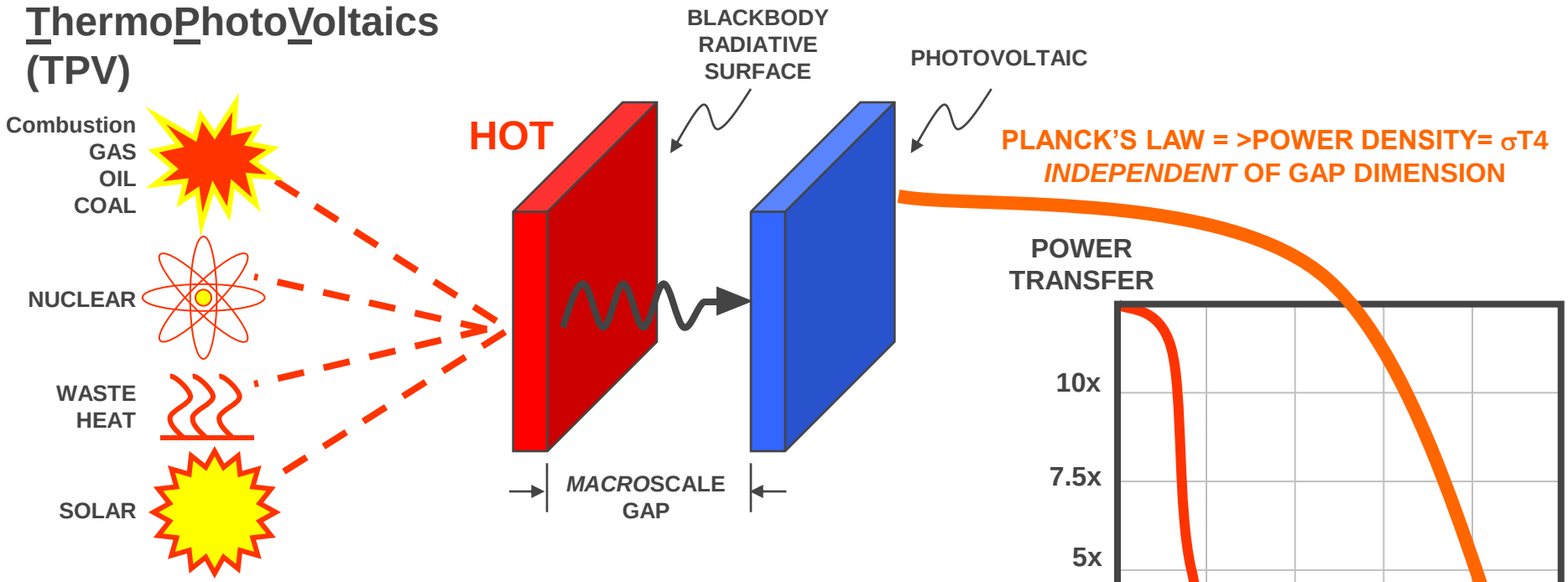
MTPV

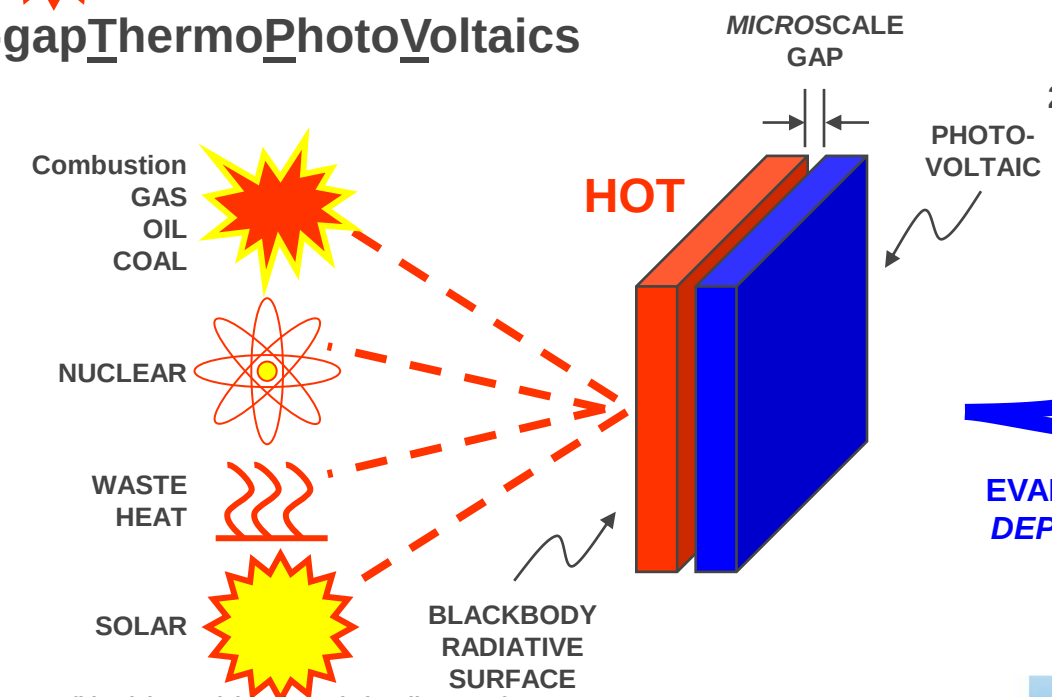
Designing Energy *for the* Future

Meeting the Worlds Energy Demands More Effectively and Efficiently

ThermoPhotoVoltaics (TPV)



