The Chairman's Forum

Paul H. Genoa
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Nuclear Energy Institute

NUCLEAR ENERGY INSTITUTE

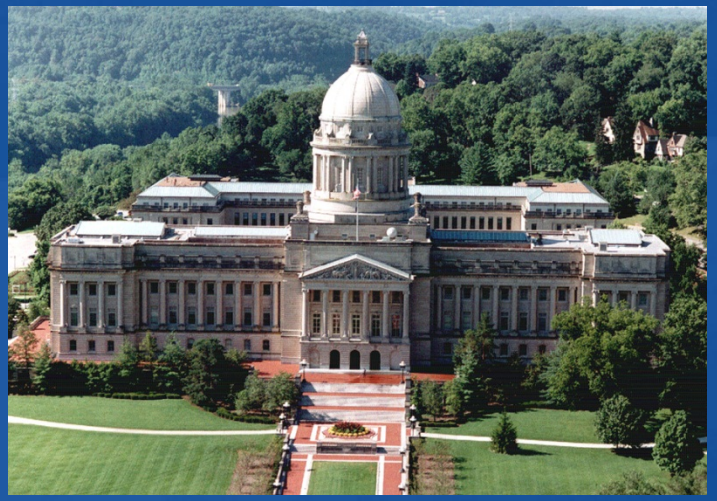
Paducah – 50 Years of Service !

Kentucky: H.B. 559

Enacted April 11, 2012

This legislation allows construction of nuclear facilities for certain industrial processes:

- **enrichment of depleted uranium hexafluoride tails;**
- **processing of metals contaminated with radioactive materials;**
- **recycling or reprocessing of spent nuclear fuels; and**
- **nuclear-assisted coal or gas conversion processes.**



Kentucky's moratorium on building new nuclear facilities to generate electricity remains in force.

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Status and Outlook for Nuclear Energy in the United States

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Life of a Nuclear Power Station

Pre-Operation

Pre-Construction (2 to 4 years)

- Engineering & procurement contract: $5-12 billion
- Siting and environmental analyses, licensing applications
- Long-lead items ordered (e.g. reactor vessel)

Construction (4 to 6 years)

- 400,000 cubic yards of concrete
- 66,000 tons of steel
- 44 miles of piping and 300 miles of electric wiring
- 130,000 electrical components
- Creates up to 3,500 workers at peak construction.

Operation

- Maintenance & refueling outages every 18 to 24 months (one third of fuel assemblies replaced; 1,000 additional workers)
- 20 metric tons of uranium fuel consumed annually*
- Steam generators and reactor vessel heads upgraded when necessary
- Power uprates occasionally implemented (~2% to 20% increase in megawatt capacity)
- Annually — $470 million in local sales of goods and services; $40 million in total labor income; $16 million in state and local taxes*
- 400-700 permanent jobs*
- Supplies electricity to 623,000 people each year (city the size of Boston or Seattle)*

Decommissioning

- Radioactive components and structures are cleaned or dismantled, packaged, and shipped to storage sites; containment and turbine buildings deconstructed

Used fuel management

- Used fuel stored in steel-lined, concrete pools or in massive steel and concrete canisters
- Reprocessing facilities recycle used fuel for new fuel and to reduce volume, heat and toxicity
- Recycling byproducts and/or used fuel sent to permanent repository

0 10 20 30 40 50 60 70 80 90 100

Pre-Operation (6 to 10 years)

Operation (40 to potentially 80 years)

Decommissioning and Used Fuel Management

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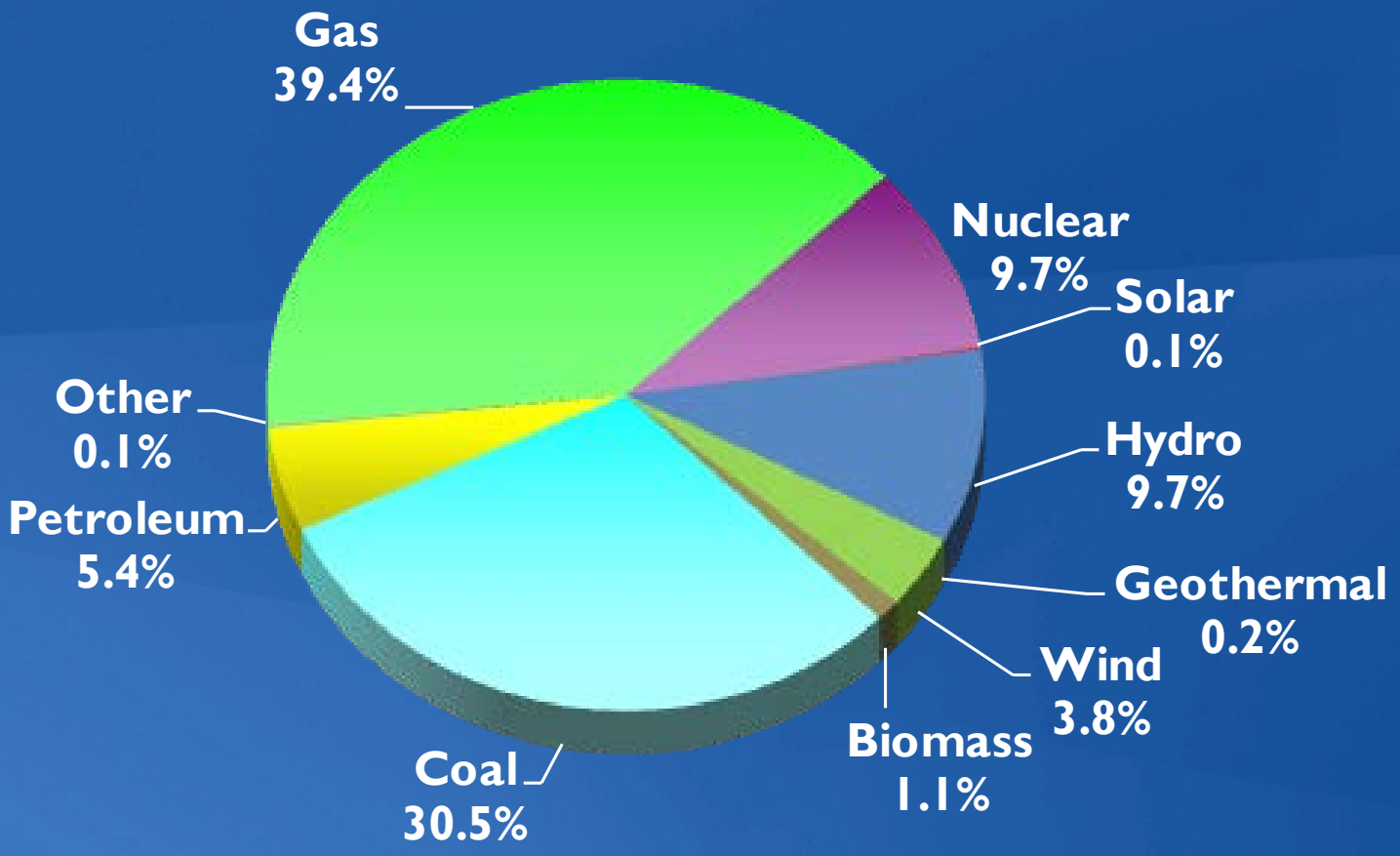
* Based on a 1,000 MW nuclear plant

U.S. Total Generating Capacity

2010



Source: Energy Information Administration

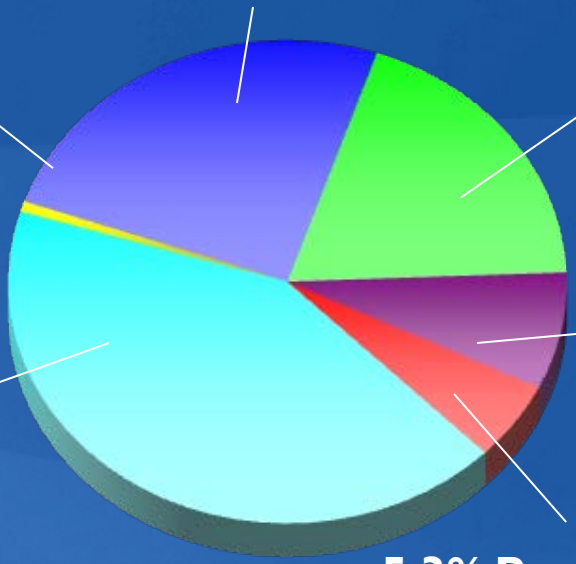
Updated: 5/12

Sources of U.S. Electricity 2011

24.8% Natural Gas
Low construction cost
Volatile fuel cost
Combined cycle capacity factor: 45.6%
Steam plant capacity factor: 13.4%
Emissions: NOx, CO_2

0.7% Oil
Volatile fuel cost
Capacity factor: 8.1%
Emissions: SO_2, NOx, CO_2

19.2% Nuclear
High construction cost
Stable fuel cost
Capacity factor: 89.0%
Emissions: None



7.8% Hydro
Large-scale opportunities gone
No fuel cost
Capacity factor: 48.3%
Emissions: None

42.2% Coal
High construction cost
Capacity factor: 61.1%
Emissions: SO_2, NOx, CO_2, particulates, mercury, toxic metals

5.3% Renewables (and Other)
Very high construction cost
No fuel cost
Wind capacity factor: 31.8%, Solar cap. fact.: 24.0%,
Geothermal cap. fact.: 69.5%, Biomass cap. fact.: 64.6%
Emissions from Biomass: SO_2, NOx, CO_2

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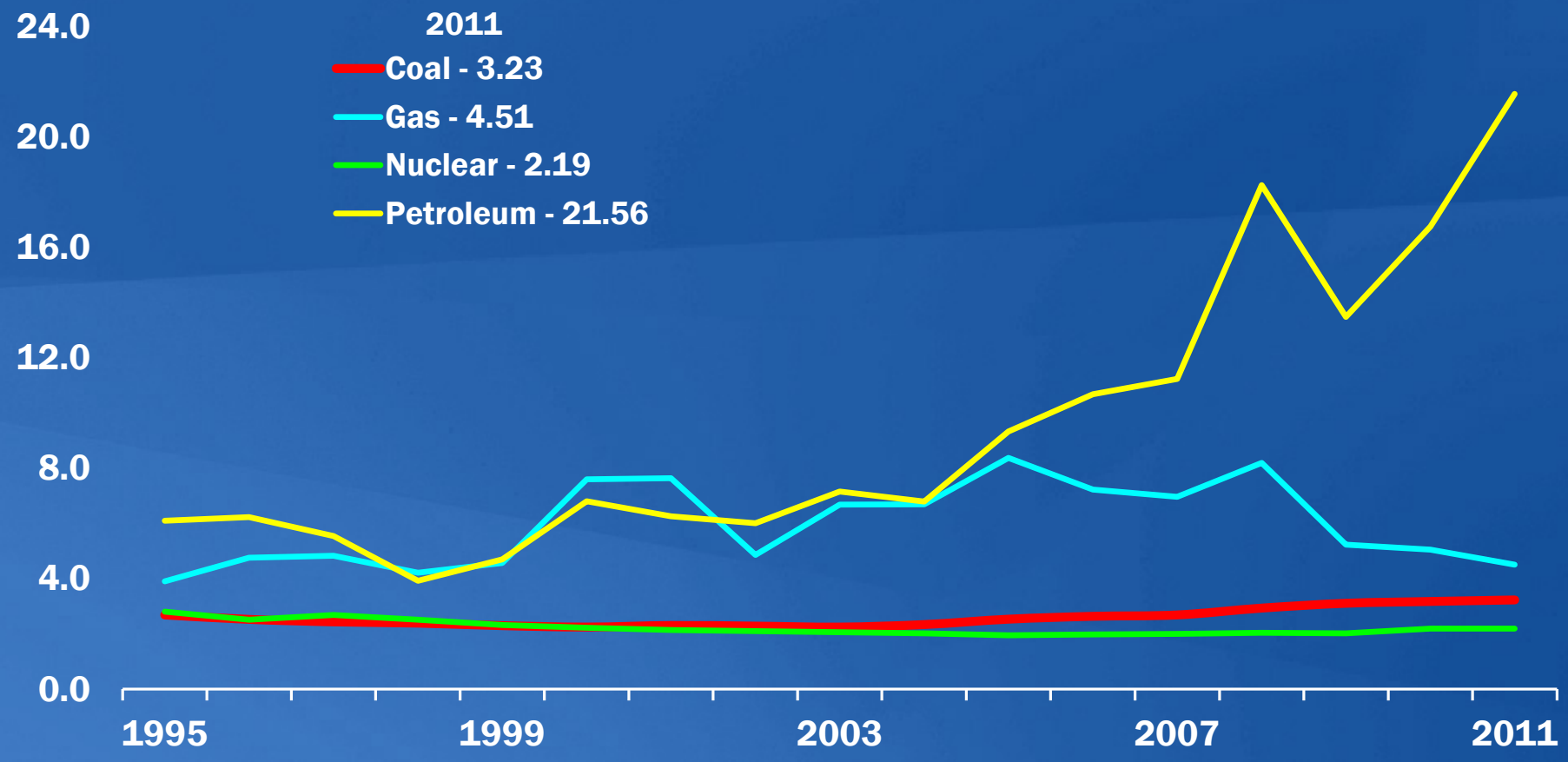
Source: Ventyx Velocity Suite / Energy Information Administration

