



■ Compressor Specification

■ Variation

- 1) Fixed displacement with Clutch
- 2) Variable displacement with Clutch
- 3) Clutch-less variable displacement

■ Compressor base

- Displacement volume: 140 cm³/ rev.
- Type: swash plate with 6 pistons



Test Conditions



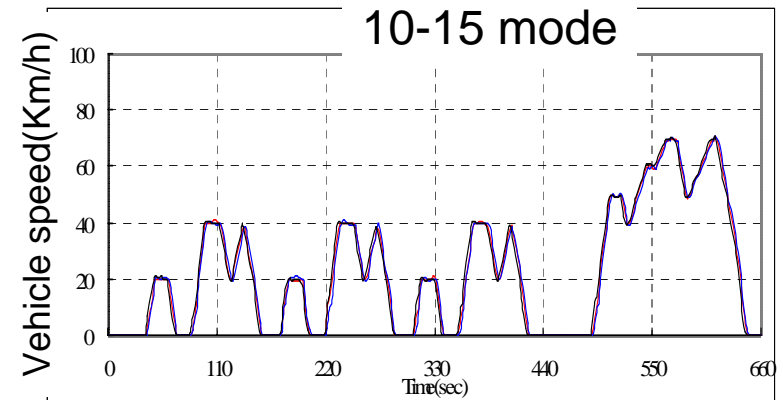
■ Vehicle running condition

→ TEWI assumption mode

Steady state IDL - 40 km / h - 100 km / h

→ 10-15 mode / JPN standard

Transient



■ Ambient Condition and AC mode

Ambient Temp(degC)	Sun load (W)	A/C Mode		Soak	10-15 mode	TEWI
		Air Mode	A/C Fan			
35	767	Rec / Vent	Hi	without		○
25	0	OSA#1/ Vent	Mid-Low	without	○	○
15	0	OSA#1/ Foot	Mid-Low	without		○

#1 Out Side Air

Assumptions



ZVCC TEWI Calculation Condition

Driving distance: 10000 [km]

Location		Climate condition #1			Driving condition #2			Average speed
		35 degC	25 degC	15 degC	Idle	40 km/h	100 km/h	
USA	Chicago	5%	24%	13%	18.5%	56.5%	25.0%	47.6 km/h
	Miami	24%	65%	8%				
	Long Island	5%	33%	16%				
	Phoenix	32%	32%	16%				
	Average	16%	38%	13%				
EU	UK	0%	13%	24%	28.0%	52.0%	20.0%	40.8 km/h
	Germany	1%	16%	20%				
	Greece	10%	46%	25%				
	Italy	7%	33%	22%				
	Spain	7%	34%	24%				
	Average	5%	28%	23%				
JPN	Tokyo	9%	38%	17%	47.1%	46.3%	6.6%	25.1 km/h

#1: SAE paper 970526, 1998 JAMA work shop report

#2: LA#4-SC3 (USA), NEDC (EU), 10-15+high way mode (JPN)

A/C operating ratio

Ambient Temp. [degC]	40	35	30	25	20	15
A/C Operating Freq.	100%	100%	100%	90%	60%	30%

