Palisade Live Webcast

Refining the Business Case for Sustainable Energy Projects Using Palisade @RISK and PrecisionTree: A Biofuel Plant Case Study

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1. Overview

Welkom in Amsterdam

- **Context**
  - Below sea level (-4M)
    www.fragilecologies.com/sep29_06.html
  - Dutch East India Co. (VOC) (1602)
    - Globalization
    - Genesis of modern stock exchange
    - Derivatives (futures & options)
    - Perpetuities

http://blog.sunan-ampel.ac.id/auliyaridwan/

- **Overview**
  1. *Profitable* sustainable energy projects
  2. Palisade as facilitating tool
  3. Biofuel project as example

- **Scott Mongeau**
  - Independent int'l consultant (NL-based)
  - Decision & risk analysis
  - www.linkedin.com/in/smongeau

1. Overview

2. Global energy quandy

3. Palisade Suite approaches

4. Biofuel plant case exemplar

5. Concluding comments

6. Questions and comments

7. Appendix: References

Global Energy: Outlook for Change

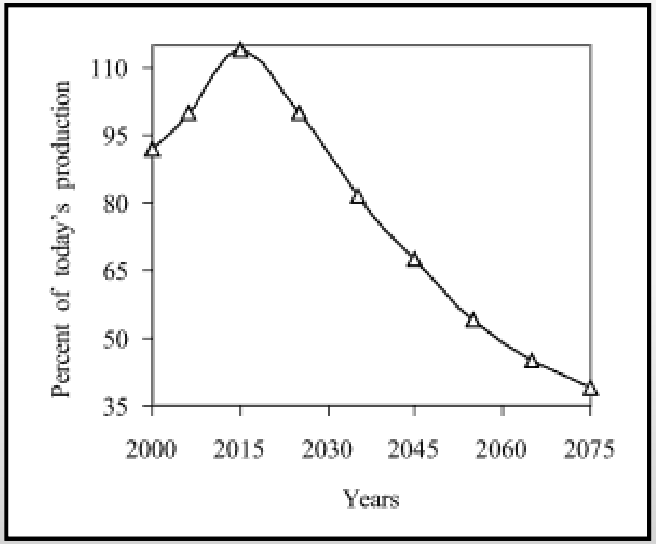
Depletion of fossil fuels

- Finite resource
- Growing demand
- Declining reserves
  - 50 years left at rate of *current consumption*
  - Peak production: 2015 *
  - **2016** onwards: several % per year decline
  - **2030** onwards: dramatic supply crisis / gap +30% primary energy needed
- Costly exploration: deep sea, oil sands, polar
- 2/3 new exploration wells drilled are dry

World Energy Sources *

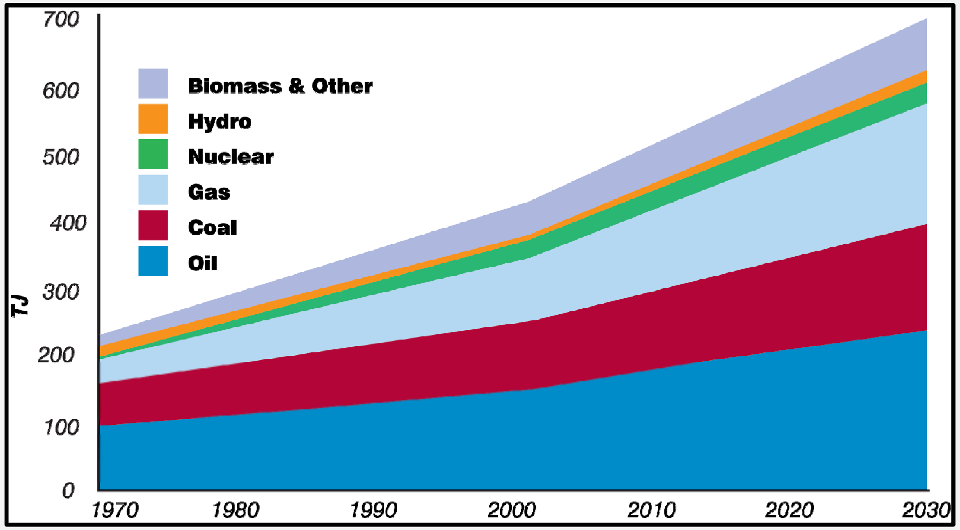
- **Fossil (86%)**
  - **Petroleum (~40%)**
  - **Coal (~23%)**
  - **Natural gas (~23%)**
  - Bitumens
  - Oil shales
  - Tar sands
- **Nuclear (8%)**
- **Renewable (6%)**
  - Biomass
  - Hydro
  - Wind
  - Solar (thermal & photovoltaic)
  - Geothermal
  - Marine
- **Exotic hypotheticals**

* 2006 figures: Demirbas, A. (2008). ***Biofuels***.

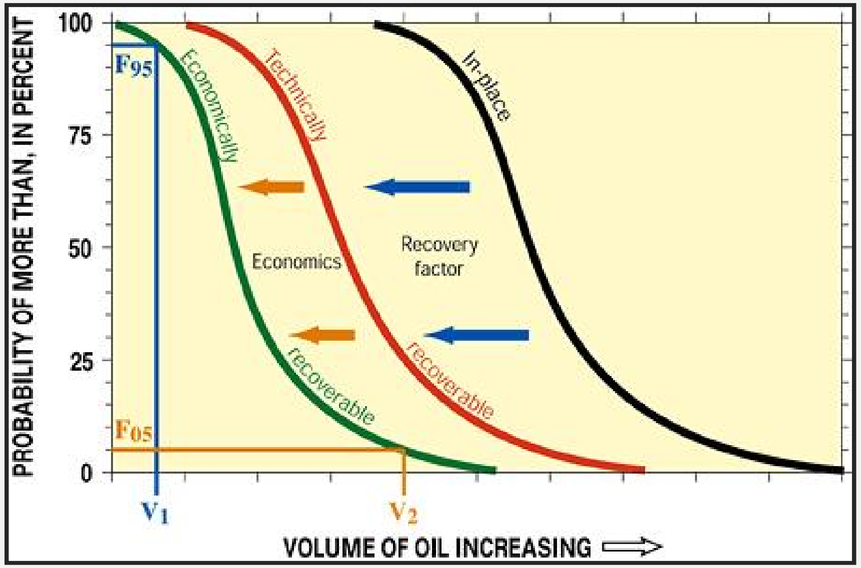


Reuters / US Coast Guard

Growing Demand + Growing Cost of Recovery



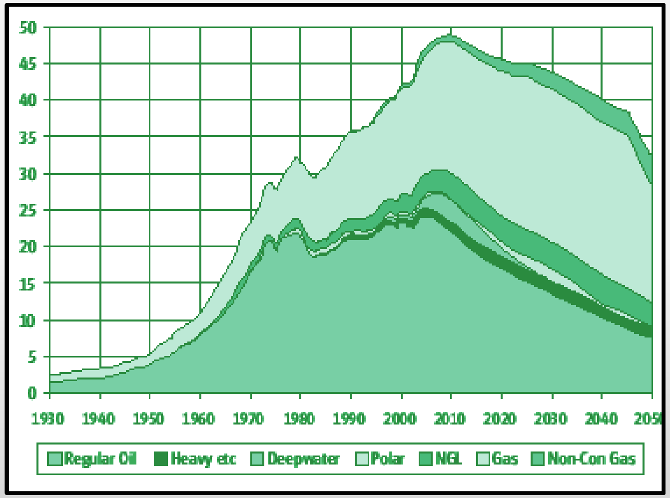
Source: OECD/IEA *World Energy Outlook* 2004
http://www.world-nuclear.org/education/ueg.htm



http://en.wikipedia.org/wiki/Oil_reserves

Geopolitical

- Middle East:
  63% global reserves
- Growth world population
- Growth developing nations

