Total Cost Assessment History, Methodology, Tools, and a Case Study

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Prepared for ASME's IMECE 2005

Outline

- History
- Method & Tools:
  - Cost Types
  - Confronting Uncertainty Head-On
  - Scenario Analysis
  - Workshop at the Core
- Case Study – Biodiesel Refinery

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Total Cost Assessment—where it came from

- Developed in 1991 by the Tellus Institute for the EPA and New Jersey Department of Environmental Protection
- Based on methods and programs developed by GE.
  "GE developed its new environmental project analysis method to better select and justify waste management investment decisions that are environmentally sound and should reduce long-term liabilities "
- Sequence of studies provided the theoretical background for Total Cost Assessment

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AIChE CWRT Project

- In 1997, AIChE Members wanted a sound TCA methodology
- Embarked on a two-part project.
- Part I: Survey of status and available methodologies world-wide
- Part II : Development of industry validated methodology
- Project Team
  - AD Little — Bristol-Myers Squibb
  - DOE — Dow
  - Eastman Chemical — Eastman Kodak
  - Georgia Pacific — IPPC of Business Round Table
  - Merck — Monsanto
  - Owens Corning — Rohm and Haas
  - SmithKline Beecham (Lead) — Sylvatica

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Methodology Tested by Industry

- Dow Chemical

  "This is an incredibly useful tool for Dow and for the industry — helping us to understand the costs of making products and giving us additional information to make better business decisions from the beginning."
- Monsanto
- GlaxoSmithKline

  "TCA's greatest contribution to GSK is likely to be at the corporate policy/strategy level." "TCA will be applied to R&D LCI/A tools under development."
- Eastman Chemical

Methodology Launch and Post-launch history

- Methodology and Manual Tools Launched in July 1999
- TCAce commissioned and completed in 1999
- TCAce commercialized for consultant use in 2004.
- The methodology is in use by numerous organizations, especially in Canada, with widespread adoption in British Columbia.

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Five Cost Types Distinguished

- Type I: Direct
- Type II: Indirect
- Type III: Contingent Liability
- Type IV: Intangibles
- Type V: External

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Cost Types

Cost Type	*Description*	*Examples*
I. Direct costs	Manufacturing site costs	Capital investment, operating, labor, materials, and waste disposal costs
II. Indirect costs	Corporate and manufacturing overhead	Reporting costs, regulatory costs, and monitoring costs
III. Future and contingent liability costs	Potential fines, penalties and future liabilities	Clean-up, personal injury, and property damage lawsuits; industrial accident costs.
IV. Intangible internal costs (Company-paid)	Difficult-to-measure but real costs borne by the company	Cost to maintain customer loyalty, worker morale, union relations, and community relations.
V. External costs (Not currently paid by the company)	Costs borne by society	Effect of operations on housing costs, degradation of habitat, effect of pollution on human health

Total Cost Assessment—How do you do it?

- Step 1 – define goal and scope
- Step 2 – streamline the analysis
- Step 3 – identify potential risks
- Step 4 – conduct financial inventory
- Step 5 – conduct impact assessment
- Step 6 – feedback to decision-making loop

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TCAce Adds to the Robustness of the Method

Scenario Builder for Accidents/Liabilities, Possibilities, "Intangible" Outcomes, etc.

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Corporate Cost Analysis System Results: *per year or per unit of production* → Integrate Functional Unit & Annual / Production Perspectives ← LCA Results: *per functional unit*

↓

Modeling, M/C Analysis

↓

Results Reporting & Cause/Factor Exploration

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Conventional (I & II) Costs

- Companies follow strict procedures for conventional capital allocation decisions:
  - Work flow / responsibilities
  - Conventions regarding
    - Discounting
    - Time horizons
    - Tax impacts in profitability analysis
- TCA Imports, integrates, meshes with existing corporate approaches to I & II

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TCA Approach to Non-Conventional Costs: Match Company Conventional Approach

- Follow & Adapt to General and Company-Specific Accounting Conventions
  - Investment costs
  - Depreciation, salvage values
  - Impacts before- or after-tax
  - Discounting
  - Time Horizon

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Uncertain

Why "get into" uncertainty?

"Never make predictions, especially about the future."
Casey Stengel

Uncertainties are pervasive

- Prices
- Costs
- Sales
- Macro-economy
- Technological Change
- Decisions by Competitors
- Accidents
- Lifetimes of investments
- Timing of events
- Impact effectiveness

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Approach to Uncertainty

- Take blinders off; acknowledge
- Ask subject experts what they know
- Brainstorm
- Model systematically
- Test for possible importance
- Refine if necessary