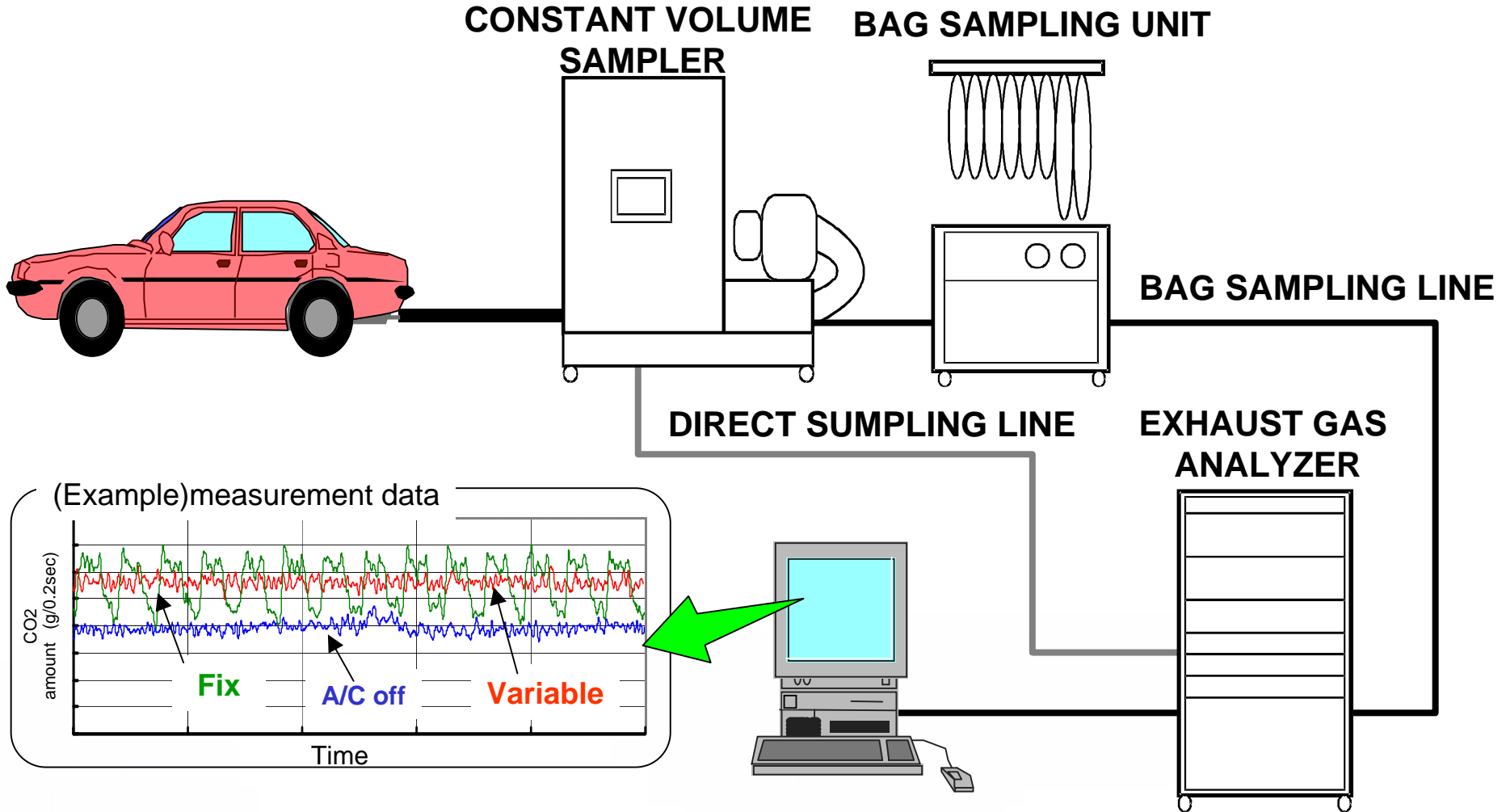
ZVCC original specification

Measuring System

Measuring System



■ Exhaust Gas Analyzer / Carbon Balance Method



Fixed vs. Variable

Vehicle Fuel Consumption for MAC

- Fixed displacement versus Variable displacement -



■ Compressor Variation

No.	Displacement	Temperature Control		Idle speed [rpm]	
		Thermostat	Control Valve	A/C off	A/C on
1	Fix	Normal	-----	750	850
2	Fix	Economy ^{#1}	-----	750	850
3	Variable	-----	Normal / Internal	750	850
4	Variable	-----	Economy ^{#1} / External	750	850
5	Variable	-----	Economy ^{#1} / External	750	750~850 ^{#2}

