



Le réseau
de transport
d'électricité



RTE's Approach to Forward-Looking Weather Data Long-Term Resource Adequacy Assessment

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Thanks to Bénédicte Jourdier and many other colleagues



Introduction: what is the problem?

Long-Term Resource Adequacy
Assessments : Energy Pathways to
2050

What's next?

Summary

Introduction: what is the problem?

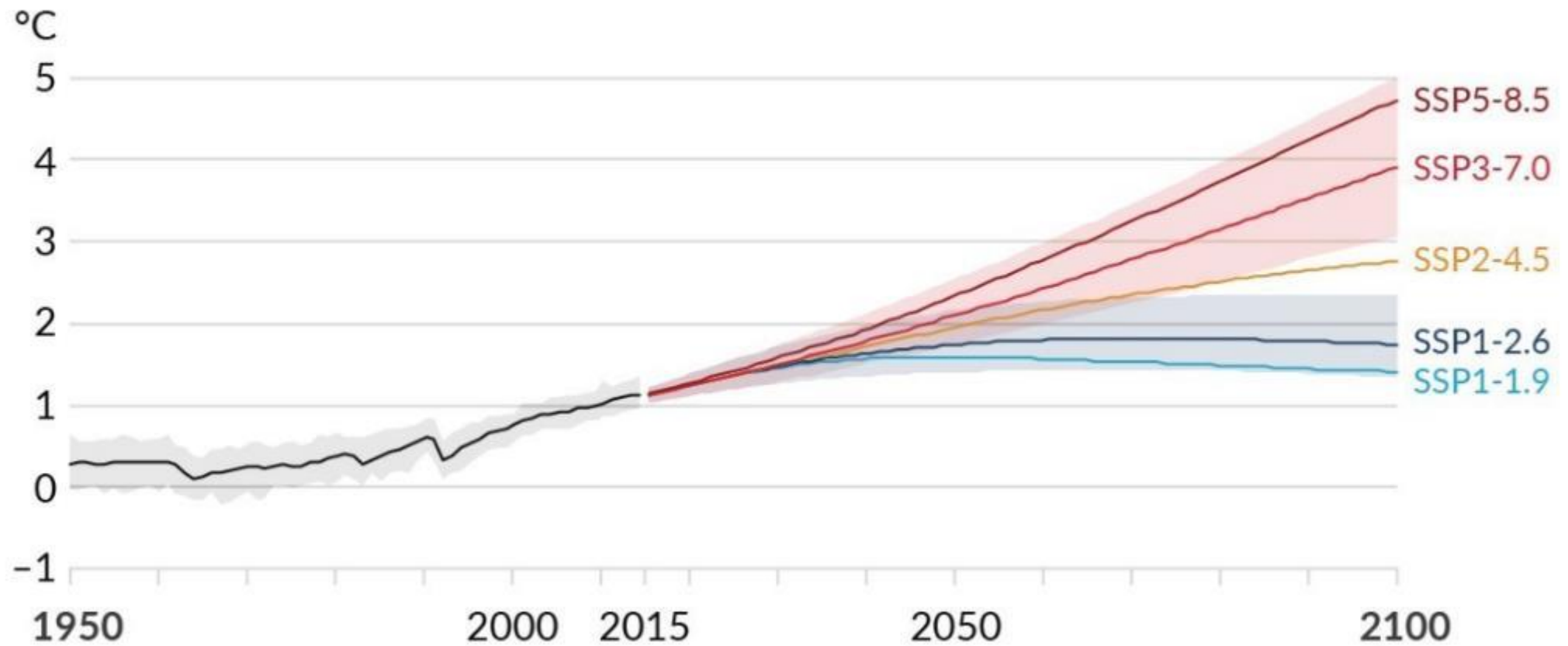
Long-Term Resource Adequacy
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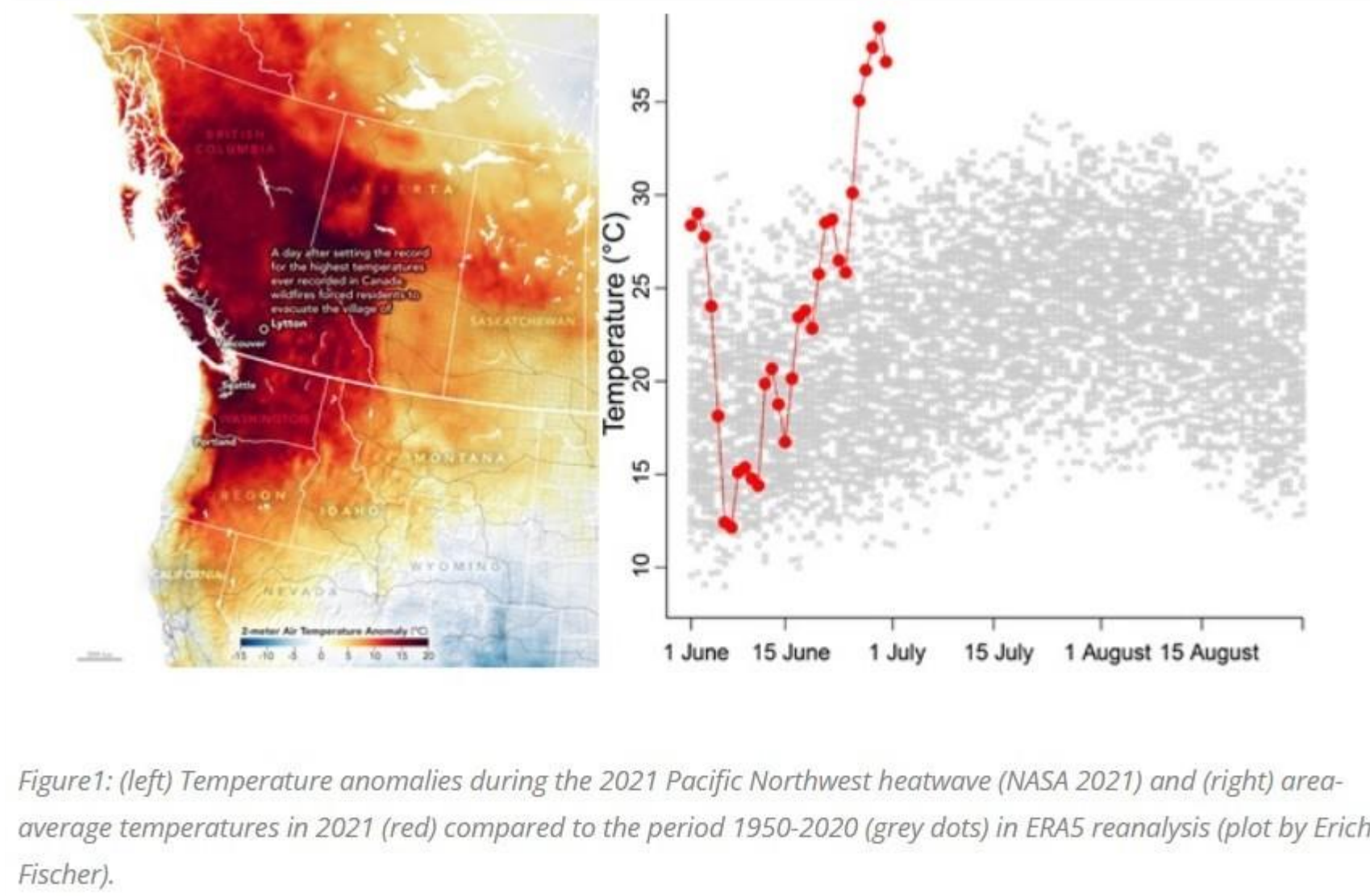
Summary