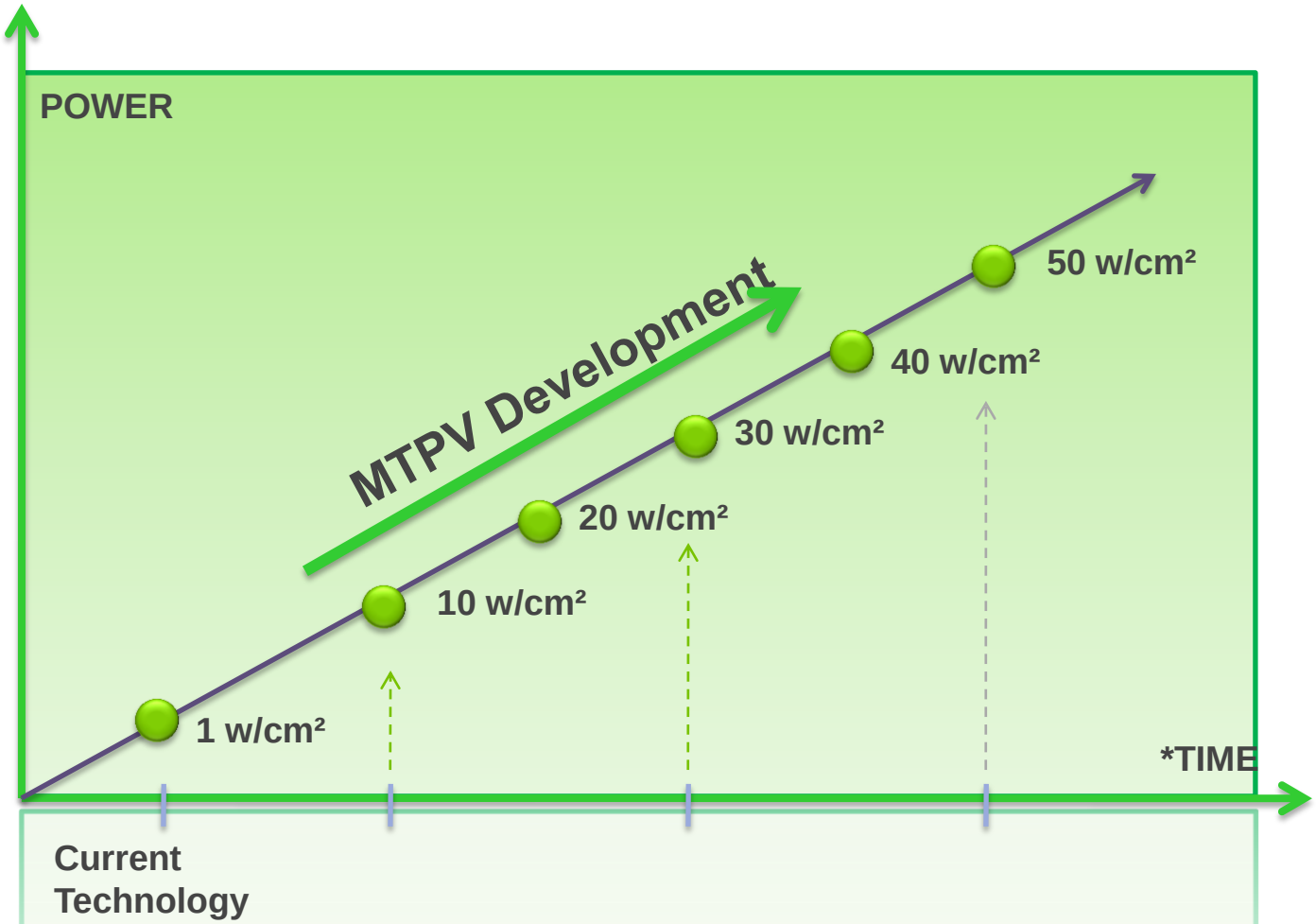
Micron-gapThermoPhotoVoltaics (MTPV)



EVANESCENT COUPLING REGIME
DEPENDENT OF GAP DIMENSION

MTPV

High Power & High Efficiency

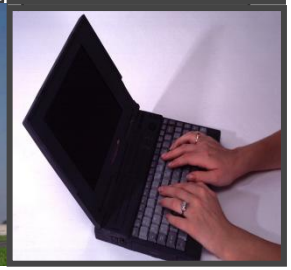


*estimated based on past performance and scientific models

Opportunities for Growth

Automotive

- All Electric Drive Hybrid Primary Power
- Stand-alone Alternator
- Waste heat recovery
- Heavy equipment industry



Industrial

- On-site CoGen
- Glass industry
- Steel industry
- Cement industry

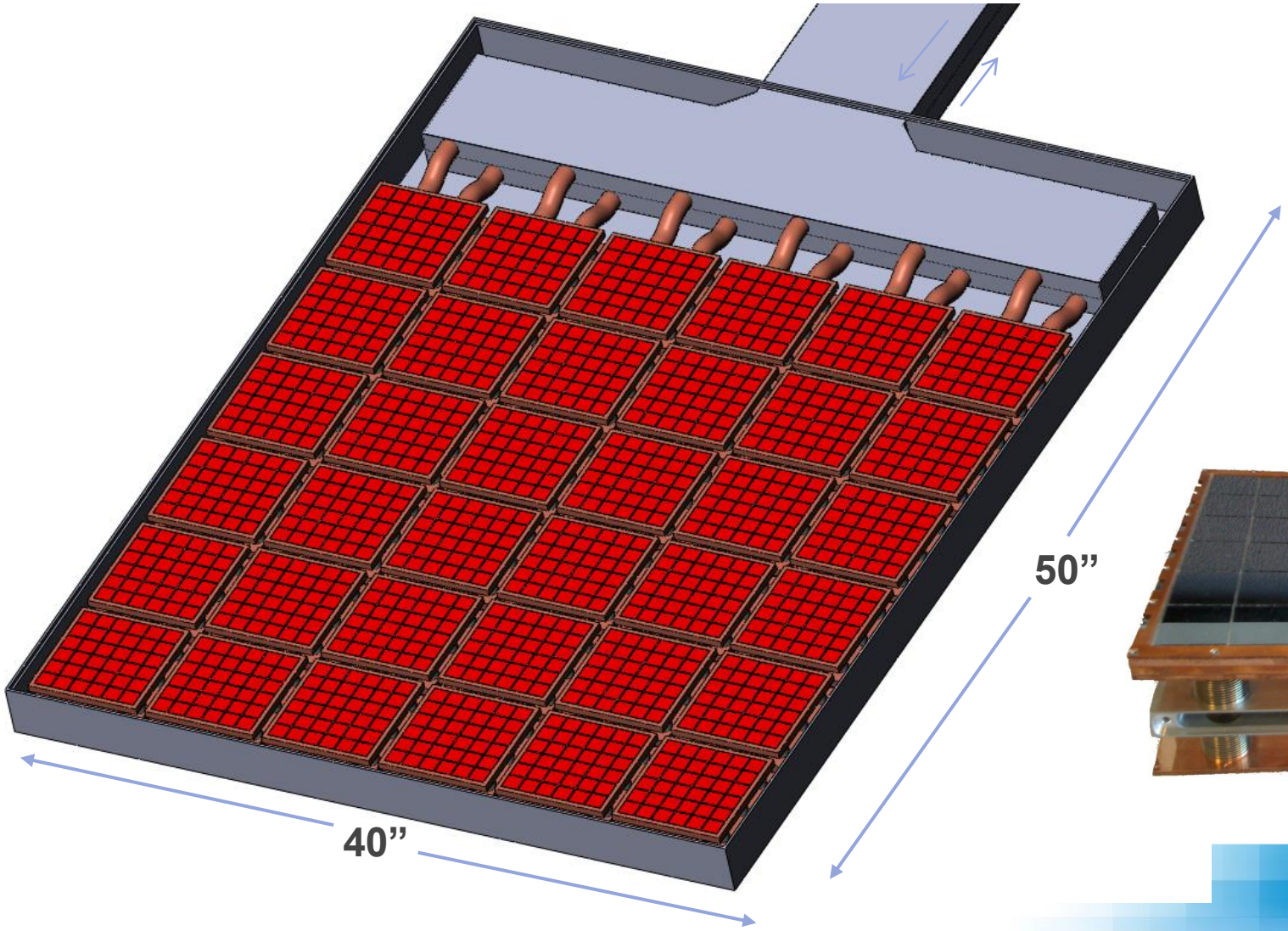
Solar

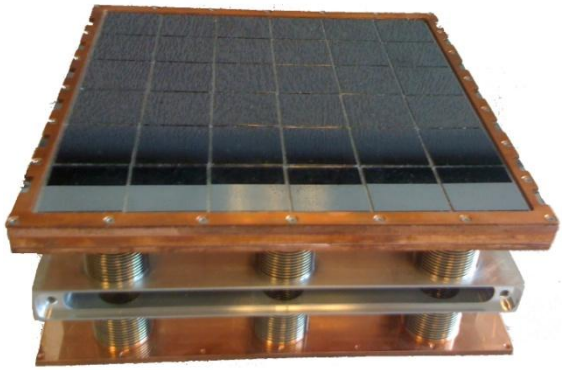
- Distributed, Modular CSP
- 24/7, Dispatchable, Cogen Solar
- Solar Storage
- Low beam uniformity req'd