Updated: 4/12

U.S. Electricity Production Costs

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

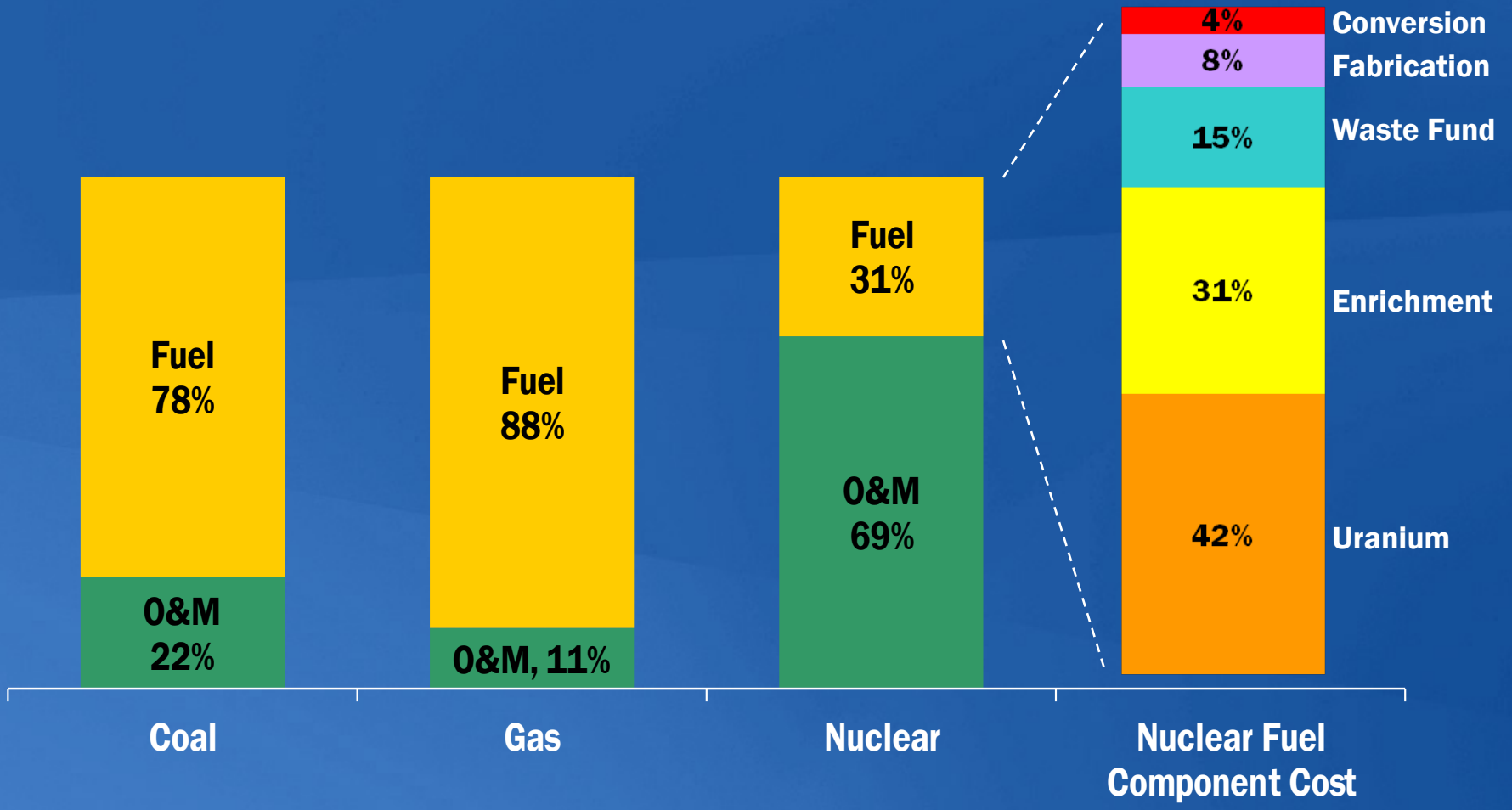


Production Costs = Operations and Maintenance Costs + Fuel Costs. Production costs do not include indirect costs and are based on FERC Form 1 filings submitted by regulated utilities. Production costs are modeled for utilities that are not regulated.

Source: Ventyx Velocity Suite
Updated: 5/12

Fuel as a Percentage of Electric Power Production Costs

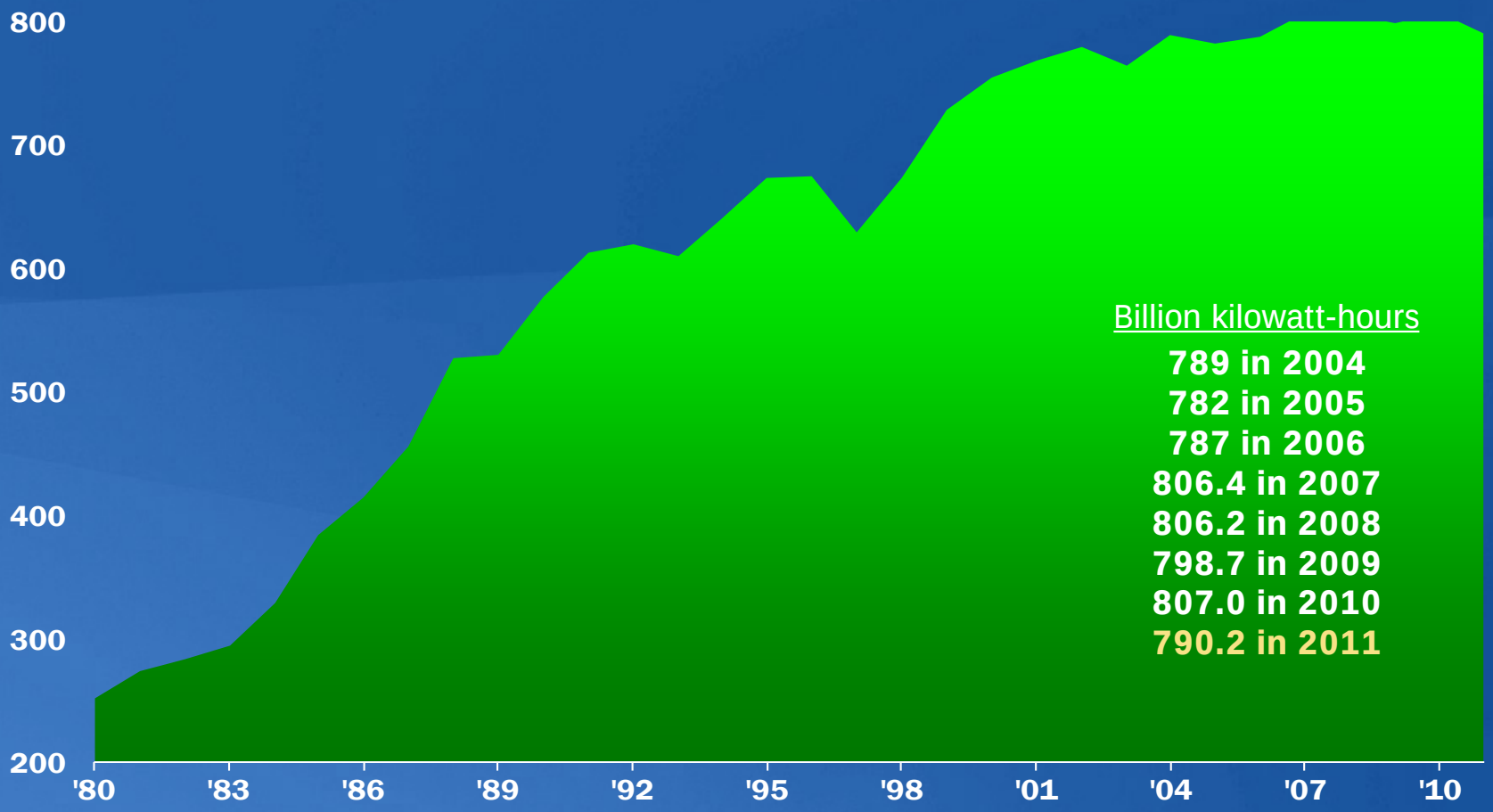
2011



Source: Ventyx Velocity Suite; Energy Resources International, Inc.
Updated: 5/12

Output Remains Near Record Levels

U.S. Nuclear Generation, BkWh

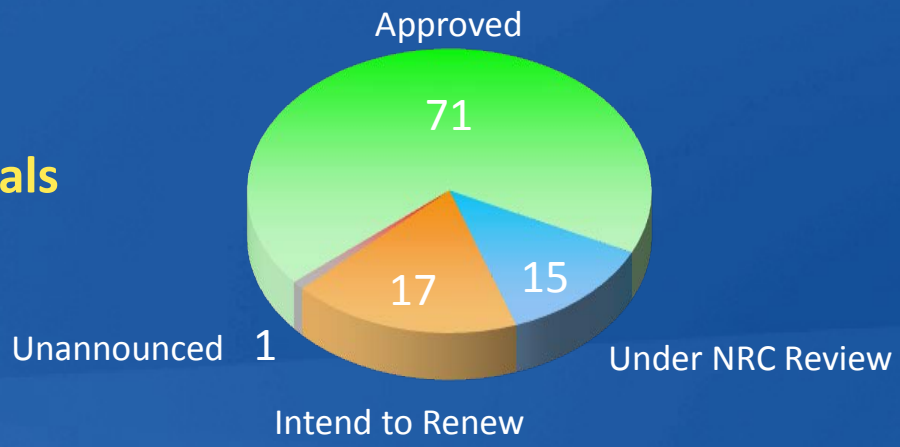


Source: Energy Information Administration

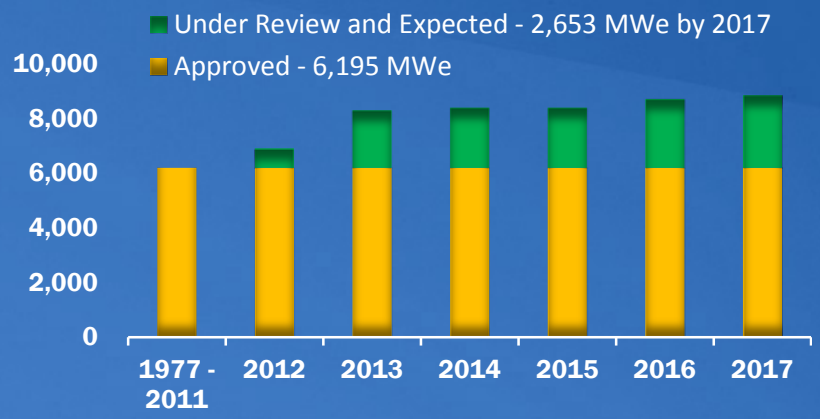
Updated: 3/12

Investing for the Future: License Renewals and Uprates Continue

License Renewals

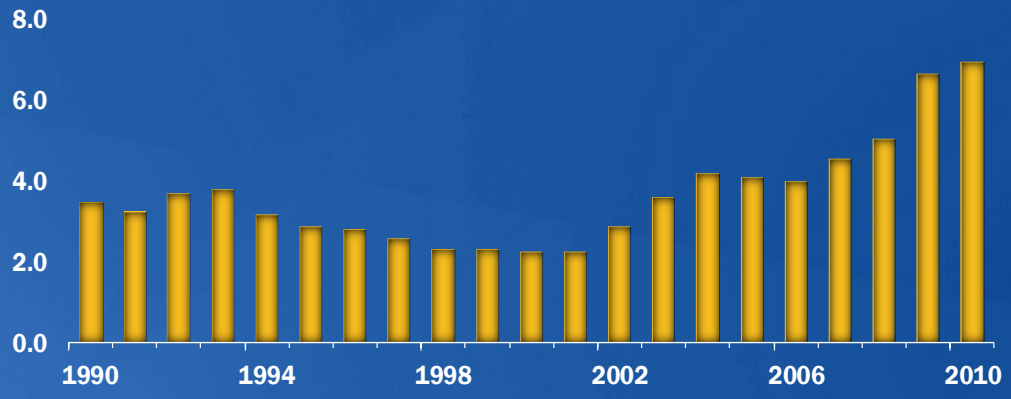


Cumulative Power Uprates



Total Capital Spending

Billions of Dollars



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Sources: Nuclear Regulatory Commission, Electric Utility Cost Group

Vogtle and Summer Projects Well Underway

Vogtle 3 & 4
Photo courtesy Southern Company

Summer 2&3
Photo courtesy SCANA

Other Designs, Licenses Under Review at NRC

- 10 COLs and 2 early site permits under NRC review
- Design certification for Westinghouse AP1000 and GE Hitachi/Toshiba ABWR
- Final design approval for GE Hitachi ESBWR
- AREVA's EPR and Mitsubishi's US-APWR under NRC review

AREVA

GE HITACHI

MNES MITSUBISHI NUCLEAR ENERGY SYSTEMS, INC.

