Architecting Smart City Solutions: Analytics-based Financial Engineering

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OVERVIEW

- **WHY?**
  - Context
  - Short-term trends
  - Long-term visions
- **WHAT?**
  - Definitions
- **HOW?**
  - Debates
  - Real options!

WHY Smart Cities?

Motivation: Why 'Smart Cities'?

2010
- ~50% (3.5 of 7B) living in urban areas*
- Rapid urbanization in emerging nations

2030
- ~60% (5 of 8.3B) will be living in urban settings ~

- **Urbanization**
  - From rural to economic opportunity
  - Energy ladder
    - firewood, dung, diesel, batteries, grid
  - Food ladder
    - subsistence, staples, meat, processed, fast

- **Dickensian byproducts**
  - Environmental degradation
  - Slums / labor exploitation
  - Sewerage & water quality
  - Disease & pandemics

2050
- ~70% (7 of 10B) of globe in urban settings ~

United Nations Population Fund (www.unfpa.org)
~ UN Department of Economic and Social Affairs

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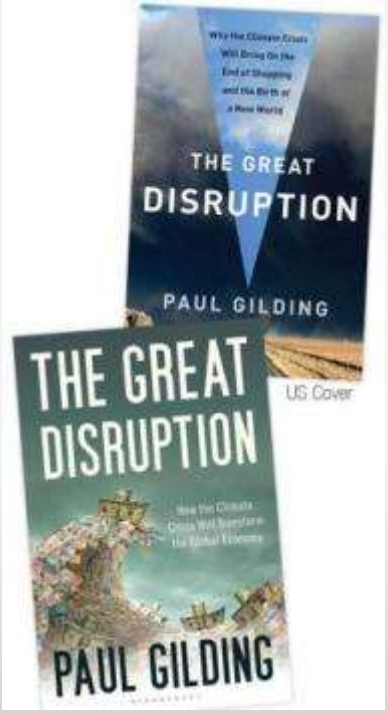
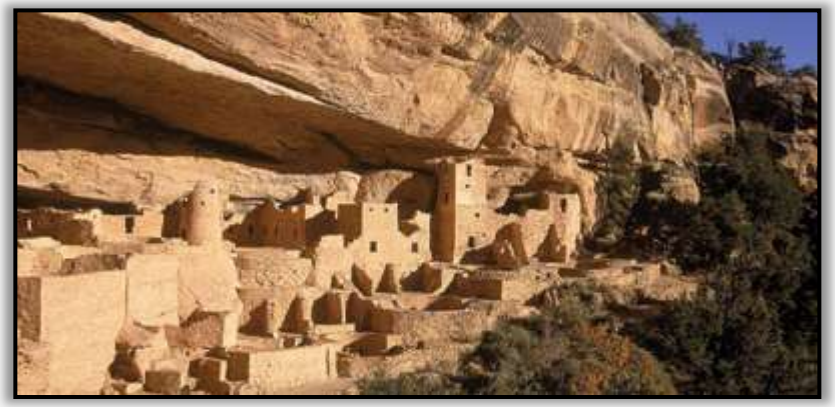
Failed Cities

- **Biblical & ancient: political**
  - Moral judgment
    - Babylon, Sodom & Gomorrah
  - Disaster - Atlantis (apocryphal)
  - Socio-economic implosion - Rome
- **Disaster: failed infrastructure**
  - Flooding - New Orleans
  - Water management - Brisbane
- **Market collapse: macro-economic crisis**
  - Economic - Detroit
  - Overgrowth – Calcutta, Delhi
- **Collapse: ecological collapse**
  - Warfare & disease - Mayan & Aztek
  - Environmental change - Anasazi
  - Ecological collapse - Easter Island
  - Overexploitation – Greenland Norse
- **Dystopian**
  - Blade Runner, 1984, Brave New World



Collapse: J. Diamond



- **Factors**
  1. Key resource exhausted
  2. Environmental/climate change
  3. Relations with partner societies
  4. Relations with hostile societies
  5. Political, economic, cultural, socials factors

- **Why did they not see?**
  - 'Boiling frog' syndrome
  - Conflict of interest: short-term interests of elites & long-term health of broader society
  - Factors are multiple: can not solve just one, need to address complexes
  - First & second order derivatives of function
    - i.e. not 'wealth', but functions
- **Once and future crisis**
  - Dickensian conditions of industrial revolution Britain
  - Legacy of Liberal Industrial Capitalism
  - How to prevent the descent into great human & environmental costs?

Global Energy: Outlook for Change

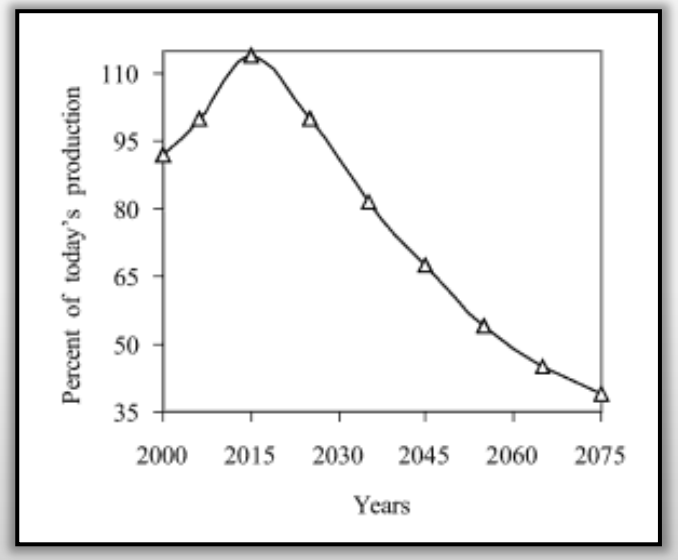
Depletion of fossil fuels

- 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 *

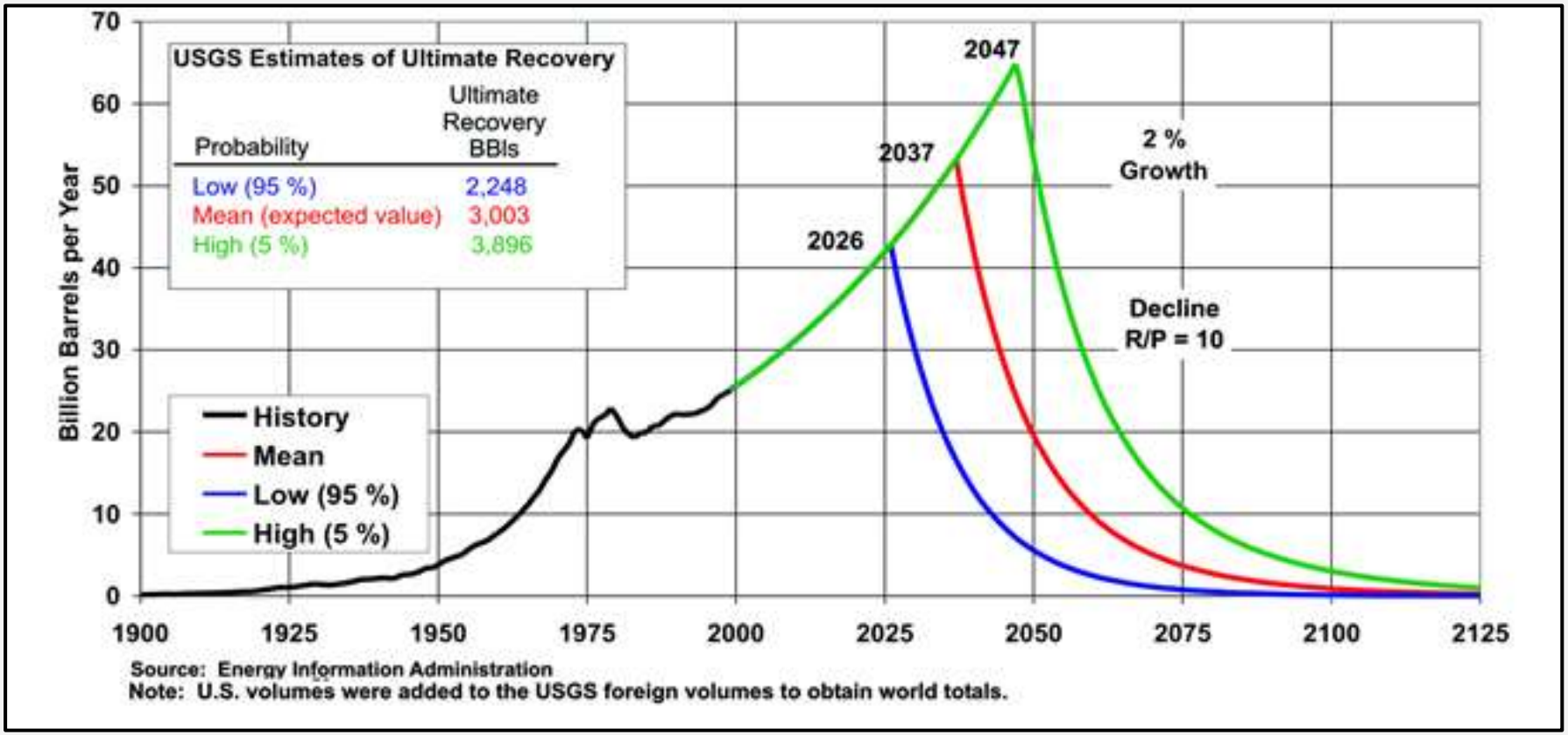
- **Fossil (86%)**
  - **Petroleum (~40%)**
  - **Coal (~23%)**
  - **Natural gas (~23%)**
  - Bitumens
  - Oil shales
  - Tar sands
- **Nuclear (8%)**
- **Renewable (6%)**
  - Biomass
  - Hydro
  - Wind
  - Solar (thermal & photovoltaic)
  - Geothermal
  - Marine
- **Exotic hypotheticals**

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



Reuters / US Coast Guard

Uncertainty: Timing of Decline?

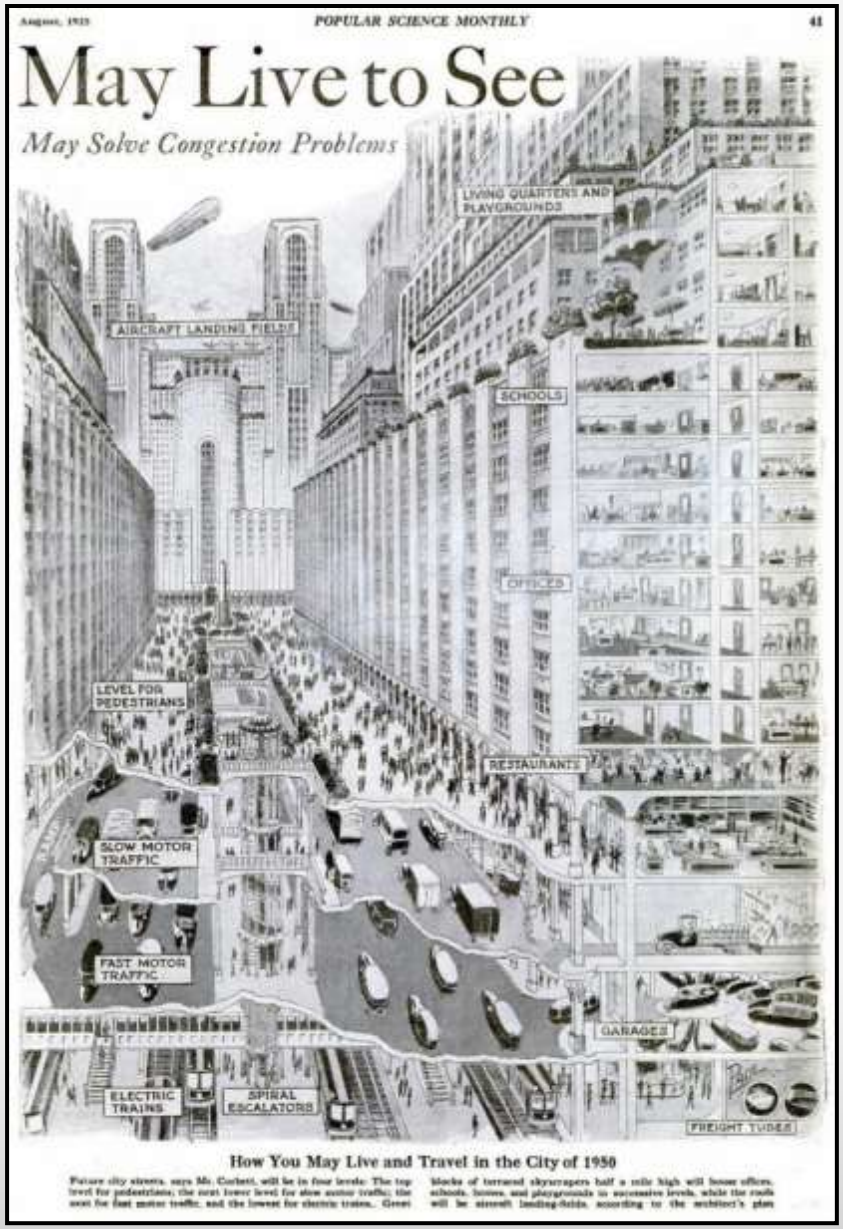


http://www.eia.doe.gov/pub/oil_gas/petroleum/feature_articles/2004/worldoilsupply/oilsupply04.html

- 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

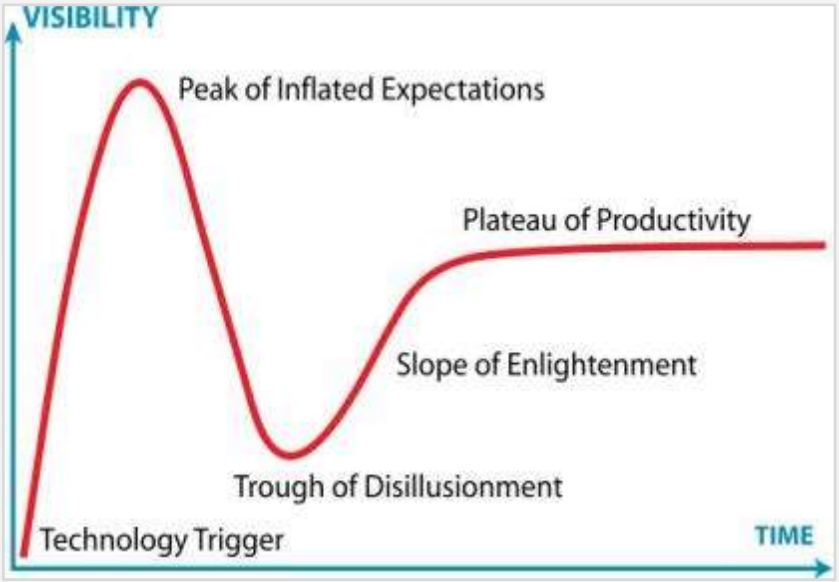
Techno-Utopianism

- **City on a Hill**
  - 'Kingdom of God'
  - Social idealism
  - Enlightenment project
  - Architecture & morality
- **Science Fiction**
  - Atlantis & Shangri-La
  - Technology as vehicle



WHAT is a Smart City?

What's in a Name? What do we mean by 'Smart'?

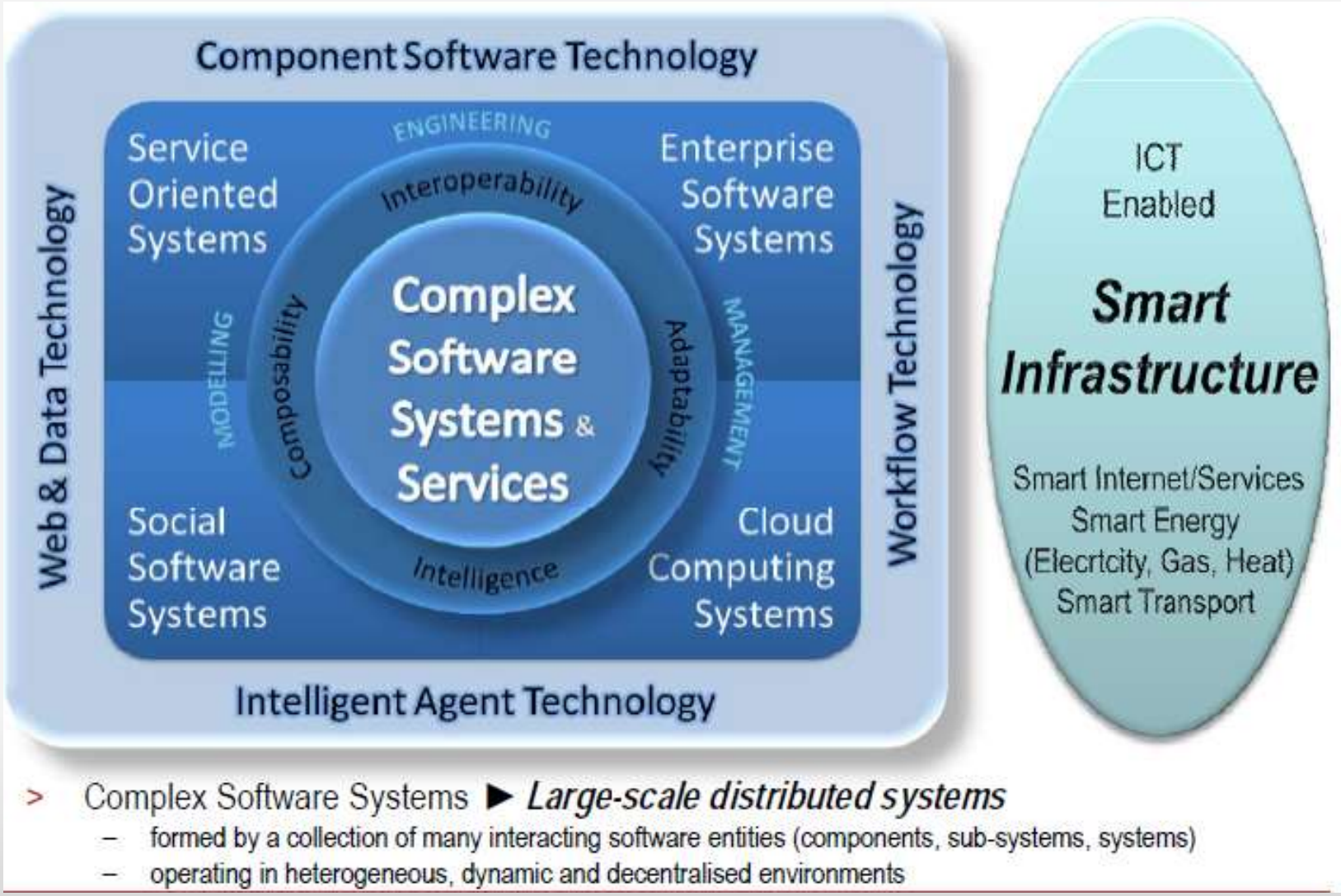


Gartner 'Technology Hype Curve'

- **Marketing hype?**
  - Science fiction futurism
  - Gartner 'Hype Curve'
  - 'Greenwashing'
  - Tokenism
  - Austerity measures

- **Reality?**
  - Technical convergence
  - Cloud / 'Internet of Things'
  - Embedded sensor networks
  - Advanced analytics / Big Data
  - 'Nudge': socially aware design
  - Developing implementations

