“50 transformative scientific & technological breakthroughs required for sustainable global development”

Selected findings

LIGTT: An Introduction

- **3,500 scientists and engineers**
- **$800 million of annual R&D**
- **13 Nobel Laureates**
- **Historically US-focused**

LIGTT

Institute for Globally Transformative Technologies
at the Lawrence Berkeley National Lab

Objective: Leverage LBNL's capabilities towards breakthrough solutions for sustainable global development

Core beliefs

1. **Populations at the bottom of the pyramid lack essential products to enjoy an adequate quality-of-life. There is a large market for such products.**

   New generation of products—low-cost, robust, energy-efficient—required to improve food security, health, work productivity, access to information & household comfort.

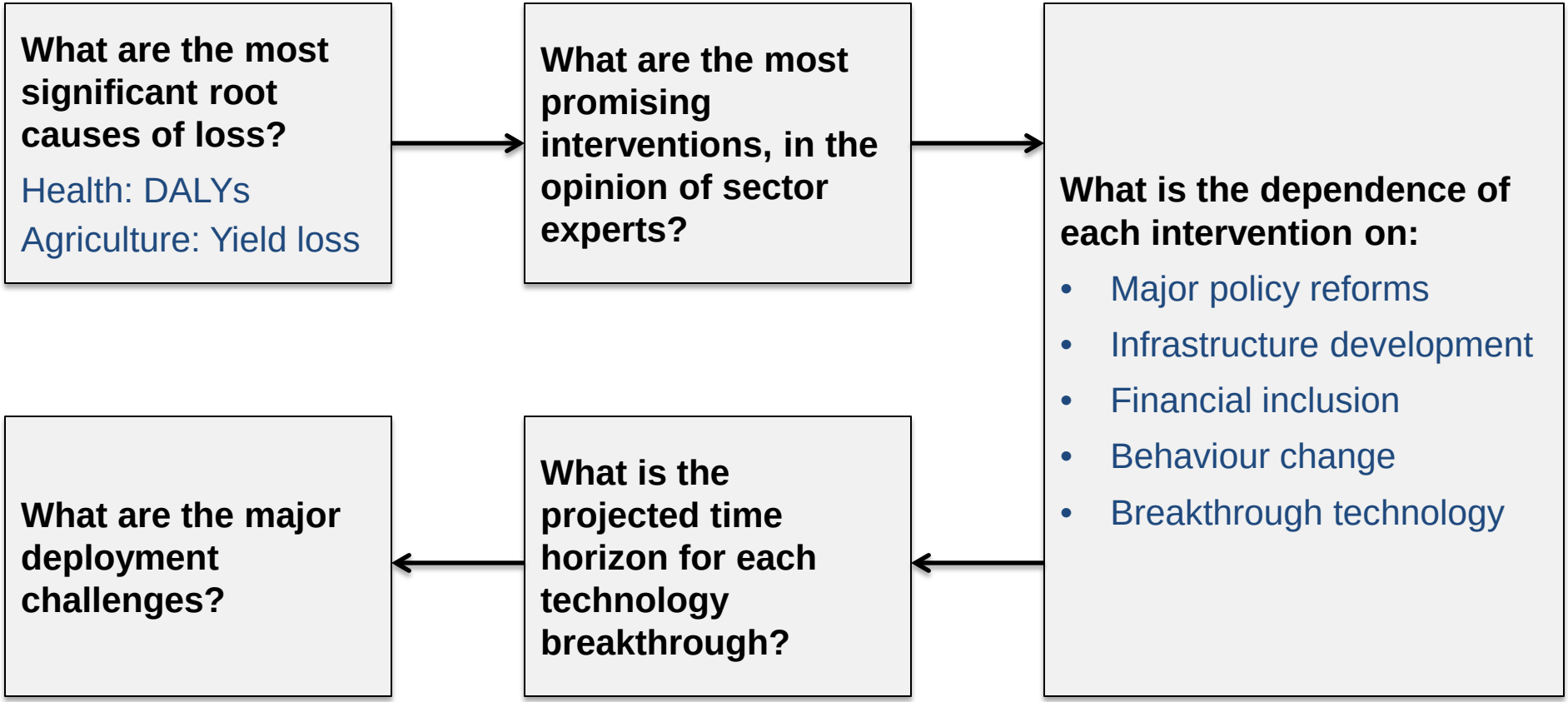
2. **Such breakthroughs require serious R&D, which the private sector has not invested in, due to low expected margins and unpredictable market dynamics**

   Leverage is key to reducing upstream costs and commercial feasibility.