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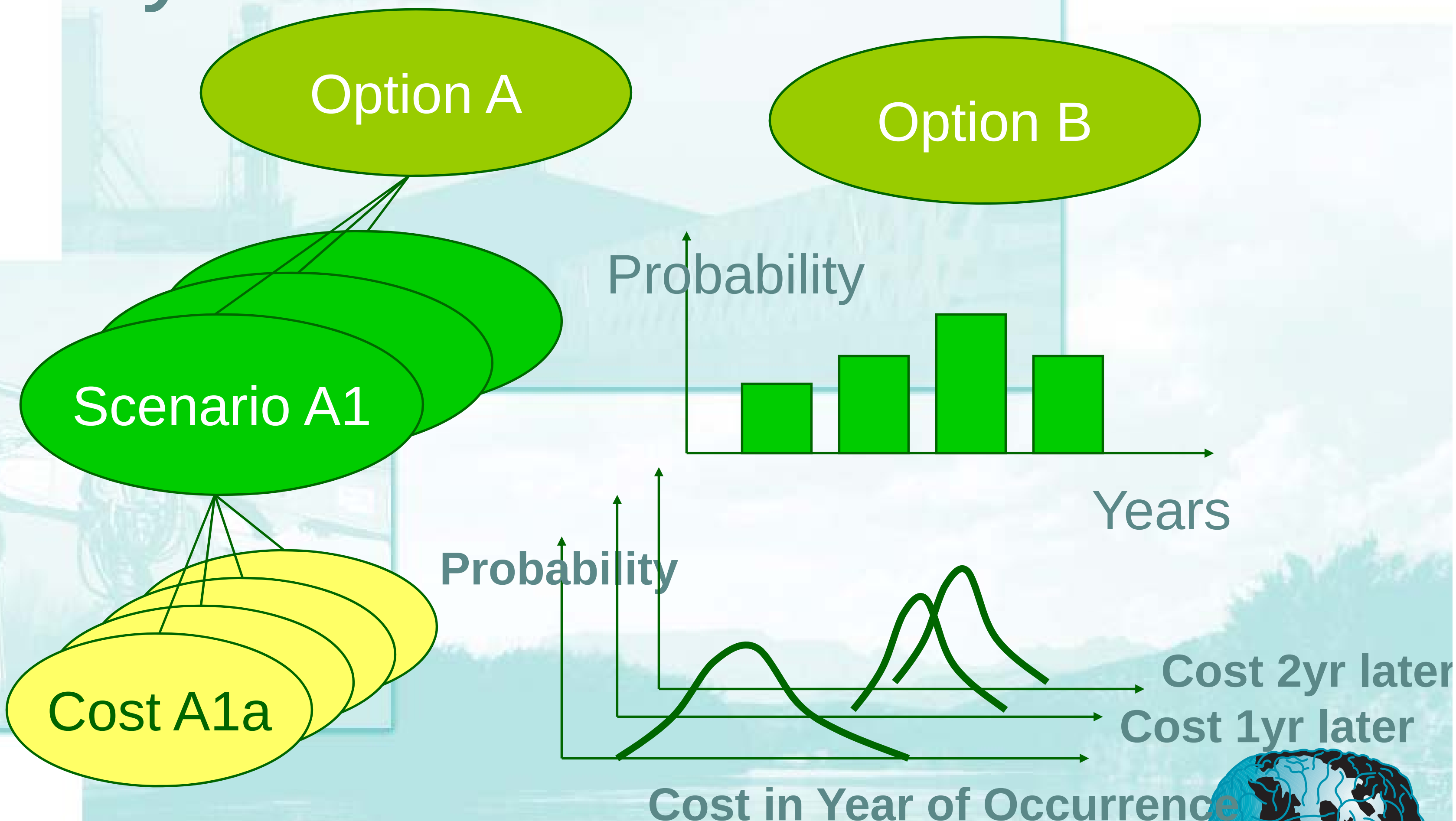
Outcomes of interest to Decision Makers

- Most likely outcome *Mode*
- Central, mid-ranked outcome *Median*
- How good/bad can it get? *Min/Max*
- What range are we pretty certain it will fall within? *Percentiles*
- What is the likelihood of a major impact? *Cumulative Density Function*

