



SUSTAINABILITY IN PRACTICE

DELIVERING HIGHER GROWTH AND LOWER RISK

A FORUM FOR CIOs AND INVESTMENT LEADERS

Digital

SEPTEMBER 8-9, 2021

Investors Should Invest

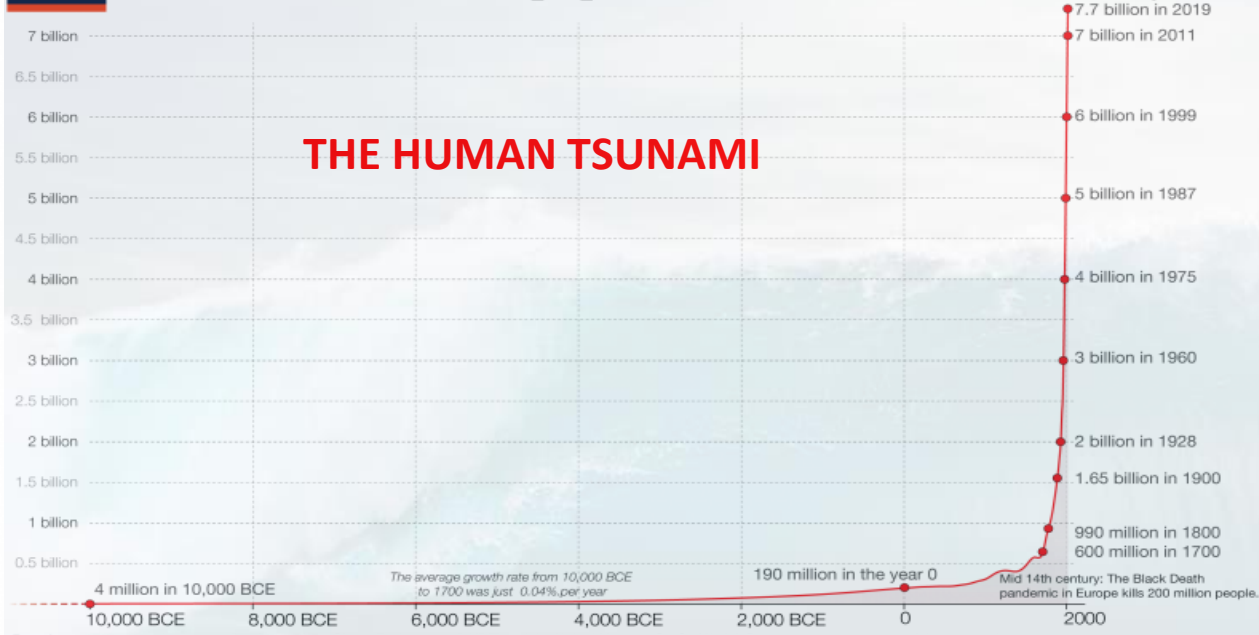
Framework for Investing in Clean Energy & Sustainability

