ECO4 - Energy Efficiency measures for the existing fleet

Christian Köbel,
Energy Efficiency Days 2009, Tours

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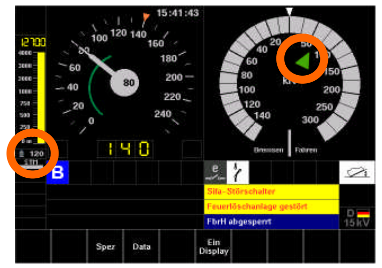
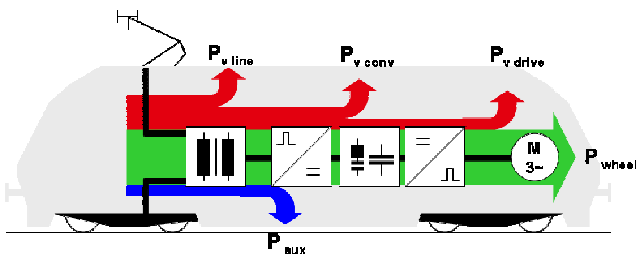
Energy efficiency
3 principals to be more efficient



1. Drive assistance system: EBI drive 50
2. Driver training

1. Driving behaviour



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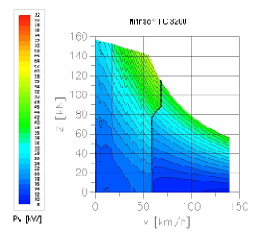
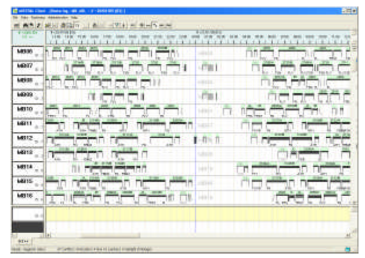
2. Efficiency

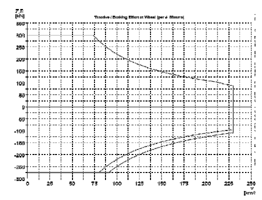


1. New technologies and components: e.g. Energy saver, PM motor, MF transformer,
2. Optimized traction chain
3. …

3. Operation

1. Smart stabling
2. Optimized recuperation
3. Energy management
4. Efficient time tabling
5. …





Optimization measures on SBB existing fleet

- Initiated by SBB, an analysis on potential energy saving off the existing fleet has been done.
- Focus was on high saving potentials (long operation time, high speed & high weight, non operation)
- Result was a list of recommendations on technical upgrades


Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement für
Umwelt, Verkehr, Energie und Kommunikation UVEK
Bundesamt für Energie BFE

