

Ingredients of climate services for the energy sector, and beyond

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2nd CLARA Multi-User Forum Workshop



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- *The Impetus*: the intimate relationship between Meteorology and Energy
- *The Appetiser*: (Co-)Developing a Climate Service prototype for the Energy Sector
- Towards the *Full Monty*: Climate Services for decision making in the Energy Sector

Caveat: no mention of Climate Service definition nor that 'Climate Services' precede their definition

The World Energy & Meteorology Council (WEMC)

WEMC primary goal is to enable

**Sustainable
energy**

For a low carbon
economy



**improved:
Resilience**

Of energy
infrastructures



Efficiency

Of energy
systems



Under ever changing weather and climate

WEMC is (akin to) a professional association but ...
its membership is free of charge!

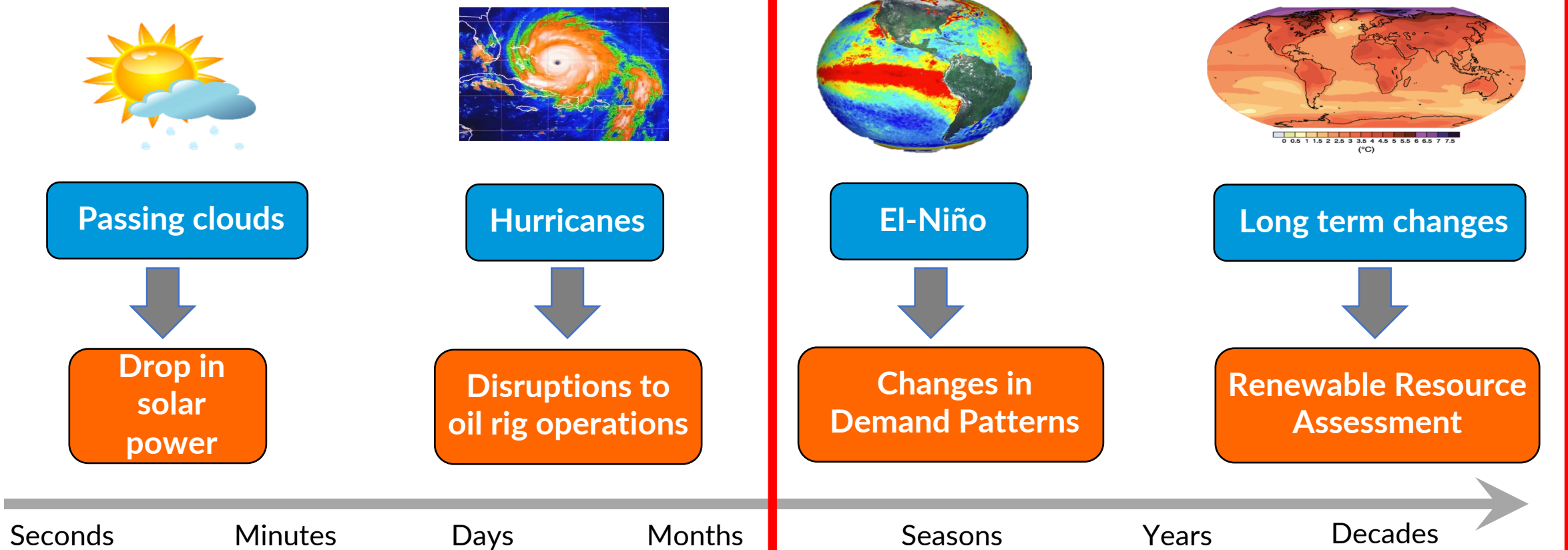
1. The **dissemination of information** on products, practices, and experiences in Energy & Meteorology including the promotion of our members' work
2. The **coordination of Special Interest Groups** leading to the production of reports, analyses and syntheses on key topics in Energy & Meteorology
3. The development and maintenance of **climate and energy demonstration tools** for the energy industry and the education of the general public
4. The **organisation of events** such as the International Conference Energy & Meteorology (ICEM), professional workshops, seminars and webinars



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The Impetus

Energy and meteorology go hand in hand



Energy Decisions & Meteorological Forecasts

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Paul Langrock



Klaus Rockenbauer

Operations



**'Weather'
Forecast (hours-
days ahead)**

**Maintenanc
e**



**Monthly
forecasts (weeks
ahead)**

Management



**Seasonal Climate
Forecasts**

**Investment/Plannin
g**



Climate projections

Seconds

Minutes

Days

Weeks

Months

Seasons

Years

Decades

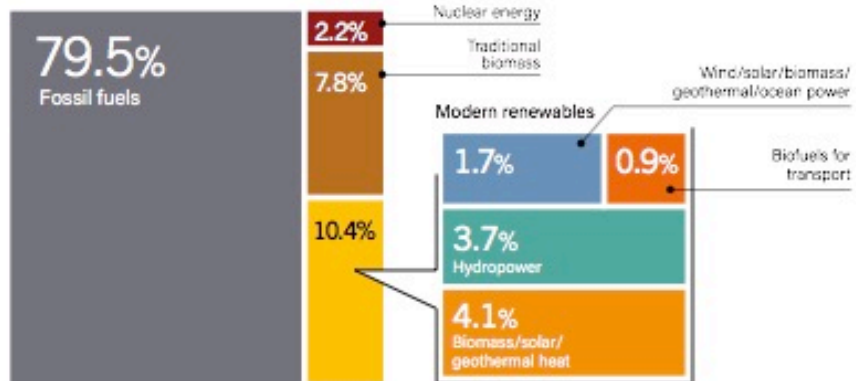


Strong growth in renewables

- 14

GSR 2018 KEY FIGURES

ESTIMATED RENEWABLE ENERGY SHARE OF TOTAL FINAL ENERGY CONSUMPTION, 2016



ESTIMATED RENEWABLE ENERGY SHARE OF TOTAL GLOBAL ELECTRICITY PRODUCTION, END-2017

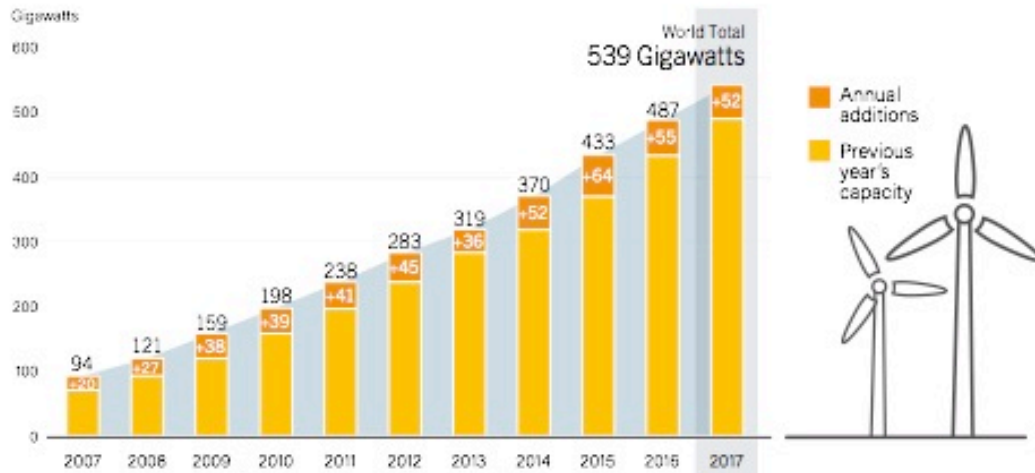


REN21 (2018)