Arun Majumdar

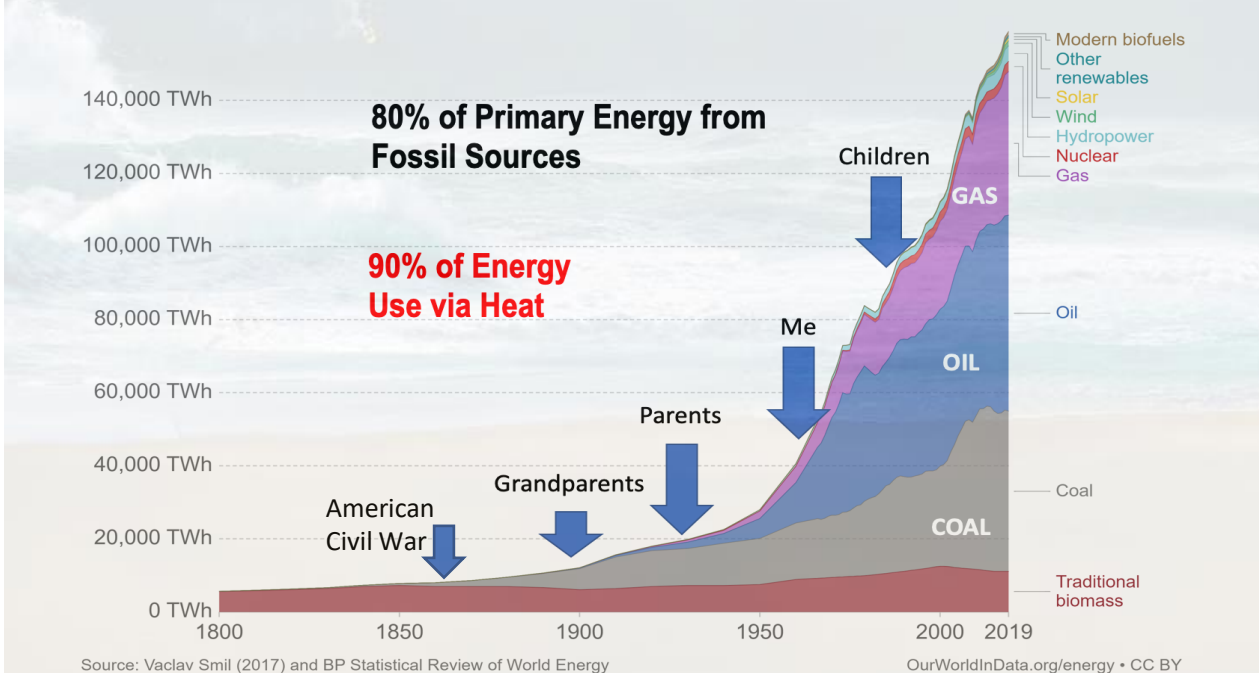
Professor, Stanford University

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The size of the world population over the last 12,000 years

