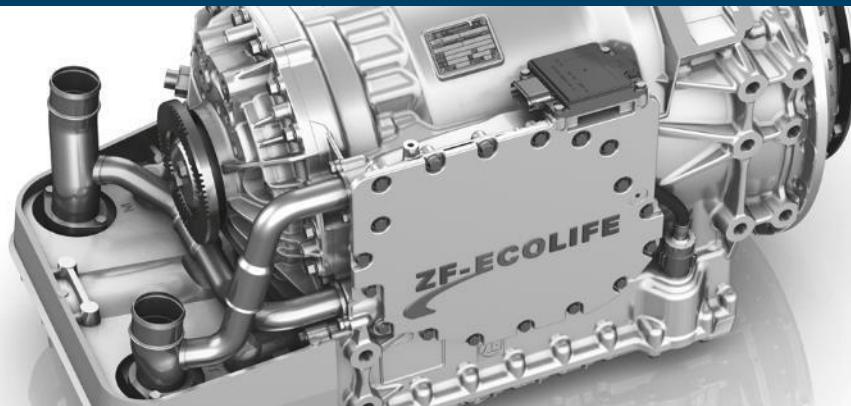


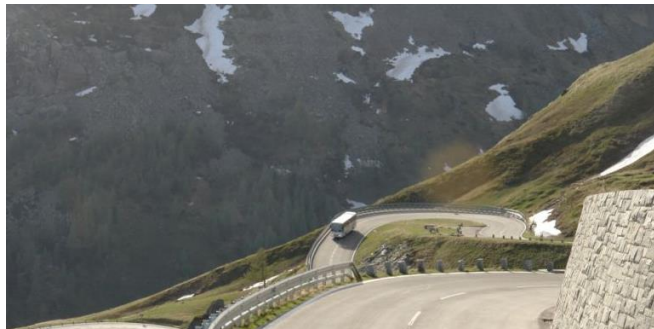


EcoLife Coach for Coaches and Intercity Buses

Commercial Vehicle Technology



EcoLife Coach for coaches and intercity buses in demanding conditions



Difficult topography



High altitudes



Shuttlebus



Stop-and-go traffic

Trend towards torque converter automatic transmissions in passenger cars – Example: BMW 320d Euro 6

Fuel consumption	Manual transmission, ZF 6-speed	Torque converter AT ZF 8 HP	Advantage due to AT
Urban [l/100 km]	5.6 – 5.7	5.2 – 5.3	7 % less
Extra-urban [l/100 km]	4.1 – 4.3	4.3 – 4.5	5 % more
Combined [l/100 km]	4.8 – 4.9	4.6 – 4.8	4 - 2 % less
CO ₂ emissions combined [g/km]	122 – 127	121 – 126	1 % less
CO ₂ efficiency	A	A	Same



Conclusion:

On average, up to 4 % savings in consumption with higher acceleration due to torque converter automatic transmissions

Driving performance			
Top speed [km/h]	235	230	2 % slower
Acceleration 0–100 km/h [s]	7.4	7.3	1 % faster

Source: www.bmw.de, accessed on 2018-04-24

Image change for automatic transmissions compared to manual transmissions

In the past...

**Fuel consumption higher,
engine speeds higher,
acceleration slower**

- Usually only 3, 4 or 5 gear ratio stages
- Small ratio spread
- Torque converter active for a long time when setting off
- Consumption-intensive shifting strategy



Today

**Fuel consumption better or
comparable,
engine speeds lower,
acceleration similar**

- 6 to 10 gear ratio stages
- Large ratio spread
- Torque converter only briefly in use, leading to higher efficiency
- Very economical shifting strategy

EcoLife Coach

Press comments in English

ROUTE
ONE

United Kingdom



"... and the input torque is handled impeccably. On a hilly route in the Allgäu region, the combination of a powerful engine and a fully automatic gearbox proved its worth.

Progress under such circumstances is made much more rapidly than with an AMT. The EcoLife Coach is a sound product."

