Report on hybrid locomotive traction schemes

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Involved partners

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Table of Contents

1 Introduction 7
2 Hybrid locomotive at Bentheimer Eisenbahn 8
2.1 Scope of work 8
2.2 Locomotive types 8
2.3 Considered line sections 11
2.4 Assumptions 12
2.5 Cost comparison 13
3 Hybrid locomotive at SBB Cargo 14
3.1 Background 14
3.2 Locomotive type Eem 923 14
3.3 First experiences of operation 17
3.4 Range of applications 17
4 Recommendations and outlook 19
5 Annex: Overview on hybrid/dual-power locomotives 20

Table of Figures

Figure 1: Locomotive type Bombardier TRAXX F140 AC "Last Mile" 9
Figure 2: Locomotive type Bombardier TRAXX F140 DE 9
Figure 3: Locomotive type D20 of Bentheimer Eisenbahn 10
Figure 4: Locomotive type D24 of Bentheimer Eisenbahn 10
Figure 5: Overview on the considered rail lines 11
Figure 6: Double traction of the locomotives D24 and D20 12
Figure 7: Locomotive type Eem 923 - sketch 16
Figure 8: Locomotive type Eem 923 - vehicle structure 16

Table of Tables

Table 1: Cost comparison of different locomotive types 13

Table 2: Locomotive type Eem 923 (hybrid locomotive) – technical data.....15

Table 3: Locomotive type Eem 923 - Maximum train weight for electric mode 18

Table 4: Locomotive type Eem 923 - Load table for diesel mode 18

Table of Abbreviations

AC	alternating current
approx.	approximately
BE	Bentheimer Eisenbahn AG
CO2	carbon dioxide
DB	National German railway company (Deutsche Bahn)
DC	direct current
ETCS	European train control system
Hz	hertz
km/h	kilometre per hour
kN	kilo newton
kV	kilovolt
kWh	kilowatt-hour
m.	metre
mm.	Millimetre
MW	Megawatt
SBB	National Swiss railway company (Schweizerische Bundesbahn)
t.	tonne
UIC	Union of International Railways
ViWaS	Viable Wagonload Production Schemes
ZUB	train control system (Zugbeeinflussung)

1 Introduction

One of the goals of the ViWaS project is the development and evaluation of SWL traction schemes with state-of-the-art hybrid locomotives. Recently, most of the leading locomotive manufacturers developed hybrid locomotive for different operation purposes.

"Hybrid"[1] is a collective term for several forms of combined propulsion. The main variants are:

- line-locomotives with electric propulsion and additional auxiliary diesel-engine for serving the "last-mile";
- line-locomotives with a "dual" propulsion: electric traction and diesel-engine;
- shunting locomotives with an energy storage module (battery pack).

Annex 1 provides an overview on currently offered vehicles and manufacturers of the above mentioned locomotive types. Within the ViWaS project, two locomotives have been analysed and tested regarding their feasibility for the specific business cases and operating conditions of Bentheimer Eisenbahn and SBB Cargo:

- Bombardier TRAXX F140 AC "with last-mile" by Bentheimer Eisenbahn;
- Stadler Typs Eem 923 ("Butler") by SBB Cargo.

[1] In the context of the deliverable, all locomotives with dual propulsion are called "hybrid locomotives"

2 Hybrid locomotive at Bentheimer Eisenbahn

2.1 Scope of work

In the framework of the ViWaS project, Bentheimer Eisenbahn evaluates potential benefits from the deployment of hybrid locomotives for their SWL services. For that purpose, a cost-benefit analysis (CBA) has been performed for Bombardier's hybrid locomotive TRAXX F140 AC "Last Mile". This hybrid locomotive is compared with Bombardier's conventional diesel engine "TRAXX F140 DE" as well as with current locomotives of Bentheimer Eisenbahn, types "D20" and "D24".

The analysis contains a comparison of the respective transport costs (in Euros per tonne) considering different line sections (electrified and non-electrified) used by Bentheimer Eisenbahn. The cost-benefit analysis is carried out based on the available cost figures and assumptions from the rail operation and practical experiences of Bentheimer Eisenbahn. In-depth field tests of the hybrid locomotive on the rail network of Bentheimer Eisenbahn are planned for spring 2015, depending on the availability of Bombardier's TRAXX F140 AC "Last Mile" testing engine.

