Creating sustainable renewable energy futures with low climate risks (SusRenew)

Kick-off seminar, Sogndal 4-5 May 2023

Agenda

Thursday 4 May, at Sogndal hotel

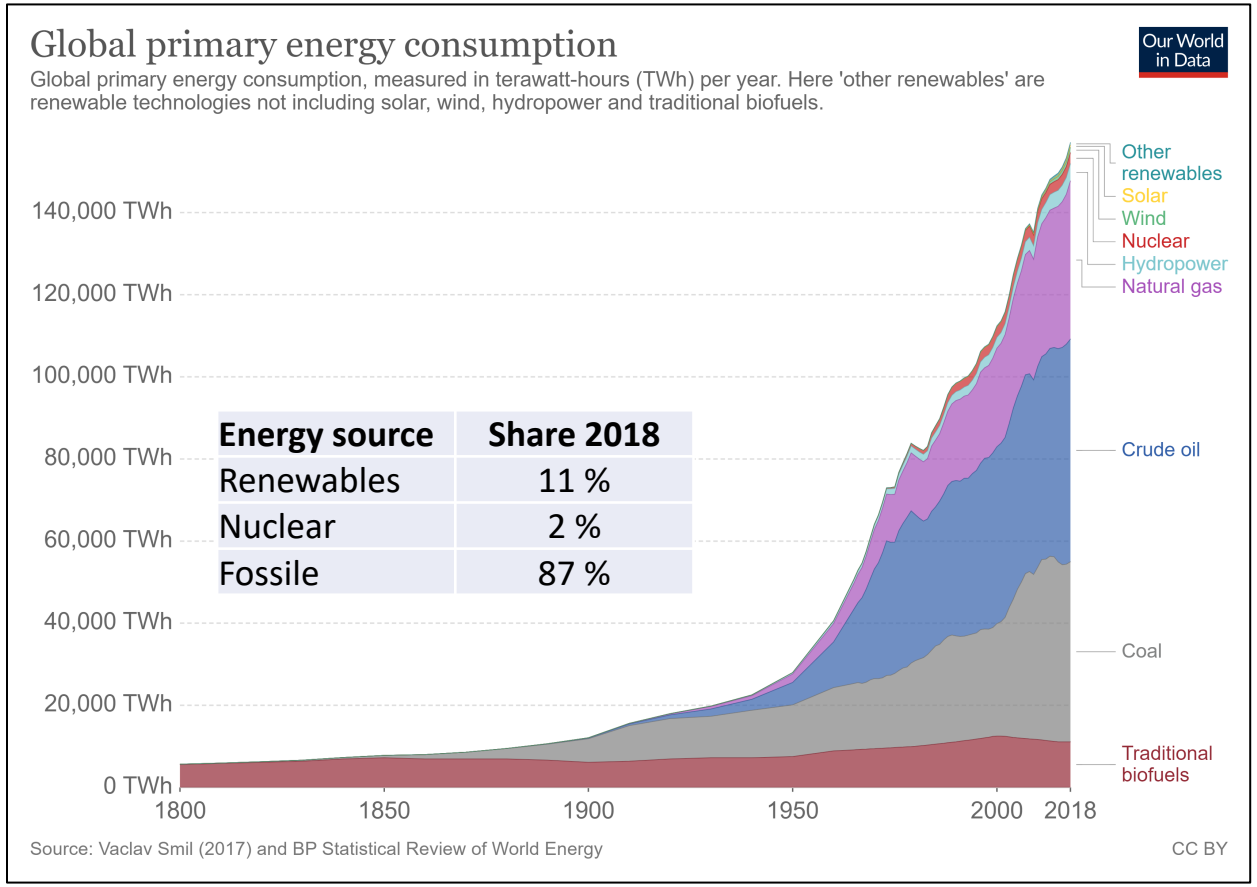
14:30	Opening, by Carlo (WNRI) • Short presentation round (name, institution, main research interest) • Introduction to the project • Formal procedures regarding contracts, introduction of new user partner
14:50	WP1 Knowledge status of climate risk in energy systems, by Carlo (WNRI) • WP-outline
15:00	WP2 Identify climate-related hazards relevant for the energy system, by Stephanie (NORCE) • WP-outline • What is 'cross boundary compound climate events' and how to apply knowledge about this in the project
15:30	WP 3 Model climate risk of the energy system, by Søren and Iva (AAU) • WP-outline, by Søren • Proposed alternatives on how to handle the emerging new debate on nuclear energy in the project, by Søren • The Energy Plan model and how it will be applied in the project, by Iva
16:00	WP 4 Integrate new knowledge about climate risk in existing energy models, by Miguel (IFE) and Stefan (SINTEF) • WP-outline, by Miguel • Brief introduction to the TIMES Norway model and how it will be applied in the project, by Miguel • Brief introduction to relevant power market models and how the selected one will be applied in the project, by Stefan
16:30	WP 5 Climate change adaptation strategies, by Carlo and Tara (WNRI) • WP-outline, by Carlo • Presentation of preliminary results from a just (as 'today'!) completed survey to representatives of the renewable energy sector in Norway on the perception of climate risks, by Tara
17:00	Program ends
18:00	Dinner at Sogndal hotel

