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Scenarios of deep decarbonization of freight transport for France by 2050

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Freight transportation is an essential economic activity. It constitutes a significant share of GDP, and is a non-substitutable input for many economic sectors. However, it relies heavily on road transport, and it contributes substantially to GHG emissions. Many countries and institutions have prepared decarbonization strategies. In France, the SNCB (National Low Carbon Strategy) states that the direct emissions of freight transport should fall by 97% in the next thirty years. However, this strategy does not describe precisely how this objective should be reached.

Freight transportation is a complex economic sector. It is undergoing constant transformations, due to the mutations of trade (including international trade), consumer behavior, technological changes, digitalization, etc. Firms are constantly reviewing and changing the way they manage their materials and information flows. Supply chains adapt to economic and regulatory environment changes, set level of service targets that depend closely on goods characteristics, market segments, spatial contexts, etc. Many institutions regulate freight transport, on their own perimeter; these regulations regard infrastructure networks, vehicles, energy, work, safety, taxation, etc. A global strategy should both address the heterogeneity and systemic complexity of freight transport, and the multidimensional nature of its regulation.

The DDP (Deep Decarbonation Pathway) approach developed by IDDRI¹ is designed with this objective in mind. Decarbonation is essentially a quantitative problem. However, due to its sheer complexity and dimensionality, modelling approaches are currently severely limited. The DDP approach combines qualitative and quantitative methods. The first side of the approach consists in elaborating qualitative narratives, combining a wide range of trends and instruments, addressing all the components of the system of interest. The second side translates these elements in quantitative assumptions. These assumptions are then combined, to check whether the global decarbonization target is reached. Iterations are made between these two sides; the narratives can be considered as global strategies; the quantification ensures they are quantitatively consistent.

This paper presents the application of this approach to the French case. Besides the specificity of France regarding freight transport (among other things: the limited importance of heavy industry in GDP, the low share of freight railway, the large share of nuclear electricity), a number of methodological difficulties specific to freight transport were revealed. The three main challenges are the heterogeneity of the freight transport system; its integration with virtually all economic activities; the very wide range and diversity of ideas and approaches to reduce its GHG emissions. They imply that, beyond the classic focus on technological improvements and solutions based on fuel

¹ Waisman et al (2019) "A pathways design framework for national low greenhouse gas emission development strategies" *Nature Climate Change* 9.4 (2019): 261-268

substitution, a systemic analysis of all of the sector's transformation determinants is required. This includes changes in behaviour, lifestyles, infrastructure, space organization and logistics strategies.

The analytical framework is built around five information families, listed below:

- 1) economic and social macrostructure: systems of production, consumption and trade of goods;
- 2) transport and storage infrastructure and its management;
- 3) logistics operations and service provision;
- 4) goods transport vehicles;
- 5) production and distribution of low carbon fuels.

These five groups provide the structure to regroup the various components on which the narratives are based. In practice, two scenarios are developed. The first one assumes a continuity of past economic and behavioral trends; the demand for road freight transport would decrease neither quickly, nor substantially. This scenario assumes an in-depth technological transformation of road transport, and a high demand for biofuels. The second scenario assumes a structural transformation of value chains, with regionalization and relocation, and mode shift. Road freight transport would play a modest role, but would still need to improve its energy efficiency and environmental impacts.

These two narratives are developed and quantified simultaneously. Quantification is based on a chain of (very simple) models, where emissions are assumed to depend on goods mobility through a sequence of quantitative indicators: goods mobility; mode shares; logistics indicators; road freight transport energy consumption; energy emissions. This quantification is based on a quite detailed representation of freight transport activity in France. Distinct types of vehicles, commodity types, and distance ranges are taken into account. In particular, commodity types have been grouped into six macro segments, which have very distinct characteristics and dynamics: agri-food products; heavy industrial products; waste; construction materials; low added-value manufactured products; high added-value manufactured products.

This research shows that the definition of a systemic decarbonation strategy for road freight transport is feasible. However, it also raises specific challenges. In particular, a defining characteristic of freight transport is its close integration with supply chains and the economy. Two important questions, then, are: how to decrease freight transport demand, and with which economic impact? and how to implement this strategy when it covers so many different institutions, regulatory perimeters, and territories? These challenges are general; however, their exact natures and intensities will depend on each country. IDDRI currently leads similar exercises with India, Brasil and South America.