

CEA Saclay –Service de Physique de l’Etat Condensé (SPEC) ([page web](#))

Laboratoire *SPHYNX* ([page web](#))

PROPOSITION DE STAGE 2024/2025

ENERGY AND MATERIAL INVESTMENT IN RAILWAY DEVELOPMENT DURING THE INDUSTRIAL REVOLUTION

INVESTISSEMENT MATIÈRE ET ÉNERGIE DANS LE DÉVELOPPEMENT DU RÉSEAU FERRÉ AU COURS DE LA RÉVOLUTION INDUSTRIELLE

As the energy transition to a zero-emission society gets underway, attempts are being made to estimate the associated costs [1], as well as the impact on the use of natural resources, particularly for energy investments [2]. The development of energy transmission and distribution networks is often a blind spot in forecasts, even though they are recognized as central to the use of low-carbon energies [3]. We propose to explore the historical case of the development of the railway network in the 19th century, in terms of the consumption of material and energy resources for its construction, maintenance and use. Our ambition is to understand the link between the dynamics of transport development and economic growth based on coal, both the raw material of the network and the beneficiary of its development [4, 5]. We will make use of the results already obtained by graph theory applied to these spatial networks [6], and will draw on a similar approach underway for electricity networks [7]. The aim of the internship will be to gather documentary resources, define the geographical study area in line with available data, and present an initial network development model. The internship is expected to end up in a PhD position.

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- [3] RTE, France, Futurs énergétiques 2050 (2022), rapport complet téléchargeable sur <https://www.rte-france.com/analyses-tendances-et-prospectives/bilan-previsionnel-2050-futurs-energetiques>
- [4] P. Malanima, The limiting factor: energy, growth, and divergence, 1820–1913. *The Economic History Review* **73**(2), 486-512 (2020).
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- [6] a. R. Louf, C. Roth, M. Barthelemy, Scaling in transportation networks. *PLoS One* **9**(7), e102007 (2014).
b. M. Barthelemy, *Spatial Networks: A Complete Introduction: From Graph Theory and Statistical Physics to Real-World Applications*. Springer Nature (2022).
- [7] E. Emery, H. Bercegol, N. Jonquieres, S. Aumaître, Complex Network Analysis of Transmission Networks Preparing for the Energy Transition: Application to the Current French Power Grid. to appear in *The European Physical Journal B*.

CONTACTS : Hervé Bercegol, 06 17 91 24 79, herve.bercegol@cea.fr

Sebastien Aumaître, 01 69 08 74 37, sebastien.aumaitre@cea.fr

Émile Émery, 01 69 08 73 36, emile.emery@cea.fr