TECHNOLOGY
INSIGHTS

April 16, 2009

California Energy Commission
Dockets Office, MS-4
Re: Docket No. 09-IEP-1G
516 Ninth Street
Sacramento, CA 95814-5512

Subject: "2009 IEPR -Energy Storage Technologies", Docket Number 09-IEP-1G

On behalf of NGK Insulators, Ltd., Technology Insights offers the following additional response to the questions posed in the "Notice of Staff Workshop on Energy Storage Technologies and Policies Needed to Support California's Renewable Portfolio Standard (RPS) Goals of 2020." In general, our response pertains to Distributed Energy Storage (DES) technologies, like NGK's NAS Battery system, i.e., multi-MW systems with 3 to 8 hours energy capacity targeted for large utility, commercial and industrial applications. Most of our experience in the U.S. is with investor owned utility (IOU) applications.

1. What barriers and/or obstacles have prevented large, utility scale electricity energy storage systems from being installed in California and the nation?

<u>Response to Question 1:</u> We have found that DES is a "new tool" in "new markets", created in response to advancements in automation, communications and renewable energy generation. The power industry culture is deeply invested in generating technologies for which market regulations are focused on the strict separation of grid and generation functions, i.e., "de-regulation", without consideration for the multiple attributes of DES. We have encountered the following major barriers in this environment:

a) *<u>"Regulatory Ownership Issues"</u> – In 2008, U.S. regulatory issues that prohibit owners from accruing benefits from multiple DES functions has delayed NAS projects totaling 10 MW for periods of 6 months to a year. These circumstances have further delayed the consideration of follow-on projects at key customers. For details, see our presentation at CEC Workshop on April 2 entitled, "NGK's Sodium-Sulfur (NAS) Battery: The Vendor's Perspective on Barriers & Issues Encountered in U.S. Deployment", a copy of which is enclosed.*

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b) *<u>Very Long Sales Cycles</u> – The time interval from DES introduction to project authorization has often required more than two years while the IOU's staff gained familiarity with DES technology, considered T&D applications and identified cost recovery options. Such evaluation periods have been followed by the purchase of a single, small installation that is then subjected to a lengthy demonstration period. When such extended periods of engagement must be repeated with each customer, the delay in bringing products to market creates expenses that must be recovered.*

c) *<u>The 2008 Credit Market Collapse</u> – The collapse of capital markets has severely disrupted the implementation of planned projects.*

2. How does energy storage affect the ramping and regulation of renewable energy sources?

<u>Response to Question 2:</u> Fast-acting DES deployed in networks of sufficient size can reduce the spinning reserve requirements and part-load operation (wear and tear) imposed on thermal units; thereby, reducing emissions and enabling a more efficient use of those assets. For example, DES technologies capable of a few minutes energy discharge can displace thermal assets used for frequency regulation, while those capable of a few hours can be used to bridge the start-up time for spinning and non-spinning reserve (similar to the motor-engine sequence of hybrid vehicles.)

3. What value does a large scale electric energy storage system provide the integration of large amounts of renewable resources as compared to other backup or intermittency support alternatives?

<u>Response to Question 3:</u> Time-shifting renewable generation (e.g., wind) can only be accomplished by energy storage with several hours capacity. That is, peak wind generation typically occurs during late-night and early-morning hours, while peak demand occurs 8 to 12 hours later. Similarly, peak solar generation occurs 4 to 8 before peak demand. While conventional generation can stabilize intermittent resources via the ancillary services market, these alternatives cannot move renewable generation to the time intervals it is most needed (or when the T&D system can deliver it).

4. Where should large, utility scale electric energy storage systems be deployed to have the greatest beneficial impact on meeting the RPS goals of 2020?

Response to Question 4: Challenges to meeting CA RPS goals of 2020 must include addressing two very different T&D constraints. Substantial investment in new transmission is required to access remote renewable resources, e.g., Tehachapi wind generation, while the distribution infrastructure (substation transformers, feeders, etc.) serving customer loads in urban areas are nearing the end of service lives and pose increasingly high outage risks in areas. Both of these constraints must be addressed to achieve "the greatest beneficial impact", and solutions may involve combinations of large bulk storage at generation sites, as well as DES located near customer loads. We note that NAS battery systems have been deployed in both locations in Japan, i.e., a 34 MW NAS installation located proximate to a 51 MW wind farm in northern Japan stabilizes wind output before it is placed on the grid, while over 160 MW of NAS installations are deployed proximate to customer load in Tokyo to improve reliability and conduct peak shaving (time-shifting generation).

5. What is the cost of ownership of electrical storage systems, what benefits will be accrued, and how will they be distributed?

Response to Question 5: Installed costs for NAS DES in the U.S. are currently in the range of $3 to $4 million per megawatt for nominal energy discharges of 6 MWh per cycle, per megawatt of installation capacity. Typical installations would accrue benefits for market services (e.g., energy trading, ancillary services) as well as grid services (grid upgrade deferral, feeder or customer service reliability). As described in our response to Question 1 above, to date "regulatory ownership" issues encountered in the U.S. market have prevented NAS owners from accruing the combined benefits of services. We believe this issue poses a barrier to other DES technologies, as well as to the use of DES technologies to achieve CA renewable goals for 2020.

