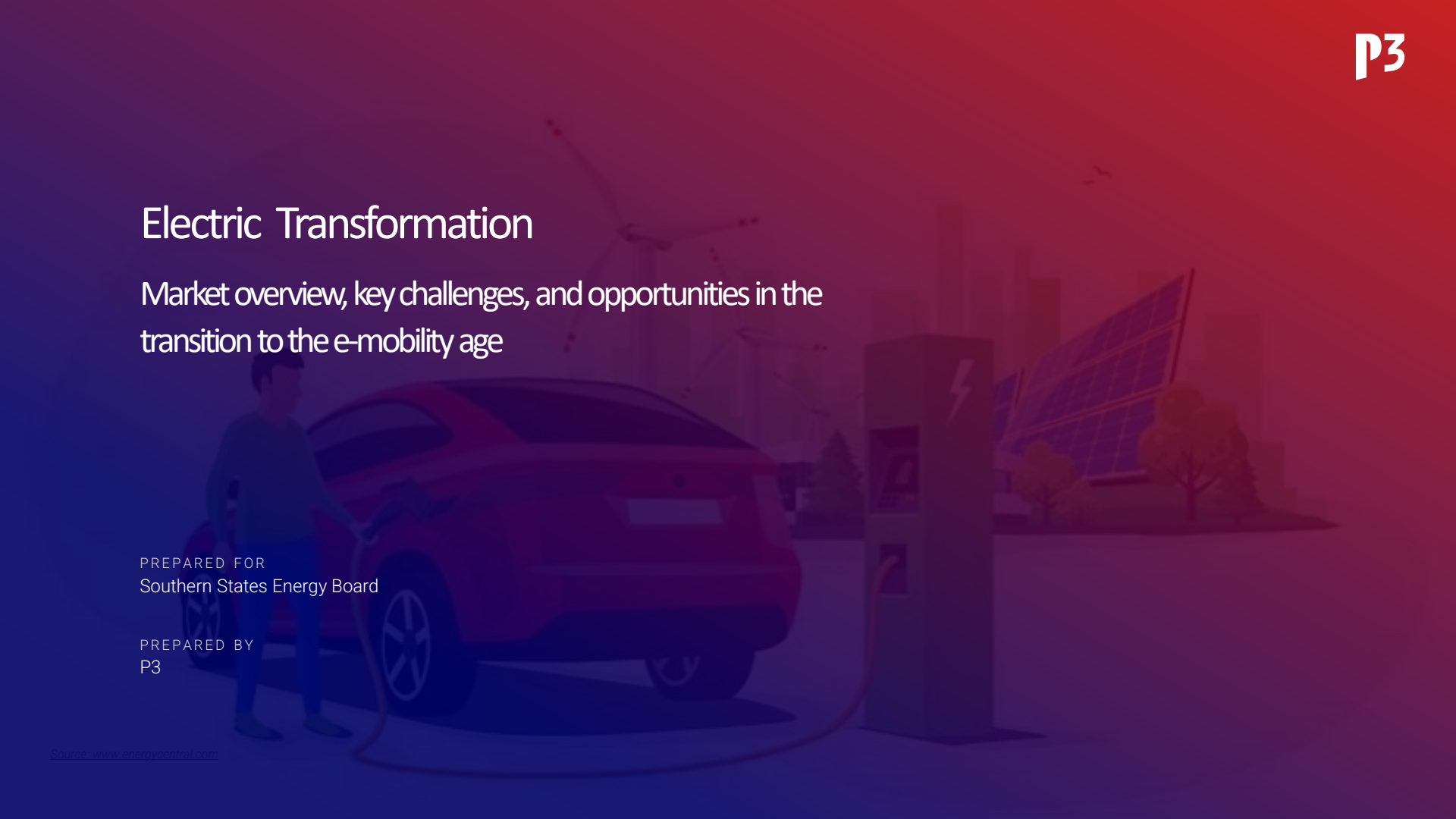
Electric Transformation

Market overview, key challenges, and opportunities in the transition to the e-mobility age