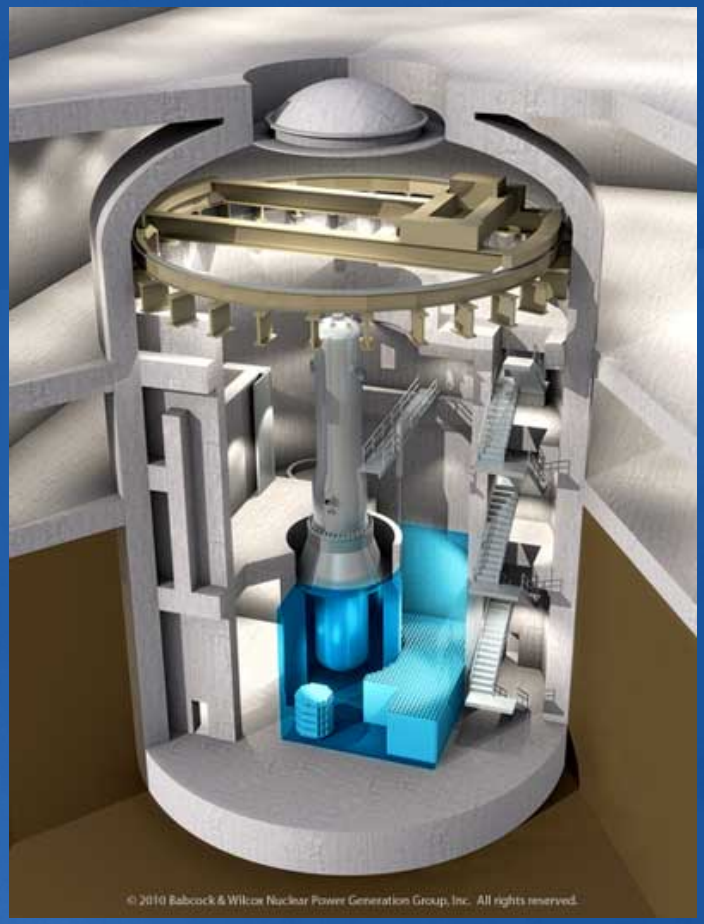
TOSHIBA

Westinghouse

NEI

Babcock & Wilcox

mPower™ Reactor



Federal Nuclear Energy Policy: Compared to The States, a Disappointing Record

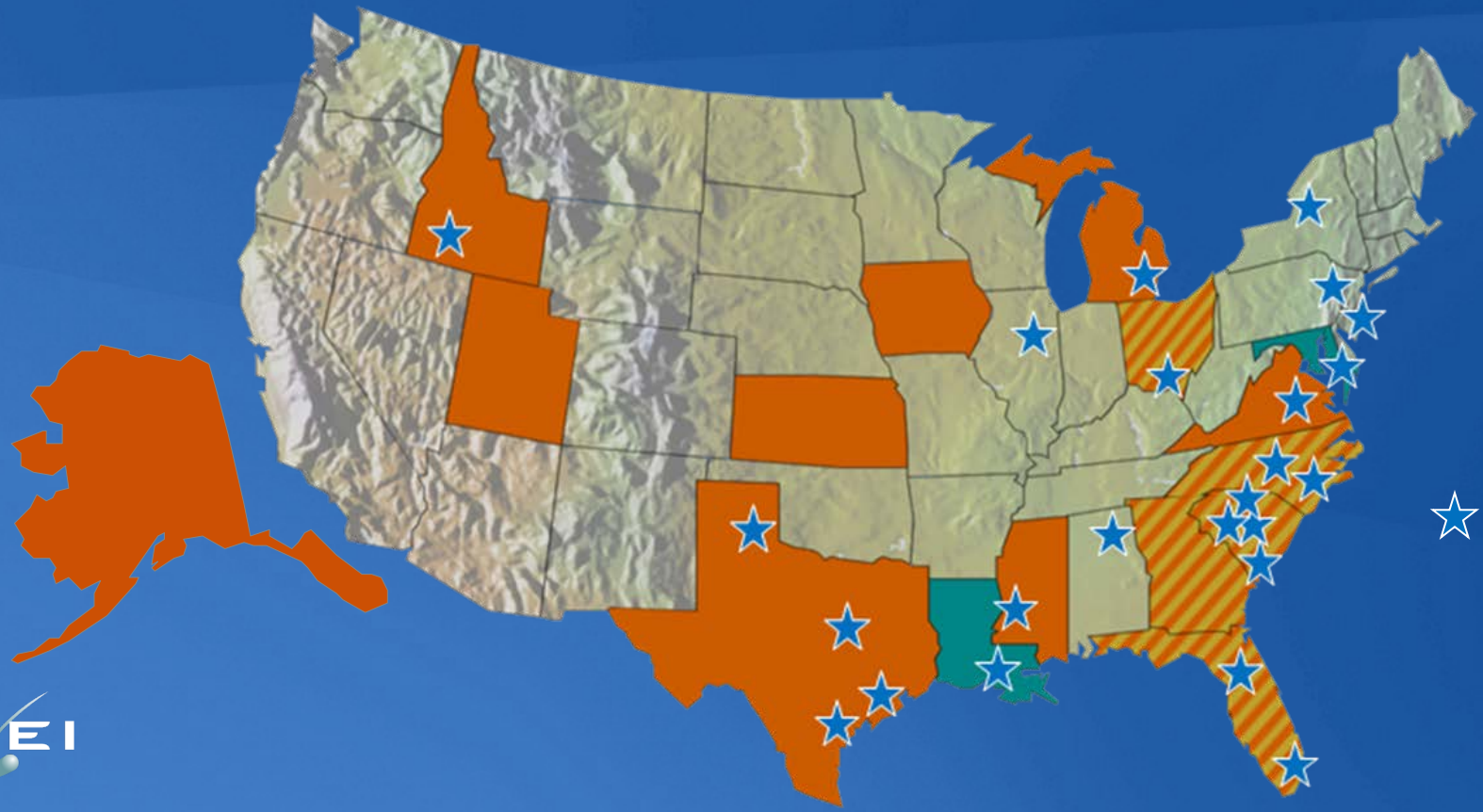
- Federal government
  - Used fuel management program
  - Loan guarantee program
- State governments
  - Investment recovery for new nuclear projects
  - Active support from governors, state legislators for industry initiatives

State Policies Supporting New Nuclear

Legislation

Regulation

Both legislation and regulation



Potential location for new nuclear facility

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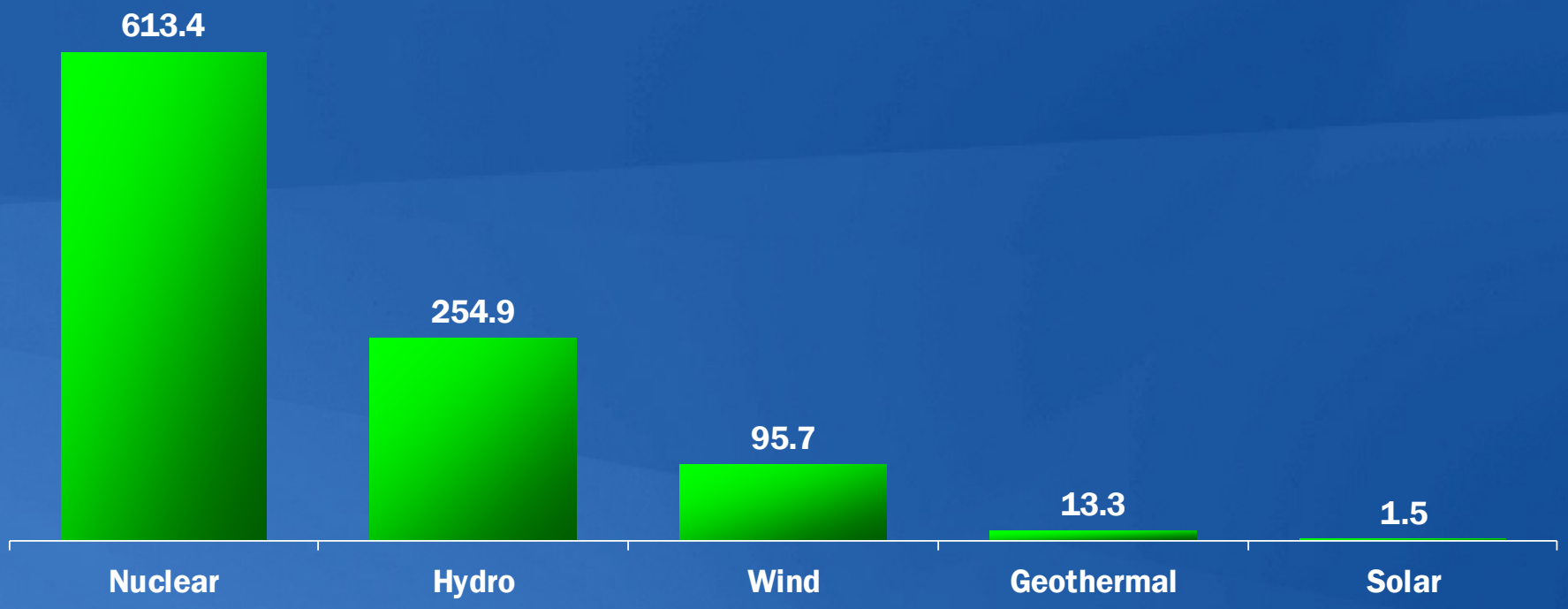
U.S. Electric Power Industry CO_2 Avoided

Million Metric Tons, 2011

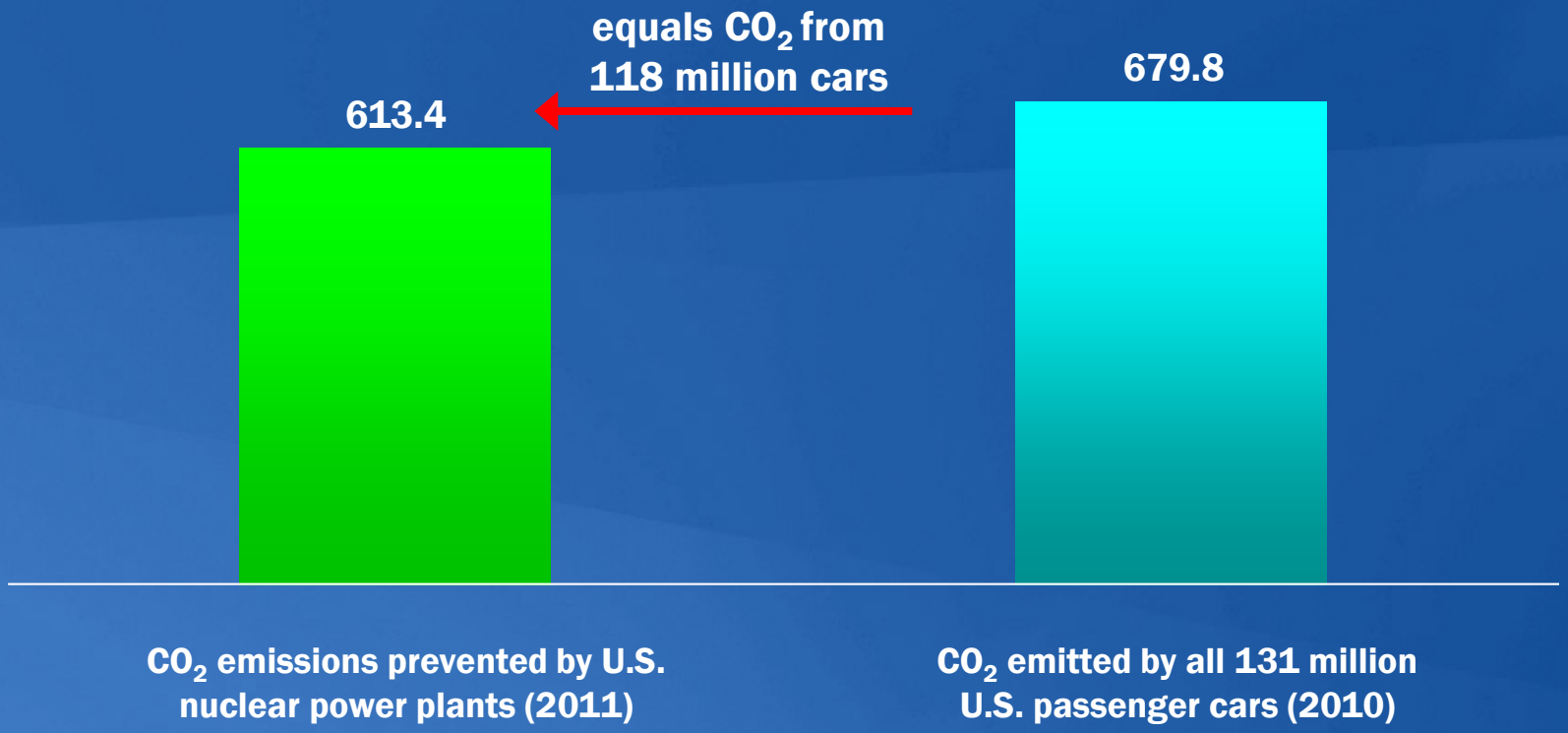


Source: Emissions avoided are calculated using regional and national fossil fuel emissions rates from the Environmental Protection Agency and plant generation data from the Energy Information Administration.