Portable Power

- Fuel to electricity
- Power tools
- Portable electronics
- Mobile power

MTPV Square Meter Panel (~10 KW)





The Challenge

Science / Invention / Idea

$$I = -e \int d\epsilon_b \int d\epsilon_1 \int d\epsilon_a \int d\epsilon_3 \rho_b(\epsilon_b)\rho_1(\epsilon_1)\rho_a(\epsilon_a)\rho_3(\epsilon_3)$$
$$\times \frac{2\pi}{\hbar}|\langle r_a, r_3|U_{\text{eff}}(\epsilon_1+\epsilon_b)|r_b, r_1\rangle|^2 \delta(\epsilon_b+\epsilon_1-\epsilon_a-\epsilon_3)$$
$$\times \{p_b(\epsilon_b)p_1(\epsilon_1)[1-p_a(\epsilon_a)][1-p_3(\epsilon_3)] - p_a(\epsilon_a)p_3(\epsilon_3)$$
$$\times [1-p_b(\epsilon_b)][1-p_1(\epsilon_1)]\}.$$

How Do You Fund The Journey?

Saleable Product

The Idea

Self Funded
Sweat Equity
Friends/Family

Science / Invention / Idea

$$I = -e \int d\epsilon_b \int d\epsilon_1 \int d\epsilon_a \int d\epsilon_3 \rho_b(\epsilon_b)\rho_1(\epsilon_1)\rho_a(\epsilon_a)\rho_3(\epsilon_3)$$
$$\times \frac{2\pi}{\hbar}|\langle r_a, r_3|U_{\text{eff}}(\epsilon_1+\epsilon_b)|r_b, r_1\rangle|^2 \delta(\epsilon_b+\epsilon_1-\epsilon_a-\epsilon_3)$$
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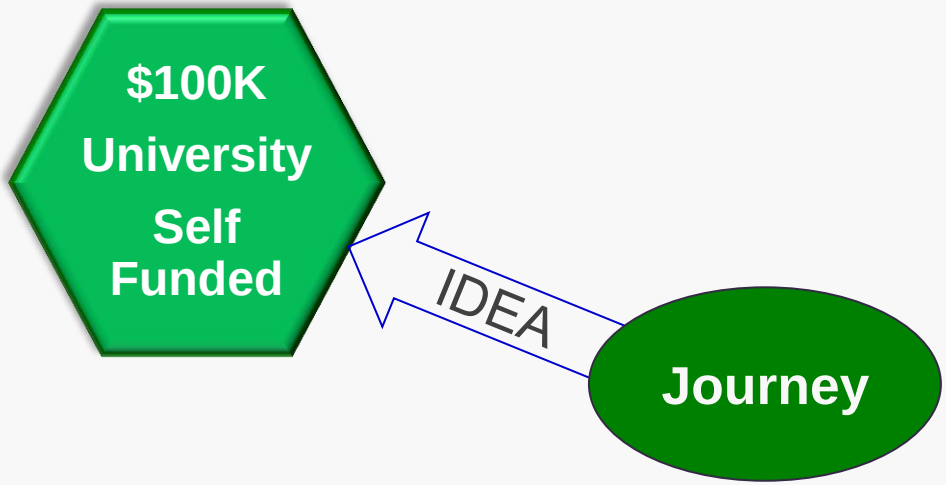
$$\times [1-p_b(\epsilon_b)][1-p_1(\epsilon_1)]\}.$$

Inventors
Entrepreneurs
Universities
Military
National Labs
Corporations
Startups

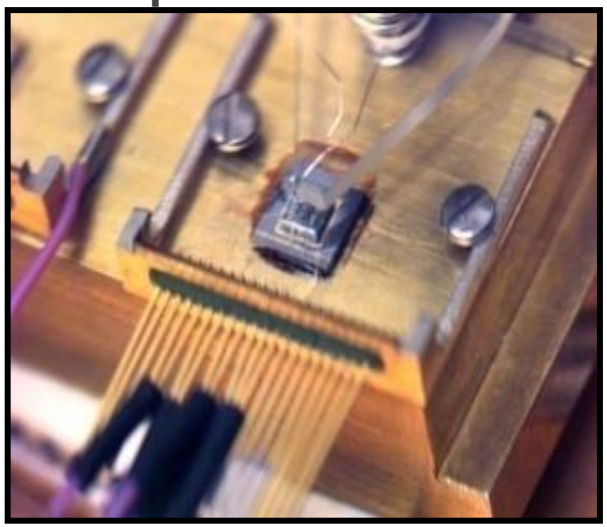
MTPV


$100K
University
Self
Funded
IDEA
Journey

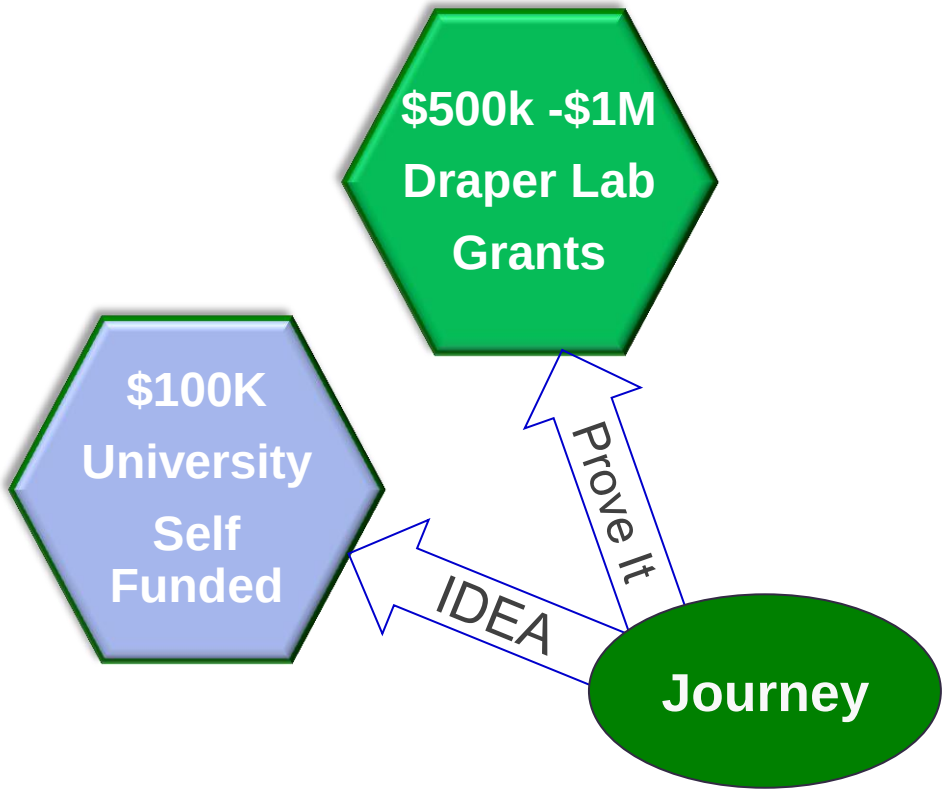
Can you prove it?

