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INFRASTRUCTURE, SAFETY,
AND ENVIRONMENT

***Decision Making
in an Uncertain World***

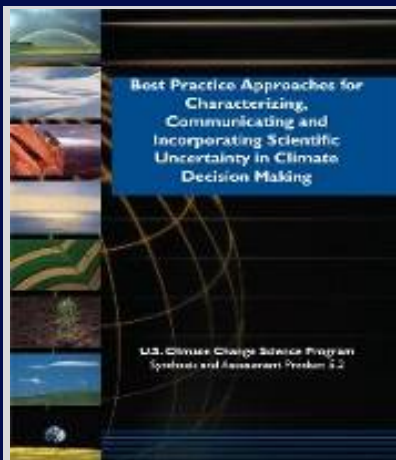
**Robert Lempert
Director**

**RAND Pardee Center on Longer-Range Global Policy
and the Future Human Condition**

**Adaptation Master Class
May 20, 2011**

Adaptation to Climate Change Poses Both Analytic and Organizational Challenges

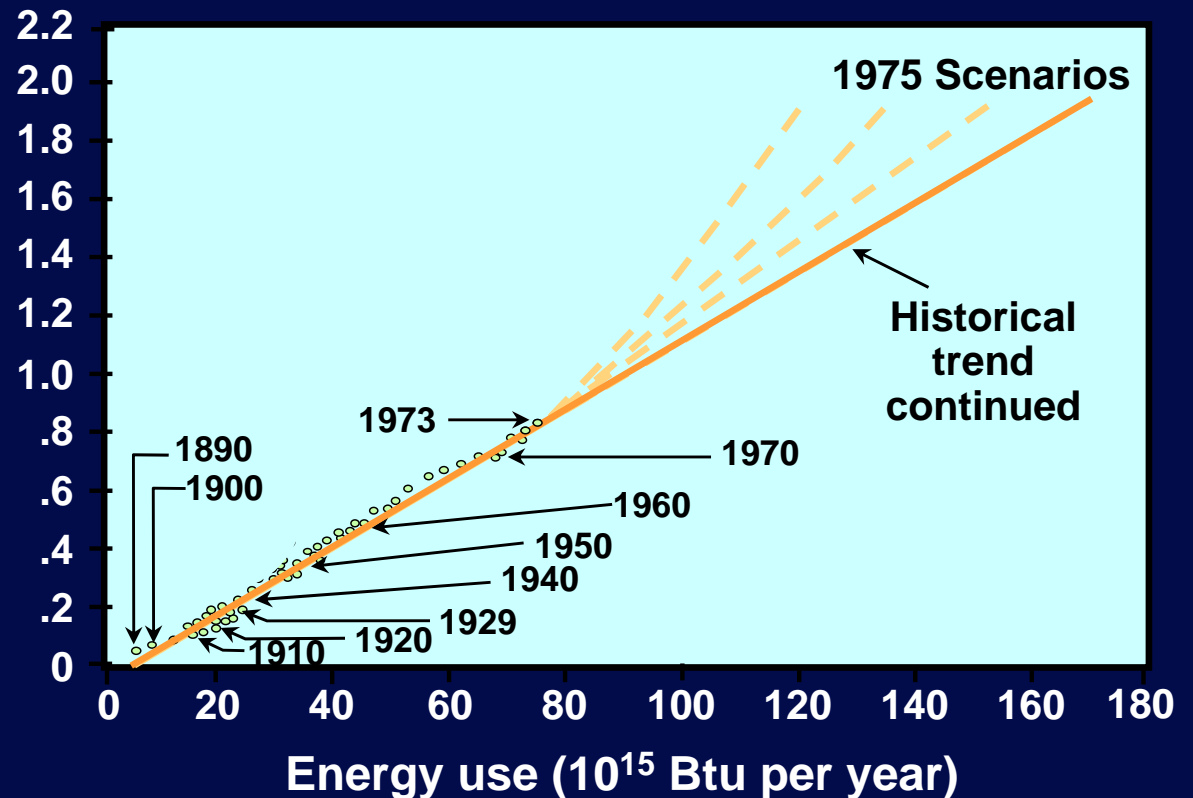
- Planning with statistics of future climate based on projections, rather than just replicating recent history, requires
 - Usefully summarizing incomplete information from new, fast-moving, and potentially irreducibly uncertain science
 - Justifying analytic choices to diverse constituencies, many of whom may object to implications of some particular choices
 - Solution requires rethinking *how we use* uncertain climate information in our planning
- Recent reports suggest:
 - There are limits to the usefulness of classic risk analysis for climate-related problems
 - Seeking robust strategies may prove a preferable approach
 - Any analytic approach should be embedded in appropriate process of stakeholder engagement



Believing Forecasts of the Unpredictable Can Contribute to Bad Decisions

- In the early 1970s forecasters made projections of U.S energy use based on a century of data

Gross national product (trillions of 1958 dollars)

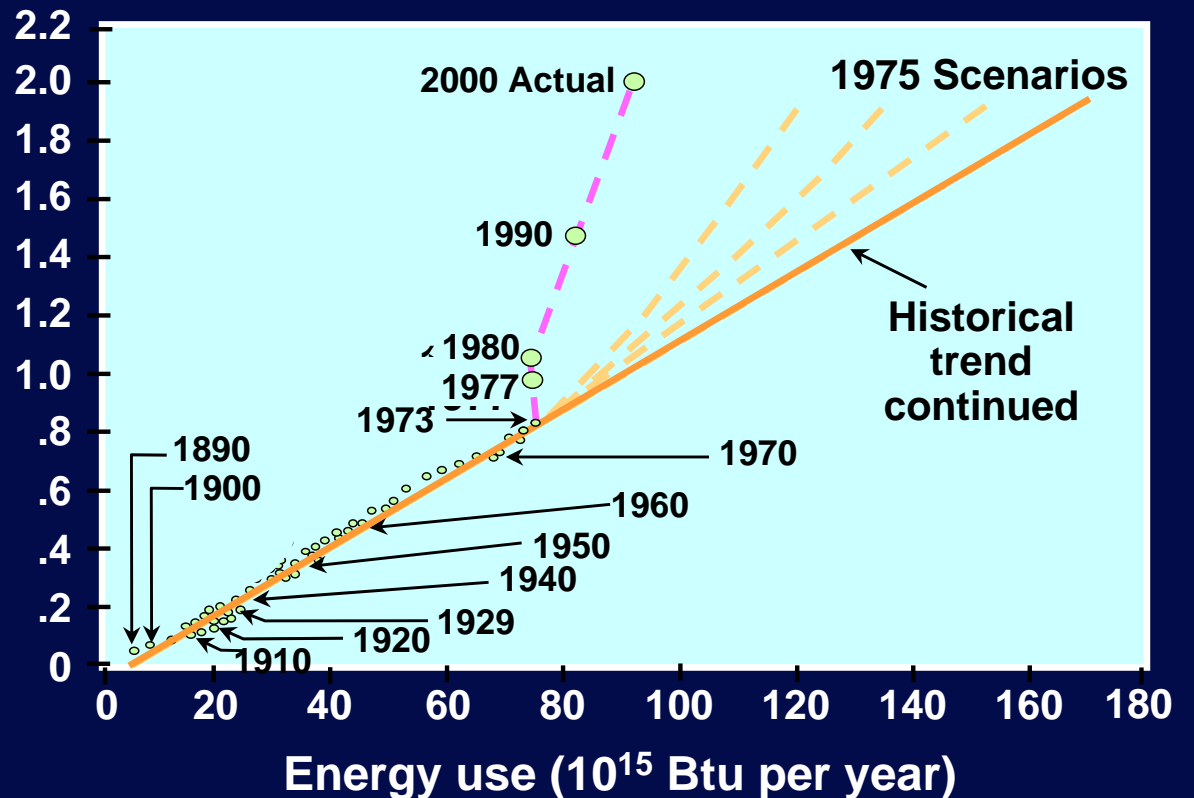


Believing Forecasts of the Unpredictable Can Contribute to Bad Decisions

- In the early 1970s forecasters made projections of U.S energy use based on a century of data

