VT2+: Further improving the fuel economy of the VT2 transmission

Gert-Jan Vogelaar
Punch Powertrain

Introduction

- VT2 in the market
- Project approach
- Transmission losses
- Flexibility and range
- Idle stop and idle speed
- Summary of improvements
- Conclusions

Current VT2 Applications





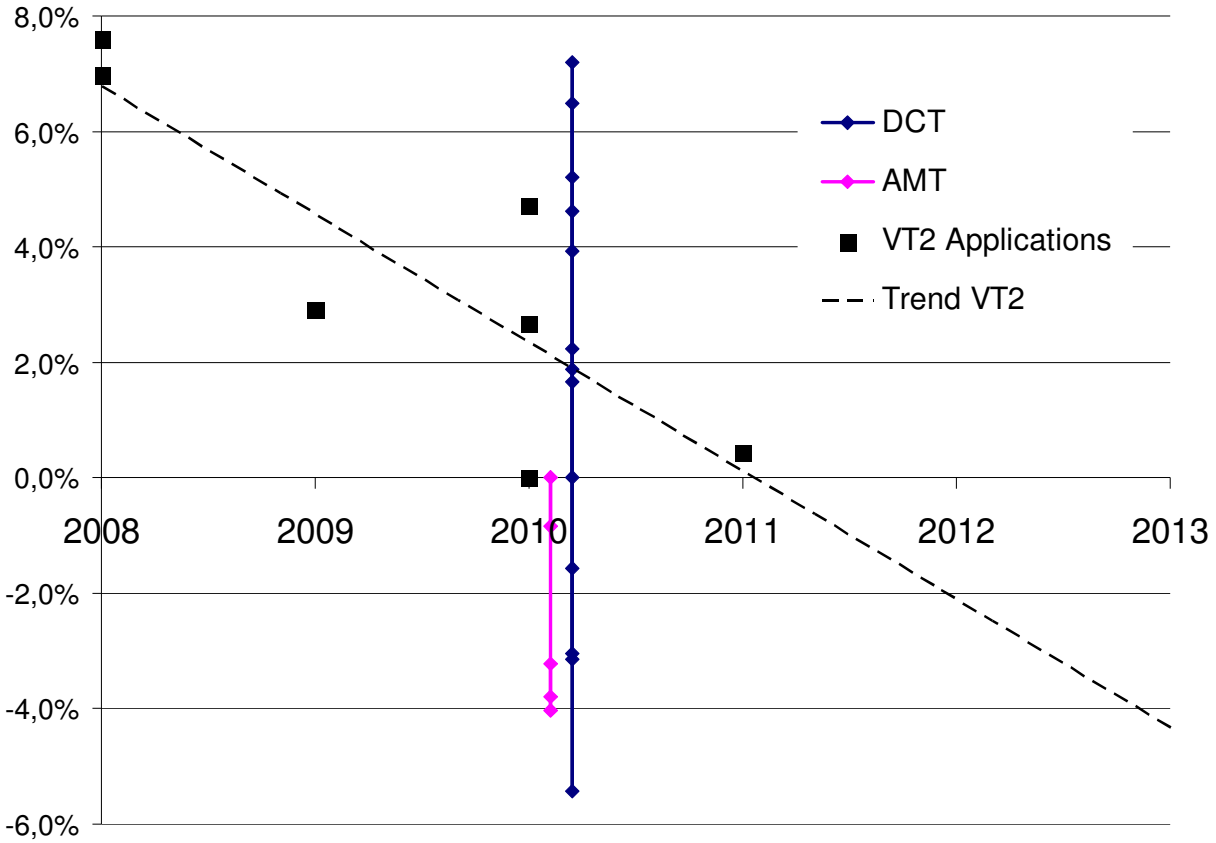









Fuel consumption comparison



- VT2 applications keep on achieving better fuel economy
- From 2011, as good as Manual Transmission
- VT2 gets within range of DCTs and AMTs

