



A Structured Approach to Risk-Benefit Assessment

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Elements in Common

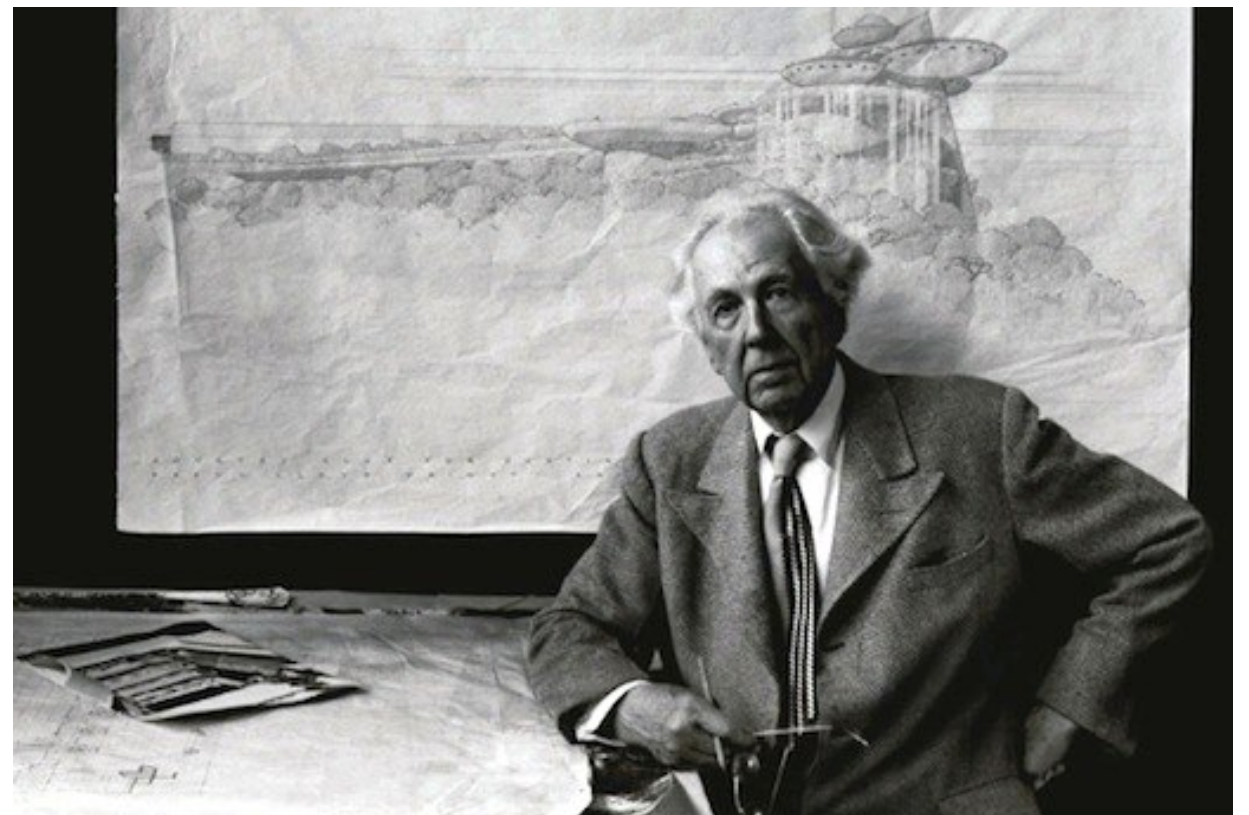
- ▶ ...contextual factors affect risk-benefit assessments...
- ▶ ...“safe” is not explicitly defined...
- ▶ ...quantitative and qualitative analyses, evidence...
- ▶ ...quantity of information...
- ▶ ...uncertainty...
- ▶ ...determining whether benefits outweigh risks...
- ▶ ...need for a structured approach...
- ▶ ...standardized predictable, accessible framework...

