



Charging Ahead

Exploring Future Opportunities for Lead Batteries

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Executive VP and COO



16-19 September
Milan, Italy 2024

100

32

165

OLD SCHOOL





**Maintenance
Free**



**Continuous Plate
Making**



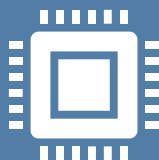
Spill Proof Lids



**Advanced
Separators**



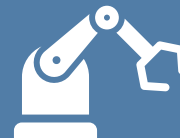
AGM



**Improved
Process Control**



**Advanced
Additives**



Robotics



Circular Economy



INNOVATION

INNOVATION – MORE THAN JUST A GREAT IDEA

Market Research/Trends
(VoC, major customer problem)

Idea

Prototype

Success

Market Pull

Technology Push

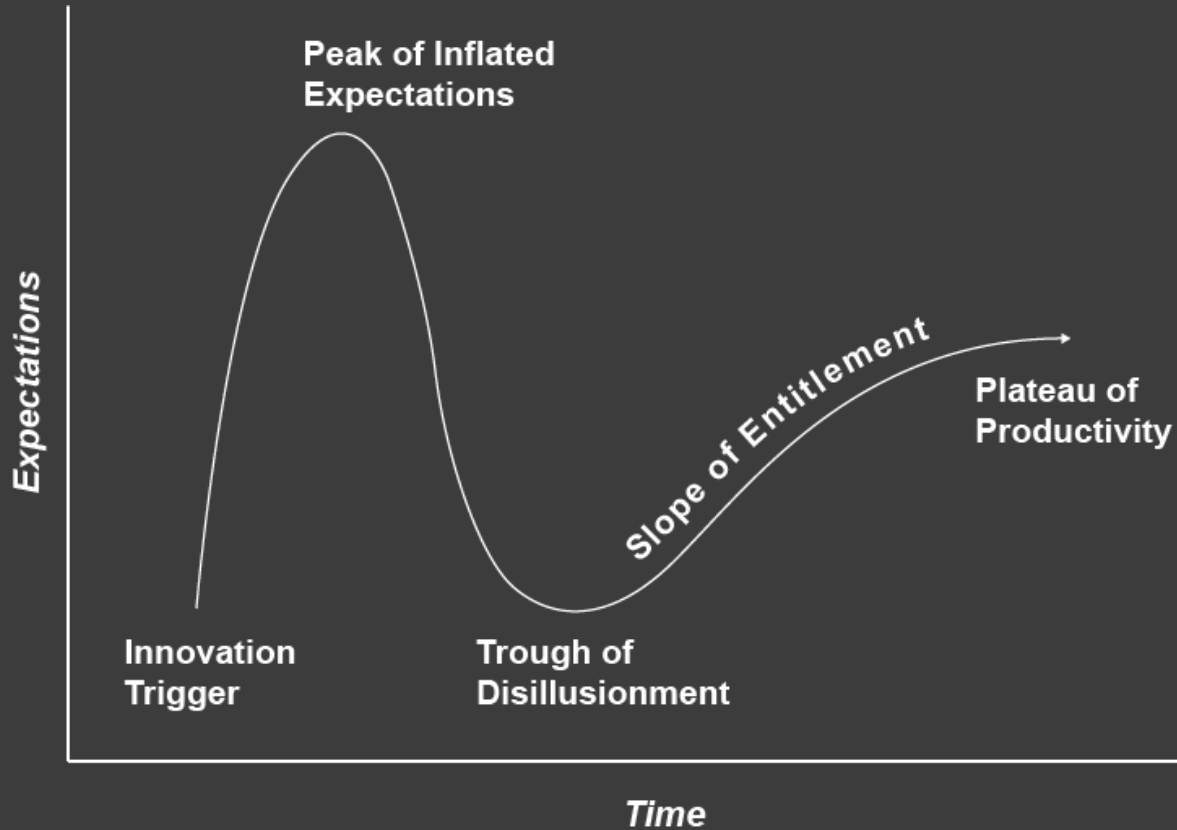
Technology & Research

Development

Production



THE INNOVATION HYPE CYCLE





EV Aux



Microgrids



EV Charging



Data Centers



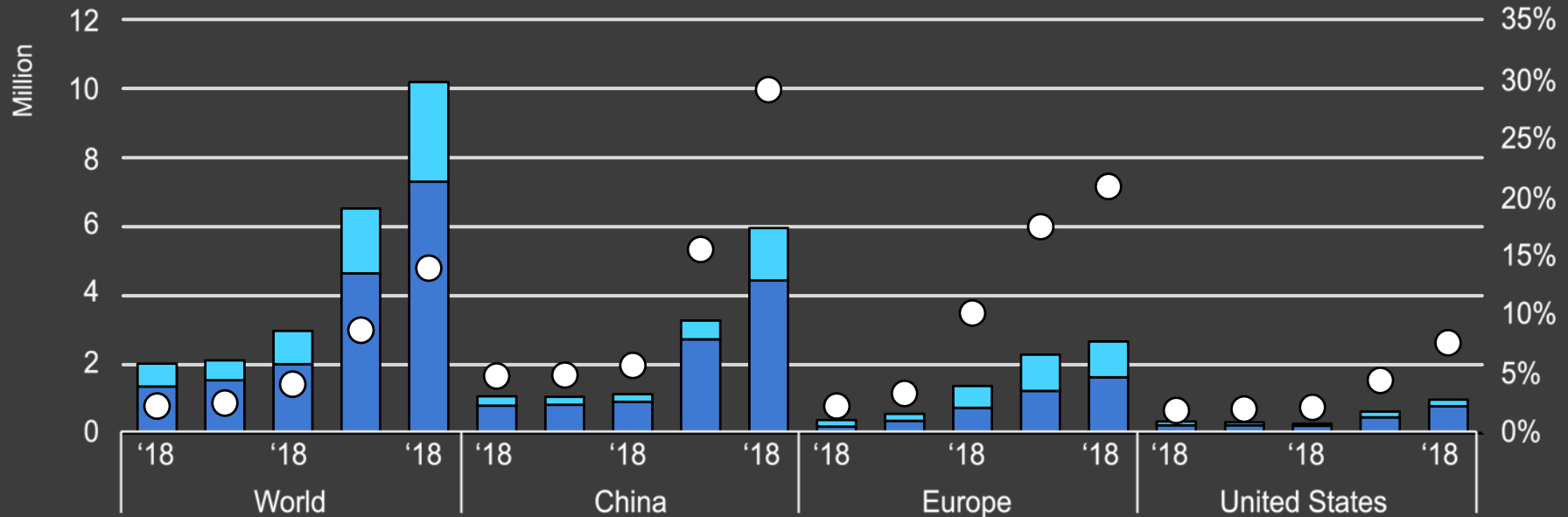
5G



OPPORTUNITIES

BEV & PHEV REGISTRATIONS

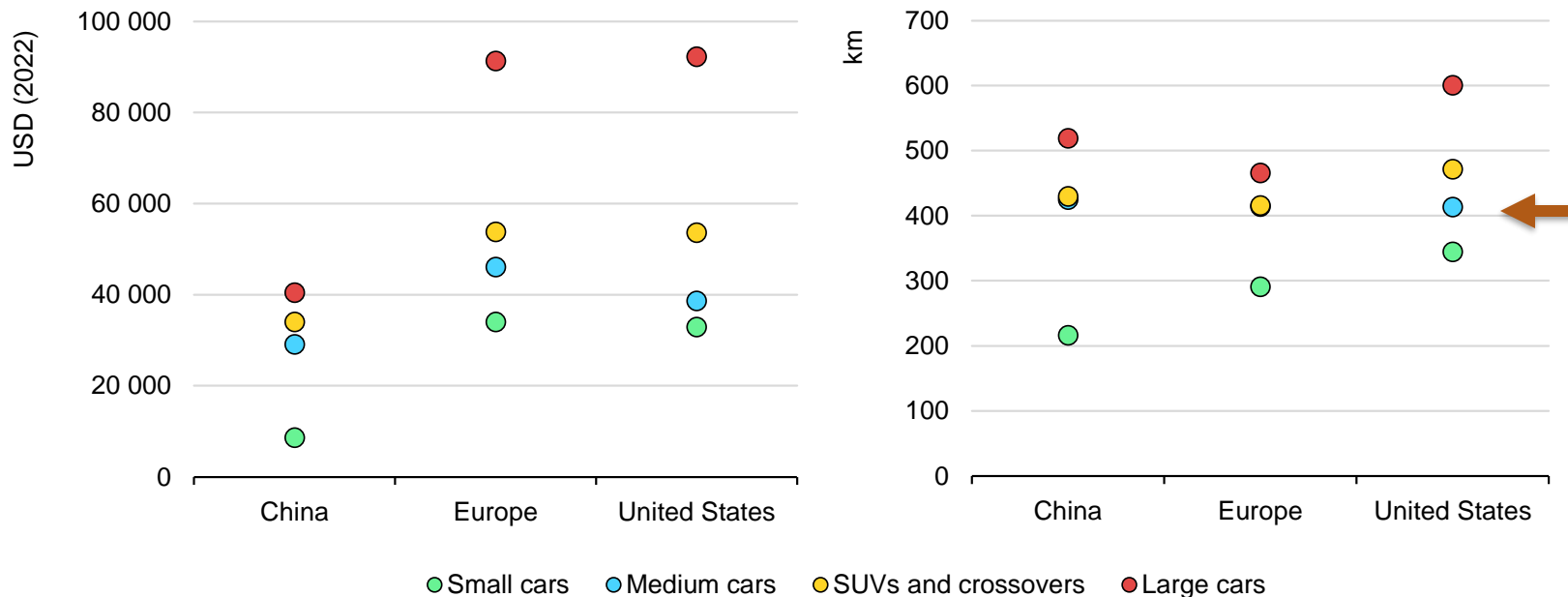
Figure 1.3 Electric car registrations and sales share in selected countries and regions, 2018-2022



