Forum

The Direction of Alternative Energy

Panelists

Shaun Guy – Regional Manager, Rockwell Automation

Peter Howe – Vice President, KBR

Simon Lott – President, MSM Consulting LLC

engineering and construction contracting association

Alternative Energy

- **Installed global power generation capacity will increase 41% over the next decade, from 4,500 GW to 6,400 GW**
- **Non-hydro renewables led by WIND, will be the largest source of capacity additions during this time period**
- **Installed renewables capacity is expected increase from 274 GW in 2008 to 1,160 GW in 2020, a 13% compounded annual growth rate**
- **Installed nuclear capacity will increase from 375 MW to 537MW, despite 50 GW of capacity being decommissioned in the same period**
- **Fossil fuel-fired power capacity will slowly rise to 3,500 GW by 2020.**
- **Biofuel capacity expected to increase to 36 Billion Gallons per year in 2022.**

engineering and construction contracting association

Alternative Energy

- **In 2007, for the first time ever, renewable energy was the leading source of electric generation capacity installed in the US.**

  - **The global revenues for solar photo-voltaic, wind power and bio-fuels expanded from $75,8 bn in 2007 to $115.9 bn.**
  - **Wind Power alone generated $50 bn**

- **In 2008:**
  - **Solar energy industry grew by +16%**
  - **Grid-tied PV capacity increased +58%**
  - **Solar water heating capacity increased by +40 %**

North American Green Energy Magazine, March/April 2009
Clean Energy Trends 2009

engineering and construction contracting association

Alternative Energy

Incentives and other Governmental Initiatives

- **Strong Federal emphasis: rapid deployment of alternative energies**
- **Solar technologies preferred**
- **The Stimulus Bill includes $70 bn in direct spending and tax credits**
- **In addition, there is a maze of additional grants available (in California alone over 150 options)**

Renewable Federal Programmes

- **Investment Tax Credits**
- **Renewable Energy Cash Grants (Treasury)**
- **"Qualifying Advanced Energy Project Program" (Renewable Energy Manufacturing Investment Tax Credit)**
- **Bonus Depreciation Deduction**
- **Other Selected Renewable Energy related Appropriations (totaling USD 30 billion)**

engineering and construction contracting association

Carbon Credits

Federal legislation in preparation: carbon dioxide emissions

- **Cost to fossil fuel industries $646 billion through 2019.**
- **Currently includes a cap-and-trade program, capping emissions 20% below 2005 levels by 2020 and 83% by the mid century**

The EPA's Proposed Mandatory Greenhouse Gas (GHG) Reporting Rule

The Chicago Climate Exchange:

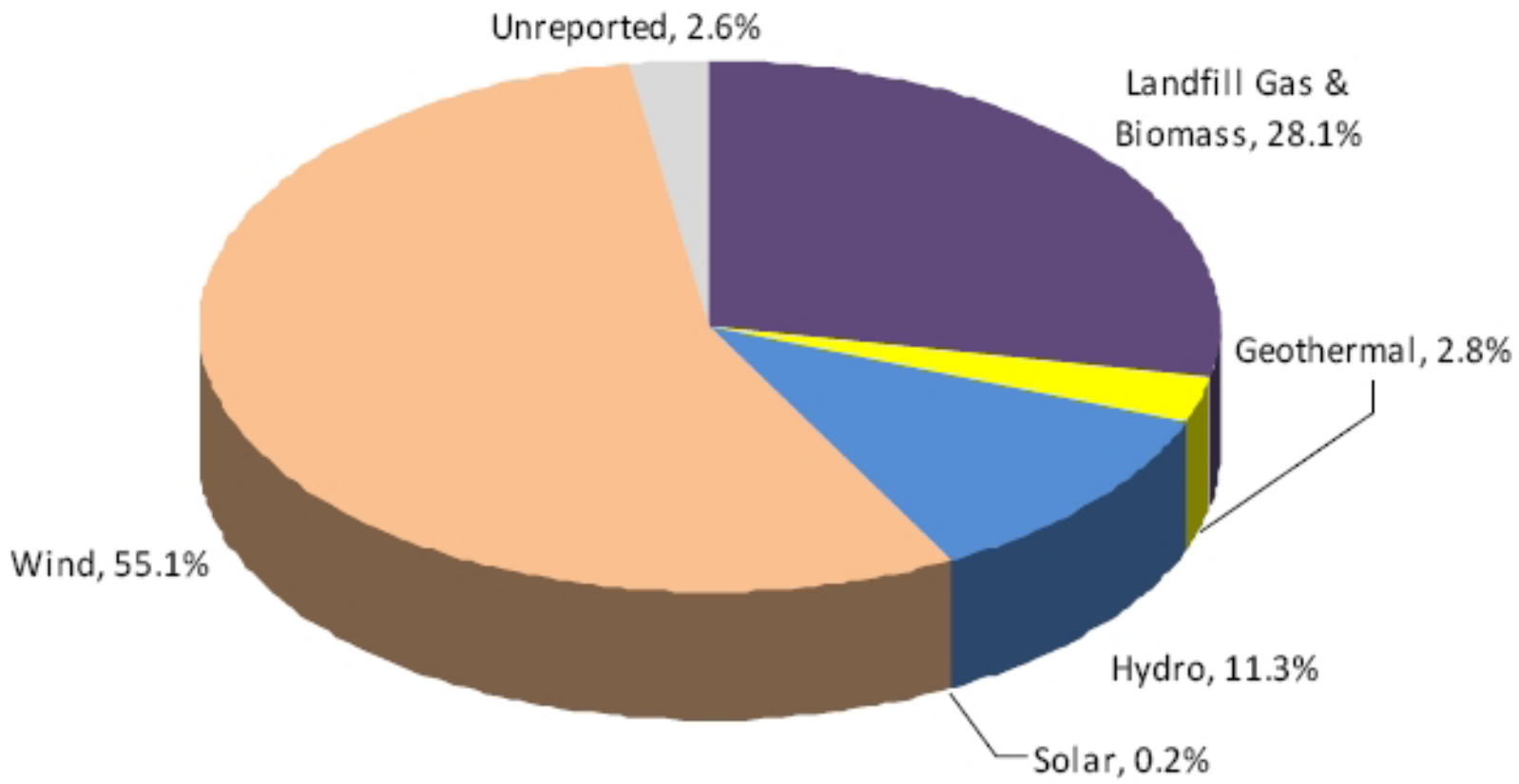
- **Voluntary and legally binding, greenhouse gas emission reduction and trading system.**

***SB 1368 Emission Performance Standards*:**

- **The Californian law Senate Bill 1368**
- **limits long-term investments in base load power generation.**

engineering and construction contracting association

2007 Estimated green power sales by energy source



Source: Green Power Marketing in the United States: A Status Report (11th Edition) Oct 08

engineering and construction contracting association

Alternative Energy

- **Over the next decade, renewables will significantly expand its share of installed power capacity as carbon policies shift the power generation investment landscape**

Examples

- **UK by 2020 40% electricity by renewable sources**
- **US by 2030 20% electricity by Wind power which equates to 16,000 MW per year to 2030**
- **India by 2020 - 20,000MW from Solar**

engineering and construction contracting association

Alternative Energy

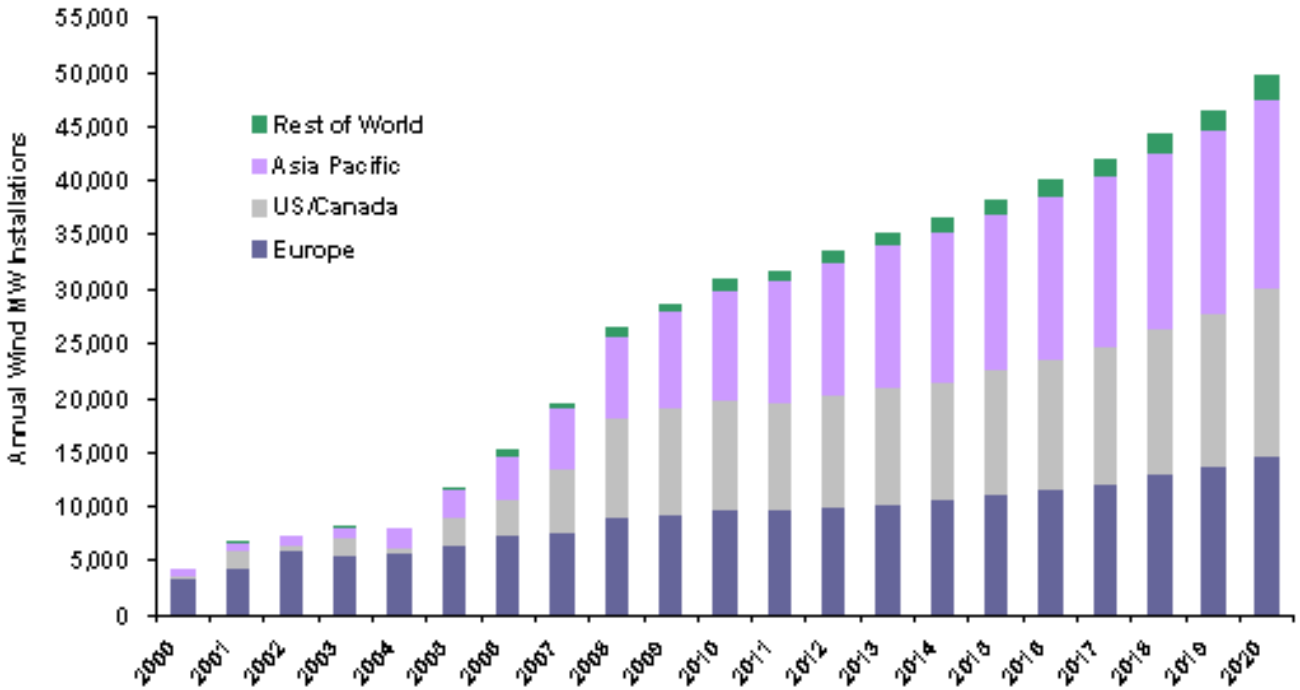
Wind
Biofuels
Solar Thermal

engineering and construction contracting association

Wind

A strong wind blowing….

