Cambio Climático y Su Impacto Sobre Fuentes de Generacion

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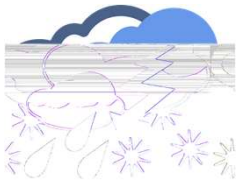
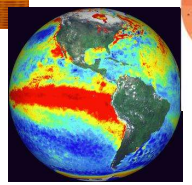
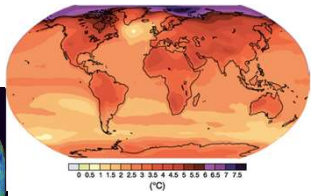
WEATHER CLIMATE WATER

WORLD METEOROLOGICAL ORGANIZATION

Energia y Meteorologia mano en la mano



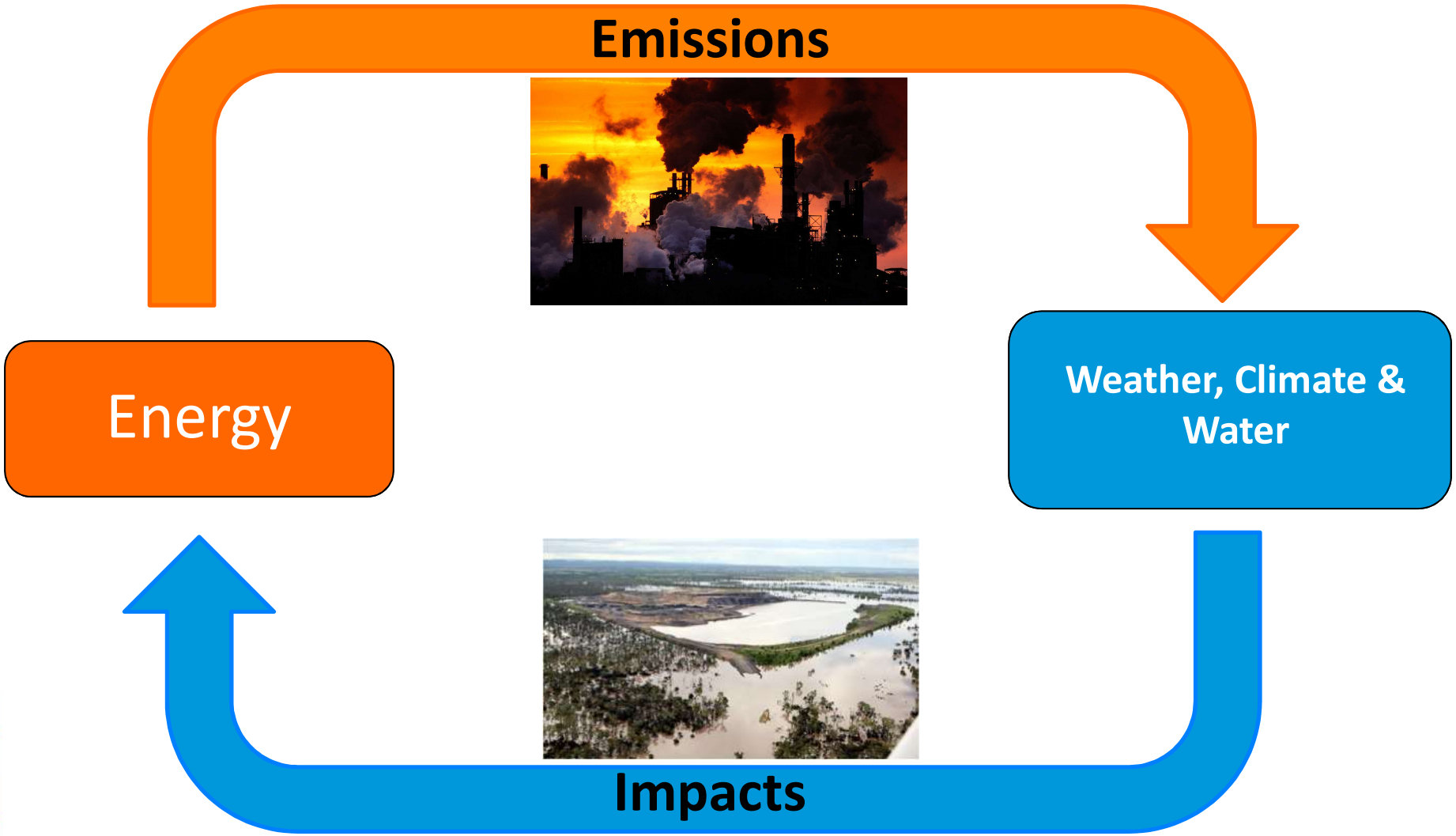


Lightning	Passing clouds	Thunder -storms	Hurricane	Drought	Heat wave	El-Niño	Long term changes
Flickering	Drop in solar power	Disruptions to energy transport	Disruptions to operations	Reduced hydro power	Changes in Demand	Maintenance	Resource Assessment

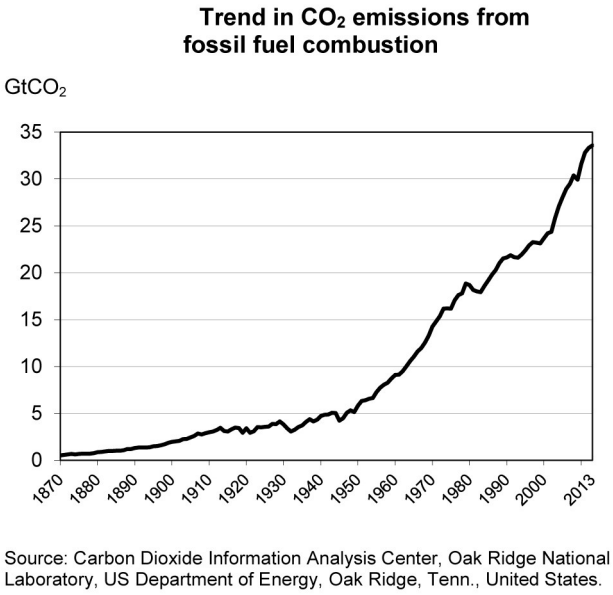
Seconds Minutes Days Months Seasons Years Decades

Energia y Clima Retroalimentacion



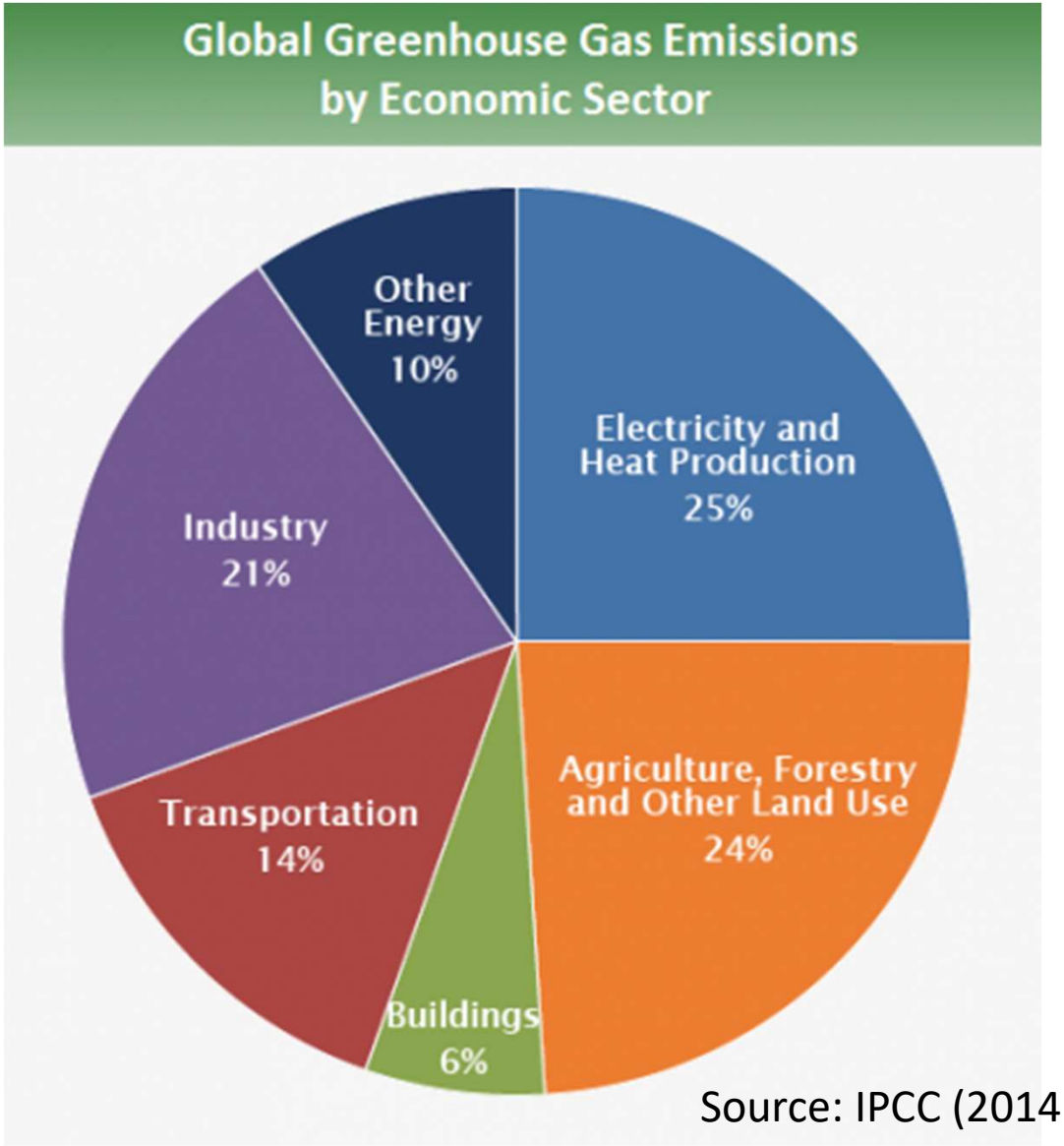
Emissiones de GHG

Energy



Source: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, US Department of Energy, Oak Ridge, Tenn., United States.

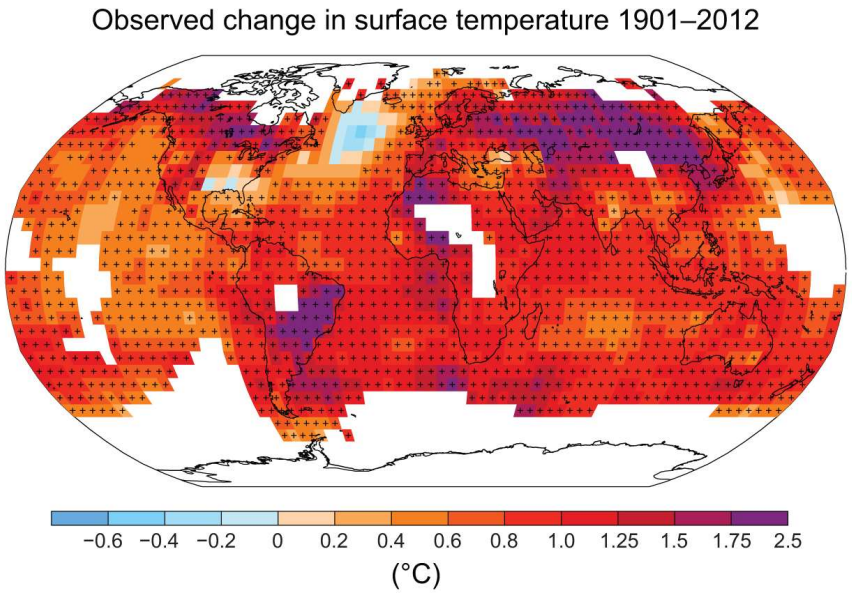
Source: IEA (2016)

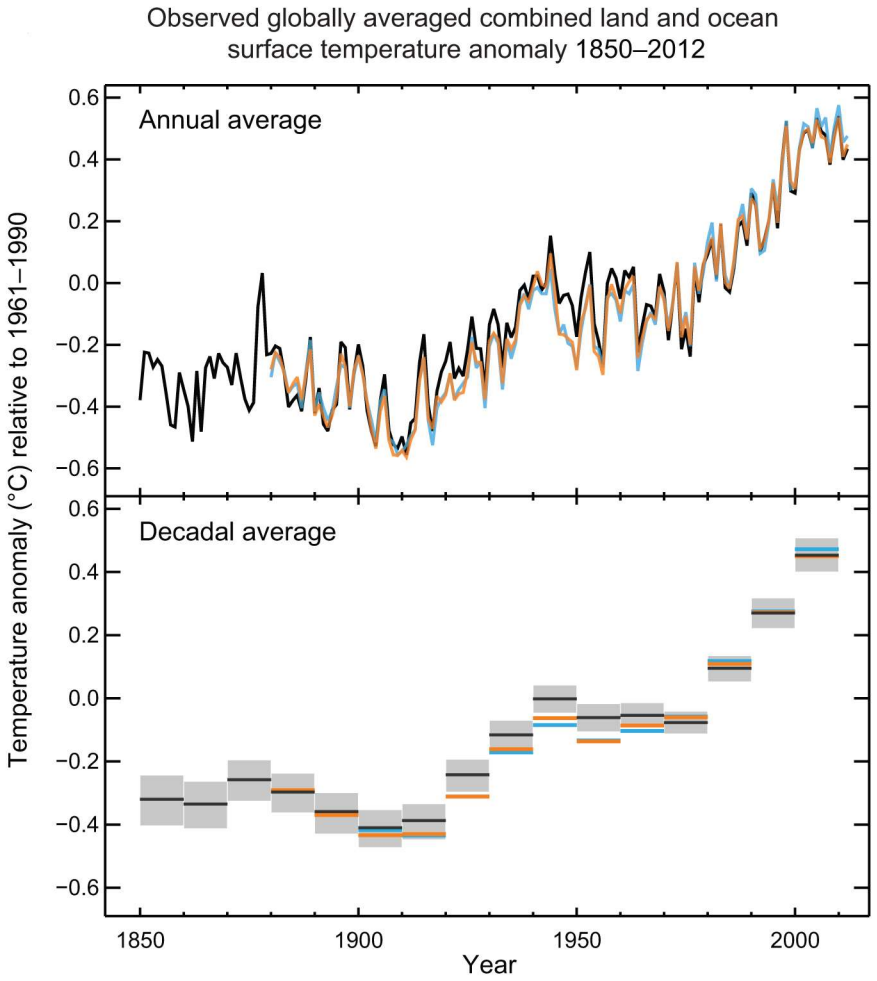


Source: IPCC (2014)

Energy

Calientemento Global

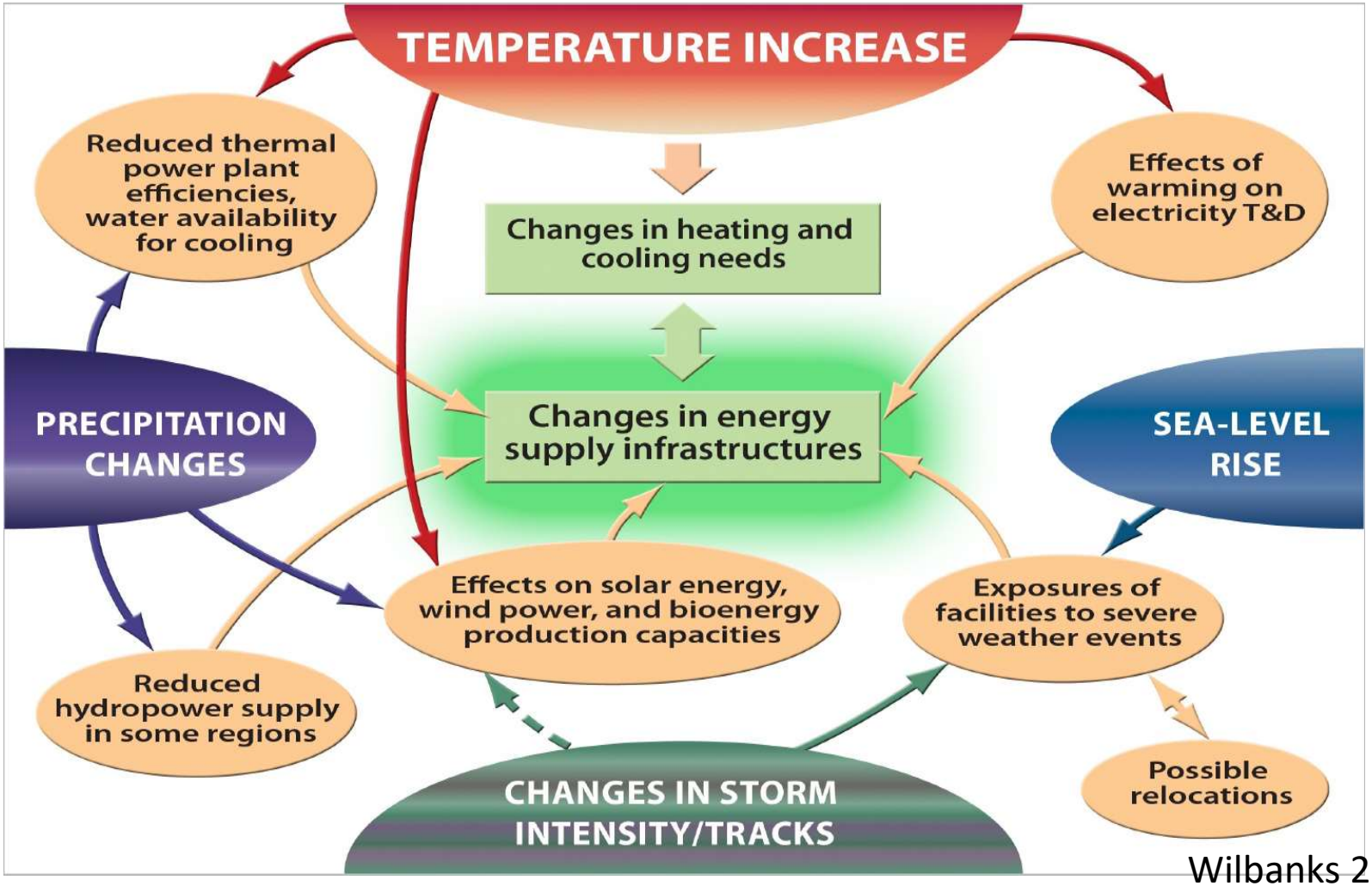




Source: IPCC (2014)

