
Fuel Cell Technologies State of the Art & Market Perspectives:

HSBC Investor Conference September 19, 2002

Phil Doran

Core Technology Ventures LLP

phil@coretecventures.com

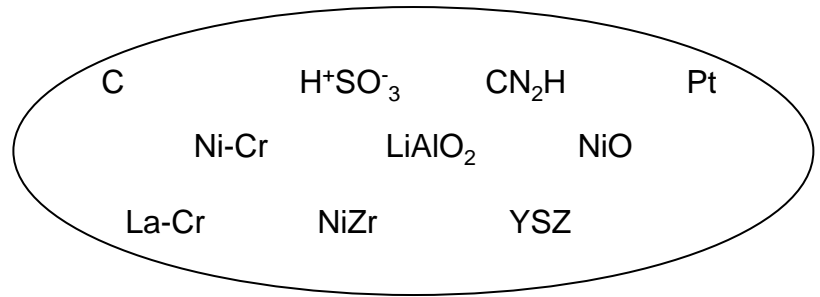
Agenda

- Supply Chain & Market Characteristics
- Drivers:
 - Global Warming
 - Local Emissions
 - Developing World's Demand for Power
 - Energy insecurity,
 - Efficiency in Energy Conversion
 - The inexorable rise of Hydrogen
- Sample Projects & Demonstrations
 - US & Europe: Automotive
 - US & Europe: Stationary
 - Emerging Markets: Automotive
- Financial Support and the Gartner Hype-Cycle
- Conclusions

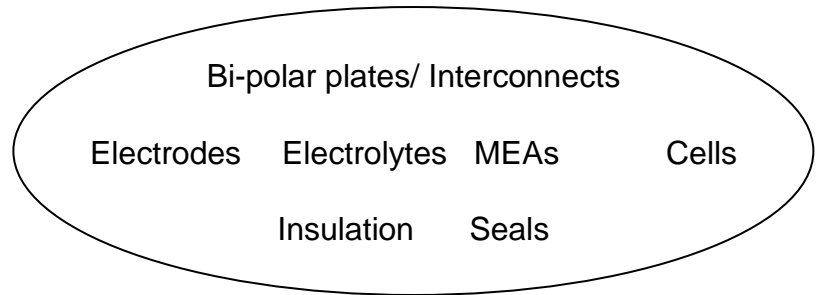
Supply Chain & Market Characteristics

A Global Supply Chain

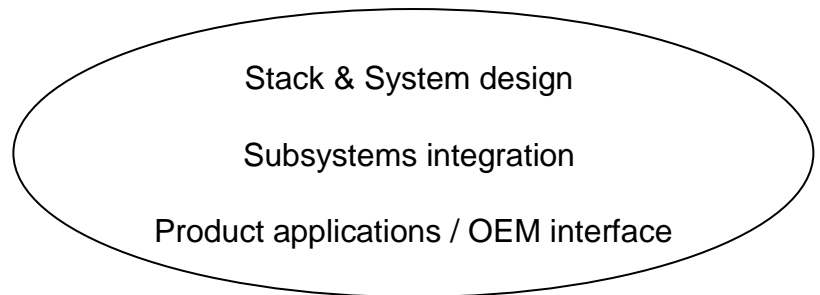
If basic materials
form the letters



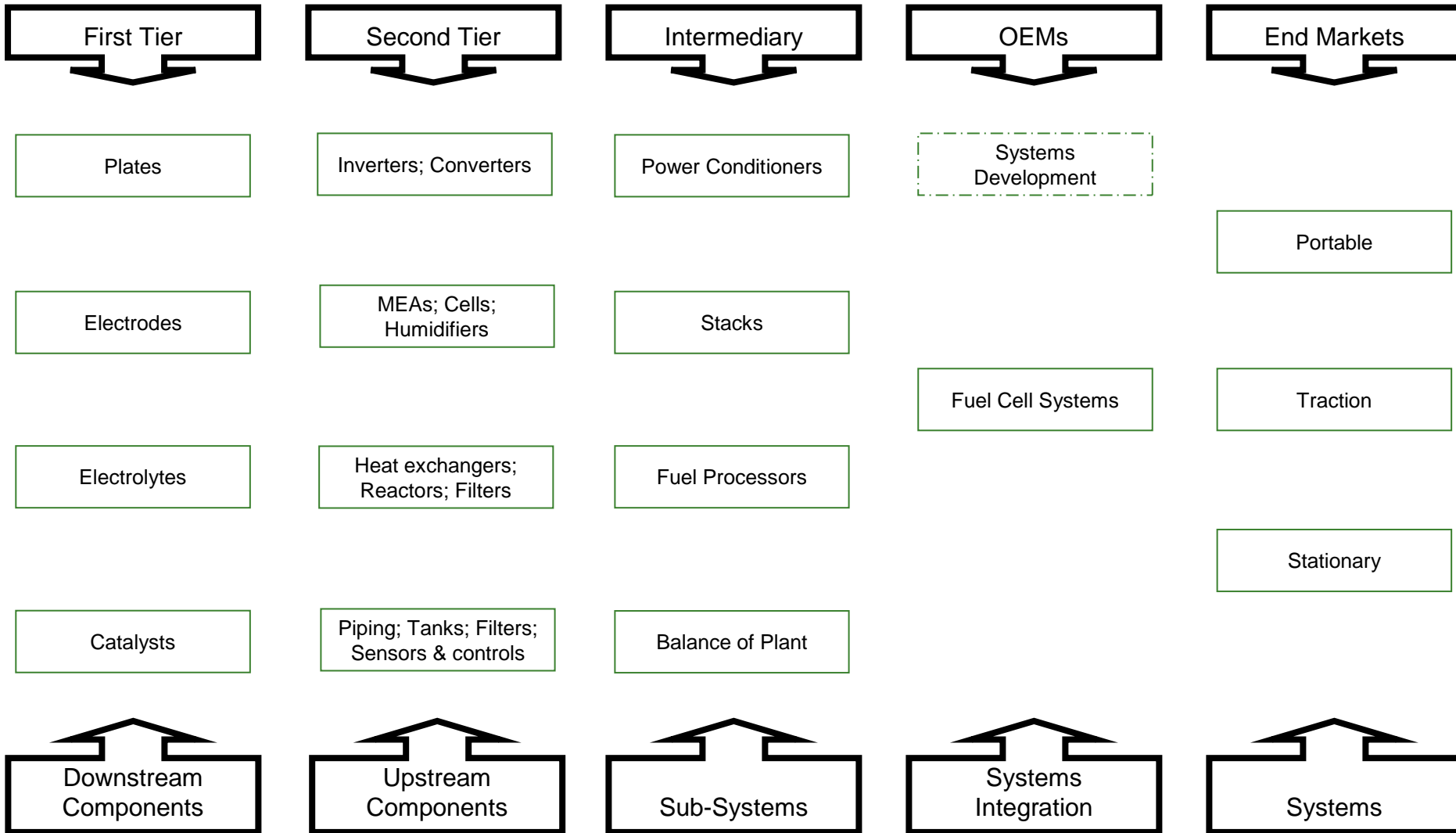
& functionally interdependent
components form the words



