Zinc for the Mobility Market

NAATBatt Zinc Battery Workshop II

SAFER – CLEANER – CHEAPER

Michael Burz
President

8 November 2019

EnZinc™

EnZinc = developing a nickel zinc battery based on US NRL technology

Meinrad Machler = Knowledge

Michael Burz = Spellng

Question to answer

Are zinc batteries competitive for the mobility sector?

What Is Mobility?

What part of the Mobility Sector?

Ground based only

- Motorized bikes/scooters
- Auto-rickshaws
- Light duty vehicles
- Trucks
- Buses

Either ICE or electrified

Why Mobility?

26% of World’s Energy

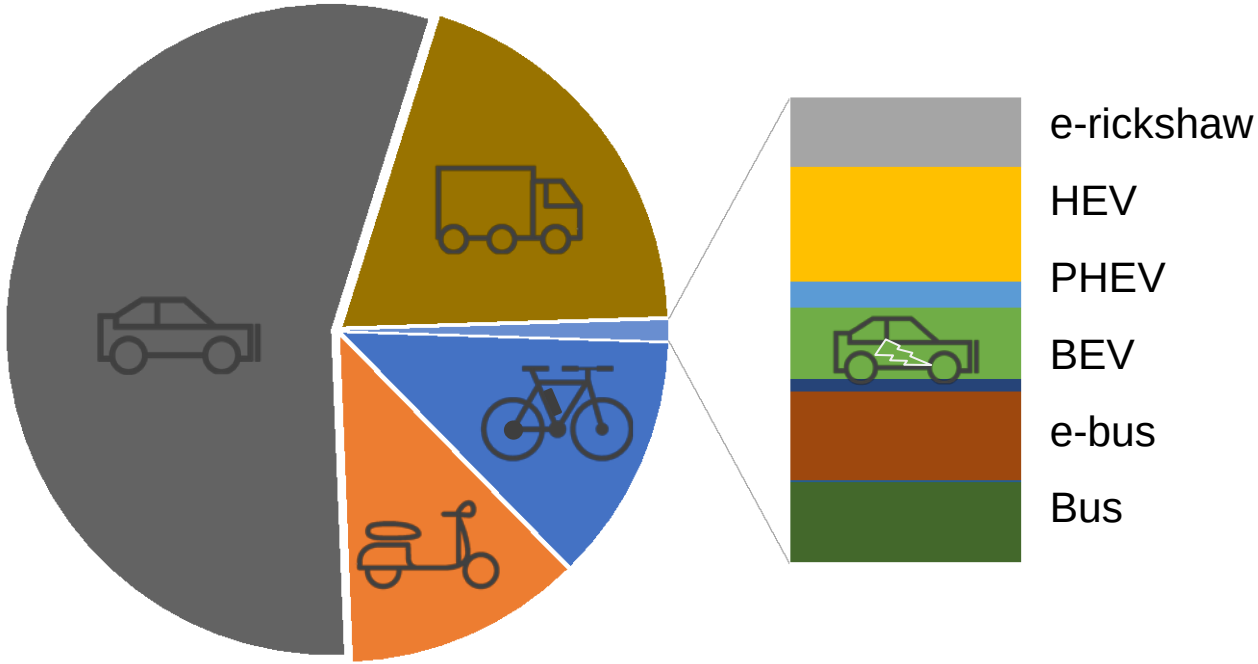
20% of Greenhouse Gases

Source: International Energy Agency (IEA/WTO) and US DoE

How big is this sector?