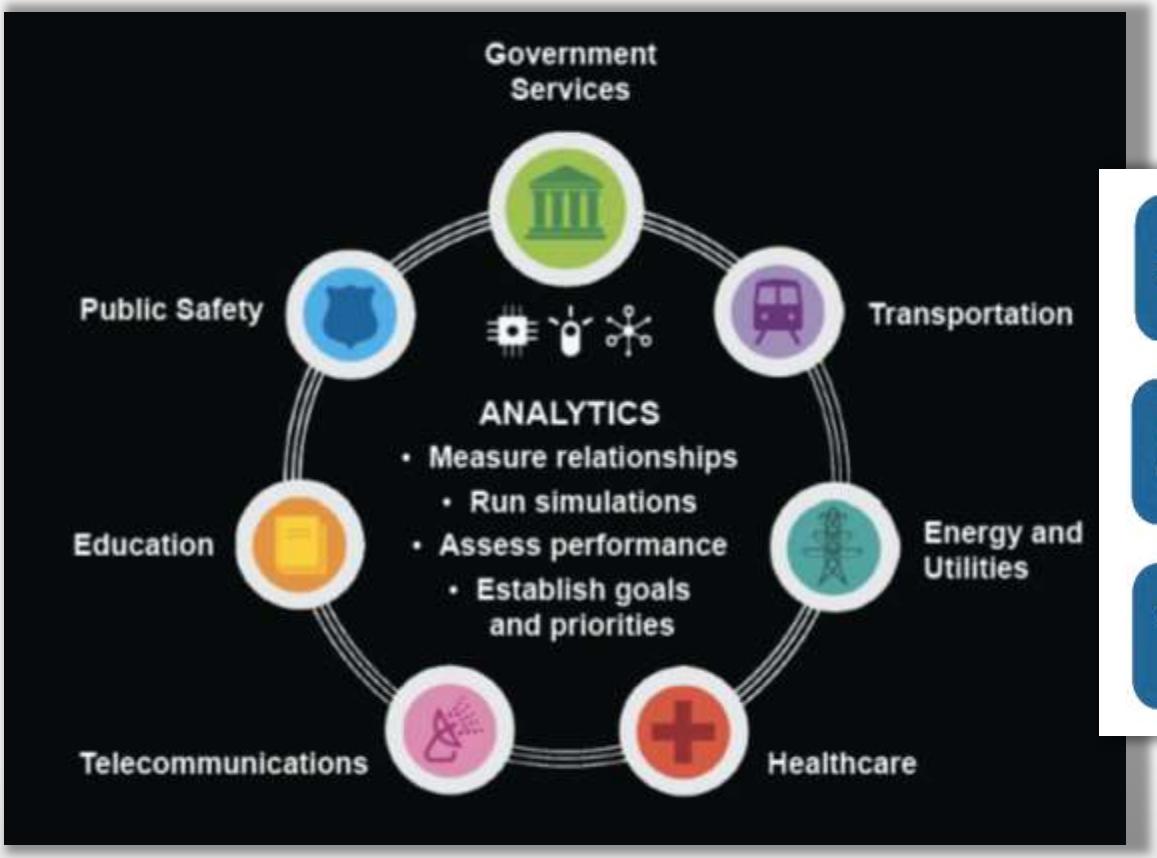
Smart Infrastructure



> Complex Software Systems ► *Large-scale distributed systems*
  - formed by a collection of many interacting software entities (components, sub-systems, systems)
  - operating in heterogeneous, dynamic and decentralised environments

Kowalczyk, R. Enabling Smart Infrastructure with Intelligent Agent Technologies. www.cetinia.urjc.es/en/node/382

IBM's Smarter Planet Architecture



Our world is becoming
INSTRUMENTED

Our world is becoming
INTERCONNECTED

All things are becoming
INTELLIGENT

Amini, L. 2010. The Role of Technology in the Transformation to Smarter Cities. IBM Corporation.

Smart City Working Definitions

"The use of Smart Computing technologies to make the critical infrastructure components and services of a city—which include city administration, education, healthcare, public safety, real estate, transportation, and utilities—more intelligent, interconnected, and efficient."

Washburn, D., Sindhu, U., Balaouras, S., Dines, R. A., Hayes, N. M., & Nelson, L. E. (2010). Helping CIOs Understand "Smart City" Initiatives: Defining the Smart City, Its Drivers, and the Role of the CIO. Cambridge, MA: Forrester Research, Inc. Available at http://public.dhe.ibm.com/partnerworld/pub/smb/smarterplanet/forr_help_cios_und_smart_city_initiatives.pdf.

A city that monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, even major buildings, can better optimize its resources, plan its preventive maintenance activities, and monitor security aspects while maximizing services to its citizens.

Hall, R. E. (2000). The vision of a smart city. In Proceedings of the 2nd International Life Extension Technology Workshop (Paris, France, Sep 28). Available at http://www.osti.gov/bridge/servlets/purl/773961-oyxp82/webviewable/773961.pdf.

An instrumented, interconnected, and intelligent city. *Instrumentation* enables the capture and integration of live real-world data through the use of sensors, kiosks, meters, personal devices, appliances, cameras, smart phones, implanted medical devices, the web, and other similar data-acquisition systems, including social networks as networks of human sensors. *Interconnected* means the integration of those data into an enterprise computing platform and the communication of such information among the various city services. *Intelligent* refers to the inclusion of complex analytics, modeling, optimization, and visualization in the operational business processes to make better operational decisions.

Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J., & Williams, P. (2010). Foundations for Smarter Cities. IBM Journal of Research and Development, 54(4). DOI: 10.1147/JRD.2010.2048257.

Emerging Smart Systems

Bleeding edge smart systems…

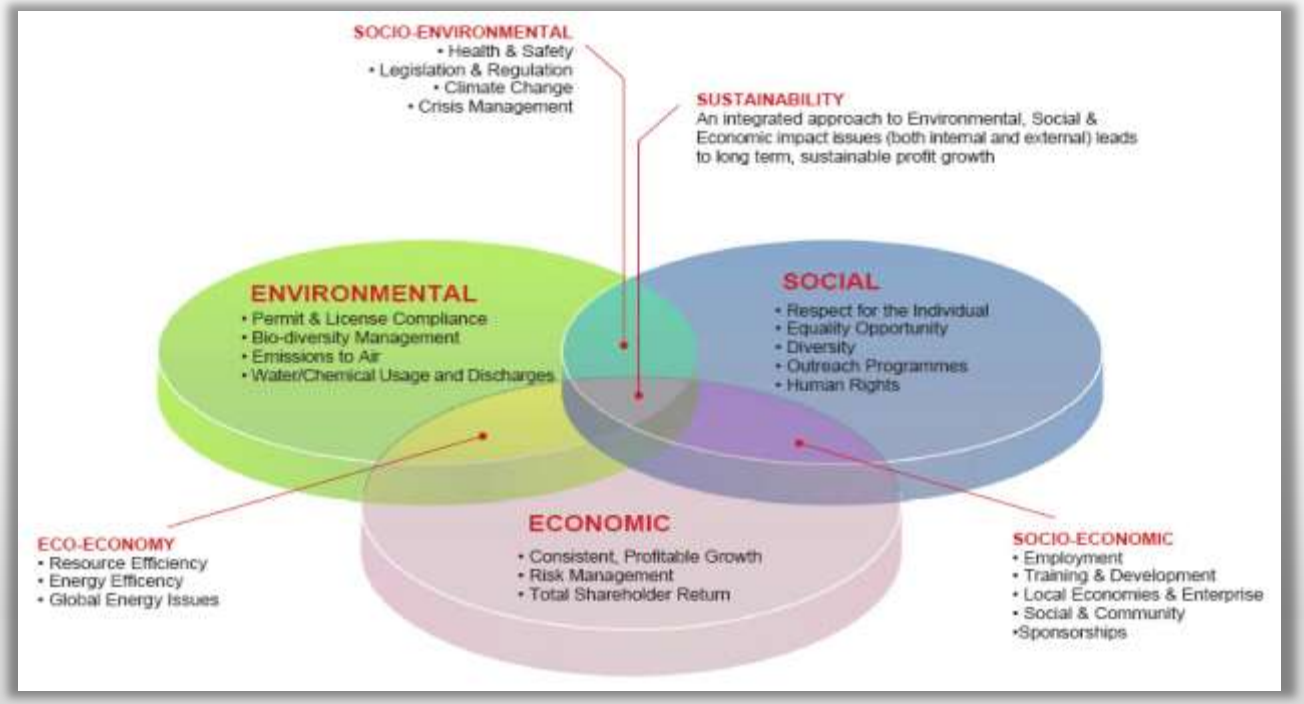
- Military drone swarm orchestration
- Cloud Computing infrastructure mgmt
- Hierarchical state machines
- Complex autopilot systems

Smart City associated reference implementations…

- Smart Grids (electricity networks)
- Water management (i.e. Dutch flood management)
- Waste management (i.e. smart sewerage treatment)
- Transport networks (i.e. train & highway optimization)
- Advanced supply chain management (i.e. Walmart)
- Oil & gas pipeline maintenance management
- Telecommunication network load orchestration

What is ‘Sustainability’?

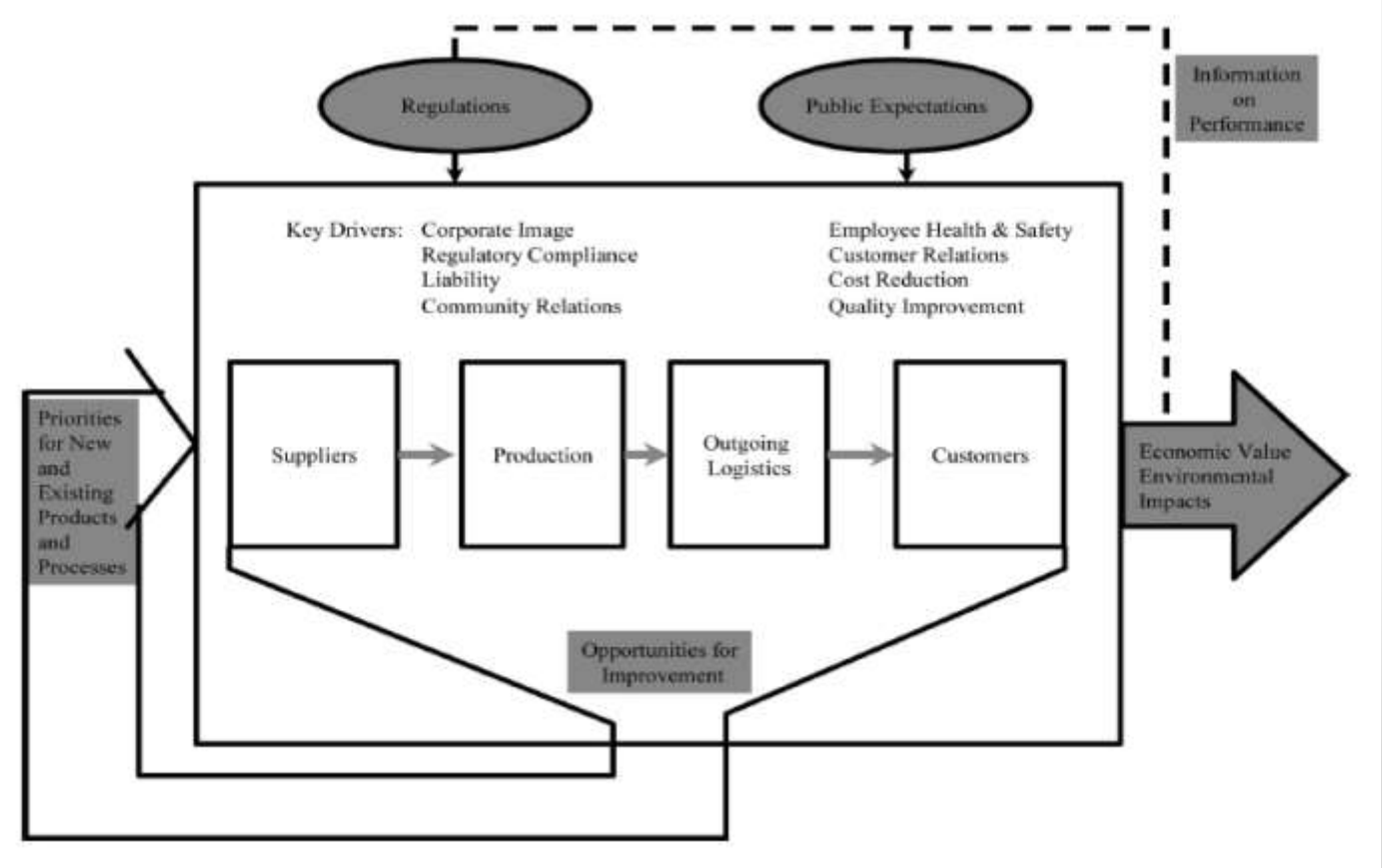
- **Austerity => conservationism populism?**
  - Malthusian scenarios (millennialist in nature)
  - Regulatory distortions & ‘tragedy of the commons’…
  - ‘Greenwashing’ and tokenism?
- **Market profit maximization!**
  - Multi-stakeholder, multi-criteria ‘satisficing’ of broad profit motives
    - ‘How to Measure Anything’ D. Hubbard www.howtomeasureanything.com
    - ‘Natural Capitalism‘ - P. Hawken, A. Lovins, L. Lovins www.natcap.org



Staff, V. T. L. (2008). "Sustainability - The Solution Matrix." Retrieved December 3, 2011, 2011, from http://www.verifysustainability.com/Pie%20Diagram/PieDiagram_Open_Page.aspx.

Sustainable Supply Chains

- **Advanced technical supply chain management outpacing understanding of macro-systemic effects**
  - **+** *Commercial*: WalMart, NetFlix, Amazon, Dell, Zara
  - **-** *Resource*: Enron, U.S. Housing Crisis, trading scandals



Kleindorfer, P. R., K. Singhal, et al. (2005). "Sustainable Operations Management." Production and Operations Management **14**(4): 10.

HOW do we realize Smart Cities?

Overview: Innovation MegaProjects

- **Innovation Architecture**
  - Blueprint of change, connecting & coordinating people, groups, technology, and capital
  - Solving long-term, large scale problems requires cooperation among a host of entities…
- "Lots of new innovation can be tapped if you can just unlock the integration problem. The government can't be that integrator, but it can be a demand customer who changes the risk profile of taking on big problems—both for large companies and startups." - *Edward Jung*

Key Questions: Coaxing Cooperation

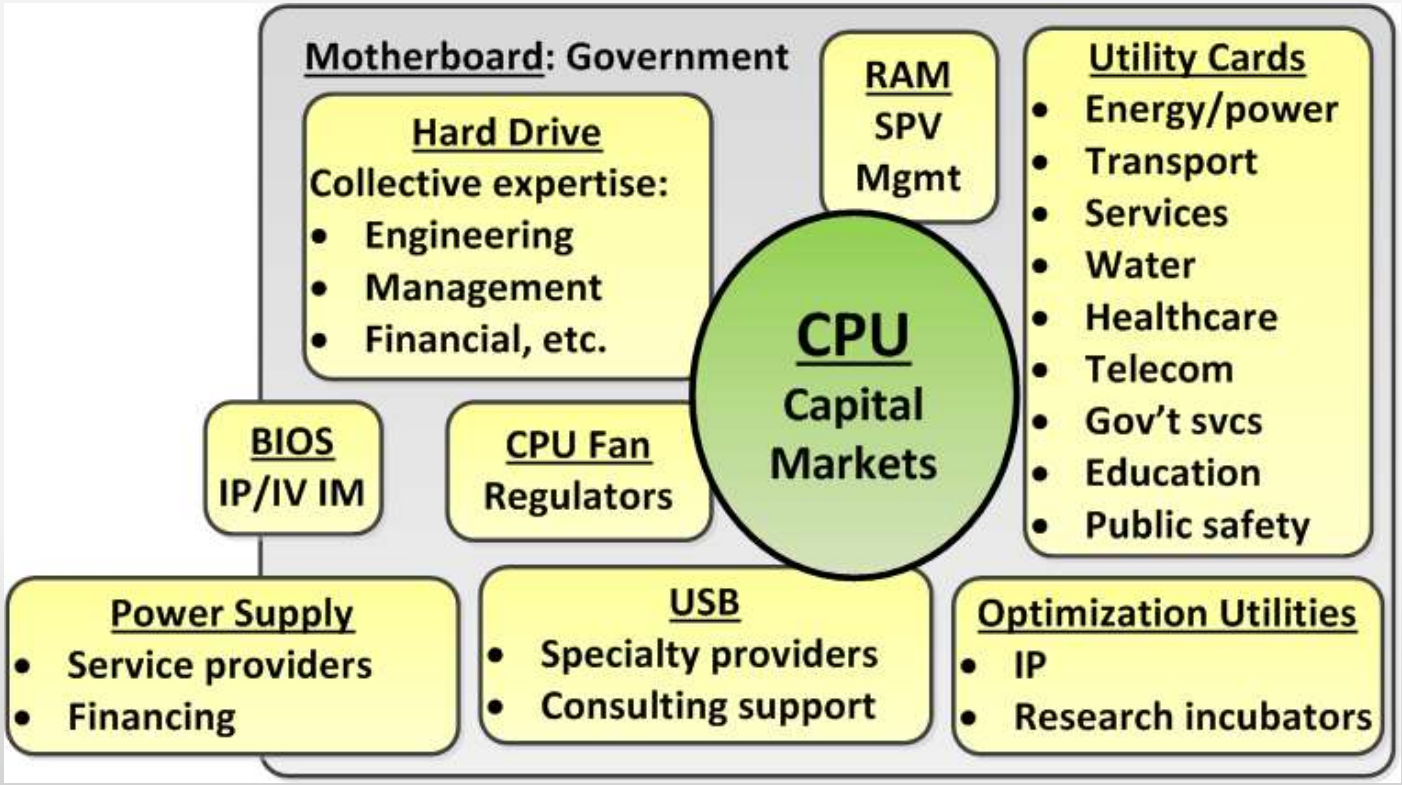
1. How to bring multiple stakeholders into a network of cooperative trust in order to build and operate a megacity implementation?

SOLUTION: INNOVATION HARDWARE

- Structured finance / project finance is a proven approach to orchestrating / coordinating megaprojects…
- However, PPP, as per a range of examples, are typically focused on a particular solution, system, or infrastructure implementation (i.e. highway, power plant, wind farm)
- How can we efficiently coordinate ‘a project of projects’ or a ‘fund of funds’?

HARDWARE: Structured Finance Substrate

- Brings diverse interests together in a structured market in which risks and rewards are apportioned via contracts and agreements which clarify agreed assumptions, segment and distribute risks and apportion incentives via sharing-out rewards (opportunities as the potential upside of risks assumed)



Key Questions: Orchestrating Complexity

2. How to orchestrate and manage ‘system of systems’ complexity resulting from a ‘hyperproject’ of megaprojects (i.e. Smart City)?

