spot: https://www.nordpoolgroup.com/en/Market-data1/#/nordic/table

- European Commission – Energy Strategy: https://energy.ec.europa.eu/topics/energy-strategy_en

- New Energy Outlook 2021. BloombergNEF, 2022. https://about.bnef.com/new-energy-outlook/

- United Nations Framework Convention on Climate Change UNFCCC -- 25 Years of Effort and Achievement Key Milestones in the Evolution of International Climate Policy http://unfccc.int/timeline/

Schedule and assigned readings

Date	Time	Content	Comment	Lecturer	Location
Look through / watch before upcoming lecture: - https://play.kth.se/media/Global+Energy+Challenges+-+Regional+Trends/0_7p3d3bje - https://www.ipcc.ch/report/sixth-assessment-report-cycle/ - IPCC WorkGroup1 6th Assessment report: IPCC WG1: https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM.pdf					
6-nov.	09.15-12.00	Lecture 1: Introduction to global energy markets and systems in transitions	On-campus lecture	Vladimir Kutcherov	Campus, FB52
Task to do before next lecture: Prepare for the workshop on 11 Nov. and upload your preparations on Canvas before next lecture.					
Look through before upcoming lecture: - https://www.iea.org/reports/russian-supplies-to-global-energy-markets - https://tinyurl.com/BPstatistics - https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/statistical-review/bp-stats-review-2022-full-report.pdf *Read before upcoming lecture:* - Urban, F., 2019. Chapter Twelve: "The economics of energy supply and universal energy access", in: Energy and Development. Routledge, Oxon. - Urban, F., 2019. Chapter Thirteen: "Financing Low Carbon Energy Transitions", in: Energy and Development. Routledge, Oxon.					
10-nov.	09.15-12.00	Lecture 2a: Coal, gas & oil markets and geopolitics	On-campus lecture	Vladimir Kutcherov Fabian Levin	Campus, W42
		Lecture 2b: Electricity & GHG-markets			
		Workshop: Electricity market	*You will be assigned to random groups. Compare your preparations. Prepare to present in class by end of lecture.*		
Task to do before next lecture: Prepare for the workshop on 14 Nov. and upload your preparations on Canvas before next lecture.					
Look through before upcoming lecture: - https://www.irena.org/publications/2022/Jul/Renewable-Energy-Statistics-2022 - https://www.irena.org/Statistics/View-Data-by-Topic/ *Read before upcoming lecture:* - Blomkvist & Johansson, 2016. Chapter 3: "Systems thinking in Industrial dynamics", in: A dynamic mind. SID, INDEK, KTH. - Geels, F.W., 2014a. A socio-technical analysis of low- carbon transitions: introducing the multi-level perspective into transport studies. Journal of Transport Geography, Vol. 24 (2012) 471–482					
13-nov.	09.15-12.00	Lecture 3a: Renewable energy, hydrogen and e-fuels	On-campus lecture	Vladimir Kutcherov	Campus, W37
		Lecture 3b: Large Technical Systems, MLP & Industrial change	On-campus lecture		
		Workshop: MLP	*You will be assigned to random groups. Compare your preparations. Prepare to present in class by end of lecture.*		
Choose preferred subject for group work - follow link on Canvas. Which group you have been assigned to will be revealed on Canvas. You will also be assigned timeslot for seminars. You cannot switch timeslot.					
Read before upcoming lecture: *- Chizaryfard et al., 2020, The transformation to a circular economy: framing an evolutionary view. Journal of Evolutionary Economics 2020. https://link.springer.com/content/pdf/10.1007/s00191-020-00709-0.pdf*					
17-nov.	09.00-10.00	*Time to ask questions online.*	*Opportunity to ask questions regarding group assignment.*	Vladimir Kutcherov	Online (zoom)
	10.15-11.00	Lecture 4: Development blocks, circular economics and EV battery supply chains	On-campus lecture	Tatiana Nevzorova	Campus, U31
Work on group project					
Read before upcoming lecture: - Blomkvist, Johansson & Laestadius, 2016. Chapter 1: "This is industrial dynamics", in: A dynamic mind. SID, INDEK, KTH. - Porter, M.E., 1990. The Competitive Advantage of Nations. Harvard Business Review, March–April 1990.					
20-nov.	09.00-10.15	*Time for group work*	*Room E3 is booked for you to work in.*		Campus, E3
	10.15-11.00	Lecture 5a: Introduction to industrial dynamics	On-campus lecture	Cali Nuur	
	11.15-12.00	Lecture 5b: Introduction to Innovation systems	On-campus lecture	Niclas Arvidsson	

