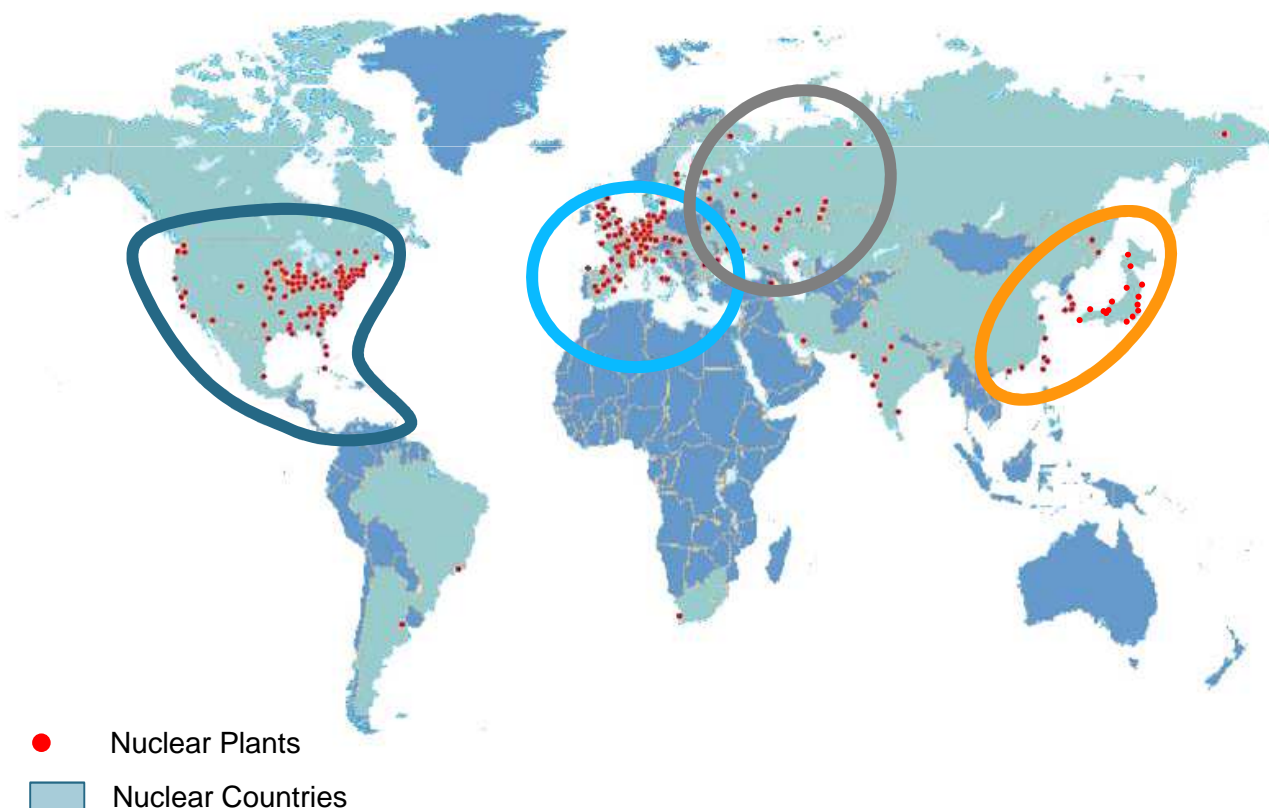


# Nuclear Power – One Year After Fukushima

4<sup>th</sup> International Forum ATOMEXPO 2012

# Before the Fukushima tragedy, worldwide nuclear capacity was concentrated in 4 locations: US, France / Europe, Japan, Russia

