Nuclear Power Trends

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Total Electricity Net Consumption (Billion Kilowatthours)

	2000	2012
World	13245.9	19710.36 (48.8% > than 2000)
Asia & Oceania	27.1%	41.1%
North America	32.2%	23.3%
Europe	22.3%	16.8%
Eurasia	7.8%	6.6%
Central & South America	4.9%	5.1%
Middle East	2.9%	4.0%
Africa	2.8%	3.0%

Source: EIA

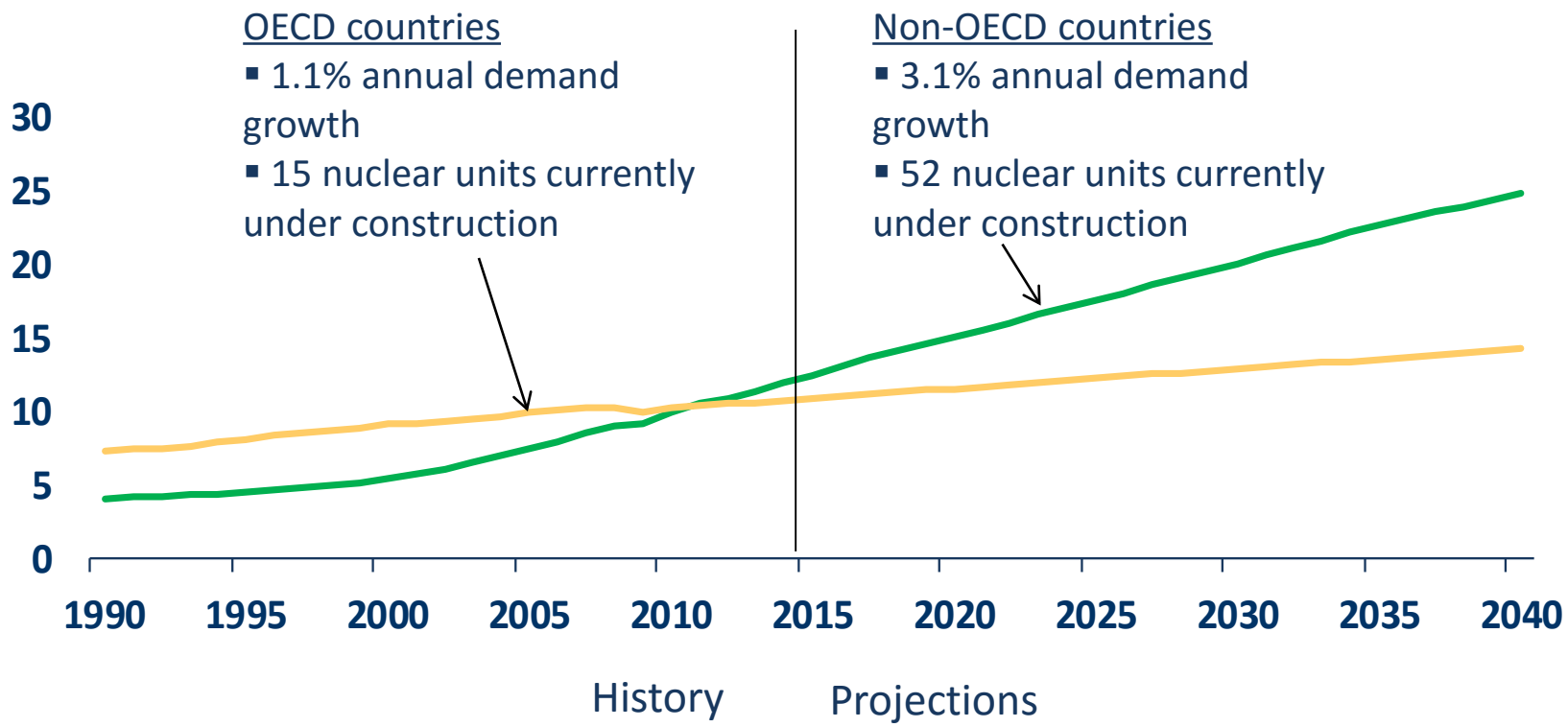
Total Electricity Net Consumption
Top 15 Countries

2000		2012	
United States	27.1%	China	22.7%
China	8.9%	United States	19.4%
Japan	7.1%	Japan	4.7%
Russia	5.4%	Russia	4.5%
Germany	3.8%	India	4.4%
Canada	3.8%	Germany	2.7%
France	3.1%	Canada	2.7%
India	2.9%	Brazil	2.5%
United Kingdom	2.5%	Korea, South	2.4%
Brazil	2.4%	France	2.3%
Italy	2.1%	United Kingdom	1.6%
Korea, South	2.0%	Italy	1.5%
Spain	1.5%	Spain	1.2%
Australia	1.4%	Mexico	1.2%
South Africa	1.4%	Saudi Arabia	1.2%
	75.4%		75.0%