Weather, Climate & Water

Impactos de Cambio Climatico



Wilbanks 2014

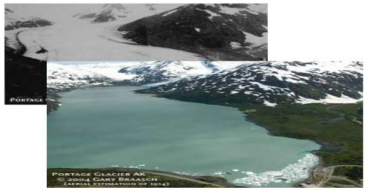
Ejemplo de impactos en la industria petrolera

Temp Increase

Droughts & Floods

Storm Events

Rising Sea Level



Snow Cover Shrinking

Ocean Acidification

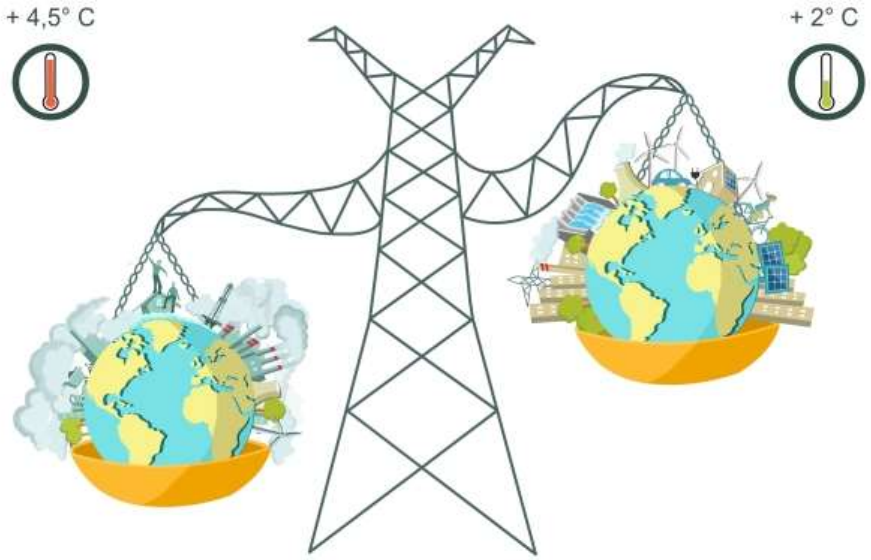
Impacts on…

Exploration	Production	Transport & Terminals	Pipelines	Refining & Processing	Neighboring Communities
					
• Subsidence • Increased wave loading • Loss of surface water access • Sound impacts on sea mammals • Delays due to Species migration	• Early season delays • Pad damage • Loss of surface water access • Production interruptions • Ice road – decreased tundra travel	• Increased ice-load variation • Damage to coastal facilities • Increased shipment interruptions • Improved or reduced shipping lanes or seasons	• Thaw subsidence and frost jacking • Increased setbacks • Loss of capacity in existing pipelines • Wildfires	• Loss of access to water • Interruptions from flooding • Loss of peak cooling capacity	• Weather-related mortality • Infectious diseases • Air-quality respiratory illnesses • Loss of species and habitat • Water

Dell & Pasteris, 2010

Weather, Climate & Water

Paris Agreement
Limit global temperature well below 2 degrees Celsius above pre-industrial level



Decarbonizing the energy sector by 2100

Energy

5 512 TWh

Amount of electricity generated from renewables in 2015

3.5%

Increase in renewable generation compared to 2014

1 100 TWh

Increase in electricity generation from renewables since 2011

15%

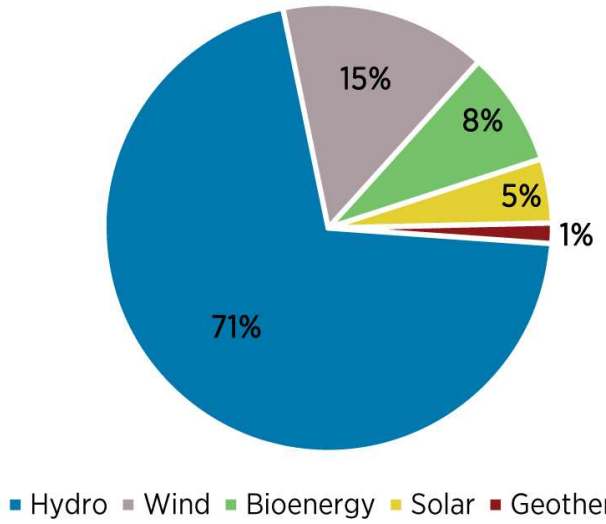
Increase in wind power generation compared to 2014

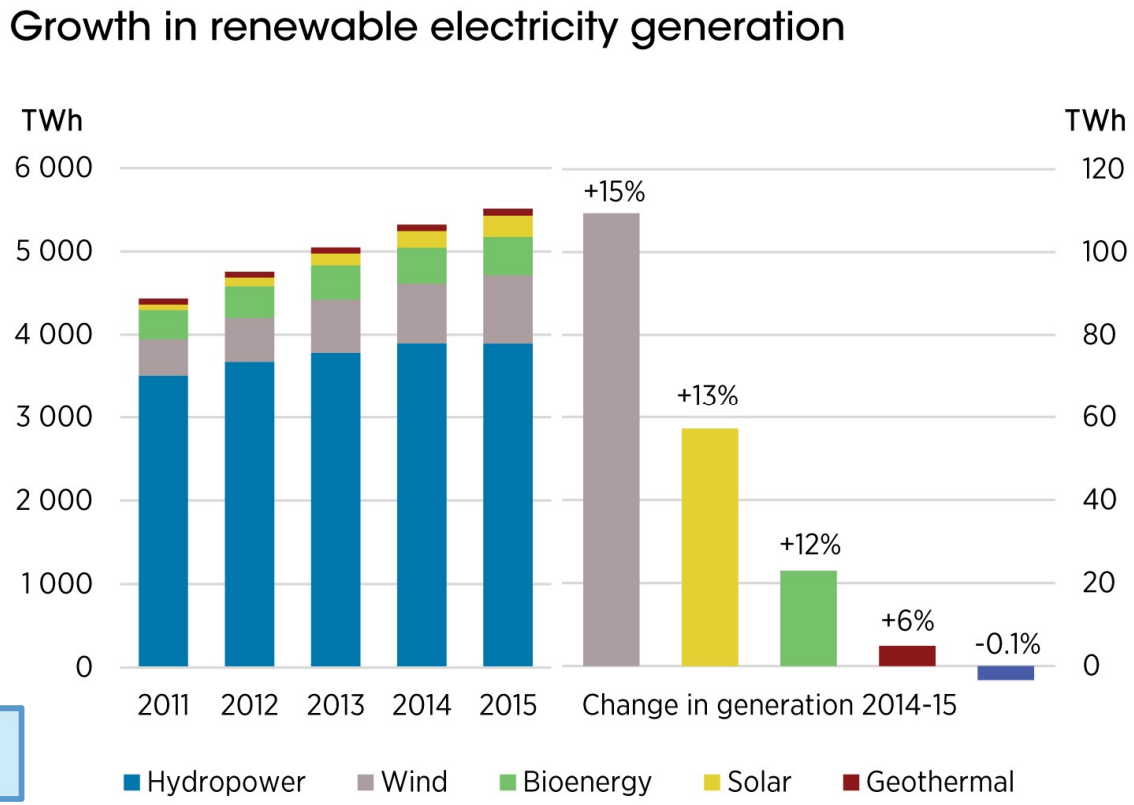
110

Renewable energy balances now available from IRENA

USD 17 bn

Amount of public investment in renewables in 2016

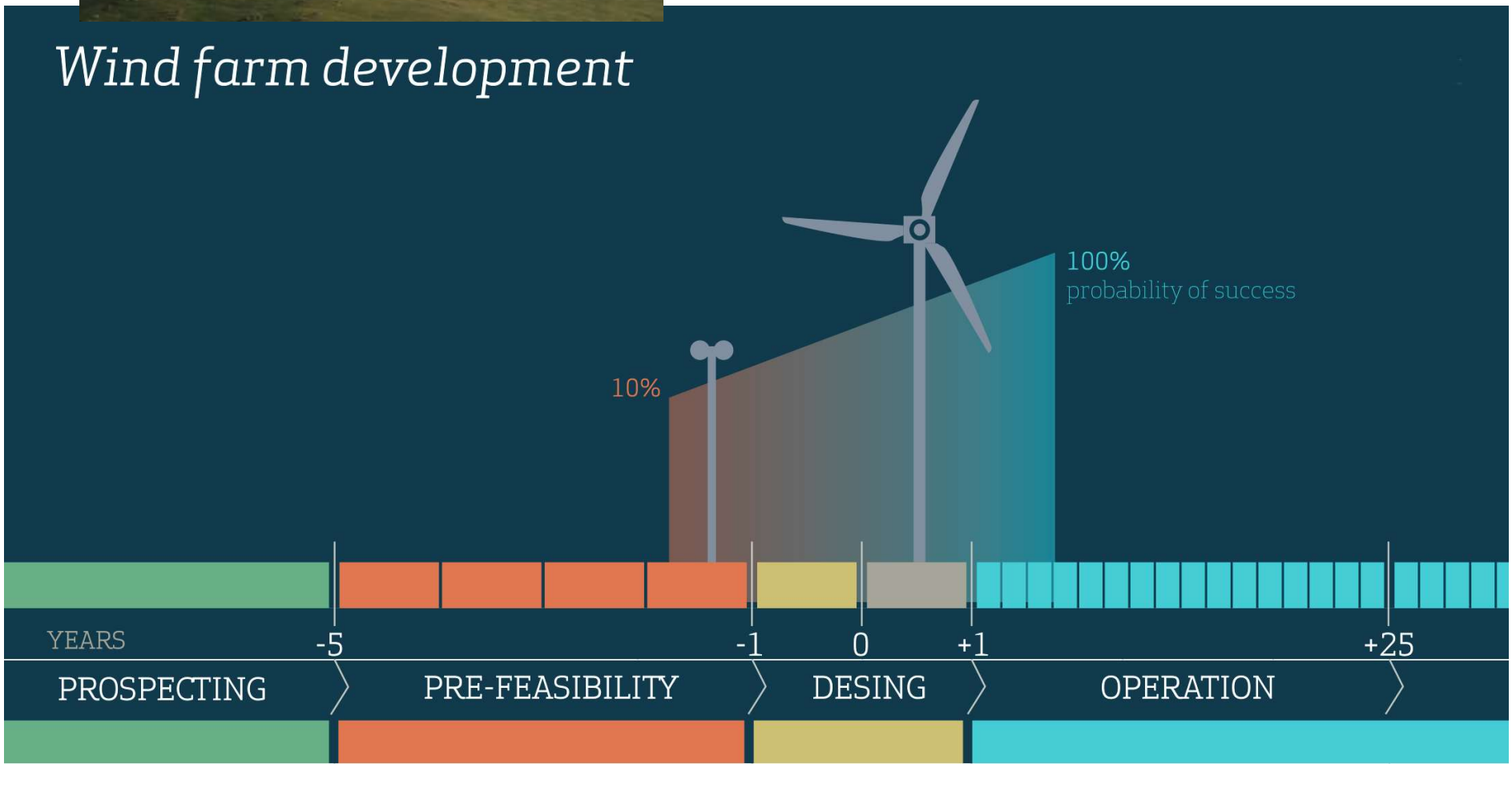




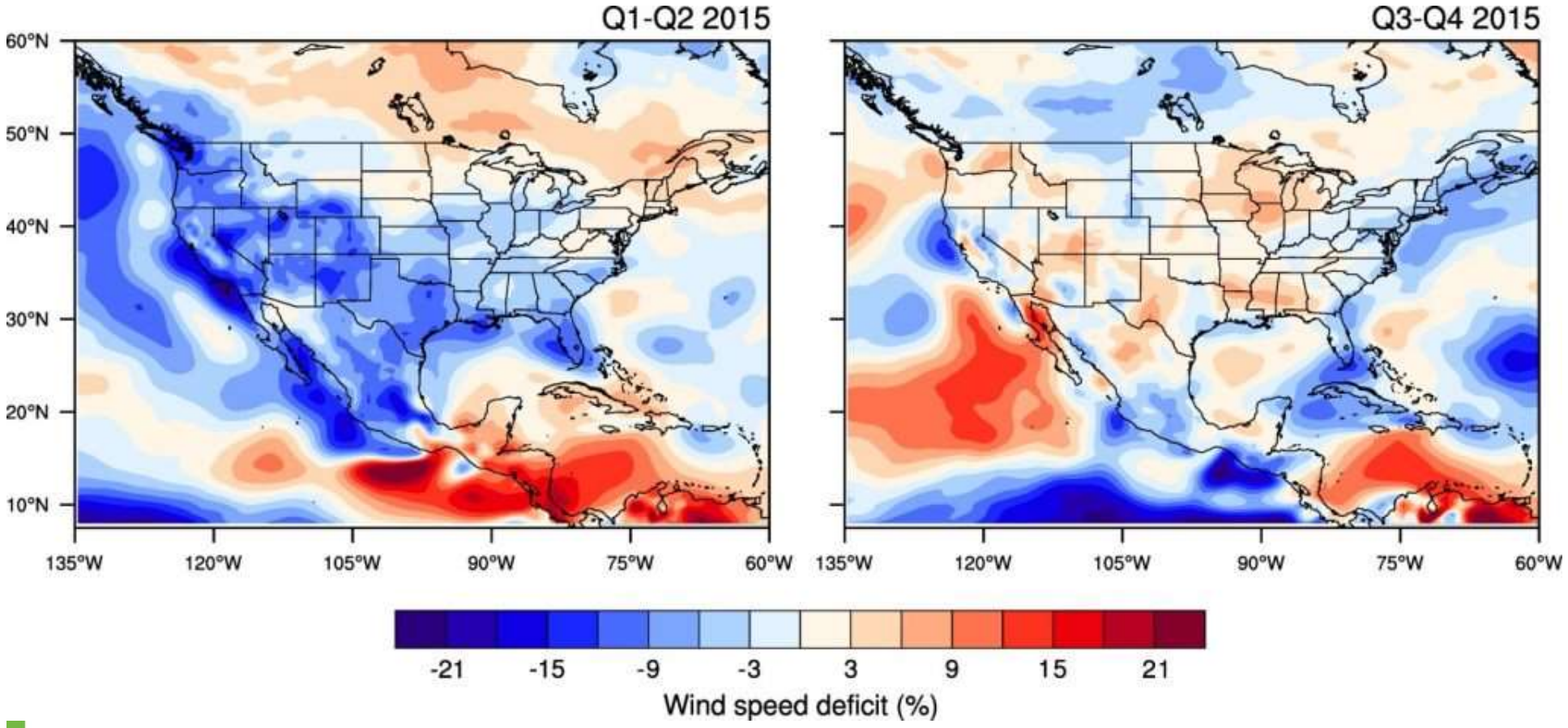
IRENA (2017)