Exhibit 1-1: Global Wind MW Added by Region, 2000–2020



Note: *Europe and US/Canada data includes repowering
Source: Emerging Energy Research

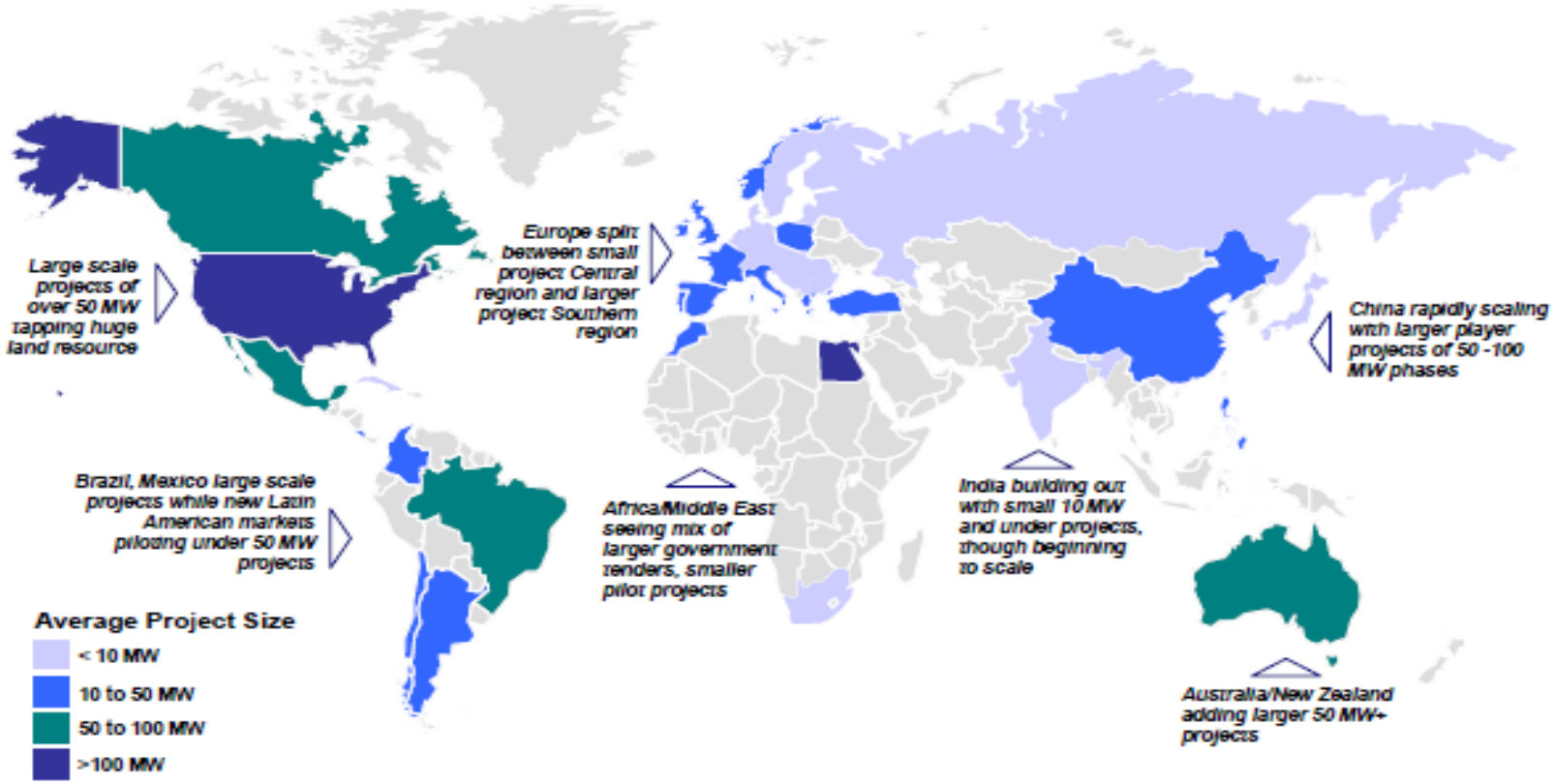
emerging energy research

1-1

engineering and construction contracting association

Global Wind Project Market

Exhibit 1-2: Global Wind Project Size Overview

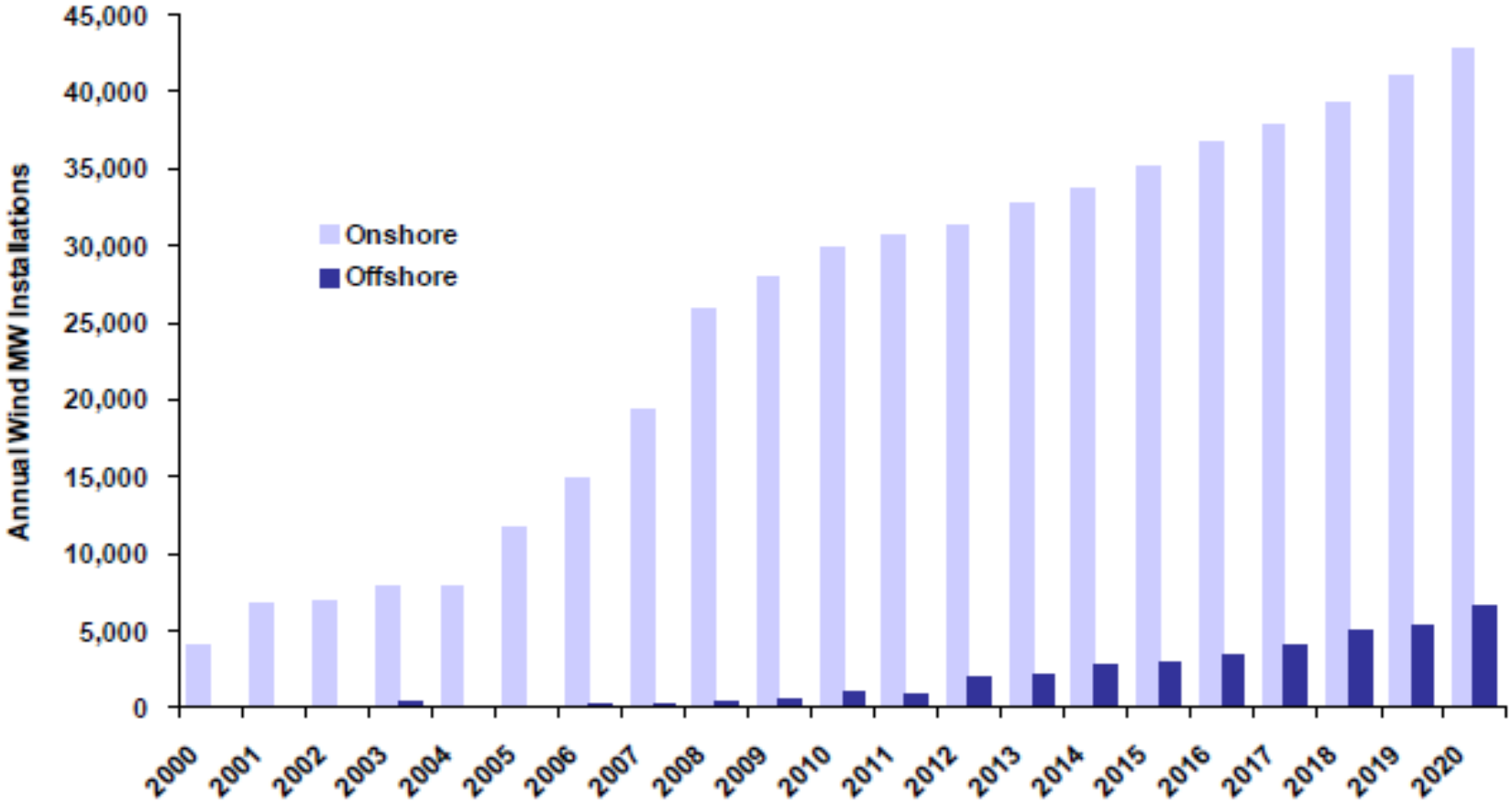


Source: Emerging Energy Research

engineering and construction contracting association

Onshore vs. Offshore

Exhibit 2-2: Global Wind MW Added – Onshore vs. Offshore, 2000–2020



engineering and construction contracting association

Outsourcing Decisions

	In-house Production	Outsource Production
Gearbox	• Key pinch point, few global multi-MW suppliers • Key component for integration into drive train concept	• Highly capital intensive component • Technically advanced, heavy industry equipment requiring specialization
Bearings	• Key pinch point	• Despite size specifications, relatively low technology value added • Large-scale tooling required, more apt to specialized industrial players
Controls	• Significant intellectual property, technology value add • Highly specific to individual turbine models	• Technically complex electrical systems component • Collaborative, customized supply viable option
Generators	• Key component for integration into drive train concept • Potential pinch point for specific turbine models	• Less wind-industry specific component • Many independent players with available capacity, global reach
Blades	• High intellectual property value of strategic models • Key component determining turbine productivity • Few large independent suppliers	• Difficult transport logistics requiring near-site sourcing • Intensive labor requirements • Technology advantages of specialization
Towers	• Pinch point in certain markets • Management of rising commodity prices • Flexible supply network needed close to site	• Difficult transport logistics requiring near-site sourcing • Heavy industry manufacturing, relatively low technology value added
Castings	• Pinch point in certain markets • Management of rising commodity prices	• Difficult transport logistics requiring near-site sourcing • Heavy industry manufacturing, relatively low technology value added