Project approach

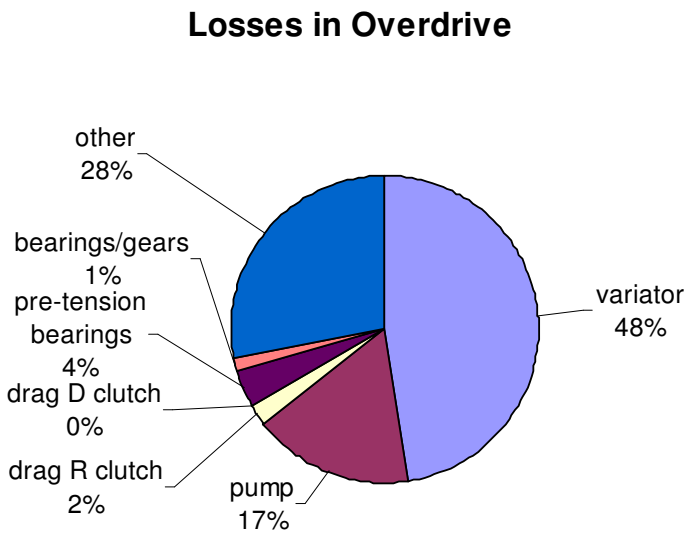
- Identify relevant working areas
- Identify contribution of different losses
- Attack the most contributing losses
- Identify limiting factors on flexibility and range
- Select and improve critical components

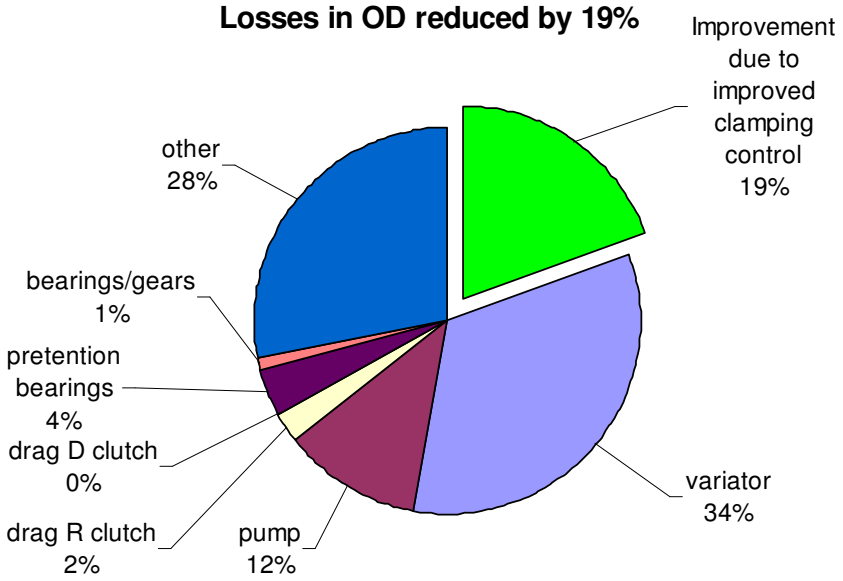
Transmission losses

- Relevant areas:
  - Driving in Overdrive
  - Losses at standstill

- Only these areas are investigated

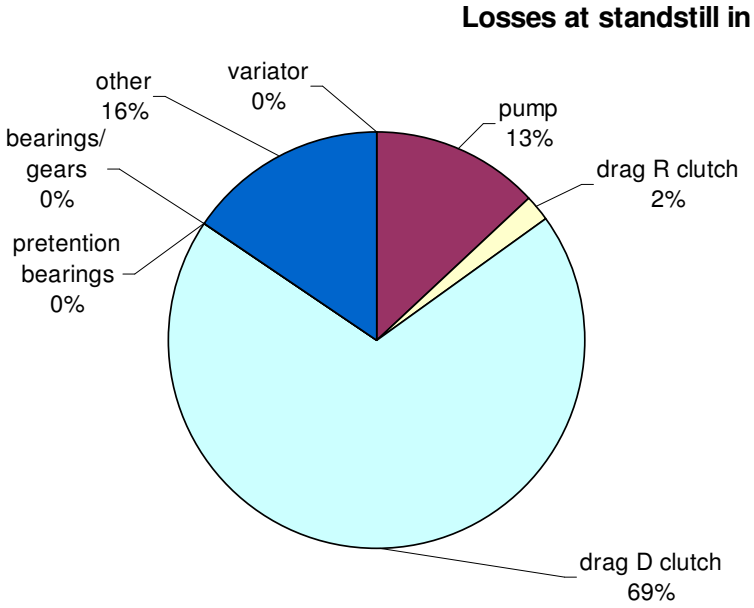
Losses in OD

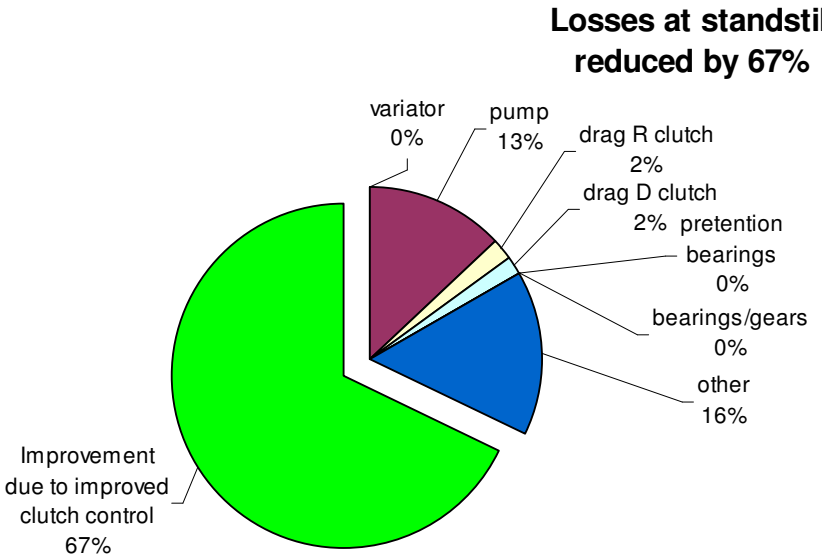




- Main losses in Overdrive caused by pump and variator
- 19% reduction via improved clamping control
- Corresponds to approximately 1.5% on NEDC cycle

