

# Storage Session Overview

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Many Central American systems are looking at ways of integrating storage technologies for various reasons, including renewable integration, grid stability, distributed generation integration, and supplying rural off-grid communities. While storage can play key roles in achieving these objectives, there is a distinct and different challenge of implementing these non-traditional technologies. Perhaps the largest is that many Central American nations need foreign investments. The important issue, therefore, becomes how utilities or government agencies develop payback mechanisms to allow cost recovery for these new technologies.

This session is aimed at starting a high level discussion among participants about some of these challenges (T. B. Tsuchida – The Brattle Group), followed by real world examples of storage technology and their applications (J. D. Cohen – The AES Corporation).

# About The Brattle Group

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The Brattle Group provides consulting and expert testimony in economics, finance, and regulation to corporations, law firms, and governments around the world. We aim for the highest level of client service and quality in our industry.

We are distinguished by our credibility and the clarity of our insights, which arise from the stature of our experts, affiliations with leading international academics and industry specialists, and thoughtful, timely, and transparent work. Our clients value our commitment to providing clear, independent results that withstand critical review.

## INDUSTRIES

- Electric Power
- Financial Institutions
- Health Care Products and Services
- Natural Gas and Petroleum
- Telecommunications and Media
- Transportation

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# Central America Nations and Energy

## Leading the World in Renewable Energy

- Mostly hydro and geothermal resources.
- Costa Rica to be carbon neutral by 2021.
- Developing other renewable energy resources.
  - Wind, solar, biofuels, waste to energy etc.
  - High solar irradiance year-round and good wind resources.



Source: <http://www.ecpamericas.org/Initiatives/?id=70>

## But there are Challenges.....

- Economic expansion leading to rising fossil fuels usage.
- Many countries have deregulated wholesale markets.
- Still a fairly large population without access to electricity.

## Where can Storage Technology Help?

- Integration of renewable and other indigenous resources.
- Improved power quality (grid).
- Off-grid systems.
- Long term system planning.

Mexico  
[Belize](#)  
[Costa Rica](#)  
[El Salvador](#)  
[Guatemala](#)  
[Honduras](#)  
[Nicaragua](#)  
[Panama](#)  
Columbia  
Dominion Republic

