WEMC
World Energy & Meteorology Council

icem 2023

27 - 29 JUNE 2023

PADOVA, ITALY

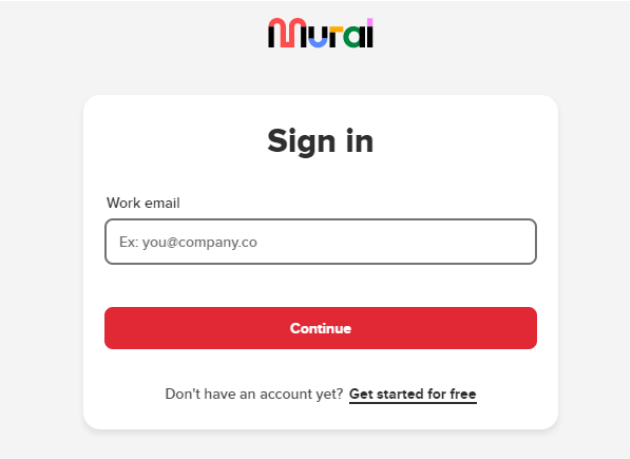
#icem2023Italy

Panel session

To participate to our discussion…

1. Download in your app store…

2. Register…



3. and scan this QR code!

…Thank you!

We will publish a summary of the discussion results on the ICEM web site .

Agenda

- 16:15-16:20 – Introduction – Laurent Dubus (RTE & WEMC)
- 16:20-16:30 – ENEL climate data for business adaptation strategy - Laura Di Bernardo and Mario Ciancarini (ENEL)
- 16:30-16:40 – Understanding climate change to support adaptation – Giuliana Barbato (CMCC)
- 16:40-16:50 - The role of multidecadal climate variability and climate change in designing future highly renewable power systems – Jan Wohland (ETH Zurich)
- 16:50-17:50 – Questions and discussion – Moderator: Sue Ellen Haupt (NCAR & WEMC)
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WEMC
World Energy & Meteorology Council

Crédit Photo: Futura Sciences

Climate stripes (@EdHawkins)

icem 2023

Trend = 1°C/century

Global

13,4 °C — 14,8 °C

Trend = 1.5°C/century

France

10,6 °C — 13,7 °C

Trend = 1.5°C/century

Paris

10 °C — 13,7 °C

1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010

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World Energy & Meteorology Council

icem 2023

Key themes

- What approach should be used for calculating the **vulnerabilities of power systems** and **assets distributed on the territory**?
- Adaptation approach from business plan to sectoral/intersectoral/national plan: **how do companies' adaptation plans meet with country plans**?
- **How** to plan adaptation actions to increase resilience of energy assets and systems where there are no scenario data or are very uncertain? What other data/approaches can be used to **integrate scenario considerations to make effective decisions**?

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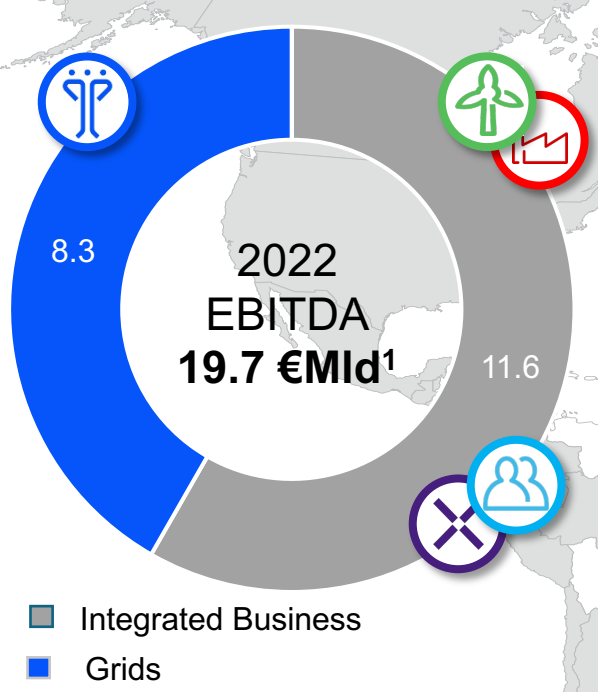
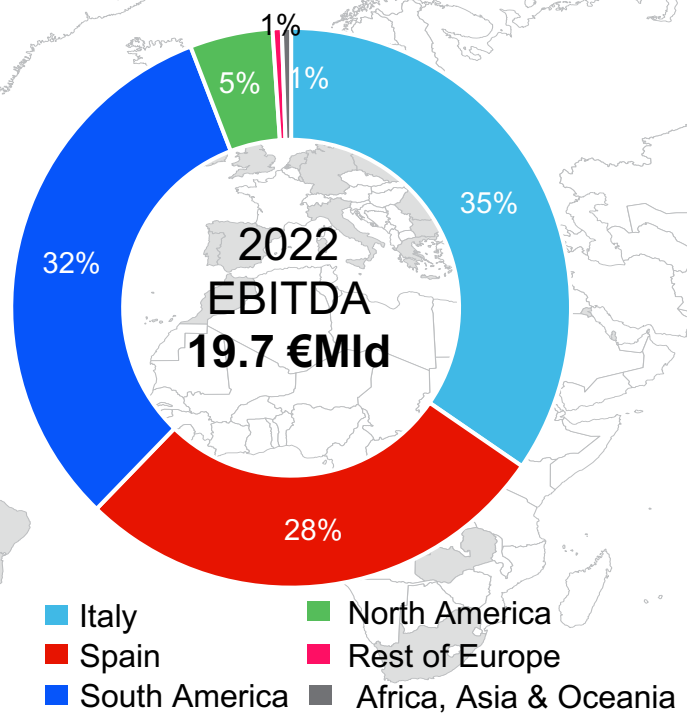
Towards Climate-Resilient Energy Systems

June 2023

Enel Leadership across the Word





Global leader in renewables[2]

~59 GW
Renewable capacity[3]

Main network operator[2]

~73 mln users

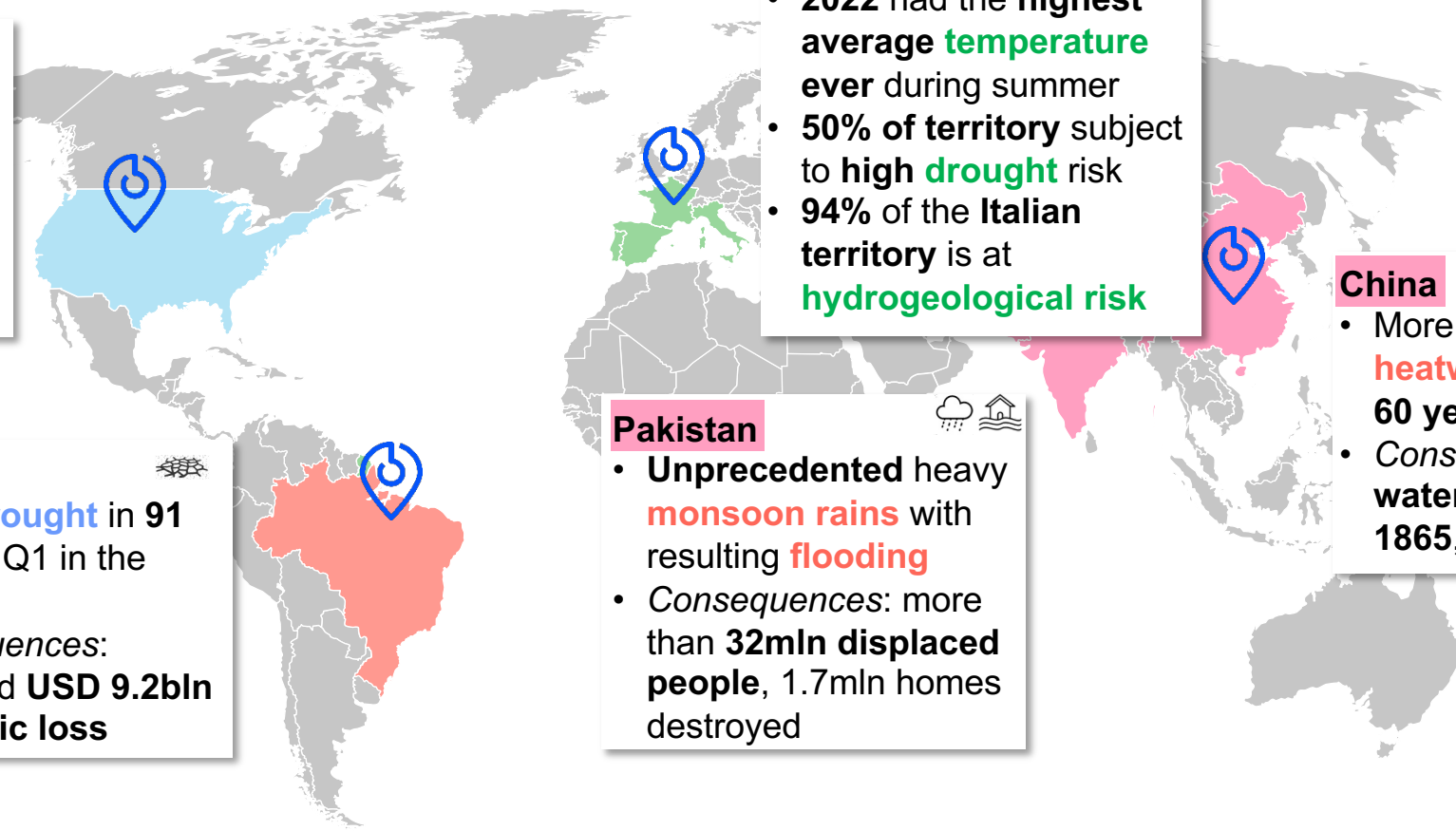
Customer base

~ 67 mln customers[4]

1. Data updated to FY 2022
2. EBITDA breakdown does not include "Services and other."
3. Enel's leadership in the various categories is defined by comparing the installed capacity of renewable sources, the number of end users, gas and electricity customers globally, excluding companies wholly owned by the state.
4. Includes managed capacity and batteries.
5. Includes customers in the electricity and gas market.

Adaptation is a Global Challenge

Some of the most affected regions around the world in 2022/2023



USA
- Heatwaves with **temperatures as high as 47°C** for the first time
- **51,000+** wildfires burning almost **7mln acres**

Europe
- **2022** had the **highest average temperature ever** during summer
- **50% of territory** subject to **high drought** risk
- **94%** of the **Italian territory** is at **hydrogeological risk**

Brazil
- Worst **drought** in **91 years** in Q1 in the South
- *Consequences*: estimated **USD 9.2bln economic loss**

Pakistan
- **Unprecedented** heavy **monsoon rains** with resulting **flooding**
- *Consequences*: more than **32mln displaced people**, 1.7mln homes destroyed

China
- More than **2-months long heatwave, worst** one in **60 years**
- *Consequences*: **lowest water levels since** at least **1865**, **extreme drought**

Extreme events push people to relocate. According to the World Bank, by 2050 between 125 and 216 million climate migrants could move internally in low- and middle-income countries depending on climate outcomes. Internationally the numbers could be even greater.

