Test Conditions

- **Compressor Specification**
  - Variation
    1) Fixed displacement with Clutch
    2) Variable displacement with Clutch
    3) Clutch-less variable displacement
  - Compressor base
    - ➔ Displacement volume: 140 cm^3/ rev.
    - ➔ Type: swash plate with 6 pistons

Test Conditions

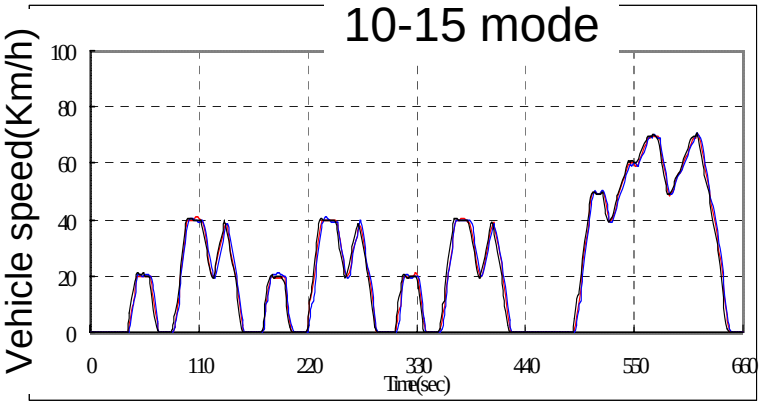
Vehicle running condition

➔ **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			
		35 degC	25 degC	15 degC	Idle	40 km/h	100 km/h	Average speed
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

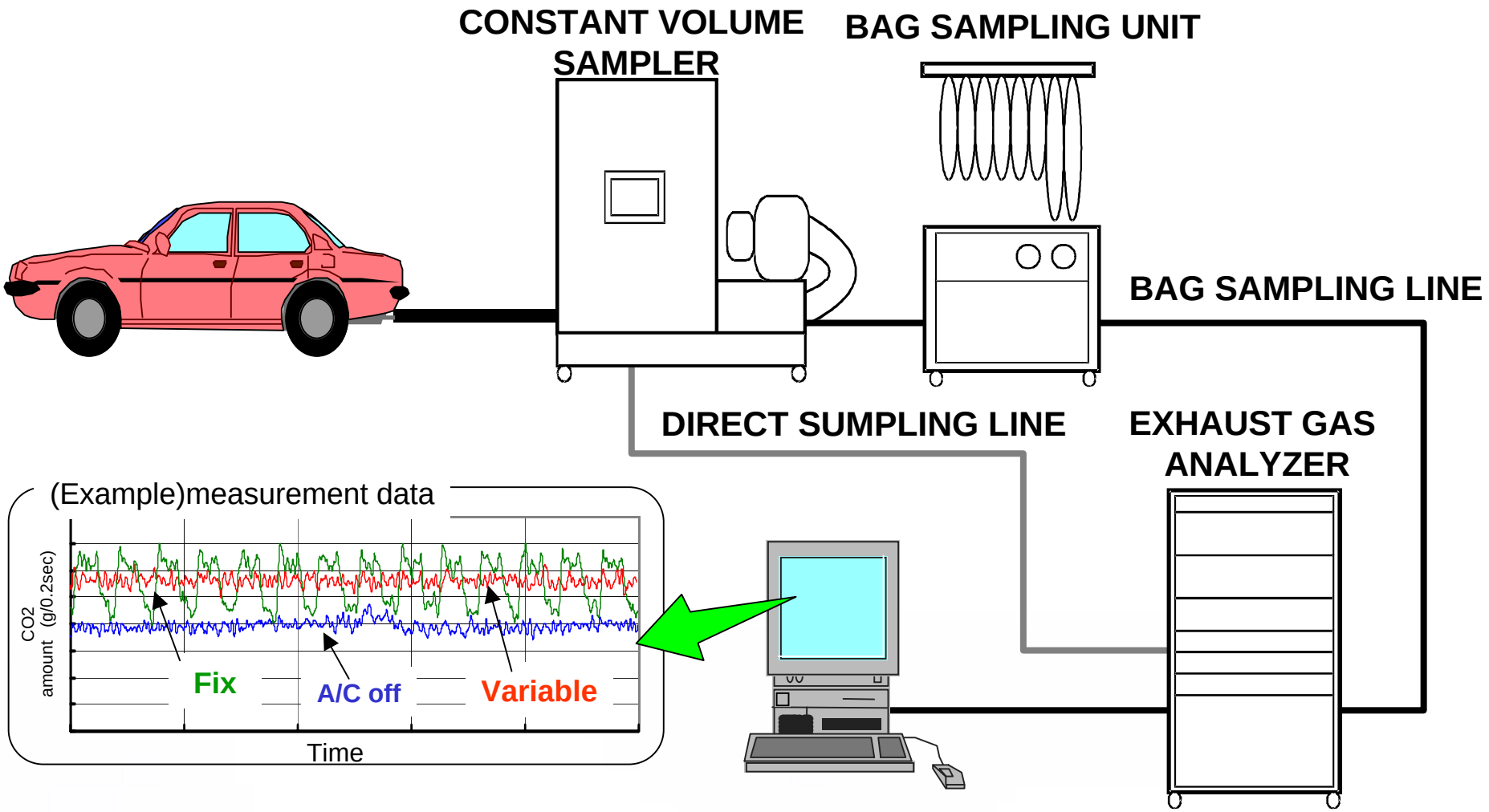
Ambient Temp. [degC]	40	35	30	25	20	15
A/C Operating Freq.	100%	100%	100%	90%	60%	30%