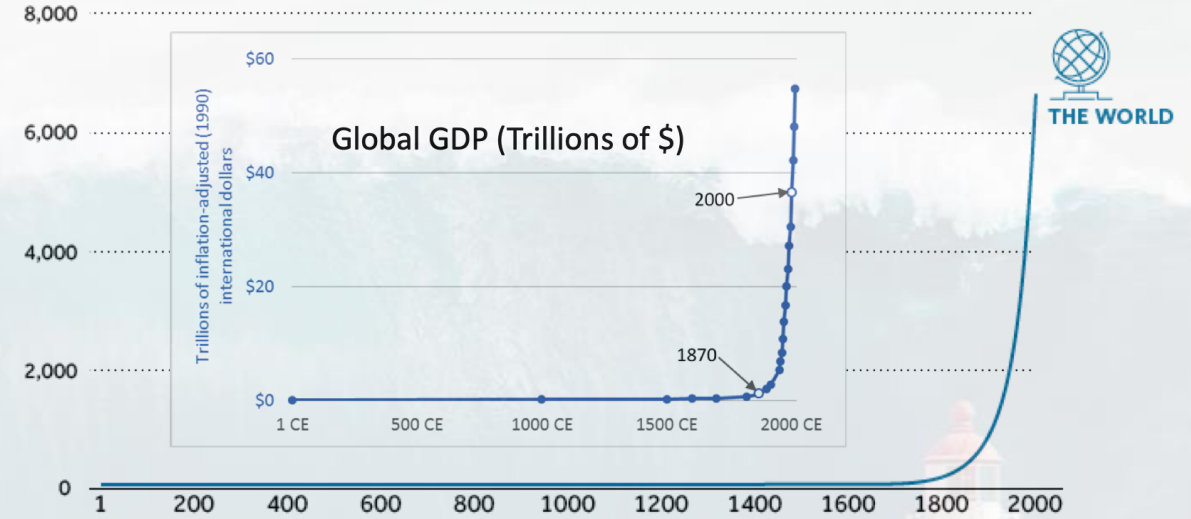


THE ENERGY CONSUMPTION TSUNAMI



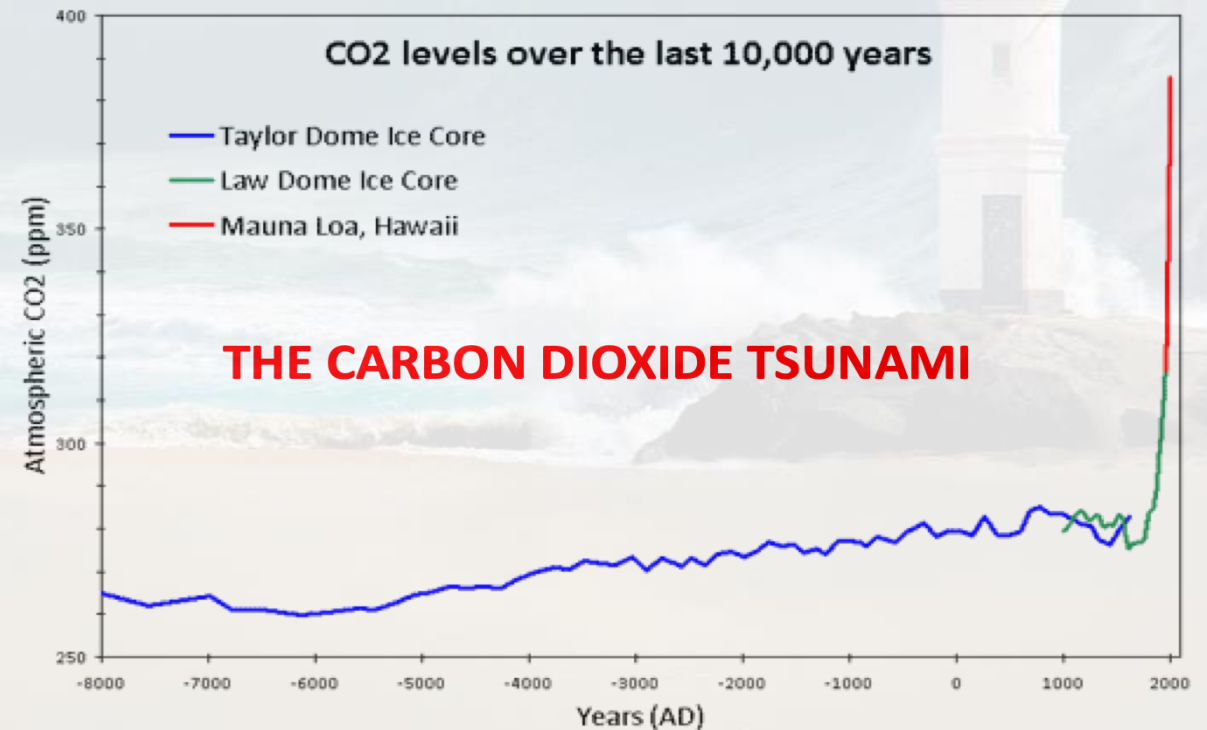
THE HUMAN CONSUMPTION TSUNAMI

World GDP Per Capita (1990\$)



SOURCE: "Statistics on World Population, GDP, and Per Capita GDP, 1-2008 AD", Angus Maddison; IMF

CO2 levels over the last 10,000 years



POP QUIZ

1 °C

2 °C

800 GtCO₂

40 GtCO₂/year

20 years

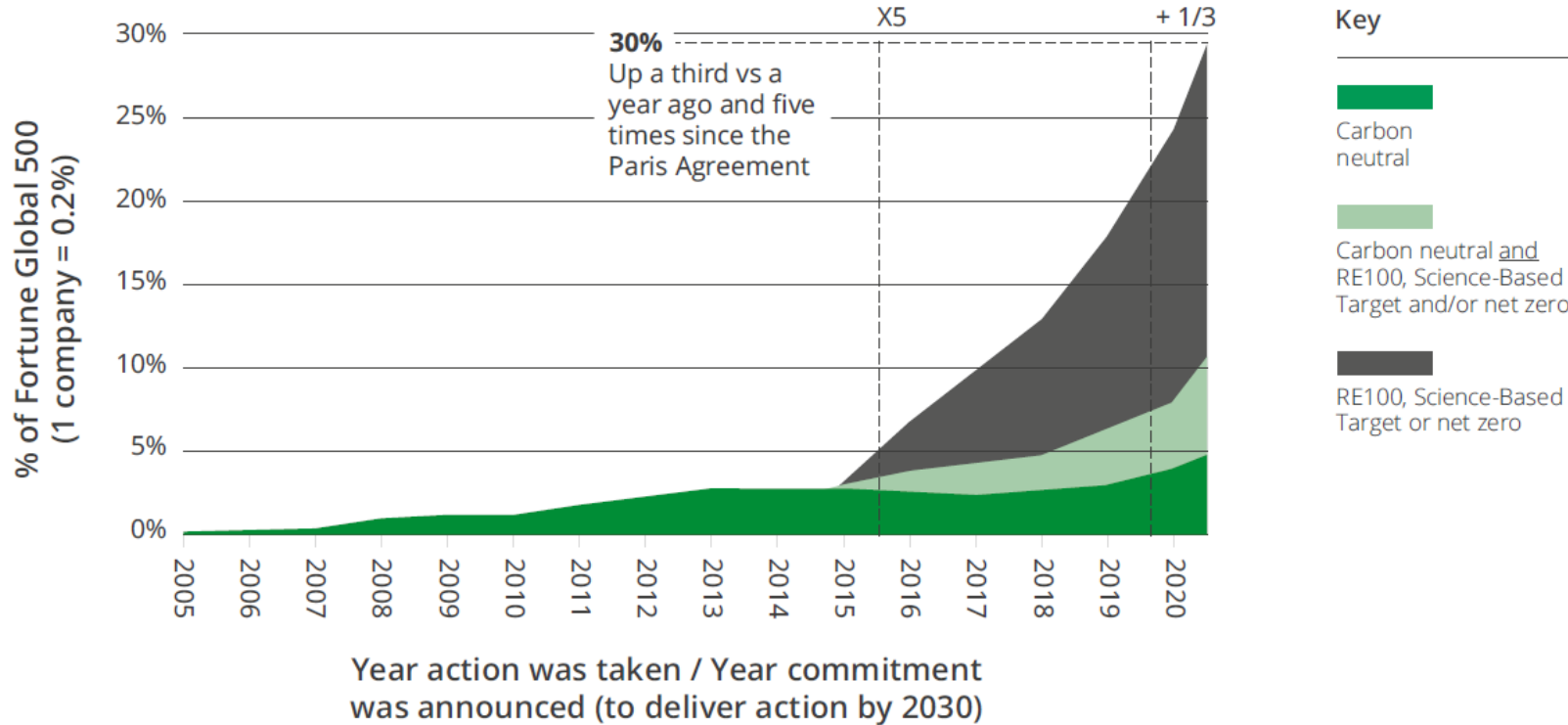
Defining Challenge & Opportunity of the 21st Century

Whatever 10 billion people consume will produce Gigaton-scale CO₂ emissions

- Electricity, heating and cooling
- Transportation
- Food
- Textile
- Water
- Steel
- Cement
- Information
- ...



