Humankind, Energy and the Climate - A EURO-CORDEX Analysis

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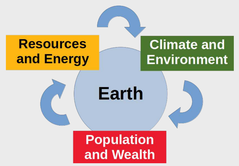
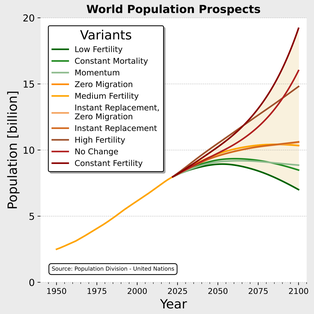
Humankind

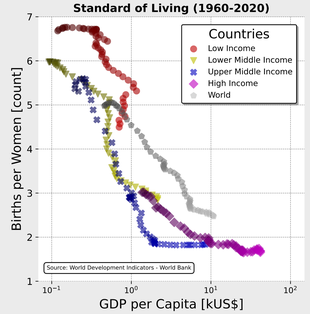
1 NO POVERTY
7 AFFORDABLE AND CLEAN ENERGY
13 CLIMATE ACTION

The United Nation's Sustainable Development Goals (SDGs) provide a comprehensive list on the various challenges humankind is facing. Besides the fight against poverty (1) and hunger (2), they comprise guaranteed access to a modern health system (3), qualified education (4), as well as clean and affordable resources like water (6) and energy (7). Climate action on the other hand does only take place (13) - far away from the everyday struggles of a vast majority in the world.



The SDGs are tightly connected to an expanding human species that is exploiting more and more of the natural resources. This in turn leads to profound impacts on the climatic and environmental conditions inside the closed Earth system - a reinforcing trilemma, which comes with a counter-intuitive exit strategy: when the living standards are raised even more, especially for the poorest, the world population will eventually stabilize.

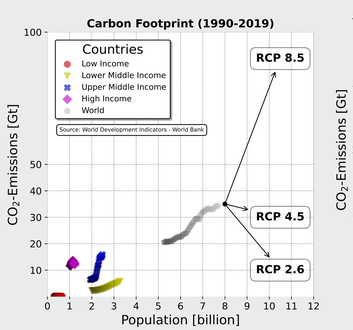


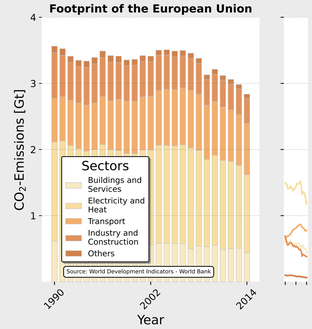


The left side shows the latest population projections under various fertility assumptions, while the right side scatters the historic decline in fertility against the rise in living standards throughout the last decades, from dark to bright.

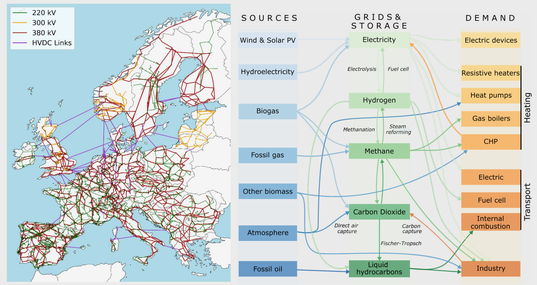
Energy

While the rich Western countries (magenta) start to decarbonize their economies, the economically growing countries (yellow/blue) are still investing into fossil driven technologies. From this position, the world (grayscale) is at a crossroads, whether towards a strong (RCP 8.5), a medium (RCP 4.5), or a weak (RCP 2.6) global warming scenario, dependent on the actual population dynamics and the economic sacrifices societies are willing to make. Note, that the poorest (red) didn't even start their fossil upswing, remaining at the highest fertility rates in the world, which will lead to the biggest share in future population growth.