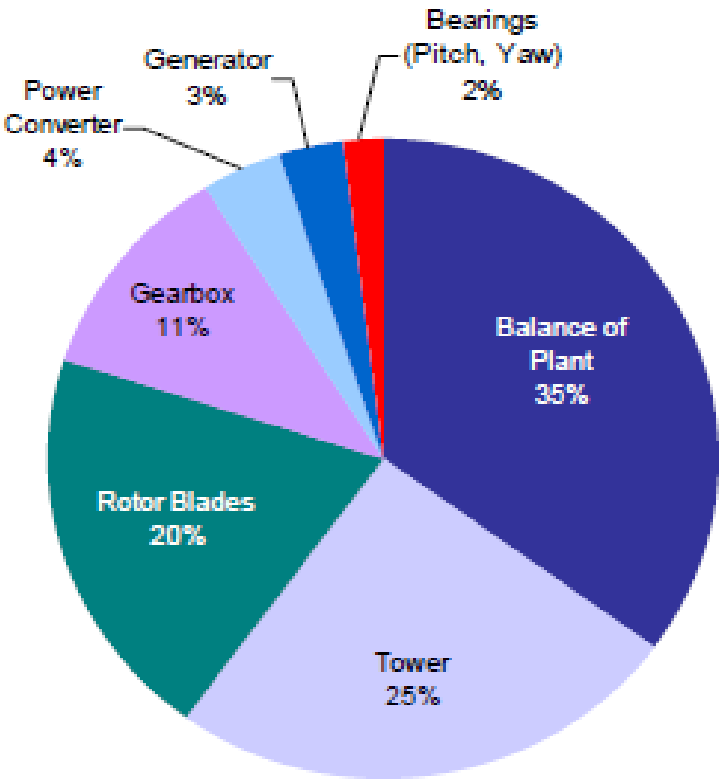
Key: Consensus Positioning Among Top 20 Suppliers

Source: Emerging Energy Research

engineering and construction contracting association

Cost of systems

Wind Turbine System Cost Split Overview



Key Cost Levers

Commodities

Steel for towers, castings as well as carbon fiber (blades) and copper (generators) have a material impact on turbine cost, with commodity increases of 20% seen since 2005.

Availability

Bottlenecks in bearing, gearbox, casting, blade, and other key components has created a seller's market for component suppliers

Supplier Margins

Turbine supplier efforts to manage growth profitability, achieve economies of scale and capture soaring demand have resulted in major EBITDA improvements through turbine mark ups.

Balance of Plant

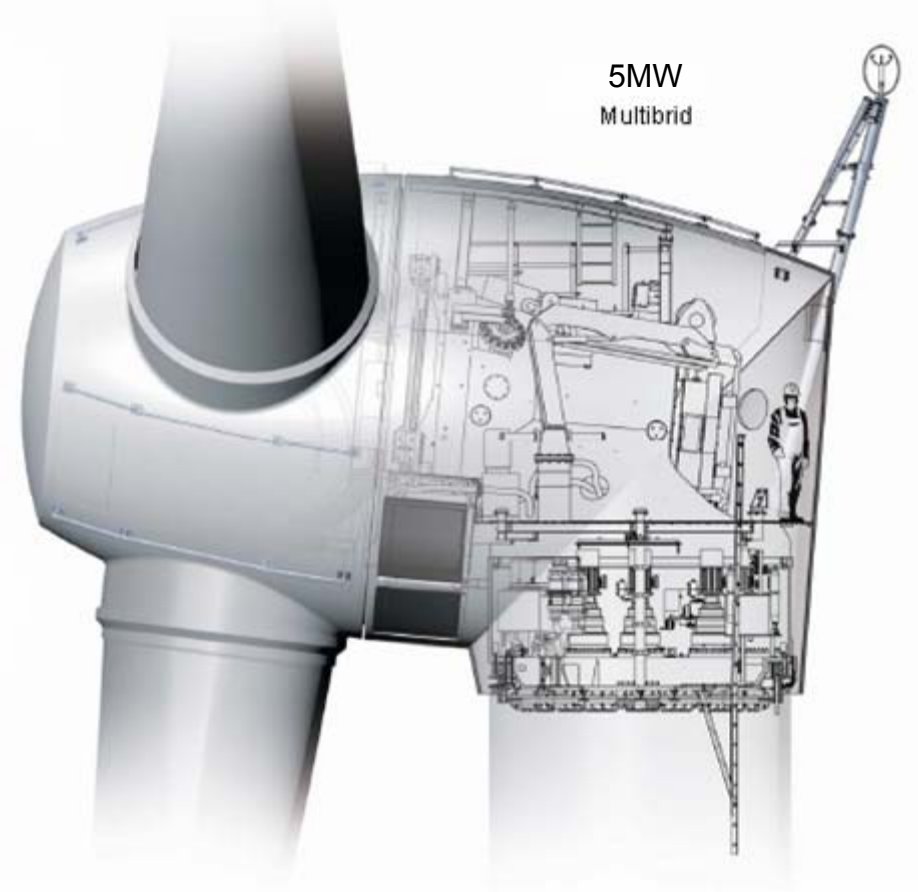
Turbine transport, and EPC costs depending on market maturity have major impact on timing and cost of project installation.

engineering and construction contracting association

Wind Industry Trends

- Explosive Growth in Asia and North America
  - Technology & Supply Chain partnerships
  - UL/CSA Experience
- Supply Chain Excellence
  - Panel Outsourcing
  - Kitting, Vendor Managed Inventory
- Larger Wind Turbines & Larger Wind Farms
  - More valuable assets to protect
  - Remote Monitoring
  - Medium Voltage Inverter Technology
- Reliability
  - Extended temperature range, Conformal Coating
  - Advance Diagnostics and Remote monitoring of all WT variables.
  - Advanced algorithm development
  - Increased emphasis on Safety

Average Wind Turbine Size



Turbine Size Range	1998-99 1,013 MW 1,418 turbines	2000-01 1,758 MW 1,987 turbines	2002-03 2,125 MW 1,784 turbines	2004-05 2,782 MW 1,937 turbines	2006 2,454 MW 1,532 turbines
0.00 to 0.5 MW	1.3%	0.4%	0.5%	1.9%	0.7%
0.51 to 1.0 MW	98.4%	73.9%	44.2%	17.6%	10.7%
1.01 to 1.5 MW	0.0%	25.4%	42.8%	56.6%	54.2%
1.51 to 2.0 MW	0.3%	0.4%	12.3%	23.9%	17.6%
2.01 to 2.5 MW	0.0%	0.0%	0.0%	0.1%	16.3%
2.51 to 3.0 MW	0.0%	0.0%	0.1%	0.0%	0.5%

Source: AWEA/GEC project database.

Largest wind turbines installed in the U.S. (rated capacity, in MW)

Rated capacity (MW)	Turbine manufacturer	Locations installed
3	Vestas	CA, TX
2.5	Clipper, Nordex	IL, IA, MN, NY, WY
2.3	Siemens	MN, ND, OR, TX, WA
2.1	Suzlon	IA, MO, OK
2	Gamesa	CA, IL, IA, MN, PA, TX

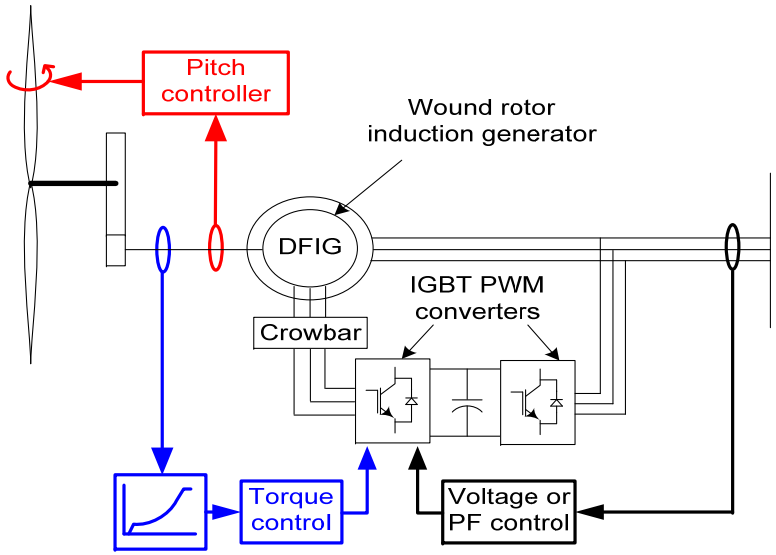
- Average size of wind turbines is *<u>increasing</u>* each year
- North American/Europe - highest volume was 1.5 MW in 2006 – moved to 2.5MW in 2008-09
- Asia growth is accelerating with 1.5MW and 2MW

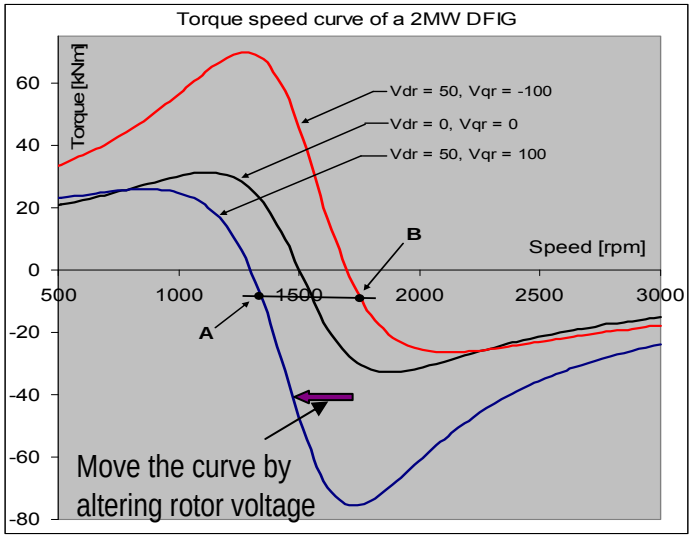
engineering and construction contracting association

