generation H

towards a sustainable hydrogen future

Forum for the Future
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Agenda

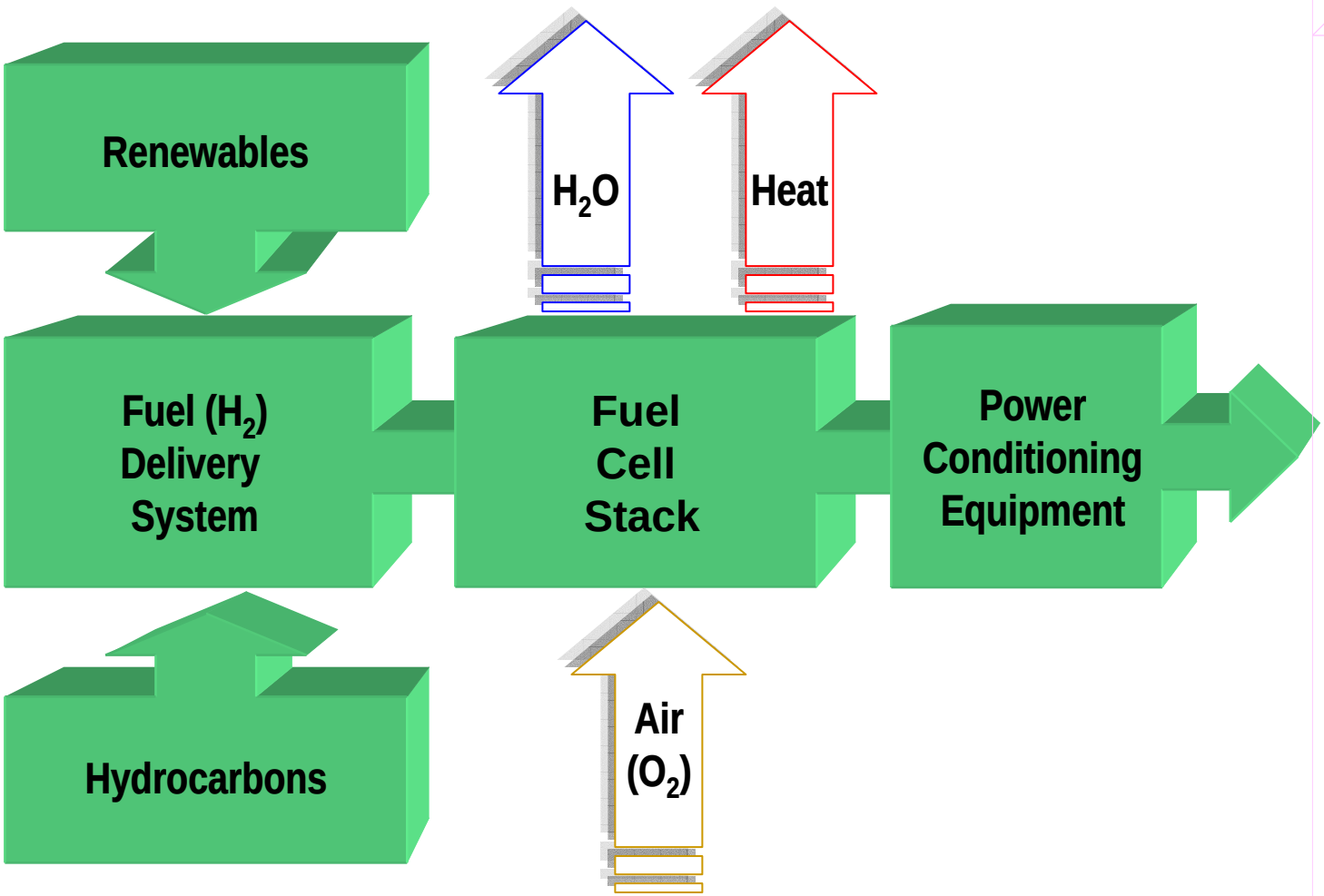
- Fuel cell system, applications range & market characteristics

- Demonstration Maps
  1. Stationary
  2. Mobile

- Financing
  1. The Hype Cycle
  2. Funding Path
  3. Funds Flow

The Fuel Cell System, The Product Range & Market Characteristics

Fuel Cell System



Applications

Consumer & Military Electronics

Transport Markets

Residential CHP

Commercial CHP

Industrial CHP

Product Range

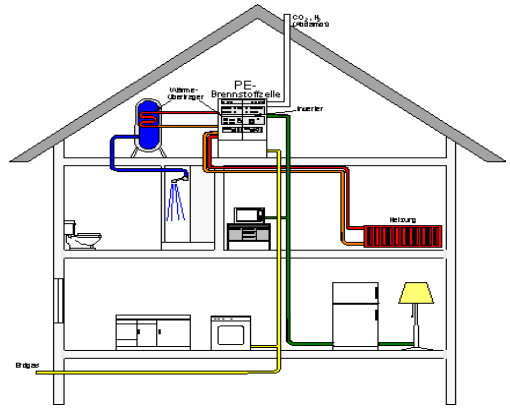
Consumer Electronics

Miliwatts

Mobile Electronics

70kW to 300kW

The Natural Electric Home



1kW - 7.5kW

Commercial Power Plant

250kW

Industrial Power Plant

Multiple megawatts

Market Characteristics

	Automotive	Stationary	Portable
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

