Implication of Achieving FreedomCAR Goals for Fuel Economy and Well-to-Wheels Green House Gas Emissions

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GREET: Industry Standard Tool

Greenhouse gases, **R**egulated **E**missions and **E**nergy use in **T**ransportation

- Argonne developed tool
- Complete fuel cycle analysis
- Greenhouse gases
  - CO_2, CH_4 and N_2O
- Criteria pollutants
  - VOC, CO, NO_x, PM10 and SO_x
- Separates energy use into

All Energy Sources

Fossil Fuels

Petroleum

2
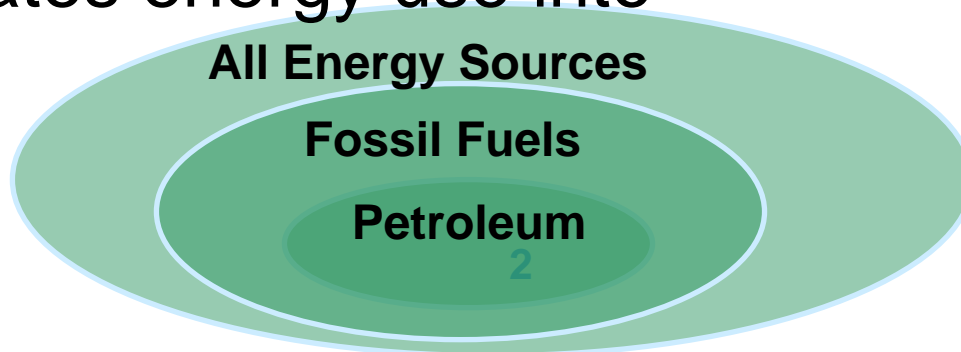
PSAT: Primary Vehicle Model For FreedomCAR Partnership

- Light to heavy duty

- Numerous predefined configurations

- Multiple-option component model libraries
- Easy implementation

- Easy to use Graphical User Interface

- Can use the control strategies for HIL/SIL

- Designed for co-simulation environment
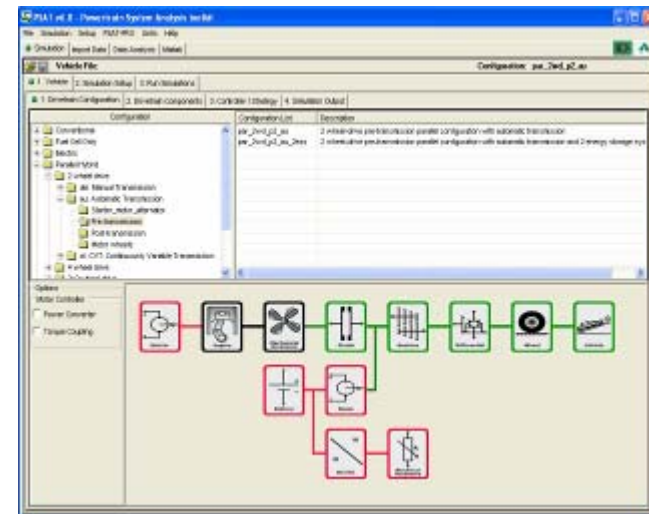
Synergy!

GREET

PSAT

Upstream:
Fuel Production,
Distribution

- Numerous Configurations
- More Detailed Components
- More Complex Control Strategies

Well to Pump

Pump to Wheels

4

Understand Assumptions ➡ Understand Results

- SUV platform

- 11 vehicles

- Vehicle performance (IVM-60 mph =10 s)

- Current (2004) and near-term (2010)

- 2010 Uncertainty – Slow and Fast Cases

- Fast Technology - FreedomCAR 2010 targets

- UDDS and HWFET

- H_2 => North American Natural Gas refueling-station

- Green House Gas Emissions Only

- No fuel economy penalty for meeting Bin 5

Component Key Characteristics

	Current 2004	Slow Technology 2010	Fast Technology 2010
Body Mass (kg)	1258	1258	1063
Specific Power (kW/kg)			
Gasoline Engine	0.8–1.6	0.8–1.6	1.0–1.8
Diesel Engine	0.60–0.72	0.60–0.72	0.80–0.90
Hydrogen Engine	0.63	0.70	0.80
Fuel Cell System with storage	0.230	0.280	**0.322**
Motor	1	1	1.3
Battery at 0.7 SOC	0.74/0.38	0.74/0.38	1.11
Peak Efficiency (%)			
Gasoline Engine	33.5	35	38
Diesel Engine	40.5	40.5	**45**
Hydrogen Engine	34	38	42
Fuel Cell System	50	55	**60**
Gearbox	95	96	97
Final Drive	97.5	97.5	97.5

