



# Technology Innovation

A disciplined approach to research portfolio management that leads to BPA applications that deliver value, reduce costs or increase revenues, and maintain low rates and reliable power for the region.

# Agenda

- **Successes**
- BPA R&D and Technology Innovation History
- Technology Innovation Structure
- Creating a Portfolio
- Project Management
- Technology Innovation Program Emulated by Industry Peers
- Summary

# Successful Project Results

- Splice Shunt
- Ductless Heat Pump
- Seismic Mitigation
- Operational Multi-Gigabit Ethernet Transport
- Synchrophasors

# Splice 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

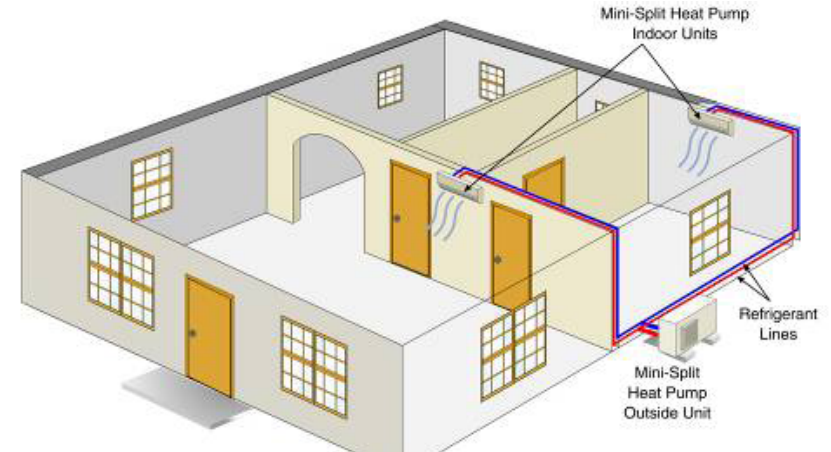


# Upgrade Ross-Lexington 230kV Line

- BPA situation: Line used at full capacity
  - ACSR Drake conductor
  - Rated at 100° C, 1070 Amps summer
  - Built in 1939 (68 years ago)
- Need: Reinforce critical North-South (I-5) grid transmission path
- Upgrade to 1300 Amps summer (N-1) continuous operation – **30 percent increase in capacity**
- Upgrade to 1500 Amps summer (N-2) emergency operation
- Avoided Cost – **20 mile re-conductor \$6M**
- Actual Cost – Shunting Compression Fittings \$2M

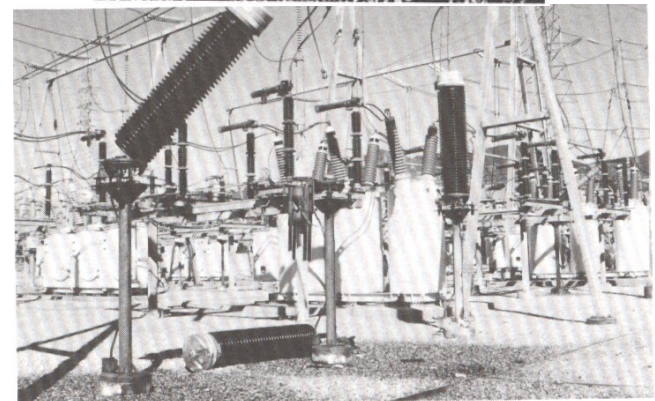
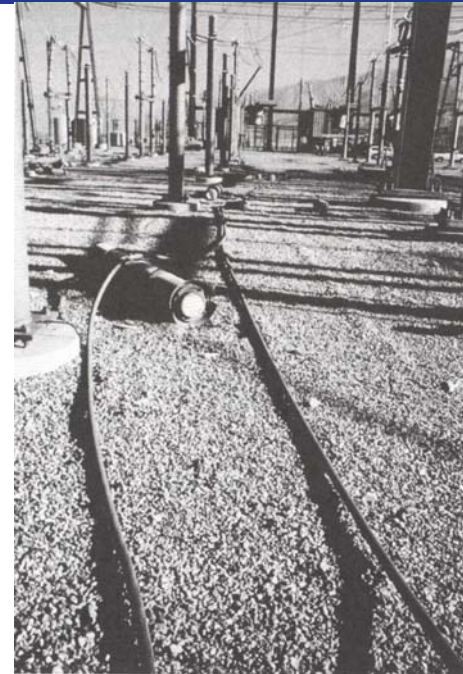
# Ductless Heat Pumps

- Heat Pump technology assessment capability
- Installation of 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



# Seismic Mitigation

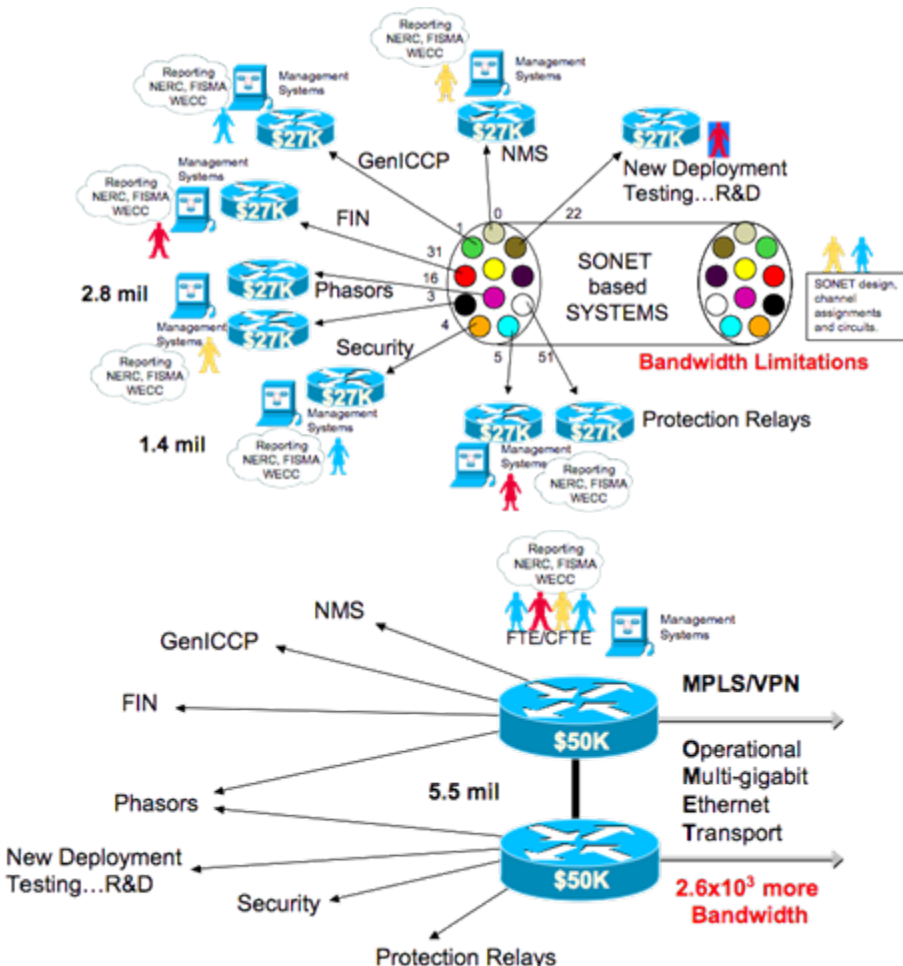
- Reduce the seismic acceleration by:
  - 50% for 500 kV equipment
  - 30% for 230 kV and 115 kV equipment
  - 10% for 69 kV equipment
- Create tools for equipment designers to
  - Validated models of seismic mechanics
  - Perform representative analysis and design approach
- Transformers perform better in earthquakes when anchored.
  - Over the last 10 years, BPA has anchored more than 200 transformers west of the Cascade Mountains where there is a greater earthquake hazard.
  - But work remains another 100 transformers, west of the mountains, need to be anchored.





# Operational Multi-Gigabit Ethernet Transport

- Enables bandwidth required for bulk smart grid & synchrophasors
- Included in Communications Asset Strategy & Capital planning
- Final long-distance test planned to conclude latency and cyber security aspects





# Synchrophasors

- Synchrophasor technology represents the first major step forward in wide-area grid control and visibility in decades.
- It has the potential to move from reactive to proactive operations and control.
- Previously unforeseen vulnerabilities and major outages may now be avoidable.
- Many tools in the project portfolio are based on synchrophasor technology.



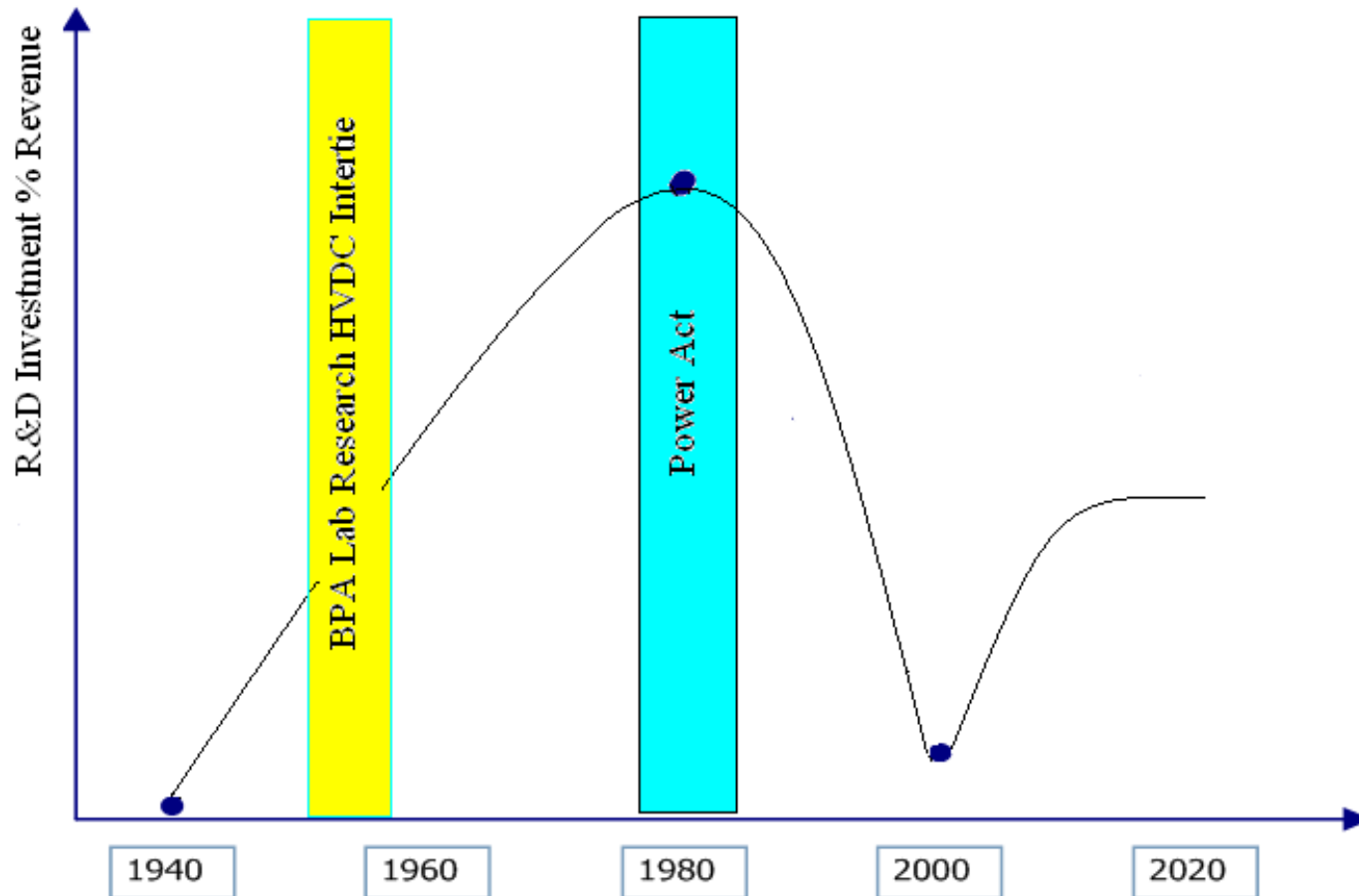
# Synchro-Phasor Project – Value for BPA

- **Reliable Wind integration**
  - Validate wind power plant models
  - Dynamic performance monitoring
  - Voltage stability controls
- **Operators understand what is happening in seconds**
  - Understand transmission utilization in real time
  - Validate power system models
  - Baseline power system performance and event analysis
- **Unlocking unused transmission capacity**
  - Real-time wide-area response-based controls
  - **Example:** How many cars could you get on I-5 if you could drive 60 mph with just one inch between you and the next car?
  - This is how the BPA transmission system may be operated
  - Avoids substantial upgrades of existing circuits to deliver more power

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# BPA R&D Investment History



# Technology Innovation History

- 2004 new technology opportunity to serve customers and contribute to the long term economic health of the Pacific Northwest.
- In 2005 BPA created a new organization, the Technology Innovation (TI) Office, to focus and manage technology initiatives.
- “We are seeking a shared innovation agenda” said Terry Oliver, BPA’s Chief Technology Innovation Officer.
- Today the TI office applies a disciplined approach to the way BPA researches, develops, demonstrates and deploys new technology.

