

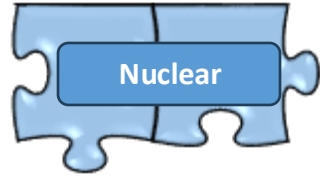
Danish Offshore Technology Conference 2024

# **Nuclear in the energy transition**

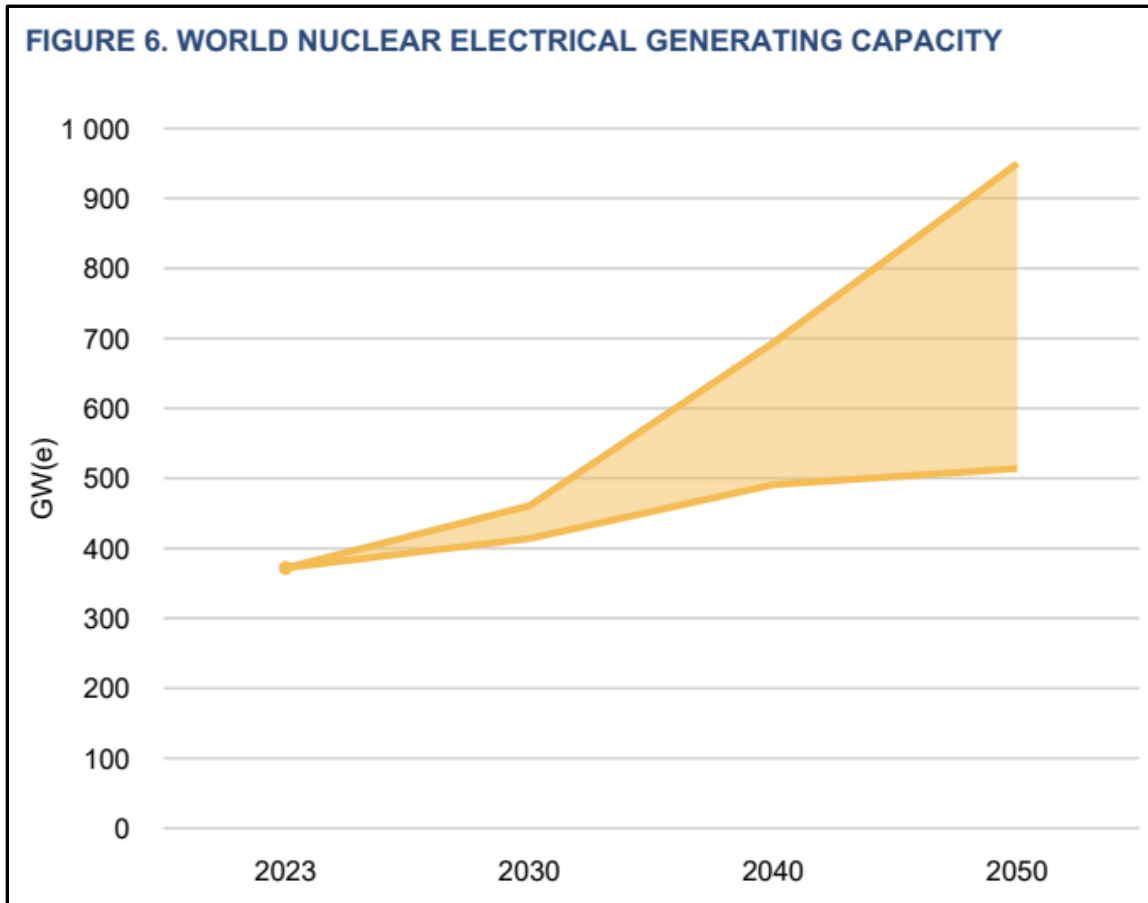
**Status and perspectives of nuclear power as part of the Danish energy system**

Bent Lauritzen  
Centre for Nuclear Energy Technology  
DTU Physics

# Tripling nuclear energy by 2050



Expected increase in nuclear capacity, with 6 - 24% from Small Modular Reactors



Source: IAEA 2024 (<https://doi.org/10.61092/iaea.e3qb-hsrr>)



