

Renewable Energy Economic Development

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March, 2010



CH2MHILL

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Where in the World?

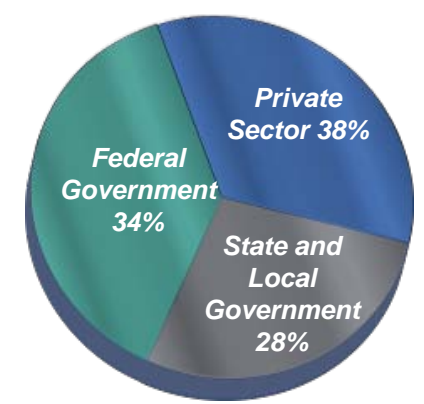


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WHO IS CH2M HILL?

CH2M HILL – Who Are We?

- Industry leader in planning, architecture, engineering, procurement, construction management, facilities management
- Broadly diversified across multiple business sectors
- >25,000 employees, >US\$6 billion in revenue
- # 1 in Site Assessment, Semiconductor, Manufacturing, Program Management, Environmental Engineering/Design
 - ENR Top 500 Design Firms Sourcebook, 2009
- 2009 Most Ethical Companies List
 - Ethisphere Institute
- Enterprise-wide focus on “Zero Incidents” in Health, Safety, Environment, and Quality



CH2M Hill – Business and Footprint



- Carbon Management and Climate Change
- Chemicals
- Industrial Systems
- Mining & Minerals
- Oil & Gas
- Power
- Renewables



- City Services/ Operations & Maintenance
- Industrial & Advanced Technology
- Transportation
- Water, Wastewater, & Water Resources



- Environmental
- Government Facilities & Infrastructure
- Nuclear

CH2M HILL has 180+ offices, worked in >130 countries, on 6 continents.

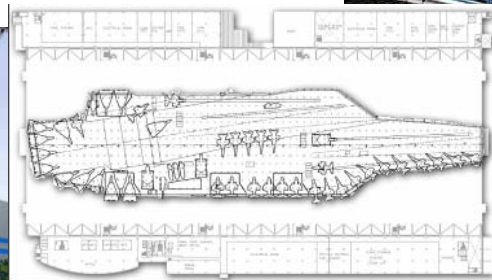
CH2M HILL leverages its expertise across all business sectors to deliver the most innovative, practical, and sustainable solutions possible



Industrial & Advanced Technology

– What We Do

- Semiconductor
 - worked on >250 sites (30 out of 56 WW 300 mm)
 - highest complexity cleanrooms, support systems
- Flat Panel Display
 - the largest cleanrooms, complex AMHS
 - most of the large fabs in China
- Solar Energy
 - fast growth, strong cost focus
 - multiple material platforms
- HDD Thin Film Heads
 - high volume, intense cost focus
- High-Density Data Centers
 - advanced modeling, energy focus
- Front End Consulting
 - advance planning, site selection, funding applications, IE reports, and high tech ED consulting



London 2012 Olympic and Paralympic Games

Client: Olympic Delivery Authority

Project Scope

- 7-year program
- A 500-acre Olympic Park with nine new venues, including modifications to historic locations such as Wimbledon and Lord's Cricket Ground
- A robust sustainable legacy plan that provides national benefits in culture, sport, volunteering, business, and tourism
- Transport program that integrates London's air, road, and rail networks
- A strong program for coordinating safety and security



Rendering courtesy of London 2012

Our Role

- One of three firms comprising the consortium, CLM Delivery Partner
- Providing global engineering, construction, and program management expertise

Panama Canal Expansion Program

Client: The Panama Canal Authority (ACP)

Project Scope

- New locks and navigational channels for both Pacific and Atlantic entrances
- Widening and deepening of Gatun Lake
- Deepening of Gaillard Cut

Our Role

- Assist client with management of all contracts and procurements
- Develop, install, and maintain Program Management Information System
- Interface with locks design/builder and with other design and construction activities
- Provide ongoing construction oversight, including quality, safety, and operability
- Interface with local and international stakeholders
- Provide ongoing training and coaching to client staff



Master Planning for Large Sites

- Confidential Client Campus, Hillsboro, Oregon, USA
 - World's largest and most advanced semiconductor manufacturing complex
 - World's largest private investment
 - Currently over 3,000,000 ft² of building area
 - Six development phases
 - Multiple fabs, R&D spaces, offices, utility plants, etc.
 - Master planning, design, construction, equipment installation, facility management
 - Significant cost and schedule savings by optimized design and construction



Masdar City

Client: Abu Dhabi Future Energy Company

Project Scope

- The first carbon neutral and zero-waste sustainable city nestled in the heart of Abu Dhabi
- Comprehensive Abu Dhabi government program to address sustainable energy sources and environmental practices
- Project focus on developing and commercializing advanced and innovative technologies in renewable, alternative, and sustainable energies (photovoltaic, wind, solar thermal, solid waste, and ground-sourced heat pumps)

Our Role

- Serve as program manager for the development of Masdar City
- Identify and measure environmental impacts throughout Masdar's life cycle (energy, water, wastewater, and transportation)



Rendering courtesy of the Abu Dhabi Future Energy Company



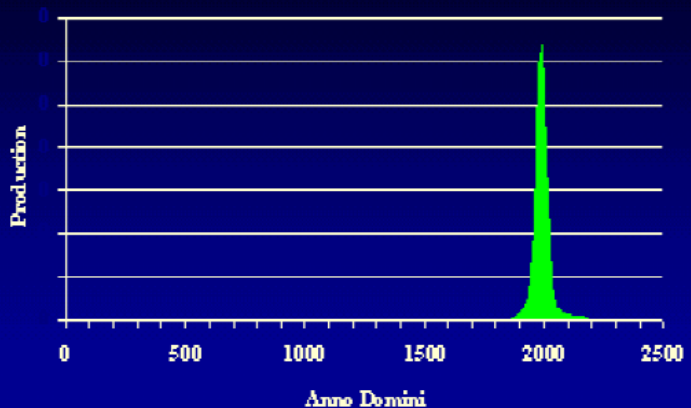
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WHY DO WE NEED RENEWABLES?

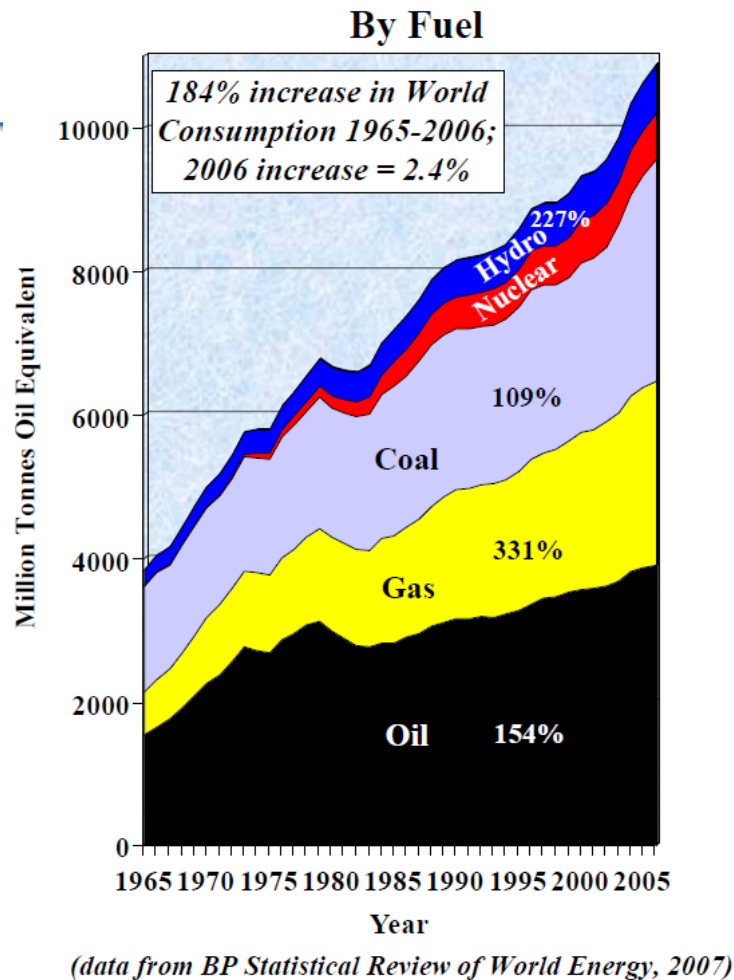
We Use A Lot Of Energy

- World per capita energy use is growing, especially in developing countries
- World population is growing, especially in developing countries
- Put them together and the forecasts for consumption are really big
- “Anyone who believes exponential growth can go on forever in a finite world is either a madman or an economist”
- Kenneth Boulding