The Core: Scenario Analysis



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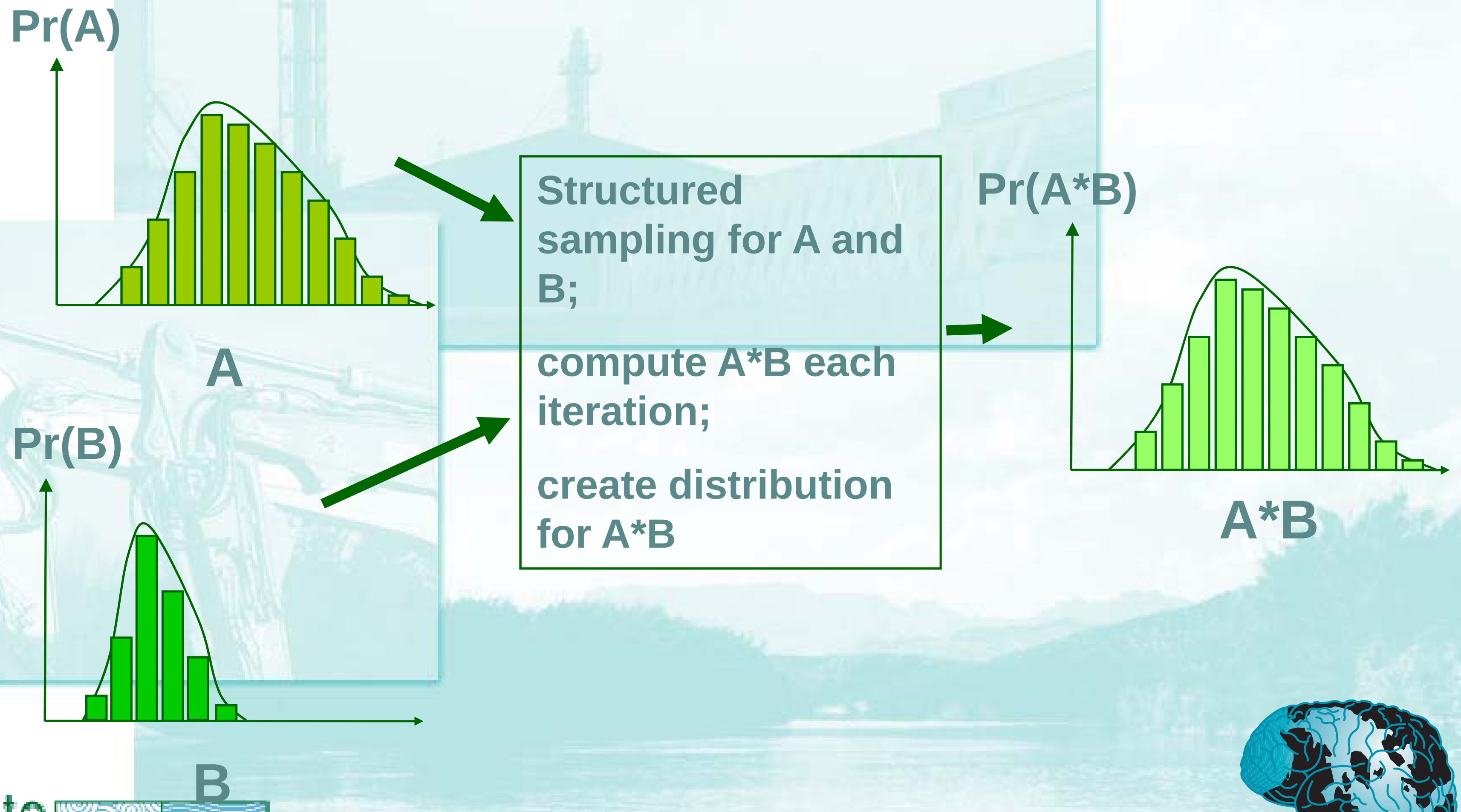
Monte Carlo Analysis



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Alternatives → Scenarios

- How could decision or course of action impact *timing*, *likelihood*, or *relevance* of
  - Future environmental regulations
  - Accidents, spills, equipment failures
  - Non-compliance incidents
  - Worker health/safety incidents
  - Interruption of supply for major inputs
  - Significant and long-term shifts of costs
  - Shifts in market share
  - Actions/pressure from one or more stakeholders

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Scenarios → Costs

- For each possible event with altered timing, likelihood, or relevance:
  - What are the possible cost impacts?
    - Direct costs / impacts
    - Long-term / “secondary” impacts
      - Customer loyalty
      - Employee attraction/retention/morale/productivity
      - Brand value
      - “License to operate” (local, state, federal)
  - Timing, duration, magnitudes

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Mechanics: "Workshop" Approach

- Workshops configured for 1-2 days - Key business and project people needed for TCA data/analysis have only limited time for TCA type analysis (current paradigm)
- Highly disciplined process with total focus on TBCA - due to limited time
- Scenarios used to clearly document key issues, data, judgements and decisions