Sources: Copernicus (Europe); The Guardian, World Weather Attribution (USA); Monitor de Secas (Brazil); Financial Times, World Weather Attribution (Pakistan); The New York Times, South China Morning Post (China). ISPRA

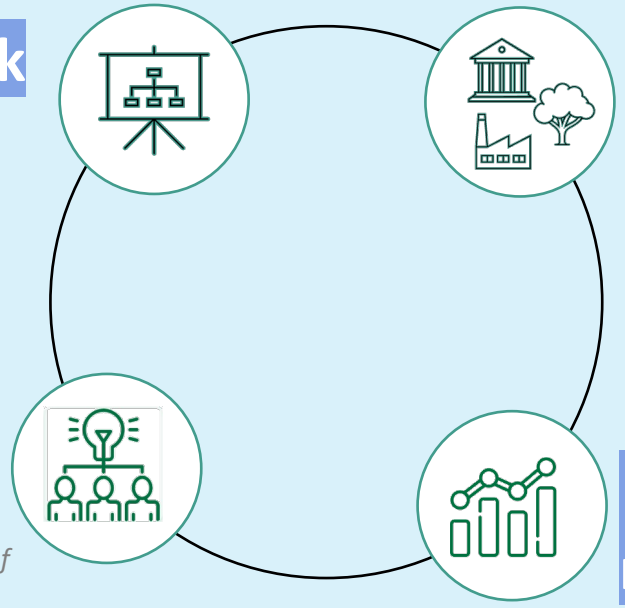
Collaboration is Crucial to Adapt Effectively

Synergy between, Policymakers, Companies and Scientific Community is crucial to face Climate Change

"We must respond to the challenges of climate change as one nation, through the collective action of government agencies, individuals, businesses and the community."

Singapore Climate Action Plan

Stakeholder should share:



«Climate change must be tackled as an integrated problem [...]. A convergence of disciplines that goes beyond mere interdisciplinarity is indispensable".

Antonio Navarra, CMCC president
@ Festival Green&Blue 2022

How can we Manage Adaptation in a Company and which are the Key Priorities?

Enel 2022 Annual Report

To **ensure** a climate change proof company, leveraging on **climate and asset data** analysis to develop effective adaptation measures both to **preserve profitability** and to foster **resilient business models** and exploit **opportunities**.

Enel Climate Adaptation Approach

Resiliency Actions

Increase asset resiliency to reduce Climate Risk **implementing adaptation measures** on existing assets and ensuring resiliency by design

Response Management

Be ready to response to adverse events **leveraging on weather and climate analysis** to prioritize efforts

Opportunities

New business or product design to adapt to future changes in climate, so as to facilitate the adaptation of all stakeholders

From Scenarios to Plan | Assess Hazard, Understand Vulnerabilities and Exposure, Implement Adaptation Measures

1. Climate Hazard assessment

Climate scenarios to assess **expected changes** in physical phenomena

2. Vulnerability to physical phenomena

Quantifying **potential damages** on assets and **business interruptions** function of intensity and probability of phenomena

3. Economic impact

Assessing the expected **economic impact** of climate change considering Hazard and Vulnerability of climate change

4. Adaptation Plan

Define Adaptation measures to be implemented, through Cost-Benefit analyses both for **Event Management (Response)** and **Resiliency measures**

Keywords

Data and tools
Probability and intensity
Geo-resolution
Models and Scenarios

Link functions
Weakness Damages
Business interruptions
Technologies
Asset@risk

Economic exposure
Cost-Benefit analysis
Overall risk assessment

Adaptation options
CAPEX and OPEX
Response actions
Resiliency by design
Opportunities

Vulnerability: Focus on Distributed Assets

Main issues:

- **Grids have heterogeneous components** and **do not benefit of technical specifications** describing the resiliency to a specific hazard
- **Evaluate climate hazard on distributed assets is more complex than for the localized ones**, usually requires a larger amount of data organized on raster to cover wide areas

Gaps to fill:

To improve vulnerability assessments is necessary:

- **improve the specifications about asset** characteristics
- **tracking the adverse events impacts and their causes**

so that the relationships between hazards and impacts will be modelled always better

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Centro Euro-Mediterraneo sui Cambiamenti Climatici

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Understanding climate change to support adaptation

CMCC Foundation

Regional Models and geo-hydrological Impacts Division

Giuliana Barbato

ICEM 2023, Padova, Italy

CMCC Foundation

CMCC's mission is to **investigate our climate system** and its interactions with society to provide **scientific results** in order to **stimulate** sustainable growth, protect the environment and develop science-driven adaptation and mitigation policies.

OFFICES

CMCC is organized in the form of a network distributed throughout Italy.

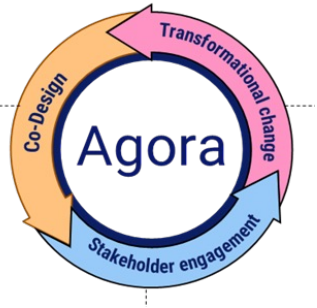
Cofounders institution

UNIVERSITÀ DEL SALENTO
UNIVERSITÀ Tuscia
RESOURCES FOR THE FUTURE
uniss
ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA
POLITECNICO MILANO 1863
Università Ca'Foscari Venezia
ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

Experiences on the issues of climate change adaptation

- Qualitative and quantitative evaluation of the effects of climate changes on **hazards and impacts**
- Evaluation with stakeholders of specific indices/indicators that can be considered as proxies of **climate-related hazardous events** (e.g. flood, drought, fire)
- Support the **integration of climate change adaptation into the work of national/regional/local authorities**

Europe



Mission

Contribute to the overall objectives of the European 'Mission 'Adaptation to Climate Change' by valorising and disseminating best practices, innovative approaches, policy instruments and governance mechanisms to foster climate adaptation.

National

MINISTERO DELL'AMBIENTE
E DELLA SICUREZZA ENERGETICA

Italian Climate National Change Adaptation Plan

Regional

REGIONE AUTÒNOMA DE SARDIGNA
REGIONE AUTONOMA DELLA SARDEGNA

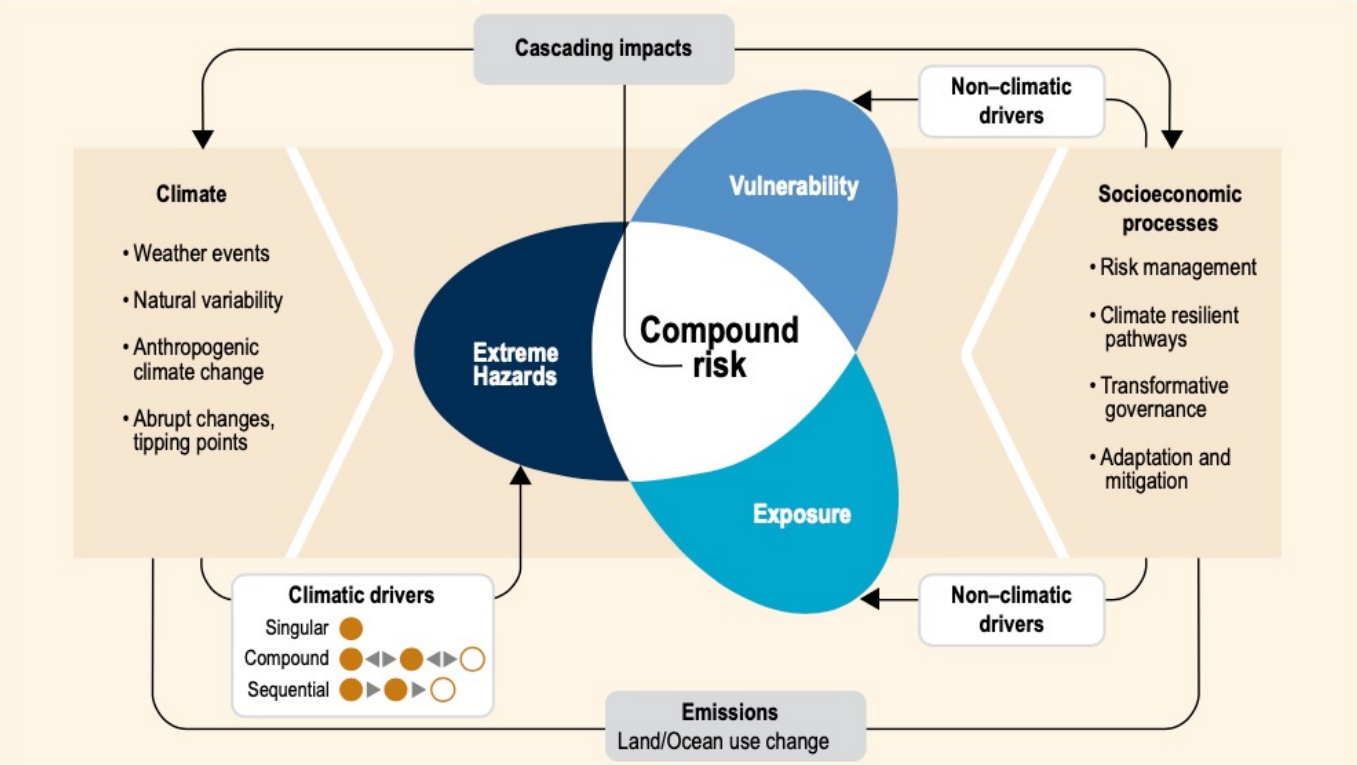
Sardinia Region Adaptation Strategy to Climate Change

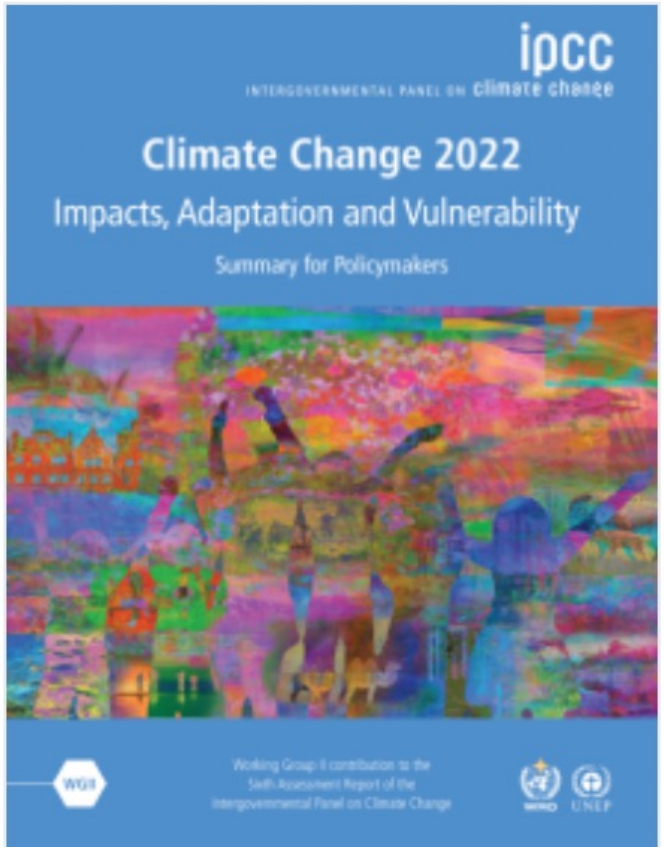
Local

Introducing climate proofing in investments and spatial planning (developed with ENEL Foundation and VIU)

Understanding climate change to support adaptation

The concept of risk in the IPCC Sixth Assessment Report
(Source: IPCC 2022)



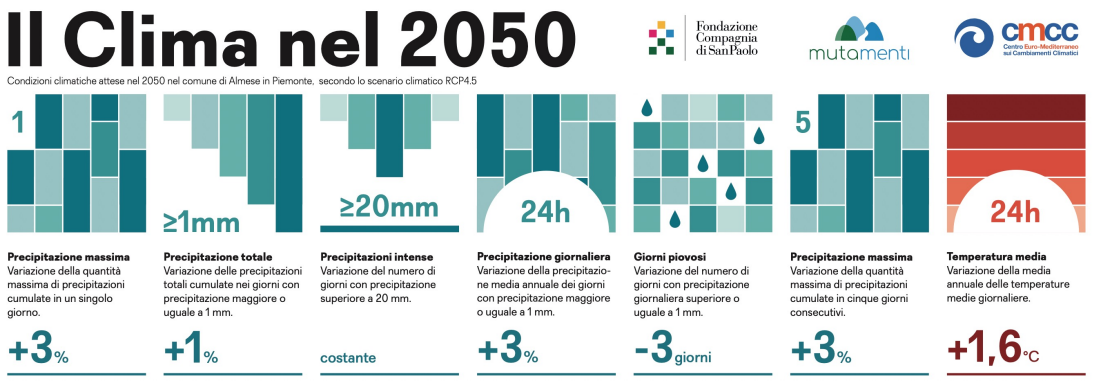


Climate hazard assessment

Step 1: planning and design the adaptation initiative and communication/involvement actions of local stakeholder

Climate change adaptation in cities
(Call for porposal «Mutamenti»)
Founded by Compagnia San Paolo Foundation
in collaboration with CMCC

1. **Development of a common knowledge framework for local climate adatpation**
2. **Definition of climate hazard, exposure samples and potential risks**
3. **……**



DEFINITION OF THE CLIMATE HAZARDS

Identify the climate hazard that affect the territories of **each entity** in order to define the indicators that will be calculated through observed and future climate scenarios.