6. What are the challenges and solutions to having the costs associated with energy storage systems be recouped from those who benefit from the technology when the benefits are expected to be provided to multiple beneficiaries?

Response to Question 6: Our perspective on major challenges to recouping costs is provided in our response to Question 1, "Regulatory Ownership Issues". One solution to these challenges is the introduction of interim market rules allowing transmission or distribution utilities to accrue benefits from both market and grid services until sufficient experience has been gained with DES functionality for regulators to develop permanent rules. For example, utilities could be permitted to place DES costs in the rate-base, with *the provision that any revenue gained from market services (or premium reliability services provided to customers) be returned to the rate-payer. Additional merits of this approach are that, in the longer term, experience gained by utilities in identifying the value of DES would enable those utilities to contract unregulated entities (e.g., Independent Storage Developers or IPPs) via power purchase agreements (PPAs) with appropriate terms for combined market and grid services.*

7. What actions are being taken by the electric energy storage industry to bring down the overall costs of large, utility scale electric energy storage systems?

Response to Question 7: As barriers are removed and the market matures, improved costs are anticipated with manufacturing scale-up, with standardization of power conversion and grid interface equipment, and with shorter sales cycles for larger transactions as planners become accustomed to the valuation of multiple storage benefits.

8. What incentive programs or other economic stimulus alternatives can be proposed that will encourage the deployment and fielding of more large, utility scale electric energy storage systems in California?

Response to Question 8: We suggest initial deployment of one or more DES networks of 50 to 100 MW each within CA urban areas. Individual 5 to 10 MW DES installations should be located at high value sites within the grid to defer the need for upgrades or to enhance the reliability of service to critical loads or feeders, possibly in conjunction with a "SmartGrid". Networked DES would also participate in the CAISO market. The DES owner should be permitted to operate under temporary market rules of ownership such that proof of principle of networked energy storage operation participating in both market (energy trading, ancillary services, etc.) and grid services can be established. As suggested above, costs could be recovered via the rate-base, with revenue from market services returned to the rate-payer. Alternatively, costs allocated to the rate base could be offered as 50% cost sharing within proposals to DOE for stimulus funding. If needed, a "feed-in-tariff" could be devised to distribute initial DES costs across all customers within the utility service area. For the longer term, we suggest that an "Energy Storage Portfolio Standard" (ESPS) be established for deployment of 3 to 4 GW of strategically located energy storage systems over the interval identified for meeting California's RPS goals.

9. What research is needed on energy storage in order for the California Grid to be capable of supporting the RPS goal of 33 percent renewables by 2020?

Response to Question 9: *We suggest that an integrated program of grid modeling and analysis to identify points of congestion and critical loads, market rule development, and training of utility T&D planning personnel in recognizing the combined benefits of energy storage installations be undertaken in concert with economic incentives. Such an effort should include development of an assessment tool for optimal distributed network planning and optimization to determine size, applications and locations of DES units.*

In addition to the foregoing, we wish to respond to CEC's request for "workshop attendees to provide written comments on the current state and future plans for their specific technology" (Email from Mike Gravely, March 30, 2009). We believe the information contained in Part 1 of our presentation at CEC Workshop on April 2 entitled, "NGK's Sodium-Sulfur (NAS) Battery: The Vendor's Perspective on Barriers & Issues Encountered in U.S. Deployment", provides the information requested. For completeness, a copy of that presentation is enclosed.

If you have any questions on this material, please do not hesitate to contact us.

Regards,

Harold Gotschall

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Principal, Technology Insights

Enclosures: 1

Copies (electronic):

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Enclosure: Technology Insights Letter to the California Energy Commission Dated April 16, 2009; Docket No. 09-IEP-1G

NGK's Sodium Sulfur (NAS) Battery

The Vendor's Perspective on Barriers & Issues Encountered in U.S. Deployment

Presented to the California Energy Commission

Staff Workshop on Energy Storage Technologies and Policies Needed to Support California's Renewable Portfolio Standard (RPS) Goals of 2020

April 2, 2009

NGK INSULATORS, LTD.

Abstract

- **NGK Insulators' Sodium Sulfur (NAS) Battery has been deployed at over 200 locations world-wide, totaling over ~300 MW, 2000 MWh**
- **9 MW are currently operating at three U.S. utilities**
- **An additional 10 MW have been delayed from 6 to 12 months due to U.S. regulatory issues.**
- **These circumstances present barriers to deployment of NAS – and similar storage technologies – in support of**
  - California RPS goals
  - "SmartGrid"deployment
- **The vendor perspective on select experiences are summarized in this presentation**

Part 1:

NGK Insulators, Ltd.
NAS Battery Technology, Status & Applications

NGK Insulators, Ltd.