# What is a Storage?

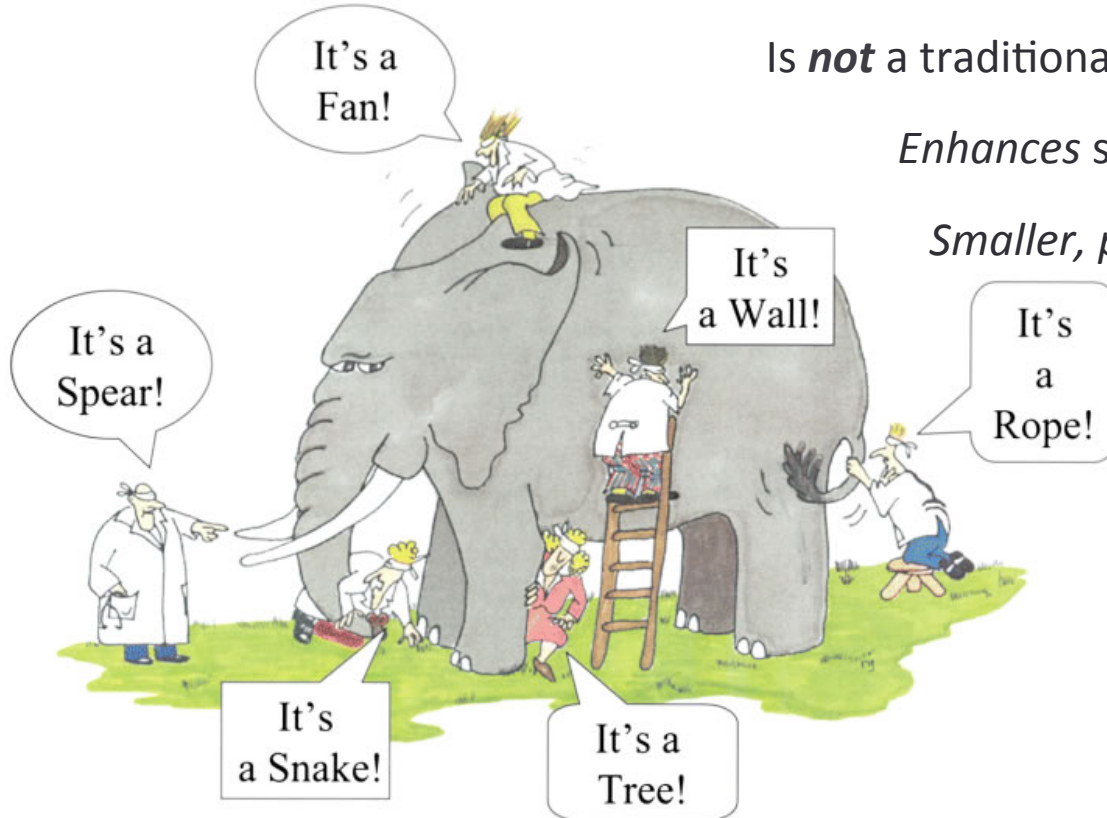
**No clear definition?**

Is *not* a traditional generation/load resource.

Is *not* a traditional T&D resource.

*Enhances* system efficiency.

*Smaller, portable* systems.



## Many Benefits?

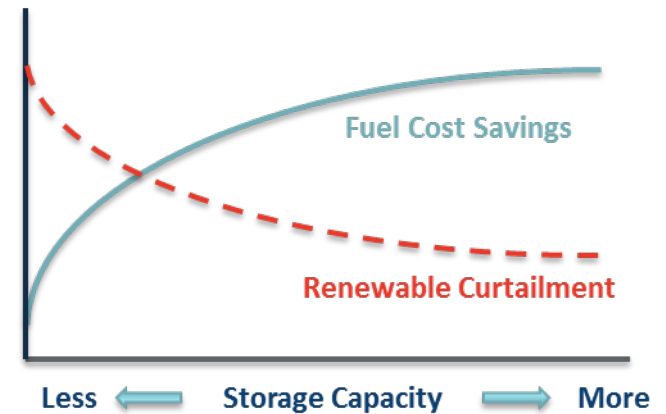
- Renewable Integration.
- Reliability.
- Efficiency.
- Transmission Losses.
- Resiliency.
- Installed Capacity.
- Smart Grid.
- Investment Options.
- Cyber-Security.

Storage is not a single technology but a *group* of technologies (*not* all technologies are necessarily new.)

