



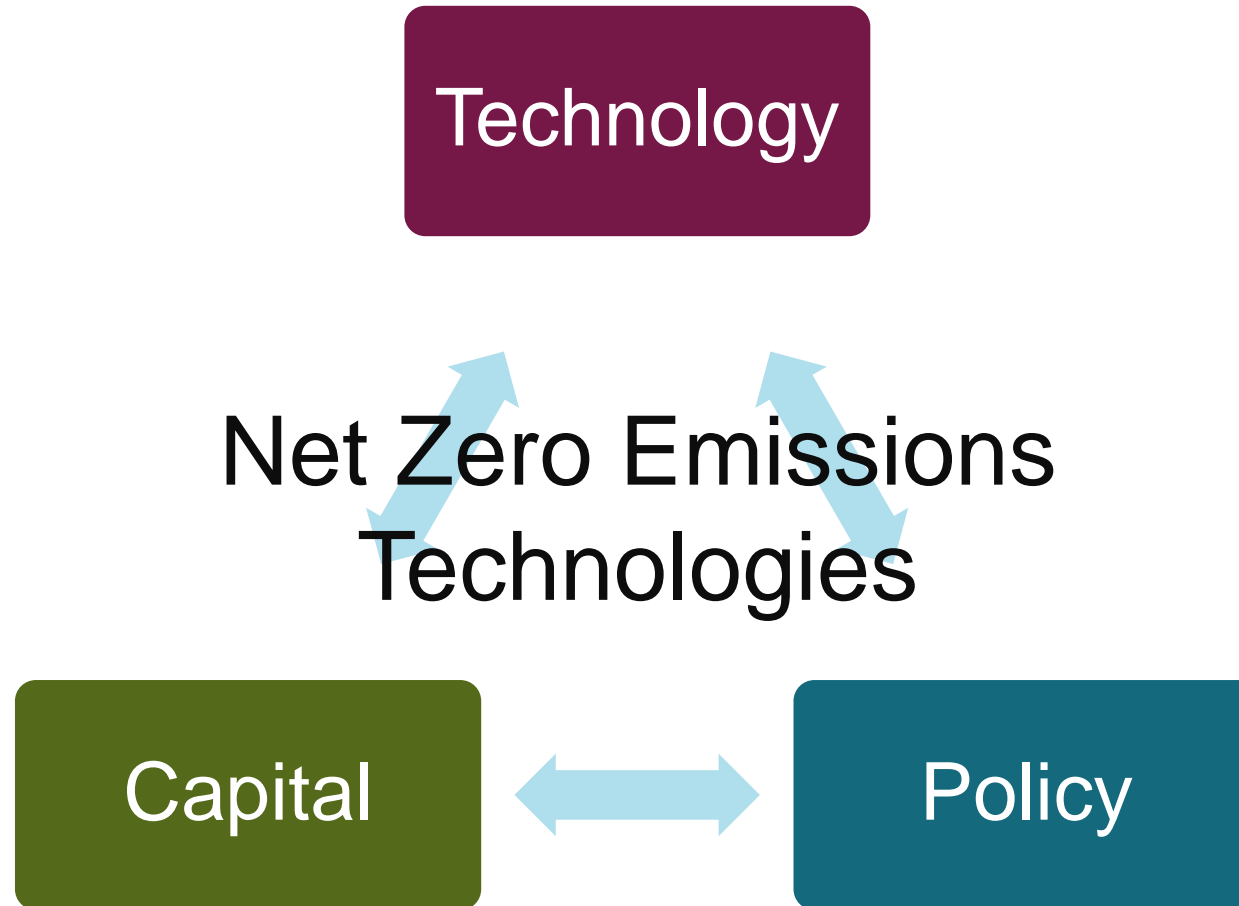
Breakthrough
Energy

New Pathways for Climate Innovation

Jim Cabot, Managing Director, Breakthrough Energy Ventures

Chicken, Egg & Nest

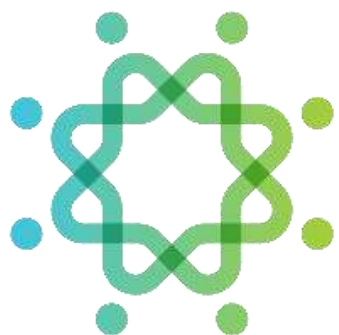
The Tri-iterative Development Cycle



The Origin of Breakthrough Energy







Breakthrough Energy VENTURES

01

CLIMATE IMPACT

We will invest in technologies that have the potential to reduce greenhouse gas emissions by at least half a gigaton.

02

OTHER INVESTMENTS

We will invest in companies with real potential to attract capital from sources outside of BEV and the broader Breakthrough Energy Coalition.

03

SCIENTIFIC POSSIBILITY

We will invest in technologies with an existing scientific proof of concept that can be meaningfully advanced.

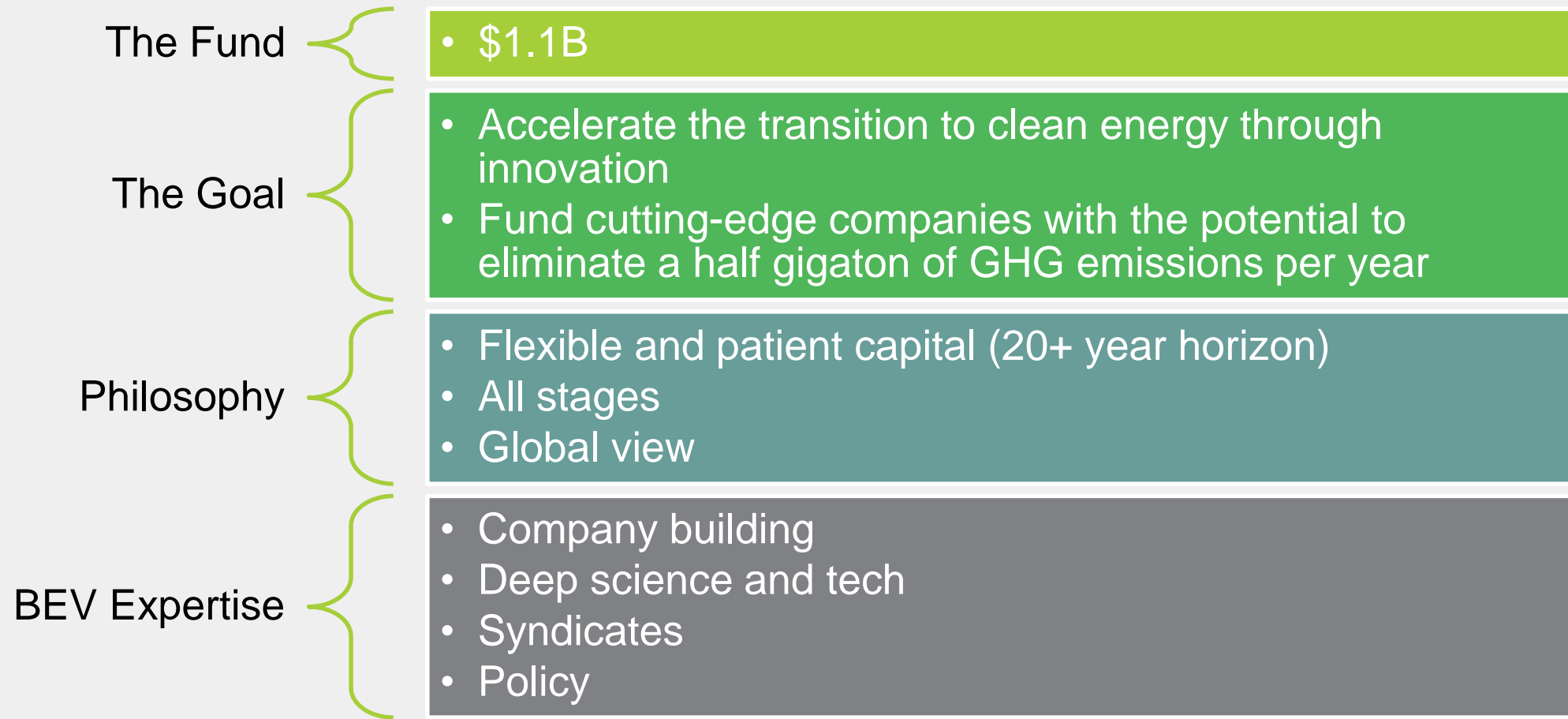
04

FILLING THE GAPS

We will invest in companies that need the unique attributes of BEV capital, including patience, judgment by scientific milestones, flexible investment capabilities, and a significant global network.



Breakthrough Energy Ventures – A New Approach



Breakthrough Landscape of Innovation



ELECTRICITY

greenhouse gas emissions

PUBLIC INVESTMENT

Governments around the world commit budget to scientific research into new energy solutions.

SCIENTIFIC INNOVATIONS

Leading research institutions, primarily funded by governments, working in collaboration will deliver new and exciting discoveries, with a variety of potential applications.

COMPANIES & PRODUCTS

New companies are formed around these innovations seeking capital from investors.

PRIVATE INVESTORS

Breakthrough Energy Coalition, BEV and other flexible capitals committed to investing in companies that will bring innovations from start-up to bankability.



