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The development of battery storage systems in Germany: A market review

The smarter E Europe 2023

14.06.2023

Jan Figgener, Prof. Dirk Uwe Sauer

E.ON Energy Research Center | RWTH AACHEN UNIVERSITY

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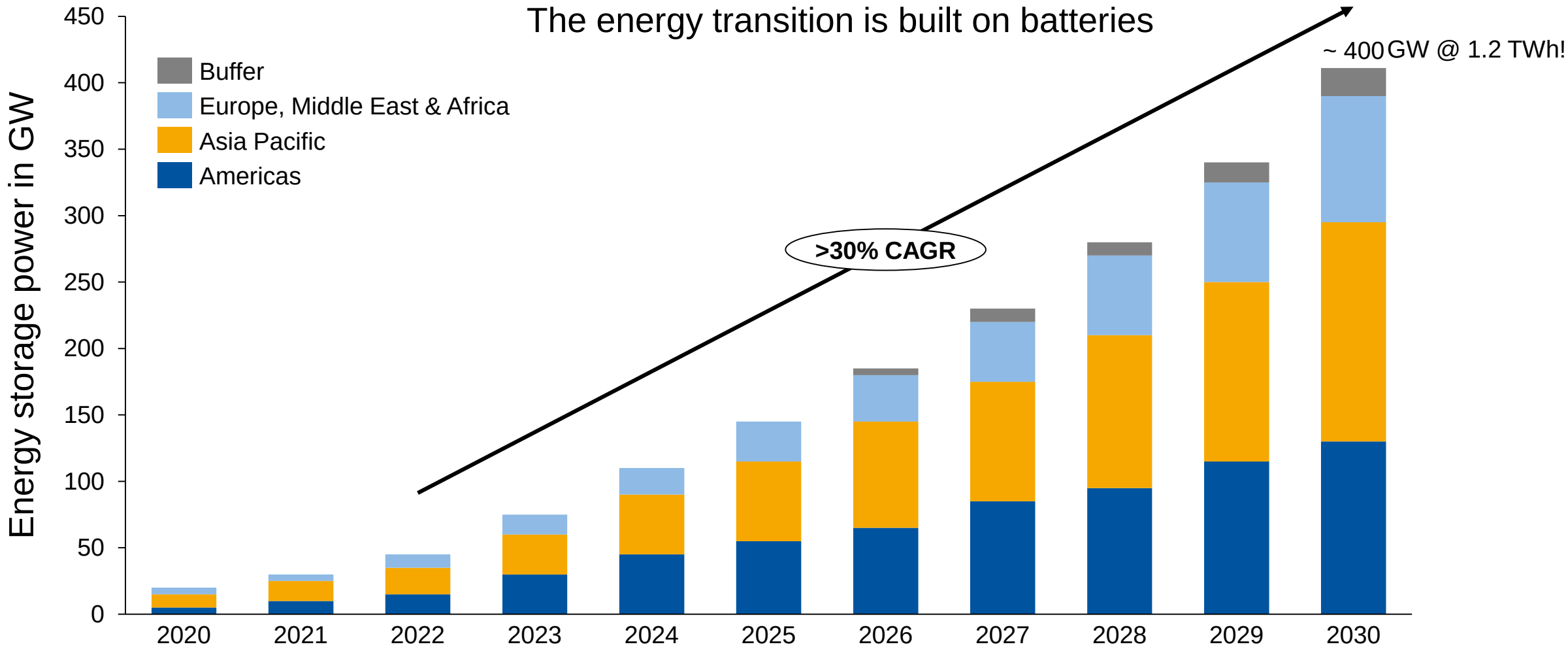
Global stationary energy storage forecast



Source: data published 2022 by BloombergNEF (majority of depicted energy storage systems are battery storage systems, no pumped hydro storage included)