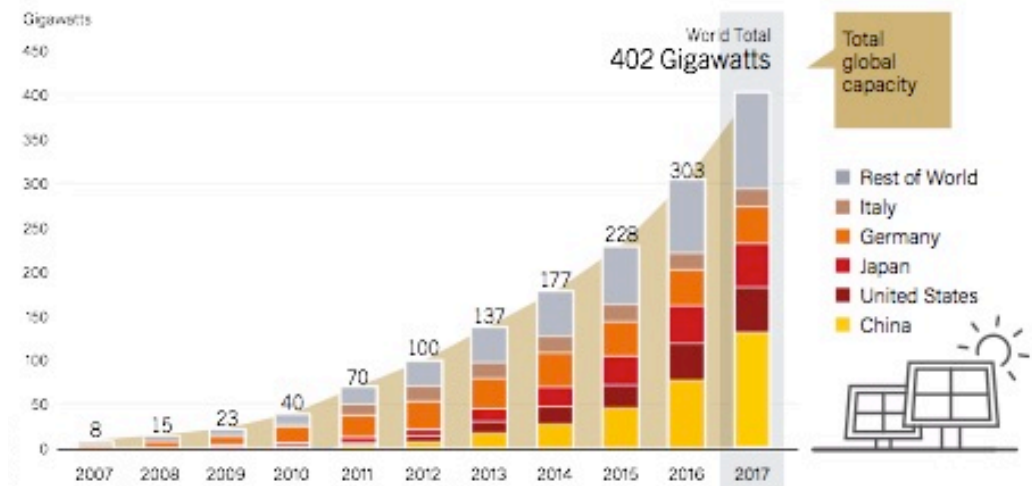
Impressive growth in Wind and Solar

- 14

WIND POWER GLOBAL CAPACITY AND ANNUAL ADDITIONS, 2007-2017



SOLAR PV GLOBAL CAPACITY, BY COUNTRY OR REGION, 2007-2017



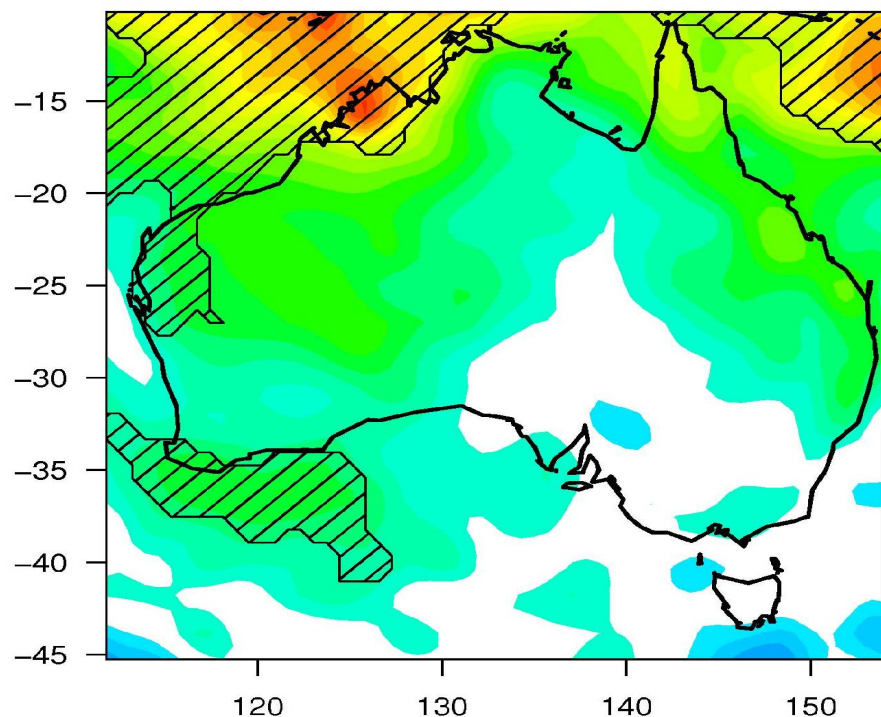
REN21 (2018)

Solar Radiation Inter-annual Variability

-14

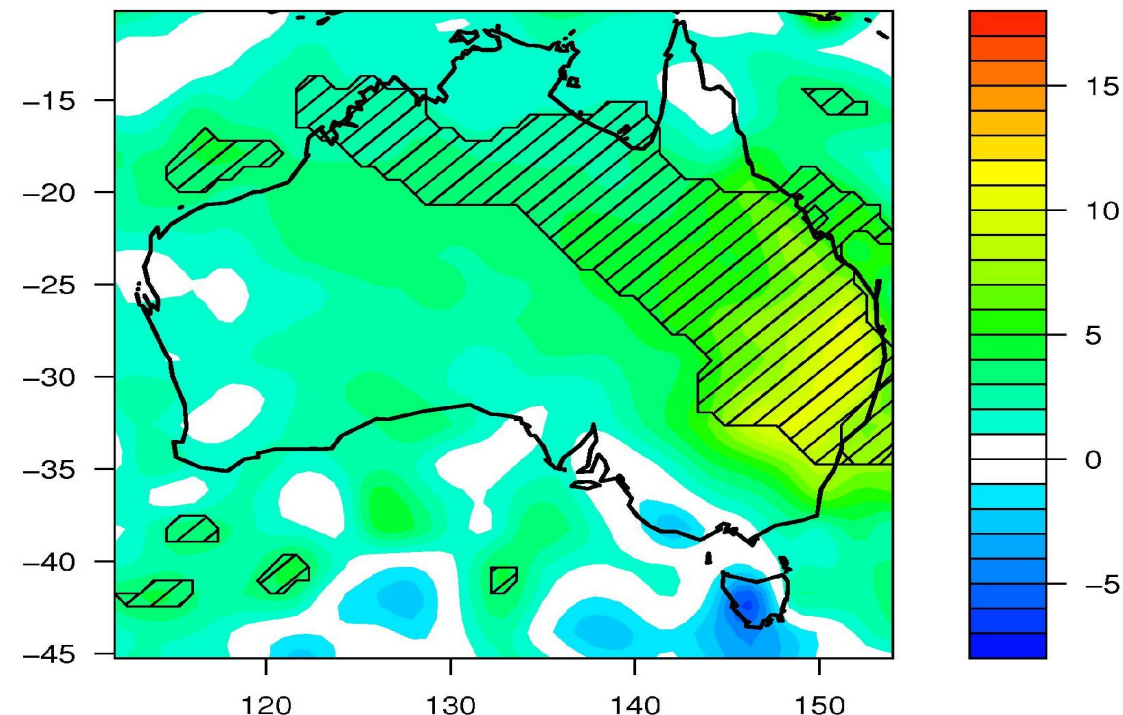
Winter (JJAS)

percent



Summer (DJFM)