The Hydrocarbon Age A fleeting epoch in history



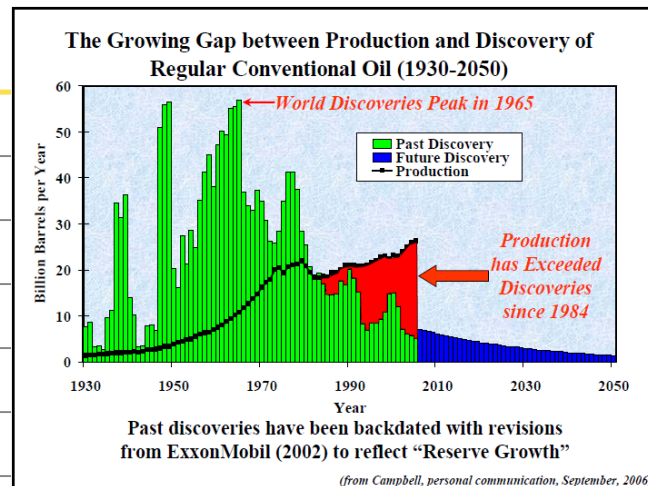
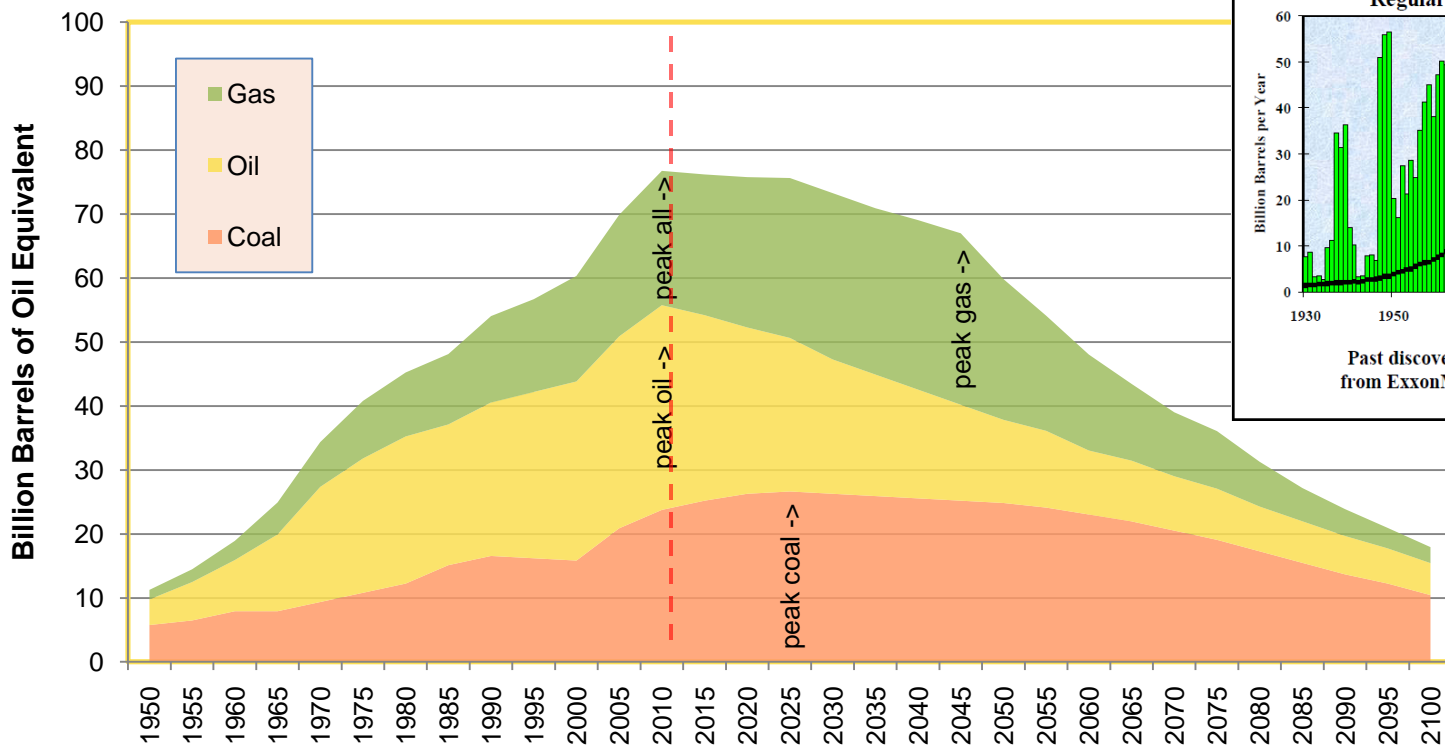
- Time is short
- Back to a wood and steam economy?



We Will Run Out Of Hydrocarbons

Hydrocarbon Production, Historical and Forecast

Oil & Gas: Campbell, 2007; Coal: Energy Watch Group, 2007
(Converted @ 7.2 barrels of oil per tonne of coal)



The Transition Could Be Massive

- Hypothetically – what would it take to replace all that cheap fuel with hydro, wind & solar?
- How much energy would be needed to build:
 - 490k tidal turbines
 - 3.8M wind turbines
 - 1.7B rooftop PV systems
- What % of the remaining hydrocarbons would be needed?
- How many jobs?



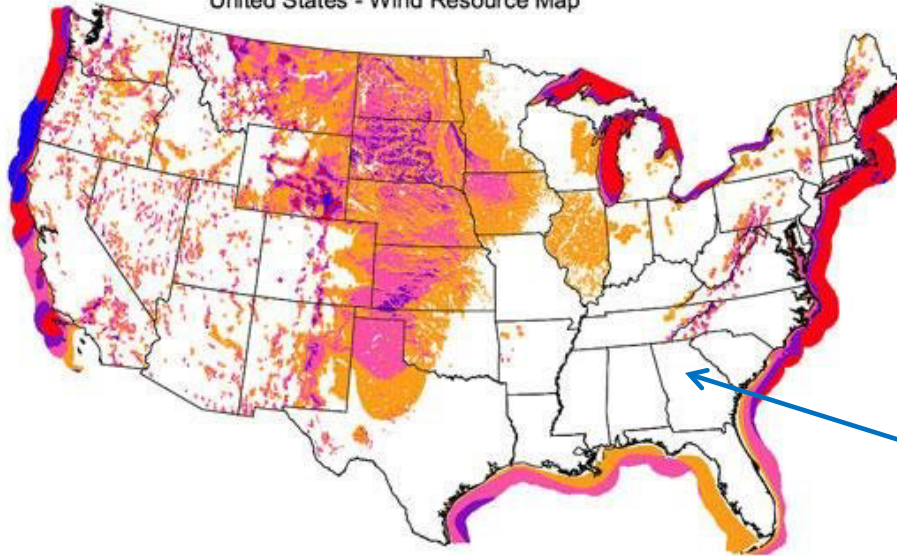


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WHERE IS THE WIND BLOWING?

The Haves and Have-Nots

United States - Wind Resource Map



Wind Power Classification

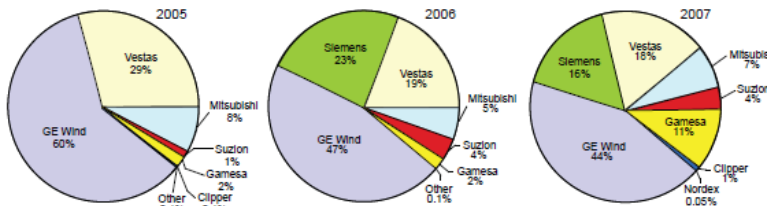
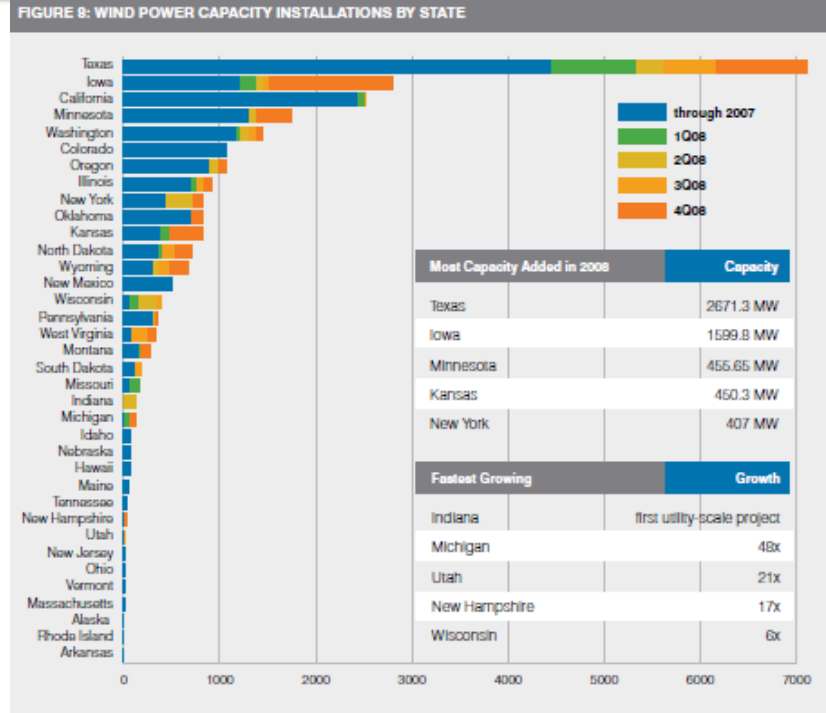
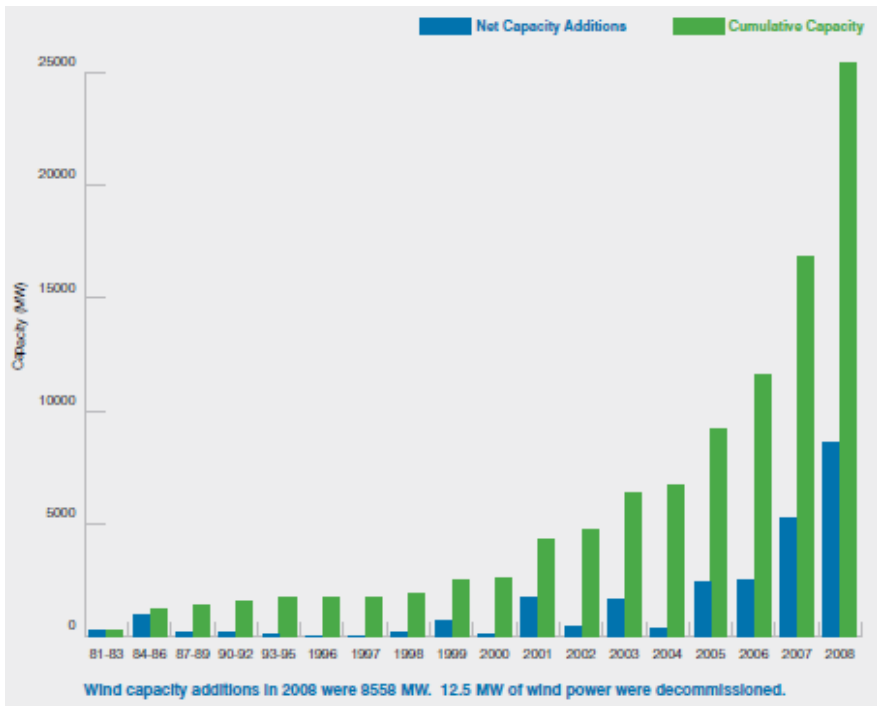
Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed at 50 m m/s ^a	Wind Speed at 50 m mph ^a
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	800 - 1600	8.8 - 11.1	19.7 - 24.8

