



Go Further



Financing the Infrastructure to Support Alternative Fuel Vehicles

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INFRASTRUCTURE INVESTMENT FOR ALTERNATIVE FUEL VEHICLES

Good Fiscal Policy In Any Global Setting

- **Most major markets globally are using some form of public support to achieve expansions of infrastructure necessary to support growth**
- **Role for public investment in supporting infrastructure build outs**
- **Job creation and manufacturing retention rates**

Convergence of Public Finance Principles, Policy and Politics

- **Sustainability**
- **Energy security**
- **Energy independence**
- **Competition and productivity**
- **Innovation**

Using Public Investment or Public-Private Partnerships Could Advance Goals of Energy Independence and Sustainability

FUTURE MOBILITY ATTRIBUTES AND WHY INFRASTRUCTURE SUPPORT IS CRITICAL

China

- **Government goal to achieve 5 million “new energy vehicles” (NEVs) by 2020**
- **Reduction in pollution a top priority (20% comes from transport)**
- **Already China imports over 50% of their domestic oil consumption**
- **At the current pace of transportation growth, by 2020, China would be importing 80+% of oil consumption**

Technology Development and Infrastructure

- **Battery switching stations**
- **CNG options for taxis, busses, heavy trucks**
- **NEVs all have common attributes of reducing particulate matter and greenhouse gas (GHG) emissions**

China Has Set a Goal of 5 Million NEVs by 2020

ALTERNATIVE FUELS OVERVIEW

Compressed Natural Gas (CNG)



Ethanol (E85)



Electricity



Hydrogen



Variety of Alternative Fuels, this Analysis Will Focus on Four: CNG, E85, Electricity, and Hydrogen

STATIONS REQUIRED

Simplified Clean Fuels Outlet Equation

$$\text{Number of Stations Required} = \frac{\frac{AVMT * LDV}{MPG/e}}{\text{Average Fuel Volume per Station}}$$

Where:

AVMT = Average vehicle miles traveled

LDV = Number of light-duty vehicles

MPG/e = Miles per gallon equivalent

Rewritten in Terms of “Vehicles/Station”

$$\frac{LDV}{\text{Required Station}} = \frac{MPG/e * \text{Average Fuel Volume per Station}}{AVMT}$$

Based on the Equation Used in California Clean Fuels Outlet Regulation

STATIONS REQUIRED

Number of Light-Duty Vehicles per Station by Fuel Type

Fuel Type		Vehicles/Station
Natural Gas (CNG)		940
Flex-Fuel (E85)		350
Plug-in Electric (BEV & PHEV)		1,950
Hydrogen (Fuel Cell)		520
Gasoline	Projection	540
	Actual (U.S.)	1,500

Number of Vehicles Supported by a Single Station Varies by Fuel Type, Difference Between Actual/Projected Vehicles Supported by Gasoline Stations

INFRASTRUCTURE COST PER VEHICLE

Infrastructure Cost per Vehicle by Fuel Type

Estimate from
Research

Fuel Type	Estimate
Natural Gas (CNG)	\$1,560
Flex-Fuel (E85)	\$240
Plug-in Electric (BEV & PHEV)	\$2,160
Hydrogen (Fuel Cell)	\$4,840

Estimate from
National
Petroleum
Council

Fuel Type	Low	High
Natural Gas (CNG)	\$1,250	\$2,500
Flex-Fuel (E85)	\$250	\$500
Plug-in Electric (BEV & PHEV)	\$875	\$1,625
Hydrogen (Fuel Cell)	\$3,438	\$5,375

