

Energy Storage Activities at ARPA-E



Scott Litzelman, Ph.D.
Program Director

Max Tuttman
Technology-to-Market Advisor

Advanced Research Projects Agency – Energy (ARPA-E)

ARPA-E program portfolio

	ELECTRICITY GENERATION & DELIVERY	EFFICIENCY	TRANSPORTATION
Active	INTEGRATE GRID DATA IONICS MOSAIC GENSETS NODES ALPHA CHARGES MEITNER DAYS ATLANTIS	SENSOR CIRCUITS PNDIODES ENLITENED SHIELD ROOTS BREAKERS MONITOR ARID DELTA HITEMMP	MARINER REFUEL NEXTCAR REMOTE TERRA RANGE
	REBELS GRIDS GENI HEATS SOLAR ADEPT IMPACCT FOCUS	SWITCHES METALS BEETIT REACT ADEPT	MOVE PETRO TRANSNET ELECTROFUELS AMPED BEEST
Alumni			

**OPEN 2009, 2012, 2015 & 2018 Solicitations
Complement Focused Programs**

DAYS* program overview

Objective

Develop innovative technologies to enable energy storage on the power grid with durations of 10-100 hours

$$LCOS(\$ \cdot kWh^{-1} \cdot cycle^{-1}) = \left[\left(\frac{1}{\eta_{RTE}} - 1 \right) P_c \sum_{t=1}^T \frac{n_c(t)}{(1+r)^t} + \sum_{t=1}^T \frac{O\&M(t)}{(1+r)^t} + \left(\frac{C_E}{\eta_D} + \frac{C_P}{d} \right) \right] * \left[\sum_{t=1}^T \frac{n_c(t)}{(1+r)^t} \right]^{-1}$$

Primarily application-dependent parameters

- P_c – input electricity price in \$/kWh
- d – duration of storage at rated power in hours
- n_c – number of equivalent full cycles

