

# Facilitating Technology Development for Sustainable Development

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on a Technology Facilitation Mechanism for Sustainable Development*

# Objective of Technology Facilitation Mechanism

Promote the development, transfer and dissemination of technologies that contribute to the achievement of sustainable development (goals)

## Our starting point:

- Business-as-usual/market-driven approaches and models of technological innovation have not addressed major sustainable development challenges at the scale and pace required
- New approaches to enhance technology R&D, translation, and dissemination should build upon past experiences so as to be as effective and efficient as possible

Development

Transfer

Dissemination

Tech Devt

Adapt/Demo

Early  
Deployment

Scale up

### ACTIVITIES

R&D, proof  
of concept

Adaptation for  
local user  
needs/context

Market creation;  
risk mitigation for  
users; business  
model devt.

Driving large-scale  
diffusion

Development

Transfer

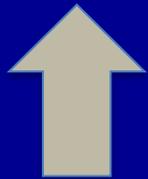
Dissemination

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TECHNICAL CAPABILITIES  
RISK

Development

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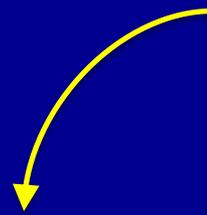
Early  
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REQUIRED INVESTMENTS  
IMPORTANCE OF LOCAL CONTEXT

Main focus of  
existing activities  
(CGIAR exception)



Development

Transfer

Dissemination

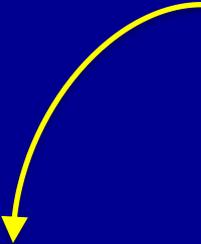
Tech Devt

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Focus of proposed activities



Development

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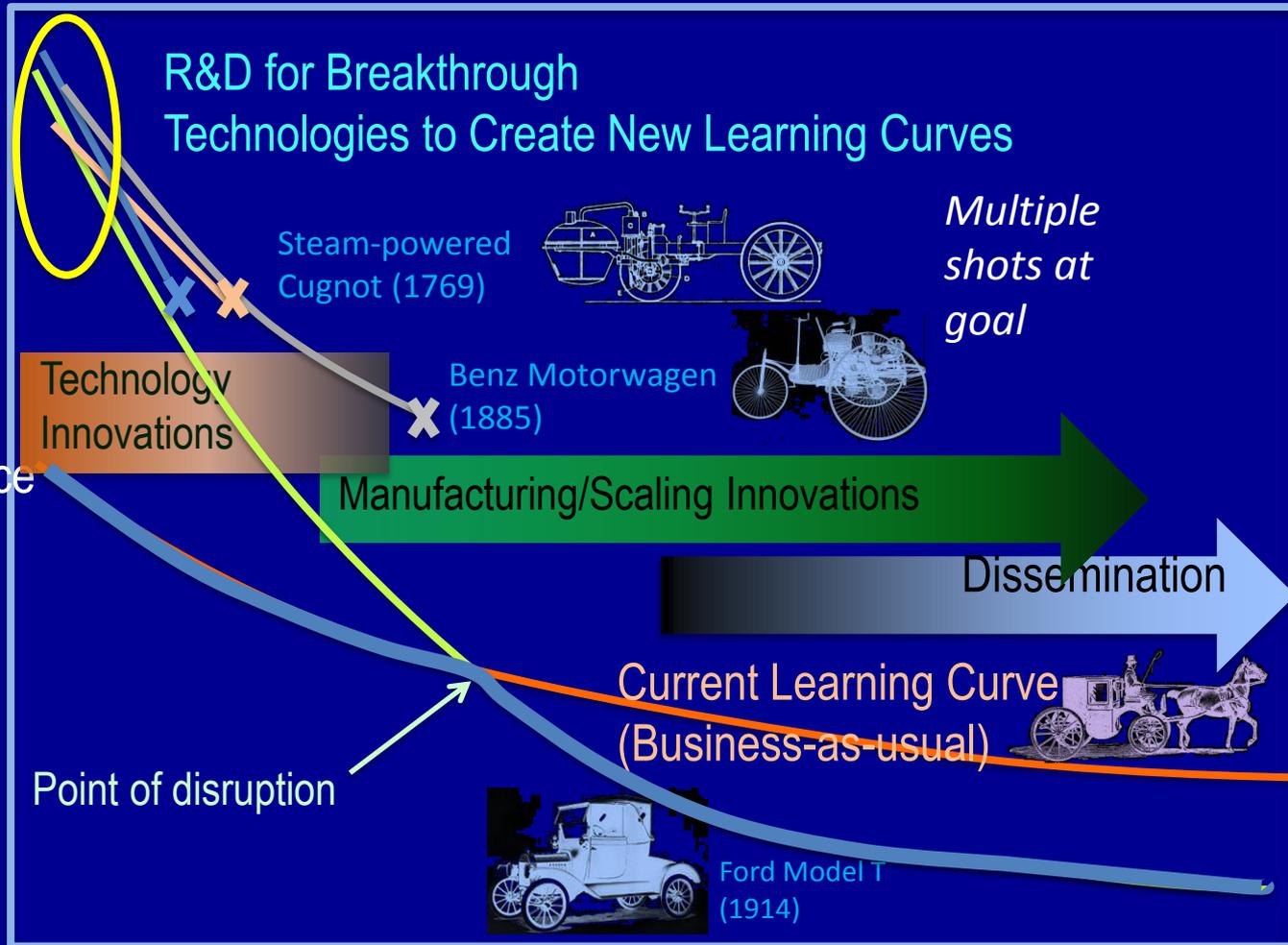
Scale up