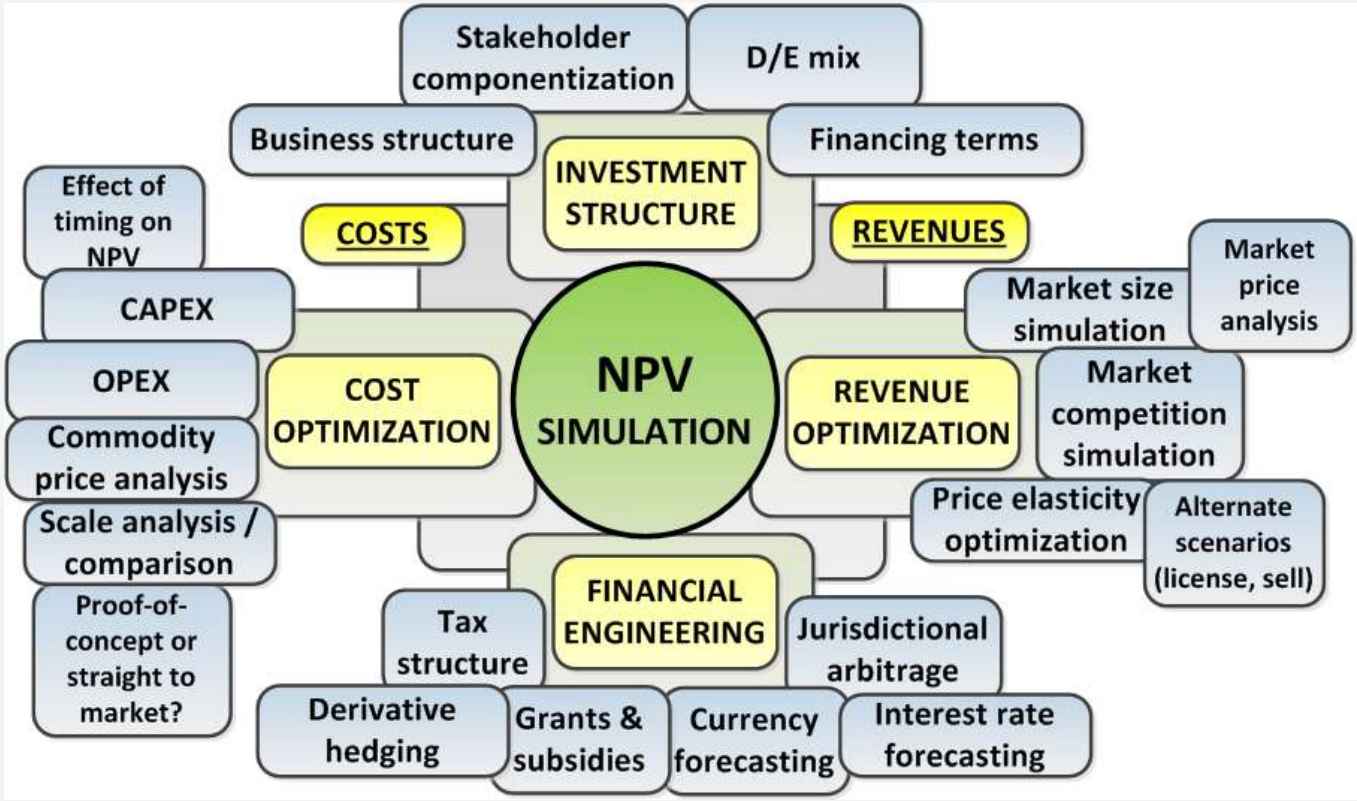
SOLUTION: ANALYTICS HYPERVISOR VIRTUAL OS

- Advanced analytics:
  - Monitoring
  - Forecasting,
  - Optimization
- Simulation (Monte Carlo & discrete event)
- Uncertainty valuation / management via decision trees

Virtualization OS: Integrated Analytics "Hypervisor"

- As a dynamic 'shared consensus model' regarding working assumptions associated with complex 'system of systems' orchestration, the analytics hypervisor informs detailed segmentation of risks / opportunities associated with the structured finance substrate
- Engine is a 'valuation' focused simulation composed of multiple aggregate sub-models which roll-up to a master assessment / simulation
- State-aware (via monitoring and sensors), the hypervisor can instantiate different modes to address various adaptive scenarios: economic crisis, natural disaster, commodity supply shortages, etc.
- As an adaptive understanding, models are reviewed and revised according to continual retrospective analysis. Real time intervention can be undertaken.
- Strategic guidance regarding strategic management is provided via Real options Analysis (ROA) (decision trees) , which allow adaptive path taking (i.e. management decision flexibility to expand, contract, or abandon future options).

Analytics "Hypervisor": Conceptual Overview



- Aggregate analytics platform: system-of-systems super-model
- Retrospective reviews, real-time monitoring, active forecasting
- From initial due-dilligence to evolving, active monitoring solution

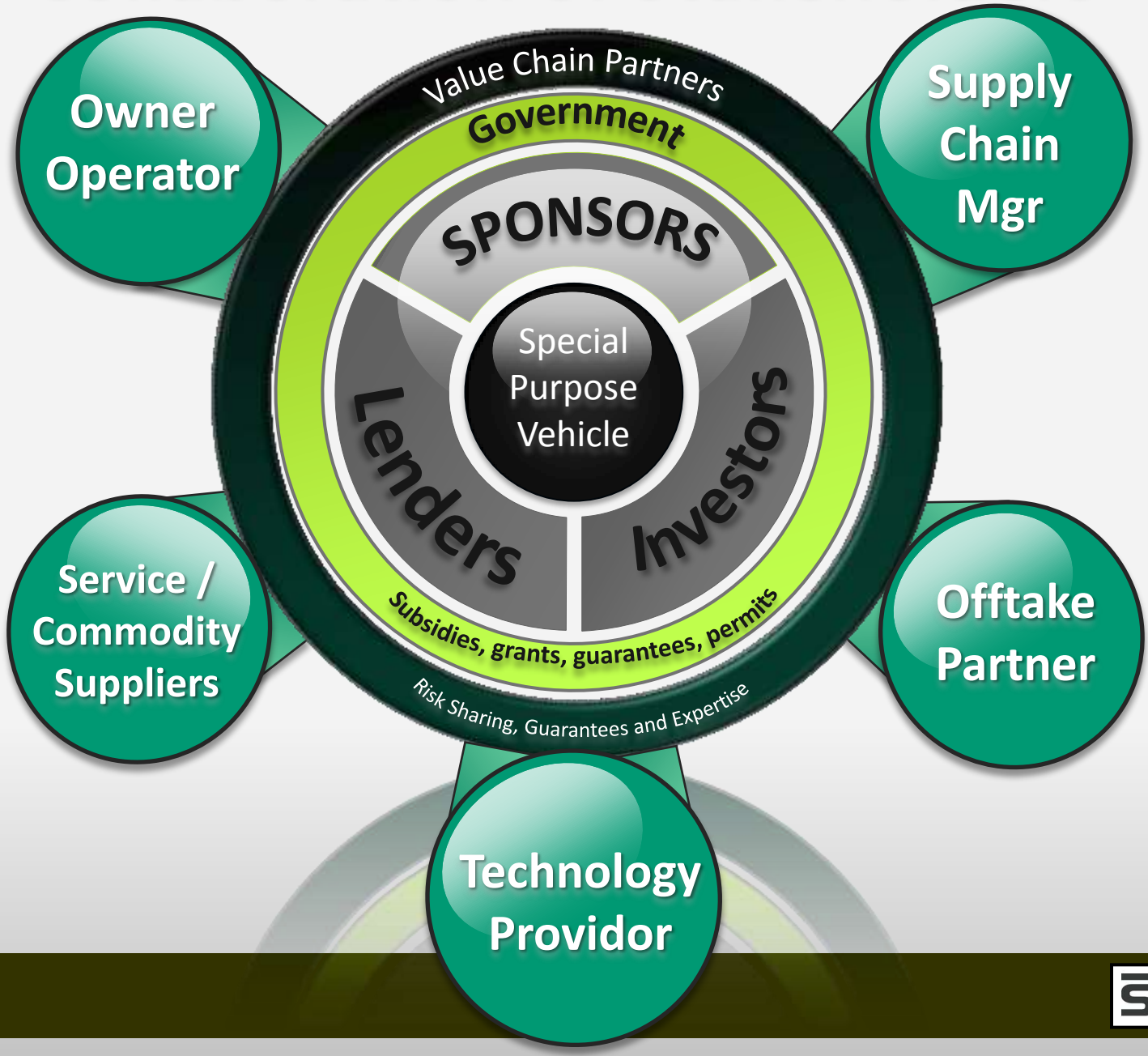
HARDWARE:
Financial Engineering

Project Financing Case Studies

1. Euro Disneyland
2. Indiatown Cogeneration Project
3. Tribasa Toll Road
4. Chad-Cameroon Petroleum Development and Pipeline Project
5. Australia-Japan Cable
6. Calpine Corporation
7. BP Amoco: Financing Development of the Caspian Oil Fields
8. Airbus A3XX: Developing the World's Largest Commercial Jet
9. Nghe An Tate & Lyle Sugar Company (Vietnam)
10. Texas High-Speed Rail Corporation
11. Contractual Innovation in the UK Energy Markets: Enron Europe, The Eastern Group, and the Sutton Bridge Project
12. Bidding for Antamina
13. Petrolera Zuata, Petrozuata C.A.
14. Poland's A2 Motorway
15. Restructuring Bulong's Project Debt
16. Mobile Energy Services Company
17. Chase's Strategy for Syndicating the Hong Kong Disneyland Loan
18. Financing PPL Corporation's Growth Strategy
19. Basel II: Assessing the Default and Loss Characteristics of Project Finance Loans.
20. Iridium LLC.

High-Level Competencies

Collaboration of Stakeholders



Sources of Funds: Capital Markets

- Equity
- Long-term debt markets (bonds)
- Commercial bank loans
- Fixed-rate debt markets
- International capital markets
- Supplier credits
- Governmental assistance
- World Bank Loans
- Inter-American Development Bank
- Export Credit
- Sovereign interests
- Local sources of capital
- Private equity
- Private pension funds
- Credit unions
- Government pension funds
- Insurance companies
- Government agencies
- Money market funds
- Banks and thrifts
- Mutual funds
- Bank trust department
- High net worth investors
- NGO interests (i.e. European Bank for Reconstruction & Development)

Financing Structure Options

Table ES-1. Description of Seven Financing Structures

Financing Structure Name	Project Capital Structure	Likely Equity Investors	Brief Description of Structure Mechanics
Corporate	All equity	Developer (corporate entity)	Corporate entity develops project and finances all costs. No other investor or lender capital is involved. Corporate entity is able to utilize Tax Benefits (no flip).
Strategic Investor Flip	All equity	Developer and Strategic Investor	Strategic Investor contributes almost all of the equity and receives a *pro rata* percentage of the cash & Tax Benefits prior to a return-based flip in the allocations.
Institutional Investor Flip	All equity	Developer and Institutional Investor	Institutional Investor contributes most of the equity and receives *all* of the Tax Benefits and, after the developer has recouped its investment, *all* of the cash benefits, until a return-based flip in the allocations.
Pay-As-You-Go ("PAYGO")	All equity	Developer and Institutional Investor	Institutional Investor finances much of the project, injecting some equity up-front and additional equity over time as the PTCs are generated. Includes a return-based flip in the allocations.
Cash Leveraged	Equity and debt	Developer and Institutional Investor	Based on the Strategic Investor Flip structure, but adds debt financing. Likely involves Institutional Investors, rather than Strategic Investors. Loan size/amortization based on the amount of cash flow from power sales.
Cash & PTC Leveraged	Equity and debt	Developer and Institutional Investor	Similar to the Cash Leveraged structure, but the loan size and amortization profile are based on the cash flow from power sales *plus* a monetization of the projected PTCs from the project.
Back Leveraged	All equity (but developer uses debt outside of the project)	Developer and Institutional Investor	Virtually identical to the Institutional Investor Flip, but with the developer leveraging its equity stake in the project using debt financing.

Overview Special Purpose Vehicle (SPV) Financing

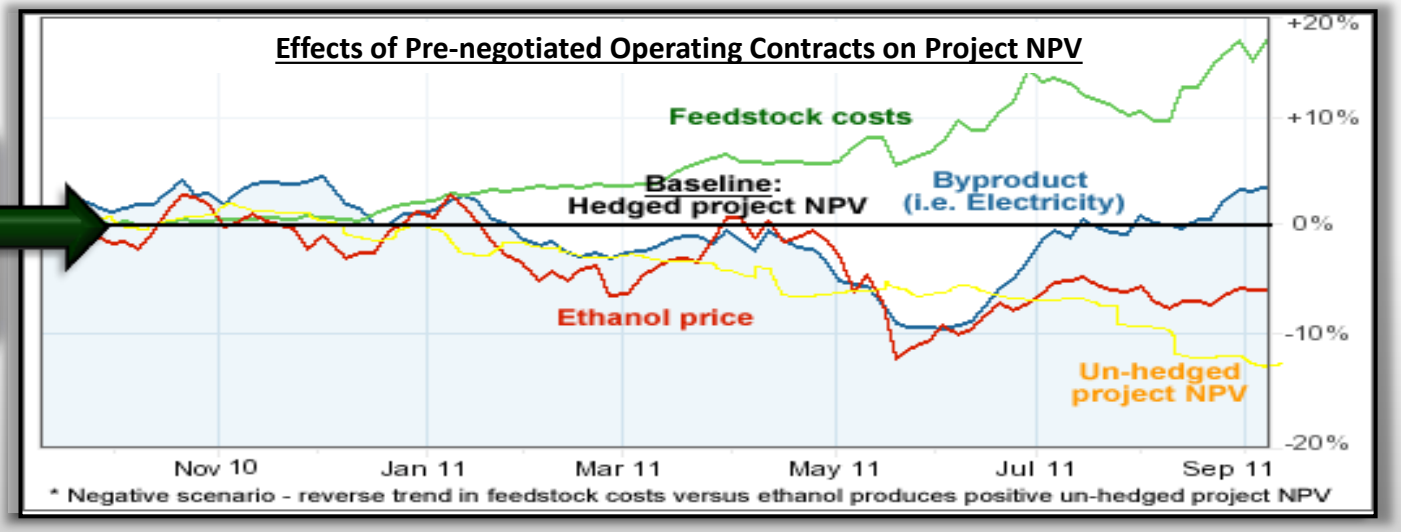
- **Special Purpose Vehicle (SPV)**
  - Insulates sponsor from risk during development
  - Isolates asset liabilities from sponsor balance sheet
  - Funds R&D via external investment
  - Establish vehicle for govt' debt guarantees / subsidies
- **Pre-negotiated operating contracts**
  - All supply, revenue & service contracts pre-negotiated
  - Lowers project risk from perspective of investors and banks
  - Consequently lowers cost of funding / capital
  - Restricts potential downside and upside (acts as hedge)

SPV created to…

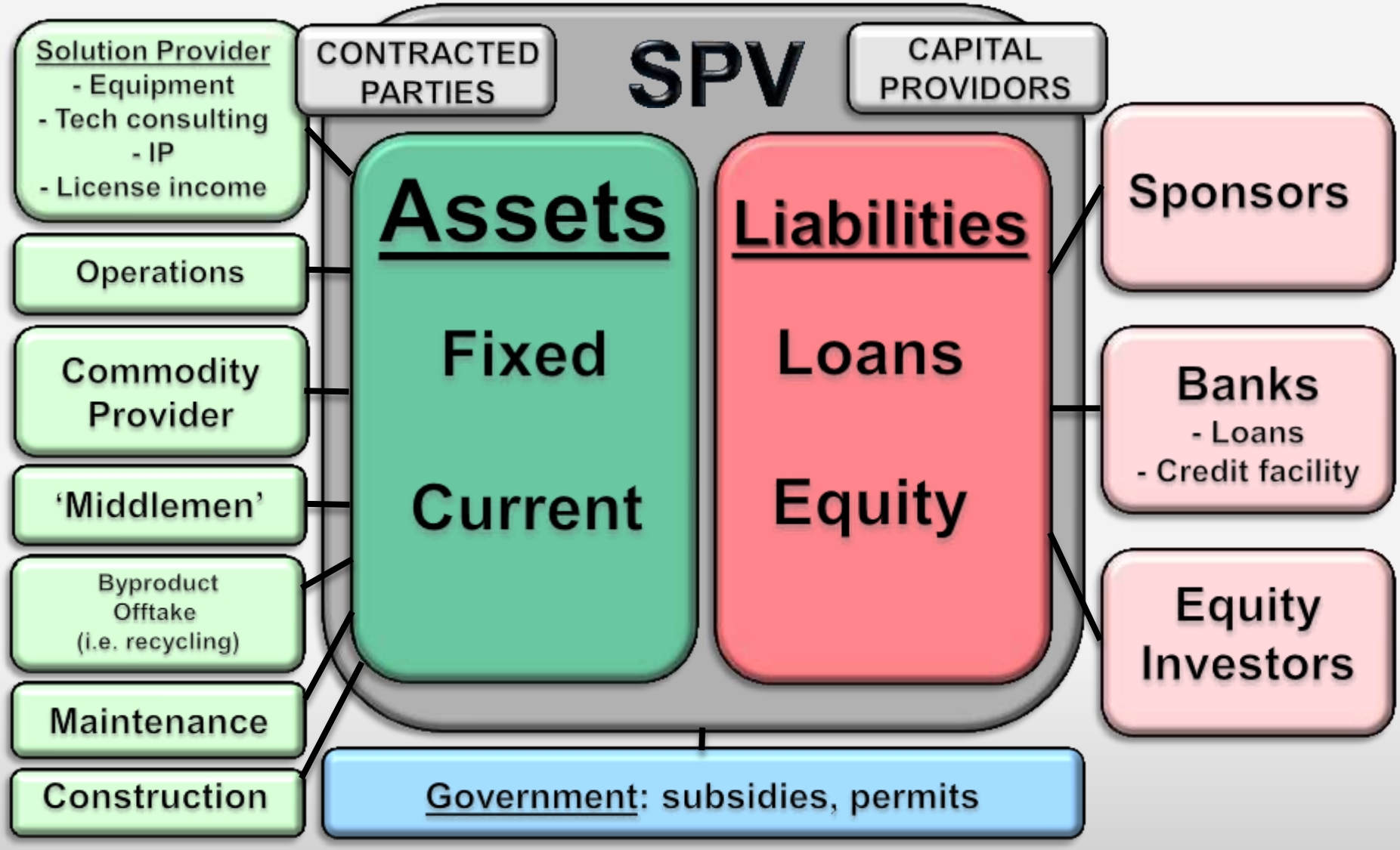
- Partner on large infrastructure projects
- Share risk
- Manage complex projects and solutions
- Attract 3rd party investment in innovation initiatives

