National Board of Boiler & Pressure Vessel Inspectors

Safety—
An Integral Part of the Energy Grand Challenge

Kenneth R. Balkey, P.E.

Senior Vice President, ASME Standards and Certification

Hyatt Regency Miami Hotel – Miami, Florida

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Safety – An Integral Part of the Energy Grand Challenge

- Overview of Global Energy Grand Challenge
- ASME Efforts to Support All Energy Initiatives with focus on Standards and Certification
- ASME Energy Incident Response Efforts including - ***"Forging A New Nuclear Safety Construct"***
- Summary

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7 billion people on Earth

- Half of world's population already live in urban areas

- 2.6 billion lack basic sanitation
- 1.3 billion lack access to clean water
- 1.4 billon lack access to electricity

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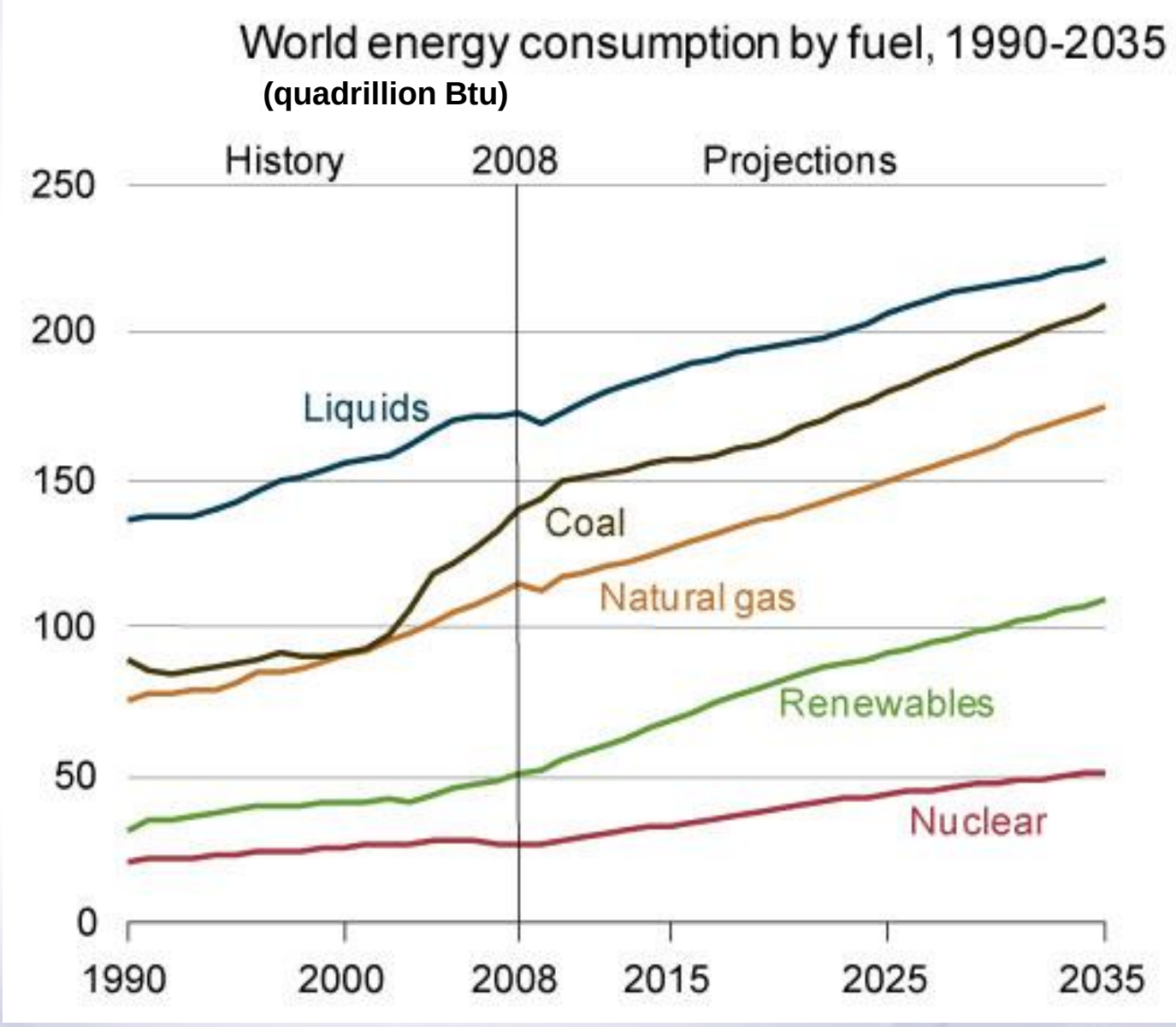

Source: Energy Information Administration, U.S. Department of Energy
Updated: 2011

