

Evaluation of Sub-Surface Compressed Air Energy Storage (SSCAES) for Energy Storage ESA meeting April 5, 2000

Dale T. Bradshaw

Senior Manager, Power Delivery Technologies

Energy Research & Technology Applications

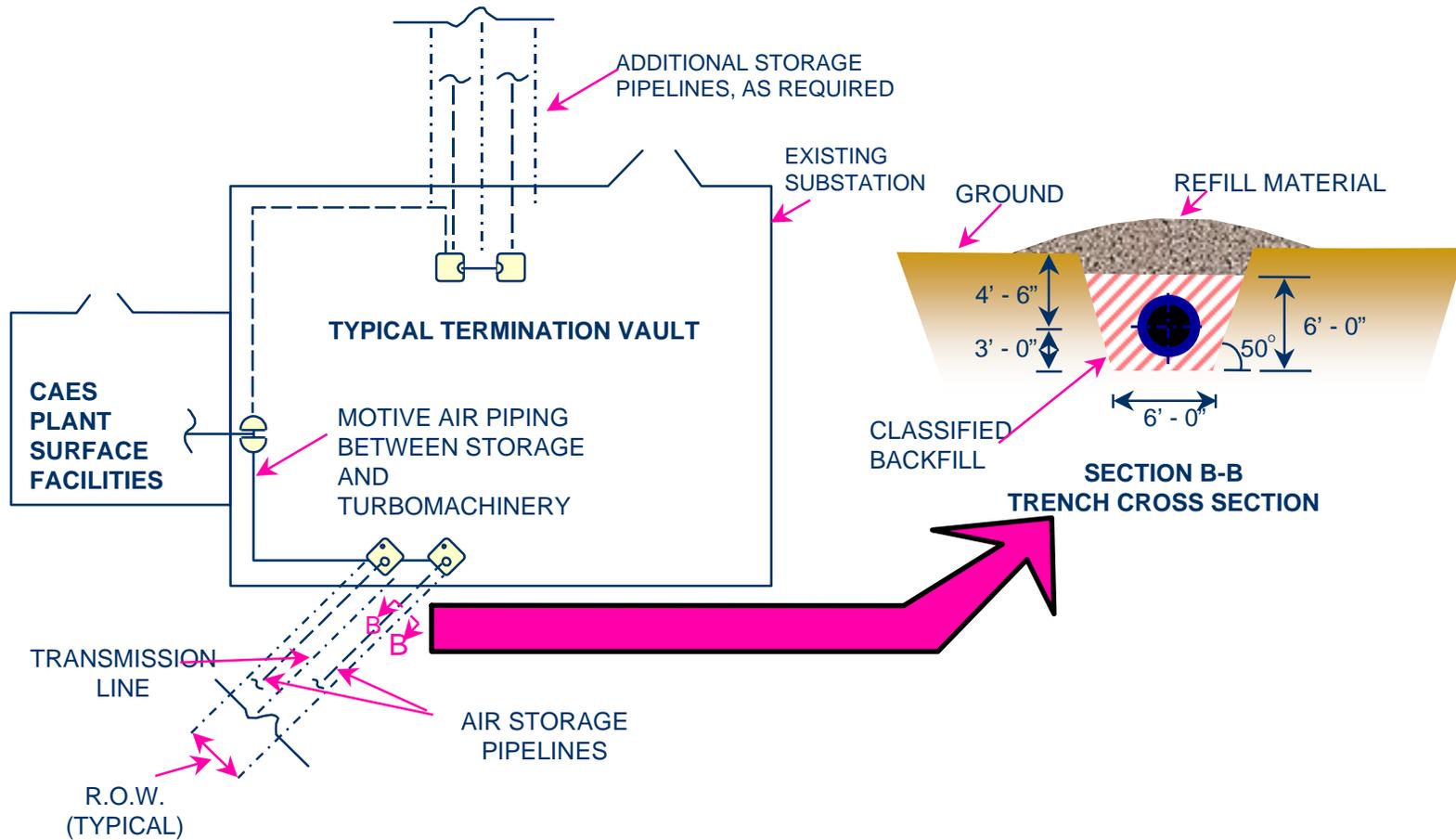
TVA



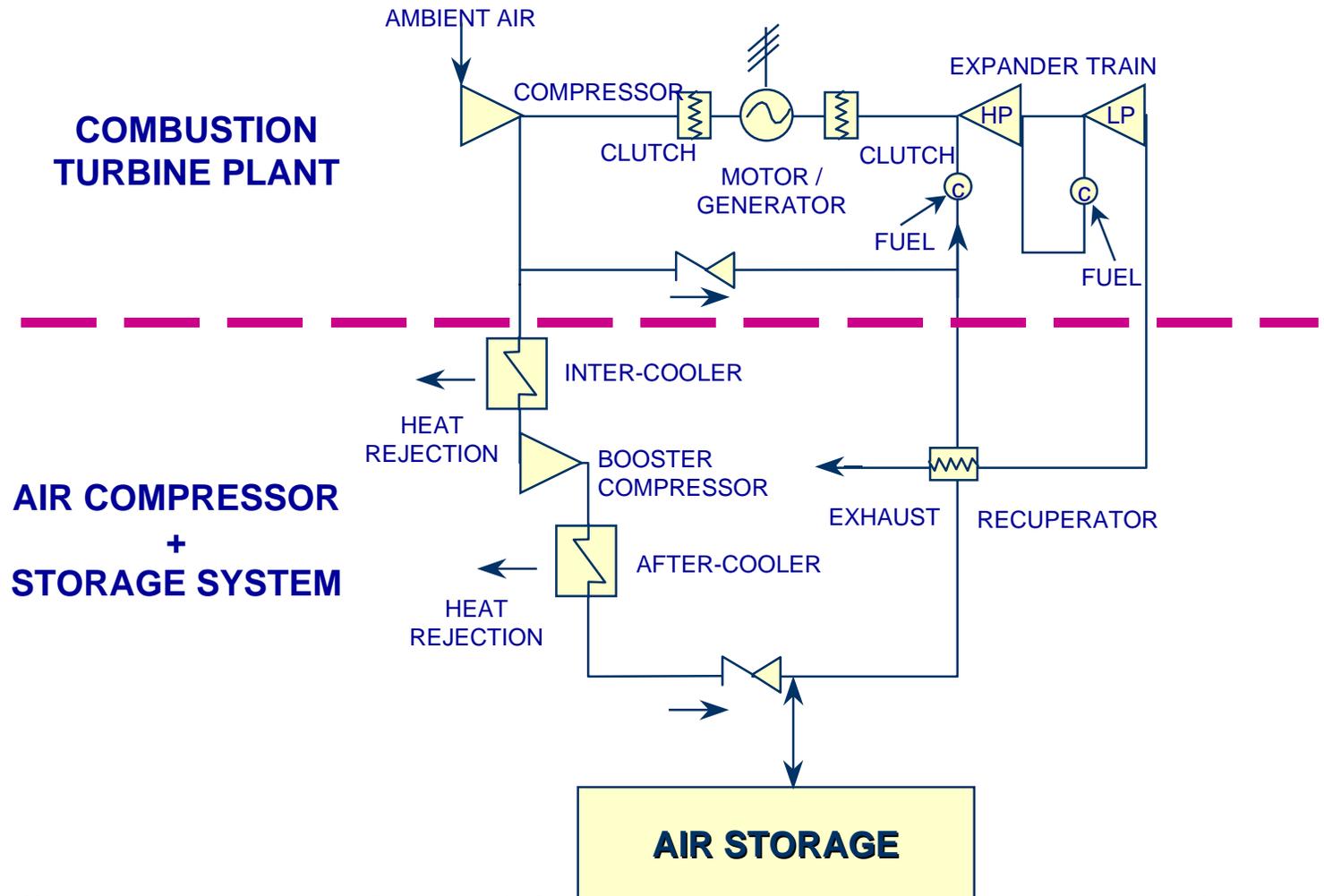
SSCAES Key Features

- ➔ Compressed Air Stored in Buried Pipe (Layout Can Vary)
- ➔ Output Insensitive to Ambient Temp
- ➔ Several Hours of Storage, Based on Economics and Need
- ➔ One or More 5 MW-20 MW SSCAES Units at a Substation (Nominal size of 15 MW)

SSCAES Conceptual Arrangement



SSCAES Cycle With Reheat and Recuperation



Saturator can be added after recuperator or reduce NOX

SSCAES Key Features

- ➔ Gaseous or liquid Fuels are required (LDC gas will most likely be high cost)
- ➔ Preferred fuel is Land Fill Gas (LFG) because rating is proportional to mass flow and LFG has large % of CO₂ as a diluent (which will also reduce CO₂)
- ➔ Start-up from a cold start in less than 10 minutes is possible.
- ➔ Start-up in seconds from hot-start is possible.

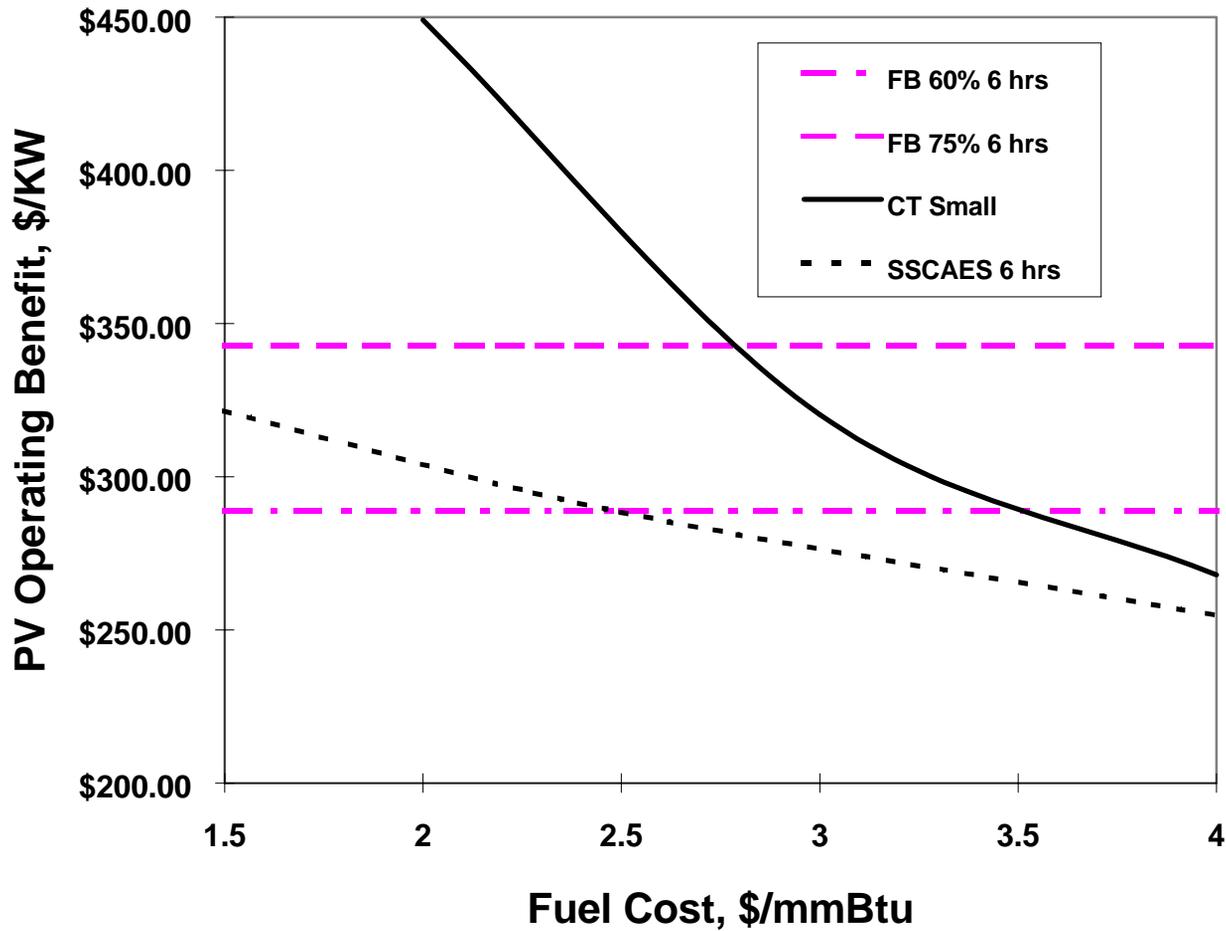
SSCAES ENERGY STORAGE PROJECT PERFORMANCE AND BENEFITS

- ⇒ SSCAES can be assembled out of high cost Allison 501-KM7 aeroderivative CTs or significantly lower cost, lower firing temperature turboexpanders.
- ⇒ Capital costs range from \$500/kw to \$600/kw for 6 hours of storage and 5 Mw to 15 Mw.
- ⇒ Capital costs for lower firing temperature turboexpanders TBD (but are estimated to be \$400/kw to \$500/kw).
- ⇒ After discharge, turbine output drops by 66% to provide option as a combustion turbine for continuous operation.