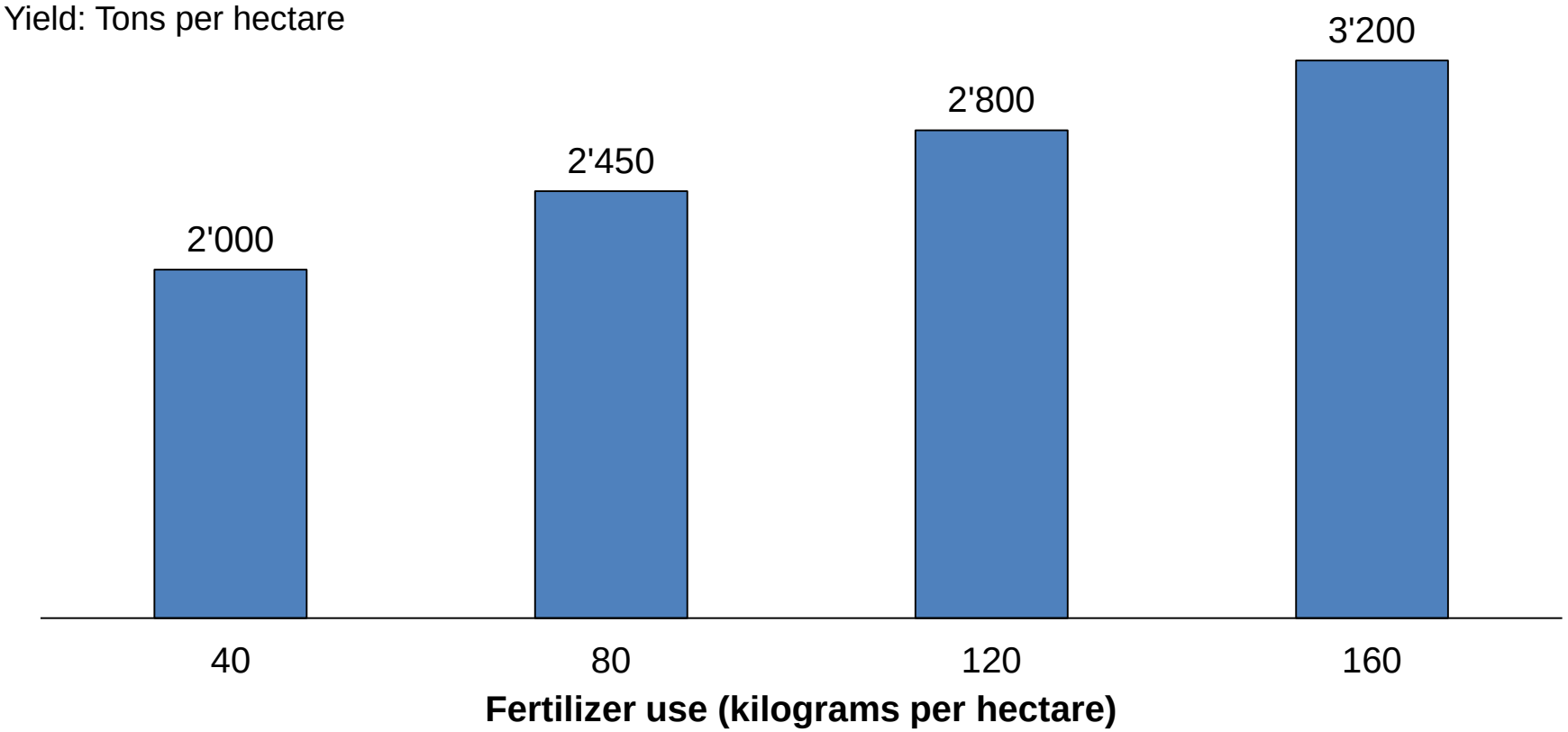
50 Breakthroughs study: breadth of topics

1. Food security and agriculture
2. Health
3. Education
4. Water: access, quality and sustainability
5. Energy
6. Inclusion of women
7. Human rights
8. Digital inclusion
9. Resilience against climate change and environmental damage