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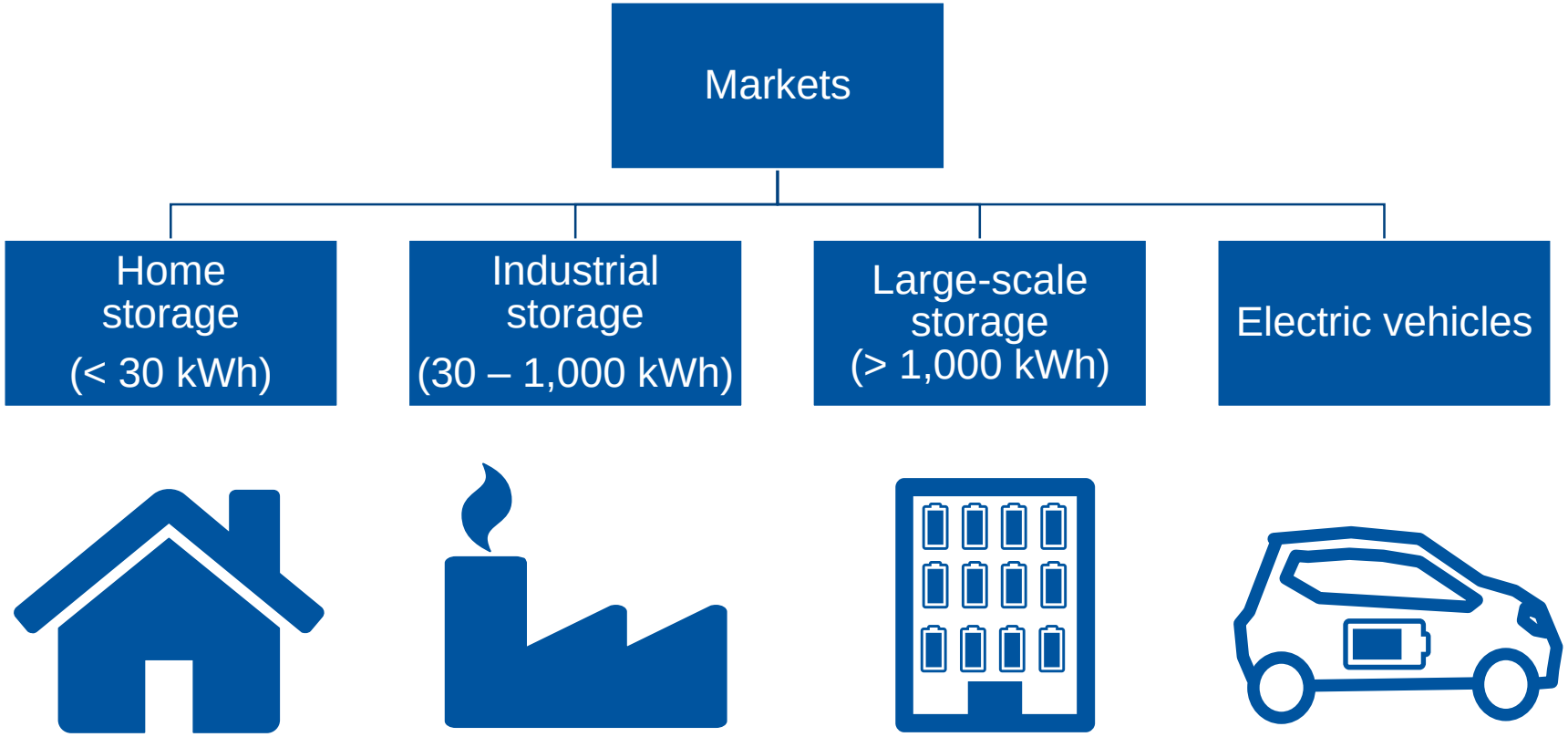
