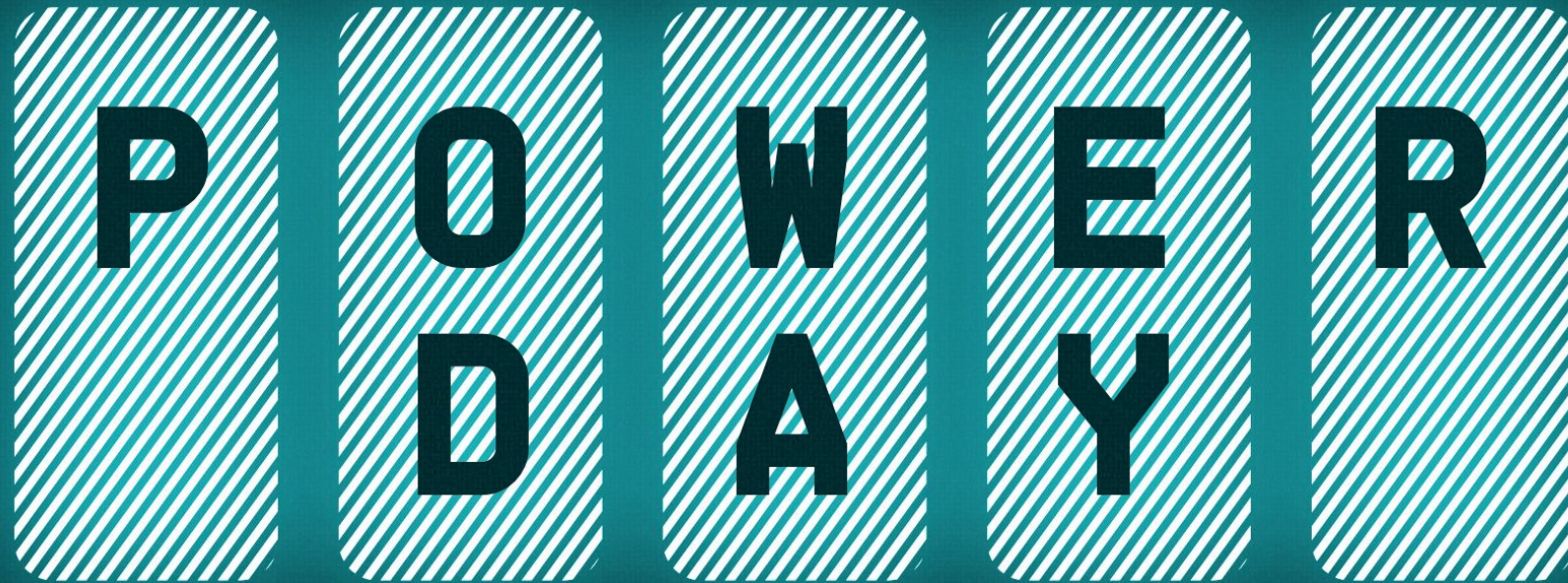


VOLKSWAGEN  
AKTIENGESELLSCHAFT



Herbert Diess, CEO of Volkswagen Group

Thomas Schmall, Member of the Board of Management  
of Volkswagen Group for Technology

March 15, 2021



## Disclaimer

The following presentations as well as remarks/comments and explanations in this context contain forward-looking statements on the business development of the Volkswagen Group. These statements are based on assumptions relating to the development of the economic, political and legal environment in individual countries, economic regions and markets, and in particular for the automotive industry, which we have made on the basis of the information available to us and which we consider to be realistic at the time of going to press. The estimates given entail a degree of risk, and actual developments may differ from those forecast. Any changes in significant parameters relating to our key sales markets, or any significant shifts in exchange rates or commodities relevant to the Volkswagen Group or deviations in the actual effects of the Covid-19 pandemic from the scenario presented will have a corresponding effect on the development of our business. In addition, there may be departures from our expected business development if the assessments of the factors influencing value enhancement and of risks and opportunities presented develop in a way other than we are currently expecting, or if additional risks and opportunities or other factors emerge that affect the development of our business.

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VOLKSWAGEN  
AKTIENGESELLSCHAFT

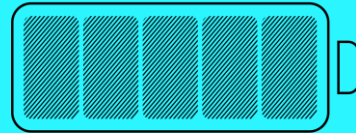


**E-Mobility**

VOLKSWAGEN  
AKTIENGESELLSCHAFT



**E-Mobility**



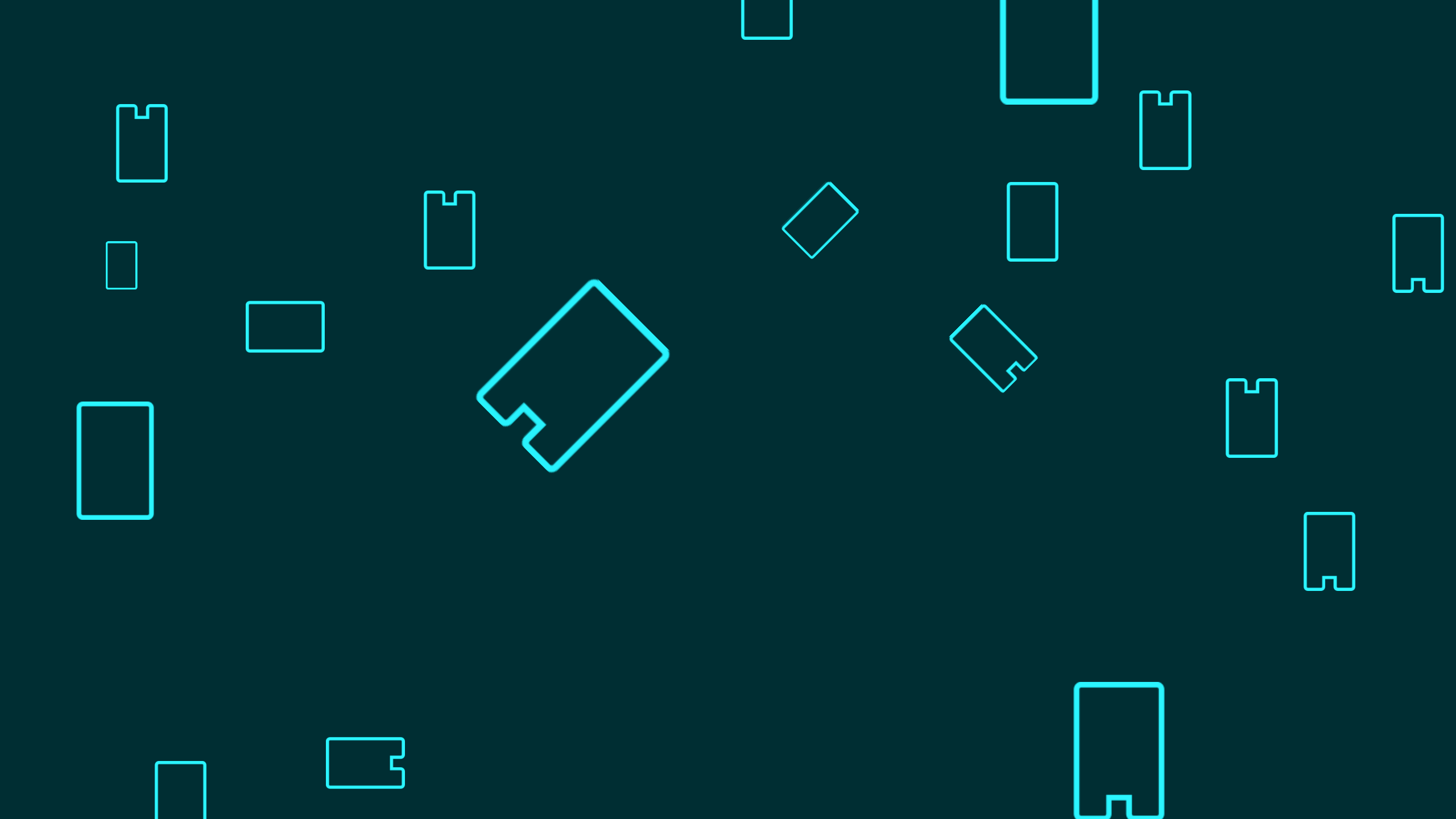
**Power**

Battery / Charging / Energy Management





BATTERY

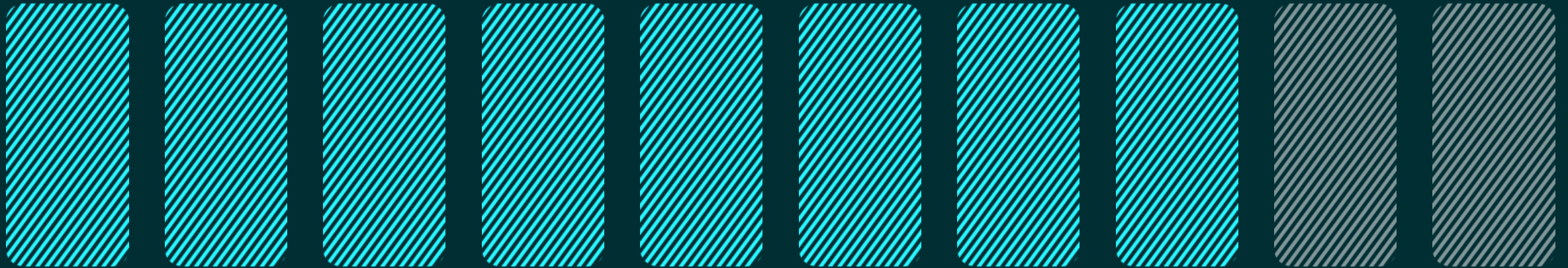


**Unified  
Cell**

**2023**



2030



Unified Cell

80%

SPECIAL

CASES

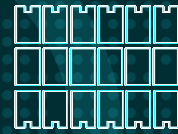


Battery costs

**-50%**

in entry segment

Battery cell



Battery systems



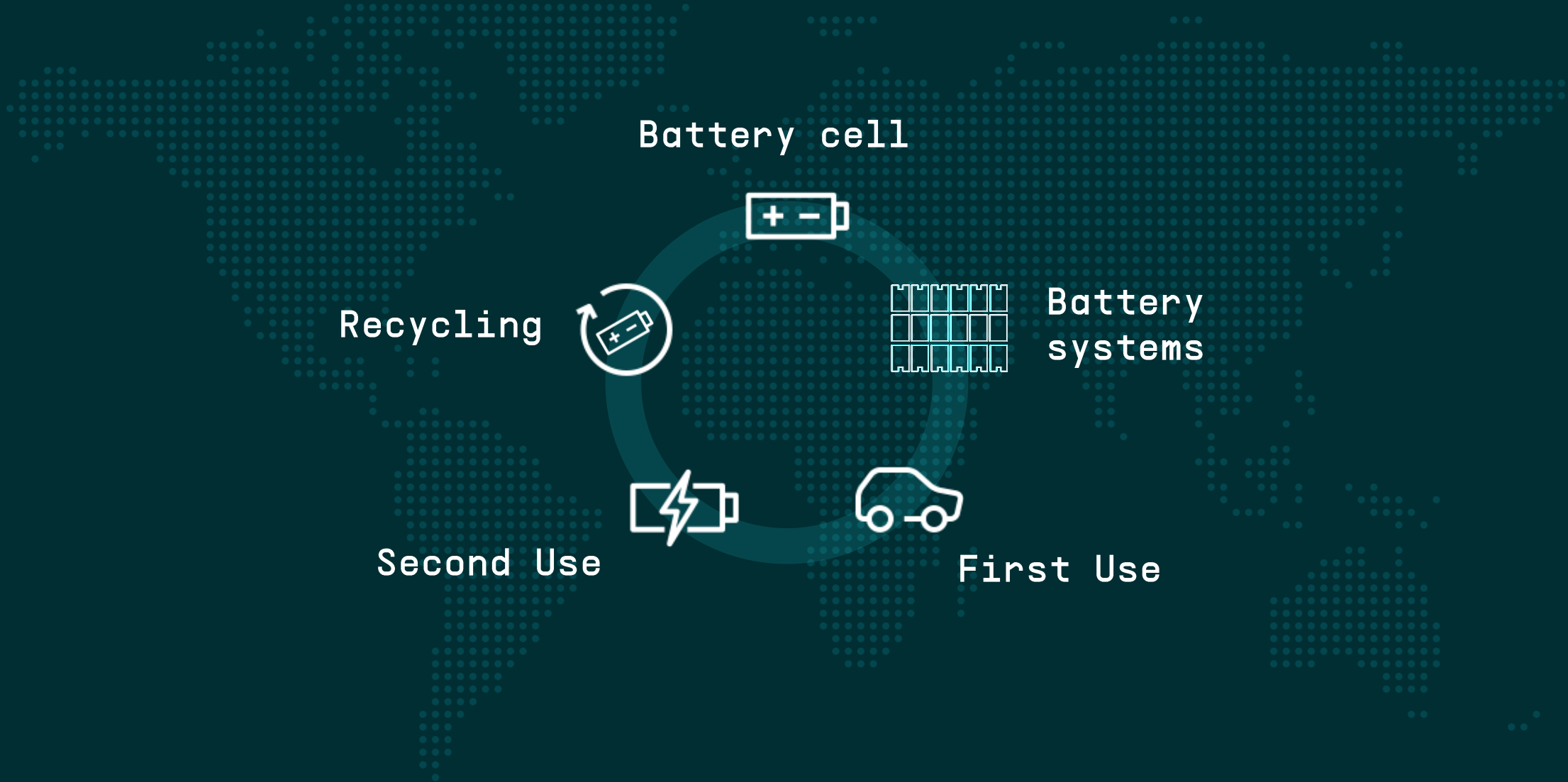
First Use



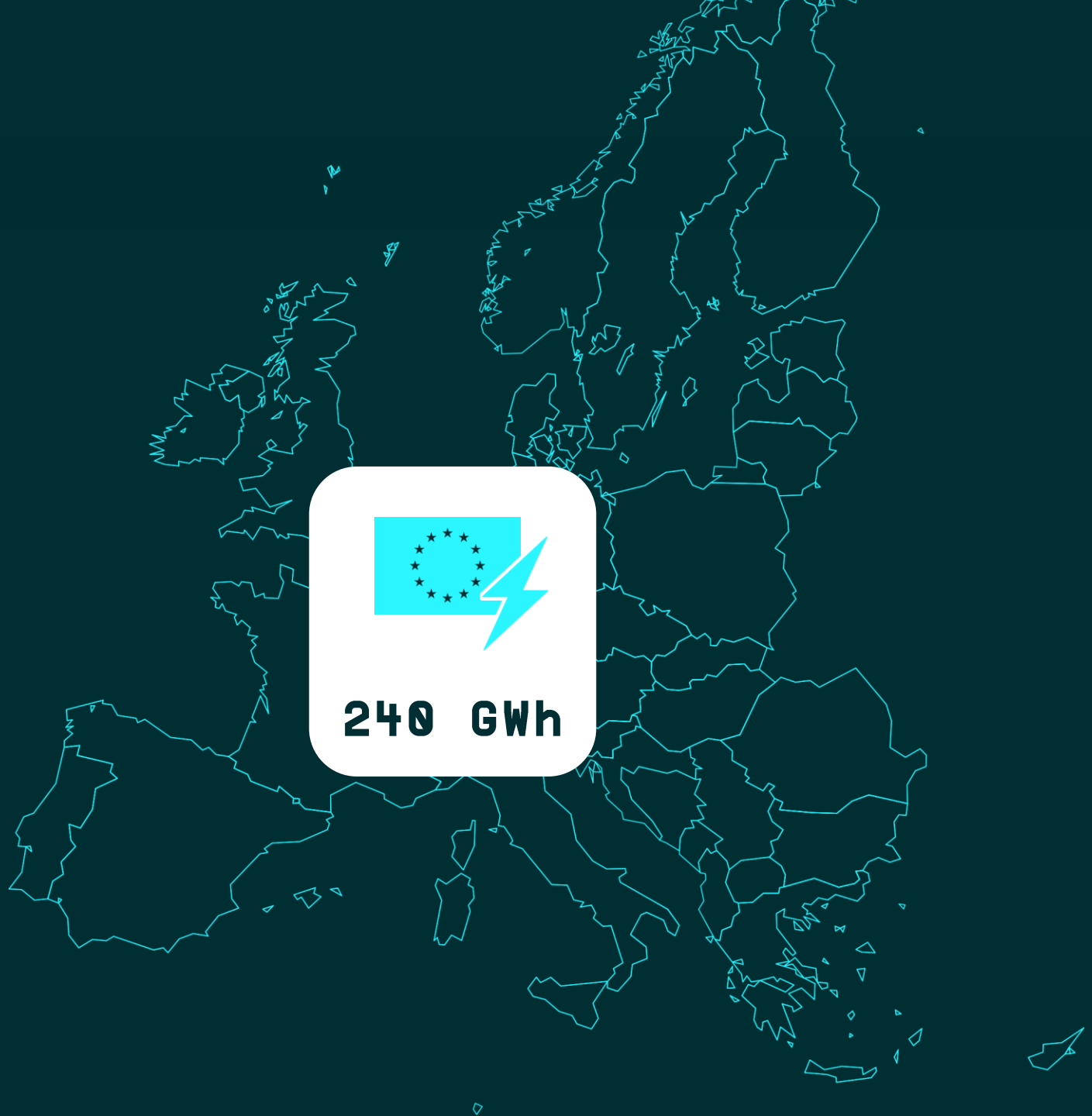
Second Use



Recycling








**240 GWh**

A white rounded square box containing a blue icon of the European Union flag (a circle of twelve stars) and a blue lightning bolt. Below the icon, the text "240 GWh" is written in a bold, black, sans-serif font.



