



**EPRI In a nutshell –  
and EPRI's new research into the  
area of Circuit Breakers**

Luke van der Zel  
EPRI – Power Delivery and Markets

## **Presentation Overview**

- Thank you IEEE
- The 4 main ways EPRI operates
- EPRI's new Circuit Breaker research
  - How we started the program
  - Project 1: Refurbishment/Replacement Methodology
  - Project 2: Using protection for Circuit Breaker diagnostics
- EPRI and IEEE collaboration






## The 4 main ways EPRI operates

### EPRI Facts






- Collaborative R&D
- Non-Profit
- 33-year history
- 450 participants in over 40 countries
- 66 technical programs
- 1600+ research and demonstration projects annually
- 10 to 1 average funding leverage



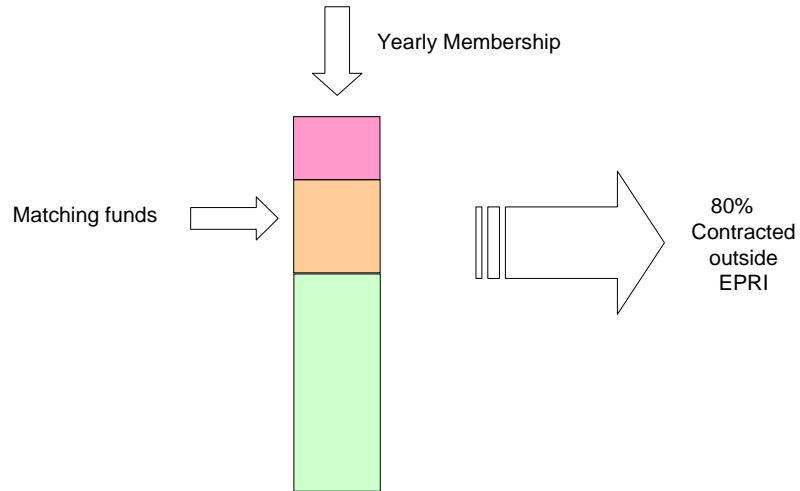
## Extensive Technology Portfolio

				
<b>Generation &amp; Distributed Resources</b> <ul style="list-style-type: none"> <li>Environmental Controls</li> <li>Major Component Reliability</li> <li>Combustion Turbines</li> <li>Maintenance, Operations and Workforce</li> <li>Advanced Coal Plant Portfolio</li> <li>Distributed and Renewable Generation Resources</li> <li>Generation Planning: Economics and Fuels</li> </ul>	<b>Nuclear Power</b> <ul style="list-style-type: none"> <li>Material Degradation/Aging</li> <li>High Performance Fuel</li> <li>Radioactive High-Level Waste &amp; Spent Fuel Management</li> <li>NDE &amp; Material Characterization</li> <li>Equipment Reliability</li> <li>Instrumentation &amp; Control Hardware and Systems</li> <li>Nuclear Asset-Risk Management</li> <li>Safety/Risk Technology &amp; Application</li> <li>New Nuclear Plant Deployment</li> <li>Environmental Benefits</li> <li>Low-Level Waste &amp; Radiation Management</li> </ul>	<b>Power Delivery &amp; Markets</b> <ul style="list-style-type: none"> <li>Strategic Initiatives</li> <li>Security</li> <li>Power Markets &amp; Risk</li> <li>Assets, Planning &amp; Operations</li> <li>Power Quality</li> <li>Transmission Reliability &amp; Performance</li> <li>Distribution Reliability &amp; Performance</li> <li>Electric Transportation and Energy Utilization</li> <li>Enterprise Asset Management</li> </ul>	<b>Environment</b> <ul style="list-style-type: none"> <li>Air Quality</li> <li>Global Climate Change</li> <li>Land &amp; Groundwater</li> <li>Water and Ecosystems</li> <li>EMF Health Assessment and RF Safety</li> <li>Occupational Health and Safety</li> </ul>	
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## Funding Inputs into EPRI