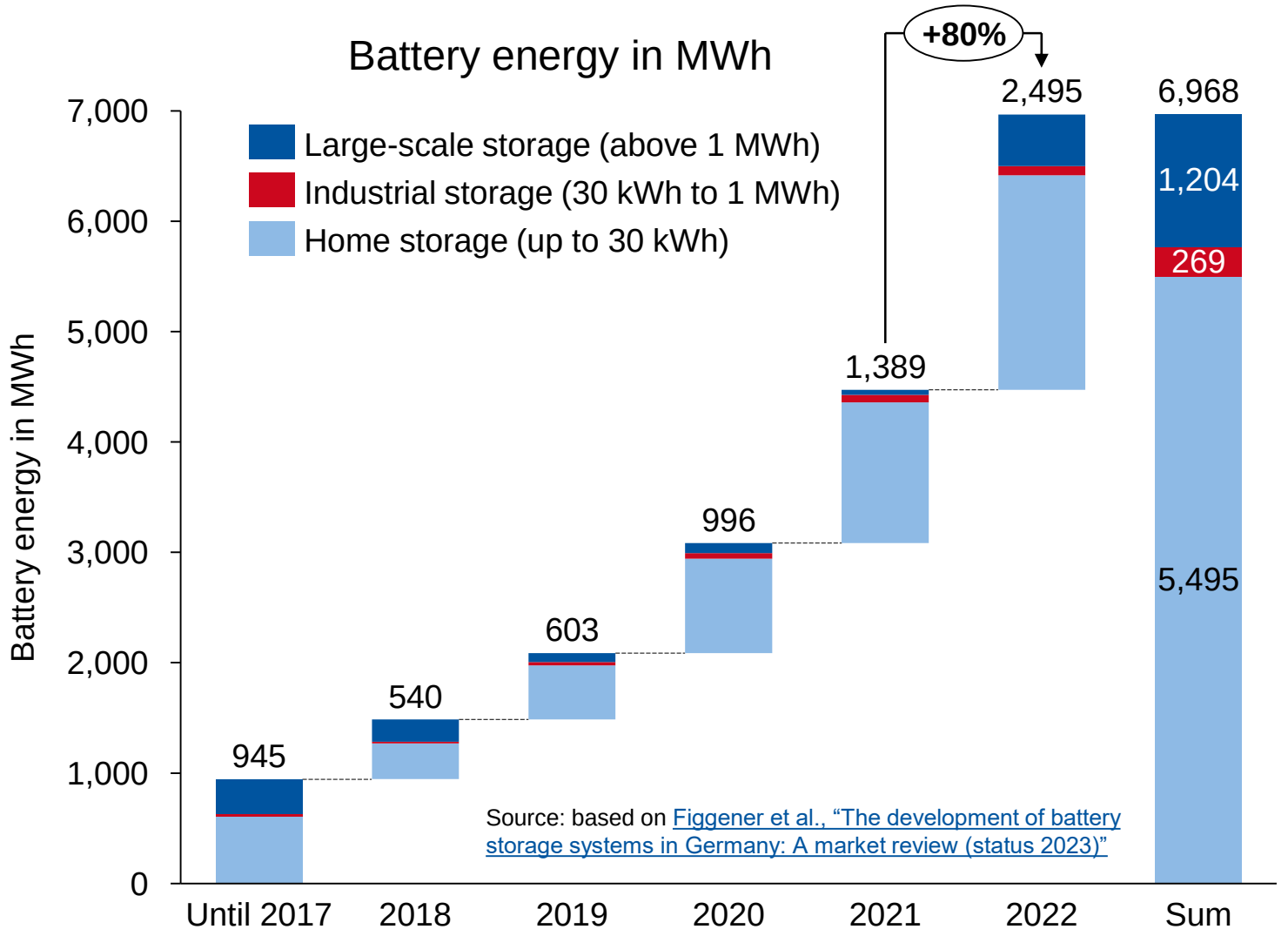
Overview – Battery storage systems