World mapping of nuclear installed base – May 2012

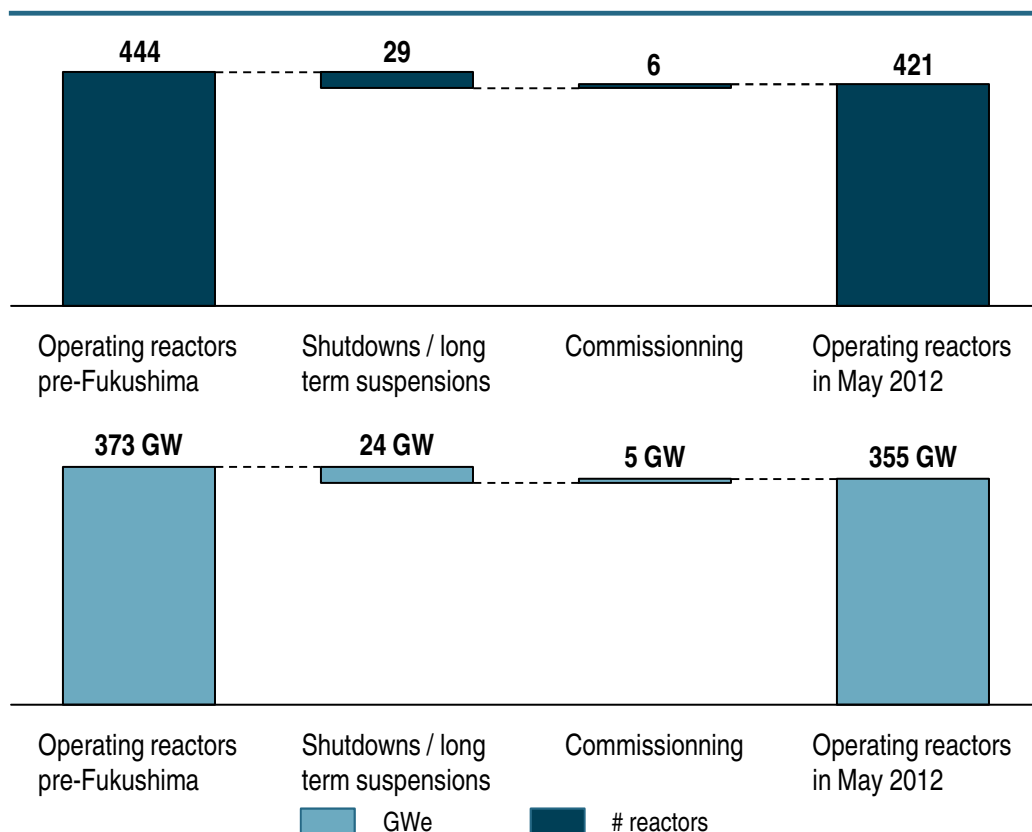


## KEY FIGURES

- > **384 operating reactors in 30 countries if excluding Japan** (vs. 444 reactors in 30 countries before Fukushima)
- > **322 GWe net capacity** if excluding Japan (vs 373 pre-Fukushima )
- > **58% of reactors (66% of capacity)** located in the USA and Western Europe (without Japan)
- > No more reactor operating in Japan as of now (last operating one put in maintenance early May)

Since Fukushima, the operating nuclear base has decreased by 5%  
– restarts of idled reactors in Japan is a question mark

