UIC Railway Asset Management
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Life cycle planning & optimisation making use of a calculation and simulation model

Railway network Asset Management
Strategic planning with Simeo™

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Agenda

1. Introduction : what answers to what questions
2. Example 1 : Railway network maintenance planning with budget constraints
3. Example 2 : Optimisation of maintenance plan
4. Example 3 : How to choose the best renewal scenario

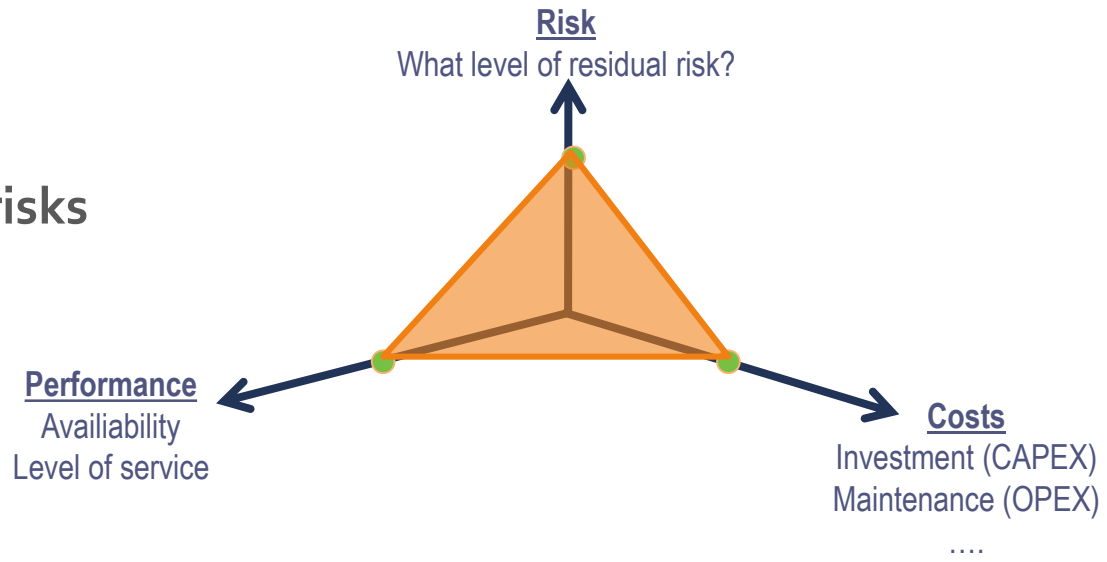
Strategic planning : objectives

- Ensure alignment between maintenance planning strategy & AM overall performance objective

For decision making related to maintenance plans with measurable indicators:

- ✓ Infrastructure **performance**
- ✓ Management **of overall costs**
- ✓ Level of services, cost of risks…: **Residual risks**

Strengthen & improve objectivity
Overall Asset Portfolio

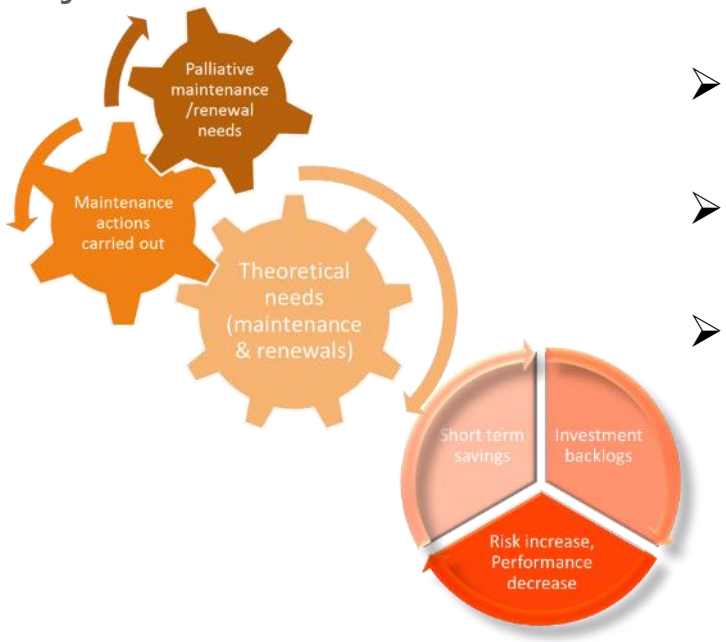


What answers to What questions?

- How to negotiate budget? ➔ Have objective arguments to negotiate upstream to decisions

- ✓ Long term **Needs**?
- ✓ Short term **Performance**?
- ✓ **Risk** from short to long term?

- How to deal with a budget plan? ➔ Identify levers to ensure to optimize budget allocation and reach objectives downstream to decisions



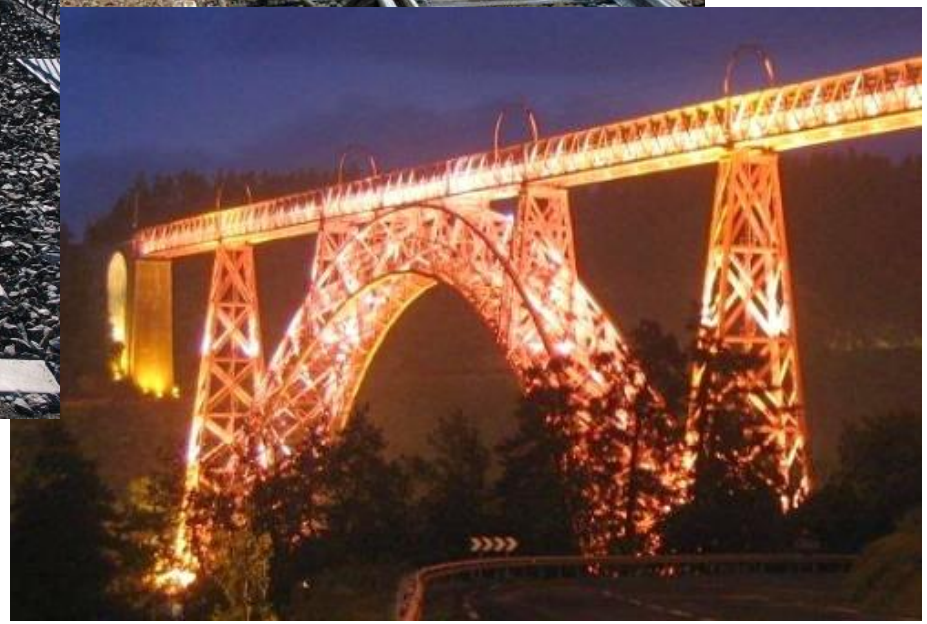
- ➢ Identify **Key maintenance action** for infrastructure performance
- ➢ **Minimize life cycle** cost
- ➢ Identify **potential saving opportunities** on the short term depending on:
  - ✓ Expected performance targets
  - ✓ Residual risks the Infrastructure is ready to cope with

What answers to What questions?