2.2 Locomotive types

The manufacturer Bombardier is an incorporated company with roughly 70,000 employees and records an annual turnover of 18.3 billion US dollars. The place of business is located in Montreal, Canada. The company is specialised on the production of regional commercial aircrafts and rail traffic engineering. The rail traffic engineering is operated by Bombardier Transportation with place of business in Berlin. This branch is responsible for around 53% of the company-wide turnover and features a manifold product range, such as locomotives, long distance and high speed trains, local trains, tramways, metros etc.[2]

The hybrid locomotive **TRAXX F140 AC "Last Mile"** is an electric driven engine with a diesel generator set (cp. Figure 1). Due to the generated electricity, this diesel generator set allows for an operation on both electrified and non-electrified track sections, thus eliminating the need for a change of engine on factory premises, terminals and ports (which are in general not electrified). This also applies to power system changing stations: with the hybrid locomotive TRAXX F140 AC "with last-mile", a seamless freight transport chain is ensured[3].

From the technical point of view, the engine has a maximum starting tractive effort of 300kN with a maximum performance of 5.6 MW. The maximum speed is at 140 km/h with a length over buffer of 18.9m, a width of 2.98m and a height of 4.28m. The diesel generator set owns a 400 litre fuel tank and ensures a wheel performance of 180kN. The diesel aggregator has the emission Stage IIIB.[4] On the line sections used by Bentheimer

[2] compare Aerospace Transportation Bombardier Inc. (2008): Presentation "TRAXX"
[3] compare Eisenbahn Kurier (2011): internet publication
[4] compare Aerospace Transportation Bombardier Inc. (2008): data file TRAXX F140 DE

Eisenbahn, this locomotive is operated with a maximum trailing load of 2,500t. For the diesel-electric operation, the engine's maximum speed is at 25 km/h.

Figure 1: Locomotive type Bombardier TRAXX F140 AC "Last Mile"

Source: www.bahn-journalisten.ch/fileadmin/dokumente/exkursionen/2013-06-Transportlogistik/LOC_F140ACLMgeneral_d_2013.pdf

Bombardier's diesel locomotive **TRAXX F140 DE** (cp. Figure 2) has a maximum starting tractive effort of 240kN with a diesel engine performance of 2,400kW according to UIC. Analogue to the TRAXX 140 AC "with last-mile", the maximum speed is at 140 km/h. The length over buffer is at 18.9m, the width 2.98m and the height 4.26m. Analogue to the hybrid locomotive, this locomotive is operated with a maximum trailing load of 2,500t on the rail network of Bentheimer Eisenbahn.

Figure 2: Locomotive type Bombardier TRAXX F140 DE

Source: www.br146.de/revisionen_daten/TRAXX%20F140%20DE_10280_LOC_Sept08_de.pdf

The locomotive **D20** (cp. Figure 3) is a type 221 DB version engine which was rebuilt in 2007/2008. The locomotive's performance is at 1,750kW and was purchased by the Bentheimer Eisenbahn in 2008. As the previously mentioned engines, the D20 is operated on Bentheimer Eisenbahn's rail sections with a maximum trailing load of 2,500t.

Figure 3: Locomotive type D20 of Bentheimer Eisenbahn

Source: Roland Hertwig

The **D24** type DE1002 MAK (cp. Figure 4) is a locomotive with diesel-electric propulsion and a performance of 1,100kW. This engine was purchased as new vehicle and is exclusively operated by Bentheimer Eisenbahn. The maximum trailing load amounts to 2,000t.

Figure 4: Locomotive type D24 of Bentheimer Eisenbahn

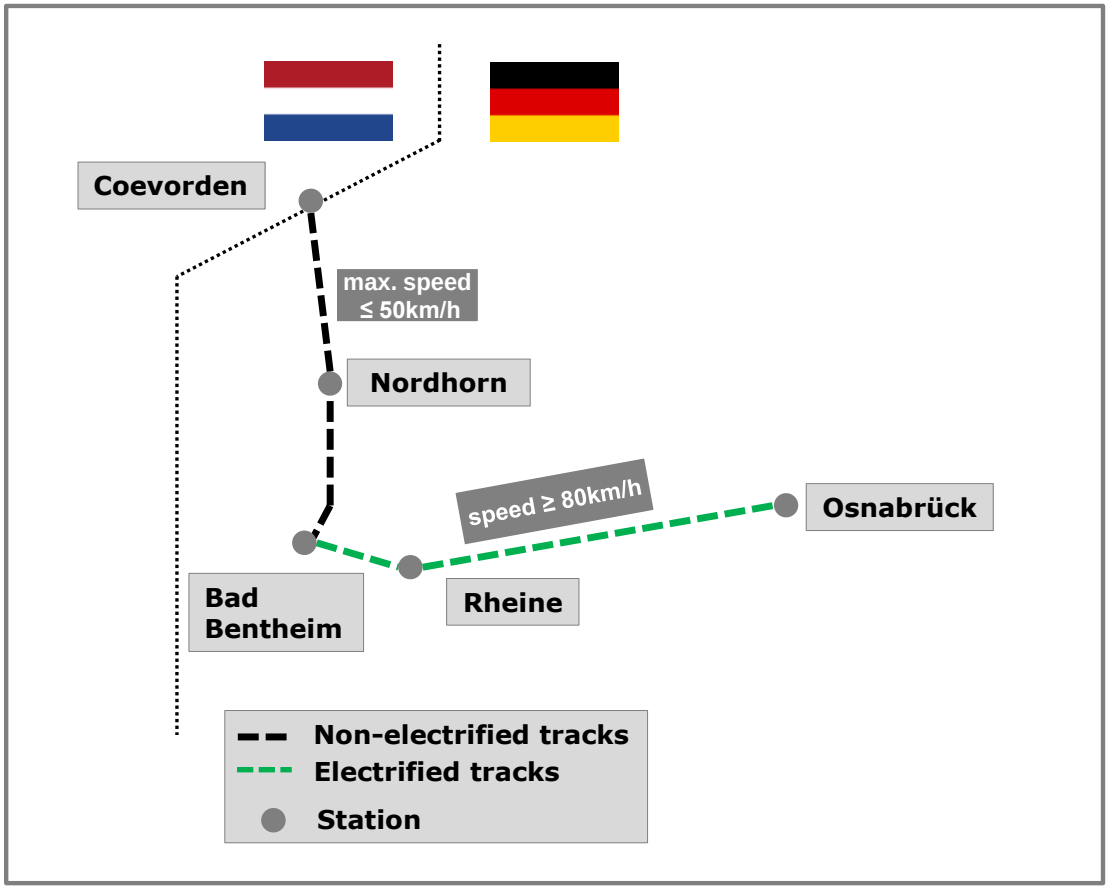
Source: Alex Heinke

2.3 Considered line sections

The following line sections have been considered within the cost-benefit analysis (cp. Figure 5):

- non electrified line between Bad Bentheim and Coevorden;
- electrified line between Bad Bentheim and Osnabrück.

Figure 5: Overview on the considered rail lines



Source: HaCon

The railway line between Bad Bentheim and the Dutch city of Coevorden is owned by Bentheimer Eisenbahn. The entire line adds up to 57.4 km with a maximum speed of 50 km/h and is not electrified.

The considered line between Bad Bentheim and Osnabrück is fully electrified, with a length of 74km and a required speed of at least 80km/h. The TRAXX locomotives run with a speed of 100 km/h. The D20 and D24 have to be operated in double traction, as elsewise the minimum speed requirement of 80 km/h cannot be met. Together, these two engines hit the required speed achieving a combined trailing load of 2,500t.

Figure 6: Double traction of the locomotives D24 and D20

Source: Johann Thien

2.4 Assumptions

According to the current price list of the DB[5], the electricity costs amount to 0.184 Euro per kWh. The current diesel fuel costs of the Bentheimer Eisenbahn AG are at 1.08 Euro per litre. For the calculations, the following assumptions are made:

The engine driver's wage costs are 45,000 Euro per year, with 22 working days per month on average. The amortisation period of the engines amounts to 25 years, without residual value[6].

For all transports, it is estimated that the engines will be fully loaded. In the framework of the calculations, working hours of 8 hours per day and employee and operating times of 16 hours per day and engine are assumed. Proportionate fixed costs and personnel costs are calculated exact to the minute, based on the transport duration with the respective locomotive.

[5] Status 2014

[6] This assumption is based on the fact that no engine manufacturer made any statements about the residual value of the engines after 25 years operation.

2.5 Cost comparison

When comparing the two types of locomotives on the section Bad Bentheim – Osnabrück, it becomes obvious that the D20 and D24 engines are highly ineffective. This can be reasoned by for this section necessary double traction, resulting in high costs for staff, fuel and fixed costs.

The "Traxx F140 AC "with last-mile" has the highest cost effectiveness. However, the "Traxx F140 DE" is more efficient on the section Coevorden – Bad Bentheim. Responsible is the high transport time for the "TRAXX F140 AC "with last-mile" (maximum speed 25 km/h), leading to higher proportionate fixed costs and personnel costs.

Table 1: Cost comparison of different locomotive types

Locomotive	Section Coevorden - Bentheim	Section Bentheim - Osnabrück	Total section
TRAXX F140 AC mit Last Mile	0.19 €/t	0.14 €/t	**0.33 € / t**
TRAXX F140 DE	0.16 €/t	0.19 €/t	**0.35 € / t**
D20	0.21 €/t	0.33 €/t	**0.54 € / t**
D24	0.20 €/t		**0.53 € / t**

Source: Bentheimer Eisenbahn

When comparing a conventional TRAXX diesel engine with a TRAXX hybrid engine "with last-mile" function, the hybrid locomotive has the cost advantage. This cost advantage refers to partly or fully electrified track sections. The more of a section is electrified, the higher the cost advantage gets. In comparison to the D20 and D24 locomotives of Bentheimer Eisenbahn, the new TRAXX engines show less energy consumption, a higher trailing load and a higher maximum speed; thus having a clear cost advantage. However, as a result for Bentheimer Eisenbahn it should also be considered that the current average capacity usage of the engines is around 35-50%. This average capacity usage is related to the assumed usage of 16 hours per working day. Due to the degree of capacity utilisation so far and the fact that the locomotives were predominantly used on own, not electrified tracks, the purchase of new engines was not considered as yet.

3 Hybrid locomotive at SBB Cargo

3.1 Background

As the existing shunting locomotive fleet was no longer meeting the modern requirements in terms of economy and performance, SBB Cargo ordered 30 new, two-axial, Eem 923 hybrid locomotives from Stadler Winterthur AG for CHF 88 million in July 2010.

They replace the existing Bm 4/4 shunting locomotives and various three-axle locomotive types. These locomotives no longer met the technical requirements, while the costs resulting from vehicle maintenance and the increasing likelihood of age-related faults were rising.

The chosen product completely satisfies the specification requirements and is set apart by the following features in particular:

- Considerably lower life-cycle costs than competing models at the same price (in comparison with a four-axle diesel locomotive, the operating costs (energy) are reduced by 75% and the maintenance costs by approx. 50%)
- Positive environmental attributes (more than 4,000 t of CO_2 saved every year, contributes to the SBB energy-saving programme, significantly lower noise generation during operation)

3.2 Locomotive type Eem 923

The Eem 923 hybrid locomotive has a powerful electric motor. It is also equipped with a small diesel generator set for operating on non-electrified lines (works sites, terminals, ports, etc.). The locomotive has a maximum starting tractive power of 150 kN (both in electric and diesel mode) and maximum power at the wheel of 1,472 MW in electric mode. In diesel mode, the maximum power at the wheel is 290 KW. The fuel tank has a capacity of around 1,000 litres. The maximum speed is 120 km/h (electric mode) at a length over buffers of 9.1 m, a maximum width of 3.1 m and a height of 4.306 m.

2 x 140 kW brake resistors allow electric braking even in diesel mode, at 300 kW and up to the full braking force of 150 kN. In addition, power is fed back into the overhead line during electric braking. The locomotive driver has to use the relevant system selection button to initiate the changeover between electric and diesel mode, which then takes place automatically.