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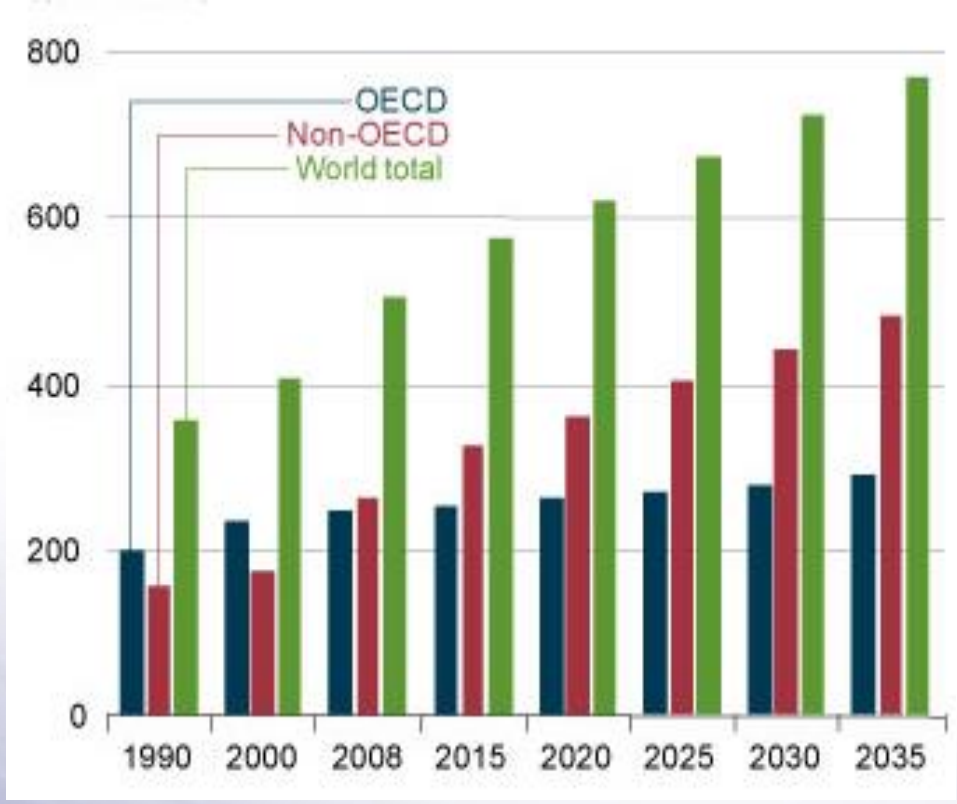
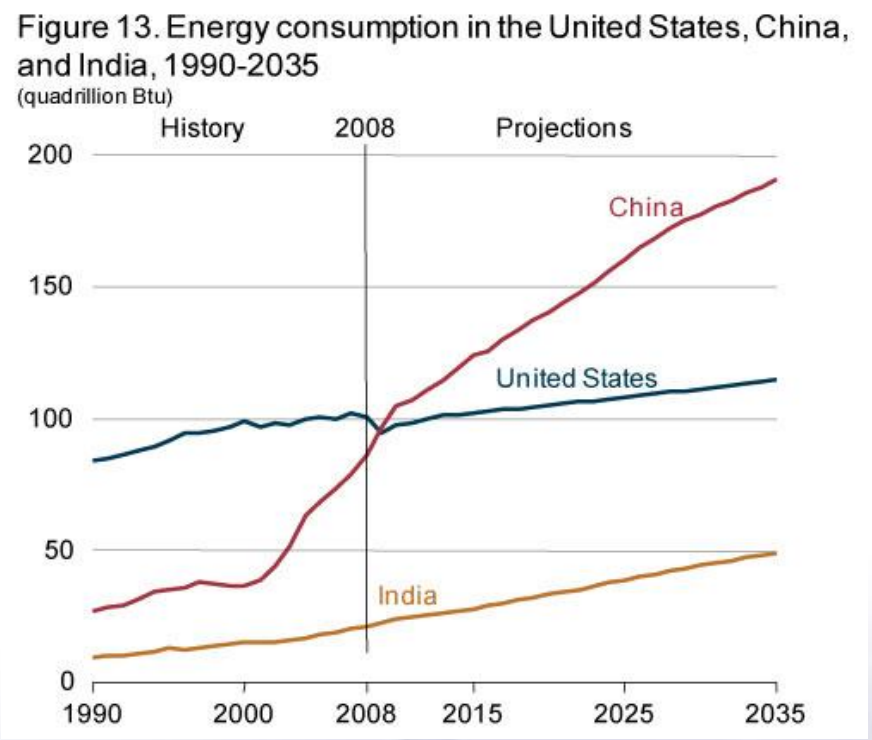
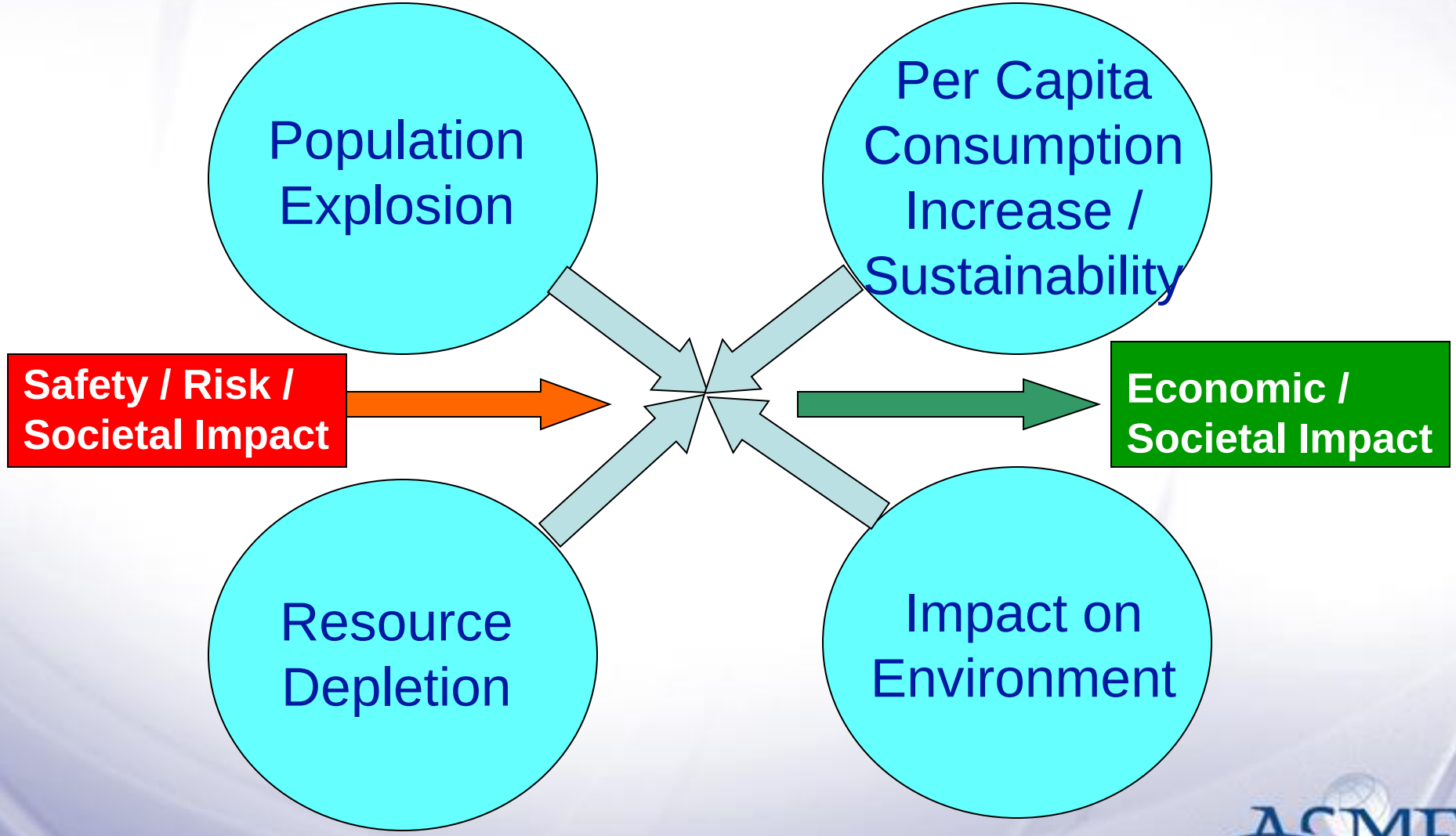
World Energy Consumption 1990-2035 (quadrillion BTU)





Source: Energy Information Administration, U.S. Department of Energy
Updated: 2011

Key Drivers of Global Energy Grand Challenge



Adapted from presentation by Dr. Frank Kreith – "A Global Perspective on Energy Technologies" to ASME Board on Nuclear Codes & Standards, September 2007