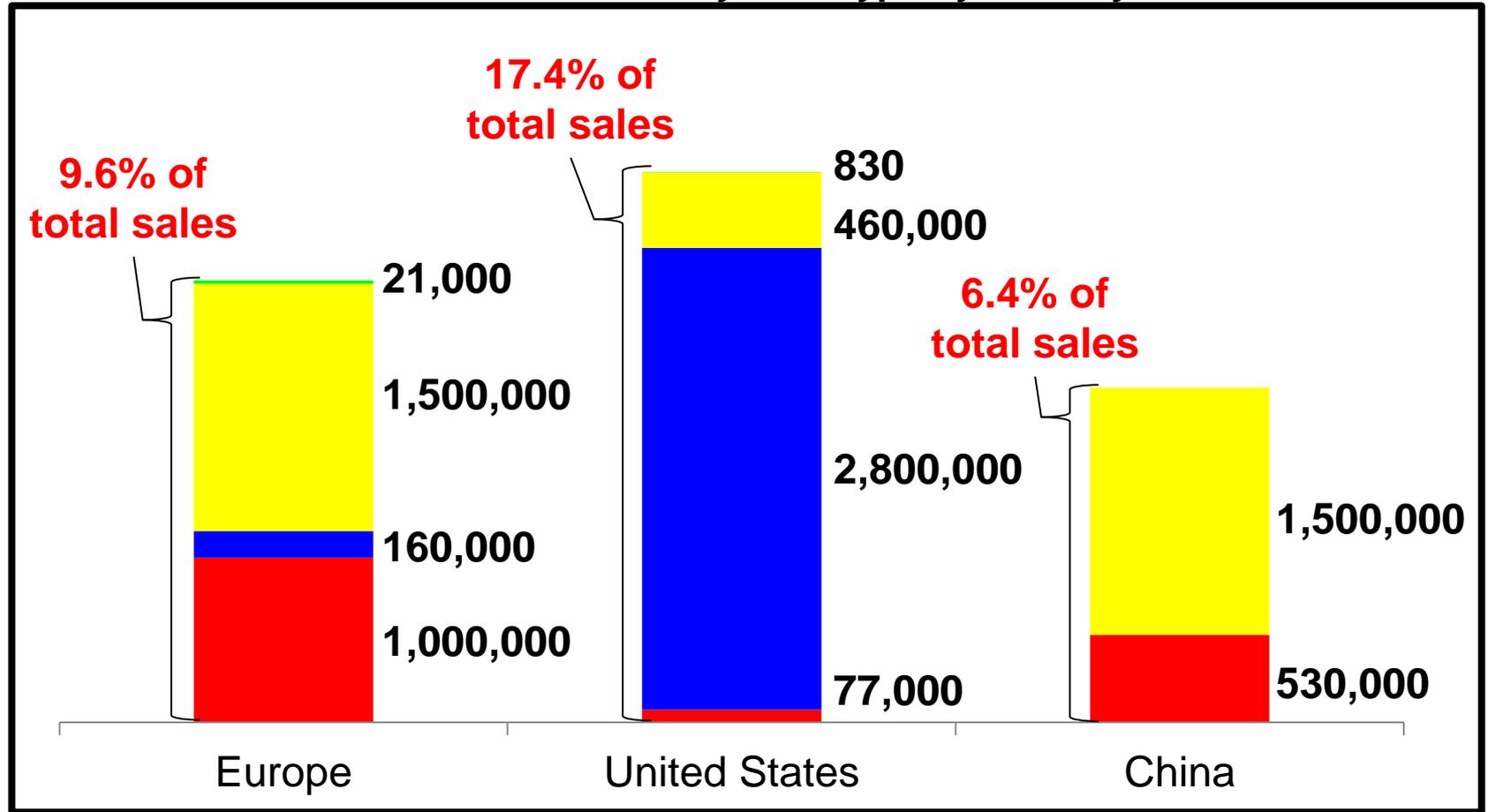
Estimate from
National
Academy of
Sciences

Fuel Type	Estimate
Natural Gas (CNG)	\$810
Flex-Fuel (E85)	\$2,760
Plug-in Electric (BEV & PHEV)	\$650-2,930
Hydrogen (Fuel Cell)	\$1,750