Updated: 5/12

Perspective on CO_2 Emissions Prevented By U.S. Nuclear Plants

Million Metric Tons, 2011



Source: Emissions avoided by nuclear power are calculated using regional fossil fuel emission rates from the Environmental Protection Agency and plant generation data from the Energy Information Administration. Car emissions from EPA, Office of Transportation and Air Quality Emissions Facts (April 2000).
Updated: 5/12

Nuclear Power Plants Provide More Jobs Than Most Other Sources of Electricity

Jobs per 1,000 megawatts of generating capacity	
Solar Photovoltaic	1,066
Nuclear	500
Concentrating Solar Power	470
Hydro	100-450
Coal	190
Gas Combined Cycle	50
Wind	50

Source: Harker, Donald, Hirschboeck, Peter Hans, "Green Job Realities—Quantifying the Economic Benefits of Generation Alternatives," March 2010, http://www.fortnightly.com/exclusive.cfm?o_id=379

Economic Benefits of Nuclear Power

Job Creation

- Construction of a new nuclear power plant creates up to 3,500 workers at peak construction.
- 400-700 permanent operating jobs: These jobs pay 36% more than average local salaries
- An equivalent number of additional jobs in local area to support the plant workforce & families

Suppliers

- 400,000 cubic yards of concrete—five times as much the 100-story Sears Tower
- 66,000 tons of steel
- 44 miles of piping and 300 miles of electric wiring
- 130,000 electrical components.

Local Economy

- $470 million a year in total output for the local community
- $40 million per year in total labor income.
- Every $1 spent by the average nuclear plant results in the creation of $1.04 in the local community.
- $16 million per year in state and local taxes. These tax payments support schools, roads and other state and local infrastructure.
- $67 million per year in federal taxes

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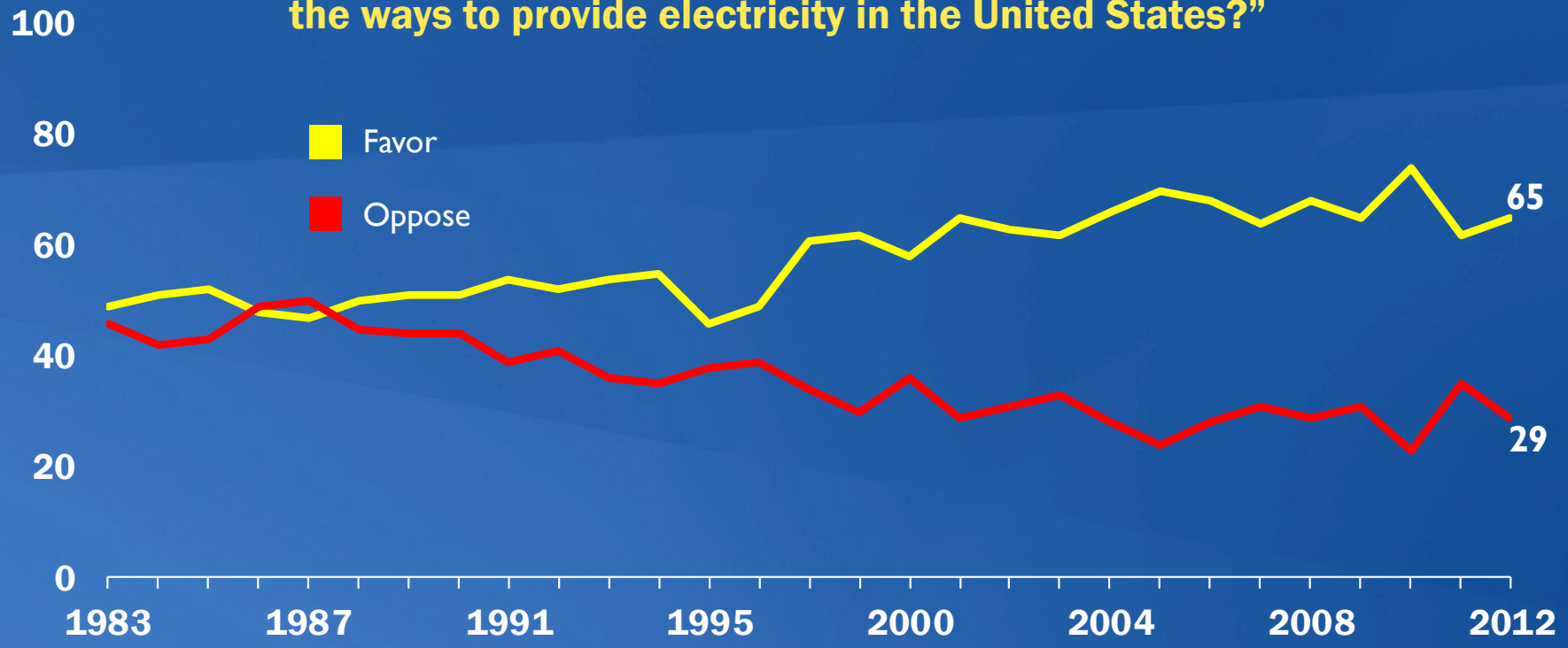
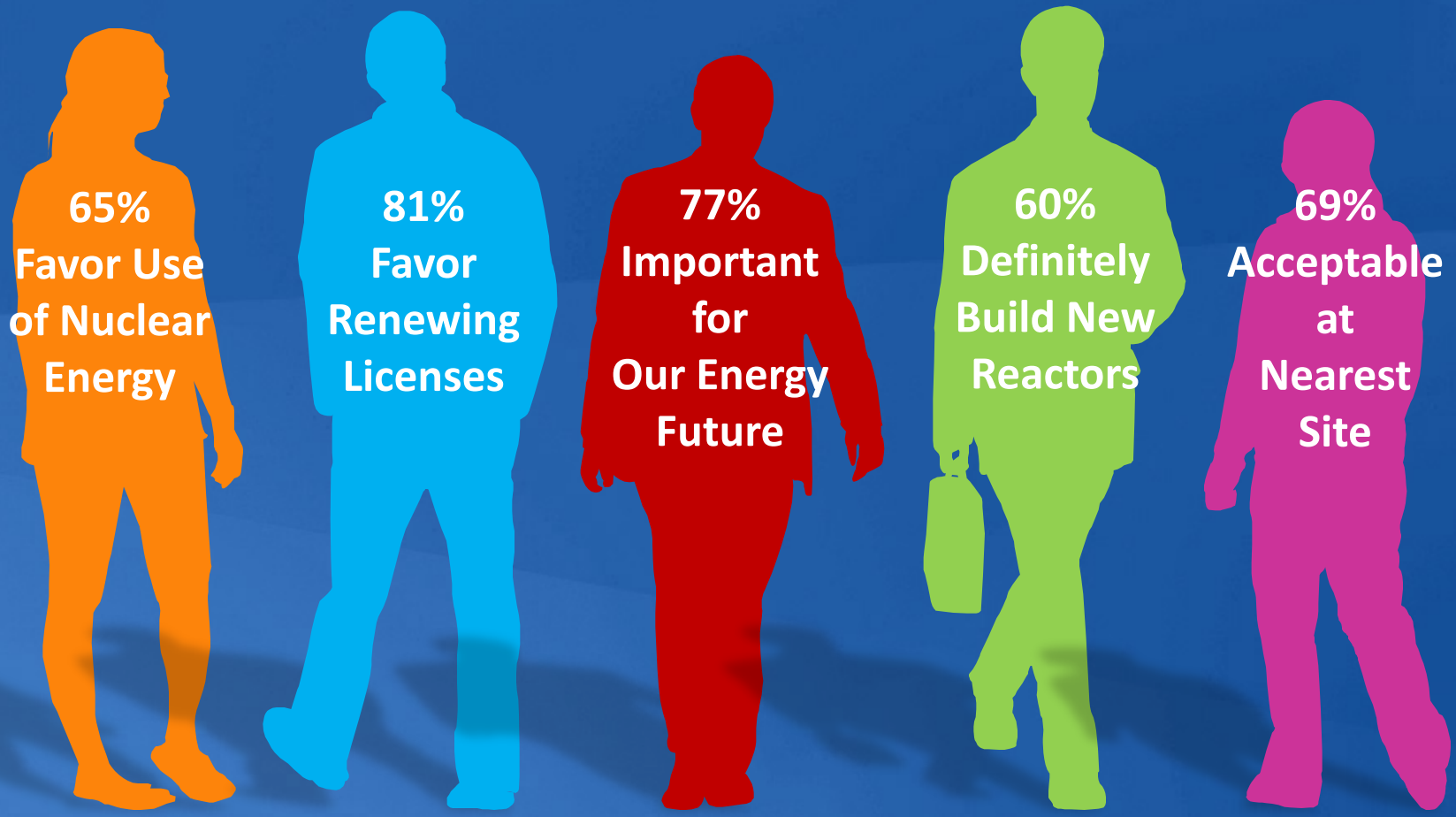
Upward Trend in Public Support For Nuclear Energy

"Overall, do you strongly favor, somewhat favor, somewhat oppose or strongly oppose the use of nuclear energy as one of the ways to provide electricity in the United States?"



Source: Bisconti Research Inc., September 2012, 1,000 U.S. Adults

Strong Public Support Continues



Source: Bisconti Research Inc.

September 2012 poll of 1,000 U.S. adults; margin of error is +/- 3%

Fukushima Response: Industry Objectives

- Prime focus is continued safe operation
- Implement strategies and actions that provide the greatest safety benefit first
- Focus on prevention of fuel damage (core and spent fuel pool) and containment integrity

Responsible, Measured Response to Fukushima In the United States

- Disciplined regulatory response from NRC
- Measured political response
- Public attitudes (particularly opinion leaders) remain strong
- Reasoned editorial reaction

FINANCIAL TIMES

"In spite of the worst atomic accident in 25 years, nuclear power is here to stay."
— December 29, 2011, editorial

USA TODAY

"Nuclear power remains an indispensable part of the U.S. energy mix."
— December 12, 2011, editorial

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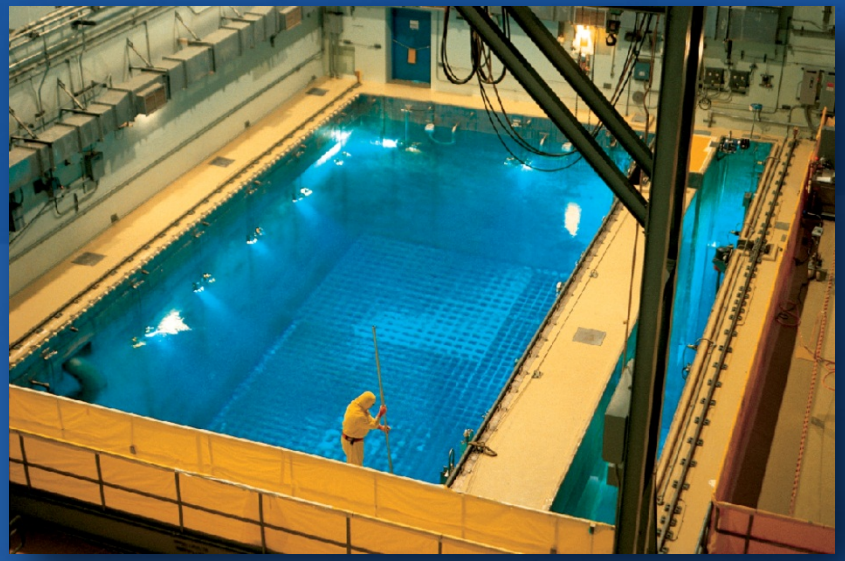
Used Fuel Management: Key Findings of Blue Ribbon Commission

- Develop consolidated fuel storage facilities at volunteer sites
- New federal corporation to enhance management of used fuel program
- Access to Nuclear Waste Fund and future collections
- R&D on advanced fuel cycles
- Need for long-term repository



U.S. Leadership In Global Nuclear Energy Development

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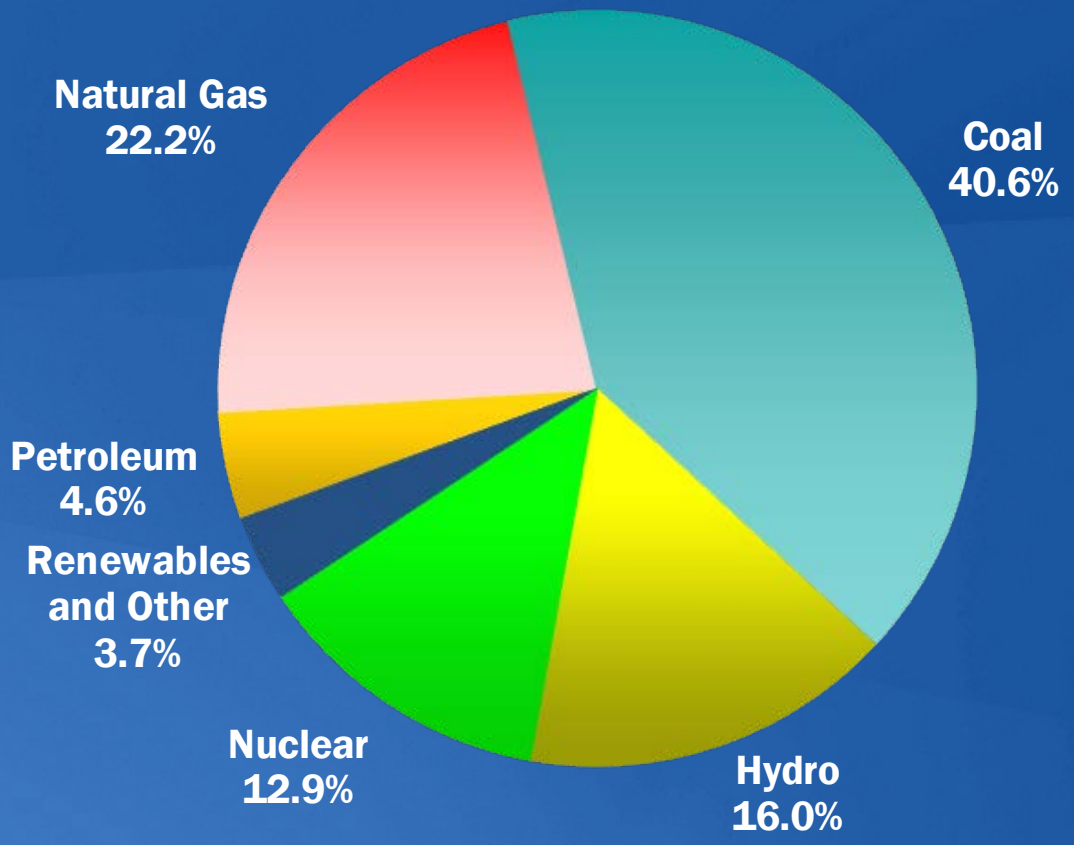
World Electricity Generation by Fuel

