UiO : Department of Technology Systems
University of Oslo

Renewable Energy Systems

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Renewable Energy Systems

In everything from sun and wind to tidal waves, we have energy that is renewable and widely available

This Master's programme aims to provide you with a solid foundation for developing the use of renewable energy systems in society

If you want a future job in the energy sector, this is the study programme for you!

Why at ITS?

- Extensive research in energy sector at Kjeller and Oslo area provides relevant up-to-date topics for your education and master thesis

- Connection to business and industry gives realistic perspectives

Energy Systems section – who are we?

Sabrina Sartori

Josef Noll

Marianne Zeyringer

Matylda Guzik

Aasmund Sudbø

Øivind Kure

Eirik Marstein

Josefine Selj

Øystein Ulleberg

Arne Lind

Martin Kirkengen
(Cenate AS)

Matin Bagherpour
Nord Pool AS

Shujun Zhang
(Høgskulen på
Vestlandet)

Competences

The section has strong competences in:

- Energy systems modelling/data analysis



- Solar cells and solar systems



- Energy conversion and storage




- Digitalization, security and safety, IoT, communication in the grid



Programme structure

- Mandatory courses, 40 ECTS credits
- Specialisation courses, 30 ECTS credits
- Elective courses, 20 ECTS credits
- Master's thesis, 30 ECTS credits

4. semester	Master's thesis		
3. semester	Specialisation course	Specialisation course	Elective course
2. semester	Specialisation course	TEK5380 - Project course 	Elective course
1. semester	TEK5300 – Renewable Energy: Science and Technology 	TEK5350 - Energy markets and regulation 	TEK5370 - Grid and smartgrid 
	10 ECTS credits	10 ECTS credits	10 ECTS credits

The specialisation courses consists of 30 ECTS credits and are primarily chosen from the courses listed below, but other relevant courses may be substituted in consultation with your supervisor:

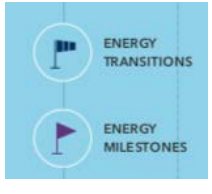
- TEK5310 – Solar Cells 
- TEK5330 – Solar Energy Systems 
- TEK5340 – Energy systems analysis: Modelling, methods and scenarios 
- TEK5320 – Battery Technology  
- TEK5390 - Hydrogen Tecknology   