ALL VEHICLES USE SOME SORT OF BATTERY

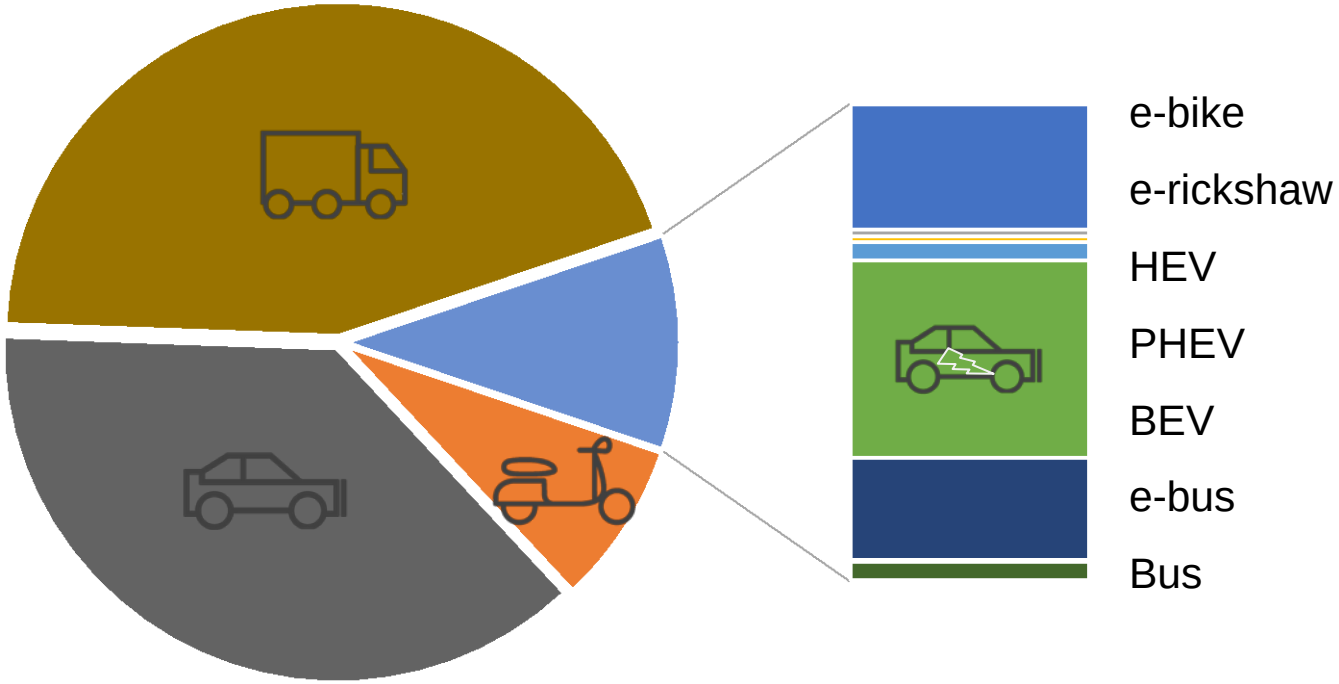
~ 1.7 bn total vehicles



Source: Author's estimates from various sources

MOST OF TODAY'S BATTERY ENERGY IS IN TRUCKS AND CARS

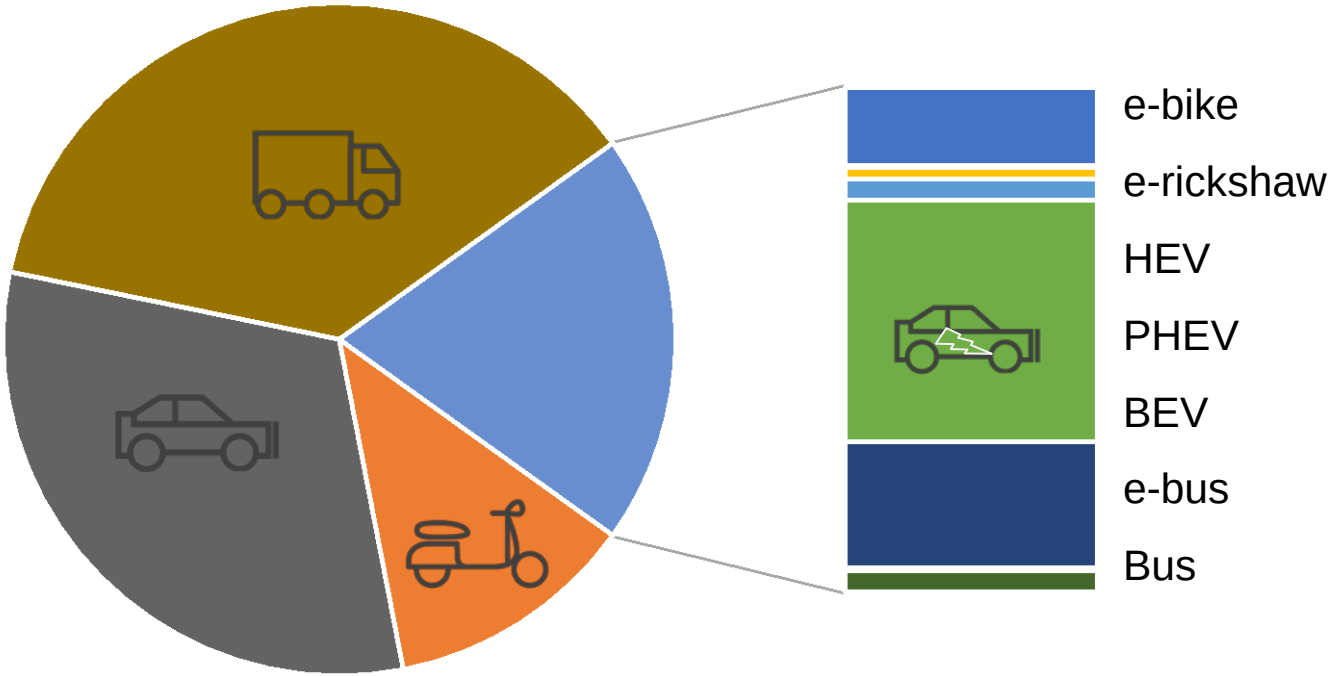
~4,000 GWh



Source: Author's estimates from various sources

BUT THE PURE ELECTRIC VEHICLES ARE BEGINNING TO TAKE A LARGER SLICE OF VALUE

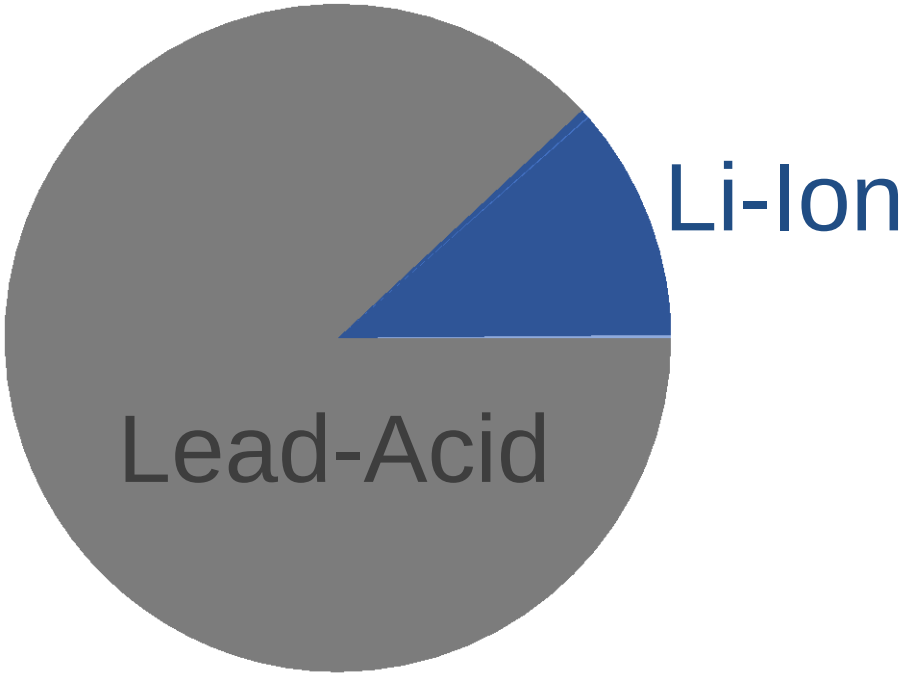
~$45 Billion



Source: Author's estimates from various sources

LEAD-ACID DOMINATES THE MOBILITY MARKET

For now



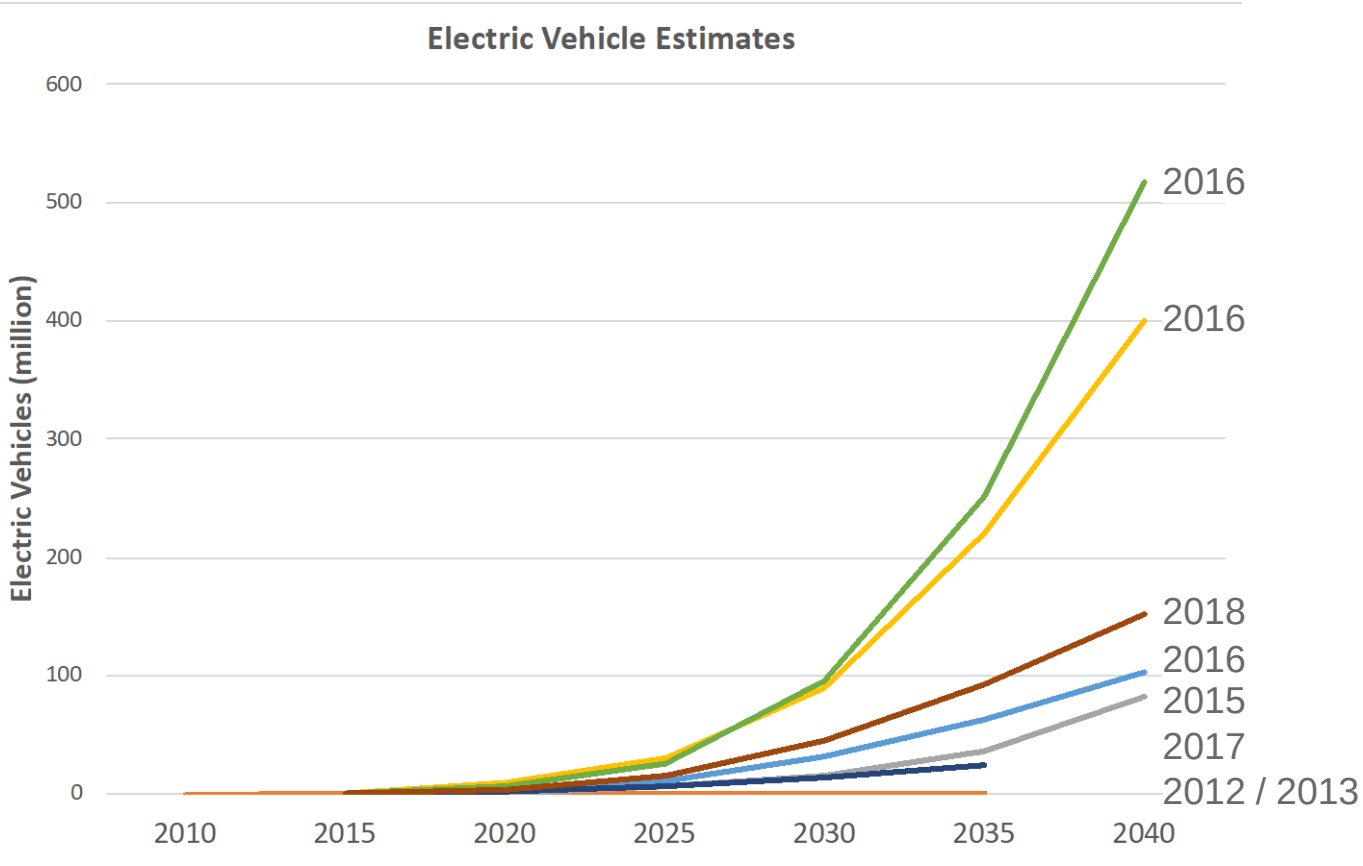
Source: Author's estimates from various sources

Where is the growth?

