

## Energy measurement and management in NSB

Jan Vetle Moen, [janvetlem@nsb.no](mailto:janvetlem@nsb.no)  
Andreas Hægstad, [andreas.hegstad@nsb.no](mailto:andreas.hegstad@nsb.no)  
NSB AS, Norway

The focus on sustainability and energy efficiency across the whole transport sector has increased during the past years and become an important competitive edge in a market where customers are more concerned about the environment than ever before. The railway sector is by many seen as the most environmentally transportation option, but this does not conclude that organizations in this sector can be satisfied with their current situation. They have to continue improving their energy consumption and environmental performance to retain the position rail transportation has today. Any business looking into its future competitiveness is looking at energy efficiency. In the railway sector the demand for more energy-efficient solutions has mostly been met by implementing more viable technology. This certainly reduces the energy consumption, but with no supporting systems to manage and evaluate the current situation and the new technology it is difficult to see and achieve the potential improvement. To overcome this we need measurement and monitoring of energy consumption and systems to manage and control the energy use.

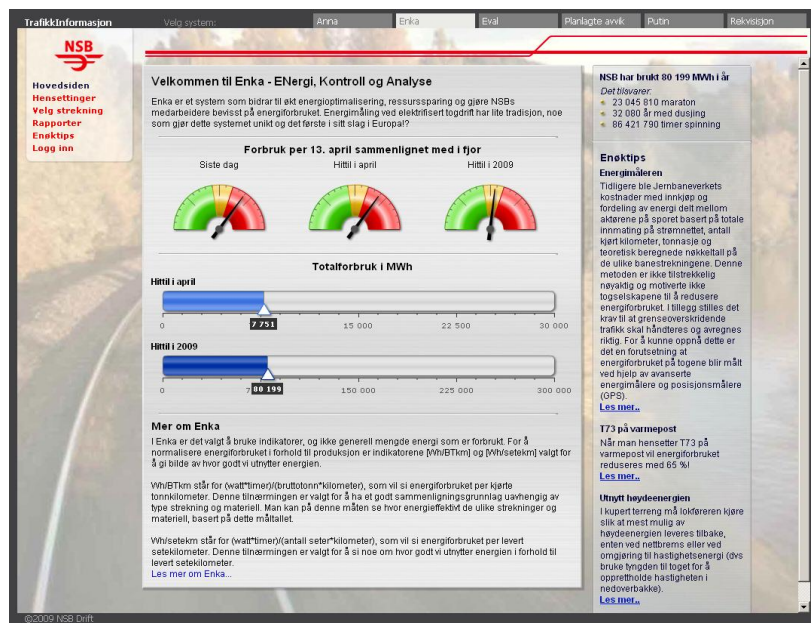


Figure 1: Main page with status indicators on energy consumption on the last registered day, so far in the current month, and so far in the current year.

NSB's solution for measuring energy consumption is based on measuring devices installed in all trains in 2006 and 2007. The devices are delivered from the infrastructure owner, the Norwegian National Rail Administration (JBV). The main purpose of the device is to provide a precise energy statement to the train companies that operate in Norway. All energy consumption is measured when driving and when stabled, and the stored data is regularly transferred to a central database belonging to JBV. The transfer is done by the GSM net and can be performed regardless of train location. The measuring devices log consumed and generated energy, GPS position and time at five minute intervals. All rail operators using the measuring devices have access to all stored energy data for their trains through a web service.

Currently, the data only gives the total energy consumption over time for the different trains with little possibility for further effective analysis. This will work as a good basis for a measurement system, but other data is needed to achieve a better level of detail and for normalizing the data. NSB

have therefore developed a measurement system that combines the energy data with their punctuality system and system for train planning. This gives the system the possibility to normalize the energy consumption based on production and combine the different data to sort energy consumption on sections, regions, train numbers, and all the way down to train driver. By combining the data, this will give the system the possibility to perform the functions required by a best practice system more efficiently.

The basic purpose of any measurement system is to provide feedback, relative to your goals, that increases your chances of achieving these goals efficiently and effectively. Measurement gains true value when used as a basis for timely decisions. The purpose of measuring is not to know how your energy consumption is, but to enable you to perform better, and use energy better and more effective. The ultimate aim of NSB's energy management system is to improve the performance and work for reduction of energy. If you can get your performance measurement right the data you generate will tell you where you are, how you are doing, and where you are going. NSB's reporting system will give the possibility for complex collocation of data to give the necessary information to all users.

The presentation system is a web-based solution that everybody in NSB can access through the internet whilst different levels of detail will be assigned each account. The individual user has easy access to the information and reports that are most relevant for that particular user, based on the employee's responsibility. The system has been designed to give the relevant information in a pre-defined and user-friendly manner, and provide a possibility for generating more specific reports when needed. To secure that the needs of the user were the priority and was fulfilled, NSB used specialists in usability in the development of the system. Presentation of the information will be based on graphs and easily understandable summaries; figure 1, 2, and 3 shows examples from NSB's system.

