Environment Center
Charles University
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# Impacts of Market Stability Reserve on $CO_2$ emissions from Czech heat and power sector – TIMES model simulations

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# TIMES model generator

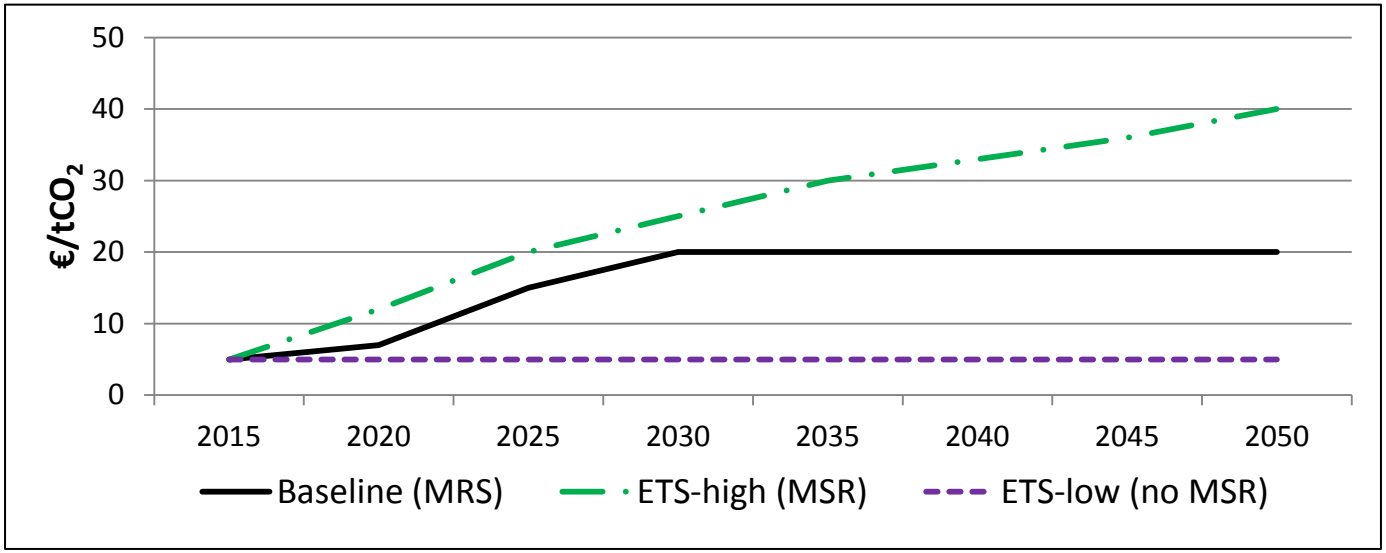
- Assessing impacts within coherent modelling framework on
  - fuel-mix, energy use, and technology-mix
  - emissions (GHGs, $SO_2$, NOx, PM, NMVOC)
  - investments and total costs
- TIMES (**T**he **I**ntegrated **M**ARKAL-**E**FOM **S**ystem)
  - **pan-European** bottom-up **technology-rich** model generator
  - a part of the IEA-ETSAP (Energy Technology Systems Analysis Program)
  - combines a technical engineering approach and an economic approach
  - linear-programming to produce **a least-cost energy system** over **whole period** (i.e. perfect foresight)
  - optimized according to a number of user **constraints** (availability of fuels, technology ban, emission cap, etc.)
  - Allow assessing impacts of exogenous variables such as RES & non-RES capital costs, fuel costs, discount rate

# Model assumptions and data – TIMES-CZ

- time horizon 2012-2050
- power and heat generation (92 % of Czech power generation, 114 % of gross domestic demand)
- plant-level data of fuel use, emissions and electricity/heat generated
- reserves of brown coal (within/beyond limits), RES potentials
- baseline prices of fuels (World Energy Outlook 2013)
- capital costs of new technologies based on EPRI (2011), Nuclear cost per kW adjusted according to outcome from the Czech tender
- moderate growth in electricity consumption (up to 1% p.a.) – *but including export of electricity*
- Time resolution:
  - electricity: 12 months, peak, off-peak and mid-load
  - heat: 12 months

