The Business of Sustainability:

Investment Decisions in the Circular Economy

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- The business of sustainability and the circular economy
- From environmental cost to value creation
- Competitive strategy: Innovation for sustainability
  - R&D vs. acquisition
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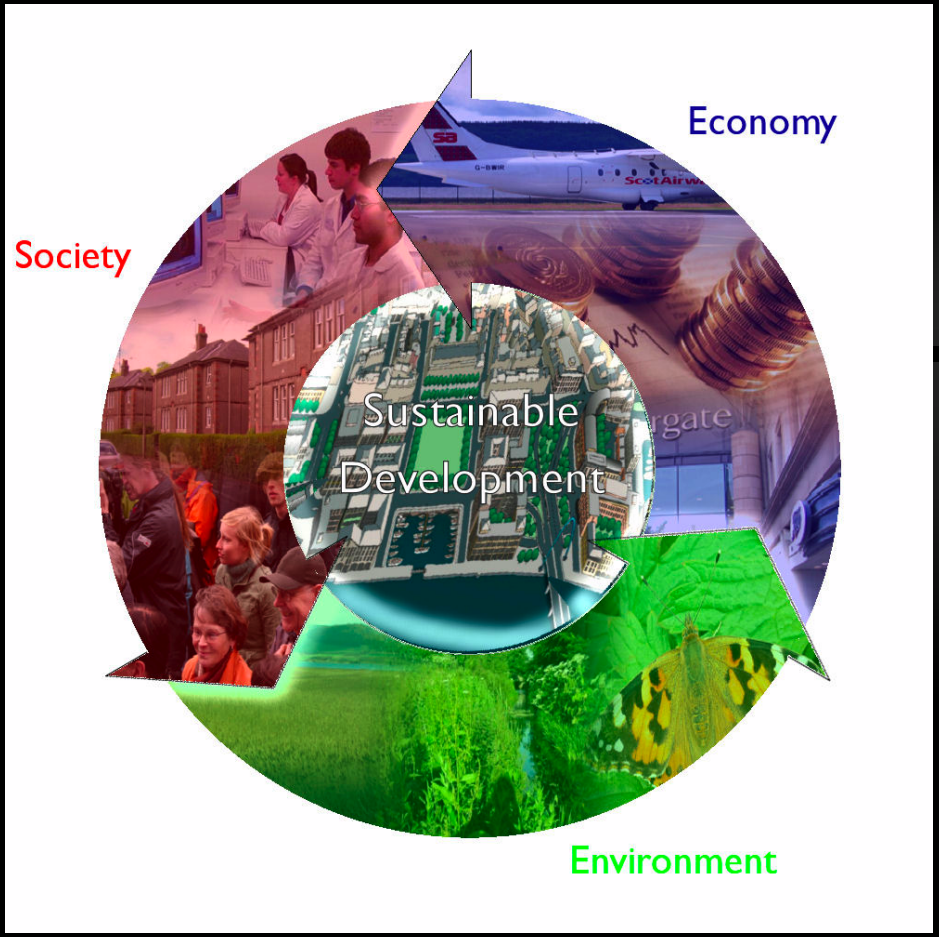
- Conclusions and future work

Environmental Sustainability

- Triple bottom line: social, economic and environmental corporate objectives
- Framework of guidelines developed by the Global Reporting Initiative (GRI)
- Supported by World Business Council for Sustainable Development , Global Environmental Management Institute, Dow Jones, etc…



The Circular Economy (China)

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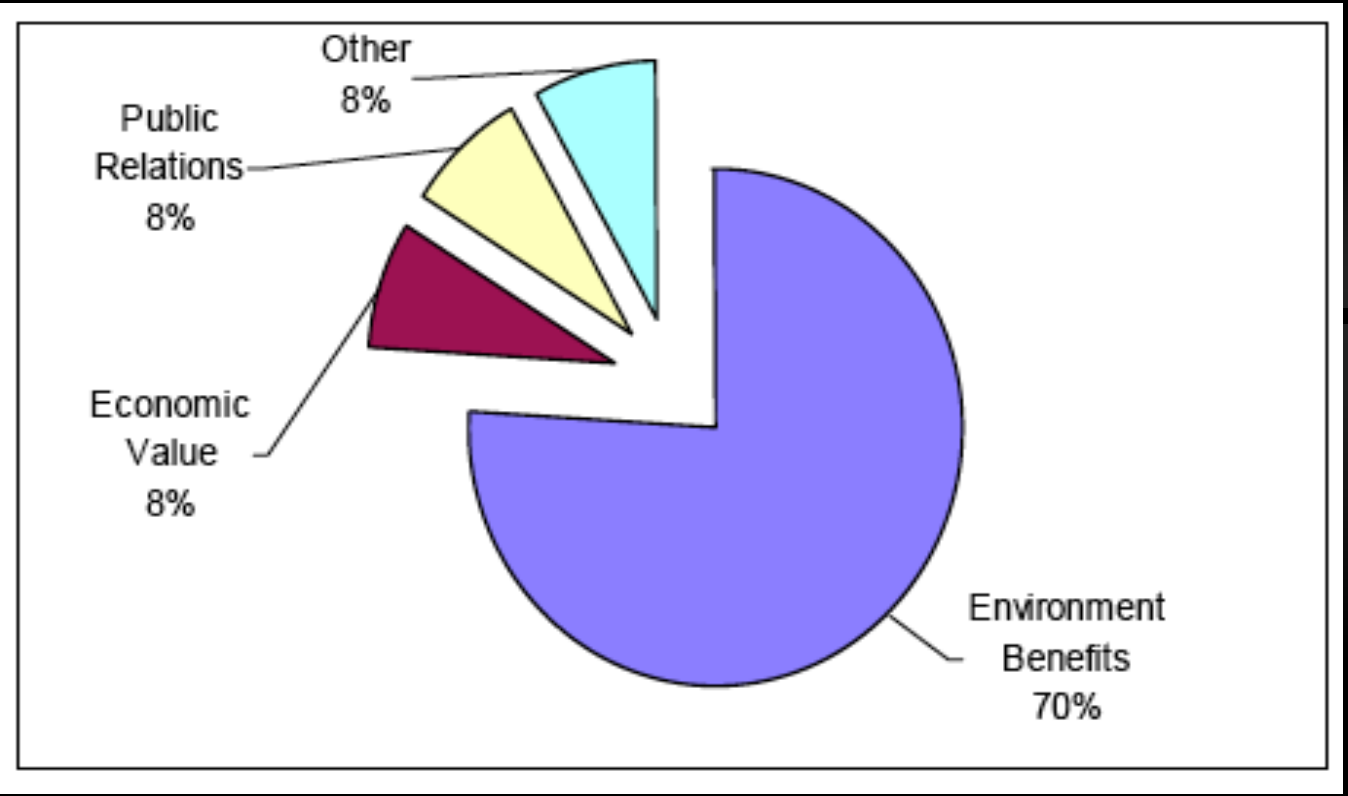
Business-Value of Sustainability