Automotive 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

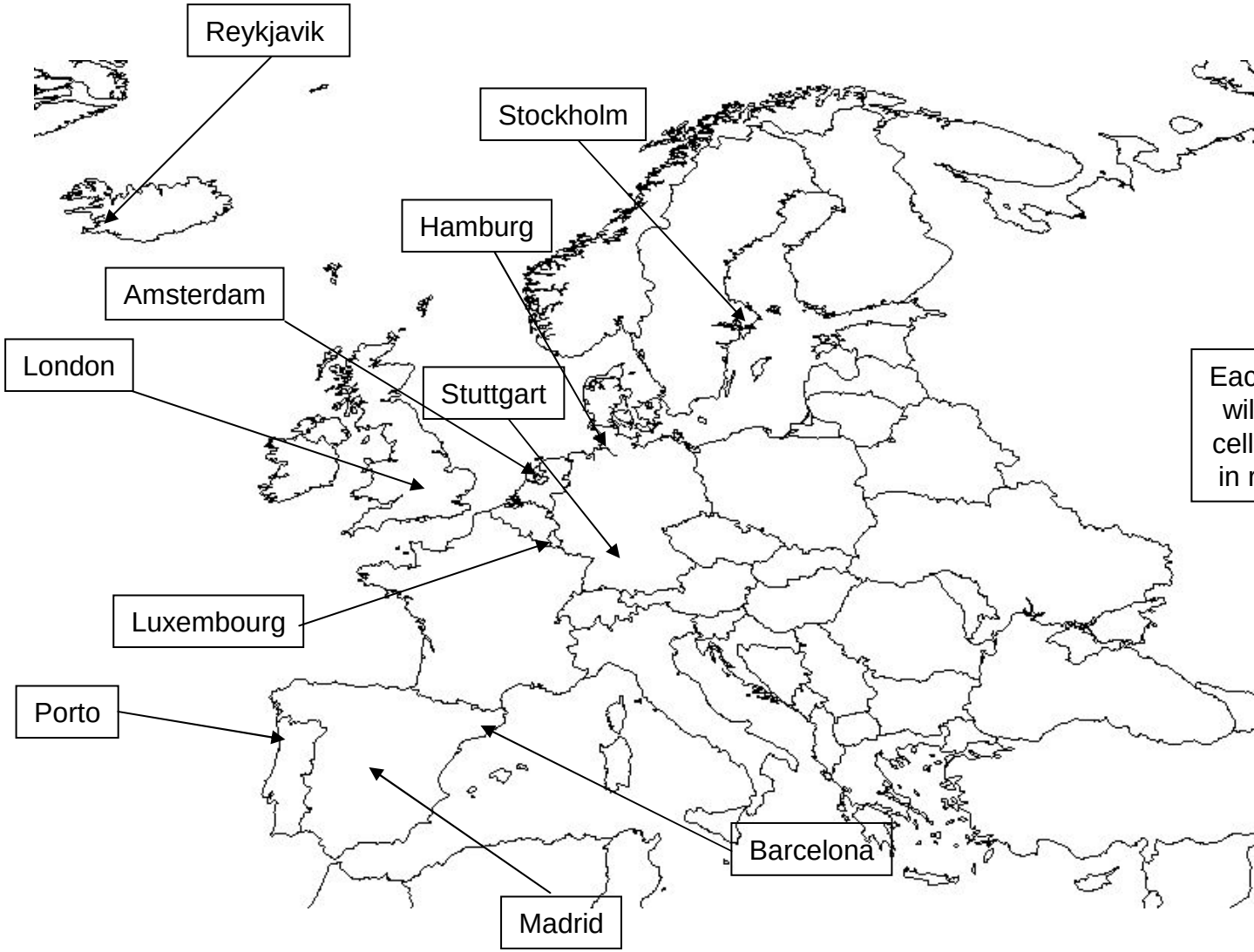
California Environmental Protection Agency, Air Resources Board, California Energy Commission, South Coast AQMD

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.