Fuentes Renovables dependen del clima para la generación de energía

Energía eólica depende da velocidad y dirección del viento

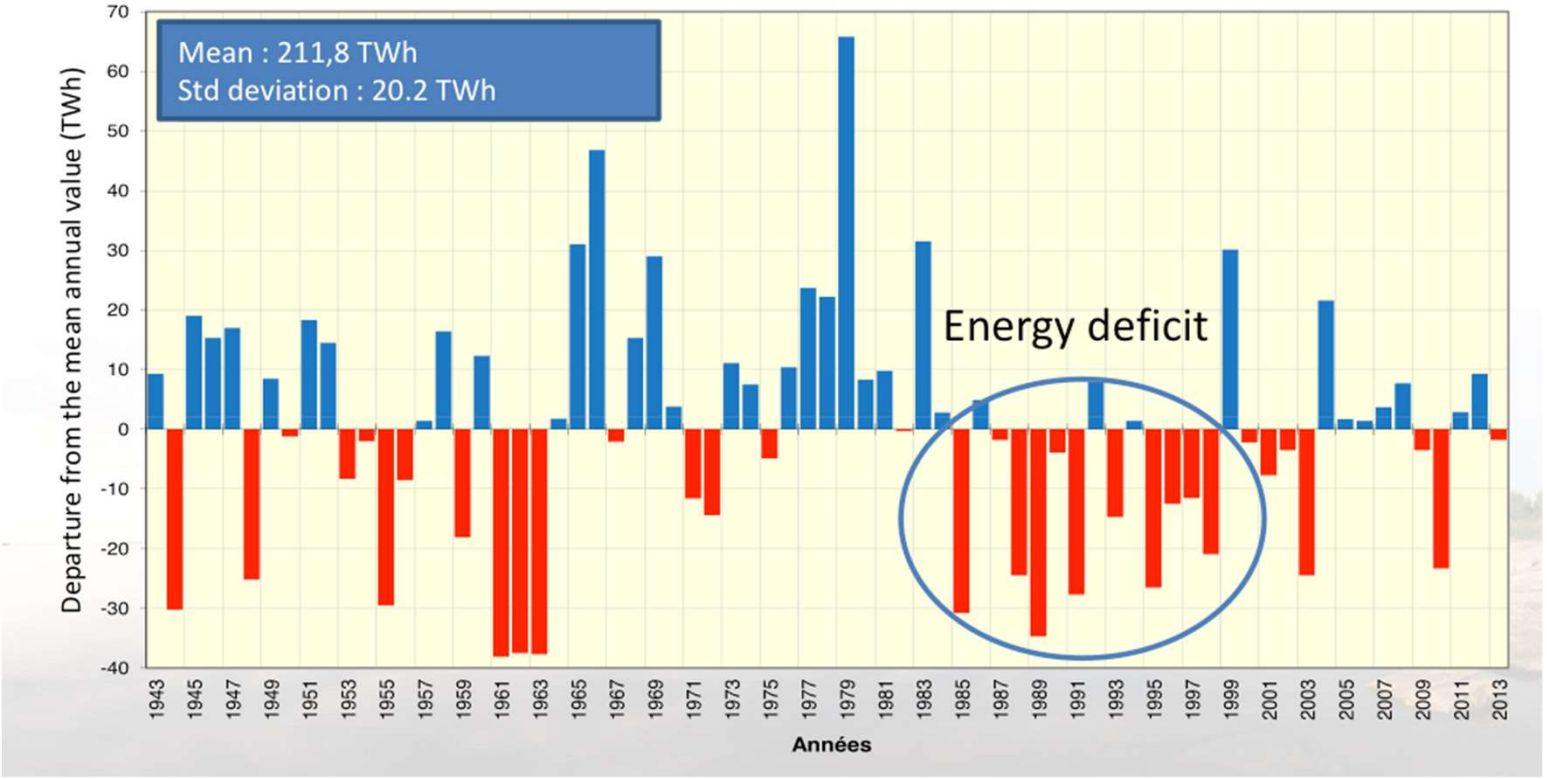


“sequia” de viento en US en 2015



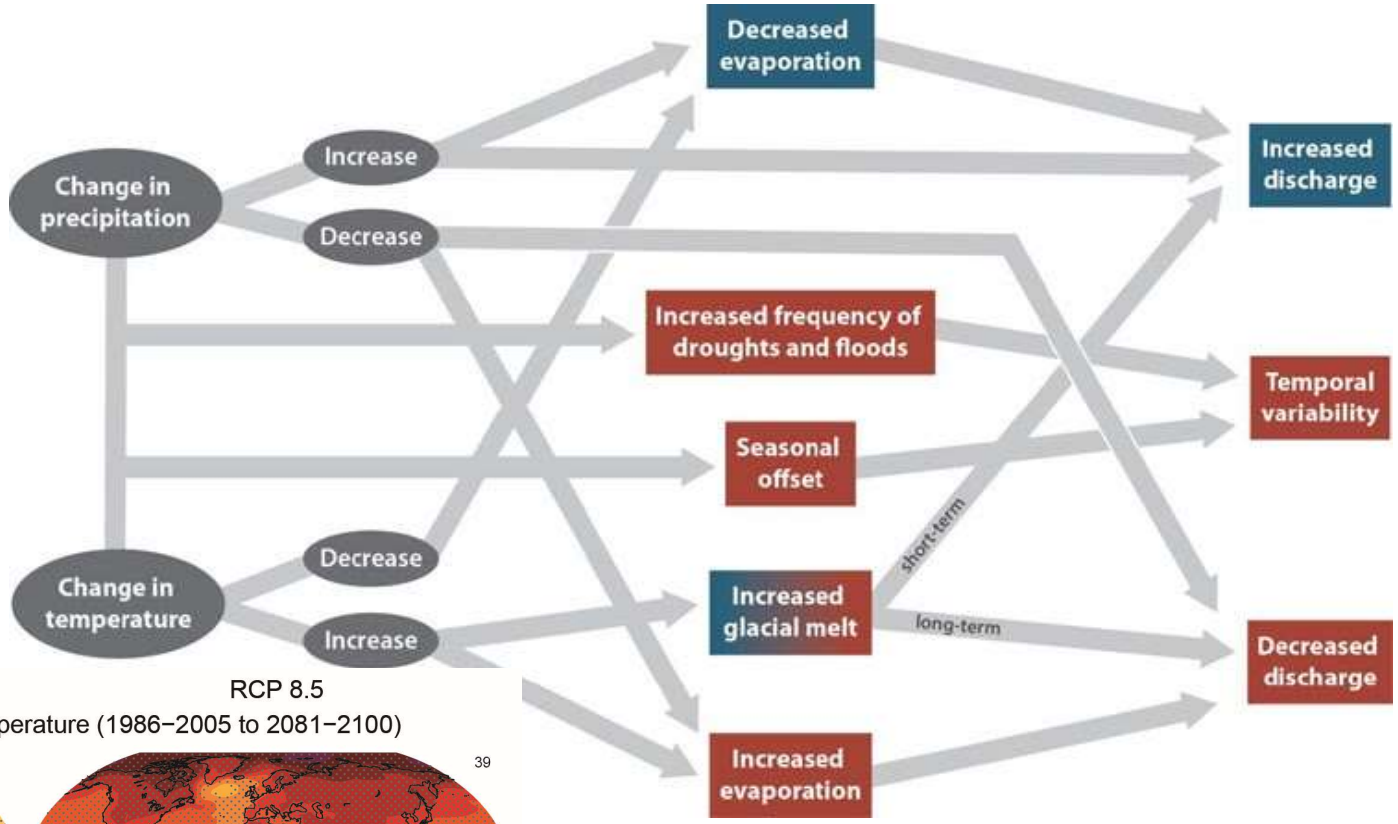
DNV GL 2016

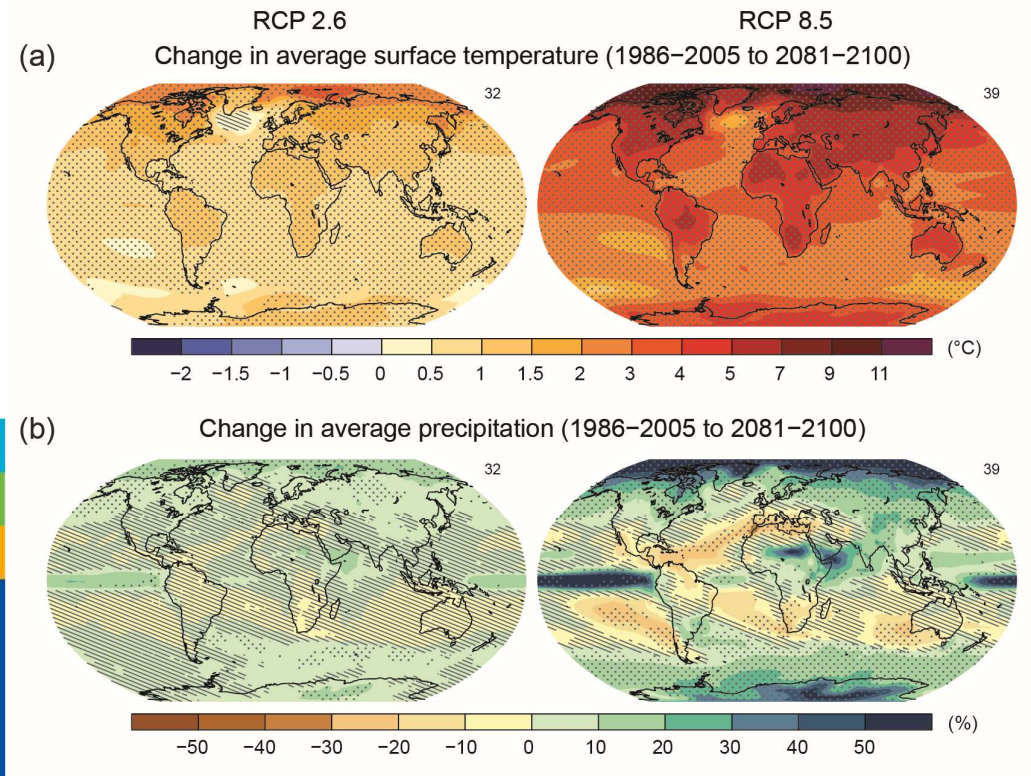
Energía hidroeléctrica depende da recursos hídricos



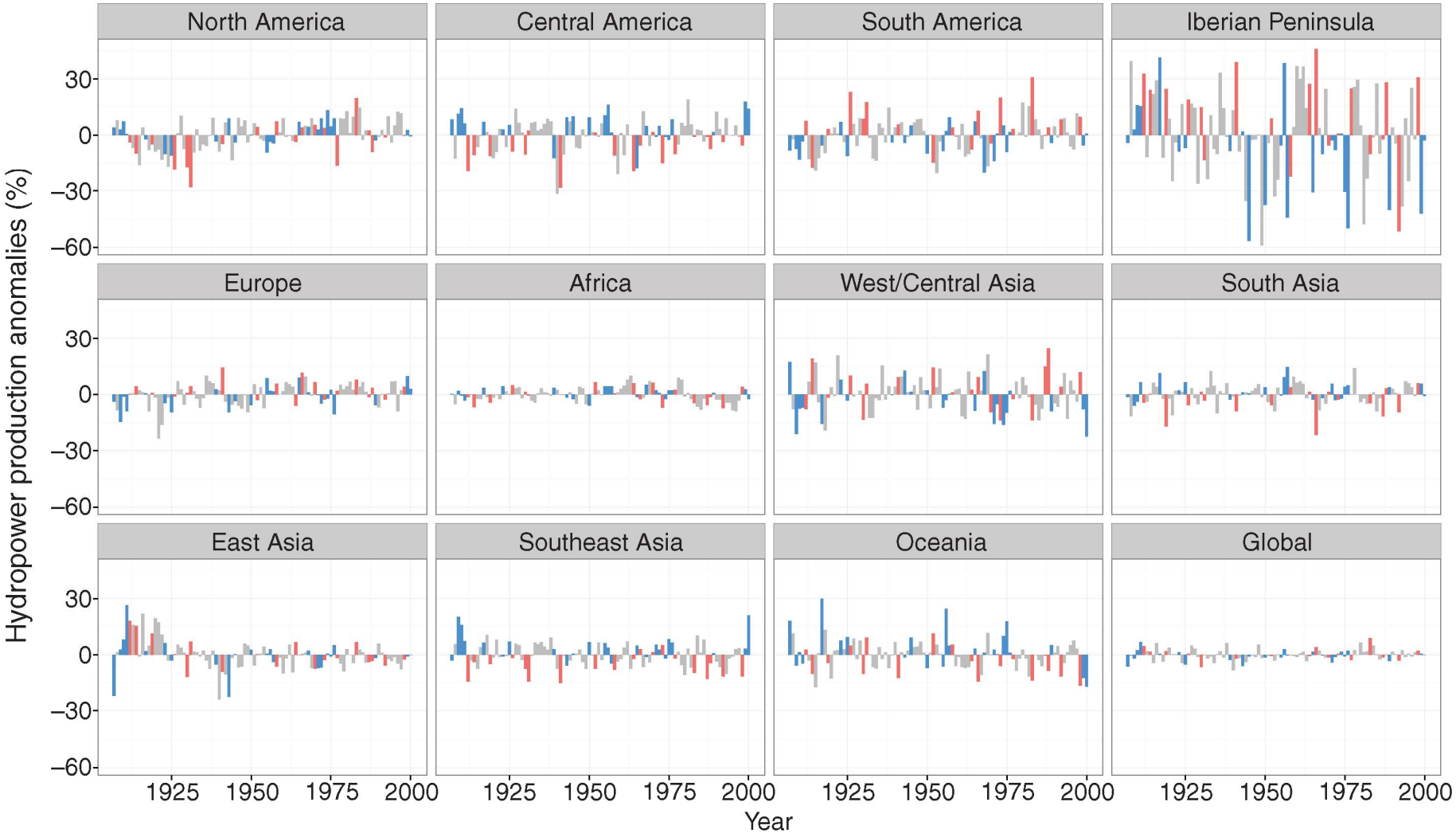
Hydro-Quebec

Impactos de cambio climático en Hidroeléctrica





IPCC AR5 2013



El Nino

La Nina

Ng at al. 2017

Energía solar depende da temperatura y nubes

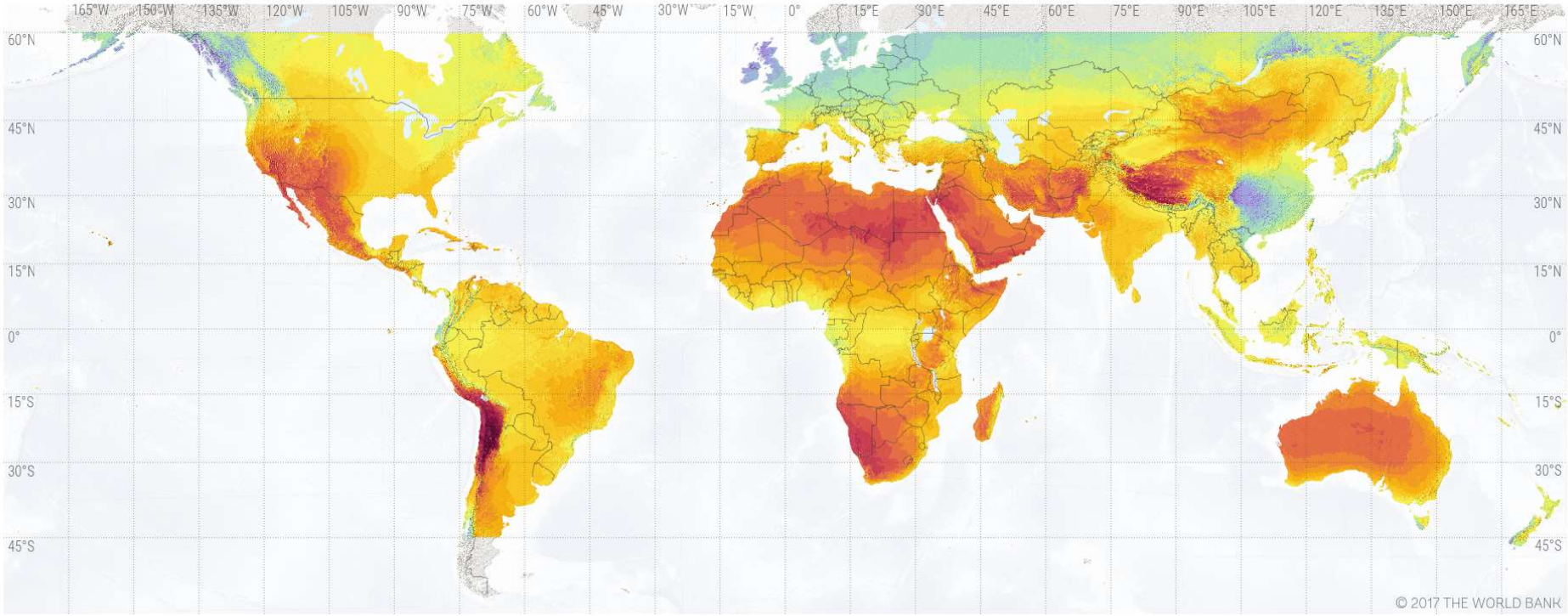
SOLAR RESOURCE MAP

PHOTOVOLTAIC POWER POTENTIAL

WORLD BANK GROUP
THE WORLD BANK IBRD • IDA | IFC International Finance Corporation

