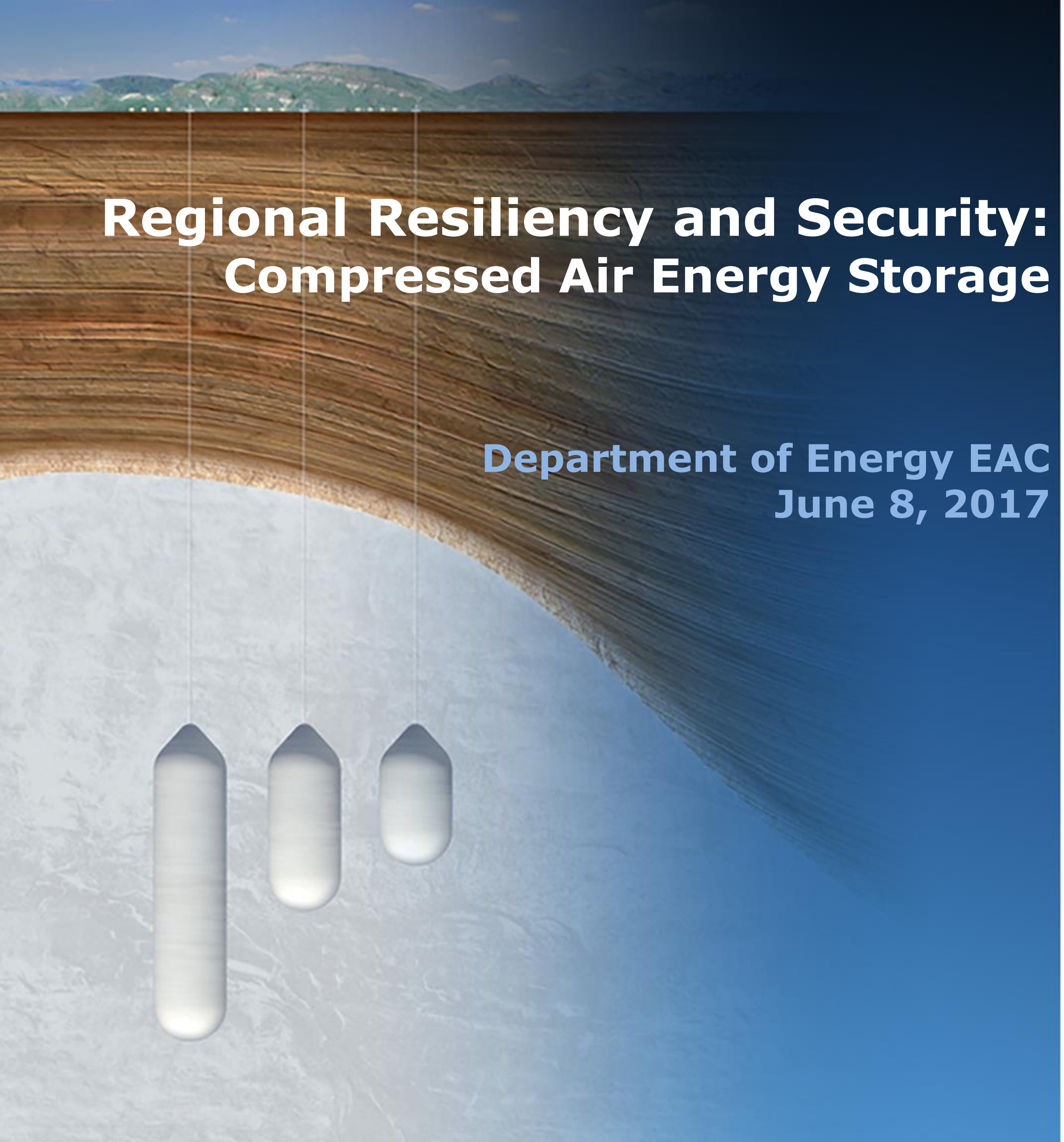
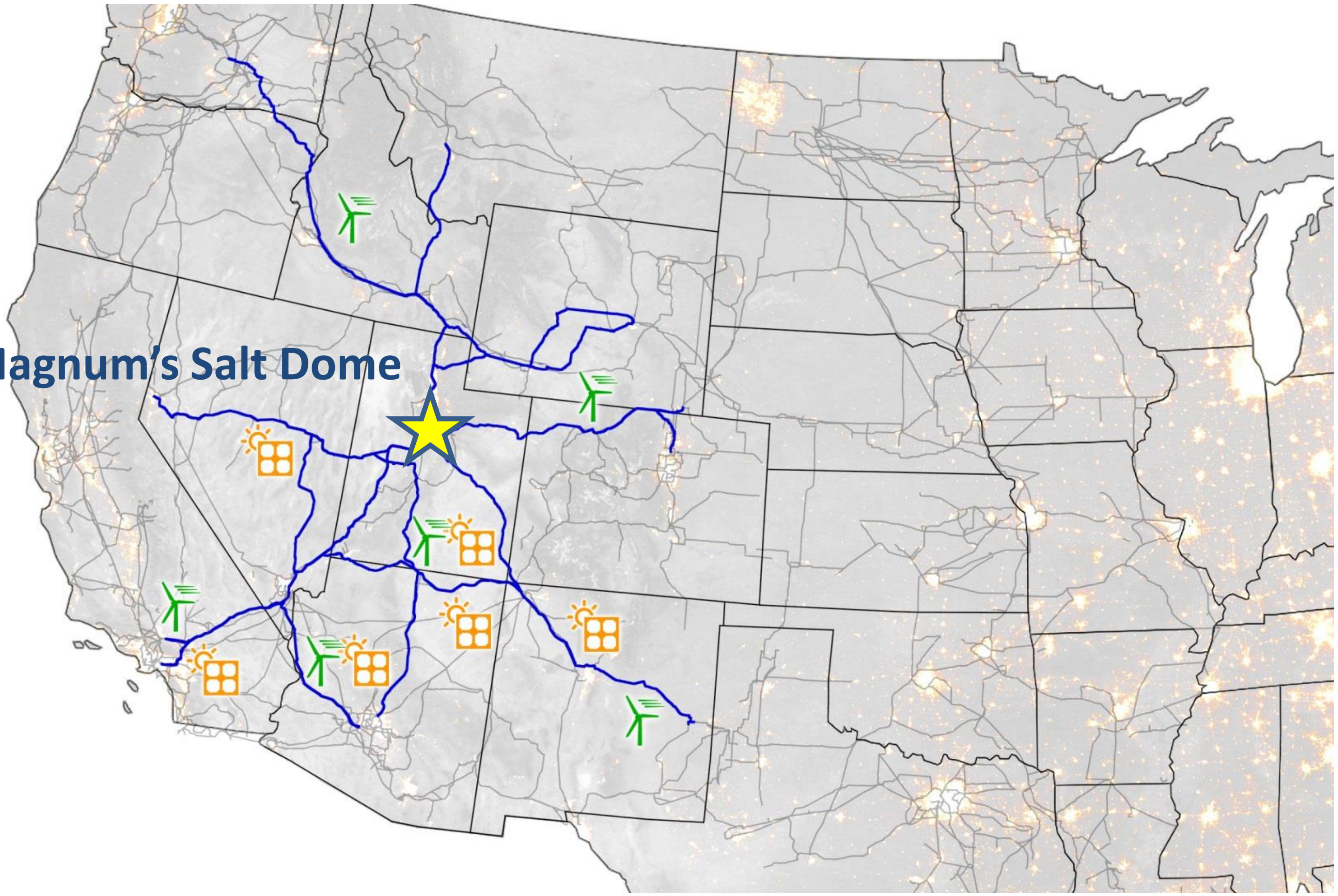
Regional Resiliency and Security: Compressed Air Energy Storage