^aWind speeds are based on a Weibull k value of 2.0

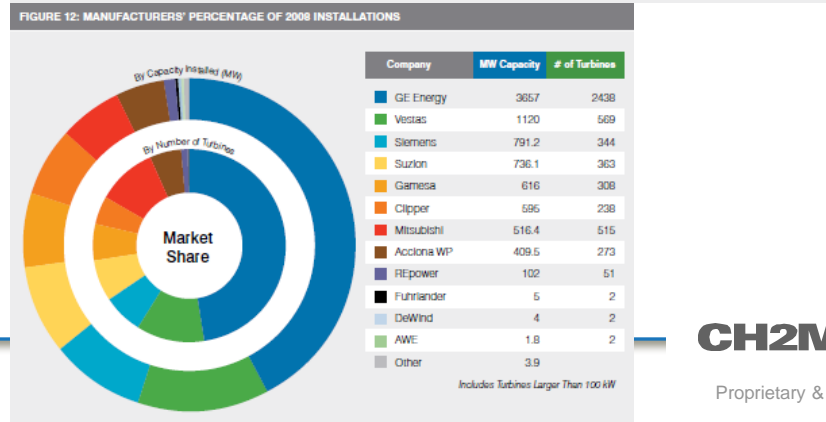
Wind Economic Development

- Manufacturing vs. Installation
- MFG = significant, but not unlimited opportunity
 - Dozen or few Dozen factories announced / year (future discount)
- Install = distributed local growth opportunities install / maintenance / and possibly tower mfg plus
- Regional and Scale differences
 - Turbine sizes, economics, risk

Putting the Wind to Work – Installations & Manufacturing



Source: AWEA project database.
Figure 7. Annual U.S. Market Share of Wind Manufacturers by MW, 2005-2007



U.S. Wind Manufacturers: What They Make & Where

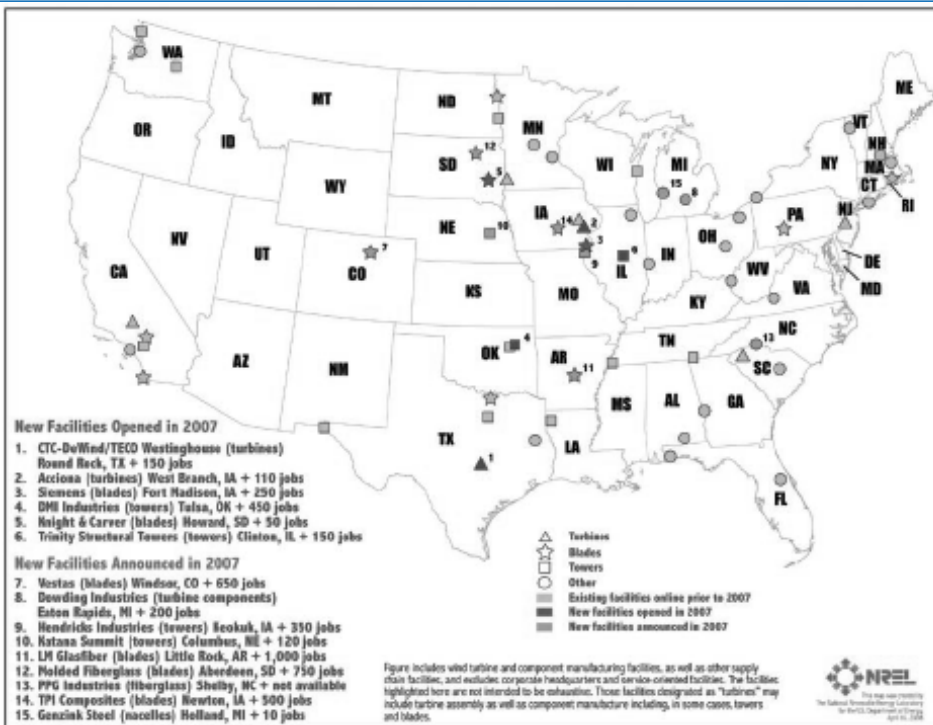
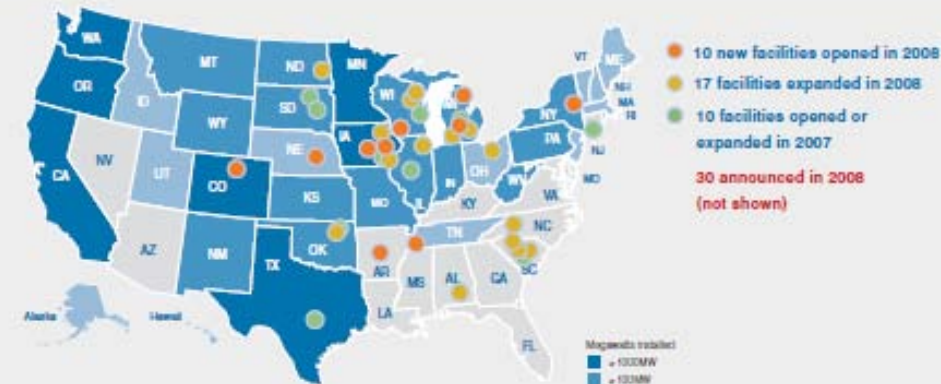


FIGURE 18: UTILITY-SCALE WIND TURBINE MANUFACTURING

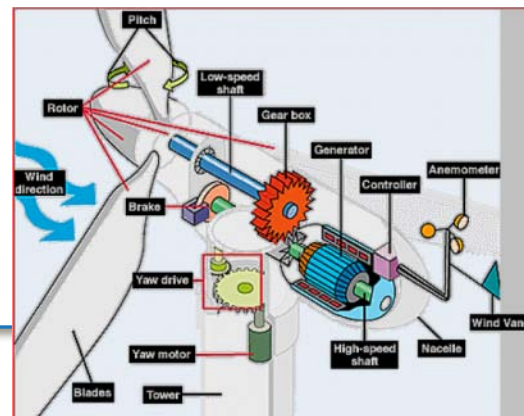
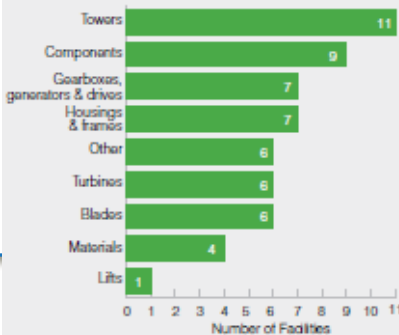


Facilities Opened or Expanded in 2008

- | | | |
|---|---|---|
| <ul style="list-style-type: none"> ● Acciona Energy*, West Branch, IA, Turbines. ● ATI Casting Service, Apopka, FL, Castings. ● E-TM Enterprises, Lansing, MI, Composite Structures. ● GE Energy, Schenectady, NY Parts Fulfillment Center ● GE Energy, Memphis, TN, Parts Operation Center ● Katana Summit, Columbus, NE, Towers. ● LM Glasfiber, Little Rock, AR, Blades. ● TPI Composites, Newton, IA, Blades. ● Vestas, Windsor, CO, Blades. | <ul style="list-style-type: none"> ● Wausaukoo Composites, Cuba City, WI, Nacelles. ● Abstrom Specialty Reinforcements, Bishopville, SC, Bearings. ● Danotek, Ann Arbor, MI, Generators. ● DMI Industries, West Fargo, ND, Towers. ● DMI Industries, Tulsa, OK, Towers. ● Finkl and Sons, Chicago, IL, Components. ● Genzink Steel, Holland, MI, Frames. ● Kaydon, Sumner, SC, Bearings. ● K&M Machine Fabricating, Cassopolis, MI, Hubs and gearbox housings. | <ul style="list-style-type: none"> ● Mart Goat, Aringo, WI, Gears. ● Molded Fiberglass Alabama, Opp, AL, Housings. ● PPG Industries, Shelby, NC, Fiberglass. ● Rolak, Aurora, OH, Bearings. ● Siemens, Fort Madison, IA, Blades. ● Siamens, Fort Madison, IA, Blades. ● Timken Company, Union, SC, Bearings. ● Wausaukoo Composites, Wausaukoo, WI, Housings. ● Winergy Drive, Elgin, IL, Gearboxes. |
|---|---|---|

