

**EE-402A: Topics in International Technology Management**

**Autumn 2010 Theme:**

**“Asia Technology Management in Energy and Cleantech Domains”**



# **Cleantech in Asia: 2010 Update**

**US-Asia Technology Management Center  
Stanford University  
September 23, 2010**

**Richard B. Dasher, Ph.D.  
Director, US-Asia Technology Management Center  
Executive Director, Center for Integrated Systems  
Stanford University**

# Visitors and Registered Students Are Welcome!

- ◆ Weekly public lecture / panel discussion series presented by the US-Asia Technology Management Center  
<<http://asia.stanford.edu>>
  - ◆ Through 12/02/10
- ◆ This year's theme: “Asia Technology Management in Energy and CleanTech Domains”
  - ◆ Technology strategies for / by companies in Asia
  - ◆ Technology strategies for / by Asian companies (anywhere)
- ◆ Today:
  - ◆ Define cleantech; discuss concrete areas of interest
  - ◆ Major recent developments in Asia: ahead of the U.S....?
  - ◆ First, administrative items:



# Important info for students registering for course credit

- ◆ Register in Axxess
  - ◆ **EE-402A** “Topics in International Technology Management”
- ◆ Credit requirements: see [Syllabus](#)
  - (1) On-site attendance at eight (8) of ten (10) sessions –  
Today: **fill out survey**;  
From next week: **sign weekly sign-up sheet at auditorium**  
Requirement #1 waived for SCPD students
  - (2) Email comments on nine (9) of the ten (10) sessions
    - ◆ **Submit comments by email within two weeks of session**
      - To Prof. Dasher <rdasher at stanford dot edu>
      - With cc to Nikolaos <bonatsos at stanford dot edu>
      - In-line text only: **NO ATTACHMENTS**



# Request for today, 9/23

## Everyone: students and visitors

- ◆ Please fill out survey form and leave with Nikolaos or with me
- ◆ For students registering, the survey form is your on-site attendance record for 9/23/10
  - ◆ In addition, you will need to submit comments on the content of today's lecture within two weeks



## A few of our upcoming sessions

Date	Speaker	Topic
9/30	Dr. Jim Caldwell Director, US-China Green Energy Council	Standards for smart buildings and smart cities in China
10/14	Scott Chou, Gabriel VP David Gong, Tsing Capital	VC Panel: Energy and cleantech opportunities in China
10/28	Farhad Forbes, Forbes Marshall Consulting	Energy infrastructure in India
various	VPs of R&D at major Japanese companies	<ul style="list-style-type: none"><li>• power systems in automobiles</li><li>• new “green” materials (e.g. CF)</li></ul>





# **Cleantech in the real world**

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# Definition of cleantech

- ◆ **New technology and related business models that offer competitive returns for investors and customers**
- ◆ **... while providing solutions to global challenges in**
  - ◆ **climate change**
  - ◆ **scarcity of food, water and other commodities**
  - ◆ **concerns about energy independence**
- ◆ **-- CleanTech Group LLC**



# CleanTech industry segments

- ◆ **Energy**
  - ◆ **Generation, storage, infrastructure, efficiency**
    - ◆ Renewable sources, biofuels definitely in; what about nuclear?
    - ◆ Smart Grids, transmission & distribution technologies
    - ◆ Fuel cells, (new) batteries
    - ◆ Efficient lighting (e.g. LEDs), buildings, glass, etc.
- ◆ **Transportation and logistics**
- ◆ **Environment**
  - ◆ **Water, waste & emissions, environment systems**
    - ◆ Processing, recycling, monitoring, systems modeling, economic aspects – trading
- ◆ **Industrial and agricultural**
  - ◆ Manufacturing equipment, packaging, control, intelligent processes, sustainable practices
- ◆ **Materials**





# Outline

- ◆ **Dominant themes in Asia energy and cleantech 2010**
- ◆ **The role of government policy and stimulus spending**
- ◆ **Patterns of venture capital investment  
(in Asia energy and cleantech)**
- ◆ **A few selected products and industry segments in Asia**
- ◆ **R&D directions**
- ◆ **Opportunities & challenges for the U.S.**
- ◆ **Discussion, Q&A**



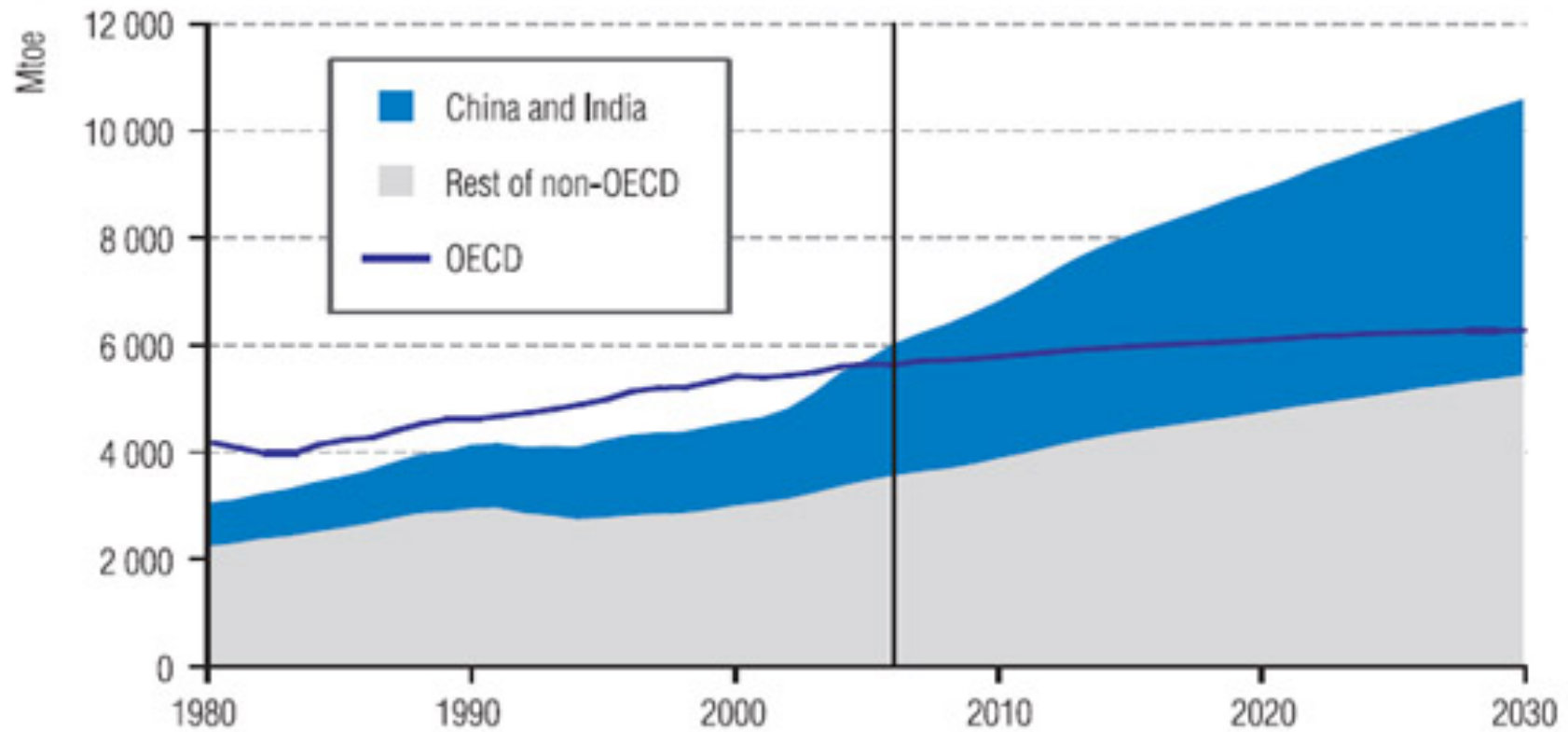
# Asia energy and cleantech: Big themes in 2010

