



What's next for clean tech?

Wednesday, May 4, 2011; 2:30 – 3:45 AM

Moderator:

Betsy Zeidman, Senior Fellow, Milken Institute

Speakers:

Toby Coppel, Partner, Virgin Green Fund

Desmond King, President, Chevron Technology Ventures

Jeffrey McDermott, Managing Partner, Greentech Capital Advisors

Marianne Wu, Partner, Mohr Davidow Ventures

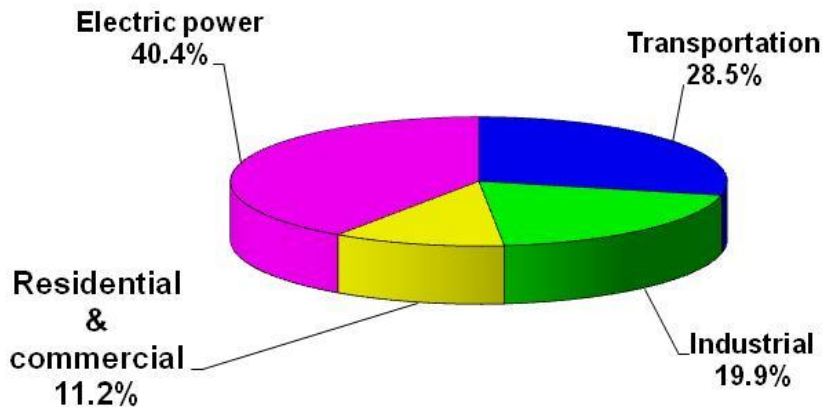
Sector share of U.S. energy consumption

2009



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Energy consumed (94.6 quadrillion Btu)

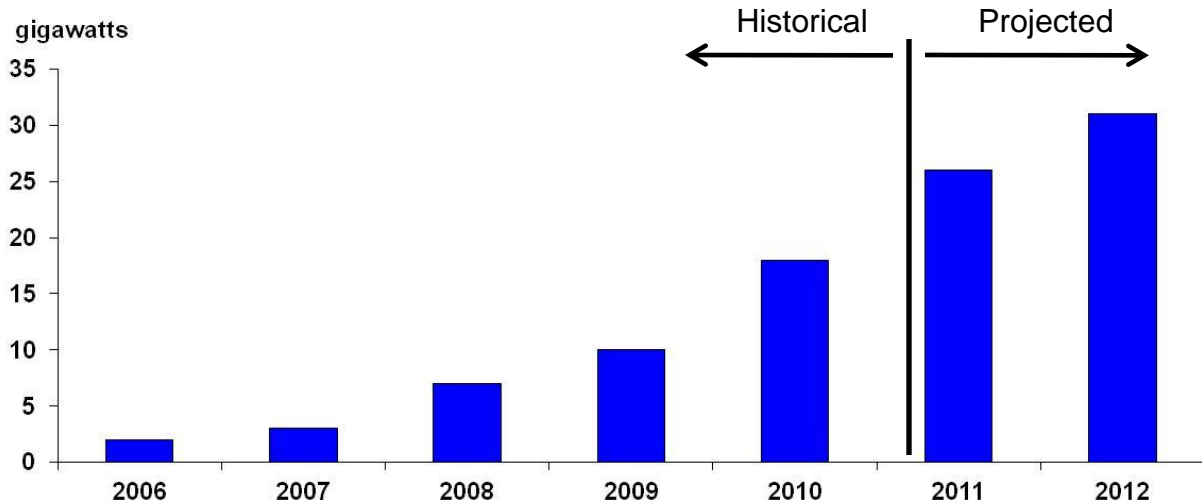


Global PV supply



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historical and projected from 2006-2012 (optimistic estimate)

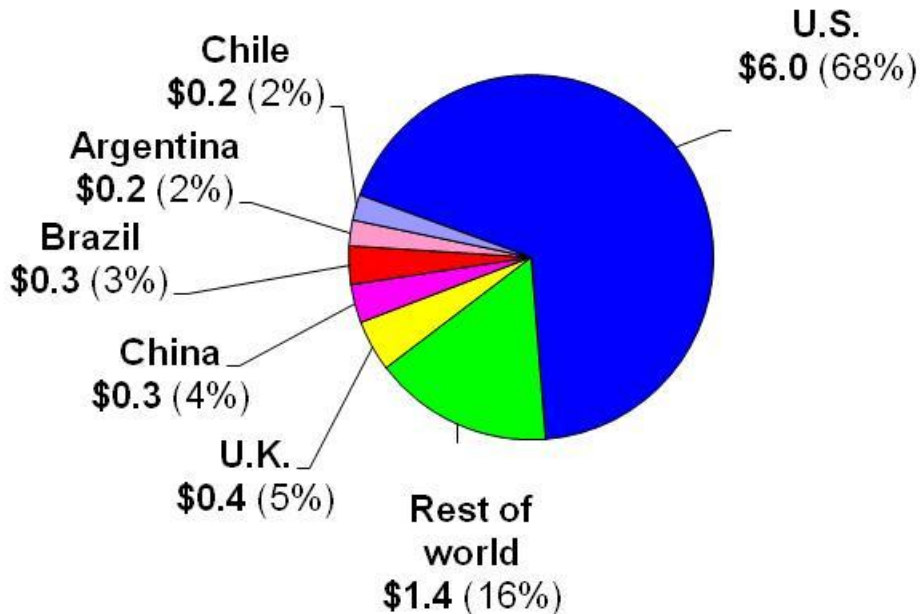


Venture capital and private equity financing

globally, 2010



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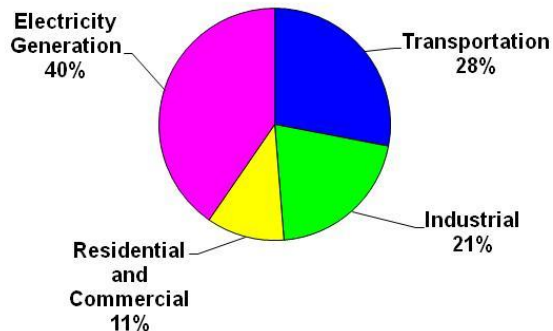


How Americans demand energy

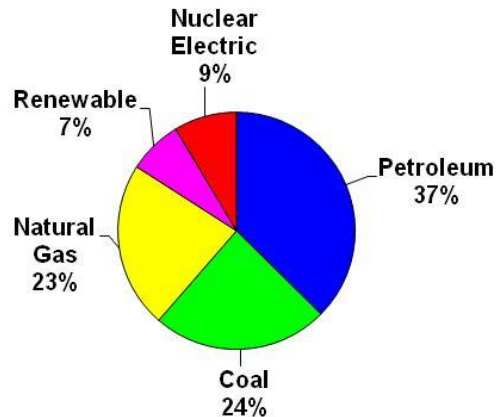


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Total U.S. Energy Consumption by Sector (2008)



Total U.S. Energy Mix (2008)

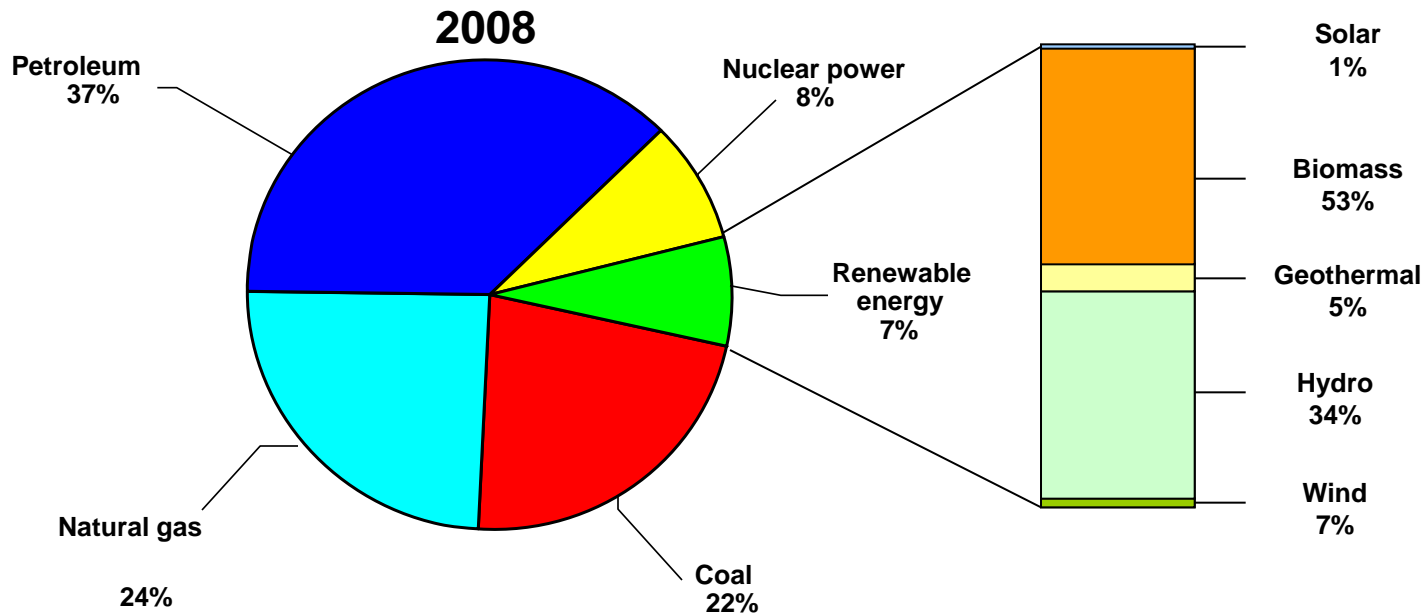


Sources: U.S. Energy Information Administration

Alternative energy accounts for 7% of energy used in the U.S.



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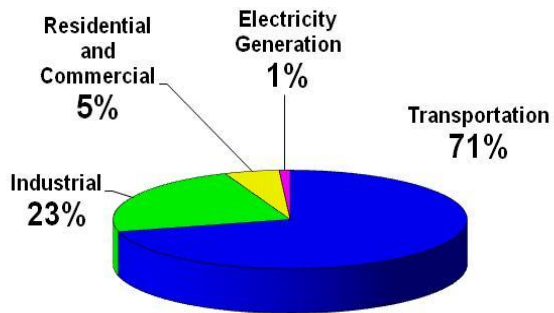
Source: Energy Information Administration.

How Americans use Petroleum and Natural Gas

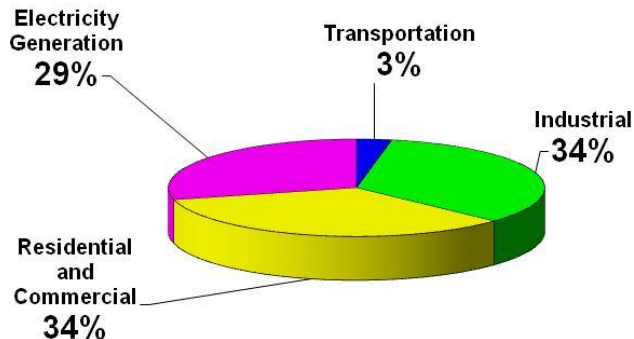


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Petroleum Use by Sector



Natural Gas Use by Sector



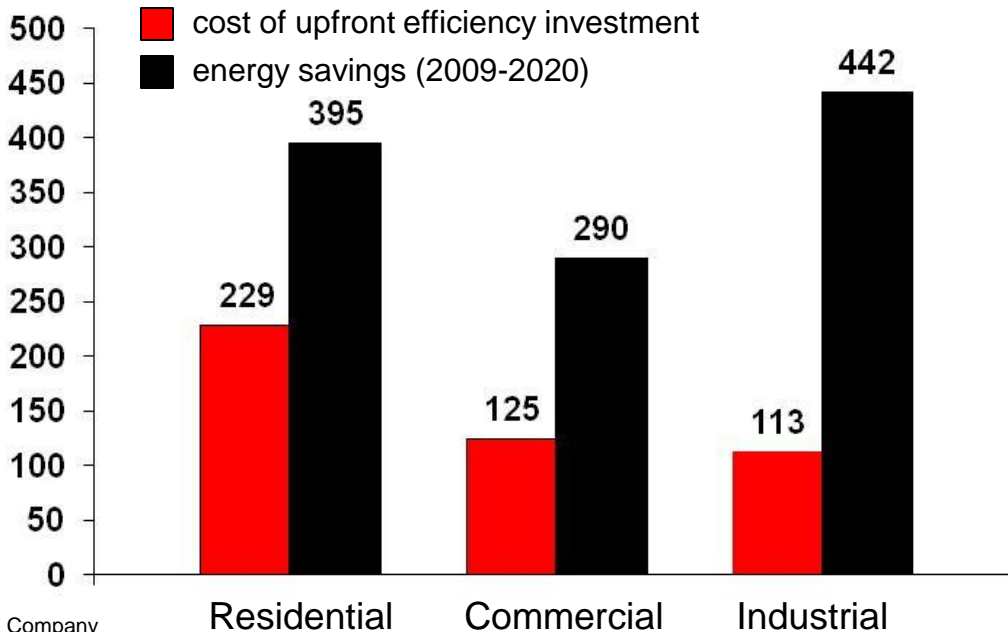
Sources: U.S. Energy Information Administration

