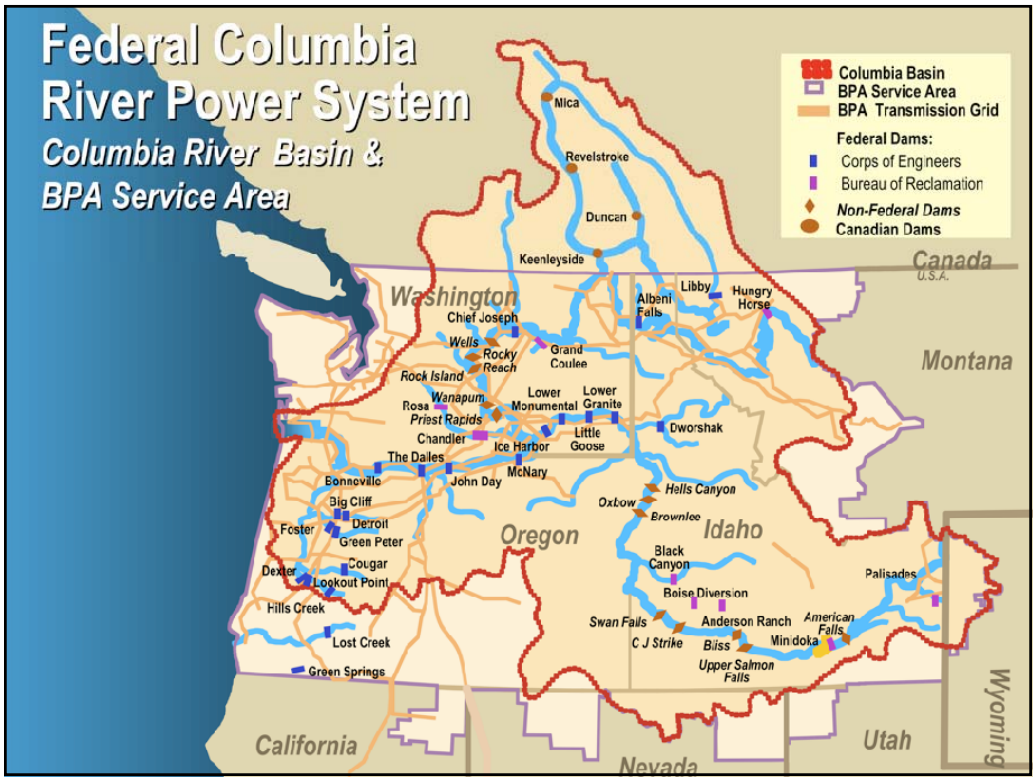
PICMET 2010
Phuket, Thailand

# Picking Up the Pace: Utilities and Innovation in a Carbon Constrained World

Terry Oliver
Chief Technology Innovation Officer
Bonneville Power Administration


Federal Columbia River Power System
Columbia River Basin & BPA Service Area
Columbia Basin
BPA Service Area
BPA Transmission Grid
Federal Dams:
Corps of Engineers
Bureau of Reclamation
Non-Federal Dams
Canadian Dams
Mica
Revelstoke
Duncan
Keenleyside
Canada
U.S.A.
Libby
Hungry Horse
Albeni Falls
Washington
Chief Joseph
Wells
Rocky Reach
Grand Coulee
Rock Island
Wanapum
Rosa
Priest Rapids
Chandler
Lower Monumental
Lower Granite
Little Goose
Ice Harbor
Dworshak
The Dalles
McNary
John Day
Bonneville
Big Cliff
Detroit
Foster
Green Peter
Cougar
Dexter
Lookout Point
Hills Creek
Lost Creek
Green Springs
Oregon
Idaho
Montana
Oxbow
Hells Canyon
Brownlee
Black Canyon
Boise Diversion
Palisades
Swan Falls
Anderson Ranch
American Falls
C J Strike
Bliss
Minidoka
Upper Salmon Falls
California
Nevada
Utah
Wyoming