## Number and capacity of nuclear reactors worldwide

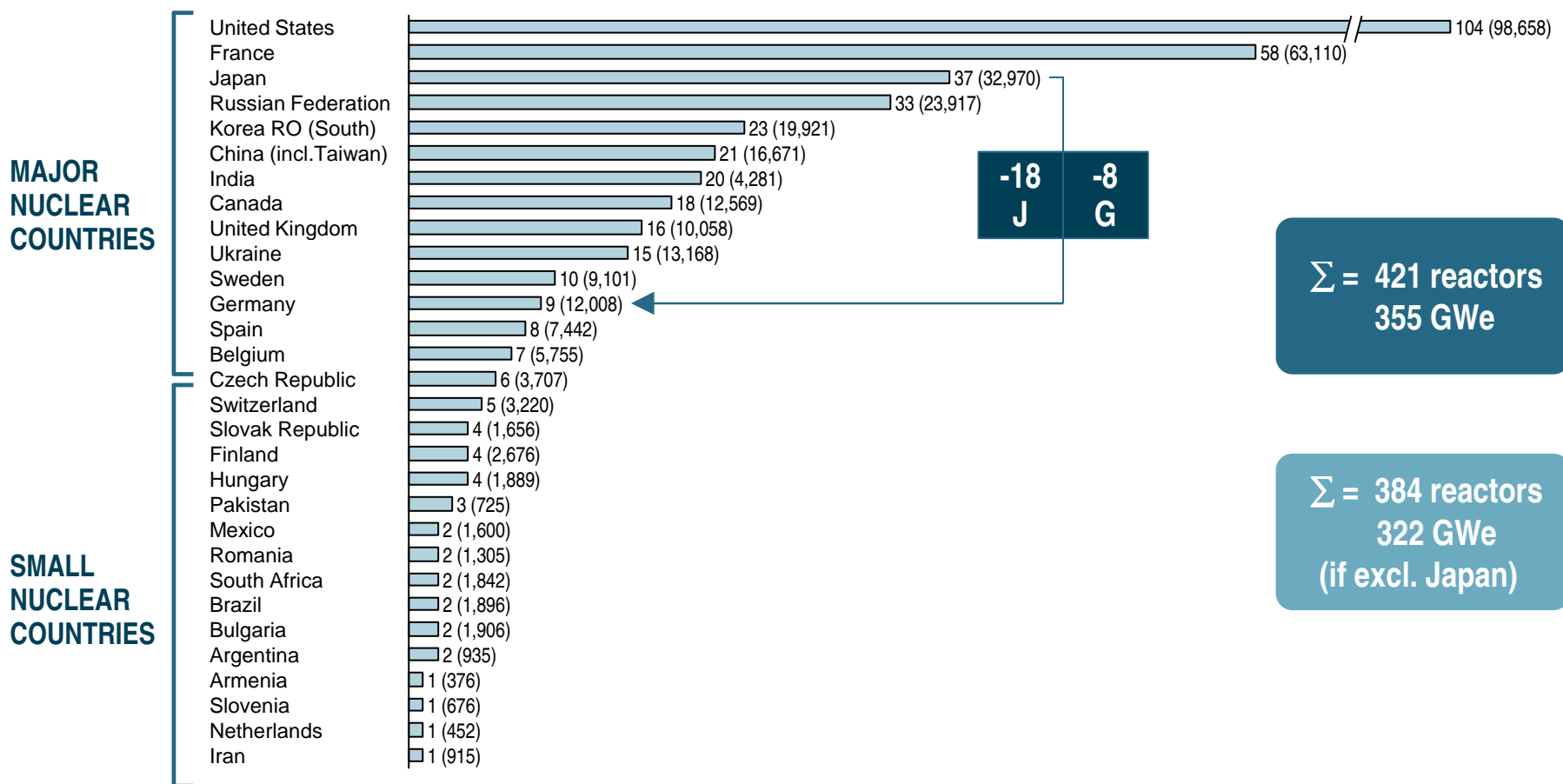


## KEY DEVELOPMENTS

- > Including Japanese reactors damaged by the tsunami or shutdown on a long term basis by government request, we observe a **net subtraction of 24 GW** (29 reactors) to the operating base
- > Shutdowns are concentrated in Japan (14.6 GW, 18 reactors), **Germany** (8.3 GW, 8 reactors) and the **UK** (0.9 GW, 3 reactors)
- > **Additions** are in **China** (1.6 GW, 2 reactors), **Iran** (0.9 GW, 1 reactor), **Russia** (0.5 GW, 1 reactor) and **South Korea** (1.9 GW, 2 reactors)

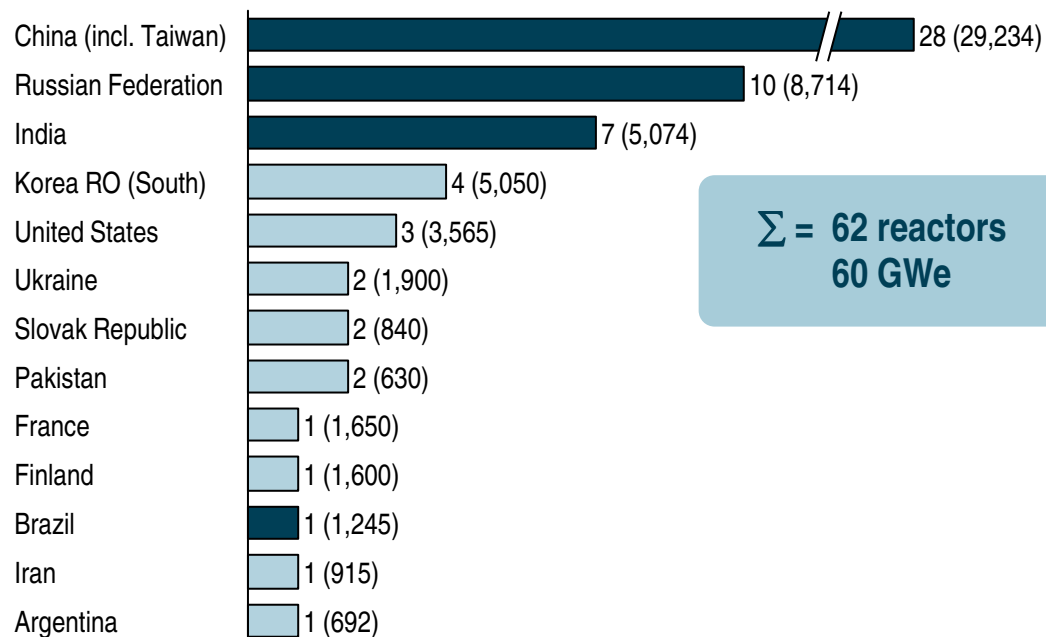
# The hierarchy among nuclear countries has not been dramatically modified – Germany and Japan as main impacted countries

Country breakdown of Installed base – May 2012 view [# units ; MWe net]



# The Nuclear market is still expanding. 60 GW under construction worldwide, thereof 75% in BRIC countries

Country breakdown of the NPP under construction – May 2012 [# units ; MWe net]

