

Well-to-Wheels Analysis of Advanced Fuel/Vehicle Systems -- Energy and Greenhouse Gases

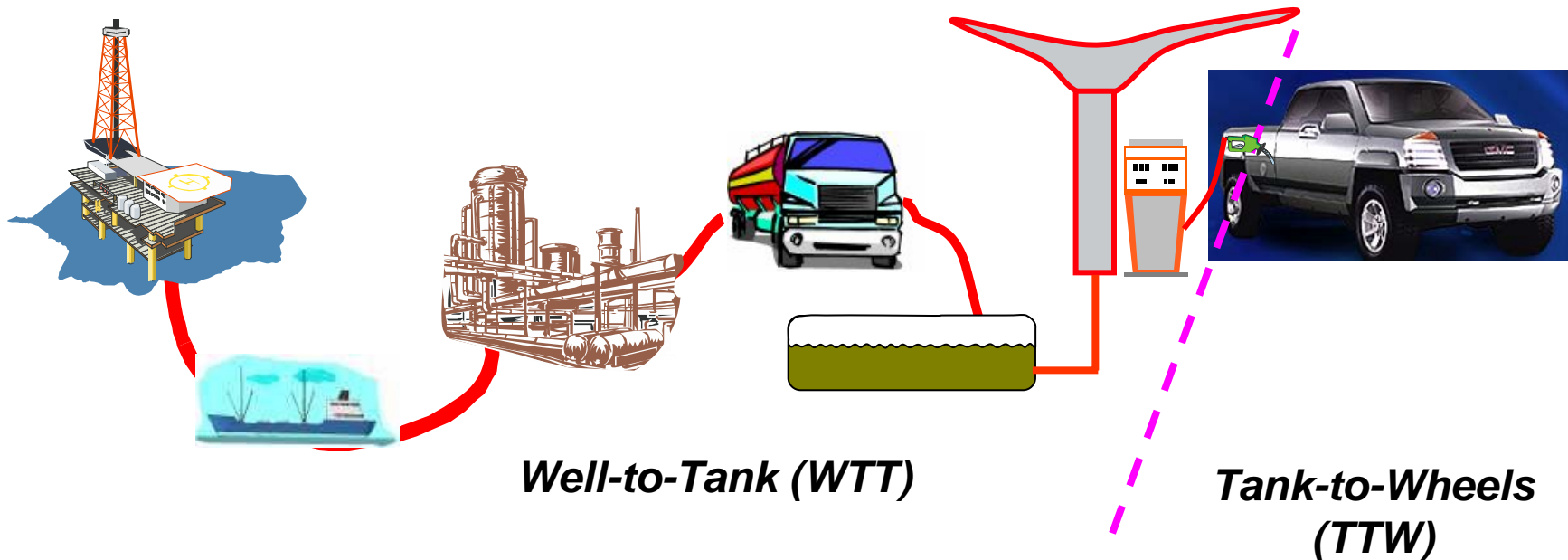
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What is a Well-to-Wheels Analysis?

- Systems approach
- Assessment of energy consumption and emissions



GM/Argonne National Labs Study

- 2010 model year, full sized pickup truck
- Equal performance maintained for all propulsion options
- Reference:

“Well to Wheels Analysis of Advanced Fuel/Vehicle Systems – A North American Study of Energy Use, Greenhouse Gas Emissions, and Criteria Emissions”, May, 2005,
<http://www.transportation.anl.gov/pdfs/TA/339.pdf>