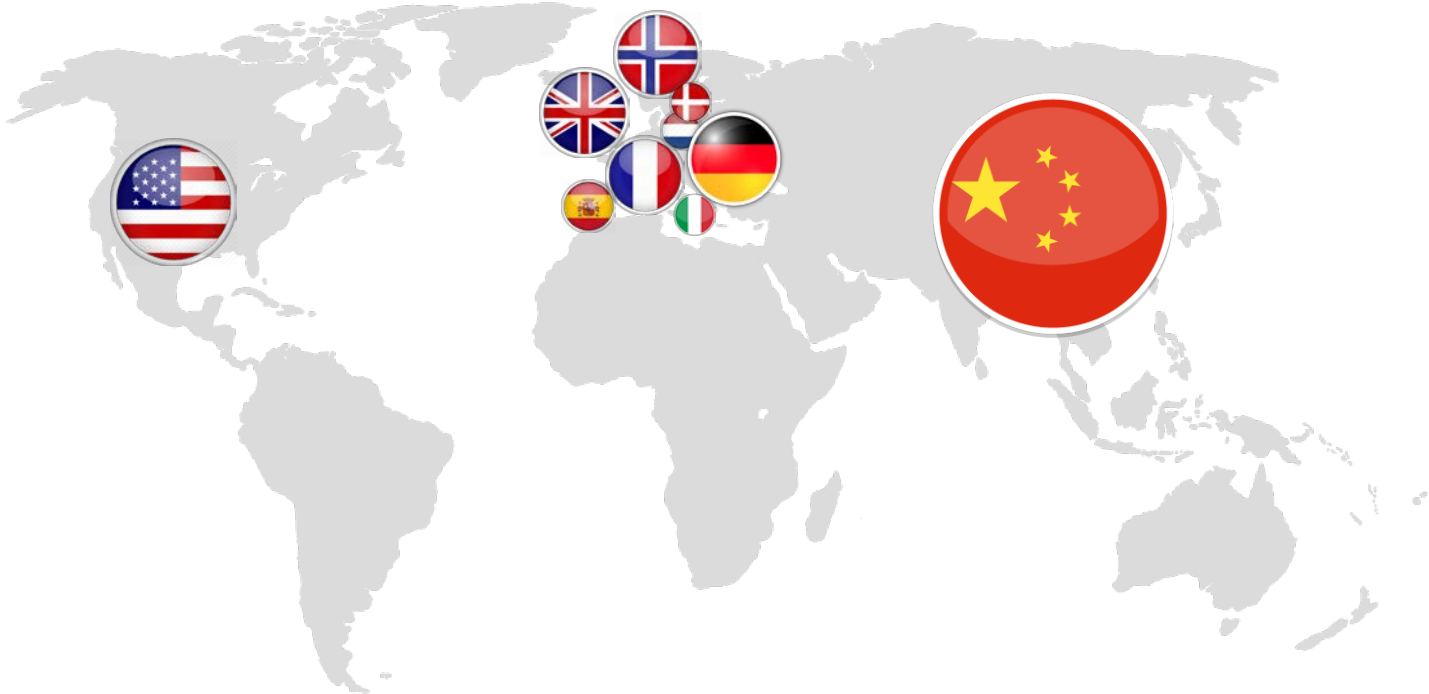
HOW MANY ELECTRIC VEHICLES?

We really don't know

IER
Bloomberg NEF
Bloomberg/OPEC
Wood Mackenzie



TODAY, EV ADOPTION IS A DEVELOPED WORLD LUXURY

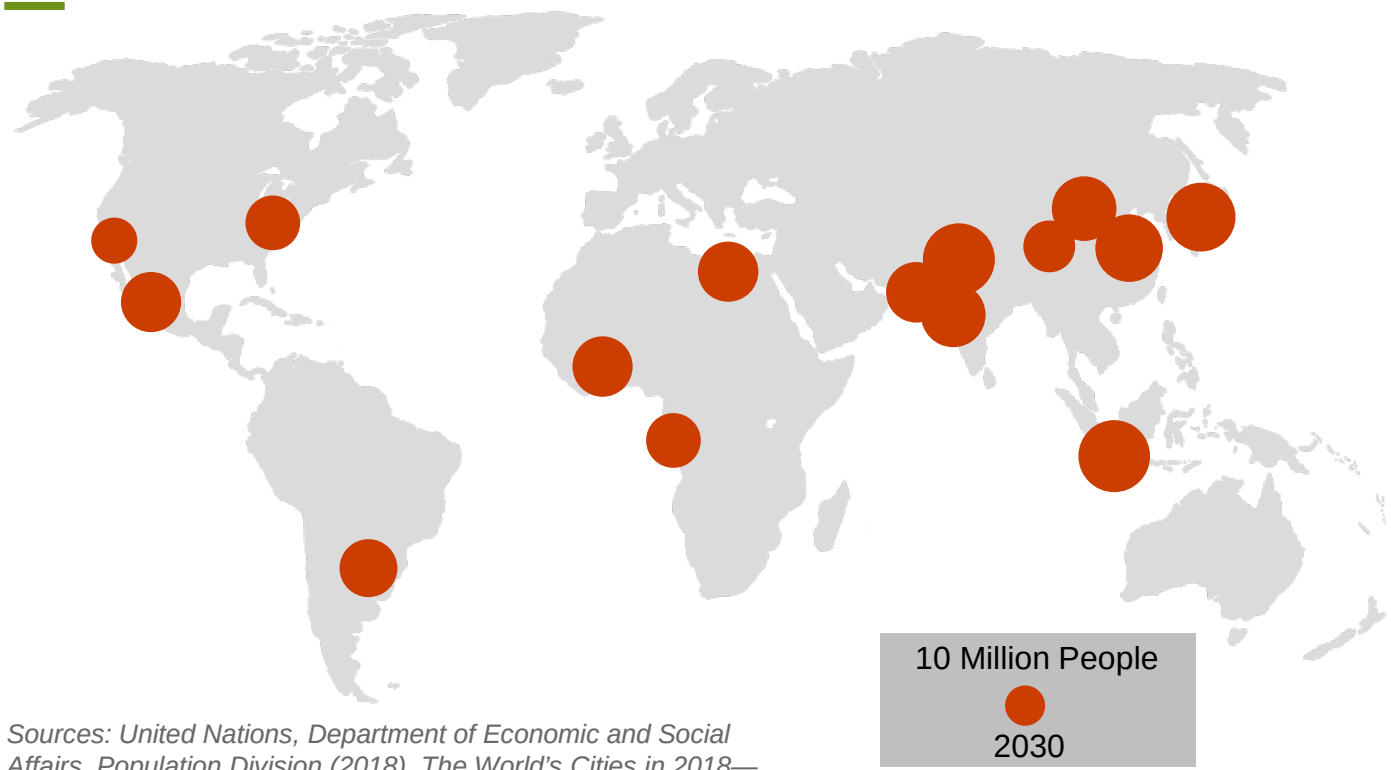


PERCENT EV PENETRATION	
NORWAY	31.2%
CHINA	2.3%
NETHERLANDS	2.0%
UK	1.7%
FRANCE	1.7%
GERMANY	1.6%
USA	1.2%
SPAIN	0.6%
DENMARK	0.5%
ITALY	0.2%

