



6th International Renewable Energy Storage
Conference and Exhibition (IRES 2011)
Berlin Congress Center (bcc), November 28-30, 2011

IRES

Store Electricity in Zinc

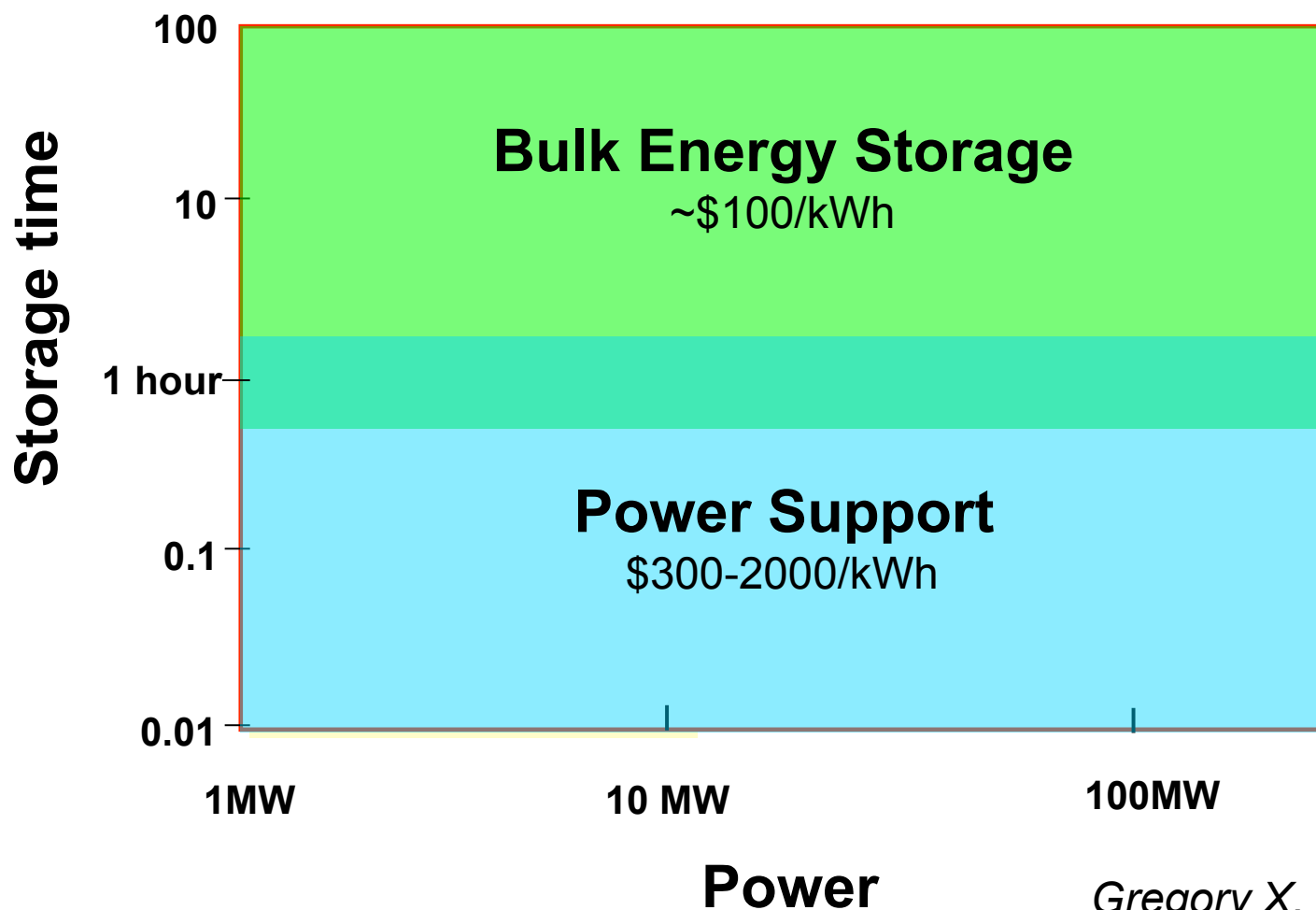
Gregory X. Zhang

On behalf of International Zinc Association

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Landscape Large Scale Storage



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Current Technologies

- Device based – transformer/storage combined
 - Fly wheel
 - Battery
 - Super capacitor
- Material based – transformer/storage separated
 - Water
 - Air
 - Hydrogen
 - Molten salt
 - Redox couples
 - Metals

