

Administration des Chemins de Fer

Capacity Model 2028

Final version
16.07.26



LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de la Mobilité
et des Travaux publics

Administration des chemins de fer



optimising railways

Public

Summary

- 1. Introduction and process overview**
2. Data and assumptions
3. Capacity planning
4. Consultations
5. Results

Introduction

Purpose of this document

The purpose of the Capacity Model 2028: publish results, describe the methodology, and list the data and assumptions used.

Context

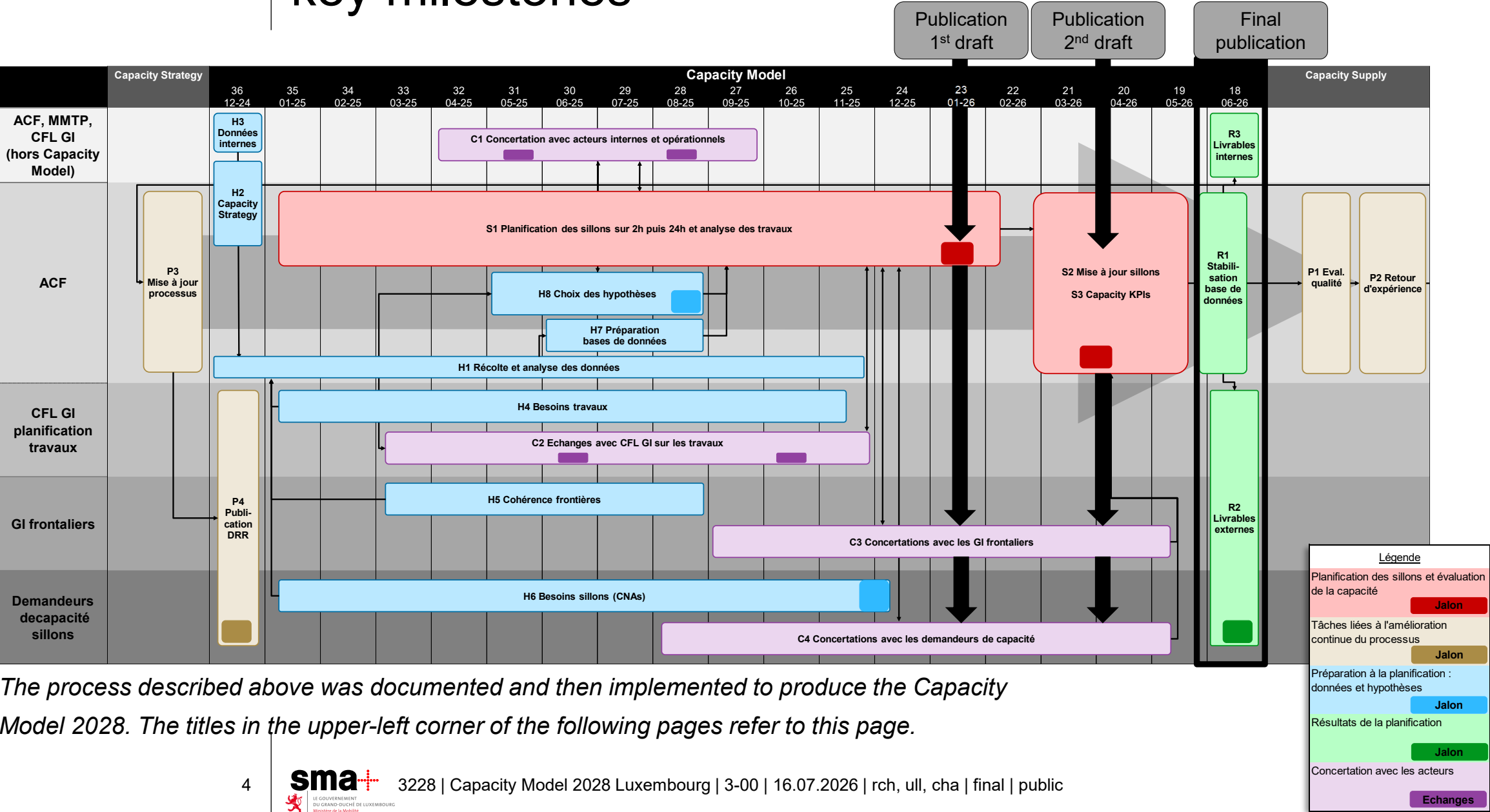
This Capacity Model is shared with:

- Neighboring infrastructure managers to harmonize capacity volumes and timetables on borders
- Applicants to coordinate capacity needs announcements
- RNE

Capacity volumes and timetables may be subject to adaptations after publication of the Capacity Model, due to the non-binding nature of the document. *For reminder : « Strategic capacity planning (Capacity Strategy, Capacity Model, Capacity Supply Plan) does not guarantee automatic allocation of capacity rights to specific applicants »*

Nevertheless, this Capacity Model serves as data source to capacity planning while implementing the Capacity Supply Plan 2028, between June 2026 and January 2027.

Timeline overview with stakeholders, steps and key milestones



The process described above was documented and then implemented to produce the Capacity Model 2028. The titles in the upper-left corner of the following pages refer to this page.

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Capacity Strategy 2028 and internal data sources

- Capacity Strategy**
- Informations provided by the Capacity Strategy 2028 were considered as main data input
 - Changes compared to the Capacity Strategy 2028 :
 - Attempted extension of an existing RB train path to Ehrang → not yet implemented
 - Attempted insertion of a cross-border freight service in Zoufftgen → not implemented
 - Attempted addition of a cross-border long-distance train path at Kleinbettingen → carried out under certain conditions

- Other internal data sources**
- A planning guide has been published for the Capacity Model 2028's timetable; it contains:
- Journey time buffers
 - Minimum turnaround times by rolling stock
 - Train headways on tracks
 - Minimum dwell times at nodes
 - Train separation times at the stations

TCRs

The TCRs planned by CFL IM and published on ACF's website for timetabling year 2028 are considered :

- The planned TCRs were analyzed to publish TCR-related KPIs,
- The following TCR scenarios are accounted for in the Capacity Model for timetable 2028:
 - Hollerich
 - Ettelbruck

Harmonization with neighboring IMs

The systematic timetable, or netgraph has been coordinated with neighboring infrastructure managers:

- The systematic timetable has been coordinated with SNCF Réseau and is consistent with the French PER netgraph,
- the systematic timetable has been coordinated with Infrabel; it is consistent for freight services, though still under review for passenger services,
- the systematic timetable is consistent with mKoK (DB InfraGO) for passenger services; it is still under review for freight services.

Stakeholder consultations on capacity needs

Meetings were held with stakeholders who had come forward:

- To present the process, discuss the methodology, the schedule, the various points of discussion, and the necessary inputs,
- To discuss the development of the systematic timetable, or netgraph, which precedes the Capacity Model.

Various requirements to establish the standard-day Capacity Model variant were collected via email.

Database preparation

ACF's Viriato database has been expanded to include:

- The railway infrastructure planned for timetabling year 2028 (topology),
- Headways and train separation times planned for timetabling year 2028, according to the Planning Guide,
- The rolling stock used to plan the various train paths.

The travel times calculated in Viriato are calibrated against those from RailSys provided by CFL IM, except for lines L1, L6, and L8, where the travel times are taken directly from RailSys and are not recalculated in Viriato. For certain train paths, the operational RailSys software (ACF) is used.

Headways and train separation times are derived from RailSys, provided by CFL IM, and from input provided by CFL EI (infrastructure operator); they are listed in the Planning Guide. For certain spacing values, the operational RailSys software (ACF) is used.

Selection of assumptions

- Reference Infrastructure 2028: selected and modeled based on the various plans provided by CFL IM. Changes compared to the current situation:
 - NBS (line L8 « Luxembourg-Bettembourg-frf ») placed into service,
 - TCRs at Hollerich,
 - Accounting for reduced capacity at Bettembourg to anticipate TCRs in the coming years,
 - Improved performance of Line 1 (through block-resizing).
- Reference rolling stock for each train path :
 - Selected and modeled; for passenger service, this corresponds to CFL RU's requirements,
 - For freight, the following characteristics are used: short MA90 = 161 m, 966 t, DE18 locomotive, 75% braking,
 - For freight, the following characteristics are used: long MA90 = 522 m, 1,662 t, BR188 locomotive, 75% braking,
 - For freight, the following characteristics are used: MA90 SNCF = 732 m, 2,400 t, 2x27000 locomotive,
 - For freight train paths in Rolling Planning, the characteristics of ATT train paths are used.

Selection of assumptions

- Minimum frequency of TCRs for integration: 6 months of the year,
- Selection of stations where track-occupation charts and shunting operations are analyzed: Luxembourg, Rodange, Pétange, Bettembourg,
- Integrated train paths: operating at least 4 days per week..

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Capacity planning: 2-hour systematic timetable

A 2-hour systematic timetable chart or netgraph is planned based on:

- The published Capacity Strategy 2028 (number of train paths by type and per hour at borders),
- the timetables of the years 2025 and 2026,
- the capacity needs for timetabling year 2028.

Train paths are scheduled on the main line and at the stations in Rodange, Pétange, Luxembourg, and Bettembourg. They are scheduled to be compatible with one another, in accordance with the values for headways and train separation times, specified in the Planning Guide.

Capacity planning: 24-hour timetable

Annual timetable

Commercial train paths from the Annual Timetable are planned for a standard day based on announced needs

Shunting operations

Shunting operations are scheduled based on needs announcements, the current timetable, and whether they impact the commercial train paths published in the Capacity Model. Without final rolling stock assignments, there is no guarantee that they will operate on the line or at stations (they do not appear in the published exports).

Conflicts

Train paths are planned on the line segments and at the nodes, such as Rodange, Pétange, Luxembourg, and Bettembourg stations. They are scheduled to be compatible with one another, in accordance with the values for headways and train separation times, specified in the Planning Guide.

Rolling stock

Track-occupation charts were planned, while including the information provided by CFL RU regarding schedules of current rolling stock.

Freight trains Rolling Planning

Both during the day and at night, train paths for freight are available in the systematic timetable but not corresponding to identified needs are accounted for in order to preserve this capacity for Rolling Planning.

Capacity KPIs

Maps illustrating capacity utilization by line segments, junctions, and stations are generated:

- Based on the systematic timetable (2-hour intervals)
- Based on the Capacity Model (24-hour time span),

They take into account the headways and train separation times, specified in the Planning Guide. The timetable is compressed in accordance with the principles of UIC 406.

Analysis of planned TCRs

Analyses of planned TCRs were conducted using two methods:

- A method in which the impact of TCRs on **available capacity is calculated in absolute terms** (safeguarded capacity for TCRs relative to the total capacity—day and night—available over the course of the year),
- A method in which this impact is calculated **relative to the train runs planned** in the Capacity Model (i.e., on a standard day), and thus relative to the number of train paths affected by the TCRs.

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Consultations with internal, external, operational and political stakeholders

CFL EI (infrastructure operator department)

CFL EI was consulted to :

- Share the values for headways and train separation times, utilized in planning phase,
- share track occupancy planning.

MoT

Discussions were held with Luxembourg's Ministry of Transport and Public Works to share planned elements, and in particular to ensure consistency with long-term planning.

Exchanges with CFL IM on TCRs

Numerous exchanges took place with CFL IM as part of CFL IM's participation in setting up the Viriato database and developing the Planning Guide for this first edition of the Capacity Model.

On TCR-related topics, discussions also took place to:

- Fully understand and integrate all TCRs planned for 2028 into Viriato,
- Model the TCR at Hollerich.

Exchanges with Neighboring IMs

Discussions were held to present the process and ensure consistency in the systematic timetable chart or netgraph; see H5.

The timetable for a standard day (24 hours) was also provided to neighboring infrastructure managers as part of the drafts, in order to harmonize not only the systematic timetable chart and capacity volumes but also the complete 24-hour graphic timetable.

As TCRs have not yet been planned in Belgium, the capacity volumes presented in this document are subject to the TCRs in Belgium.

Exchanges with Applicants

Discussions took place to present the process, gather input, and develop the systematic timetable chart; see H6.

Discussions were also held to finalize the various drafts and this final publication. Capacity requests from applicants were accounted for.

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Deliverables (published)

Method for producing the deliverable: number of train paths per segment, per direction, per time slot, and per type.

The number of train paths in the Capacity Model is calculated:

- By homogeneous network segment,
- By direction,
- By type of train (path).

The following choices are made for graphical representation:

- Time slots are assigned based on the start time of each train path in the section in question,
- Available capacity (particularly for ad hoc train paths, such as technical movements), which is unplanned, can be calculated by subtracting the number of planned train paths from the theoretical number of possible train paths on the line (see following pages), although this exercise remains highly theoretical and has limitations.

Deliverables (published)

Definition of ICL (TTR Handbook)

The ICL (Intended Capacity Usage Line) represents the level of traffic that a line can accommodate on a stable basis without resorting to exceptional traffic management measures. It indicates whether there is any remaining available capacity, particularly to meet requests for ad hoc train paths without compromising the stability of the schedule. It is expressed as the number of train paths per hour.

ICL calculation

The ICL must be calculated on a line-by-line basis, excluding nodes, for:

- each line on the network, it is possible to refine the data by section,
- a specific time period of your choice: the ICL is broken down here by time of day. One value for the daytime period [5:00 a.m.; 12:00 a.m.], and a value for the nighttime period [12:00 a.m.; 5:00 a.m.].

Reminder: The ICL does not account for all constraints. This value must be interpreted with the utmost caution.

Deliverables (published)

ICL calculation based on the Draft V2

Calculation for daytime (05:00 → 00:00)

The ICL is calculated based on the systematic timetable. The systematic timetable is saturated—without modifying the timetable—by adding train paths similar to those in the systematic timetable, while analyzing their entire route on Luxembourg’s network.

The resulting volume over a 1-hour period of the saturated systematic timetable is the ICL. If it is not possible to add additional train paths, the value assigned to the ICL is the train path volume of the systematic timetable.

Deliverables (published)

Based on the Draft V2

Calculation for nighttime (00:00 → 05:00)

Capacity is measured in freight train paths and depends on speed (consistency) and train scheduling. This capacity is measured in freight train paths, but it would be possible to allocate passenger train paths within it, depending on demand.

Residual capacity (at night, the freight train paths of the systematic timetable are activated) is filled by freight train paths (those from the systematic timetable are used, analyzed over their entire route on Luxembourg's network), by alternating train paths with different characteristics to provide an estimate of the number of available freight train paths within the residual capacity.

The various ICLs therefore cannot be added together. If an additional train path is requested on L3, it may conflict with a saturated train path on L6. This method is used to avoid making assumptions about traffic volumes.

The nighttime ICL is therefore the sum of the saturated train paths and the freight train paths from the systematic timetable that are activated for Rolling Planning.

When the section is not subject to nighttime ICL calculations, the daytime ICL is displayed.

Deliverables (published)

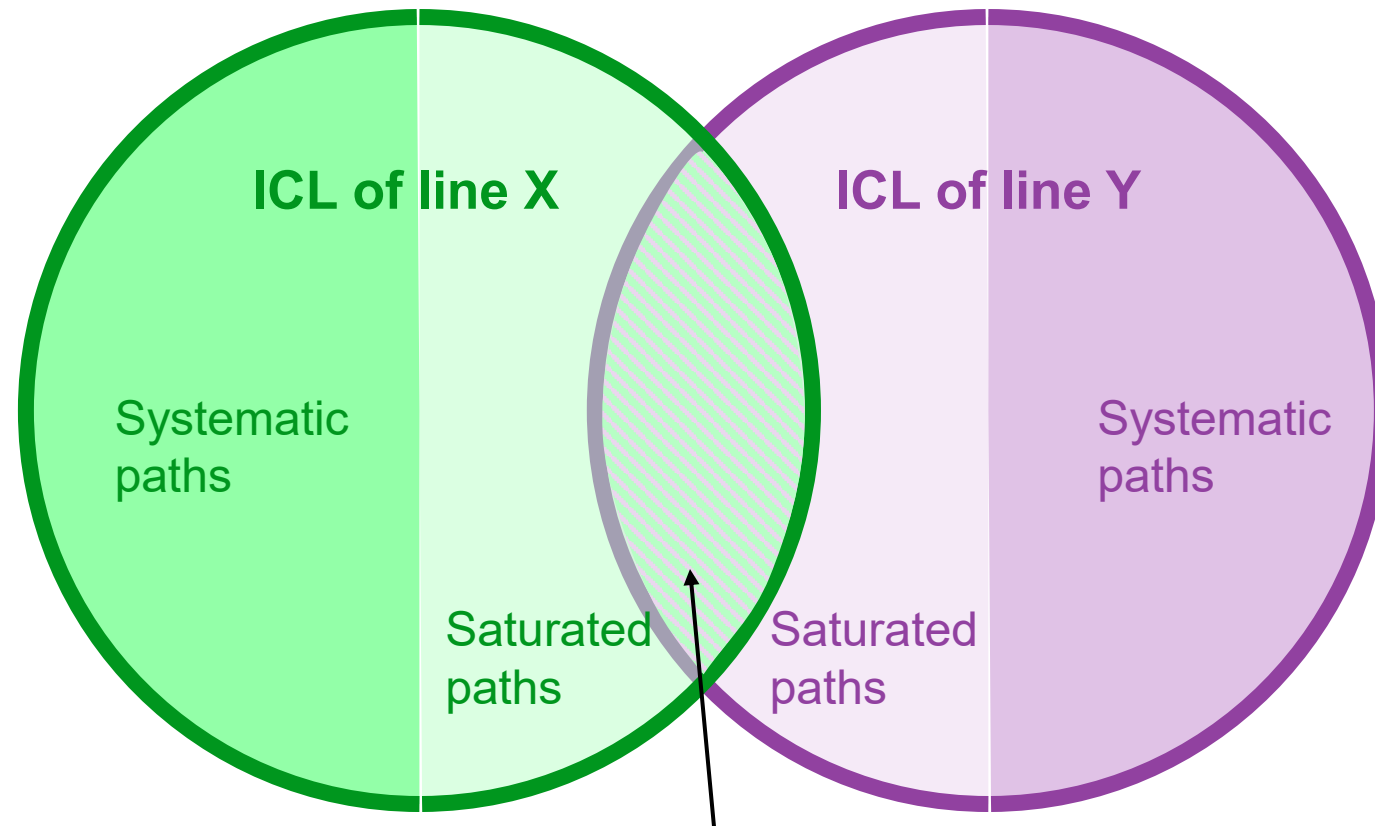
sur la base du draft V2

On certain lines, the calculated nighttime ICL is lower than the daytime ICL. These cases may seem inconsistent because only the timetable of freight trains is maintained at night. Cases where the nighttime ICL is lower than the daytime ICL on the same line are due to the routes of the freight train paths:

- The calculation rule chosen for the nighttime ICL is to saturate the line with freight train paths whose routes match those of the freight schedule, while maintaining the freight train paths from the schedule across all lines and prioritizing alternating service (no consecutive freight trains),
- Freight routes operate in mixed traffic across multiple lines—and thus with freight train paths from the systematic timetable of different lines—and, furthermore, run on sections with operational constraints, thereby multiplying the challenges of fitting them into the saturated timetable.