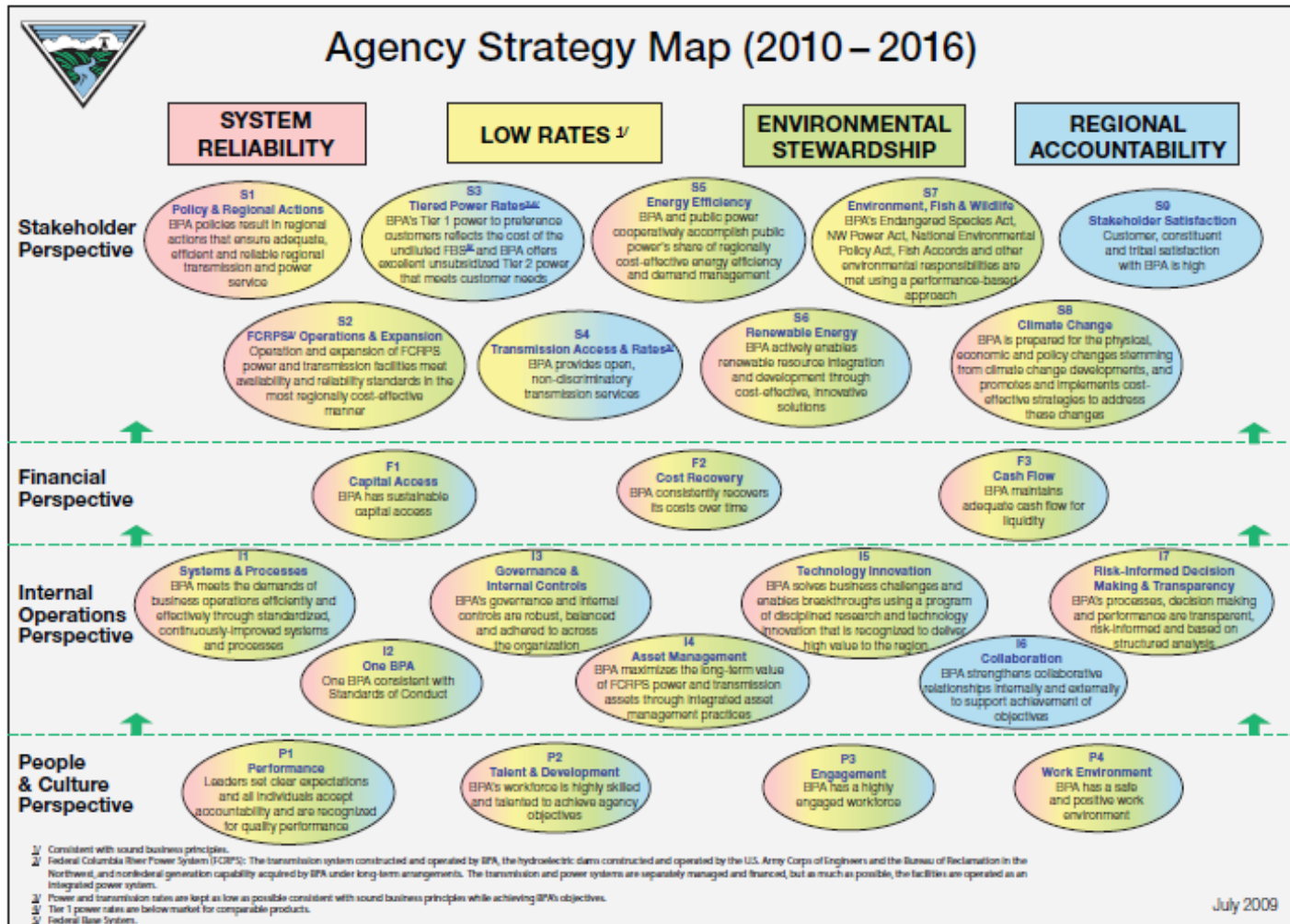
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# Strategically Driven

B O N N E V I L L E P O W E R A D M I N I S T R A T I O N



# Agency Strategy I5

## Technology Innovation

### **Agency Strategy Map Technology Innovation-I5**

BPA solves business challenges  
and enables breakthroughs  
using a program of disciplined  
research and technology  
innovation that is recognized to  
deliver high value to the region