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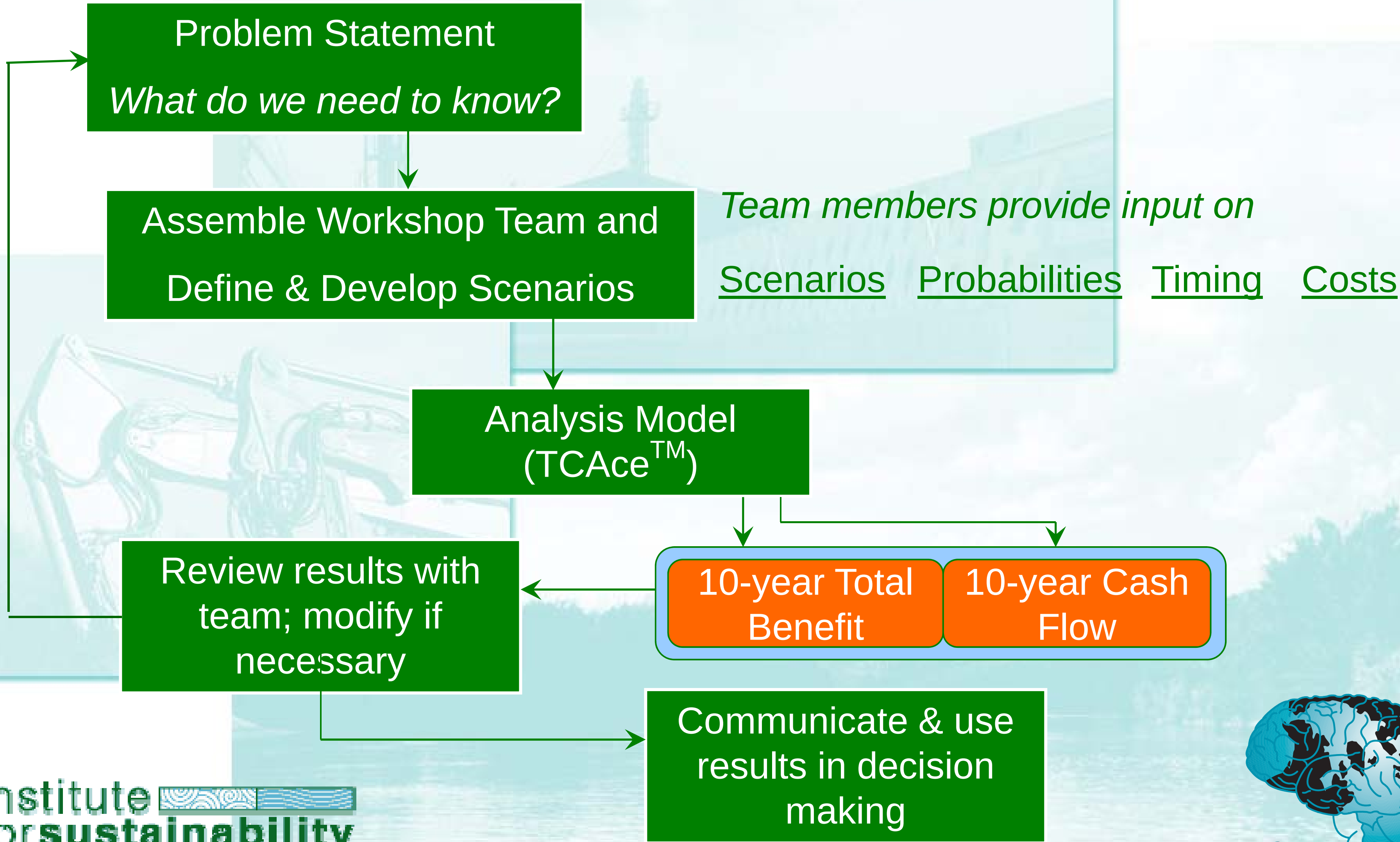
Dow TBCA Process Overview



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Optional Spreadsheet Tracking/Recording of Inputs and Results

	A	B	C	D	E	F	G	H	I	J
1	**Use this sheet to store and summarize information about Type 3 and 4 scenarios and costs.**							Cost risk data		
2			Major spill	New Env. Reg.	Green shift	Depreciation Method	Salvage Value ($)	Yrs After Occurrence		
3	Scenario Types	1. Annual Probs, Repeatable	1	0	0					
4		2. Ann Probs, Non-repeatable	0	1	0					
5		3. Overall & Relative Probs	0	0	1					
6	Overall Probablity (For Type-3 Scenarios)		0	0	0.2			0	1	2
7	Tie Scenarios to Costs	Cleanup, fines, penalties	1	0	0	0	0	Uniform(200000,400000)	50000	0
8		Install control equipment	0	1	0	10sl	10000	1000000	0	0
9		Control equipment O&M	0	1	0	0	0	0	100000	100000
10		Brand value loss	1	0	1	0	0	10000000	-5000000	-3000000
11	Tie Scenarios to Options	Business-as-usual	1	1	1					
12		Green substitute	0	0	0					
13	Annual Probabilities	2003	0.05	0	0					
14		2004	0.05	0	1					
15		2005	0.05	0.05	1					
16		2006	0.05	0.1	2					
17		2007	0.05	0.15	2					
18		2008	0.05	0.2	3					
19		2009	0.05	0.2	3					
20		2010	0.05	0.2	3					
21										
22										
23	Key:	Scenario names								
24		Scenario cost names								
25		Option names								
26		Scenario horizon years								
27		Years after occurrence								

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Goals for Biodiesel Facility

- Community Goals
  - Maintain agricultural land
  - Minimize environmental impact
  - Add revenue stream
- Corporate Goals
  - Profitability
  - Sustainability
  - Use of economical raw materials
  - Safe and environmentally sound processes and practices.