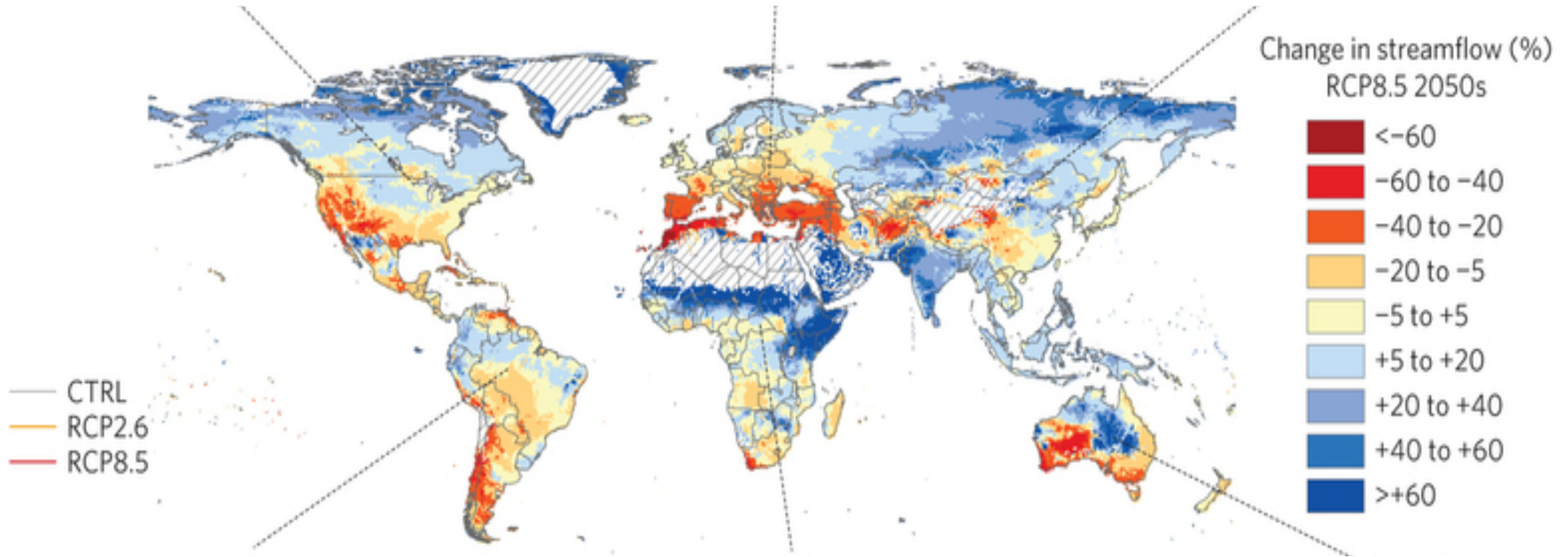
percent



Percentage difference in monthly solar radiation in El Niño relative to La Niña

Global changes in streamflow projections

- 14

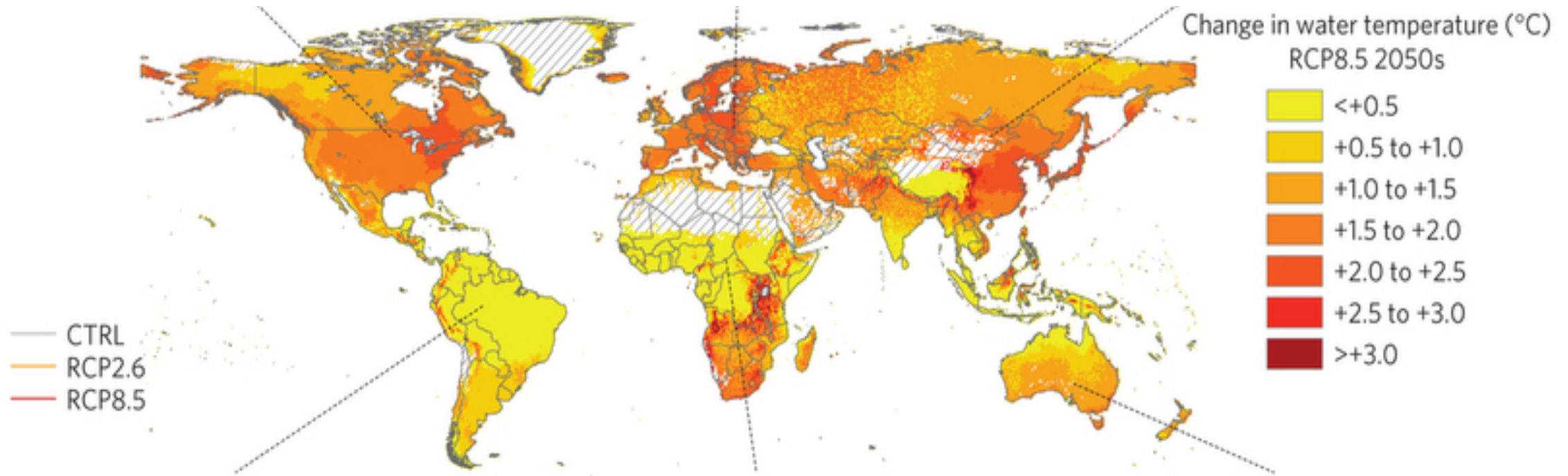


Change in streamflow for RCP8.5, 2040–2069 (2050s)
vs 1971–2000

Reductions in usable capacity for 61–74% of the hydropower plants
van Vliet et al. (2016)

Global changes in water temperature projections

- 14



Change in water temperature for RCP8.5, 2040–2069 (2050s) vs
1971–2000

Reductions in usable capacity for 81–86% of the thermoelectric power
plants



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The background of the slide is a satellite image of a hurricane, likely Hurricane Irma, as it approaches the Caribbean. The hurricane's eye is clearly visible in the lower-left quadrant of the image. The swirling cloud bands are a mix of white and grey, contrasting with the dark blue of the ocean. The coastline of South America is visible on the right side of the frame.

The *Appetiser*

The Copernicus Climate Change Services (C3S) European Climatic Energy Mixes (ECEM) developed a **demonstrator** to assess how well **different energy supply mixes** in Europe will meet demand, over different time horizons, focusing on the role climate has on the mixes.

Calibrated Climate Variables

River
Discharge

Temperature

Rainfall

Wind
Speed

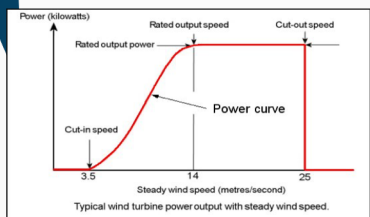
Solar
Radiation

Cloud
Cover

Others
?

+Ancillary

Define models & transfer functions
Select / Gather relevant datasets



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Energy Variables

Hydro
Power

Demand

Wind
Power

Solar
Power

Thermal
Power

- Skill & Reliability
- Assessment of Seasonal Forecasts of Energy Variables

+ Extreme Events Case Studies



- Sub-Country Scale
- Historical Period
- Seas. Fcst
- Clim. Proj.

Countries Clusters

Time Period Historical

Variables Climate ?