... they all were wrong

Gross national product (trillions of 1958 dollars)



Traditional Planning Methods Can Complicate Decisions Under Deep Uncertainty

Traditional analytic methods characterize uncertainties as a prelude to assessing alternative decisions



Climate change (and many other challenges) confront decisionmakers with **deep uncertainty**, where

- They do not know, and/or key parties to the decision do not agree on, the system model, prior probabilities, and/or “cost” function

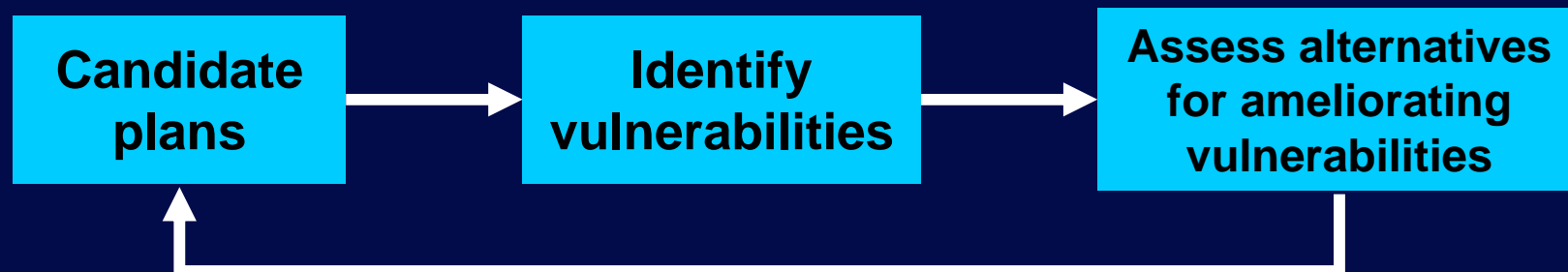
Decisions can go awry if decisionmakers assume risks are well-characterized when they are not

- Uncertainties are **underestimated**
- Competing analyses can contribute to **gridlock**
- Misplaced concreteness can blind decision-makers to **surprise**

Robust Decision Making (RDM) Helps Inform Good Decisions Without Reliable Predictions

Key idea – conduct the analysis in reverse order from predict then act:

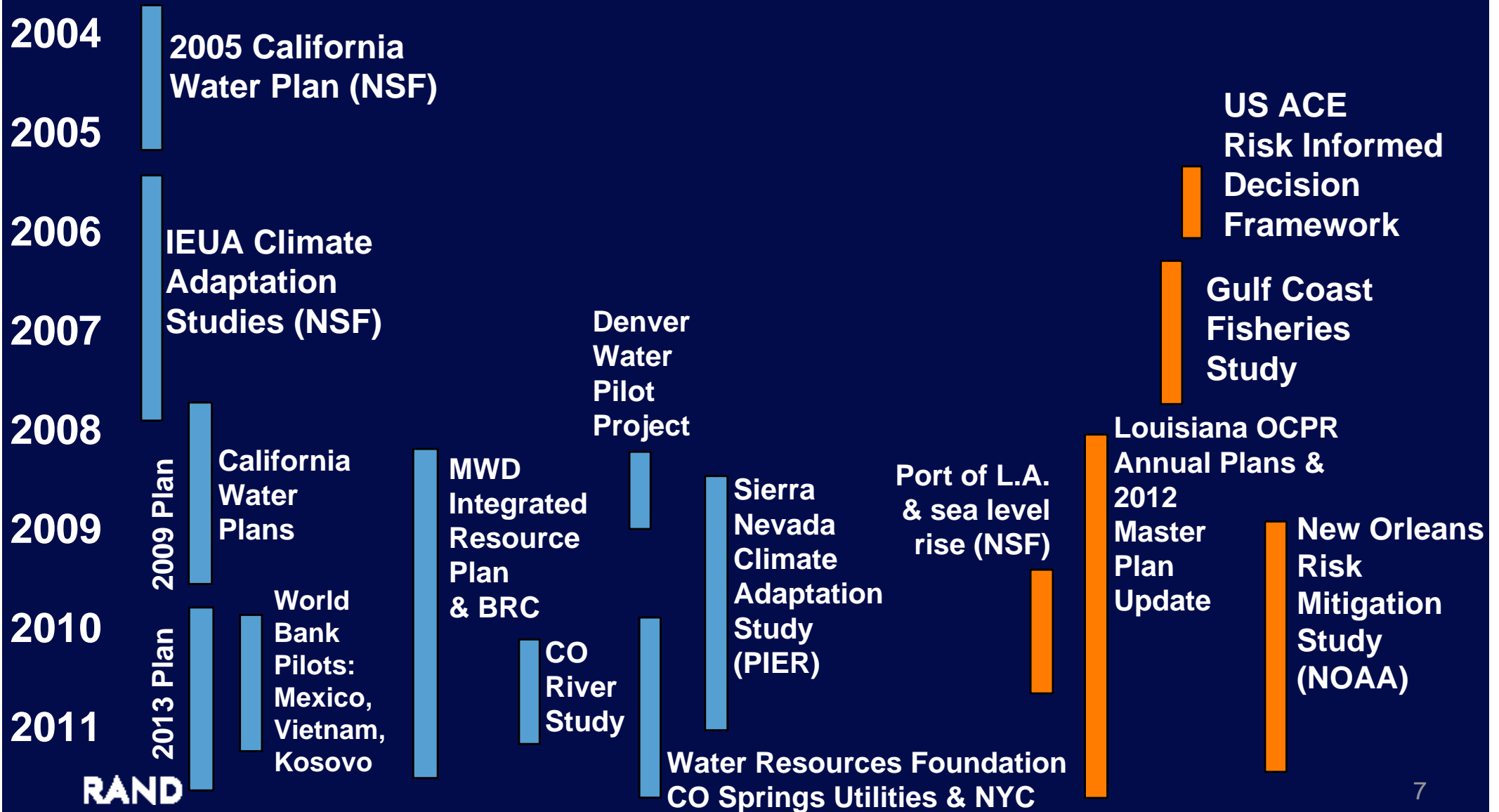
- 1. Start with a proposed plan for a specific decision maker**
- 2. Use analytics to identify (multi-attribute) scenarios that describe the future conditions where proposed plan fails to meet its goals**
- 3. Use these scenarios to identify potential actions to address vulnerabilities and evaluate tradeoffs among them**
- 4. Repeat until stakeholders agree the resulting plan is robust across multiple views and unknowns regarding the future**



Currently Applying This Approach With Many Resource Management Agencies

Long-term Water Resources Planning

Coastal Protection and Restoration



Importantly, RDM Consists of Analytic Methods Embedded in a Process of Stakeholder Engagement

Effective climate-related decision support often requires **deliberation with analysis**, an iterative process that:

- Begins with the many participants to a decision working together to define its objectives and other parameters,
- Working with experts to generate and interpret decision-relevant information, and
- Then revisiting the objectives and choices based on that information.