Friday 5 may, at the locations of Western Norway Research institute

09:00	Various cross-WP project management elements, by Geir, Tara and Carlo • Internal reporting procedures, by Geir • Involvement of user-representatives, by Tara • Scientific publication plan, by Carlo • Outreach and dissemination, by Carlo
10:30	Annual plan for 2023, by Carlo
11:30	Lunch

Introduction to the project

The energy challenge



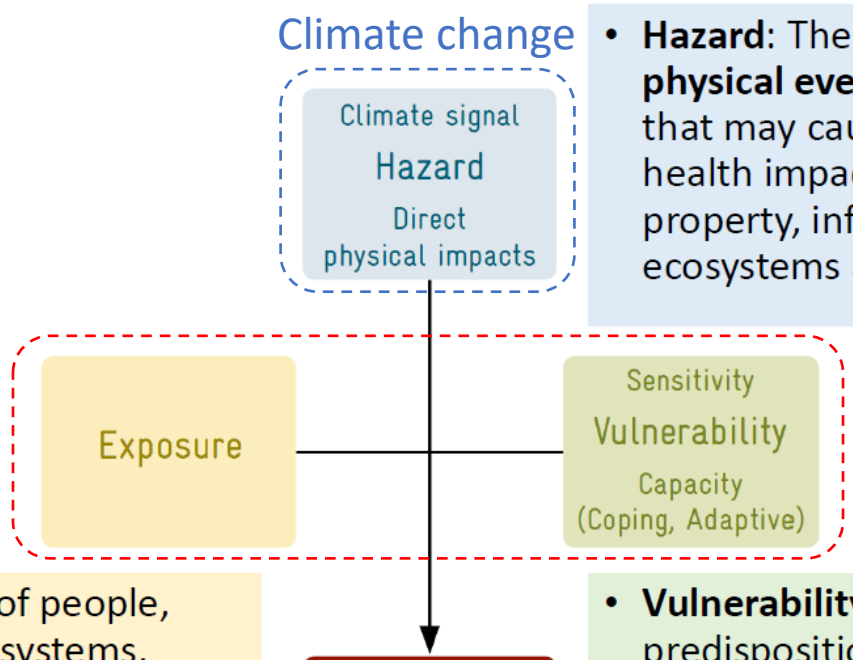
Energy source	Share 2018
Renewables	11 %
Nuclear	2 %
Fossile	87 %

Energy source	Share 2050
Renewables	100-ish %
Nuclear	? %
Fossile	0-ish %

CCS?

https://ourworldindata.org/

The ICPP AR5 climate risk concept



- **Hazard**: The **potential occurrence** of a **physical event** or **trend** or physical **impact** that may cause harm: loss of life, injury, health impacts, damage and losses of property, infrastructure, livelihoods, ecosystems and environmental resources.

- **Exposure**: "The presence of people, livelihoods, species or ecosystems, environmental functions, services and resources, infrastructure or economic, social, or cultural assets in places and settings that could be adversely affected"

- **Vulnerability**: "The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including **sensitivity** or **susceptibility** to harm and **lack of capacity to cope and adapt"**.