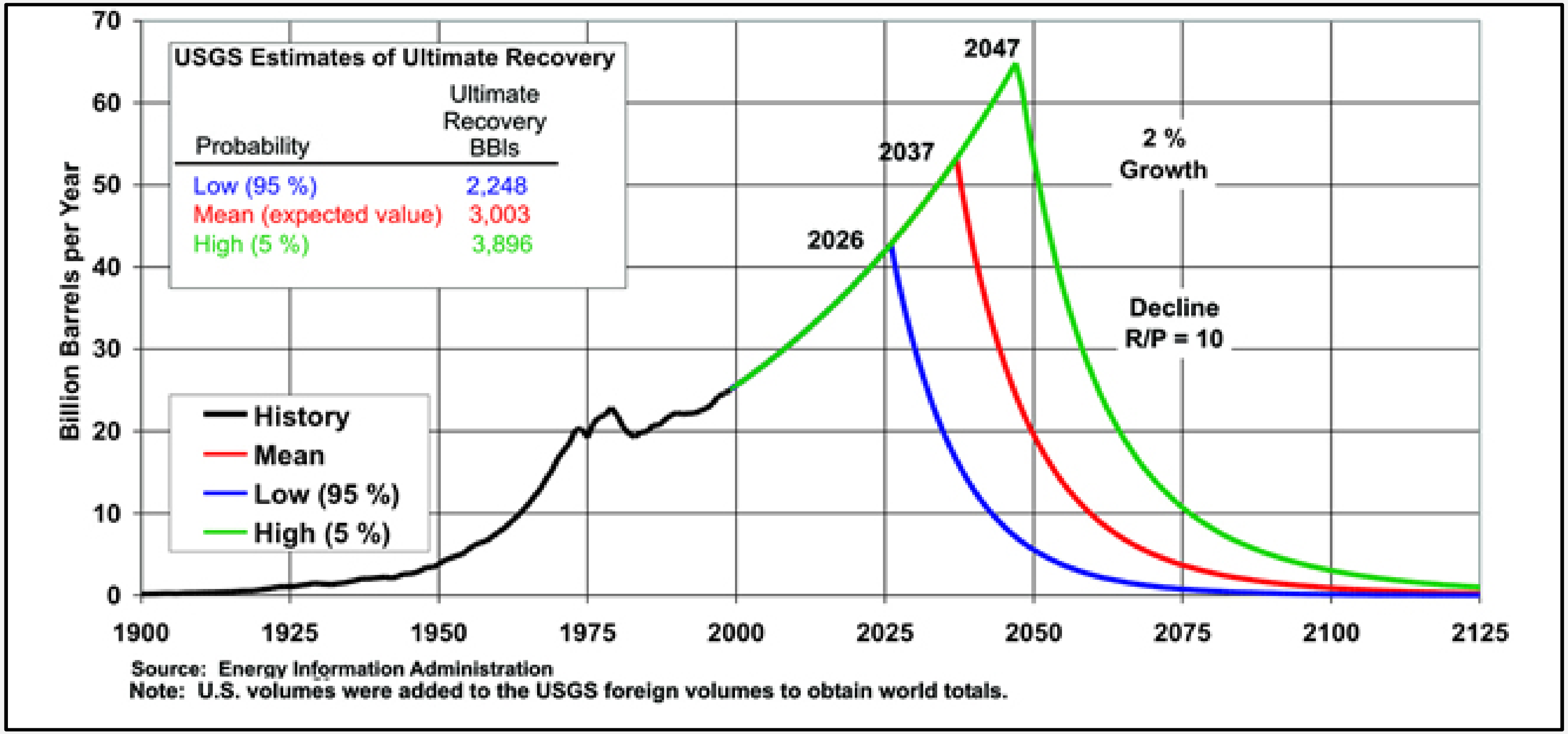


http://www.feasta.org/documents/energy/rationing2007.htm

Environmental

- Carbon emissions
  (98% from fossils)
- Greenhouse effect
  1950: *315 PPM CO_2*
  2010: *390 PPM CO_2*

Uncertainty: Timing of Decline?

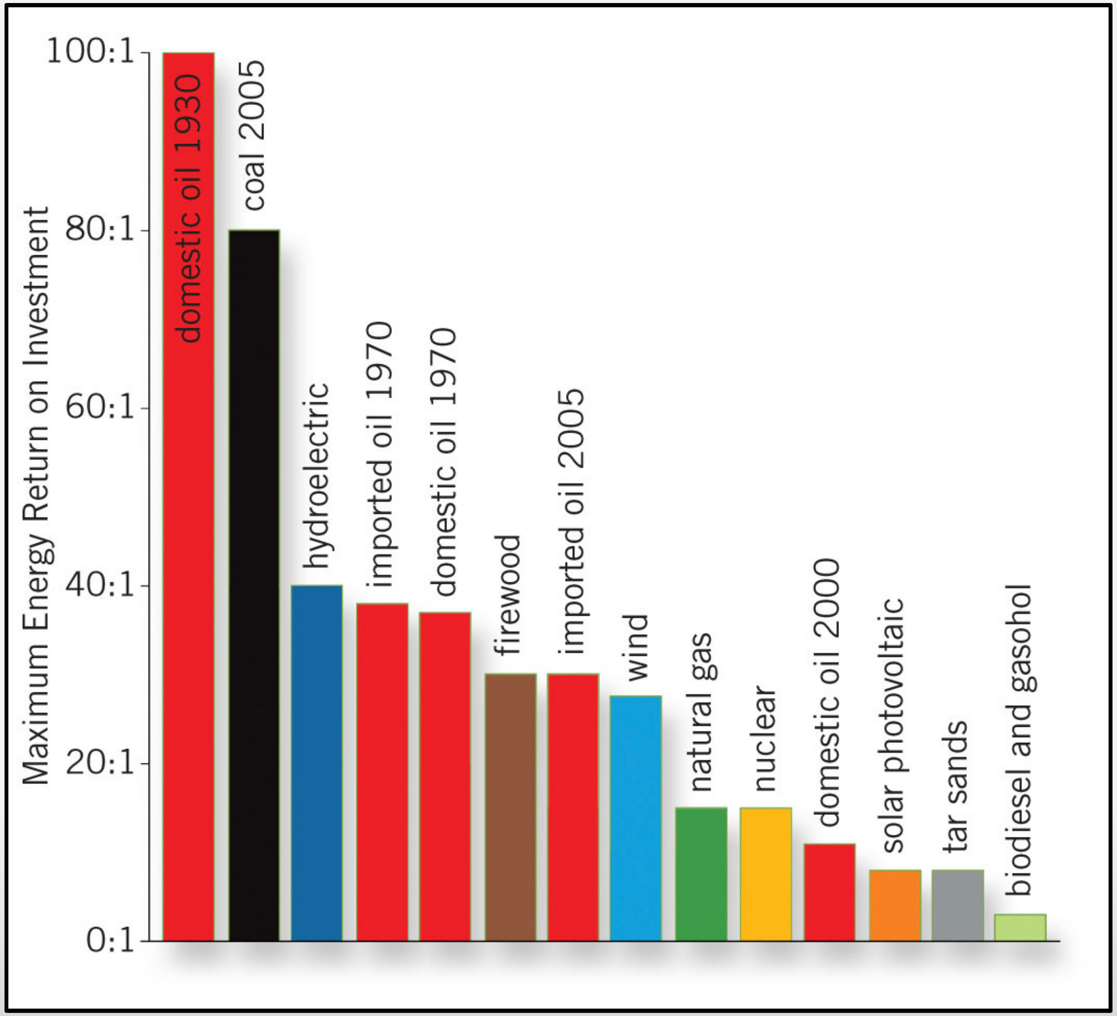


http://www.eia.doe.gov/pub/oil_gas/petroleum/feature_articles/2004/worldoilsupply/oilsupply04.html

- 2000 Global Supply Analysis: US Geological Survey (USGS) and US Energy Information Administration (EAI)
- Steady global demand growth trend of 2% per year (highest trend in developing world, India & China in particular)
- Reserves to Production (R/P) ratio of 10 (US) used for all nations as 'peak level'
- Three scenarios use varying recoverable reserve estimates remaining, in Billions of Barrels (BBbls)
- Asymmetric 'plunging' decline hypothesized

Uncertainty: Marginal Tipping Point?

- ‘*Energy return on energy invested*’ (EROEI) ratio
  - **Oil**: 16-to-1 (and falling)
  - **Tar sands:** 7-to-1?
  - **BioEthanol**: 4-to-1? Negative?
- Unknown point: where marginal cost of next average barrel of oil yields less energy than alternative sources?
- Compounded issue of *systematized efficiencies* related to oil value chain (i.e. refining, transport, trading)
- Political risk: waiting causes oil marginal value to reduce while development costs for alternatives remains high
- ‘Boiling frog’ syndrome



http://www.motherearthnews.com/renewable-energy/net-energy-zm0z10zrog.aspx

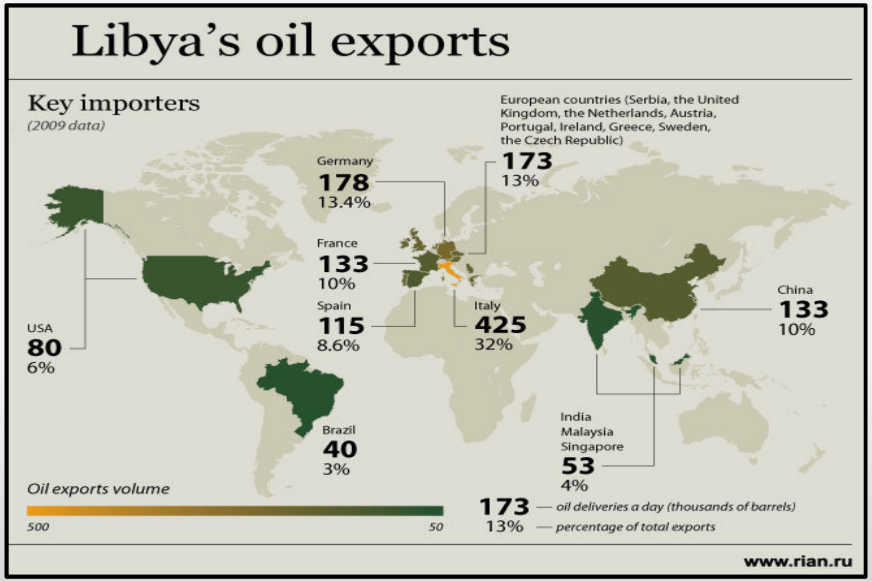
Energy and Realpolitiks…

- **Systematized dependence**
  - Embedded surcharge attached to virtually all transactions
  - Systemic efficiencies have evolved via market forces
- **Pushing the envelope**
  - Deep sea drilling
  - Oil sands
  - Polar exploration
  - Regional military pressures
- **Alternative solutions**
  - Will remain marginal if 'one offs'
  - Need for deep systemic economic *analysis* and *engineering (financial)*
- **Oil industry: biofuel plays (liquid)**
  - Shell & Cosan
  - BP & Verenium
  - Chevron & Weyerhaeuser