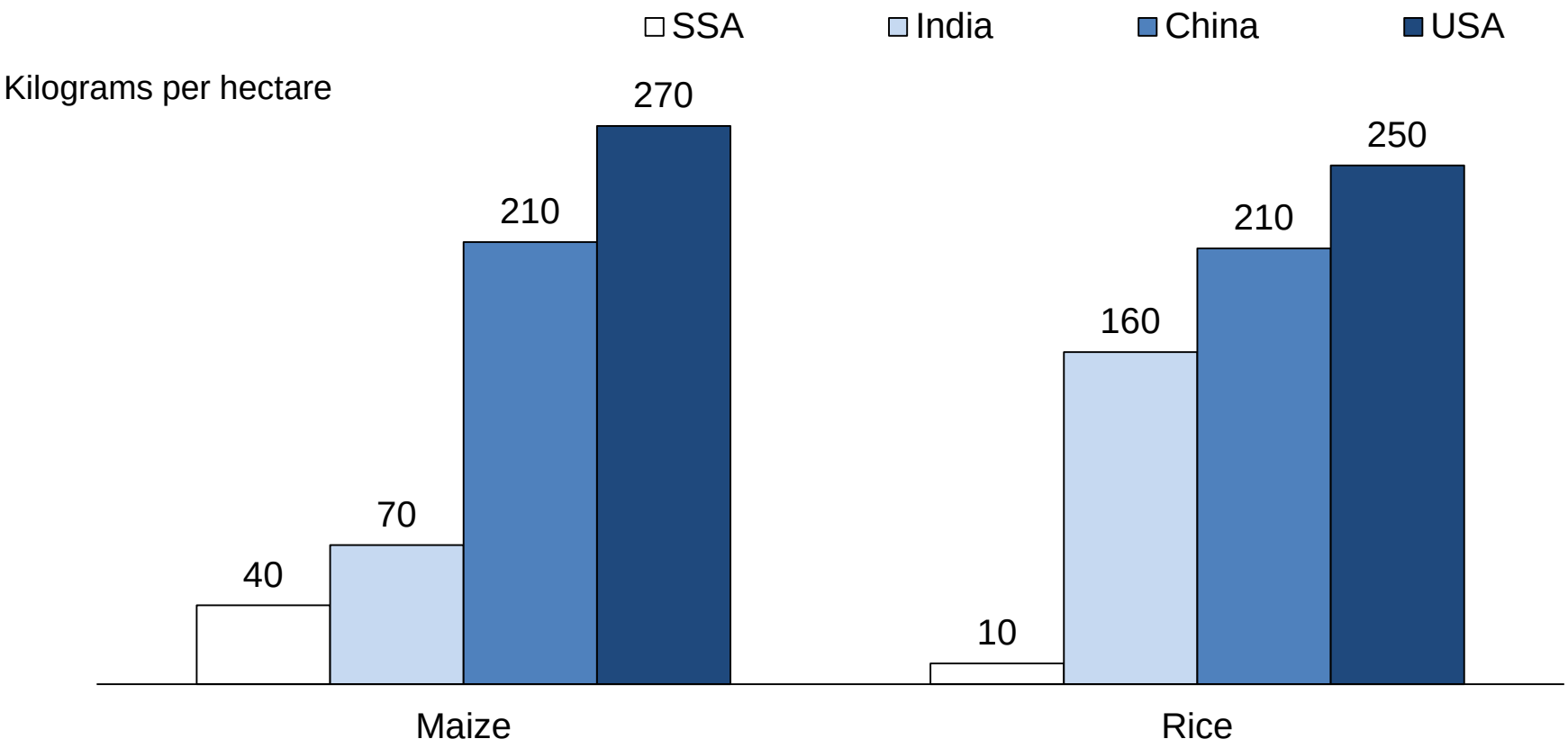
Methodology



Food security and agriculture: Fertilizer



Fertilizer usage around the world



Fertilizer: Key nutrients

Nitrogen

Occurs naturally in air,
but needs fixation:
Haber-Bosch Process

Phosphorus