The mitigation-adaptation-sustainability matrix

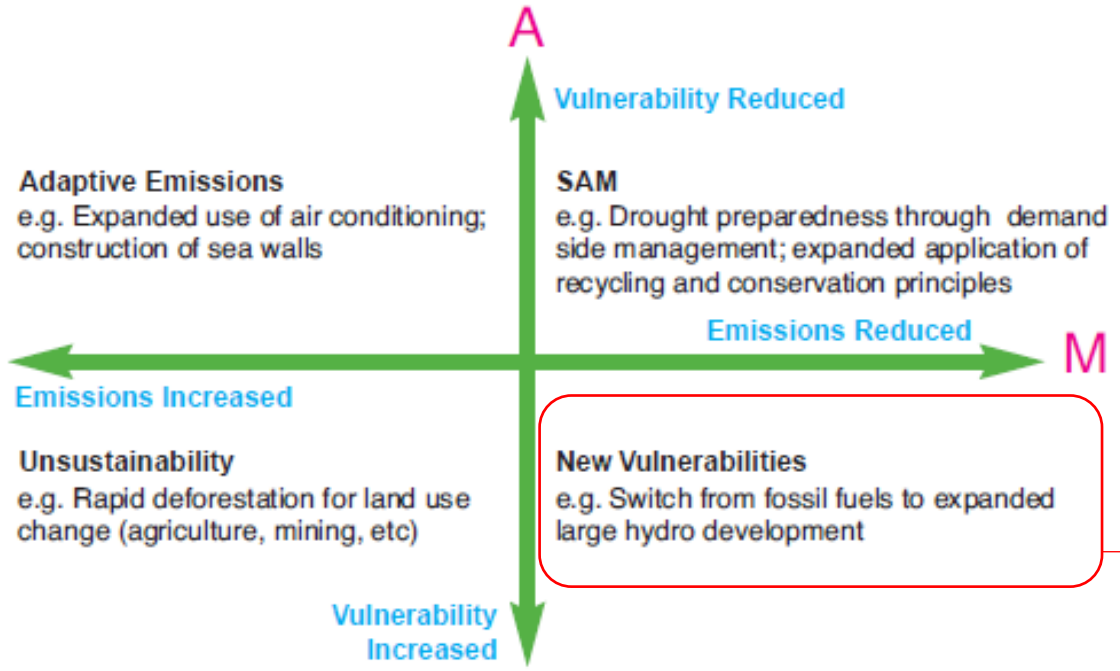
