



# Keeping Europe lights on

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Fortum, FORATOM Vice President

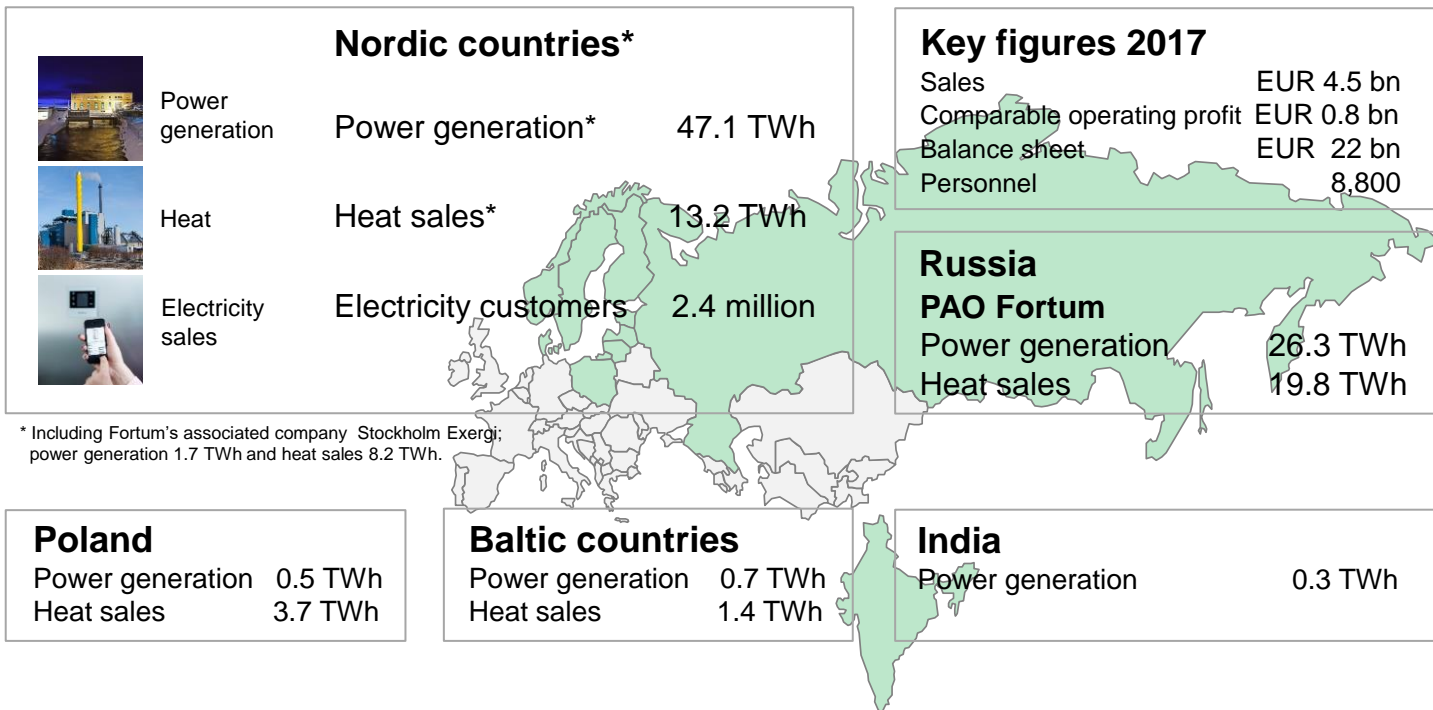
*9 April 2018*



# About Fortum



# Our current geographical presence



# 30% of Fortum's power generation comes from nuclear

## Loviisa

Two units  
502 + 502 MW = 1004 MW

Fortum's ownership 100%

## Olkiluoto

Two units, third under construction

880 + 880 MW = 1,760 MW  
Under construction 1,600 MW

Fortum's share: 27% (468 MW)

## Oskarshamn

One operating unit  
1,400 MW

Fortum's share: 43% (602 MW)