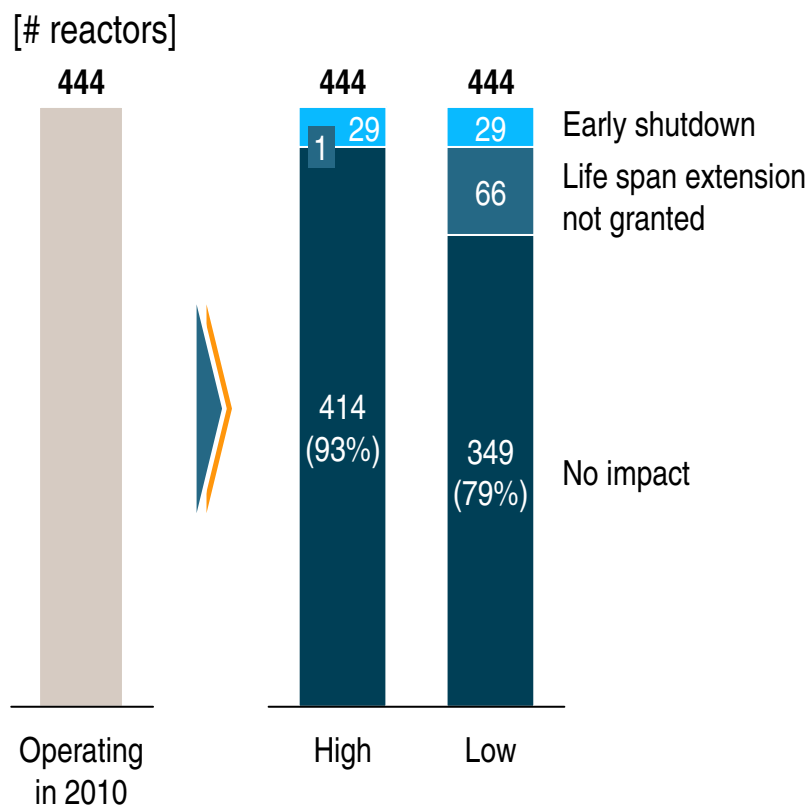


## COMMENTS

- > Most of NPPs under construction are located in Asia and Eastern Europe :
  - China (mainland and Taiwan) is the main country for reactors under construction
  - Significant activity in Russia, South Korea and India
  - Very few projects in developed countries
- > All NPP under construction should be in operation by 2020

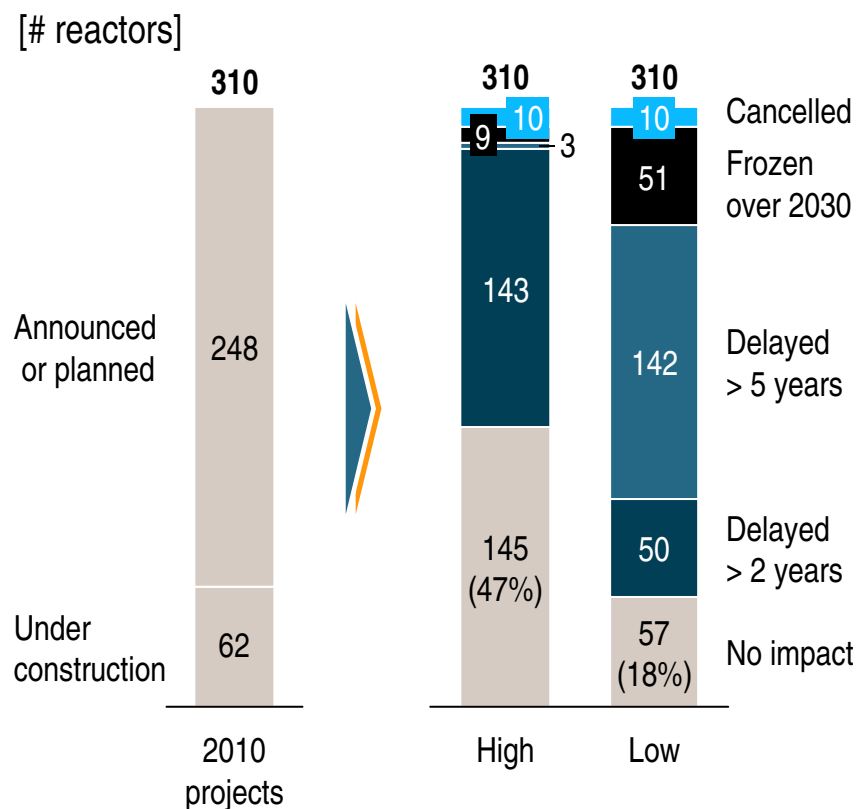
Overall, the Fukushima impact will remain small on installed base, but more significant on new build— over 60% delays in "low" scenario

### Impact on INSTALLED BASE



Typical life span: 40 years. Typical extension: 20 additional years

### Impact on NEW BUILD



# Germany has been preparing phase-out for 10 years, but does it make any difference?



## PHASE-OUT PLAN

### Gradual and long-time discussed phase-out

- > Voted in 2000, brief U-turn in 2010, but phase-out confirmed in 2011
- > Complete phase-out gradual until 2022. 8/17 plants already down
- > As early as 2010, a plan for 2050 energy was voted: Energiewende)

### Brutal event breaks long time nuclear expansion

- > Before: non stop nuclear-expansion policy since 1974. Plan to double capacity by 2050. Tomari 3 built in 2009
- > After: only 11% of typical nuclear capacity still operating (Feb. 2012)

## ELECTRICITY IMPACT

### Electricity supply is sufficient, albeit by a lesser margin

- > Electricity imports +25% in 2011, export surplus -62%
- > Germany passes the winter freeze without restarting nuclear plants

### Electricity supply is not sufficient

- > Electricity available 10% inferior to the needs
- > Rolling blackouts and 15% demand reduction rules instituted

### An organized transition towards renewables

- > Clear energy policy, pro-active laws & funding to upgrade the network, and renewable energy generation.
- > Renewables share 17% and growing

### A hazy path forward

- > Energy policy pulls out all the stops to make supply and demand match (nuclear plants 60y extension, oil fields research, demand reduction, partnerships for fossil fuels imports and power production)
- > Renewables share 10%