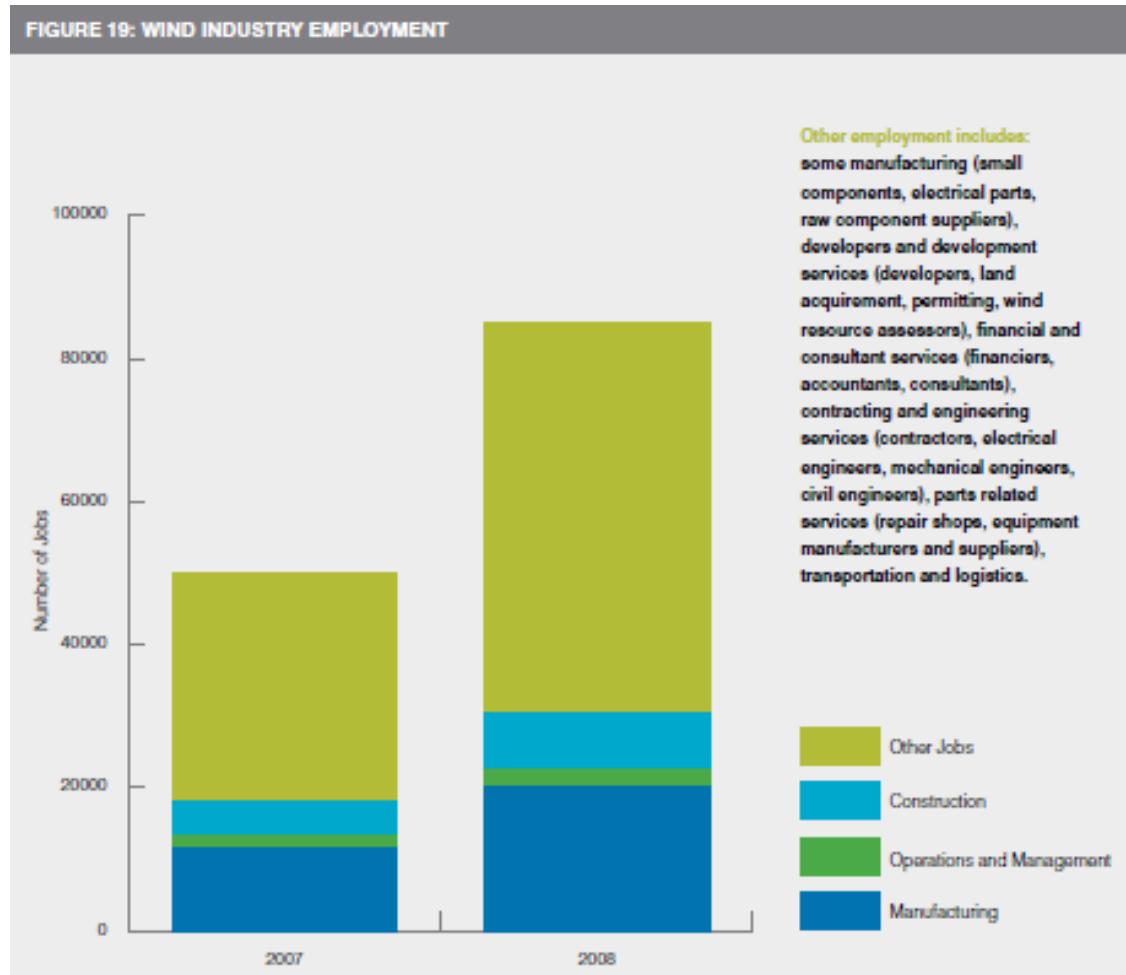
*subsequently expanded in 2008

FIGURE 17: 2008 FACILITIES BY COMPONENT



What About Jobs?

- Most of the wind jobs are “other”
 - Components manufacturing
 - Development, siting, permitting
 - Financing
 - Engineering & Construction
 - Maintenance
 - Transportation & Logistics





3.0

WHERE IS THE SUN SHINING?

Soaking Up The Sun

Front End Manufacturing

- High Value Direct Jobs
 - Centralized base of 10s of Scientists, Engineers & Managers, 100's of skilled technicians
 - Needs a high tech community of University, legal, and financial experts
 - High multiplier
- Construction of High Tech Factories
- Focused high tech supply chain of materials and services
 - 'Big Wins' get more press/publicity
 - Best in areas with existing and relevant knowledge economy and expertise
 - Dominated by incentive packages



Assembly & Installation

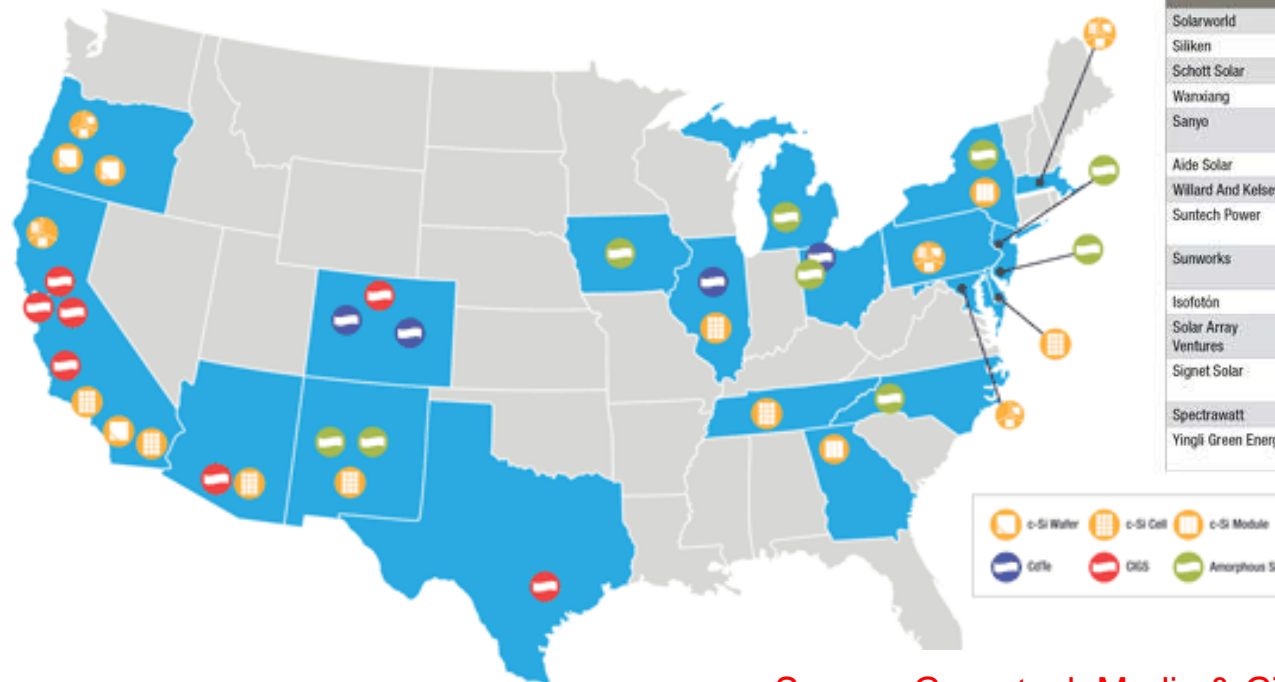
- Medium Value Direct jobs
 - 100s to 1000s in a de-centralized workforce
 - Wider net - Incremental growth of existing contractors
 - Lower multiplier
- Some retraining
- Lower value materials & supply chain
- Decentralized platform = less attractive incentives



Who Makes Panels?

What Drives Factories?

