DEPARTMENT OF ENERGY PHYSICAL-BASED STORAGE WORKSHOP:
Identifying Potential Pathways for Lower Cost 700 Bar Storage Vessels

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Dr. Ned Stetson

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The DOE Hydrogen Storage Team

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http://energy.gov/eere/fuelcells/fuel-cell-technologies-office

Mission and Focus

To enable and accelerate the **successful commercialization of hydrogen fuel cell technologies through development of advanced hydrogen storage technologies** able to cost-effectively meet application performance requirements.

Light-duty fuel cell electric vehicles

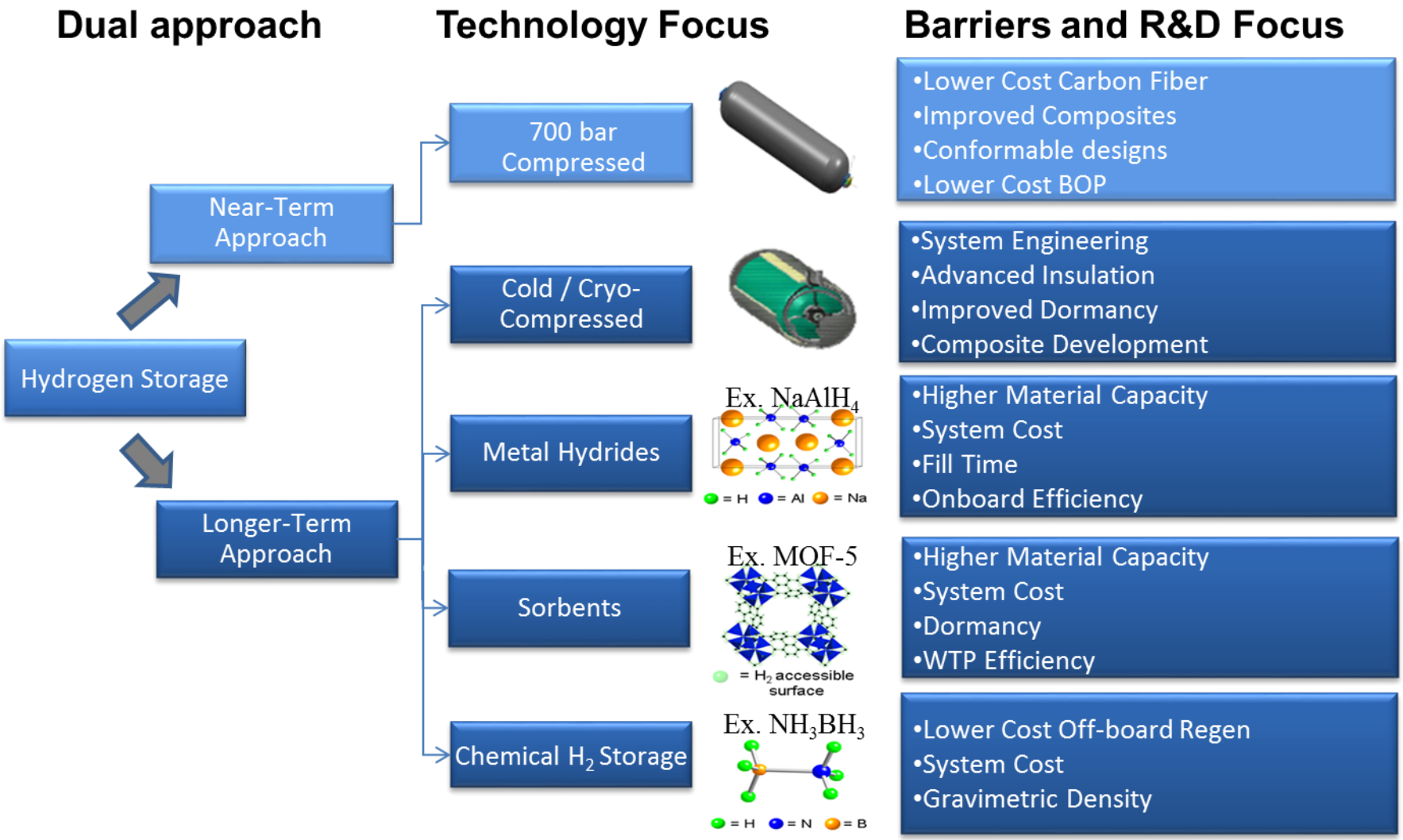
- Primary focus
- Driving range of at least 300 miles without compromising passenger and cargo space or vehicle performance
- Cost & performance targets established in consultation with automotive OEMs