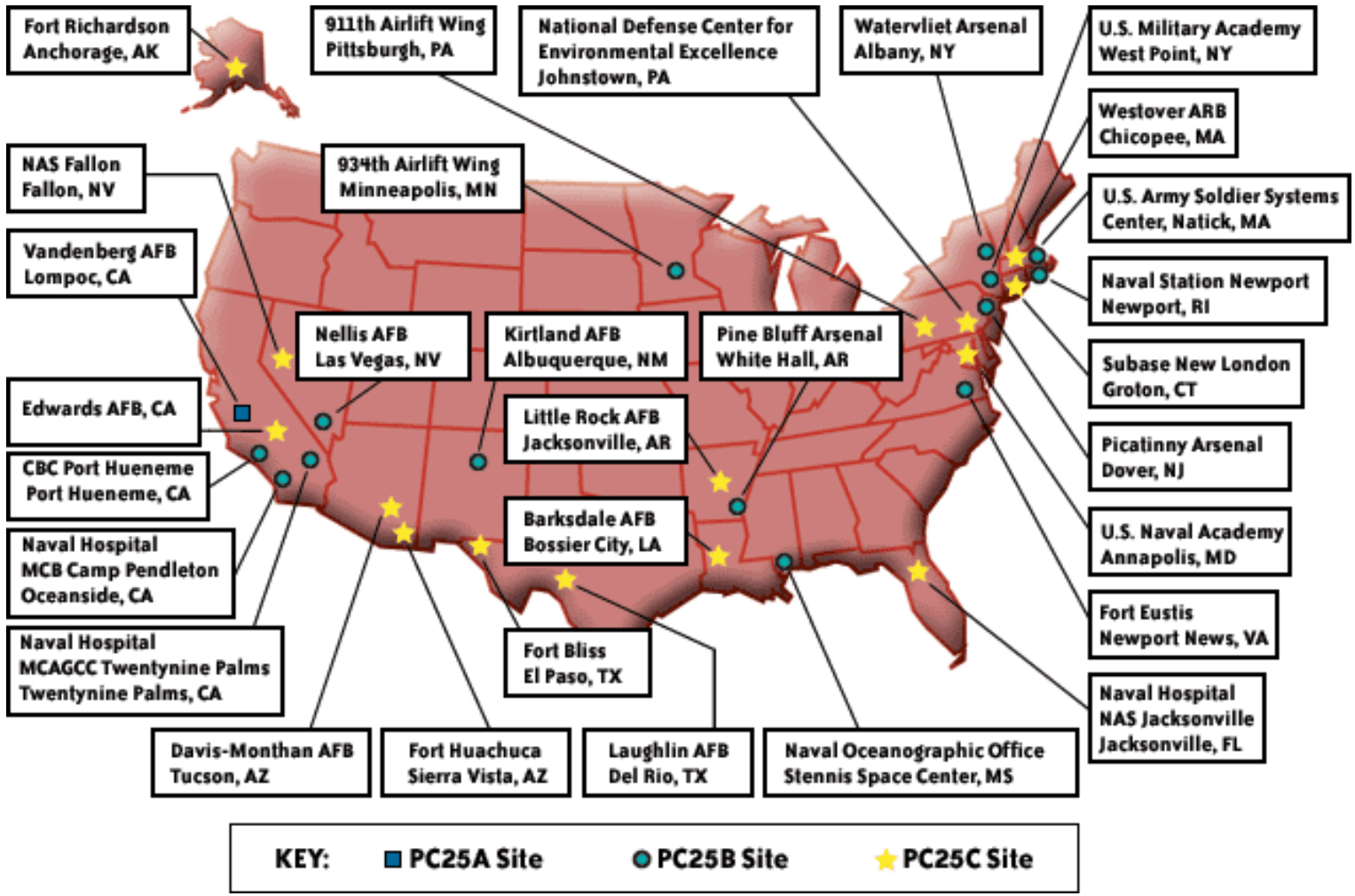
European Bus Demonstrations



Each of the10 cities will operate 3 fuel cell powered buses in revenue service

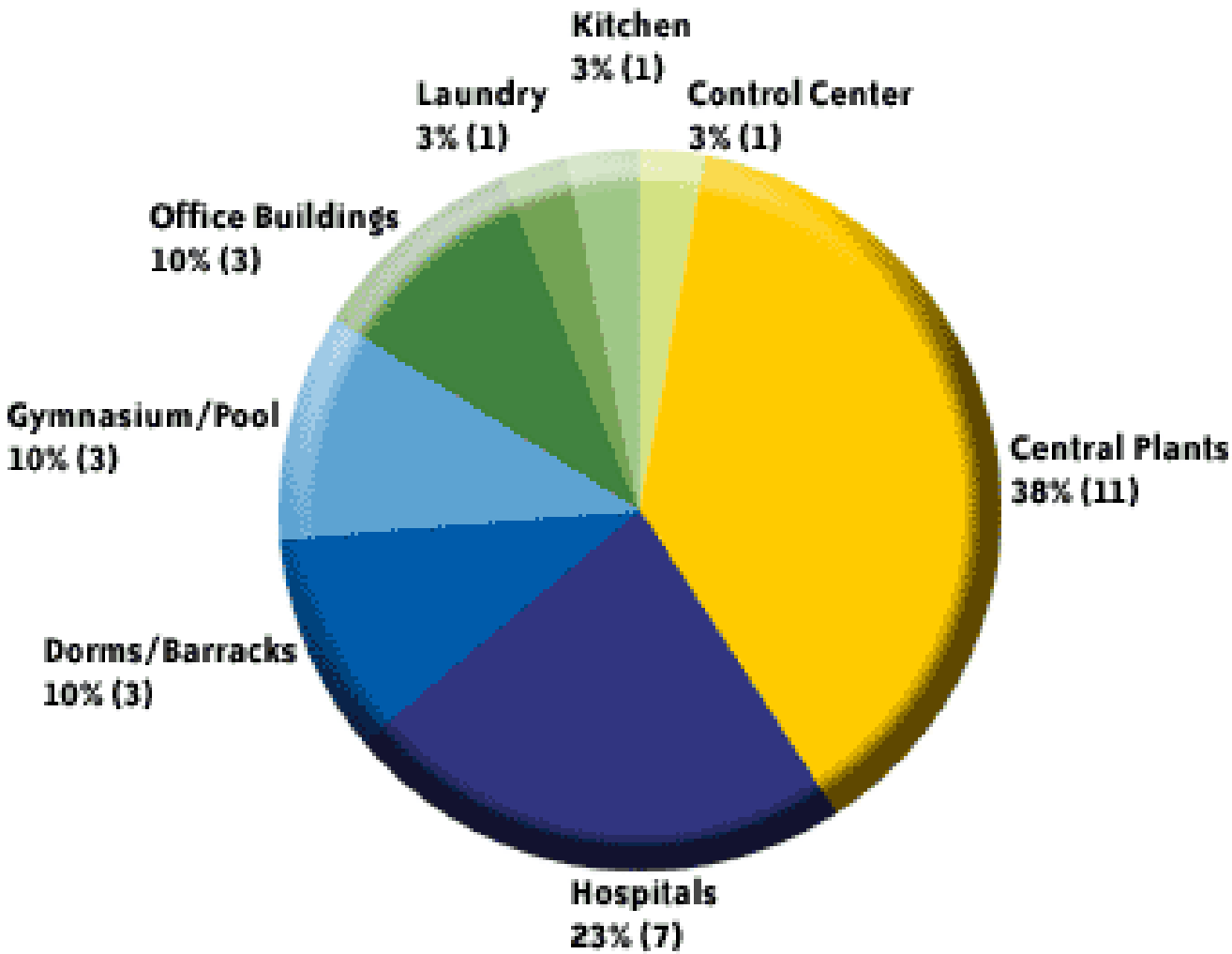
Stationary Demonstrations

US DoD PAFC Demonstrations

