The role of nuclear in the future energy system – a power producer's perspective

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Energy crisis in Europe – CO_2-free nuclear power reduces energy dependence on Russia in the ongoing transition

Reduce reliance on **Russian gas**, while ensuring security of supply

EC mandate challenges the future role of gas putting stress on baseload solutions

Nuclear included in European **Taxonomy**

The inclusion of nuclear is a positive signal of political acceptability as climate friendly technology. This is a key driver for private investments in Nuclear.

Decarbonization will need to speed up while ensuring system balance

All IEA 2 °C scenarios require emissions to be minimized by 2050, not only power sector but also hard-to-abate sectors. Not only renewables, but also firm capacity is needed.

Increasing electricity demand driven by industry electrification

Global demand to double by 2050 will imply large capacity additions required to meet demand

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Nuclear is important for maintaining balance of the electricity system

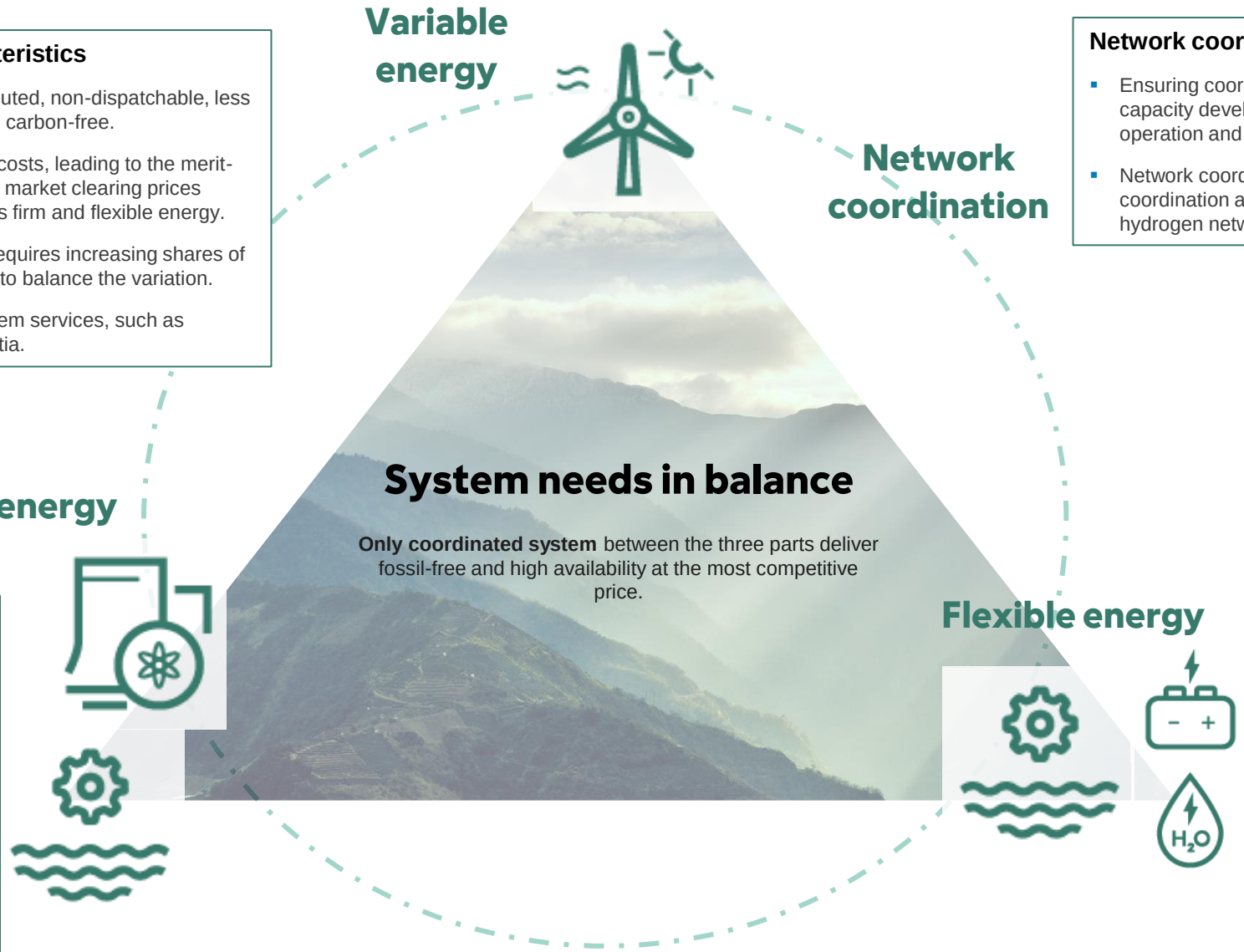
Firm and flexible energy maintains system balance while variable energy share increases

