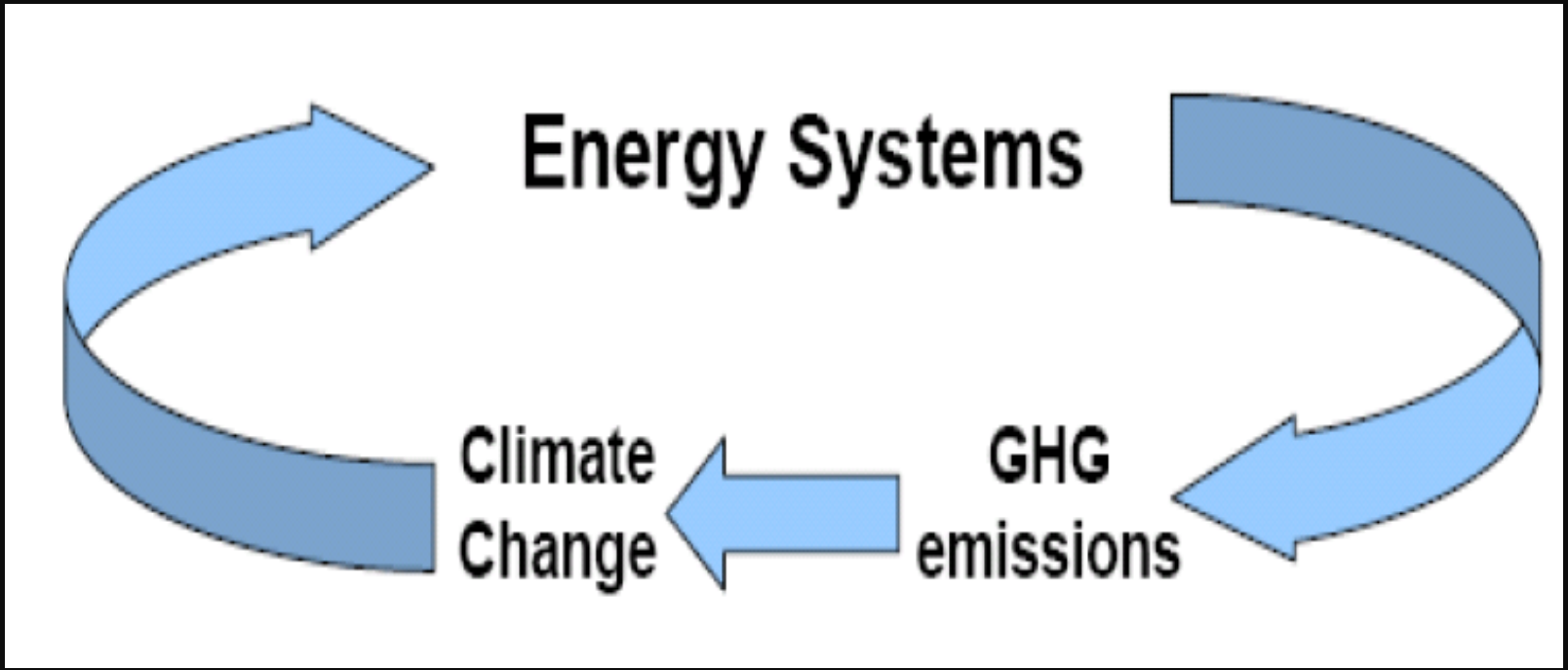