Pre-Negotiated Contracts

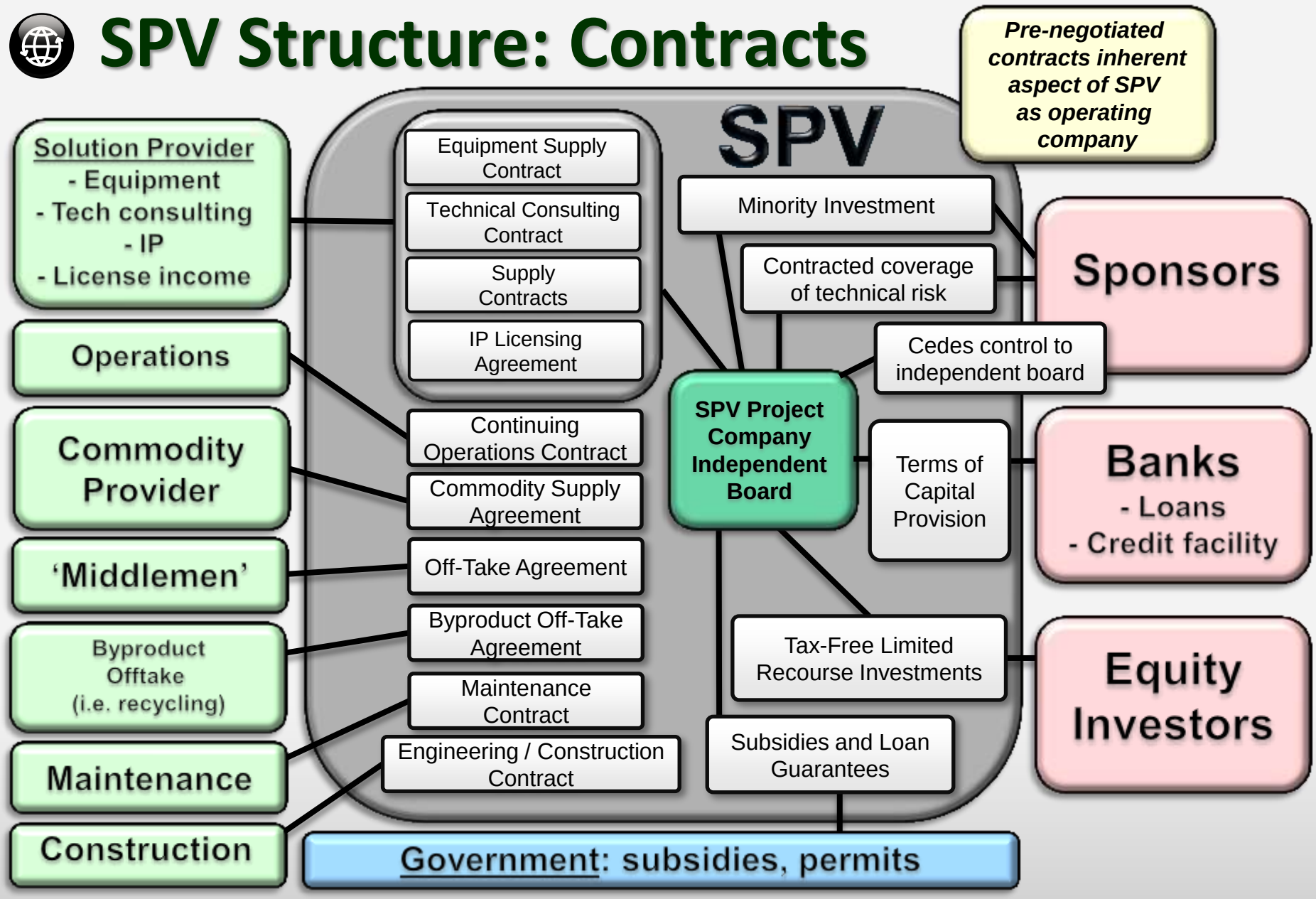
- Reduce cash flow risks
- De-risk project for banks
- Lowers cost of capital



SPV Structure



SPV Structure: Contracts



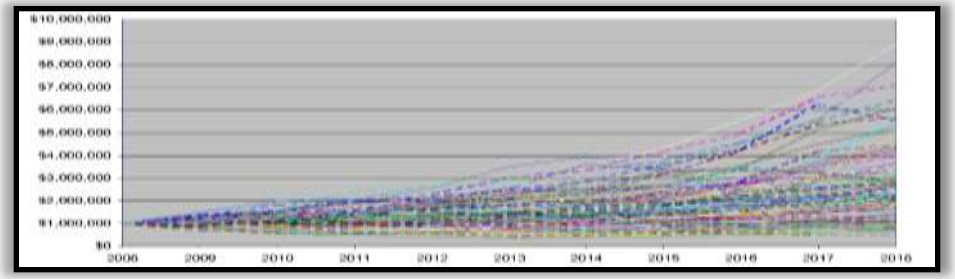
Vehicles for Commodity Price Risk Hedging

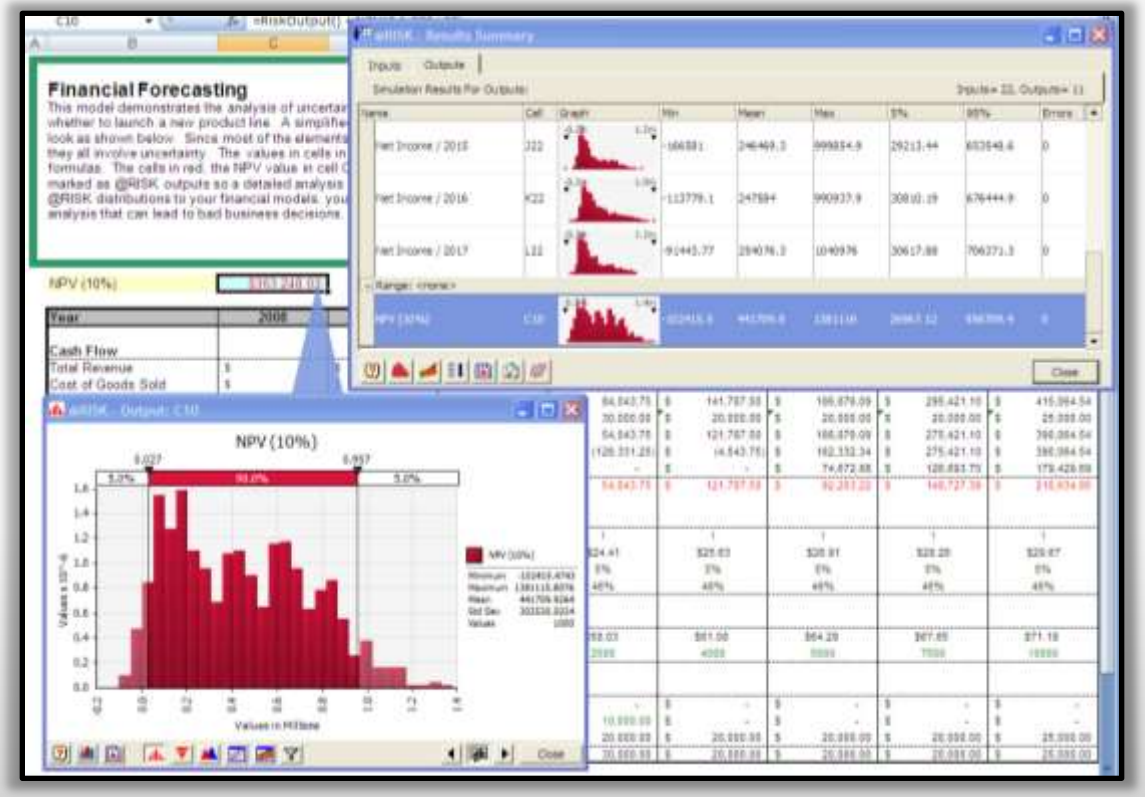
- **Toll / Offtake:** Pre-negotiated contracts
- **Futures:** Trade future-dated spot prices for volume
- **Forwards:** Contract to deliver X on date Y for Z price
- **Swaps:** Set a spot price by exchanging for variable price
- **Options** (typically on Futures):
  - **Basic structures:** calls and puts (sell or buy)
  - **Settlement:** US, European (set date), Asian (average over time)
  - **Collars:** long put, short call (sacrifice upside for downside protection)
  - **3 Ways:** allows upside for high peak
  - **Participation:** % of upside for downside protection
  - ***Example*:** Capped Price Physical (CPP) transaction
- **Swaptions:** option to enter a swap and lock price
- **Synthesized Offtake:** i.e. via bank Pre-Paid Physical Forward
- **Carbon Finance / Emissions Markets**

SOFTWARE:
Analytics

Structured Financial Analysis

- Risk mitigation
- Segmentation
- Hedging
- Insurance
- Offload
- Offtake
- Sell





IP / Patent Valuation

- Model whole system as operating business
- Determine gross profit margins with variance
- Determine ‘fair’ value in situ: as part of operating system (as a holistic ‘business’)
- Similar industries / innovations as benchmark
- Fine tune desired profit in terms of desired exposure to risk
- Will patent be part of a ‘package’?
  - i.e. service offering of consulting / engineering guidance / plans / on site experts / etc.?

Analytics as a Value Driver

- Reduce resource use
- Hedging strategy formation: reduce vulnerable to price and supply volatility
- Anticipate future developments in supply, demand, and price from a probabilistic perspective
- Lock-in advantageous resource purchases: set advantageous long-term supplier provision agreements (commodities and/or services)
- Determine where off-take agreements are advantageous (i.e. recycling contracts) and lock in lower prices as a contracted hedge

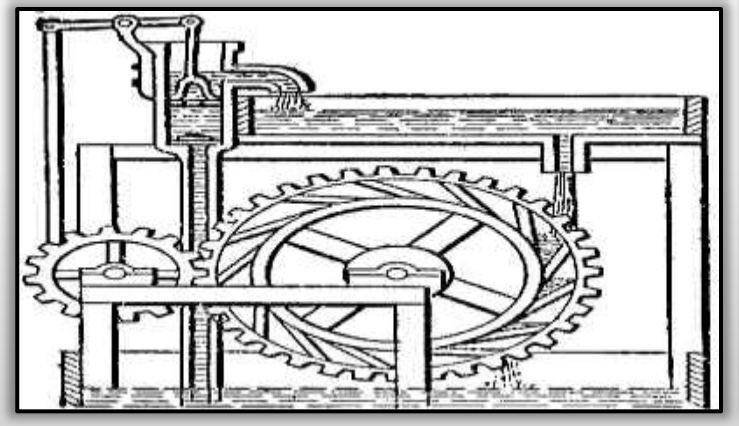
Financial Analytics Guidance

- **Monte Carlo Simulation**
  - Analysis of key risks/opportunities
  - Structuring / planning optimization
  - Optimal / risk scenario identification
  - Volatility of outcomes
- **Real Options Analysis**
  - Valuation of gross uncertainties, oppportunities, risks
  - Specification of optimal decision paths
  - Flexibility to expand / contract

Analytics Example Toolset

TOOLKIT…

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



PALISADE DTS

- @Risk
- PrecisionTree
- NeuralTools

- StatTools
- Evolver
- TopRank
- RISKOptimizer

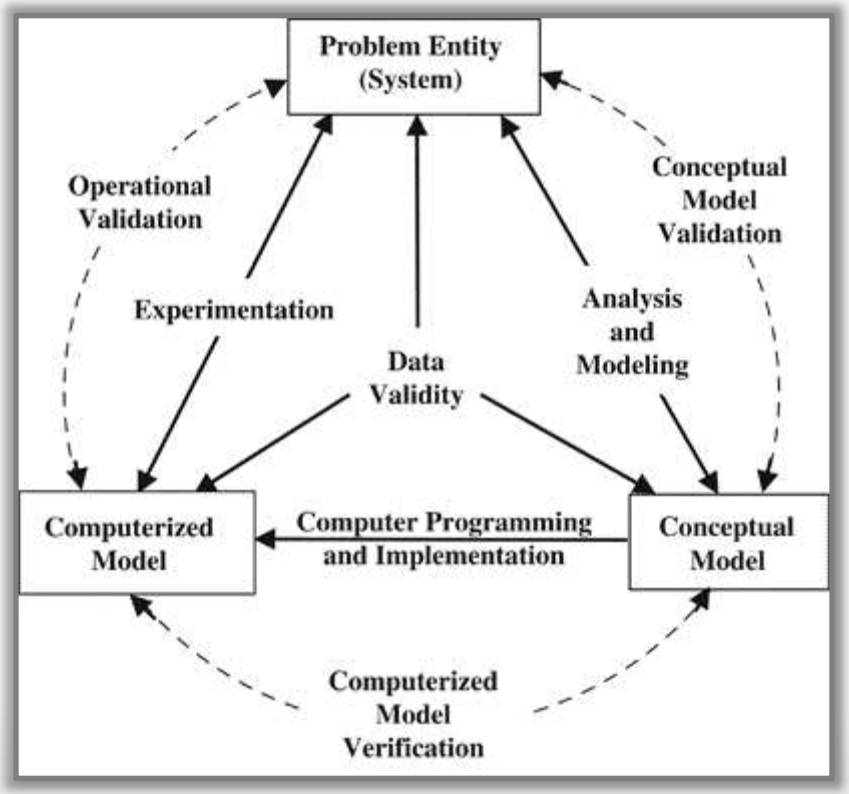
EXAMPLE USES

- **Supply chain optimization:** vendor mgmt.
- **Market price uncertainty:** fuel costs
- **Cost control:** service offering efficiency
- **NPV:** uncertainty in new initiatives
- **Risk Management:** profitability analysis
- **Optimization**: floor configuration, services

Process: Analytics Lifecycle

1. Framing (stakeholders, problem)
2. Data Analysis
   - Data gathering & handling
   - Segmentation (categorization, clustering)
   - Linear (multiple regression, econometrics)
   - Non-linear (neural nets, decision trees, Monte Carlo)
3. Modeling
   - Integrated multi-systems models
   - Understanding of key dependencies
   - Attention to interfaces

   i.e. discrete to continuous
4. Verification & validation
5. Simulation
   - Multi-framework
6. Optimization
7. Iterative design
8. Valorization
   - Communication of results

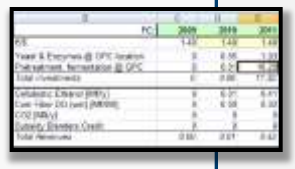


Managing Uncertainty → Analysis Process

Uncertainties Categorized

1. Target 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?

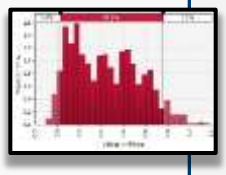
Process Defined



1. NPV analysis

– Three processes

– Product strategies



2. Volatility simulation

– Monte-Carlo simulation

3. Real Options Analysis

– Use range of NPV end-points

– Add volatility (probability)

– Add key decision points

Integrated Simulation & Decision Making

1

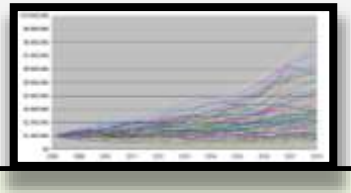
Commodity Price Analysis / Econometircs

Investment Simulation

Revenue w/ Competition Simulation

Costing Analysis

2



Monte Carlo Simulation

- Commodity price scenarios
- Investment costs
- Revenues (Main & Byproducts)
- Feedstock variable costs
- Energy costs
- R&D costs
- License income
- Market competition

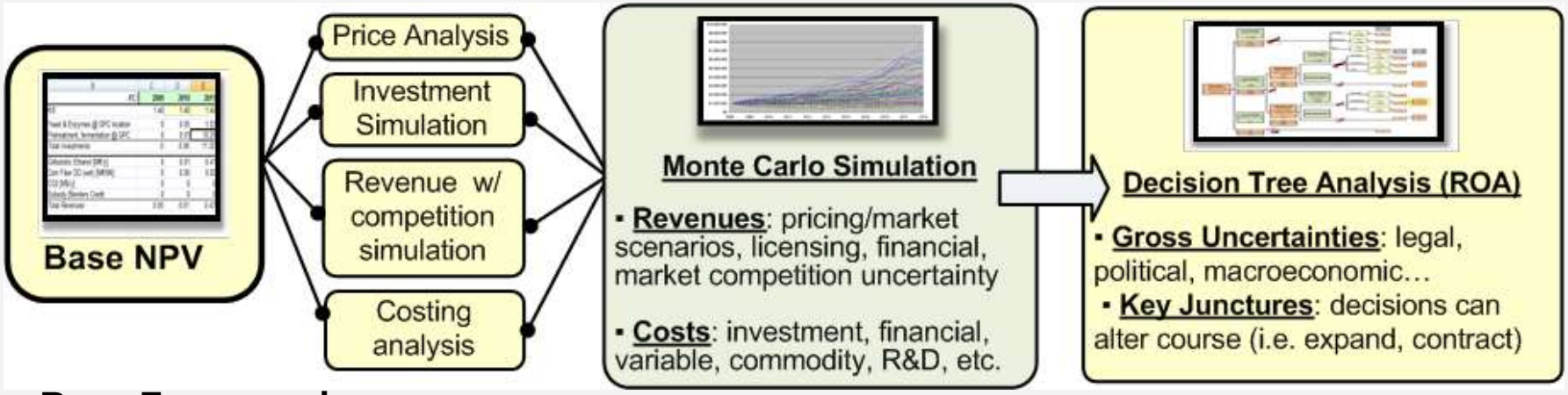
3

NPV & σ
CEtOH
NPV Model

4

Decision Tree Analysis

Integrated 'Uncertainty Valuation' Process



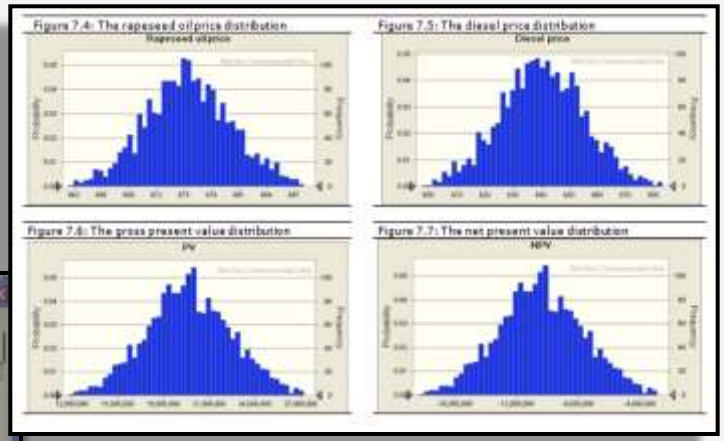
- **Base Framework**
  - Discounted Cash Flow (DCF) analysis via Net Present value (NPV)
  - Allows for 'like-to-like' comparison of variant scenarios
  - Cost of Capital: hybrid industry/market derivation and aggregate volatility assessment
- **Variability Analysis**
  - Monte Carlo allows for sensitivity analysis, structural optimization, and quantification of volatility (risk/opportunity) – chiefly concerned with readily quantifiable financial and physical variables
  - Assists in pinpointing key risks/opportunities and suggests strategies for mitigating, offloading, selling, insuring, hedging, or retaining said risks (with upside exposure)
- **Decision Tree / Real Options Analysis**
  - Chiefly concerned with classification of gross uncertainties (i.e. large, nebulous scenarios)
  - Segments financial variables in MC model and allows for structured high-level management conversations at the Decision Tree Level (NPV values connected a tree end-points)
  - Final value of aggregate opportunity quantified back to regressed present point
  - Allows for ongoing managerial 'options based' decision making (continual maintenance of 'tree')

