

Electrification Challenges & Energy Storage Solutions

2010 Advanced Energy Conference

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November 8, 2010



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ecomaginationSM

Challenge

Oil concerns are driving changes in transportation

Oil Security

Price instability

Foreign Reliance

Peak Oil

Climate Change

CO2 emissions

Pollution

**Solve challenge
with electrified
transportation**



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Hybrid & Electric Solutions Today



Electric Vehicle ¹



Range Extended Electric Vehicle ²

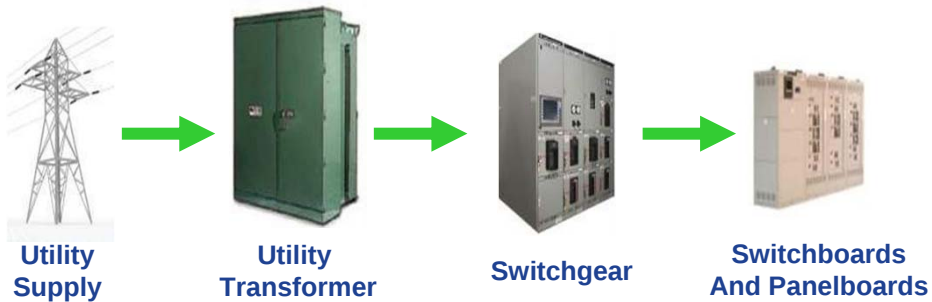


Hybrid Electric Vehicle ³

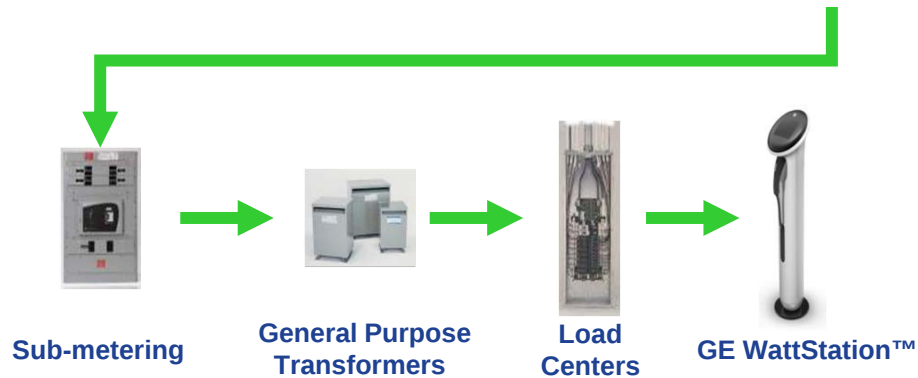
They are here... BUT

- Expensive
- Lack charging infrastructure
- Grid concerns for full adoption
- Battery warranty and costs
- Financing / Leasing uncertainty
- Credibility / Consumer Acceptance

Electrification has Wide Impacts



Energy Storage ⁴



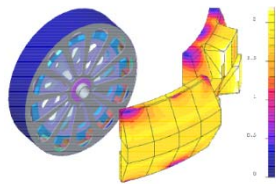
Financing ⁵

Generation T&D Protection Buildings EV

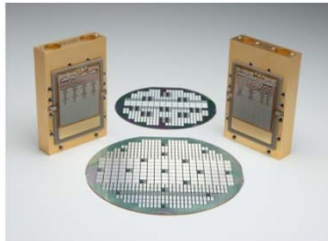


Service & Warranty ⁶

What Technologies Are Needed?