Deliverables (published)

The ICLs between several lines cannot be added together because saturated train paths are scheduled without considering the saturated train paths of other lines, which are likely to conflict. These saturated train paths are, however, compatible with the network train paths of all other lines.



Incompatible saturated train paths
between both lines

Analysis of planned TCRs

The tables below present the capacity analysis of the various types of TCRs, **as currently scheduled by CFL IM**, and published on ACF’s website.

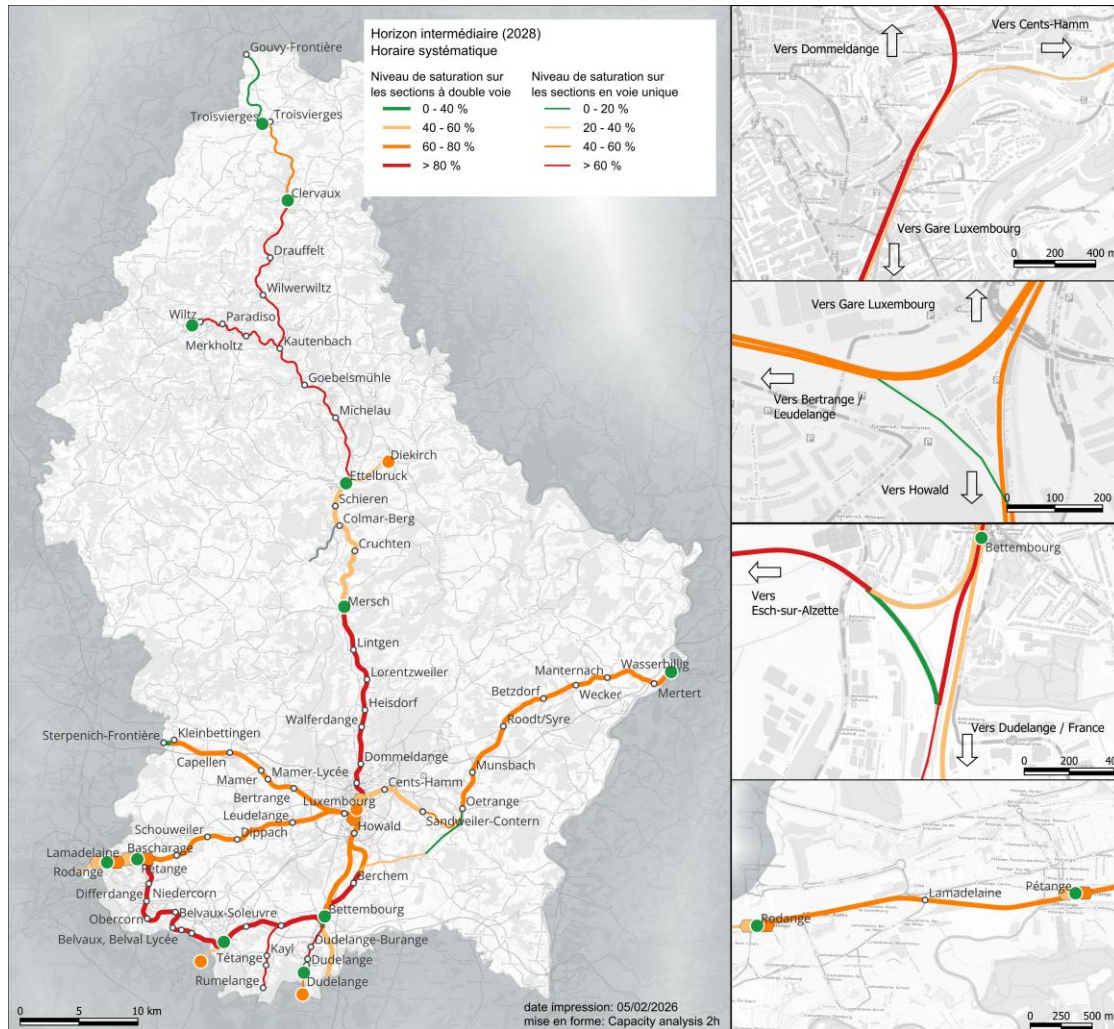
The analyses of the scheduled TCRs were conducted using two methods:

- A method in which the impact of TCRs on **available capacity is calculated in absolute terms** (safeguarded capacity for TCRs relative to the total capacity—day and night—available over the year),
- A method in which this impact is calculated **relative to the train runs planned in Draft V2 of the Capacity Model** (i.e., on a standard day), and thus relative to the number of train paths affected by the TCRs.

	Method 1	Method 2
	By period of restriction	Based on the train movements affected
Total capacity reserved for TCRs	10%	12%

Major/High Impact	4%	7%
Medium Impact	6%	6%
Minor Impact	> 1%	> 1%

Infrastructure utilization rate based on the systematic timetable (netgraph)



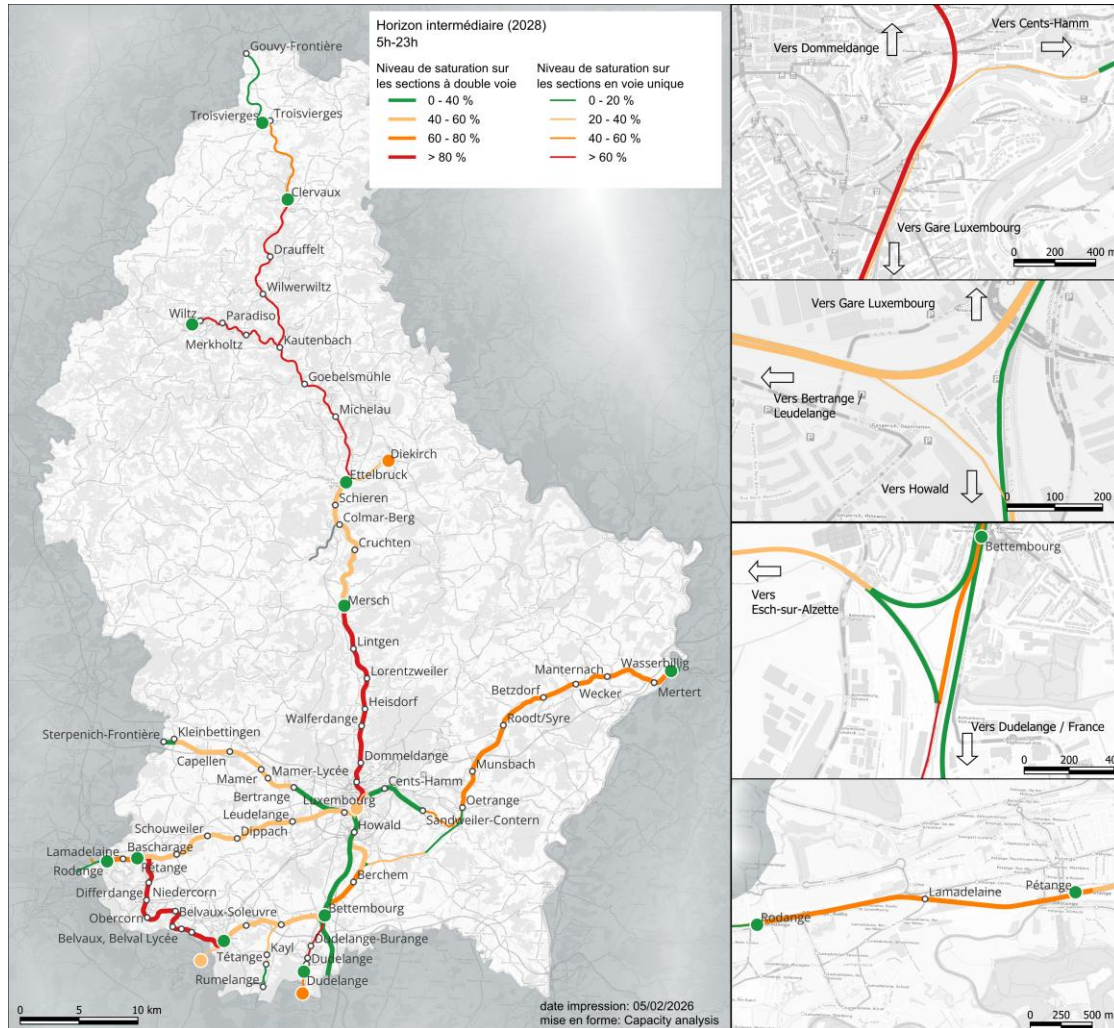
Please note: The map shown here was created by compressing the timetable using the UIC 406 method; the results are highly dependent on the division into basic sections.

These results show the level of capacity utilization on the sections, not whether or not it is possible to insert end-to-end train paths on them.

These calculations were based on:

- The systematic timetable underlying Draft V2
- The headways and train separation times initially provided by CFL IM

Infrastructure utilization rate by timetable – Capacity Model (daytime)



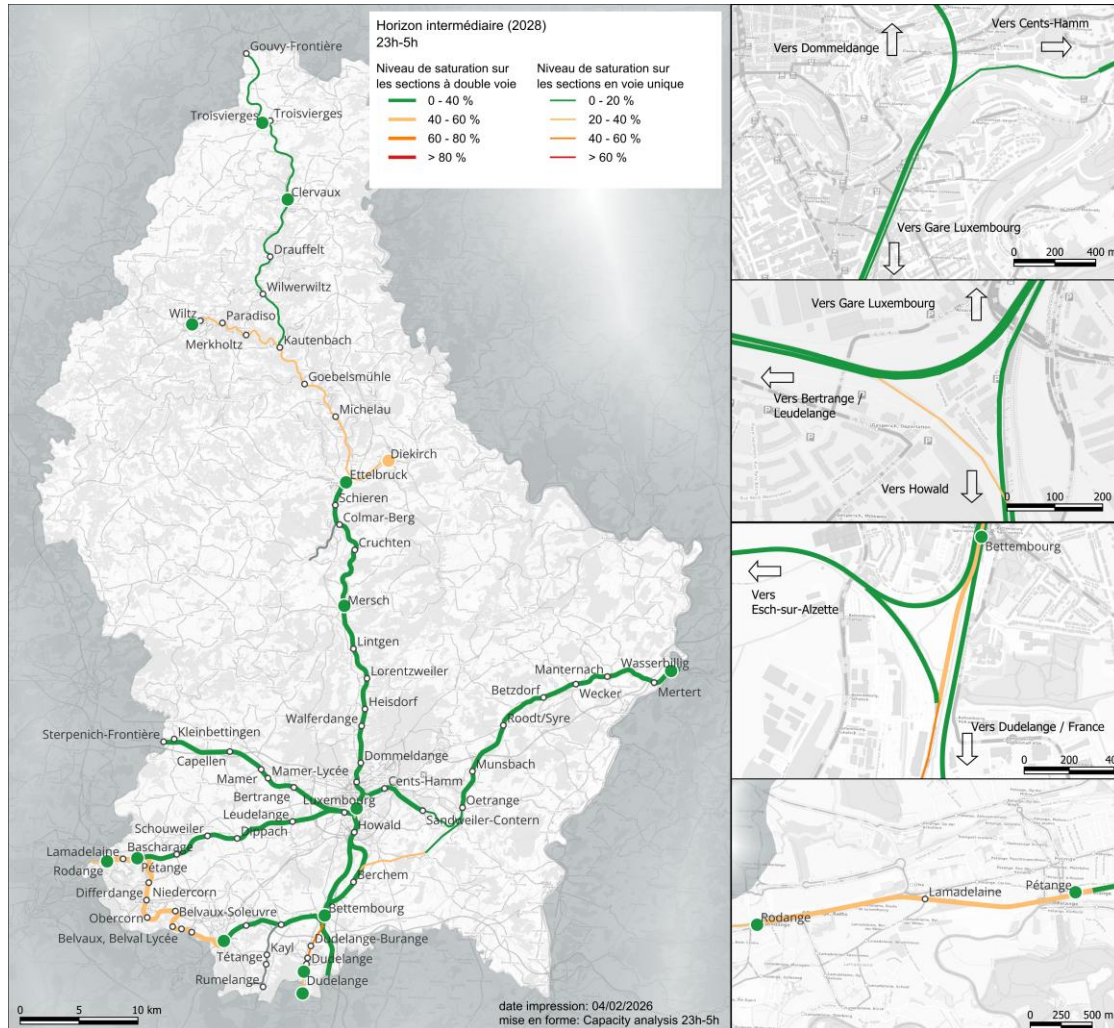
Please note: The map shown here was created by compressing the timetable according to the UIC 406 method; the results are highly dependent on the division into basic sections.

These results show the level of capacity utilization on the sections, not whether or not it is possible to insert end-to-end train paths there.

These calculations were based on:

- The timetable underlying Draft V2
- The headways and train separation times initially provided by CFL IM

Infrastructure utilization rate by timetable – Capacity Model (nighttime)



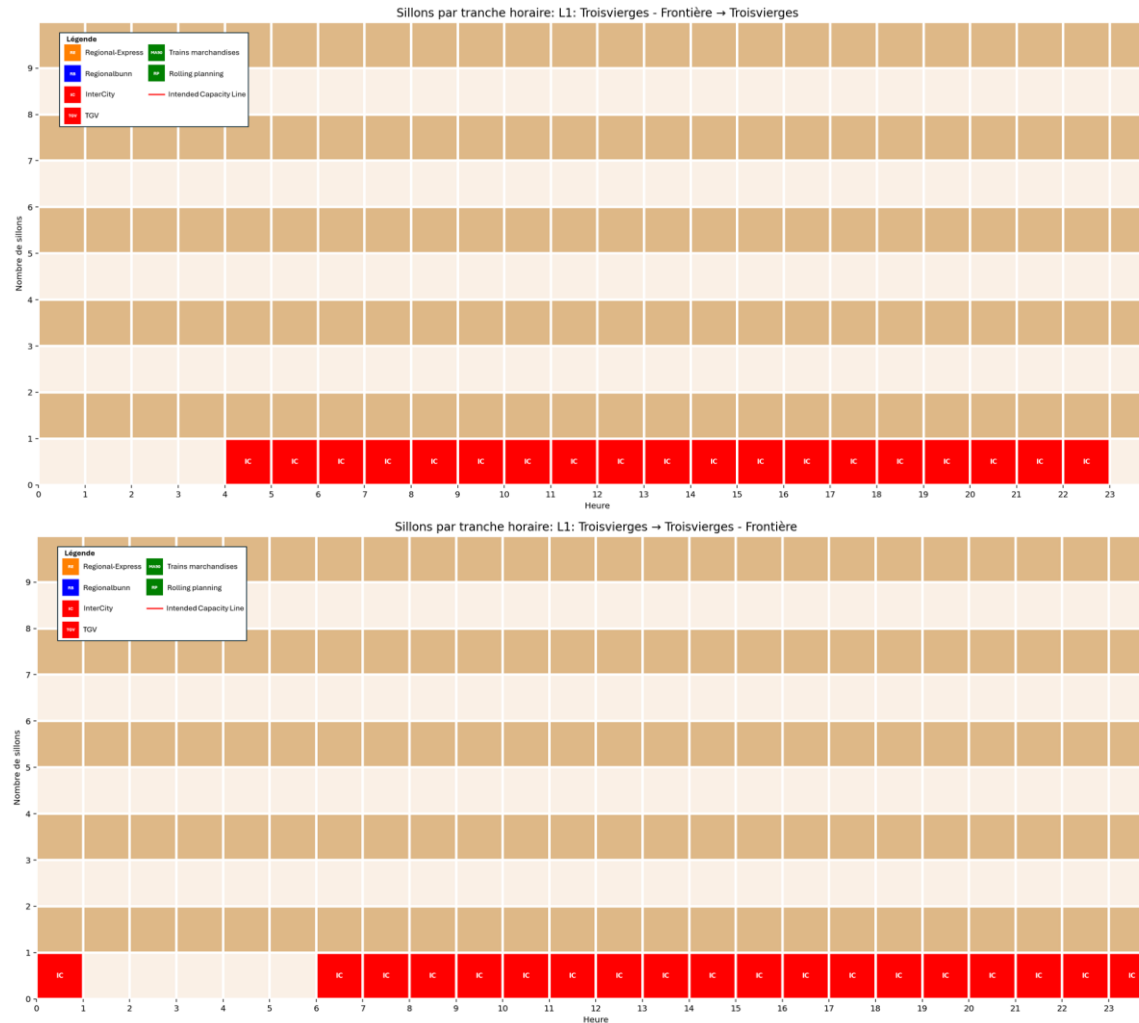
Please note: The map shown here was generated by compressing the timetable using the UIC 406 method; the results are highly dependent on the division into basic sections.