PREPARED FOR
Southern States Energy Board

PREPARED BY
P3

Source: www.energycentral.com

P3 Facts and Figures

AT A GLANCE

1450

Employees
from 70 nations

13

Subsidiaries
within P3

26

Years of experience in Europe,
Asia and America

26

Locations
across 4 continents

75

% of our employees are
Engineers & Software-
Developers

100

% up for
new challenges

Three topics for today

RAW MATERIAL SUPPLY

RECYCLING

CHARGING INFRASTRUCTURE

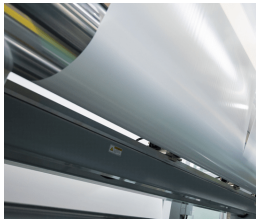
Topics to be discussed

- Expected lithium-ion **battery production ramp-up**
- **Raw Material** supply is and remains critical
- **Resulting challenges** for the U.S. and Southern States

- **Expanding recycling market** in the U.S.
- **Economic benefits** for the Southern States through recycling

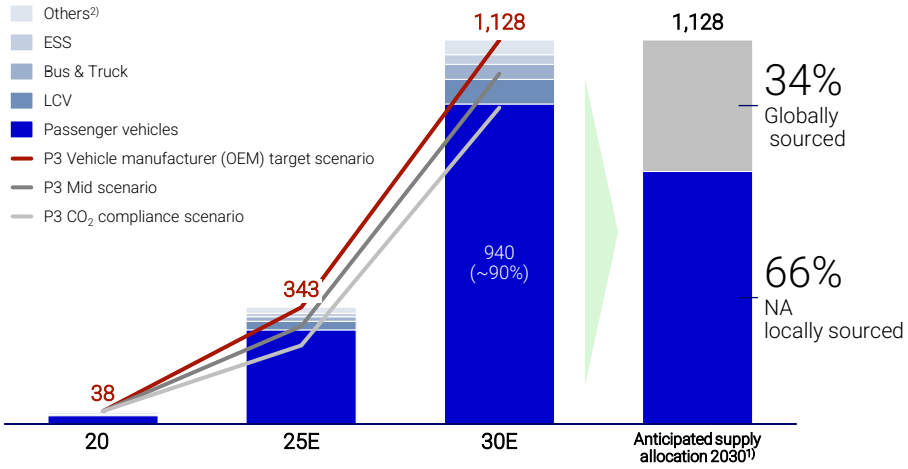
- **Increase in energy demand** to support the electric transformation
- The role of **bi-directional charging, battery energy storage** and **second life** for electric vehicle batteries

The highest impact on the value add in the battery value chain is in four areas : (1) Raw material (2) Material refinement (3) Cell manufacturing and (4) Recycling

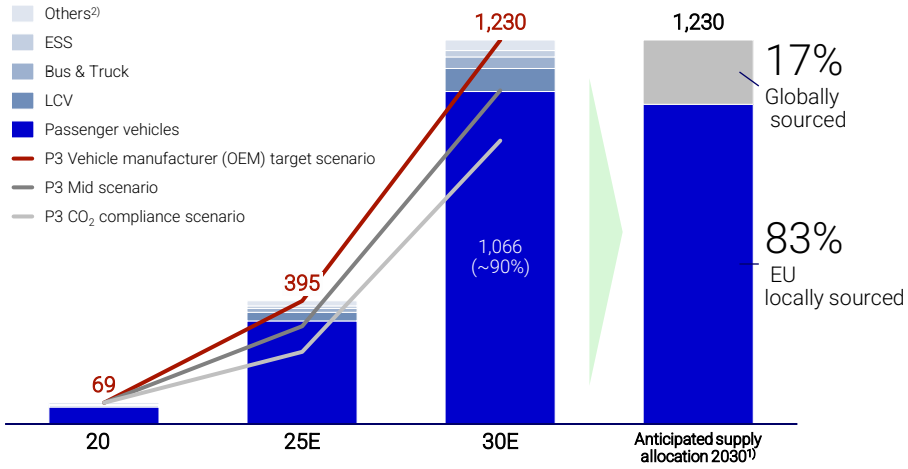
Li-ion value chain	Raw material extraction	Material refinement	Component production	Cell manufacturing	Module & pack assembly	Battery recycling
						
