

# Community Energy Storage

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Communicating with a Smart Utility Grid

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# CES – A “Virtual” Power Plant

A distributed, storage based power plant...

- 2 MW Storage-based
- Substation-located



- 2 MW Storage-based
- Grid-edge



Communications



# CES – A “Virtual” Power Plant

- Unlimited scalability – no financing
- Cost-competitive within 1-2 years
- Superior feature set
- Limited energy storage
- Barriers are regulatory and “mindset”

# Leveraging the Capabilities of Distributed Storage

- Risk-averse climate of electric distribution
- Control system must leverage capabilities
- Edge-of-the-grid capacity management
- Balance/prioritizing multiple constraints
- Improved service reliability
  - Islanding
  - Reserve capacity for reconfiguration

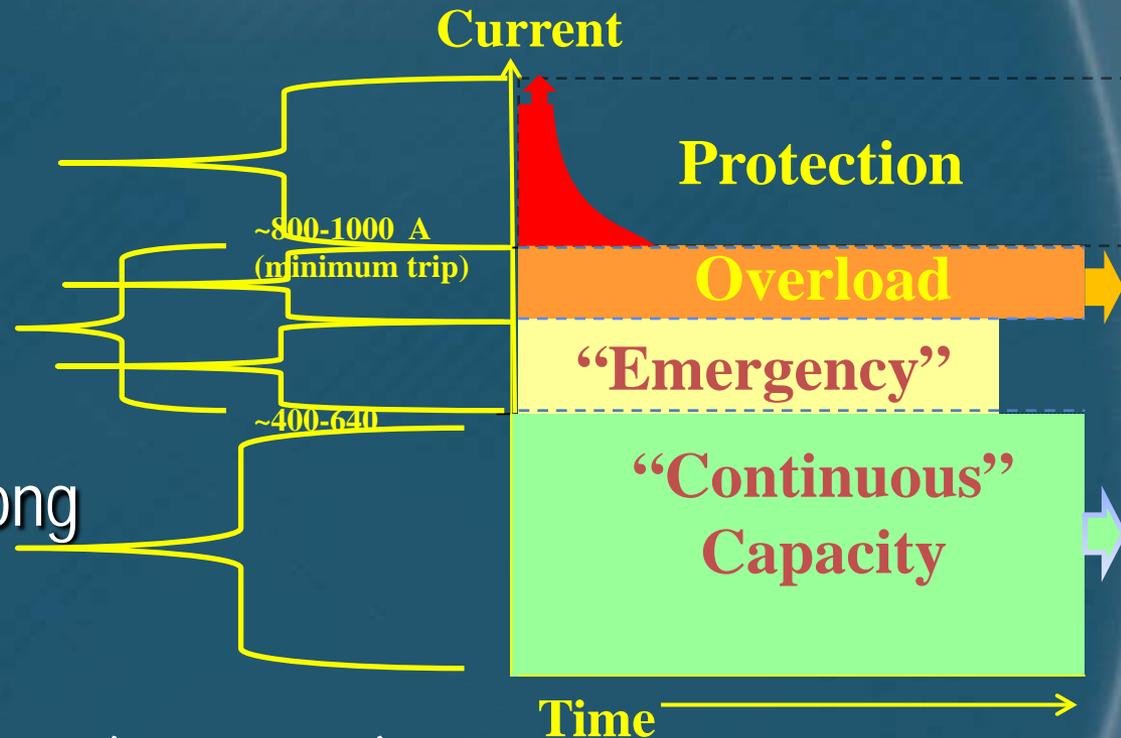
# New Challenges in Distribution

- Distribution grid design – built for estimated growth
- Electric vehicles – significant new load
  - High non-linear demand while charging
  - Two cars per household
  - Multiple customers per transformer
  - Growth cannot be predicted
- Multiple cars per transformer already happening
- Mindset-changing circumstances