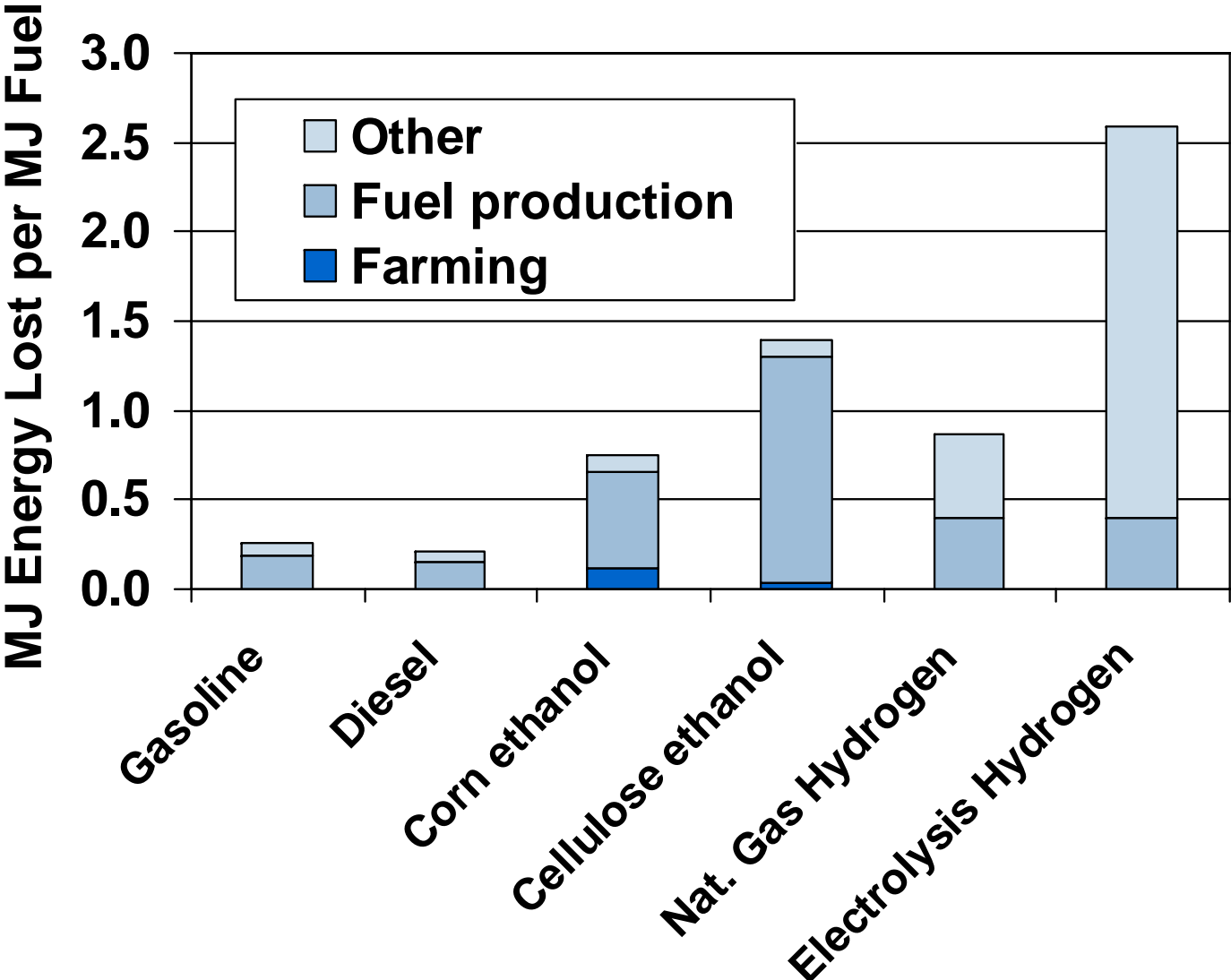
Vehicle Propulsion Systems Analyzed

	IC Engine	IC Engine Hybrid	Fuel Cell	Fuel Cell Hybrid
Gasoline	X	X	X*	X*
Diesel	X	X*		
F-T Diesel	X*	X*		
CNG	X*	X*		
Methanol			X*	X*
Ethanol	E85	E86 *	E100*	E100*
Hydrogen	X*	X*	X	X*