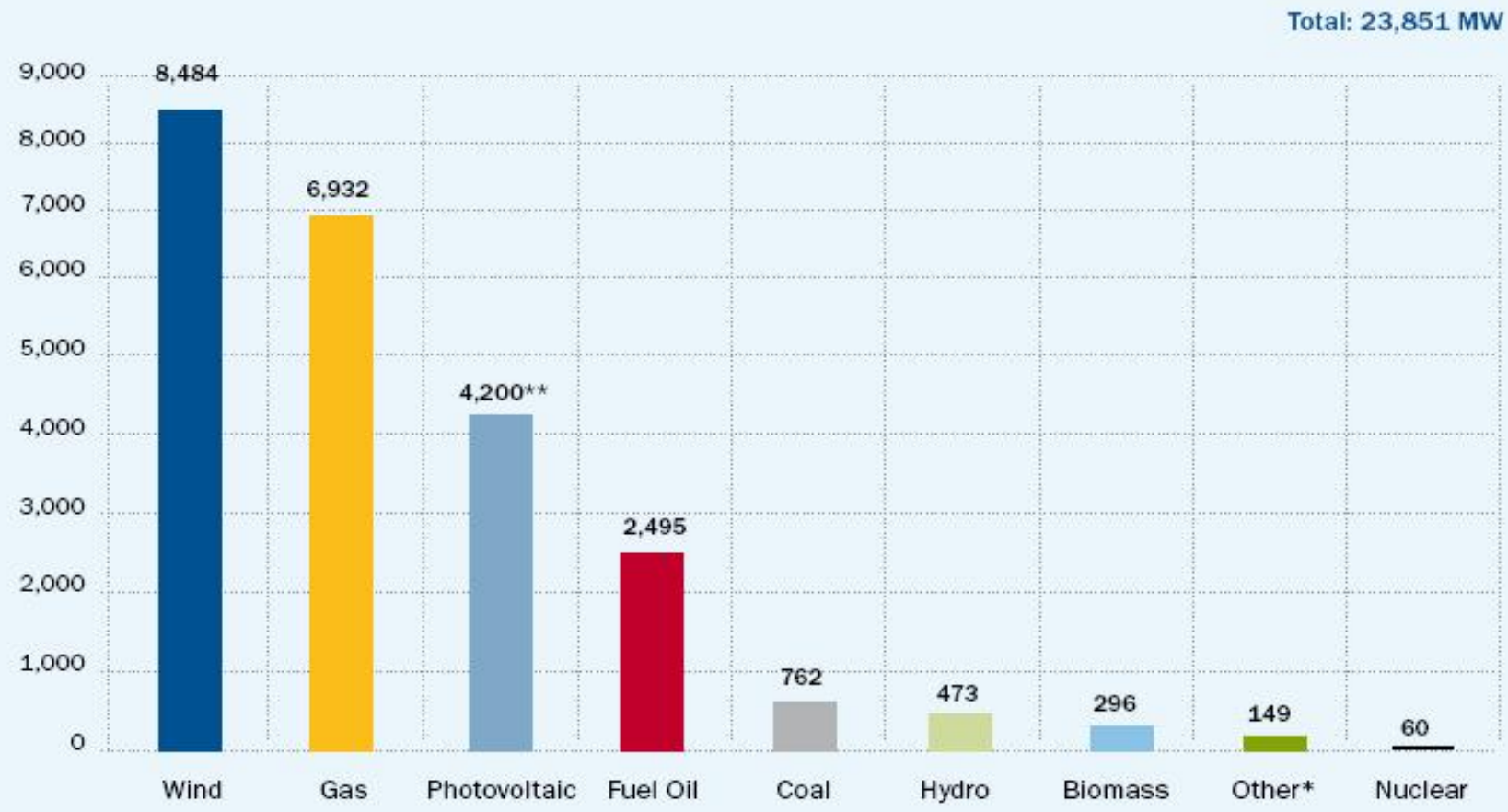
CLIM-RUN