FreedomCAR 2010 Goals

Estimating Fuel Economy – Combined Cycle

SAE 2005 WORLD CONGRESS
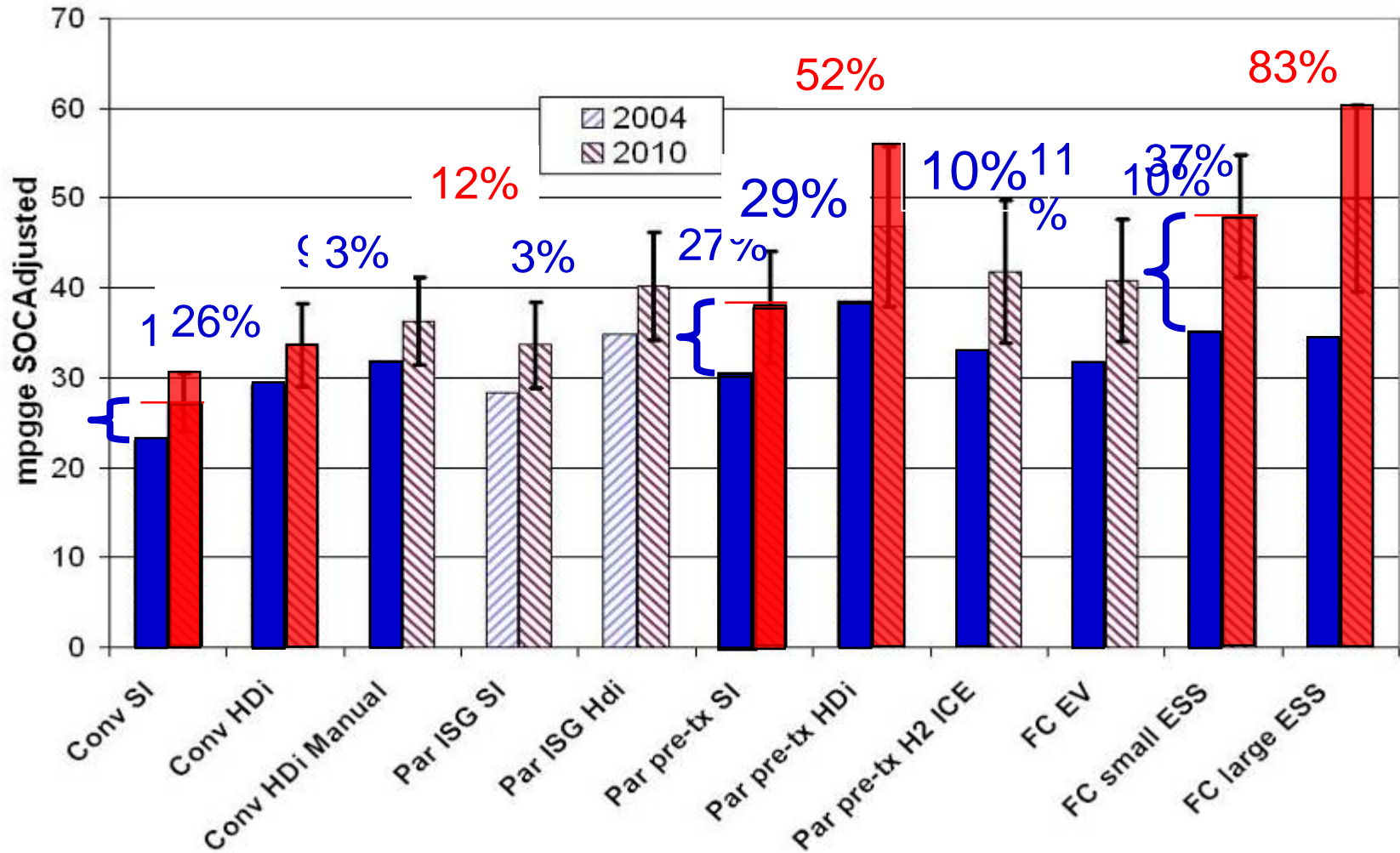
Greenhouse Gases – Combined Cycle