Fires

Droughts

Hydrogeological risk and flooding

Climate hazards for mountain areas (e.g. heatwaves)

Climate hazards for agricolture system

https://www.sciencedirect.com/science/article/pii/S2590252022000198

Introducing climate proofing in investments and spatial planning (developed with ENEL Foundation and VIU)

Local Pilot project to support the **introduction of climate proofing** (process of mainstreaming climate change) in **strategic planning and decision-making to cope with climate risk**.

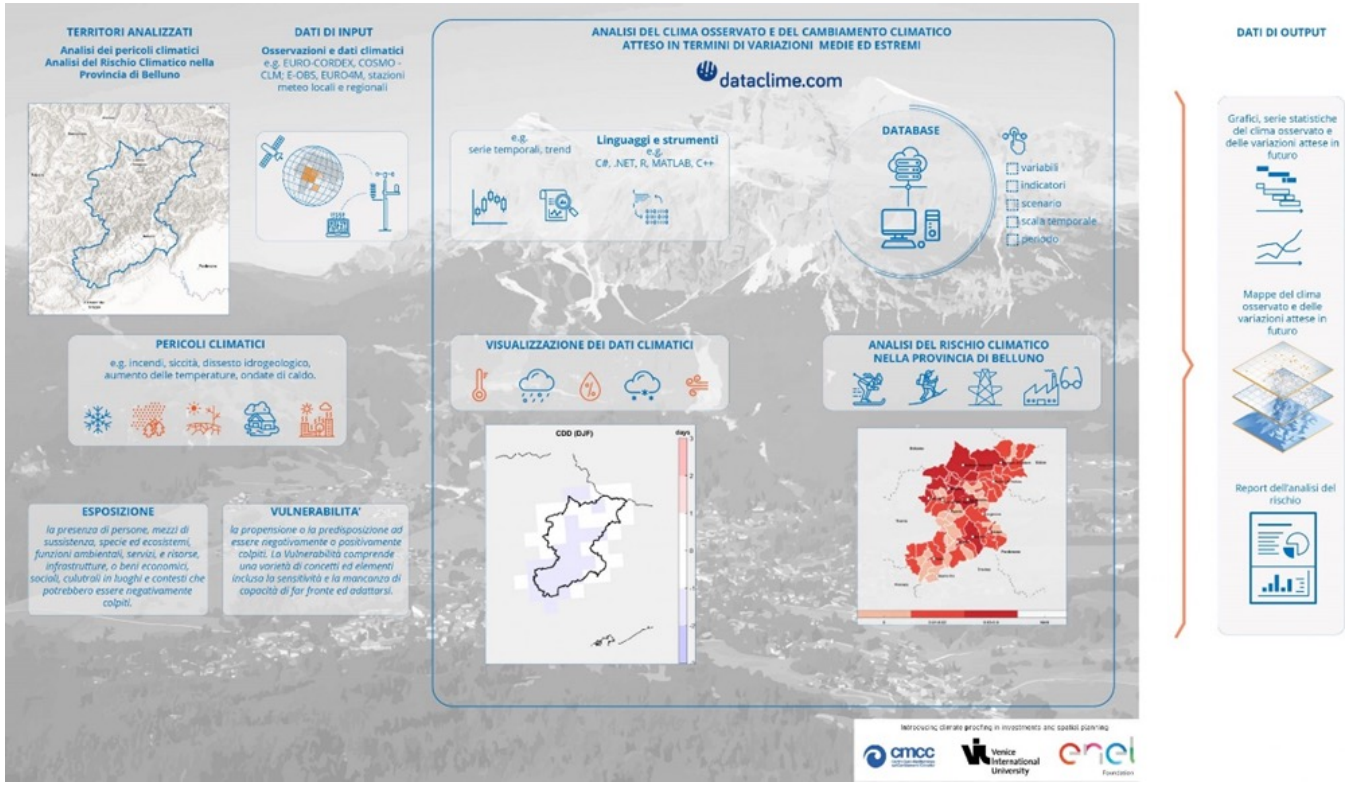
Climate-related hazard assessment

TASK 1
Definition of a database of maps on expected local climate change conditions

TASK 2
Hazard assessment supporting risk analysis

Four main economic activities

- **Winter sports and events**
- **Summer Tourism**
- **Electricity distribution**
- **Eyewear industries**



https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4080578

Introducing climate proofing in investments and spatial planning (developed with ENEL Foundation and VIU)

Climate-related hazard assessment (CMCC)

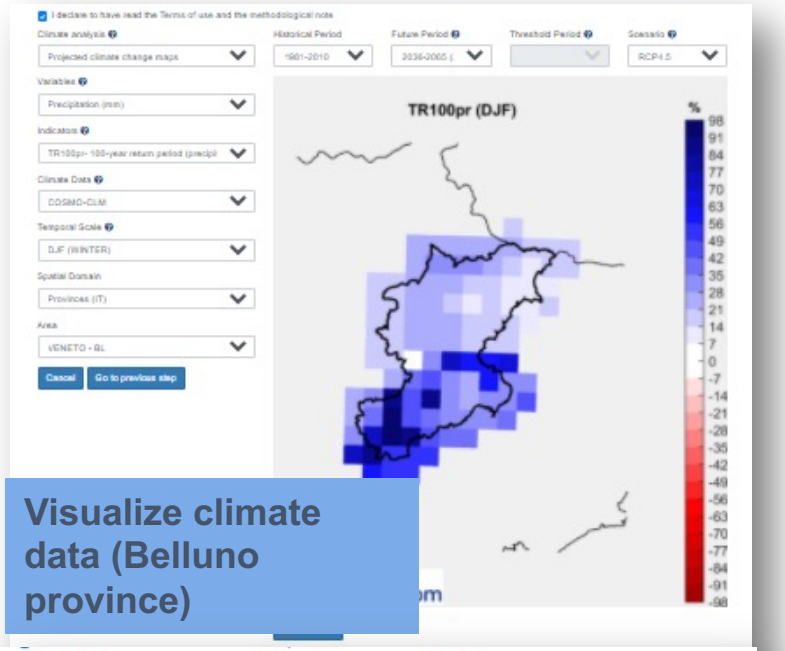
TASK 1
Definition of a database of maps on expected local climate change conditions

TASK 2
Hazard assessment supporting risk analysis

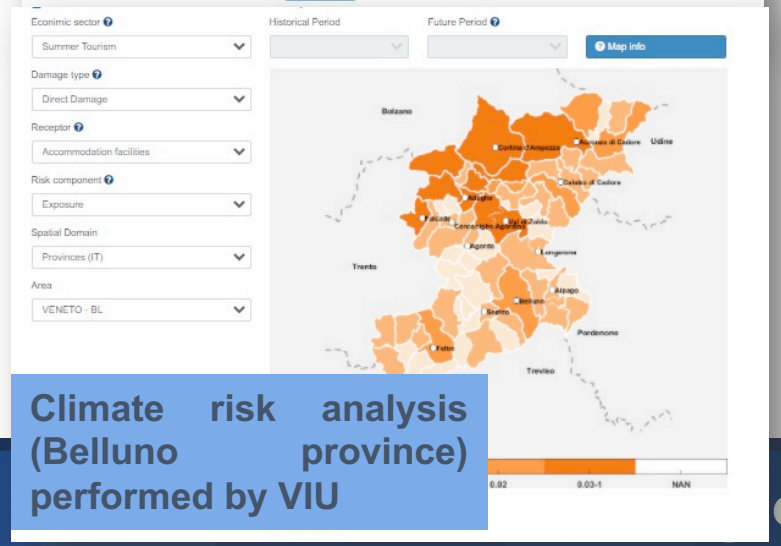
- Provide information of the **general characteristic of the climate change** expected over the Belluno for specific indices related to selected hazardous events.

- Provide information on the **evolution of the hazards having impacts** on the **economic sectors** selected in order to provide a **local assessment of the risk evolution** considering climate change.

DATACLIME TOOLS



Visualize climate data (Belluno province)



Climate risk analysis (Belluno province) performed by VIU

SECTOR– ELECTRICITY DISTRIBUTION

Summer Tourism

Winter Tourism

Electricity distribution

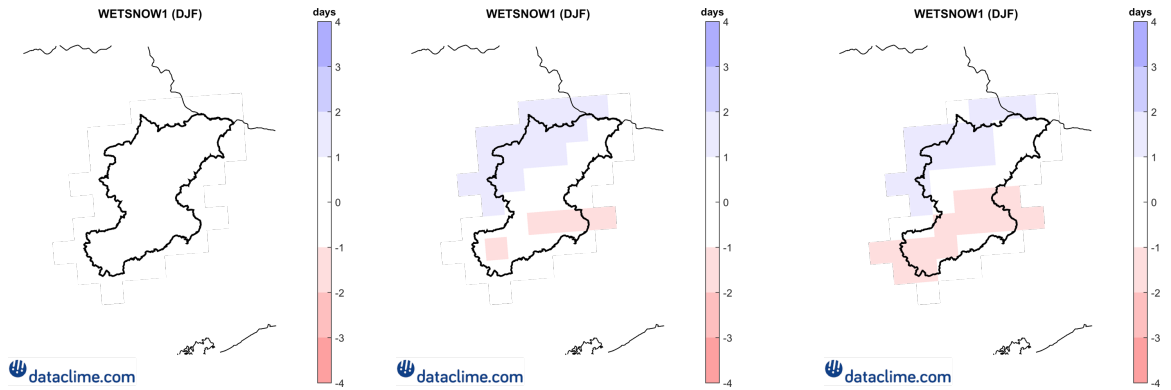
Eyewear industries

The hazardous events of interest for this sector are (i) **extreme rainfall events** that can generate landslides or flooding events with consequent damage to lines and cabins; (ii) **wind storms** that can determine the fall of trees on the energy distribution lines; (iii) the formation of **ice sleeves**, due to the combination of specific temperature and wind conditions (moderate winds, snowfall and temperatures that favour the accumulation of wet snow).

Several indicators have been selected for the hazard assessment, tailored accounting for the comprehensive risk assessment procedure and specific user's requirements

2036-2065 vs 1981-2010 (WINTER)

RCP2.6 **RCP4.5** **RCP8.5**



EURO-CORDEX (Jacob et al., 2014). The models, developed under the EURO-CORDEX program, cover all Europe with a spatial resolution of about 12 km.

