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Biodiesel in Vermont—the environmental impact and the total cost

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Outline

- Goals
- Method & Tools:
 - LCA
 - TCA
- Scope
- Costs
- Analysis Results
- The Decision



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.



Methods and Tools—Life Cycle Assessment

- Method used to assess the environmental impacts of a product from raw materials extraction through disposal.
- Credible, robust, scientific method for estimating and comparing environmental impacts
- Standardized through ISO



Total Cost Assessment— what is it?

- A method that allows uncertain costs to be considered along side traditional fixed and variable costs
- Developed to assess the true costs of environmental risks, but has been used to assess other uncertain outcomes and scenarios
- The methodology was developed and tested by industry leaders led by the AIChE



Five Cost Types Distinguished

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



Cost Types

<i>Cost Type</i>	<i>Description</i>	<i>Examples</i>
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



Scope

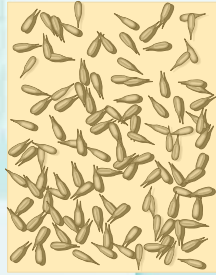
- Plant to produce 2.5 million gallons biodiesel per year
- Design & construction to begin in 2005
- Operations to begin 18 months later
- Plant to be built on brownfields
- Up to 50% of feedstock to come from “yellow grease” (used cooking oil), the remainder from locally grown rapeseed



