

Technology-to-Market

Transmutation Workshop

Christian Vandervort, PhD, PE

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How do I define the market?



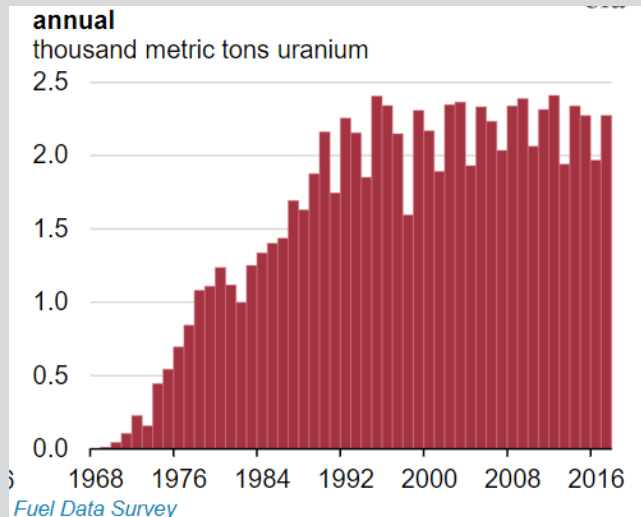
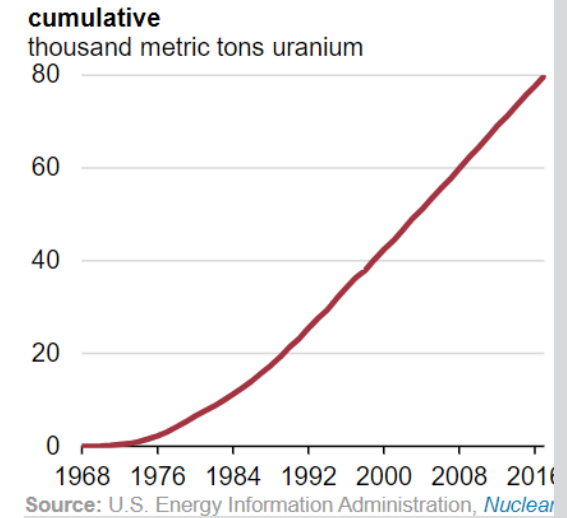
Market opportunity

“There are about 86,000 metric tons of spent nuclear fuel from commercial reactors stored at 75 U.S. sites. This amount continues to grow. Policymakers have been at an impasse over what to do with the spent fuel since the licensing of the Yucca Mountain repository stopped in 2010. Unable to meet its disposal commitment, the U.S. government has paid reactor owners about \$9 billion for storage.”

[Commercial Spent Nuclear Fuel: Congressional Action Needed to Break Impasse and Develop a Permanent Disposal Solution | U.S. GAO](#)



[Oconee Nuclear Station shows cooling pools to media \(independentmail.com\)](#)



[U.S. Energy Information Administration - EIA - Independent Statistics and Analysis](#)

T2M Perspective on Transmutation

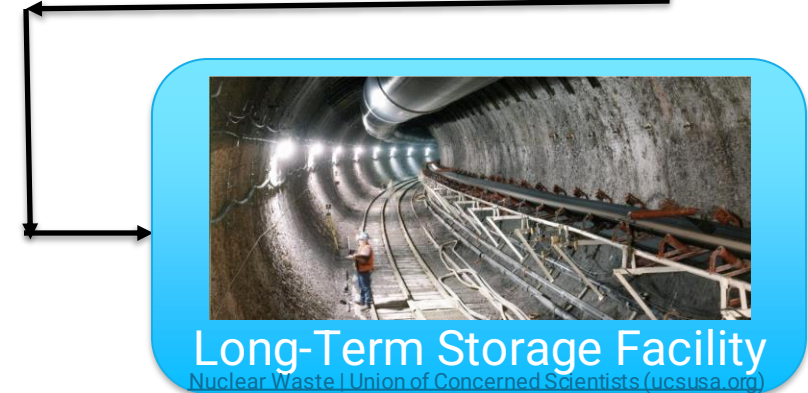
- Necessary to address existing spent nuclear fuel + future accumulation
- Need to assume success of CURIE & ONWARDS along with existing DOE initiatives
- Next generation of nuclear power plants will require solutions for spent nuclear fuel
- Complimentary to reprocessing
- Need to be realistic about public sentiment (Heed the lessons of Yucca Mountain)