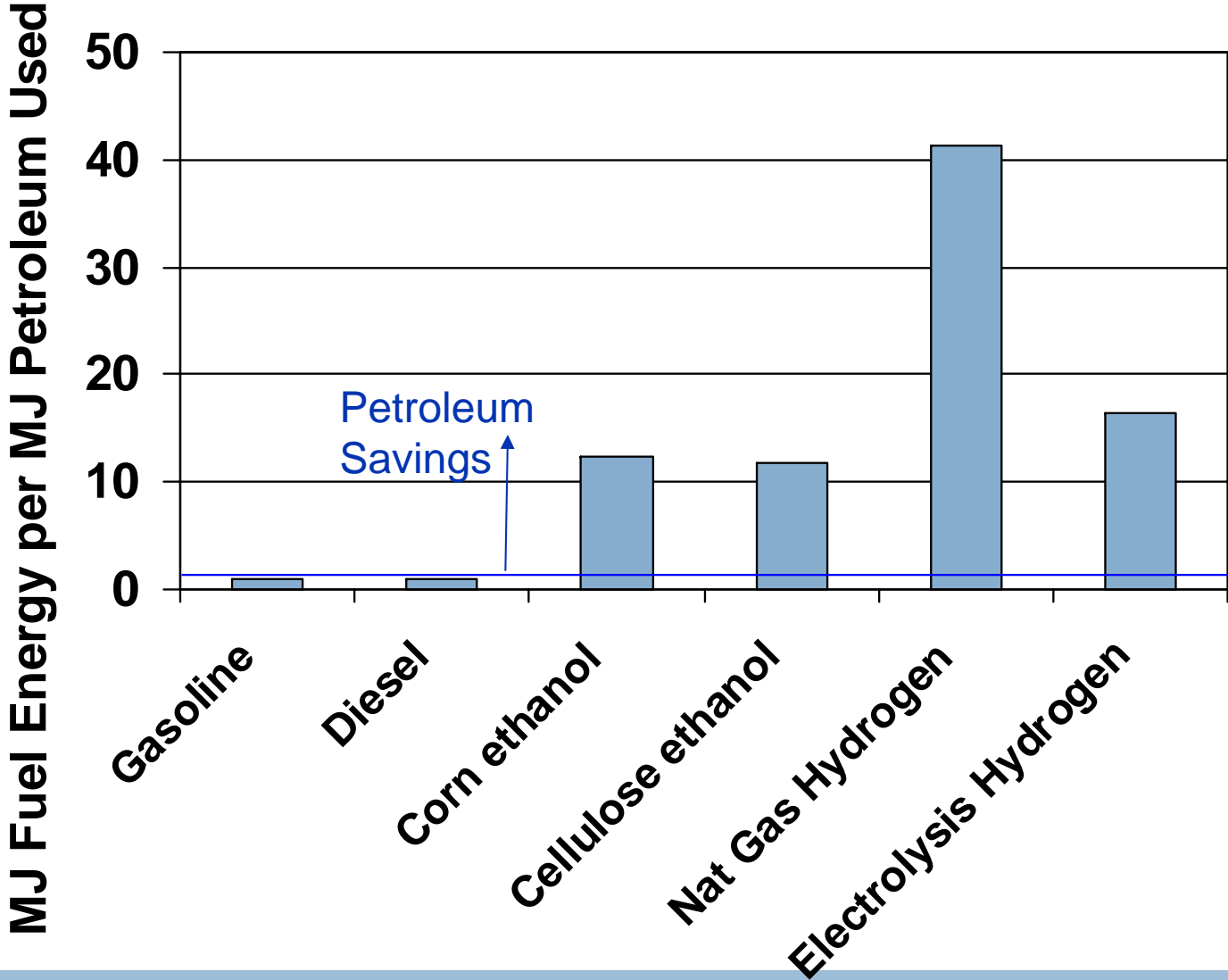
*Included in study but not in today's presentation