Outline of NGK

Company Name	NGK INSULATORS, LTD.
Date of Establishment	May 5, 1919
Paid-in Capital	69,849 Million Yen
Representative Directors	

Shun Matsushita (President and CEO)
Tsurayuki Okamoto (Senior Vice President)

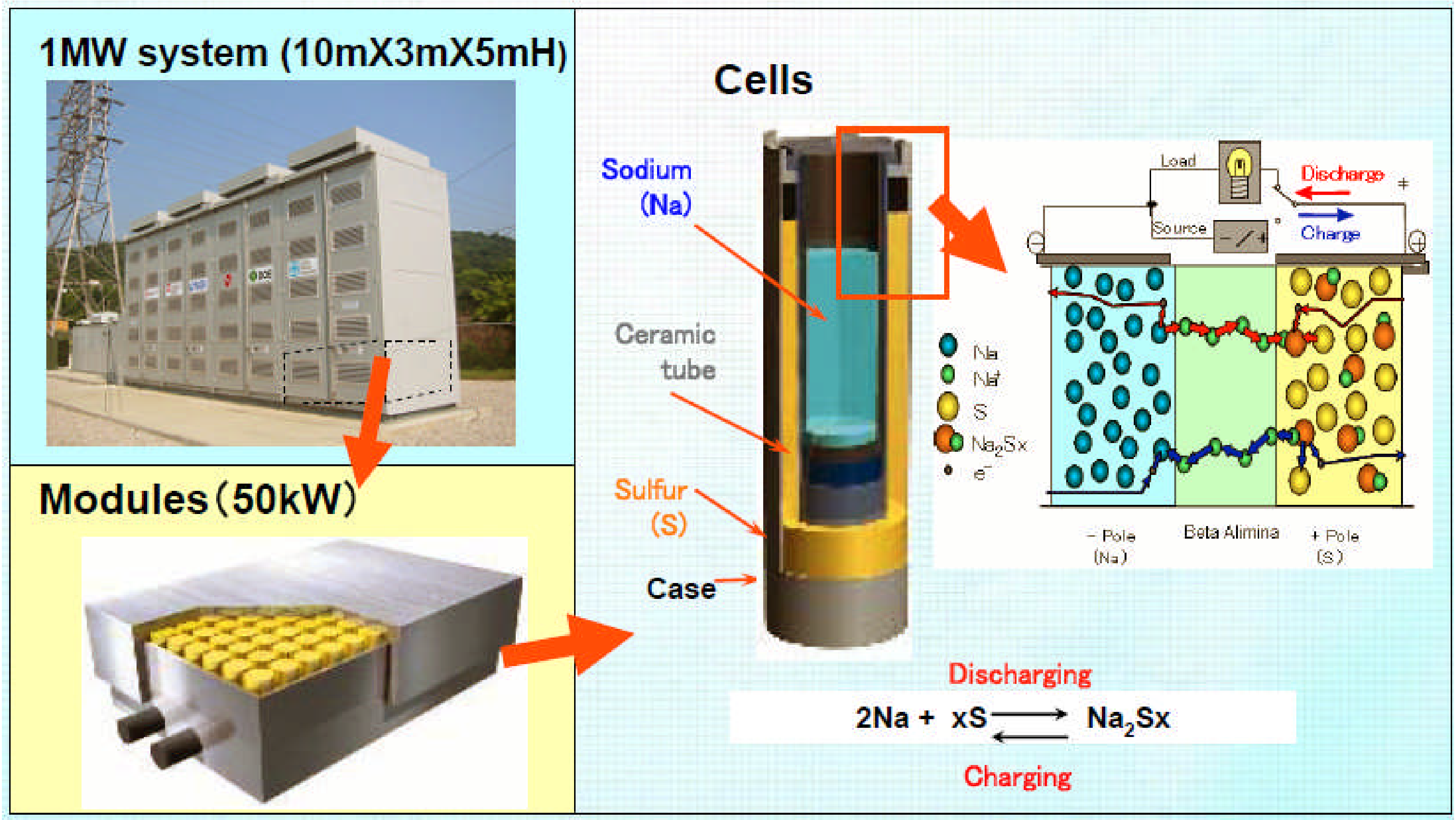
Number of Employees	3,356 (non-consolidated) 10,342 (consolidated)
Consolidated Subsidiaries	52 companies

As of March, 2007

NGK INSULATORS, LTD.