Elements in Common

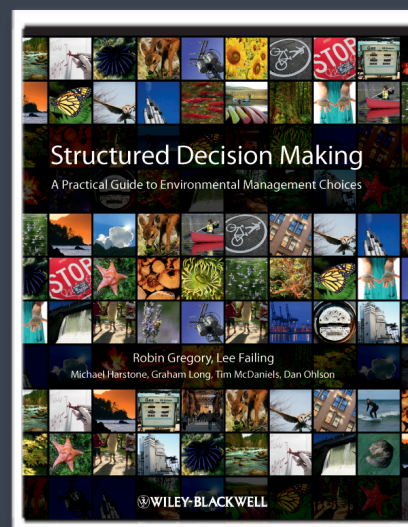
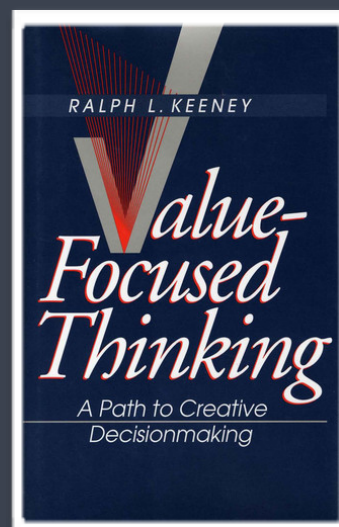
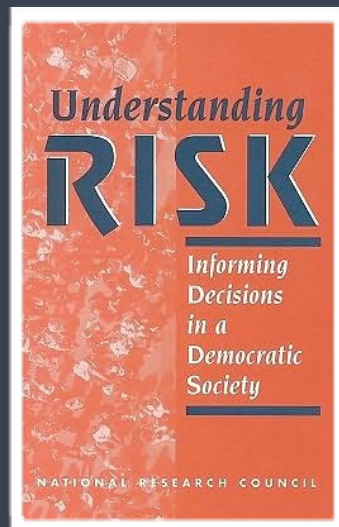
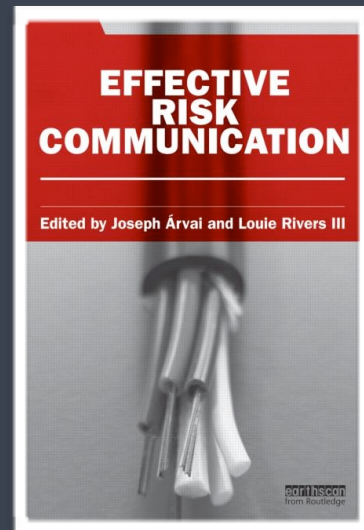
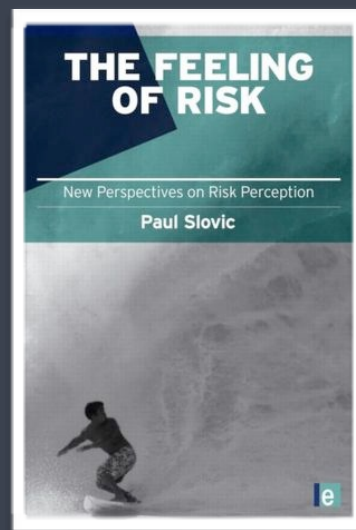
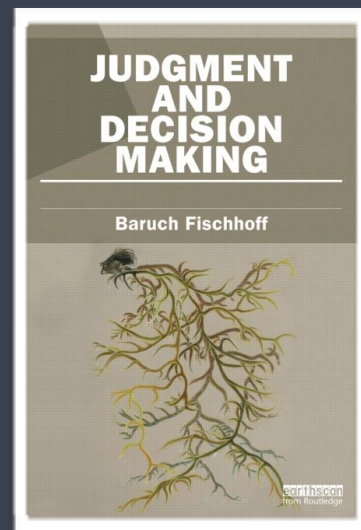
- ▶ **Energy Development (US, Canada)**
- ▶ **Point-of-Use Water Treatment (Africa)**
- ▶ Institutional Arrangements (UN Environmental Programs)
- ▶ Economic Development & Indigenous Land Use (Costa Rica)
- ▶ Superfund Clean-Up (US)
- ▶ Private Wealth Management (Australia)
- ▶ Natural Hazards (Fire, Floods) Management (US, Canada)
- ▶ Climate Change Adaptation (US, Canada)

