‘Gröna Tåget’ Technologies

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KTH Railway Group

Banverket
Bombardier Transportation
SJ
Green Cargo
SL
Interfleet Technology

- 20 senior researchers
- 18 PhD students
- 16 PhD exams since1999
- Approx. 60 scientific papers annually
- Turn-over >1.5 MEuro

EURNEX
Railenergy

Background

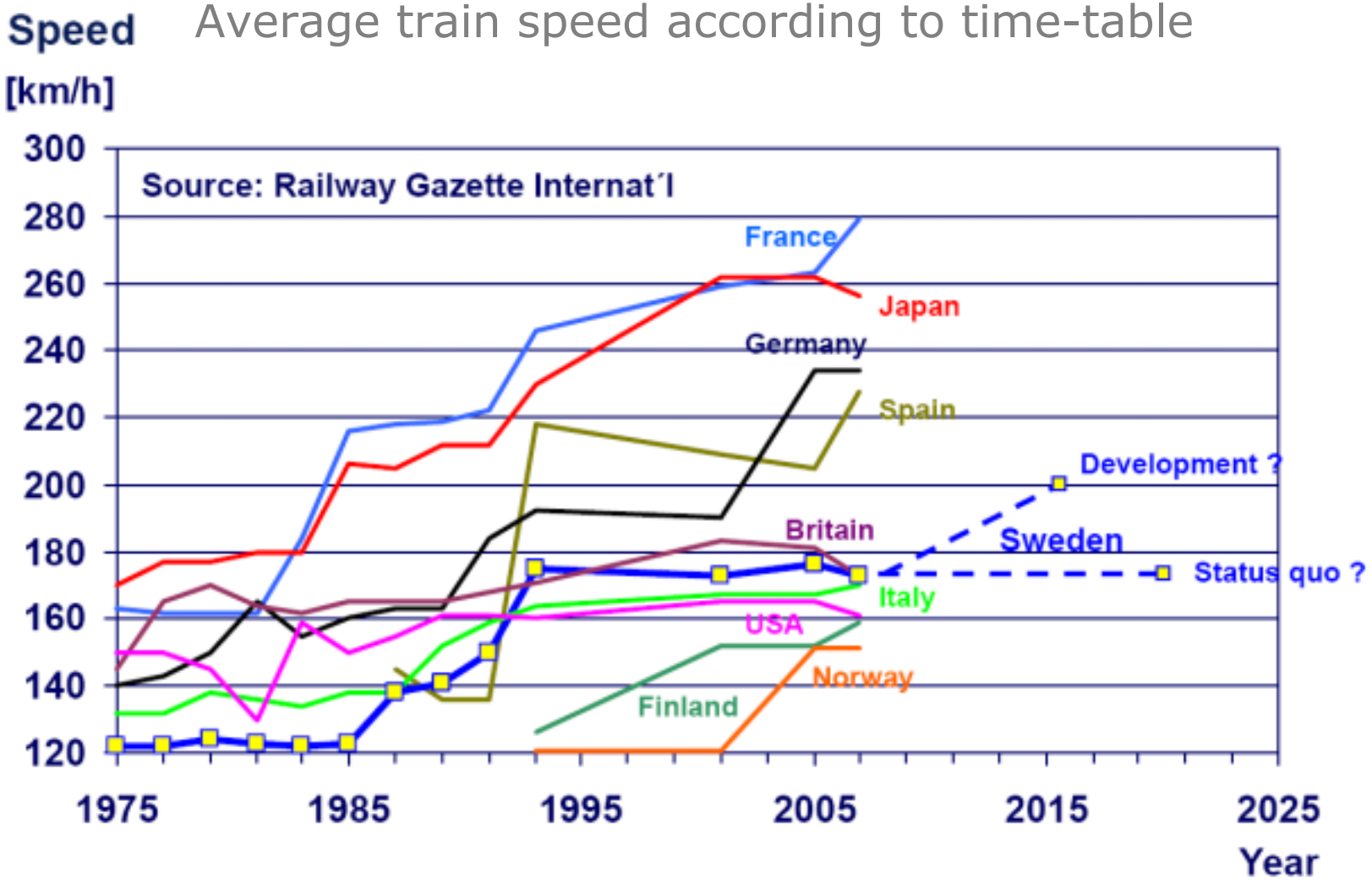
- A replacement of X2000 has to be initiated within the next years.
- Large investments in new rail infrastructure are made until 2015
- The project name refers to the inherent capacity of the railways to contribute to a sustainable transport system through high capacity, high energy efficiency, high safety and low emissions

Objectives

- To develop the prerequisites for the next generation of Swedish high-speed trains
- To strengthen the ability to influence European rail research and standardization
- To improve research collaboration between universities, research institutes, Banverket, Swedish rail operators and Swedish industry

International comparison

Average train speed according to time-table



Characteristics of a new Swedish high-speed train

- Shorter travelling time
  - Maximum speed at least 250 km/h
- Less environmental impact
  - Noise and energy
- Improved comfort
- Reliability in winter climate
- Lower cost
  - Capital
  - Maintenance
  - Energy
  - track fees
  - etc

and…

- Low track forces
- Relatively short trains that can operate in multiple
- As much as possible follow European standardisation
- The Swedish high-speed train must be part of an all-European train where special Swedish requirements are integrated by modularisation.