Source: Global EV Outlook 2023 - IEA

REGIONAL VIEW ON PRICE AND RANGE

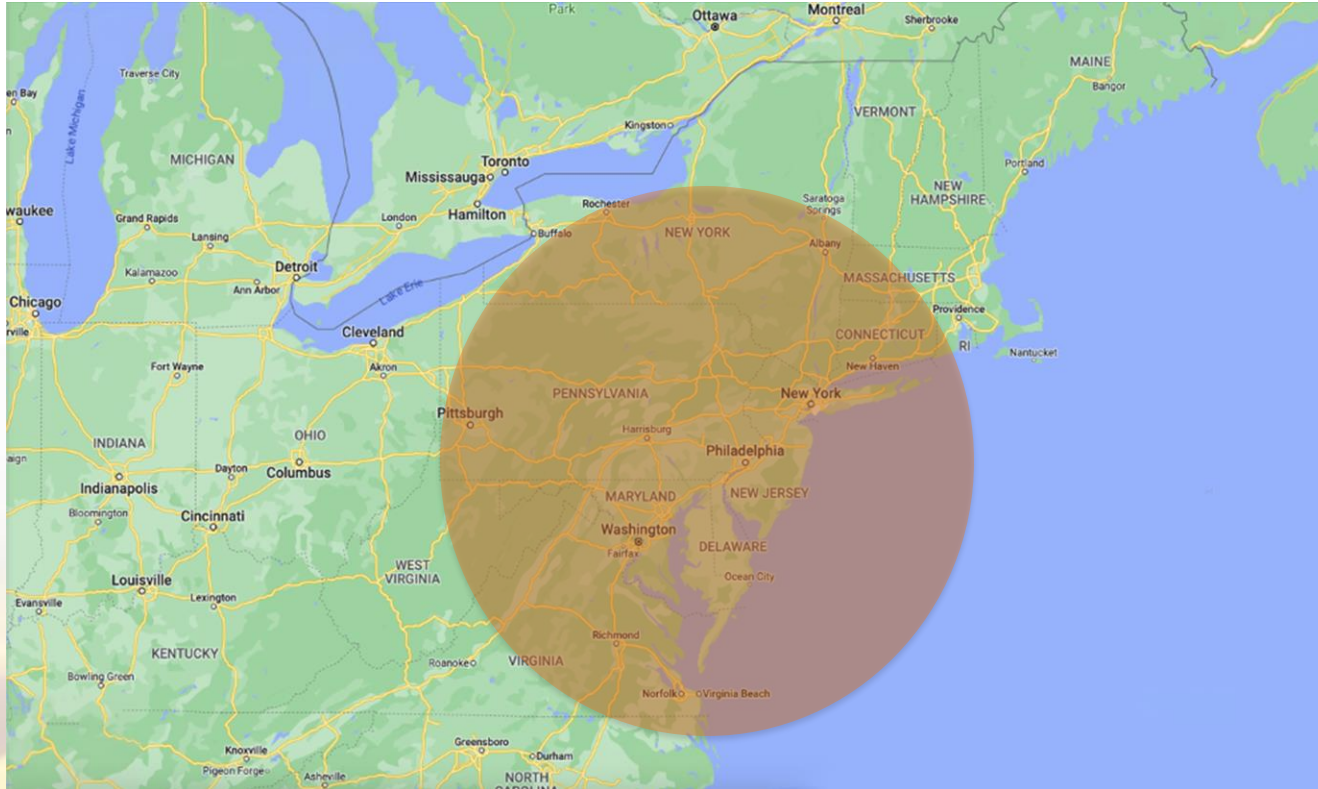
Figure 1.7 Sales-weighted average retail price (left) and driving range (right) of BEV passenger cars in selected countries, by size, in 2022



Source: Global EV Outlook 2023 - IEA

IEA. CC BY 4.0.

WHERE DOES A 250-MILE RANGE GET YOU



Source: Global EV Outlook 2023 - IEA

FUTURE OF 12V LEAD AUX (AUXILLARY) BATTERIES IN EV'S

ACTIVE SAFETY SYSTEMS

- Constantly monitor the performance and surroundings of a vehicle
- Can prevent accidents from happening altogether ...or actively help the driver to reduce the impact
- Avoid or mitigate an accident **pre-impact**, so before it happens



EXAMPLES OF ACTIVE SYSTEMS THAT GIVE THE DRIVER MORE CONTROL IN DANGEROUS SITUATIONS



Anti-lock
braking



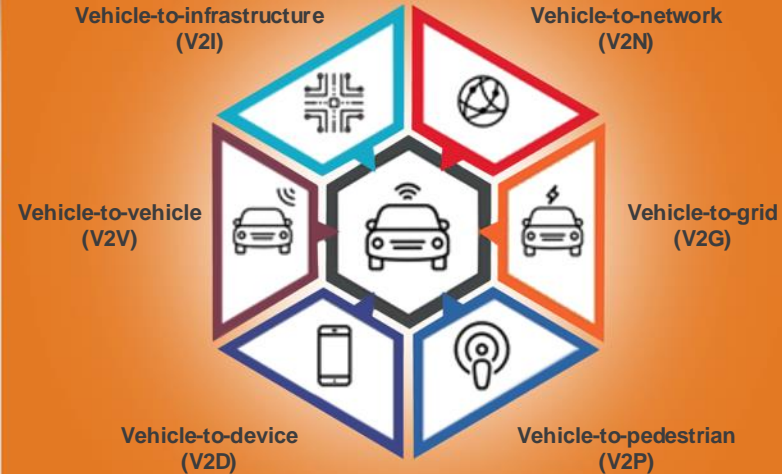
Electronic
stability
control (ESC)



Autonomous
emergency
braking (AEB)