Size of bubble represents number of EVs sold

Sources: RMI Report "Breakthrough Batteries"; October 2019

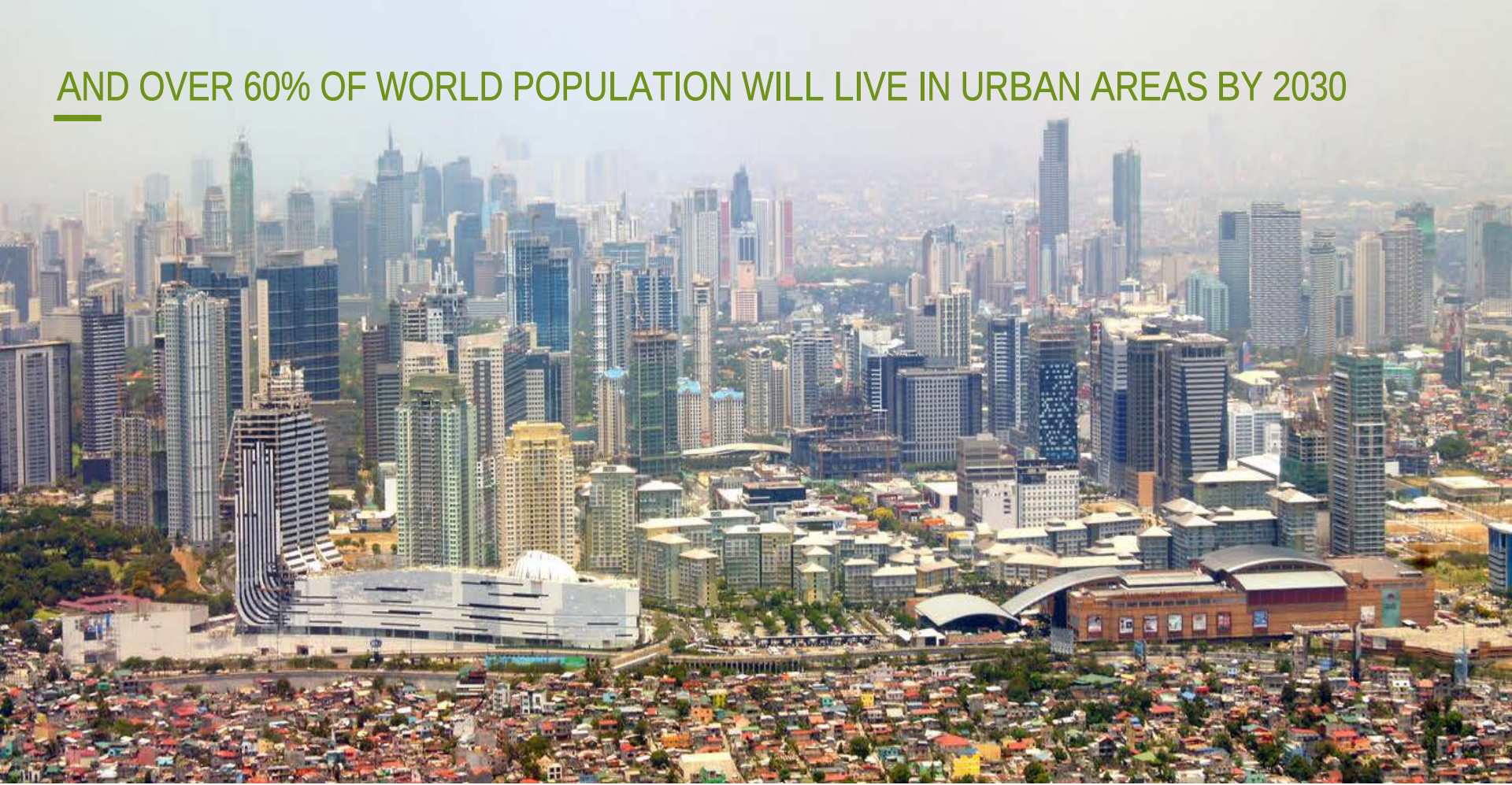
BUT BY 2030 OVER 9% OF WORLD POPULATION WILL LIVE IN MEGACITIES – THAT'S WHERE THE MARKET WILL BE



TOP 10 MEGACITIES BY 2030	
DELHI	39M
TOKYO	37M
SHANGHAI	33M
DHAKA	28M
AL-QAHIRAH	25M
MUMBAI	25M
BEIJING	24M
CIUDAD de MEXICO	24M
SAO PAULO	24M
KINSHASA	22M

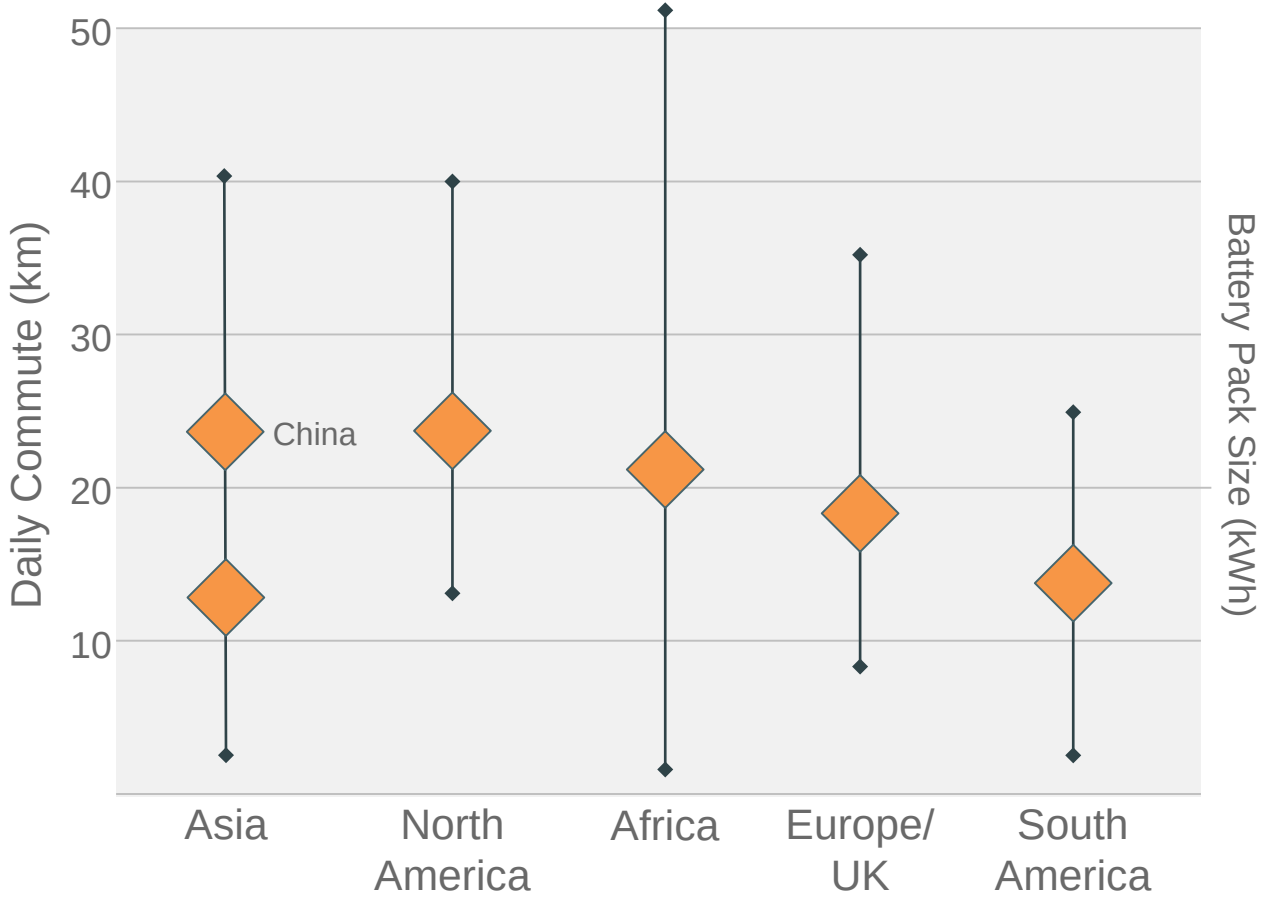
Sources: United Nations, Department of Economic and Social Affairs, Population Division (2018). The World's Cities in 2018—Data Booklet (ST/ESA/ SER.A/417)