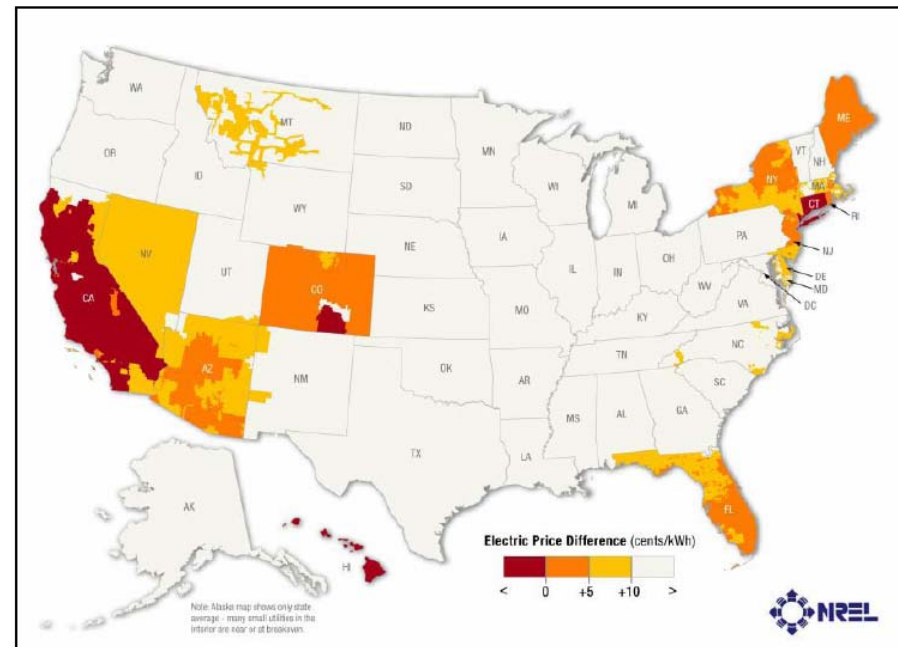
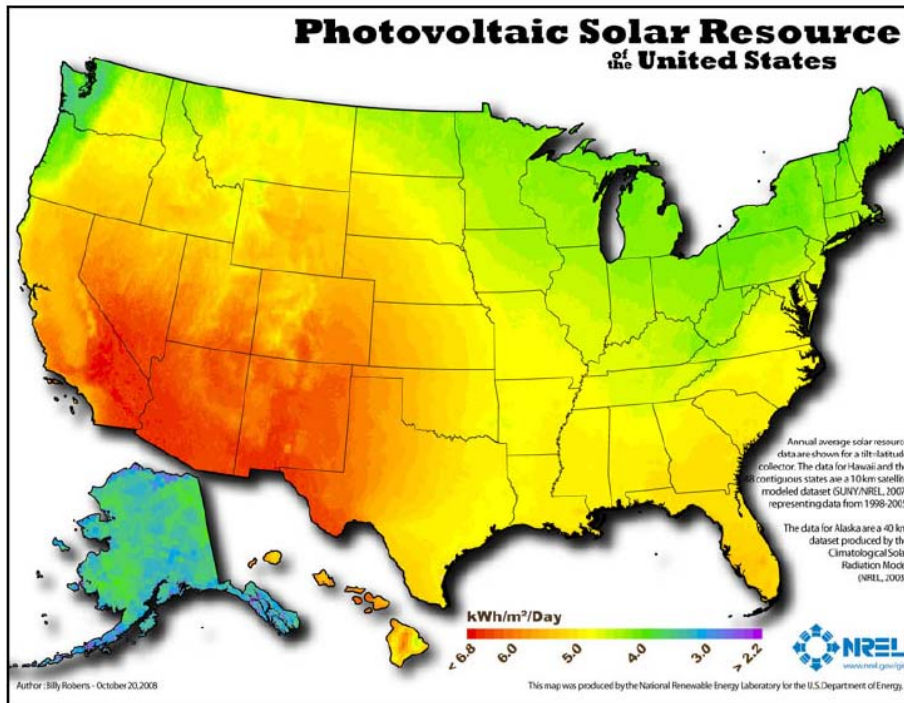
- Hinges on **technology** and **incentives**. If a U.S. location doesn't have a clear advantage in either/both, it will be an uphill battle
 - The U.S. is forecasted to have ~37 PV manufacturing facilities by 2012, compared to 26 at the beginning of 2009, this and other methods support a ***prediction of ~3 U.S. factories per year***
 - 18 states will have some PV manufacturing presence by 2012 (9 > 100MW), compared to only 3 (Ohio, Michigan, Oregon) in 2009.



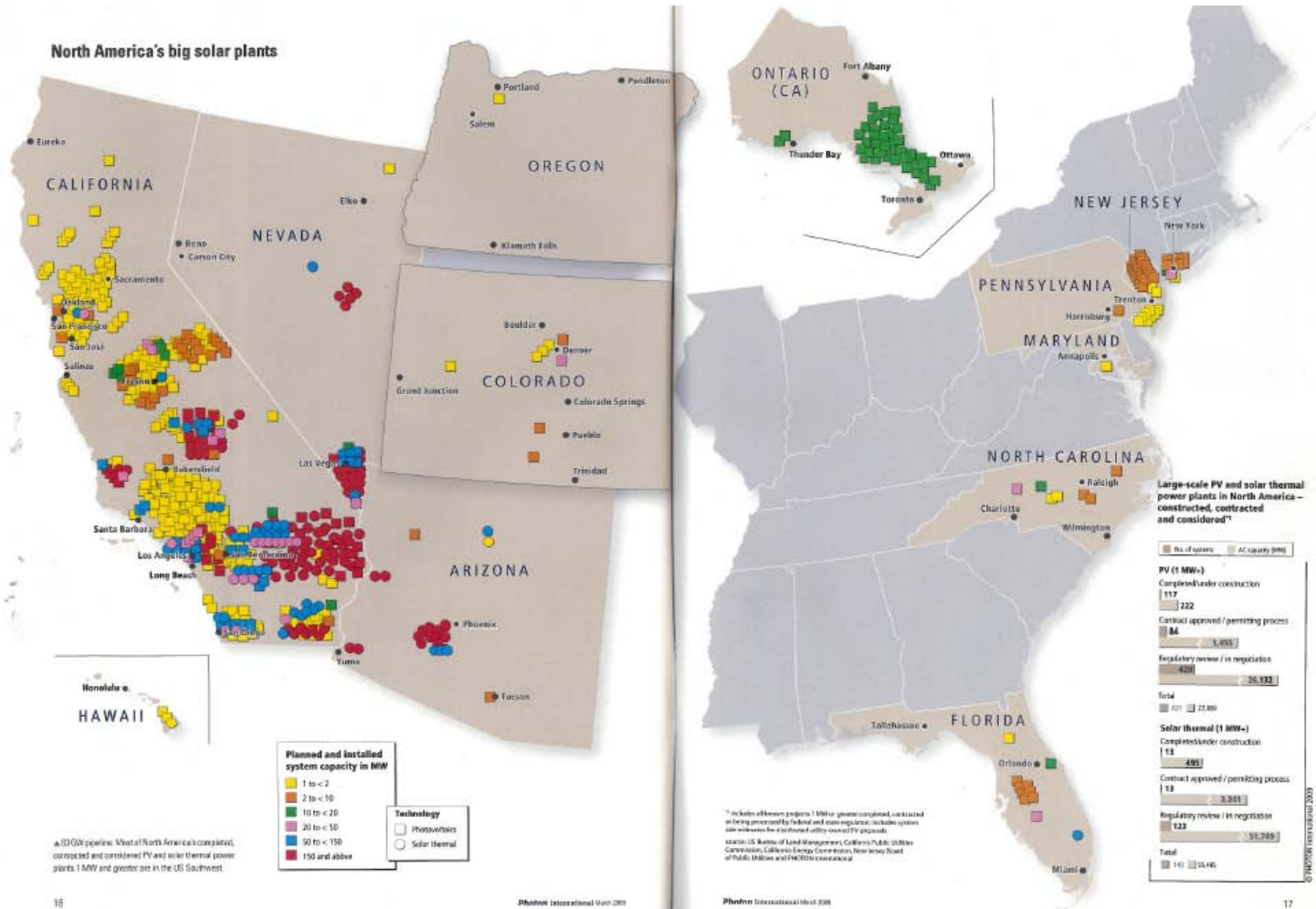
Company	Value Chain	Location	Production-Ready Date	Estimated 2010YE Capacity (MW)	
Solarworld	Crystalline Si	Wafer, Cell	Oregon	10/2008	375
Siliken	Crystalline Si	Module	California	12/2008	50
Schott Solar	Crystalline Si	Module	New Mexico	5/2009	102
Wanxiang	Crystalline Si	Module	Illinois	Q3 2009	36
Sanyo	HIT (High-efficiency Mono Si)	Ingot/Wafer	Oregon	10/2009	70
Aide Solar	Crystalline Si	Module	Arizona	Q3 2009	Unknown
Willard And Ketsky	CdTe	Cell/Module	Ohio	Q4 2009	60
Suntech Power	Crystalline Si	Module	TBD (Arizona or Texas)	Q1 2010	100
Sunworks	Tandem-junction Amorphous Si	Cell/Module	TBD (possibly New York)	Q4 2010	45
Isotofón	Crystalline Si	Module	Ohio	Q4 2010	30
Solar Array Ventures	Tandem-junction Amorphous Si	Cell/Module	New Mexico	Q4 2010	60-70
Signet Solar	Tandem-junction Amorphous Si	Cell/Module	New Mexico	2010	46
Spectrawatt	Crystalline Si	Cell	New York	2010	30
Yingli Green Energy	Crystalline Si	TBD	TBD	2010 (Estimated)	TBD

Where The Solar Energy Is (and Isn't)

- Focus on creating good conditions for end-use
 - driven by electricity rates, solar resources, transmission infrastructure, popular and political willpower, and incentives (the latter can overcome solar resources, see the NE region below)



Where Are Solar Utilities Installed or Planned?