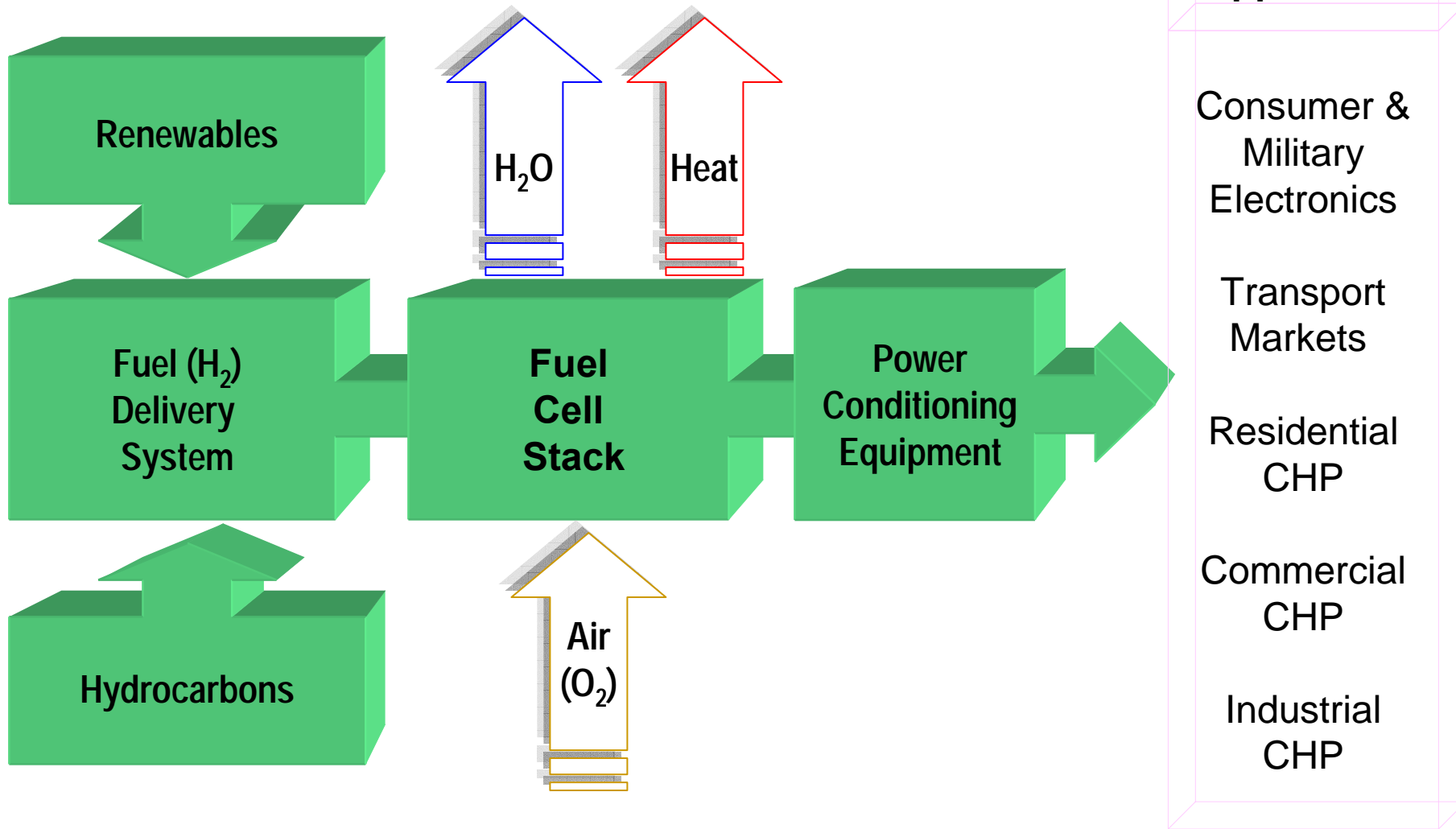
then the system developers
write the text



Simplified Fuel Cell Supply Chain



Fuel Cell System



Market Characteristics

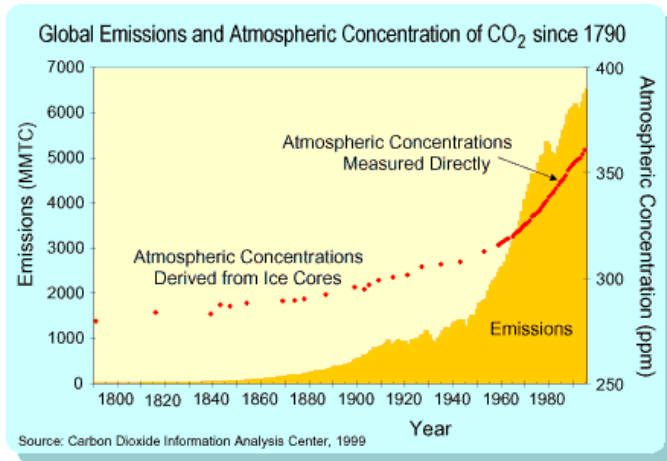
	<u>Automotive</u>	<u>Stationary</u>	<u>Portable</u>
Drivers	Environment Energy Security	Environment Energy Security	Consumer Electronics Digital Battlefield
Price Drivers	Regulation	Regulation	Innovation
Demonstrations	Cars & Buses	Residential & Commercial	Largely Invisible
Products	Homogeneous	Homogeneous	Highly Heterogeneous
Margins	Low	Medium	High