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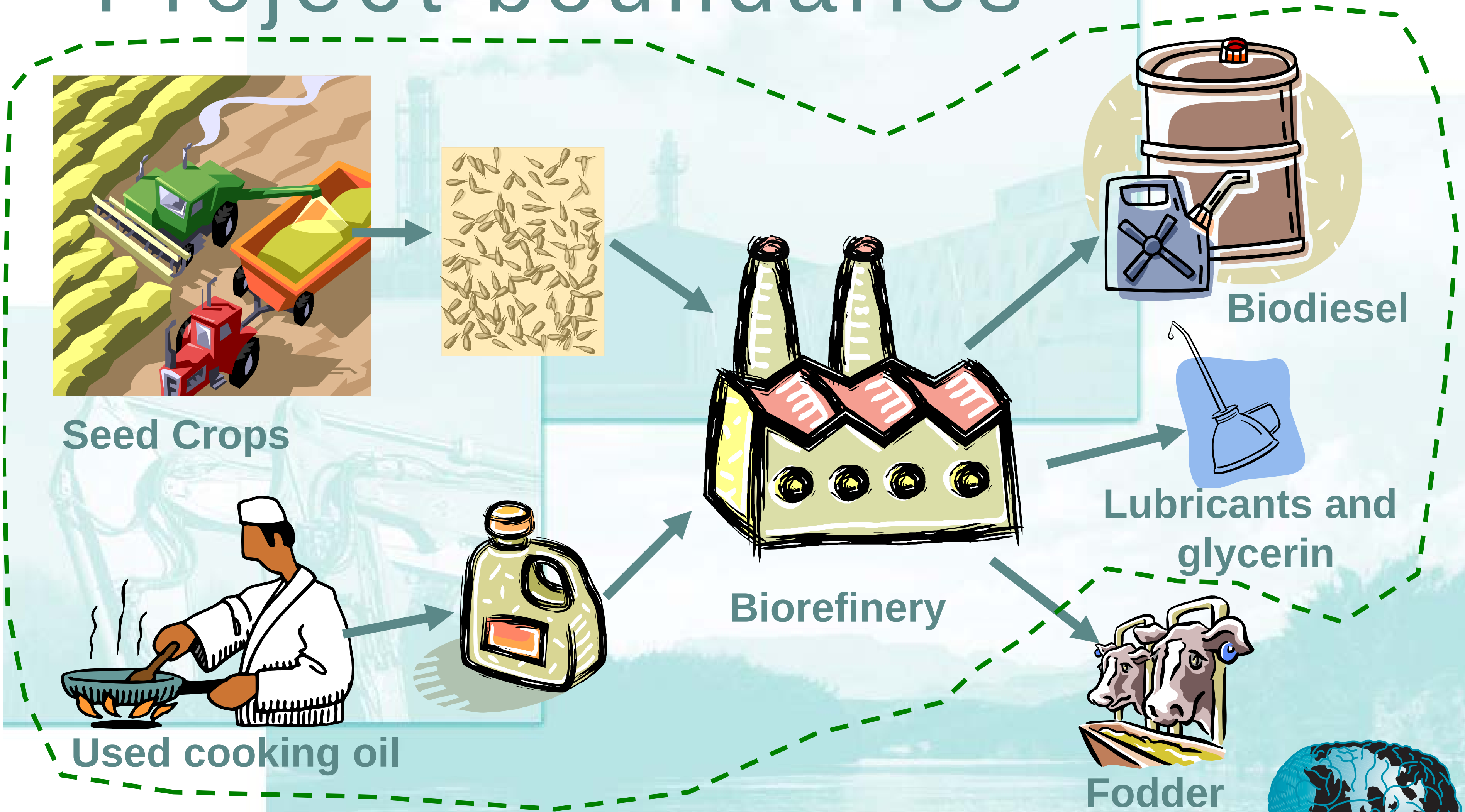
Project boundaries



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Scope

- Plant to produce 2.5 million gallons biodiesel per year
- Design & construction to begin in 2005
- Operations to begin 18 months later
- Plant to be built on brownfields
- Up to 50% of feedstock to come from "yellow grease" (used cooking oil)

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TCA Options

- Option 0. Do Nothing
- Option 1. Build Biorefinery with purchased virgin seed oil
- Option 2. Build Biorefinery as a cooperative with oil seed farmers

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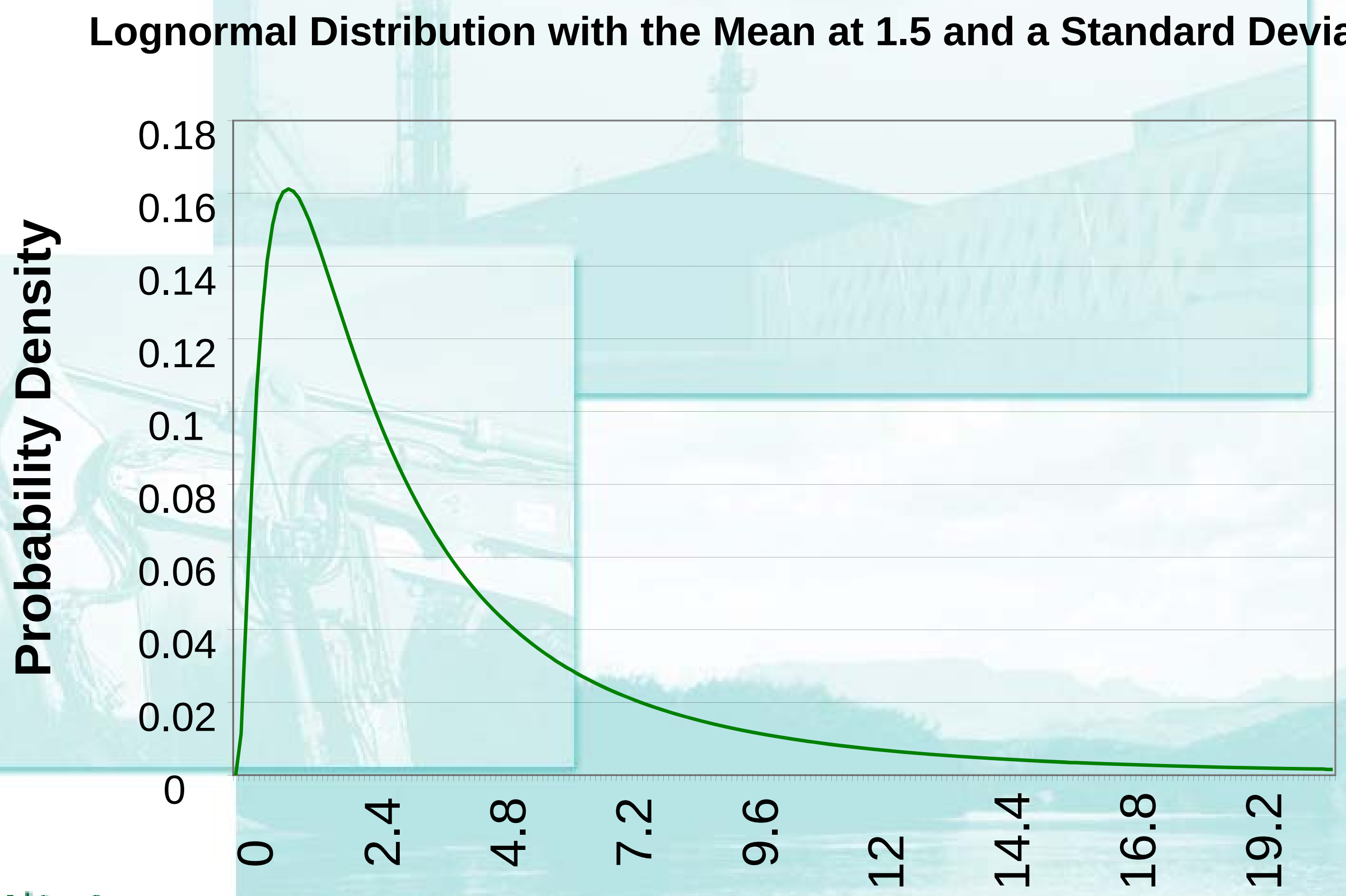
Type I & II Costs