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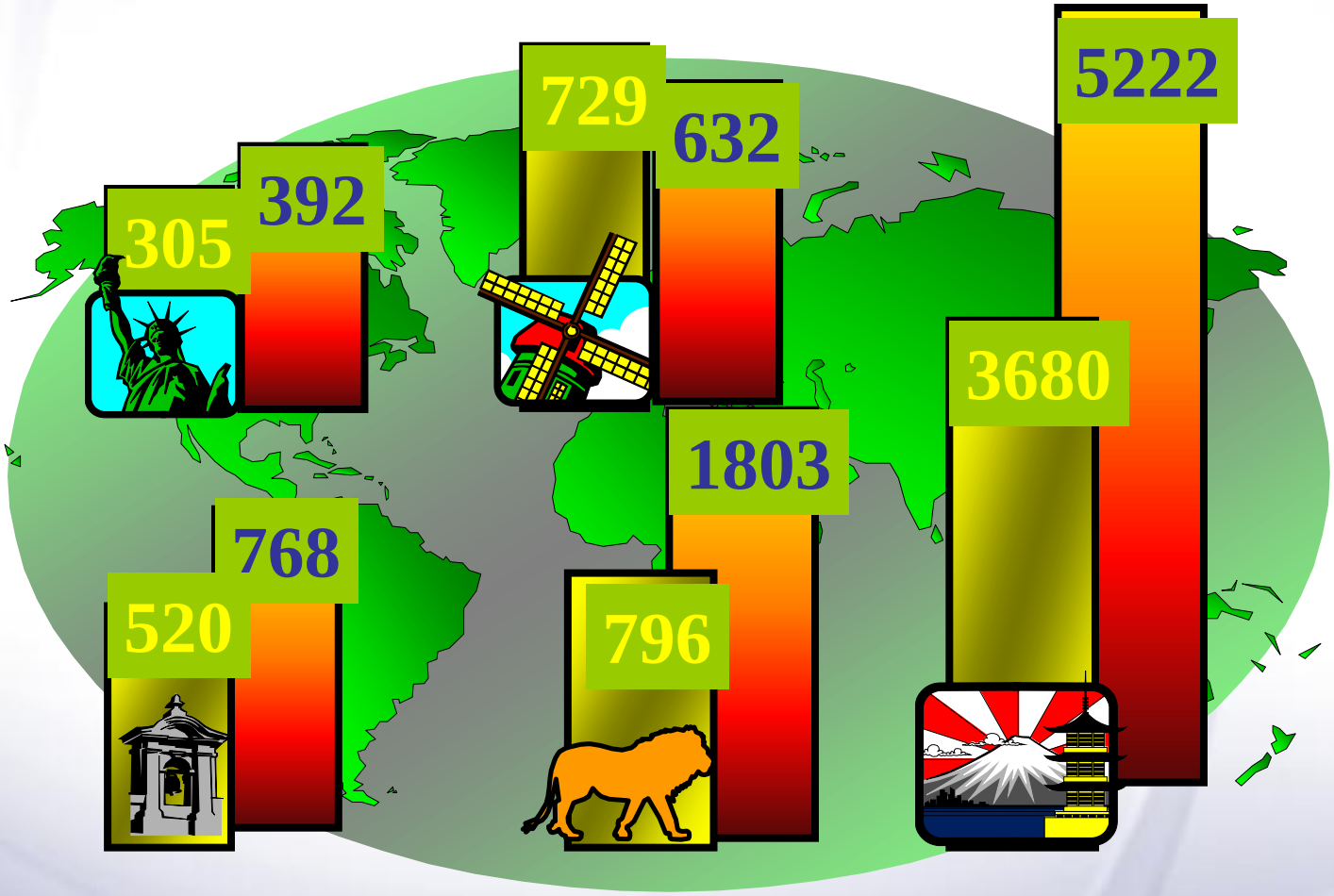
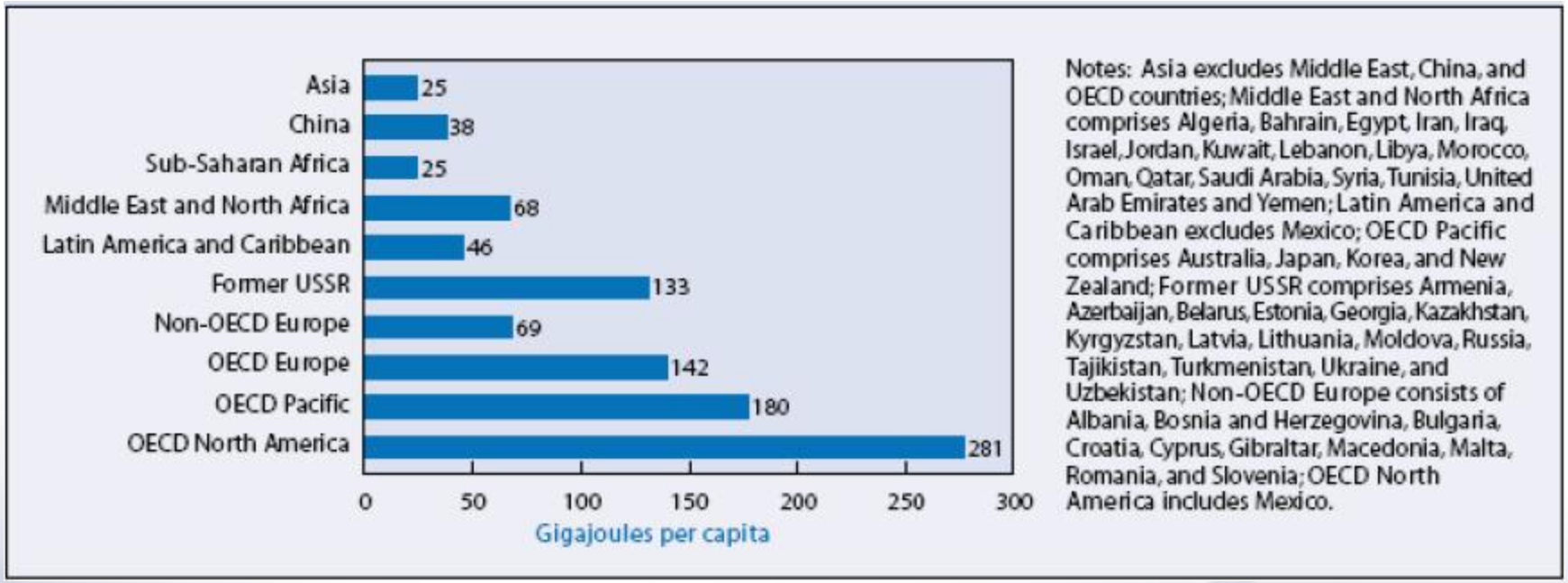
Demographics (in Millions of People)



Source: Presentation by Rohit Talwar, CEO, Fast Future – "Grand Challenges," ASME Global Summit on the Future of Mechanical Engineering, April 2008

Per Capita Energy Use by Region (Commercial and Non-Commercial) 2000



Source: Presentation by Dr. Frank Kreith – "A Global Perspective of Energy Technologies" to ASME Board on Nuclear Codes & Standards, September 2007

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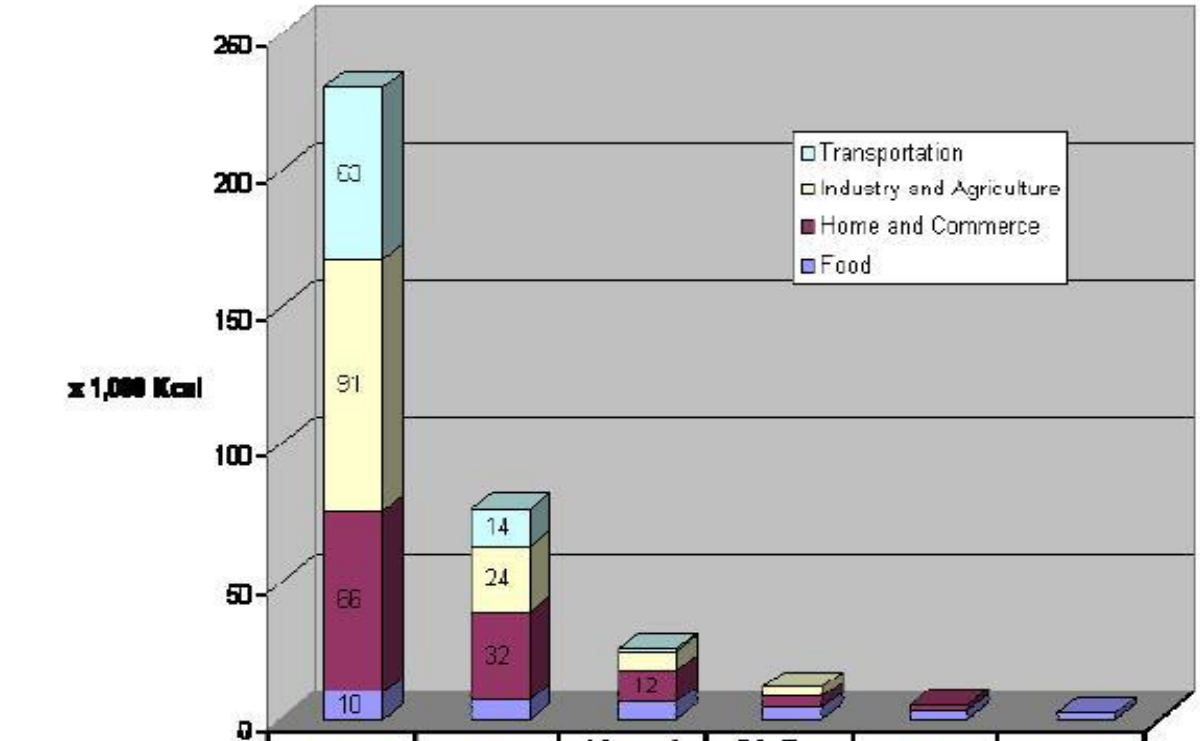
Daily Consumption of Energy Per Capita as a Function of Human Evolution



	Technological Man	Industrial Man	Advanced Agricultural Man	Primitive Agricultural Man	Hunting Man	Primitive Man
Transportation	63	14	1			
Industry and Agriculture	91	24	7	4		
Home and Commerce	66	32	12	4	2	
Food	10	7	8	4	3	2

Source: Presentation by Dr. Frank Kreith – "A Global Perspective of Energy Technologies" to ASME Board on Nuclear Codes & Standards, September 2007