AND OVER 60% OF WORLD POPULATION WILL LIVE IN URBAN AREAS BY 2030



Sources: Euromonitor Forecast, 2018

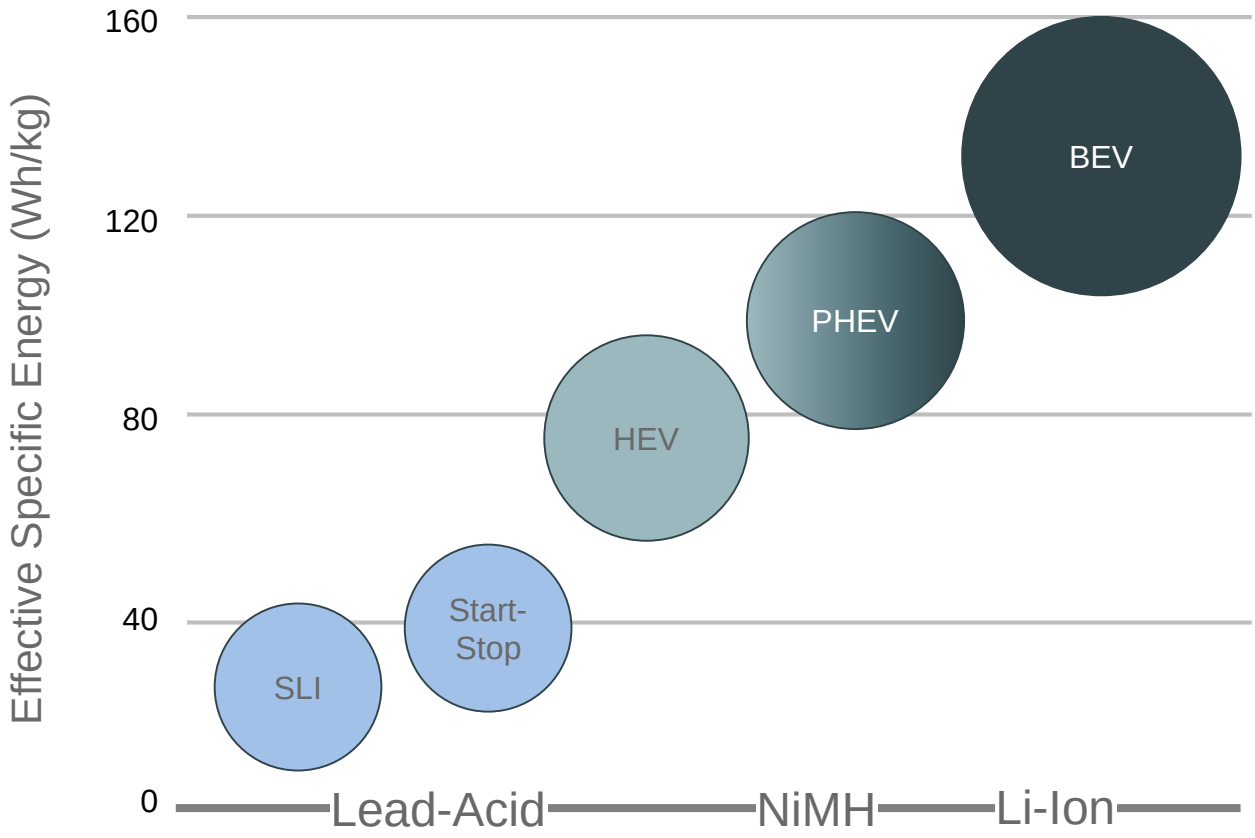
WORLDWIDE DAILY COMMUTES ARE SIMILAR



Source: numbeo.com survey Jan 2011 to Feb 2014
Transportation, September 2018, Vol 45, Issue 5, pp 1269-1295; "The Impact of urban form on commuting in large Chinese cities"

SO ELECTRIFYING TODAY'S MOST POLLUTING URBAN VEHICLES IS CRITICAL

TODAY'S MOBILITY BATTERY CHEMISTRIES



What about zinc?

ZINC HAS ALL THE RIGHT ATTRIBUTES

30
Zn
zinc
65.38
2
8
18
2

HIGH ENERGY
HIGH POWER

INEXPENSIVE

SAFE

ABUNDANT

RECYCLABLE

ZINC FOR BATTERIES IS NOT RESOURCE CONSTRAINED

4%

of the world's **annual** zinc production could deliver batteries for:

All the cars produced in the world today, both gas and electric

72 MILLION
gas powered

1 MILLION
EVs

14 MILLION TONS
Worldwide annual zinc

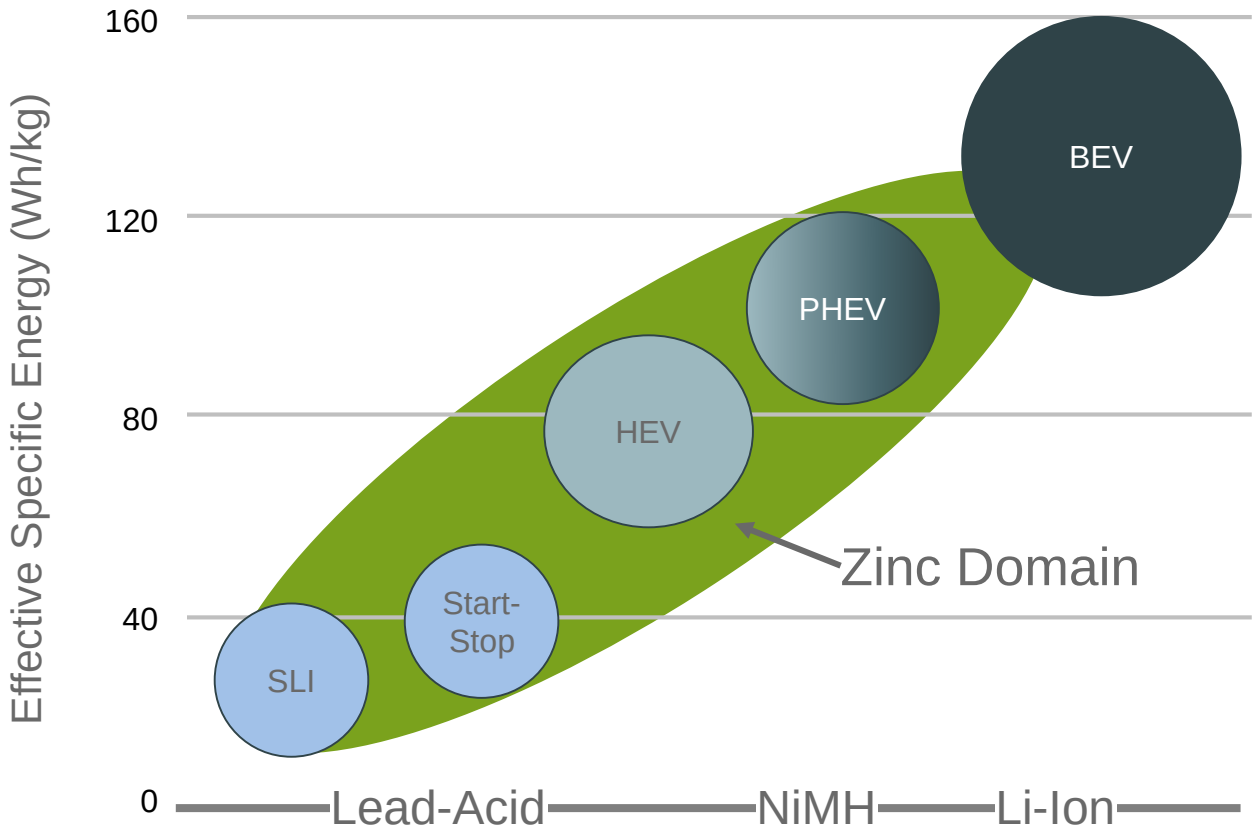
AND UNLIKE LI-ION, ALL ZINC BATTERIES ARE RECYCLABLE