#1 : Economy Control

Evaporator outlet Temp. is controlled **10 degC** on following condition

→ 35degC @ 100km/h , 25degC and 15degC @ Idle-100km/h

#2 : Idle speed control

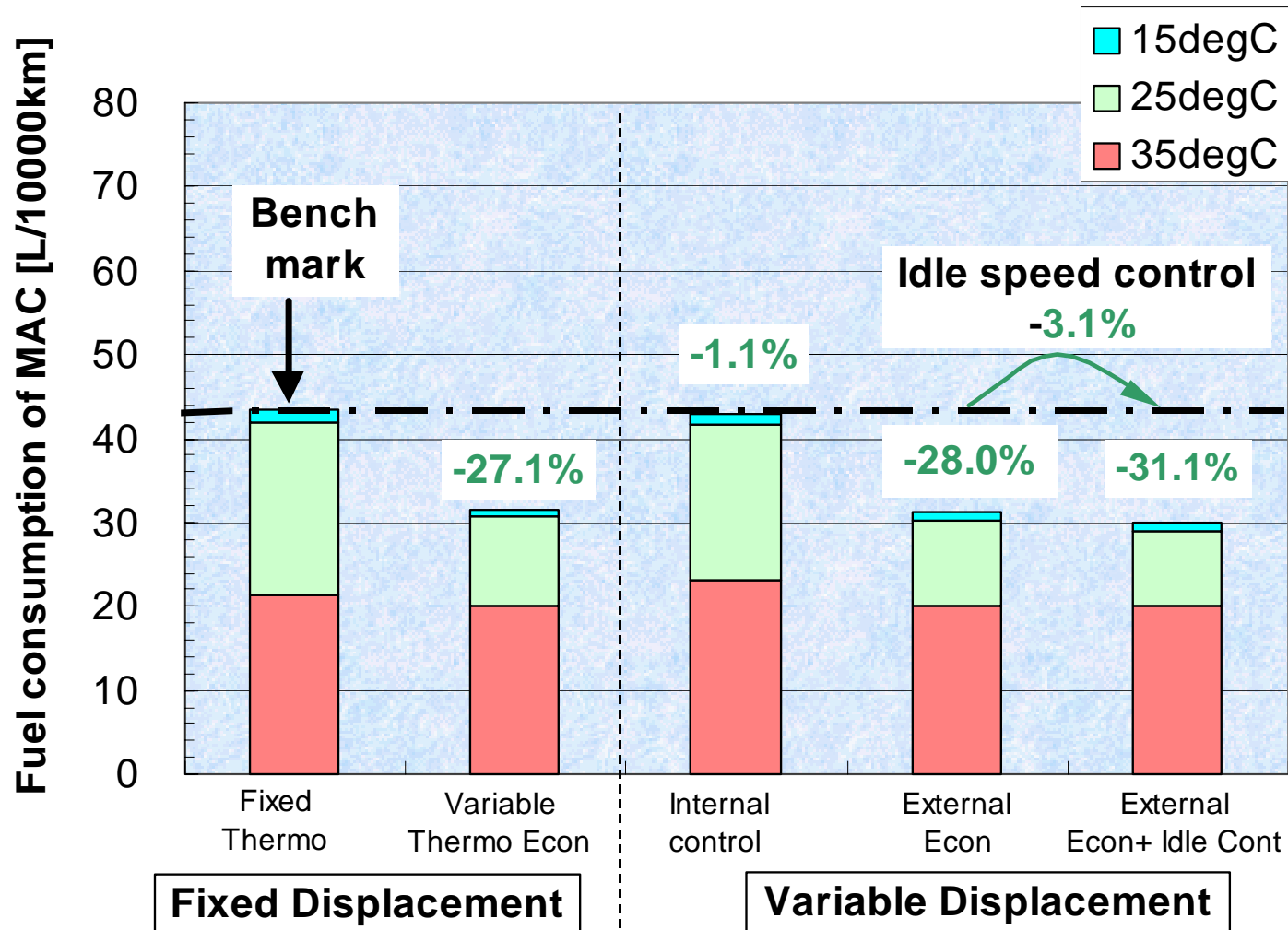
→ 25degC and 15degC = 750rpm , 35degC = 850rpm