SECTOR– ELECTRICITY DISTRIBUTION

Econimic sector: Electricity distribution

Damage type: Direct Damage

Receptor: Network infrastructures

Risk component: Risk

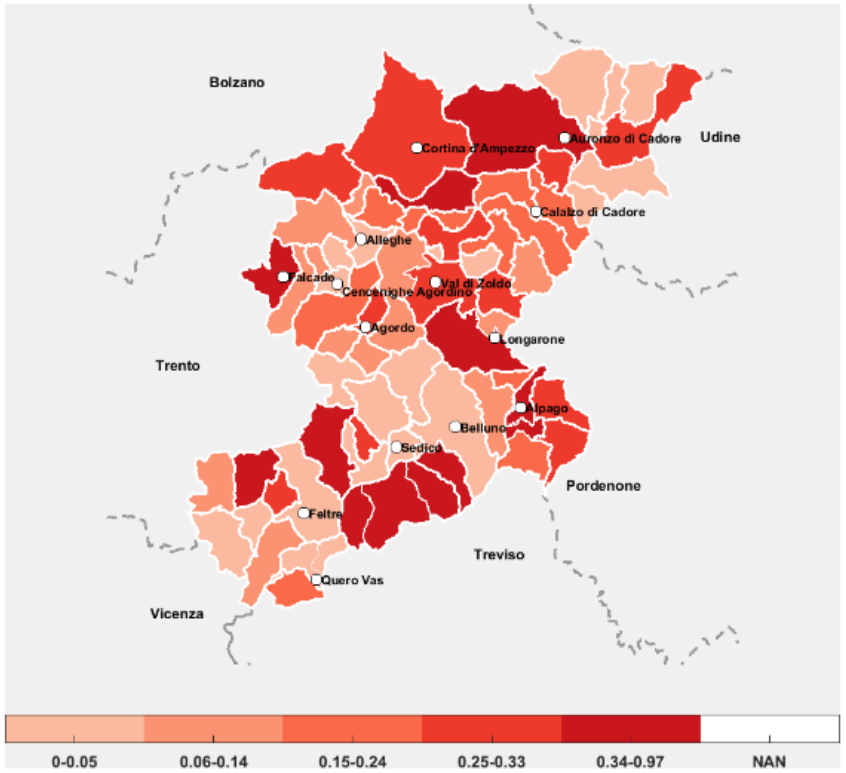
Spatial Domain: Provinces (IT)

Area: VENETO - BL

Historical Period: 1981-2010

Future Period: 2036-2065

Map info



download

ELECTRICITY DISTRIBUTION, DIRECT DAMAGE, NETWORK INFRASTRUCTURES

In the analysis of the electricity distribution sector, the climatic hazard refers to **wet snow events** which can cause ice accretion on electrical cables, under particular atmospheric conditions of temperature, wind and precipitation, **with a return period of 100 years**. The infrastructure exposed to the climatic hazard therefore consists of medium and low voltage overhead electricity distribution networks. Risk is calculated depending on the frequency with which the climatic hazard can have a direct physical impact on infrastructures. An overall 6.2% increase in the future risk is detected in comparison with the historical one, associated with a level of uncertainty that ranges, in the different parts of the province, between 2 and 9%. Such an increase is mainly due to climatic anomalies which locally show a limited but positive trend in the northern part of the province.

Technical Article | Utility Practice & Experience

Impact of Climate Change on Power Systems & Electrical Insulation: Experience in Italy

October 19, 2019 | Climate, Maintenance, Power Systems | 37 min read

Climate services through dataclime platform: Support Decision-Makers with customized climate info

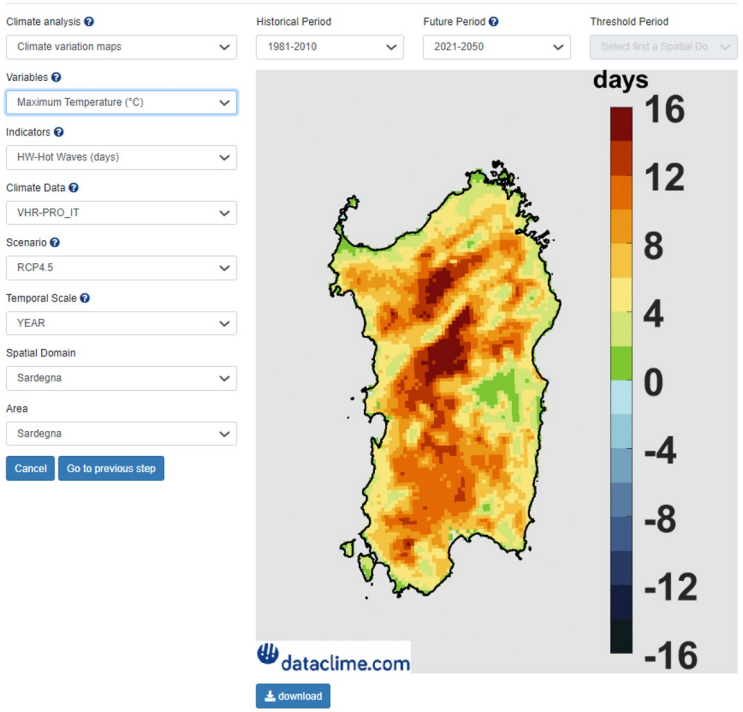
Among the different tools developed there is **Dataclime**:

- Dataclime enables the provision of data and information for both the society and scientific community.
- Dataclime facilitates climate analysis at the European and national levels, contributing to initiatives such as the National Adaptation Plan.
- Over 500 users are registered on the platform, benefiting from its capabilities.

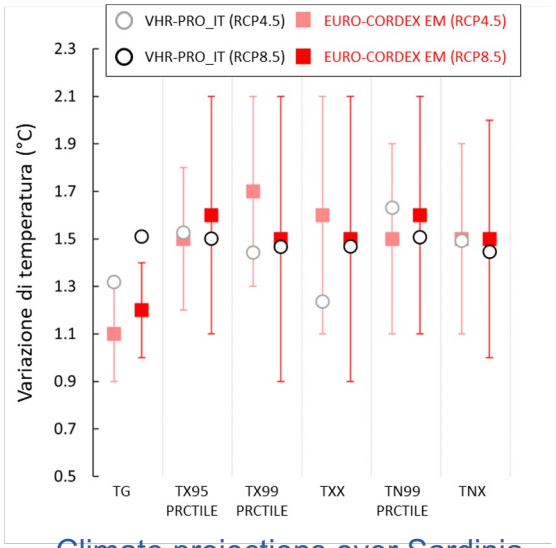
Additional info at:

dataclime.com | cmcc

SRACC – Sardinia Region

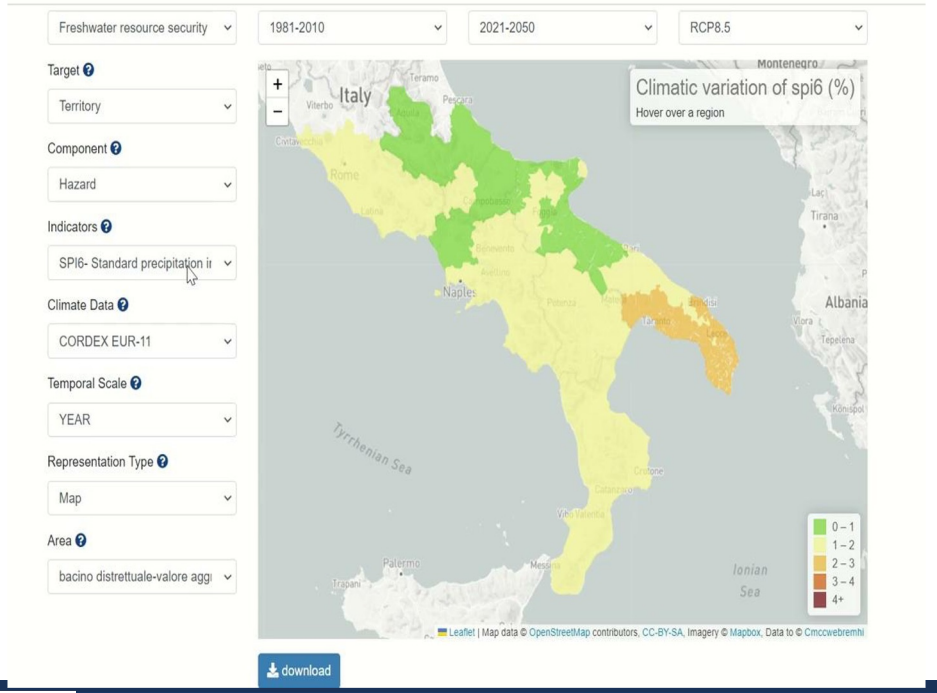


Tailored climate indicators and analysis with climate projections and re-analysis at 2 km.



Climate projections over Sardinia Region (comparison of the 2km projections with EURO-CORDEX.

New Dataclime functionality: dynamical maps (for visualizations of indicators up to NUT3 Levels).



UnipolSai · Leitha · BigData · Fondazione Compagnia di San Paolo · mutamenti · enel Foundation · RFI Rete Ferroviaria Italiana · Gruppo Ferrovie dello Stato Italiane · smat · SINA

Dataclime users

cmcc

Agora

just and inclusive
climate adaptation

AGORA is a HORIZON project started in January 2023. It supports the EU Mission on Adaptation to Climate Change promoting societal transformation and empowering local communities to address the climate crisis through a multidisciplinary and integrated approach and four living laboratories all around Europe. Just as its inspirational name suggests, the project aims at building a wide community of aware and informed citizens, who can actively participate in public life giving their contribution to ensure a safe and sustainable local development.

www.cmcc.it

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ETH zürich

Institute for Atmospheric and Climate Science

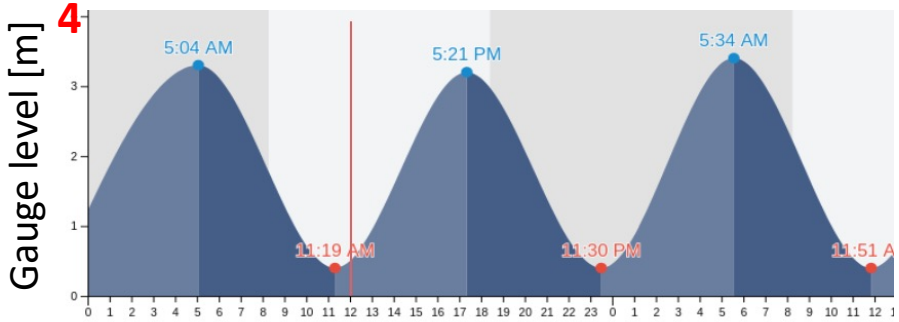
The role of multidecadal climate variability and climate change in designing future highly renewable power systems

Dr. Jan Wohland | 27/06/2023 | ICEM

Picture by Nicholas Doherty shared on unsplash

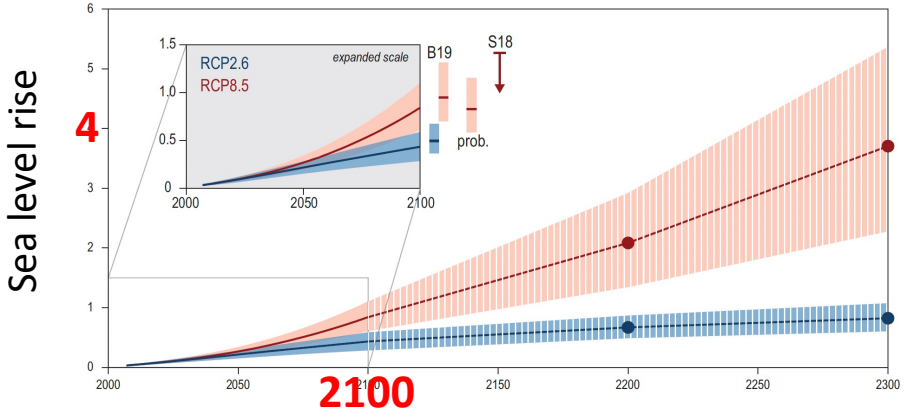
A climate-proof asset?