Estimates from Research Are Similar to Other Estimates

AFV SALES, 2030

AFV Sales in 2030 by Fuel Type by Country

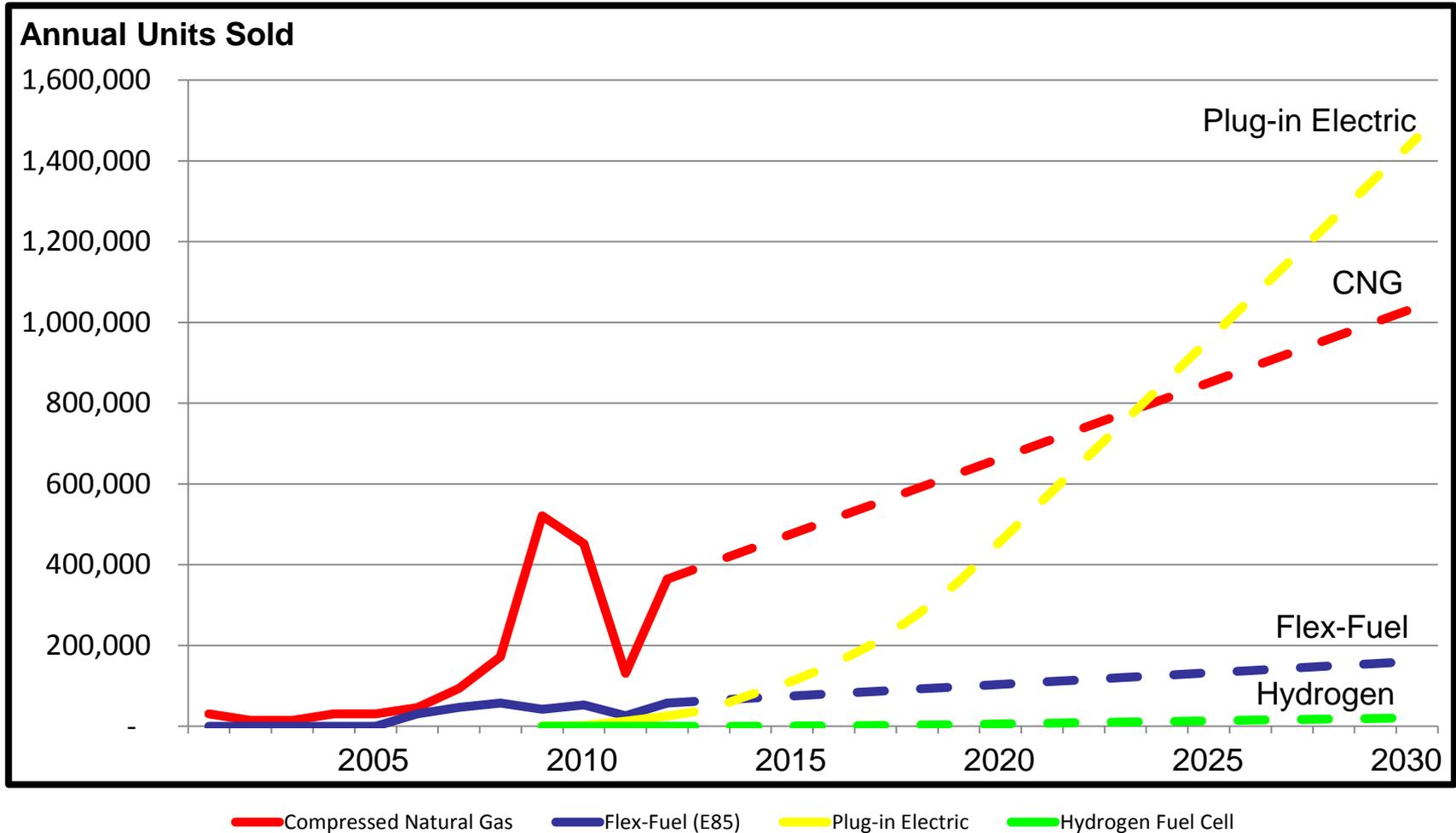


■ Natural Gas (CNG) ■ Flex-Fuel (E85) ■ Plug-in Electric (BEV & PHEV) ■ Hydrogen (Fuel Cell)

2030 Scenario Suggests Strong Sales for PEVs in All Countries, CNG in Europe and China, Flex-Fuel Vehicles in United States