Corporate Action



>30% of Fortune 500 Companies have made climate commitments

Aggregate Annual Revenue ~ \$11 Trillion

US Government Action



Biden Climate Change Goals

- 100% Clean Power by 2035; 80% by 2030
- Net-Zero Emissions Economy by 2050; 50% by 2030
- Environmental Justice, EJ40
- American Jobs

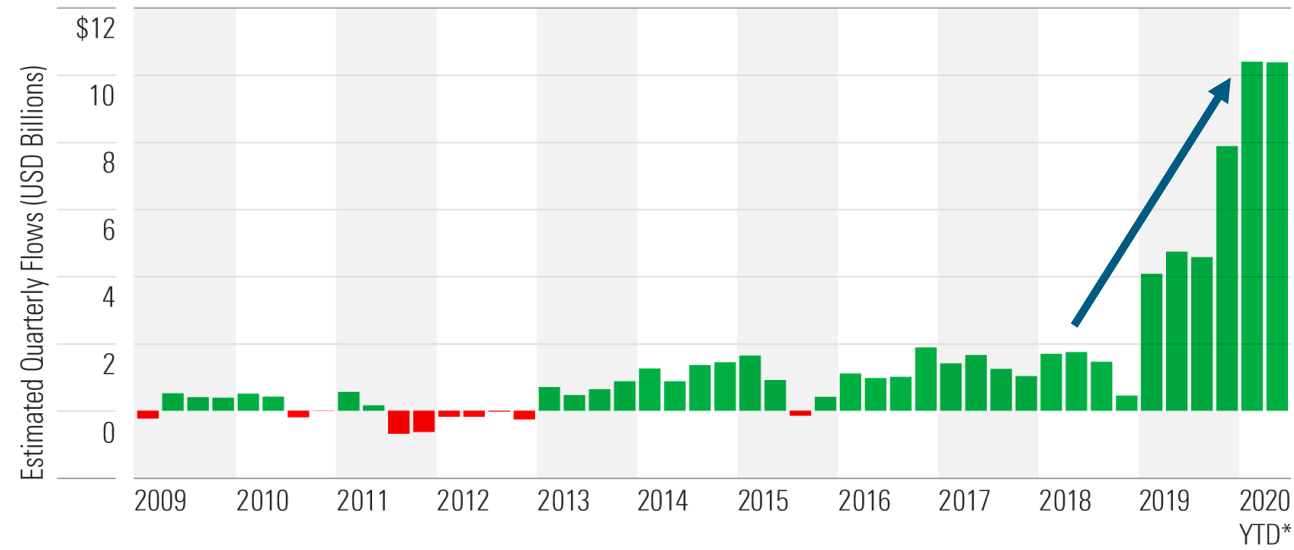
Senate Passed \$1.2Tr Infrastructure Bill



Budget Reconciliation \$3.5Tr Proposed



U.S. Sustainable Funds Quarterly Flows



Source: Morningstar Direct. Data as of 6/30/2020. *YTD 2020 as of 6/30/2020.
Includes ESG Integration, Impact, and Sustainable Sector funds as defined in Sustainable Funds U.S. Landscape Report, 2018. Includes funds that have been liquidated; does not include funds of funds.

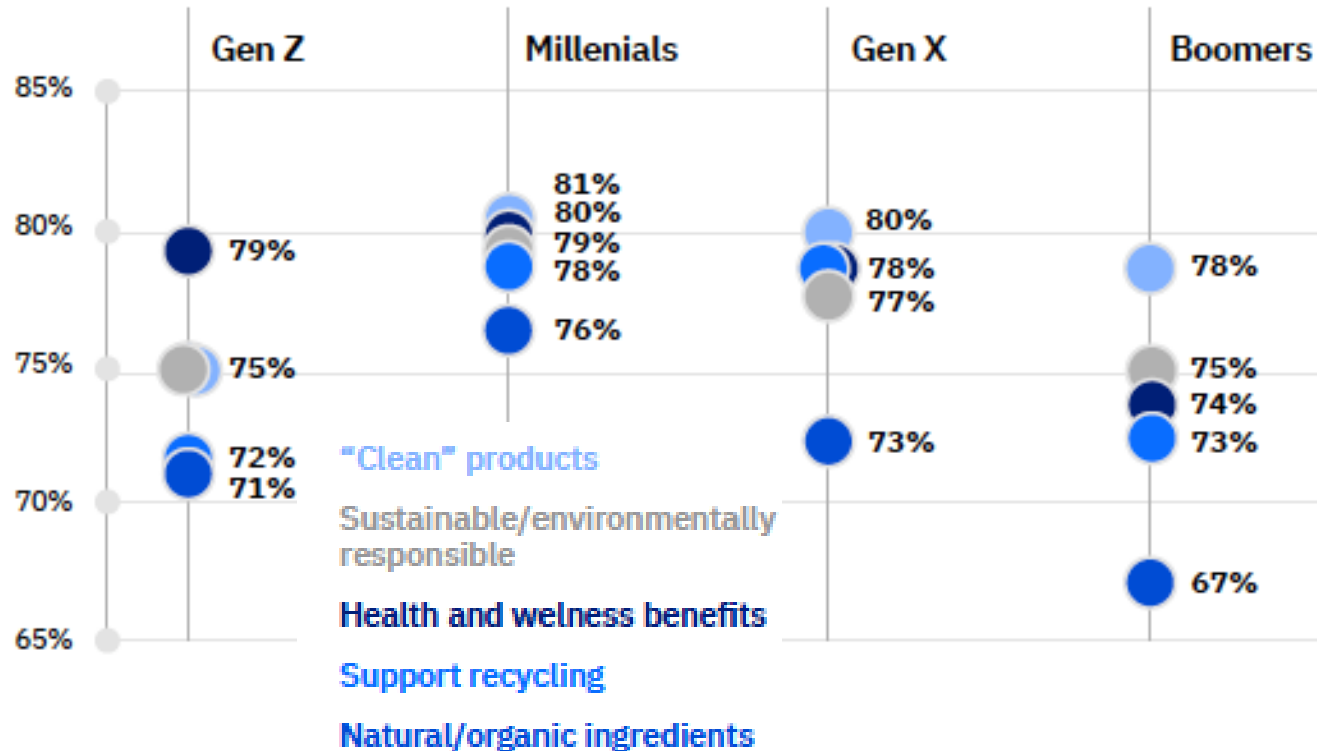
\$4 Trillion annual investment needed globally to achieve net-zero emission economy by 2050