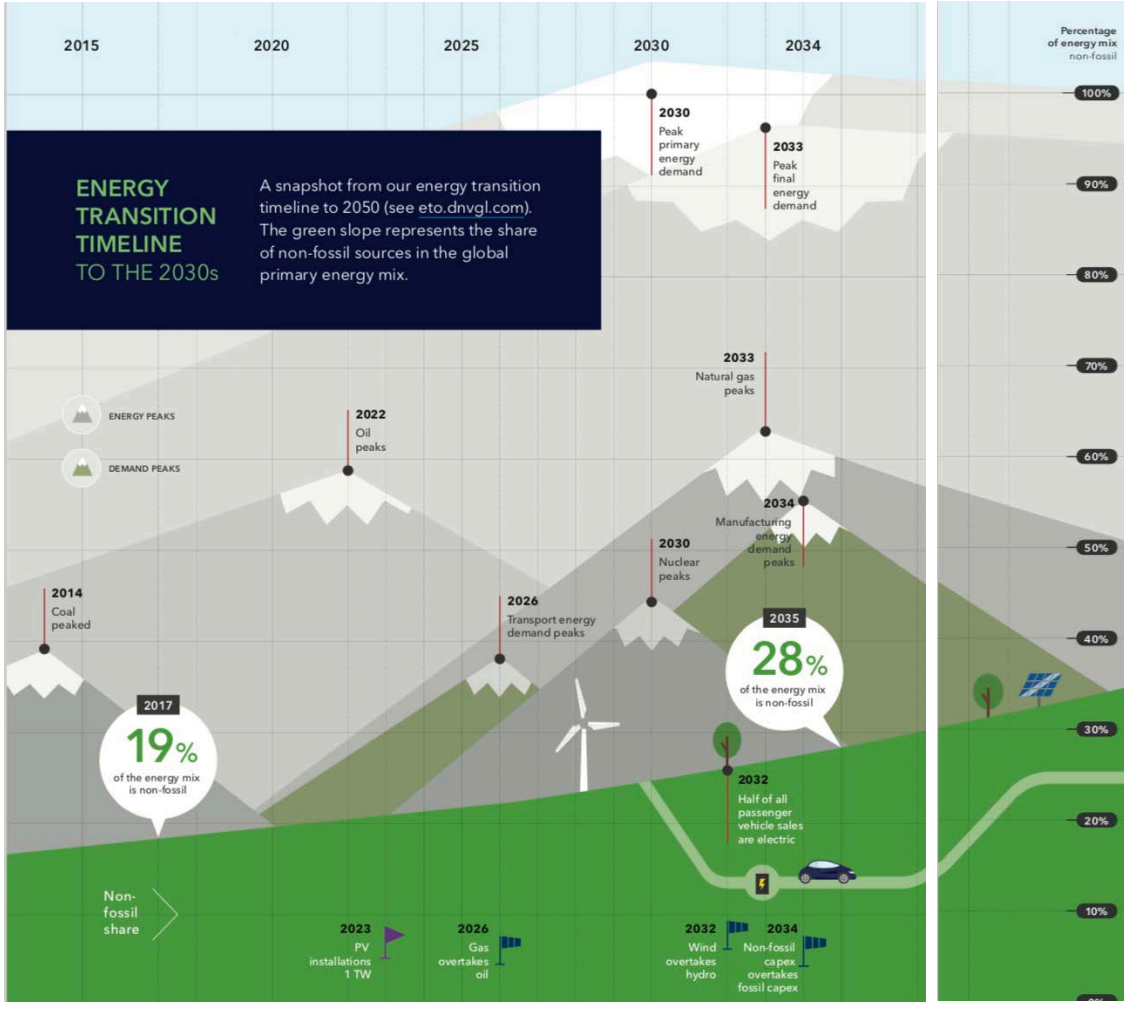
The need for a big transition

(…and maybe why you are here?)

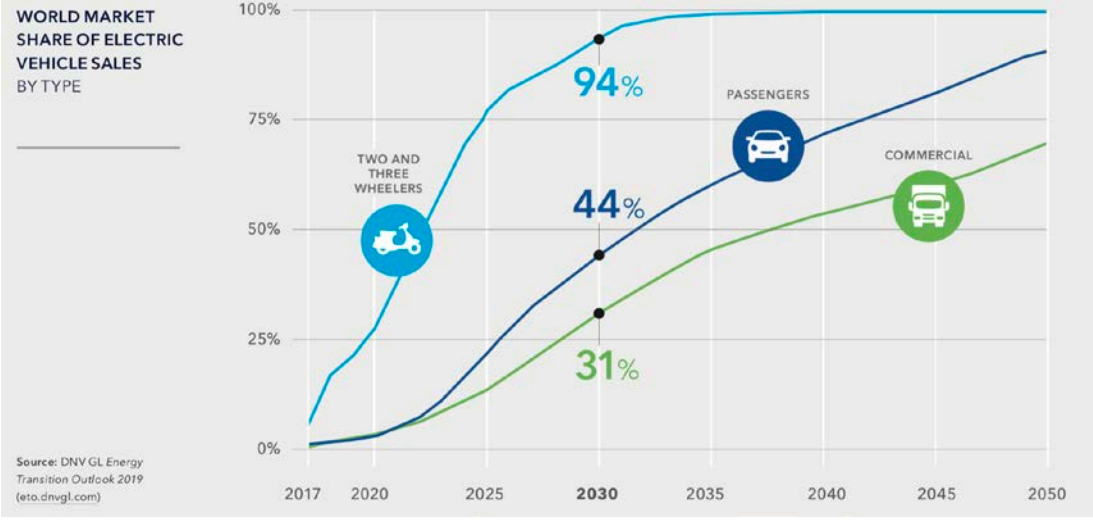
Energy transition timeline to 2030s

Market and policy driven, with **climate-related concerns** expected to have a significant **regulatory impact.** **Local pollution** and **environmental** problems also play a part





Electric vehicles – the most visible transition



Globally, EVs will surpass the 50% mark for new passenger vehicles by 2032

Battery costs will continue to plummet as emerging chemistries further improve their **energy densities** and **charge rates**, supporting electrification of the transport sector

Technologies that matter for the energy transition

Battery storage
Need of cost reduction and advancing new chemistries to improve both energy density and charging rates, to support RES

Electric vehicles Plunging total costs of vehicle ownership is the main reason for quick uptake

Solar PV
Variability and competition from wind, flexibility from batteries and peak gas plants will determine the amount of PV that can be integrated into the power system

Wind onshore and offshore
Wind will move offshore to avoid competing with land and food production

Technologies that matter for low carbon systems

Carbon capture and storage
Three future uses of CCS technology in the energy system:
1) Carbon-neutral hydrogen production through steam methane reforming
2) Removal of CO_2 emissions at gas and coal fired power plants
3) CO_2 emission mitigation in industrial processes (eg. petrochemical, cement, waste-to-energy)

Synthetic fuels/gas and blue hydrogen
Scale hydrogen production from natural gas using steam methane reforming with CCS (blue hydrogen), with a gradual expansion into green hydrogen