Drivers

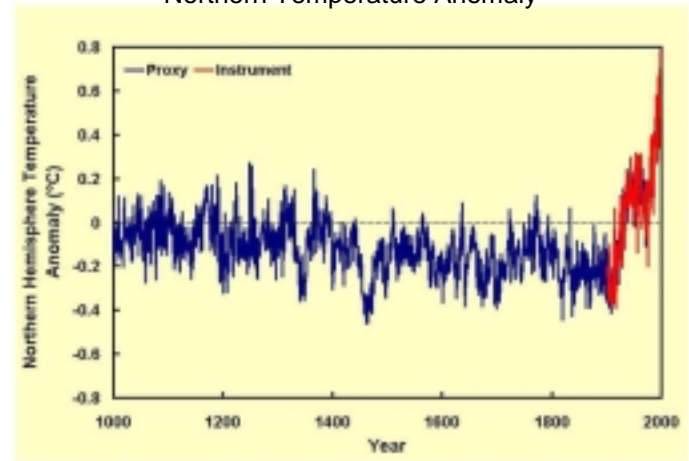
Drivers and Hurdles



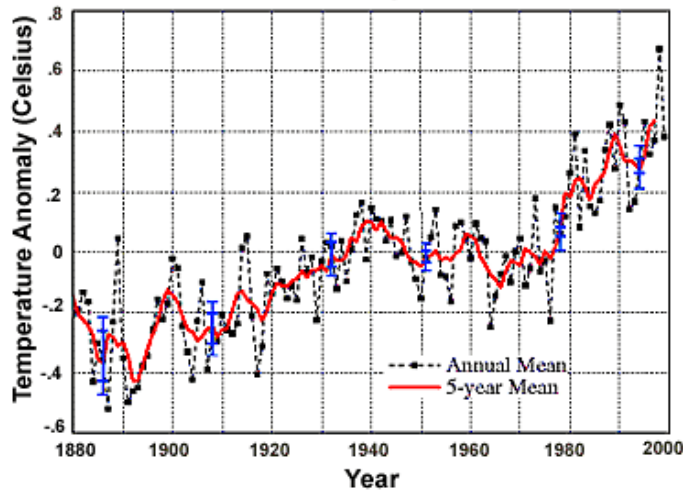
Global Warming



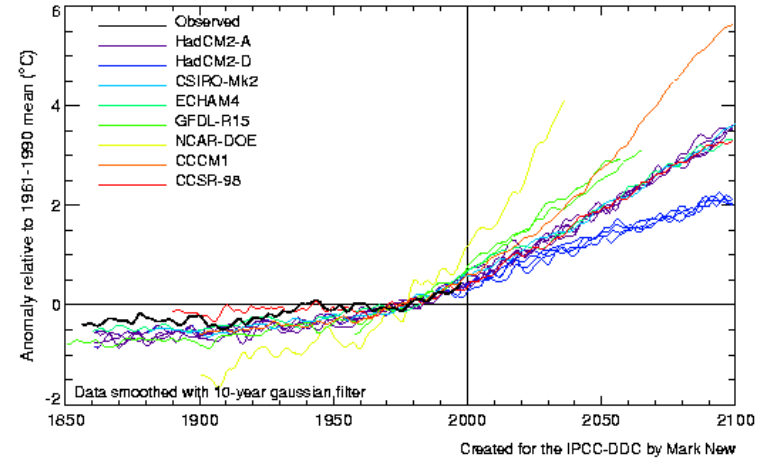
Northern Hemisphere Temperature Anomaly



Global Temperature



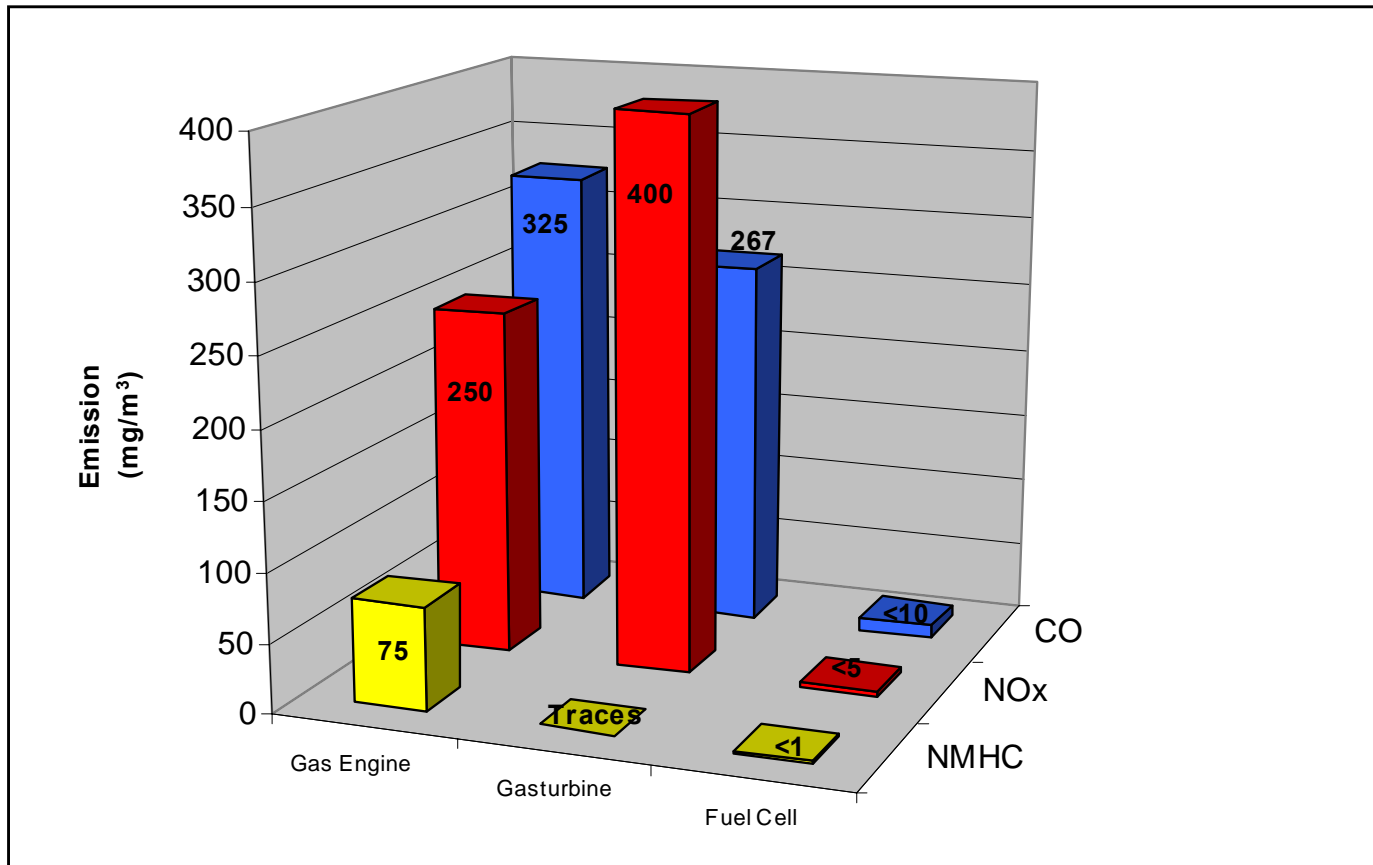
GGa - GLOBAL TEMPERATURE



Insurance Evaluation

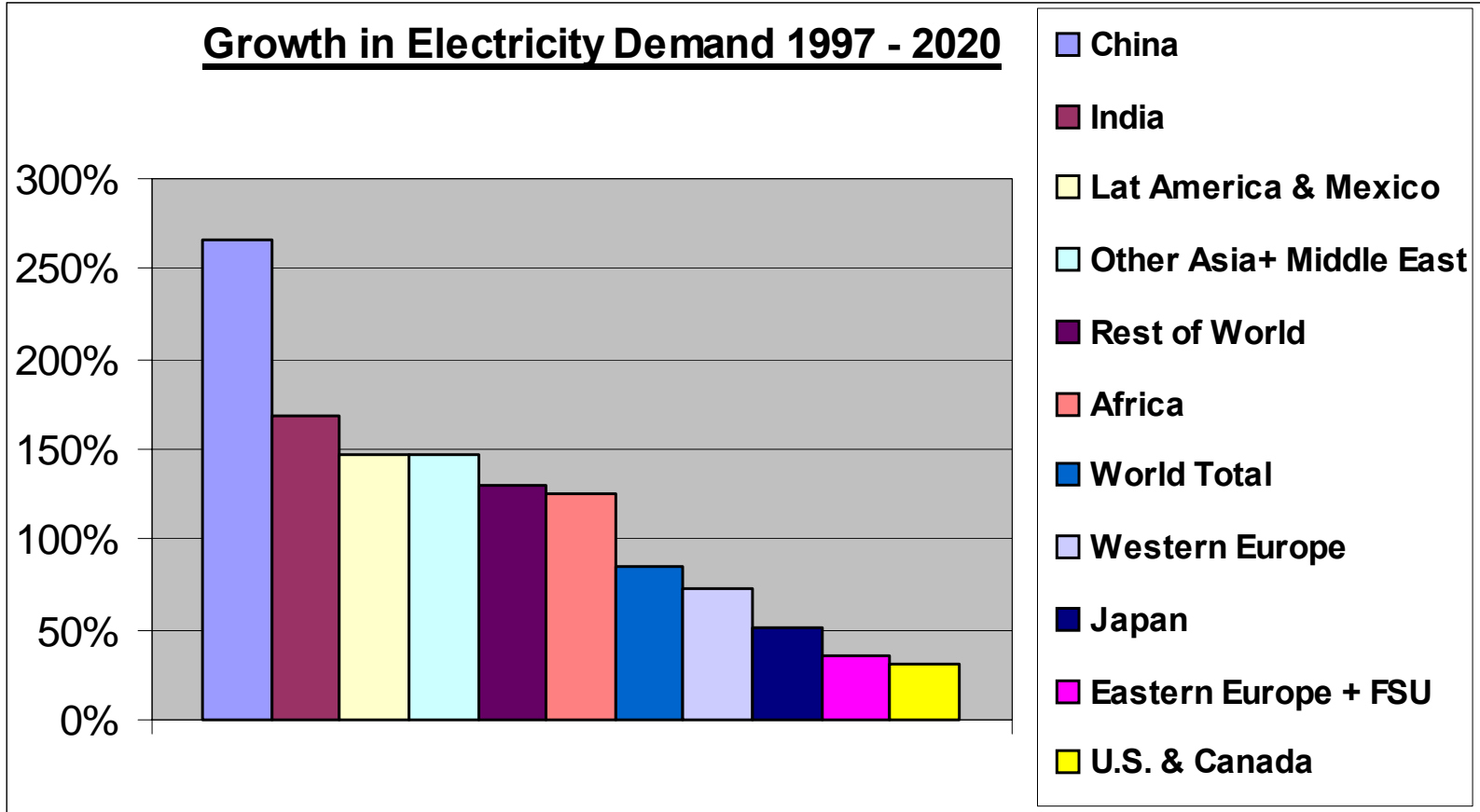
- “Global warming impacts could cost \$300 billion annually by 2050”
Source: Munich Re
- “The carbon emissions trading market could grow to between \$75bn and \$145bn annually”
Source: Swiss Re
- “The renewables market is worth trillions of dollars – the biggest market in history.”
Source: UK Chartered Insurance Institute research report, ‘Climate Change and Insurance’

Local Emissions: fuel cells versus heat engines



Source: Verband der Industriellen Energie- und Kraftwirtschaft e. V. (VIK) Bericht Nummer 214

