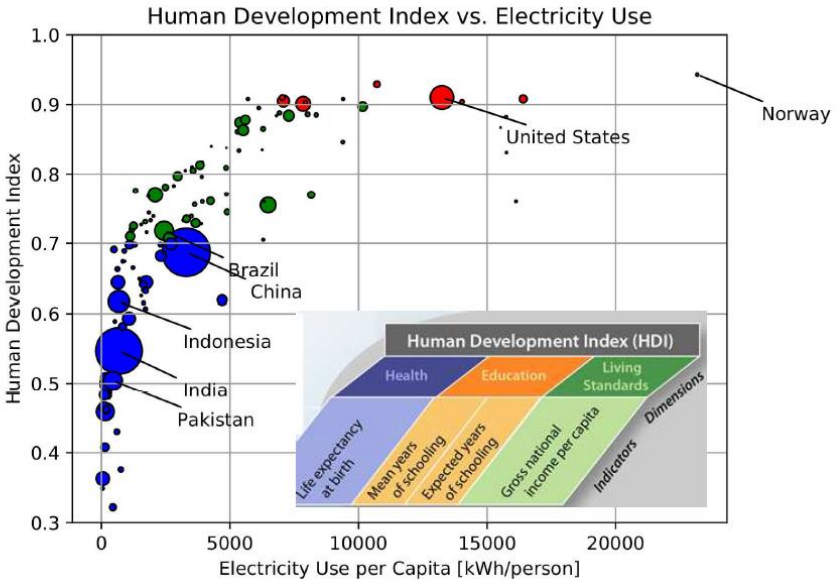
The Role of Nuclear in Future Energy Systems

Ms Daniela Lulache
Head of the Office of Policy and Co-ordination
OECD Nuclear Energy Agency

Entretiens européens
Helsinki (Finland), 12-13 November 2019

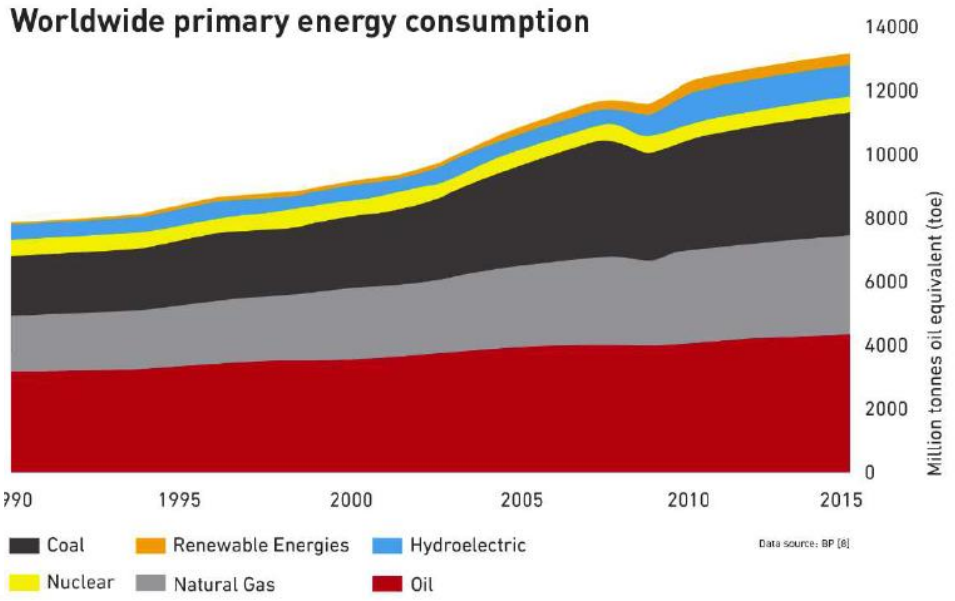
The key dilemma is how to meet energy demand growth while limiting global warming

The World will need a lot more energy.