These results show the level of capacity utilization on the sections, not whether or not it is possible to insert end-to-end train paths there.

These calculations were based on:

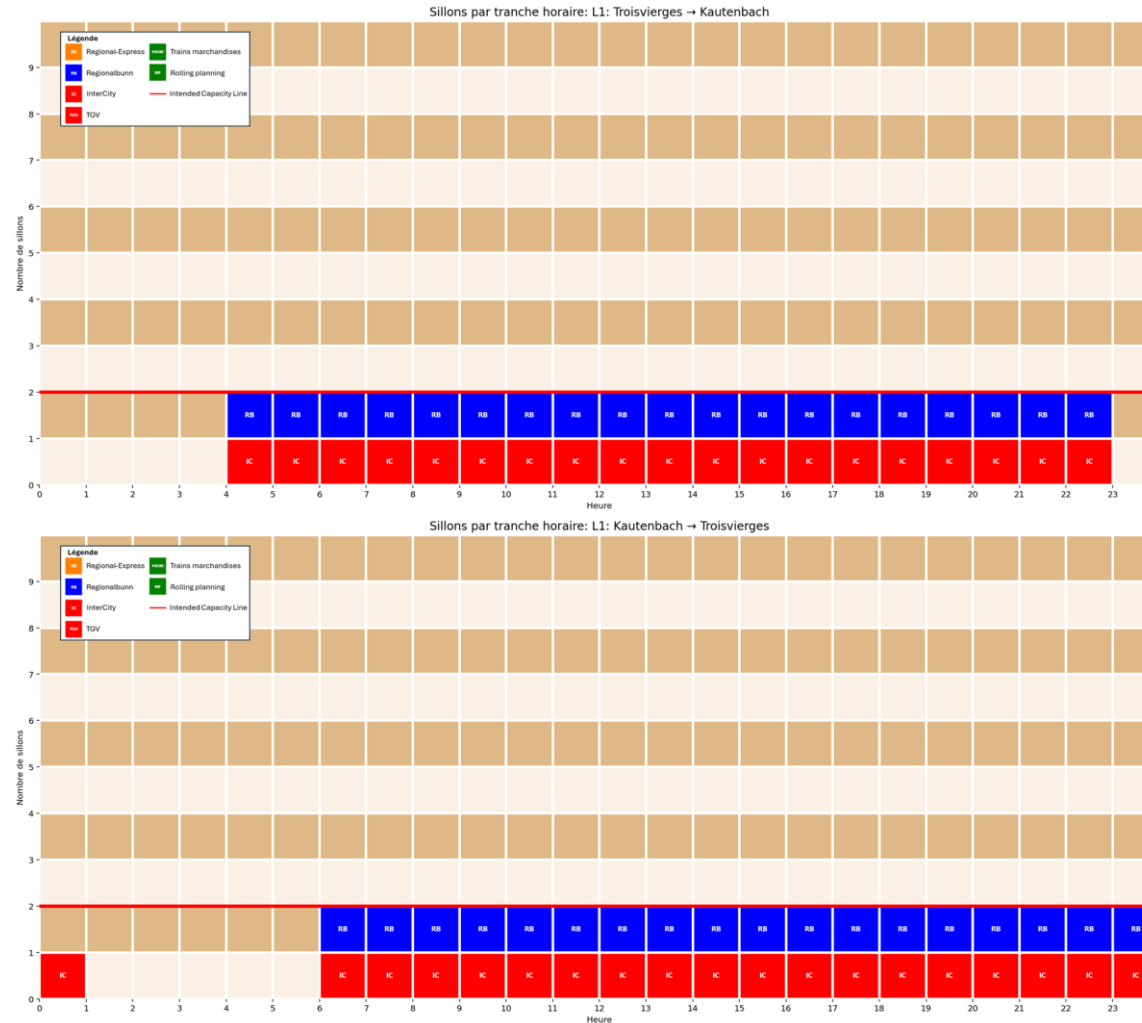
- The timetable underlying Draft V2
- The headways and train separation times initially provided by CFL IM

L1 – Gouvy border point ↔ Troisvierges

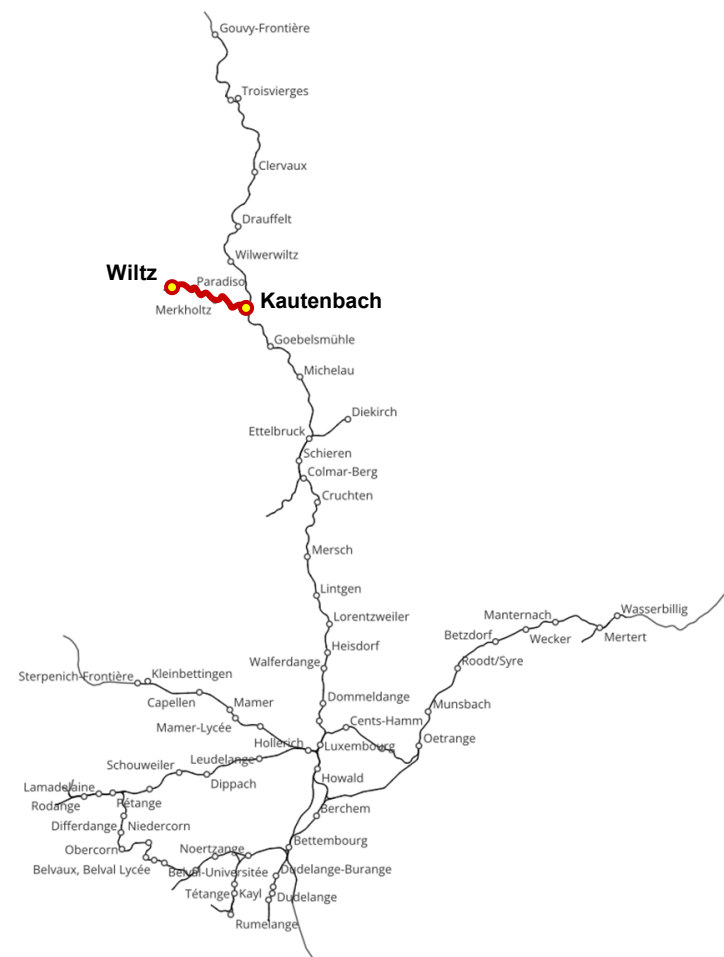
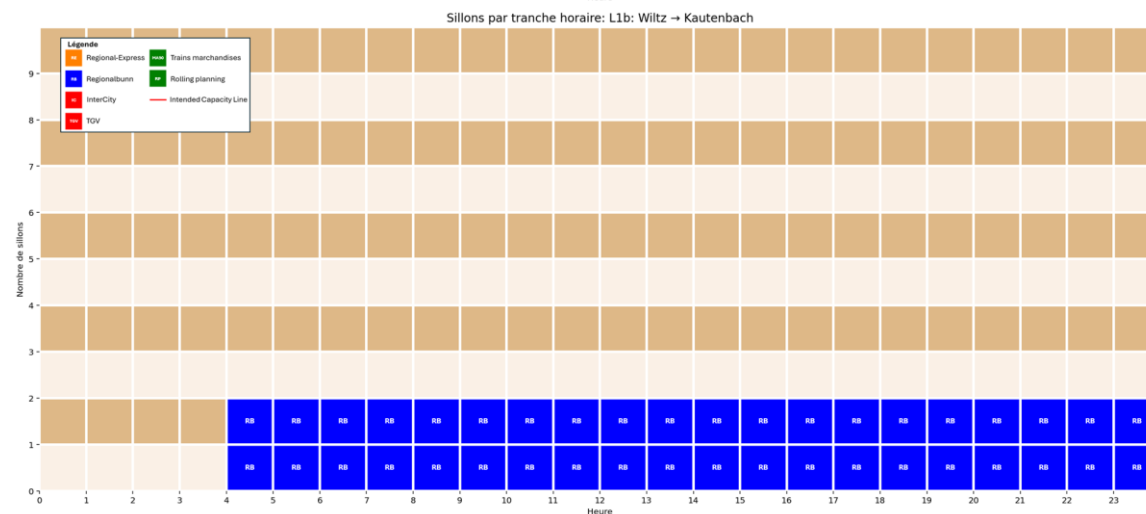


R2

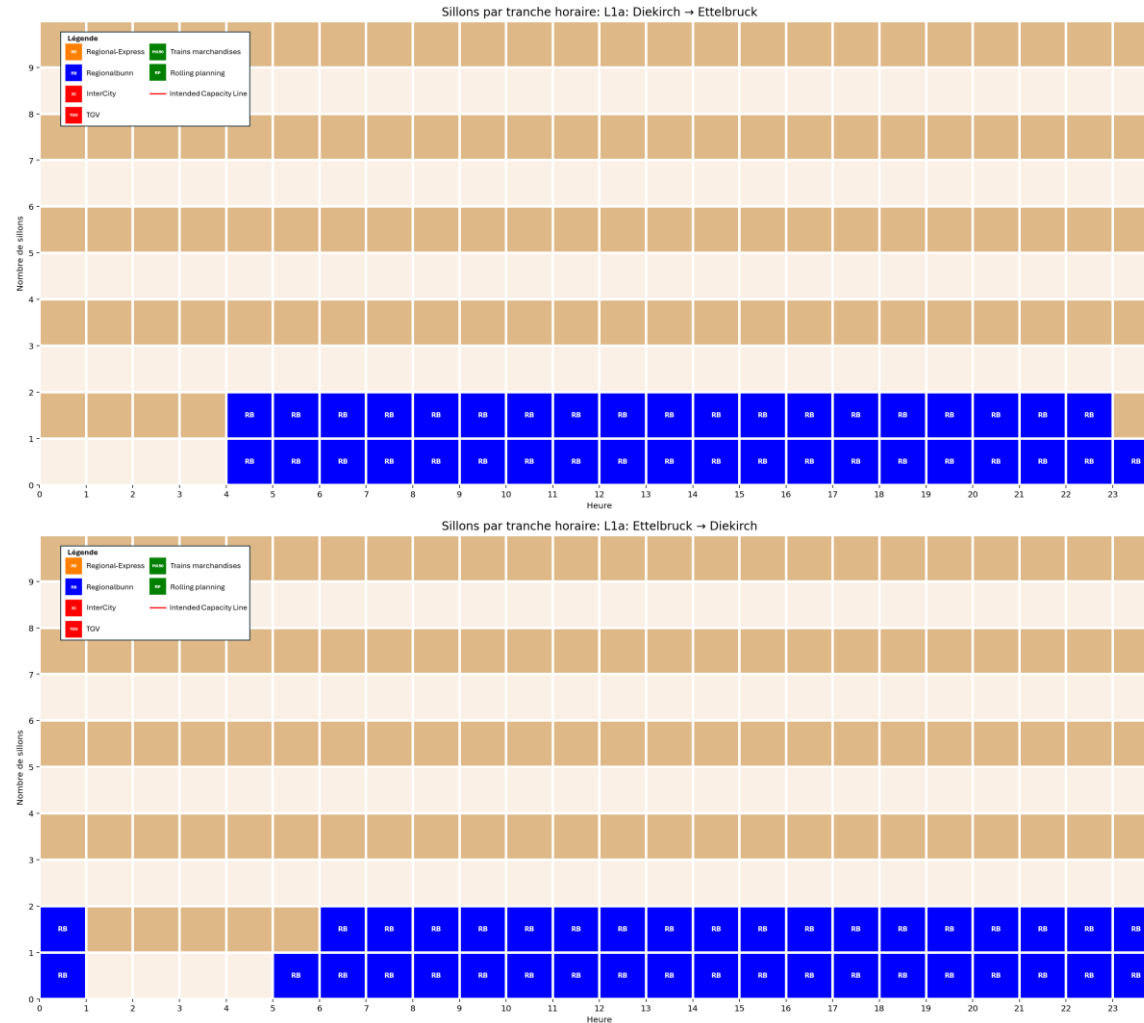
L1 : Troisvierges ↔ Kautenbach



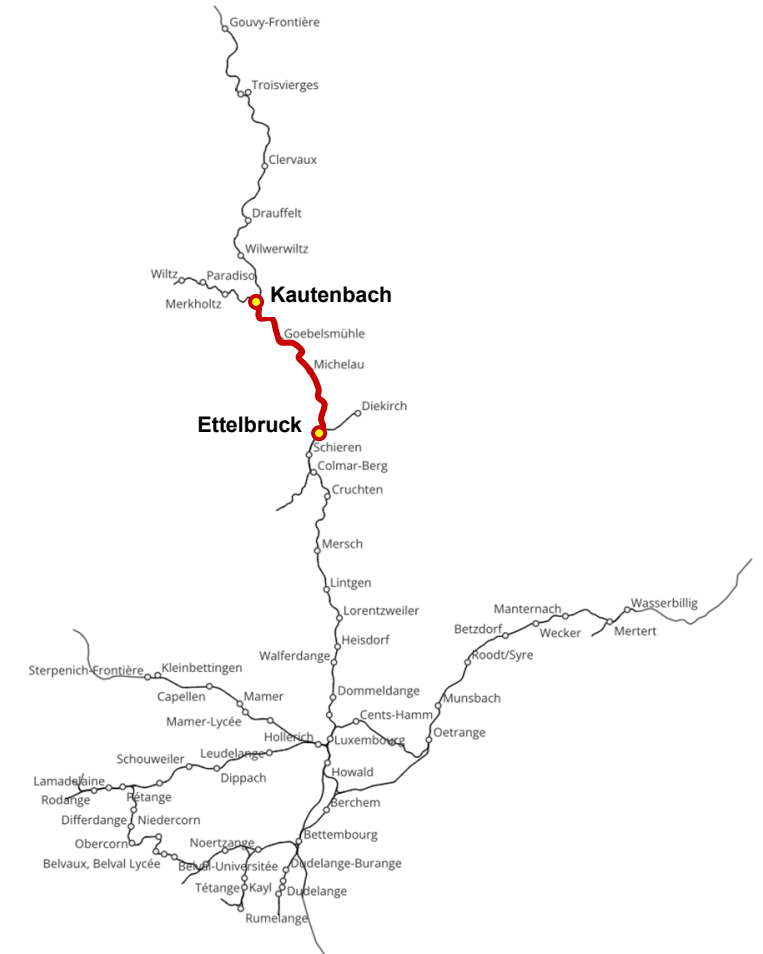
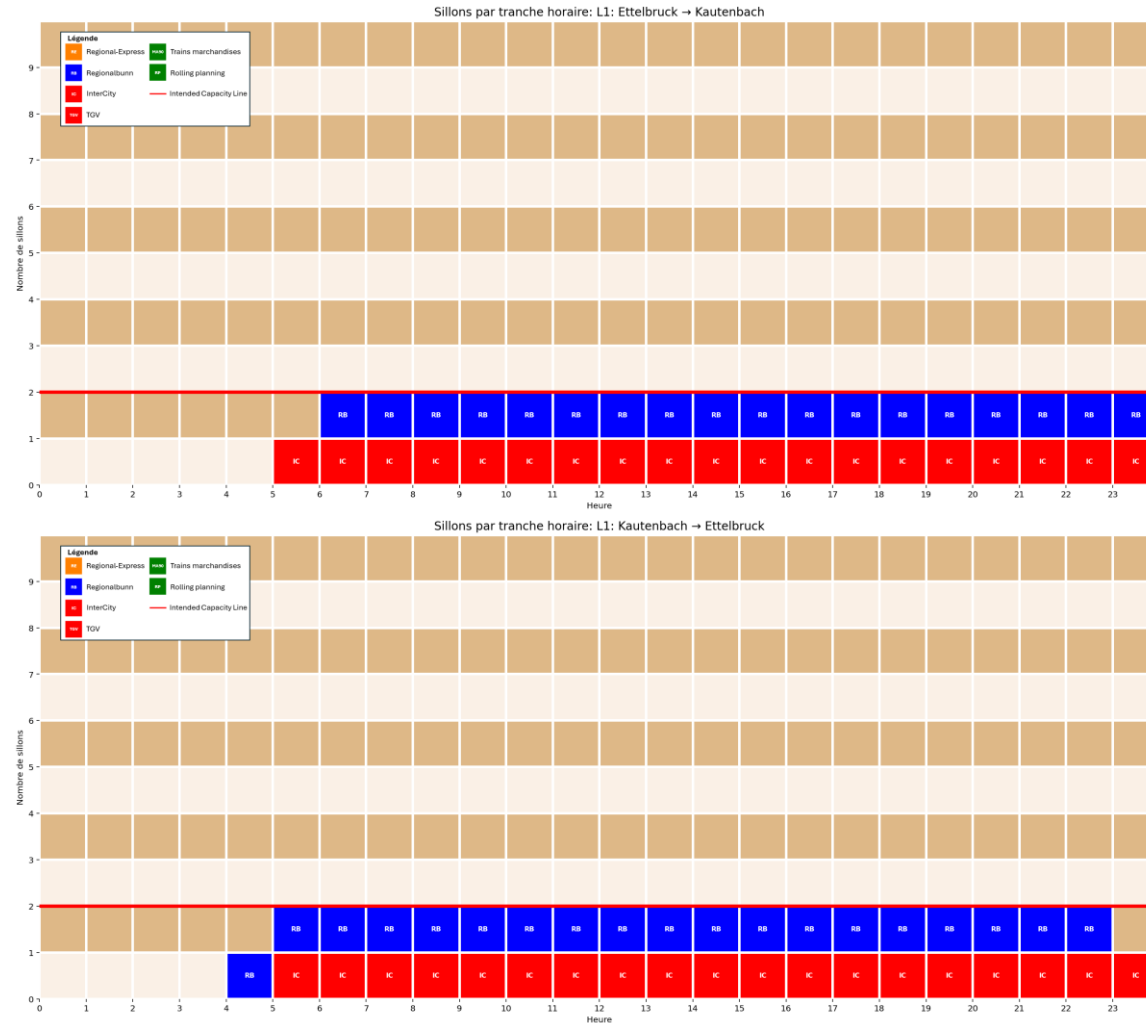
L1b : Wiltz $\leftrightarrow$ Kautenbach