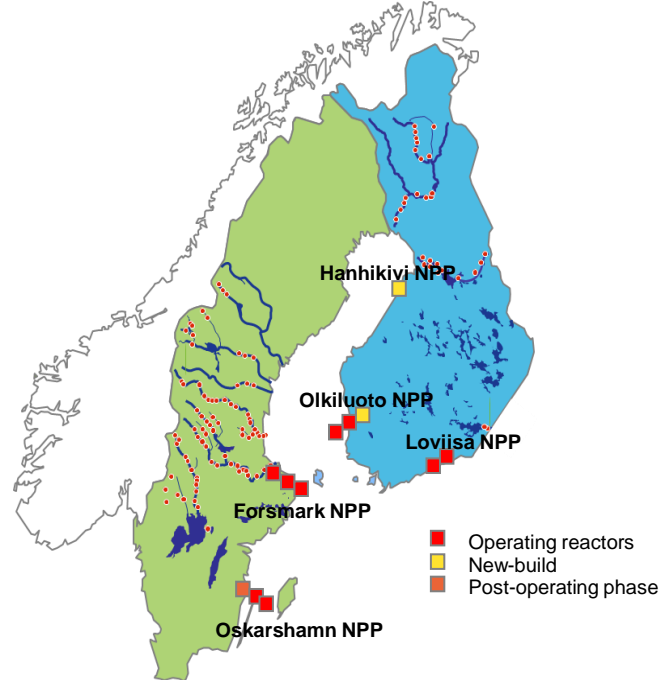
In addition, Unit 2 of 630 MW was permanently shut down in 2015 and Unit 1 of 473 MW in 2017

## Forsmark

Three units  
984 + 1,120 + 1,167 = 3,271 MW

Fortum's share: 22% (720 MW)

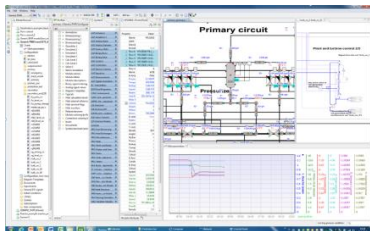
## Fortum's nuclear fleet





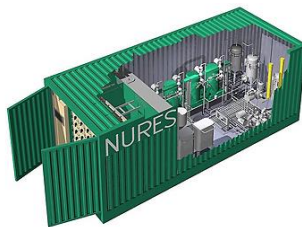
# We offer a wide range of nuclear services

## Our expertise is based on nuclear experience since the 1960's



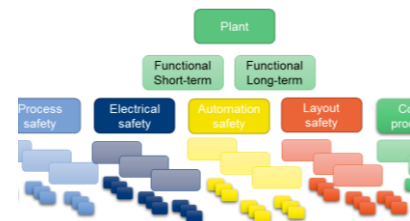
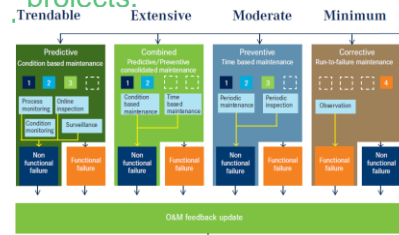
Highly efficient software Apros® for simulating all processes of a power plant and testing I&C; different simulators.

One of the World's most effective solutions for purification of radioactive liquids NURES®



Solutions for interim storage and final disposal of nuclear waste. Decommissioning services.

Method of system engineering ADLAS® for licensing and safety systems design. Consulting for safety upgrade, power upgrade, lifetime extensions, new-build projects.



Methods ReMaint® for optimization of maintenance activities and execution of annual outages to increase nuclear plants availability and safety.

Applications of virtual reality, augmented reality, 360 video for training and more efficient maintenance and projects execution.