The battery storage market in Germany by the end of 2022

- Home storage
  - 52% growth, 220,000 new systems
  - 650,000 systems in total
  - 75% of new PV systems with storage
  - 2022 mean system: 9 kWh / 5.5 kW
- Industrial / commercial storage
  - 24% growth, 1,200 new systems
  - 4,000 systems in total
  - 2022 mean system: 70 kWh / 35 kW
- Large-scale storage
  - 910% growth, 47 new systems
  - 150 systems in total
  - 2022 mean system: 10 MWh / 9 MW



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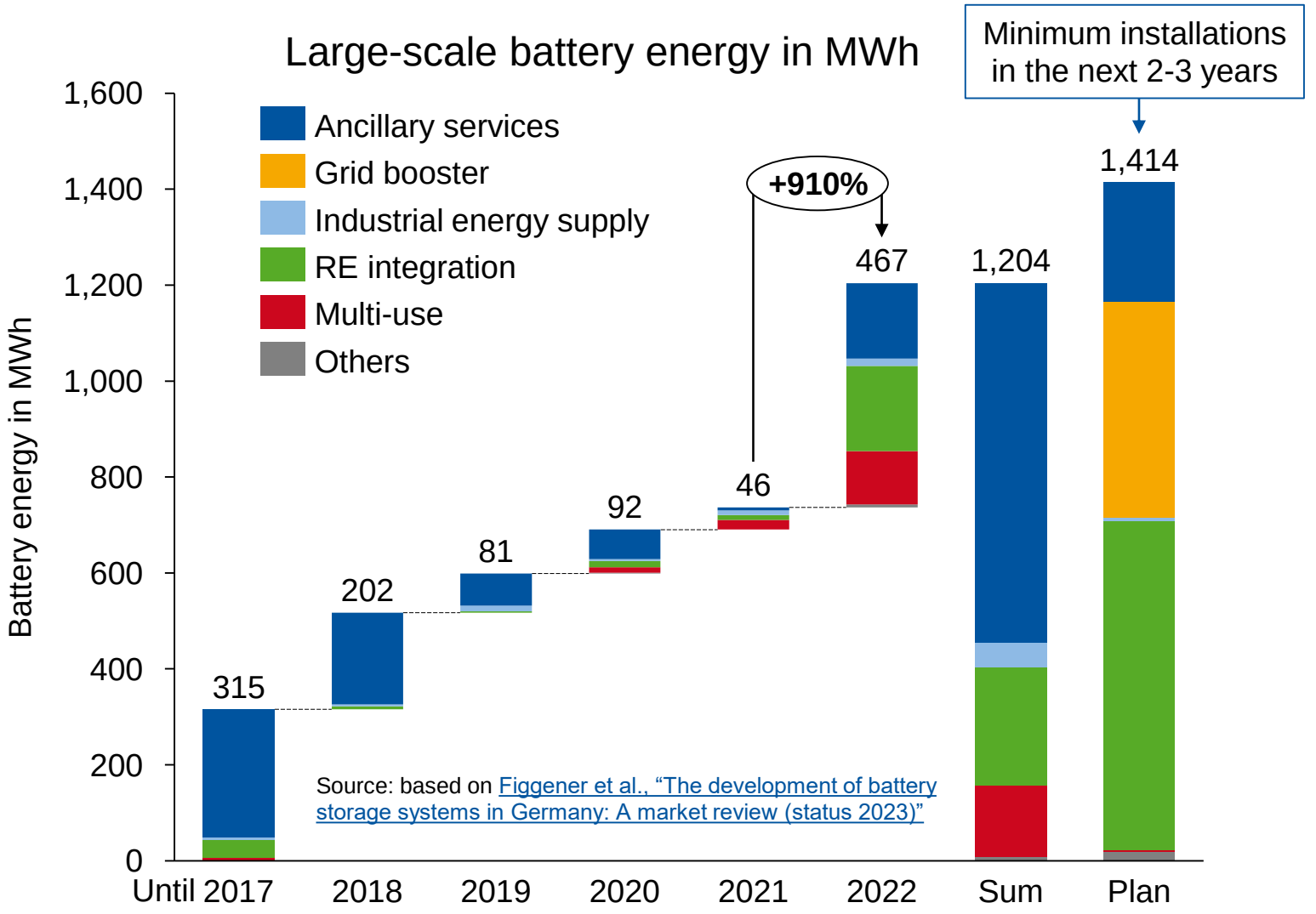
Large-scale storage above 1 MWh in Germany