TRANSPORTATION



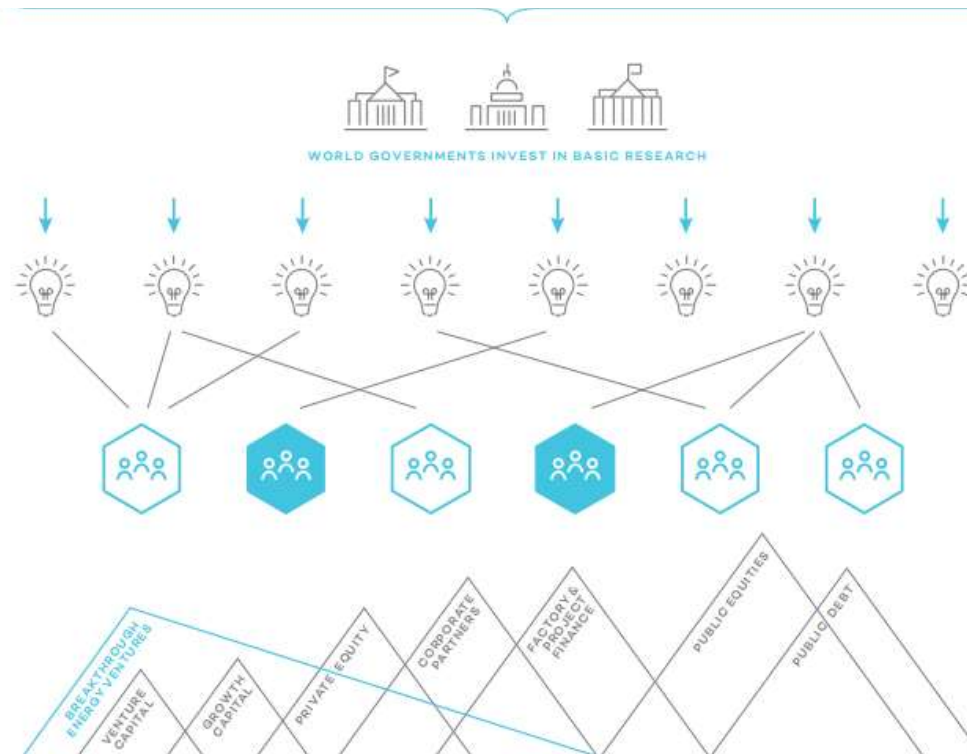
AGRICULTURE



MANUFACTURING



BUILDINGS



- Lightweight Materials and Structures
- Low-GHG Liquid-Fuels Production—Non-Biomass
- Low-GHG Gaseous Fuels Production—H₂, CH₄
- High-Energy-Density Gaseous Fuel Storage
- High-Efficiency Thermal Engines
- High-Efficiency, Low-Cost Electrochemical Engines

AGRICULTURE

- Reducing CH₄ and N₂O Emissions from Agriculture
- Zero-GHG Ammonia Production
- Reducing Methane Emissions from Ruminant Animals
- Developing Low-Cost, Low-GHG New Sources of Protein

MANUFACTURING

- Low-GHG Chemicals
- Low-GHG Steel
- Low/Negative-GHG Cement
- Waste Heat Capture/Conversion
- Low-GHG Industrial Thermal Processing
- Low-GHG Paper Production
- Extreme Efficiency in IT/Data Centers

BUILDINGS

- High-Efficiency, Non-HFC Cooling & Refrigeration
- High-Efficiency Space/Water Heating
- Building-Level Electricity and Thermal Storage
- High-Efficiency Envelope: Windows and Insulation

- Production—Biomass
- Transportation-System Efficiency Solutions
- Technology Solutions that Eliminate the Need for Travel
- Technology-Enabled Urban Planning and Design
- Low-GHG Air Transport
- Low-GHG Water-Borne-Goods Transportation

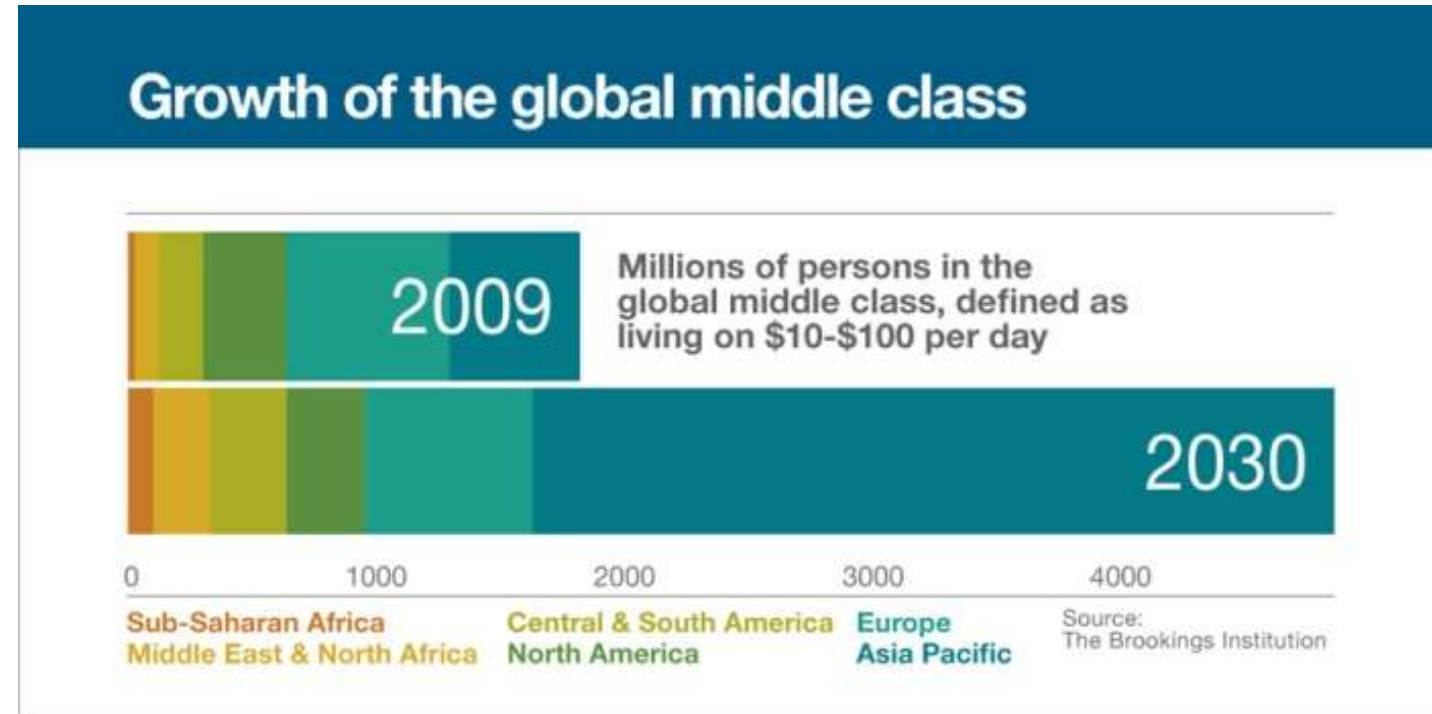
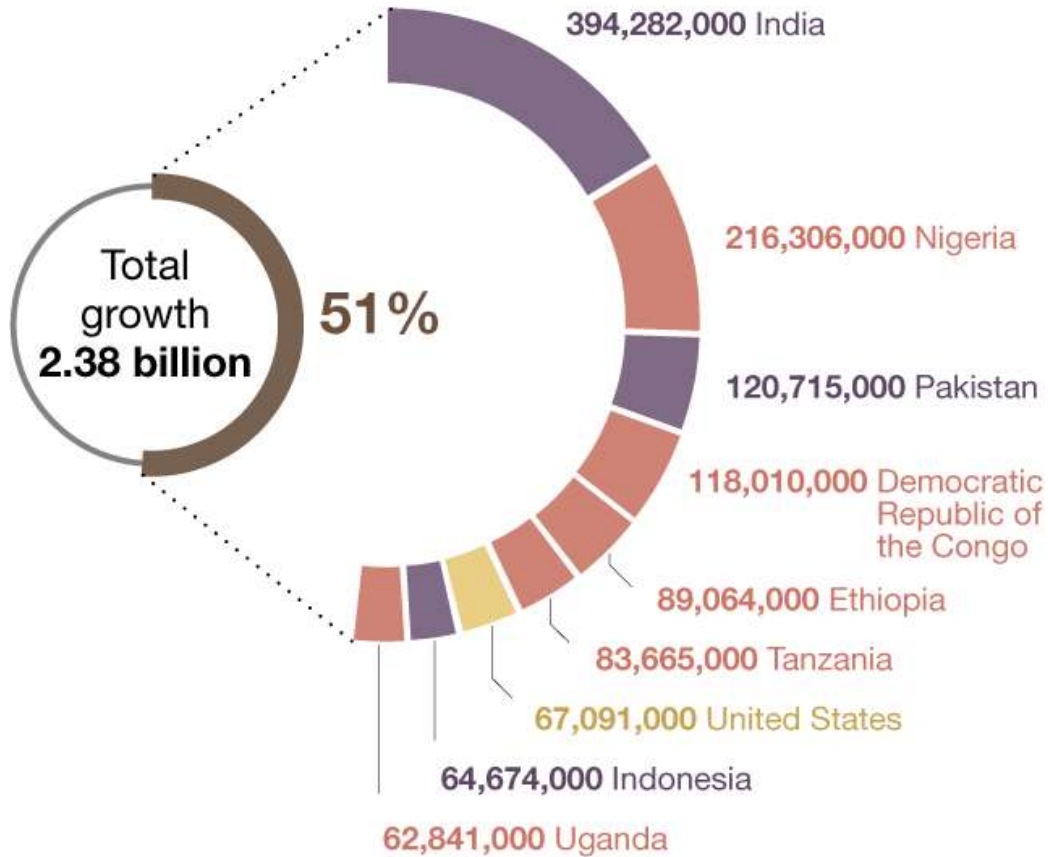
- Eliminating Spoilage/Loss in the Food-Delivery Chain
- Soil-Management Solutions for GHG Reduction and CO₂ Storage
- Manure
- Agriculture-Related Deforestation

