THE ECONOMICS OF POWER GENERATION FROM RENEWABLE AND NON-RENEWABLE ENERGY SOURCES

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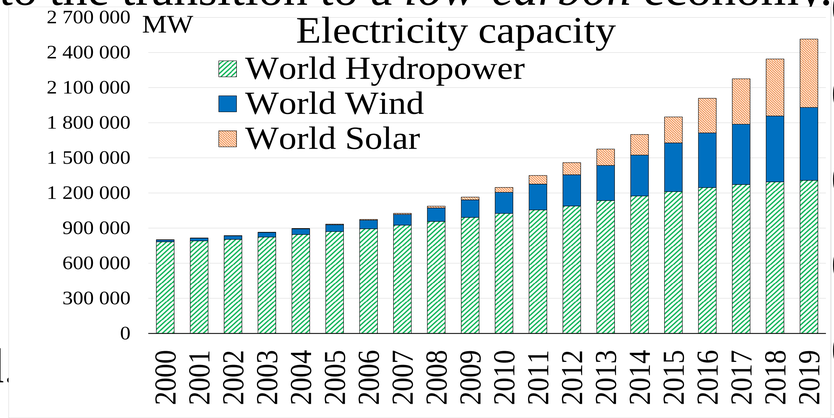
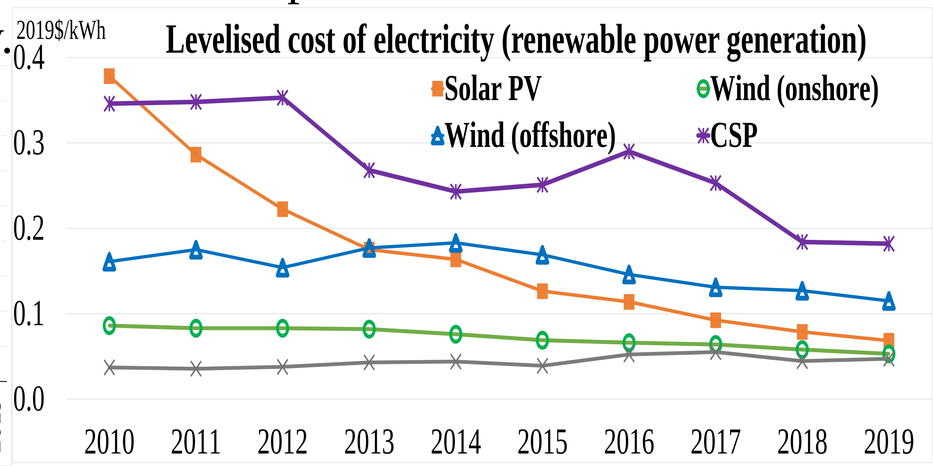
Low-cost and relatively *low-carbon intensive* fuels, e.g. shale gas, as well as the development of *solar and wind energy*, will greatly contribute to the transition to a *low-carbon* economy.

- Surge in production
- Decline in prices

Due to a decline in the costs of *clean energy* production, global *electricity capacity* (solar & wind) has accelerated.





Source: Constructed using data from IRENA (2020), Renewable Power Generation Costs in 2019, International Renewable Energy Agency

Output (Y) is produced using efficiency indices for K and S (E_K and E_S).

$$Y = E(E_K K + E_S S)^{\sigma}, 0 < \sigma \leq 1, E > 0$$

The model maximizes welfare of households, where discounted utility is constrained by state variables: capital stock (K), accumulated fossil fuel extraction in the past (m), existing stock of fossil fuel (R), damages arising from cumulative greenhouse gas emissions (D). Costs *are* incorporated in this theoretical dynamic-optimization model.

$$\max_{C,S} \int_0^{\infty} e^{-rt}(\ln(C) - \nu(D - D^*)^2)\, dt$$

Subject to

$$\dot{K} = Y - C - \delta K - \phi(R^0 - m)^{-2} S$$

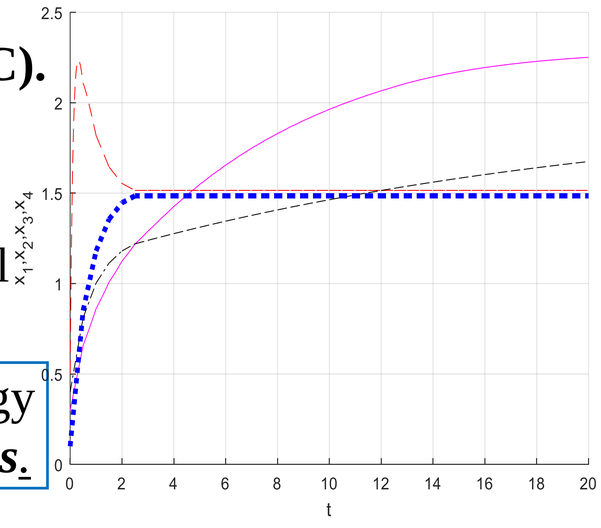
$$\dot{R} = \alpha(R^0 - m - R - R^z) - S$$

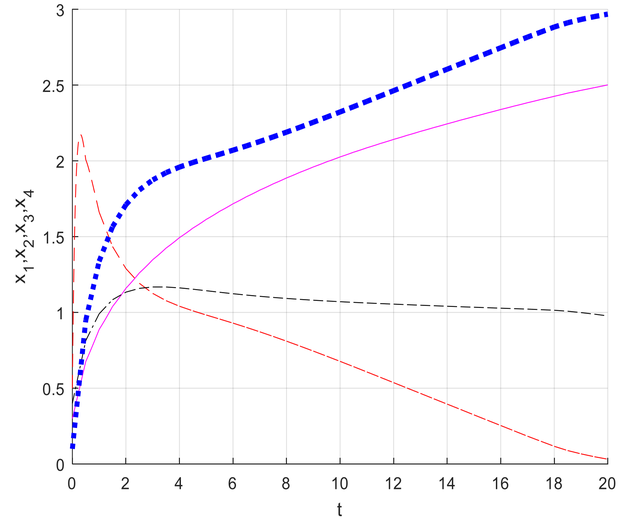
$$\dot{m} = S$$

$$\dot{D} = \psi S - \rho(D - \xi D^*)$$

To show the relationship between fossil fuels, renewable energy, the environmental externalities, and the damages arising from it, our model is solved using **Nonlinear Model Predictive Control (NMPC).**

Optimal paths: (K) using x_1 (solid pink line), (R) using x_2 (dashed red line), (D) using x_3 (**dash-dot black line**), and (m) using x_4 (single-dot blue line); assuming different initial levels of state variables and parameter values.





Numerical solutions suggest that promoting renewable energy *will* contribute to significant ***reductions in carbon emissions***.