- Financial markets react to corporate exposure and management of climate and water scarcity risks
  - Protection of supply chains and operations
- Buyer markets react to corporate citizenship
  - Market share, pricing strategies
- Alliances, business partners and investors
  - Innovations to ‘green’ supply chains
  - Facilitation of access to (new) markets

Example: Motivation for Energy Efficiency in Construction Industry

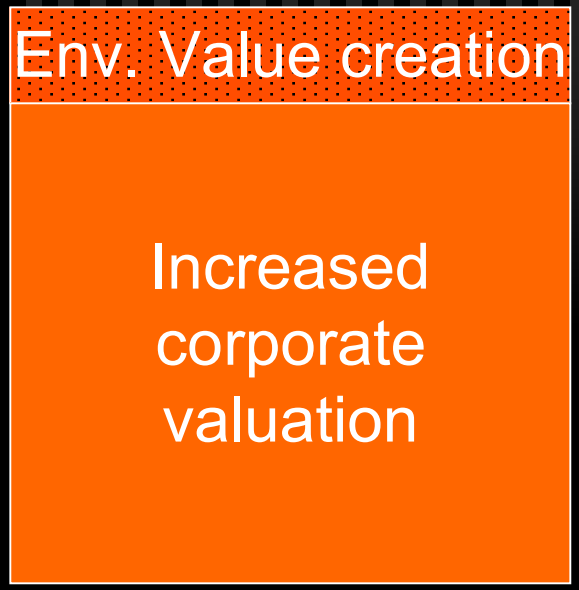


- ✓ Impact of sustainable processes: environmental, economic value, PR, and access to new markets/partnerships

From Cost to Value Creation

- ✓ Traditional: environmental cost external to operations were a liability impacting valuation of the company
- ✓ Future: internalized sustainability principles represent value creating opportunities for the company

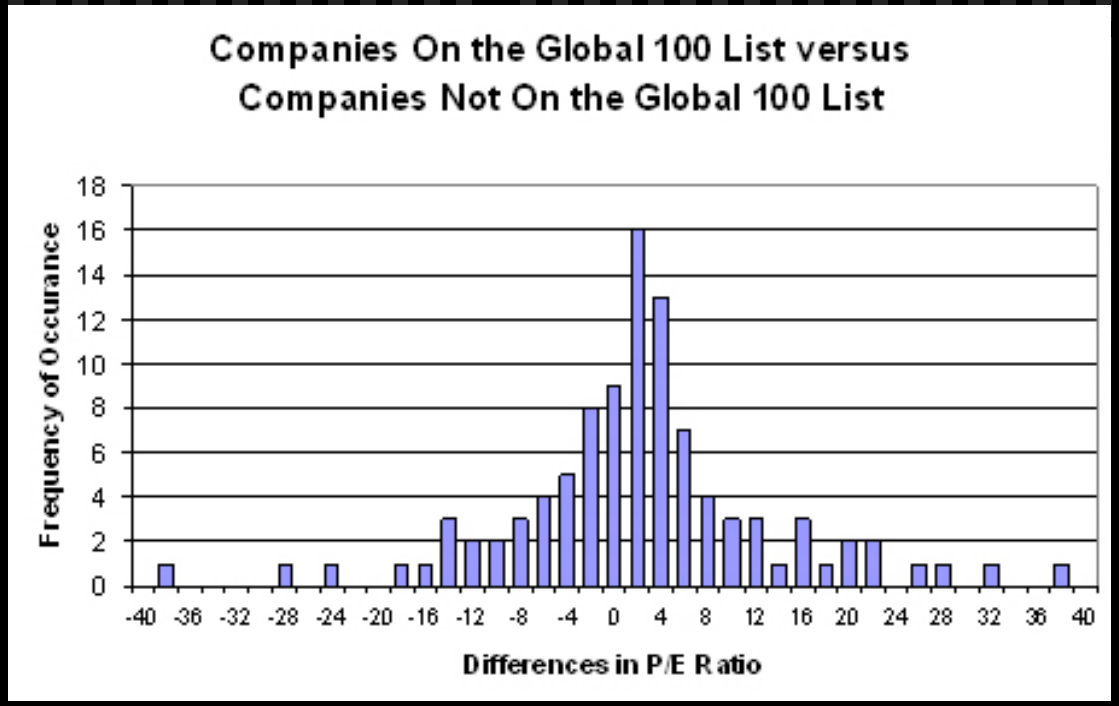
Avg. price/share increase: 6 c.
P/E increase: 15%



The Stock Market Value of Environmental Sustainability

- The stock market may give better share price valuation to companies that are perceived of as sustainable.
- Due to the massive amount of value of stocks in global markets, the implications are enormous.

Prediction of a 15% difference in P/E ratio, which would mean billions of dollars of stock market increased value for most large companies traded on major exchanges



Dow Jones Sustainability Indexes

- Launched in 1999, DJSI track the financial performance of the leading sustainability-driven companies worldwide.
- Currently 70 DJSI licenses are held by asset managers in 16 countries to manage a variety of financial products (see table).
- In total, these licensees presently manage close to 6 billion USD.