ESMAP Energy Sector Management Assistance Program

SOLARGIS

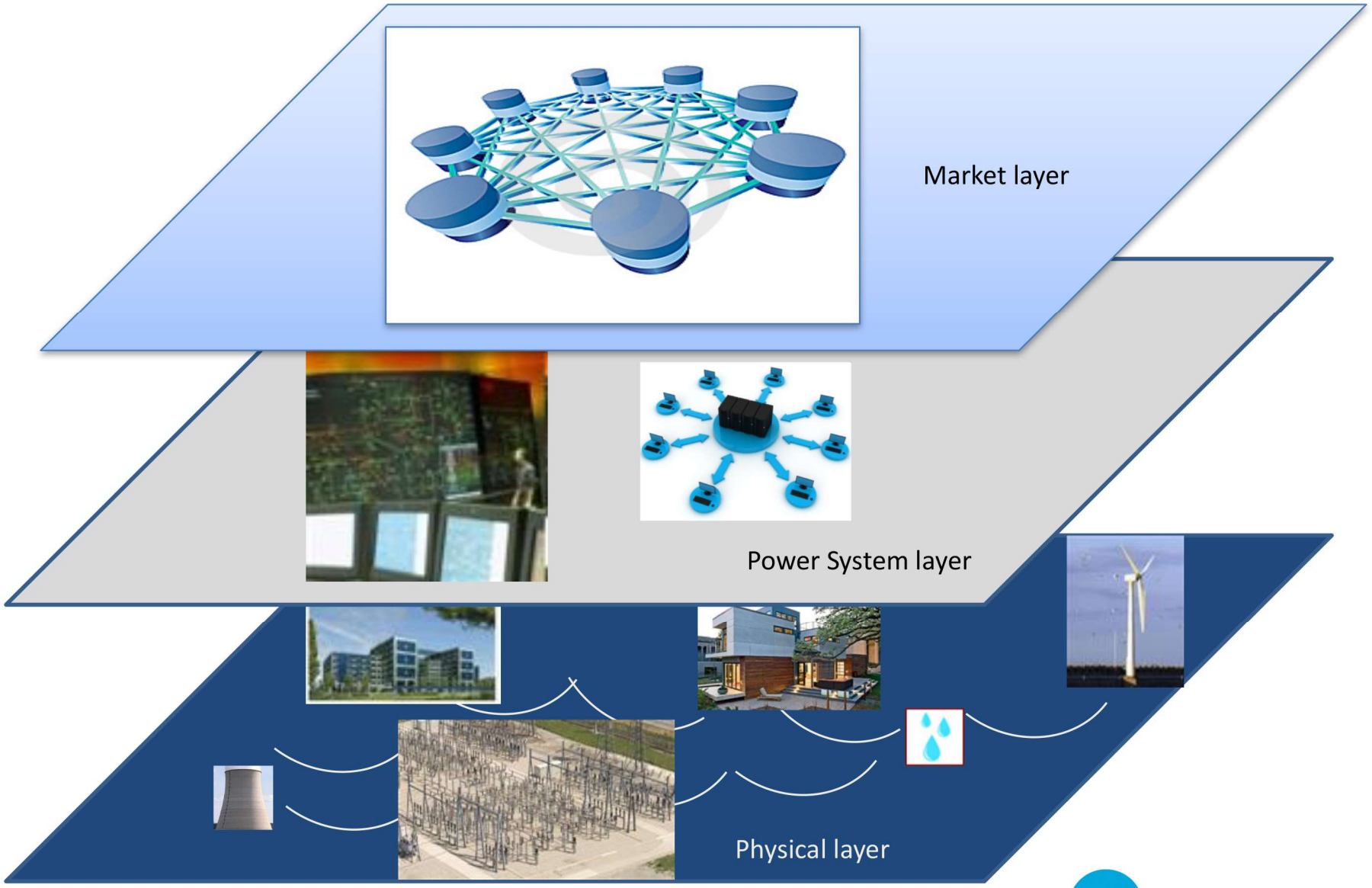


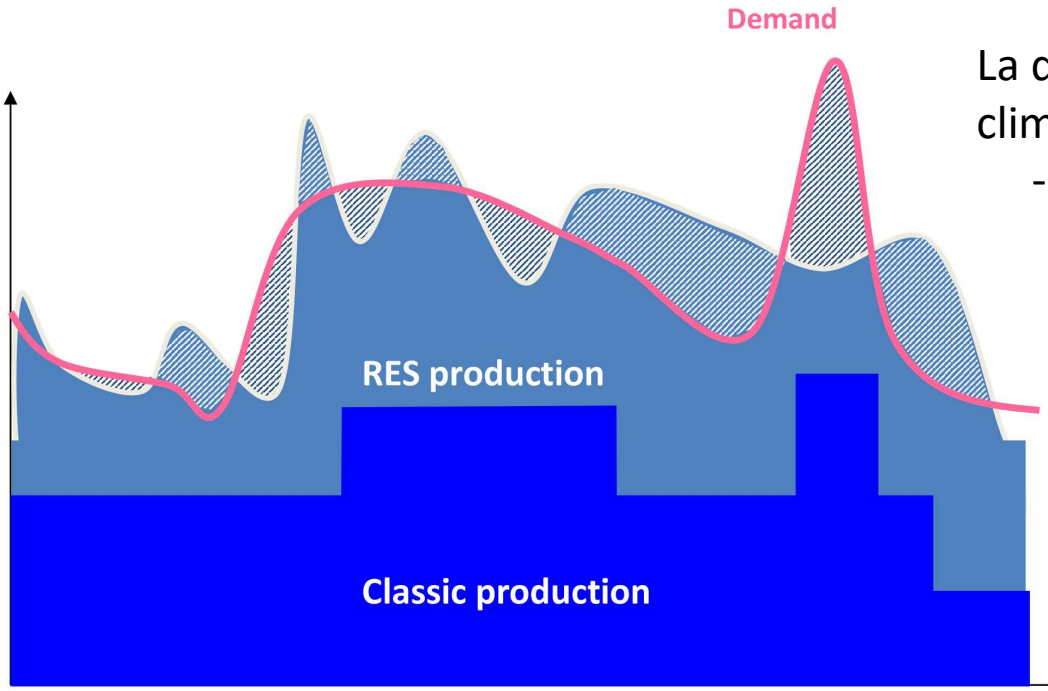
Long-term average of daily/yearly sum

Daily sum:	<	2.0	2.4	2.8	3.2	3.6	4.0	4.4	4.8	5.2	5.6	6.0	6.4 > kWh/kWp
Yearly sum:	<	730	876	1022	1168	1314	1461	1607	1753	1899	2045	2191	2337 >

Los Operadores tienen que gestionar la Variabilidad Climática

Managing climate variability consequences

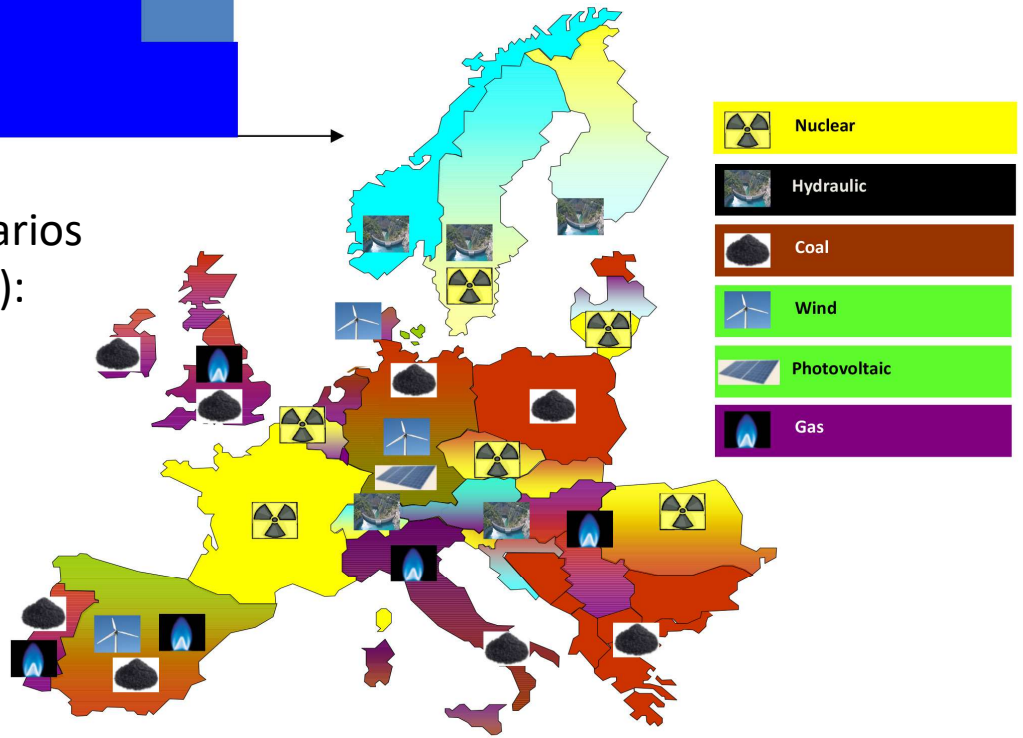

Market layer
Power System layer
Physical layer



La demanda depende de las condiciones climáticas. RTE Francia estima:

-1°C = 2400 MW

RTE usa predicciones de MeteoFrance a corto plazo (+5 dias)



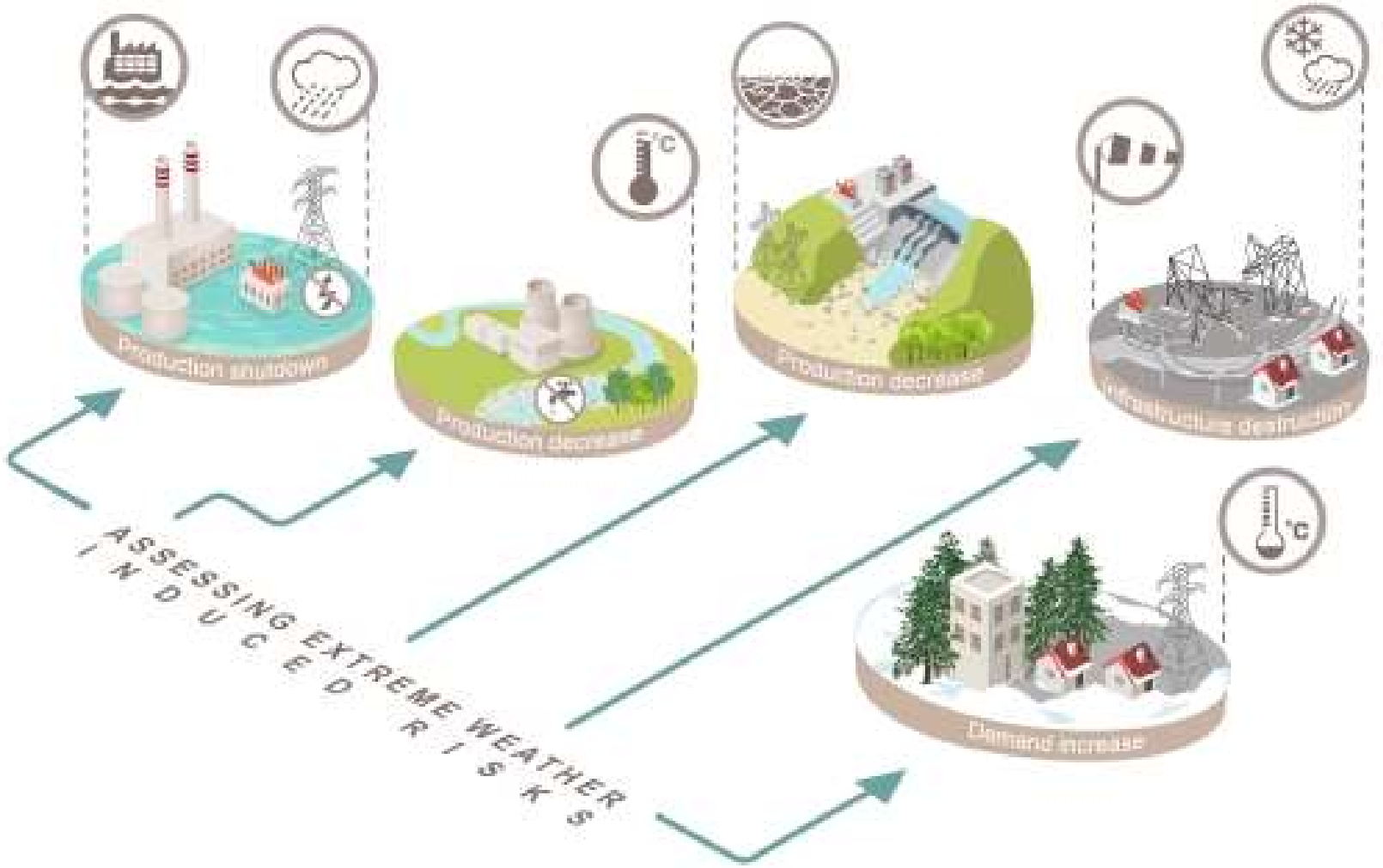
MeteoFrance proporciona a RTE escenarios de medio y largo plazo (+ meses y anos):

- Seguridad
- Eficiencia
- Resiliencia

Operaciones de Mantenimiento y Redefiniciones

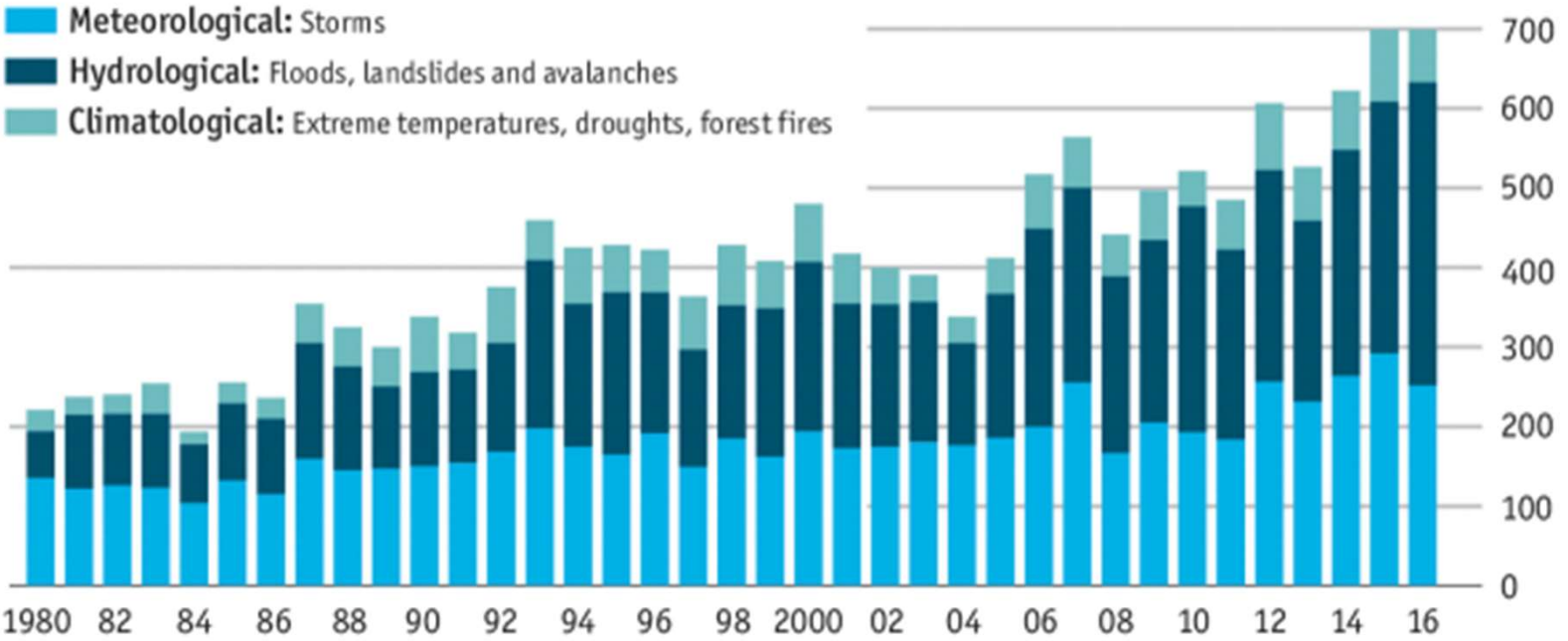
- Zonas costeras - nivel del mar y temporales
- Extender las operaciones – flujos de los ríos, sequia, viento
- Operaciones offshore – condiciones del mar
- Eliminación de infrastructura offshore