- Which parameter to play with to adapt my strategy and what would be the “price” to pay ?
  - Lifetime extension vs failure probability
  - Maintenance intervals vs
    - Scheduled unavailability
    - Risk (unscheduled unavailability)
  - Maintenance typology vs criticality of risk

Scenarize and compare trends

Railway Network Exercise 1



Railway Network Exercise 1

- Network breakdown : railway network
  - ≈ 55km of tracks
  - 12 Switches and crossings, ≈ 1km
  - 4 bridges

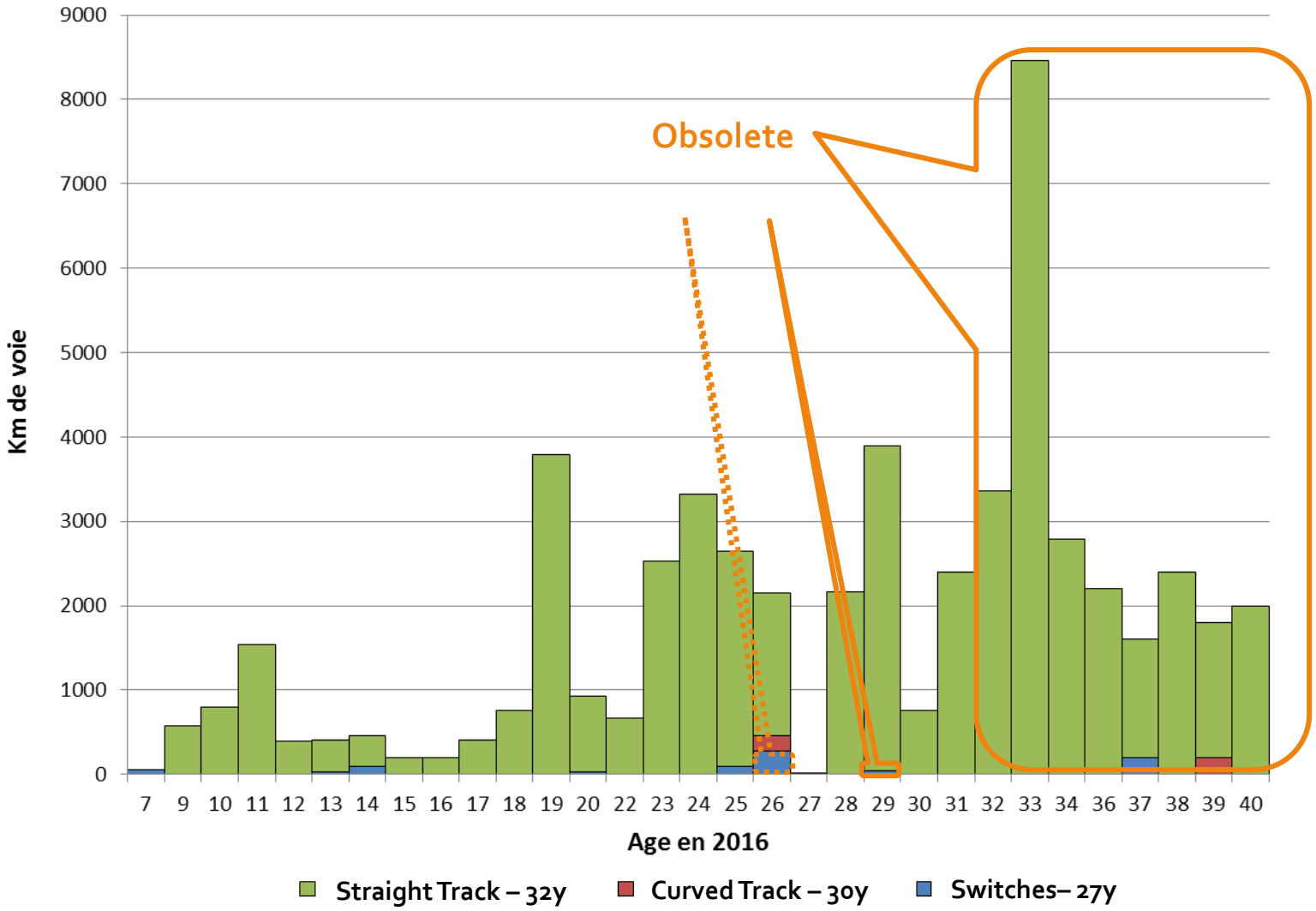
- Type of assets :

	Technical domain	
	Bridges	**Tracks**
COMPONENT TYPE	Metallic bridge	Switches
	Prestressed concrete bridge ≥ 1971	Straight track
	Reinforced concrete bridge < 1971	Curved track

Age Pyramid (1/2)

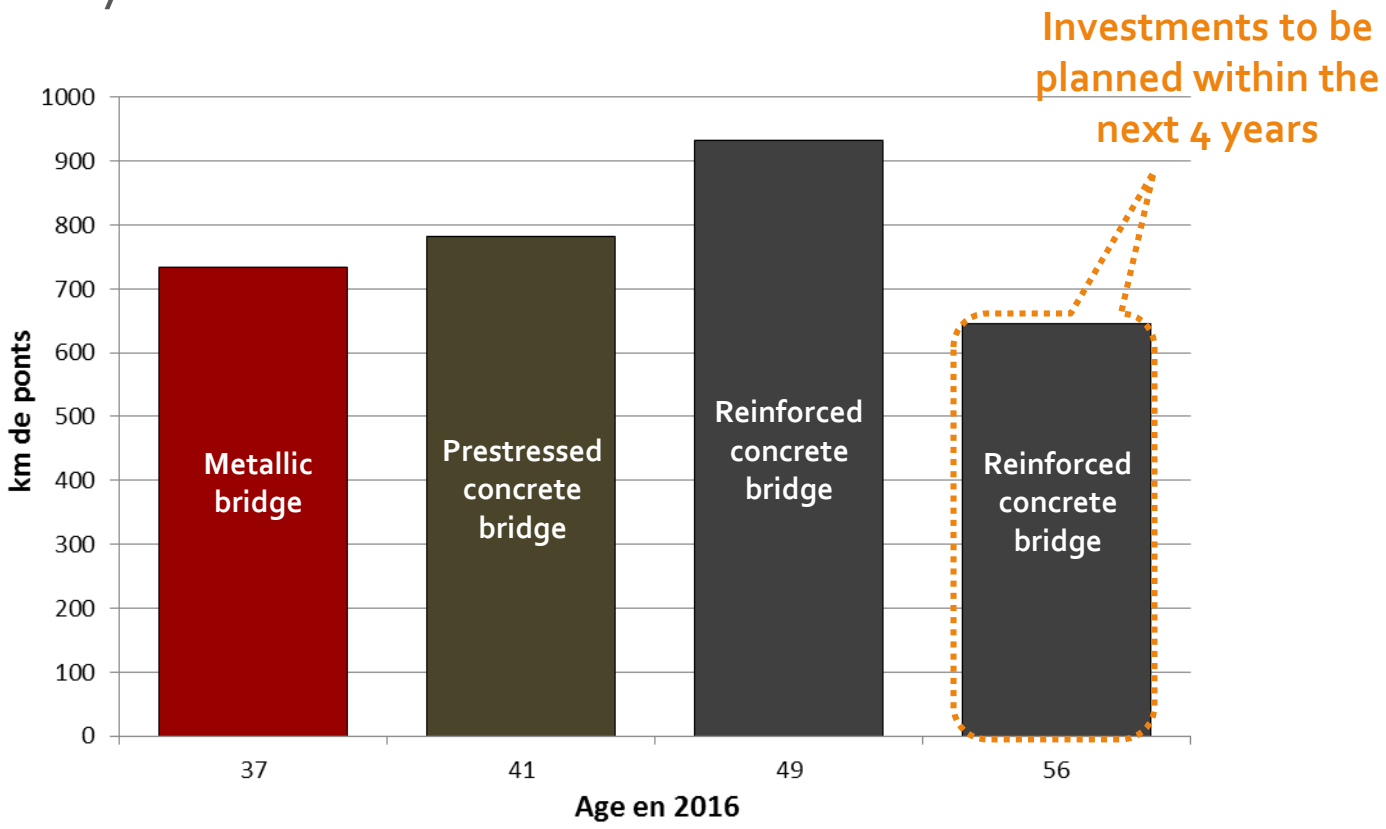
- Tracks :

Preliminary analysis of needs



Age Pyramid (2/2)