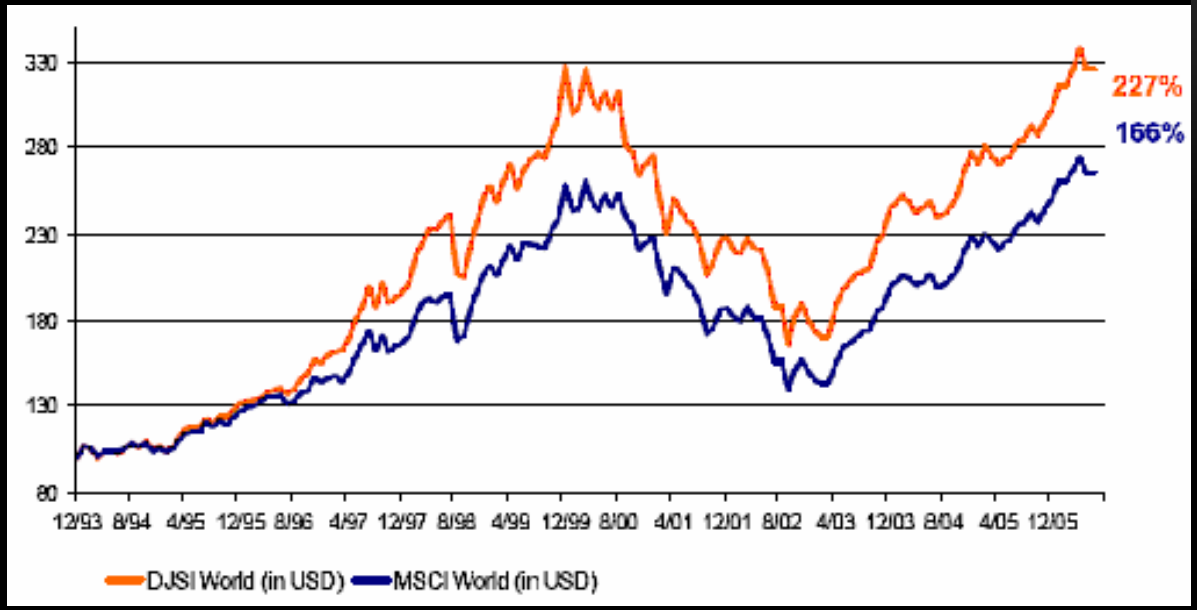
Sector Allocation	
Utilities	4.2%
Telecommunications	5.0%
Technology	11.0%
Oil & Gas	11.0%
Industrials	10.1%
Health Care	9.8%
Financials	21.0%
Consumer Services	5.7%
Consumer Goods	13.6%
Basic Materials	8.8%

Country Allocation	
USA	22.7%
UK	21.6%
Japan	6.8%
Switzerland	8.0%
Germany	8.6%
France	6.9%
Spain	5.6%
Netherlands	2.5%
Australia	4.9%
Others	12.4%

Sustainability & Competitive Strategy

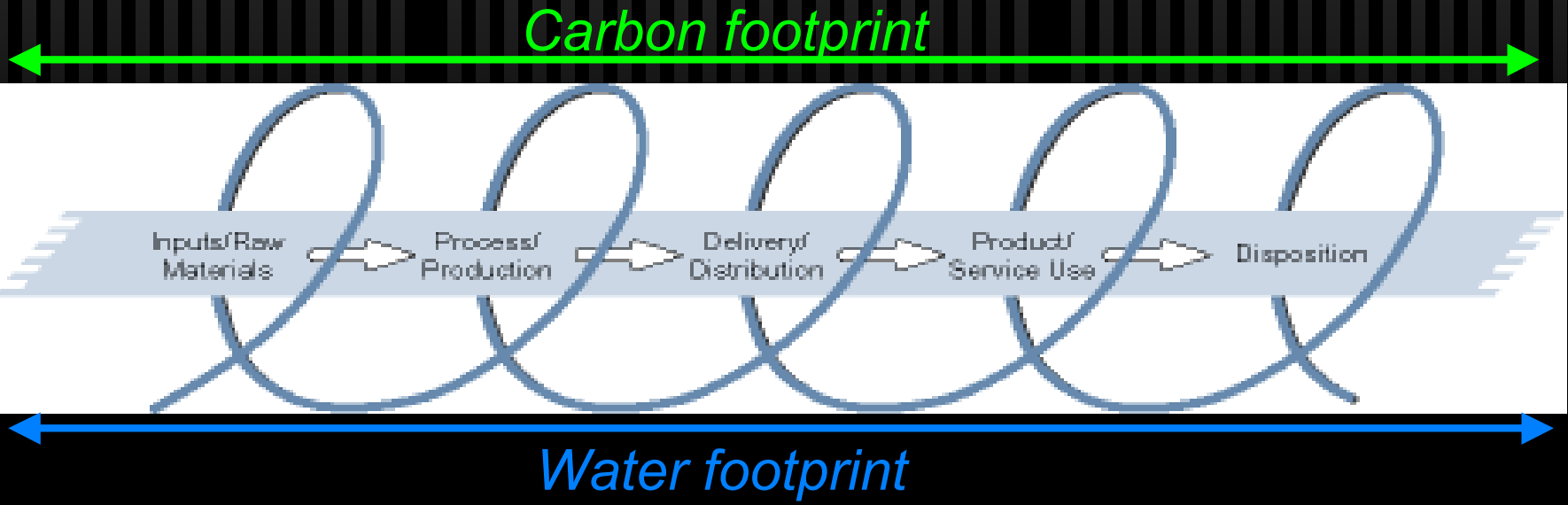
- ✓ Greening supply chains (e.g. Walmart, Coca Cola)
- ✓ Rebranding company (e.g. BP, GE)
- ✓ Innovation through R&D or investments in disruptive technologies (e.g. GM, 3M)

Note: The value of DJSI has dropped since last year, along with other indices



Where to Innovate? A Value Chain Perspective

1. Where is value captured and why?
2. What are the opportunities for greening the value chain segment?
3. Invest now, defer investment, and the option value of flexibility



Sustainability Finance: Real Options Analysis (ROA)

- ✓ Sustainability issues are highly subject to policy, market and product pricing uncertainties
- ✓ These uncertainties are usually taken into account as probability weights to compute an expected value of discounted cash flow (DCF).
- ✓ DCF does not quantitatively take into account investment risks and the value for decision-makers and managers of keeping their investment options open.
- ✓ ROA offers a nuanced approach to strategic investment that quantitatively takes into account investment risks and the value of the open options for budget decision-makers.