Variable energy characteristics

- Weather dependent, distributed, non-dispatchable, less predictable, renewable and carbon-free.
- Low production (marginal) costs, leading to the merit-order effect of reducing the market clearing prices which in turn disincentivizes firm and flexible energy.
- The production variability requires increasing shares of flexible and firm capacities to balance the variation.
- Limited contribution to system services, such as frequency stability and inertia.

Network coordination characteristics

- Ensuring coordination between network and capacity developments and transparent system operation and congestion management
- Network coordination also refers to integrated coordination among power, district heating, gas/ hydrogen networks.



Firm energy characteristics

- Firm resources are synchronously connected generators that momentarily keep the system in a normal operation, ~ 50 Hz.
- Typical technologies are hydro, biomass, nuclear power.
- Supports system function and delivery in all weathers and at all hours of the day through scheduling and the provision of important support services.

Flexible energy characteristics

- Balances the system in the short and long term, ensures system restoration capability.
- Typical technologies are storages, DSR, hydro, thermal.
- Primary tasks include frequency stability, voltage stability and rotor angle stability.
- The need for flexible energy is linked to security targets, and the shares of non-dispatchable power in the system.

Data source: Compass Lexecon study for Fortum

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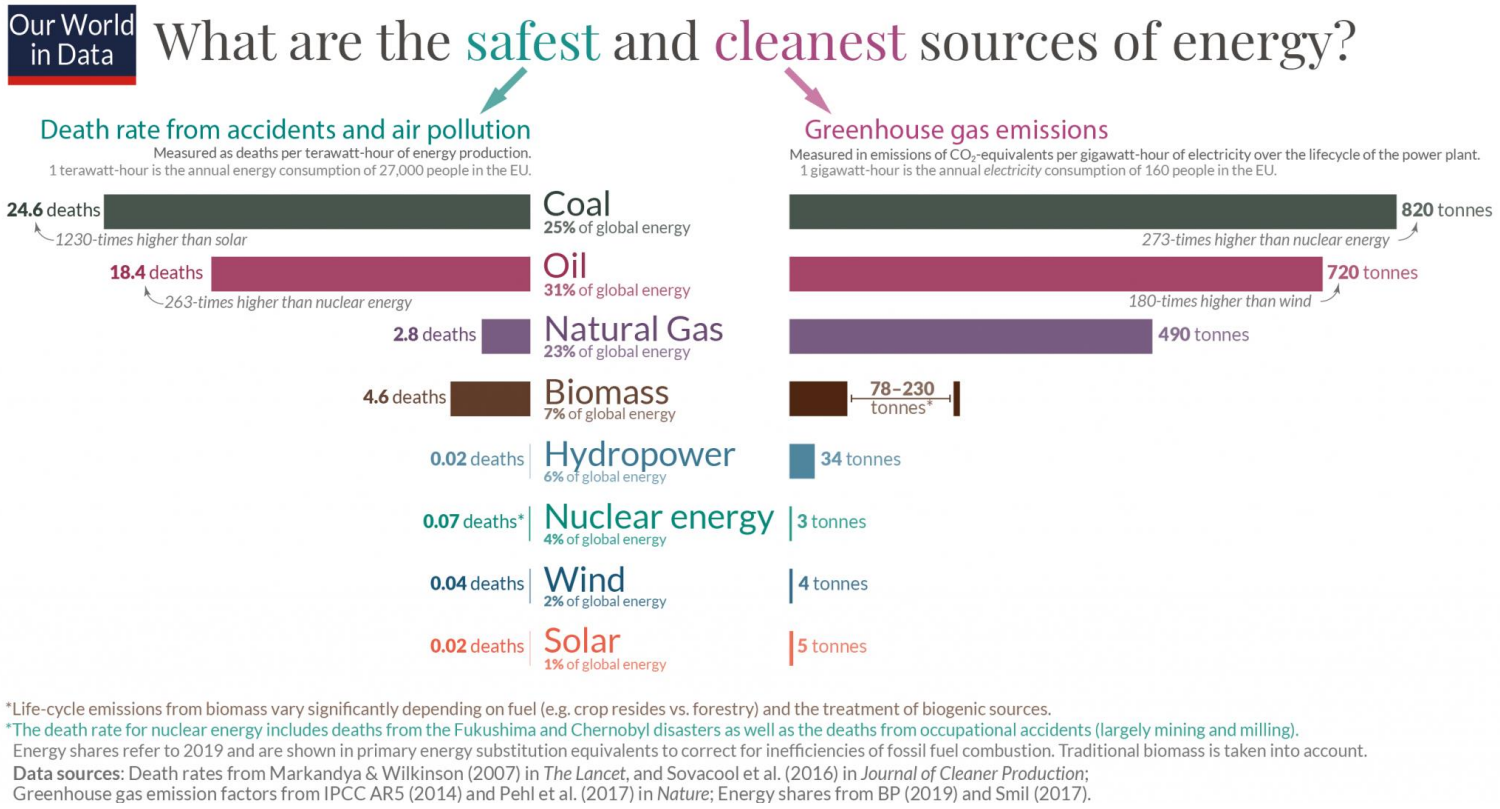
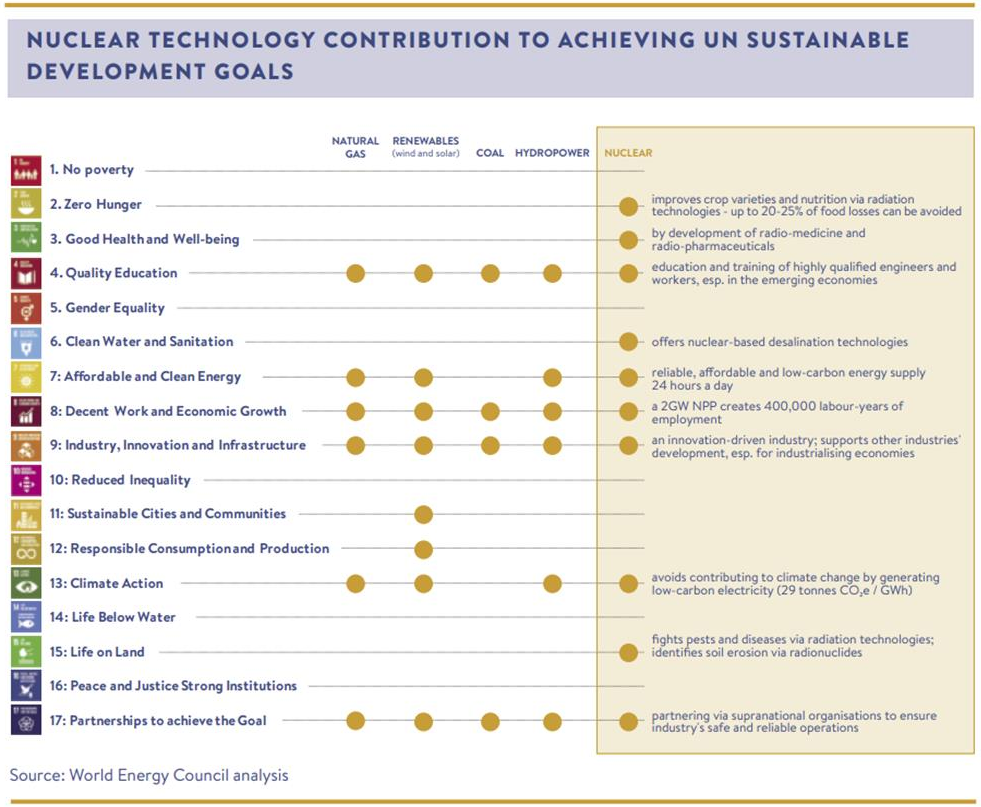
Nuclear is well positioned to play an important role in decarbonization