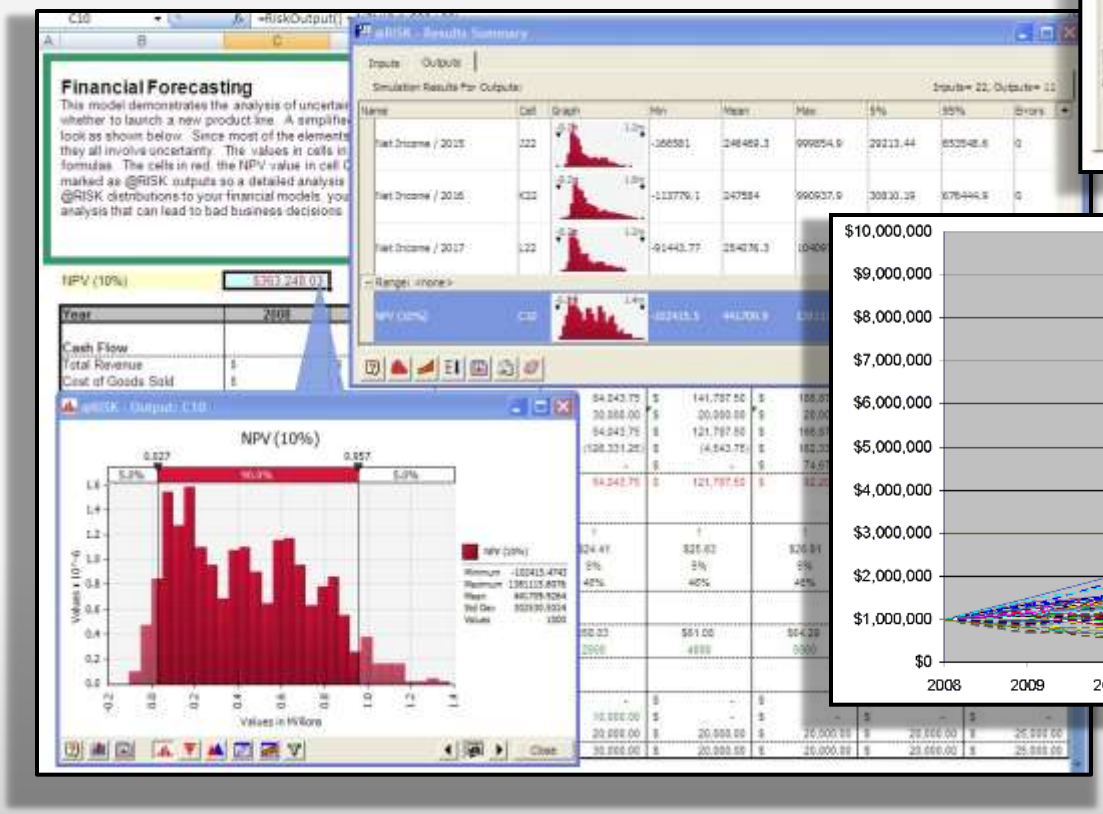
Simulation: Monte Carlo Analysis

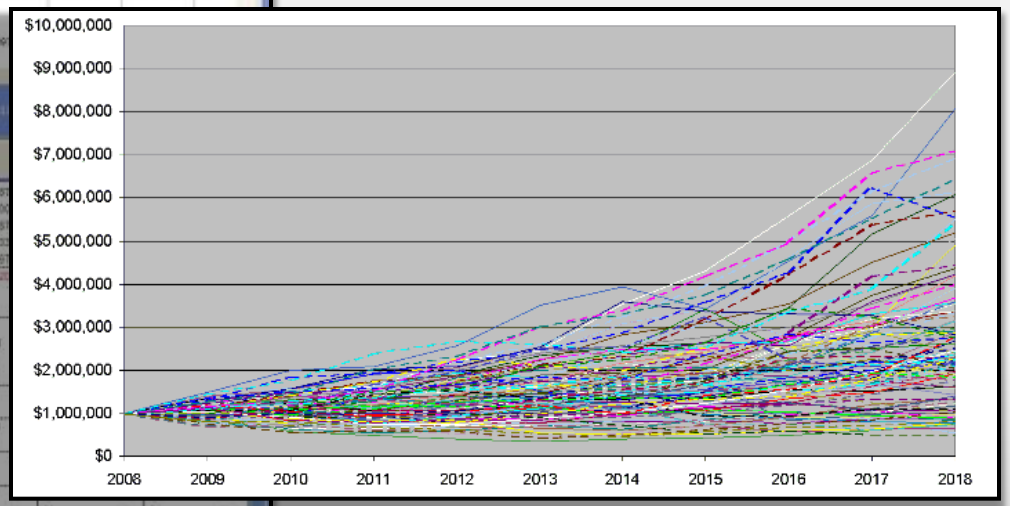
- **Typical financial models are deterministic & static**
- **Simulation is probabilistic & variable...**
  - Individual variables have likelihood & skew
  - Aggregate NPV line items (total cost, revenue) become subject to layers of independent & dependent variation
  - Generating random numbers many hundereds of times (according to defined distributions) produces aggregate probability distributions
  - Can be used to predict sensitive variables, probability of overrun and identification of contingency strategies
  - Excellent for dynamic market and competition analysis

Simulation: Monte-Carlo Analysis

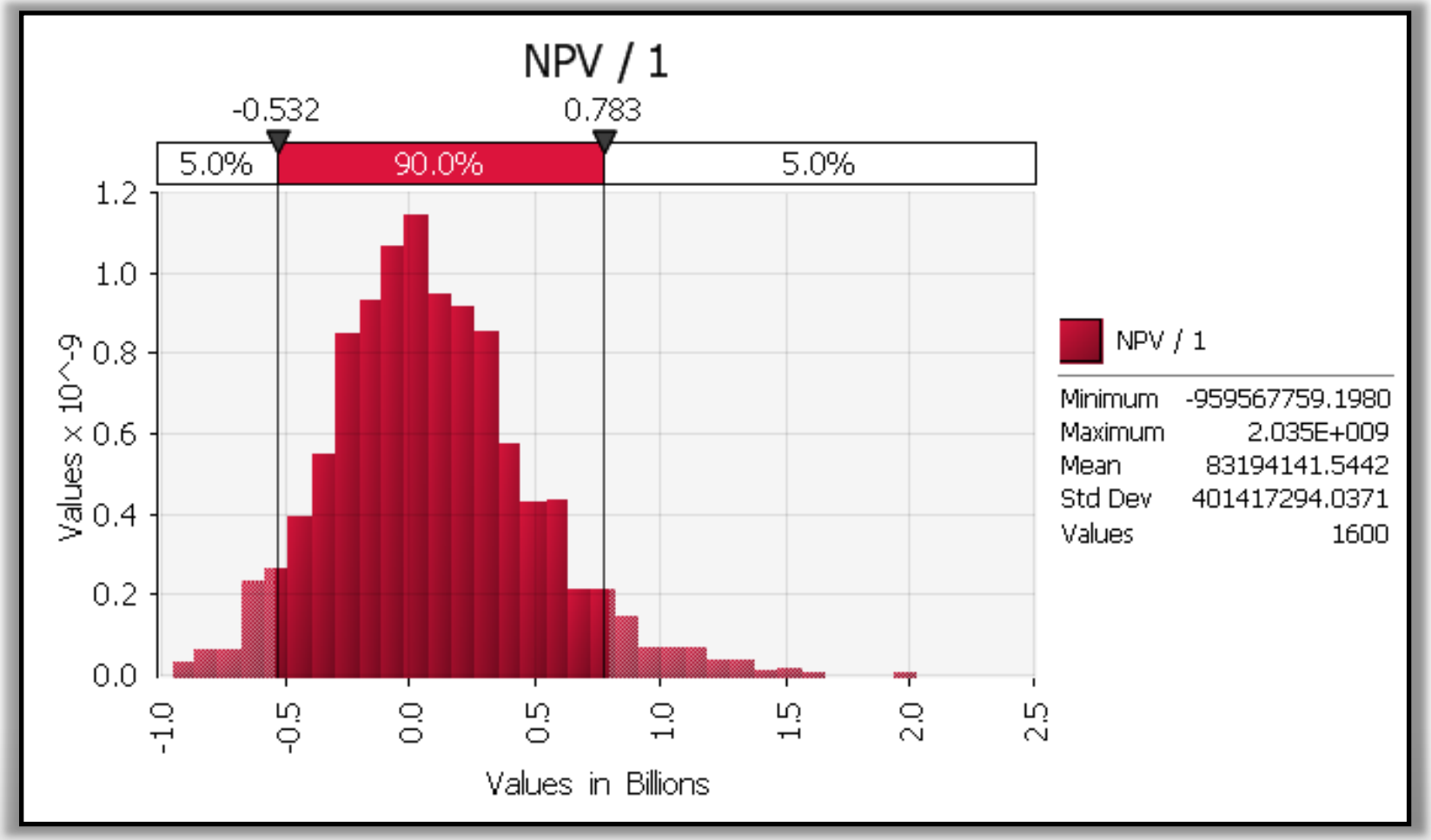
- Probability distributions for all major variables
- Multiple outcome simulations run (1000's of X)
- Aggregate probabilities and sensitivities emerge





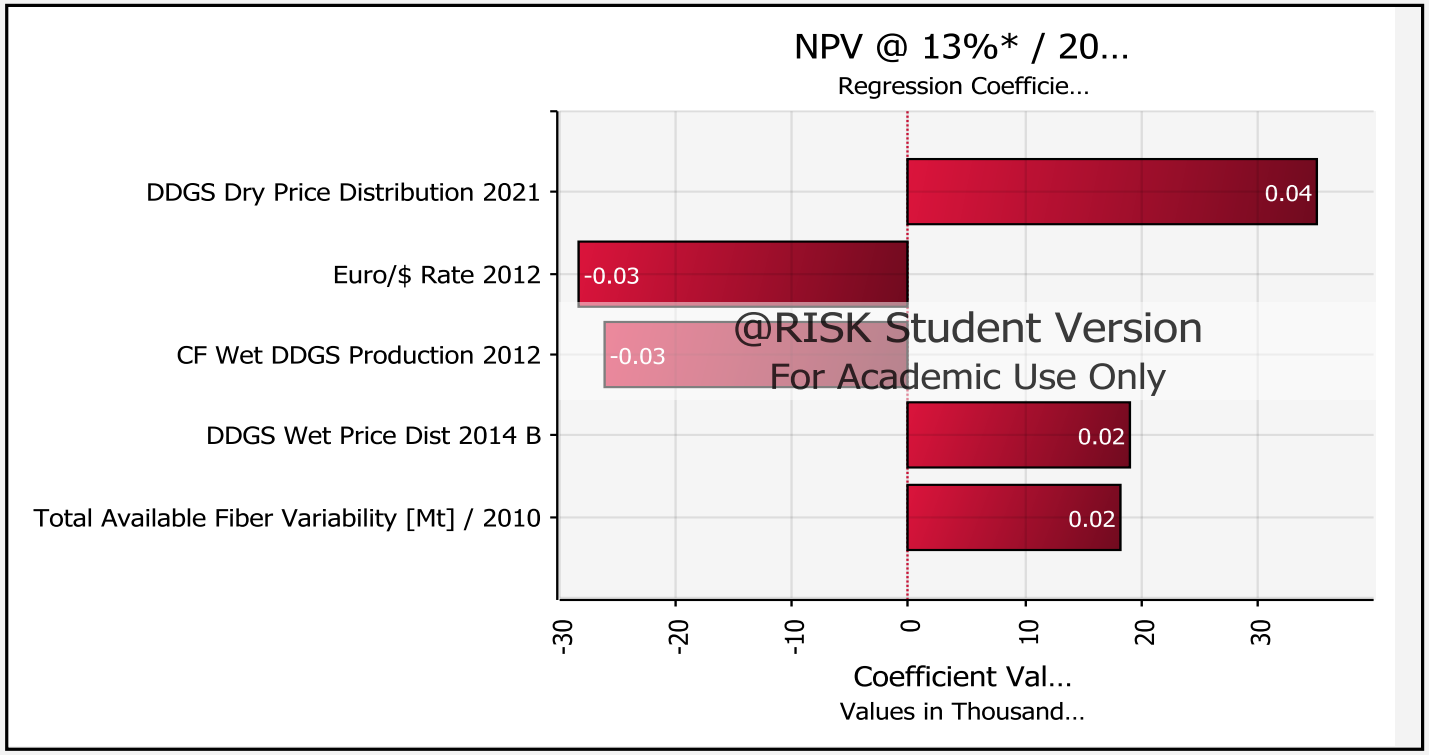


Histogram: NPV Distribution / Initiative Volatility



- **Right skew**
- **Large mean and less spread equates to lower risk of returns**
- **Spread around mean: SD of NPV $410 million**

Simulation: Tornado Graph - Identifying NPV Key Drivers



- 1 SD for NPV: **€2.6 mil**
- 1 SD increase in Commodity (2021) affects NPV by 0.04 SD **€124k (x12 €1.2 mil) ***
- 1 SD decrease in Currency rate (2012) decreases NPV by -0.03 SD **€78k**
- 1 SD decrease in Commodity 2 (2012) decreases NPV by -0.03 SD
- 1 SD increase in Commodity 3 (2014) increases NPV by 0.02 SD *
- 1 SD increase in Service Availability (2010) increases NPV by 0.02 SD

Simulation: Possible Scenarios

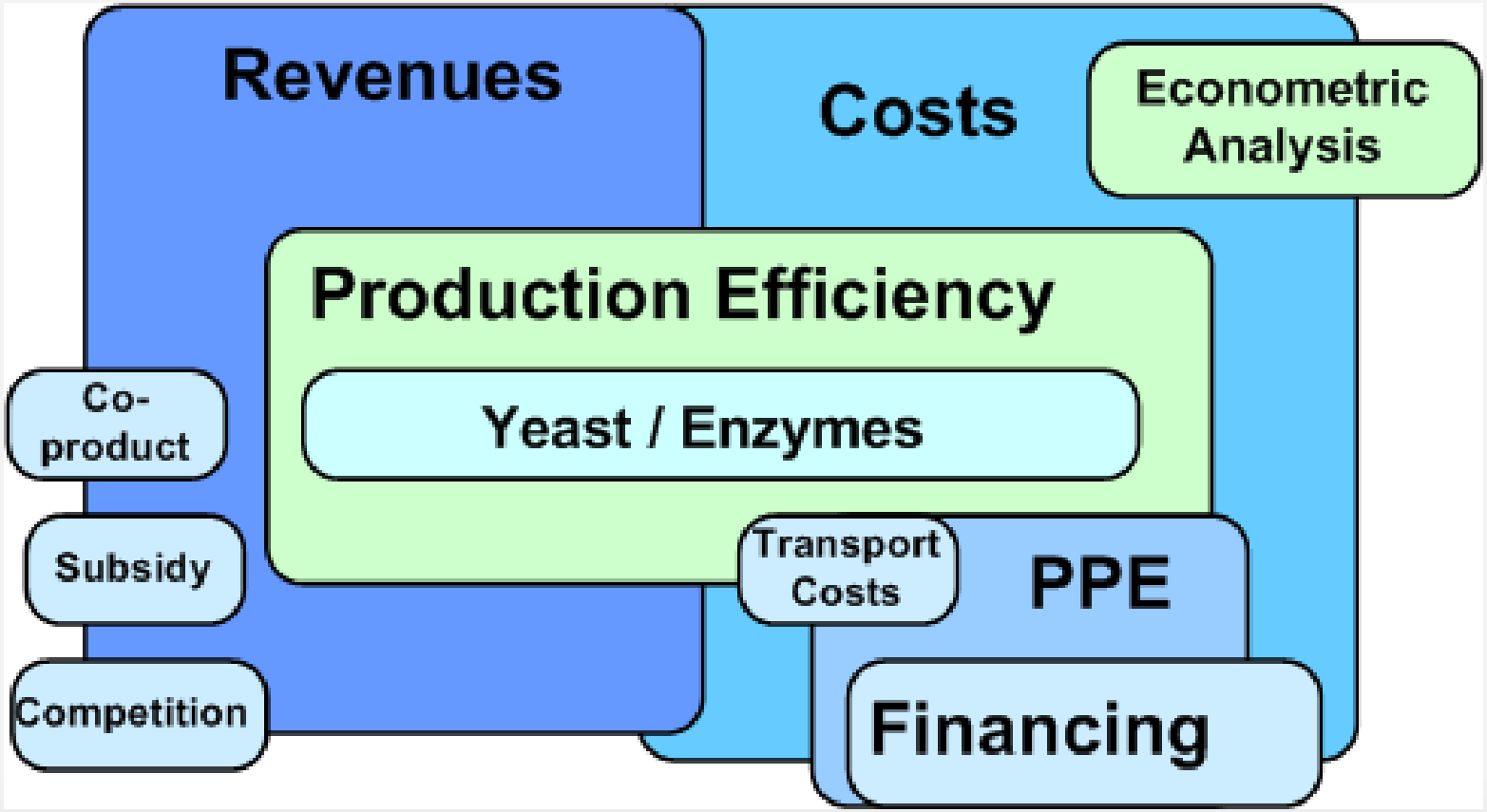
- Investment
  - Estimated cost
  - Product development cost
- Production
  - Capital expense
  - Overhead
  - Total expenses
- Economic conditions
  - Inflation
  - Currency exchange
  - Unemployment
- Commodity cost scenarios
- Market Simulation
  - Estimated # Customers
  - Competitors
  - Cost per installation
- Sales
  - Sales price
  - Sale volume

Case 1: Market Behavior Simulation

- Market competition and consumer behavior simulation
  - Market size
  - Usage per customer
  - Chance of competitor entering market
- NPV distribution result
- Monte Carlo analysis
- Results in distributions concerning market size and potential profits

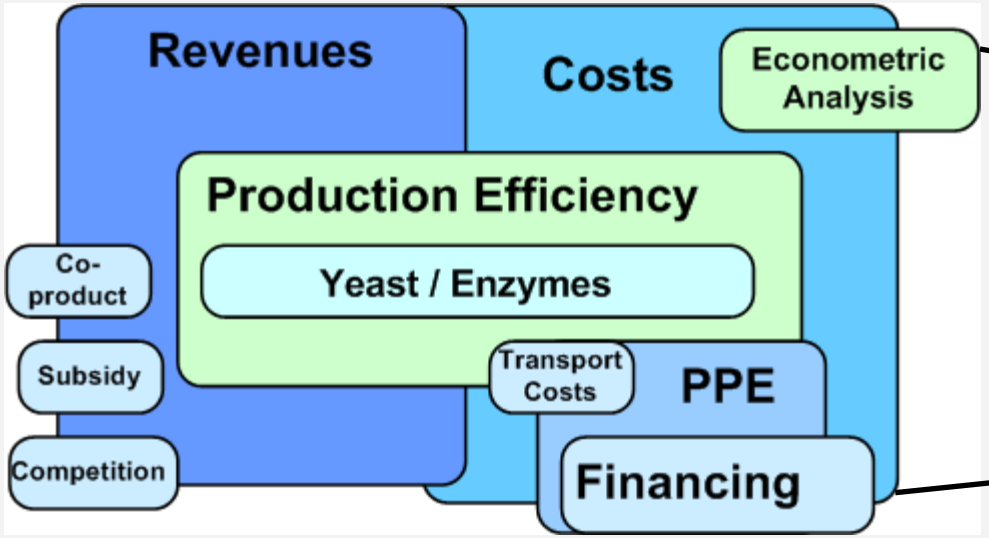
Pigco						
Price	$	2.20	Compet %age			0.2
Unit Var Cost	$	0.40	Year 1 Market Si			1000000
Interest Rate		0.1	Year 1 worst sha			0.2
Entrant Prob		0.4	Year 1 most likel			0.4
			Year 1 best shar			0.7
Year		1		2		3
Market Size		1000000		1050000		1102500
Use per hippo of our drug		0.433333333		0.346666667		0.277333333
Competitors (beginning of year)		0		1		2
Entrants		1		1		0
Unit Sales		433333.3333		364000		305760
Revenues	$	953,333	$	800,800	$	672,672
Costs	$	173,333	$	145,600	$	122,304
Profits	$	780,000	$	655,200	$	550,368
NPV		$2,435,545				

