Transportation Transition
BUILDING A BETTER TOMORROW

Our purpose is to build a safer, more enriching and sustainable world by harnessing the power of family
HG Ventures partners with entrepreneurs building a sustainable future in materials, infrastructure and industrial systems.

Early & Growth Stage Investments

$50 Million Investment Target Each Year

Hard Tech & Digital Startups

Leveraging THG Help Entrepreneurs Succeed
Battery Materials
Heavy Duty EVs
Massive Plug-in Growth

- **Plug-In Hybrids**
- **Battery Electric Vehicles**


- 2012: 125 '000s
- 2013: 208 '000s
- 2014: 321 '000s
- 2015: 543 '000s
- 2016: 792 '000s
- 2017: 1,263 '000s
- 2018: 2,082 '000s
- 2019: 2,264 '000s
- 2020: 3,240 '000s
- 2021: 6,400 '000s

Yearly Growth:
- 2012: +55%
- 2013: +69%
- 2014: +46%
- 2015: +59%
- 2016: +65%
- 2017: +9%
- 2018: +43%
- 2019: +98%
- 2020: 69%

EV Volumes vs. Growth
Electric vehicles would account for 35% of all new vehicle sales.
Materials Criticality

Materials Criticality Matrix, Medium Term (2015-2025)⁴

- **Critical**
- **Near-Critical**
- **Not Critical**

REE Predicted Shortfall (million US $)

- **Yttrium**: 85
- **Dysprosium**: 22
- **Erbium**: 12
- **Terbium**: 7
- **Thulium**: 3
- **Scandium**: 1

Importance to clean energy: ★★★

Supply risk: ▼ ▼ ▼ ▼ ▼ ▼
Nickel Metal Hydride Batteries

Materials Criticality Matrix, Medium Term (2015-2025)

Importance to clean energy
Supply risk

Rare Earth Element Predicted Shortfall (2013)

REE Predicted Shortfall (Million US $)

Yttrium 85
Dysprosium 22
Erbium 12
Terbium 7
Thulium 3
Scandium 1

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Lithium-Ion Batteries

Materials Criticality Matrix, Medium Term (2015-2025)²³

Importance to clean energy

Supply risk

REE Predicted Shortfall (Million US $)

Yttrium: 85
Dysprosium: 22
Erbium: 12
Terbium: 7
Thulium: 3
Scandium: 1
EV & Windmill Motors (Magnets)

Materials Criticality Matrix, Medium Term (2015-2025)

- Importance to clean energy
- Supply risk

- Critical
- Near-Critical
- Not Critical

Rare Earth Element Predicted Shortfall

- Yttrium: 85
- Dysprosium: 22
- Erbium: 12
- Terbium: 7
- Thulium: 3
- Scandium: 1

Importance to clean energy:
- Neodymium
- Dysprosium
- Erbium
- Terbium
- Thulium
- Scandium

Supply risk:
- Lithium
- Tellurium
- Nickel
- Samarium
- Europium
- Yttrium
- Terbium

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What can be done?
Startups and Innovative Solutions
Circular Battery Supply Chains

- Mining
- Refining
- Pyrometallurgy
- Hydrometallurgy
- Direct recycling
- Cathode production
- Battery manufacture
- Battery use
- Landfill
- Second uses
- Lithium-ion battery recycling
Circular Motor & Magnet Supply Chain Diagram

Purdue Chemical Engineering Professor, Linda Wang with American Rare Earth

Mineral Ores → Urban Mining → Manufacturing → LOADING ELUTION → LIGAND-ASSISTED DISPLACEMENT → PR, Nd, Dy → Purified REEs → Urban Mining → Manufacturing → Landfill
Electrify The Roads
Moving Beyond Vehicle Sensors

Adaptive Cruise Control

Emergency Braking
Pedestrian Detection
Collision Avoidance

Traffic Sign Recognition
Lane Departure Warning

Cross Traffic Alert

Surround View

Blind Spot Detection

Park Assist

Rear Collision Warning

Park Assistance/Surround View

Long-Range Radar
LIDAR
Camera
Short-/Medium Range Radar
Ultrasound

Intellias
Moving Beyond Vehicle Sensors

Data Sources:
- Weather App
- Patrol
- CAV's
- Legacy ITS
- IoT Sensors
- Social Media
- Navigation Apps

Monitor

Fusion Engine

Manage

Insight

Valerann