Climate change is a reality

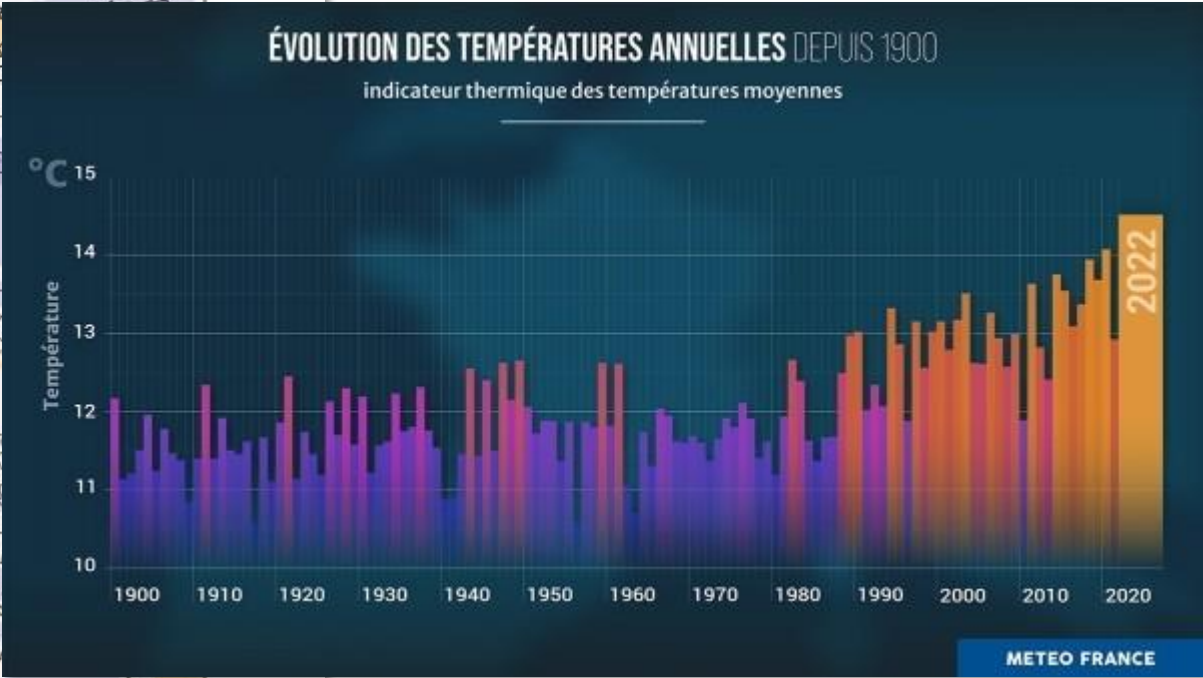
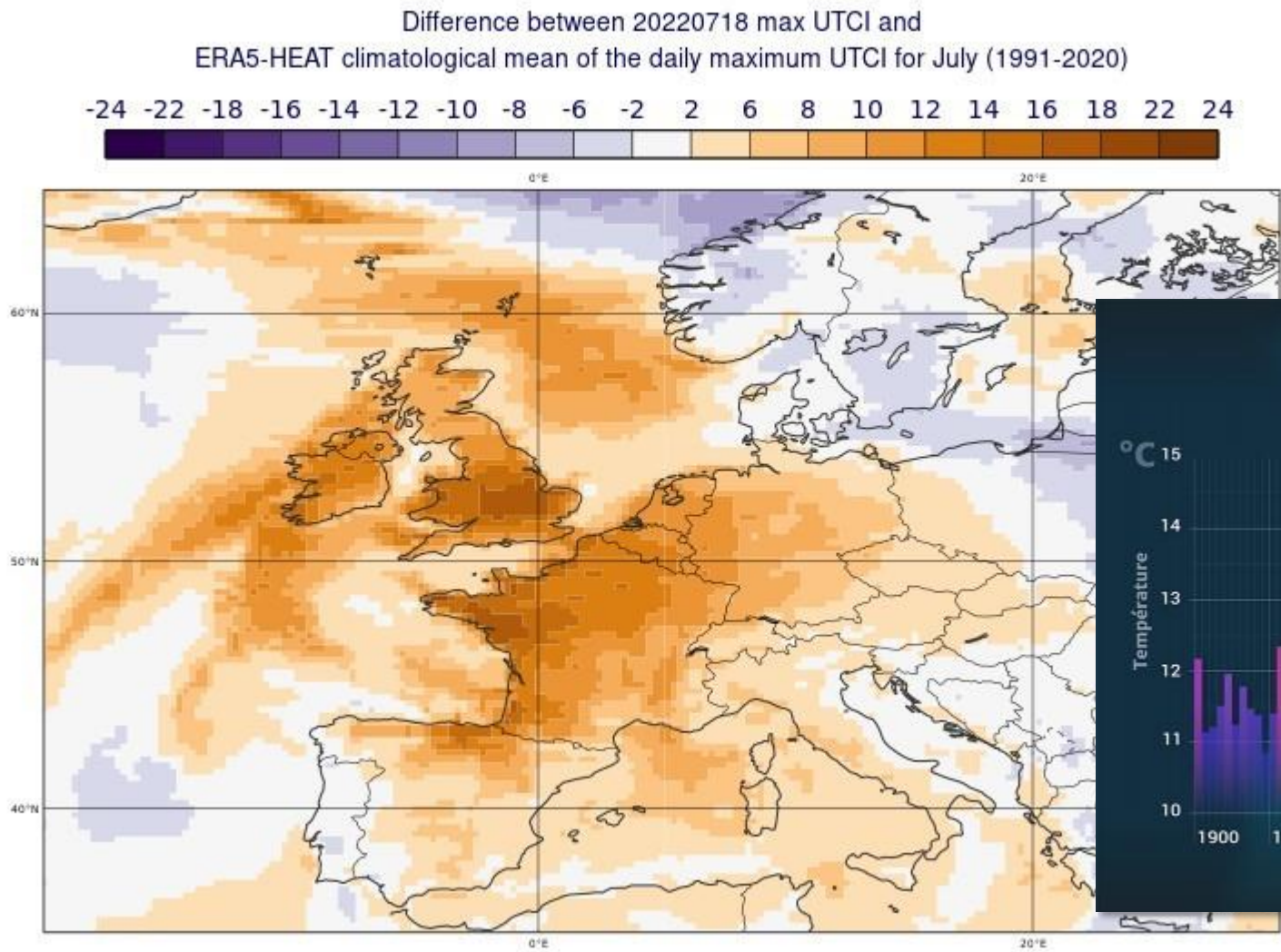
(a) Global surface temperature change relative to 1850–1900