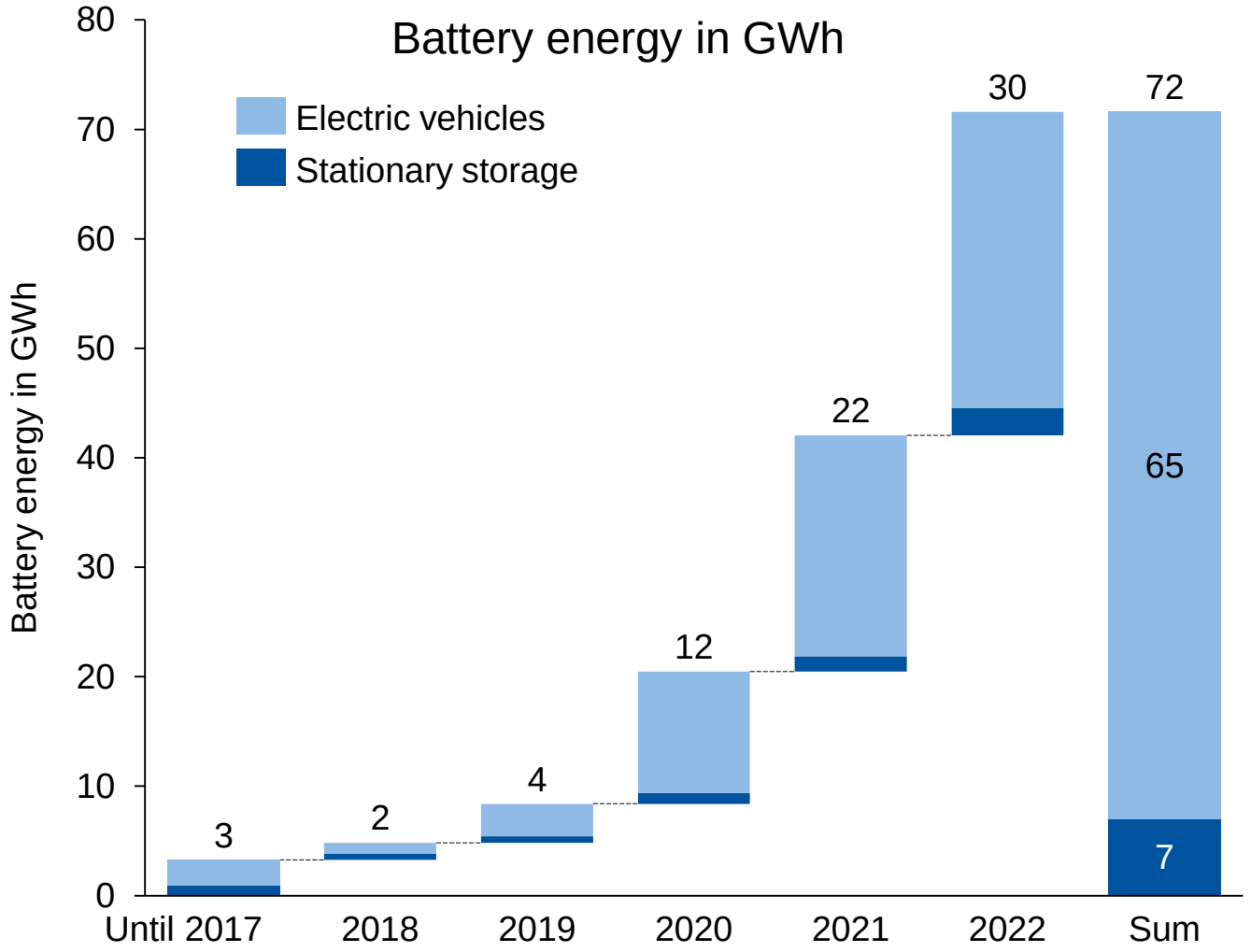
- First, large-scale storage was mainly driven by ancillary services with a strong focus on frequency containment reserve

- Now, new use cases emerge
  - RE integration
  - Grid booster
  - Industrial energy supply
  - Multi-use
  - Others



