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Boulder City Battery Energy Storage

Peer Review Presentation

November 14, 2001

NEVAREST RESEARCH

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Presentation Overview

- **Presenters**
  - **Larry Stoddard - Black & Veatch**
  - **Ben Norris - Gridwise Engineering**
- **Boulder City Description**
- **Technology Evaluation**
- **Pre-Conceptual Design**
- **Benefits of Boulder City Project**

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Black & Veatch Team Scope

- Evaluate the proposed site
- Evaluate candidate battery technologies
- Prepare pre-conceptual design of BESS on the site
- Prepare an artist's conception of BESS on the site
- Prepare preliminary estimate of capital and operating costs
- Evaluate economic benefits of BESS to Boulder City

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Boulder City

- **Bedroom community of about 15,000 people**
- **Built to house workers on Hoover Dam**
- **Loads are primarily residential and light commercial**

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City of Boulder City Municipal Utility

- Owns no generation
- Purchases hydroelectric generated power from
  - Western Area Power Administration (WAPA)
  - Salt Lake City Area/Colorado River Commission (SLCA/CRC)
- Other power purchased from Nevada Power Company (NPC)

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Regular Boulder City Power Sources

Source	Resource	MW	Capacity Price ($/kW-mo)	Energy (MWh)	Energy Price (¢/kWh)	Expira-tion
Hoover Dam (WAPA)	Sch. A Sch. B	20 8.5	0.99	80,000 17,870	0.75	2017
SLCA (CRC)	Summer Winter	6.0	3.44	13,149 17,419	0.81	2019
Nevada Power Co.	Amend. 1 Sch. D		5.02	No limit As needed	2.3 Marginal Cost	NA NA
Reliant Energy		10		Open	5 to 9	2022

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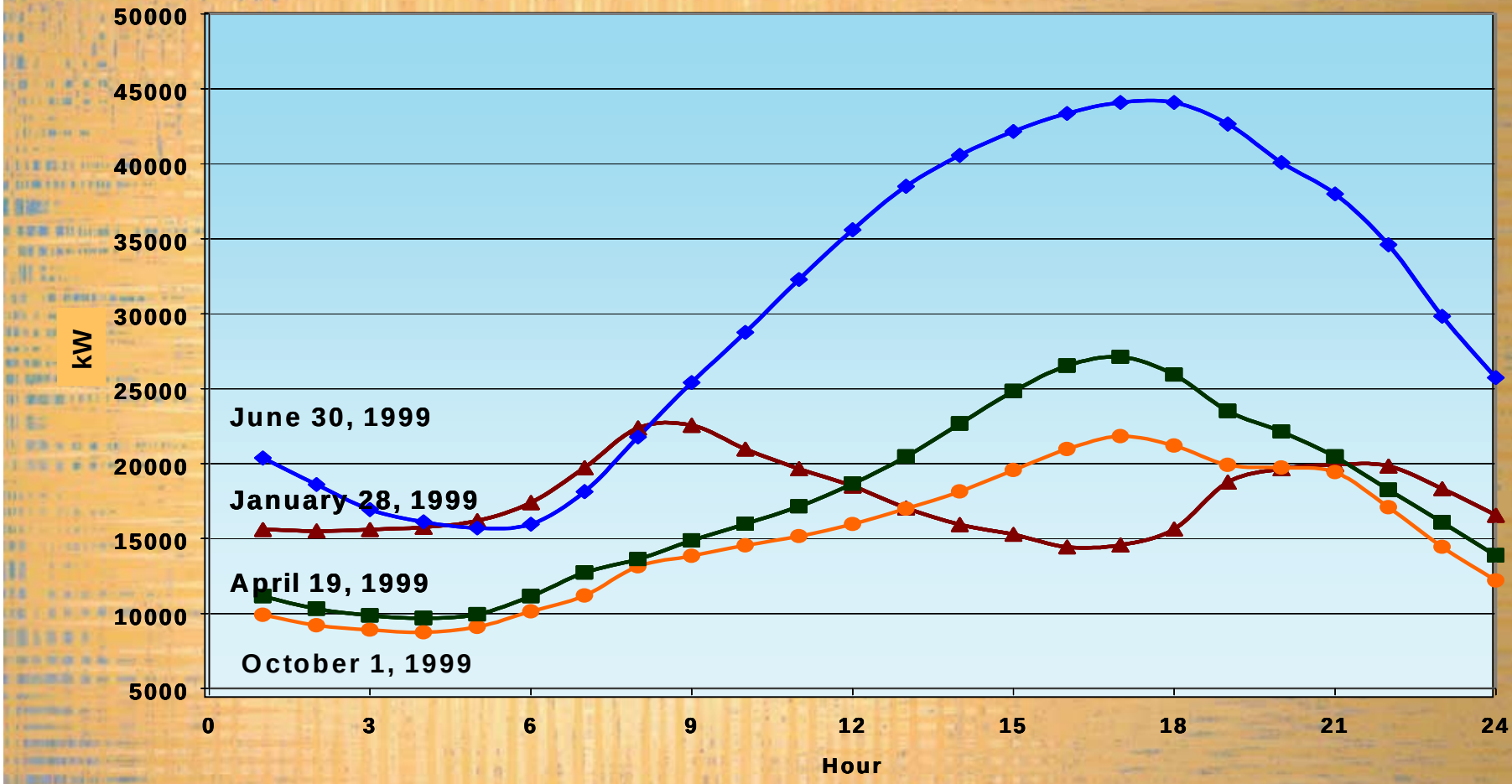
Typical Load Profiles