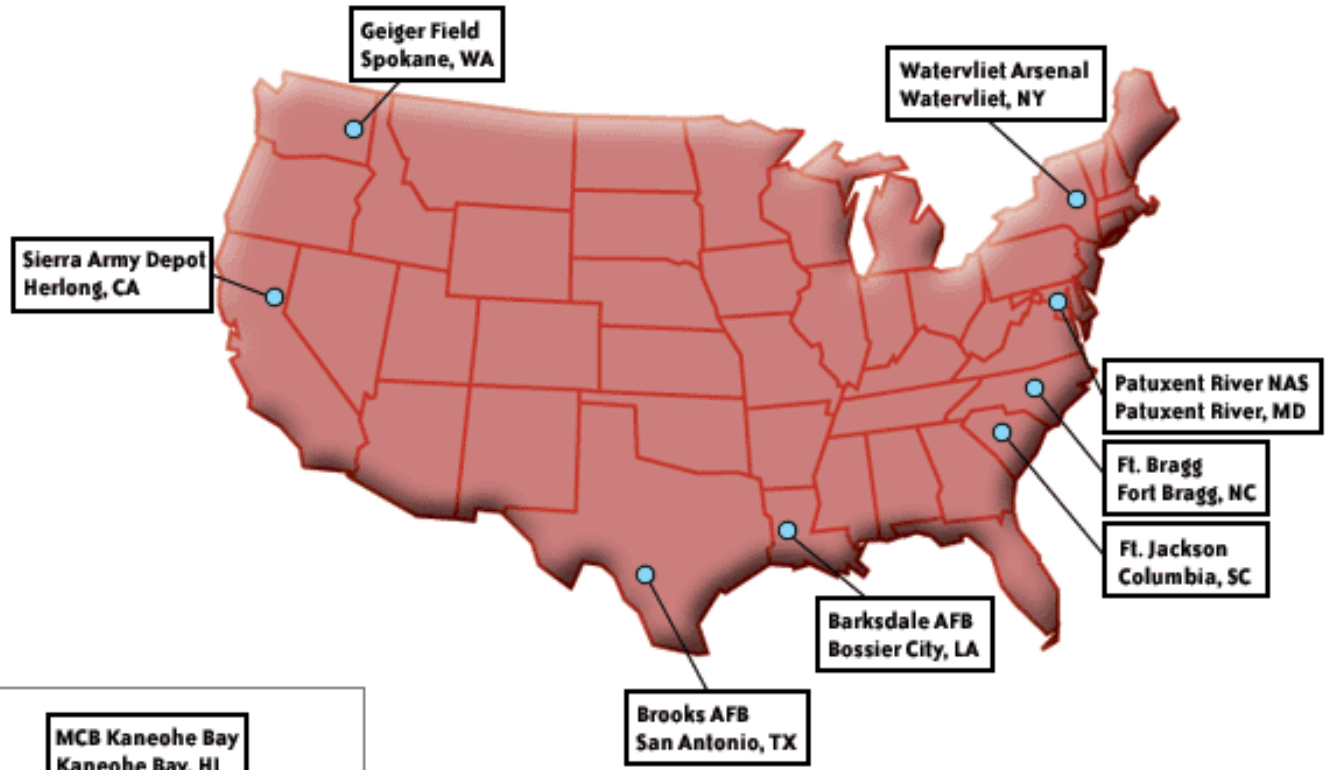


Between 1994 and 1997 30 PAFC were installed at U.S. Department of Defense bases

DoD PAFC Applications



US DoD Residential Fuel Cell Demonstrations



Total Sites:	9
Total Units:	21
Total kWe:	93.5
Fuel:	17 Natural Gas
	3 Propane
	1 Hydrogen