Source: EIA

World net electricity generation by region

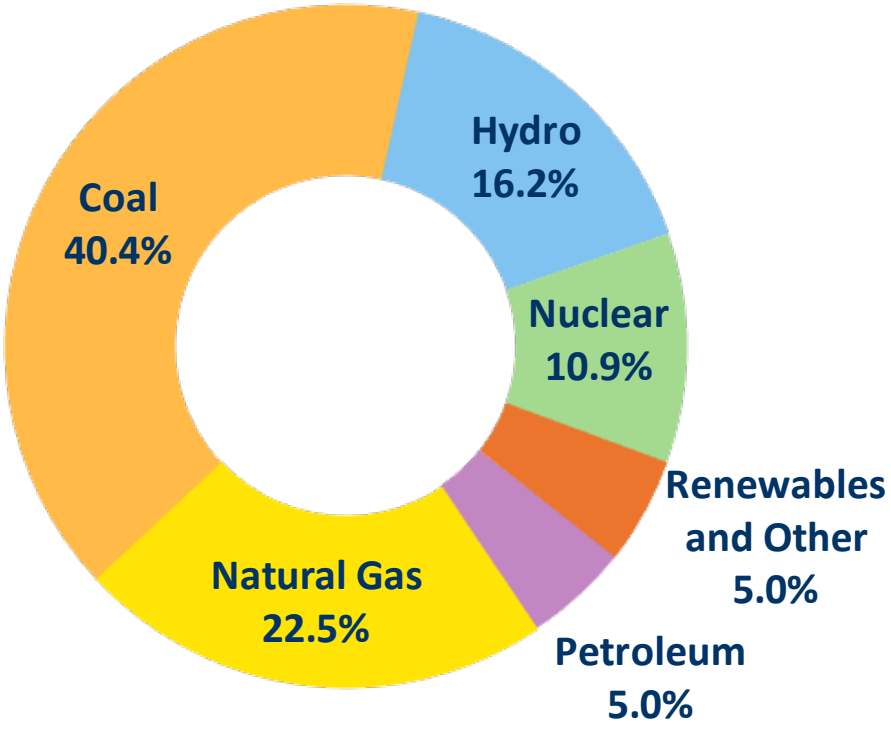
1990-2040, trillion kilowatt-hours



Sources: Energy Information Administration's *2013 International Energy Outlook*, International Atomic Energy Agency
Updated: 6/15

World Electricity Generation By Fuel

2015



Source: International Energy Agency's *Key World Energy Statistics 2014*
Updated: 4/15

Comparing Attributes

	Nuclear	Coal steam	Gas CCGT	Wind onshore and solar PV
Investment cost	Very high	Moderate	Low	Moderate-high
Construction time*	4-10 years	4-5 years	2-3 years	0.5-2 years
Operational cost	Low	Low-moderate	Low-high	Very low
Operational characteristics	Baseload, limited flexibility	Baseload, moderate flexibility	Mid-load, high flexibility	Variable output, low load factor
CO_2 emissions	Negligible	High-very high	Moderate	Negligible
Key risks	Regulatory (policy changes), public acceptance, market	Regulatory (CO_2 and pollution), public acceptance, market	Regulatory (CO_2), market	Regulatory (policy changes)

* Construction time is the time between the start of a reactor's construction and its connection to the grid.

Source: International Energy Agency *World Energy Outlook 2015*

Nuclear Electricity Production

Year	Number of Reactors Operational	Billion kWh Generated
1995	434	2190.94
2000	435	2443.44
2005	441	2626.34
2010	441	2629.82
2013	434	2358.86
2014	438	2410.37

- Between 1995 and 2014, 79 new reactors connected to the grid
- Nuclear electricity production was 8% lower in 2014 than in 2010
- Japan's reactors are included in number of reactors operational

Source: IAEA Nuclear Power Reactors in the World 2015 Edition

Nuclear Share of Electricity Generation - 2014

FRANCE	77%
SLOVAKIA	57%
HUNGARY	54%
UKRAINE	49%
BELGIUM	48%
SWEDEN	42%
SWITZERLAND	38%
SLOVENIA	37%
CZECH REP.	36%
FINLAND	35%
BULGARIA	32%
ARMENIA	31%
KOREA,REP.OF	30%
SPAIN	20%
USA	20%