# Direct Linkages

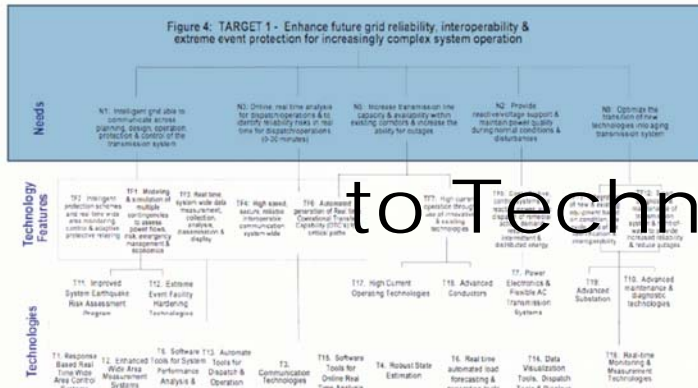
BPA Strategy



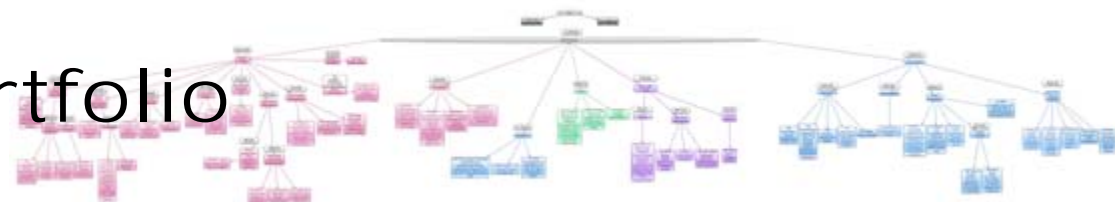
to Business Challenges



to Research Portfolio



to Technologies



# Technology Innovation Council

**Dave Armstrong**, Deputy Adm

**Larry Bekkedahl**, VP Tx Eng

**Kathy Black**, General Counsel

**Allen Burns**, VP, Bulk Marketing

**Larry Buttress**, VP IT, CIO

**Jack Callahan**, Energy Efficiency

**Scott Coe**, VP Req Markets

**Anita Decker**, Chief Op Officer

**John Haner**, Tx Plan

**Jeff Hildreth**, Labs

**Mark Jones**, Hydro Generation

**Elliot Mainzer**, EVP Strategy

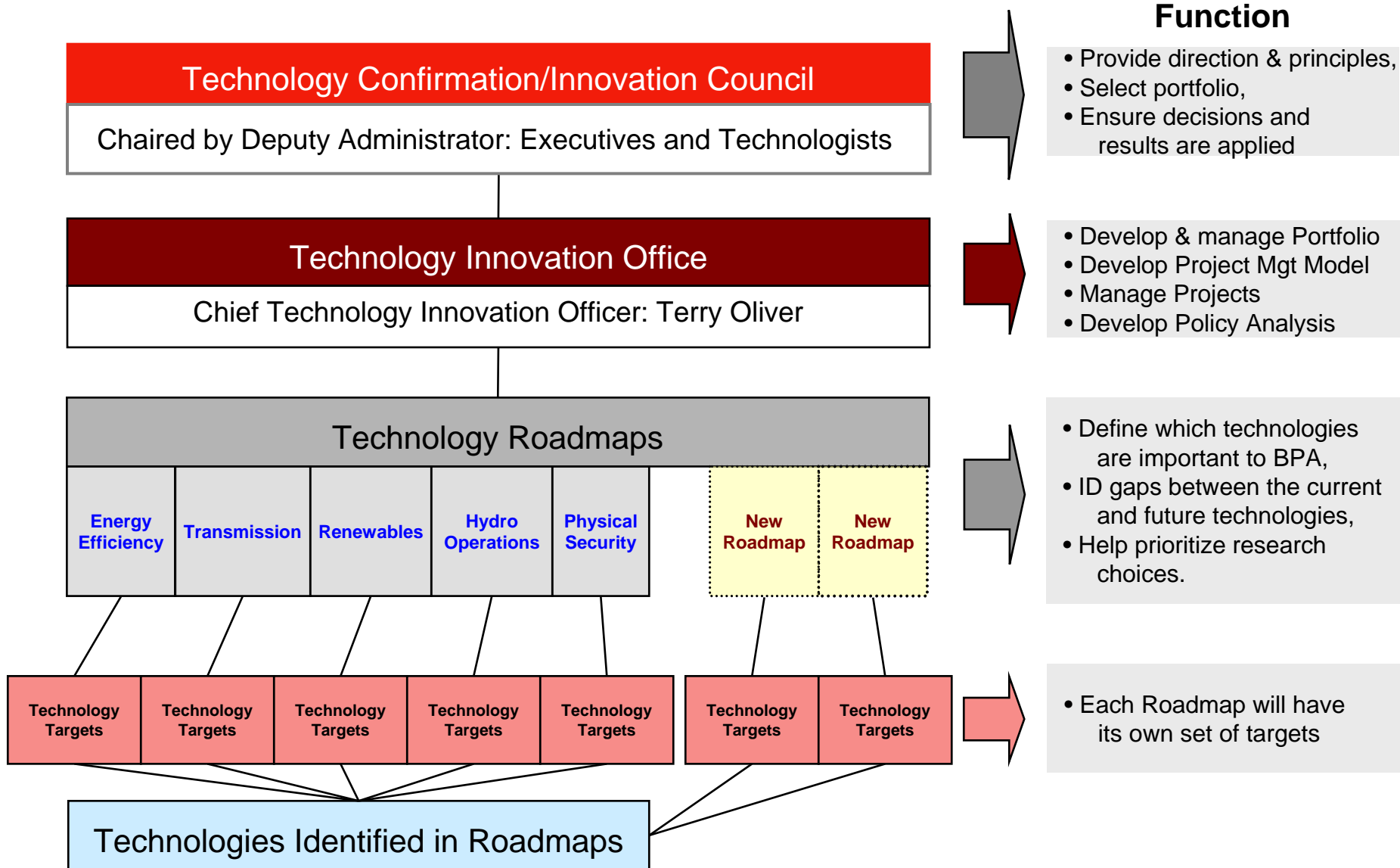
**Terry Oliver**, Chief TI Officer

**Peter Raschio**, Tx Tech Ops

**Don Watkins**, Tx WECC NERC

*Executives & Technologists*

# Technology Innovation Council

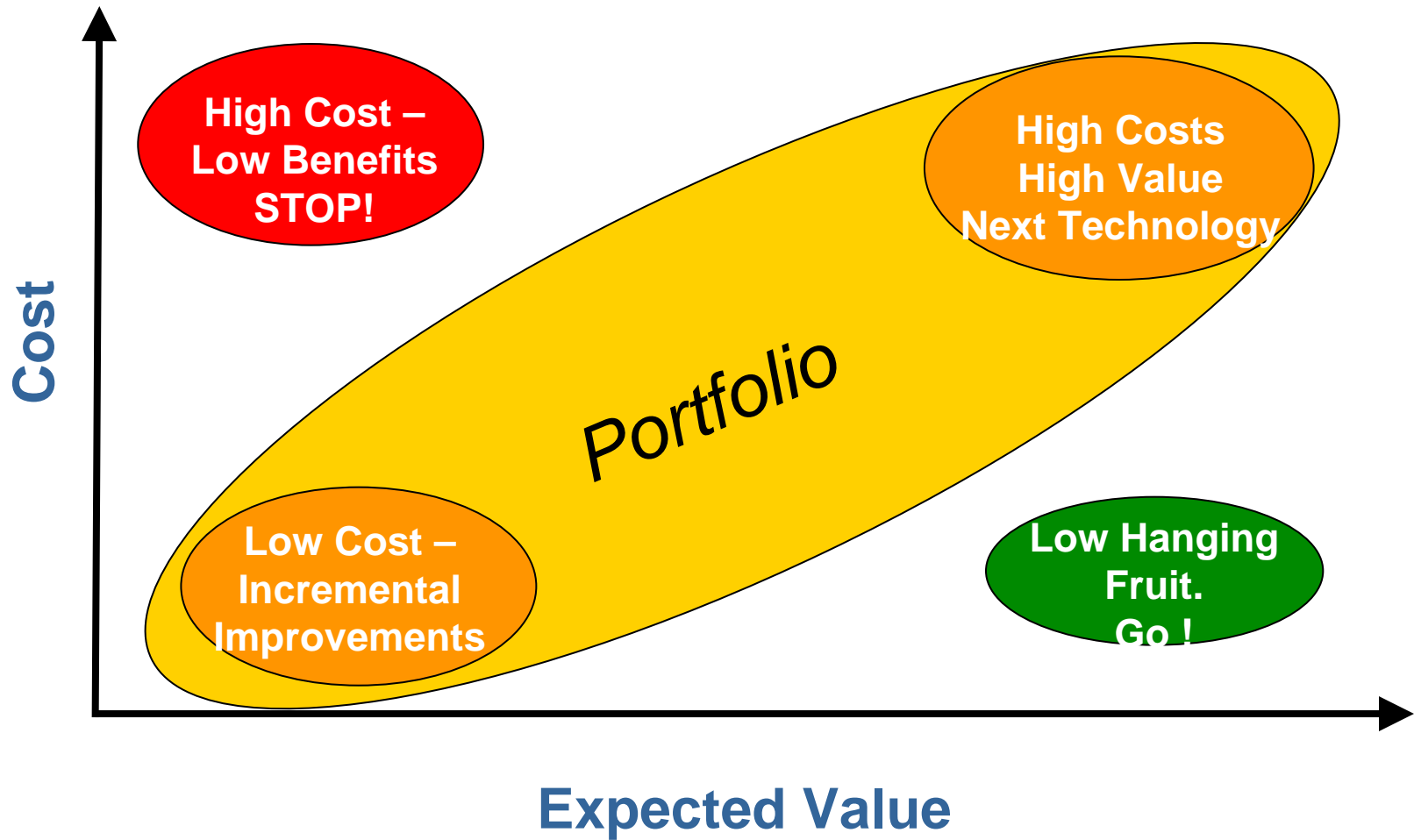


# Agenda

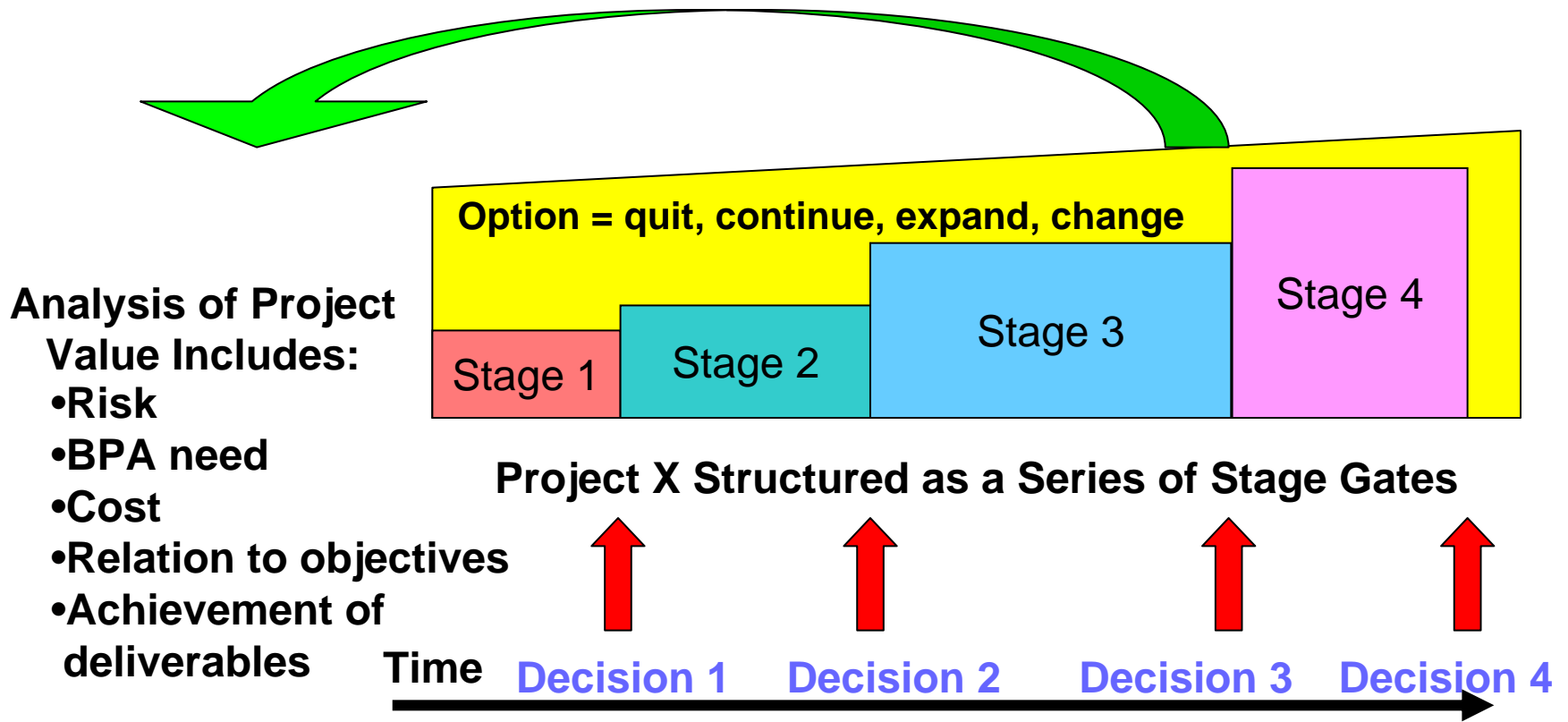
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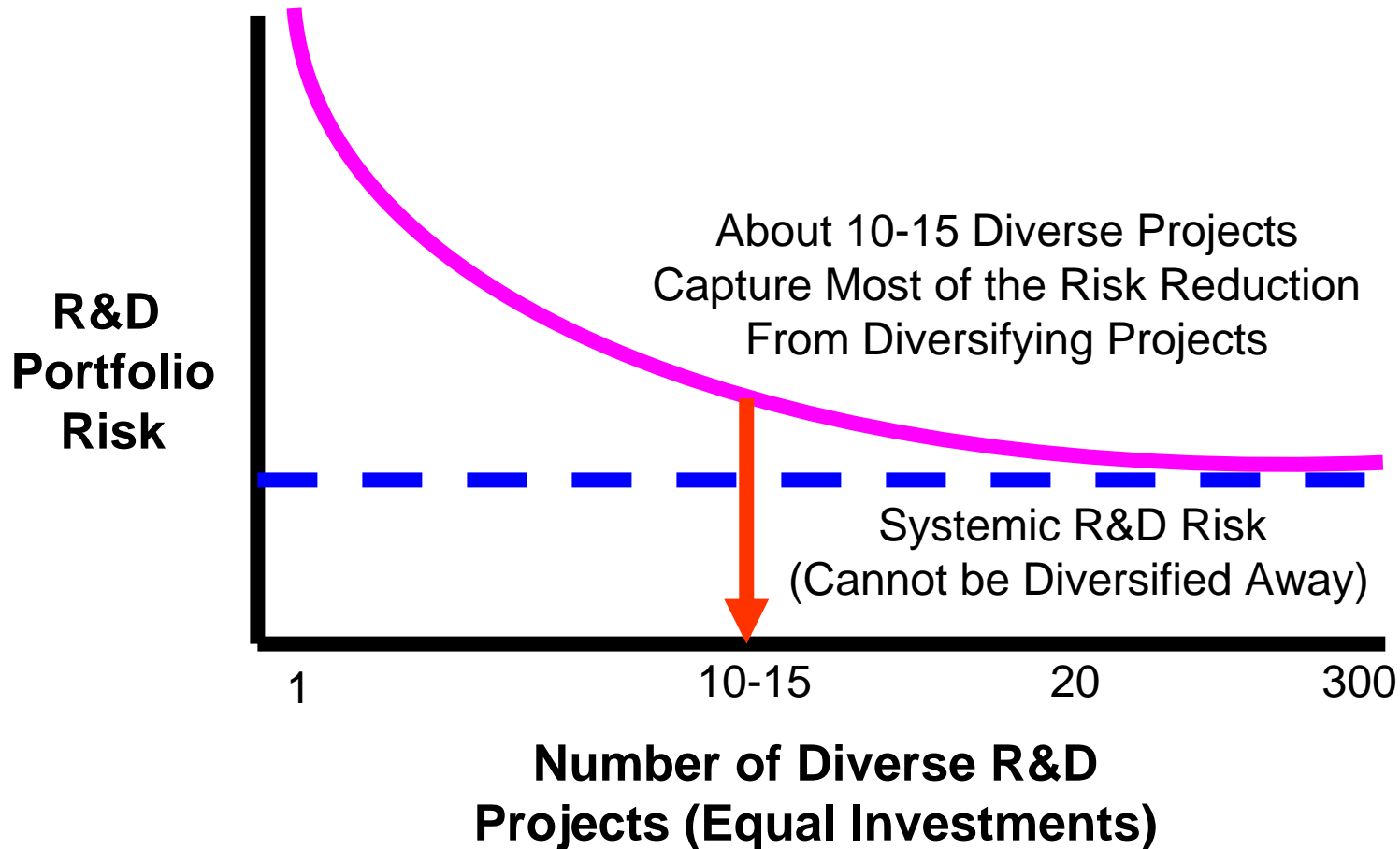
# Portfolio Conceptual Approach