Value add	~ 80%	~ 50%	~20%	~ 50%	~ 25%	~ 30%

Challenge 1 | Only a small share of cell components and even a smaller share of raw materials are currently produced/ or mined locally in North America.

NORTH AMERICAN BATTERY DEMAND DEVELOPMENT *[GWH/A]*



EUROPEAN BATTERY DEMAND DEVELOPMENT *[GWH/A]*



KEY FINDINGS

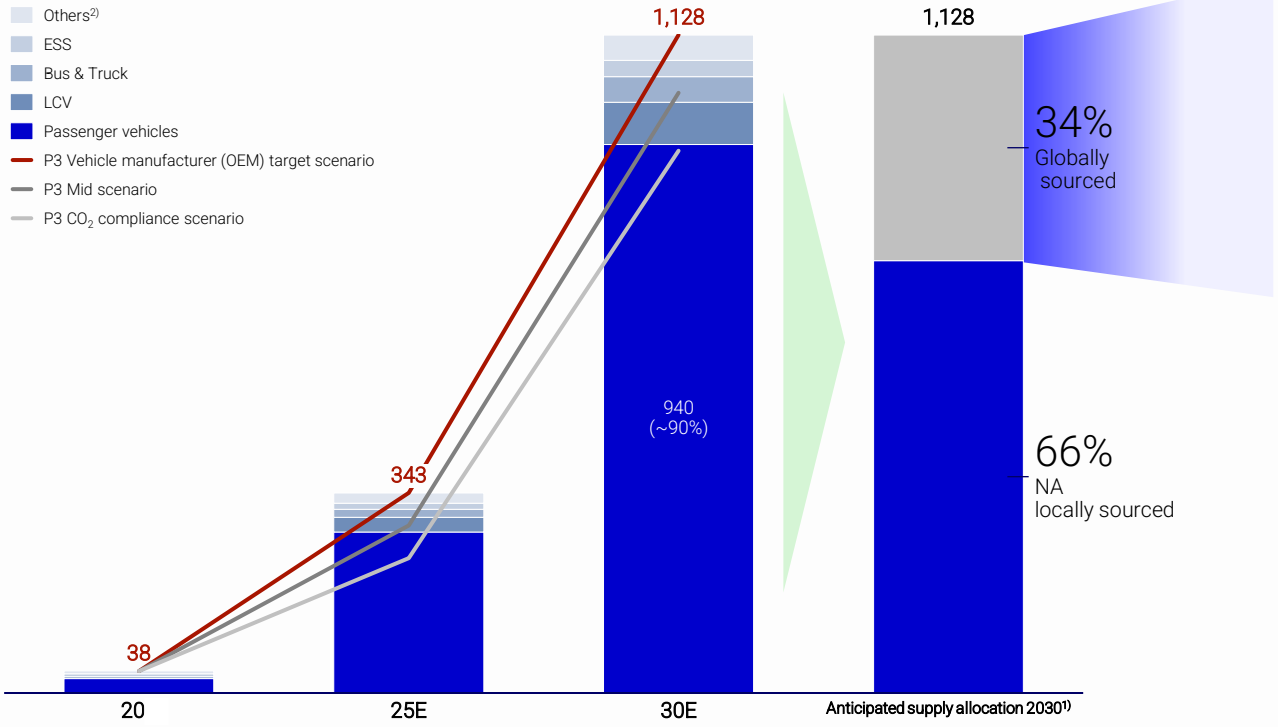
- Strong market growth is announced by battery manufacturers
- Expected battery capacities do not meet the announced demand
- The region is expected to have a larger dependency on foreign battery supply

Sources: P3 demand-based market model (2022)

Opportunity 1 | The southern states are well positioned to capture additional cell manufacturing along with the build up of specialized capabilities.