Locomotives for use in mainline services are generally designed with bogies. Two-axle designs with large axle loads and compact dimensions are generally not suitable for relatively high speeds, as systemic, critical operational instabilities can occur. In order to allow this much less technically complex vehicle type to be used in previously impossible ranges of application, the manufacturer has developed a special "vibration absorber" to eliminate undesired instability vibrations (as per its more common use in high-rise buildings or suspension bridges). This opens up new horizons for the two-axle principle in

terms of speed, and in contrast to the behaviour of conventional vehicles, the Eem 923 even tends to get "quieter" as its speed increases.

Table 2: Locomotive type Eem 923 (hybrid locomotive) – technical data

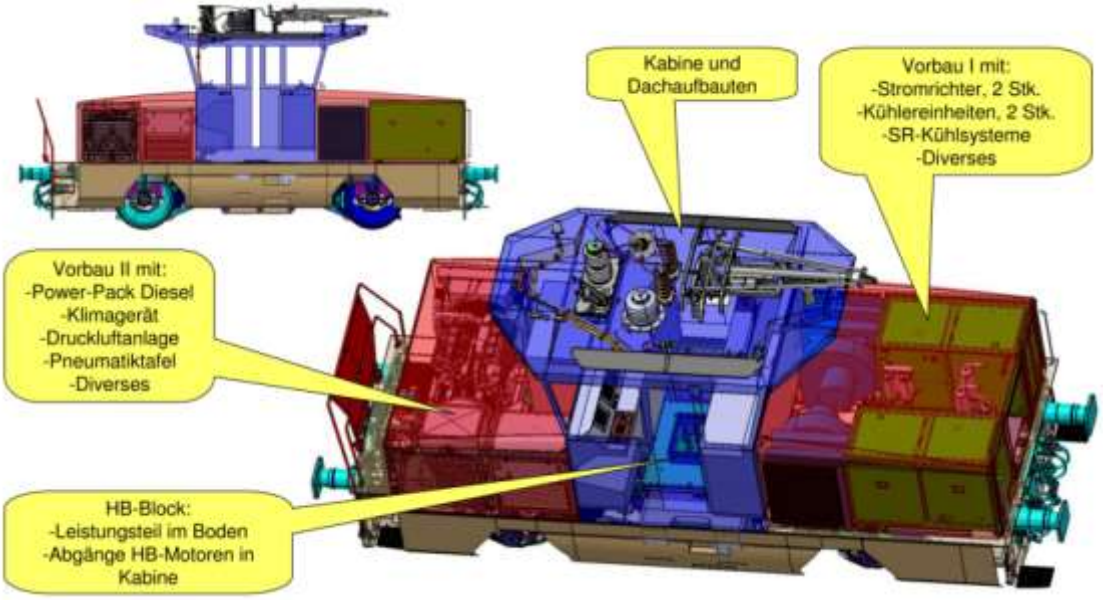
Technical data Eem 923 Hybrid Locomotive	
Drive concept	Two electric traction motors (one power converter per traction motor, single-axle drive), power supply via contact wire or diesel generator
Systems	11 kV/16⅔ Hz, 15 kV/16⅔ Hz, 25 kV/50 Hz, diesel engine
Weight	40–45 t
Dimensions (length/width/height)	9,100 mm/3,100 mm/4,306 mm
Gauge	1,435 mm
Axle base	4,300 mm
Maximum speed	120 km/h
Maximum power at the wheel	1,500 kW (electric mode) / approx. 290 kW (diesel mode)
Starting tractive power	approx. 150 kN
Multiple-unit control	Yes (up to four vehicles)
Radio control	Yes (optional in multiple-unit traction)
Train control system	ZUB262ct/Integra/ETCS Level 2 optional (prepared)
Clearance gauge	UIC 505-1, AB-EBV U3 and O1

Source: SBB Cargo

Figure 7: Locomotive type Eem 923 - sketch

Source: SBB Cargo

Figure 8: Locomotive type Eem 923 - vehicle structure



Source: SBB Cargo

3.3 First experiences of operation

All 30 vehicles ordered have been in operation since January 2014. The vehicle fulfils the specification requirements and has been successfully used for light- and medium-duty shunting operations and mainline service. The new vehicles have allowed SBB Cargo to significantly increase its flexibility and to simplify processes (reduction in shunting manoeuvres and the use of mainline locomotives). In addition, the locomotive drivers appreciate the smooth running and low noise generation of their new work tool. A limiting factor is the reduced traction in poor rail and weather conditions, caused by the physical limitations of only having two axles.

The high maximum speed of 120 km/h helps to secure train paths on the very busy Swiss network. This also simplifies transport to the workshop; all major maintenance work is now only conducted at one single (central) location. Repair of relatively small faults and basic maintenance can be performed by mobile teams in the field. Therefore, the envisaged maintenance concept has worked well in practice so far.

In addition, as suggested at the start of the project, energy-related operating costs have been significantly reduced. Between 2012 and 2014, SBB Cargo reduced the diesel consumption of its shunting locomotive fleet by 1 million litres. This is aided by the automatic start-stop function installed in the diesel engine.

The Eem 923 is currently only approved for use in Switzerland, but use abroad in its current configuration is also conceivable. However, this only makes sense if the destinations are connected by long stretches of electrified line, as the locomotive has a maximum speed of only 40 km/h in diesel mode and is thus not suitable for mainline service in this mode.

3.4 Range of applications

The Eem 923 vehicles are currently being used for Swiss wagonload freight in light- to medium-duty shunting operations and mainline service. Owing to the very high proportion of electrified lines in Switzerland, the locomotive is largely operated exclusively in electric mode, with the diesel engine only being used in short, non-electrified sidings belonging to clients.

Therefore, the locomotive is suitable in principle for Swiss Split operations. However, the possibilities for use depend heavily on the train weight and route profile (compare load data depending on gradient in Table 3 and Table 4).

Table 3: Locomotive type Eem 923 - Maximum train weight for electric mode

gradient	20 km/h	40 km/h	60 km/h	80 km/h
0 ‰	2,000 t	2,000 t	2,000 t	1,374 t
4 ‰	1,792 t	1,720 t	1,081 t	732 t
8 ‰	1,144 t	1,114 t	710 t	490 t
12 ‰	834 t	818 t	523 t	363 t
16 ‰	653 t	642 t	410 t	285 t
20 ‰	533 t	526 t	335 t	232 t
24 ‰	449 t	443 t	281 t	194 t
28 ‰	386 t	382 t	240 t	164 t

Source: SBB Cargo

Table 4: Locomotive type Eem 923 - Load table for diesel mode

gradient	20 km/h	40 km/h	60 km/h	80 km/h
0 ‰	2,000 t	1,134 t	905 t	634 t
4 ‰	1,317 t	629 t	397 t	279 t
8 ‰	834 t	391 t	243 t	168 t
12 ‰	604 t	278 t	168 t	113 t
16 ‰	469 t	211 t	125 t	81 t
20 ‰	381 t	167 t	96 t	60 t
24 ‰	318 t	136 t	75 t	45 t
28 ‰	272 t	113 t	60 t	33 t

Source: SBB Cargo

The Eem 923 is well-suited to relatively light trains on routes with low gradients, but not to heavy loads on routes with steep gradients (this is due to the lower power (1.5 MW vs. 5.6 MW) and starting tractive power (150 kN vs. 300 kN) in comparison with the TRAXX F140 AC "Last Mile".

4 Recommendations and outlook

In the scope of the ViWaS projects the use of hybrid locomotives has been analysed on the basis of two different business cases and related operational framework conditions:

- Bentheimer Eisenbahn, regional SWL rail services;
- SBB Cargo, light- to medium-duty shunting operations and SWL mainline service.

Both cases show that hybrid locomotives are able to increase competitiveness and cost-efficiency of SWL transport chains. However, the magnitude of benefits depends greatly on the chosen hybrid engines as well as the on the specific economic and operational framework conditions. With respect to the considered cases the following conclusions have been drawn:

To increase the economic efficiency of Bentheimer Eisenbahn and its SWL services, the operational activity area has to expanded in the long-term. This means that in future, traction services of Bentheimer Eisenbahn should not be limited to the company-owned network but should also involve rail lines of DB Netz. In the framework of this analysis it became obvious that this shift is only feasible with new and more efficient locomotives. Specifically, the purchase of a hybrid locomotive would offer substantial advantages due to the increased flexibility in operation and good performance parameters. However, it became obvious that the theoretically calculated benefits of the hybrid locomotive from the cost comparison need to be further verified based on the trailing loads and energy consumptions and last but not least the actual purchasing price. Hence, it is planned to carry out in-depth field tests of the hybrid locomotive in spring 2015, depending on the availability of Bombardier's TRAXX F140 AC "Last Mile" testing engine.

The plans of SBB Cargo to purchase an additional number 10–13 vehicles are currently being reviewed. In future, these additional vehicles would be used for wagonload operations, for which a four-axle shunting locomotive (which is in fact too powerful) is currently still being used. If respective train weights and route profiles are suitable, the hybrid locomotives Eem 923 will be operated in the Swiss Split services and support the competitiveness and cost-efficiency of SWL transport chains.

5 Annex: Overview on hybrid/dual-power locomotives

Liner-locomotives with "last-mile" auxiliary diesel/shunting module				
Manufacturer	Bombardier	Siemens	PESA Bydgoszcz S.A.	Stadler
Type	**TRAXX F140 AC3 "Last Mile"**	**Vectron AC mit Rangiermodul**	**GAMA MARATHON**	**Eem 2/2 "Butler"**
Series	187	192	111 Ed	Eem 923
1. propulsion	electric	electric	electric	electric
2. propulsion	diesel	diesel	diesel	diesel
Power supply voltage	AC 15 kV/16,7 Hz AC 25kV/50 Hz	AC 15 kV/16,7 Hz AC 25kV/50 Hz	DC 3 kV	AC 15 kV/16,7 Hz AC 25kV/50 Hz
Bogie placement	Bo'Bo'	Bo'Bo'	Bo'Bo'	Bo
Max. axle load	22 t	22,5 t	20,5 t	(22,5 t)
Service weight	87 t	85 t	82 t	45 t (SBB Cargo)
Max. speed	140 km/h	160 km/h	160 km/h	120 km/h
Length over buffer	18.90 m	18.98 m	19.50 m	9.10 m
Max. performance	5,600 kW	5,600 kW	5,600 kW	1,500 kW (on wheel)
Max. starting tractive effort	300 kN	300 kN	300 kN	150 kN
Diesel motor	Deutz 2013 4V, 7,8 l, 230 kW	180 kW	Caterpillar C15, 400 kW	
Max. starting tractive effort "last-mile"	300 kN (diesel + battery), 260 kN (diesel only)	210 kN	300 kN	
Diesel: Performance on wheel	180 kW			290 kW
Fuel tank	400 l		900 l	
"Last-mile": max. speed	50 km/h; 2,000-t-train ca. 20 km/h	8 - 15 km/h (1,200-600 t, 2 per mill)	40 km/h	
Diesel: cruising range	ca. 8 h		42 km (3,200 t)	ca. 2 weeks of operation
Remote control	yes			yes
Presentation(s)	Transport Logistic 2011, München; Innotrans 2012, Berlin; Transport Logistic 2013, München	Innotrans 2010, Berlin; with shunting module: Innotrans 2012, Berlin	Innotrans 2012, Berlin	Innotrans 2012, Berlin
References	Railpool: 8 locmotives, 3 of which for BLS Cargo; Akiem: 4 locomotives (all version "D-A-CH")	1 prototype; shunting diesel retrofittable for AC and DC locomotives	1 prototype; 01.2013 at Lotos Kolej/Poland with first operation; 03.2013 at PKP Intercity for test operation	30 Eem 923 for SBB Cargo, plus options for 3x 10 locomotives
Certification/expected operation	2013 (CH)/2014 (D, A)	expected 2015	2013	2012
Sources	[1], [2], [20], [21], [24]	[3], [4], [25]	[5], [6], [7], [8], [28]	[13], [14]