High-value, non-automotive applications

- Secondary Focus
- Support advancement of FCEVs:
  - Infrastructure / supply chain development (e.g., material handling equipment)
  - Leverage prior DOE-supported R&D
- Targets for MHE and portable power established with stakeholder input

Advanced H_2 storage technologies are critical for successful commercialization of hydrogen fuel cell technologies

Dual strategy to address near and long-term needs



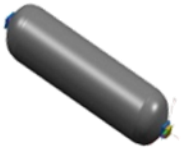
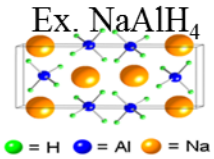
Near-term – address cost and performance of 70 MPa H_2 storage; Long-term – develop advanced technologies with potential to meet all targets

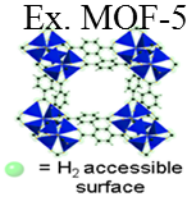
Dual strategy to address near and long-term needs

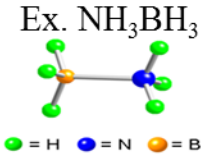
Dual approach | **Technology Focus** | **Barriers and R&D Focus**

Workshop focus

Hydrogen Storage

- Near-Term Approach
  - 700 bar Compressed
    - 
    - •Lower Cost Carbon Fiber
      •Improved Composites
      •Conformable designs
      •Lower Cost BOP
  - Cold / Cryo-Compressed
    - 
    - •System Engineering
      •Advanced Insulation
      •Improved Dormancy
      •Composite Development
- Longer-Term Approach
  - Metal Hydrides
    - 

    - •Higher Material Capacity
      •System Cost
      •Fill Time
      •Onboard Efficiency
  - Sorbents
    - 

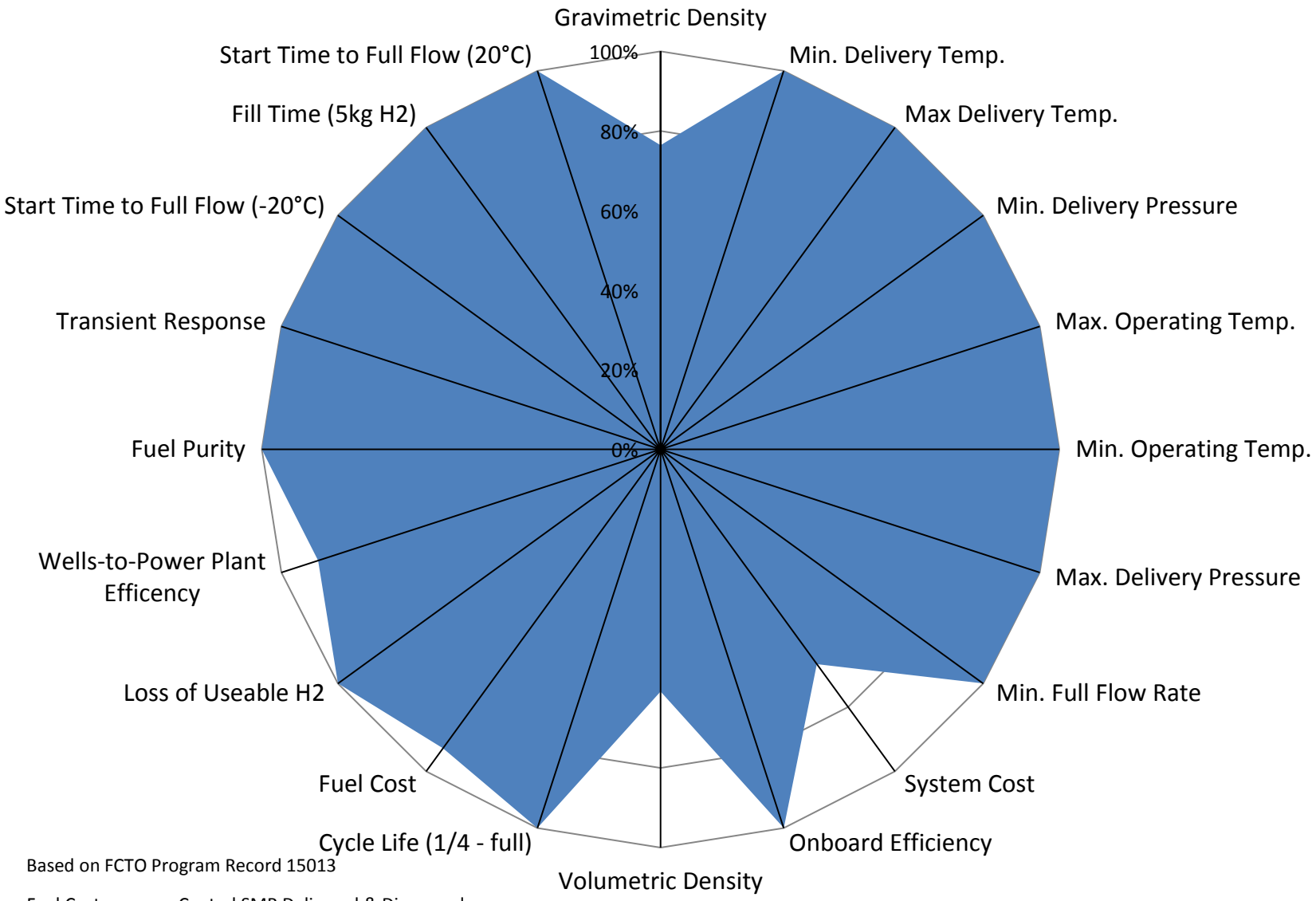
    - •Higher Material Capacity
      •System Cost
      •Dormancy
      •WTP Efficiency
  - Chemical H_2 Storage
    - 