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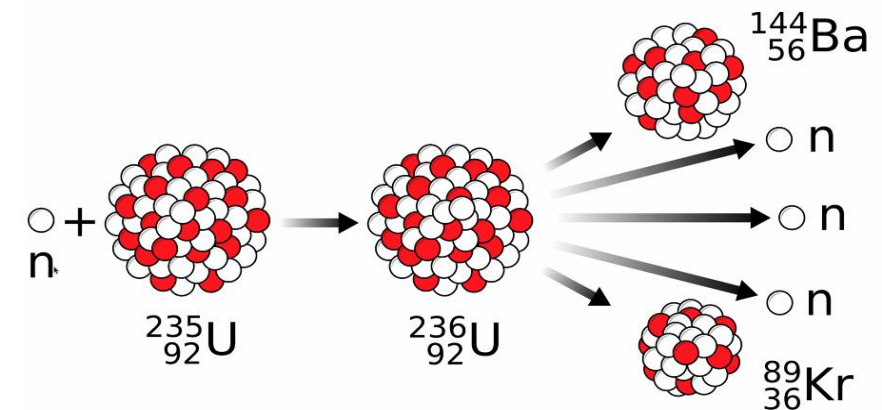
Home > Bureau of International Security and Nonproliferation > Remarks & Releases > Declaration to Triple Nuclear Energy

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**Declaration to Triple Nuclear Energy**  
 OTHER RELEASE  
 BUREAU OF INTERNATIONAL SECURITY AND NONPROLIFERATION  
 DECEMBER 2, 2023

# Outline ...

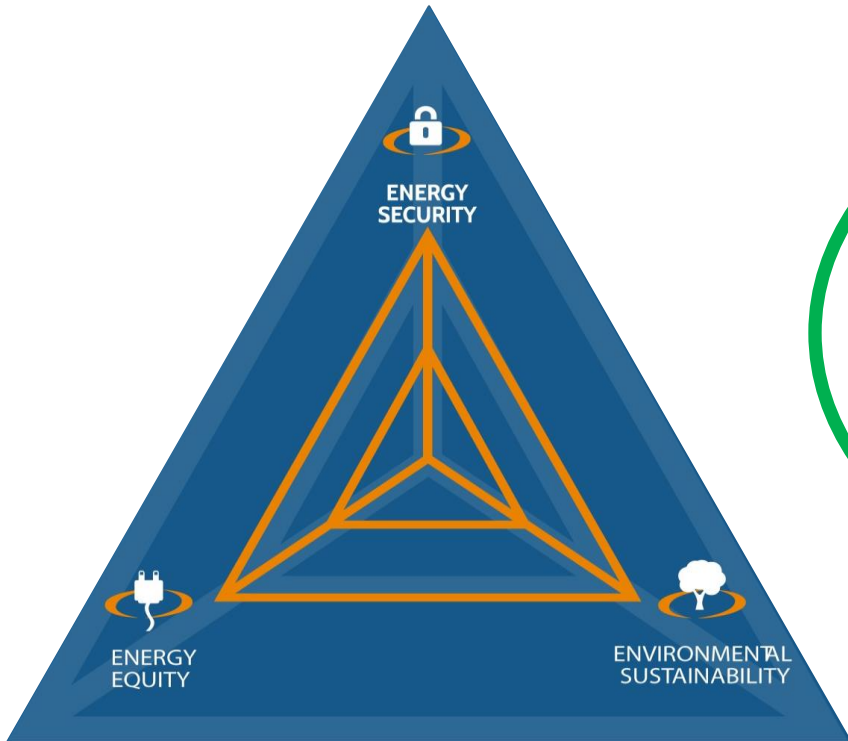
- **Why nuclear ?**
- **Sustainability and outlook**
  - **small modular reactors**
- **Nuclear power in Denmark?**

Olkiluoto 3, Finland



# Why nuclear?

Energy policy trilemma: the provision of secure, clean and affordable energy



**Electricity: need for**

- Dispatchable energy
- Scalable energy
- Zero carbon



**Olkiluoto 3**

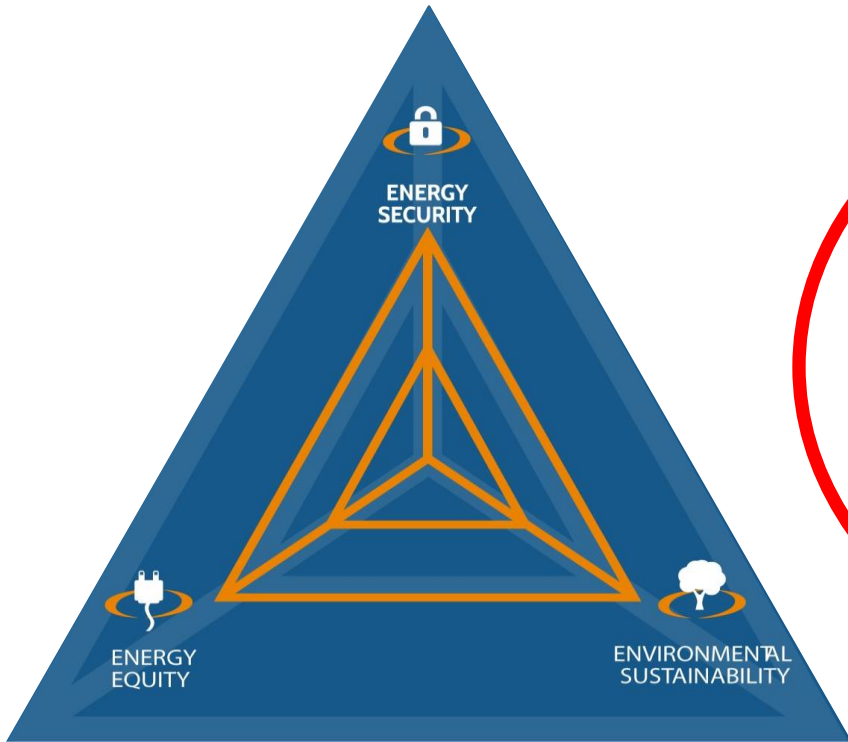


**Nord Stream 2**

Source: WEC (2024)  
[World Energy Trilemma 2024 Full Report.pdf](#)

# Why nuclear?

Energy policy trilemma: the provision of secure, clean and affordable energy



## Barriers to nuclear:

- Public acceptance
- Lack of skills
- High unit costs
- Lack of innovation
- Regulations



**Olkiluoto 3**



**Nord Stream 2**

Source: WEC (2024)

[World Energy Trilemma 2024 Full Report.pdf](#)

**Nuclear power**

**– sustainability and outlook**

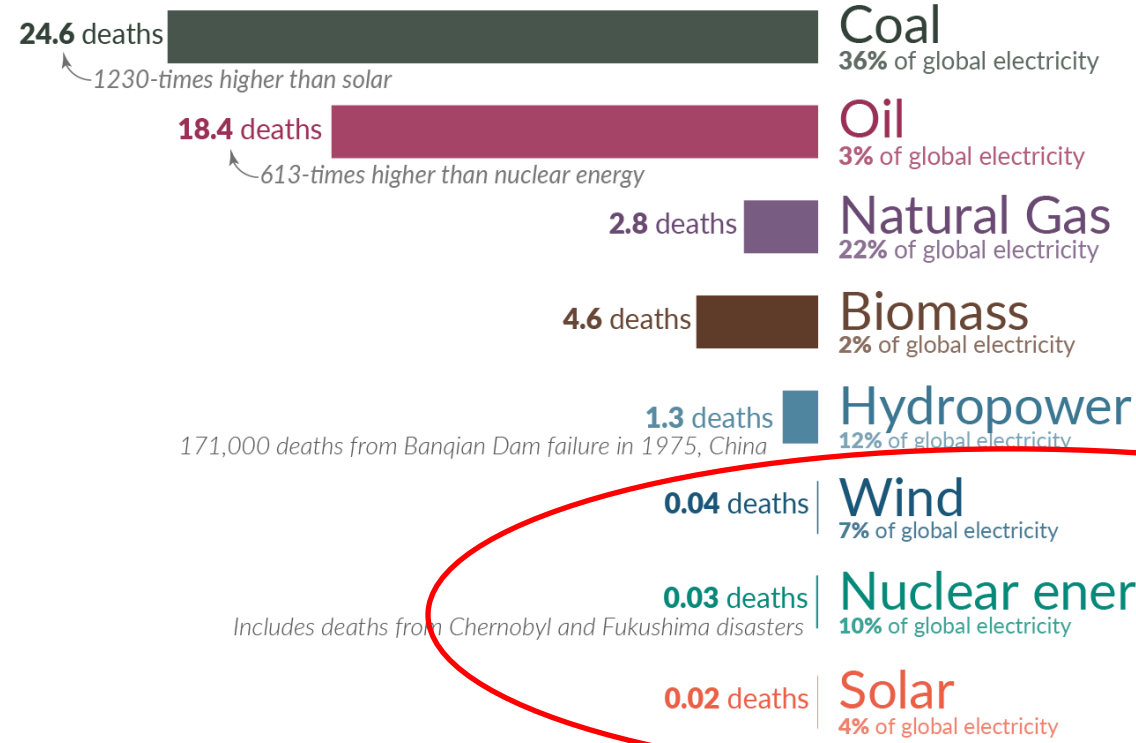
# 2022: EU to label nuclear as a sustainable energy source