NORTH AMERICAN BATTERY DEMAND DEVELOPMENT

[GWH/A]



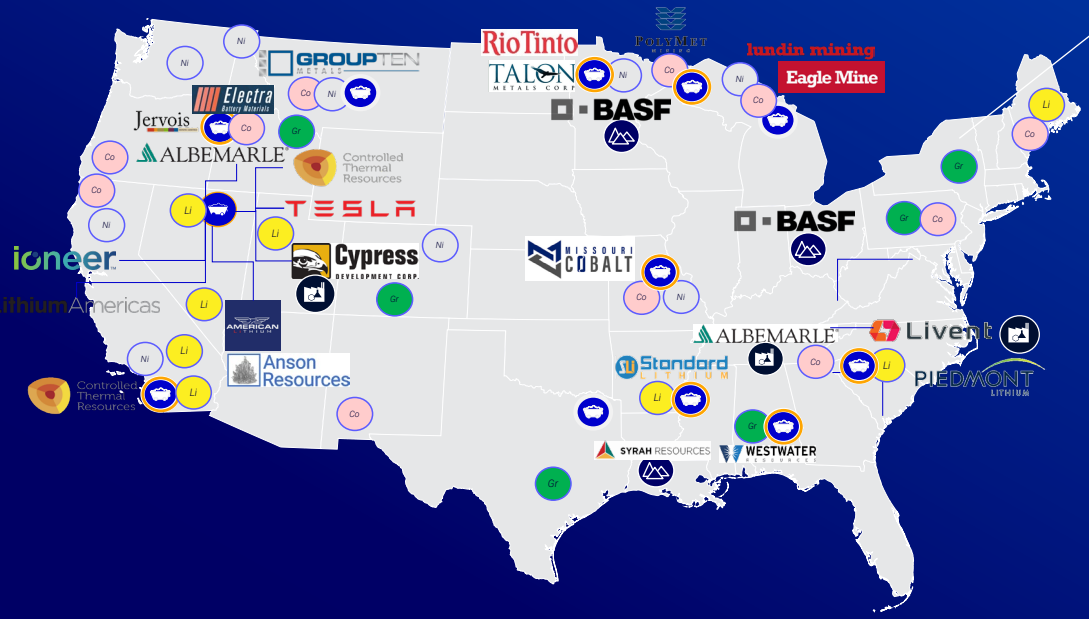
OPPORTUNITIES FOR SOUTHERN STATES

- An increase in cell production
- Ramp up of local supply chain capacities and capabilities

Economic Growth

Sources: P3 demand-based market model (2022)

Challenge 2 | Known reserves in the U.S. can cover a large portion of the demand, if mining and refining are ramped up.



Mining Activities in the U.S.

