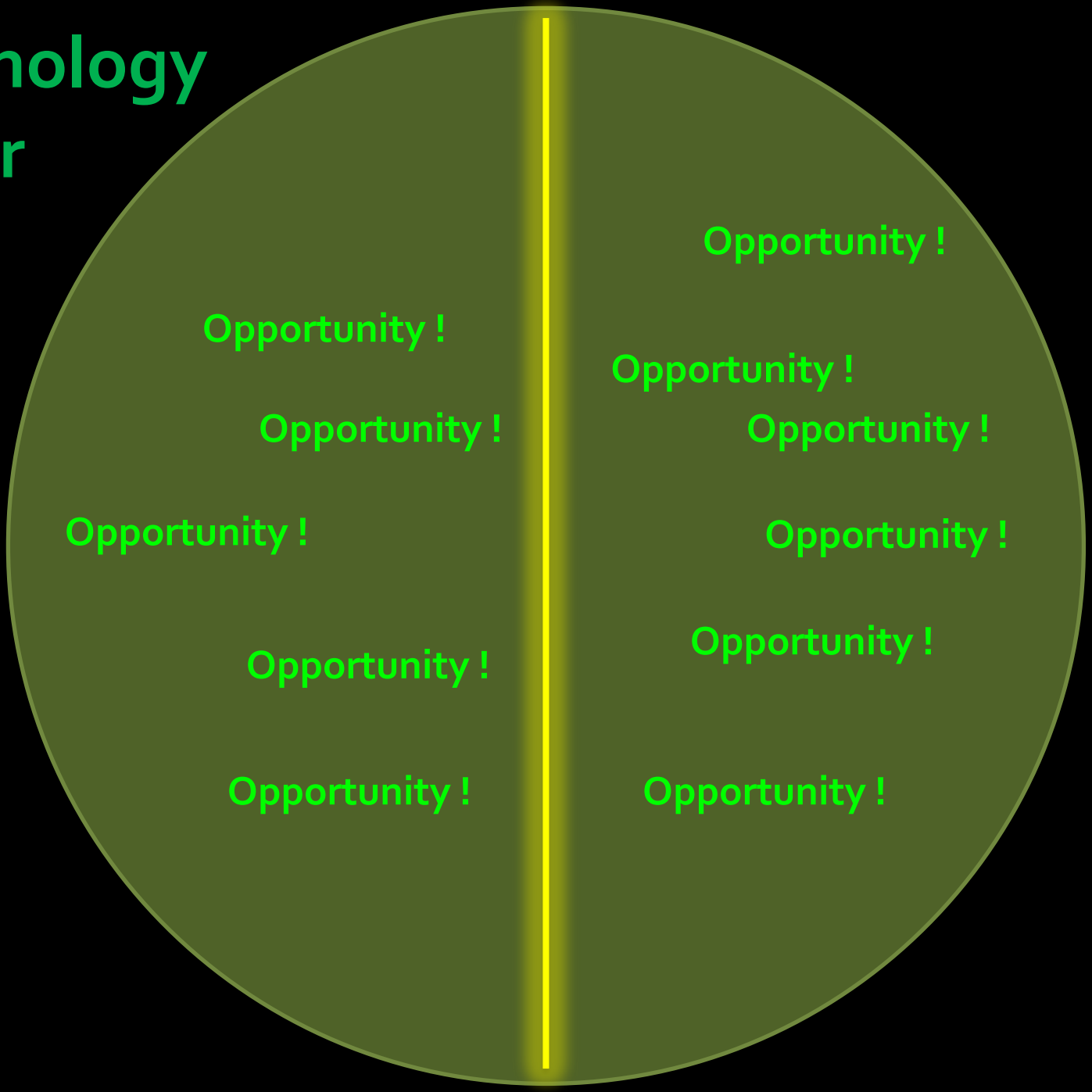
Technology Radar

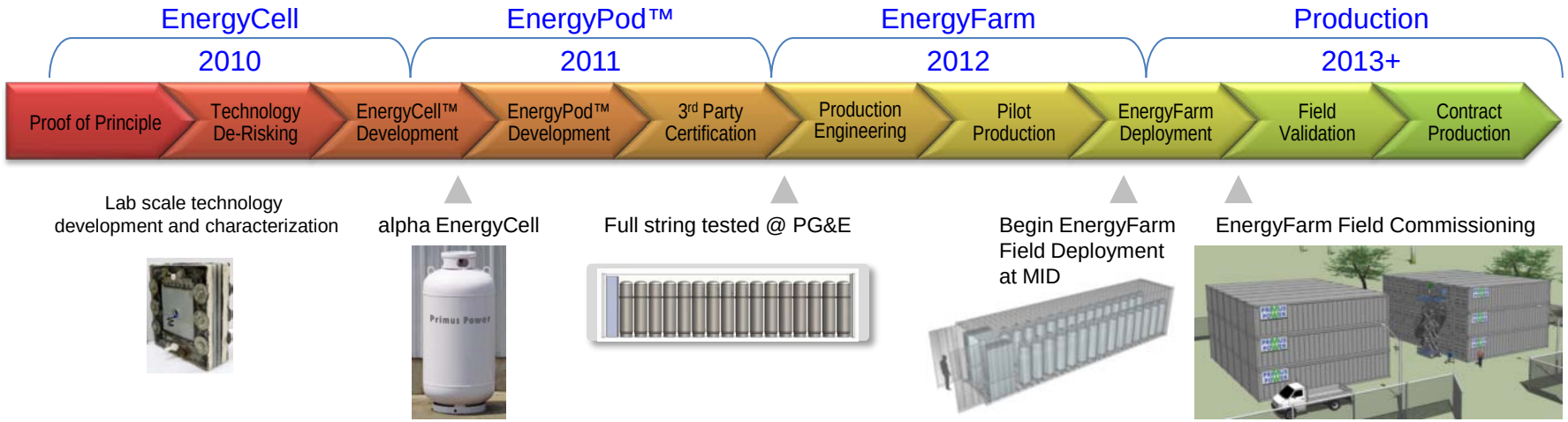


Wind Firming EnergyFarm Project

presented by Rick Winter, CTO Primus Power

Funded in part by the Energy Storage Systems Program of the U.S. Department Of Energy through *National Energy Technology Laboratory*

- Bridge the gap to the practical application of a mature and high-performance electrochemistry for grid storage.
- Provide the required application definition with utility and other customer input to optimize benefits to the community
- Facilitate technology and system development in 2010 – 2011
- Field demonstration at **PG&E Modular Generation Substation** early 2012
- Field deployment at **Modesto Irrigation District** late 2012



Primus Power – a Domestic Powerhouse!

PRIMUS POWER
Smart Grid Storage

Aligning the Pieces for a complete Grid Storage Solution

- Leverage 60 man-years of grid storage technology leadership