Phosphate rock:
Mining

Potassium

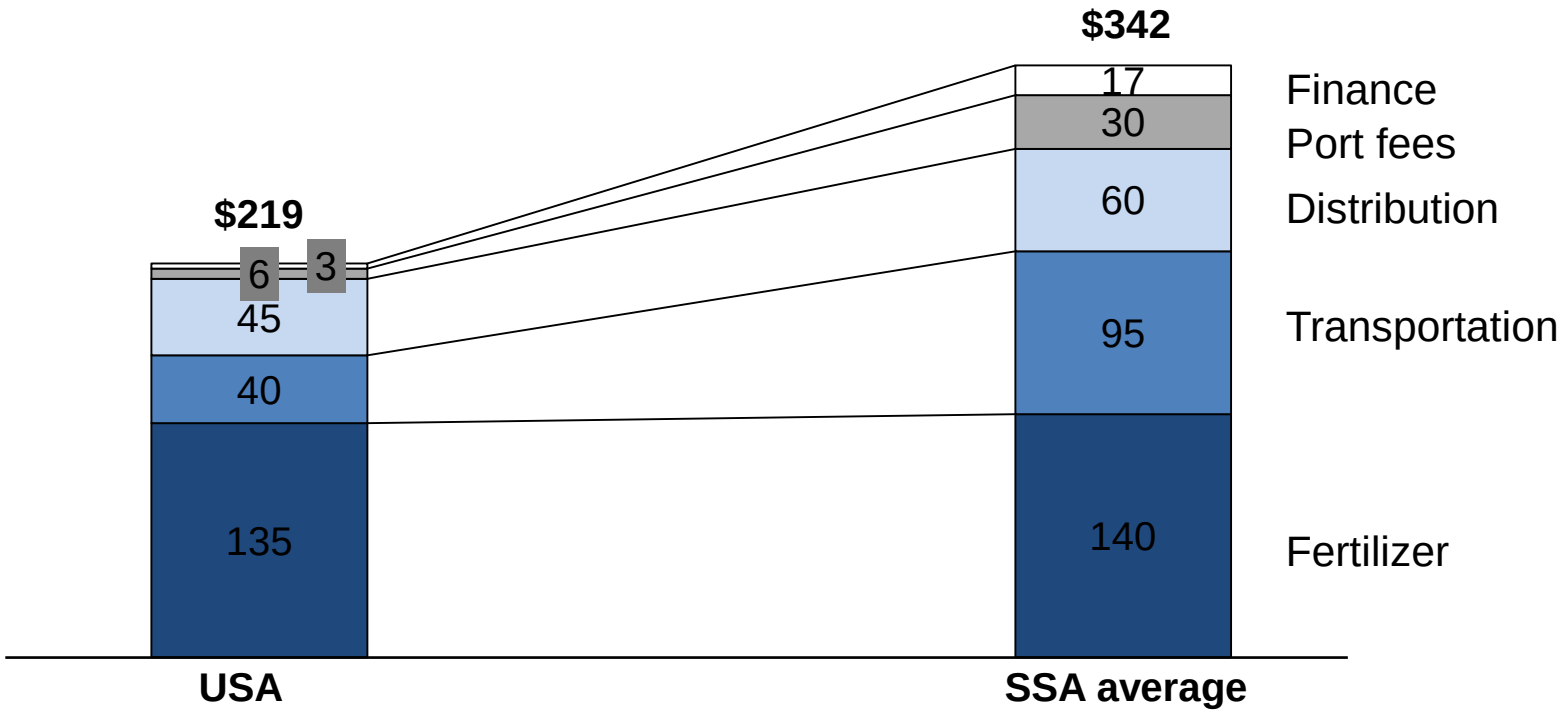
Potash: Mining

The Haber-Bosch Process: Extremely capital-intensive

- **Cost to build and operate >> US$100 million**
- **Needs to be located near natural gas source**