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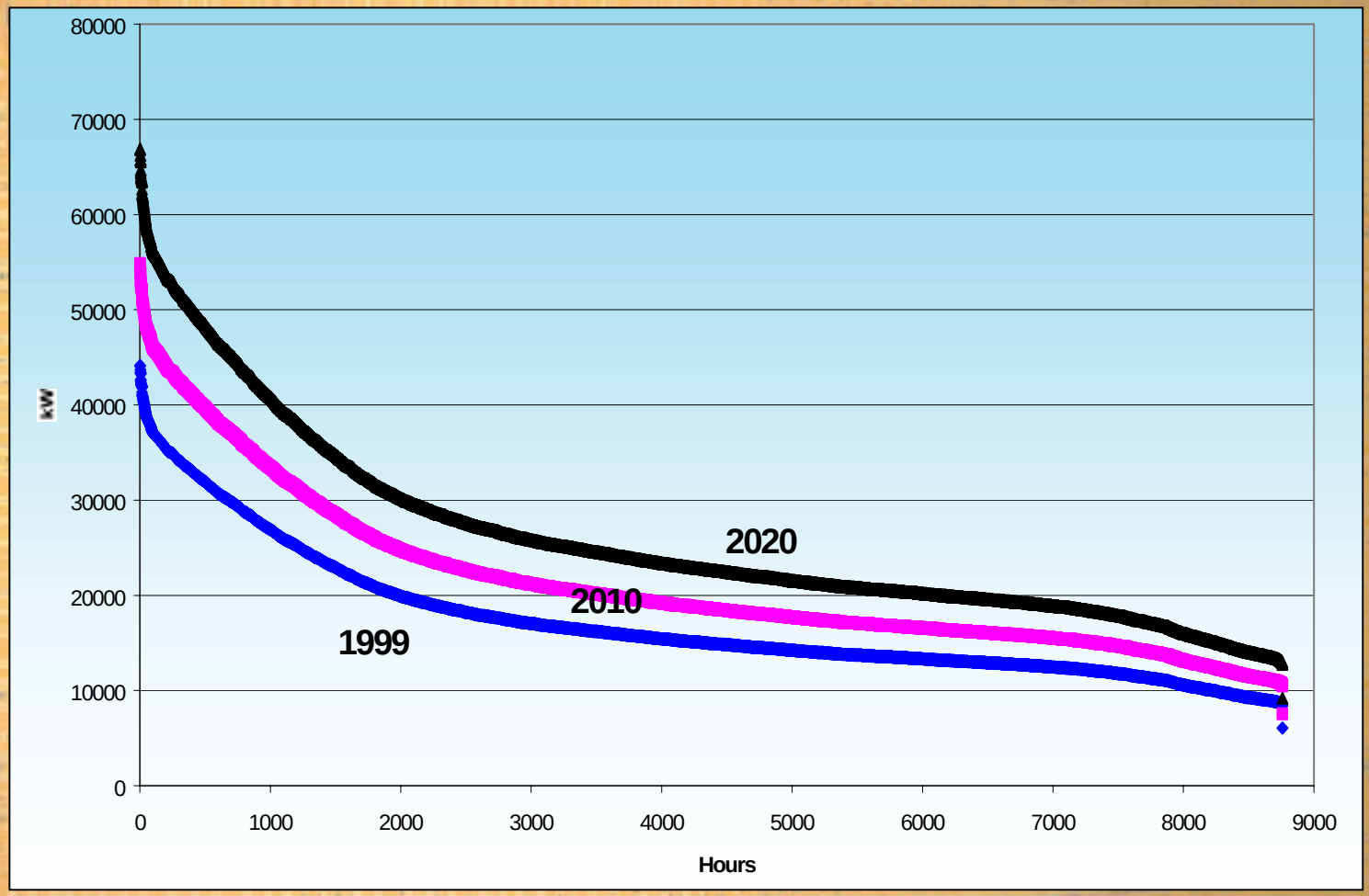
Load Duration Curve



