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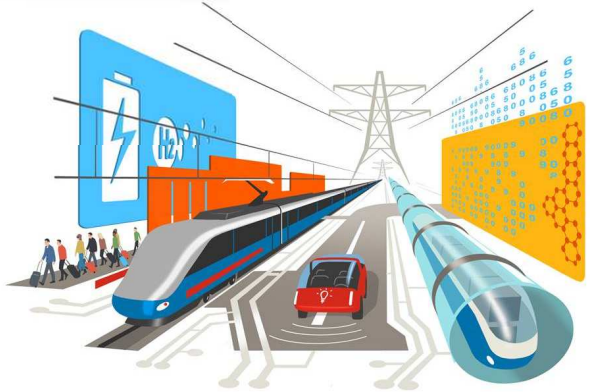


HYBRID TRACTION

Energy efficiency of future trains – UIC Workshop
October 2017, 4th

SNCF

HYBRID TRACTION

CONTENTS

1. Context and SNCF energy strategy
2. Hybridisation, a solution among others …
3. Challenges
4. Roadmap

1. Context and SNCF energy strategy

TRACTION ENERGY CONSUMPTION

16,9 TWh

SNCF energy consumption in 2015

1st

SNCF is the biggest industrial energy consumer in France with 10% of the industrial energy consumption and 3% of total national consumption.

60%

Of total energy consumption is used for traction

10 TWh

Electricity	78 %
Diesel	22%

790 kteqCO_2

	47%
	53 %

53 % of all emissions are from diesel traction though it represents only 22% of the consumption.

SNCF Energy Strategy Targets 2015-2025

+ 20% ENERGY PERFORMANCE

+ 25% CARBON PERFORMANCE

2. HYBRIDISATION, A SOLUTION

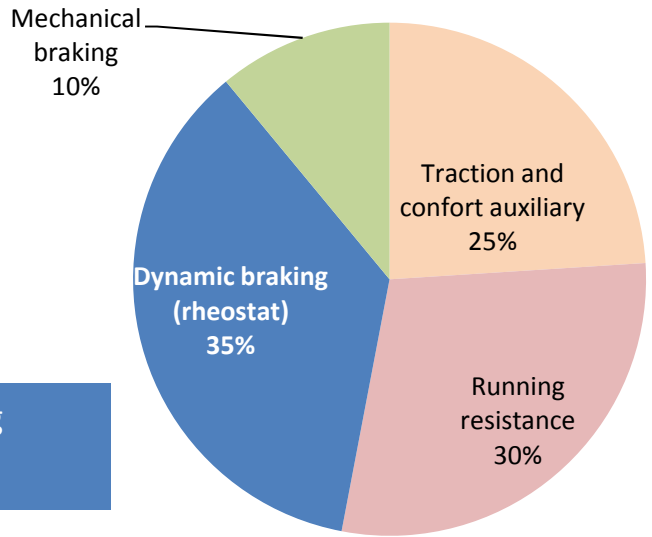
Among others …

HYBRIDISATION, AS ONE SOLUTION

ENERGY LOSSES DUE TO BRAKING

SNCF made an energy diagnostic on its rolling stock : measurement on 28 000 km travelled by bi-modes DEMU “Régiolis” (commuter trains)

Distribution of energy consumption (Diesel and 1,5 kV mode)



First energy-saving potential : recover dynamic braking

30 to 60 M€ energy loss per year

HYBRIDISATION AS A SOLUTION

RECOVERING AND USING BRAKING ENERGY

CONCEPT OF HYBRIDISATION

> Installation of on-board storage capacities to recover the braking energy

> Energy storage is a new energy source on board, that can be used for all energy needs of the train