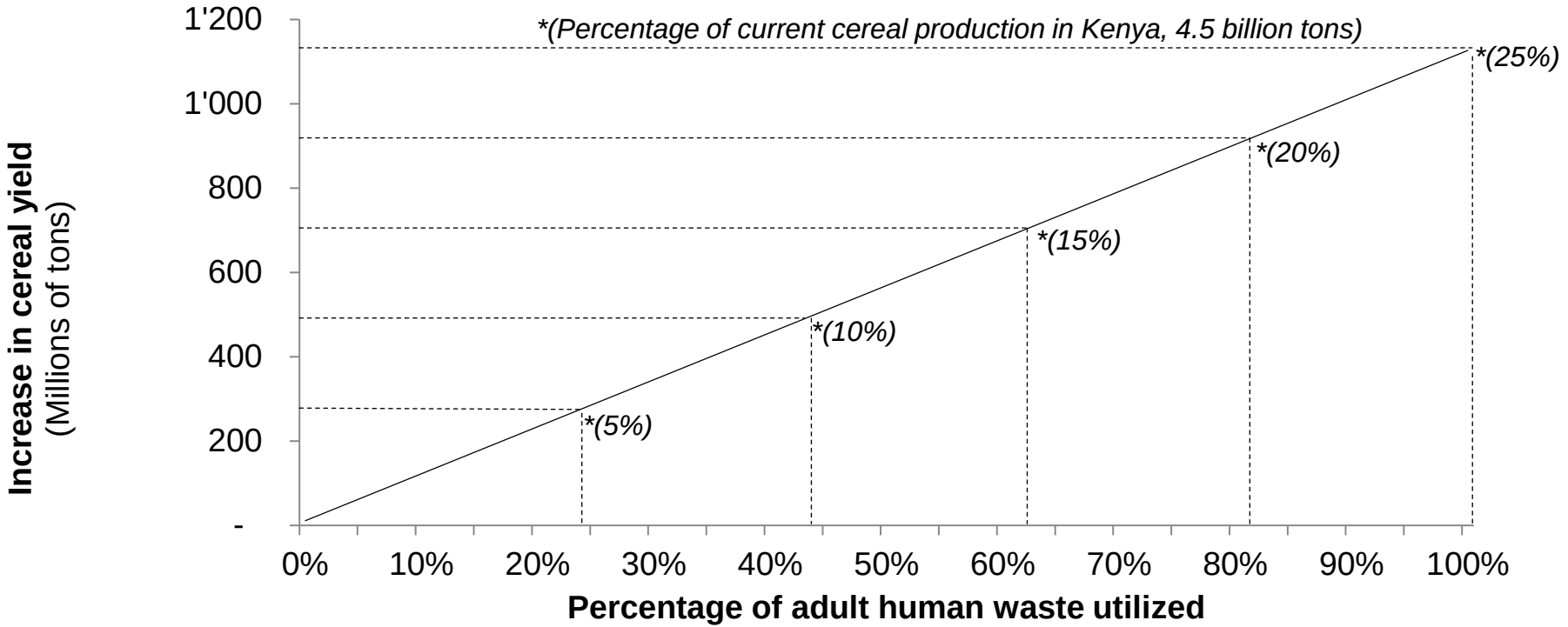
Cost of fertilizer: US vs. Sub-Saharan Africa

$ per metric ton



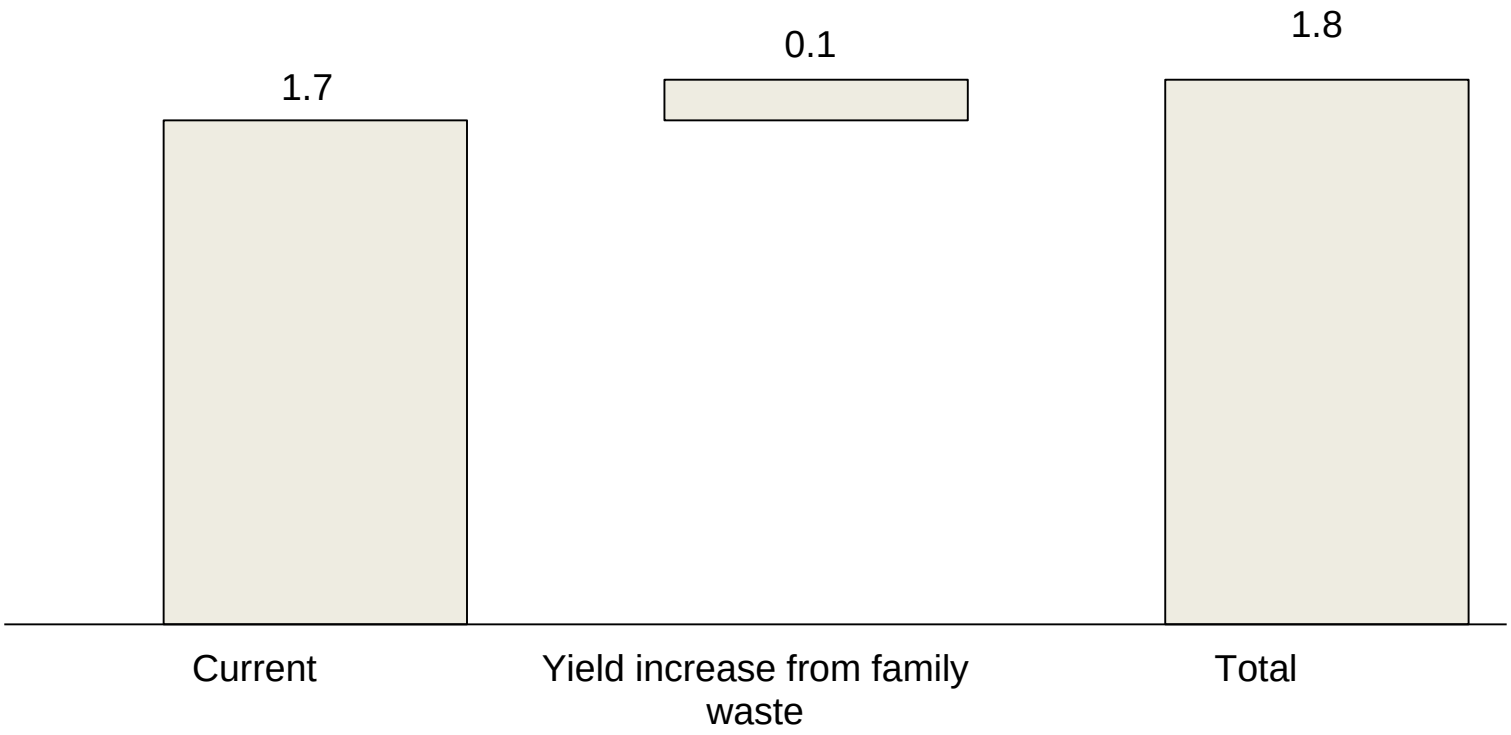
Human waste is not sufficient

Potential increase in cereal production vs. percent of adult human waste utilized for fertilizer



Human waste is not sufficient

Current maize yield on a 1 hA farm in Kenya, and potential increase from using human waste from 3 adults, Tons per year



Fertilizer: Breakthrough required

A new method for nitrogen fixation, as an alternative to the Haber-Bosch Process

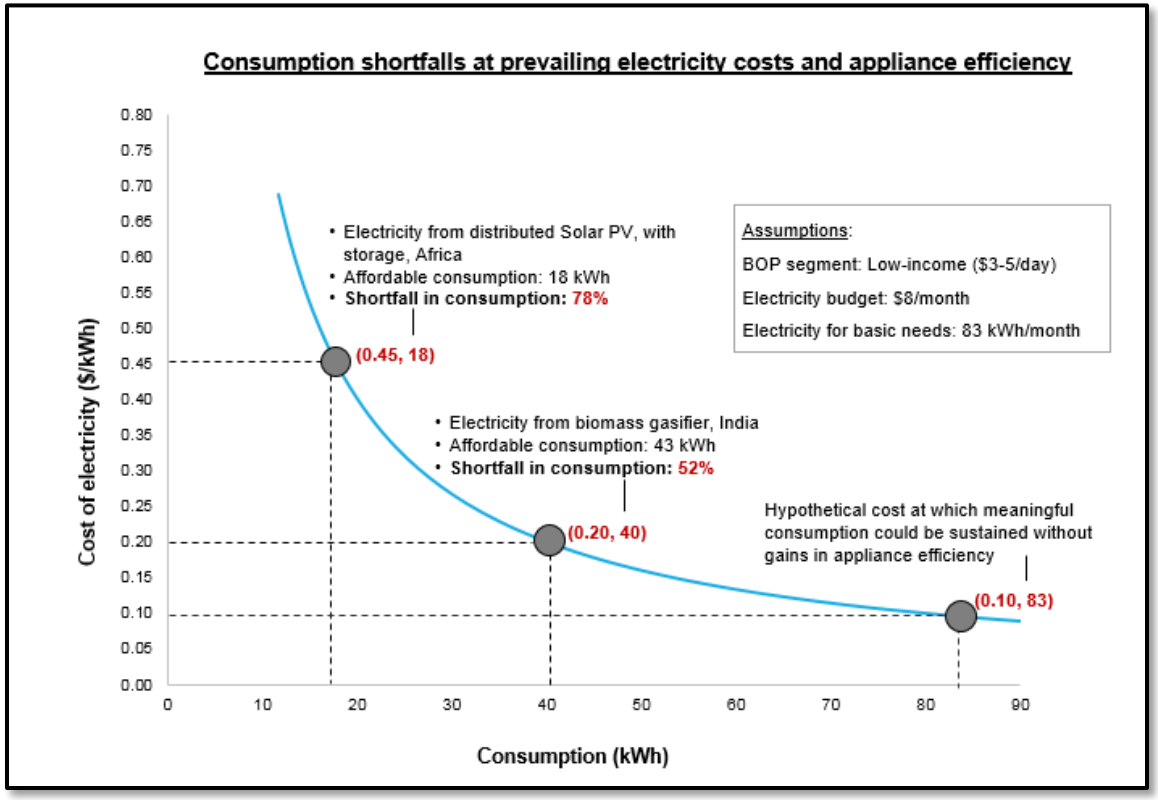
- To enable smaller-scale production at a larger number of facilities across Africa
- Significantly less capital-intensive and less energy-intensive
- Does not require production close to sources of natural gas
- Can be biological or electrochemical