# Feeder Capacity Management

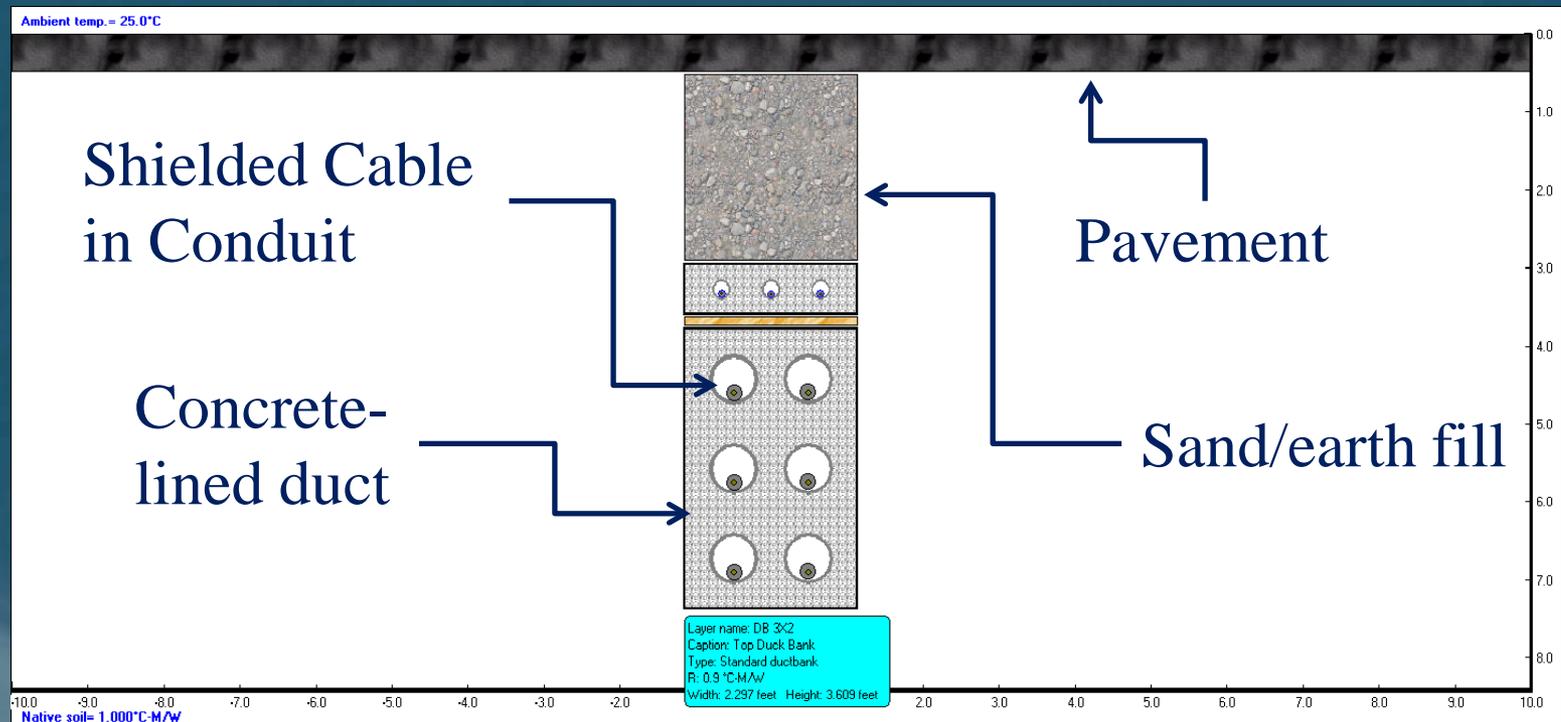
## "Overcapacity Zone"

- Assumptions gone wrong
- Abnormal weather
- Unexpected growth
- Unanticipated technology (Ex. PEVs)



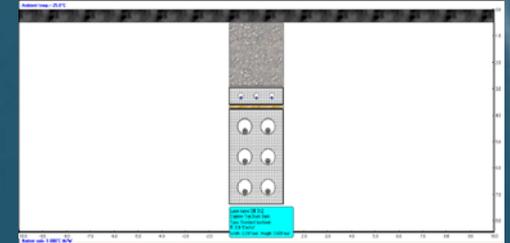
# Feeder Capacity Management

## Underground Feeder – Cutaway View



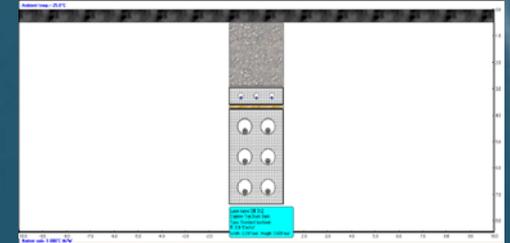
# Underground Feeder Capacity

- Thermal factors are complex
- Variation over length of run
- Cable life is dominated by thermal history
  - Through-fault duty
  - Integrated time while "overcapacity"