- Plant construction
- Operational costs
- Feedstock costs (complex equation allowing 0-50% to come from less expensive, but price-volatile yellow grease)
- Licensing and Reporting
- Hazardous material handling
- Testing
- Revenues – modeled as negative costs (complex price distribution)

Distribution curve for biodiesel revenues



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Scenarios

1. Delay due to permitting or other regulatory requirements
2. Methanol discharge to air
3. Massive Methanol discharge to land
4. Employee exposure
5. Improper disposal by subcontractor
6. Plant Contamination
7. Union negotiation
8. Product does not meet test criteria

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Results of Life Cycle Assessment (Virgin Oil only)

- 78% reduction in greenhouse gas production = -18 lbs CO_2 /gal (a)
- Nearly equal energy to produce: 0.23 MJ vs 0.20 MJ (b)
- 3.2 MJ produced per MJ of fossil fuel used (b)
- Fewer particles, CO, and, SOx by reducing levels at the tailpipe. (a & b)
- NOx and total hydrocarbons higher for biodiesel (tailpipe hydrocarbons lower) (a & b)

(a) Berlin-based Institute for Energy and Environmental Research (IFEU) "Life Cycle Assessment of Biodiesel: Update and New Aspects",

(b) National Renewable Energy Laboratories (NREL) publication "An Overview of Biodiesel and Petroleum Diesel Life Cycles"