Sources: Author's estimates from various sources

ZINC OFFERS OPTIONS

	INTERNAL COMBUSTION ENGINE	START-STOP	HYBRID, PLUG-IN, ALL ELECTRIC
POWERTRAINS			
BATTERY CATEGORIES	SLI for Lower Vehicle Electrification	Advanced Battery for Moderate Vehicle Electrification	Advanced Battery for High Vehicle Electrification
BATTERY INCUMBENTS	Lead Acid	Advanced Lead Acid Lead Acid + Li-Ion	NiMh Li-Ion
Ni-3D Zn OFFERS	Higher energy Lighter weight	More energy & cycles than PbA Cheaper/safer than Li-Ion	Low/Medium range equivalency while cheaper/safer than Li-Ion

ZINC CAN COVER ALL MOBILITY APPLICATIONS

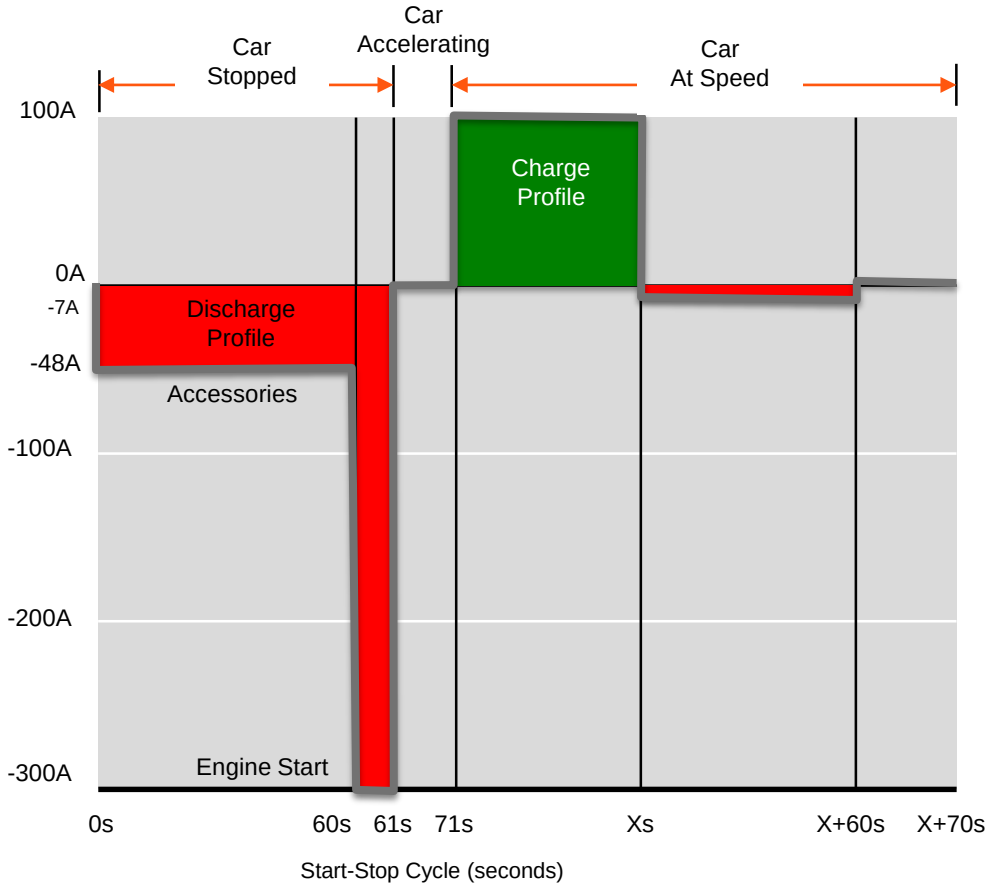


Zinc vs. Lead Acid

Start-Stop

Large Market
Obvious Advantages

START-STOP DESIGN REQUIREMENTS



Source: BMW

What's prevented adoption of Zinc for start-stop?

Cycle consistency
Performance consistency
Legacy entrenchment

Zinc vs. Li-Ion

Li-Ion has momentum

Entrenched chemistry

Established testing and supply chain

Performance advantages

Lots of R&D

But not without vulnerabilities

Safety

Cost

Recycling

Resource constraints

Supply chain

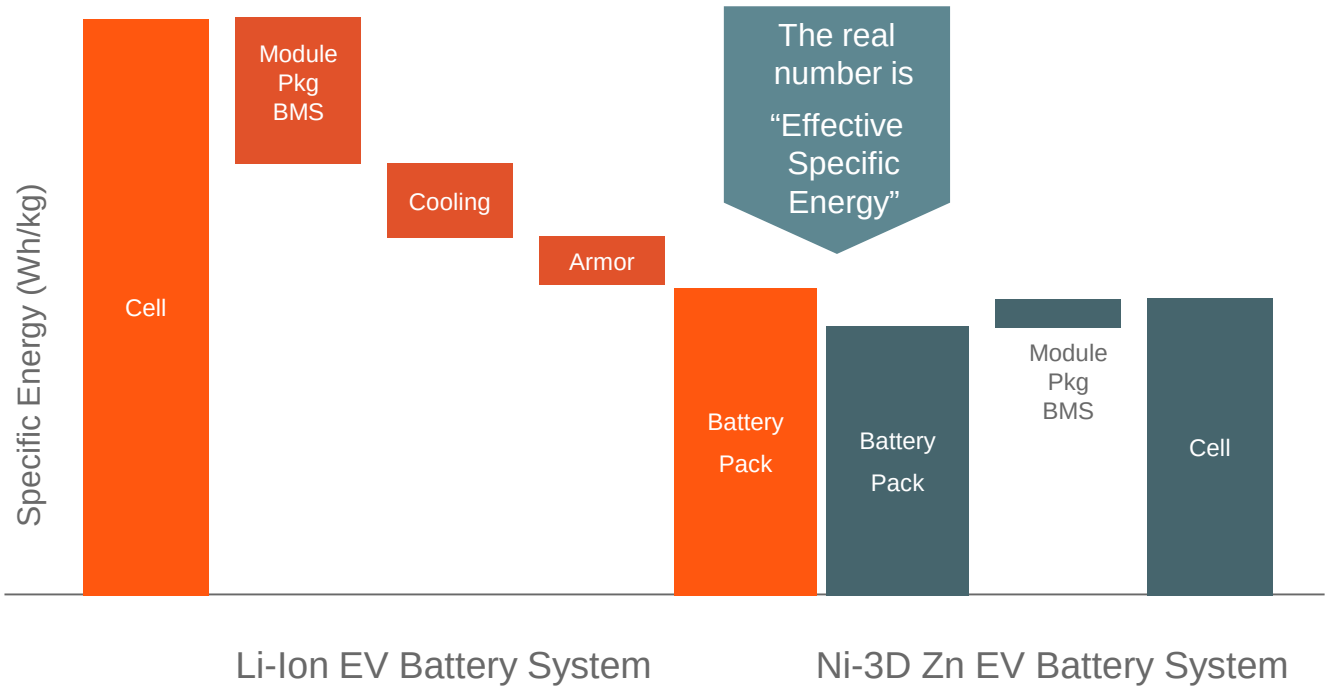
Let's look at performance

Specific energy vs Effective specific energy

Zinc needs a specific energy of >120 Wh/kg

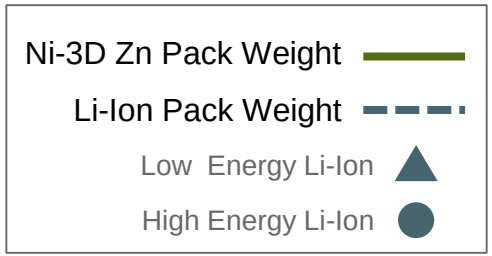
“EFFECTIVE SPECIFIC ENERGY”

