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The future carbon footprint of materials as a bottleneck for the transition to Net-Zero Emissions – case study on France

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Paris climate agreement has been a major step forward to limit the global mean temperature rise to below 1.5°C above pre-industrial levels. For many countries, it has led to adopt Net-Zero GHG Emissions (NZE) targets by mid-century. Such objectives imply renewing much existing infrastructures and equipment through low-carbon investments in key sectors (buildings, transport, and power supply). However, there is a risk to overshoot the objectives due to base carbon-intensive materials (steel, cement, etc.). Indeed, material demand is already expected to double by mid-century following economic trends. Deploying intensively low-carbon infrastructure and technologies is expected to increase material demand even more. The size of this surplus is unclear as most energy prospects neglect the feedback between the low-carbon transition and material needs. In addition, most countries restrict their NZE targets to territorial emissions, whereas a carbon footprint approach is essential to account for carbon linkage and industrial relocation toward more carbon-intensive countries. Also, the potential for a fast transition to zero-carbon industrial processes and materials as required is still uncertain, all the more in developing countries producing most materials. The design of stringent climate policy needs a clearer vision of the role of materials in the low-carbon transition to prioritizing mitigation actions.

Our study aims to quantify the link between GHG emissions, low-carbon investments, and the demand for materials. We develop an Input-Output model called MatMat designed (i) to integrate various sets of expertise about low-carbon scenarios and (ii) to track the role of investment demand and material supply in the evolution of the carbon footprint. We apply our method to the french governmental NZE scenario and global mitigation scenarios until 2050. By disentangling key drivers impacting GHG emissions embodied in materials, we show that the carbon footprint of materials could offset national NZE targets due to (i) the indirect material demand embodied in imports and (ii) the potential delay in decarbonizing the material production compared to other sectors, especially abroad. To relieve the material bottleneck for the transition to NZE strategy, we recommend (i) developing material efficiency and circular economy policies, (ii) relocating low-carbon industrial productions, and (iii) supporting imports of clean industrial products at the national level.