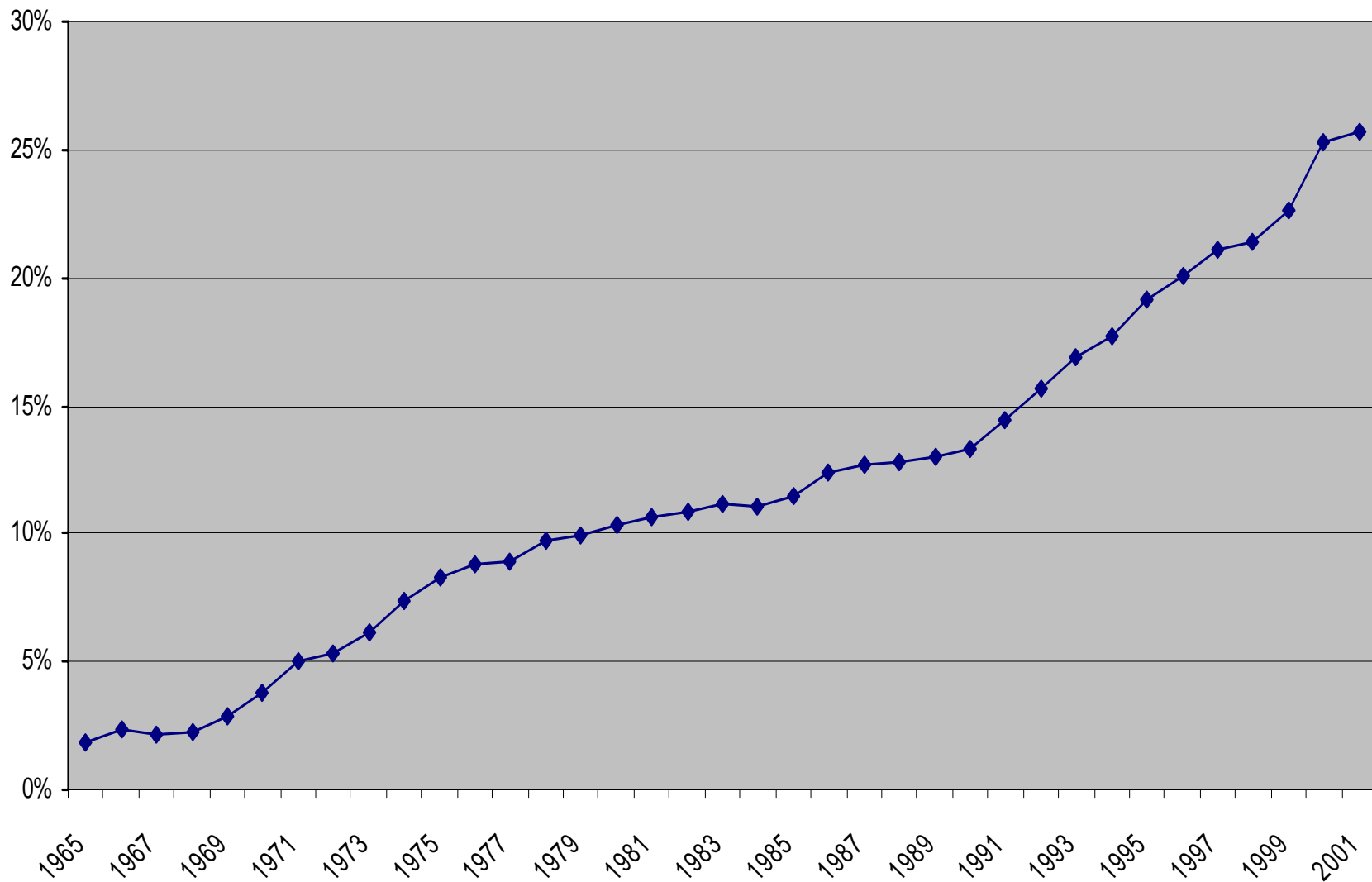
Developing World Electricity Demand



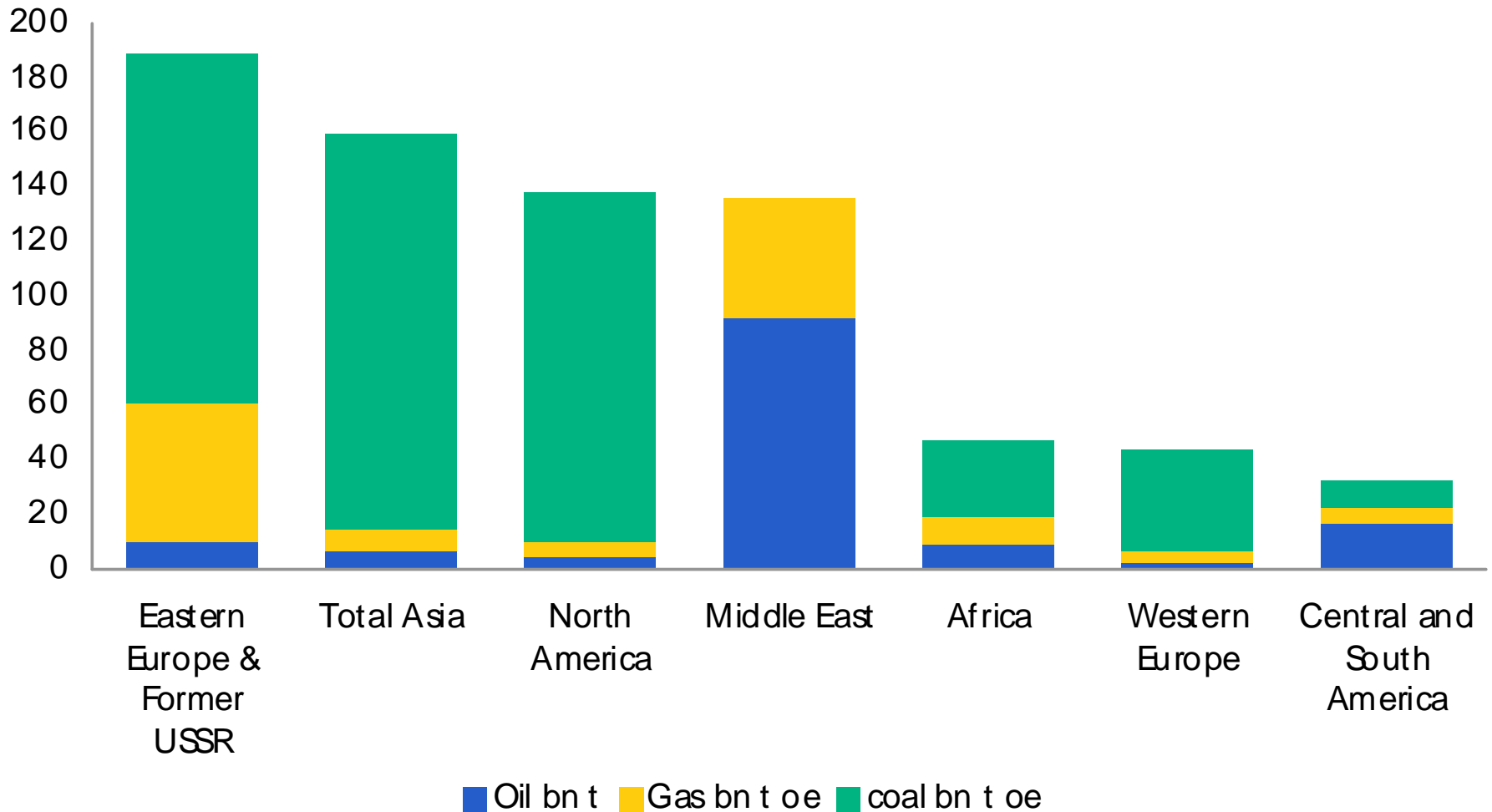
◆ China's generating base will rise by around 270% over the period, almost 10 times greater than North America

◆ Yet China's 2020 per-capita base of just 643kW will be less than one fifth of the North American per capita base