Takes all the subsystems into account

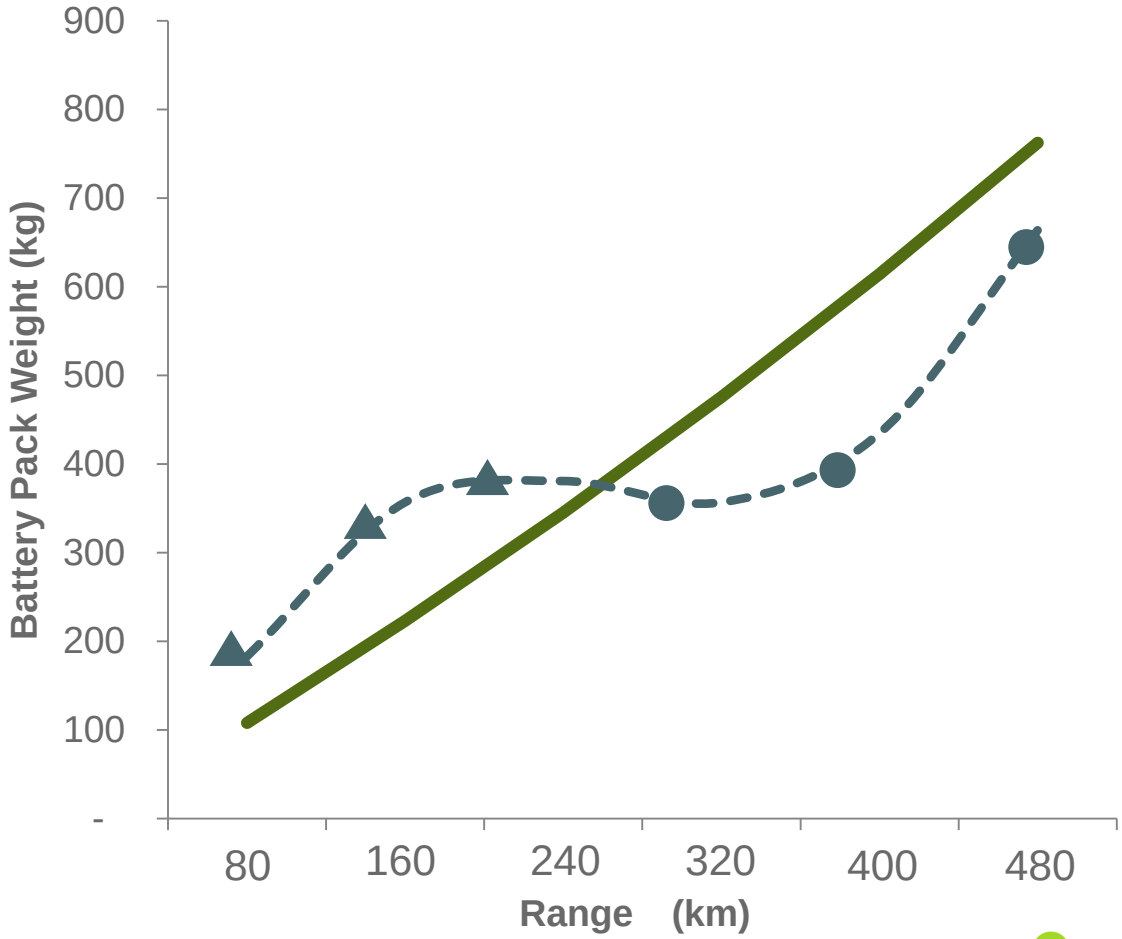


3D ZINC FOR MEDIUM RANGE EV

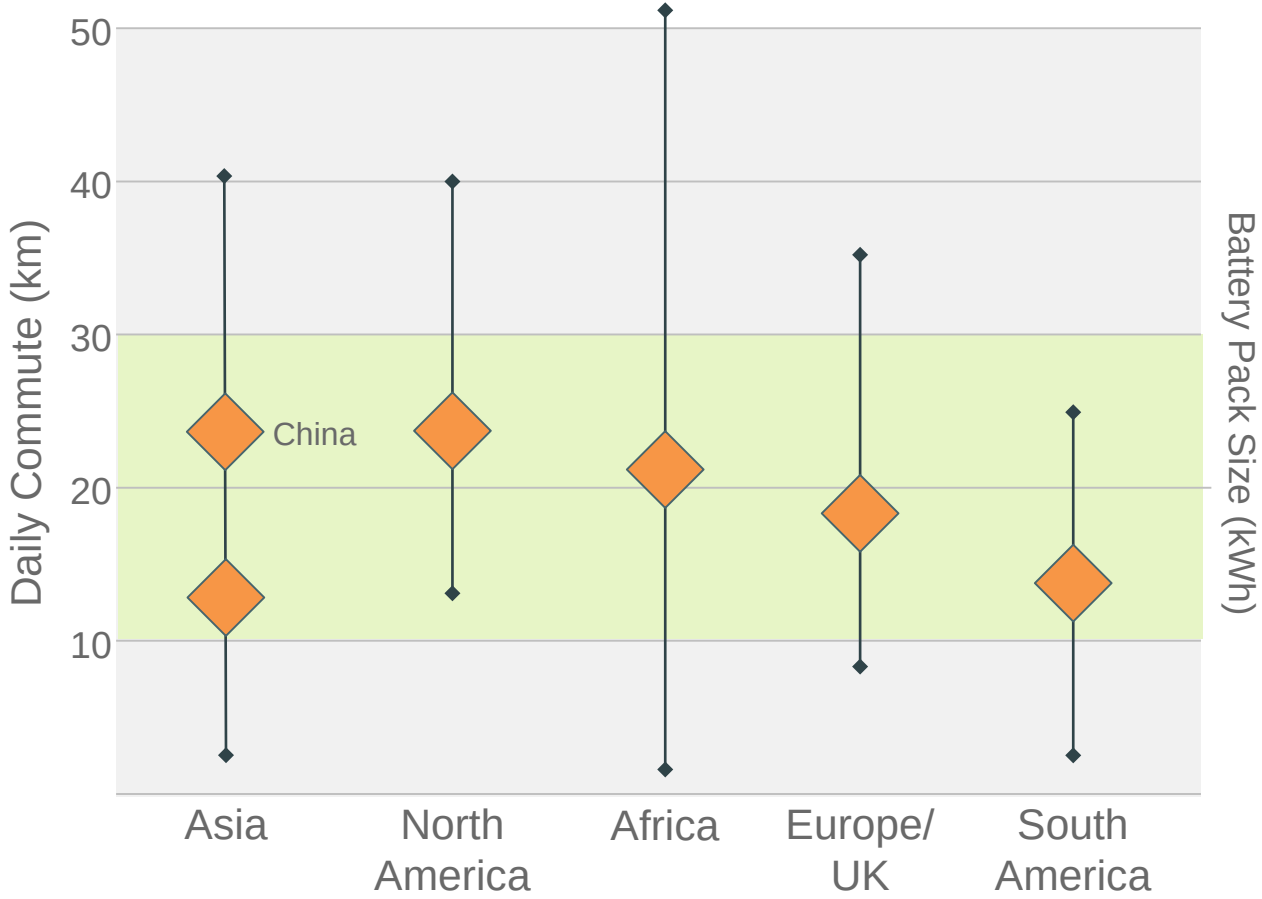
3D zinc is equivalent on range but at half the cost