Constructed Preferences

- ▶ In certain contexts, preferences are not simply “uncovered”.
- ▶ Judgments are “constructed” based on cues present during the decision making process.
- ▶ Constructive processes occur:
 1. When the decision problem is complex or novel.
 2. When quantitative-qualitative translation is necessary.
 3. When tradeoffs must be made.



Science-Based Decision Making + Decision Making Based on Science



- ▶ **Judgmental Processes:** How do people instinctively approach decisions, and how do the outcomes depart from normative standards?
- ▶ **Risk Characterization:** How do people think (and feel) about risks and benefits; how we can make attributes more relevant?
- ▶ **Internal Consistency:** How we can we help to bring choices in line with decision makers' values, objectives, and concerns?

Science-Based Decision Making + Decision Making Based on Science

-
- 1 Define **problems**, opportunities, and constraints; identify stakeholders
 - 2 Identify **objectives** and appropriate **performance measures**
 - 3 Develop sensible, creative, and substantially different **alternatives**
 - 4 Forecast **consequences**, uncertainties; identify thresholds, tipping points
 - 5 Confront **tradeoffs** explicitly and thoroughly
 - 6 **Implement** decisions; monitor, learn, and adapt

Energy Development

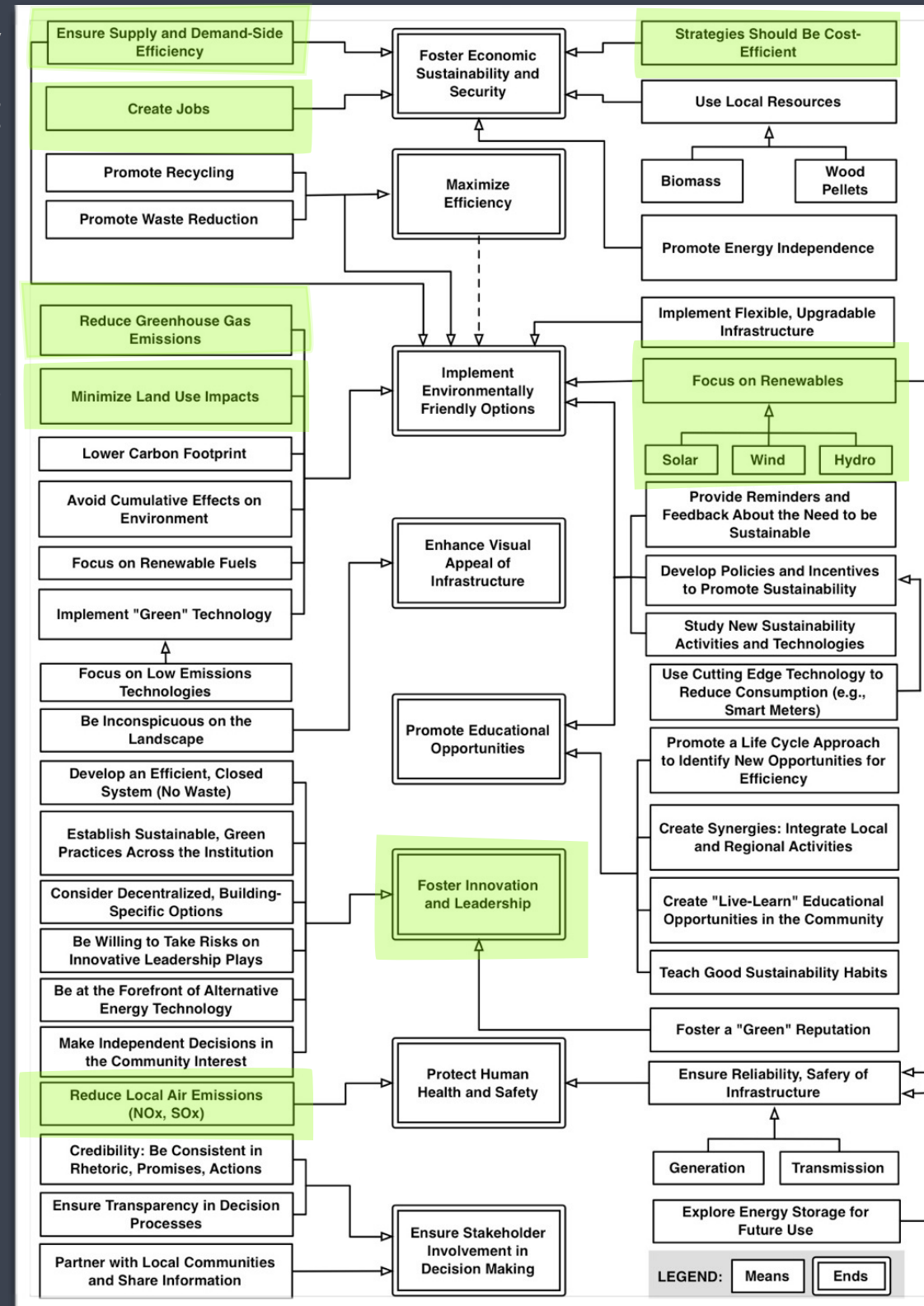


- ▶ Applied work on behalf of Michigan State University.
- ▶ A key decision in the university's sustainability initiative revolved around the decommissioning and replacement of a coal/NG/ biomass co-fired power plant.
 - ▶ Peak Electricity: 99.3 MWh
 - ▶ Peak Thermal: 1.3×10^6 PPH

Efficiency
Employment

GHG Emissions
Land Use

Air Emissions



Cost

Renewable Fuels

Leadership

MSU ENERGY PORTFOLIO BUILDER



Whenever you **Efficiency Options** your portfolio.

5 Generation Units & Fuel Options

Efficiency Options



Energy
Eff. Prog.

Power Plant Options



Natural
gas



Natural
gas



Natural
gas



Not Used



Not Used

Decentralized Energy Options



Distr. Gas



Distr. Gas



Distr.
Solar PV

Off-Campus Options



Offsite
Wind

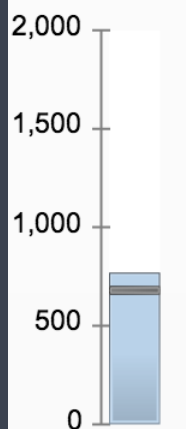


Not Used

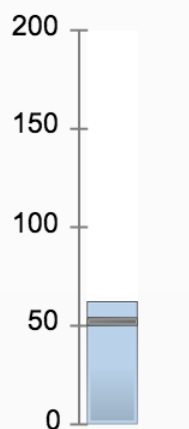
Objectives

Demand Requirements

Steam
000 lbs/hr



Electricity
MW



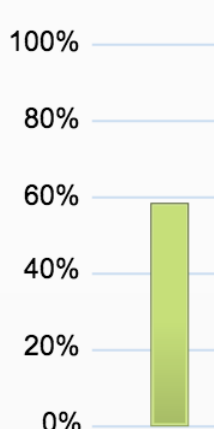
You have met the demand requirements of the campus