# Security of energy supply in the European Union

# Security of Energy Supply – the basics



## Energy security

=

*the uninterrupted availability of energy sources at an affordable price\**



## Security of energy supply\*\*



### External dimension

- ⑩ Geopolitics
- ⑩ Safety & adequacy of international infrastructure
- ⑩ Unanticipated resource exhaustion
- ⑩ Resilience to changes in climate policy



### Internal dimension

- ⑩ Generation capacity
- ⑩ Domestic transport infrastructure
- ⑩ Market design & regulation
- ⑩ Price stability
- ⑩ Operational reliability

\*Source: International Energy Agency 2014

\*\*Source: OECD NEA "The Security of Energy Supply and the Contribution of Nuclear Energy" 2010

# Current state of play in the EU



## Import of energy:

- EU imports **54%** of energy
- oil - **90%**, gas - **69%**, solid fuels - **42%**

## Key challenges:

- External suppliers - **mostly gas**
- New projects - **Nord Stream II**

## Costs:

- **€1 billion per day**  
– EU external energy bill
- **€300 billion** – import of crude oil & oil products to EU

## Affected countries:

- Every **Member State** - in particular the Baltics & Eastern Europe

## Examples:

- **6 MSs** depend from Russia (gas supply)
- Russia & Norway supply: **+50%** of gas & **+40%** of oil
- **Algeria** is the EU's third-largest energy supplier

## Additional challenges:

- Energy demand worldwide - increase by **27%** by **2030**



# EU Energy Security Strategy – key objectives



Reaching the proposed 2030 energy and climate goals



Increasing energy production in EU (nuclear, RES & sustainable production of fossil fuels)



Completing the creation of an internal energy market



Building good relations with suppliers & producers of energy



Speaking with one voice in external energy policy discussions

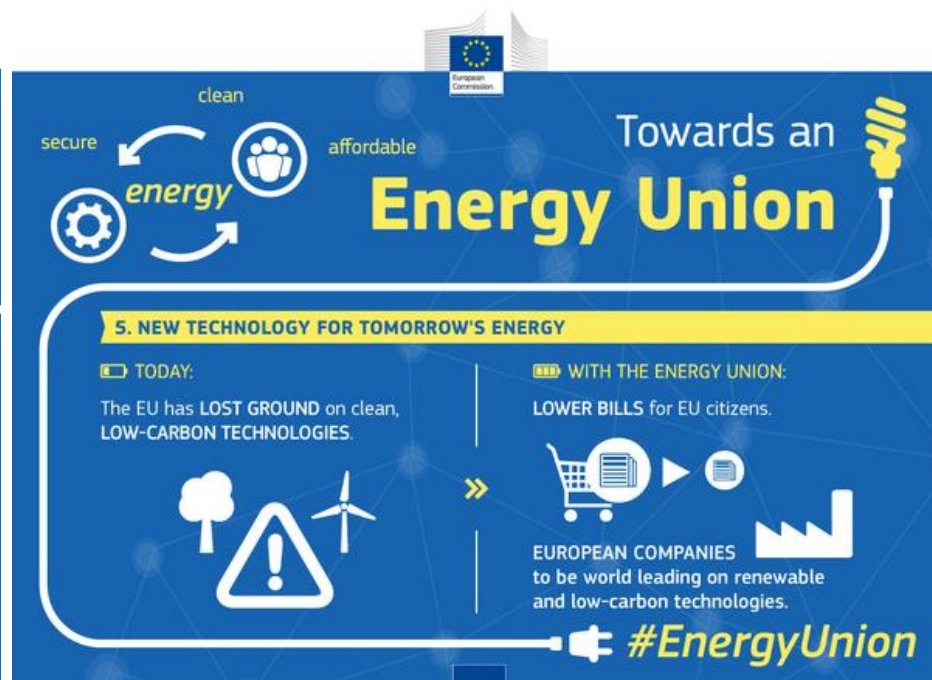
# EU Energy Union



A package of energy security measures to equip the EU for global energy transition to address possible energy supply interruptions

## Policy areas:

- ✓ Security, solidarity & trust
- ✓ A fully-integrated internal energy market
- ✓ Energy efficiency
- ✓ Decarbonising the economy
- ✓ Research, innovation & competitiveness



Source: European Commission



Why nuclear?