Transmutation value chain



Participants

- Utilities, owners & investors
- EPC's
- Fuel suppliers
- Operations & servicing
- Transport
- Trades & Crafts
- Insurers
- Security & safeguards
- Gov't



Techno-economic analysis: Understanding the economics

- ▶ **More than a Cost Model**, not a business plan
- ▶ Inherently challenging and interdisciplinary
- ▶ Low Fidelity at Start of Project → Increasing Fidelity as Project Advances

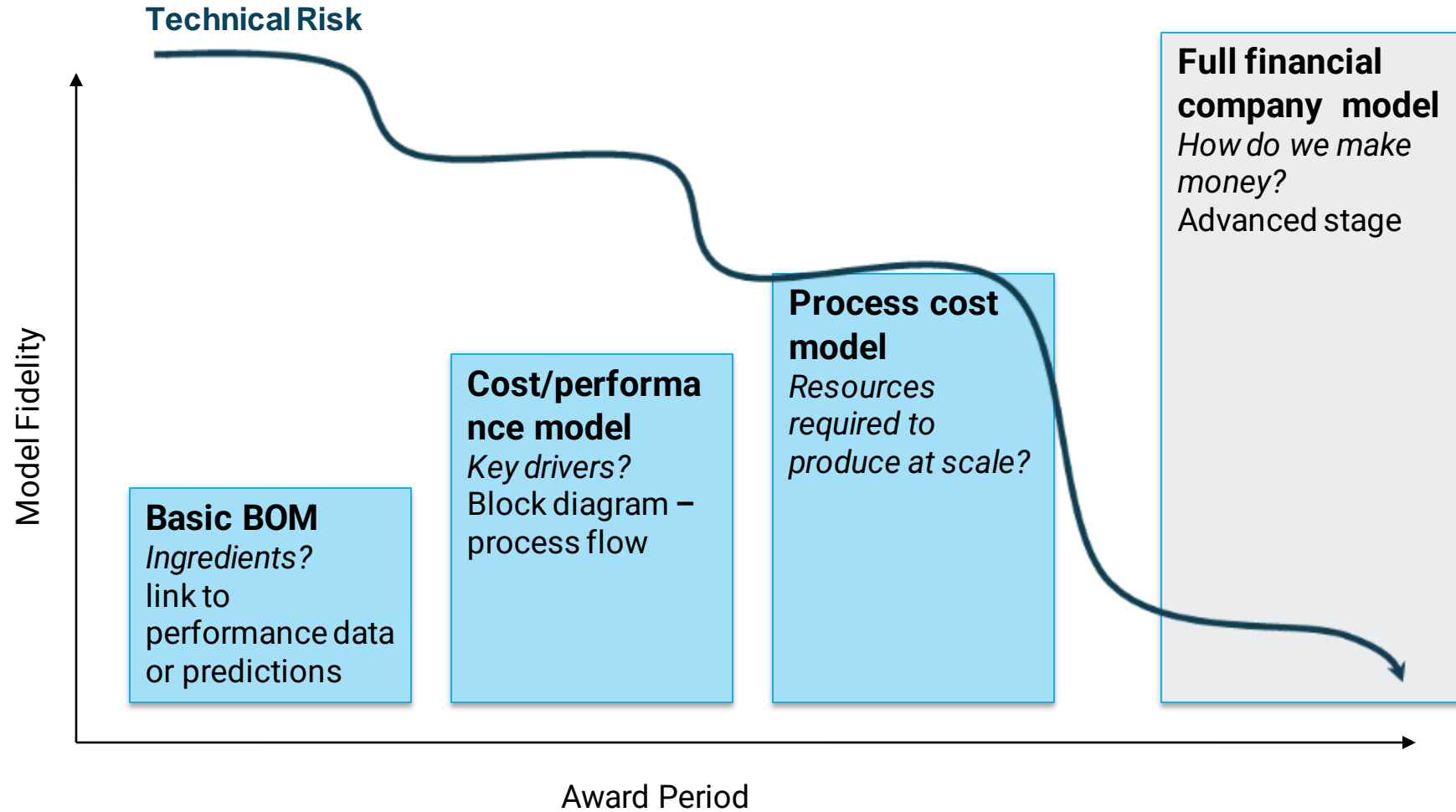


T-E Analysis
Cost

- Establish **theoretical limits**
- Identify Most **Valuable Improvements**
- **Inform** Potential **Trade-offs**, Targets, and Metrics
- Ultimately...Understand the **Minimum Viable Pricing**
- Starting point based upon ... **“Value Pricing”**

