

JEC Well-To-Wheels Study

TTW Version 4: Draft Results

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TTW: General

General Methodology

- ❑ Define and characterize baseline vehicle & vehicle technologies
- ❑ Establish performance criteria based on customer expectations
 - Range, acceleration times, grade ability, top speed, ...
- ❑ Comparison based on same reference vehicle
 - Alternative vehicles share same glider as reference vehicle (body & chassis)
 - Weight impact of tanks, extra batteries, ... needs to be included
- ❑ Future technologies
 - The potentials of future advanced technologies need to be carefully assessed

TTW: General

General Methodology : **what is new**

- ❑ Generic C-segment vehicles
 - Conventional “ICE-only” vehicles
 - **Portfolio of electrified vehicles (xEV)**
 - Hybrids, **Plug-in Hybrids, Range extended, Battery** and Fuel Cell
- ❑ **Compliance with Euro V and Euro VI regulations**
- ❑ New European Driving Cycle (NEDC) as basis
- ❑ Fuel consumption & **electric energy consumption**
- ❑ GHG emissions: CO₂, CH₄ & N₂O
- ❑ **Comprehensive vehicle simulations with AVL Cruise**
 - Data, calibrations, controls, etc agreed amongst the EUCAR and AVL expert team
- ❑ **2010 & 2020+**



Vehicle Characteristics

The **C-segment reference vehicle** model year 2010 is equipped with a **1.4L DISI ICE**, a **6 speed Manual Transmission (MT)** and **Front Wheel Drive (FWD)**.

Generic C-segment reference vehicle with 1.4L DISI ICE (2010)			Improved Reference Vehicle for 2020+
Curb weight	kg	1235	*
ITW class	kg	1360	1250
Length	mm	4326.5	
Width (without exterior mirror)	mm	1789.4	
Height	mm	1484.8	
Cross-sectional area	m ²	2.2	
Air drag coefficient	---	0.30	0.24
Rolling resistance coefficient	---	0.007	0.005
Wheel base	mm	2638.9	
Height of gravity center	mm	600	
Distance of gravity center from front axle	mm	1200	
Dynamic Rolling Radius	mm	309	
* Vehicle mass is reduced by 110 kg; Additional Information is shown in chapter "3.3.1.1 Vehicle mass"			

Vehicle Performance Criteria

- Like in TTW V3: **equal vehicle minimum performance** criteria for all powertrains
- **Top-speed** criterion for **BEV / REEV** reduced to reflect the market reality in 2010
- The **driving range** criterion for **BEV** is reduced for **2010** (120km vs. 500km)
- **BEV** driving range increased by **2020+** due to restricted battery capacities.
- However, **acceleration** and **gradeability** criteria are identical.

		2010					2020+				
		PISI DISI DICI Hybrid SI Hybrid CI	PHEV SI PHEV CI	REEV SI	BEV	FCEV	PISI DISI DICI Hybrid SI Hybrid CI	PHEV SI PHEV CI	REEV SI REEV CI REEV FC	BEV	FCEV
Time lag for 0-100 km/h	[s]	11	11	11	11	11	11	11	11	11	11
Time lag for 80-120 km/h	[s]	11	11	11	11	11	11	11	11	11	11
Gradeability at 1 km/h	[%]	30	30	30	30	30	30	30	30	30	30
Gradeability at 10km/h	[%]	20	20	20	20	20	20	20	20	20	20
Minimum Top speed	[km/h]	180	180	130	130	180	180	180	130	130	180
Minimum Top speed pure electric	[km/h]	#	100	130	130	180	#	100	130	130	180
Total driving range	[km]	500	500	500	120	500	500	500	500	200	500
Battery powered driving range	[km]	#	20	80	120	#	#	20	80	200	#
Fuel consuming range	[km]	500	480	420	#	500	500	480	420	#	500