Sean Gallup/Getty Images

http://www.topnews.in/law/region/tripoli

http://tinyurl.com/6hbuyrg

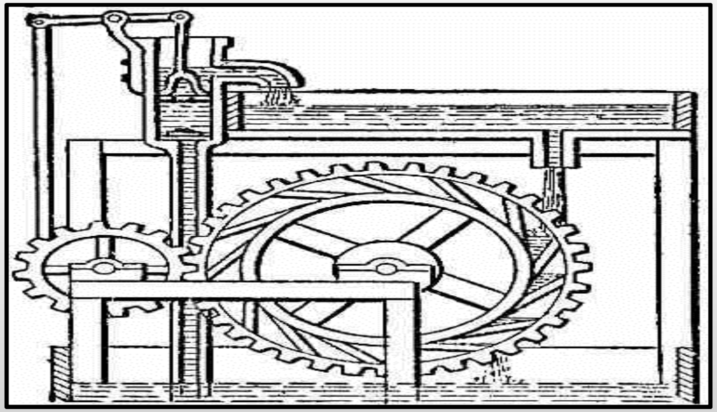


http://oilandglory.foreignpolicy.com/category/wordpress_tag/saudi

Sustainability & Palisade Decision Suite

TOOLKIT…

- Simulation
- Sensitivity analysis
- Optimization
- Correlation
- Econometrics
- Decision Trees
- Real Options



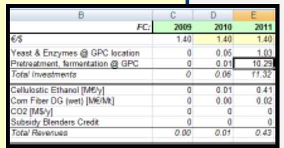
- Plant / processing optimization
- Commodity price uncertainty
- Cost control
  - Sampling, regression analysis and optimization
- Integrated FCF / NPV analysis
- R&D decision / project management
  - Monte Carlo sensitivity analysis for uncertain, multi-stage programs
  - Decision tree analysis to determine best path
  - Project portfolio optimization via analytic hierarchy process and optimization
- Commercialization/market simulation
  - Modeling new product profitability via regression & sensitivity analysis, simulation
- Competition & product pricing
  - New product profitability simulation
  - Simulation based on uncertain market competition parameters

Modeling Method: Staged Process

Uncertainty Categorization

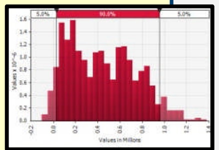
1. *Process(es) to employ*
   - Associated costs?
2. *Product strategy*
   - Associated revenues?
3. *Revenue forecasting*
   - Competition, economic factors?
4. *Process cost analysis*
   - Productivity variability?
5. *R&D planning / decision making*
   - What decisions, made when?

Analytical Process

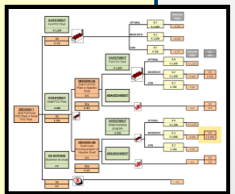


B	C	D	E
FC:	2009	2010	2011
€/$	1.40	1.40	1.40
Yeast & Enzymes @ GPC location	0	0.05	1.03
Pretreatment, fermentation @ GPC	0	0.01	10.29
Total Investments	*0*	*0.06*	*11.32*
Cellulostic Ethanol [M€/y]	0	0.01	0.41
Corn Fiber DG (wet) [M€/Mt]	0	0.00	0.02
CO2 [M$/y]	0	0	0
Subsidy Blenders Credit	0	0	0
Total Revenues	*0.00*	*0.01*	*0.43*

1. **Valuation (NPV) analysis**
   - Three processes
   - Product strategies
2. **Volatility simulation**
   - Monte-Carlo simulation



3. **Real Options Analysis**
   - Use range of NPV end-points
   - Add additional probabilities
   - Add key decision points



Integrated Analysis for Sustainability Projects

1

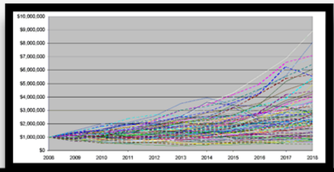
Feedstock, Ethanol & Oil Price Analysis

Investment Simulation

Revenue w/ Competition Simulation

Costing Analysis

2



Monte Carlo Simulation

- Oil price scenarios
- Investment costs
- Revenues (Ethanol & Byproduct, Carbon Credit)
- Feedstock variable costs
- Energy costs, yeast & processing costs
- R&D costs
- License income
- Market competition

3

NPV Model

4

Decision Tree Analysis

Practical Implementation

- **METHODS**
  - **Qualitative**: comprehensive interviews & stakeholder mapping
  - **Quantitative**: multivariate uncertainty aggregation, correlation
  - **Techniques**: Monte Carlo simulation, computational optimization, formal decision analysis, sensitivity analysis, optimization, regression analysis, econometrics…

- **ORGANIZATIONAL**
  - Decision portfolio management
  - Decision Trees = managerial flexibility
  - Decision architecture / audits
    - 'The Decision-Driven Organization' Harvard Business Review, June 2010

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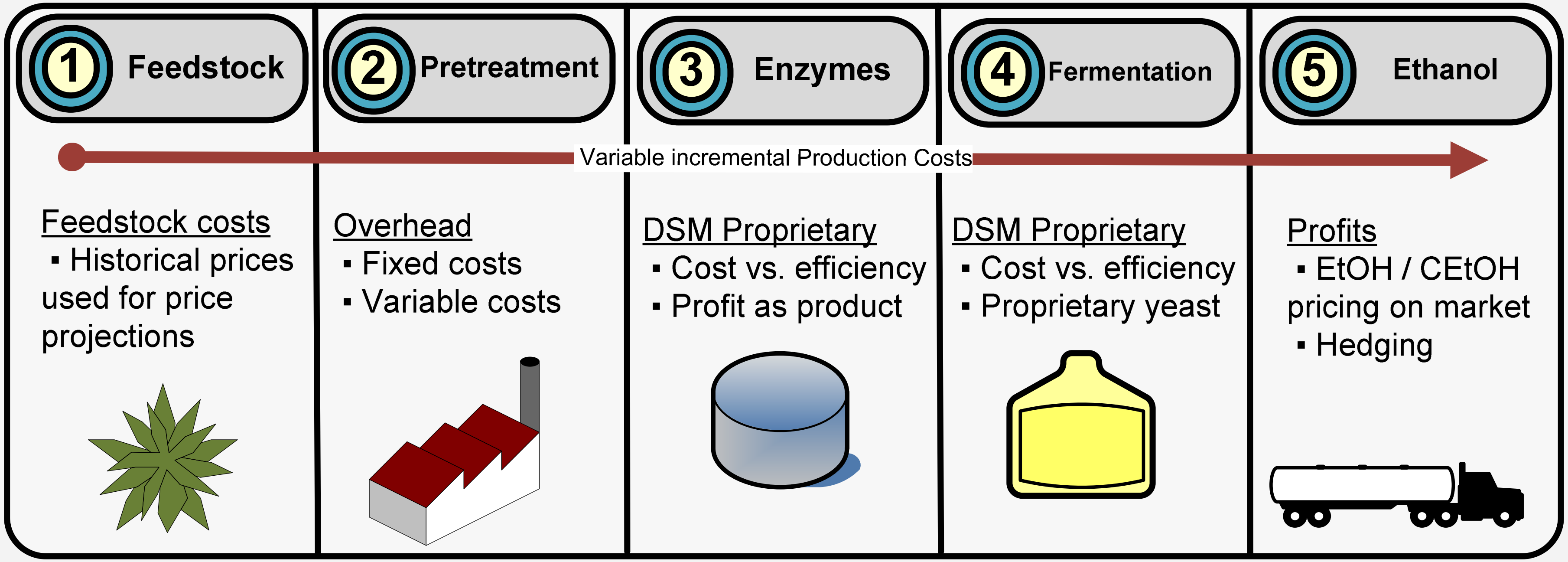
Overview: BioEthanol

- **Ethanol (EtOH)**
  - Blended into petrol (most autos can run on 10% blend)
  - 5.4% ethanol component in global gasoline (2008)
  - 90% world supply produced between US & Brazil
  - Increasingly target of mandates & subsidies
  - Basic process similar to beer brewing
  - Particular processes, feedstock, catalysts & agents vary
- **1st gen**
  - Feedstock-based (i.e. corn, sugarcane) => backlash!
- **2nd gen**
  - Cellulose-based: structural component green plants & algae
  - Most common organic compound: ~33% of all plant matter
  - Indigestible by humans
- **3rd gen**
  - Genetically altered microbal agents => still in lab stages