Performance Indicators

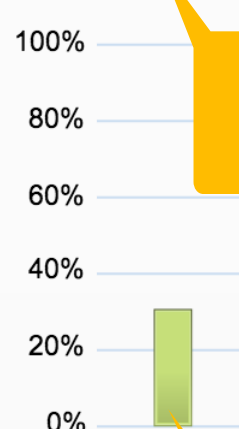
Cost
annual tuition



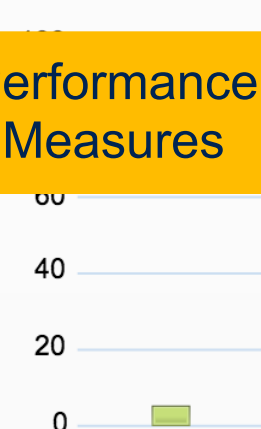
GHG
% reduction



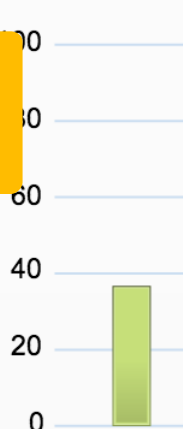
Air Emissions
% reduction



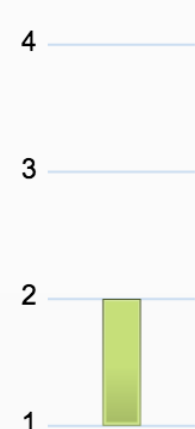
New Local Jobs
full time



Land Use
increase in



Innovation
relative



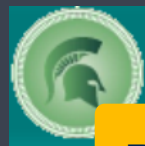
Performance Measures

Consequences



Interactive software developed by Compass Resource Management, Vancouver, BC, Canada.
Database from Black & Veatch, Overland Park, KS, USA.