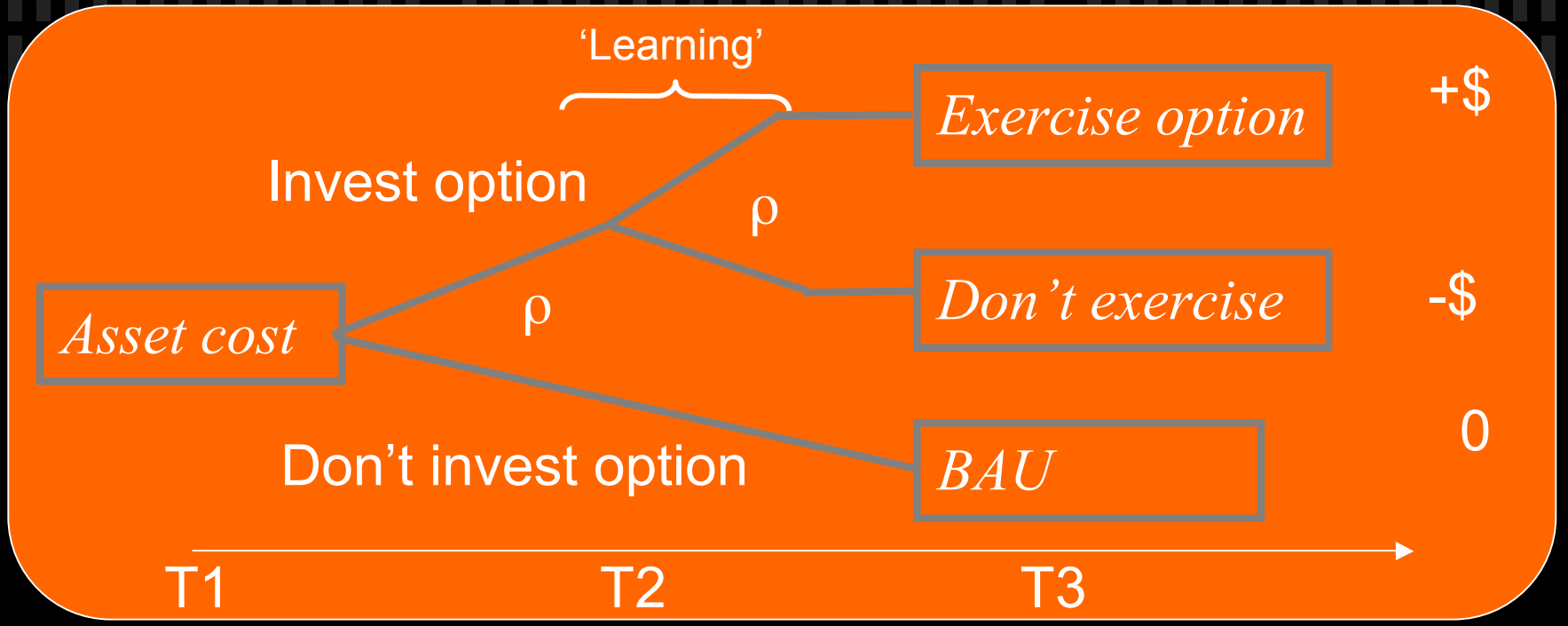
ROA: Investment Opportunity Decisions and Call Options

Investment Opportunity	Variable	Call Option
Present value of project assets	S	Stock price
Expenditure required to acquire project assets	X	Exercise price
Length of time the decision may be deferred	t	Time to expiration
Time value of money	r_f	Risk-free rate of return
Riskiness of project assets	σ^2	Variance of returns on stock

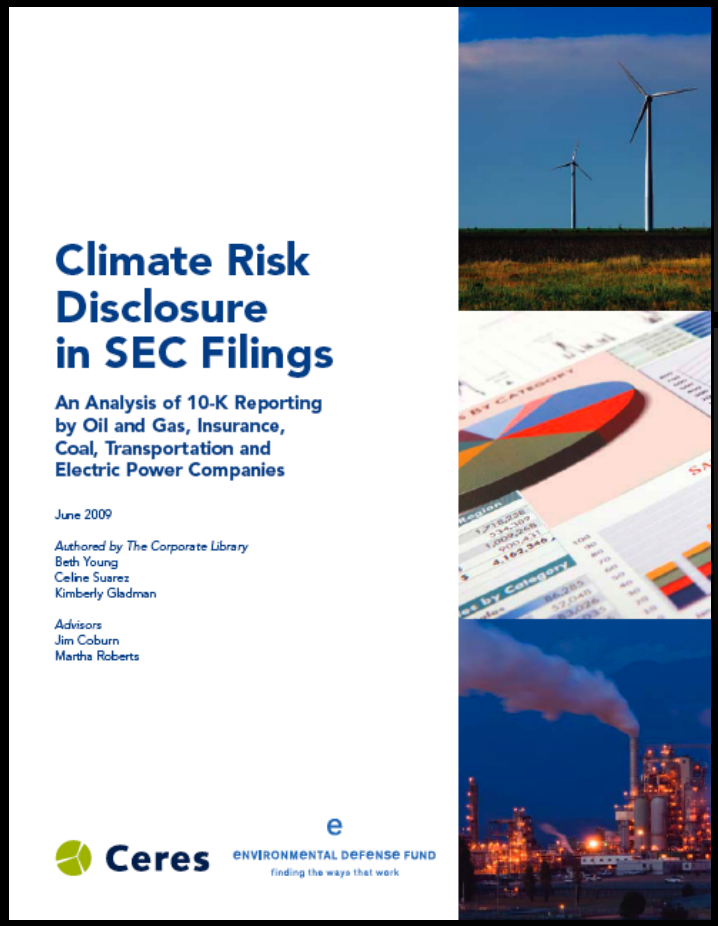
The challenge is to define and price the volatility of the options