# Storage Technologies?

## Storage Technology

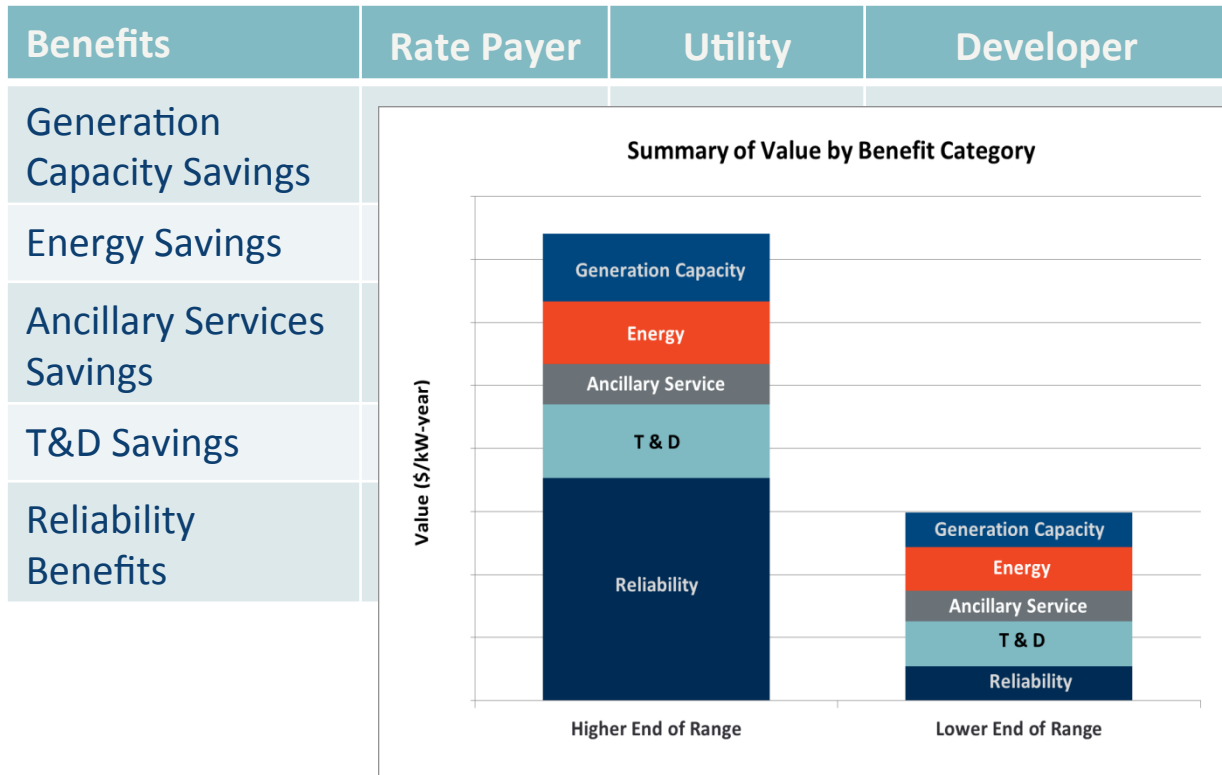
- Uses existing resources more efficiently.
- Provides multiple applications.
  - Energy management and back-up power.
  - Load leveling.
  - Regulation and frequency control. →
  - Voltage support.
  - Grid stabilization.



Portable! { →  
→

Types\Benefits	Time Horizon
Pumped Storage	Long Term
Compressed Air	Long Term
Others (mostly thermal storage)	Long Term
Batteries	Short Term
Flywheels	Short Term
Capacitors	Really Short Term

# Economic Assessment of Storage Technology



Assessing the Benefits of Storage Technology (or any new technology)..

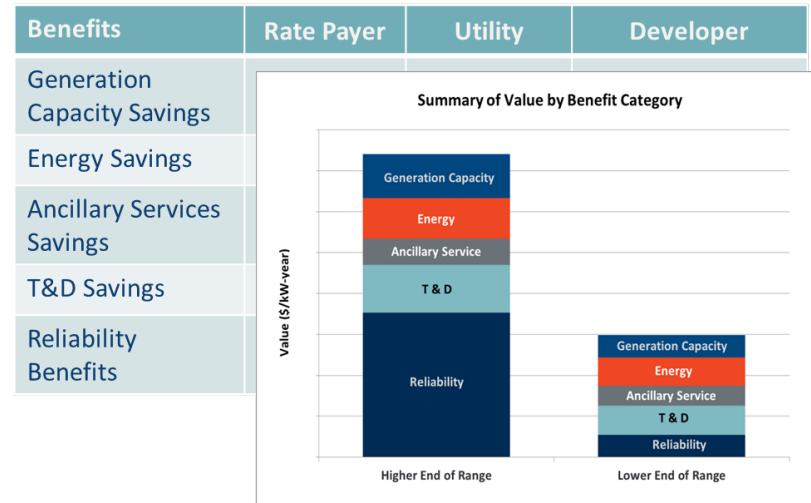
- Values will have a range and vary by stakeholder/position.
- So will the proper incentives!