Case 2: Integrated Operational Cost/Revenue Analysis

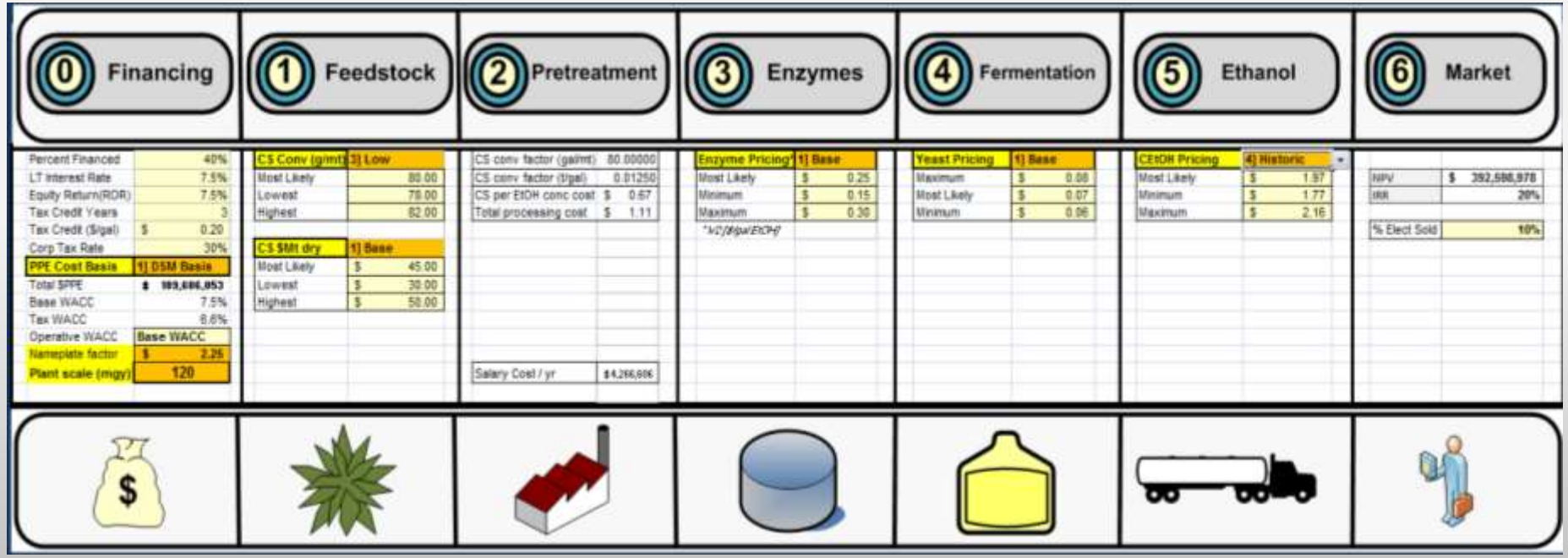


- ***SEE**: Mongeau, S. 2010. Cellulosic Bioethanol Plant Simulator: Managing Uncertainty in Complex Business Environments. 2010 Palisade EMEA Conference*
- Iterative model development working with area experts

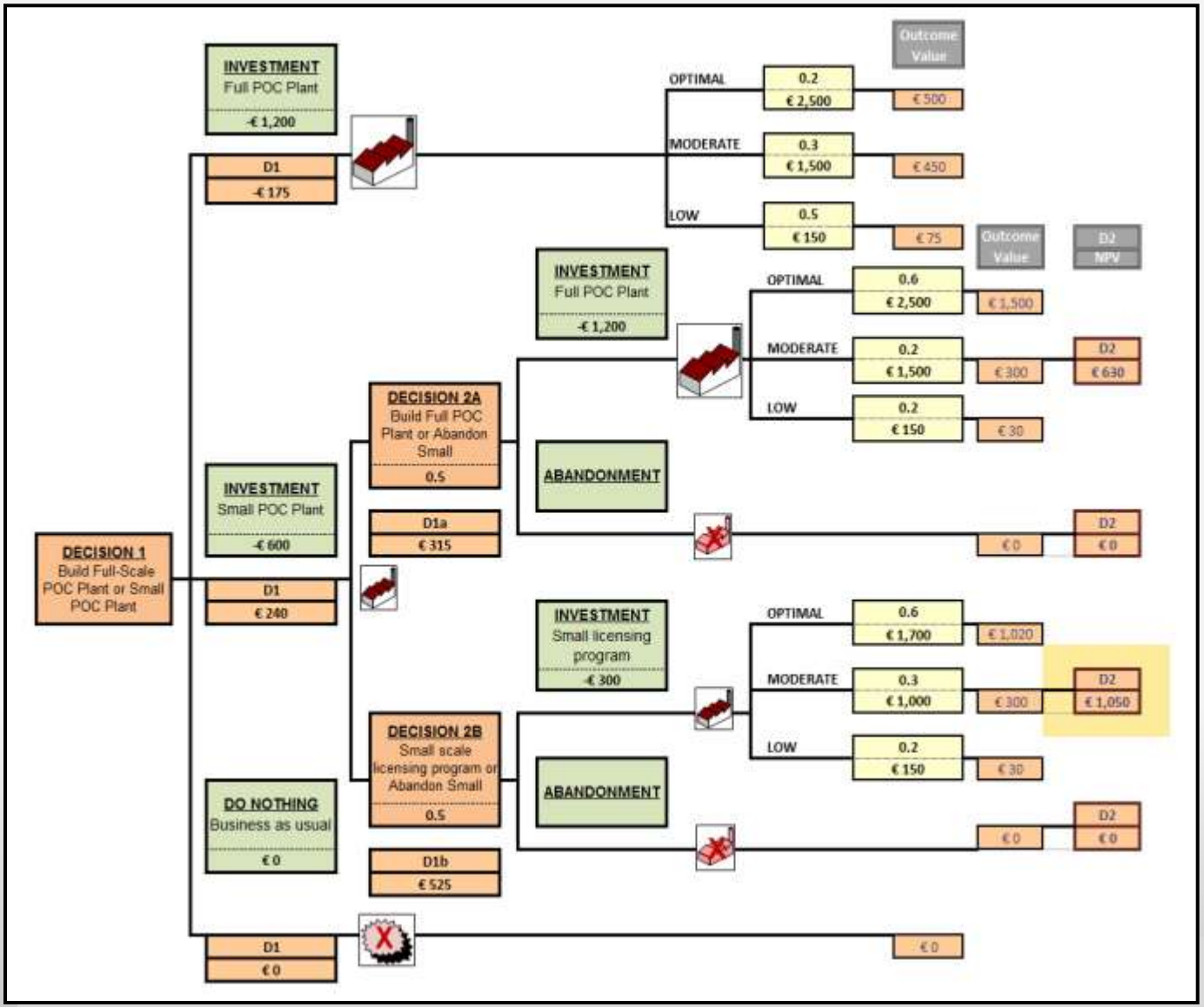
Case 3: Optimization & Scenario Ranking



- Monte Carlo Simulation
- Optimization analysis
- Scenario ranking

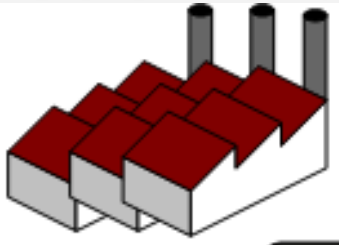


Case 4: Decision Tree Analysis



1. Add management decision points, investments required, and probabilities
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

Case 5: Market Size Valuation



- **Market revenue**
  - **Plant revenue**
    - **Yield per plant**
      - **Plant capacity**
      - **Productivity per capacity unit**
    - **Profit margin**
  - **Number of plants**

Regional Factors:

- Blend rates
- Tax rates
- Inflation
- GDP growth
- Material costs
- Labor costs
- Transport costs
- Productivity
- Political risk premium
- Cost of capital
- Subsidy factor
- Local biofuel prices

Productivity Factors
(variable activity based costing):

- Yield rates
- Yeast strain yields
- Enzymatic techniques
- Pre-processing effects
- Relative supply costs

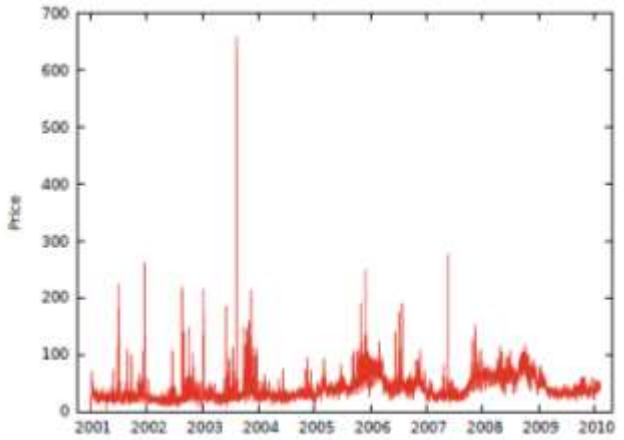
Global Factors:

- Productivity range
- Overhead/COGS
- Global oil prices
- Global supply costs

Case 6: Electricity Price Analysis

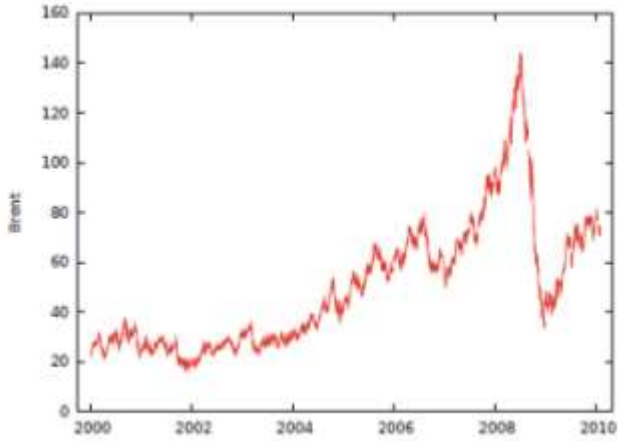
Day ahead electricity:

Mean-reversion
Non-constant volatility
Spikes
Seasonality (volatility)



Oil prices:

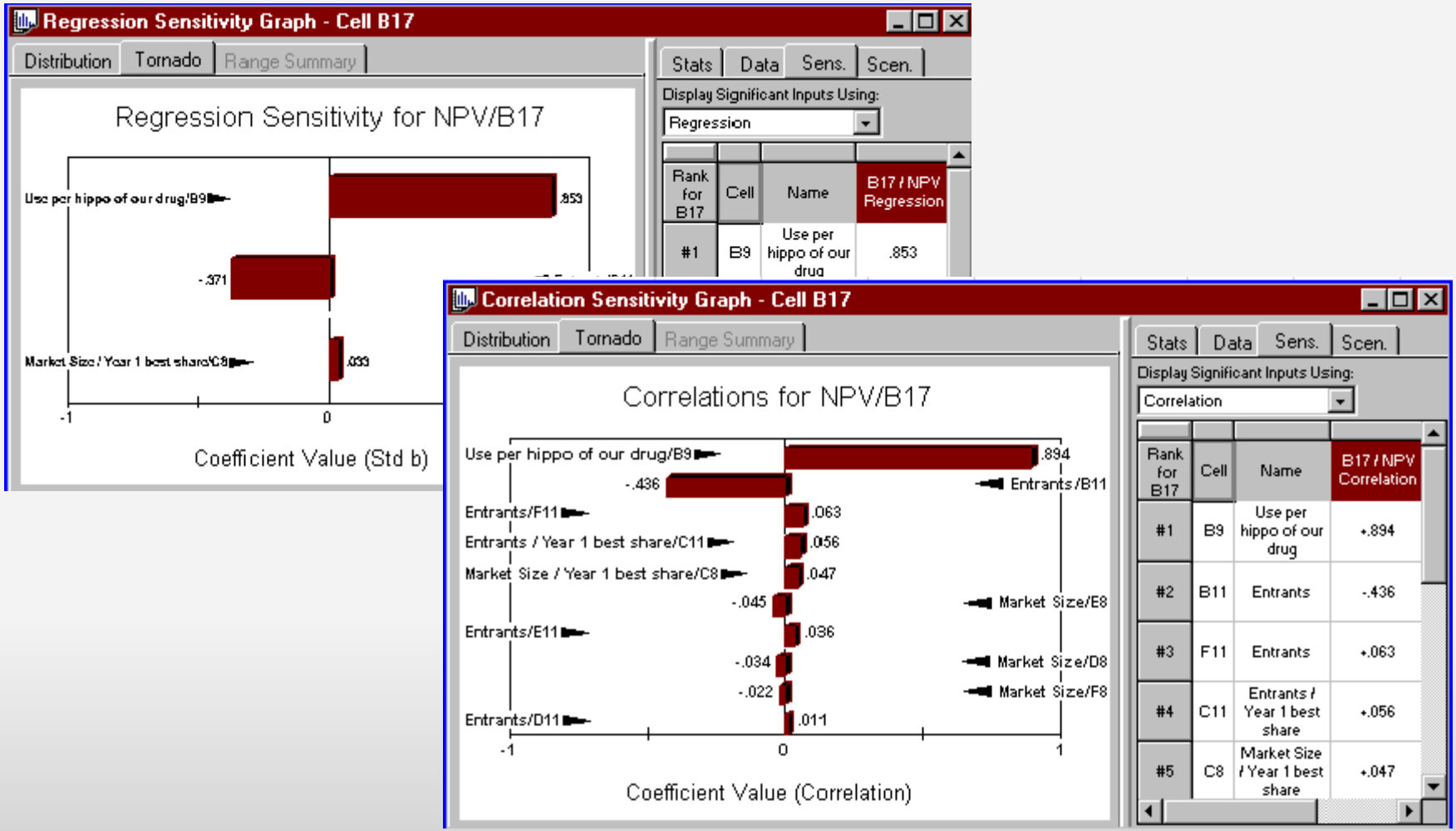
Trends
Non-constant volatility



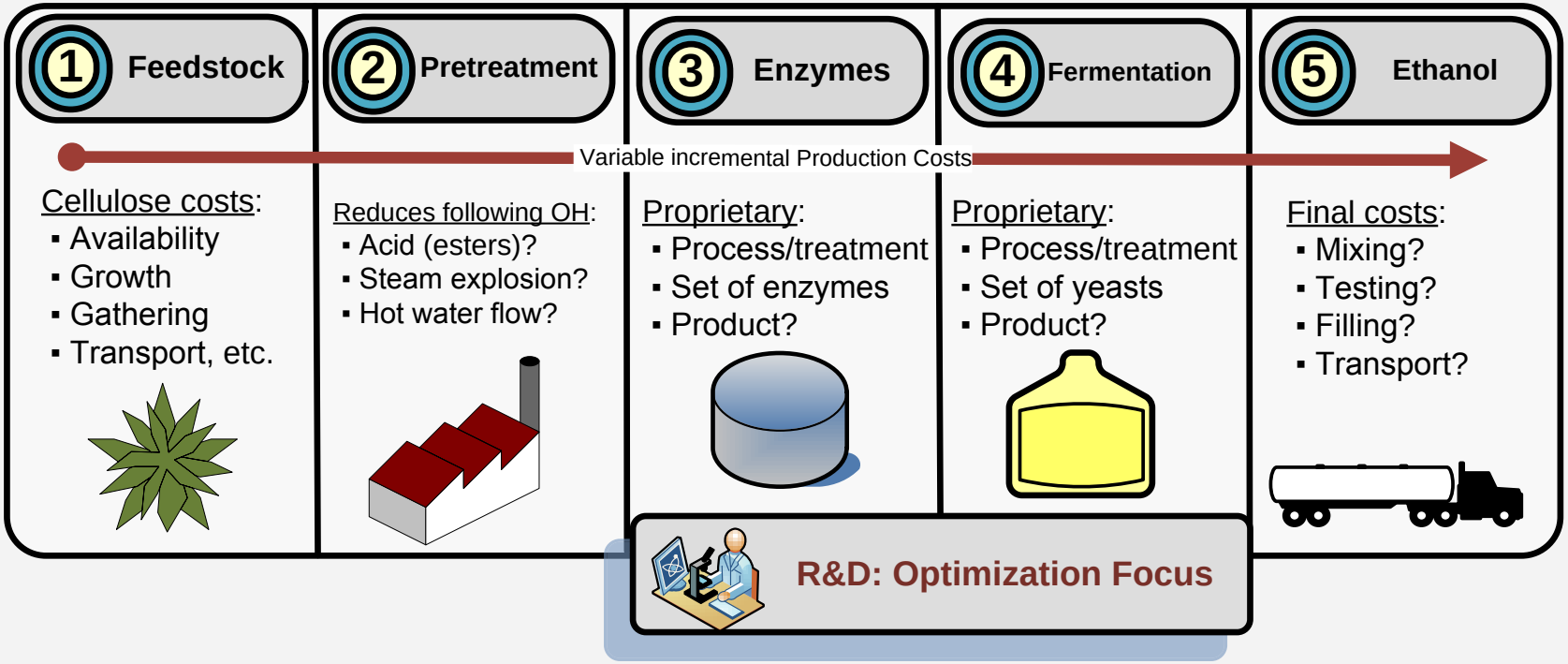
Huisman, Ronald. Erasmus School of Economics “Measuring price risk in the short run”

Huisman, Ronald. (2009) “An Introduction to Models for the Energy Markets”

Example: Tornado Graph – Profit Sensitivities and Competitive Effects



Example: Process Optimization Analysis



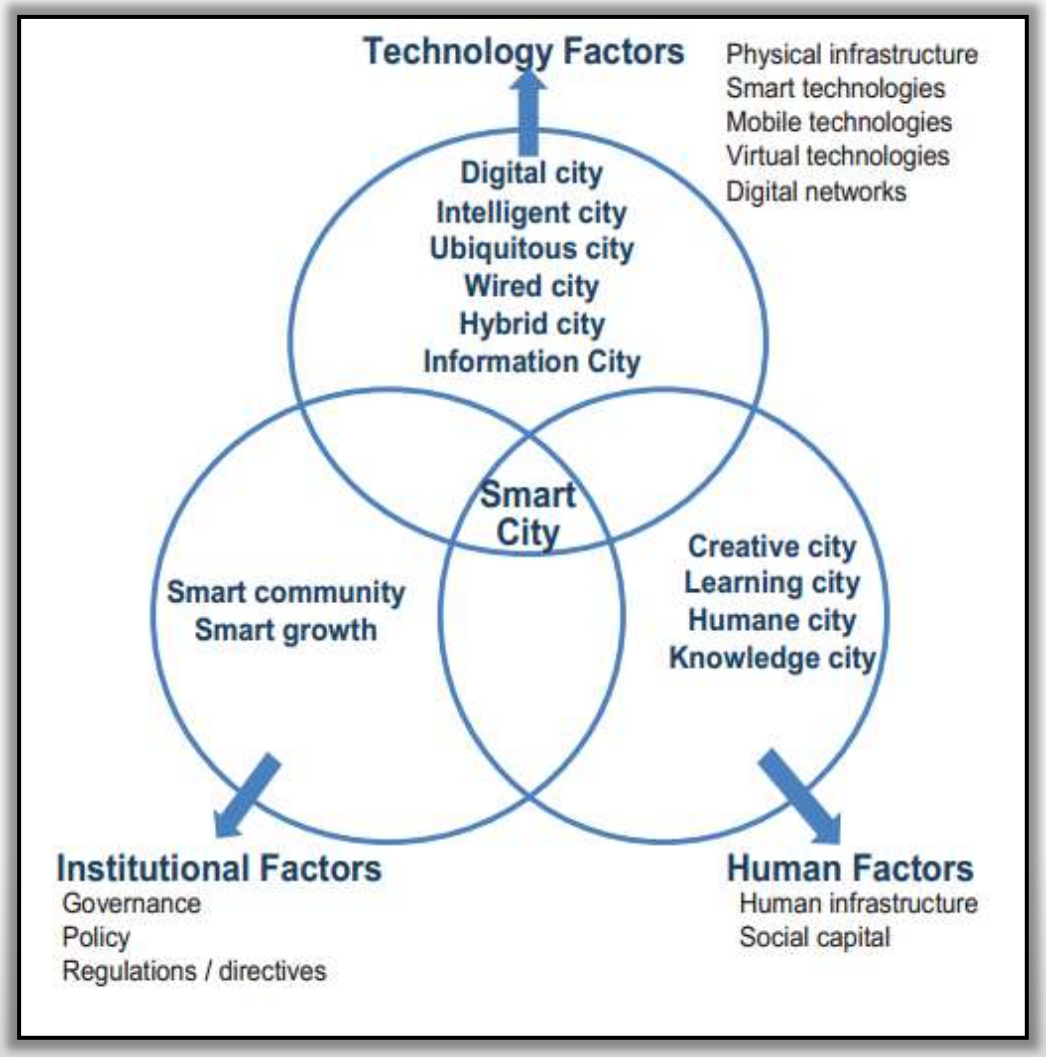
Subject to Monte Carlo sensitivity/ scenario analysis

CONCLUSION

Social & Market Engineering Interface

Smart City: Complex System Optimization

- Multi-stakeholder
- Market-based
- Incentive-driven
- Multi-criteria utility optimization
- Emergent hybrid technology solutions as mediator
- Advanced analytics as facilitator



Nam, T., Pardo, T. Conceptualizing Smart City with Dimensions of Technology, People, and Institutions. The Proceedings of the 12th Annual International Conference on Digital Government Research.