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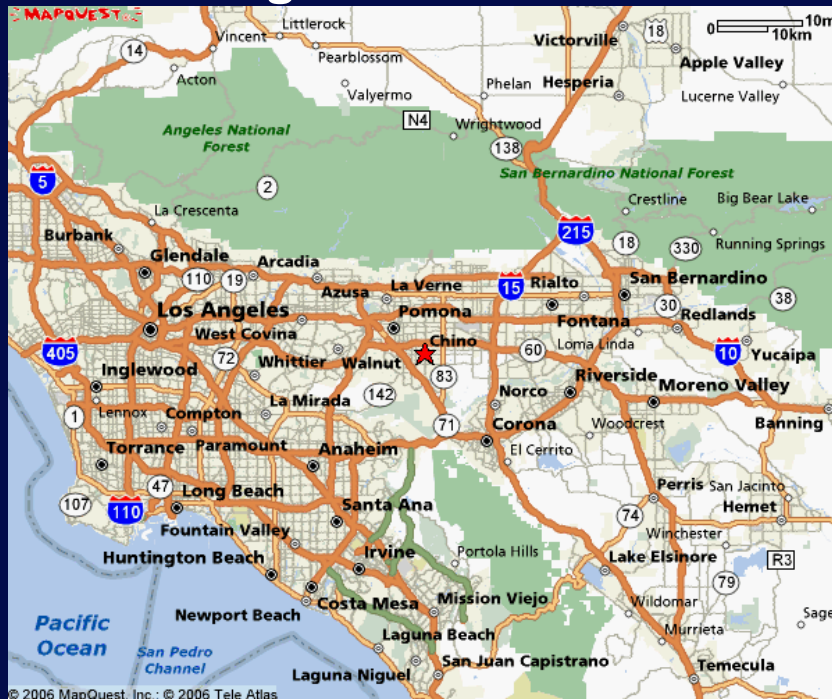
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To address specific cognitive and organizational barriers to good decisions, RDM implements such a process by:

- Beginning with one or more policies under consideration, and an understanding of what would constitute success
- Identifying vulnerabilities of those policies
- Identifying and evaluating potentially robust responses

Helped Inland Empire Utilities Agency (IEUA) Include Climate Change in Their Long-Range Plans

- IEUA currently serves 800,000 people
 - May add 300,000 by 2025
- Water presents a significant challenge

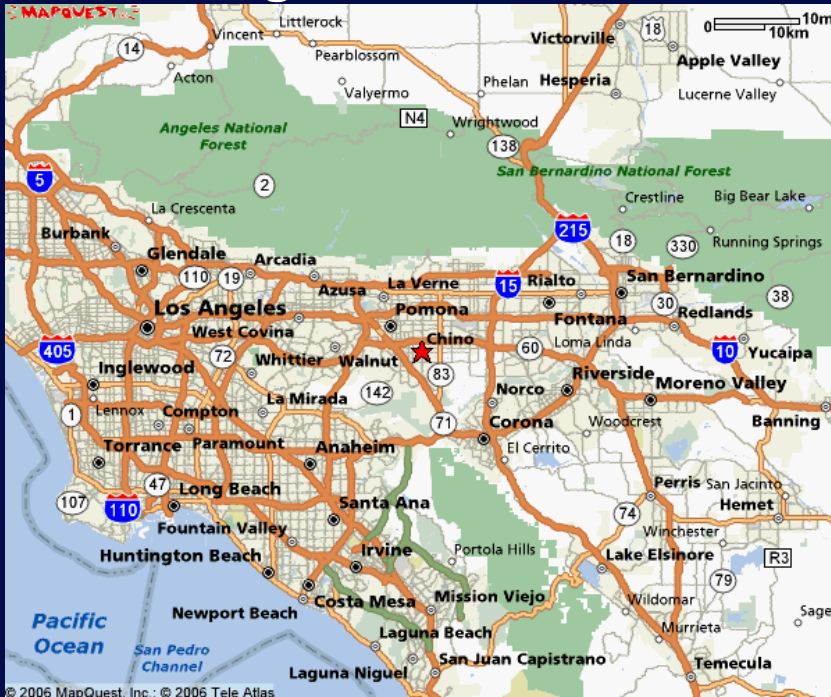


– Current water sources include:

- Groundwater 56%
- Imports 32%
- Recycled 1%
- Surface 8%
- Desalter 2%

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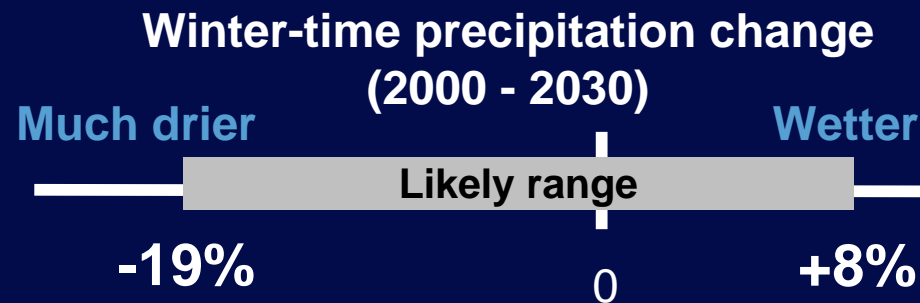
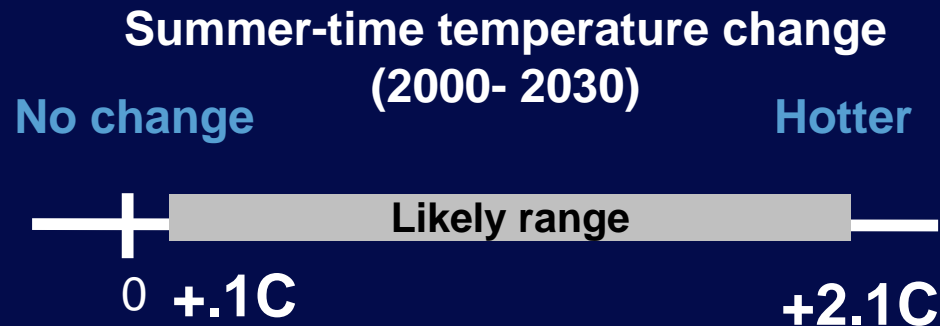
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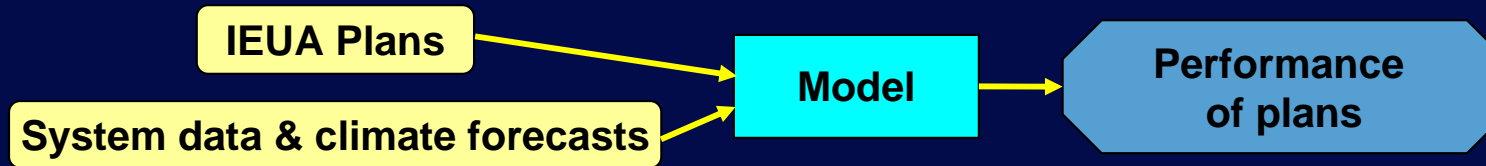
Focus of IEUA's 25 year plan

IEUA Faces a Range of Possible Future Climate Conditions



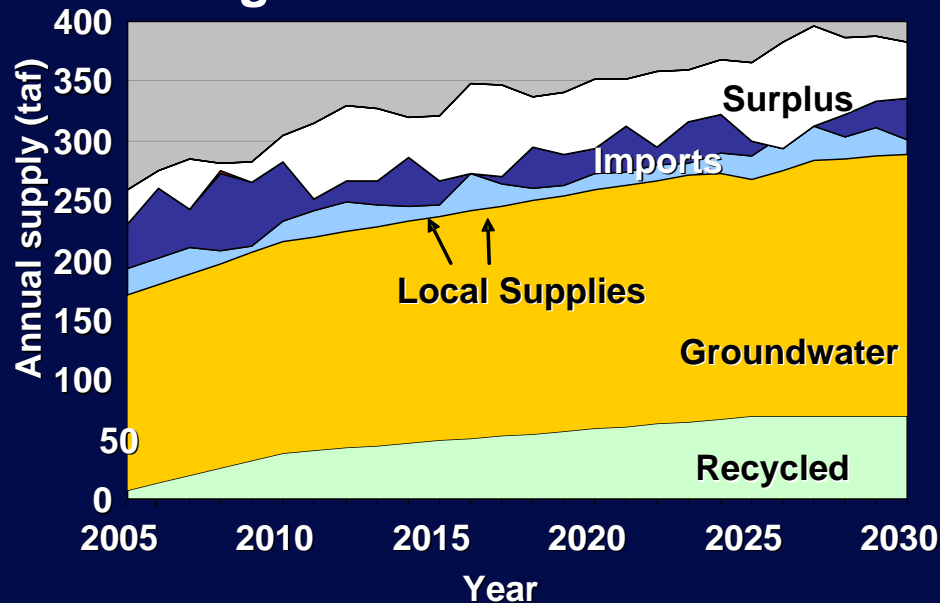
*Results based on statistical summary of 21 of the world's best
Global Climate Models*