Source: International Energy Agency

Consumer Choice at a Tipping Point

77%

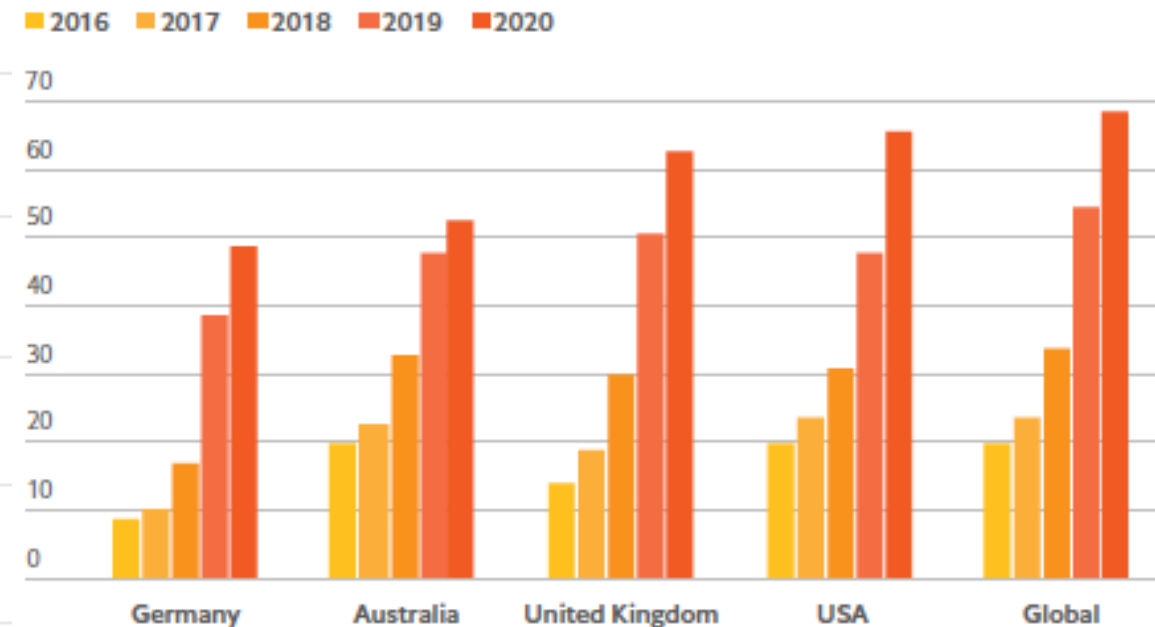
Consumers are willing to pay a premium for brands that offer clean products



Source: Meet the 2020 Consumers Driving Change, IBM & National Retail Federation

Shopping sustainably?

Google searches for sustainable products in the 'shopping' category. All countries. English. Index Value per Yearly average.