- Bridges : Preliminary analysis of needs
  - Lifespan : 60 years



Asset Management Scenarios

- Maintenance activities
  - CAPEX :
    - Renewal of bridges
    - Renewal of tracks
  - OPEX :
    - Tracks : Grinding, tamping, and rail renewal (preventive maintenance)
    - Switches : Grinding and tamping (preventive maintenance)

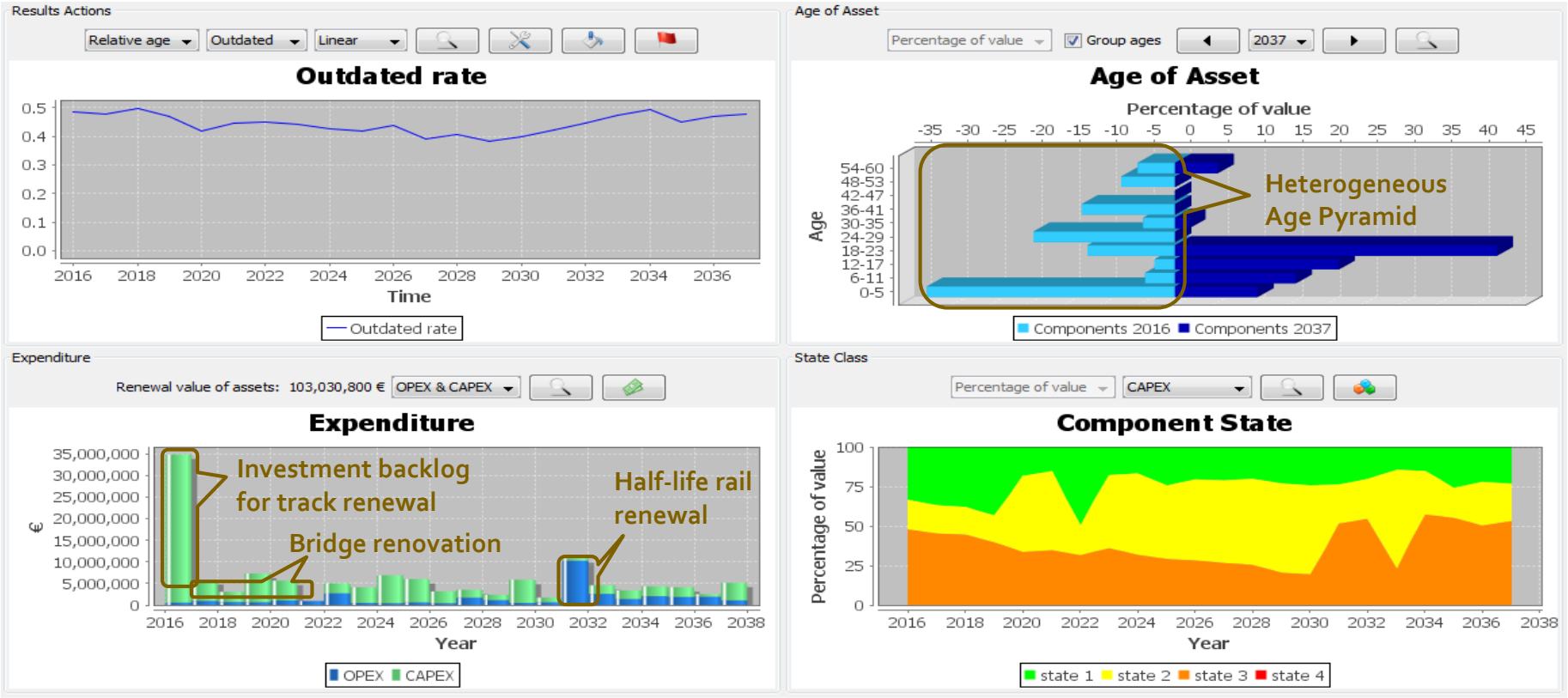
- Budget scenarios and maintenance strategies over 20 years (with Simeo™)

	Budget Constraint - Capex	Budget Constraint - Opex
Sc1 - « free of constraints » → gross needs	-	-
Sc2 - Capex constraints (tracks only)	3'200 k€ / year	-
Sc3 – Capex and opex constraints (tracks only)	3'200 k€ / year	200k€ / year

No Capex constraints for bridges

Sc1 – « Free of constraints » : Expenses vs ageing

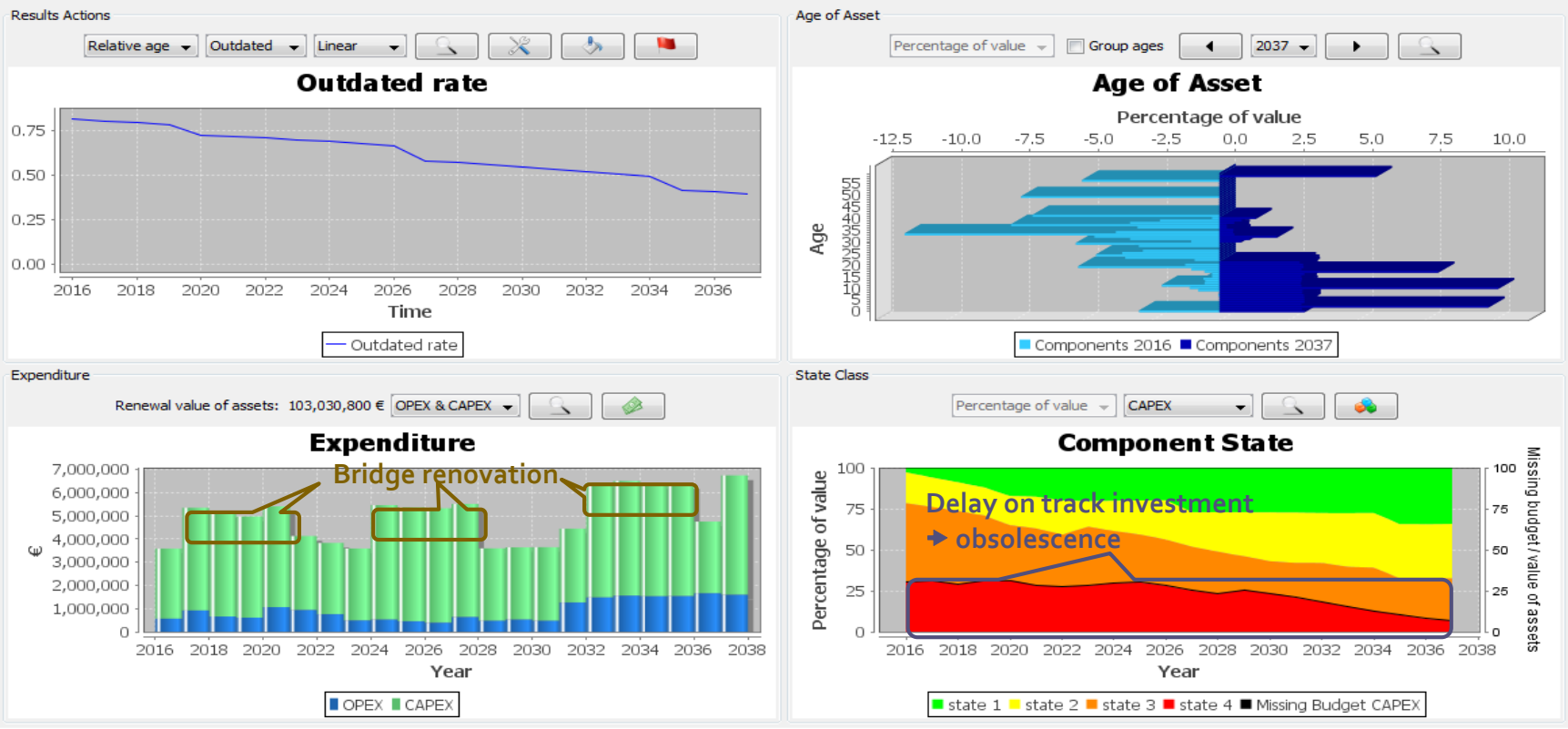
- Gross needs: important investment needs on the short-term