- Fugitive Methane Emissions from Industry
- Extreme Durability for Energy-Intensive Products and Materials
- Transformative Recycling Solutions for Energy-Intensive Products and Materials
- Increasing Biomass Uptake Rate of CO₂
- CO₂ Extraction from the Environment

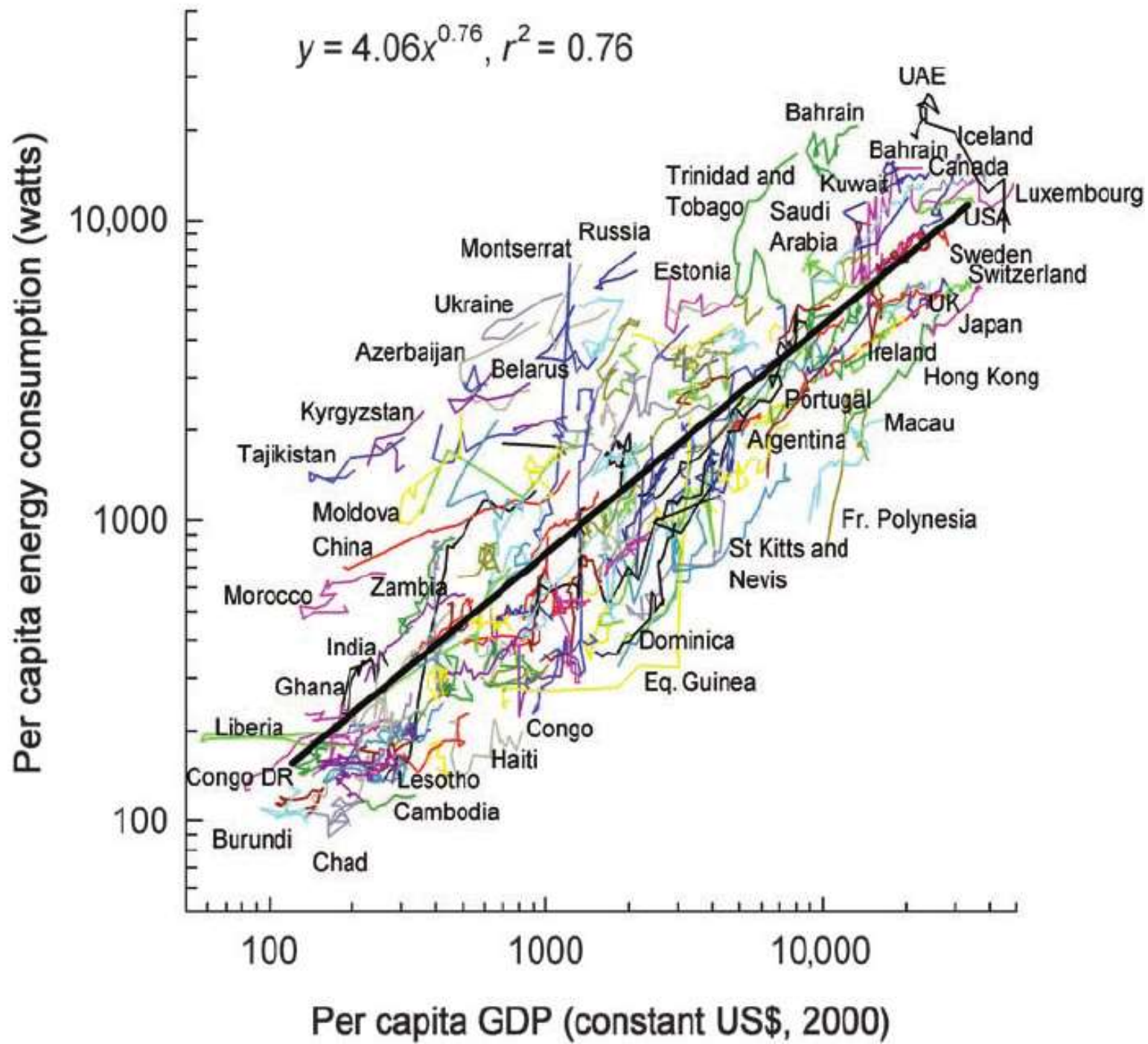
- High Efficiency Lighting
- High-Efficiency Appliances and Plug-Loads
- Next-Generation Building Management
- Technology-Enabled Design of Efficient Buildings and Communities



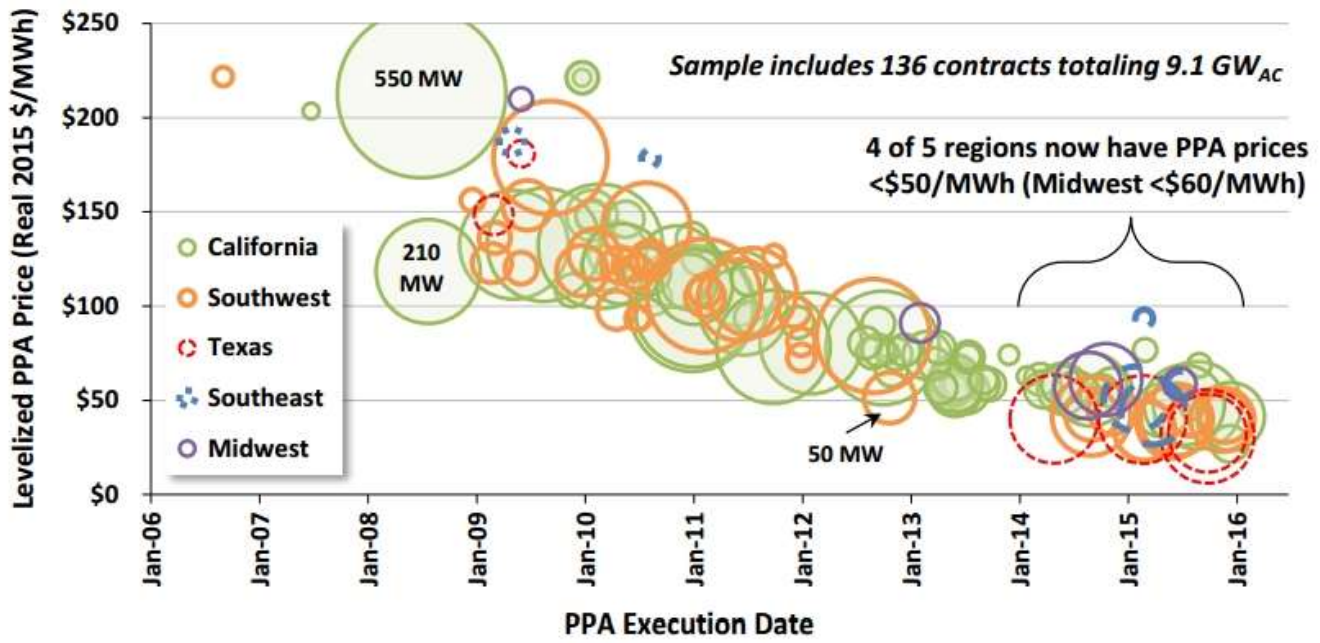
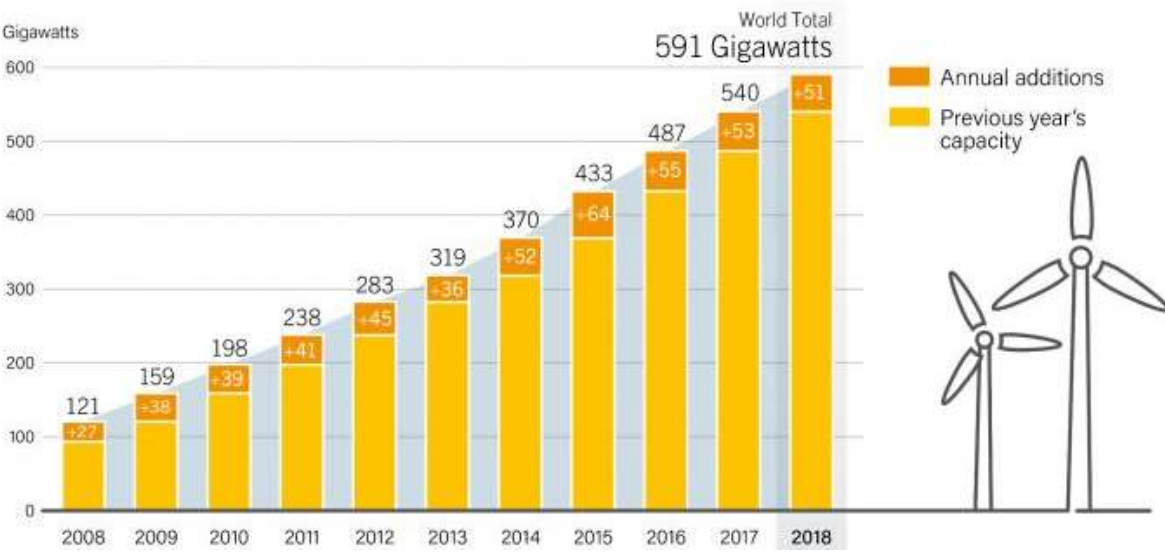
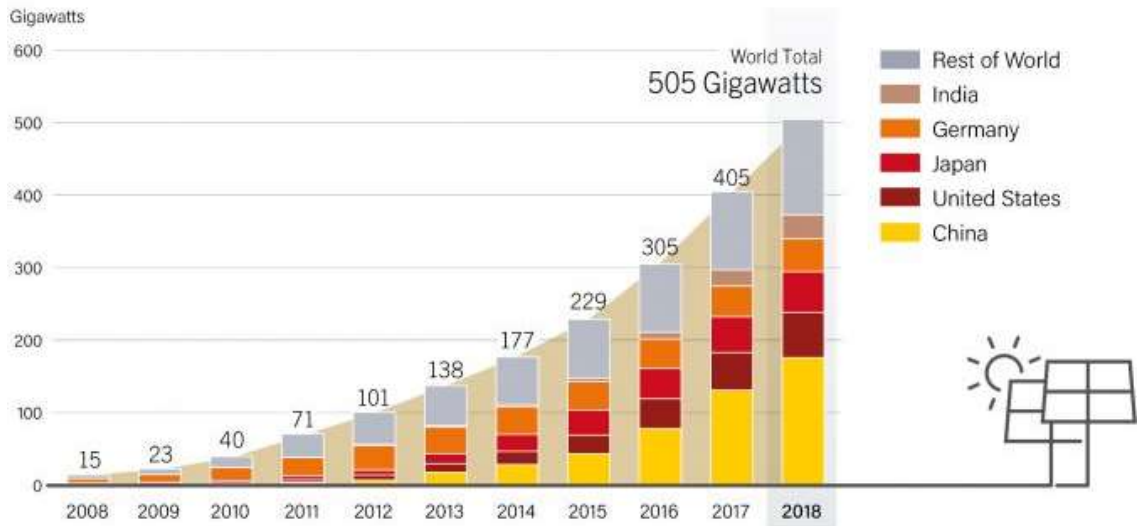
Megatrend: A Burgeoning Middle Class



