TODAY is the 130th Anniversary of...
On December 13, 1892 Nikola Tesla patented the “system of electrical transmission of power”
Electricity market study

Niloufar Zarei, Heta Heinonen, Vittorio Casucci, Idowu Odesanmi and Daniel Sendino
Three sections

1. OPERATION
2. INVESTMENTS
3. PLANNING
10 jurisdictions across the world
Average monthly electricity wholesale prices in selected countries in the European Union (EU) from January 2020 to October 2022 (in euros per megawatt-hour)
Three subsections

1. OPERATION

2. INVESTMENTS

3. PLANNING
Day-ahead & intraday markets

- **Financial market**: Days, weeks, months or years before
- **Spot market: Day-ahead**: Day before
- **Intraday market**: Until one hour
- **Balance market**: In operating hour (Real time)
- **Imbalance payments**: Day after

Aalto University
Wärtsilä – Electricity market study – Aalto University – AAE-E3000 – Team 7
Zonal vs. nodal price mechanism
Three sub-sections

1. OPERATION
2. INVESTMENTS
3. PLANNING

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Maintaining grid stability

- Capacity market – long-term
- Balancing market – short term

50 Hz

49.5 Hz

50.5 Hz

Generation
Demand

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Be aware that...

Not all jurisdictions have all these markets. For example, ERCOT does not operate a capacity market while PJM does.
Three subsections:

1. OPERATION
2. INVESTMENTS
3. PLANNING
The share of renewables
The duck curve shows overgeneration risk and steep ramping needs.

- Overgeneration risk: ~13,000 MW
- 3-hour ramp

Net Load (MW)

Potential for grid instability*
CHALLENGES TO DECARBONIZE THE GRID

GRID OPERATION
1. Handle consumer control of consumption
2. Increase share of renewables

UP

DOWN

GENERATION
1. Fossil fuel-free resources
2. Avoid overgeneration
Summary
Conclusions

Electrification and renewables integration requires flexibility.

Energy-only markets with low interconnection are less resilient.

Capacity markets may not result in dispatchable generation capacity which is critical for feasible renewables integration.