Simulation Model Assesses Performance of IEUA Plans in Alternative Scenarios



Scenario A

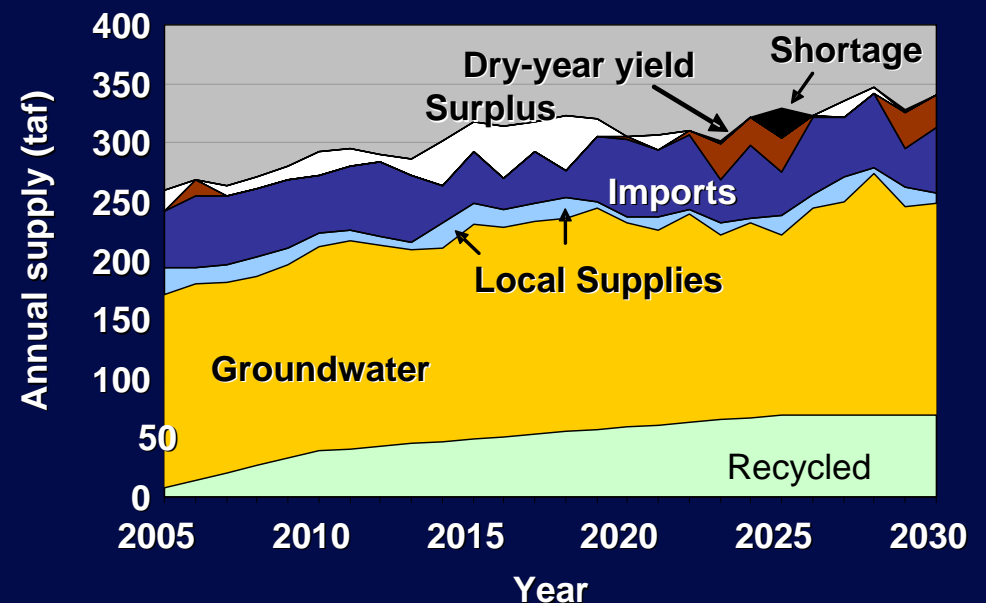
Plan generates surpluses in benign future climate



Temp: +0.7°C Precip: +3%

Scenario B

Plan suffers shortages in adverse future climate



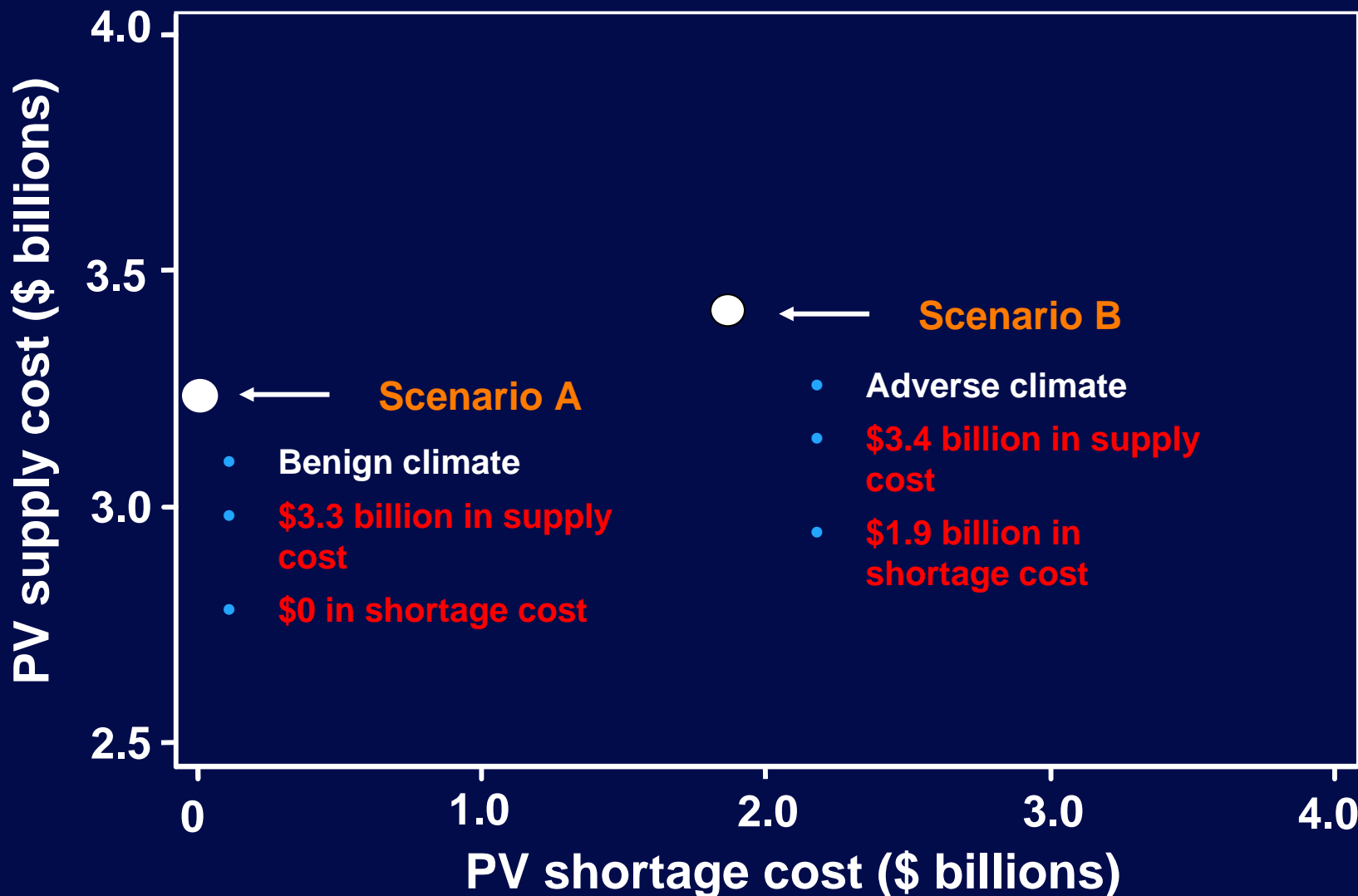
Temp: +1.6°C Precip: -10%

Many Uncertain Factors Could Impact the Performance of Current IEUA Plan

Natural Processes	<ul style="list-style-type: none">• Future temperatures• Future precipitation• Changes in groundwater processes
Performance of Management Strategies	<ul style="list-style-type: none">• Development of aggressive waste-water recycling program• Implementation of groundwater replenishment
Costs of Future Supplies and Management Activities	<ul style="list-style-type: none">• Imported supplies• Water use efficiency