> This energy can be used in combination with diesel or catenary power

OBJECTIVES

> Cut down fuel consumption and greenhouse gas emissions

> Reduce operating cost : fuel, electricity and diesel engine maintenance

> Provide on-board new services

Hybridisation of Diesel trains : first step on the way to low carbon emissions

SERVICES OF HYBRIDISATION

NEW FUNCTIONS AND SERVICES TO DEVELOP

ENVIRONMENT AND ENERGY TRANSITION

ENERGY & MAINTENANCE COST REDUCTION

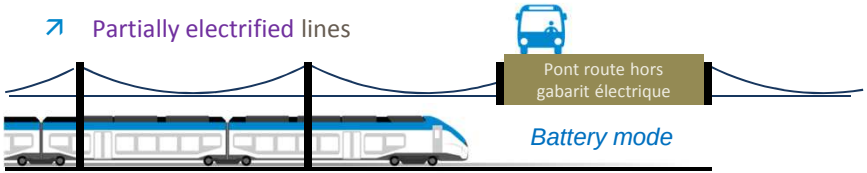
NOISE, GREENHOUSE AND OTHER POLLUTANT REDUCTION

INNOVATING SERVICES

INCREASE OF OPERATING PERFORMANCE

- Traction boost
- Comfort services (HVAC, light) in case of disturbances
- Zero emission traction inside cities

RECONSIDERING TRACTION ENERGY SUPPLY



SERVICES OF HYBRIDISATION

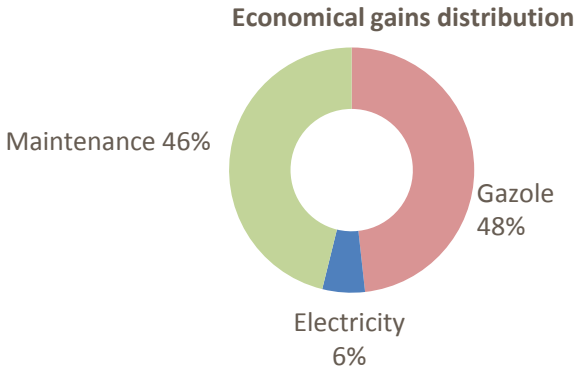
GAINS TARGETED

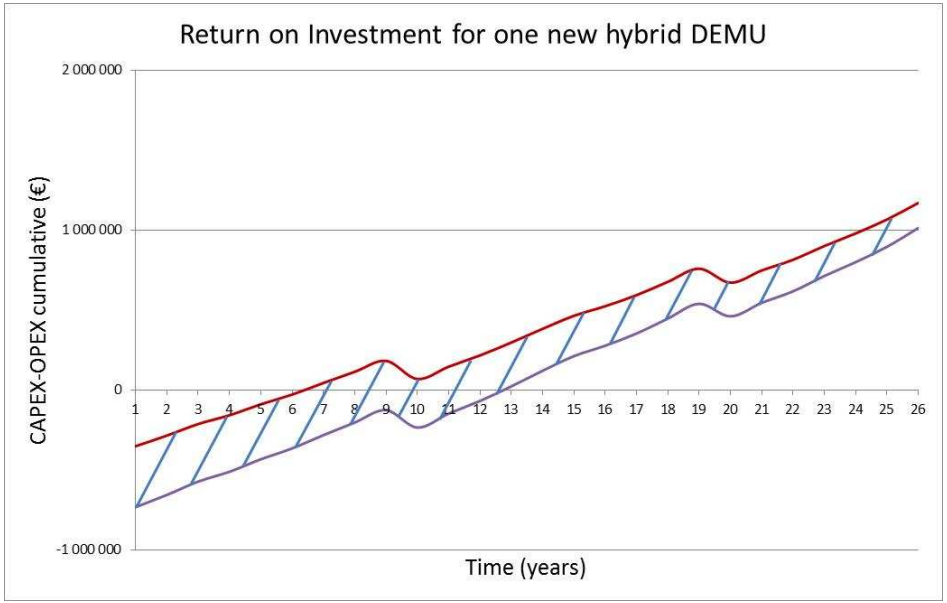
-20 % energy consumption

-30 to -50% diesel motor maintenance cost (by reduction of number of motors)