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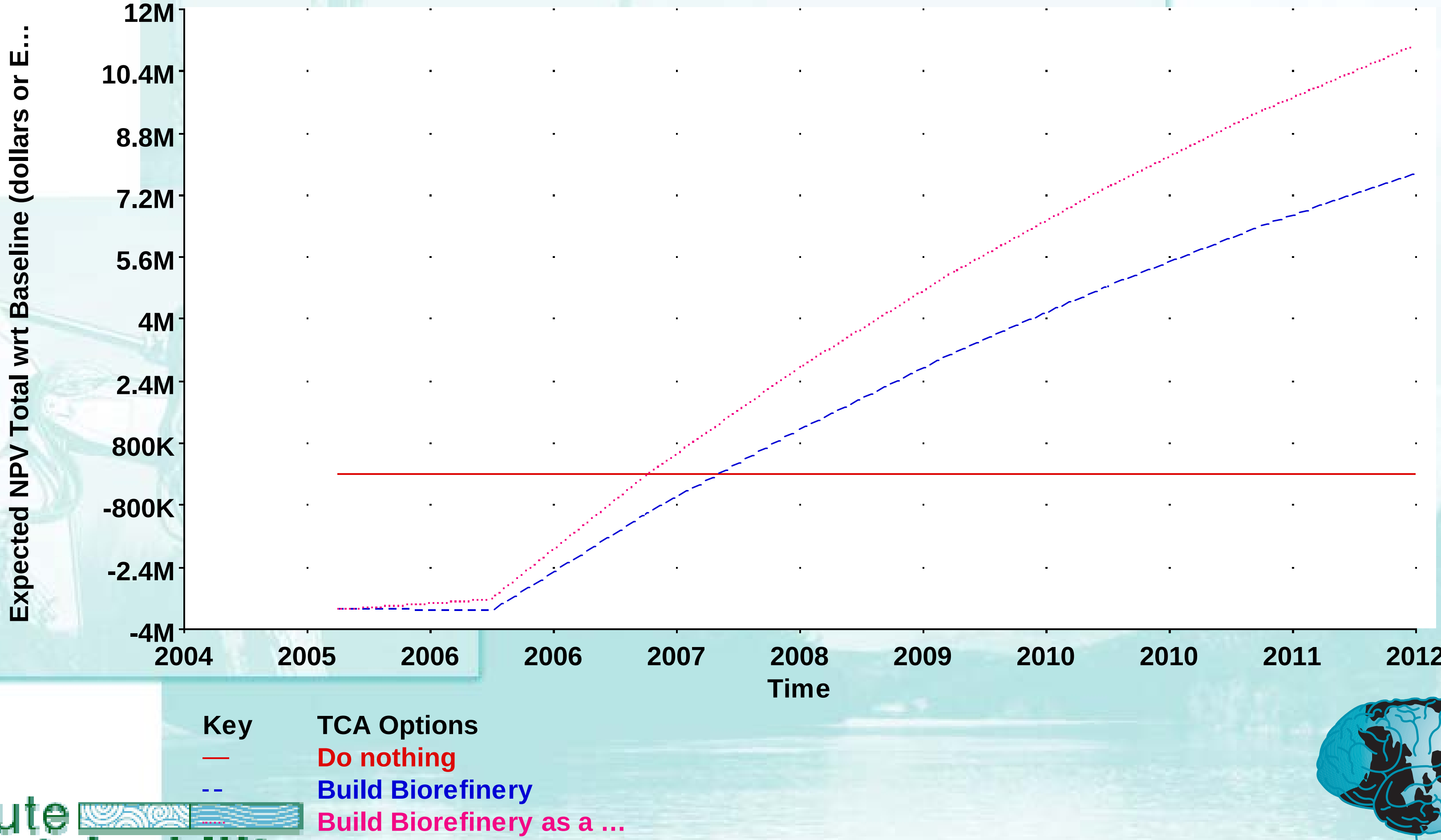
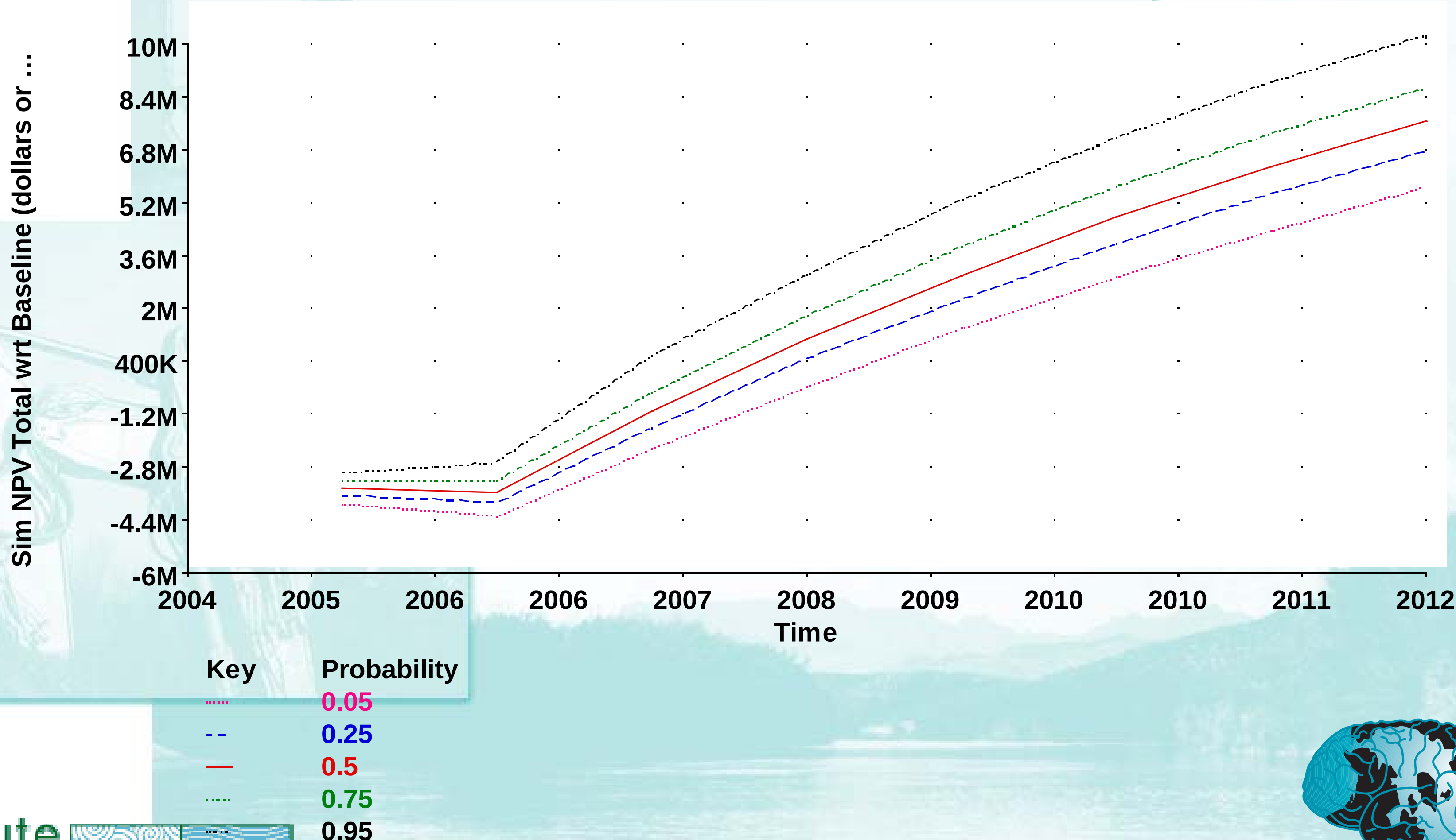
TCA Results