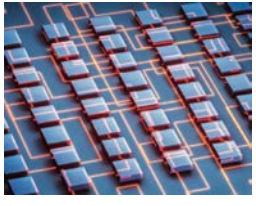
$$CH_4 + H_2O \rightleftharpoons \underbrace{CO + 3\,H_2}_{\text{syngas}}$$

$$CO + H_2O \rightleftharpoons CO_2 + H_2$$
Water-gas shift reaction

Technologies that matter – digital technologies

Autonomy
Autonomous controllers are essential to a stable grid. Autonomy enables distributed and remotely operated solar PV, wind farms, and grids, further reducing costs

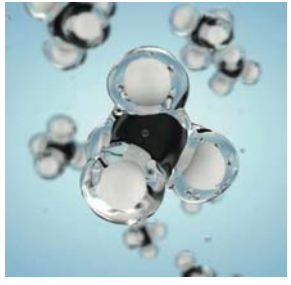
Artificial intelligence and machine learning
By connecting all parts of the energy system, AI can support the implemenation of a stable power and energy market based on variable renewables



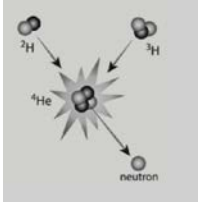
Blockchain (decentralized shared database) could transform and enable local markets and direct trading, creating opportunities for prosumers (avoiing centralized data storage)

IOT
Sensors and communication networks will connect an increasing number of energy supply and demand assets, enabling remote and autonomous operations

Technologies that matter – potential breakthorugh



Green hydrogen
Electrolysis from renewables: making use of low electricity prices during periods with high renewable power generation



Small scale nuclear
New designs of small-scale reactors and progress on stable fusion reactors would be an attractive source of energy with limited radioactive waste

Battery storage chemistry
If significantly more efficient and cheaper batteries based on earth-abundant materials

Ultra-efficient heat pump
Industrial use of heat pumps is emerging. Today's performance could be improved by integrated systems capturing the waste heat

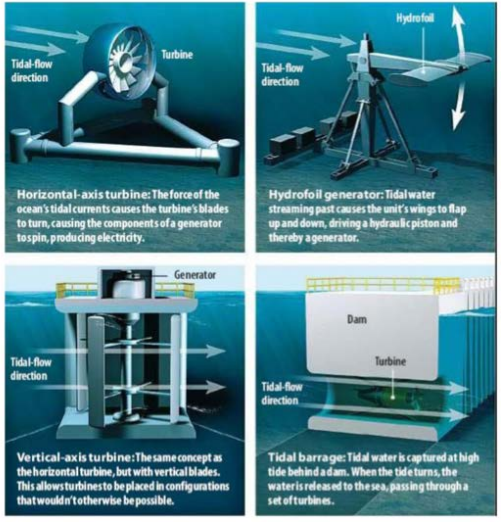
The energy transition is a daunting challenge but also an unprecedented opportunity