Energy Development



MSU | Campus Energy Supply Survey

Step 5 : weight the scenarios

Objectives

Performance Measures

Directionality

Worst Level

Best Level

Objectives Rank

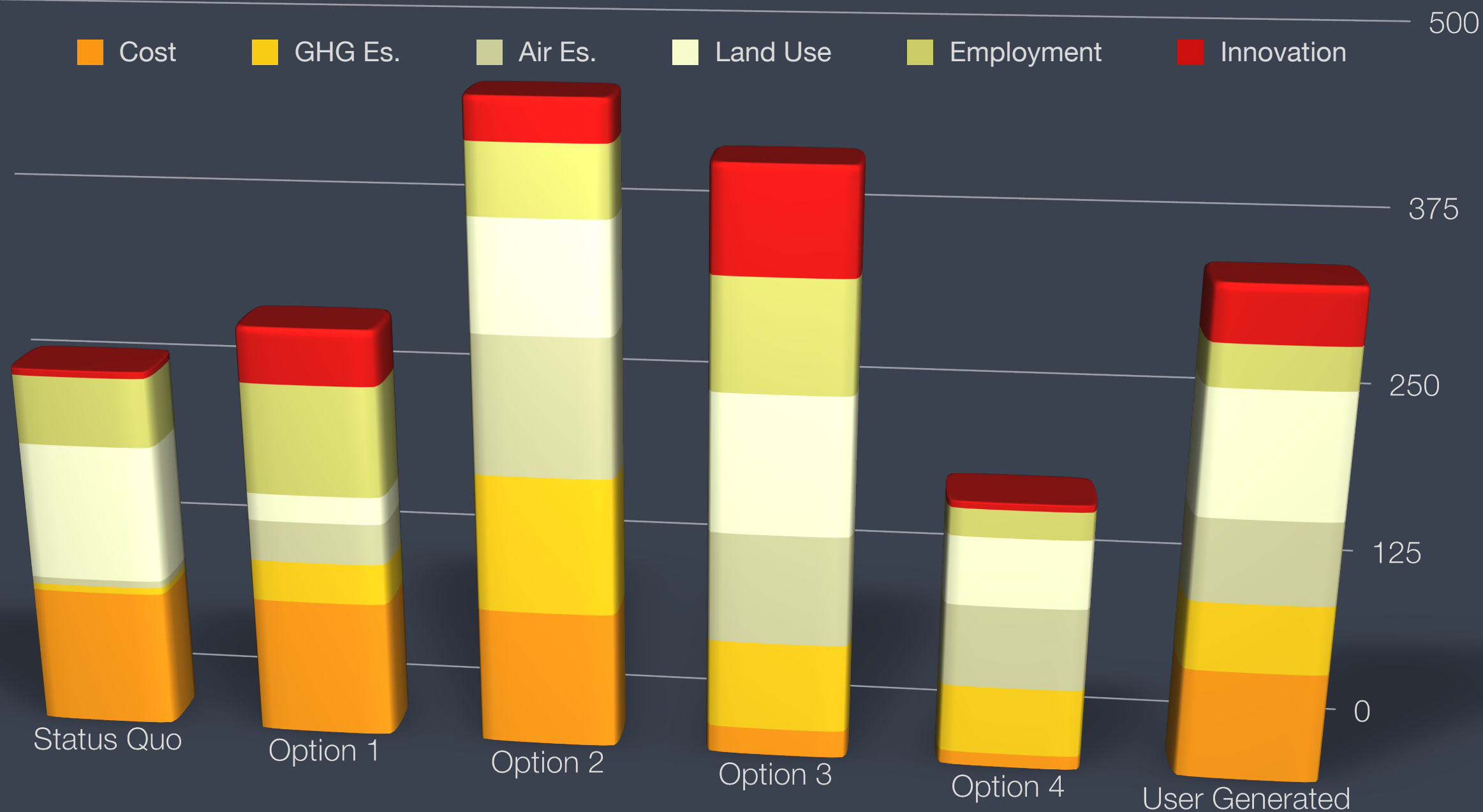
Objectives Weight

Performance Indicator	Units	What's Better?	Worst	Best	Importance (1 = Most, 6 = Least)	Relative Weighting
Cost	tuition premium / yr	Less	\$866	\$133	1	100
GHG	% reduction from current	More	0%	55%	2	80
Air Emissions	% reduction from current	More	0%	41%	2	80
Local Jobs	full time equivalent	More	0.2	20.0	5	20
Land Use	increase in acres	Less	28.7	0.0	3	60
Innovation	relative scale	More	1.0	1.9	4	40



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Energy Development



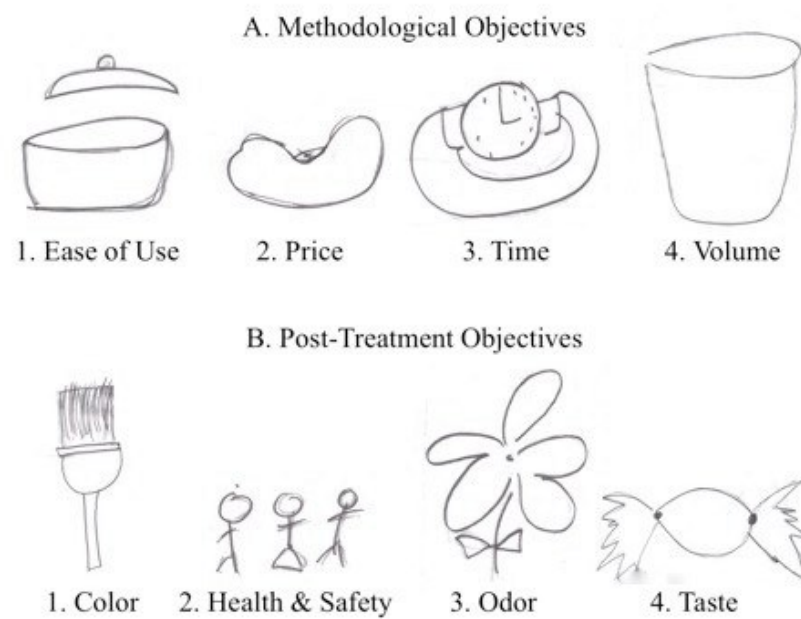
POU Water Treatment



- ▶ Over one billion people in the developing world lack access to clean water.
- ▶ Many POU water treatment methods exist.
- ▶ Multiple objectives in play (cultural → economic).
- ▶ Not all of these methods are appropriate.
- ▶ Seldom are users of these methods consulted during decision making.







POU Water Treatment

Table II. Consequence Matrix Depicting Participants' Mean Ratings and Rankings of POU Methods in Naitolia; Ratings Were Provided on a 0–5 Scale, Where 0 = the Worst Possible Performance and 5 = Best Possible Performance on a Given Attribute; The “Efficacy” Attribute Shows the Results from the Pre- and Posttreatment Assays for the Presence (+) or Absence (–) of Both *E. coli* and Coliforms

	plan B Boiling		GO-TO option Water Guard		phase in slowly PUR® Sachet		Non Starter Ceramic Filter	
	$\bar{x}$ Rate	Rank	$\bar{x}$ Rate	Rank	$\bar{x}$ Rate	Rank	$\bar{x}$ Rate	Rank
Taste	4.7	1	3.9	2	3.6	3	3.1	4
Color	4.2	2	4.1	3	4.5	1	4	4
Odor	4.6	1	4.0	2	3.8	3	3	4
Ease of use	1.2	4	1.6	2	1.4	3	1.7	1
Volume·time ⁻¹	Low	2	High	1	High	1	Low	2
Perceived risk	Low	1	Low	1	High	2	High	2
Efficacy	Tank	Pond	Tank	Pond	Tank	Pond	Tank	Pond
Pretreatment	+	+	+	+	+	+	+	+
Posttreatment	–	–	–	+	–	–	–	–

Dealing With Uncertainty

Strategy '1'

	Alternative 1	Alternative 2	Alternative 3
Objective 1	$H \pm H_u$	$M \pm L_u$	$L \pm H_u$
Objective 2	$L \pm M_u$	$M \pm M_u$	$H \pm L_u$
Objective 3	$L \pm L_u$	$H \pm L_u$	$M \pm H_u$

Uncertainty-Focused
Sensitivity Analysis

Strategy 'A'

	Alternative 1	Alternative 2	Alternative 3
Objective 1	H	M	L
Objective 2	L	M	H
Objective 3	L	H	M
Objective 3 (Uncertainty)	H	M	L

Composite Uncertainty Index
(Tolerance as an Objective)

Decision Support Framework for Developing Regional Energy Strategies

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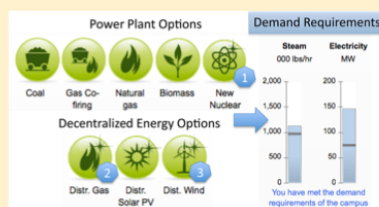
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Supporting Information

ABSTRACT: In an effort to reduce "carbon pollution" as well as prepare the U.S. for the impacts of climate change, President Obama's 2013 Climate Action Plan calls for changes to be made to the nation's energy system. In addition to focusing on alternative portfolios of different fuels and power-generation technologies, researchers and advisory panels have urged that changes to the nation's energy system be based on a decision-making framework that incorporates stakeholders and accounts for real-world resource, supply, and demand constraints. To date, research and development on such a framework have proven elusive. The research reported here describes the development and test of a potential decision support framework that combines elements from structured decision-making (SDM) with portfolio analysis, methods that have been used independently to elicit preferences in complex decision contexts. This hybrid framework aimed to (1) provide necessary background information to users regarding the development of coupled climate-energy strategies; (2) account for users' values and objectives; (3) allow for the construction of bespoke energy portfolios bounded by real-world supply and demand constraints; and (4) provide a more rigorous basis for addressing trade-offs. Results show that this framework was user-friendly, led to significant increases in users' knowledge about energy systems and, importantly, led to more internally consistent decisions. For these reasons, this framework may serve as a suitable template for supporting decisions about energy transitions in the United States and abroad.