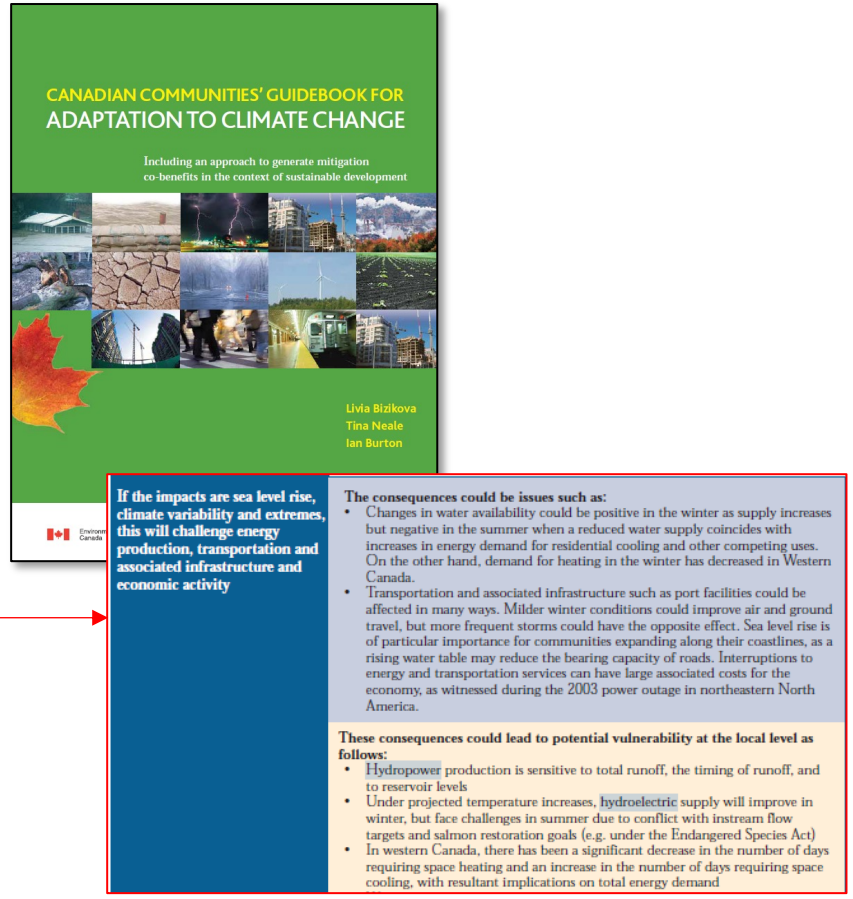
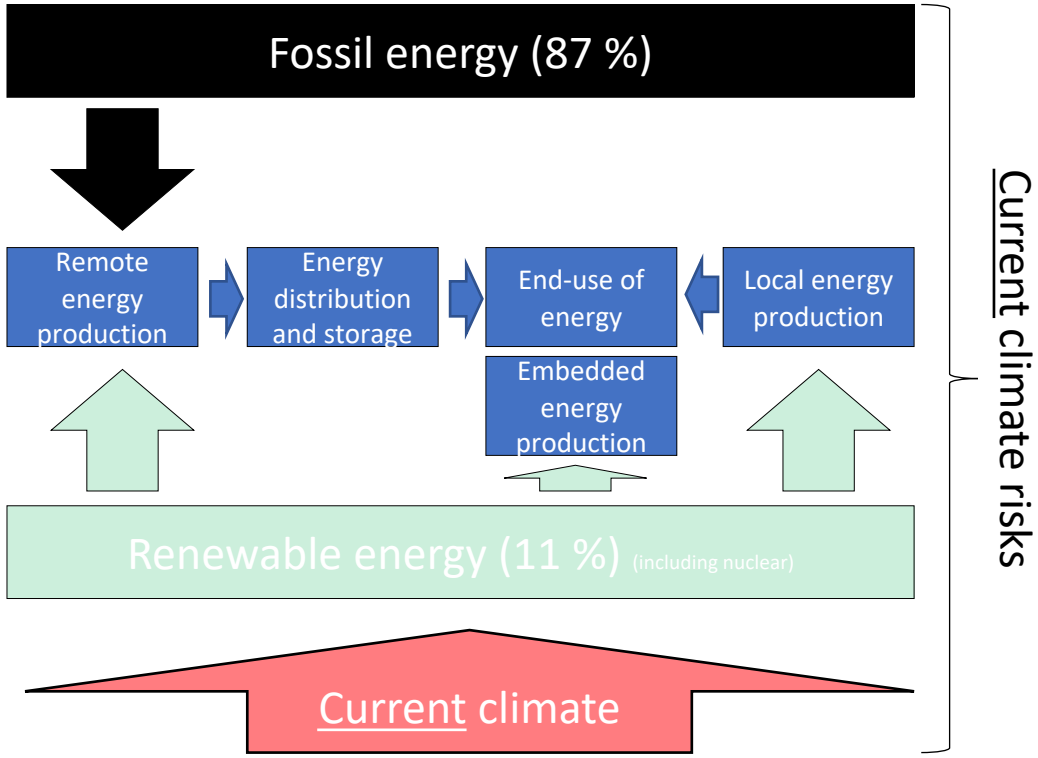
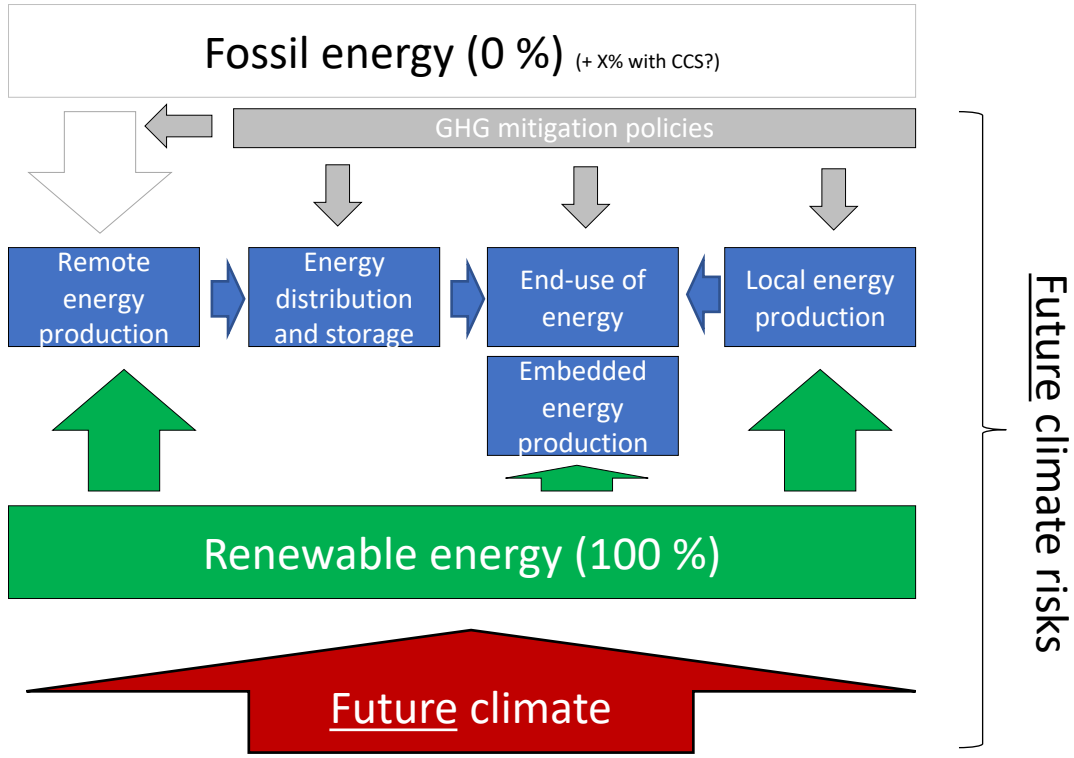