US Civilian Fuel Cell Demonstrations

1PEMFC
3 MCFC
2002 20MW
2003 100MW
2004 300MW

1 SOFC

1? PEMFC

1 PEMFC
1 MCFC

1 MCFC

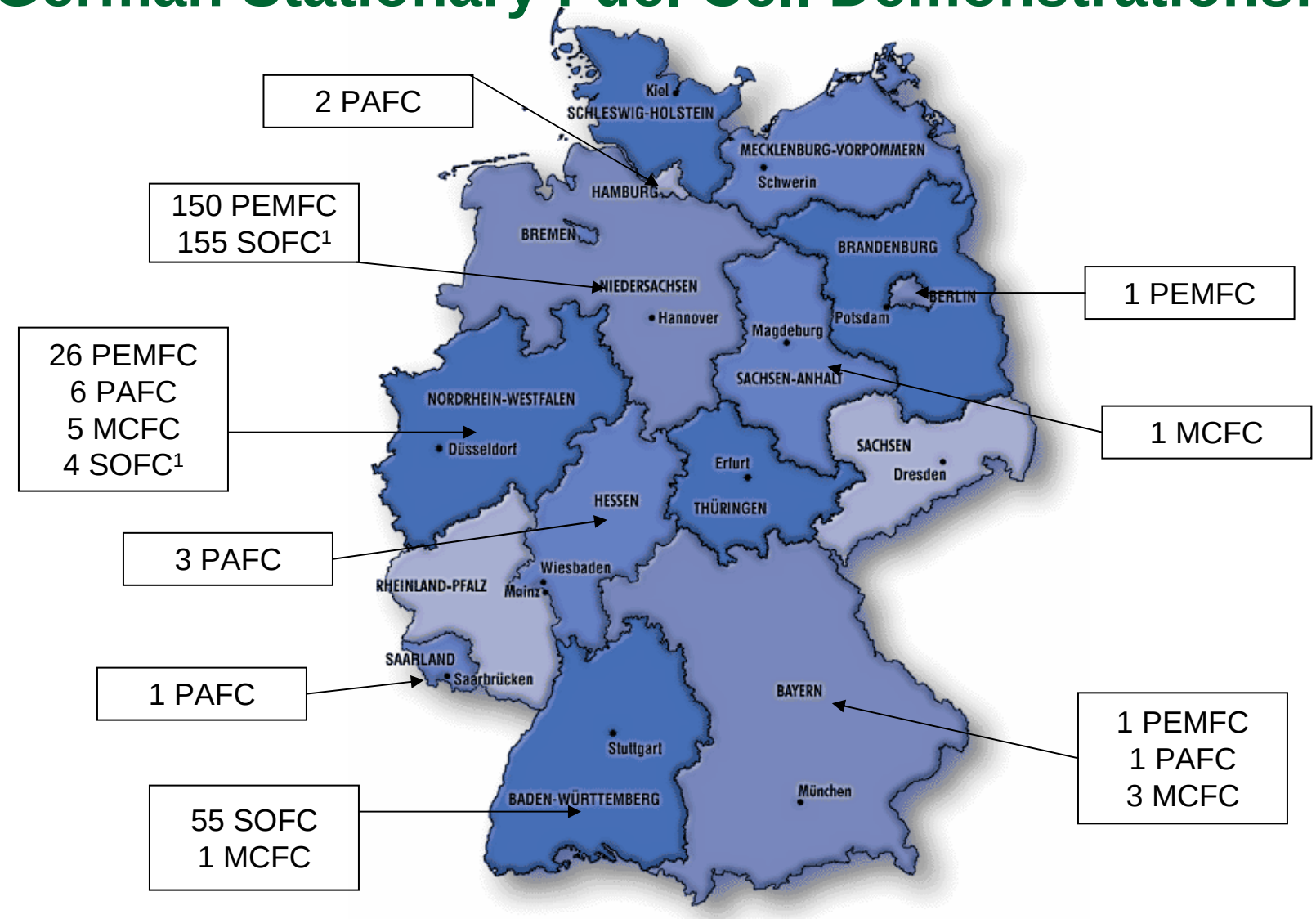
8 PAFC
121 PEMFC

1 MCFC