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

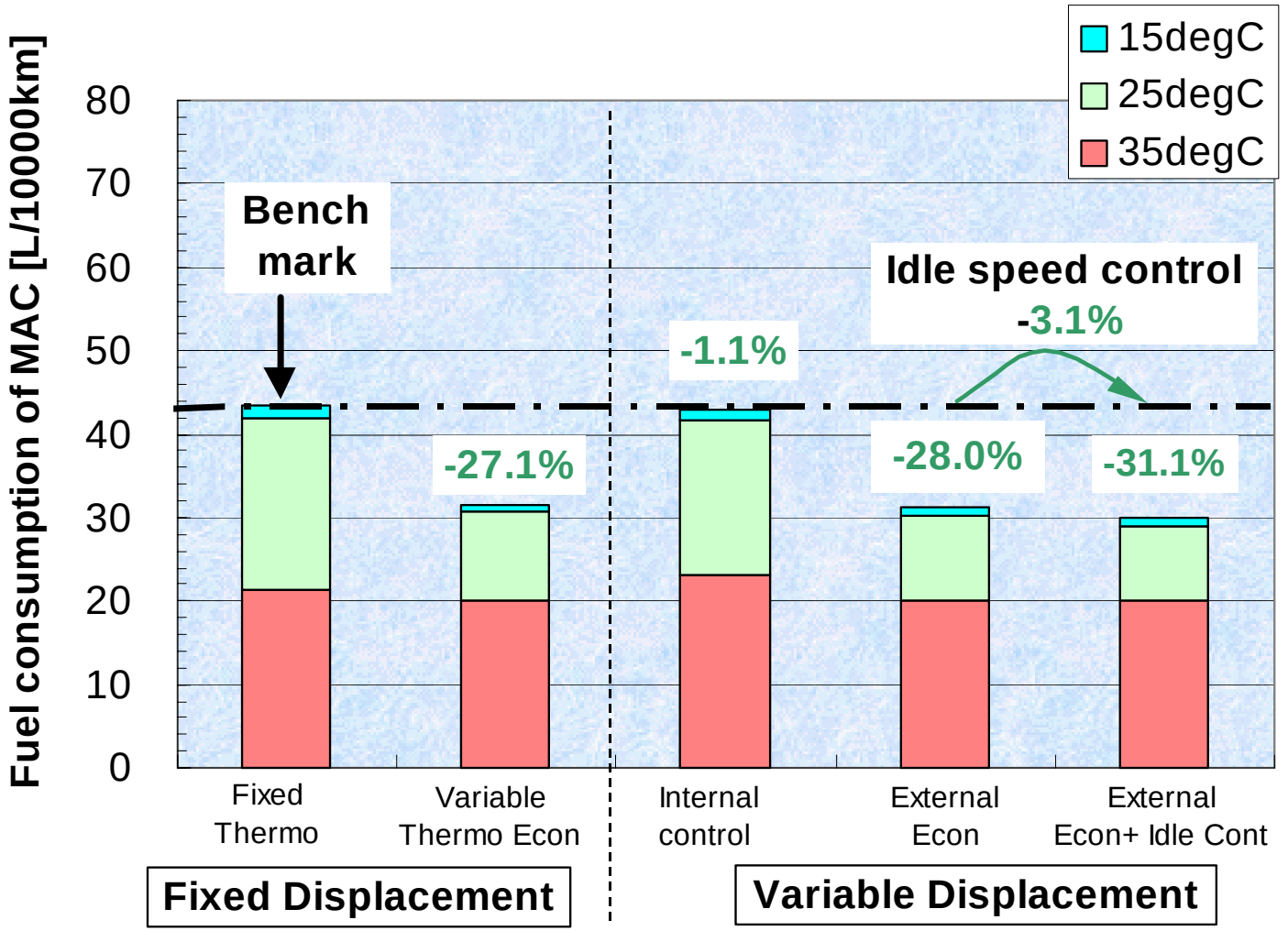
➔35degC @ 100km/h , 25degC and 15degC @ Idle-100km/h