40 GWh



40 GWh



40 GWh



40 GWh



40 GWh



40 GWh

CHARGING



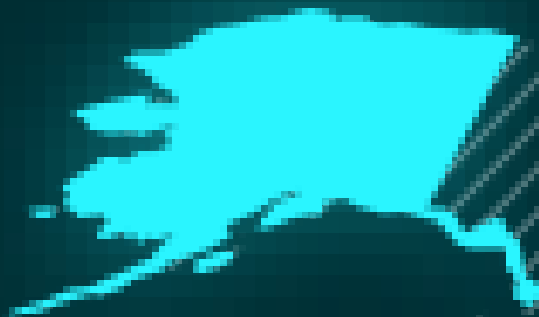




High Power Charging  
**GLOBAL NETWORK**



EUROPE



USA

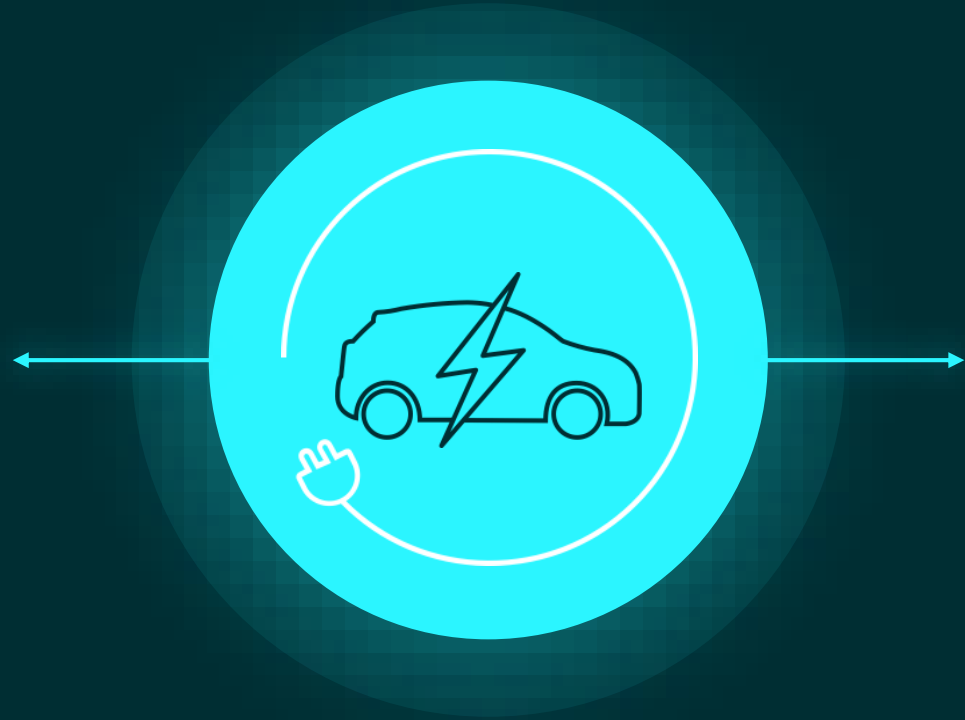


CHINA



**ENERGY  
MANAGEMENT**





# Power as Core Competence

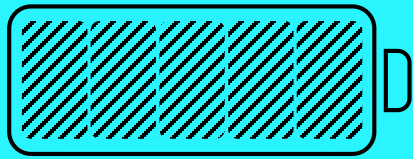


NEW TECHNOLOGY DIVISION:

**WE ARE THE  
POWERHOUSE OF  
VOLKSWAGEN**



## TWO MAIN PILLARS



**BATTERY CELL  
& SYSTEM**



**CHARGING &  
ENERGY**

# FIRST CHALLENGE: SCALE VOLUME TO HUGE SPREAD OF PRODUCT PORTFOLIO



IF YOU HAVE THE VOLUME...  
THE NEXT CHALLENGE WILL BE

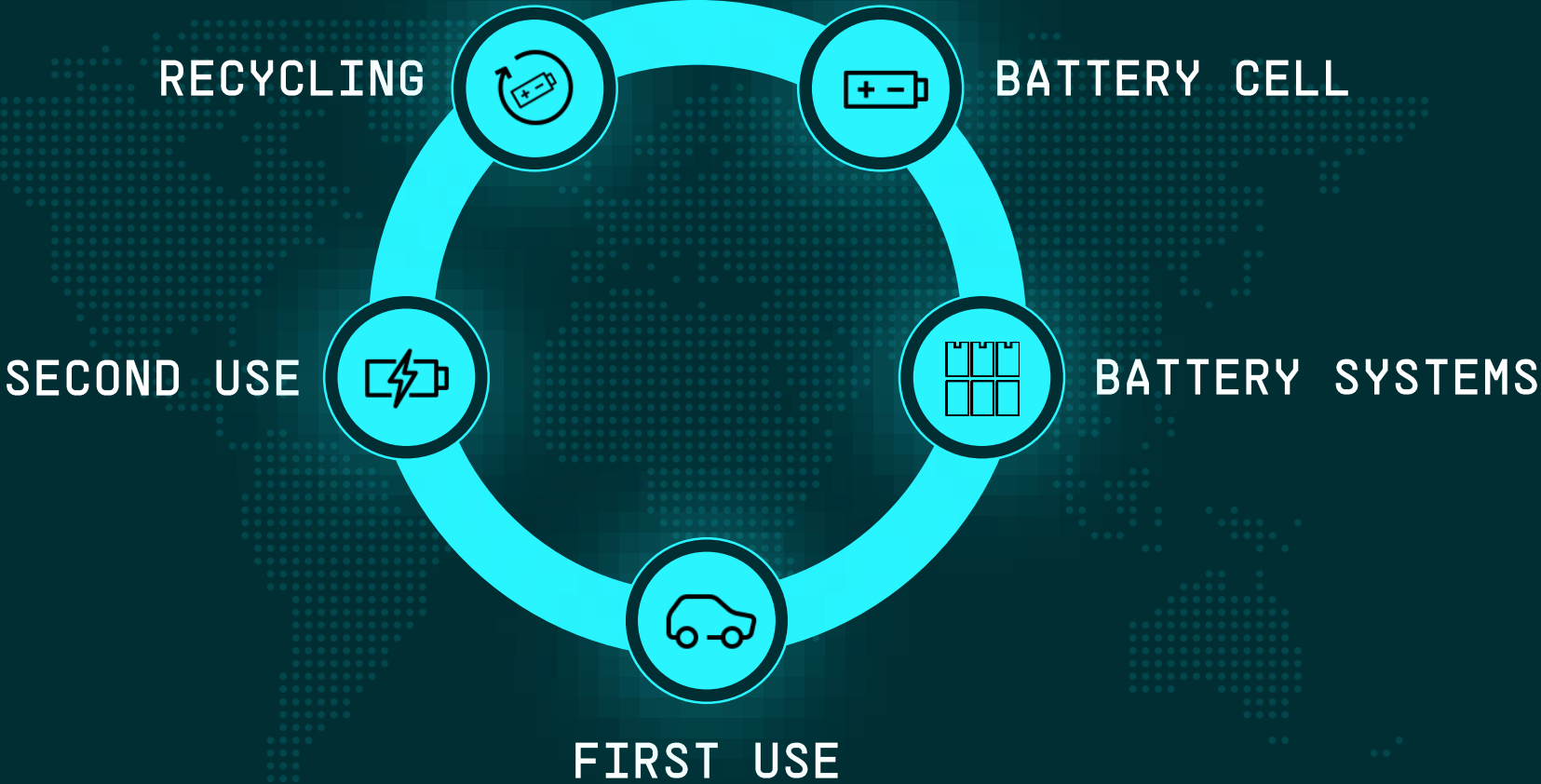
**TECHNOLOGY,**  
**TIMING**  
AND **PRICE!**

**THERE IS  
NEED FOR SPEED!**



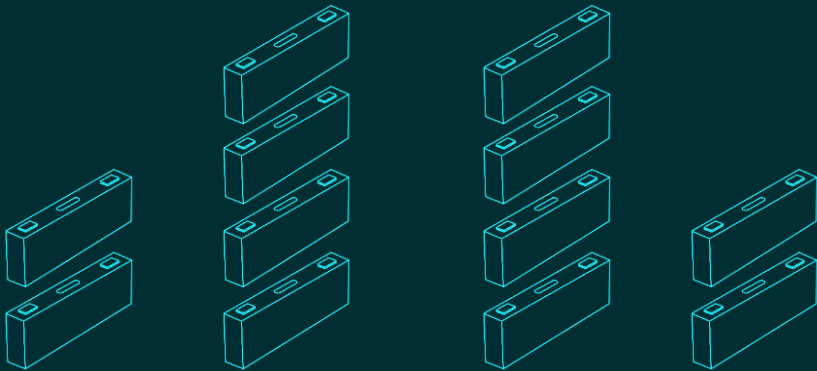
# MINDSET CHANGE IN FUNCTIONAL RESPONSIBILITIES

## CLOSED LOOP APPROACH

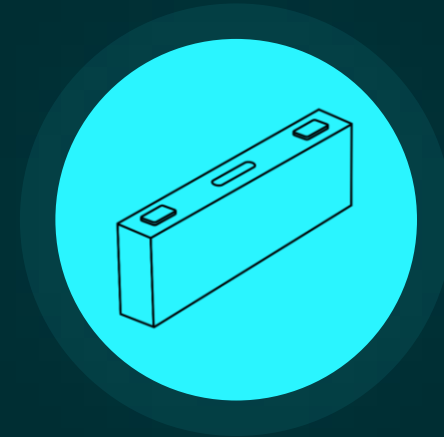


# AND A FUNDAMENTAL MINDSET CHANGE IN **TECHNOLOGY SETUP**

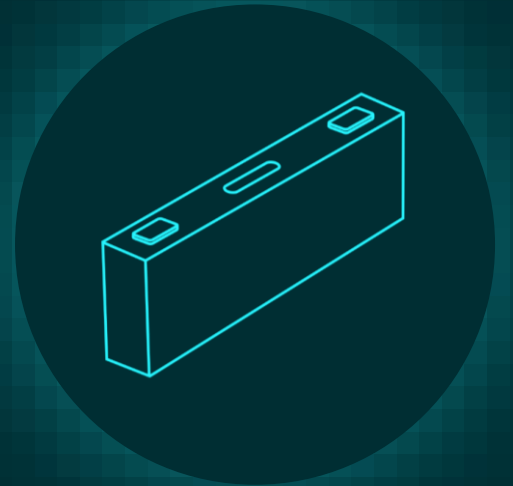
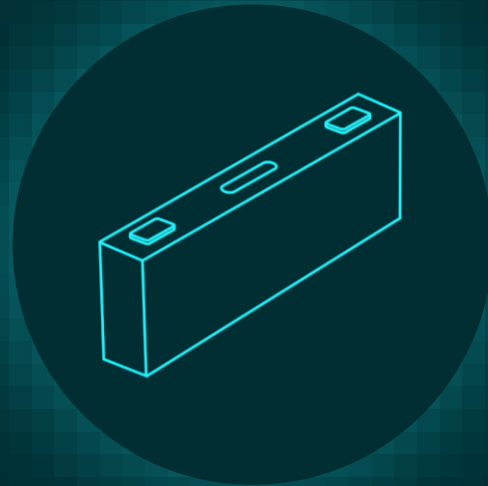
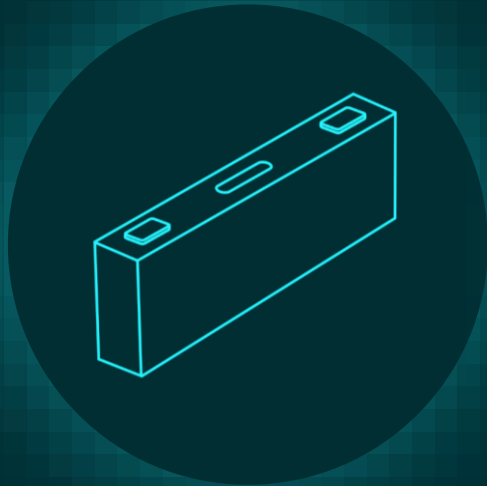
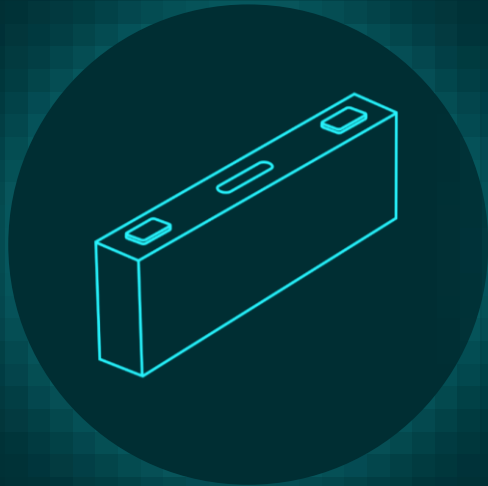
## CURRENT APPROACH



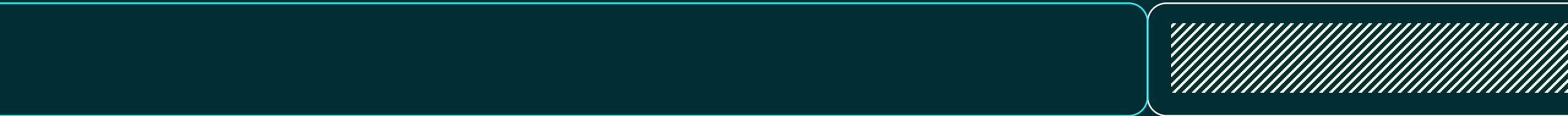
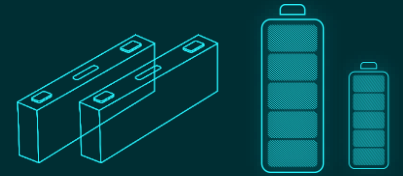
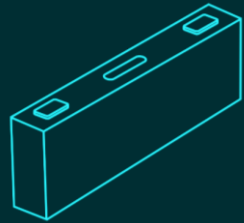
## UNIFIED CELL



THE INTELLIGENCE OF THE BATTERY CELL  
**IS INSIDE**



ACTUAL PRODUCT PORTFOLIO SHOWS POSSIBLE  
**UNIFIED CELL UTILIZATION OF 80%**



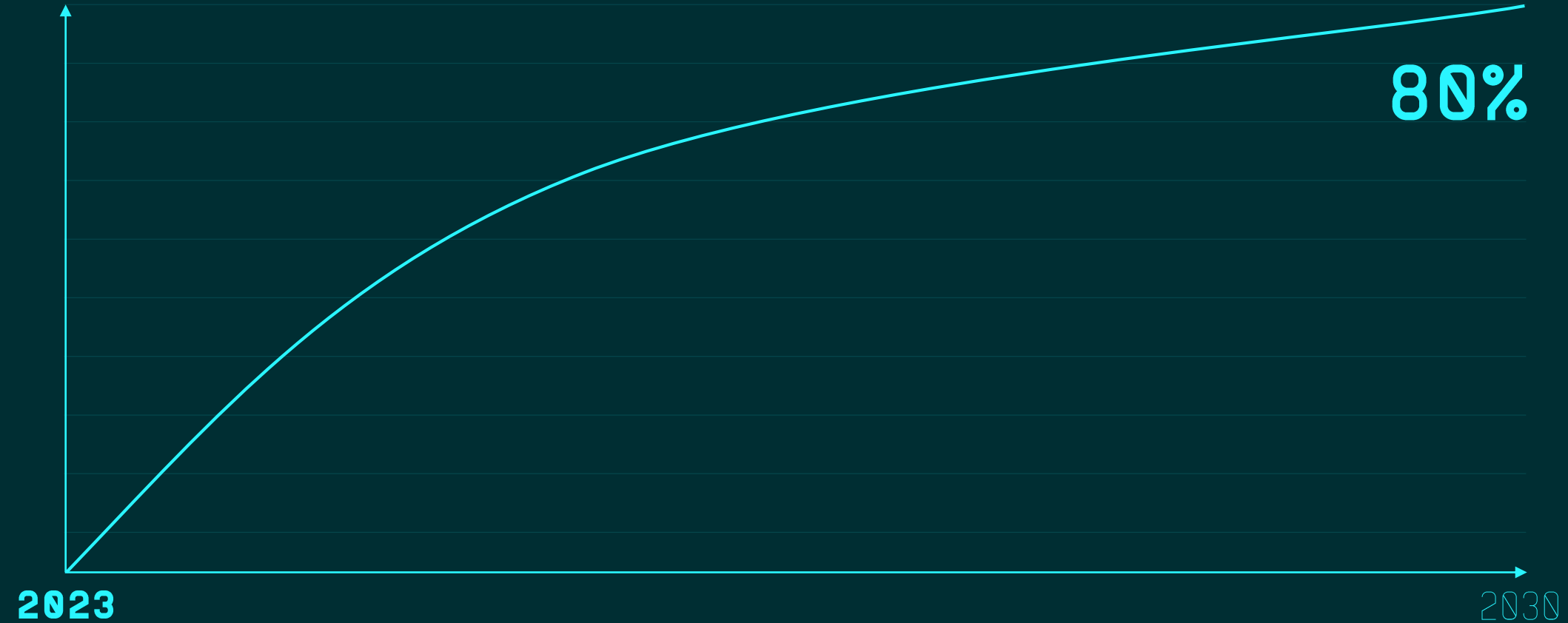
**80%**  
Volume

**20%**  
Specific Solutions



ROLLOUT UNIFIED CELL CONCEPT  
**STARTS 2023**

START



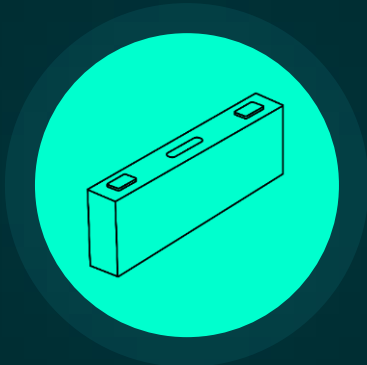
# REACHING COST TARGETS

WITH UNIFIED CELL CONCEPT

## ENTRY

COST: -50%

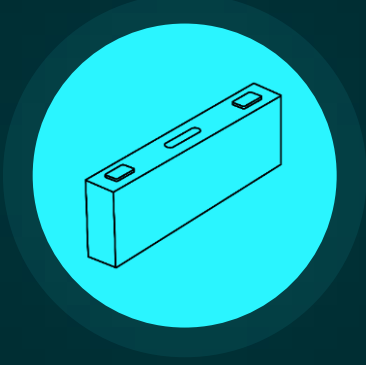
Inexpensive  
Chemistry



## VOLUME

COST: -30%

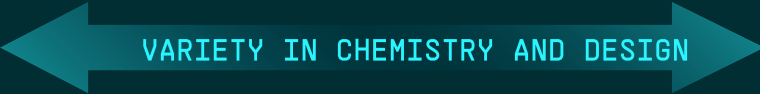
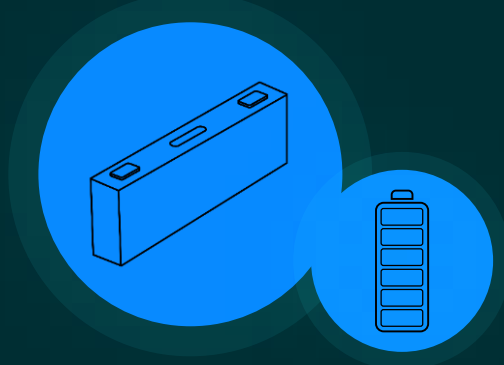
Mainstream  
Chemistry