# Revolutions and Evolutions of Technologies

Techno-economics of innovations and market disruptions

# Low-Cost Long-Term Capital (>20 years)

Project Size & Time	<\$10M (2-5 yrs)	\$10-100M (5-10 yrs)	\$100M-1B (>10 yrs)	>\$1-10B
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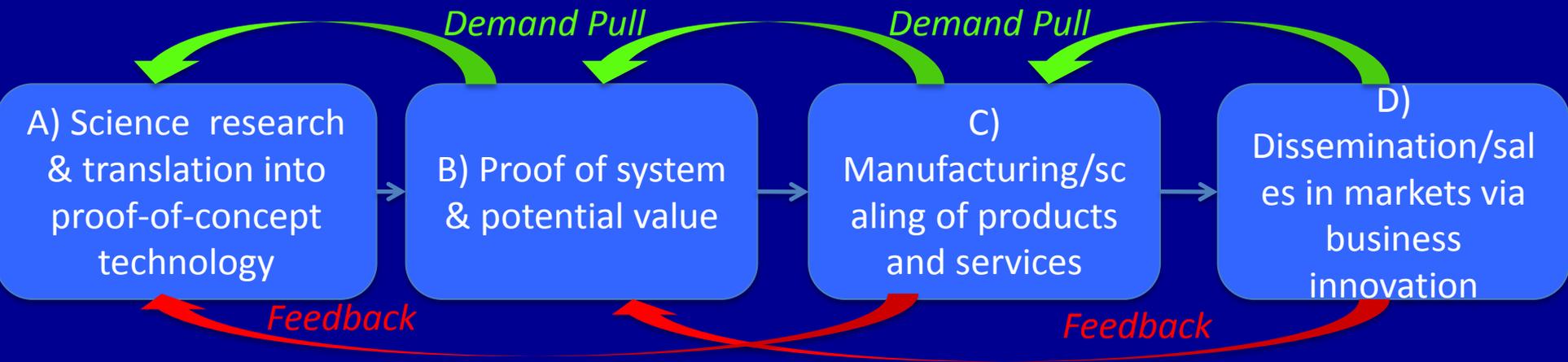
## Time and Money Needed for Projects