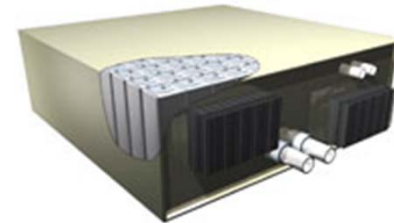
Motors



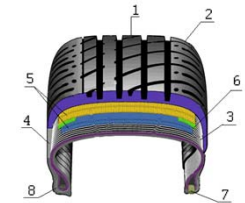
Power Electronics



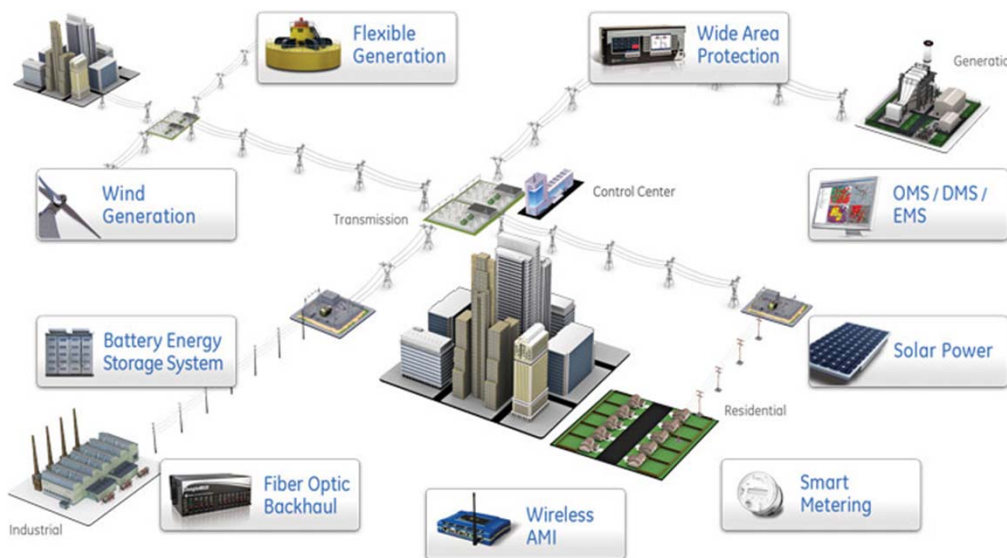
Lightweight Materials
Aerodynamic Designs ⁷



