CAPT JT Elder, USN
Commanding Officer,
NSWC Crane

Dr. Brett Seidle
Technical Director
NSWC Crane

2017 NDIA Joint Service Power Expo

DoD Approaches for Future Battery Technology

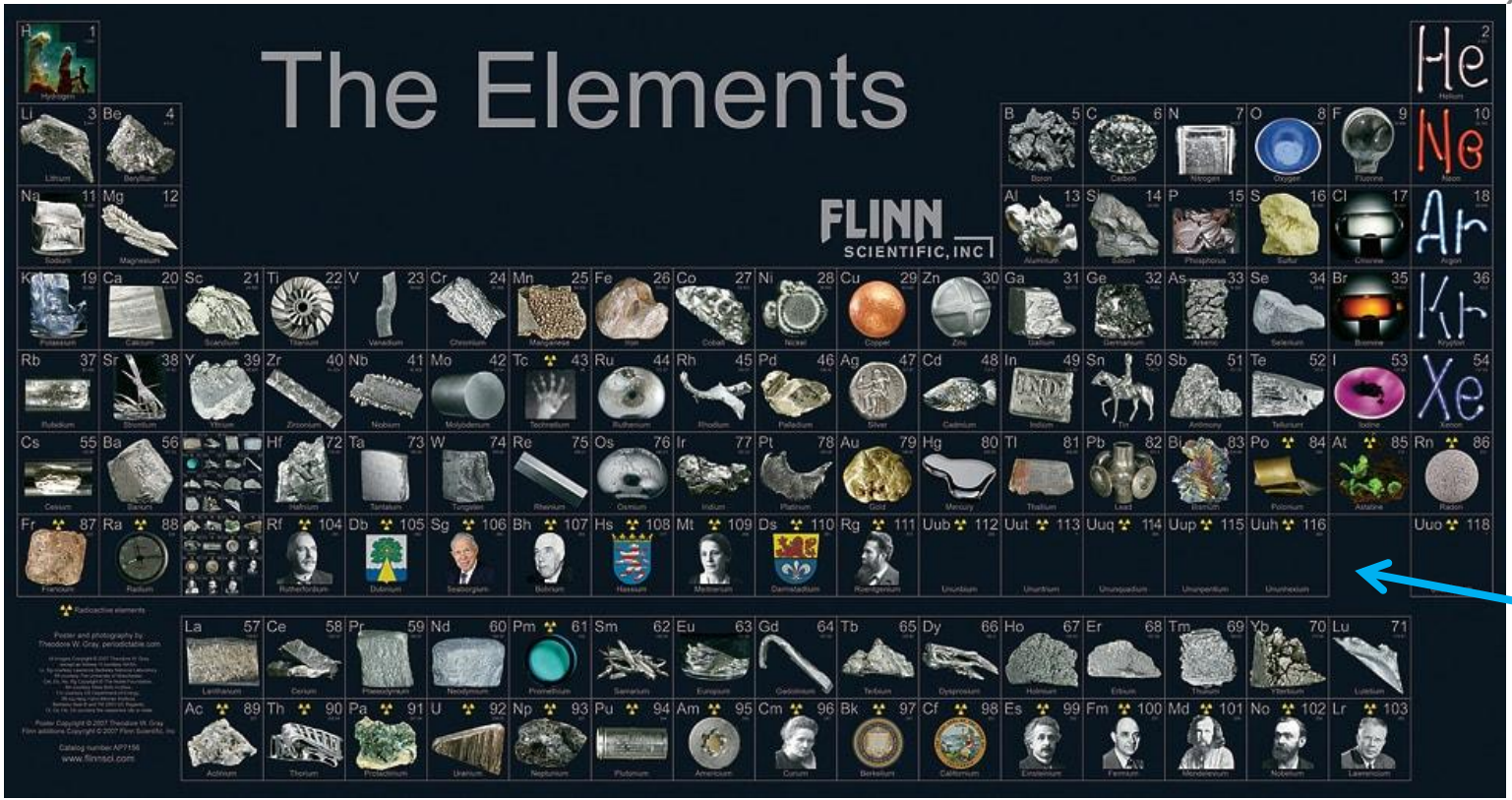
Sam Stuart, NSWC Crane

“More Power, More Energy, More Progress"

We sure could use some new elements…

DoD Battery Approaches – 2017 JSPE

From: flinnsci.com



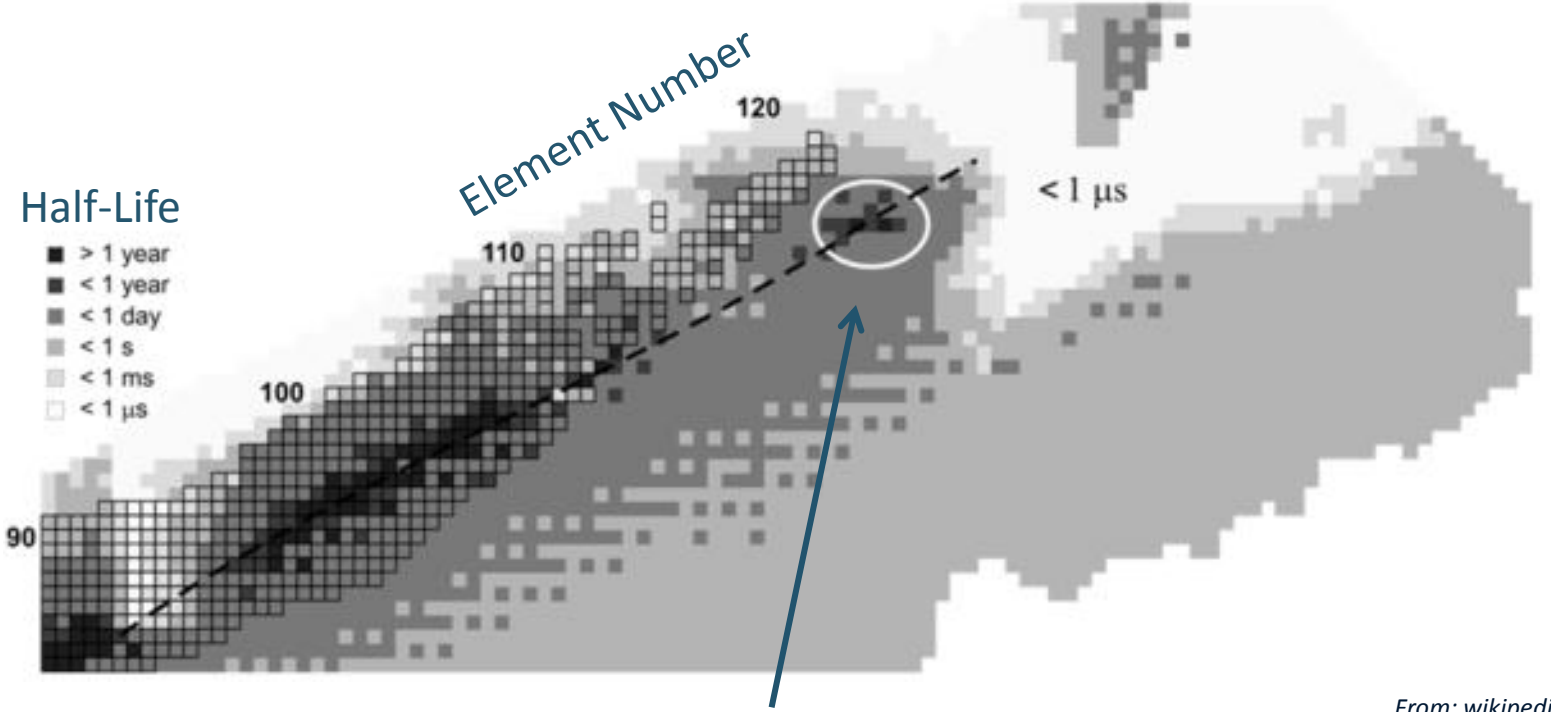
The old ones we know and love (well, kind of)…