DEAKIN, Tim. ZF targets coaches in full-auto range expansion. *Route One*, 18 April 2018. Full text of the article will be available at [this link](#).

Bus&Coach
Buyer

United Kingdom



"I took the wheel of the tri-axle Cityliner on ZF's short test track and accelerating down the straight found it was only the figures changing on the dash display that betrayed the change of ratios within the transmission; I don't mean you could hardly tell, I mean you couldn't tell.

Feedback from those already operating the new transmission has been overwhelmingly positive. Among the advantages mentioned has been an unexpected one, a greater feeling of security when overtaking because the manoeuvre can be completed more quickly without the change related hesitations."

JONES, Stuart. EcoLife Coach for high power. *Bus&Coach Buyer*, 04 May 2018, p. 34-36

EcoLife Coach

Press Opinions in Other Languages

**lastauto
omnibus**
TEST • TECHNIK • TRENDS

Germany



"The accelerative force on the coach can't be described as anything less than breakneck power. [...] This is completely different from how it performs in the mountains – here, it's a sheer delight and very relaxing to drive. The driver can simply go straight ahead as if there was no mountain at all, [...]. The mountain effectively feels like a level playing field, not frightening anymore."

WAGNER, Thorsten. A Mountain Goat with Bite.
Lastauto Omnibus, June 2018, p. 48-51

OMNIBUSREVUE
Besser in Management, Technik, Touristik

Germany



"With the ZF-EcoLife, it doesn't matter if you need to switch down a gear in the middle of a hairpin bend: It shifts gears at the drop of a hat, and within split seconds. The whole action is done so quickly that neither the driver nor the passengers feel it. This actually proves that the ZF-EcoLife changes gear at the exact optimal time, which is really impressive."

BÖHNKE, Sascha. A Real Converter Miracle?
Omnibusrevue, May 2018, p. 34-39

BUS transNews

Switzerland



"With imperceptible gear shifts and no tractive force interruption, passengers can rest assured that they're in for an extremely pleasant ride. As a result of our terrain and the increasing traffic on the roads, the ZF-EcoLife Coach is sure to find buyers here in Switzerland who are keen to implement it in coaches that are not specifically designed for long-haul routes."

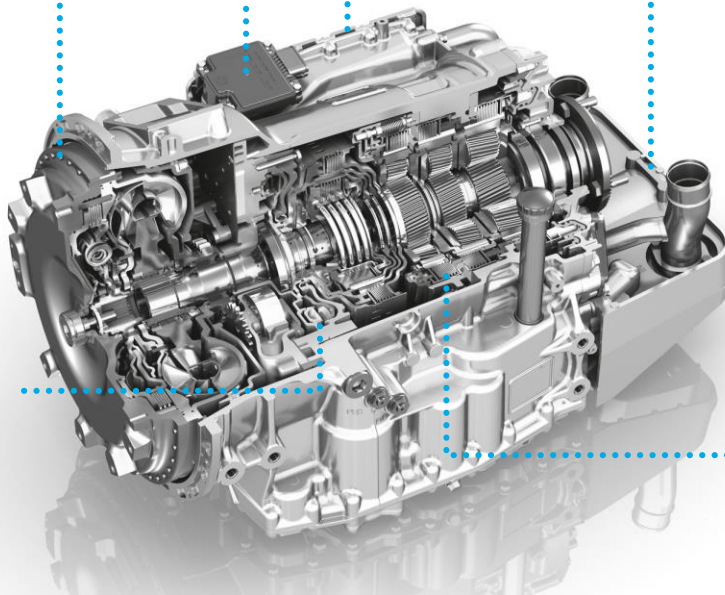
NIEDERBERGER, Bruno. ZF-EcoLife Coaches for Demanding Tours. *BUS transNews*, May 2018, p. 46-47

EcoLife Coach product description

Reinforced **torque converter**,
lock-up clutch and torsional
vibration damper for engine
torques up to 2,300 Nm

Adapted **software and functions** for coach application
(e.g. Bremsomat)

Dual cooling system with two
heat exchangers



Integrated **retarder**,
up to 1,900 Nm braking torque,
can be combined with engine
brake, total braking torque up to
2,800 Nm

