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Impact of storage applications on the carbon imprint of electricity systems

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Battery ENERGY STORAGE

ESS enable transition towards low-carbon electricity systems – CO₂ imprint changes however remain elusive



Evidence on emissions impact of the usephase of ESS is less well established

Losses due to ESS roundtrip efficiency increase emissions

Shifts in generation-mix from storage charging and discharging with non-trivial

A holistic understanding of ESS' CO₂ effects in electricity systems is relevant to: (i) policy makers, fostering the low-carbon energy transition; (ii) investors, aiming to increase impact transparency

focus

Schematic of a merit-order curve



Clearing Volume



Existing literature painting rather negative picture, lacking cross-system and –application insights

Existing research

Mostly looking at single electricity storage applications

Most literature from the field originates in the US, no studies investigating continental Europe

Method

Case Selectio

> No systematic investigation of the role of underlying energy system contexts, often because use-phase related emissions are derived from past generation mixes using marginal emission factors

Due to focus on past generation mixes and wholesale market applications, overall picture rather negative

Research Questions

How does storage change the CO₂ imprint of European electricity systems?

2

How does this change with various storage applications?

3

How does this change with various electricity system contexts?

How we address this: Model coupling, bespoke model building for research questions at hand



Broad range of countries selected to understand various mechanisms at play



Average CO₂ Emissions [tCO2e/MWh]

Applications with different dispatch profiles selected that are already relevant or have great potential

EPG | Energy Politics Group

Changes in CO₂ imprint by application and CO₂ price

Mechanisms behind use-phase emission impacts

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SOURCE Icons from www.flaticon.com

Clean-energy transition to be accelerated and CO₂ impacts to be incorporated in dispatch decisions

Key findings

Investors

Implications

Investors and policy makers need to take a nuanced view as to ESS' emissions impact, beyond black and white

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A higher CO_2 price and subsequent fuel switch is likely to positively influence emissions imprint of ESS, in particular for "market-price-oriented" applications, such as wholesale arbitrage and vehicle-to-grid Policy makers should accelerate the transition towards low-carbon electricity systems, e.g. via CO₂ prices or support for Renewables

Negative view on ESS use-phase emissions in literature is not justified, already today, certain applications and system contexts show positive impact It is generally possible to include emissions impact in ESS dispatch optimization; this can be taken into account in tariff designs, design of deployment policies, as well as by investors decision metrics

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Contact information and credits

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The work has been carried out by the funding support from The Swiss Competence Centre for Energy Research for Storage of Heat and Electricity (SCCER-HaE) - http://www.sccer-hae.ch/

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