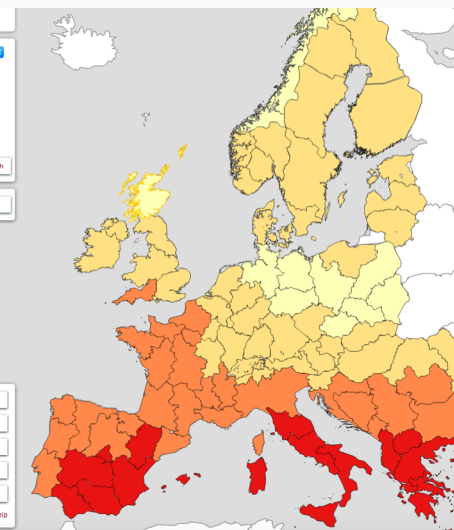
Surface Solar Radia

Temporal Resolution 1 month

Cluster 94 United Kingdom

New graph Refresh graph Add to graph

Labels On Close Graphs Reset Map



Using the demonstrator

Methods & assumptions

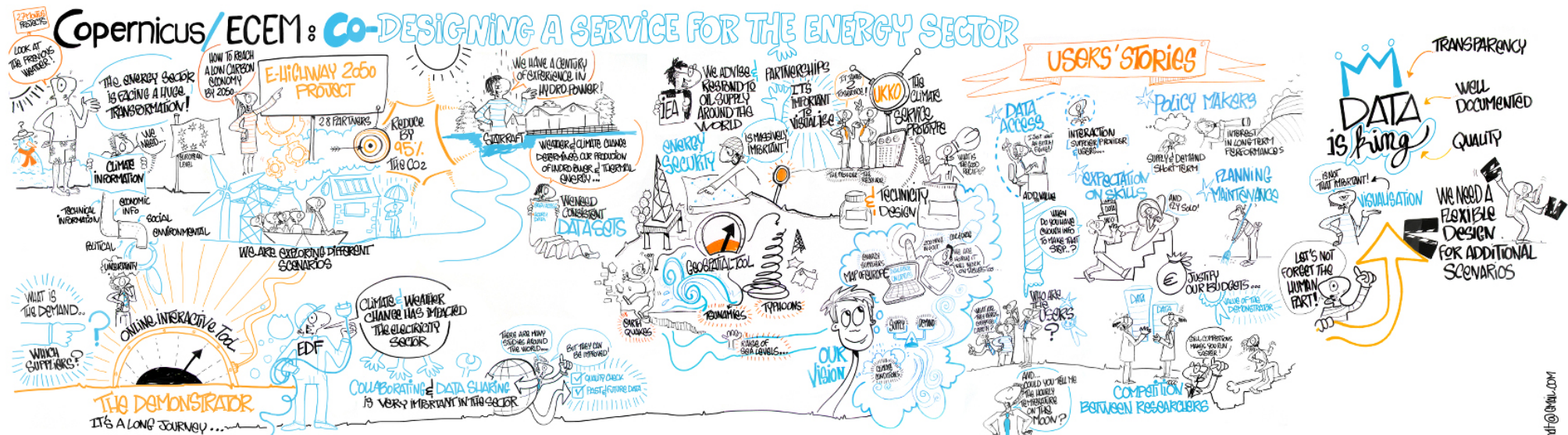
Key messages

Case studies

About Cookies

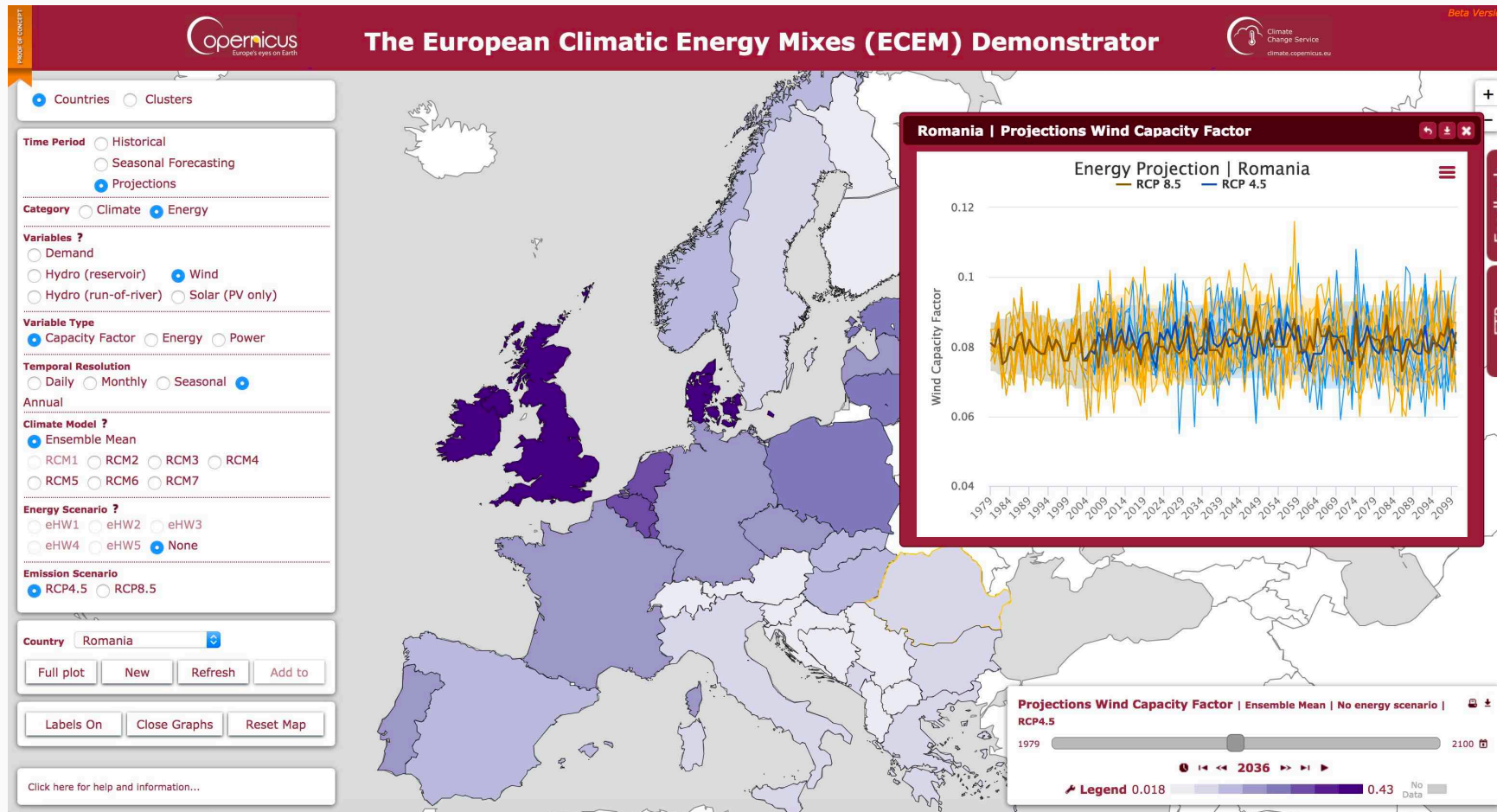
Hide Help

Stakeholder Engagement: Workshops



WE
World
Metec

An online interactive tool to test energy mixes



https://www.youtube.com/watch?v=U-w5_sTHqG4

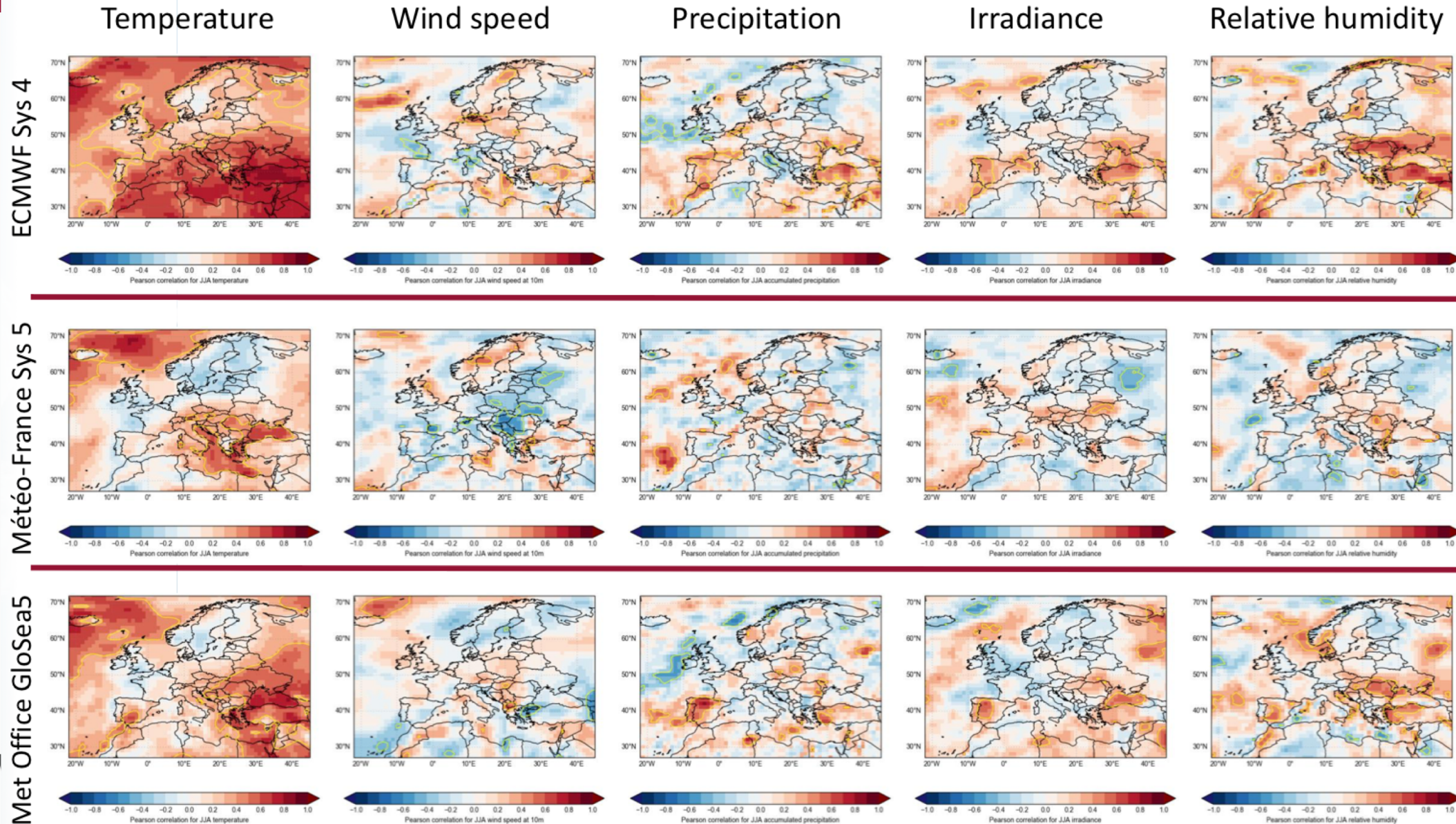
<http://ecem.wemcouncil.org>

Seasonal Forecasting systems used in C3S ECEM

Originator	Forecast System	Model	Spatial resolution	Hindcast period	Hindcast ensemble size	Forecast ensemble size
ECMWF	System 4	IFS Cyc36r4	T255 L91 (~ 80 km)	1981–2010 (30 years)	51	51
Météo-France	System 5	Arpege-IFS Cyc37	T255 L91 (~ 80 km)	1993–2014 (22 years)	15	51
Met Office	GloSea5-GC2	HadGEM3-GC2	N216 L85 (~ 60 km)	1993–2015 (23 years)	28	42

Bett et al (2017)

Seasonal forecasting skill: correlations for summer



Bett et al (2017)



ECMWF

European
Commission

Seasonal forecast: summary table skill for Summer

Country		Met Office					ECMWF					Météo-France				
Code	Name	WS	TA	RH	TP	GHI	WS	TA	RH	TP	GHI	WS	TA	RH	TP	GHI
AL	Albania	---	---	---	---	---	---	C--	---	---	---	---	---	---	---	---
AT	Austria	---	---	---	---	---	---	--R	---	---	---	---	C--	---	---	---
BE	Belgium	---	---	---	---	---	---	---	---	C--	---	---	---	---	---	---
BA	Bosnia-Herzegovina	---	C--	---	---	---	---	C--	---	---	---	---	---	---	---	---
BG	Bulgaria	---	C--	---	---	---	---	C-R	C-R	---	---	---	C-R	---	---	---
HR	Croatia	---	C--	C--	---	---	---	C-R	---	---	---	---	---	---	---	---
CZ	Czechia	---	---	---	--R	---	---	---	---	---	---	---	---	---	---	---
DK	Denmark	C-R	---	C-R	---	---	---	---	---	---	---	---	---	---	---	---
EE	Estonia	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
FI	Finland	---	---	---	---	---	---	C--	---	---	---	---	---	---	---	---
FR	France	---	---	---	---	---	---	C-R	---	---	---	---	---	---	---	---
DE	Germany	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
GR	Greece	---	C--	---	---	---	---	C-R	---	---	---	---	---	---	---	---
HU	Hungary	---	C--	C--	---	---	---	C-R	CBR	---	---	---	C--	---	---	---
IE	Ireland	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
IT	Italy	---	---	---	---	---	---	C-R	---	---	---	---	---	---	---	---
LV	Latvia	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LT	Lithuania	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
LU	Luxembourg	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
MK	Macedonia	---	---	---	---	---	---	C--	---	---	---	---	---	---	---	---
ME	Montenegro	---	C--	---	---	---	---	C--	---	---	---	---	C--	---	---	---
NL	Netherlands	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
NO	Norway	---	---	---	---	---	---	--R	---	---	---	---	---	---	---	---
PL	Poland	---	---	---	---	---	--R	---	---	---	---	---	---	---	---	---
PT	Portugal	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
RO	Romania	---	CBR	C--	---	---	---	CBR	C-R	---	---	---	C-R	---	---	---
RS	Serbia	---	C--	---	---	---	---	C--	---	---	---	---	---	---	---	---
SK	Slovakia	---	C--	---	---	---	---	--R	C-R	---	---	---	C--	---	---	---
SI	Slovenia	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
ES	Spain	---	---	---	C--	---	---	CBR	C-R	---	---	---	---	---	---	---
SE	Sweden	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
CH	Switzerland	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
UK	United Kingdom	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

skill:

Where a skill score is significantly greater than zero, it is marked with a **C** (correlation), **B** (Brier skill score) or **R** (ROC skill score).