Identify specific technology improvements that affect major cost drivers
Determine economic viability of end product

TEA evolution



Required inputs for TEA

Cost

- Annual storage cost of on-site, spent fuel storage (\$/kg/year)
- Transportation cost of spent fuel (\$/kg/km)
- Reprocessing facility
 - CapEx
 - OpEx (O&M)
 - Decommissioning
- Transmutation facility
 - CapEx
 - OpEx (O&M)
 - Decommissioning
- Transportation of fission products (\$/kg/km)
- Long-term storage cost of fission products (\$/kg/year)

Price

- Value of transmuted fission products (\$/kg)
 - Risk reduction (transmuted products in long-term storage vs on-site pools)
 - Addresses a public and governmental concern for waste handling as required by next generation of nuclear power.

Value Proposition

- *Realistic alternative to long-term disposal (Yucca Mountain)*
- *What is the value ... purpose of breakout session*

Creating a business plan

Guiding document describing a company's core business activities and how it plans to achieve its goals.
Consistently updated.

Concept Analysis

- Exploring entrepreneurship
- Defining vision/mission
- Defining target market
- Conducting market research and analysis
- Testing business concept
- Regulations & permitting
- Finance, Insurance, & Warranties
- Public relations
- Competition (International)

Business Planning

- Entering market
- Financial planning
- Building/compensating team
- Protecting business and IP
- Identifying funding and working with investors
- Managing and operating business
- Gov't relations
- Communications

► Fantastic resource – FastTrac Entrepreneur Manual by Kauffman Foundation

Building a solid team is crucial!

Management

Boards/advisors

Recruitment

Growing pitfalls

Culture

Outsourcing



QUESTIONS?



U.S. DEPARTMENT OF
ENERGY

chris.vandervort@hq.doe.gov

<https://arpa-e.energy.gov>



If it works...

will it matter?