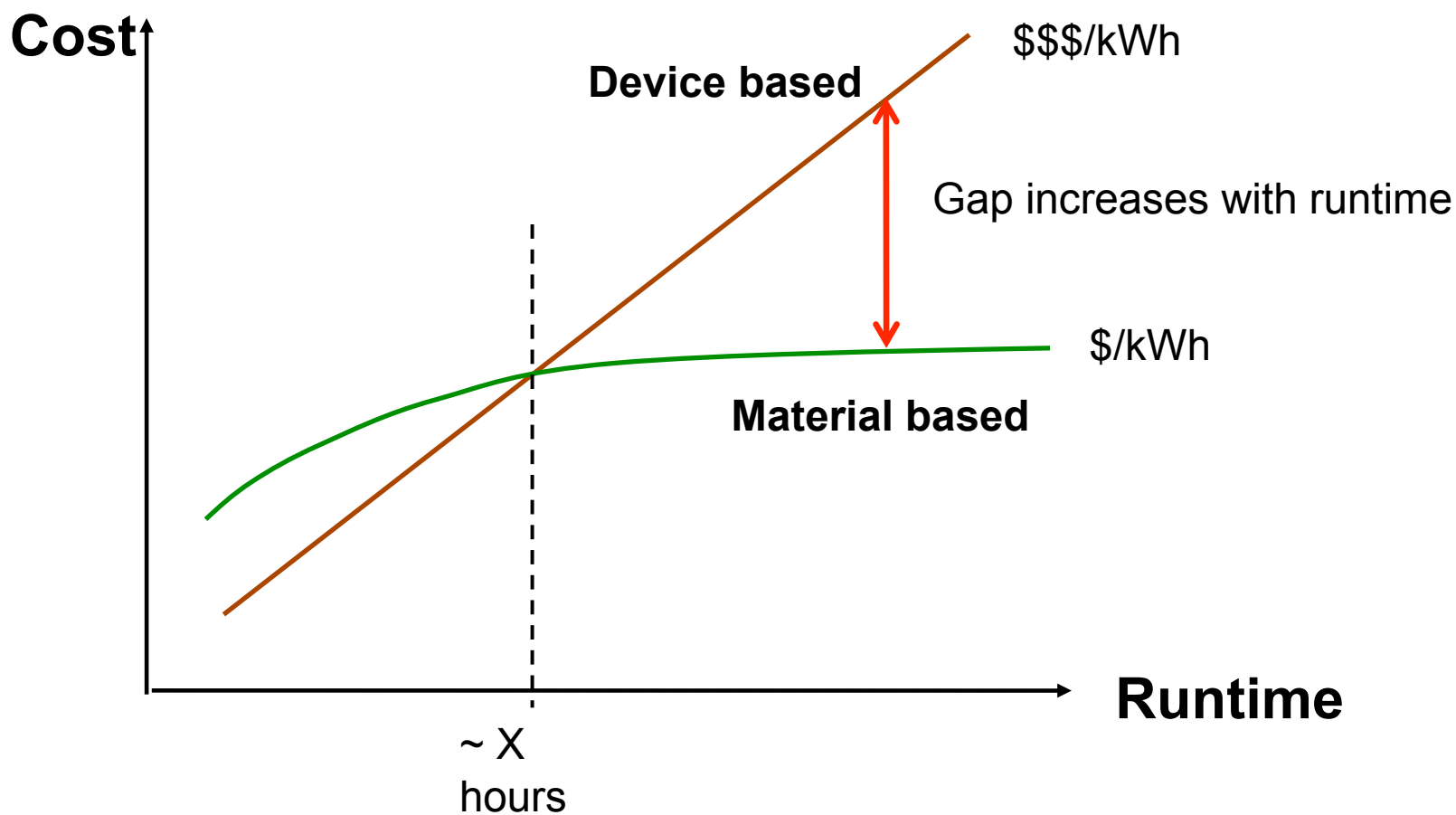
Materials based technologies
- solution for bulk storage

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Advantage of Material Based Technology

- *power not involved in scaling*



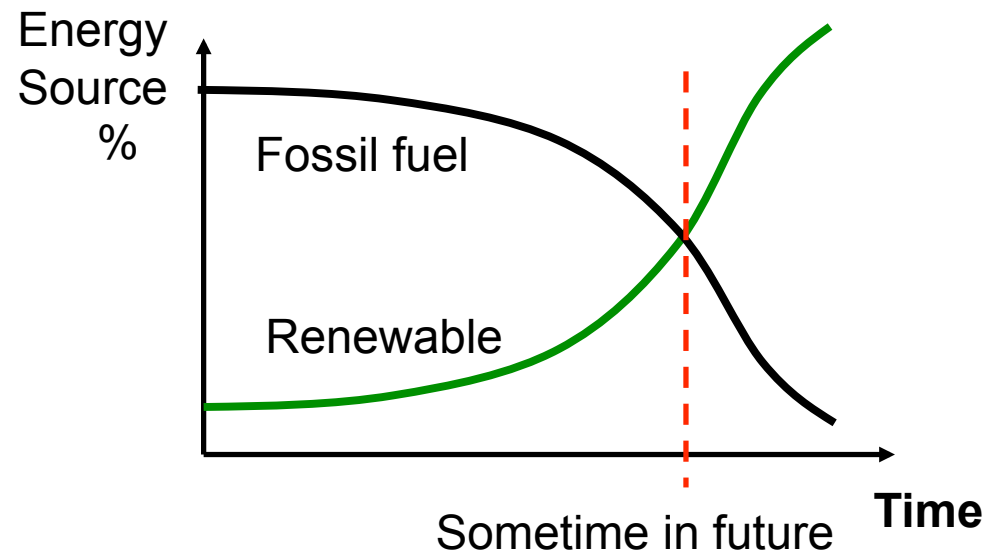
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Store Electricity at large scale & in long term

- An economical necessity in the future

- Storage in sunny days for use in rainy days
- Storage in windy season for no-wind seasons
- Storage in summer for use in winter