Losses at standstill

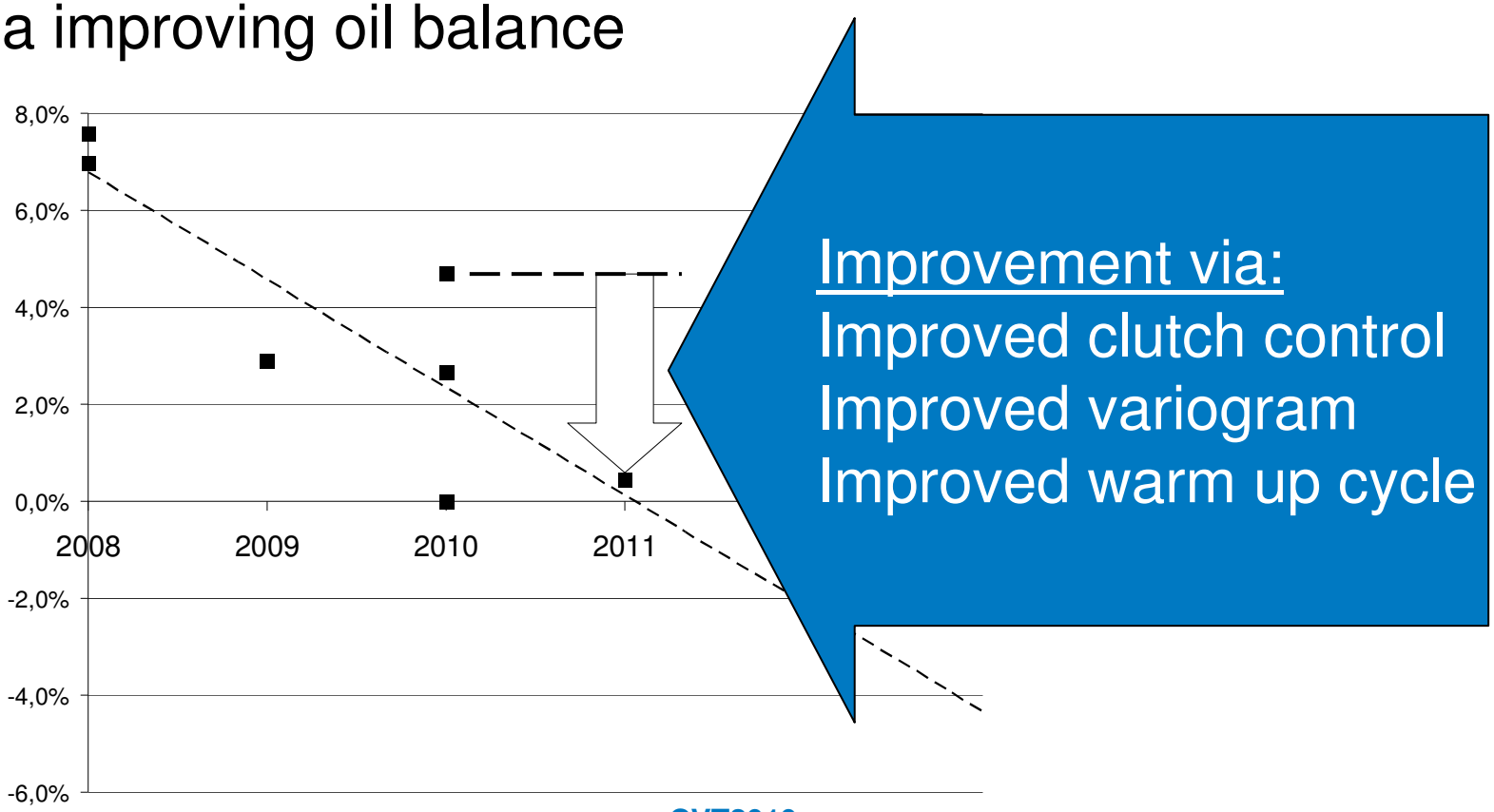




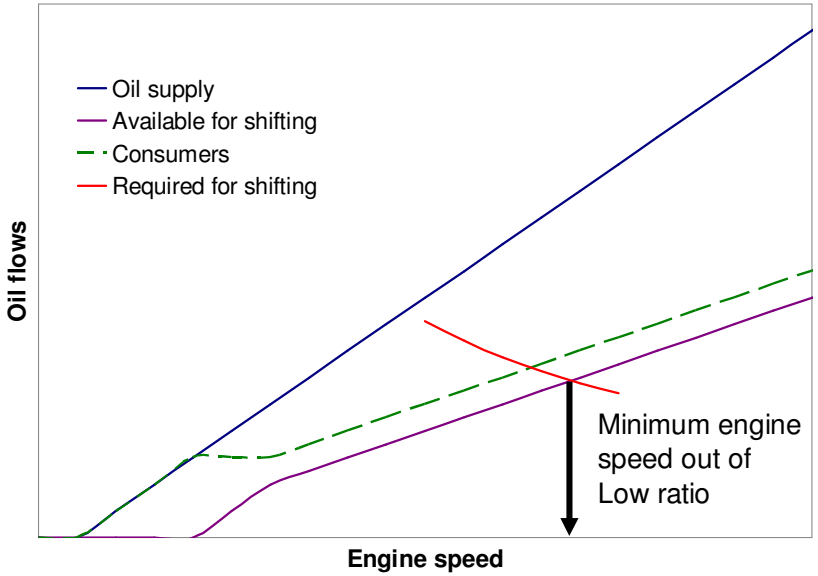
- Drag in D clutch by far the biggest cause of losses
- Reduction of 67% realised via improved clutch control
- Corresponds to 1-1.5% on NEDC cycle

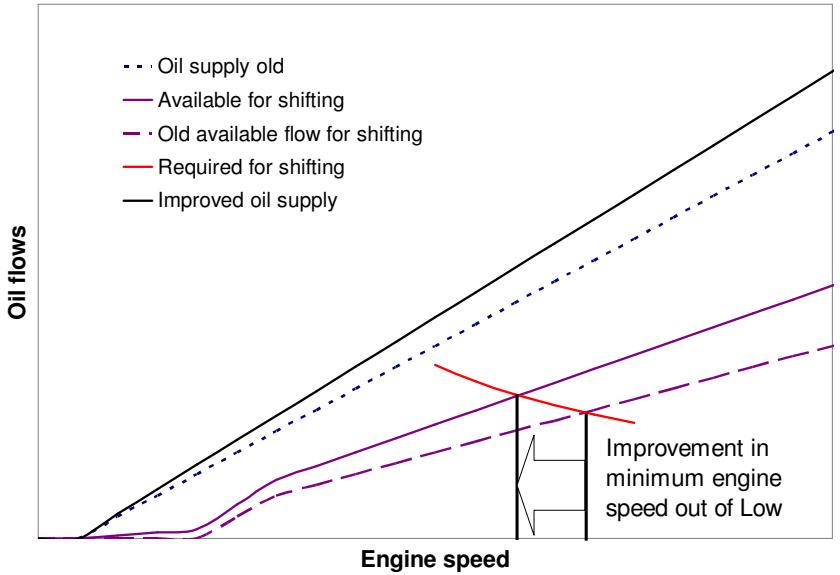
Flexibility and range

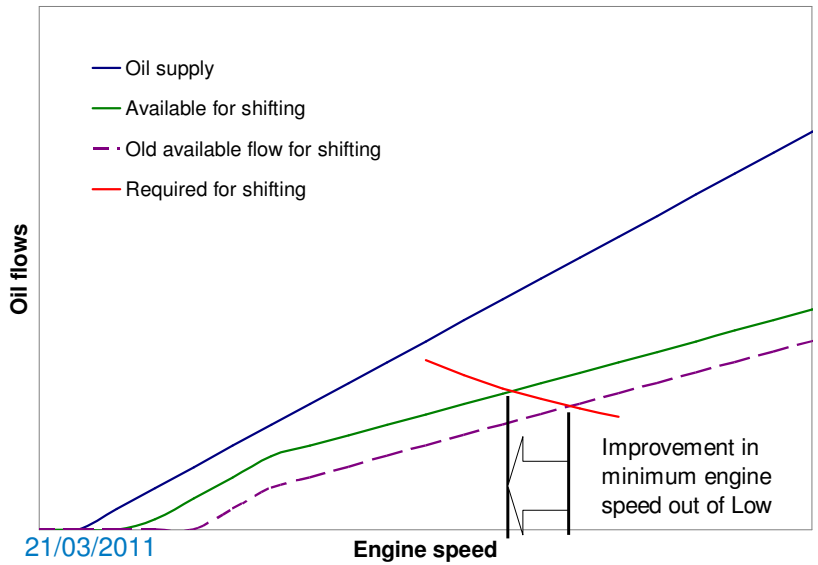
- Approach: Try to lower engine speed whenever possible
- Via optimising variogram in software
- Via improving oil balance