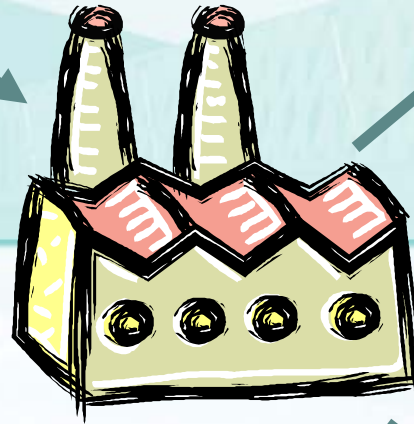
Project boundaries



Seed Crops



Used cooking oil



Biorefinery



Biodiesel



Lubricants and glycerin



Fodder



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



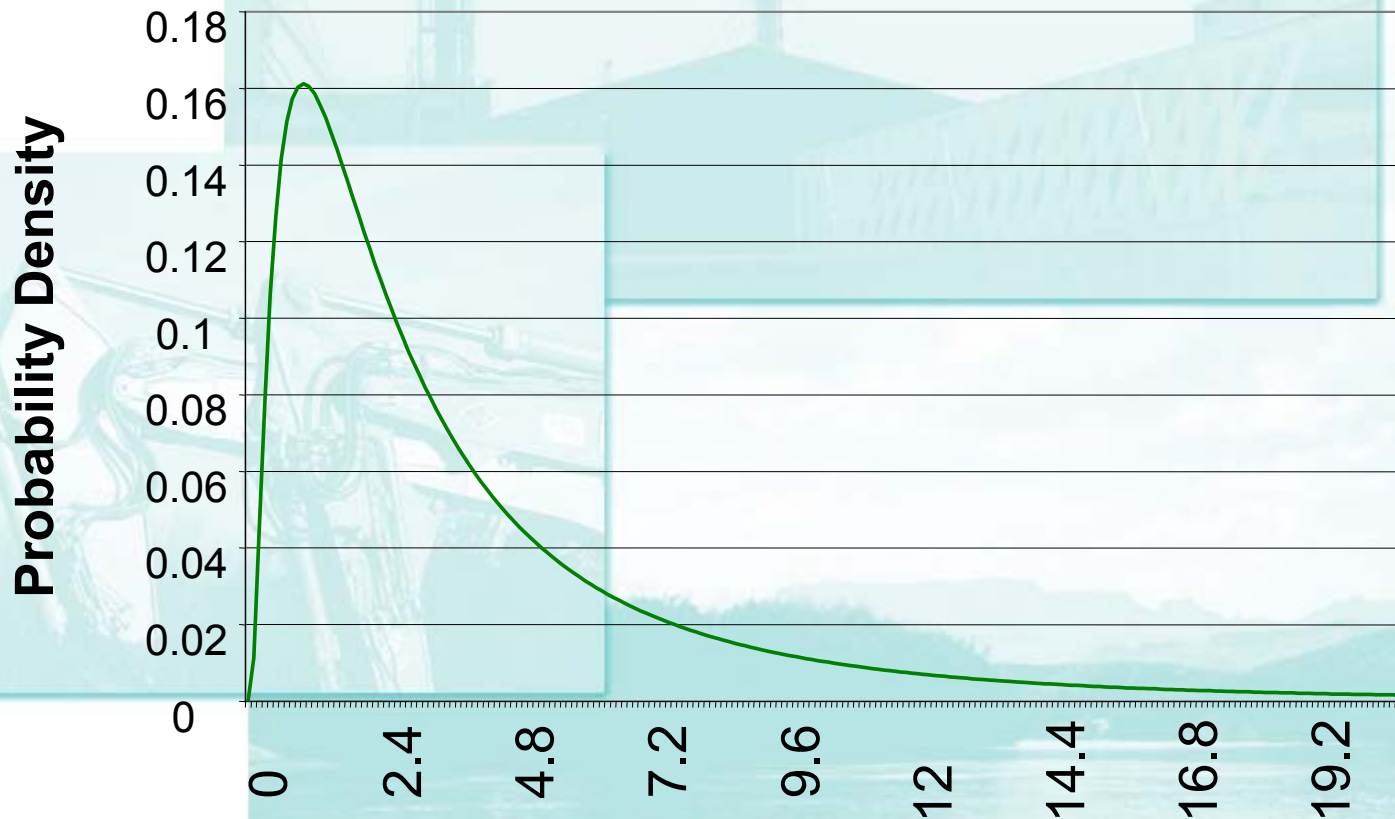
Type I & II Costs

- 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 (diesel price as a stochastic, dynamic variable)



Distribution curve for biodiesel revenues

Lognormal Distribution with the Mean at \$1.50/gallon and a Standard Deviation of 1.5



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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



Results of Life Cycle Assessment (Virgin Oil only)

- 78% reduction in greenhouse gas production = -18 lbs CO₂ /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, SO_x by reducing levels at the tailpipe. (a & b)
- NO_x and total hydrocarbons higher for biodiesel (tailpipe hydrocarbons lower) (a & b)

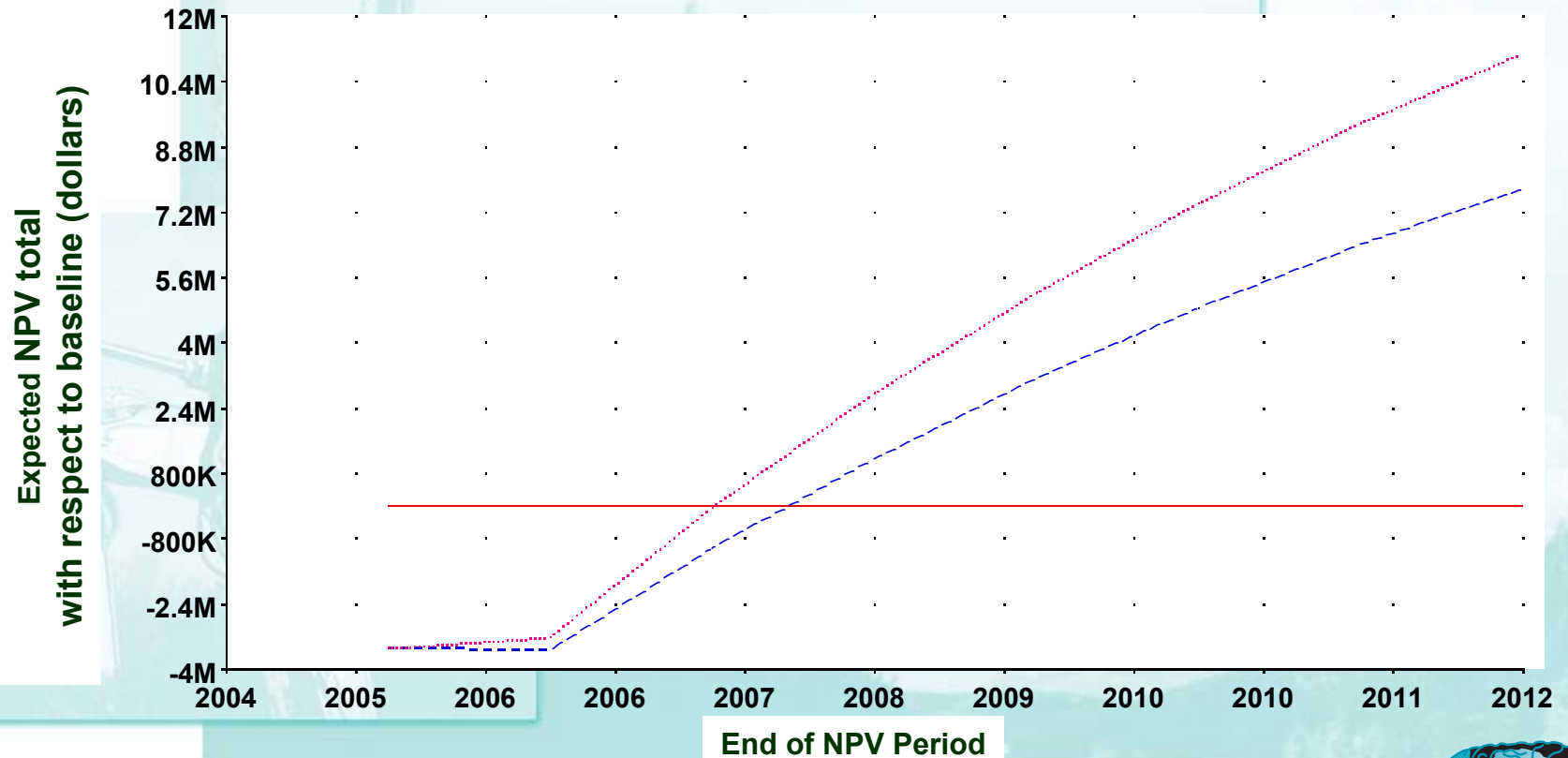
(a) Berlin-based Institute for Energy and Environmental Research (IFEU) “Life Cycle Assessment of Biodiesel: Update and New Aspects”,