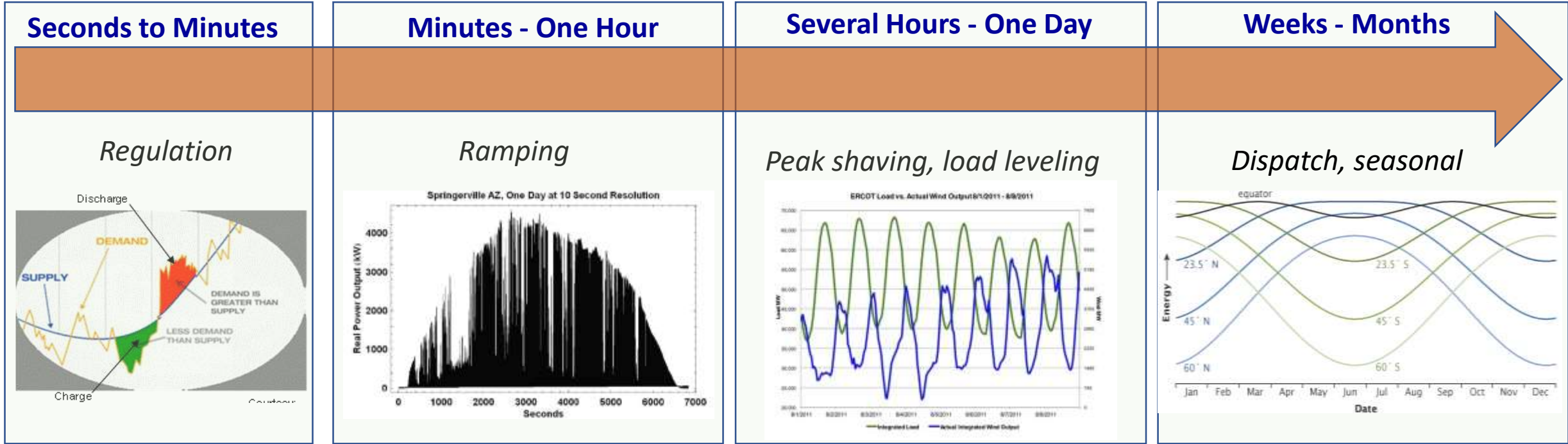
Energy
=
Prosperity



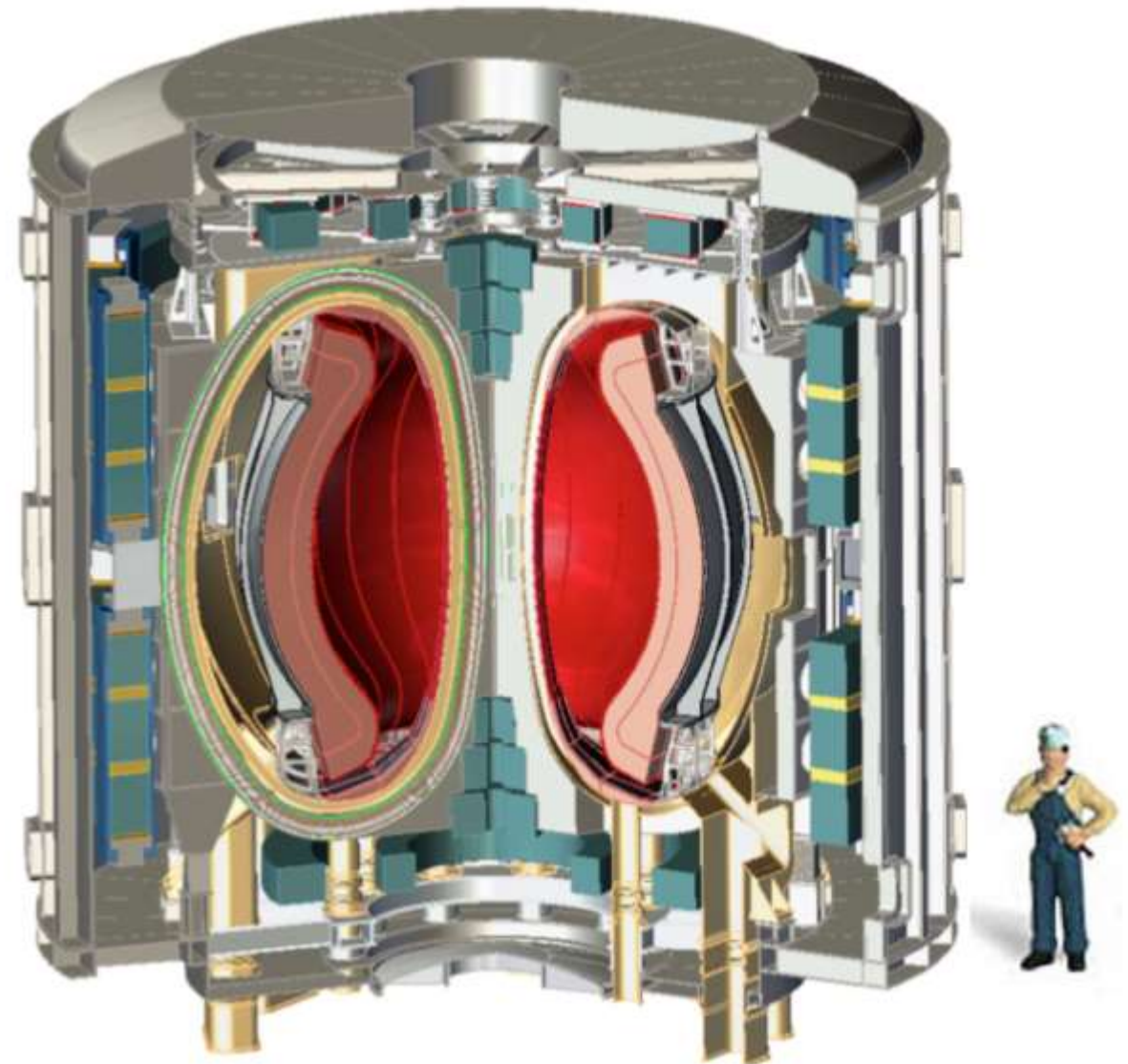
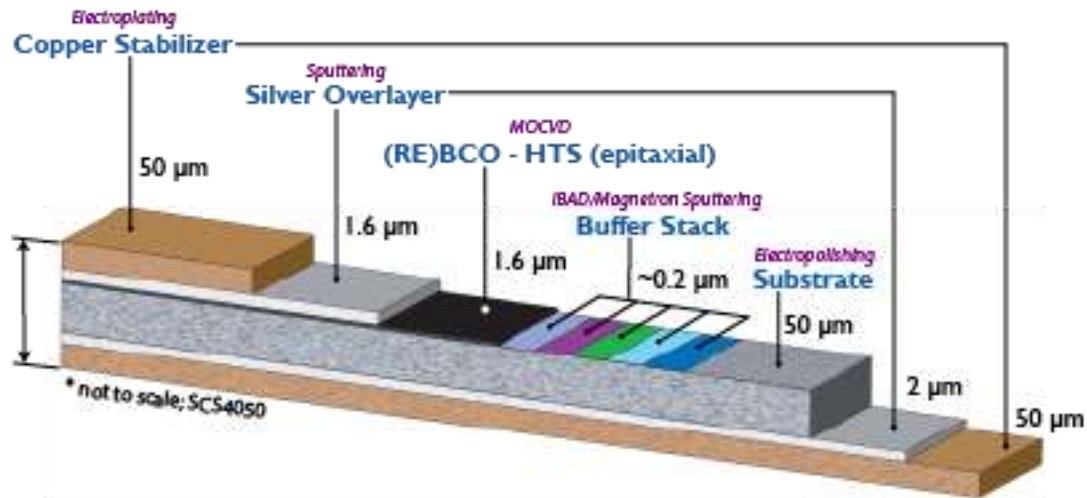
Megatrend: Enormous Quantities of Cheap Renewable Electricity



