

Technology to Market

GENSETS

GENerators for Small Electrical and Thermal Systems

John R Tuttle, Ph.D.

Senior Commercialization Advisor

November 3, 2015



Outline

- ▶ **What is “Technology to Market” (and what it isn’t)**
- ▶ ***What you will be doing in your T2M Program***
 - *Technoeconomic Analysis*
 - *Business strategy*
 - *Follow-on Funding*
 - *Messaging*
- ▶ ***Summit preparation***

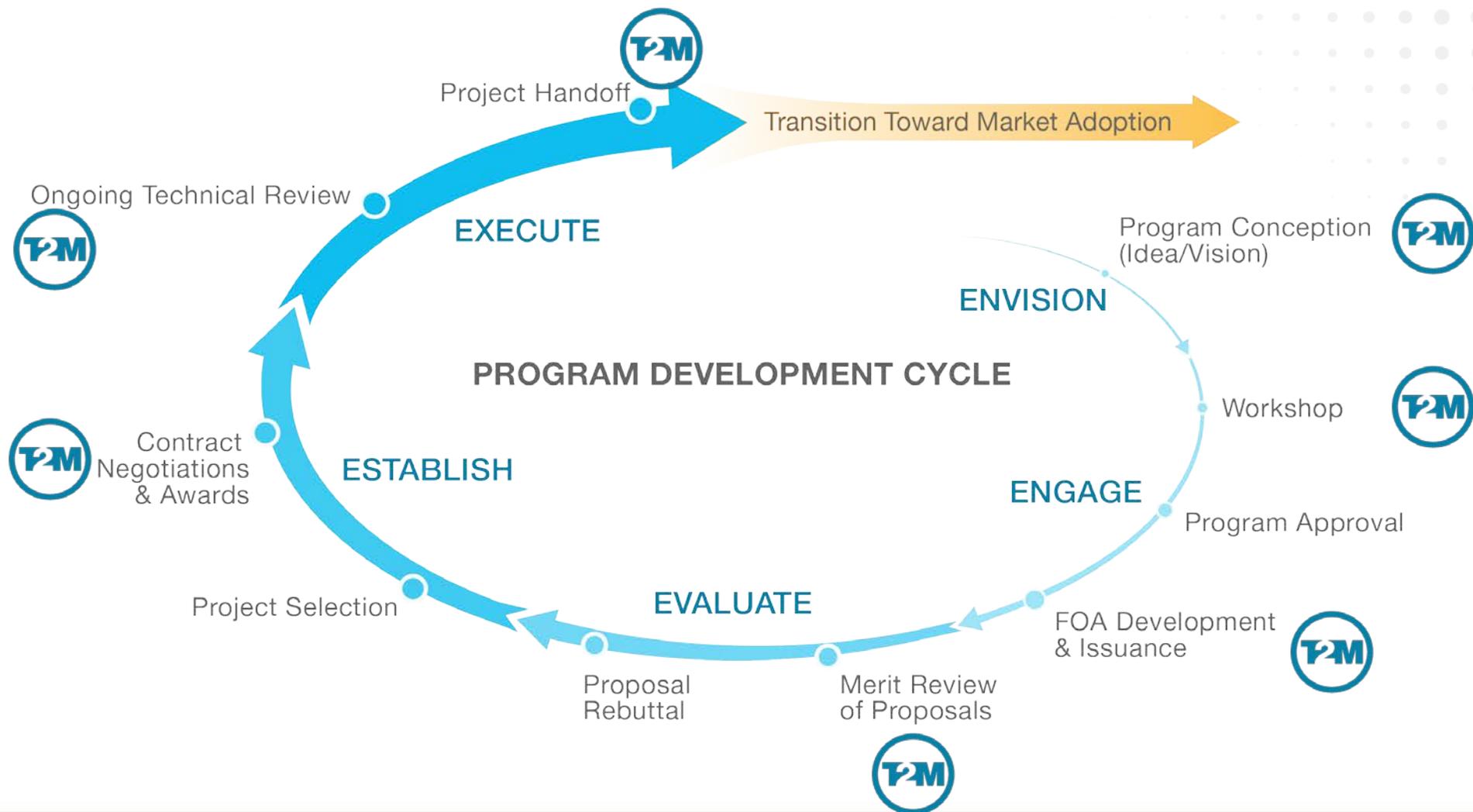
About the Speaker

- ▶ **Senior Commercialization Advisor (“T2M”) – ARPA-E (2013-present)**
 - Program development and market-facing execution
- ▶ **Technologist**
 - ~30 yrs in semiconductors (including μ -electronics)
 - ~30 yrs in solar-PV (11 yrs @ NREL, 10 yrs as CTO) – CIGS Technology
 - ~7 yrs consulting to companies large and small
 - ~3 yrs focusing on Storage, (other) Distributed Gen, Efficiency
- ▶ **Serial Entrepreneur / Executive (~20 yrs)**
 - Founded DayStar Technologies, Inc – (1996)
 - Built R&D, development and pilot-production facilities
 - 3rd pure-play solar company to go public (Nasdaq: DSTI)
 - Founded Skypoint Solar, Inc. - (2008)
 - \$500M factory construction project / LOI’s for factories in China
 - Consulted for several early-stage startups
 - Worked with public & private sectors in Senegal, Ghana, Brasil & China

Innovative & Disruptive?



At what points does T2M engage?



Our GENSETS Performers

Internal Combustion



Solid State



Microturbine



Stirling



What is Technology to Market?

- ▶ The **Technology to Market (“T2M”) program** is complementary to the Awardee’s technical program.
- ▶ Its primary purpose is to imprint market-facing elements to your technology development – whether your ready for market at the end or not
- ▶ What does “Success” look like?
 - Sufficient technological advancement to ultimately enable product introduction and differentiation in the market
 - Possible successful outcomes include:
 - New Company formation
 - New Investment into existing private entity
 - License to / funding from a Strategic Partner