Review: Smart Cities => Complex Analytics

- ***Smart Systems*: emergent hybrid technologies**
  - networked infrastructure that…
  - uses sensors and communications technologies…
  - to better utilize or sustain resources via analytics…
  - addressing a broad notion of efficiency or optimality
- ***Multi-Stakeholder*: multi-criteria interests**
  - each of whom evidence bounded rationality…
  - and autonomy in striving after incentives…
  - whom together result in a 'market equilibrium'
- ***Complex systems*: management ***
  - Orchestration (not control)
  - Dynamic stability (not formal equilibrium)
  - Shifting 'regimes' of stability & volatility
  - Emergent behavior presages phase-changes

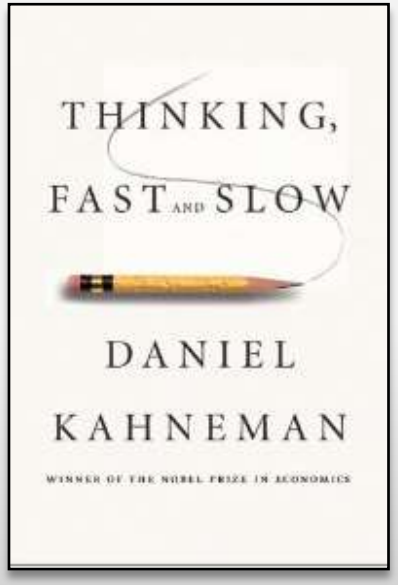
** Otherwise less represented in 'Smart City' research*

BUT… Decision Making Behavioral Biases

- **We are 'boundedly rational'**
  - We suffer incomplete information
    - Information is 'expensive'
    - There is more & more of it (sorting costs)
  - Prone to particular cognitive 'biases'

- **Two decision making systems**
  - **System 1**
    - Fast & emotion/impression driven
    - Often priming us unconsciously
    - Often effective, but can mislead
    - Stories: *"The bitter butler stole the money!"*

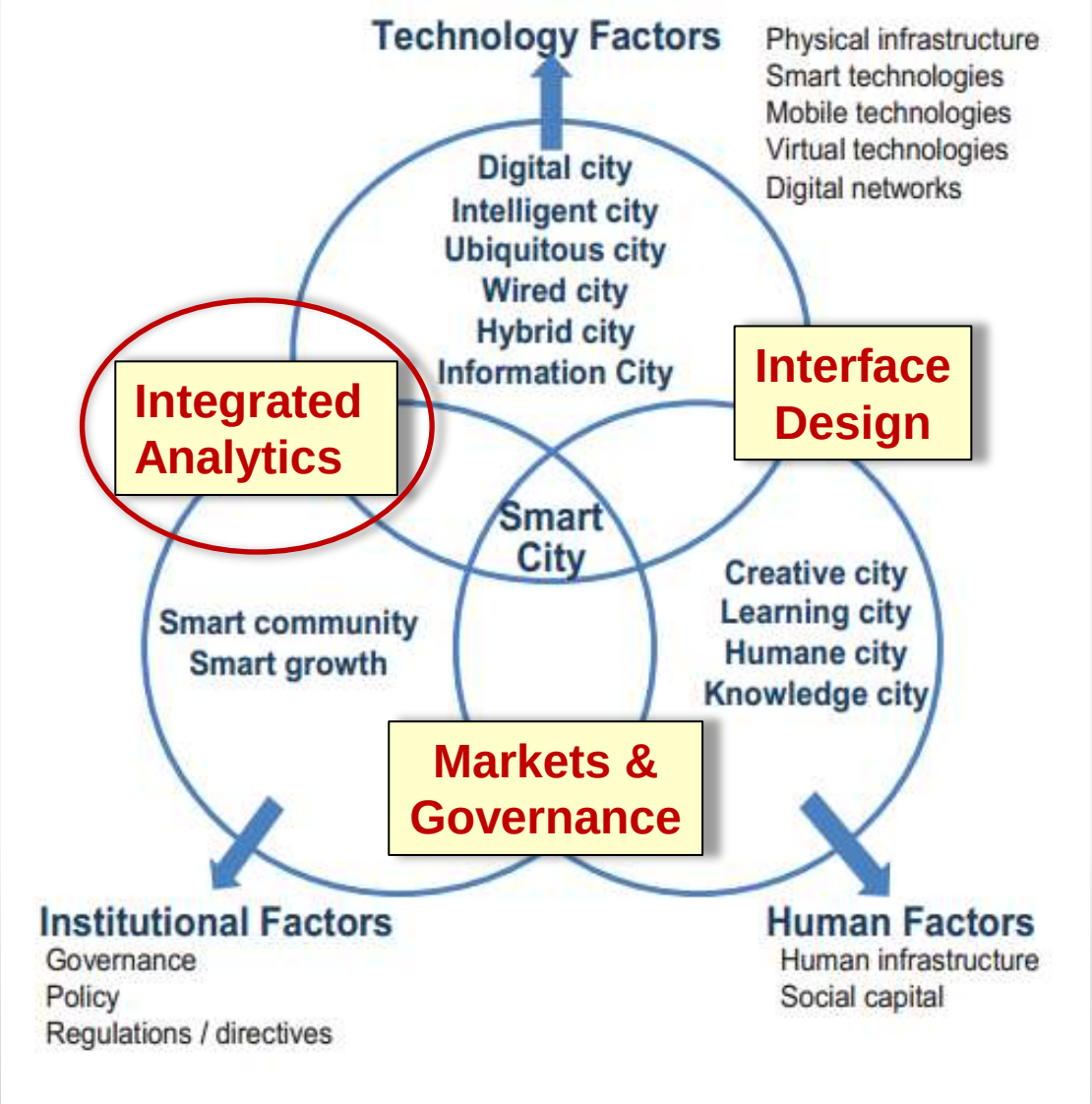
  - **System 2**:
    - Slow & deliberate
    - Checks, but susceptible to System 1 biases
    - Fact assessing: *"There has been a cash shortfall"*



Smart City: Complex Techno-Economic Phenomenon

- **Cities are 'complex' systems (beyond 'complicated')**
  - Evidence unpredictability / volatility
  - Long-term prediction difficult (i.e. weather & stock market)
  - Emergent behavior (unexplainable behavior via interactions)
  - Sensitive in periods of non-linearity (small effects = large perturbations)
  - Require redundancy, safe-guards, emergency procedures…
  - Border between **discrete** and **continuous systems** views
- **… connect to larger human behavioral systems**
  - **Supply / Demand decision making**
  - **Market trading / purchasing dynamics**
  - **Consumer behavior (i.e. commuters on transport network)**
- **… aggregate probabilistic aspect**
  - Requires intensive data analysis
  - Susceptible to trends analysis & forecasting
  - Multi-system analysis & optimization

Smart City: Revised Definition



Smart City: Position Paper

BLOG POST:
http://sctr7.com/2013/03/11/architecting-smart-cities-an-integrated-analytics-platform-for-aligning-market-based-sustainability/
PAPER:
http://www.sark7.com/docs/Integrated_Smart_City_Design.pdf

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APPENDIX

SPV / SPE Definition

- **Special Purpose Entity** (aka **SPE**, **special investment vehicle**, **SIV**, **special purpose vehicle**, **SPV**, **special purpose corporation**, **SPC**) is a limited-purpose legal vehicle, organized as a corporation, limited liability company, or business trust, that is formed to securitize assets, such as loans and receivables, and sell them as asset-backed securities (ABS)
- Can also be an operating asset with strict operational parameters and contracts in place to formalize and standardize operating cash flow (i.e. effectively synthesizing an operating plant into a fixed income instrument)
- Since most ABSs are sold to institutional investors that require an investment grade credit rating, the SPE provides *bankruptcy remoteness* from the seller of the assets, which includes banks and finance companies, and allows the credit rating of the SPE to be higher than that of the seller or sponsor of the ABS

SPV Sponsorship Versus Ownership

- **Bankruptcy remoteness** is accomplished by legally segregating the collateral from the originator or seller for the benefit of ABS holders. For bankruptcy remoteness to be legally effective, there must be a **true sale** of the assets at arm's length.
- Uniform Commercial Code (UCC) of most states stipulates that this transfer can be accomplished either by transferring the loan documents from the seller to the SPE, or by filing a UCC finance statement. Filing UCC statements is usually done because it is cheaper and faster.
- Legal counsel for the seller will render a **legal opinion** concerning the effectiveness of the transfer, including a **true sale opinion** and a **nonconsolidation opinion**, stating that if the sponsor enters bankruptcy, the assets of SPE would not be consolidated with the assets of the sponsor.

SPV Notes

- **Limited Recourse**: lender can require repayment under special conditions, but otherwise must look to collateral (which can include operating asset)
- **Operating Asset**: Debt repaid from operational cash flow and secured by assets (including any revenue producing contracts), priority given to lenders
- **Technology Risk**: require surety/guarantees of sponsors

- SPV structure compared to a 'computer program': *programed cash flows*
  - Collateral clearly identified and valued
  - Risks comprehensively identified: credit, interest rate, prepayment, delayed payment, exchange-rate, servicing, legal, tax
  - Handling procedures for all risks under different scenarios regarding prepayments, default rates, and recovery values
- 3rd party support
  - Owners of distressed asset
  - Bankers
  - Lawyers
  - Rating agencies
  - Accounting firm (provides 'comfort letter')
  - Service providers (including feedstock provision & offtake)
  - Gov't funding support
  - Construction contractor

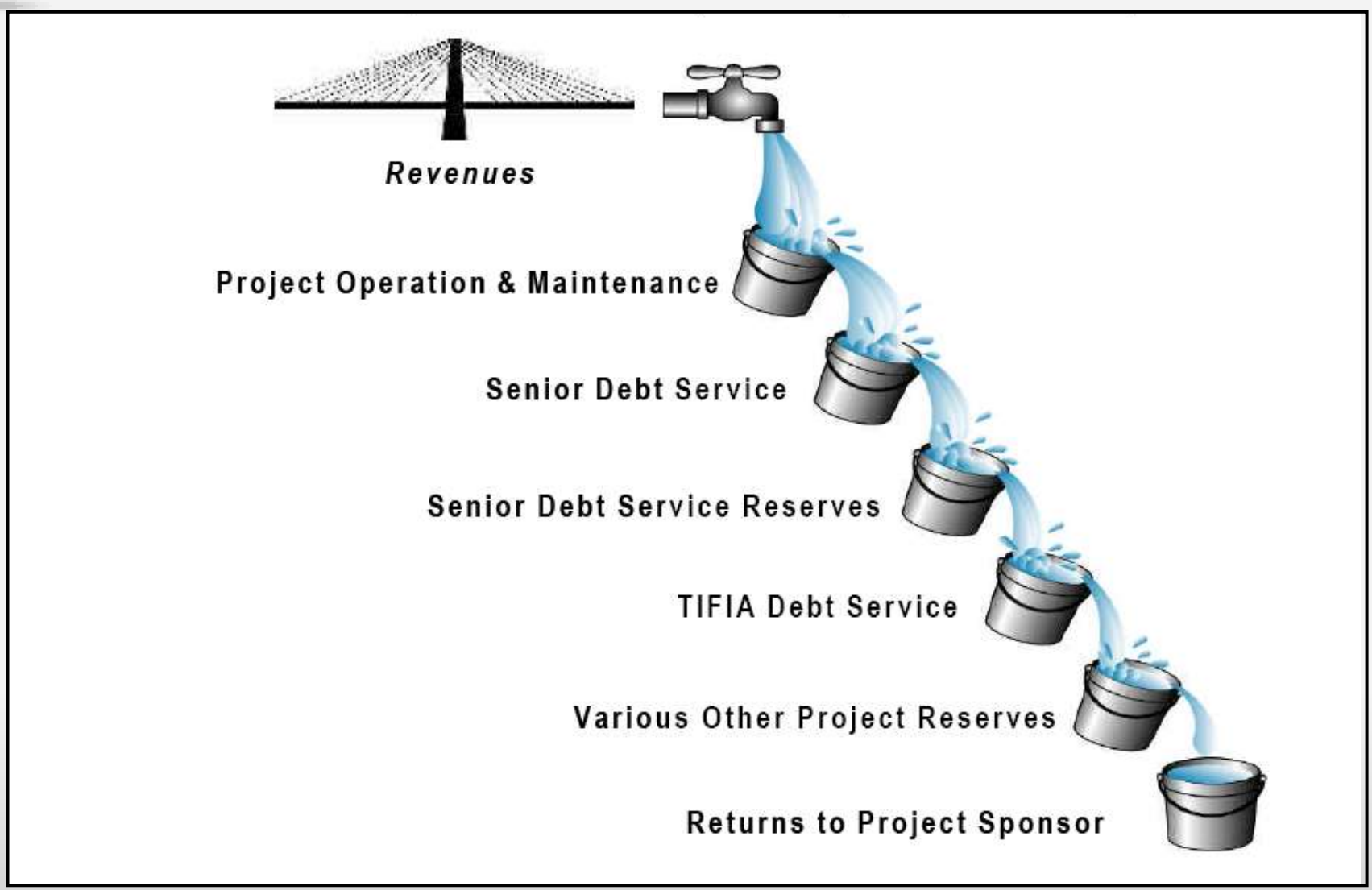
Some Uses of SPEs

- Can be misused (e.g., to conceal involvement of transferor), but justifiable and legitimate business purposes exist for use of SPEs, such as
  - Securitization of assets
  - Transferring risk in new technology infrastructure initiative
  - Securitization/recognition of liabilities
  - Pre-funding certain payments
  - Managing risks in financial entities
  - Facilitating market development
  - Limiting tax liabilities
  - Gaining efficiency

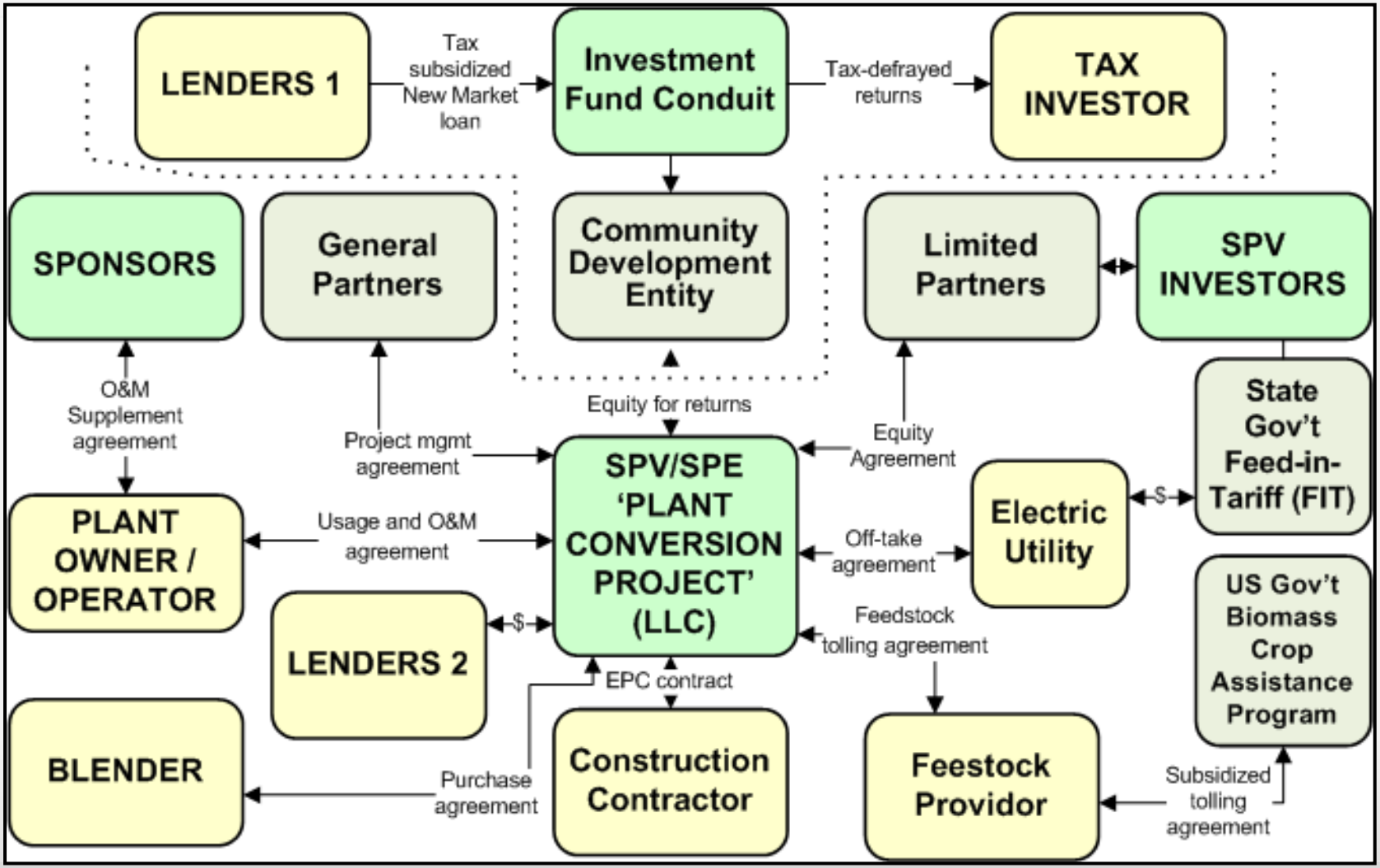
SPV Company Structures

- Undivided joint interest
- Corporation
- Partnership
- Limited Liability Company (LLC)
- Cogeneration Project

Project 'Cash Flow Waterfall' (example)



SPV Financial Engineering Strategy Example



NOTE

* Options and futures can be used to hedge commodity prices. Offtake can also be arranged with banks as pre-paid physical forwards.
* All project contracts are interrelated (in terms of risk and financial effects) and should be negotiated as such. See Appendix.