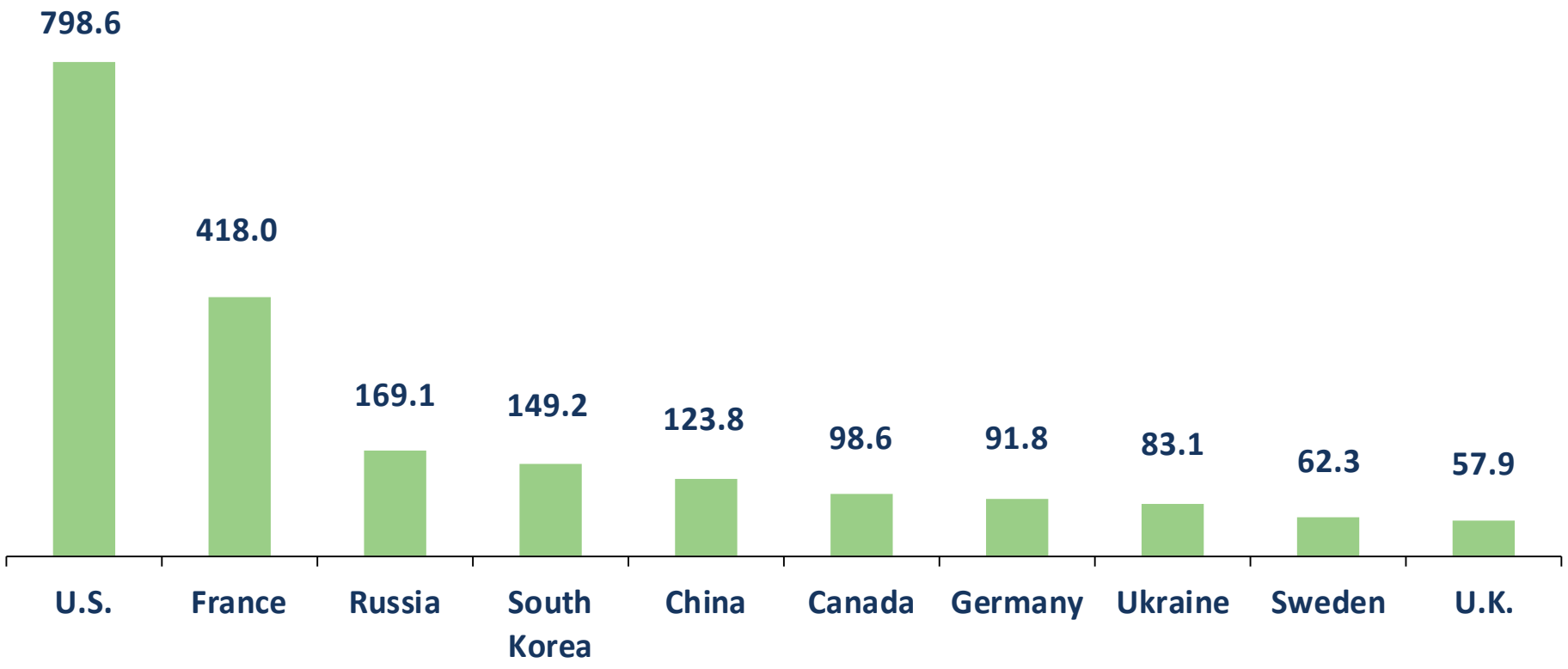
RUSSIA	19%
ROMANIA	19%
UK	17%
CANADA	17%
GERMANY	16%
SOUTH AFRICA	6%
MEXICO	4%
PAKISTAN	4%
ARGENTINA	4%
NETHERLANDS	4%
INDIA	3%
BRAZIL	2%
CHINA	2%
IRAN,ISL.REP	2%