On average, over 20 years, 3'600 k€/year spent on track renewal, 1'600k€/year spent on maintenance. 47 % of expenses on tracks between 2016 and 2036 should be spent in 2016……

Sc2 – « Capex constraints » : Expenses vs ageing

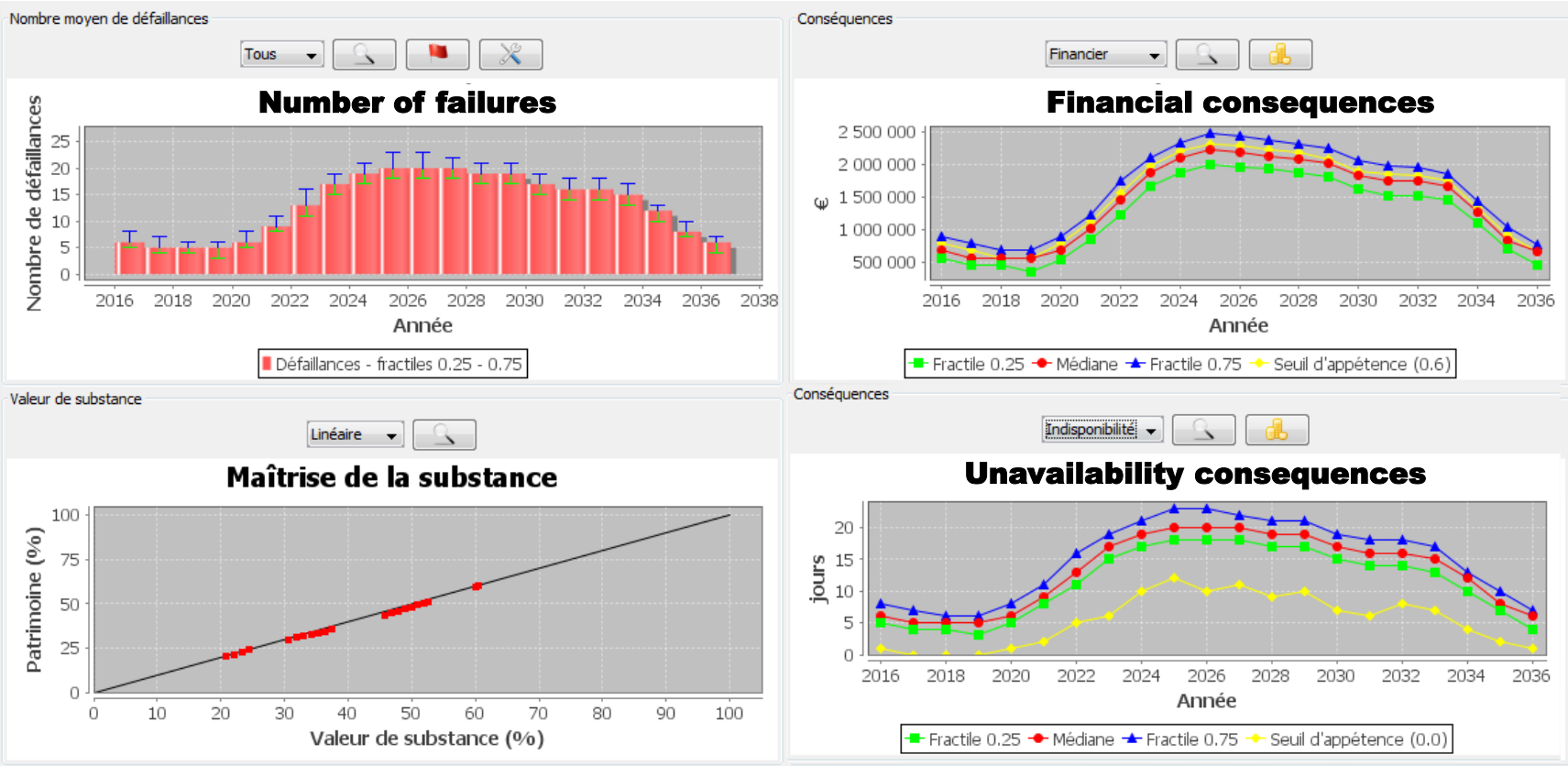
- Budget Constraints: Tracks' CAPEX (3'200 k€ / year)



Although on average the invested amount is similar to the gross needs over the same period, the delays on investment lead to 25% of assets at risk over the next 16 years.

Sc2 – « Capex constraints » : Risks

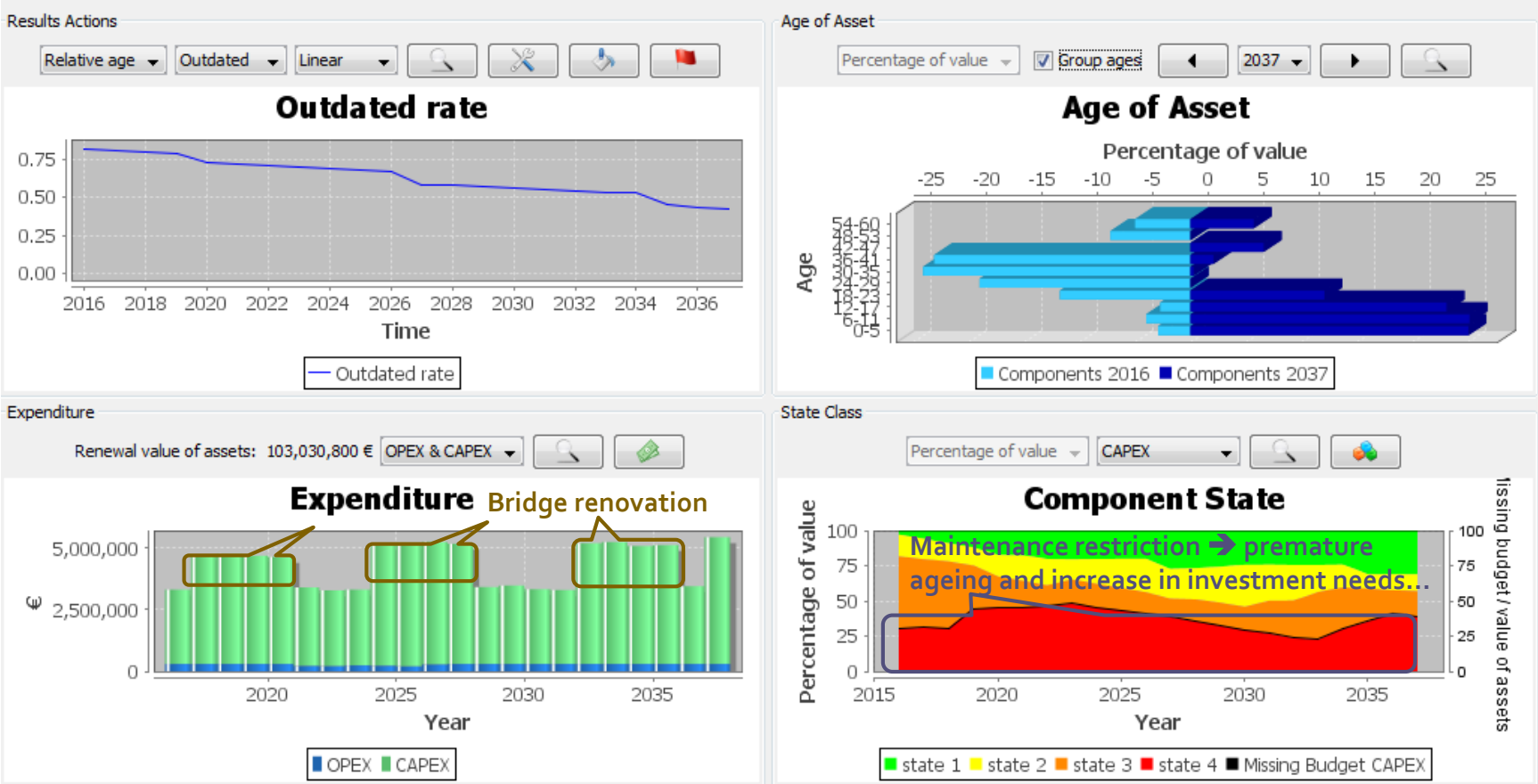
- Budget Constraints: Tracks' CAPEX ➔ Risks