## ECONOMY IMPACT

### An accepted and limited price increase

- > More than half of Germans ready to pay an additional 75€/year to have a nuclear-free electricity
- > Energy price +20% expected by 2020

### An erratic rate hike

- > A rise of 18% was announced (representing 40% of the night rate used by the steel furnaces), then banned by the government
- > Energy price +70% expected in 2030 (Nikkei)

### No significant negative impact on economy

- > Balance of trade +3% in 2011
- > 280.000 jobs in green energy technologies
- > 15 000 jobs at risk in nuclear industry

### Dramatic impact on economy

- > Balance of trade -138% in 2011, negative for first time since 1980, Increase of energy imports make up for 2/3 of this evolution

# In Japan, no final decision has yet been taken regarding the future of nuclear energy

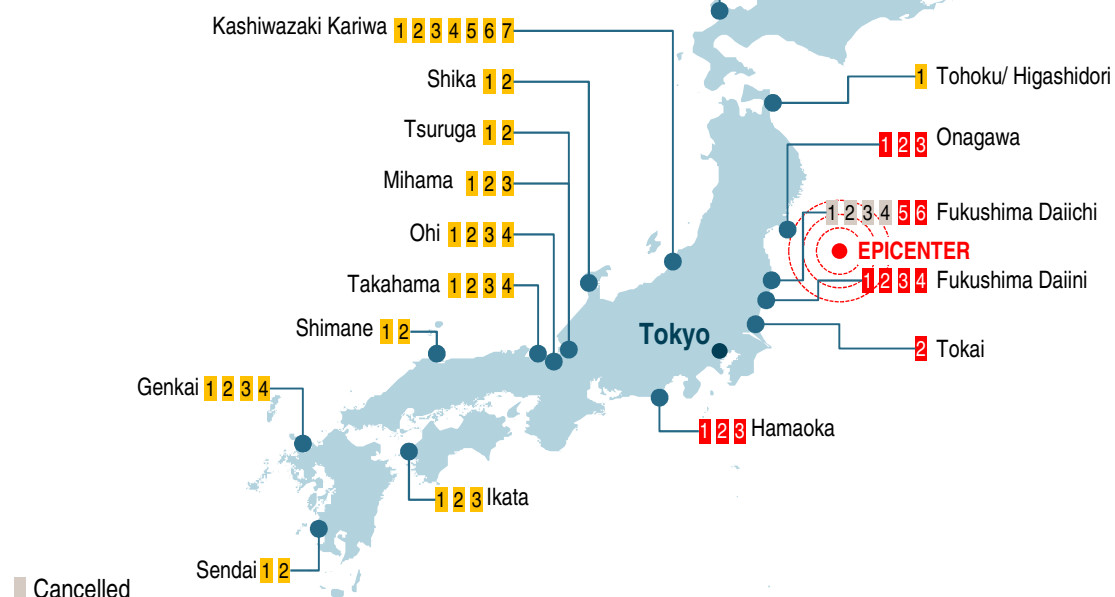
## Overview of Japan nuclear plants

### CURRENT STATUS OF THE NUCLEAR POWER PLANTS IN JAPAN

**In operation** (0 unit, 0Gwe)

**Outage for the periodic inspection and others**  
(37 units, 32.97Gwe)

**Shutdown due to tsunami and the government request**  
(13 units, 13.18Gwe)



### POSSIBLE SCENARIOS

- > Since May 5 2012, all nuclear reactors in Japan have been shut down. All reactors under construction or planned are cancelled
- > Low scenario anticipates a definitive shut-down of all nuclear reactors in Japan
- > High scenario plans a restart of the reactors shut down for periodic inspection with a 1 year delay and no life extension
- > Only one reactor authorized for restart so far



# Public opinion on nuclear technology in Europe today – Implications for future applications of nuclear technology in France, Italy and Germany

## Nuclear power in the EU

- > In 2012, **14 of the EU-27 countries have operating NPPs** to generate electricity (BE, BG, CZ, FI, FR, DE, HU, NL, RO, SK, SI, ES, SE and the UK) – **partially a major pillar of national electricity supply**
- > Germany, Switzerland and Belgium have announced plans to progressively phase out nuclear energy (by 2022, 2034 and 2025 respectively)

## BEFORE THE EVENTS IN JAPAN

- > **France (63 GW<sup>1</sup>) nuclear leader in Europe** – historically positive on nuclear power – also due to dependence on this technology
- > **Italy (0 GW<sup>1</sup>) abandoned NPP in 1990** as a Chernobyl consequence, reversed decision 2008 – in 2011 a referendum on NPPs
- > **Long lasting debate** about nuclear power generation in **Germany (20 GW<sup>1</sup>)** – nuclear power plant lifetime extension in 2010

## AFTER THE EVENTS IN JAPAN

- > France government kept faith with nuclear after Fukushima, but **recent political changes** (election of M. Hollande) should reverse its position
- > **Italy canceled its nuclear plan after Japan crisis**
- > **Last state elections were strongly dominated by energy policy**, pushing the green party significantly
- > Public survey shows than approx. **64% of Germans want to exit nuclear power generation by 2020**, **48% would accept to pay EUR 40 per year more for electricity** if this supports the process (n=1086)