FIGURE 1. Linkages between adaptation and mitigation, in the context of sustainable development (Source: Cohen and Waddell, 2008)



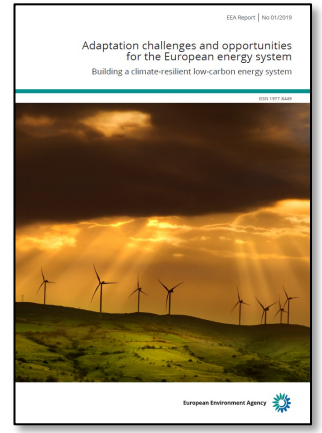
Analytical model

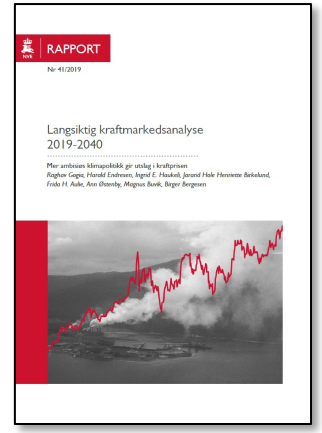




The energy policy-discourse

- **The European Environment Agency (2019): "Adaptation challenges and opportunities for the European energy system"**
  - "The European energy system increasingly needs to adapt and become more climate resilient"
  - "Climate change and extreme weather events increasingly impact all components of the energy system. They affect the availability of primary energy sources (in particular renewable energy sources), the transformation, transmission, distribution and storage of energy, and energy demand. It is crucial that these impacts are considered in the clean energy transition"
- **The Norwegian Energy Directorate (2019) "Langsiktig kraftmarkedsanalyse 2019-2040"**
  - Impacts of climate change mostly addressed as an 'opportunity' (increased capacity for hydro-energy production)
  - Possible negative impacts are only mentioned once (my translation): "Climate change can also lead to larger and more frequent floods that can present challenges for hydropower plants. This is not taken into account in the production projections"



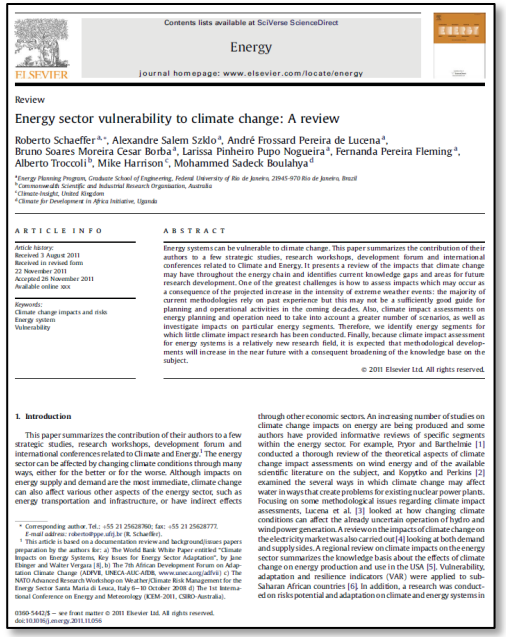


The energy research-discourse

- **General impression of the energy research literature**
  - Mostly about how climate change might increase the resource basis for renewable energy
  - Less about how a transition to a renewable energy society might increase the climate change exposure and vulnerability of the energy system
- **One example of the latter of the two perspectives**
  - Schaeffer, R. et al (2012): Energy sector vulnerability to climate change: A review. Volume 38, Issue 1, pp 1-12.
  - «One of the greatest challenges is how to assess impacts which may occur as a consequence of the projected increase in the intensity of extreme weather events"
  - "the majority of current methodologies rely on past experience but this may not be a sufficiently good guide for planning and operational activities in the coming decades..[therefore] climate impact assessments on energy planning and operation need to take into account a greater number of scenarios, as well as investigate impacts on particular energy segments"