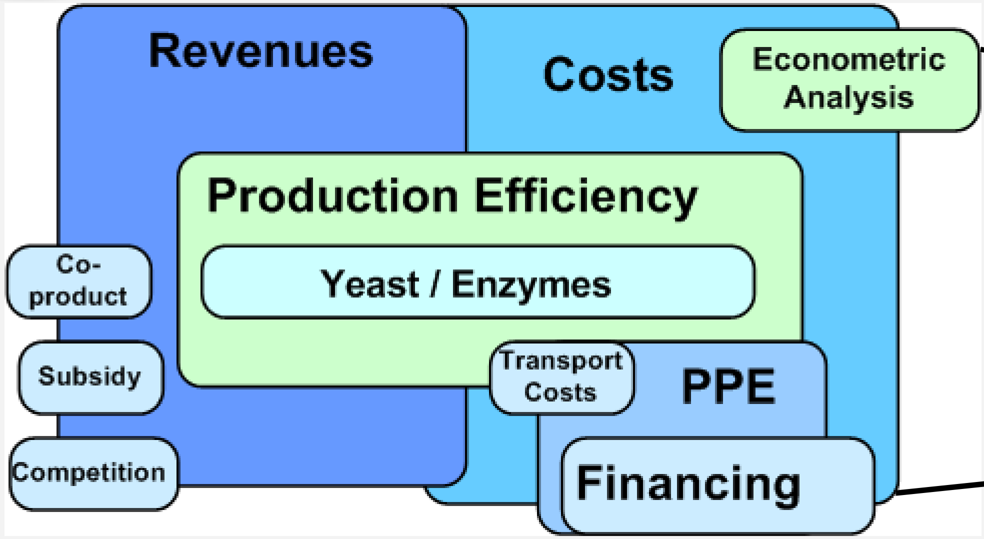
Modeling: Operating EtOH Plant



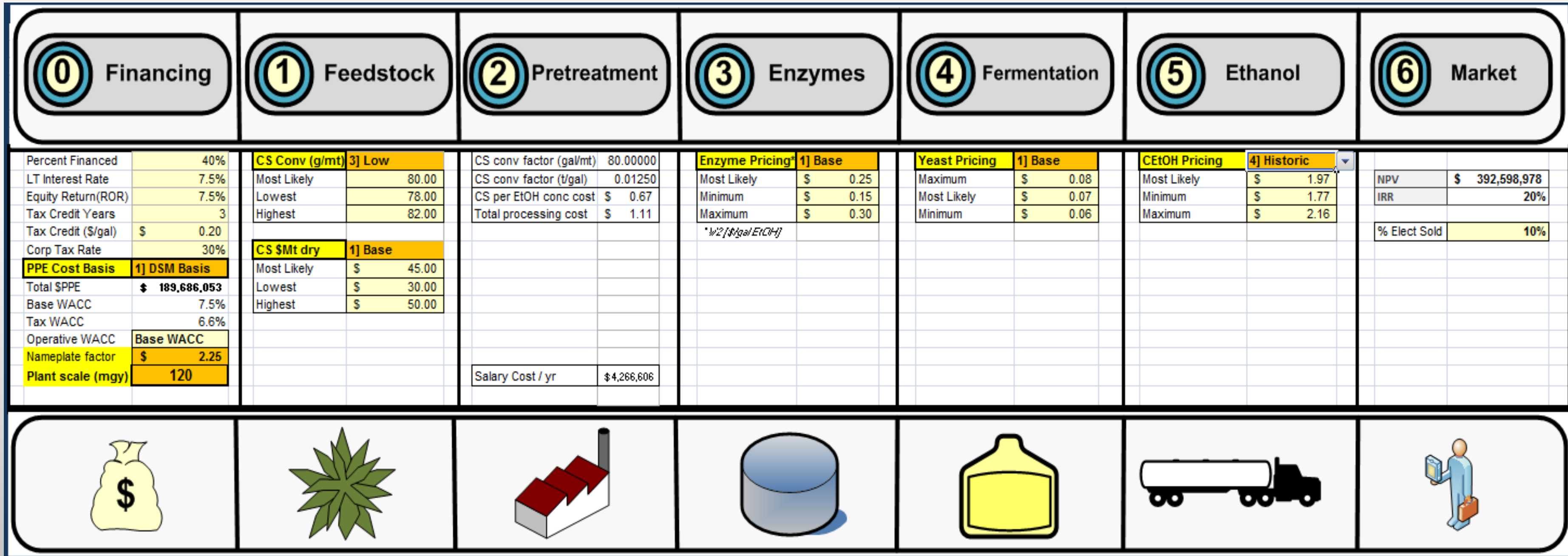
- PPE costs
- Capital costs per gal output
- EtOH & byproduct prices
- Feedstock costs

- Enzyme and yeast pricing
- Fixed & variable oper. costs
- Byproduct / subsidy
- Terminal value

Sensitivity & Optimization



MONTE CARLO SIMULATION
- Iterative development working with engineers / experts
  - US NREL research
- - U. Oklahoma CEtOH model



Percent Financed	40%
LT Interest Rate	7.5%
Equity Return(ROR)	7.5%
Tax Credit Years	3
Tax Credit ($/gal)	$ 0.20
Corp Tax Rate	30%
PPE Cost Basis	1] DSM Basis
Total $PPE	$ 189,686,053
Base WACC	7.5%
Tax WACC	6.6%
Operative WACC	Base WACC
Nameplate factor	$ 2.25
Plant scale (mgy)	120

CS Conv (g/mt)	3] Low
Most Likely	80.00
Lowest	78.00
Highest	82.00

CS $Mt dry	1] Base
Most Likely	$ 45.00
Lowest	$ 30.00
Highest	$ 50.00

CS conv factor (gal/mt)	80.00000
CS conv factor (t/gal)	0.01250
CS per EtOH conc cost	$ 0.67
Total processing cost	$ 1.11
Salary Cost / yr	$4,266,606

Enzyme Pricing*	1] Base
Most Likely	$ 0.25
Minimum	$ 0.15
Maximum	$ 0.30

*W2 [$/gal EtOH]

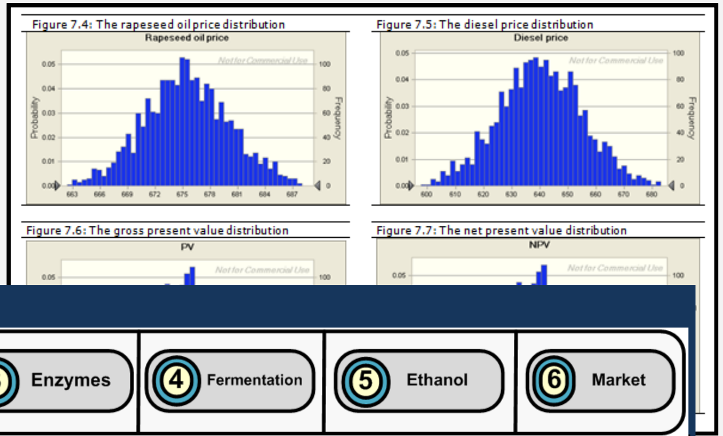
Yeast Pricing	1] Base
Maximum	$ 0.08
Most Likely	$ 0.07
Minimum	$ 0.06

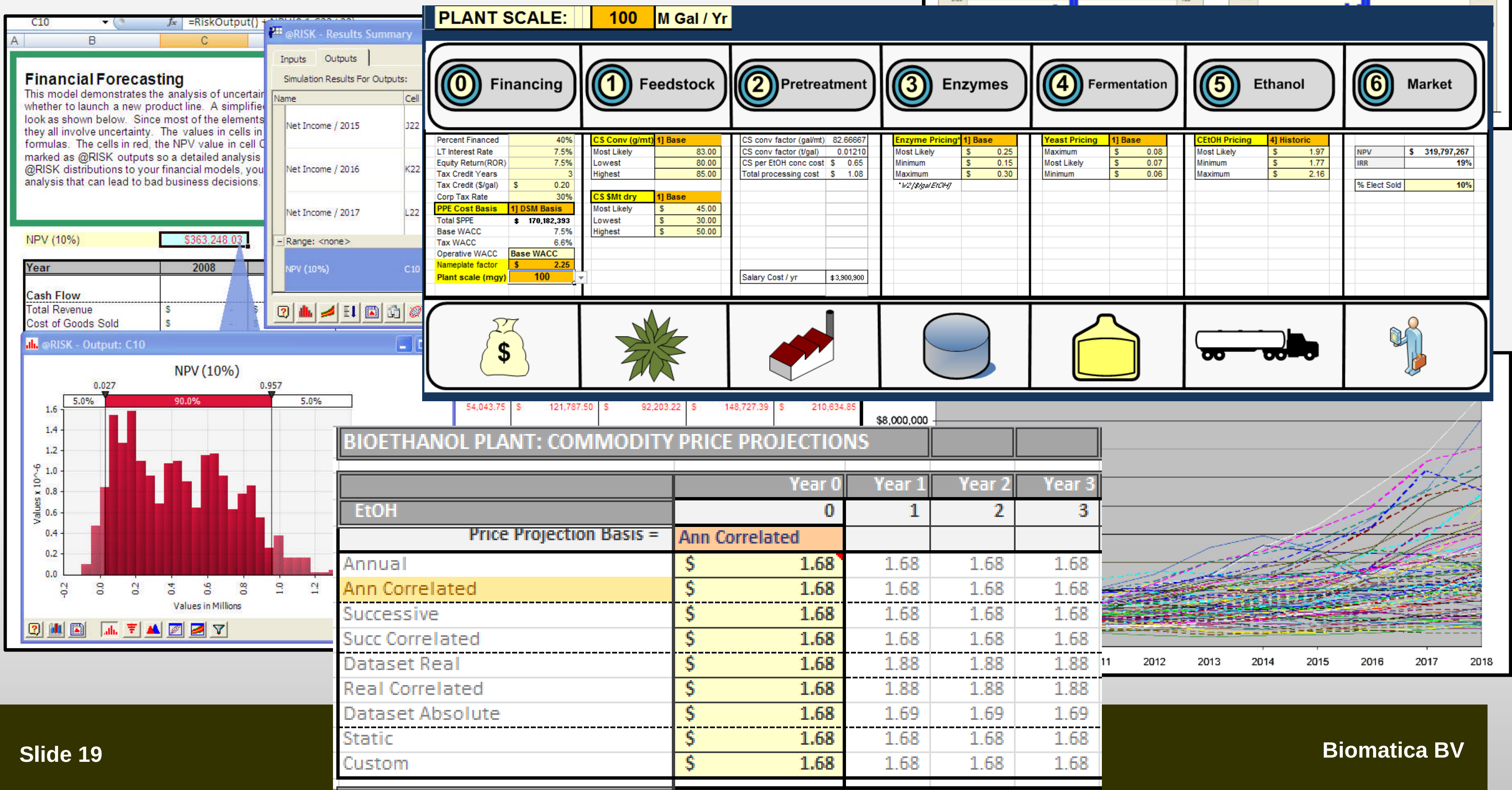
CEtOH Pricing	4] Historic
Most Likely	$ 1.97
Minimum	$ 1.77
Maximum	$ 2.16