Colours: 1 score, 2 scores, 3 scores

Skill is diverse across models, variables and seasons.

Having more significant skill scores can add confidence, but the behaviour of the models should be examined in detail for each use case.

Bett et al (2017)



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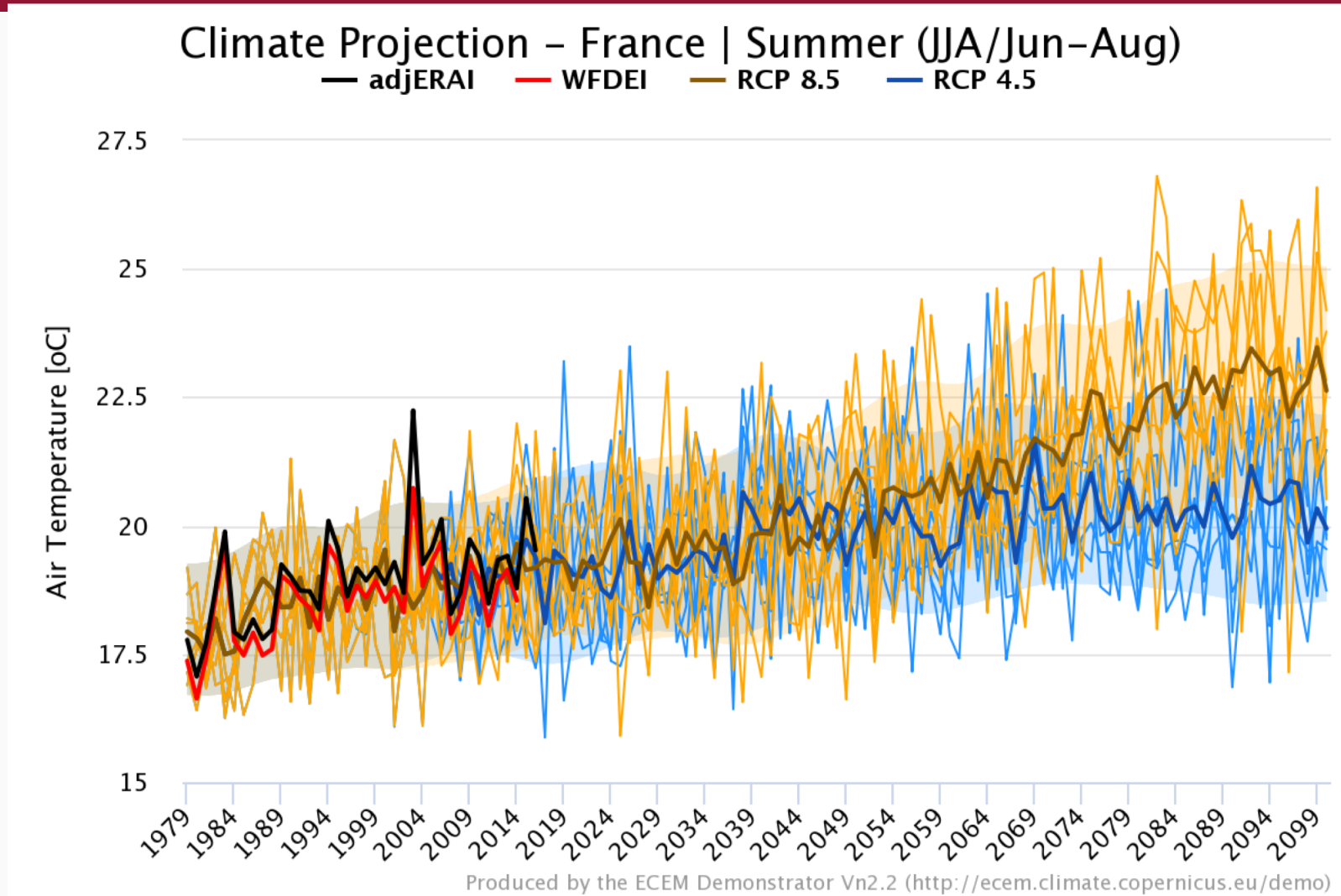


University of
Reading



European
Commission

Climate Projection time series – Temperature



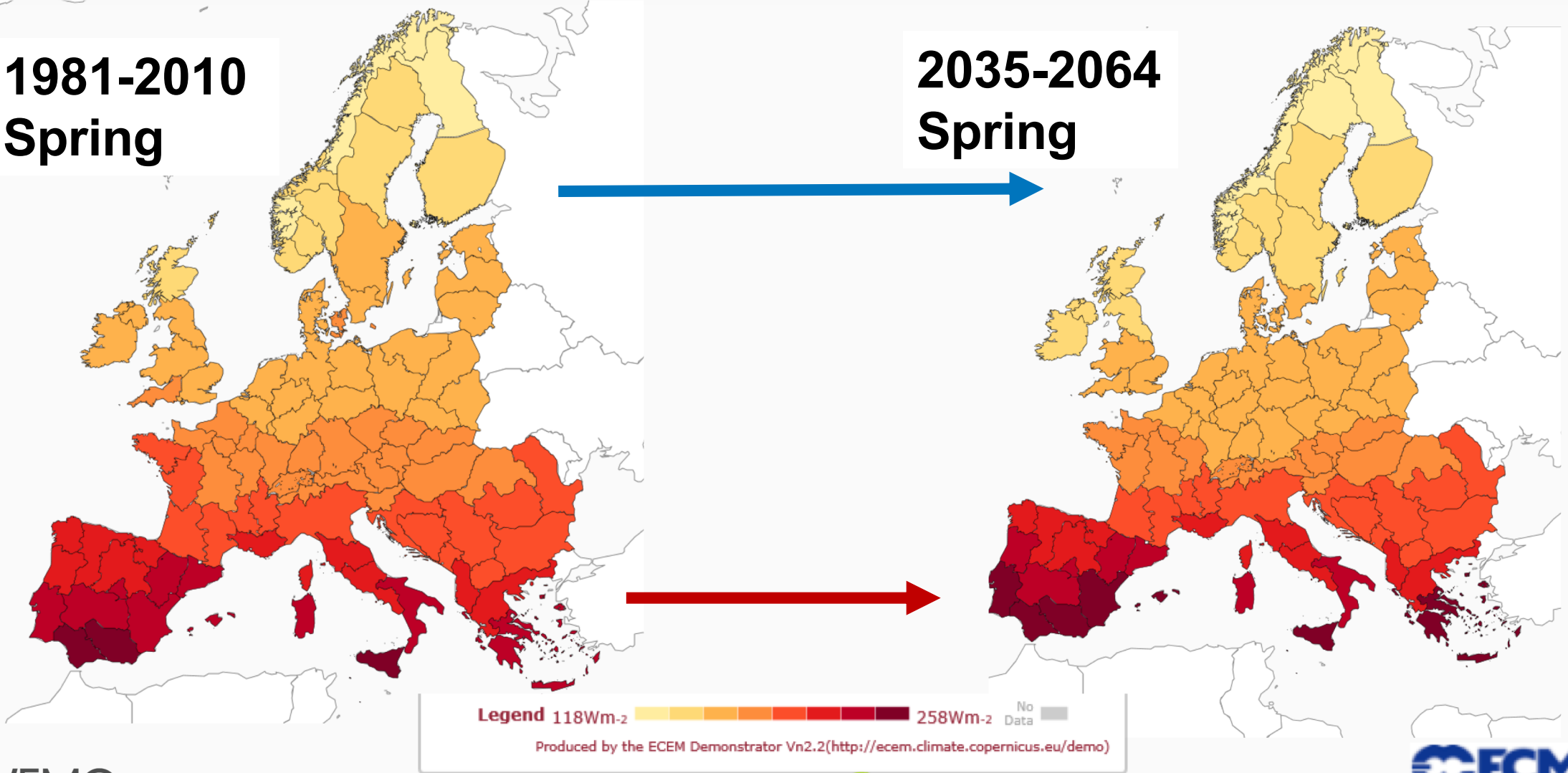
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Climate Projection (RCP 8.5) Radiation