JAPAN Nuclear Share in 2010 – 29%

Source: IAEA Nuclear Power Reactors in the World 2015 Edition

Top 10 Nuclear Generating Countries

2014, Billion kWh



Source: International Atomic Energy Agency
Updated: 5/15

Reactors Under Construction or Planned

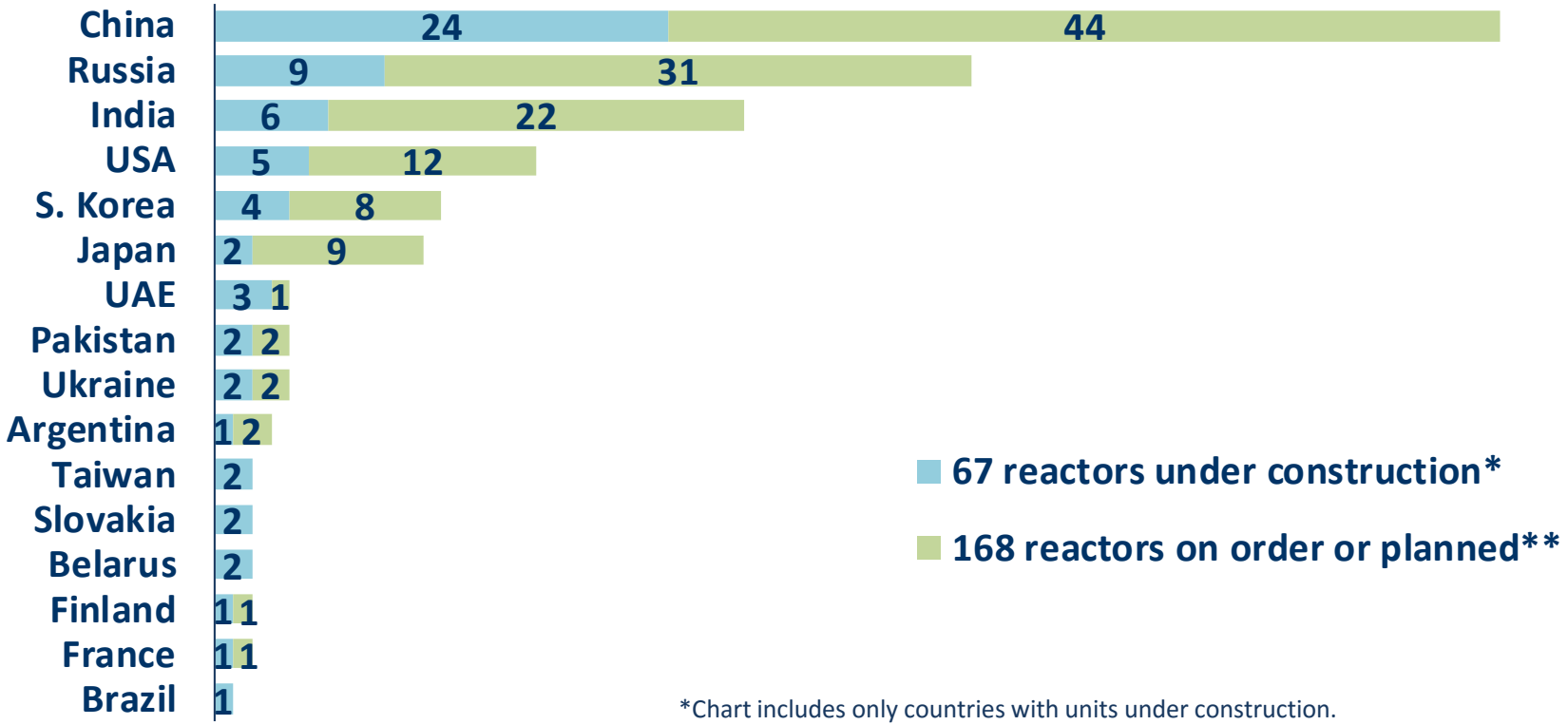


*Chart includes only countries with units under construction.

**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.

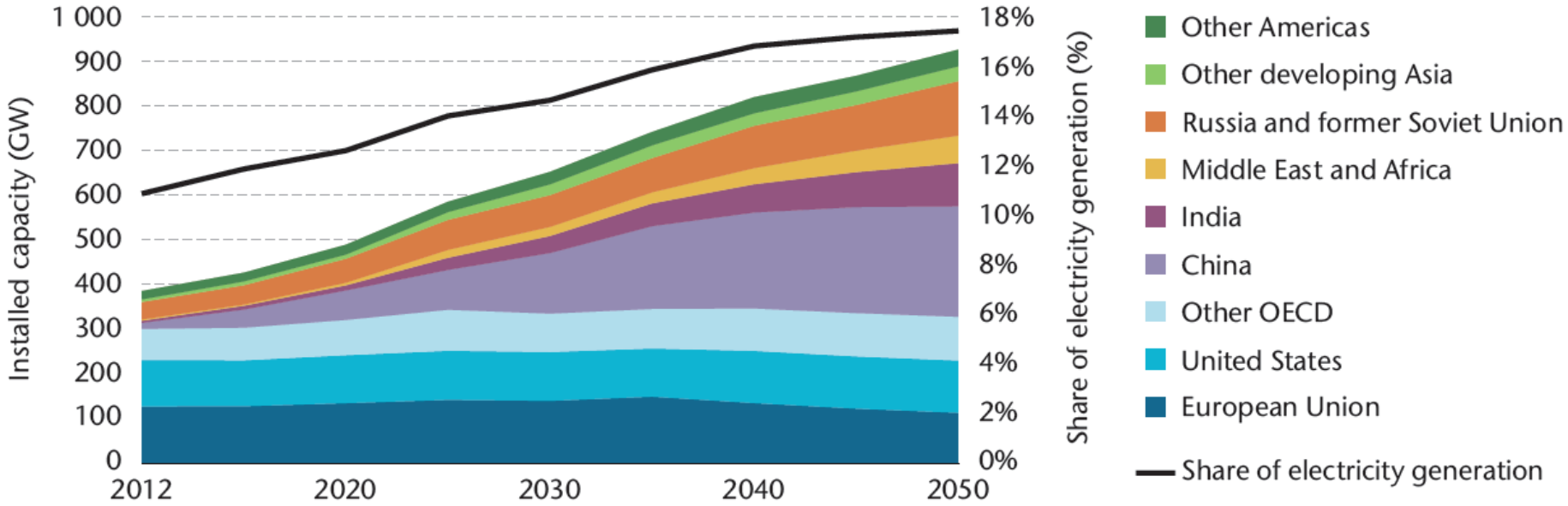
Sources: International Atomic Energy Agency and project sponsors for units under construction and World Nuclear Association for units on order or planned except for USA – planned units are those applications under NRC review (Fermi 3 is counted and the PSEG Early Site Permit application is considered one reactor for the purposes of this chart).
Updated: 7/15