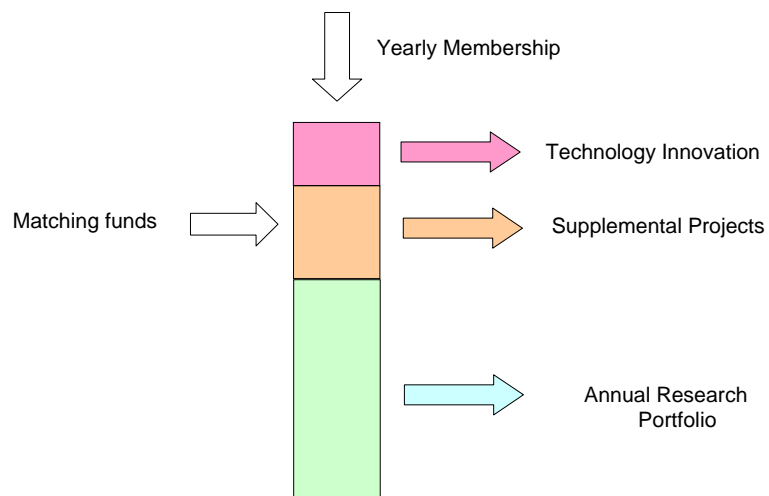


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## Research outputs from EPRI

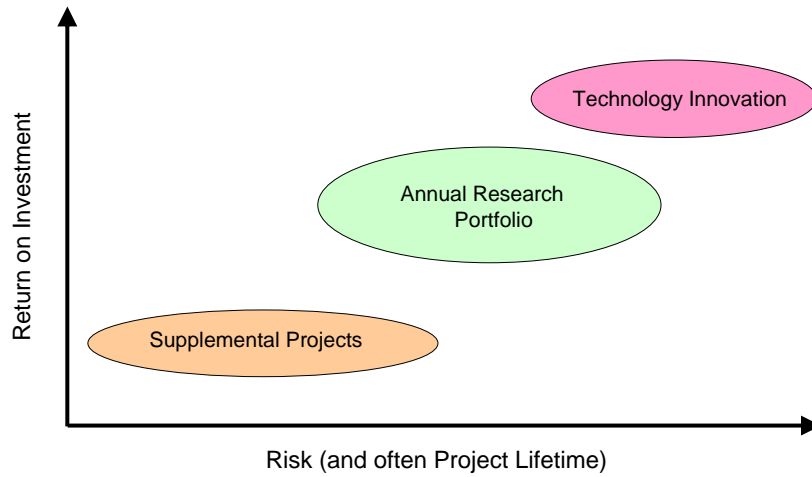


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## EPRI's Research Portfolio

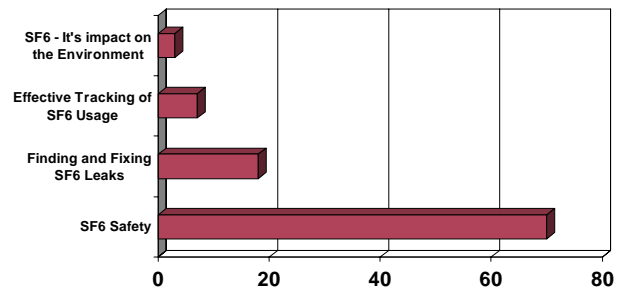


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## Supplemental Example: SF<sub>6</sub> Training and Reference



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## Supplemental Example: SF<sub>6</sub> Training and Reference

		EPR						
		Home	Objectives	Contents	Glossary	Reference	About	Exit
<b>Main Menu</b>								
	<b>Fundamentals</b>							
	<b>Safety</b>							
	<b>Handling</b>							
	<b>Analysis</b>							
	<b>Leaks</b>							
	<b>Environment</b>							

## Supplemental Example: SF<sub>6</sub> Training and Reference

<b>Using Personal Protective Equipment</b>		EPR						
<b>Personal and Workplace Safety</b>		Home	Objectives	Contents	Glossary	Reference	About	Exit
<b>Lesson Introduction</b>		2 of 8						
<p>When working with SF<sub>6</sub>-related equipment, you must pay constant attention to personal protection and safe work procedures. One of the most important elements of SF<sub>6</sub> safety is the use of Personal Protective Equipment (PPE).</p> <p>PPE promotes personal safety by protecting you from exposure to gaseous and/or solid SF<sub>6</sub> decomposition products, which can pose serious health risks.</p> <p>This lesson describes the proper use of Personal Protective Equipment. When you have completed this lesson, you'll be able to:</p> <ul style="list-style-type: none"> <li>Identify the different types of Personal Protective Equipment</li> <li>Explain the purpose of each type of Personal Protective Equipment in the safe handling of SF<sub>6</sub></li> </ul> <p>Click  to continue.</p>								

## Detecting Leaks with the SF<sub>6</sub> Camera

Detecting Leaks
Home   Objectives   **Contents**   Glossary   Reference   About   Exit

1 of 2

### Detecting Leaks with the SF<sub>6</sub> Camera

The video at right demonstrates how a laser imaging system allows gases to be seen on a TV monitor.