WTW GHG Emission (g/mile)
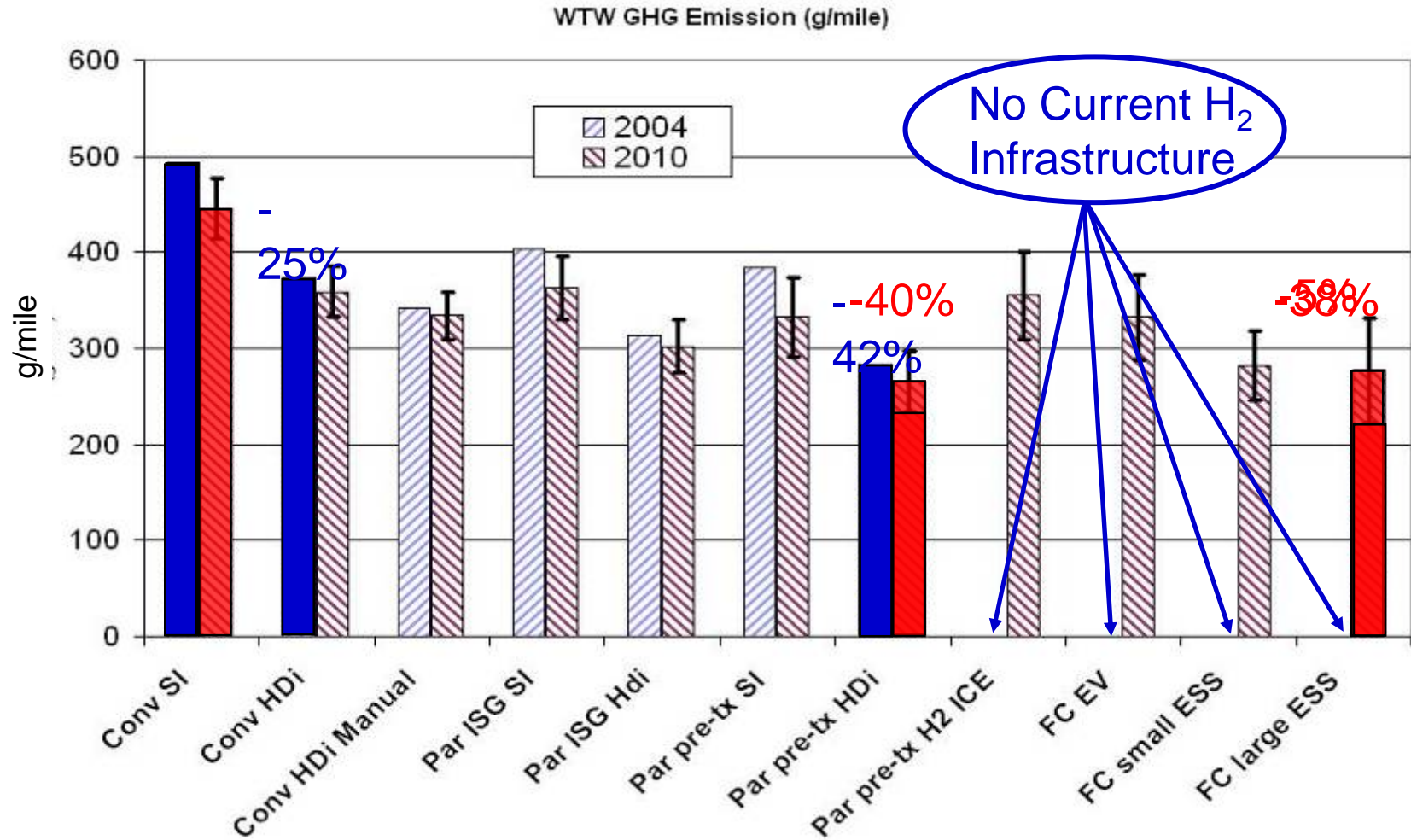
Summary

With 2004 Technology

- Conventional CI FE within 3% SI full hybrid FE
- Fuel cell hybrid FE within 11% CI full hybrid FE
- CI full hybrid lowest GHG

With 2010 FreedomCAR Goals and North American NG

- SI full hybrid FE 12% > Conventional CI FE
- Fuel cell hybrid FE 8% > CI full hybrid FE
- H_2 ICE hybrid FE 10% > SI full hybrid FE
- CI full hybrid GHG 5% > Fuel cell hybrid GHG
- H_2 ICE hybrid GHG comparable to SI mild hybrid GHG

Future Guiding Considerations

- Fuel cell configuration improvements
  - Wheel motors
  - Through-the-road - front/rear motors
  - Two speed transmission
- H_2 Renewable pathway
- H_2 Freedom from criteria pollutants (PM and NO_x)
- H_2 Freedom from petroleum

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Models information available at
http://www.transportation.anl.gov

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