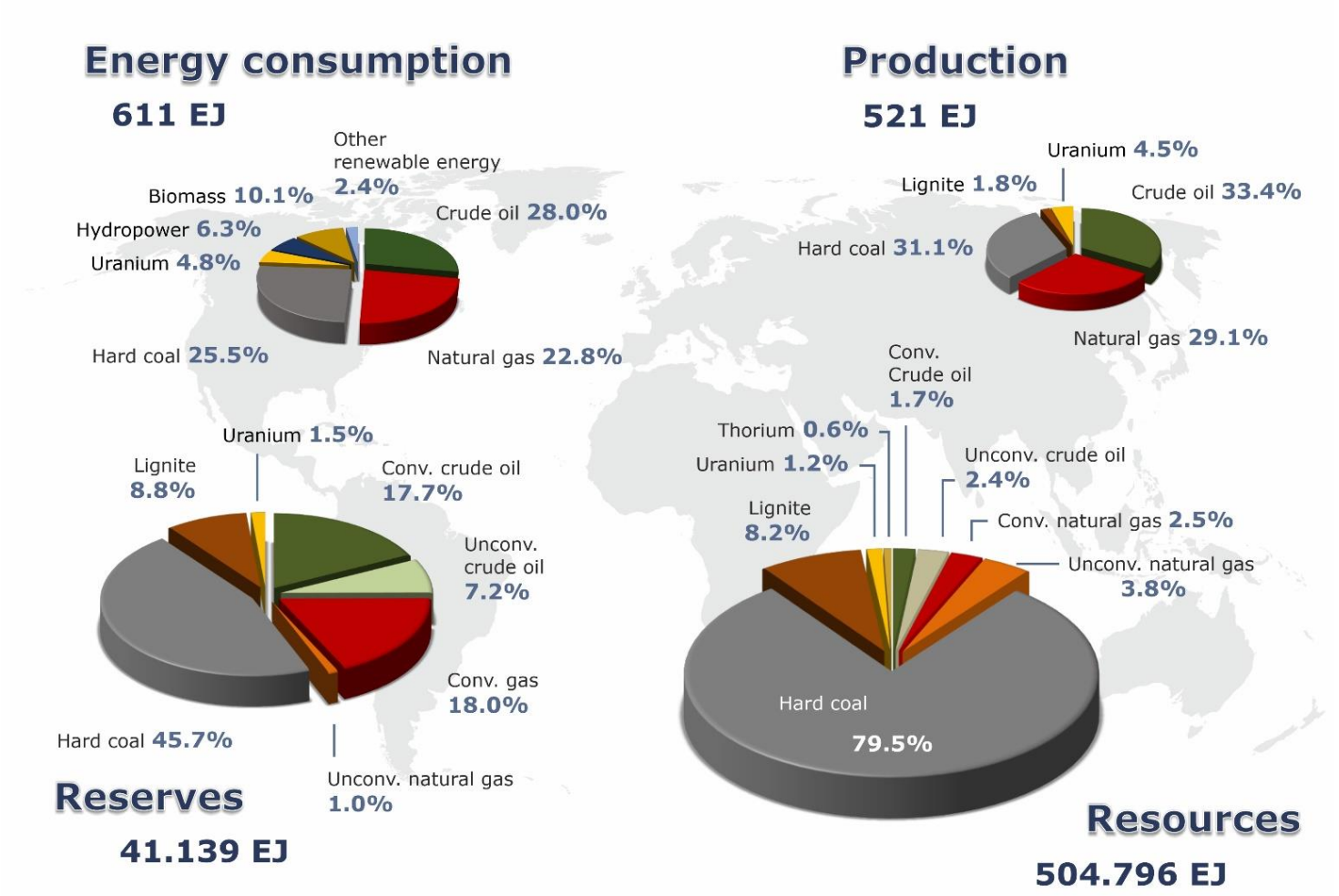
TECHNISCHE UNIVERSITÄT BERLIN

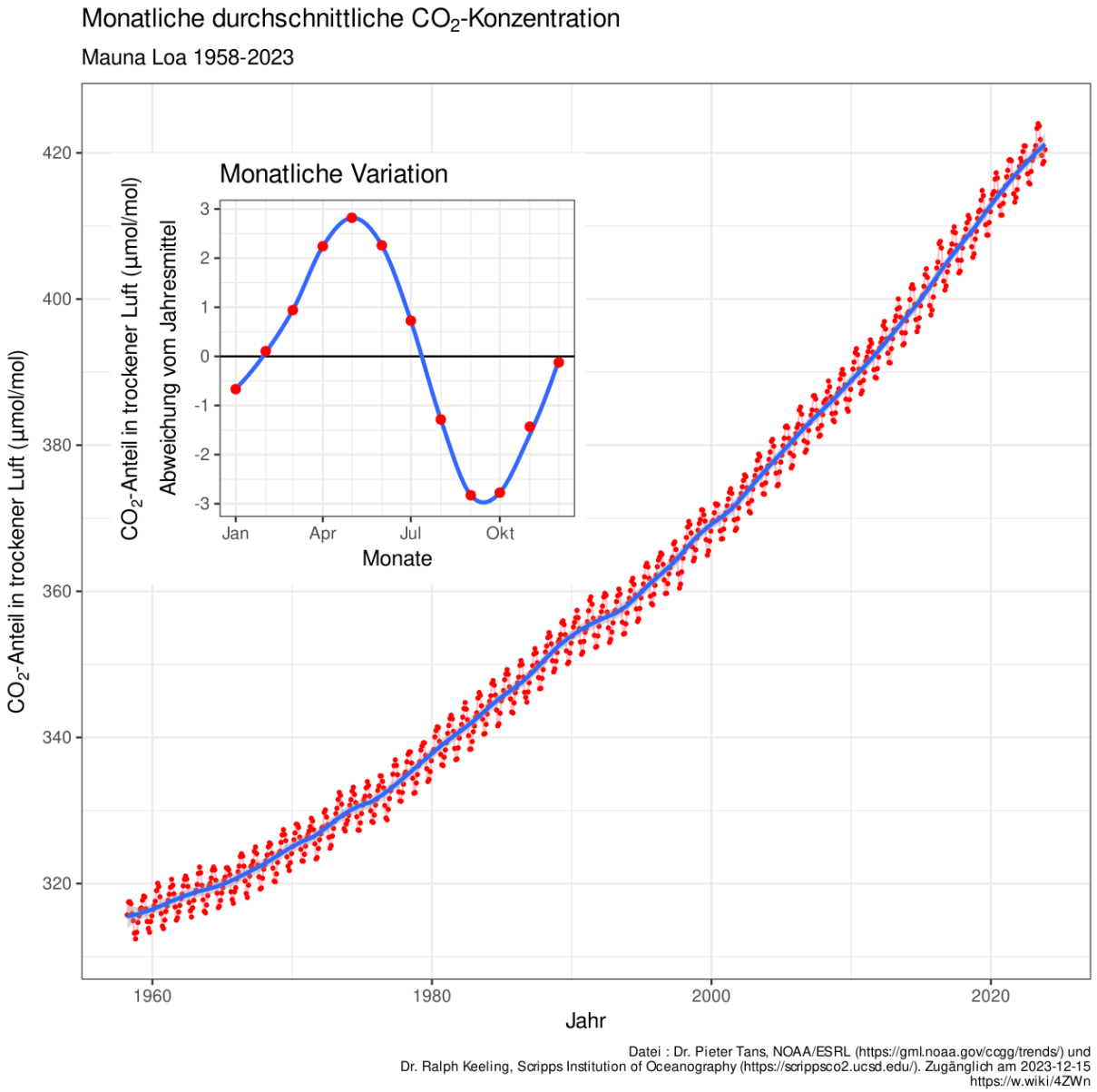
Energy Supply as a Challenge
- Remarks on Sustainability

Prof. Dr. Frank Behrendt

A Starting Point to be kept in Mind
- Reserves and Resources



Global shares of all energies and energy sources in consumption (Data from: IEA World Energy Outlook 2021) and of non-renewable energy commodities in production, reserves and resources for the end of 2020
(Source: BGR Energy Study 2021)



So why give up fossil fuels? The Keeling Curve

The Keeling curve reflects the measurement of the CO_2 concentration in the atmosphere, which has been carried out on Mauna Loa in Hawaii since 1958. It is the longest-running measurement of its kind in the world.

The CO_2 measurement program at the Scripps Institute (CA, USA) was initiated by Charles David Keeling in 1956 and continued under his direction until his death in 2005. It is currently being continued by his son Ralph F. Keeling.

Sustainability – Not a totally new concept

Hans Carl von Carlowitz (1645-1714)

- Von Carlowitz wrote his book at a time of crisis. The ore mines and smelters of the Erzgebirge region (at that time one of the largest mining areas in Europe) had to be supplied with a lot of wood as a source of energy and raw materials (e.g., for 2 Fe_2O_3 + 3 C > 4 Fe + 3 CO_2).
- In addition, population and urban growth contributed significantly to the "wood shortage".
- There were no controlled silviculture and laws, ecological standards or certifications for afforestation.
- Deforestation, land use change and direct competition with other economic activities still play a major role in the use of wood as a fuel and raw material.