Example 1: The Pacific North American Heatwave in June 2021

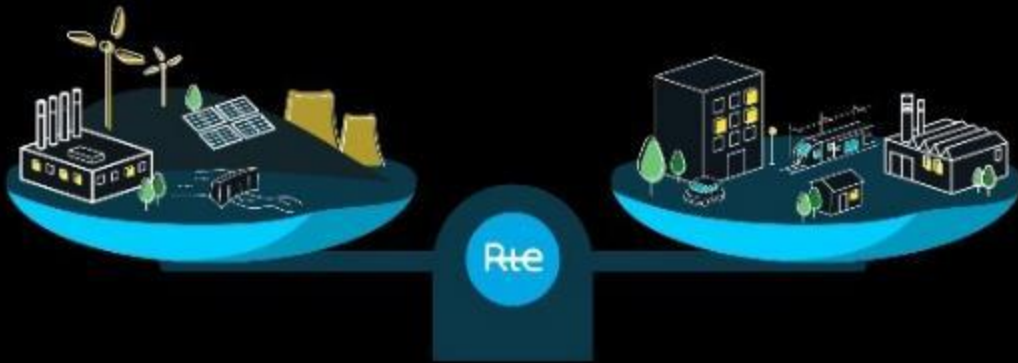


Example 2: Heatwave in western Europe in July 2022



The power transport network is dependent on weather and climate...

Supply / Demand Balance Resource Adequacy Assessment



... at all time scales

Network Resilience



**... Climate Change & RES Development will increase the dependance
➔ Climate Change MUST be taken into account for prospective studies**



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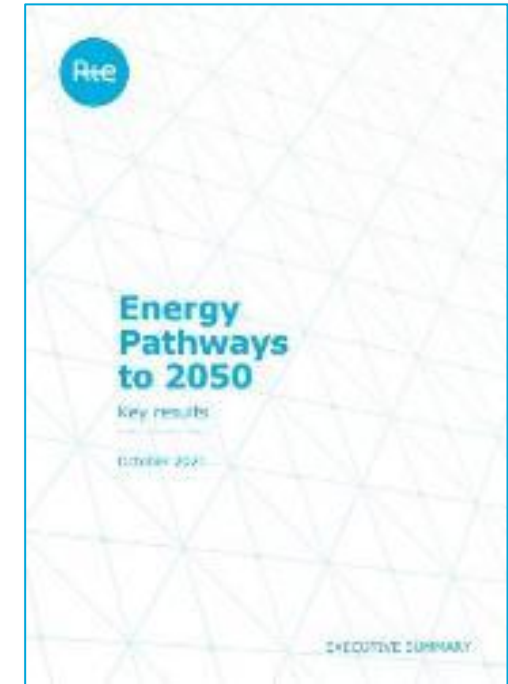
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Long term prospective: « Energy Pathways to 2050 »

A comprehensive modelling and an extensive analysis

- A document required by the French authorities
- Based on International, European and French objectives and policies to fight climate change and reach decarbonation targets by 2050
- Complete power system modeling under different energy mix scenarios and several consumption trajectories
- First such study of its kind to include climate change considerations



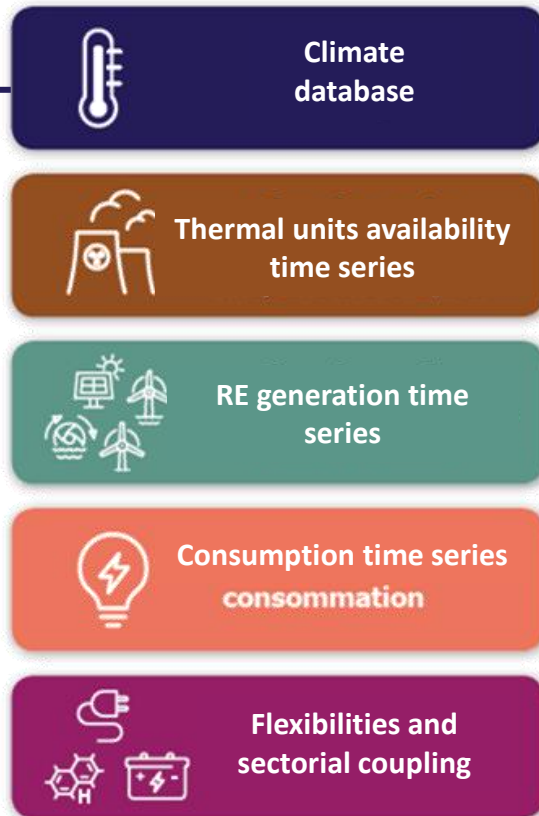
Long term prospective: « Energy Pathways to 2050 »

A comprehensive modelling and an extensive analysis

3 sets of **200 climate years**,
hourly data, 20 km
resolution over Europe:

- 2000
- 2050 - RCP4.5
- 2050 - RCP8.5

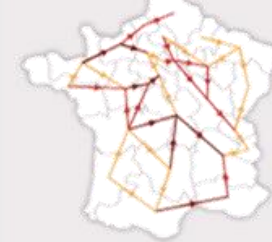
Assumptions France & Europe



Simulation of
supply/demand balance at
hourly time resolution +
economic closure



Network needs study




Network volumes


Energy balance,
flexibilities


Complete system
costs, investments
needs


CO2 emissions, raw
materials
consumption, soil
artificialisation,
nuclear wastes...