- ◆ **China and India (and to lesser extent “developing economies”)**
  - ◆ Going green at the same time as . . .
  - ◆ They frantically roll out energy infrastructure to match skyrocketing demand
- ◆ **Infrastructure roll-out = business for current generation technologies**
  - ◆ Wind surprisingly dominant
  - ◆ Nuclear
- ◆ **Hot topics in new products & R&D**
  - ◆ Solar, smart grids, (biofuels)
  - ◆ Efficiency: smart buildings, cities, cars, water & waste management
  - ◆ Promises about CO<sub>2</sub> reduction (but not much on sequestration)



# Emerging energy demand

World primary energy demand by region, reference scenario



Mtoe = Millions of tonnes of oil equivalent

Source: IEA, *World Energy Outlook 2008* page 81

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# Chinese cities' energy demand by fuel type

	2006		2015		2030		2006-2030*
	Mtoe	Cities as a % of national	Mtoe	Cities as a % of national	Mtoe	Cities as a % of national	
Coal	1 059	87%	1 665	88%	2 206	90%	3.1%
Oil	271	77%	428	77%	648	80%	3.7%
Gas	40	81%	84	82%	158	84%	5.9%
Nuclear	12	84%	39	84%	67	87%	7.5%
Hydro	31	84%	52	84%	76	87%	3.8%
Biomass and waste	10	4%	12	5%	37	16%	5.6%
Other renewables	2	45%	9	62%	27	67%	12.2%
<b>Total</b>	<b>1 424</b>	<b>75%</b>	<b>2 289</b>	<b>79%</b>	<b>3 220</b>	<b>83%</b>	<b>3.5%</b>
<i>Electricity</i>	<i>161</i>	<i>80%</i>	<i>314</i>	<i>80%</i>	<i>495</i>	<i>83%</i>	<i>4.8%</i>

\* Average annual growth rate.

MTOE = millions of tons of oil equivalent

International Energy Agency, *Energy Outlook 2008*, page 193

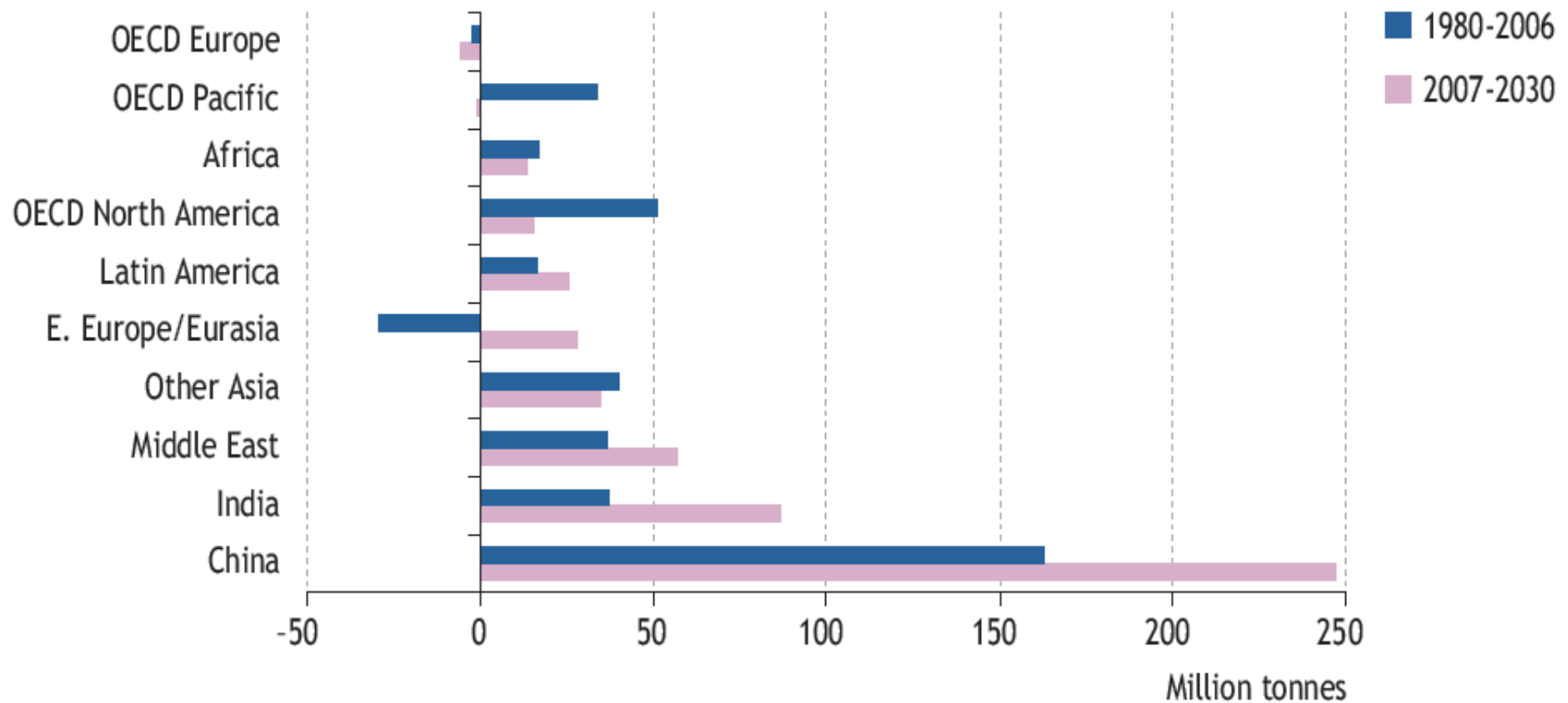
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# Average annual increase in energy-related CO<sub>2</sub> emissions