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



TCA Results

In both biorefinery options, the NPV calculated through 2008 is positive, showing rapid return on investment. Discount rate is set to 12%.



Key
— Do nothing
- - Build Biorefinery
..... Build Biorefinery as a ...

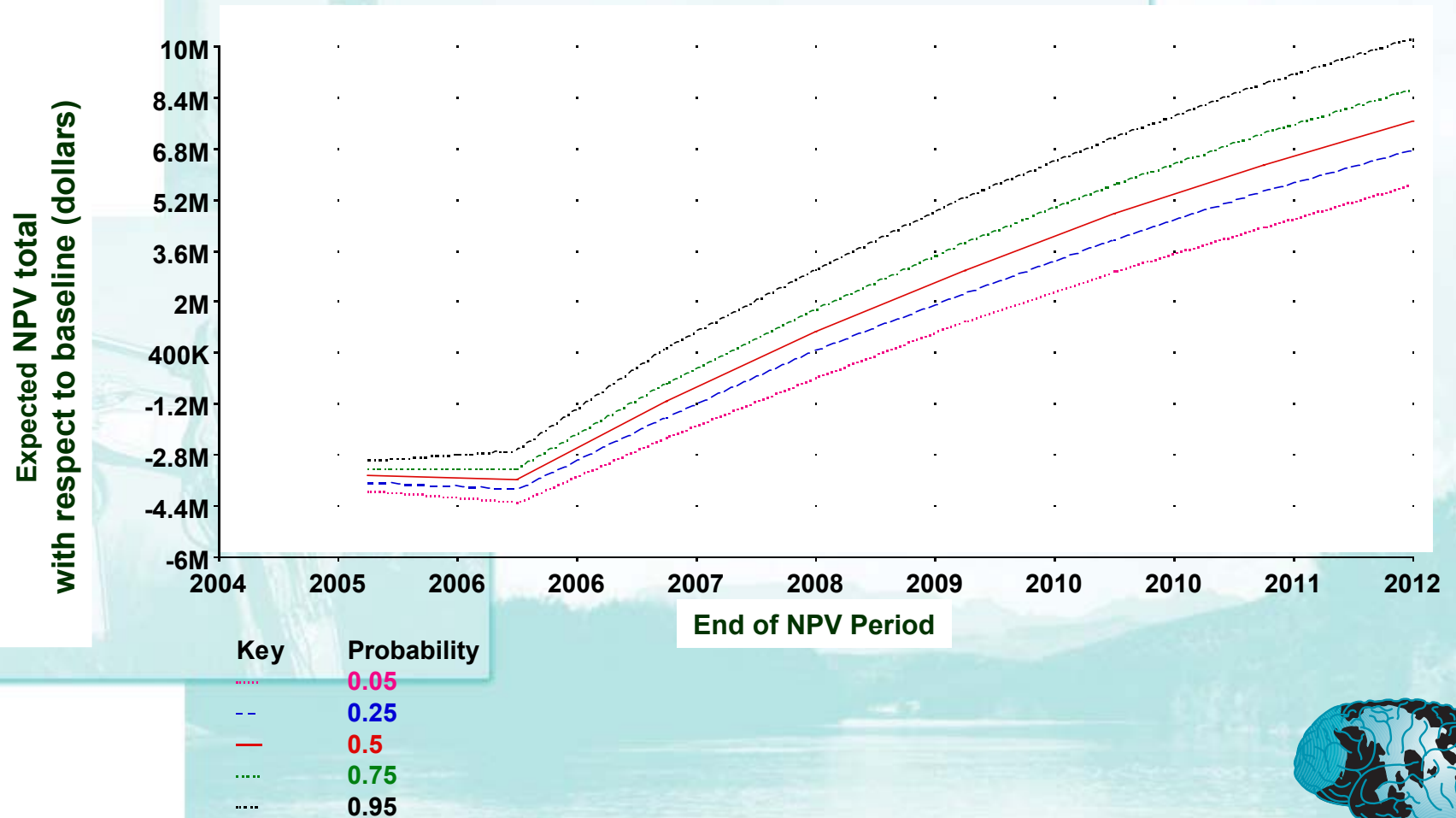


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Simulated NPV for the first biorefinery option shows a 95% probability of a positive NPV calculated through about 2009. Discount rate is set to 12%