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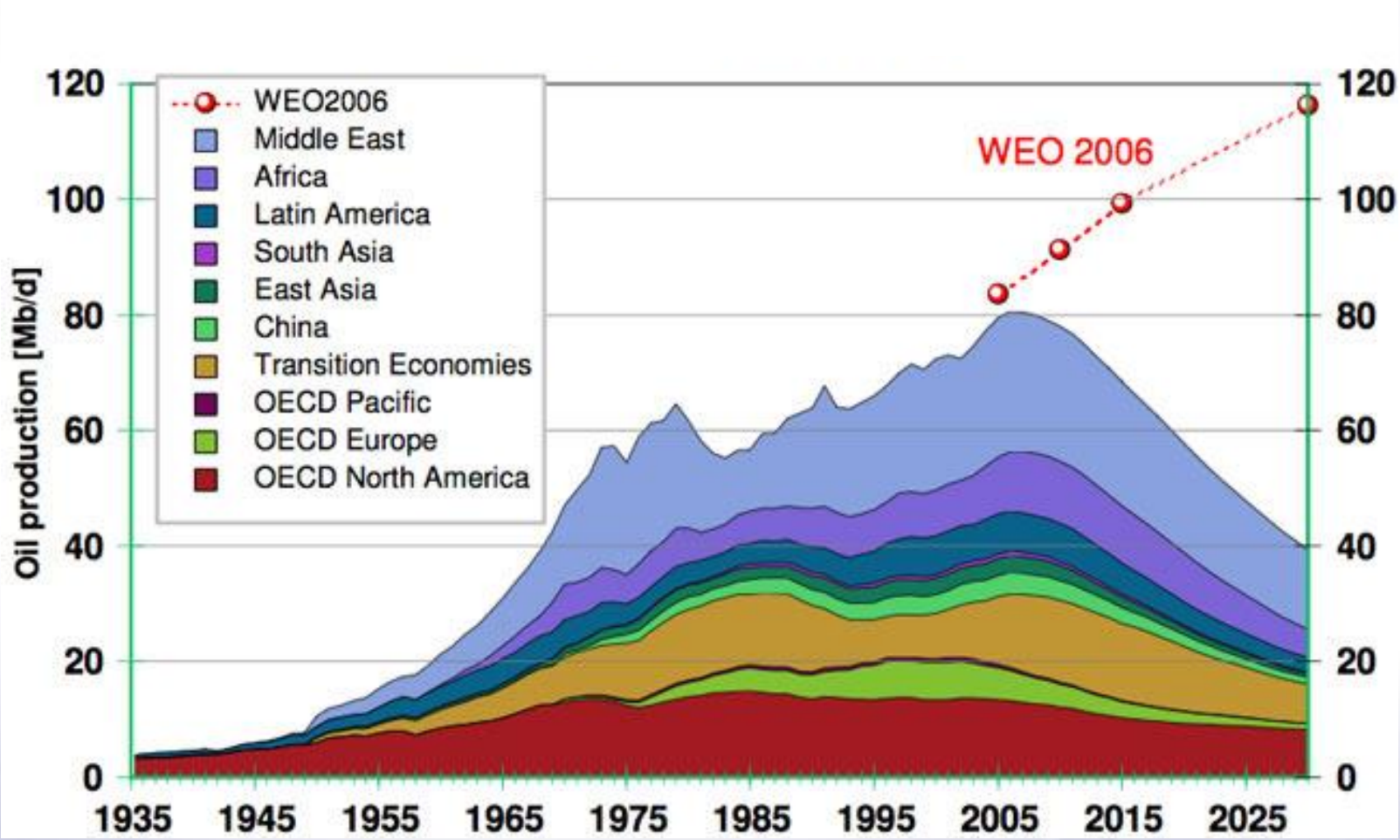
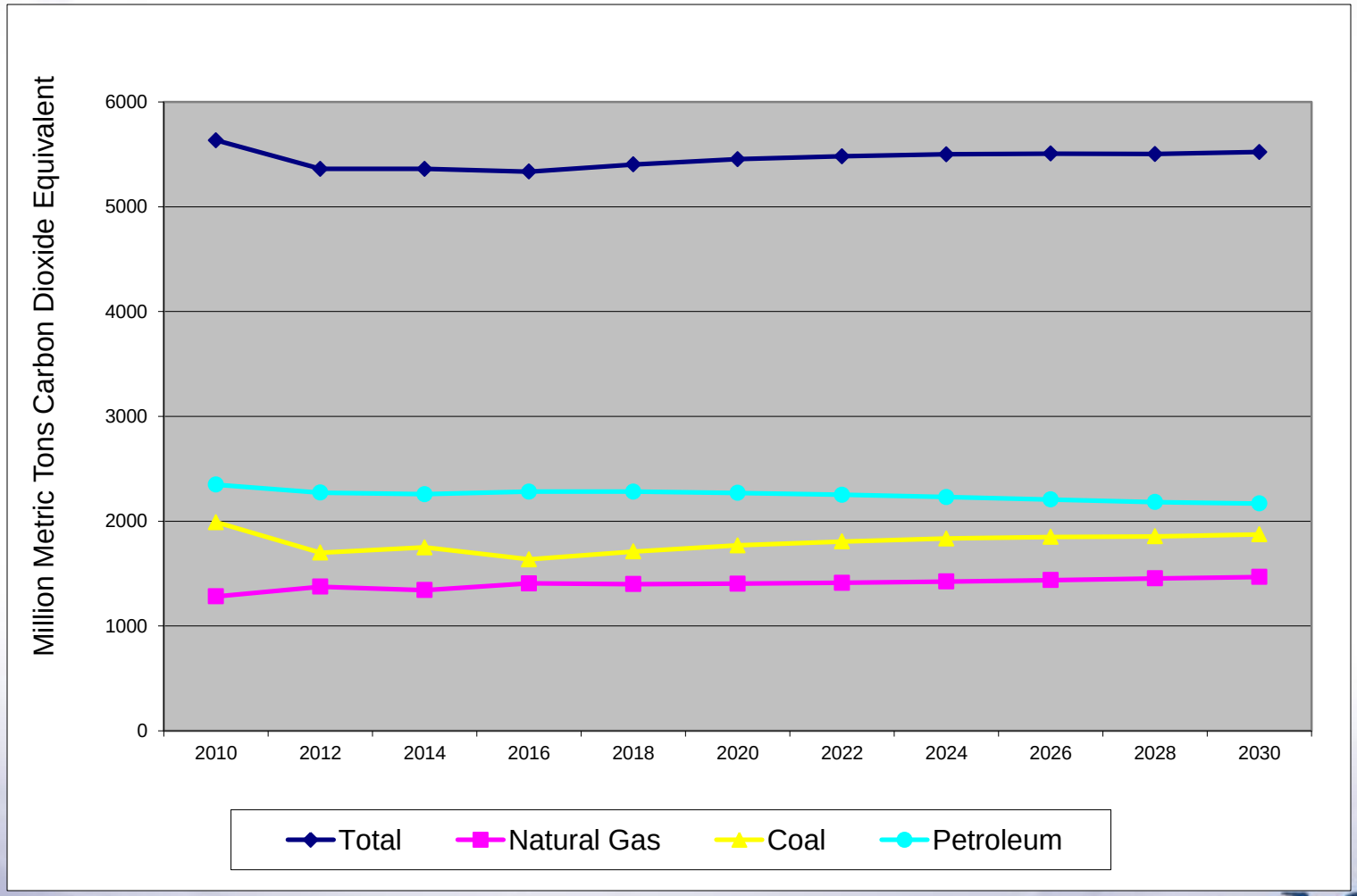
Oil Production World Summary



http://www.beodom.com/assets/images/education/peakoil/oil-production-world-summary-forecast.jpg [IMF World Economic Outlook (WEO)]

Energy-Related Carbon Dioxide Emissions

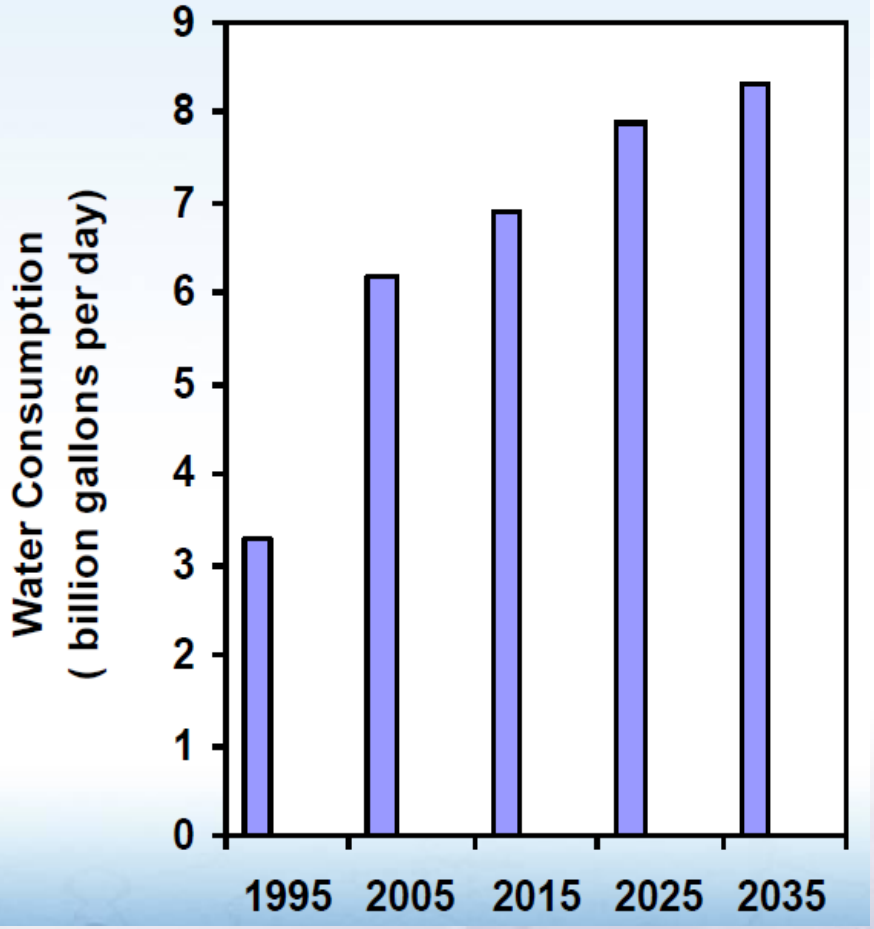
(Sectors: Residential, Commercial, Industrial, Transportation, Electric Power)