International Energy Agency, *Energy Outlook 2008*, page 385

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# Government policy on CO<sub>2</sub> emissions reduction

- ◆ **China (11/26/2009): Unilateral announcement: they will reduce CO<sub>2</sub> intensity in 2020 by 40 – 45 percent from 2005 level**
  - ◆ Would yield about same total emissions as at present
  - ◆ Announcement made several weeks before the Copenhagen Accord (12/18/2009)
- ◆ **Other Copenhagen Accord pledges (eventually not binding)**
  - ◆ India: 20 – 25% intensity reduction
  - ◆ Japan 25%
  - ◆ South Korea 30%
  - ◆ Indonesia 26%
  - ◆ USA, Canada each 17%



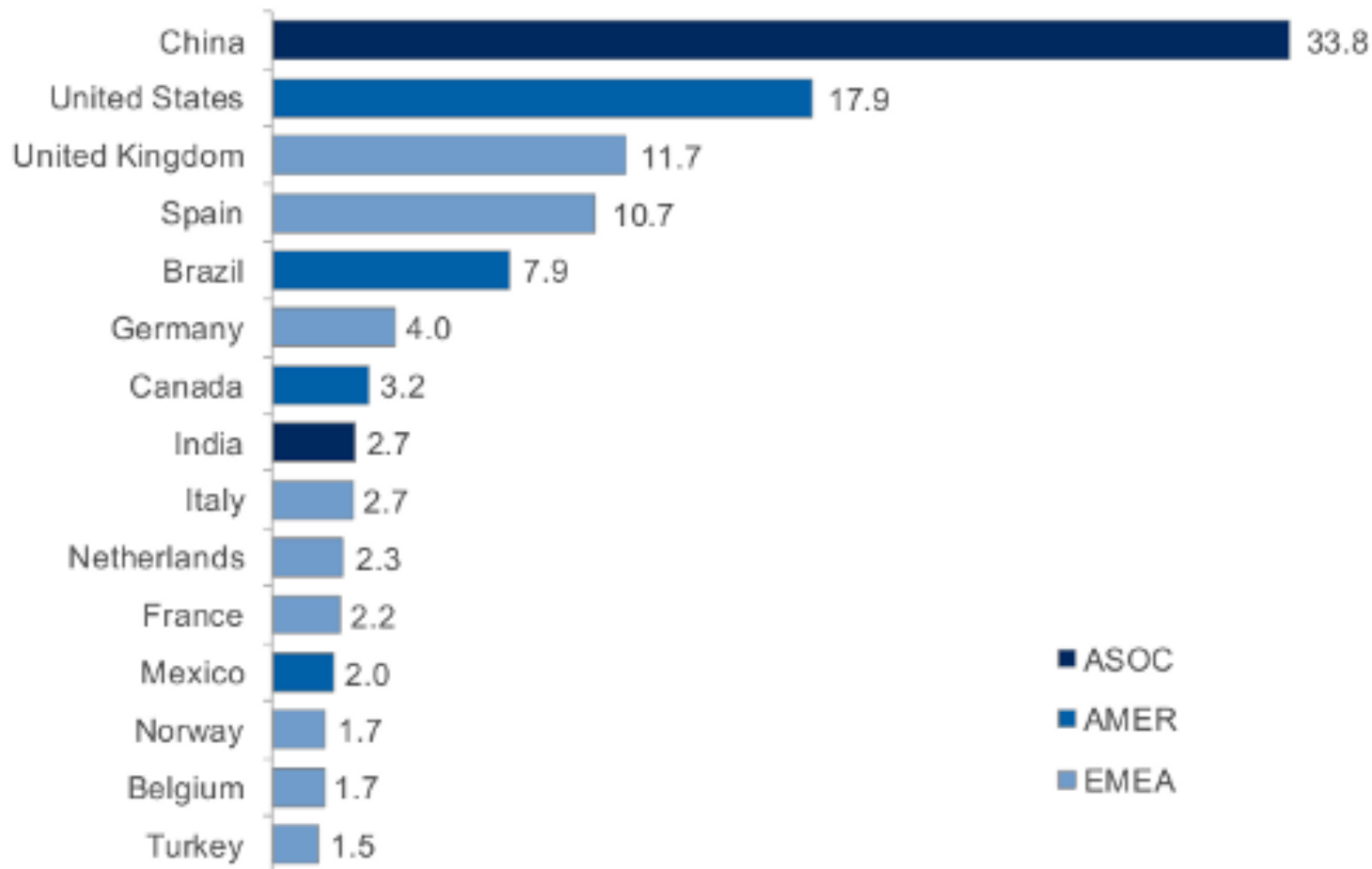
# Second major impact of government on cleantech: stimulus spending

<b>2009 – 2013 (government) pledges for stimulus spending and stimulus components targeted at clean energy</b>	
<b>U.S.A.</b>	<b>(billions) \$66.6</b>
<b>China</b>	<b>46.9</b>
<b>South Korea</b>	<b>27.8</b>
<b>Japan</b>	<b>8.6</b>
<b>EU-27</b>	<b>12.7</b>

Bloomberg New Energy Finance, 12 Feb 2010



# New financial investment in clean energy - top 15 countries 2009 (\$bn)



Source: Bloomberg New Energy Finance

Note: Excludes corporate and government R&D, and small distributed capacity). Not adjusted for re-invested equity. Total values include estimates for undisclosed deals