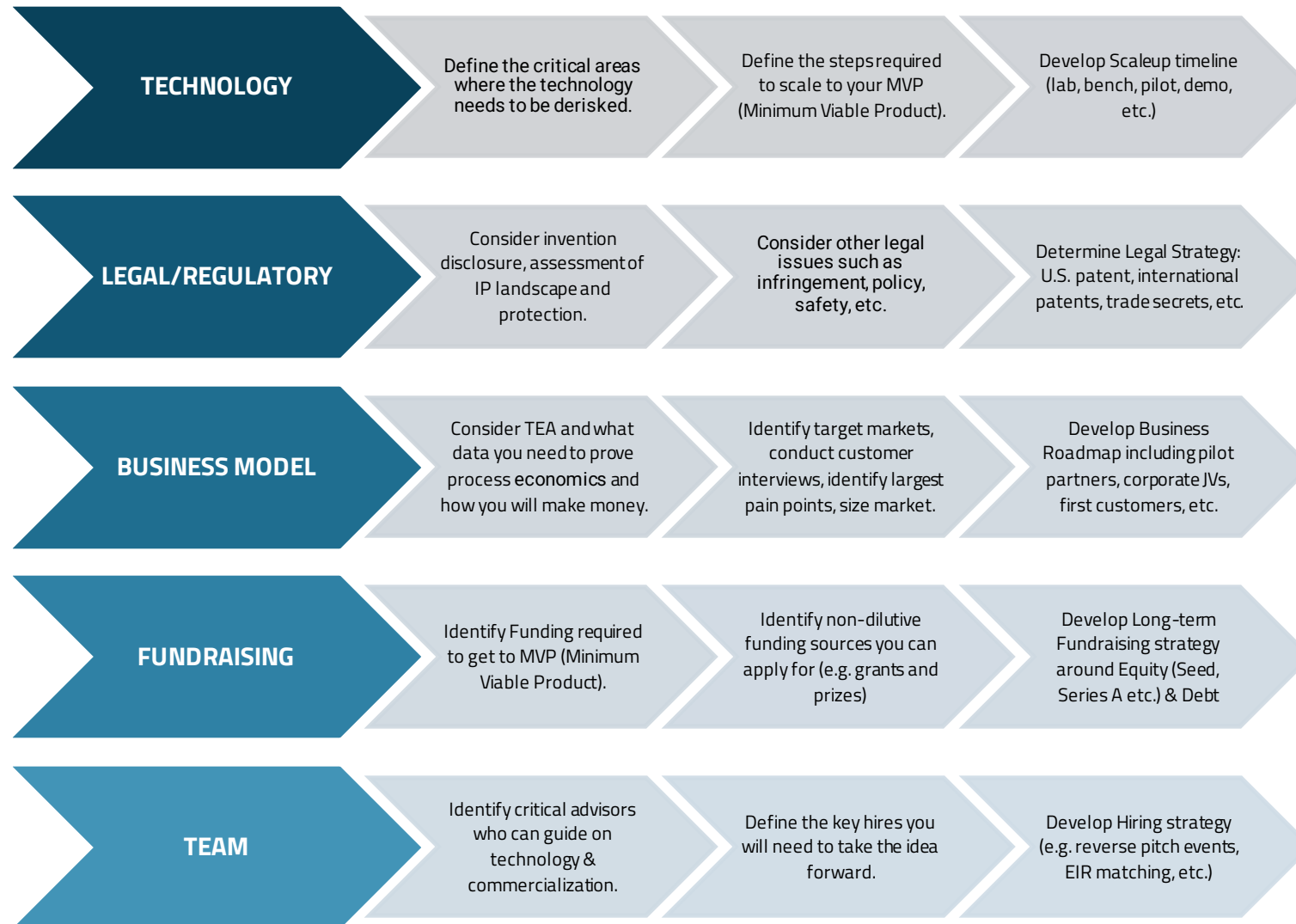
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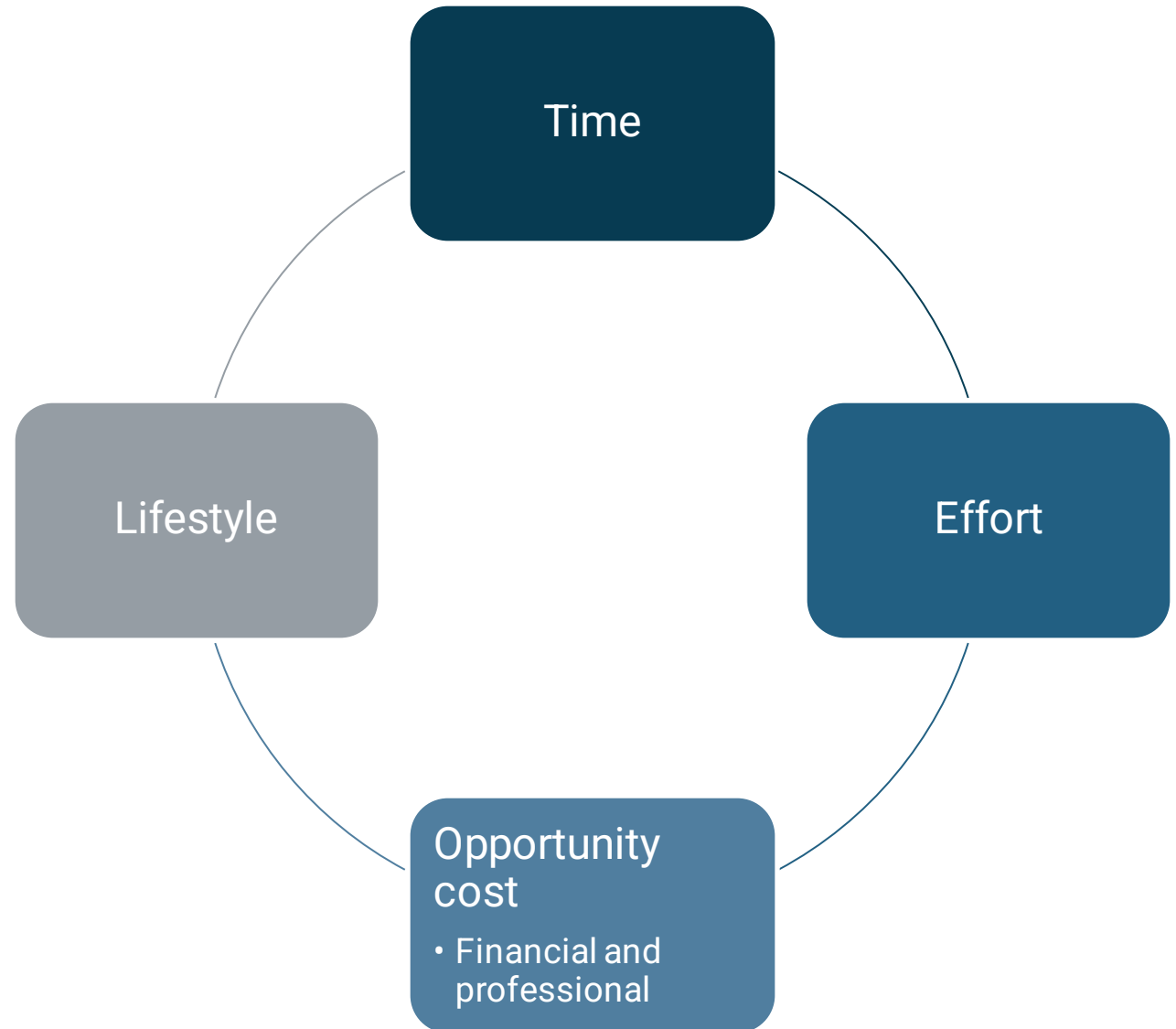