Eventos climáticos extremos generan riesgo



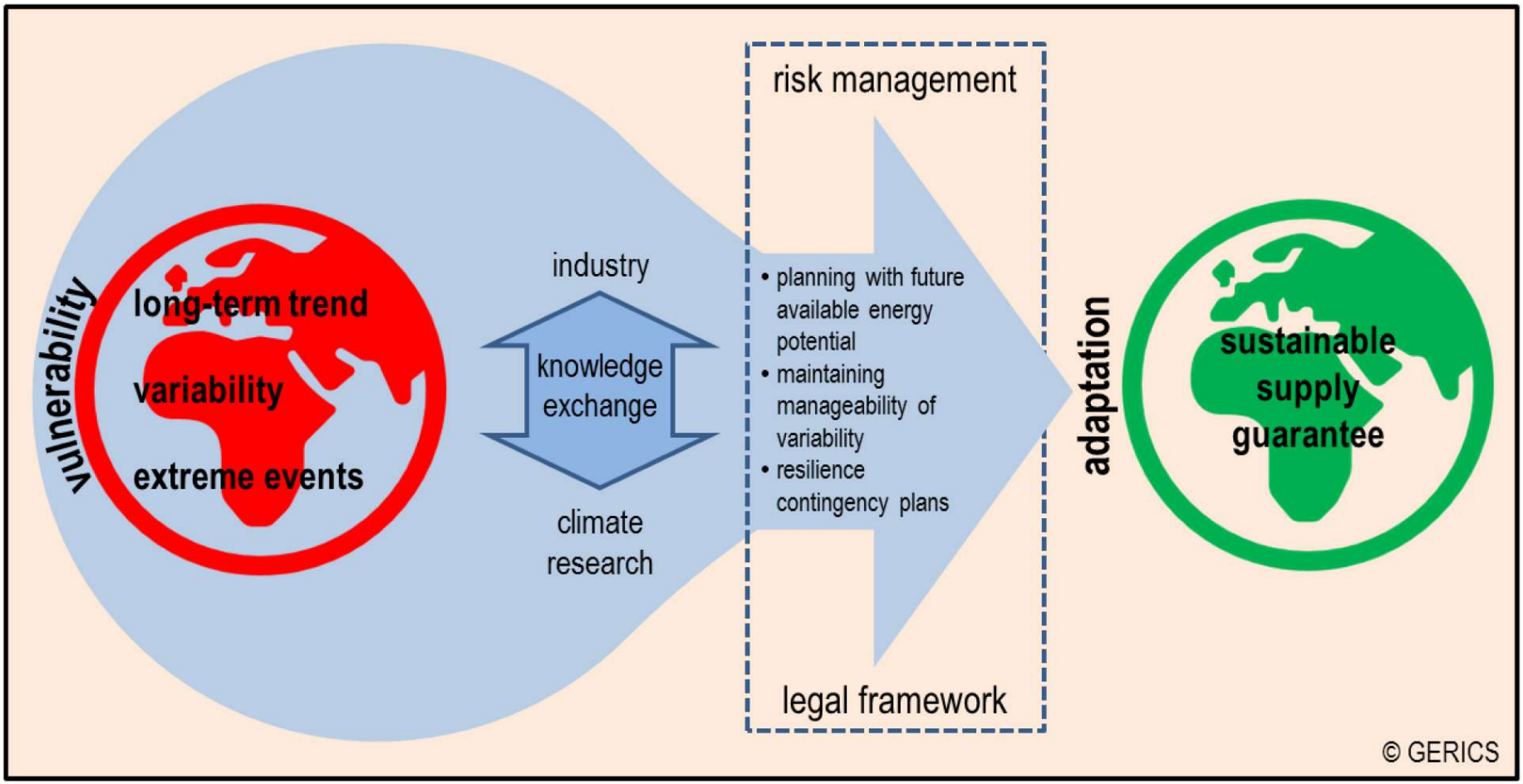
A rising tide

Natural disasters by cause

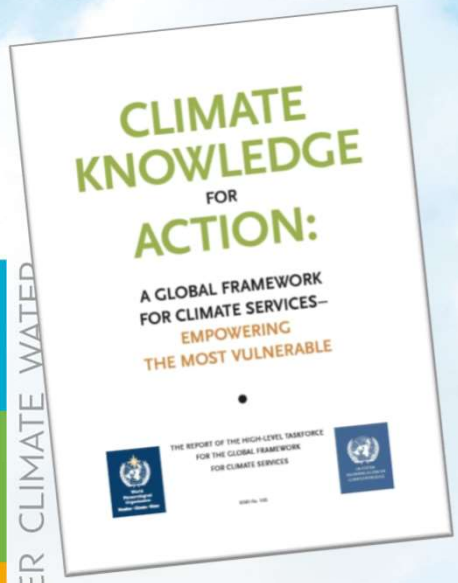


Source: Munich Re

El desarrollo de medidas efectivas de adaptación puede garantizar una generación de energía sostenible



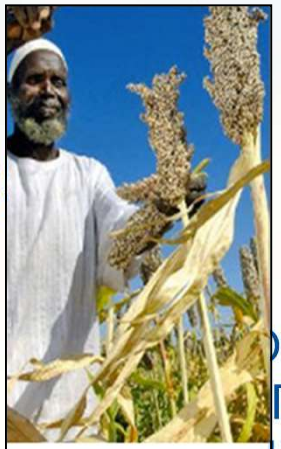
Vision



GFCS
GLOBAL FRAMEWORK FOR CLIMATE SERVICES

To enable **better management of the risks** of climate variability and change and **adaptation to climate change**, through the development and incorporation of science-based climate information and prediction into planning, policy and practice on the global, regional and national scale.

Priority Areas



Agriculture and food security

Disaster risk reduction

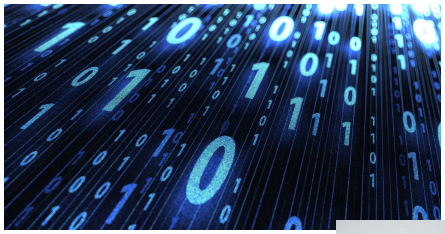
Water

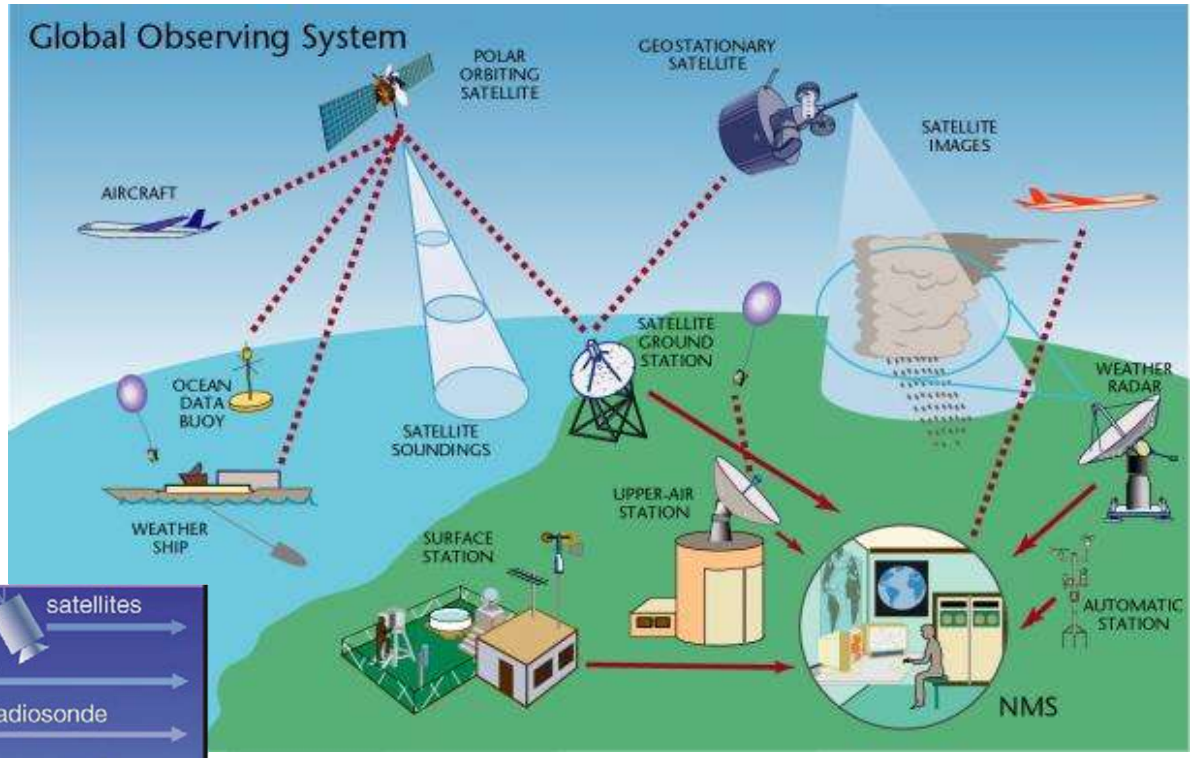
Health

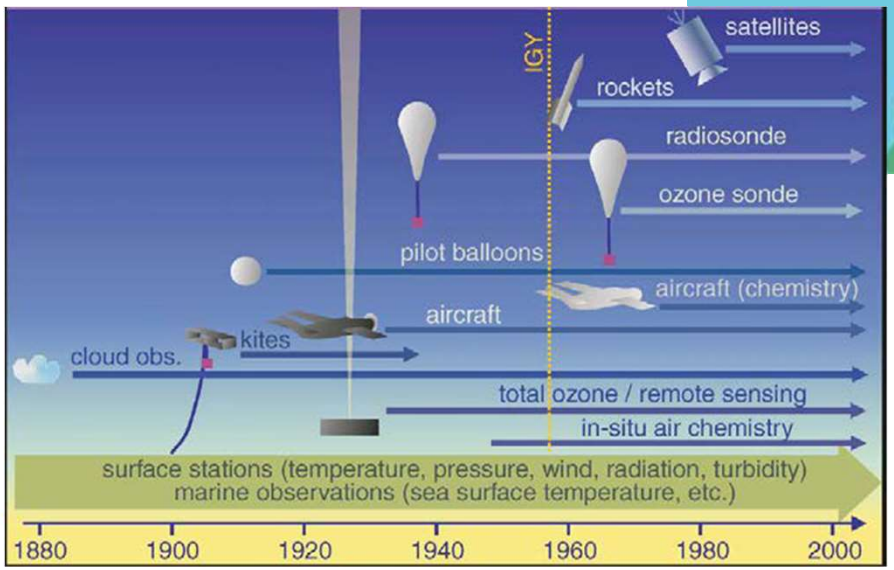
Energy


7
Climate services for access to affordable, reliable, sustainable and modern energy for all
Greater climate resilience & adaptation
Efficiency & reduction of energy consumption
Renewable energy sector growth
Energy Exemplar to the User Interface Platform of the Global Framework for Climate Services
WORLD METEOROLOGICAL ORGANIZATION
GFCS
GFCS Energy Exemplar

Observaciones Hydrometeorological Globales







National Meteorological Service: Forecasts, warnings, monitoring, data collection, maintain observation networks

GFCS
GLOBAL FRAMEWORK FOR CLIMATE SERVICES

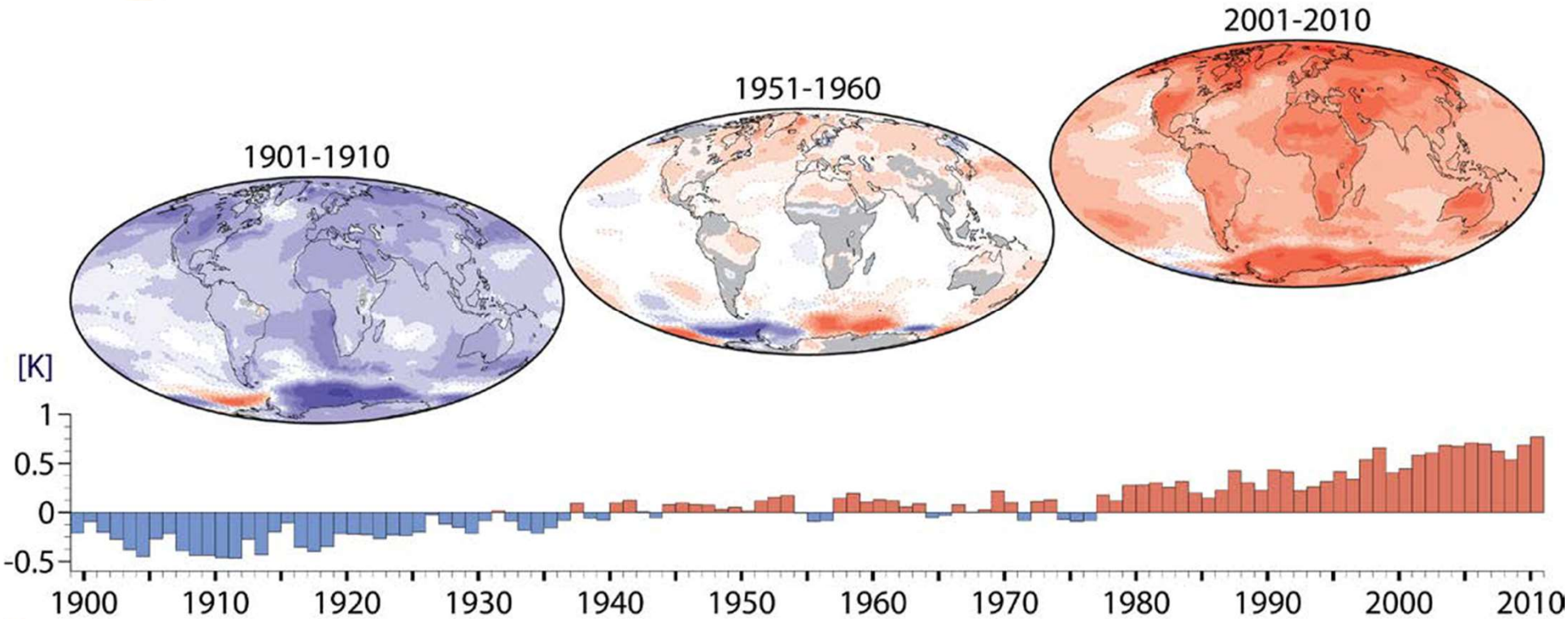
Serie Histórica de datos Hydrometeorological

- Atmosphere/land/wave parameters
- 31 km global resolution, 137 levels
- Hourly output from 1979 onward

- Using 2016 ECMWF forecast system
- Using improved input observations
- Ensemble data assimilation method
- Uncertainty estimates for all ECVs

GFCS
GLOBAL FRAMEWORK FOR CLIMATE SERVICES

Reanalysis Products



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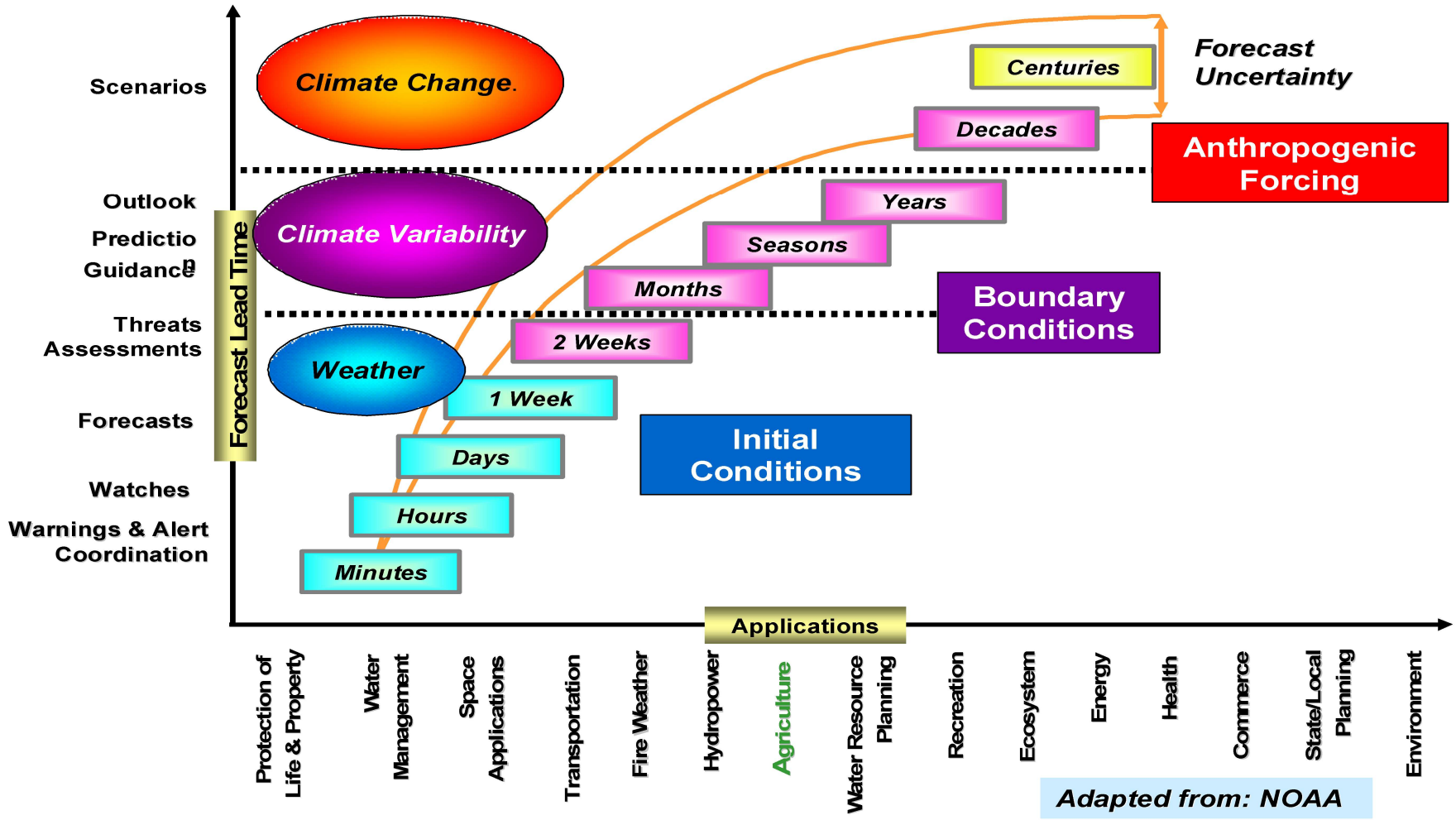
Climate Prediction Framework



GFCS
GLOBAL FRAMEWORK FOR CLIMATE SERVICES

1: Priority Applications

Improving decision making in climate-sensitive areas:

- Health
- Food security and agriculture
- Disaster risk reduction
- Water resources
- Energy

3: Foundational Pillars

Enhancing technical and scientific capabilities to support user-driven climate services:

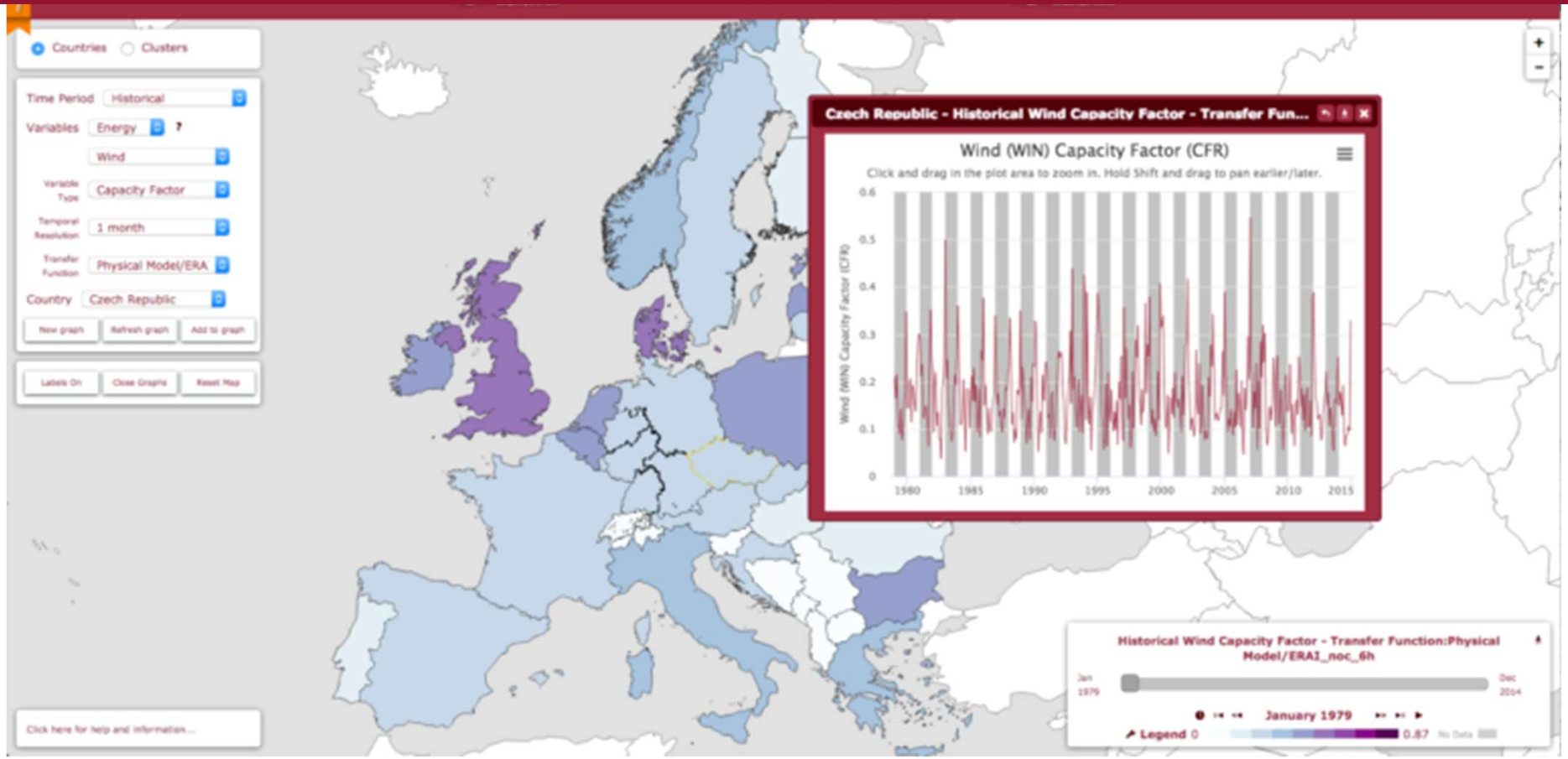
- Observations and monitoring
- Research, modeling, and prediction
- Climate services information systems
- Capacity building

2: Bridge

Connecting user needs with climate services through sustained engagement mechanisms:

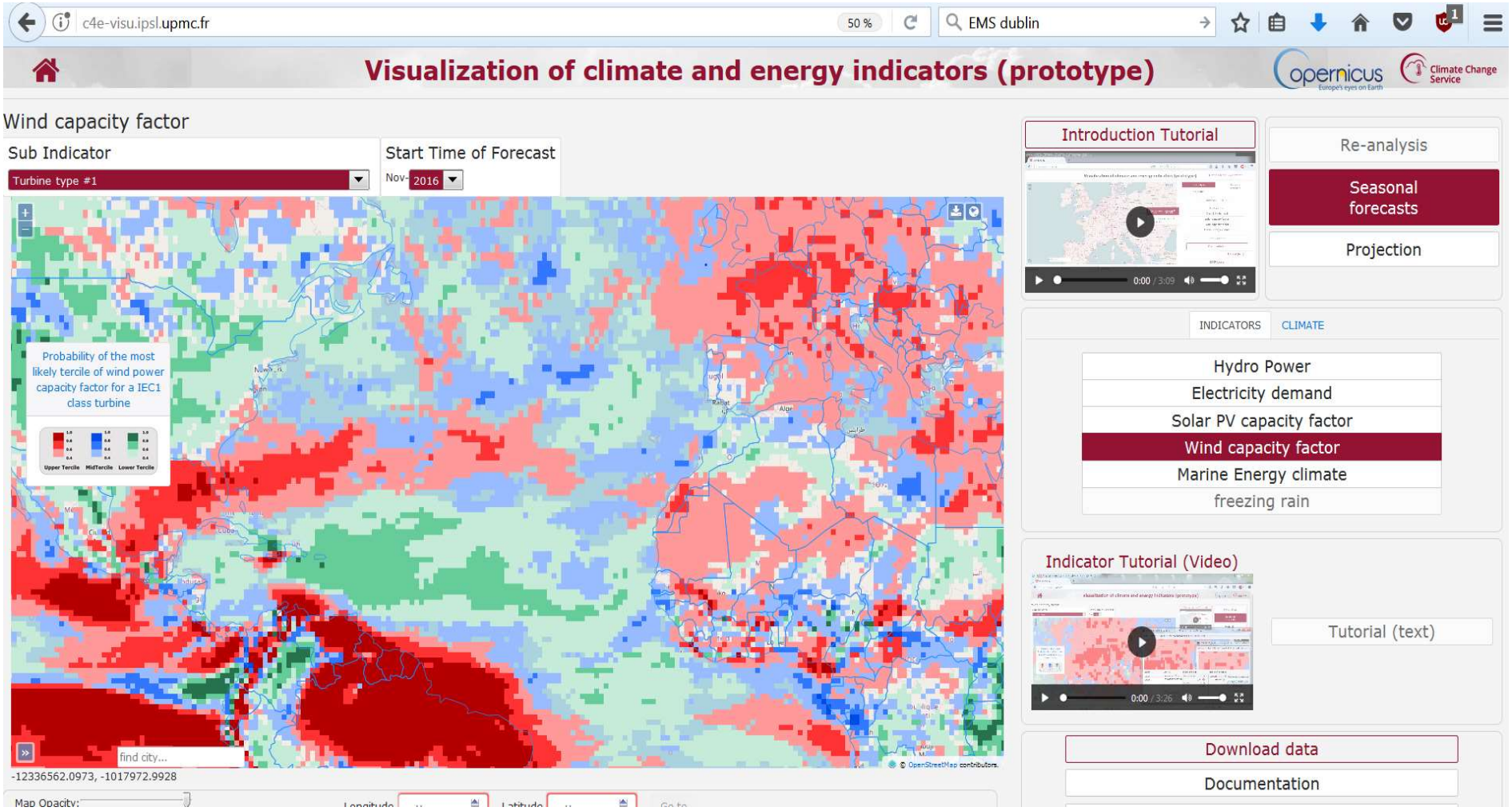
- National activities
- Regional activities
- Global activities

Hierramienta Interactiva On-line: test energy mixes



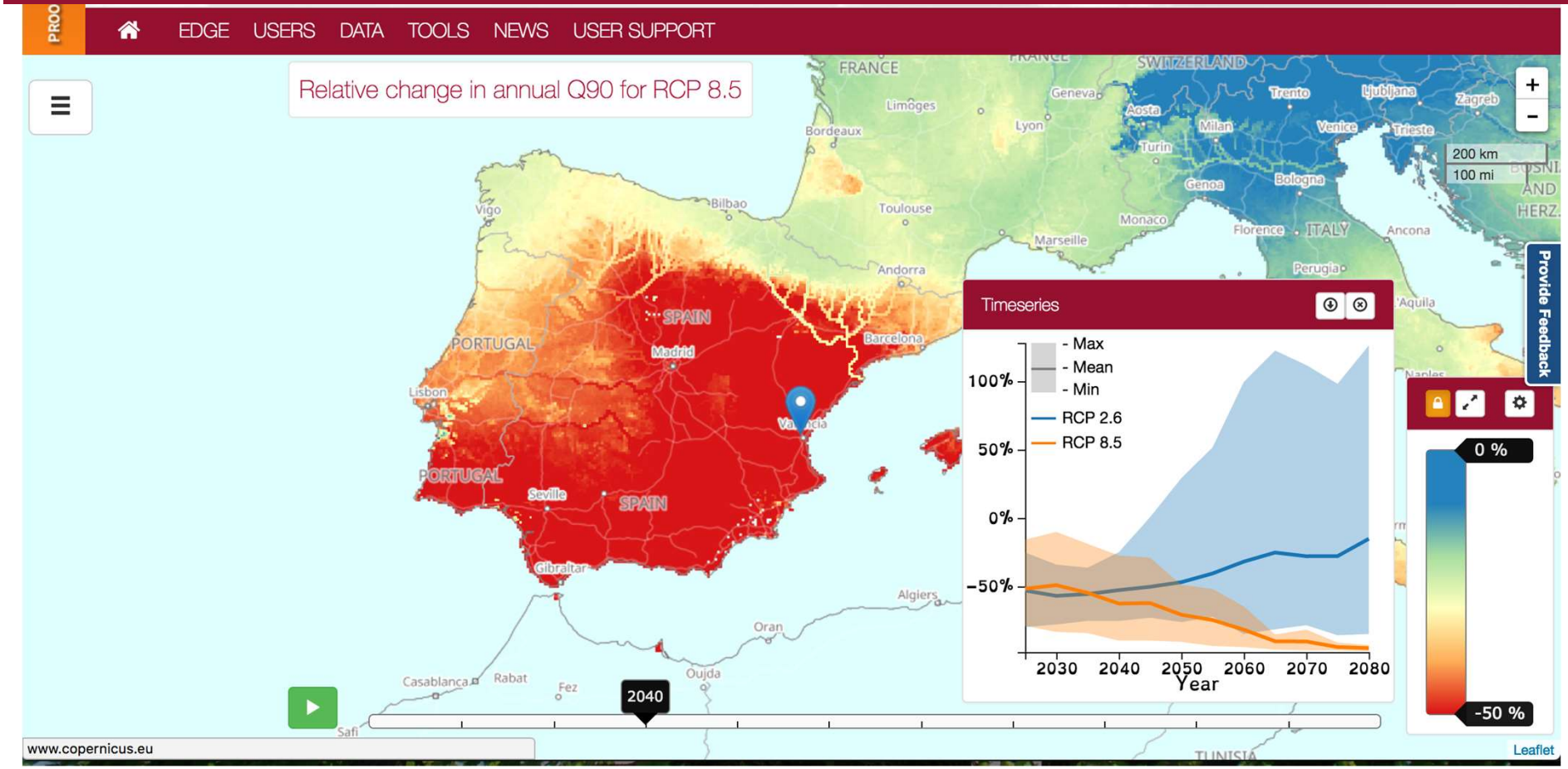
https://demos.the-iea.org/ecem/

Prenostico Estacional: Wind Power



http://clim4energy.climate.copernicus.eu/access-products

Escenarios Climatico : Hydrological Outlook

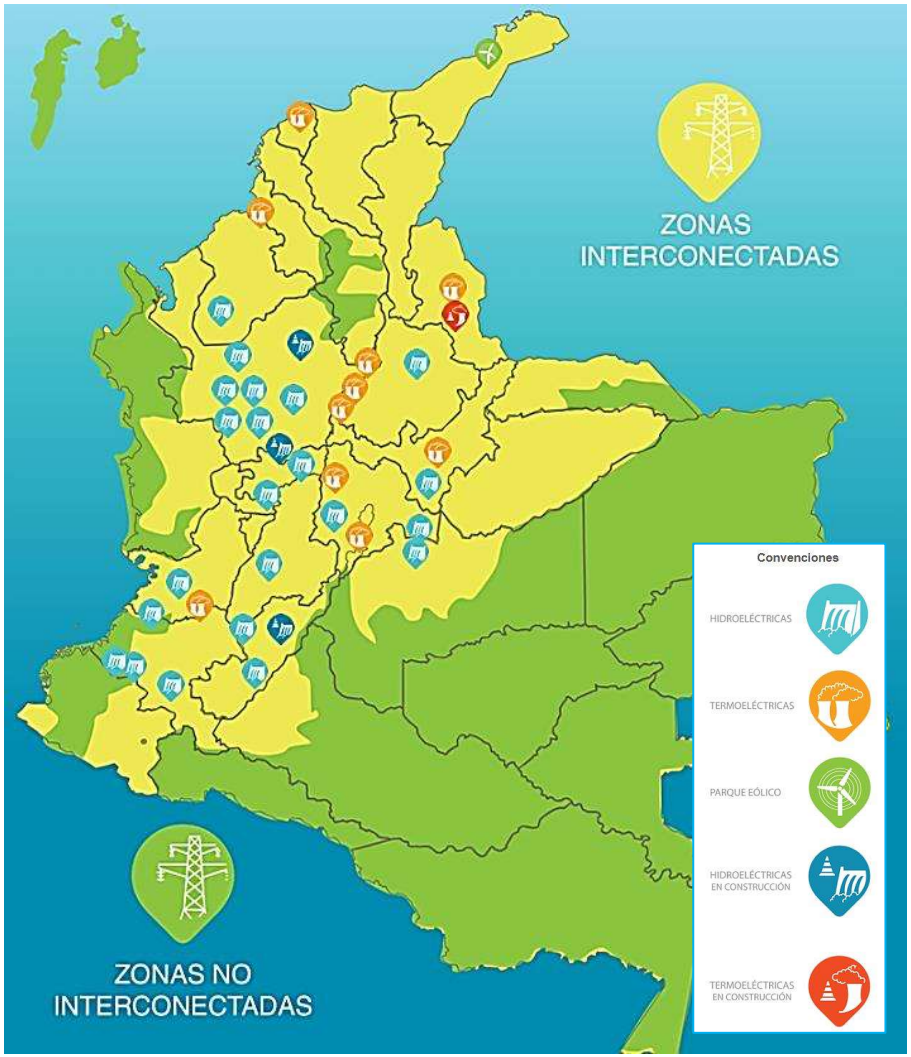


A climate-projection data set suited to the energy sector

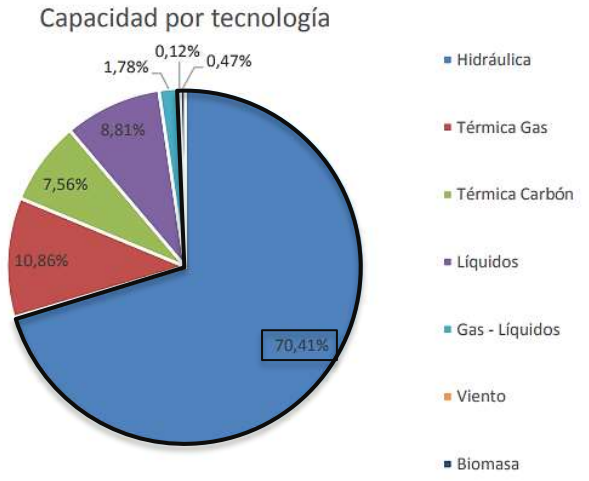
High-resolution 3-hourly, 12 km, 11 models, 2 scenarios, bias adjustment and model selection recommendations

https://esgf-node.ipsl.upmc.fr/search/c3s-energy/

Generalidades Sector Energético



Fuente: ACOLGEN



Fuente de datos: Sistema de información de XM
Fuente de gráfica: UPME

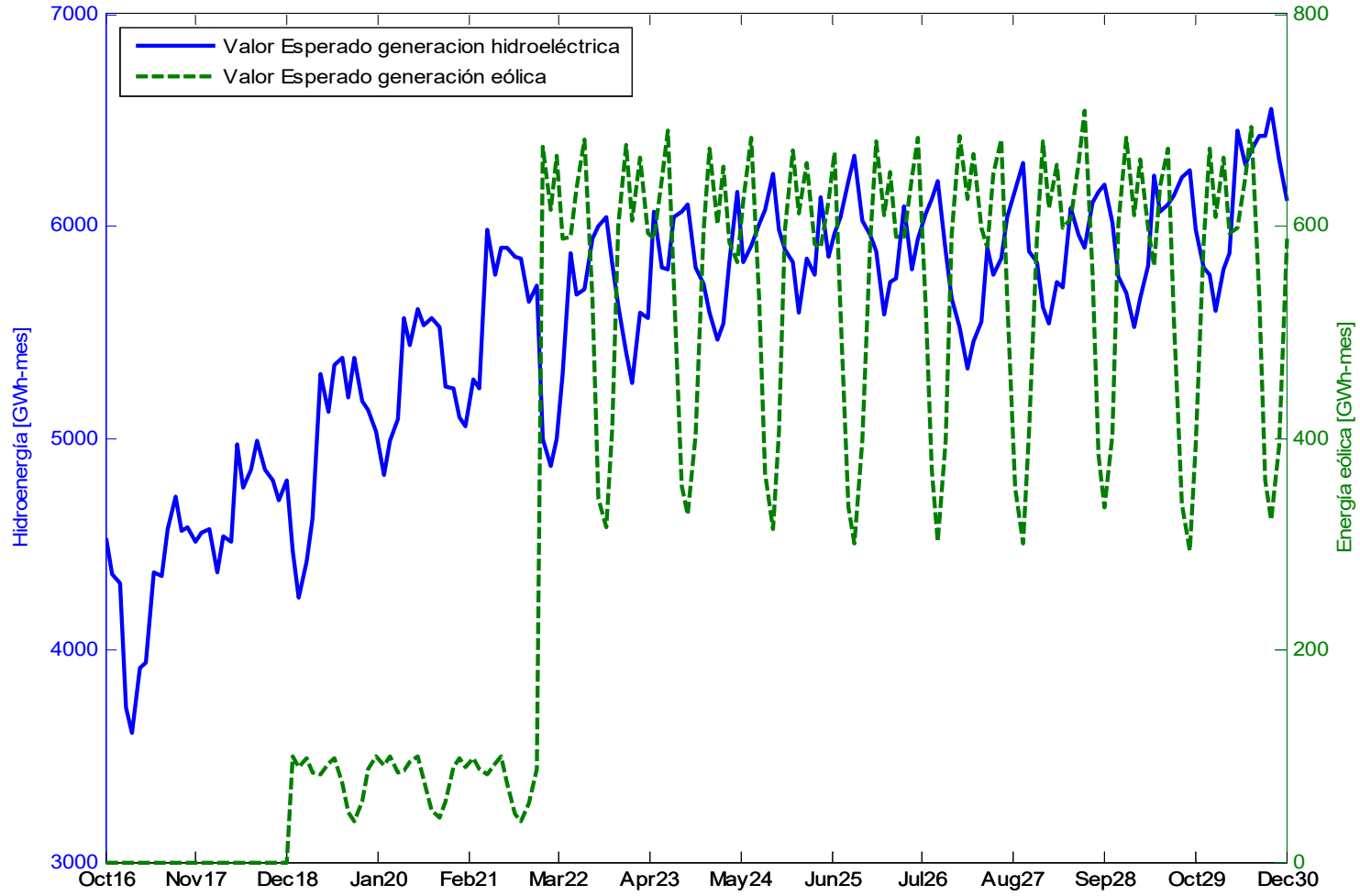
Alta dependencia a la variabilidad Climática