Two Prevalent Wind Turbine Generator Technologies

- Direct Fed Generator / Converter
  - Becoming more common in large European manufacturers
  - A higher percentage are low voltage drives but medium voltage is becoming attractive on larger Wind Turbines (> 5 MW)
- Doubly Fed Induction Generator (DFIG) / Converter
  - Currently a large share of wind market
  - Most common architecture in Asian (>85%)
  - Prevalent in Europe though Direct Fed is becoming dominant technology
  - exclusively low voltage drives

Doubly Fed Induction Generator (DFIG)

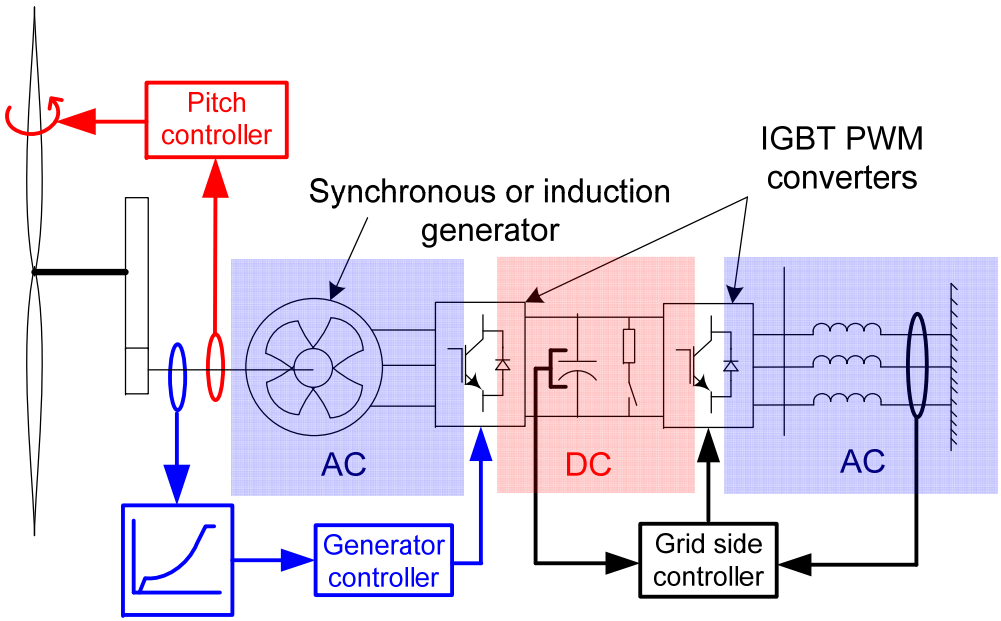




- Electronic converter fully controls generator torque
- Magnetizing current is supplied through the rotor terminal
  - Inverter size is approximately 30% of full turbine rating
- Speed can be changed by 40%, therefore maximum power production is achievable
- Very fast torque control -- 5-50ms response time depending on the type of control
- Aerodynamic fluctuation can be filtered before entering the generator
- Will require some maintenance of the slip rings

engineering and construction contracting association

Direct Fed Generator (Full Power)

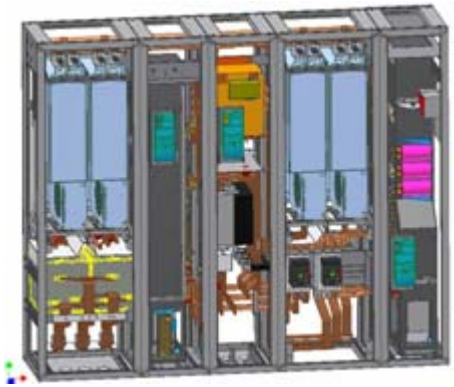


- Direct fed power converters handle full generator power
  - This allows for good power factor control
- Gearbox can be avoided if a multi-pole synchronous generator is used
  - e.g. Enercon turbines with 64 poles
- DC-link totally decouples the generator from the grid
  - Grid frequency is decoupled, wind turbine can operate at any rotor speed
  - Grid voltage is decoupled, change in grid voltage does not affect the generator dynamics

engineering and construction contracting association

Rockwell Automation DFIG Solution

- DFIG Converter in development
  - Having Premier Integration allows access to all Converter parameters via Ethernet IP for remote monitoring and troubleshooting with no programming.
  - ***You don't have to go up the tower to look at all the Converter diagnostics/parameters***
  - 1.5MW & 2.0MW DFIG inverter with Ethernet IP
  - Development of MV and LV Fully rated converters for future



+

=

DFIG Wind Power Structure

Ethernet/IP Card (w/ AOP code)

Rockwell Automation Wind Turbine Converter with "Premier Integration"

engineering and construction contracting association

Wind Farm Products and Capabilities

- Rockwell Automation can provide several products and services for Wind Turbines
  - Power and Safety Components
  - Wind Farm Management
  - Networks
  - Turbine Blade Pitch & Hub Safety Control
  - DFIG Converters
  - Condition monitoring

Wind Turbine projects – *What Really Matters*

- Faster Time to Market
  - Shorter design, test and commissioning cycles
  - Provide custom machinery within standard build cycle
- Lower Total Cost to Design, Develop, and Deliver^{SM} (TCD)
  - Reduce costs involved in machine production
    - Use standard components
    - Reusable Engineering content
    - Outsourcing
- Improved Machine Innovation, Throughput, and Performance
  - Competitive machine requirements increasing
  - Focus on reliability and OEE effectiveness
- Product Lifecycle Management
- Global support

Direct Costs
Indirect Costs

Total Cost to Design, Develop, Deliver (TCD) vs. Total Cost of Ownership (TCO)

engineering and construction contracting association

Biofuels

engineering and construction contracting association

BIO FUELS 2009 AND BEYOND

- Bio fuels are developing faster than ever before.
- Bio fuels technologies today are so much broader than 5 years ago.
- The interest in Bio fuels by the major oil and chemical companies has increased significantly over the past few years.
- New Bio fuels sources from Algae are beginning to emerge.
- Many companies are announcing large gains in production yields.
- Which companies and technologies will prosper ?
- Will enough investment funding be in place to achieve the goals?
- Will the oil price, technology development, government incentives drive the bio fuels industry to a financially sustainable industry?

engineering and construction contracting association

Renewable Fuels Standard

- RFS2 (May 26, 2009) – Sets the strategy for achieving mandates set forth in EISA of 2007. (Energy Independence and Security Act)
- Mandated US transportation fuel to include 21 billion gallons of advanced Bio fuels by 2022.
- 4 unique categories of renewable fuel.
- GHG emission threshold.
- Feedstock to meet renewable definitions.
- In 2015 and thereafter, the maximum amount of corn-based ethanol that can be applied to the overall RFS is 15 billion gallons.
- The cellulosic Bio fuel requirement starts in 2010 at 0.1 billion gallons and rises to 16 billion gallons in 2022

Renewable Fuel Categories

Year	Conventional Biofuels (Grandfathered or 20% Reduction)	Advanced Biofuel				Total Renewable Fuel
		Biomass-Based Diesel (50% Reduction)	Non Cellulosic Advanced (50% Reduction)	Cellulosic Biofuel (60% Reduction)	Total Advanced Biofuel	
2006	4.00					4.0
2007	7.70					4.7
2008	9.00					9.0
2009	10.50	0.5	0.1		0.6	11.1
2010	12.00	0.65	0.2	0.1	0.95	12.95
2011	12.60	0.80	0.3	0.25	1.35	13.95
2012	13.20	1.0	0.5	0.5	2.0	15.2
2013	13.80	1.0	0.75	1.0	2.75	16.55
2014	14.50	1.0	1.00	1.75	3.75	18.15
2015	15.00	1.0	1.50	3.0	5.5	20.5
2016	15.00	1.0	2.00	4.25	7.25	22.25
2017	15.00	1.0	2.50	5.5	9.0	24.0
2018	15.00	1.0	3.00	7.0	11.0	26.0
2019	15.00	1.0	3.50	8.5	13.0	28.0
2020	15.00	1.0	3.50	10.5	15.0	30.0
2021	15.00	1.0	3.50	13.5	18.0	33.0

GHG Emissions are defined as the aggregate emissions attributed to ALL components of fuel production and use, including feedstock production and distribution, delivery, use and significant indirect emissions from land use change.

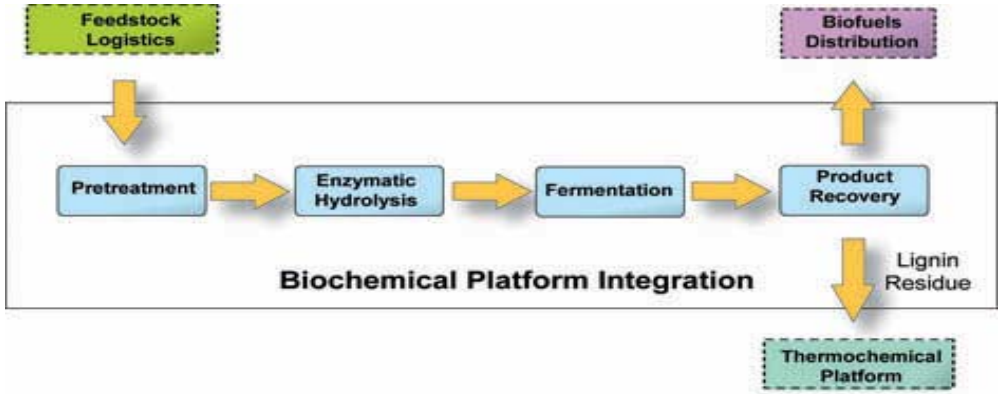
engineering and construction contracting association