# Stage Gate Reporting

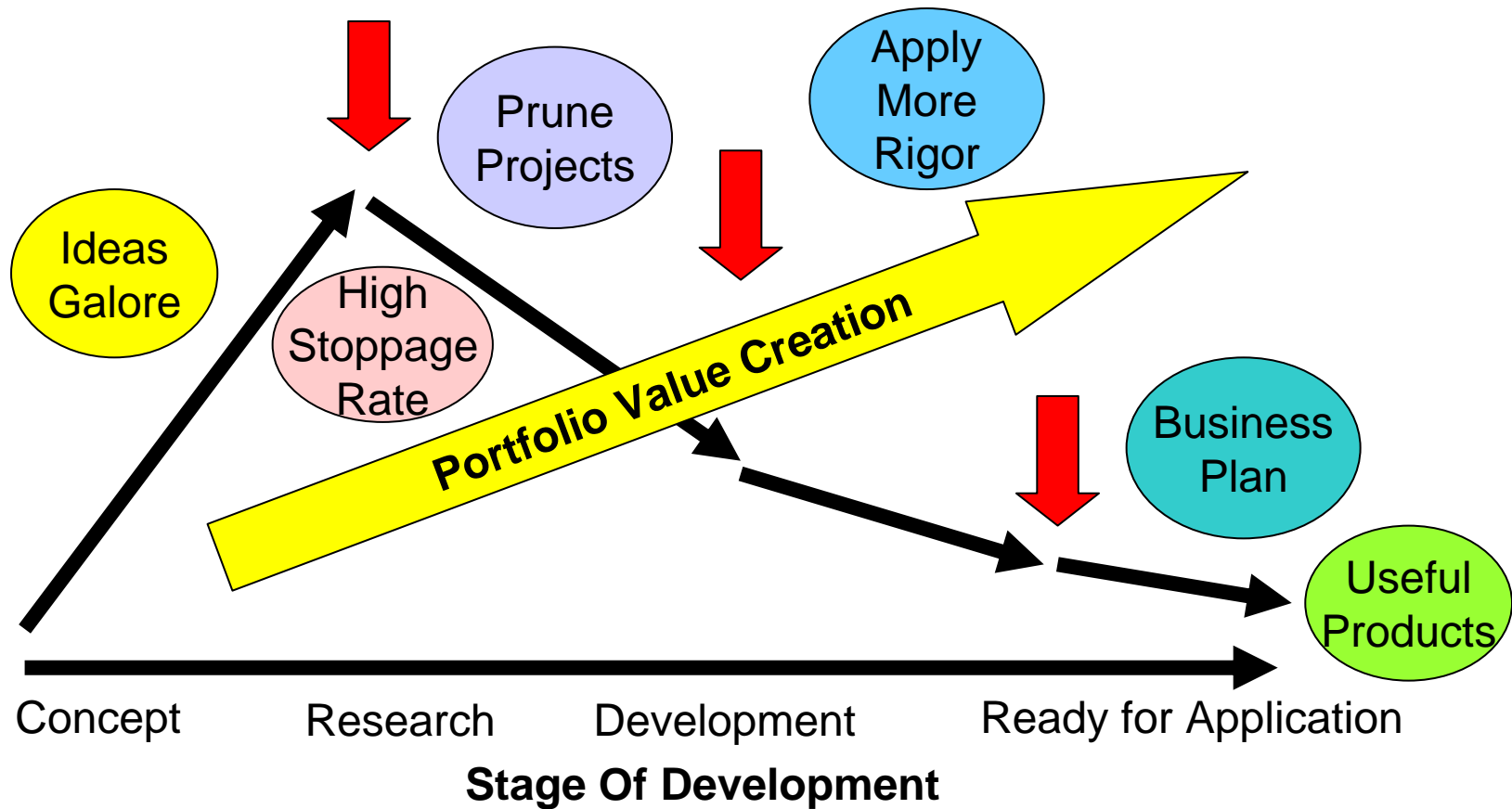


# Objective Measures of a Good Portfolio: Diverse Projects Reduce Portfolio Risk



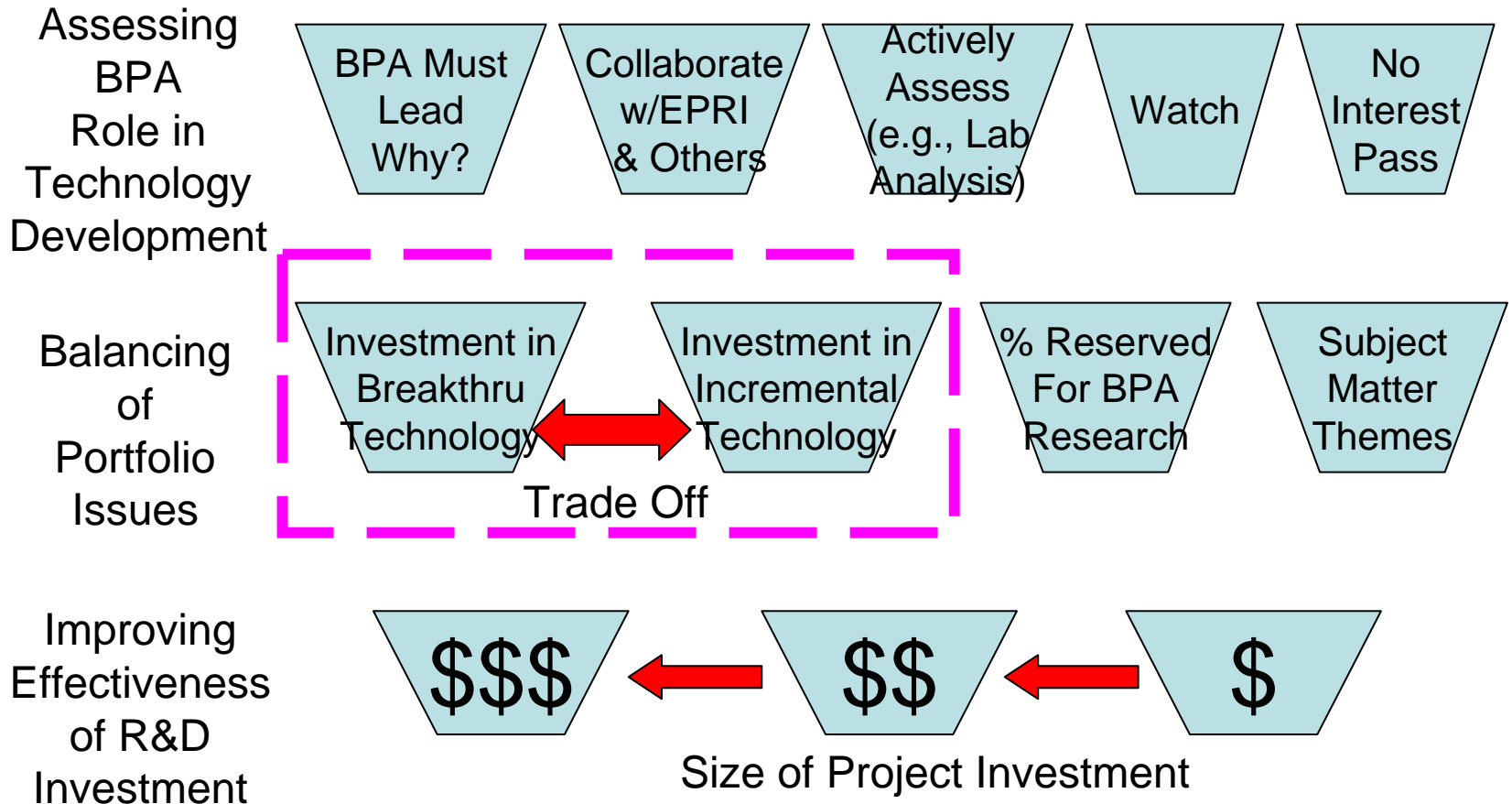
# Sow Lots of R&D Seeds

(Invest Modest Funds in Lots of Ideas)



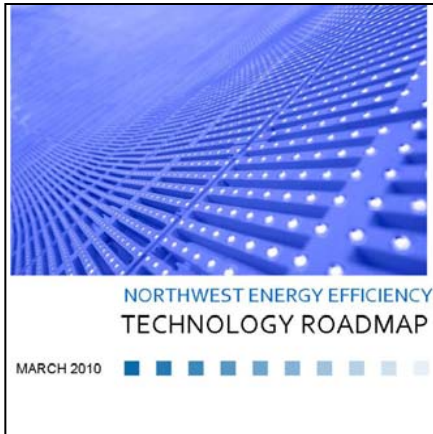
# Portfolio Considerations

## R&D “Buckets”




# Technology Roadmaps Guide the Initiative

Explicit Linkages to Business Challenges




**TRANSMISSION TECHNOLOGY ROAD MAP**  
September 2006




1885 Generator  
At first glance one may think, "My how things have changed,"  
But at second glance one may admit, "Things haven't changed much at all."

**Physical Security Technology Road Map**  
February 2007



*The Enigma was a portable cipher machine used to encrypt and decrypt secret messages*

**POWER SERVICES TECHNOLOGY ROAD MAP**  
March 2008



**Hungry Horse Dam**  
Research is to see what everybody else has seen, and to think what nobody else has thought.  
- Albert Szent-Gyorgyi

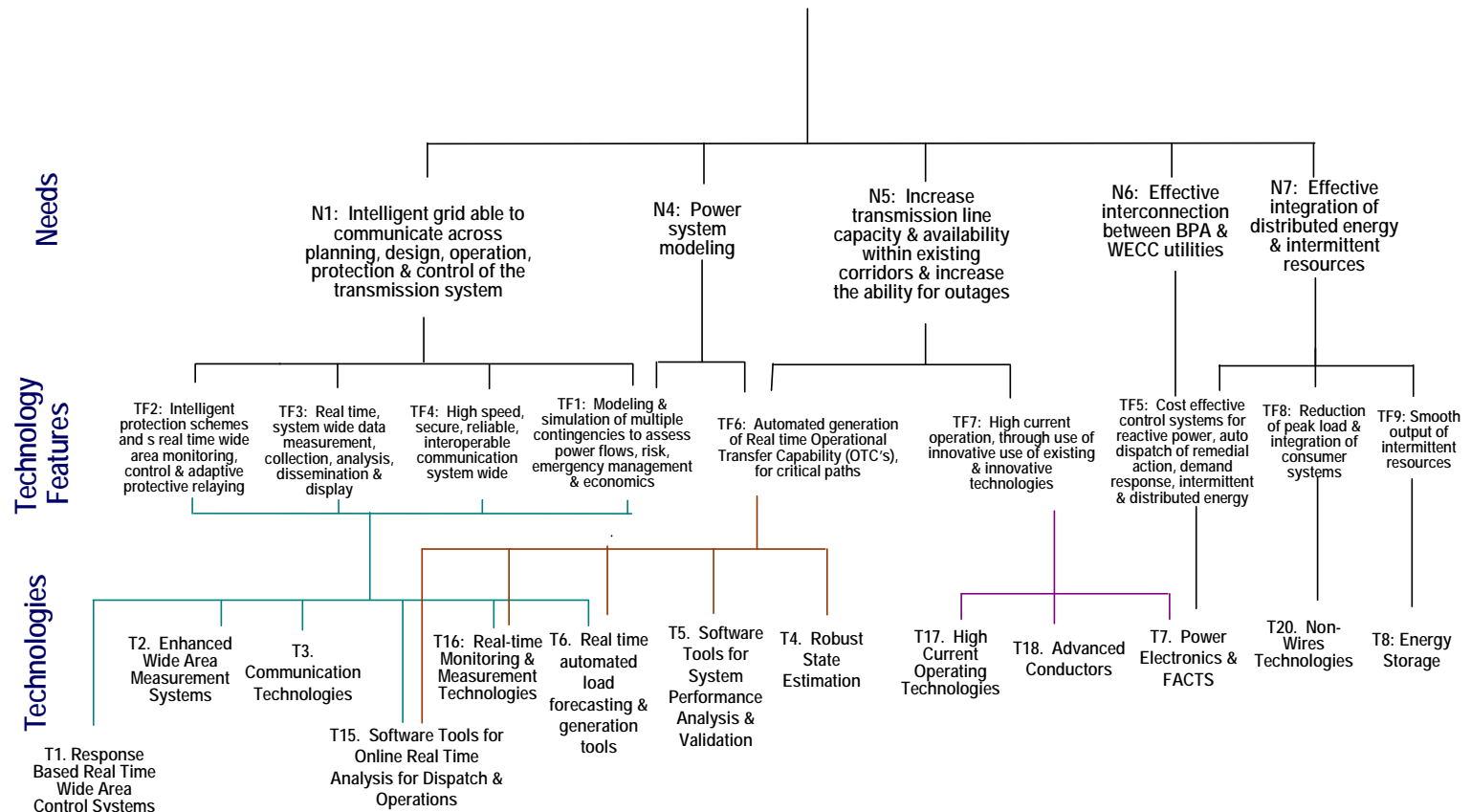
**Renewable Energy Technology Road Map**  
(Wind, Ocean Wave, In-Stream Tidal & Solar Photovoltaic)  
September 2006