Capacidad por tecnología

Tecnología	Potencia (MW)	Participación (%)
Hidráulica	10.919,8	70,41%
Térmica Gas	1.684,4	10,86%
Térmica Carbón	1.172,0	7,56%
Líquidos	1.366,0	8,81%
Gas - Líquidos	276,0	1,78%
Viento	18,4	0,12%
Biomasa	72,3	0,47%
Total	**15.508,8**	**100%**

Fuente de datos: Sistema de información de XM
Fuente de tabla: UPME

Complementariedad energética del viento y del agua



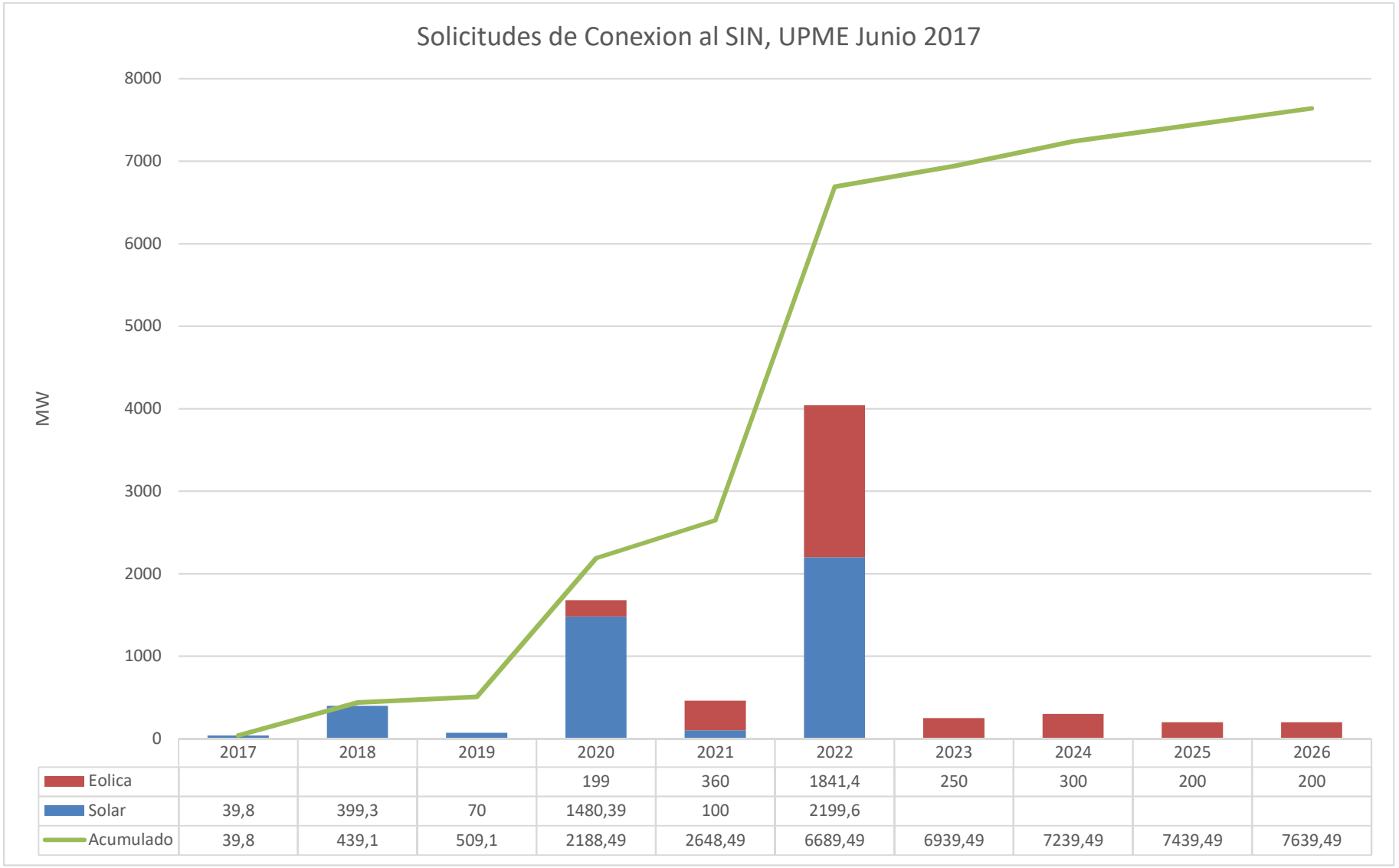
Analysis a partir de serie históricas de datos medios de los recursos renovables (IDEAM, gremios y promotores de proyectos eólicos)

upme
Unidad de Planeación Minero Energética

Beneficios Demostrados

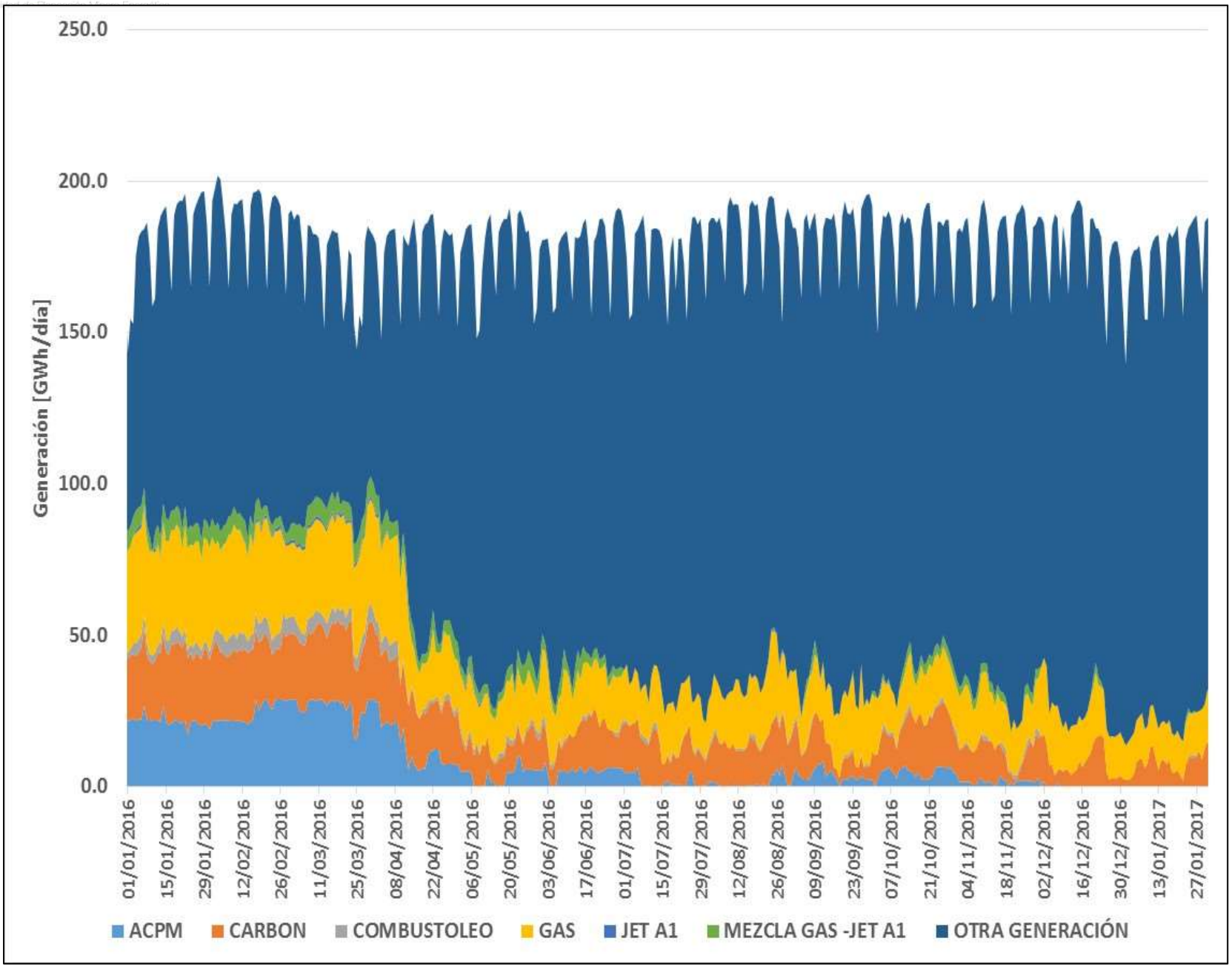
1. Diversificación de la matriz de generación de electricidad (**16.6 GW año base 2016**) tomando inicialmente un escenario referente como objetivo sería de una capacidad adicional de **2,252.2 MW eólicos, solares y de biomasa** entre los principales.
2. Los impactos sobre la **Demanda de electricidad** llega a **ahorros mayores de 200 millones de dólares al año** para los casos analizados.
3. Mayor **competitividad para el sector productivo y ambiental**, con una energía eléctrica más barata y más limpia.
4. La **reducción de las emisiones** con la integración de las Energías renovables de 74.6 Mte-CO2.

La Ley 1715 ha acelerado la penetración de las fuentes con más de 8,6 GW e proyecto solicitando en la UPME conexión al SIN.



	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Eolica				199	360	1841,4	250	300	200	200
Solar	39,8	399,3	70	1480,39	100	2199,6				
Acumulado	39,8	439,1	509,1	2188,49	2648,49	6689,49	6939,49	7239,49	7439,49	7639,49

Histórico de generación térmica por fuente [GWh]



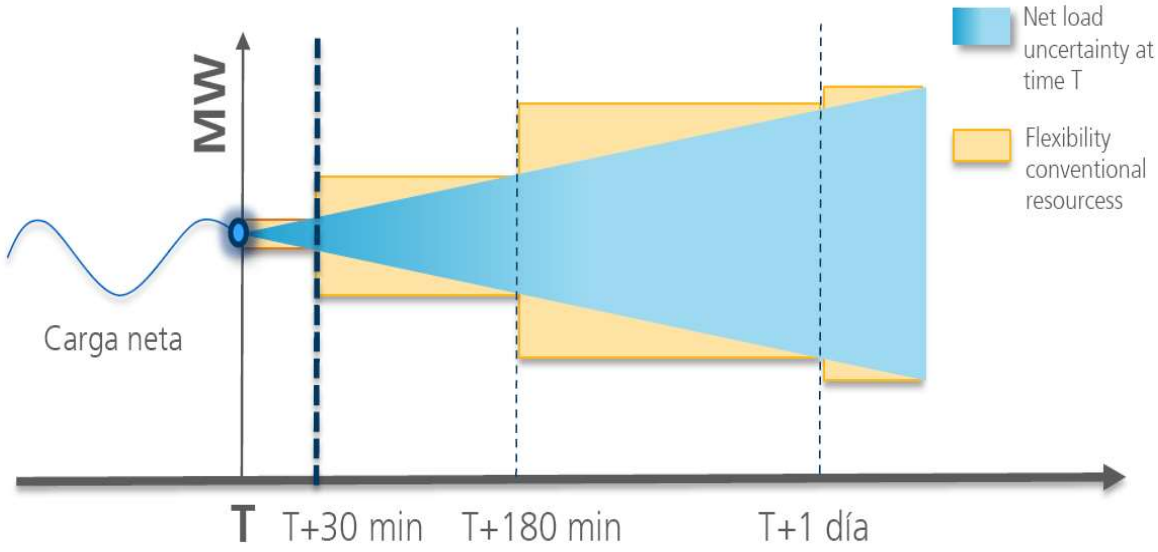
Altos Riesgos de la integración de las energías renovables

1. La **intermitencia de las energías solar y eólica desbalancean el despacho** en todo momento, generando riesgos

2. **Sobre costos para la demanda** debido a balancear las altas variaciones de la generación eólica y solar

3. Una integración de fuentes intermitentes sin cumplimiento de estándares internacionales desde la toma del dato hasta el establecimiento de pronóstico, incrementa los errores y los costos económicos del sector energético, productivito y ambiental, así como incrementará las emisiones de gases de efecto invernadero…. *contrario a lo buscado con la Ley 1715 y los objetivos de las políticas nacionales ambientales y energéticas.*

Importance of forecast



Given the uncertainty in the power that plants can deliver with FRNC, continuous updates of the forecast by the system operator are required.

It is required by the operator to carry out forecasting of demand and generation of FRNC to take operational decisions.

Recomendaciones futura implementación

- Contar con estándares en los procesos de toma y procesamiento de los datos, para evitar errores adicionales que afecten los estudios y mapas que incrementen la incertidumbre y el riesgo en la toma de decisiones.

- Mecanismos y fortalecimiento institucional (1.sector ambiental -Ministerio, IDEAM, Corporaciones Ambientales-, 2. energético -ministerio entidades adscritas- e 3. industrial -Instituto Nacional de Metrología, encargado de los patrones y medidas-)

- Servicios de capacitación y certificación de calidad, así como cumplimento de estandades en instrumentos y procesos de toma y procesamiento de datos.

- Bases históricas y pronósticos mas confiables a diferentes plazos (horas, días, meses, años...) así como estudios de impactos del el cambio climático sobre los recursos energéticos renovables.