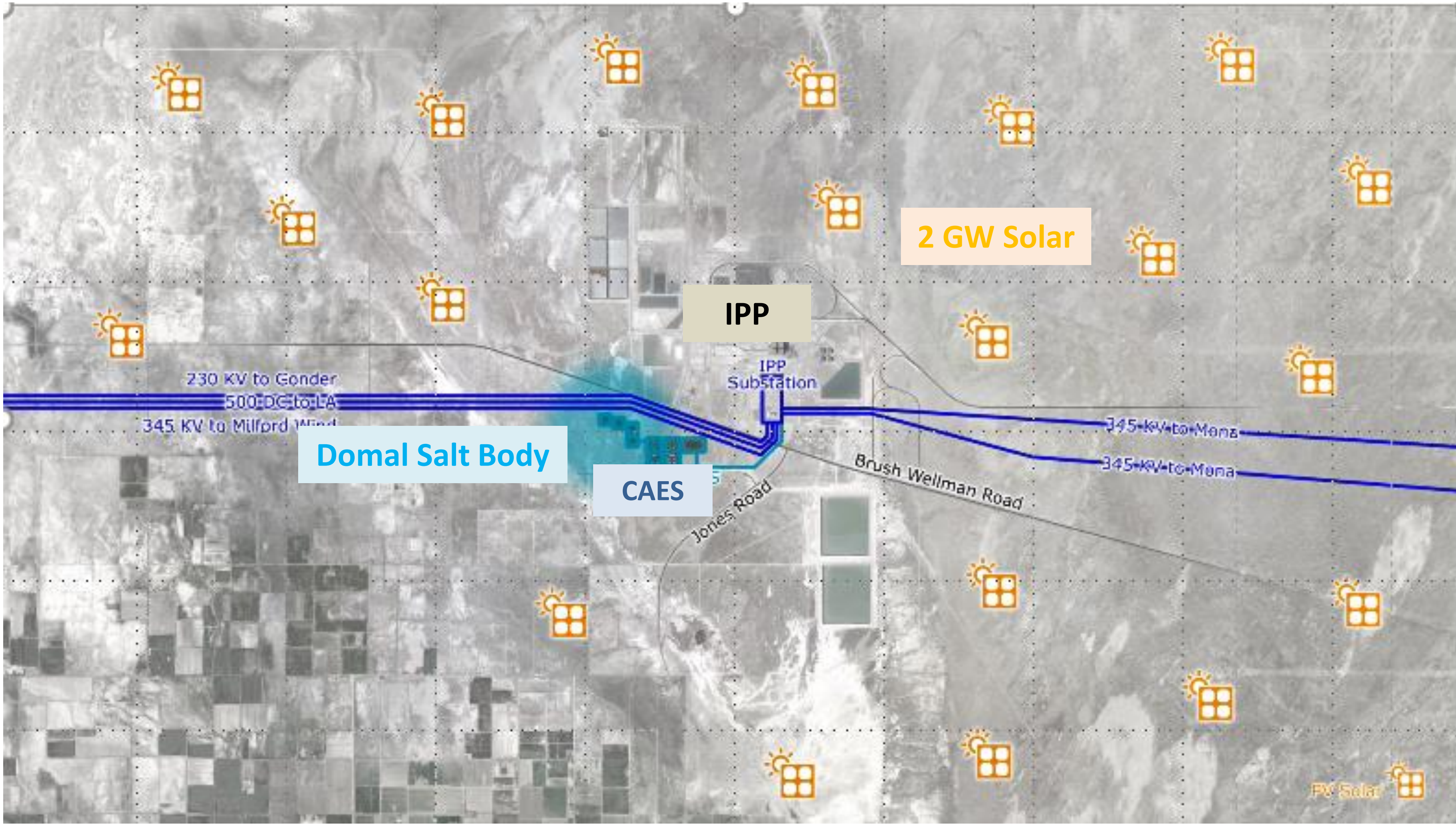
Department of Energy EAC
June 8, 2017

MAGNUM CAES

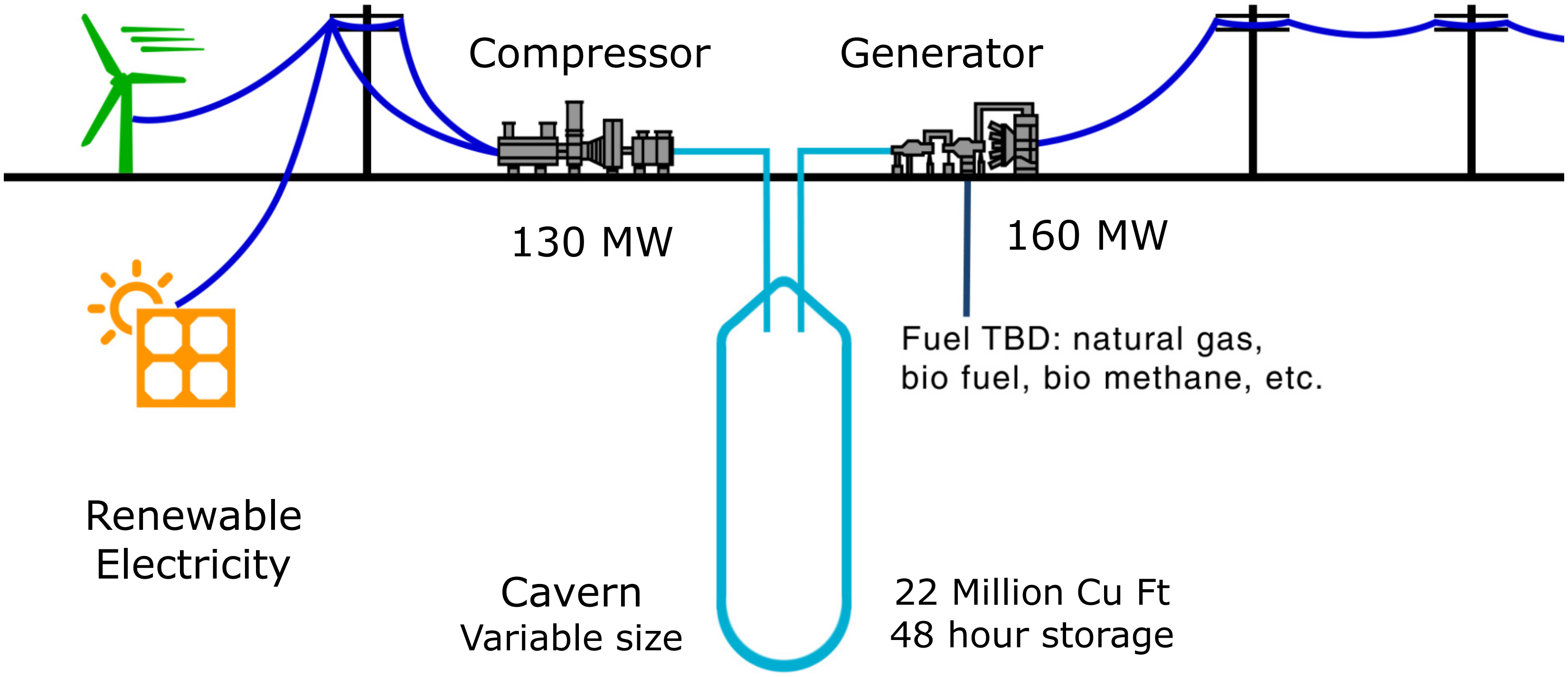
Magnum's Renewable CAES Location



Renewable CAES Layout



Renewable CAES Description



- From a “depleted” cavern – 7680 MWh of storage
- Multiple modules can developed >1000 MW possible

What Differentiates CAES?

- CAES potential, like PHS, is based on geology and geography
- Requires scale to spread fixed costs over many units
- Therefore not widely deployable
- CAES is not a direct competitor with Li-Ion batteries
  - Output is defined, i.e. expander/generator size (160 MW)
  - Duration is variable, i.e. cavern size (up to 48 hours or 7680 MWh)
  - Design supports simultaneous storage and return
- Equipment capability does not deteriorate over time
  - Maintenance required
  - 30 years+ experience
- Capacity not affected by operating range and frequency
- The combination of compressed air and expansion results in 1.2 MW of output for each MW of renewable input
  - P_{max} heat rate ~ 4230 BTU/kWh

System Resilience, Reliability & Security

Stressing the grid: loss of spinning mass, more regional transactions, difficulty in siting new transmission, variability in renewable supply, deployment of distributed energy resources

- CAES is grid scale: 160 MW, 7680 MWh
- Firming and shaping renewables, levelizing transmission use
- Ancillary services available from compressor <u>and</u> generator
- Ramp rates for regulation up & down, and spinning reserve
  - Compressor 30%/min or 38 MW/min
  - Expander 20%/min or 32 MW/min
- Non-spinning reserve: start to 160 MW in <10 minutes
- Volt / VAR management from generator and compressor
- Frequency regulation through automatic generation control