Vehicle Fuel Consumption for MAC

- Fixed displacement versus Variable displacement -



Fuel consumption result - ZVCC TEWI USA condition-

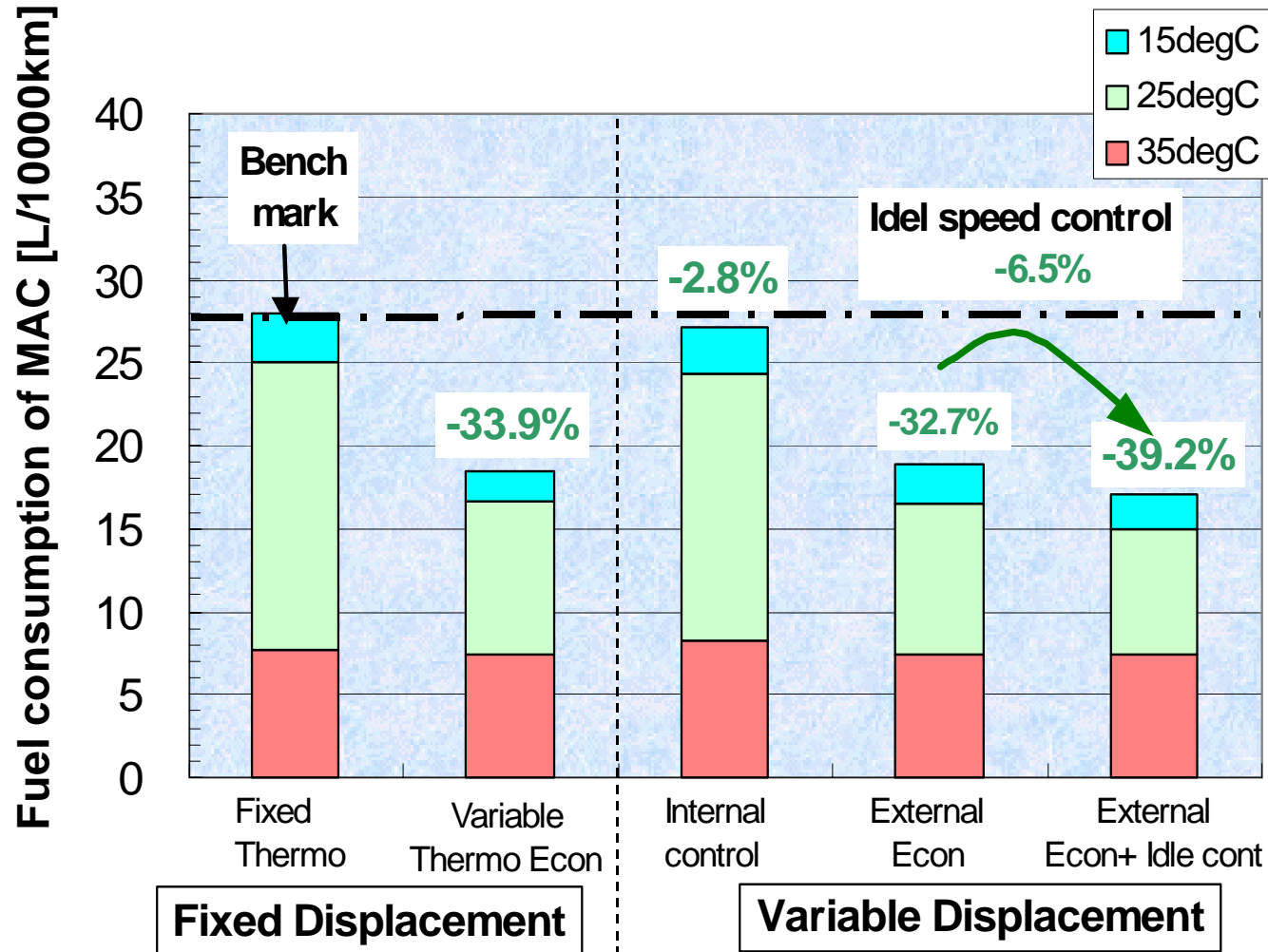


Vehicle Fuel Consumption for MAC

- Fixed displacement versus Variable displacement -