’Gröna Tåget’ projects

- **Track friendly Bogies**
  - Radial self-steering bogies
  - Mechatronic bogies
- **Active secondary suspension**
- Aerodynamic optimization of the train front
  - Slip stream and front shape for wide body trains
  - Design of high-speed trains to avoid instabilities at sudden cross-winds
- **External noise reduction**
- **Energy consumption**
- **Permanent magnet traction motors**
- Optimal tilting
- Vertical contact forces
- …

Track friendly bogies

- Passive radial steered soft bogie

- New design of:
- Primary suspension
- Bogie frame
- Yaw damper

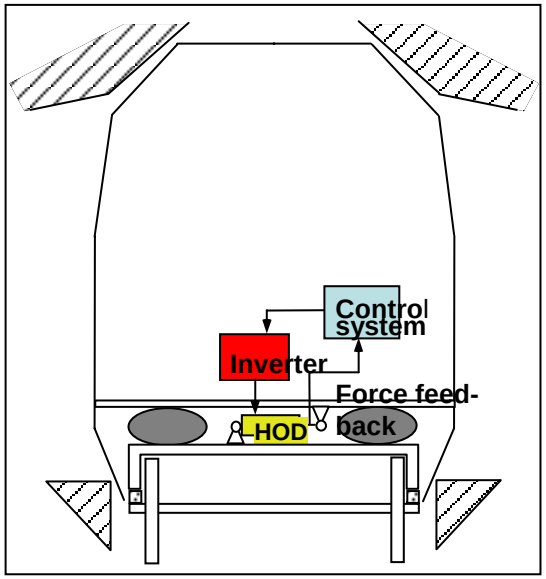
Lateral track forces “half” of UIC limits

- Mechatronic bogie

- Actively controlled radial steering

Active secondary suspension

- *Hold-off device* to centre the car body
  - A wider car body is permitted
- Improved passenger comfort
- Different actuators have been considered
  - Electro-mechanical
  - Electro-hydraulic



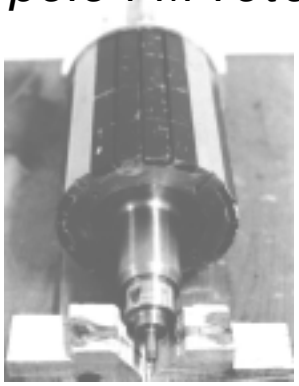
External noise reduction

- **Bogie skirts for lower external noise and lower energy consumption**
- **Low noise screens along the track**

Energy consumption

- Target: Reduced energy consumption per seat-km by 25-35% (compared to X2000) despite an increase in maximum speed from 200 km/h to 250 km/h
- A corresponding reduction in CO2 emissions is obtained.
- KTH studies show that a reduction in the range of 15-30% is feasible depending on the width of the car-body and thus the number of seats.
- For a wide body train that is approximately 0.052 kWh per passenger-km ("cabin factor" 60%)

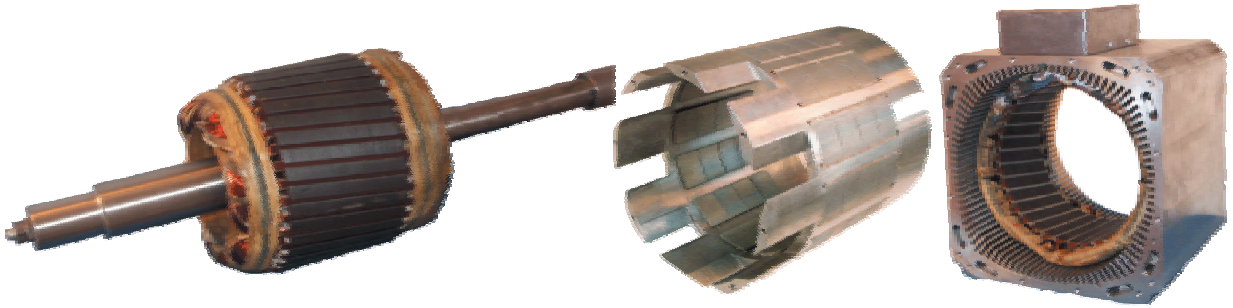
4-pole PM rotor



Permanent Magnet Motor Technology

-from emerging technology to state-of-the art

- Fixed speed applications
- Robotics
- Wind Power
- Electric and hybrid electric vehicles
- **Electric Railway traction**



Four-quadrant energy converter for hybrid electric vehicles

Permanent Magnet Traction motors
– general characteristics

- Higher efficiency than comparable Induction motor drive (2-3%)
  - Lower losses in the rotor
  - Simpler cooling
- High torque density
  - Lower weight OR
  - Improved performance can be obtained for a given weight and volume
- A high pole-pair number is possible thus making a direct drive feasible
- Synchronous motor, in general single-axle drive
- Application and system issues are important
- **More specific information will be given at the afternoon presentations**

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