Climate change impacts on energy generation from renewable energy sources

Robert Pasicko, UNDP


Energy Systems
Climate Change
GHG emissions

New instaled capacity in 2009



* Geothermal, peat and waste

** This is a preliminary figure for solar photovoltaic installations (source: European Photovoltaic Industry Association (EPIA).

Energy status

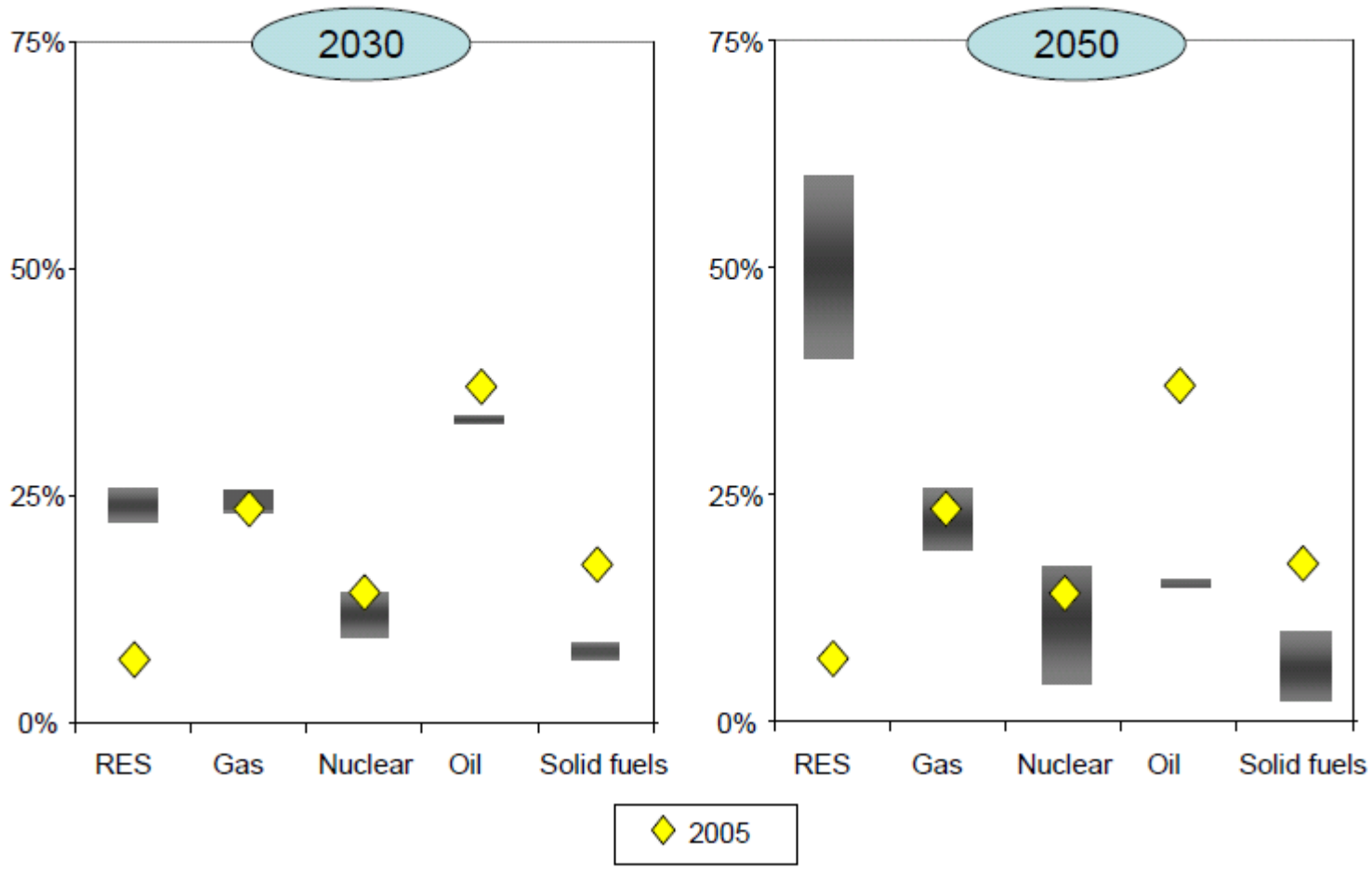
Germany, 6.6.2011: decision on immediately shut down of 8 nuclear power plants; other nine are shutting down slowly by 2015, and three more in 2022

USA: Obama or Romney?