Global electricity consumption is projected to grow by 60% by 2040.
(source: WEO, 2018, NPS)

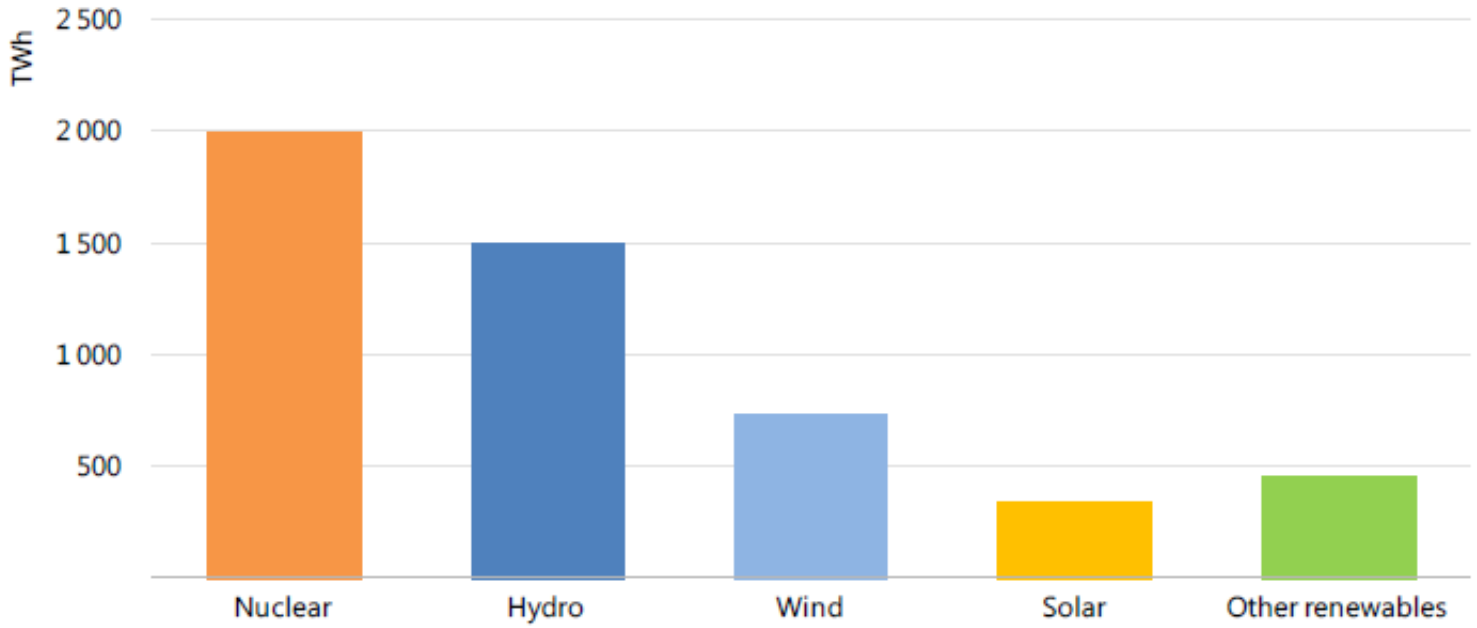
Fossil fuels represent 80% of the world energy mix.



CO_2 emissions are rising: +2% in 2018.
(source: WEO, 2018)

Nuclear remains the leading low-carbon source of electricity in advanced economies

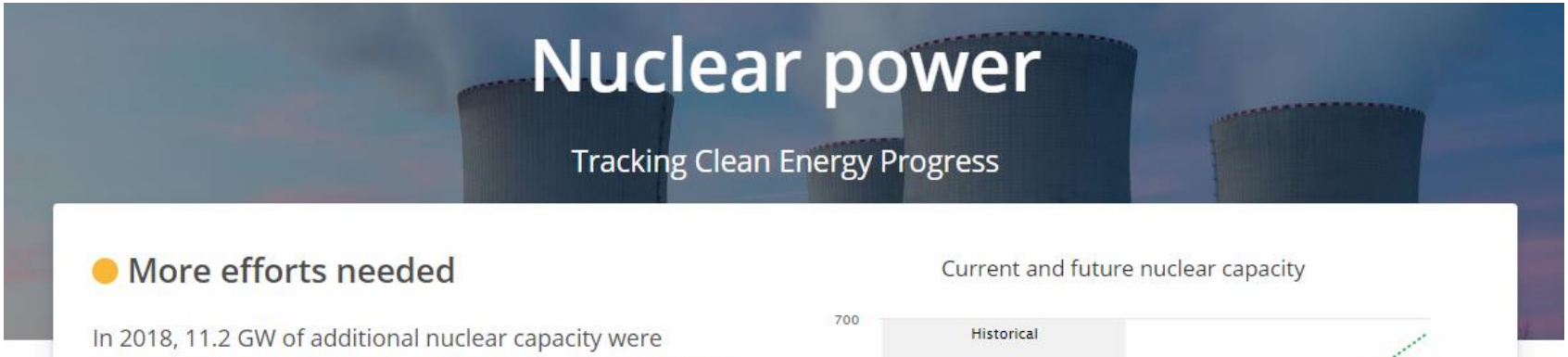
Low-carbon electricity generation in advanced economies by source, 2018.