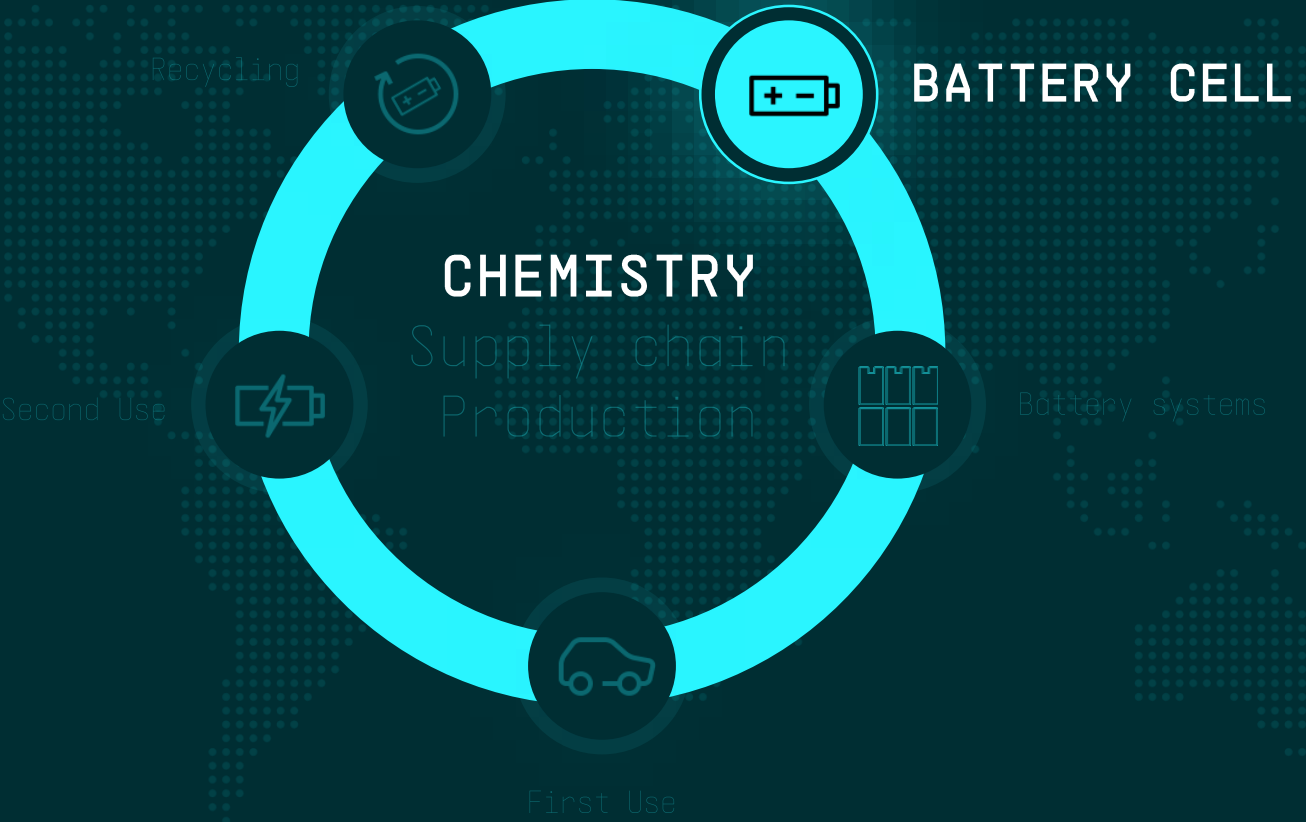
## SPECIFIC SOLUTIONS

COST: +xx%

High end chemistry for  
high performance



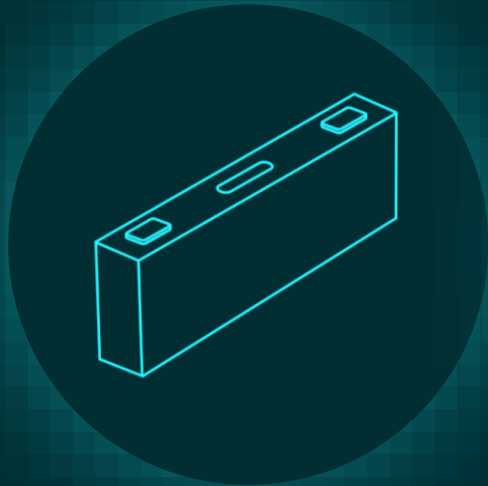
# CLOSED LOOP APPROACH



THE INTELLIGENCE OF THE BATTERY CELL  
**IS INSIDE**

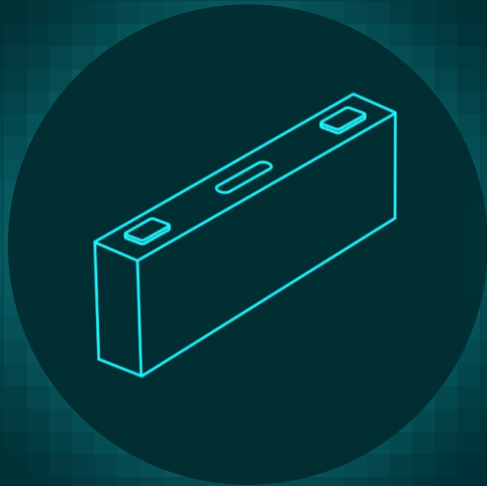
**ENTRY**

IRON PHOSPHATE



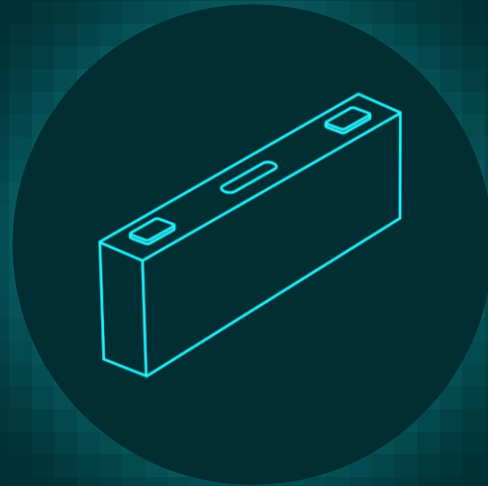
**VOLUME**

HIGH MANGANESE

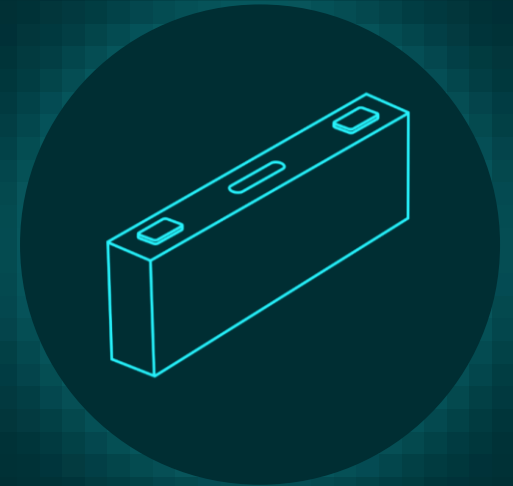


**SPECIFIC SOLUTIONS**

NICKEL MANGANESE COBALT

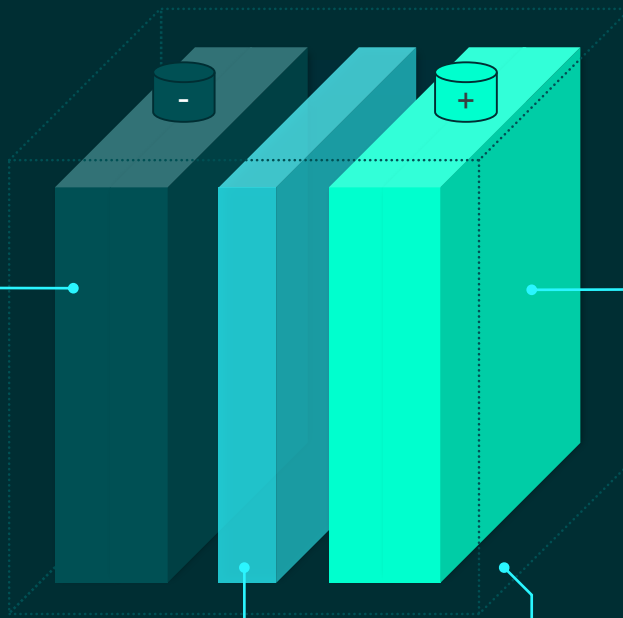


SOLID STATE



# MOST IMPORTANT CONTROL LEVERS FOR BATTERY FUTURE COMPETITIVENESS

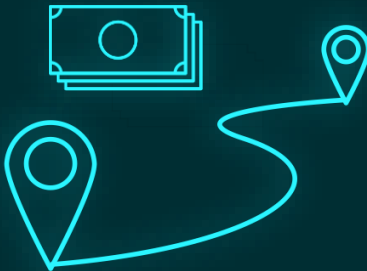
**ANODE**  
CHARGING TIME



SEPARATOR

ELECTROLYTE

**CATHODE**  
COSTS AND RANGE





# CATHODE

CONTROL LEVER FOR  
SUSTAINABLE SUPPLY CHAIN,  
COSTS AND RANGE

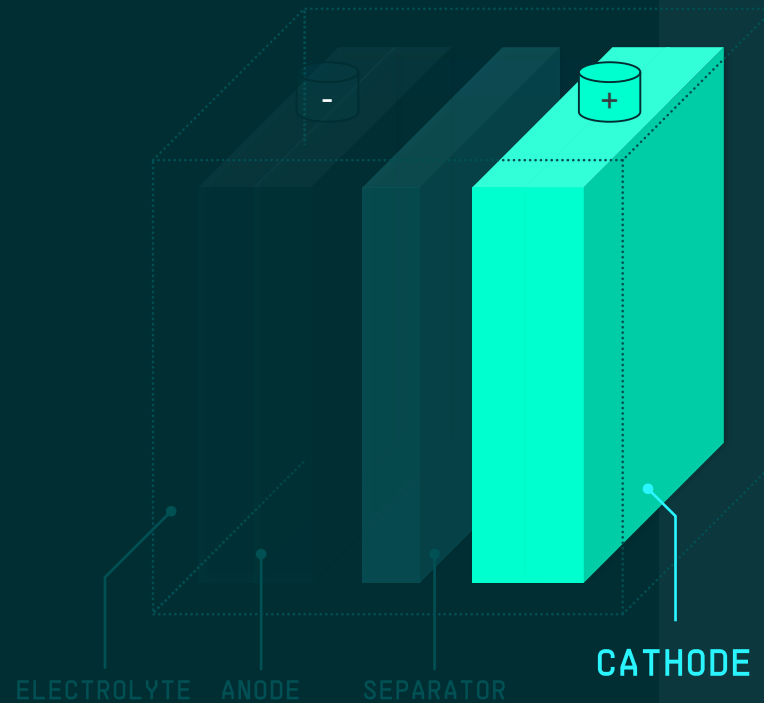
# CATHODE

CONTROL LEVER FOR SUSTAINABLE SUPPLY CHAIN, COSTS AND VEHICLE RANGE

## STATE OF THE ART – NMC-CELL

### CATHODE

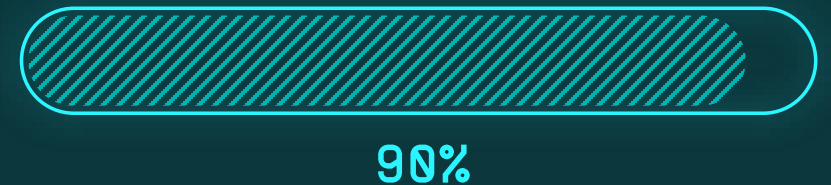
- Nickel
- Manganese
- Cobalt



### CATHODE CELL COST SHARE



### CATHODE RANGE IMPACT





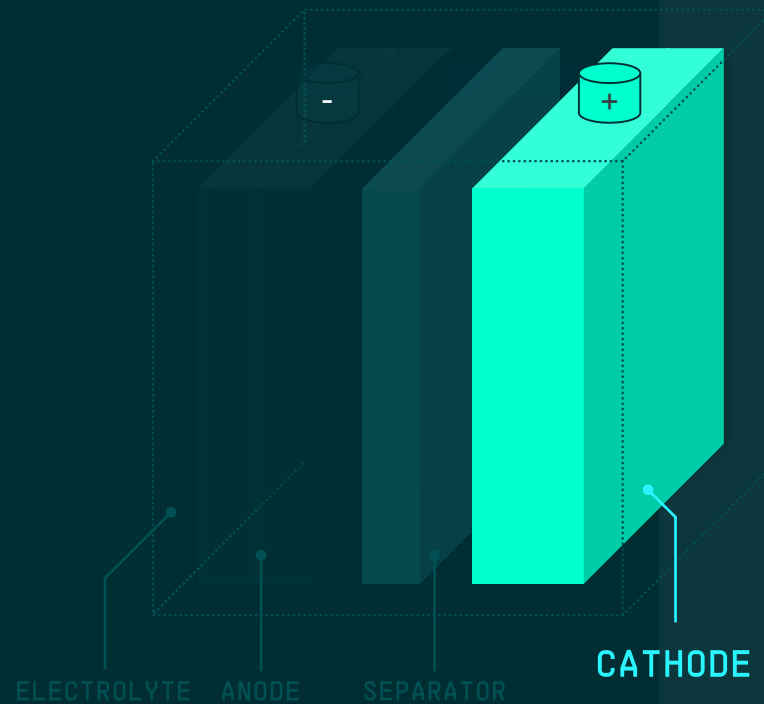
# CATHODE

ROBUST AND INEXPENSIVE CHEMISTRY FOR ENTRY VEHICLES

## LFP-CELL

### CATHODE

- Iron-Phosphate
- Nickel
- Manganese
- Cobalt



