THE INDUSTRIAL CHALLENGE OF GREENING THE ELECTRICITY SYSTEM: A FOCUS ON THE SUPPLY OF MINERAL RAW MATERIALS

During my first year as Senior Fellow (2021-2022), I conducted a research on the role of natural gas in the electricity generation mix. This objective of the study was to analyze the role of natural gas in electricity generation and the implications for public policies by comparing the evolution of two hypothetical global electricity systems: one designed to reach zero-CO2 emissions by 2035 and another one with the objective to maximize global social welfare by instituting an international CO2 tax reflecting the estimated social cost of carbon.

In the resulting paper (M-RCBG Associate Working Paper N°174), it is shown that that the implicit CO2 cost of imposing a zero-CO2 emission target is an order of magnitude higher than the typically accepted social cost of carbon as a consequence of the non-dispatchable nature of renewable technologies. A tax approach would be much more cost-efficient and leads to a different mix in which natural gas still plays an important role as firm capacity provider. Public policies should better take into account the additional costs of integrating renewable technologies above 70% penetration level and dedicate more R&D efforts for alternative storage solutions.

For my second year, my focus switches to another aspect of the evolution of the electricity system: the supply of the required raw materials, minerals and metals more specifically, the potential impacts on geopolitics and in turn, on the rate of the energy transition. The path to a renewable energy based electricity system implies a significant industrial effort and in particular the availability of different raw materials, which seem today to be heavily controlled by a limited number of countries, China in particular:

- new transmission lines will be required (up to 5 times increase in the US by 2050 according the recent study "Net-Zero America" at Princeton University), resulting in a surge in copper demand;
- Wind farms also require copper as rare earth metals to manufacture magnets for instance;
- Battery technology are based on cobalt, nickel and lithium as well rare earth metals. The development of electric vehicles will also enhance demand;
- Materials to manufacture photovoltaic cells.

The approach I am proposing is to:

- Map the required quantity of various metals for the electricity generation trajectories I have considered in my first paper;
- Gain an understanding of current production and transformation value chains as well as available resources and their location. Who is producing, who is refining and where?
- Putting the above two analyses in perspective:
    - How large would the required scale-up be in terms of mining and refining?
    - Can we identify industrial bottlenecks? Role of recycling?
    - Can the size of the challenge, value chain structure/control and localization of resources lead to geopolitical issues? How are related investment and trade flows in comparison to natural gas for instance?
    - What are the potential consequences in terms of industrial/public policy and speed of the energy transition?

Philippe Tordoir
Senior fellow 2021-2022
Mossavar-Rahmani Center for Business and Government
Harvard Kennedy School