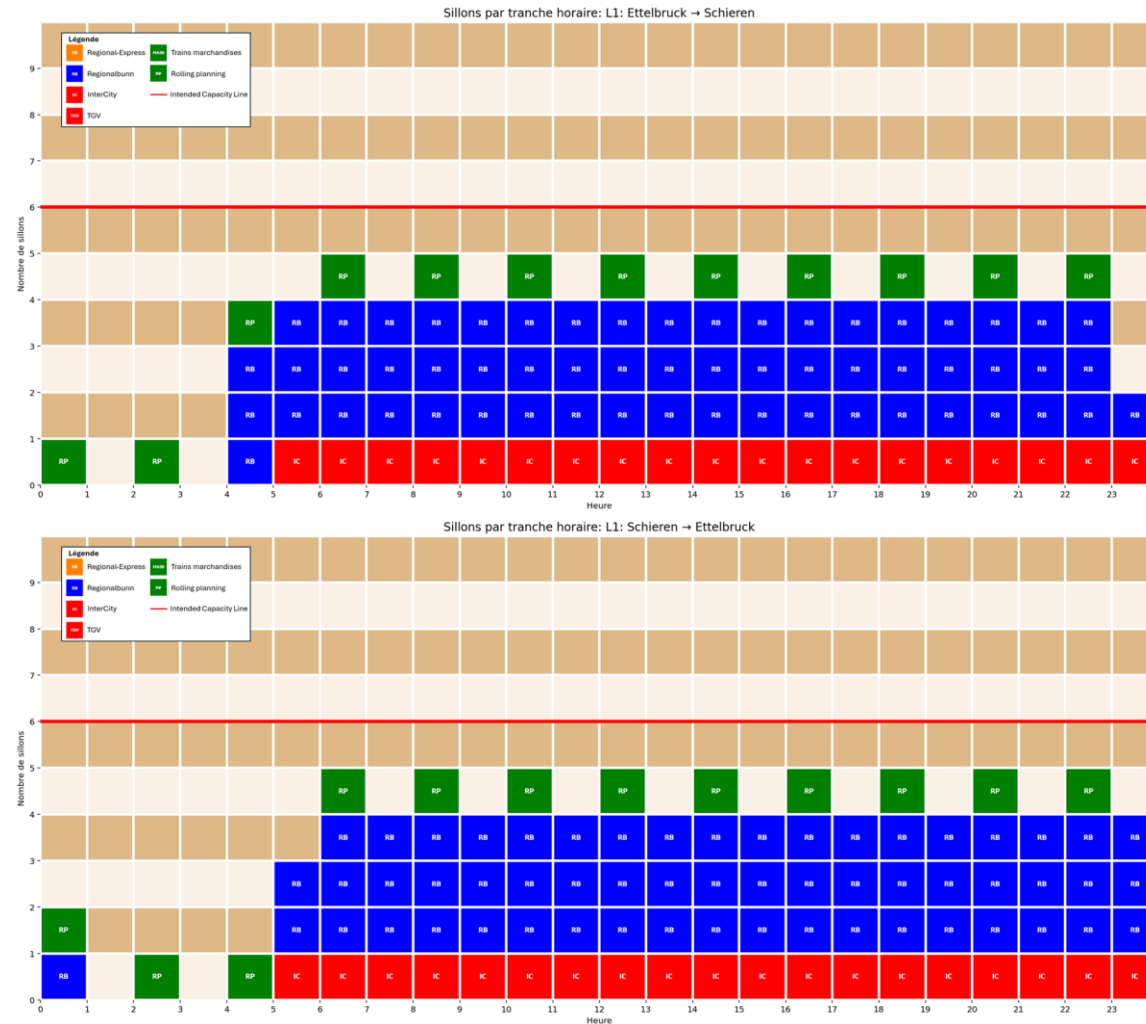
L1a : Diekirch ↔ Ettelbruck



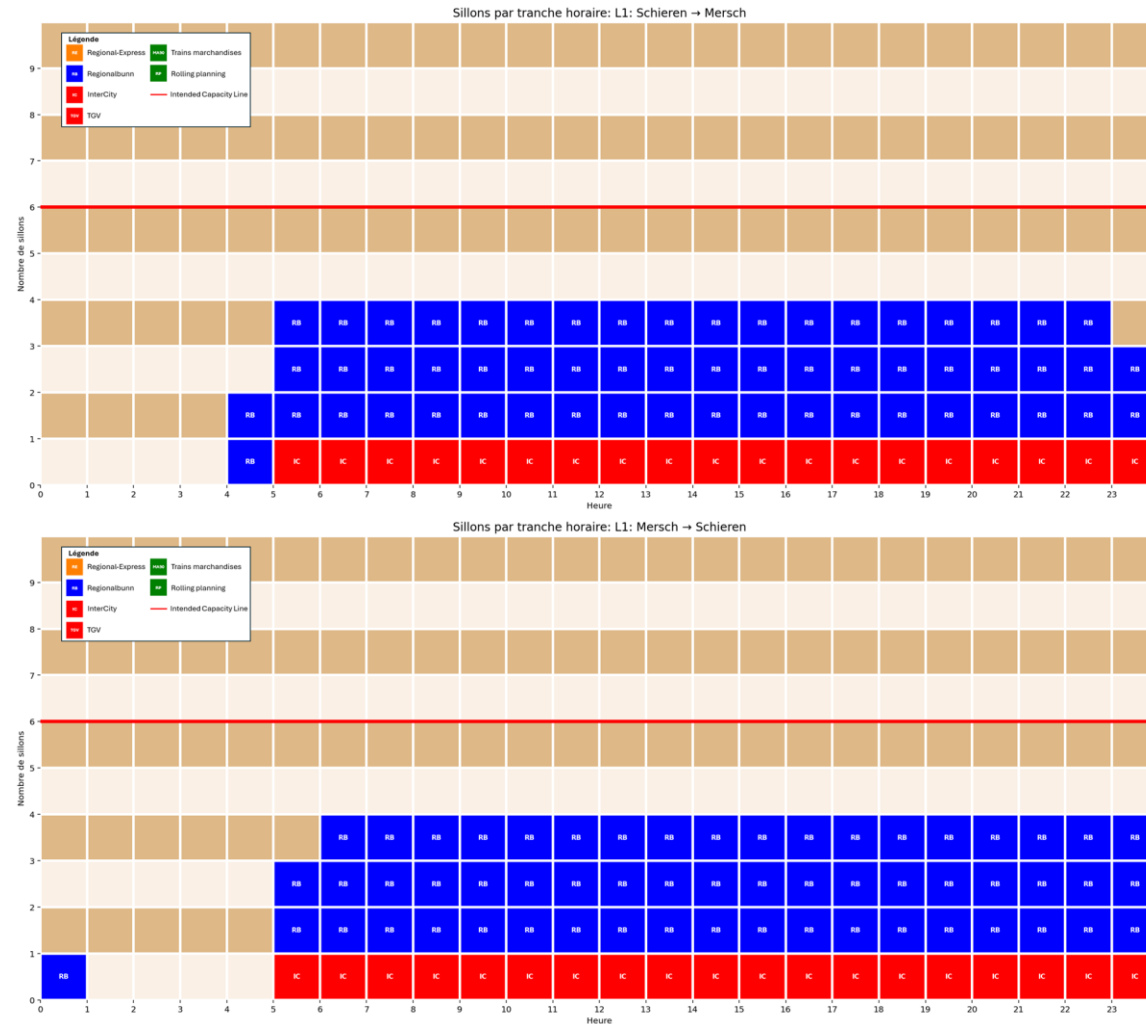
L1a : Kautenbach ↔ Ettelbruck



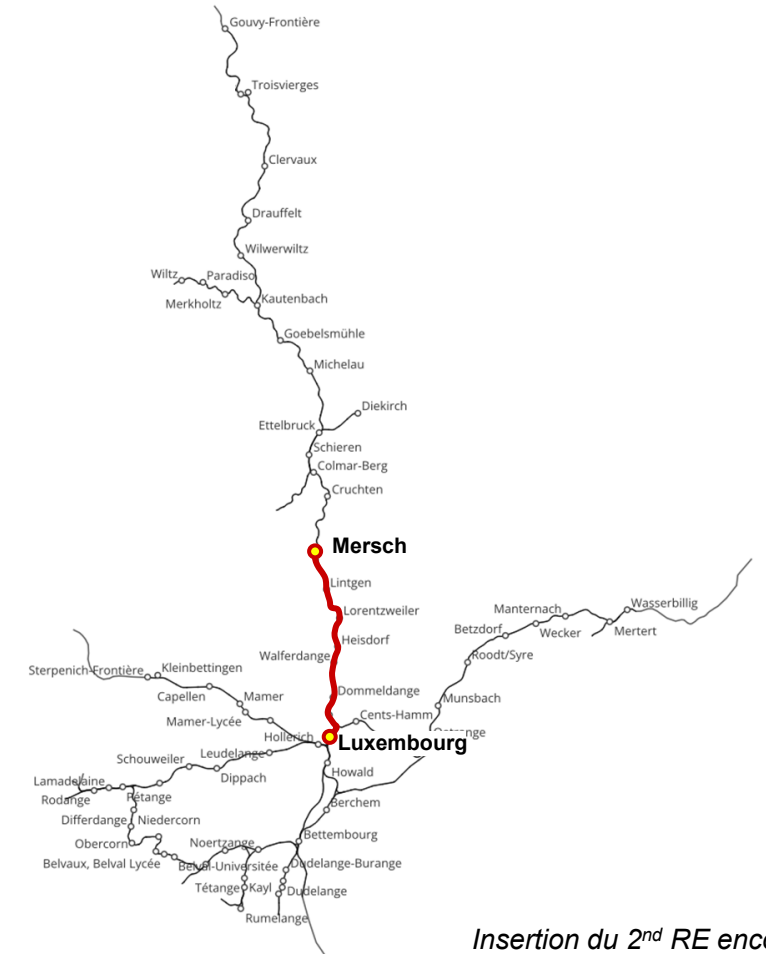
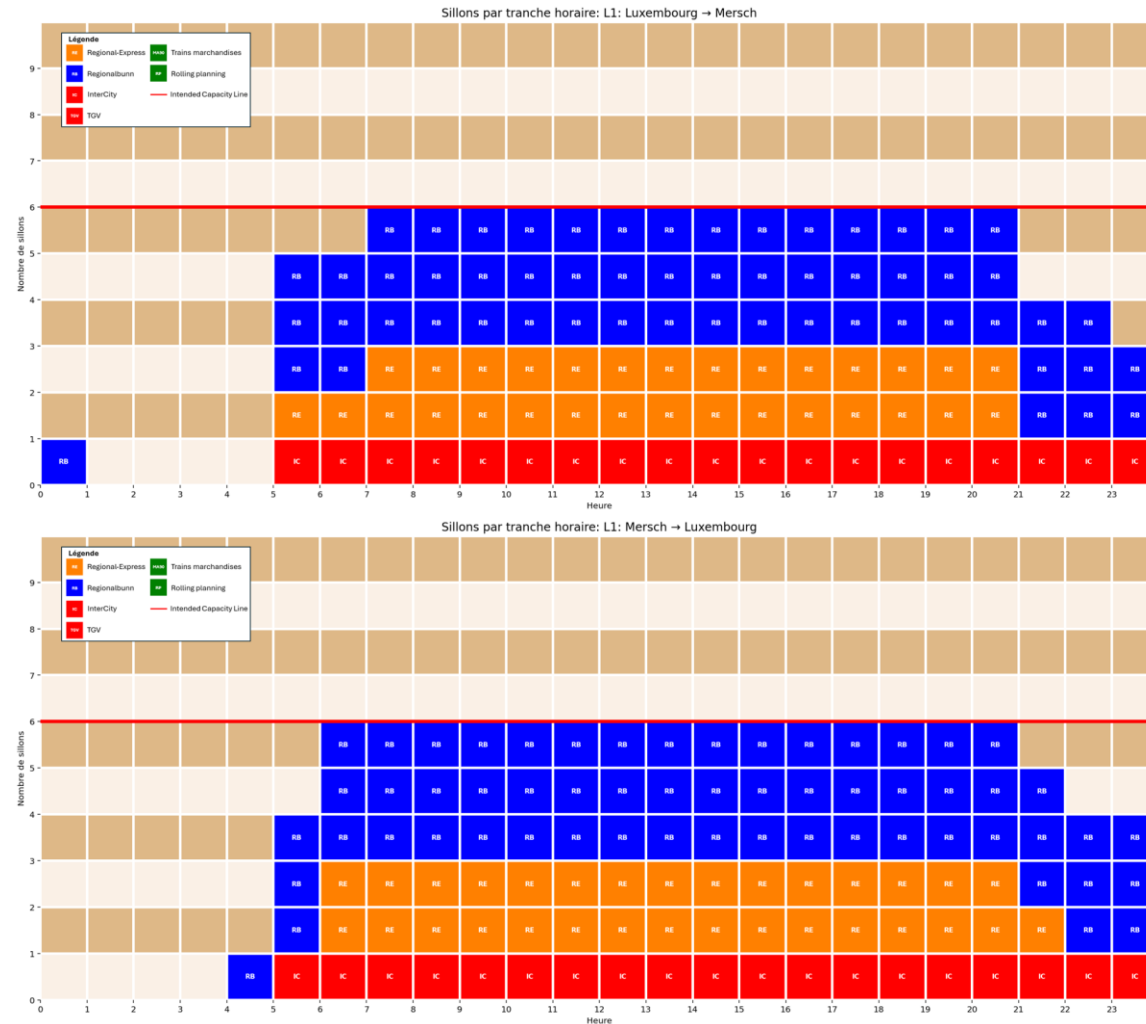
R2 L1a : Schieren ↔ Ettelbruck