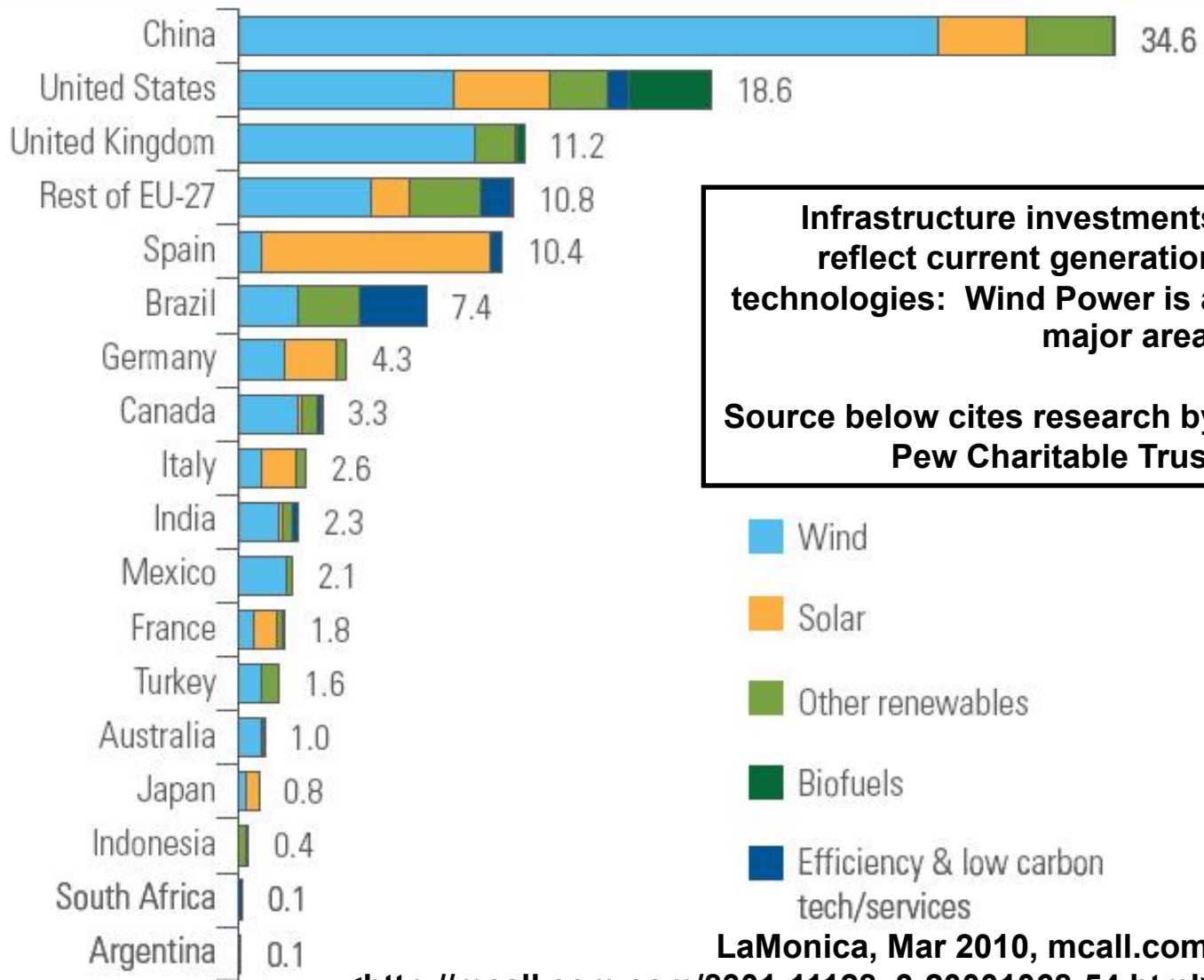


# So, commentators now saying that Asia (China) has passed the U.S. in cleantech

- ◆ Reuters 9/22/2010 “U.S. seen losing renewable energy race to Asia.” <http://www.newzfor.me/news/93137658.aspx>
- ◆ Statement by venture capitalist Ravi Viswanathan, partner at New Enterprise Associates, to U.S. congressional committee
- ◆ Specifically: China, India, South Korea, Malaysia, Philippines
- ◆ Selected quotes:
  - ◆ “These nations have outpaced the U.S. in recruiting, incenting [sic] and developing domestic manufacturing of solar, wind, and battery technology,” (Viswanathan said)
  - ◆ China already has more than half of the world's market for solar panels and its companies are looking to export wind turbines
- ◆ Push toward getting congressional approval for a “Renewable Energy Standard” (percentage that a utility must produce)



FIGURE 10. INVESTMENT BY SECTOR, 2009 (billions of \$)



**Infrastructure investments reflect current generation technologies: Wind Power is a major area.**

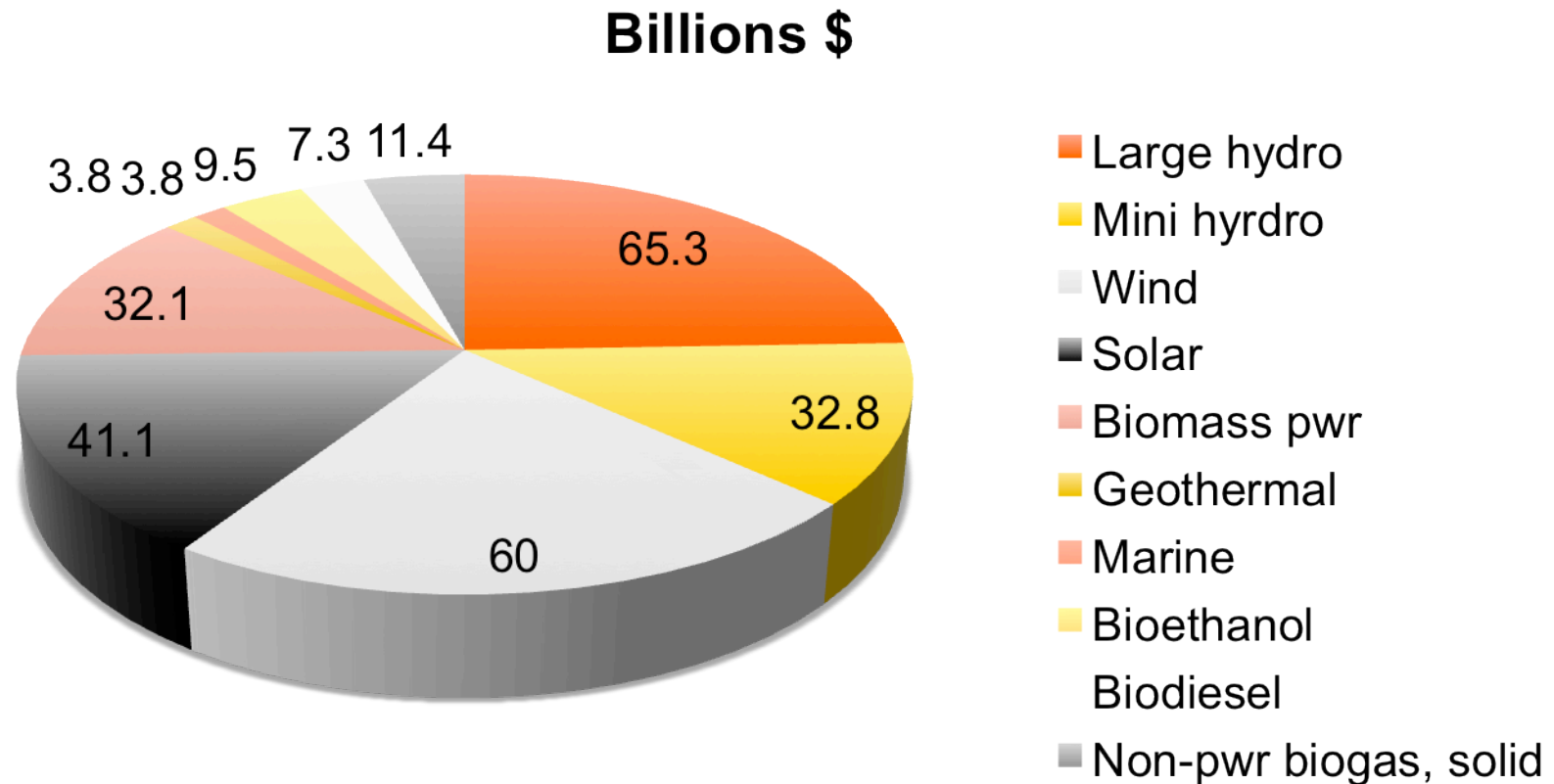
**Source below cites research by Pew Charitable Trust**