\$1-5M  
2-3 yrs

\$5-10M  
1-2 yrs

\$10M-1B  
5-10 yrs

\$10M-1B+  
>10 yrs



Government investment in Univ/National Lab research is insufficient & not stable to get best minds to work on many new ideas to address sustainable development challenges

Need for science & engineering talent & research ecosystem

Need for entities and funding that can help translate proof-of-concept into proof-of-system that catalyzes products and businesses

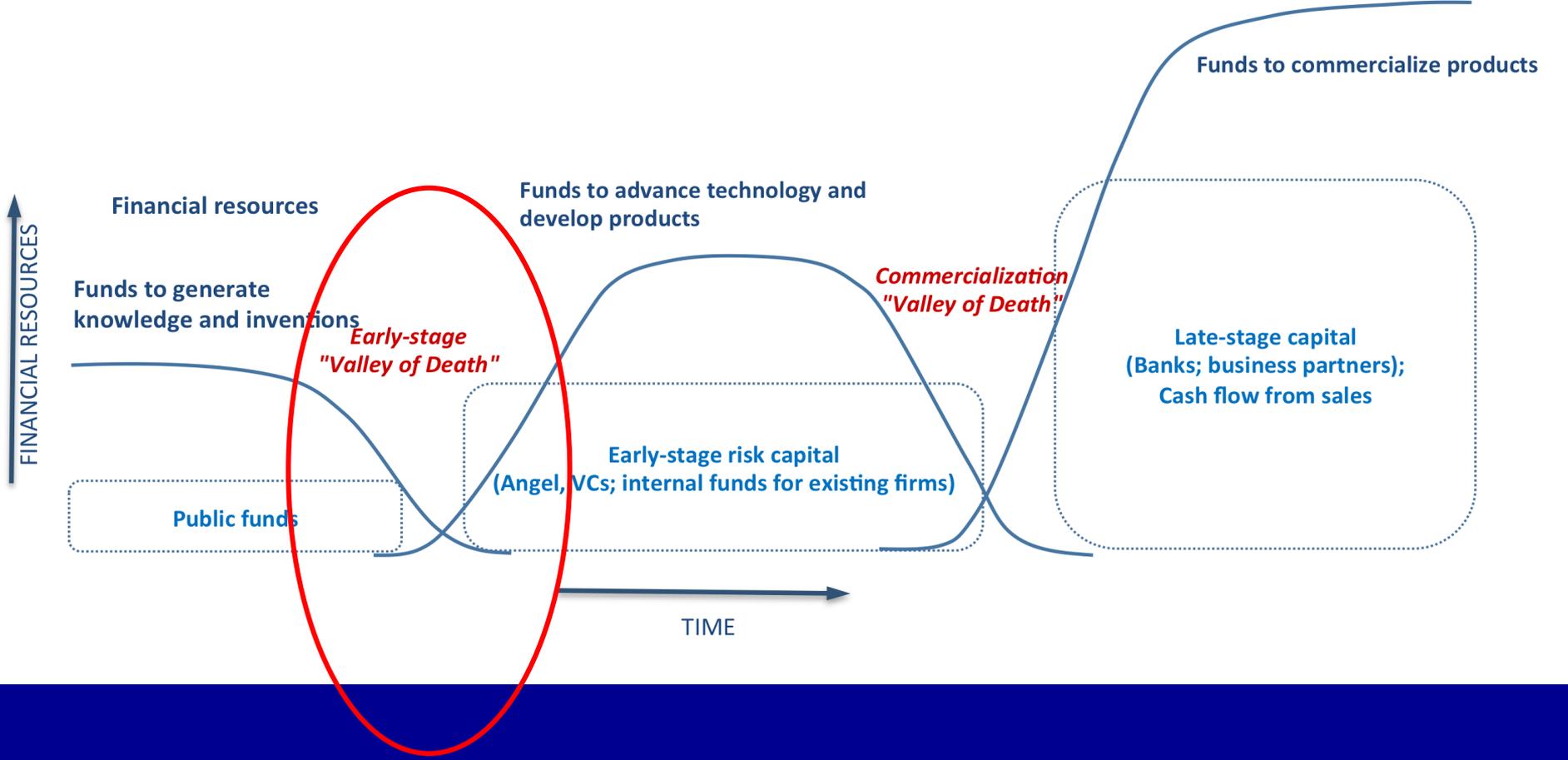
Need for science & engineering talent & research ecosystem