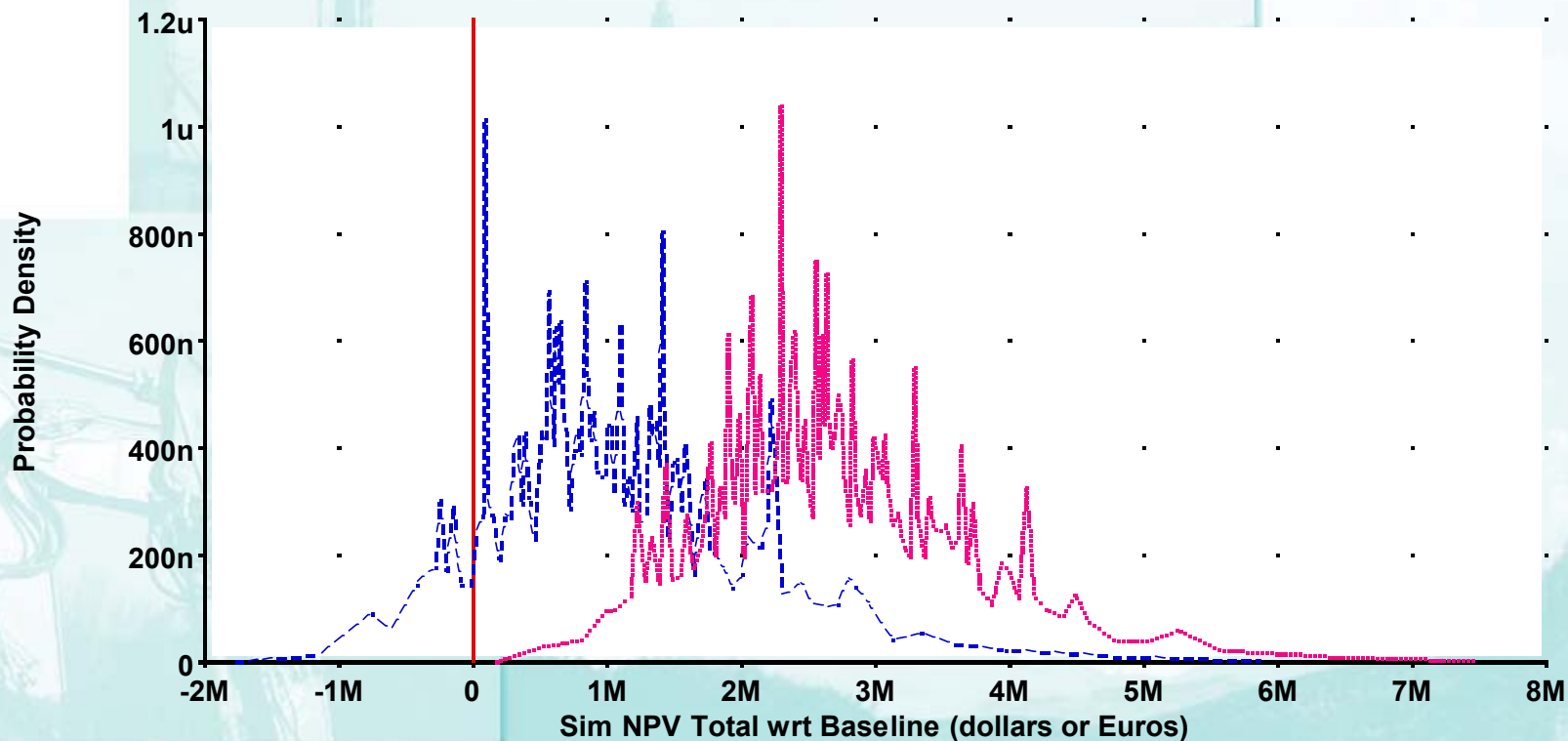


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The probability density for simulated NPV shows the higher probability of positive NPV for the co-op calculated through 2007



Key TCA Options
— Do nothing
-- Build Biorefinery
... Build Biorefinery as a ...



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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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