SOURCES

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* Elrod, C. "Recovery Zone Facility Bond and New Market Tax Credit Financing." Energy Asset Advisors, LLC website.

Structured Funding Process: SPEs & Securitization Markets

Basic Securitization Structure

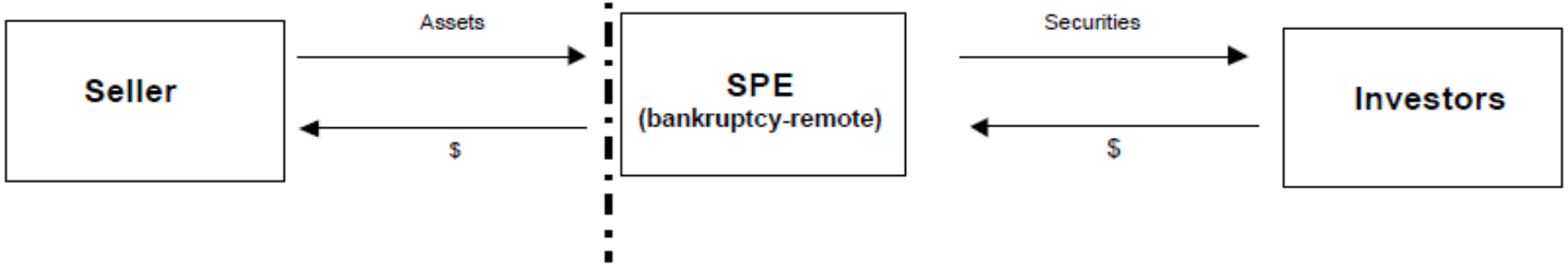
Additional Parties:

Trustee: Performs fiduciary role and administrative functions for investors

Underwriter: Distributes securities to investors

Rating Agency: Rates securities issued by SPE

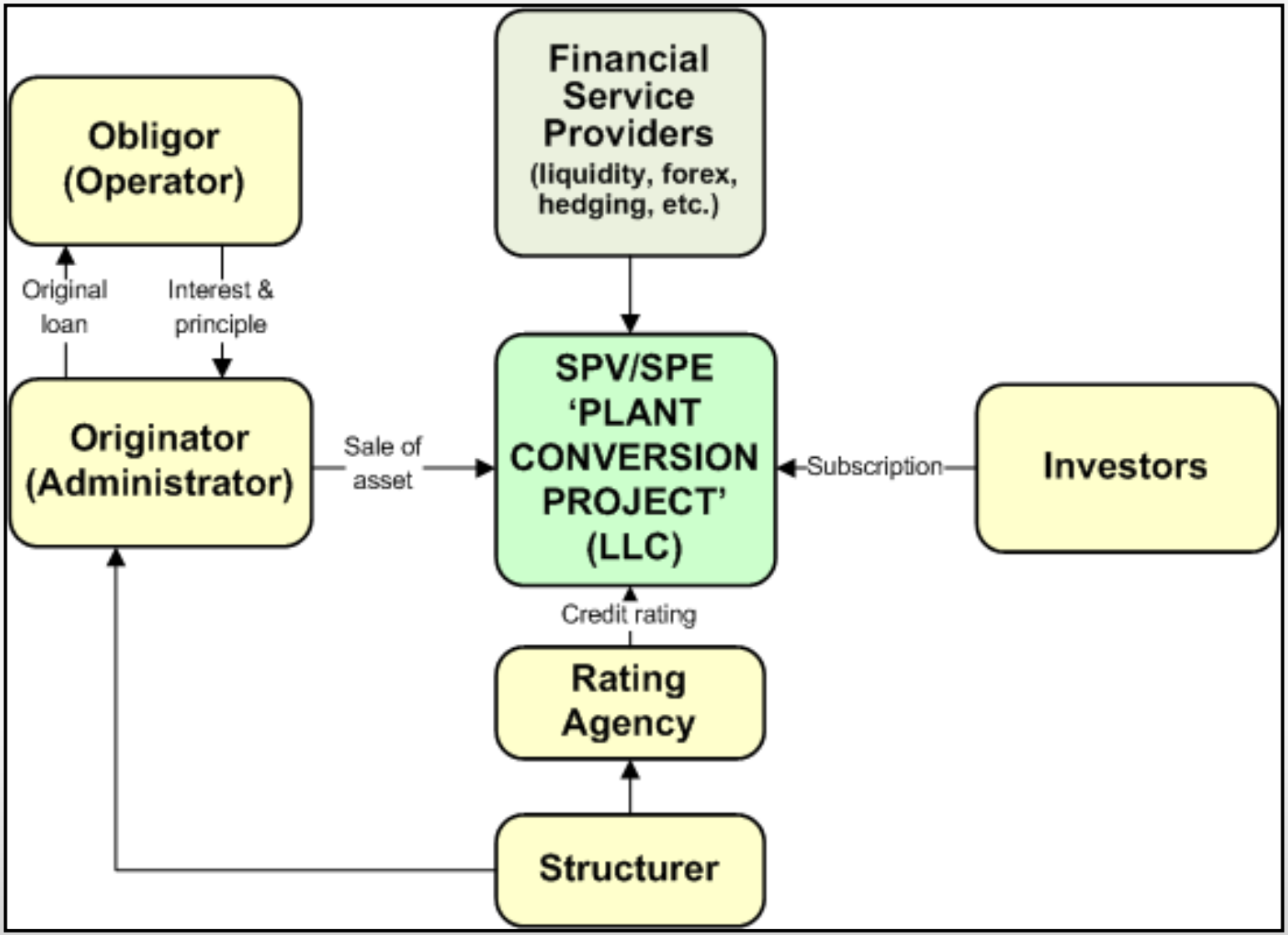
After assets are sold to the SPE, they are no longer available to creditors of the seller and are available solely to pay investors in securities. The securitization process does not transfer debt of the seller to the SPE; only assets are exchanged for cash. The SPE's obligation to pay investors is the obligations of the SPE, not the seller's.



Example: Following is a general description of the securitization process, using mortgages and mortgage-backed securities as an example. Although there may be additional steps involved in a securitization, we describe here the basic process:

1. Seller (typically a mortgage lender) extends mortgage loans to borrowers.
2. Seller and a trustee representing investors create an entity (an "SPE").
3. Seller then sells a group, or "pool" of assets (mortgage loans) to the SPE into which the loans are deposited. The payment it receives in exchange for the loans replenishes the funds used to make the original loans. Those funds now are available to the lender for other uses, including making loans to other potential homeowners.
4. Based on the income stream expected from the mortgages held in the SPE, the SPE issues securities. The monthly principal and interest to be received from the mortgage borrowers will be used to make monthly principal and interest payments to investors in the issued securities. The securities that the SPE issues are called "mortgage-backed securities" ("MBS") because they are backed by the pool of mortgage loans that the SPE holds.
5. The securities then are sold into the marketplace to investors.

Example Structured Funding Process



Typical Bank Review Procedures

TIME REQUIRED	ACTIONS / TASKS
2 – 10 days	Preliminary evaluation of application (business plan, cashflows, etc)
2 – 10 days	Issue/negotiate Indicative Term Sheet
< 20 days	Bank's Loan Committee Approval
30 – 60 days	Facility & Security Documentation; Execution of Conditions Precedent
1 day	Drawdown of Loan Funds & Wire Transfer to Customer's MTB A/c

Structuring Operating Contract

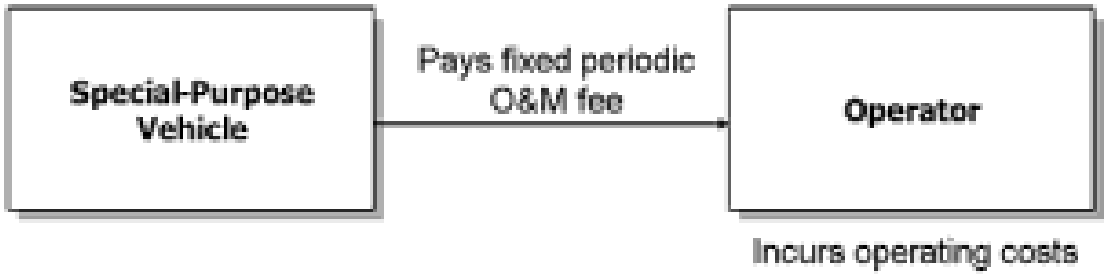


FIGURE 3-6 Structure of a Fixed-Price Maintenance Contract

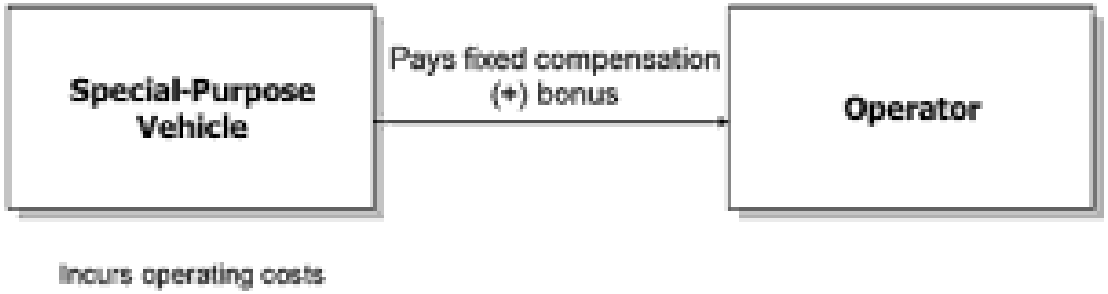
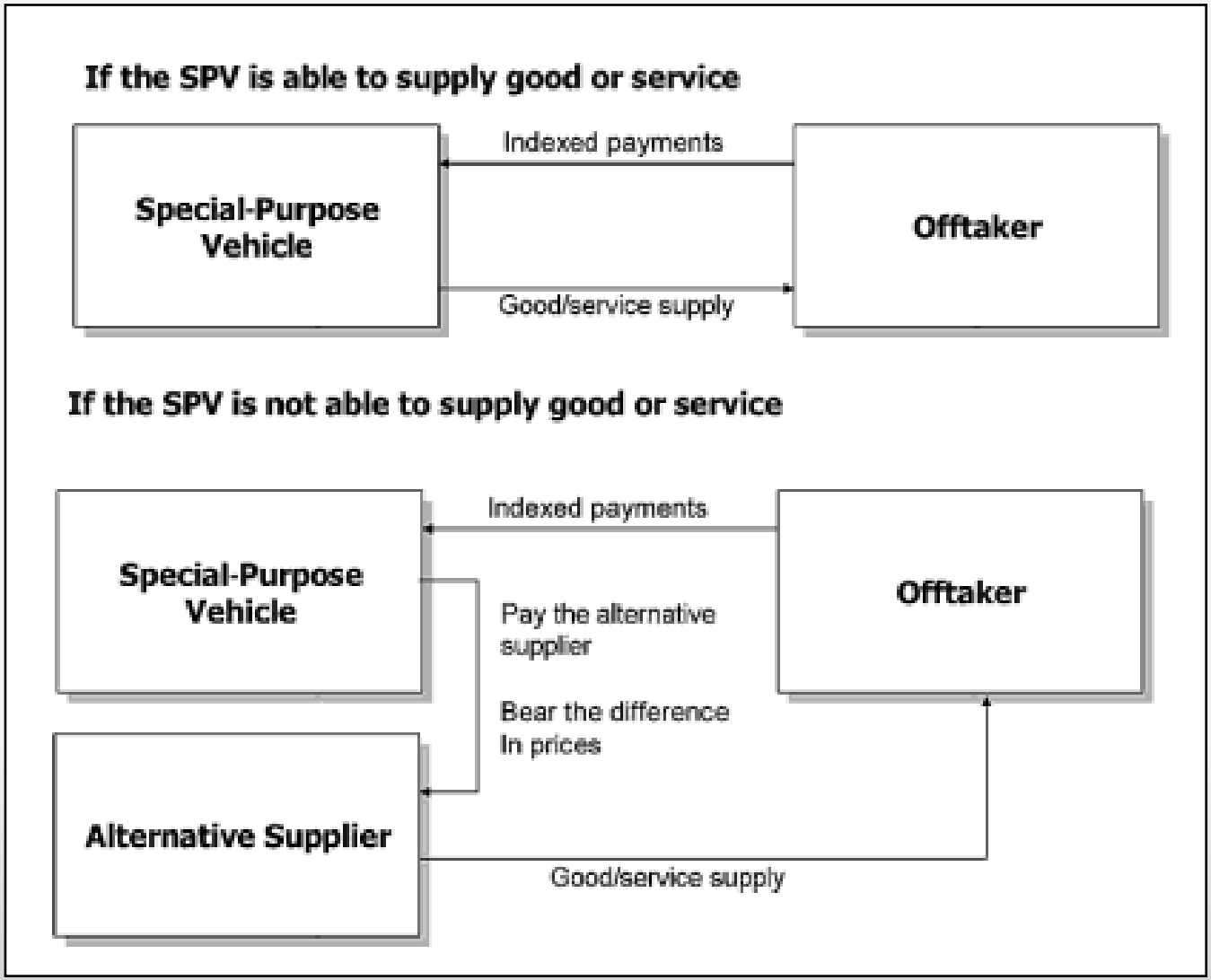
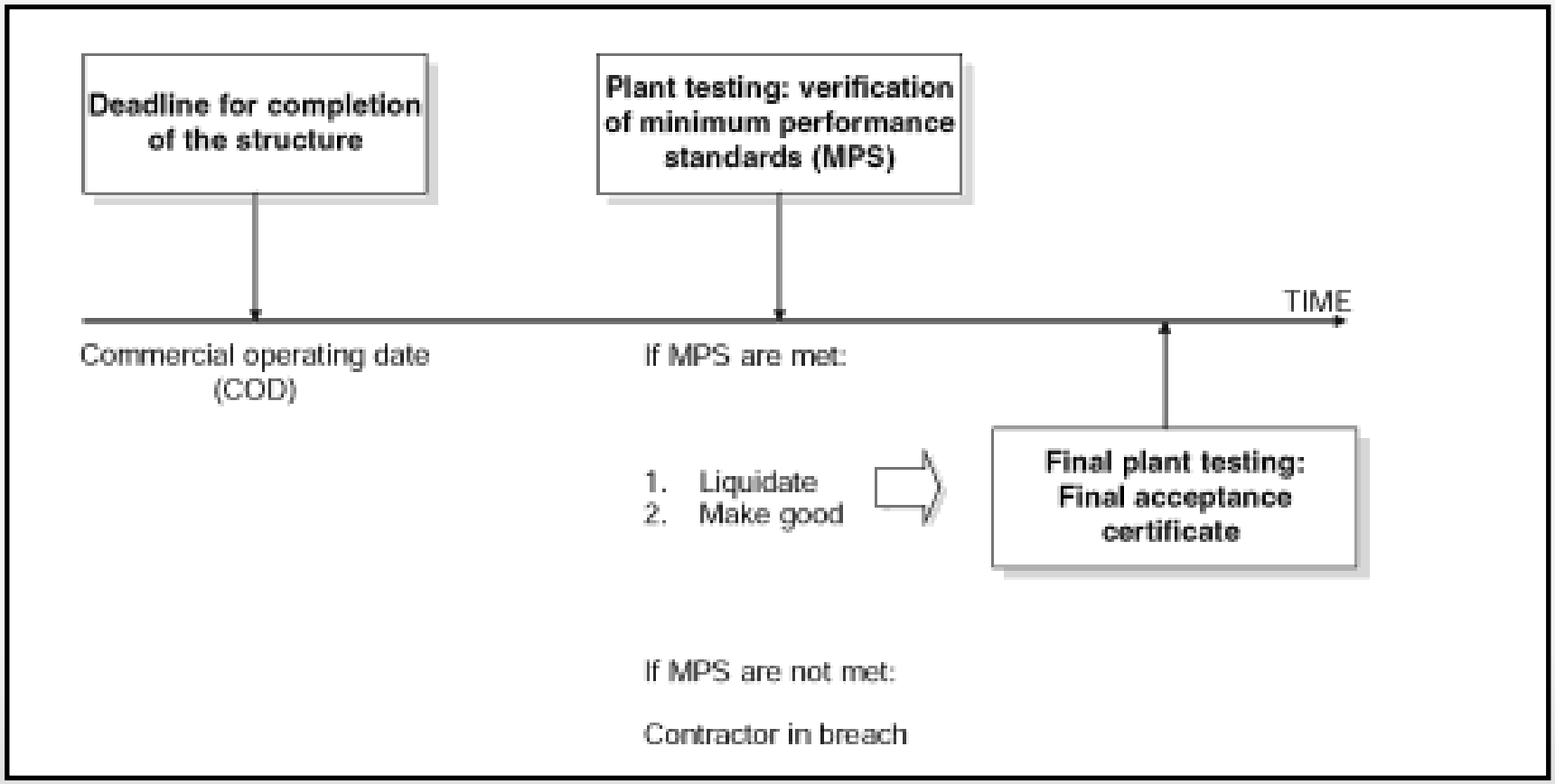


FIGURE 3-7 Structure of a Pass-Through Maintenance Contract

Structure Offtake



Construction Phase



Monitor Success Criteria

1. ***Strong feasibility study and financial plan with reasonable economic assumptions***
2. Identified, suitable, and willing target plant with aligned stakeholders
3. Cost of raw materials assured / hedged (natural and/or synthetic hedge)
4. Supply of energy at reasonable cost (perhaps with discount based on re-sale)
5. Market / offtake for product assured, ideally at pre-negotiated / contracted price
6. Transport logistics secured
7. Command, control, and communications infrastructure / logistics outlined
8. Building materials / equipment available at CAPEX prices quoted
9. Contractor experienced and reliable (track record)
10. Operator experienced and reliable
11. Management personnel experienced and reliable
12. Risk of untested technology is hedged or otherwise covered via assurances
13. Contractual agreements satisfactory
14. Sponsors make adequate equity contribution
15. Satisfactory appraisals of collateral (PPE) and operating value made
16. