



Proposal for a comprehensive 10-steps solution to the problem / uncertainties and questions

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Agenda

- Rail4Earth project and partners / global key figures
- A multi-levels processus : involved entities with multi-level plannings
- Finaly an Innovation V Cycle to solve an extension of existing needs and solutions
- 10-steps problem-solving process

Rail4Earth project and partners / global key figures

- Scope: sustainability performances improvements of Railway systems covering Rolling Stocks, Infra (but not signalling), Stations
- 95 M€, 71 partners including 23 Main Partners...
 - ...serving **worldwide markets**
 - These partners represents more than **1,2 millions of railway professionals** and 180 B€ of yearly turnover
 - Industrials and equipment manufacturers
 - Operators
 - Infra managers
 - Some research entities are involved too.



A multi layer processus : involved entities with their multi-level planning

- **Level1 politic** at European and National levels, political request to be resilient within a certain time horizon
- **Level2 politic-administration**: Ministries responsible for Transport at Member States levels
- **Level3** : large public or semi-public **operators** who are also **writers of specifications** and **co-writers of standards** (European Norms/TSI or world level / IEC)
- **Level 4 industrial companies** : will develop the technologies, the hardened products, and provide the serie-solutions that must be viable from a techno-economic point of view
- **All these levels must be in phase, both in the way the problem has to be solved and in the plannings.**





A multi layer processus : involved entities with their multi-level planning

- In parallel or pure technical experts, other actors have to be involved:
 - **Standardisation/regulation bodies**
 - **Certification authorities**, etc.
 - **Insurers**
 - **Lawyers** (working on stakeholders responsibilities / accidents related to extreme weather events)
 - **Financials : funding for R&D, then for series production and finally for commercial projects + verification of return on investment (ROI)**



Finally an Innovation V Cycle to solve an extension of existing needs and solutions

Main stages of the V-cycle method

Politics and administrations : define the general needs and fix the quantified objectives of resilience

Politics and administrations check that new trains/infra/stations answer the new resilience objectives

Public main operators and infra managers :
* define the needs specs for RS/Infra/Station
* co-write norms/regulation/TSI

Public main operators and infra managers:
* receive and validate the new hardened solutions resilient to extreme weather events

Macro planification to be made on this V cycle basis (see the 10 steps process)



Industrials:

- co-write norms/regulation/TSI
- develop technologies and products
- Sell them on commercial projects at accepted prices (customers ROI)

10-steps problem-solving process

- Ne pas oublier d'écrire que dans plusieurs pays européens c'est le **principe de precaution** qui prévaut par def à l'encontre de la demande de resilience Ex France (checker aussi en pratique comment ça se traduit sur le terrain: qui decide d'annuler les trains en cas de tempête? Le prefet, qui participe à la prise de decision? Meteo France (fourniture des données, SNCF, president de region ? autres?) il faut expliquer cette réalité de terrain aux gugus de la DG Move qui ne doivent pas savoir ça
- A affiner : decision collégiale entre : SNCF, Meteo France, puis qui ? Prefet (voir **Amaury**), Region? (VP Transport? Directeur Transport).

10-steps general problem-solving process

- Working hypothesis: wish to **address the general problem** at the EU27 level and its 244 Regions (NUTS 2) , as opposed to a local, case-by-case resolution.
- Step1 : **Actual precise state of play**
 - Creation of a **uniformly structured European database to link extreme weather events to incidents** (delays) **or accidents** on the rail network. Collection of data from the 27 EU countries (+ the United Kingdom)
 - Put into perspective of existing climate-related problems in relation to the total number of trains in nominal operation (or train-km) each year.
- Actual status : **not started at EU level (but some local national initiatives), not consolidated at EU27 level**