Source: The EIU, Google Trends

Source: "An EcoAwakening", The Economist, 2021

Targets and Enablers

TARGETS

Decarbonization

Circular Economy

Clean Water

Climate Adaptation & Resilience

Sustainable Food/Agriculture

INNOVATION

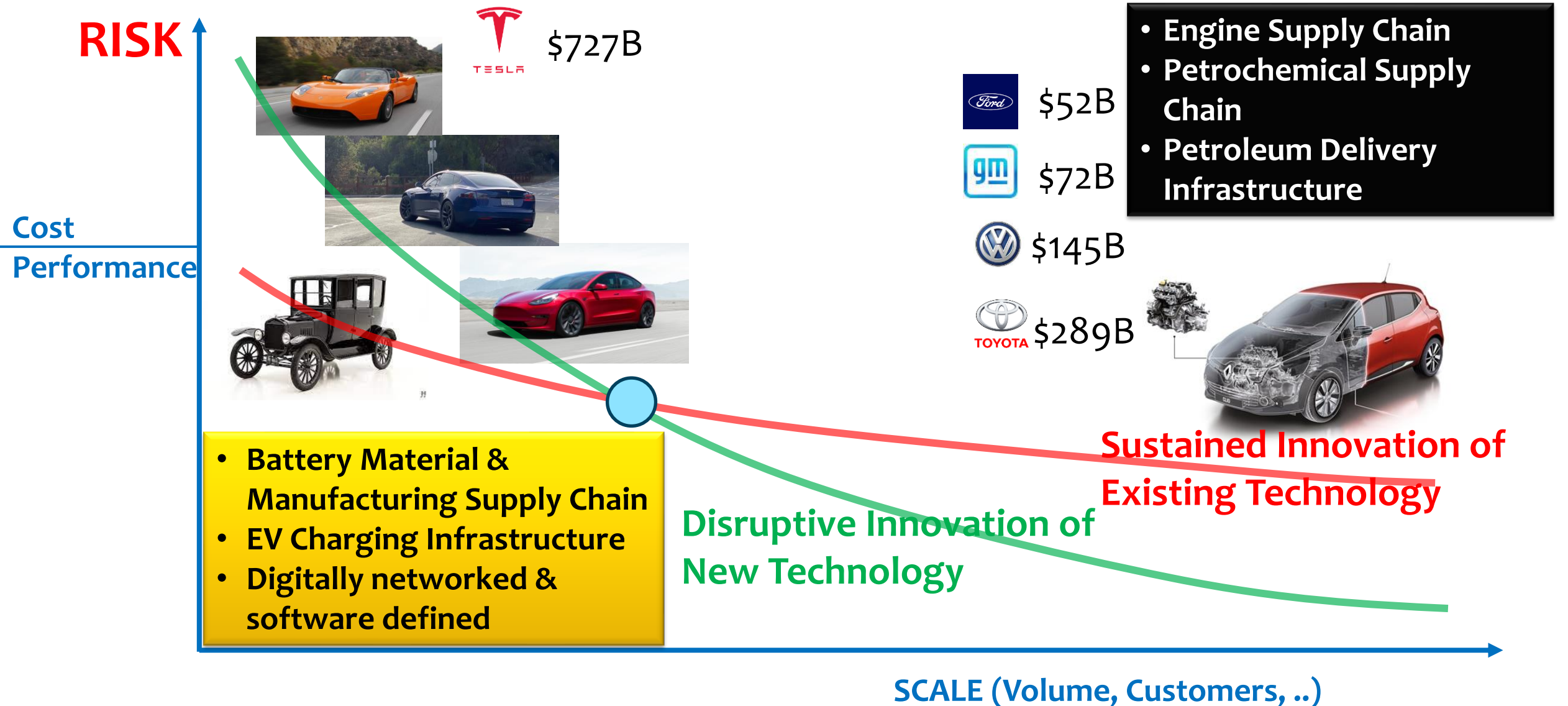
KEY ENABLERS

Clean Technology
(e.g., Renewables,
Hydrogen, Carbon
Capture, Energy
Storage, Electrification)