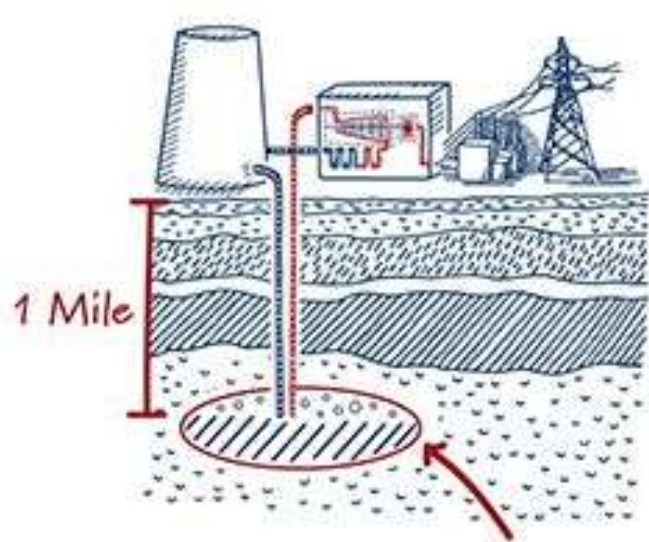
Energy Storage Application Time Regimes



New Superconductors = New Approaches

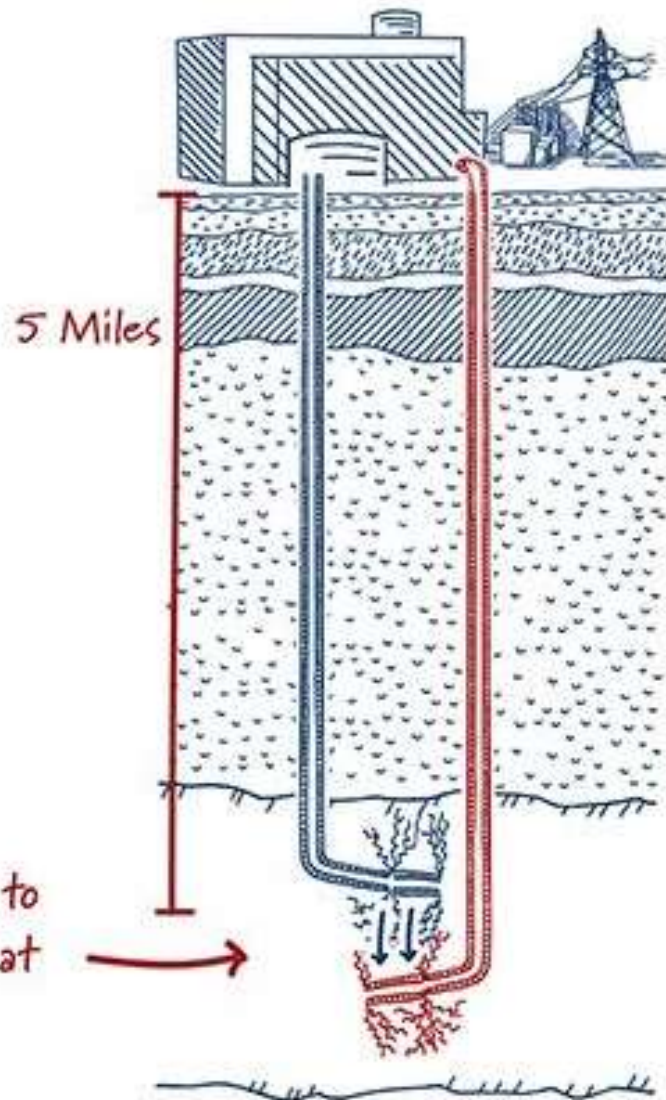


EGS: A 100 GW Opportunity

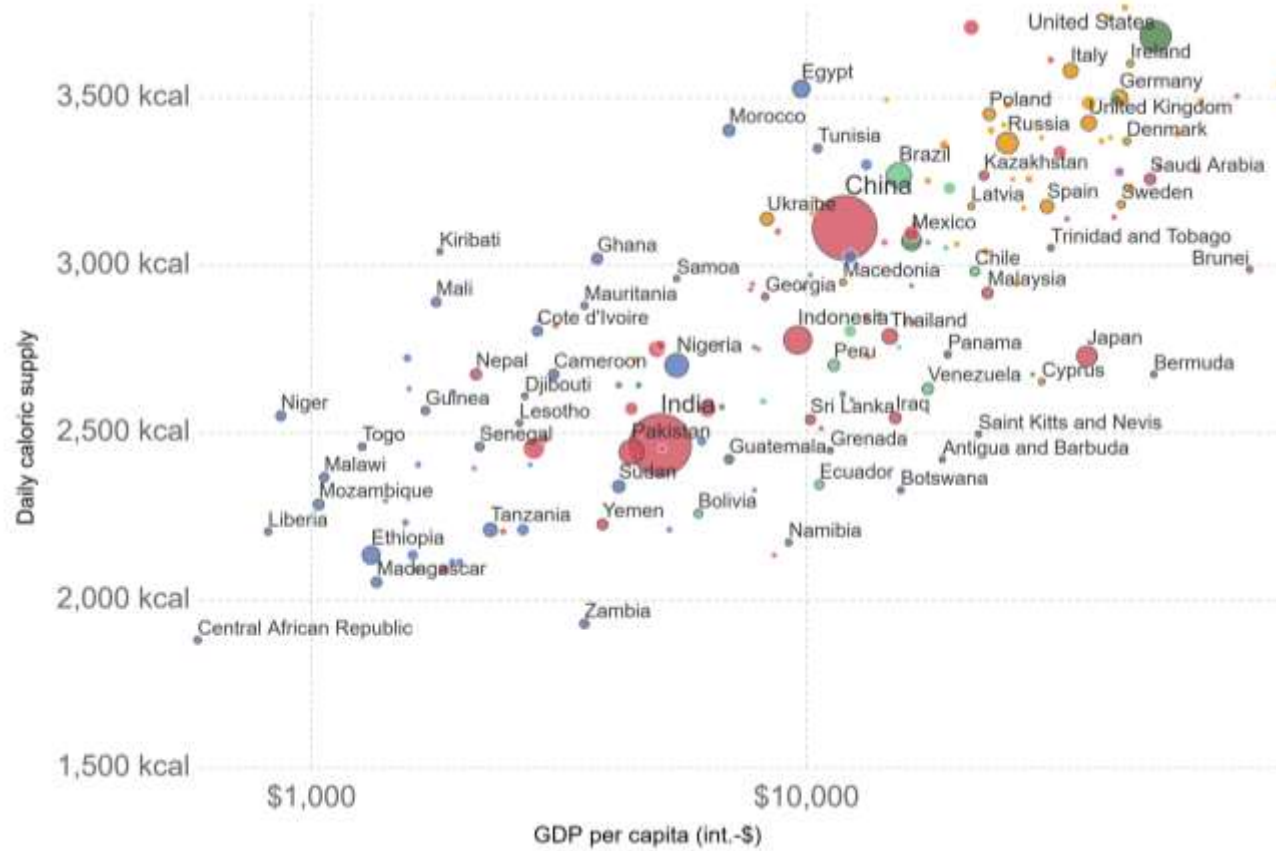


Traditional geothermal utilizes existing high-temp reservoirs to generate electricity