# Current status of nuclear energy in the EU

127 Operational nuclear reactors in the EU

Nuclear share of electricity

**72% France**  
58 reactors - 63 130 MW

**54% Slovakia**  
4 reactors - 1 814 MW

**52% Belgium**  
7 reactors - 5 913 MW

**51% Hungary**  
4 reactors - 1 889 MW

**40% Sweden**  
8 reactors - 8 629 MW

**35% Bulgaria**  
2 reactors - 1 926 MW

**35% Slovenia**  
1 reactor - 688 MW

**34% Finland**  
4 reactors - 2 764 MW

**29% Czech Republic**  
6 reactors - 3 930 MW

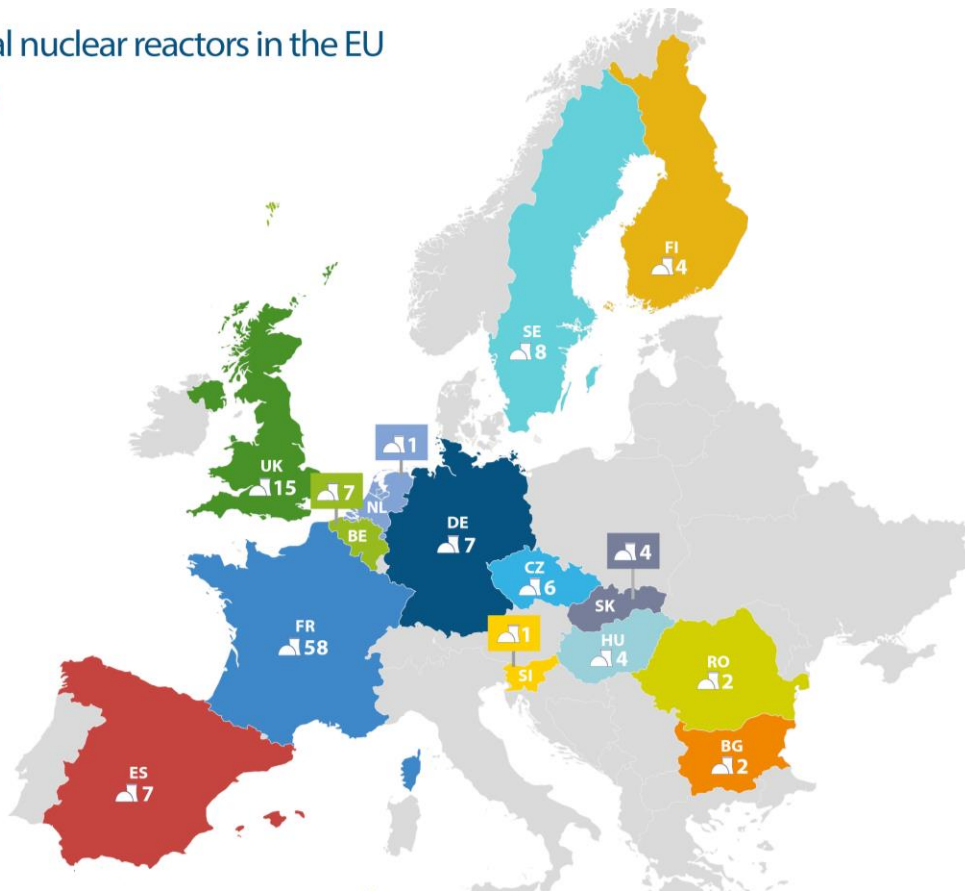
**21% Spain**  
7 reactors - 7 121 MW

**19% UK**  
15 reactors - 8 918 MW

**17% Romania**  
2 reactors - 1 300 MW

**13% Germany**  
7 reactors - 9 515 MW

**3% Netherlands**  
1 reactor - 482 MW



**ELECTRICITY  
PRODUCTION**

**27%**



**LOW-CARBON  
ELECTRICITY**

**50%**

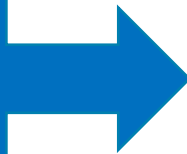




# EU Energy Union



*Nuclear energy contributes to all the Energy Union's key energy objectives*



*"A **high share of nuclear** in the energy mix helps to limit import dependency"*

*"The countries with the lowest greenhouse gas intensity have a high share of low-carbon technologies (renewable and **nuclear**) in their electricity mix"*

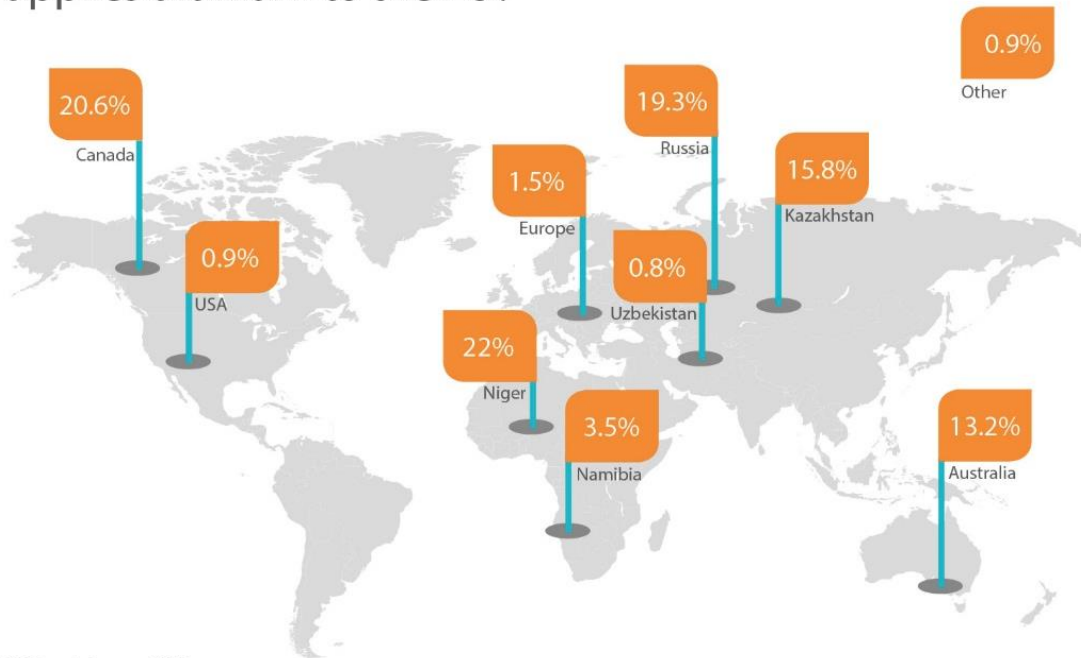
*"The three Nordic countries had the lowest prices, facilitated by a high share of renewables and **nuclear** in the electricity mix".*

**Second report on the State of the Energy Union (2017)**



# Diversity of suppliers

Who supplies uranium to the EU?



Source: EURATOM Supply Agency 2017

## In addition:

- Identified resources of uranium are sufficient to support continued use of nuclear for over **120 years**
- Additional exploitable resources would extend this to over **300 years**
- New reactor designs & recycling fuel could increase this to **thousands of years**

# Reducing dependence upon imported fossil fuels



## Quantity

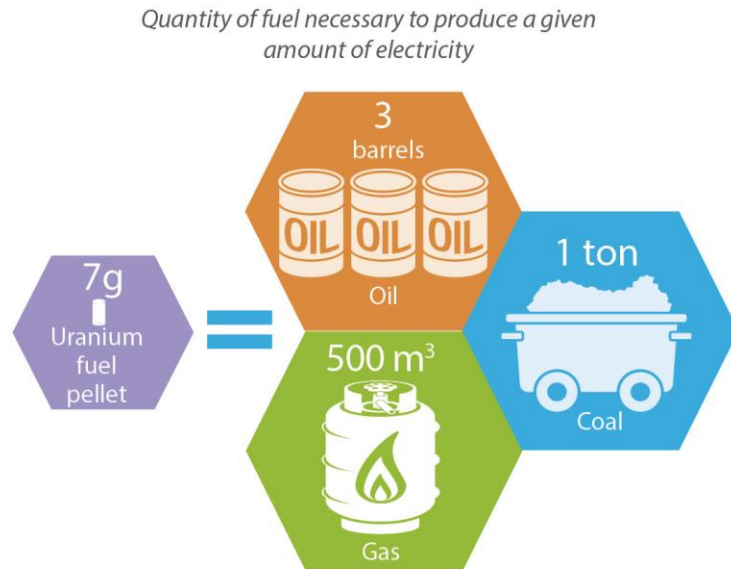
- The quantity of uranium needed to produce electricity is **extremely low**