Return on efficiency investment, by sector



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Present value of efficiency investments, \$US billions



World ethanol production estimates

2008, 2009, and 2010



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Country	Millions of Gallons		
	2008	2009	2010
USA	9,000	10,600	13,000
Brazil	6,472	6,578	6,922
European Union	734	1,040	1,177
China	502	542	542
Canada	238	291	357
Other	128	247	347
Colombia	79	83	105
India	66	92	154
Australia	26	57	66
Total	17,245	19,530	22,670

With estimates for
23.4 billion gallons to be
produced in 2011

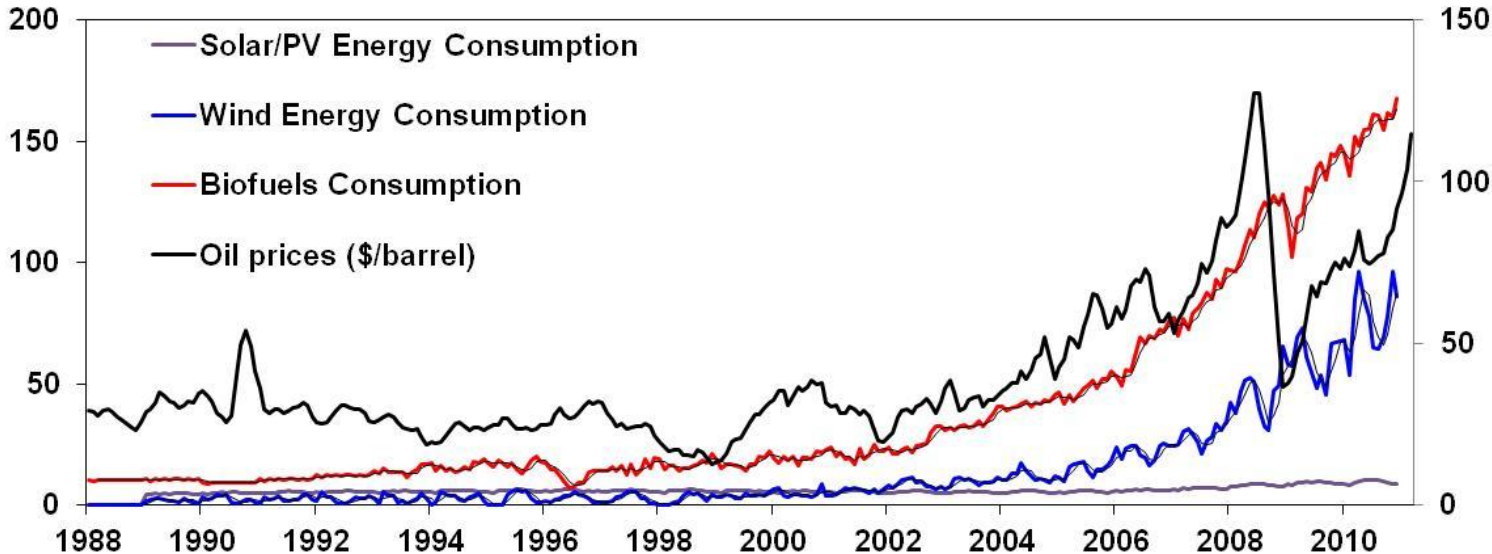
Renewable energy consumption vs. oil prices



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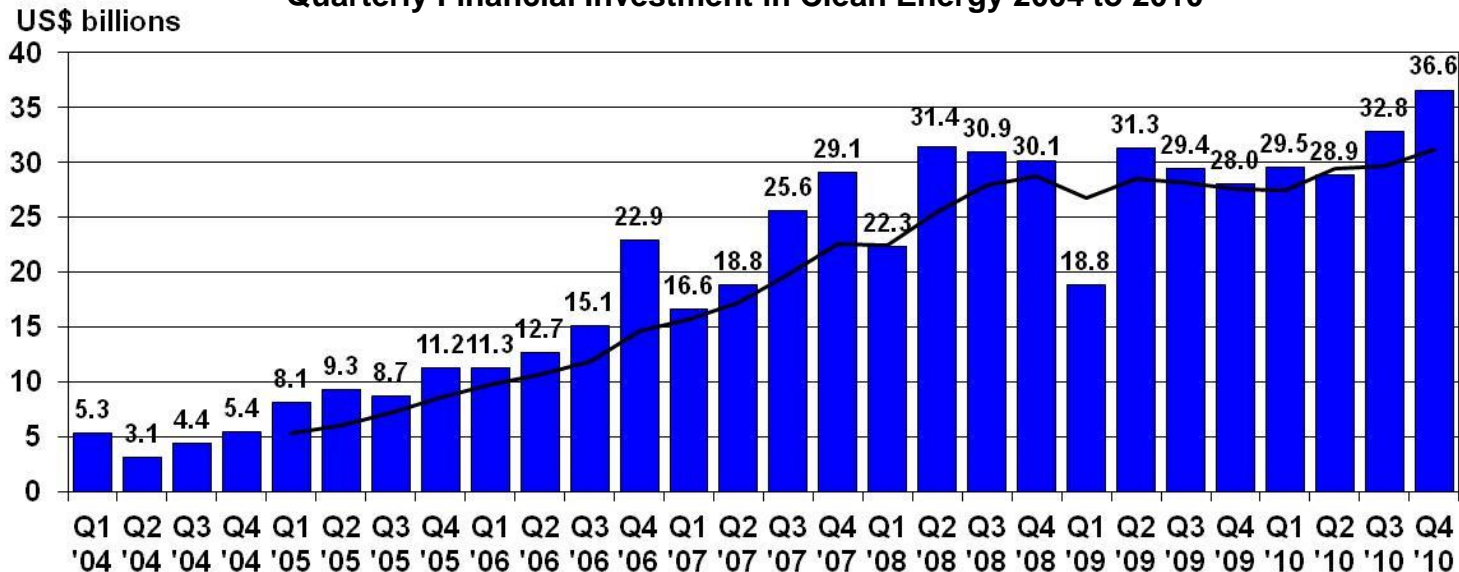
Trillion Btu

\$/barrel



Investment in clean energy might be coming back

Quarterly Financial Investment in Clean Energy 2004 to 2010

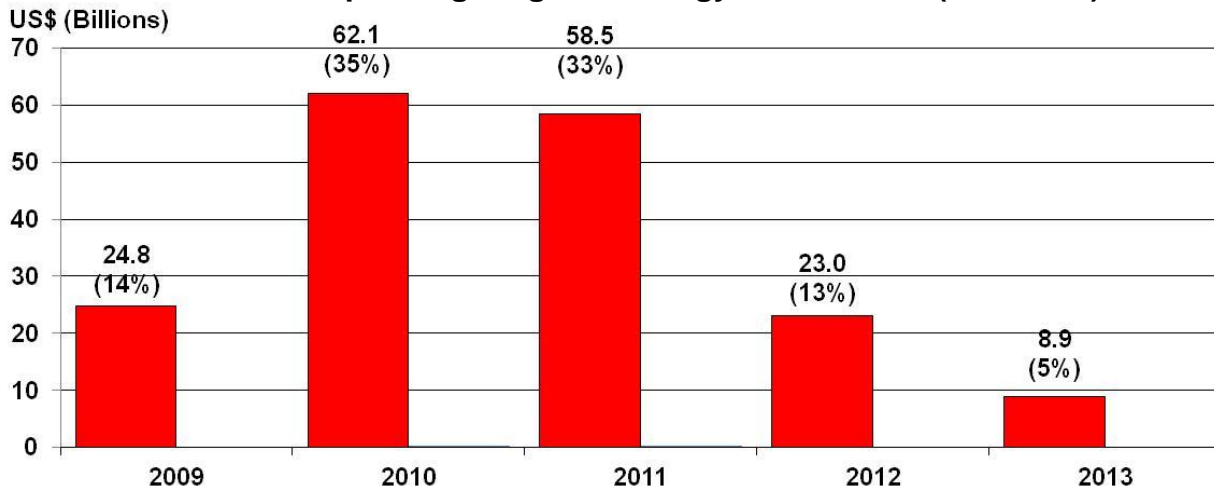


US government spending on clean energy has risen but is likely to fall



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Government spending on green Energy US\$ Billions (% of total)

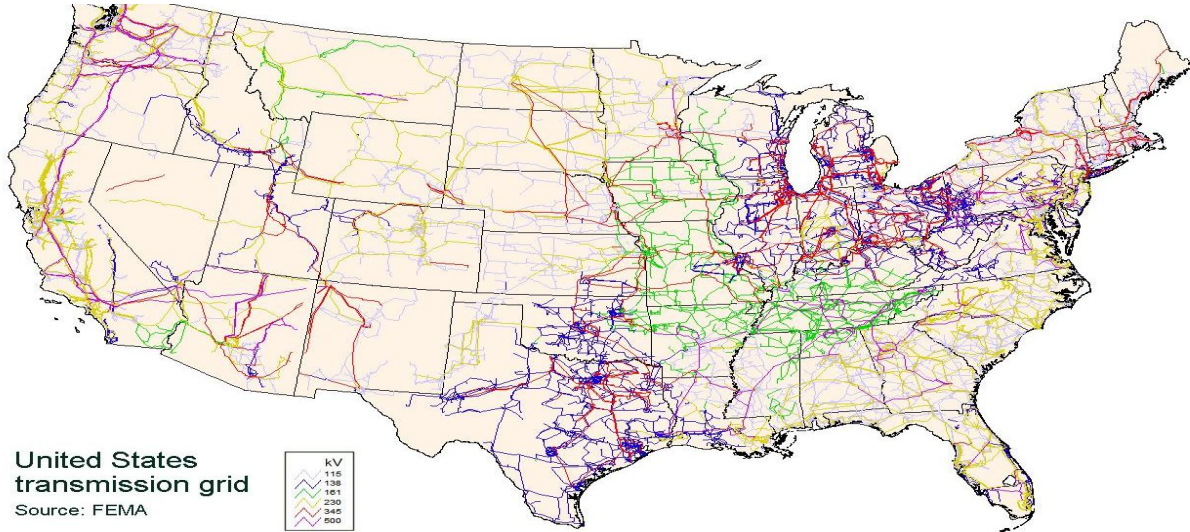


Source: New Energy Finance

Today's grid: 164k miles of wire, 3000 utilities



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Elements of the Smart Grid

Higher functioning technology and infrastructure elements of the electricity delivery system beyond primary production

- transmission,
- substation,
- distribution, and
- customer interface
- Investment required to meet load growth and to correct deficiencies – such as power flow bottlenecks and high-fault currents that damage critical equipment -- through equipment installation, upgrades and replacement.
- Investment needed to develop and deploy advanced technologies to achieve “smart” functionality of power delivery systems, and interface with distributed generation including renewable energy technologies.

What's wrong with the grid?



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- Majority of electricity capacity infrastructure 30 years old or more, with transmission bottlenecks
- Since 1990, demand for electricity up 25%, construction of transmission facilities down 30%
- Renewable energy inputs are limited due to the grid's age and distance from consumers
- Much of the new capacity will need to come from renewable resources
- Lack of security leaves the grid vulnerable

Costs of installing smart grid technologies

The smart grid is an energy transmission system that can handle variable energy levels, and can pull energy from homes and businesses as easily as it can send energy there.