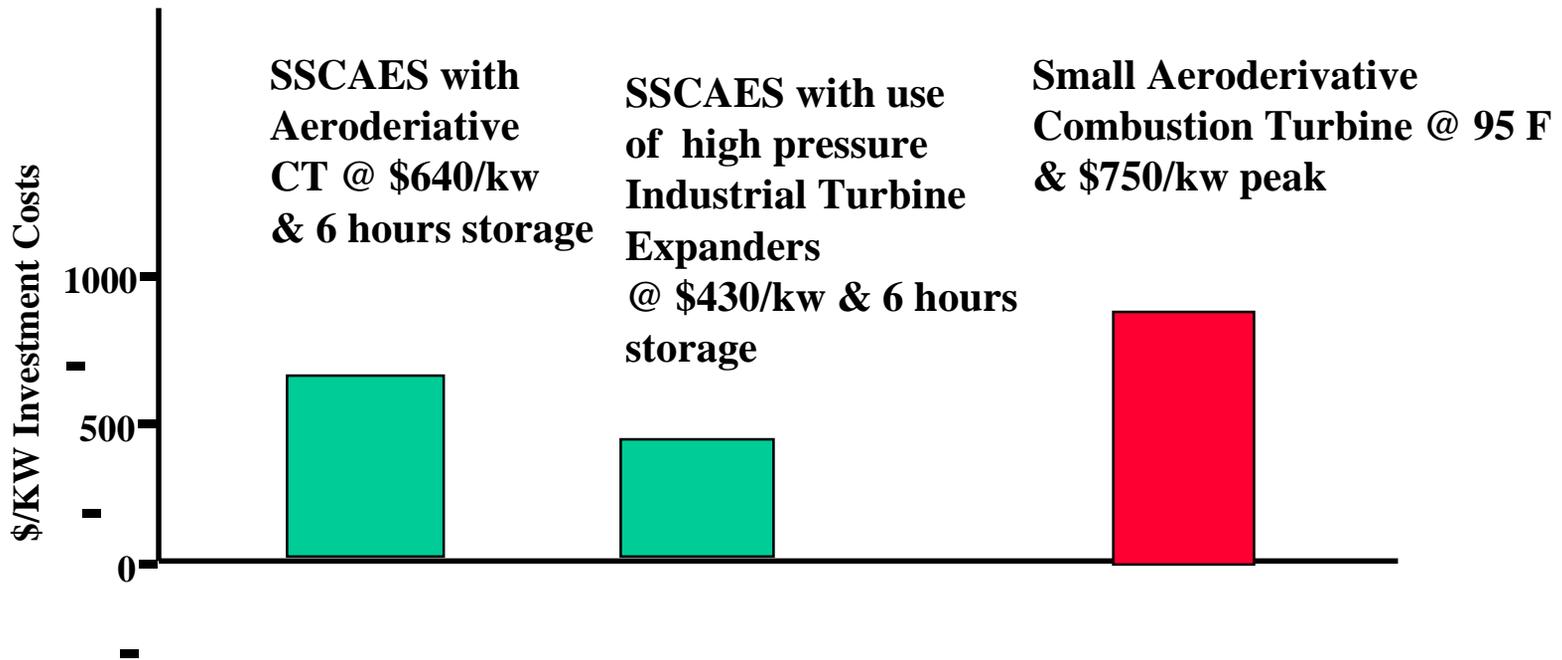
SSCAES ENERGY STORAGE PROJECT PERFORMANCE AND BENEFITS

- ⇒ Low cost option for spinning reserve**
- ⇒ Can hot start in seconds, and cold start in minutes**
- ⇒ Can efficiently use landfill gas, coal bed methane gas, or natural gas**
- ⇒ Heat rates of 5,300 Btu/kwh to 6,700 Btu/kwh**
- ⇒ Charging ratio of 1.00 to 0.78**
- ⇒ When operating as a combustion turbine, heat rate jumps to 12, 400 Btu/kwh.**

Operating Benefit from Power Sales



SSCAES Technology Improvement Plan



Promising Results for SSCAES

- ➔ SSCAES and SSCASH Can Compete with Simple Combustion Turbine.
 - Less Sensitive to Gas Prices
 - No Summer MW Reduction with increased ambient temperatures
- ➔ SSCASH with low cost turboexpander can compete with Flow batteries down to \$550/kw assuming fuel is available.
- ➔ Coal bed methane and especially LFG are ideal low-cost fuel options.
- ➔ Low cost Turboexpander needs to be evaluated