Source: Author's estimates from various sources



NI-ZN BATTERY CAN FULFILL MOST OF THE WORLD'S DRIVING REQUIREMENTS



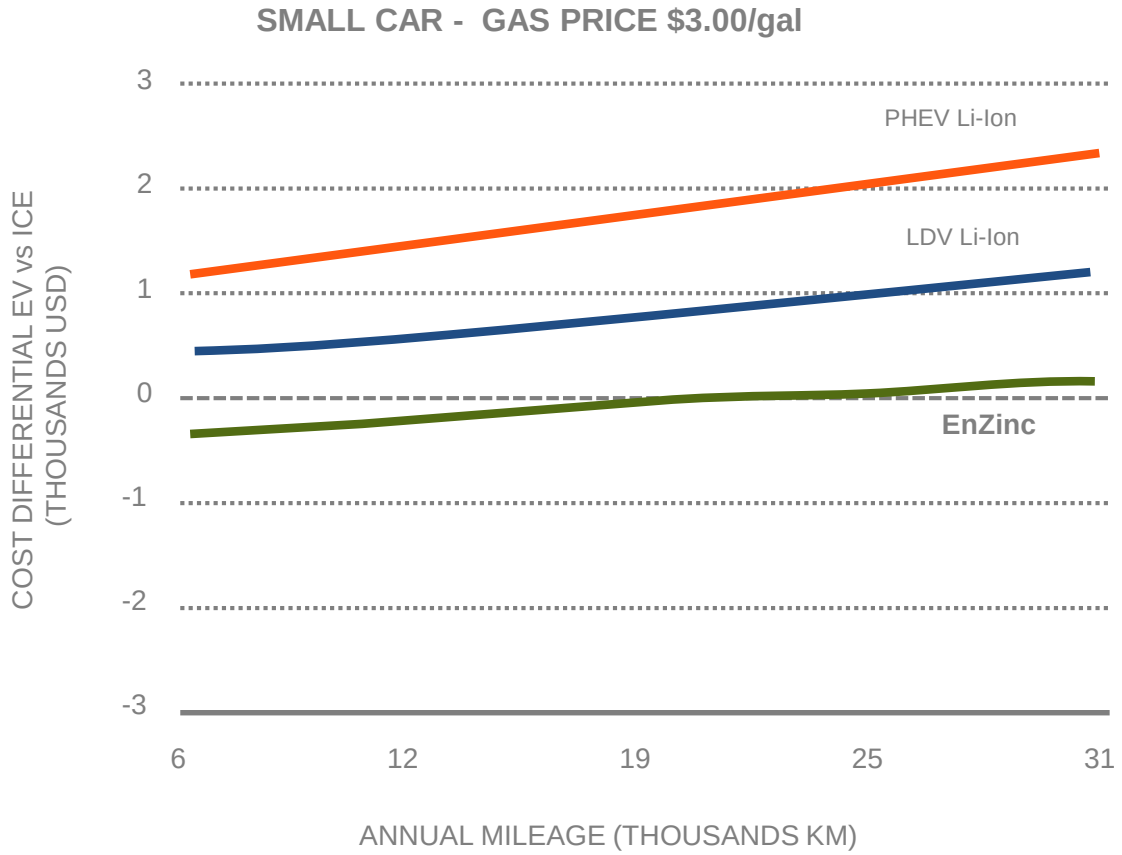
Source: numbeo.com survey Jan 2011 to Feb 2014
Transportation, September 2018, Vol 45, Issue 5, pp 1269-1295; "The Impact of urban form on commuting in large Chinese cities"

UNITI ONE
URBAN EV

150km to 300km
12kWh to 24 kWh
$23,000

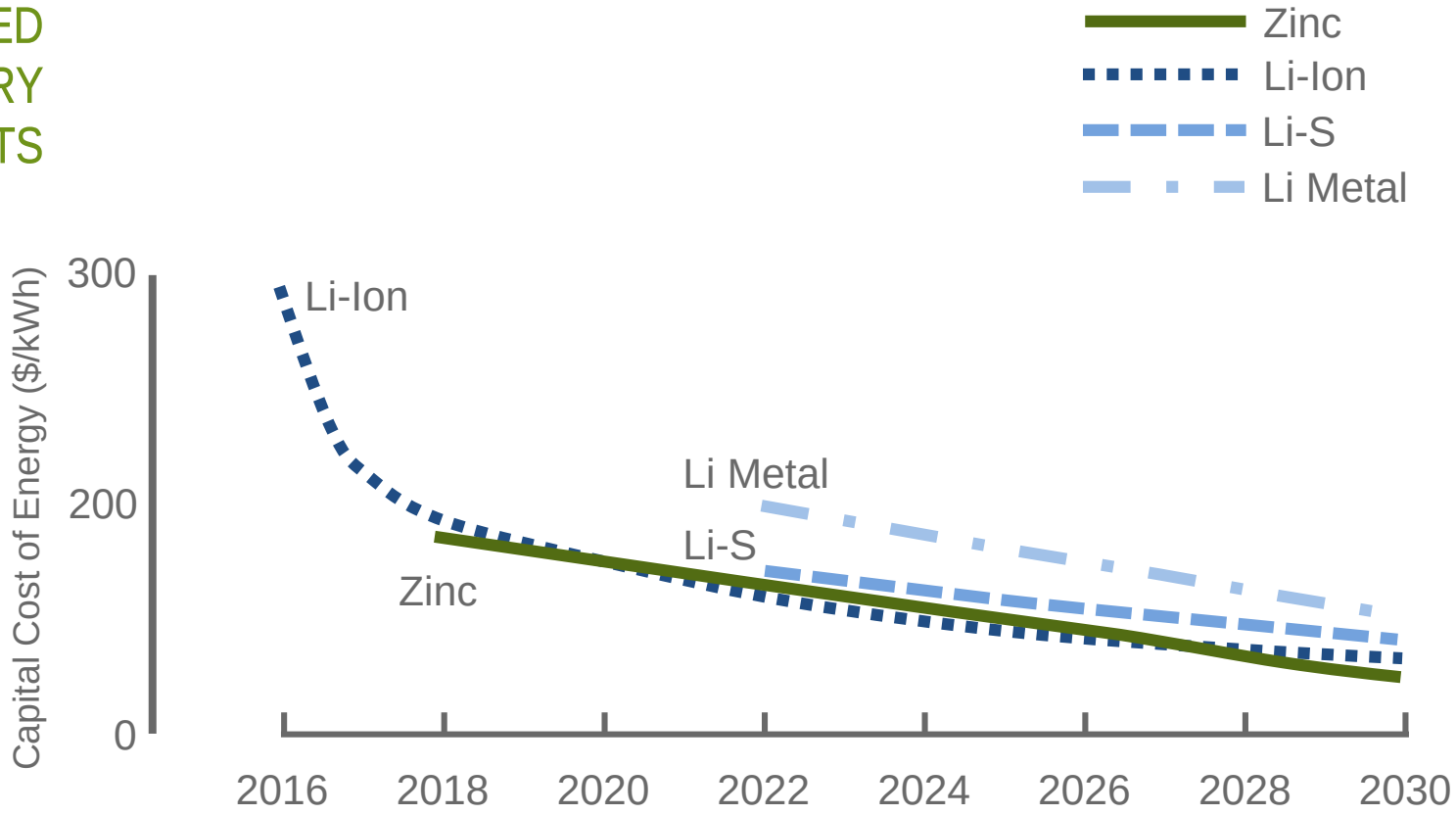
Source: Company brochure

TCO ADVANTAGE OF ENZINC BATTERY



Source: IEA analysis based on ANL (2018a)

RMI PROJECTED FUTURE BATTERY COSTS



Source: RMI Report, "Breakthrough Batteries, Powering the Era of Clean Electrification; Oct 2019

So is zinc attractive for the mobility market?

Depends

Against Lead-acid
Absolutely

Need to overcome legacy

Depends

Against Li-Ion?
A challenge

Improve specific energy
Lots of testing

ZINC BATTERY PERFECT FOR URBAN ELECTRIC VEHICLES

e-bikes/scooters

e-rickshaws

Urban Electric Vehicle/Vans/Bus

Zinc batteries can:

Replace Lead Acid

Compete with Li-Ion

and be

Safer

Cheaper

Recyclable

EnZinc™