ROA-Based Investment Decision Trees

- ✓ Compare invest option with business as usual (BAU) option over time
- ✓ The value of the option will go up or down depending on the volatility of the policy, market, pricing or environmental changes
- ✓ Compute in time when the option should be exercised (value > 0), and the value of waiting (Don't exercise - BAU) --> value of investment flexibility



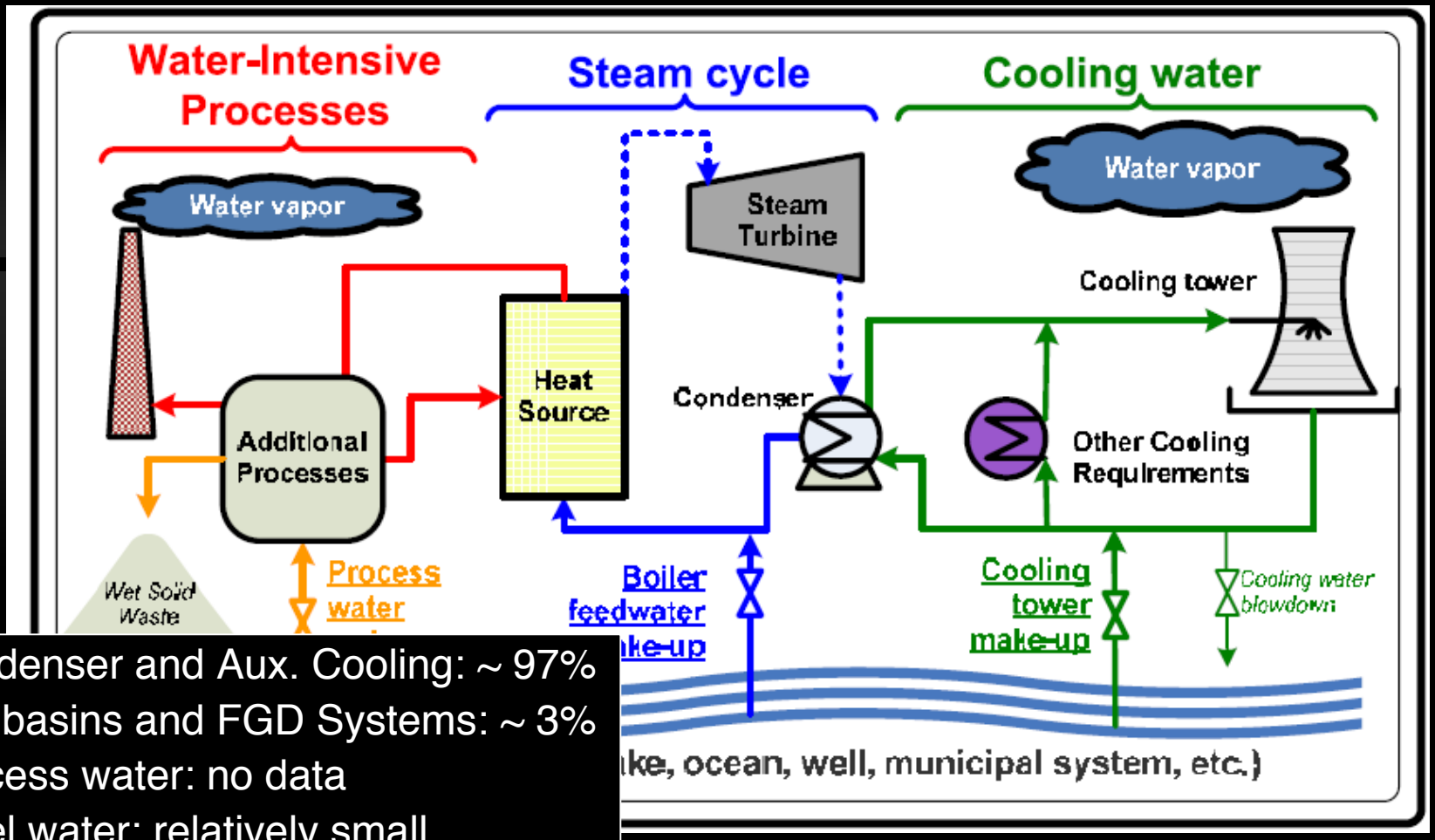
Example: Cooling Water Investments for Energy Production



Climate risk exposures for electric power

- ✓Carbon emissions
- ✓Water quantity and quality

Water Use in ThermoElectric Plants



Condenser and Aux. Cooling: ~ 97%
Ash basins and FGD Systems: ~ 3%
Process water: no data
Hotel water: relatively small

Water-Based Uncertainties for Power Plants

- Regulation: EPA's ruling on 316b (impingement and entrainment) discourages once-through cooling systems, in future may try to increase standardization of 316a (temperature)
- New Plant Development or Retrofits: new plants may consume more water, especially if moved to cooling towers, or if carbon capture and sequestration becomes commercial
- State of Technology: currently limited cost effective options, but many nascent technologies under development by government R&D programs and vendors
- Precipitation and global warming: changes in frequency and severity of extreme events or changes in average availability
- Complex Stakeholder Networks: electricity customers may also be our competitors in the water arena - multi-stakeholder water use

Water Efficiency Objectives: Corporate Perspective

- Potential Priorities
  - Maximize benefit to the environment?
  - Highest levels of water-use efficiency, g/MWh?
  - Build goodwill with stakeholders?
  - Mitigate risk of drought?
  - Lower long-term risk from exposure to water volatility?
    - Access-Legal, Availability-Physical, Price-Financial
- Potential Benefits/Barriers
  - Current Plant Set-Up –is it once through or already has a tower
  - Regulatory Process – include in rate base?

