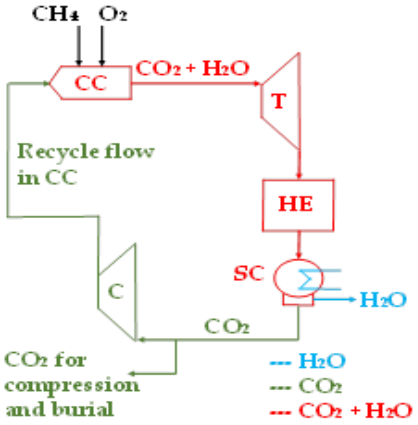
Prague Business School

Power market formation for clean energy production



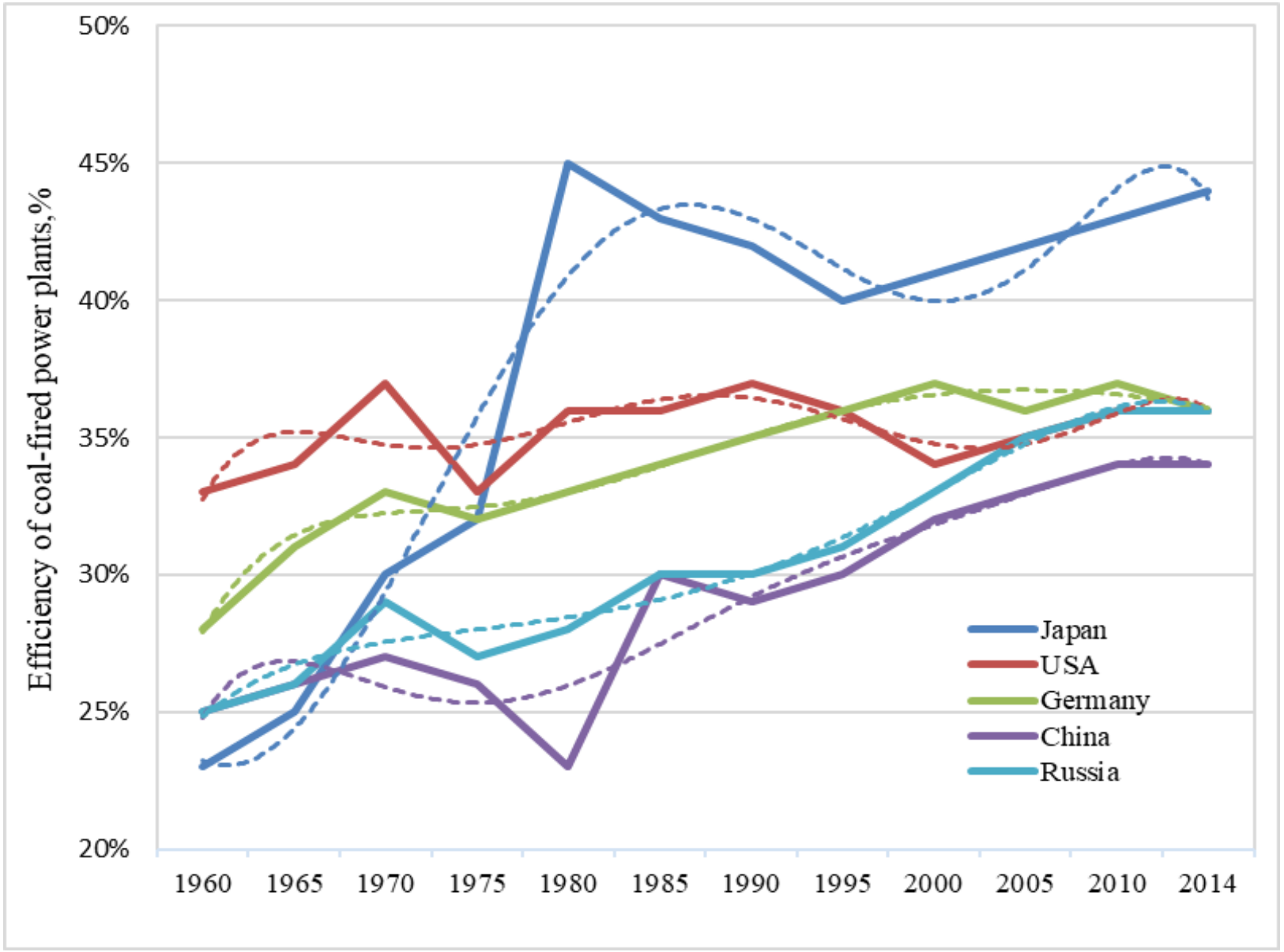
Prof. Evgeny Lisin
Centre for Energy Studies, Prague Business School

Rationale

- Although the future electricity markets would most likely depend on the high shares of renewable energy sources (RES) in the electricity system, energy efficiency such as the one based on the near-zero emission technologies might also play a crucial role in the transition to the carbon-free energy future.