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© 2009 International Utility Group

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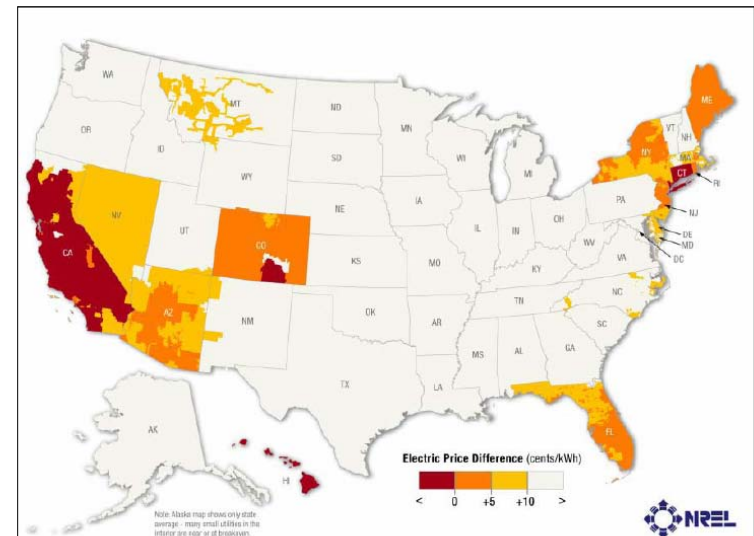
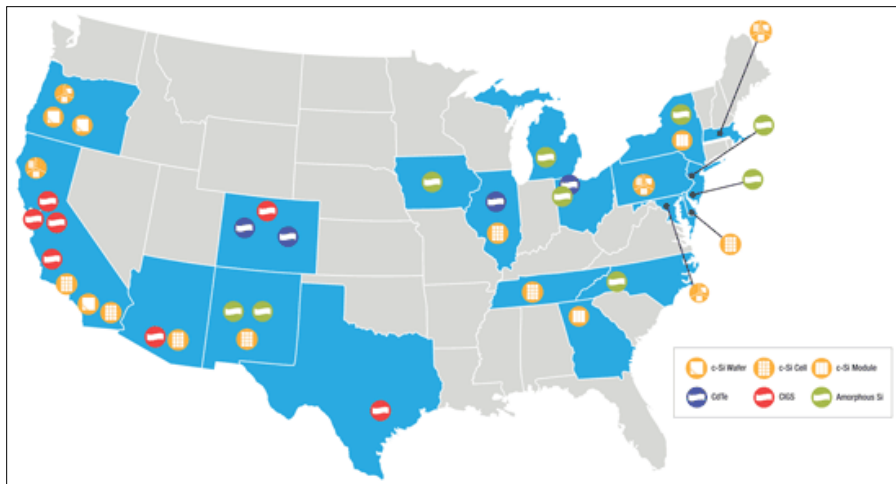
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Can I Do Both?

They Don't Always Overlap

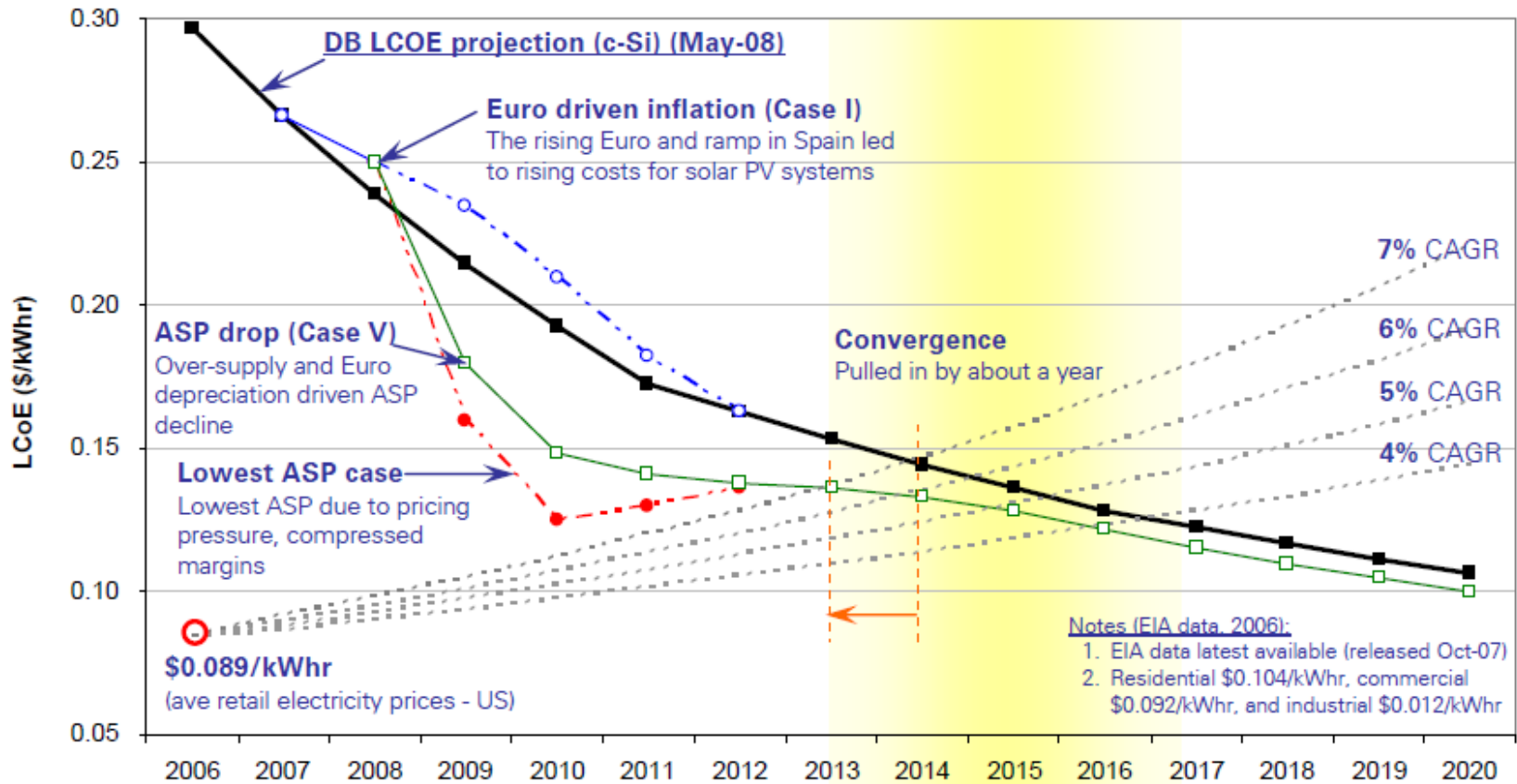
- Best manufacturing regions are driven by different factors than the best end-use regions
 - Power Cost
 - Available Materials
 - Sites & Buildings
 - Competing Generation Sources

- Population and Infrastructure Bottlenecks
- Labor Skills and Costs
- Technology Business and R&D Access
- **Incentives**, Popular Will, RPS & Politics



When Can I Stop Subsidizing?

Figure 23: Convergence projection – c-Si solar PV LCOE versus average grid electricity prices in the US