POTENTIALERMITTLUNG ENERGIEEFFI-
ZIENZ TRAKTION BEI DEN SBB

Schlussbericht

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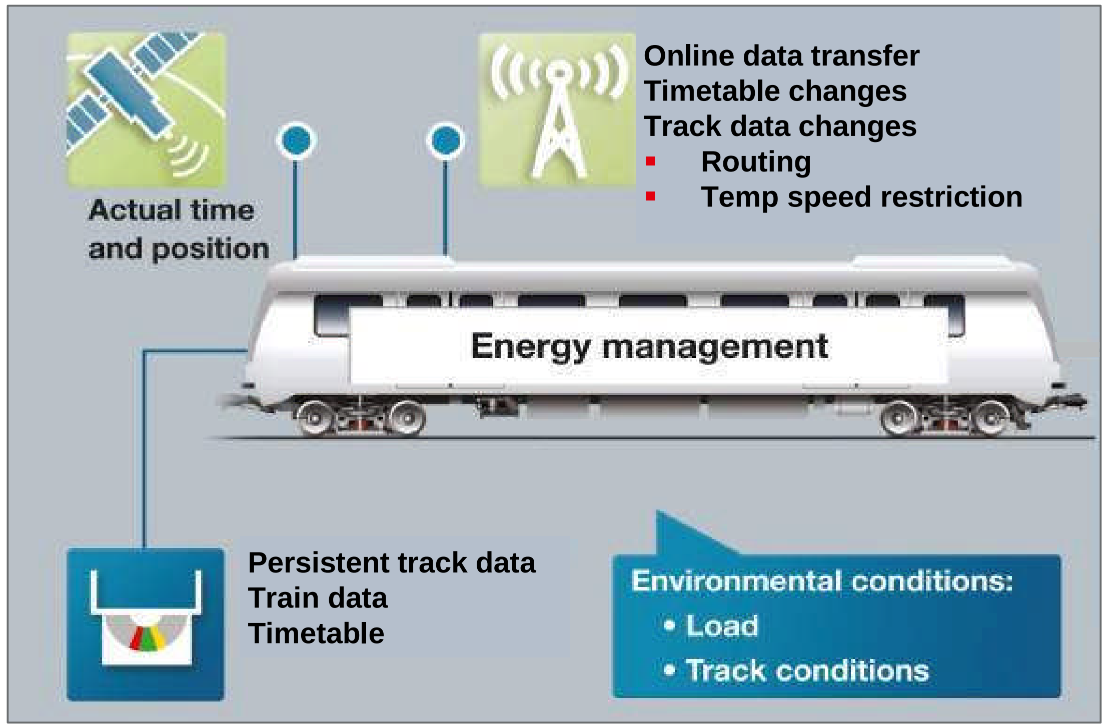
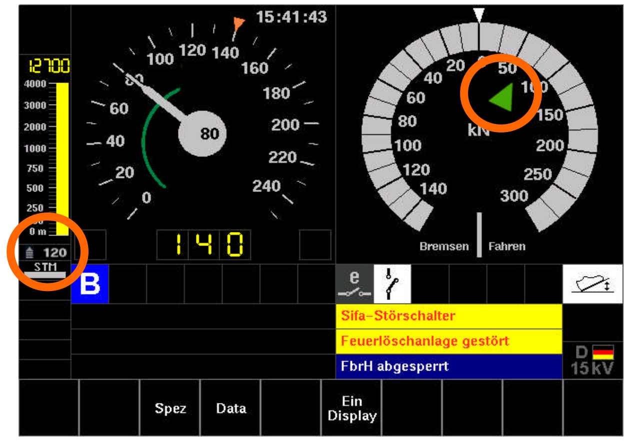
Re 460, ICN, Flirt, Thurbo-GTW	Optimized traction chain (motor flux and DC-link voltage optimization)	7.7 GWh/year	→ Optimized traction chain
Re 460	Increase of breaking effort curve	1.0 GWh/year	→ Optimized recuperation
Re 450, Re 460, NPZ	Switch off oil pumps in parking position	9.3 GWh/year	→ Energy management
Ae 6/6	Temperature controlled air cooling	3.0 GWh/year	→ Optimized traction chain
Re 4/4 II, Re 6/6	Switch off ventilation in standstill	2.5 GWh/year	→ Energy management
Re 10/10	Split of braking effort between locos via digital control	2.0 GWh/year	

Source: POTENTIALERMITTLUNG ENERGIEEFFIZIENZ TRAKTION BEI DEN SBB

EBI Drive 50
Driver Assistance System





- Intelligently combining the goals: Punctuality, energy savings and reduced wear
- Generating recommendations to the driver for:
  - optimized speed
  - optimized traction force