- There are the oxy-fuel combustion technologies that might help to reduce the proportion of unburned fuel and increase the efficiency of the power plant while reducing the emissions of flue gases. It is crucial to understand the role and the place of the near-zero emission technologies in the production of clean energy.

- We apply economic and mathematical models for assessing the prospects for applying oxy-fuel combustion technology in thermal power plants taking into account the system of emission quotas and changes in the fuel cost.



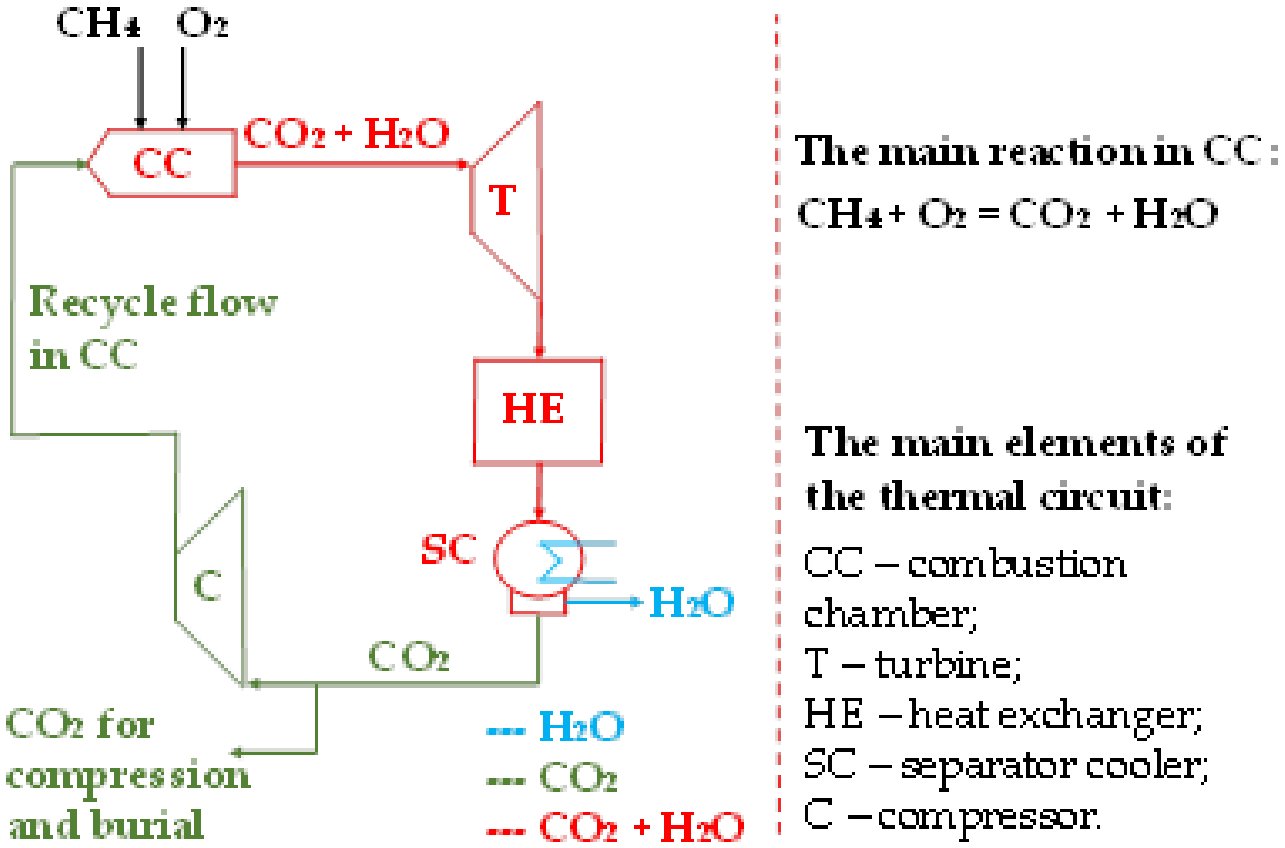
Development of coal TPPs in countries with the most developed energy sector

Environmental benefits of oxy-fuel combustion technology

- Significant reduction in the emissions of these substances into the atmosphere is cumbersome for technical and economic reasons. In particular, the emission of carbon dioxide from flue gases is inefficient due to its low partial pressure.