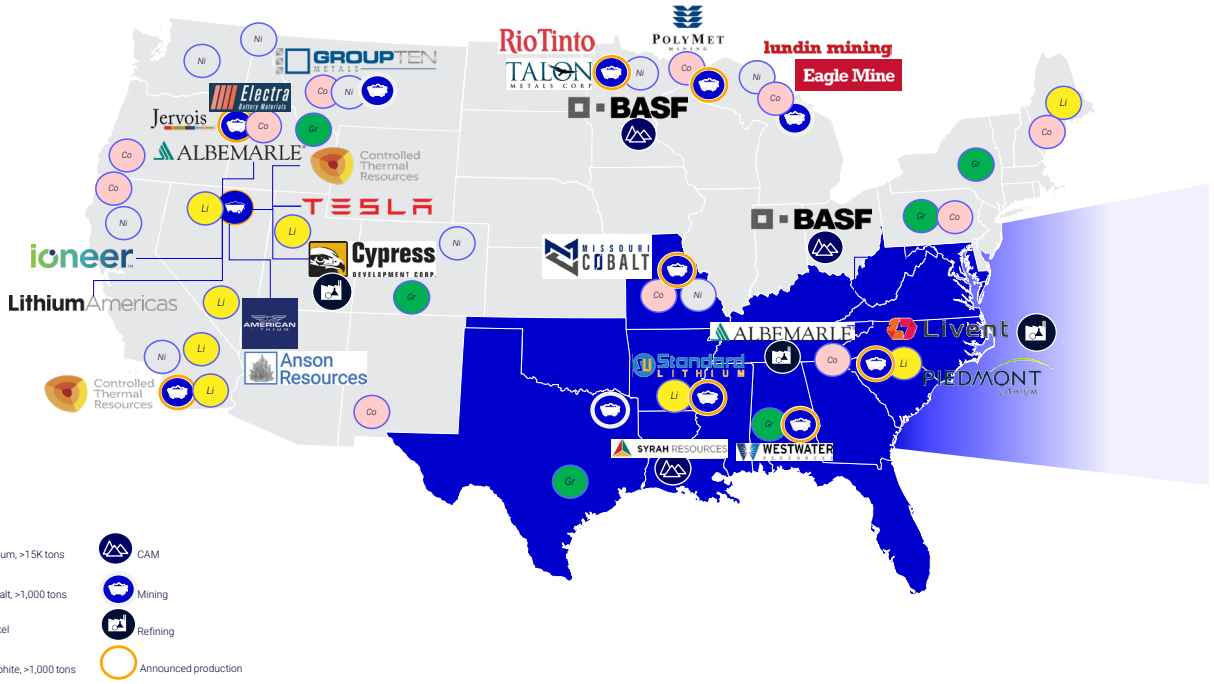
- **Strong dependency** on raw materials from **foreign supply**
- According to USGS, **78%** of Cobalt and **100%** Graphite raw material is imported
- **U.S. demand can partially be covered** via domestic sources.
- Total U.S. reserves* 2022
  - Lithium (750K tons)
  - Nickel (340K tons)
  - Cobalt (69K tons)

**Reserves* refer to amount that can be economically extracted at this time, given current mining and production practices (total USA resources are greater)*

Sources: USGS, P3 demand-based market model (2022)

Opportunity 2 | An increase in mining and refining activities would bring great benefits for the southern states.

Current Mining Activities



Opportunities for Southern States

Increase in mining and refining activities

- Attract local & FDI
- Boost the economy in "new technologies“
- Create new jobs
- Reduce dependencies on foreign supply

Sources: P3 demand-based market model (2022)

Challenge 3 | Building up a highly skilled workforce for battery manufacturing is an important part of the overall electric transformation.