Improving oil balance

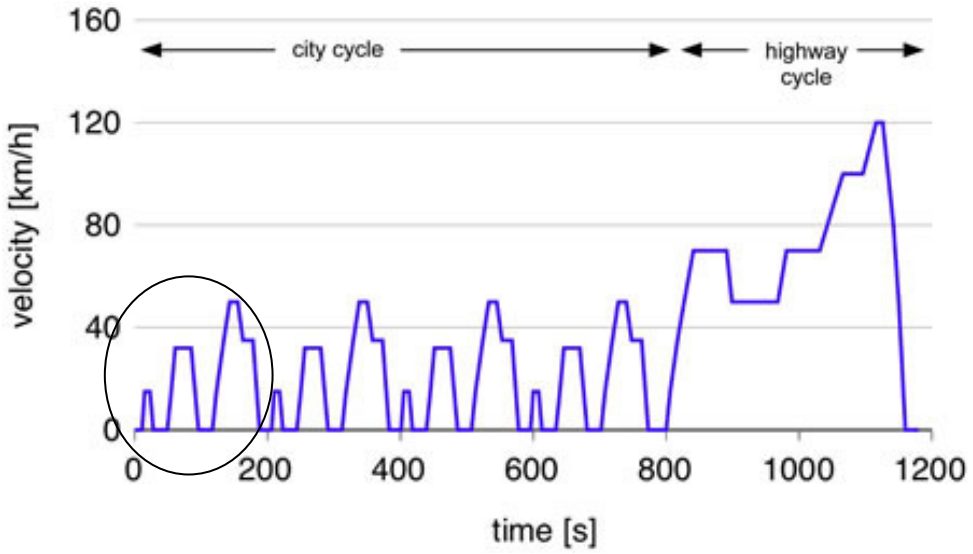


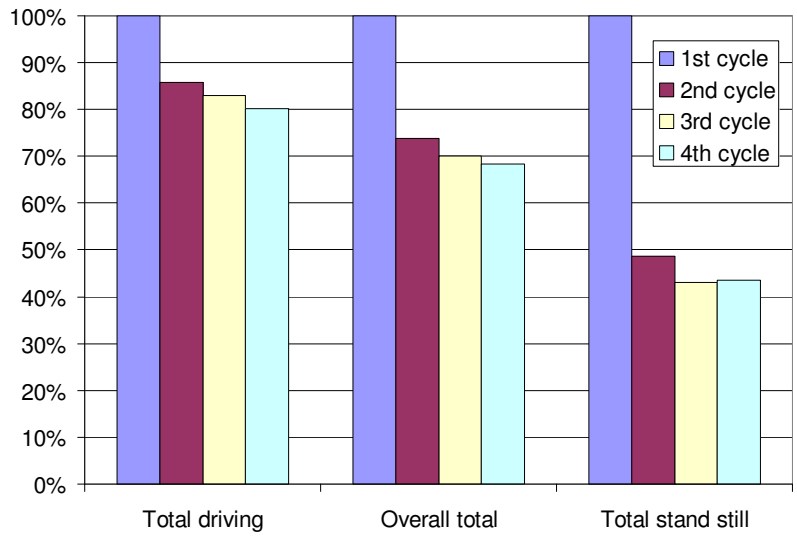




- Bigger oil pump improves supply, but increases transmission losses
- Improved pressure regulators reduce the oil consumption
- Via both measures an improvement of 1.9% can be realised (measured)

Idle stop and idle speed





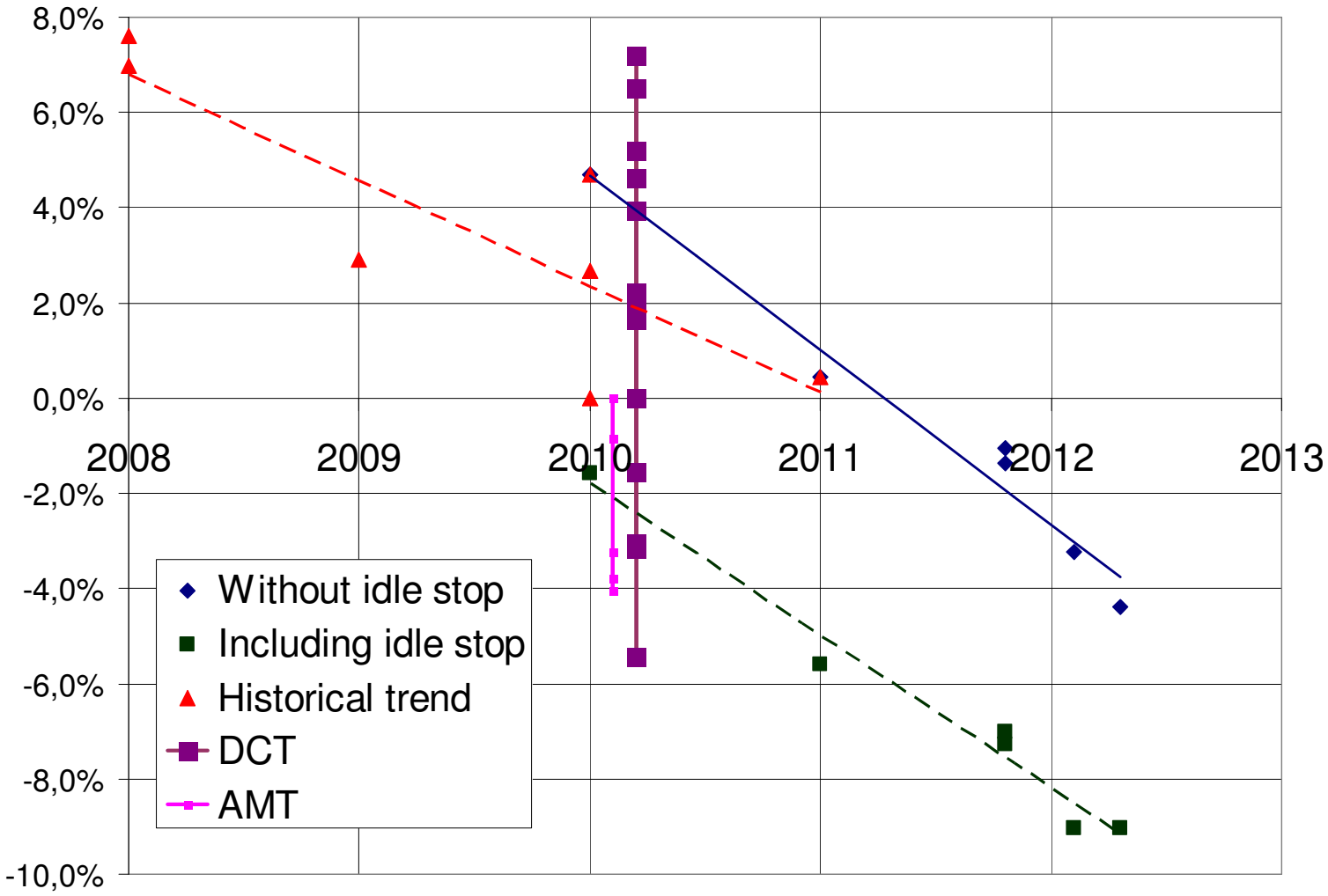
- VT2 includes idle stop capability, without mechanical adaptation
- Contribution of fuel consumption during idle measured between 8-14%, but what part can effectively be reduced?
- In case during first two ECE cycles, idle stop is not yet applied, approximately 6% improvement can be realised