Potential Nuclear Newcomer Countries

	GDP < $50 billion and/or grid capacity < 10 GW	GDP > $50 billion and grid capacity > 10 GW
First reactor(s) under construction*	Belarus	UAE
Actively preparing or has expressed interest in starting a nuclear power programme	Albania, Azerbaijan, Bangladesh, Bolivia, Croatia, DR Congo, Ghana, Jordan, Kenya, Libya, Lithuania**, Mongolia, Morocco, Namibia, Niger, Nigeria, Peru, Senegal, Sri Lanka, Sudan, FYR Macedonia, Tunisia, Uganda, Uruguay	Algeria, Chile, Egypt, Indonesia, Kazakhstan, Nigeria, Malaysia, Philippines, Poland, Saudi Arabia, Thailand, Turkey, Venezuela, Vietnam
Total countries	24	15

Source: International Energy Agency *World Energy Outlook 2015*

NEA 2015 Technology Roadmap: Nuclear Generation Capacity in the 2DS by Region



Energy Technology Perspectives 2015 2°C Scenario project nuclear capacity at 930 GW in 2050

Key Nuclear Policies and Targets – South America and Asia

Argentina	15-18% share of nuclear in electricity mix.
Brazil	Increase nuclear capacity to 3.4 GW by 2022 (from 1.8GW).
China	Increase nuclear capacity to 58GW by 2020 (with further 30 GW under construction); preferential tariffs for electricity generation from new nuclear.
Japan	Reduce reliance on nuclear power, but recognize it as an important baseload source; potential for operating lifetimes to be extended from 40 to 60 years.
India	Increase share of nuclear to 5% by 2020, 12% by 2030 and 25% by 2050.
Korea	Increase nuclear capacity to 29% of installed capacity by 2035.

Source: International Energy Agency *World Energy Outlook 2015*

Key Nuclear Policies and Targets - European Union

Belgium	Phase out nuclear by 2025.
France	New energy law set a target of 50% for nuclear contribution to electricity supply by 2025, with a nuclear power capacity cap at the present level of 63.2 GW.
Germany	Phase out nuclear by the end of 2022.
Sweden	Construction of new reactors only permitted at existing sites, but only to replace current units.
Switzerland	Reactors will not be replaced at the end of design life, implying a nuclear phase-out by 2034.
United Kingdom	Agreed to a "contract-for-difference" with EDF that reduces the investment risk for Hinkley Point C (first new unit since 1995). UK's 2013 Nuclear Industrial Strategy proposes building 16 GW of new capacity by 2030.

Source: International Energy Agency *World Energy Outlook 2015*

Key Nuclear Policies and Targets – U.S.A. and Russia

United States	Loan guarantees and production tax credits to support investment in new nuclear; operating license extensions granted to 60 years for three-quarters of plants.
Russia	Increase nuclear capacity to 50GW by 2035 (22.5% of electricity mix).