### COSTS



### RANGE




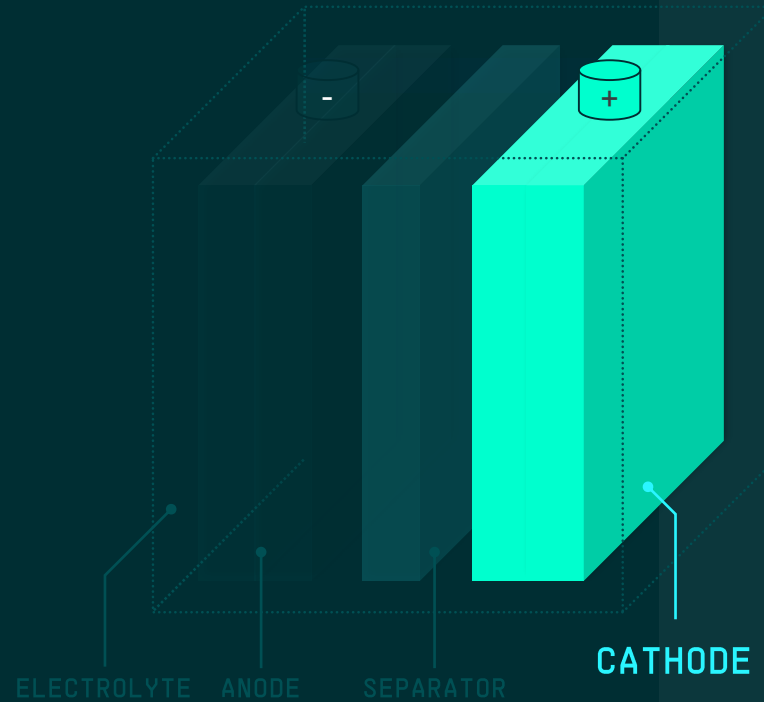
# CATHODE

FUTURE BEST COST TO VALUE FOR MAINSTREAM CHEMISTRY

## HI-MN-CELL

### CATHODE

- Nickel 
- Manganese
- Cobalt



### COSTS



### RANGE





**ANODE**

CONTROL LEVER FOR  
CHARGING PERFORMANCE

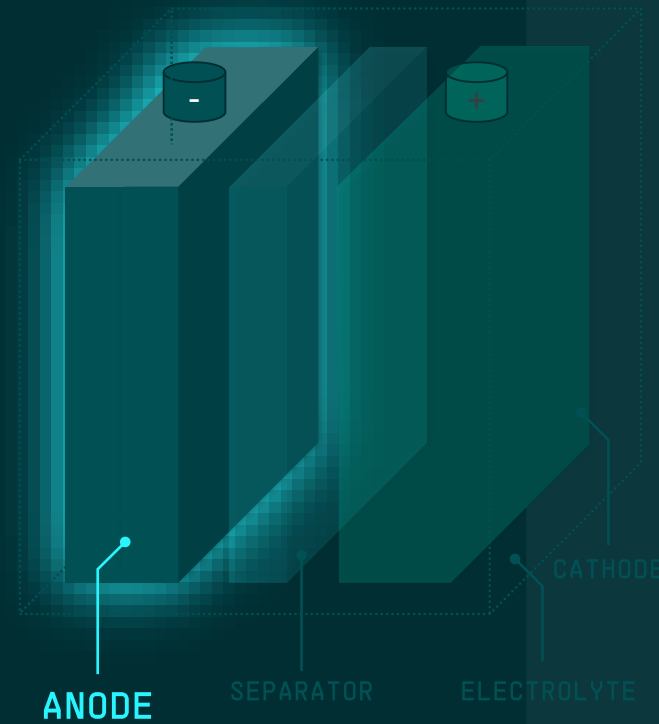
# ANODE

CONTROL LEVER FOR CHARGING PERFORMANCE

## STATE OF THE ART – GRAPHITE

### ANODE

- Synthetic graphite



### ANODE CHARGE TIME IMPACT



100%

### ANODE RANGE IMPACT



10%

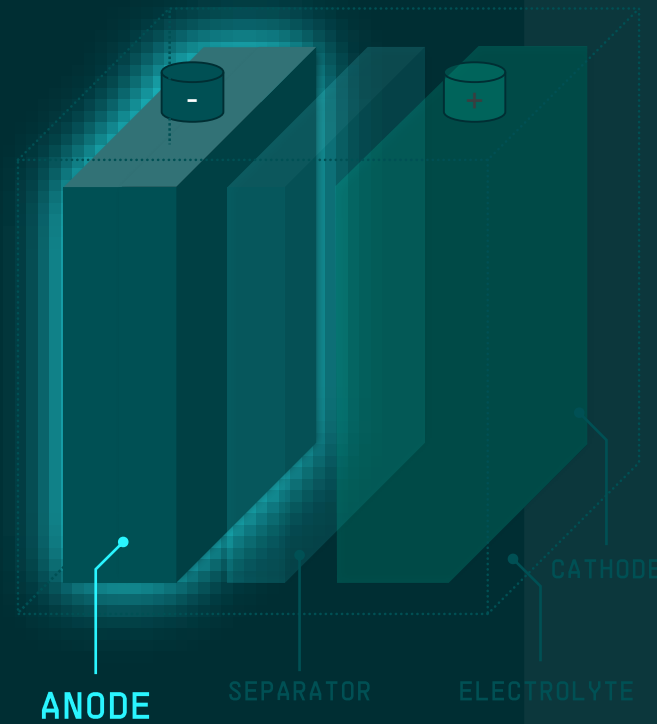
# ANODE

SILICON ANODE SIGNIFICANTLY REDUCES CHARGING TIME AND IMPROVES RANGE

## HI-SI-CELL

### ANODE

- Synthetic graphite
- Silicon



### CHARGING TIME



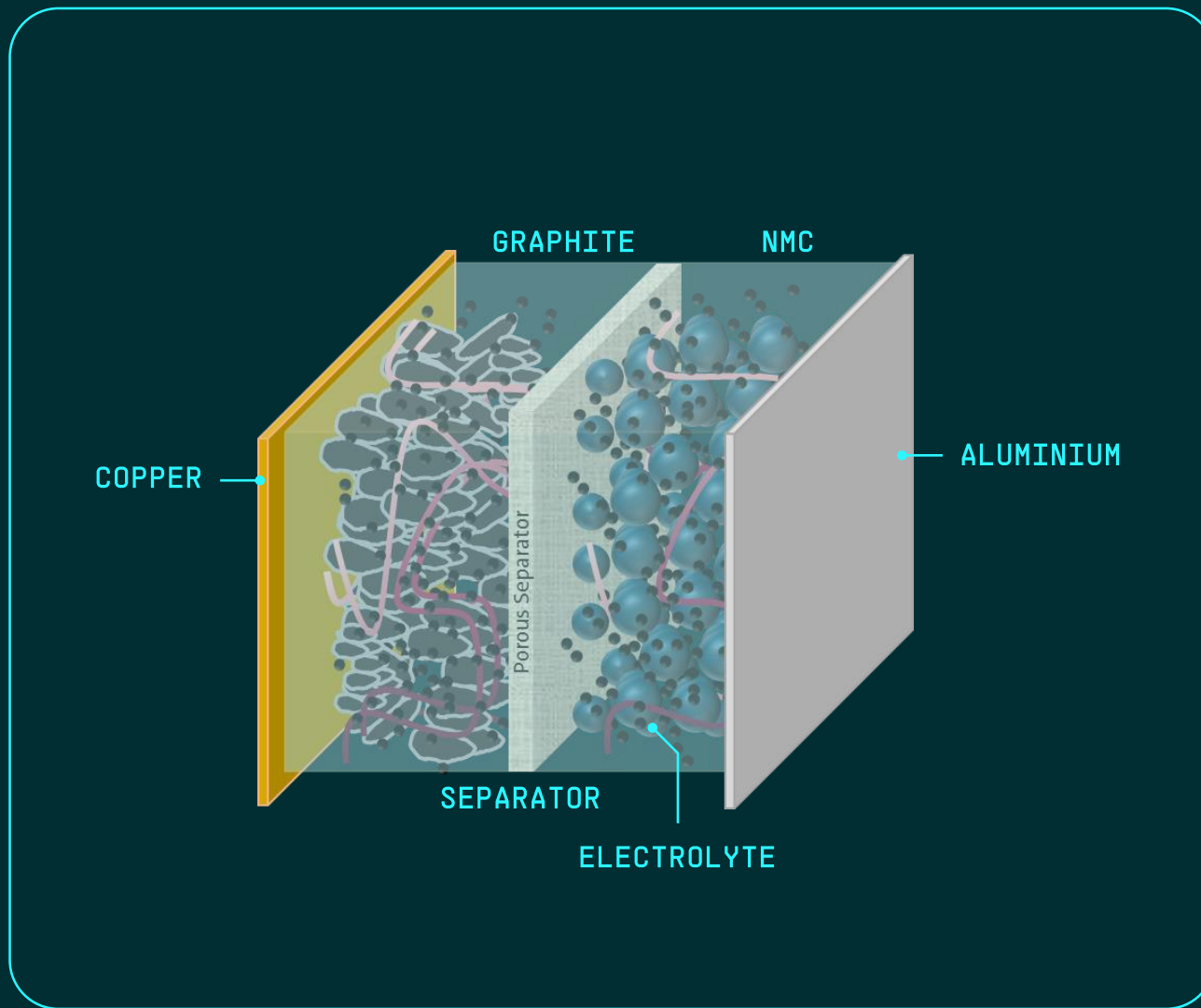
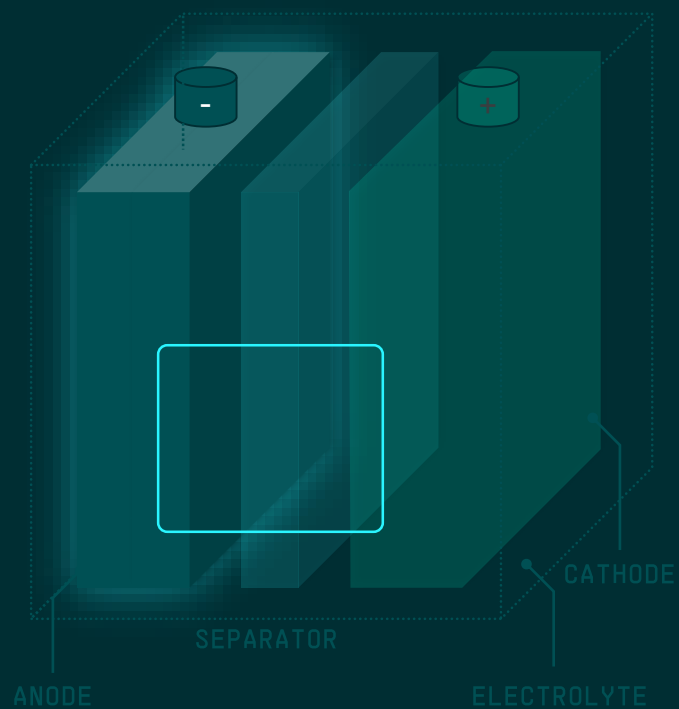
### RANGE



# ● SOLID STATE

SIMPLER DESIGN LEADS TO HIGHER  
PERFORMANCE AND LOWER COSTS

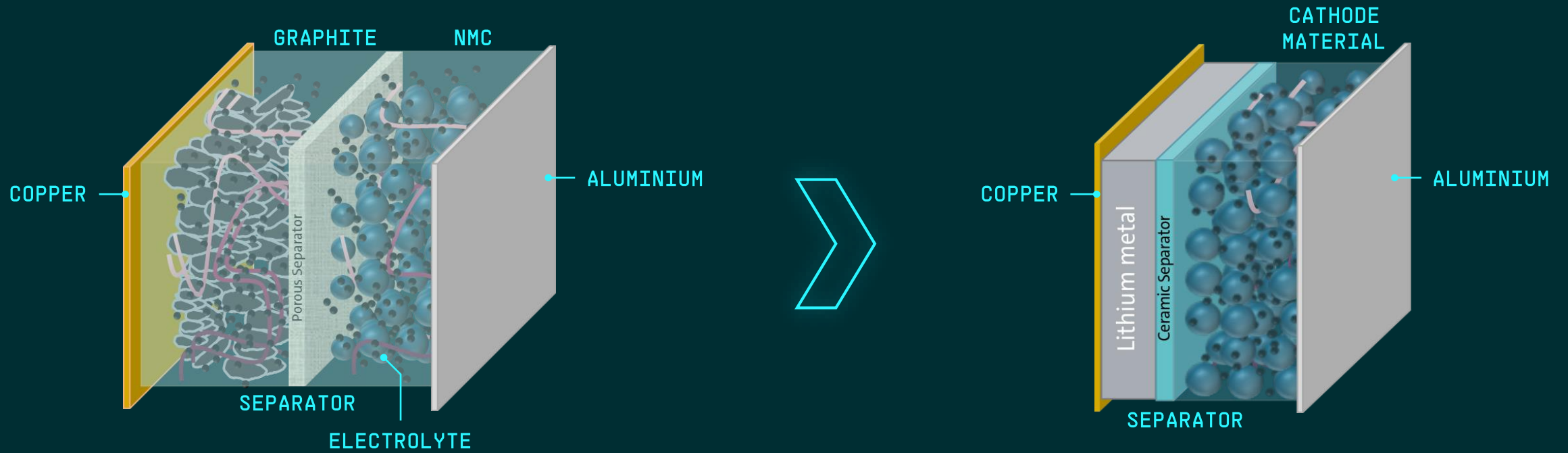
# STATE OF THE ART BATTERY CELL IN DETAIL





# SOLID STATE BATTERY CELL

SIMPLER DESIGN LEADS TO HIGHER PERFORMANCE



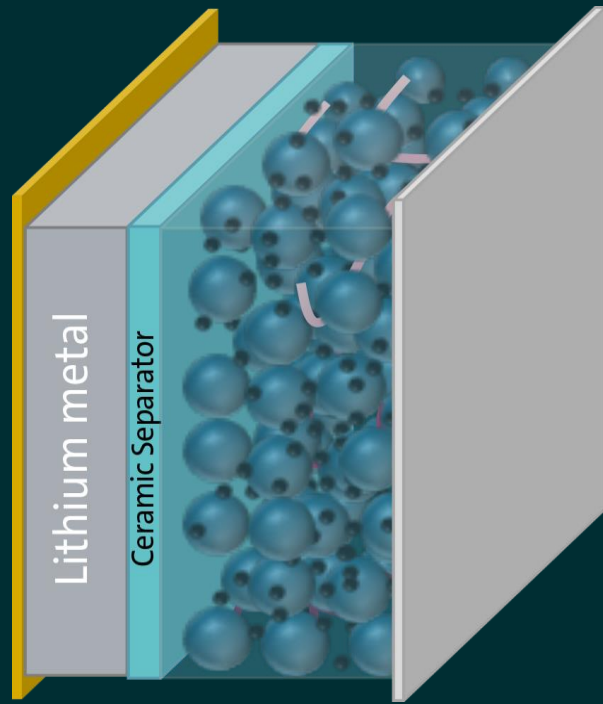
STATE OF THE ART

SOLID STATE

# SOLID STATE BATTERY CELL

BEST IN CLASS CHARGING TIME AND INCREASED RANGE

## SOLID STATE BATTERY



### CHARGING TIME



### RANGE



# ULTRA FAST CHARGING WILL IMPROVE

EV LONG DISTANCE CAPABILITY

VOLKSWAGEN ID.4 PRO

[77 kWh]



DISTANCE



450 km / 280 mi

CHARGING TIME

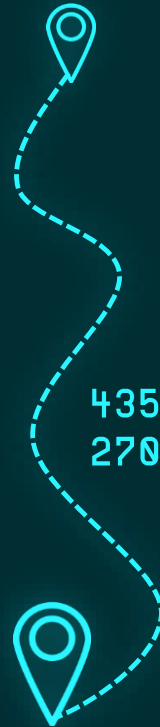


today ~ 25 min

until 2025 ~ 17 min

after 2025 ~ 12 min

LOS ANGELES



435 km  
270 mi

LAS VEGAS

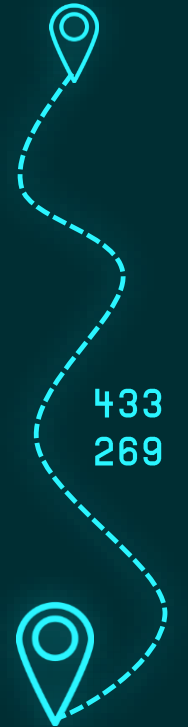
LEIPZIG



430 km  
267 mi

MUNICH

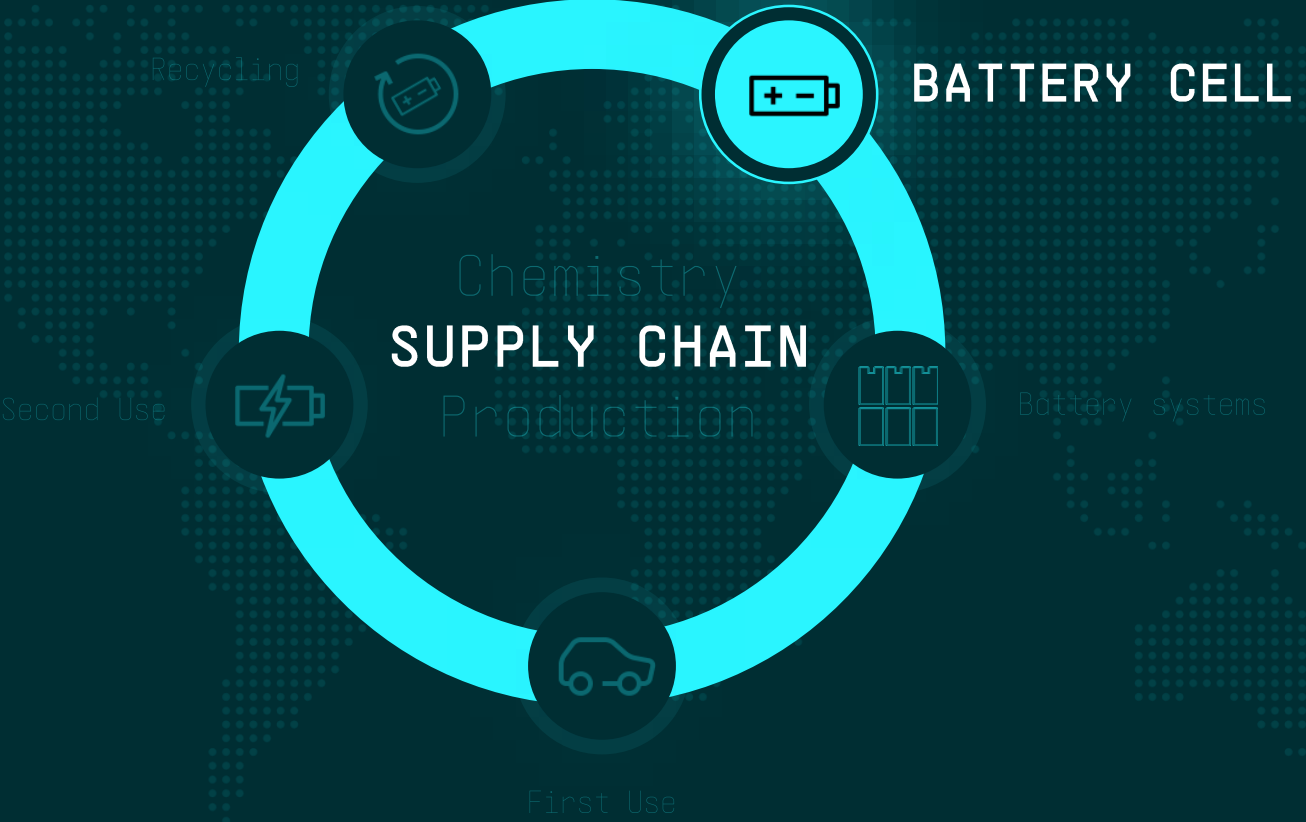
BEIJING



433 km  
269 mi

DONGYING

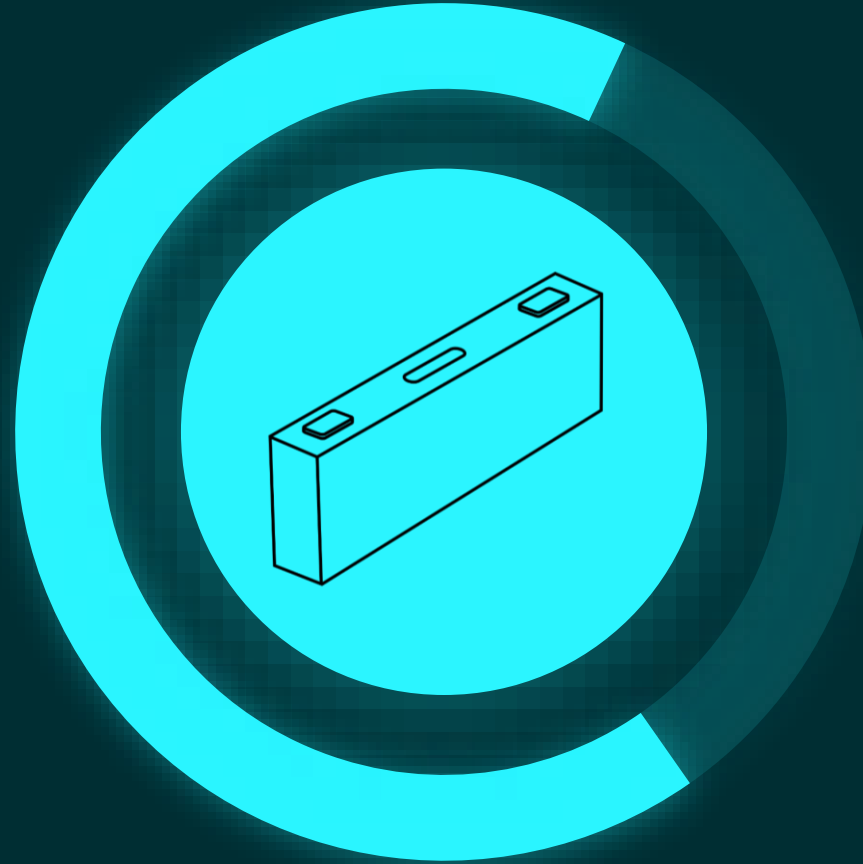
# CLOSED LOOP APPROACH



# COST-SPREAD BATTERY SYSTEM

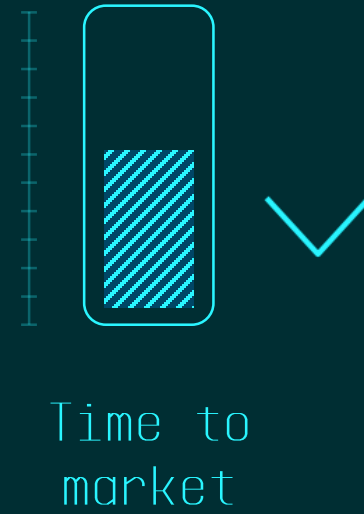
2 / 3

CHEMISTRY

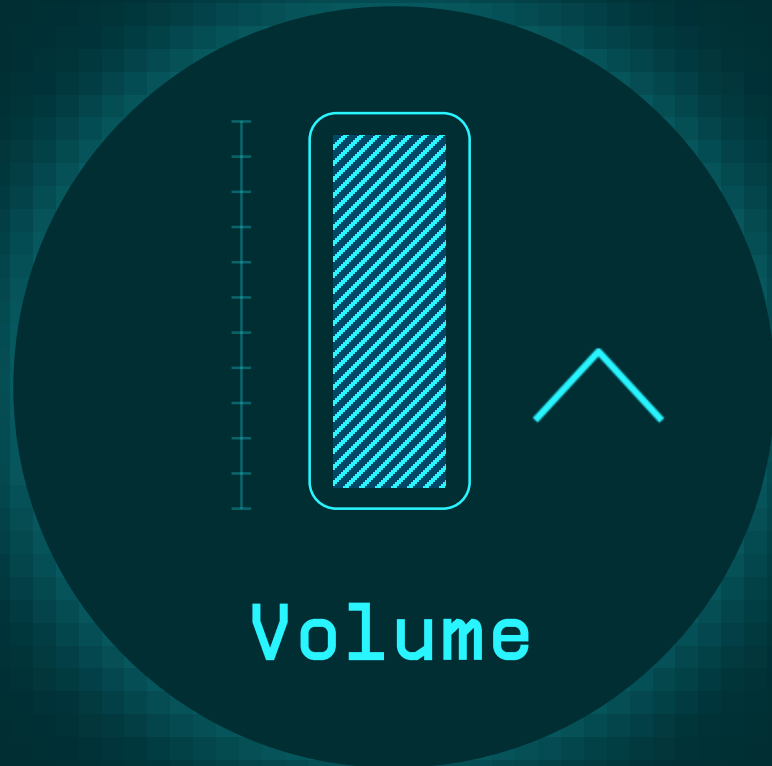


1 / 3

# MAIN OBJECTIVE FOR BEV RAMP UP

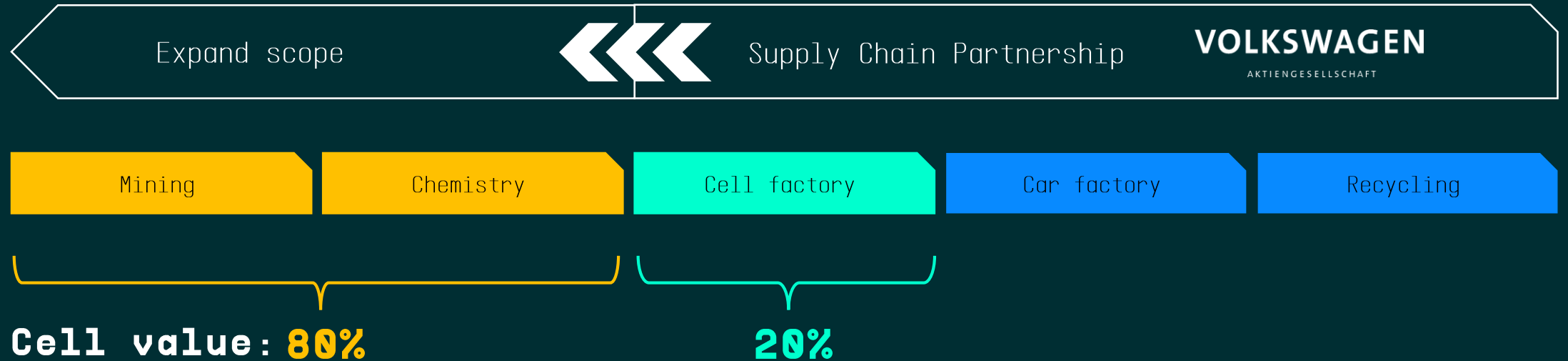


# MAIN OBJECTIVE FOR BEV RAMP UP

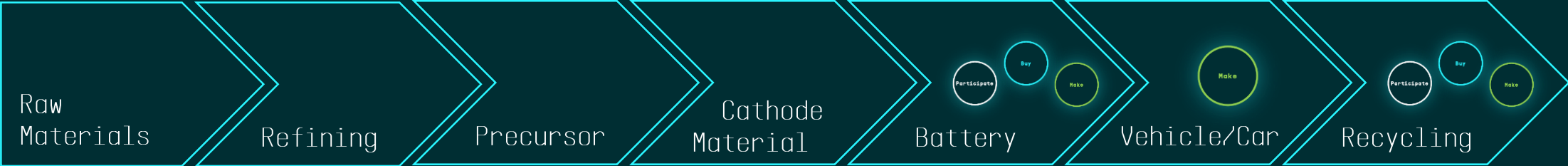




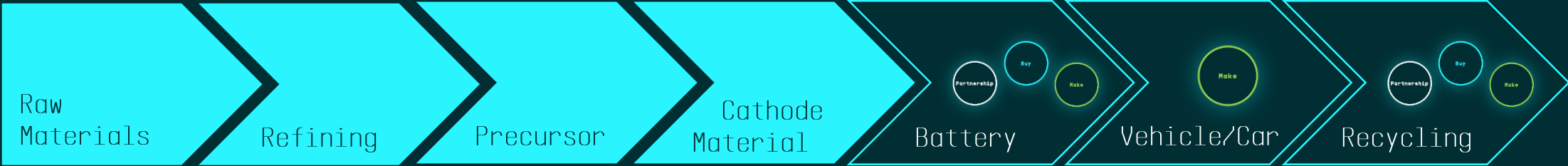
# VOLKSWAGEN EXPANDS SCOPE ALONG VALUE CHAIN



# THE RIGHT BALANCE



# THE RIGHT BALANCE

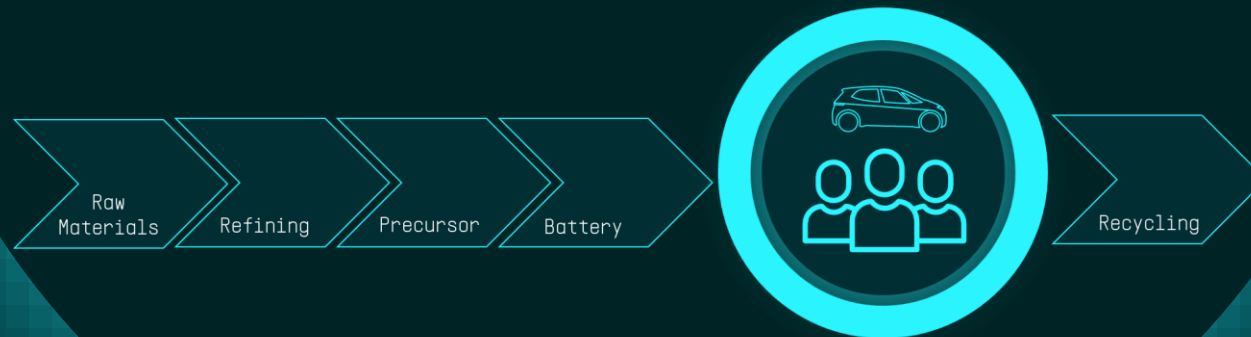


Vertical Integration

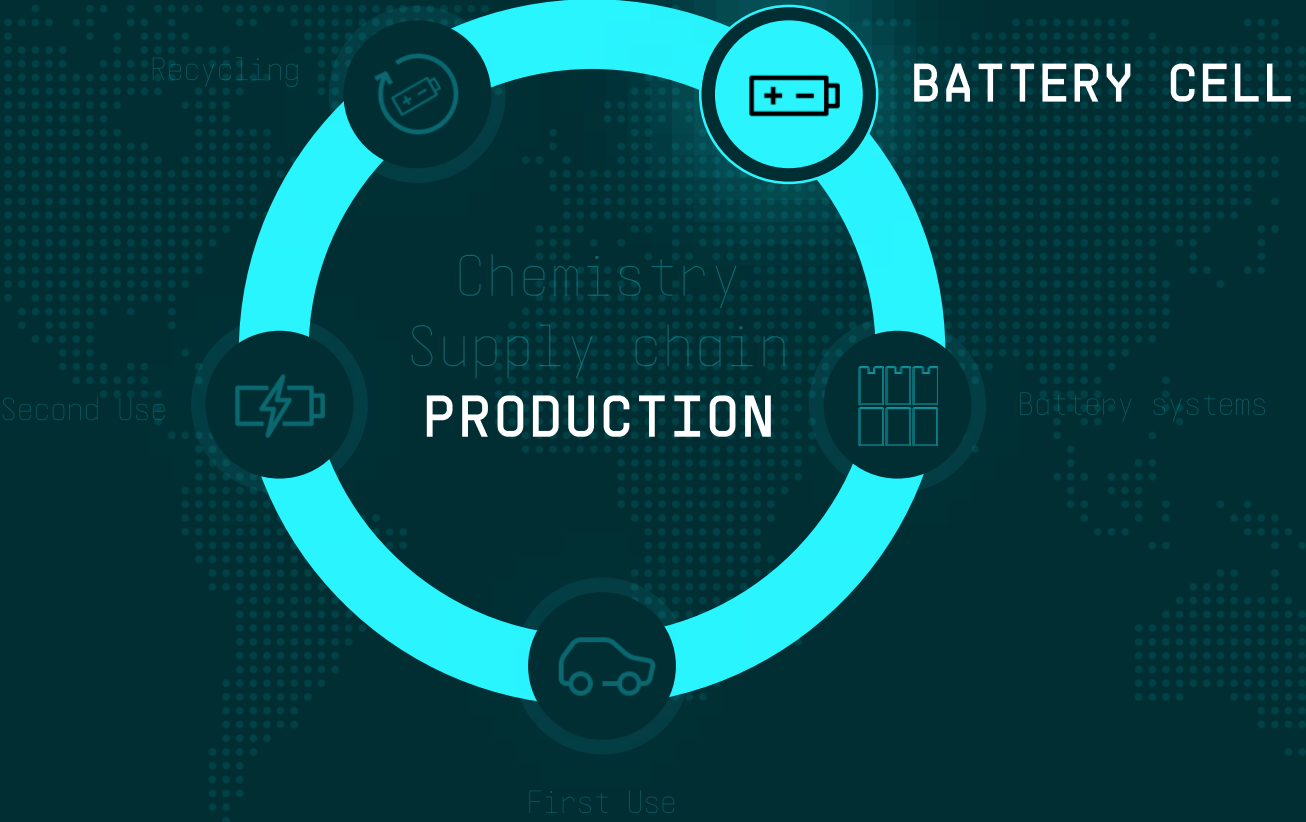
# CUSTOMER DEMANDS



NEW STRONG PARTNERSHIPS –  
**KEY TO FUTURE SUCCESS!**

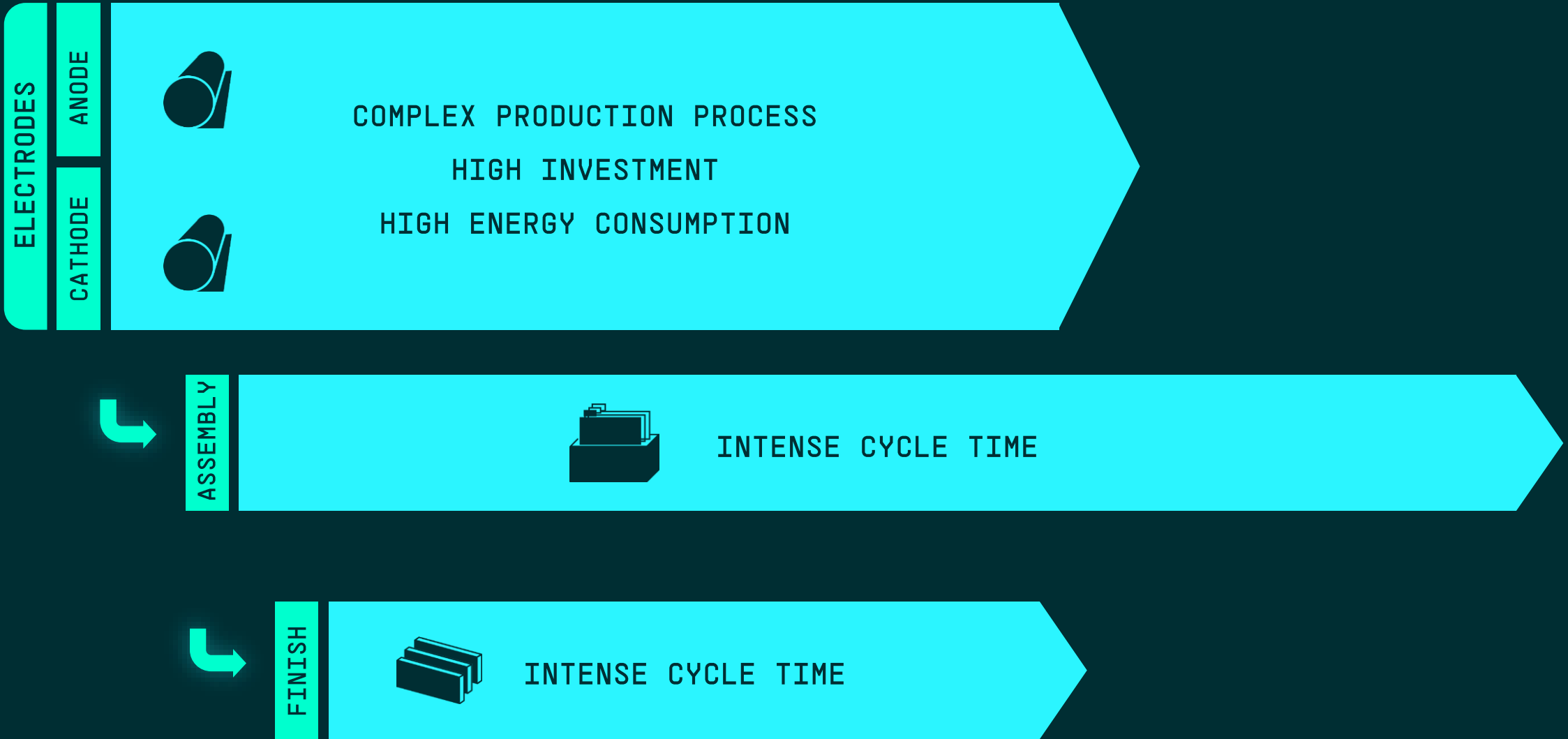


# CLOSED LOOP APPROACH



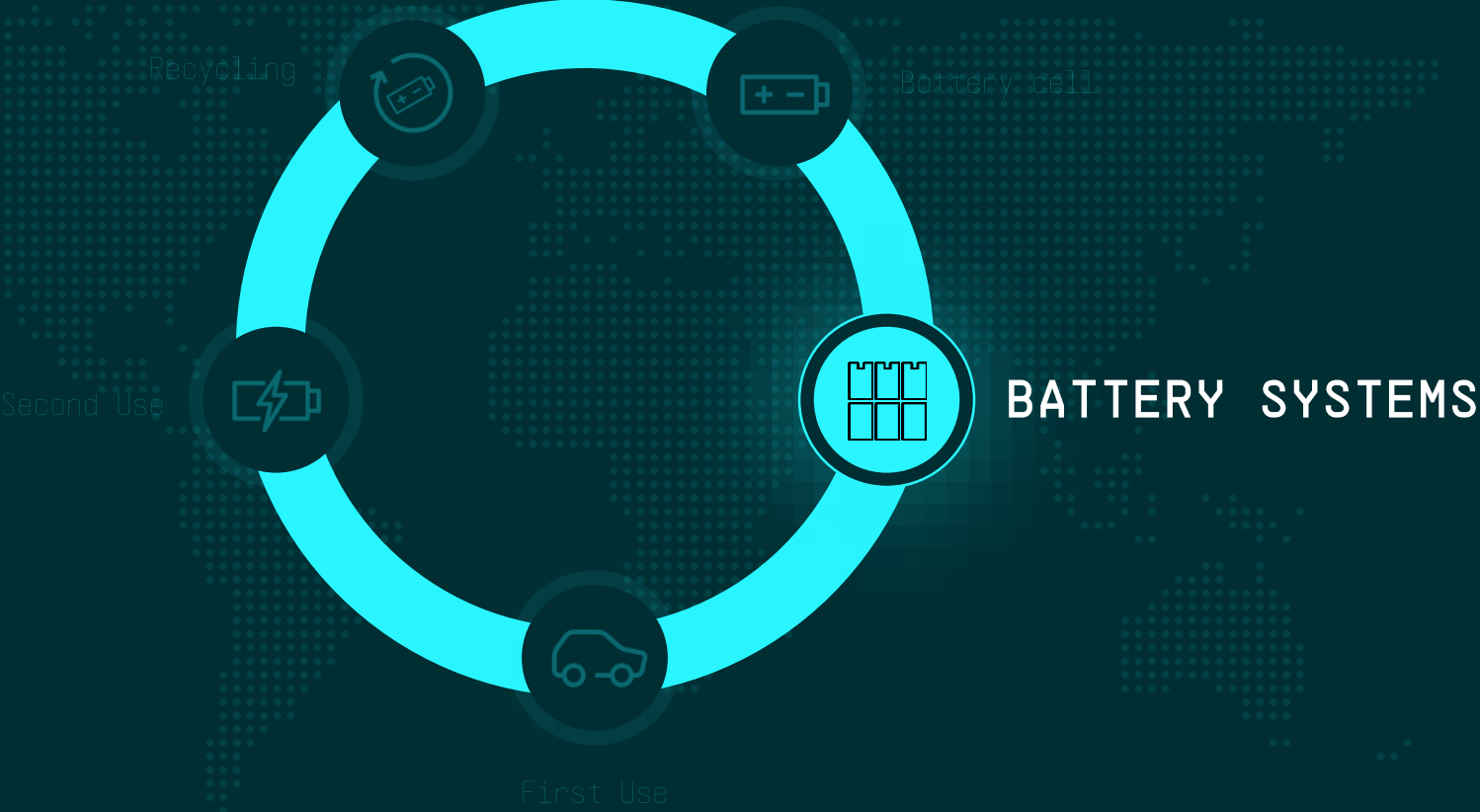
# STATE OF THE ART BATTERY CELL PRODUCTION