Safety in combination with clean and sustainable production are key enablers





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There is a significant amount of innovation taking place for nuclear to become more competitive, particularly SMR development

Key Dimension	Small Modular Reactors (SMR)
Economics	**New design concepts and lower absolute capital investment / financing costs are expected to drive down cost for SMRs**
Safety	Usage of **simple but robust** passive safety **systems.** Need for only a **small emergency planning zone.** Siting close to residential areas with district heating demand possible
Scalability	Plant **capacity expansion** after deployment comparably easily possible by **installing additional modules** into existing (prepared) buildings without need for significant plant modification.
Flexibility	Design-dependent **application flexibility**, including also heat supply for industrial purposes (e.g. desalination other process heat) as well as heat only supply for **district heating** and **co-generation**
Deployability	Possibility to be deployed also at small sites that lack infrastructure for large NPP, remote areas with **small grids** and in relatively **short construction times** (approximately 2-4 years[1)])
Implication	**SMRs are safe, simple and cost competitive plants that are expected to be easily deployed and be applied flexibly for a variety of electricity and / or heat target applications**

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Important to develop the business model!

The typical “merchant electricity” business model may become challenging in the future

Due to the volatility of the electricity price and an abundance of low-cost intermittent RES in the future, the historical business model (i.e. merchant electricity w/o subsidies) may become risky and difficult to proceed with for nuclear operators

Improved business models and financial securing mechanisms must be used to:

Increase and diversify the income streams
Secure the income
Optimize the CAPEX exposure
Optimize the OPEX costs

In our view there are three concrete opportunities to secure nuclear economics:

Co-generation

Other end-products than electricity can be generated to limit the exposure to the electricity market.

The synergies with e.g. heat production, hydrogen, e-fuels represent promising diversification and growth opportunities.

Partnerships

Finding reliable partners enables sharing the risks and the costs of the projects, including possible co-investment models.

Global partnerships can be created involving utilities, end-users (industrials), vendors and also regulators. Topics such as licensing and technology assessments are particularly appropriate.

Financial securing mechanisms

Long-term agreements such as PPAs (Power Purchase Agreement), CFDs (Contract For Difference) or RAB (Regulated Asset Base) can be used to limit the economical risks of nuclear projects.

These mechanisms can be agreed either with end-users (industrials) willing to control their own costs or with a state as part of a national energy policy.

Nuclear is a core business of Fortum, and we are developing for the future

Fully-owned nuclear power plant in Loviisa, Finland and co-owned nuclear power plants in Finland and Sweden

3rd largest Nuclear generator in Europe

Nuclear production 36,4 TWh total

3rd largest CO_2-free power generator in Europe

Expertise from new builds to decommissioning and final disposal of nuclear waste

We develop new innovative products and services

Well-positioned to utilize small modular reactors (SMRs) with nuclear expertise and knowhow on power and district heating

Strong nuclear safety and engineering competence for own fleet and customers

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Thank you!

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