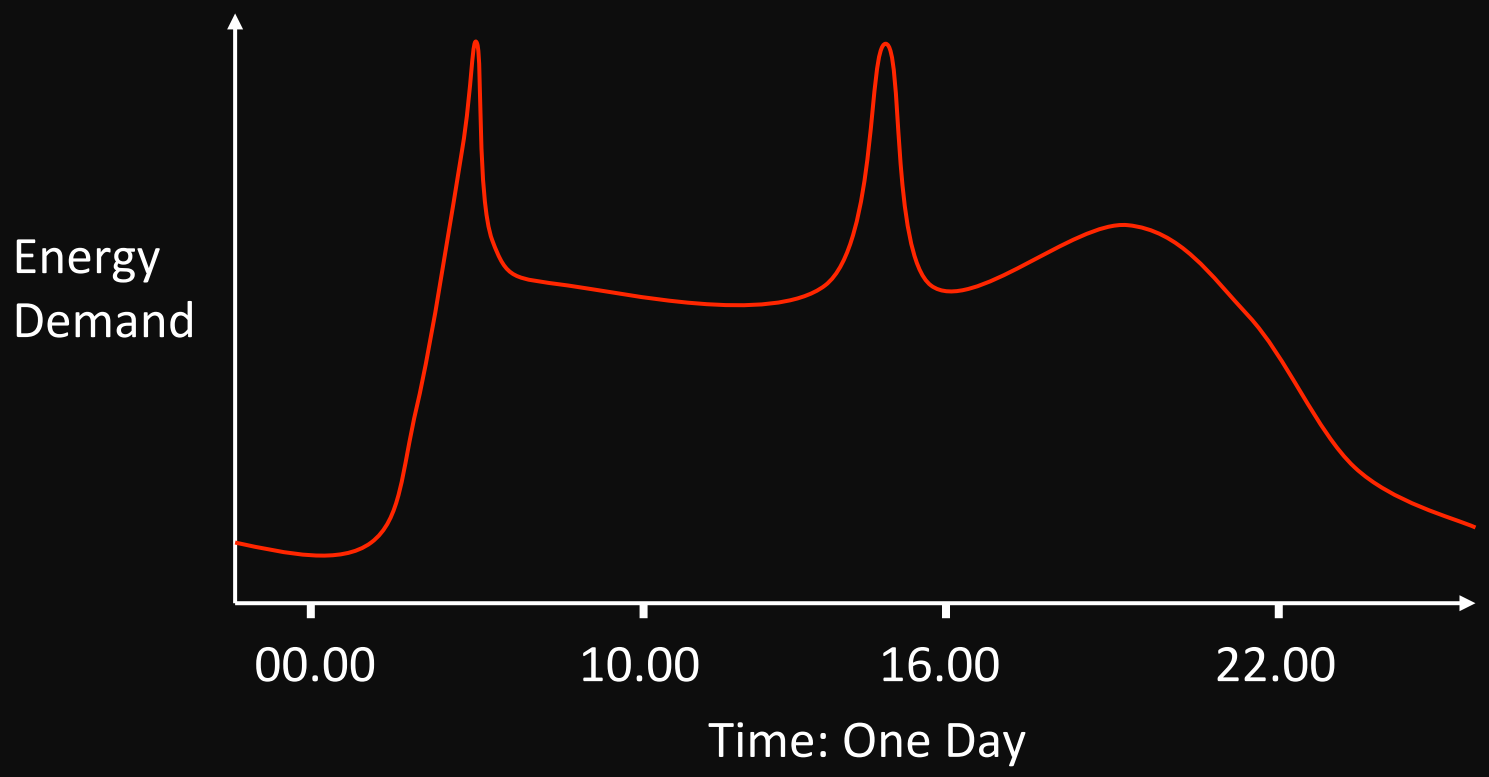
EU targets:
- 20% renewables by 2020;
- 25, 30% or more in 2030?
- 40-70% by 2050?

Energy Roadmap to 2050

Graph 1: EU Decarbonisation scenarios - 2030 and 2050 range of fuel shares in primary energy consumption compared with 2005 outcome (in %)



Renewable Challenge



Climate Data and RE

1. Site selection
2. Predicted annual energy yield
3. Long-term energy yield performance
4. Frequency when energy yield below a defined threshold