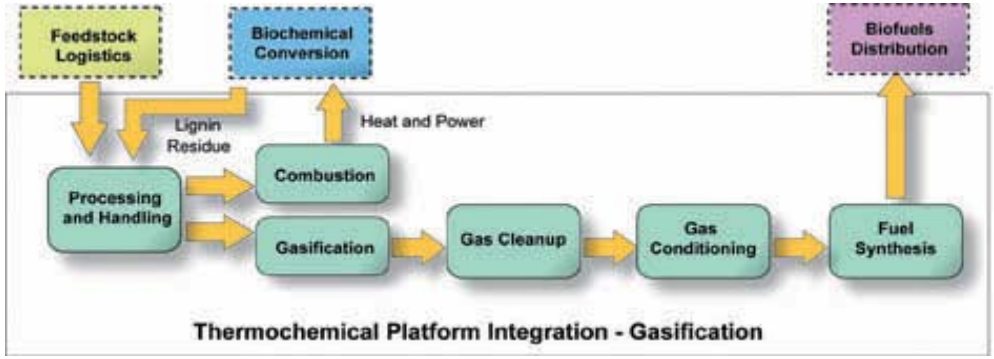
Types of Technologies – Cellulosic Ethanol

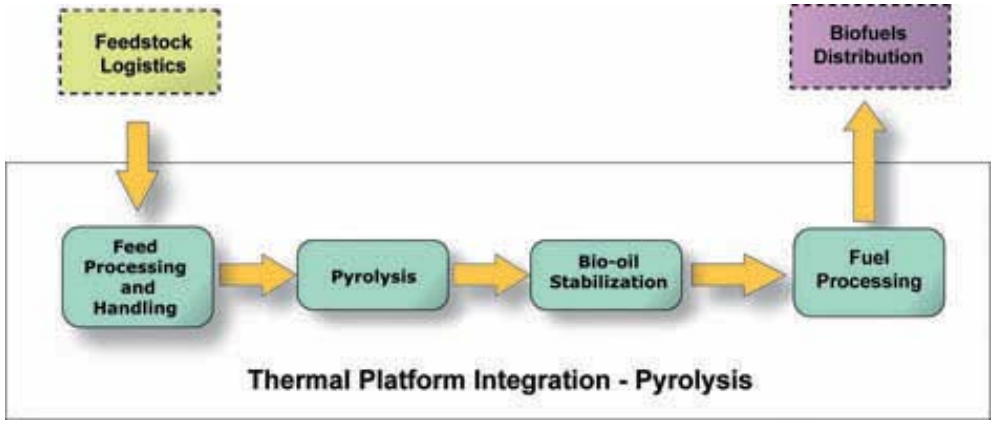
A key to developing cost-competitive cellulosic biofuels is reducing the processing and capital cost and improving the efficiency of separating and converting cellulosic biomass into fermentable sugars.

- **Biochemical Conversion - Biomass is broken down to sugars using either enzymatic or chemical processes and then converted to ethanol via fermentation**
- **Thermochemical Conversion - Biomass is broken down to intermediates using heat and upgraded to fuels using a combination of heat and pressure in the presence of catalysts**
  - **–Gasification**
  - **–Pyrolysis / Reaction**
- **Algae**

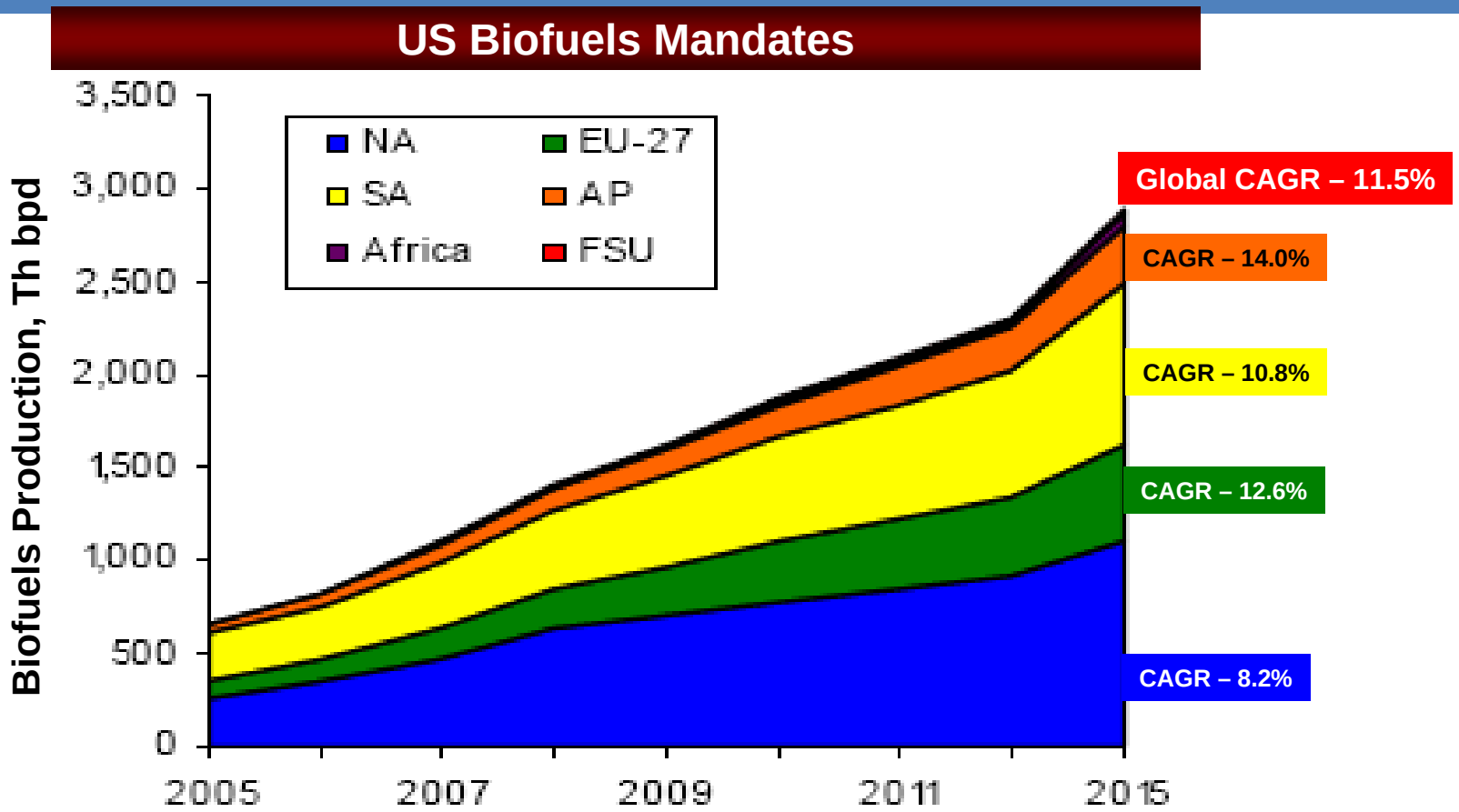
  Significant recent strides with oil yield per acre significantly higher than land crops. Large global research projects with commercial projects within a few years.







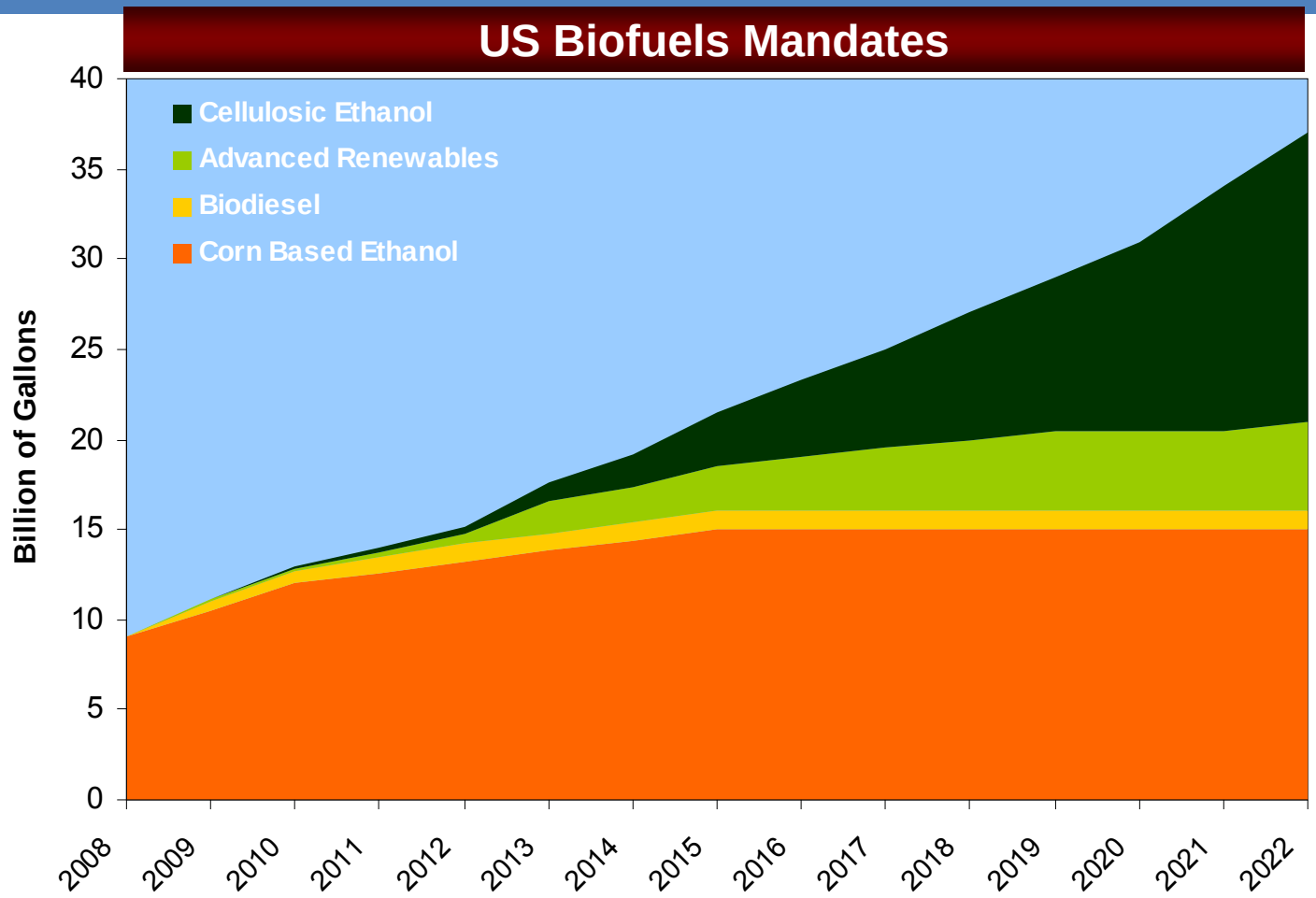
Global Biofuels Capacity Projection



- Global production will reach almost 46 billion gallons per year by 2015 – about 5% of global transport pool from 21.5 billion gallons per year
- US (North America) bio fuels production will increase from 9 billion gallons in 2008 to 18 billion gallons in 2015 per year
- Largest increase of bio fuels by volume will be in US (North America)