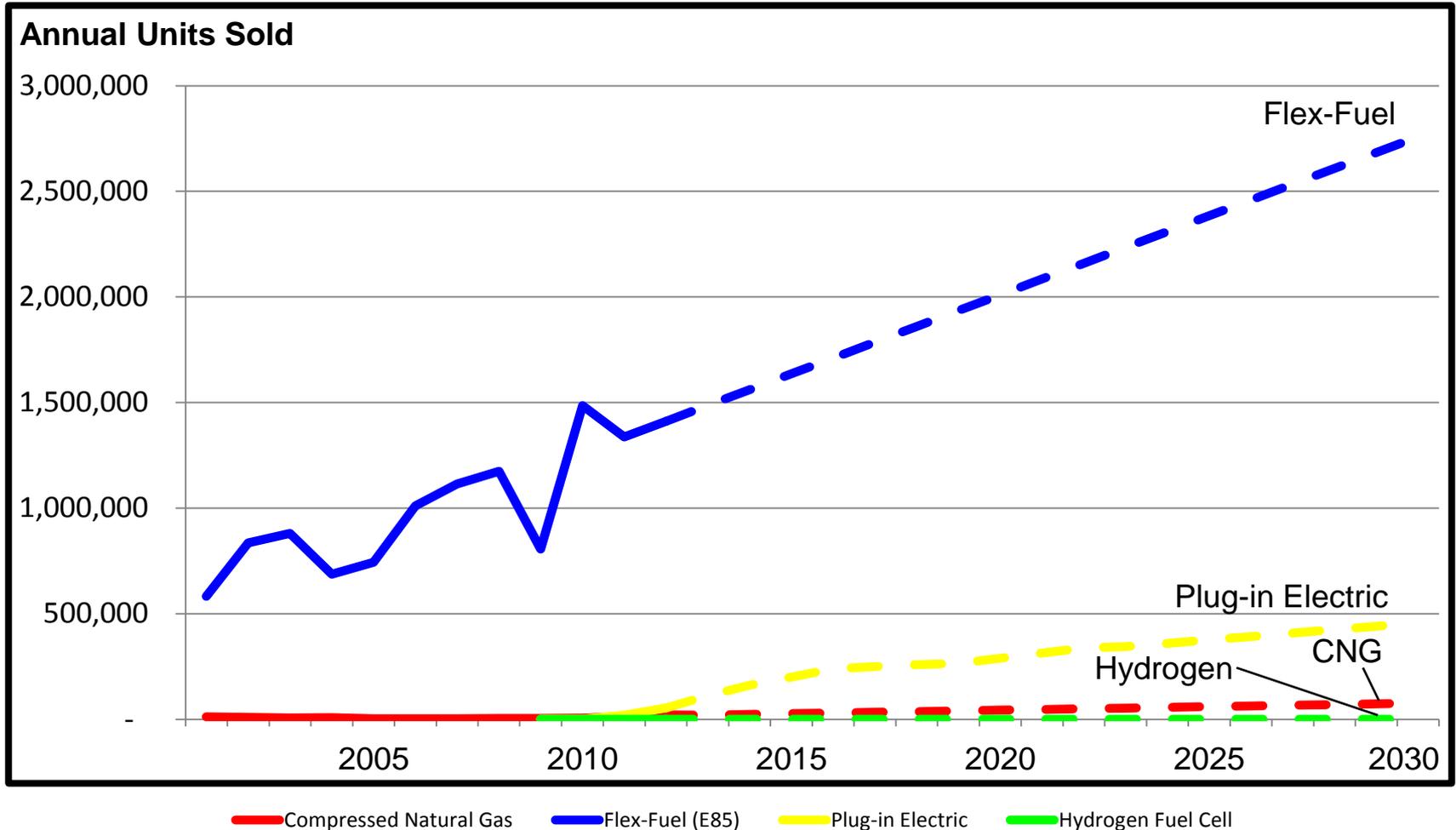
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VEHICLE SALES BY COUNTRY, EUROPE