    - •Lower Cost Off-board Regen
      •System Cost
      •Gravimetric Density

Near-term – address cost and performance of 70 MPa H_2 storage;
Long-term – develop advanced technologies with potential to meet all targets

70 MPa System Performance

Projected Against DOE 2020 Targets

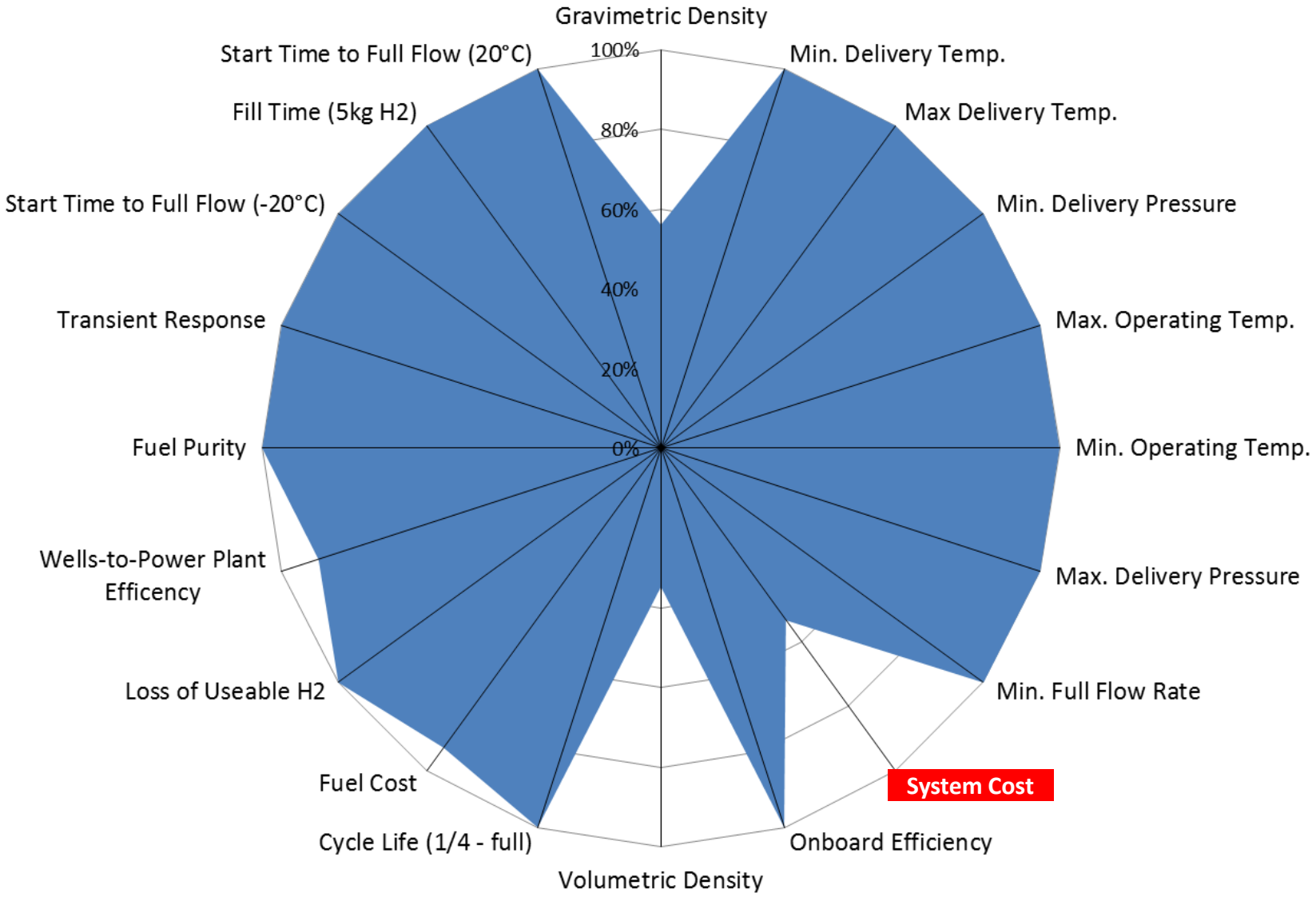


