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# High speed U-turn shows rail's strength



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Editor-in-Chief

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But the event shouldn't be allowed to obscure other important developments, and one of the most exciting is the complete U-turn by Sweden's rail professionals and politicians in their attitude to high-speed rail, having gone from either outright opposition or indifference, to being in favour. In the meantime, Sweden is working on its Green Train initiative to develop a 250km/h train (see page 51).

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Several factors have brought about this dramatic change of opinion, not least soaring fuel prices, concerns about global warming, and rail's improving green credentials helped in Sweden by the Green Train project.

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There is another factor at play in Sweden as well. The traditional models for calculating profit do not take into account the dynamic effects of investing in high-speed lines, such as industrial or residential development.

Two high-speed lines are planned: the Götaland line from Stockholm to Gothenburg via Jönköping and Borås, and the Europa line from Jönköping to Helsingborg and Malmö. Together, they will involve about 1000km of new construction at an estimated cost of around SKr 100 billion (\$US 16.4 billion). Not only will the new lines dramatically reduce journey times, even

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Now that Banverket is in favour of building these lines, political support for them is

growing fast. Six out of the seven parties in the Swedish parliament support the construction of the Götaland line, which will be music to the ears of the pressure group that has been campaigning for years to gain support for the project. Only the finance minister in the cabinet is against the project, but then finance ministers are generally opposed to spending money anyway.

Even if the government decides in favour of building the Götaland line, it will take several years to get the project through Sweden's tough planning and environmental legislation, so Banverket has been studying how to get more out of the existing network, in particular by investigating whether it will be possible to increase the maximum speed on some main lines from 200 to 250km/h. The introduction of the European Rail Traffic Management System (ERTMS)

in Sweden will help to make this possible on the train control front. Banverket also sees opportunities for line speed improvements through fairly minor activities such as new point machines designed for speeds above 200km/h and improvements to the catenary.

Thought will need to be given soon for a replacement for SJ's fleet of X2000 trains, and a 250km/h train will be required to operate on the new Bothnia line in northern Sweden and to provide intermediate shuttle services on the high-speed lines when they open. Hence Green Train, a joint project between the railways, research organisations and industry in Sweden to develop an environmentally-friendly economical 250km/h train for Scandinavia.

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**T**HE five-year Green Train research and development project to produce a green, lean 250km/h train for Scandinavia achieved an important milestone on July 23 when it broke the Swedish rail speed record by reaching 295km/h during tests on a line designed for 200km/h operation.

Green Train was launched in 2005 by a Swedish consortium (see panel) of research institutes, consultants, and train operators led by Banverket, the national track authority, and Bombardier. It will run until 2010-11 and involves a series of tests of new technology conducted each summer (and during one winter) on a standard Bombardier Regina two-car emu owned by Transitio.

"The main aims of the project are to reduce energy consumption by 20 to 30%, reduce journey times, and achieve lower operating costs," says Mr Per Kyhle, Banverket's senior network strategist. "We also want to operate as fast and efficiently as possible using the

present infrastructure, which often means sharing single tracks with freight and regional trains. The tests have proved that these aims are realistic."

Professor Stefan Östlund of the KTH Railway Group says the time is fast approaching when SJ's fleet of 200km/h X2000 tilting trains will need to be replaced. "In Sweden, we must decide whether we continue to operate at 200km/h or we take the opportunity to improve train performance," says Östlund. Momentum is also gathering for the construction of two high-speed lines in southern Sweden, and a fleet of 250km/h trains could be used to provide intermediate shuttle services.

The new train would have the following characteristics:

- a maximum speed of at least 250km/h to reduce the Stockholm - Gothenburg journey by 15 minutes (the current fastest time for the 455km trip by X2000 is 2h 45min non-stop, although most trains take about 3h)
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The Green Train project is being used to test many innovative technologies. It is fitted with track-friendly soft bogies (TFSB). The train currently has a passive radially-steered soft bogie which has a new design of primary suspension, bogie frame and yaw damper, and achieves lateral forces of half the UIC limit. A so-called mechatronic bogie with actively-controlled radial steering was tested last year.

"The TFSBs are based on 25 years'

experience with such bogies," says Mr Henrik Tengstrand, Bombardier's director of R&D and specialist engineering. "They meet UIC 518 requirements for 250km/h operation and a cant deficiency of 168mm ( $1.1m/s^2$ ) and their track forces are within 50 to 60% of limits. We have now found the right balance between a track friendly bogie and the ability to operate at high speeds."

As Tengstrand points out: "Banverket is pushing for low track deterioration, and a model to determine the cost of track deterioration is likely to be the basis for future track access charging."

### Active lateral suspension

Another innovation is active lateral suspension. "This has two functions in one piece of hardware," says Tengstrand. "It keeps the carbody in a central position in curves which means that we can have a 3.6m-wide body within the Swedish loading gauge, compared with 3.45m on a Regina train, and a better ride by avoiding contact with the bump stops. It also gives better lateral ride comfort by reducing lateral acceleration of the carbody by between

10 and 47%, and we have done some tests to improve the vertical ride as well. Active lateral suspension produces the same ride comfort at 250km/h as on a train travelling at 200km/h without active lateral suspension."

Although Regina already has 3+2 seating, the wider body means that 3+2 seating will be possible in more luxurious high-speed train without any discomfort to passengers. This in turn helps to increase the number of seats in a high-speed train - X2000, in common with other European high-speed trains, only has 2+2 seating in second class - which means a lower consumption of energy per passenger. The wide-body train consumes 0.052kWh/passenger-km.

"The target is to reduce energy consumption by 25 to 30% per seat-km compared with X2000 despite an increase in speed from 200 to 250km/h," says Östlund. "The studies show we can cut energy consumption by 30% if we use a wide carbody."

Bombardier is also using the Green Train project to test two of its range of ECO4 energy-saving technologies, which it will be highlighting at InnoTrans. The overall objective of



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## Innovative trains

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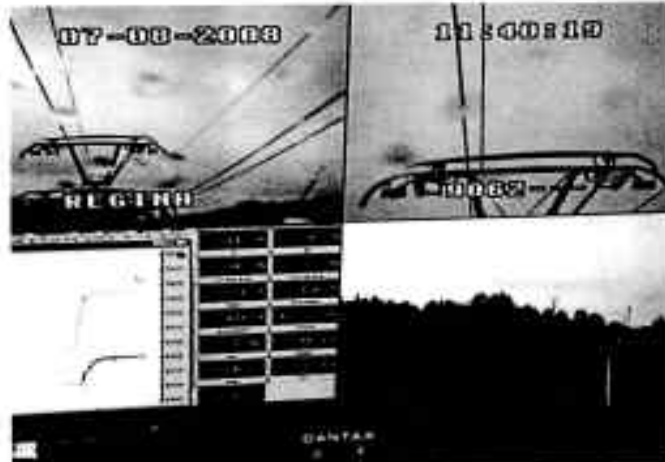
ECO4, which stands for energy, efficiency, economy and ecology, is to reduce energy consumption by up to 50%.

The two ECO4 technologies on Green Train are Bombardier's first permanent magnet motor and its EBI Drive 50 driving assistance system. The permanent magnet motor, which has the same interfaces as a conventional ac motor, operates at 97% efficiency, which is about 2% more than an induction motor drive, because of lower losses in the rotor and a simpler cooling system.

Its high torque density allows either a reduction in weight compared with an induction motor or improved performance for the same weight. It is a synchronous motor, and in general is suitable for single-axle drive. It has a low-pair number which should make direct drive feasible.

The permanent magnet motor fitted to Green Train has the same weight and dimensions as a Regina induction motor, but its tractive effort at 300km/h is 2.65 times that of an induction motor. It is rated at 302kW, but its maximum measured power output is 1046kW. This made it possible to replace four induction motors with two permanent magnet motors.

Ms Åsa Sandberg, Bombardier's permanent magnet motor development project manager, is naturally enthusiastic about the technology: "I



feel we are on the right side of introducing this new technology. The permanent magnet motor produces less electromagnetic noise than an induction motor, and it is versatile electrically. There are no technical limits as to where we can use the motor and it is totally compatible with other components such as the bogie and brakes."

The driver assistance system, which can be fitted to all types of existing and new trains, is designed to produce energy savings of up to 15%. It recommends the ideal speed and rates of acceleration and braking to the driver in order to maintain the timetable. The information is constantly updated to take account of current operating conditions.

The Green Train project is an excellent example of academics and railway engineers working together to develop new technologies that will bring real benefits to rail transport worldwide. It also demonstrates that, despite the separation of operations from infrastructure, it is possible for operators and infrastructure managers to work together for the common good. **IRJ**

### ECO4 innovative technologies

Innovation	Main features	Energy saving
Mitrac energy saver	Double-layer capacitors used to store energy during braking and release it for acceleration	30%
EBI Drive 50	Driving assistance system	15%
Smart Air	A low-energy train interior climate control system that takes account of train occupancy	40%
AeroEfficient	System to reduce aerodynamic drag	12%
EnerGplan	Software simulation tool to enable transit system planners to optimise power distribution systems	20%
Energy Management Control System	Modelling and analysis tool to integrate energy awareness, efficiency and carbon control into an operator's business	10%
PM motor	High-power traction motor (see article)	2%†
Clean Diesel Power Pack	Driv drive system that meets Stage III-B exhaust emission limits in the 500kW class. Propulsion system is based on a 560kW eight-cylinder engine connected to a power shift transmission	87%*‡

† Increase in efficiency  
\* Reduction in particulate emissions

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*Talgo*



# Creative thinking powers train design

Get ready for InnoTrans with our show preview - turn to page 59

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## Innovative trains

Monitoring of the performance of the pantograph and power collection.

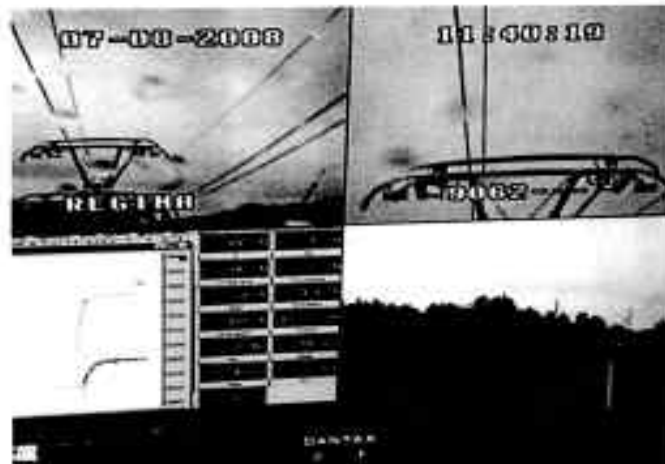
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The driver assistance system, which can be fitted to all types of existing and new trains, is designed to produce energy savings of up to 15%. It recommends the ideal speed and rates of acceleration and braking to the driver in order to maintain the timetable. The information is constantly updated to take account of current operating conditions.

The Green Train project is an excellent example of academics and railway engineers working together to develop new technologies that will bring real benefits to rail transport worldwide. It also demonstrates that, despite the separation of operations from infrastructure, it is possible for operators and infrastructure managers to work together for the common good. **IRJ**

### ECO4 innovative technologies

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*Talgo*



# Creative thinking powers train design

Get ready for InnoTrans with our show preview - turn to page 59

# High speed U-turn shows rail's strength



David Briginshaw  
Editor-in-Chief

**S**EPTEMBER in an even-numbered year can only mean one thing: another gigantic InnoTrans exhibition in Berlin. This year the show is bigger than ever, with nearly 20% more exhibitors and a 30% increase in floor space – a clear indicator that the global railway industry is in excellent health.

Naturally, IRJ will be there, reporting on the new launches and latest developments. As our comprehensive preview coverage in this and our previous two issues demonstrates, there will be an awful lot of companies vying for attention: InnoTrans is now by far the largest railway show on earth.

But the event shouldn't be allowed to obscure other important developments, and one of the most exciting is the complete U-turn by Sweden's rail professionals and politicians in their attitude to high-speed rail, having gone from either outright opposition or indifference, to being in favour. In the meantime, Sweden is working on its Green Train initiative to develop a 250km/h train (see page 51).

Real high-speed lines with a speed of more than 320km/h first came on the agenda one and a half years ago. High speed has also become a hot topic on the political agenda, and the government will announce its decision on

whether to push ahead with high-speed rail this autumn.

Several factors have brought about this dramatic change of opinion, not least soaring fuel prices, concerns about global warming, and rail's improving green credentials helped in Sweden by the Green Train project.

"We have seen big increases in rail traffic, and we now recognise the big benefits in terms of overall capacity by separating high-speed trains from slower freight and commuter trains," says Mr Per Kyhle, senior network strategist with Banverket.

"We have also witnessed what happens when you make a major improvement in infrastructure. You don't get a

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linear increase in traffic, but a big a jump." The 2014 traffic forecast for the Öresund link to Denmark was reached two years ago. The Swedes have also seen what the Spanish are doing to develop their high-speed rail network. "If they can do it, so can we," says Kyhle.

There is another factor at play in Sweden as well. The traditional models for calculating profit do not take into account the dynamic effects of investing in high-speed lines, such as industrial or residential development.

Two high-speed lines are planned: the Götaland line from Stockholm to Gothenburg via Jönköping and Borås, and the Europa line from Jönköping to Helsingborg and Malmö. Together, they will involve about 1000km of new construction at an estimated cost of around SKr 100 billion (\$US 16.4 billion). Not only will the new lines dramatically reduce journey times, even

compared with 200km/h X2000 services today, but they will also address major shortcomings in the existing Swedish rail network. Borås and Jönköping are the two most important towns in central southern Sweden, but are situated on secondary lines and have very poor rail services. The Götaland line would also enable through services to be provided from Norrköping and Linköping to Gothenburg for the first time. As Kyhle points out, by adding these traffic generators and using the new model, the two lines should be profitable in socio-economic terms.

Now that Banverket is in favour of building these lines, political support for them is

in Sweden will help to make this possible on the train control front. Banverket also sees opportunities for line speed improvements through fairly minor activities such as new point machines designed for speeds above 200km/h and improvements to the catenary.

Thought will need to be given soon for a replacement for SJ's fleet of X2000 trains, and a 250km/h train will be required to operate on the new Bothnia line in northern Sweden and to provide intermediate shuttle services on the high-speed lines when they open. Hence Green Train, a joint project between the railways, research organisations and industry in Sweden to develop an environmentally-friendly economical 250km/h train for Scandinavia.

There is much to commend Sweden's step-by-step approach to high-speed rail. Sweden was one of the pioneers of 200km/h operation using tilting trains on existing lines, which achieved a step change in inter-city travel in Sweden, and it looks set to pioneer 250km/h running on conventional railways, followed hopefully by true high-speed rail.

Sweden's example is indicative of a growing and welcome trend suppliers across the railway industry can contemplate at InnoTrans. The drive for increased efficiency combined with ambitious vision is vital to make rail ever more attractive in the future.

The IRJ team look forward to seeing as many of you as possible in Berlin. We are in Hall 5.2 on Stand 202. We wish you an enjoyable and productive visit to InnoTrans.

*David Briginshaw*

db@railjournal.co.uk



# Green Train shows Swedish technology

Sweden's Green Train project to produce an environmentally-friendly cost-efficient high-speed train for Scandinavia is pioneering several new technologies, reports David Briginshaw from Stockholm.

**T**HE five-year Green Train research and development project to produce a green, lean 250km/h train for Scandinavia achieved an important milestone on July 23 when it broke the Swedish rail speed record by reaching 295km/h during tests on a line designed for 200km/h operation.

Green Train was launched in 2005 by a Swedish consortium (see panel) of research institutes, consultants, and train operators led by Banverket, the national track authority, and Bombardier. It will run until 2010-11 and involves a series of tests of new technology conducted each summer (and during one winter) on a standard Bombardier Regina two-car emu owned by Transio.

"The main aims of the project are to reduce energy consumption by 20 to 30%, reduce journey times, and achieve lower operating costs," says Mr Per Kyhle, Banverket's senior network strategist. "We also want to operate as fast and efficiently as possible using the

present infrastructure, which often means sharing single tracks with freight and regional trains. The tests have proved that these aims are realistic."

Professor Stefan Östlund of the KTH Railway Group says the time is fast approaching when SJ's fleet of 200km/h X2000 tilting trains will need to be replaced. "In Sweden, we must decide whether we continue to operate at 200km/h or we take the opportunity to improve train performance," says Östlund. Momentum is also gathering for the construction of two high-speed lines in southern Sweden, and a fleet of 250km/h trains could be used to provide intermediate shuttle services.

The new train would have the following characteristics:

- a maximum speed of at least 250km/h to reduce the Stockholm - Gothenburg journey by 15 minutes (the current fastest time for the 455km trip by X2000 is 2h 45min non-stop, although most trains take about 3h)
- reduced environmental impact in

## Green Train partners

**T**HE Green Train project is led by Banverket, Sweden's track authority, and Bombardier. It also includes Sweden's Royal Institute of Technology (KTH), Chalmers University of Technology, Konstfack (University College of Arts, Crafts & Design), the Swedish Government Agency for Innovation Systems (Vinnova), the Swedish National Road & Transport Research Institute (VTI), Swedish Rosco Transio, consultants Interfleet Technology and Transrail, the Association of Swedish Train Operators (BT), and operators SJ and Svenska Tågkompaniet.

terms of noise and energy consumption

- improved comfort
- improved reliability in winter - the trains must be able to cope with temperatures down to -40°C and more importantly when the temperature fluctuates around zero which causes constant freezing and thawing
- reduced costs
- reduced track forces
- relatively short trains which can operate in multiple (Östlund says this is more demanding than building long single trains), and
- follow European standards as much as possible, while meeting the special needs of Scandinavian railways.

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## Innovative trains

Monitoring of the performance of the pantograph and power collection.

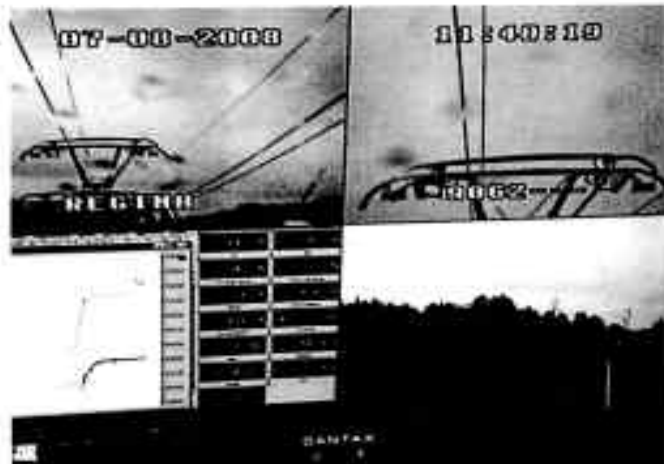
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