

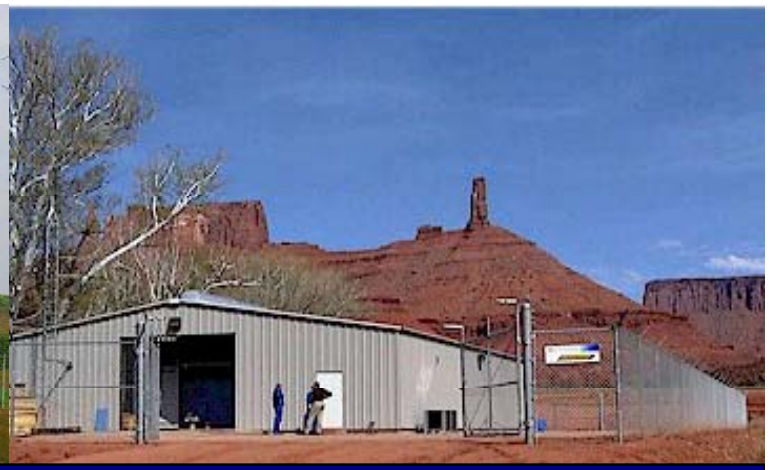

Energy Storage Technologies and Policies Needed to Support California's RPS Goals of 2020

California Energy Commission Staff Workshop
April 2, 2009 – Sacramento
Utility Savings & Refund, LLC for
Prudent Energy, Inc.

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Prudent Energy Inc.

Storage for a sustainable future

The Global Leader in Advanced Energy Storage based on the Vanadium Redox Battery (VRB-ESS™)

www.pdenergy.com

World leader in Energy storage

March 2009

Prudent Energy

About Prudent Energy Inc.

- Prudent Energy is based in Beijing China. It is a Private VC funded company founded in 2006
- Staff of approximately 50 including dedicated Vanadium and membrane research scientists
- Investors: DT Capital (www.dtcap.com) DFJ (www.dfj.com)
- Purchased VRB Power Systems Inc. assets, IP and knowhow in January 2009
- Formed Prudent Energy International Inc. a Canadian based company
- Investors see the company's business model as one where systems engineering development is performed in the USA and Canada, whilst the innovation of low cost and rapid manufacturing occurs in China.

Merged company strengths – a shared vision

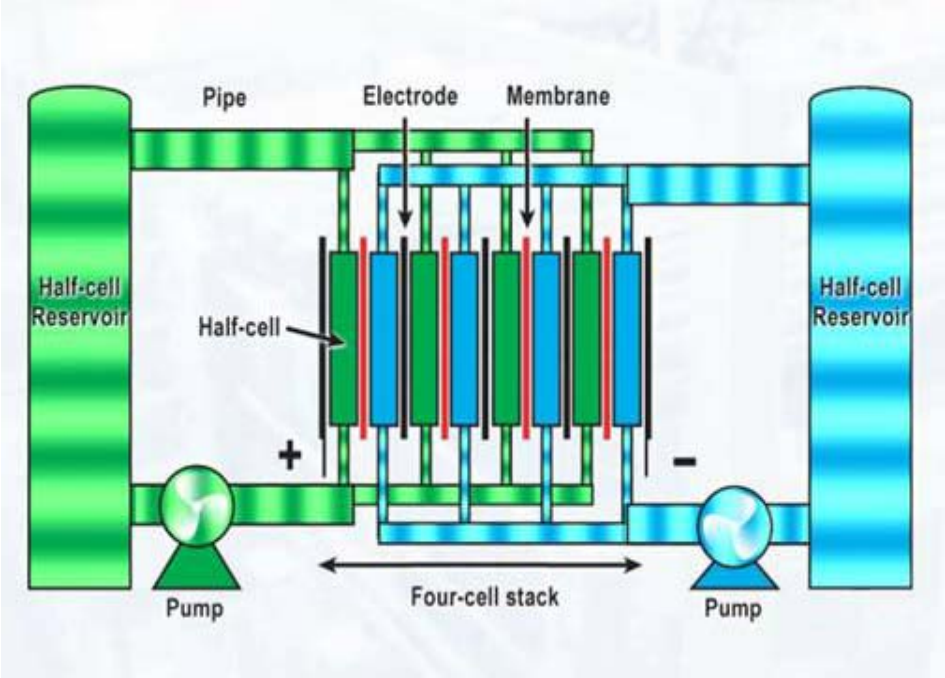
- Active experienced and successful global Investors
- The Combined experience and knowledge of flow batteries from VRB Power, Regenesys and Sumitomo Electric Industries spanning 15 years.
- Low Cost manufacturing base in China and global sales and support locations
- Proven products - Highly skilled staff – including several technical staff who joined from VRB Power
- Chinese Materials science research into membrane technology and vanadium chemistry