6 ratios with optimized **shifting
elements** and hydraulics for
engine torques of up to
2,300 Nm

EcoLife Coach

Customer benefits compared to automatic transmissions

Sample applications

- Mountainous roads with frequent accelerating and braking
- High share in city traffic at low speeds and stop-and-go traffic, such as for shuttles between city hotels and airports and sightseeing tours



Benefits

- Less fuel consumption:
 - Through powershifting – no tractive force interruption
 - Due to engine speeds that are reduced overall, also with auxiliary units (alternator, air-conditioning compressor, etc.)
- Even and very comfortable acceleration
- Lower LCC and greater availability: no clutch replacement
- Increase in torque due to torque converter: same performance with lower engine output possible
- Primary retarder for high braking power even at low speeds, including Bremsomat function
- Very powerful cooling: no overheating uphill and downhill
- Full flexibility when in operation

Consumption advantages of powershift transmissions compared to automatic transmissions (1)

Results of comparative measurements with EcoLife and AS Tronic

- 2-axle bus for mixed operation (intercity/travel) of a European OEM, test weight 15.5 t
- Identical bus except transmission and rear axle, engine power in the range 1,500 - 2,000 Nm
- Measurements on a roller test bench

	Consumption according to cycle (l/100 km)				
Transmission, rear-axle ratio	WHVC, Ø 40 km/h	SORT 1, Ø 12 km/h	SORT 2, Ø 18 km/h	SORT 3, Ø 25 km/h	SORT 4, Ø 34 km/h
EcoLife, i = 4.6	29.5	52.9	45.2	39.8	34.1
AS Tronic, i = 3.4	30.6	56.8	46.6	42.3	34.9
Reduction with EcoLife	- 3.7 %	- 6.8 %	- 3 %	- 6.1 %	- 2.2 %

Conclusion

- Up to approx. 45 km/h average speed, EcoLife saves a significant amount of fuel with an adapted axle ratio
- Automated manual transmissions such as TraXon and AS Tronic continue to be more economical for pure travel use

Consumption advantages of powershift transmissions compared to automatic transmissions (2)

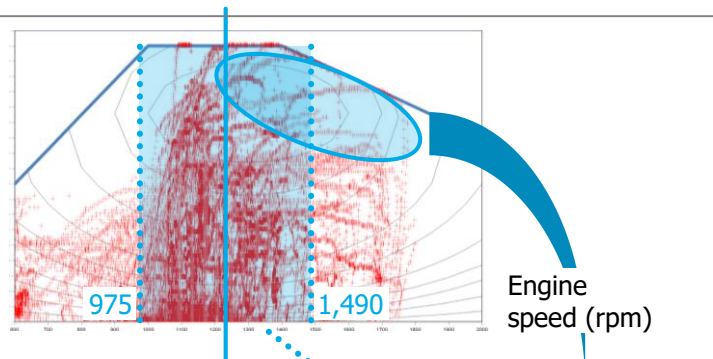
Operating points in the engine map

Effects of EcoLife with identical performance:

1. Engine speeds reduced overall
2. Less operation in the fuel-intensive area of the map (high engine load with high speed at the same time)

With AS Tronic

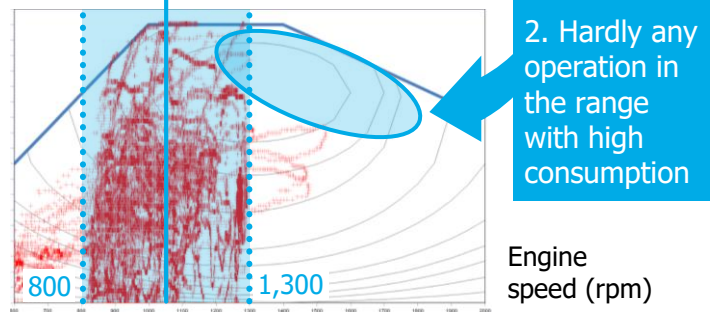
Engine torque (Nm)