>>> require tremendous capacity

>>> possible only with material based storage

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Store Electricity in Zinc

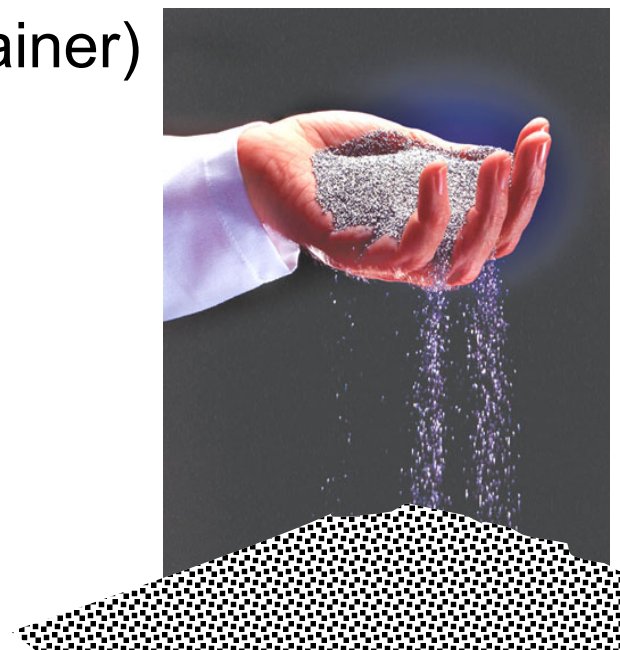
Media	\$/kWh (materials, container)
Zinc	< \$ 10
V redox	> \$100

- Water: low energy density

1kg zinc contains energy equivalent to raising 5 cubic meters of water for 100m

-Air, H₂ also low energy density

**>>> Containing zinc is cheap;
Containing water, air and hydrogen is not.**



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Why Zinc?

- High energy density
- Reaction reversible in aqueous solution
- Safe and environmentally compatible
- Low cost: ~ \$2/kg
- Abundant
 - Storage for 10% of projected 2020 world wind capacity for 8 hours
 - 2.3M tons of zinc
 - 2010 world production: 13 Mt

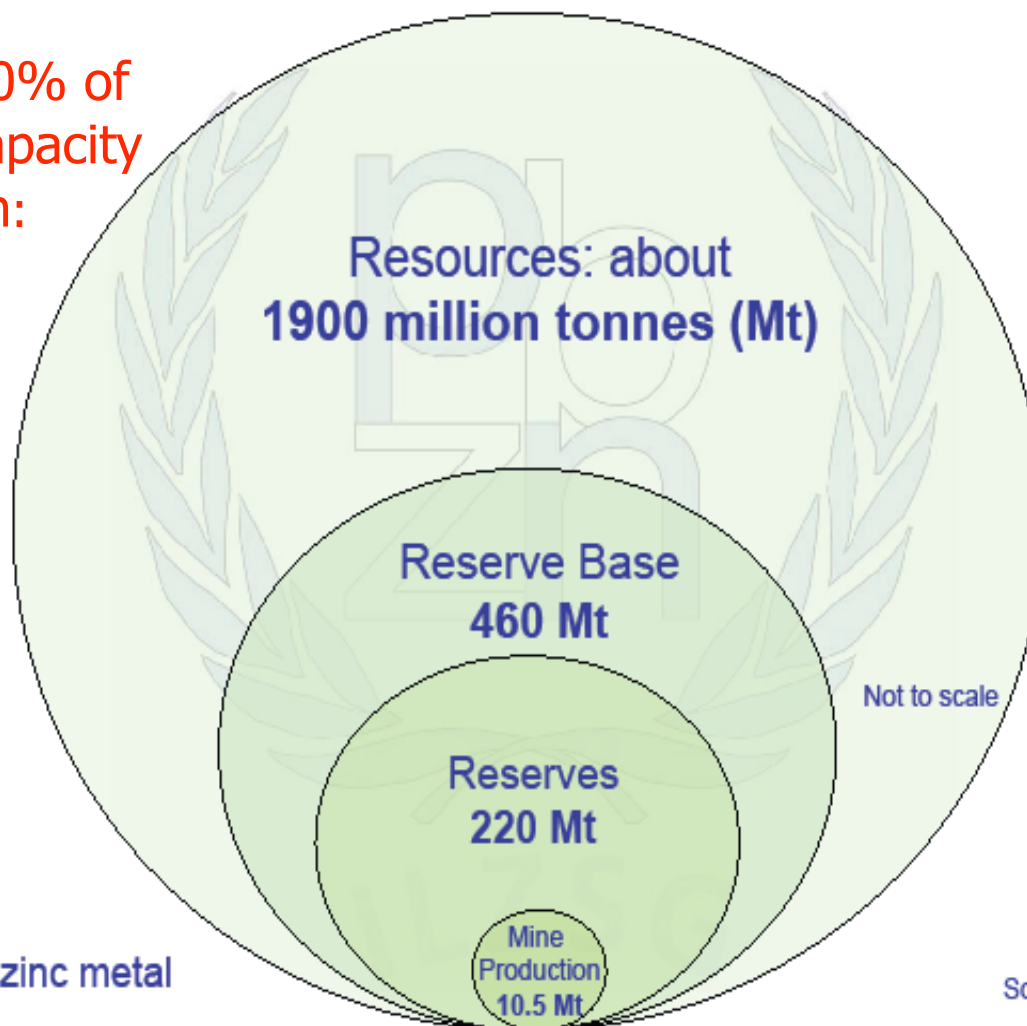


Plenty of Zinc in Earth

World Zinc Reserves 2006

Storage for 10% of
world wind capacity
in 2020 for 8h:

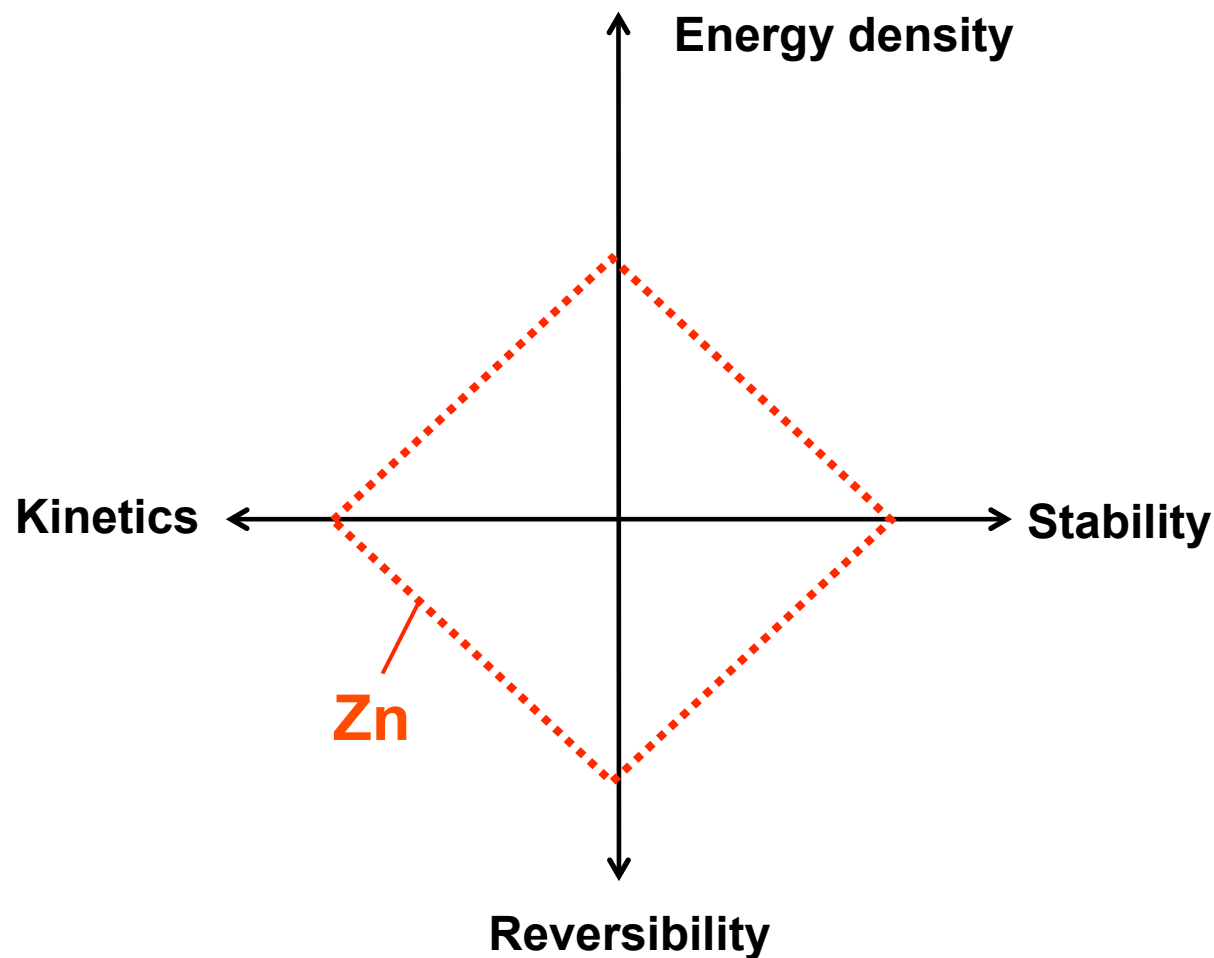
● 2.3Mt



Sources: USGS, ILZSG



Most Balanced Electrochemical Properties

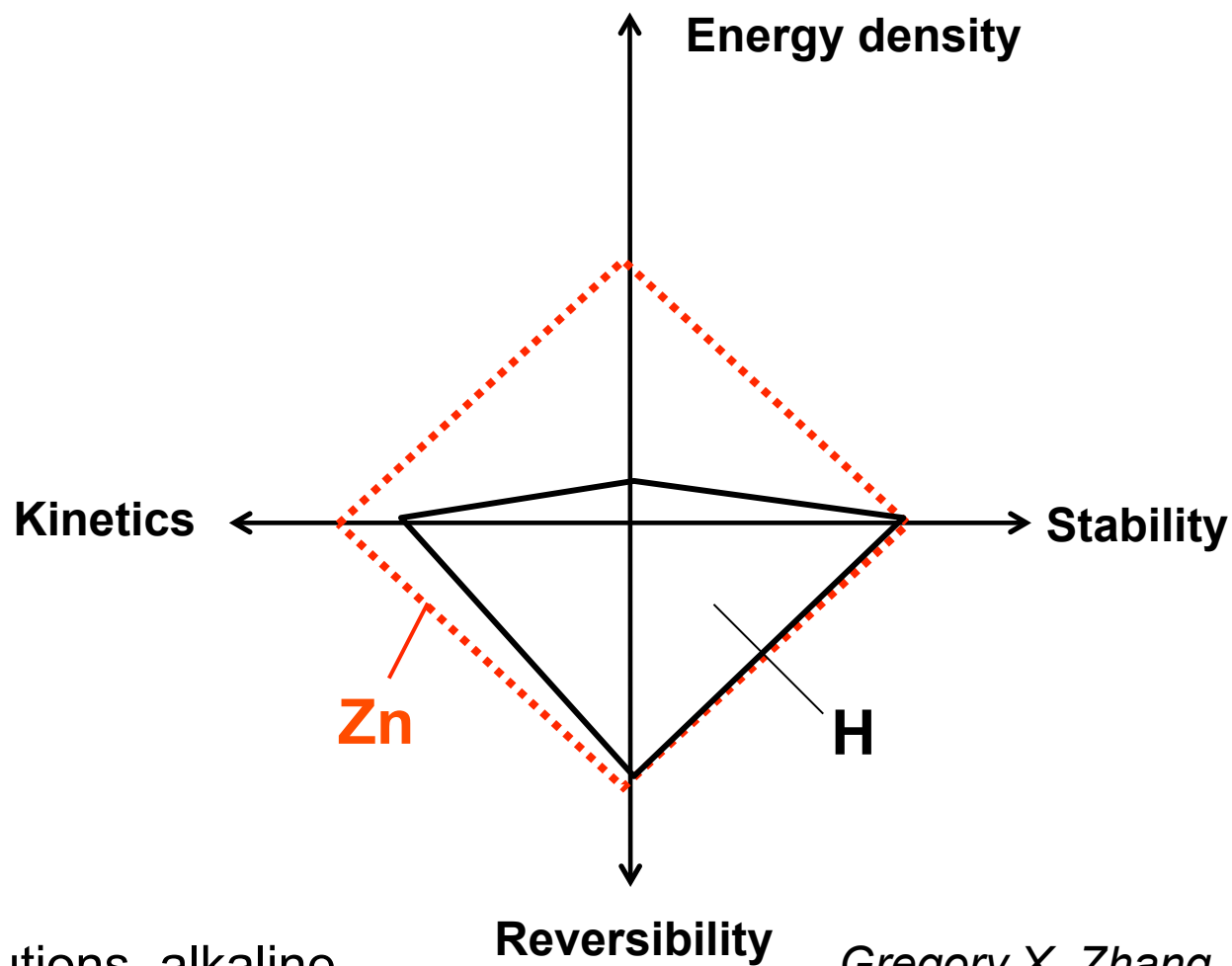


In aqueous solutions, alkaline

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Most Balanced Electrochemical Properties

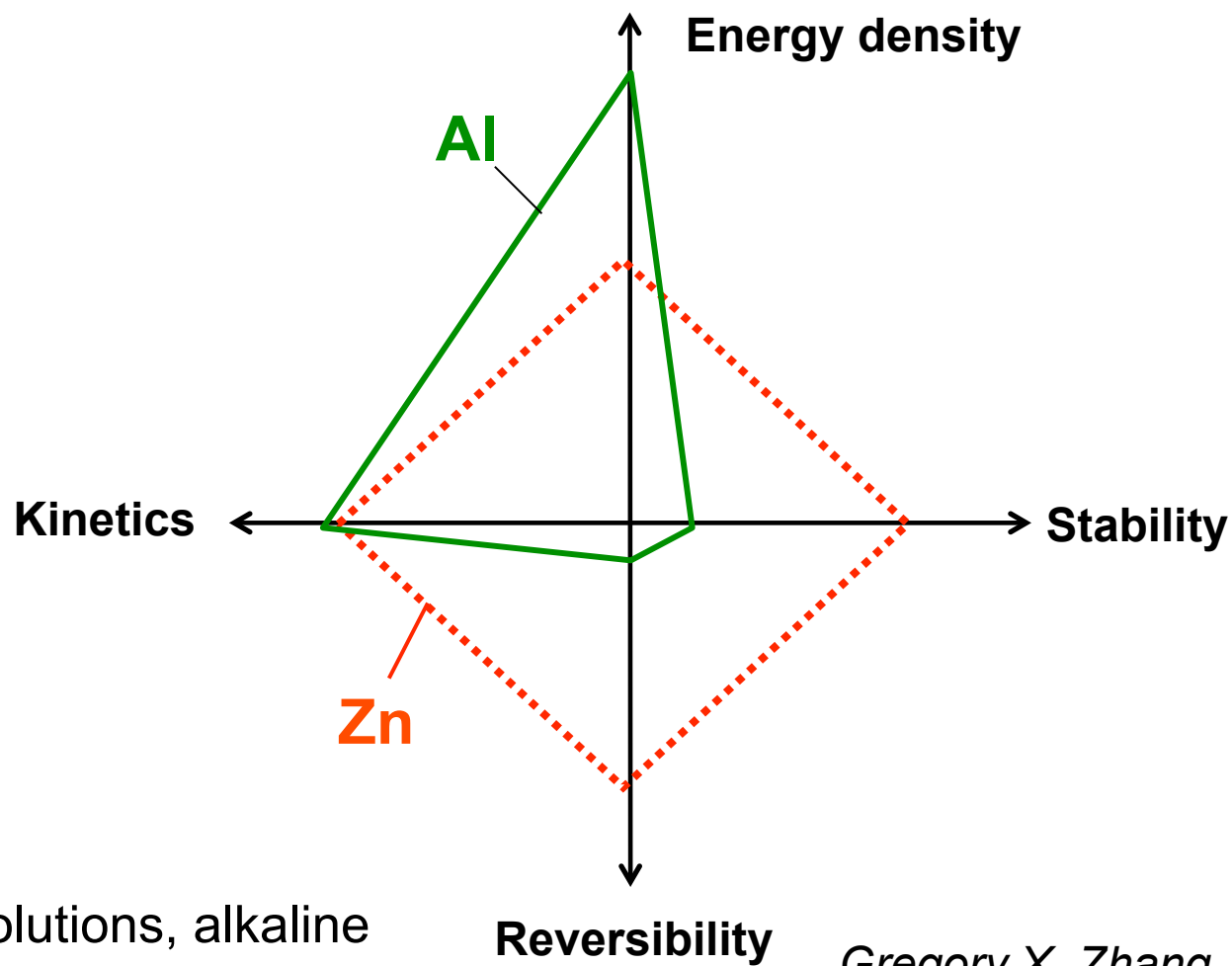


In aqueous solutions, alkaline

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Most Balanced Electrochemical Properties



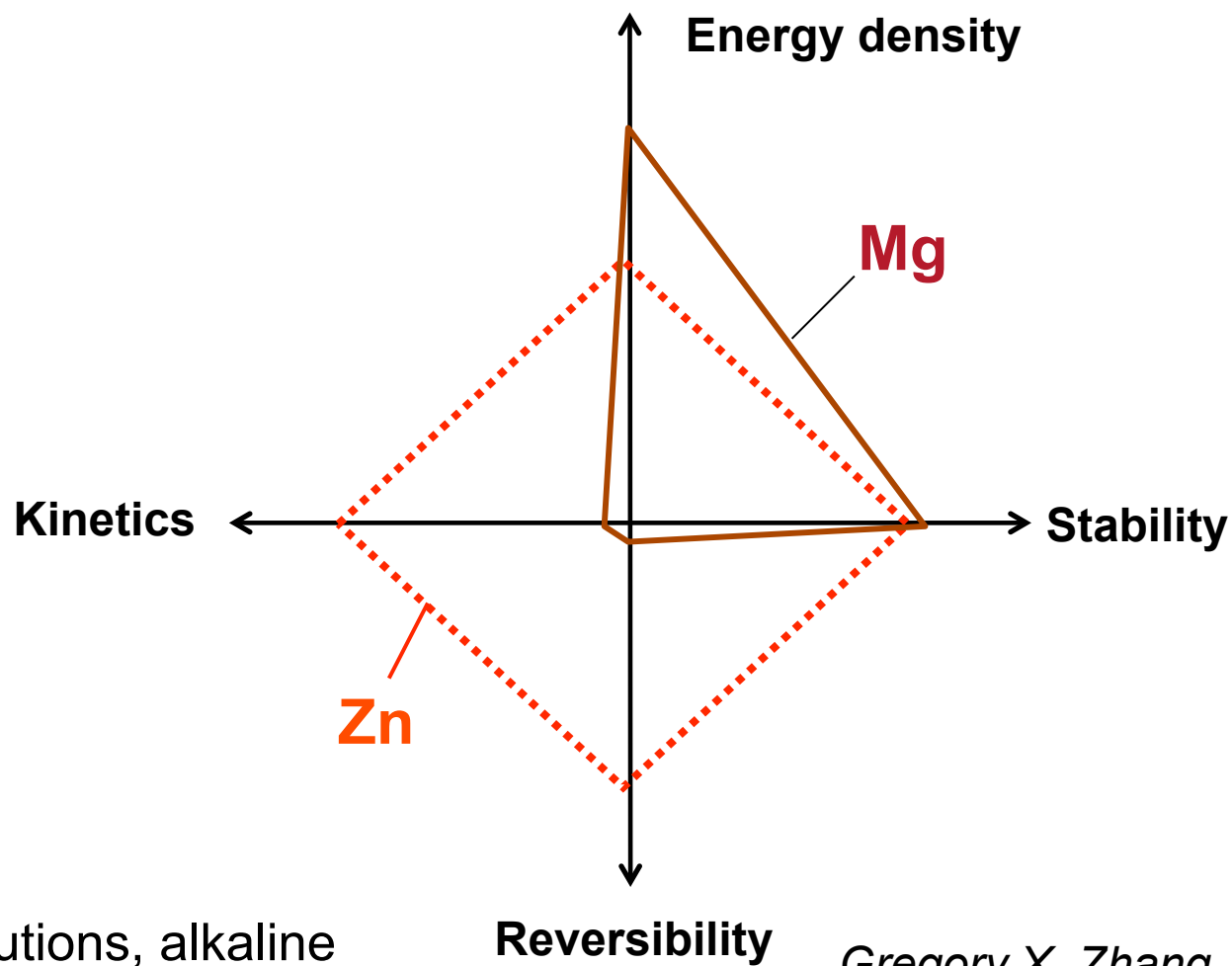
In aqueous solutions, alkaline

Reversibility

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Most Balanced Electrochemical Properties



In aqueous solutions, alkaline

Reversibility

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Most Balanced Electrochemical Properties