Vehicle and fuel combinations

	PISI	DISI	DICI	Hybrid DISI	Hybrid DICI	PHEV20 DISI	REEV80 SI	PHEV20 DICI	REEV80 CI*	BEV	FCEV	REEV80 FC**
Gasoline	■	■		■		■	■					
Gasoline E10 market blend	■	■		■		■	■					
Gasoline E20 high RON	■	■		■		■	■					
Diesel			■		■			■	■			
Diesel B7 market blend			■		■			■	■			
LPG	■	■										
CNG	■	■										
E85	■	■		■		■	■					
FAME			■		■			■	■			
DME			■		■			■	■			
FT-Diesel			■		■			■	■			
HVO			■		■			■	■			
Electricity						■	■	■	■	■		■
Hydrogen (CGH ₂)											■	■
Hydrogen (cCGH ₂)										■		

■ 2010 & 2020+

■ 2020+ only

PISI / DISI: Port Injection / Direct Injection Spark Ignited engine

DICI: Direct Injection Compression Ignited engine

PHEV20: Plug-In Hybrid Vehicle with an electric range of 20km (NEDC)

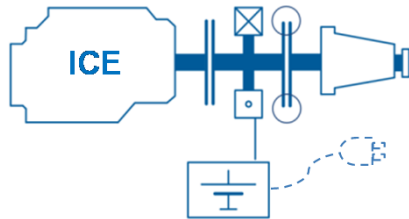
REEV80: Range Extended Electric Vehicle with an electric driving range of 80km (NEDC)

BEV: Battery Electric Vehicle

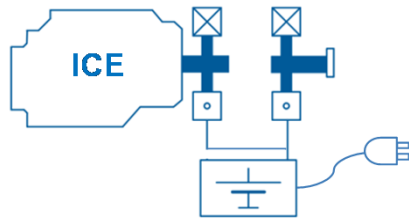
FCEV: Fuel Cell Electric Vehicle

REEV80 FC: Range Extended FC. Vehicle with an electric driving range of 80km (NEDC) and Fuel Cell Range Extender

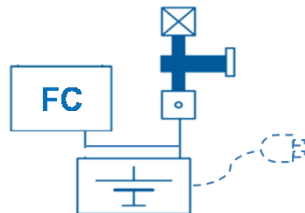
xEV Topologies



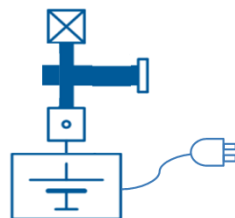
Hybrid Electric Vehicle (HEV) & Plug-in Hybrid Electric Vehicle (PHEV)



Range Extended Electric Vehicle (REEV)



Fuel Cell Electric Vehicle (FCEV)



Battery Electric Vehicle (BEV)

xEV Functionalities

Start / Stop

In order to avoid the operation at ICE idle, the ICE is switched-off in case of vehicle standstill.

Regenerative Braking

Regenerative Braking is applied in situations where the driver requires negative traction power.

ICE / Fuel Cell Off Mode

ICE / Fuel Cell Off Mode (in public also known as “electric driving”) is applied to avoid low-efficiency operating points of the ICE (in HEV, PHEV and REEV variants) or the Fuel Cell (in FCEV and REEV FC variants), if enough Battery energy is available to drive the vehicle. This mode is typically selected in case of low driving power request.

ICE / Fuel Cell On Mode

ICE / Fuel Cell Alone Mode is mainly applied in case the ICE / Fuel Cell works at high efficiency. This strategy implies no usage of the energy reserve of the battery.

Battery Assistance

Battery Assistance (also called e-Boost) is applied to support the full load driving performance of the vehicle, if enough Battery energy is available.

