



TRENDS IN NUCLEAR POWER DEVELOPMENT IN SELECTED EUROPEAN COUNTRIES

Ondřej Novák
Václav Šísl

ondrej.novak2@fjfi.cvut.cz sislvacl@fjfi.cvut.cz

Department of Nuclear Reactors, Faculty of Nuclear
Sciences and Physical Engineering, CTU in Prague

Why nuclear energy

- energy security
- power supply stability
- generation adequacy
- low emission



European Union - Energy Roadmap 2050

- cut greenhouse gas emissions by 80–95 % by 2050
- electricity production needs to be almost emission-free, despite higher demand
- in this decade, a new investment cycle is taking place, as infrastructure built 30–40 years ago needs to be replaced.
- Nuclear energy will be needed to provide a significant contribution in the energy transformation process in those Member States where it is pursued. It remains a key source of low carbon electricity generation.



Energy policy of selected countries



Great Britain

- current capacity will be shut down
- life extension
- new unit construction
- import from France
- oil reserves diminish
- natural gas - almost 75% will be imported
- energy independency
- emissions reduction
- energy poverty is an issue in the UK



Current plans

- the energy secretary said: “Opponents of nuclear misread the science. It is safe and reliable. The challenge, as with other low carbon technologies, is to deliver nuclear power which is low cost as well. Green energy must be cheap energy.”
- currently - 15 operating reactors in the UK totalling 9.5 GWe capacity
- government ministers have consistently said that 16 GWe of new nuclear capacity should be built at five sites by 2025, though this target date has slipped to 2030