Climate variability:



Climate change:

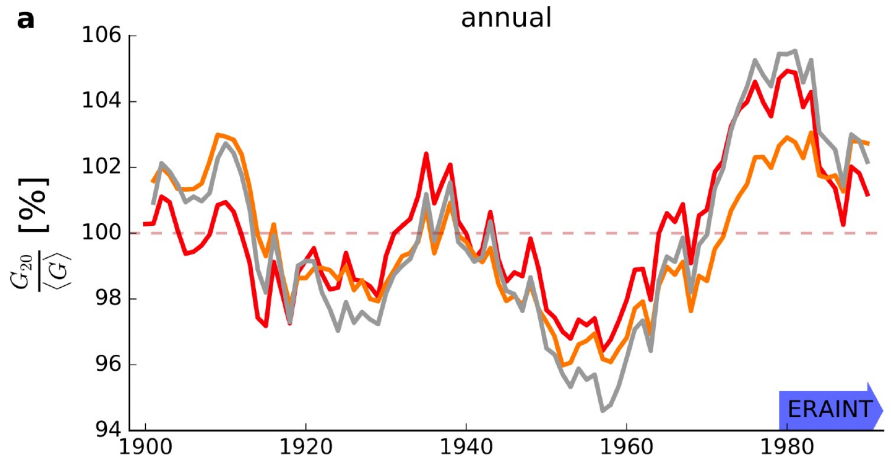
[IPCC, 2019]



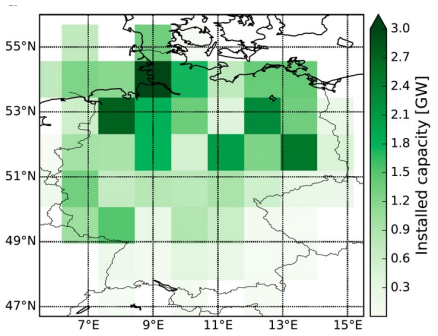
Energy system planning must include risks from variability and climate change!

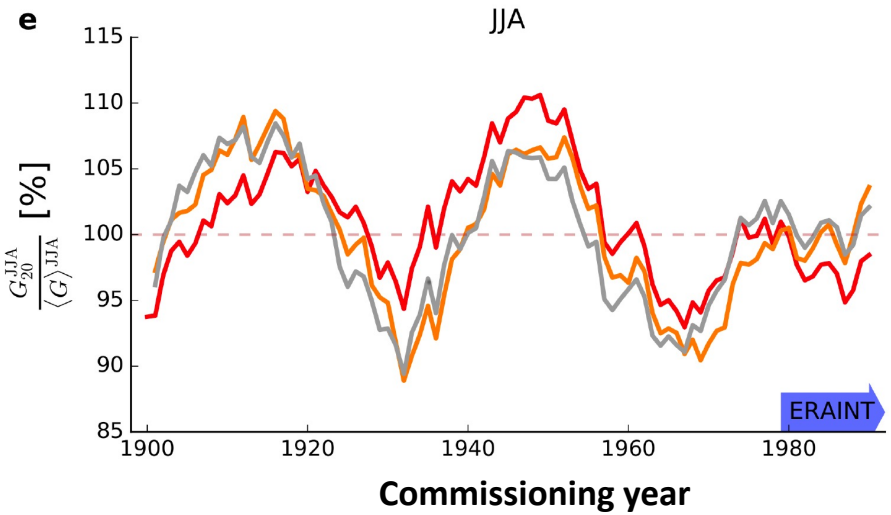
Part 1: How wind and solar potentials varied since 1900

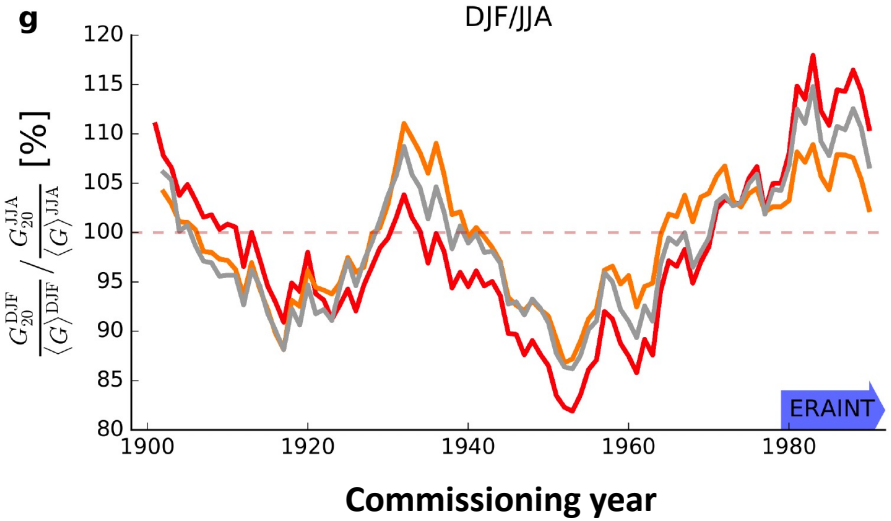
Case study: German 20y mean wind power generation



Spurious trends in
(C)ERA20C removed







[Wohland et al., 2019b]

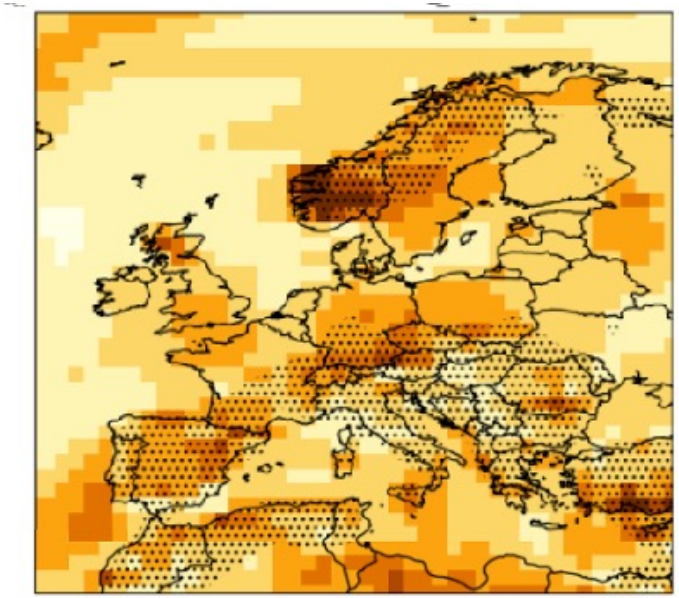
Multi-decadal fluctuations in lifetime energy generation up to +- 5% (whole year), +-10% (summer), +-15% (winter-to-summer ratio)

European picture

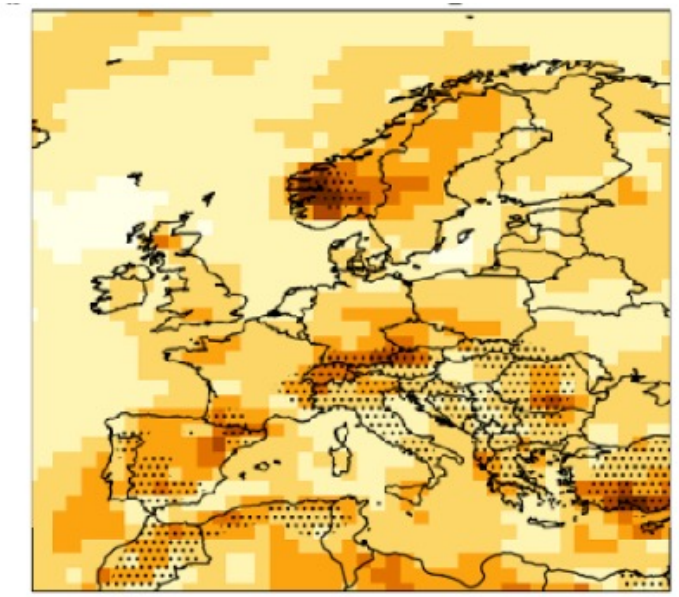
1905-2004

Method:
Combination of 20CRv3 and CERA20C, using 100m winds as input

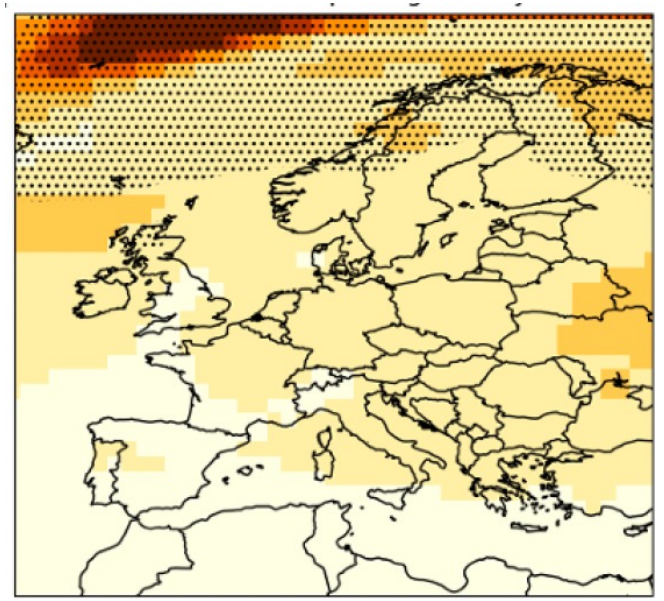
E-126_7580

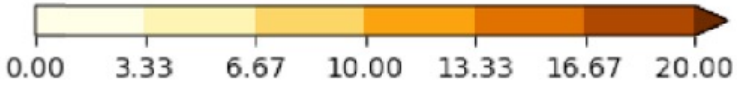


SWT120_3600



Silicon PV





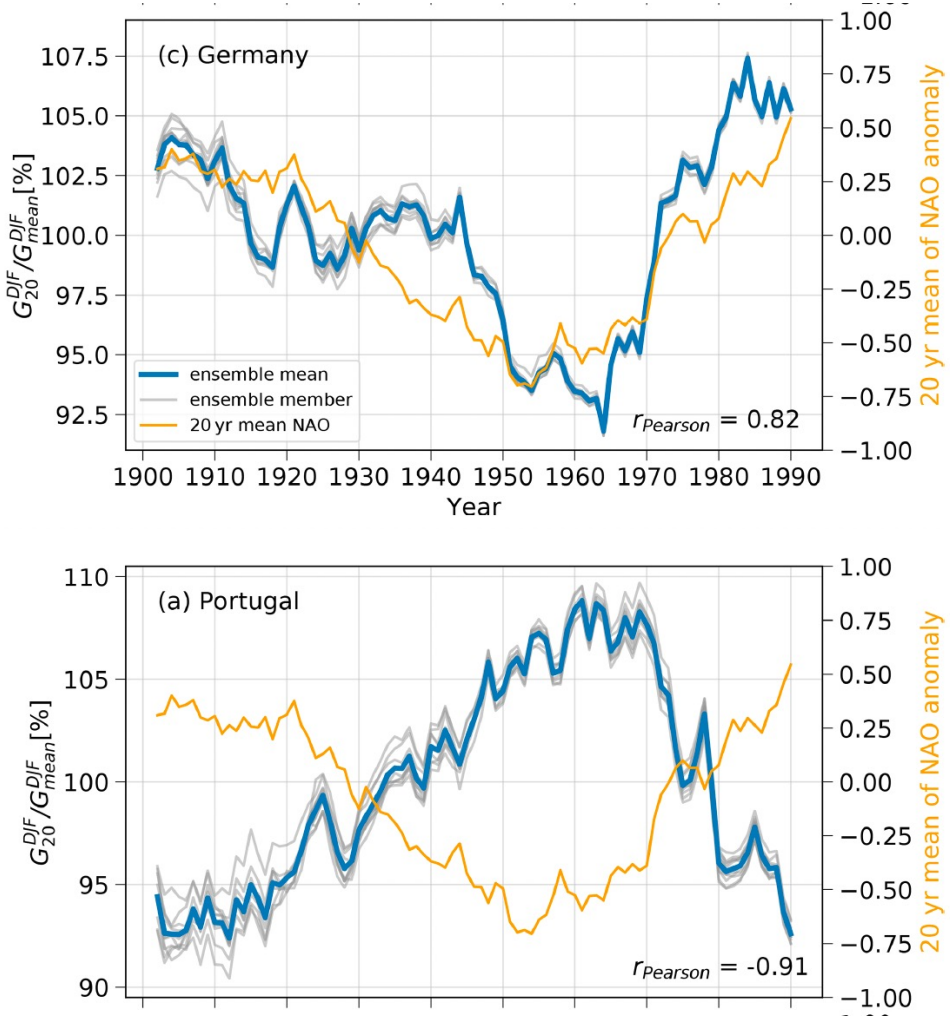
Amplitude of multidecadal variability [%]

[Wohland et al., 2021]

10% amplitude means: the best consecutive 20 years had **10%** mehr yield than the worst 20 years

Early evidence for inter-country balancing potential

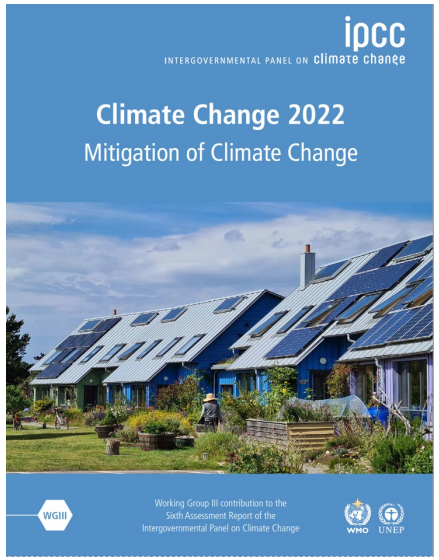
[Neubacher et al., 2019]



Spreading capacity over the continent can be a successful risk minimization strategy

Part 2: How will climate change impact renewable potentials and system integration?