Climate change impacts on energy systems

Energy sector	Climate variables	Related impacts	Energy sector studies
Thermoelectric power generation (natural gas, coal and nuclear)	Air/water temperature	Cooling water quantity and quality	[2,50,65]
	Air/water temperature, wind and humidity	Cooling efficiency and turbine operational efficiency	
	Extreme weather events	Erosion in surface mining	
		Disruptions of offshore extraction	
Oil and Gas	Extreme weather events	Disruptions of offshore extraction	[35,36]
	Extreme weather events, air/water temperature, flooding	Disruptions of on-shore extraction	
	Extreme weather events, flooding, air temperature	Disruptions of production transfer and transport	
	Extreme weather events	Disruption of import operations	
	Flooding, extreme weather events and air/water temperature	Downing of refineries	
		Cooling water quantity and quality in oil refineries	
Biomass	Air temperature, precipitation, humidity	Availability and distribution of land with suitable edaphoclimatic conditions (agricultural zoning)	[7,24–26,94]
	Extreme weather events	Desertification	
	Carbon dioxide levels	Bioenergy crop yield	
Hydropower	Air temperature, precipitation, extreme weather events	Total and seasonal water availability (inflow to plant's reservoirs)	[7,17,19,25,38,39,95–99]
		Dry spells	
		Changes in hydropower system operation	
		Evaporation from reservoirs	
Demand	Air temperature, precipitation	Increase in demand for air conditioning during the summer	See Table 1
		Decrease in demand for warming during the winter	
		Increase in energy demand for irrigation	
Wind Power	Wind and extreme weather events	Changes in wind resource (intensity and duration), changes in wind shear, damage from extreme weather	[1,7,23,31,42–47]
Solar Energy	Air temperature, humidity and precipitation	Insolation changes (cloud formation)	[7]
		Decrease in efficiency due to decrease in radiation	
		Decrease in efficiency due to ambient conditions	
Geothermal	Air/water temperature	Cooling efficiency	–
Wave Energy	Wind and extreme weather events	Changes in wave resource	[31]



Schaeffer, R. et al (2012): Energy sector vulnerability to climate change: A review. Volume 38, Issue 1, pp 1-12.

The SusRenew project

Aim

1. develop a framework for analysing climate risk that may arise from the transition to a renewable energy system
2. propose strategies and principles for how to reduce the identified climate risk

Research questions

Overarching: How can the Norwegian renewable energy sector obtain low-emission goals set by Norwegian governments in 2050 and beyond while simultaneously build resilience to climate risks?

1. To what extent do current energy models used in energy policy decision-making cover climate risks of a future renewable energy system?
2. What are the most important climate hazards that may contribute to climate risks of a future renewable energy system?
3. What are the climate risks of a future renewable energy system?
4. How can new knowledge about climate risks of a future renewable energy system be implemented in current energy models used in energy policy decision-making?
5. How can climate risks be reduced in the ongoing transition towards a renewable energy system?