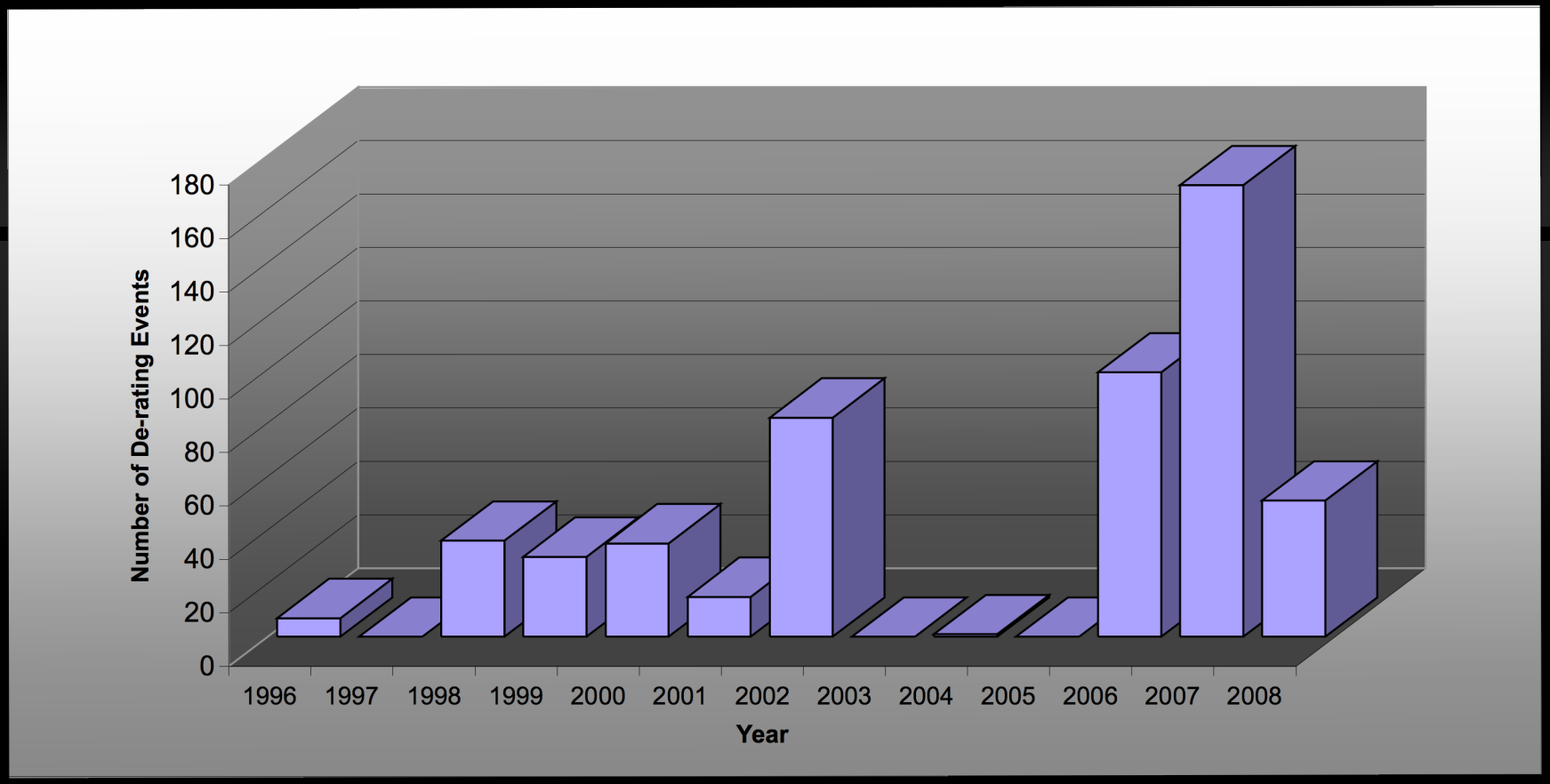
The "Value" (not cost) of Water to the Utility

- Due to river temperatures, a de-rating event at Plant A results in the need to shift production to Plant B
  - Example: A 100 MW reduction at Plant A will result in an increase of 80 MW production at Plant B in order to satisfy system demand
    - Net system reduction of 20 MW