And why this is a complex question



6.5.2.2 Wind Energy

Climate change will not substantially impact future wind resources and will not compromise the ability of wind energy to support low-carbon transitions (*high confidence*). Changing wind variability may have a small to modest impact on backup energy and storage needs (*low confidence*); however, current evidence is largely from studies focused on Europe.

Long-term global wind energy resources are not expected to substantially change in future climate scenarios (Karnauskas et al. 2018; Yalew et al. 2020; Pryor et al. 2020).

Don't panic

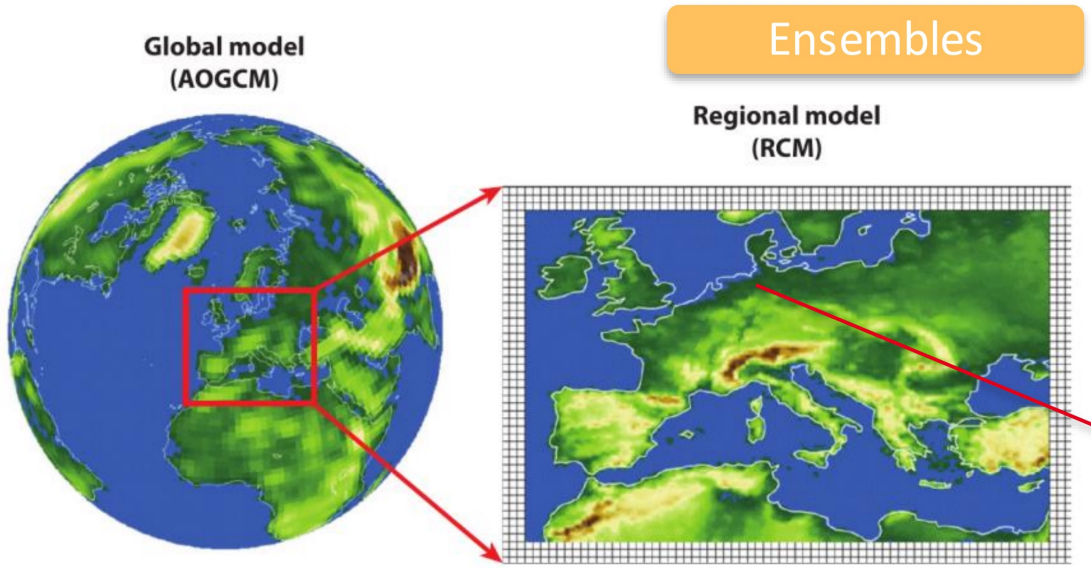
Don't chill to hard

And: Some things remain poorly understood.

The climate modeling chain

Scenarios

- Greenhouse gases
- Land use change
- Aerosols
- etc.

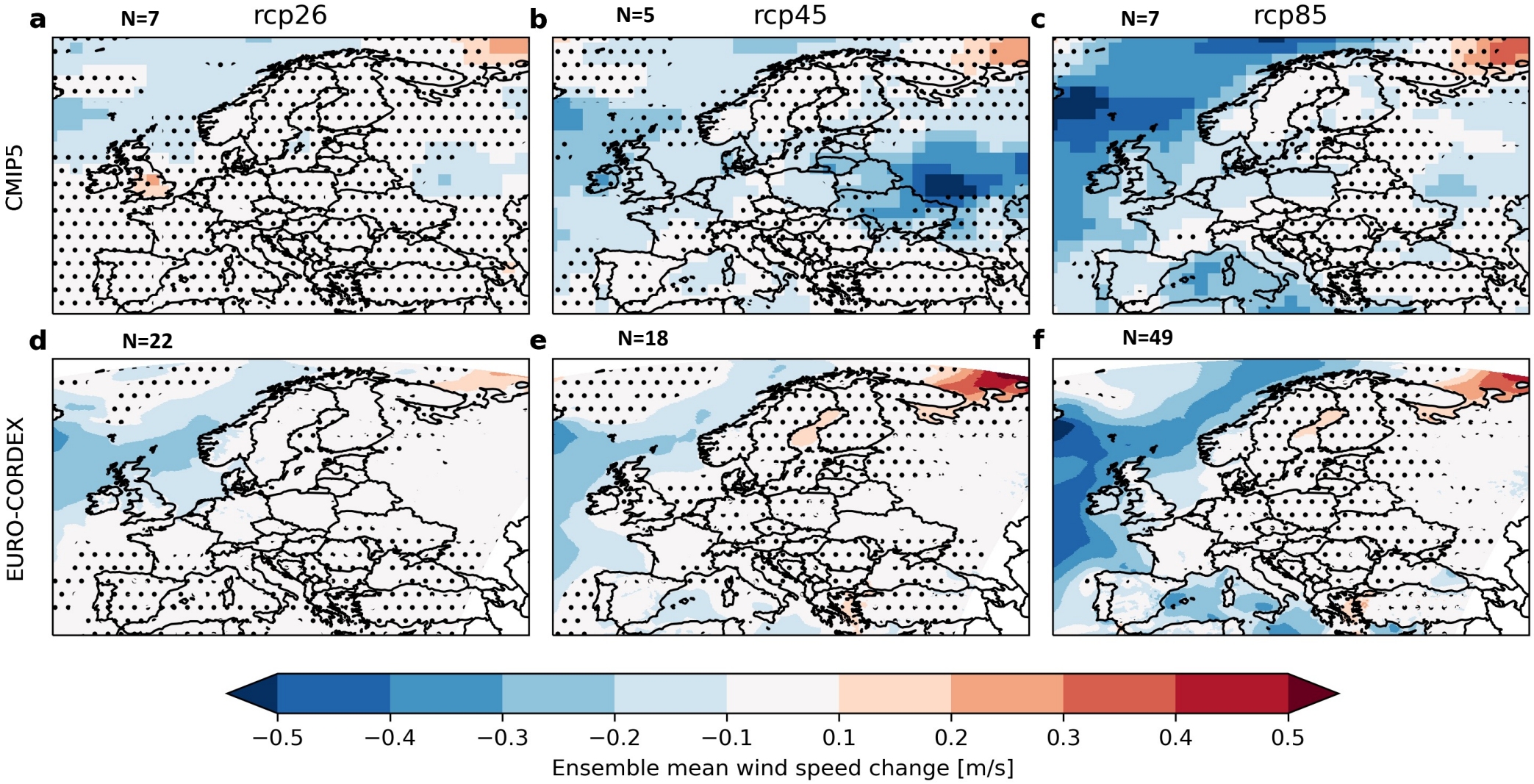


[Giorgi & Gutowski, 2015]

Impacts

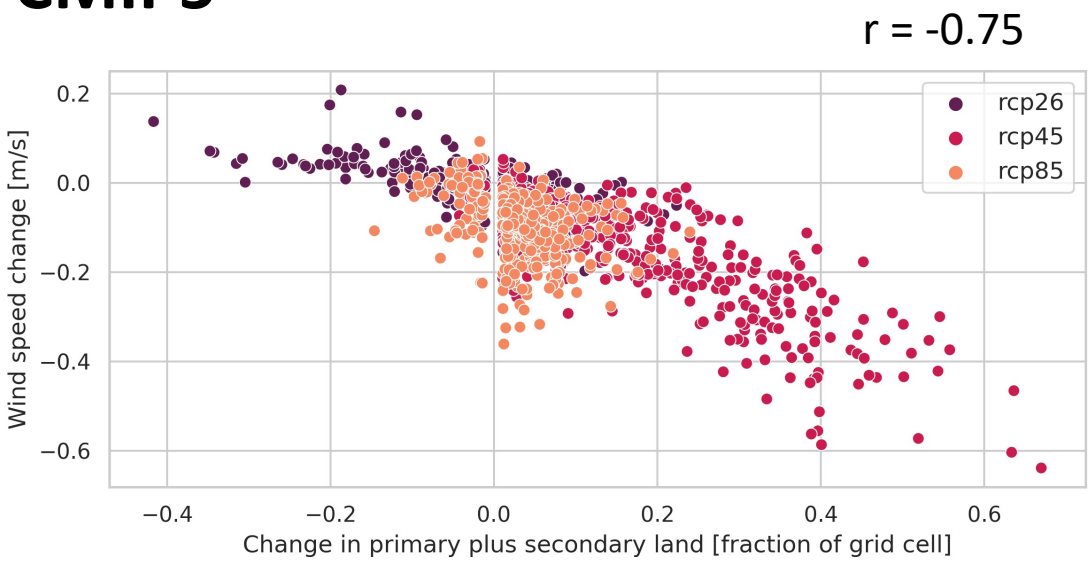
Method: Analyze large ensemble of regional and global simulations

Changes in 10m wind speeds (2080-2100 minus 1985-2005)



Onshore: Land use change reduces winds in CMIP5 but not in EURO-CORDEX

CMIP5



Rcp45 is the strong change scenario

EURO-CORDEX

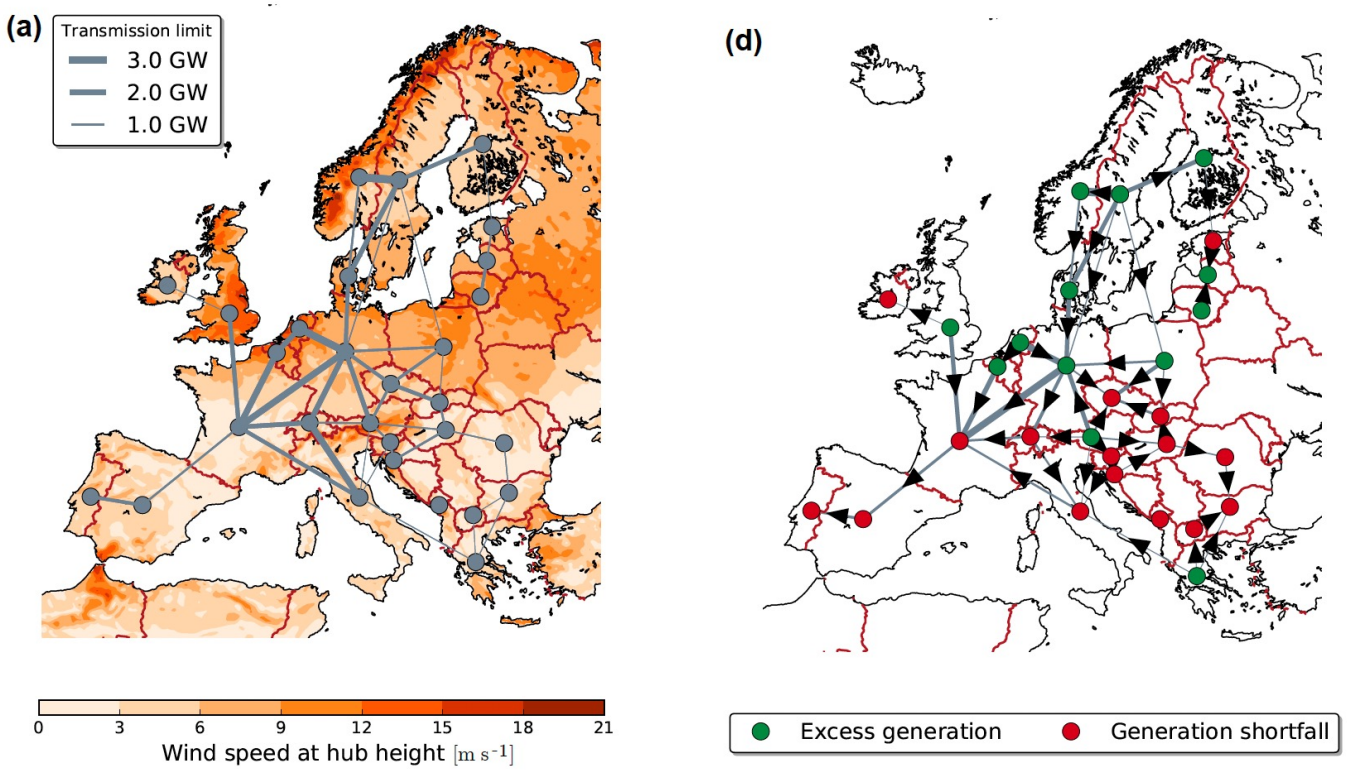
- Constant land use
- Unclear whether time-varying land use applied in CMIP6 downscaling

Scenario assumptions are different in regional and global climate models!

(also relevant for other techs, e.g., Gutierrez et al., ERL, 2020; Boe et al., Climate Dynamics, 2020)

[Wohland, 2023]

Climate change impacts beyond the mean: system integration of wind energy

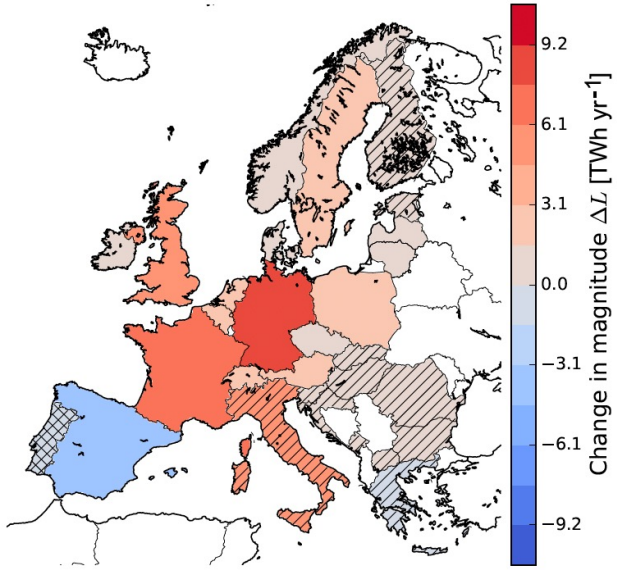


Using a strong climate change scenario and EURO-CORDEX data

[Wohland et al., 2017]

Climate change causes more uniform generation patterns

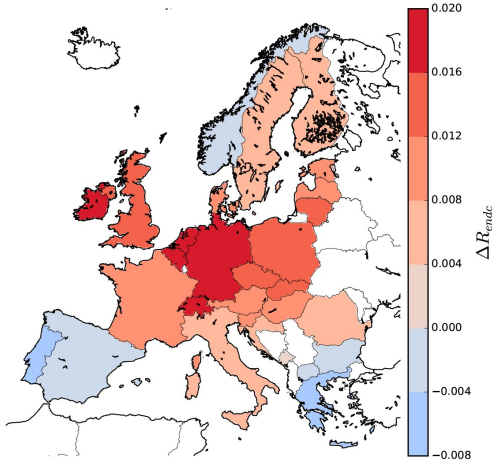
How much more energy does a country want to import during European-wide wind scarcity?



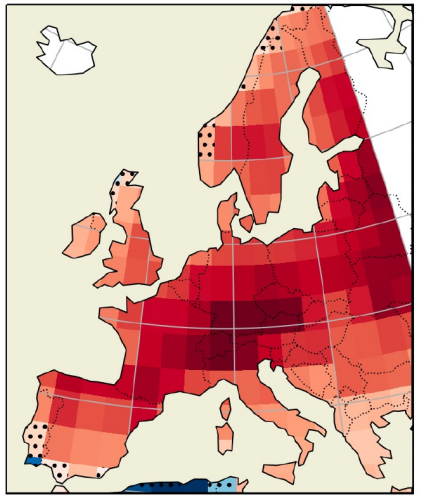
[Wohland et al., 2017]

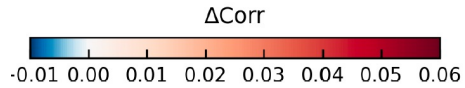
How does correlation between generation in one country and all others change?

wind



PV **CMIP6, SSP585**

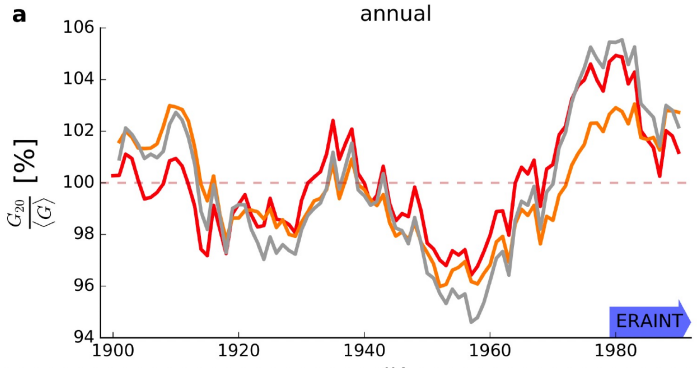


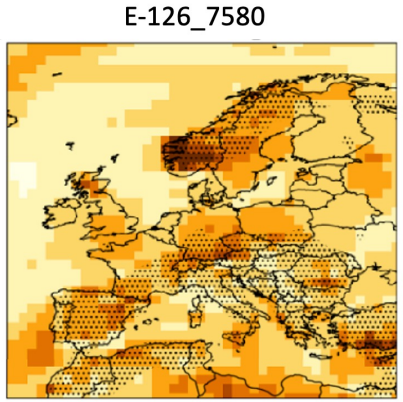


[Hou et al., 2021]

Physical climate change risk for the energy sector has 2 parts:

Climate variability matters

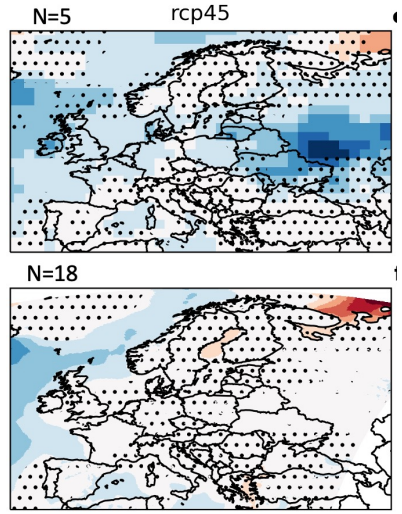




Magnitude depends on location, turbine and season

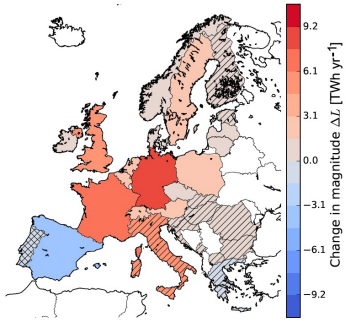
Implication: Need long input data to quantify risk

Climate change impacts on renewable potentials small-ish but large enough to require attention



Climate model selection critical

Negative impacts on system integration



Literature

Hou, X., Wild, M., Folini, D., Kazadzis, S. & Wohland, J. Climate change impacts on solar power generation and its spatial variability in Europe based on CMIP6. *Earth Syst. Dynam.* **12**, 1099–1113 (2021).

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Wohland, J., Omrani, N., Witthaut, D. & Keenlyside, N. S. Inconsistent Wind Speed Trends in Current Twentieth Century Reanalyses. *J. Geophys. Res. Atmos.* **124**, 1931–1940 (2019).

Wohland, J., Omrani, N. E., Keenlyside, N. & Witthaut, D. Significant multidecadal variability in German wind energy generation. *Wind Energ. Sci.* **4**, 515–526 (2019b).

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Wohland, J., Brayshaw, D. & Pfenninger, S. Mitigating a century of European renewable variability with transmission and informed siting. *Environ. Res. Lett.* **16**, 064026 (2021b).

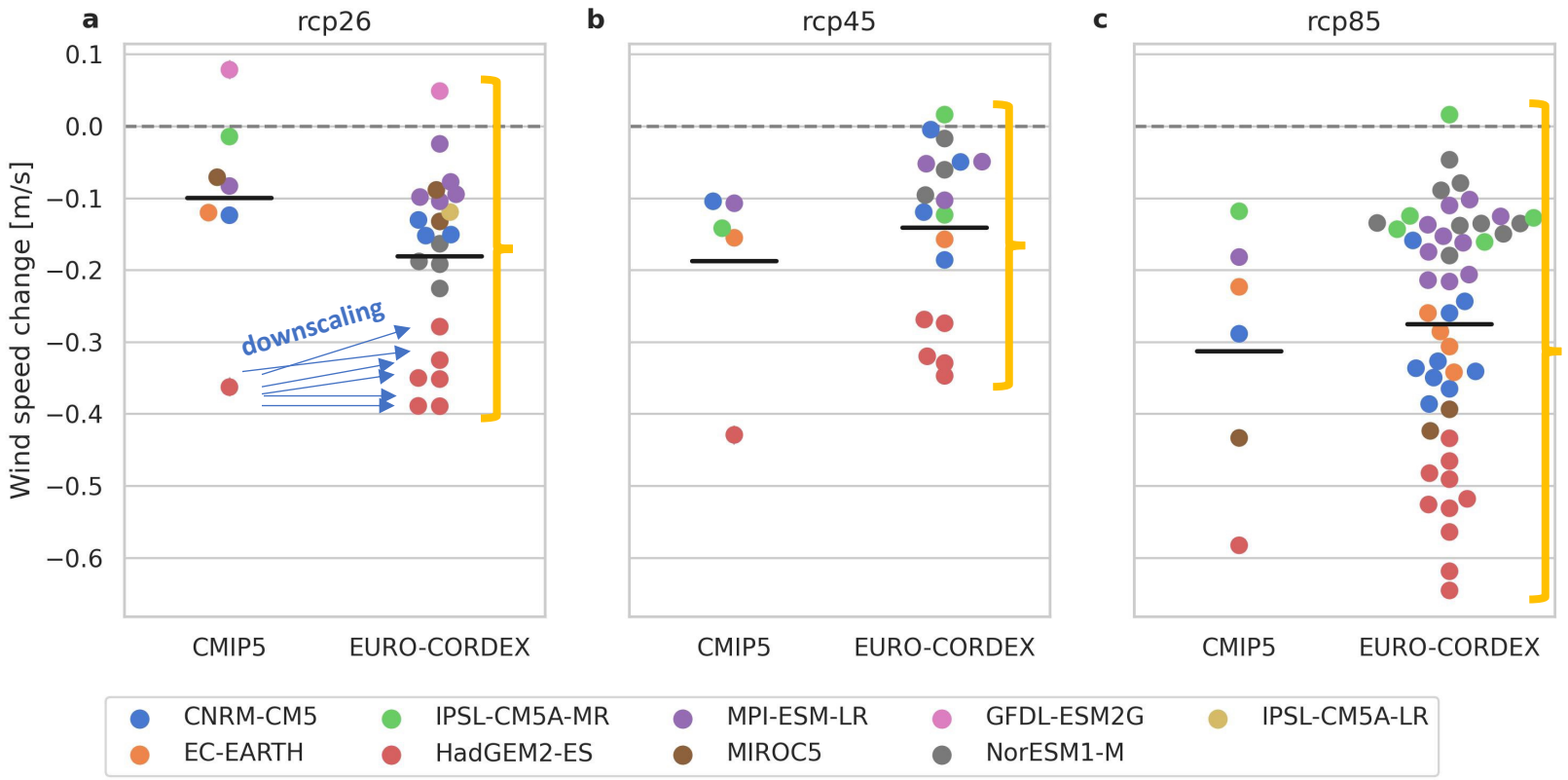
Wohland, J. Process-based climate change assessment for European winds using EURO-CORDEX and global models. *Environ. Res. Lett.* **17**, 124047 (2022).