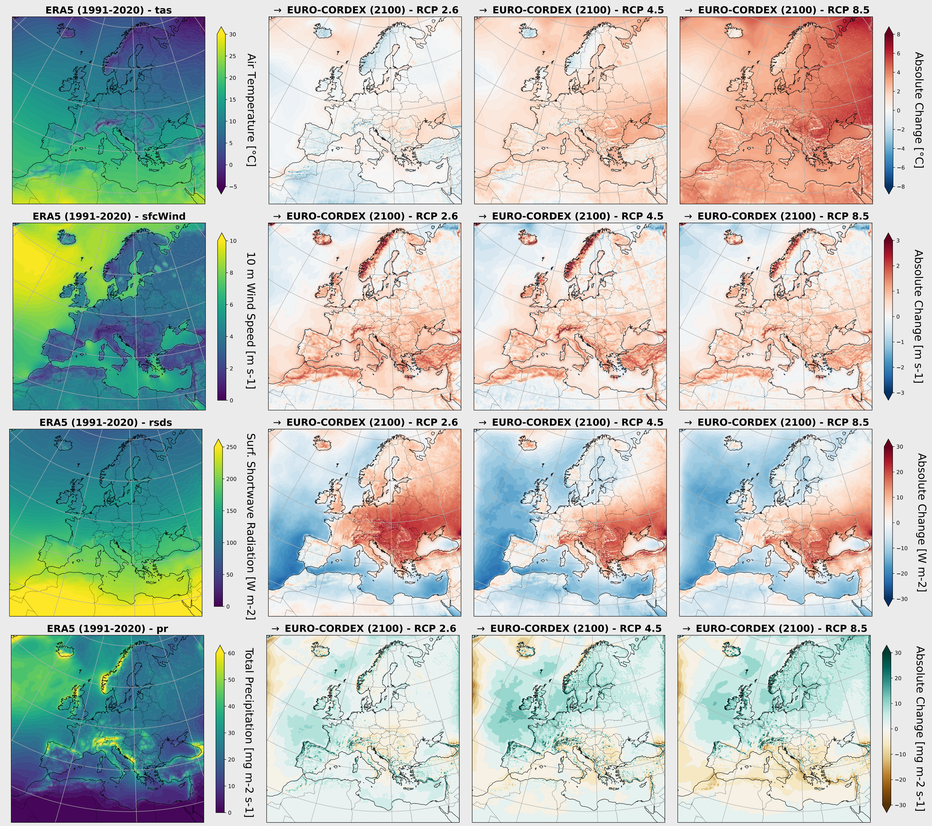


With the Paris Agreement from 2015, in particular with the Green Deal from 2019, the European Union (part of magenta) took up its responsibility to achieve climate neutrality. The actual European share of carbon dioxide amounts to about 3 Gt per year, distributed to the energy sectors as shown in the two diagrams on the right side of this column.



Adopted from the ENTSO-E transmission grid, PyPSA-Eur (https://github.com/PyPSA/pypsa-eur) provides a detailed energy system model for Europe. It allows for network based analyses, combining arbitrary weather input data as well as boundary conditions. This model will be the starting point for further research, with special attention to the climate models presented in the third column to the right.

and the Climate



At the end of century climate change will heavily affect the availability of natural resources like water and food. The figure above shows the current climatic state (ERA5 reanalysis, 30-year mean) and the absolute changes until the end of century (EURO-CORDEX projections, 1-year mean, 16 RCP 2.6 + 13 RCP 4.5 + 38 RCP 8.5 ensemble members), each time for the following meteorological variables: Air Temperature, 10 m Wind Speed, Surface Shortwave Radiation, and Total Precipitation. While temperature and precipitation shifts are most pronounced in the strong RCP 8.5 experiment, wind and radiation variations are already appearing in the medium RCP 4.5 and the weak RCP 2.6 ones. The full time-series of these variables will be the main input data for the energy system analysis as described at the end of the second column to the left.