After 2023: one failure every 2.8km, unplanned interventions and additional costs

Sc3 – « Constraints on CAPEX and OPEX » : Expenses vs ageing

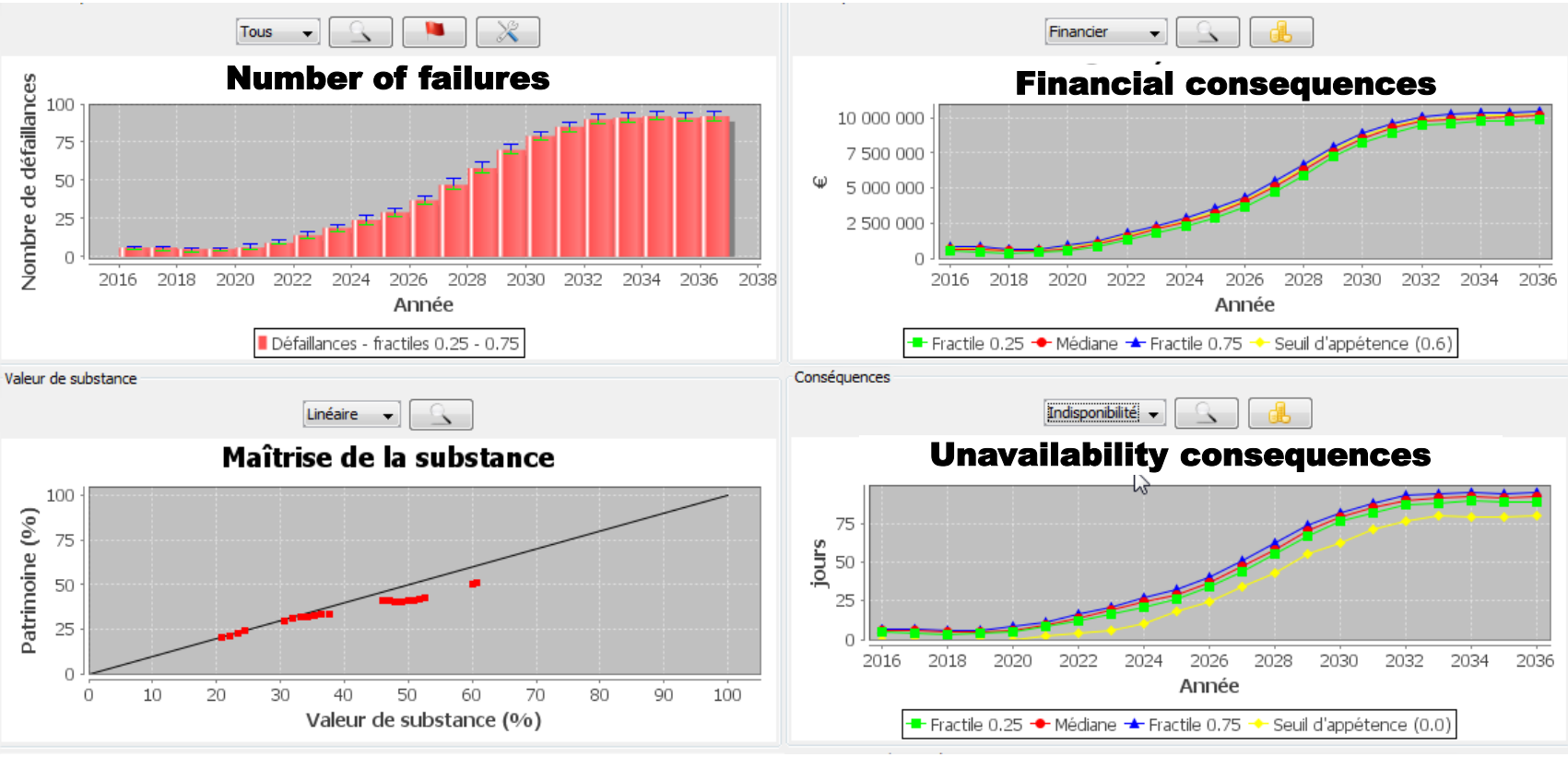
- Budget Constraints on Capex and Opex for tracks : what impact on lifecycle ?



Maintenance restrictions are detrimental to ageing management : up to 50% of assets are at risk

Sc3 – « Constraints on CAPEX and OPEX » : Risks

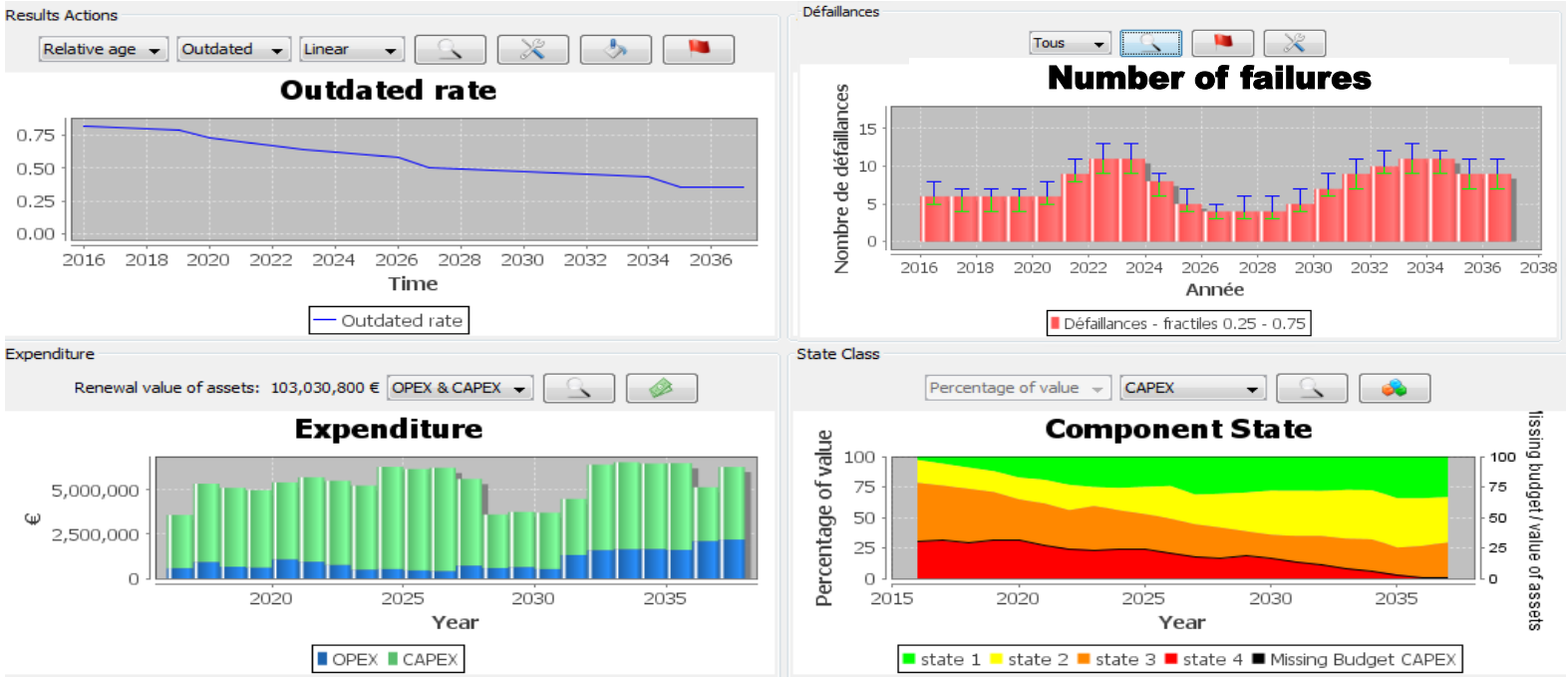
- Budget Constraints on Capex and Opex for tracks : what impact on risks ?