 - Follow-on funding from another Govt agency

Basic Elements of Success

- ▶ What are the elements necessary for attracting interested parties to your project?
 - **Month 0:**
 - Technical plan that will produce results with metrics that are relevant
 - Commercialization (T2M) plan that is achievable / realistic for the technology sector in which your project competes
 - **Month T-X** (T= length of project, X=3, 6, or 12 mos.)
 - Significant data set;
 - 1st prototype or demonstration;
 - Refined Commercialization plan;
 - Ongoing discussions with potential partners / investors / govt agencies;
 - Solid techno-economic analysis (TEA);
 - **Project Completion**
 - An appropriate “hand-off” to the next phase of development

Role of T2M milestones

T2M milestones reflect a philosophy that we are technologists engaged in product creation

T2M Plan
Willingness to pay

- Who is the **customer**?
- How is their **need met now**?
- What is performance of **incumbent** technology?
- What **capabilities and resources** are needed to get to the next stage of development?

T-E Analysis
Cost

- Establish **theoretical limits**
- Identify Most **Valuable Improvements**
- **Inform** Potential **Trade-offs**, Targets, and Metrics
- Ultimately... Understand the **Minimum Viable Pricing**

Economic Modeling for Technology

Full Company Financial Model

Cash flow, dynamics of ramping production and varying sales, investments timing

Similar information for other projects competing for resources

Production Cost Model

Determine resources required for at-scale production

Tabulate material/component flow, labor & energy use, equipment, etc

Basic Materials & Process

Bill of Materials (BOM) – list of “ingredients”

Simple block diagram of production steps

Most early-stage companies begin with a basic form of “Production Cost Model”

Messaging: Market Engagement

Getting past the Standard Interaction

Hey check out my super-expensive, unreliable gadget that we cooked up in lab and have no idea what to do with!

What they hear:

Hey - check out my new **Generator** that can solve all your **Problems!**

Lab Researcher

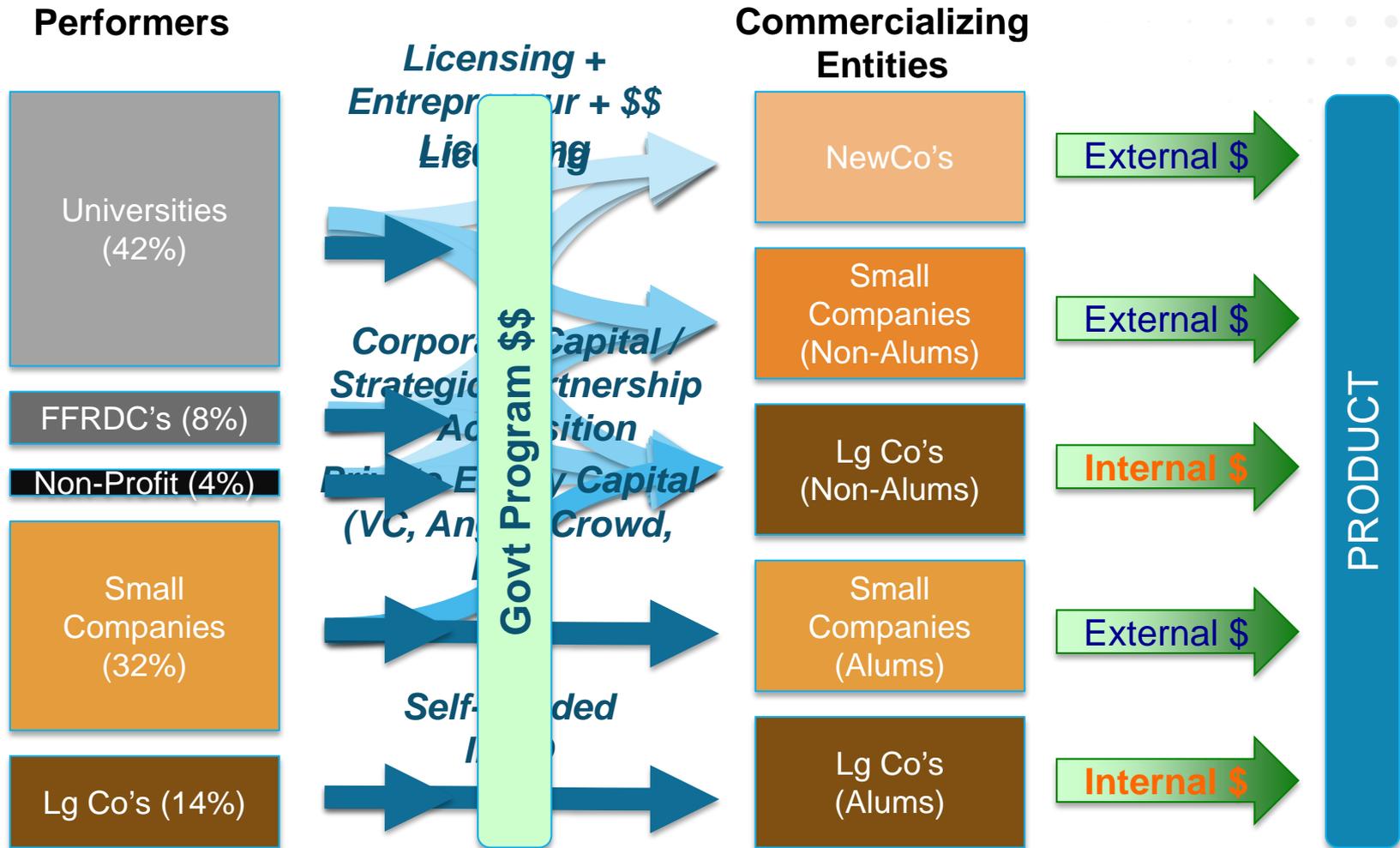
I'm trying to be polite. Actually, you haven't told me enough to have any clue of how interesting this is for me.

What they really mean:

Interesting!

Strategic Partner / Investor

Various Pathways to Follow-On Funding



What Does it Take to Attract Capital?