The new ones tend to be unacceptably radioactive…

Otherwise, anything better is a difficult materials problem…

Even when we find new ones, not so helpful…

DoD Battery Approaches – 2017 JSPE



From: wikipedia

"Island of Stability"

What does it take to get a better battery?

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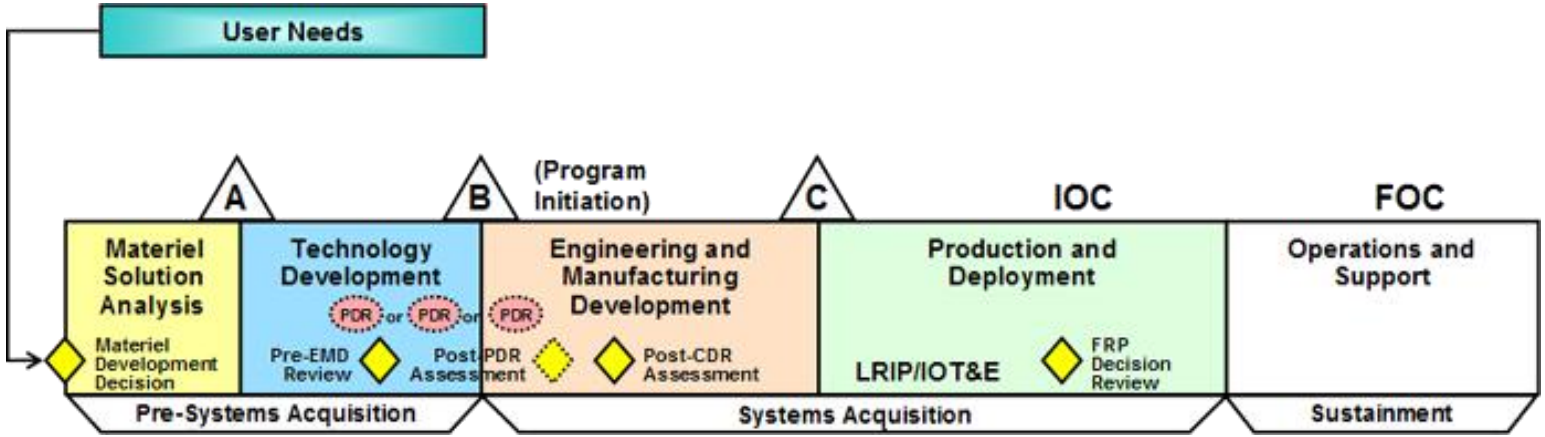
User's want better capability…



From: dap.dau.mil

Weapon systems are specified, designed, developed, prototyped, tested and acquired for achieving a capability…

But, if you also need better energy storage…

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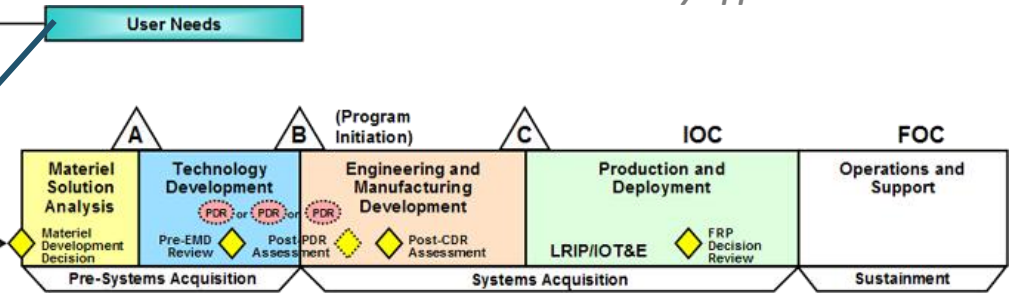
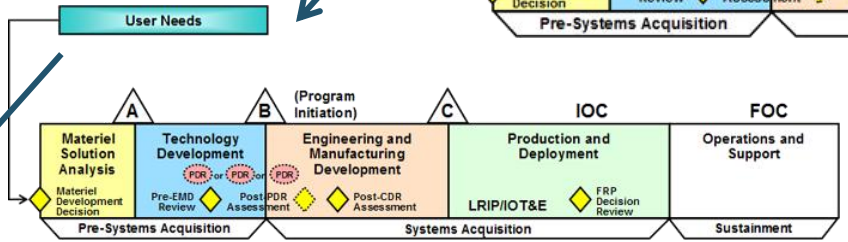
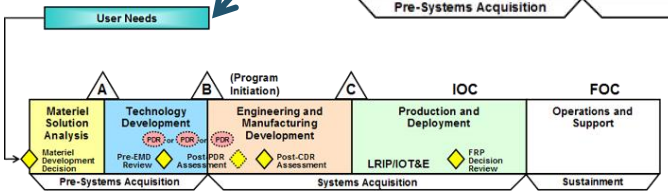
The Better System