Risk-matrix and Impact Chain

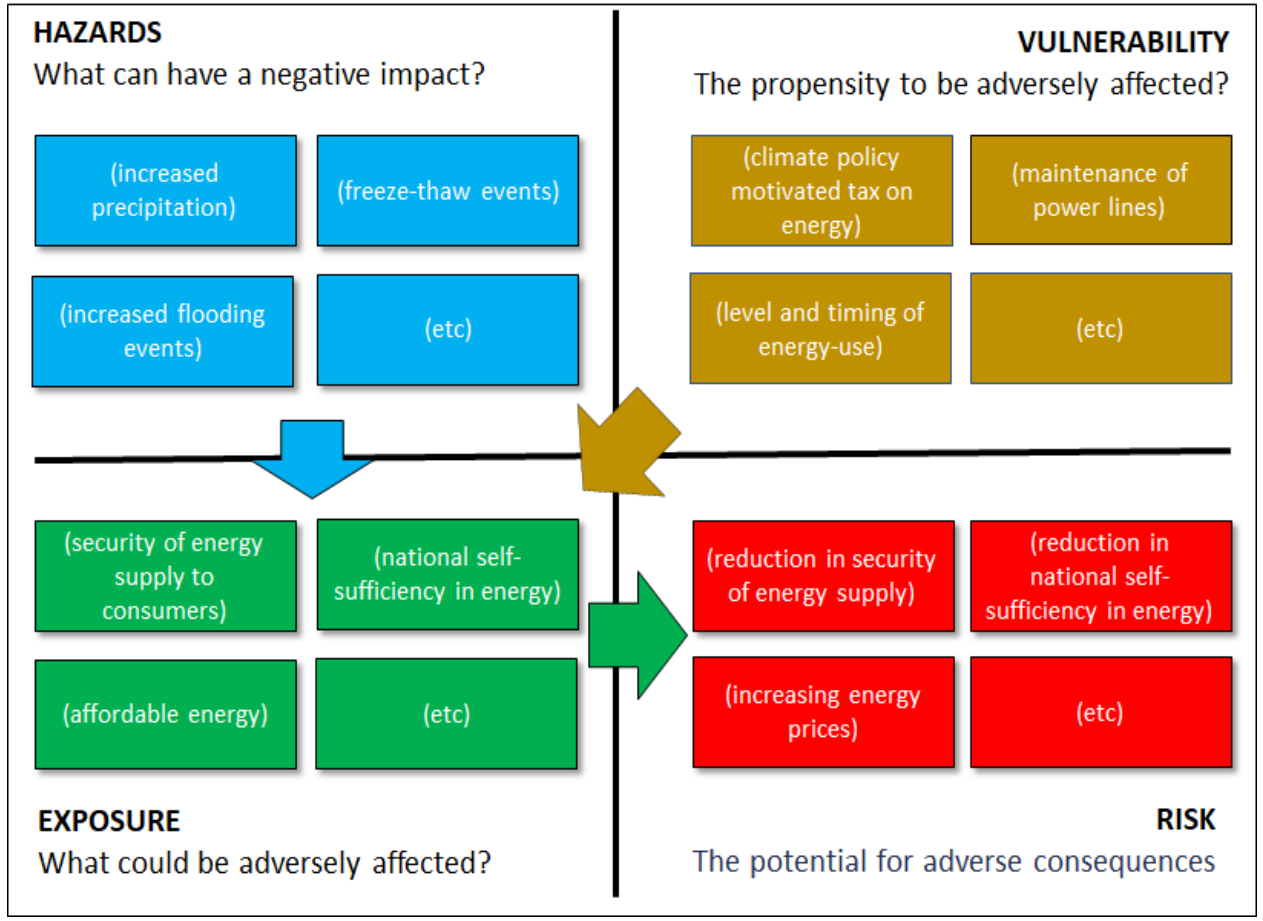
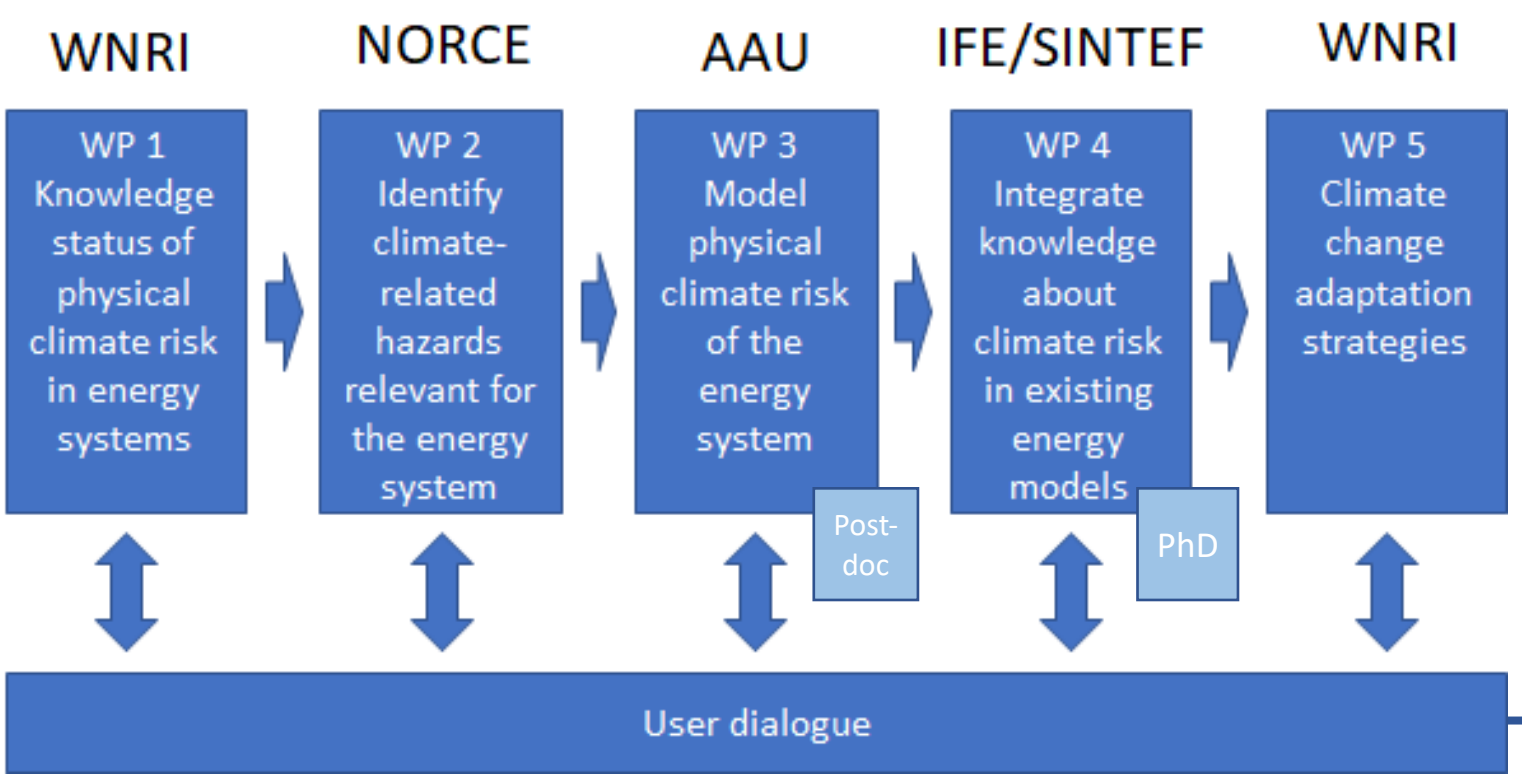