L1 : Schieren ↔ Mersch

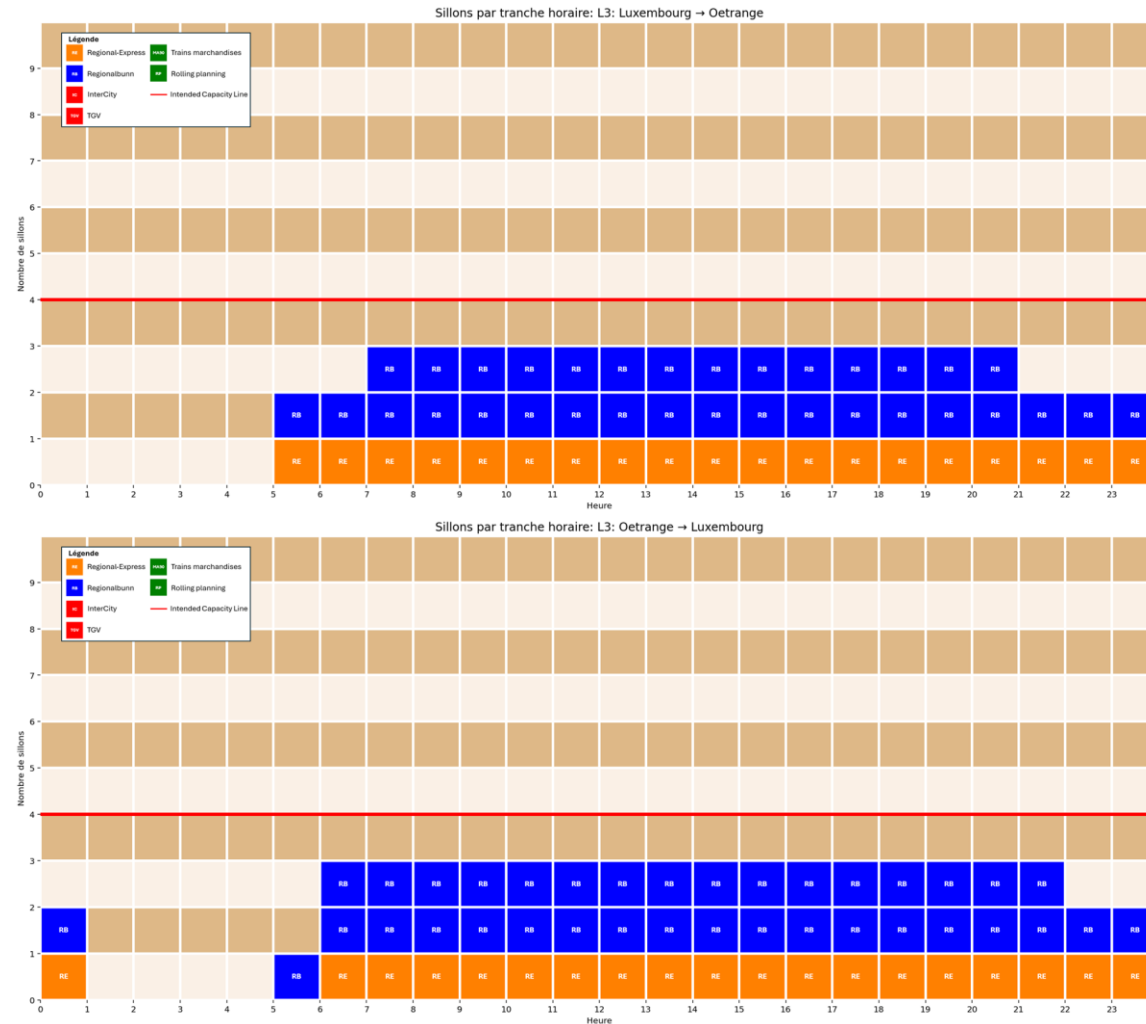


R2 L1 : Luxembourg ↔ Mersch

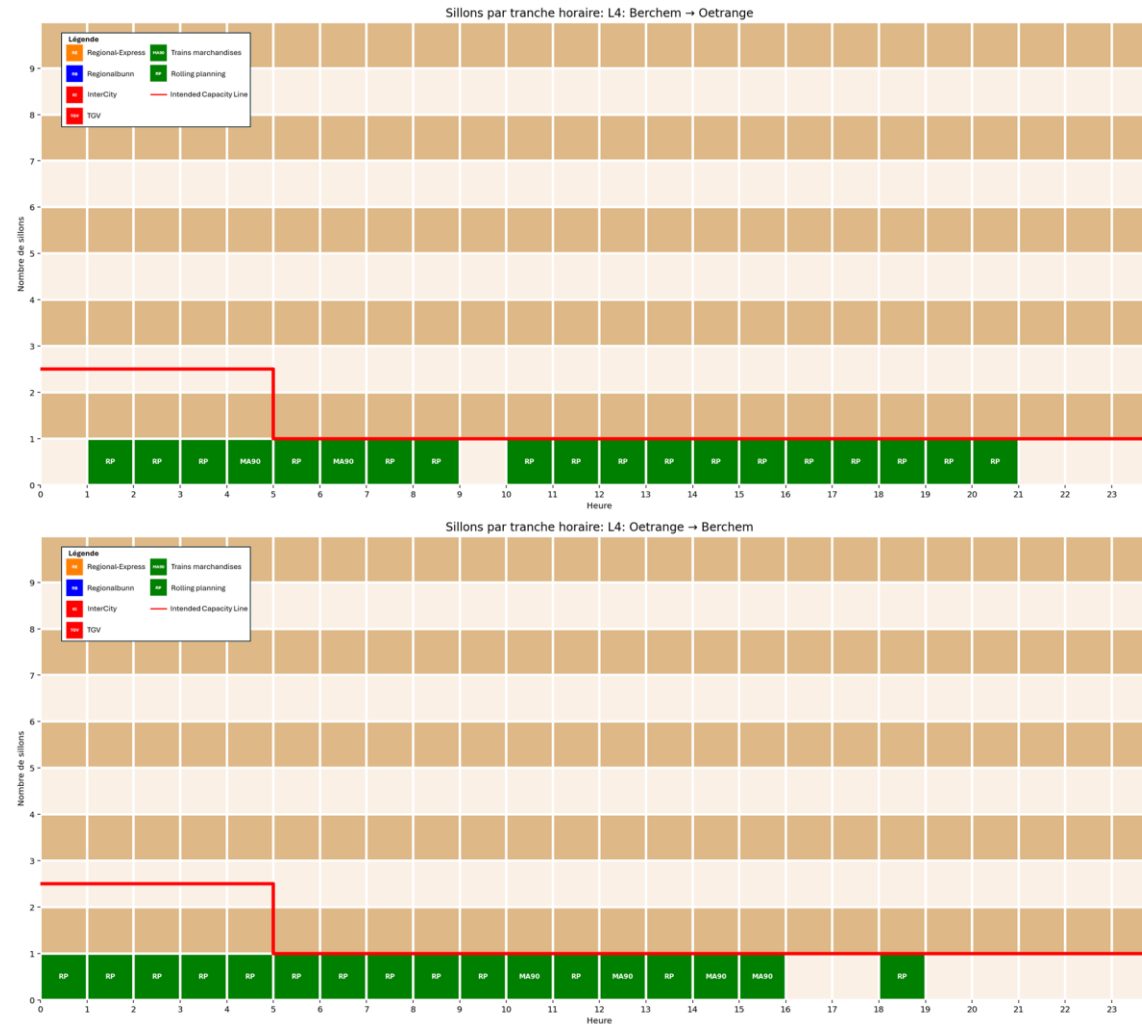


Insertion du 2nd RE encore à l'étude

L3 : Luxembourg ↔ Oetrange



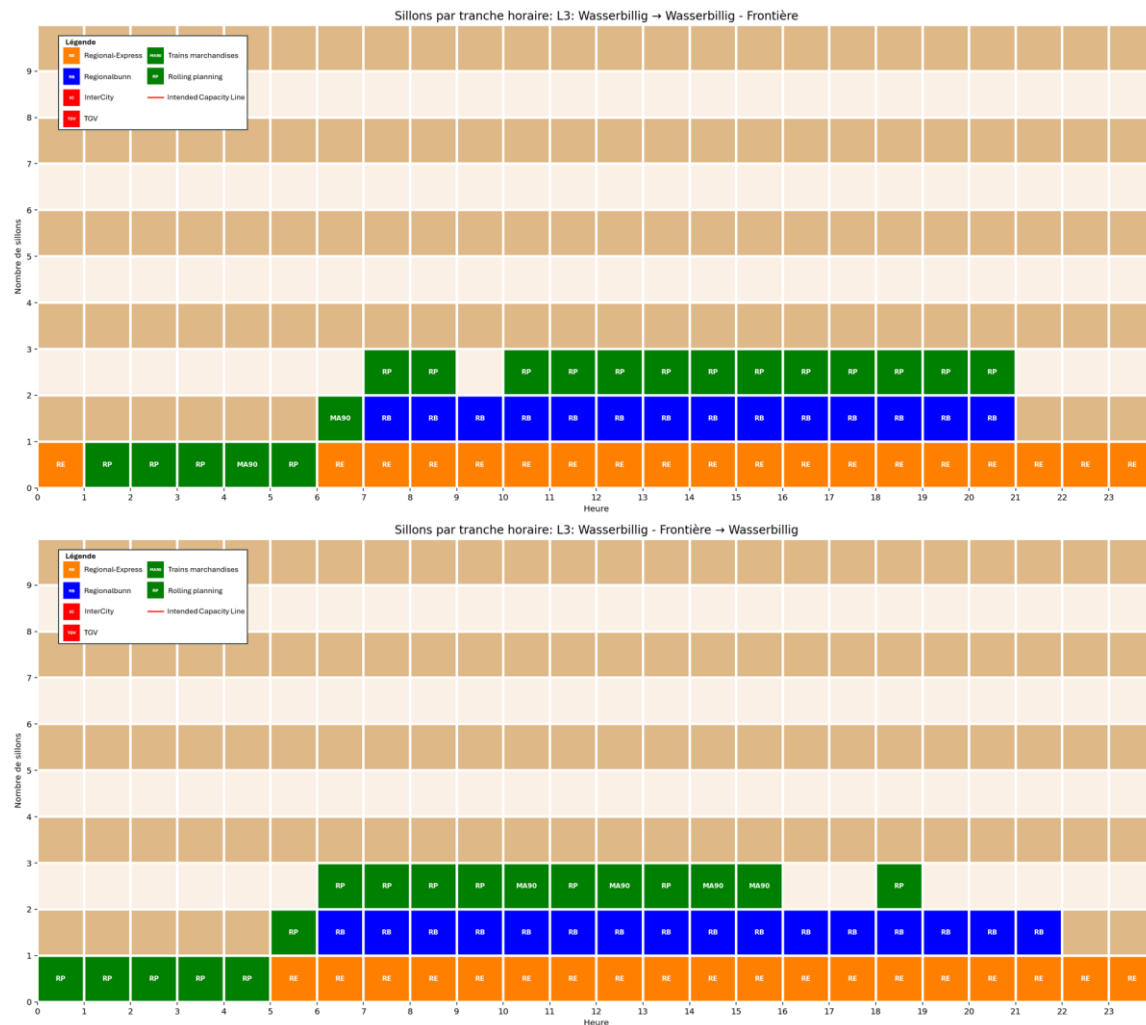
L3 : Berchem ↔ Oetrange



L3 : Wasserbillig $\leftrightarrow$ Oetrange

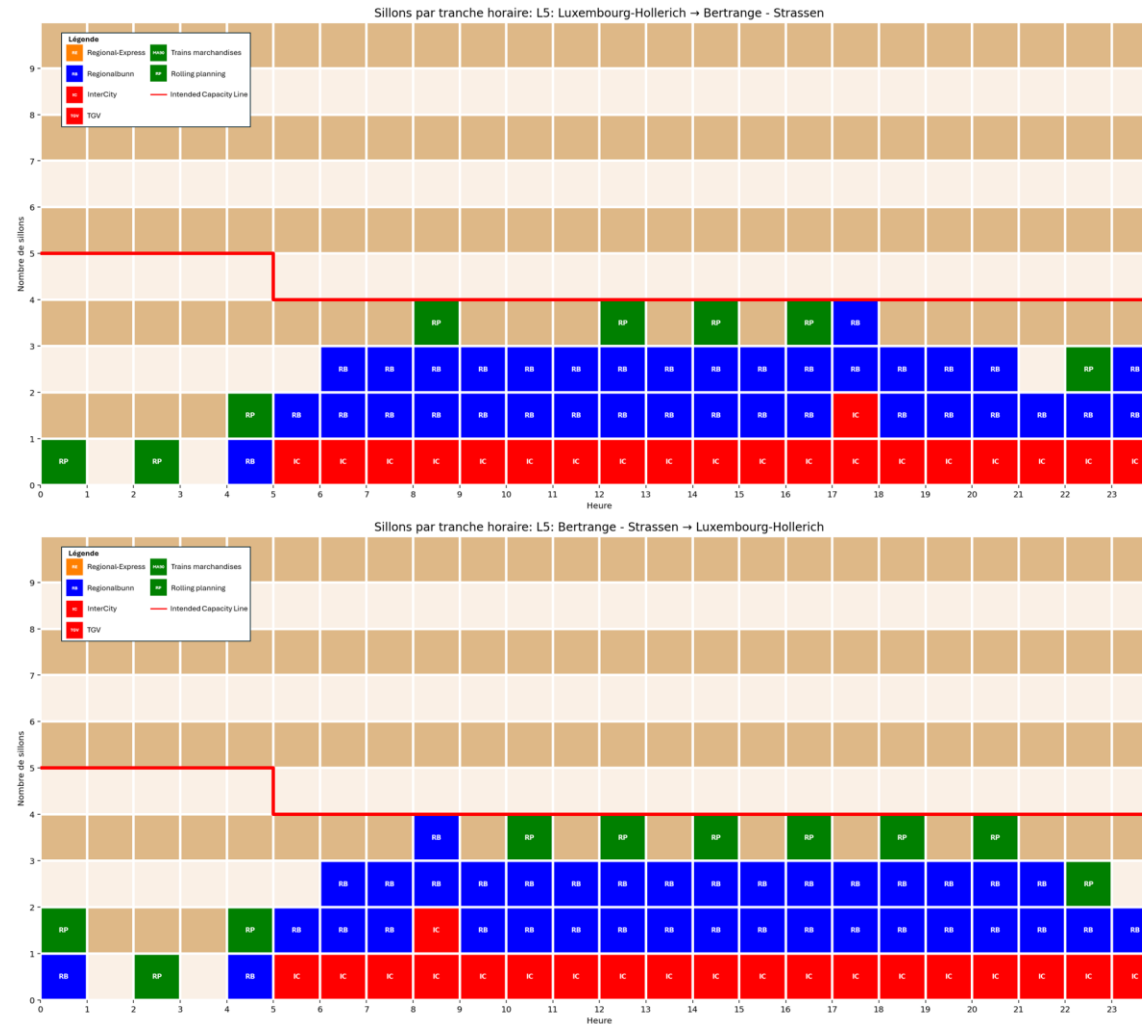


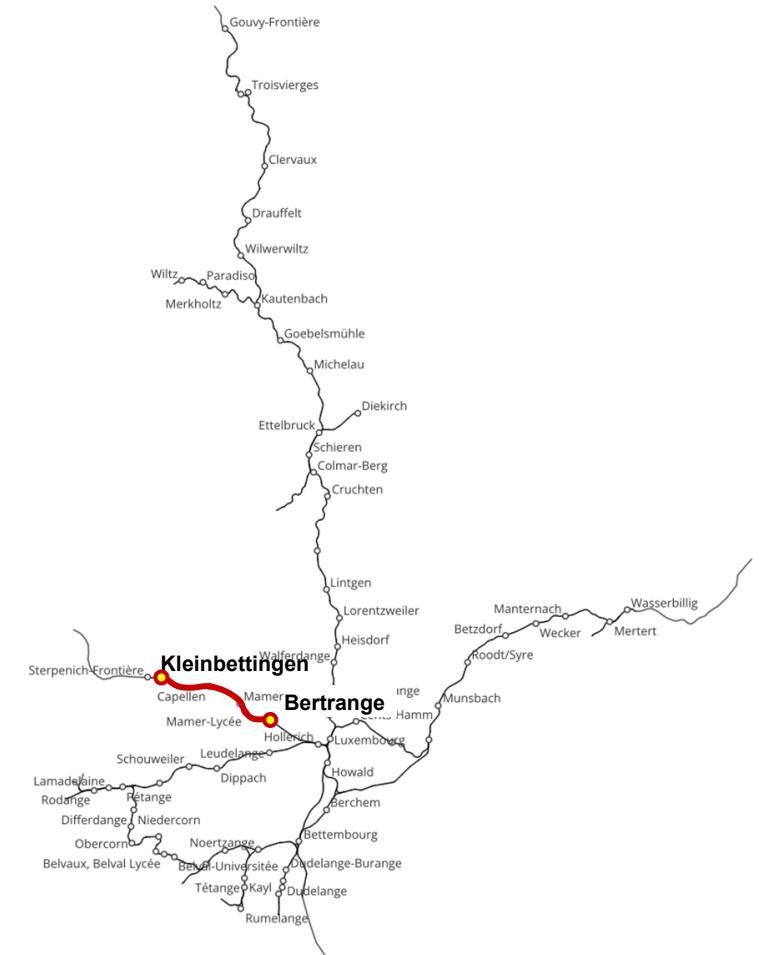
L3 : Wasserbillig ↔ Wasserbillig border point



