

Full Scale Deployment: Making the Business Case

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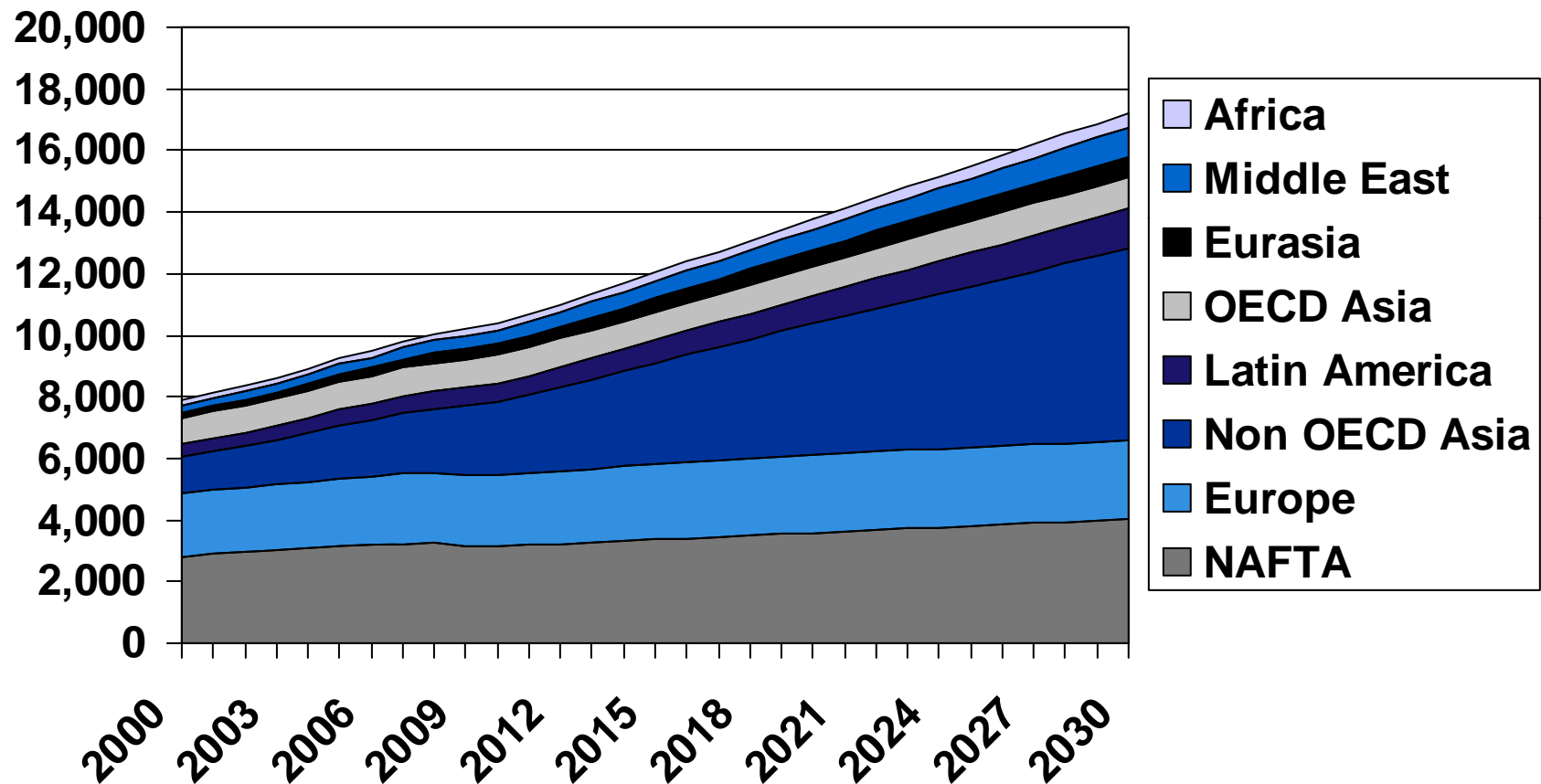
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A Net 50% Reduction in CO₂ is Required...



While Vehicle Miles Traveled More Than Doubles!

Billions of Miles Traveled Per Year



Source: IHS Global Scenarios Project



A Combination of Advanced Engines and Energy Recovery Will Yield ~ 50% Reduction

Relative Fuel Consumption of Engine/Hybrid Combinations

(US/EU/JPN)

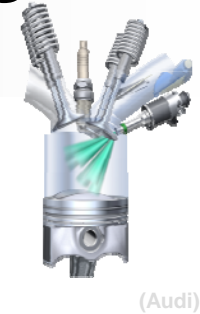
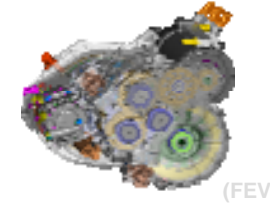
Engine	Acro- nym	14-Volt Conv.	Lead MNG	Micro- Hybrid	Mild Hybrid	Full Hybrid
Spark Ignited	Conv. SIE	1.00	.95	.93/.87/.90	.80/.70/.70	.70/.65/.65
Advanced Spark Ignited	Adv. SIE	0.91	.86	.84/.79/.82	.73/.64/.64	.64/.59/.59
Direct Injection Gasoline	GDI PM	.98	.93	.91/.85/.88	.78/.69/.69	.69/.64/.64
Stoichiometric Direct Injection Gasoline	GDI SC	NA/0.95/0.90	0/.90/.86	0/.83/.81	0/.67/.63	0/.62/.59
Stratified High Speed Direct Injected Diesel	HSDI	0.82	0.78	.76/.71/.74	.66/.57/.57	.57/.53/.53