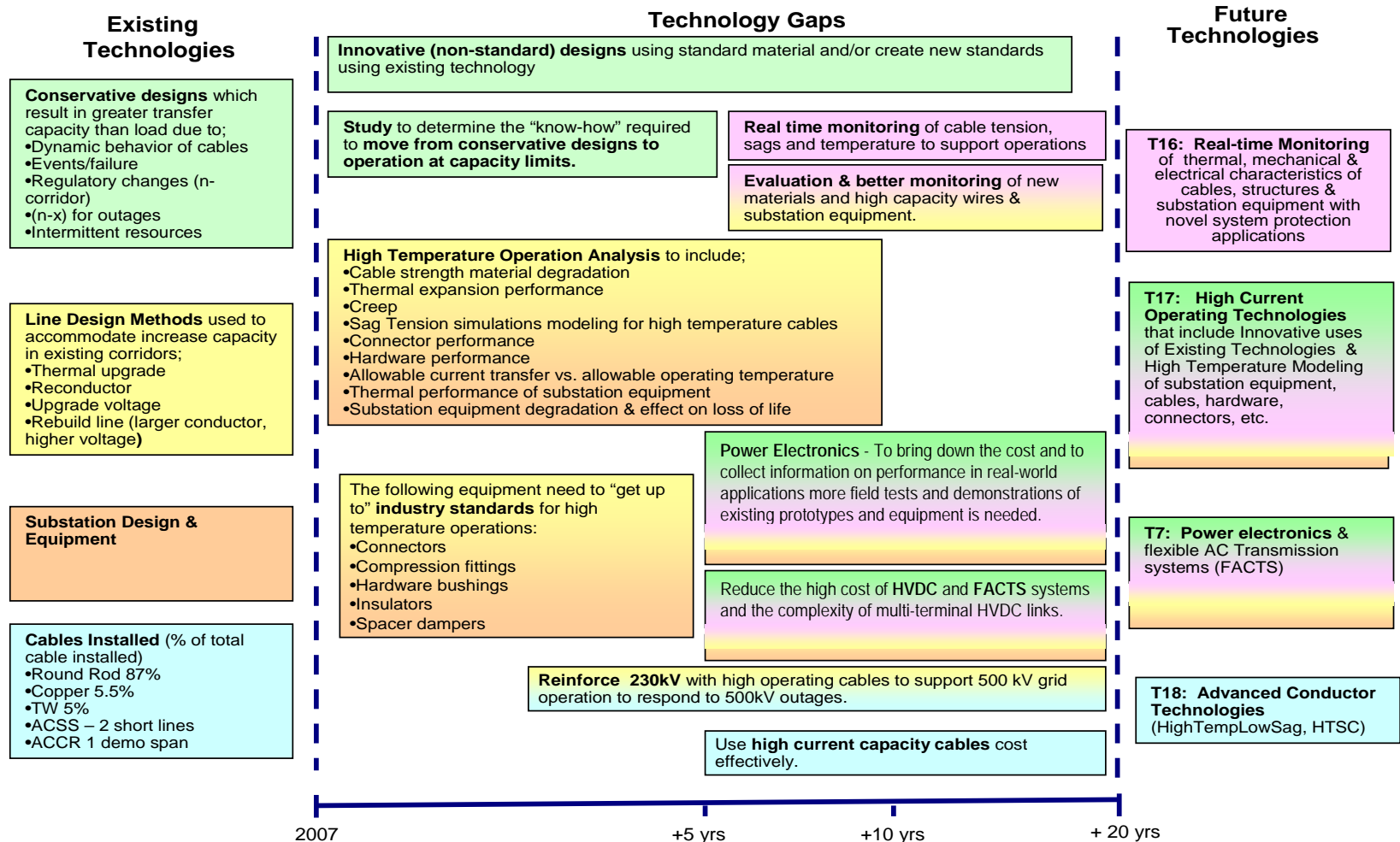
# Transmission Roadmap Target

Figure 5: TARGET 2 - Increase transmission transfer capabilities & control of power flows

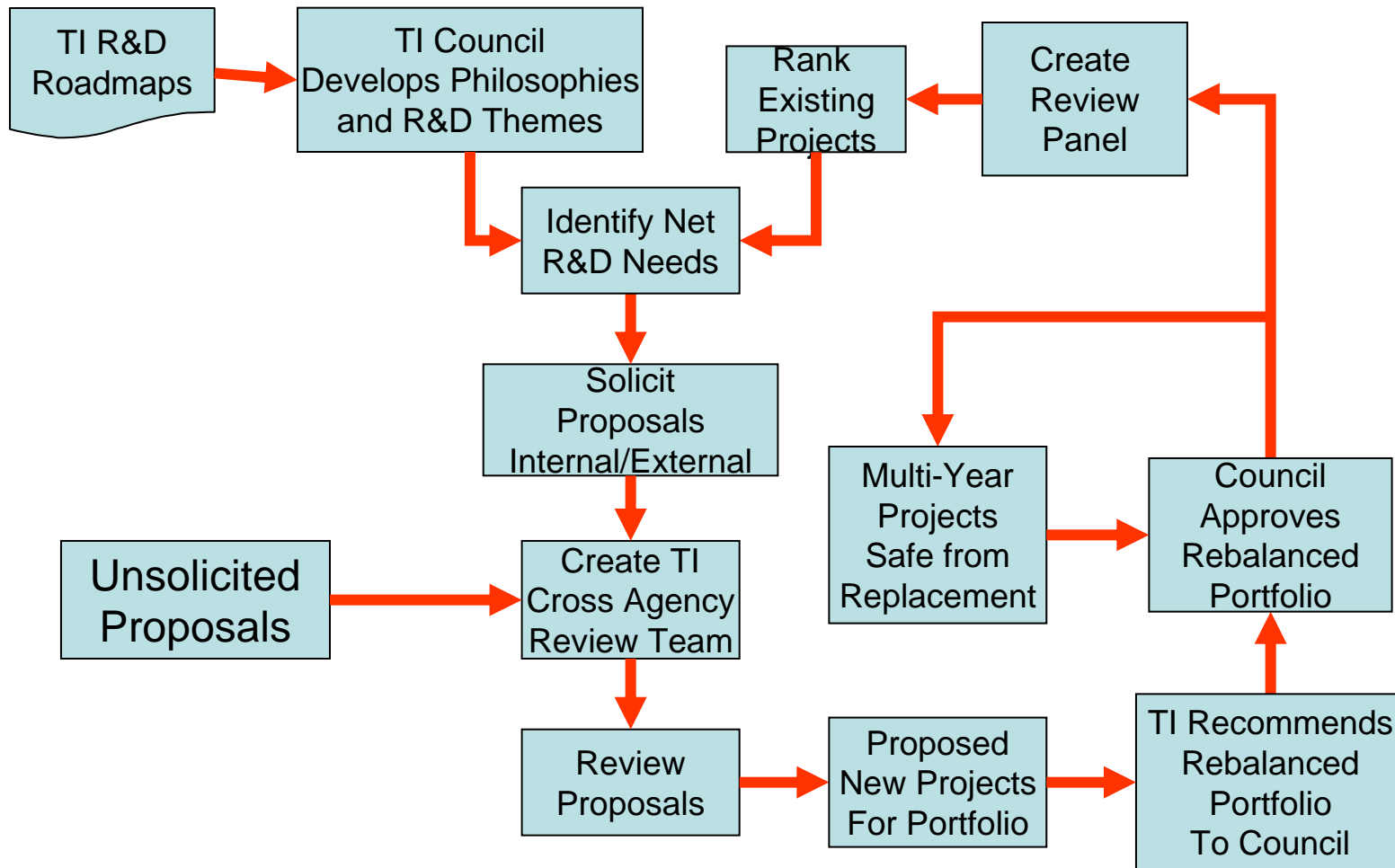


# Transmission & Control of Power Flow

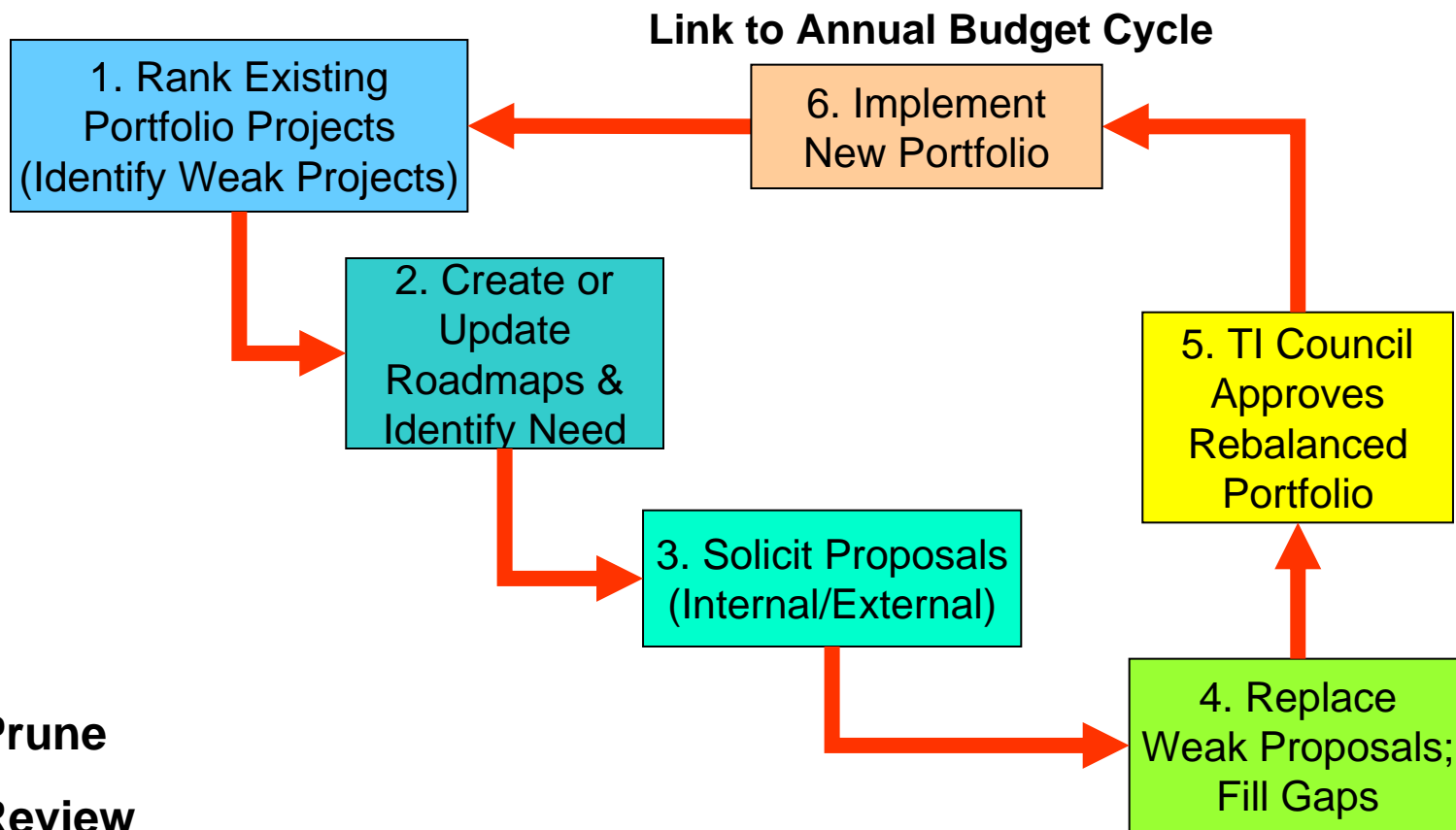
Figure 11: Increased Transmission & Control of Power Flows Gap Analysis