Without nuclear power, CO2 emissions from electricity generation would have been almost 20% higher over the last 50 years.

More efforts needed for nuclear power to meet climate objectives

https://www.iea.org/tcep/power/nuclearpower/



More efforts needed

In 2018, 11.2 GW of additional nuclear capacity were connected to the grid, the largest increase since 1989. New projects were launched representing over 6 GW, and refurbishment projects are under way in many countries to ensure long-term operation of the existing fleet. Nevertheless, more efforts in terms of policies, financing and cost reductions are needed to maintain existing capacity and bring new reactors online. Under current trends, nuclear capacity in 2030 would amount to 497 GW, compared with 542 GW under the SDS. At least a doubling of the annual rate of capacity additions is therefore required.

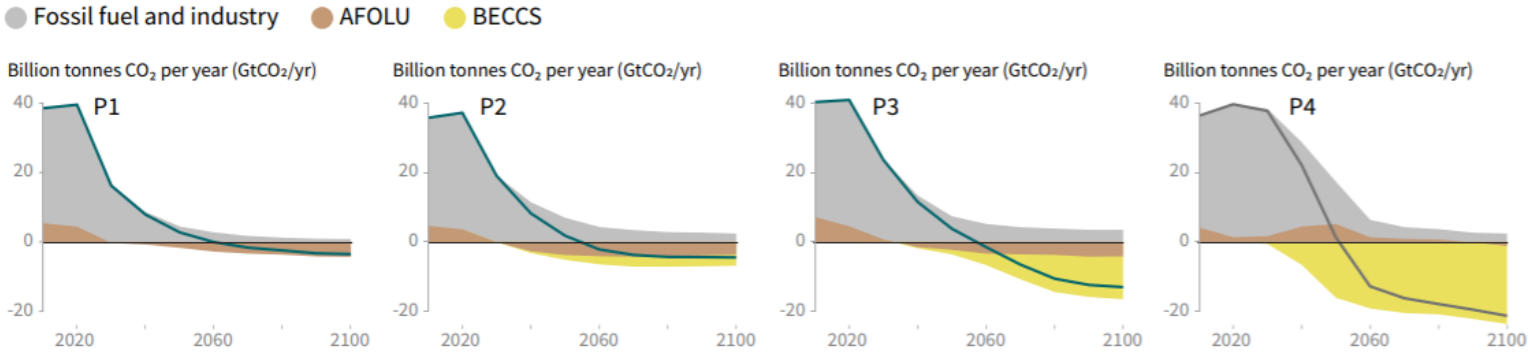
Current and future nuclear capacity

This section was authored by the Nuclear Energy Agency, Division of Nuclear Technology Development and Economics (NTE)

Henri Paillere, Malisol Ohirko
Lead author

IPCC: Nuclear power a key pillar to meet climate objectives under the Paris Agreement

Latest IPCC report: contributions to global net CO_2 emissions in four pathways.



P1: A scenario in which social, business and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4: A resource- and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

Nuclear in 2050 compared to 2010:

P1	P2	P3	P4
+150%	+98%	+501%	+458%

Source: IPCC, 2018

Future of nuclear is uncertain
IEA report, May 2019: calling for a policy change

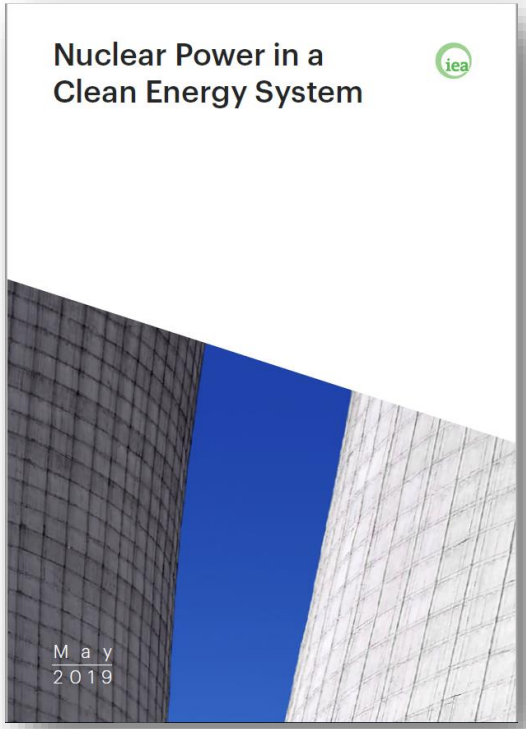
Steep decline in nuclear power would threaten energy security and climate goals

28 May 2019

A new IEA report finds nuclear power capacity in advanced economies could fall sharply, making the global energy transition harder and more costly.