Costs to Upgrade the Existing System (\$M)

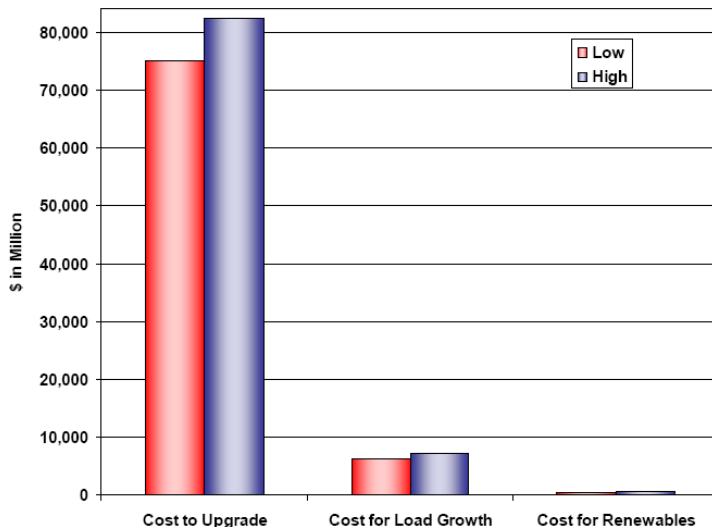
	Low	High
Transmission and substations	75,157	82,509

Costs to Embed Smart Grid Functionality While Accommodating Load Growth (\$M)

	Low	High
Transmission and substations	6,312	7,281

Costs to Embed Smart Grid Functionality While Accommodating Large-Scale Renewables (\$M)

	Low	High
Transmission and substations	577	623
Total	82,046	90,413

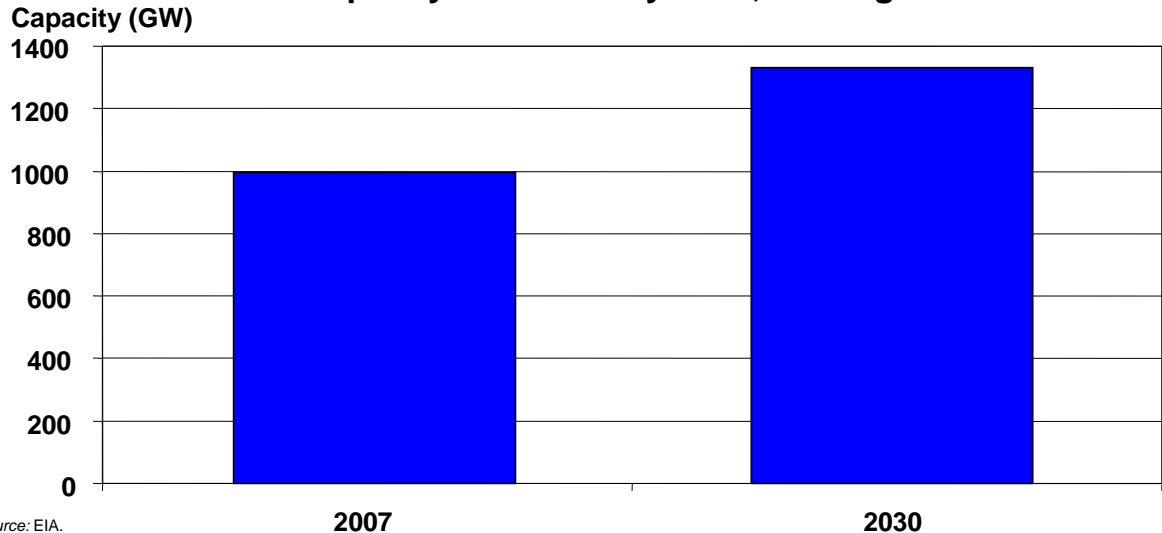


How can United States build the needed capacity by 2030?



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EIA Estimate for additional capacity = 338 GW by 2030, costing 300 US\$ billions



Source: EIA.

Renewable incentives programs in the United States



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- New Solar Homes Partnership - California Energy Commission
 - Provides incentives for solar production from PV installations applicable to custom homes and small developments
- California Solar Initiative – California Public Utilities Commission
 - Performance based incentives focused on reaching 3000 MW Solar capacity by 2016 applicable to non-residential buildings and existing homes
- Wisconsin
 - Has four solar buy back programs offered by utilities to electricity consumers to purchase renewable energy
- Green Tag Purchase - Northwest Solar Cooperative
 - An agreement by the NWSC to purchase solar and wind power at \$0.02/kWh through December 31, 2009
- Alternative Energy Investment Tax Credit - Montana
 - Alternative energy investments greater than \$5000 receive a tax credit of 35% on corporate income tax

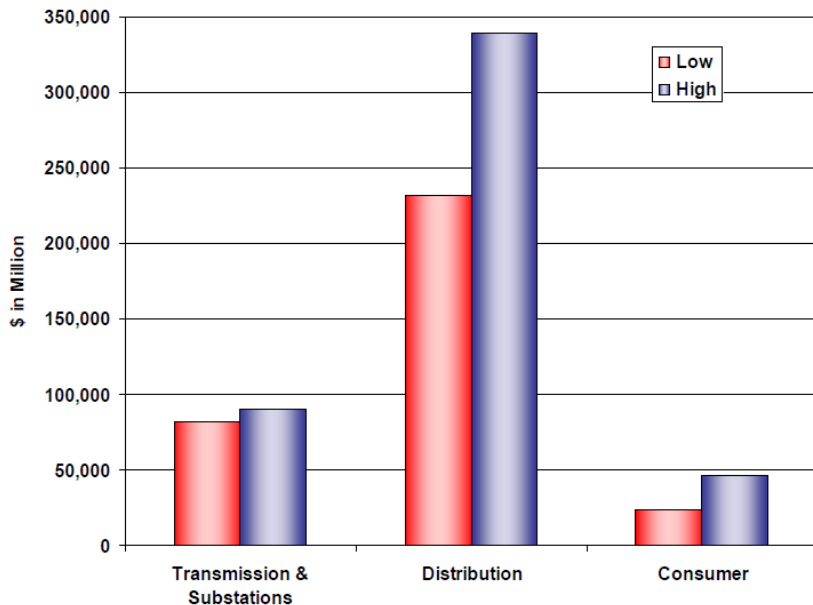
Total cost of grid upgrades



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high and low estimates in three categories needing most upgrades

\$338 billion to \$476 billion
can result in benefits between
\$1.3 trillion and \$2 trillion.



EV Adoption

EV market penetration (% of fleet)	Electricity load increase (TWh)
1%	8
5%	41
10%	84
15%	126
20%	168
100%	840



U.S. Electricity customers



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Load growth without increased EV adoption estimates

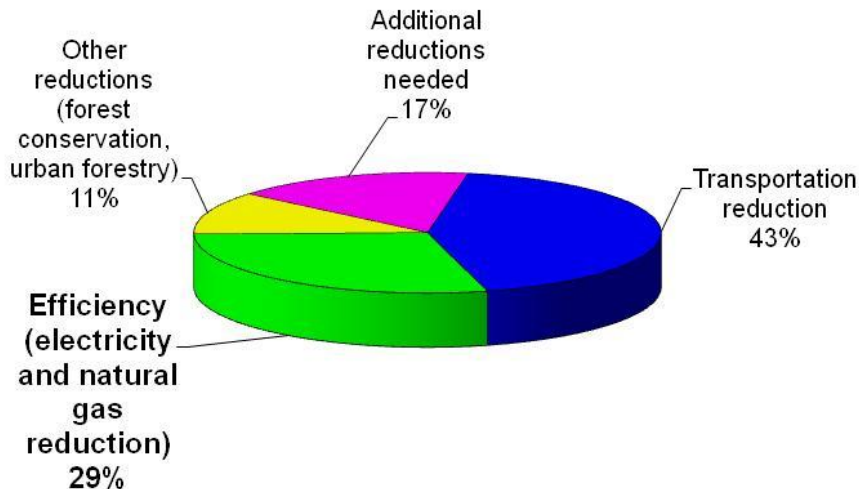
Number of electric customers	2007	2030	Load growth
Residential	13,949,916	143,928,676	19,978,760
Commercial	17,377,219	20,178,151	2,800,932
Industrial	193,767	921,709	127,942
Transportation	750	750	0
Total	142,121,652	165,029,286	22,907,634

Does not consider EV load growth



California emissions reduction goals

- California wishes to reduce emissions to 1990 levels by 2020 (426 MMt CO₂e)
Business as usual levels in 2020 are projected to be approximately 600 MMt CO₂e



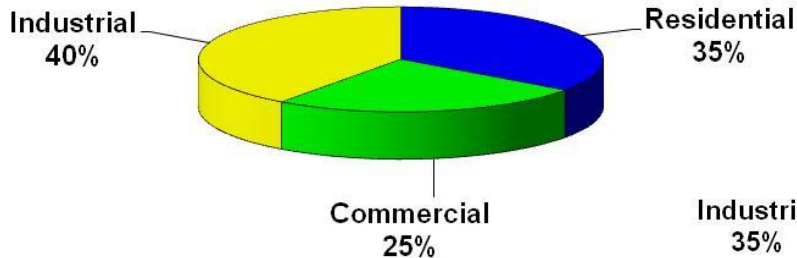
Potential energy efficiency gains by sector

and sector share of primary electricity production

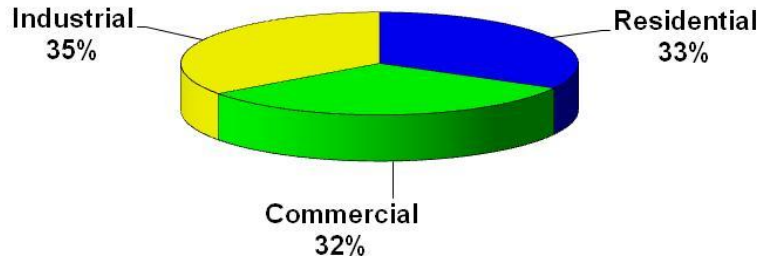


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End-use efficiency potential (U.S.)



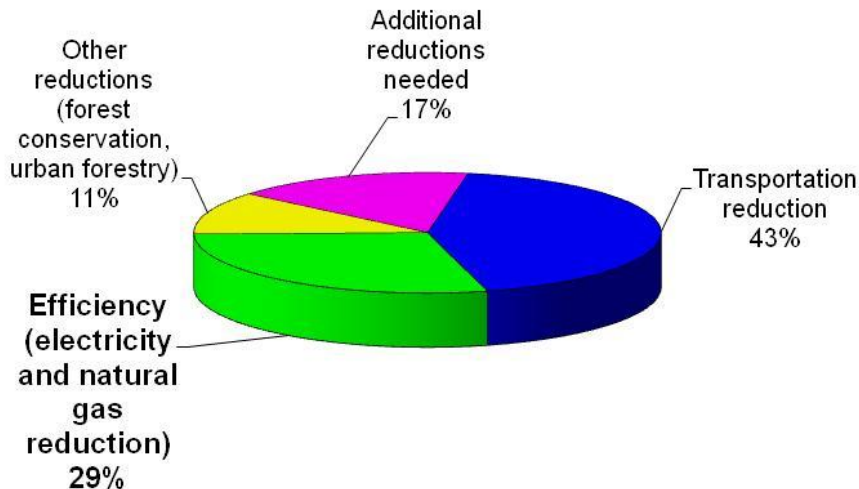
Sector share of primary production





California emissions reduction goals

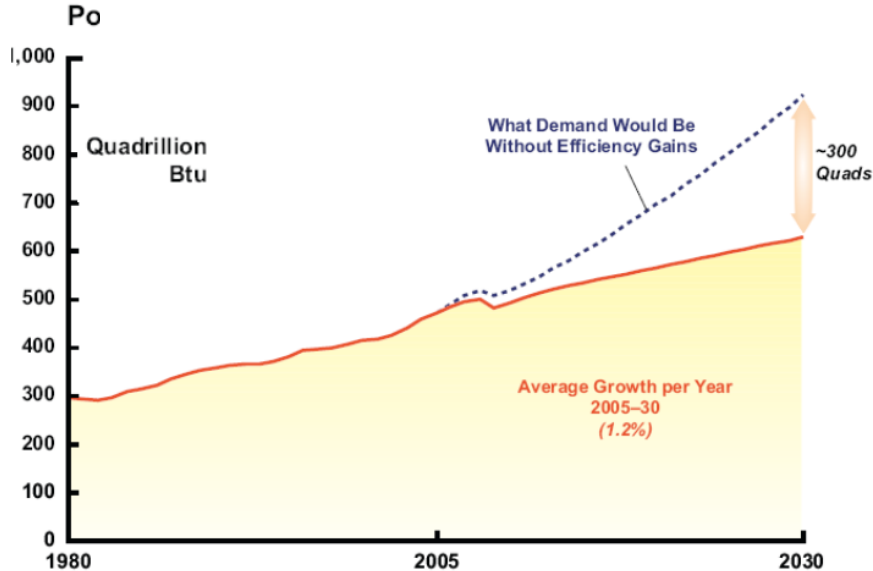
- California wishes to reduce emissions to 1990 levels by 2020 (426 MMt CO₂e)
Business as usual levels in 2020 are projected to be approximately 600 MMt CO₂e



Potential impact of efficiency *on global energy demand*



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**Approximately
300 quadrillion
Btu**