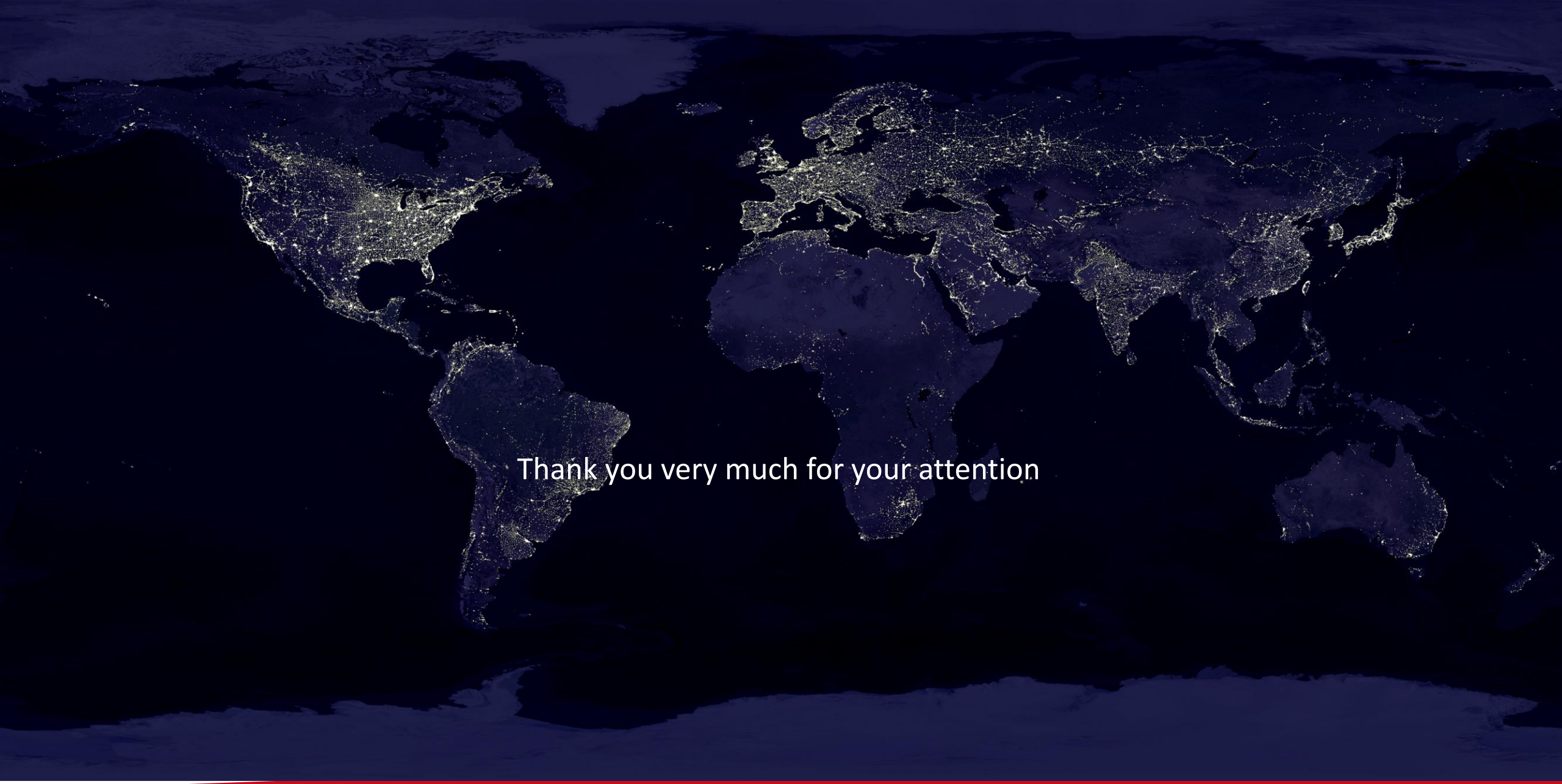
How new are the technologies that are in focus today?

Silicon solar cell

- **1839**: Alexandre Edmond Becquerel discovers the photovoltaic effect, demonstrating that light can generate electric current.
- **1873**: Willoughby Smith discovers the photoconductivity of selenium.
- **1883**: Charles Fritts creates the first selenium-based solar cell, achieving less than 1% efficiency.
- **1954**: Bell Labs develops the first practical silicon solar cell with 6% efficiency, marking a major breakthrough.
- **1970s**: The energy crisis drives interest and investment in solar technology, leading to improvements in efficiency and cost.
- **1980s**: Photovoltaic technology begins to see wider use in remote and off-grid applications.
- **2000s**: Advancements in materials and manufacturing processes significantly reduce the cost of solar panels.

Fuel cell

- **1839**: Sir William Grove invents the first fuel cell demonstrating the principle of generating electricity through chemical reactions.
- **1932**: Francis Thomas Bacon develops the alkaline fuel cell (AFC), improving the technology for practical use.
- **1959**: Bacon demonstrates a 5 kW stationary fuel cell system.
- **1960s**: NASA uses hydrogen-oxygen fuel cells in space missions for onboard electricity and water production.
- **1980s**: Renewed interest in fuel cells for automotive and stationary power applications due to their efficiency and low emissions.
- **1990s**: Development of proton exchange membrane (PEM) fuel cells.
- **2000s**: Commercialization efforts accelerate, with various companies and governments investing in fuel cell technology for clean energy solutions.


Thank you very much for your attention

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