# Portfolio Decision Framework



# Annual Portfolio Rebalancing Cycle

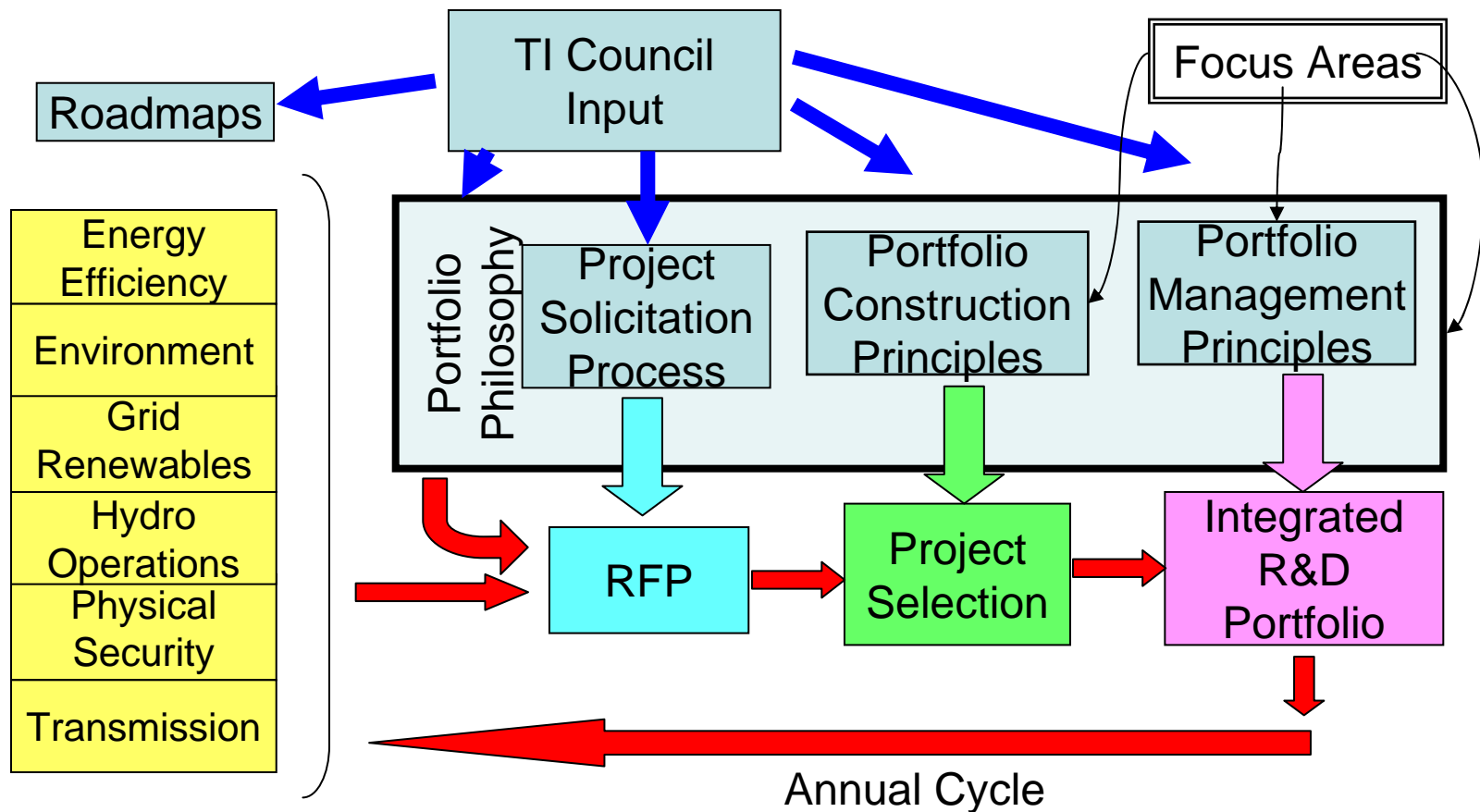


- Prune
- Review
- Fill Gaps

# Project Solicitation

- Request for Qualifications
  - Evaluate Proposals and Proposers
- Request for Offers
  - Sent only to those Proposers that qualified
  - Plus any past project manager in the agency
  - And announced to everyone in the agency
- Evaluate Proposals
  - This gets them considered in the Portfolio.
- Select Portfolio based on direction from the Council.

# BPA Process for Constructing and Managing an Integrated R&D Portfolio



# Portfolio Considerations Philosophy

- Select through Portfolio Decision Framework.
- Balance risk & reward across broad technology spectrum.
- Improve portfolio value over time.
- Accomplish most Portfolio objectives through collaboration.
- Minimize “living dead” risk—projects that consume ever-increasing amounts of time and money, forever look promising, but go nowhere slowly.
- Avoid large investments until failure risk relatively low (stage gates).
- Focus on projects within BPA’s mission and expertise (technology roadmaps).
- Provide opportunities for developing employees.
- Reward innovative thinking, testing of new ideas (even if these ideas don’t reach fruition), excellence in managing R&D projects, and achieving results.

# Portfolio Considerations

## Construction Principles 1

- 20% of budget in projects <\$500k; 80% in >\$500k
- Closely link funding and approvals to a project's merits and its effect on the overall portfolio.
- Preference to projects using stage gates, to create portfolio flexibility, reduce risk, and manage costs.
- Each of the following areas will have an opportunity to sponsor projects.
  - Energy Efficiency
  - Environment
  - Grid Renewables
  - Hydro Operations
  - Physical Security
  - Transmission

No construction principle is so hard and fast that it cannot be violated for good reason.



# Portfolio Considerations

## Construction Principles 2

- Net present value (NPV) analysis, a useful tool for evaluating & comparing late stage R&D projects, will not limit investment decisions, particularly for early stage R&D projects.
- The amount of time and effort already spent on a project will not be a factor in deciding whether to continue funding (Sunk Costs don't count).
- No “Lone Ranger Projects.” No R&D project may be funded without going through the Portfolio Decision Framework.
- New ideas may compete with existing projects. Normally, all projects will be at risk for replacement by a better project.

# Portfolio Considerations

## Management Principles 1

- New ideas may compete with existing projects. Normally, all projects will be at risk for replacement by a better project.
- A project that requires long-term funding (defined as two or more years) may be given a funding preference in subsequent budget cycles for the term of the project as long as the project meets milestones set forth in advance, continues to be connected to BPA's mission, and otherwise continues to show promise.
- To keep the portfolio fresh, we will prune it annually.

# Portfolio Considerations

## Management Principles 2

- It may be appropriate for BPA to fund but not manage a project in favor of outsourcing. Factors affecting BPA's decision whether to fund or manage a project are:
  - Availability of project management expertise and FTE to manage the project effectively;
  - Availability of internal FTE necessary to perform tasks to complete the project;
  - whether or not the project is a “BPA Should Lead” project; and
  - the availability of an internal champion among senior executives to sponsor the project.

# Provisions for Success & Failure

- Technology Innovation embodies high potential for failure
  - 80% failure
  - 20% success
- Success = working application on BPA system = system improvement = home runs
- Problem: don't know in advance what that 20% are.
- Best Practices Solutions:
  - Portfolio Approach
  - Pruning via stage gates and portfolio selection
  - Value estimated at start & calculated at application

# Institutional Partners

EPRI Overhead Transmission Substations	Power System Engineering Consortium (PSERC)	University Electricity Industry Center (Carnegie Mellon)
Center for Energy Advancement through Technology Innovation (CEATI)	International Council on Large Electric Systems (CIGRE)	Portland International Center for Management of Engineering and Technology (PICMET)
PNW Universities (OSU, OIT, WSU, UW, Boise State)	Shared research agenda using technology roadmapping	USDOE & National Laboratory System (Pacific Northwest / Sandia / Oak Ridge / et al)

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# Project Management

**RESEARCH PROJECTS WILL FAIL**



# Project Management Maturity Model

***Purpose:*** To provide value to BPA by establishing standards and repeatable processes that guide PMs about project management and performance for a project's complete lifecycle.



# Gap Analysis

- PM Skills
- Project Process Lifecycle
  - Initiating
  - Planning
  - Executing
  - Close-out

# Project Management Methodology

## Construction Principles

1. Provide clarity about requirements, roles, responsibilities and processes.
2. Achieve results without being overly structured and detailed.
3. Focus on managing to objectives.
4. Cultivate effective communication, cooperation and trust to achieve project management success.
5. Strengthen the support and involvement of the supervisors of the project team members.
6. Institute project manager training program with periodic updates based on lessons learned.

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# Technology Innovation Program Emulated by Industry Peers

- Southern California Edison



- First Energy



- Ameren



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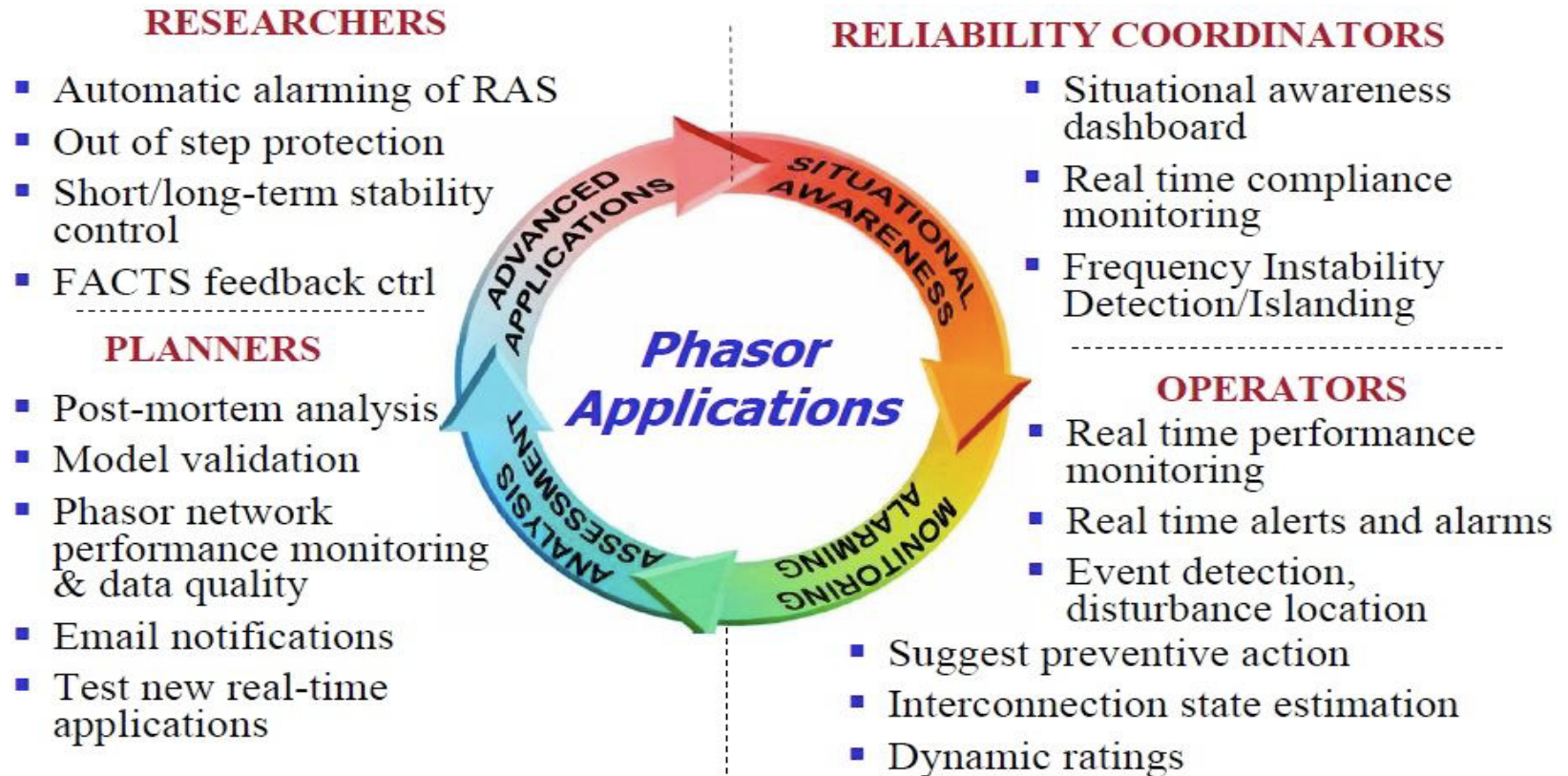
# Summary