2010



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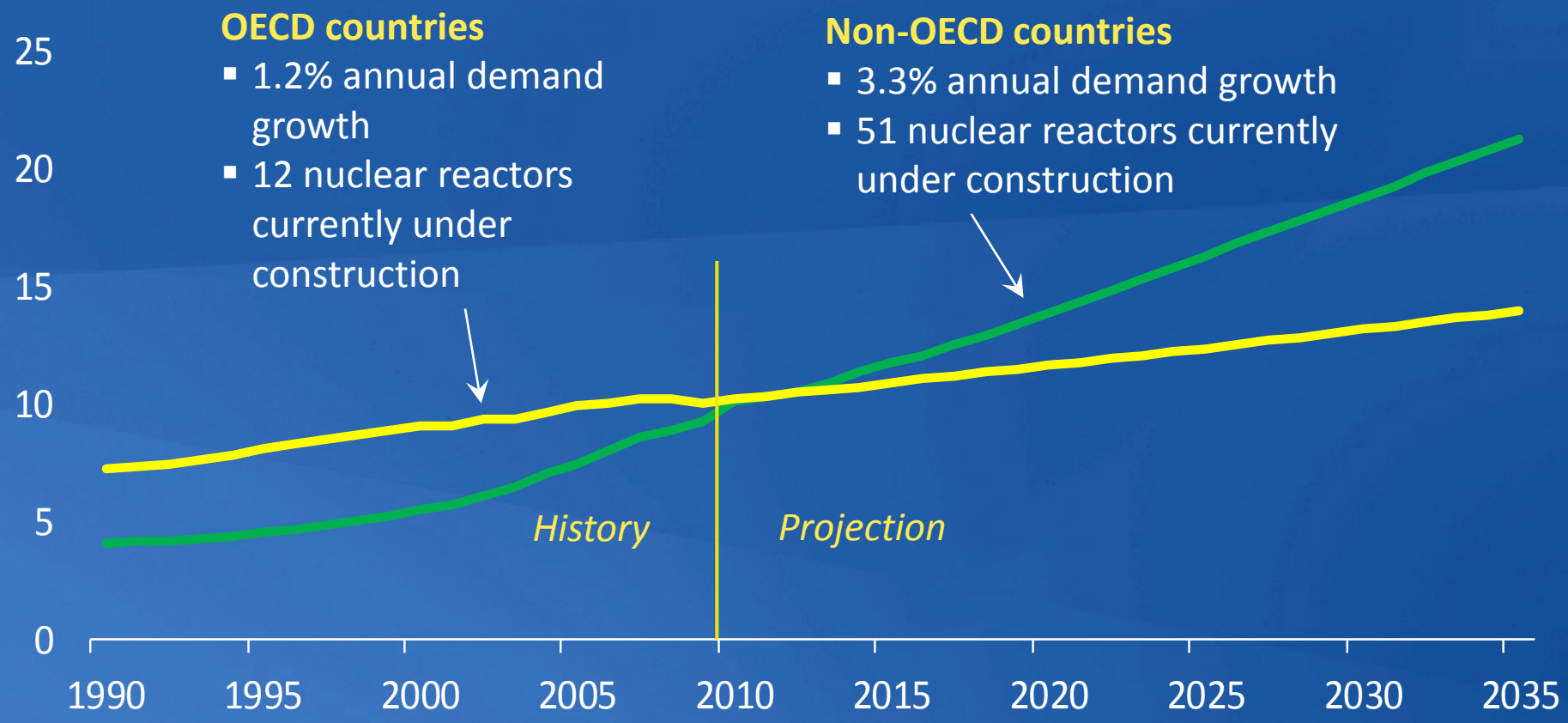
Source: International Energy Agency's *Key World Energy Statistics 2012*

Updated: 10/12

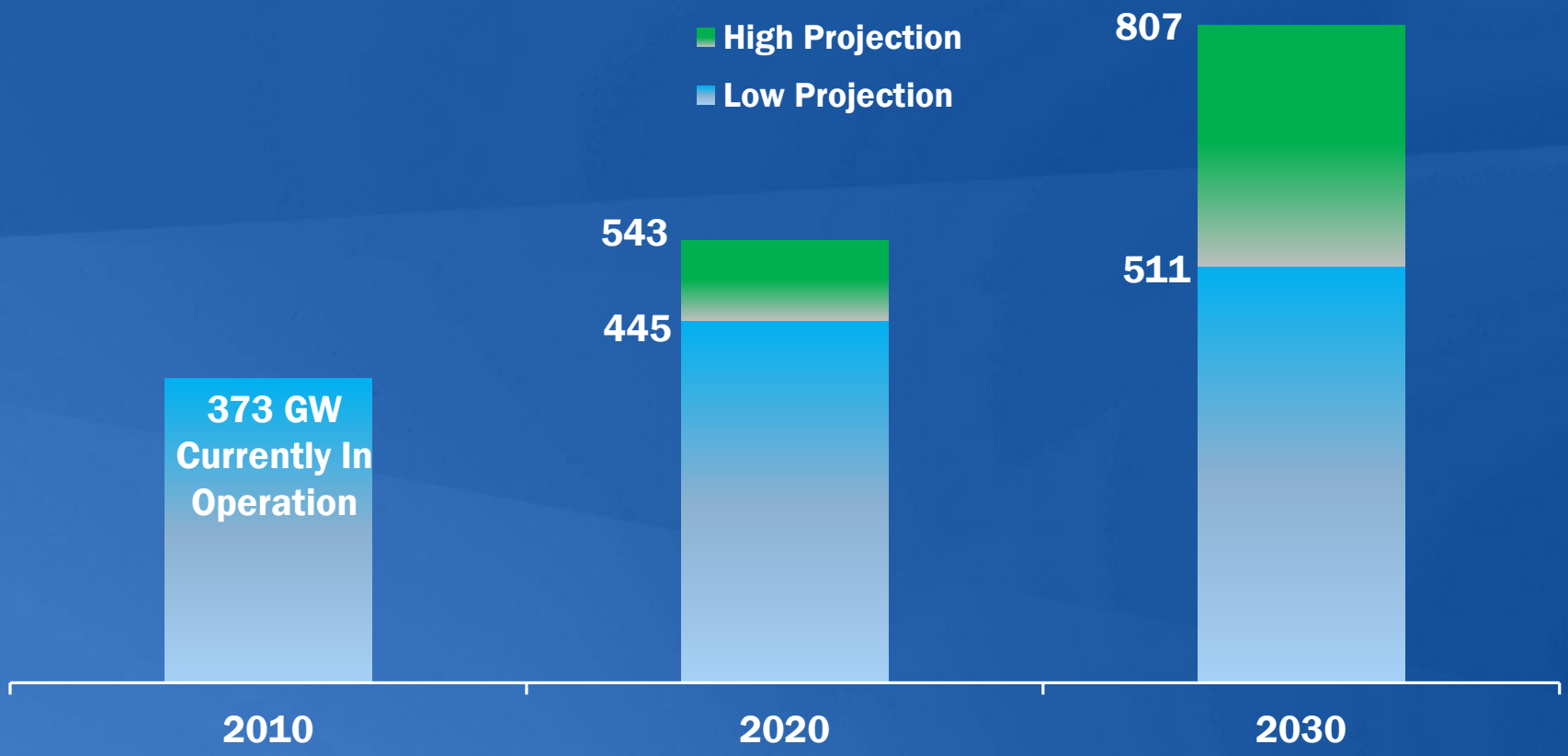
World Electricity Demand Will Rise

(trillion kilowatt-hours)



Sources: Energy Information Administration's 2011 International Energy Outlook, International Atomic Energy Agency

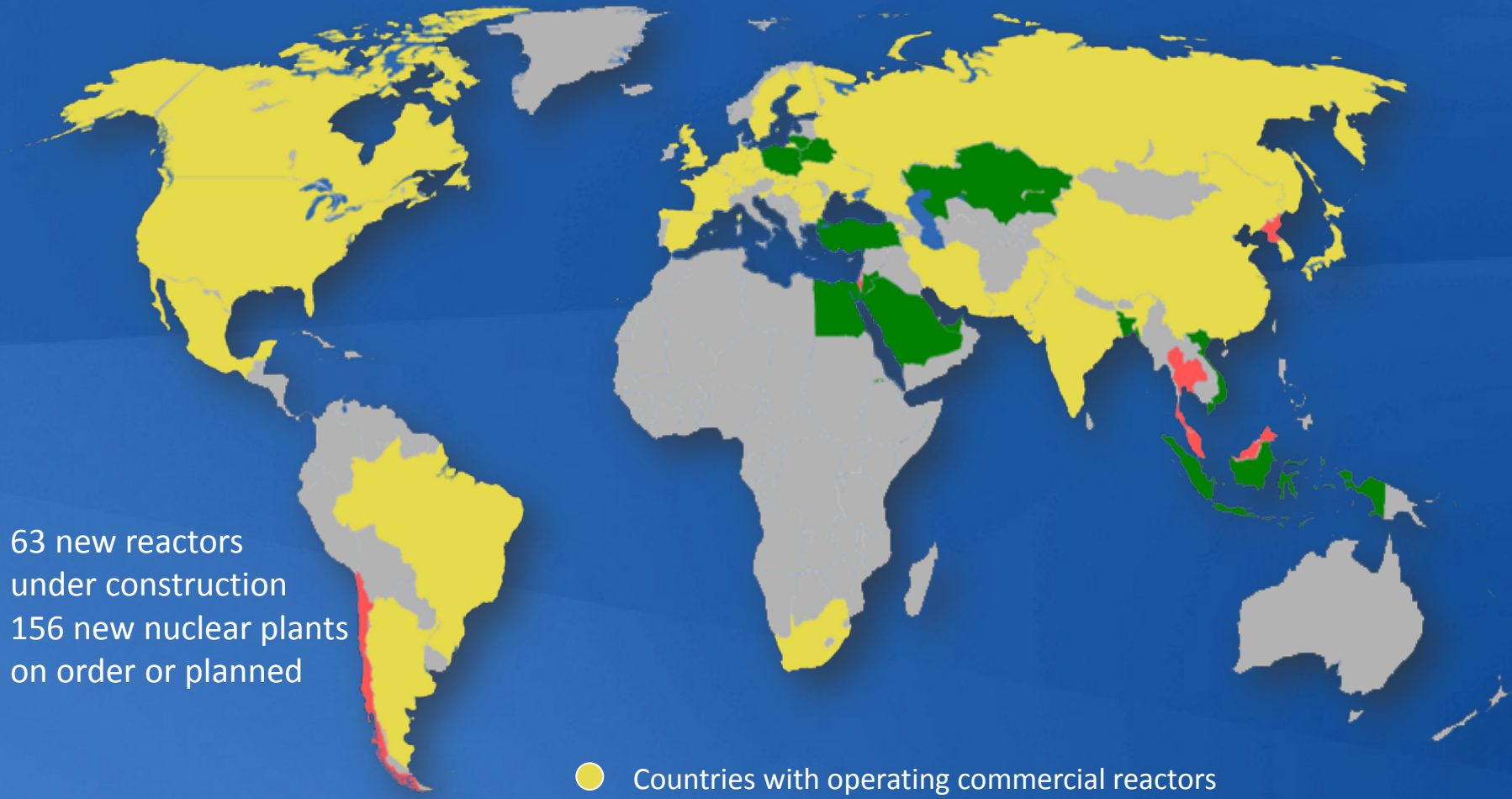
World Nuclear Generating Capacity Projections, Gigawatts



Source: International Atomic Energy Agency, "Energy, Electricity and Nuclear Power Estimates for the Period up to 2030." 2009 Edition

Updated: 8/10

Global Nuclear Energy Development



- 63 new reactors under construction
- 156 new nuclear plants on order or planned

- Countries with operating commercial reactors
- Emerging nuclear countries with planned reactors
- Emerging nuclear countries with proposed reactors