Different scenarios for electricity consumption

CONSUMPTION TRAJECTORIES OUT TO 2050

Final electricity
consumption
per sector

 Industry
 Residential

 Tertiary
 Transport

 Hydrogen

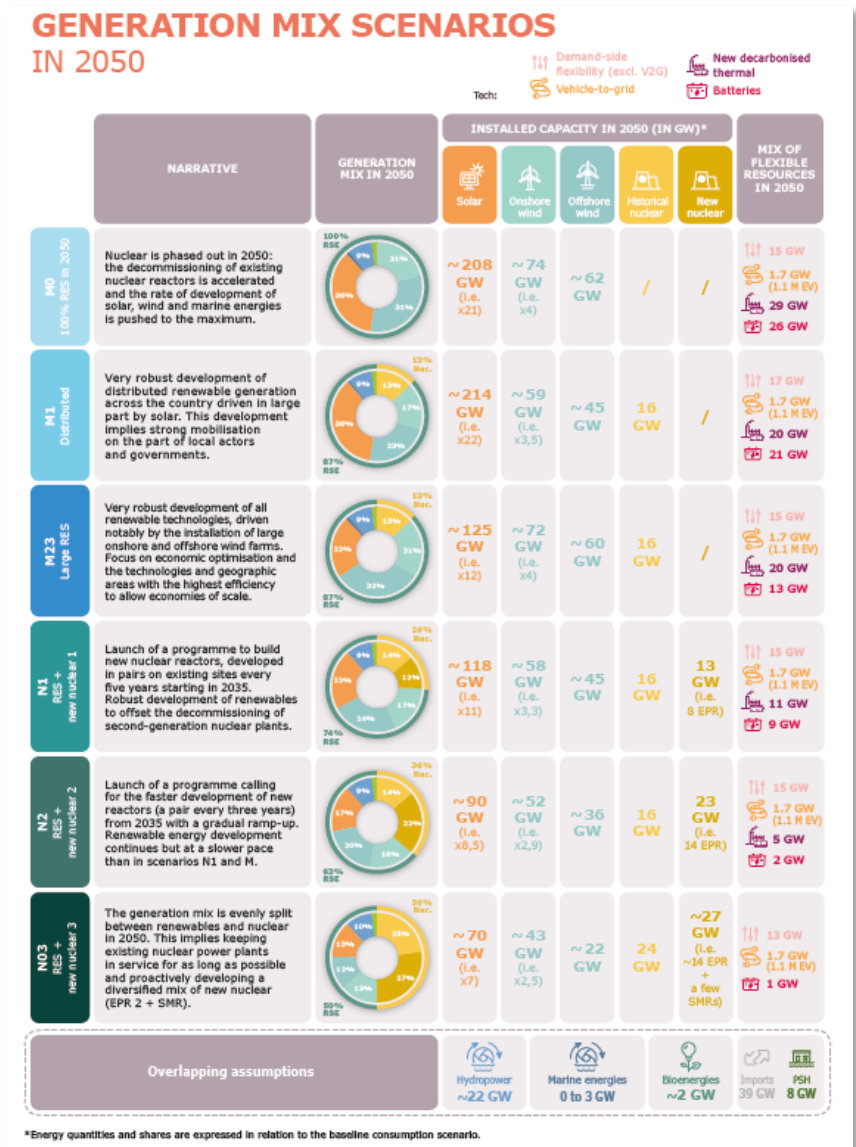
SCENARIOS			
	ASSUMPTIONS	LEVEL 2050	KEY CHANGES
Baseline	Gradual electrification (substitution for fossil fuels) and ambitious targets for energy efficiency (NLCS assumption). Assumes continued economic growth (+1.3% per year from 2030) and demographic growth (INSEE's low fertility scenario). The baseline trajectory assumes a high degree of efficacy of public policies and plans (stimulus, hydrogen, industry). The manufacturing industry expands, and its share of GDP ceases to decrease. Building renovation is factored in but so is the related rebound effect.	645 TWh	 180 TWh  134 TWh  113 TWh  99 TWh  50 TWh
	ASSUMPTIONS	LEVEL 2050 (vs. baseline)	KEY CHANGES (+ difference vs. baseline)
Sufficiency	Lifestyles change to increase energy sufficiency in terms of end-uses and consumption (less individual travel favouring soft mobility and mass transport, less consumption of manufactured goods, sharing economy, lower set point temperatures for heating, increase in remote working, digital sustainability, etc.), resulting in an overall reduction in energy needs, and thus electricity needs.	555 TWh (-90 TWh)	 160 TWh (-20 TWh)  111 TWh (-23 TWh)  95 TWh (-18 TWh)  77 TWh (-22 TWh)  47 TWh (-3 TWh)
Extensive reindustrialisation	Without returning to the same level as the early 1990s, the manufacturing industry's share of GDP rebounds sharply, reaching 12-13% in 2050. This scenario models an investment in cutting edge, strategic technologies and takes into account the reshoring of some high-carbon production in order to reduce the carbon footprint of consumption in France.	752 TWh (+107 TWh)	 239 TWh (+59 TWh)  134 TWh (0 TWh)  115 TWh (+2 TWh)  99 TWh (0 TWh)  87 TWh (+37 TWh)

+ Variants

And 6 generation mix scenarios

Family 1: RES mainly

Family 2: new nuclear plants



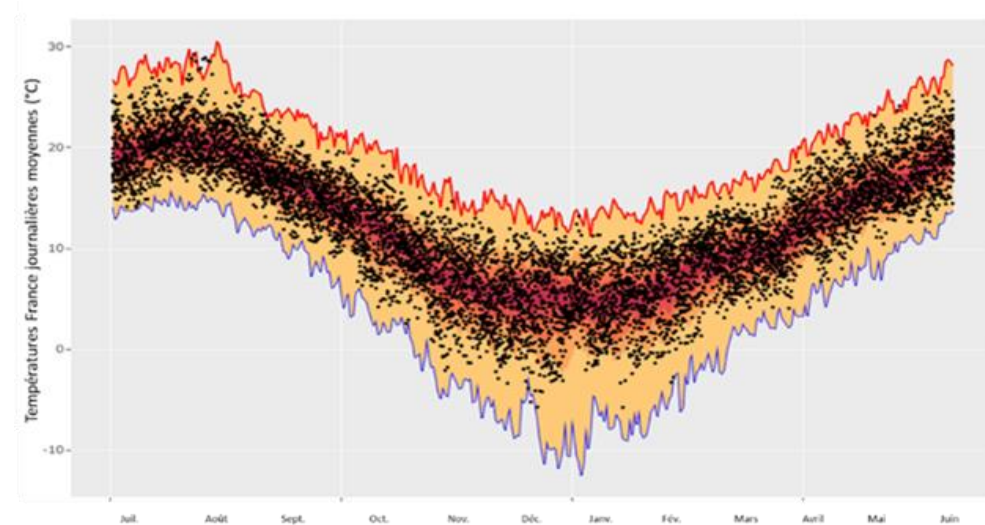
Climate: our current approach

→ Météo-France specific climate simulations with fixed GHG

Available data

- Temperature
- Cloud Cover
- Wind Speed
- Solaire Irradiance
- Precipitation & river flow

