Improving environmental performance

Evert Andersson

Royal Institute of Technology (KTH)

Centre for Railway Engineering and Education

KTH VETENSKAP OCH KONST

BOMBARDIER

TRAFIKVERKET

Gröna Tåget
www.gronataget.se

Two main issues

- **External noise**
- **Energy use and related emissions**

External noise, in particular pass-by noise

- With the same train and track, the external noise level increases with higher speed.
- Due to improved technology, the future Gröna Tåget is expected **not** to produce higher noise at 250 km/h than current Swedish passenger trains at 160–200 km/h (freight trains at 90–100 km/h), most likely lower.

  This also complies with the new pan-European standards (TSI, EN).

  Different effective means have been tested in the Gröna Tåget programme.
- In sensitive areas (i.e. local communities disturbed by noise) additional means can be applied in the infrastructure, if deemed neccessary.

  Such effective means have also been tested in the programme.

Technologies for improved noise performance

- Noise-attenuating wheels
- Bogie skirts
- Aerodynamic measures - mainly above 250 km/h
  - Rounding of sharp edges, shielding of roof equipment, etc.
  - Also the bogie skirts reduce aerodynamic noise.

Example:
Tested bogie skirt
on Gröna Tåget test train

Additonal measures, possible to use in local sensitive areas

- Tuned rail dampers
- Low track-close barriers
  being less visually intrusive than high barriers,
  but suitable for noise sources on the rail and wheel level.
  Very efficient in combination with bogie skirts.

Example:
Tested low barrier

Energy use

- With the same train, energy use increases with higher speed.
- But trains are not the same.
  Improved technology compensates the effect of higher speed.
- High-speed trains are more attractive => more passengers =>
  => **higher load factor (LF)** (40–50% => 55–70%).
- High-speed trains are often the most energy-efficient trains
  - Swedish X 2000 is up to now the fastest and the most energy-efficient in Sweden:

    200 km/h, LF=60% => **71 Wh/pass-km**

  - Japan's Shin-kansen have likely the most energy-efficient trains in the world:

    285 km/h, LF=65% => **50 Wh/pass-km**

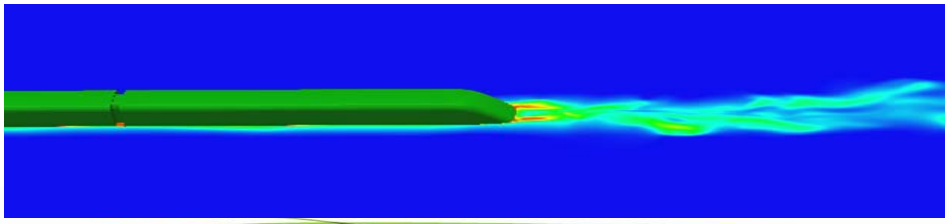
Measured as electricity from public grid.

Gröna Tåget – proposed technology for energy efficiency

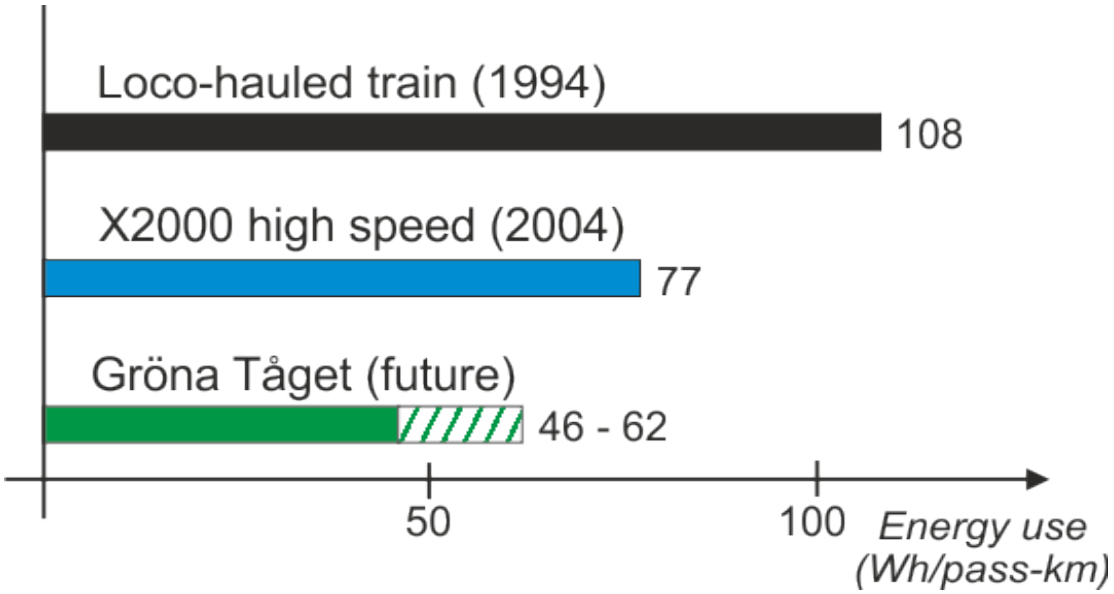
- Reduced **aerodynamic resistance**
- **Eco-driving** and increased **regeneration** of electric energy at braking
  - At least 50% powered axles + high electric braking power =>
    => electric brakes used a the main braking mode, without loss of time.
  - Driver support for eco-driving
- Reduced **energy losses** in trains and electric supply system
  - Example: Permanent magnet motors
- Improved **space utilization** (more seats per metre train)
  - Wide-body + intelligent space utilization and seat design
    (both saves some 10% each) . Nevertheless, interior is very comfortable!

Note: All the above technologies also have a positive impact on cost!

Example: Aerodynamic optimization



Energy evolution over time – example of Swedish trains



Max 160 km/h; LF=44%

Max 200 km/h; LF=55% *

250–320 km/h; LF=60–65%

* Since year 2004
the load factor of the
X2000 train has improved

KTH VETENSKAP OCH KONST

BOMBARDIER

TRAFIKVERKET

Gröna Tåget
www.gronataget.se

Green-house gas emissions:
Indirect, related to the use of electric energy

- **5 – 10 g CO_2 per pass-km**

depending on train alternative, speed and electric power generation in Northern Europe.

This is very low compared with other transport modes, now and in the future.

For example:

Gröna Tåget produces only 2.5 – 5 %
of current aircraft CO_2 emissions per pass-km on 500 km distance *.

* Source: NTM (Network for Transport and Environment)

Independently of how many per cent energy is saved:

- Long- and medium-distance electric trains are superior to any other passenger transport mode regarding energy use and its related greenhouse gas emissions.

  In particular this is the case with the electric power produced in the Nordic market (low content of fossil fuels).

Therefore, the most important aspect as regards the envrionment is that the train is **attractive** and **cost effective**, so that travellers use the train instead of other modes of transport.

Conclusions

- No higher external noise on future trains despite higher speed, due to legislation (TSI) and technology development
- Technology development and efficient space utlilization contribute to higher energy efficiency, despite higher speed
- Attractiveness to travellers and operators is a crucial issue

Spin-off – a step forward: SJ 3000 (Class X55)

to be introduced in revenue service during 2012

- **20–25% less energy use per pass-km than X 2000**

due to

- improved space efficiency (2.3 seats/m instead of 1.9 seats/m)
- high proportion of powered axles, for increased energy regeneration at braking

Thank You!

www.gronataget.se

KTH VETENSKAP OCH KONST

BOMBARDIER

TRAFIKVERKET

Gröna Tåget
www.gronataget.se