Summary of improvements

Improvement	FE vs. VT2	FE vs. MT (cumm)	By	Status
Baseline	-	+4.7%	2010	Production
Clutch control, variogram, warm up cycle	-4.1%	+0.4%	2011	Improvement measured, SW validated
Clamping control	-1.5%	-1.1%	2011	Simulation result, SW under development
New oil	-1.2%	-2.3%	2011	Test result. Validation on-going
Oil consumption	-1.9%	-4.1%	2012	Improvement measured. Hardware testing started.
Idle speed	-1.2%	-5.3%	2012	Improvement estimated, hardware testing started.
Idle stop	-6.0%*	-9.9%	Now	Option available

* Maximum value. Value will reduce if idle speed is reduced, but the sum of idle stop and idle speed improvements will not be lower than 6%.

Future improvements on VT2



Conclusions

- Via a simple and straightforward approach, the weak areas in the VT2 could be determined and improved
- From 2011, VT2 can deliver similar fuel economy as the MT of the same vehicle
- Additional planned SW and HW improvements will give the VT2 a benefit over MT of 4.4% in the NEDC by 2012
- From 2011, VT2 can be 5% better than an MT in the NEDC if the idle stop option will be used
- From 2012 VT2 can be 9% better than an MT in the NEDC if the idle stop option will be used
- With these improvements, VT2 can match or do better than the best AMTs and DCTs

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Gear up for the future

Thank you for your attention

Further outlook

Improvement	FE vs. VT2	FE vs. MT (cumm)
Baseline	-	+4.7%
Clutch control, variogram, warm up cycle	-4.1%	+0.4%
Clamping control	-1.5%	-1.1%
New oil	-1.2%	-2.3%
Oil consumption	-1.9%	-4.1%
Idle speed	-1.2%	-5.3%
Curved pulleys / chain	-1.5%	-6.7%
Hydraulics, controls	-2.0%	-8.5%
Idle stop	-6.0%*	-13.0%

* Maximum value. Value will reduce if idle speed is reduced, but the sum of idle stop and idle speed improvements will not be lower than 6%.

- Hybridisation: See presentation by P. Debal