**1981-2010
Spring**

**2035-2064
Spring**



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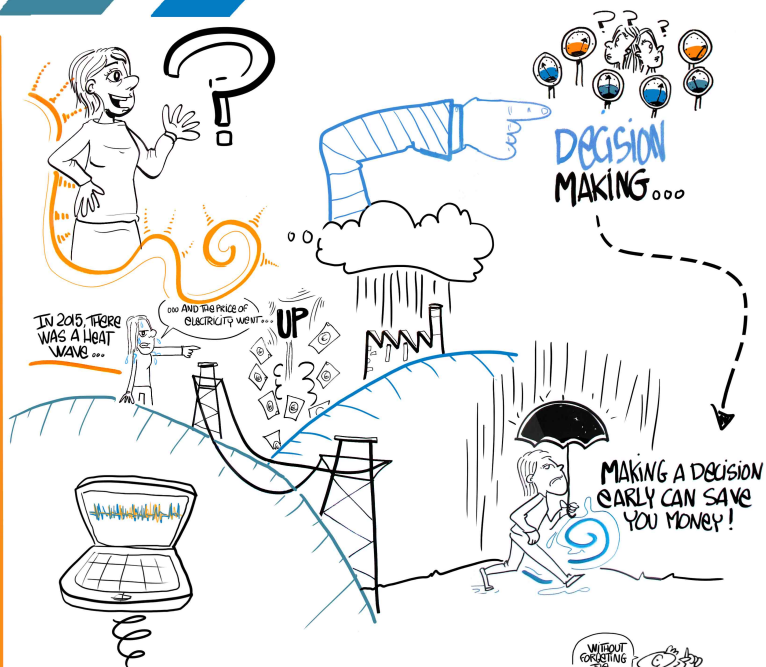
A satellite image of a large hurricane swirling over the Atlantic Ocean. A black rectangular box is centered over the hurricane, containing the title text in blue. The text 'Towards the' is in a standard blue font, while 'Full Monty' is in a larger, italicized blue font.

Towards the *Full Monty*



How can seasonal climate forecasts help your business?

The Why

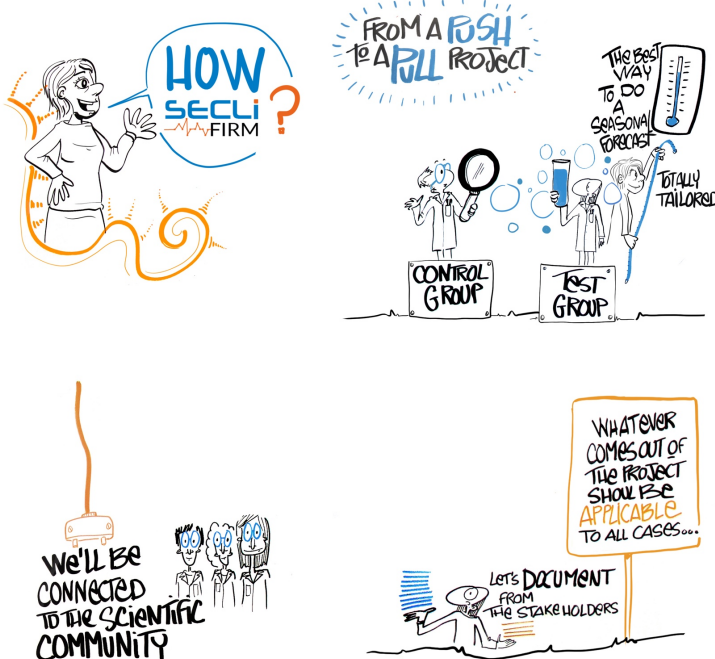


Let's keep the focus on the **SEASONAL**

WWW.SECLI-FIRM.EU

SECLI
FIRM

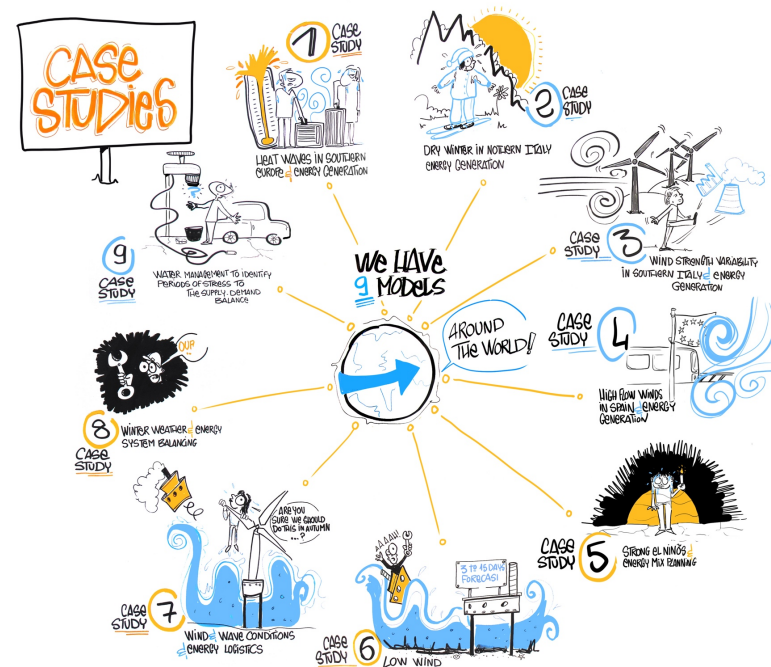
The How



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FIRM

The What

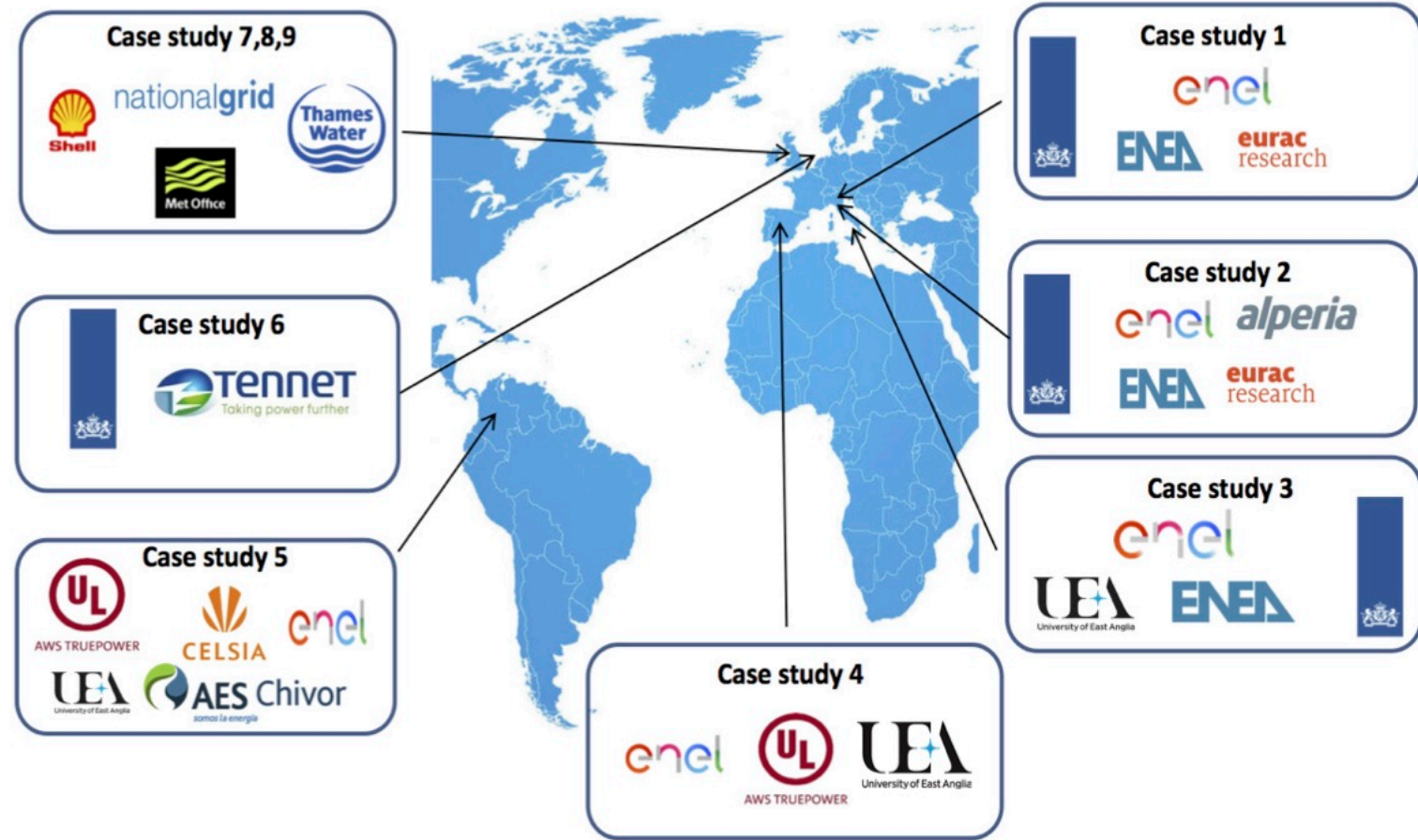


WWW.SECLI-FIRM.EU

SECLI
FIRM

Nine cases for Europe and S. America will be investigated.