1) Capacity of nuclear power in respektive country in 2011

# The UK is facing strong challenges to replace its nuclear facilities – new build have been delayed due to financial constraints

Scenario considered for the United Kingdom



## OVERVIEW ON UK CURRENT STATUS

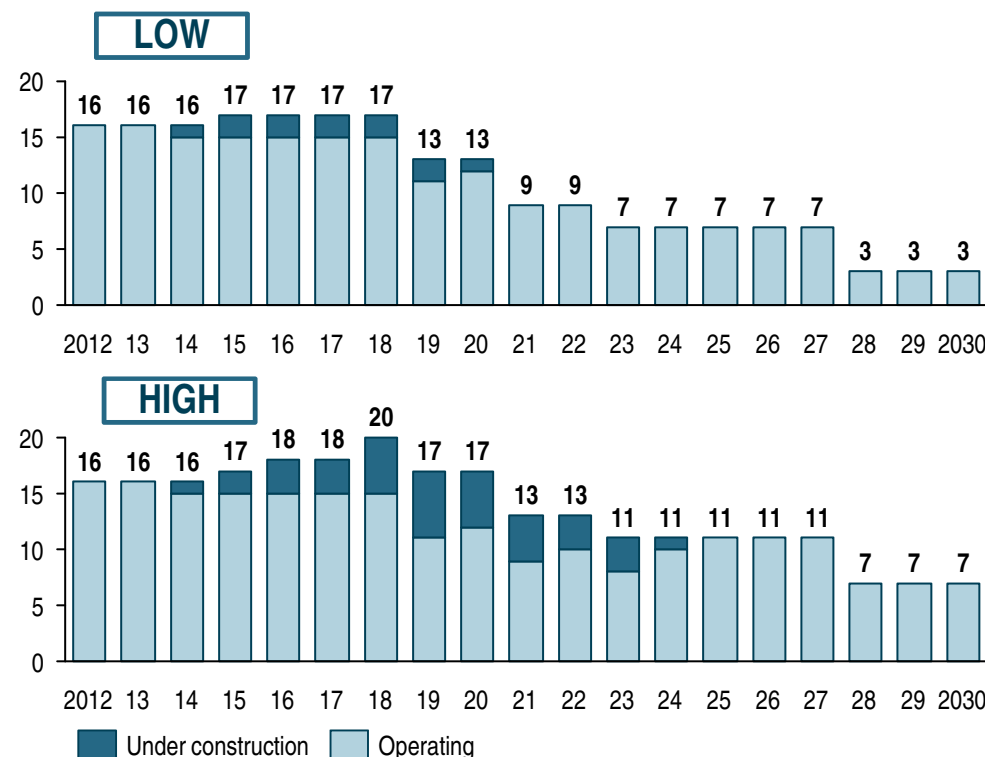
### Recent development

- > 3 reactors closed recently (924 MWe): Oldbury 1-2, Wylfa 2
- > Financial difficulties for planned projects: "Horizon" and "NuGeneration" projects are seriously threatened (3 reactors in total). Horizon put up for sale. EDF has not announced any change yet (4 reactors)
- > Life extensions of existing reactors are expected

### Roland Berger scenario

- > EDF reactors to enter in service in 2018, 2019, 2020 and 2022
- > Other projects not before 2030
- > Life extension on a case by case approach based on EDF "high confidence scenario" for existing plants in the UK

## CHANGES IN UK INSTALLED CAPACITY [# REACTORS]



# This has caused some private interests to disappear on new plants construction – but the impact remains limited (UK mainly)

## Overview on main nuclear projects in the United Kingdom

### EDF PROJECTS

#### Structure of the project

- > **JV** between **EDF** and **Centrica**
- > EPR reactors should be built by **Areva**
- > Partners claimed **not** to change their plans despite difficulties on other UK projects

#### Expected power plants:

- > Hinkley Point C - 1 & 2
  - 2 reactors
  - 1,650 MW each
- > Hunterston B – 1 & 2
  - 2 reactors
  - 1,650 MW each

### HORIZON PROJECTS

#### Structure of the project

- > Originally a **JV** between E.ON and RWE
- > Horizon recently announced for sale
- > **Among others, Russian** and **Chinese** operators have expressed interest

#### Expected power plants:

- > Oldbury-B
  - 3 reactors
  - ~ 3,500 MW in total
- > Wylfa-B
  - 4 reactors
  - ~ 5,000 MW in total

### NUGENERATION PROJECTS

#### Structure of the project

- > Originally a **JV** between GDF Suez and Southern Scottish Power
- > SSP left the JV in September 2011
- > no investment expected before 2014- 2015

#### Expected power plants:

- > Sellafield
  - 3 reactors
  - ~ 3,500 MW in total

- > **Some private investors in the UK have been discouraged by the government's uncertainty – projects should continue though**
- > **In other countries, private interests have been preserved**