engineering and construction contracting association

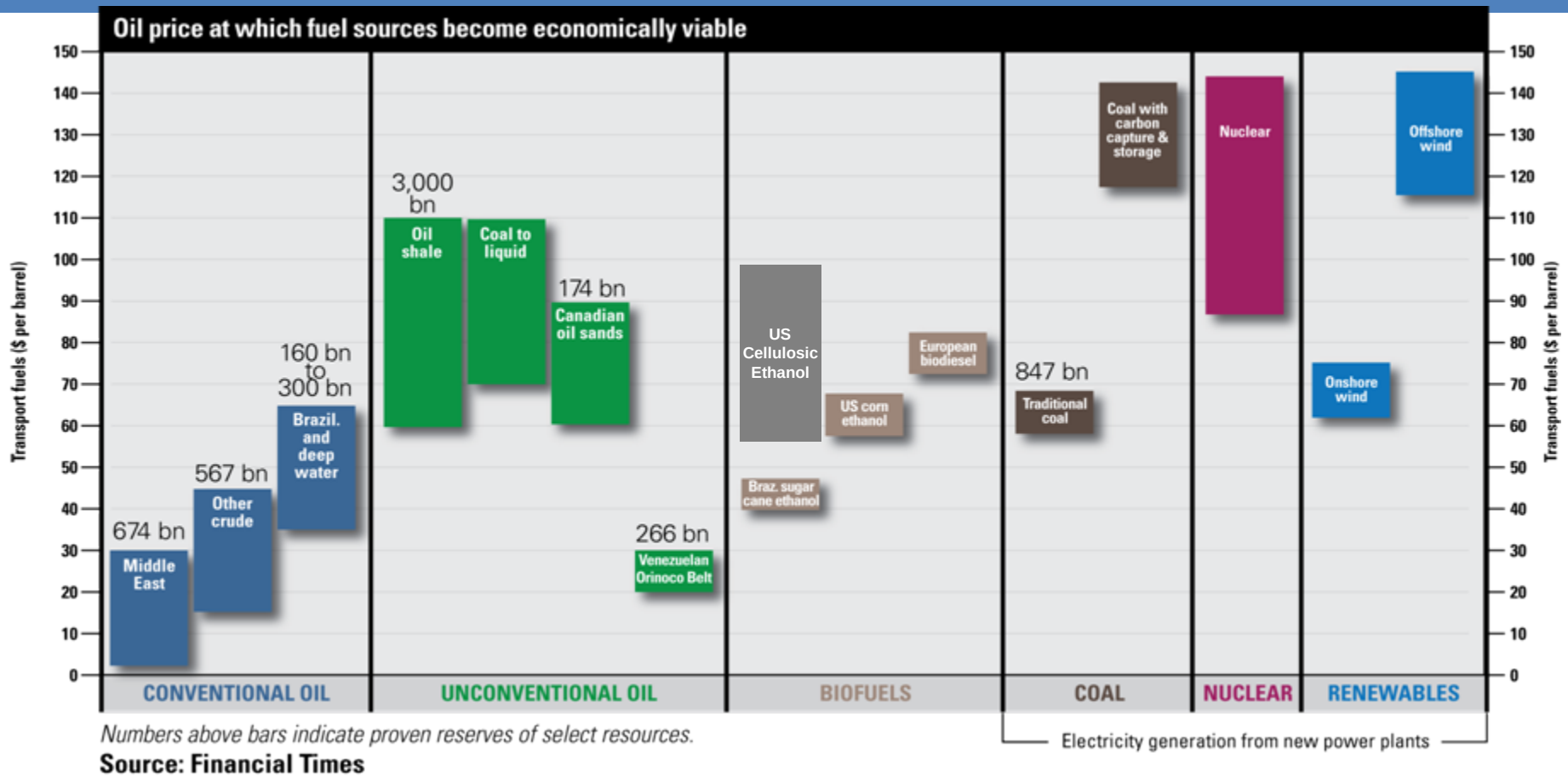
US Biofuels Capacity Projections



- US Bio fuels production will grow at CAGR 10.6% from 9 billion gallons in 2008 to 36 billion gallons by 2022
- Cellulosic ethanol is the fastest growing among bio fuels grow from nil to 100 million gallons in 2010, 3 billion gallons in 2015 and 16 billion gallons by 2022

engineering and construction contracting association

Oil Price at which Fuel Sources Feasible



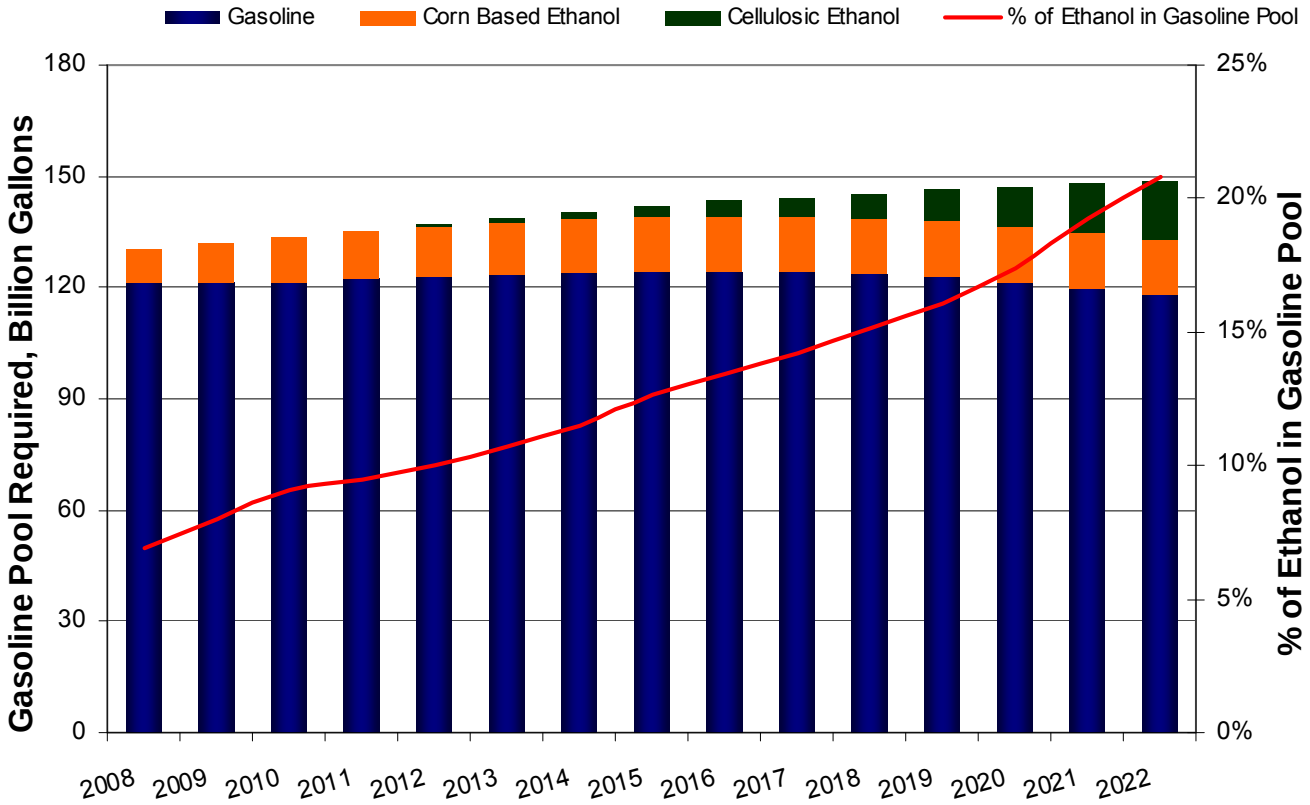
Numbers above bars indicate proven reserves of select resources.
Source: Financial Times