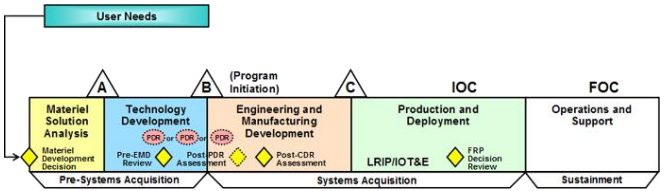


The Better Battery





Better Battery Materials A through D



Better Battery Manufacturing Processes 1 through 20

Now, just have to pay for it all…

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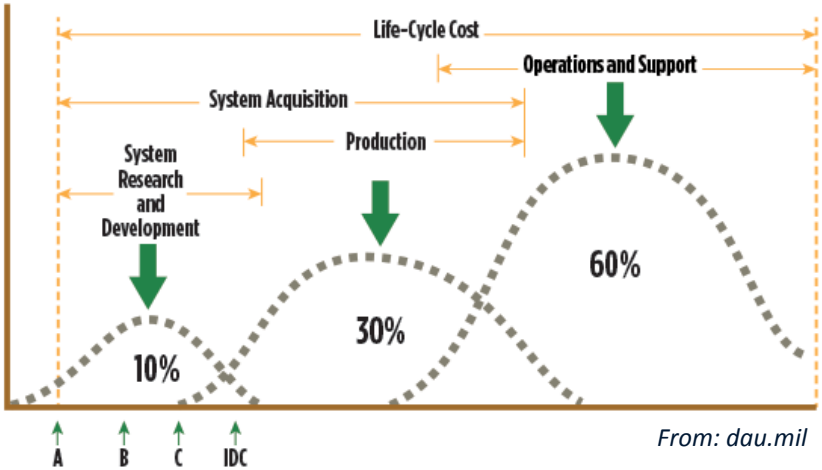
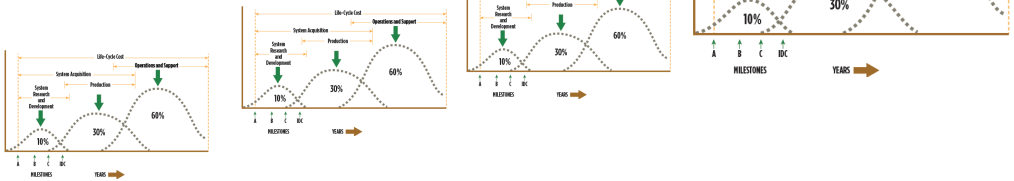
System Costs



From: dau.mil

Better Battery Costs

Better Battery Materials Costs



Commercial industry has similar problems…

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From: Electrek.com

Tesla Gigafactory Enables Favorable Economies of Scale…

For better batteries, size matters…

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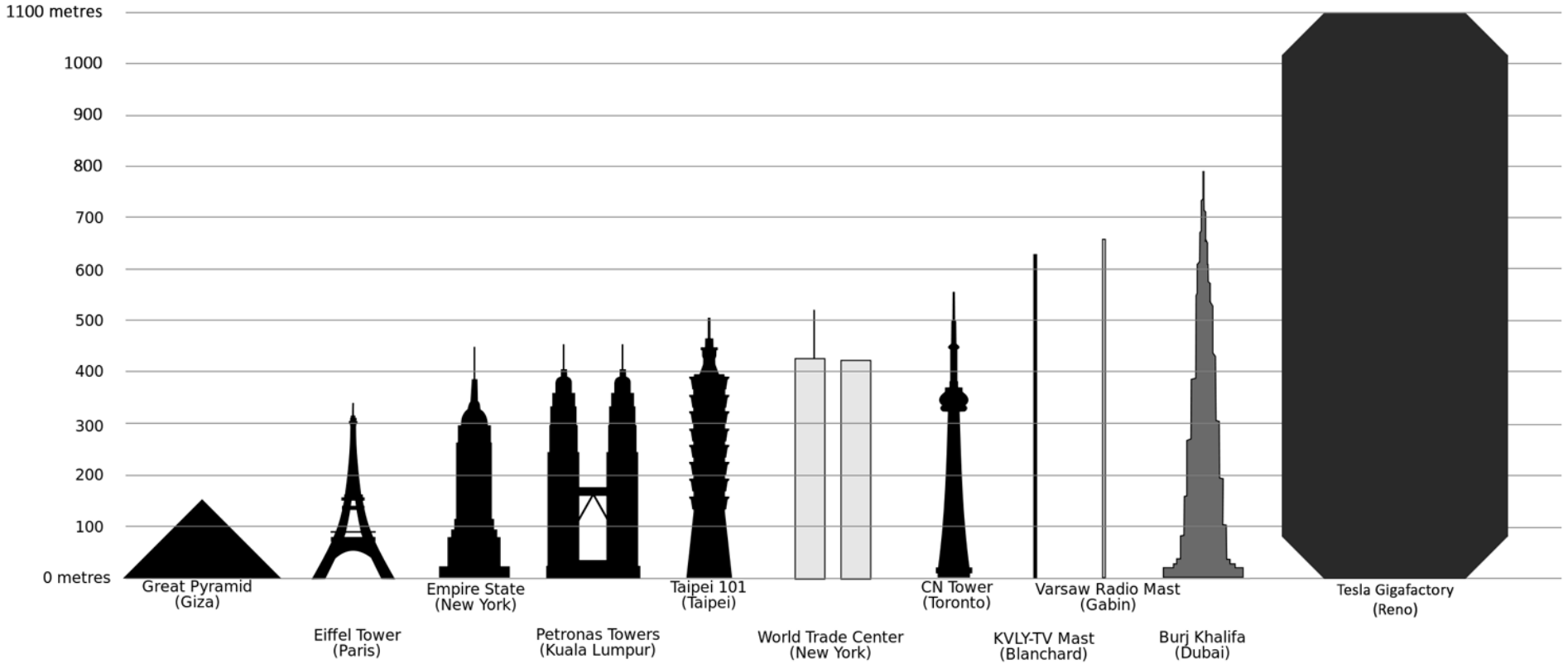
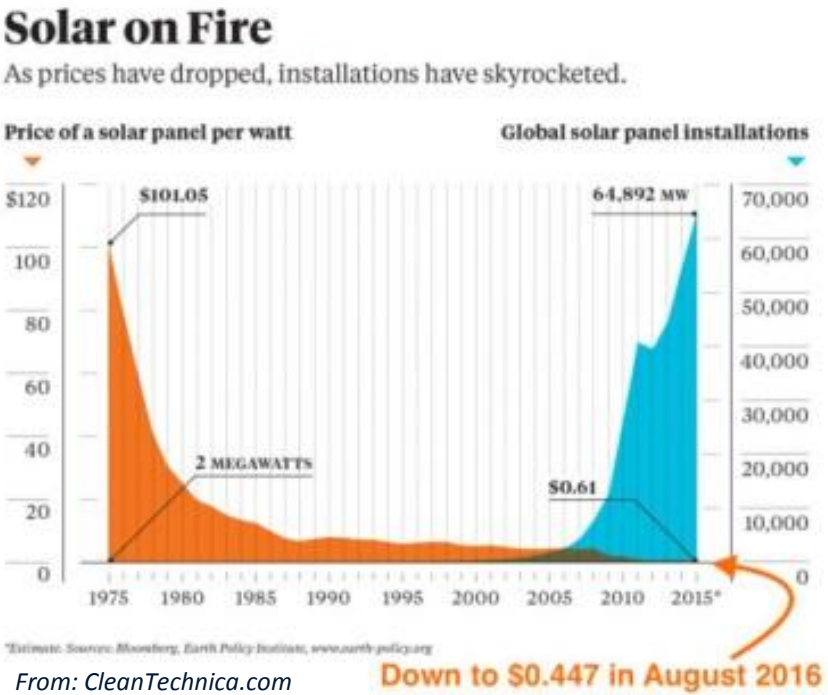
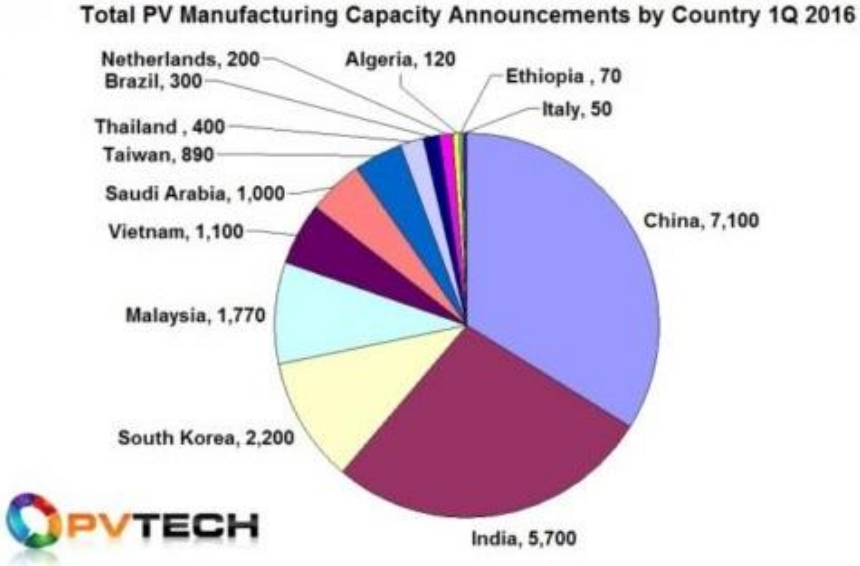