# Russia did not change its plan in nuclear development after the Fukushima accident

## Scenario considered for the Russia



### OVERVIEW ON RUSSIA CURRENT STATUS

#### Recent development

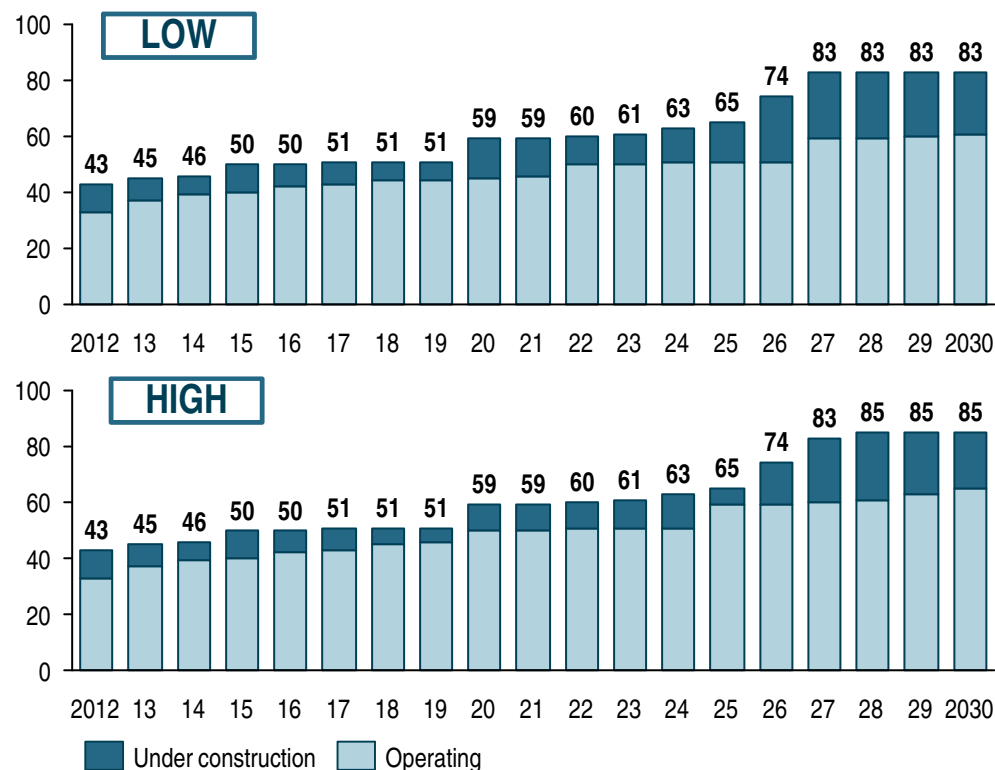
- > Following Fukushima, authorities announced their intention to improve security – back-up power and water supply as main concerns – and to extend the life of the existing reactors
- > The Kaliningrad plant is now under construction
- > Kalinin 4 is operating since November 2011
- > Russia is strongly pushing exports in nuclear energy, with plans in 7 countries at least<sup>1)</sup>

#### Roland Berger scenario

- > No delays for reactors under construction
- > 2 years delays in low scenario for "planned" or "announced" reactors