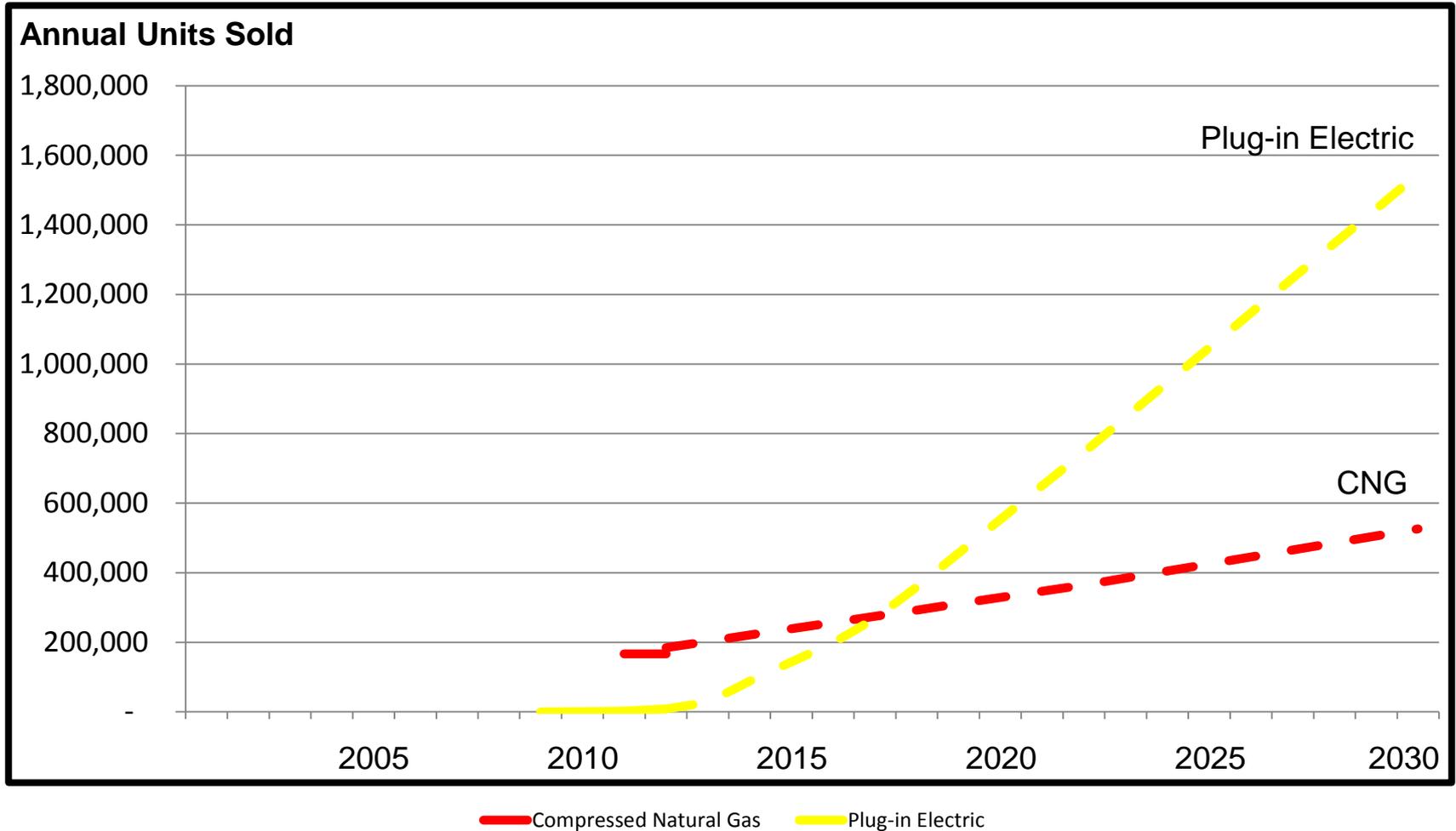
Scenario Based on Trends and Forecasts

VEHICLE SALES BY COUNTRY, UNITED STATES



Scenario Based on Trends and Forecasts