# Underground Feeder Capacity

- Measurement tools
- Modeling tools
- Real-time capability



# CES – Distributed Energy Management

- Ability to address thermal capacity
- Transformer overload
- Phase-dependent issues
  - Phase imbalance
  - Voltage support
  - Reactive power

# Control System Architecture - Challenges

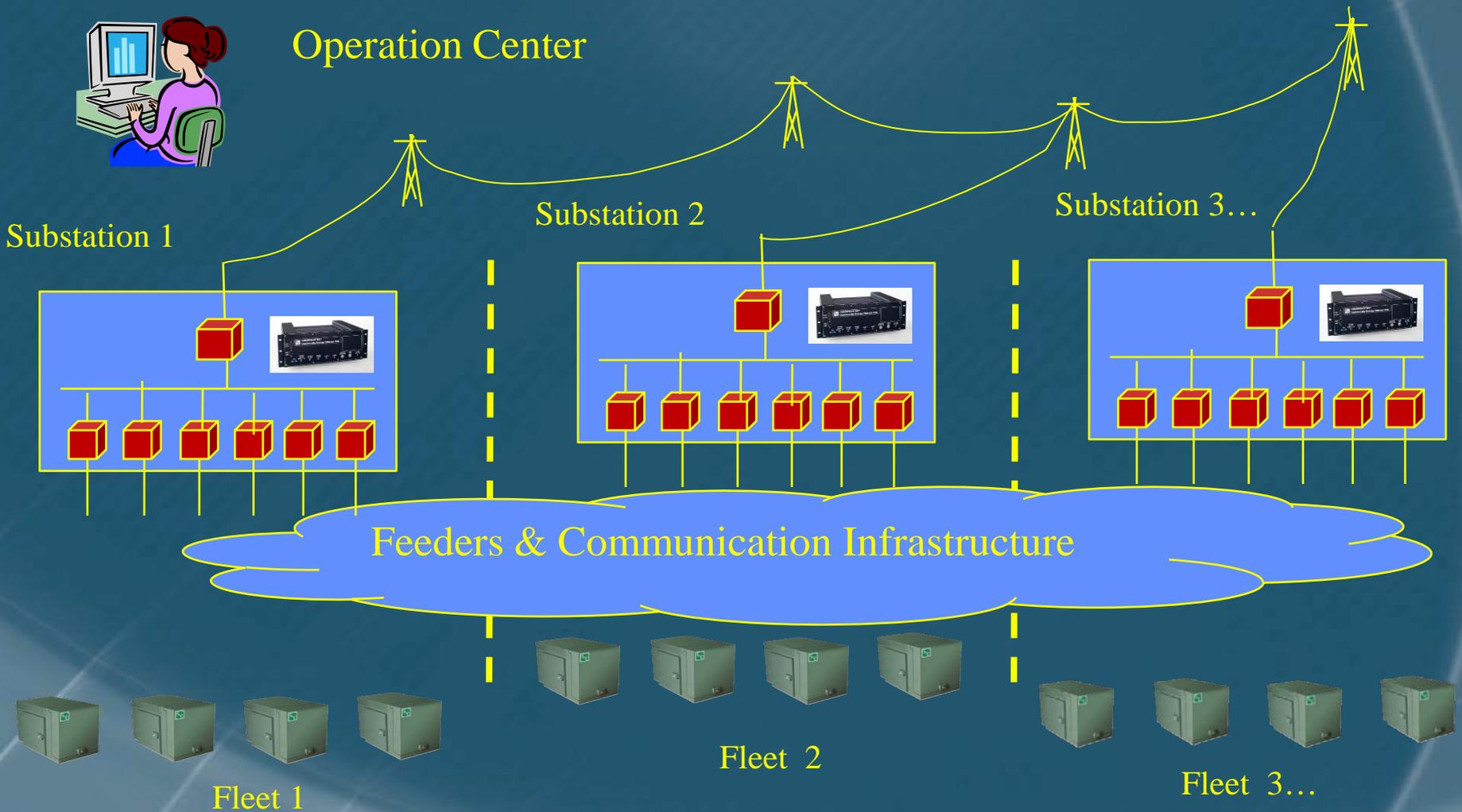
- Distribution equipment communications ... no
- Algorithms
- Reliability
- Integration with central office applications
- Cyber Security

# Control System Architecture - Reliability

## Substation-centric application

- Colocation with critical equipment
- Reduction of NERC-level impacts
- Cyber security isolation