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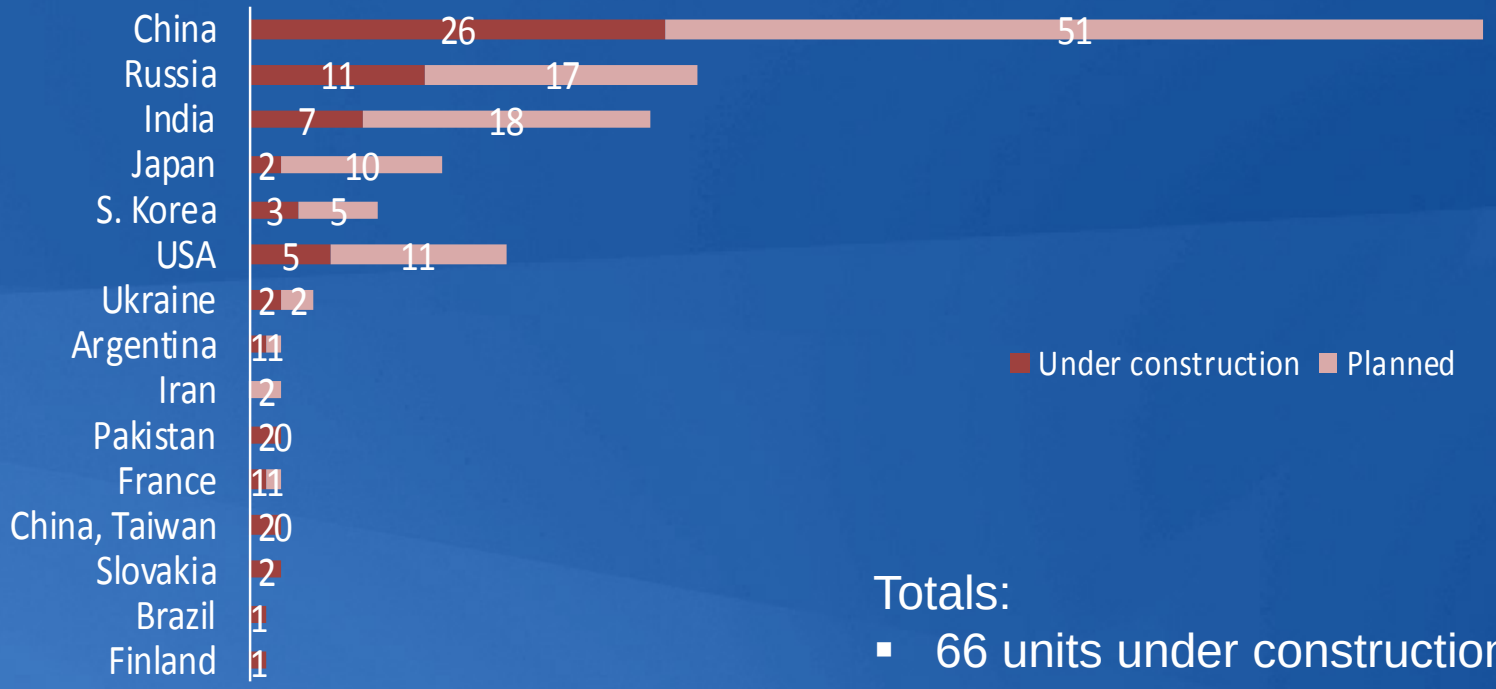
U.S. Participation in World Nuclear Energy Market Supports U.S. Strategic Objectives

- U.S. technology among the most innovative – *e.g.*, the only "passive safety" designs
- Participation in the world market enhances U.S. ability to achieve nonproliferation goals, export safety practices
- NRC approval of reactor designs considered the gold standard
- Global sales will create thousands of jobs
  - manufacture key components and fuel
  - provide design, engineering and other services

Nuclear Units Under Construction and Planned Worldwide



Totals:

- 66 units under construction*
- 158 units on order or planned**

Sources: International Atomic Energy Agency and project sponsors for units under construction and World Nuclear Association for units on order or planned.

***Chart includes only countries with units under construction. **Countries planning new units are not all included in the chart.**

Planned units = Approvals, funding or major commitment in place, mostly expected in operation within 8-10 years.

Updated: 8/12

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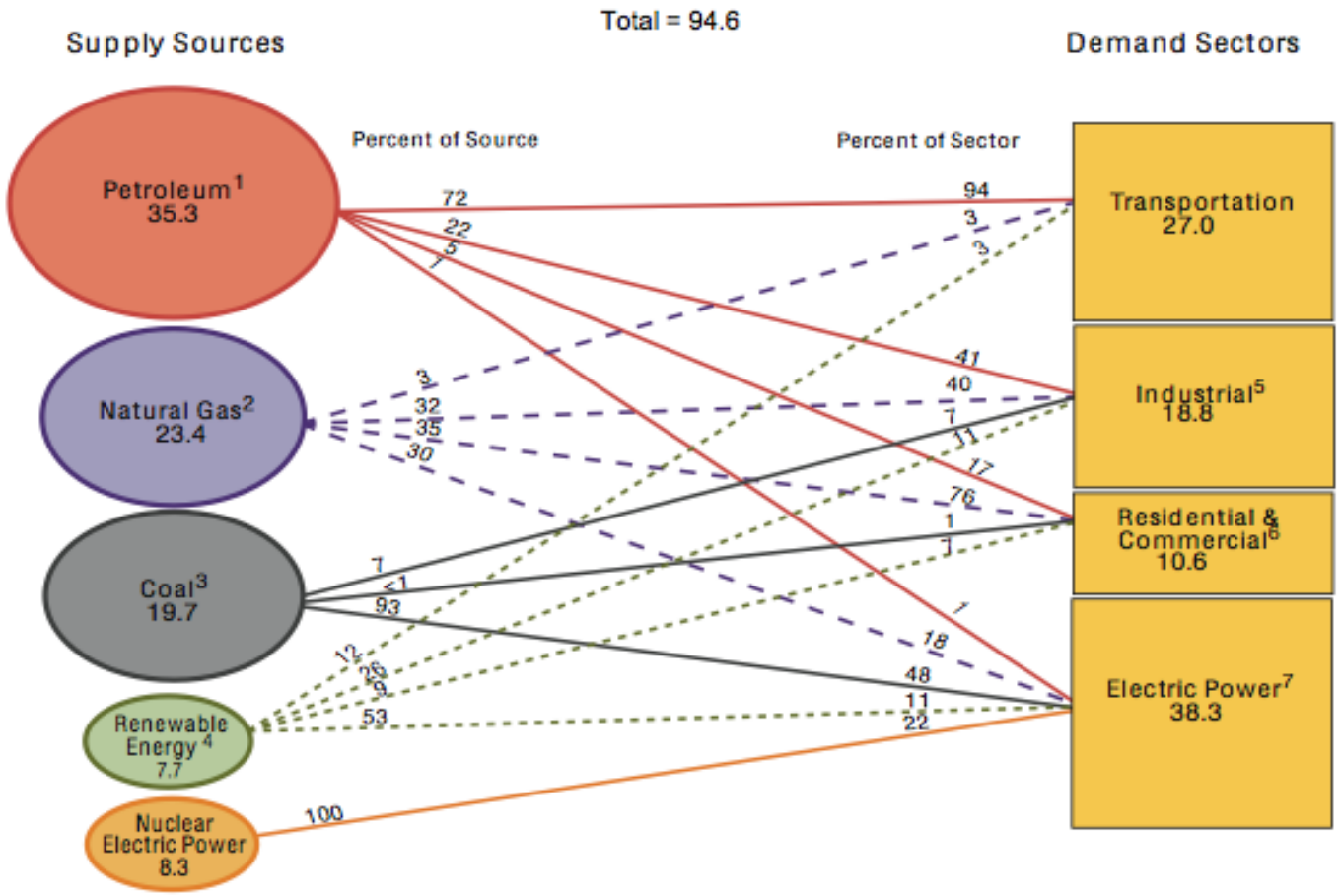
NUCLEAR ENERGY: BEYOND ELECTRICITY

Figure 2.0 Primary Energy Flow by Source and Sector, 2009

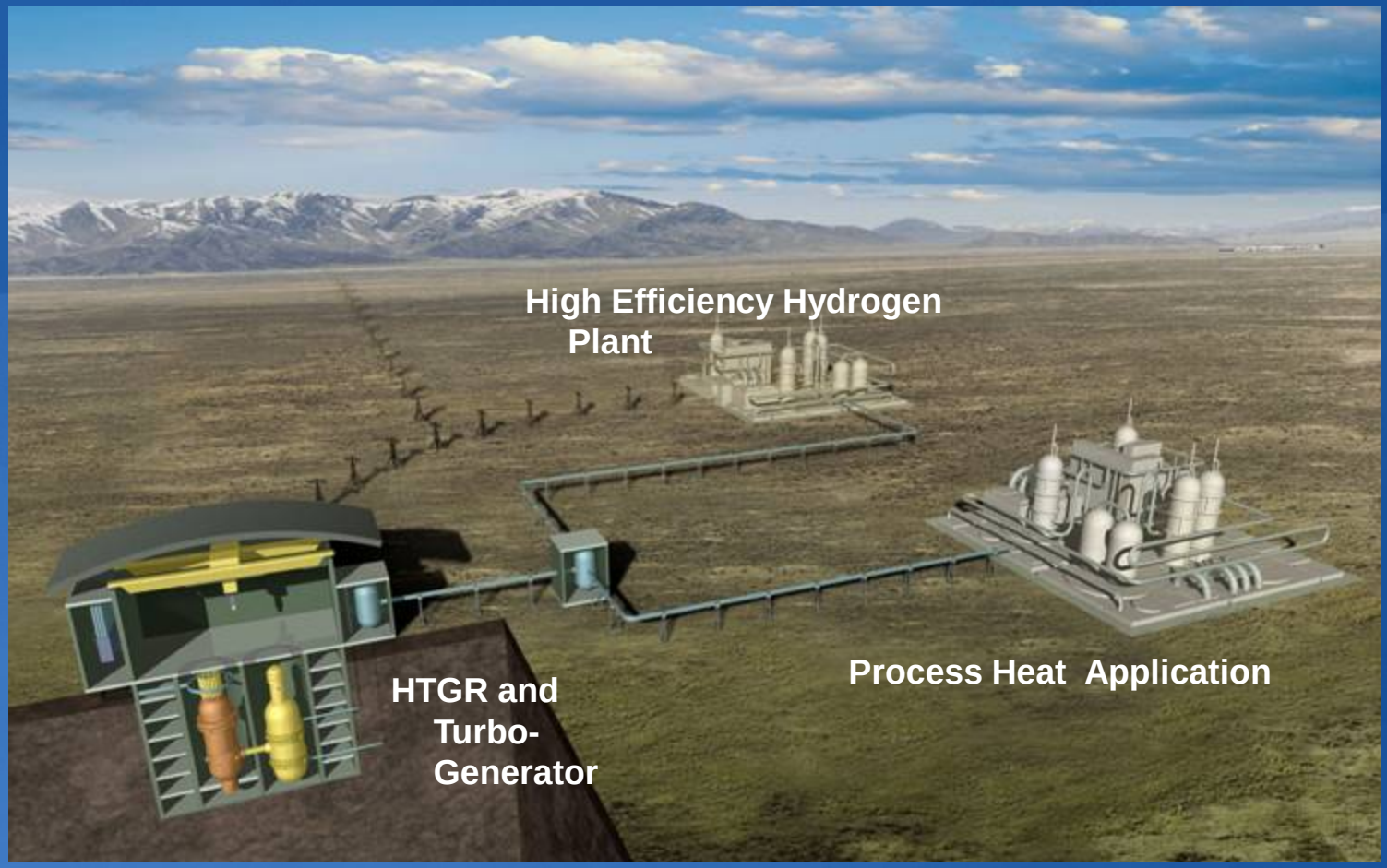
(Quadrillion Btu)



[1] Does not include biofuels that have been blended with petroleum—biofuels are included in "Renewable Energy."
[2] Excludes supplemental gaseous fuels.
[3] Includes less than 0.1 quadrillion Btu of coal coke net exports.
[4] Conventional hydroelectric power, geothermal, solar/PV, wind, and biomass.
[5] Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.
[6] Includes commercial combined-heat-and-power (CHP) and commercial electricity-only plants.
[7] Electricity-only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public.

Note: Sum of components may not equal total due to independent rounding.
Sources: U.S. Energy Information Administration, *Annual Energy Review 2009*, Tables 1.3, 2.1b-2.1f , 10.3, and 10.4.