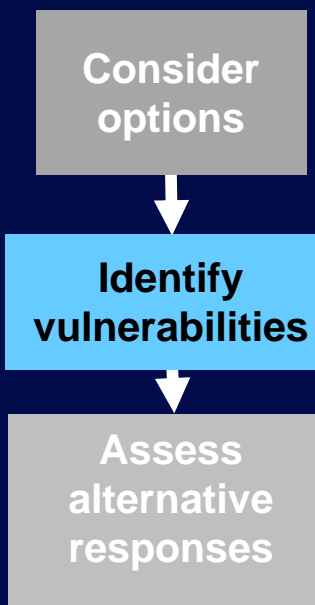
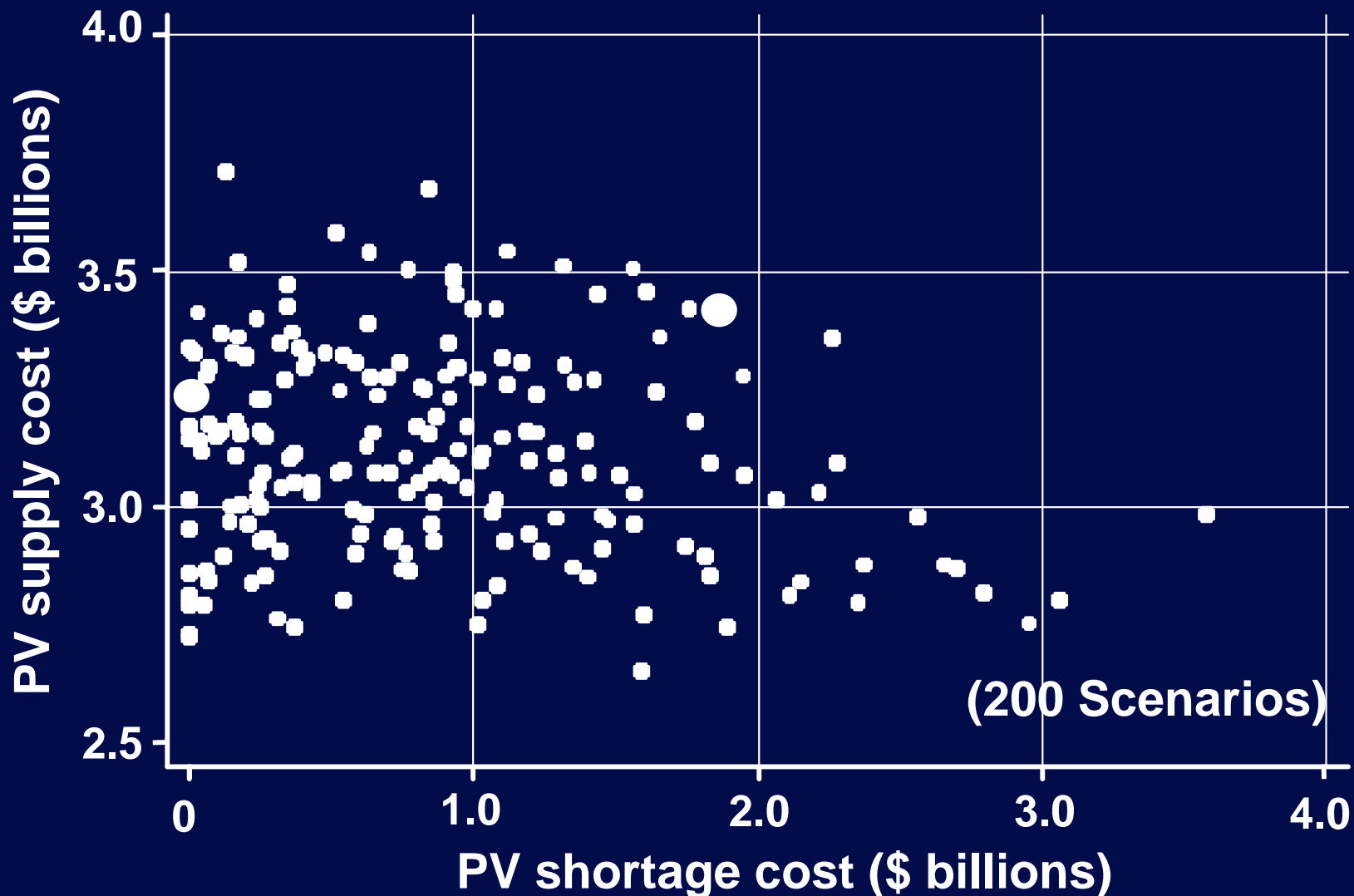
“Scenario Maps” Help Decision Makers Visualize a Plans’ Vulnerabilities

Current IEUA plan forever



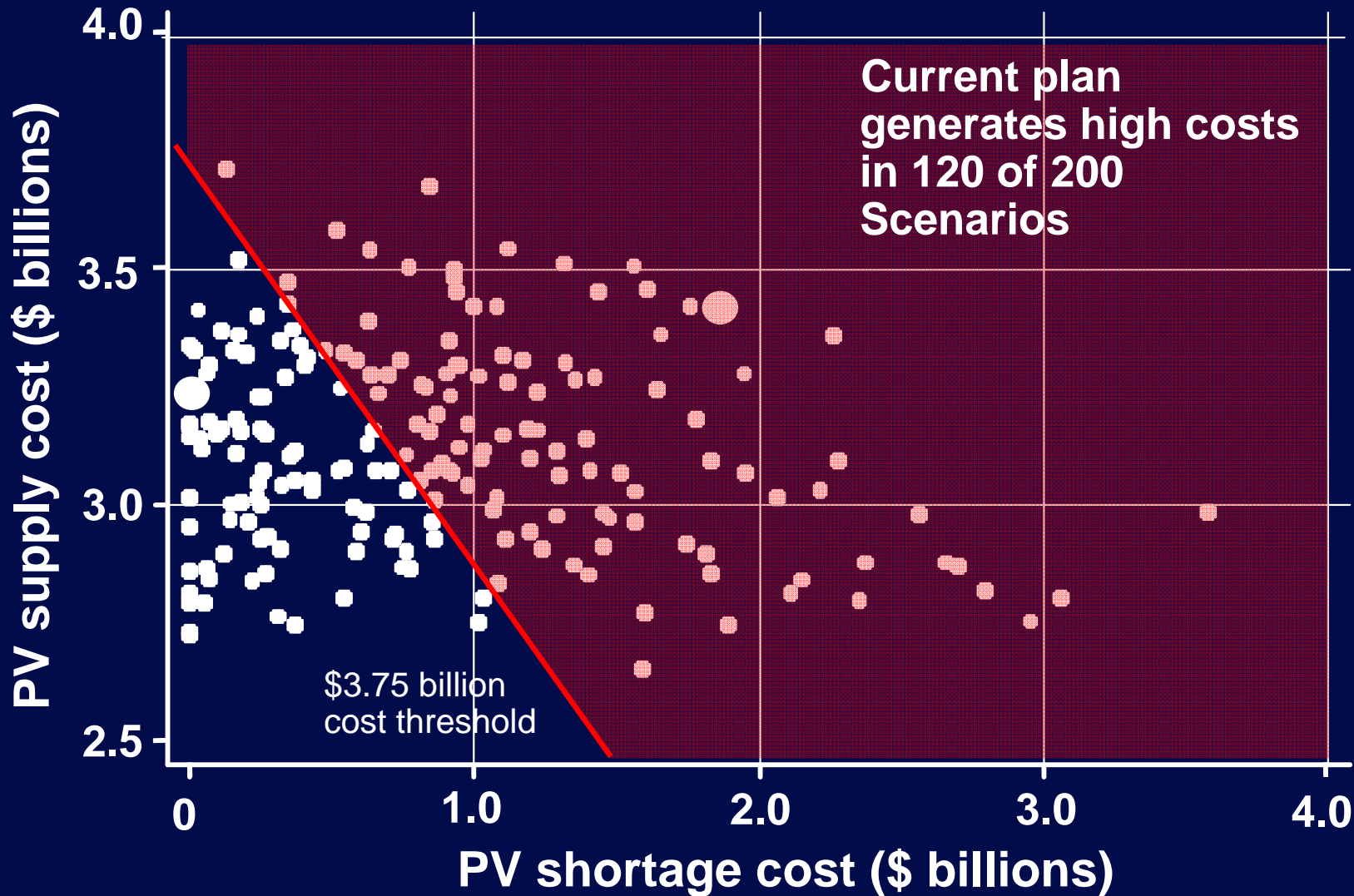
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“Scenario Maps” Help Decision Makers Visualize a Plans’ Vulnerabilities