Windy Point
PARTNERS LLC
119.6
MEGAWATTS OF CLEAN RENEWABLE ENERGY
Windy Flats Wind Farm
509-772-2620
24 Stringstreet Rd.
Goldendale, WA 98620

## R&D Challenges Solved

- Operate a 230kV system over 780,000 $km^2$

  Power System Analytical Tools
  BPA Load Flow Program
  BPA Transient Stability Program (EMTP)

- Exchange electricity seasonally with southern California

  Pacific HVDC Intertie - 1,400 km

# Challenge Scale

- Need lots of new must-run variable electricity generation
- Unique operational characteristics

2004 New York:
- 3 GW Wind
- 10% of Peak Load
- 4% of Energy

2005 Ontario:
- 15 GW Wind
- 50% Peak Load
- 30% Energy

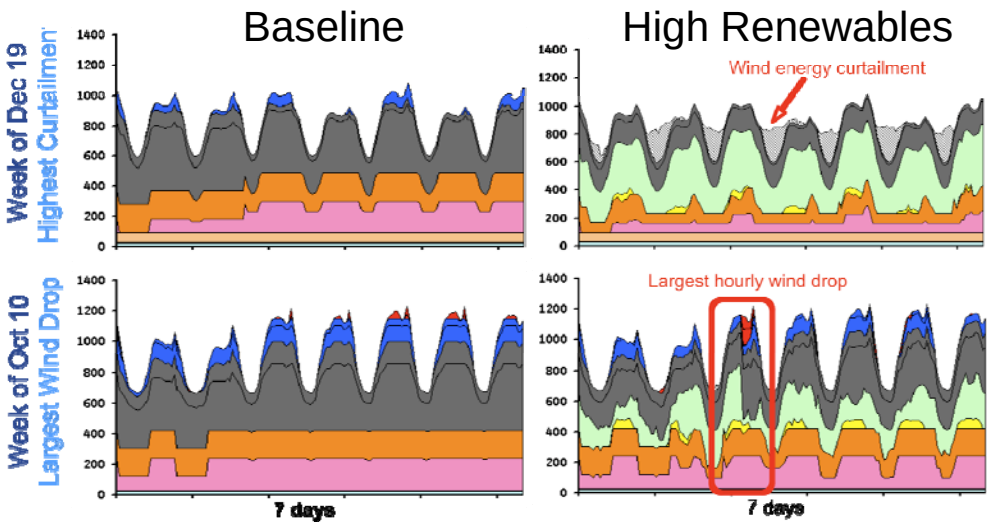
2006 California:
- 13 GW Wind & 5GW Geothermal
- 3 GW Solar
- 26% Peak Load
- 15% Energy (33% total)

2007 Texas:
- 15 GW Wind
- 25% Peak Load
- 17% Energy

2009 Western region:
- 72 GW Wind
- 15 GW Solar
- 50% Peak Load
- 27% Energy

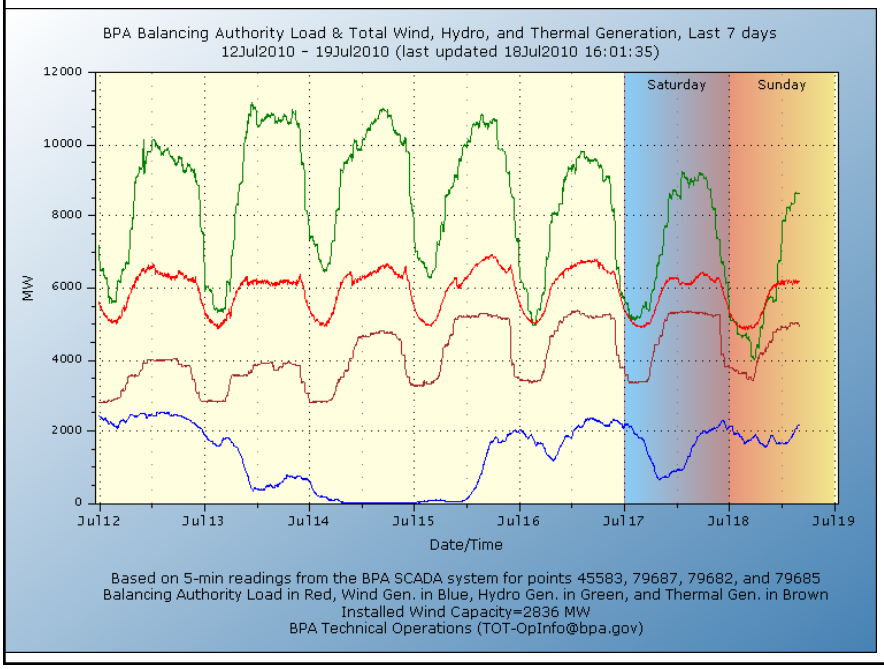
2010 Oahu:
- 500 MW Wind
- 100 MW Solar
- 50% Peak Load
- 25% Energy