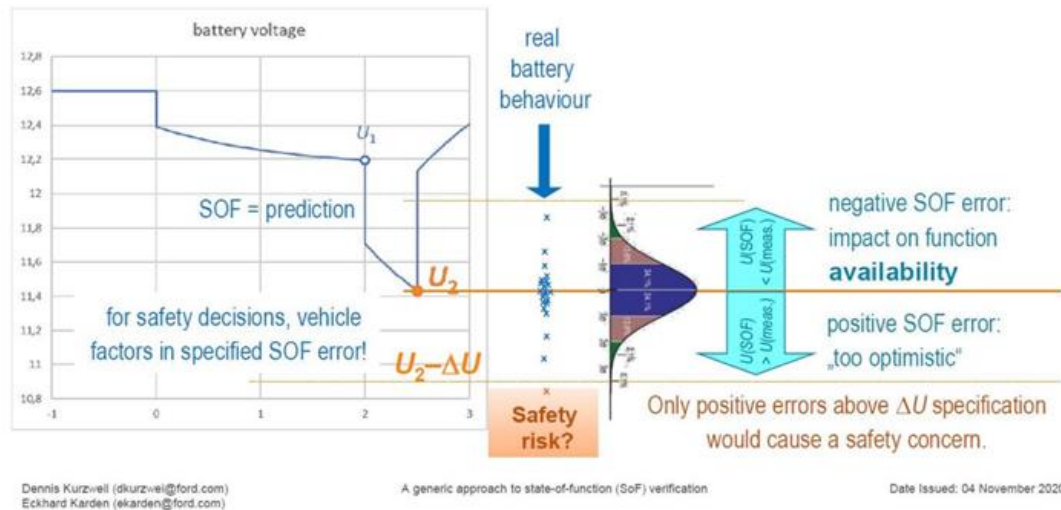
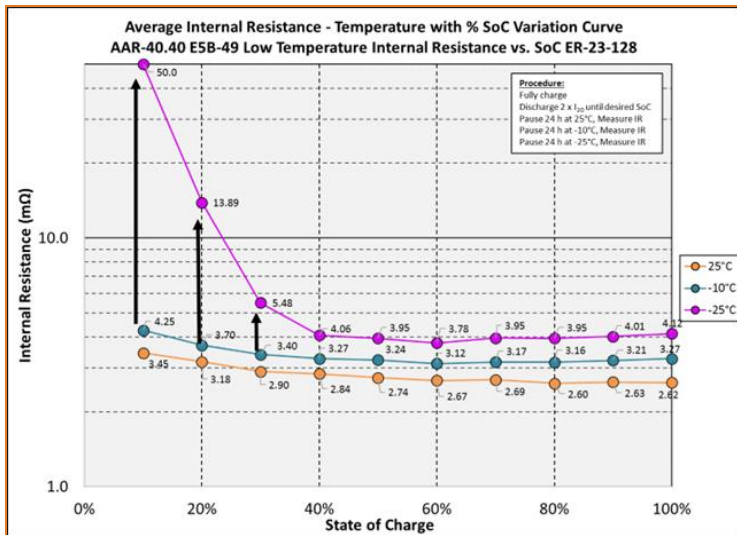


Lane departure
warning (LDW)



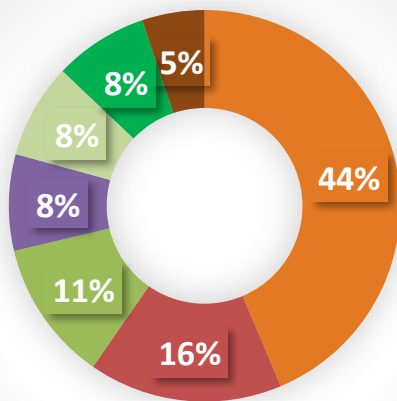
CHALLENGES FOR AUX APPLICATION

- Definition of warning and replacement criteria
 - Safety State of Function Criteria
 - Internal resistance measurement
- How does the car know the AUX Battery need to be replaced?