Current IEUA Plan Forever



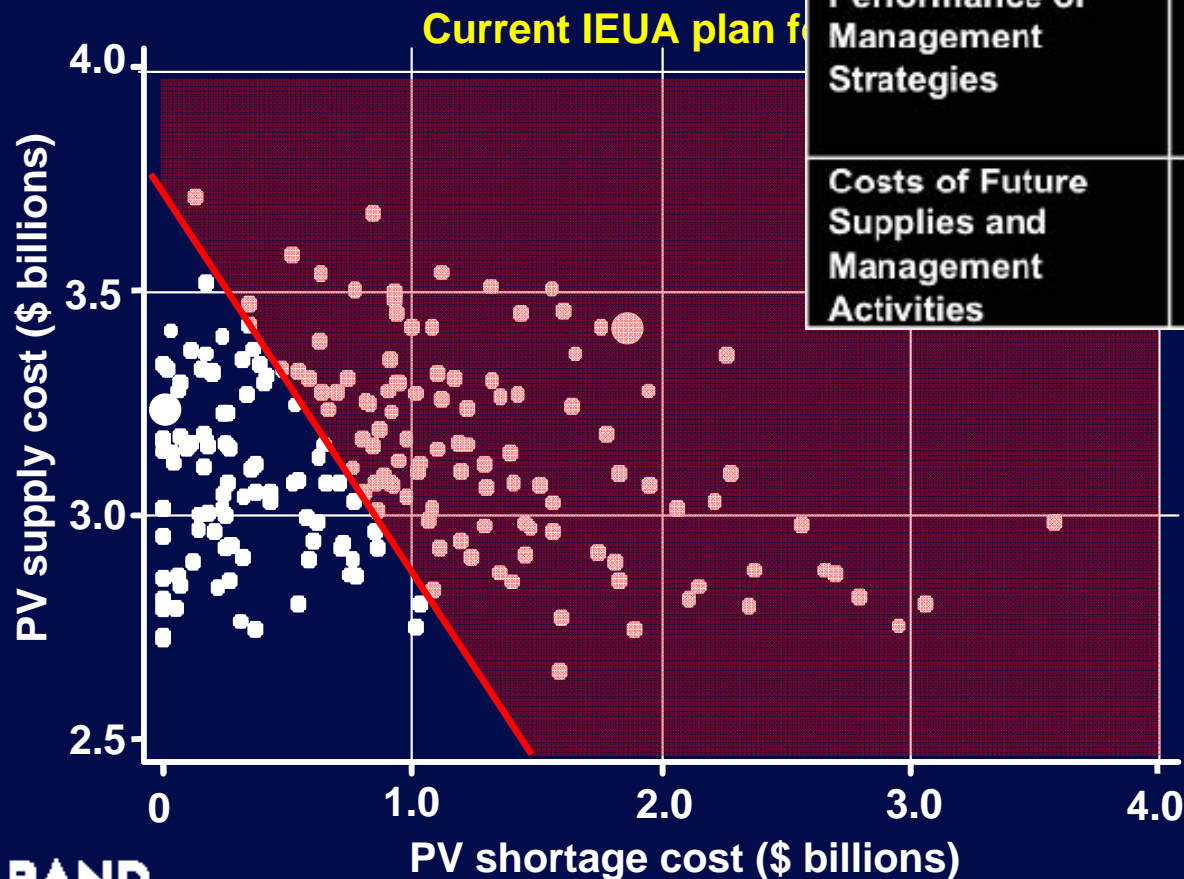
Consider options

Identify vulnerabilities

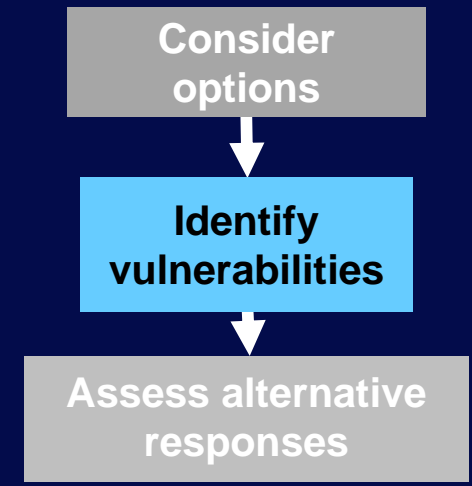
Assess alternative responses

Statistical “Scenario Discovery” Analysis Identifies Scenario Where Existing Plan Fails

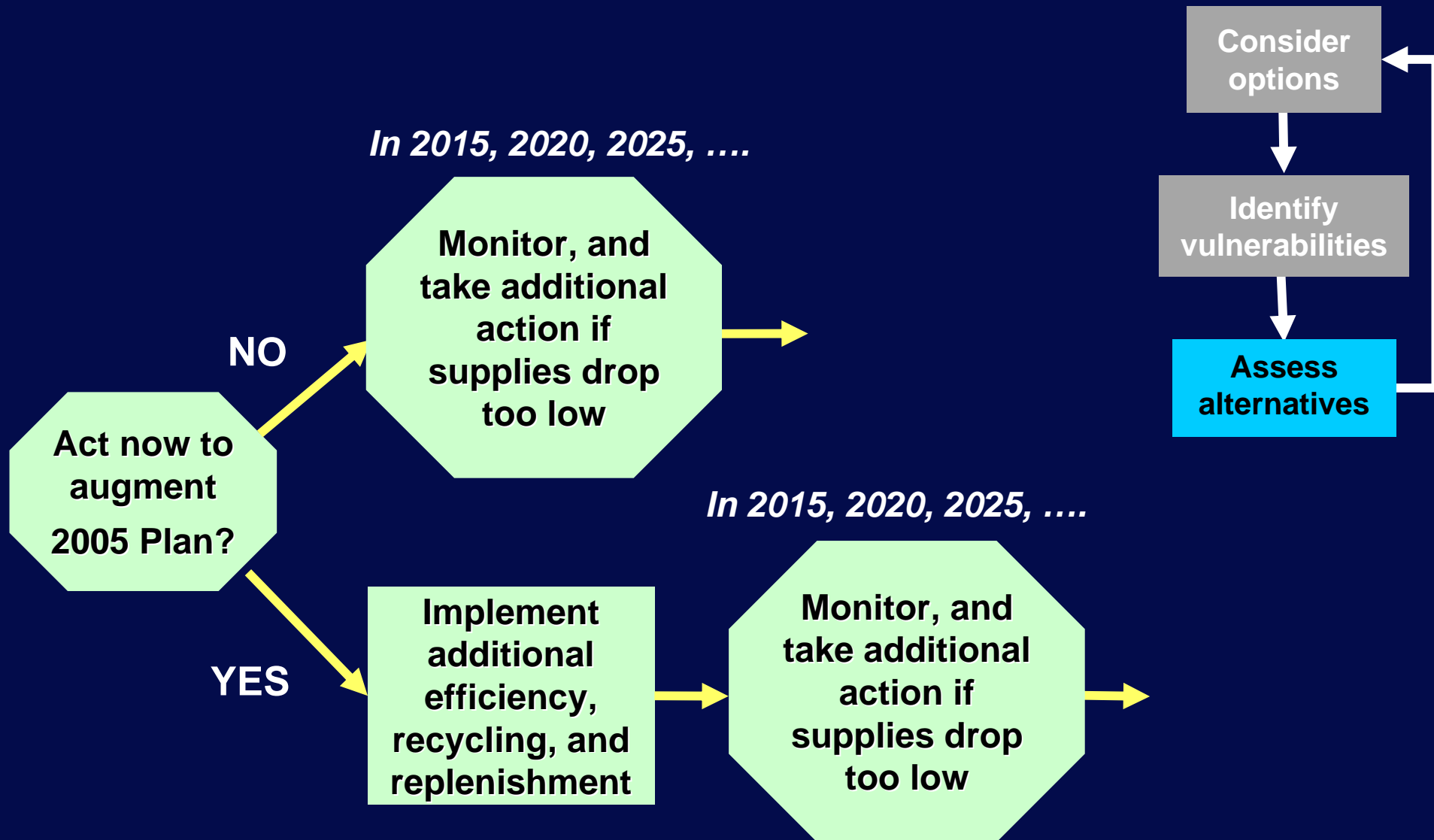
These three factors explain 70% of vulnerabilities of IEUA’s current plans