10-steps general problem-solving process

- **Uncertainties** about the main input data of the below predictions : probability of occurrence of the GIEC 4 scenarios, from SSP1-2.6 (+1,6 to +1,8°C in 2100) to SSP 5-8.5 (+4,3 to +5°C)
 - **There is no most likely scenario, only proposed scenarios.**
- Step2 : **Predict** the future characterized weather problems, based on GIEC Scenario
 - **Predict** for the 244 European Regions the **future extreme weather events** for the coming decades to better characterize the risks in front of us.
 - Location of the phenomenon's occurrence
 - Type of extreme weather event (heat waves, floods, etc)
 - Amplitude of the problem (ex : Water level in the floods)
 - Frequency of the phenomena (once a century? Once a year?)
- Actual status :
 - **Extremely complex** scientific problem (long-term weather prediction, linked to real future GHG emissions).
 - Industrial need **prediction**, not **projections** (as we can't pay several studies/developments on different potential scenarios, too expensive, too uncertain in term of future market needs)

10-steps general problem-solving process

- **Uncertainties** about the main input data of the below predictions : probability of occurrence of the GIEC 4 scenarios, from RCP 2.6 (+1,6 to +1,8°C in 2100) to RCP8.5 (+4,3 to +5°C)
 - **There is no most likely scenario, only proposed scenarios.**
 - Variability of scenarios too large, to be refined to allow studies of new solutions with limited R&D budget.
 - See D2.2 Fig 4:

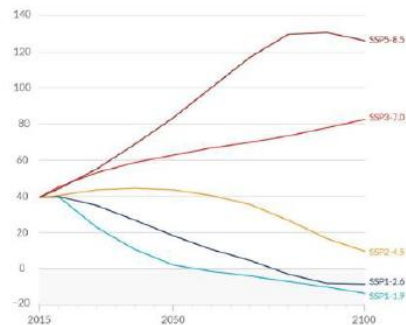


Figure 10: future annual CO2 emissions of the SSP scenarios

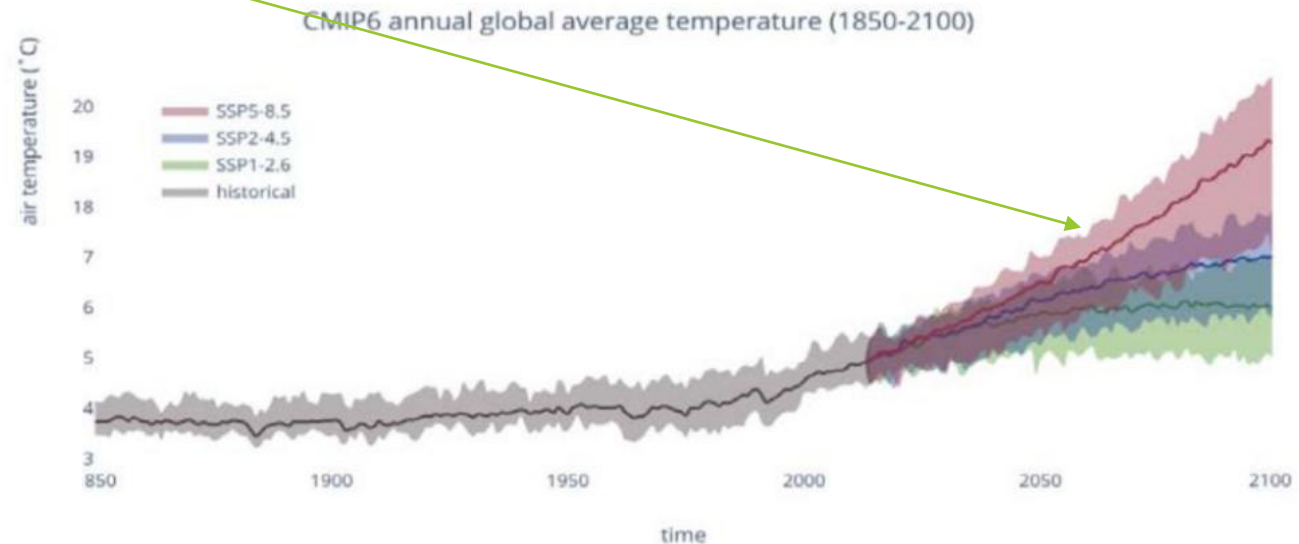


Figure 4: CMIP6 annual global average temperature (1850-2100) [19].