NPV	$ 392,598,978
IRR	20%
% Elect Sold	10%

Sensitivity & Optimization

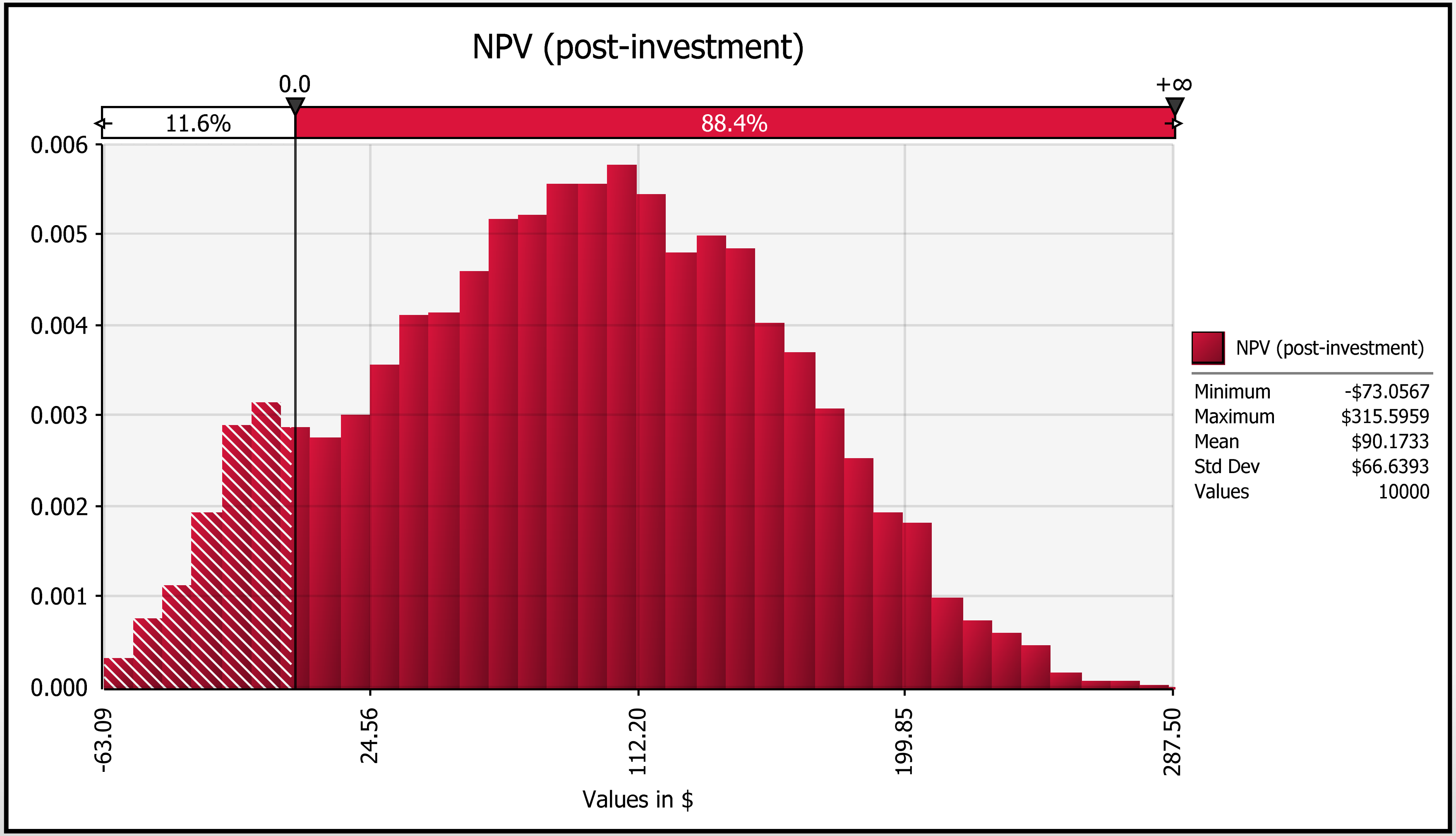
- Dynamic NPV analysis
- Probability distributions for all major variables
- Multiple outcome simulations run (1000's of times)
- Aggregate probabilities and sensitivities emerge



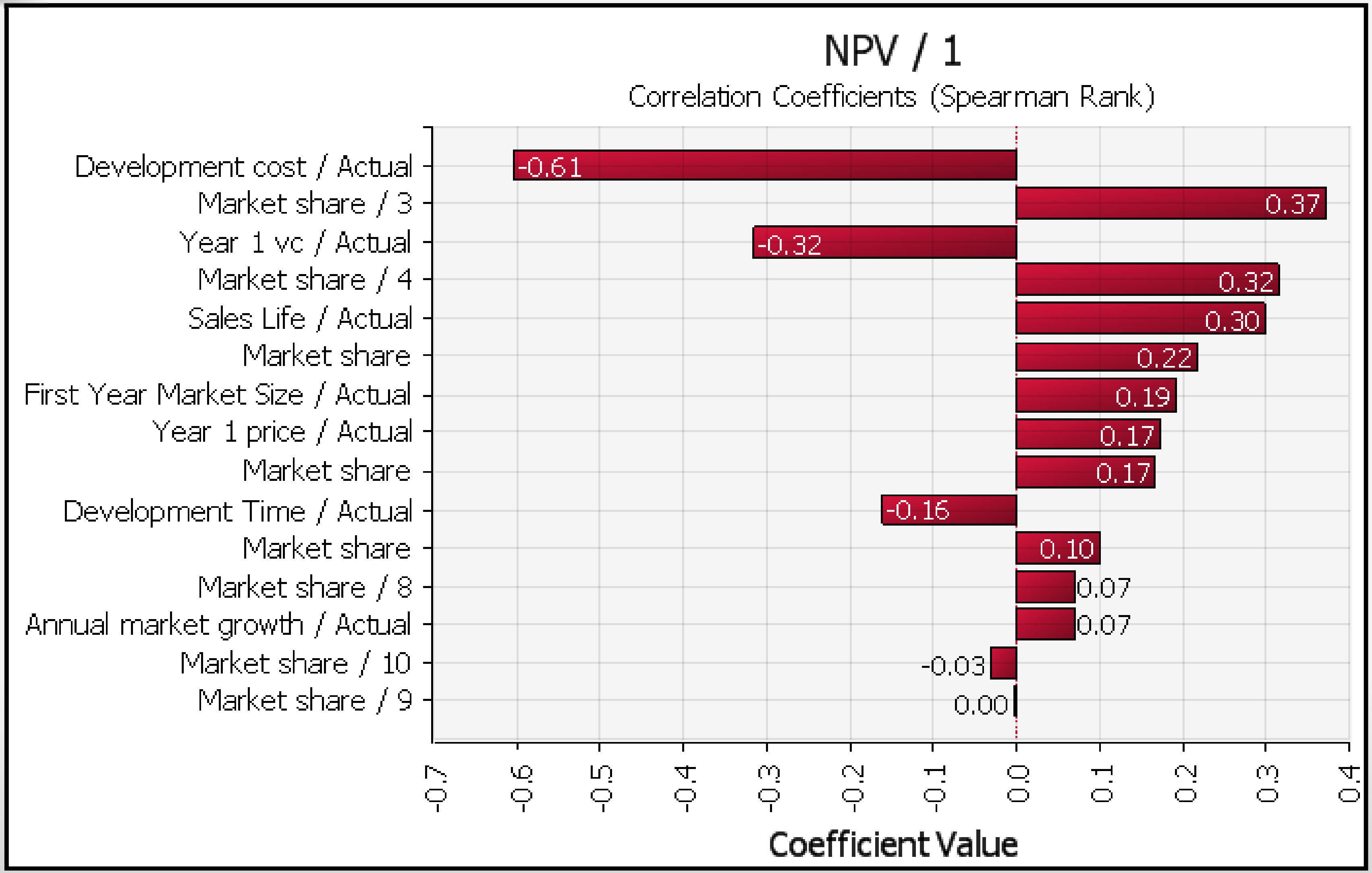


	Year 0	Year 1	Year 2	Year 3
EtOH	0	1	2	3
Price Projection Basis =	Ann Correlated			
Annual	$ 1.68	1.68	1.68	1.68
Ann Correlated	$ 1.68	1.68	1.68	1.68
Successive	$ 1.68	1.68	1.68	1.68
Succ Correlated	$ 1.68	1.68	1.68	1.68
Dataset Real	$ 1.68	1.88	1.88	1.88
Real Correlated	$ 1.68	1.88	1.88	1.88
Dataset Absolute	$ 1.68	1.69	1.69	1.69
Static	$ 1.68	1.68	1.68	1.68
Custom	$ 1.68	1.68	1.68	1.68