Source: Deutsche Bank estimates

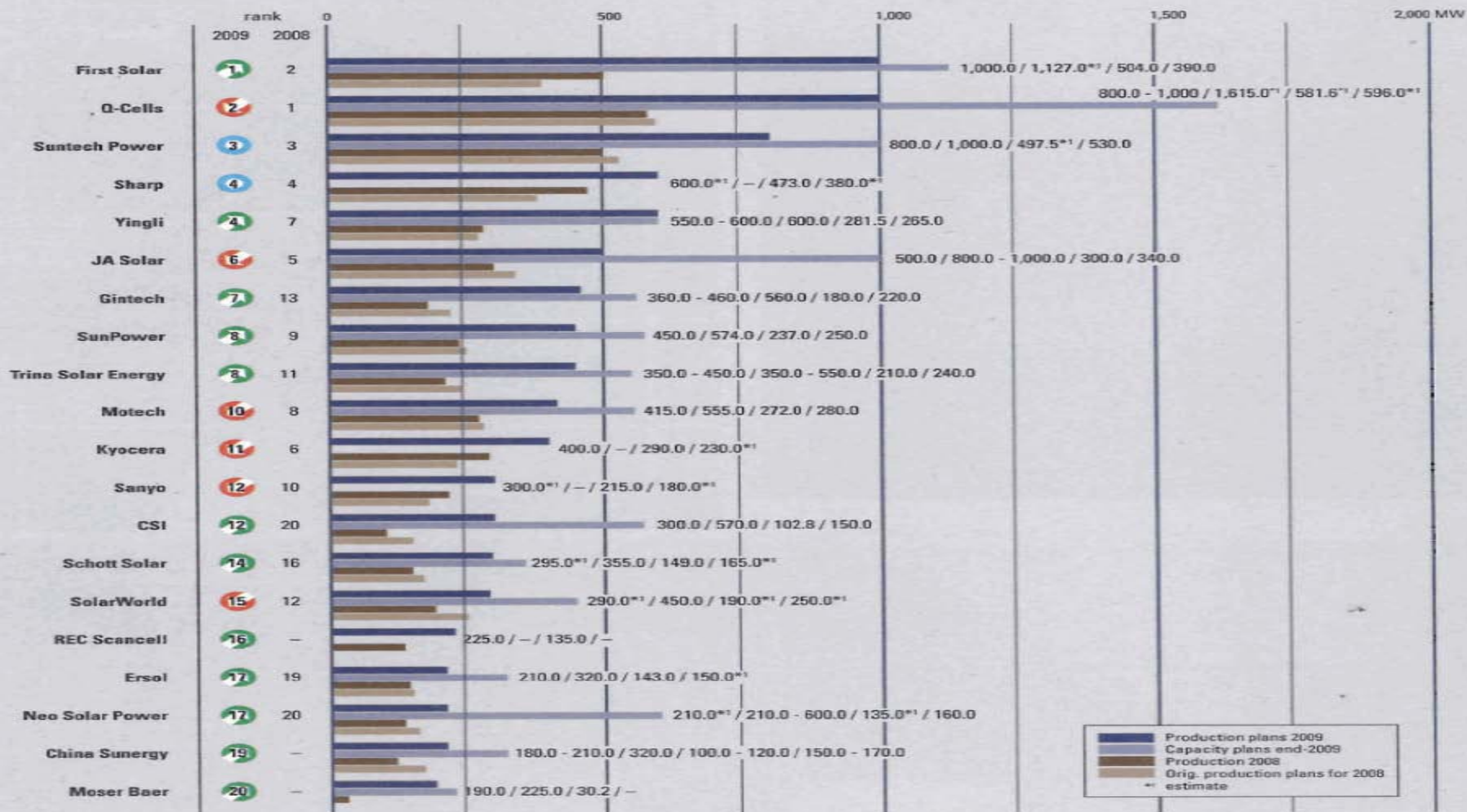


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HOW TO CATCH SOME RAYS

The Big Players in PV

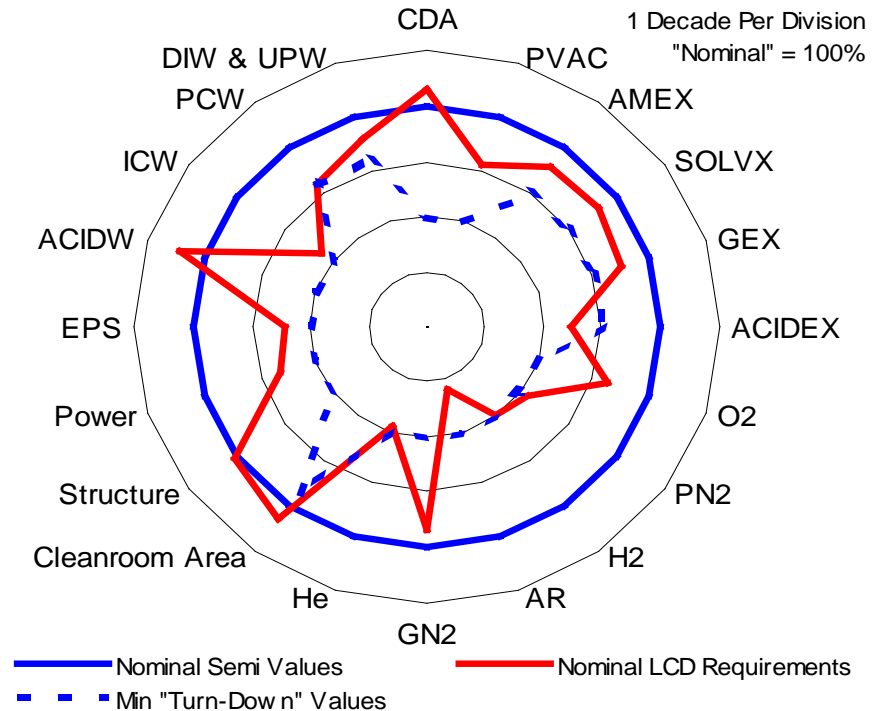
Planned cell production and capacity of top 20 for 2008 and 2009



■ Production plans 2009
■ Capacity plans end-2009
■ Production 2008
■ Orig. production plans for 2008
 ** estimate

Maybe You've Already Got A PV Manufacturing Building?

- There are many underutilized 6" and 8" semi fabs in the US
- The facility systems needed for solar manufacturing are similar
 - cleanroom, air handling, bulk chemicals, abatement, structural loading, etc.
 - workforce!
- Typical semi system exceed solar requirements, but most within efficient operating range
- Retrofit can save time, energy, materials, and money



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RENEWABLE RELATED OPPORTUNITIES



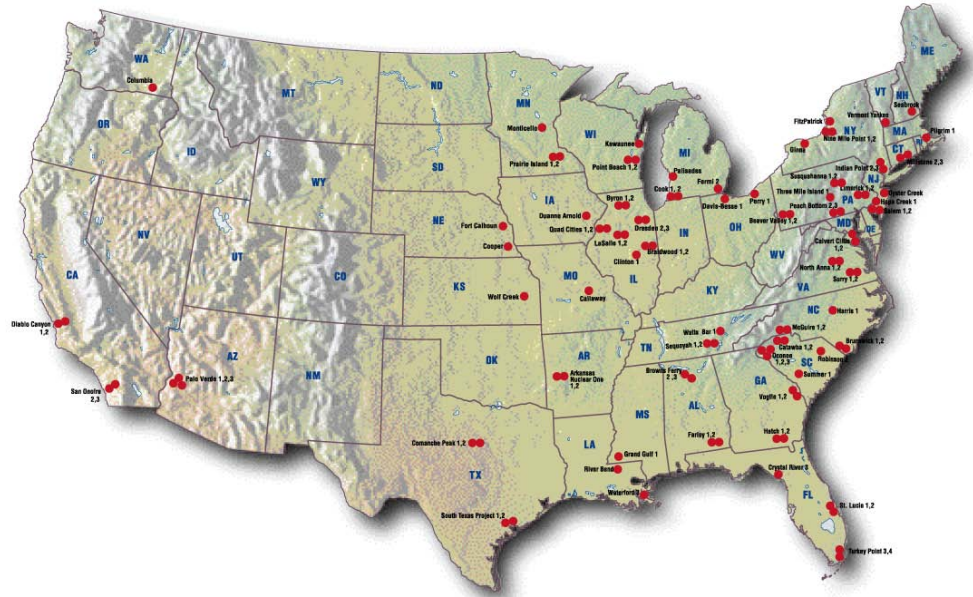
"Say ... what's a mountain goat doing way up here in a cloud bank?"

Return of Nuclear

Despite debate, nuclear power opportunities are returning

Industry Trends:

- Development will be tied to existing nuclear sites and infrastructure through plant life extensions and expansion
 - Approx 3 years to permit and approve, and 5 years from concrete to power
 - 4-8 new units may come on line by 2018, the first of 17 licensed applications to build 26 new nuclear reactors (2007)
- Ownership and operations will continue to consolidate

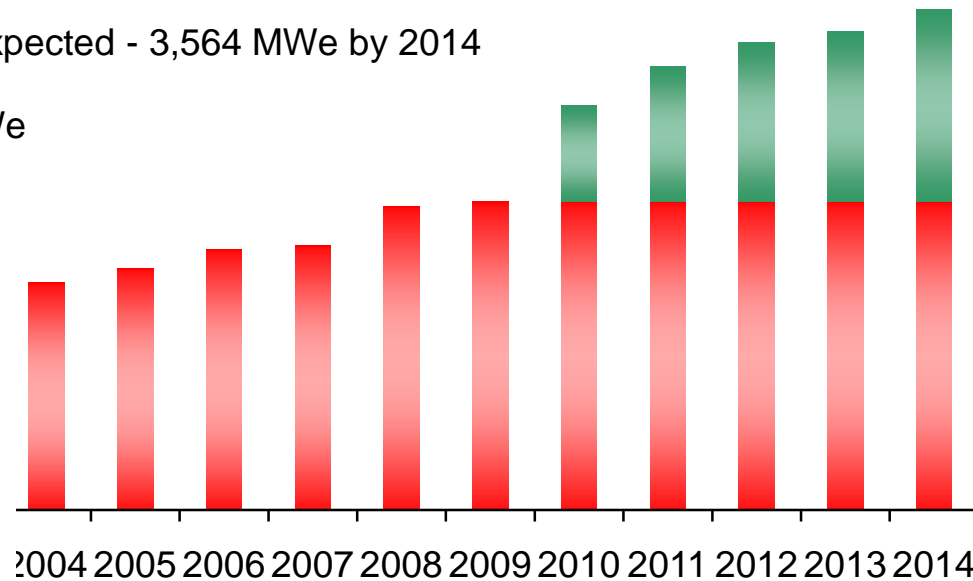


- 104 reactors in 31 states generate substantial economic value.
- In 2008, the nuclear energy industry procured more than \$14 billion in materials, fuel and services from more than 22,500 domestic suppliers in all 50 states.

Cumulative U.S. Nuclear Capacity Additions

10,000
9,000
8,000
7,000
6,000

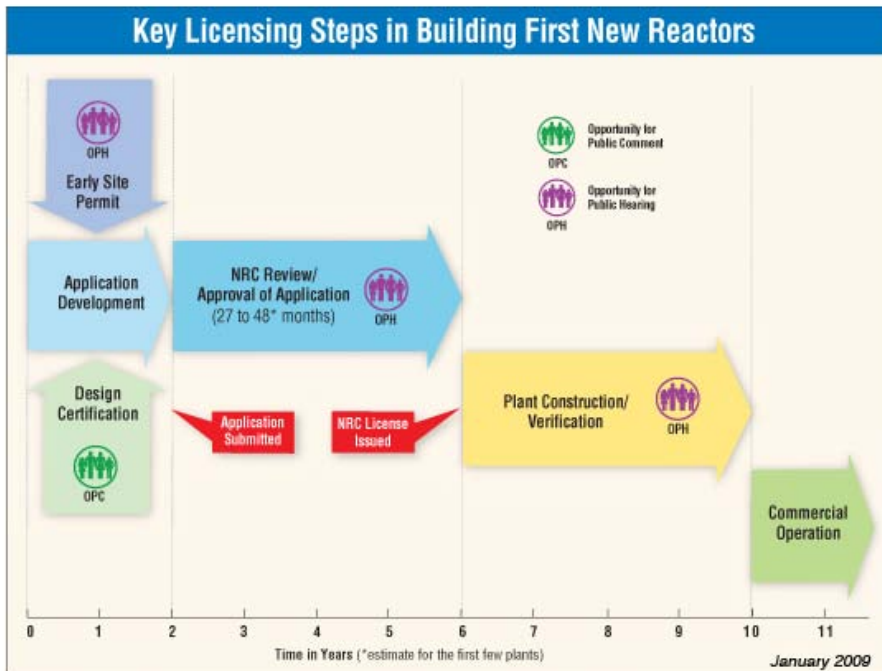
■ Under Review and Expected - 3,564 MWe by 2014
■ Approved - 5,726 MWe



Source: Nuclear Regulatory Commission

Updated: 1/2010

Key Licensing Steps in Building First New Reactors



The NRC's new licensing process offers multiple opportunities for public input.