The "Na"+"S" → "NAS" Battery

Unit Rating: 1 MW, 6 MWh/cycle, 300 cycles/yr, 15 years



NAS Battery Development Highlights

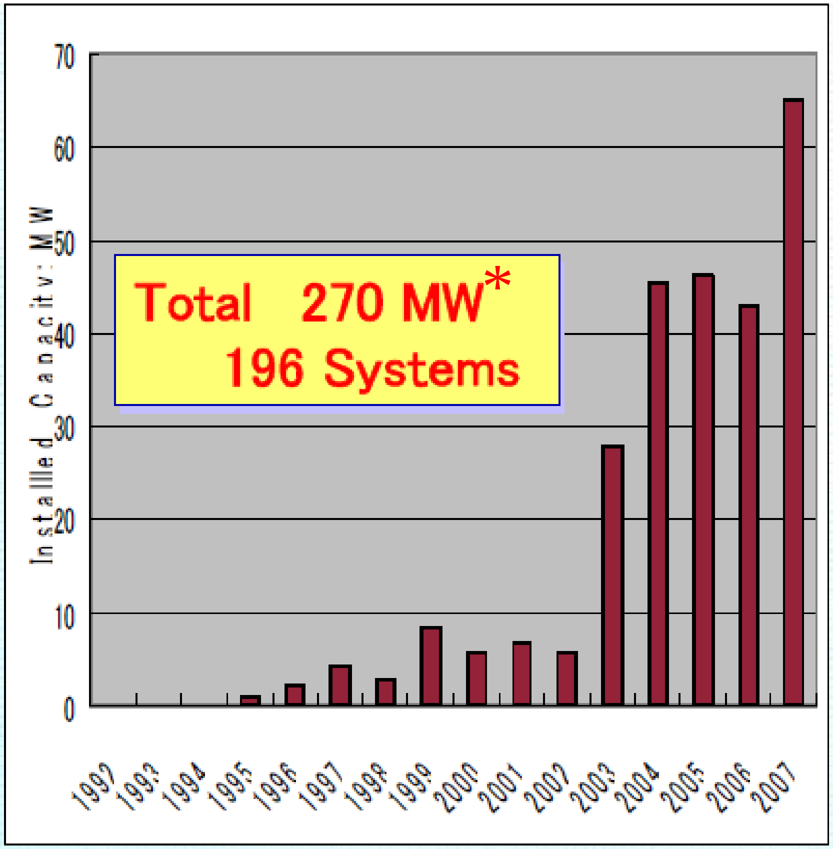
- Joint Development by NGK and Tokyo Electric Power Company (TEPCO)
- Initial Target: Utility-Scale (Multi-MW, Multi-Hour) Distributed Energy Storage (DES)
  - 1984 ~ Technology – Beta Alumina Ceramic Electrolyte
  - 1989 ~ Cell and Battery Module Development
  - 1997 ~ Field Tests at Substations (6 MW, Tsunashima, JPN)
  - 2000 ~ Field Tests at Customer Sites
  - 2002 ~ Commercialization in Japan
  - 2006 ~ First US Utility-Scale Installation at AEP (1 MW)
  - 2008 ~ Largest to Date: 34 MW, Wind Stabilization, JPN

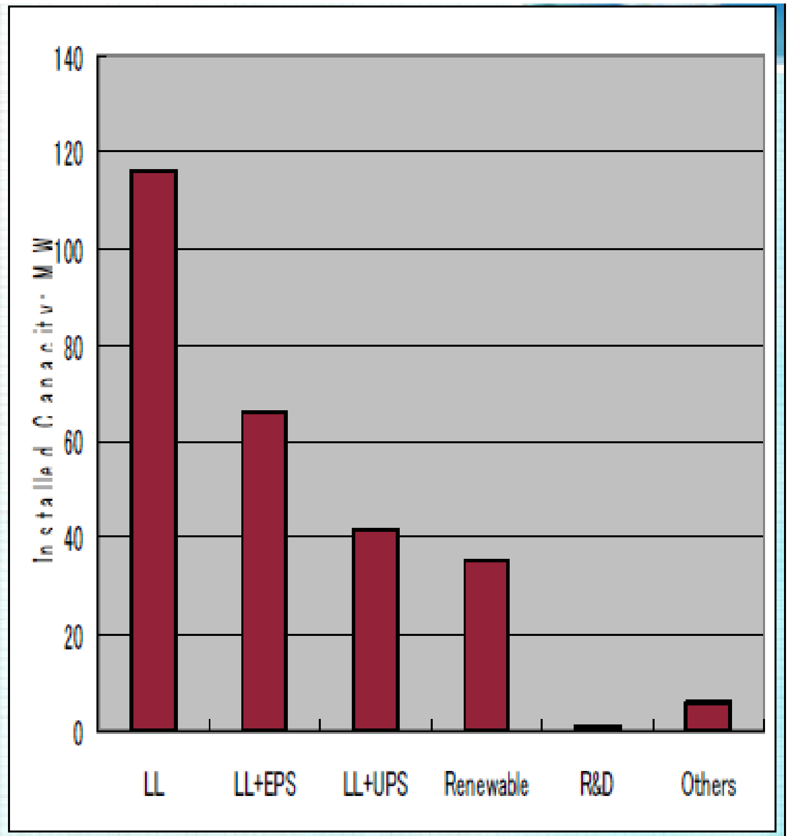
NAS Battery Manufacturing

- **2003 – Commercial-scale manufacturing plant commissioned**
- **2005 – 48 MW/yr production (960 modules)**
- **2008 – 90 MW/yr (1800 modules)**
- **2010 – 150 MW/yr (expansion in-progress)**

NGK INSULATORS, LTD.