VANCOUVER – With nuclear power facing an uncertain future in many countries, the world risks a steep decline in its use in advanced economies that could result in billions of tonnes of additional carbon emissions, according to a new report by the International Energy Agency.

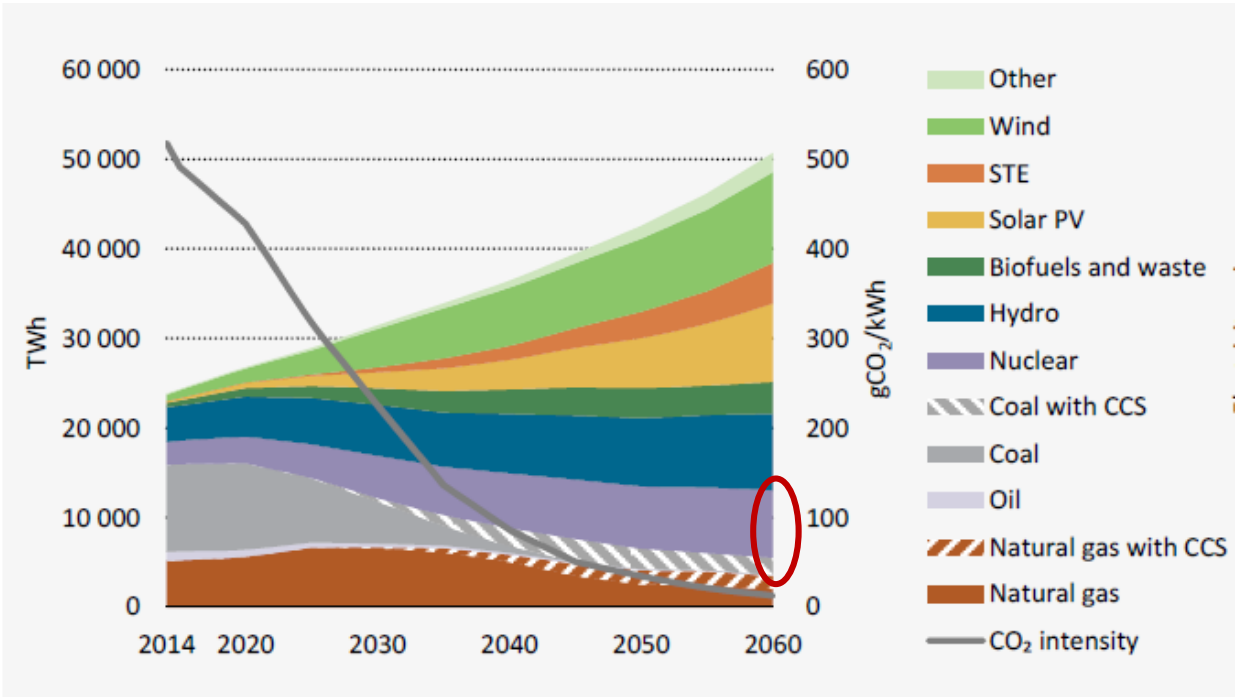
Nuclear is the second-largest low-carbon power source in the world today, accounting for 10% of global electricity generation. It is second only to hydropower at 16%. For advanced economies – including the United States, Canada, the European Union and Japan – nuclear has been the biggest low-carbon source of electricity for more than 30 years and remains so today. It plays an important role in electricity security in several countries.



F. Birol: "*Despite the impressive growth of solar and wind power, the* ***overall share of clean energy sources in total electricity supply in 2018, at 36%, was the same as it was 20 years earlier*** *because of the decline in nuclear*"

Role of nuclear in future low carbon electricity mix

IEA projects an increase in the share of nuclear electricity (from 10% to 15-16%), as well as a massive increase in renewables, together with a *complete phase-out* of coal and oil, a drastic decrease of gas & the deployment of CCS, to meet " 2°C or less" objectives.