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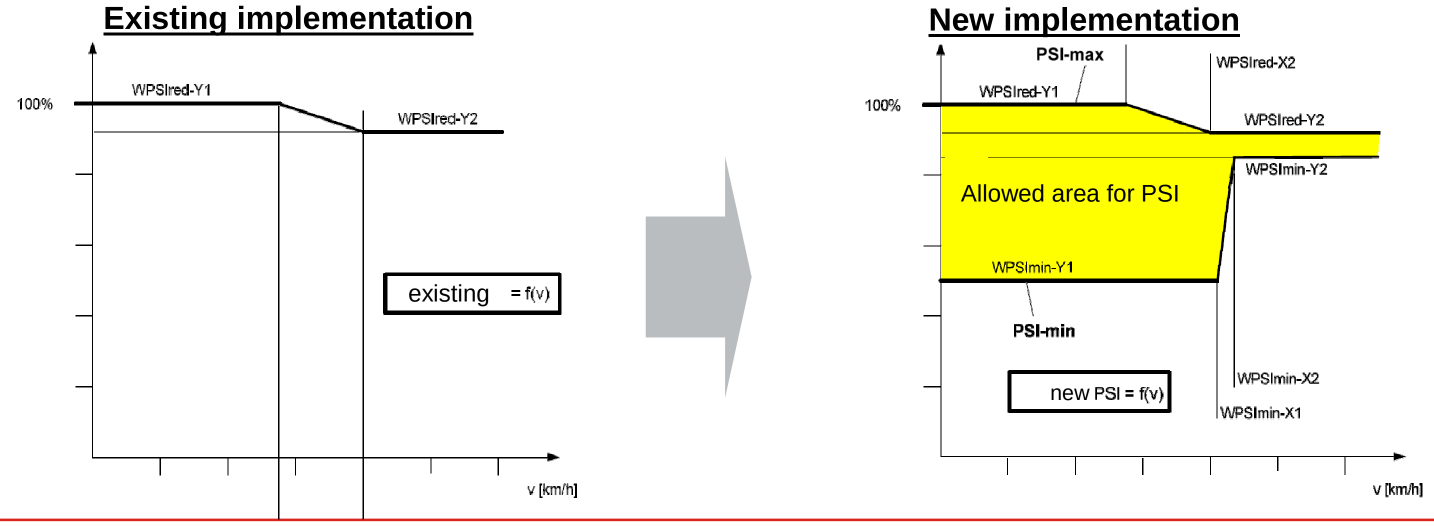
Optimized traction chain
Adaptive motor converter flux optimisation

- Original: fixed motor flux curve
  → result: high losses at low traction effort

- Upgrade: flux curve depending on speed and TE
  → result: reduced losses for the majority of operational cases

- State-of-the-art for new vehicles, applicable for the majority of GTO controlled vehicles!



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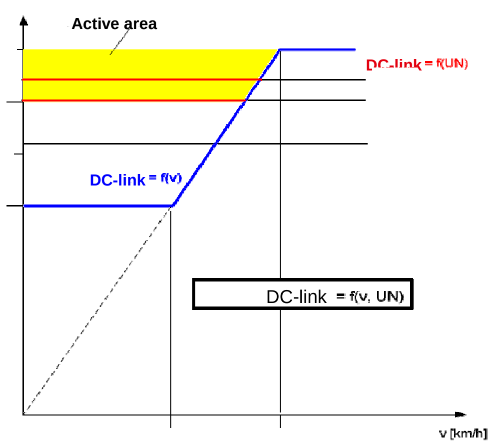
Optimized traction chain
Adaptive converter DC-link control

- **Original: DC-link voltage U_D= f(v, U_L) depending on line voltage and speed**
  → result: unnecessary high DC-link voltage

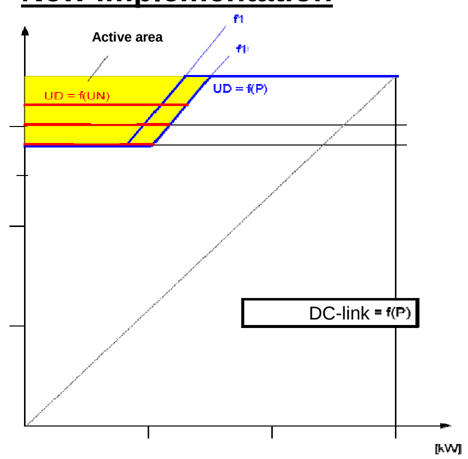
- **Upgrade: DC-link voltage U_D= f(v, U_L, P)**
  → result: reduced losses for the majority of operational cases

- **State-of-the-art for new vehicles, applicable for the majority of GTO controlled vehicles!**