Click the Play (right arrow) button above to view the video clip.

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## Supplemental Project example: GIS Monitoring tools and Techniques

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## Supplemental Project example: GIS Monitoring tools and Techniques



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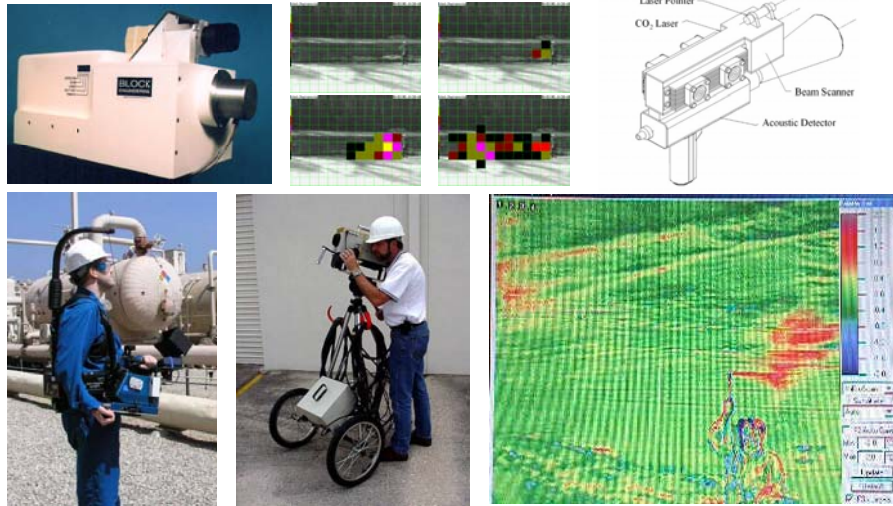
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## Annual Research Portfolio Example: SF<sub>6</sub> Research technologies investigated



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## Technology Innovation Example: Wireless Battery-less sensor research



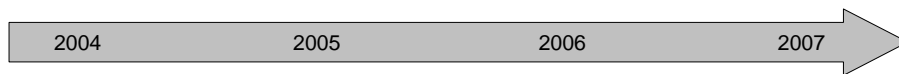
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## **EPR2's new Circuit Breaker research program**

### **Starting a focused research area in Circuit Breakers**



Group all CB  
research in EPRI

Funded a hard look  
at member needs

Execute the highest  
priority research needs

## Some snippets of past EPRI Circuit Breaker research

- 1980-Present: Life Extension Guidelines
- 2000- present: SSCL
- 2001: Reliability Centered Maintenance (RCM) Technical Reference for Power Delivery
- 2002-2005: Integrated Monitoring and Diagnostics: Maintenance Ranking and Diagnostic Algorithms for Circuit Breakers
- 2002: The Management of SF6 (Sulfur Hexafluoride) Leakage
- 2003: UHF and AE Condition monitoring tools for GIS (and possibly outdoor and Hybrid breakers)
- 2004: Oil Analysis as a Diagnostic Tool for Circuit Breakers

## Ranking of candidate topics (Matched by voting by member dollars)

PROJECT	High	Medium	Low
Candidate 1 – End Of Life Model	7	1	
Candidate 2 - Risk-based Replacement Decision Support	7	1	
Candidate 3 - Health Index	6	2	
Candidate 4 - Establish Benefits of Using Available Data	3	4	
Candidate 5 - SF <sub>6</sub> Guidelines		1	7
Candidate 6 - RCM FMEA		2	6
Candidate 7 - Breaker Industry Database Model	2	4	3
Candidate 8 - Replacement Parts Methodology	2	1	6
Candidate 9 - Collect and Catalogue Best Practices		6	2

## Ranking of candidate topics

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Candidate 5 - SF <sub>6</sub> Guidelines		1	7
Candidate 6 - RCM FMEA		2	6
Candidate 7 - Breaker Industry Database Model	2	4	3
Candidate 8 - Replacement Parts Methodology	2	1	6
Candidate 9 - Collect and Catalogue Best Practices		6	2

## Candidate 1- EOL Model

- **Objective:** Develop a practical and **affordable** circuit breaker end-of-life model, to support decisions related to circuit breaker replacement or refurbishment.
  - Identification of factors and information, which should be included in the decision support model.
  - Relate information available to appropriate EOL factors for circuit breakers, with the application of appropriate factor values and weightings.
  - Apply the model to sample groupings of representative circuit breaker populations and perform a sensitivity study
- Probability of technical success: **High**
- Number of utilities to which applicable: **High**
- Project length: **Estimated 9 - 12 months** (usable results)