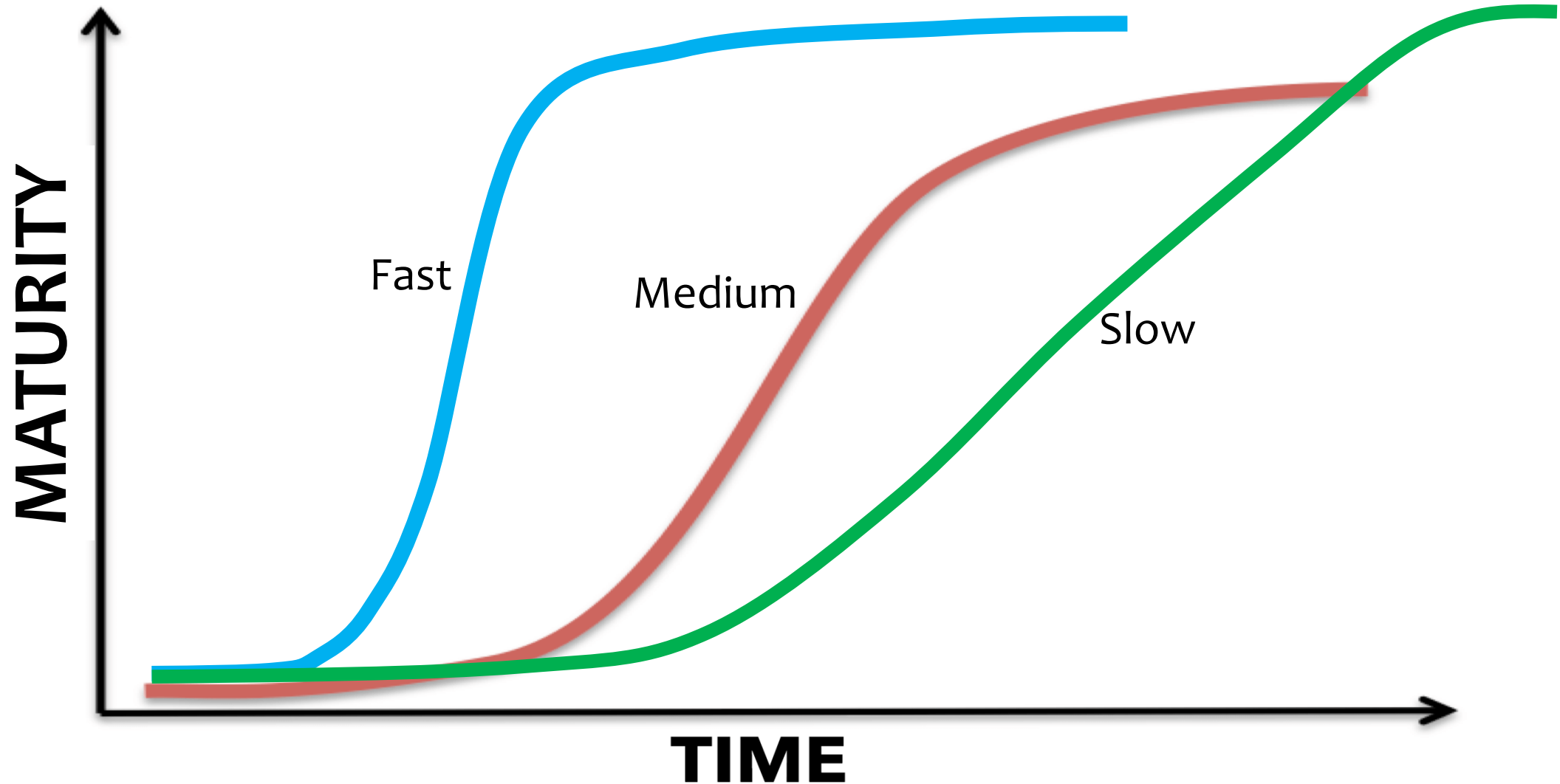
Biology
(e.g., Gene editing,
Synthetic biology)

**Digital
Automation**
(e.g., AI/ML, IoT, Cloud
computing)

Innovation Types



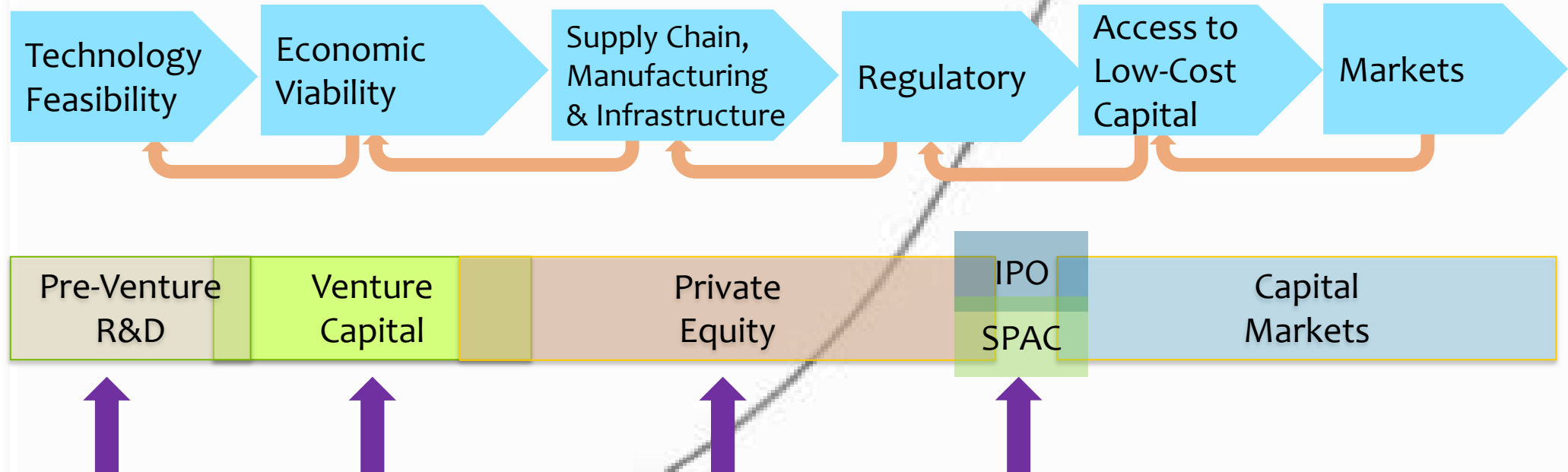
Innovation Value Chain & Growth Rate



Holistic Understanding of Innovation Value Chain

You've got to be very careful if you don't know where you are going, because you might not get there.
-Yogi Berra

Risks, Barriers & Constraints



GHG-Free Hydrogen



GHG-free Hydrogen at \$1/kg by 2030

- Decarbonize steel, cement, fertilizer & industrial heat
- Long-haul heavy duty transportation
- Energy storage for the electricity grid

