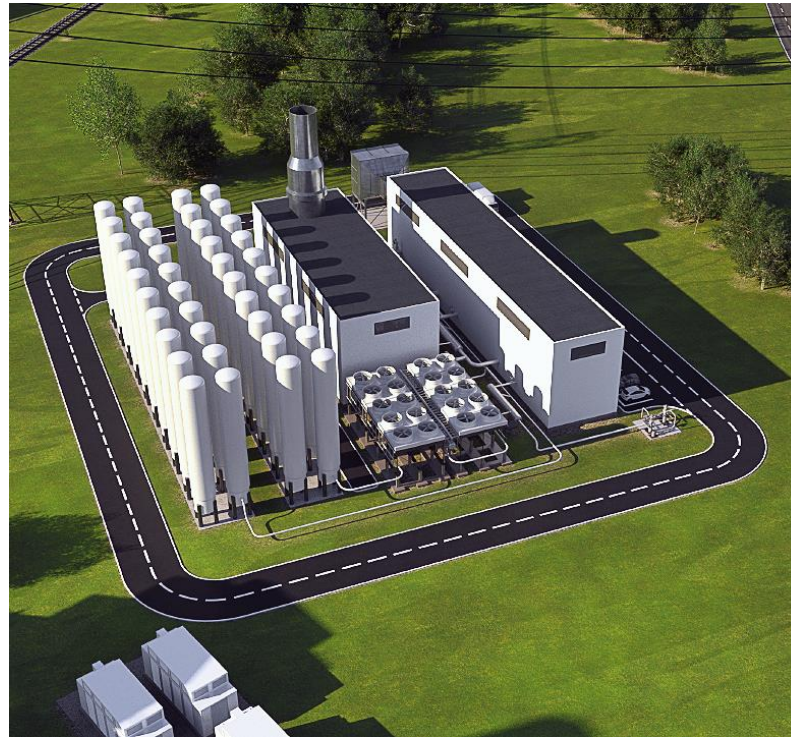


# Adiabatic Compressed Air Energy Storage



**SIEMENS**  
energy

## Your challenges

- Absorbing renewable energy that might otherwise be curtailed
- Regulatory requirements of black-start capabilities, resulting in bound capital and resources
- Balancing load with new mix of generating assets and end client expectations
- Volatile fossil prices cause increase in OPEX

## Our storage systems enable

- Energy and ancillary services without CO<sub>2</sub> and NO<sub>x</sub> emissions
- Increased grid capacity utilization, balancing and reserve services
- Decarbonization by high utilization of renewable energy sources
- Flexible cycling operations by independent operation for compression and expansion train
- District heating and process heat supply

## Our offerings

- Entire surface plant scope including CAES cycle, balance of plant, and construction
- Future-ready design: Deep decarbonization by unlocking synergies between thermal storage and traditional compressed air energy storage
- GWh-scale energy storage solution
- Proven components coupling together for unlocking a new market

## Typical properties

|  |                |                                    |
|--|----------------|------------------------------------|
|  | Power range    | 50–260 MW <sub>el</sub> * per Unit |
|  | Discharge time | 4–8+ hours                         |
|  | Reaction time  | <10–15 min                         |
|  | Storage size   | > 2000 MWh <sub>el</sub>           |
|  | Storage period | Multiple days/ weeks               |

\* Power range is per expansion train

## Benefits

|  |                           |     |        |      |
|--|---------------------------|-----|--------|------|
|  | Efficiency                | low | Impact | high |
|  | Availability              | low | Impact | high |
|  | Flexibility               | low | Impact | high |
|  | CO <sub>2</sub> reduction | low | Impact | high |

# Diabatic Compressed Air Energy Storage



**SIEMENS**  
energy

## Your challenges

- Absorbing renewable energy that might otherwise be curtailed
- Long duration energy storage for supporting load management
- Balancing load with new mix of generating assets and end client expectations
- Regulatory requirements of black-start capabilities, resulting in bound capital and resources

## Our storage systems enable

- Energy and ancillary services with low fuel consumption
- Increased grid capacity utilization, balancing and reserve services
- High flexible operating modes, including simultaneous charging and discharging
- Excellent load-following capacity and part-load efficiency
- Decarbonization by high utilization of renewable energy sources

## Our offerings

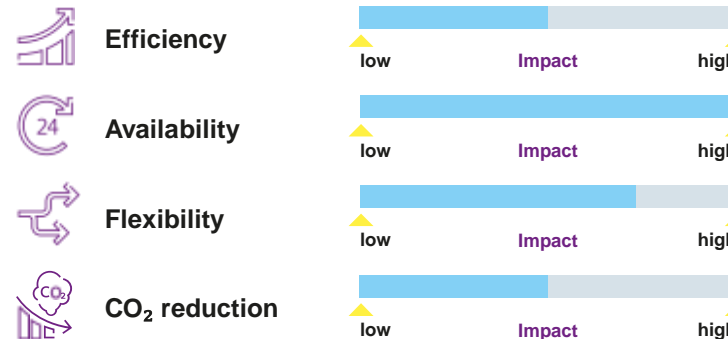
- Entire surface plant scope including CAES cycle, balance of plant, and construction
- Future-ready design: Further CO<sub>2</sub> reduction via co-firing with H<sub>2</sub> based fuels
- GWh-scale energy storage solution
- Proven components coupling together for unlocking a new market

## Typical properties

|  |                       |                                     |
|--|-----------------------|-------------------------------------|
|  | <b>Power range</b>    | 140–160 MW <sub>el</sub> * per Unit |
|  | <b>Discharge time</b> | 8–24 hours                          |
|  | <b>Reaction time</b>  | <10–15 min                          |
|  | <b>Storage size</b>   | > 4.000 MWh <sub>el</sub>           |
|  | <b>Storage period</b> | Multiple days/ weeks                |

\* Power range is per expansion train

## Benefits



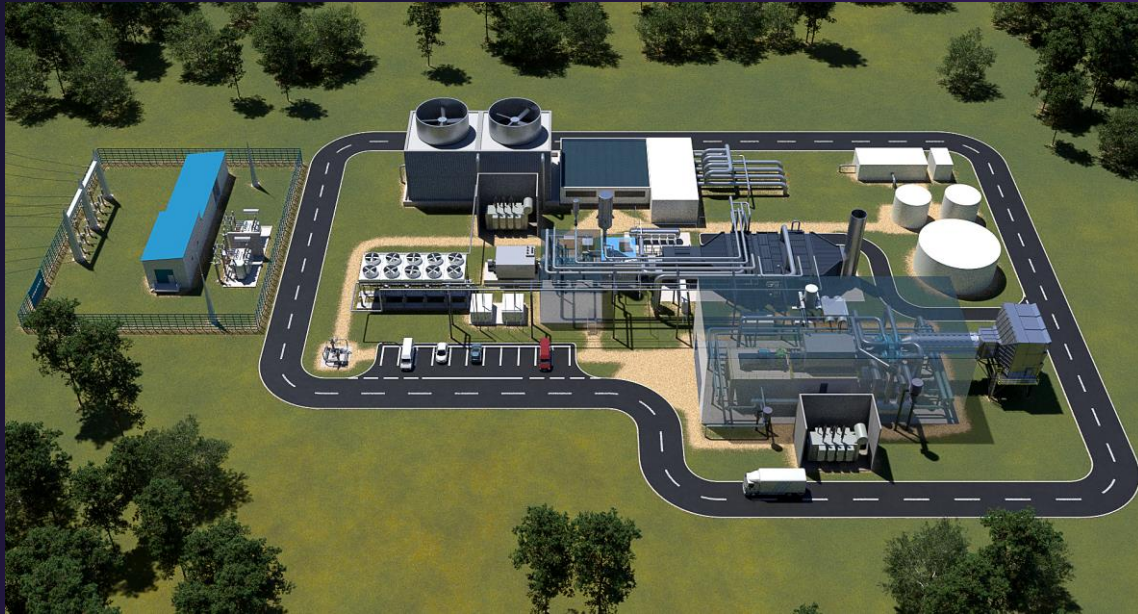
# A-CAES Power Plant

## Characteristics



- Round trip efficiency up to 65 to >70% (Power to Power)
- Approx. 200- 250 €/kWh calculated with 6h discharge time (incl. Civil, excluding Air storage, no fuel needed)
- Train size 50 to 250 MW, multiple trains possible
- Discharge duration as per customer request (modular system)
- ZERO Greenhouse Gas Emission → No NOx and no CO2
- 25 ... 30+ years expected useful life
- 10.000+ cycles
- Negligible annual degradation
- No commodity risk
- operation at high / cold ambient temperature
- Frequency response, reactive power, voltage management
- Rotating Inertia / Short circuit power
- Black start capability
- District heat application possible

# D-CAES Power Plant



## Characteristics

- Round trip efficiency up to approx. 60% (Power to Power)
- Approx. 200- 250 €/kWh calculated with 6h discharge time (incl. civil, excluding Air storage, excl. fuel)
- Typical Power Train size 160 MW, multiple trains possible
- Discharge duration as per customer request (modular system)
- No CO2 emission when operation with H2
- 25 ... 30+ years expected useful life
- 10.000+ cycles
- Negligible annual degradation
- No commodity risk
- operation at high / cold ambient temperature
- Frequency response, reactive power, voltage management
- Rotating Inertia / Short circuit power
- Black start capability
- Continuous / parallel operation can be specified (no Storage!)