# Payback Mechanism for New Technology



## Benefits Allocation?

- Investors require higher returns.
  - Unfavorable market conditions?
  - Limited economies of scale and scope?
  - Relatively large overhead costs?
  - Counter party credit-worthiness?
  - Limited number of players?
- Utilities are taking the risk as well.
- Customers want the benefits too!
- Balance between encouraging foreign investment and internal fairness to customers.



***How do we make this work?***

# Incentives by Stakeholder/Position (1/2)

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## Incentives will vary by stakeholder/position

- Utilities and System Operators
  - Focus is on grid management imperatives (primarily regulation/frequency control and other A/S).
  - Reflecting the technology as an option for long term planning needs to be developed.
  - Processes, such as interconnection process, needs to be developed and standardized.
- Customers
  - Driven by economic drivers, including emergency back-up power, time-of-use price arbitrage, A/S market revenues, or sometimes simply having access to electricity.
- Developers/Investors
  - Not willing to take the risk of deploying a relatively new technology without financing from the market place.
    - Standardized contracts (similar to PPAs) needed for financing.
  - Market needs to recognize value of storage.
    - Markets may not have multiple value streams.
    - Hard to capture value without price signals.
    - Value may be driven by Regulators.



# Incentives by Stakeholder/Position (2/2)

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## Incentives will vary by stakeholder/position

### ■ Regulators

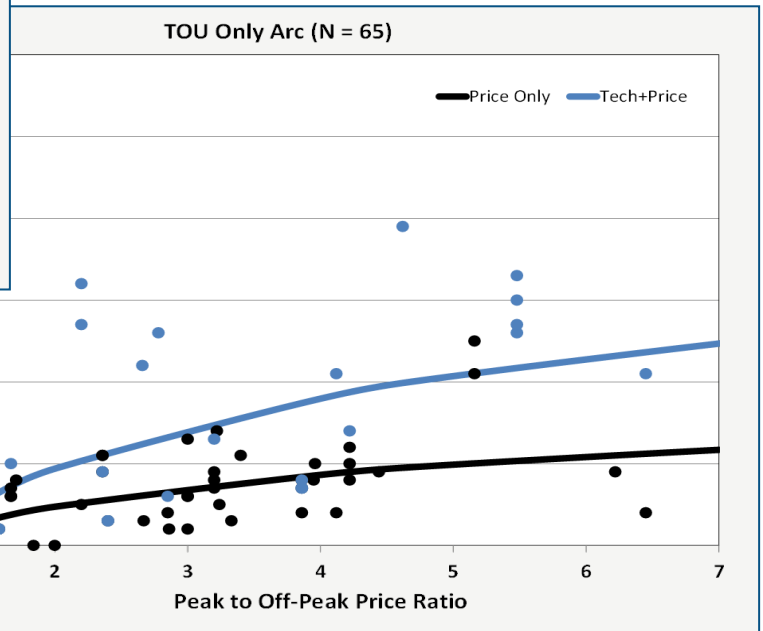
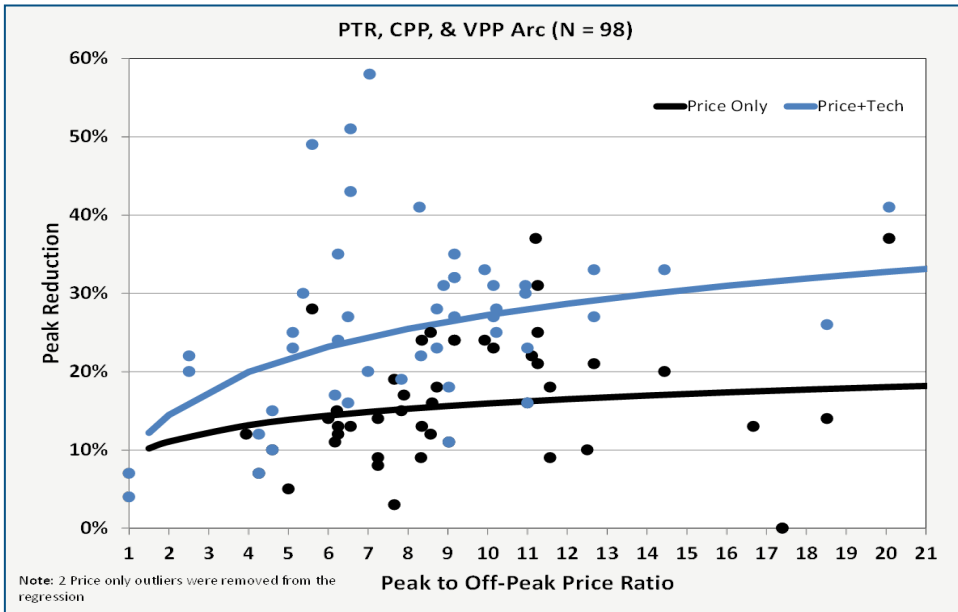
- Need to weigh between the value and risk of the new technology.
  - Cost competitiveness.
  - Reliability and safety validation.
  - Industry acceptance.
  - Equitable regulatory environment.
- Regulatory policy and rules provide the framework for business cases and economics.
  - Single country (or region) vs. larger region?
  - Incentives, such as tax structures and asset depreciation rates, will impact economics.
  - Types of storage services, market opportunities, cost recovery methods, cost-effectiveness criteria, tariff and rebates, are all governed by a well-established regulatory oversight.
  - Overall, policies can create or inhibit market opportunities and determine compensation.