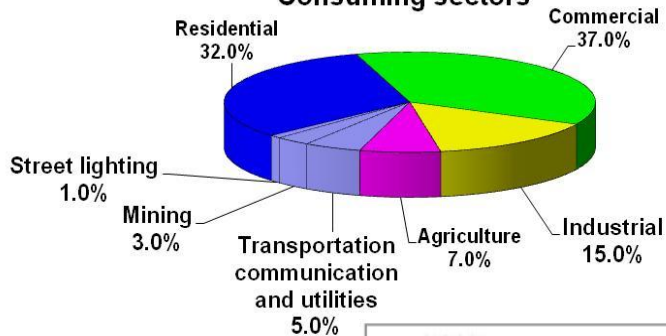
California energy profile

2009

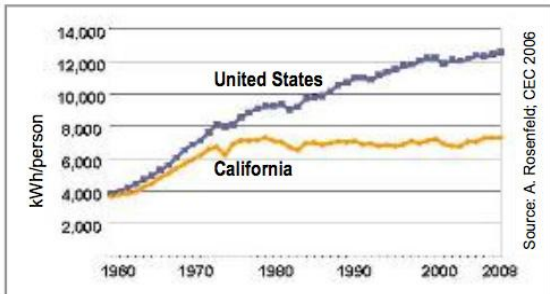
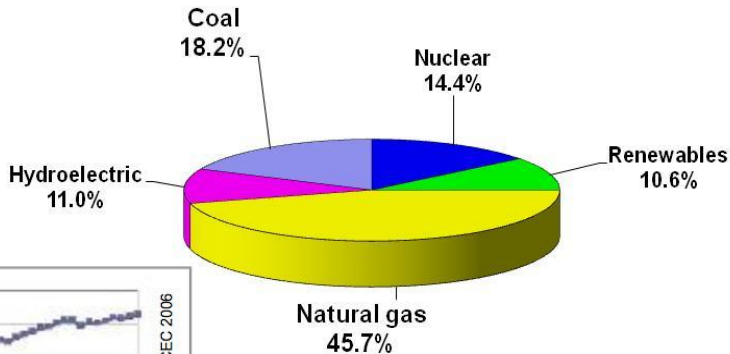


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Consuming sectors



Electricity production by primary fuel

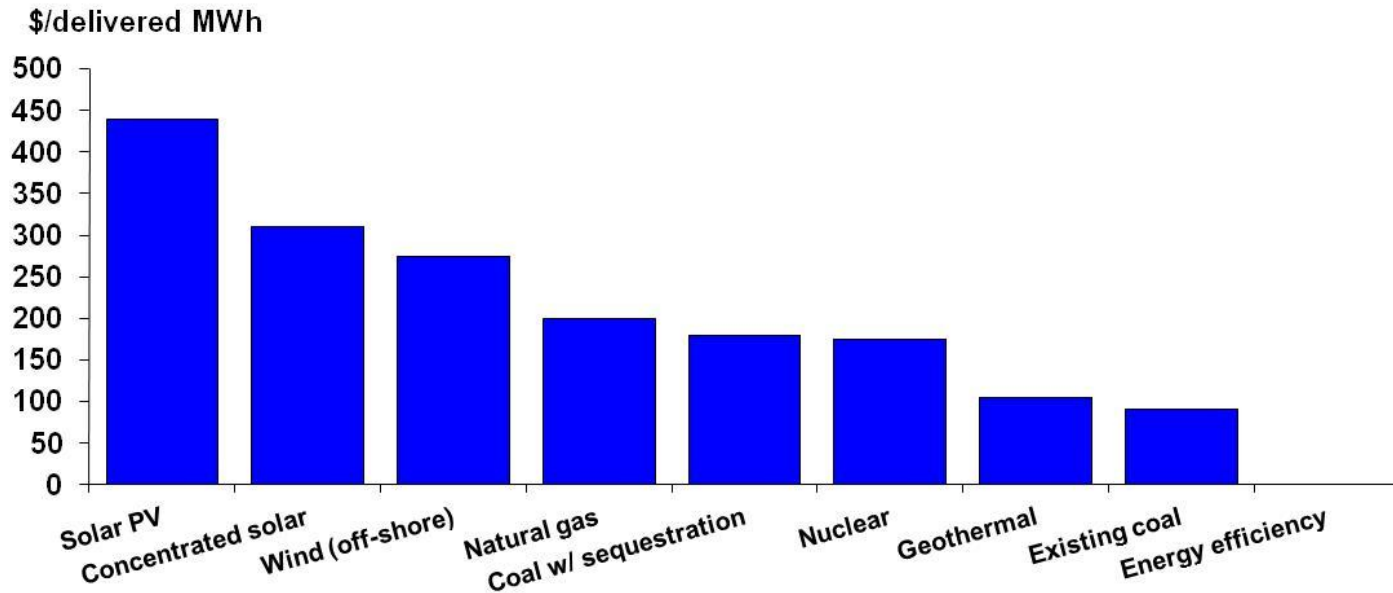


Cost of delivered electricity

by primary energy source



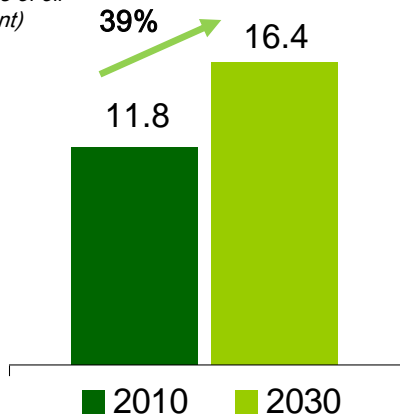
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Meeting Future World Energy Demand

World Demand

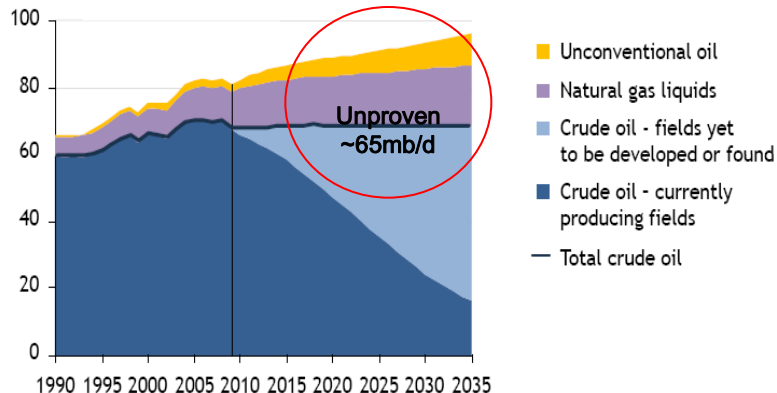
(Billion tonnes of oil equivalent)



Source: BP Energy Outlook, 2011

World Oil Production by Source

(million barrels per day)



Source: World Energy Outlook 2010


Significant Supply Risk For Fossil Fuels

Top Oil Producing Nations

(000 barrels per day)

Saudi Arabia	10,782	Kuwait	2,741
Russia	9,790	Venezuela	2,641
United States	8,514	Norway	2,466
Iran	4,174	Brazil	2,402
China	3,973	Iraq	2,385
Canada	3,350	Algeria	2,180
Mexico	3,186	Nigeria	2,169
United Arab Emirates	3,046		

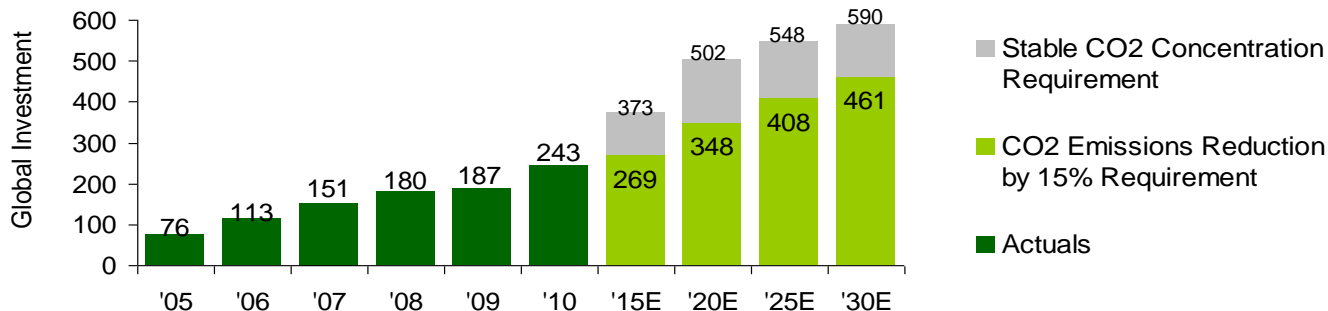
Source: EIA, 2008

 = supply risk

Increased Public Pressure For Low-Carbon Economy

Sector Capital Investment

(USD billions)

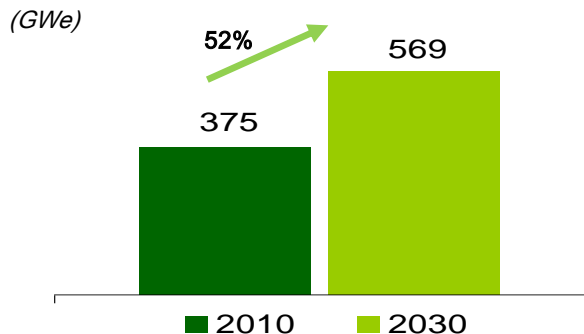


Source: IEA, IMF, NEF

Note: Includes corporate R&D, government spending and other

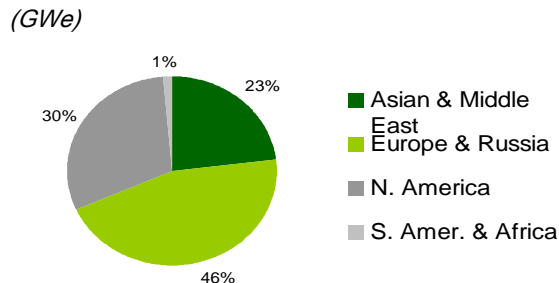
Future of Nuclear Power ?

Planned World Nuclear Capacity Growth



Source: Morgan Stanley 2011

2010 Nuclear Capacity by Region



Source: Morgan Stanley 2011

Robust Future Growth for Renewables

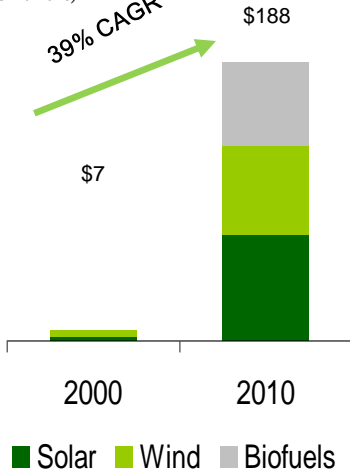


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Historical Growth

(USD billions)

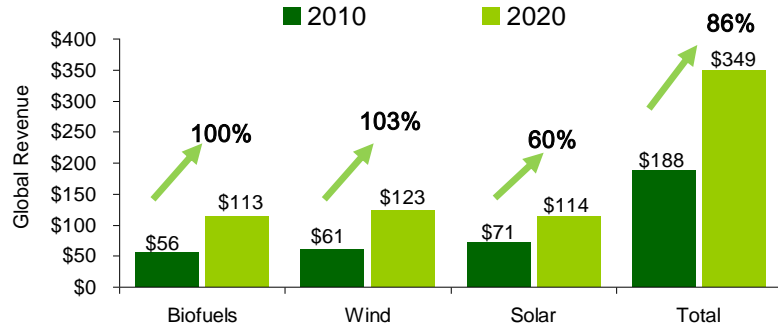
39% CAGR



Source: CleanEdge, 2011

Projected Growth

(USD billions)