# Operations Impacts




National Renewable Energy Laboratories studies

# Wind @ BPA




Hydro

Load

Thermal

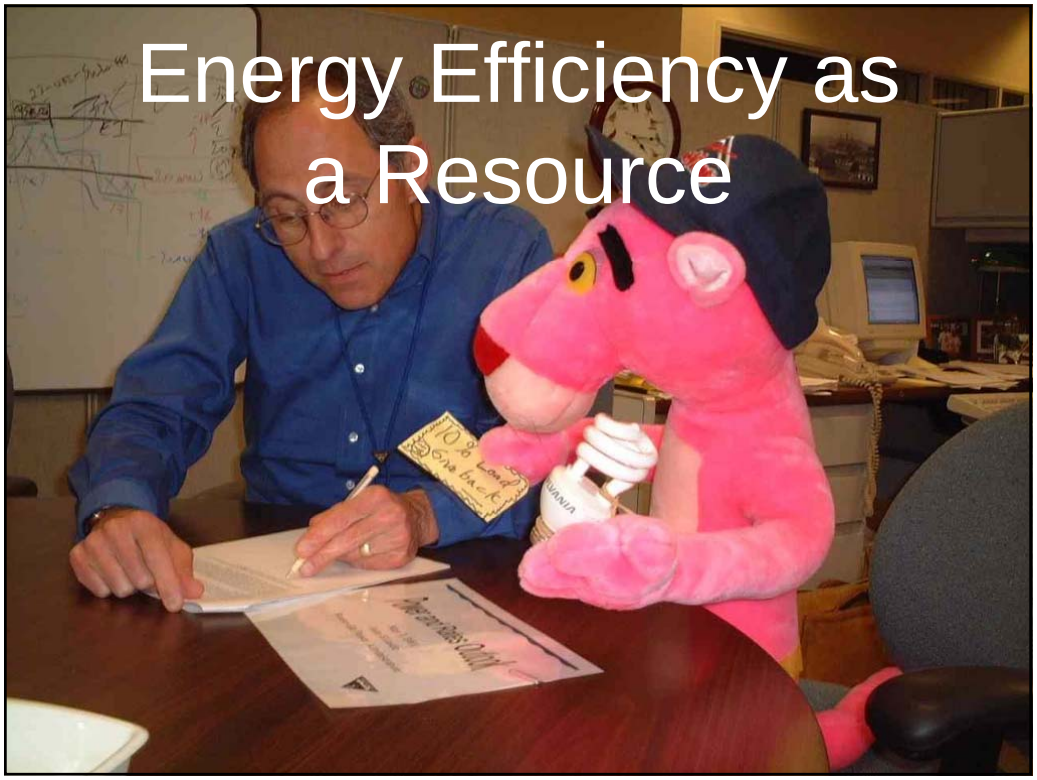
Wind

# R&D Challenges Solved

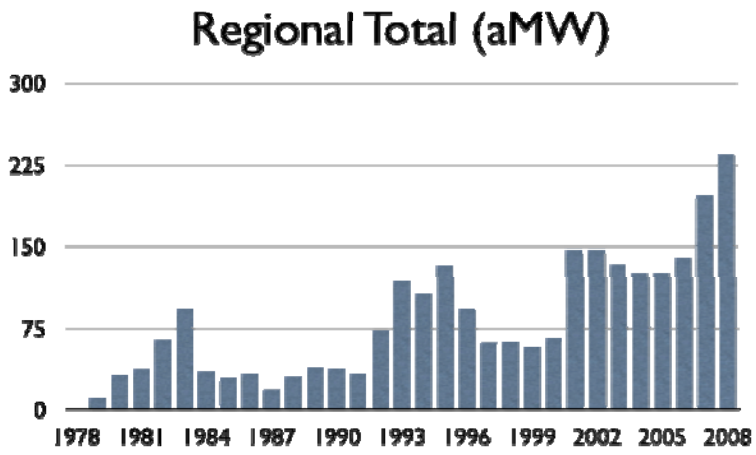
- Important to BPA
  - Improved wind forecasting in PNW
  - Operations real-time study improvements
- Important to others
  - Turbine reliability