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Proposed Site: Hemenway Station

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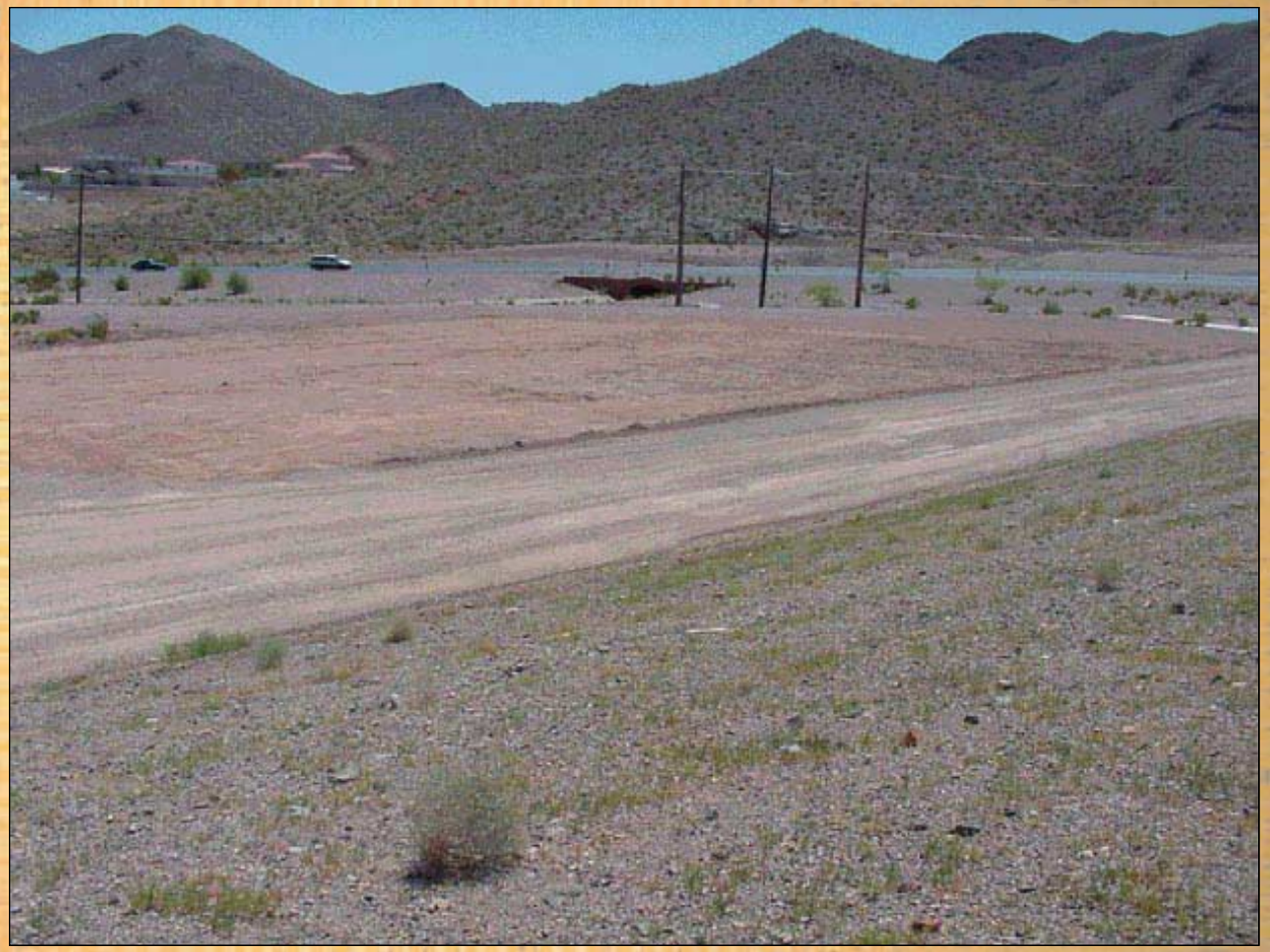