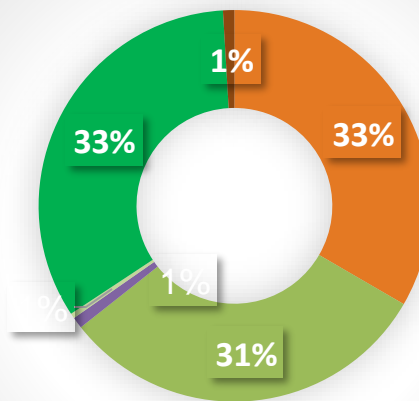
USA ELECTRICITY GENERATION AND ADDITION

1,296,875 MW Generation 2023



■ Natural Gas ■ Coal ■ Wind ■ Nuclear
■ Hydro ■ Solar ■ Other

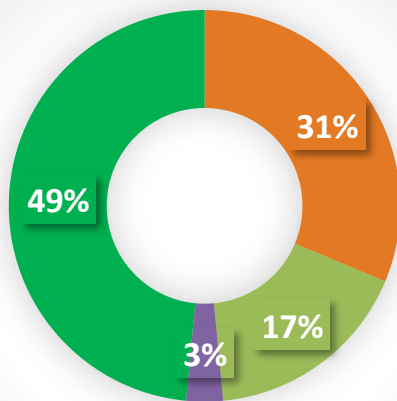
253,262 MW Addition 2016-2023



■ Natural Gas ■ Coal ■ Wind ■ Nuclear
■ Hydro ■ Solar ■ Other

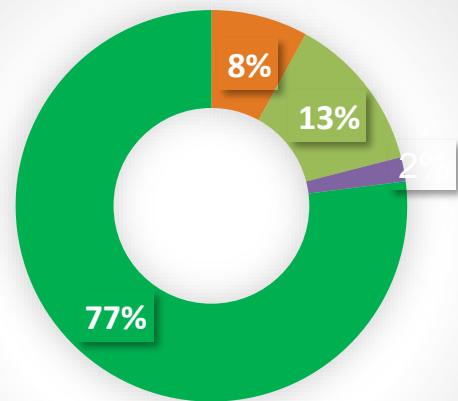
USA ELECTRICITY GENERATION AND ADDITION

35,800 MW Addition 2023



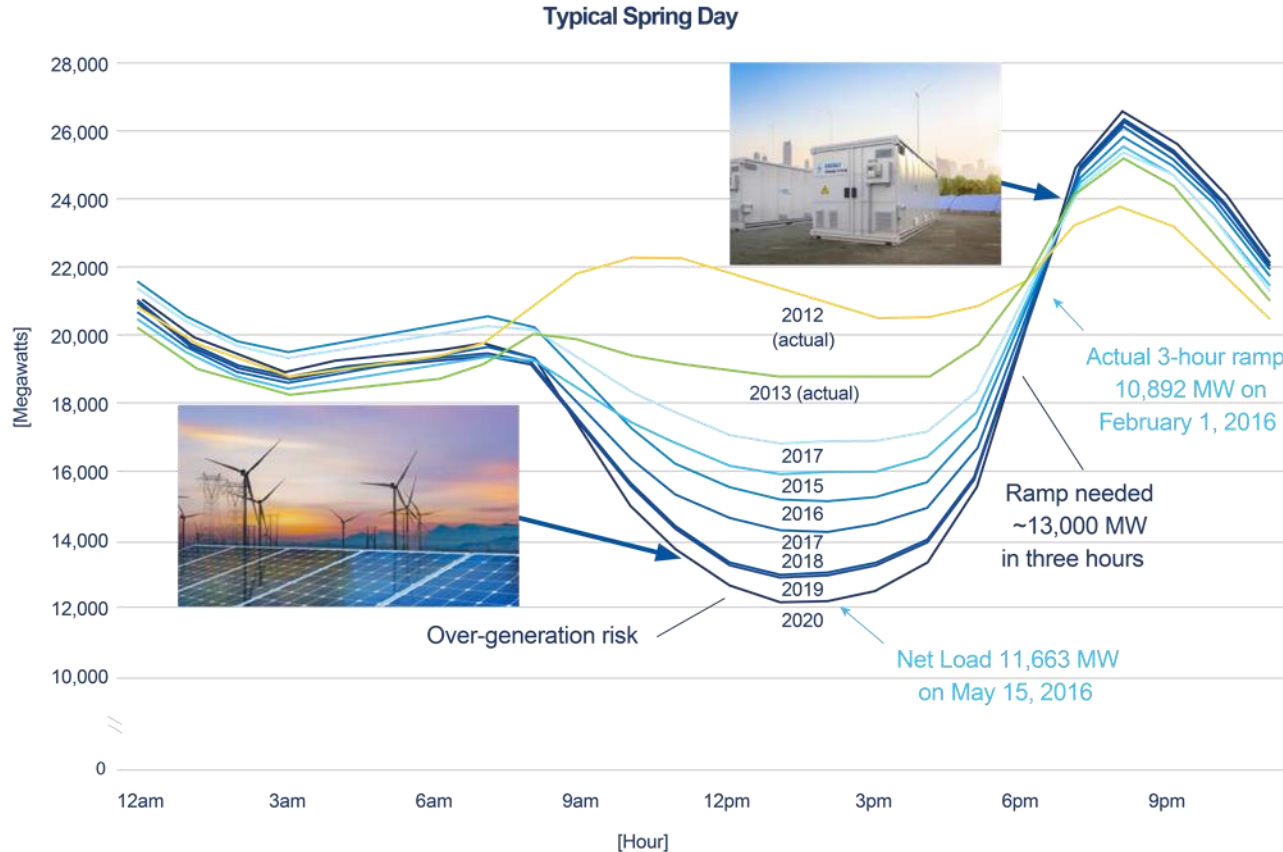
■ Natural Gas ■ Coal ■ Wind ■ Nuclear
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45,300 MW Addition Projection 2024

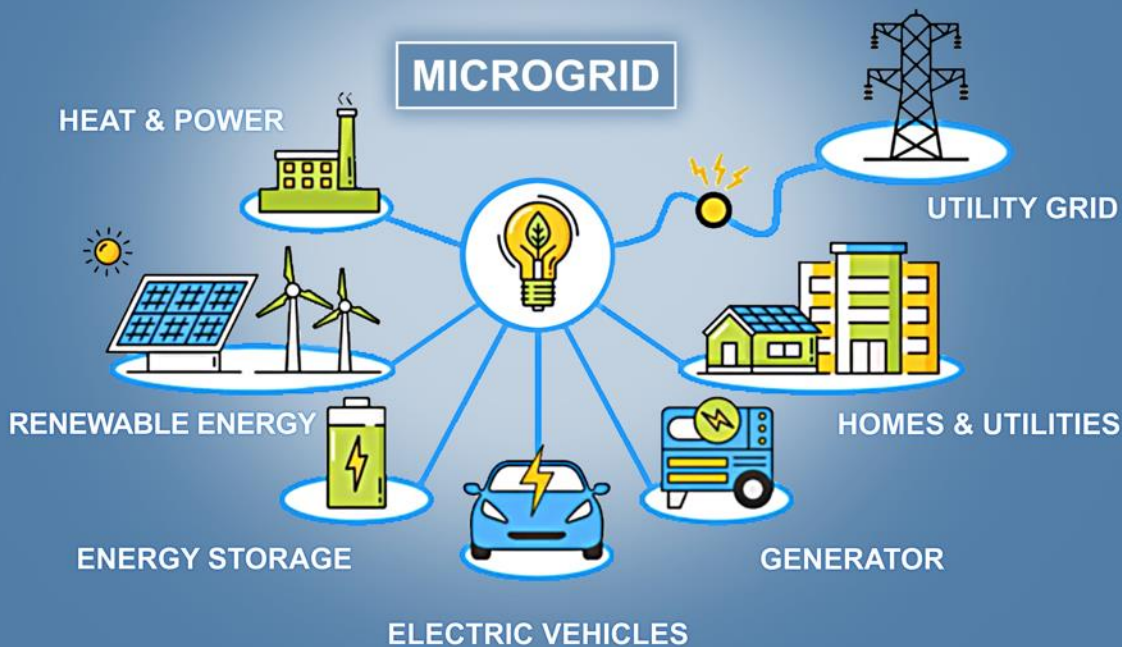


■ Natural Gas ■ Coal ■ Wind ■ Nuclear
■ Hydro ■ Solar ■ Other

THE DEMAND AND SUPPLY ISSUE OF RENEWABLES (CA)



MICROGRID OPPORTUNITY



Lyons Solar Field

- 20 MW solar field (max peak on a sunny day) ... we are getting 15 MW
- Site is 110 acres
- Projected generation kwh = 37,538,024
- Assuming a typical home uses around 10,000kwh annually, this project generates enough electricity to power around 3,754 homes per year.