1. Main speed range reduced

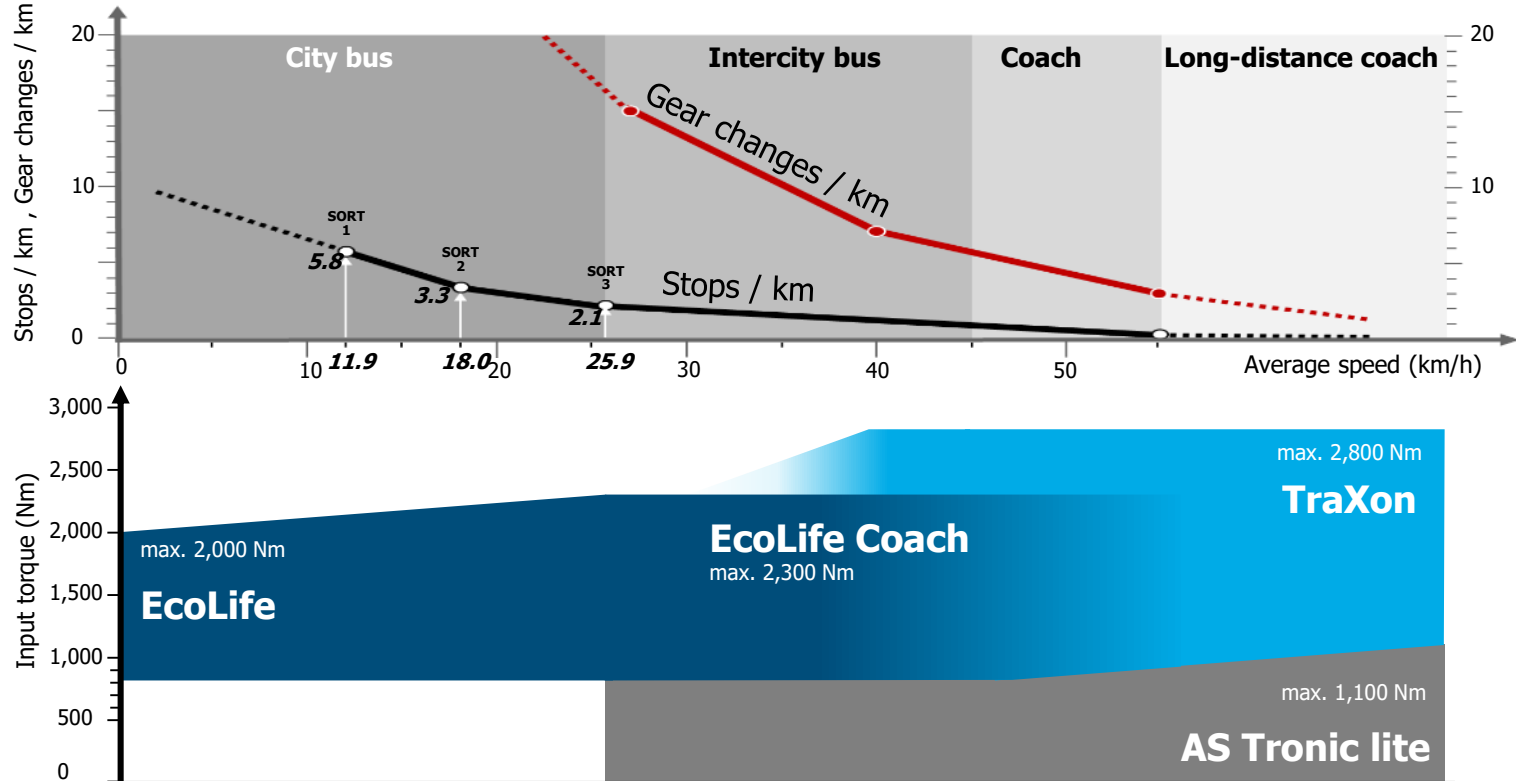
With EcoLife

Engine torque (Nm)