1) Ukraine, Belarus, India, China, Turkey, Vletnam, Bangladesh

### CHANGES IN RUSSIA INSTALLED CAPACITY [# REACTORS]



# Indian has not changed its ambitions in nuclear energy

## Scenario considered for India



### OVERVIEW ON INDIA CURRENT STATUS

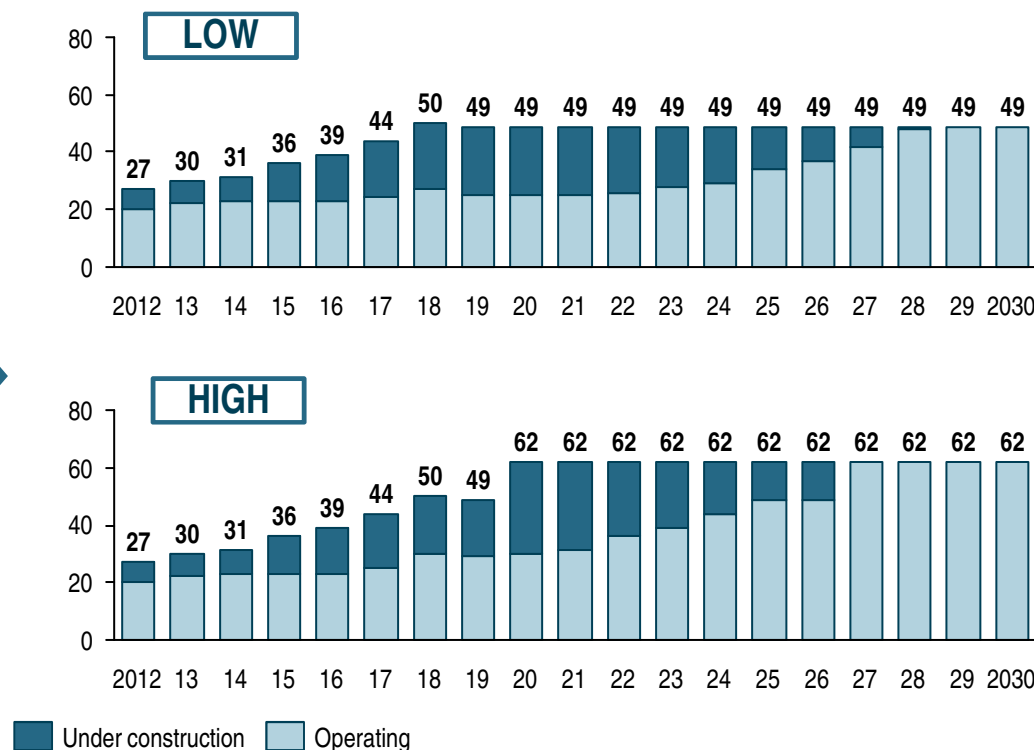
#### Recent development

- > India has affirmed plans to boost nuclear capacity to 63 GW by 2032, doubling current capacity in service by 2015
- > 2 reactors entered recently into construction: Kakrapar 4 and Rajasthan 7 (630 MW each)
- > Some delays are expected for reactors under construction due to public protests (Kudankalam 1&2). All reactors being built in India are potentially concerned by such delays as India is a democratic country with strong power given to local authorities

#### Roland Berger scenarios

- > High: considering delays, about a half of the reactors under construction or planned enter service by 2030
- > Low: all reactors are somehow delayed

### CHANGES IN INDIA INSTALLED CAPACITY [# REACTORS]



# China is expected to rely strongly on nuclear energy in the future – 40 reactors expected to be in construction by the end of 2012

## Scenario considered for Greater China



### OVERVIEW ON GREATER CHINA CURRENT STATUS

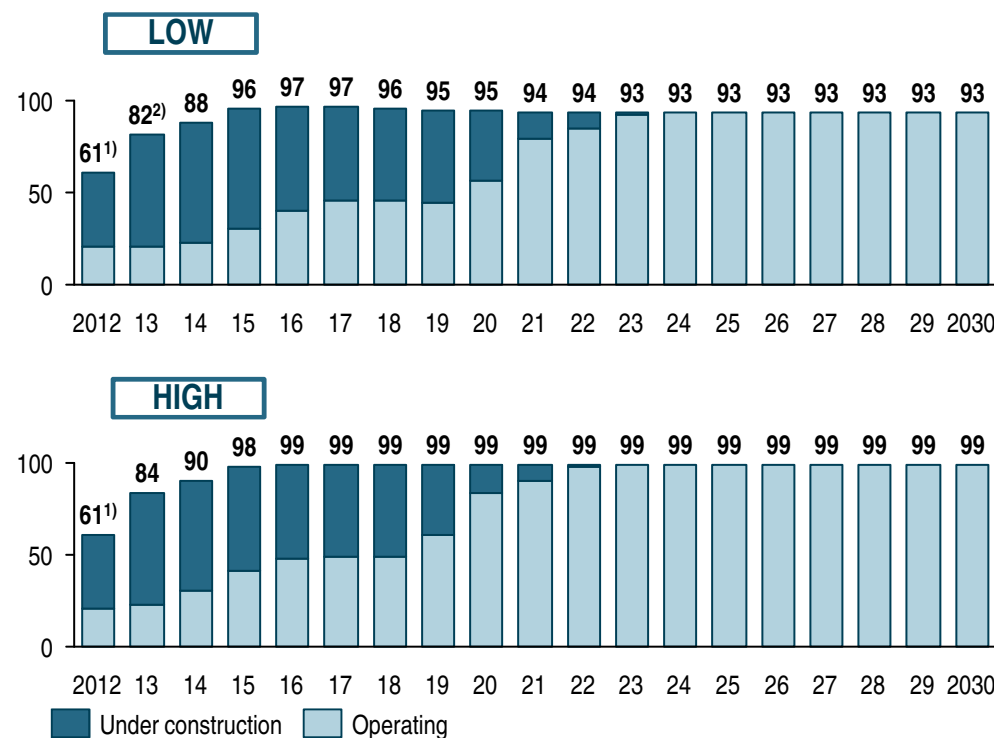
#### Recent development

- > Stress tests following Fukushima : small impact on projects under construction, delay on planned reactors
- > Taiwan announced a progressive phase out
- > 2 new reactors completed in mainland since Fukushima, adding 1650 MWe to the total capacity

#### Roland Berger scenarios

- > Reactors under construction: delay assumed vs WNA expected date of completion (2 years in low scenario, 1 year in high scenario)
- > Reactors planned or announced: new estimated starting date for construction (based on WNA if available, RB estimates otherwise) + 6 years estimated to complete construction + delay due to potential post-Fukushima potential measures (2 years in low scenario, 1 year in high scenario)

### CHANGES IN GREATER CHINA INSTALLED CAPACITY [# REACTORS]



1) 28 reactors already in construction in May, 12 more expected to start by the end of 2012. 21 reactors operating

2) 2 reactors under construction in Taiwan expected to be cancelled in RB low scenario