Technology readiness: >10 years

Deployment challenges:

Dependence on policy changes: Low
Needs infrastructure development: High
Lack of demand: High
Market fragmentation: High
Need for user finance: Medium

Access to electricity: Key analysis



Electricity itself does not change lives, it's what people do with electricity

- New generation of low-cost, energy-efficient appliances required: refrigeration, TV, fan
- Tradeoff between cost of electricity vs. energy consumed by appliances

Other breakthroughs

Digital Inclusion	**Biometric ID** So that data about individuals and market segments can be used by service providers
Human Rights	**A digital rape kit** So that DNA evidence can be collected, digitized and transmitted without the need for a lab process
Health & Quality-of-life	**A new kind of home for the urban poor** Lightweight, weather/fire-resistant, and double-storied, with improved lighting, sanitation and ventilation
Healthcare Delivery	**An integrated “clinic-in-a-box” for maternal, neonatal and primary care, costing $10,000-15,000** Integrating the essential 10-15 medical devices with respect to solar power, imaging/computation, patient data, reference material for the clinician, and communication
Agriculture/ Irrigation	**A sensor to detect the depth of shallow groundwater** So that smallholder farmers and well-diggers can substantially reduce the cost of finding and using water
Climate change & Environmental Damage	**Desalination** An alternative to the current energy-intensive, highly expense approaches (e.g., reverse osmosis)

Why do most technology innovations fail?

1. Confusing “needs” vs. “wants”

“Adoption”

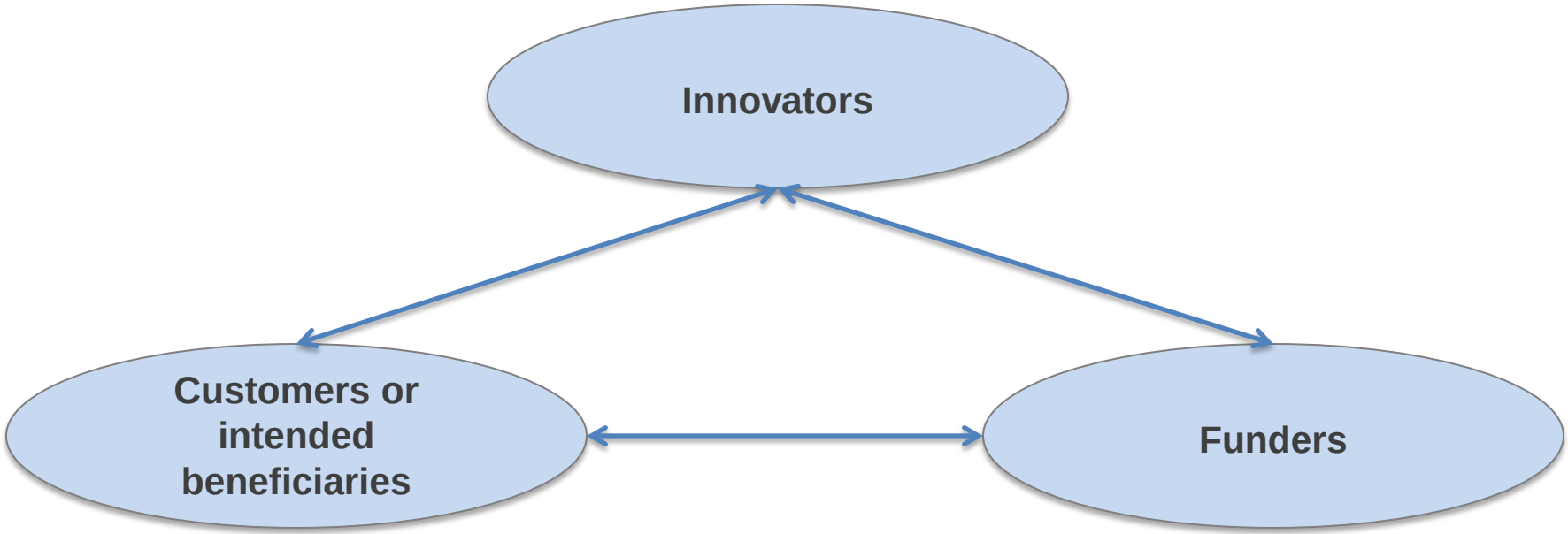
Why aren’t they using this AMAZING technology I made?