Source: U.S. Department of Energy, "Annual Energy Outlook 2013" December 2012

Water Demands for Electric Power Development

- Water demands could almost triple from 1995 consumption for projected mix of plants and cooling
- Carbon emission requirements will increase water consumption by an additional 1-2 Bgal/day



Source: Presentation by Mike Hightower, Sandia National Laboratories – "Energy-Water Nexus Landscape & Opportunities for Engineers," ASME Emerging Technology Webinar Series – August 2, 2011

Example - Impact and Water Use for Hydraulic Fracturing (Fracking) in Gas Drilling Operations

Complex System Failures

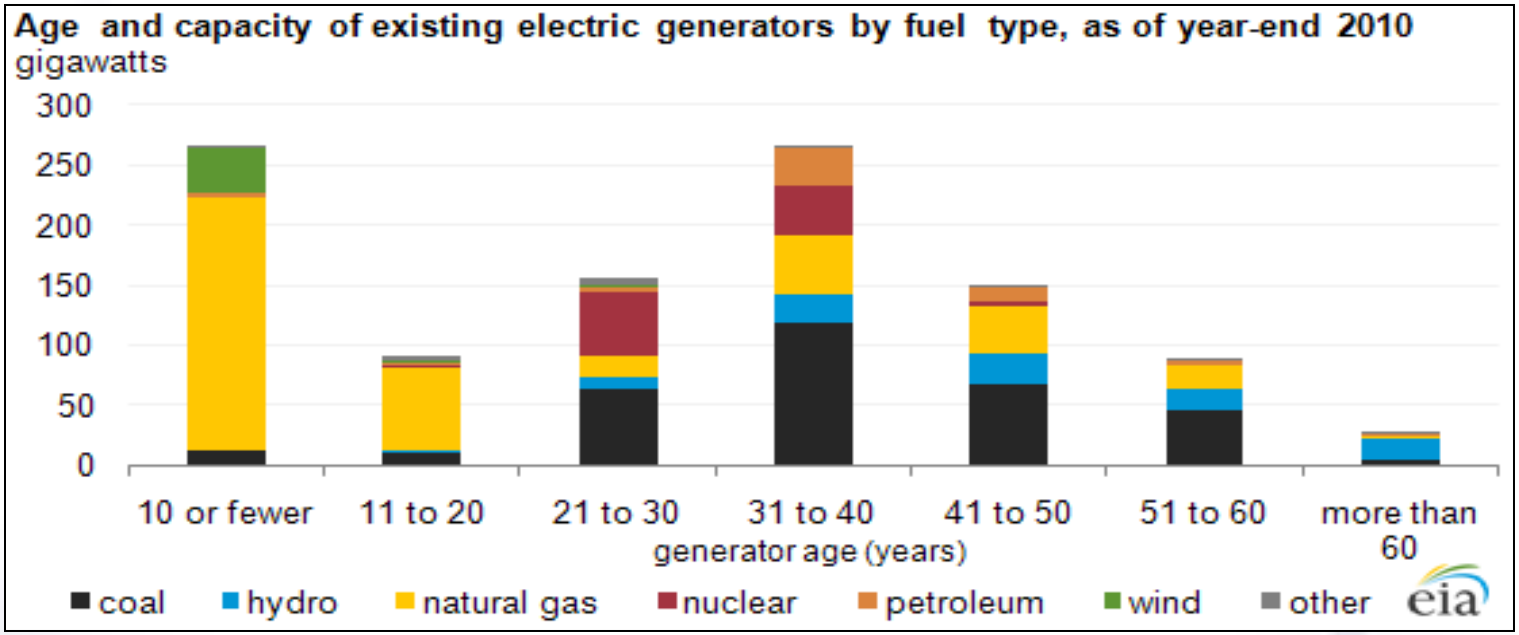
Sayano-Shushenskaya Hydroelectric Dam - 2009

Deepwater Horizon - 2010

Fukushima Dai-ichi - 2011

India - 2012

Infrastructure Trend: Aging of Power Generation Systems



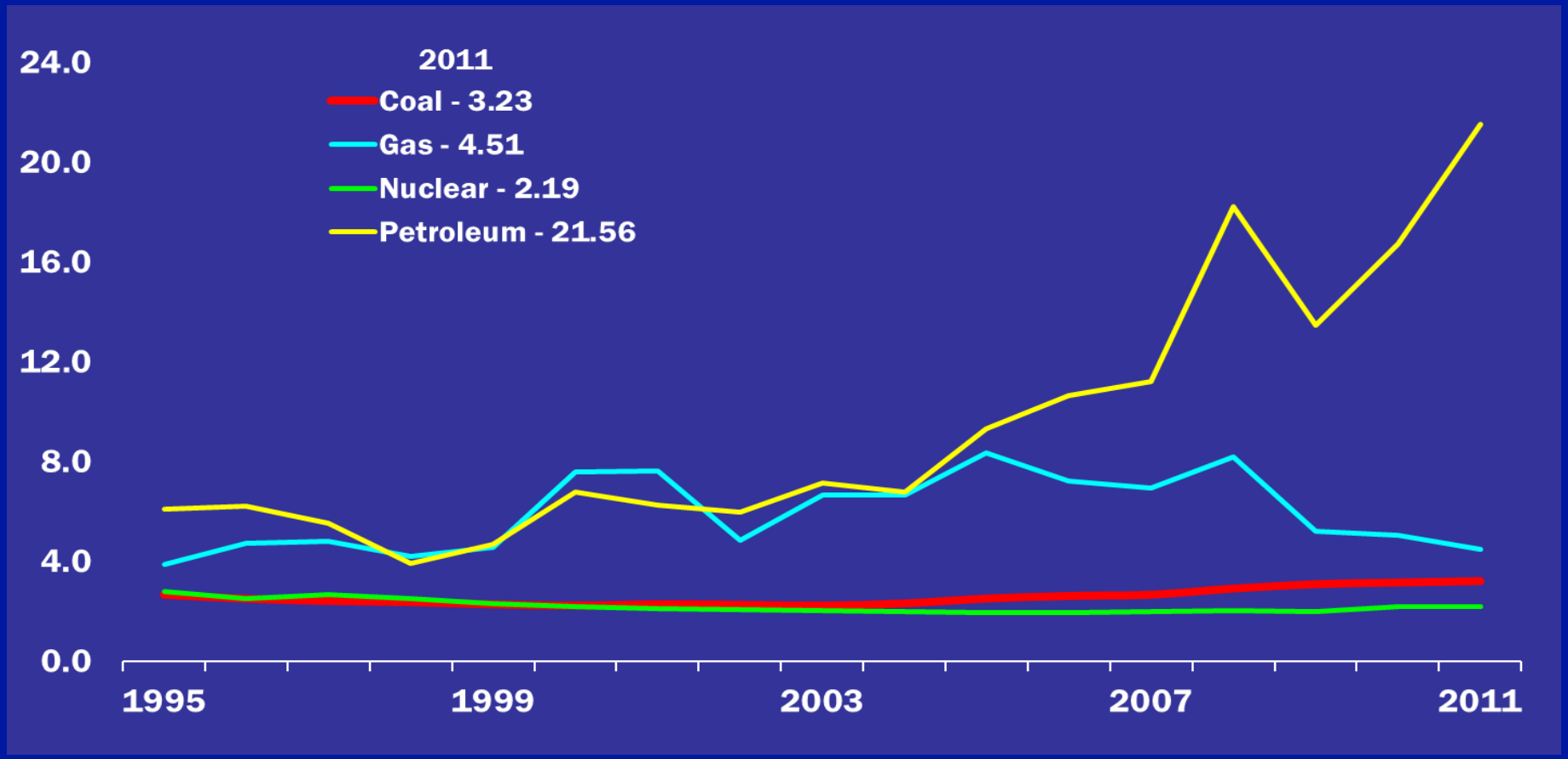
Source: EIA "Today in Energy" 6/16/2011 http://www.eia.gov/todayinenergy/detail.cfm?id=1830

The grid (transmission and distribution systems) is only one part of the aging infrastructure. Power plants are also aging as is the workforce and the regulatory structure.