#2 : Idle speed control

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

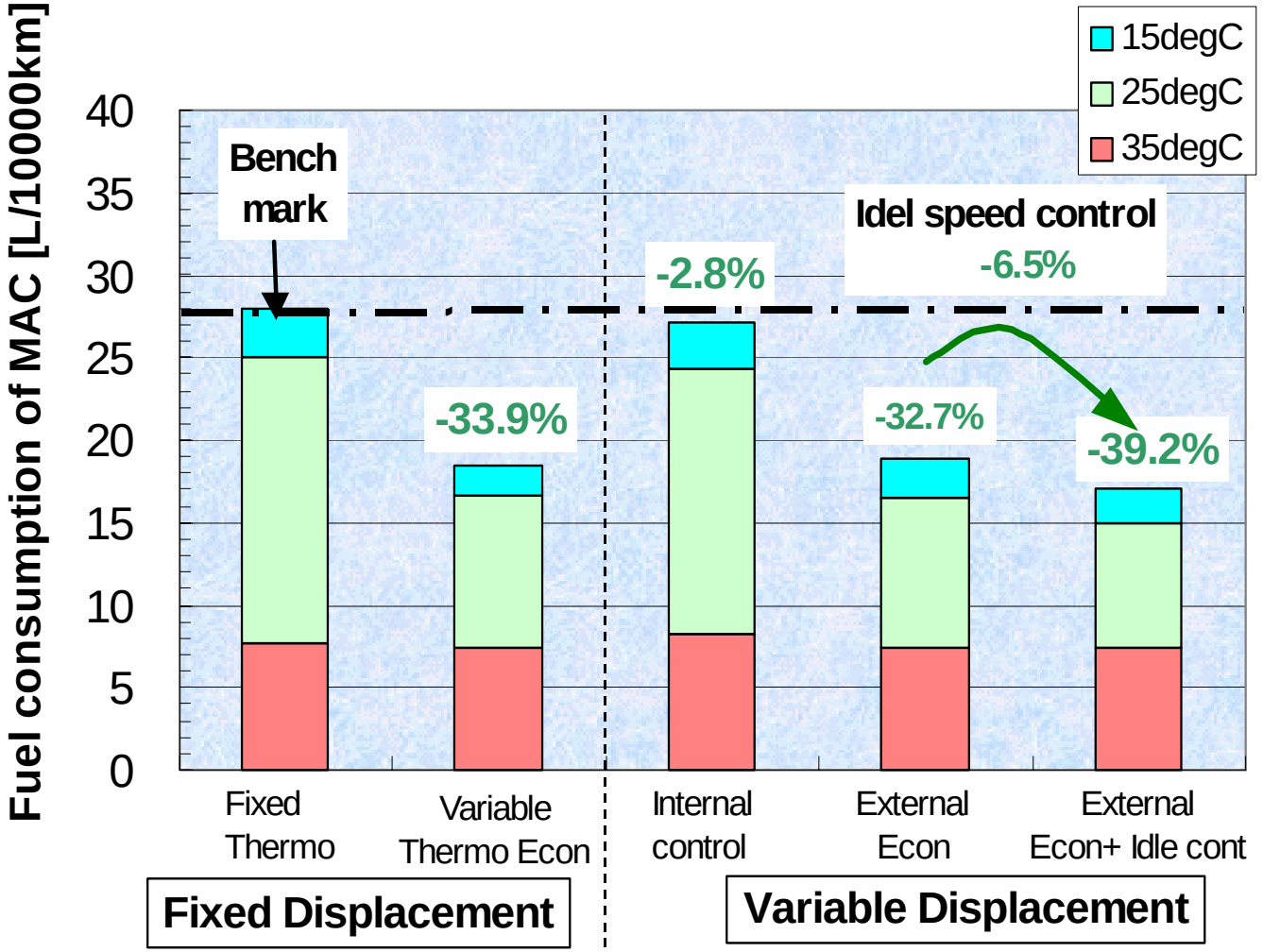
Vehicle Fuel Consumption for MAC
- Fixed displacement versus Variable displacement -