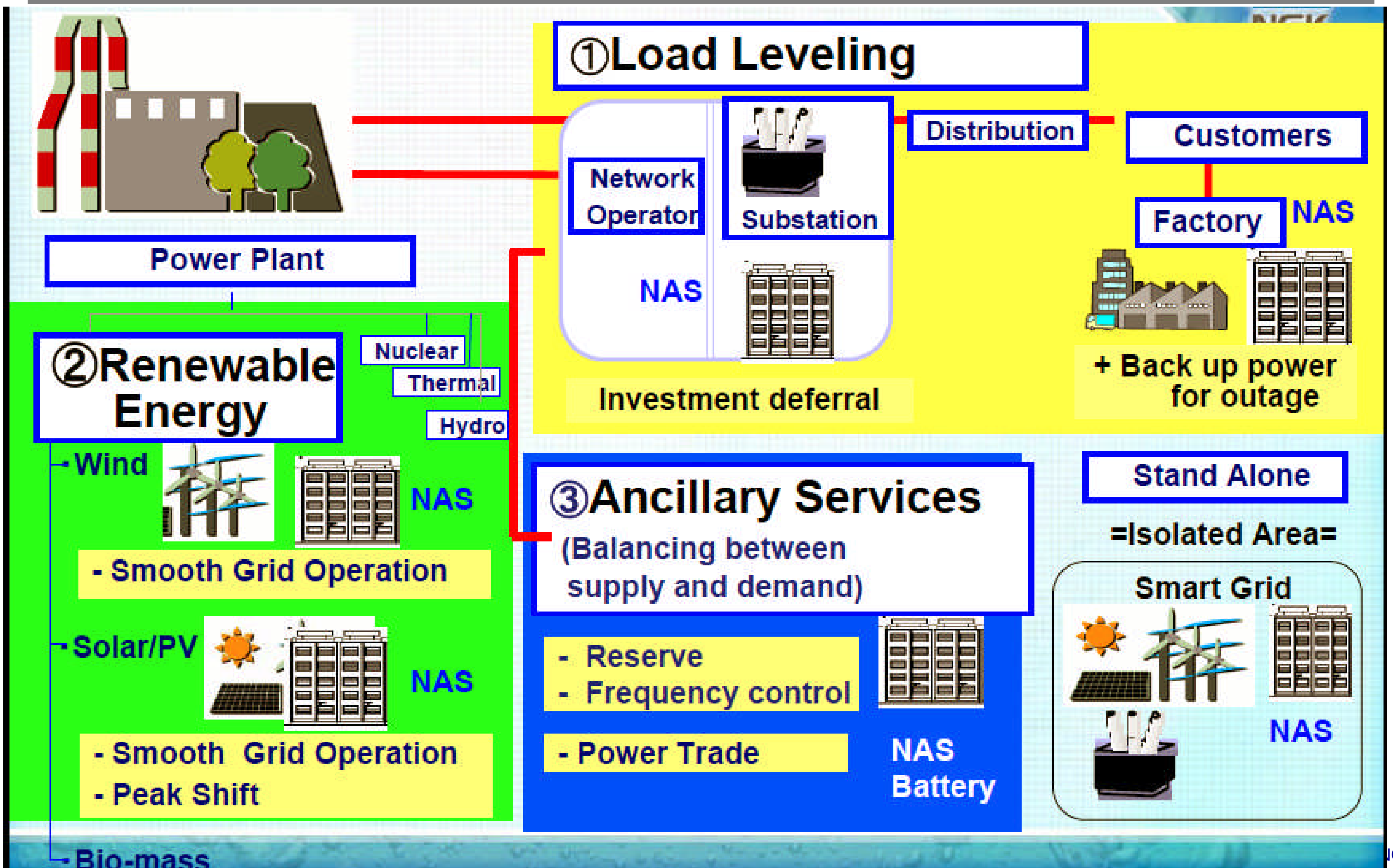
NAS Deployment History





*** Includes 160 MW NAS Distributed Energy Storage within Tokyo**

NAS Battery Applications



Part 2

Barriers & Issues Encountered in US Deployment

The Regulatory "Ownership" Issue

Ownership regulations have obstructed NAS owners from accruing the combined benefits of both
MARKET SERVICES and GRID SERVICES

Organized (ISO) Markets
(competitive, unregulated)

- **Market Services**
  - Energy Trading, e.g., time-shift wind
  - Ancillary Services, e.g., frequency regulation

Grid Infrastructure
(rate-based, regulated)

- **Grid Services**
  - Reliability Enhancement
  - Upgrade deferral

- **This issue –**
  - Creates owner uncertainty on investment recovery
  - Applies to all DES technologies like NAS (multi-MW, Hrs)
  - Presents a barrier to DES contribution to CA RPS goals

Cases

- **Case 1: 6 MW DES (NAS) Project delayed ~ 1 year**
  - Owned by a California Investor Owned Utility, Transmission Company (abbreviated, CA-IOU(T))
- **Case 2: 4 MW DES Project approval delayed ~ 6 months**
  - Customer is a Texas Investor Owned Utility, Transmission and Distribution Company (abbreviated, TX-IOU(T&D))
- **Case 3: Multi-MW DES Proposal to CA-IOU – combined benefits were NOT considered**
  - Proposed by a California Independent Storage Developer (abbreviated, CA-ISD)