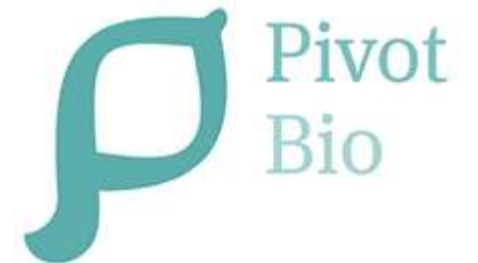
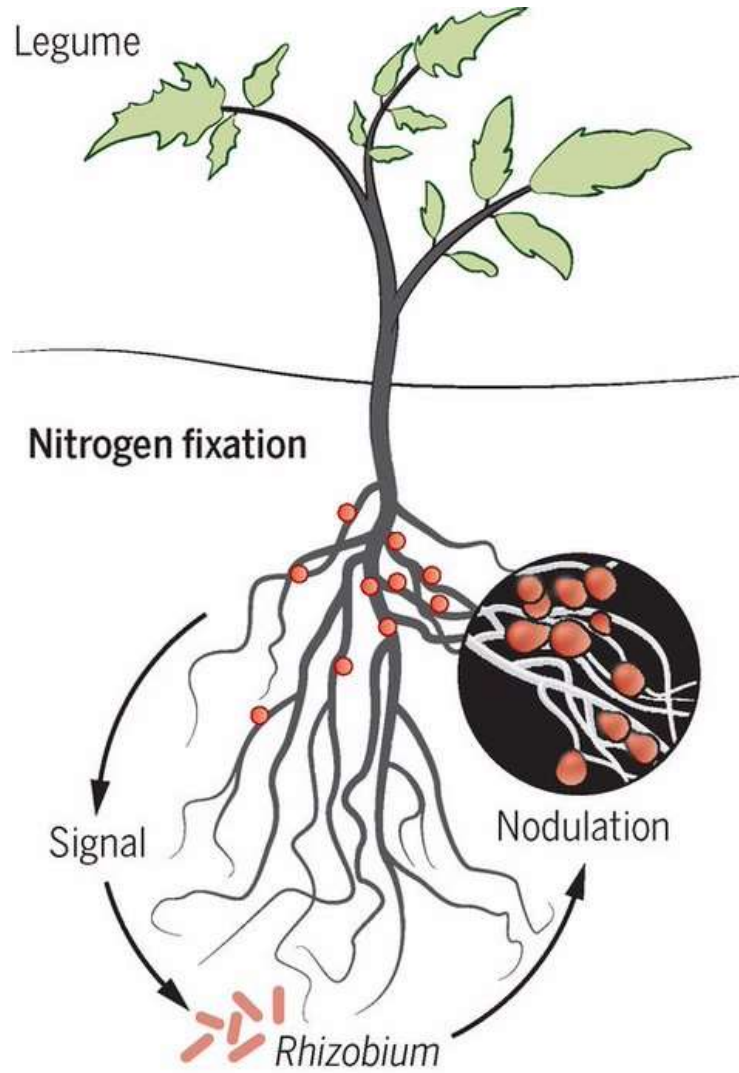
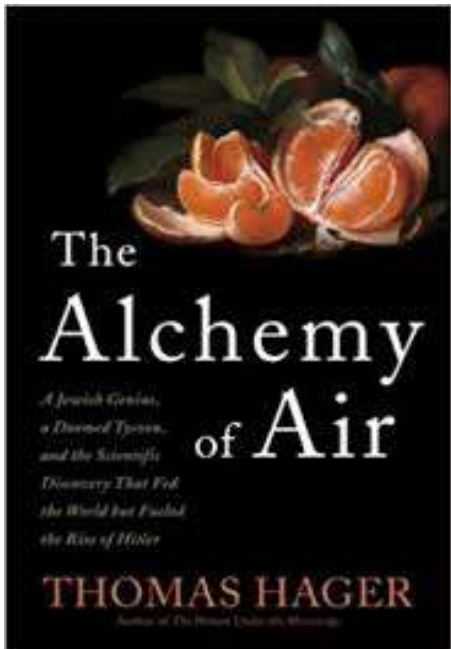
EGS creates channels to utilize higher temp heat in deep dry rocks



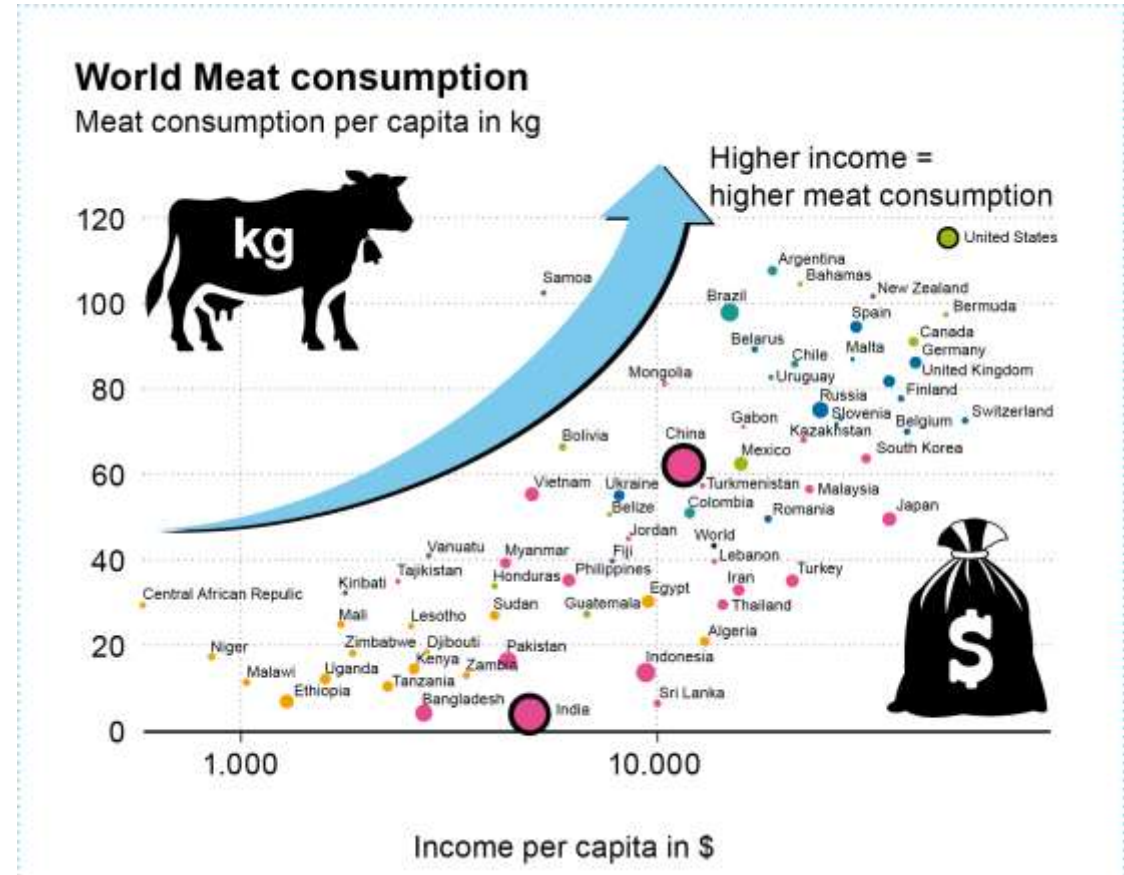
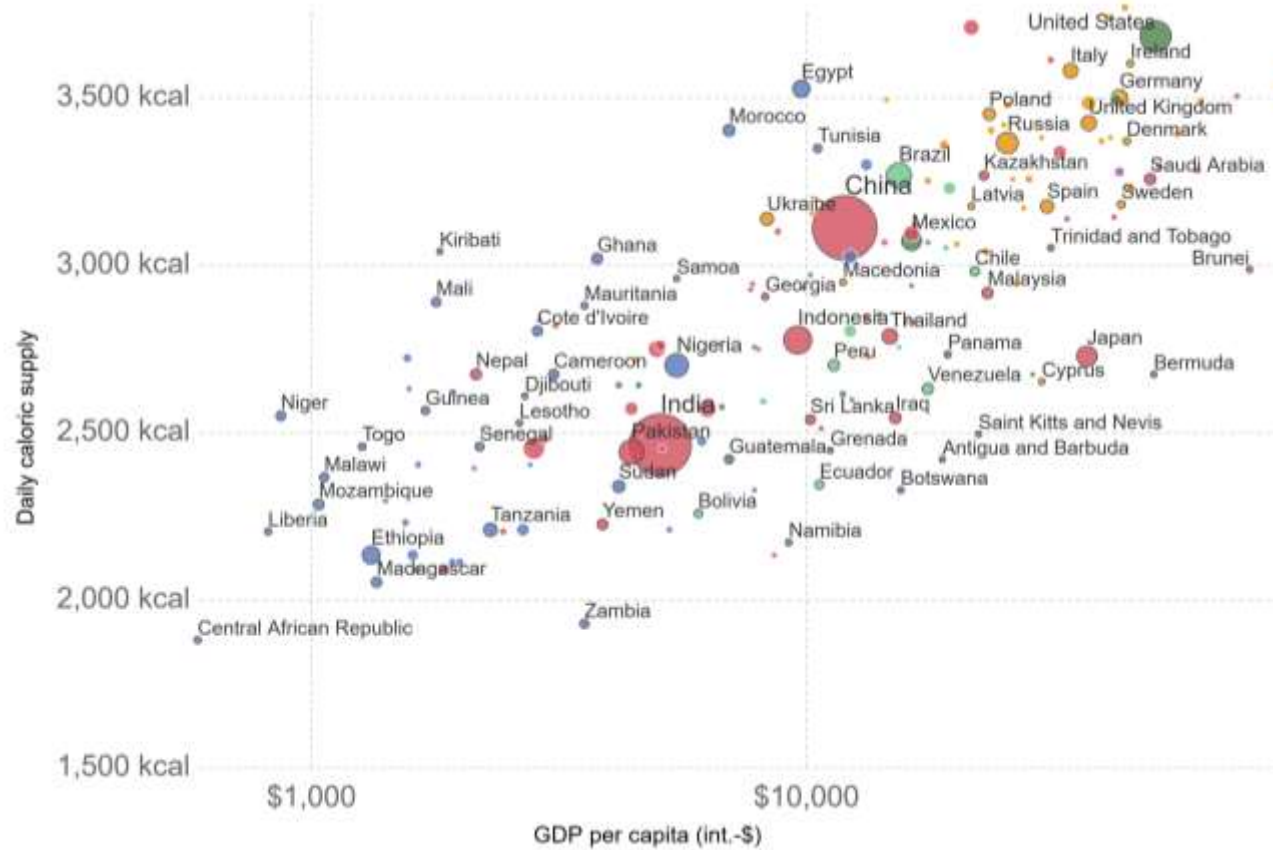
Wealth = Calories