Sales of VRB–ESS units – a proven technology

- VRB-ESS systems have been operating throughout the world for over 10 years.
- Sumitomo Electric Industries (SEI) completed about 12 projects ranging from 4MW wind smoothing to MW scale UPS systems.
- VRB Power systems sold and have history of utility scale systems operating unmanned for over 5 years.
- PacifiCorp (USA), Risø, Alaska, National Research Council Of Canada, Safaricom (Kenya) – two telecomm systems
- Israel, Romania, Denmark, Germany, New Zealand

VRB Flow Battery Technology

A liquid electrolyte that is separate from the electrode.



Positive Electrolyte

$V^{4+} \Rightarrow V^{5+} + e^-$

$V^{5+} + e^- \Rightarrow V^{4+}$

Charge

Discharge

Negative Electrolyte

$V^{3+} + e^- \Rightarrow V^{2+}$

$V^{2+} \Rightarrow V^{3+} + e^-$

- An electrochemical energy storage system operating at **ambient** temperatures
- Reversible fuel cell – reduction and oxidation of single unique element: Vanadium (no catalysts)
- **No cross** contamination
- Electrolyte **never wears out** – high residual value
- Very low maintenance
- Deep cycles >**unlimited or ten years**
- Sized 5kW to 10MW – indefinite energy storage
- Energy can be recovered instantaneously
- Battery can recharge as almost as fast as it discharges (1.5 to:1)
- Power and Energy separately scalable

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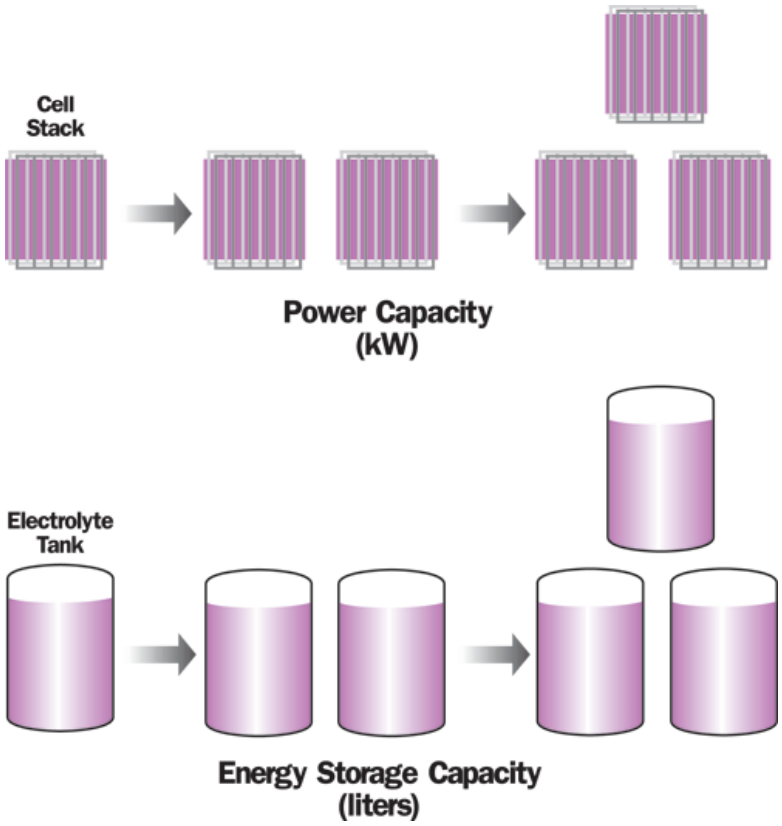
VRB Technology – the evolution - Scaleable / Flexible



Original concept - Built on site

Current systems - Modular Packaged

- 5kW – 10MW
- Prudent Energy controls worldwide patents*
  (*excludes Japan)

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Renewables – VRB-ESS™ Proven with wind

- 4MW x 1.5 hour (50% pulse factor) VRB-ESS Grid-Coupled Wind Smoothing Tomamae, Japan
- One of several Sumitomo VRB-ESS installations in Japan
- 270,000 cycles in 3 years