- **Fuel consumption result - ZVCC TEWI USA condition-**



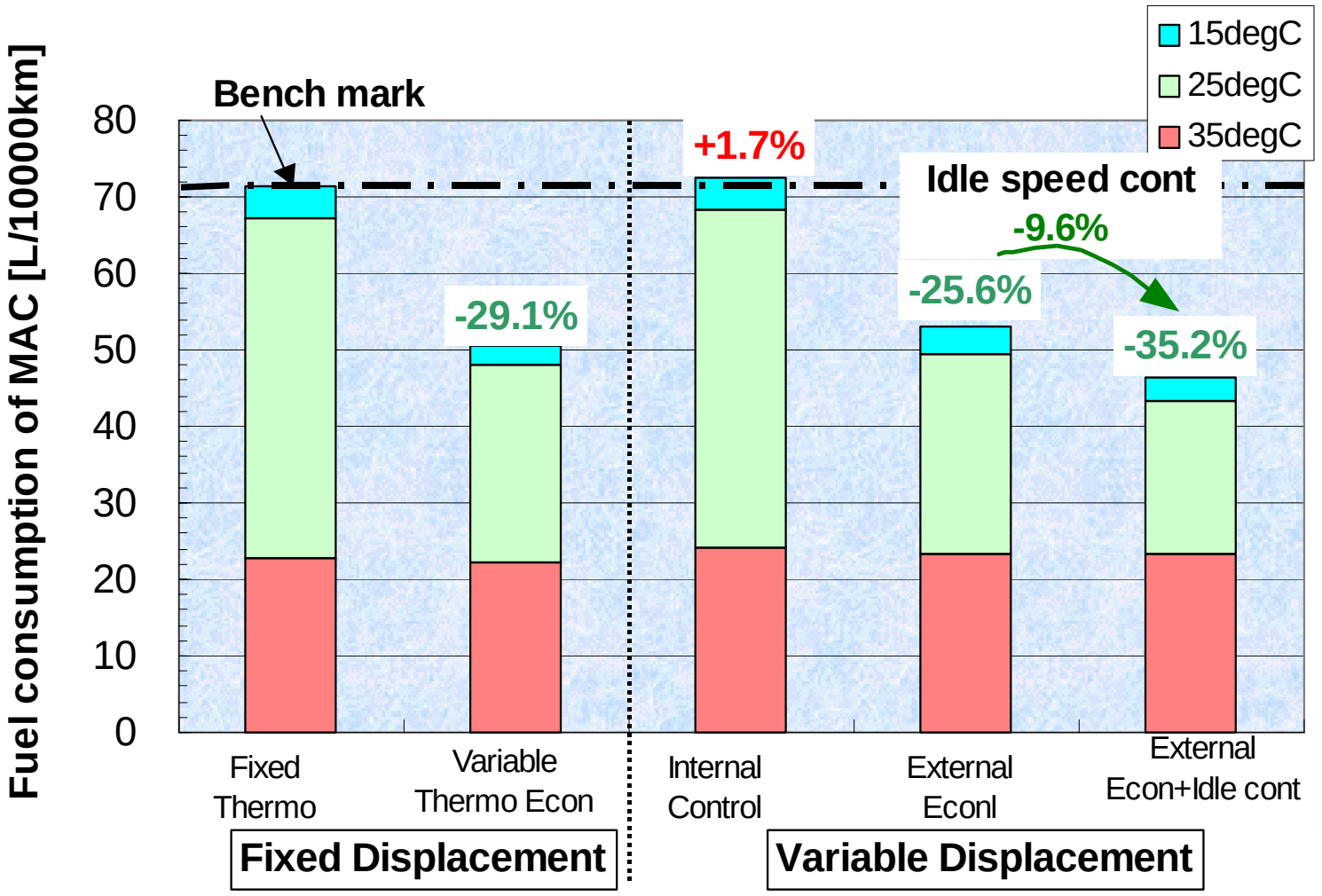
Vehicle Fuel Consumption for MAC
- Fixed displacement versus Variable displacement -

