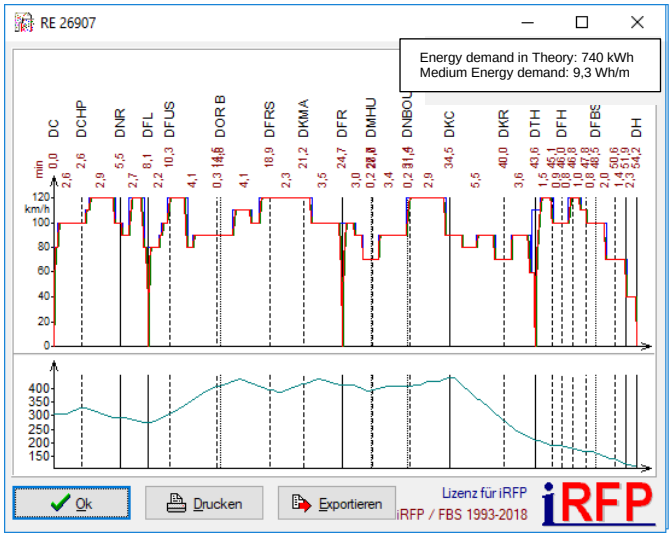
Energy Consumption Calculation for Trains in FBS

- **In the upcoming future, a new function will enable users to perform energy consumption calculations in FBS on their own.**
- **The focus particularly lies on *energy-efficient driving*.**

Solutions Available So Far



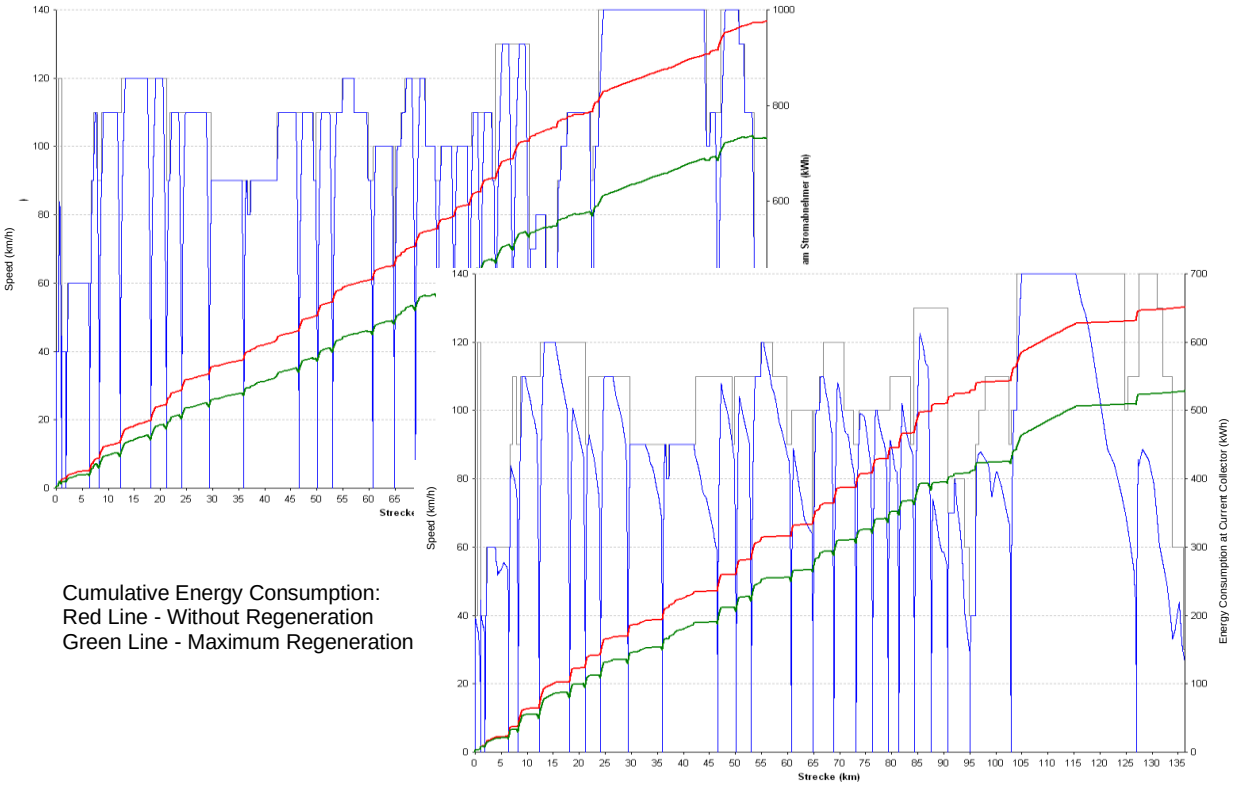
Familiar FBS- users already know the possibility of quickly determining the energy requirement at the driving wheel for a specific train journey in the graphic timetable program. This value, which represents the applicable case for moving the train (within travel time or train path listed there), can be easily read off the train data window in the travel diagram. Of course, energy is required not only for moving, but also during the stops, and energy transfer within the vehicles is not possible without losses. In addition, the driver can influence energy consumption by their driving style, and electricity can be recuperated (fed back into the grid) when braking. Until now, anyone who wanted detailed information on these aspects of energy use, e.g. for calculative evaluations of operating programs in tendering procedures,

could have an expert opinion prepared by iRFP. This involves calculating and comparing how much energy would be expected to be required for the operating services of a tendered timetable with specific stopping and turning times - depending on the respective driving regime (energy-saving or not). Of course, this expert opinion solution will also be possible in the future.

New Functions in FBS for Calculating Energy Consumption

However, users now also have a tool to answer some of the above-mentioned questions independently with the program. The extended functionality in the graphic timetable makes it possible not only to show the energy demand for the concretely constructed train path (train line), but also to include the so-called energy-efficient driving and recuperation and to determine how high the savings effect in percent would be when using a more economical driving regime. In addition, the transmission loss can be taken into account by specifying an average efficiency (the ideal case would be the existence of vehicle-specific efficiency maps.

In the *energy-efficient driving* regime, the surcharges (travel time extensions) contained in the timetable specifications are utilized for the purpose of saving energy. All (linear and non-linear) travel time surcharges are utilized by coasting) along the route. The time spent in the (access) stations does not increase compared to their minimum values (no "standing out" of surcharges during stops).



Cumulative Energy Consumption:
Red Line - Without Regeneration
Green Line - Maximum Regeneration

In contrast, the *shortest travel time* regime does not include any travel time surcharge and no minimum dwell time. Stopping times are extended when arriving "ahead of schedule" and increase the energy consumption when stationary.

During regeneration, there is a range of energy consumption depending on the absorption capacity of the power supply network. The upper limit is the actual energy consumption without regeneration (values shown in red in the graphs). Subtracting the maximum amount of energy available for recovery from the braking processes from this results in the lower limit (values shown in green in the graphs).

	Savings due to energy efficient driving	
Vehicle	Excl. Backfeed	Incl. Backfeed
Version 1	26,8 %	19,4 %
Version 2	24,5 %	19,4 %

FBS users will be able to call up diagrams like the ones shown here, which visualize the train's travel progression
(depending on the driving regime, visible (coasting) phases for energy saving) and visualize the maximum possible effect of recuperation. In addition, the respective consumption values (incl. those for dwell times) are given in tabular form.

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