From: CleanTechnica.com

Solar Energy, Same Story…



From: CleanTechnica.com



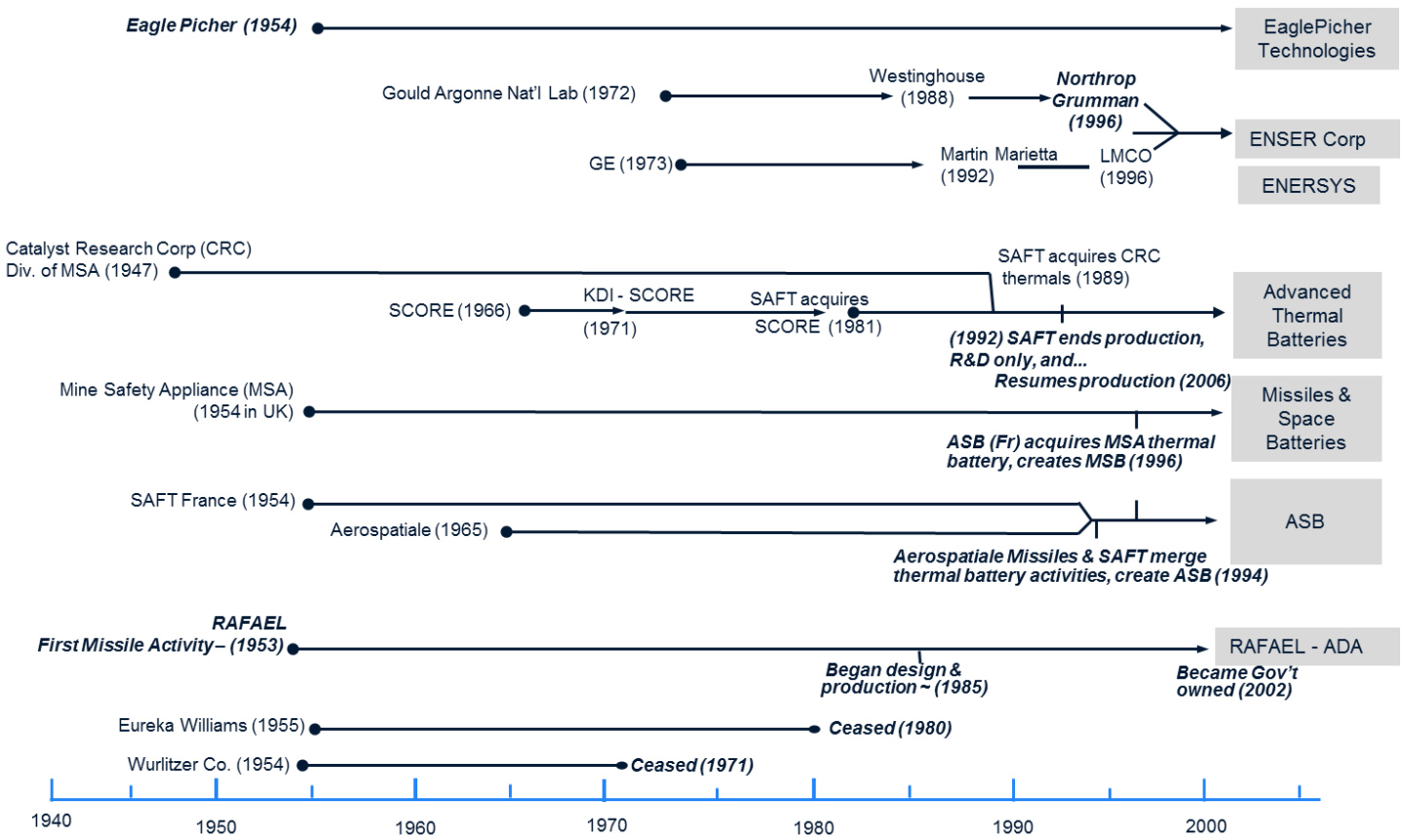
How much DoD funding do we have?