- Wind
- Solar
- Other renewables
- Biofuels
- Efficiency & low carbon tech/services

LaMonica, Mar 2010, mcall.com, <[http://mcall.com.com/8301-11128\\_3-20001068-54.html](http://mcall.com.com/8301-11128_3-20001068-54.html)>

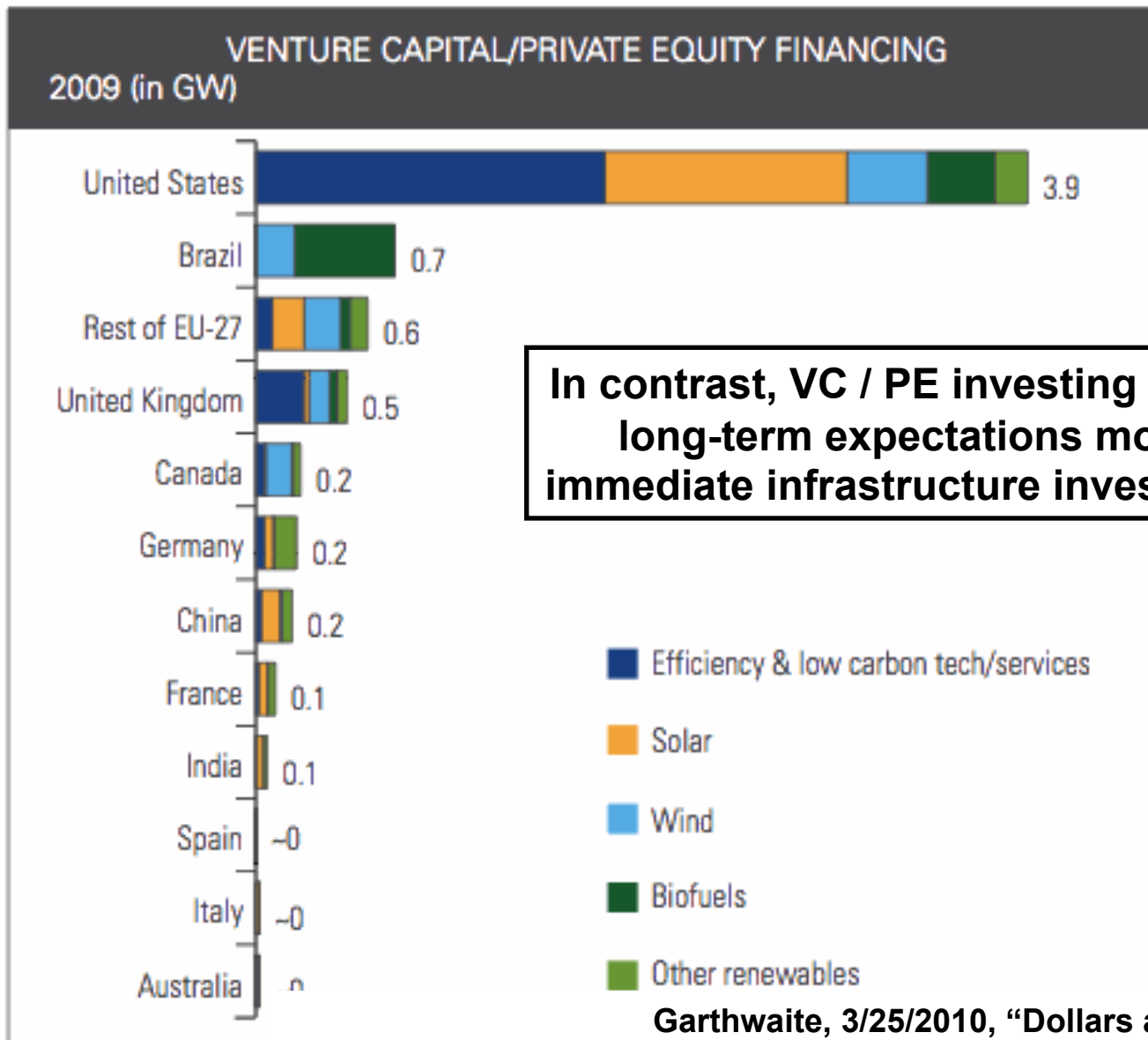


# China renewable energy investment forecast 2006 - 2020



Ying, Feb 2007, "Powering progress: China's clean energy revolution," *Renewable Energy World International Magazine*, v 10 no. 1





Garthwaite, 3/25/2010, "Dollars and Yuan: Snapshot of Global Green Energy Investment," Gigaom.com



# Selected industry segment – 1: Asian companies among global leaders: power gen

## Wind turbines

Name (Country)	Production (GW)
Vestas (DK)	6.3
GE Wind (US)	5.8
Sinovel (CN)	5.8
Gamesa (SP)	4.4
Suzlon (IN)	3.5
Goldwind (CN)	3.4
Enercon (DE)	3.3
DFSTW (CN)	3.3
Repower (DE)	2.9
Nordex (DE)	2.5

## Crystalline Silicon PV cells

Name (Country)	Current capacity (MW)
Suntech (CN)	1090
Q-Cells (DE)	1000
JA Solar (CN)	800
SolarWorld (DE)	710
Sharp (JP)	695
Trina Solar (CN)	600
Yingli (CN)	600
Canadian Solar (CN)	420
SunPower (US)	414
Solarfun (CN)	360

