HOW TO DEFINE THE BEST CONFIGURATION FOR A NEW/RENEWED LINE (ENERGY IN TCO)?

A CROSS-COMPANY COLLABORATIVE WORK

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JEAN-FRANCOIS TREMONG
ITG PROJECT MANAGEMENT CONSULTANT
SNCF INNOVATION & RECHERCHE

TECH4RAIL
INNOVATION & RECHERCHE
HOW TO DEFINE THE BEST CONFIGURATION FOR A NEW/RENEWED LINE (ENERGY IN TCO)?

Current situation

EXTERNAL PRESSURE TO IMPROVE ENVIRONMENTAL SOLUTION DEPLOYMENT

French Prime minister mission in June 2018 to evaluate technologies available to lower railway emissions
End of thermic cars in 2040
Pressure on air quality in 15 cities in France

LOM Law & PPE to define energy balance between massive consumers

Industrial release (hydrogen train, Innotrans announcement.)
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HOW TO DEFINE THE BEST CONFIGURATION FOR A NEW/RENEWED LINE (ENERGY IN TCO)?

Current situation

IN FRANCE THERE ARE A LOT OF ELECTRIFICATION OR RENEWED PROJECTS! BUT ONLY SOME MATERIALIZE…
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Current situation – infrastructure point of view

Length of electrified lines: 14500 km (45 % of the RFN)
• 5900 km in 1500 V DC
• 8500 km in 25 kV - 50 Hz (2 x 25 kV comprised)

88 % of the traffic is carried out on electrified lines

ORsay-AUSTeRLITZ
600 V = par 3ème rail
PERPIGNAN-VILLEFRANCHE
12 kV - 16\(^{2/3}\) Hz
MIDi - PO - PLM
1500 V =
AIX LES BAINS - ANNECY
20 kV - 50 Hz
PARIS-LyON
2x25 kV 50 Hz

1900 1912 1919 1951 1954 1980
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Current situation – infrastructure point of view

ECONOMIC MODEL OF ELECTRIFICATION

![Diagram showing total cost (CAPEX + OPEX) vs. traffic density with two lines: Electric traction supply with catenary and Autonomous traction supply. The financial balance point is marked.]

- Electric traction supply with catenary
- Autonomous traction supply

Financial balance point

Total cost (CAPEX + OPEX)

Traffic density
NEW ALTERNATIVE SOLUTIONS

- **0% ELECTRIFIED LINES WITH :**
  - Hybrid (ex: Hydrogen / Diesel + Battery)
  - Biofuel

- **FRACTIONATED ELECTRIFIED LINES WITH :**
  - Bi-mode (Diesel + catenary)
  - Tri-mode (ex: Diesel / Hydrogen + Battery / Supercapacitor + Catenary)

- **100% ELECTRIFIED LINES OPTIMIZED WITH :**
  - EMU
  - EMU battery (Battery + Catenary)
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Optimized solution system Approach

NEW SYSTEM SOLUTIONS IN THE ECONOMIC MODEL

Total cost (CAPEX + OPEX)

- Electric traction supply with catenary
- Autonomous traction supply
- New solutions

Traffic density

Zone of relevance of new solutions
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ELECTRIFICATION DECISION PROCESS OVERVIEW

Mobility needs expressed by Regional authorities

Operator

Role:
1. Define an mobility offer in order to meet regional expectations

Network

Role:
1. Study line structure & parameters
2. Build an electrification scenario

Rolling Stock

Role:
Chose within a list of rolling stock type taking into account the network answer and the operator constraint

The historical ways:
A phasing & binary process which mostly lead to overate infrastructure capacity & RS performance
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NEW DECISION PROCESS

Operator

Network

Rolling Stock

Operator

Network

Rolling Stock

Phasing process

Iterative optimization of railway system for our client

And for internal cost & time reduction
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Study on a French use Case

**PRINCIPLE**

- Create electrification scenarios
- Calculate operation cost of different Rolling Stocks solutions
  - Biofuel
  - Hybrid
  - Bi-modes
  - Tri-modes

FIND THE BETTER ECONOMICAL SOLUTION
HOW TO DEFINE THE BEST CONFIGURATION FOR A NEW/RENEWED LINE (ENERGY IN TCO)?
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RESULTS AND CONCLUSION

• Those study allowed us to compare solutions from an economic point of view

• But results are too close to reach real conclusions.

IT TAKES MORE INDICATOR TO REACH A FINAL DECISION
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Collaborative work

CROSS COMPANY SEMINARY : MINILAB “ÉLECTRIFICATION FRUGALE”

• 30-50 expert from Railway Infrastructure, Railway operator, RS, Research,… gathered to imagine the solutions starting from the problematic

• Objective : Create working groups able to find system solutions and method to give to Regional authority answers for each lines
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Collaborative work

STRATEGY IMPLEMENTED

Layer 1
Upstream study

- Technology performance
- Economic conditions
- Political & environmental rules
- Fiscal & legal conditions

Layer 2
Tools & method

- Minilab Organization & project generation
- Pre-industrialization Projects Frugal electrification TER Hybride H2 train
- Generic modelization Solution integration to SNCF portfolio

Layer 3
Line & Regional Use cases

Lines specifics: lengths, slope, infrastructure, etc.

Layer 1 Diagram:
- Technology performance
- Economic conditions
- Political & environmental rules
- Fiscal & legal conditions

Layer 2 Diagram:
- Minilab Organization & project generation
- Pre-industrialization Projects Frugal electrification TER Hybride H2 train
- Generic modelization Solution integration to SNCF portfolio

Layer 3 Diagram:
- Lines specifics: lengths, slope, infrastructure, etc.

Solution 1 / Use case 1
Solution 2 / Use case 1
Solution 3 / Use case 2
Solution 4 / Use case 2
JEAN-FRANCOIS TREMONG
ITG PROJECT MANAGEMENT CONSULTANT
SNCF INNOVATION & RECHERCHE

TEL: +33 (0)9 88 81 68 47
MOB: +33 (0)6 47 23 53 44
E-MAIL: EXT.JEAN-FRANCOIS.TREMONG@SNCF.FR

TECH4RAIL
1/3 avenue François Mitterand
93212 La Plaine Saint Denis