Decarbonizing Nitrogen

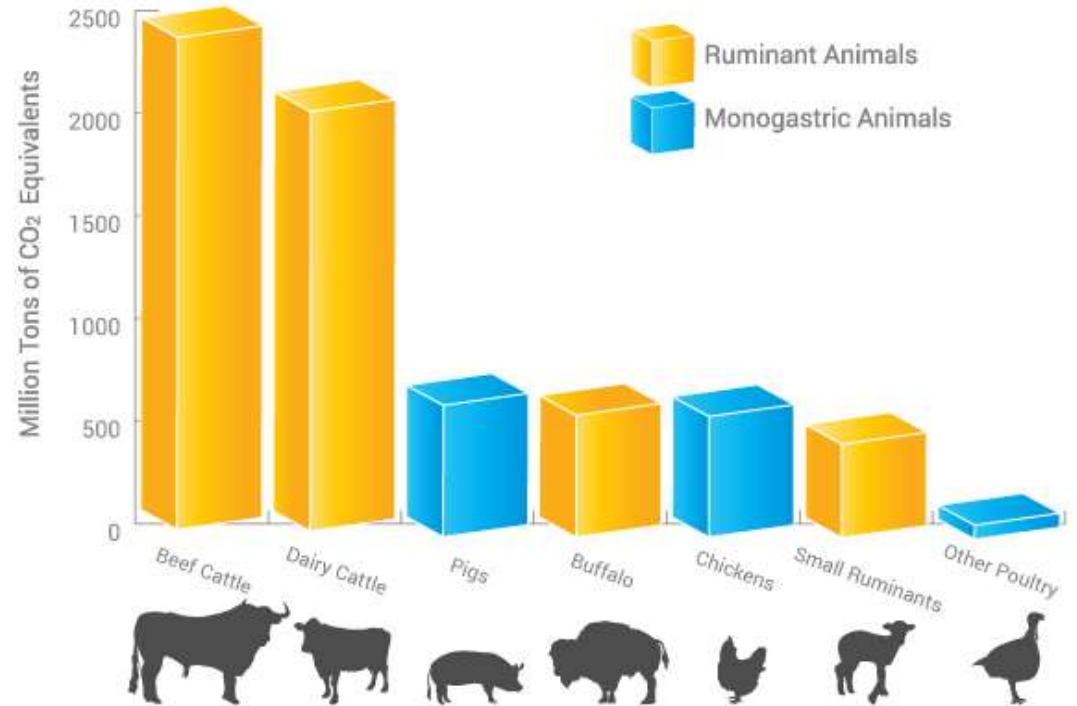
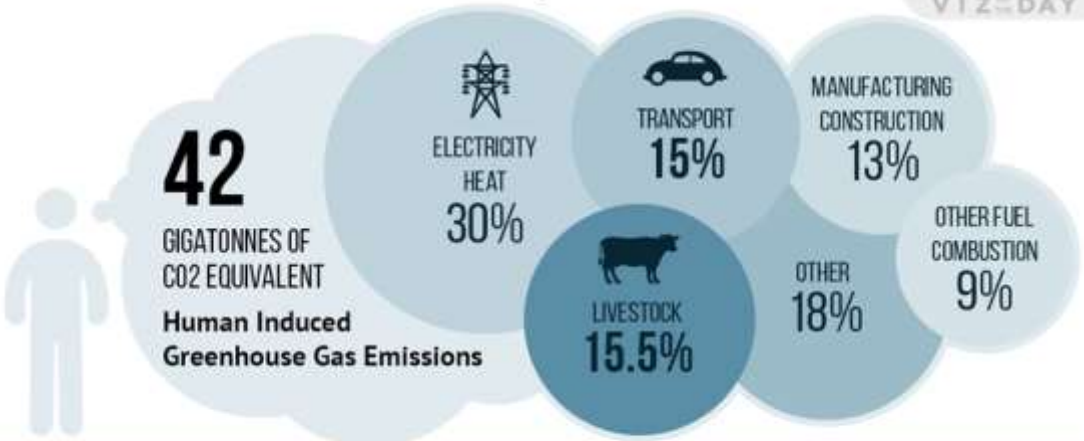


Wealth = Calories = Meat





Emissions of Greenhouse Gases by Sectors





TRY IT AND
DON'T TASTE
THE DIFFERENCE.

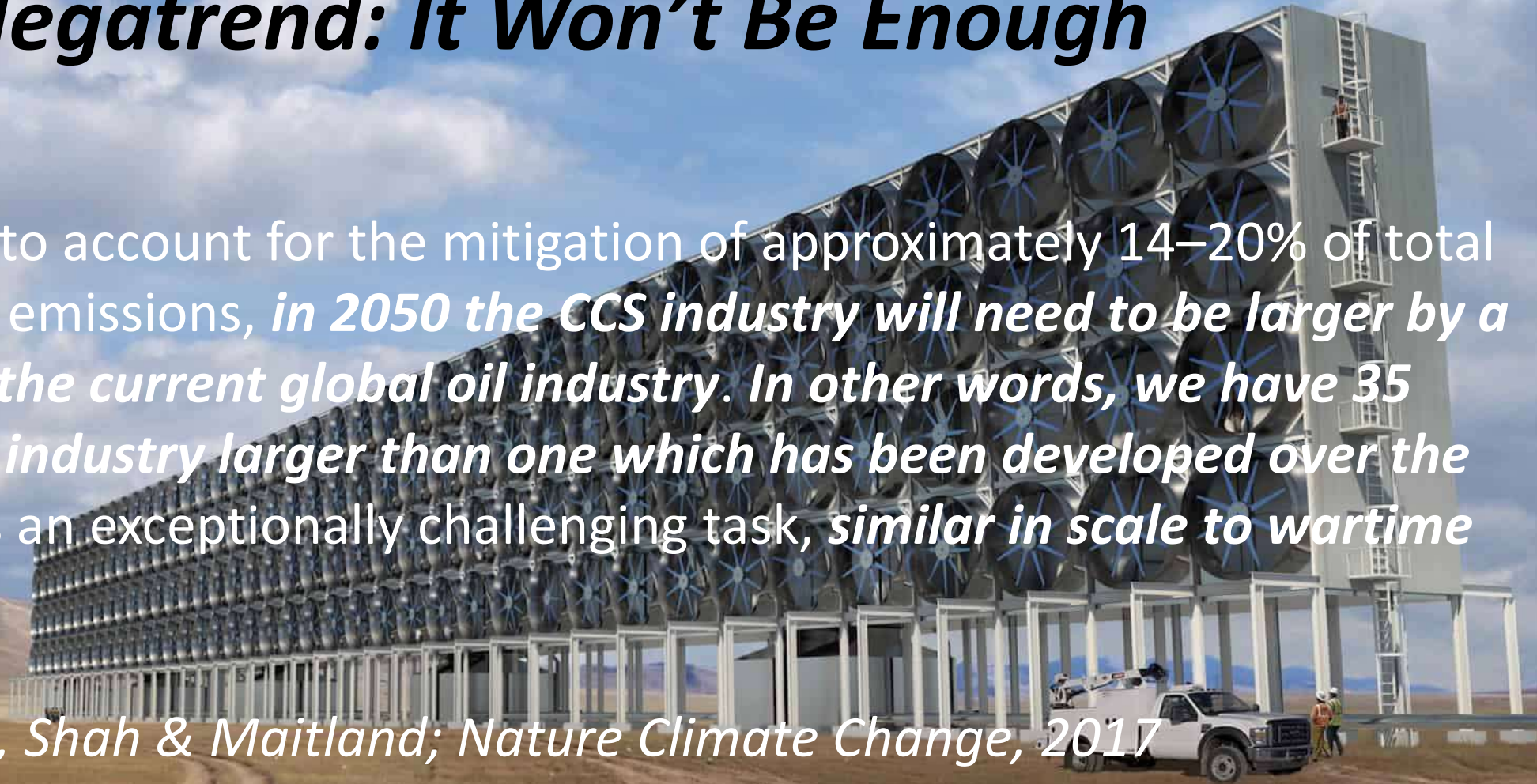
SB

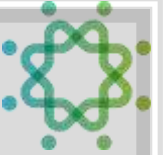
~ **motif**

Megatrend: It Won't Be Enough

“If CCS is expected to account for the mitigation of approximately 14–20% of total anthropogenic CO₂ emissions, in 2050 the CCS industry will need to be larger by a factor of 2–4 than the current global oil industry. In other words, we have 35 years to deploy an industry larger than one which has been developed over the last century. This is an exceptionally challenging task, similar in scale to wartime mobilization.”