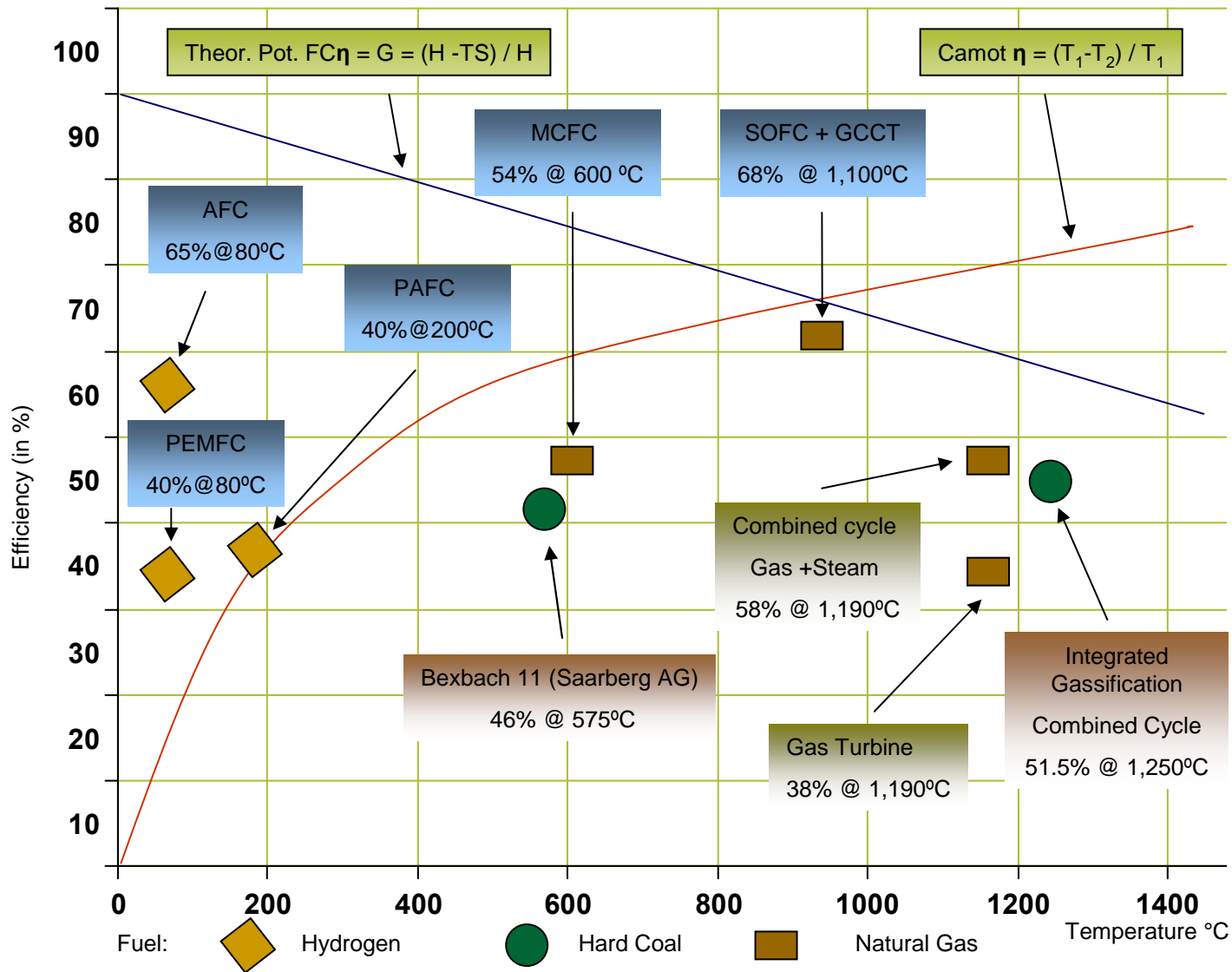
Chinese Oil Consumption as a % of US



Energy Insecurity:



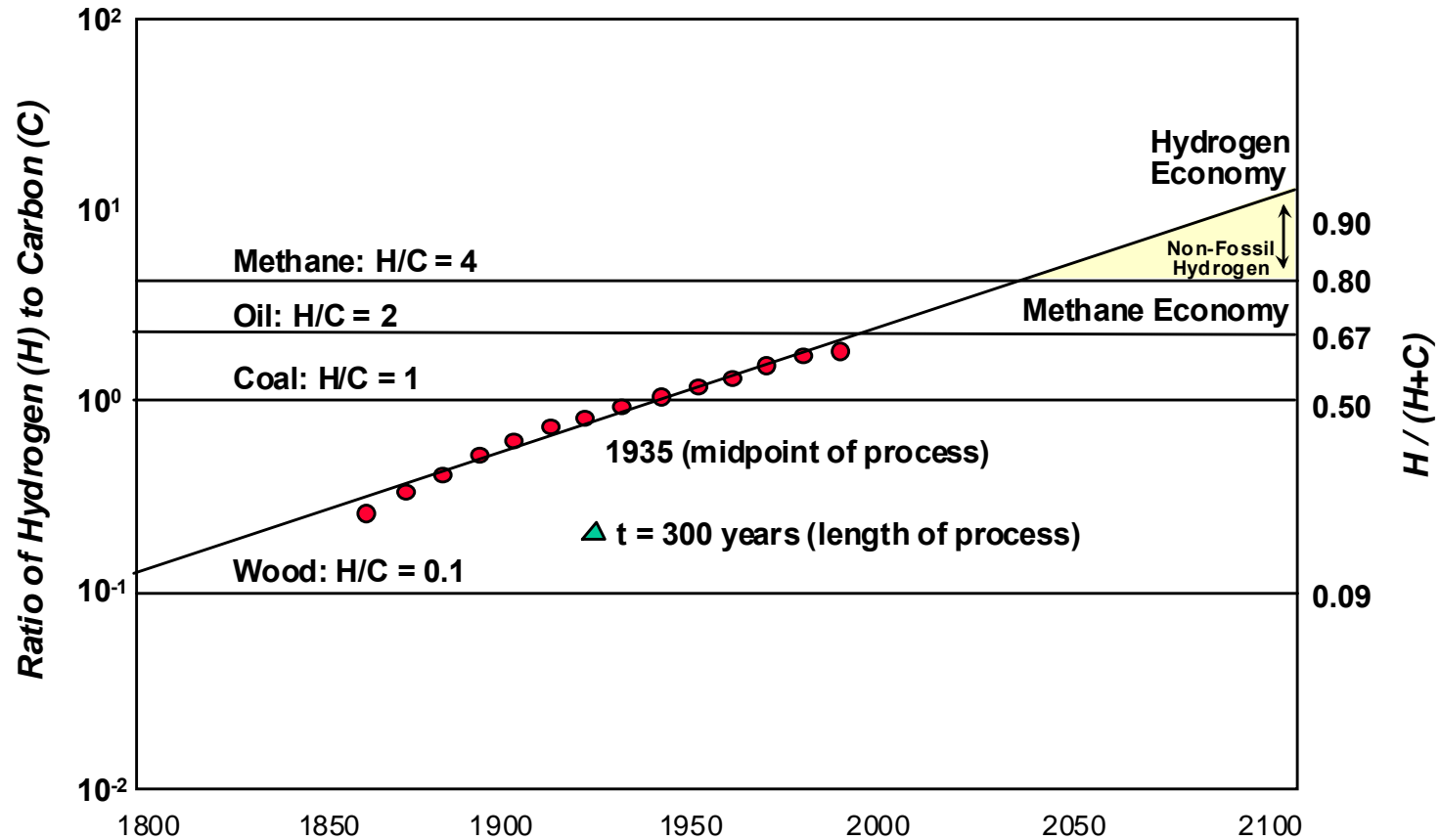
Fuel Cell Efficiency Versus Heat Engines



Source: Verband der Industriellen Energie- und Kraftwirtschaft e. V. (VIK) Bericht Nummer 214

The Inexorable Rise of Hydrogen

Global Primary Energy Consumption: Ratio of Hydrogen to Carbon



Source: IIASA, Nakicenovic

PXG/98Scenarios/Decarbonisation.ppt

Sample Projects & Demonstrations

Fuel Cell Vehicles Built

OEM	FC Engine No of Units	FC-Battery Hybrid No of Units	Total Units
DaimlerChrysler	7	2	9
General Motors	6	1	7
Honda	5	0	5
Ford	4	0	4
Hyundai	2	0	2
Nissan	2	0	2
Toyota	1	4	5
Mazda	1	1	2
Renault	1	1	2
Suzuki	1	0	1
Volkswagen	1	0	1
Daihatsu	0	2	2
Fiat	0	1	1
Mitsubishi	0	1	1
Total	31	13	44



California



Members of the California Fuel Cell Partnership:

Ballard Power Systems, International Fuel Cells, XCELLSiS

DaimlerChrysler, Ford, General Motors, Honda, Hyundai, Nissan, Toyota, Volkswagen,