Friends/Family
Government
Angels

Experiment / Proof



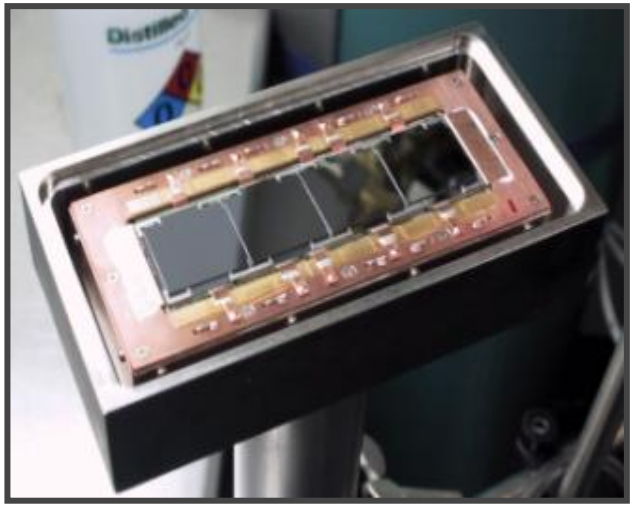
Basement
Garage
Universities
National Labs
Strategic Corp.
Customers


$500k -$1M
Draper Lab
Grants
$100K
University
Self
Funded
Prove It
IDEA
Journey

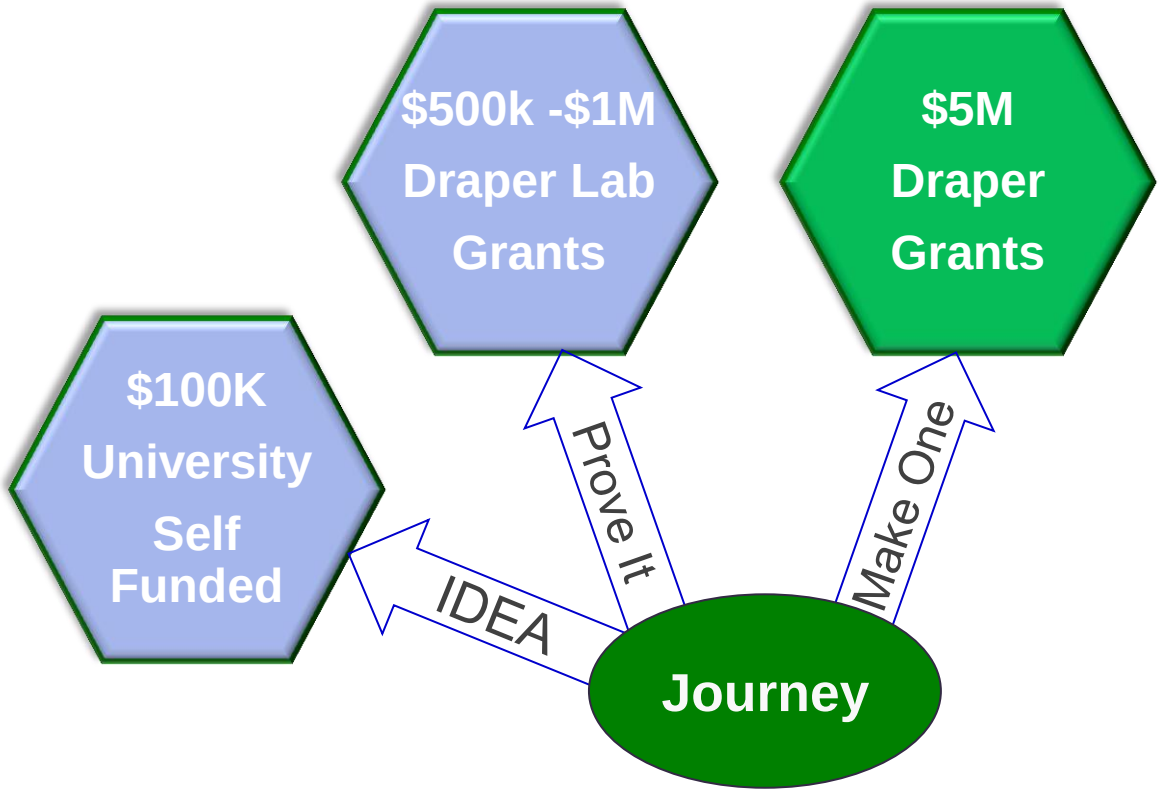
Can you build one?

Angels Groups
Grants
Early Stage VC

Initial Prototype



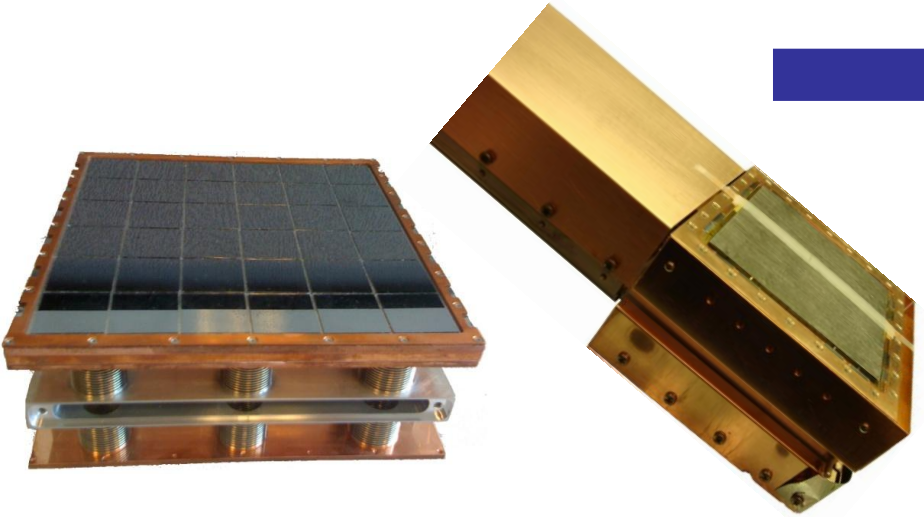
Incubators
Universities
National Labs
Strategic Partners
Machine shops
Design shops


$500k -$1M
Draper Lab
Grants
$5M
Draper
Grants
$100K
University
Self
Funded
Prove It
Make One
IDEA
Journey

Scalability
(Can You Build One of Commercial Size)