Bus Applications

Automatic ZF Transmission Application Limits



EcoLife Coach

Application examples

MAN Lion's Coach



Operator:
H.M.K.,
Norway
www.hmk.no



Irizar i6



Operator:
Ashley Travel,
United Kingdom
<http://ashleytravel.co.uk/>



Neoplan Cityliner



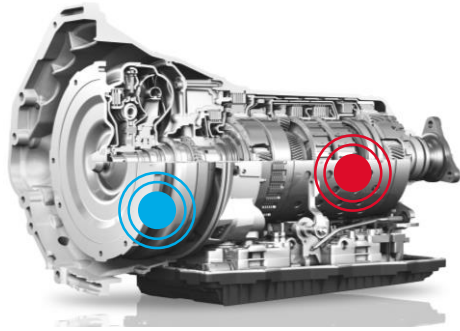
Operator:
Beck-Bus,
Germany
<http://beck-bus.com/>



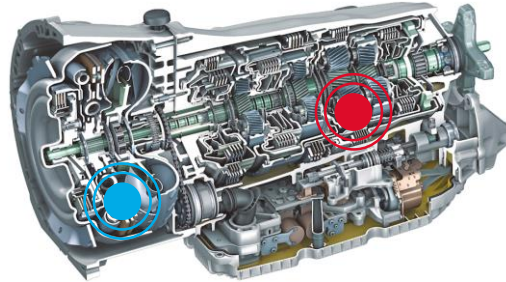
EcoLife principle is identical to that of modern automatic passenger car transmissions

Automatic passenger car transmissions

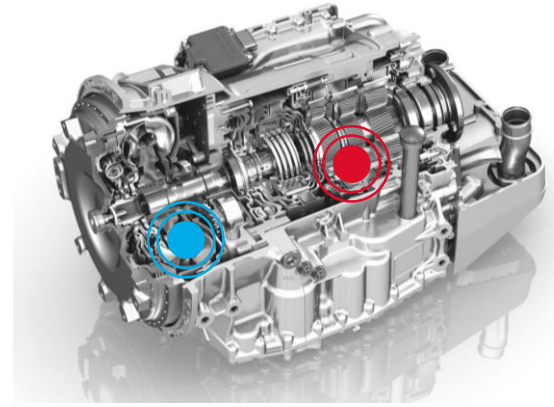
ZF 8-speed



9-speed Mercedes-Benz



ZF 6-speed EcoLife



 Torque converter with lock-up clutch and torsional damper

 Planetary gearset with wet shifting elements (clutches and brakes)

Benefits of EcoLife compared to AMT under demanding conditions (1/2)

Advantages of EcoLife vs. automated manual transmissions (AMT)

- Torque converter and 6 gears
- Powershifting, no tractive force interruption
- Designed for multiple gear changes

Benefits of EcoLife

- Simple maneuvering and slow driving without clutch wear
- Gentle and efficient acceleration
- Optimum shift comfort



Benefits of EcoLife compared to AMT under demanding conditions (2/2)

Advantages of EcoLife vs. automated manual transmissions (AMT)

- Primary retarder
- 2 radiators, oil sump is constantly cooled

Benefits of EcoLife

- Maximum deceleration even at medium and low speeds
- Retarder can be used for very long periods
- Increased Safety

Conclusion: ✓ **Low life cycle costs**
✓ **Full flexibility in use**
✓ **High resale value**



Advantages of EcoLife Coach vs. AMT under demanding conditions (1) – Setting off

EcoLife (AT)

Hydrodynamic torque converter:

- Power transmission delivered by flowing liquids



Automated manual transmissions (AMT)

Friction clutch:

- Power transmission delivered by pressure and friction



Advantages with EcoLife

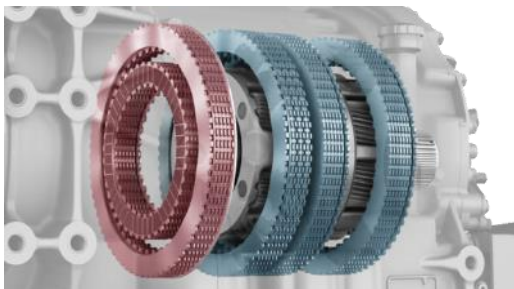
- Setting off and slow driving without wear
- Torque boost when setting off