- **Fuel consumption result - ZVCC TEWI Europe condition-**



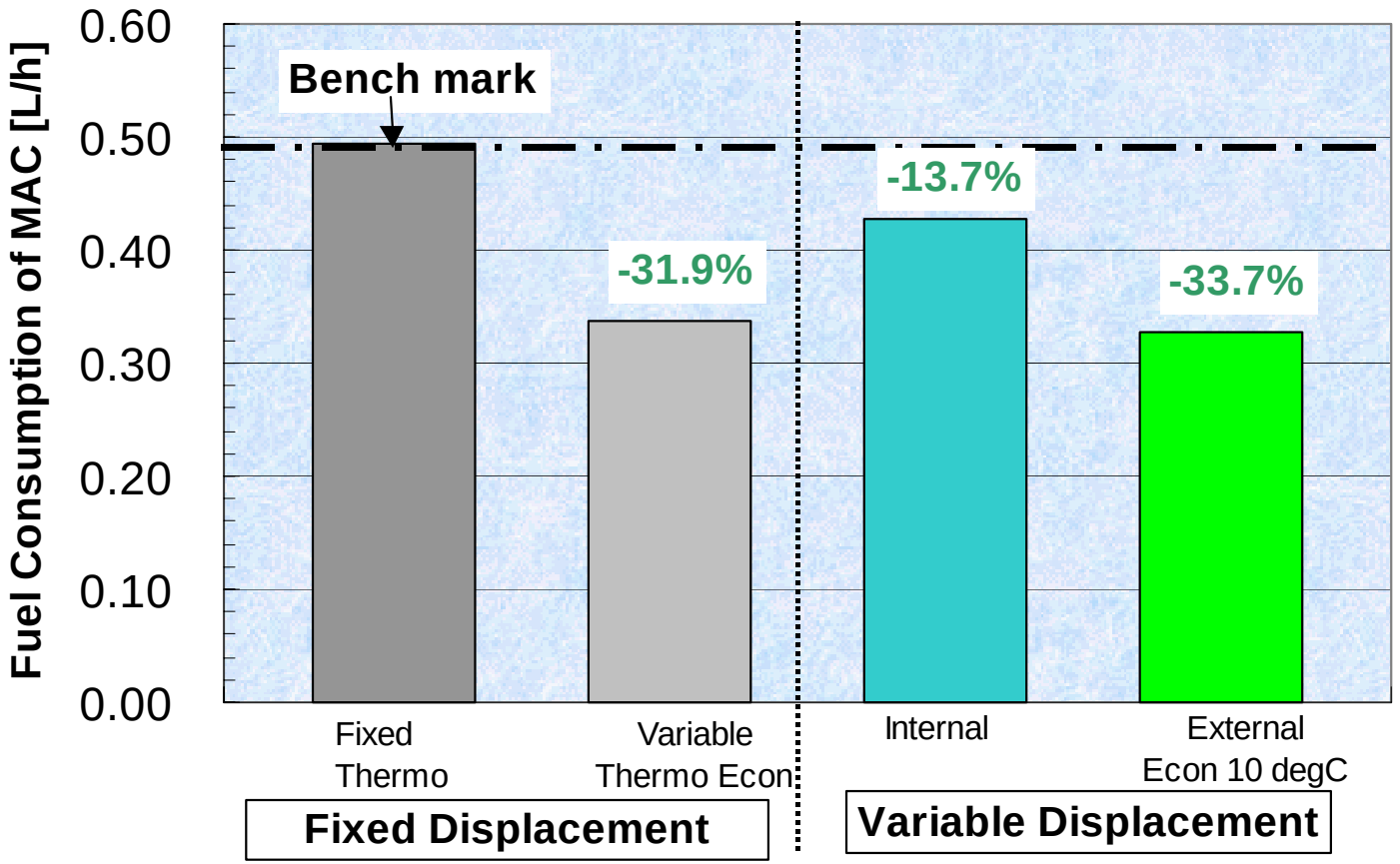
Vehicle Fuel Consumption for MAC
- Fixed displacement versus Variable displacement -

- **Fuel consumption result - ZVCC TEWI Japan condition-**



Vehicle Fuel Consumption for MAC
- Fixed displacement versus Variable displacement -

