Relevance and Costs of Long- and Short-Term Energy Storage Systems

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Introduction

- EU’s goal: Carbon neutrality by 2050.

- Challenge: Intermittency of renewable energy sources (solar, wind).

- Solution: Long-Term Energy Storage (LTES) systems.

Role of Long-Term Energy Storage (LTES)

- Captures excess renewable energy during high production.

- Provides energy during low production (e.g., winter or calm periods).

- Enhances grid stability and resilience.

Examples of LTES Technologies and economic input

- Pumped Hydro Storage (PHS):Seasonal, large-scale, 70-85 % efficiency, mature tech
- Hydrogen Storage: Seasonal, transportable, 40-70 % efficiency, proven but expensive
- Flow Batteries: Scalable, 50-80 % efficiency, proven but still problems with control technology
- CAES: weekly - monthly, 40–70 % efficiency, Site-specific, proven tech
- Thermochemical: seasonal, 40–70 % efficiency, High density, still nascent

Technology	**CAPEX (€/kWh)**	**OPEX (%/yr)**	**Lifespan (years)**
Hydrogen	180–550	2–5 %	20–30
PHS	370–440	~ 2 %	50–100
CAES	270–550	1–2 %	30+
Flow Batteries	350 - 600	2-4 %	20 - 30

Advantages of LTES

- Energy Security: Reduces reliance on fossil fuels.

- Grid Stability: Provides frequency regulation and voltage support.

- Decarbonization: Enables higher renewable energy penetration.

- Flexibility: Supports electrification of other sectors (e.g., transport, heating).

Disadvantages of LTES

- High Costs: Significant upfront investment.

- Efficiency Challenges: Lower round-trip efficiency for some technologies (e.g., hydrogen).

- Infrastructure Needs: Requires suitable geological or physical conditions.

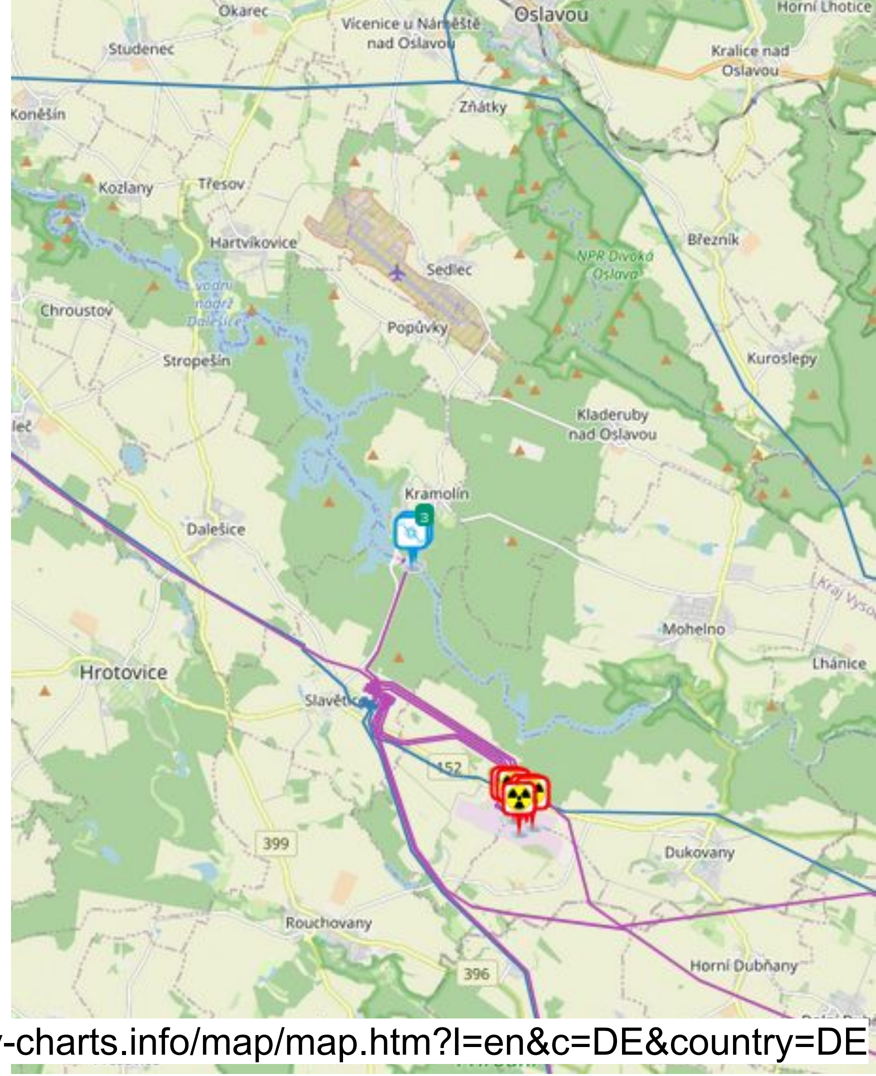
- Safety Concerns: Hydrogen storage and thermochemical systems face safety risks

Case Study: Czech Republic

- Pumped Hydro Storage (PHS): Examples include Dlouhé Stráně (650 MW, 3.7 GWh)

- Battery Energy Storage Systems (BESS): Emerging, supported by new regulations

- Hydrogen Storage: Underground facilities for seasonal storage.