Advantages of EcoLife Coach vs. AMT under demanding conditions (2) – Powershifting principle

EcoLife Coach (AT)

Powershifting without tractive force interruption:

- Wet clutches maintain power transmission during gear changes



Automated manual transmissions (AMT)

No powershifting, tractive force interruption occurs:

- Power transmission is interrupted by clutch

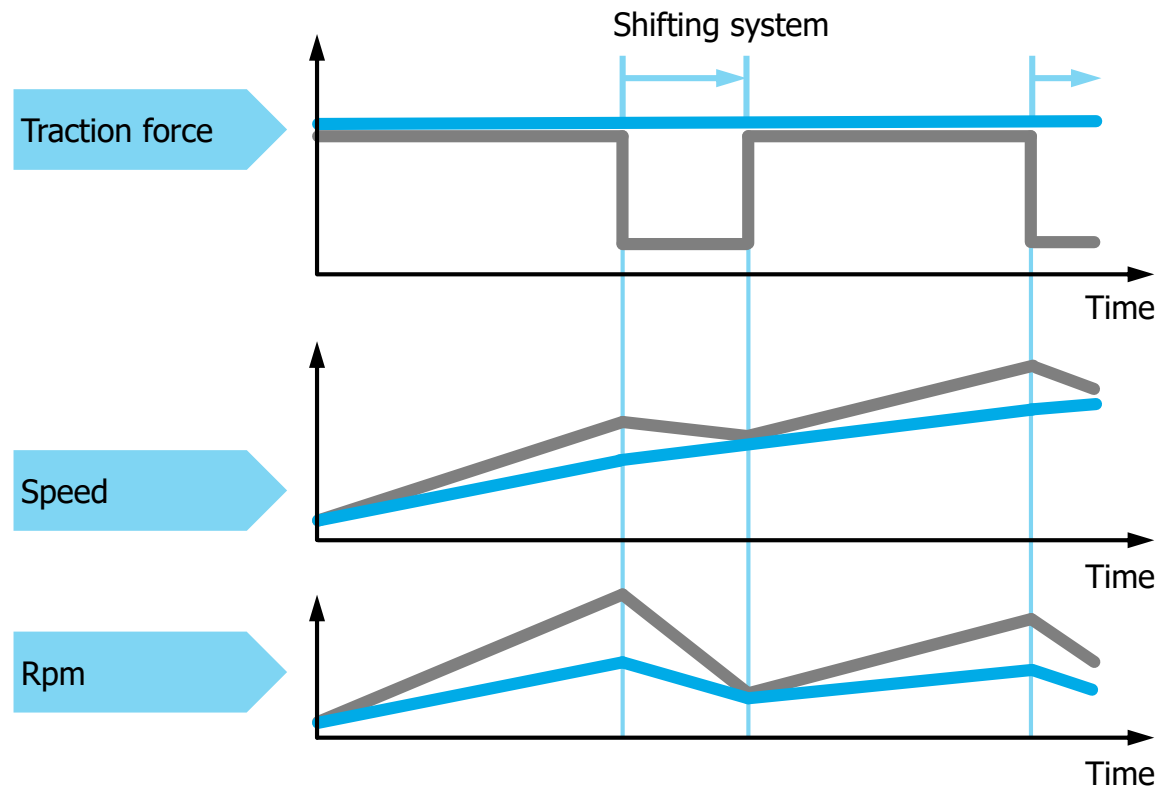


Benefits with EcoLife Coach

- No loss of speed when shifting gears, fuel consumption advantage
- Higher average speed
- Optimum ride comfort

Advantages reinforced with frequent gear changes or difficult topography

Advantages of EcoLife Coach vs. AMT under demanding conditions (3) – Powershifting sequence