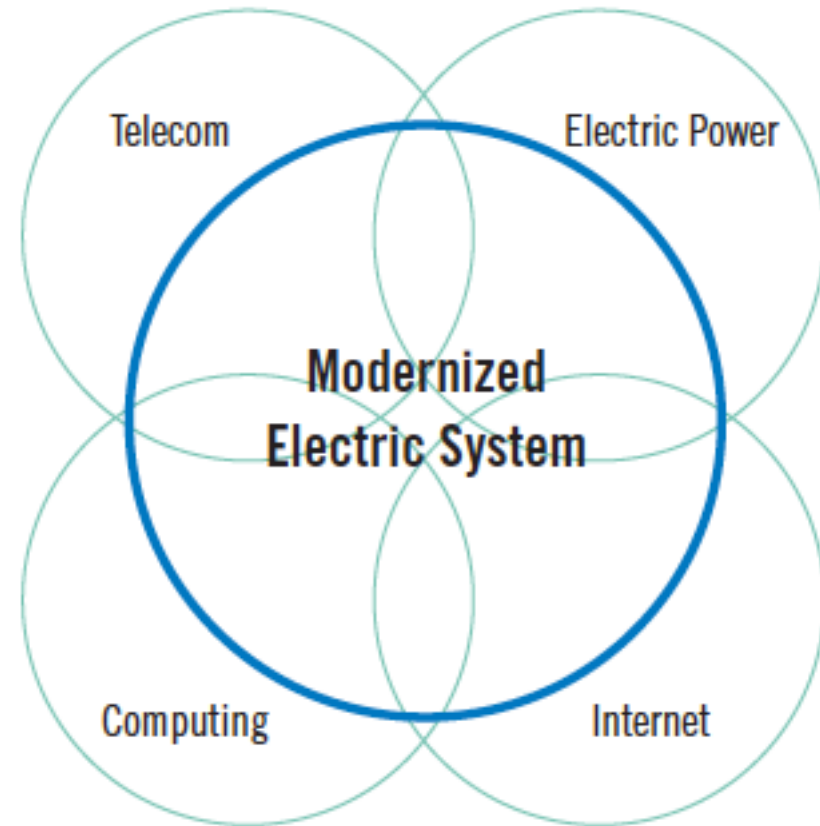
■ United States 
 ■ China 
 ■ Europe 
 ■ Rest of world

Hodge, July 7, 2010, *Energy\_and\_Capital.com*



## Selected segments – 2: Smart grids

- ◆ Add computing and communications intelligence to electric power transmission and distribution
- ◆ This brings together several \*different\* industries



# About the background of smart grids

- ◆ **Became a hot topic in the U.S. from about 2004 - 2005**
- ◆ **Positive motivations**
  - ◆ Major new application area for computing & networking technology
  - ◆ Recognition that “smart grids” could bring many new opportunities
- ◆ **Negative concerns**
  - ◆ U.S. power grid infrastructure was getting old – over half needed to be replaced within the next five to ten years
  - ◆ New energy sources would be difficult to incorporate into the existing grid topology
- ◆ **Interest is more recent in Japan: power companies already had newer infrastructure**
  - ◆ Negative reply to Dasher inquiry in November 2008 about smart grid interest



# Comparing old and new

<b>20<sup>th</sup> Century Grid</b>	<b>21<sup>st</sup> Century Smart Grid</b>
<b>Electromechanical control</b>	<b>Digital, more automatic control by computer</b>
<b>Radial from central generation point</b>	<b>Network (ring) with distributed generation points of various sizes</b>
<b>Very limited monitoring, few sensors</b>	<b>Many sensors allow self monitoring, auto restoration, self-healing</b>
<b>Prone to security threats, natural failures and blackouts</b>	<b>Algorithms to analyze situation, changes; more predictive control</b>
<b>Distributes a commodity: power</b>	<b>Empowers consumer to make more choices about power use; possible applications</b>





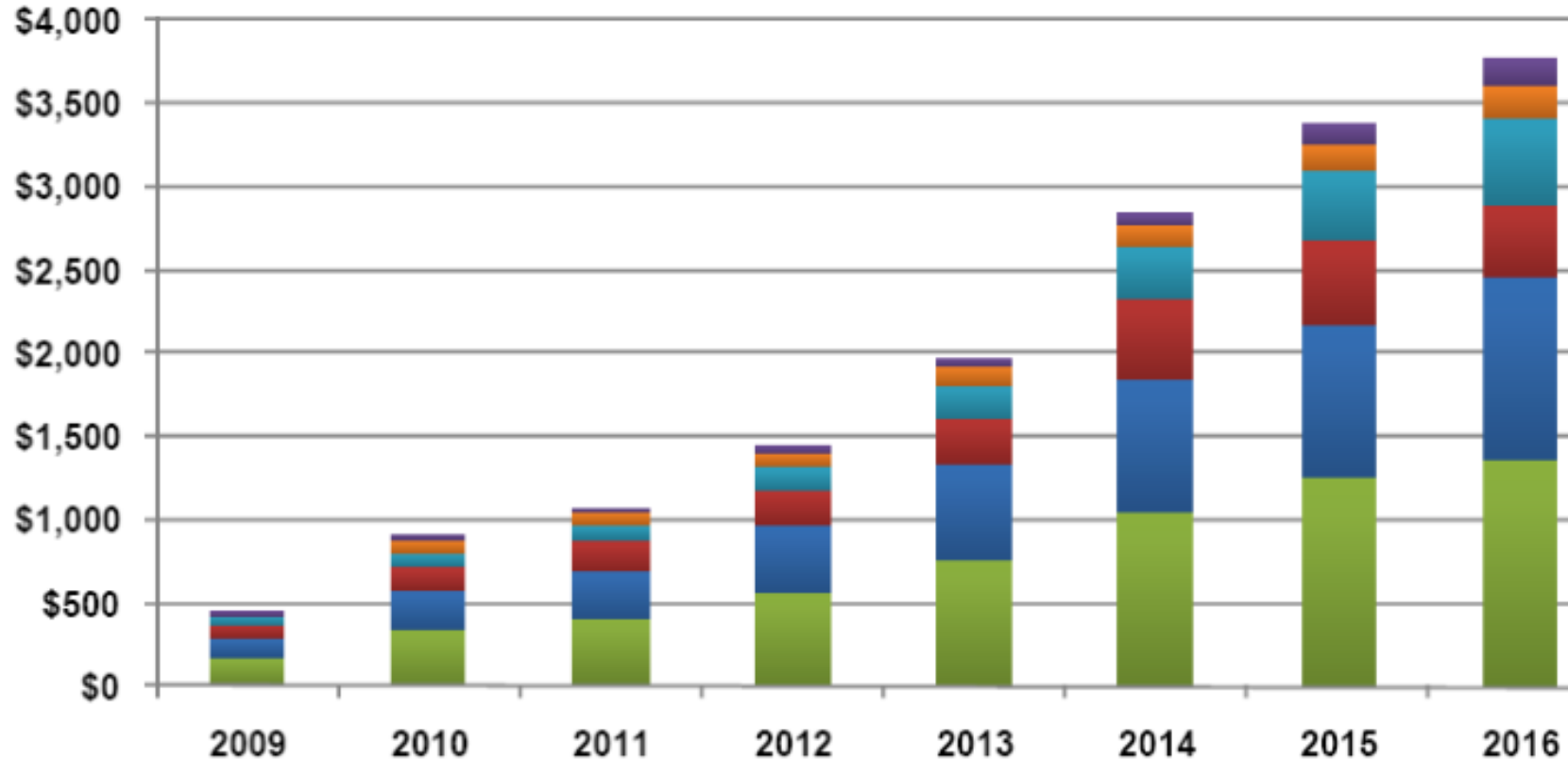
# What's happening with Smart Grids in Asia