	Work on group project				
	Look through before upcoming lecture: - https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement *Read before upcoming lecture:* - Urban, F., 2019. Chapter Seven: "Energy and climate policy of major emitters", in: Energy and Development. Routledge, Oxon. - Su, C., Madani, H., Palm, B., 2018. Heating solutions for residential buildings in China: Current status and future outlook. Energy Conversion & Management, Vol. 177(12): 493-510.				
24-nov.	09.15-11.00	Lecture 6a: Energy and climate policy	On-campus lecture	Frauke Urban	Campus, FB52
	11.15-12.00	Lecture 6b: Role of hydropower in the global energy system transition	On-campus lecture	Vladimir Kutcherov	
	Prepare for the seminar				
27-nov.	09.00-12.00	Seminar 1	On-campus seminar	Vladimir Kutcherov	U31
1-dec.	09.00-12.00	Seminar 2	On-campus seminar	Vladimir Kutcherov	FB53
	Revise group project according to oral and written feedback from the seminar sessions				
	Look through / watch before upcoming lecture: https://www.youtube.com/watch?v=DGiLkXOcPsw&feature=youtu.be https://www.youtube.com/watch?v=0XPCOIo0byY *Read before upcoming lecture:* - Capurso et al (2022), Perspective of the role of hydrogen in the 21st century energy transition *Optional reading:* - Staffell et al., 2019.The role of hydrogen and fuel cells in the global energy system. Energy and Environmental Science, Vol.12, 463-491. - Nurdiawati et al., 2019. Novel configuration of supercritical water gasification and chemical looping for highly efficient hydrogen production from microalgae. Renewable and Sustainable Energy Reviews, Vol 112, 369 – 381				
4-dec.	09.00-10.15	*Time for group work*	*Room FB52 is booked for you to work in.*		Campus, FB52
	10.15-11.00	Lecture 7a: Towards a hydrogen society	On-campus lecture	Fabian Levin	
	11.15-12.00	Lecture 7b: Electrifying global transport systems	On-campus lecture	Emily Christley	
	Work on group project				
	Look through before the lecture: - https://www.reuters.com/business/sustainable-business/swedens-hybrit-delivers-worlds-first-fossil-free-steel-2021-08-18/ - https://www.hybritdevelopment.se/en/				
8-dec.	09.00-10.30	*Time for group work*	*Room V3 is booked for you to work in.*		Campus, V3
	10.30-12.00	Lecture 8: Energy Future	On-campus lecture	Vladimir Kutcherov	
	Finalize group project and upload to Canvas (see Canvas for deadline)				
	Look through before upcoming lecture: - Sanguesa et al., 2021. A Review on Electric Vehicles: Technologies and Challenges. https://www.mdpi.com/2624-6511/4/1/22/htm				
11-dec.	09.15-10.30	Guest lecture: Energy related transformation of the transport sector	Guest lecture: Mandatory presence!	Tomas Björnsson (Vattenfall)	Campus, W38
	11.00-11.45	Summing up the course, preparing for the examination.	Online session (not mandatory presence)	Vladimir Kutcherov	Online (zoom)
	Do the home exam and upload to Canvas (see Canvas for deadline)				