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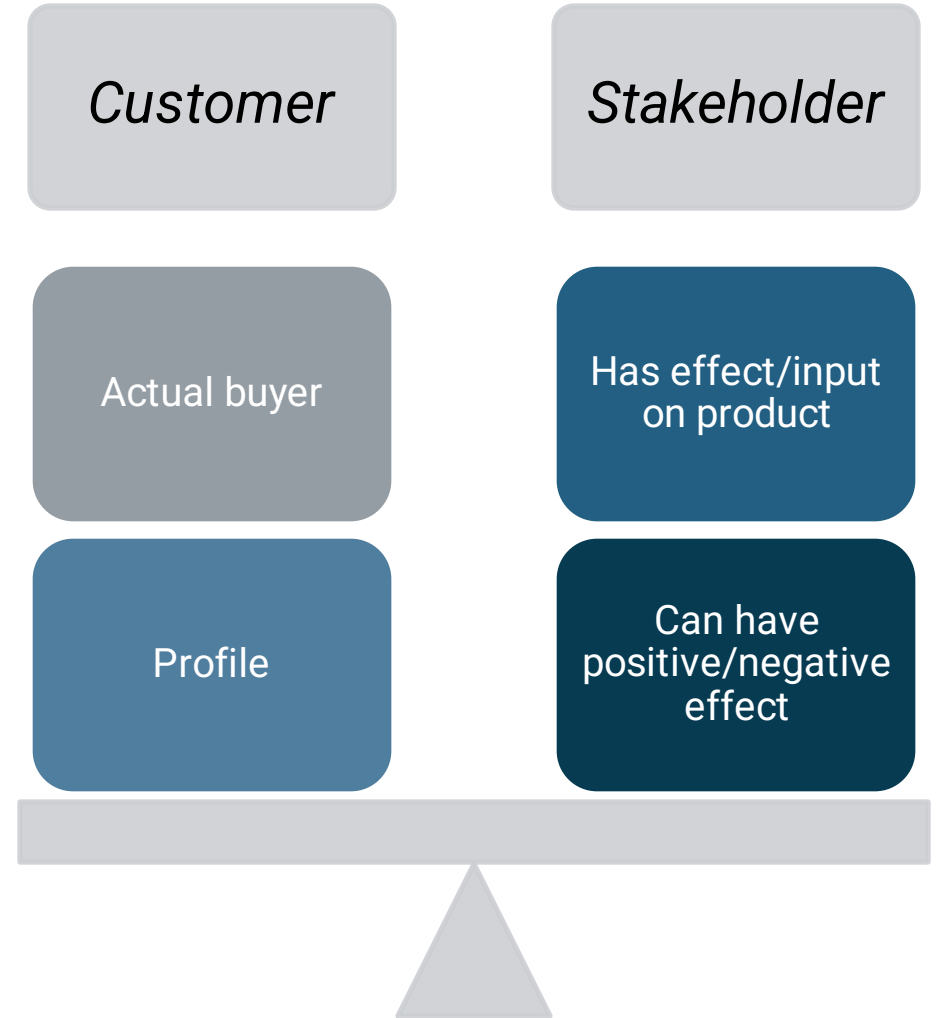
I'm a technologist – but where do I start?