Liner-locomotives with "dual"-propulsion					
Manufacturer	Bombardier	Vossloh	Vossloh	Vossloh	Vossloh
Type	**ALP-45DP**	**Euro Dual**	**UK Dual DRS Class88**	**Euro Dual Swifambo/PRASA**	**DM 20**
Series			Class 88		
1. propulsion	electric	electric	electric	electric	electric
2. propulsion	diesel	diesel	diesel	diesel	diesel
Power supply voltage	AC 25 kV/60 Hz AC 12 kV/25 Hz, AC 12,5 kV/60 Hz	AC 15 kV/16,7 Hz (25 kV/ 50 Hz, DC 1,5 kV, DC 3,0 kV)	25 kV/50 Hz	3 kV DC	
Bogie placement	Bo'Bo'	Co'Co'	Bo'Bo'	Bo'Bo'; 1,067 mm	Bo'Bo'
Max. axle load	32,66 t	19 t (21 t)	21,5 t	19 t (21 t)	
Service weight	130.64 t	114 t (126 t)	86 t	114 t (126 t)	90 t
Max. speed	200 km/h (eletric)	120 km/h	160 km/h	140 km/h	120 km/h
Length over buffer	21.80 m	23.02 m	20.05 m		17.00 m
Max. performance	4,000 kW	5,000 kW	4,000 kW	2,800 kW	2,000 kW
Max. starting tractive effort	316 kN	475 kN	317 kN		
Diesel motor	2x CAT 12 Cyl. 3512C HD, 2x 1,567 kW	CAT 8-16 Cyl., 1 - 2,8 MW	CAT 8-16 Cyl., 1 - 2,8 MW	CAT 8-16 Cyl., 1 - 2,8 MW	MTU/CAT, 1 MW
Max. starting tractive effort "last-mile"			317 kN		
Diesel: Performance on wheel			engine: 700 kW	engine: 2,800 kW	
Fuel tank	5,700 l	2,500 l (up to 5,000 l)	2,500 l (up to 5,000 l)	2,500 l (up to 5,000 l)	1,200 l
"Last-mile": max. speed	160 km/h (diesel)				
Diesel: cruising range					
Remote control					
Presentation(s)	Innotrans 2010, Berlin	(Transport Logistic 2011, München ,Innotrans 2012, Berlin)			(Innotrans 2010, Innotrans 2012, Berlin)
References	NJT/USA: 26 + 10 , AMT/Canada: 20	Concept (2011/2012)	Direct Rail Service 10 Loks Class 88	Swifambo Rail Leasing/PRASA 50 locomotives (+ 10 optional)	Concept/model
Certification/expected operation	2012	not known	2015/2016	Swifambo/PRASA: 2014 - 2016	not known
Sources	[12]	[9], [26]	[29], [31], [32]	[29], [30], [32]	[10], [11], [26]

Locomotives with an energy storage module			
Manufacturer Type	Vossloh **G6 Hybrid**	Alstom **BR 1001**	Alstom **H3 Hybrid**
Series 1. propulsion 2. propulsion Power supply voltage	 Energy storage module Motor-generator-unit (electric power transfer)	203.7 Energy storage module/ Accumulator Motor-generator-unit (electric power transfer)	 Energy storage module/Accumulator (FNC-NiCd- battery) Motor-generator-unit 350 kW (electric power transfer)
Bogie placement Max. axle load Service weight Max. speed Length over buffer	C (22,5 t) 60 - 67,5 t 80 km/h 10.79 m	B´B´ 67 t 60 km/h 14.24 m	A´AA´ 67,5 t 100 km/h 12.80 m
Max. performance Max. starting tractive effort Diesel motor	700 kW 220 kN 350 kW	600 kW 200 kN TCD 2014 L6 4V (Deutz), 238 kW	700 kW 240 kN
Max. starting tractive effort "last-mile" Diesel: Leistung am Rad Fuel tank "Last-mile": max. speed Diesel: cruising range Remote control	 1,800 l 80 kWh	 yes	 2,000 l
Presentation(s) References Certification/expected operation	(G6: Innotrans 2008, Berlin) Project/platform	 Prototype; 2012: 4 Loks MEG 2009 (Prototyp); 2012	(Transport Logistic 2011, München; Innotrans 2012, Berlin) Project/platform; for shunting operation with low speed; VW Wolfsburgwith 3 hybrid-locmotives off 2014; DB Regio Franken off 2015 5 H3-locomotives for Nuremberg and Würzburg, 8 years of testing 2014 (Werksverkehr, BOA), 2015 (EBA)
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