Access to

- low-cost long-term financial capital
- skilled human capital
- low-cost & reliable infrastructure
- low-cost & reliable supply chain
- local demand

Access to

- Markets
- stable financial institutions
- legal institutions and framework
- stable governance



# A proposal to facilitate technology development for addressing SD challenges

## Current state of R&D for addressing SD challenges:

- 'Market failure' - often underinvestment in public goods
  - ✓ Support for applied R&D to explore/develop concepts/technologies with potential public benefit (e.g., horizontal drilling supported by DOE underpinned the fracking revolution; computer networking supported by DARPA led to the internet revolution)
  - ✓ Such R&D often carried out in 'national labs' but almost no models for global public goods (other than CGIAR)
  - ✓ Long lead times to application – mis-match with firms' business perspectives

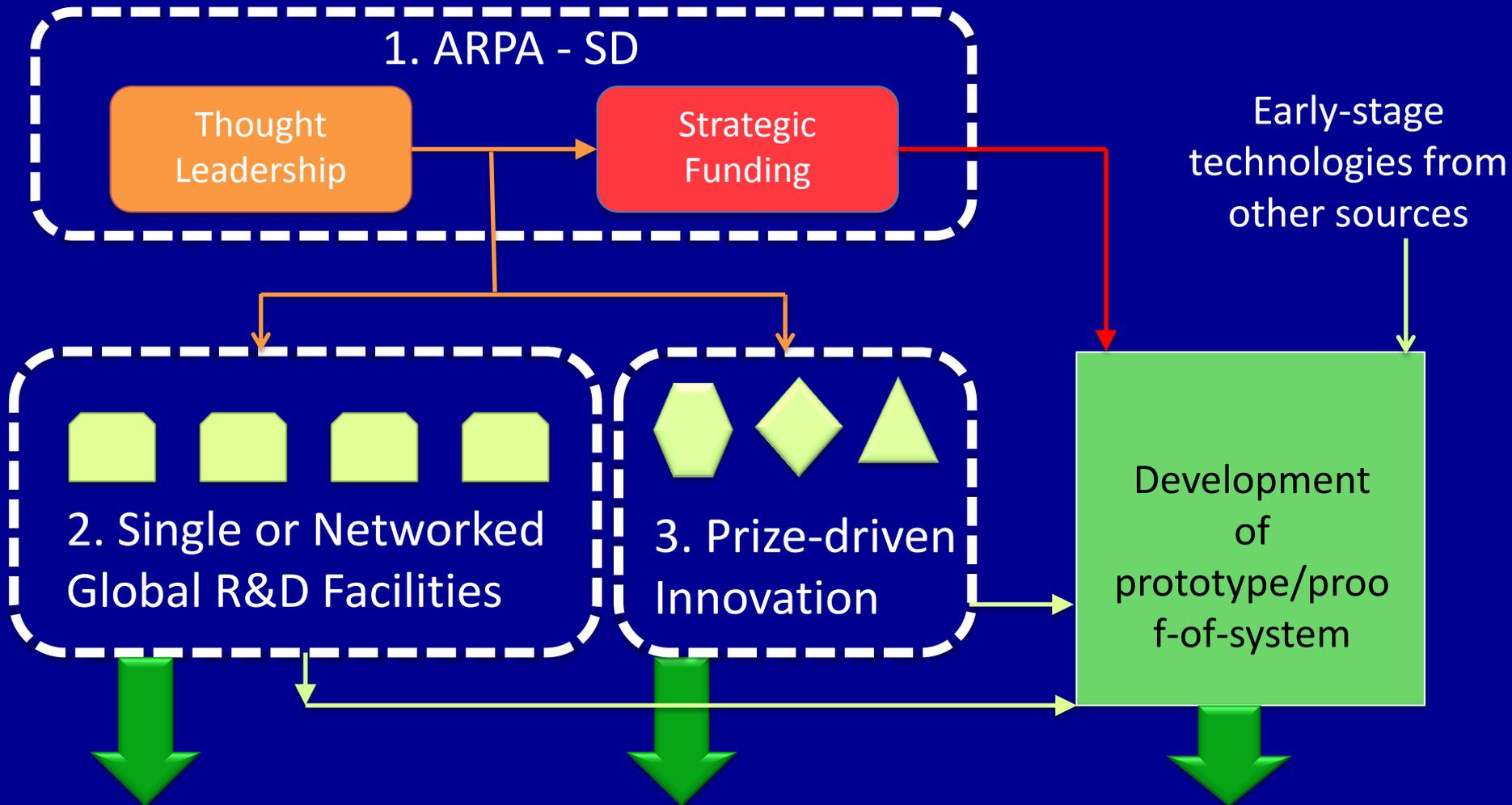
=> Gap between technology development efforts and needs