Based on FCTO Program Record 15013

Fuel Cost assumes Central SMR Delivered & Dispensed

70 MPa System Performance- Cost is the objective

Projected Against DOE Ultimate Full Fleet Targets

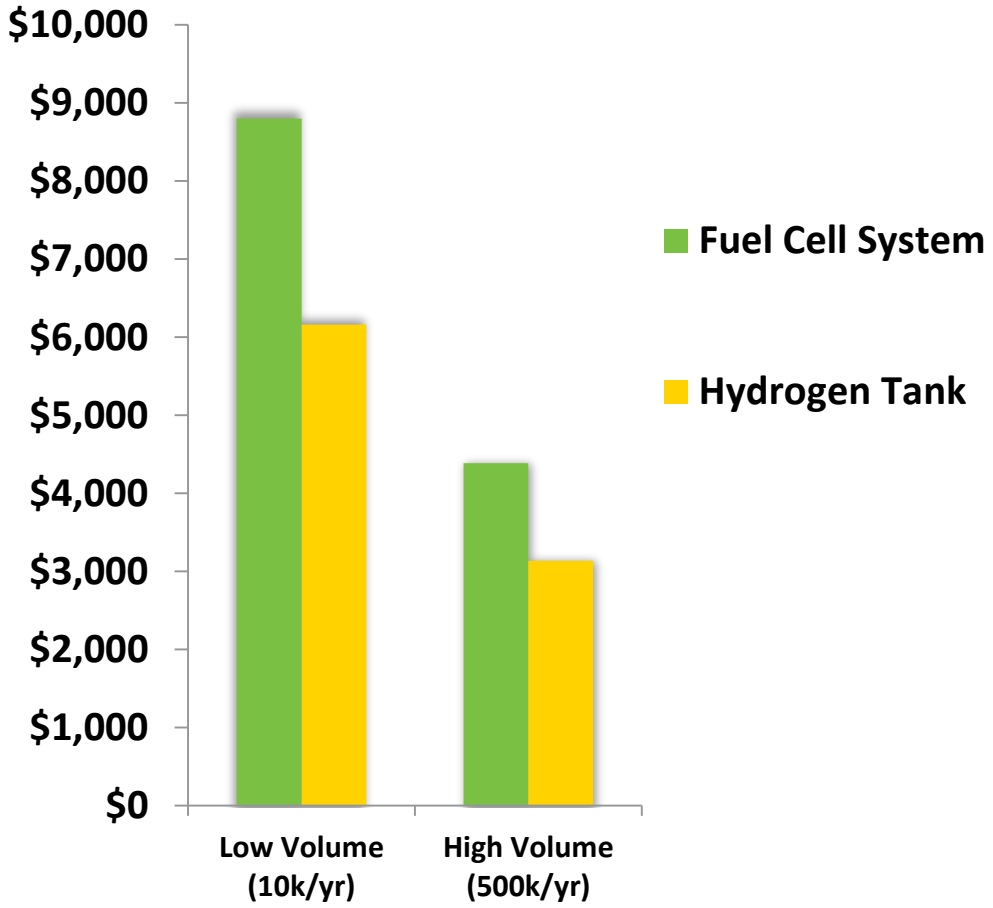


Based on FCTO Program Record 15013

H_2 Storage Relevance to FCEV Commercialization

Major cost items on a FCEV:

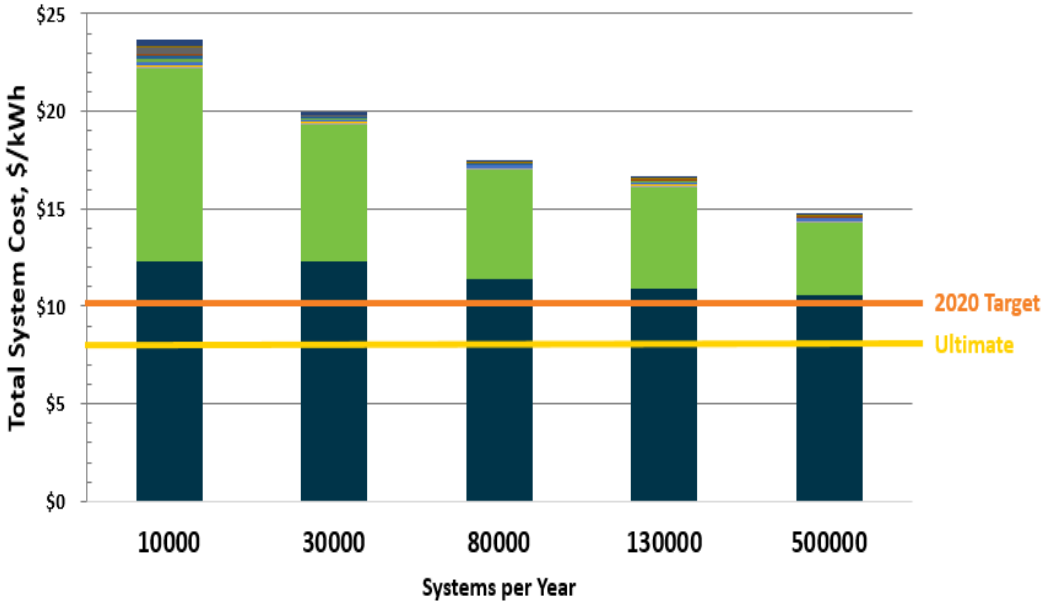
- **Storage System Cost is a close 2nd to the fuel cell system** (projections based on 5.6 kg usable H_2 and 80 kW net fuel cell), both of which need further cost reductions

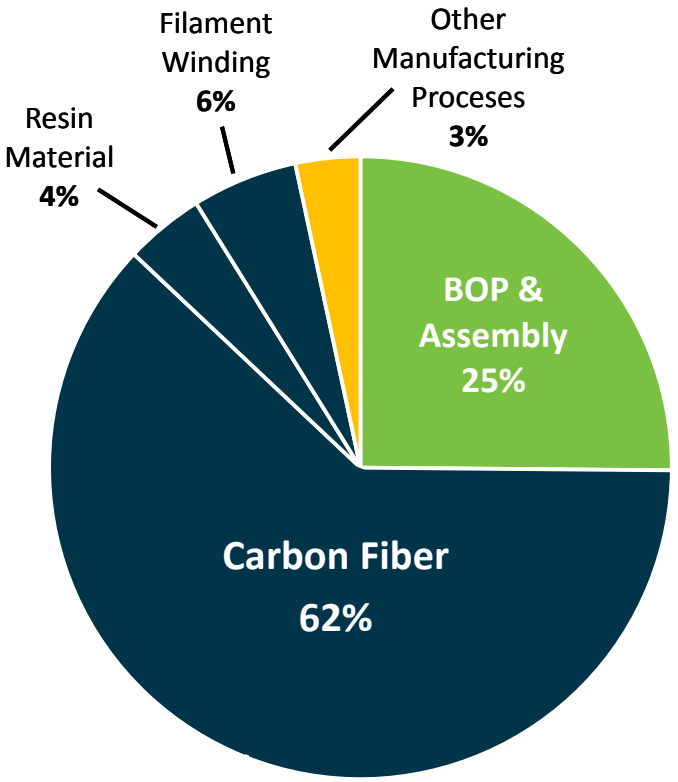


(credit: SA / ANL)