  - Technology neutral selection of a simple & powerful electrochemistry
- Incorporated Primus Power in 2006
  - Proof-of-principle ($95k California Energy Commission grant)
  - Filed central patent (8 additional patents filed to date with >300 claims)

Dr Phil Symons
Invented the Flow Battery

From a standing start to critical mass in 18 months

- 2009 venture capital + $16M DOE funding + $1M CEC
  - DOE funding has enabled the 3-year roadmap to commercialization
- 26 employees with a maniacal product engineering focus!
  - ✓ Electrochemical Engineering (8)
  - ✓ Mechanical Engineering (8)
  - ✓ Electrical Engineering (3)
  - ✓ System Engineering (4)
- Demonstrated technology & established commercial viability
- Developing advanced electrode ($2.7M ARPA-E project)

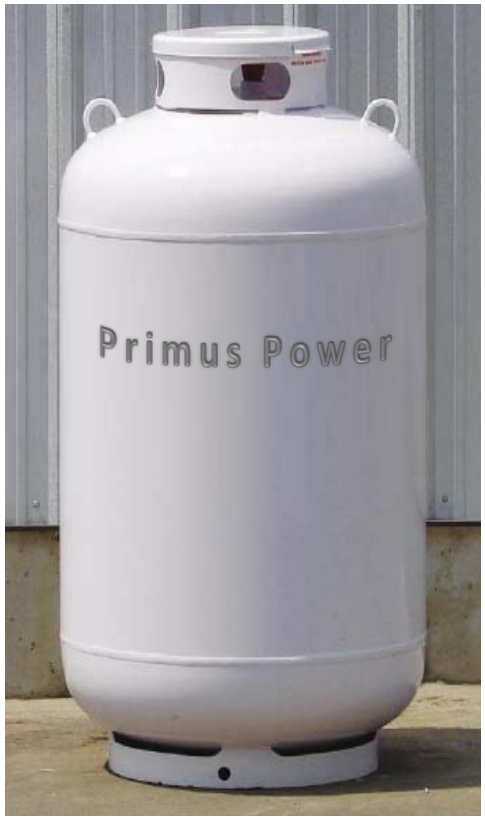
Tom Stepien & Rick Winter
CEO CTO

Affordable + Powerful + Bullet-Proof !