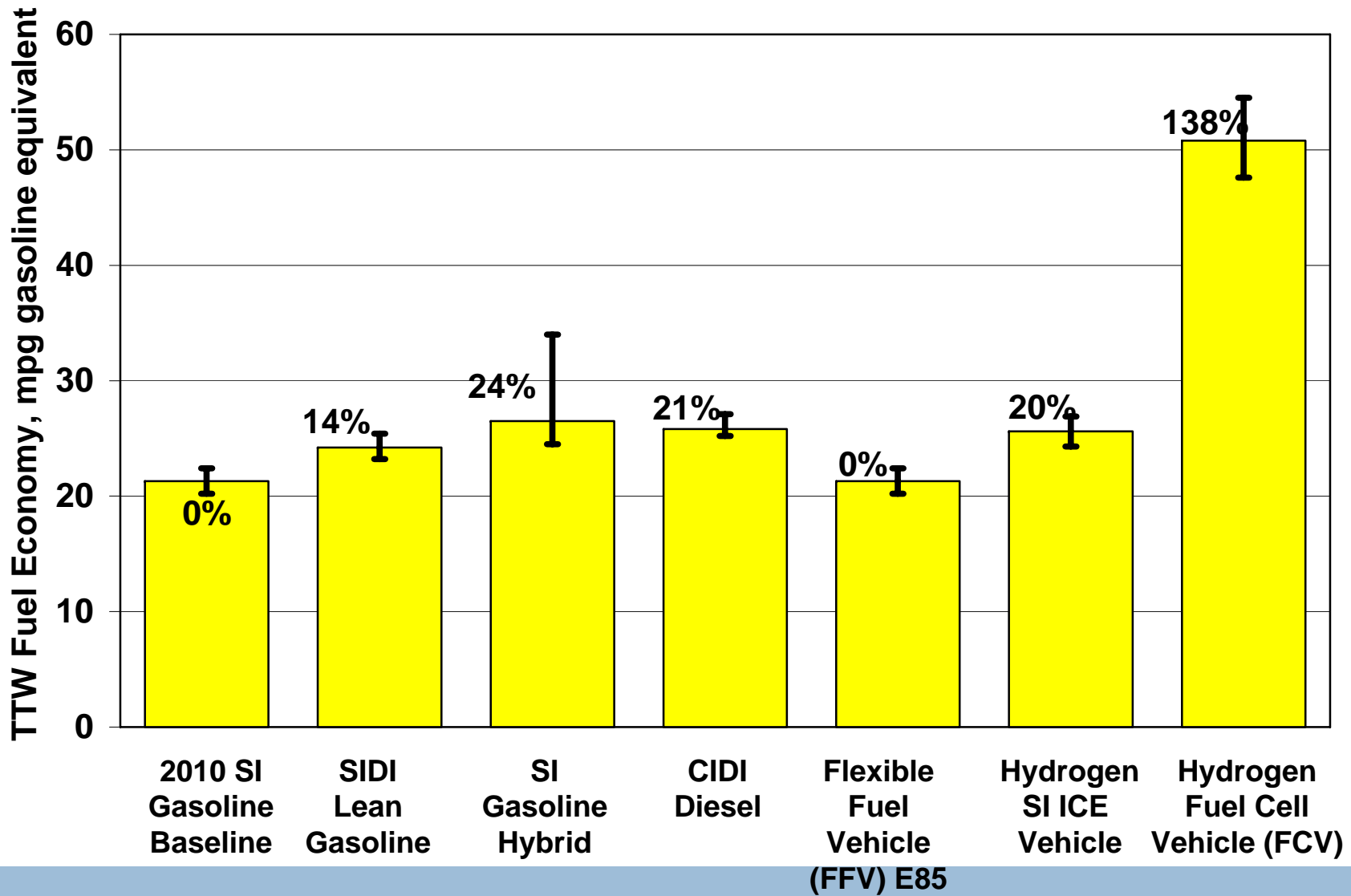
Well-to-Tank Energy Consumption