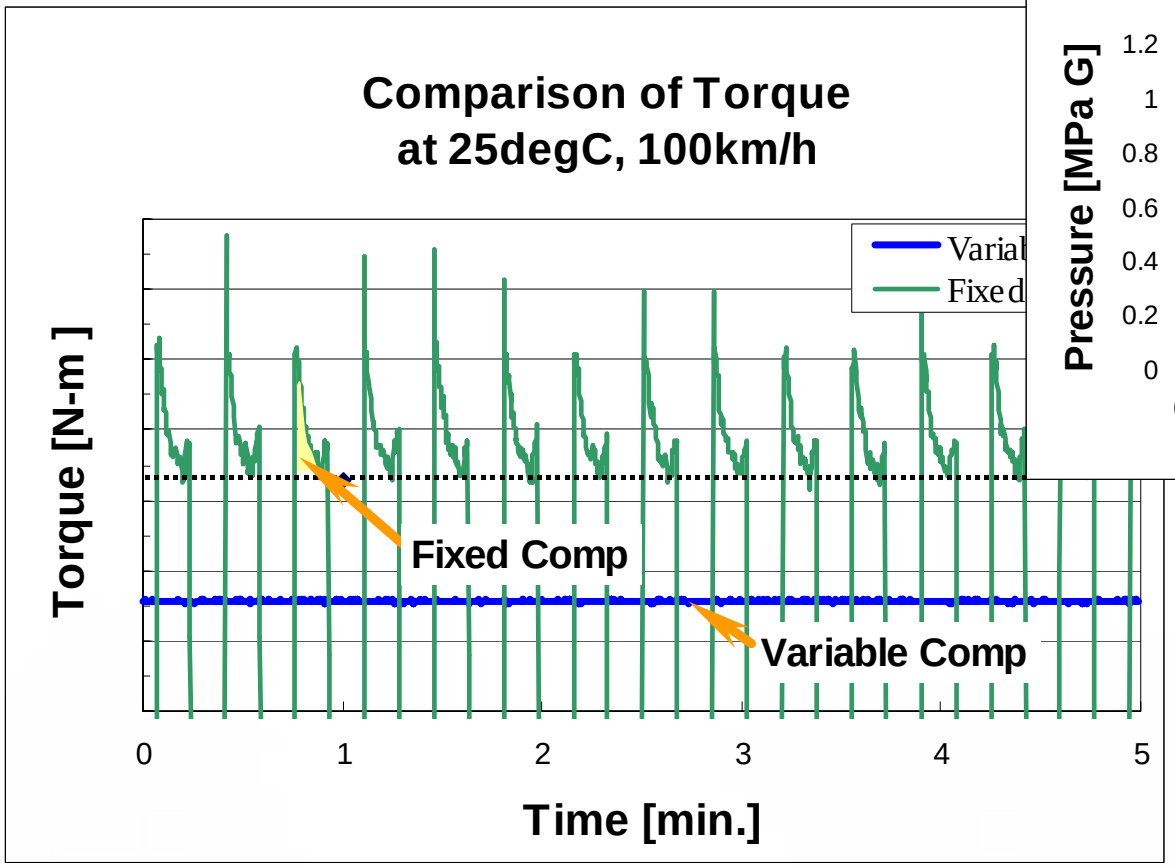
- **10-15 mode Fuel consumption - 25 degC-**