H_2 Storage is a key enabler for FCEV commercialization

70 MPa System Cost Breakdown

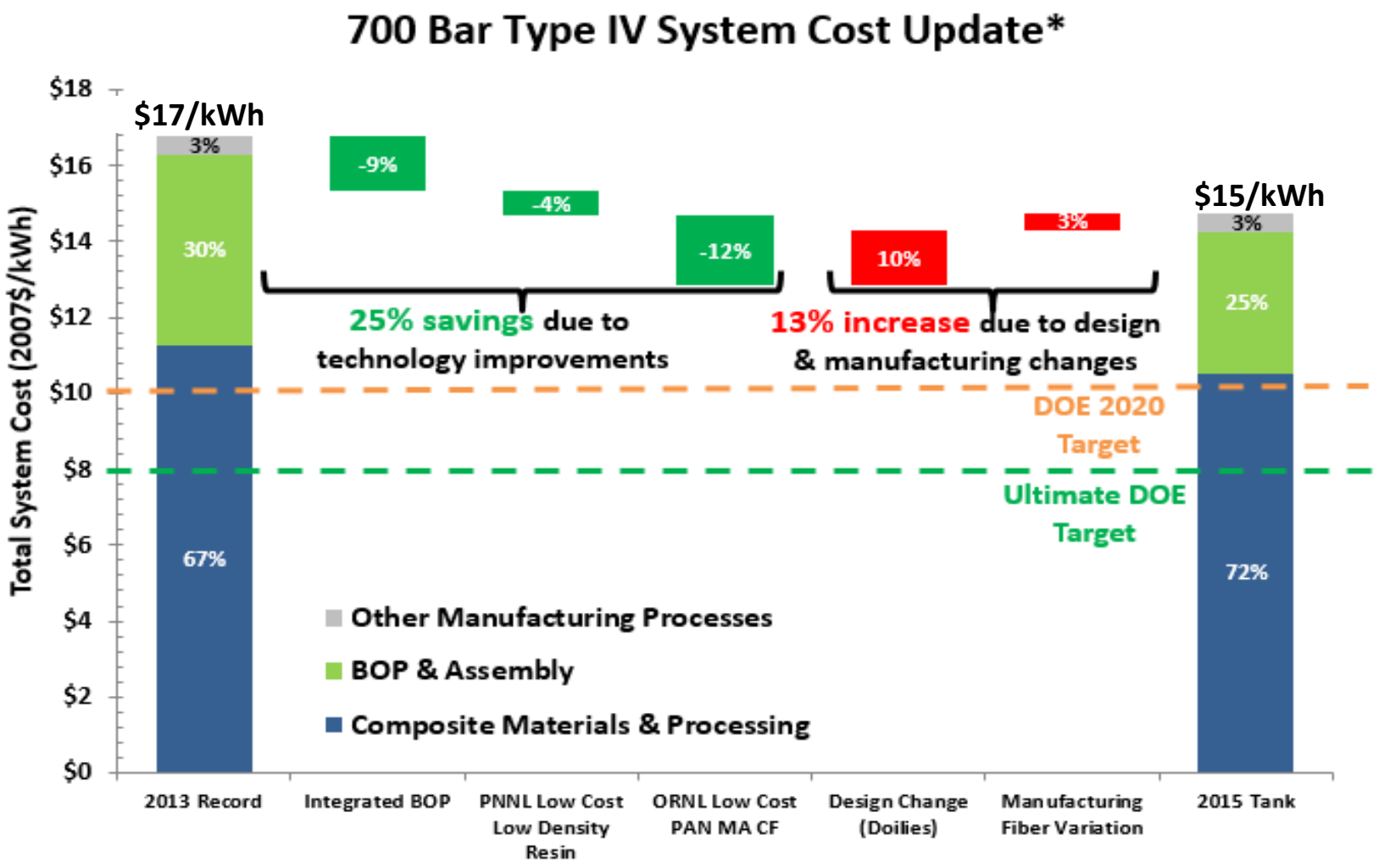




Cost targets cannot be met without significant reduction in high-strength carbon fiber composite costs