Lower Cost
Energy Storage /
Intelligent Controls



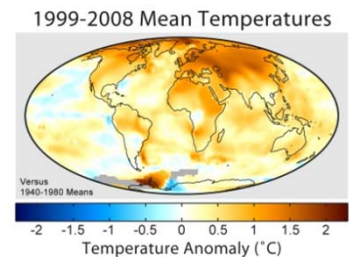
Low Rolling
Resistance
Tires ⁸



Grid Integration

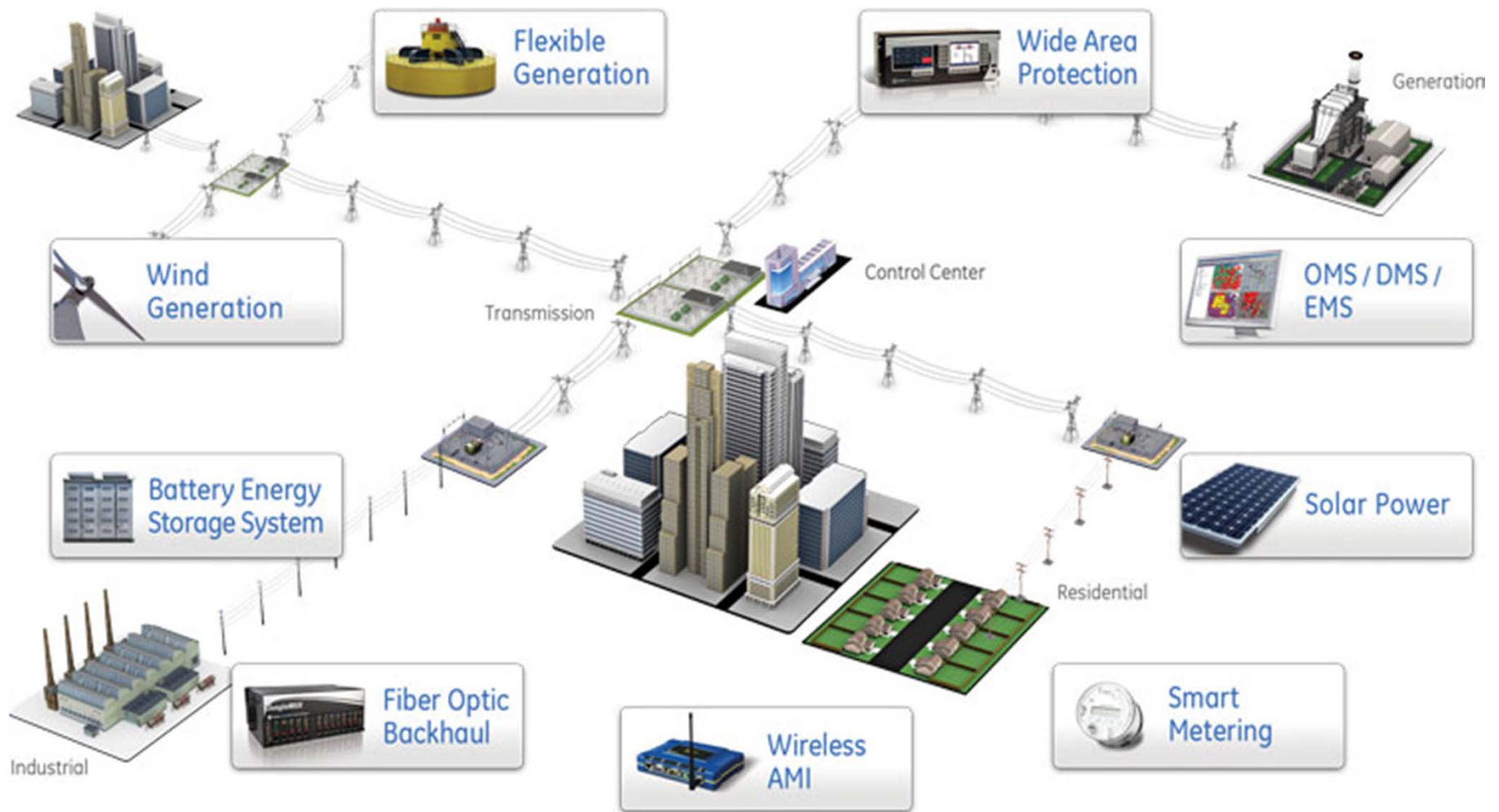


Financing
Actuarial Risk
Management ⁹



Renewables
Clean Fuels ¹⁰

Renewables and Grid Integration



Lower Cost Energy Storage

A123
SYSTEMS



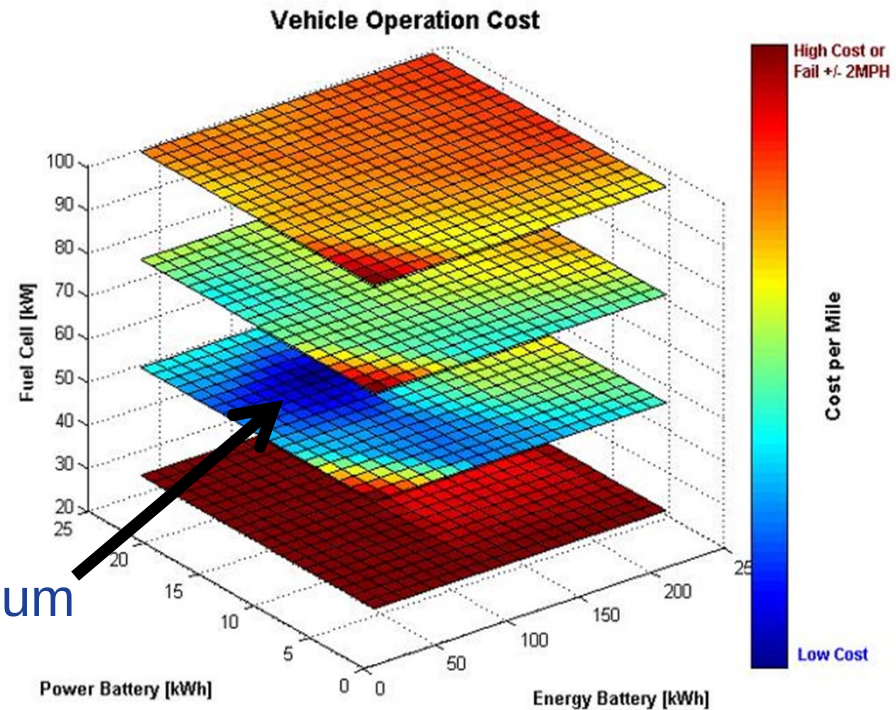
Strategic
Investment ¹¹

GE Durathon™



Organic
Growth

Optimum



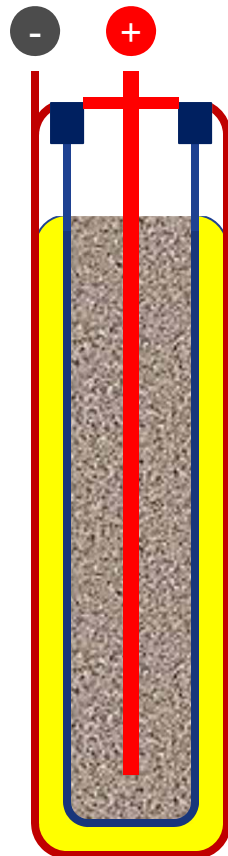
Multiple Energy Storage
and System Optimization

Sodium Metal Halide Batteries

GE Durathon™ (not Sodium Sulfur)