Electric vehicles account for the largest share in Germany

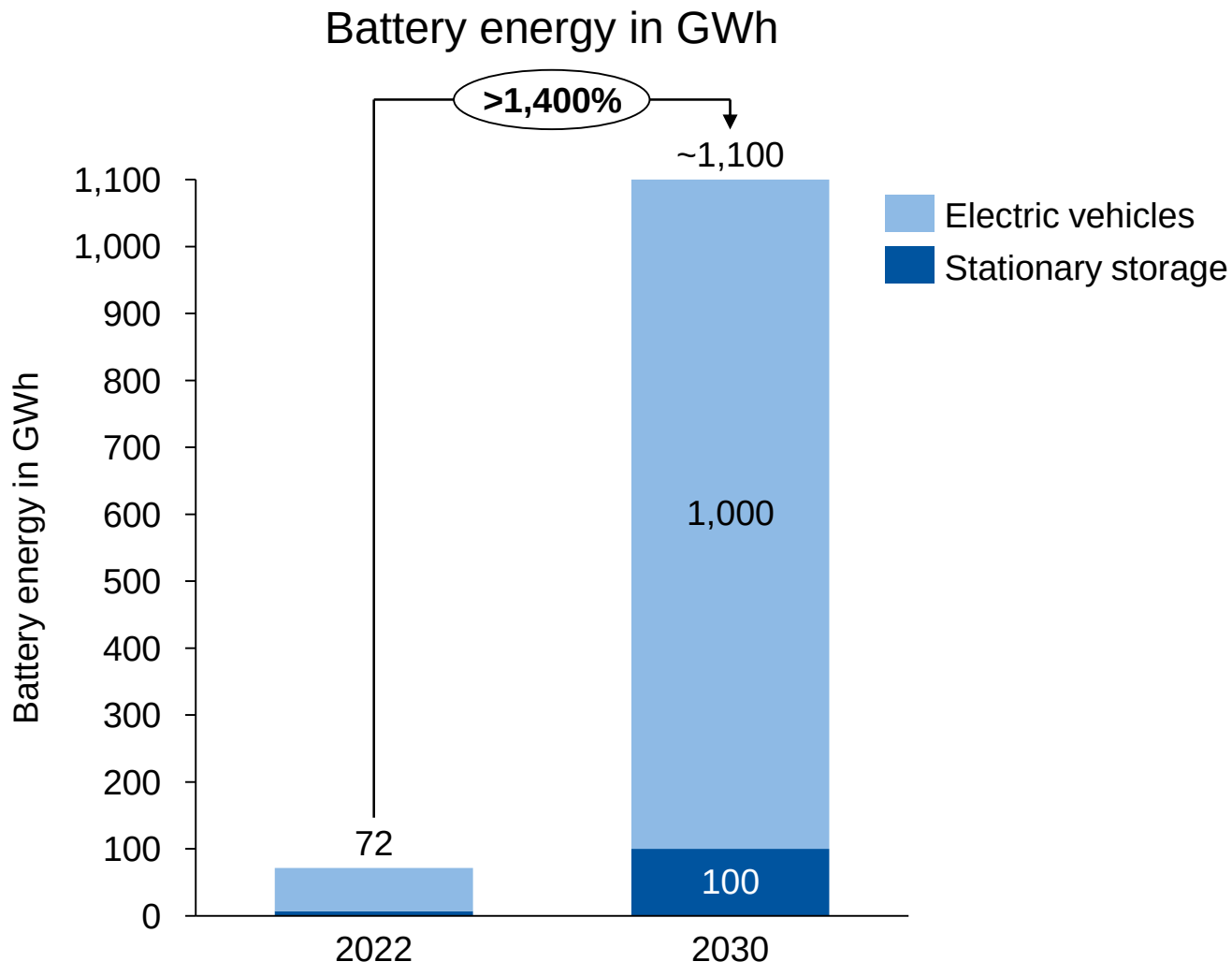
- Compared to 39 GWh of pumped-hydro storage in Germany, stationary battery storage already offers significant flexibility potential of 7 GWh
- But: Electric vehicles account for about 90% of the 72 GWh battery energy (the same ratio is true for the world)
- This flexibility needs to be unlocked through vehicle-to-X technology and regulation



Source: based on Figgener et al., "The development of battery storage systems in Germany: A market review (status 2023)"

And the future is even bigger

- Under the assumption of a mean battery energy of around 70 kWh per EV, the 2030 fleet with 15 million EVs will have 1 TWh of battery energy
- If only a small share is connected to the grid, this already offers great flexibility for the energy system
- Again: This flexibility needs to be unlocked through vehicle-to-X technology and regulation