Source: With Permission by Marc Goldsmith & Associates LLC, "Utility Trends 2012: Mitigating Risk," January 2012

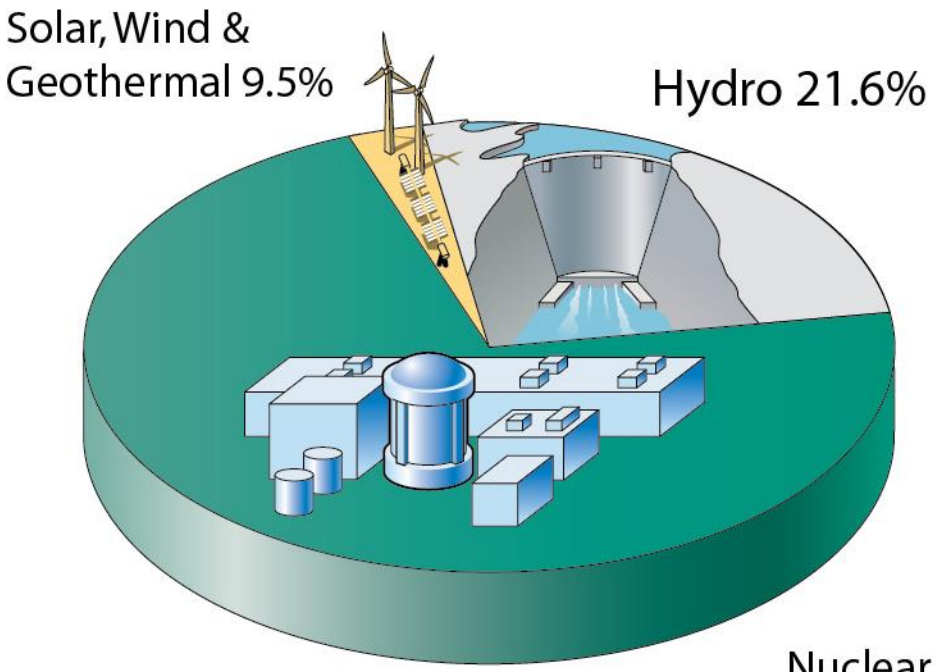
U.S. Electricity Production Costs

1995-2011, *In 2011 cents per kilowatt-hour*



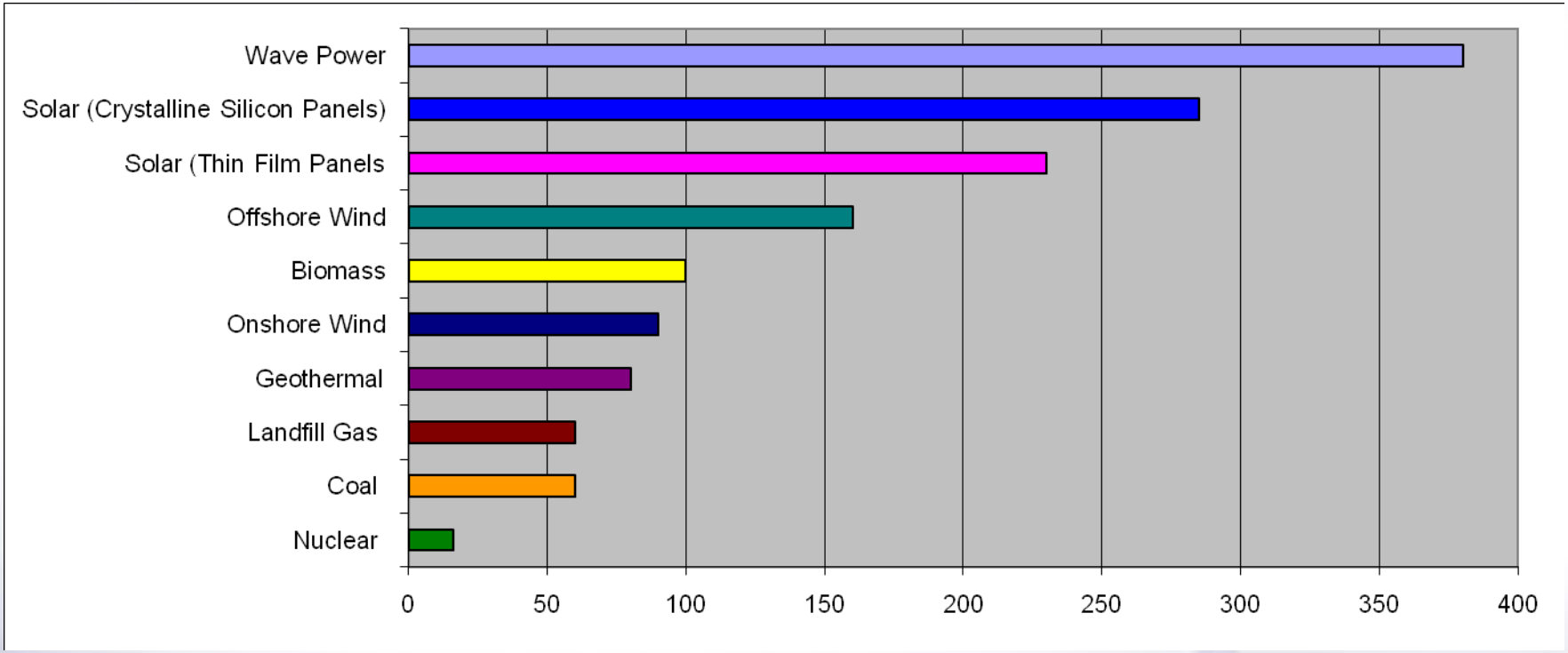
Source: Ventyx Velocity Suite
Updated: 5/12

U.S. Electricity Sources That Do Not Emit Greenhouse Gases



Source: Ventyx, Energy Information Administration, U.S. Department of Energy
Updated: 5/11

Cost of Producing Clean Energy (dollars per megawatt hour)



Source: Bloomberg

U.S. Capacity Factors by Fuel Type - 2011

Fuel Type	Average Capacity Factors (%)
Nuclear	89.0
Geothermal	69.5
Biomass	64.6
Coal (Steam Turbine)	61.1
Hydro	48.3
Gas (Combined Cycle)	45.6
Wind	31.8
Solar	24.0
Gas (Steam Turbine)	13.4
Oil (Steam Turbine)	8.1

Source: Ventyx, Energy Information Administration, U.S. Department of Energy
Updated: 4/12