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Proposed Site: Hemenway Station

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Evaluation of BESS Technology: Background

- **Purpose**
  - **Evaluate technology readiness**
  - **Evaluate footprint**
  - **Evaluate capital and O&M costs**
- **Technologies Considered**
  - **Regenesys ® (Declined by Innogy - size range)**
  - **Sodium Sulfur**
  - **Vanadium Redox**
  - **Zinc Bromine**

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Evaluation of BESS Technology: Background

- **Assumed project schedule**
  - **Late 2001 – Release solicitation to developers**
  - **April 2002 – Award turnkey contract**
  - **April 2003 – Commissioning**
- **Site characteristics**
  - **25-foot height zoning restriction**
  - **1.25 acres available – for BESS, parking lot, visitor center, transformation to 12 kV**
  - **Residential area (high value homes)**

Evaluation of BESS Technology: Developer Questionnaire

Respondents	Technology	Headquarters	US Representatives
NGK Insulators	Sodium Sulfur	Nagoya, Japan	Technology Insights San Diego, CA
Powercell Corp.	Zinc Bromine	Boston , Massachusetts	Boston, Massachusetts
Sumitomo Electric Industries, Ltd.	Vanadium Redox	Osaka, Japan	Sumitomo Electric USA, Inc. Torrance, CA
Vantech (VRB) Technology Corp.	Vanadium Redox	Vancouver Canada	(None)
ZBB Energy Corp.	Zinc Bromine	Milwaukee, Wisconsin	Milwaukee, Wisconsin

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Evaluation of BESS Technology: Developer Questionnaire

- Project experience
- Production capabilities
- Safety
- Site layout for the demonstration plant
- Electrical configuration
- Component UL listing
- System life
- Performance
- Load following capabilities
- Maintenance requirements and costs
- Project and future capital costs

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Evaluation of BESS Technology: Technology Readiness

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Evaluation of BESS Technology: Technology Readiness

	Sodium Sulfur	Vanadium Redox	Zinc Bromine
Field Experience	Over 30 projects, 25 kW to 6 MW, Largest 48 MW	Several projects 100 kW to 3 MW (pulse power) Largest 1.5 MWh	Several projects 50 kW to 250 kW, Largest 400 kWh
Production Capacity	160 MWh/yr	30 MWh/yr	40 to 70 MWh/yr
Actual Production	50 MWh/yr	10 MWh/yr	4.5 MWh/yr
UL Listing	UL report by early 2002	Electronics only	Electronics and possibly battery