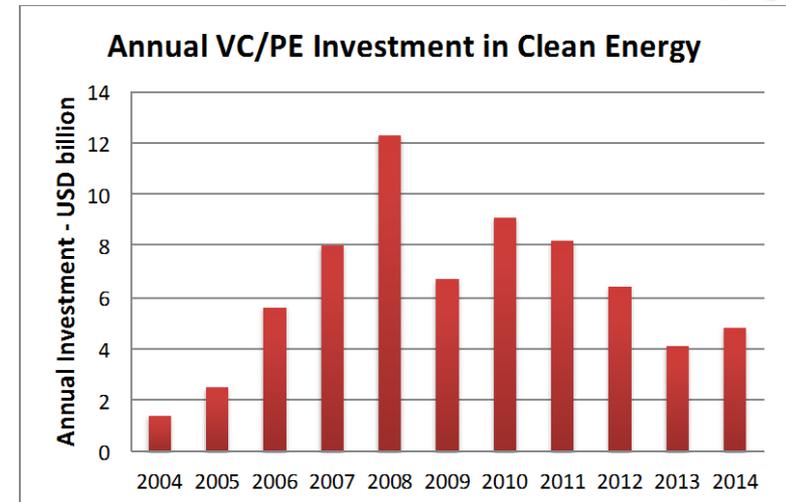
- **Reasonable Risk / Reward Scenario**
 - *Staged development can lower risk while maintaining ROI*
 - *Don't hide – highlight – potential risk*
- **A Differentiated Value Proposition**
 - *Your audience will have likely heard many undifferentiated pitches*
- **A Techno-Economic Analysis**
 - *Reasonable assumptions impress reasonable people*
- **Customer Conversations**
 - *No better way to illustrate Need*
- **Management Team**
 - *Someone on the Team needs to have been there before*

Funding Challenges Unique to Clean Tech/Energy

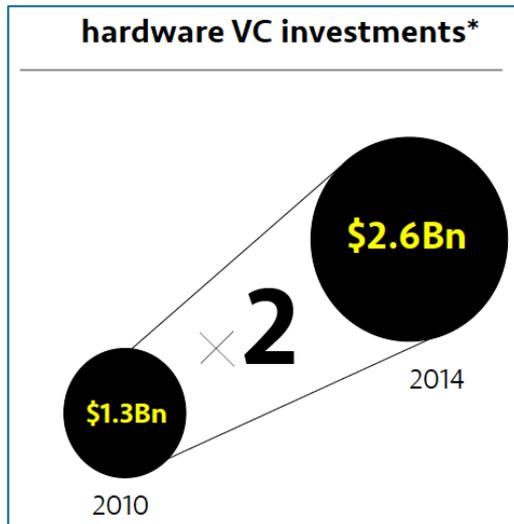
- ***Penetrating Energy Markets is a “Push” rather than “Pull” process***
 - Value proposition for cleaner, more distributed energy technologies is not as clear or sexy as a new smartphone or App.
 - Non-level playing field with traditional hydro-carbon energy markets (*no current monetization of carbon attributes*)
 - Regulatory barriers to changing legacy infrastructure
- ***Energy technologies are not typically “capital light” as VC’s prefer***
 - Investing in manufacturing development is not cheap
- ***Energy is a political issue***
 - Regulatory reform, policy changes to encourage clean energy are absent

Good News / Bad News

- **World Clean Energy technology investments dropped 67% since 2008**
 - Dropped from ~\$12bn in 2008 to ~\$4bn in 2013.
 - Led by Solar PV investment losses following Chinese product dumping



Source: Bloomberg New Energy Finance



Source: Dow Jones VentureSource

- **Investments in Hardware have doubled since 2010**
 - Hardware components commoditized & cheaper
 - Easier prototyping & manufacturing

Best Practices / Deliverables

▶ Ongoing Effort

- Ideally, T2M lead is NOT the PI.
- We are interested in supporting / reporting successes that may be outside Project goals

▶ Quarterly Reviews

- Always begin with a high-level summary of project
- Provide quarterly updates on T2M milestones (TEA, Pitch) even when there is no milestone deliverable

▶ Milestones

- Provide draft versions to Advisor in time for discussion
- Deliver Final versions to EPIC system & Advisor (for review)