## Comparison with other sources

- A 1 000 MW PWR consumes less than **30 tonnes of fuel** a year while a 1 000 MW coal plant would consume **4.3 million tonnes** of coal

## Inventories

- Current resource could cover **3 years** of the EU reactor requirements
- Most utilities keep a sufficient quantity of inventories for **at least one reload**



Source: American Nuclear Society 2013

# Enrichment & fuel fabrication



Annual production capacity of  
enrichment plants in the EU

**22.5 mil\***  
SWUs\*\*

\* WNA, Nuclear Fuel Report 2015 \*\* Separative Work Units



Equivalent of powering

**210**  
reactors



Providing carbon-free energy to

**+270 mil**  
households/year

The biggest and most effective  
enrichment capacity is located in the  
European Union

⑩ 2 out of 4 major global players

⑩ 1 single technology

⑩ Plants located in:

- France
- Germany
- Netherlands
- UK



## + 6 fuel fabrication facilities in the EU

Romans (France), Lingen (Germany), Juzbado (Spain),  
Västerås (Sweden), Springfield (UK), Pitești (Romania)



# Capacity levels

Nuclear reactors operate at high capacity levels = nuclear is a reliable source of base-load electricity.

In addition, nuclear energy's capacity factor is constantly improving.

Nuclear produces electricity at full power

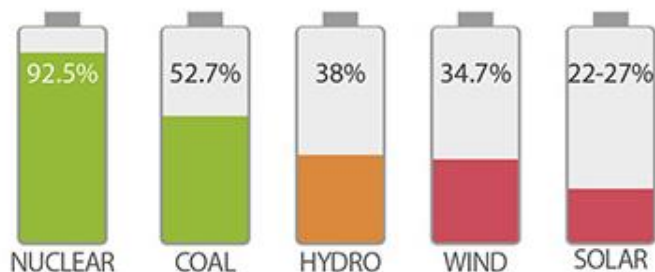
85 to 90%

of the time thus enhancing security of supply

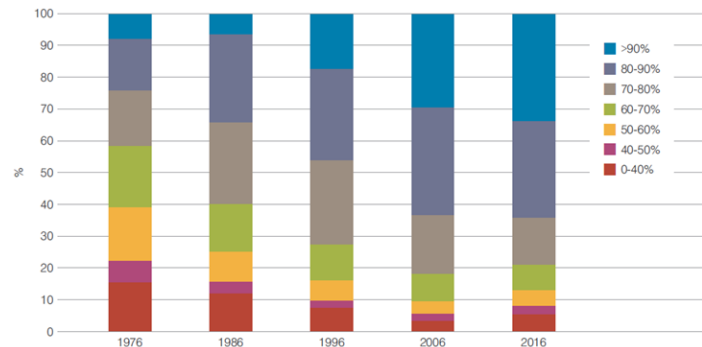


Source: NEI 2012

## Energy performance\*



\*% of rated capacity factor

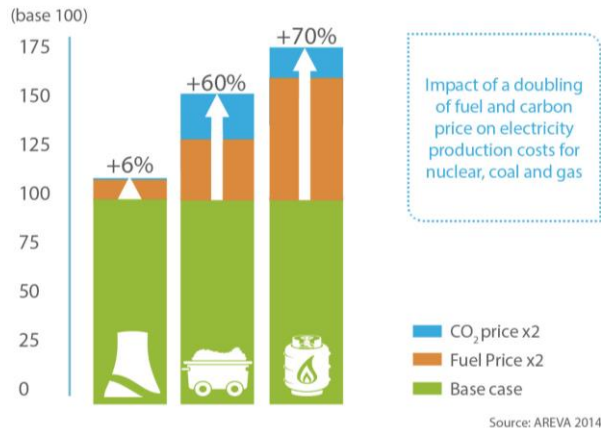


Source: World Nuclear Association, IAEA PRIS

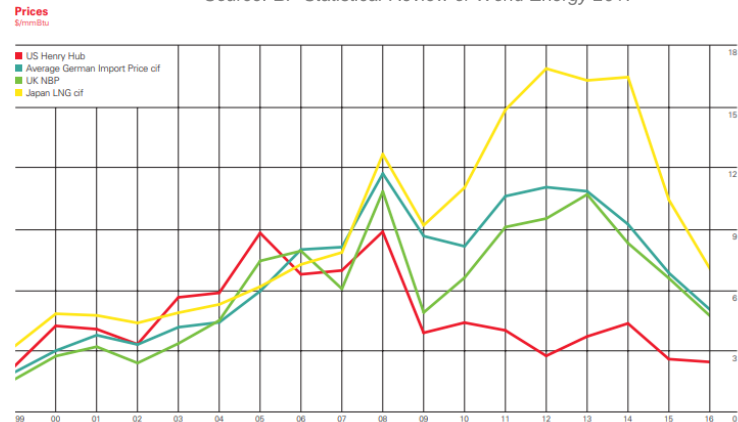
Source: World Nuclear Association 2017

# Price of uranium

The cost of nuclear power is less vulnerable to fuel price fluctuations

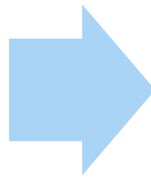


Average price of natural gas: \$/mmBtu  
Source: BP Statistical Review of World Energy 2017



Uranium costs (a small part of the nuclear fuel costs) are marginal in the total cost of electricity produced by a nuclear reactor.

Uranium price changes have little effect on production costs.



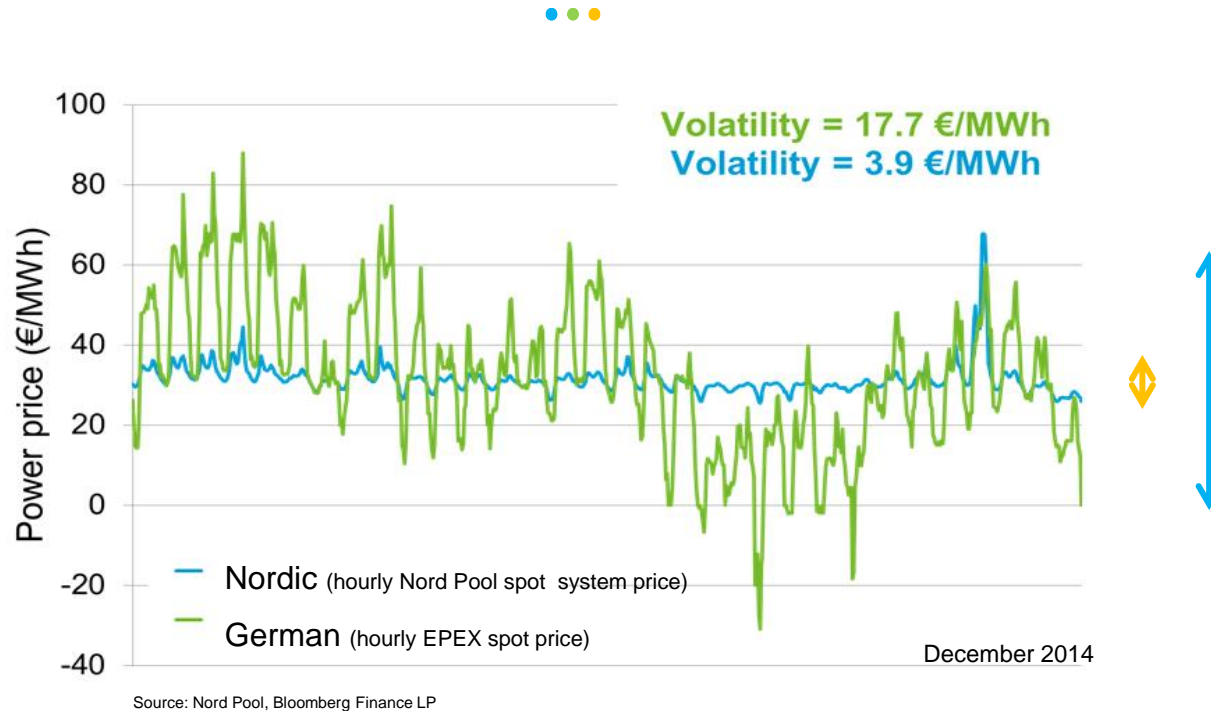
The same cannot be said of fossil fuels, which comprise a major proportion of operating and fuel costs as market prices can be volatile, especially in the face of geopolitical turmoil.