MacDowell, Fennel, Shah & Maitland; Nature Climate Change, 2017





Policy Principles

The Least-Cost Path to Net-Zero Includes a Broad Portfolio of Technologies

The least-cost path to achieving economy-wide net zero greenhouse gas emissions will involve a diverse toolkit of options. There are six essential ingredients to get to net-zero greenhouse gas emissions across all sectors of the economy: (1) zero carbon electricity; (2) electrification across sectors, including transportation, buildings, and industry; (3) fuel decarbonization; (4) efficiency; (5) reducing emissions from agriculture and other non-energy sources; and (6) carbon dioxide removal through both natural and technical means.

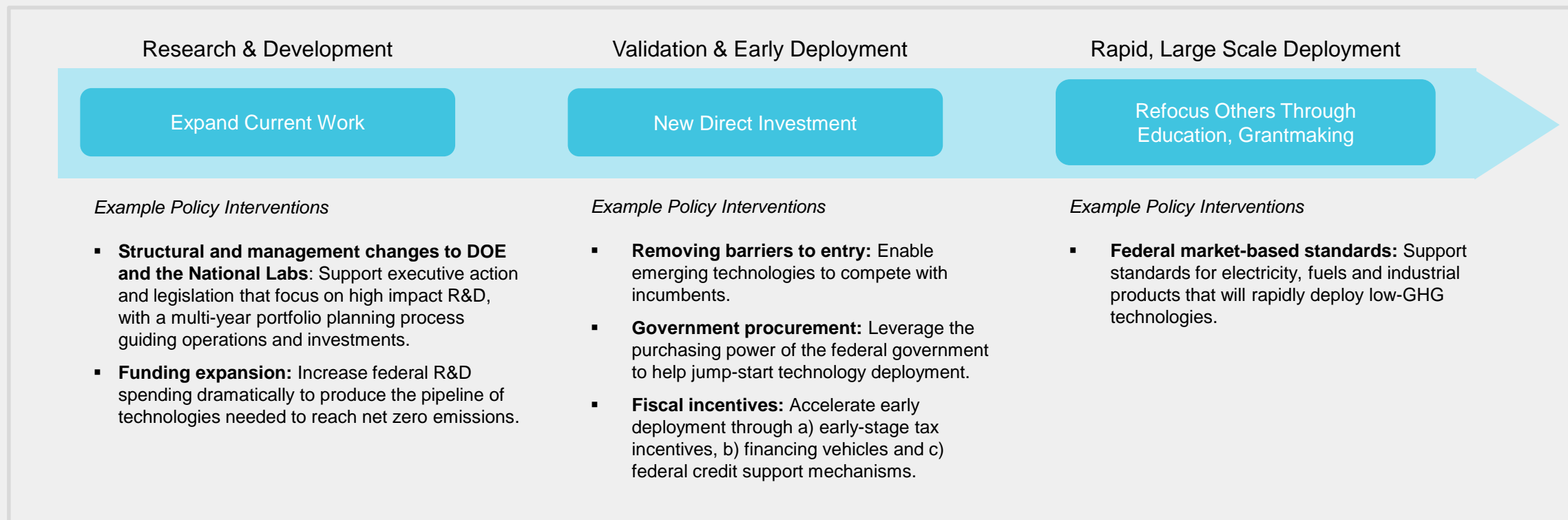
Addressing Climate will Require a Comprehensive Approach from R&D to Deployment

Policies should address emissions in all relevant emitting sectors of the economy: electricity, transportation, industry, buildings, and agriculture. A plan for deep decarbonization should also employ a suite of policy solutions that can provide tailored support across the technology continuum from discovery to commercial scale adoption.

Both Technology-Push and Demand-Pull Interventions are Needed to Overcome Current Market Barriers

Energy is a highly capitalized commodity business with complex supply chains and established customer bases. These features lead to systems with considerable inertia and intrinsic market barriers. In the absence of an economy-wide price or cap on carbon emissions, other demand-pull incentives such as tax credits, financing mechanisms, and government procurement will likely be needed to complement robust supply-side R&D and motivate investment in clean energy.

Our Policy Framework





Partners

Policy Makers:

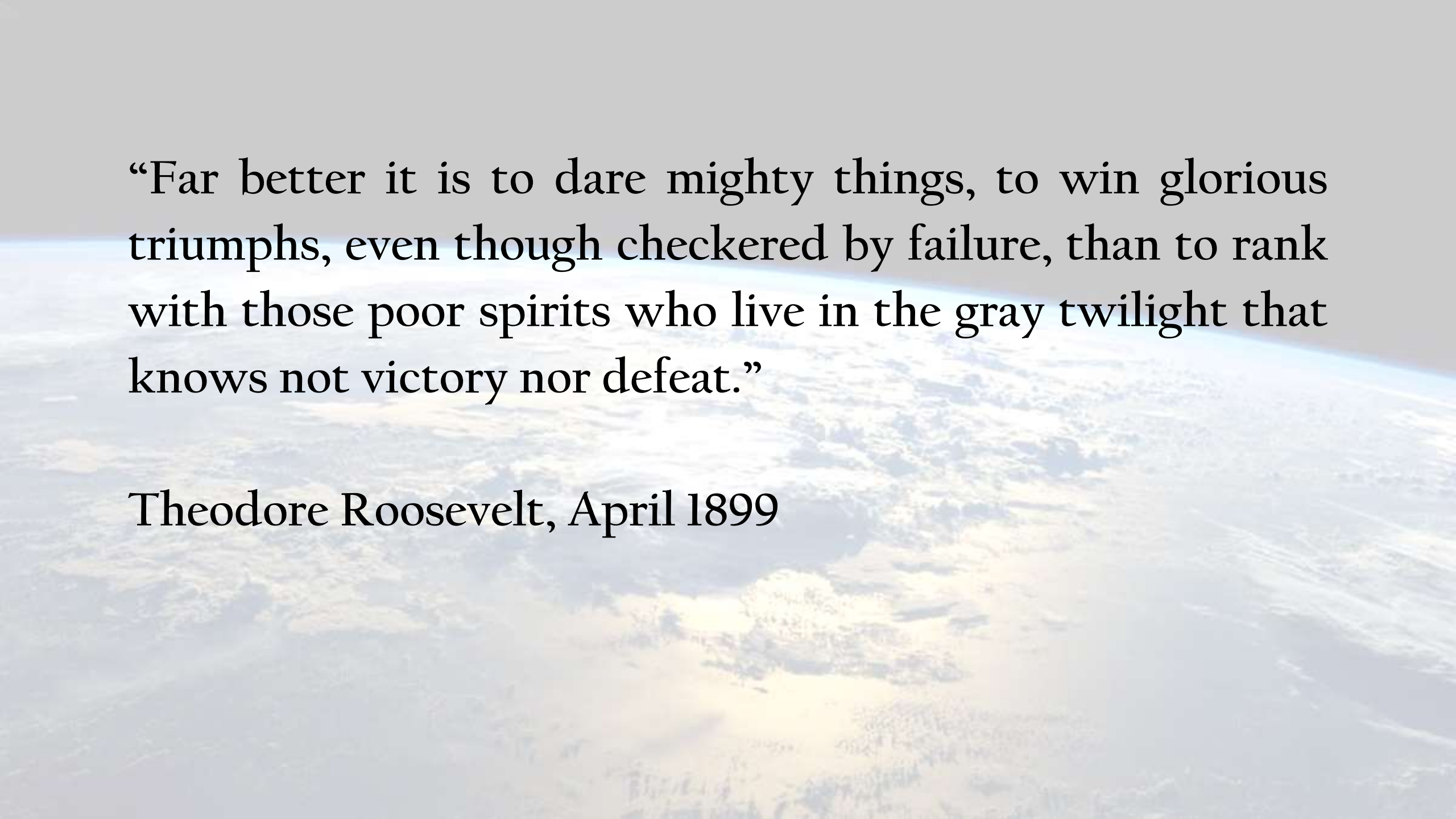
Global, Federal, State, Local

Academic, Public and Private Research Institutions

Wallstreet/Sources of Capital

Corporate Strategic Partners

NGOs & Advocates

An aerial photograph of a vast, flat landscape, likely a coastal plain or a large field, with a clear horizon line. The terrain is a mix of light and dark patches, possibly representing different types of vegetation or soil. The sky is a pale, clear blue. The text is overlaid on the upper portion of the image.

“Far better it is to dare mighty things, to win glorious triumphs, even though checkered by failure, than to rank with those poor spirits who live in the gray twilight that knows not victory nor defeat.”

Theodore Roosevelt, April 1899