▶ You are your first investor!

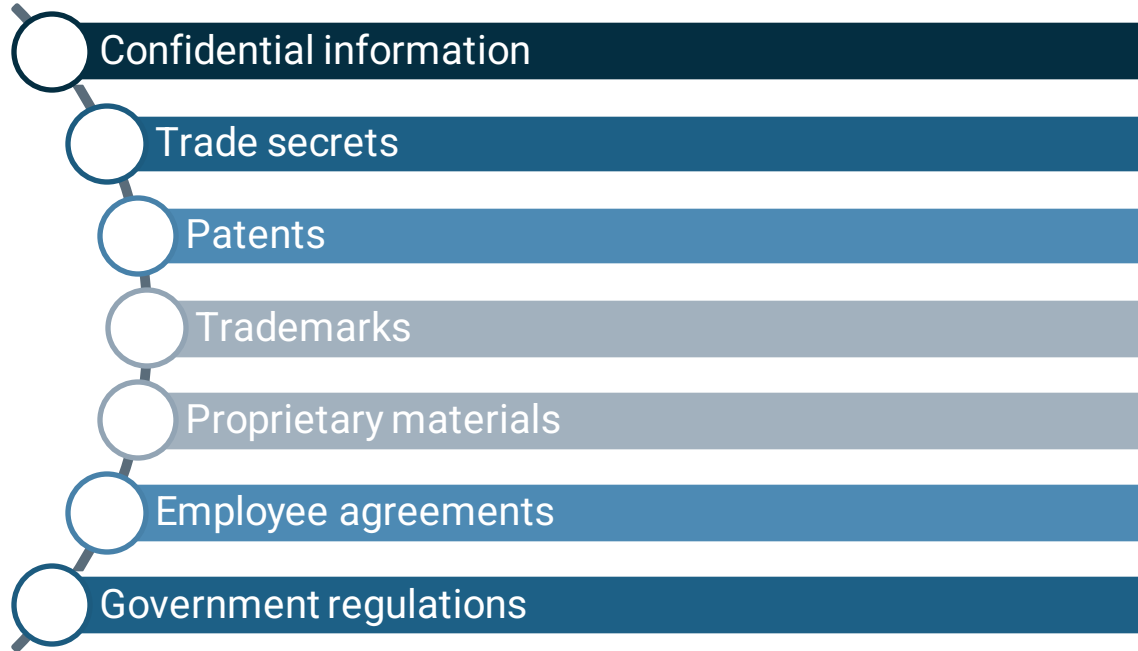
- ▶ How would you evaluate your own tech?
- ▶ Would you put your own money into it?



Identify customers and stakeholders



Protect my IP (*internally and externally*)



ARPA-E can provide funds for IP protection

❖ Use institution's tech. transfer office or identify legal counsel

What are my options for setting up shop?

Spin-off/Start-up

- Type of business/Legal structure
- Incubators
- Accelerators
- Business school
- TTO
- Hire/contract experienced resource

Licensing tech.

- In-, out-, cross-licensing
- Fees, Royalties, Milestones

What is my business model?

Market penetration	Sales channels	Marketing	Value chain and vertical integration	Servicing	Pricing
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Top down	<input type="checkbox"/> Distributors	<input type="checkbox"/> Print	<input type="checkbox"/> Sole source	<input type="checkbox"/> Warranties	<input type="checkbox"/> Break-even
<input type="checkbox"/> Bottom up	<input type="checkbox"/> Direct/indirect	<input type="checkbox"/> Media	<input type="checkbox"/> Insource/outsource	<input type="checkbox"/> Guaranties	<input type="checkbox"/> Products
<input type="checkbox"/> Adoption curve		<input type="checkbox"/> Trade shows	<input type="checkbox"/> Development capital	<input type="checkbox"/> Liabilities	<input type="checkbox"/> Services
		<input type="checkbox"/> Marketing alliances			
		<input type="checkbox"/> PR			

What are my risks?

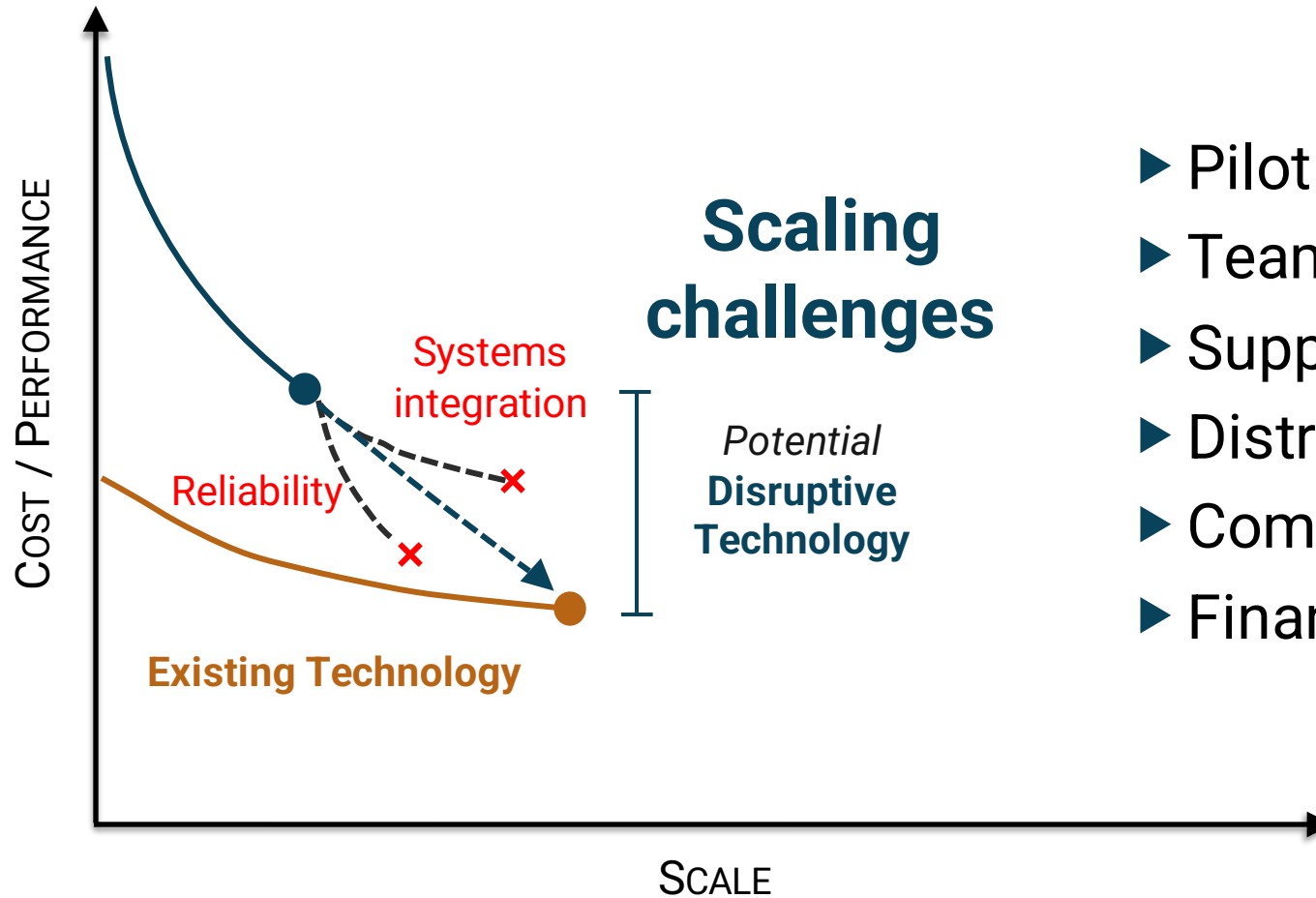


Create a risk register!

Can be simple or complex:

- Risk
- Risk type
- Probability
- Consequence
- Mitigation
- Residual risk

My technology works nicely at small scale, but what next?



- ▶ Pilot and Manufacturability
- ▶ Team makeup
- ▶ Supply Chain
- ▶ Distribution Channels
- ▶ Commercial Partners
- ▶ Financial Partners

What are my options for raising money?