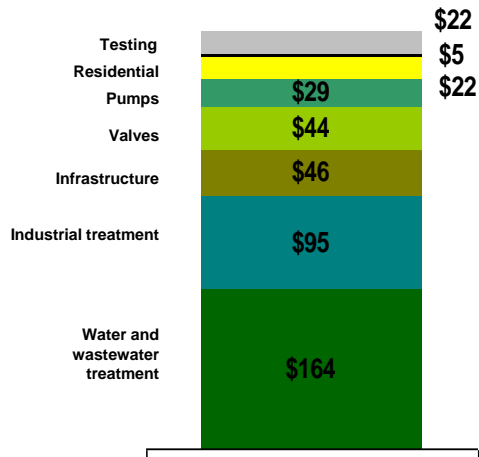
Source: CleanEdge, 2011

Attractive Opportunities in the Water Sector MILKEN INSTITUTE

Global Water Market

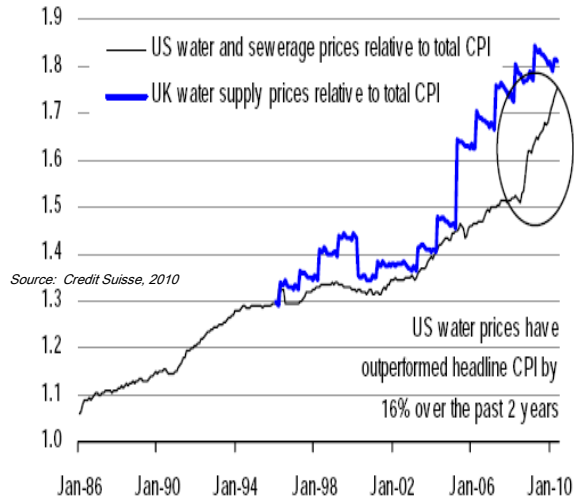
(USD billions) Other

\$425bn



Global water market is growing 5% annually

Increasing Prices

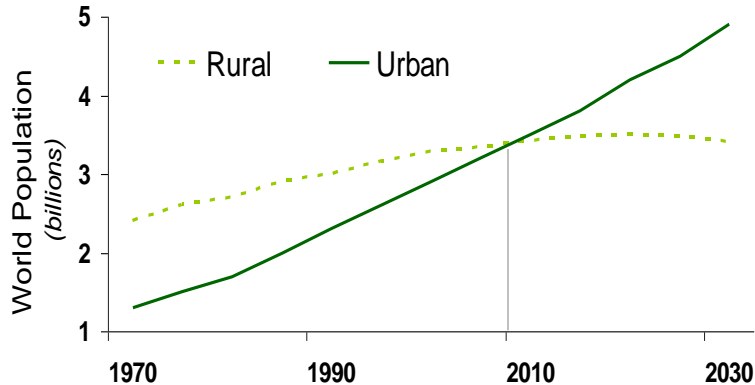


Waste Management Challenge



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Urbanization



Source: UN World Urbanization Prospects 2009

Dirtytech

RECYCLING AND WASTE TO ENERGY (WTE) RATES

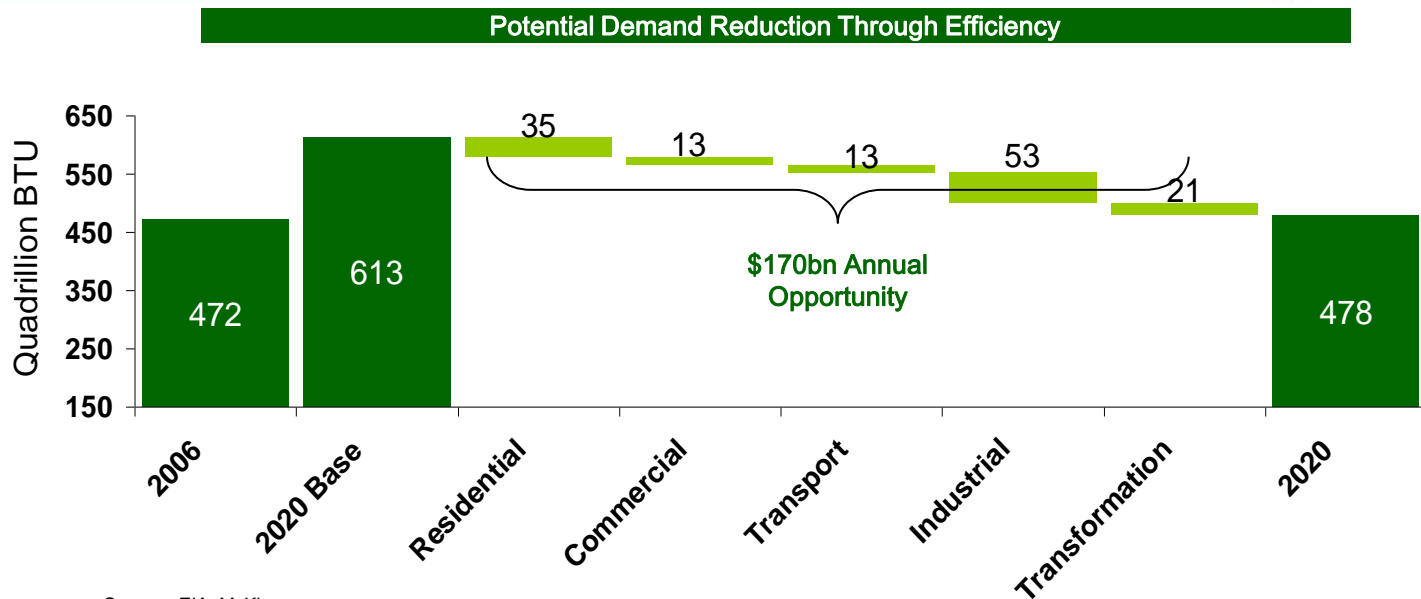
	Recycling	WTE	Total
Germany	66%	33%	99%
Netherlands	66%	33%	99%
Austria	70%	27%	97%
Sweden	49%	49%	97%
France	33%	32%	64%
Italy	39%	12%	51%
USA	33%	13%	46%
UK	36%	10%	45%
Spain	34%	9%	43%
Portugal	17%	19%	36%
Greece	23%	0%	23%

Source: Eurostat, EPA

High ROI Opportunities in Energy Efficiency



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Source: EIA, McKinsey

What's Next in Sustainable Infrastructure?

Seven Key Trends



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1. *Shale gas is real*

2. *Solar PV is scaling*

3. *Spending on the grid will continue*

4. *Energy efficiency*

5. *Offshore wind*

6. *Next generation biofuels*

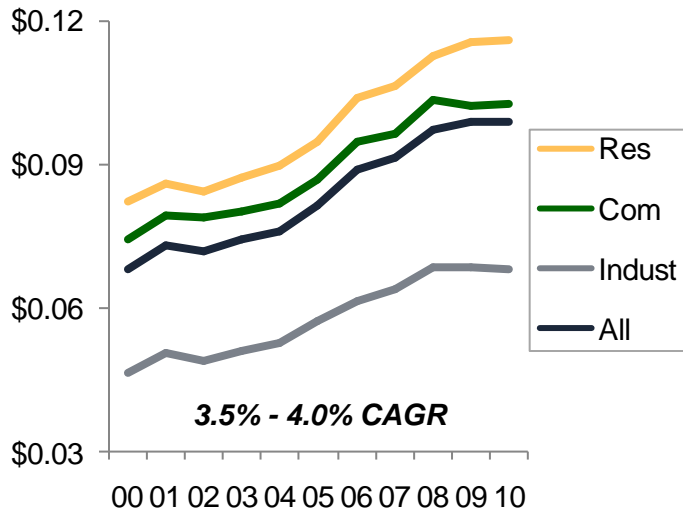
7. *Asian demand growth*

Industry Dynamics Highlight the Opportunity for Renewable Energy

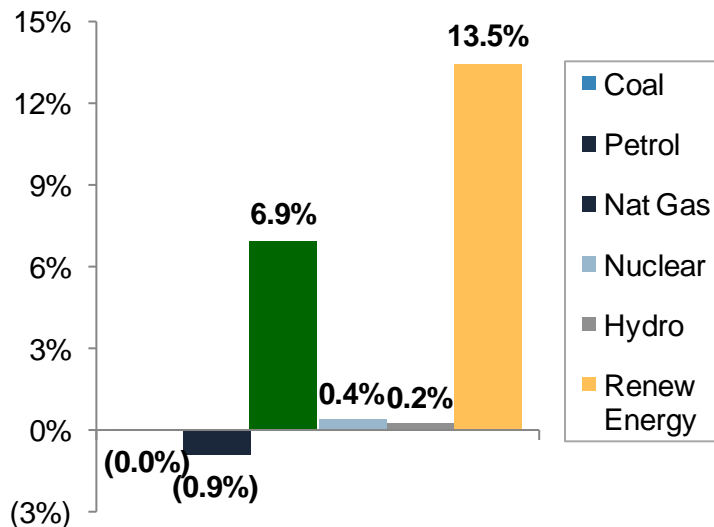


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U.S. Electricity Rates (\$ / kWh)



2000 – 2009 CAGRs for Existing Capacity

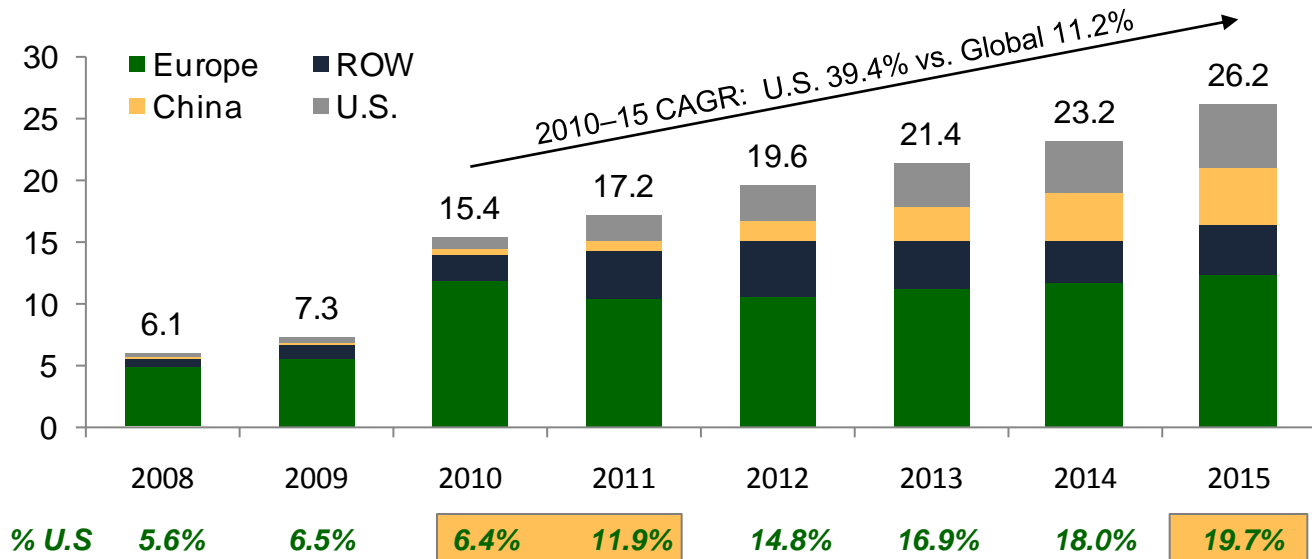


The U.S. Has Become a Key PV Module Market

Annual PV Demand by Region (GW), 2008 – 2015E



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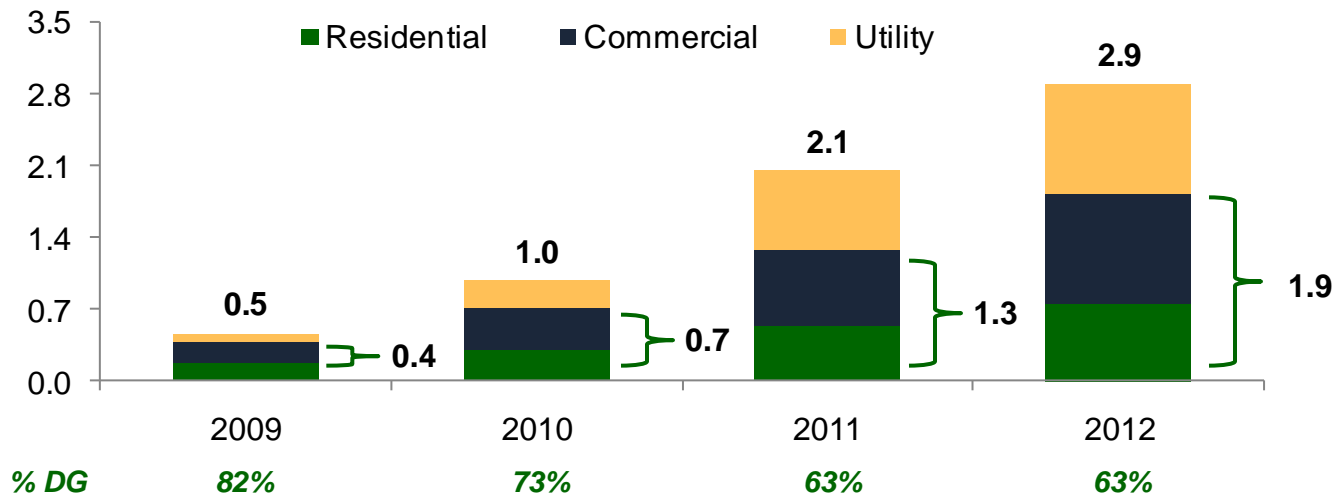