Case 1: CA-IOU(T)* 6 MW DES Project Delay

- **In Feb 08, CA-IOU(T) purchased 6 MW DES to provide:**
  - Reliability enhancement [a grid service]
  - Renewables generation support (time-shift wind) [a CAISO market service]
  - Ancillary services - regulation control, VAR support [CAISO market services]
- **In May 08, the vendor was advised that**
  - "CA-IOU(T) is facing the challenge of establishing the precedent for Battery Energy Storage Systems (BESS) as a Transmission Asset recoverable in the Transmission Access Charge (TAC)."
- **The vendor's understanding is that**
  - The CA-IOU(T)'s challenge to qualifying BESS as a Transmission asset is due to a FERC ruling on the rigid separation of Generation and Transmission.
    - *. . ."[asset] may not be operated and/or managed by the California Independent System Operator Corporation or functionalized as transmission for rate recovery purposes,"*
  - The CA-IOU(T) considered the ruling to place the cost recovery of energy storage assets at risk
  - No FERC or CPUC rulings have been obtained

*** California Investor Owned Utility, Transmission Company**

Case 2: TX-IOU(T&D)* 4 MW DES Project Delay

- **In July 08, TX-IOU(T&D) received ERCOT approval of 4 MW DES for reliability enhancement**
  - No ISO market services (energy trading, ancillary services) planned
- **In Aug 08, two Market Participants (TX-MPs) filed objections**
  - *". . . it is not clear [to TX-MP] that the storage device should be owned and operated by the TX-IOU(T&D), causing the TX-IOU(T&D) to effectively take ownership of the energy while it is stored in the battery. " ". . . TX-MP believes that the intent of the Legislature was to distinctly separate generation, transmission and retail functions."*
- **ERCOT tabled the issue**
  - *". . . until the PUCT issues a decision in the proceeding relating to the ownership issue (PUCT Docket No. 35994)."*
- **In Feb 09, PUCT expressed approval for TX-IOU(T&D) to proceed**

***Texas Investor Owned Utility, Transmission and Distribution Company**

Case 3:
CA-ISD* Multi-MW DES Proposal to CA-IOU

- **During 2008, CA-ISD submitted a proposal based on networked multiple DES systems in response to CA-IOU RFO.**
- **CA-ISD projected value based on combining both**
  - CAISO market services (e.g., frequency regulation, energy) and
  - Grid services (e.g., upgrade deferral, feeder reliability)
- **The vendor's understanding is that**
  - CA-IOU proposal evaluators were not equipped to consider the combined benefits of market and grid services, i.e.,
    - *DES only credited for MARKET SERVICES (as though DES were a generator)*
    - *DES benefits for GRID SERVICES ignored.*

***California Independent Storage Developer, (Storage counterpart to IPP)**

Case Summaries

- **Case 1: CA-IOU(T) Owner - 6 MW DES Project Delay**
  - FERC ruling appears to deny BOTH market and grid services
- **Case 2: TX-IOU(T&D) Owner - 4 MW DES Project Delay**
  - Market participants (TX-MP) objected to storage for grid services
    - *PUCT has recently approved project*
  - The use of storage for market services was not addressed
- **Case 3: CA-ISD Owner - Multi-MW DES Proposal to CA-IOU**
  - Storage valued by CA-IOU for ONLY market services
  - Value of proposed grid benefits denied

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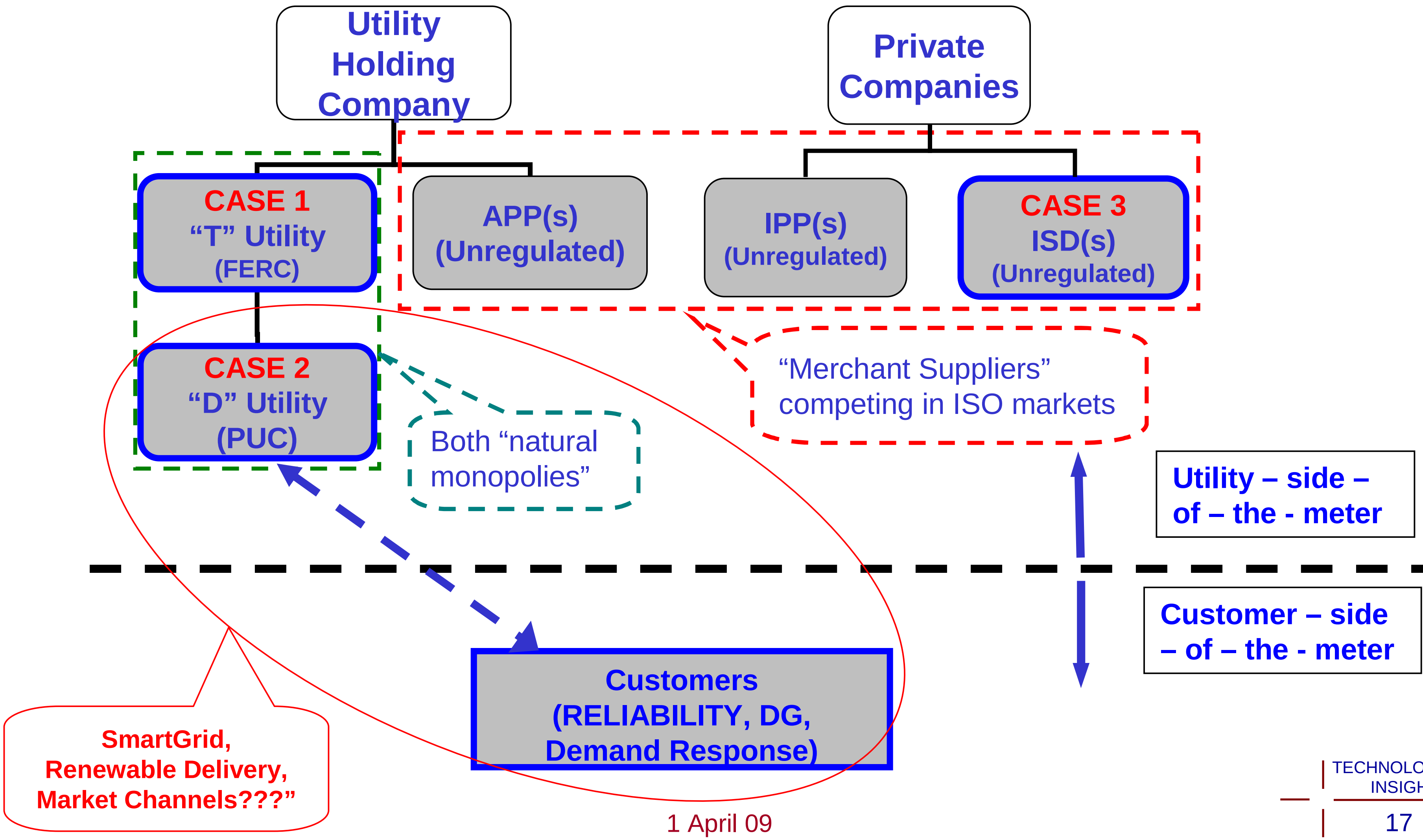
Vendor Perspective of US Market Structure