- Resource Adequacy
- Improved transmission efficiency and congestion relief
- Transmission deferrals
- Black start

CAESS Contribution to Grid Resilience

- Grid scale
- Black start capabilities
- Storage duration can be increased by bigger caverns
- Multiple standardized CAES modules can be installed
- Potential fuel storage in salt caverns
- Multiple fuel sources: natural gas, bio-methane, bio-fuel, NGL
- Augmented by battery storage

CAES Development Challenges

- Individual state's environmental treatment
- Expensive engineering required – before contracts and pricing
- Modeling thermodynamics and design capabilities
- Qualifying the project for ITC
- Maintaining Renewable Energy Credit value
- Evolving market structures and resource portfolios
- Recognition of capacity value – storage and generation
- Treatment as a transmission or generation asset or both
- Assuring stacked benefits capability are recognized by markets: Comments provided to FERC Storage NOPR

The Lack of a Western U.S. Transmission RTO/ISO limits the regional value of grid scale CAES

Renewable CAES Activities Underway

- Southern California Public Power Authority's (SCPPA) Request for Information on Storage Technologies submittal
  - Includes an integrated 150 MW solar project
- Power Purchase Agreement discussions underway
- California Energy Commission – RPS Eligible storage project submittal
- Investment Tax Credit eligibility assessment
- FERC Storage NOPR comments provided
- Energy Imbalance Market impact expansion analysis

Thank You

contact

Richard Walje
rwalje@westernenergyhub.com
801-232-2261 mobile

www.westernenergyhub.com

3165 East Millrock Drive, Suite 330
Holladay, Utah 84121
801-993-7001

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