## What are the **safest** and **cleanest** sources of energy?



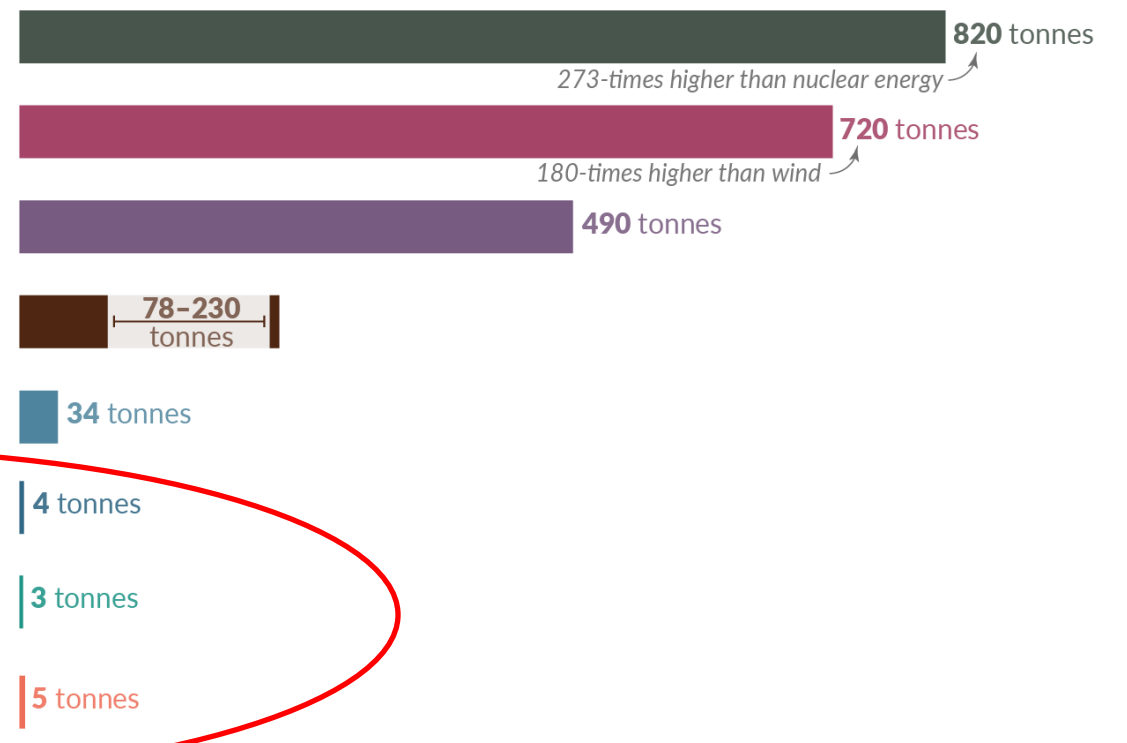
### Death rate from accidents and air pollution

Measured as deaths per terawatt-hour of electricity production.  
1 terawatt-hour is the annual electricity consumption of 150,000 people in the EU.



### Greenhouse gas emissions

Measured in emissions of CO<sub>2</sub>-equivalents per gigawatt-hour of electricity over the lifecycle of the power plant.  
1 gigawatt-hour is the annual electricity consumption of 150 people in the EU.



# Costs of electricity production, with and without nuclear

Studie		Estimated cost WITH nuclear are Higher / Equal to / Lower than costs WITHOUT nuclear		
		Higher	Equal to	Lower
1	Pfenninger & Keirstead (2015)		X	
2	Brouwer et al. (2016)		X	X
3	Pattupara & Kannan (2016)			X
4	Buongiorno et al. (2018)			X
5	Sepulveda et al. (2018)			X
6	Cometto et al. (2019)			X
7	Van Zuijlen et al. (2019)		X	X
8	Zappa et al. (2019)		X	X
9	Kerkhoven et al. (2020)	X	X	
10	Kan et al. (2020)		X	X
11	Fattahi et al. (2022)		X	X
12	Scheepers (2022)			X
13	Veenstra et al. (2022)			X