The NGNP Concept – HTGR Demonstration



HTGRs Extend Nuclear Benefits Beyond Just Electricity

HTSE & Thermo-Chemical Hydrogen Production Coal Gasification

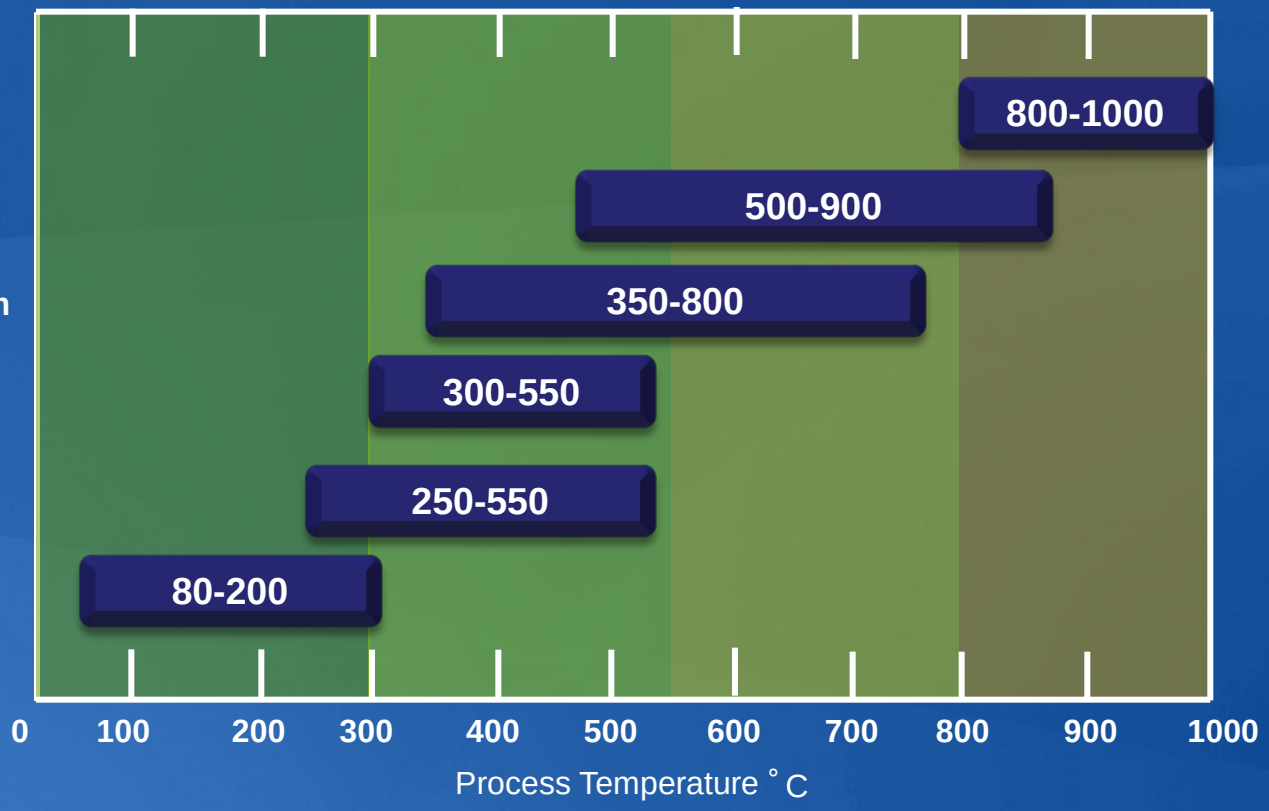
Steam Reforming of Natural Gas Biomass Hydrothermal Gasification

Cogeneration of Electricity and Steam

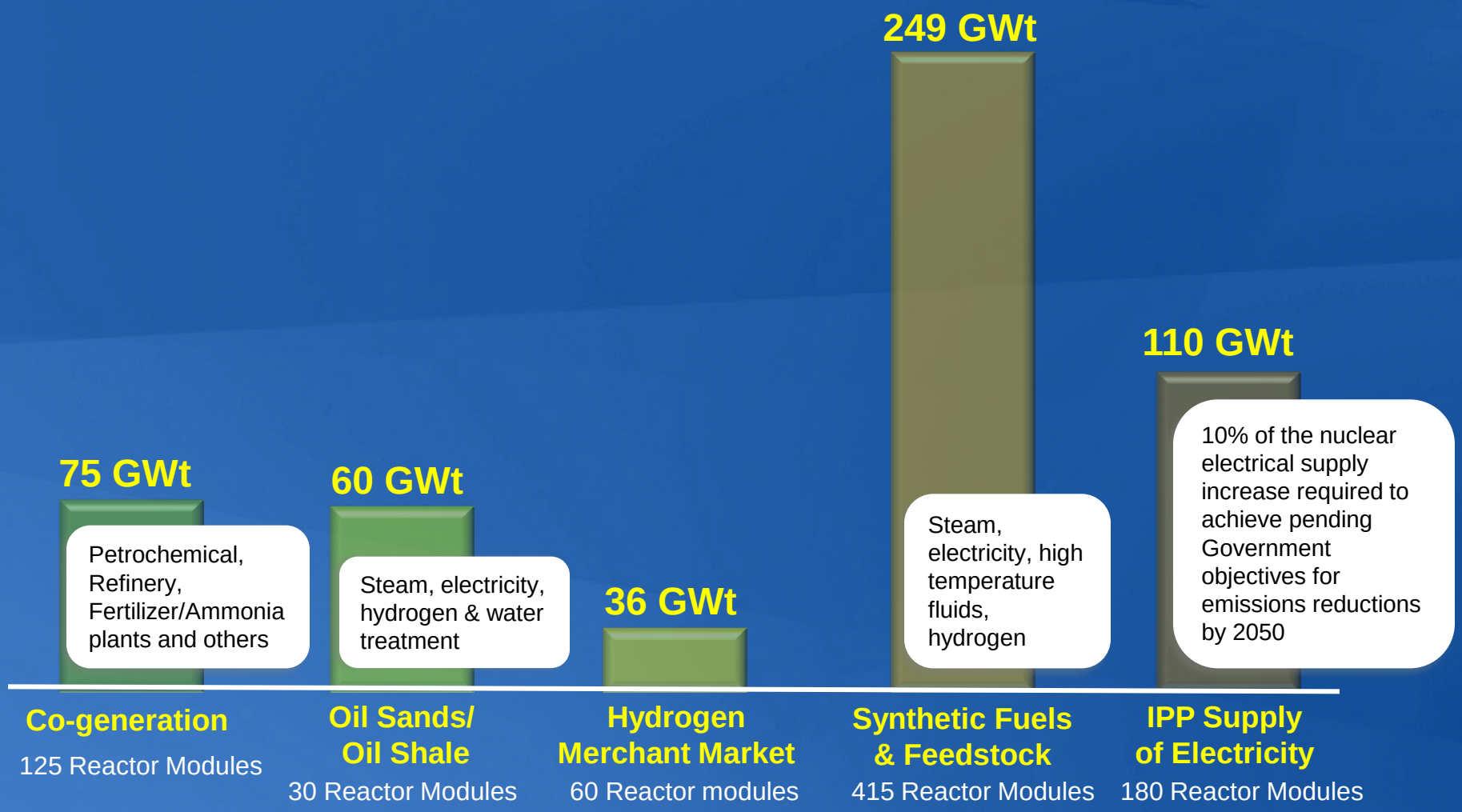
Oil Shale and Oil Sand Processing

Petroleum Refining

Ethanol Concentration Seawater Desalination District Heating

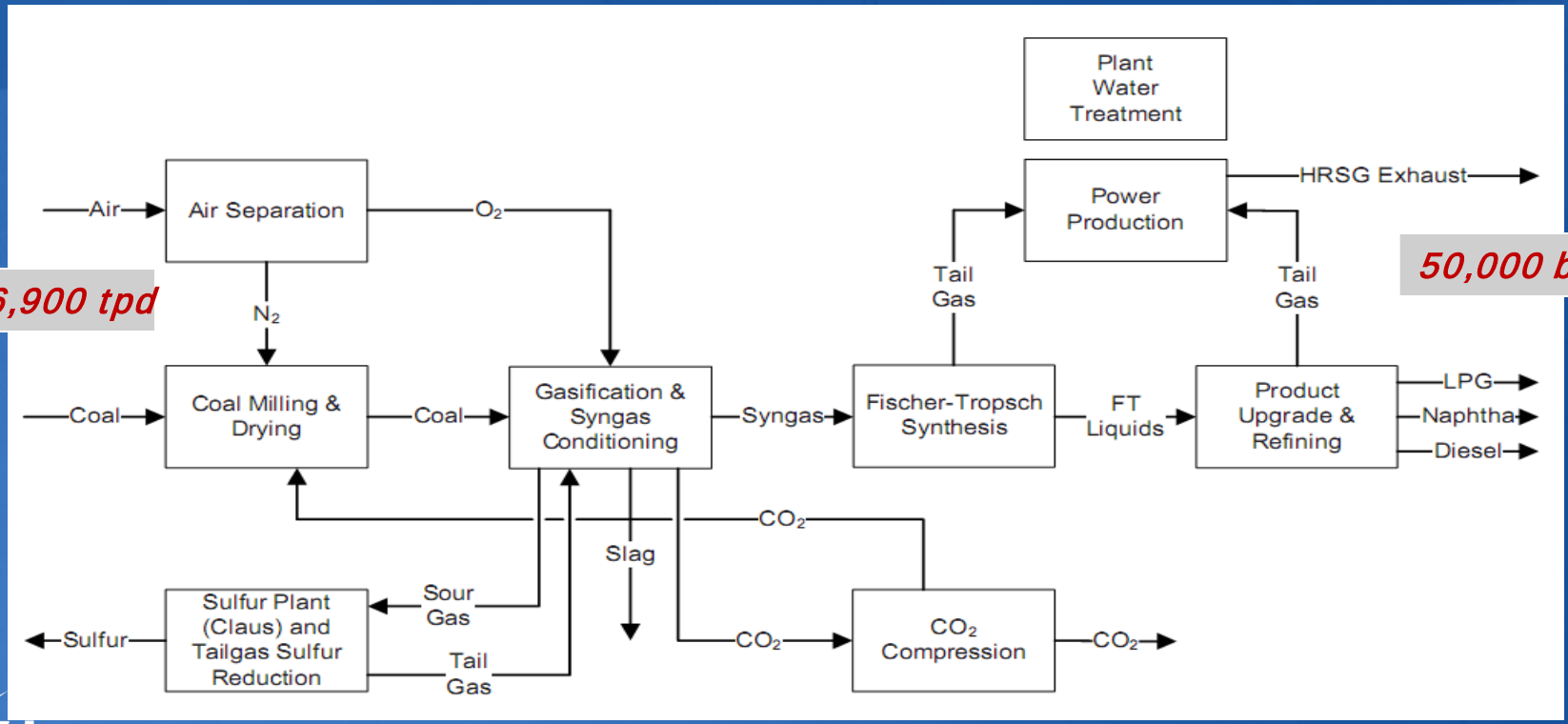


Significant Market Opportunities



Coal Conversion: Conventional Coal to Diesel

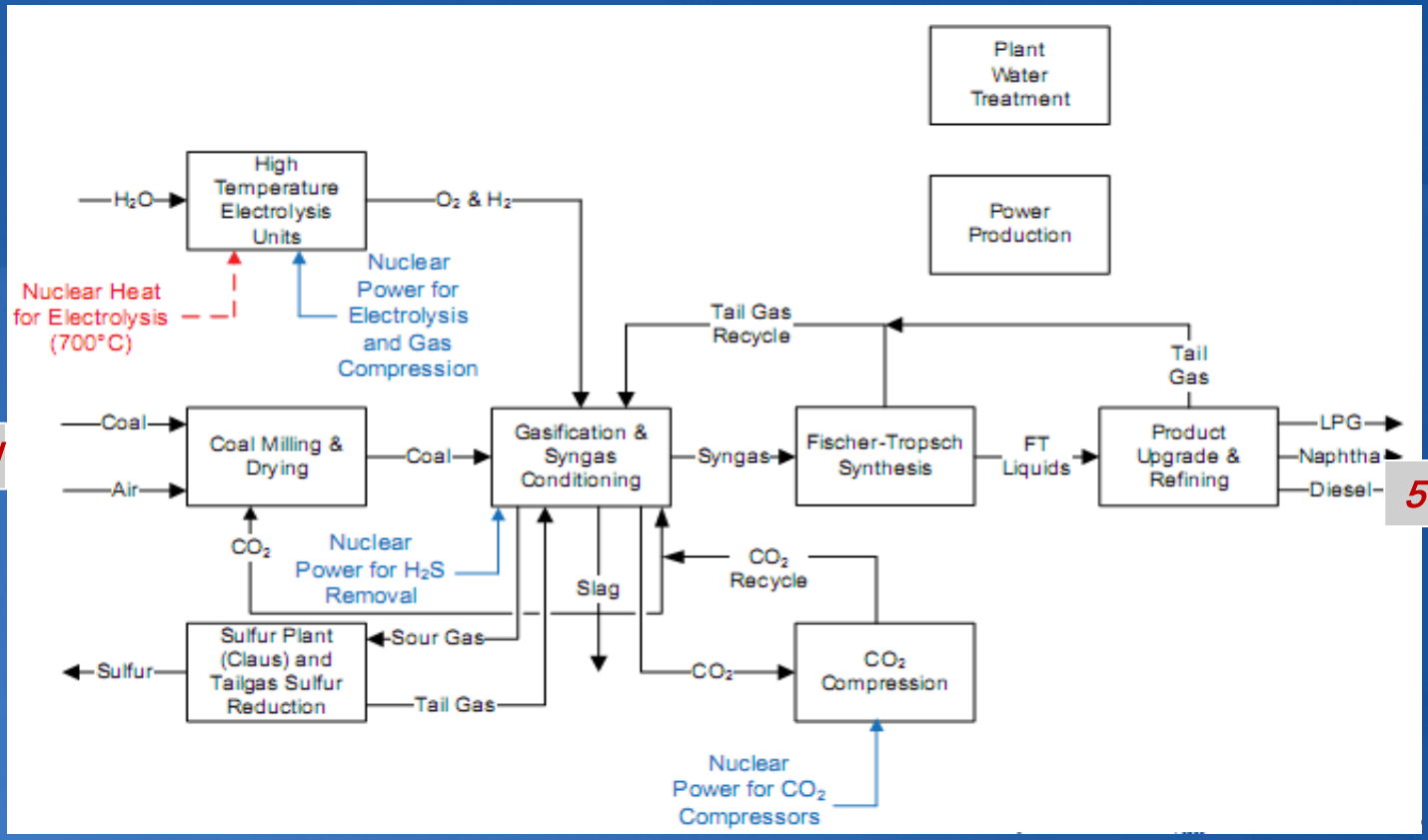
~32% Carbon Conversion
~42,000 tpd CO_2 Emissions