INVESTMENT AND ENERGY INTENSE PROCESSES





# CLOSED LOOP APPROACH

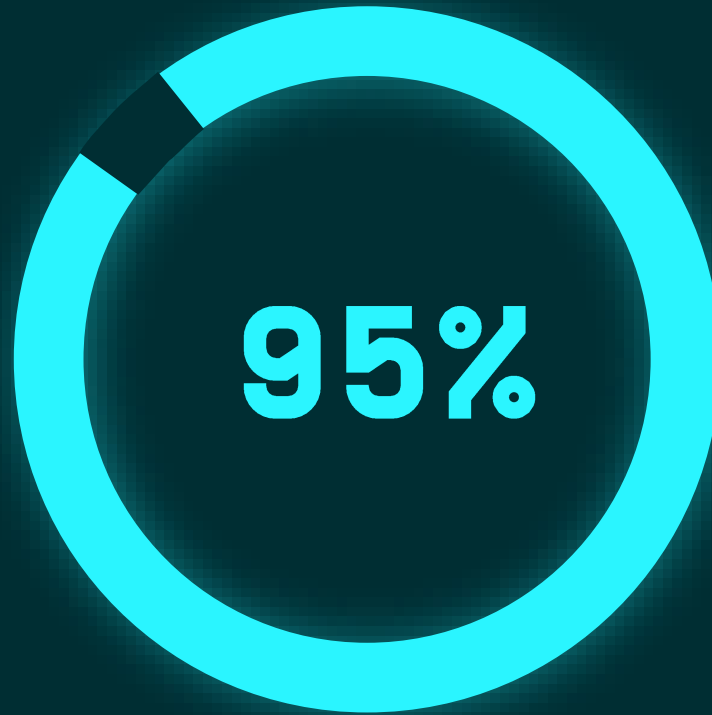


# CLOSED LOOP APPROACH

RECYCLING



REUSING 95% OF THE RAW MATERIALS THROUGH  
**HYDROMETALLURGY PROCESS**



THE **FIRST PLANT**  
FOR **RECYCLING**  
USED ELECTRIC CAR  
BATTERIES!



PRODUCTION IN  
**SALZGITTER**  
STARTED IN  
**JANUARY 2021**

1

PRODUCE CATHODES FROM RECYCLED MATERIAL:  
**SAVING MORE THAN ONE TON OF CO2 PER  
VEHICLE**

2

ECOLOGICALLY AND ECONOMICALLY  
**SUSTAINABLE EFFECT**

3

THE COSTS FALL  
**THE CUSTOMER BENEFITS INCREASE**

# LOCALIZATION AND VOLUME STRATEGY



THROUGH GREEN DEAL SHARE OF BEVs INSIDE  
**VOLKSWAGEN GROUP WILL INCREASE...**



BEV SHARE GROUP  
2030



THROUGH GREEN DEAL SHARE OF BEVs INSIDE  
**VOLKSWAGEN GROUP WILL INCREASE...**



BEV SHARE GROUP 2030  
**inkl. Green Deal**





THIS WILL CREATE A  
**DEMAND OF 240 GWH FOR  
VOLKSWAGEN IN EUROPE**

THAT MEANS: **6x40 GWH!**

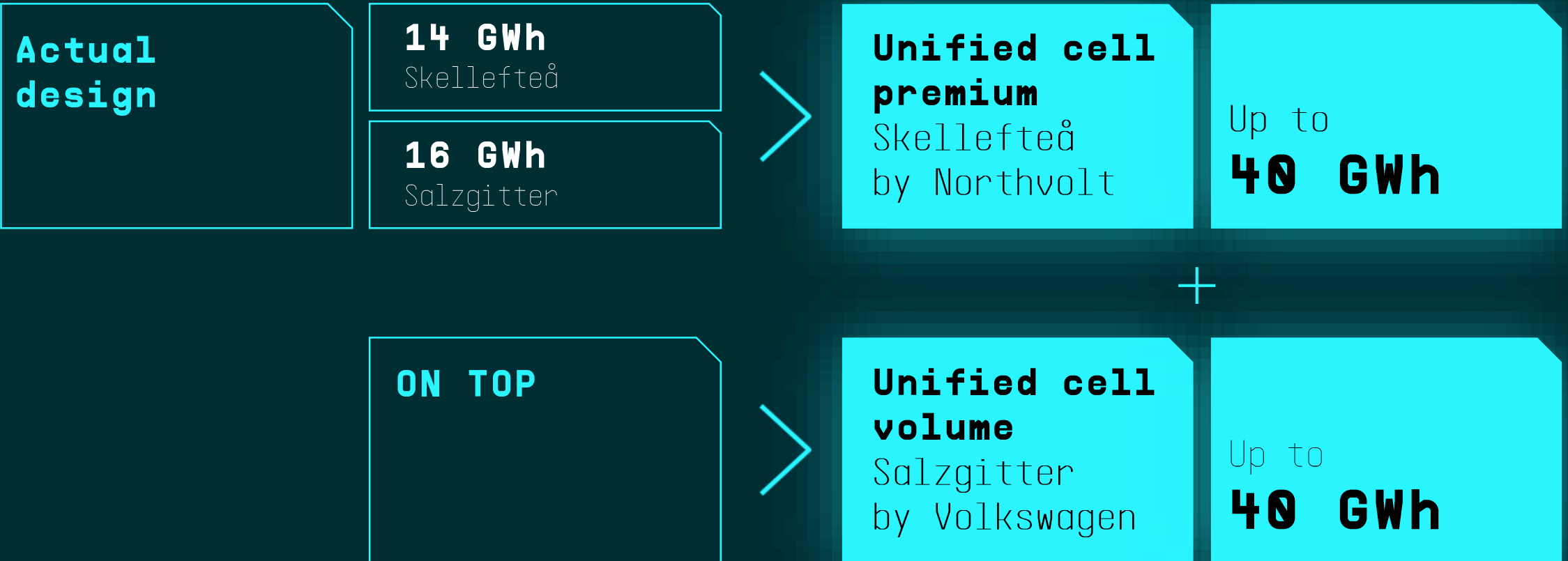
# FIRST PLANT: **NORTHVOLT**

**Start of  
production  
2023**  
up to 40 GWh



## Actual setup

## New setup



**\_CLEANER** PROJECT SETUP

**\_BUNDLING** RESSOURCES

**\_LESS** COMPLEXITY

**\_FASTER** RAMP UP

**\_HIGHER** VOLUME OUTPUT

## SECOND PLANT: **SALZGITTER**

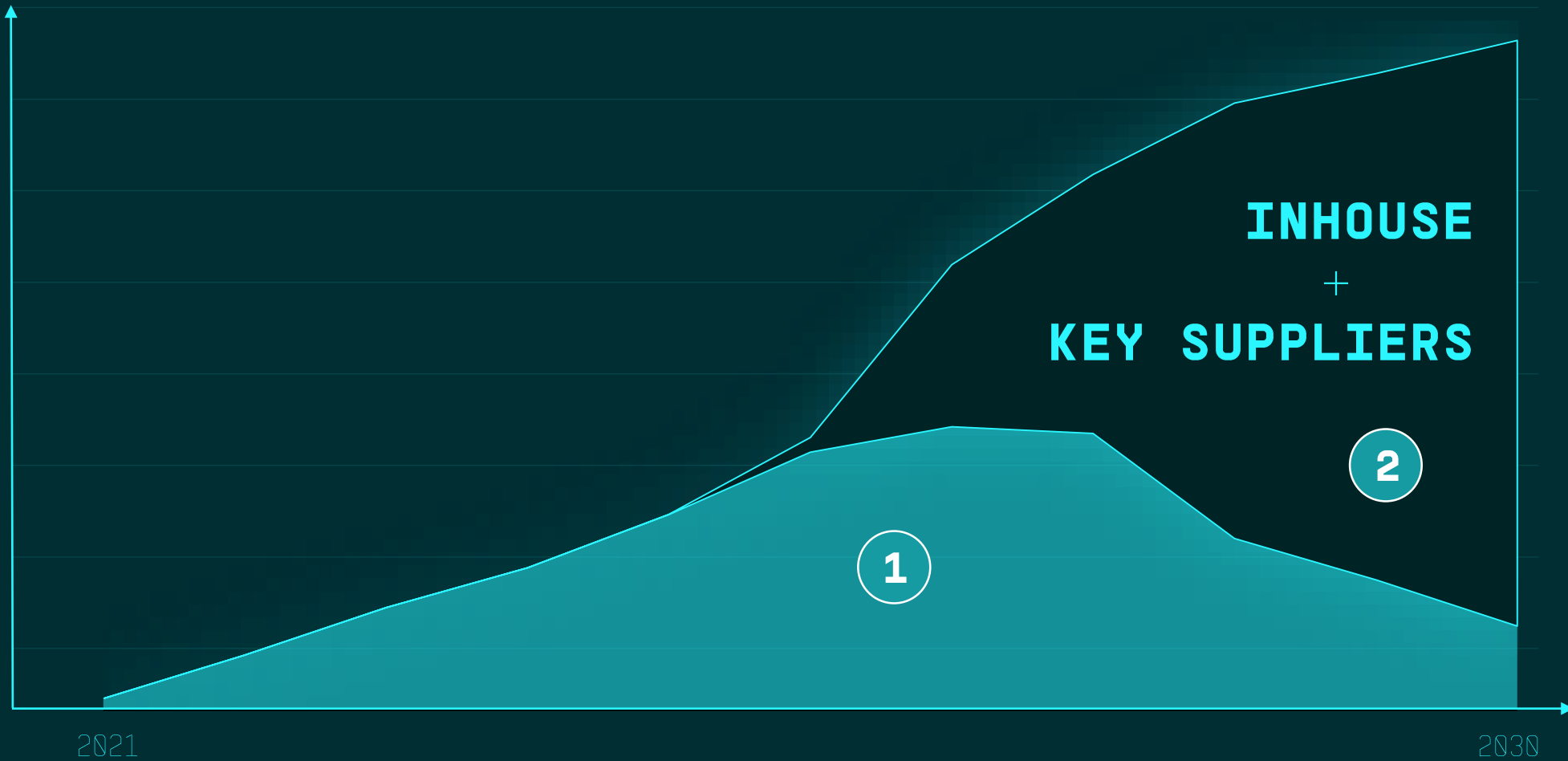
**Start of  
production  
2025**  
up to 40 GWh



**2nd**

# SECOND WAVE OF BATTERY TECHNOLOGY

GWH WORLDWIDE

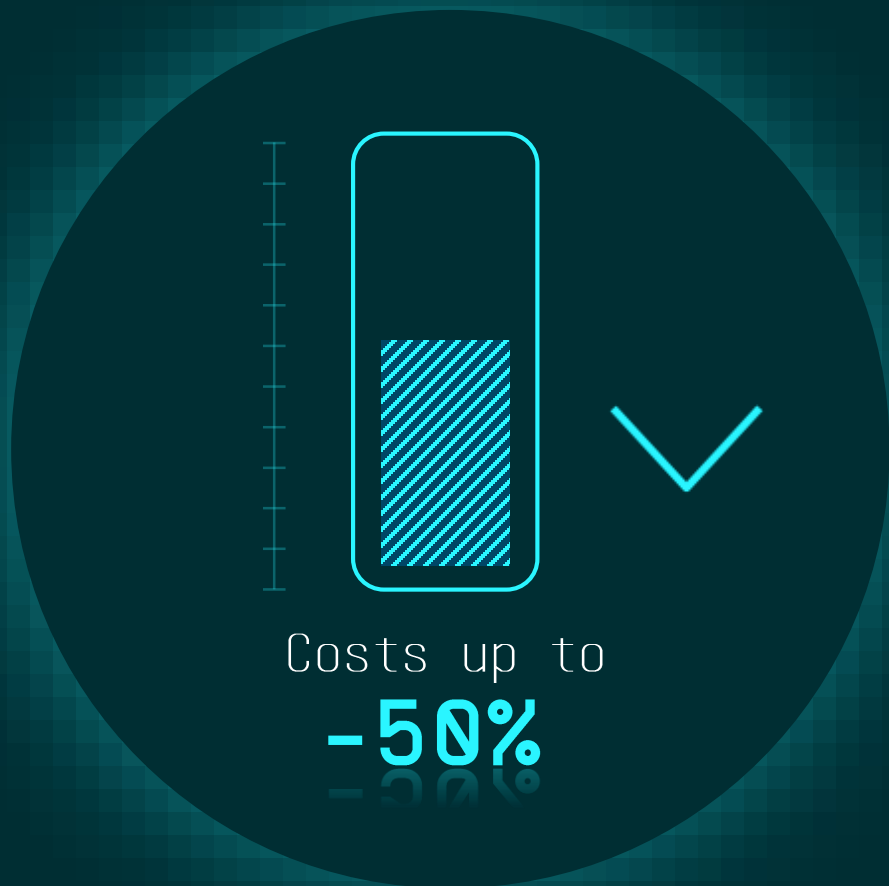


# A FUTURE SUCCESS

DEPENDS ON A STRONG COLLABORATION



# HOW TO REACH **COST TARGETS**



Cell design **-15%**

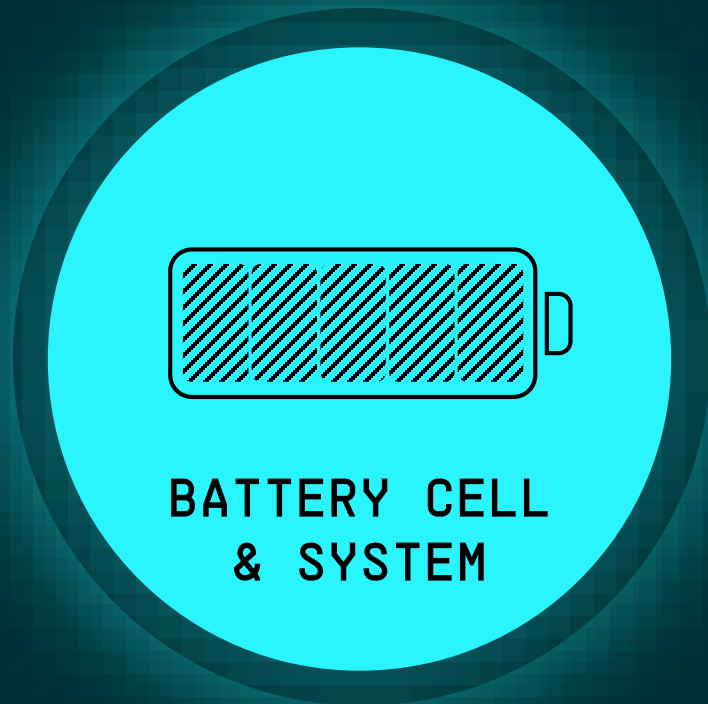
Production process **-10%**

Cathode / anode material **-20%**

Battery system concept **-5%**

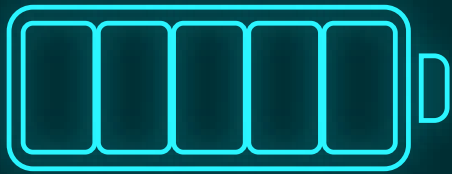


# KEY TAKE-AWAYS

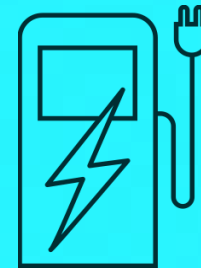


- \_ **Technology roadmap** with possible unified cell utilization of 80%
- \_ Action fields to **achieve cost targets** defined
- \_ **Closed Loop** process installed
- \_ **SOLID LOCALIZATION STRATEGY** to secure volume and timing

## TWO MAIN PILLARS



BATTERY CELL &  
SYSTEM



CHARGING &  
ENERGY

Among **TOP 3** reasons  
to **NOT** buy  
an electric car:

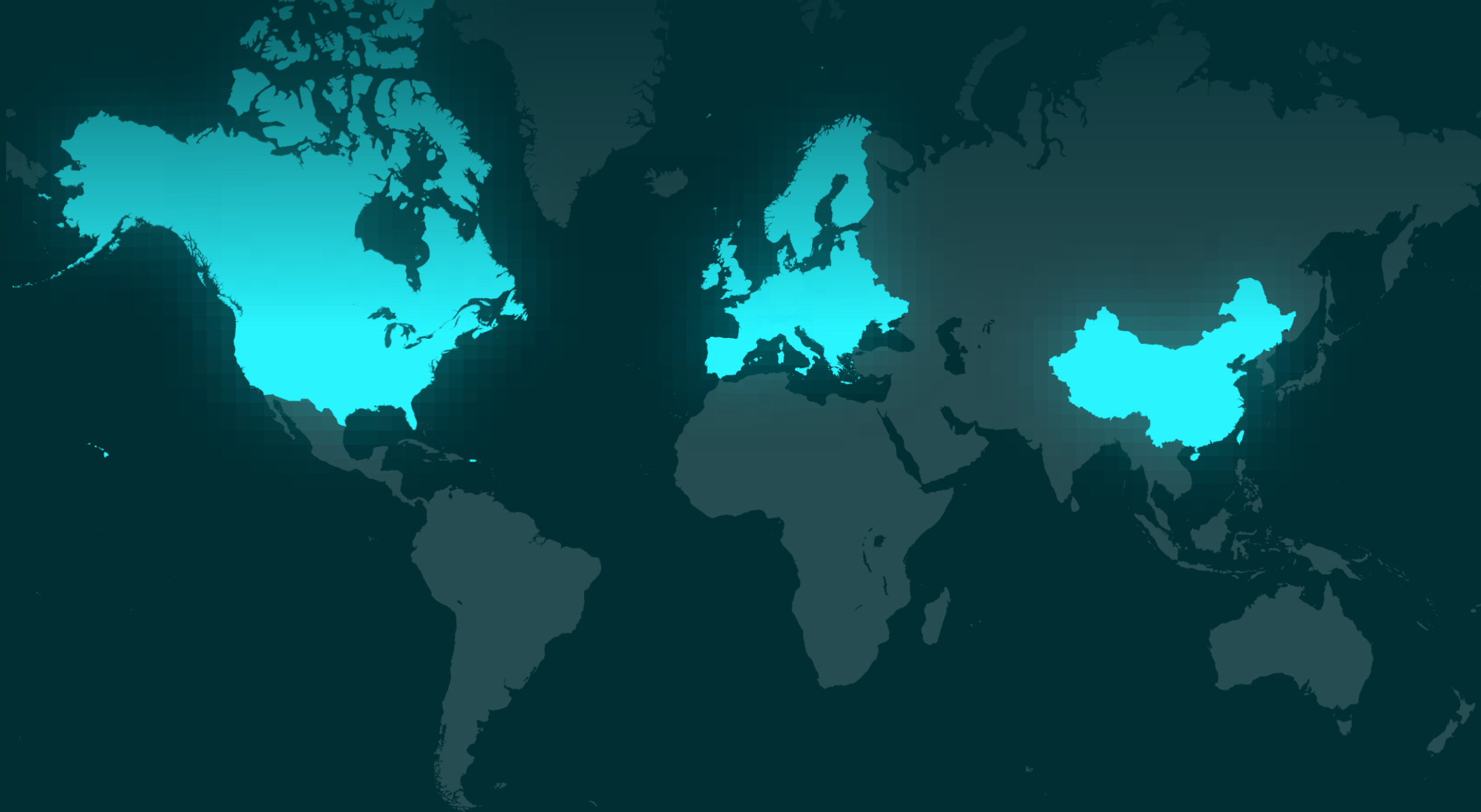
**CHARGING  
INFRASTRUCTURE**





DIFFERENT CITIES,  
DIFFERENT CHALLENGES

Volkswagen covering  
**most important e-mobility markets**





EUROPE

Our HPC-Boost-Program  
for Europe

**IONITY**



Italy

ROME

Our HPC-Boost-Program  
for Europe

enel

Our HPC-Boost-Program  
for Europe



**IBERDROLA**



MADRID

Spain



Starting 2021

**United Kingdom**

LONDON

BERLIN

Starting 2021

**Germany**

**Our HPC-Boost-Program**  
for Europe

bp



**8,000**  
**HPC Points**  
by 2025

Our  
HPC-Boost-Program  
for Europe

IONITY

enel

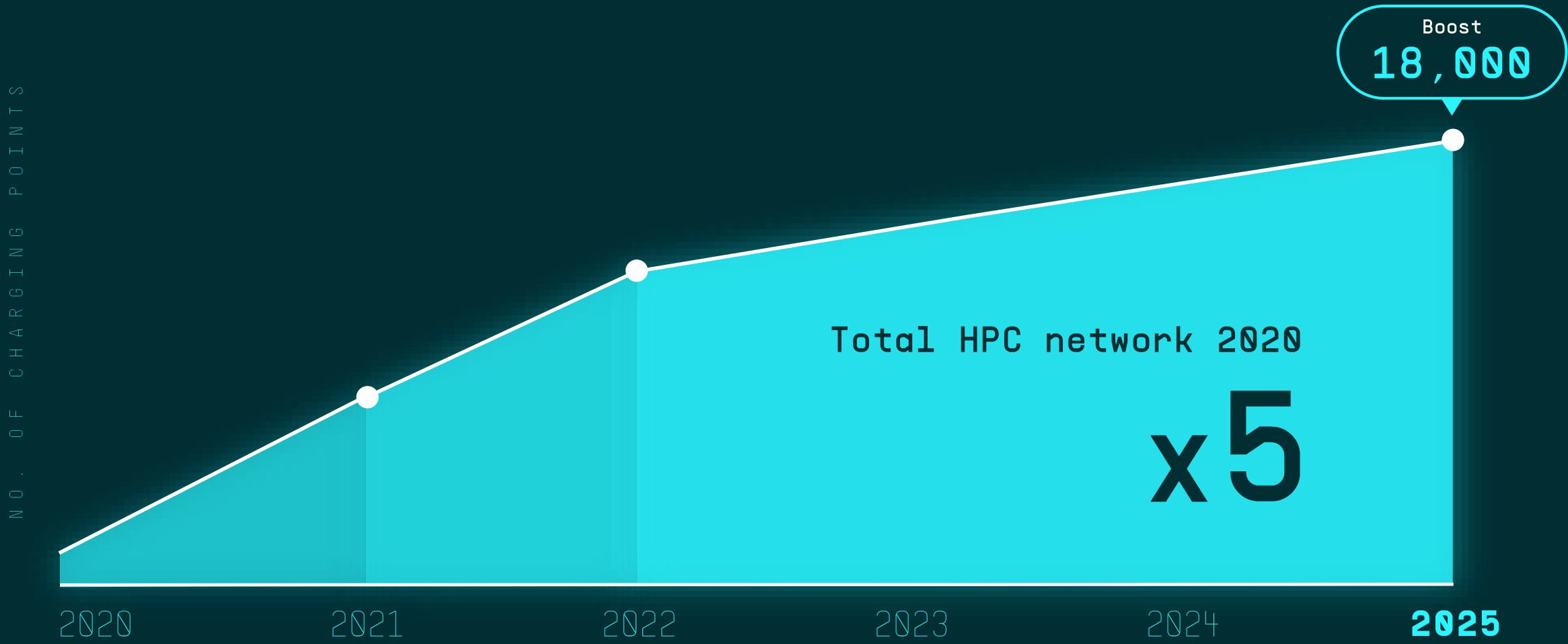


IBERDROLA

bp



# Our contribution: We will expand today's HPC network in Europe by factor 5 until 2025





Our  
**HPC-Boost-Program**  
for Europe

about **18,000**  
HPC points by 2025

**1/3**  
of essential HPC  
Infrastructure in Europe



# FLEXPo1e

2x DC UP TO 150 kW

BATTERY BUFFER

2nd LIFE OPPORTUNITY

GRID INDEPENDENT

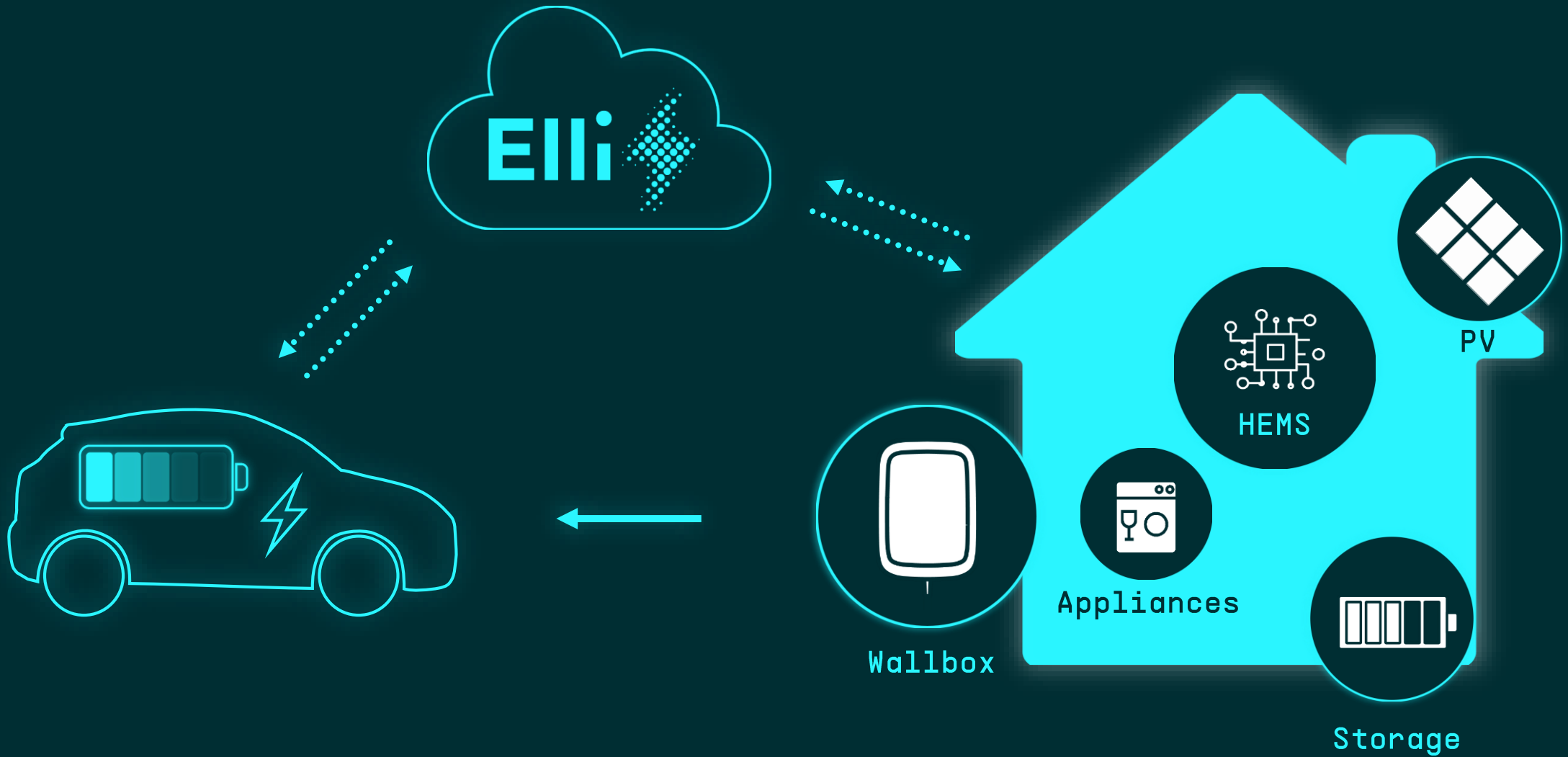
2 PRODUCTION SITES

SUZHOU [China], HANOVER [Germany]

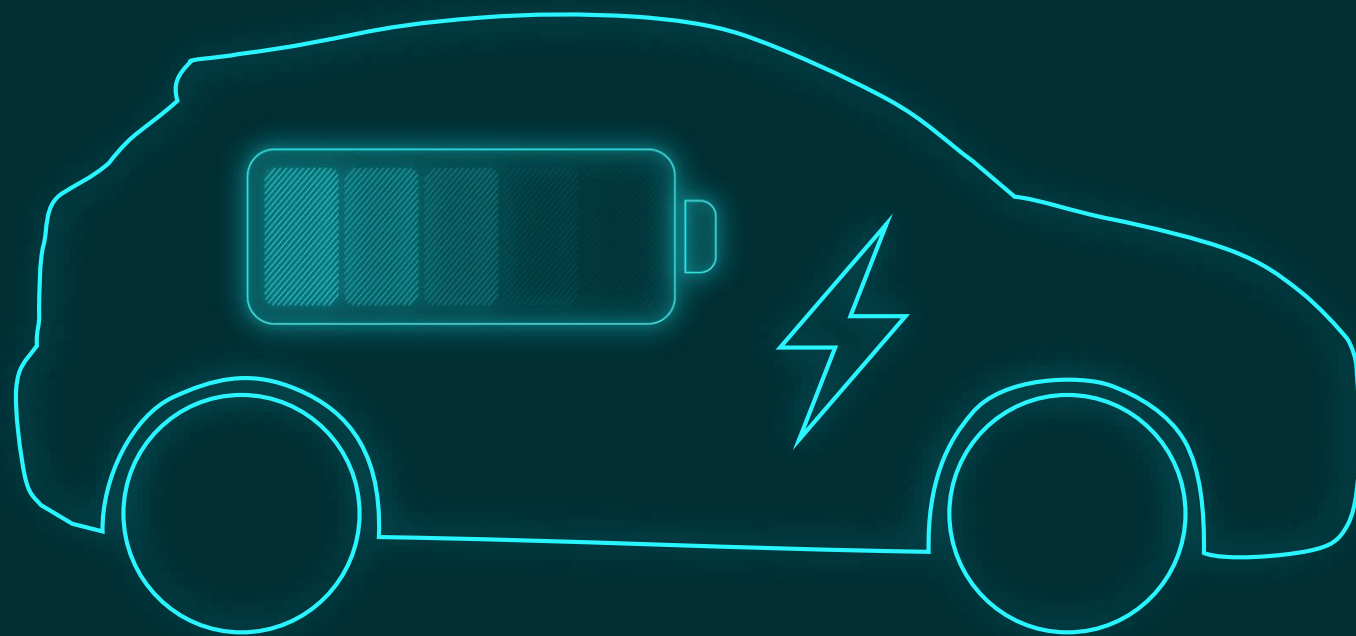
# INNOVATIONS MADE BY VOLKSWAGEN GROUP COMPONENTS