EV FAST CHARGING

KNOW YOUR EV CHARGING STATIONS

AC Level One



VOLTAGE

120V 1-Phase AC

AMPS

12–16 Amps

CHARGING LOAD

1.4–1.9 kW

CHARGING TIME

3–5 Miles per Hour

AC Level Two



VOLTAGE

208V or 240V 1-Phase AC

AMPS

12–80 Amps (Typ. 32 Amps)

CHARGING LOAD

2.5–19.2 kW (Typ. 6.6 kW)

CHARGING TIME

12–60 Miles per Hour

DC Fast Charge



VOLTAGE

208V or 480V 3-Phase AC

AMPS

>100 Amps

CHARGING LOAD

50–350 kW

CHARGING TIME

60–80 Miles in 20 Minutes

Blueprint Project CBI

Consortium for Battery Innovation

- 100k EV fast charging stations p.a.
- 50+ Billion \$ invest
- 2V Lead and 12V Lead options
- Battery Characteristic defined
- Design Phase started in December 23
- Partner with system designer and integrator
- SEL (BMS – Battery Management System)
- EPC (Inverter)
- Project close out Fall 2024

Source ZDWL

Aggressive goal from VTO (Vehicle Technology Office of the Department of Energy) = 200 miles in 10 minutes

ENERGY STORAGE GRAND CHALLENGE - DOE

2030 Suitability Ratings

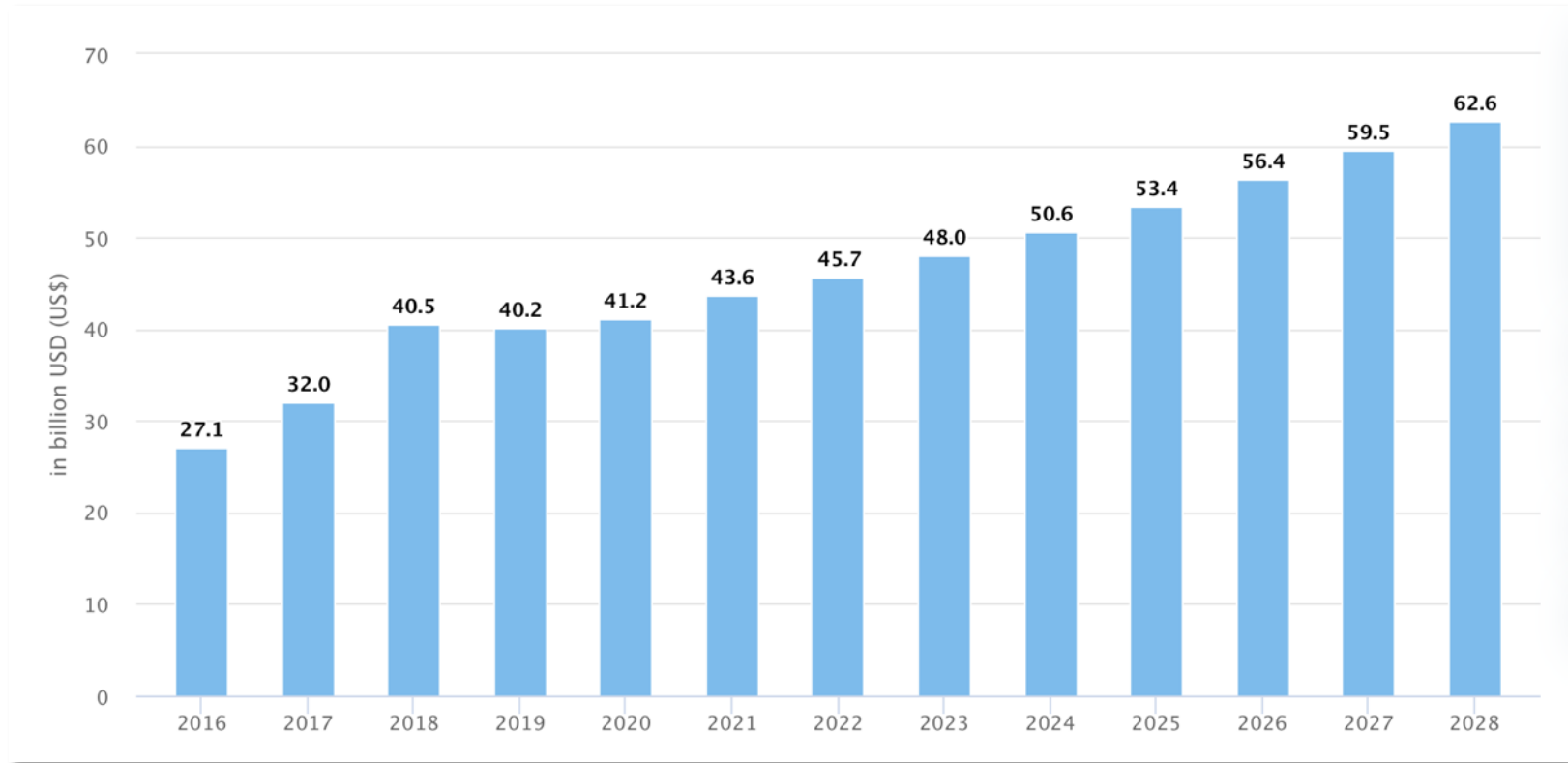
100 = Perfect Score. Traffic signal-style color coding with green being more positive than yellow, which is more positive than shades of red.