- ◆ **Lots of interest: public programs, symposia, etc.**
  - ◆ **“Smart Grids Asia 2010,” Singapore, Oct. 27 – 28, 2010**
  - ◆ **“Smart Grids China 2010,” Shanghai, Nov. 2 – 4, 2010**
- ◆ **Most business push coming from Japanese and Korean new equipment providers (e.g. smart meter makers)**
  - ◆ **They report difficulty with very conservative grid operators**
- ◆ **Grid operators primarily concerned with safety, security, reducing maintenance costs**
  - ◆ **May be waiting to see if they can get government stimulus funds...**



# Smart Grid Revenue by Application, So. Korea, 2009-2016

millions



<ul style="list-style-type: none"> <li><span style="color: purple;">■</span> Electric Vehicle Management Systems</li> <li><span style="color: cyan;">■</span> Renewable Energy Management Systems</li> <li><span style="color: blue;">■</span> Transmission Upgrades</li> </ul>	<ul style="list-style-type: none"> <li><span style="color: orange;">■</span> Smart Meters</li> <li><span style="color: red;">■</span> Substation Automation</li> <li><span style="color: green;">■</span> Distribution Automation</li> </ul>	<p><b>Revenue from areas that save grid operators money, not really new apps.</b></p>
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(from Pike Research)

New Energy News, (blog)  
April 4, 2010



# Industry segment 3: What ever happened to fuel cells?

- ◆ **Still active and going commercial! Large size, micro-, and FCHV (fuel cell hybrid vehicle)**
- ◆ **Panasonic: Household fuel cell system for electricity and heating (next page)**
  - ◆ **On sale (OEM) from utility companies in Japan since April 2010**
  - ◆ **Runs on city gas: methane**
  - ◆ **Total 85% efficiency (electricity generation plus heat recovery)**
  - ◆ **Other companies planning competing products: Toshiba, (Sanyo), Ebara, Toyota, Honda (also provides H<sub>2</sub> for FC vehicles)**
- ◆ **Panasonic, Toshiba: micro- fuel cells for laptop computers, battery chargers**
  - ◆ **Also on sale**



- Fuel cell unit -

<b>Fuel type</b>		City gas (13A)
<b>Power supply</b>		Single phase three lines, 100/200 V AC, 50/60 Hz
<b>Electric output</b>	<b>Rated output</b>	1000 (W)
	<b>Output range</b>	300 - 1000 (W)
<b>Electricity generation efficiency (rated)</b>		HHV:35% LHV:39%
<b>Heat recovery efficiency (rated)</b>		HHV:50% LHV:56%
<b>Dimensions</b>		Width 780 x Depth 400 x Height 860 (mm)
<b>Weight</b>		125 (kg)
<b>Noise level (during electricity generation)</b>		39 dB (A)

## Panasonic ENE FARM



- Hot water storage unit -

<b>Hot water storage capacity</b>	200 L
<b>Hot water supply performance</b>	41.9 kW (types 24) Capable of air heating and water reheating
<b>Dimensions</b>	Width 750 x Depth 480 x Height 1883 (mm)
<b>Weight</b>	125 (kg)



# Fuel cell electric & fuel cell hybrid vehicles: on the streets (in demo mode)



- ◆ **Toyota fuel cell hybrid vehicle demo program (Jan. 2010)**
  - ◆ 100 vehicles to universities, private co's and gov't agencies in both California and New York
  - ◆ Already 20 vehicles on the road



- ◆ **Honda FCX Clarity FCEV**
  - ◆ Being leased in Southern California since 2008
  - ◆ Jamie Lee Curtis was one of first customers
  - ◆ Flat lease rate: \$600/month includes maintenance, no purchase option

## **R&D trends for the future: international collaboration seems to be the trend: random exs.**

- ◆ **June 2010: U.S. and Japan, State of Hawaii, and Okinawa Prefecture sign an agreement**
  - ◆ **To establish joint experimental next-generation ‘smart grid’ power transmission network project (NSF Tokyo Office June Highlights)**
- ◆ **September 2010: US-China Clean Energy Research Center (Department of Energy funding)**
  - ◆ **\$25M over five years to Lawrence Livermore National Lab for U.S. team led by West Virginia University**
  - ◆ **Will develop and test new technology for capturing and storing carbon gas**
  - ◆ **Separate \$25M to U. Mich. for clean energy vehicles, with Chinese partners to be announced**