# What's Been Done in Other Systems

## Dynamic Pricing and New Technology

*Technologies include:*

- Advanced metering infrastructure
- Smart appliances
- Home energy controllers
- Energy storage



- New technology implementation increases (at a diminishing rate) as the peak to off-peak price ratio
- *Enabling technologies* boost price responsiveness

# Payback Mechanism and Incentives (1/2)

## Incentives should be based on contribution level to the system

- Time-of-use based.
  - Time varying rates may not work on some systems.
    - The high mix of renewable resources may results in limited price difference between on-peak and off-peak periods.
  
- Peak demand charge based.
  - May work for long-term storage.
  
- Avoided capacity expansion cost based.
  - May work for long-term storage.
  
- Marginal cost or avoided cost based.
  - Likely required for short-term storage.

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# Payback Mechanism and Incentives (2/2)

## Incentives should be based on contribution level to the system

- Marginal cost or avoided cost based.
  - Likely required for short-term storage.
    - Evaluation will require splitting the technology valuation into capacity (spinning reserves etc.), incremental energy (regulation-up/down etc.), and others (voltage support etc.)
    - The proper allocation and attribution of cost savings from storage technology is needed but difficult (e.g., renewable resources combined with storage saving fuel oil consumption and the setting of renewable resource PPA are two sides of the same coin.)
    - Reviewing the current payback mechanism structure (split between fixed and variable costs) will be the starting point but after that will be system specific.
    - To avoid further erosion of utility's revenues, the starting analysis will need to more appropriately allocate most or all of the fixed costs to the fixed rate component, and the variable cost would only reflect the variable cost of generation.

# Other Considerations (and Complications)

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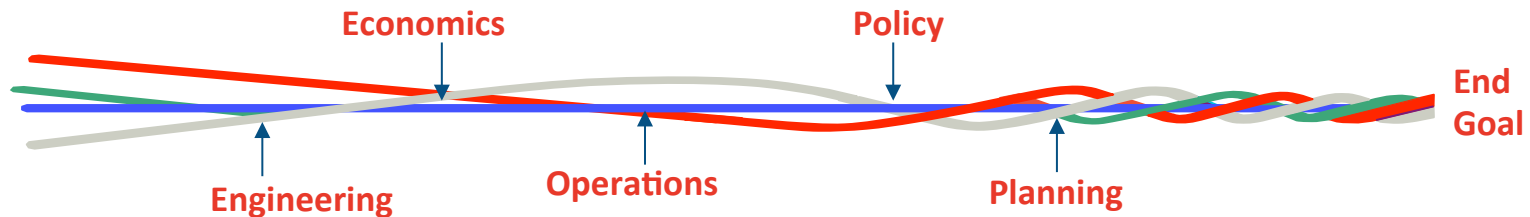
## Looking at the Future

- Longer-term renewable penetration goals.
  - Diminishing returns of renewables as penetration level increases.
- Electrification of the transportation sector.
  - Integration and balance of energy between the power grid and electrical vehicles.
- Expansion of the utility business.
  - Utilities expanding into other business (e.g., telecom.)
- Smart-Grid and/or distributed generation development.
  - Storage is a well-accepted contributor to realization of smart-grid and/or distributed generation benefits.
- Potential saturation of the market.
  - A/S market is relatively small and in some cases the market can be saturated pretty quickly. In that event, A/S prices drop and storage technologies may no longer be economically viable even if the marginal cost of providing the service is lower than other sources, including traditional generators.

# Other Considerations (and Complications)

## Operation and Ownership

- In small systems, operation should perhaps be by one entity, not multiple.
  - Ultimate goal is to reduce electricity prices by co-optimizing the usage of various resources, including the new storage assets.
    - Applies for planning as well.
  - Less overhead costs.
    - Contracts, billing, etc.
  - Allows the designation of the last resort (obligation to serve).
  - May require functional separation between owner and operator.
  - Will changing a monopoly to a duopoly (or oligopoly) really have an impact?



# Finally, What is a Tariff????

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“There has never been any lack of interest in the subject of electricity tariffs. Like all charges upon the consumer, they are an unfailing source of annoyance to those who pay, and of argument in those who levy them. In fact, so great is the heat aroused whenever they are discussed at institutions or in the technical press, that it has been suggested there should be a “close season” for tariff discussions. Nor does this interest exaggerate their importance. ***There is general agreement that appropriate tariffs are essential to any rapid development of electricity supply, and there is complete disagreement as to what constitutes an appropriate tariff.***”

-D.J. Bolton, Costs and Tariffs in Electricity Supply, 1938

# What is it going to look like....?

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# So Let's Think About It.....

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What benefits do storage technologies provide?

- Balancing variability of renewable resources.
- Allowing generators to provide power rather than hold back capacity for A/S.
- Avoiding start-up of a new generator.
- Relaxing minimum generation constraints.
- Increasing generators that can provide operating reserves.
- Transmission & Distribution benefits.

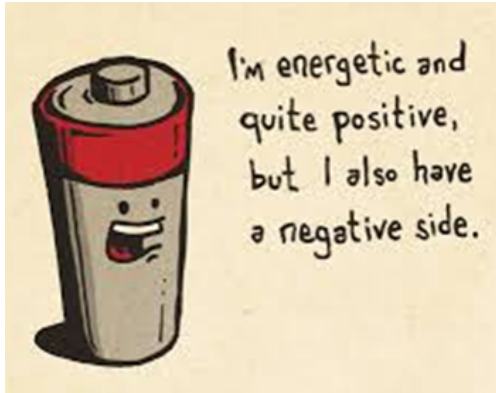


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- How do we measure the benefits?
- Will paying the system lambda be enough?
- Is there a need to split capacity, energy, A/S, and even more?
- Should tax mechanism or other means to reduce fixed cost be introduced?
- How do we recognize the advantages of storage technology over traditional generation technology (faster response, double A/S capacity, etc.)?
- How do we measure the cost effectiveness of subsidies and societal benefits?
- Should it be rate based?

# Contacts

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# And Now Real Storage Applications....



**More Power. Less Plant.**

**Energy storage for flexibility, security, and integration**  
*Market solutions in and out of Central America*  
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