YOUR TASK IS NOT TO FORESEE THE FUTURE BUT TO ENABLE IT

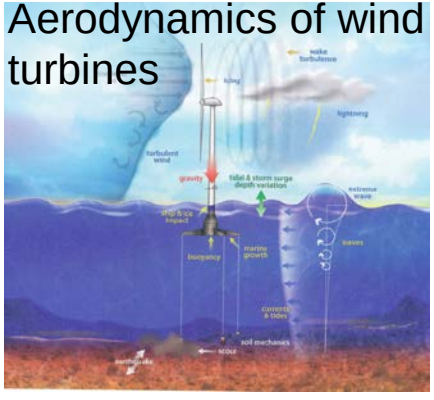
Antoine de Saint Exupéry

What will you learn? Some examples

How to harness tide and wave power



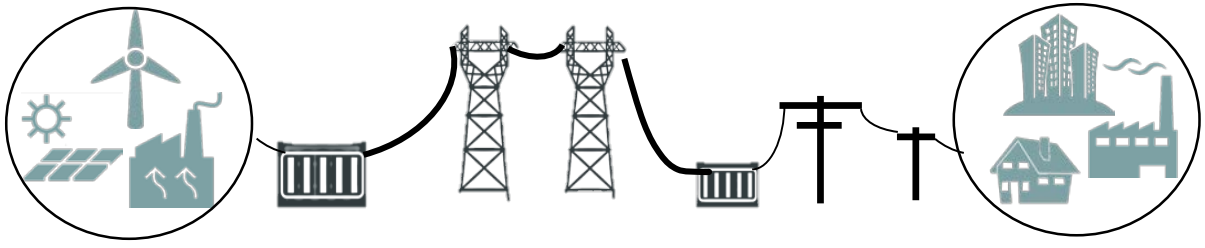
Aerodynamics of wind turbines

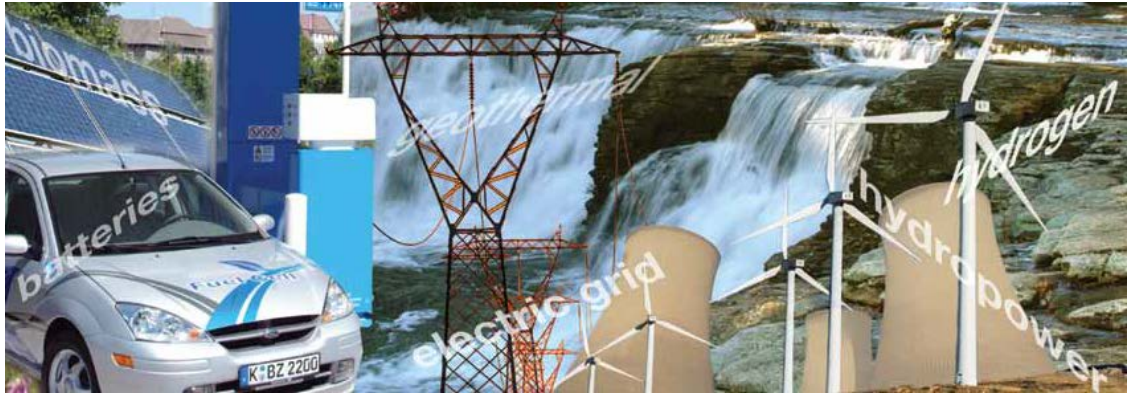


Effect of the blade design

Principles of solar devices

Scientific principles and technologies related to harnessing and conversion of the renewable energy sources, combined with a wide range of case studies, and excursions





Energy storage solutions (e.g. batteries, and hydrogen storage)

How grid and smart grid work

Discuss the integration of intermittent renewable electricity into the grid system

The look of future climate-friendly cities?

Daytime: high tech solar collectors will act as umbrellas to provide shade

Solar panels and solar collectors

Evening: the collector will flap together

Analyze the sustainability of renewable energy, the carbon abatement policies, discuss how the risks and benefits of a particular strategy can be assessed

Energy systems modelling

Link energy market design to climate change mitigation and global governance

With analysis of the connection between the three, energy-economic modelling provides valuable information for making investment decisions for private energy firms and governments

RES programme: Semester abroad

- We encourage the second or third semester abroad
- It may also be possible to work on your master thesis at a partner institutions

University of Utrecht University (the Netherlands)

Aalborg University (Denmark)

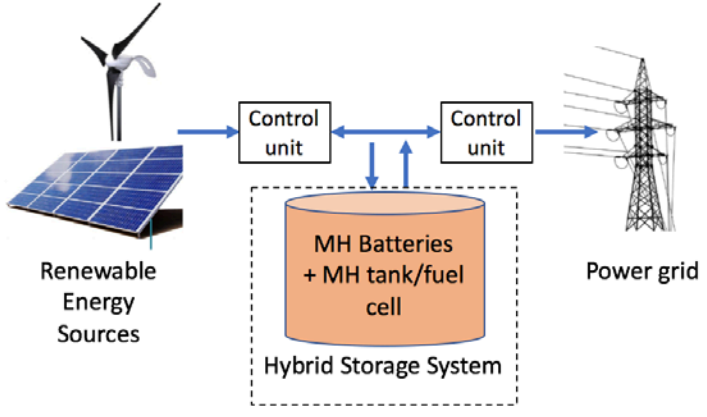
...

Which career is waiting?

- Scientist and/or manager in an Energy-based industry
- Researcher in institutes (e.g. Sintef, IFE...) or industries (e.g. UNITECH Offshore AS, NEL...)
- Academic career through a doctorate (PhD)
- Advisor/consultant in energy companies
- Project responsible (e.g. at The Norwegian Water Resources and Energy Directorate (NVE)...)
- Project leader (e.g. at DNV GL...)
- ...

Examples of current thesis topic

- Energy storage systems for the integration of renewable energy sources into the power grid (collaboration with Chinese company)
- Hydrides for thermal hydrogen compression (collaboration with USA company)
- Energy systems modelling (collaboration with Norwegian company)
- Modeling fuel cells for buses (collaboration with IFE)
- Safety for batteries (collaboration with FFI)
- Demand flexibility to integrate high shares of wind and solar energy
- The effects of interconnection on Norway's electricity system
- …
- …




Starter fornybar-master
sabrina.sartori@its.uio.no
MASTERKLARE: Seksjonsleder og førsteamanuensis Sabrina Sartori (foran til venstre) har undervist i masteremnet Renewable Energy: science and technology siden 2013. Nå blir emnet en del av den nye mastergraden i fornybare energiteknologier ved UiO. Her er Sartori sammen med et av sine studentkull.
FOTO: METTE JOHNSRUD, INSTITUTT FOR TEKNOLOGISYSTEMER