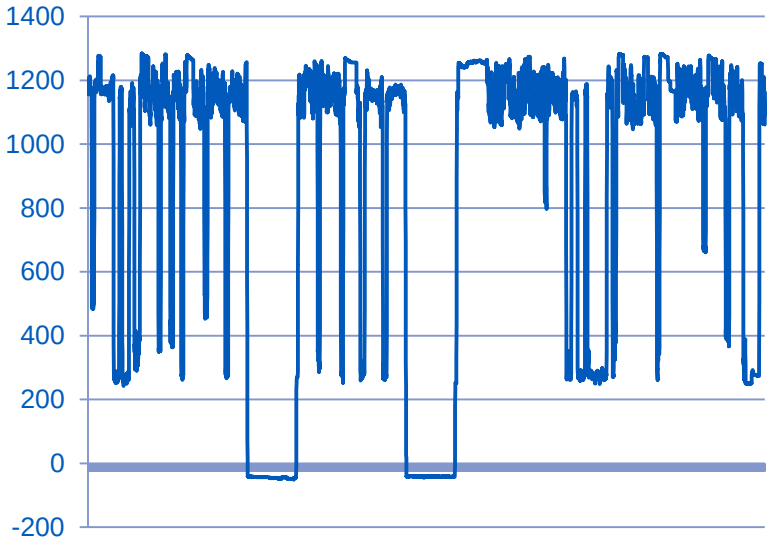
Nuclear (and other "baseload" generators) will need to **co-exist with large shares of variable renewables.** *What attributes should nuclear have to ensure it can play its full role?*

Source: IEA Energy Technology Perspectives, 2017 – (2 degree scenario (2DS).

67% renewables incl. 30% wind/solar.
16% nuclear.

In Europe, nuclear and renewables are complementary to decarbonise the electricity mix

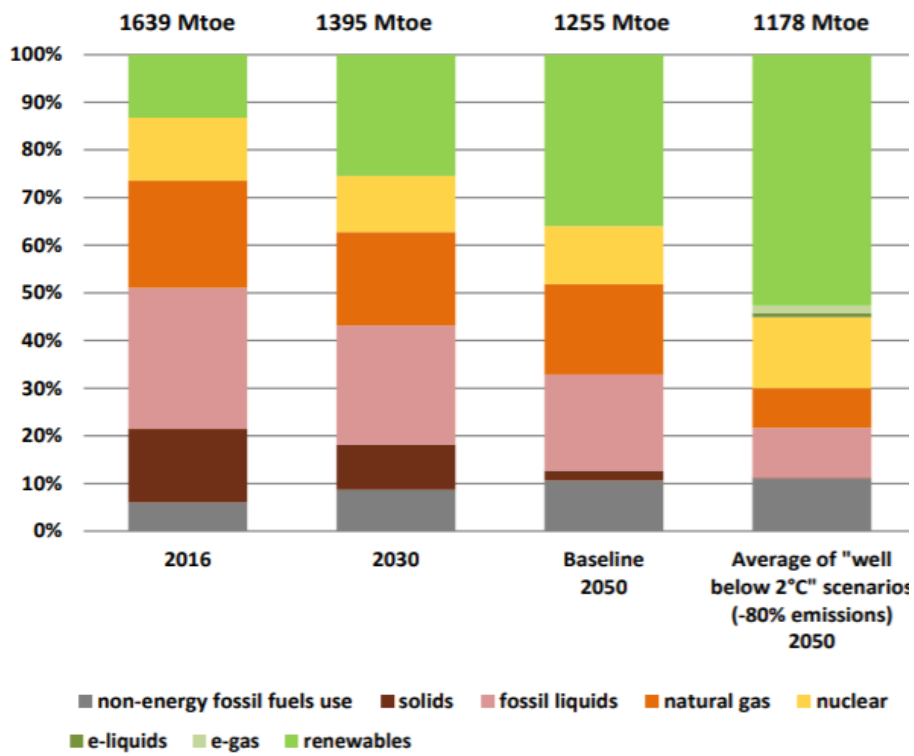
Today nuclear reactors are flexible which fosters the integration of renewables.



Example of EDF Golfech-2 nuclear reactors load-following in France (summer 2013).

Source: data from RTE.

EU long term energy strategy : nuclear and renewables the backbone of the future energy mix.



Source: EC Long Term Energy Strategy (2019).