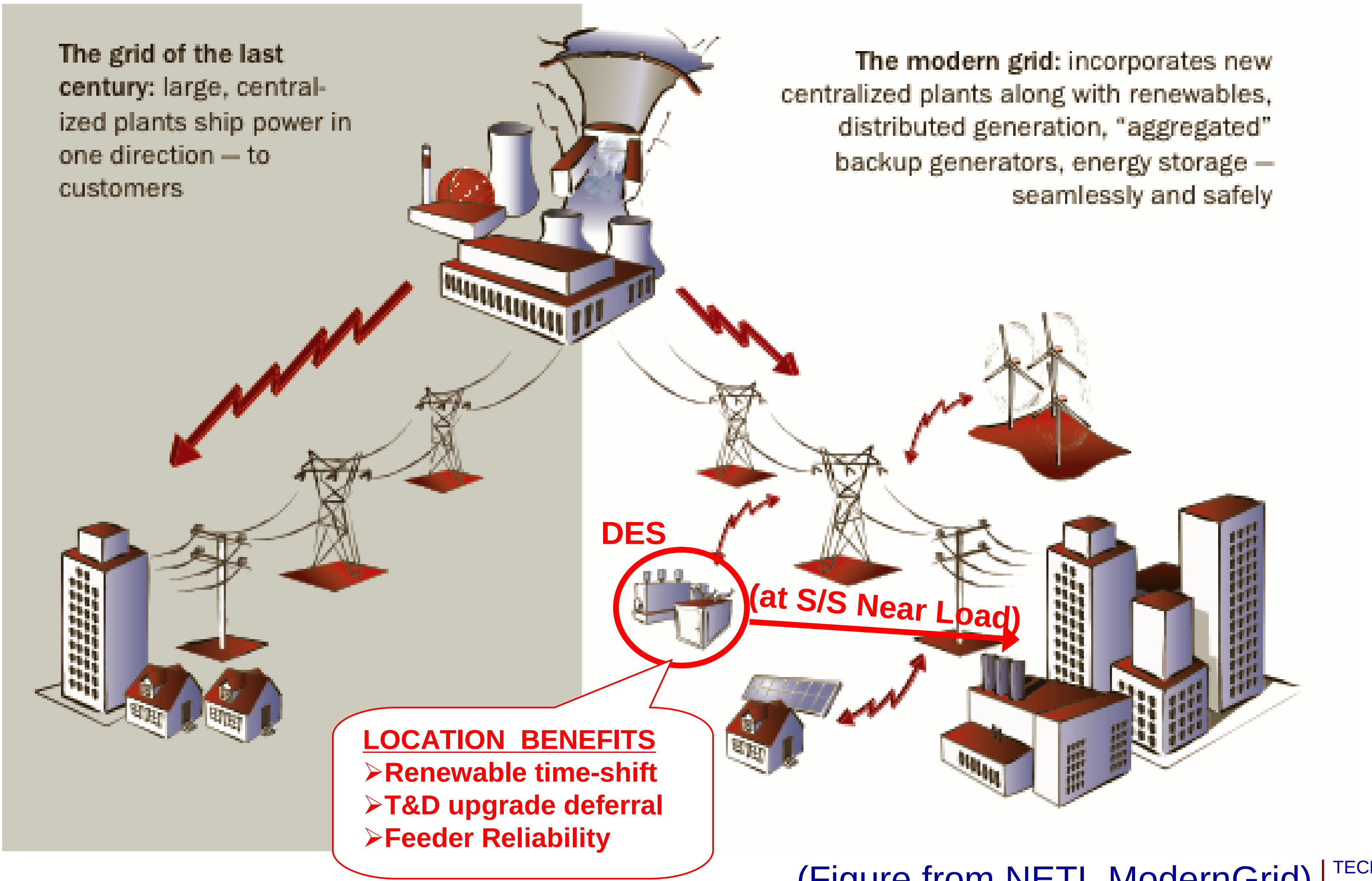
Shaded denote candidate energy storage owners, i.e., MARKET CHANNELS



Alternative Rules for Owners of Distributed Energy Storage (DES)

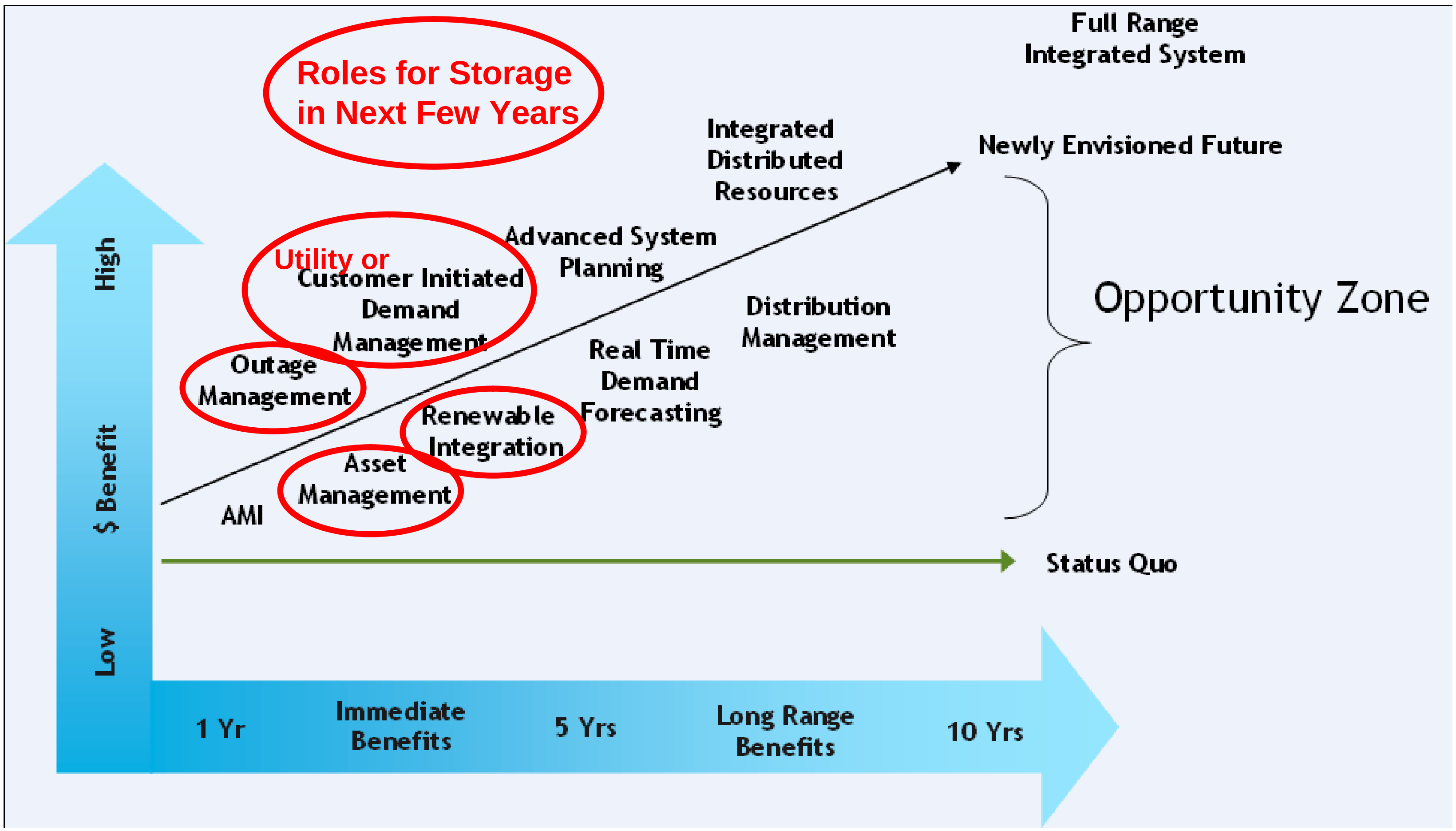
- **DES technologies are "new tools" in "new markets"**
  - Existing rules appear to stem from "deregulation" of generation assets, and strict separation generation and T&D functions
  - "Storage" is being treated "generation"
- **Alternative rules for DES ownership should allow owners to accrue benefits from COMBINED market and grid services. Options include:**
  - Interim Rule-Making/Flexibility – while experience is gained with DES technologies, e.g.,
    - *Allow "T&D" utilities to place storage in rate-base for grid services and return market revenues to rate payers*
  - New Rule-Making – to recognize "energy storage" as a regulatory category separate from generation and T&D

Networked DES Located Near Load in SmartGrid



(Figure from NETL ModernGrid)

Networked DES in SmartGrid Deployment



(Figure from Energy Pulse)

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