200 years, hourly time resolution
37 000 points over Europe



Black dots represent the actual observations over the last 33 years

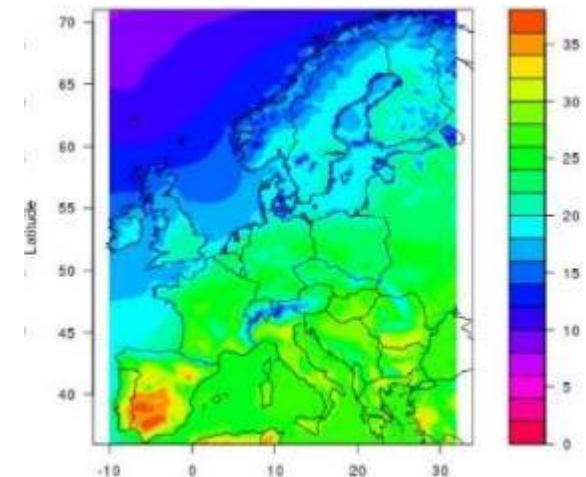
Bias correction with Hirlam Reanalysis

Extrapolation of extreme temperature values

Data on more than 37,000 grid points over Europe

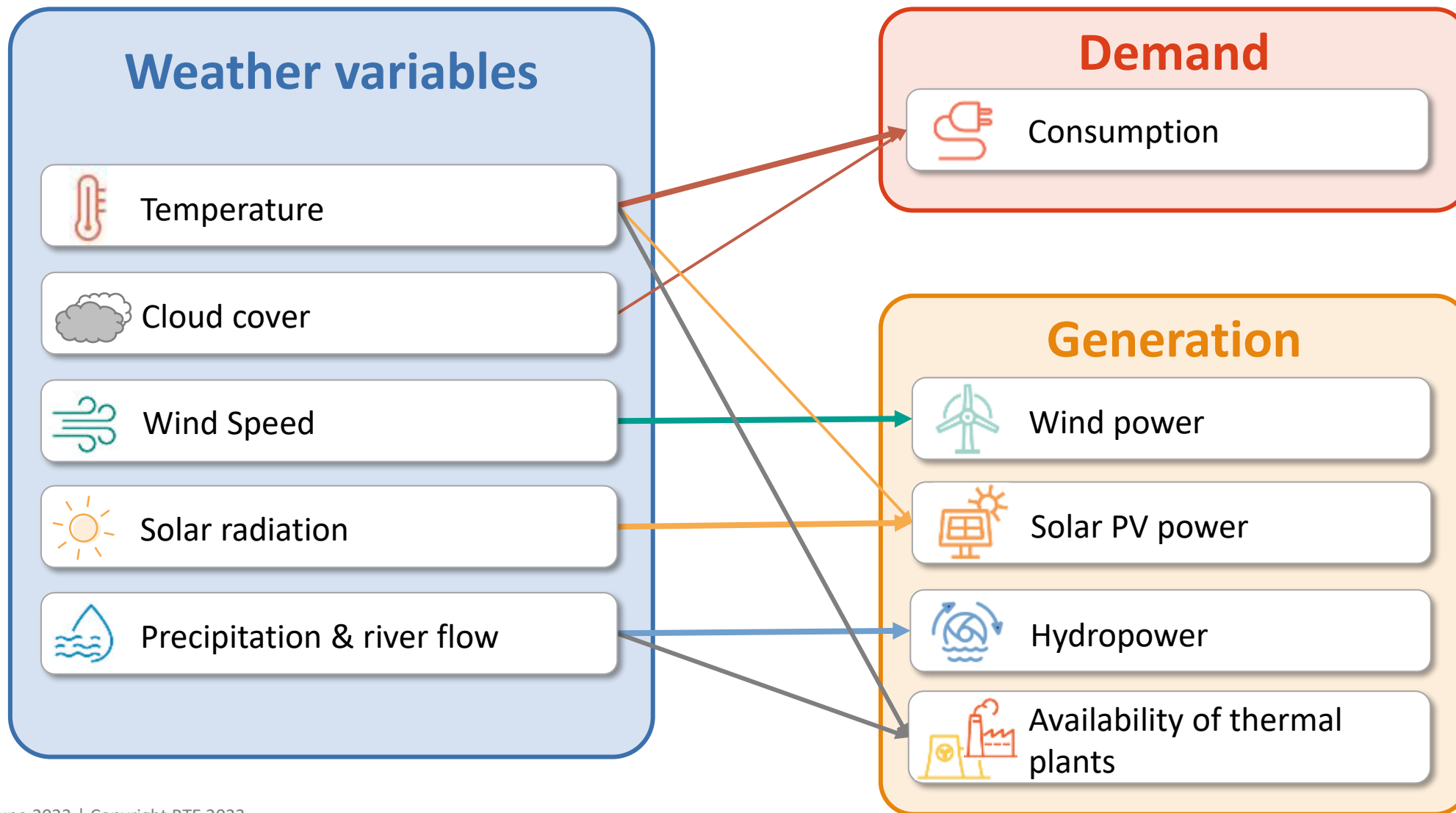
■ 3 simulations sets with « constant climate »

- ☐ 200 years « climate 2000 »
- ☐ 200 years « climate 2050 » RCP4.5
- ☐ 200 years « climate 2050 » RCP8.5