The absence of preventive maintenance leads to premature ageing and to an increase in the number of failures after 2025.

Sc4 – « Optimisation » : Expenses vs ageing

- Invest differently ➔ invest at the right moment and on the right components
- Wait too long before investing ends up costing more : what is the key deadline ? how to preserve an acceptable performance level and quality of service ?



- Concentrate financial effort over the next 10 years and considerer corrective maintenance to mitigate risks :
  - Concentrate effort between 2022 and 2026 (between bridge renovations) ;
  - Corrective maintenance compensates for lack of investment after 2026

Example 2 : Maintenance plan Optimisation

(1/5)

- Optimisation of maintenance plans covers three disciplines:

Asset Management

Approach according to ISO 55.000

Better understanding of portfolio

In control of budgets

Alignment of management and operations

Risk Management

Mapping your assets on two axes:

- Probability of failure in line with the condition of the asset

- Consequence of failure in line with the strategic objectives of your organisation

Prioritise actions on riskier assets

Ageing Management

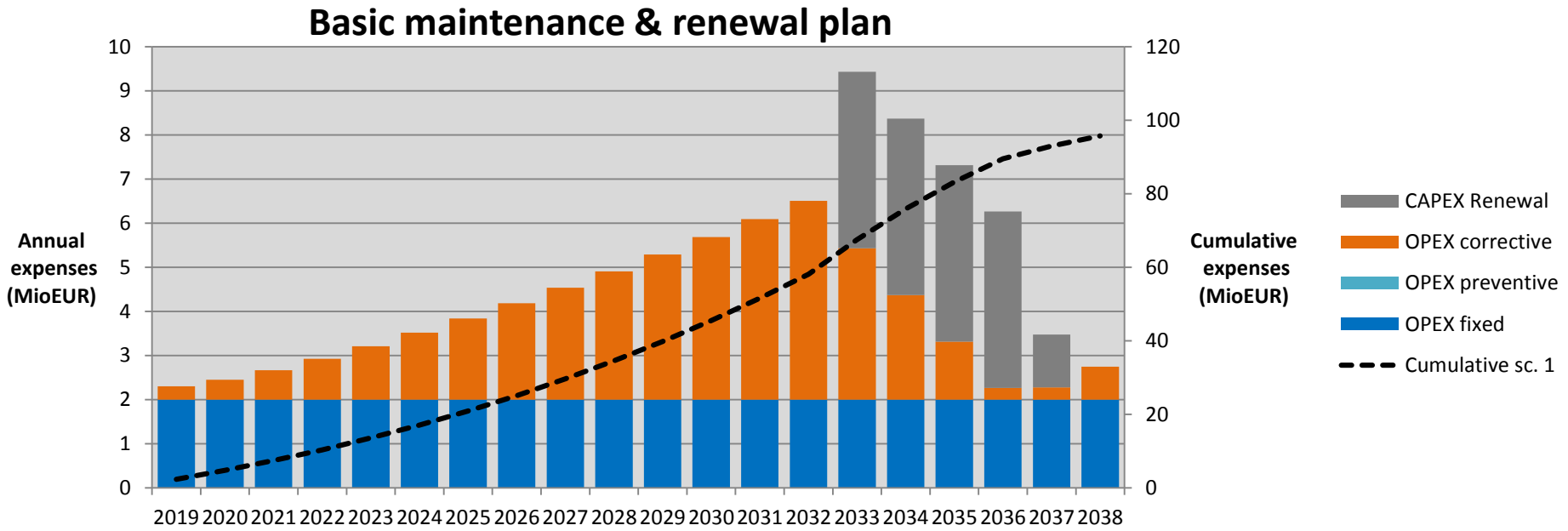
Simulation of ageing of your assets aiming to:

- Forecast failures

- Plan predictive maintenance at the right moment

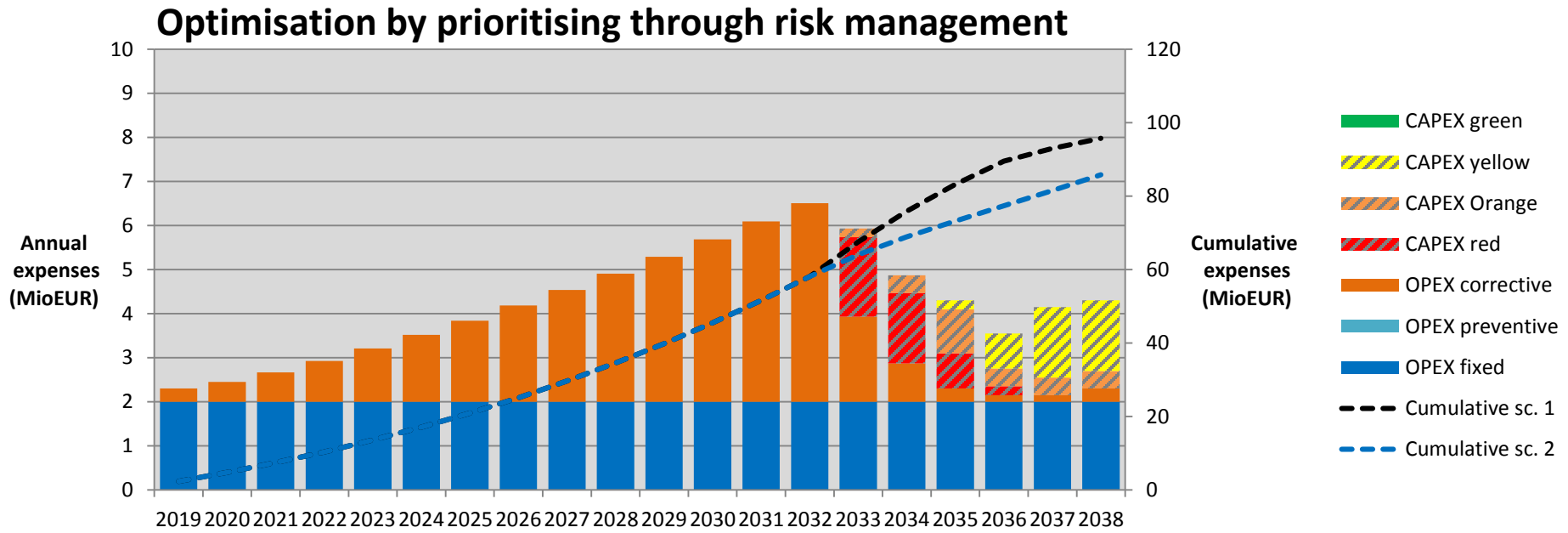
- Balance OPEX with CAPEX

Maintenance Plan Optimisation (2/5)