BP, ExxonMobil, Shell, Texaco

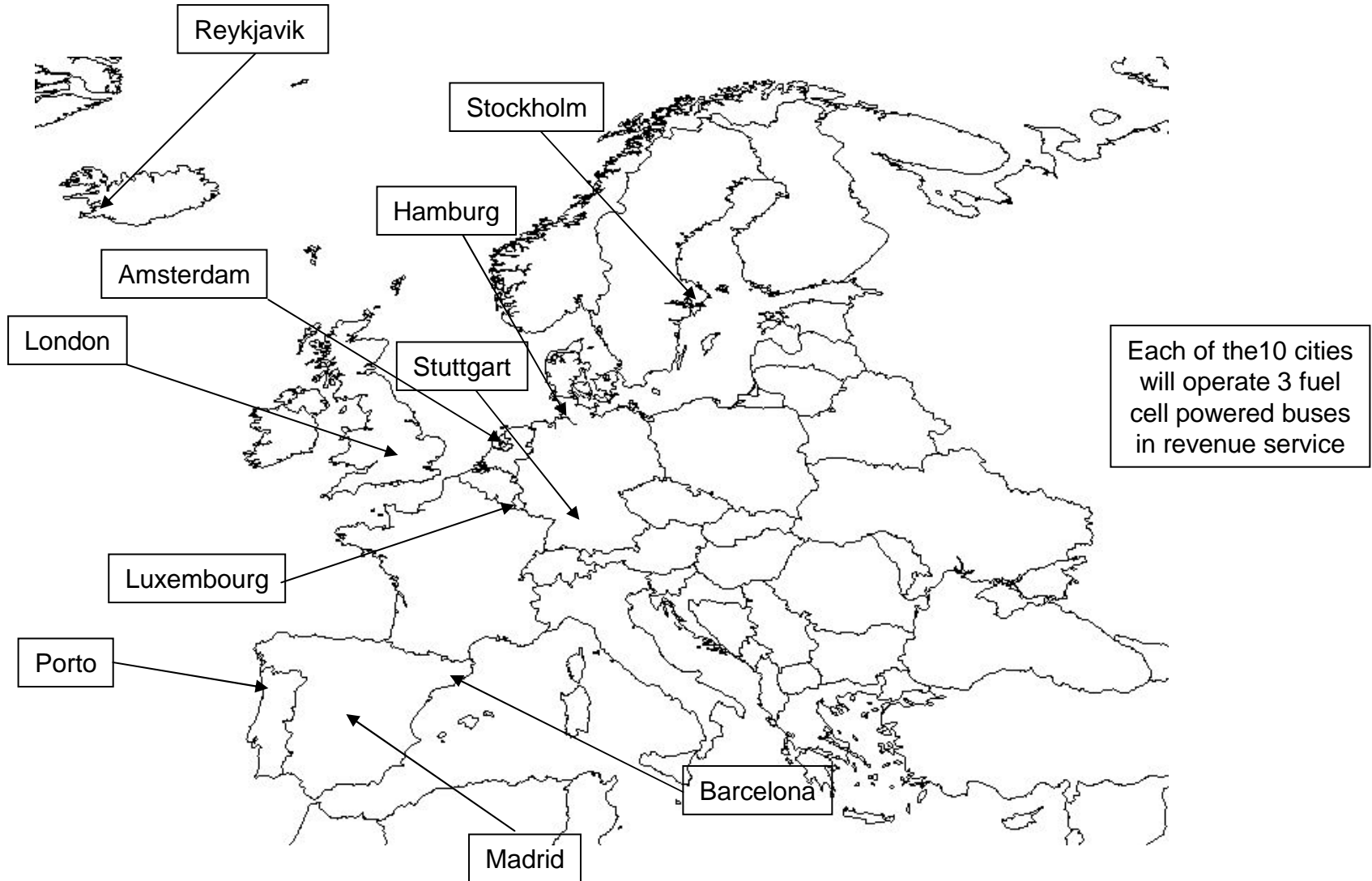
California Environmental Protection Agency, Air Resources Board, California Energy Commission, South Coast AQMD

U.S. Department of Energy, U.S. Department of Transportation

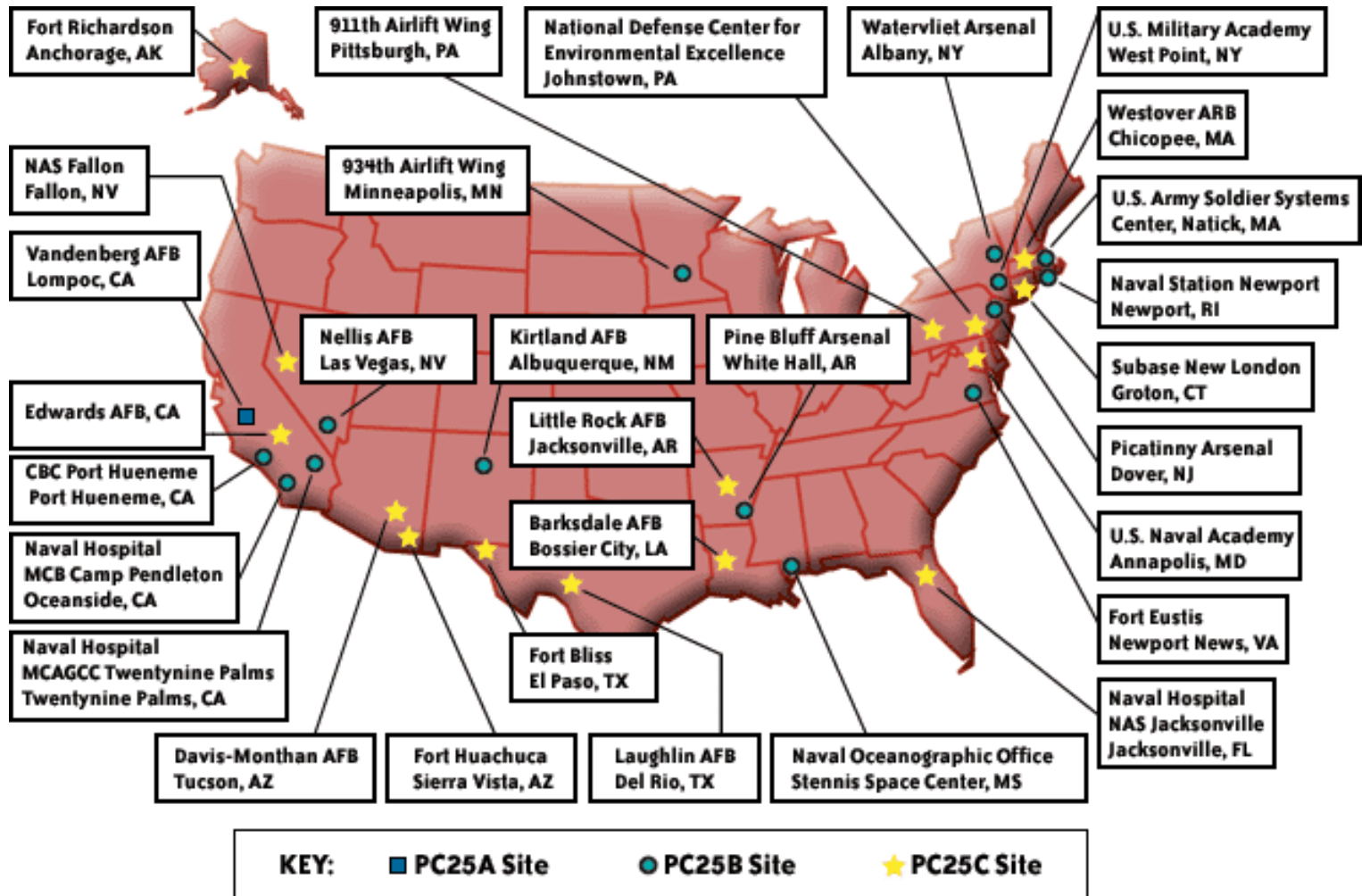
50 fuel cell cars and 20 fuel cell buses will be distributed and tested across the state between 2000 – 2003.

From 2003 the 'Zero Emissions Mandate', requiring 10% of all vehicles offered for sale to have zero exhaust emissions takes effect.