https://www.hydrogen.energy.gov/pdfs/15013_onboard_storage_performance_cost.pdf

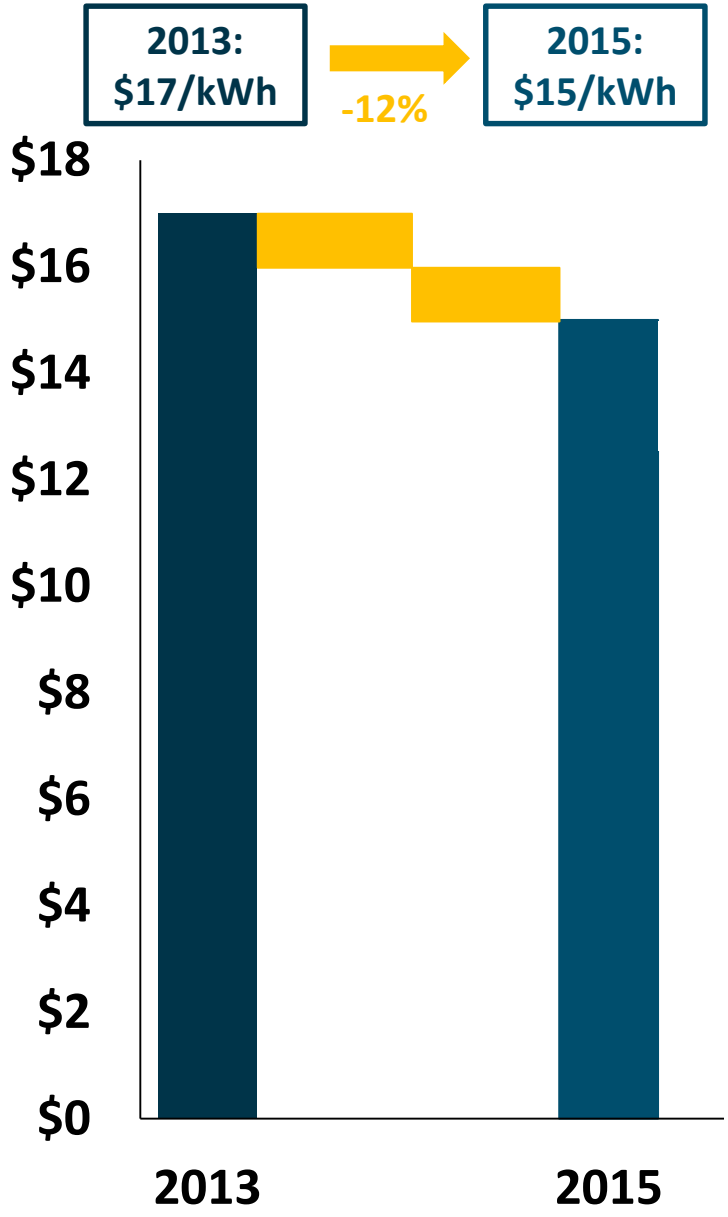
How far have we come? – 70 MPa System Cost



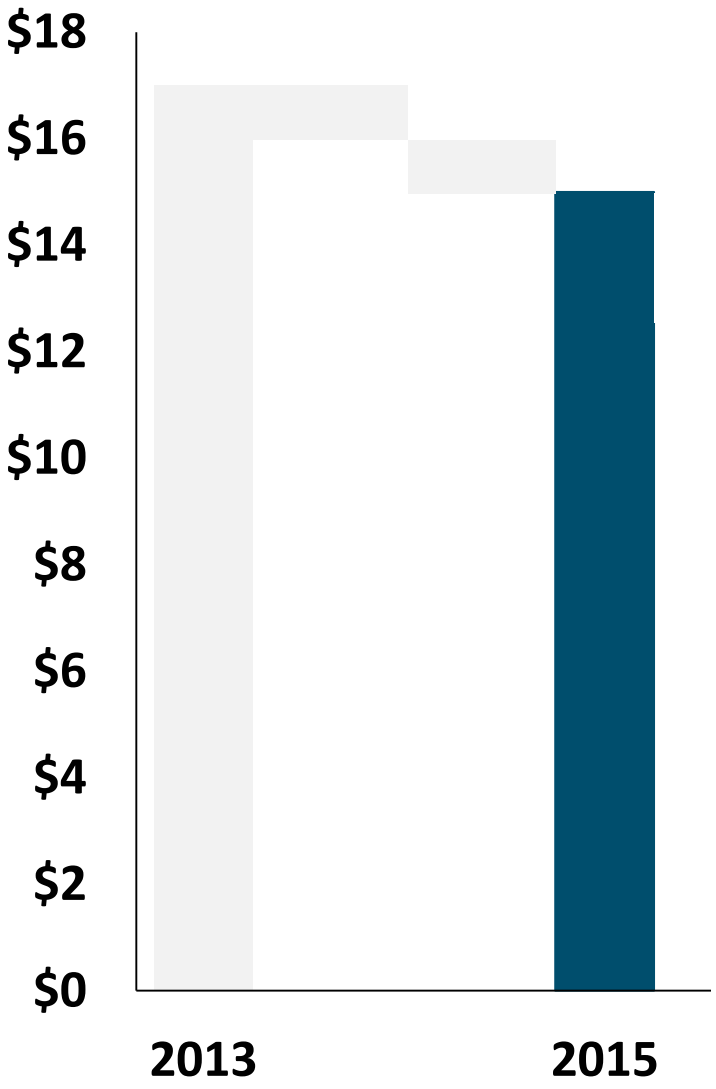
*At 500k units/yr. Based on Program Record 15013

12% Net Cost Reduction since 2013

Progress- 70 MPa System Cost ($/kWh)