- Simplified maintenance plan (20 year)
- Fixed operational cost (blue bars)
- Increasing corrective maintenance cost due to an increase of defects as a result of an ageing portfolio (orange bars)
- Spread of renewal investments over 5 years after technical lifetime is reached (grey bars)
- Decrease in corrective maintenance cost after rejuvenation of portfolio through renewal investments (after 2033)
- Cumulative maintenance cost grows exponentially due to increase of corrective maintenance and becomes steeper when investments are realised (dotted line)

Maintenance Plan Optimisation (3/5)

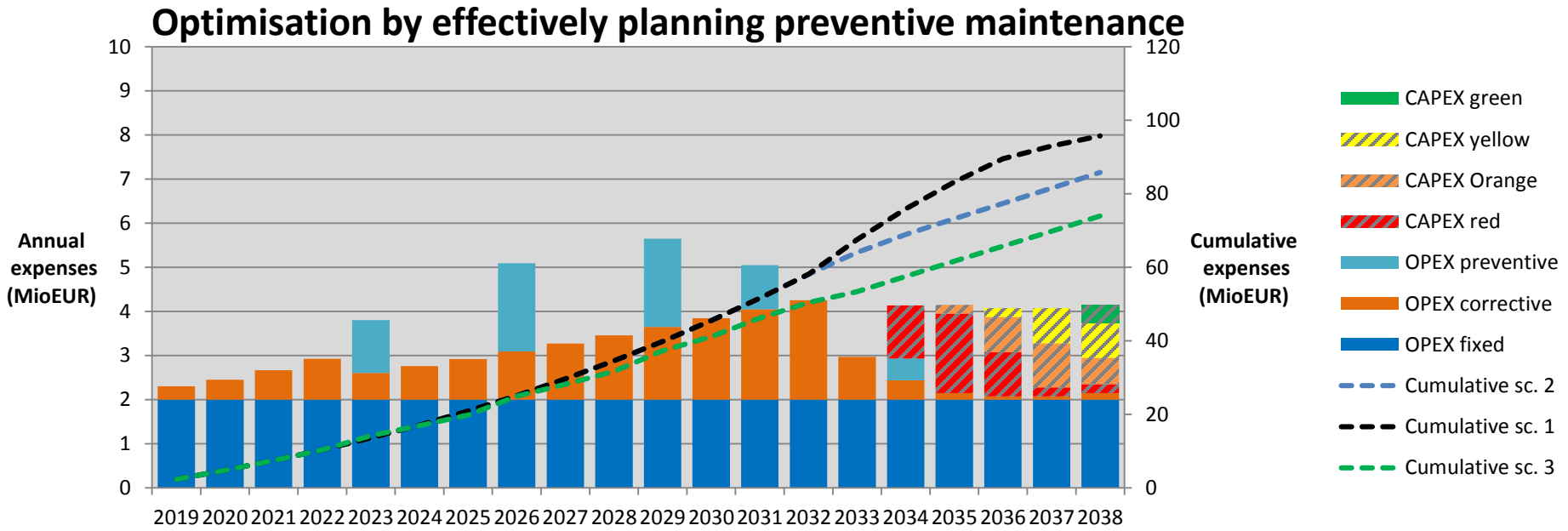


- Looking at planned renewals (grey)
- Map the assets on matrix (probability x consequence)
- Prioritize renewals in red zone
- Reduce corrective maintenance by renewing riskiest assets
- Push less important assets (green & yellow) back in time (perhaps even over contract period)
- Reduction of cumulative expenses + control of risk

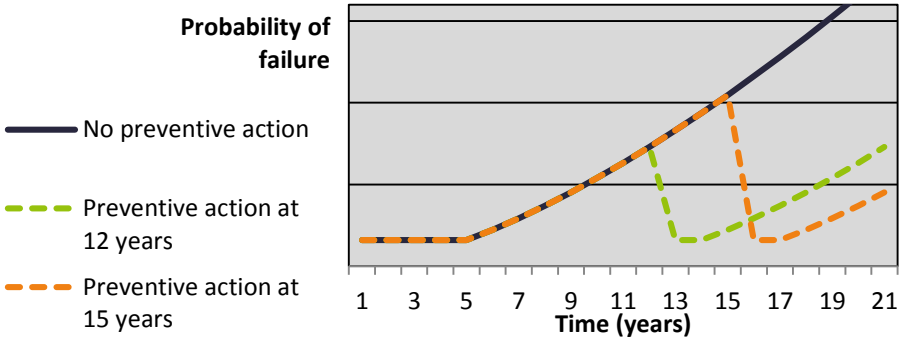
fréquency of occurrence	*Consequence*			
	Minor	Significant	Major	Catastrophic
1 per year	●			
1 per 5 years		●●		●
1 per 10 years		●	●	
Incidental				

Mapping of risks on a risk matrix

Maintenance Plan Optimisation(4/5)



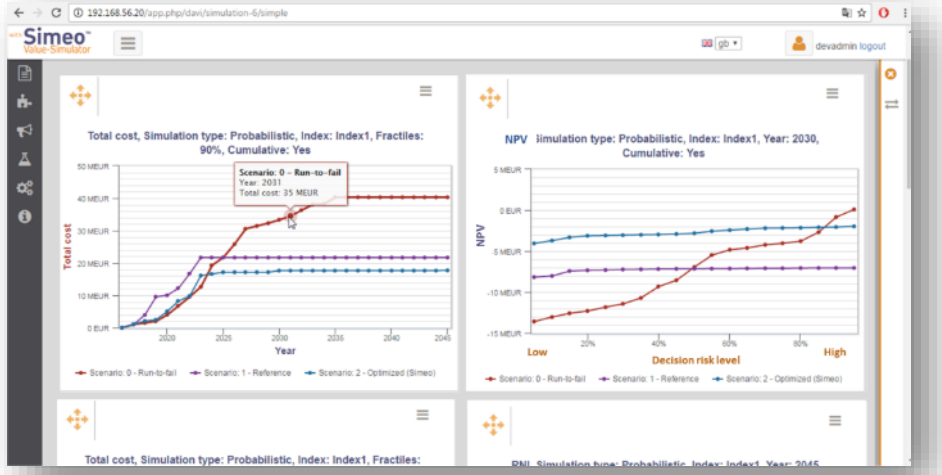
- Incorporate increase of probability of failure due to ageing (e.g. bathtub curve)
- Estimate effect of preventive maintenance actions on risks
- Plan preventive maintenance actions to extend technical lifetime (light blue)
- Push renewal investments back in time
- Reduction of cumulative expenses
- Reduction of corrective maintenance

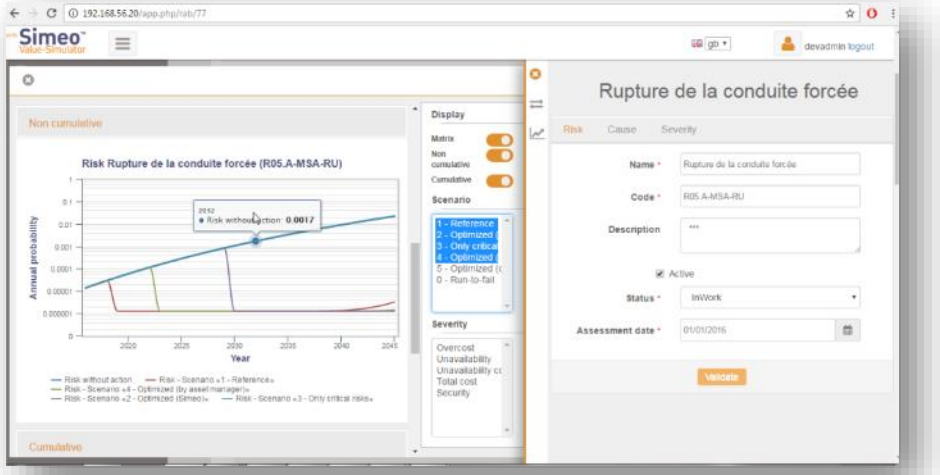


The effect of a preventive action on the probability of a risk

Maintenance Plan Optimisation (5/5)