Source: Raad voor de leefomgeving en infrastructuur, 2022



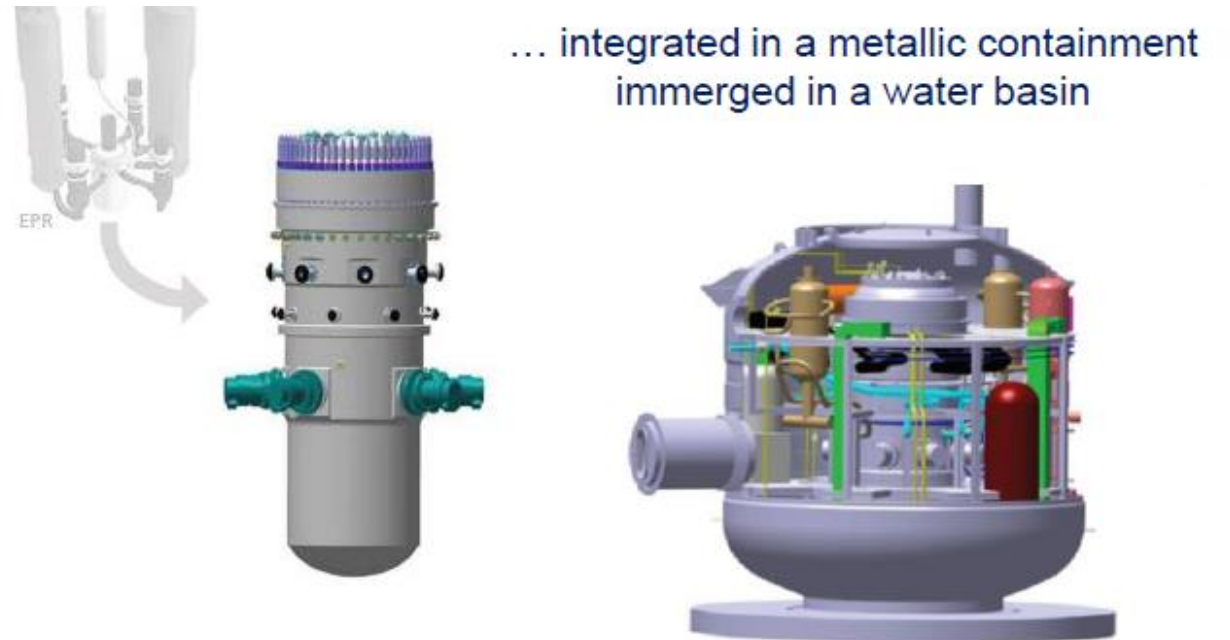
## Improved economy

- **Modular manufacturing**
- **Simple and safe designs**
- **Standardization and series production**
- **Single design approval**

→ **Reducing construction times and costs**

## French conceptual design (CEA/EDF)

NUWARD, 170 MW<sub>e</sub> PWR



# New applications of nuclear energy

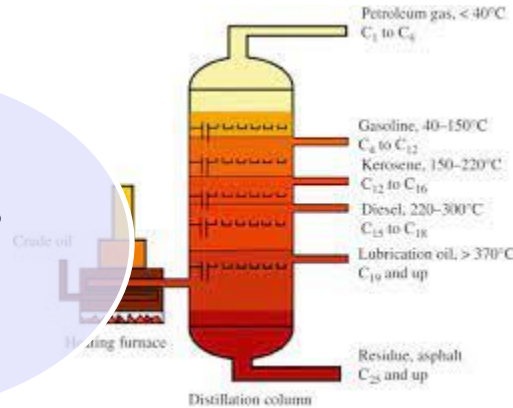


**Flexible  
electricity**



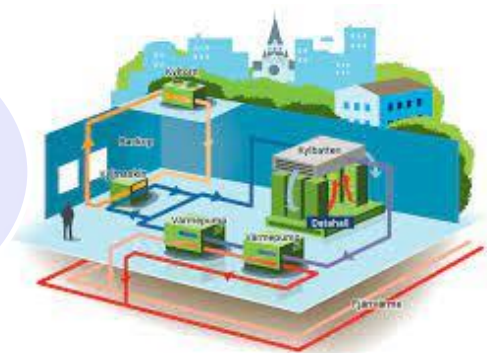
**Hydrogen**

**Process  
heat**



**Desalination**

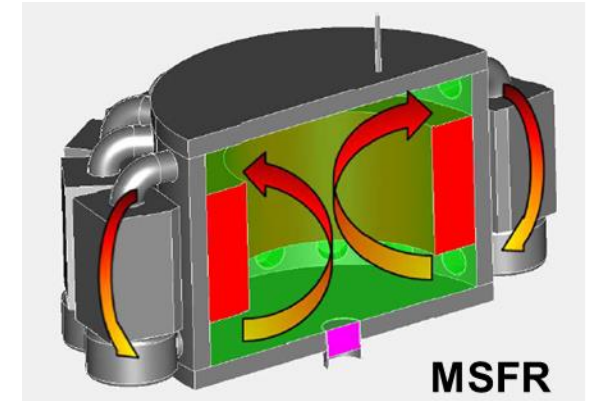
**District  
heating**







# Advanced liquid-fueled Molten Salt Reactors (MSRs)

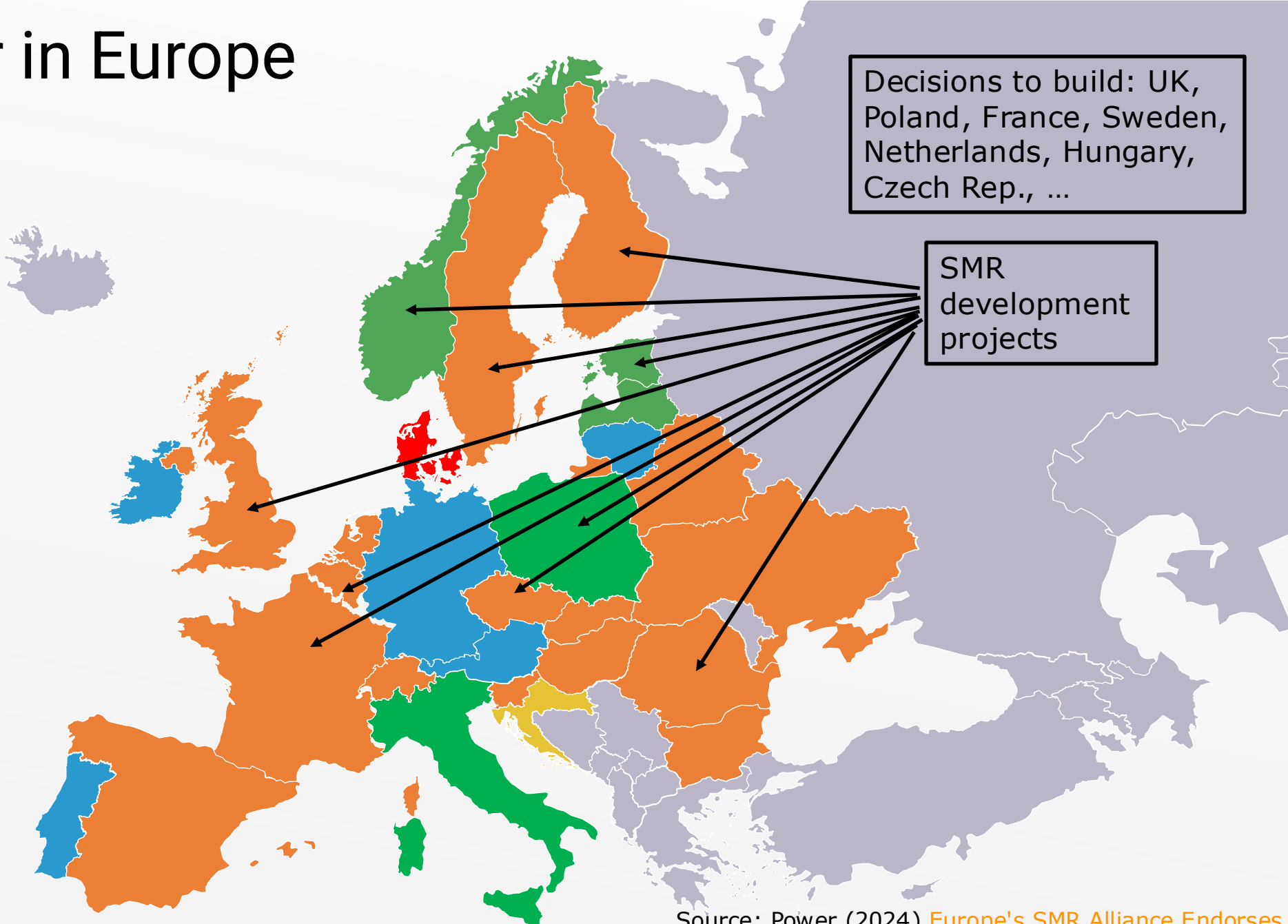
MSRs can provide sustainability benefits:

- Improved safety
- Significant load-following capabilities
- Increased fuel utilization
- Transmutation of nuclear waste
- Process heat for industry (~ 700 °C)
- and improved economy?



# Nuclear power in Europe

-  Countries with nuclear power
-  Countries planning or considering nuclear power
-  Countries without nuclear power
-  Denmark

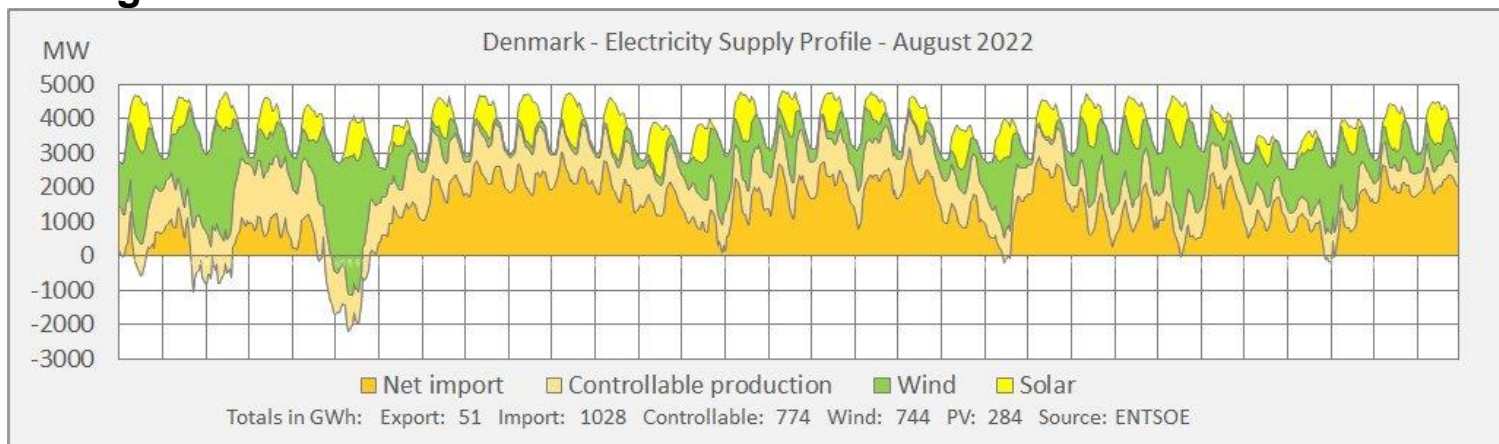


Source: Power (2024) [Europe's SMR Alliance Endorses Nine Nuclear Projects in Push for 2030s Deployment](#)

**Nuclear power in Denmark?**

# Danish electricity supply – a role for nuclear?

## August 2022

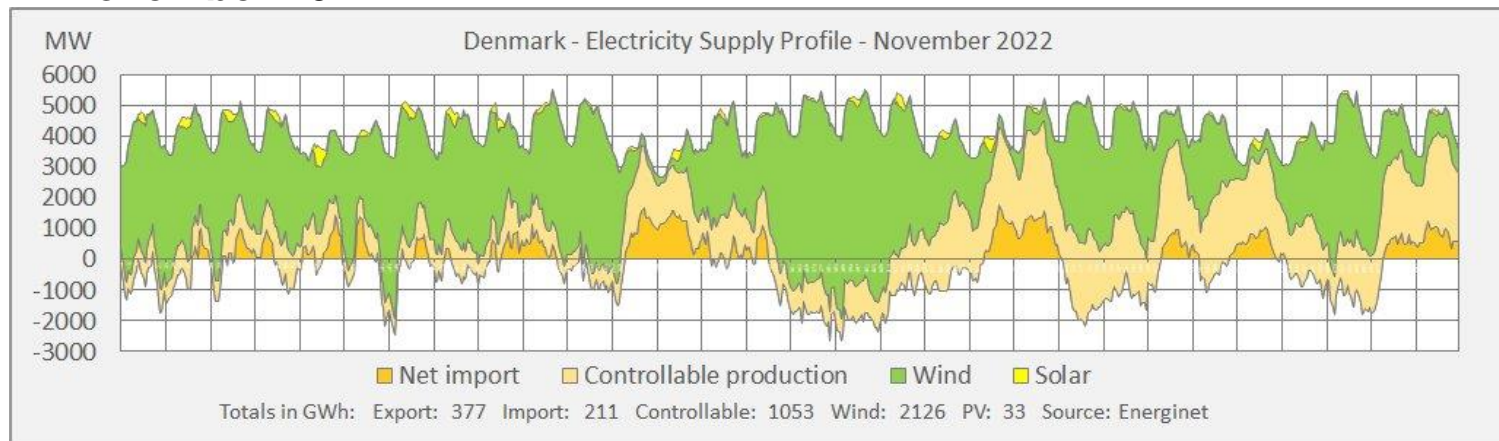


Need to balance weather-dependent wind and solar:

### Large scale energy storage?

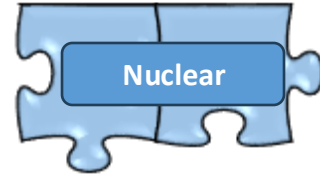
- Batteries
- Thermal, mechanical
- Chemical – P2X

## November 2022



### Dispatchable production

- Biomass (sustainability?)
- Hydropower (import)
- Gas turbines (fossil)
- **Nuclear power**



## Benefits

- Security of supply
- Energy autonomy
- Low environ. impact

## Perspectives

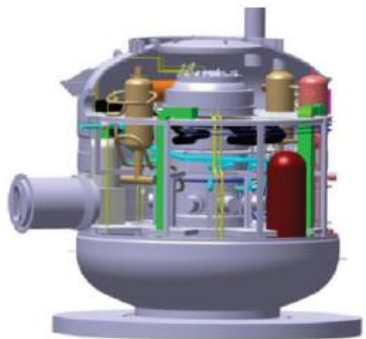
- New applications
- New technologies
- Danish industry

## Challenges

- Public acceptance
- Radioactive waste
- Lack of skills

## Uncertainties

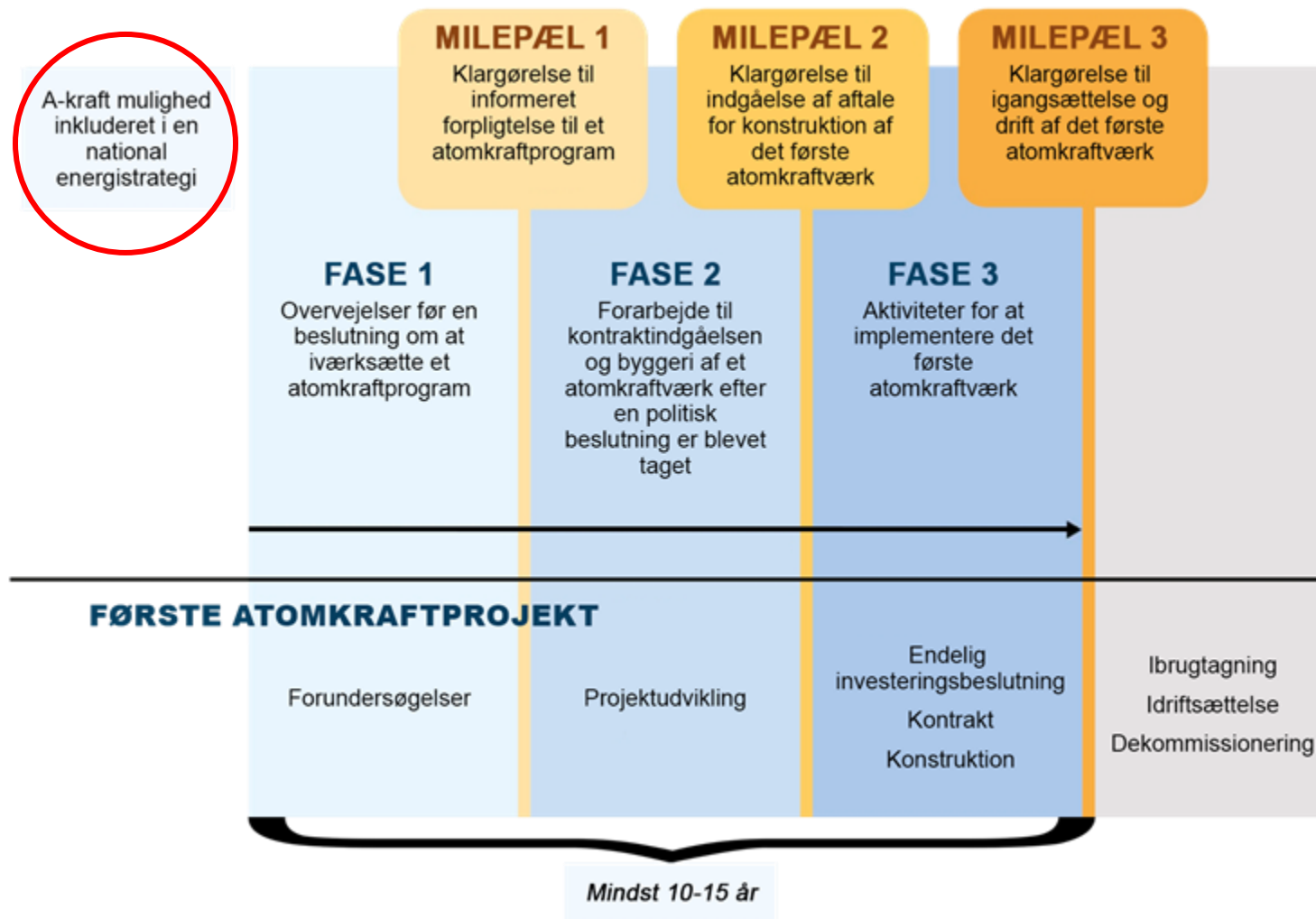
- Decarbonizing ?
- Economy ?



## Roadmap for nuclear power infrastructure development

(IAEA Milestones Approach)

- 1) Ready to commit to a nuclear energy programme
- 2) Ready to invite bids for construction
- 3) Ready to commission and operate







Thank you!