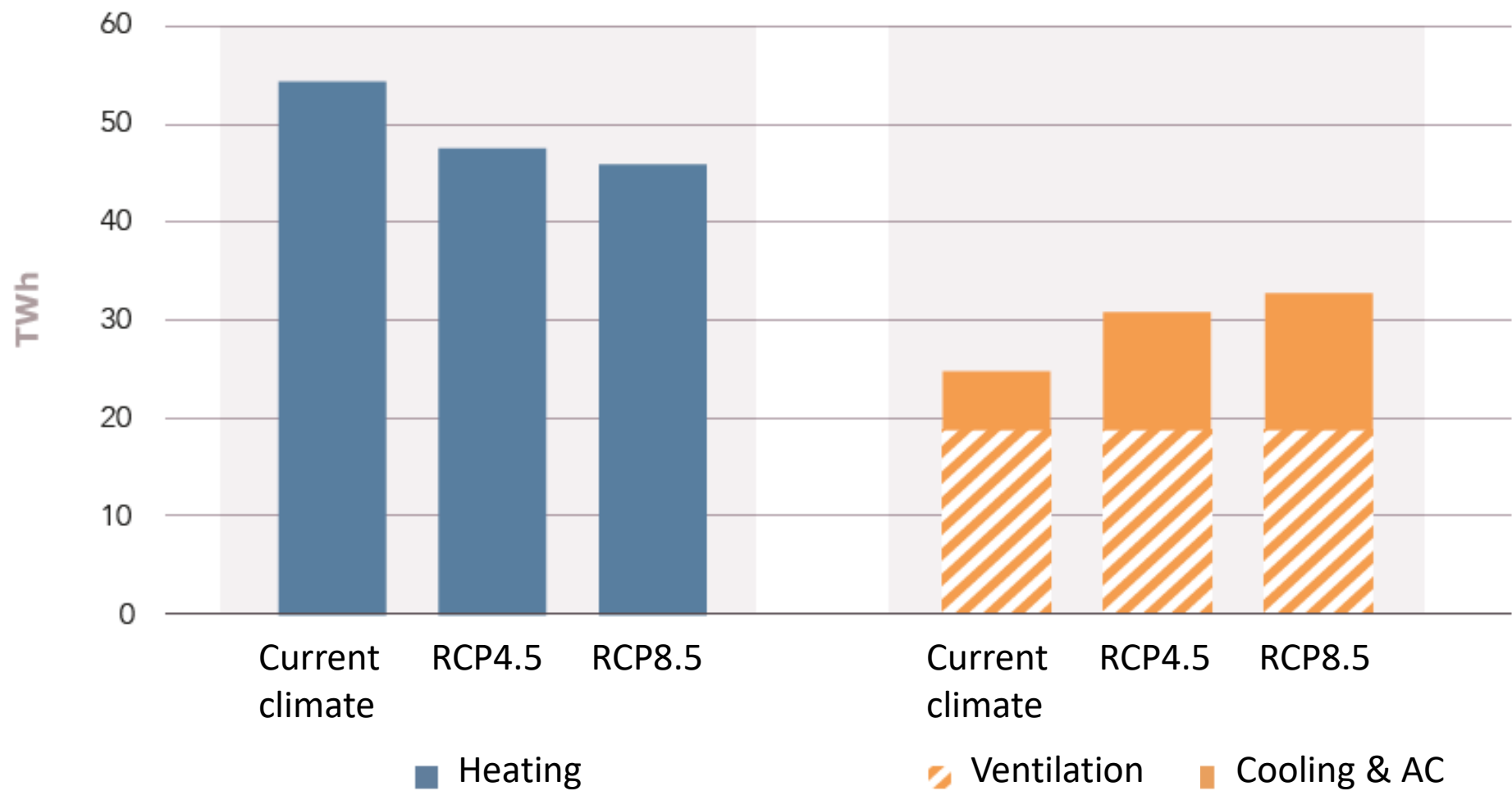


Source Météo-France

From climate to energy

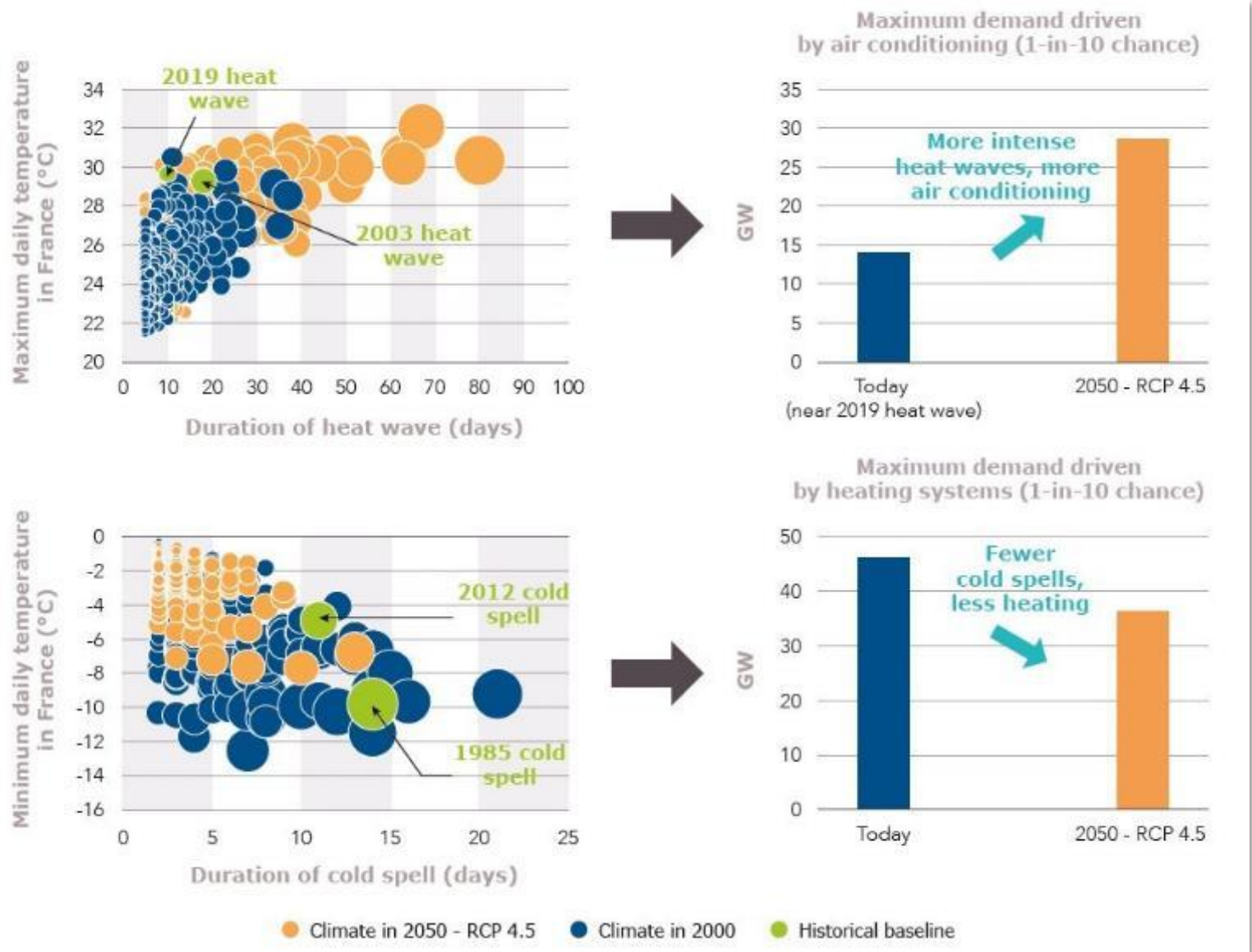


2050 Heating & cooling consumption in the reference scenario



Evolution of heat and cold waves and power consumption

Heat waves

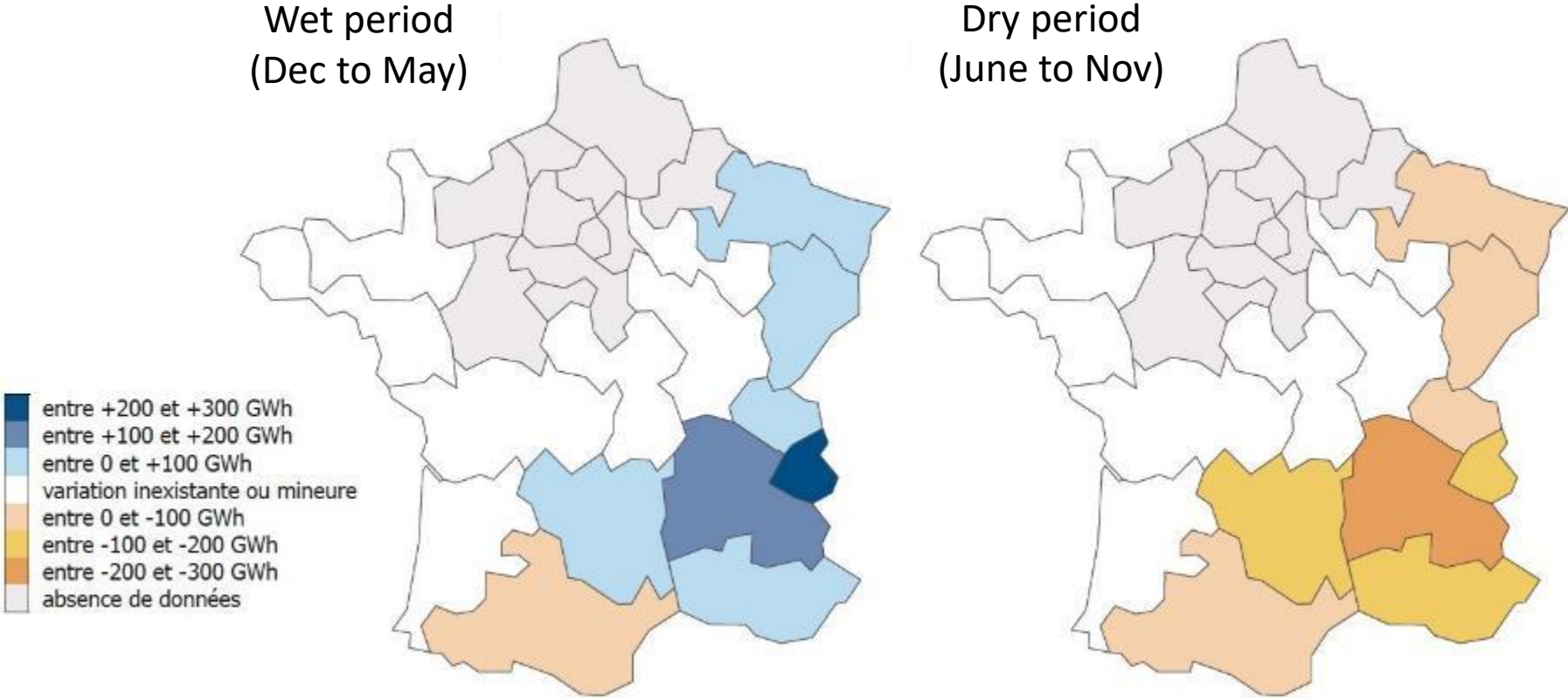


Cooling needs

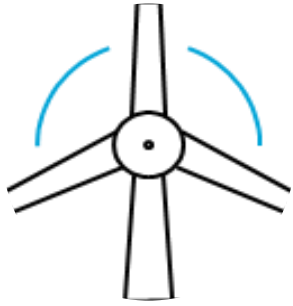