# Facilitating Technology Development:

- Strategic agenda-setting
  - ✓ *Identifying the sweet spot between technological possibilities and needs, i.e., high-value-adding opportunities*
- Enhance the development of new concepts/technologies that could help address SD challenges
  - ✓ *Enhancing scale and scope of relevant R&D activities by creating new institutions and inducing relevant innovation in existing institutions*
- Facilitate translation of technologies into viable products
  - ✓ *Help advance particularly promising options, e.g., by overcoming ‘valley of death’*

=> Significantly expand pool of technological options for meeting SD challenges

# Advancing innovation for SD - 3 elements



Innovations for local and/or global SD

# Element 1: Focusing on sweet spots for value addition

## An Advanced Research Projects Agency for Sustainable Development (ARPA-SD)\*

- Provide thought leadership in identifying sweet spots where technology can address major challenges
- Provide targeted funding to fill gap between research/proof-of-concept and demonstrable prototype/proof-of-system prototype (i.e., overcoming 'valley of death')
- Aim to create successful outcomes that can then find application at scale

# Element 1: Focusing on sweet spot for value addition

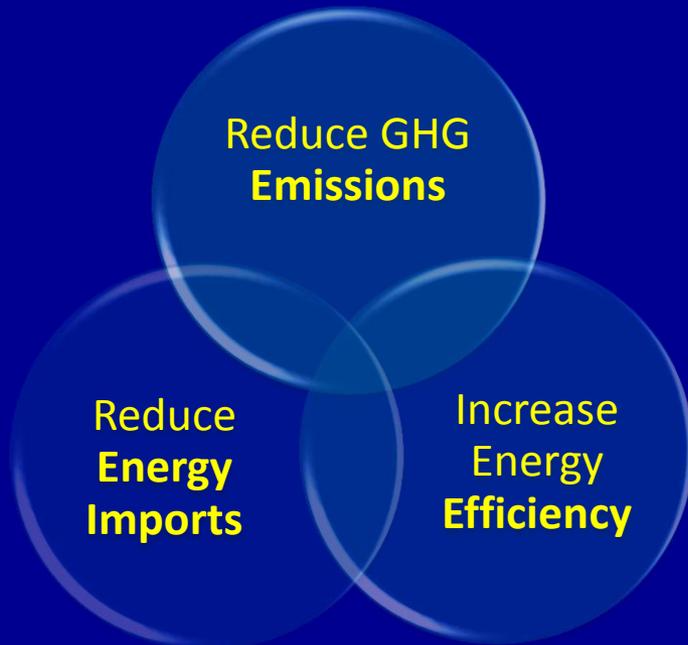
An Advanced Research Projects Agency for Sustainable Development (ARPA-SD)\* (continued)