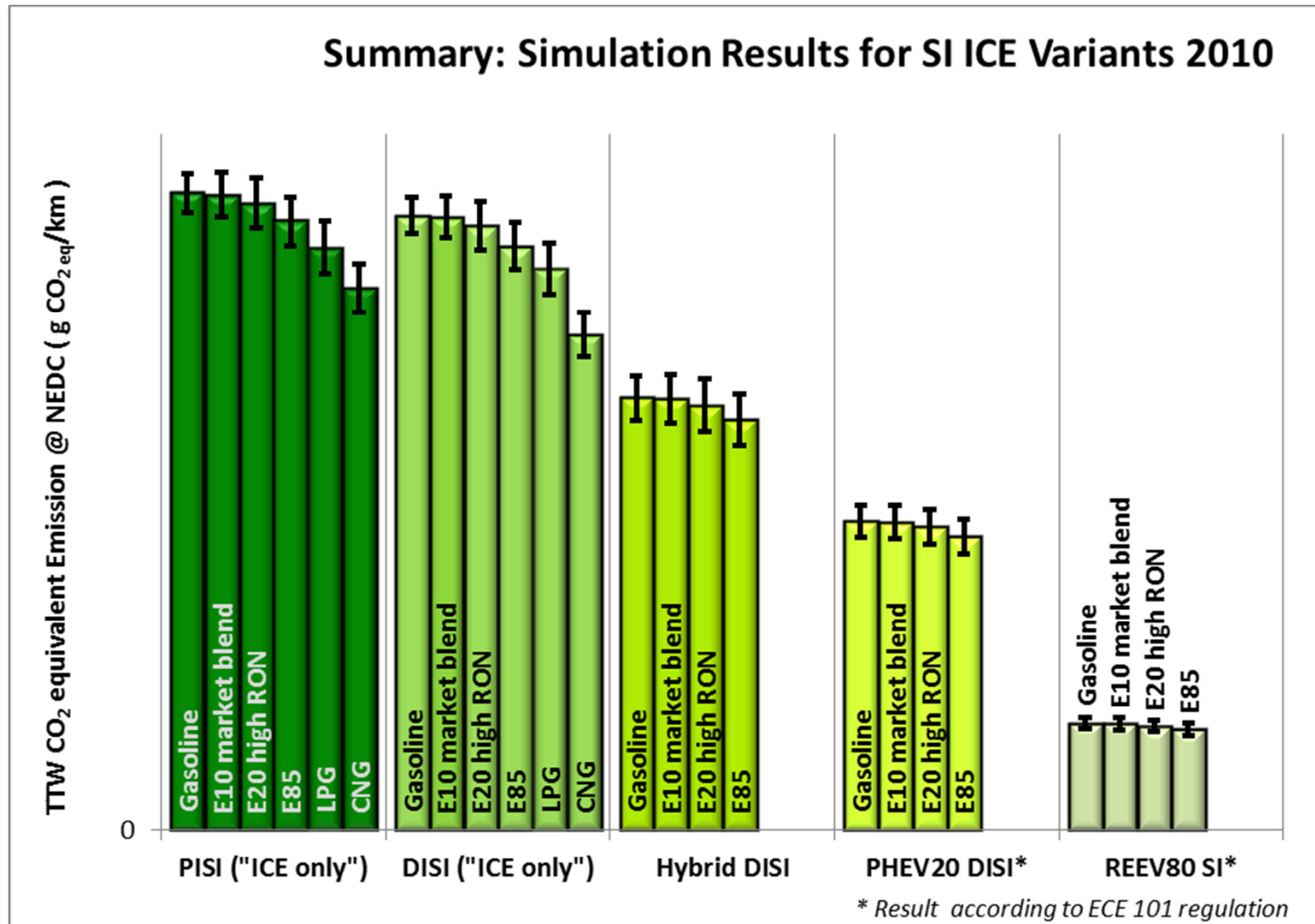
xEV: Charging losses

Charging losses (Charger & battery charging) [%]