Power system planning

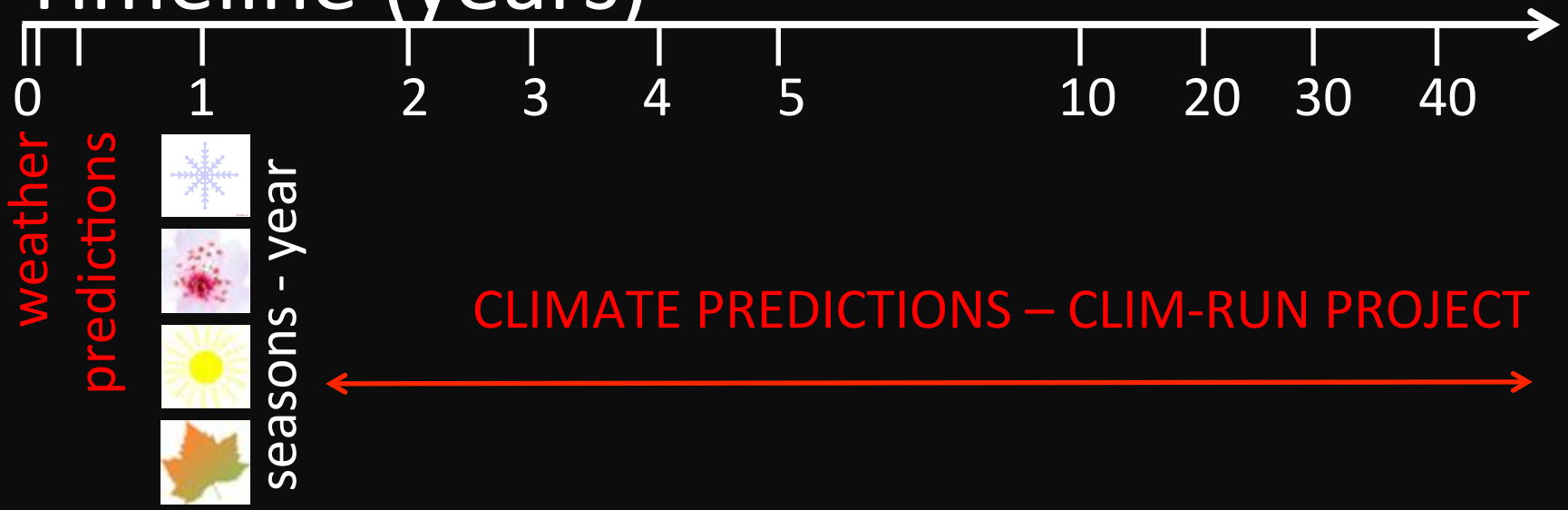
Power system planning demands long-term approach:

- long planning and construction process (1-10 years)
- long life time of new power plants (25-60 years)

5-10% loss of the future planned income can make a difference between economically justified and unjustified power plant

Climate Predictions – Current Status

Timeline (years)



Implications:

Assumed consistency in RE climatic resources

Results...??? Many...

Considerable multiplication of RE costs

Climate Prediction Sensitivities

´´Components of uncertainty are commonly based on subjective estimations rather than on statistical sound data analysis´´

Heinz-Theo Mengelkamp *et al.* 2010,
Risk analysis for a mixed wind farm and solar power plant portfolio.

Climate Prediction Sensitivities

CLIM-RUN activities

1. Characterising the climate using statistical analyses

2. Improving the reliability of databases and techniques

3. Collaboration with energy stakeholders

Climate Prediction – Current Status

Aims to *provide climate predictions* from days to decades into the future.

Climate predictions are produced with numerical models of the climate system.

Used alongside observed climate patterns in order to *project to future timescales.*

Improves understanding of how the climate works and helps predict *how it will act and react in the future.*

Climate Prediction with RE

Contribute to:

- Climate change adaptation policy
- Energy security policy
- Building codes and other regulations (HDD - Heating Degree Days)
- Investment opportunities

CLIM-RUN Questions

- How representative is current climate data for estimating the performance of a RE plant over its lifetime (e.g. 30 years)?
- How confident can we be about the energy yield forecasts?
- What are the likely lowest level of energy yield from a RE project in a season/year? (known as ´´climate droughts´´)
- How can solar and wind climatic resources co-vary to supply a more consistent stream of energy?