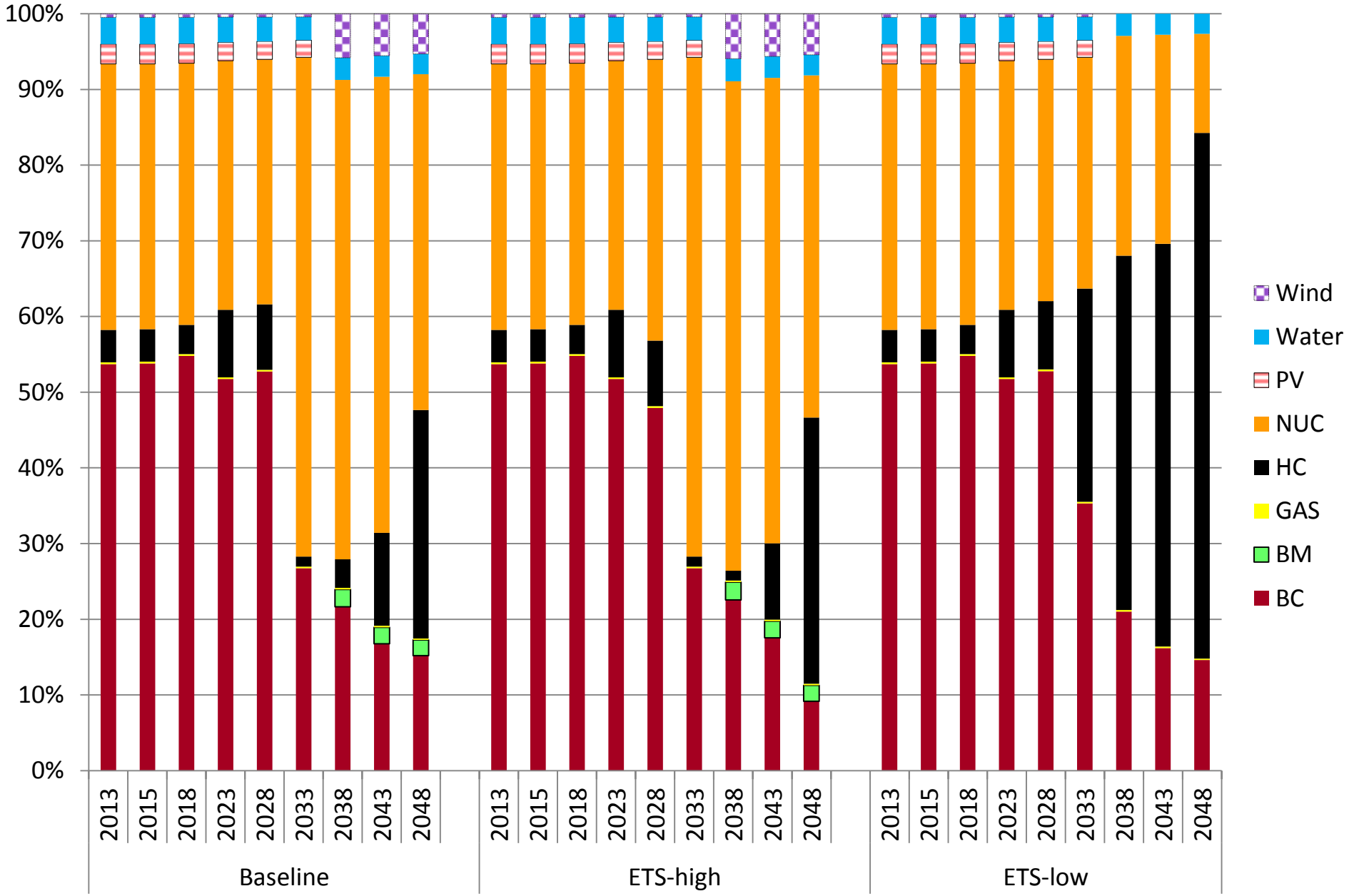
# Scenarios

**EUA prices assumptions**

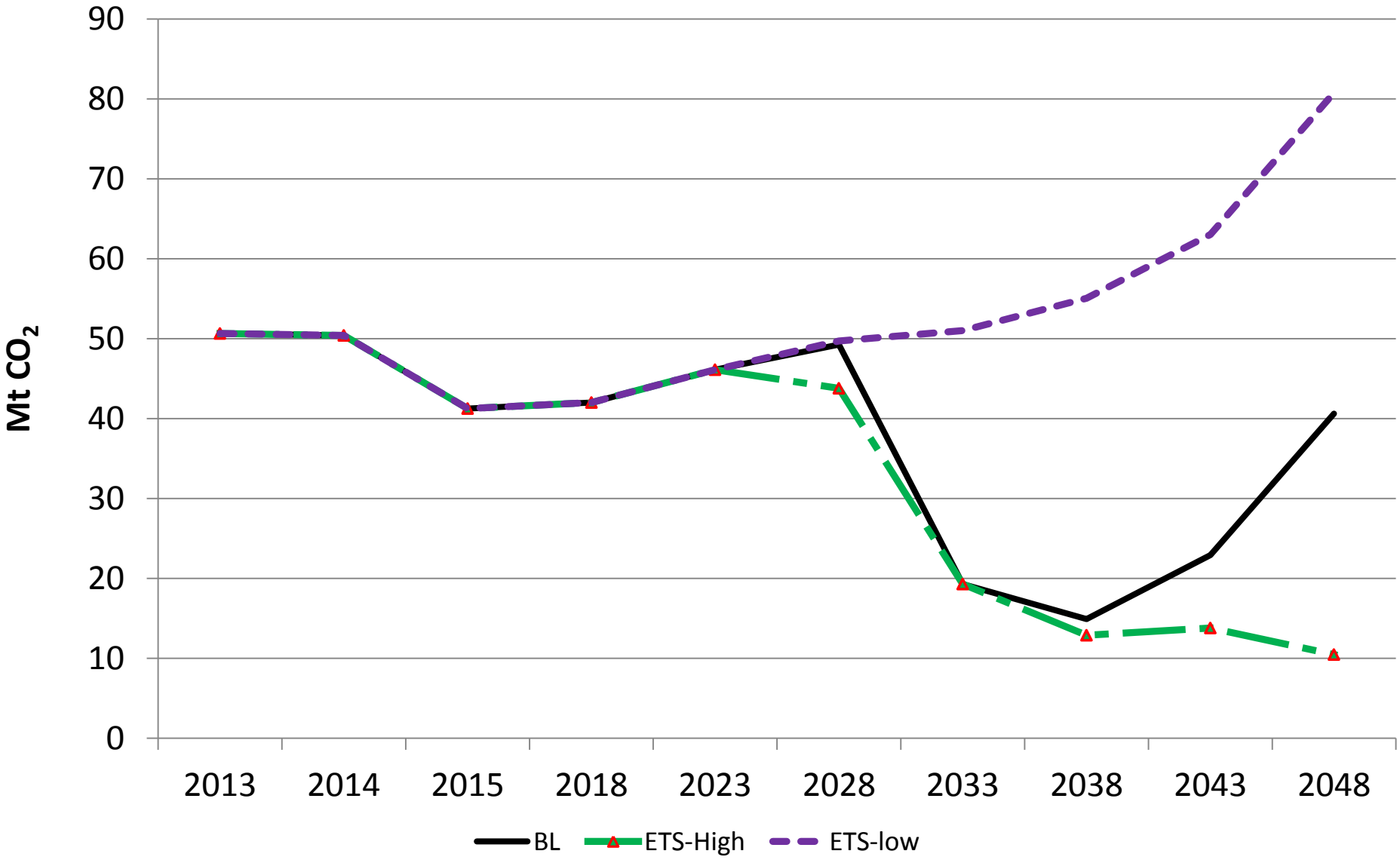



- Derogated allowances taken into account
- Implicit assumptions about MSR
  - Corrections of EU ETS in order to get on expected carbon price pathway: Baseline & ETS-high
  - Lack of price credibility and consistency might have similar effect on investments as very low price of EUA: ETS-low

