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Sustainable and intelligent management of energy for smarter railway systems in Europe: an integrated optimization approach

D1.2 Global consumption map and analysis

SUMMARY

The main objective of Task 1.2 of WP1 is to obtain a global energy consumption map. An energy consumption map is a comprehensive and graphic way of representing the energy flows in the whole railway power supply systems. These maps provide a good overview of the energy, allowing a better understanding of what the energy has been used for (running the trains, operating stations or workshops, etc.) and enhancing the decision making processes within the project Merlin (consumption maps are a powerful tool to identify when and where measures oriented to increase energy efficiency can be implemented).

To prepare the energy consumption maps, a general representation of the power supply infrastructure has been included and infrastructure managers involved in this deliverable (the Swedish network of Trafikverket, the British network of Network Rail, the French network of RFF and the Spanish network of ADIF) have provided data of network topologies and energy consumption of their networks in a homogeneous manner.

After describing the networks, they were each analyzed and the energy consumption maps elaborated. The main conclusions reached are:

1. Despite of the heterogeneity of the different data sources provided, it is possible to perform a generic estimation of the main railways energy flows.
2. Due to the fact that the energy provided data is measured to the supply point in the traction substations, the calculation of the energy flows has consider all the losses upstream and downstream produced in the electrical path (public transmission and distribution grid, railways transmission and distribution grid, converter station, connection stations, substations, catenary, etc.).
3. The amount of energy generated that fees the different railway systems varies between 2,268.4 GWh (Sweden) and roughly 3,174.9 GWh (United Kingdom), with the exception of the French railway network that needs approximately 7,800 GWh. These amounts give a clear idea of the size of the analyzed systems.
4. The energy balance changes substantially, depending on whether the train has regenerative braking or not and how it is used. As we can see in the different maps, the annual lost energy due to the lack of regenerative braking is in the range of 36 GWh (Spain) -117 GWh (United Kingdom), which is a similar amount to the energy required to feed the auxiliary services of the infrastructure.
5. The amount of energy regenerated by all trains and returned to the public grid is very similar in all the analyzed scenarios (between 53 GWh and 63 GWh), with the exception of the Swedish case; due to its architecture, all the regenerated power is consumed internally by other trains.

6. Regarding the energy consumption for other uses different than traction, it has been assessed to be a considerable amount. In the Swedish case it represents 2% of the energy imported at pantograph level, but in the other analyzed cases it represents between 10% (Spain) and 17% (France) of the energy imported at pantograph/shoe level (between 300 GWh in Spain and 650 GWh in France).