Short answer – nowhere near enough.

MIT: '500M$ to achieve manufacturing capability'

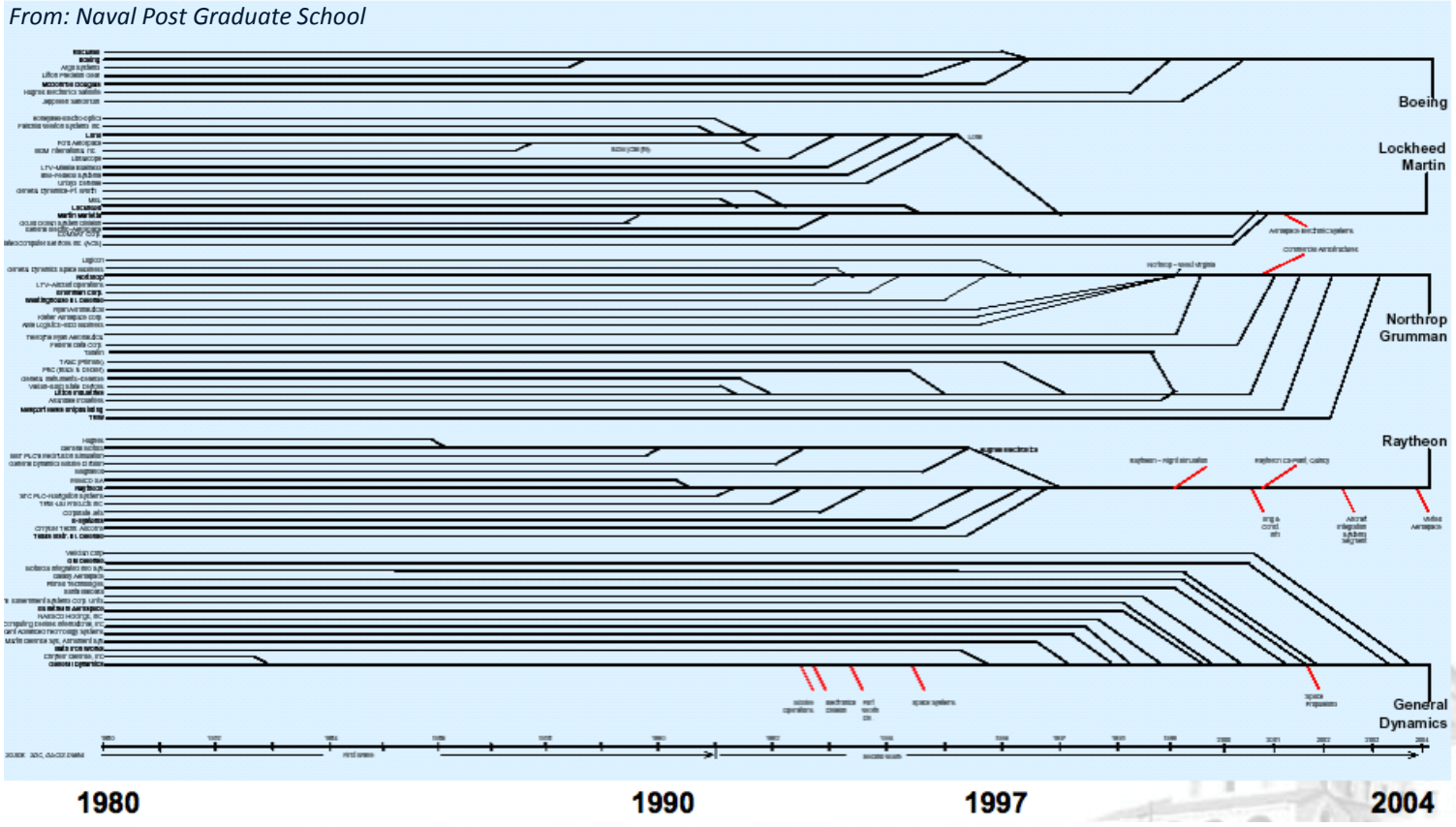
Used to buy more batteries…

Thermal battery manufacturers are an example…



And, we used to have more Primes…

From: Naval Post Graduate School



What funding do we have?

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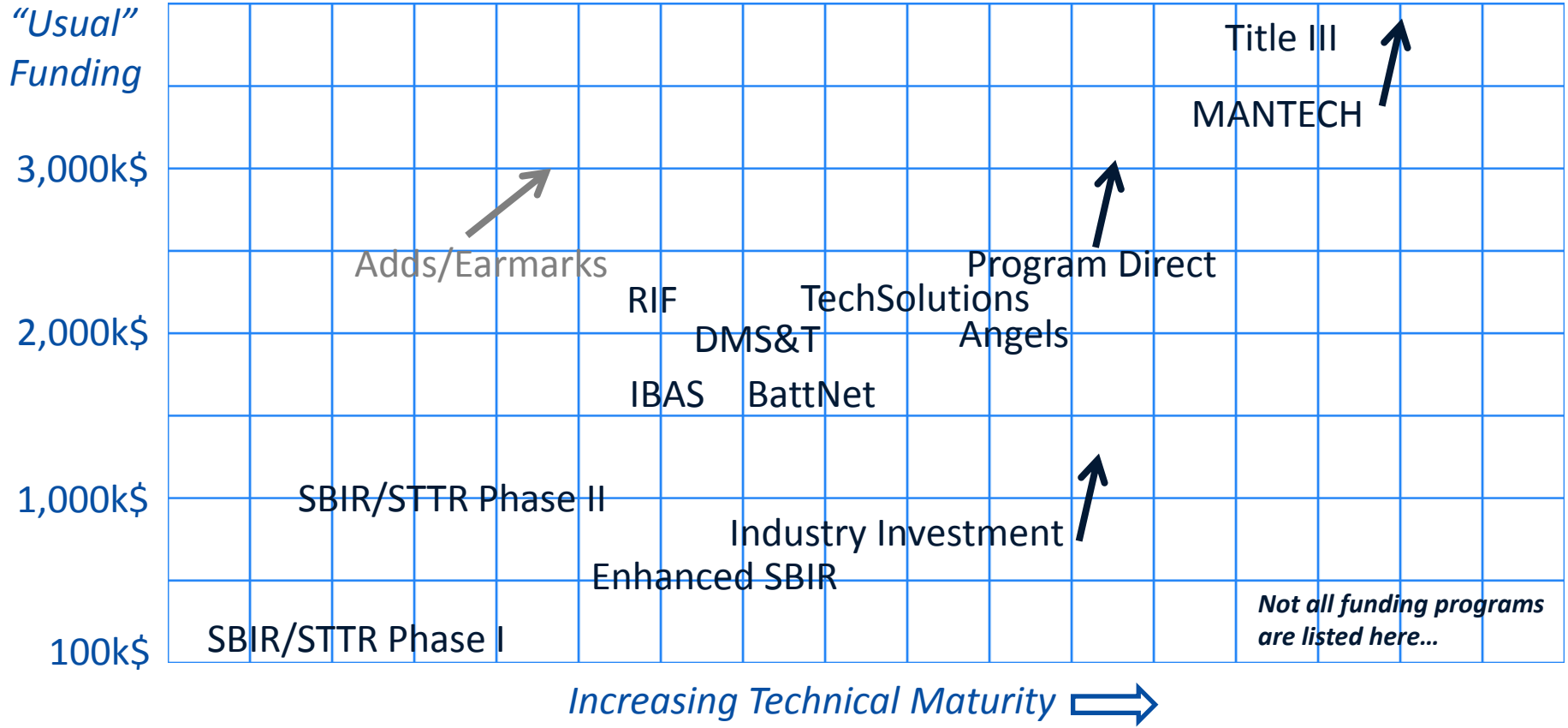