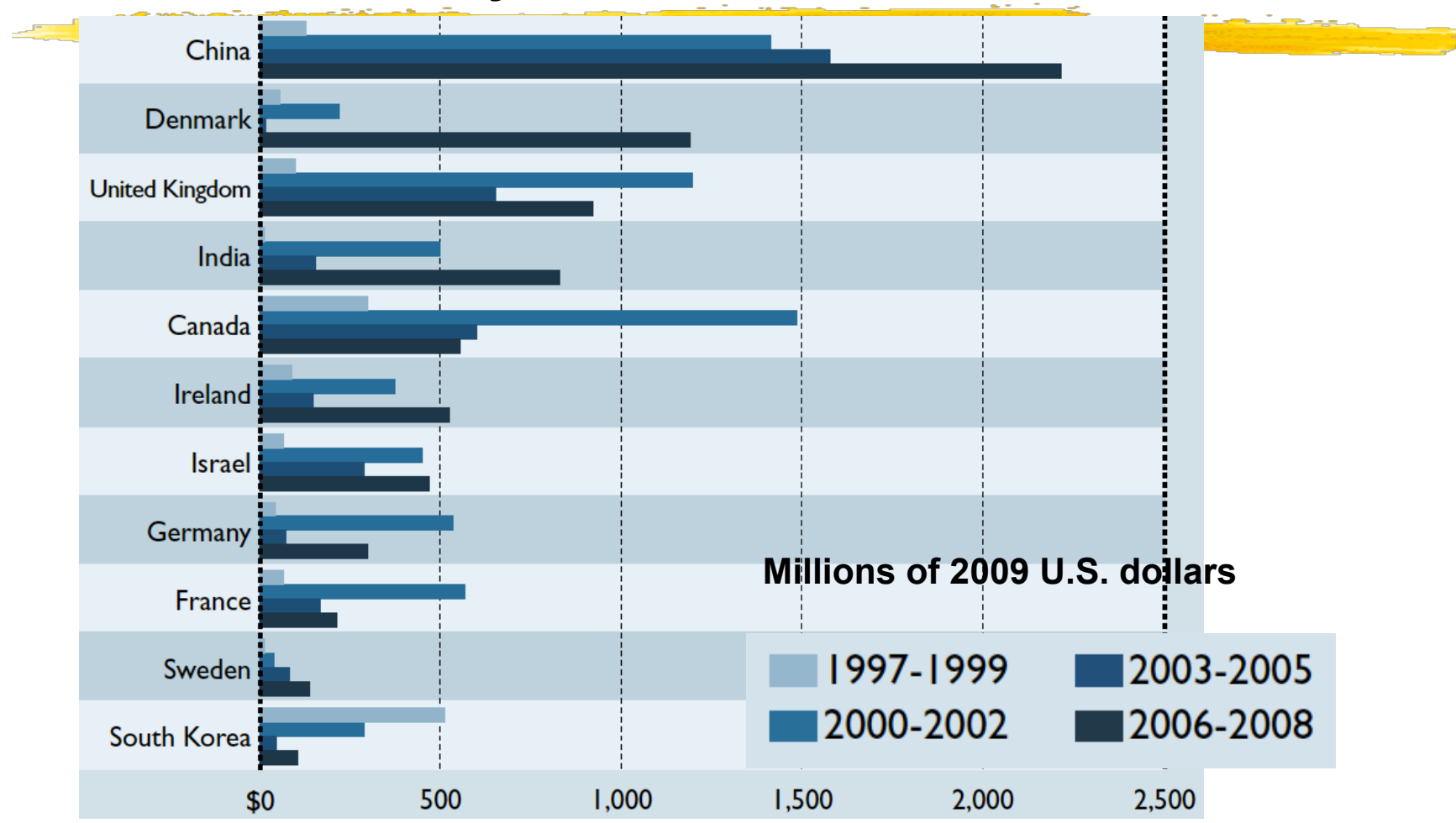


# What does all this mean for the U.S.?

- ◆ Continuing pressure for global approach to business
- ◆ Need attention to some areas in which U.S. is traditionally passive:
  - ◆ International standards development
- ◆ Considerable investment and business partnership relationships between Silicon Valley and Asia
  - ◆ See Joint Venture Silicon Valley, *Index of Silicon Valley, 2010*
- ◆ Resource issues may become a problem:
  - ◆ China controls 97% of rare earth metals
  - ◆ Implementing export controls



# Flow of Venture Capital out from Silicon Valley to Other Countries



Millions of 2009 U.S. dollars

1997-1999
  2003-2005  
 2000-2002
  2006-2008

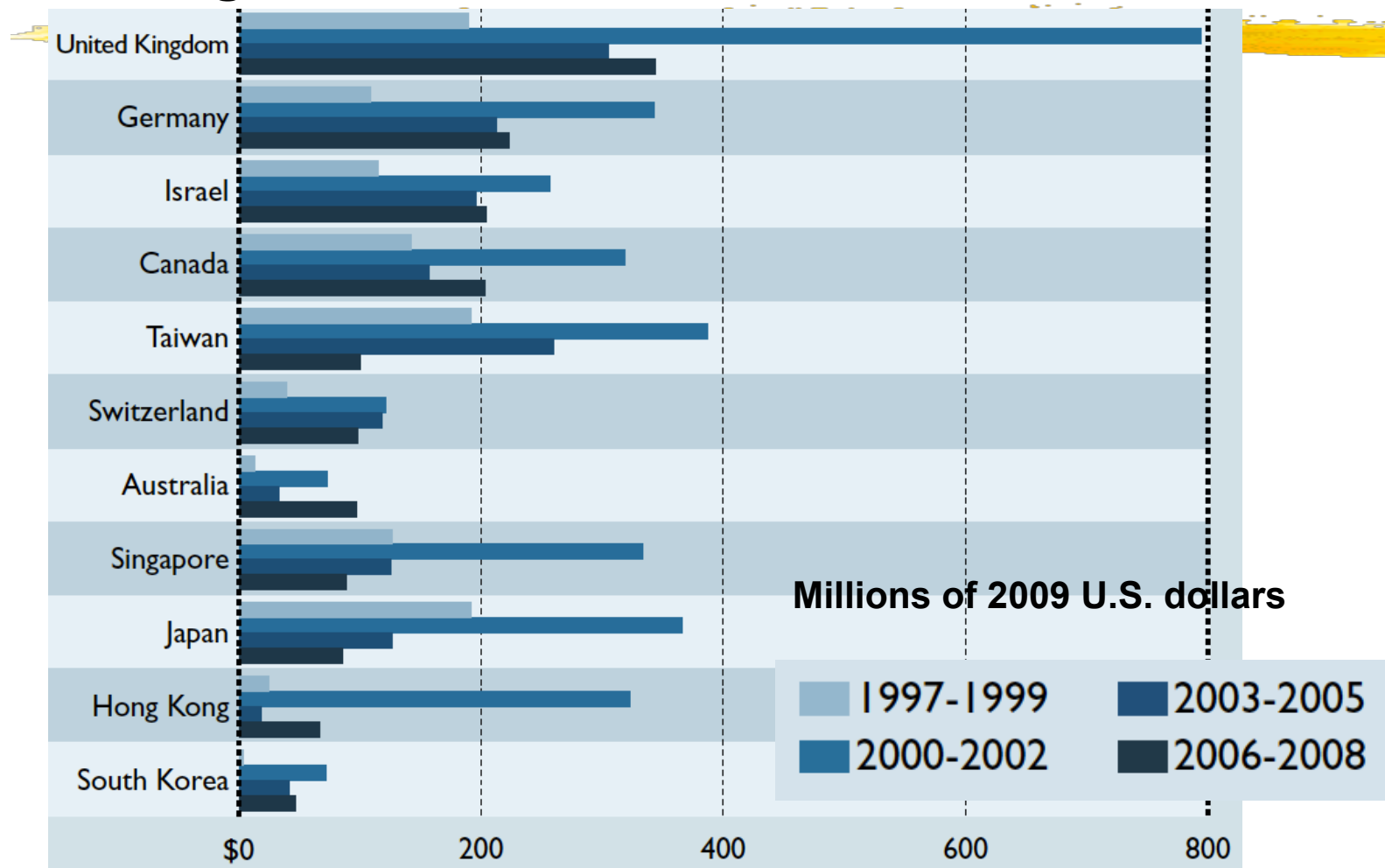
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# Venture Capital Flows into Silicon Valley from Foreign Countries



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# Concluding remarks

- ◆ **Surprised at how prominent and proactive is China investment in clean energy**
  - ◆ Many news items
  - ◆ May include some posturing: must watch for implementation
- ◆ **Japan: very strong, long-term environmental awareness**
  - ◆ Being exploited by major electronics, home appliance firms, auto makers
- ◆ **India: major investments in energy infrastructure and R&D**
  - ◆ Not much chance to talk about today
- ◆ **Many areas of exciting technology development**
- ◆ **The biggest challenges may be about doing global business**
  - ◆ Open access, ability to succeed in Asia markets