Angels/ Grants
Family Firms
Early Stage VC

Initial Prototype



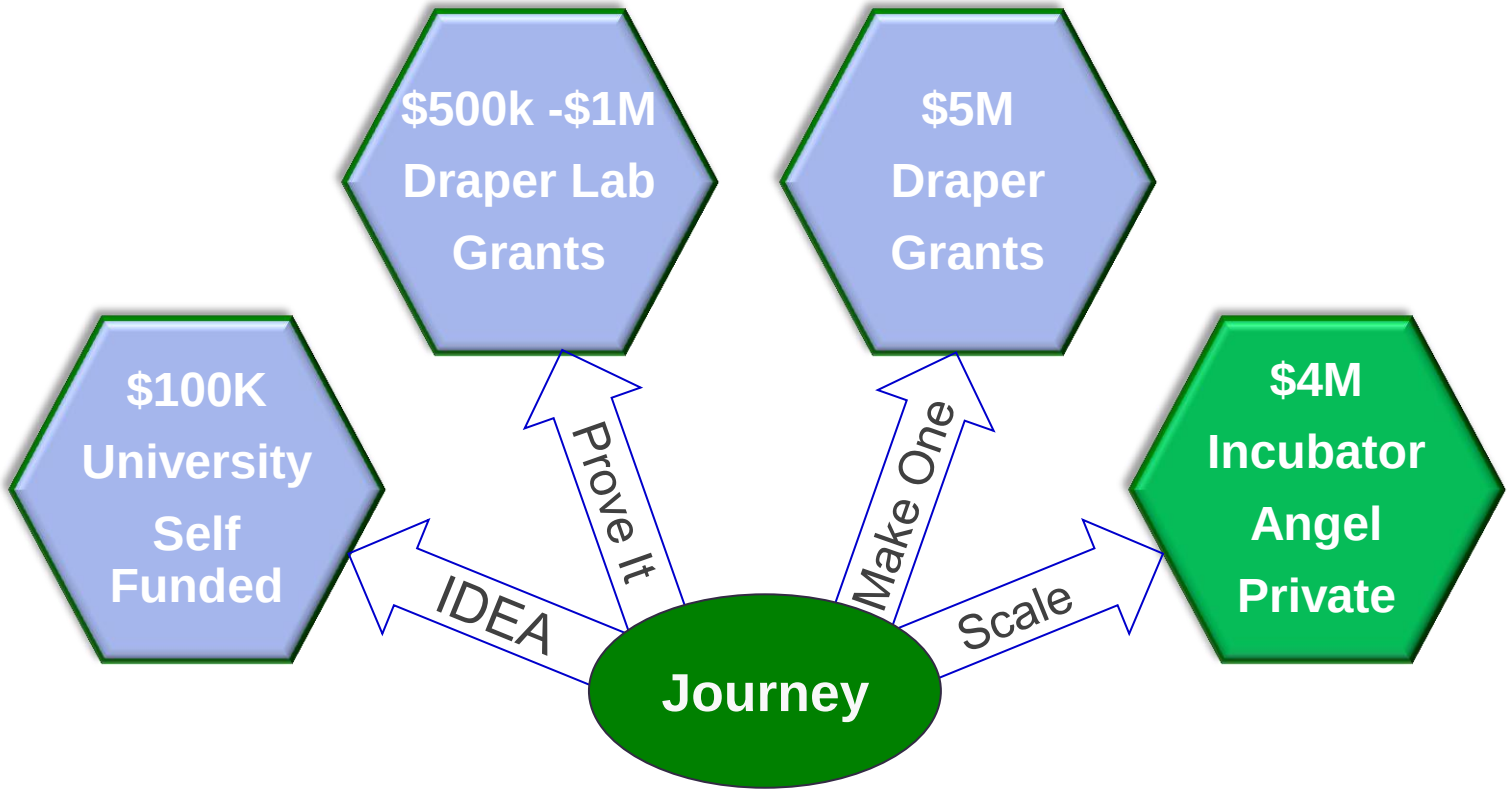
Plant/Property

Incubators

Universities

National Labs

Strategic Partners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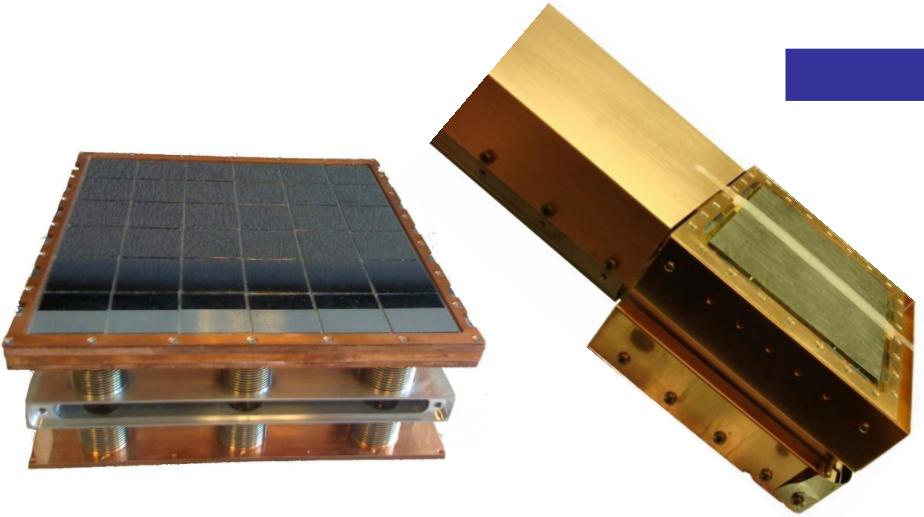
Draper Lab
Grants
$5M
Draper
Grants
$100K
University
Self
Funded
$4M
Incubator
Angel
Private
Prove It
Make One
IDEA
Scale
Journey

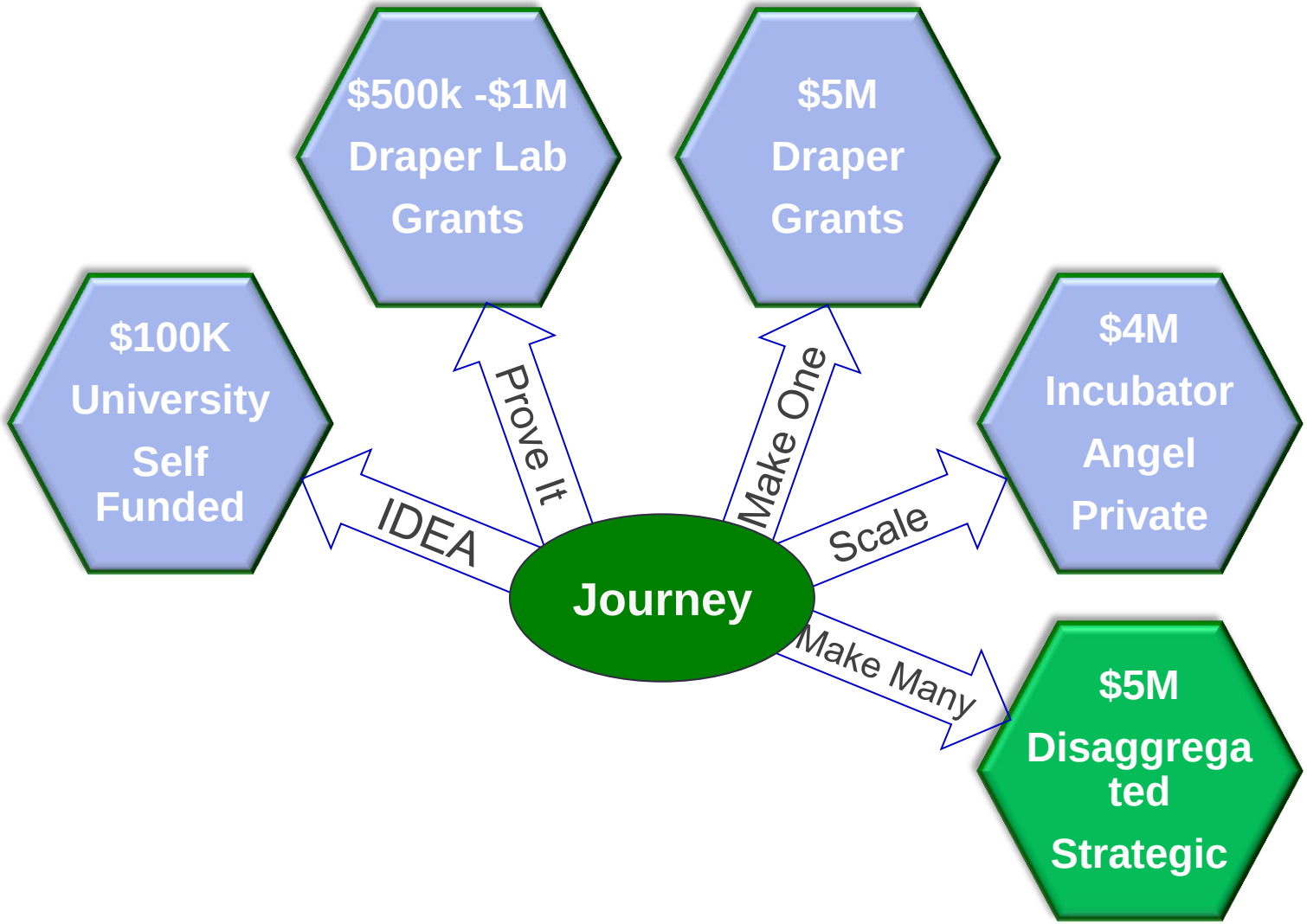
Manufacturability (Can You Build Many)

Angels
Government
Mainstream VC

Manufacturability



Integrated
Disaggregated
Outsourced
Hybrid


$500k -$1M
Draper Lab
Grants
$5M
Draper
Grants
$100K
University
Self
Funded
$4M
Incubator
Angel
Private
$5M
Disaggrega
ted
Strategic
Journey
IDEA
Prove It
Make One
Scale
Make Many

Commercialization
Can You Sell One / Can You Sell Many

Government
VC
Debt / PE

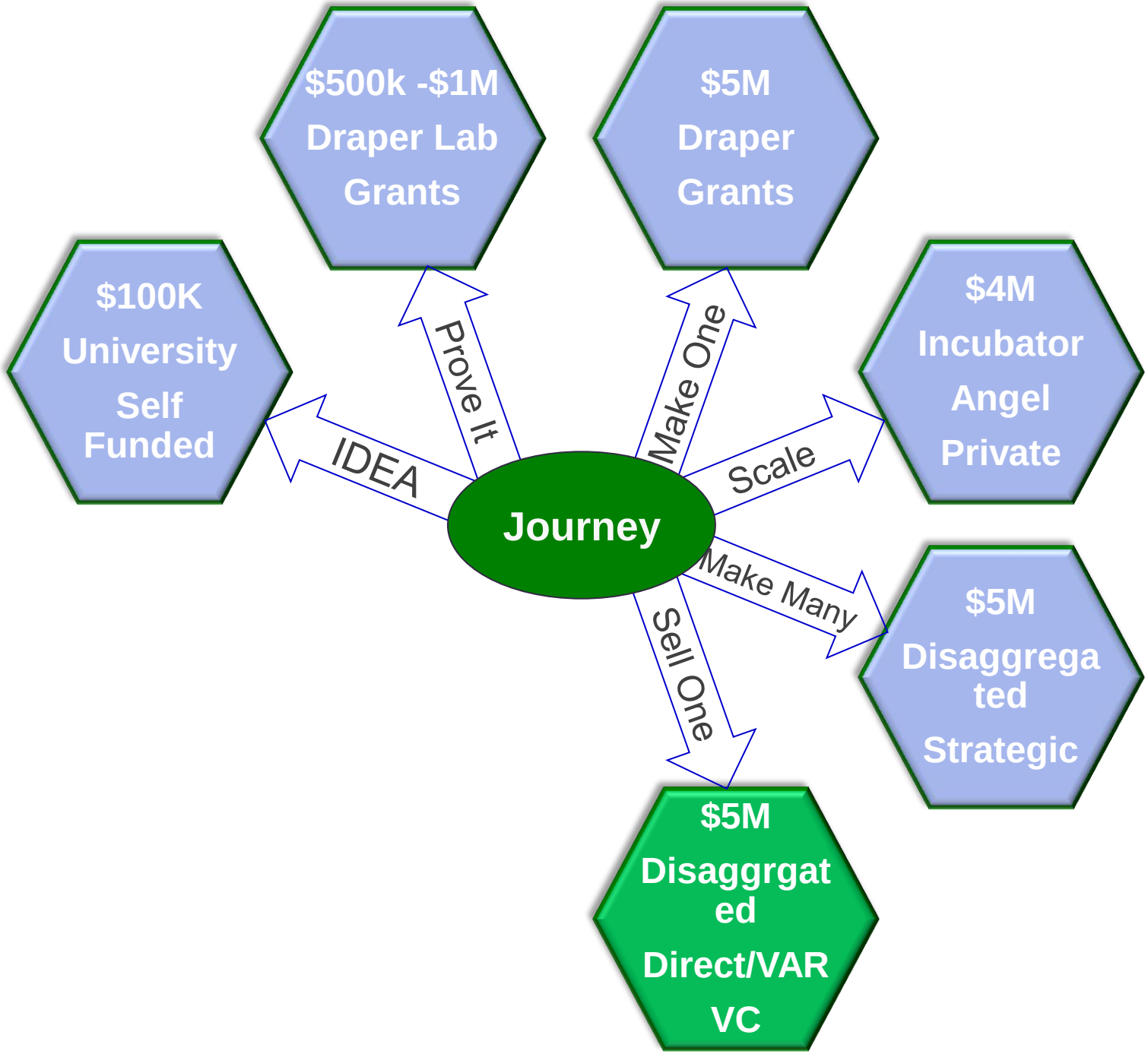
Direct Sales

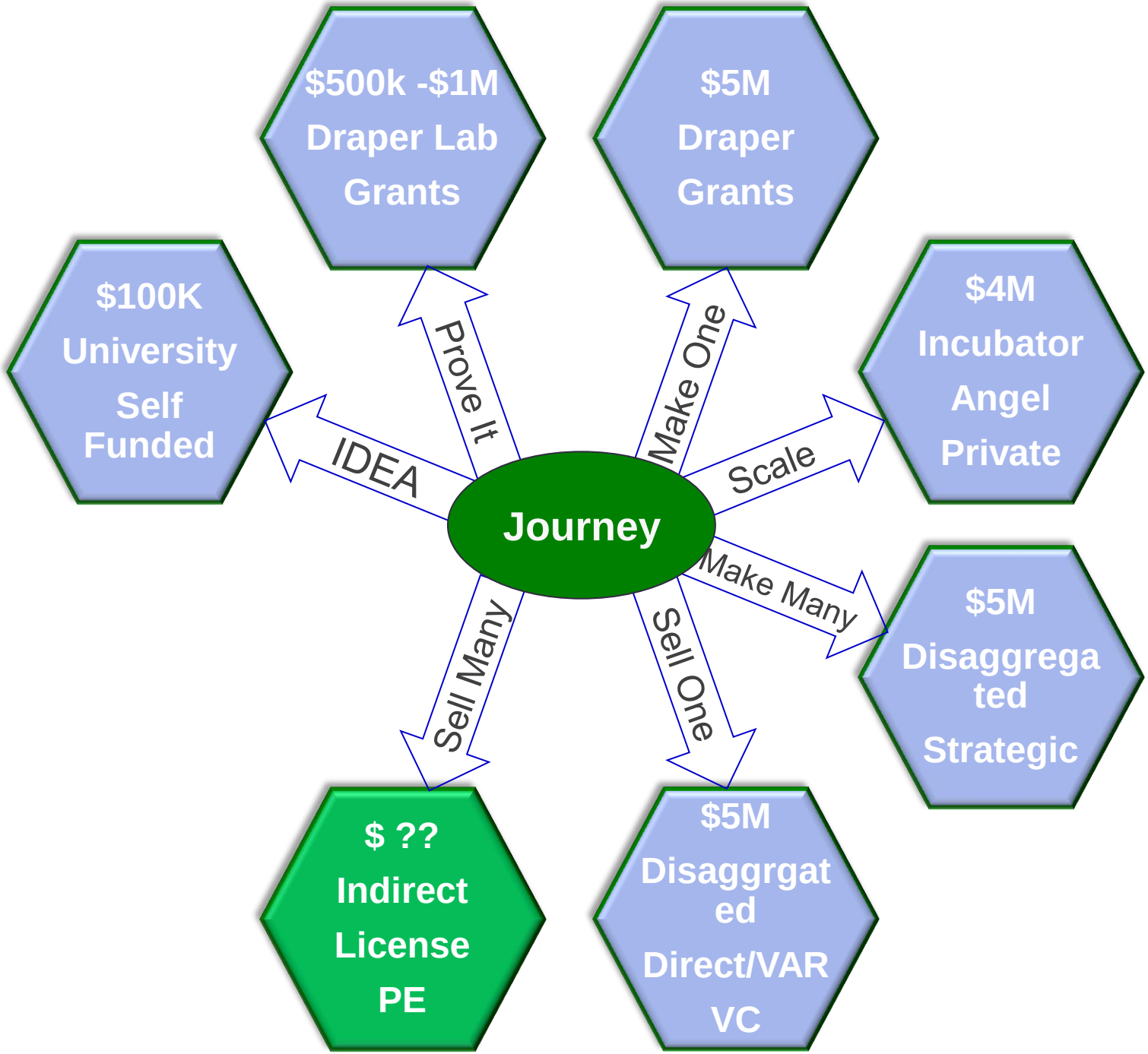
Indirect Sales
- **VARs**
- **Dealers**
- **Distributors**

Licensing

Sale of Company

Sale of IP


$500k -$1M
Draper Lab
Grants
$5M
Draper
Grants
$100K
University
Self
Funded
$4M
Incubator
Angel
Private
Prove It
Make One
IDEA
Scale
Journey
Make Many
Sell One
$5M
Disaggrega
ted
Strategic
$5M
Disaggrgat
ed
Direct/VAR
VC