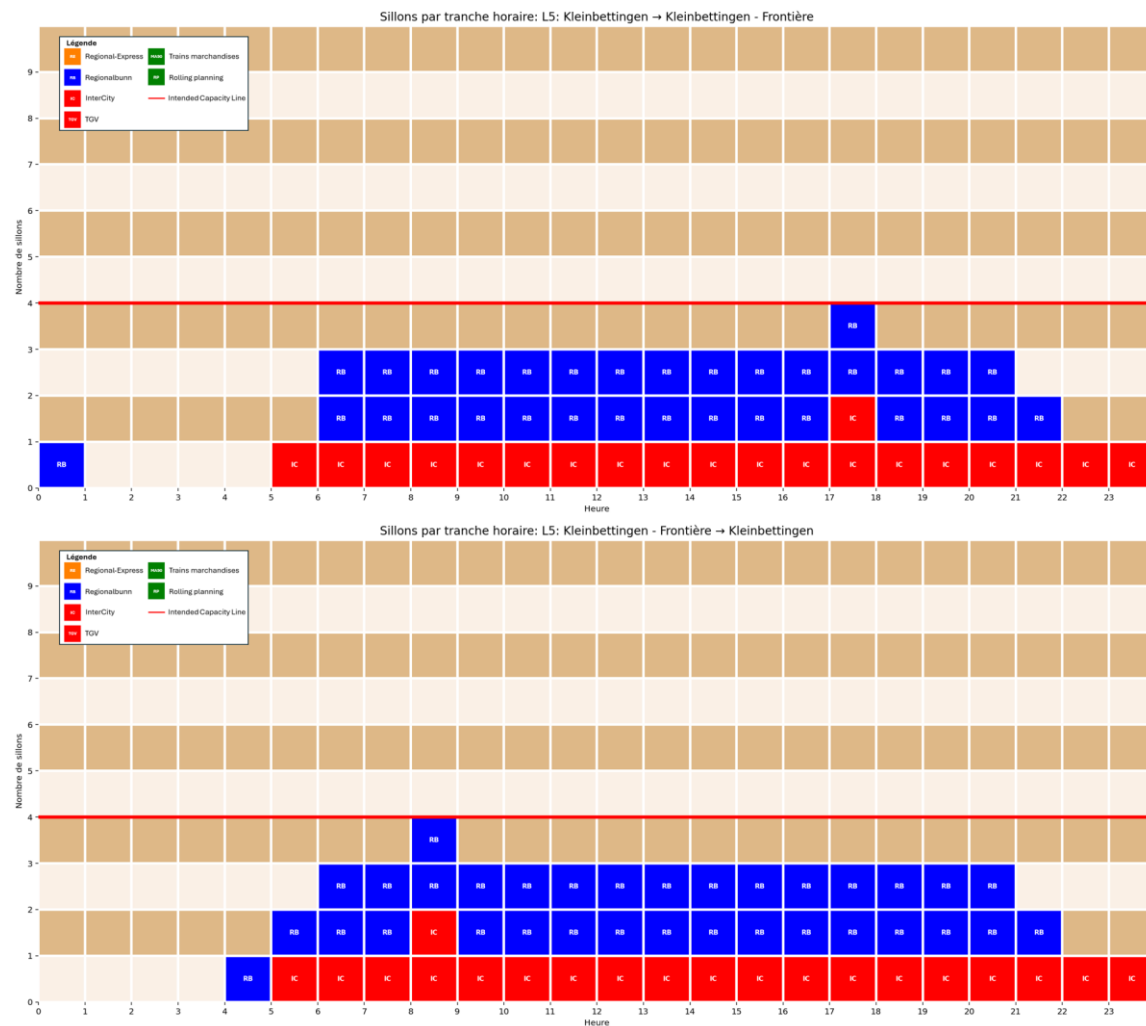
A concerter avec
DB InfraGO

L5 : Luxembourg Hollerich ↔ Bertrange-Sassem



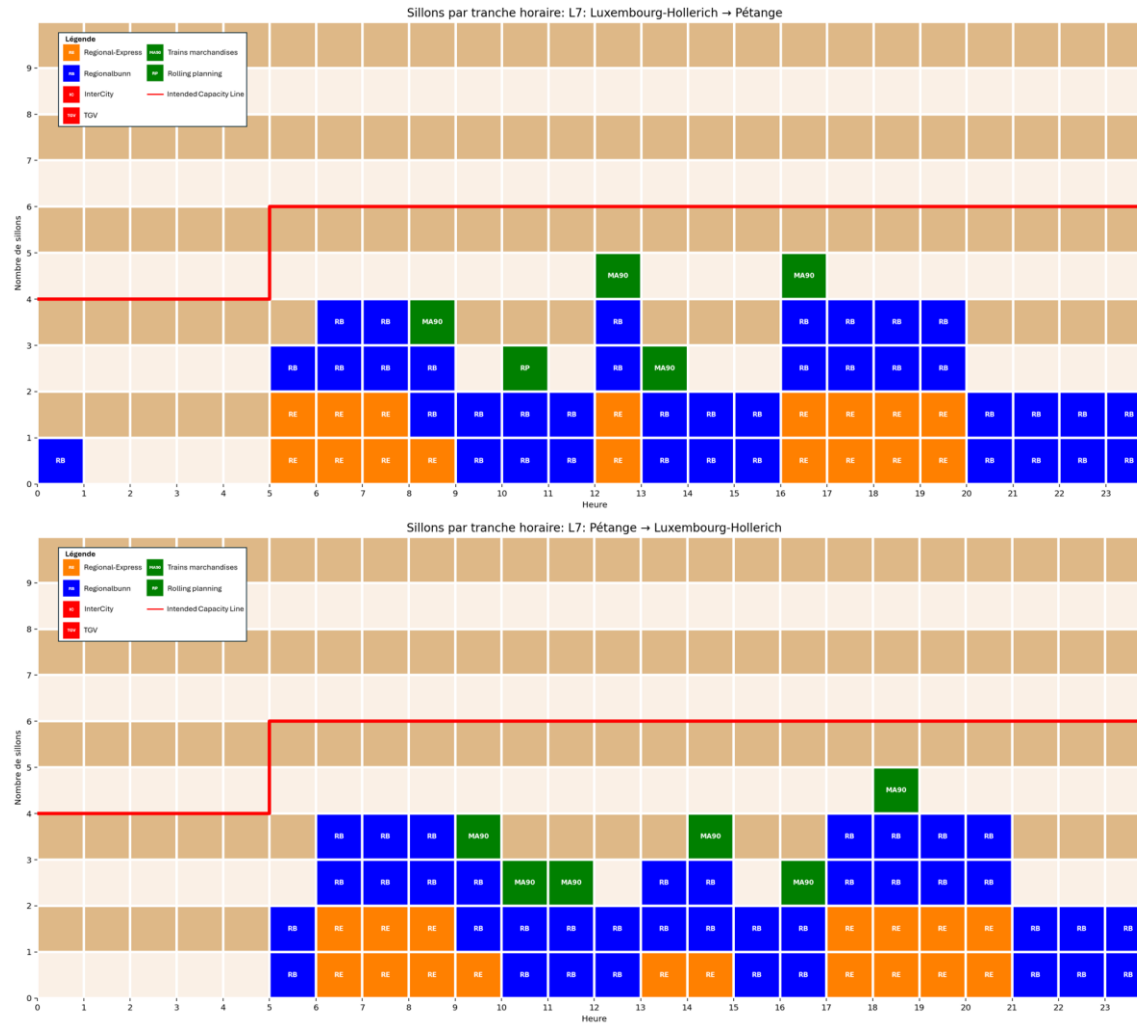


L5 : Kleinbettingen ↔ Kleinbettingen border point

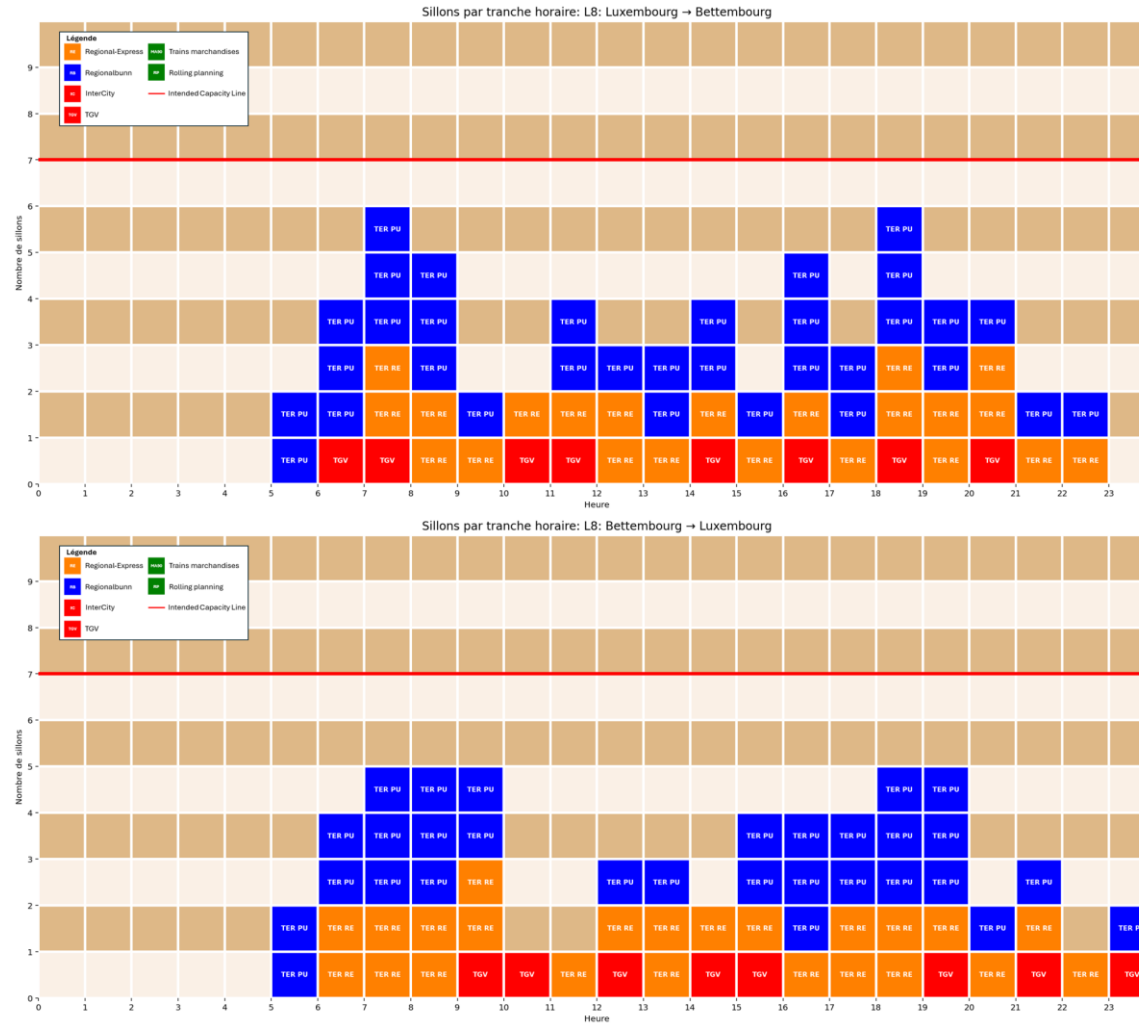


A concerter avec Infrabel

L7 : Hollerich ↔ Pétange

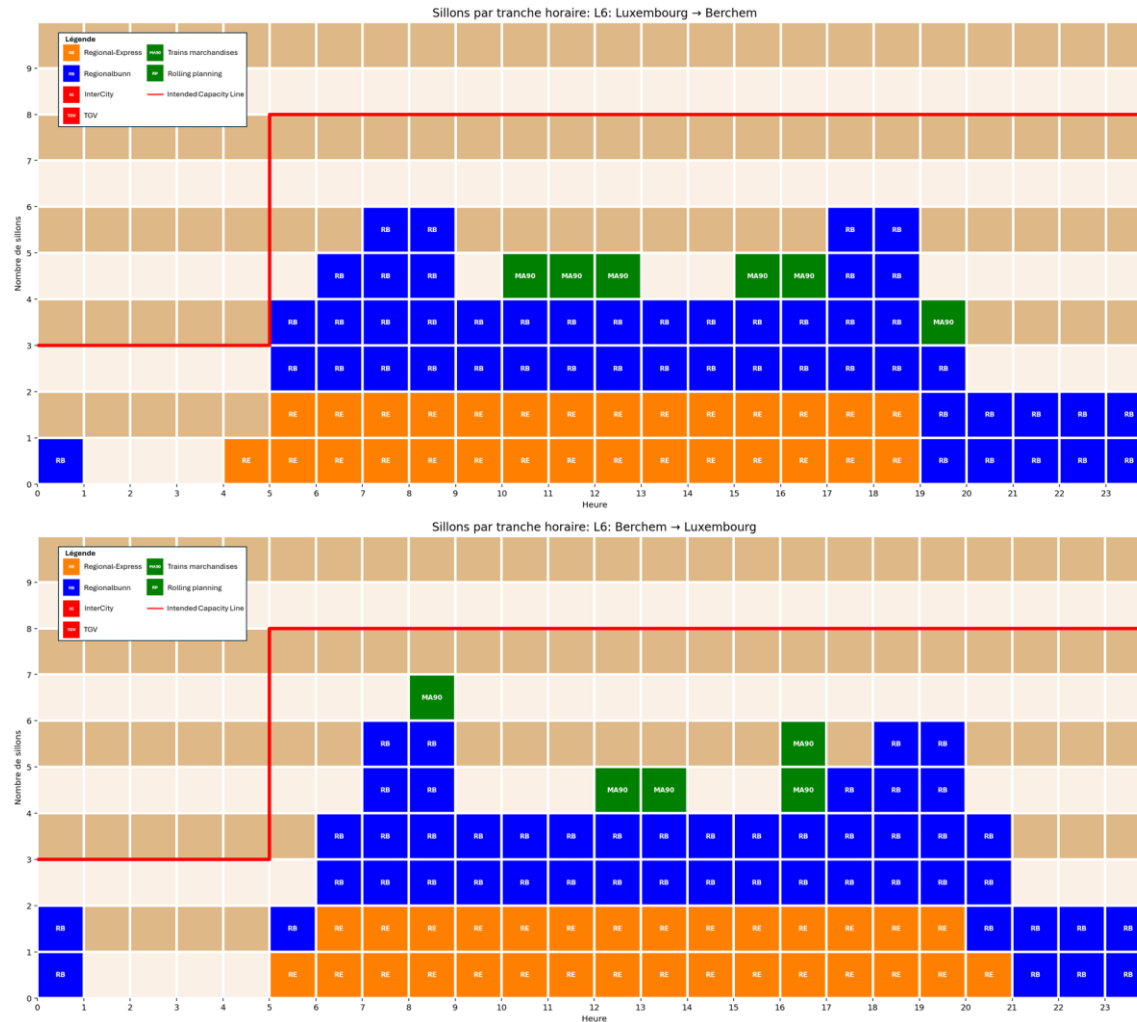


L8 : Howald → Bettembourg

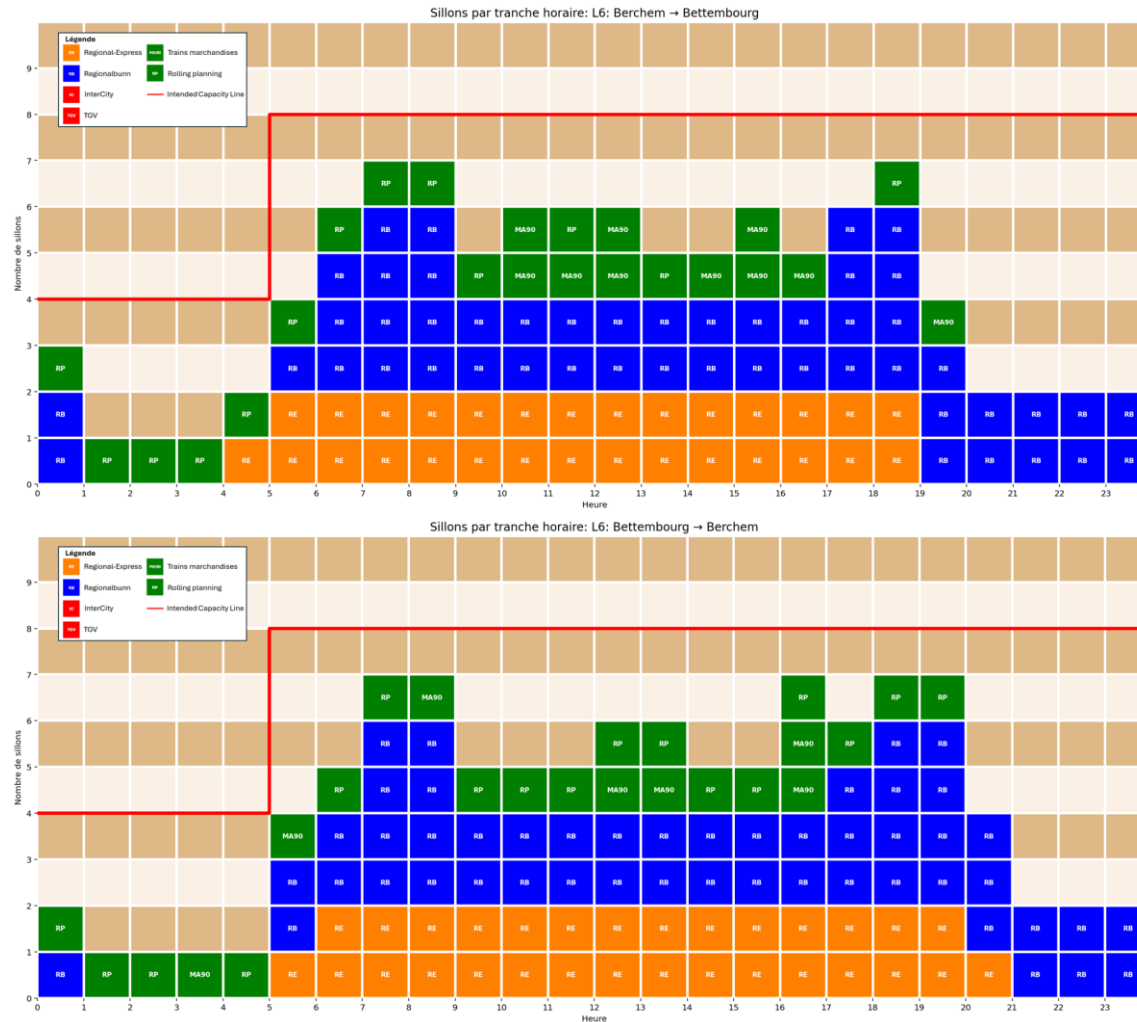


TGV : horaires provisoires

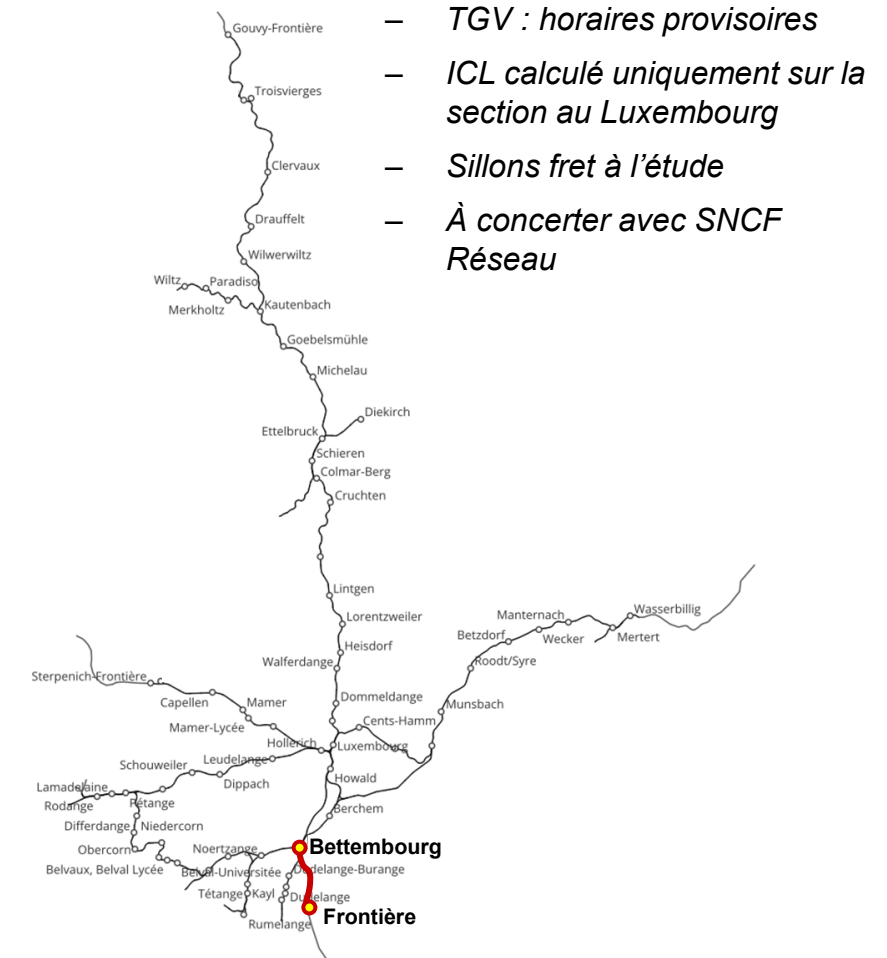
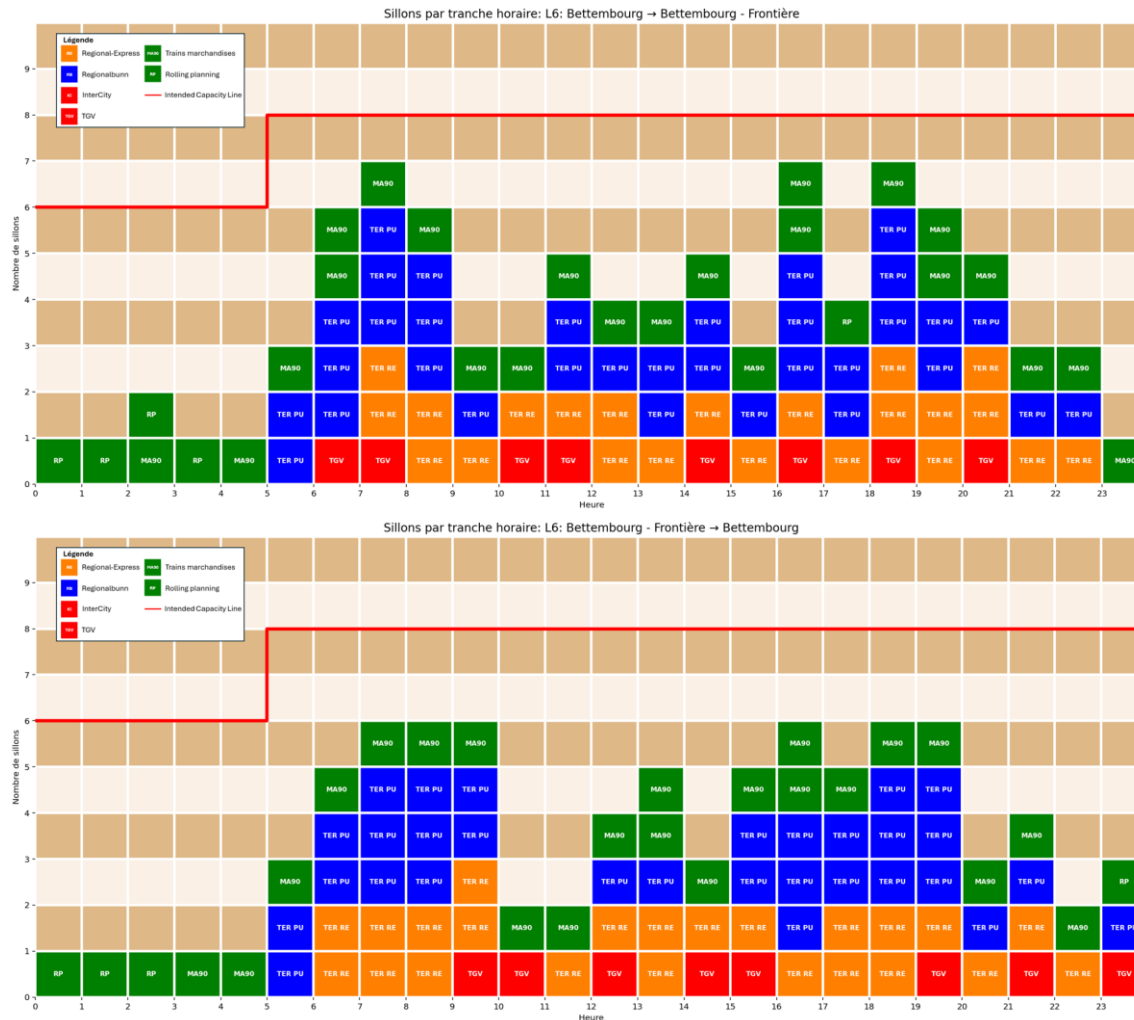
L6 : Luxembourg ↔ Berchem



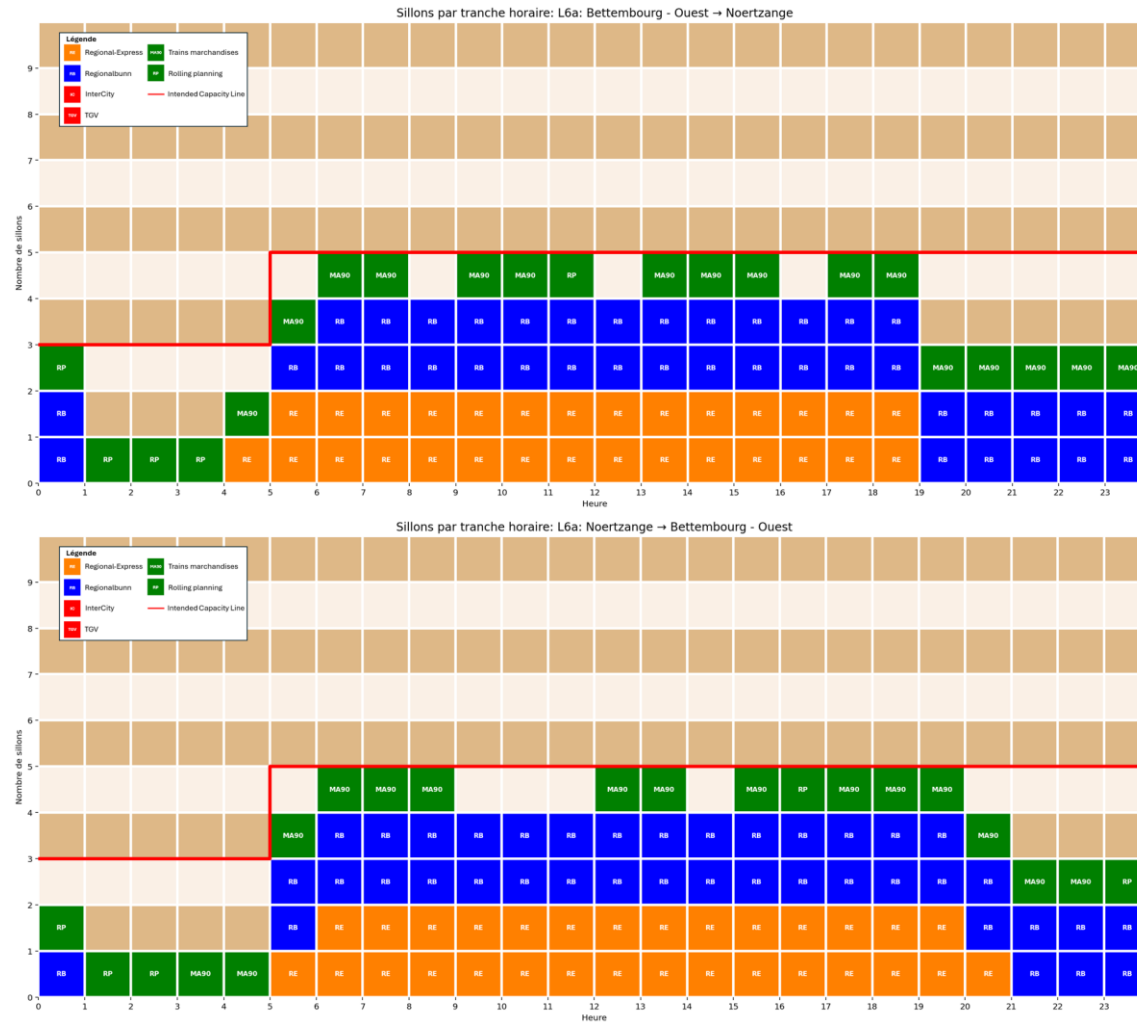
L6 : Bettembourg ↔ Berchem



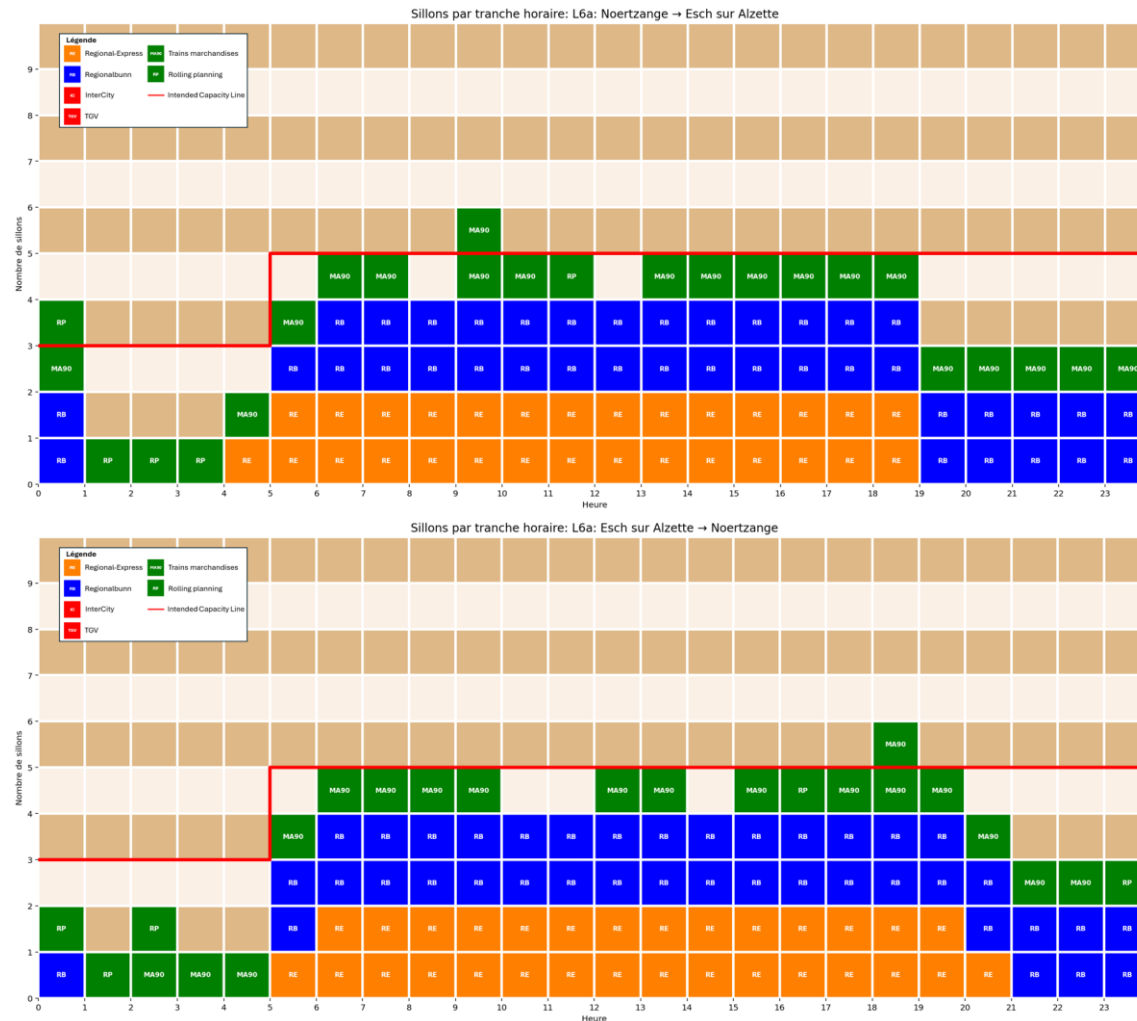
L6 : Bettembourg ↔ Bettembourg border point