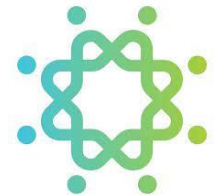
Non-Equity

- Bootstrapping
- Grants
- Debt



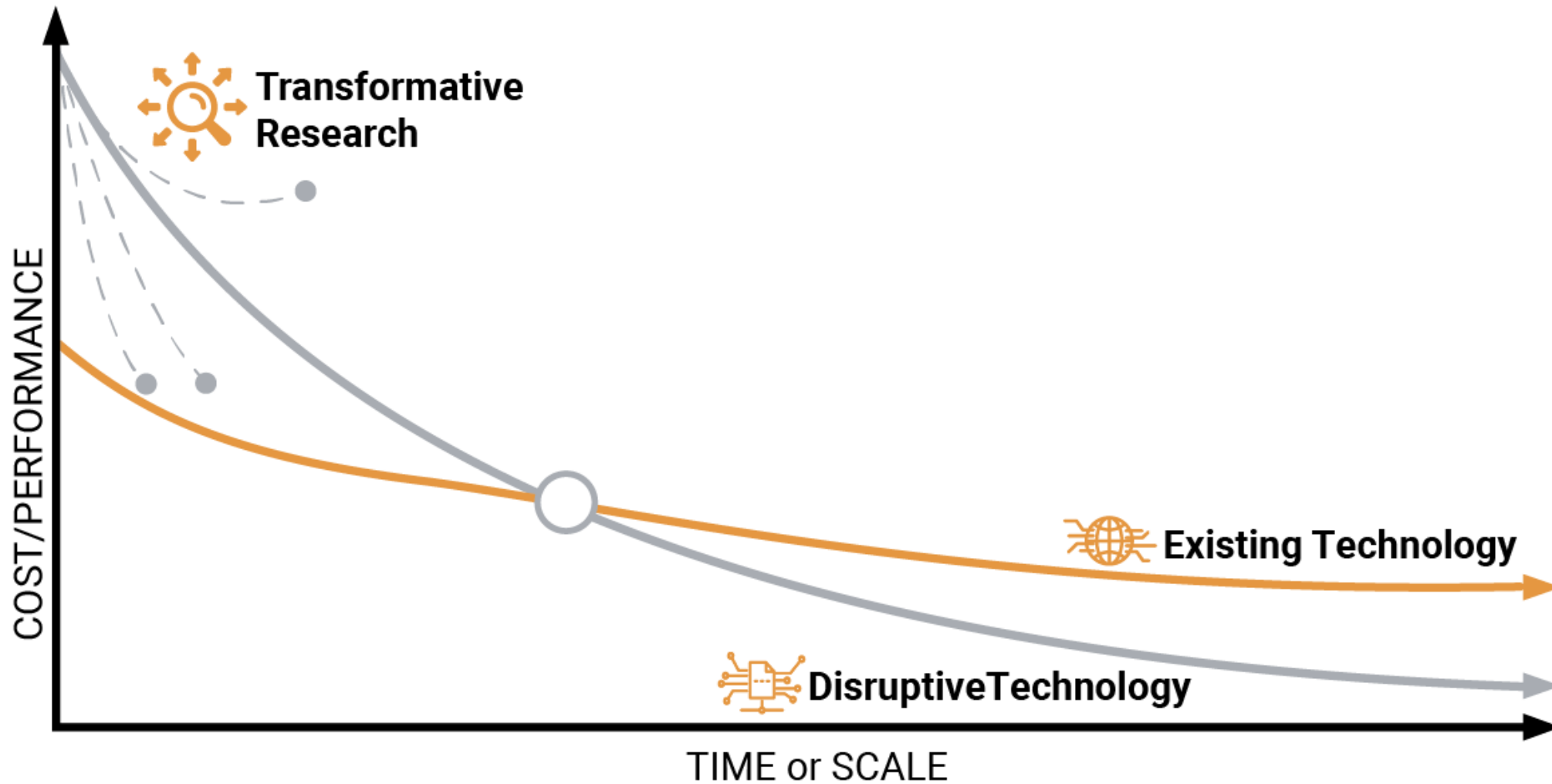
Equity

- Friends and family
- Angel
- Venture



What is the long term strategy/exit?

ARPA-E Role in Research



Business opportunities

Transportation

Reprocessing

Transmutation

Long Term Storage