SBIR/STTR to "Seed" Success…

TABLE 3-1 Phase I Awards

Number of Phase I Awards

Year	DHS	DoC	DoD	DoE	DoT	ED	EPA	HHS	NASA	NRC	NSF	USDA	Total
1992		19	1,078	196	29	23	41	636	346	17	169	45	2,599
1993		19	1,292	167	49	29	34	659	384	8	255	55	2,951
1994		39	1,394	209	33	20	35	596	413	12	307	62	3,120
1995		72	1,245	196	20	27	47	666	309	8	295	72	2,957
1996		38	1,367	167	30	18	27	560	349		249	62	2,867
1997		63	1,519	194	29	50	35	764	339		252	72	3,317
1998		45	1,276	204	21	41	37	725	344		211	77	2,981
1999		33	1,398	185	17	40	47	931	290		243	84	3,268
2000		40	1,380	292	25	0	58	1,233	287		320	125	3,760
2001		37	1,606	310	38	55	54	1,293	307		291	127	4,118
2002		54	2,308	328	19	72	63	1,339	267		342	125	4,917
2003		53	2,319	323	15	31	51	1,393	312		510	122	5,129
2004	97	65	2,078	257	12	54	43	1,135	291		236	101	4,369
2005	80	34	2,364	259	8	22	38	862	297		152	92	4,208
Total	177	611	22,624	3,287	345	482	610	12,792	4,535	45	3,832	1,221	50,561

NOTE: This is a correction of the prepublication version released on July 27, 2007.

SOURCE: U.S. Small Business Administration, Tech-Net Database; and National Aeronautics and Space Administration.

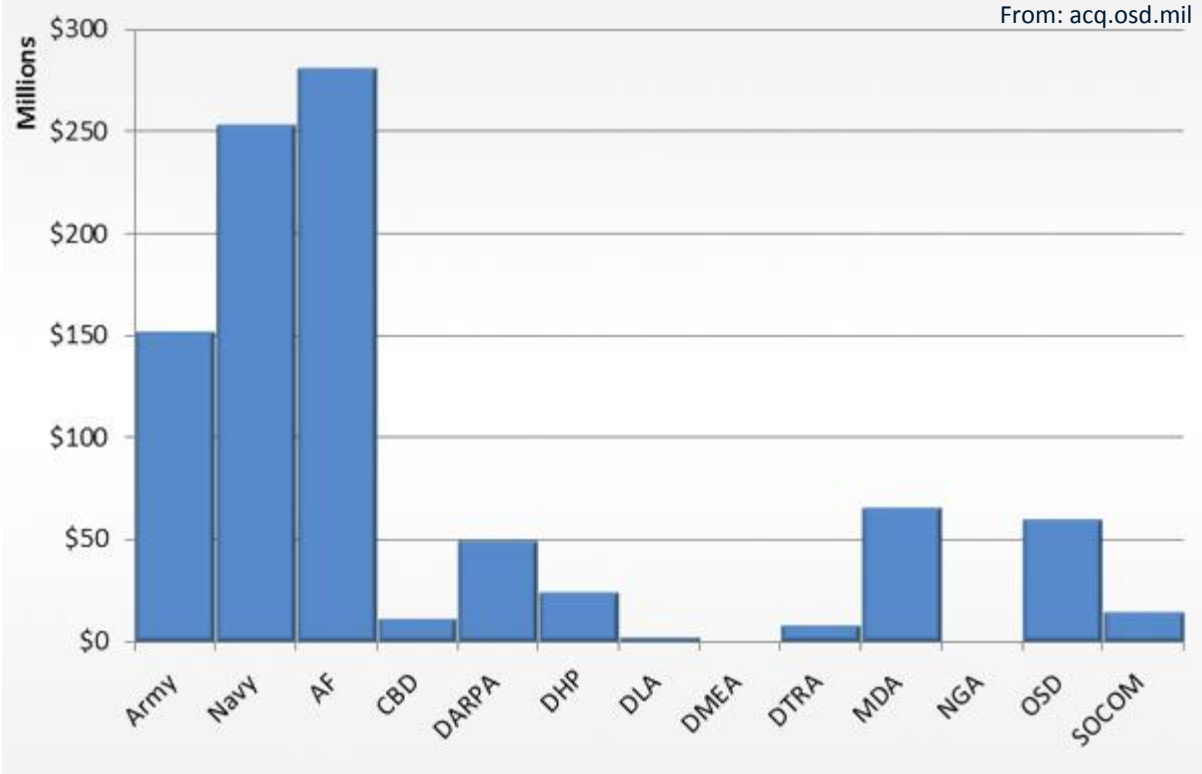
From: nap.edu

SBIR investments represent the largest "open" development fund for DoD…

- Total DOD SBIR Investment yearly of approximately $1B
- For every four Phase I awards, approximately one phase II award is made

DoD SBIR Investments by Service

From: acq.osd.mil



But very few are battery related…

Solicitation	1	2	3	Total Topics	A	B	C	Total Topics
Air Force	1	0		169	0			30
Army	1	0	1	136	0			16
Chem Bio	0			6				
DARPA	0	0	1	37			0	3
Defense Health	0		0	19	0		0	8
DLA	1	0	0	10				
Defense Microelectronics		0		1		0		1
DTRA		0		7	0			4
MDA		0	0	23			1	5
Navy	4	1	0	140	1	0		26
OSD		0		6				
SOCOM	0		0	14				
All	7	1	2	568	1	0	1	93