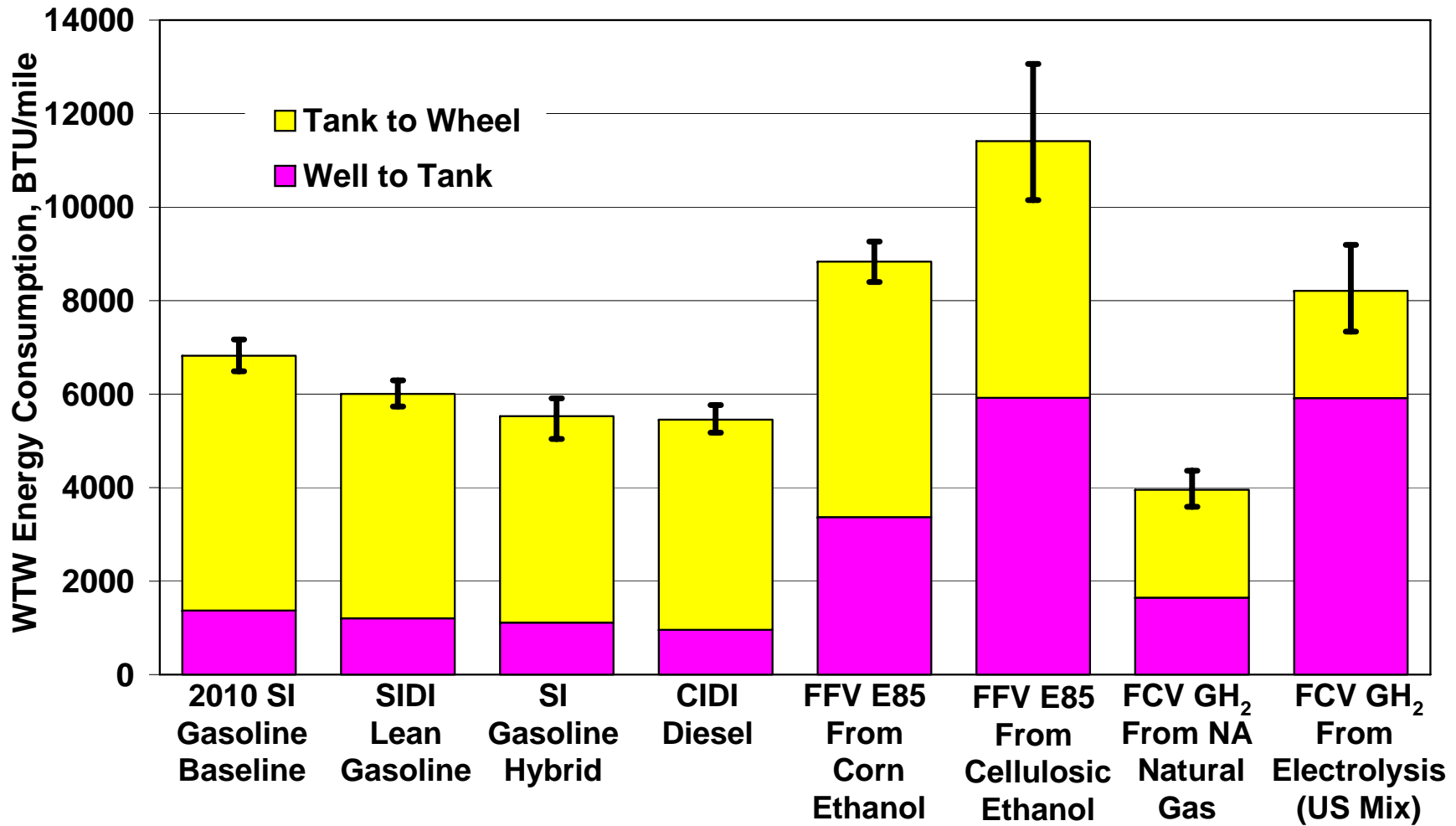
Well-to-Tank Fuel/Petroleum Energy Ratio