These represent recent seasons with anomalous climate conditions leading to problematic and quantifiable impacts for the energy and/or water industry. They will be co-designed by industrial and research partners

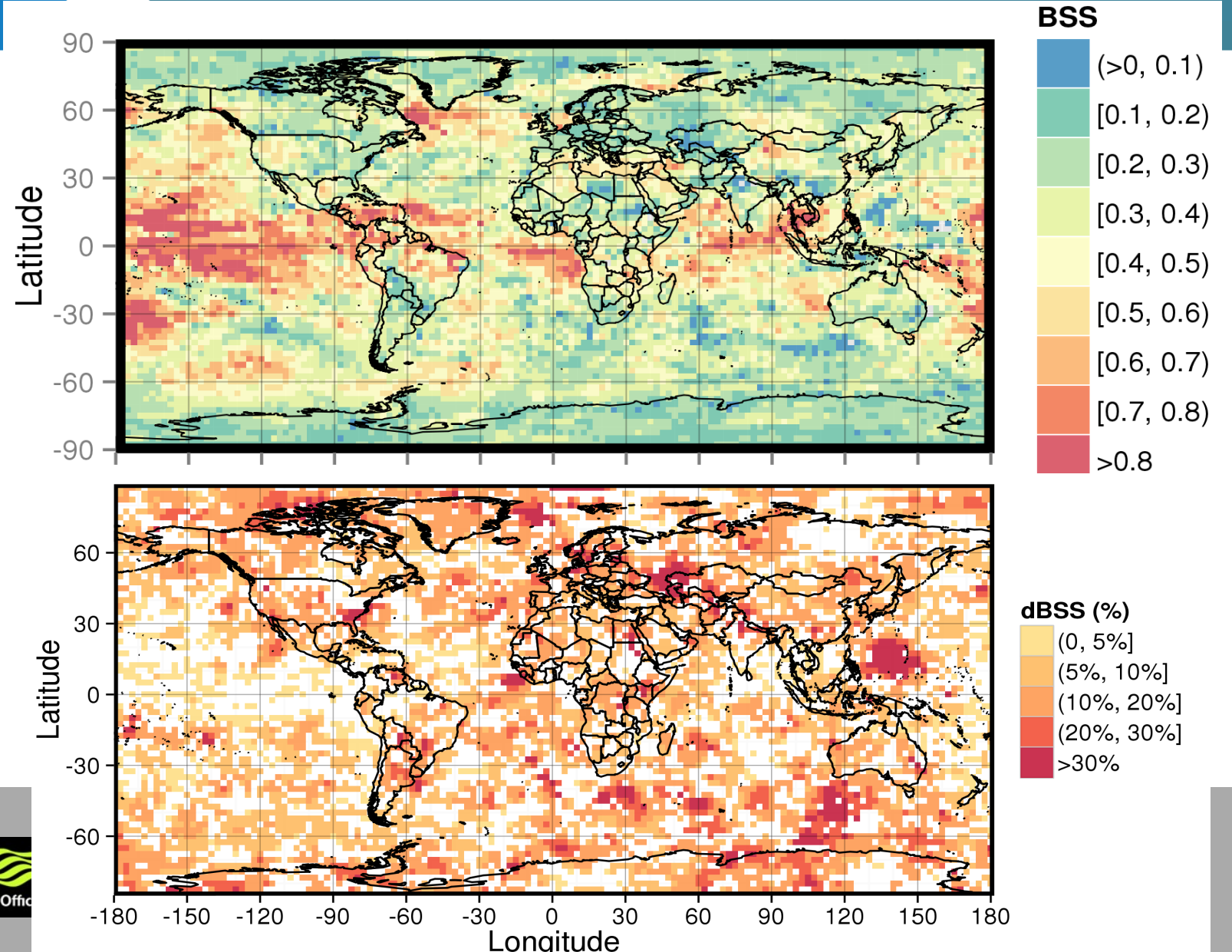


The 'power' of the multi-model

Max [Grand MME]

Max [Grand MME] minus
Max [ENSEMBLES or
CliPAS/APCC] JJA

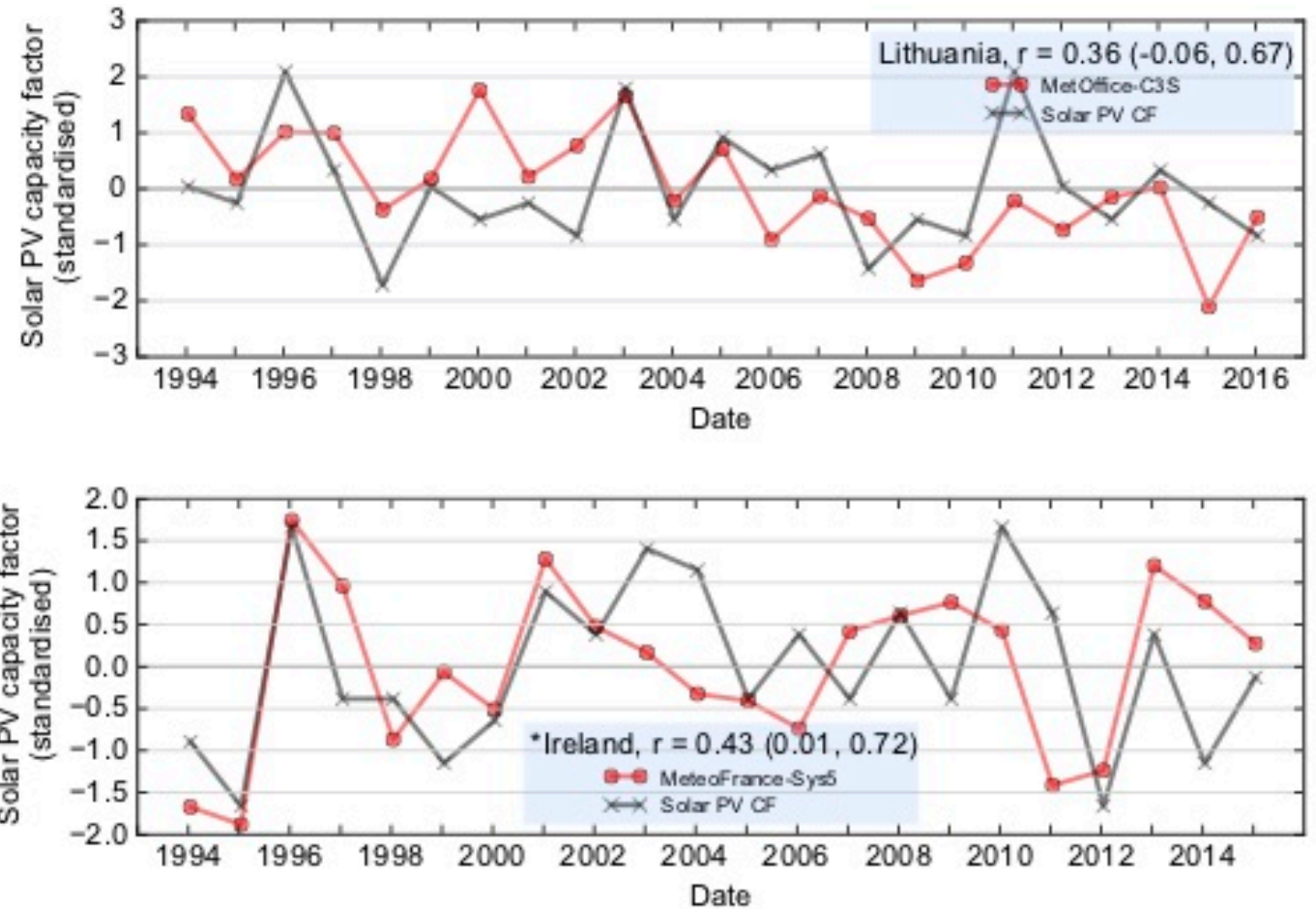
Alessandri et al., 2017



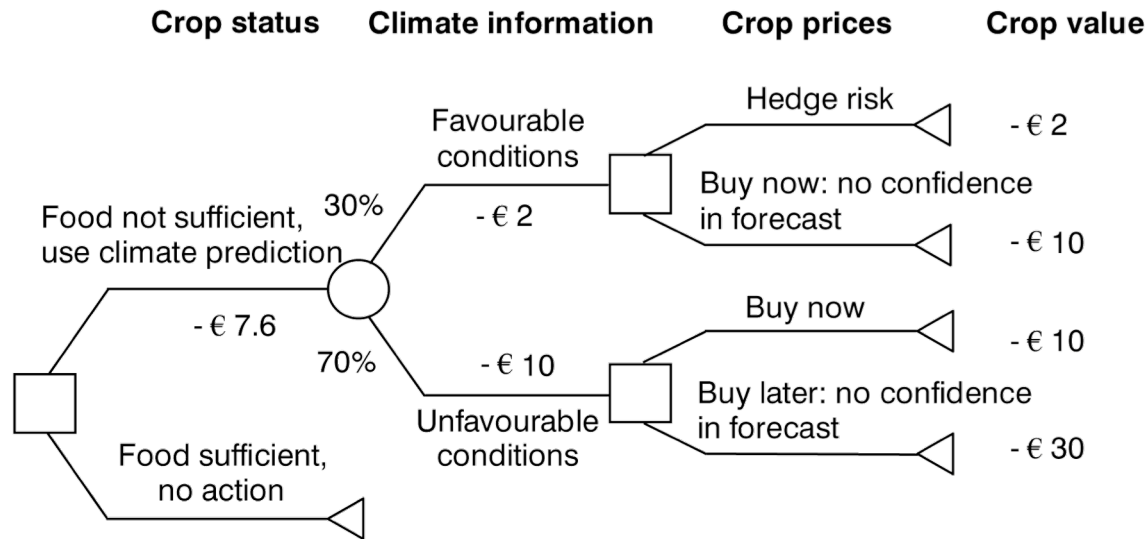
Beyond the simple long term statistics

Standardised forecasts of solar PV capacity factor for DJF, using Met Office (top, Lithuania) and Météo-France (bottom, Ireland) SF systems.