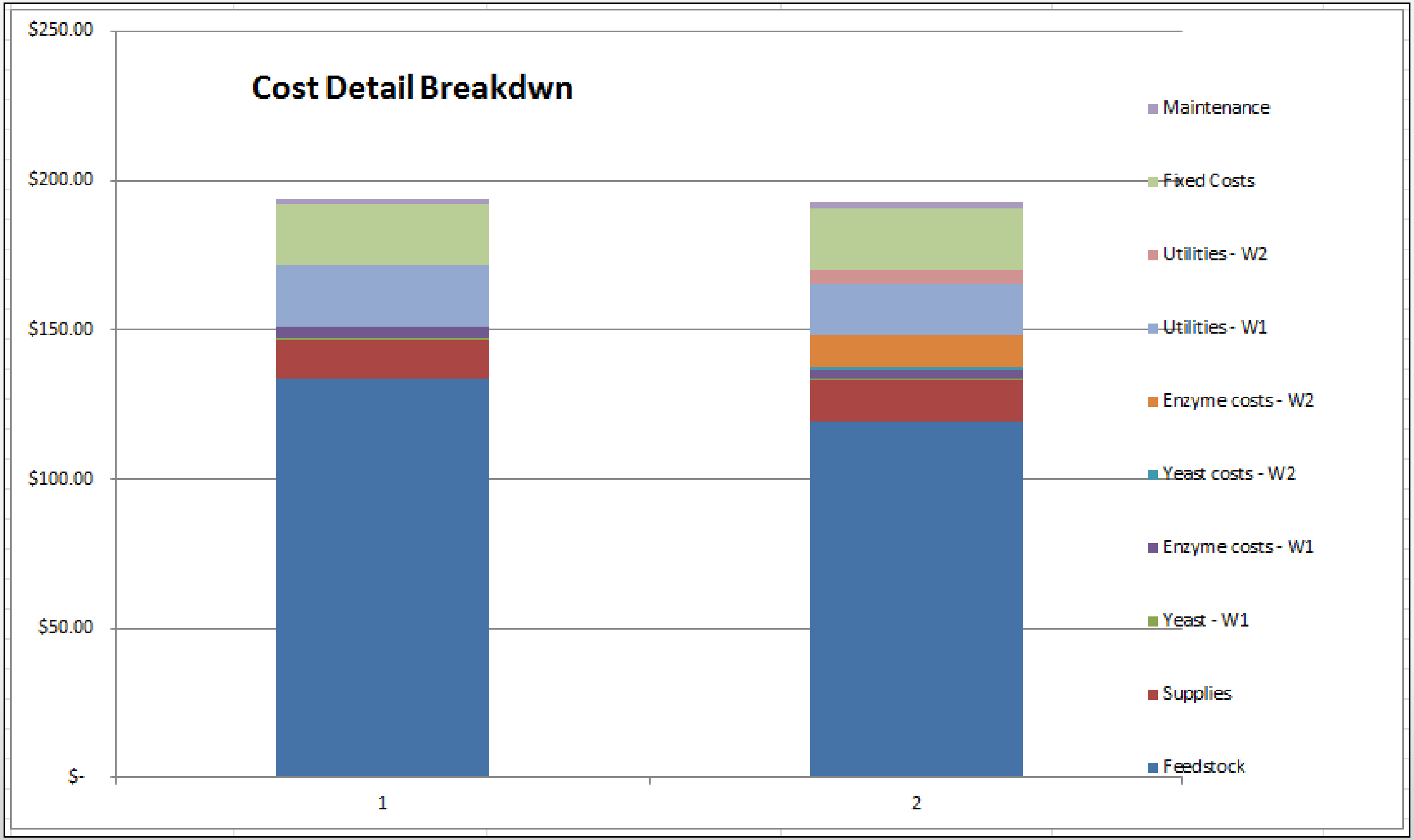
Volatility of Project NPV Outcome



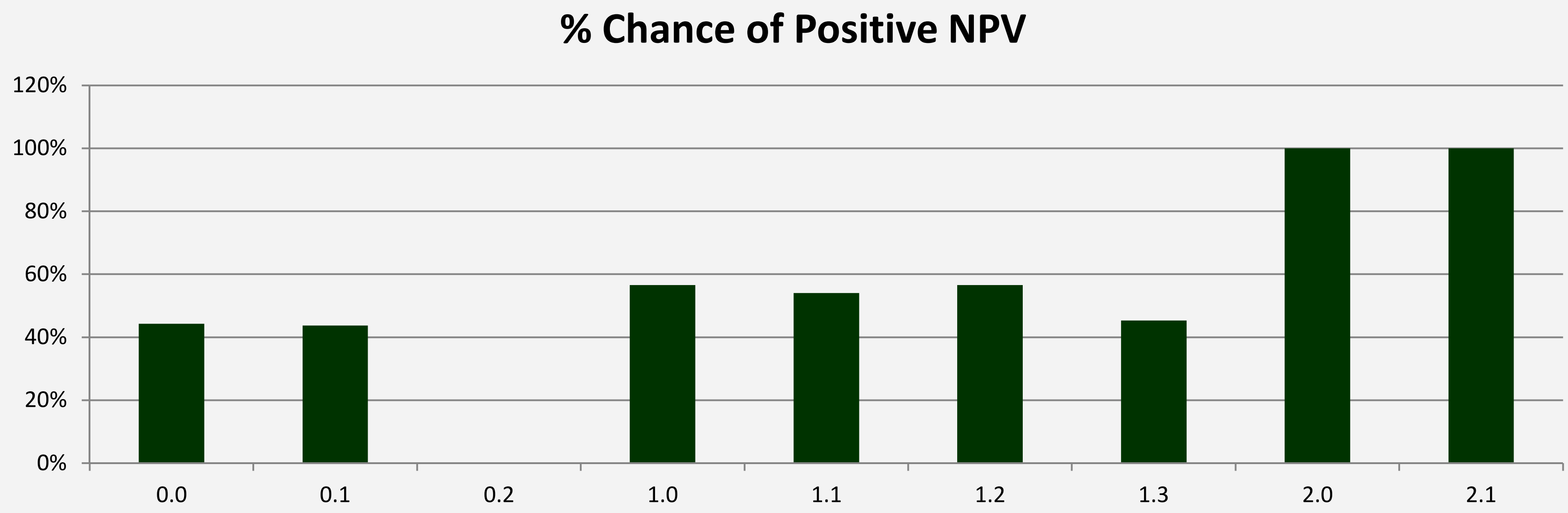
Sensitivity Analysis: Tornado Graph

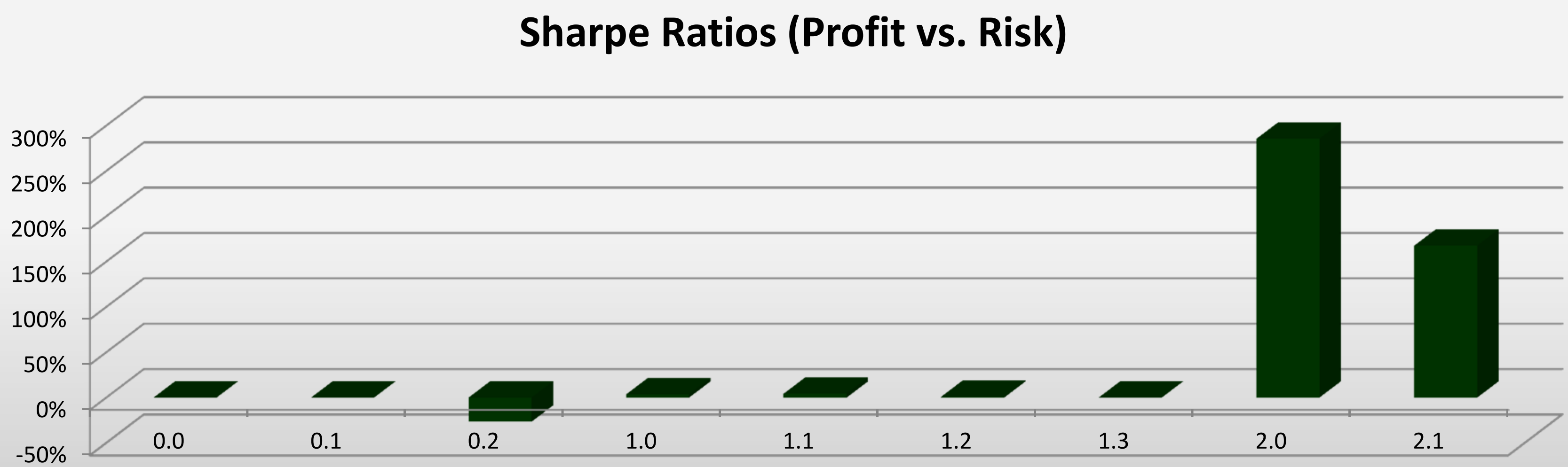


Cost Anlysis & Optimization

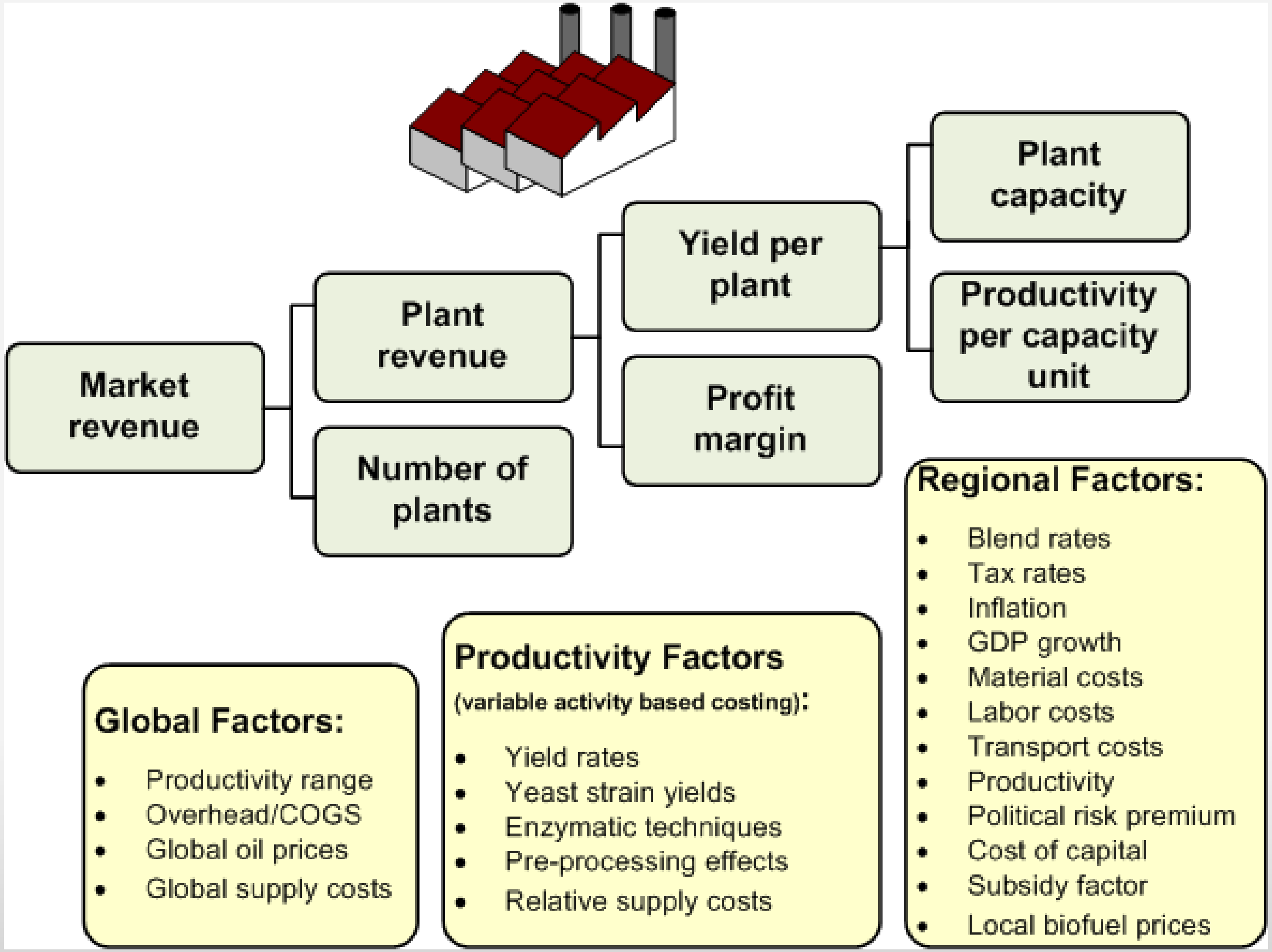


Risk Optimization: Profit vs. Risk



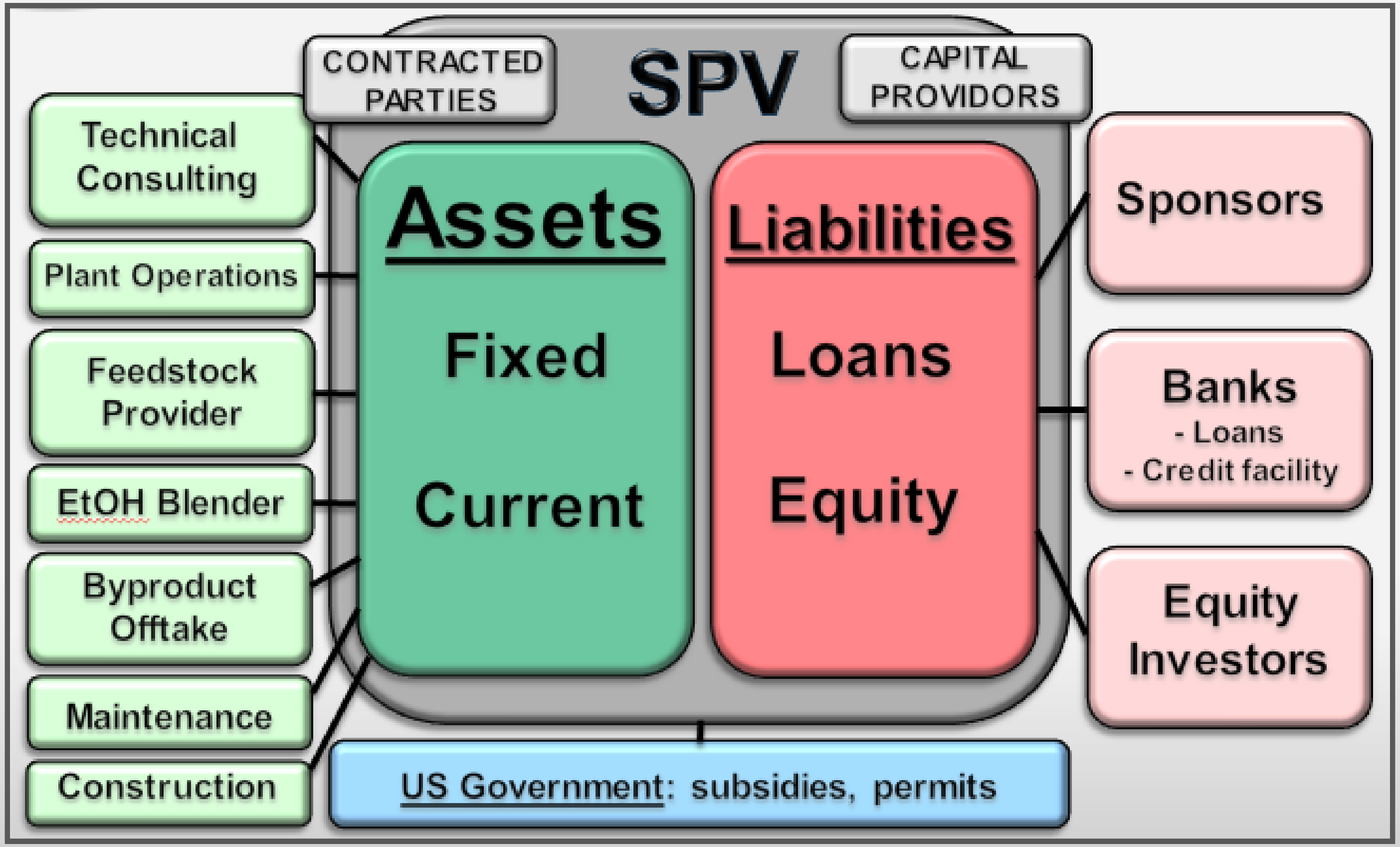


Comparative: Commercialization

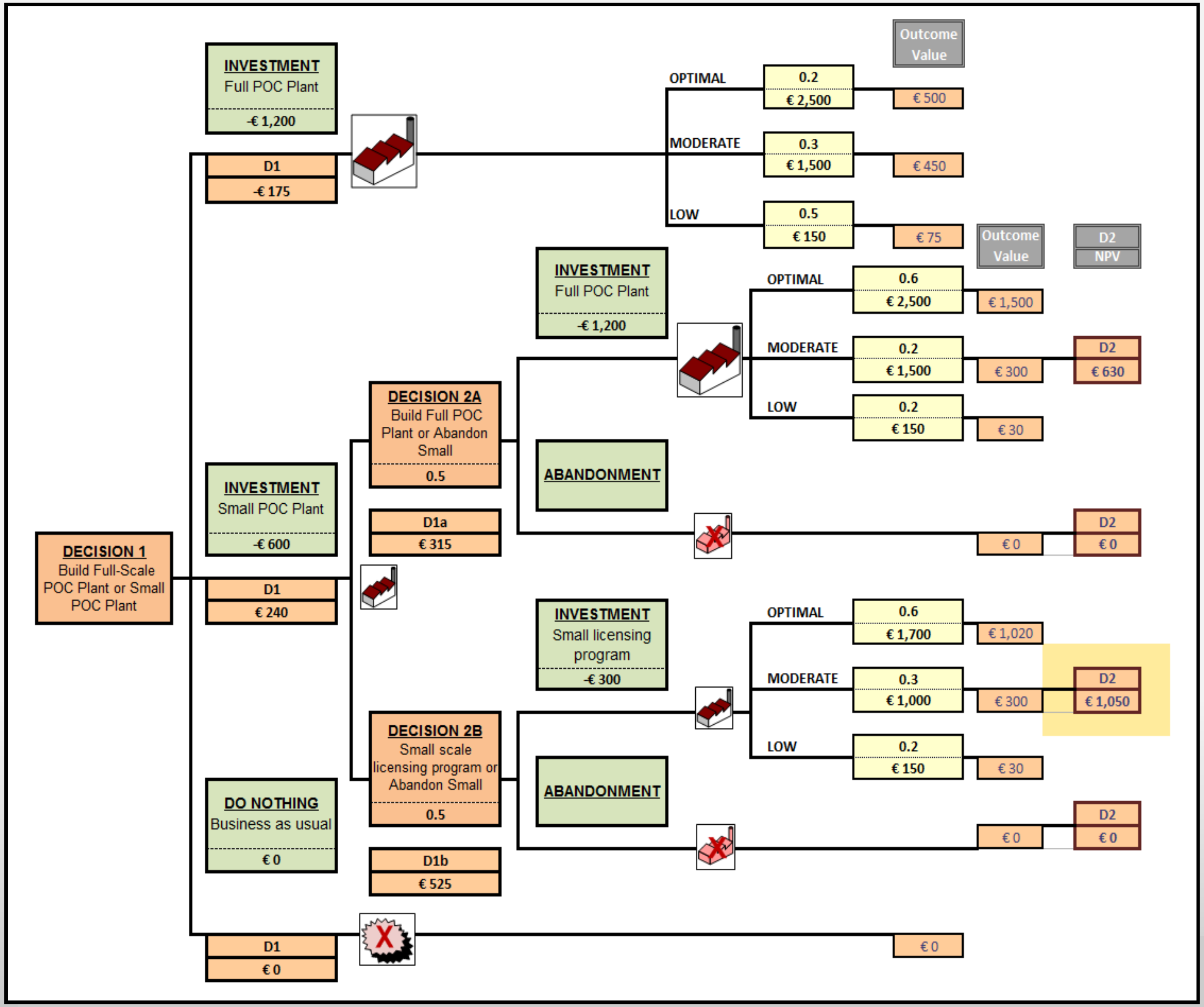


Integrative: Structured Finance

- **Structured finance / project finance**
  - Insulates sponsor from risk during development
  - Isolates asset liabilities from balance sheet
  - Funds R&D via external investment
  - Vehicle for debt guarantees & subsidies
- **Pre-negotiated contracts**
  - All contracts pre-negotiated
  - Lowers project risk for investors and banks
  - Consequently lowers cost of funding / capital
  - Restricts potential downside and upside (acts as hedge)