- Results- Technology innovation brings value to and saves BPA and rate payers money
- Disciplined approach
  - Research Agenda
  - Pick Portfolio
  - Pruning
  - Project Management

# Questions

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# Synchrophasor Applications Taxonomy

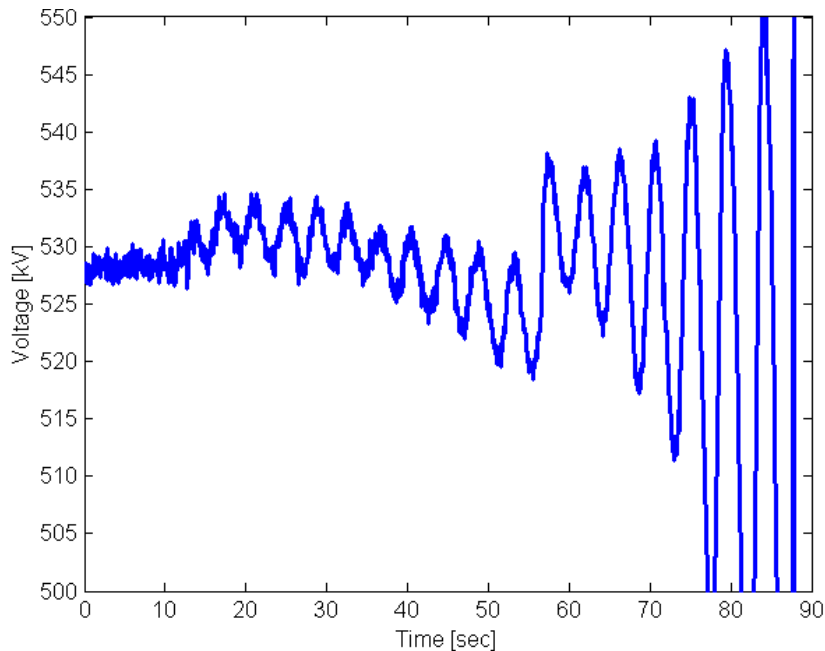




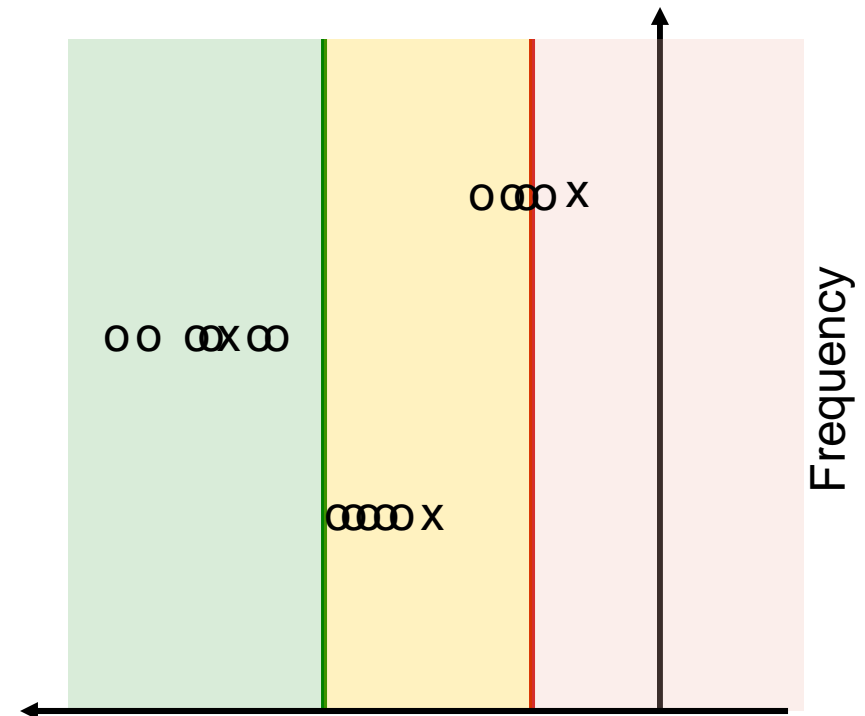
# Oscillation Detection / Mode Meter

- This is how operators will be able to detect power disturbances with synchro-phasors, **increasing reliability** (more cars on the highway)

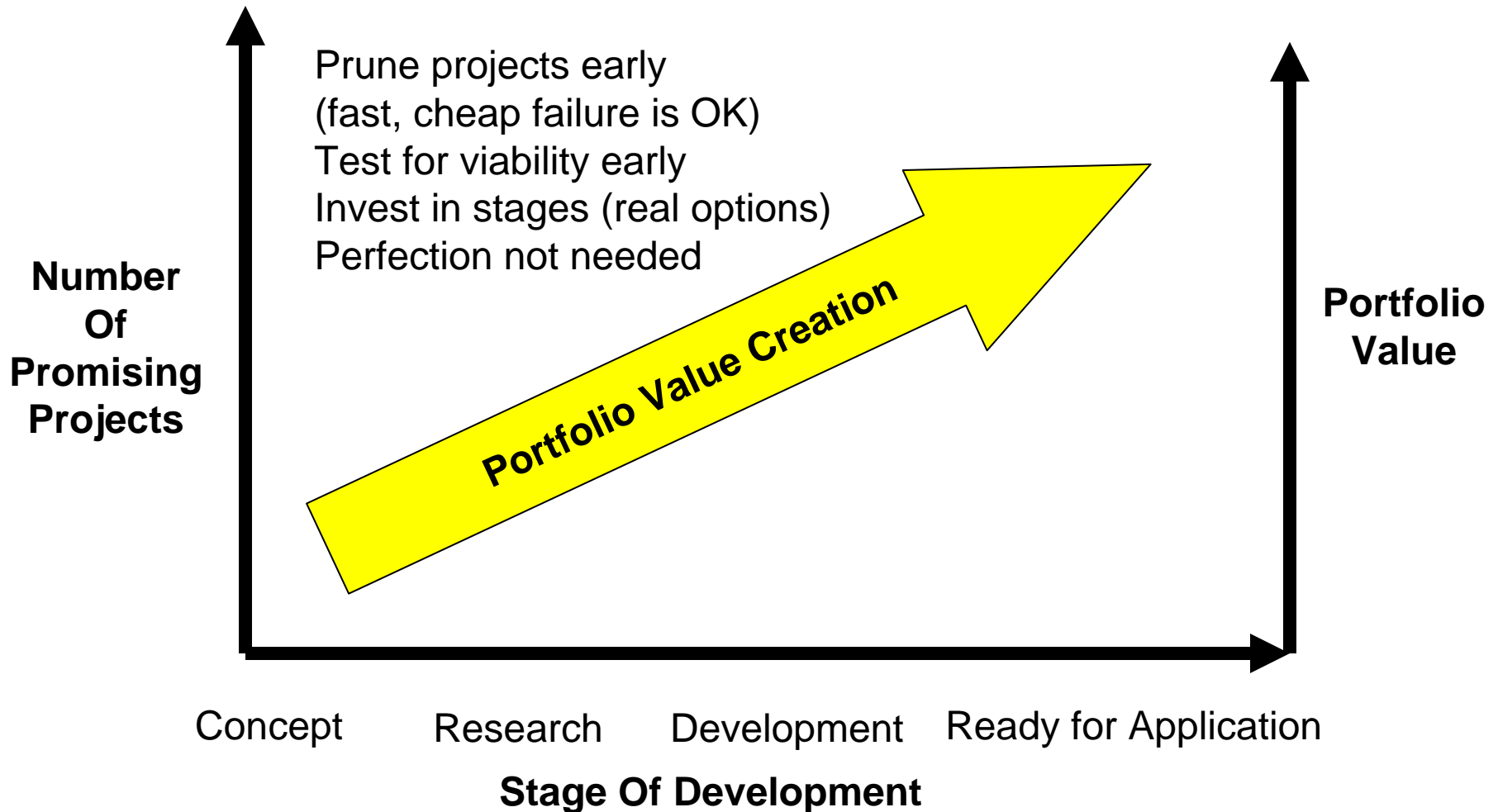
Trending Display



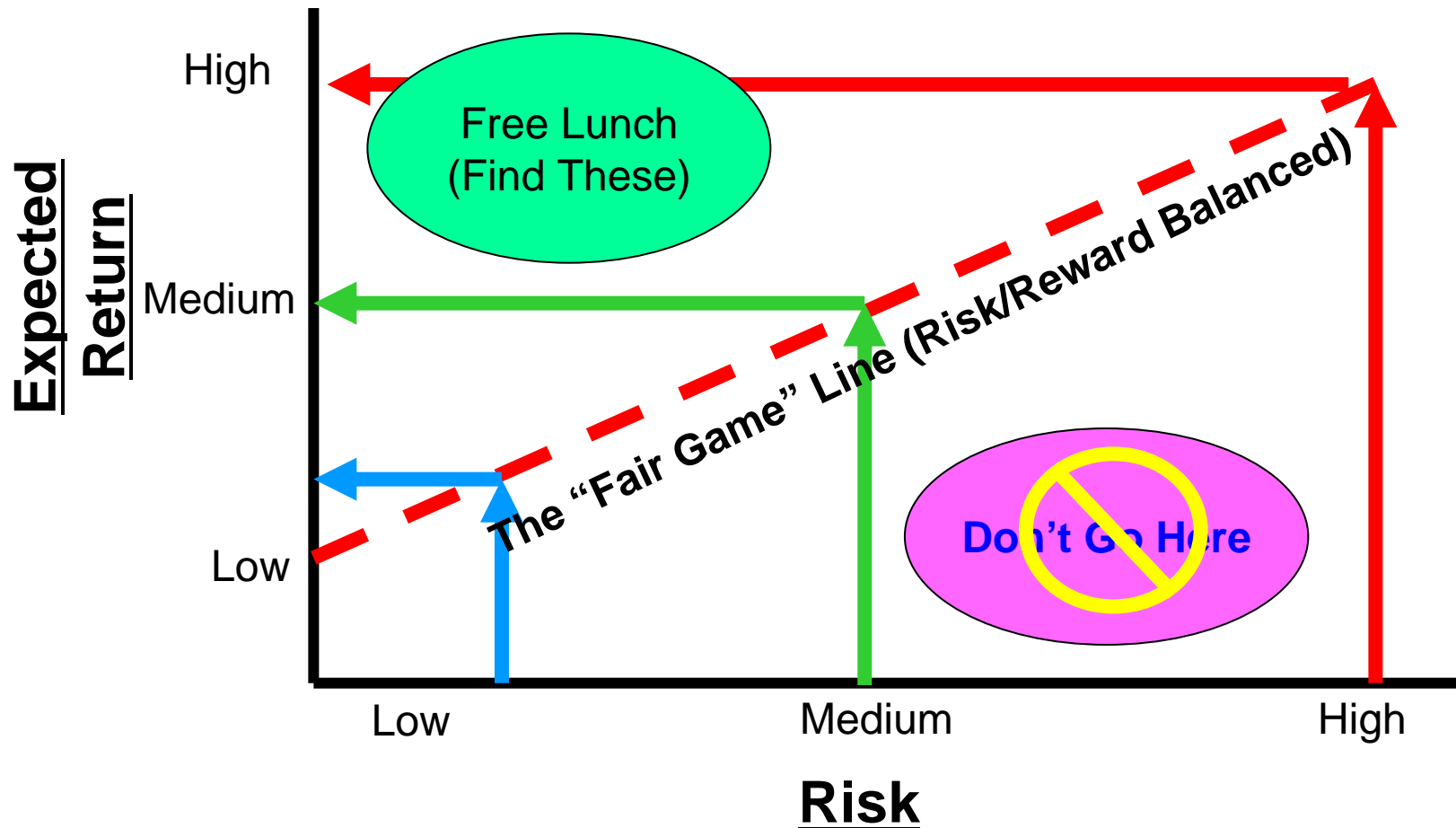
Mode Meter



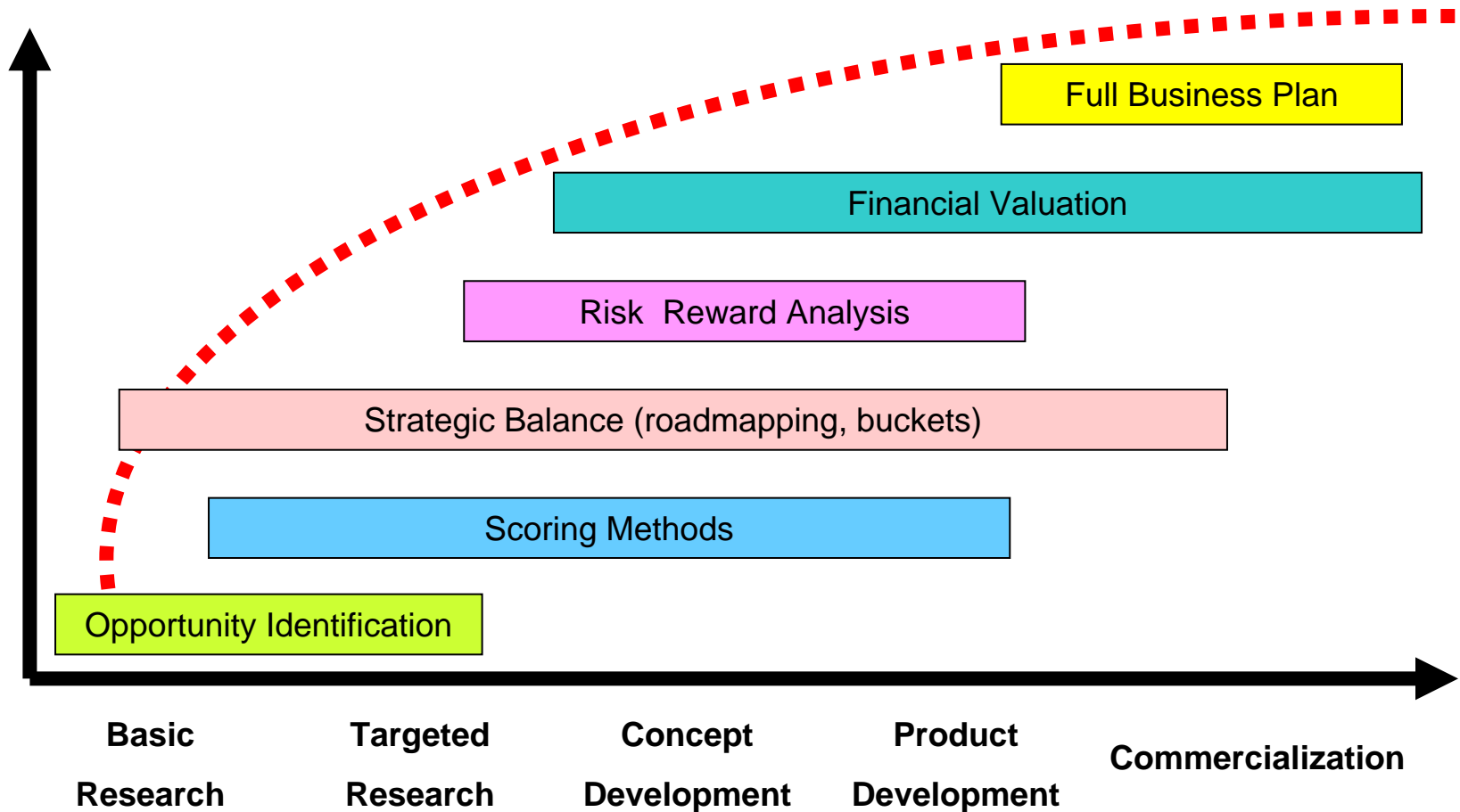
# Measuring Portfolio Value



# Objective Measures of a Good Portfolio: Expected Return Matches Risk



# Product Development Cycle



# Project Management Requirement Maturity Model

PROJECT PHASE	REQUIREMENT	CRITERIA	TOOL	HOW WILL THE REQUIREMENT BE USED	WHO WILL USE THE REQUIREMENT	Tool	MATURITY MODEL			
							Year of Implementation	External or Internal Process	Project	
							FY08	FY09	FY10	FY11
Project Initiation	Qualification Request - External	All Projects	RFSOQ	Project Portfolio Selection	Supply Chain Services, TI Office	◆	(			
	Proposal Request - Internal	All Projects	TI Project Proposal Template	Project Portfolio Selection	Supply Chain Services, TI Office, Proposal Evaluation Team	◆	(			
	R&D PM Culture Meeting	All PMs	Meeting	To communicate roles, PM methodology, project planning, project tracking and get Work Order for project	PM, PM Team, PM Sponsor			(		
Project Planning	Request for Offers - External	All Projects	RFO	Project Portfolio Selection	Supply Chain Services, TI Office, Evaluation Team	◆	(			
	Lessons Learned Revisited	Projects > \$5		Apply findings of recent post-project lessons learned to current project	PM, Project Sponsor					(
	Statement of Work	Projects > \$5	SOW Template	Management of Project	PM, Project Team, Stage Gate Review Team			(		
	Cost Estimate Adjustment	Projects > \$5	Cost Adjustment Template	TI Approval for Project Cost Adjustment	TI Office					(
	Process Flow Chart	Projects > \$5	Visio, MicroSoft Power Point	Project Portfolio Selection, Management of Project	Proposal Evaluation Team, PM, Project Team, Stage Gate Review Team	◆	(E		(	
	Pert or Gantt Chart	Projects > \$5	Visio, MicroSoft Project	Project Portfolio Selection, Management of Project	Proposal Evaluation Team, PM, Project Team, Stage Gate Review Team	◆	(E		(	
	Risk Analysis	Sponsor Requested	Enterprise Risk Management Process, ADF	Management of Project	PM, Project Team, Project Sponsor	◆				(
	Non-Disclosure Agreement	Sensitive Data	NDA Agreement Template	Protect the Sharing of BPA Data	Office of General Counsel, Supply Chain Services, Contractor, Project Manager			(		
	Non-Disclosure Data Appendix	If NDA Agreement	Data List Template	Tracking of What BPA Data is Shared	Office of General Counsel, Supply Chain Services, Contractor, Project Manager				(	
	IP Considerations	PM Team Identified, Sponsor Requested	IP Decision Flowchart	Guide for Project Manager	Supply Chain Services, TI Office Technology Transfer Manager, BPA Staff, Intellectual Property Rights Policy Development Team					(
	Contract Negotiations	All Contracts	Clarifying Questions Checklist, Cost Review Checklist	To Prepare Final SOWT with IP Contract Language	Supply Chain Services, Contractor, Evaluation Team					(
Project Execution	Stage Gate Review	All Projects	Stage Gate Process Checklist	To Evaluate Stage Gate Go/No Go/Rescope	PM, Project Team, TI Office					(
	Status Report	All Projects	Status Report Template, Periodic Meetings	To Evaluate Project Progress	PM, Executive Sponsor, TI Office, PMO					(
	Mid Year Presentation	All Projects	TI Power Point Template	Mid Year Portfolio Review Presentation	PM, TI Council, TI Office	◆	(			
	Re-scope	As Required	BPI Appendix 14-A,	To Modify SOW	PM, Project Team, Supply Chain, Contractor, TI Office	◆		(		
	COTR/Field Inspector Function	COTR, PM Requested	BPI Appendix 14-A	To perform COTR function within Supply Chain Guidelines	PM, Project Team, Supply Chain, Contractor, TI Office	◆		(		
	Risk Management	Sponsor Requested	Risk Management Template	To Assess and Manage Risk	PM, Project Team, Executive Sponsor, TI Office					(
	IP Management	Sponsor Requested	IP BPI Contract Language	To Manage IP Development	PM, Intellectual Property Rights Policy Development Team					(
Project Closure	Project Termination	All Projects	BPI Appendix 14-A, TI Council Stage Gate Review Evaluation Template	To Stop/Close-Out Project	PM, TI Council, Supply Chain, TI Office, Stage Gate Review Team	◆	(			
	Acceptance of Project Deliverables	All Projects	BPI Appendix 14-A, Close Out Checklist, Peer Review Process Checklist	Technology Transfer, Quality Assurance, KM	PM, Project Team			(		
	Non-Disclosure Data Returned	If NDA Agreement	Close-out Checklist	To Close-Out Contractor Data Usage	PM, COTR, Contractor, TI Office				(	
	IP Application	Projects with IP	Technology Transfer Checklist	Technology Transfer, Technical Expert Recognition	PM, Project Team, Intellectual Property Rights Policy Development Team					(
	Lessons Learned	All Projects	Lesson Learned Template	KM, Continuous Improvement	PM, Project Team, TI Office					(
	Value Report	All Collaboratives	Value Report Template	KM, Technology Transfer, Continuous Improvement	PM, Project Team, TI Office					(
	Close Out Contract and WO	All Contracts	Close Out Checklist	To Close-Out Project, WO, NDA and notify CO that NDA info is gotten back	PM, COTR, Contractor, TI Office					(

# Best Practice Maturity Model

FUNCTIONAL CATEGORY	DESCRIPTION	MATURITY MODEL			
		Year of Development			
		FY'08	FY'09	FY'10	FY'11
<b>Communication Protocol</b>	Communication guidelines between BPA employee and external entities as it relates to Technology Innovation's •External Proposal Pre-Submittal, Evaluation, Execution •Internal Proposal Pre-Submittal, Evaluation, Project Planning, Execution	<			
<b>Project Documentation</b>	Project Charter, Plan, Scope Statement, Collaborative	<	<		
<b>Stage Gate</b>	Definition of Stage Gate (stage gates may be different for research vs. development vs. demonstration.... Maybe needs to be go/no go/rescope/hold), How resource availability constraints factor into stage gate decisions, How to write a good stage gate or milestone Stage gate review Team formation, Contract Implications, Define stage gate process, Review panel, Consistent Implementation Criteria (project manager needs to know how to apply stage gates), How can a stage gate be changed as the R&D project team learns more, Usual reasons why a project is killed or placed on hold, Lessons learned from stage gate process	<	<		
<b>Contract Management</b>	BPI Appendix 14-A, BPI Appendix 6-A, Practical contracting techniques (task orders, contracting support for CRs, BES reports, ways to expedite contractor background check	<	<		
<b>Financial Management</b>	BES Financial Reporting of actual expenditures for FTE, contracts, travel, equipment		<		
<b>NDA Determination</b>	Identification of Data Requirements, NDA Process, Prioritization of data security and classification of data, (ALF agency load forecasting tool, DRI new outage system, SCADA, scheduling tags), NDA decision document		<		
<b>Definition of Project Success and Failure</b>	Project Success, Project Failure, How to document, How is acceptance of technology defined		<		
<b>Examples of Required Documents</b>	Project Proposal, SOW, Stage Gate, Gantt Chart, Pert Chart, NDA, Monthly Progress Report (includes financials), Project Closure Checklist		<	<	
<b>Role, Responsibility and Authority Defined</b>	Project Stakeholders, Sponsor, Manager, Project Team Members, Subject Matter Expert		<	<	
<b>Creation of Project Team</b>	How to pull together a team with Tier 3 support, Defining project skill requirements (i.e., need specialized equipment person)		<	<	
<b>Project Re-Scope</b>	What is process for changing scope of work so that Project Manger is not "called on it" that original proposal was wrong, Allowance for project scope and budget flexibility as new information is learned		<	<	
<b>Project Tracking</b>	Monitoring, Templates, Checklists, Report Formats, Measure & Metrics		<	<	
<b>Project Management Tools</b>	Use of standard project management software tools in CITRIX application		<	<	
<b>Project Termination</b>	Process to cancel project (midyear review, 2 <sup>nd</sup> conversation after midyear review with project manager and project team, council decision), Project manager initiated recommendation to cancel project, Complete Close-out Checklist (to be determined)			<	<
<b>Project Recovery</b>				<	<
<b>Risk Assessment, Analysis &amp; Management</b>	Agency Decision Framework, Risk Management during Project Initiation, Planning, Execution			<	<
<b>Intellectual Property</b>	IP Decision Framework, BPI language			<	<
<b>Market Research</b>	BPI Appendix 6-A		<		