- At lower oil price (bottom of bars), investment is uneconomic and will proceed only with government regulations or incentives
- At higher oil price (top of bars), technology/energy source will be commercially viable
- The larger the bars, the greater the range of variations or uncertainty in costs
- All figures shown do not include any subsidies such as US production tax credits or costs on CO_2 emissions as in EU's emissions trading scheme

engineering and construction contracting association

Ethanol in Gasoline Pool

US Gasoline & Ethanol Requirement

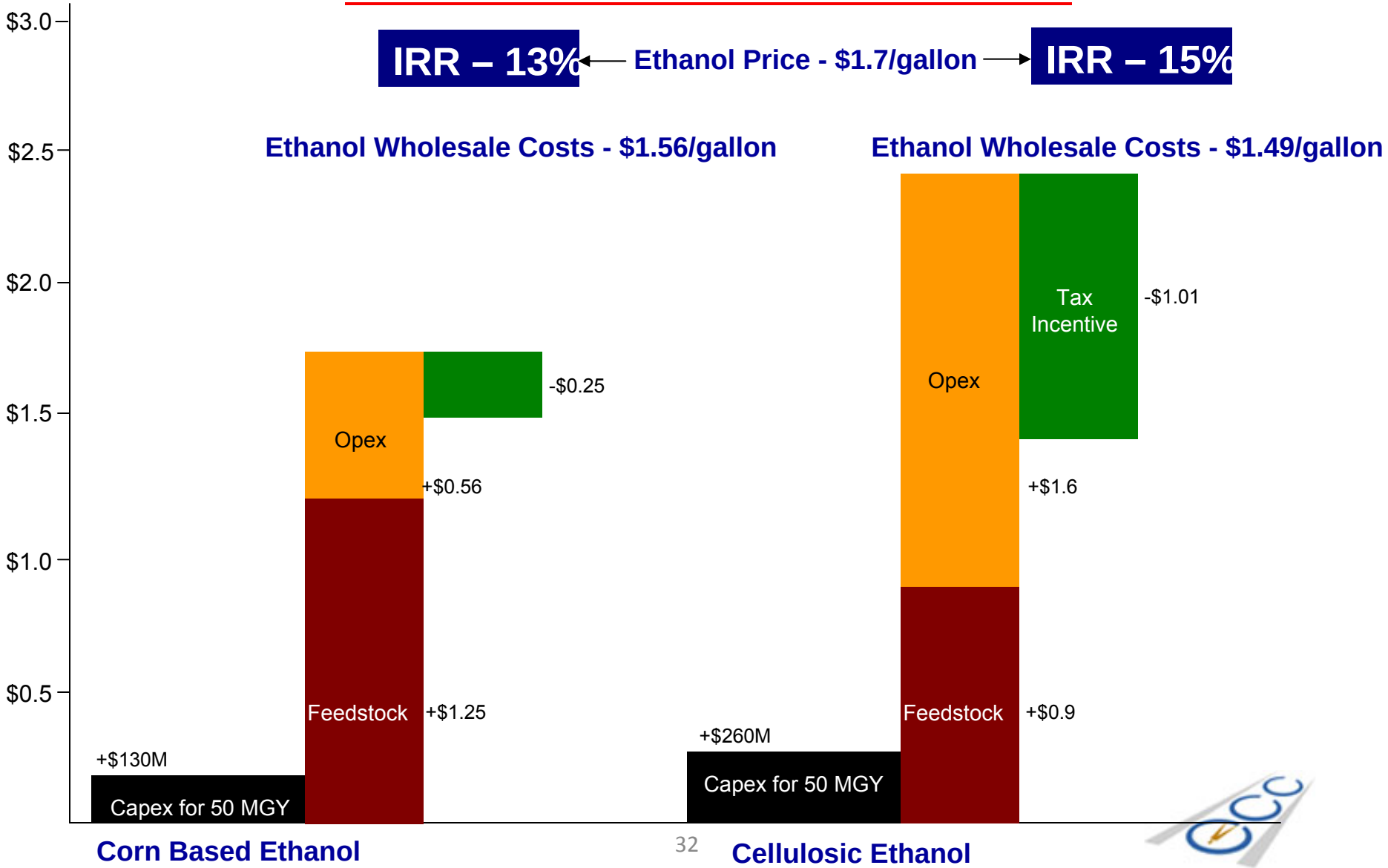


- Gasoline demand growth is now expected to average less than 0.5% through the decade, with demand entering a declining period after 2015
- Gains in per capita demand for gasoline are expected to decrease over the forecast period, largely as a result of efficiency improvements, despite modest increases in per capita miles traveled and the driving age population
- It is anticipated that ethanol would grow to just under 10% of the gasoline pool by 2013
- If technological breakthroughs allow cellulosic ethanol to be produced competitively, then the contribution could increase

engineering and construction contracting association

Corn vs Cellulosic Investment Analysis

For 1 Gallon Ethanol Production



engineering and construction contracting association

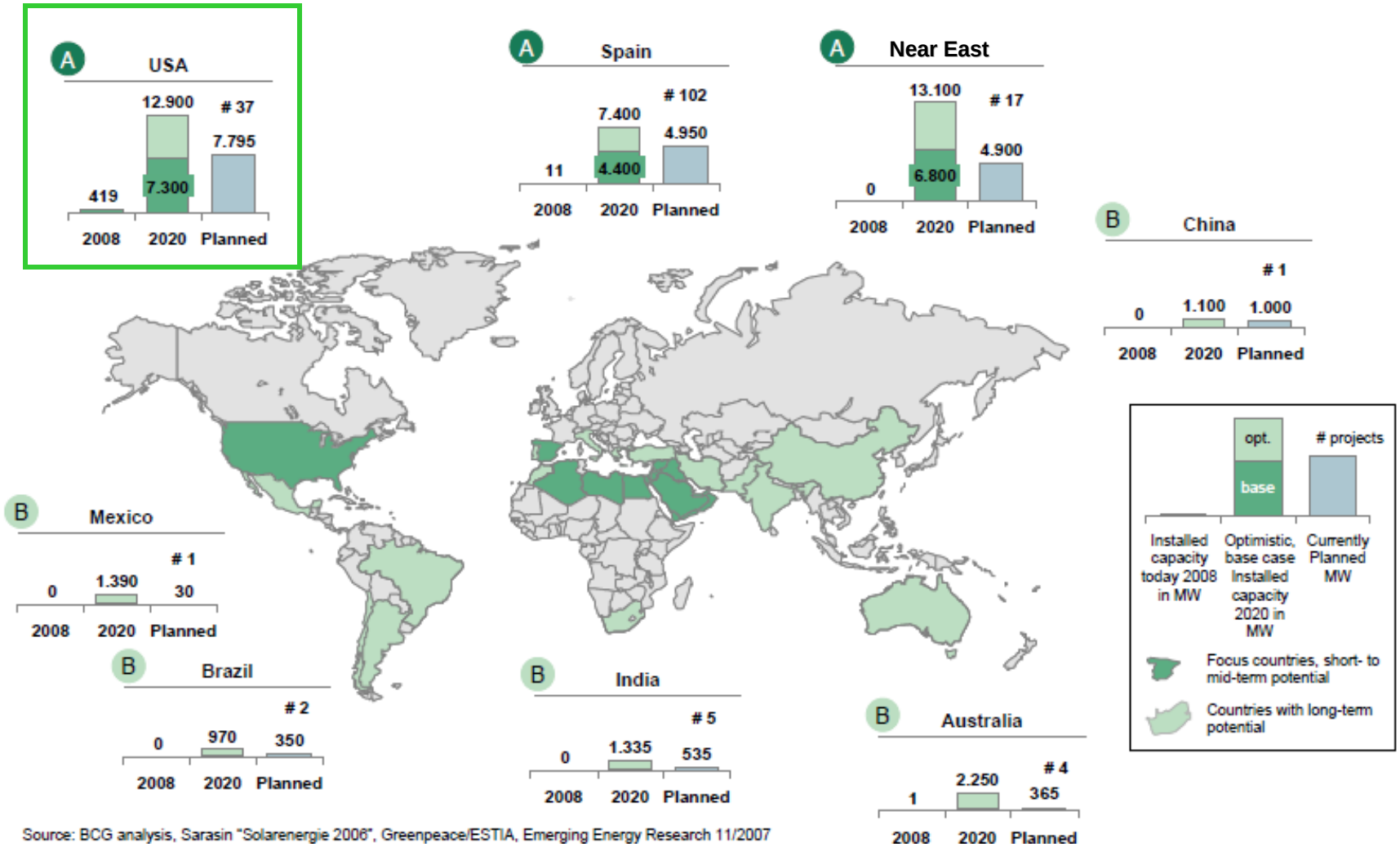
What next

- 2010 – Increased Cellulosic Project announcements.
- Construction will start on some major projects.
- Algae pilot and demonstration facilities will start getting more attention.
- Technology winners may start to emerge in the next few years.
- Broad range of advanced bio fuels will go ahead based on regional and feedstock advantages.
- More major oil and chemical companies will start to invest. Examples of this during recent years are:
  - Shell / Iogen
  - DuPont Danisco
  - BP / Verenium
  - Exxon Mobil / Synthetic Genomics Inc.
  - Valero
- With Corn Ethanol production increases slowing, the next growth phase of advanced bio fuels will start taking traction in 2010.

Solar

engineering and construction contracting association

World Thermal Solar Power Market



Source: BCG analysis, Sarasin "Solarenergie 2006", Greenpeace/ESTIA, Emerging Energy Research 11/2007

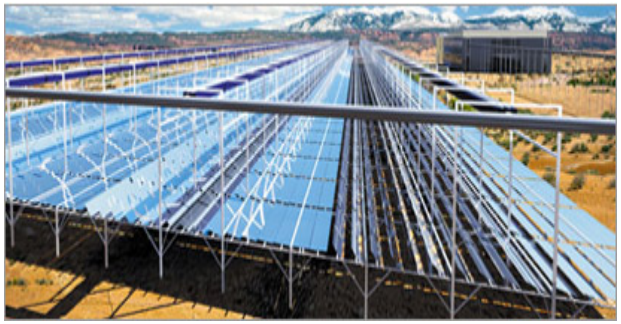
engineering and construction contracting association

Technical Alternatives of Solar Thermal Applications

Line focusing
(2D)

Parabolic Trough

Linear Fresnel



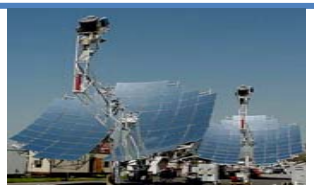
Point focusing
(3D)