Limited Confidence in results for sodium, supercaps, thermal, and hydrogen due to poor response rate.

	Lead Acid	Flow	CAES	Li-Ion	Sodium*	Supercaps*	Thermal*	Hydrogen*	PSH	Zinc
Facilitating an Evolving Grid	81.4	90.7	84.0	83.6	81.6	68.3	81.8	77.4	82.9	75.6
Serving Remote Communities	86.0	89.5	80.9	81.8	83.3	73.3	84.1	87.0	84.5	80.6
Electrified Mobility (Vehicles)	65.5	32.0	30.1	84.8	85.5	80.1	20.0	81.7	64.8	75.8
Electrified Mobility (Charging Infrastructure)	77.8	87.0	58.3	85.7	85.0	82.1	62.0	81.5	70.5	77.0
Interdependent Network Infrastructure	81.2	82.5	63.3	88.7	83.3	86.8	54.8	58.3	78.4	73.3
Critical Services	87.4	85.3	79.6	80.2	86.0	90.3	66.8	78.5	90.4	80.1
Facility Flexibility, Efficiency, and Value Enhancement (Buildings)	86.9	88.5	47.3	83.9	86.2	92.3	91.7	78.5	80.5	78.7
Facility Flexibility, Efficiency, and Value Enhancement (Generators)	85.3	91.7	83.1	79.4	84.0	93.4	58.2	78.7	91.1	82.1

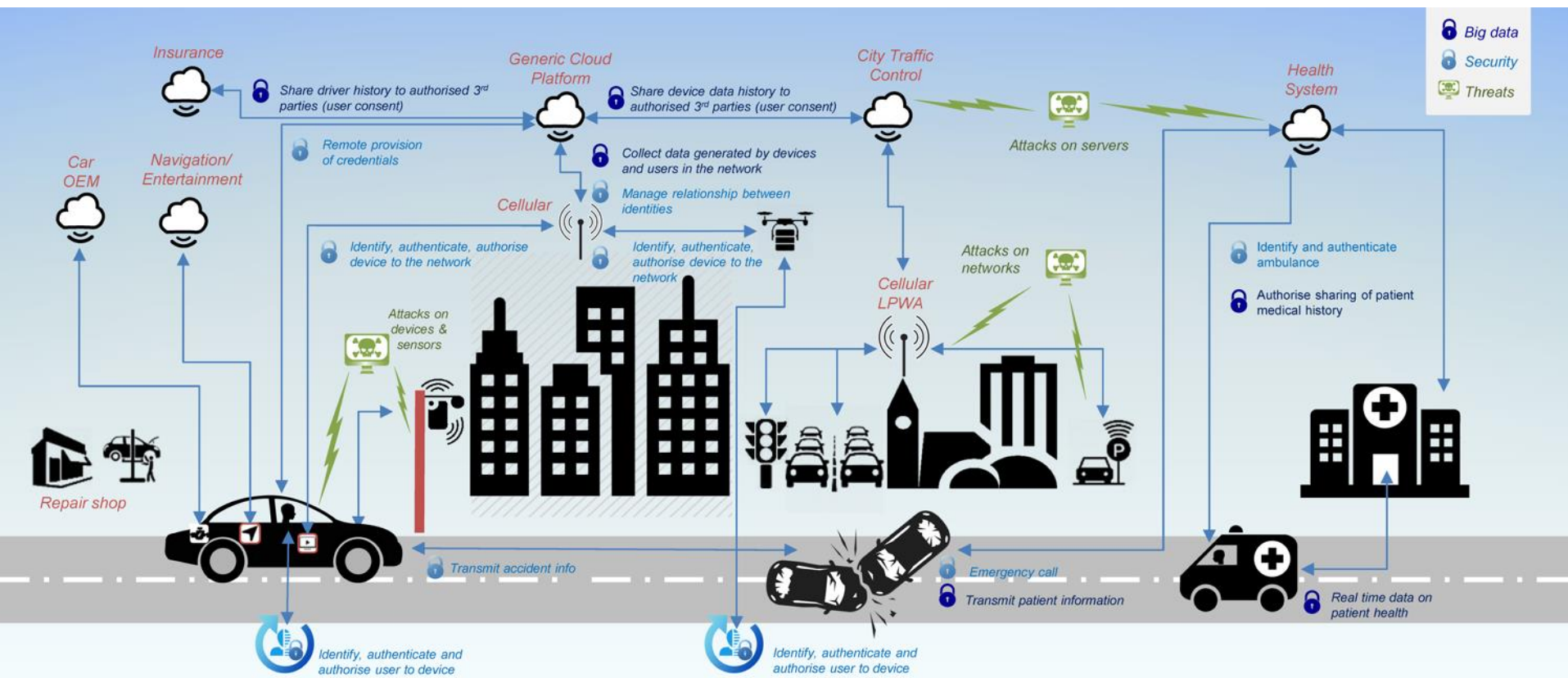
Significant improvement envisioned for nascent technologies, with particularly strong performance predicted for flow batteries.