  - Blade efficiency

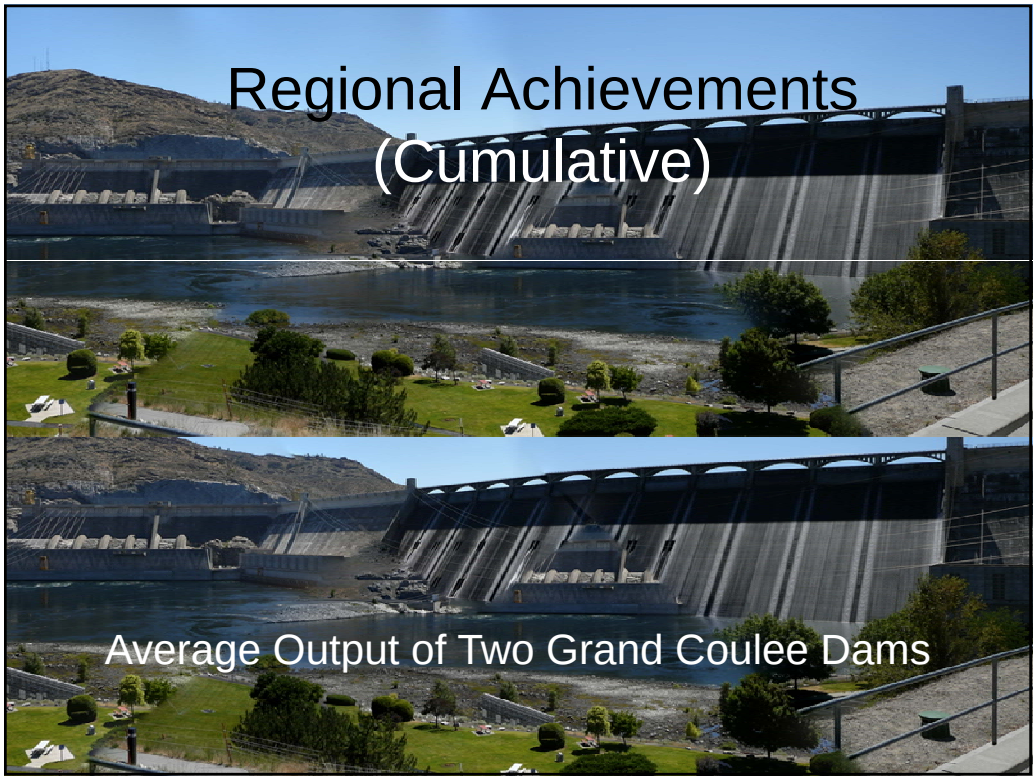
## R&D Still to Go

- Price points, Price points, Price points
- Energy Storage
  - Capacity / Capability / Cost (more materials science)
  - Integration to smart grid
- How to have end-use resources adopt performance characteristics (ride-through, voltage, etc) of generating resources.