# Reliability – Fault tolerance



# Control System Architecture - Reliability

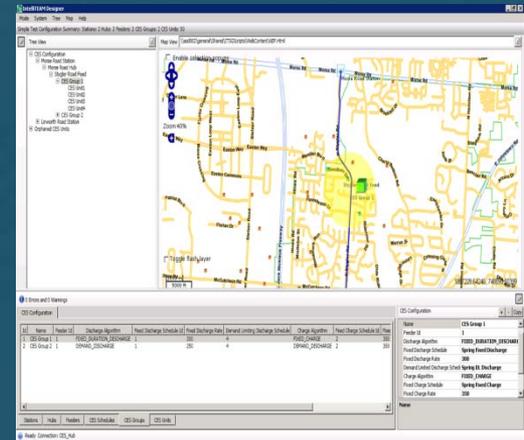
- Substation-hardened
- Self-contained
- Sized for individual substation
- Protected from failures of comm. backbone



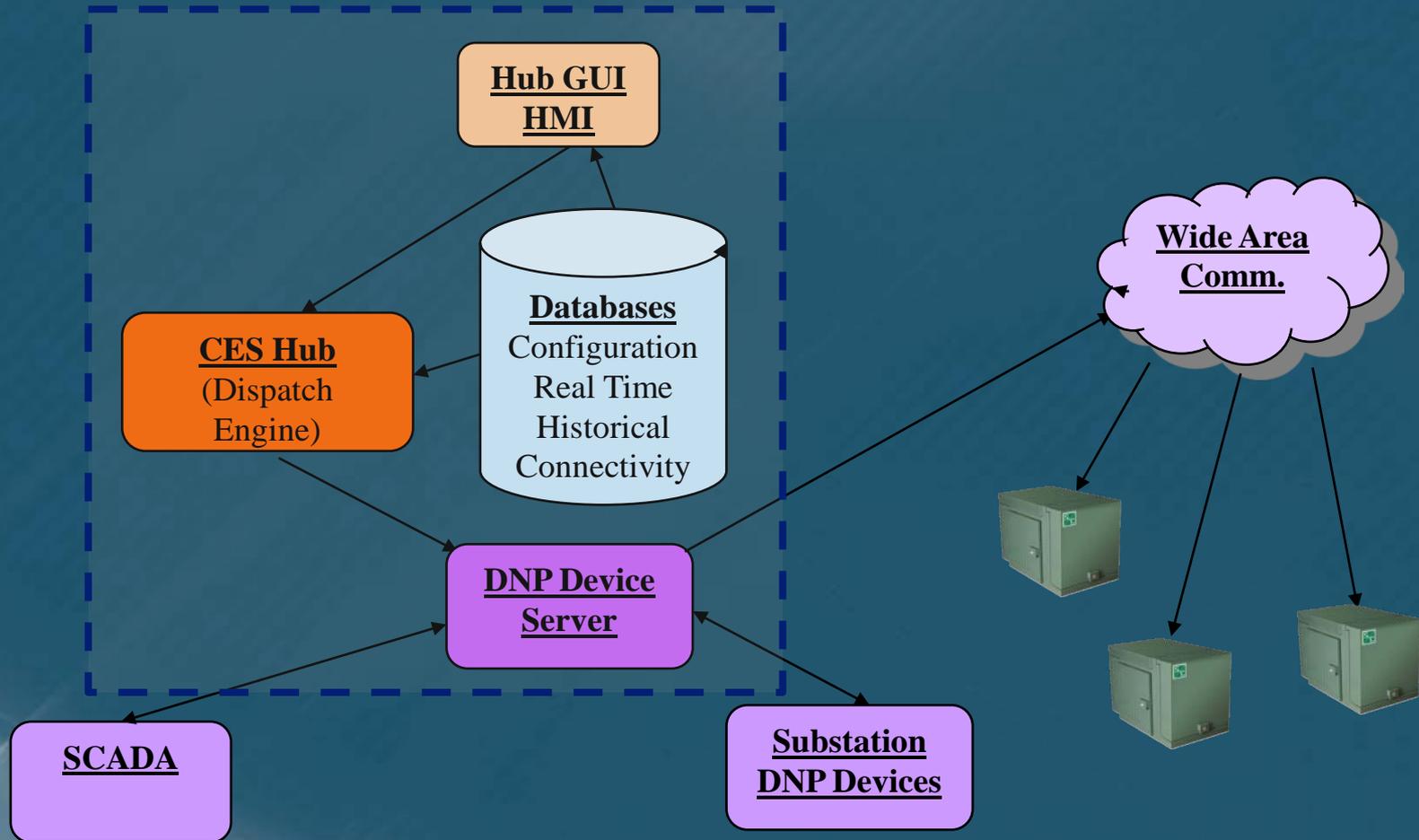
# Control System Architecture

## Integration with operation center & substation applications

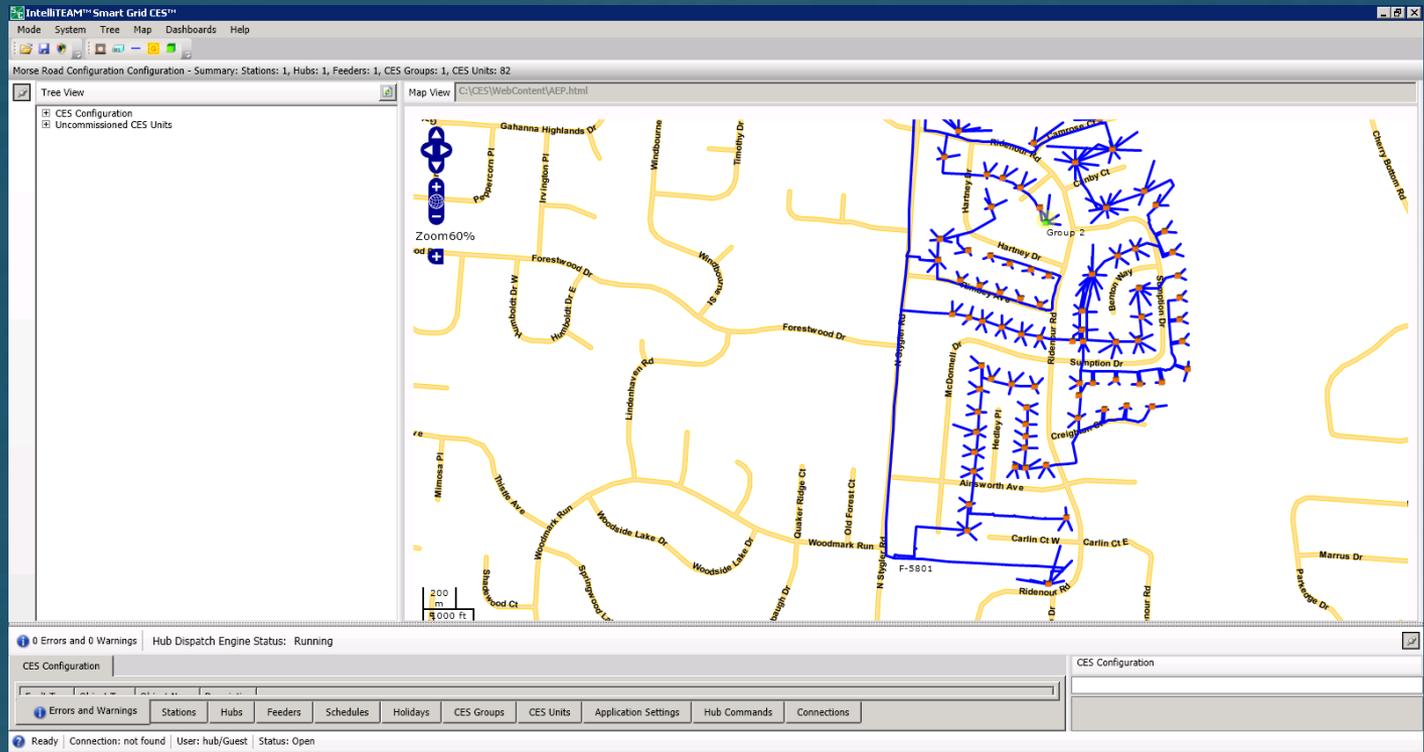
- GIS
- OMS
- DMS/SCADA
  - Circuit reconfiguration
  - Volt/VAR



# The Smart Grid CES™ Hub Control System



# The Smart Grid CES™ Hub Control System



# Control System Architecture

## Database-driven design

- Oracle database
- Secure
- Interoperable

# Control System Architecture

## DNP Device Server

- XML-configurable
- Isolates applications
- DNP-agile

# Control System Architecture

Security... again...

- Self-contained
- Limited application environment
- Application whitelisting
- Application blacklisting
- Isolated from the Internet
- "Call-home" functions can't
- Intrusion protection
- Intrusion detection
- Single sign-on

... convenient and transparent

# Conclusion

- Scalability and adaptability uniquely address uncertainty
- CES can be secure, reliable, cost-effective solution