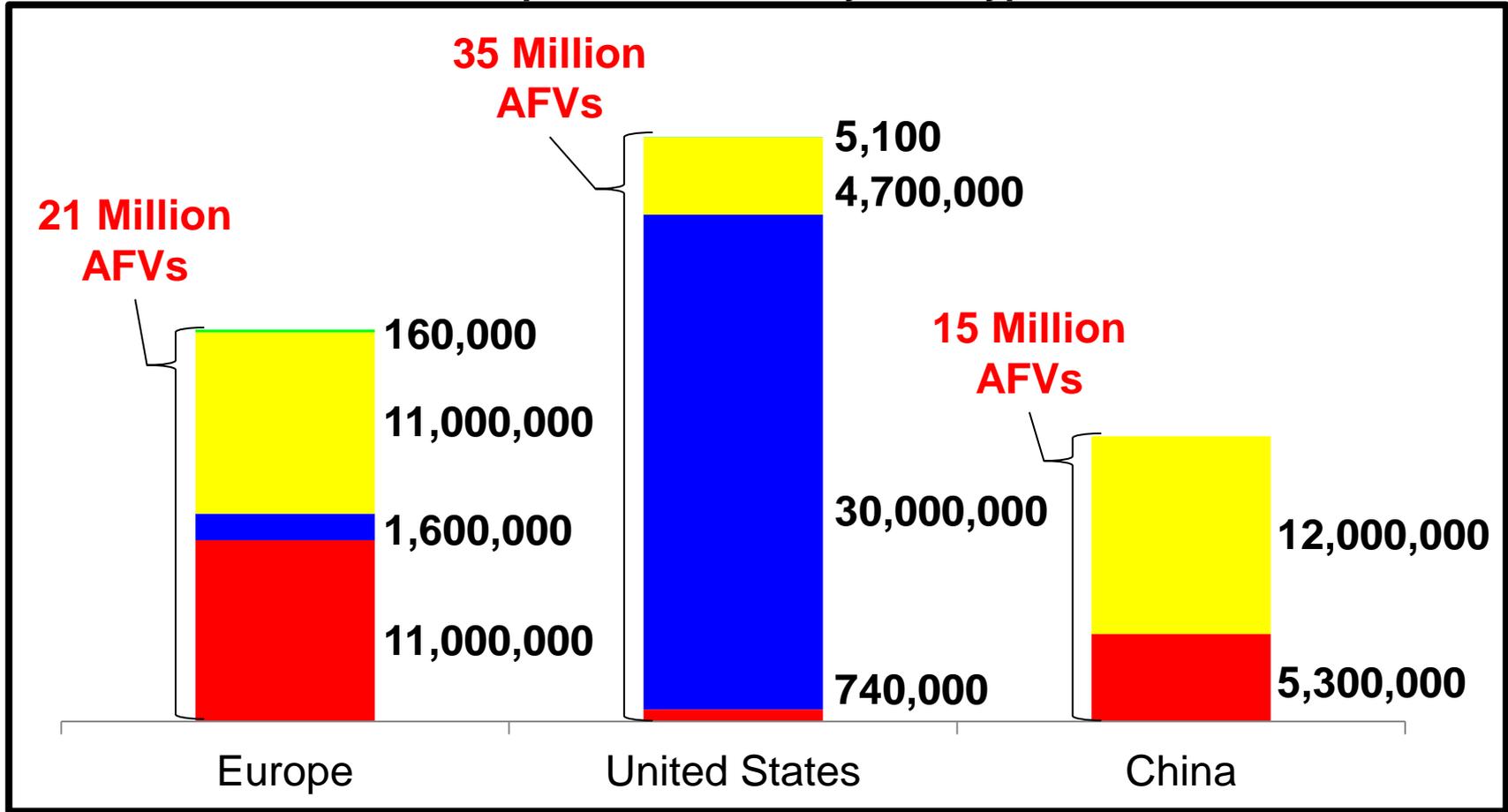
VEHICLE SALES BY COUNTRY, CHINA



Scenario Based on Trends and Forecasts

AFVS IN OPERATION, 2030

Total AFVs in Operation in 