# EE Achievements

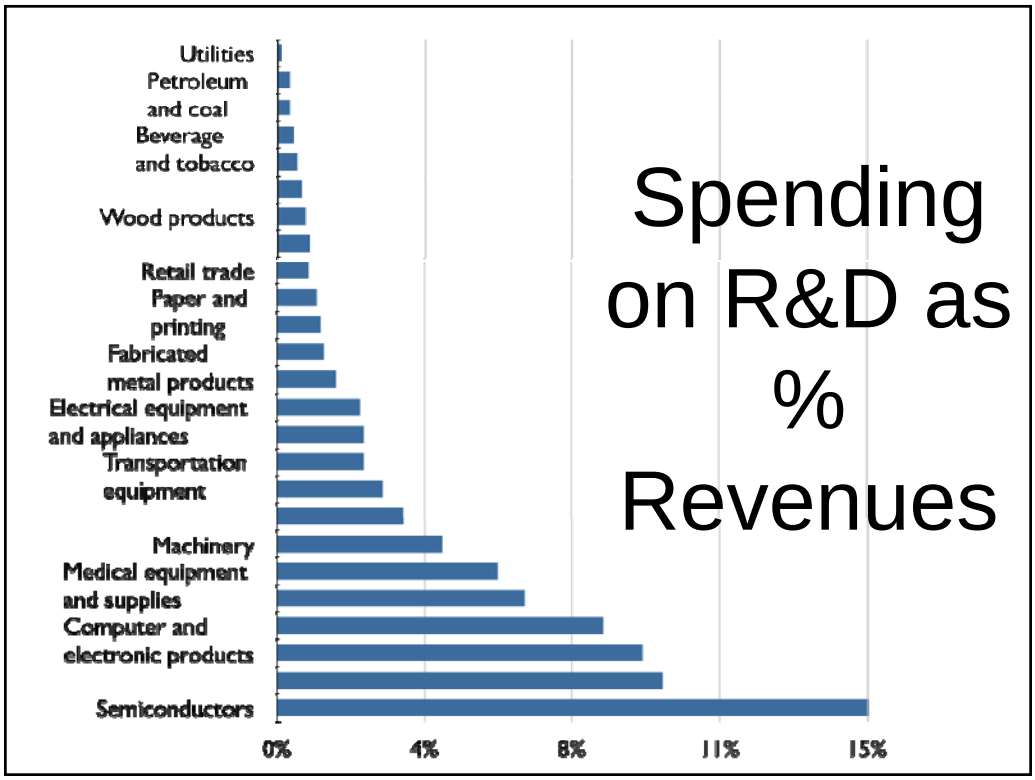


## R&D Achievements
(& Needs)

- Hood River Conservation Project (c 1985)
  - Test consumer acceptance and performance of “extreme” home energy savings
- Super Efficient Refrigerator Program - Golden Carrot (c 1990-95)
- Self-diagnosing, self-correcting rooftop package HVAC (c ???)
- Much much more - see Technology Roadmap at www.bpa.gov/ti

## About R&D




## What's Wrong with Spending 0.01%?

- Power sector "owns" about 40% of climate change issues
  - **R&D needs:** $CO^2$ sequestration, energy efficiency, effective renewables and storage integration, & smart grid
- Power sector could "own" another 30% related to transportation (electric vehicles)
- Utterly new and more complicated grid operations coming - Smart Grid