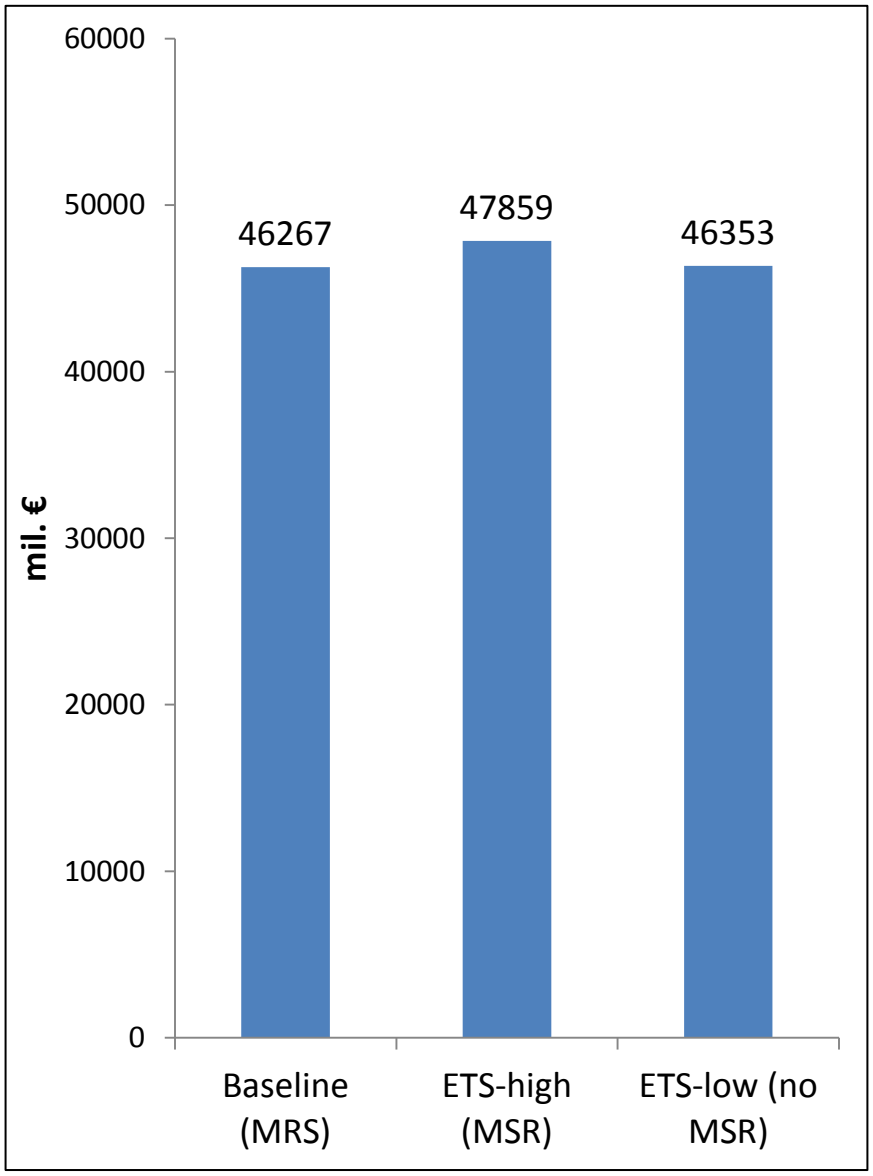
# Share of Electricity production per type of source



# $CO_2$ emission



# Total discounted costs till 2050




- Discounted value for the unused portion of technical live of investments, whose technical lives exceed the model's horizon, is subtracted from the total discounted cost.

- Difference of total discounted cost till 2050 is up to 3.5 %

# Conclusions

- Price of $CO_2$ allowance is the most important factor for $CO_2$ emission reduction
  - 20 €/tCO2 is sufficient price level for reducing emission by 70-80% in 2050, while the current low price of CO2, as in the ETS-low scenario, would lead to 60% increase in CO2 emissions by 2050
  - Under the ETS-low, WIND is not installed, share of NUCLEAR is declining, while HARD COAL is more used
  - Costs till 2050 are 3.5 % higher ETS-high than in Baseline scenario with 20 €/tCO2
  - Redistribution between investment and variable costs depending on EUA price
  - more volatile price may induce higher rate of return (discount rate) → it would penalize investment-more intensive technologies, such as nuclear or RES

  → MSR may support investments into new technologies
- Different technology deployment
  - PV systems and gas turbines are not competitive without subsidies or low gas price
  - WIND turbines are fully installed with constrains on coal extraction and with EUA price €20+/tCO2
- Constraints matter
  - Opening BC reserves would induce investments into BC and CCS (under €20+/tCO2)
  - Putting a ban on new nuclear would induce use of biomass and investments into BC and HC power plants (Recka and Scasny 2012 by MESSAGE)