Distributed Generation Is Driving PV Demand

Annual U.S. PV Demand by End-Market (GW), 2009 – 2012E



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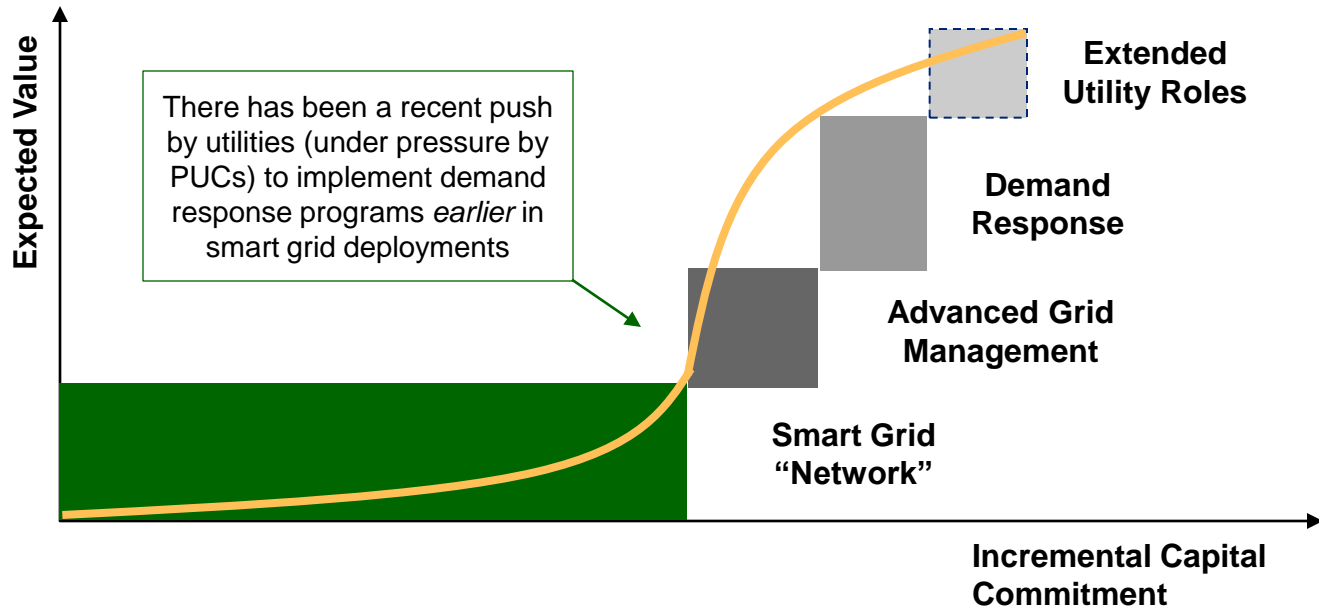


Smart Grid Continues to Evolve

Incremental Spending & Value Capture in Smart Grid



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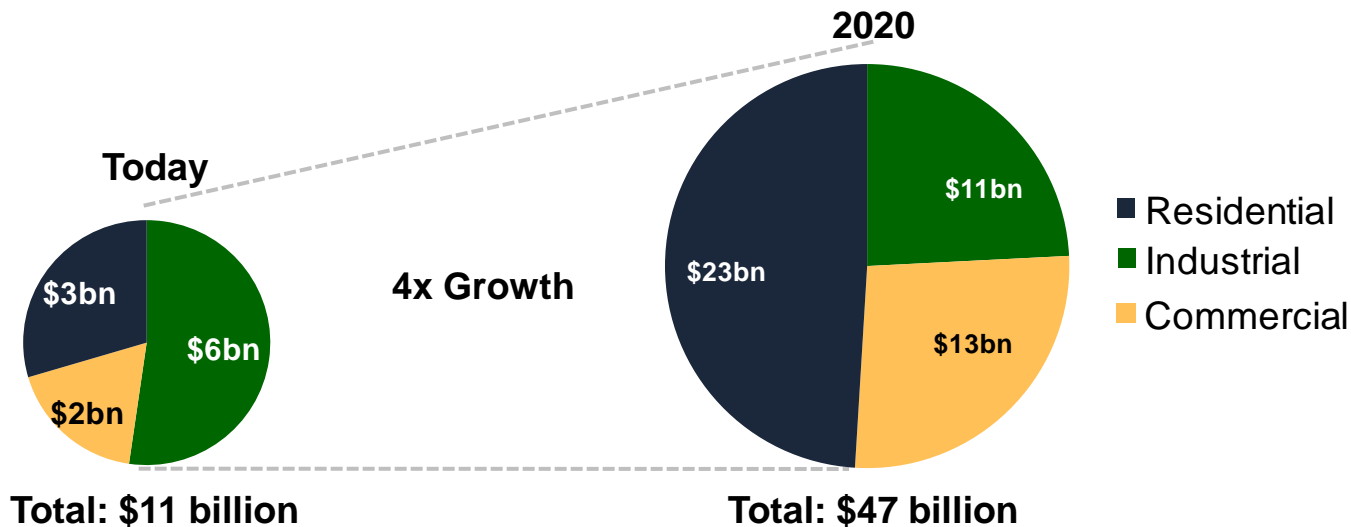


Annual U.S. Capacity Spend on Efficiency

Efficiency Spend by End-Market (\$ bn)

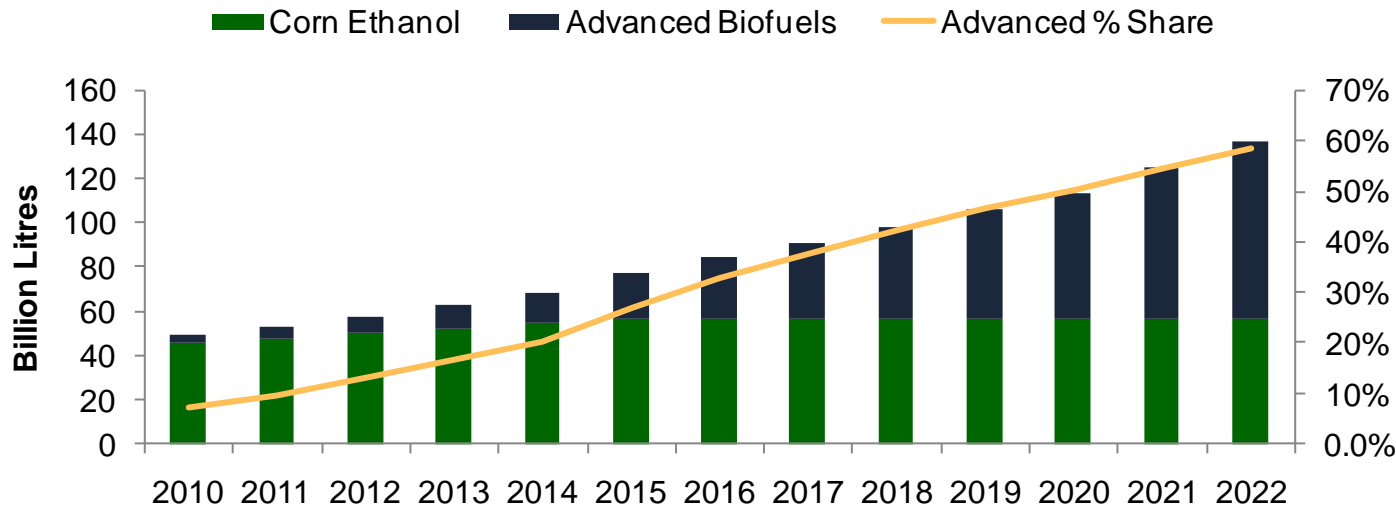


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U.S. Renewable Fuel Standard 2 (RFS2)

EPA Rules Are Driving the Adoption of Next-Gen Biofuels

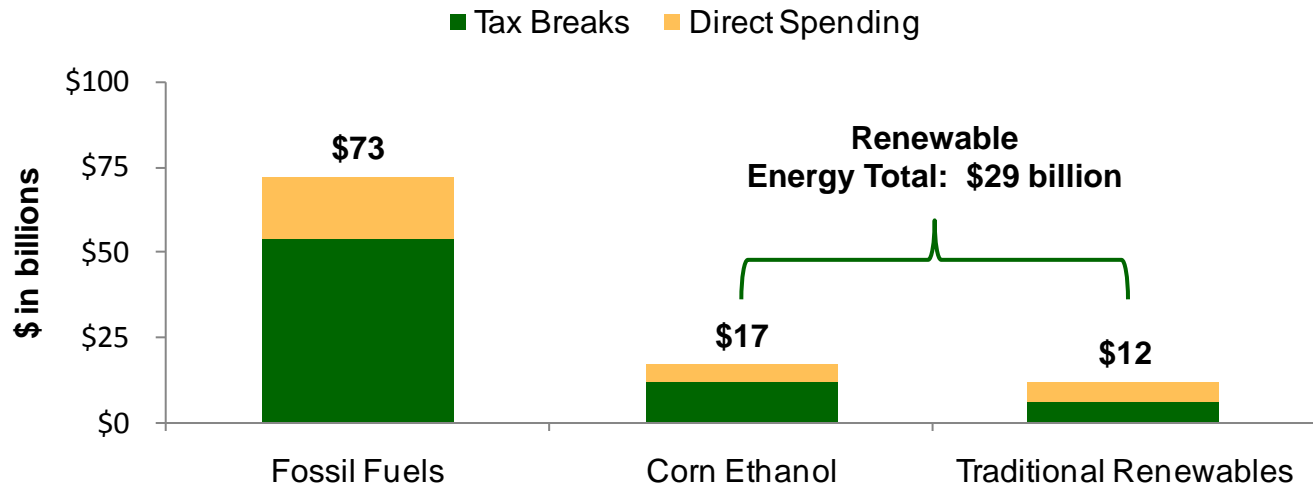


U.S. Federal Energy Subsidies

Direct Expenditures and Tax Breaks (2002 – 2008)



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China Has Emerged as a Cleantech Power

Investments by Country, 2009 – 2010



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2010 Rank	Country	Investment (\$bn)		Y-o-Y	2009
		2010	2009	Growth	Rank
1	China	\$54.4	\$39.1	39.1%	1
2	Germany	\$41.2	\$20.6	100.0%	3
3	United States	\$34.0	\$22.5	51.1%	2
4	Italy	\$13.9	\$6.2	124.2%	8
5	Rest of Europe	\$13.4	\$13.3	0.8%	4

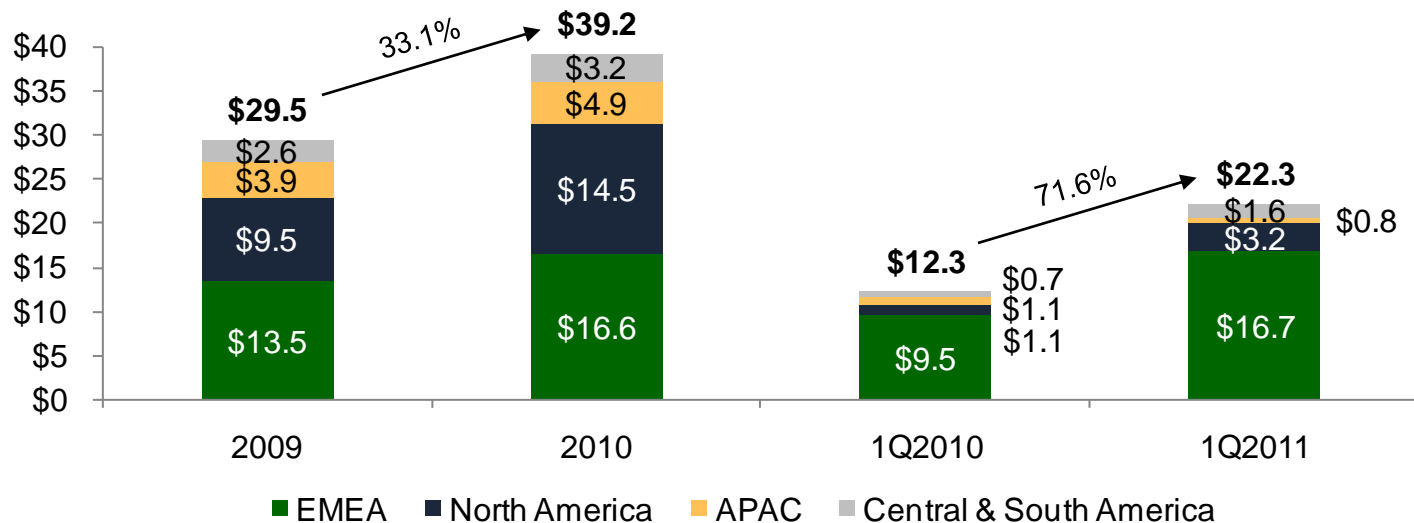
Source: Bloomberg New Energy Finance, Pew Environment Group. Rest of Europe excludes France, Spain, and the United Kingdom.