Table 1: Stages of the Impact Chain assessment of climate risks

participative	**1. Scoping, i.e., defining system boundaries of the energy system.** **2. Developing impact chains, i.e., identifying the main exposures and the corresponding climate risks (current and future possibilities), and then the related hazard and intermediate impacts factors and possible vulnerabilities.** **3. Identifying and selecting indicators to assess or measure hazards, vulnerabilities, and exposures through an iterative process between stakeholders and researchers.**
operational	1. Data acquisition and management, i.e., identify sources, availability, quality, and how to access the data. 2. Normalizing indicators, i.e., decide the possibility (and if possible, ways of) transforming the indicator values measured on different scales and using different units of measurement into unitless values on a common scale. 3. Weighting indicators and components. 4. Aggregating indicators and components. 5. Presenting outcomes.

WP-structure and user-group



Energy *users*:

- Huseiernes landsforening
- Norsk elbilforening

Energy *providers*

- Deep Wind Offshore ~~Tibber~~
- Norsk Varmepumpeforening
- Småkraftforeningen
- Samfunnsbedriftene

Energy *policy actors*

- Vestland fylkeskommune, Statsforvalter Vestland

Project management

- **Day-to-day (WNRI)**
  - Carlo Aall (project leader)
  - Tara Botnen Holm (project manager)
  - Geir Olav Haugen (controller)
- **Project management group (virtual meetings x 4/year) – check!**
  - Aall (leader)
  - Holm (secretary)
  - Løkke from AAU
  - Sørland from NORCE
  - Espegren from IFE
  - Haavard Stensvand from Statsforvalter Vestland to represent the user group
- **Scientific advisory board (physical meetings x 1/year)**
  - Dr Hans Jakob Walnum
  - Professor Sirkku Juhola, Professor of urban environmental policy at the University of Helsinki
  - Dr Stefan Jaehnert, project manager at SINTEF
  - Research professor Brigt Dale, research director at Nordland research institute

Progress plan (to be adjusted)

WPs and tasks	2023				2024				2025				2026				2027
	q1	q2	q3	q4	q1	q2	q3	q4	q1	q2	q3	q4	q1	q2	q3	q4	q1
WP1 Knowledge status ofclimate risk in energy systems																	
T. 1.1: Systematic literature review																	
T. 1.2: Workshop #1																	
T. 1.3: Reporting																	
WP2 Identify climate-related hazards relevant for the energy system																	
T. 2.1 Workshop #2																	
T. 2.2 Establishing the knowledge basis																	
T. 2.3 Develop tools to assess compound-events																	
T. 2.4 Reporting																	
WP 3 Model climate risk of the energy system																	
T. 3.1 Workshop#3-#5 user cost																	
T. 3.2 Survey on climate risks and adaptation acceptability																	
T. 3.2 Modelling																	
T. 3.3 Reporting																	
WP 4 Include climate risk in energy models																	
T. 4.1 Select energy models																	
T. 4.2 Test selected energy models																	
T. 4.3 Workshop#6																	
T.4.4 Reporting																	
WP 5 Climate change adaptation strategies																	
T. 5.1 Sum up climate risks																	
T. 5.2 Develop adaptation proposals																	
T. 5.3 Workshop #7																	
T. 5.4 Analyse adaptation acceptability																	
T. 5.5 Reporting																	
Mid-term evaluation																	

Annual plan (to be discussed tomorrow)

VESTLANDSFORSKING

Contracts

WP1 Knowledge status of climate risk in energy systems

- **Responsibilities**
  - Lead: WNRI
  - Involved: AAU, IFE, users.
- **Content**
  - By means of a systematic review of both research and policy literature, (a) map existing knowledge on climate risk in all parts of renewable energy-based systems, and (b) map to what extent (and eventually how) climate risk is assessed in existing energy models that form the basis for energy decisions in public government and private enterprises.
- **Tasks (2q 2023 → 1q 2024)**
  - Systematic literature review (WNRI, AAU, IFE)
  - Workshop with all user representatives, presenting and discussing the preliminary findings from task 1.1. (WNRI, AAU, IFE)
  - Reporting (WNRI, AAU, IFE)
- **Outputs**
  - A popular report in Norwegian (WNRI)
  - A research articles: (1) Literature review about climate risk in the various parts of the renewable energy-based an analysing to what extent (and eventually how) climate risk is assessed in existing energy models (WNRI, AAU, IFE)