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Evaluation of BESS Technology: Site Layout

	Sodium Sulfur	Vanadium Redox	Zinc Bromine
Structure	Outdoor rated battery enclosures and PCS enclosures	Building enclosure	Building enclosure
Footprint (54,000 ft^2 available)	About 5,000 ft^2	12,000 to 17,000 ft^2	5,000 to 7,000 ft^2

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Evaluation of BESS Technology: Life and Performance

	Sodium Sulfur	Vanadium Redox	Zinc Bromine
Life	15 years	7 to 15 years	10 to 20 years
Efficiency	72%	70 to 80%	65 to 70%

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Evaluation of BESS Technology: O&M Requirements

	Sodium Sulfur	Vanadium Redox	Zinc Bromine
Operators	None	None	None
Required Maintenance	Remote monitoring, Three year inspections	Quarterly or annual maintenance, periodic parts replacement	Remote monitoring, annual inspections, maintenance reqs. Still under development
O&M Cost	$32.5k per year	$50k per year	$30-150k per year

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Evaluation of BESS Technology: Capital Cost Estimates

- **Costs included in developer's estimates:**
  - ***Battery and Auxiliaries***
  - ***PCS & AC Switchgear***
  - ***Transformation to 12 kV***
  - ***Utility Protection***
  - ***Structures/Containers***
  - ***Control & Monitoring System***
  - **Design and Engineering**
  - **Construction & Installation**
  - **Startup Testing/Commissioning**
  - **Spare parts**
  - **Shipping**
  - **All taxes, duties, licenses**
  - **Bonds & insurance costs**
  - **Commissioned in April 2003**

Evaluation of BESS Technology: Capital Cost Estimates (Cont.)

- **Costs excluded from developer's estimates:**
  - **Interconnection to substation**
  - **Land**
  - **Grading**
  - **Fencing**
  - **Access road**
  - **Parking lot**
  - **Visitor's center**
  - **Financing costs to owner**

Evaluation of BESS Technology: Capital Cost Estimates (Cont.)

	Sodium Sulfur	Vanadium Redox	Zinc Bromine
2.5 MW, 10MWh Boulder City Project	$12 M	$10.9 to $11 M	$5.8 M to $8 M
100 MWh (Near Term)	$35 M	N/A	$38 M
100 MWh (Long Term)	$30 M	$66 to $83 M	$32 to $50 M

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Evaluation of BESS Technology: Conclusions

- **Sodium sulfur, vanadium redox, and zinc bromine technologies each**
  - **are technically viable**
  - **have sufficient project experience**
  - **are compact enough to fit in available land**
  - **can be constructed in the anticipated timeframe**
- **The Regenesys ® technology is designed for larger project sizes and should not be considered for Boulder City.**

BESS Pre-Conceptual Design

- **Battery Energy Storage Building Block**
- **Electrical/Control interconnects with substation**
- **Visitor's Center and Parking Lot**

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Pre-Conceptual Design

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Pre-Conceptual Design

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BESS Demonstration Unit Capital Costs

	Sodium Sulfur	Vanadium Redox	Zinc Bromine
EPC Battery System Cost	12,000	11,000	5,800 - 8,000
Electrical Upgrade	65	65	65
Visitor's Center	275	275	275
Parking Lot	121	121	121
Engineering	300	300	300
Construction Management	150	150	150
Contingency	632	612	323 - 432
Total	13,543	12,523	7,034 – 9,343

Thousands (2001$)

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Battery Storage at Boulder City

- **Peak Shaving Value to Boulder City: Would Displace Part of "Schedule D" Purchases from Nevada Power Company**
- **Provide Utility Setting Experience for Advanced Battery Energy Storage System**
  - **Identify/Resolve Design and Operating Issues**
  - **Establish O&M Costs**
  - **Determine Ancillary Benefits**
- **Provide Industry and Public Education on BESS**

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