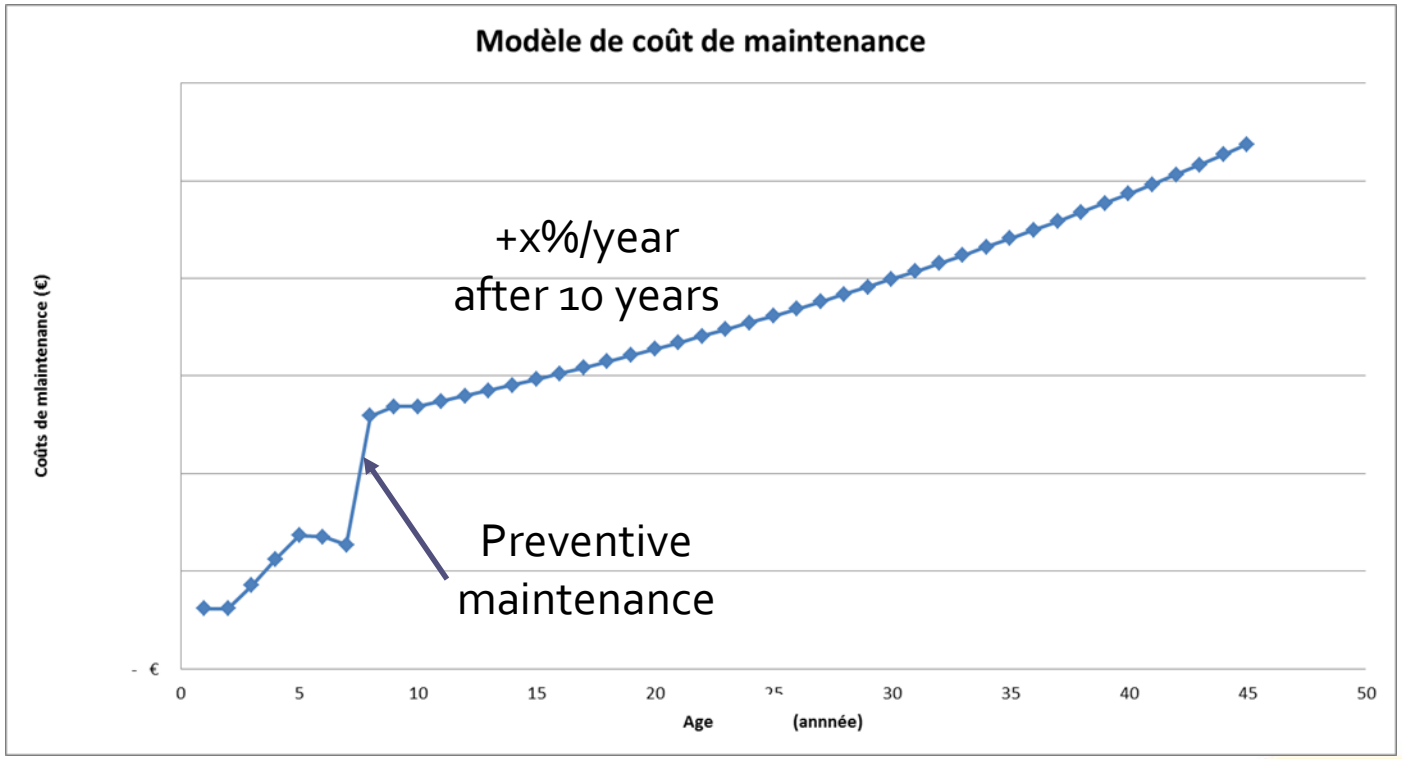
- Complexity increases with:
  - Heterogeneous asset portfolio (e.g. civil works and rolling stock)
  - Different ages and lifecycles in portfolio (existing, new)
  - Budget constraints and expenditure peaks
  - Multiple issues (financial, safety, environment, etc.)
  - Politics





Example 3 : Maintenance hypothesis

- Maintenance costs
  - Model based on **operating experience** taking into account a preventive action after 8 years



Example 3 : Scenario definition

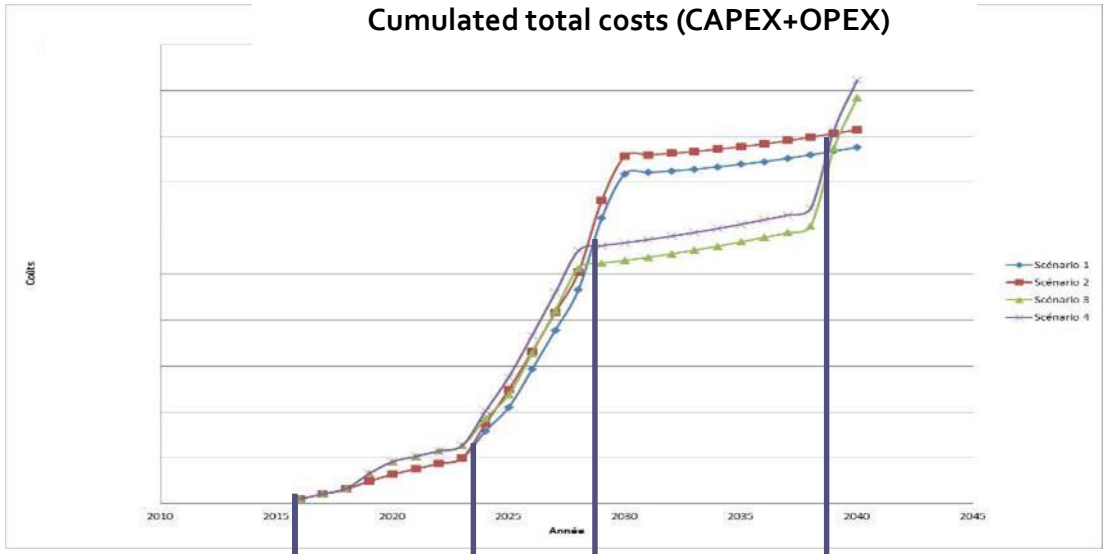
- Asset management strategy
  - 2 maintenance options :
    - normal maintenance
    - heavy maintenance increasing lifespan
  - 2 renewal options
    - Replacement with same technology
    - Replacement with different technology

    → Impact on renewal direct cost

- 4 scenarios
  - Sc1-2 : Normal maintenance then renewal around 2025
  - Sc3-4 : Heavy maintenance allowing to postpone part of the renewal around 2040

Example 3 : Results

- Which investment scenario is the best (financially) ?
- What period of time are we considering ? : short term, long term ?



Sc1-2 : Normal maintenance then renewal around 2025

Sc3-4 : Heavy maintenance allowing to postpone renewal around 2040

2 renewal solutions

2015-2023 : best scenario : Sc 1&2

2015-2028 : best scenario : Sc 1

2015-2038 : best scenario : Sc 3

2015-2045 : best scenario : Sc 1

Conclusions

- Added value of a simulation tool such as Simeo™
  - ✓ Be aware of the needs (what, where and when) from short to long term
  - ✓ Be able to optimise budget allocation / maintenance strategy over the time
  - ✓ Be able to "quickly" have objective arguments to defend a budget and a maintenance strategy

Reach the right balance according to strategic goals