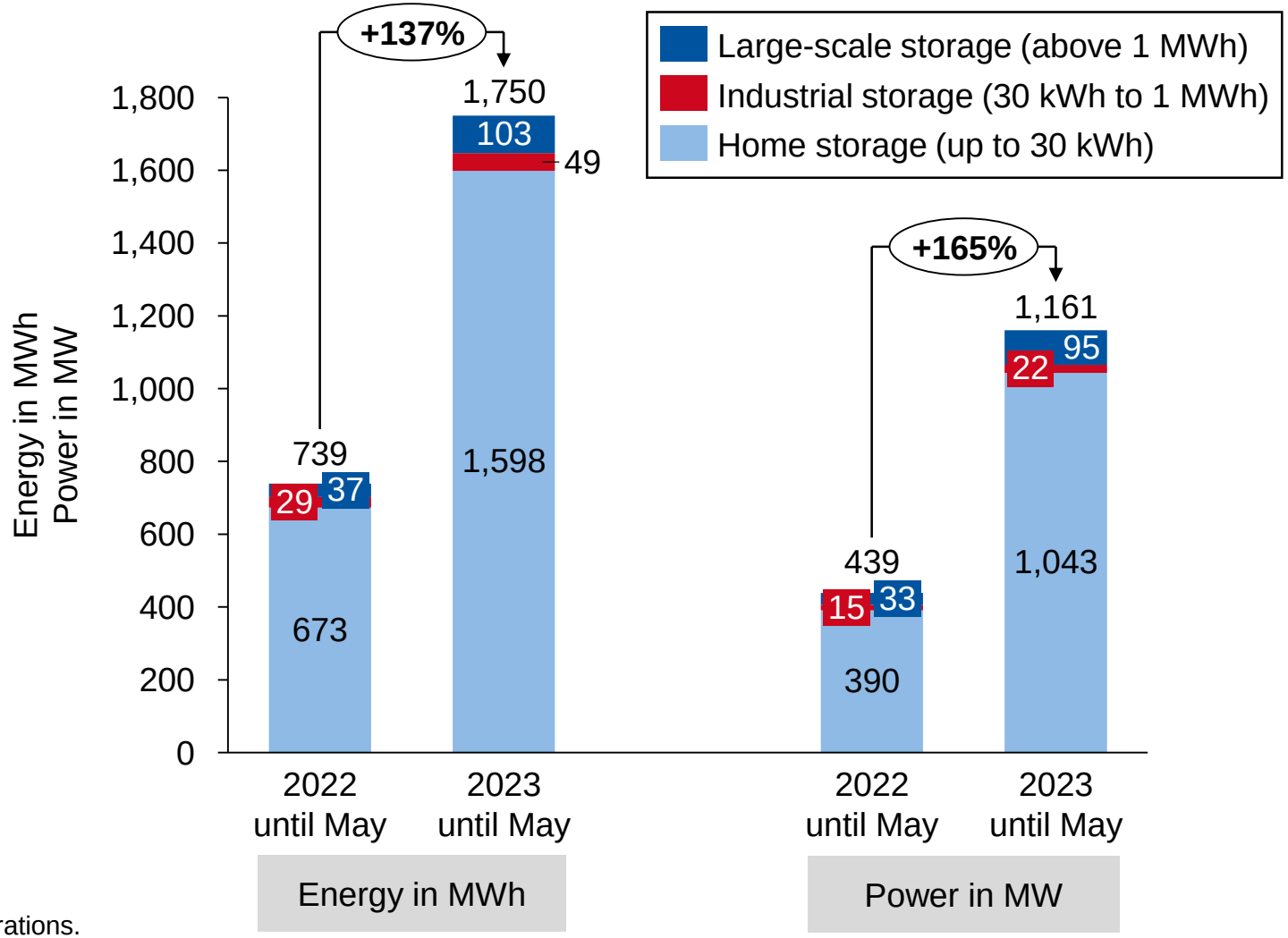


2022 & EV 2030: Figgener et al., "The development of battery storage systems in Germany: A market review (status 2023)"
BSS 2030: Wille-Haussmann et al. "Batteriespeicher an ehemaligen Kraftwerksstandorten"

Exclusive number on battery storage installations in Germany until the end of May 2023

- In 2023, the battery storage market shows good growth
- Home storage growth was incentivized by the removal of VAT
- Find the latest numbers daily on

www.battery-charts.de



Preliminary analysis: Numbers will increase slightly due to delayed registrations.
Source: www.battery-charts.de according to Figgener et al., The development of battery storage systems in Germany: A market review (status 2023)

Find more information on the market development in our report

- Methodology
  - Evaluation and combination of all public databases on stationary and mobile storage systems
  - Industry interviews
  - Monitoring of subsidy programs