Global M&A Transaction Volume

Sustainable Infrastructure, Alternative Energy & Cleantech (\$bn)



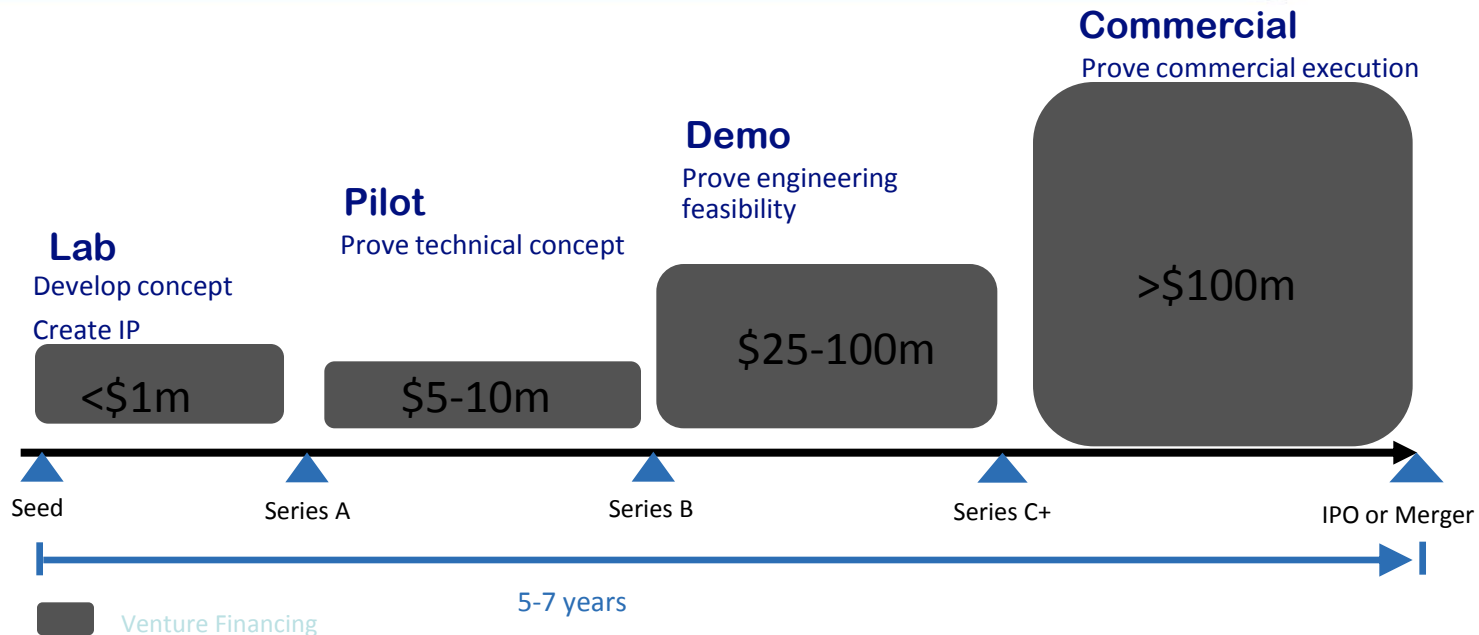
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Building a cleantech start-up



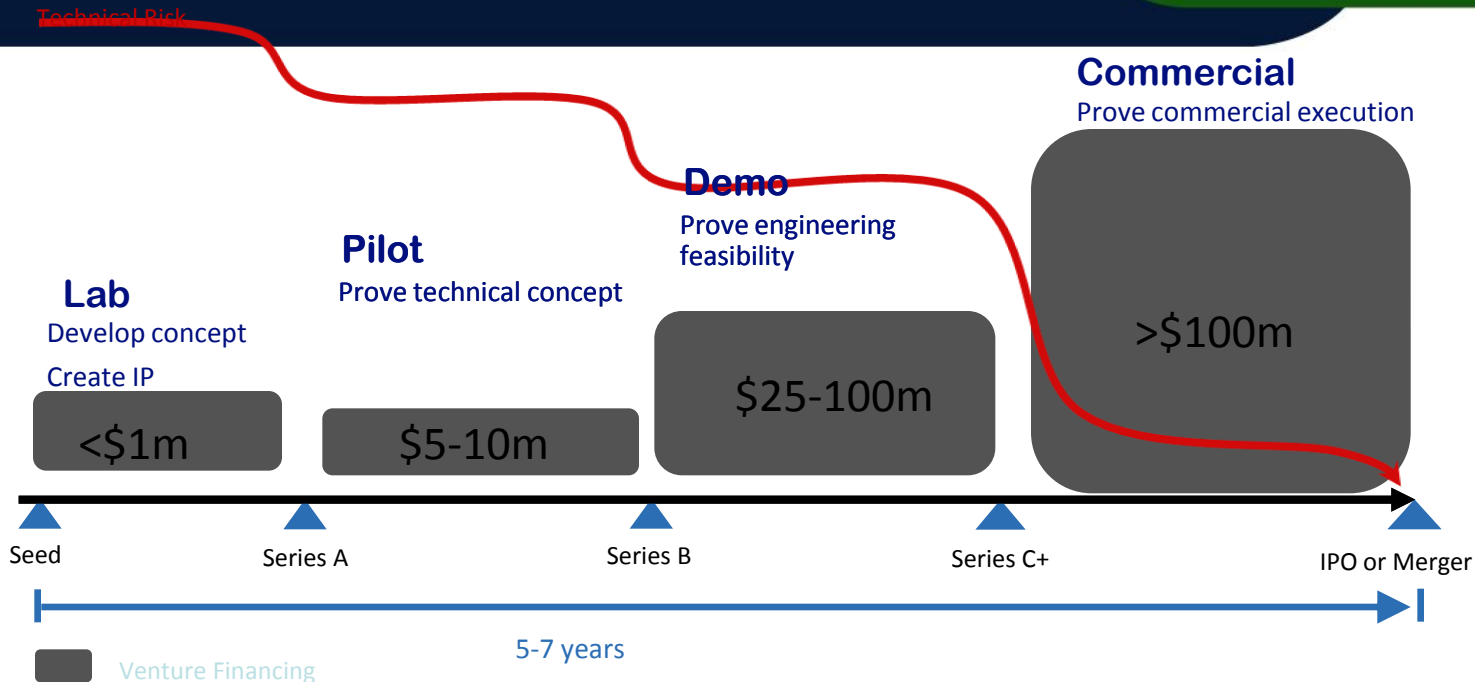
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Building a cleantech start-up

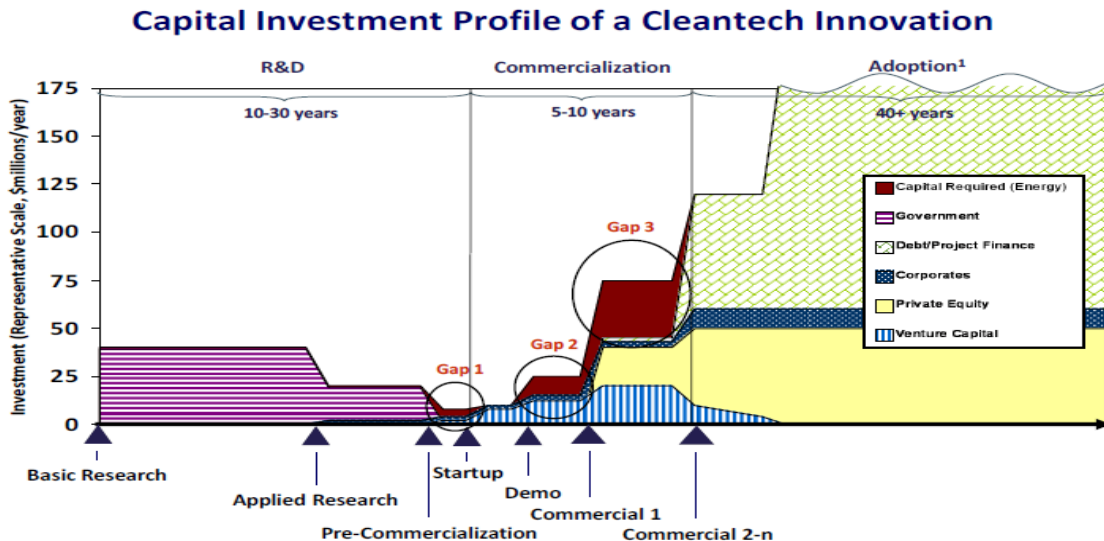


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Different types of capital fill different needs



(*The chart represents a hypothetical innovation's funding needs – scale and gaps may vary by technology)

Source: Mohr Davidow Ventures.

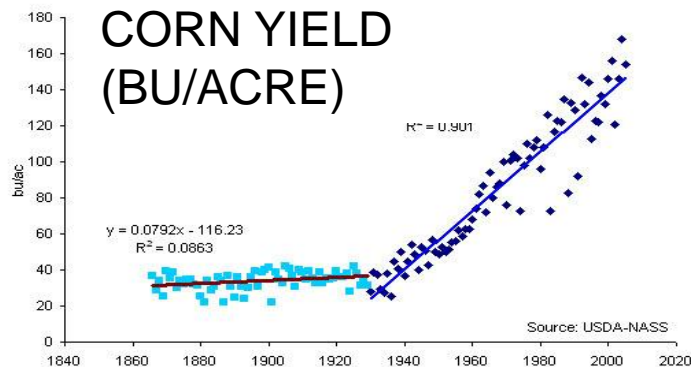
¹ The capital investment associated with adoption is depicted to indicate that it may well exceed \$175 million/ year.

Technology to the Rescue...

Moore's Law



Crop Yield

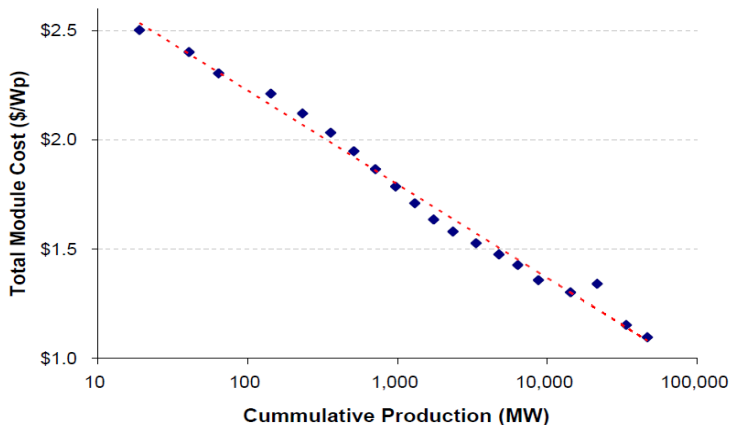


- Cleantech leverages expertise in Information Technology and Life Sciences

Morgan Stanley

MORGAN STANLEY RESEARCH
Costs of CIGS vs. Other Thin Film Technologies and c-Si
February 16, 2011

The industry has been able to lower cost by \$0.13/w for every doubling of output



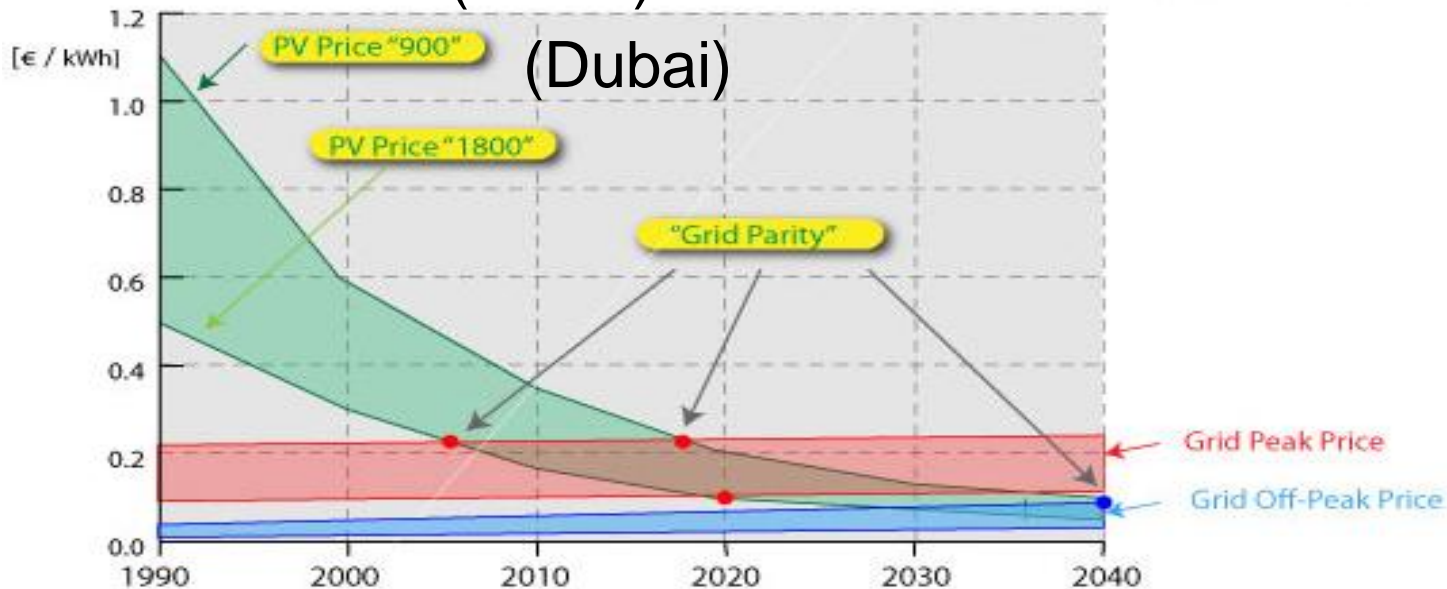


But we are getting close to “grid parity”