LED's

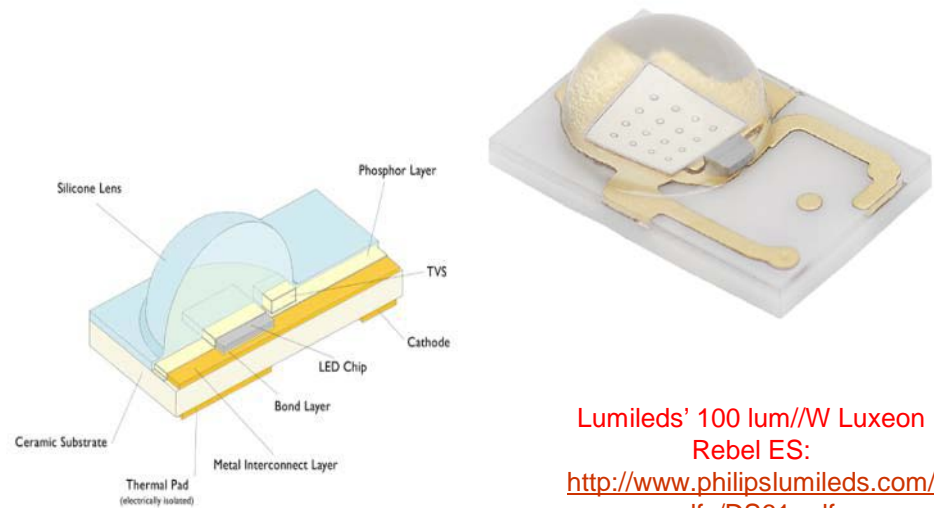
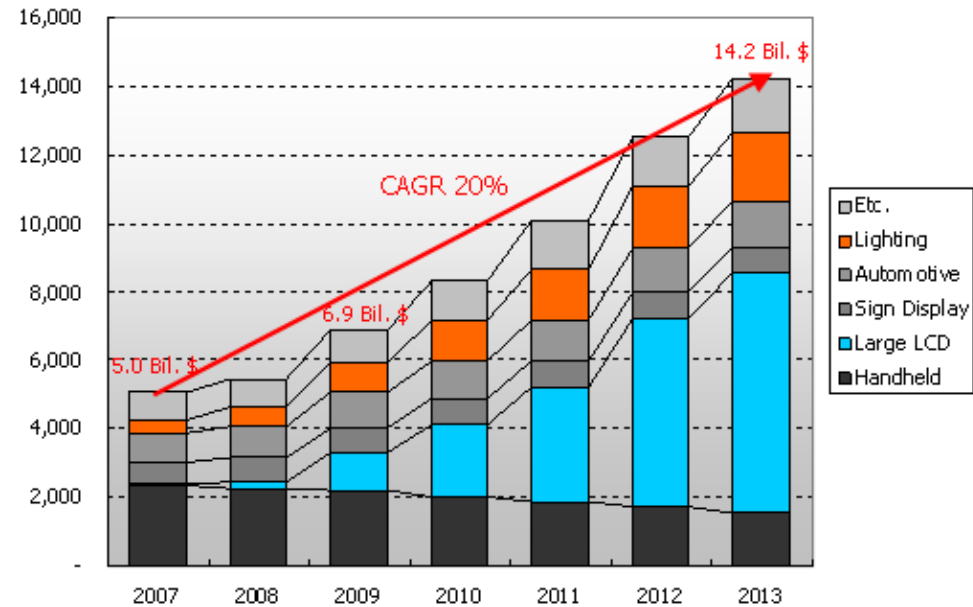
- Lighting accounts for ~ 20% of WW electricity
- Traditional incandescents bulbs are being legislated out
- CFL's contain mercury
- LED's are coming – 1st in notebooks, then TV's, then lighting
- LED manufacturing is similar to semiconductor from 30 years ago



How Big / Important Will LED's Be?

- High brightness light emitting diodes (LED's) market is growing rapidly
 - LCD backlights and specialty and general lighting
- Currently a \$7B market, expected to double in the next 5 years
- Notebooks & TV's will switch over the next few years
- 60 W Incandescent bulb can be replaced by a 10 W LED lamp

Global LED Market Forecast by Segment (Mil. US\$)
 (Source: Displaybank report, 'LED Lighting Industry Growth Perspective', May 2009)



Lumileds' 100 lum/W Luxeon Rebel ES:
<http://www.philipslumileds.com/pdfs/DS61.pdf>

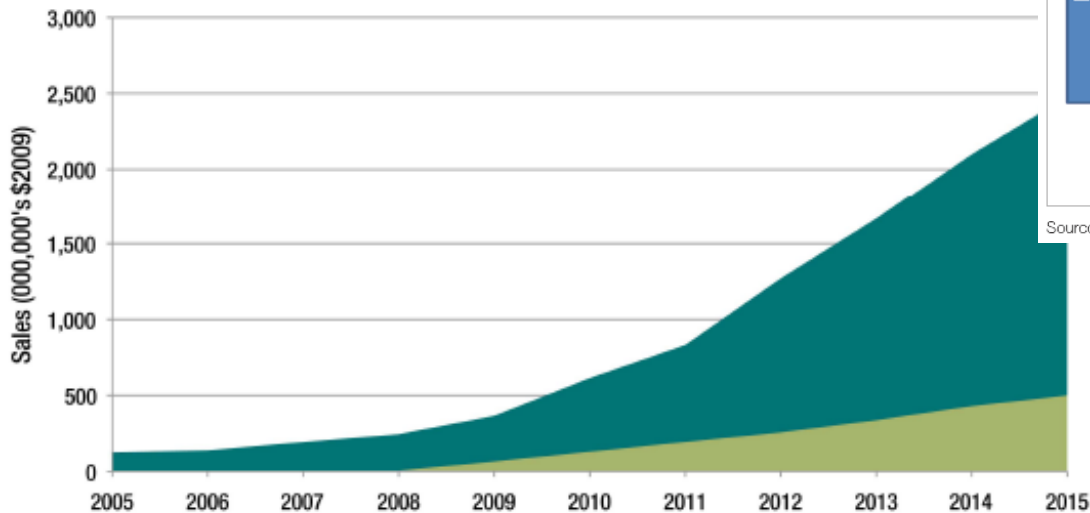
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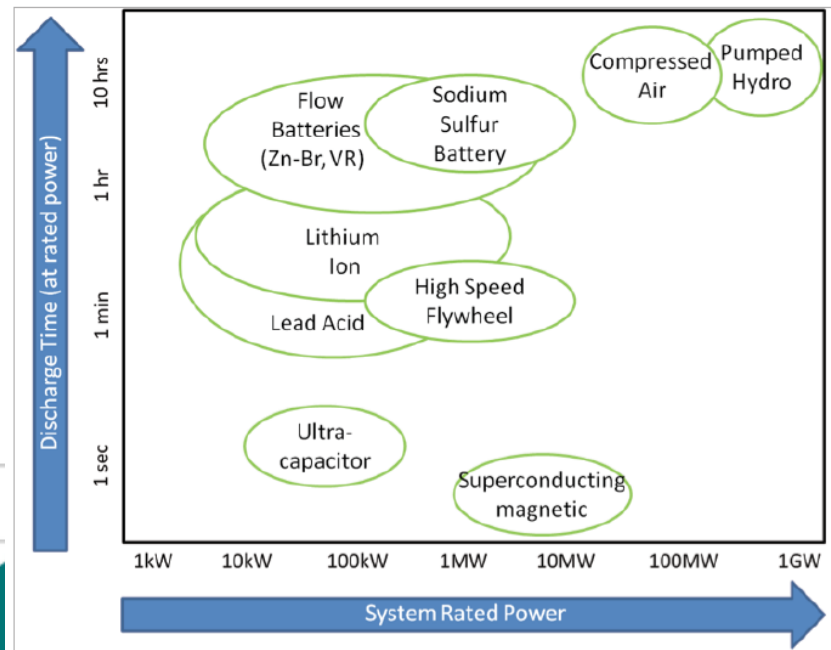
Advanced Batteries and Energy Storage

- Energy Storage is forecasted to be a fast-growing, diverse, and extremely complex market.
- It is driven by other new markets:
 - Renewable energy / Smart grid
 - Electric/hybrid vehicles

Production of Grid Scale Energy Storage



Global utility-scale energy market forecast, \$USB

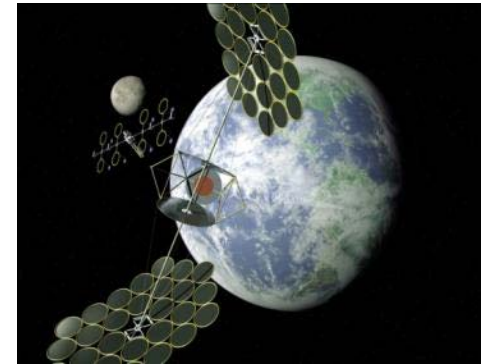


Source: GTM Research

■ Energy ■ Power

What Else Is Just Beyond The Horizon?

- OLED lighting & displays
 - ePaper
 - Quantum Dot Materials
 - Biotech / MEM Devices for Sensors & Actuators
 - Next Generation Vehicles
- And Things We Can't Yet Imagine...



Where in the World?



Thank You

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