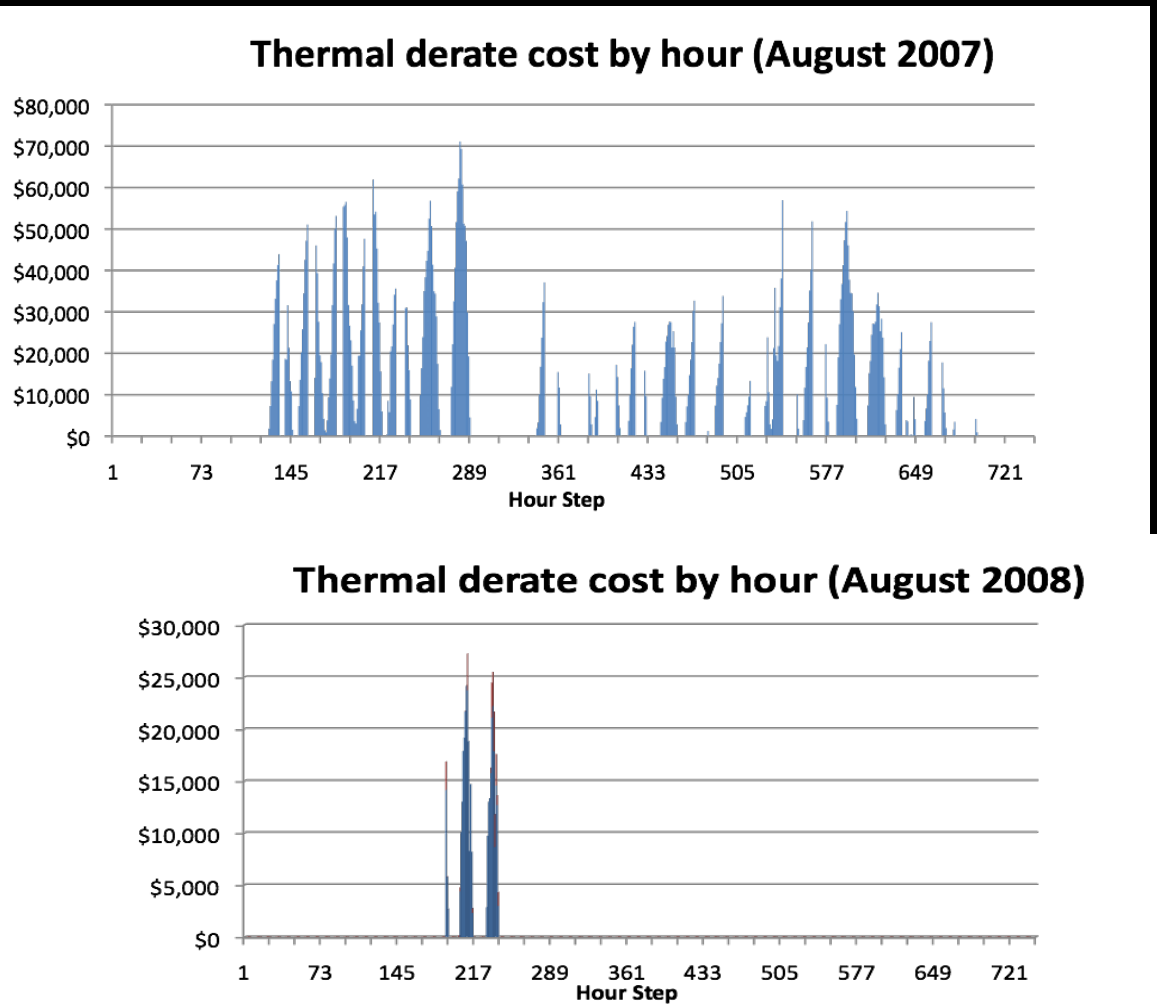
- Cost of de-rating is a function of:
  - Replacement Cost: $/mWh at Plant B > $/mWh at Plant A
  - Market Cost: Lost revenue from excess capacity (20 MW) not sold into wholesale electric markets

Replacement Cost + Market Cost = Implied Value of Water

Water Related De-rating Events (1996-2008)



De-rate Costs Variable in Frequency and Severity



Cost: $5.9 M

Cost from year to year are uncertain (35%+ volatility)

Cost: $390 K

Corporate Investment Decisions

- ✓ Buy energy on open or regional market to meet long term purchasing contracts
- ✓ Invest in water conservation technology
- ✓ Defer investment in conservation technology until better understanding of uncertainties
- ✓ R&D on new solutions (innovation)

SEC "Climate change is for many companies a material risk. Rising seas and stronger storms will severely damage physical infrastructure, water availability will impact company performance, capital investments are placed at risk, requiring costly adaptation measures, and threatens the profitability of insurance providers."

Technologies Considered

Technology	Water Savings	Effect on Heat Rate	Research Stage, Issues	Capital Cost*
Coal Drying w/ Waste Heat and Flue Gas	10%	-3%	Bench Pilot, technical effectiveness	0.5x
Evaporation Capture from Cooling Towers	20%	Depends	Utility Pilot, size and cost	3x
Wet Surface Air Condenser for Aux Towers	Make-up water and blowdown disposal	minimal	Cost, changing condenser, pilot underway	1.5x
Heller Hybrid	80-90%	+1.5%	Cost reduction, minimize parasitic load	4x

***Capital & Installed Cost: closed-loop cooling tower retrofit cost, ~$40m**

Real Option: Water Technology

- To determine whether the option to install the Heller hybrid should be exercised we compare the cost of installing today to the value of the option to construct the facility in the future.
- When value of option to build in future exceeds value of construction today, utility owner of Plant A should wait, and vice-versa

Real Options Analysis: Binomial Lattice Approach

- Underlying asset of the option is the cost of a derating event
  - Model cost over time based on historical volatility (Up ,down (u, d)

Yealry Derate Cost For Plant A

Node	Year	2009	2010	2011	2012	2013	2014	2015
		0	1	2	3	4	5	6
0		($1,000,000)	($1,419,068)	($2,013,753)	($2,857,651)	($4,055,200)	($5,754,603)	($8,166,170)
1			($704,688)	($1,000,000)	($1,419,068)	($2,013,753)	($2,857,651)	($4,055,200)
2				($496,585)	($704,688)	($1,000,000)	($1,419,068)	($2,013,753)
3					($349,938)	($496,585)	($704,688)	($1,000,000)
4						($246,597)	($349,938)	($496,585)
5							($173,774)	($246,597)
6								($122,456)
7								

- The alternatives

Command and Control

Install (NPV)

t0

Static

Install vs. not install (NPV)

t0

Dynamic

Install vs. wait

t0

E(Install vs. wait)

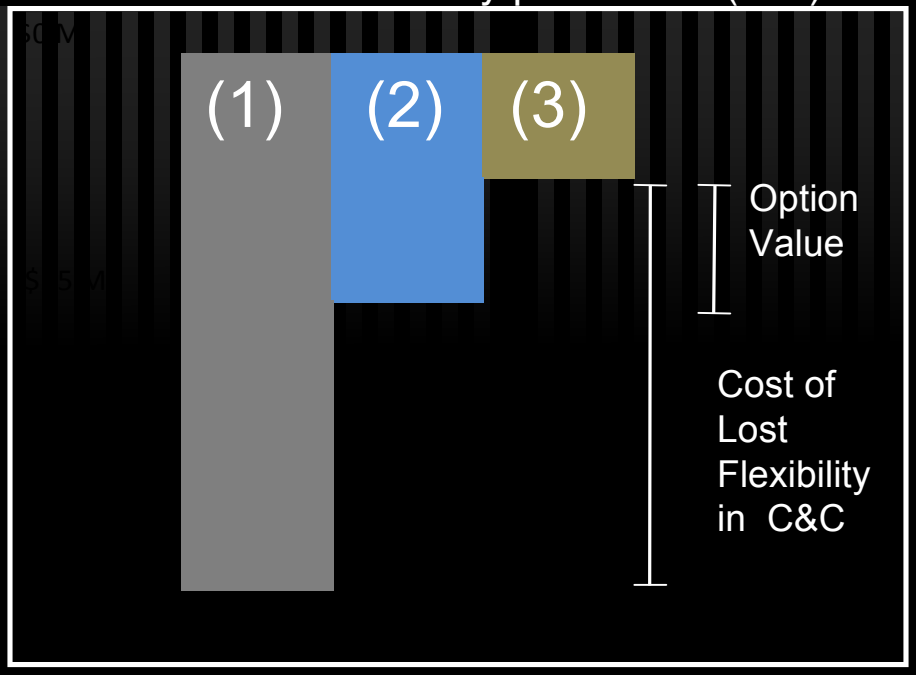
E(Install vs. wait)