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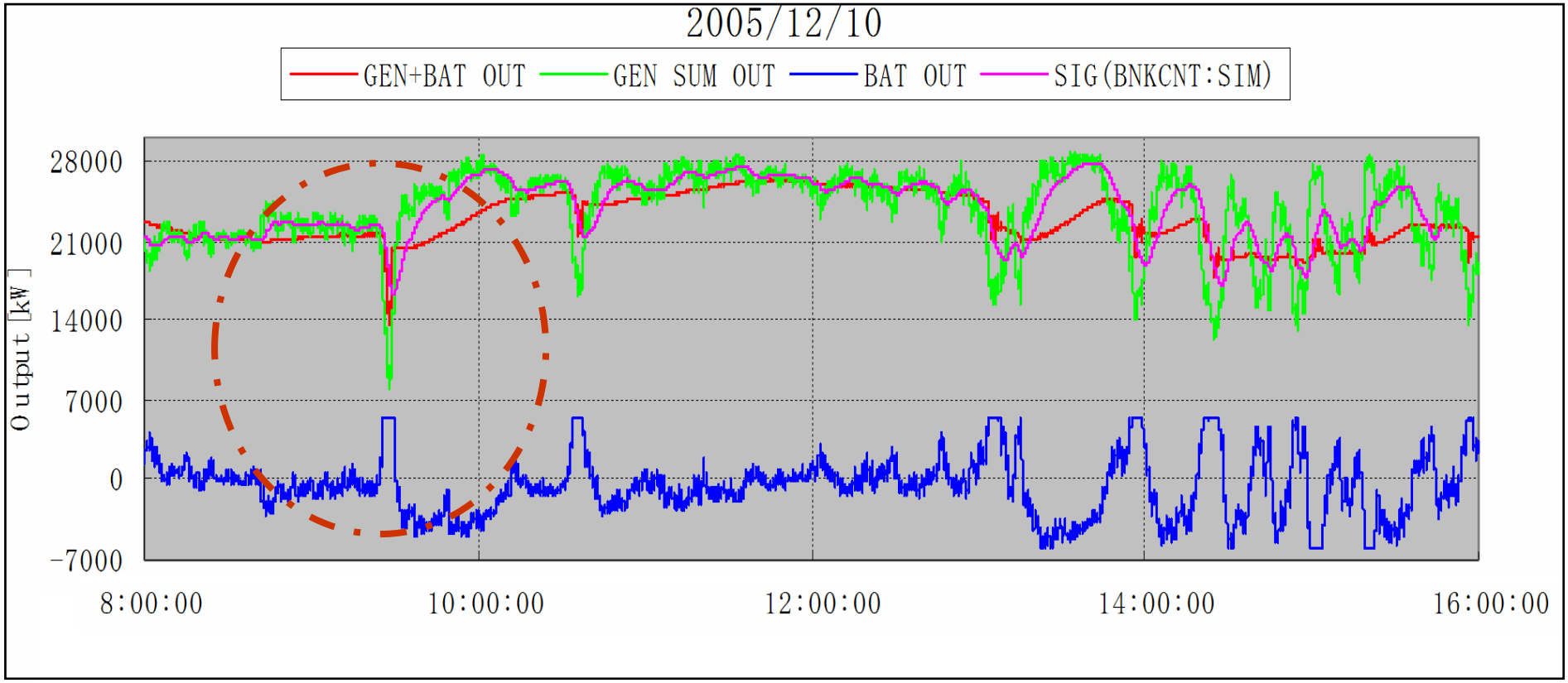
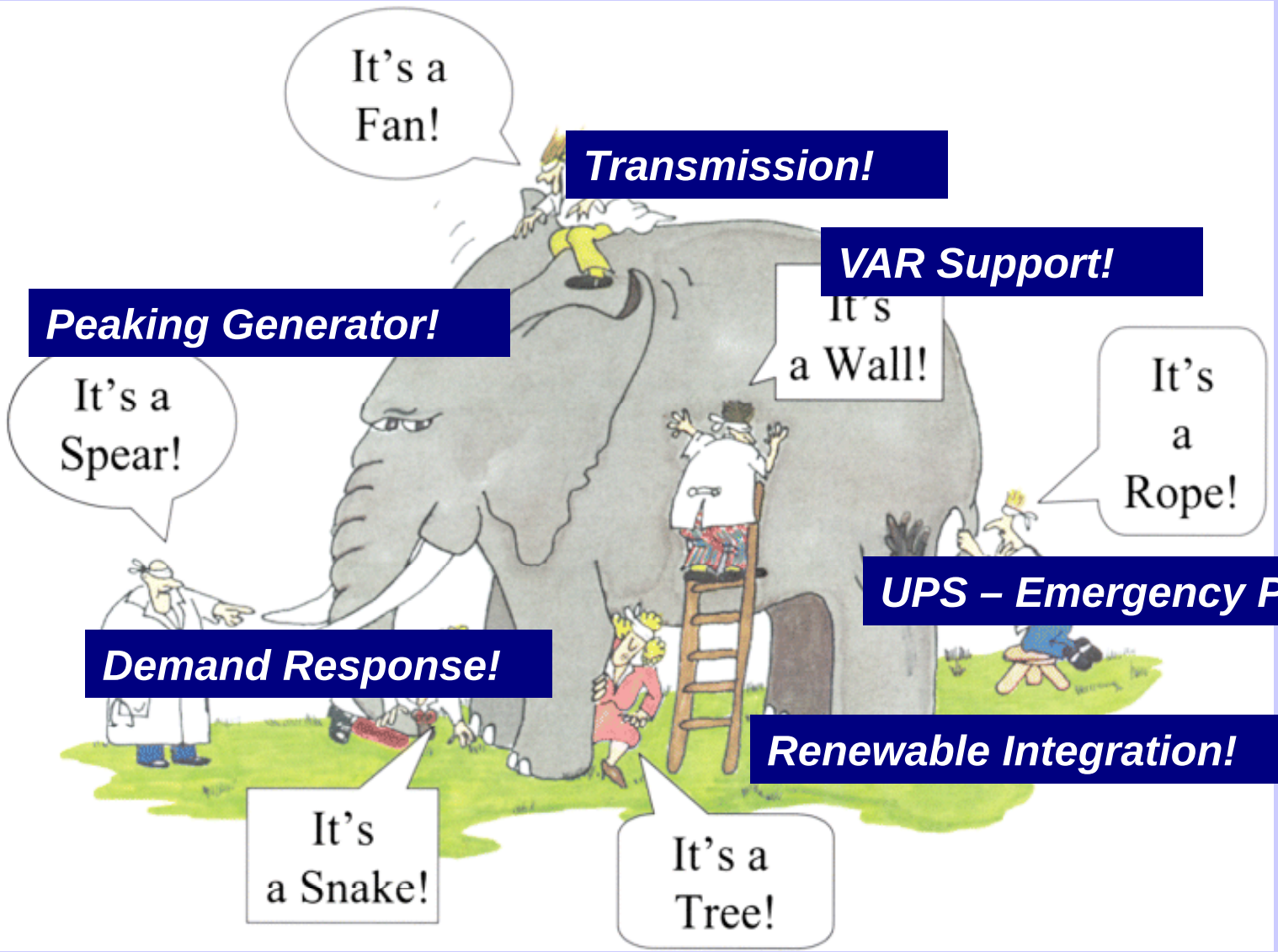
Daily Wind Output Smoothing - Japan



- The VRB-ESS (blue line) runs continuously to smooth wind farm production (green line).
- At only 20% of the wind farm's nameplate capacity, the VRB ESS has a significant smoothing effect to total wind farm + battery output (red line)
- The VRB-ESS intelligently recharges throughout the day so that it maintains 50% SOC

How is Bulk Storage like an Elephant?



Merchant v. Contract Services

CAISO Ancillary Services Markets
- Frequency Regulation
- Spinning Reserve
- Energy Market
- Capacity?

Utilities
- Demand Response
- TOU Rates
- Peaker Plants

End User
- UPS / Emergency Power
- Peak Shaving

Renewable
- Firm / Dispatchable Power
- Integrated Electronics

Contracted services easier to finance than merchant plants.

Easier financing – faster deployment for 2020.

Idea
- Utilities contract for power and services.
- Contract for ancillary services provided by energy storage.
- No additional cost to rate payers – A/S is already an expense.

Monetize one part of the elephant – get more elephants! And more of the various elephant benefits.

Example – Hedge Costs of Regulation

Some bulk storage technologies can provide frequency regulation in current and future CAISO markets.

CAISO forecasts increased need for regulation for renewables – increased cost to market participants?

Long term contract with bulk storage hedges utility cost – fixed price.

Storage facility, like generator, gets financed and installed.

Once it is installed, it can then provide additional benefits depending on location:

- Wind / Solar Smoothing, Firming, Fast Ramps – Avoid curtailments.
- Reactive Power / Voltage support
- Peaking Power – Emergency Power
- Black Start
- 5 MW to 20 MW distributed systems. 120 MW by 2012

Where do you want to start?