— AT with powershifting

— AMT with tractive force interruption

Fuel consumption and comfort advantages thanks to powershifting

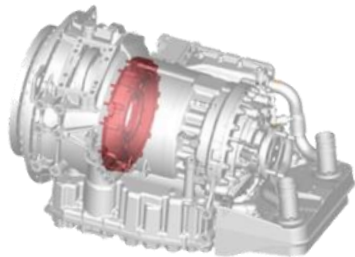
- Lower speed level because there is no loss of speed
- Gentle and efficient acceleration

Advantages of EcoLife Coach vs. AMT under demanding conditions (4) – Retarder

EcoLife Coach (AT)

Primary retarder:

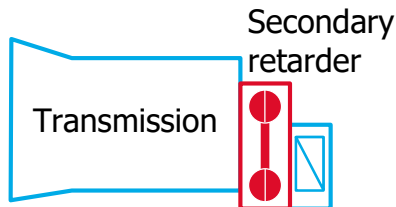
- Connected to the transmission input shaft
- Braking performance depends on engine speed and gear transmission ratio



Automated manual transmissions (AMT)

Secondary retarder

- Connected to the transmission output shaft
- Braking performance depends on vehicle speed



Benefits with EcoLife Coach

- Braking force is independent of the vehicle speed
- Maximum deceleration even at medium and low speeds (on winding roads, in urban environments, etc.)

Advantages of EcoLife Coach vs. AMT under demanding conditions (5) – Cooling system

EcoLife Coach (AT)

Very efficient with two radiators, oil sump is constantly cooled

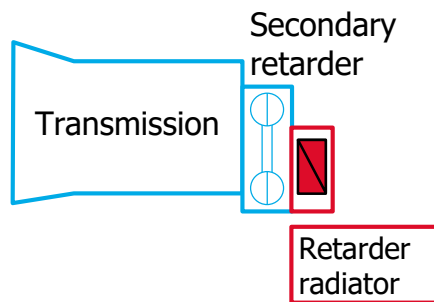


Retarder radiator

Transmission cooler

Automated manual transmissions (AMT)

Only one retarder radiator

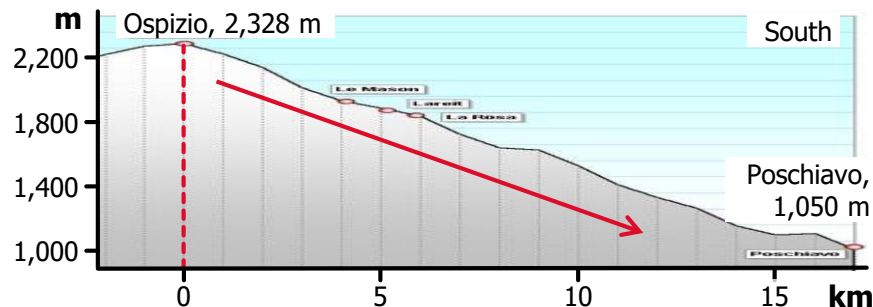


Benefits with EcoLife Coach

- Maximum deceleration even at medium and low speeds
- Retarder can be used for very long intervals, even on long and extreme downhill routes
- Increased safety

Advantages of EcoLife vs. AMT under demanding conditions (6) – Cooling system at low speed

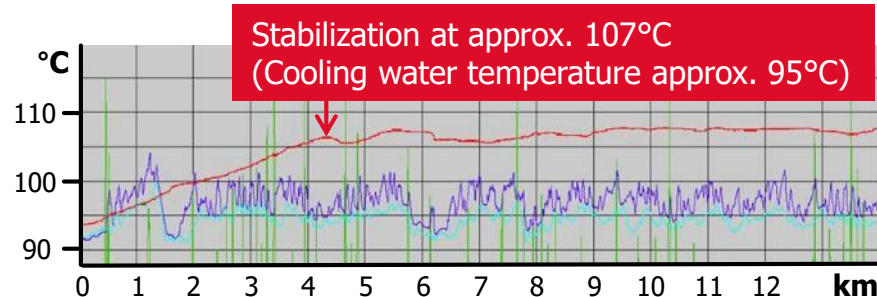
Topographic profile of the test route



Oil sump and cooling water temperatures stable despite high retarder usage, retarder fully efficient

→ **High operating cost savings through extended use of primary retarder**

Oil sump temperature



Route with downhill gradient:

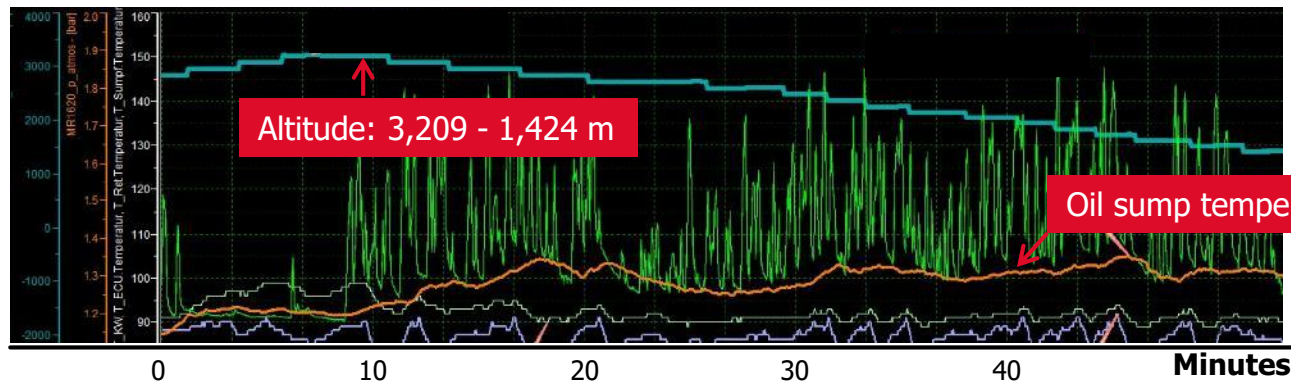
Bernina Pass, Switzerland, length: 17 km, altitude difference: 1,278 m

Bus:

Mercedes-Benz Citaro 15 m, 3 axles, 19.5 t
Engine OM 457 hLA, 260 kW, 1,600 Nm
EcoLife 6 AP 1700 B

Advantages of EcoLife vs. AMT under demanding conditions (7)

Cooling system, measurement on a downhill gradient



Downhill route:

Length approx. 43 km, difference in altitude: 1,785 m
(Quito, Ecuador)

Coach:

On Mercedes-Benz Chassis IBC 1842, 12 m,
engine OM 457 LA, 310 kW, Euro 3
EcoLife 6 AP 2000

Retarder performance largely remains at 100 %.

→ **High operating cost savings through
extended use of primary retarder**

Advantages of EcoLife Coach vs. AMT under demanding conditions (8) – Less LCC, more value retention



Reduced operating costs (LCC)

Clutch, clutch components and brake pads must be replaced less frequently:

- Torque converters for setting off, powershifting systems
- Primary retarder available for longer thanks to improved cooling

Increased resale value

Thanks to fully flexible application, even in its second life



Advantages of EcoLife Coach vs. AMT under demanding conditions (9) – Example: Oxford Tube, ECP costs* for 2016

ECP for + 3 years up to 800,000 km



AS Tronic 12 AS 2301
without clutch

≈ € 12,000



EcoLife 6 AP 2300

≈ € 2,000

Lowest life cycle costs with EcoLife Coach



* Extended Coverage Program = repair-related risk coverage program

Advantages of EcoLife Coach for coaches and intercity buses for operation at high altitudes

Usage above approx. 2,000 m altitude:

- Engine performance is considerably less
- Torque increase is significantly delayed after a gear change

Vehicle handling with MT and AMT:

- Pausing in low gears, very high engine speeds

Problem:

- High fuel consumption and noise
- Excessive stress on and damage to the transmission

Benefits with EcoLife Coach

- Consistently delivers full engine torque thanks to powershifting, no loss of speed
- Long dwell times in low gears are no problem

Reduced fuel consumption, longer service life and more ride comfort