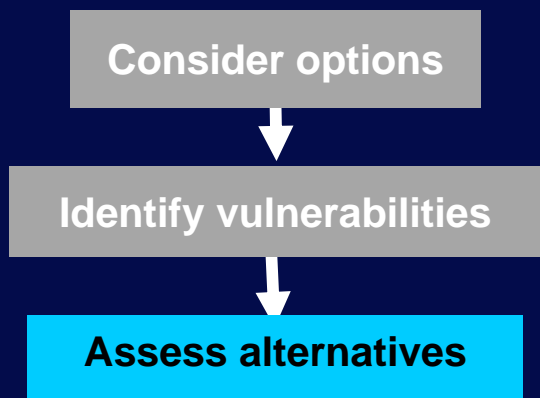
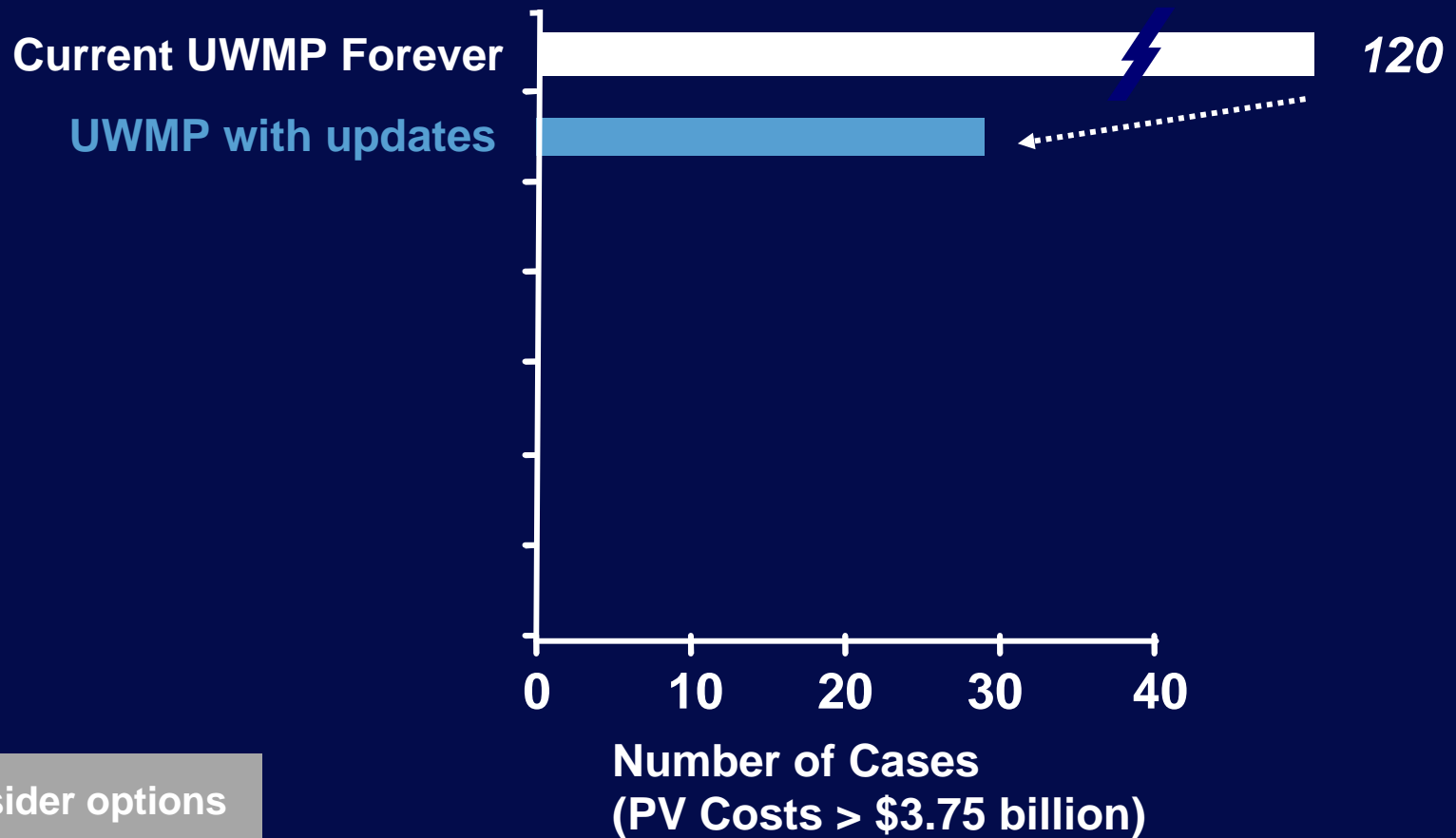
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What Should IEUA Do Now, and What Can They Wait to Do Later?

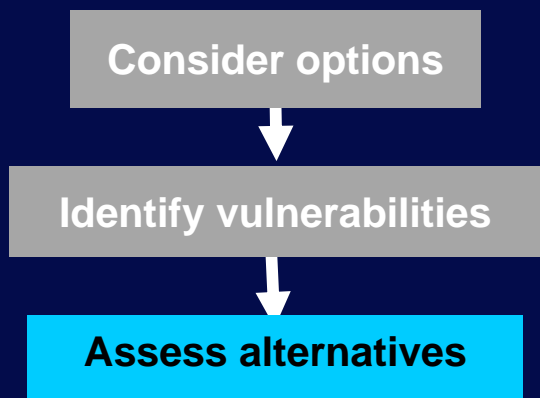
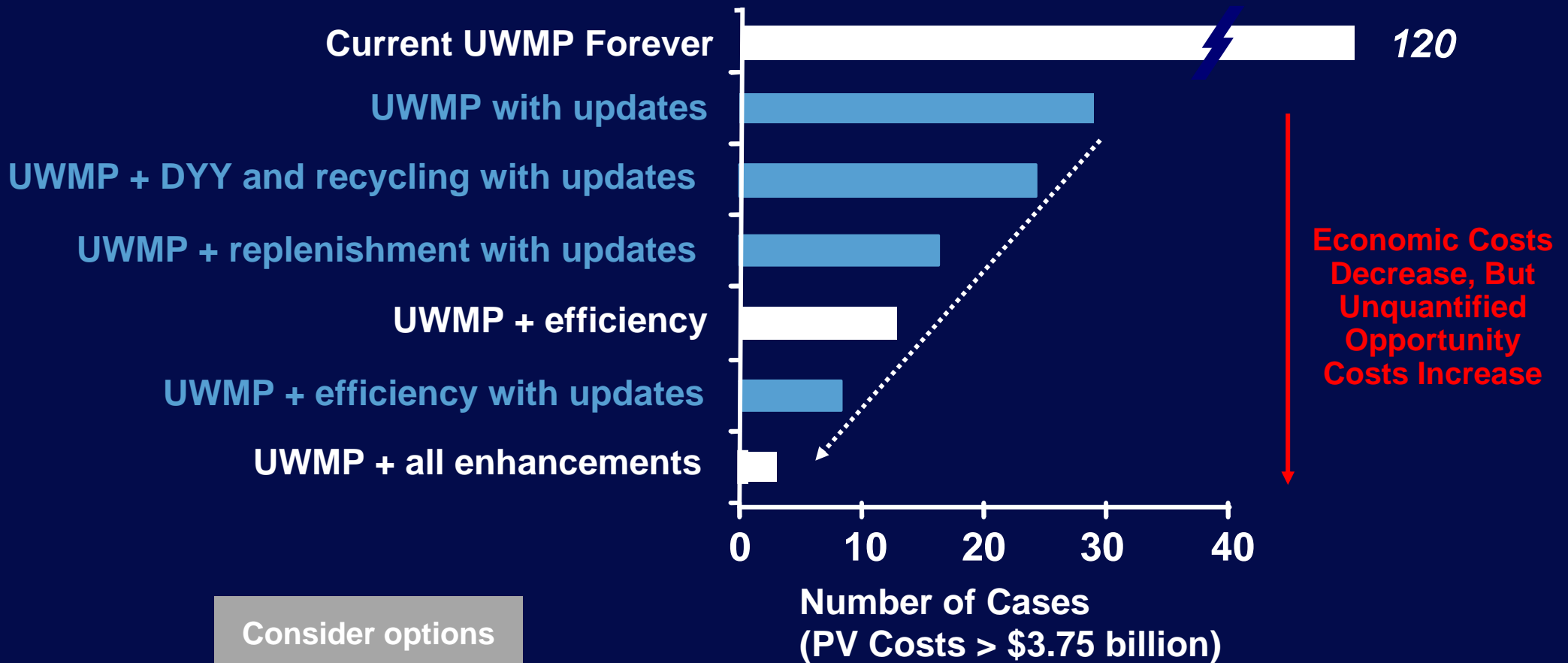