Existing implementation

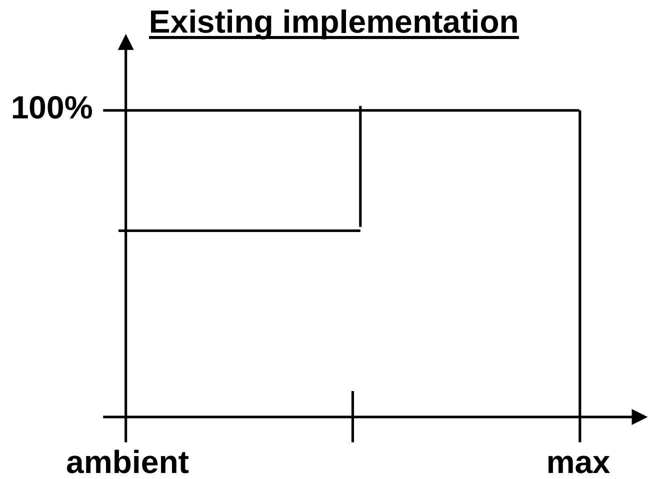


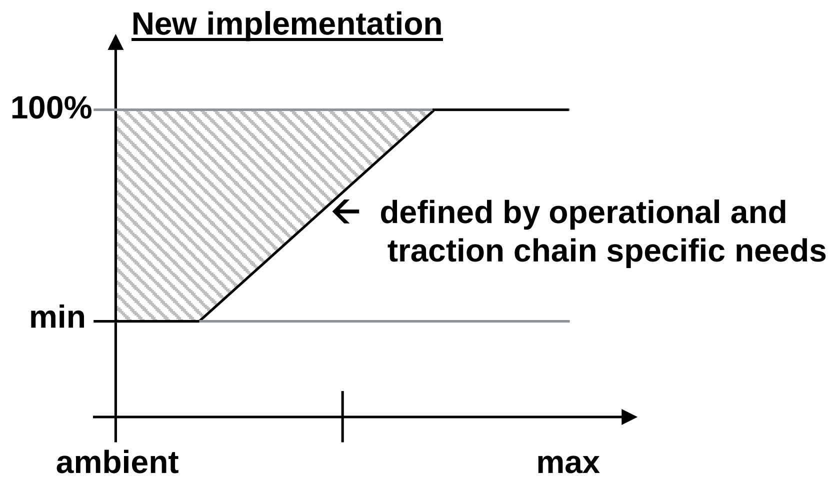
New implementation



Optimized traction chain
Temperature controlled air cooling

- **Original: Air cooling is very often only digital on/off or a non optimized 2 stage fan speed cooling → result: unnecessary operation of fan**
- **Upgrade: temperature controlled fan speed with min speed and increasing according a defined curve → result: reduced losses and reduced noise**
- **Applicability has to be evaluated!**