noise reduction **up to -6 dB** in station

-20% greenhouse gas emissions





HYBRIDISATION AS A SOLUTION

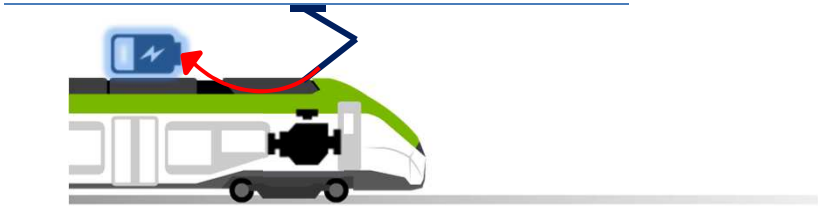
FLOWS OF ENERGY

CHARGING THE BATTERY

1. Recover dynamic electric braking energy

2. Use diesel motor at its best performance

3. Use the catenary : low cost and pollution energy



HYBRIDISATION AS A SOLUTION

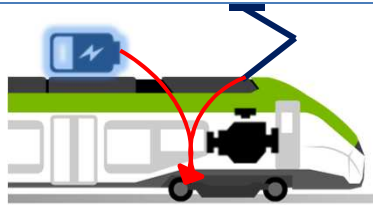
FLOWS OF ENERGY

USING THE POWER OF BATTERY

1. In combination with diesel motor :
    - Normal hybrid traction
    - Boost mode

2. Battery only mode
    - Arriving and leaving station
    - During stop in station
    - In case of lack of power on catenary
    - Crossing non-electrified section
    - In maintenance facility

3. In combination with catenary
    - Boost mode with low catenary voltage



3. CHALLENGES

DEVELOPMENT OF HYBRIDISATION

CHALLENGES

DIGITAL SIMULATION WERE MADE TO

> Choose the right technology : Li-ion batteries, Lithium Capacit
Flywheels, Supercapacities

> Size the capacity and the power of the storage

> Elaborate the on-board energy management in order to optim
gains and costs

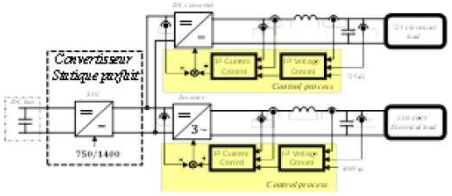
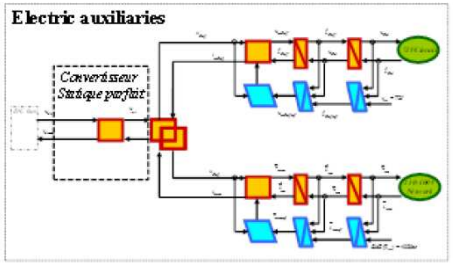


Schéma fonctionnel du circuit des auxiliaires



REM du circuit auxiliaires

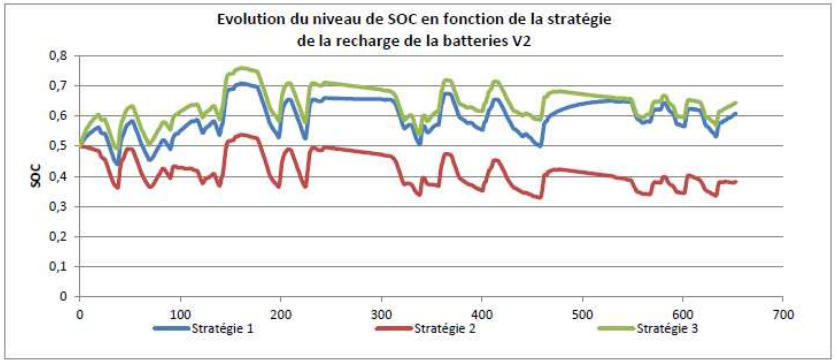
CONCLUSIONS

> Energy gains are dependent of the route operated

> Best compromise is Li-ion batteries

> Sizing and energy management need further works :

- On-going thesis with SNCF to optimize all parameters
- Need to experiment in real conditions as simulation requires validation



DEVELOPMENT OF HYBRIDISATION

CHALLENGES

SAFETY

Li-ion batteries bring new risks :

> Permanent energy :

- operators protection needed (electrical switching devices, …)

> Fire, explosion :

- cells temperature control with high safety standard needed (BMS)
- constructive features : safety valve on cells, confined box if necessary

First safety analyses have started : European Common Safety Methods for risk assessment will be applied

FINANCIAL CHALLENGES

> Hybridisation of an existing train remain an expensive project

> Energy cost and carbon tax are still relatively low

> Value of new services brought by hybridisation is not easy to evaluate

> Search for financing is a long work …

4. Roadmap

INNOVATION ROADMAP

ROADMAP FOR HYBRIDISATION

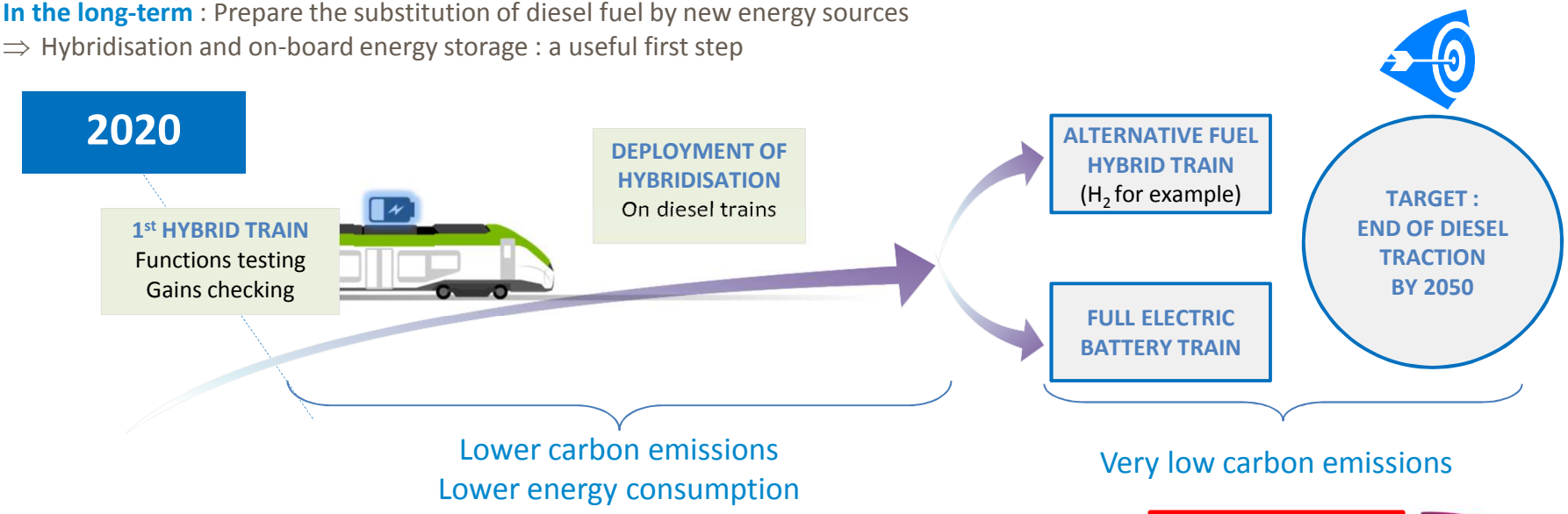
First step (medium-term) : Reach the goals of SNCF energy strategy by deployment of an hybridisation solution

⇒ Implies that the solution must be technically and economically realistic and mature

⇒ Target the regional Diesel-electric fleet of SNCF **(up to 700 DEMU)**

In the long-term : Prepare the substitution of diesel fuel by new energy sources

⇒ Hybridisation and on-board energy storage : a useful first step



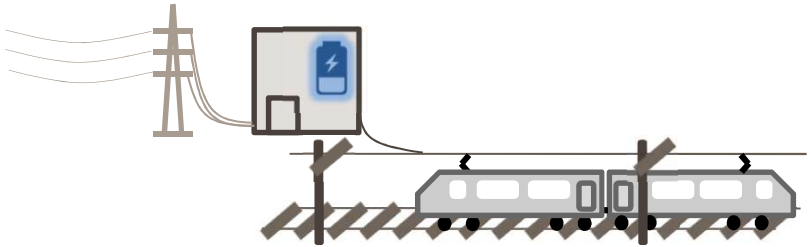
INNOVATION ROADMAP

HYBRIDISATION MAY NOT BE A UNIVERSAL SOLUTION

At this stage, energy storage appear more relevant :

> On-board, in trains, on non-electrified lines or partially electrified lines

> Static, in electric substation, on electrified lines, as it offer its services for all trains on the line



INNOVATION ROADMAP

ROADS TO LARGE SCALE
LOW CARBON ENERGY SYSTEM

	BATTERY TRAIN + CATENARY CHARGING	NEW ENERGY ON BOARD
Energy sources • Production techno & cost • Distribution infrastructure techno & cost	✓ Already existing ✓ Mastered by railways ? Climate change adaptation ? Cost evolution	Work on progress
On board generators • Reliability, safety & costs • Performances	✓ Existing for cars, busses, trams, trains ✓ Lower costs expected ✖ Industrial rail-products	Work on progress
Circular economy • Reuse (2nd life), Recycle • Natural resources depletion	Work on progress	Work on progress

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