1 MCFC

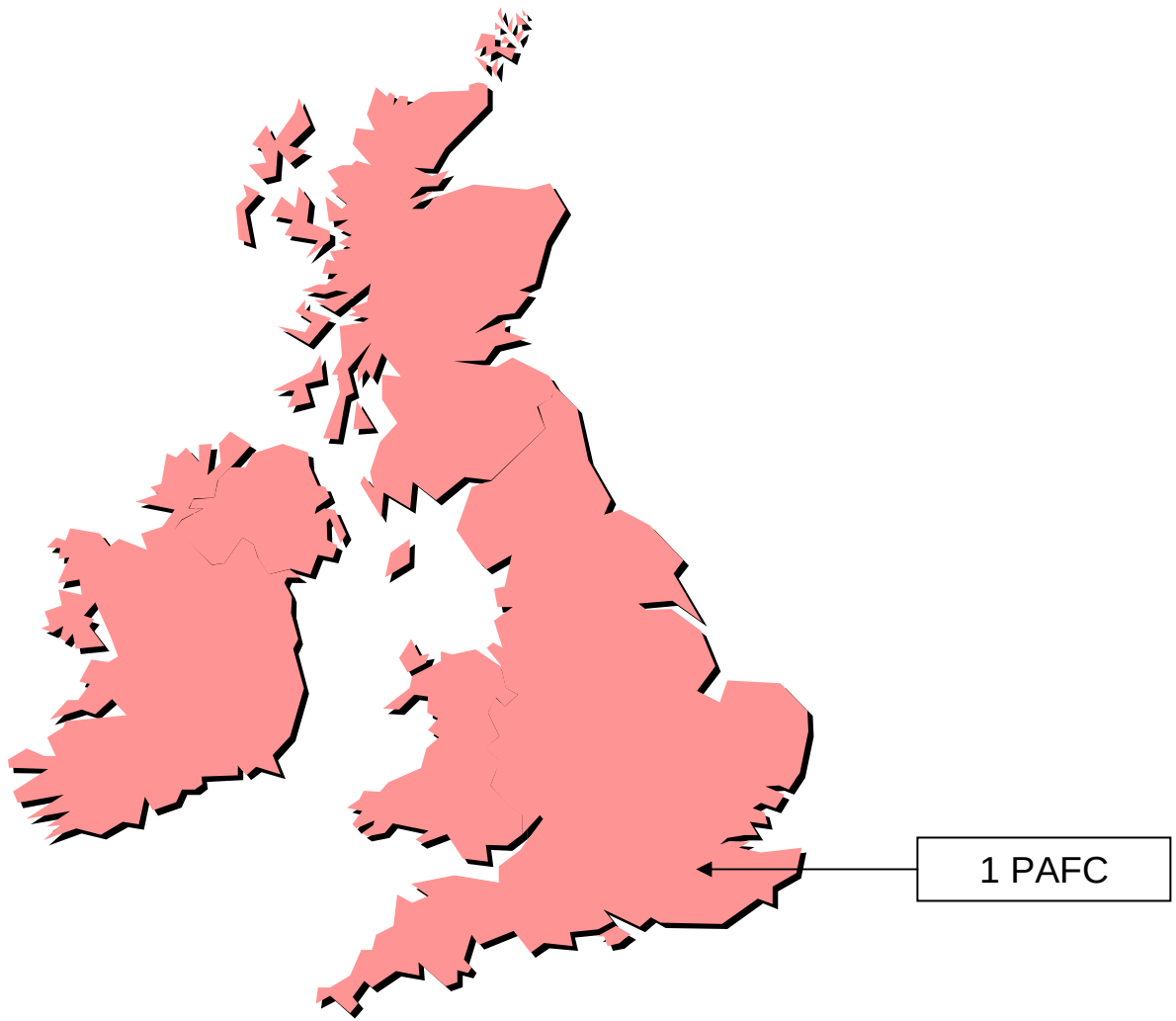
1 MCFC

German Stationary Fuel Cell Demonstrations:



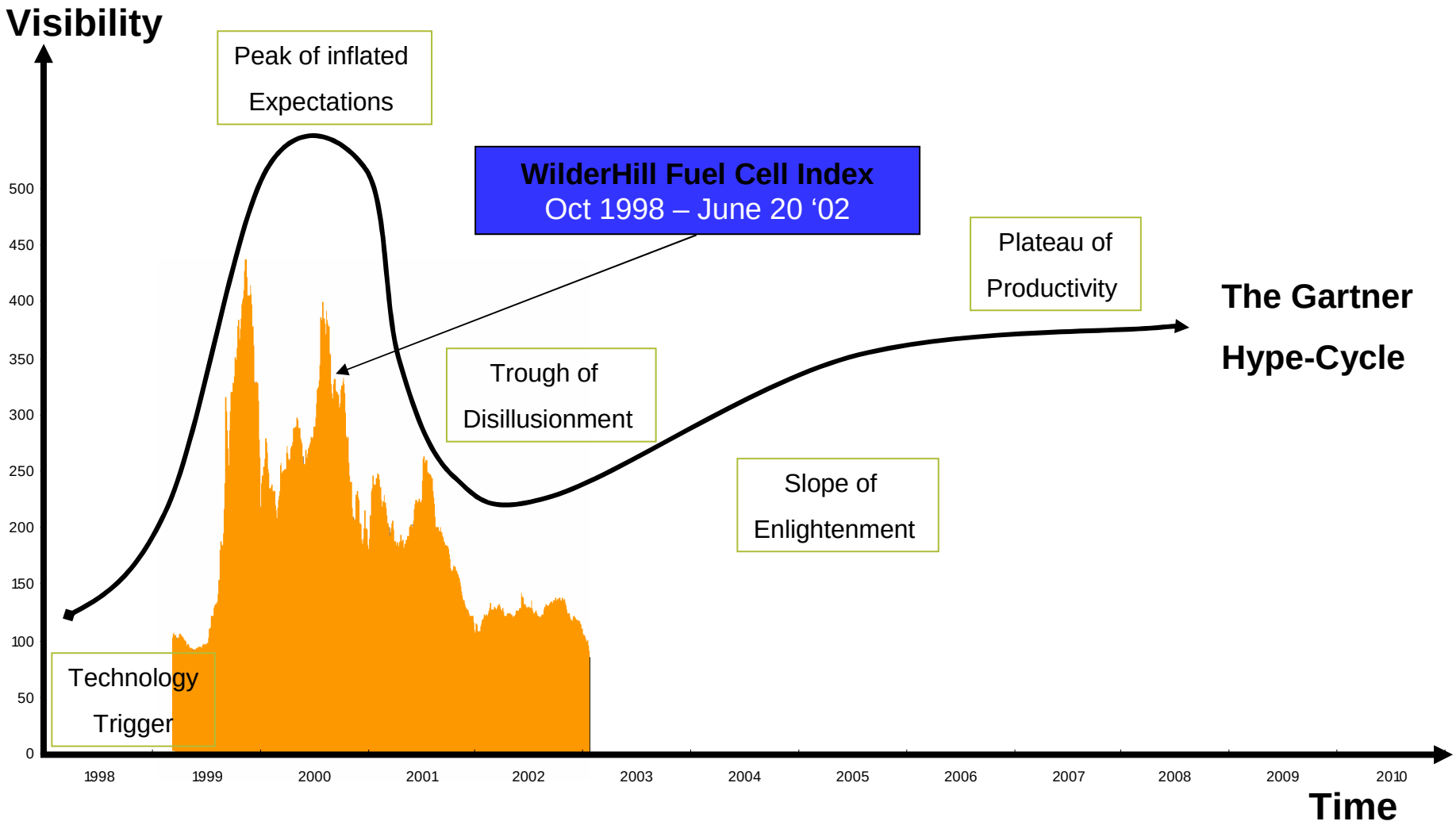
[1] Includes one 300Kw$_e$ combined cycle unit