▶ Annual Summit

- Booth / Poster should reflect T2M focus of Event



Unparalleled
Networking



Highly Selective
Technology Showcase



Inspiring Keynotes

www.arpae-summit.com

Feb. 29 - Mar. 2, 2016 | Washington, DC

Summit Programming of Interest

▶ Panel Discussions:

- Summit will include multiple breakout sessions focused on current trends and best practices in technology commercialization

▶ Networking Sessions:

- *Government Agency Networking*: Representatives from 15-20 federal offices will attend a structured networking session to discuss funding opportunities
- *General & Industry-Specific Networking Receptions*: Multiple opportunities to network with investors, corporate executives and other attendees

▶ Student Program:

- 100 selected graduate-level students will be invited to attend the Summit and participate in student programming. Application deadline is December 4.

Awardee Participation



Awardees contracted before **December 31, 2015** are required to attend the Summit. GENSETS performers are strongly encouraged to exhibit in the poster section.



Summit is a key part of ARPA-E's Tech-to-Market approach

- Summit connects awardees with financial institutions, government agencies and companies looking for partnership opportunities



Engagement and learning opportunities at the Summit include:

- Targeted **networking receptions**
- **Panel discussions** on best practices in commercialization, trends in technology development
- **Corporate Acceleration Program** pairs investors with project teams

Key Responsibilities

October –
November



Register for Tech Showcase **with eventPower** (not via public website). eventPower will contact you in late October / early November.

November -
December



Register all members of your team participating and make travel, hotel accommodations; Plan your exhibit

January -
February



Discuss best practices for exhibiting, pitching and networking with your Program Director, Tech-to-Market advisor

Feb. 29 –
Mar. 2, 2016



Attend the Summit; Provide feedback to ARPA-E on your experience

HOW TO DELIVER AN EXTENDED “ELEVATOR PITCH”

ARPA-E UNIVERSITY

Dr. John R. Tuttle

<http://arpa-e.energy.gov/?q=video-arpa-e-university/arpa-e-university-how-deliver-extended-elevator-pitch>



Distributed Generation

- ▶ *“The transformation occurring across the world’s electrical systems represents one of the greatest technological challenges industrialized societies have undertaken.”*
 - *The Resnick Institute*

- ▶ *“Each Year, U.S. utilities and factories send enough energy in the form of heat up their chimneys to power all of Japan.”*
 - Pew Charitable Trust / Oak Ridge National Laboratory

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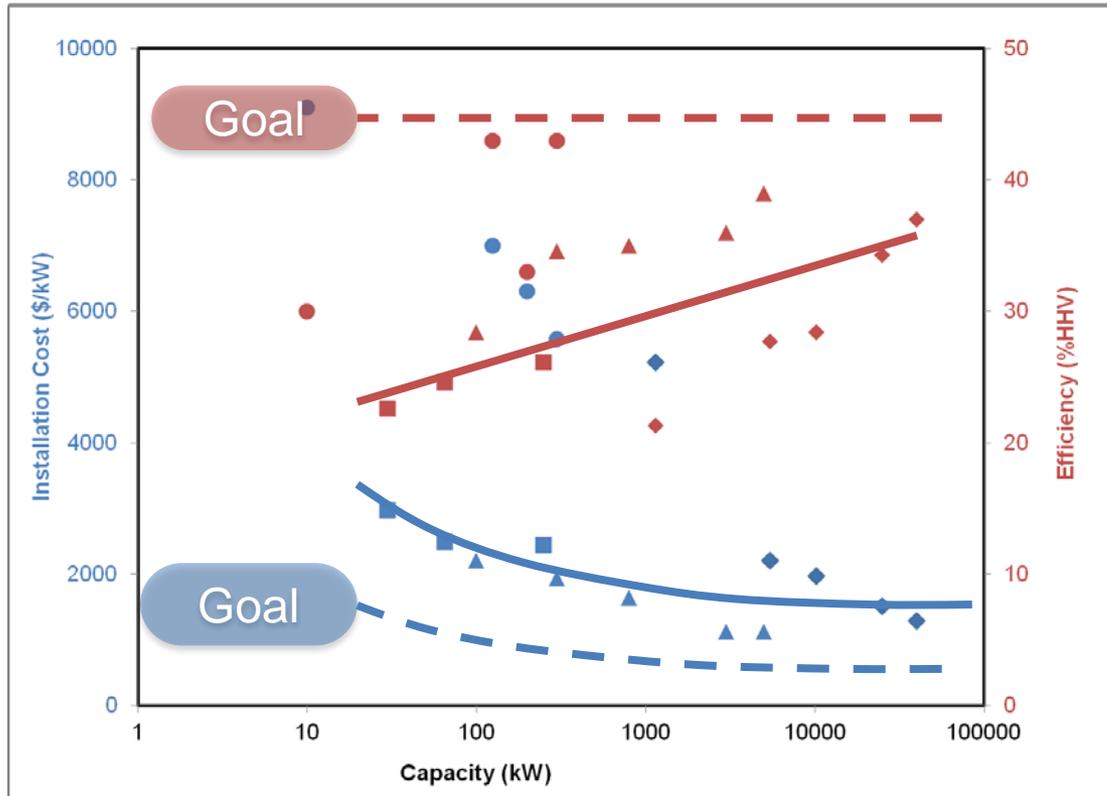
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Program Challenges