- Staffed by domain experts from around world with 'big-picture' perspective and sophisticated understanding of technology cycle
- Close engagement with funded groups to increase likelihood of success

# What is ARPA-E?

An organization that provides thought leadership, funding and stewardship of breakthrough disruptive energy technologies (initiate new techno-economic learning curves) that are too risky for the private sector to initiate but, if successful in the future, they would create the foundation for entirely new industries (historical examples - internet, GPS from DARPA)

## MISSION



*Enhance U.S. economic and energy security*

*Ensure U.S. lead in advanced energy technologies*

# What makes ARPA-E successful?

## People, Culture, Funding and Leadership

- 1. People:** Highly selective in recruiting top-notch active scientists and engineers with certain key attributes from R&D community as Program Directors (PDs) for finite time (3-5 yrs). Create sense of urgency and mission, it is not a permanent job!
- 2. Bottom-Up Programs:** Maintain very high expectations for creativity & thought leadership for PDs to spread their wings and identify “whitespace” to create new programs with audacious goals via internal debates and external workshops with research community. Programs are sunset when PDs leave.
- 3. Decision Making:** Autonomy in decision making based on science and engineering with rigorous technical review and feedback from external community. No non-technical external influence. Empower PDs to make decisions about projects, but hold them accountable.

# What makes ARPA-E successful? (Contd.)

- 4. Funding Excellence:** Fund few top notch projects with adequate funding so that they can make a dent – no dilution in excellence by funding many. Each program contains 15-20 projects with \$30-40M over 3 years, managed by a PD. Each PD can manage 2-3 programs during their tenure at ARPA-E.
- 5. More than just money:** Active program management by PDs with project site visits, technical scrutiny and support, networking within community, stewardship beyond ARPA-E. It is more than just money!
- 6. Ideas Fail, People Don't:** Encourage failing fast and terminate projects if they are dead ends. Create environment with no shame in failing, and encourage researchers to return with better ideas.
- 7. Success:** Define success (project, individual, organizational) early before others define it for you.

## Element 2: Enhancing scale and scope of R&D for SD

### A Global R&D Facility for Sustainable Development\*

- Directed problem solving through application of state-of-art knowledge
- Long-term perspective in R&D efforts
- R&D performed by talented individuals drawn from all over the world but limited-term engagement
- Lean, state-of-art, institutional design to maximize effectiveness
- Single institution (e.g., “Bell Labs 2.0”) or networked design (e.g., CGIAR) models possible

## Element 3: Crowd-sourcing solutions

### A platform for prize-driven innovation for SD

- Useful when clear-objective goals but multiple possible paths and multiple potential participants
- Specific technical performance criteria used to define prize parameters (e.g., water purifier that cleans specified quantity of water to specified level of cleanliness in specified time)
- Can potentially leverage technological expertise (and resources) from multiple individuals/organizations
- Results-based investments (i.e., prize only if goal met)

Can combine with advanced market commitments that give additional incentive and clear cost signals

## Regarding implementation:

- Elements are discrete but complementary and mutually reinforcing – possible to advance on different elements at different pace
  - ✓ Strategic focus on high-value-adding opportunities (ARPA-SD)
  - ✓ Broadening technological options by leveraging existing R&D activities/institutions (Innovation Prizes) and creating new, targeted, institutions (Global “Bell Labs 2.0” for SD)
  - ✓ Deepening technological options by advancing particularly promising options through funding to overcome “valley of death” (ARPA-SD)
- Focus on early stage of technology cycle allows for delocalization (although connection to user needs important)

## Governance and funding:

- Objective is to significantly enhance the capabilities to develop technologies to meet SD challenges – useful to both developed and developing countries
- Goal-setting by policy-makers from developed and developing countries but problem-solving approaches determined by technical experts
- Funding possible through contributions from private actors (e.g., foundations) and developed and developing countries
- Long-term stable funding to isolate from political vagaries