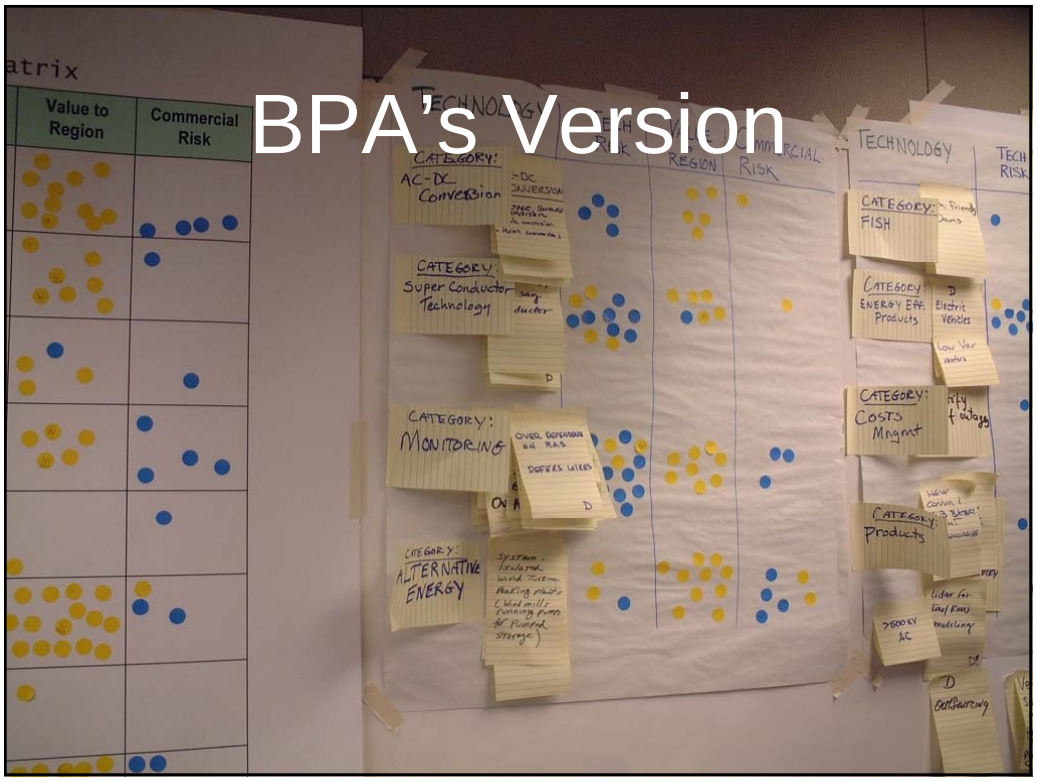
## Good R&D Practices

- Publicly articulated research interests and agenda (www.bpa.gov/ti)
- Portfolio concept across key dimensions
- Great project management including built-in kill decision points
- In-company integration addressing business needs

## Doesn't the Utility Industry Have an R&D Org?

- Yep - the Electric Power Research Institute (EPRI)
- Not yet as effective as it needs to be - do they use good R&D practices?
  - Some - they have a portfolio and public research agenda. But no effective project kill decisions, and only good (not excellent) project management practices.

Some Research isn't Collaborative




## Buckets

BPA Role in Technology Development

Balancing Portfolio Issues

R&D Investment Effectiveness

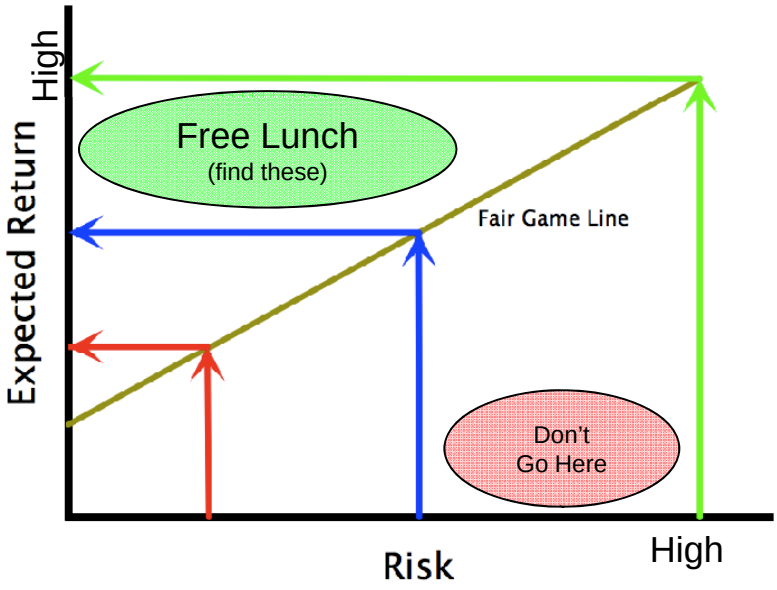
BPA Leads | EPRI, CEATI | Active Assess | Watch/ Pass