1. INTRODUCTION

In his 2013 Climate Action Plan (CAP), U.S. President Barack Obama stated that the United States stands at a "critical juncture" with respect to climate change and its environmental consequences and economic costs.¹ In response, the President put forth a broad-based plan to reduce air pollution, spark business innovation, "grow" new fuels and engineer new sources of energy, and increase the efficiency of cars and appliances. Obama linked these objectives specifically to climate change by calling for a reduction of what he termed "carbon pollution" in America.

At its heart, the President's CAP calls for changes in the nation's energy system, which relies on a portfolio of different fuels and power-generation technologies, as well as research and development activities targeted at new infrastructure and energy investment. Thus, despite the CAP's clear emphasis on climate change, it also speaks to the development of a new national energy strategy. This call for linking climate change to a national energy strategy echoes several high profile calls from both researchers^{2–5} and advisory panels^{6,7} working domestically and abroad.

Developing rigorous and stakeholder-based climate-energy strategies will be a complex and challenging undertaking. To cut through this complexity, Arvai et al.² and the National Research Council⁷ have argued that energy strategy development should go beyond identifying specific generation and delivery options to also include the development of transparent, inclusive, and scientifically rigorous decision-making frameworks. These frameworks, which may be deployed regionally or nationally, should guide multistakeholder, evidence-based deliberations about energy development and delivery. Having these kinds of frameworks at the ready would add legitimacy to efforts like the President's CAP, as well as to many regional energy transitions currently underway, while also ensuring that the most common judgmental obstacles preventing defensible decision-making are being addressed.

These judgmental obstacles are considerable. For instance, decision makers often fail to fully characterize and bound

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Risk Management in a Developing Country Context: Improving Decisions About Point-of-Use Water Treatment Among the Rural Poor in Africa

Joseph Arvai^{1,2,*} and Kristianna Post³

More than 1 billion people, the vast majority of which live in the developing world, lack basic access to clean water for domestic use. For this reason, finding and promoting effective and sustainable solutions for the provision of reliable clean water in developing nations has become a focus of several public health and international development efforts. Even though several means of providing centrally located sources of clean water in developing communities exist, the severity and widespread nature of the water problem has led most development agencies and sanitation experts to strongly advocate the use of point-of-use treatment systems alongside whatever source of water people regularly use. In doing so, however, development practitioners have been careful to point out that any interventions or infrastructure regarding water safety and human health must also adhere to one of the central principles of international development: to facilitate more democratic and participatory models of decision making and governance. To this end, the research reported here focused on the development of a deliberative risk management framework for involving affected stakeholders in decisions about POU water treatment systems. This research, which was grounded in previous studies of structured decision making, took place in two rural villages in the East African nation of Tanzania.

KEY WORDS: Africa; international development; structured decision making; water

1. INTRODUCTION

More than 1 billion people—or one out of every eight worldwide—lack basic access to clean water for domestic use, with the vast majority of these people living in the developing world. In the East African nation of Tanzania, for example, extreme

water shortages are the norm for much of the rural population living in the interior of the country. Despite the presence some of the world's largest lakes (e.g., Lake Victoria and Lake Tanganyika), this region of Sub-Saharan Africa receives an average annual rainfall of less than 800 mm. As a result, people in this area—most of them living in extreme poverty—typically obtain whatever water they can from transient sources. These include seasonal ponds and streams, and in some extreme cases, puddles.

Making matters worse, much of the water that is available for domestic use in this region of Tanzania is contaminated with an array of viruses, bacteria, and protozoa. Associated with these agents are water-borne diseases, including cholera, typhoid, shigellosis, and a range of other diarrheal

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