10-steps general problem-solving process

- Step3 : Define technically what “resilience to climate change” means exactly in railways
 - For Rolling Stock, Infra, Station, for each extreme weather event (flooding, heavy rains, heat waves, etc..), define the pertinent resilience KPIs and propose a single/agreed method of quantification at European level
- Actual status :
 - First step done (progress in Rail4Earth WP2)
 - General approach still pretty far away from being detailed enough to generate specifications of new solutions with these objectives : not yet exhaustive/mature/agreed/normalized at EU level).

10-steps general problem-solving process

- Step4 : **Define resilience objectives**
- Politics or Transport Authorities should describe their resilience to climate change technical and accurate objectives **for each type of extreme weather event** (linked to resilience KPIs of step 3)
 - Ex : maintain 95% the max speed of VHST in French Rhone Valley, the passenger load factor being maintained at 100%, when strong exceptional crosswinds of XX km/h blow in a given direction.
 - Potentially, define degraded accepted performances vs nominal performances
- Actual status : **Not started**

10-steps general problem-solving process

- Step5 : Update norms with new environmental conditions
- Update the suitable norms and technical specifications of RS, Infra and their sub-suystems / components to be fully compatible with points 2,3 and 4
- Actual status : first debate realised (list of potentially impacted norm), no general vision of what will be needed (too early)

10-steps general problem-solving process

- Step6 : Industrials : **Developp new technical solutions, more resilient to extreme weather events**
- **Technical future solution depends on the problem to solve** (ex : cross winds in storm generate very different solutions to Heat wave resistant trains)
- **R&D Costs, Product Development cost will be mainly assumed by private companies** : *clear business plans* (per platform and per problem to solve) will have to be built. **Customer ROI has to be demonstrated for each development**
- Actual status : **Not started (too early) except very limited exemple** (ex: potential impact on HVAC if ambient temperature rise by 5°C in Europe)

10-steps general problem-solving process

- Step6 : Developp new technical solutions, more resilient to extreme weather events
- An exemple of analysis on one of the most simpler use case : RS on board HVAC versus heat waves (D2.2 Fig 25) . The other problems are probably more complex....

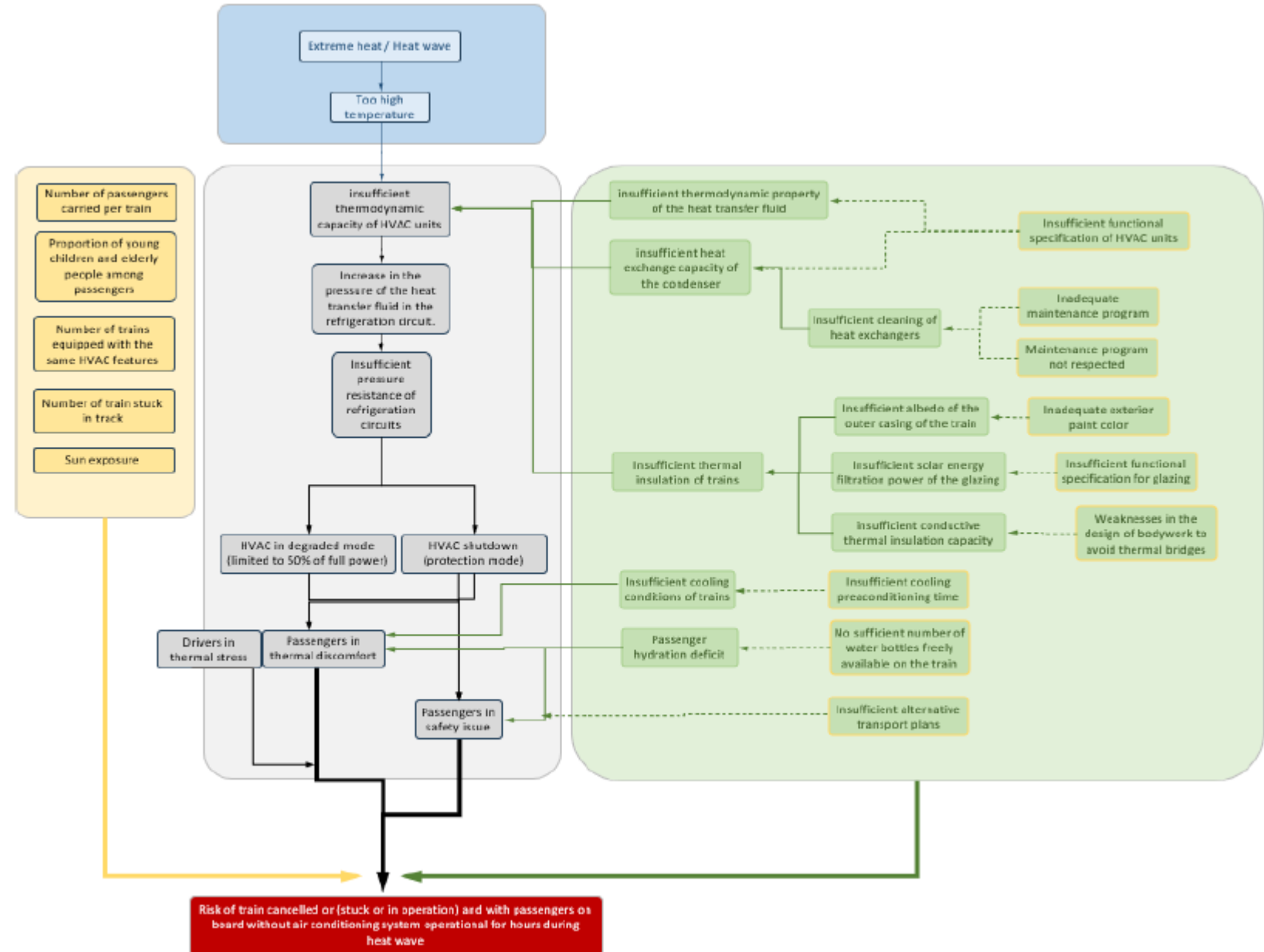


Figure 25: Impacts chain on rolling stock HVAC related to extreme heat events.

10-steps general problem-solving process

- Step7 : **Size the budget costs to deploy all of these solutions at European level/countries/ Regions**
- Consolidate the generalized costs to deploy resilient solutions for all assets (RS,Infra,Stations) for all needed extreme weather events
- Actual status : **Not started(too early) because the previous steps are not completed.**

Existing academic assessments are, by definition, very approximate because they are not directly linked to the reality of operators and industrials, the resilience objectives are not defined, and the costs of the solutions will have to be provided by industry only.

10-steps general problem-solving process

- Step8 : **Find the budget** to update the railways infra and RS with the solutions developed in point 6
- Question : if budget needs to have resilient solutions cost 50B€/year in Europe, **who is paying?** (Regions, States, private investment, ROSCO) and **how** (ticketing, public fundings, taxes) ?
- Actual status : **Not started**

10-steps general problem-solving process

Step9 : in parallel to step 8 : refined the budgets needs and **planify** work/developments per priorities

- Exchange with the related “**Finance for Climate Change**” project (ERJU) and European/National funding source to pay such new solutions deployment.
- Built a 2026-2050 years planning ,prioritize as needed and plan the investments for next decades
- Actual status : **Not started (too early).**

10-steps general problem-solving process

Step10 : **Organize the Call for tenders** of Commercial projects and deliver

- Check also that new solutions fullfill the resilience technical original objectives
- update the ROI files (additional cost vs economic savings)
- Actual status : **Not started (too early)**



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