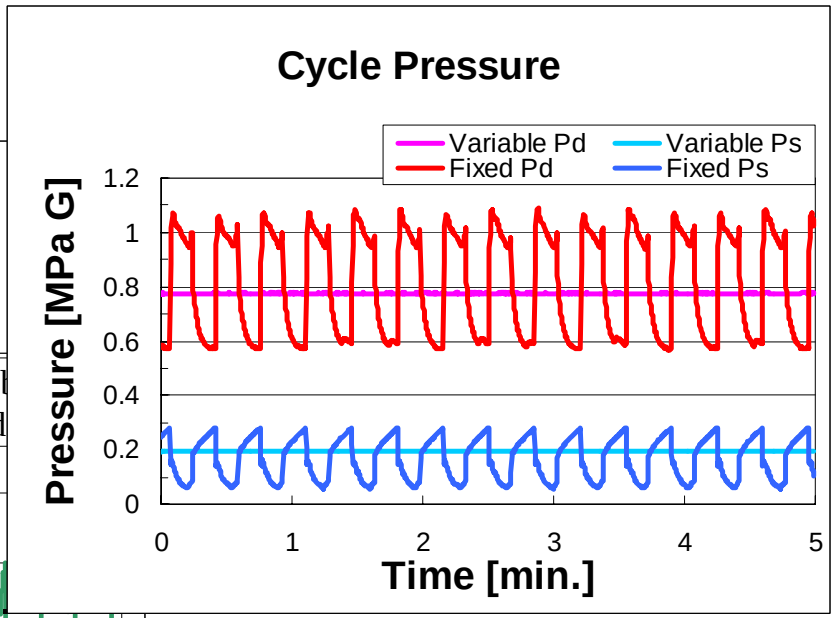


Vehicle Fuel Consumption for MAC

- Fixed displacement versus Variable displacement -

- **Operating Torque at High Speed**

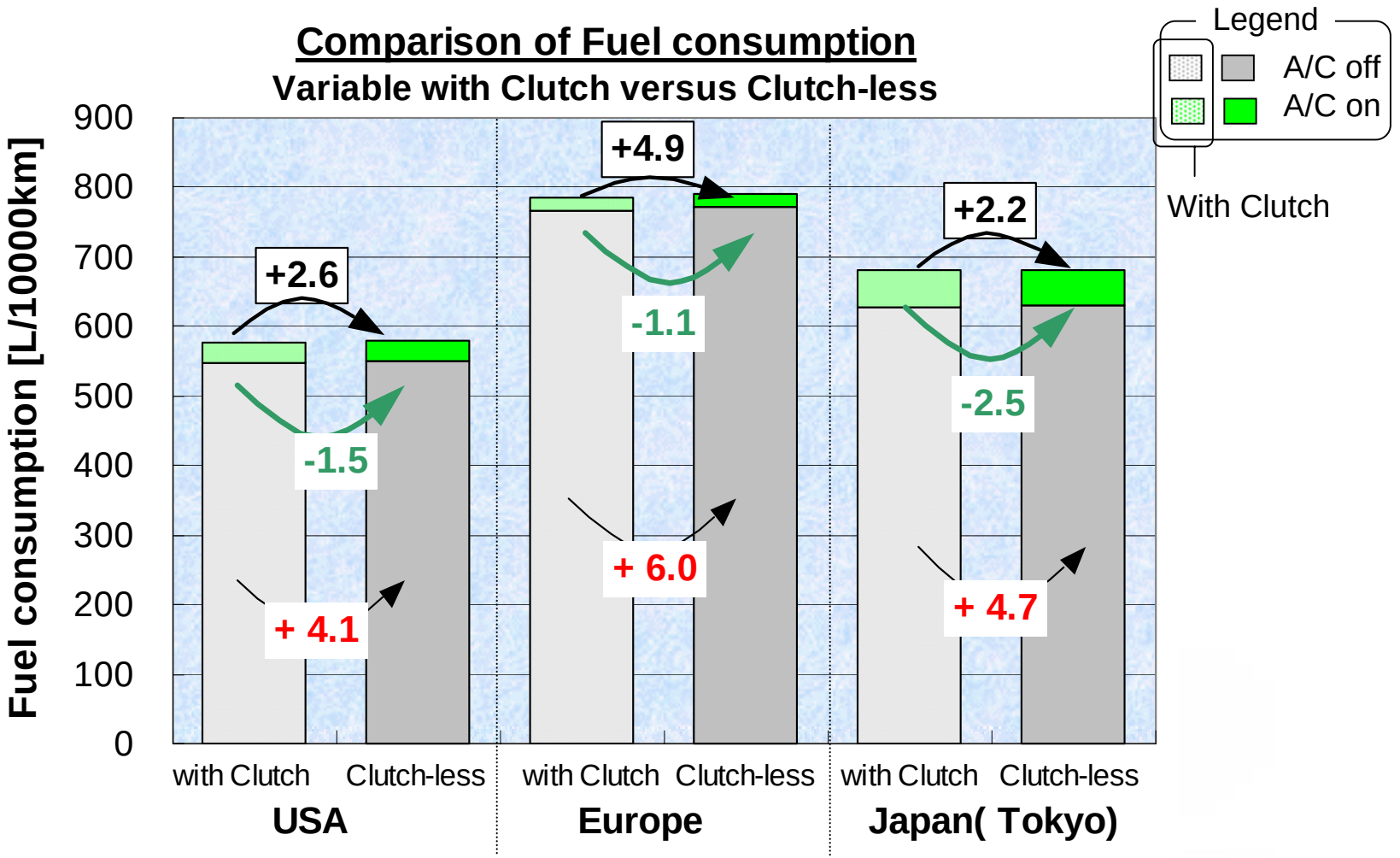




Clutch vs. Clutch-less

Vehicle Fuel Consumption for MAC
- Variable displacement with Clutch versus Clutch-less -