JOBS IN PRODUCTION

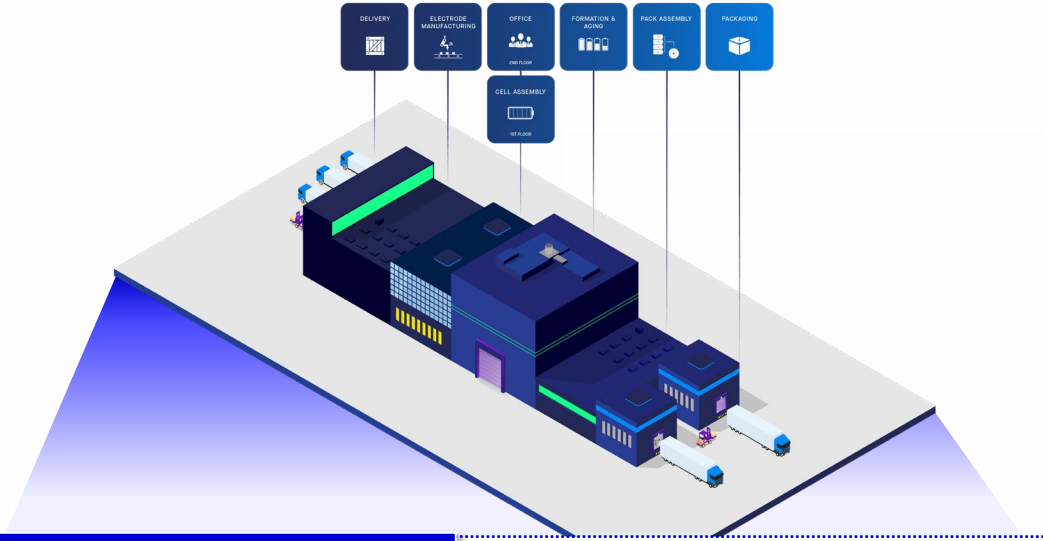
- ~70 workers per GWh[1] are necessary
- ~80,000 jobs will be created by 2030 in the U.S. based on OEM announcements [1]

JOBS ALONG THE VALUE CHAIN

(> mining, refining, cathode material)

- ~330 additional employees per GWh of produced batteries [1]
- ~370,000 jobs will be created until 2030 in the U.S., if the entire value chain is localized 1)

Opportunity 3 | To meet the job demand, early counter-measures and programs are needed to enable and accelerate the transition of the workforce into the age of e-mobility.



OPPORTUNITIES FOR SOUTHERN STATES

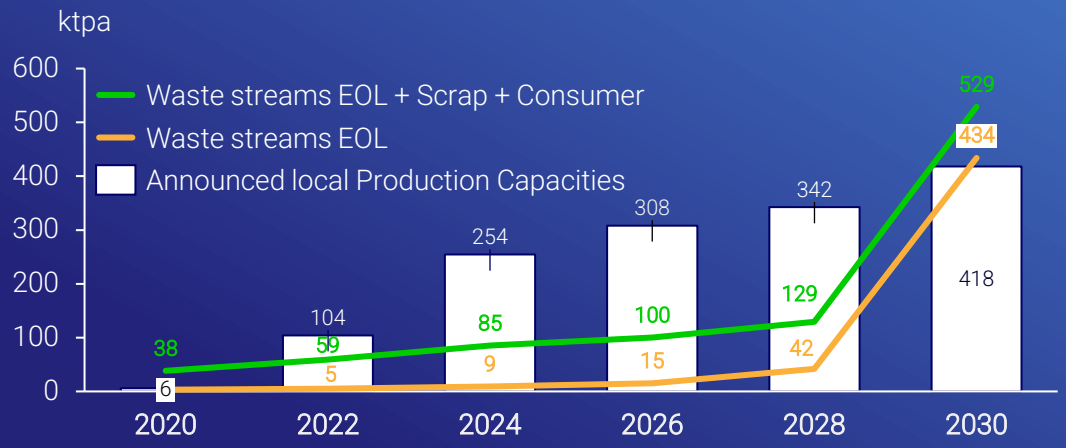
- An increasing **demand for** highly skilled **workers**

Solutions

- Enhance & support **college programs** with focus on EV curriculums (now)
- **Easier entry** for foreign experts to transfer knowledge (short term)
- **Retraining of available workers** e.g., from ICE to EV production (now)

Challenge 4 | With the increasing roll-out of electric vehicles, the number of end-of-life batteries will rise.

RECYCLING MARKET



P3 VIEW

- Over time, the charging capacity of batteries decrease
- After ~10 years batteries are at the end of life (EOL)
- A recycling industry needs to establish capacities before 2030

UNDERLYING ASSUMPTIONS

- All volumes referring to front end input material weight
- All numbers based on either publicly announced numbers or P3 estimates
- Scrap volumes derived from announced cell manufacturing capacities and expected supplier performances
- EOL batteries: expected average use time ~10 years; based on P3 CO2 compliance tool (conservative scenario) considering current legislative thresholds: Battery sizes BEV (60 kWh), PHEV (15 kWh), HEV (2.5 kWh) and MHEV (1.0 kWh) in 2025+.