10/ 568 SBIR
0.4%

2/93 STTR
2.2%

In 2016, had 568 SBIR topics, of which 10 were energy storage development related…

And some SBIRs do succeed…

InteliSpark

Famous SBIR Companies

QUALCOMM
Market Cap: $100B

Symantec
Market Cap: $15.64B

INTUITIVE SURGICAL
Market Cap: $25.44B

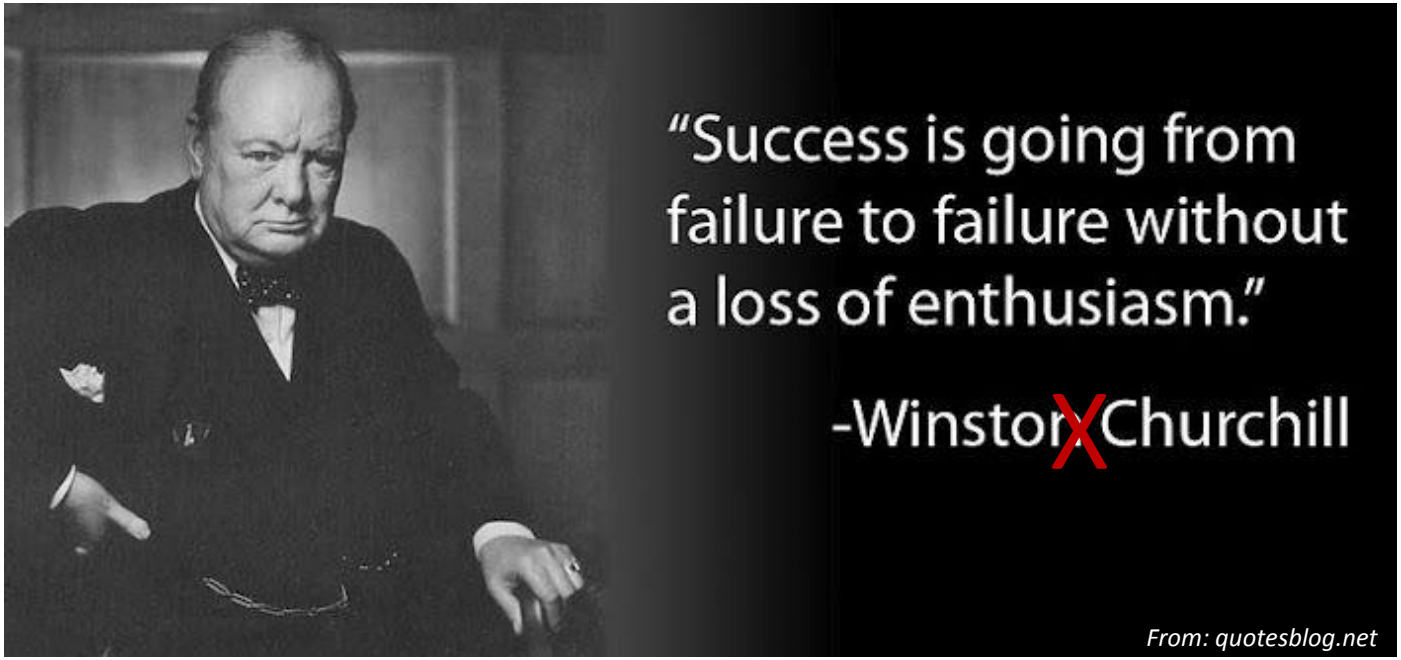
iRobot
Market Cap: $1.5B

None received more than $9 million in SBIR/STTR funding
Total combined funding less than $20 million

www.InteliSpark.com

But, none of the big SBIR, or STTR successes are battery companies…

But obviously, some things do get done…



"You must put your head into the lion's mouth if the performance is to be a success."

–19 February 1900, South Africa, *London to Ladysmith via Pretoria*, 1900.

From: richardlangworth.com

Energy Storage Successes

- SBIRs/STTRs
- Rapid Innovation Fund
- Congressional Adds / Earmarks
- Angel / Industry Investments
- Program Direct Funding
- MANTECH
- Title III

And certainly there are others…

SBIR/STTR

U.S. Department of Defense
SMALL BUSINESS INNOVATION RESEARCH
SMALL BUSINESS TECHNOLOGY TRANSFER

- Example 1: well-scoped manufacturing improvement
  - Relatively low risk, achievable within
  - Strong battery manufacturer involvement
- Example 2: “lucky” material improvement
  - Leveraged prior efforts
  - Small business had established industrial partner market

Rapid Innovation Fund

Rapid Innovation Fund (RIF)

Program Overview
February 2017
PE 0604775D8Z

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OSD Research & Engineering
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Office of Small Business Programs (OSBP)
Email: theodore.j.bujewski.civ@mail.mil
Phone: 571-372-6256

Distribution Statement A. Approved for public release

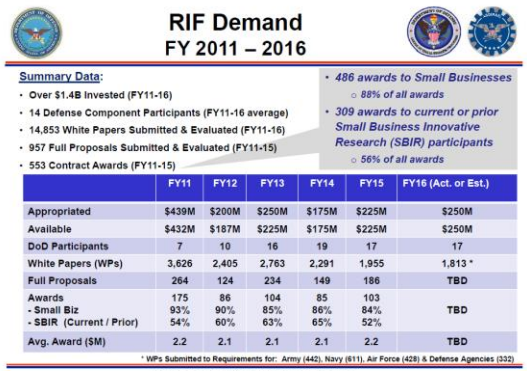
Background

- Established as the Rapid Innovation Program (RIP) in Section 1073 of the Fiscal Year 2011 National Defense Authorization Act (NDAA)
  - A competitive, merit-based program
  - Accelerate fielding of innovative technologies into military systems
- Reauthorized in the FY 2016 NDAA until Sep 30, 2023
- Re-designated as the Rapid Innovation Fund (RIF) within the Department of Defense (DoD)

Bottom Line Goal: Transition Small Business Technologies into Defense Acquisition Programs

Distribution Statement A. Approved for public release

4



RIF Demand
FY 2011 – 2016

Summary Data:

- Over $1.4B Invested (FY11-16)
- 14 Defense Component Participants (FY11-16 average)
- 14,853 White Papers Submitted & Evaluated (FY11-16)
- 957 Full Proposals Submitted & Evaluated (FY11-15)
- 553 Contract Awards (FY11-15)