■ Fuel consumption result - ZVCC TEWI Europe condition-

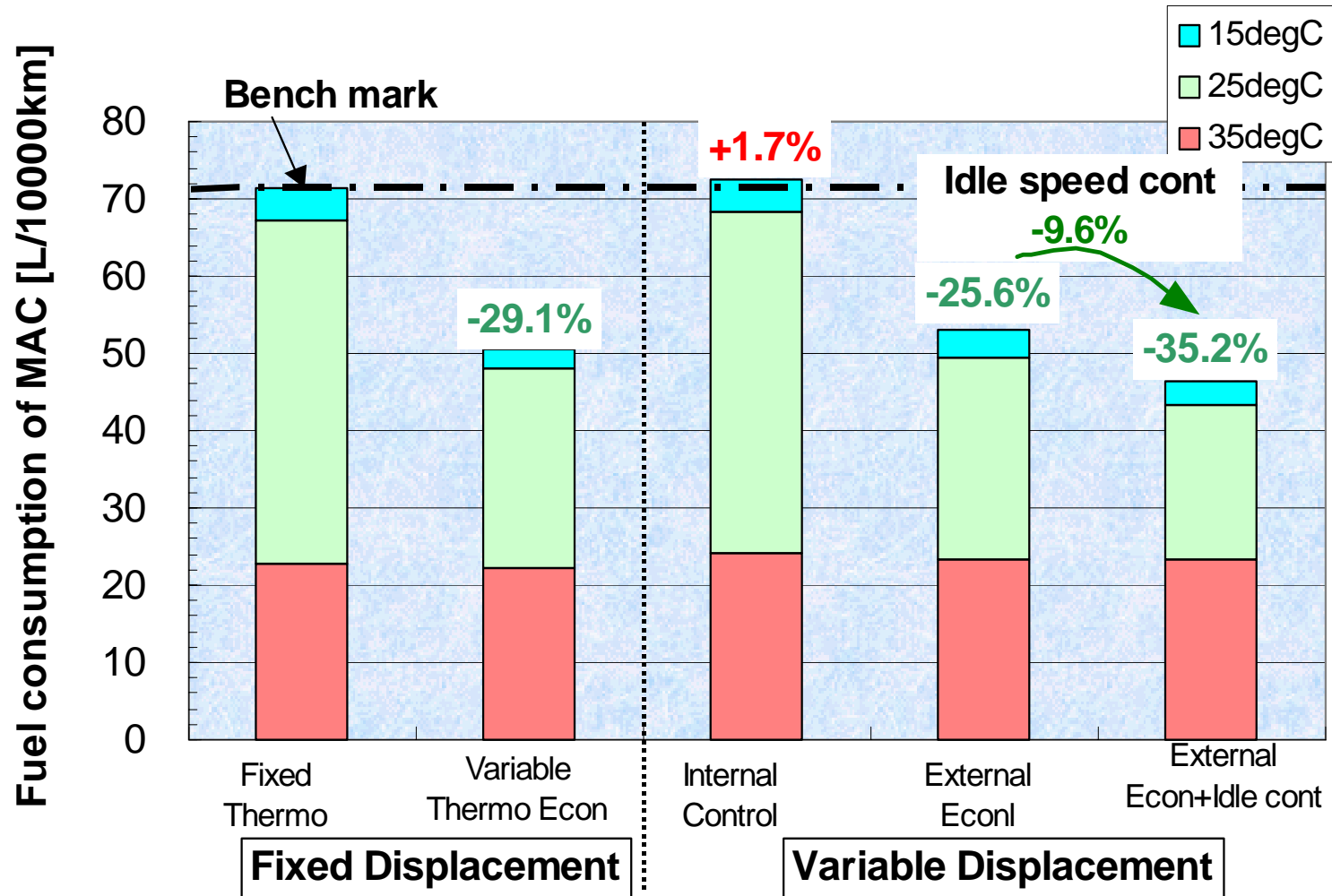


Vehicle Fuel Consumption for MAC

- Fixed displacement versus Variable displacement -



■ Fuel consumption result - ZVCC TEWI Japan condition-

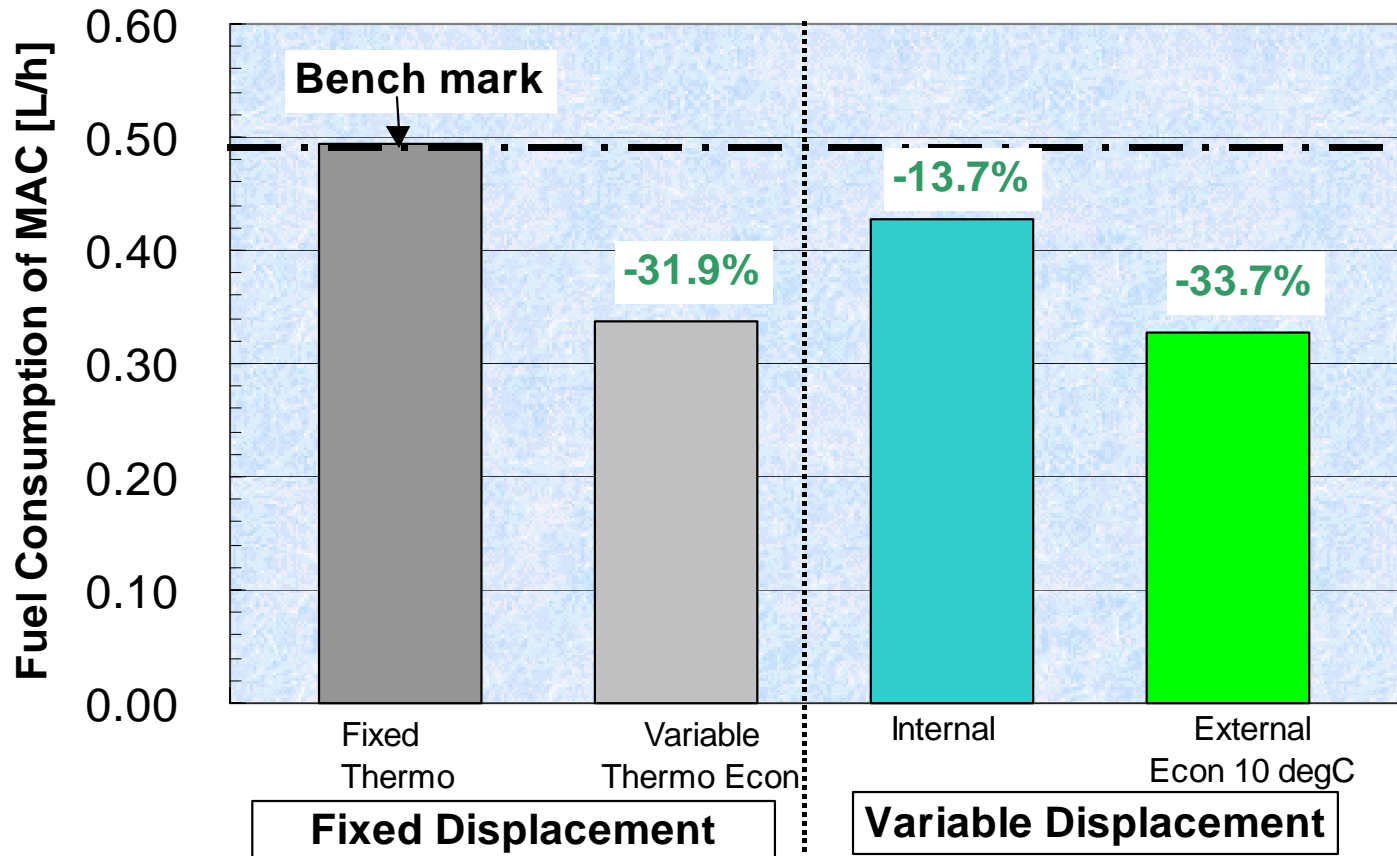


Vehicle Fuel Consumption for MAC

- Fixed displacement versus Variable displacement -



■ 10-15 mode Fuel consumption - 25 degC-

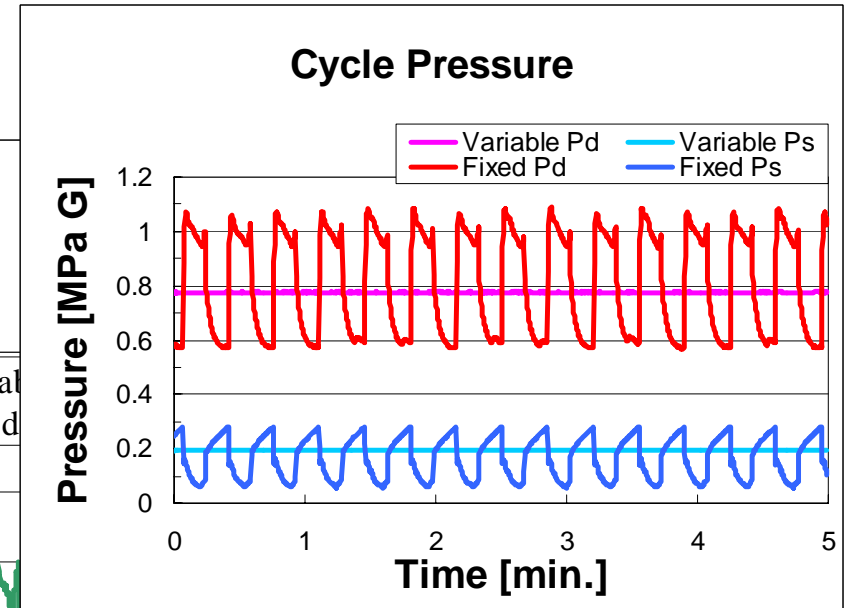
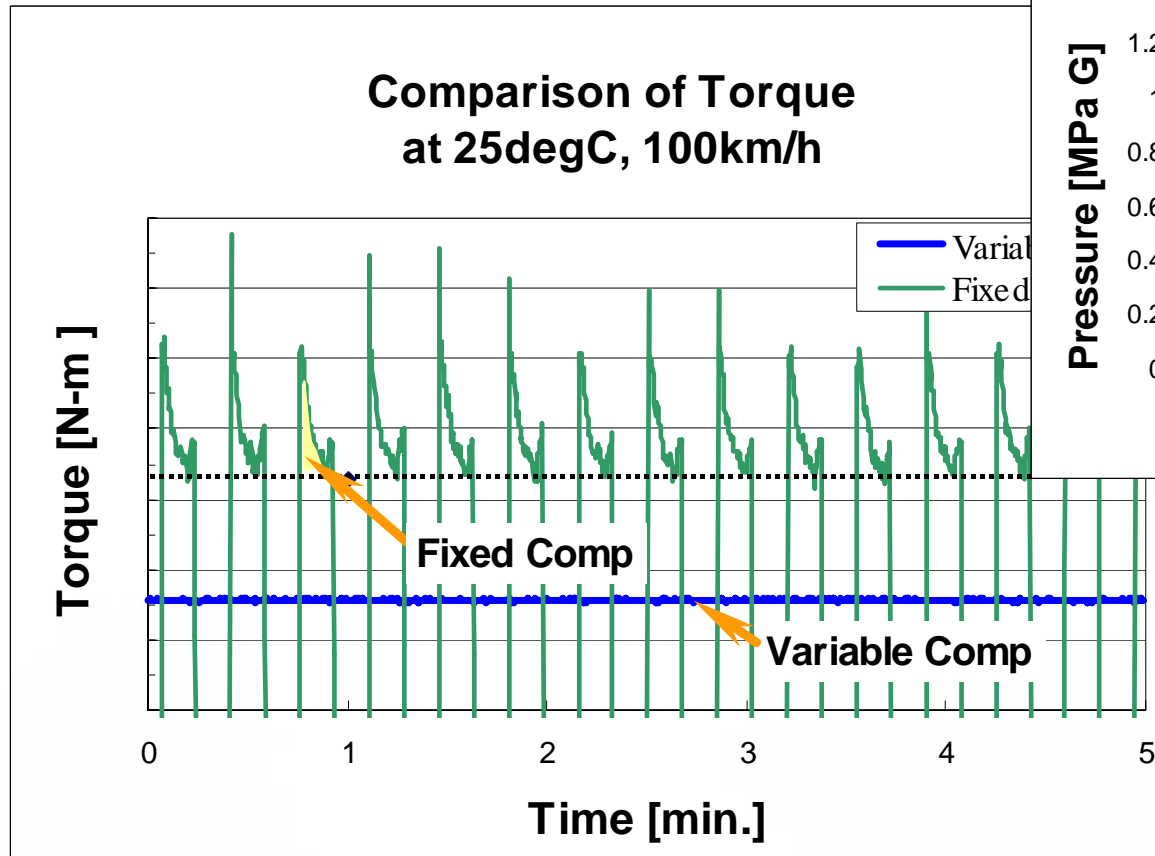