Opportunity 4 | Battery recycling can be used as a counter-measure to reduce dependencies on foreign raw material supplies, control the disposal of toxic material and reduce CO_2 emissions.

ENVIRONMENT & HEALTH

- Toxic materials are safely managed
- Controlled collection, treatment and recycling will ensure the reuse of resources
- Prevent uncontrolled disposal

Benefit

REGULATION

Opportunities

- Specific recycling guidelines, quotas are needed
- Policies to support economic development
- Policies to keep valuable materials in the U.S. (Recycling)

RESOURCE AVAILABILITY

Benefit

- Strong market growth will require more raw materials
- Lithium, nickel and cobalt are in undersupply
- Recycling of batteries is an alternative source of these raw materials

CO2 FOOTPRINT

Opportunities

- Mining and refining of raw materials make up a significant CO2 footprint in cell production
- Establish local recycling value chains to reduce cost and overall impact

Challenge 5 | The shift to electric mobility brings an increased energy demand and stress on the electric grid.

ENERGY DEMAND NA

1 kWh of battery output = ~40kWh electricity is needed in production

55 TWh per year will be needed for production of electric vehicles in the USA in 2030

175 TWh per year will be needed to charge all battery electric vehicles in the USA based on OEM announcements

4 -6 kWh / m² and day in the southern states

➔ ~31,000 acres of solar power

➔ ~23,000 football fields

Hoover dam produces in average ~4TWh/year

➔ 57 Hoover dams

Average wind turbine in Texas ~2,320 kWh/year

➔ ~100,000 wind turbines

R.E. Ginna reactor near New York ~4.7 TWh/year

➔ ~48 reactors

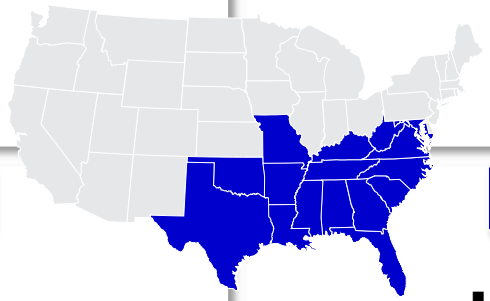
Opportunity 5 | Beside the buildup of new energy sources, bi-directional charging, battery energy storage and second life for batteries are counter-measures to reduce the stress on the grid.

INCREASE OF ENERGY DEMAND

- Energy demand is mainly driven by
  1. Battery production
  2. Charging demand

ENERGY STORAGE

- Decentralized battery energy storage in energy banks
- Reduce stress on grid



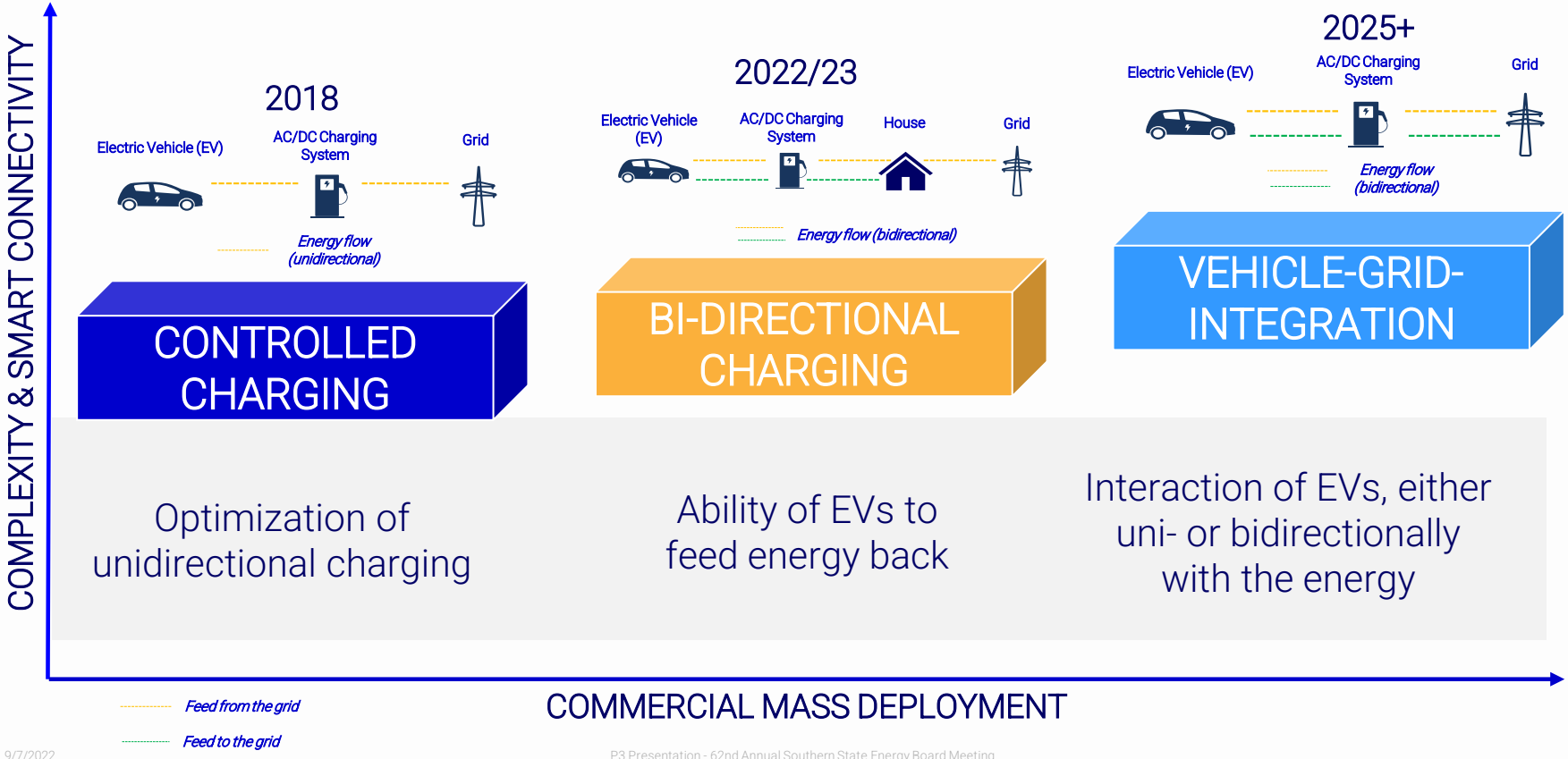
BI-DIRECTIONAL CHARGING

- Cars can be used as energy storage
- Return energy back to the grid
- Reduce stress on the grid

SECOND LIFE BATTERIES

- Reduction of material needs
- Reduction of energy needs
- Reduction of CO2 emissions

Charging technologies | Today, controlled charging is available. With next step bidirectional charging is enabled. Full vehicle-grid-integration will take some more time to develop.



Key takeaways

MINING AND PRODUCTION CAPACITY

- Good base reserves to **expand capacities**
- **Increase mining and refining activities** to reduce dependencies
- **Economic boost** through localized value chains

RECYCLING

- Develop **Battery recycling to reduce dependencies** on foreign raw material supplies
- **Control the disposal** of toxic materials
- **Economic boost** through the buildup of recycling capabilities

ENERGY SUPPLY

- **Bi-directional charging, battery energy storage and second life** for batteries **are countermeasures** to reduce stress on the electric grid
- **Bi-directional charging is currently possible**, but not throughout implemented
- Development of **full vehicle-grid-integration as future opportunity**

Thank you

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