Benefits	Challenges

White Space in Small Power Generation



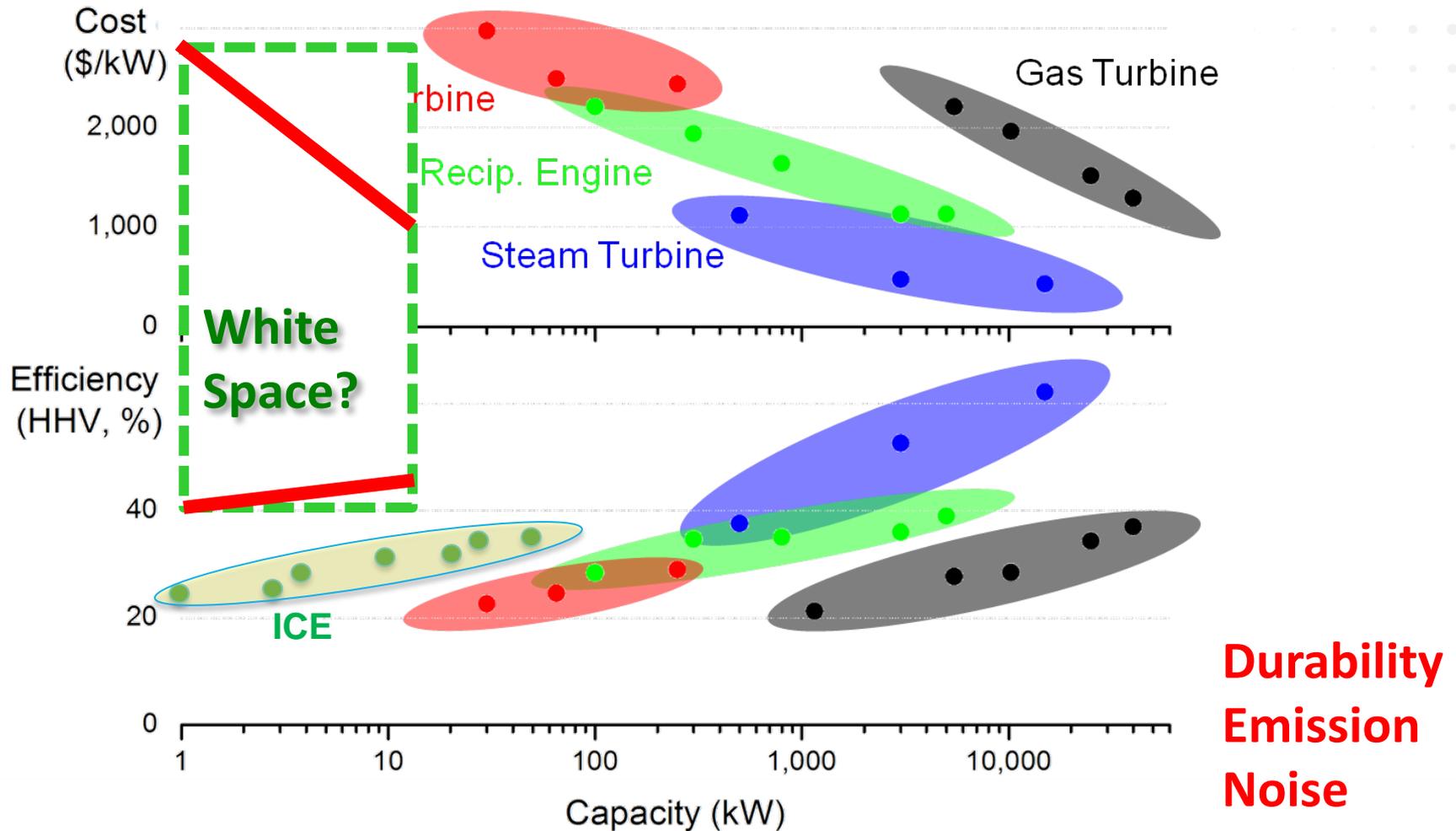
- ◆ Gas Turbine
- Microturbine
- ▲ Recip Engine
- Fuel Cells
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Maintenance Intervals (hrs)