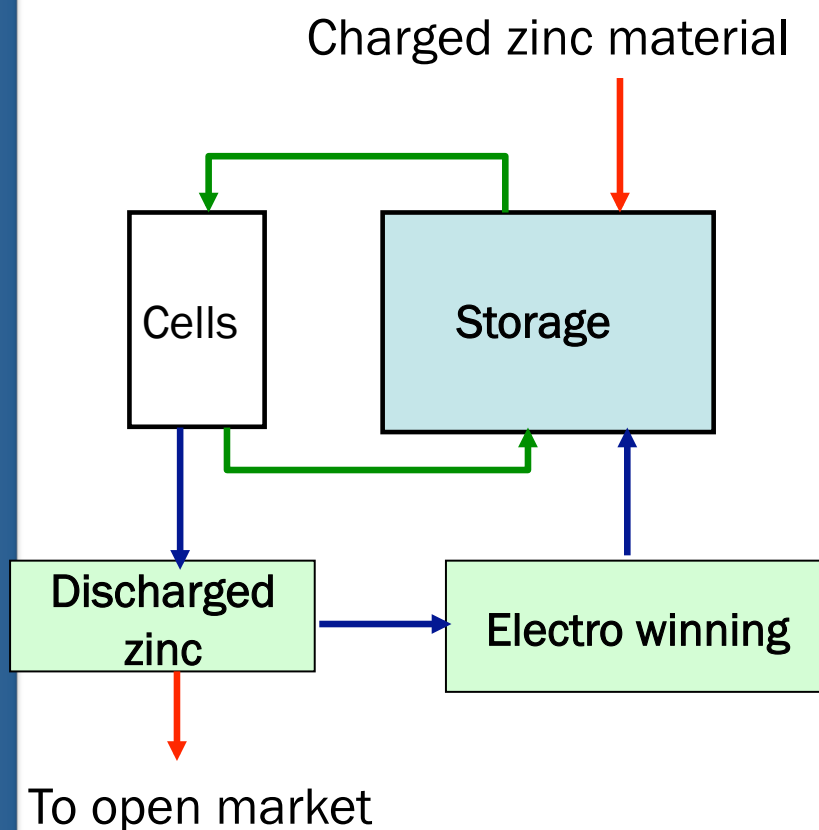
Other elements in the Periodic Table:

- C & organics – not reversible
- Si, Ti – not reversible
- Fe, Cd, Pb – low energy density
- Li, Na, K, Ca – not stable, not reversible



Many Operation Possibilities

- Zinc-air cell and electro winning



Place of electro winning

— Locally

— Centralized

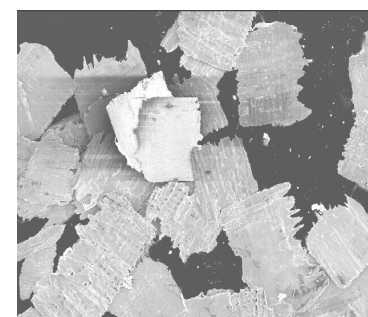
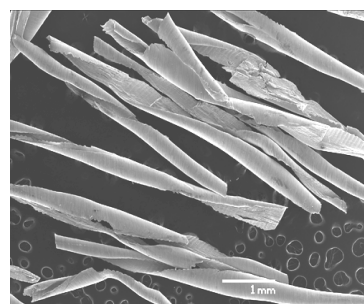
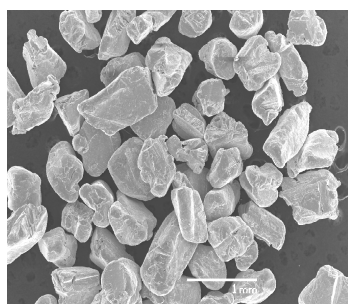
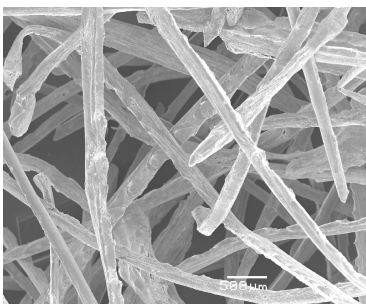
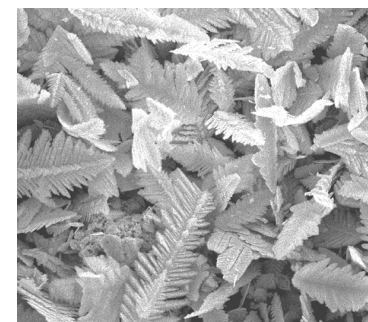
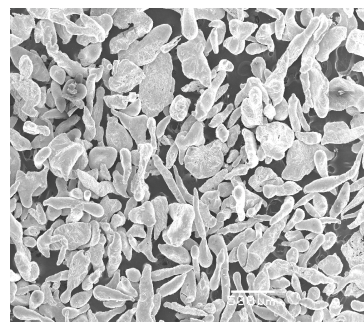
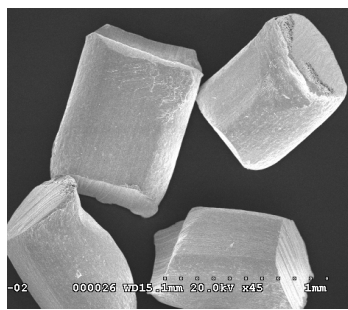
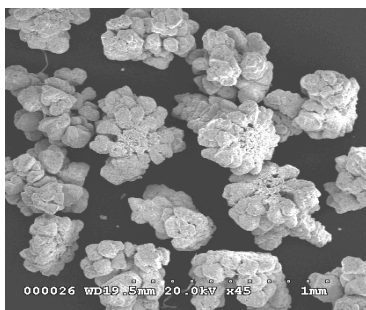
— Societal