New flexibility attributes for tomorrow's nuclear energy systems

Expanded Flexibility Adds Value and Supports Reliability, Resilience

Attribute	Sub-Attribute	Benefits
Operational Flexibility	Maneuverability	Load following
	Compatibility with Hybrid Energy Systems and Polygeneration	Economic operation with increasing penetration of intermittent generation, alternative missions
	Diversified Fuel Use	Economics and security of fuel supply
	Island Operation	System resiliency, remote power, micro-grid, emergency power applications
Deployment Flexibility	Scalability	Ability to deploy at scale needed
	Siting	Ability to deploy where needed
	Constructability	Ability to deploy on schedule and on budget
Product Flexibility	Electricity	Reliable, dispatchable power supply
	Process Heat	Reliable, dispatchable process heat supply
	Radioisotopes	Unique or high demand isotopes supply

30 www.epri.com EPRI ELECTRIC POWER RESEARCH INSTITUTE

Source: A. Sowder (EPRI), NEA workshop Advanced Reactors and Future Energy Market Needs (ARFEM), 4 Sept 2019, https://www.oecd-nea.org/download/nssnexus/WorkshopARFEM4September2019.html.

Several nuclear cogeneration applications with often well proven technical feasibility

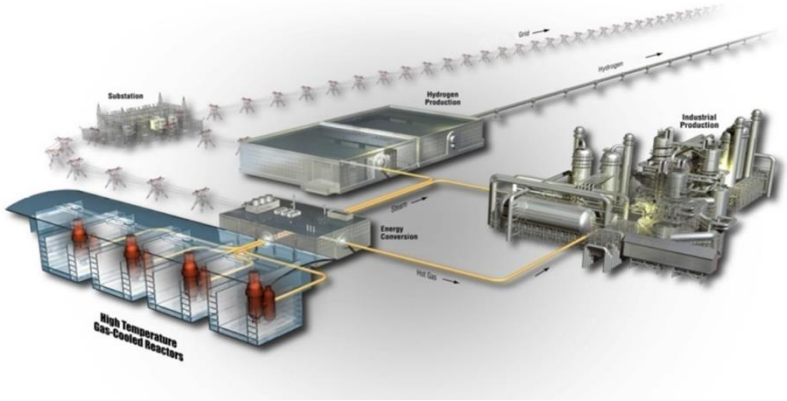
District heating

swissnuclear
Nuclear Energy Section of swisselectric

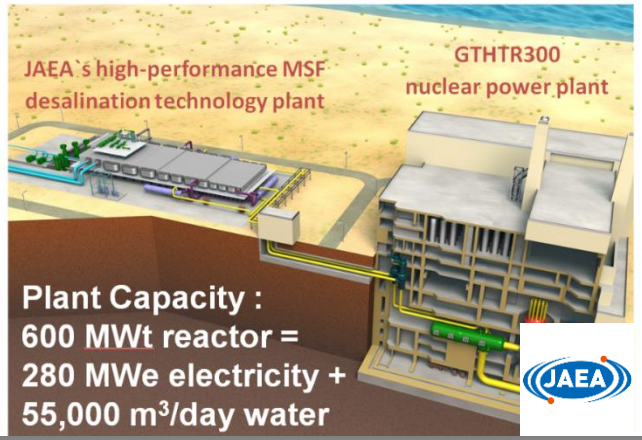
Steam extraction from NPP Beznau

- Max. connection load 76 MW_{th}
- Length: 146 km (total 290 km)
- Heat sold: 150 GWh per year
- Grid connection to 11 communities
- Thermal power for 2600 connections (households, commerce and industry)
- Five backup heating plants (oil and waste)
- Set up end of 1970s to beginning of 1980s (oil crisis)

Process heat (chemical, oil, bio-refineries, H2)



Desalination



Some take-aways

- Current fleet provides ~10% of the world's electricity, the second largest source of low carbon electricity. Ageing fleet – **LTO major issue** in coming years.
- Replacing the existing fleet and deploying new build to produce 15-16% of global electricity will require major **new build investments.**

- **Policy change** and **better public support** needed to ensure success:
  - valuation of nuclear attributes: CO_2-free, security, reliability, dispatchability;
  - financing framework for nuclear new build.

- **Innovations** are needed:
  - to reduce costs of Gen III/III+ reactors;
  - to ensure success (costs, manufacturability, flexibility) of SMRs and Gen IV;
  - to demonstrate at industrial scale nuclear non-electric applications.

- Need better **communication** on benefits of nuclear as part of future clean energy systems.

Thank you for your attention