2030 by Fuel Type and Market

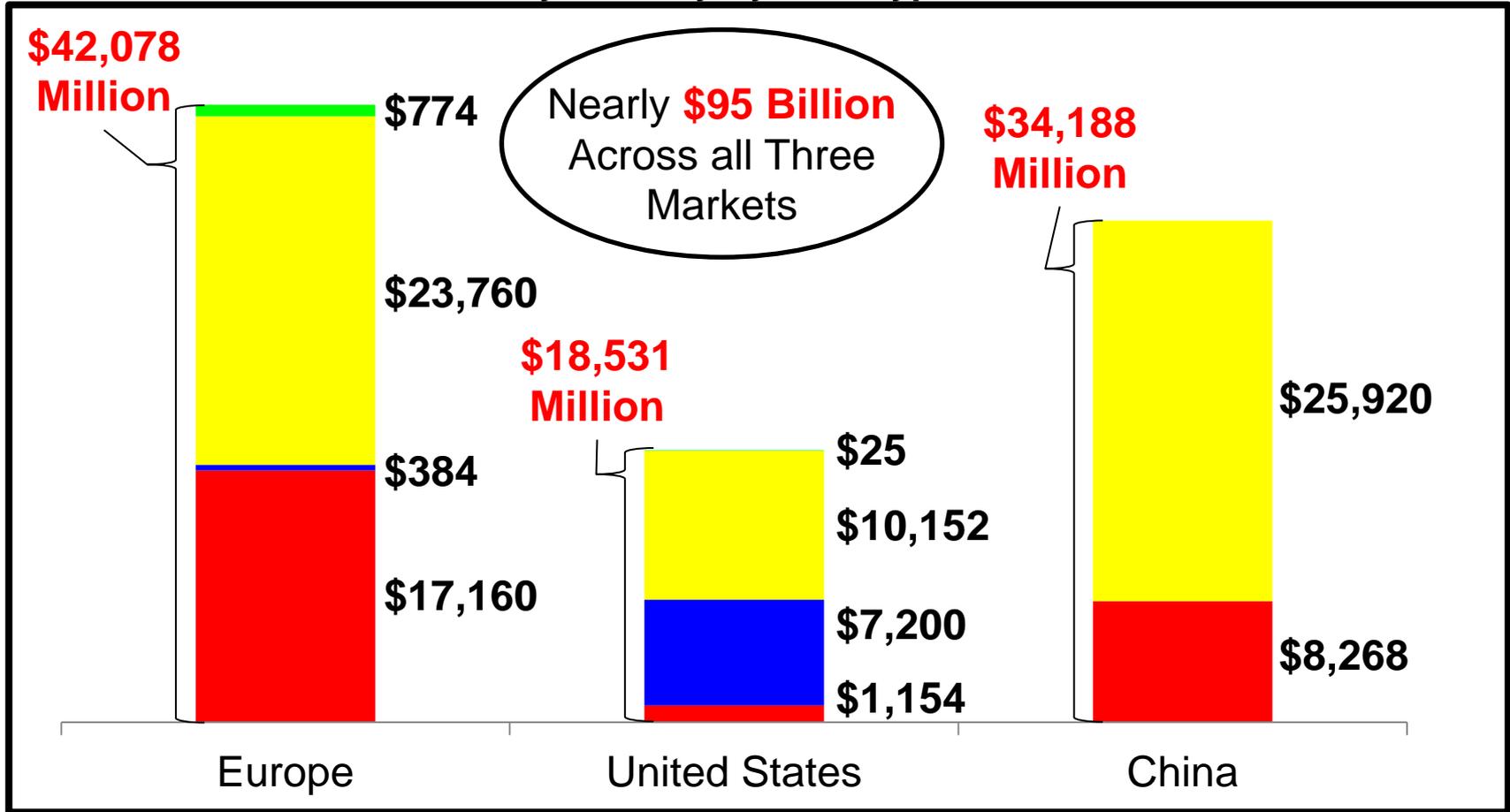


■ Natural Gas (CNG) ■ Flex-Fuel (E85) ■ Plug-in Electric (BEV & PHEV) ■ Hydrogen (Fuel Cell)