(Berlin)

(Dubai)

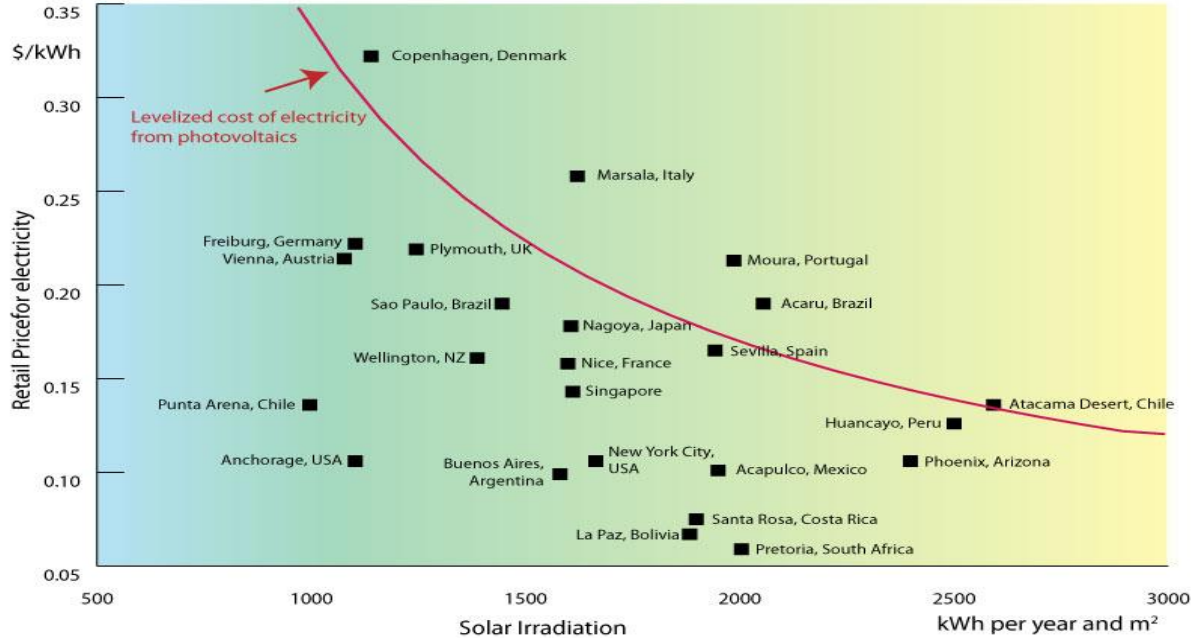
Cost of PV Electricity 1990 - 2040



Specifically...



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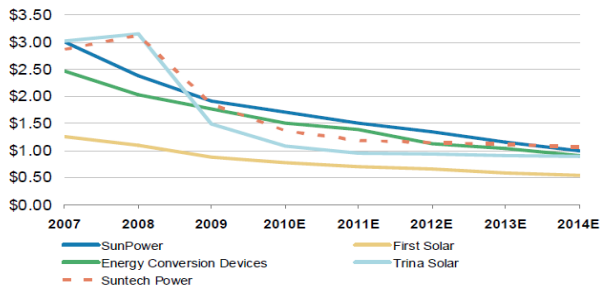


Morgan Stanley

MORGAN STANLEY RESEARCH
Costs of CIGS vs. Other Thin Film Technologies and c-Si
February 16, 2011

Forecasted Cost Structures Through 2014

Module Cost (\$ per Watt)



	2007	2008	2009	2010E	2011E	2012E	2013E	2014E
Capacity (MW)								
SunPower	214	414	574	580	930	1,580	1,935	1,975
First Solar	308	676	1,244	1,462	2,416	3,073	4,179	5,356
Energy Conversion Devices	58	118	180	150	150	200	256	321
Trina Solar	125	325	475	725	1,200	1,450	1,876	2,393
Suntech Power	540	945	1,075	1,500	1,925	2,115	2,644	3,305
Conversion Efficiency								
SunPower	21.7%	21.7%	21.7%	22.0%	23.0%	23.5%	24.0%	24.5%
First Solar	10.3%	10.7%	11.0%	11.2%	11.9%	12.6%	13.3%	14.0%
Energy Conversion Devices	--	--	--	8.0%	10.0%	12.0%	12.7%	13.3%
Trina Solar	17.0%	17.2%	18.1%	18.8%	19.7%	20.6%	21.5%	22.0%
Suntech Power	16.1%	17.0%	18.0%	19.0%	20.0%	21.0%	22.0%	22.5%

Source: Company Data, Morgan Stanley Research

What's next for Clean Tech?



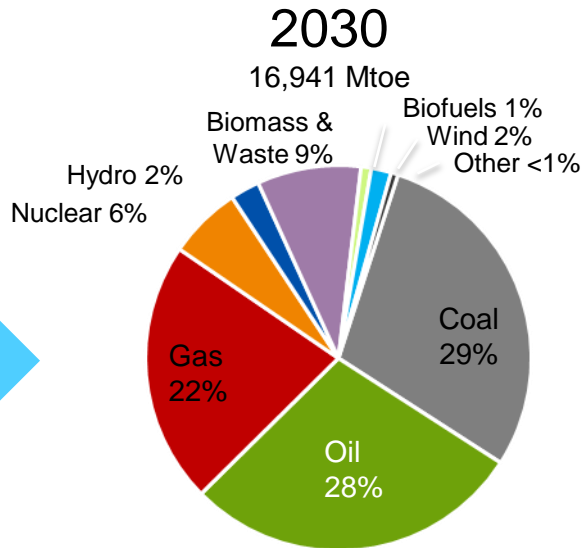
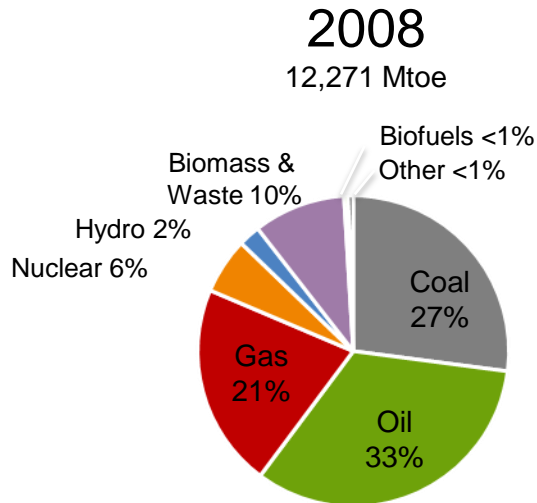
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**Desmond King, President of Chevron Technology
Ventures**

2011 Milken Institute Global Conference



Where will the supply come from?



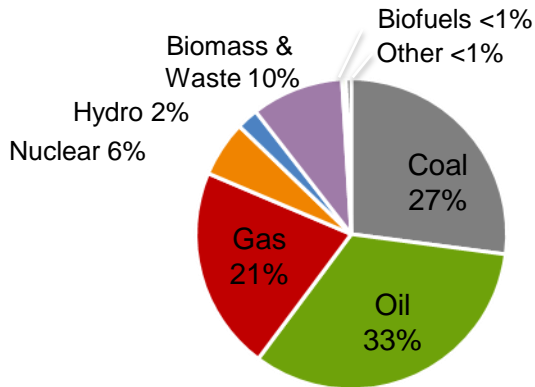
Where will the supply come from in a 450 ppm CO₂ future?



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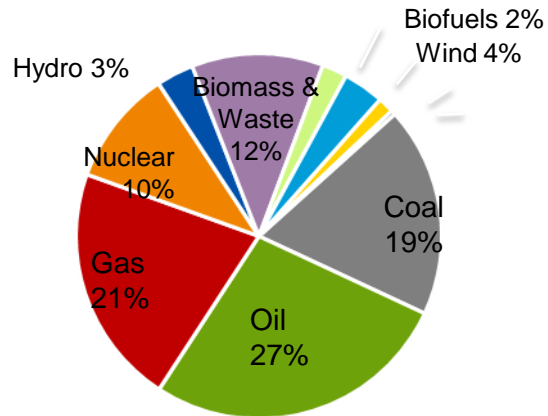
2008

12,271 Mtoe



2030

14,584 Mtoe

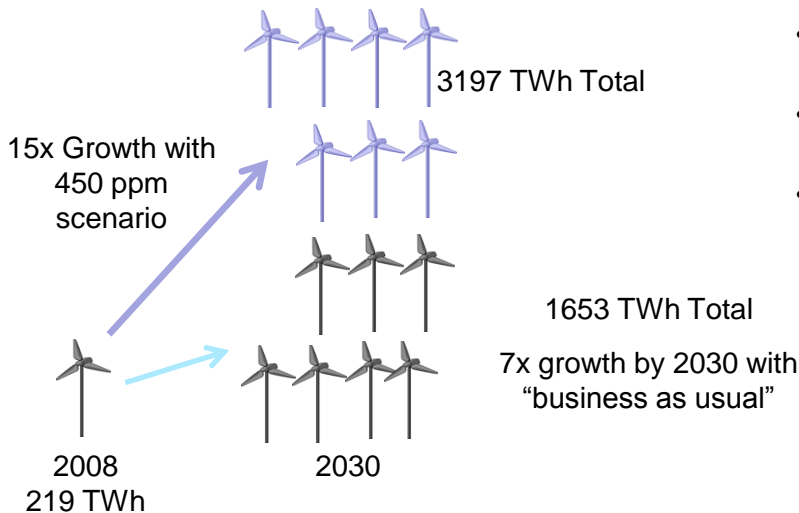


Wind power projected to grow 7x to 15x by 2030



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IEA wind power generation
forecast



Key Challenges

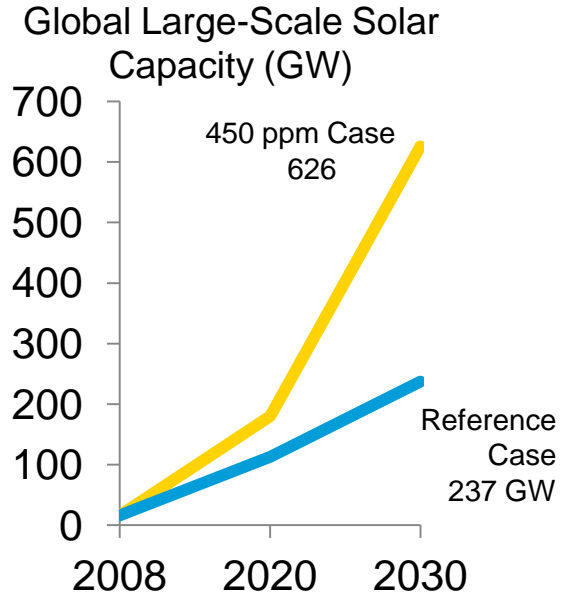
- Intermittent - unreliable as base load power
- NIMBY concerns - visual and noise pollution
- Needs large footprint per MW

Solar Power

Projected to Grow 15x to 40x by 2030



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Key Challenges

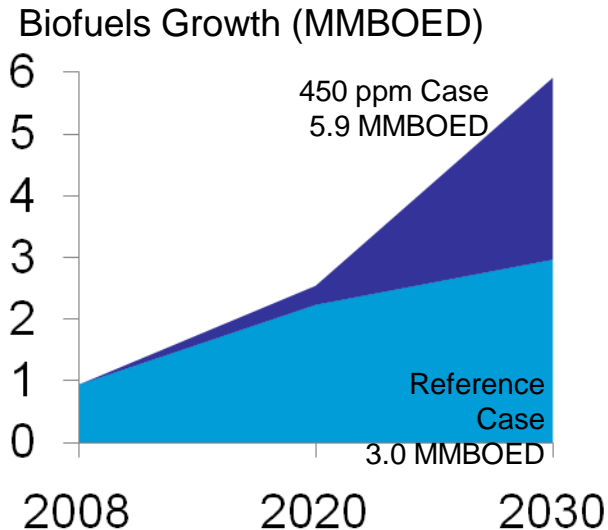
- Intermittency - unreliable as base load power
- Highest investment cost of all commercially deployed renewable energy resources
- Long-term dependency on government subsidies to compete



Biofuels production projected to grow 3x to 6x by 2030



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Key Challenges

- Commercially viable scale up
- Advanced Biofuels
 - Conversion technology
 - Biomass generation at scale

Conclusions



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Energy

We need it all

Oil & Gas

Majority of energy
supply

Renewables

Rapid growth from small
base

Energy Efficiency

Significant Opportunity