- Moreover, the insufficient combustion temperature leads to the formation of unburned fuel and its emissions into the atmosphere along with the flue gases. With regard to the above, oxygen-fuel technologies for energy production have special meaning. They allow to almost completely reduce emissions of harmful substances into the atmosphere.

- According to the technology of oxy-fuel combustion, three flows enter the combustion chamber:
  - fuel (gaseous, including based on coal gasification),
  - oxygen,
  - carbon dioxide flow limiting the maximum temperature in the combustion chamber.



Schematic diagram of the oxygen-fuel energy complex

Conclusions

- Our research demonstrated the prospects for the oxy-fuel combustion technologies from the position of ensuring sustainable economic development of the country. Moreover, we also took into account the introduction of quotas for the greenhouse gas emissions.

- The development of the technologies aimed at the production of electricity at traditional TPPs is associated with an increase in the temperature of fuel combustion in the combustion chamber and the beneficial use of flue gases. Thus, the initial steam parameters at the turbine inlet are significantly increased, which leads to an increase in the efficiency and environmental friendliness of the power plant due to a decrease in the formation of unburned fuel and its emissions into the atmosphere. At the same time, capital costs are rising and have an impact on the cost of electricity through depreciation.

- Our results demonstrate that at the current fuel prices it is advisable to use economical combined cycle gas turbines (CCGT). When quotas for greenhouse gas emissions are introduced and fuel costs increase by 1.3 times, it becomes economically feasible to use the oxy-fuel combustion technology which has significant economic advantages over CCGT with the capture and storage of GHG

References

- Tvaronavičienė, M., Lisin, E., & Kindra, V. (2020). Power Market Formation for Clean Energy Production as the Prerequisite for the Country's Energy Security. *Energies*, 13(18), 4930. doi: 10.3390/en13184930
- Lisin, E.; Shuvalova, D.; Volkova, I.; Strielkowski, W. Sustainable development of regional power systems and the consumption of electric energy. Sustainability 2018, 10(4), 1111. doi: 10.3390/su10041111
- International Energy Agency. Market Report Series: Energy Efficiency 2018 Available online: https://webstore.iea.org/market-report-series-energy-efficiency-2018 Accessed on 25 July 2020
- Lisin, E.; Strielkowski, W.; Krivokora, E. Economic Analysis of Industrial Development: a Case of Russian Coal Industry. Montenegrin Journal of Economics 2016, 12(4), 129-139. doi: 10.14254/1800-5845/2016.12-4.12
- Lisin, E.; Rogalev, A.; Strielkowski, W.; Komarov, I. Sustainable modernization of the Russian power utilities industry. Sustainability 2015, 7(9), 11378-11400. doi: 10.3390/su70911378
- Lisin, E.; Sobolev, A.; Strielkowski, W.; Garanin, I. Thermal efficiency of cogeneration units with multi-stage reheating for Russian municipal heating systems. Energies 2016, 9(4), 269. doi: 10.3390/en9040269
- Strielkowski, W.; Štreimikienė, D.; Bilan, Y. Network charging and residential tariffs: A case of household photovoltaics in the United Kingdom. Renewable and Sustainable Energy Reviews 2017, 77, 461-473. doi: 10.1016/j.rser.2017.04.029
- Rogalev, A.; Grigoriev, E.; Kindra, V.; Rogalev, N. Thermodynamic optimization and equipment development for a high efficient fossil fuel power plant with zero emissions. Journal of Cleaner Production 2019, 236, 117592. doi: 10.1016/j.jclepro.2019.07.067
- Balitskiy, S.; Bilan, Y.; Strielkowski, W.; Štreimikienė, D. Energy efficiency and natural gas consumption in the context of economic development in the European Union. Renewable and Sustainable Energy Reviews 2016, 55, 156-168. doi: 10.1016/j.rser.2015.10.053
- Lisin, E.; Strielkowski, W.; Garanin, I. Economic efficiency and transformation of the Russian energy sector. Economic research-Ekonomska istraživanja 2015, 28(1), 620-630. doi: 10.1080/1331677x.2015.1086886

Thank you for your attention!

Q&A