“Demand”

Why am I not making what the products they REALLY want?

Why do most technology innovations fail?

2. Emphasizing the wrong constituents



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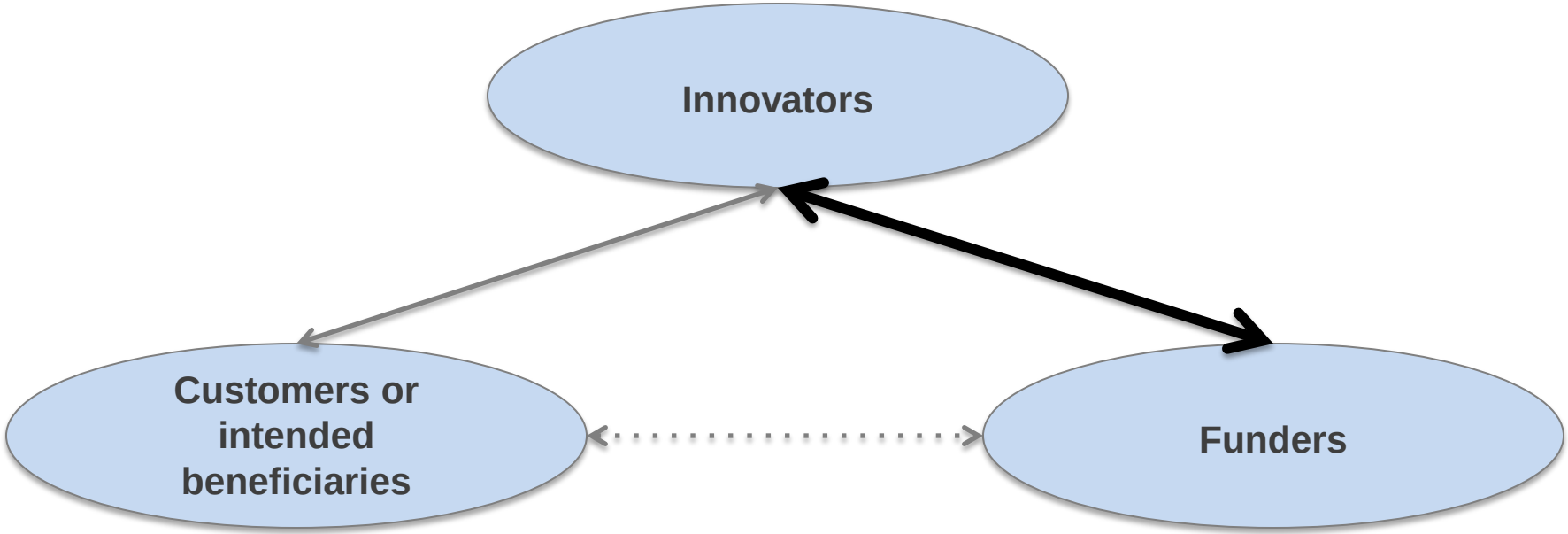

Why do most technology innovations fail?

3. The myth of the one-product social entrepreneur

Why do most technology innovations fail?

4. Who is leading the show?

Why do most technology innovations fail?

5. “Feel good” vs. “problem-solving”