PRIMUS POWER
Smart Grid Storage

The EnergyCell™ is our volume production module

- *Starting with compelling active materials*
  - » *$1.80/kWh vs. $30/kWh for lead paste*
  - » *700Wh/kg & 1700Wh/l (gasoline yields 1600Wh$_e$/l)*
- ***Maintenance-proof*** welded triple containment
  - » 15-year design life w. 200,000h pumps
  - » >>5,000 cycles to 100% DOD
- Economy of scale
  - » One of the largest batteries modules in the world
  - » 20kW/60kWh @ 48Vdc (equiv. 30,000Ah Pb-A battery)
- Economies of mass production
  - » small enough for a production line
  - » 75% part count reduction
  - » low cost commodity materials
  - » standard manufacturing processes

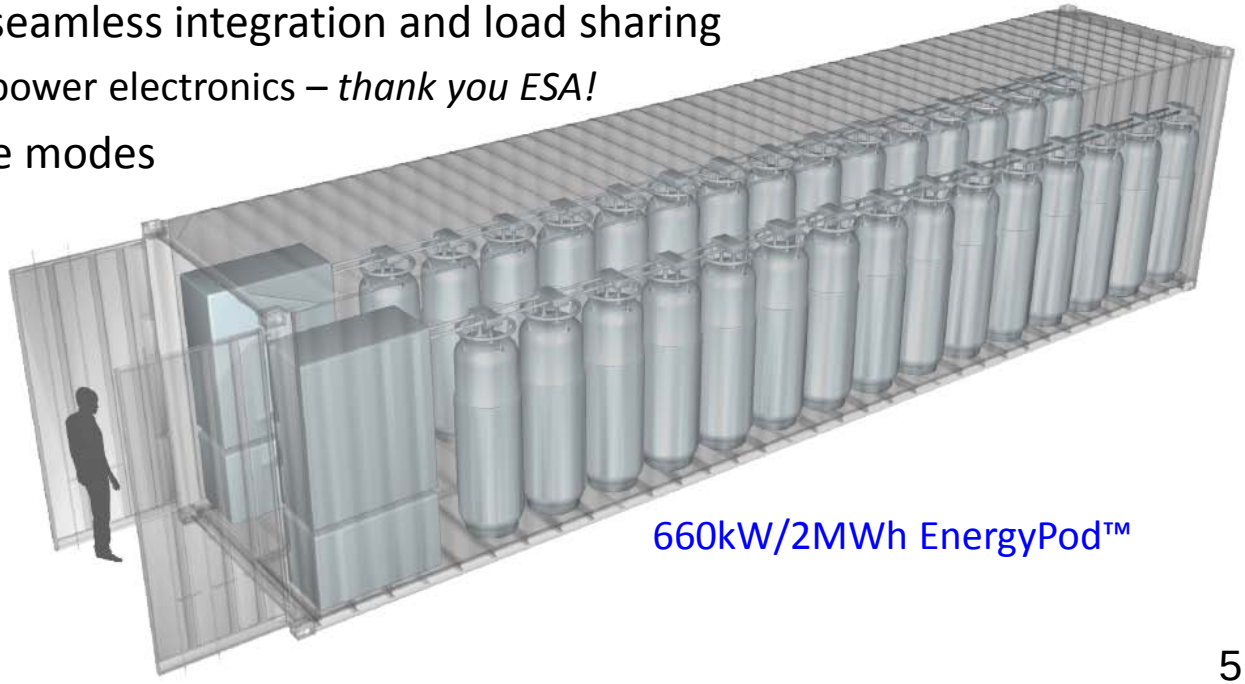


Standard 28”ϕ steel ASME, NFPA58 conforming tank

Robust "Plug & Play" **EnergyPods™**

PRIMUS POWER
Smart Grid Storage

- Elegant System Integration
  - Direct DC to AC conversion w/o dc boost phase
    - » half the parts; half the failure modes; half the losses; half the cost!
  - No active cooling or heating – reduces system loads by 70%
  - ***Module-swap maintenance*** achieved through Common Module Design
    - » no engineers; no forklifts; no special tools; no advanced training
- "Rack & Stack" Cargo Containers
  - Transformerless and seamless integration and load sharing
    - » Parker's advanced power electronics – *thank you ESA!*
  - No single-point failure modes
  - 200MW/acre



660kW/2MWh EnergyPod™

Primus Power will begin Installing the EnergyFarm in Modesto, California in 2012

PRIMUS POWER
Smart Grid Storage

Water & Power
Modesto Irrigation District

- ✓ *Ease of permitting*
- ✓ *Incremental capital*
- ✓ *Strategic siting*
- ✓ *Proximity to load*
- ✓ *Can be relocated*

Summary of Objectives

PRIMUS POWER
Smart Grid Storage

- Help trigger ***rapid adoption of grid storage systems*** in the US by demonstrating a low cost, robust and flexible EnergyFarm
- Accelerate adoption of renewable energy and ***enhance grid stability*** by firming the output of wind & solar farms
- Demonstrate ***improved grid asset utilization*** by storing energy during off-peak periods for dispatch during local load peaks
- Establish an ***advanced battery manufacturing*** industry in the U.S.
- ***Reduce CO_2 emissions*** from utilities