Source: International Energy Agency *World Energy Outlook 2015*

Age of Nuclear Plants Worldwide

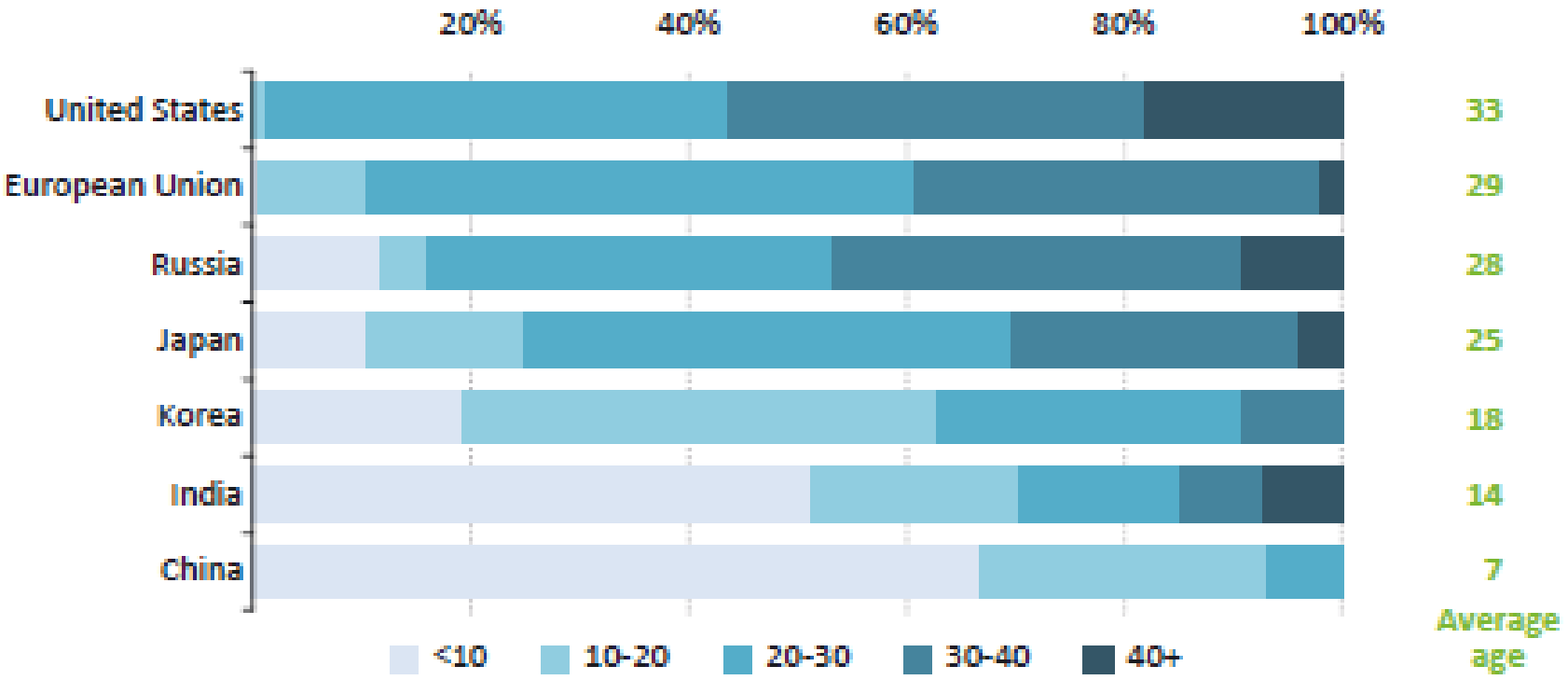
Age (years)	Number of Reactors Operating	Percentage of Total Reactors Operating
Over 40	62	14%
Over 35	115	26%
Over 30	224	51%
Over 25	326	74%
Over 20	360	82%
Total	438 (376 GWe)	

- Average Age of Operating Units: 28 Years Old
- Assuming Global Average 55-Year Lifespan:
  - By 2030, Loss of 72 Units & 48 GWe
  - By 2040, Loss of 243 Units & 206 GWe
  - By 2050, Loss of 362 Units & 329 GWe