$500k -$1M
Draper Lab
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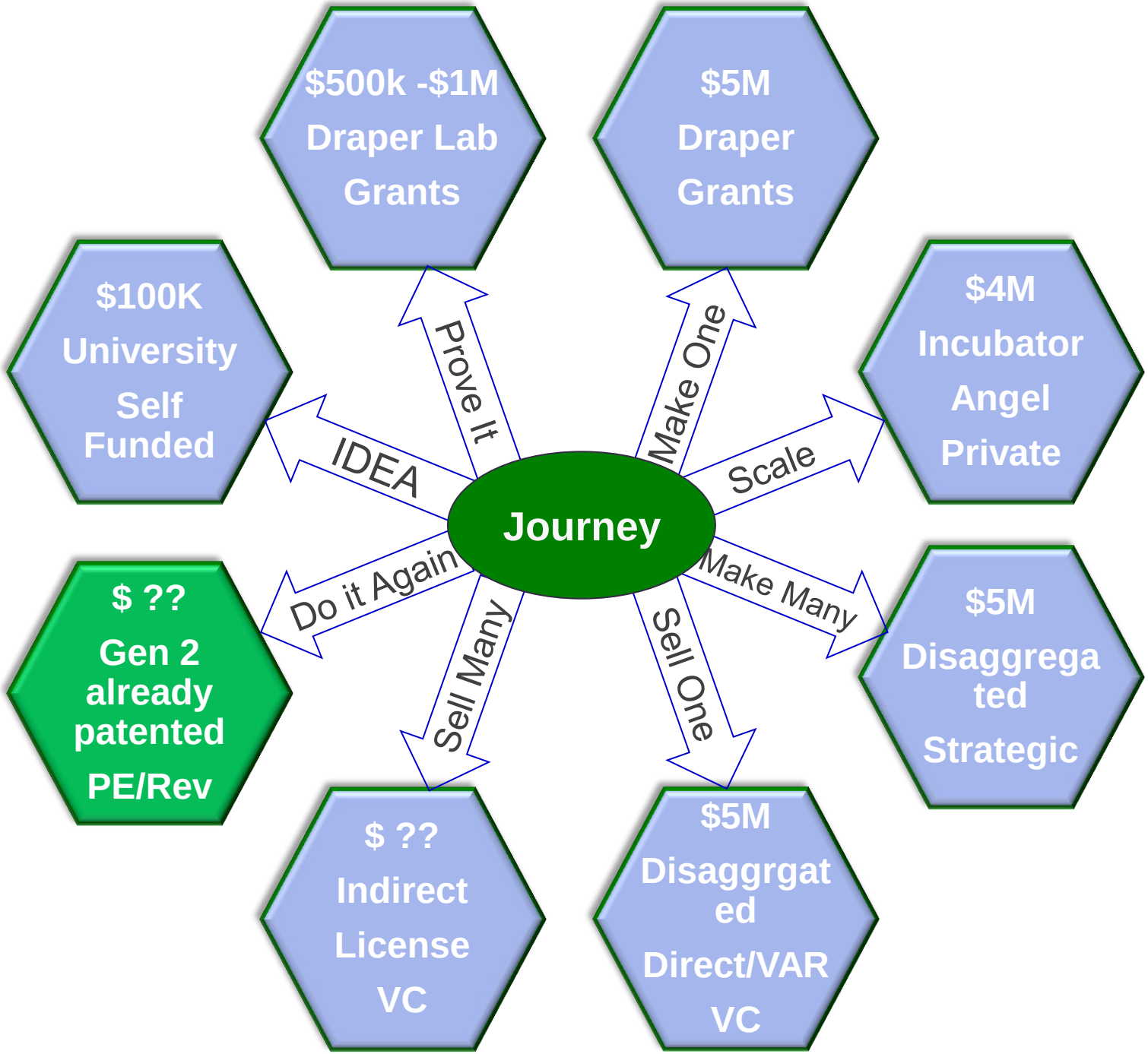
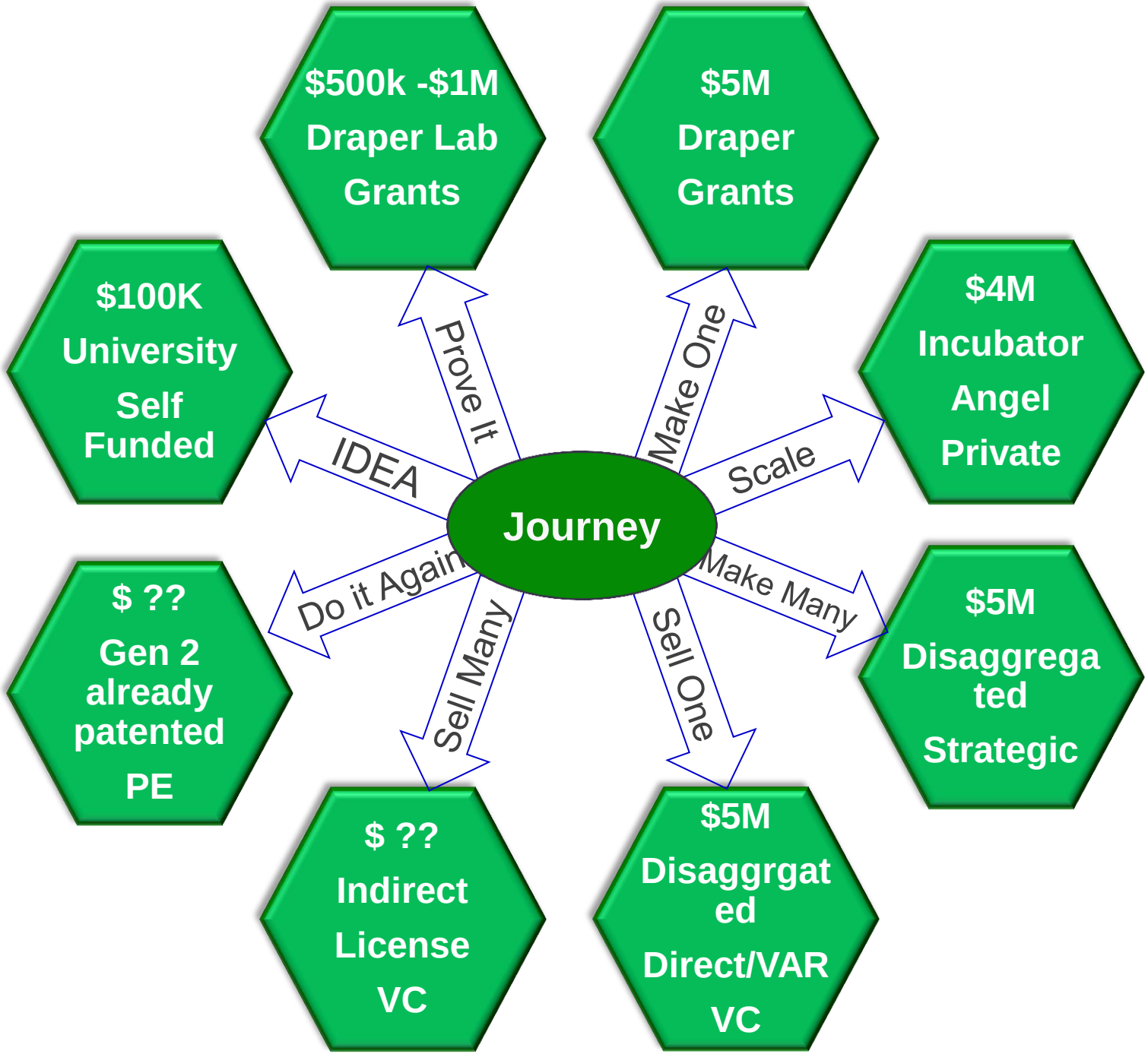
Private
Prove It
Make One
IDEA
Scale
Journey
Make Many
$5M
Disaggrega
ted
Strategic
Sell Many
Sell One
$??
Indirect
License
PE
$5M
Disaggrgat
ed
Direct/VAR
VC


Journey
IDEA
$100K
University
Self
Funded
Prove It
$500k -$1M
Draper Lab
Grants
Make One
$5M
Draper
Grants
Scale
$4M
Incubator
Angel
Private
Make Many
$5M
Disaggrega
ted
Strategic
Sell One
$5M
Disaggrgat
ed
Direct/VAR
VC
Sell Many
$??
Indirect
License
VC
Do it Again
$??
Gen 2
already
patented
PE/Rev


Journey
IDEA
$100K
University
Self
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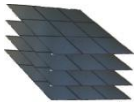
Disaggrega
ted
Strategic
Sell One
$5M
Disaggrgat
ed
Direct/VAR
VC
Sell Many
$??
Indirect
License
VC
Do it Again
$??
Gen 2
already
patented
PE

Value Chain (Sample flow)

Sub Assembly

Chips

APPLIED MATERIALS. SVTC.

Cold housing


Scientific Machine & Welding

Hot housing

SAINT-GOBAIN

Balance of System

GE Johnson Controls McMASTER-CARR.

Contract Manufacturer



Celestica.

System Installation

Engineering Firms/ Manufacturers

Aura Engineering, LLC
TECO Toledo Engineering Co., Inc.
RAVEN RIDGE RESOURCES
JW Technologies, LLC
SWINDELL DRESSLER
KOCH INDUSTRIES INC.

Value added Resellers (TDB)

MTPV Authorized Installers (TDB)

Value Chain Cont'd (Sample flow)

System Installation

Engineering Firm/ Manufactrurers

RAVEN RIDGE RESOURCES

Aura Engineering, LLC

JW Technologies, LLC

Value added Resellers (TDB)

MTPV Authorized Installers (TDB)

MTPV components integrated into a larger solution

Lower Margin/ Lower SG&A Larger Market Reach

Siemens as an example

Lower Margin/Lower SG&A Larger Market Reach

Higher Margin & Higher SG&A

Capital Equipment

Or

Electricity

Capital Equipment

Or

Electricity

Customers

Peabody ENERGY

LBC TANK TERMINALS

Chevron

Human Energy

PPG

SAINT-GOBAIN

OWENS CORNING INNOVATIONS FOR LIVING

CARDINAL Glass Industries

MTPV

Designing Energy *for the* Future

Thank you