Source: IHS Automotive and TIAX Future Powertrain Technology, Final Report based on modeling over the FTP using GT Drive for a typical C-segment car

Four Complementary Technology Pathways Include Several Forms Of Electrification

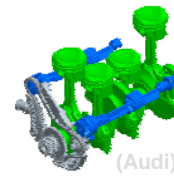
1. Advances in engine & transmission technologies

- Improved air flow and in-cylinder air motion
- New combustion systems
- Wide ratio-range transmissions
- Reduced parasitic losses



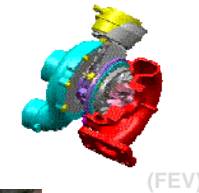
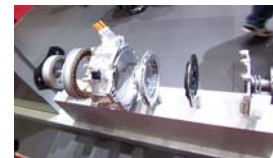
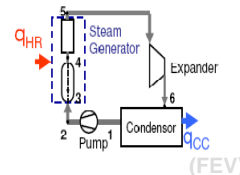
2. Alternative fuels

- Biofuels
- CNG
- Electricity



3. Energy recovery

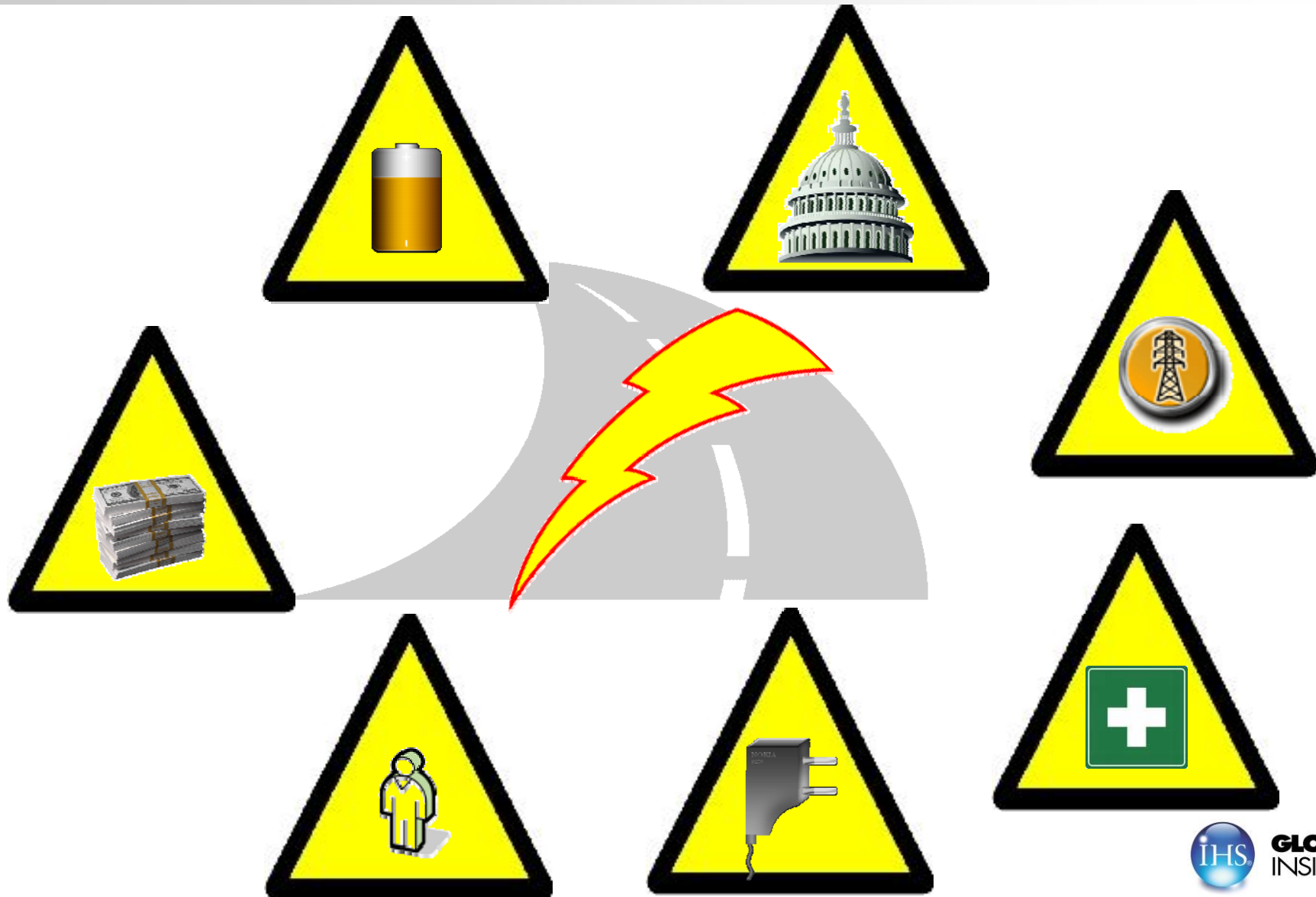
- Electrical hybrids
- Hydraulic hybrids
- Waste heat



4. Reduced energy intensity



Seven major factors must be addressed for grid-based electric vehicles to be successful



Thank you!

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