GHG-Free Hydrogen



Natural Gas Infrastructure

Steam

Gray Hydrogen
(95% of Today)

Hydrogen + CO₂ Emissions

\$1.2/kg-H₂

CO₂ Capture (CO₂ Pipelines)

Blue Hydrogen

\$1.50-1.75/kg-H₂

Potentially \$1.25/kg-H₂



GHG-Free Electricity

Water

Electrolysis

Green Hydrogen

Today \$3-5/kg-H₂

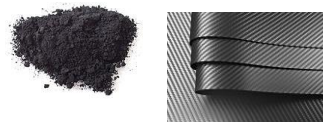
Potentially \$1-2/kg-H₂



Natural Gas Infrastructure

Pyrolysis

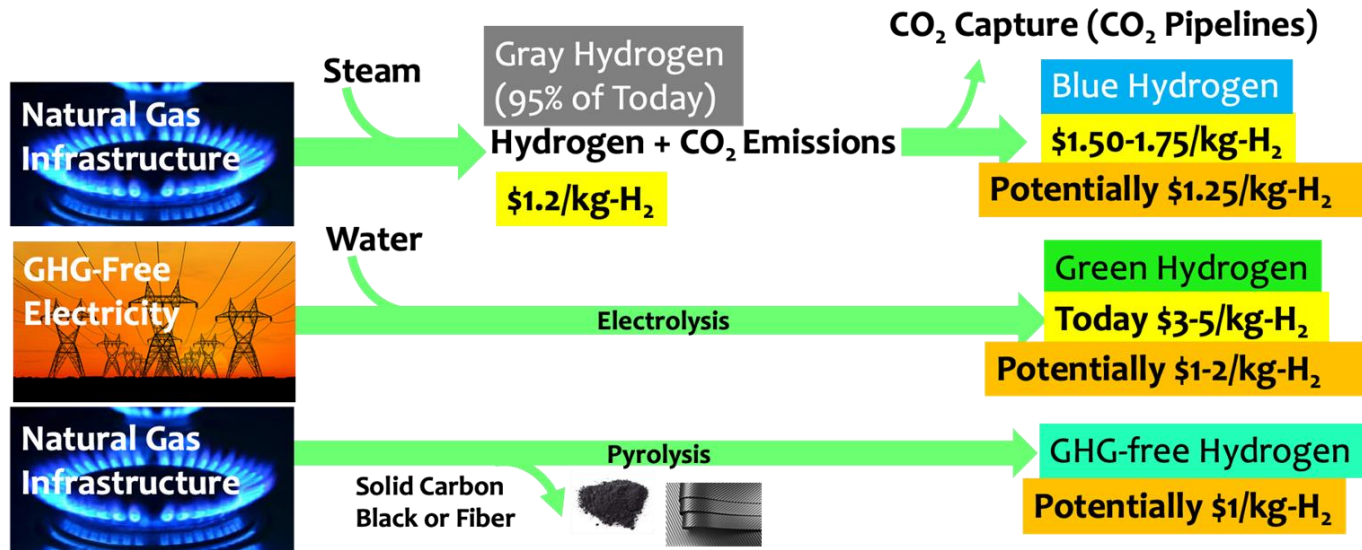
Solid Carbon
Black or Fiber



GHG-free Hydrogen

Potentially \$1/kg-H₂

Innovation Value Chain of Hydrogen



Joule

Commentary

A framework for a hydrogen economy

Arun Majumdar,^{1,5,*} John M. Deutch,^{2,5} Ravi S. Prasher,^{3,5} and Thomas P. Griffin⁴

America needs a new hydrogen economy to tackle climate change

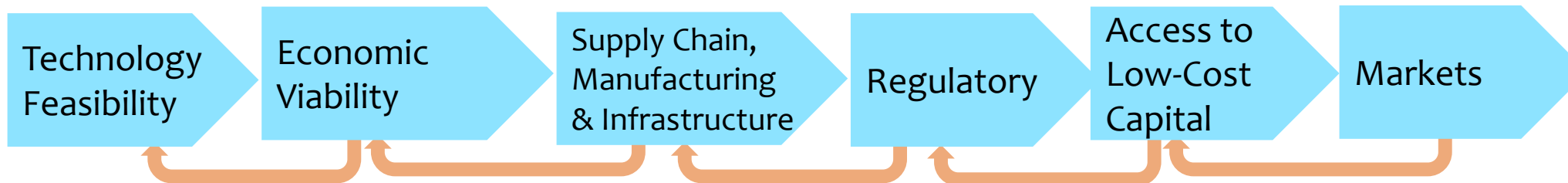
BY ARUN MAJUMDAR, JOHN DEUTCH, RAVI PRASHER AND TOM GRIFFIN, OPINION CONTRIBUTORS — 08/29/21 12:30 PM EDT
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480 COMMENTS

OpEd in The Hill

Google: Majumdar Hill

Risks, Barriers & Constraints for Hydrogen



Thank you!
Look forward to engaging with you.

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