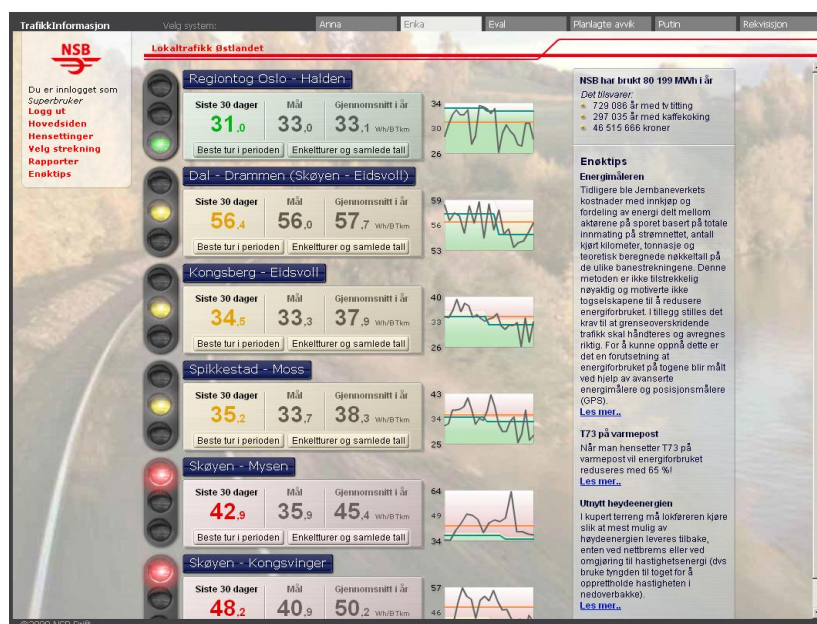


Figure 2: Overview of energy consumption on the different routes/courses

During the development of the system one of the main focuses has been on the drivers. Beyond the fixed periodic reporting the train drivers will get access to more specific data and reports on the energy performance of their own driving. This use of the system will be voluntary for the train drivers, but by giving them opportunity to track progress and evaluate their driving NSB hope this will promote use of the system. The train driver will have access to energy information on his/her own driving and additional information on energy performance, but will not have access to energy data

on other drivers. They will get the opportunity to evaluate their driving based on energy consumption as a trend over a period of time to see progress, but also based on energy consumption on specific trips for a more thorough evaluation.

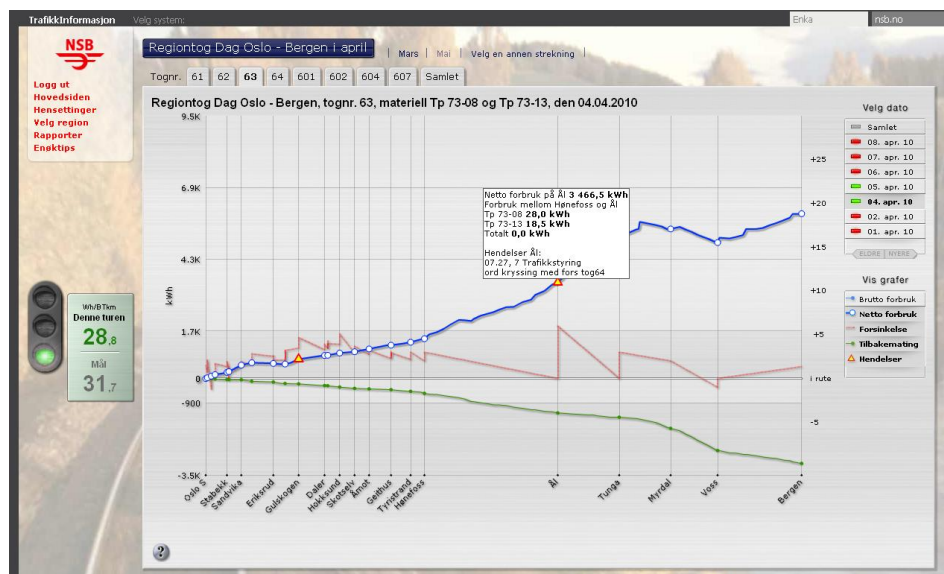


Figure 3: A specific trip from Oslo to Bergen

Since the plan for measuring energy consumption all the way down to train driver level was introduced in 2005, there has been some resistance among the train drivers and their management. They have been concerned that poor performance might cause punishment and that the introduction of such a system will cause additional work. They also see the system as surveillance of the employees. To cope with the resistance, NSB included representatives from the train drivers and their management in both the energy teams and in the development of the measurement system. The use of usability specialists when developing the reporting and presentation of the measurement system also had positive influence due to the focus on fulfilling the train drivers' needs. Like many others in NSB the train drivers see energy as a more important topic now than when project started. Training in energy efficient driving has increased the commitment and initiative for many of train drivers who have completed the training.

The combination of training in energy efficient driving and feedback on performance through measurement will provide the trains drivers with an improvement tool that has the potential to motivate and actuate behavioral change. The training alone has already increased the awareness among the train drivers on how they influence the energy consumption

As NSB now nearly has a complete measurement system and has access to energy data, it will provide the organization with a good basis for an energy management system on. The process of defining targets and objectives will be easier and more accurate, and they now have the possibility to evaluate and monitor their performance more precisely. By introducing a measurement system with good data base, both on energy and other factors that influence the energy consumption, NSB have the opportunity to gain full control over the energy consumption of their trains. NSB is now working on making energy management a permanent process. Which will embed energy as an important topic into the entire organization. This may have a positive influence on the commitment to saving energy.

By the end of 2010 all train drivers will have access to the system and energy management will be implemented on all levels of the organization. A reduction of 6 % in total energy consumption is expected due to the measurement system and the energy management system.