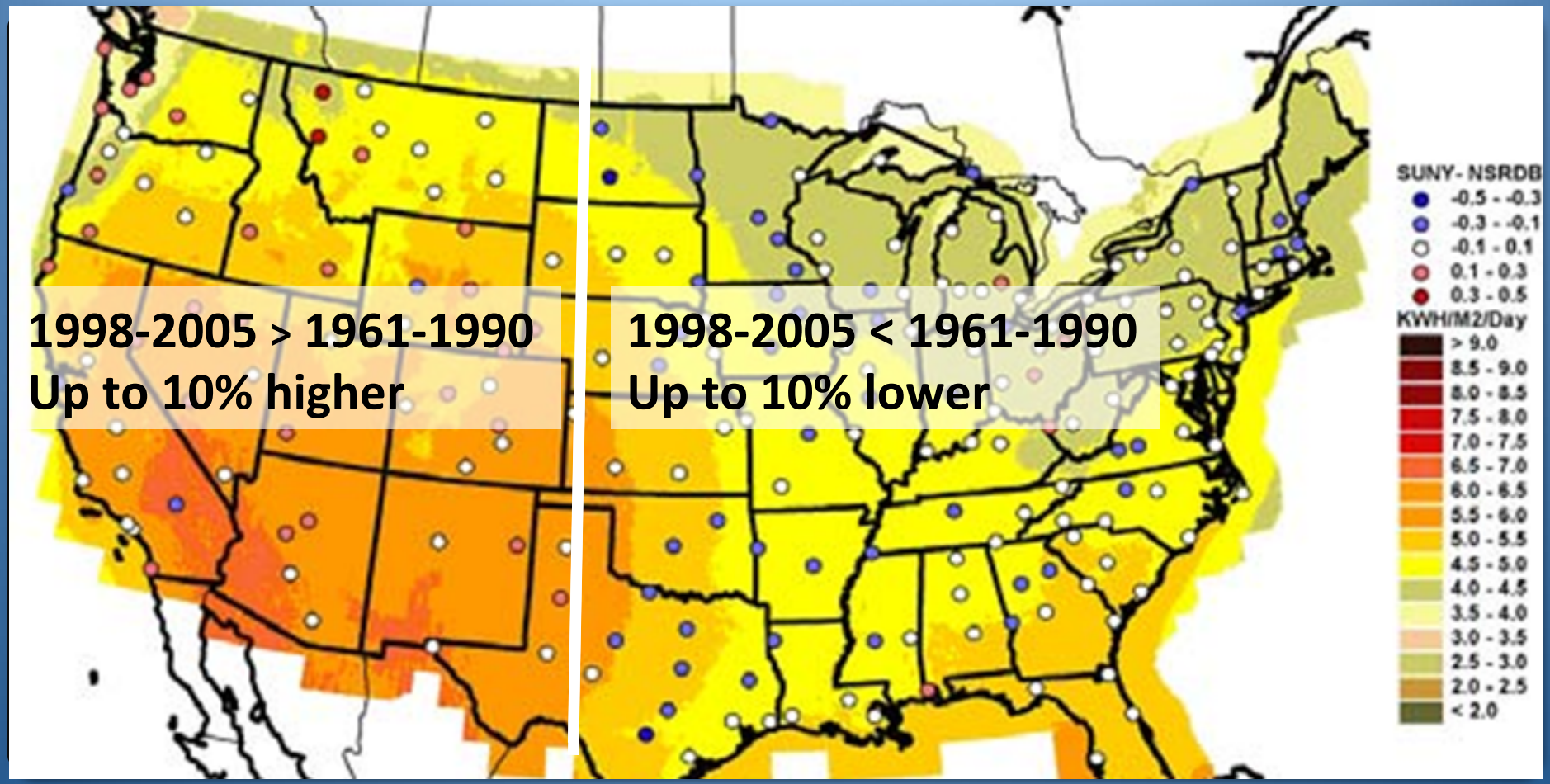
CLIM-RUN Questions

Worst case scenarios:

? Can we characterise the frequency, amplitude and duration of high energy demand (extreme heat/cold periods) and low RE yield climatic resources?

Example: low hydro production during the summer (high season) period

Climate Prediction - Results



Conclusion

For the RE sector as a whole, simple and reliable climate predictions are needed.

Higher-quality RE climate resource assessment can accelerate technology deployment by making a positive impact on decision making and reducing uncertainty of financial investments.

Climate change impacts on renewables in Croatia

* Regional climate model RegCM
  - horizontal resolution 35 km; Most part of Europe and Mediterranean

* Global model ECHAM5/MPIOM:
  - horizontal resolution~ 200 km

- Climate of 20th century 1961-1990 P0 (reference period)
- Future climate: 2011-2040 P1
  2041-2070 P2

GHG emissions according to A2 IPCC scenario

* Output from RegCM model every 3 hours

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Assessment of climate change impacts on energy generation from renewable sources in Croatia

Robert Pašičko [a,*], Čedo Branković [b], Zdenko Šimić [c]

[a] United Nations Development Programme (UNDP), Energy and Environment, Radnicka 41, Zagreb, Croatia
[b] Croatian Meteorological and Hydrological Service (DHMZ), Zagreb, Croatia
[c] University of Zagreb, Faculty of Electrical Engineering and Computing, Croatia

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ABSTRACT

Although the subject of climate change attracts enormous attention, there is limited number of analyses dealing with climate change impacts on the power system planning. It is important to understand these influences since the power system planning must consider very long time spans, and therefore it might be affected by potential climate change in multiple ways.