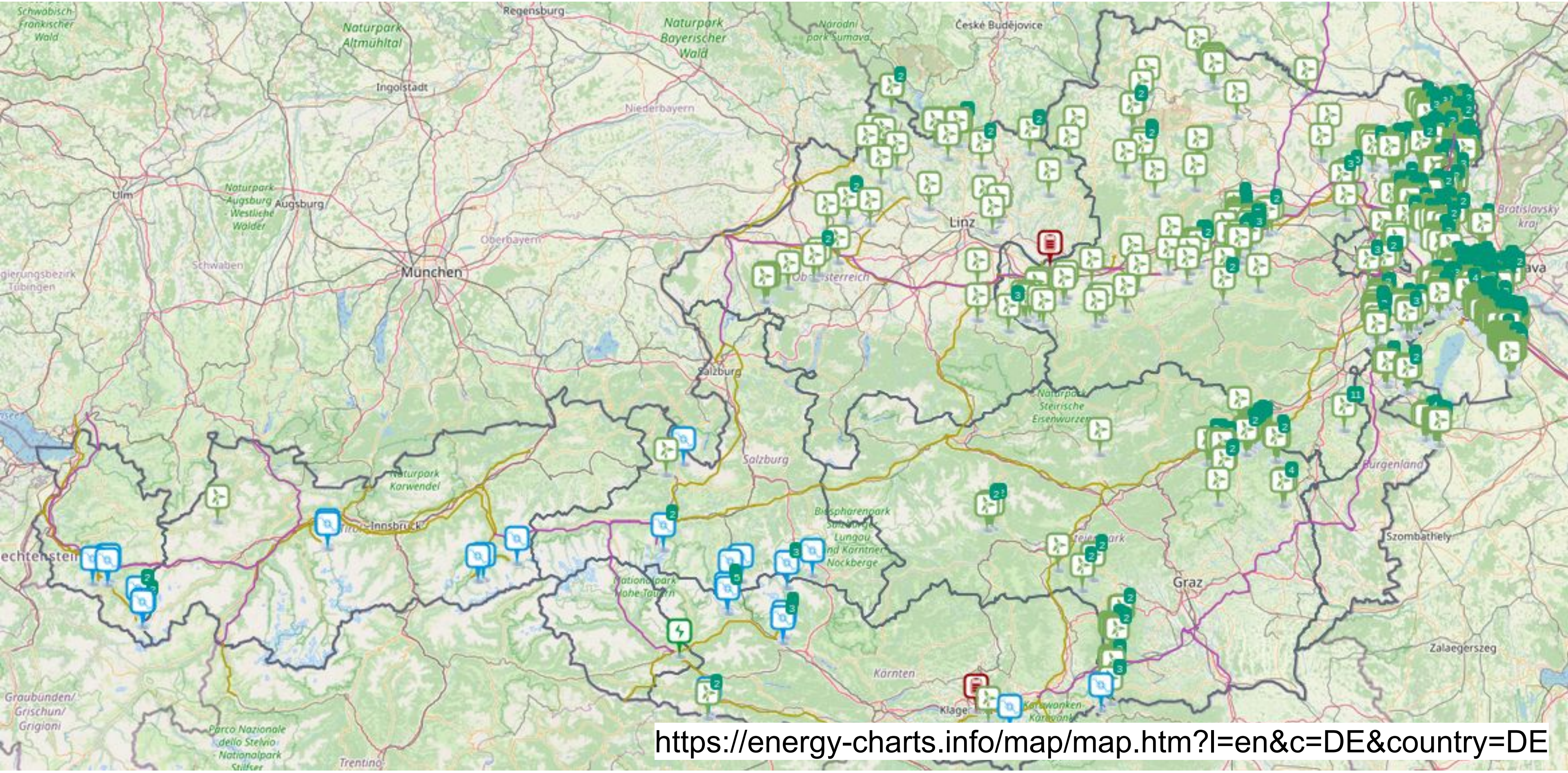
https://energy-charts.info/map/map.htm?l=en&c=DE&country=DE

https://www.reded.cz/redmag-online/pve-dlouhe-strane/

Case Study: Austria

- Hydrogen Storage: "Underground Sun Storage" project (4.2 GWh capacity).
- Pumped Hydro Storage: Alpine hydropower plants for grid flexibility.
- Battery Storage: Large-scale projects like the Fürstenfeld facility (12 MW/24 MWh).

Problem with PHS in Austria and renewables?



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Policy Recommendations

- Financial incentives: Subsidies, tax credits, low-interest loans.

- Streamlined permitting processes.

- Support for research and innovation.

Future Outlook

- EU-wide initiatives to support LTES.

- Opportunities for innovation and investment.

- Increasing role in decarbonization and energy security.

Conclusion

- LTES is essential for integrating renewables and achieving EU climate goals.

- Despite challenges, the benefits outweigh the costs.

- Collaboration among governments, industry, and researchers is key.