European Bus Demonstrations

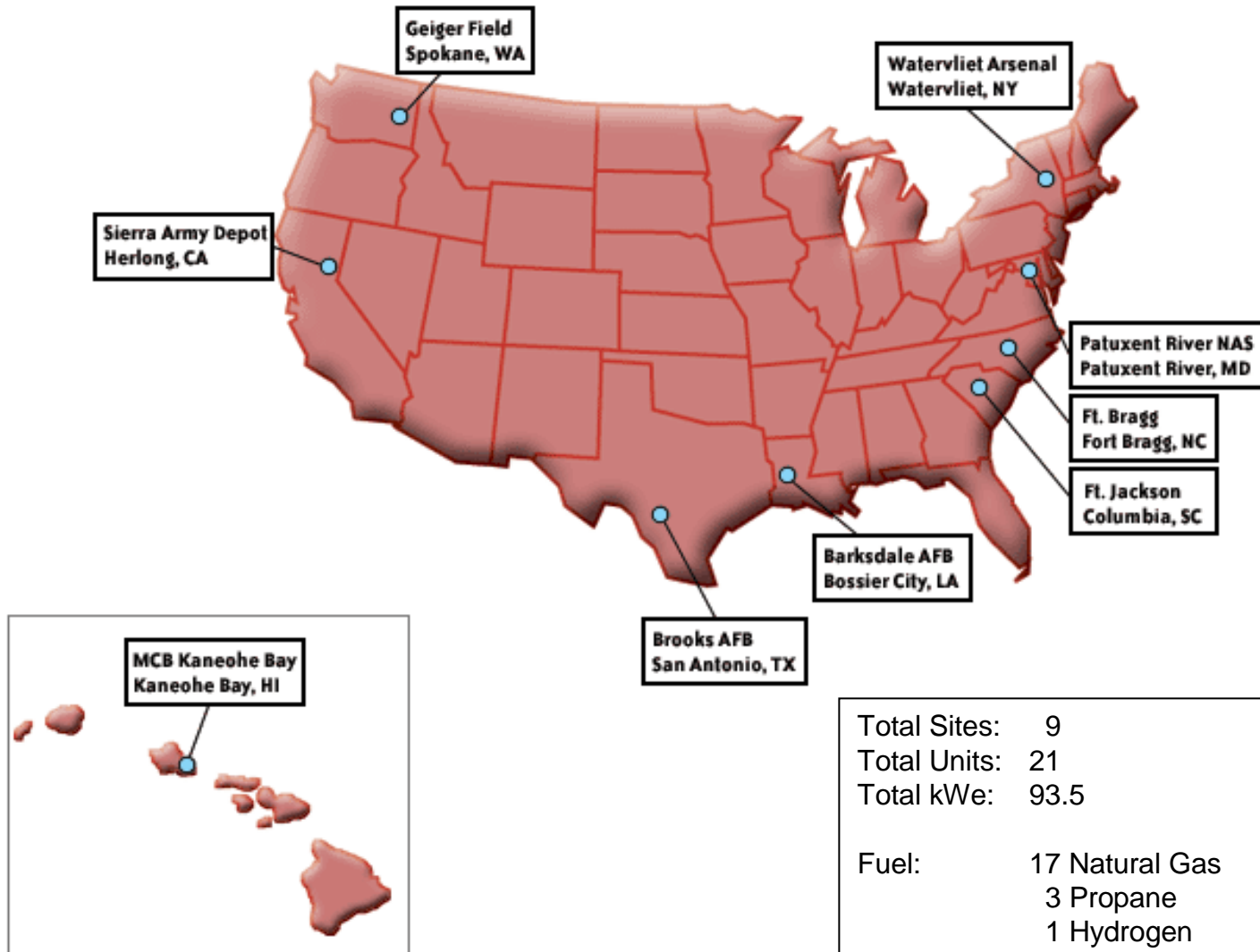


US DoD PAFC Demonstrations

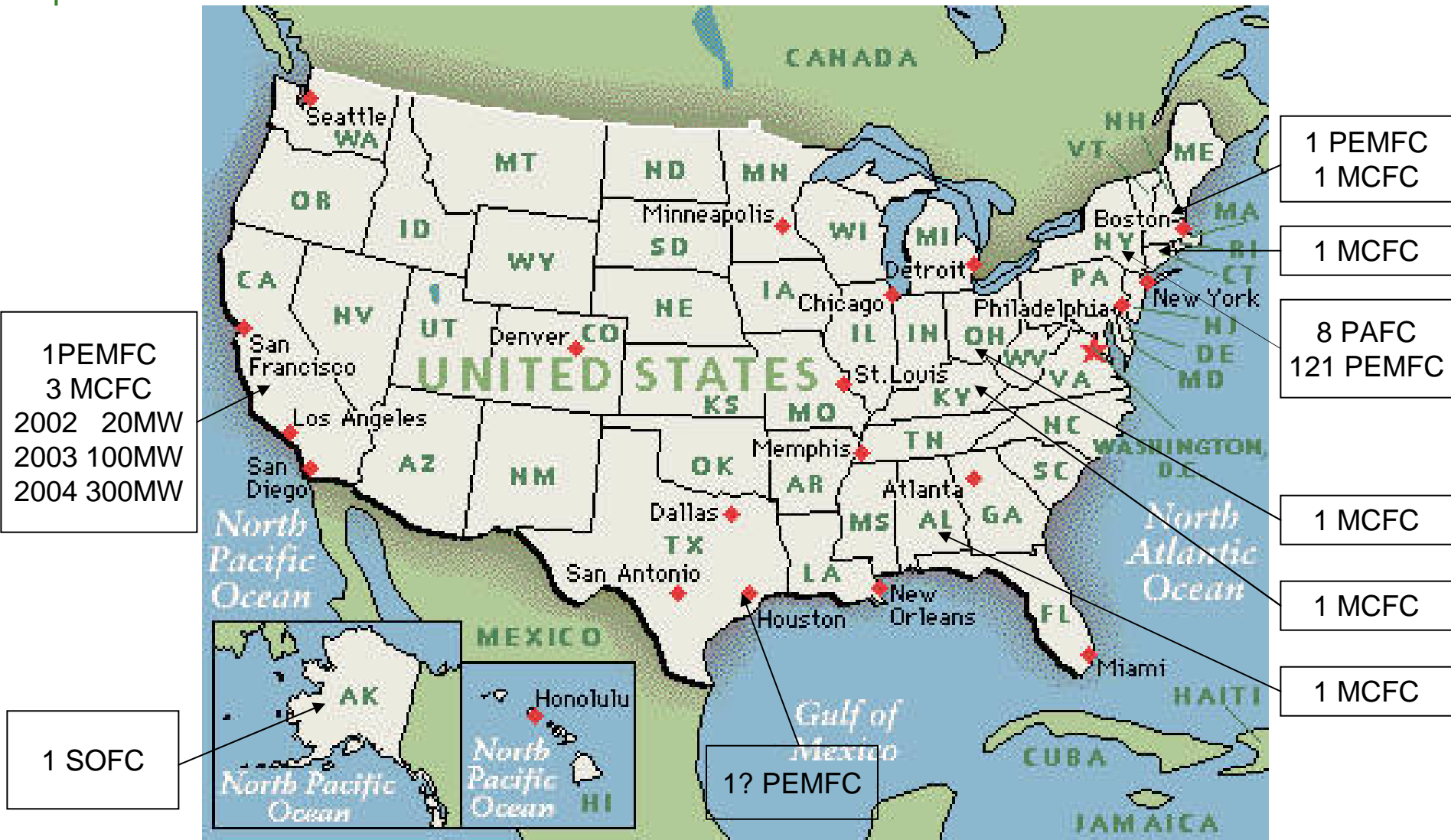


Between 1994 and 1997 30 PAFC were installed at U.S. Department of Defense bases

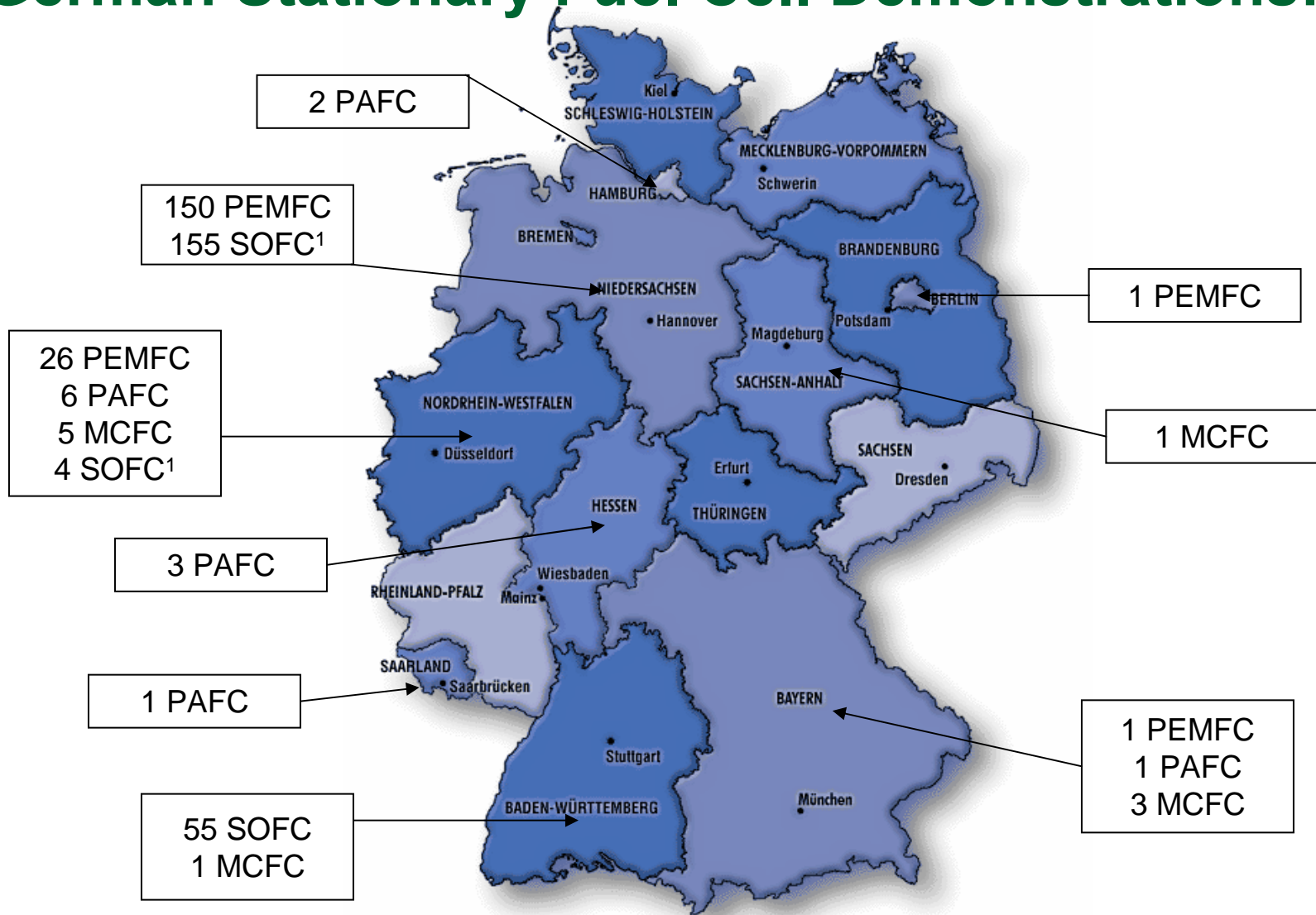
US DoD Residential Fuel Cell Demonstrations



US Civilian Fuel Cell Demonstrations



German Stationary Fuel Cell Demonstrations:



¹ Includes one 300Kw_e combined cycle unit

UNDP-GEF Developing Countries \$60m Fuel Cell Bus Programme

Technology transfer to combat greenhouse gas emissions

<u>Country</u>	<u>Ministry Responsible</u>	<u>City</u>	<u>FC Buses</u>
Brazil	(Ministry of Mines and Energy)	São Paulo	Eight
Mexico	(Secretary of Transport of Mexico City Govt.)	Mexico City	Ten
Egypt	(Environmental Affairs Agency)	Cairo	Eight
India	(Ministry of Non-Conventional Energy Sources)	Delhi	Eight
China	(Ministry of Science & Technology)	Beijing	Six
China	(Ministry of Science & Technology)	Shanghai	Six

**1995 Stage 1
(Preparation)**

**2000 Stage 2
(Demonstration)**

**2007 Stage 3
(Commercialisation)**

Sources: www.gefweb.org, www.undp.org/gef

Financial Support & the Gartner Hype-Cycle

State & Corporate Financial Support

Government's annual fuel cell spend:

	Region	Spend ⁽¹⁾	Per Capita
-	Japan	\$220m	\$1.74
-	U.S.	\$210m	\$0.81
-	European	<u>\$ 60m</u>	\$0.19