Break-through | In-crement | Reserve External | Urgency

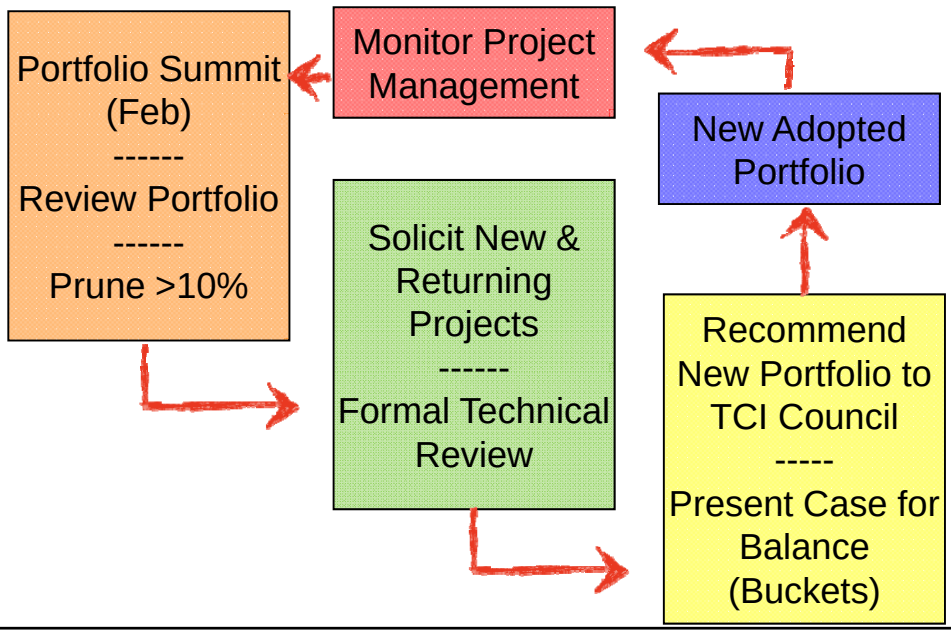
Trade-Off

$$$ | PMO | Annual Review | Built-in Kill

## Risk v Reward




## Cycles



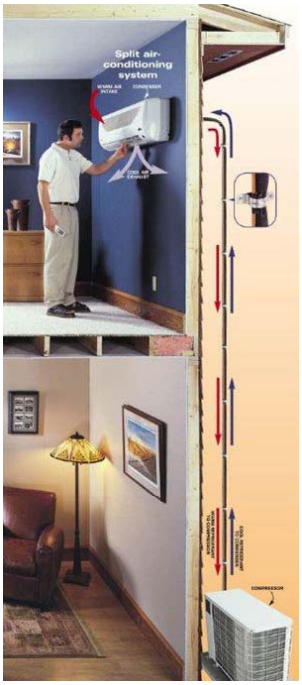
# Integration

Larry Bekkedahl, VP Tx Eng
Kathy Black, General Counsel
Dave Armstrong, Deputy CEO
Larry Buttress, VP IT, CIO
Jack Callahan, Energy Efficiency
Anita Decker, COO
Mark Gendron, VP Req Markets
John Haner, Tx Plan
Jeff Hildreth, Labs
Mark Jones, Hydro Ops
Elliot Mainzer, EVP Strategy
Terry Oliver, Chief TI Officer
Peter Raschio , Tx Tech Ops
Don Watkins , Tx WECC NERC

Executives & Experts Paneled as Peers

# Ductless Heat Pumps

- Heat Pump technology assessment capability
- Installed more than 4,800 ductless heat pumps into homes in the Pacific Northwest
- Success resulted in expansion of program for small business applications
- Provides future savings to BPA




Value Delivered = $Millions in Least Cost Energy

# Seismic

- Reduce the seismic acceleration by: 50% for 500 kV equipment; 30% for 230 kV and 115 kV equipment &10% for 69 kV equipment
- Created tools for equipment designers to validate models of seismic mechanics & perform representative analysis and design approach

Value Delivered = $000 Millions Faster System Restoration

## Conductor Shunt

- 20 mile Ross-Lexington upgrade
- Increased capacity with “splice shunts” instead of new wire
- Half outage time
- One BPA crew vs. multiple
- $4 million direct savings first application
- Multiple applications in progress and pending