- *486 awards to Small Businesses*
  - *88% of all awards*
- *309 awards to current or prior Small Business Innovative Research (SBIR) participants*
  - *56% of all awards*

	FY11	FY12	FY13	FY14	FY15	FY16 (Act. or Est.)
Appropriated	$439M	$200M	$250M	$175M	$225M	$250M
Available	$432M	$187M	$225M	$175M	$225M	$250M
DoD Participants	7	10	16	19	17	17
White Papers (WPs)	3,626	2,405	2,763	2,291	1,955	1,813 *
Full Proposals	264	124	234	149	186	TBD
Awards - Small Biz - SBIR (Current / Prior)	175 93% 54%	86 90% 60%	104 85% 63%	85 86% 65%	103 84% 52%	TBD
Avg. Award ($M)	2.2	2.1	2.1	2.1	2.2	TBD

* WPs Submitted to Requirements for: Army (442), Navy (611), Air Force (428) & Defense Agencies (332)

Distribution Statement A. Approved for public release

7

- Began in 2011, relatively new program
- Example 3: small business had degree of SBIR success
  - Improvement to batteries compelled further investment
  - DoD championed the transition effort

Congressional Adds

- Was a resource that helped traverse that valley o' death
  - Contributed $10M's each year
  - Was targeted for specific interests
- Example 4: Battery manufacturers improved processes
  - Aligned to program requested battery improvements
  - Funded efforts that otherwise would be difficult to do, and were out of range of most other funding programs
  - There are many more examples…

Those days are probably long gone…

Angel & Industry Investment

- Angel (private) investments in DoD-specific batteries do not meet their criteria for payback and rate of return
  - DoD has leveraged angel investments in commercial batteries that can be used in DoD applications, only ~4% energy-related
  - Acquisitions by private investors *can* help DoD as well
- Best case for DoD is when industry self-invests in better batteries, better materials, better manufacturing
  - Usually done because volume of DoD acquisition justifies it
  - But, investment scales with acquisition volume

These are rare…

Program Direct Funding

- There are multiple, successful examples of battery improvements funded directly by beneficiary programs
- In most cases, the presumed risks and initial funding required were thought acceptable
  - Initial results were favorable enough to convince “ok”
  - Timeline for achieving production was “reasonable” under the program overall schedule
- These efforts tend to be “incremental” type energy storage improvements

MANTECH

DoD Battery Approaches – 2017 JSPE

U.S. ARMY MANTECH Manufacturing Technology

Energy Storage Manufacturing—High Power, High Energy Density Lithium Ion (Li-Ion) Batteries

PROBLEM / OBJECTIVE

ACCOMPLISHMENTS

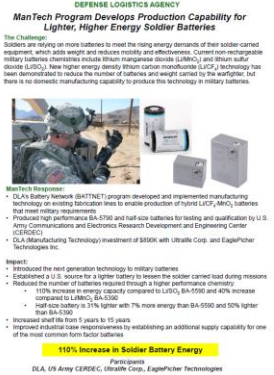
BENEFITS AND WARFIGHTER PAYOFF

FUNDING

TIME LINE / MILESTONE

PARTICIPANTS

DLA ManTech



DEFENSE LOGISTICS AGENCY

ManTech Program Develops Production Capability for Lighter, Higher Energy Soldier Batteries

The Challenge:

ManTech Response:

Impact:

110% Increase in Soldier Battery Energy

Participants

DLA, US Army CERDEC, Ultralife Corp., EaglePicher Technologies

- Example 5: Battery manufacturer unable to get required production rate -- MANTECH investment scaled up fabrication processes
- Example 6: Augmented battery manufacturer efforts to make a producible, improved battery

Title III

- Title III investments have successfully achieved better batteries with multiple projects
  - Focused on manufacturing improvements
  - Prefers “established” technology readiness
- Must meet certain criteria for eligibility

Common Elements of Battery Successes

- Technology can be developed, transitioned within one program's available funding
- Plan transitioning to leverage COTS and other investments suited for each of the various tech stages
- Select technology with "low enough" risk that a program office is willing to fund the transition to production
- Favorable cost vs. benefit
- Technology must have strong champions (difficult!)

Oh, and be "lucky"…

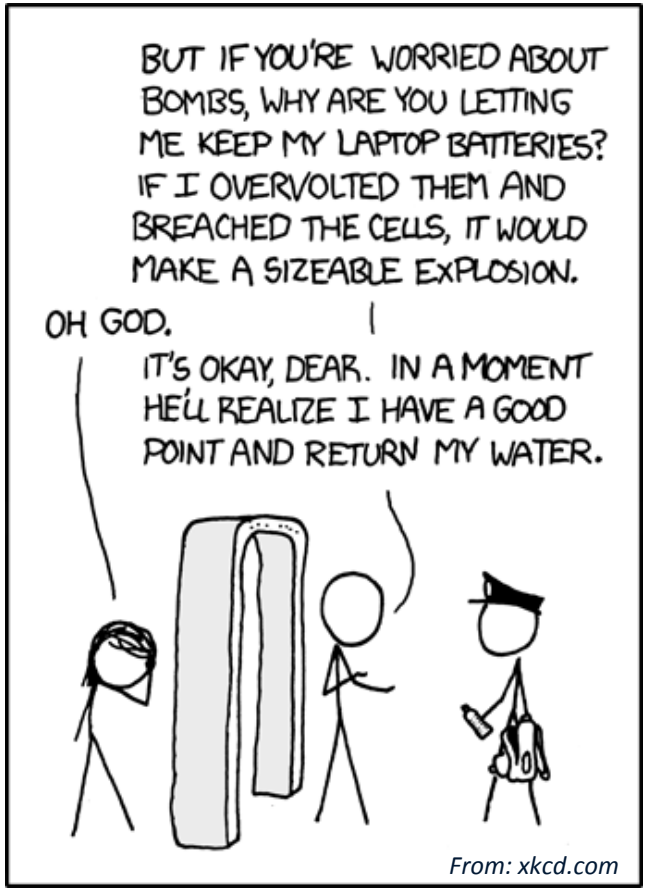
DoD Approach Going Forward…

”We can no longer afford, strategically or fiscally, to let the perfect be the enemy of the good—or the good enough—when it comes to critical war fighting capability.”

- Admiral Jonathan Greenert (Chief of Naval Operations, 2012)

From: dau.mil

A final note on “good intentions”…



From: xkcd.com

THANK YOU!

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