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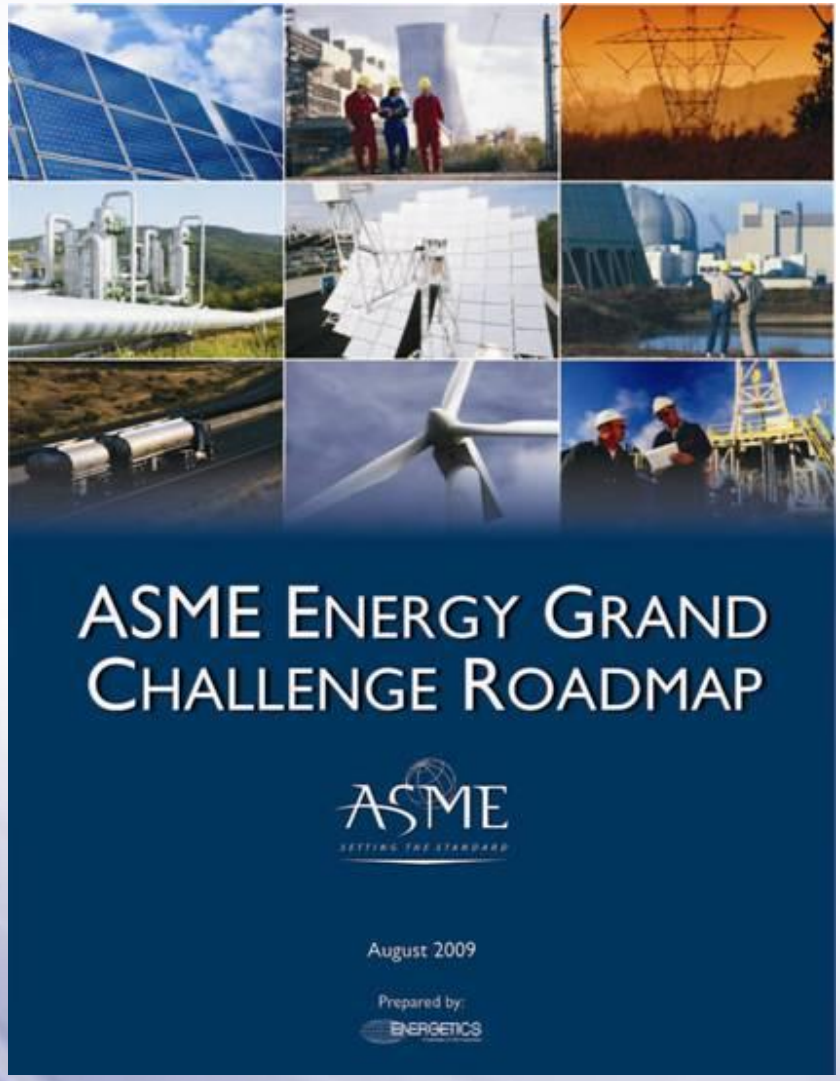
ASME Efforts to Support All Energy Initiatives

ASME will serve as an essential energy technology resource and a leading advocate for technically sound energy policies

ASME Energy Grand Challenge



Noteworthy citations:

- ***"Develop …codes and standards***…to support energy technology innovation and commercialization"
- **"*Identify standards needs***… perform standards gap analyses and develop comprehensive standards development plans…"
- "High-priority energy technology areas include wind, solar, hydrokinetics, geothermal, biofuels, hydrogen, energy efficiency, carbon capture and storage, and energy storage."
- "…build on existing capabilities and expertise in the nuclear area to address nuclear and other energy technology issues."
- "…complements public-private R&D, technology demonstration, and infrastructure construction programs."

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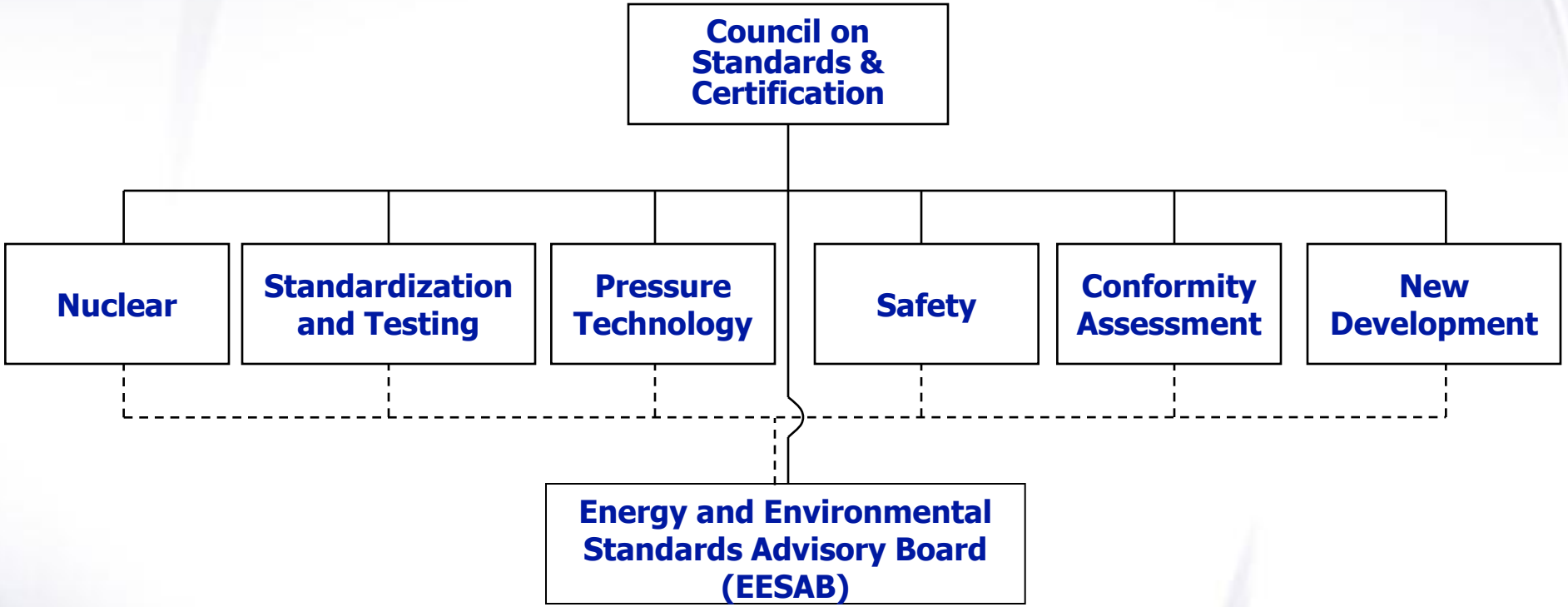
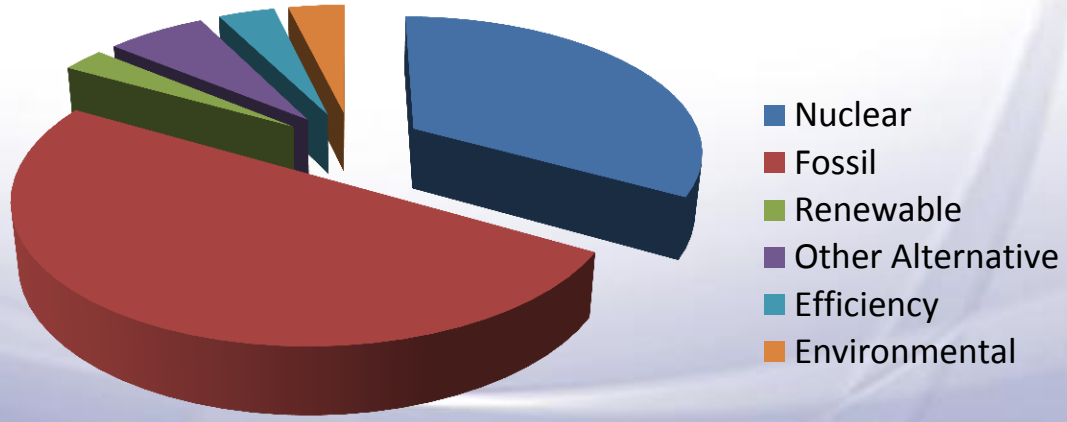
ASME Energy Standards Organization





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ASME Standards & Certification – Traditional Energy-Related Safety Standards

Pressure Technology

- boilers, pressure vessels, piping, materials, welding, valves, flanges

Standardization / Performance Test Codes

- turbines and plant equipment including heaters, heat exchangers, compressors, and condensers

Safety

- cranes, conveyors, rail transit

Nuclear

- component design, containment, quality assurance, air and gas treatment, inspection, operation and maintenance

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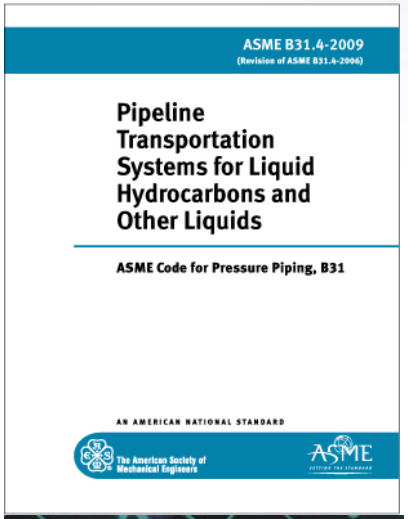
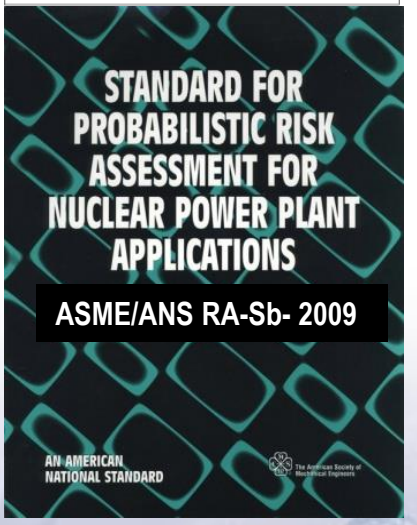
Some Recent ASME Standards & Certification Programs Impacting Energy

- ASME EA-1 Energy Assessment for Process Heating Systems
- ASME EA-2 Energy Assessment for Pumping Systems
- ASME EA-3 Energy Assessment for Steam Systems
- ASME EA-4 Energy Assessment for Compressed Air Systems
- ASME B31.4 Pipeline Transportation Systems for Liquid Hydrocarbons and Other Liquids
- ASME B31.12 Hydrogen Piping and Pipelines
- ASME PTC PM Performance Monitoring Guidelines for Power Plants
- ASME PTC 47 Integrated Gasification Combined Cycle (IGCC) Power Generation Plants
- ASME / ANS Standard for Probabilistic Risk Assessment For Nuclear Power Plants





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Technology Areas

ASME standards are under development or consideration in the following emerging energy technology areas:

- Hydrogen
- Wind
- Solar
- Hydrokinetics
- Geothermal
- Biofuels
- Hydraulic Facturing
- Small Modular Reactors
- Energy Storage
- Energy Efficiency
- Carbon Capture Utilization and Storage; Enhanced Oil Recovery
- IGCC Pre-Combustion Carbon Capture
- Verification & Validation
- Water Efficiency

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ASME Energy Incident Response Efforts

- ASME Project – Mitigating Consequences of Complex Systems Failure (August 2010 Start)

  - Develop Tool/Standard on Global Methodology for Risk Analysis
  - Educate Students to Better Understand Complex Systems
  - Enable Companies to Better Understand Ethical Implications and Consequence of Decisions

- Post Fukushima Response (May 2011 Start)

  - ASME (Multi-Standards Development Organization) Standards Task Force on Design Basis and Response to Severe Accidents

    Chair: Bryan Erler, Immediate Past Vice President, ASME Nuclear Codes & Standards
  - ASME Presidential Task Force on Response to Japan Nuclear Power Events (Complete)

    Chair: Dr. Nils Diaz, Past Chairman, U.S. NRC
    Vice Chair: Dr. Regis Matzie, Past SrVP & CTO, Westinghouse

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Impact of Fukushima Daiichi Event

- Four reactors destroyed
- 100,000 citizens evacuated
- Extensive land contamination in surrounding area
- Majority of the 54 reactors in Japan remain shutdown
- Major economic impact on Japan
- Significant changes to nuclear programs throughout the world
- Reactive decisions in some countries depart from nuclear power and return to increased reliance on fossil fuels (>CO_2); Germany is attempting major increase in use of renewables

Units 1 – 4 after Event

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ASME Report – "Forging a New Nuclear **Safety Construct**"

The ASME Presidential Task Force on Response to Japan Nuclear Power Plant Events

June 2012

- History of Nuclear Power
- Extended Design Basis
- Accident Prevention & Core Cooling
- Human Performance & Decision Making
- Accident Management
- Emergency Preparedness
- Public Acceptance
- Role of Codes & Standards
- Forging the New Nuclear Safety Construct

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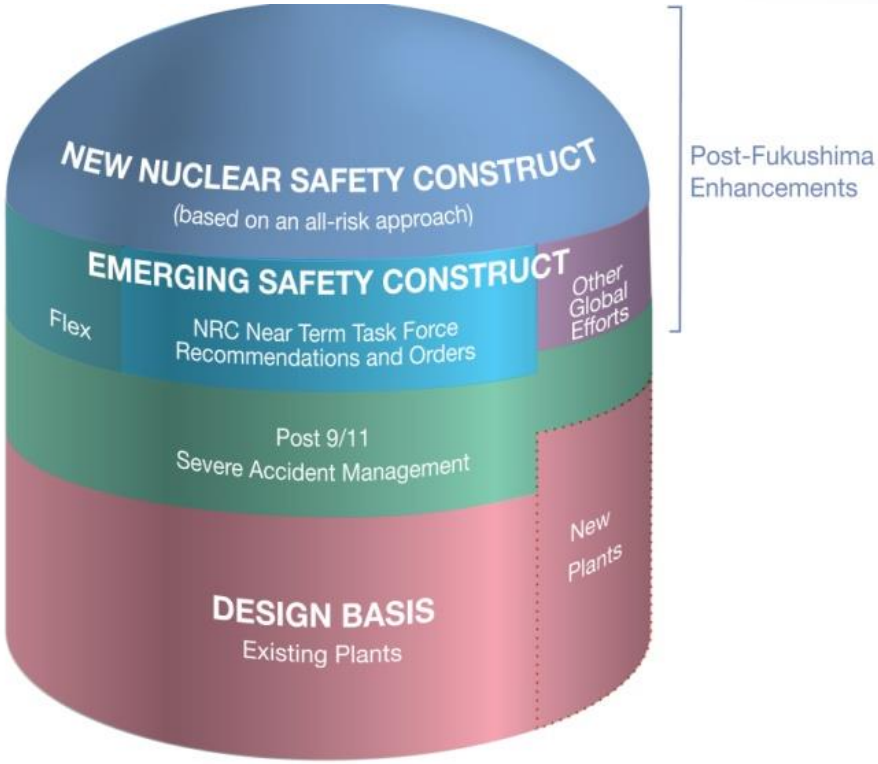
Forging a New Nuclear Safety Construct



"The set of planned, coordinated, and implemented systems ensuring that nuclear plants are designed, constructed, operated, and managed to prevent extensive societal disruption caused by radioactive releases from accidents, using an all-risk approach"

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Essential Elements of a New Nuclear Safety Construct

- Capability to address potential events beyond the design basis and possible cliff-edge effects
- Confirmation that the design basis or extended design basis includes rare yet credible events
- Use of an all-risk approach
- Improved elements –
  - human performance
  - organizational infrastructure
  - command and control
  - accident management
  - emergency preparedness

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The Regulator / Operator Contract

- The regulator must provide the adequate safety framework, with independent safety decision-making authority
- The owner/operator is ultimately responsible for safety, including upgrades demanded by newly revealed risks

Necessary and Sufficient?

Compliance with regulations is not and will not be sufficient to satisfy the demands of society

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ASME Workshop – "Forging a New Nuclear Safety Construct," Dec 2012

A Call for…

- A set of globally applicable principles for a new safety construct: *a visible, sustainable and sufficient construct*
- An initiative that functions effectively across multiple international interfaces, with the capability and commitment to pursue the development, assimilation and implementation of the new set of safety principles
- Eventual ownership by the global industry

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Energy Resources on ASME.org

- ASME Energy Grand Challenge report (2009)
- Technology and Policy Recommendations and Goals for Reducing Carbon Dioxide Emissions in the Energy Sector (2009)
- National Energy Policy Goals Proclamation (2009)
- ASME Report, “Initiative to Address Complex Systems Failure: Prevention and Mitigation of Consequences (2011)
- ASME Presidential Task Force Report, “Forging a New Nuclear Safety Construct” (June 2012); Summary Report of ASME Workshop – “Forging a New Nuclear Safety Construct” (February 2013)
- Energy Choices -- A Guide to Facts and Perspectives

Note: ASME Energy Committee is an excellent resource to reach experts in all energy fields

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ASME Energy Forum

- A new, year-long multi-media series that explores the technical aspects and workings of a broad range of energy sources and related technologies
  - Hydrokinetics (February 2013)
  - Concentrated Solar Power (March 2013)
  - Waste-to-Energy (May 2013)
  - Wind Farms (July 2013)
  - Fuel Cell Vehicles & Stations (September 2013)
  - Fracking (November 2013)
- http://www.asme.org/events/asme-energy-forum

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Summary

- Energy Grand Challenge requires the skills of engineers and related professionals worldwide to keep **"*SAFETY: First Choice, Last Chance*"**
- Growing global energy needs have many nations looking to expand the use of all energy sources with emphasis on those that are renewable & emission free
- ASME has several efforts underway to address global energy & environmental needs and safety impacts

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