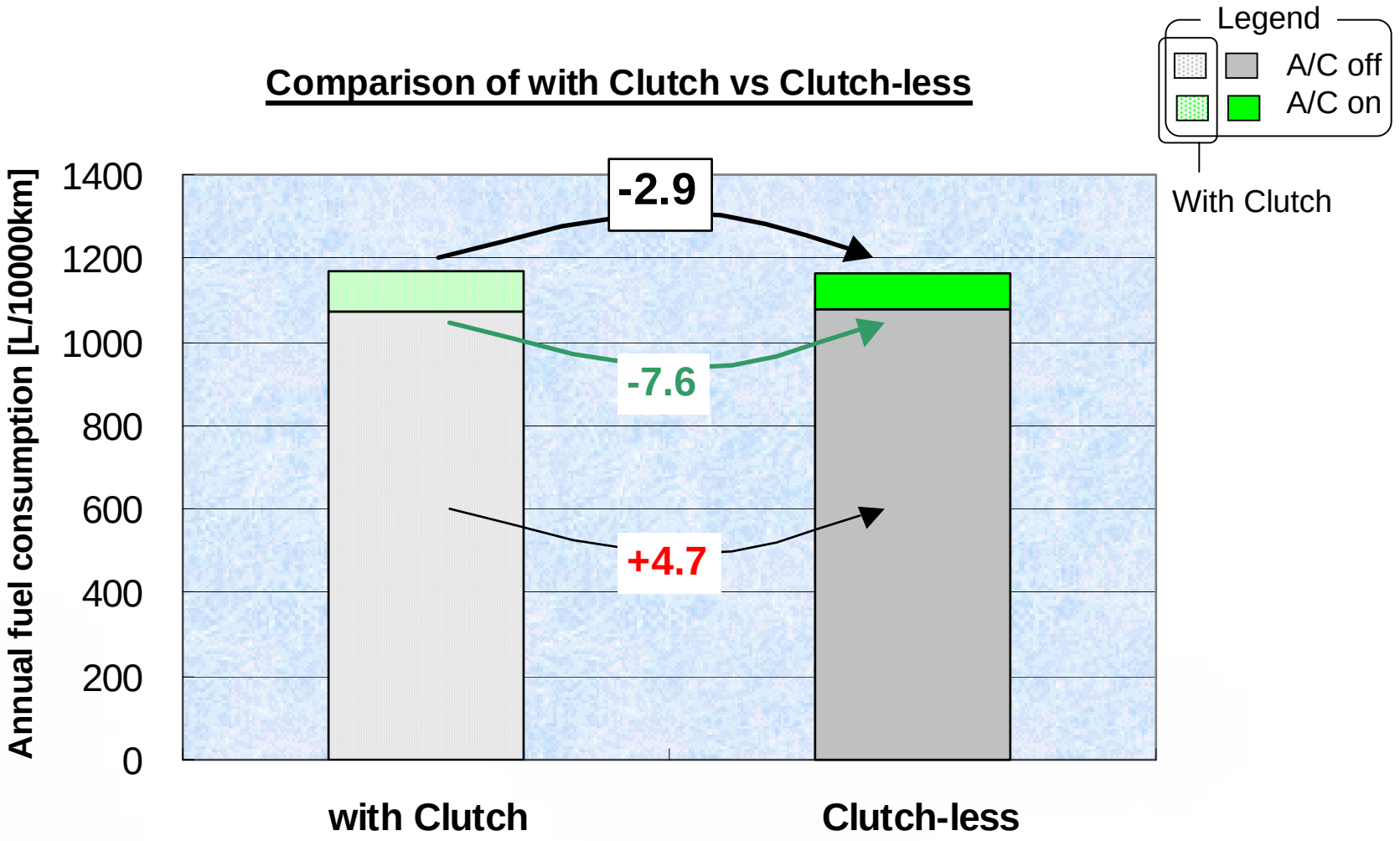
- **Vehicle fuel consumption result - ZVCC TEWI condition -**



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**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