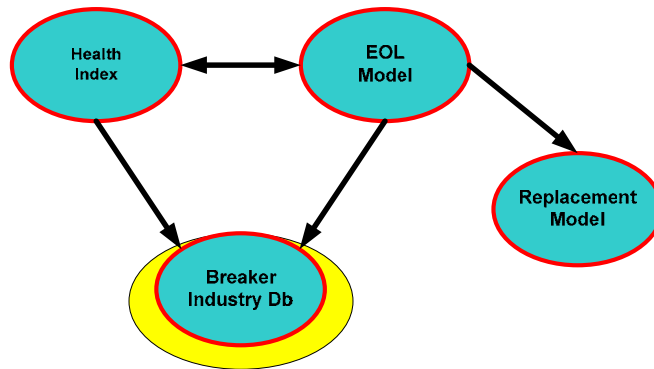
## Candidate 2 – Risk-based Replacement Decision Support

- **Objective:** Compliment EOL model with a customizable risk-based business case analysis tool for circuit breaker replacement.
- Assist in risk-based analysis of various business scenarios and factors, taking into account safety, financial, reliability, business and regulatory drivers and factors.
  - Identify KPIs and measures,
  - Customize the weighing of each measure in accordance with utility's business, financial and regulatory drivers/environment
  - Identify the business cases to be considered
- Probability of technical success: **High**
- Number of utilities to which applicable: **Medium**
- Project length: **Estimated 9 - 12 months**

## Candidate 3 - Health Index

- **Objective:** Develop a Circuit Breaker “Health” or “Action” Index
  - Develop a set of criteria which would contribute to a health index “score”
  - Establish appropriate weightings for each criterion, and establish which values would require action
  - Establish process for evaluation
- Probability of technical success: **High**
- Number of utilities to which applicable: **High**
- Project length: **Estimated 9 - 12 months**

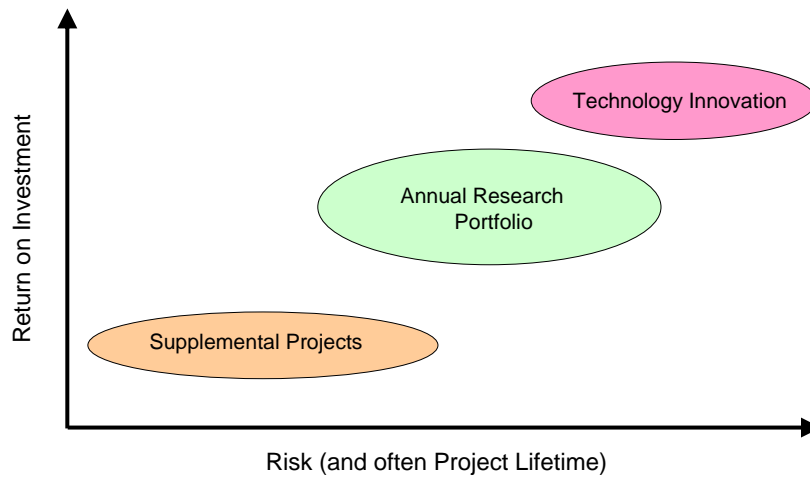
## Project Synergies



## Research and demonstration of the appropriate use of new microprocessor relays for circuit breaker monitoring

- Task 1: Literature Review
- Task 2: Member needs assessment
- Task 3: Detailed Research into the specific needs addressed by the members
- Task 4: Laboratory Demonstration
- Task 5: Identify data management issues
- Task 6: Task Force and Webcast participation
- Task 7: Final Report

## What are we missing ?



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## Feedback from IEEE Monday presentation

1. Develop and document a practical methodology for circuit breaker replacement and refurbishment decisions
  - The work could provide a helpful summary of methodologies
  - The project could benefit from more input from field and equipment staff
2. Research and demonstration of the appropriate use of new microprocessor relays for circuit breaker monitoring
  - Breaker contact wear monitoring should be set as a low priority compared to mechanism issues
  - A simple timing limit to quantify a slow trip may be a valuable starting point
  - A number of members have gathered data from relays – but haven't seen the value yet. ***There is thus an important gap to bridge to determine how to convert the data into information.***

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