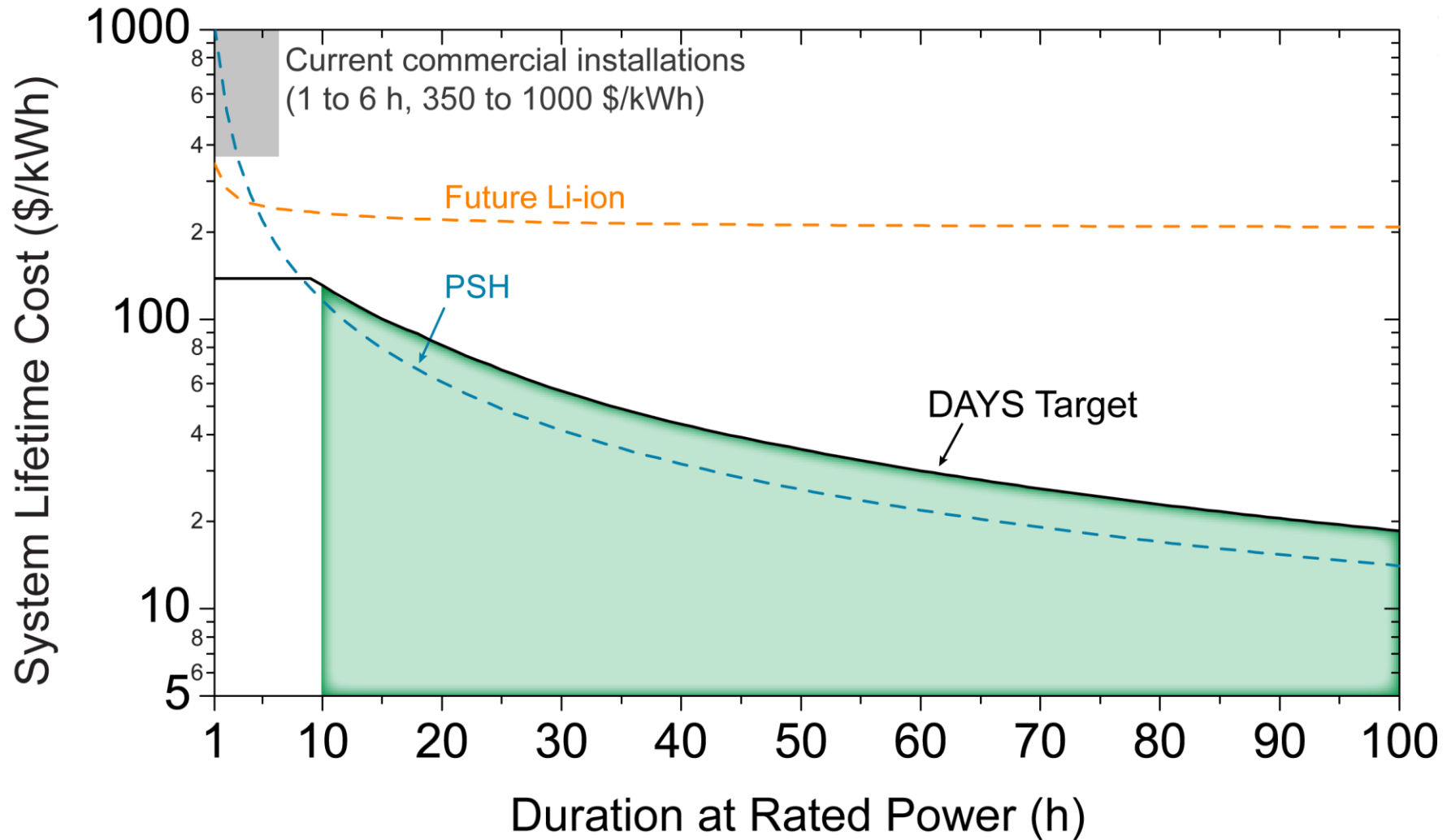
Performance Targets

- ▶ Levelized cost of storage of \$0.05/kWh-cycle
- ▶ No siting constraints

Primarily technology-dependent parameters

- η_{RTE} – round-trip efficiency of storage (AC basis)
- η_D – discharge efficiency of storage (AC basis)
- $O\&M$ – fixed and variable operations and maintenance cost (including component replacements)
- C_E – installed marginal capital cost of energy in \$/kWh
- C_P – installed marginal capital cost of power in \$/kW

DAYS cost-duration target



Long-duration technologies and applications

DAYS Technologies

Energy Storage



Electrochemical



Thermal



Pressure

Power Conversion



Rotating
Equipment



Power
Electronics

Applications

- ▶ Provide extended backup power for critical loads
- ▶ Optimize utilization of transmission and distribution infrastructure
- ▶ Improve reliability and resiliency of high-VRE grids
- ▶ Increase capacity value as VRE and storage penetrations increase

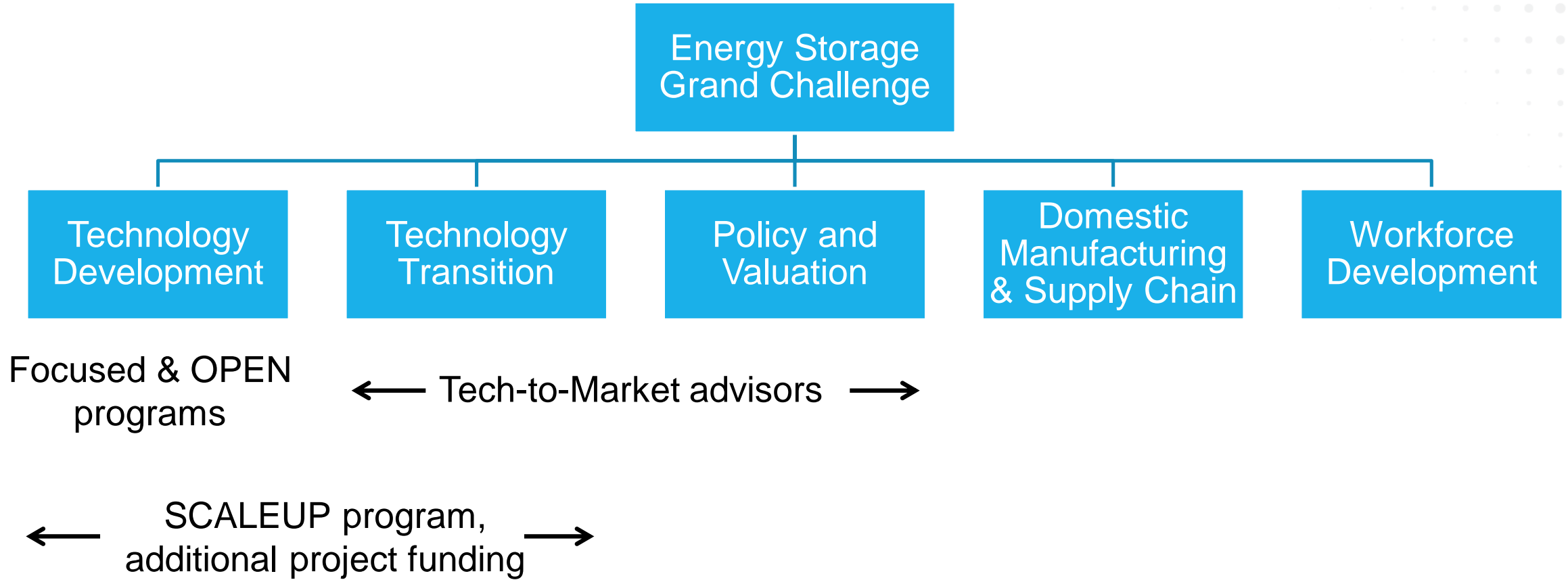
Near-term

Longer-term

Early barriers to commercialization

- ▶ Technology
- ▶ High quality techno-economic models and analysis
- ▶ Market development
- ▶ Building the right partnerships
- ▶ Bankability

ARPA-E and the Energy Storage Grand Challenge



Thank you!



U.S. DEPARTMENT OF
ENERGY

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

scott.litzelman@hq.doe.gov

max.tuttman@hq.doe.gov