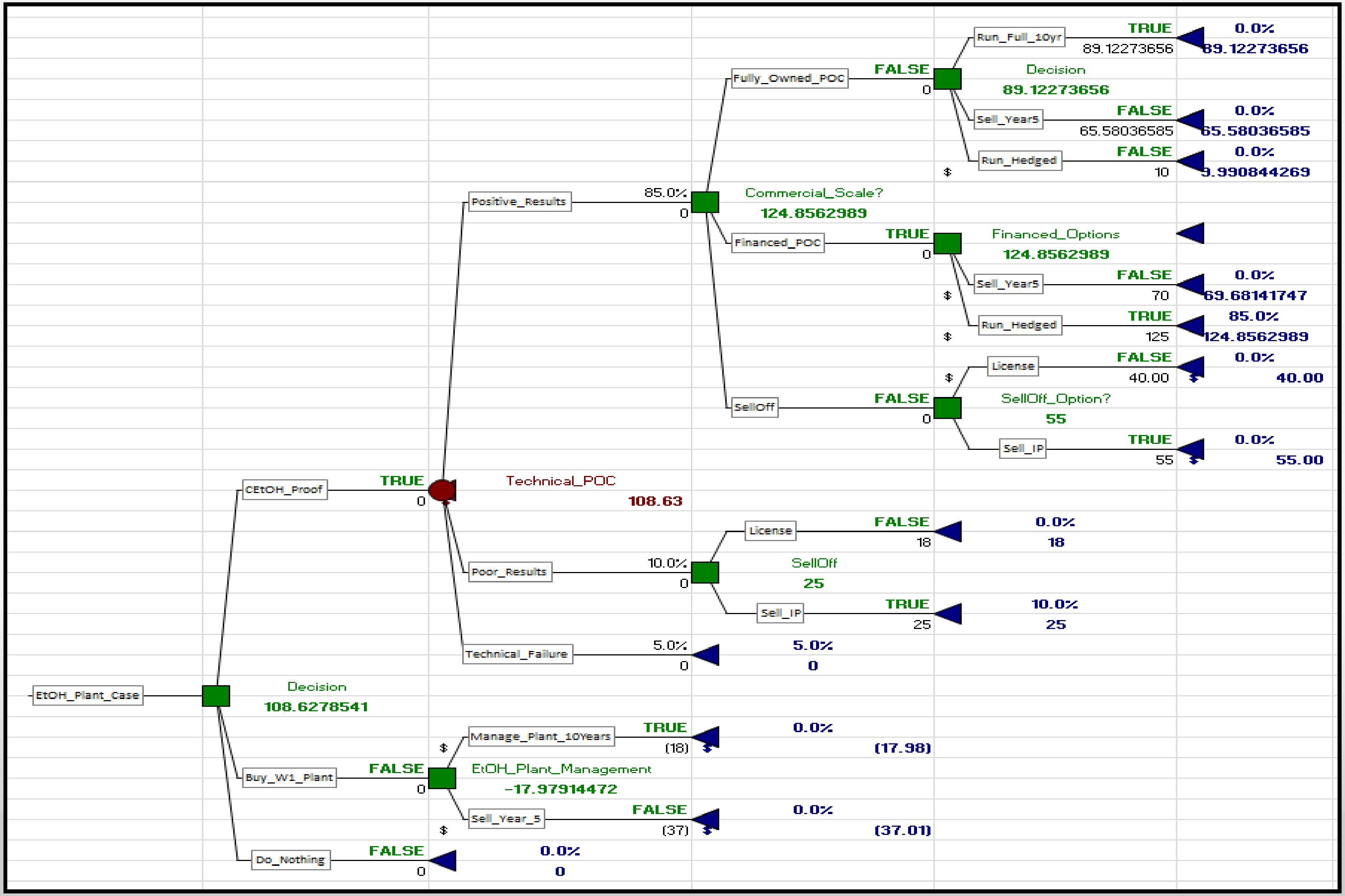


Strategic: Decision Tree Analysis

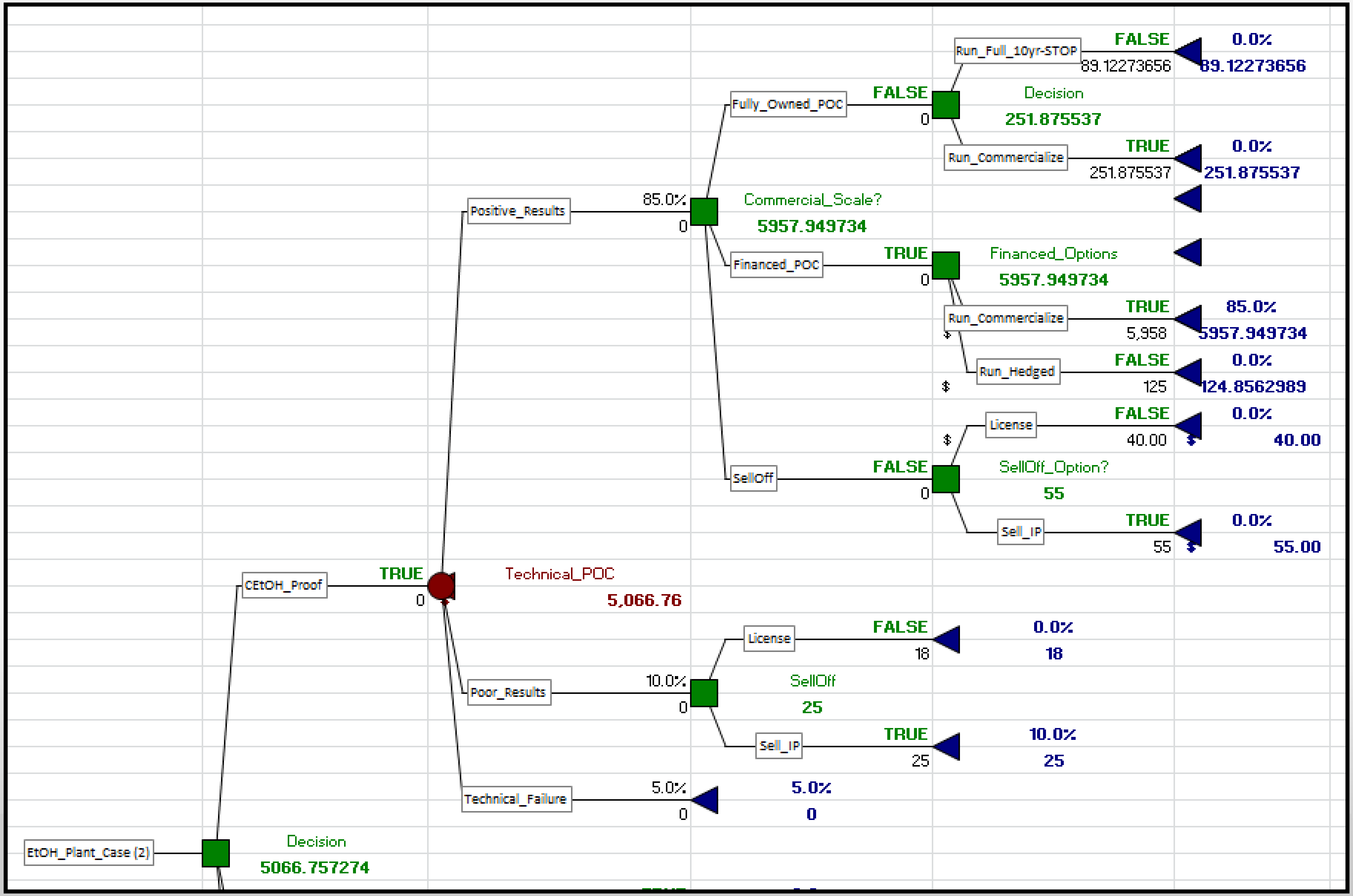


1. **Add management decision points, investments required, and probabilities (i.e.: chance of technical success)**
2. **NPV valuation of each node in scenarios (DCF)**
3. **Work backwards to probabilistic 'inherent value' of management option to expand/contract at each step**
4. **Choose for highest NPV value at each decision point**
5. **Revise as probabilities, decisions, and values as time progresses**

PrecisionTree: Proof-of-Concept



PrecisionTree: Commercialization



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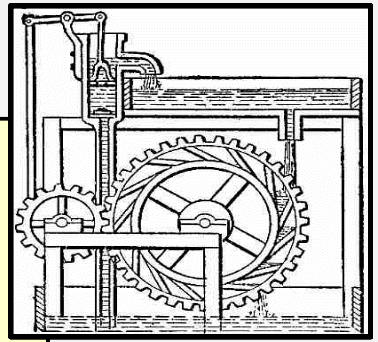
Natural Capitalism

- **Status quo: ‘the lurking crisis’**
  1. ‘Business as usual’ approaches & models
  2. Token populist and cynically reductive responses
  3. Survival thinking / rationing
  4. Lack of ‘systemic’ vision & leadership

Lovins, Lovins & Hawken. **A Road Map for Natural Capitalism**. *Harvard Business Review*, July – August 2007.

- **Shifts advocated in business practices**
  1. Increase productivity of natural resources
  2. Shift to biological production models
  3. Solutions-based business models
  4. Reinvest in natural capital
- **Solutions are at hand** – require systemic thinking, deep analysis & coordination

Concluding Themes



- **Economic phenomenon**
  - Drive to marginal optimality
  - Perverse incentives
  - ‘The tragedy of the commons’ and free-riders
- **Sustainability project characteristics**
  - Marginally profitable
  - Highly sensitive
  - Requires systemic engineering / optimization
- **Coordinated management of *systemic complexity***
  - Core NPV variance analysis
  - Profitable *systemic* market scenarios
- **Leadership gap:**
  - Transcend politics and sentiment
  - Need for market-based solutions
- **2030 syndrome**
  - Outside democratic political cycle
  - Outside career cycle
- **Palisade evolution**: Multi-Agent Simulations

6. Questions and comments

Questions? Comments!

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Source: Economist Staff, September 2nd 2010

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