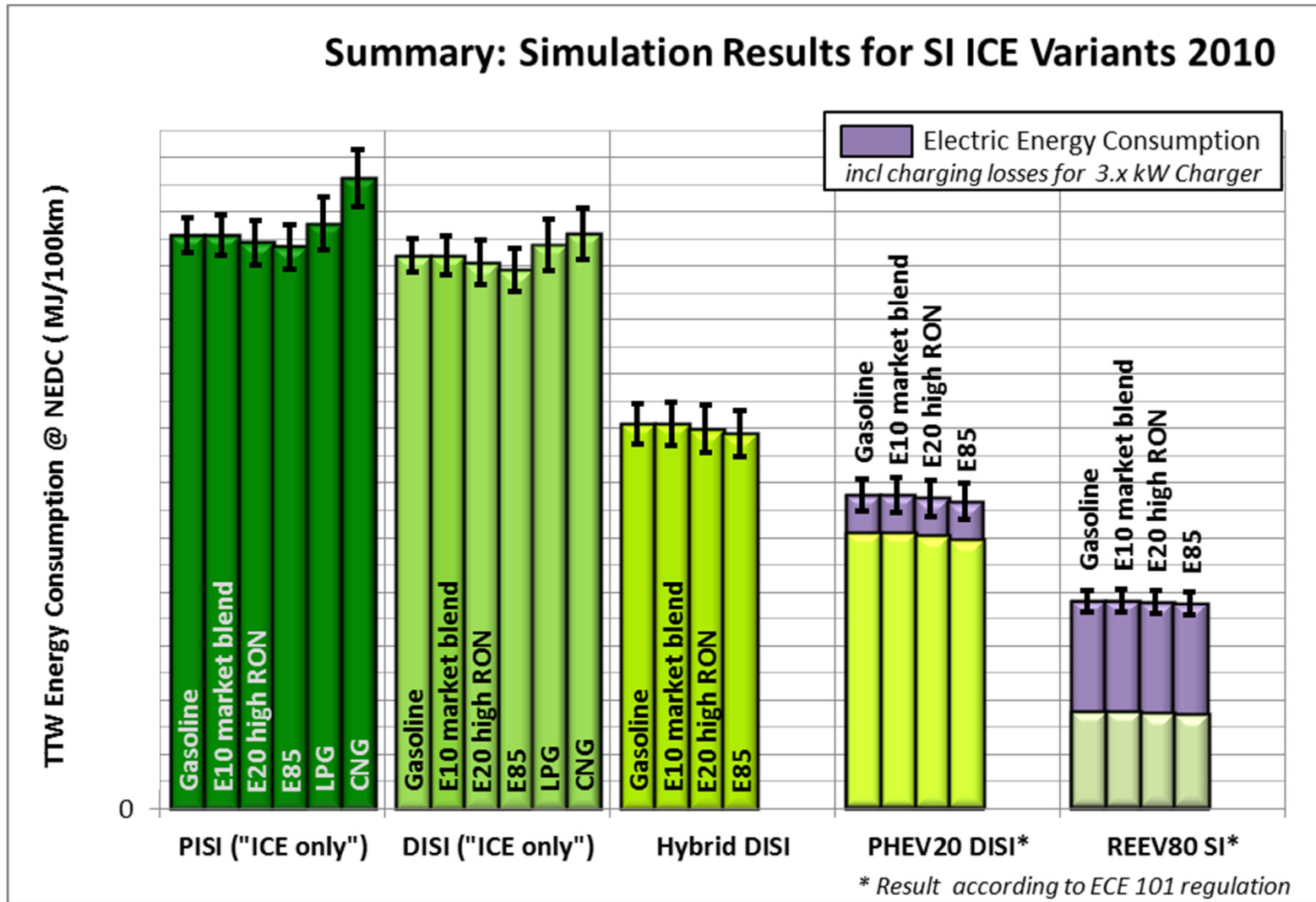
	Charge Type	PHEV	REEV & FC REEV	BEV
2010	3.x kW (1x 16A)	20%	20%	20%
	10.x kW (3 x 16 A)	18%	18%	18%
2020	3.x kW (1 x 16A)	15%	15%	15%
	10.x kW (3 x 16A)	14%	14%	14%
	43.x kW	<i>Not Featured</i>	15%	15%

The 3.x Charging type is used as reference for the result tables of the energy consumption calculations.

DISI: 2010 GHG Emissions



DISI: 2010 Energy Consumption



Summary

- ❑ A portfolio of vehicles and assigned fuels have been simulated for a generic European C-segment vehicle
- ❑ Fuel consumption, Electric energy consumption & GHG emissions have been calculated for the NEDC
- ❑ 2 time horizons: 2010 and 2020+
- ❑ The results for the various vehicle technologies and fuels span a wide range in the Energy Consumption – GHG emissions manifold

- ❑ Next Steps
 - Final evaluation of results
 - Publishing at May/June 2013