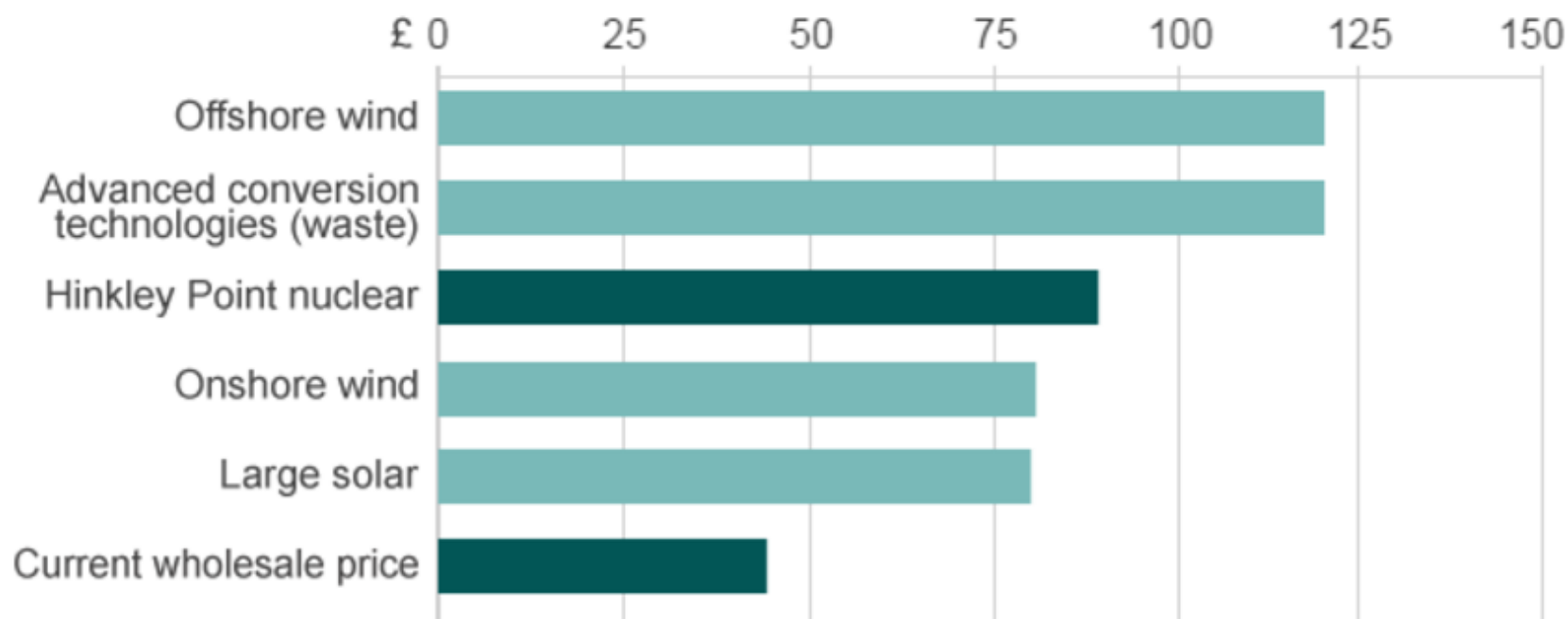
- 13 units ~ 17,900 MWe

Proponent	Site	Type	Start-up
EDF Energy	Hinkley Point C	2 EPR	2026-2027
EDF Energy	Sizewell C	2 EPR	?
Horizon	Wylfa Newydd	2 ABWR	2025
Horizon	Oldbury B	2 ABWR	late 2020s
NuGeneration	Moorside 1	3 AP 1000	2025 - 2027
China General Nuclear	Bradwell B	2 Hualong One	



Strike prices for new renewable energy projects in 2016-18

Price per megawatt hour the government has guaranteed for electricity*



*Prices represent the average price per Mwh agreed by the Department for Energy and Climate Change for projects commissioned for 2016/17 and 2017/18 during round one of CFD auctions in February 2015

Source: DECC, Ofgem

BBC



France

- 75% electricity from nuclear -> reduction to 50 % by 2025
- world's largest net exporter of electricity, gains over €3 billion per year from this.
- developed nuclear industry
- about 17% is from recycled nuclear fuel
- 58 reactors- 63.2 GWe
- 77% total generated



- thanks to that:
 - independence
 - extremely low emissions of CO₂
 - retail price very low
 - households - 8 c/KWh, 50 % of EU average
 - industry - 90 % of EU average



Energy Transition for Green Growth Bill

- nuclear power capacity cap at the present level of 63.2 GWe
- reduce greenhouse gas emissions by 40% by 2030 and by 75% by 2050
- to halve final energy consumption by 2050
- to reduce fossil fuel consumption by 30% by 2030
- increase the share of renewables in final energy consumption to 32% by 2030

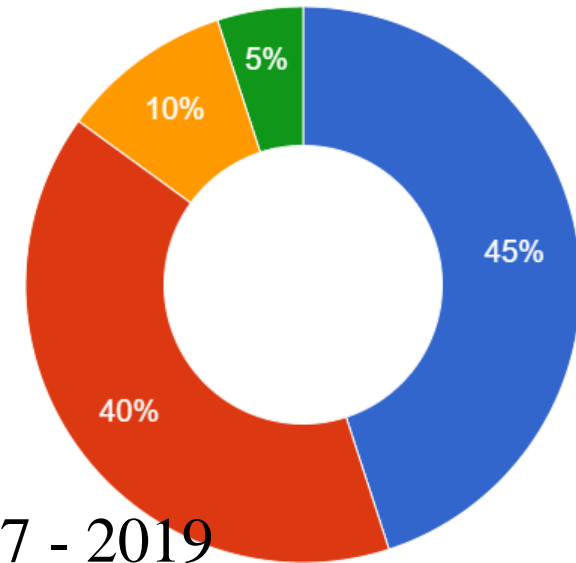


Future

- one 1650 MWe unit will be added each year
- Generation IV sodium-cooled fast reactor



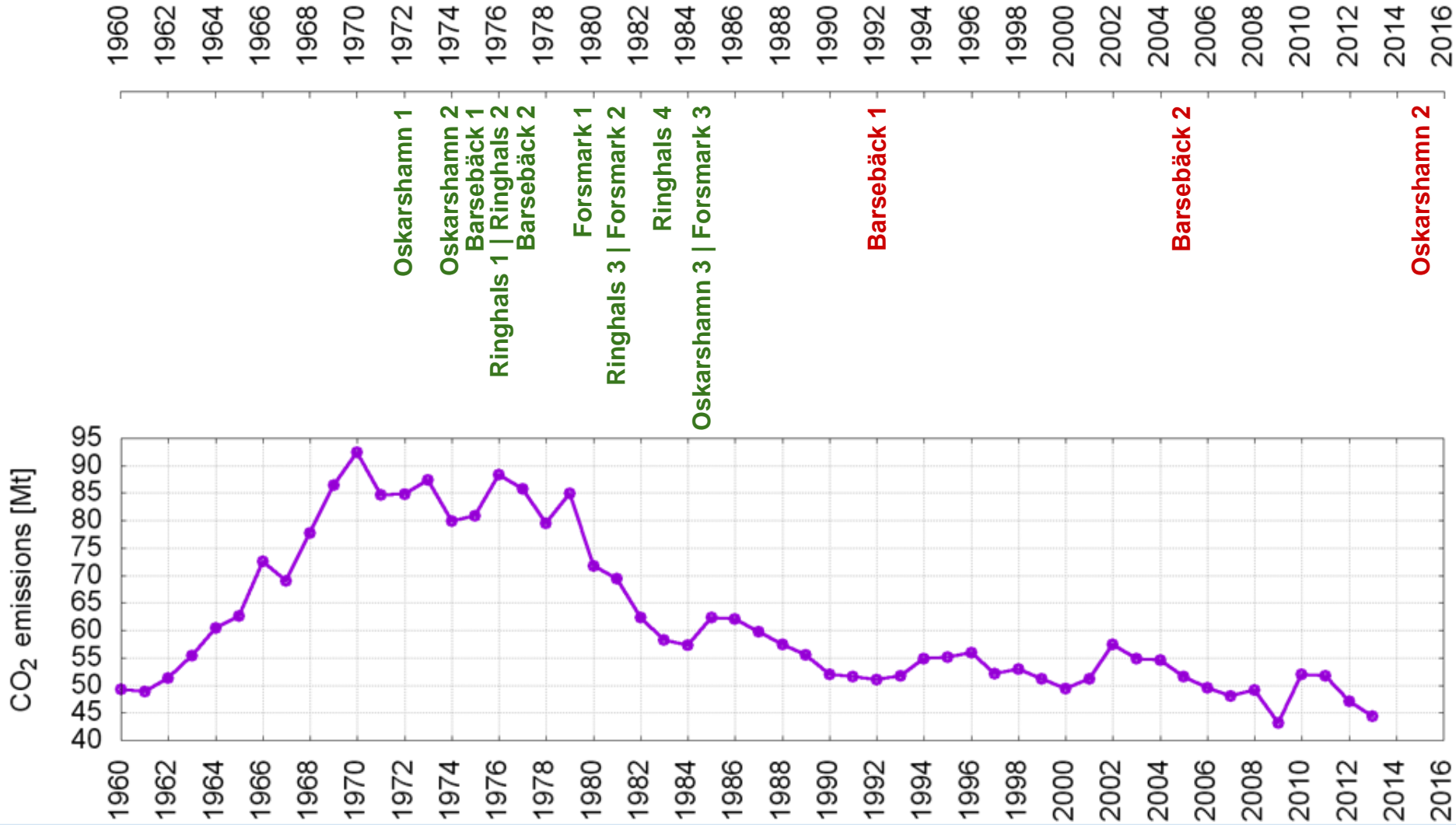
Sweden



- low-carbon electricity production
- 9 reactors in operation - 8.85 GWe
- june 2016 - change in energy policy
 - *capacity tax* to be cancelled between 2017 - 2019
 - current reactors are expected (but not required) to close till 2050
 - 3 units till 2020
 - 6 units between 2040 and 2050
 - up to 10 new units are allowed to be build as a replacement for current units