Cold waves

Heating needs

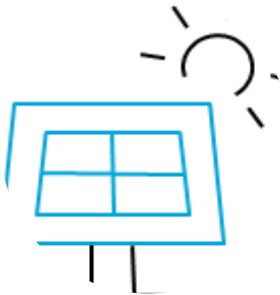
Evolution of hydro power inflows in 2050 RCP 4.5 wr.r.t. 2000



Impact of climate change on Wind and Solar PV generation

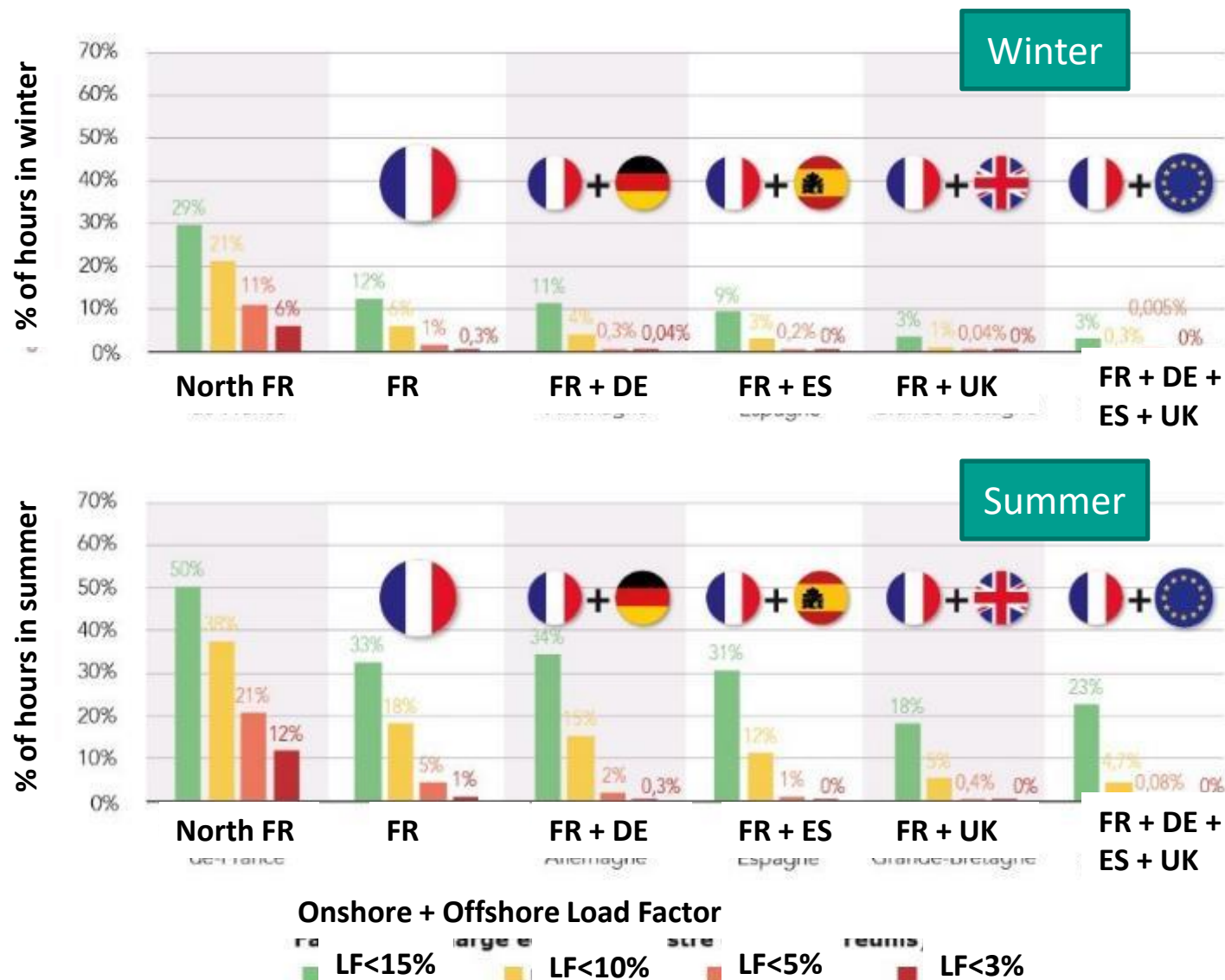


Wind energy capacity factor marginally influenced by climate change, but increases due to the development of offshore installed capacity