GLOBAL REVENUE IN DATA STORAGE

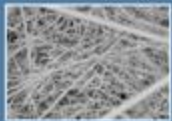


Source: Statista.com

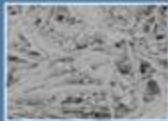
5G – THE ENABLER FOR AUTONOMOUS DRIVING



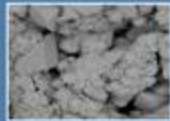
Cycle Life



AGM
Compression



NAM
Sulfation



PAM crystal
structure

Design



Product
Design

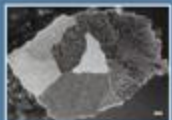


Process
Design



Systems
Design

Cost



Positive
grid alloy



Overcharge
potentials



Container
materials

High Temperature Durability



Raw
Materials



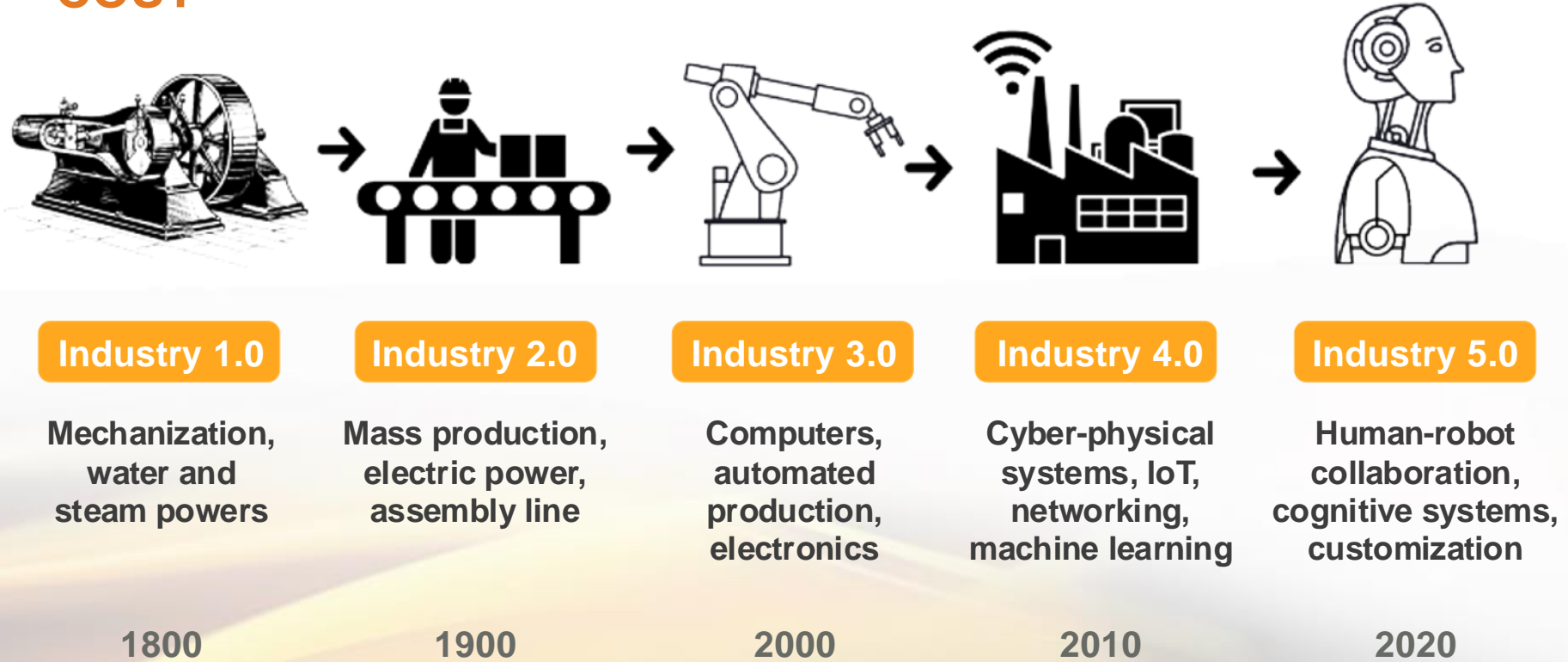
Equipment



Human
Action

Variability

COST



KEY TAKEAWAYS

**The future of
transportation
is electric**

*and lead
batteries will play
a significant role*

**Energy
Storage
present
opportunities
for batteries**

*not only for
Lithium but also
for Lead*

**From Batteries
to Systems**

*generate added
value by
extending the
product offering
into a system
offering*

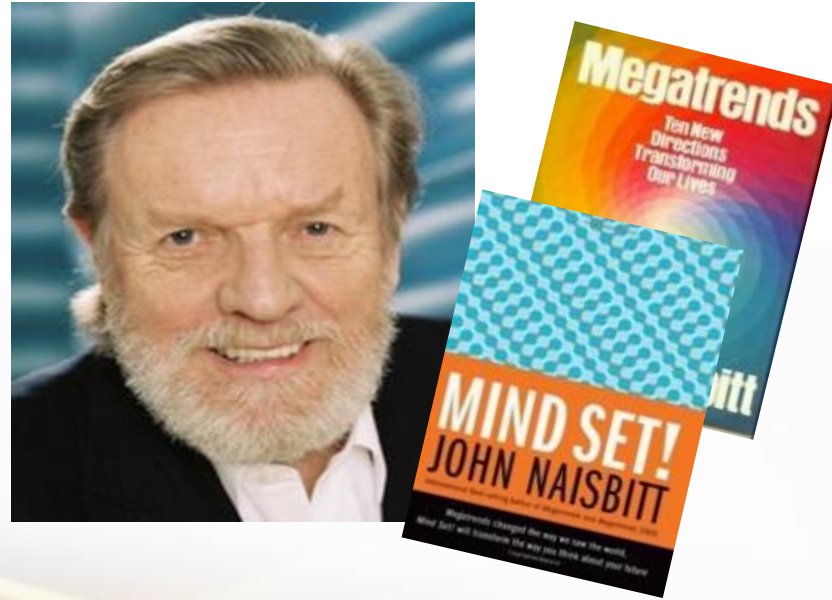
Industry 5.0

*use technology
to help the
human being for
better work
conditions and
decision making*

Innovation

*the driving force
to relevance and
sustainability*

*“The future
is embedded
in the
present”*





Thank you for your attention