ETH zürich

jan.wohland@env.ethz.ch

Appendix – what happens offshore

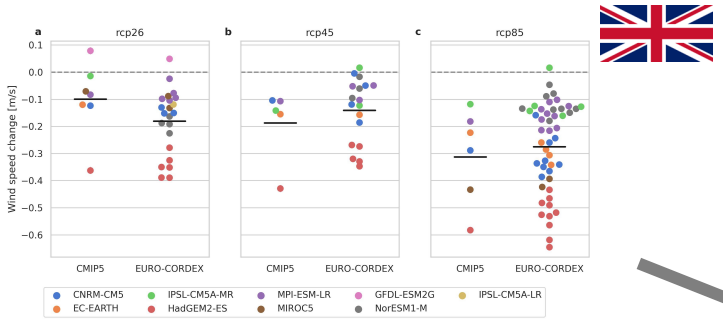
Offshore example: UK winds weaker but uncertainty is large



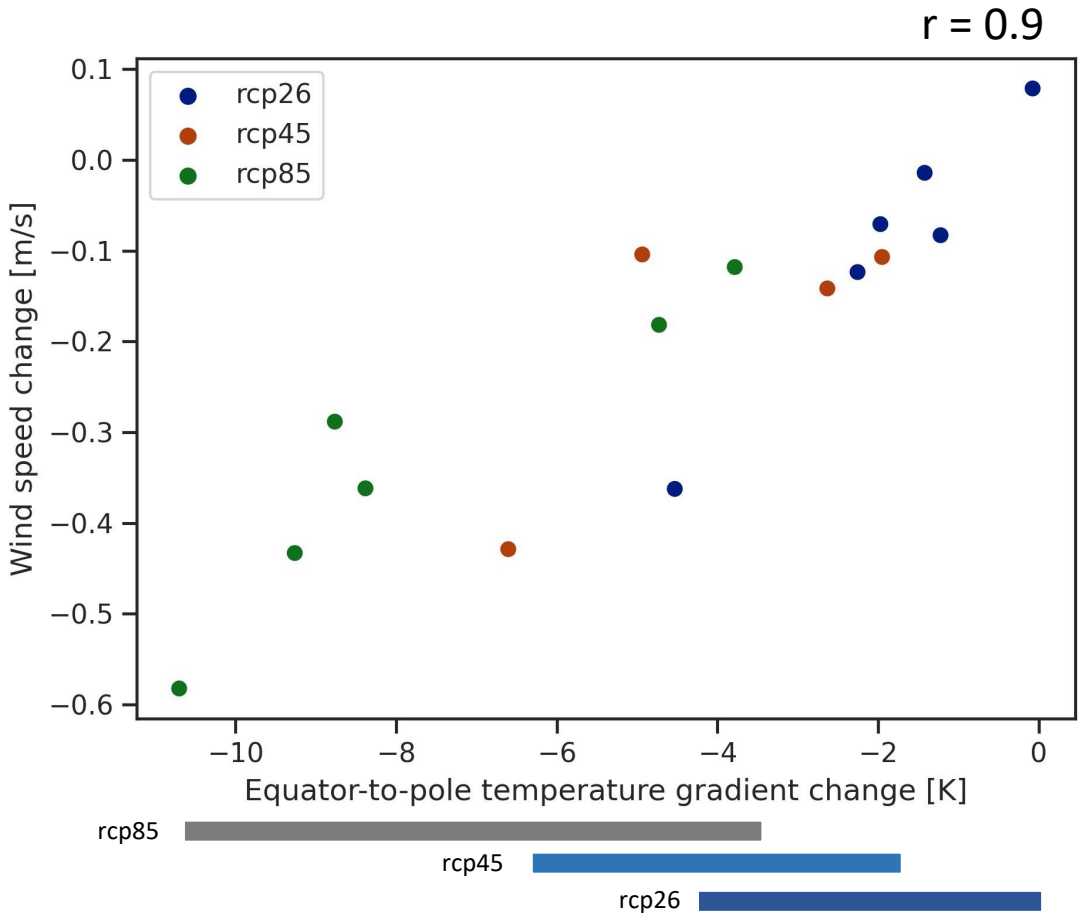
- Large spread often including zero
- Extreme ends (-0.6 m/s) would be highly relevant for wind energy

[Wohland, 2023]

Uncertainty is linked to equator-to-pole temperature gradient



CMIP5



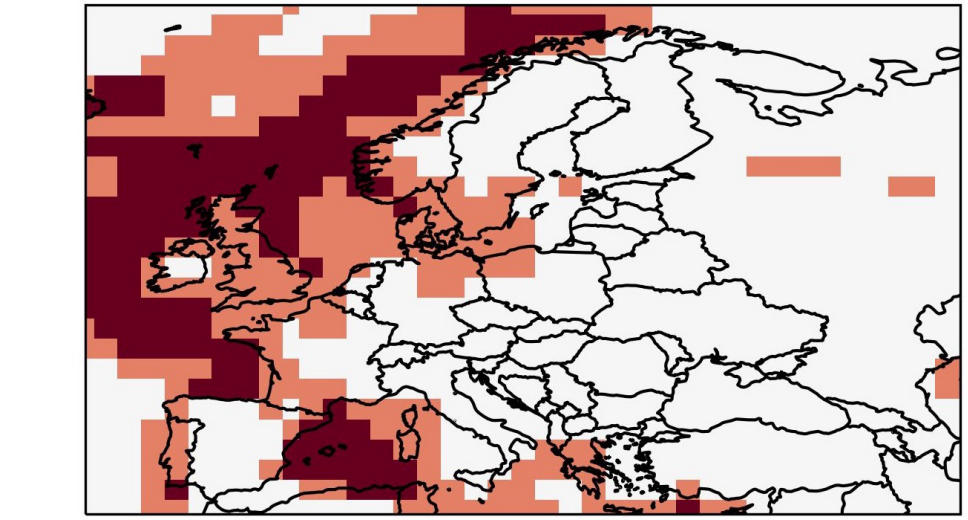
ERA5: about -4K change from 1940 to today

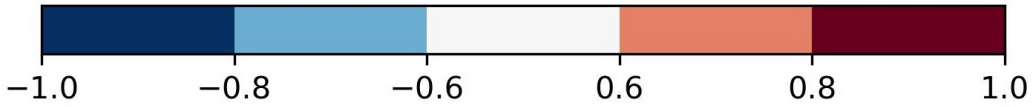
CMIP5 GCMs agree fairly well on wind reduction per temperature gradient!

[Wohland, 2023]

Arctic amplification threatens European offshore wind energy

CMIP5 sub-ensemble [Wohland, 2023]



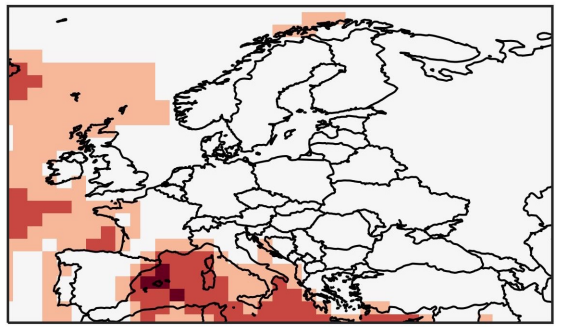


Correlation between temperature gradient change and wind speed change

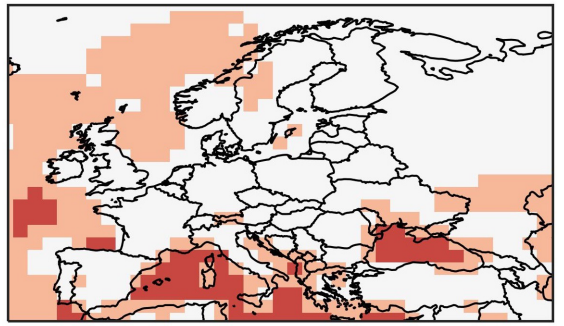
Relationship holds in most locations suitable for offshore wind energy

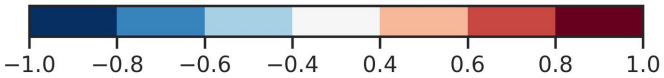
Full ensembles

CMIP5



CMIP6





Patterns similar but less strong in full CMIP5/6 ensemble

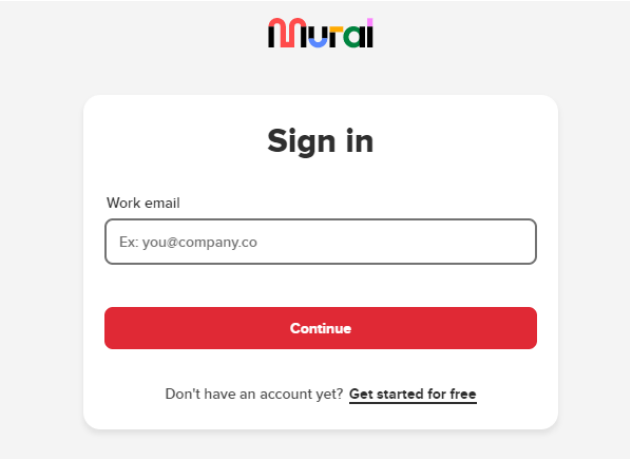
Agenda

- 16:15-16:20 – Introduction – Laurent Dubus (RTE & WEMC)
- 16:20-16:30 – ENEL climate data for business adaptation strategy - Laura Di Bernardo and Mario Ciancarini (ENEL)
- 16:30-16:40 – Understanding climate change to support adaptation – Giuliana Barbato (CMCC)
- 16:40-16:50 - The role of multidecadal climate variability and climate change in designing future highly renewable power systems – Jan Wohland (ETH Zurich)
- **16:50-17:50 – Questions and discussion – Moderator: Sue Ellen Haupt (NCAR & WEMC)**
- 17:50-18:00 – Closing remarks and adjourn – Laurent Dubus (RTE & WEMC)

To participate to our discussion…

1. Download in your app store…

2. Register…



3. and scan this QR code!

…Thank you!

We will publish a summary of the discussion results on the ICEM web site .

Questions and discussion
Moderator: Sue Ellen Haupt

- What approach should be used for calculating the **vulnerabilities of power systems** and **assets distributed on the territory**?
- Adaptation approach from business plan to sectoral/intersectoral/national plan: **how do companies' adaptation plans meet with country plans**?
- **How** to plan adaptation actions to increase resilience of energy assets and systems where there are no scenario data or are very uncertain? What other data/approaches can be used to **integrate scenario considerations to make effective decisions**?

Final remarks

- Thanks for attending the panel discussion
- A short report will be published soon on the WEMC/ICEM2023 web site
- If you have further comments, remarks, ideas, do not hesitate to share with us:
  laurent.dubus@wemcouncil.org


CLIMATE CHANGE IS CAUSED BY TWO THINGS: HUMAN ACTIVITY ...
... AND HUMAN INACTION!
Time to act!
COP24
CHAPPATTE
The New York Times

” Pour ce qui est de l’avenir, il ne s’agit pas de le prévoir, mais de le rendre possible. “

– Antoine de Saint Exupéry,
***Citadelle,* 1948**