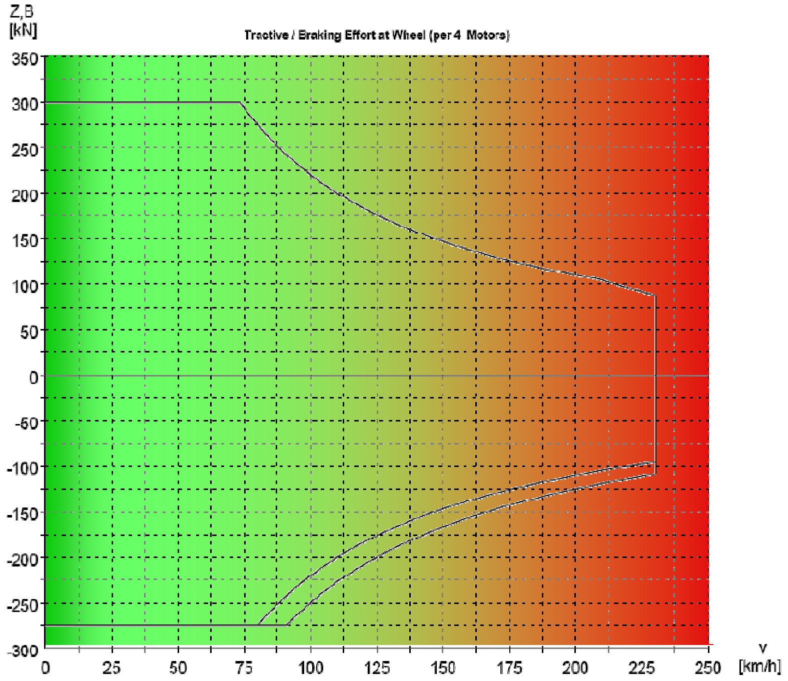
Optimized recuperation

Increase of braking effort

- **Original: Lower braking effort curve than tractive effort curve**
  → result: use of mechanical brake at high speed

- **Upgrade: Increase the BE curve to the maximum possible (+10% of TE)**
  → result: increased use of electrical braking at higher speed.

- **Applicability has to be evaluated!**



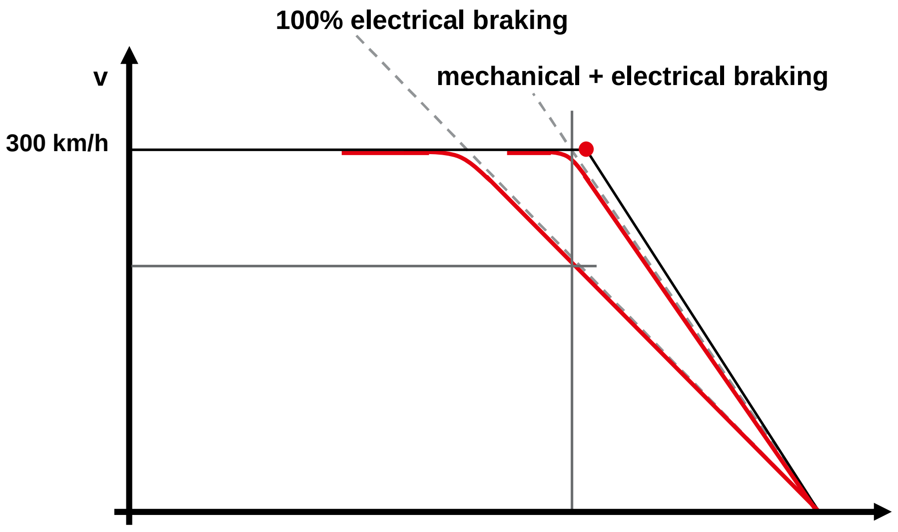
Optimized recuperation

100% recuperative braking in regular traffic operation

- Original: Braking from top speed into the railway station, the maximum allowed braking is used by applying the latest brake position.
  → result: high use of mechanical brake, especially at high speed.

- Upgrade: Use the target distance and target speed data from ETCS (or LZB) and braking according the maximum recuperation curve (100% electric braking)
  → result: maximum use of electrical braking.

- Applicability must be evaluated and time table must allow it.



Example: brake optimisation AVE S102

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Energy Management Control System
Managing Energy Consumption of Locomotives and Trains

Features

- **Managing energy consumption of all consumers on-board a vehicle**
- **<u>Energy Management - Energy Display</u> shows the driver actual & average energy consumption compared to fleet average**
- **<u>Energy Management - Energy Metering</u> allows billing and tracking the energy consumption for operators (new norm!)**
- **<u>Energy Management - Smart Stabling</u> reduces unnecessary auxiliary loads at turnaround, inter-peak and overnight**

Benefits

- Increases cost awareness of the driver
- Prepared for future European norm in energy metering
- Reduces energy consumption at standstill

Energy management
Operation during standstill

Pulsing during standstill:

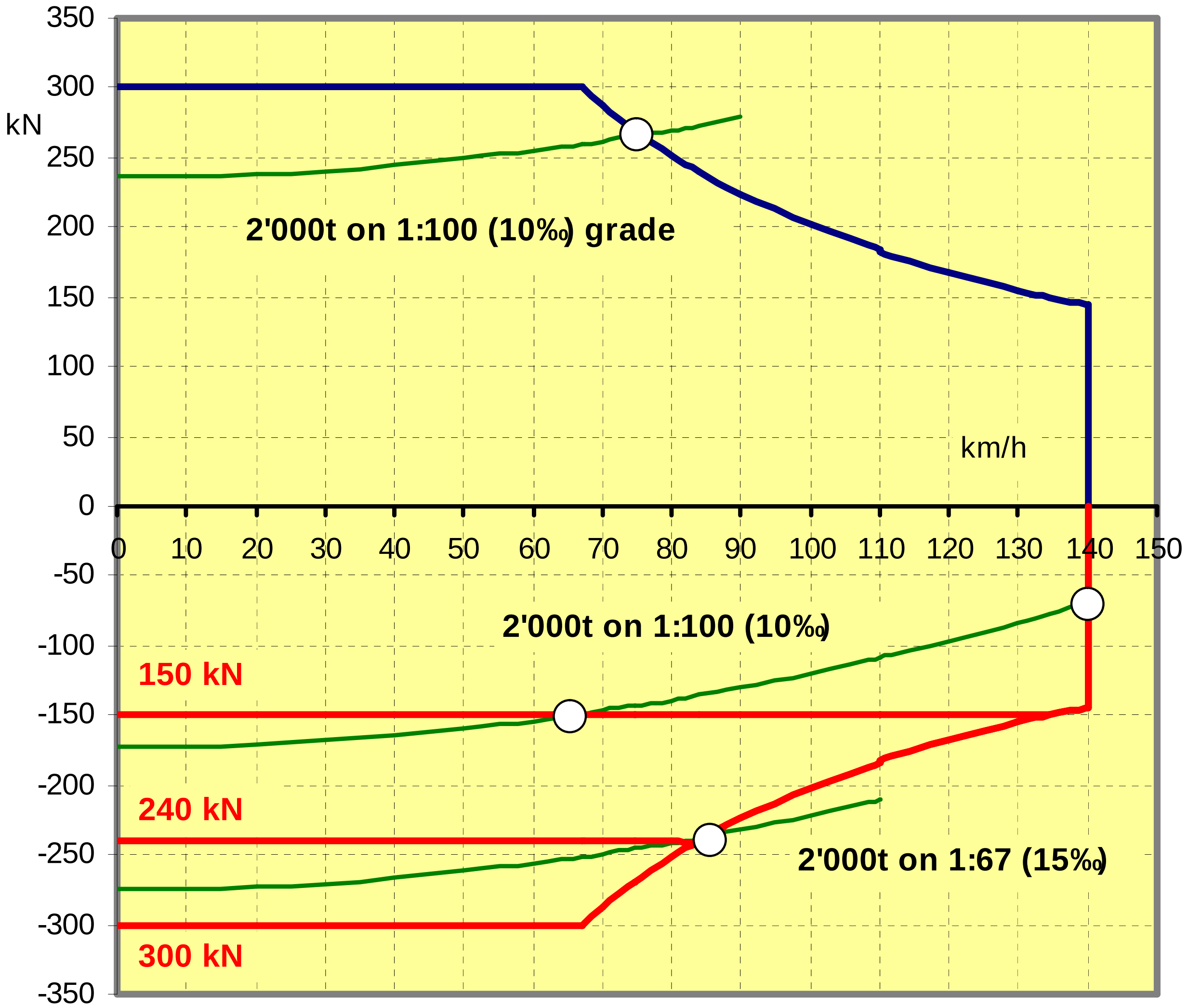
- **Original: Traction chain is in operation (transformer and motors magnetized, converter pulsing) during standstill operation**
  → result: losses in the traction chain and cooling
- **Upgrade: Switch off the pulsing mode if standstill exceeds a certain time limit and by that reducing the power consumption**
- **All new trains, from loco to regional trains!**

Oil pumps during standstill

- **Current state: Oil pump is constantly in operation during parking position**
  → result: unnecessary operation of pumps
- **Upgrade: Operation depended oil pump management resulting in oil pump only switched on when needed.**
- **E.g. oil cooled converters**