This study focuses on the initial evaluation of climate change impacts on renewable energy sources in Croatia - specifically, photovoltaic, wind and hydro energy. The climate data used for this assessment were taken from the global climate model ECHAM5-MPIOM and dynamically downscaled by the regional climate model RegCM at Croatian Meteorological and Hydrological Service (DHMZ). The results based on the IPCC A2 scenario for the two future climate time periods, 2011–2040 and 2041–2070, are analyzed.

The climate change that would potentially have the most significant impact on renewables is expected in the coastal and adjoining areas of Croatia during summer where an increase by 20% in the mean wind speed is projected already for the first time period, and more than 50% until 2070. This would, theoretically, imply almost a doubling in electricity production even in the first period. The impact of climate change on electricity production from photovoltaics might be neutral since it is balanced by opposing dominant factors, while a reduction of more than 10% in the production of electricity from hydro power plants could be expected after 2050.

Estimates of uncertainties related to climate change are necessary in order to be able to determine the

Summary of expected climate variable changes with potential impact on renewable production.

Projected climate change	Impact on renewables production
Temperature: The mean temperature increase up to 3.5 °C in the period 2041–2070.	*Photovoltaics*: For an increase in average temperature of 6 °C, the efficiency and production of energy would decrease 3–5% *Wind*: The temperature increase of 1 °C yields a decrease of about 0.5% of wind power electricity production. Overall, no more than 1% change expected. *Hydro*: The projected higher temperature would lead to more evaporation from hydro storages.
Precipitation: Precipitation is projected to be reduced by 10–15% in the major Croatian basins.	*Photovoltaics*: Small positive influence. *Wind*: No impact expected. *Hydro*: A reduction in water inflow implies that the energy generation is expected to decrease by 10% by 2050 and 15–35% by the end of the 21st century.
Global horizontal irradiance: An increase in irradiation is projected for all regions in Croatia.	*Photovoltaics*: Electricity generation increase by 3% during the summer and 1–2% during spring and winter months in the period to 2040. *Wind*: No impact expected. *Hydro*: No impact expected.
Days under snow cover: Expected decrease in days under the snow cover.	*Photovoltaics*: An increase in electricity generation due to less snow on the panels. *Wind*: No impact expected. *Hydro*: An increase in evaporation from hydro storages should be taken into account.
Extreme weather events: More forest fires expected in the Mediterranean due to more draughts in the summer; stronger winds can impact energy technology installations	*Photovoltaics*: A cautious choice of locations due to strong winds and forest fires. *Wind*: Winds stronger than the maximum anticipated in wind power plants could be expected. *Hydro*: More severe and more frequent draughts and precipitation should be taken into account than previously observed.
Hailstorms: More severe hailstorms could be expected.	*Photovoltaics*: Large-size hail stones can damage some types of PVs *Wind*: No impact expected. *Hydro*: No impact expected.
Wind speed change: Higher wind speeds projected in coastal and adjacent areas in the summer – an increase of 15–25% in 2011–2040 and 35–60% in 2041–2070.	*Photovoltaics*: Increased construction or maintenance cost. *Wind*: More electricity could be generated from wind power plants in the southern regions of Croatia during the summer - theoretically double than the current production (until 2040) or more than double up to 2070. *Hydro*: No impact expected.
Change in wind speed variability: More variability should be expected in the future.	*Photovoltaics*: No impact expected. *Wind*: Can make a big impact on electricity generation from wind power plants: even with the wind speed increase, a higher variability of wind can lead to less generation of energy. *Hydro*: No impact expected.
Wind direction change: In some regions wind direction changes could be expected.	*Photovoltaics*: No impact expected. *Wind*: Wind power plants are located according to prevailed (climatological) wind direction and any change in the wind direction influences their electricity production. *Hydro*: No impact expected.