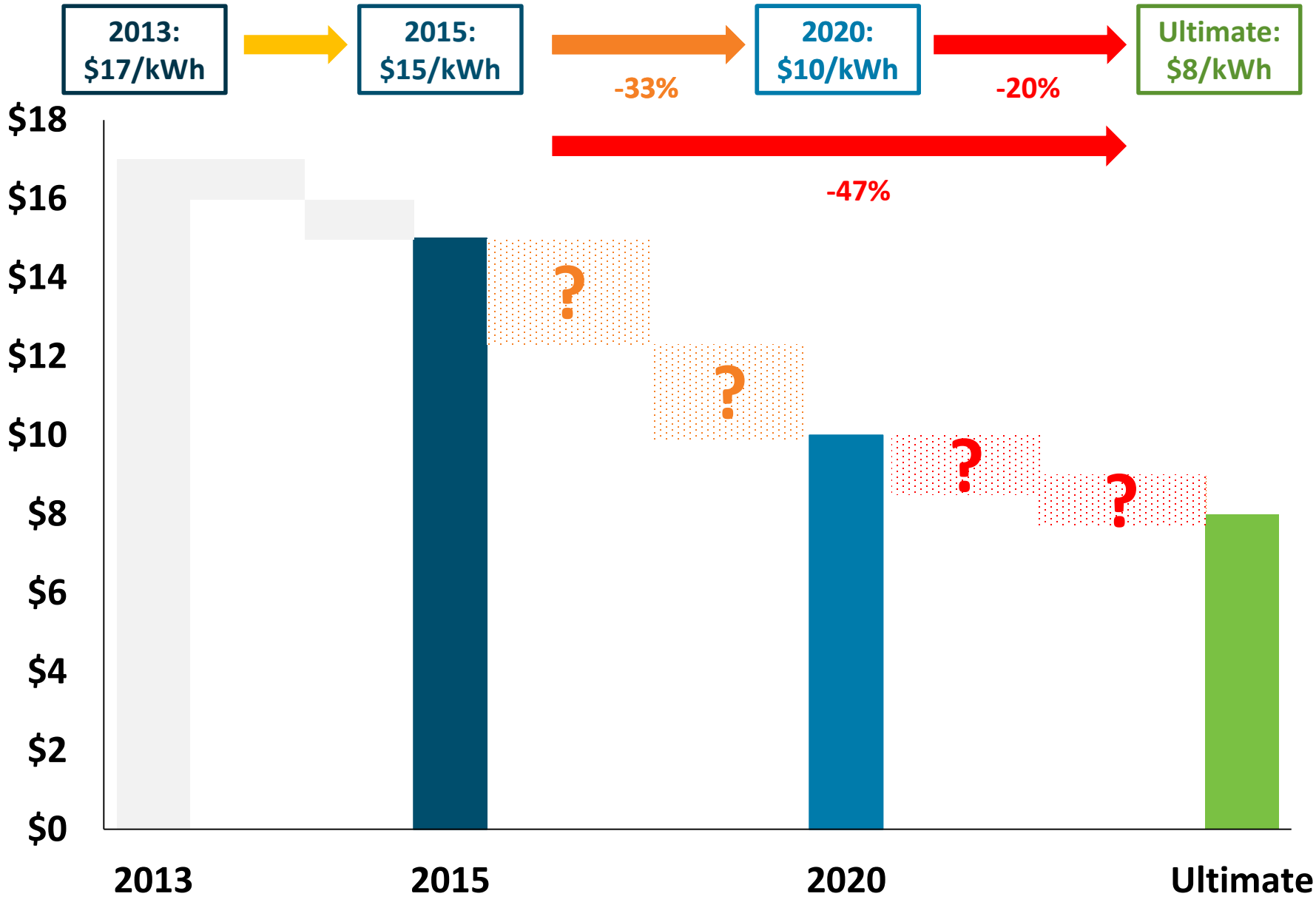


Progress- 70 MPa System Cost ($/kWh)



Where do we go from here?

R&D Gaps- 70 MPa System Cost ($/kWh)



Today's Objectives

Before Workshop

After Workshop

Tangible R&D strategies to reduce cost

- Identify and prioritize specific R&D strategies **to reduce costs of COPVs for 700 bar hydrogen storage** to achieve the 202 and Ultimate onboard storage cost targets
- Identify and prioritize potential onboard storage strategies **to reduce the cost and complexity of the refueling infrastructure**

Frank, open and honest discussion and recommendations based on your expertise are what we are looking for!

Thank you

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