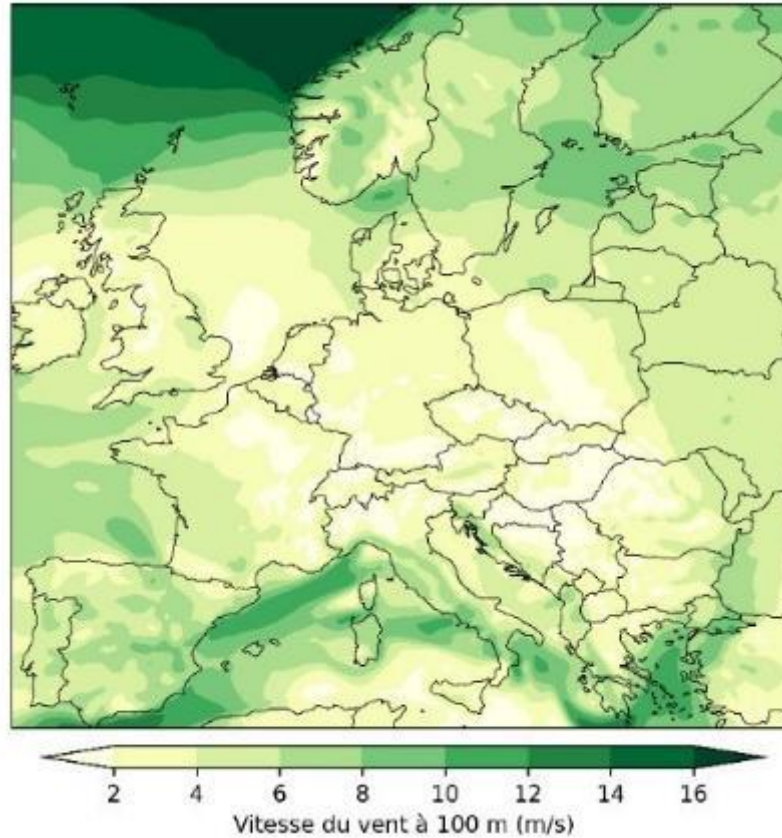
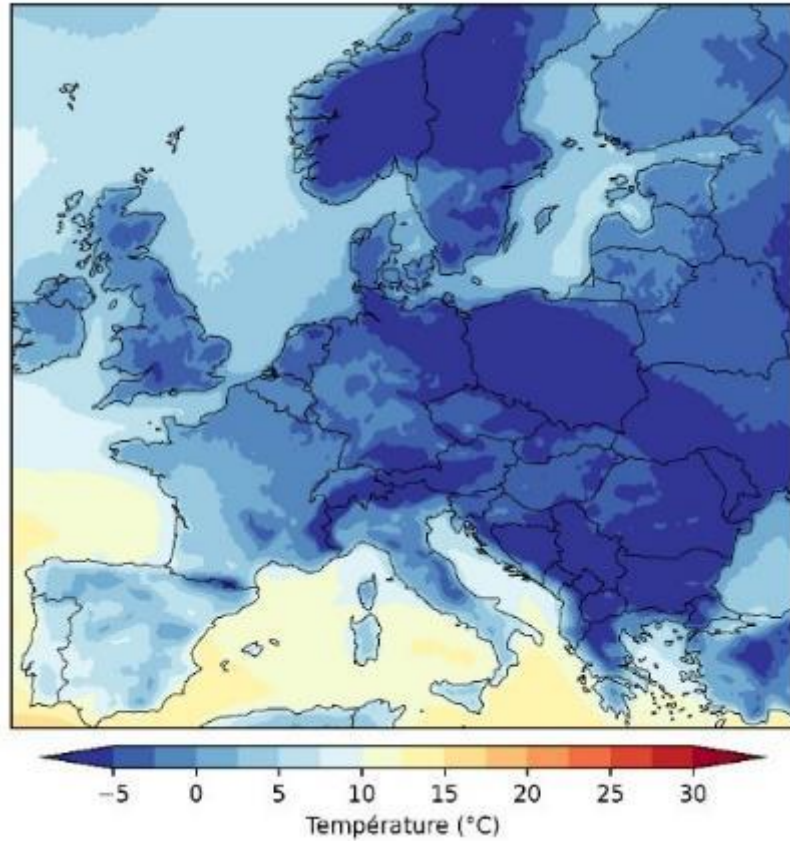


Solar PV load factor is ~not affected by climate change, larger and more uncertain changes to be expected due to technological evolutions and changes

Geographical compensation of wind variability



Stress tests: the nature of critical situations changes from [extreme cold] to [cold wave + wind drought]



Due to:

Temperature

Wind power
installed capacity



Typical daily temperature and wind speed during energy scarcity situations



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Limits of our current approach

- ❑ 1 single climate model → overall a good one, but does not cover the full climate response spectrum
- ❑ Based on ~CMIP5 model → quite « old »
- ❑ Fixed time horizon to 2050 [2040-2060] → not adequate to study the time evolution of the climate impacts
- ❑ Not public data → lack of transparency & replicability

What's next? New Target Databases

Currently

❑ RTE

- 1 climate model (Météo-France)
- 2 GHG emission scenarios (RCP4.5 & RCP8.5)
- Climate ~2000 and ~2050

❑ ENTSO-E

- Historical data (reanalysis)

Target

- Convergence of the approach at EU level
 - ✓ Switch from 1 model to multi models
 - ✓ Add other emission scenarios (other RCPs, new SSPs2.6, 1.5°C, 2.0°C ...)
 - ✓ Include the temporal dynamics (1950 to 2100)
 - ✓ Integration of more recent projections when available (CMIP6)
 - ✓ Data in open access

Status

- MoU ENTSO-E / Copernicus Climate Change Service, 3-year contract (2022-2025)
- Bilateral contracts RTE + French academics (IPSL, CERFACS...)



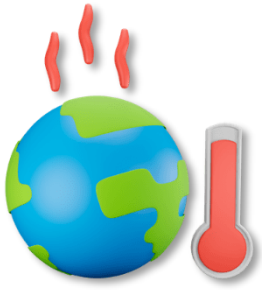
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Take away messages



Climate change is a reality, it is already there, and MUST be taken into account in power systems planning, prospective and infrastructure design



Climate change and **power systems evolution** towards low emissions generation mixes **increase** energy systems' **dependance on weather and climate**



Energy planning and operations require **relevant, state-of-the-art** and **authoritative information** about climate



Climate services are key, and user/provider collaboration is essential to deliver user-driven & science-based information and services



Le réseau
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27 - 29 JUNE 2023
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Energy & Meteorology

**TOWARDS CLIMATE-RESILIENT
ENERGY SYSTEMS**

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Thank you

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