Just Allowing the Current UWMP to Update Reduces Vulnerable Cases Substantially



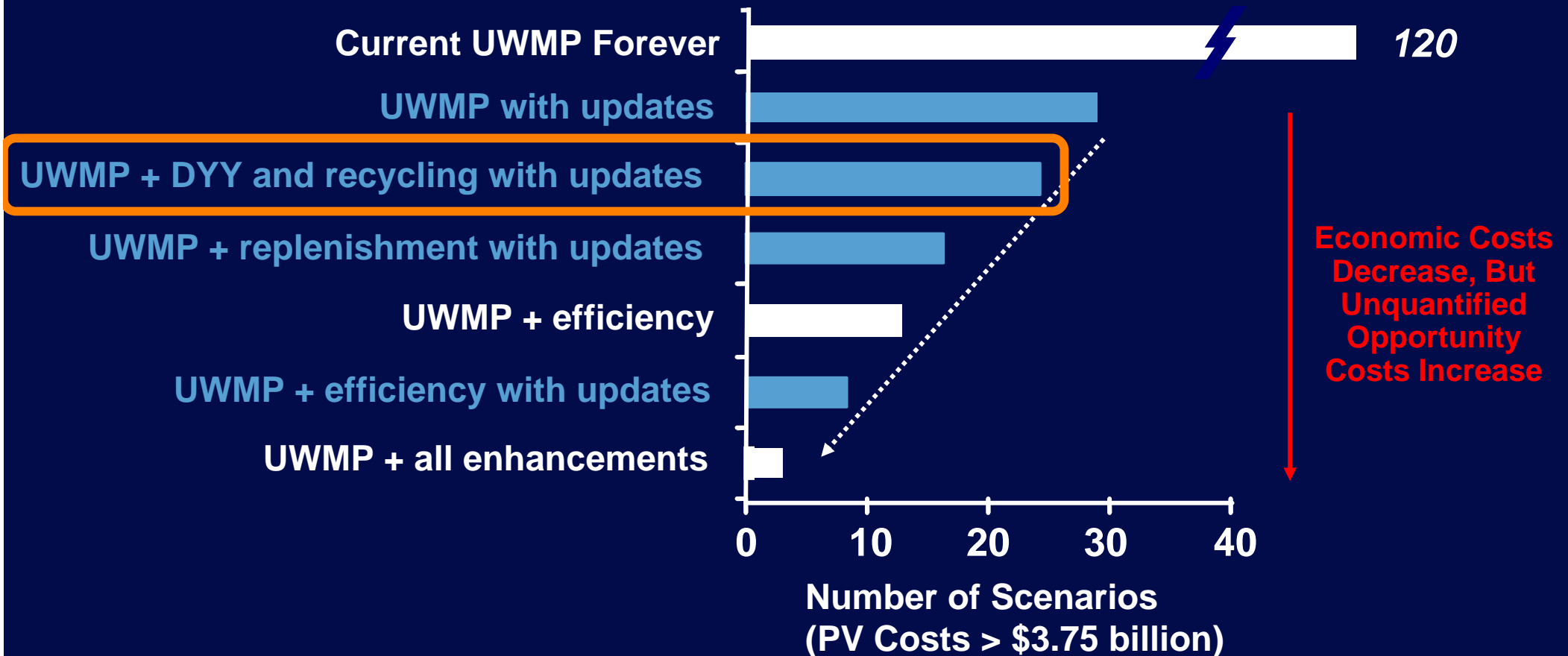
- Static options
- Update options

Compare Alternative Plans With Different Mixes of “Act Now” vs. “Act Later”



Static options
 Update options

Compare Alternative Plans With Different Mixes of “Act Now” vs. “Act Later”

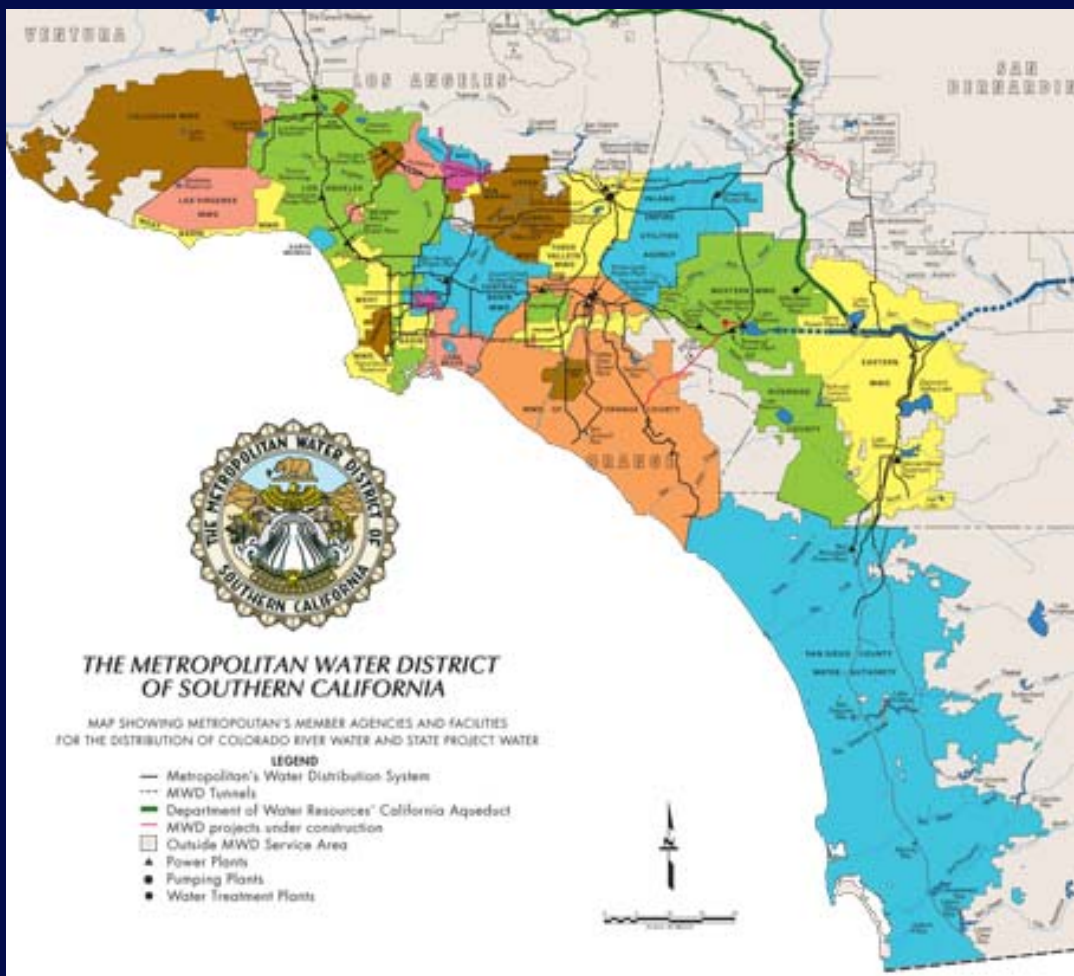


IEUA chose to accelerate their dry-year yield and recycling programs, and adapt as needed down the road

Such Robust Adaptive Plans Also Proving Useful at the Regional Level

Metropolitan Water District of Southern California is using these approaches

- **Planning staff identifies early warning indicators needed to implement their adaptive management Integrated Resources Plan**
- **Blue Ribbon Committee looks out 50 years to “identify and recommend new business models and strategies that will help the region meet its long-range water needs.”**



Some Key Ideas for Adaptation Planning

- Approach described here uses sophisticated analytic tools within a specific process of stakeholder engagement
- Key idea is even more broadly applicable:
 - *Use analysis to identify vulnerabilities of specific plans and compare robust responses*
 - See for instance, suite of approaches described by World Resources Institute: <http://www.worldresourcesreport.org/decision-making-in-depth/managing-uncertainty>

Encourage policy makers to change the question from

“What will the future bring?”

to

“What steps can we take today to most assuredly shape the future to our liking?”

More Information

Lempert, Robert J. David G. Groves, 2010. "Identifying and evaluating robust adaptive policy responses to climate change for water management agencies in the American west" Technology Forecasting and Social Change, 77, pp. 960-974.

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www.rand.org/ise/projects/improvingdecisions/

Thank you!