WEATHER CLIMATE WATER

Gracias

WORLD
METEOROLOGICAL
ORGANIZATION

Wind farm development

PROSPECTING | PRE-CONSTRUCTION | POST-CONSTRUCTION | END OF LIFETIME

Climate projections

Climate predictions

Weather forecasts

Site selection

Wind turbine manufacturers

Wind farm developers

Wind farm constructors

Operation and energy generation

Maintenance and repairs

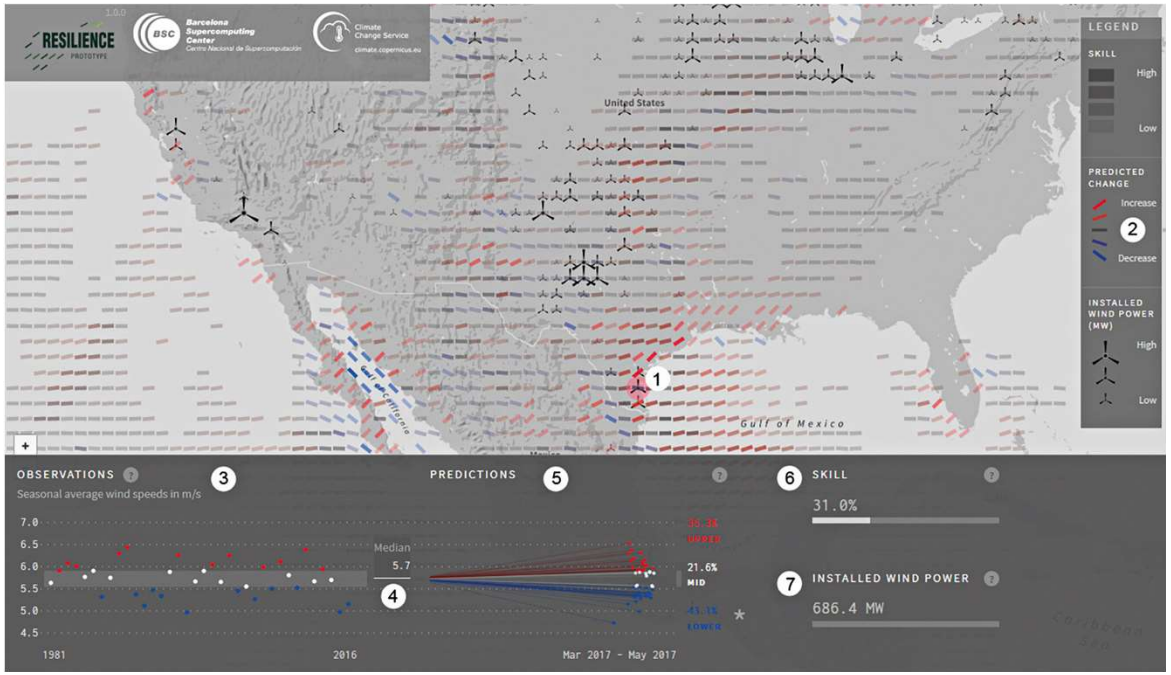
Wind farm decommissioning

Investors
Consultants

Energy traders and producers

Wind farm operators

http://www.bsc.es/ess/resilience/

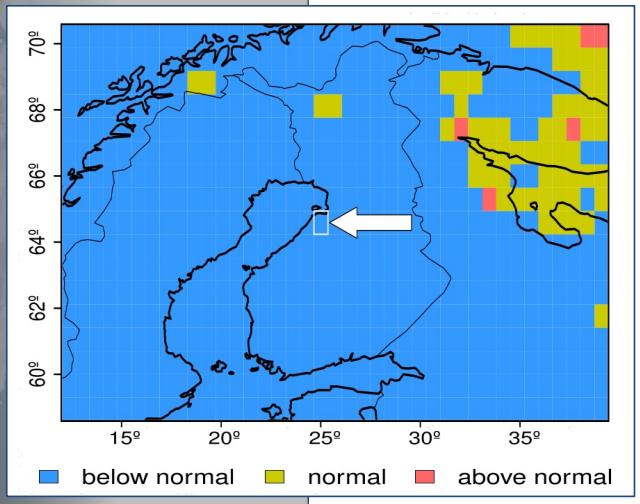


WIND POWER – SEASONAL FORECASTS

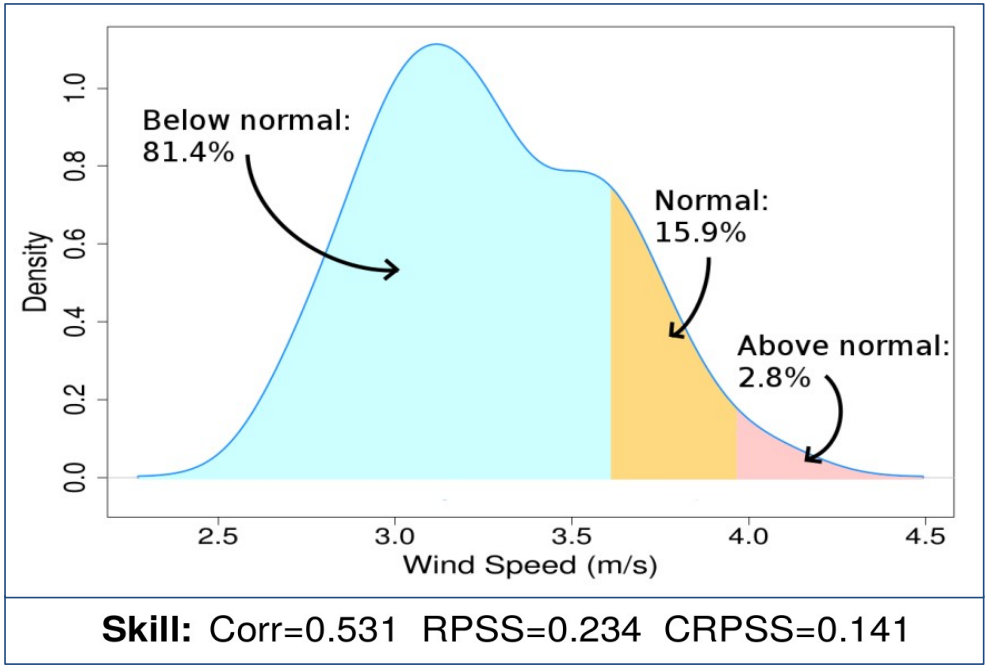
SEASONAL FORECASTS:

- average wind conditions
- for the next season
- delivered one month in advance
- probabilistic forecast

Observed tercile for DJF 2009/2010
Source: ERA-Interim



Wind speed forecast for Finland (64.5N 25.0E)
Average expected conditions for DJF 2009/2010
Issued: 1st November 2009
Source: ECMWF System4



Skill: Corr=0.531 RPSS=0.234 CRPSS=0.141

Co-designer: EDPR

Copernicus Europe's eyes on Earth
European Commission

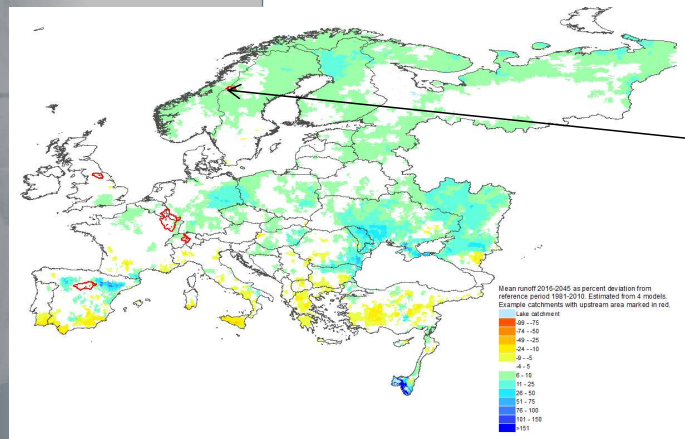
H Y D R O P O W E R

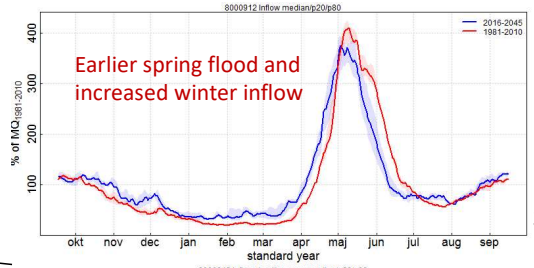
What is the potential for future hydropower poduction in Europe?

Climate change will lead to a change in river flow, which affects hydropower production.

Hydropower producers need price forecasts of very long time range as a base for investments and long term company strategy.

Overview: Change in mean inflow in relation to reference period.
2016-2045 versus 1981-2010

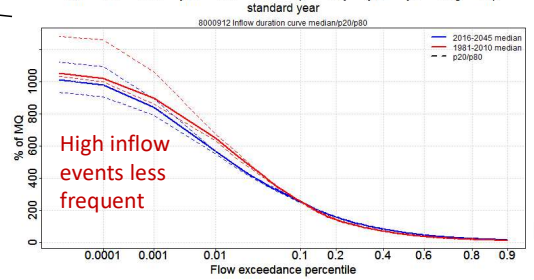




2016-2045
1981-2010

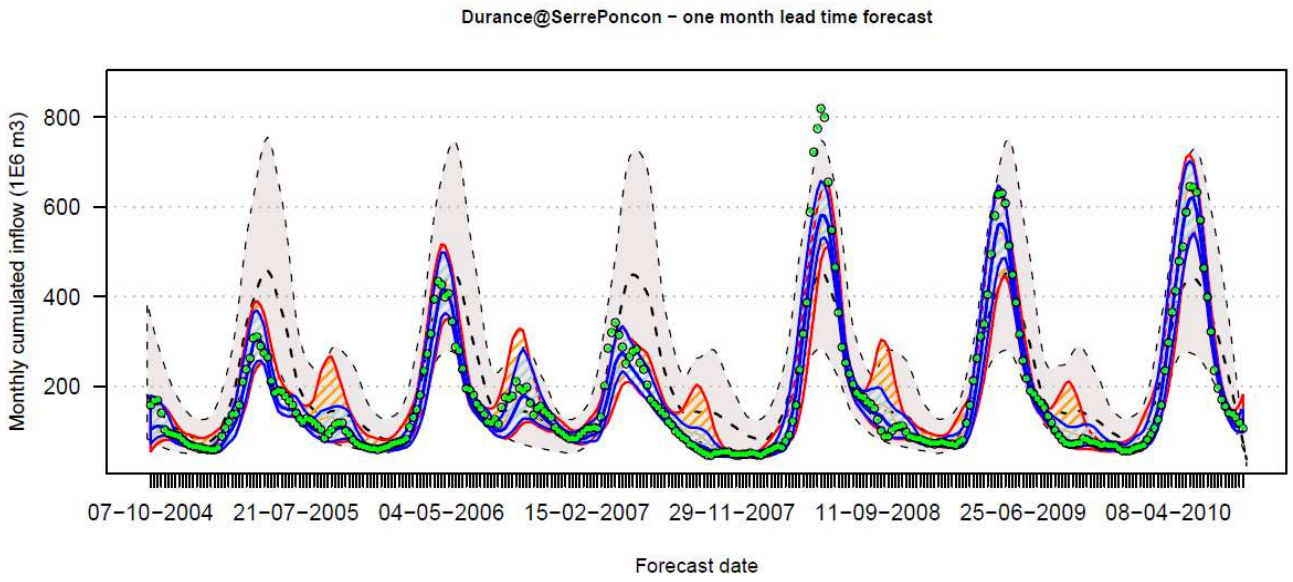
Mean and 20th and 80th percentile of four models

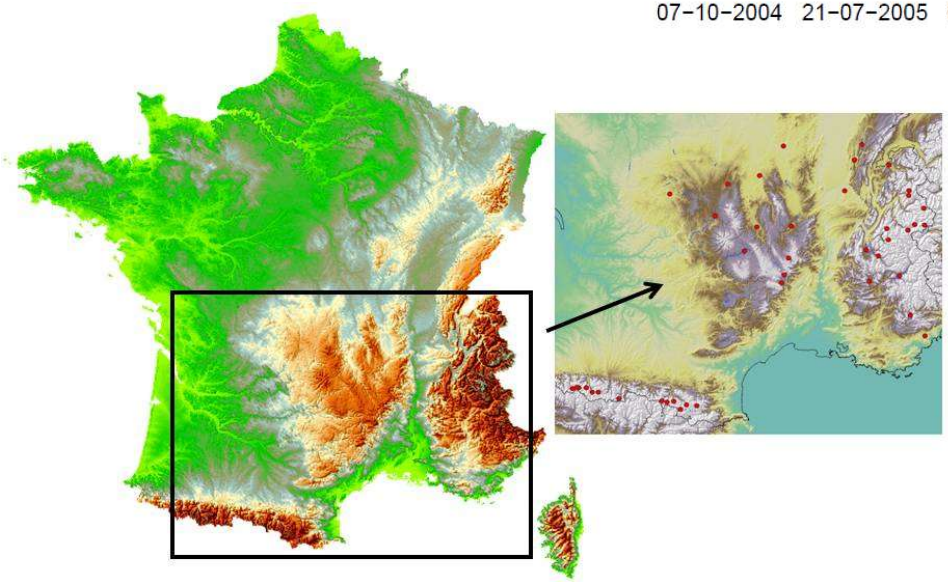
Seasonal distribution



Duration curve

Time series





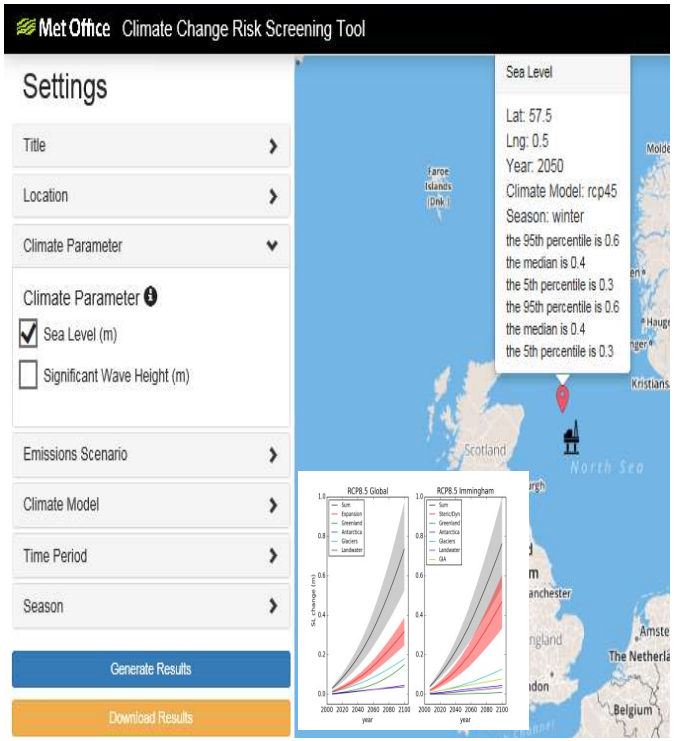
GFCS
GLOBAL FRAMEWORK FOR CLIMATE SERVICES

Dubus (2014)

OIL AND GAS OFFSHORE ASSETS

Service: to assist in evaluating risks

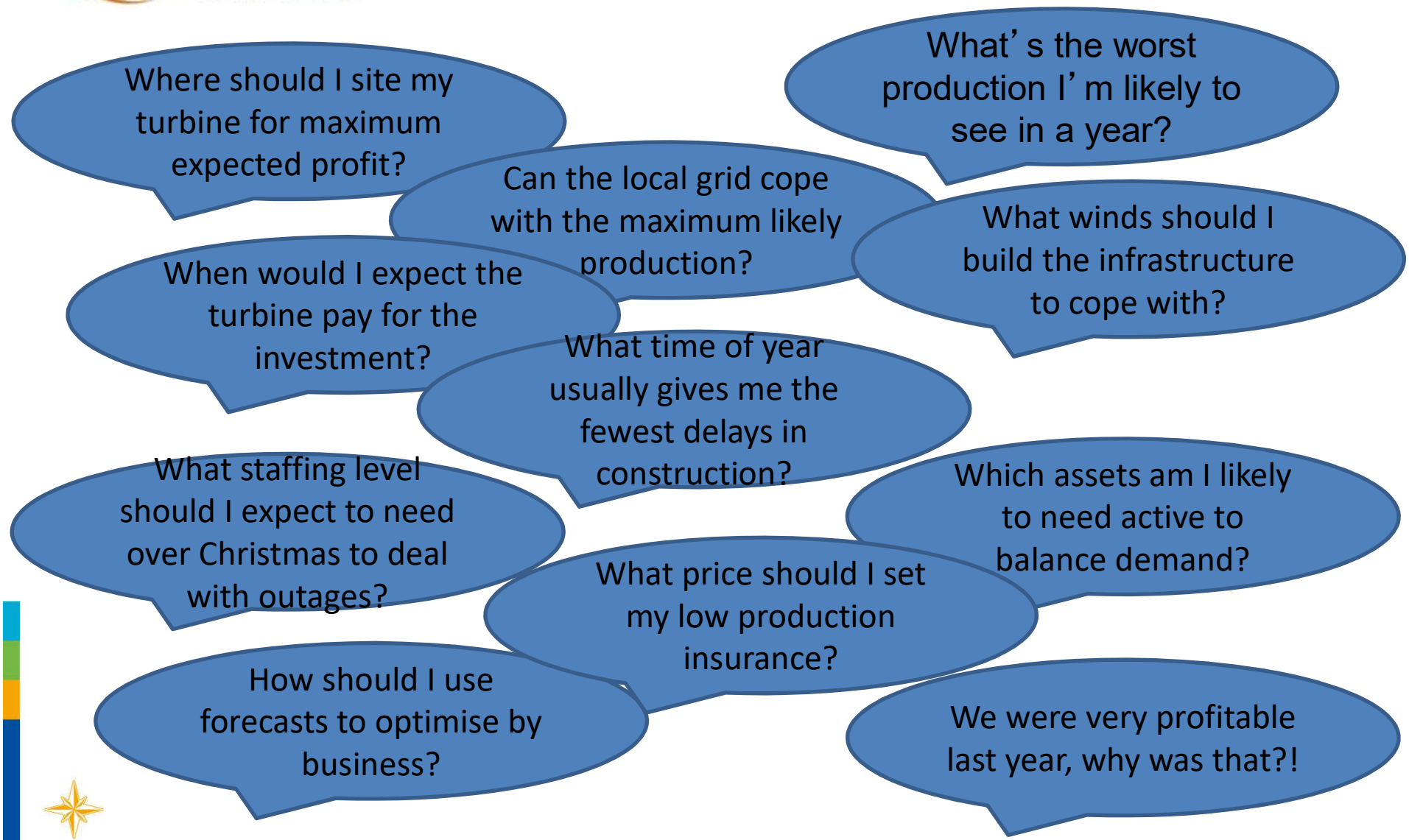
- Working together with **Shell and Total** to identify climate indicators which may impact their operations in the **North-West European shelf**
- Provision to the C3S demonstrator of **waves** and **sea level** products
- Development an internal user-friendly web enabled tool to allow user interaction with data and plots
- Demonstrating how the tool can support key climate adaptation decisions



Copernicus Europe's eyes on Earth

European Commission

Do we have the answer?



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GLOBAL FRAMEWORK FOR CLIMATE SERVICES

There are no answers, only choices

Stanislaw Lem/Steven Soderbergh (Solaris)