Sweden

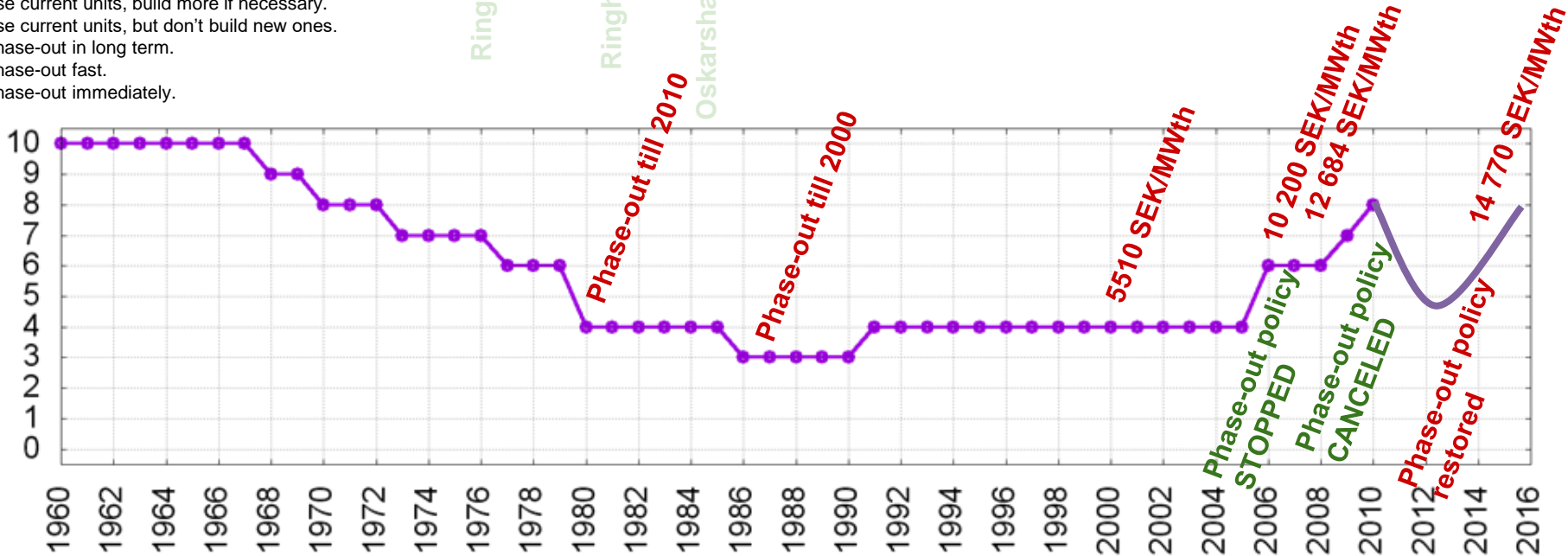


Sweden

1960 1962 1964 1966 1968 1970 1972 1974 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016

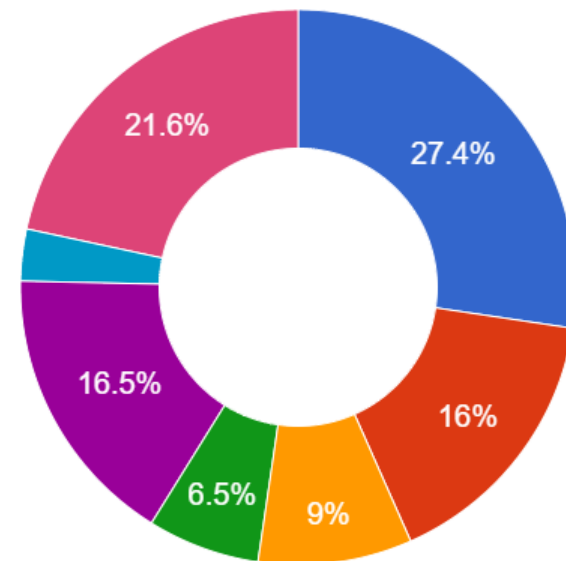
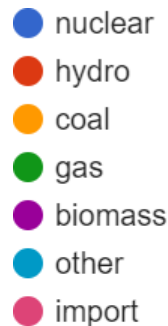
Oskarshamn 1
 Oskarshamn 2
 Barsebäck 1
 Ringhals 1 | Ringhals 2
 Barsebäck 2
Three Mile Island referendum
 Ringhals 3 | Forsmark 2
 Ringhals 4
 Oskarshamn 3 | Forsmark 3
Chernobyl
 Barsebäck 1
 Barsebäck 2
Fukushima
 Oskarshamn 2

- *10 - Build more nuclear reactors.
- 8 - Use current units, build more if necessary.
- 6 - Use current units, but don't build new ones.
- 4 - Phase-out in long term.
- 2 - Phase-out fast.
- 0 - Phase-out immediately.