-	Total	\$490m	\$0.69

'Entrenched' industries reportedly embracing fuel cells:

- Major auto manufacturers have fuel cell engine programmes
- Oil majors devoting resources to hydrogen infrastructure
- Utilities pursuing fuel cell demonstration programmes

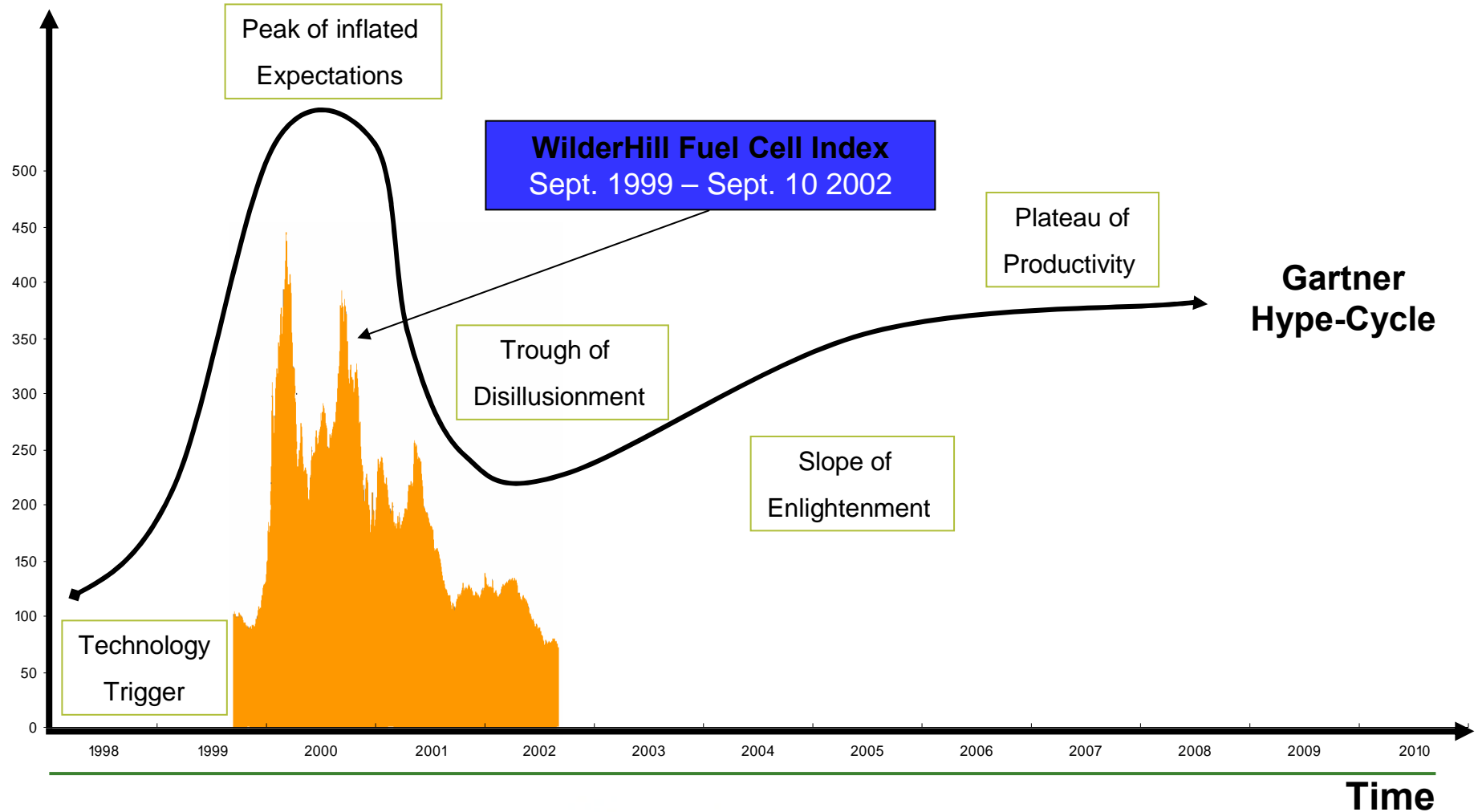
Corporate expenditure

- Annual industry spend up to \$3bn
- Auto industry alone has invested \$4.5bn to-date

⁽¹⁾ Sources: Fuel Cells 2000; US Dept of Energy; Japanese Fuel Cell Development Information Centre; European Commission

The Gartner Hype-Cycle

Visibility



Conclusions

- **The unfolding fuel Cell industry is:**
 - **Inherently knowledge-based**
 - **Barriers to entry are significant**
- **It is supported by a number of drivers including:**
 - **The threat of global warming**
 - **Pollution legislation**
 - **Demand for (clean) energy in the developing world**
 - **Demand for premium energy in the first world**
 - **An increasing awareness of energy security**
- **Government-supported large-scale demonstration projects are underway**
- **Billions of dollars have been invested in the technology by both**
 - **Various governments and**
 - **A range of industries including the automotive, power and chemical sectors**
- **The correction in prices makes the sector attractive to specialist venture capitalists**