2030 Scenario Suggests Substantial Fleets in All Countries

INFRASTRUCTURE COST

Infrastructure Cost by Country by Fuel Type in 2013 \$U.S. Millions



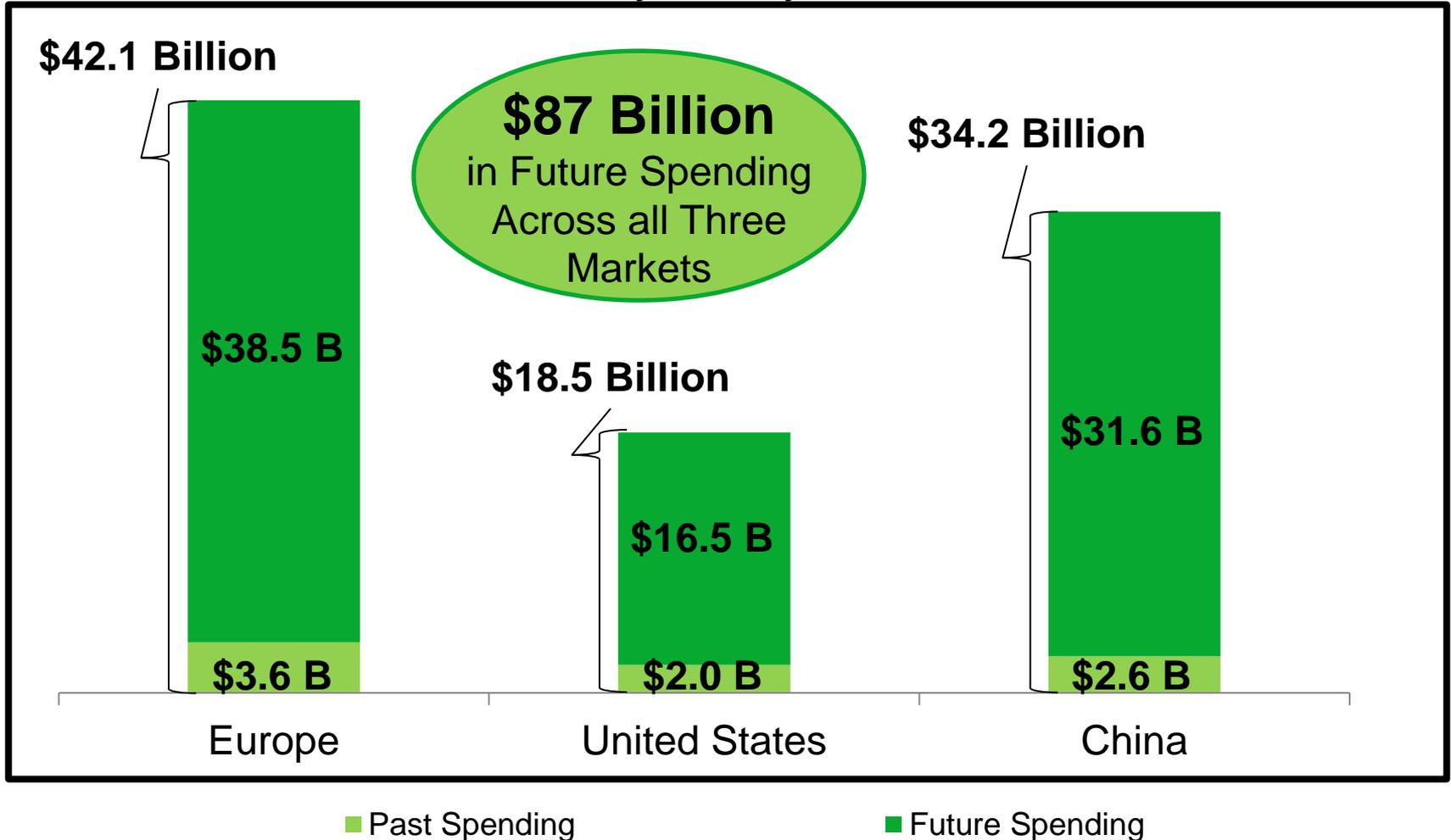
■ Natural Gas (CNG) ■ Flex-Fuel (E85) ■ Plug-in Electric (BEV & PHEV) ■ Hydrogen (Fuel Cell)

Nearly \$95 Billion Will Be Required to Build Refueling Infrastructure for AFVs in Europe, the United States, and China

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FUNDING REQUIREMENT THROUGH 2030

Infrastructure Cost by Country in 2013 \$U.S. Billions



\$8 Billion Spent So Far, \$87 Billion to Go

FUNDING OPTIONS FOR INFRASTRUCTURE SPENDING

Public Support

- **Direct government expenditures**
- **Bond issuance**
- **Subsidies**
- **Infrastructure banks**

Public-Private Partnership

- **Government loans to private entities**
- **Collateralized support for private issuance**
- **“Green” bonds**

Private

- **Electric utilities’ funding of grid upgrades and charging stations through privately issued bonds**

Many Publicly Supported Infrastructure Projects Have Provided Positive External Impacts Through Employment Gains and Business Growth

SUMMARY

- **Through 2030, an estimated \$90 billion would be needed to support AFV volume projections in the U.S., Europe, and China**
- **China’s central government has committed to expanding “new energy vehicles” in order to reduce pollution and its dependence on oil imports**
- **Historically, most major markets have relied on public funding to support infrastructure investments**

Using Public Investment or Public-Private Partnerships Could Advance Goals of Energy Independence and Sustainability