L6a : Bettembourg ↔ Noertzange

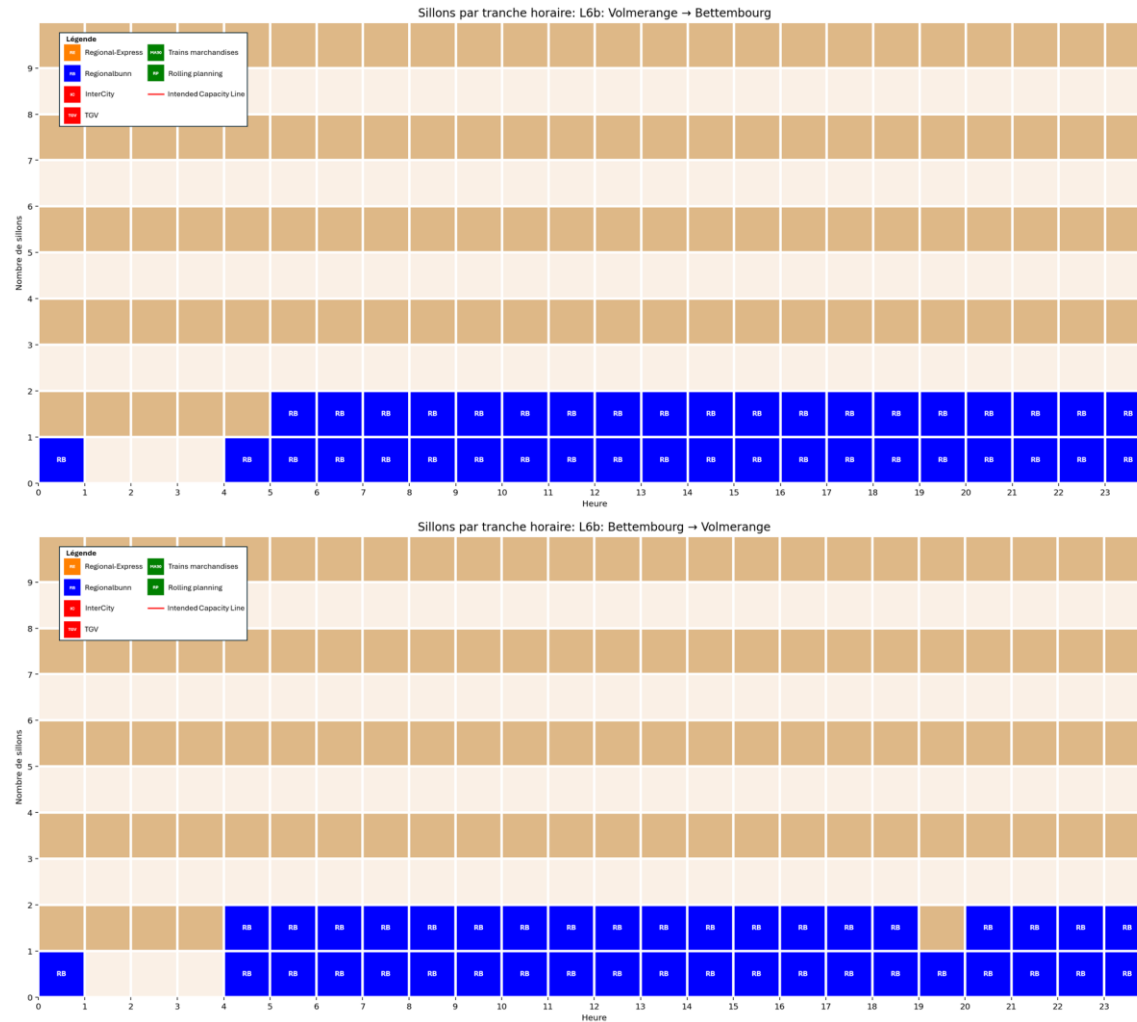


L6a : Noertzange ↔ Esch-sur-Alzette

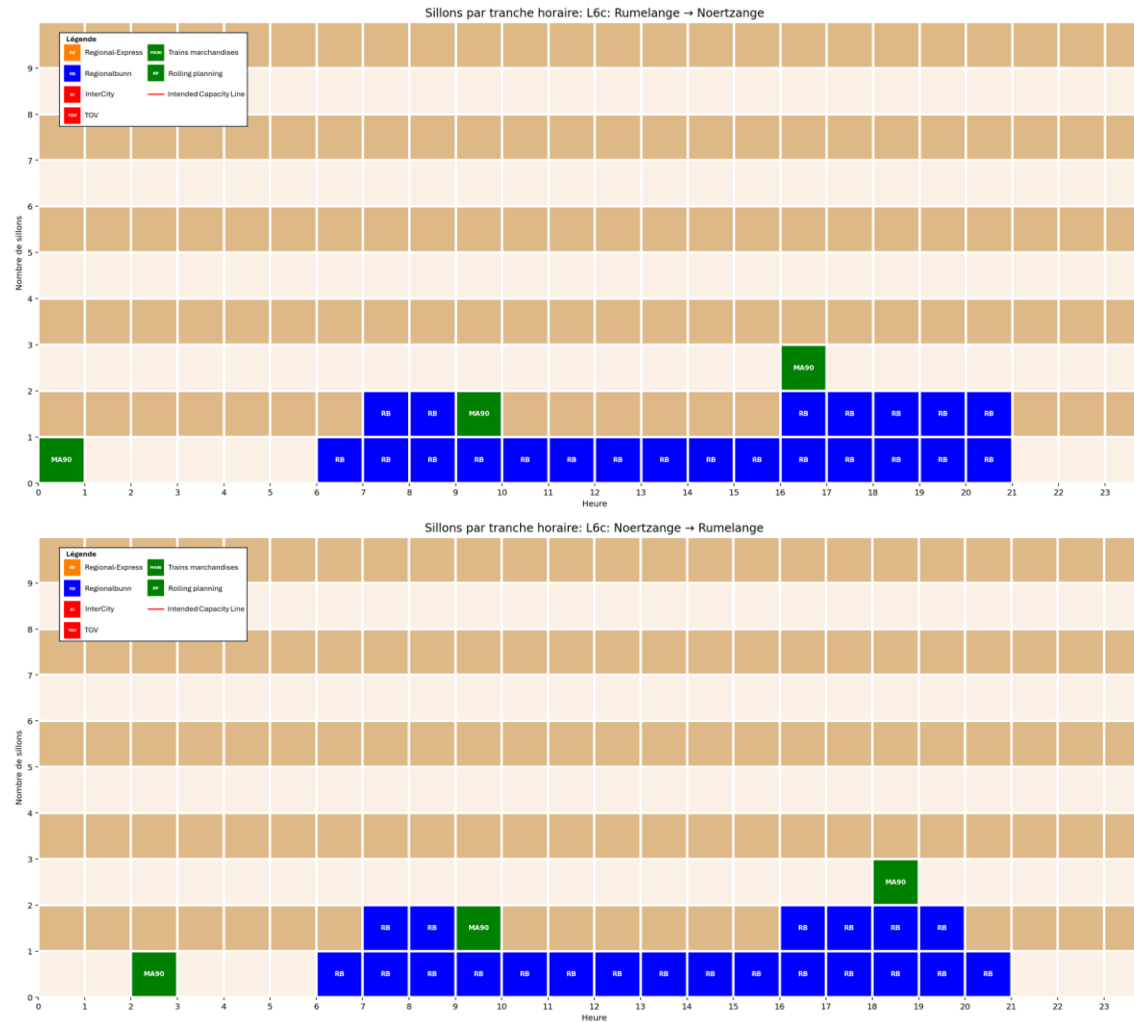


*L'ICL est calculé sur la base des sillons de la trame.
Le nombre de sillons sur certaines heures dépasse
l'ICL car certains sillons n'ont pas le même itinéraire
que les sillons de la trame.*

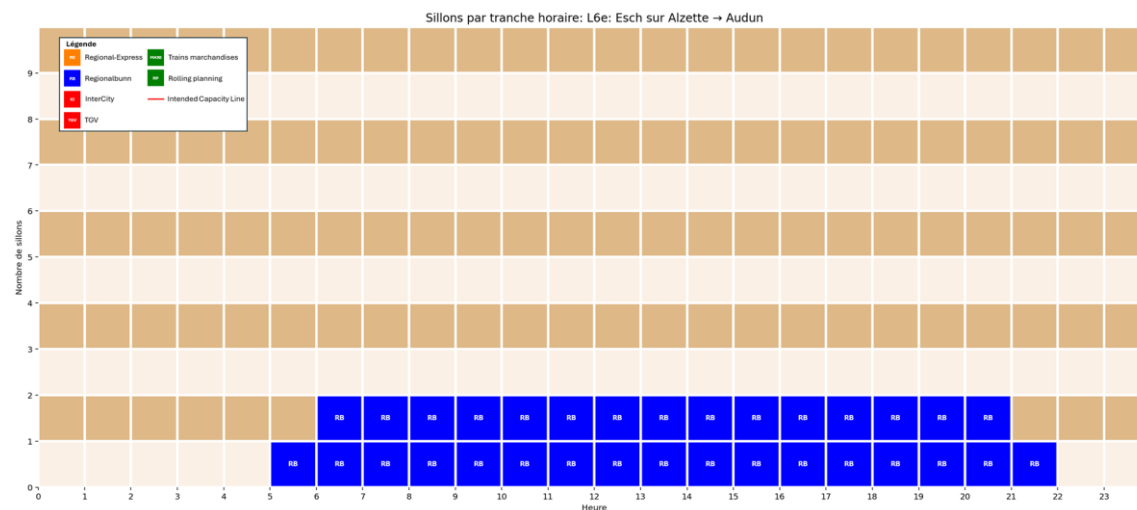
L6b : Volmerange ↔ Bettembourg



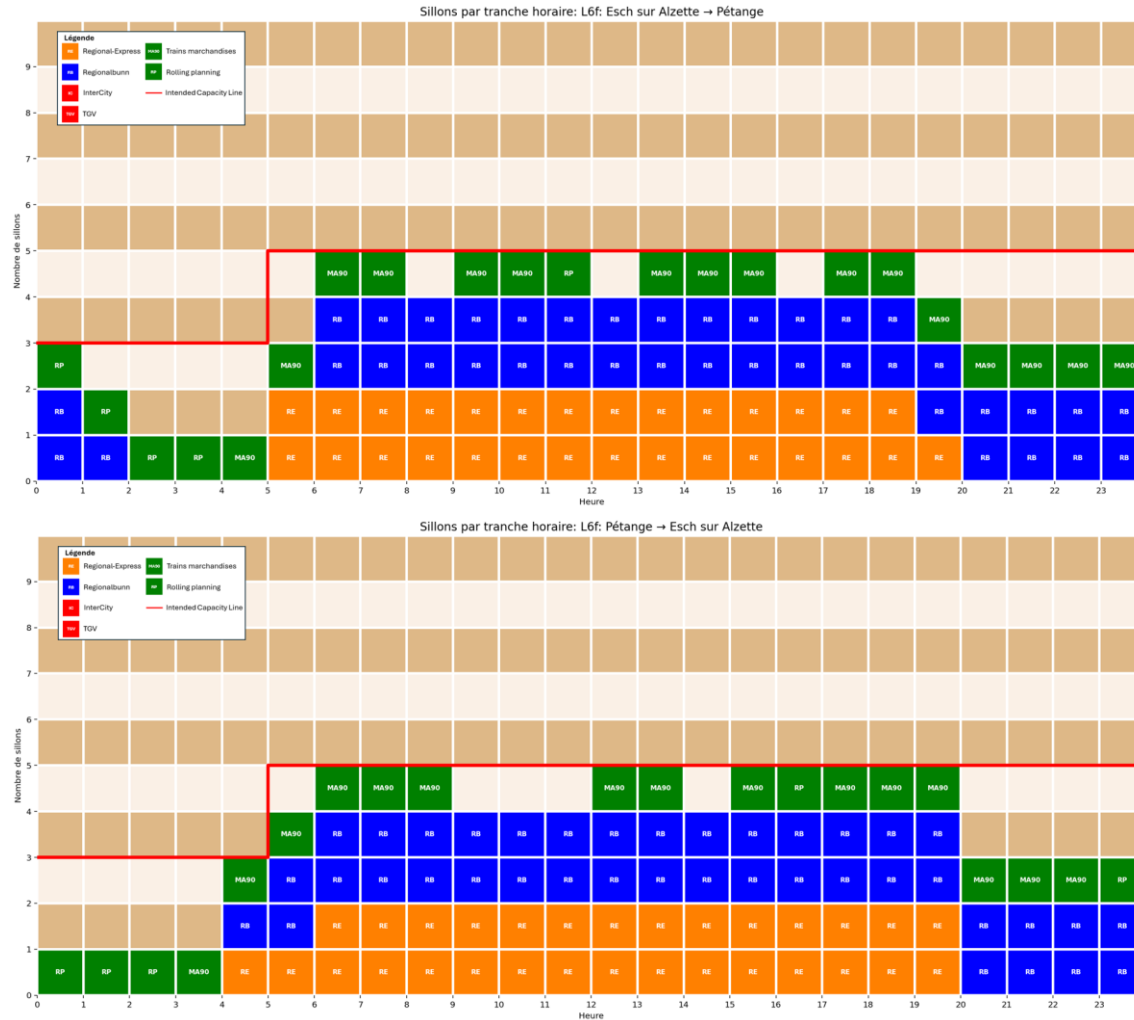
L6c : Rumelange ↔ Noertzange



L6e : Audun-le-Tiche ↔ Esch-sur-Alzette

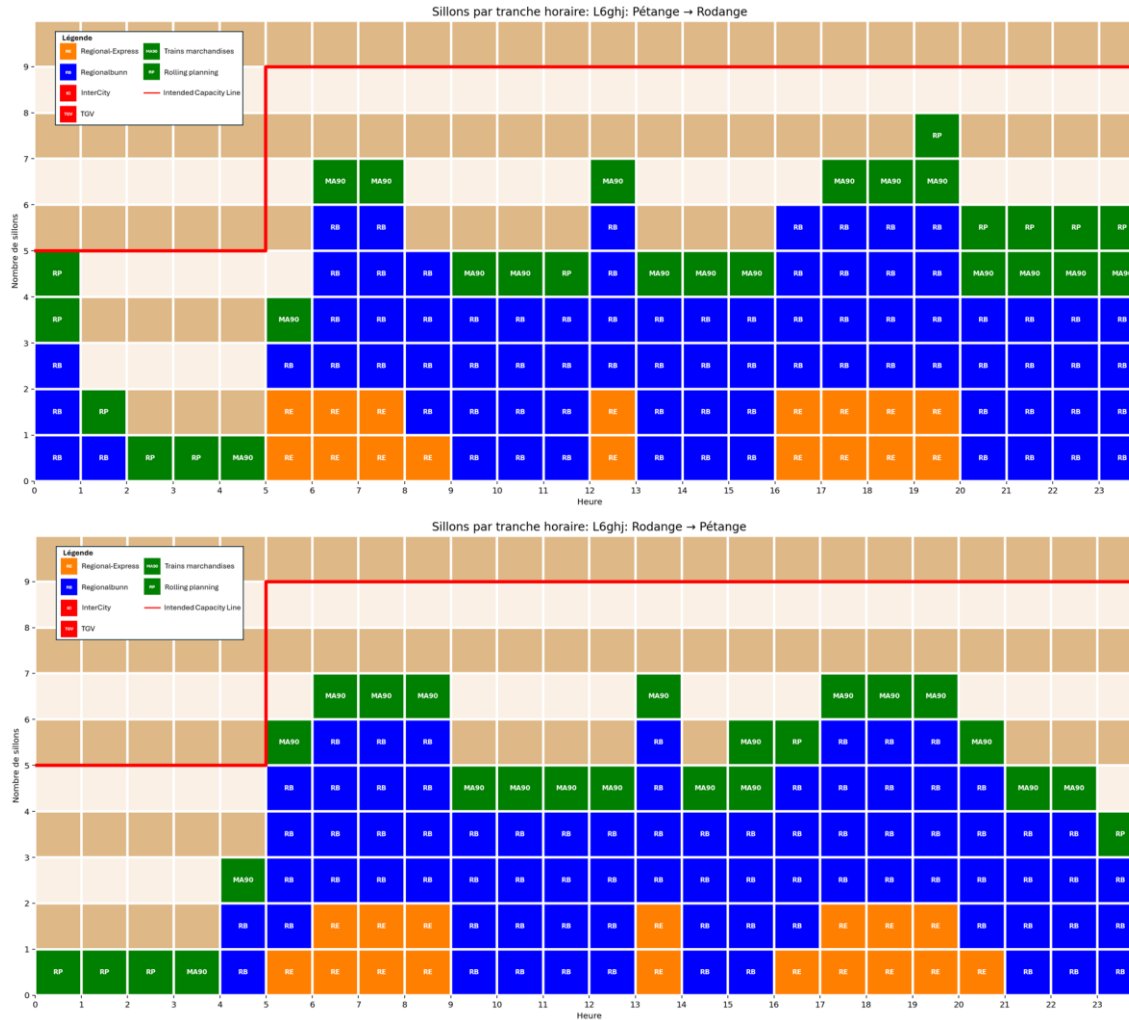


L6f : Pétange ↔ Esch-sur-Alzette

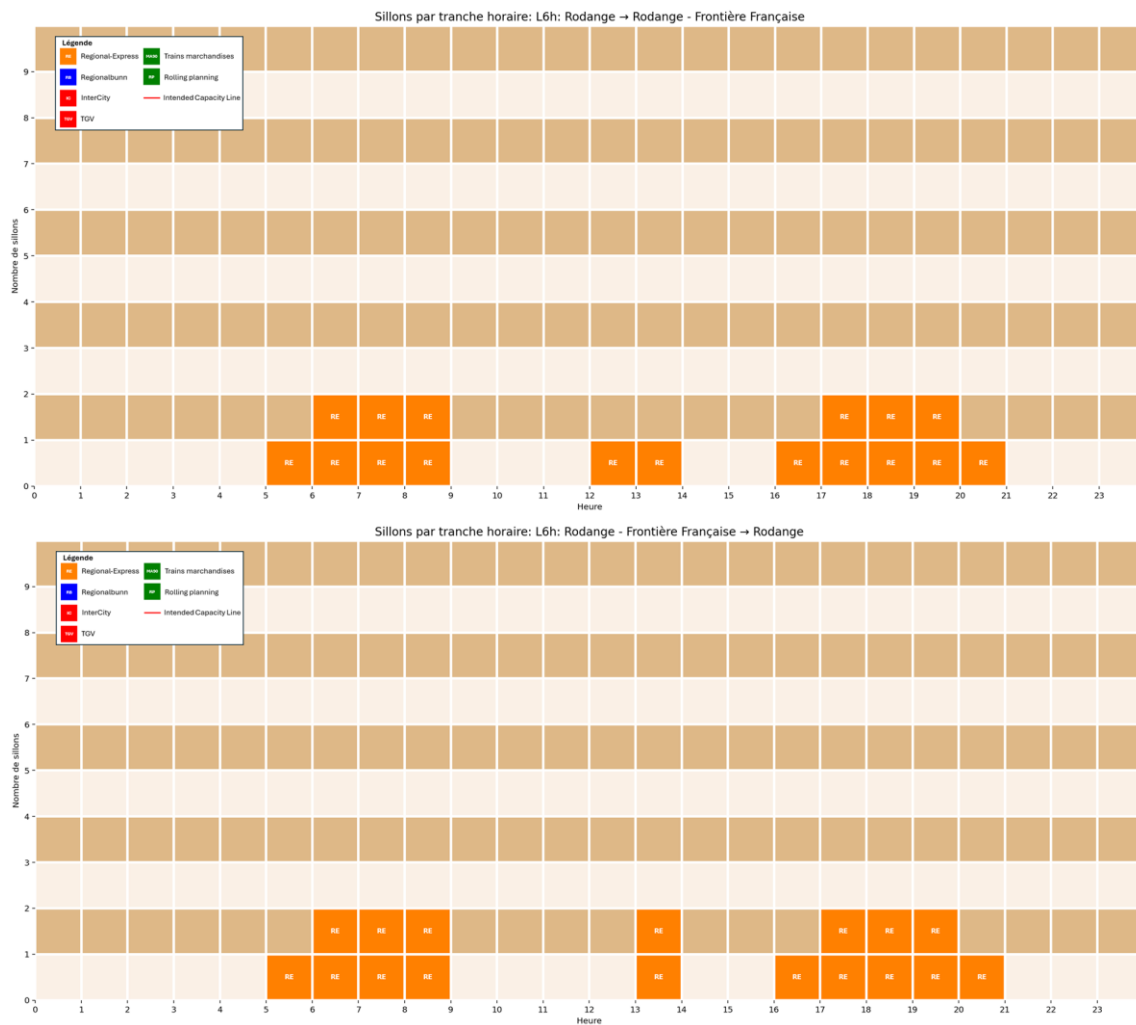


R2

L6g, L6h, L6j : Pétange → Rodange



L6h : Rodange ↔ French border point



L6h : Rodange ↔ Belgian border point