Operation between cell and storage can be mechanical or hydraulic

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Diverse Material Possibilities

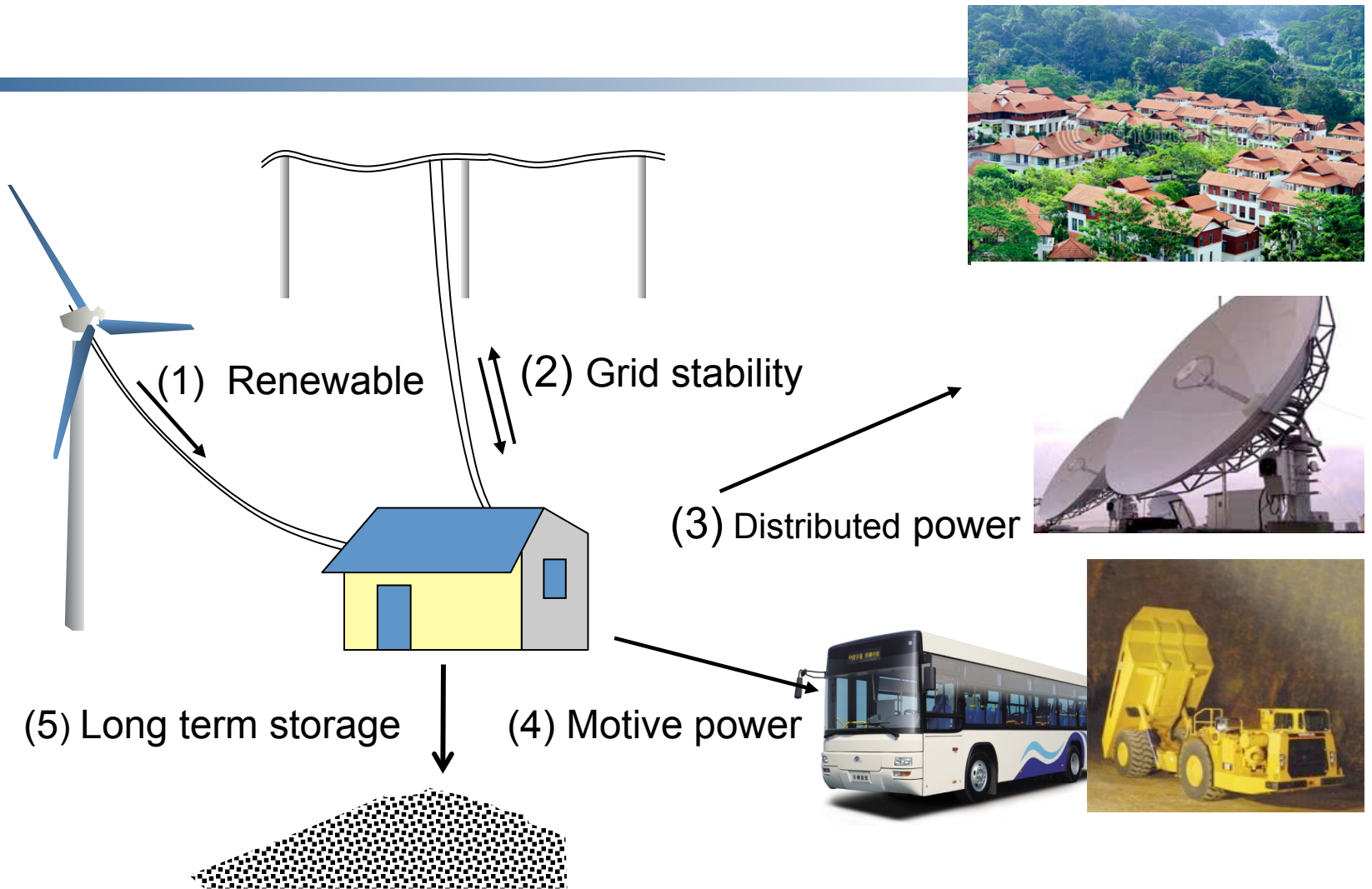


Dischargeable as gel, liquid suspension,
solid particles and plate

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Wide Reaching Application Potential



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What to do?

- New paradigm
 - Grid scale thinking
 - Out of battery paradigm (device paradigm)
 - As fuel for mobile powers – higher value than going back to grid
 - Zinc electro winning plant (100MW) as part of operation
- Investment and development
 - Business model – operation/technology/scale
 - System functionality - zinc movement
 - Component technologies
 - Round trip efficiency – O_2 electrode kinetics
 - Life of air cathode



Summary

- Bulk storage at \$100/kWh
 - Solution in material based technologies
- Zinc: the most suitable material
 - Many material/operation possibilities
 - Excellent electrochemical properties
 - Safe and environmentally compatible
 - Low cost & abundant
- Grid scale problem needs grid scale thinking & new paradigm
- Need investment and development

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Thank You!

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