## Average power prices in Nordics and Germany were very close in December 2014 ...



Source: Nord Pool, Bloomberg Finance LP

... but hourly prices were very different!



**Price pattern is getting more important than average price!!**



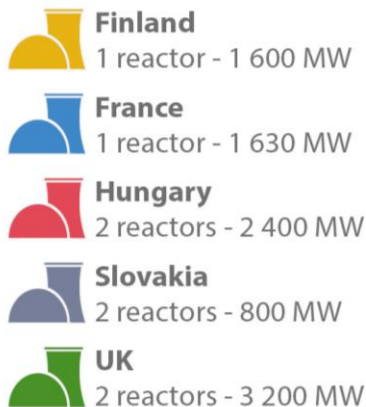
# Strengthening the security of supply in the EU – next steps



New build

Long-term operation

Nuclear power plants  
under construction

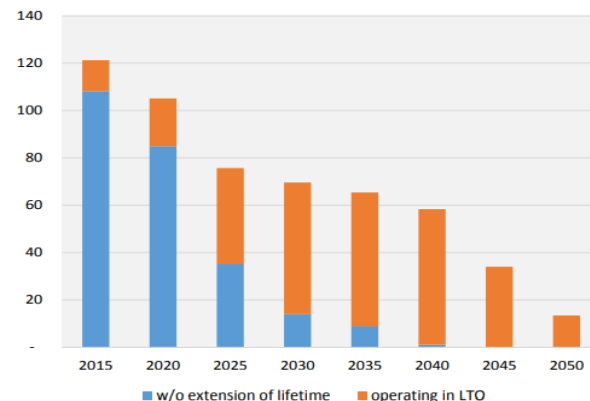


Countries preparing  
or considering  
new build:

- ✓ Bulgaria
- ✓ Czech Republic
- ✓ Finland
- ✓ France
- ✓ Lithuania
- ✓ Poland
- ✓ Romania
- ✓ Slovenia
- ✓ UK



LTO\*  
Projected evolution  
of existing fleet (GW)

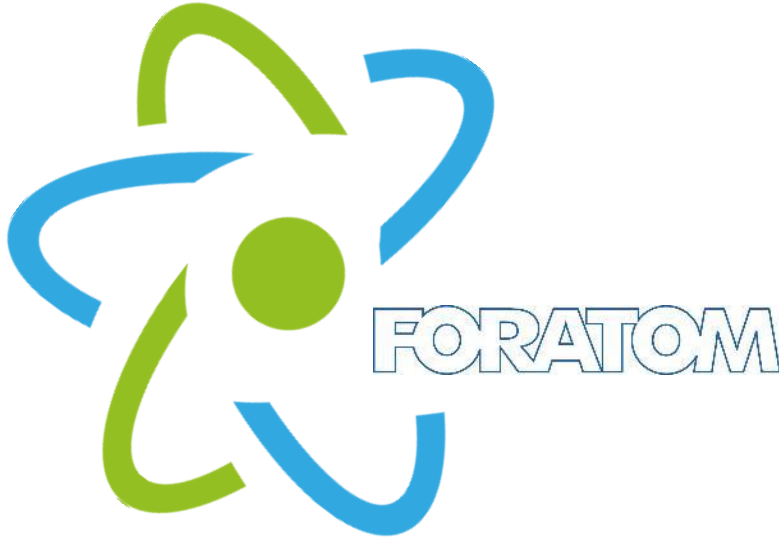


\*Source: PINC, European Commission, 2017  
Estimated investment needs in LTO (until 2050): EUR 46,9 billion

# Nuclear energy...

- ✓ Must remain safe
- ✓ Is needed to replace fossil fuels & mitigate climate change
- ✓ Has to become more affordable
- ✓ Must be treated equally with other technologies in the power market
- ✓ Would benefit from standardization, harmonization & more simple design
- ✓ Big doesn't necessarily mean the most beautiful

# Thank you



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