Gas Turbine	4,000-8,000
Microturbine	5,000-8,000
Recip. Engine	1,000-2,000
Fuel Cells	20,000 – 40,000+

Can small size electrochemical devices help solve the problem?

Technology Gap - CHP



ICE data from W. Liss, ARPA-E Small Engine Workshop presentation

Source: Adapted from Catalog of CHP Technologies, U.S. Environmental Protection Agency Combined Heat and Power Partnership (2008).

About the Speaker

- **Senior Commercialization Advisor (“T2M”) – ARPA-E (2013-present)**
 - Assist program awardees / performer in achieving their goals;
- **Principal / CEO of Skypoint Solar, Inc. (2007- 2013)**
 - Initially focused on thin-film photovoltaics (PV) manufacturing technology;
 - Providing technology & business consulting services to the cleantech industry;
- **Founder, CEO & Chairman of DayStar Technologies (1996-2007)**
 - Pioneered thin-film photovoltaics on flexible media / under low concentration;
 - Raised ~ \$45M in public equity (Nasdaq:DSTI) / ~\$20M in incentives and grants;
- **Senior Scientist - National Renewable Energy Laboratory (1986-1997)**
 - Multiple World-Record device efficiencies;
- **Board of Advisors – Cornell Energy Institute**

Upgrading our Electricity Infrastructure

The Edison Foundation - 2008

Table 1: Model Results Overview

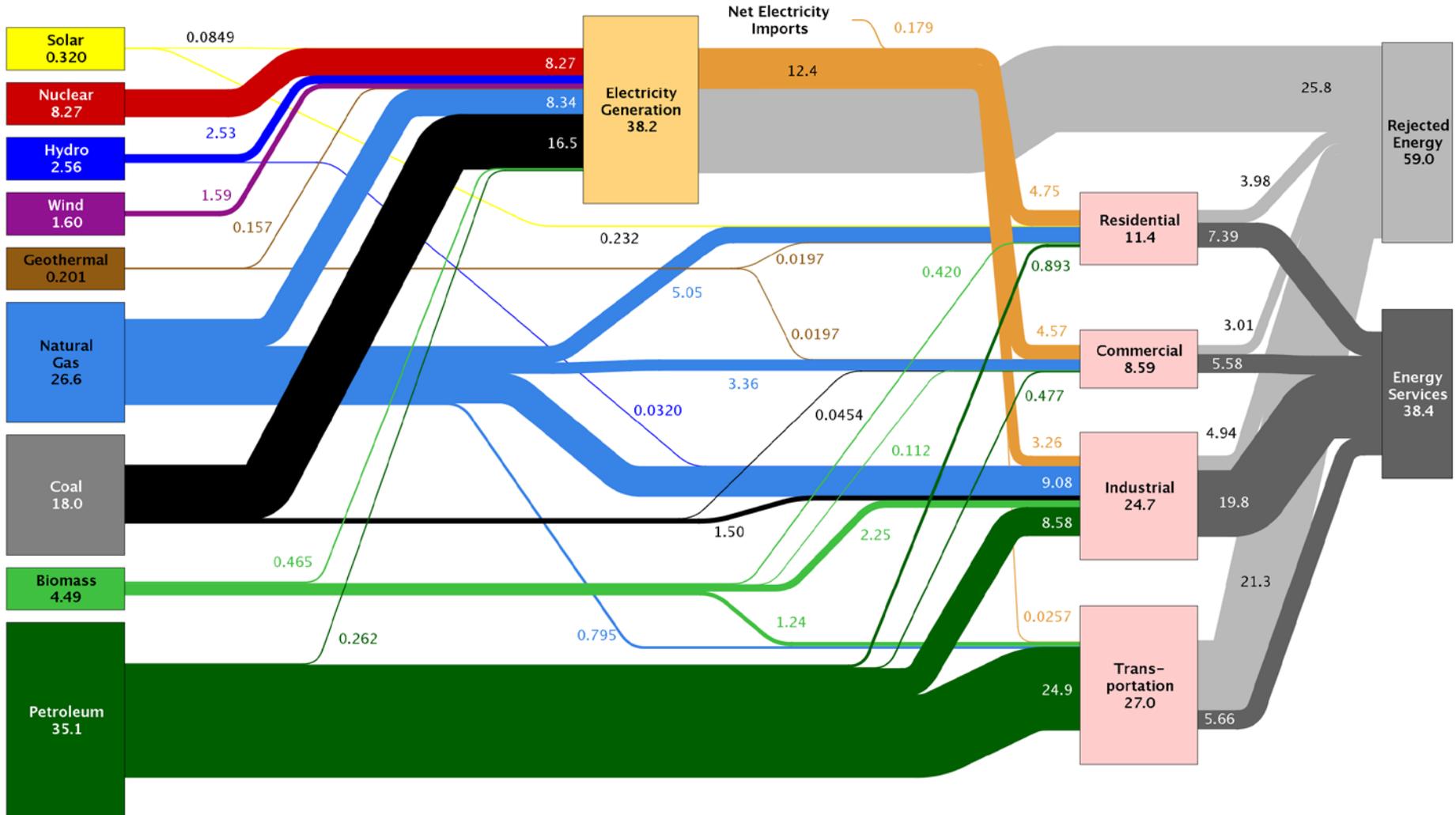