Finland

- pillars of energy policy
 - diversification
 - **decreasing import dependence**
 - fossil fuels - Russia, Poland
 - electricity - Sweden
 - strategic reserves
 - deepening integration in the Nordic electricity market
 - lowering CO₂ emissions and energy consumption



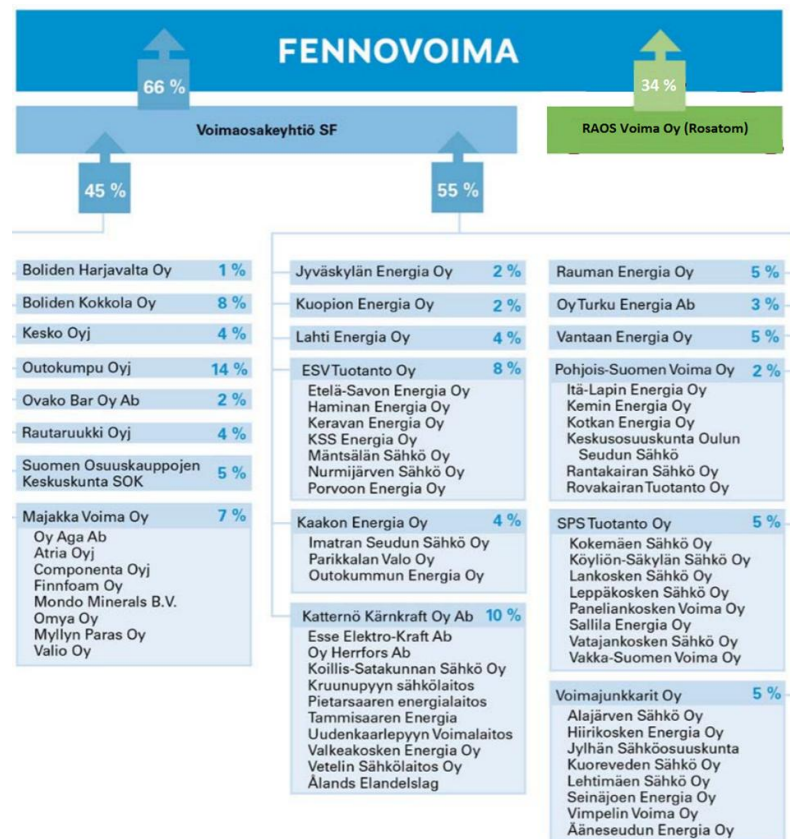
Finland - nuclear power units

	Operator	Type	MWe net	First power	Shut down
Loviisa 1	Fortum	VVER-440	488	1977	2027
Loviisa 2	Fortum	VVER-440	488	1980	2030
Olkiluoto 1	TVO	BWR	885	1978	2039
Olkiluoto 2	TVO	BWR	880	1980	2042
Olkiluoto 3	TVO	EPR	1640	2018?	
Hanhikivi 1	Fennovoima	VVER-1200	1200	2024	



Finland - Mankala Model

- joint venture of industry and energy companies, municipalities and other subjects for purpose of electricity production
 - electricity for operation costs
 - stability of price
 - cost- and risk-sharing**
- e.g. TVO, Fennovoima



Conclusion



Conclusion

- long term prediction of electricity prices are hard to estimate, similar to fuel prices => long term strategy is key
- low emission energy
- unique approach of each country
- after years of stagnation, new arise is happening
- role of government is vital



Thank you for your attention



Sources

- [European Commission Energy Roadmap 2050](#)
- [world-nuclear.org - United Kingdom](#)
- [world-nuclear.org - France](#)
- [world-nuclear.org - Sweden](#)
- [world-nuclear.org - Finland](#)
- [Energy Policies of IEA Countries - Sweden 2013](#)
- [Energy Policies of IEA Countries - Finland 2013](#)
- [France's Nuclear Storm: Many Power Plants Down Due to Quality Concerns](#)