Coal Conversion: HTGR Integrated Coal to Diesel

~90% Carbon Conversion
~1,900 tpd CO_2 Emissions

9520 tpd



50,000 bpd

Helium Cooled Reactor History

	1950s	1960s	1970s	1980s	1990s	2000s	Future
HTGR 4 — He Cooled, Prismatic		UK — Dragon	USA — Peach Bottom (PB-1)	Ft. St. Vrain (FSV)		Japan — HTTR	USA — NGNP
HTGR 3 — He Cooled, Spherical			Germany — AVR	Germany THTR-300		China HTR-10	China HTR-PM, RSA- PBMR

EXPERIMENTAL REACTORS

COMMERCIAL SCALE DEMONSTRATION OF BASIC HTGR TECHNOLOGY

DRAGON
(U.K.)
1963 -1976

AVR
(FRG)
1967 - 1988

HTTR
(Japan)
1998 - Present

HT10
(China)
2003 - Present

PEACH BOTTOM 1
(U.S.A.)
1967 - 1974

FORT ST. VRAIN
(U.S.A.)
1976 - 1989

THTR
(FRG)
1986 - 1989

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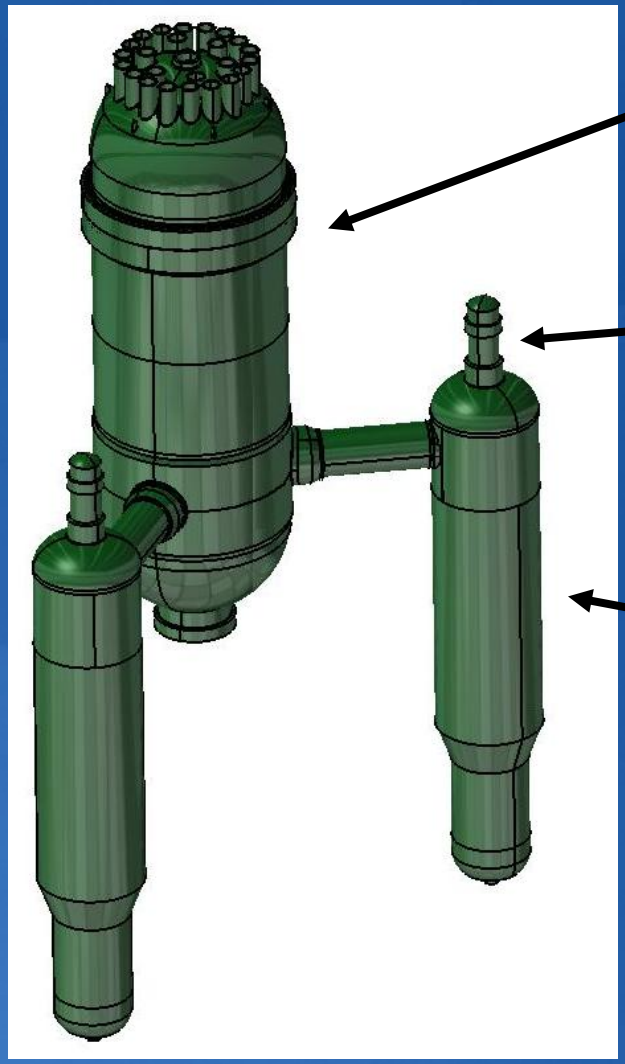
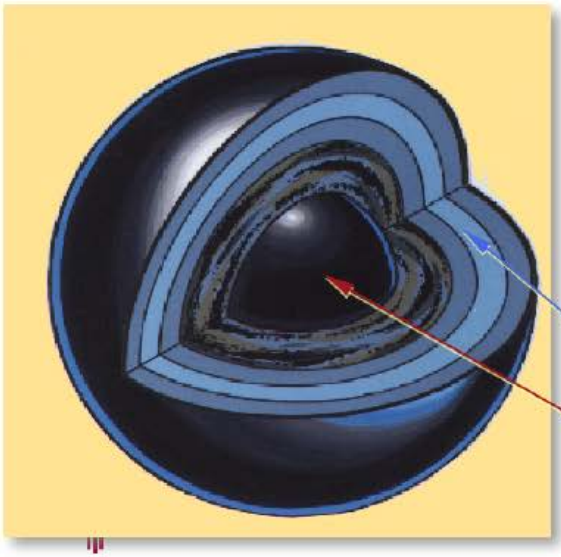
Safety Makes HTGRs Relevant to Industry

- The HTGR: Inherent safety characteristics. No internal or external event can lead to release of radioactive material from the plant that endangers the safety of the public.
- The HTGR safety case: confidence that collocation to end-user's facilities is an acceptable business risk.
- Confidence that NRC licensing activities will confirm that the safety case for the HTGR will be as currently anticipated.

Alliance End-Users Have Selected 625MWt Prismatic



Prismatic Reactor Core



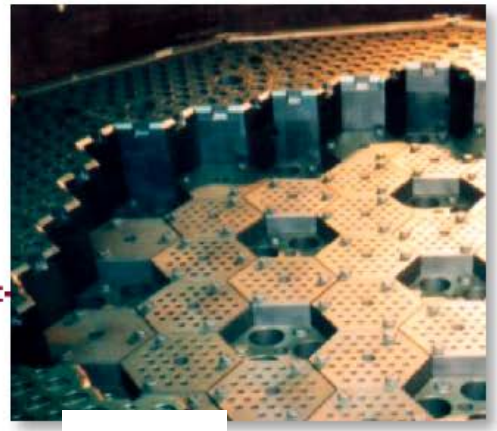
TRISO Coated Fuel Particles:

- *Lots of cladding - extremely strong*
- *Little fuel - fully encapsulated*

Each fuel particle forms a separate pressure containment vessel for the kernel (to 1000 atm)

Ceramic Coatings

Fuel Kernel (U, Pu, Th, TRU)

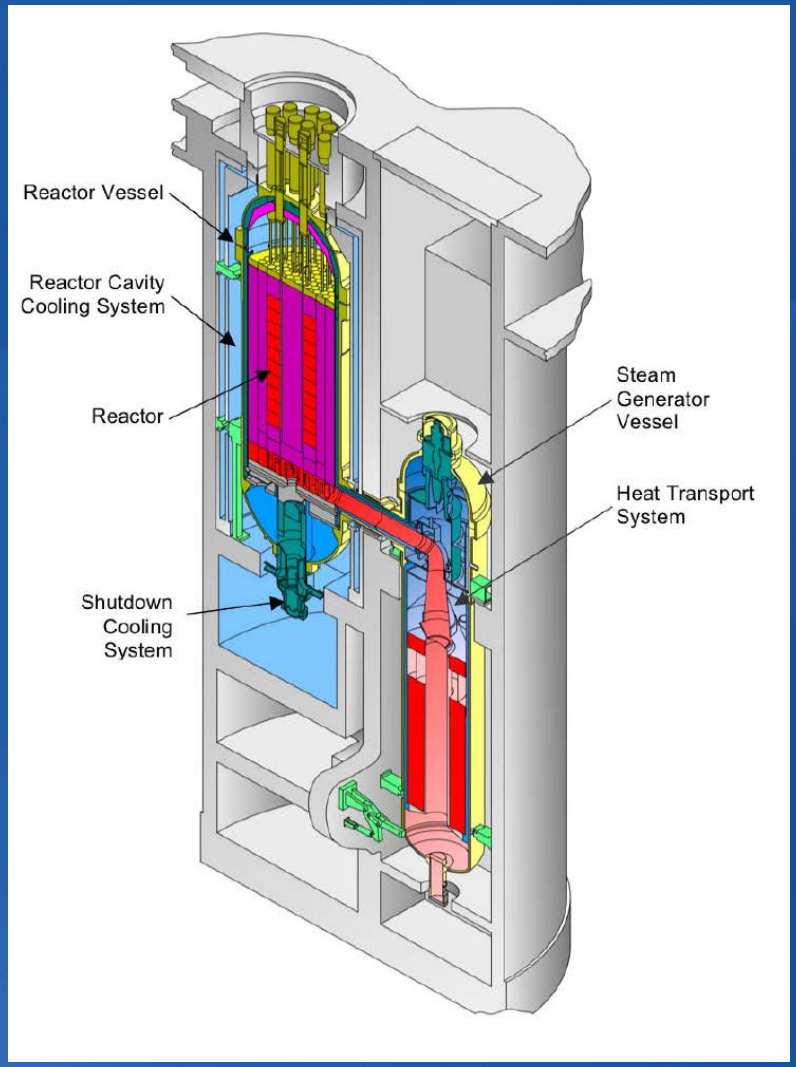


PARTICLES **COMPACTS** **FUEL BLOCK** **MHR CORE**

Prismatic concept illustrated - Pebble Bed variant also possible

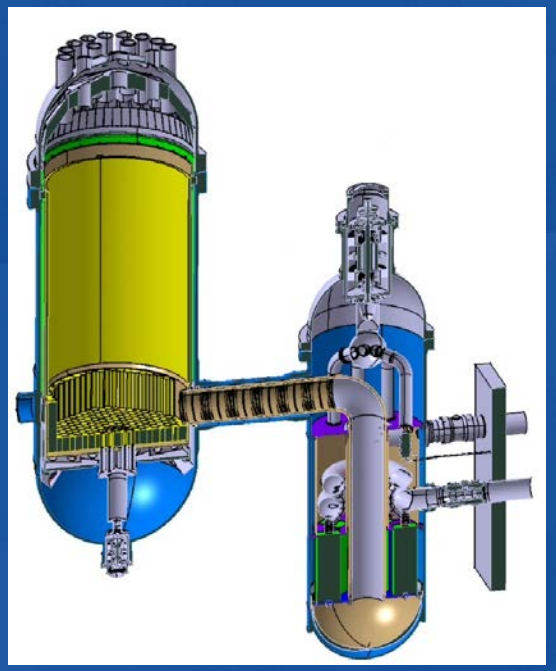
Nuclear Heat Supply Can Be Contained In An Underground Silo

- Cylindrical silo with 2 main cavities:
  - Reactor cavity
  - Steam generator cavity
- Silo depth to place SG thermal center well below core
- Main advantages of below grade silo:
  - Secure sabotage/damage resistant below-grade installation
  - Increased safety approach. . .in the ultimate event the decay heat can be dissipated to earth
  - Better seismic load capability
  - Cost-effective construction method with elimination of many above-grade structures



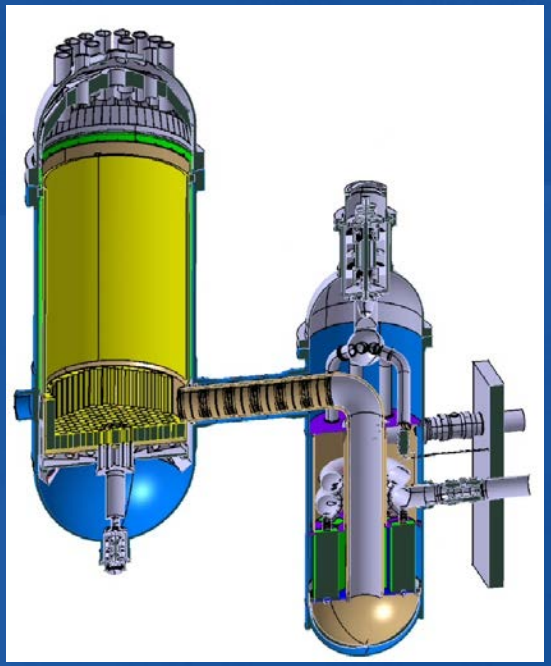
Highest Level of Safety

- Strong negative temperature coefficient – reaction shuts down when normal temperatures are exceeded
- Core power levels are limited: amount of fuel per core volume is relatively small
- Vessel heat radiating surface is large
- High temperature ceramic fuel
- Reactor materials and fuel are chemically compatible and in combination will not react or burn to produce heat or explosive gases.



Highest Level of Safety

- Air or water intrusion do not result in substantive safety consequences
- No power and no water or other cooling fluid is required to protect safety of public
- Used fuel is stored in casks or tanks cooled by natural air circulation and shielded by steel plugs and concrete structure



No actions by plant personnel or backup systems are required to either ensure shutdown of the reactor or ensure cooling.

No need to evacuate or shelter the public and no threat to food or water supplies under any conditions.

NEI

Questions?

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