Parabolic Dish

Central Receiver/Tower

engineering and construction contracting association

Technical Alternatives of Solar Thermal Applications

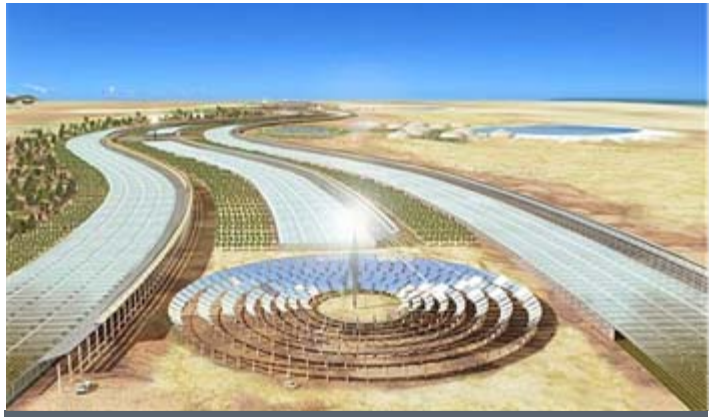
	Parabolic Trough	Linear Fresnel	Central Receiver/ Tower	Parabolic Dish
				
	Parabolic mirrors concentrate solar energy on tubes (2D) **Tubes mounted in optical Focus**	**Flat mirrors concentrate solar energy on tube (2D)** **Stationary Tubes mounted above the mirror**	**Heliostats concentrate solar energy on receiver (3D)** **Receiver in tower heats salt, water or air**	**Parabolic dish concentrates energy on receiver (3D)** **Centrally mounted receiver powers Stirling engine**
Operating Temp.	662 – 752 °F	536 – 752 °F	1022 – 1112 °F	1382 °F
Efficiency	13 – 16%	8 – 11%	15 – 18%	18 – 22%
Storage	Molten Salt	Molten Salt	Molten Salt	NA
Size (2008) [MWe]	50 – 250	10 – 30	11 – 20 (single tower)	10 – 25 (single dish)

engineering and construction contracting association

Applications

Solar applications

Power generation



De-salination

Solar cooling

Process Steam

engineering and construction contracting association

Market Players

	Abengoa	Solar Trust of America	FPL Energy	Solargenix (Acciona)	SES Solar Inc.	Bright Source	Ausra	Sky Fuel	Solel	eSolar
Technology Development	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
Component Manufacturing	✓	✗	✗	✗	✓	✓	✓	✗	✓	✓
Basic Engineering	✓	✓	✗	✓	✓	✓	✓	✓	✓	✓
Site Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
Project Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
EPC Management	✓	✓	✗	✓	✗	✗	✗	✗	✗	✗
Financing	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗
PPA	✓	✓	✓	✓	✗	✗	✗	✗	✗	✓

engineering and construction contracting association

Solar Project List in US

Projects Under Development

Developer	Project Name	Electricity Purchaser	Location	Technology	Capacity (MW)
Concentrating Solar Power (including Concentrating Photovoltaic)					
Abengoa Solar	Solana plant	Arizona Public Service	Gila Bend, AZ	Trough	280
Acciona	Ft. Irwin plant	U.S. Army/surrounding utilities	Ft. Irwin, CA	Trough	500
Abiaxa	Kingman project		Kingman, AZ	Trough	200
Ausra	Carrizo Energy Solar Farm	Pacific Gas & Electric	Carrizo Plain, CA	Linear Fresnel	177
Boulevard Associates LLC	Sonoran Solar Energy Project		Maricopa County, AZ	Trough	375
BrightSource Energy	Ivanpah	Pacific Gas & Electric	Barstow, CA	Tower	300
BrightSource Energy	Ivanpah	Southern California Edison	Barstow, CA	Tower	100
BrightSource Energy		Southern California Edison	California	Tower	1,200
Encore/SunPeak Power			Southwest US	Lens CPV	200
eSolar	Gaskell Sun Tower (Phase I)	Southern California Edison	Kern County, CA	Tower	105
eSolar	Gaskell Sun Tower (Phase II)	Southern California Edison	Kern County, CA	Tower	140
eSolar	Santa Teresa New Mexico SunTower	El Paso Electric	Santa Teresa, NM	Tower	92
eSolar	Alpine SunTower	Pacific Gas & Electric	Lancaster, CA	Tower	92
Florida Power & Light Co.	Martin Next Generation Solar Energy Center	Florida Power & Light Co.	Martin County, FL	Trough[1]	75
GreenVolts, Inc.	GV1	Pacific Gas & Electric	Byron, CA	CPV	2
Harper Lake, LLC	Harper Lake Solar Plant		California	Trough	250
Inland Energy, Inc.	Palmdale Hybrid Gas-Solar plant		Palmdale, CA	Trough	50
Inland Energy, Inc.	Victorville Hybrid Gas-Solar plant		Victorville, CA	Trough	50
NextEra Energy Resources	Beacon Solar Energy Project		Kern County, CA	Trough	250
San Joaquin Solar, LLC	San Joaquin Solar 1	Pacific Gas & Electric	Coalinga, CA	Trough[1]	53
San Joaquin Solar, LLC	San Joaquin Solar 2	Pacific Gas & Electric	Coalinga, CA	Trough[1]	53
SkyFuel	SkyTrough demonstration	Southern California Edison	Daggett, CA	Trough	43
Solar Millennium	Amargosa Farm Road Solar Energy Project 1	NV Energy	Nye County, NV	Trough	242
Solar Millennium	Amargosa Farm Road Solar Energy Project 2	NV Energy	Nye County, NV	Trough	242
Solar Millennium	SoCal Edison Project 1 of 3	Southern California Edison	Blythe, CA	Trough	242
Solar Millennium	SoCal Edison Project 2 of 3	Southern California Edison	Ridgecrest, CA	Trough	242
Solar Millennium	SoCal Edison Project 3 of 3 (Expansion Option	Southern California Edison	Blythe or Ridgecrest, CA	Trough	242
Solel	Mojave Solar Park	Pacific Gas & Electric	Mojave Desert, CA	Trough	553
Sopogy	Demonstration plant		Kailua-Kona, HI	MicroCSP	1
Starwood Energy Group Global, LLC	Starwood Solar I	Arizona Public Service	Hanquahala Valley, AZ	Trough	290
Stirling Energy Systems	SES Solar One	Southern California Edison	Victorville, CA	Dish-engine	500
Stirling Energy Systems	SES Solar One Expansion	Southern California Edison	Victorville, CA	Dish-engine	350
Stirling Energy Systems	SES Solar Two	San Diego Gas & Electric	Imperial County, CA	Dish-engine	300
Stirling Energy Systems	SES Solar Two Expansion	San Diego Gas & Electric	Imperial County, CA	Dish-engine	600
Stirling Energy Systems	Western Ranch	CPS Energy	San Antonio, TX	Dish-engine	27
		Public Service Co. of Colorado (Xcel Energy)	CO		200
				Concentrating Solar Power Total	*8,619*
Photovoltaics (excluding Concentrating Photovoltaic)					
American Capital Energy/Renewable	Vineland project		Vineland, NJ	PV	5
BP Solar	BNL Area 1	Long Island Power Authority	Brookhaven, NY	PV	19
BP Solar	BNL Area 2	Long Island Power Authority	Brookhaven, NY	PV	18
Chevron Energy Solutions	Lucerne Valley Solar Project	Southern California Edison	San Bernardino County, CA	Thin-film PV	45
enXco	Long Island	Long Island Power Authority	Long Island, NY	PV	13
First Solar	Topaz Solar Farm	Pacific Gas & Electric	Carrisa Plains, CA	Thin-film PV	550
First Solar	Cimarron I Solar Project	Tri-State Generation and Transmission	Cimarron, NM	Thin-film PV[2]	30
First Solar	FSE Blythe	Southern California Edison	Blythe, CA	Thin-film PV	8
First Solar/ Wyandot Solar LLC	Wyandot Solar facility	American Electric Power Co Inc	Salem Township, OH	PV	10
Florida Power & Light Co.	DeSoto Next Generation Solar Energy Center	Florida Power & Light Co.	DeSoto County, FL	PV	25
Florida Power & Light Co.	Space Coast Next Generation Solar Energy Center	Florida Power & Light Co.	Kennedy Space Center	PV	10
LS Power	Dover Sun Park	Delmarva Power	Dover, DE	PV	10
MMA Renewable Ventures and Suntech Power Holdings		Austin Energy	Austin, TX	PV	30
NextLight Renewable Power	Silver State South Solar Project (1 of 2 Combined 400 MW)		Primm, NV	PV	200
NextLight Renewable Power	Silver State North Solar Project (1 of 2 Combined 400 MW)		Primm, NV	PV	200
SunEdison		Lakeland Electric	Distributed in FL Service Area	PV	24
SunEdison		California State Universities	California	Thin-film PV	8
SunPower	California Valley Solar Ranch	Pacific Gas & Electric	San Luis Obispo County, CA	PV	250
SunWorks Solar Systems			Central Florida	PV	2
Teanaway Solar Reserve, LLC	Teanaway Solar Reserve		Cle Elum, WA	PV	75
	Commercial Rooftop Installations	Southern California Edison	Southern California	PV	250
		Public Service Electric & Gas Company	New Jersey	PV	120
				Photovoltaics Total	*1,902*
Total Under Development					**10,520**

Projects in Operatic

Developer	Technology	Capacity (MW)
Concentrating Solar Pow		
Acciona	Trough	64
Solargenix	Trough	1
eSolar	Tower	5
Luz	Trough	14
Luz	Trough	30
Luz	Trough	30
Luz	Trough	30
Luz	Trough	30
Luz	Trough	30
Luz	Trough	30
Luz	Trough	80
Luz	Trough	80
	rating Solar Power Total	*424*
Photovoltaics (excluding		
Conergy	PV	3
First Solar/Sempra Gener	Thin-film PV[2]	10
SunEdison	PV	8
SunPower	PV	14
	Photovoltaics Total	*35*
Total Operational		**459**

http://www.seia.org/galleries/pdf/Major%20Solar%20Projects.pdf

SEIA Solar Energy Industries Association®

engineering and construction contracting association

The End

No,
This Is The Beginning