Optimized recuperation

EU wide the same regulations



Recuperation energy depends on the maximum allowed dynamic braking effort:

- **150 kN**
  Current EU Standard
- **240 kN**
  Allowed in Switzerland for freight traffic
- **300 kN**
  maximum possible recuperation

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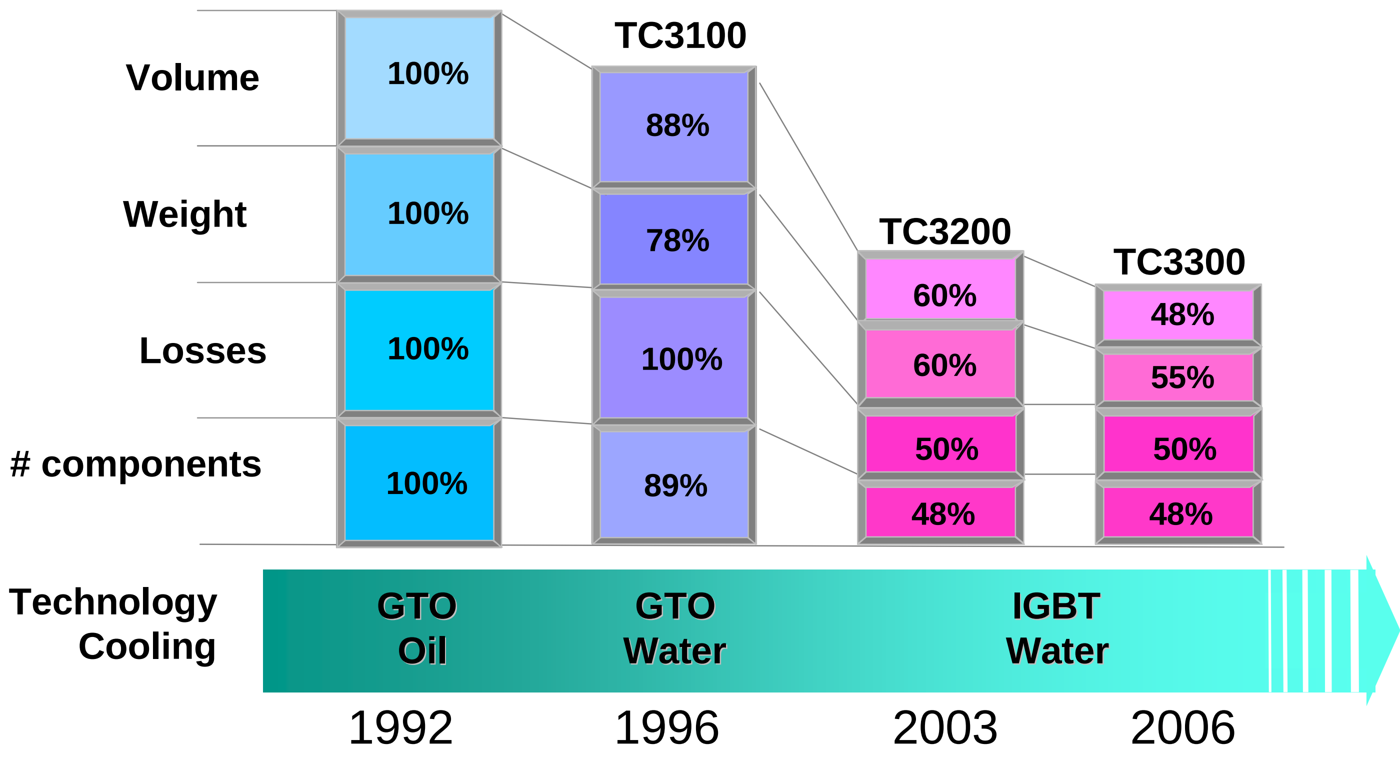
MITRAC TC traction converter
Evolution from GTO to IGBT technology



The challenges of our world demand a new formula for economic sustainability

Saving Energy
Improving Efficiency
Achieving sound Economic value
Protecting the Environment

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The new formula for
total train performance
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