Bett et al (2017)

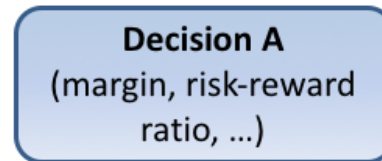
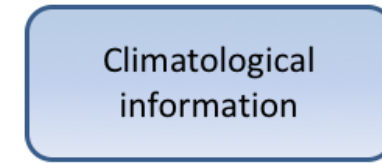


Decision Theory (and Trees), Avoided Costs, Cost-benefit analyses

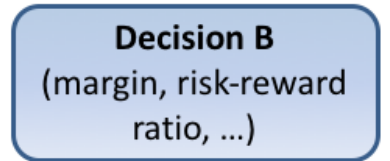
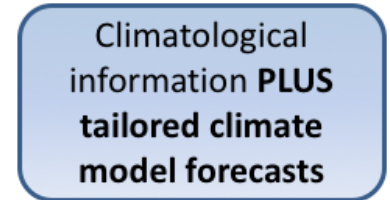


Harrison et al., 2007

Group A "control"



Group B "test"



Assessment of seasonal climate forecast value-add

Use of seasonal forecasts by the UK National Grid Operator



The objective is to illustrate the benefits of using seasonal forecast information to better predict the UK winter mean electricity demand and wind power



Focus: The use of seasonal forecasts by the UK National Grid Operator

Boosting decision making

- The main objective of this case study is to illustrate the benefits of using seasonal forecast information to better predict the UK winter mean electricity demand and wind power.

The seasonal forecasting context

- This case study focuses on demonstrating the impact of using seasonal temperature, wind and atmospheric circulation forecast information for the United Kingdom (UK) National Grid operator.
- The climate forecasts will be translated into energy information, to give a forecast of winter UK energy demand and wind power.

Sectoral challenges and opportunities

- The grid network has a central role to play in the future energy mix. In a fast-changing energy landscape, National Grid is working to meet ambitious low carbon energy targets, connect new sources of energy to the people who use them, and find innovative ways to enable the decarbonisation of heat and transport.
- Ahead of each winter, the UK grid operator must estimate the demand over the coming winter, with a particular focus on peak electricity demand. This is to ensure there is sufficient electricity supply available to meet this demand.
- By identifying potential risks to the system ahead of the winter, we will explore whether it is possible to reduce balancing costs over the winter period.

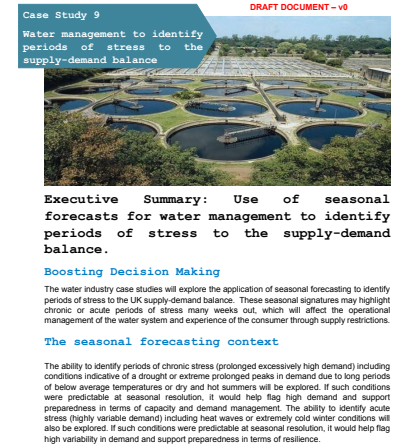
Use of seasonal forecasts for water management to identify periods of stress to the supply-demand balance

Case Study 9

Water management to identify periods of stress to the supply-demand balance



By targeting periods of stress to the UK supply-demand balance, we will assess the role of seasonal forecasts in the operational management of the water system and in the experience of the consumer through supply restrictions

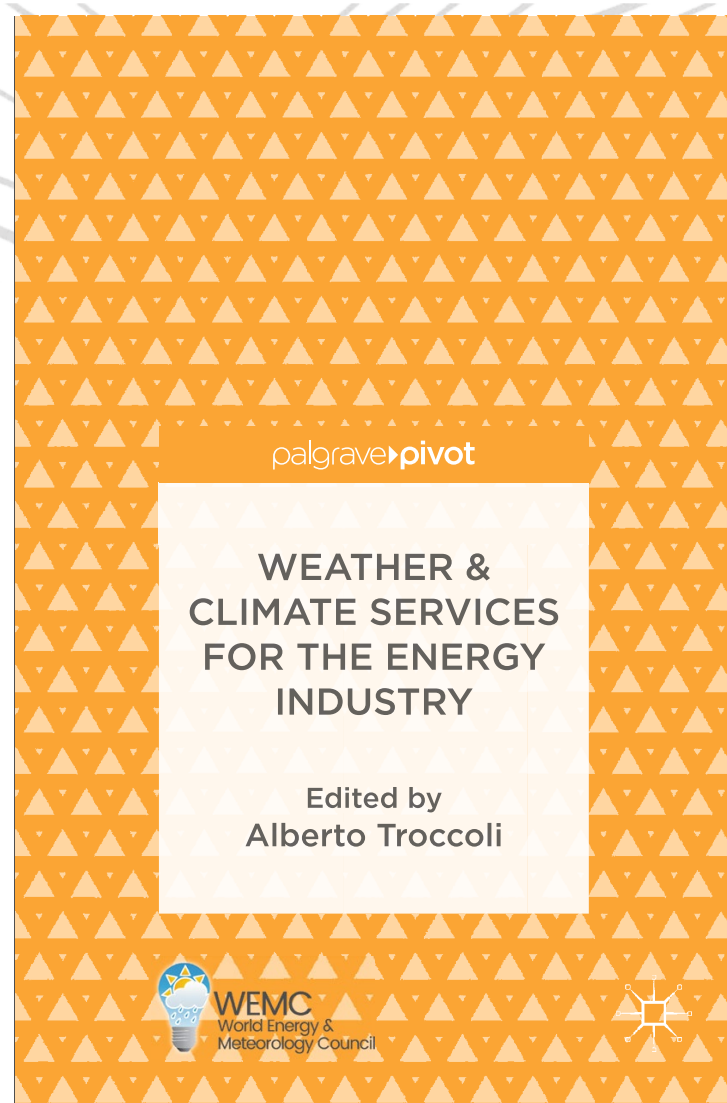




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To download it (it's free!), please visit:

<https://link.springer.com/book/10.1007%2F978-3-319-68418-5> or
<http://www.wemcouncil.org/wp/resources/>

SECLI
FIRM

Seasonal Climate Forecasts:
Latest Advances in their
Skill and Value Assessment

Milan - Italy 17.01.2019

STAKEHOLDER WORKSHOP

Join climate researchers and experts from the energy and water industries, to explore the ways seasonal climate forecast models can be assessed and combined to increase their value.

Collaborate with colleagues and help influence the next stage of our research.



The SECLI-FIRM project has received funding from the European Union's Horizon 2020 Research and Innovation Program under Grant Agreement 776868.

UEA
University of East Anglia

enel

ENEA

UL

AWS TRUEPOWER



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research



6th International Conference Energy & Meteorology

24-27 June 2019
Copenhagen, Denmark

<http://www.wemcouncil.org/wp/icem2019/>

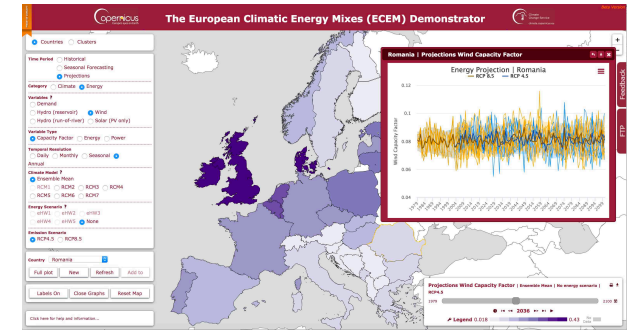
icem
2019

<http://www.secli-firm.eu/events>

Would like to learn more?

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<http://ecem.wemcouncil.org>



For SECLI-FIRM, please visit:
<http://www.secli-firm.eu/>



See also 'what's SECLI-FIRM' video.
https://www.youtube.com/watch?v=uYW_TptJJo0



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Thank You



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