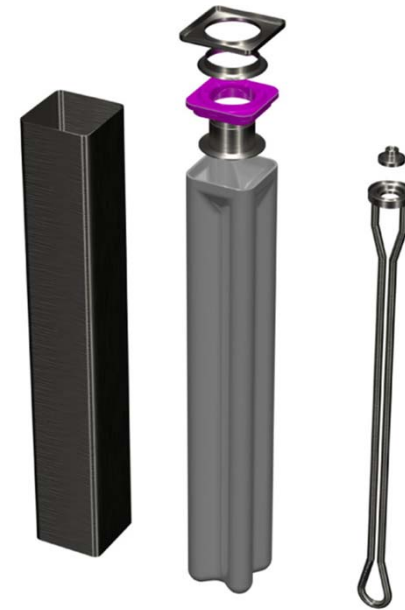
Discharged 250-300°C
Charged



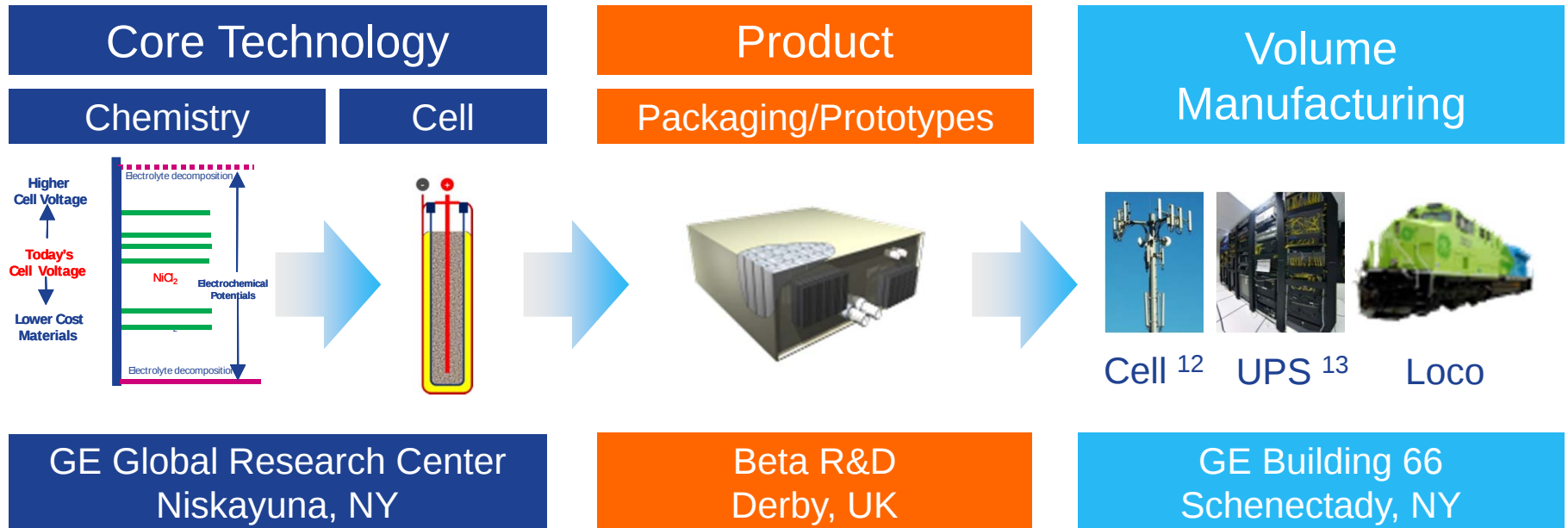
Na⁺ ions transfer through ceramic electrolyte between salt + nickel and sodium metal

Strengths

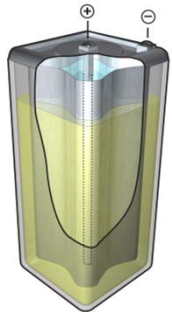
- High energy density
- Long cycle life
- Wide window of use-temps
- No self discharge
- Faults to short
- Safety: Impact, Immersion, Crash
- Recycle, EHS, Life-Cycle
- Abundant raw materials (nickel, NaCl)



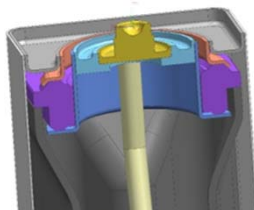
Durathon™ Commercialization Status



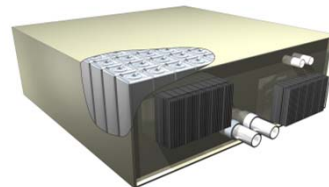
Cell Chemistry



Cell Materials & Processes



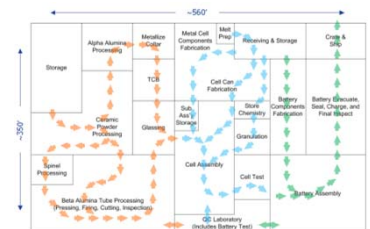
Battery Packaging



Application Integration



Manufacturing Design



Summary

- **Energy Storage advances are needed**
 - Lithium, Sodium, Nickel, ...
 - System Optimization & Controls
- **Energy storage is not enough alone**
 - Charging, T&D, Renewables
 - Financing, Service, Warranties



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