UK Stationary Fuel Cell Demonstrations:

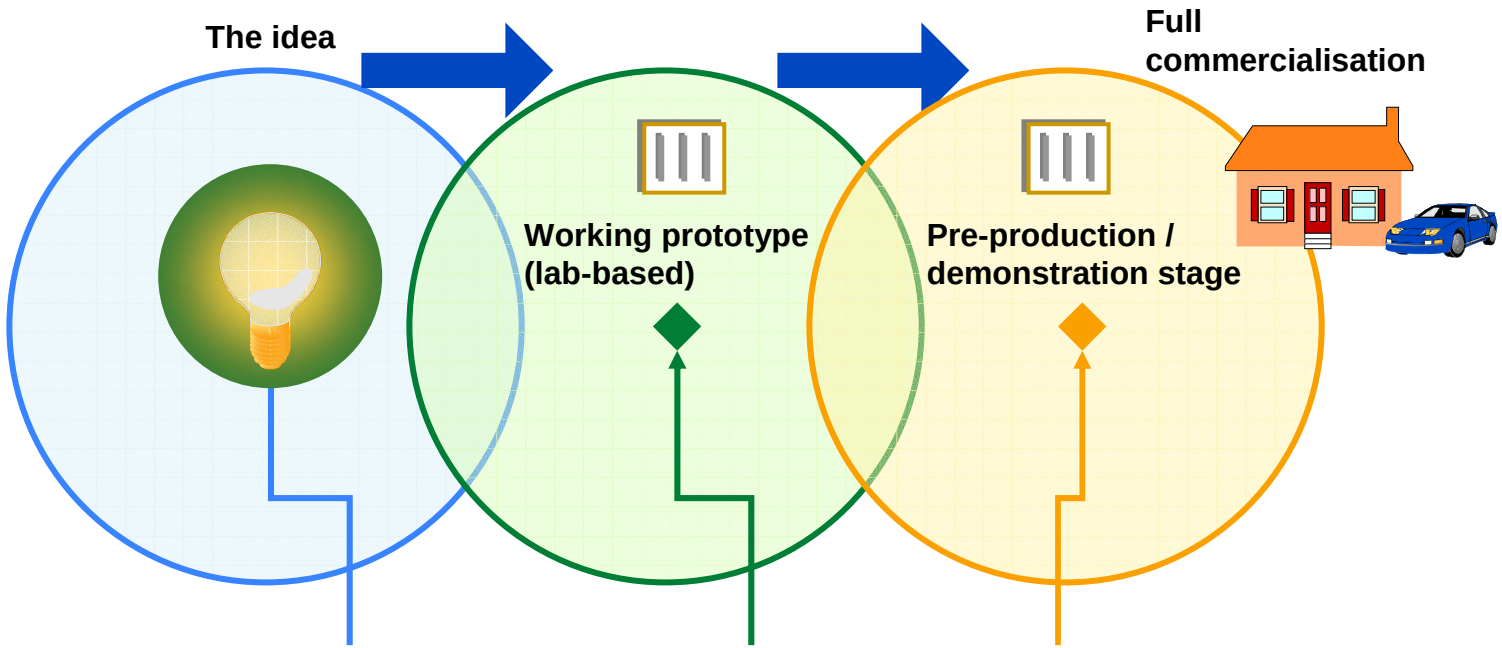


Funding

Emerging Technology Hype Cycle - Gartner

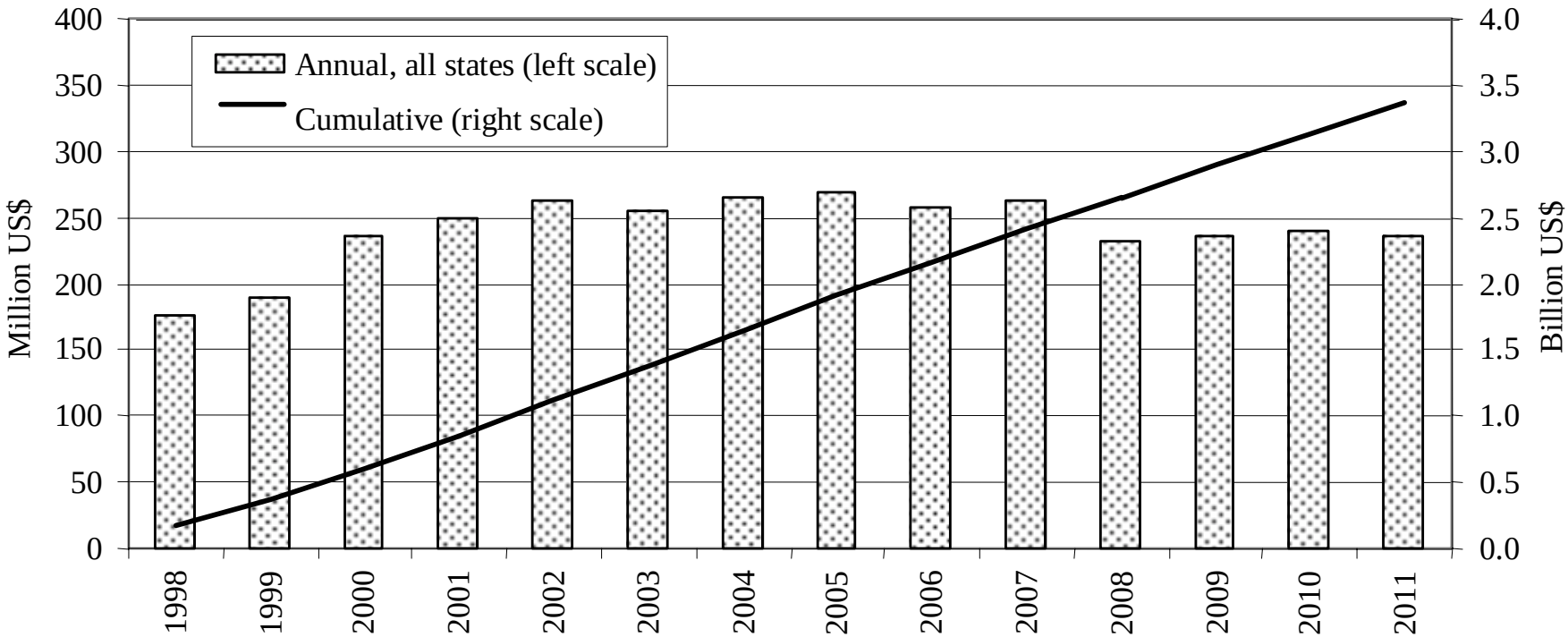


Funding Route



Funding level	Incubator phase/ seed-corn funding	2nd round financing	IPO
Capital providers	'Angels'/government corporate sponsorship	Venture Capital funds	The investment banks/ Stock Market
Comment	Little investigative rigour	IPO -2 to 5 years detailed business plan required	Full prospectus for listing

US States Clean Energy Funds



(**Source**: Mark Bolinger, Ryan Wiser, Lew Milford, Michael Stoddard, and Kevin Porter: "States Emerge as Clean Energy Investors: A Review of State Support for Renewable Energy", *Electricity Journal,* p. 84, November 2001.)

US DoE FY2003 Budget Request

Program	FY 03 Request ($M)	FY 02 Funding ($M)	Change ($M)	Change (%)
Transportation sector	50.0	41.9	8.1	19%
Distributed Generation Fuel Cells	47.0	58.1	-11.1	-19%
Fuel Cells in Buildings	7.5	5.5	2.0	36%
Total DoE Fuel Cell Request	**104.5**	**105.5**	**-1.0**	**-1%**
Hydrogen Research	39.9	29.2	10.7	37%
Total Including Hydrogen	**144.4**	**134.7**	**9.7**	7%

Stock activity in North America in 2000

Company	Country	Amount raised (US$)	Type of Issue
H-Power Corp	US	100,000,000	Primary
Millennium Cell Inc.	US	45,000,000	Primary
Hydrogenics Corp.	Canada	78,000000	Primary
Stuart Energy	Canada	100,000,000	Primary
Ballard Power	Canada	346,000,000	Secondary
Global Thermo	Canada	70,000,000	Secondary
Fuelcell Energy Inc.	USA	61,000,000	Secondary
TOTAL		**800,000,000**	

Conclusions

- **There is growing interest in the fuel cell industry from all quarters**
- **Billions of dollars have been invested in the technology**
- **But this is just a drop in the ocean compared to what will be required if fuel cells prove commercially viable**
- **The financial markets will provide the overwhelming bulk of this cash**

Governments could lay the ground work and create the jobs of the future by

- **Promotion of large-scale demonstration projects**
- **Promotion of a regulatory framework consistent with its stated policy objectives**
- **An early commitment to Education and Training**