t1

Model Inputs and Outputs

Inputs

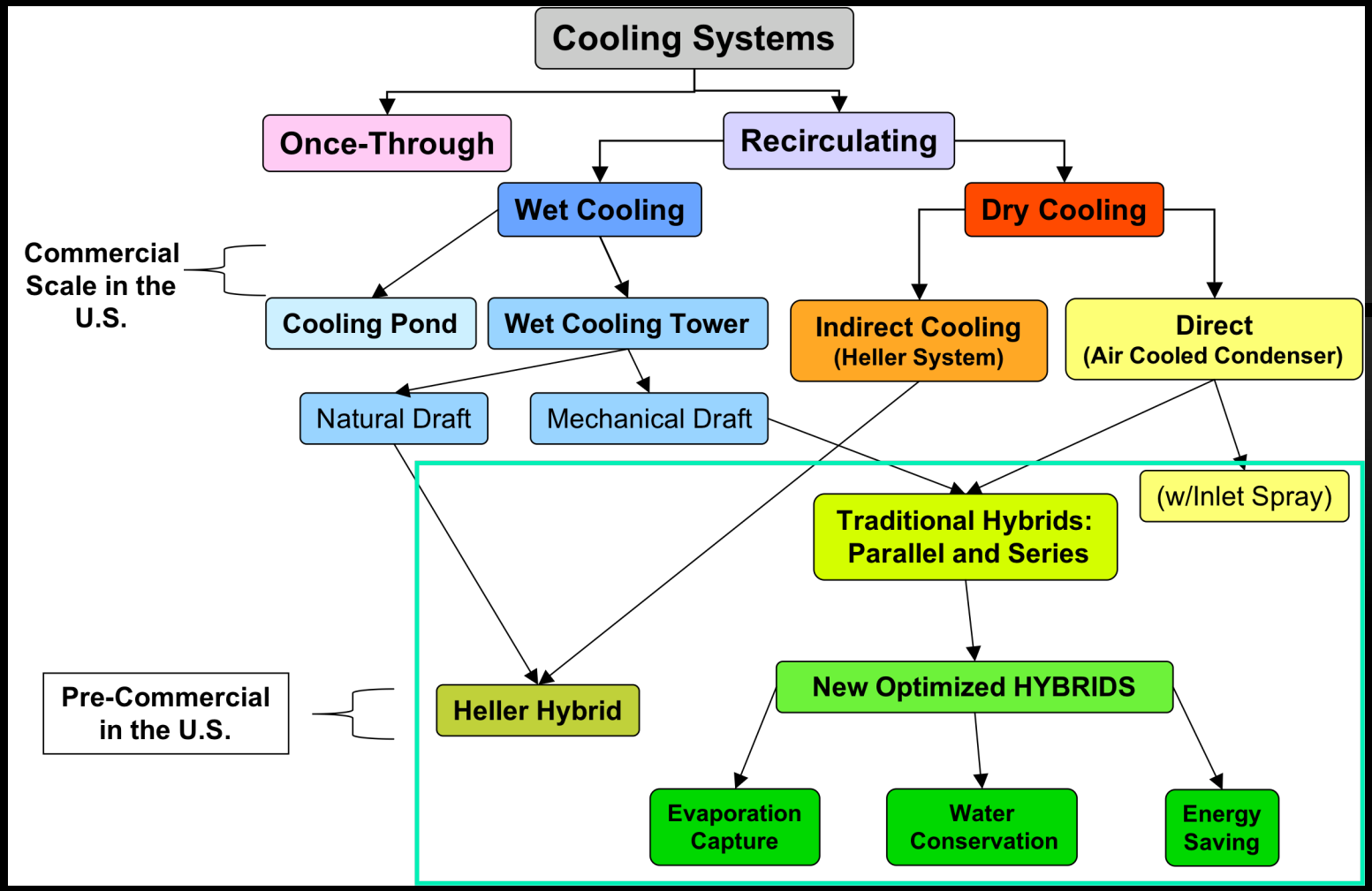
- ✓ Capital Cost of Cooling System: ($39 M.)
- ✓ Volatility in yearly de-rate costs: 35%
- ✓ Cost of Technology: Constant (real)
- ✓ Increase in electricity prices: 2% (real)



Outputs

- Present Value of Command and Control Alternative **(1)**
  - ($51 million)
- Present Value of Static Alternative **(2)**
  - ($25.5 million)
- Present Value of Dynamic Alternative **(3)**
  - ($16.3 million)
- Option Value = Static – Dynamic
  - $9.2 million
- First time period to install: 2015

Interpretation and Next Steps



Conclusions

- ✓ The business of sustainability (circular economy) increases market value, results in new partnerships, stimulates investment, and builds public good-will.
- ✓ The conditions for sustainabilty are very volatile, depending on policies, markets, politics, etc - and investment in assets tends to be high
- ✓ Investing in the circular economy will require flexibility in investment decision-making, such as offered by real options framework
- ✓ The challenge is to define alternate options and volatility spread of the uncertainties impacting the business.