EfS 2019

4th ENERGY FOR SUSTAINABILITY INTERNATIONAL CONFERENCE
DESIGNING A SUSTAINABLE FUTURE
24 – 26 July 2019 | Turin, Italy

PROGRAMME

WEDNESDAY, 24 JULY
9:30-9:35 Registration
9:30-9:35 Opening Ceremony
9:30-10:15 Plenary Lecture
9:30-11:00 Coffee-break
11:00-12:30 Parallel Sessions
12:30-14:00 Lunch
14:00-15:40 Parallel Sessions
15:40-16:00 Coffee-break
16:00-17:40 Parallel Sessions
18:15 Welcome Drink

THURSDAY, 25 JULY
8:30-10:10 Parallel Sessions
10:00-10:30 Coffee-break
10:30-12:30 Parallel Workshops
12:30-14:00 Lunch
14:00-15:40 Parallel Sessions

NEWS

EfS 2019 in Munich

AVAILABLE DOCUMENTS

Scientific Programme [347 KB]
ON THE FUTURE MARKET PROSPECTS OF ELECTRICITY STORAGE

Reinhard HAAS, Energy Economics Group, TU Wien

EfS, Turin, July 2019
1. Introduction: Motivation

2. How variable renewables impact the electricity system

4. Storing every peak?

3. The costs of storage

5. The role of flexibility

6. Conclusions
Introduction:
Electricity generation EU-28
2 HOW VARIABLE RENEWABLES IMPACT THE ELECTRICITY SYSTEM
Supply and Demand

RES Production > Demand

RES Production < Demand

Hours per week

GW
Key term of the future: Residual load (base load is “dead”)

Residual load = Load – non-flexible generation

Excess electricity

Under coverage
Classified residual load over a year

Under coverage

2016

Surplus due to excess generation

2030
3. Specific question: How much storage do we need?

Under coverage

How to use?

Store all?

excess generation

Hours/year

MW
Storing every peak?

- Under coverage
  - High power at few hours!

- Excess generation
  - E.g. 20% less capacity stored
  -> 1% less energy!
4. The costs of storage

\[ C = \frac{IC \cdot \alpha + C_{OM}}{T \eta_{STO}} + C_E \left( \frac{EUR}{kWh} \right) \]

\[ C \quad \text{... Storage costs (EUR per kWh)} \]
\[ C_E \quad \text{... Energy costs (EUR per kWh)} \]
\[ C_{OM} \quad \text{... O&M costs (cent per kWh)} \]
\[ IC \quad \text{... Investment costs (EUR/kW)} \]
\[ \alpha \quad \text{... Capital Recovery factor} \]
\[ T \quad \text{... Fullloadhours (hours per year)} \]
\[ \eta_{SP} \quad \text{... Efficiency of storage} \]

**Key factors:**
- T (Fullloadhours)!
- \( C_E \) (electricity price)
Short term vs Long term storage

- Batteries
- Flywheel
- Compressed air energy storage
- Pumped hydro storage
- PtG hydrogen
- PtG Methane

Storage capacity

- 1 kWh
- 1 MWh
- 1 GWh
- 1 TWh
- 1 PWh

Decharging time [h]

- 1 Day
- 1 Monat
- 1 Year

Long term storage

- Short term vs Long term storage
Impact of fullloadhours

At 500 h/a: four times the costs of 2000 h/a!

Price spread
Spotmarkt

Pump storage
Battery

EUR/kWh

Stunden/Jahr

H2
PRINCIPLE OF SELF CANNIBALISM IN ENERGY ECONOMICS:

Example storage:
Every additional storage unit makes this one and every other less cost-effective!
Decreasing full-load hours of storages

Under coverage

excess generation
5. Flexibility

Load increase by technical Demand-side management (incl. Power-to-heat)

Storage (if reasonable Fullloadhours)

Extention of transmission grid

Price very low (-2000 EUR/MWh ???)

Direct marketing

Shedding of peak power
Demand for long-term storage

Long-term storage needed

Energy Economics Group

TU WEN
Sector coupling / Sector integration

* In times of surplus generation: How to use excess electricity in meaningful way?

Heating/Cooling

Transport

* Vague simplified suggestions, no convincing long-term solutions

* Central (Ptx approaches, e.g. H2) vs decentral (end user level, E.g. Evs, heat pumps for heating) applications

* How to fit use with time of surplus, e.g. of PV for heating?
Sector coupling hydrogen: Storage and fuel in transport?

- Electricity
  - Electrolyser
    - η=60-70%
  - Compressor
    - η ≈ 90%
  - Combined cycle
    - η=50-60%
- H₂-Storage
  - η=27-38%
- Electricity
  - Fuel cell
  - η=27-38%

Wind turbine

Electricity

Electrolyser

H₂

Compressor

Combined cycle

H₂

H₂-Storage

Fuel cell

H₂

Electricity
Long term scenarios

- Methane
- Hydrogen
- Pumped hydro

- Hydro pumped storage daily
- Hydro pumped storage seasonal
- PtG-H2 small
- PtG-H2 large
- PtG_CH4 small
- PtG_CH4 large
6. CONCLUSIONS

- Increasing electricity generation from variable RES → need for new long-term storage options
- Economic problem of all storage options: low full-load hours
- Decentralized batteries: major benefit relieve of the distrib grid
- PtG as electricity storage: low round trip efficiency
- Stated storage needs do not comply with economics
- In transport: need for environmentally friendly technologies → Zero-emission vehicles