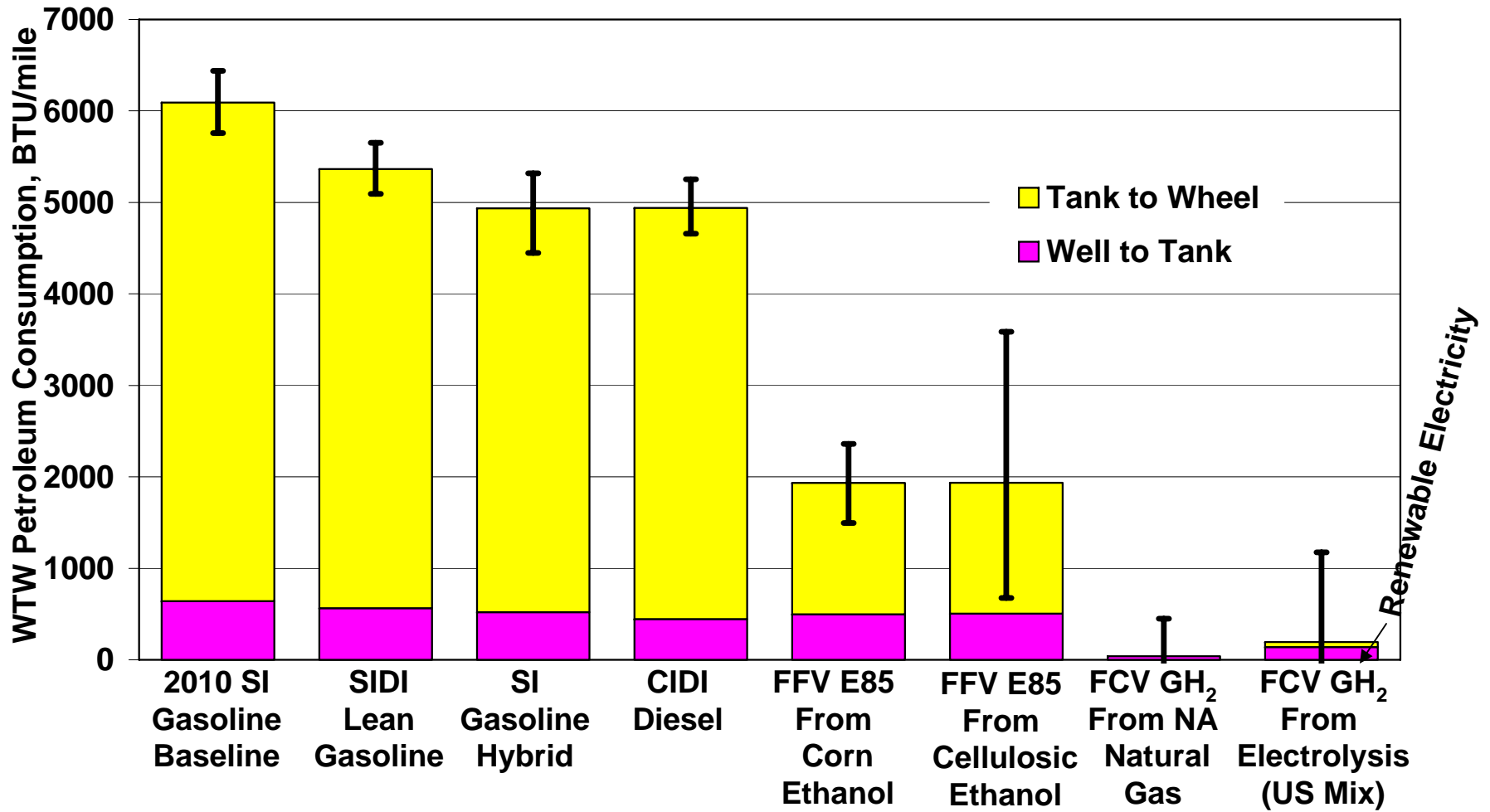
Tank to Wheels Gasoline-Equivalent Fuel Economy