- Topics covered
  - Home storage
  - Industrial storage
  - Large-scale storage
  - Electric vehicles
  - Charging infrastructure
  - Production capacities
  - Policy

- Contributors
  - RWTH Aachen University
  - ACCURE Battery Intelligence
  - JARA-Energy
  - Helmholtz Institute Münster
  - TH Köln

- Download here, and check out www.battery-charts.de

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The development of battery storage systems in Germany: A market review (status 2023)

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Abstract - **The market for battery storage systems (BSS) has been growing rapidly for years and will multiply in the future. This fast growth leads to a lack of information regarding current developments. With this extension of our previous works, we contribute key figures for model parametrization and political decision-making and depict the market development in Germany, one of the leading storage markets worldwide. In empirical analyses, we evaluate and combine all major public databases on national stationary and mobile storage as well as our databases from subsidy programs and extend the insights by literature research and bilateral industry exchange. In comparison to 2021, the market for home storage systems (HSS) grew by 52% in terms of battery energy in 2022 and is by far the largest stationary storage market in Germany. We estimate that about 220,000 HSS (1.9 GWh / 1.2 GW) were installed solely in 2022. The emerging market for industrial storage systems (ISS) grew by 24% in 2022, with a total of 1,200 ISS (0.08 GWh / 0.04 GW) installed. The market for large-scale storage systems (LSS) increased strongly by 910% with 47 LSS (0.47 GWh / 0.43 GW) commissioned. The electric vehicle (EV) market grew with 693,000 new EV (27 GWh / 43 GW (DC) / 4.5 GW (AC)) by 34% in terms of battery energy. The number of EV per charging point grew from 9 in 2017 to 23 in 2022. System BSS prices increased significantly in 2022 and were estimated at 1,200 €/kWh for HSS. LSS prices ranged on average from 310 €/kWh to 465 €/kWh. In comparison, if the 2022 BEV prices for the whole vehicle are simply divided by their battery energy, the mean specific BEV system prices range from 800 €/kWh for medium to 1,240 €/kWh for luxury cars. In total, we estimate that over 650,000 stationary BSS with a battery energy of 7.0 GWh with an inverter power of 4.3 GW and 1,878,000 EV with a battery energy of 65 GWh and a DC charging power of 91 GW (12 GW AC) were operated in Germany by the end of 2022. The cumulative battery energy of about 72 GWh is therefore nearly twice the 39 GWh of nationally installed pumped hydro storage demonstrating the enormous flexibility potential of battery storage for the energy system.**

Index Terms – **battery storage, charging infrastructure, electric vehicles, energy storage, market development, prices**

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I. INTRODUCTION

This paper is an update of our existing peer-reviewed works [1–4] and extends large parts of the previous analyses.

In current forecasts on the development of the global battery market, everyone agrees: it is going steeply upwards. Nevertheless, the estimates differ significantly from each other and change over time, which is due to different future scenarios, changing regulatory, geopolitical circumstances, and a lack of transparently accessible information as a study on the European storage market explicitly points out [5]. To understand the market dynamics, we can have a look at the past: A 2017 study predicted the cumulative stationary battery world installations for the year 2030 to range between around 100 GWh and 420 GWh depending on the scenario [6]. Another 2017 study estimated

Table 1: Abbreviations sorted alphabetically.

Abbreviation	*Description*
aFFR	*Automatic frequency restoration reserve*
ADAC	*General German Automobile Club*
BEV	*Battery electric vehicle*
BSS	*Battery storage system*
CP	*Charging point (for electric vehicles)*
CS	*Charging station (for electric vehicles)*
DB	*Database*
EPR	*Energy-to-power (ratio)*
EV	*Electric vehicle*
FCP	*Fast charging point (for electric vehicles)*
FCR	*Frequency containment reserve*
FMTA	*(German) Federal Motor Transport Authority*
FNA	*(German) Federal Network Agency*
HSS	*Home storage system*
ISEA	*Institute for Power Electronics and Electrical Drives*
ISS	*Industrial storage systems*
LSS	*Large-scale storage system*
PHEV	*Plug-in hybrid electric vehicle*
PV	*Photovoltaic*
SOC	*State-of-charge*
TSO	*Transmission system operator*

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Thank you
for your attention

More market data:
www.battery-charts.de
www.mobility-charts.de

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