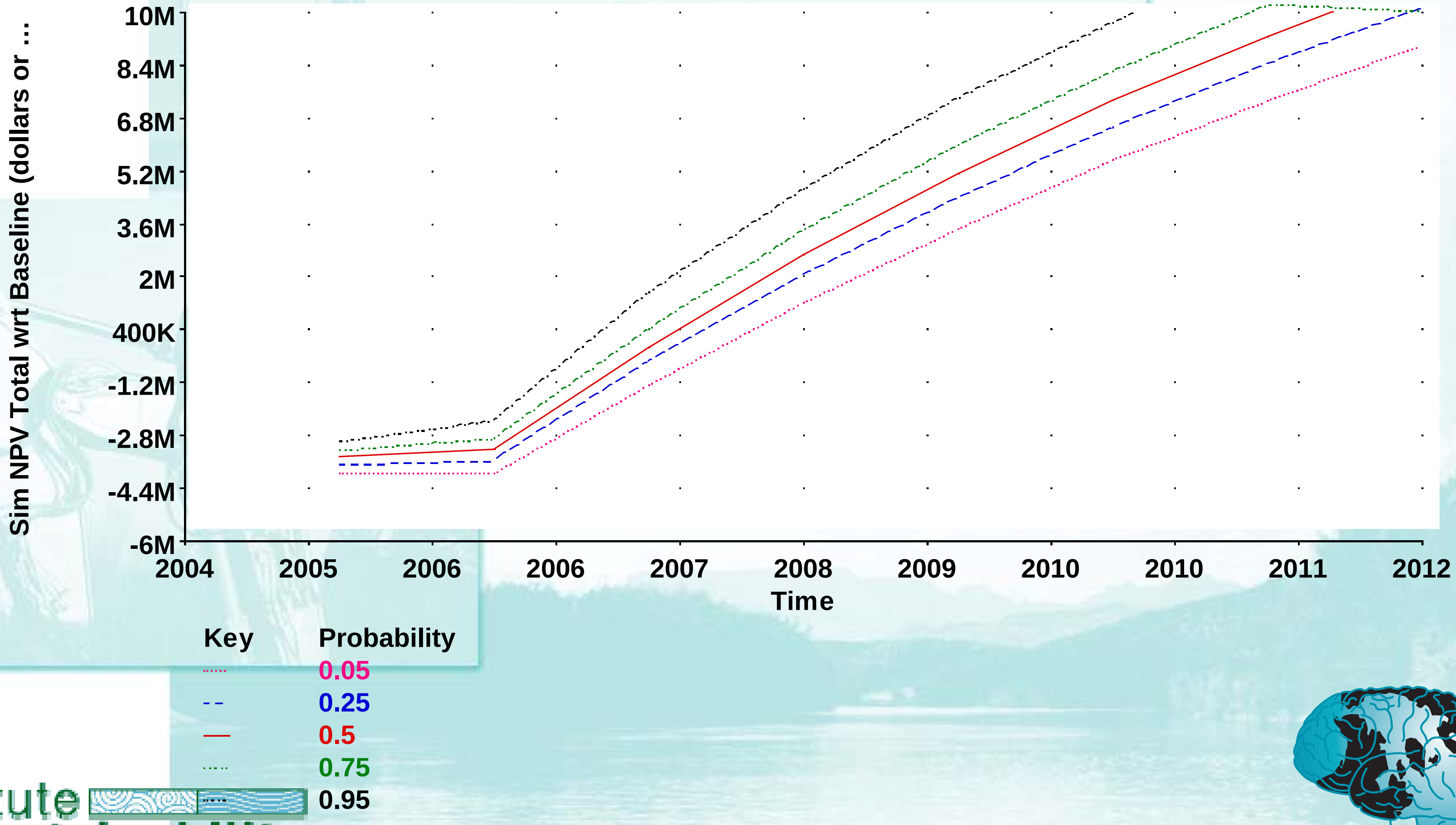
In both biorefinery options, the NPV calculated through 2008 is positive, showing rapid return on investment. Discount rate is set to 0.12.



Simulated NPV for the first biorefinery option shows a 95% probability of a postitive NPV calculated through about 2009. Discount rate is set to 0.12.



Simulated NPV for the cooperative situation shows a high potential for excellent results.



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The Decision

- LCA shows biodiesel lowers local environmental impacts
- TCA shows profitability for the company with little environmental risk
- Company looking at other tools to make their final decision

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