Vehicle Fuel Consumption for MAC

- Fixed displacement versus Variable displacement -



■ Operating Torque at High Speed



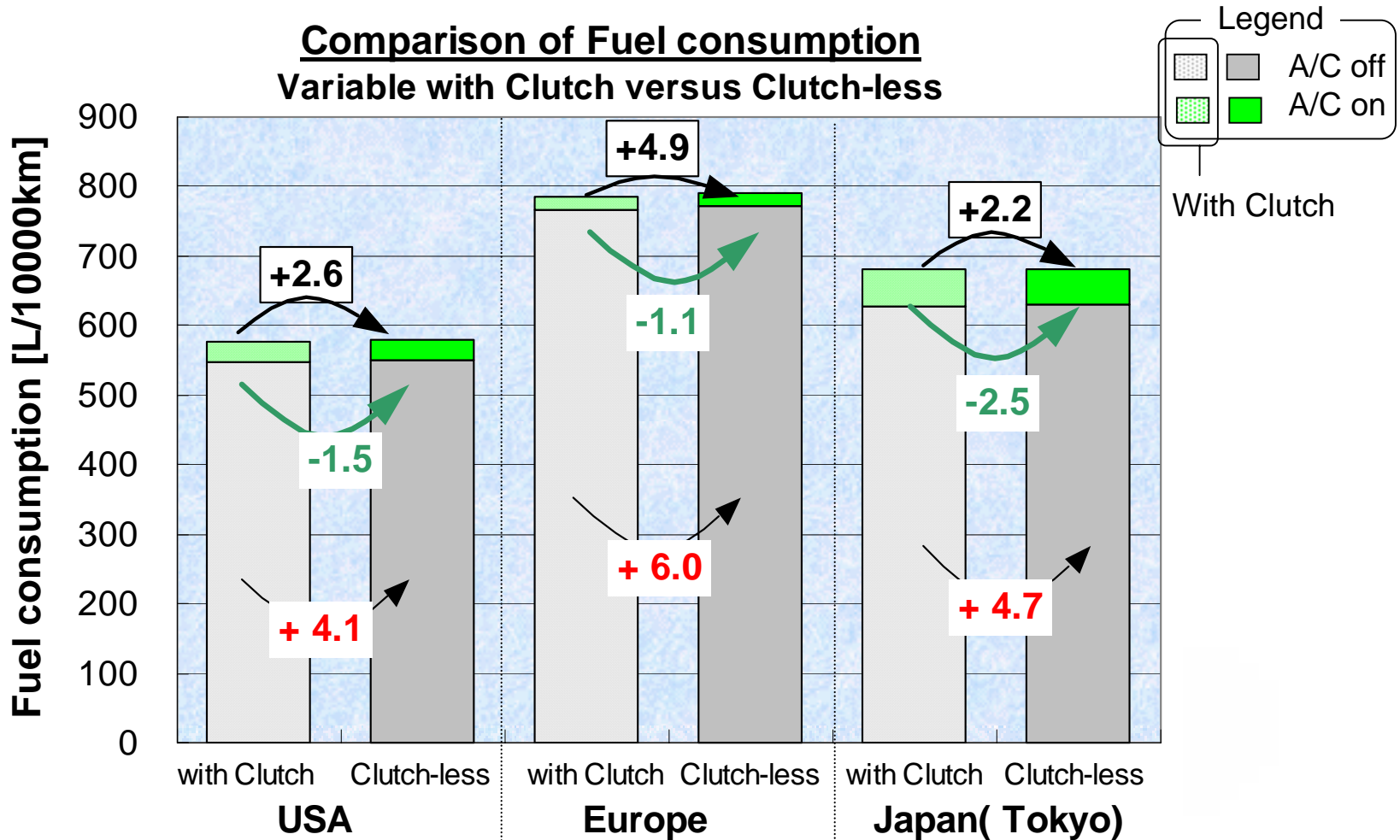
Clutch vs. Clutch-less

Vehicle Fuel Consumption for MAC

- Variable displacement with Clutch versus Clutch-less -



■ Vehicle fuel consumption result - ZVCC TEWI condition -

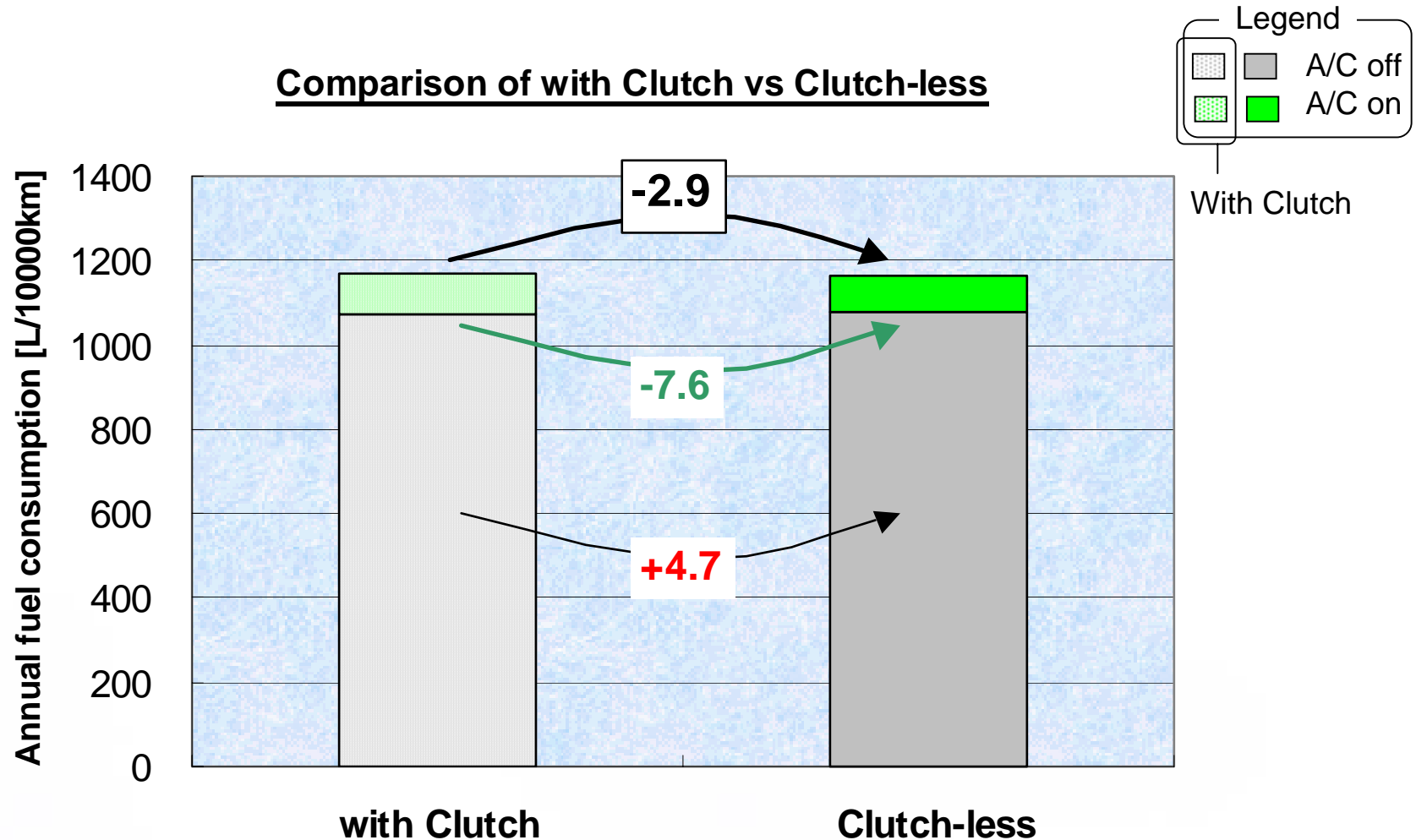


Vehicle Fuel Consumption for MAC

- Variable displacement with Clutch versus Clutch-less -



■ Vehicle fuel consumption result - 10-15 mode -



Conclusion

Vehicle Fuel Consumption for MAC



■ **Conclusion** - Fixed vs Variable -

- Annual fuel consumption is almost same under TEWI mode (steady state condition)
- Fuel consumption of Variable is better than Fixed under 10-15 mode (transient condition)
- External Variable compressor has more potential of fuel consumption reduction than Fixed compressor

Potential

- Idle speed reduction
- Good response for torque reduction at acceleration state
- Potential of Evaporator outlet air highly controlling

Vehicle Fuel Consumption for MAC



- **Conclusion - Clutch vs. Clutch-less -**
 - Annual fuel consumption with Clutch and Clutch-less is almost same.

 - Customer Benefit with Clutch-less Variable Compressor
 - ✓ Weight Reduction (-700~-900g)
 - ✓ Miniaturization of Pulley Diameter

ZEXEL

Valeo

**CLIMATE
CONTROL**