# BEVs to become smart charging devices for solar and grid integration

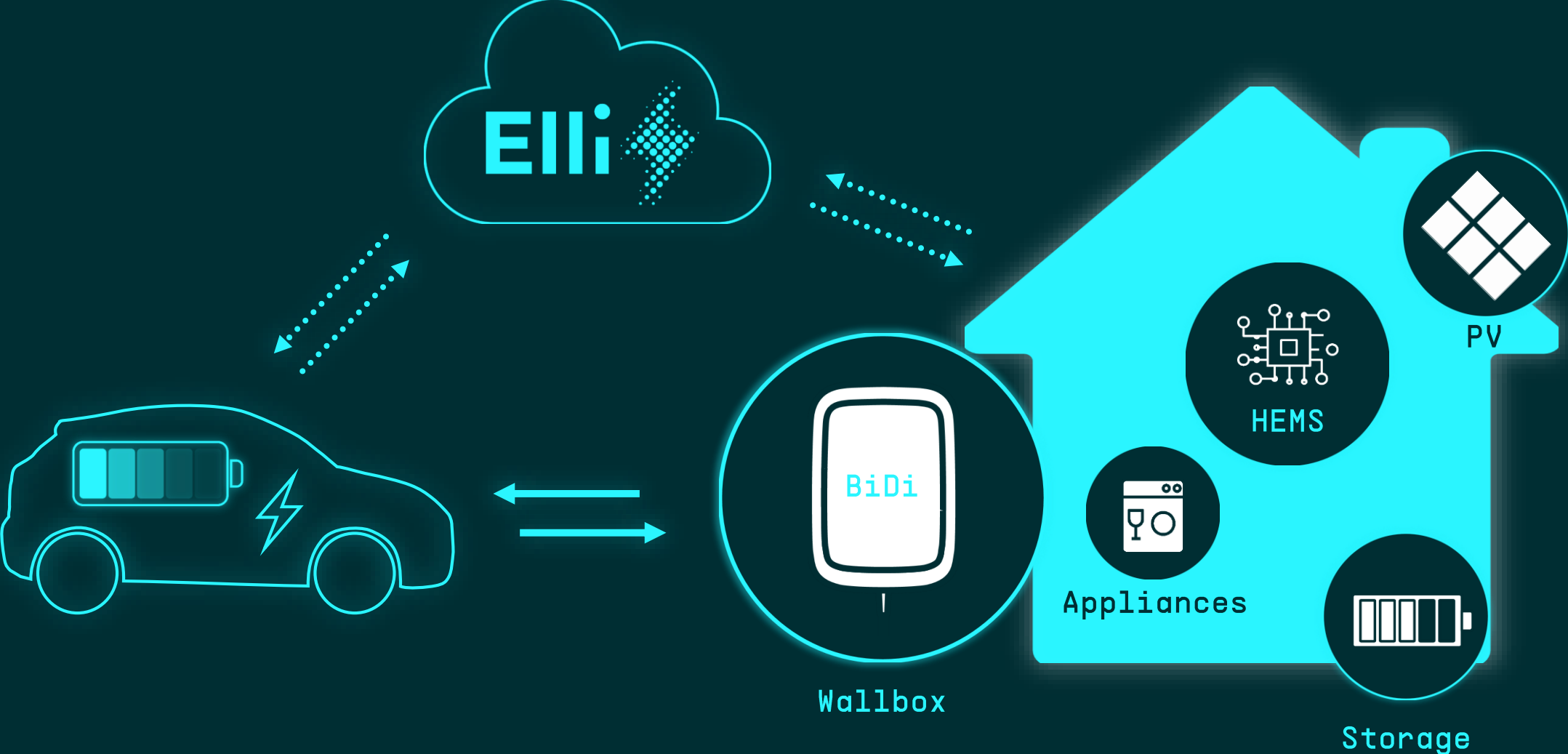


# The car as a mobile power bank

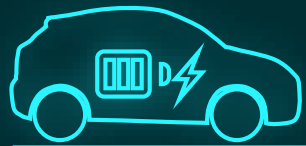




# BiDirectional charging enables car-owners to become their own utility



# Mobility and renewable energy are complementary

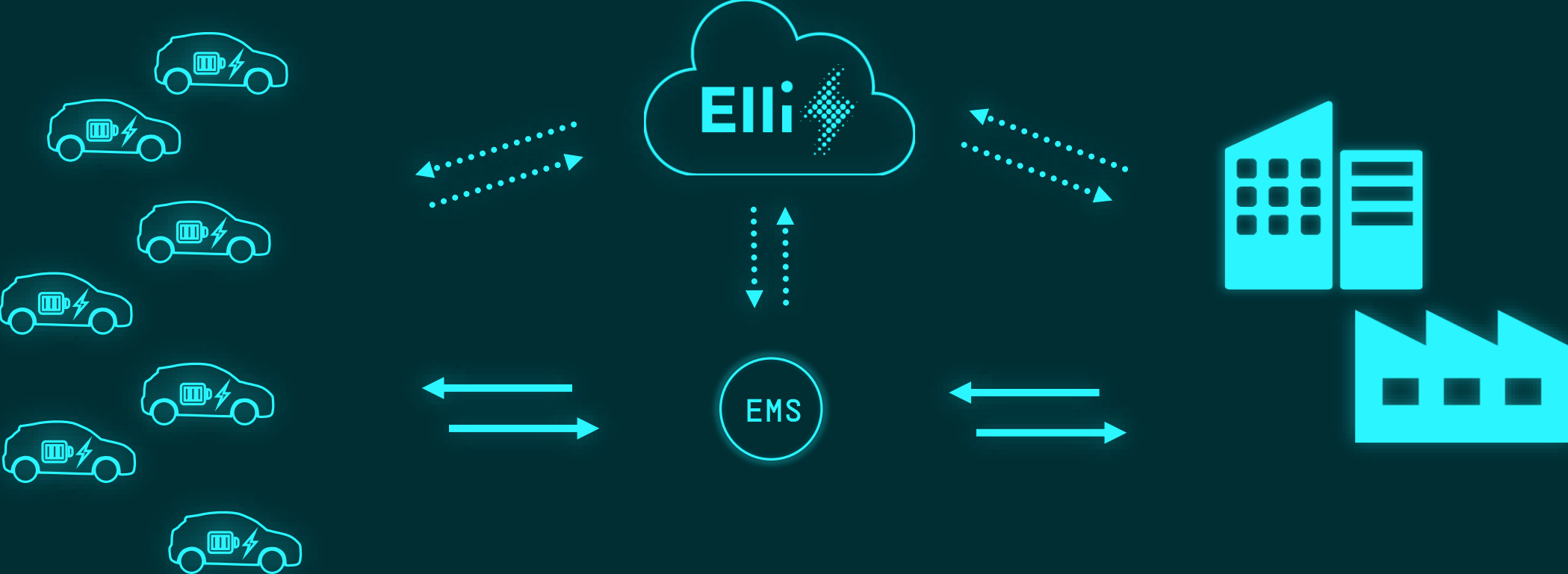


200 km / 125 miles  
driving

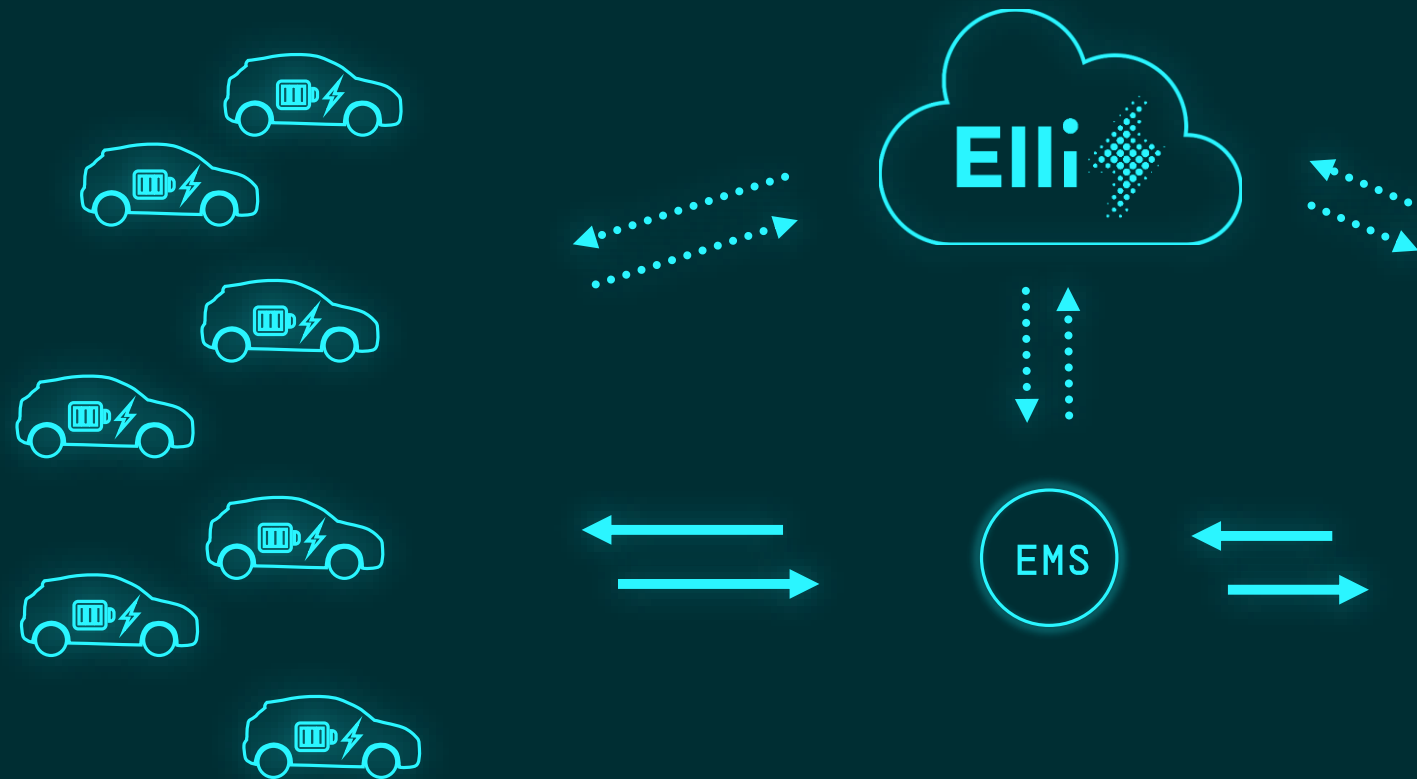


House to be powered  
by the car

# Business model scalable to fleet level



# Business model scalable to fleet level - first running project



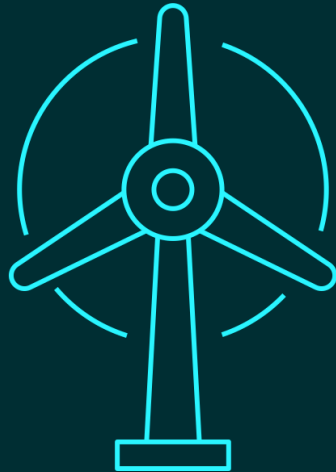
- 1,250 apartments
- 2 MWh storage capacity
- 270 wallboxes
- 720 kWp photovoltaics



Pilot @ Wolfsburg, Germany

# Activating unused renewable energy with the new storage capabilities

6,500 GWh/year



in Germany are **not used** due to lack of storage capacity



2.7 million BEVs



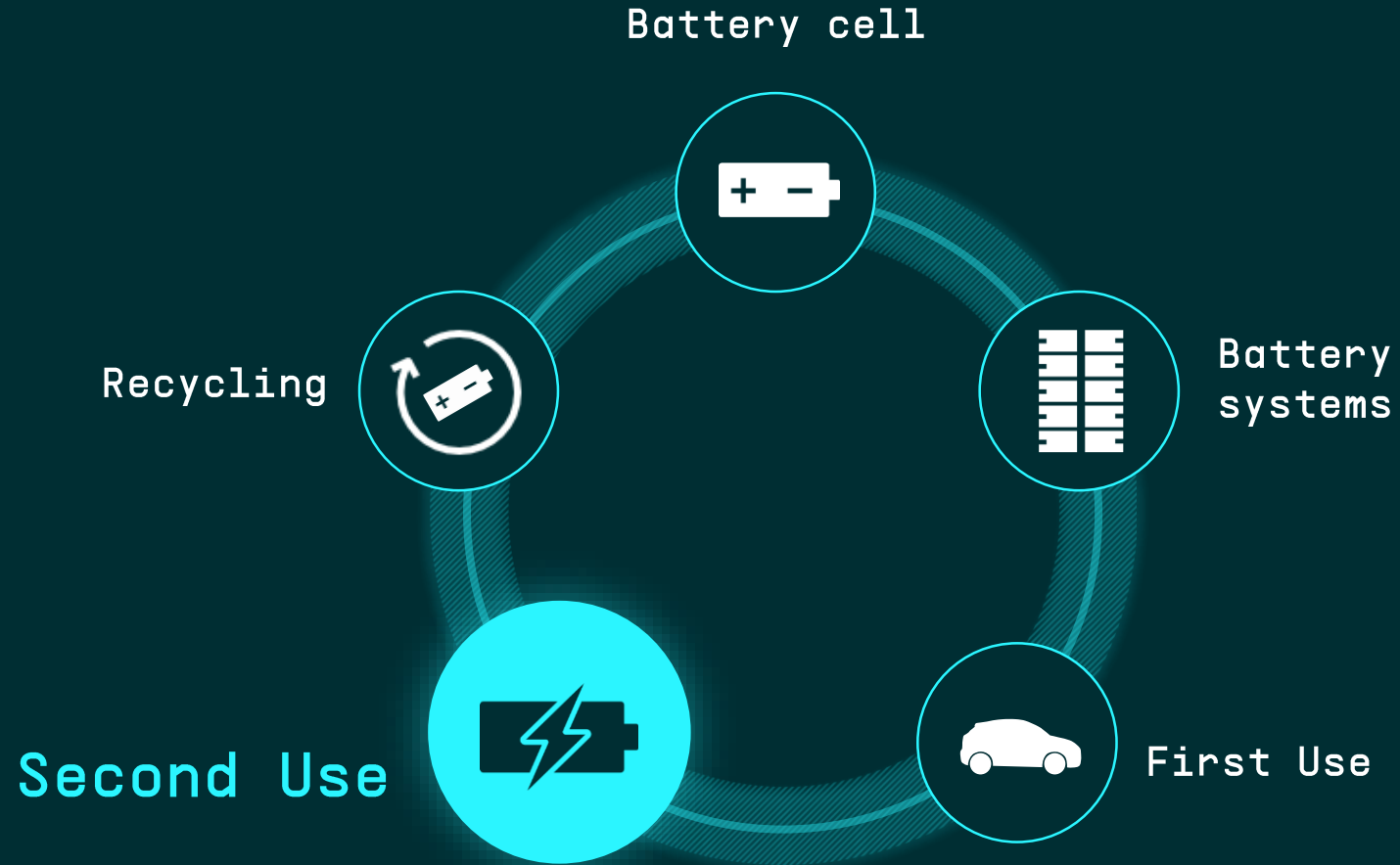
could be driving **one year** with the energy

**Volkswagen will use battery production capacities for large scale storage including 2nd life options**

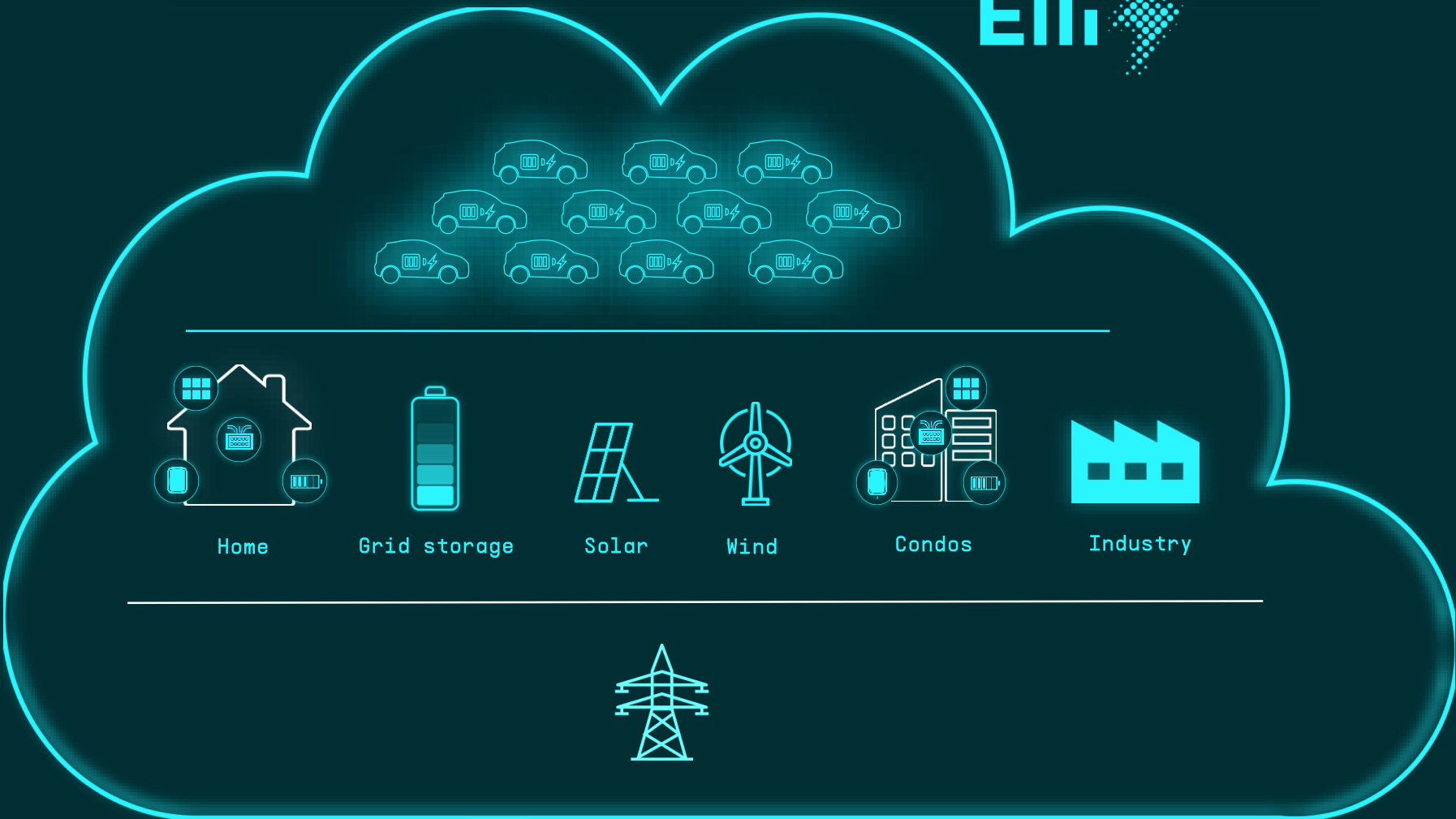




Large scale storage as part of  
**THE CLOSED LOOP.**



# Energy integration: Fully digital and data driven



Home



Grid storage



Solar



Wind



Condos

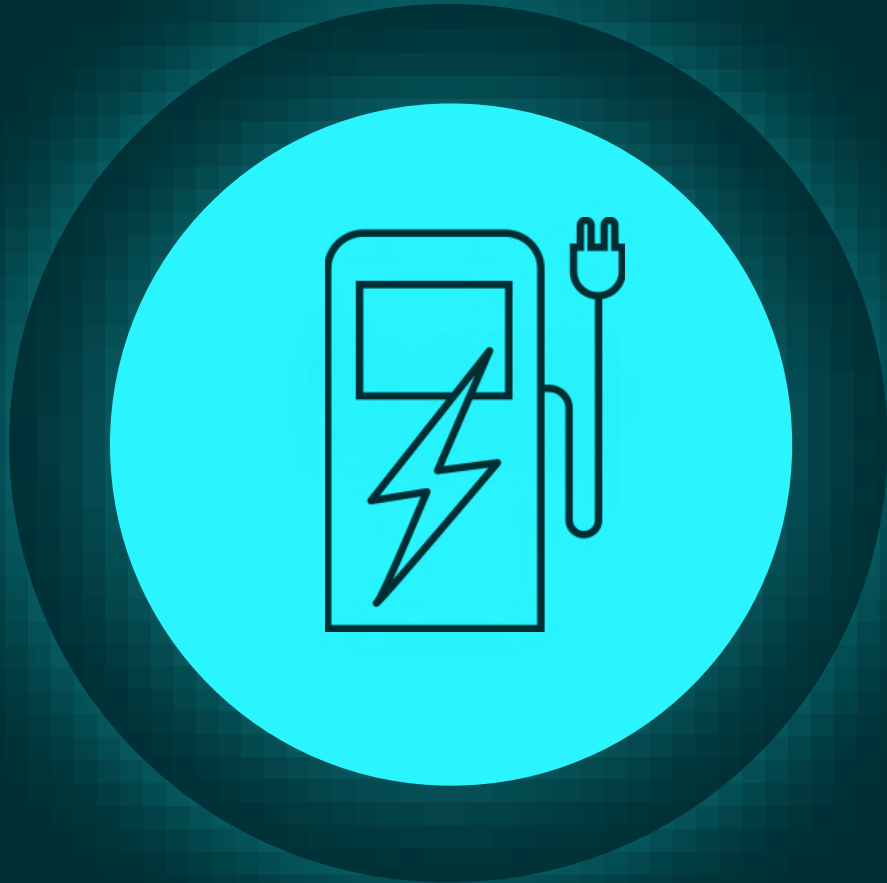


Industry





# Key Take-aways



- \_ **Global Boost-Plan** for charging infrastructure
- \_ Expand **fast charging** in strong partnership with **local partners**
- \_ The car will be a part of the **energy system**
- \_ **Storage systems** to facilitate fluctuating **renewable energy supply**
- \_ **Cloud based energy management**

# OUR VISION & MISSION

With the right energy management and  
intelligent storage systems

**ONE DAY, CHARGING WILL BE FOR FREE**