	Reference Scenario No Carbon Policy	RAP Efficiency Base Case Scenario No Carbon Policy	MAP Efficiency Scenario No Carbon Policy	Prism RAP Scenario Carbon Policy	20-45% Solar PV on rooftops
Average Peak Load Growth Rate		0.70%	0.30%	0.70%	0.30%
New Capacity Through 2030 (in GW)					
Renewables	38.6	39.2	38.8	103.7	380
Combustion Turbine	25.0	4.3	0.0	5.5	0
Nuclear	29.1	28.9	26.2	64.0	26.2
Conventional Combined Cycle	39.5	12.9	3.8	5.4	3.8
Coal	81.8	47.6	42.1	36.9*	0
Total New Capacity (GW)	214.0	132.9	110.9	215.5	410
Capital Investment Through 2030 (rounded to nearest billion)					
Generation	\$697	\$505	\$455	\$951	965
Transmission	\$298	\$298	\$298	\$298	99
AMI and EE/DR	\$0	\$85	\$192	\$192	192
Distribution	\$582	\$582	\$582	\$582	192
Total Capital Investment (\$ Billions)	\$1,577	\$1,470	\$1,527	\$2,023	1448

*32 GW of EPRI Prism coal generation incorporates carbon capture and storage.

Can Distributed Generation offset cost of T&D upgrade?

- 20-45% rooftop PV penetration can offset costs of T&D upgrade and more efficient HC central generation

Estimated U.S. Energy Use in 2013: ~97.4 Quads



Source: LLNL 2014. Data is based on DOE/EIA-0035(2014-03), March, 2014. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant "heat rate." The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential and commercial sectors 80% for the industrial sector, and 21% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527