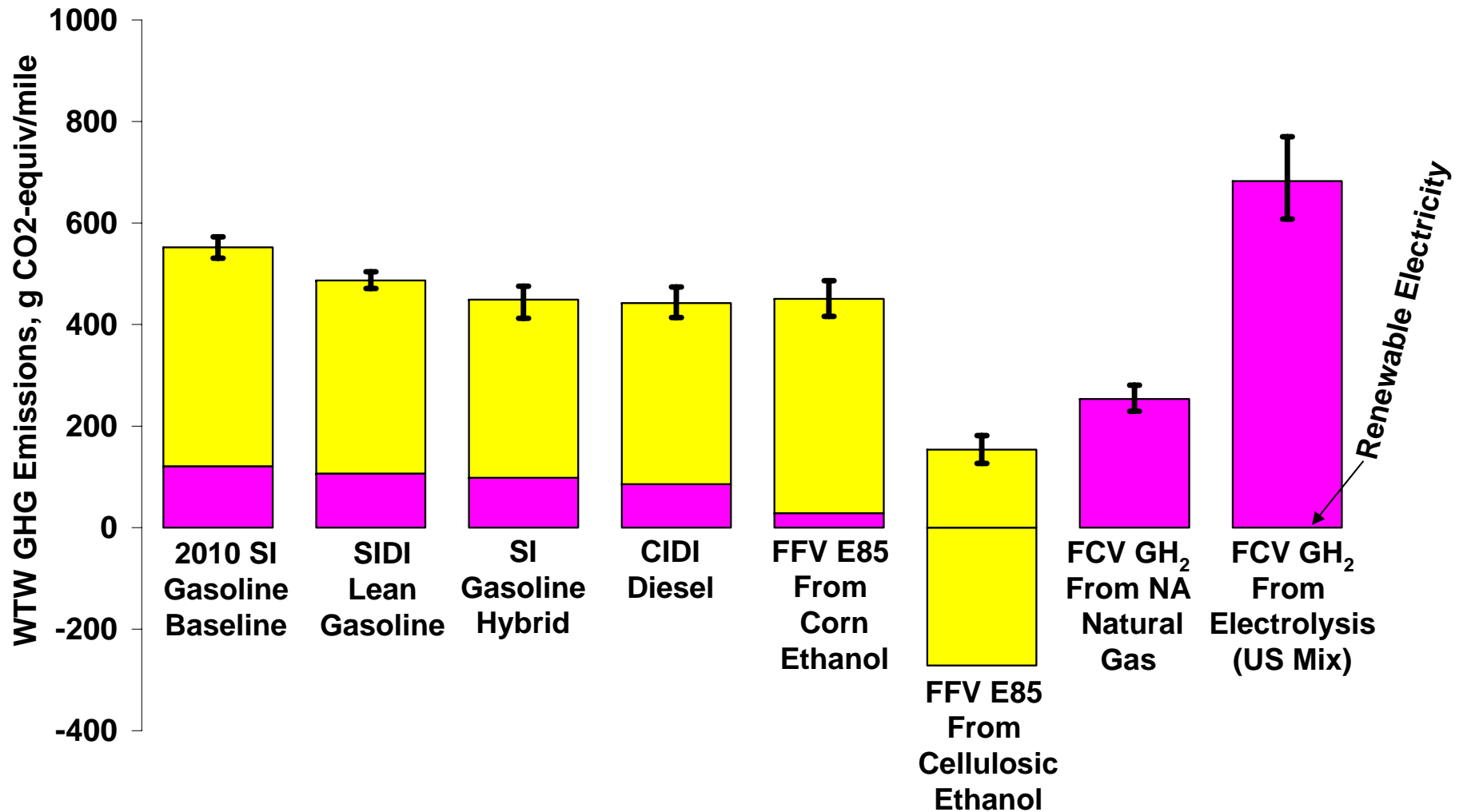
Well to Wheels Energy Consumption



Well to Wheels Petroleum Consumption



Well to Wheels Greenhouse Gas Emissions



Conclusions for Greenhouse Gas Emissions

- **Well-to-Wheels greenhouse gases can be significantly reduced with the following (ordered by increasing impact):**
 - **Advanced gasoline and diesel engines and hybrids**
 - **Fuel cells with hydrogen from natural gas**
 - **Cellulosic ethanol in internal combustion engines**
 - **Fuel cells with renewable electricity used to produce and compress hydrogen**