Source: Ux Consulting and IAEA Nuclear Power Reactors in the World 2015 Edition

Aging Nuclear Fleets

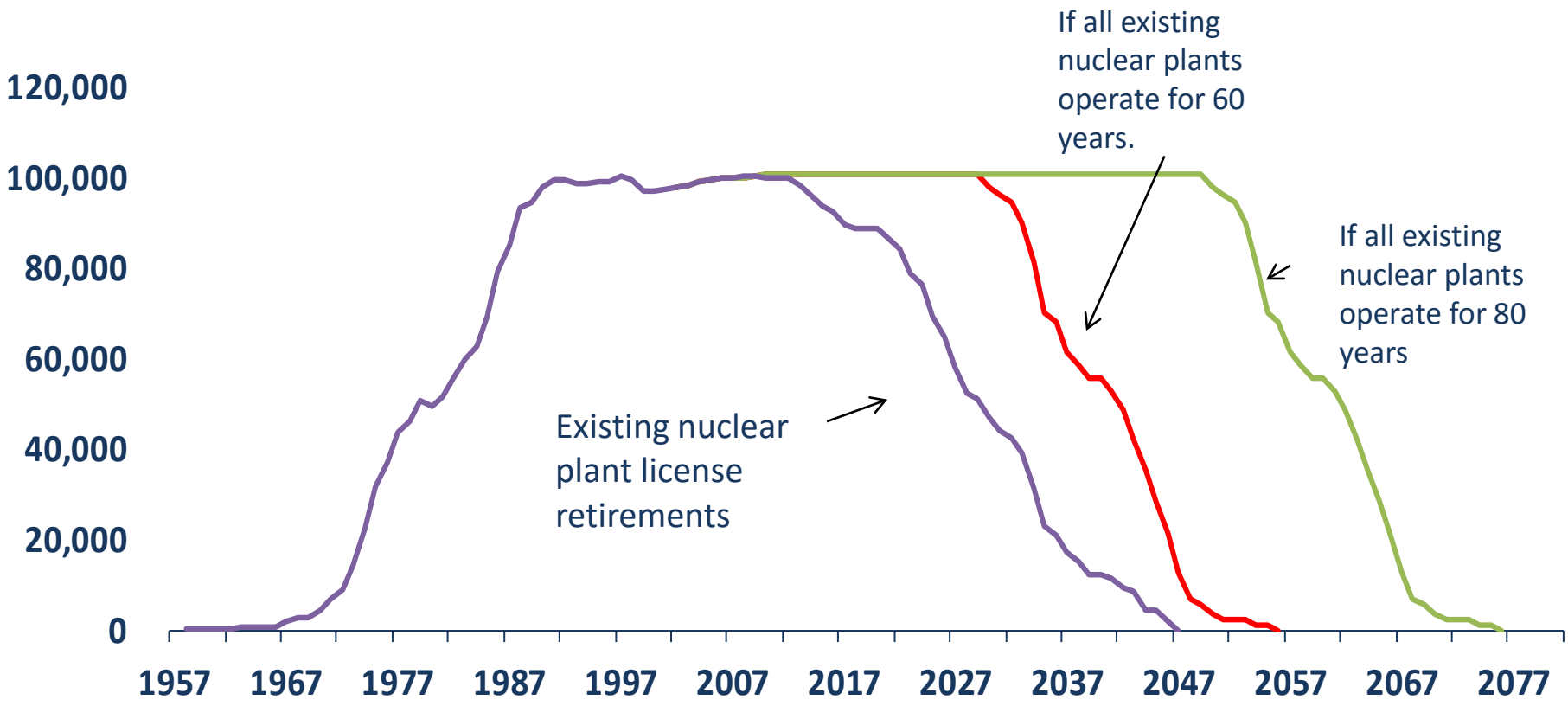
Age profile of nuclear capacity by selected region (years)



Source: International Energy Agency *World Energy Outlook 2015*

Projected U.S. Nuclear Power Capacity

(Megawatts)



Sources: Energy Information Administration, Nuclear Regulatory Commission
Updated: 4/14

If All U.S. Reactors Retire After 60 Years of Operation

Year	Total U.S. Electric Demand (bkWh)	Nuclear Capacity (GW)	Nuclear Generation (bkWh)	Nuclear Fuel Share	New Generation Needed to Meet 20% Fuel Share	
					GW	Reactors
2015	4,134.3	100.2	790.2	19.1%		
2020	4,351,3	104.0	820.0	18.8%	6.4	5
2025	4,513.2	104.0	820.0	18.2%	10.5	9
2030	4,691.2	100.0	788.0	16.8%	19.1	16
2035	4,860.4	72.4	570.4	11.7%	50.9	42
2040	5,055.5	57.5	453.2	9.0%	70.8	59