Value Delivered = $Millions in First Cost Savings

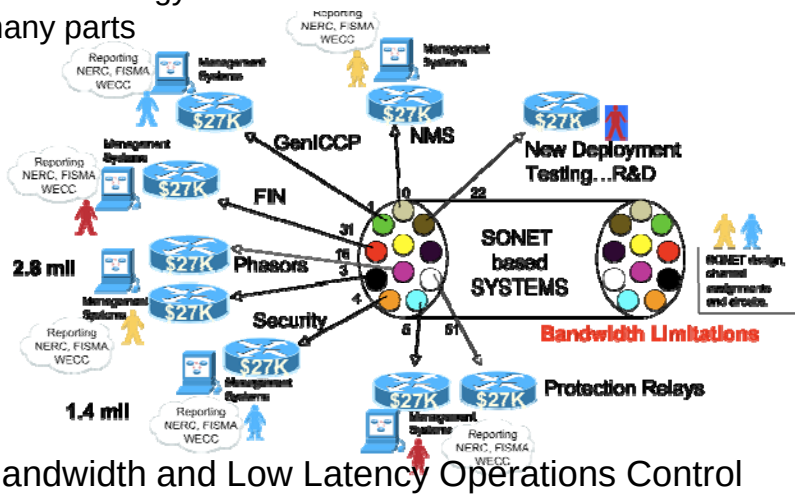
## Synchrophasors

- SCADA @ BPA = 2 seconds
- Synchrophasors = 60 / second (120 times faster)
- Now - sleuth grid issues (looking backward)
- Soon - control functions for reliability
- Mid-term - oscillation damping
- Long-term - additional Pacific Intertie throughput

Value Potential = $000 Millions in Additional Revenue

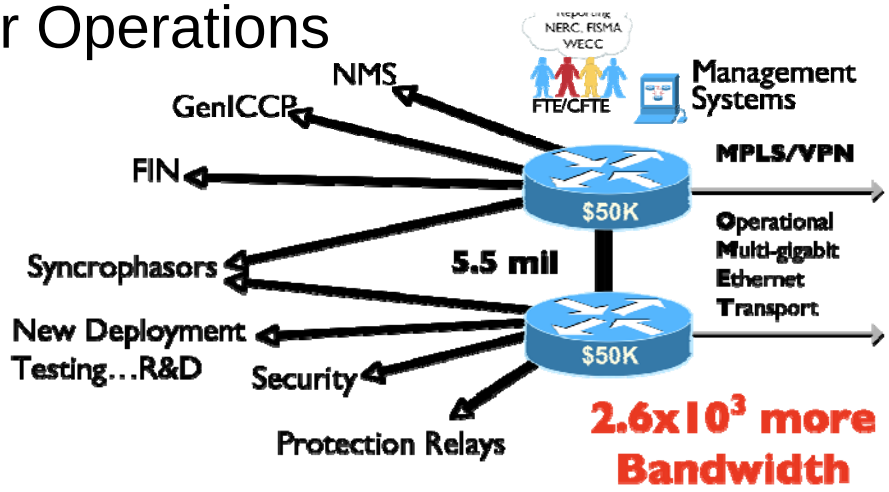
# Operations Telecommunications

- Used for SCADA, etc
- Needs to be used for smart grid, synchrophasors, etc
- Current technology is reliable but low bandwidth and has many parts




Huge Bandwidth and Low Latency Operations Control Needs

# Multi-Gigabit Ethernet Transport for Operations




Value Delivered = $Millions in First Cost
multiples of that for operations savings
Plus critical bandwidth

# Conclusions

- Threshold for essential R&D activity varies by industry - but is universally closer to 1% of revenues than 0.01% of revenues
- Money is not enough -

  What are we trying to accomplish must be known **- Clarity of Purpose**

  Good choices require metrics - why is B more important than A? **- Clarity of Choice**

  “Management” requires systems - brownian motion does not good research make **- Clarity of Systems**

Disciplined R&D = $000 Millions in Value