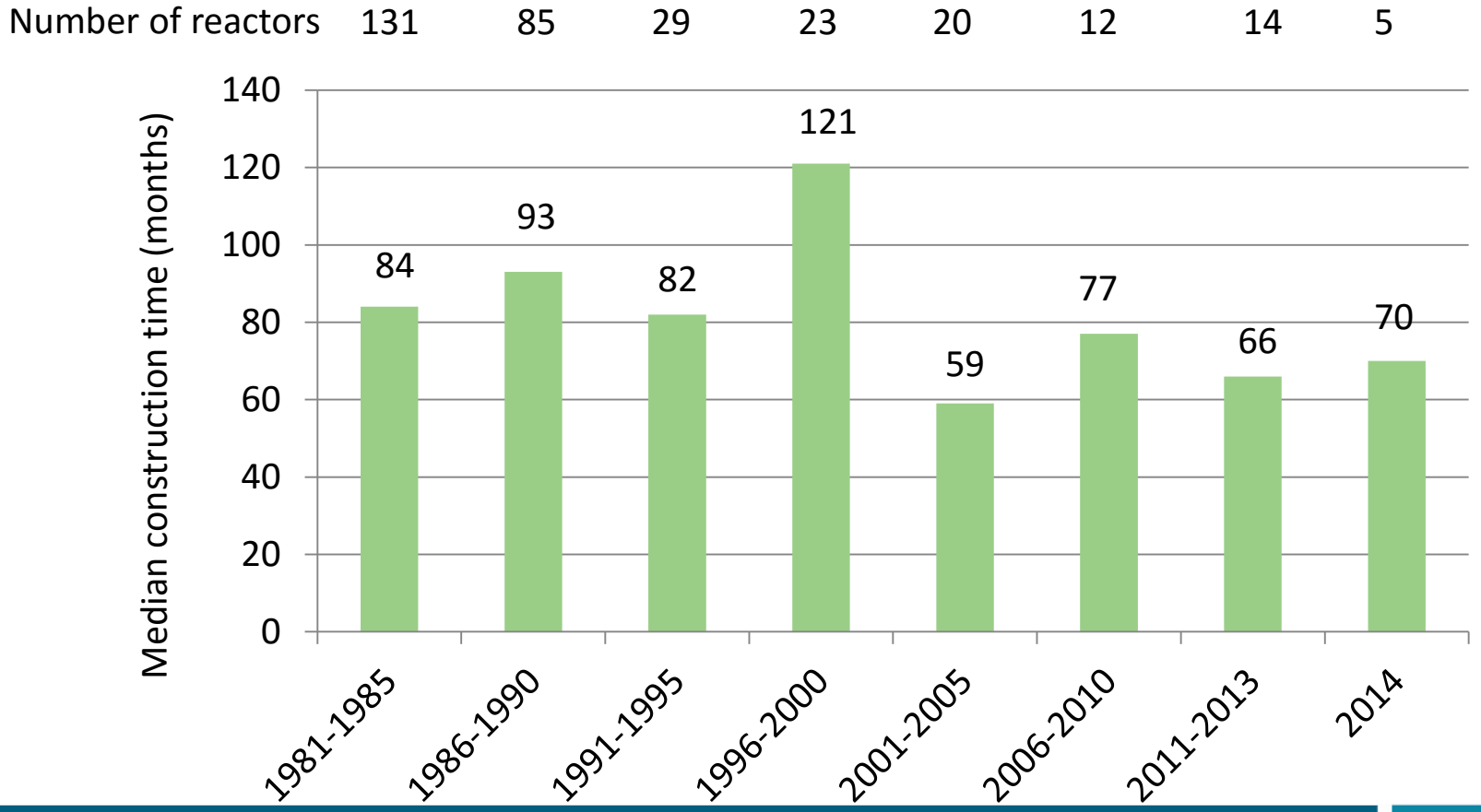
Reactor estimate based on AP-1000 output of approx. 1.2 GWe

If All U.S. Reactors Retire After 80 Years of Operation

Year	Total U.S. Electric Demand (bkWh)	Nuclear Capacity GW	Nuclear Generation (bkWh)	Nuclear Fuel Share	New Generation Needed to Meet 20% Fuel Share	
					GW	Reactors
2015	4,134.3	100.2	790.2	19.1%		
2020	4,351,3	104.0	820.0	18.8%	6.4	5
2025	4,513.2	104.0	820.0	18.2%	10.5	9
2030	4,691.2	104.0	820.0	17.5%	15.0	13
2035	4,860.4	104.0	820.0	16.9%	19.3	16
2040	5,055.5	104.0	820.0	16.2%	24.2	20

Reactor estimate based on AP-1000 output of approx. 1.2 GWe

Median Construction Time for Commercial Reactors



Source: IAEA Nuclear Power Reactors in the World 2015 Edition

Estimate of New Nuclear Plant Construction Challenges

- Target: 930 GW of Nuclear in 2050
  - 376 GW in 2014
  - Assume 300 GW retires by 2050 (more than 326 of the current 438 reactors will be older than 60 years)
  - Need to construct 854 GW by 2050 or ~**711 new reactors** of AP-1000 size (67 reactors currently under construction)
- In 2050, 930 GW will be roughly equivalent to demand for Eurasia, Central & South America, Middle East, and Africa combined

Hypothetical Time Line for Connections to Grid to Meet 930 GW by 2050

Year Range	Number of Reactors Connected to Grid
2015-2022	5 per year
2023-2029	10 per year
2030-2049	30 per year (total of 710 new reactors)

- Historical maximum connections to the grid were 33 in 1984 and 1985
- Assuming a construction time of 5 years per reactor, a peak of 150 reactors will be under construction per year

Key Public Considerations for Nuclear Power

	Potential concerns	Potential benefits
General	• Competence and independence of regulatory regime • Proliferation of nuclear weapons • Long-term disposition of high-level radioactive waste • Adequacy and availability of funds for waste disposal, plant decommissioning	• Reduction of CO_2 emissions and other air pollutants • Boost energy self-sufficiency • Increase balance of payments
Local/regional	• Radioactive contamination • Public/worker health and safety • Environmental impact and site restoration • Restricted land use or loss of land • Visual amenity and noise • Decreased property value • Increased traffic • Impact on local communities, in some places indigenous	• Employment opportunities • Income growth • Public infrastructure availability (roads, lighting, power, health and education) • Increased tax revenue • Economic stimulus

Source: International Energy Agency *World Energy Outlook 2015*

Policy Issues

- How many years could/should reactors operate for?
- Where will expansion of nuclear occur? Will it occur in U.S., Europe, Japan?
- Should countries be planning to replace retiring nuclear plants with new nuclear plants?

Questions?

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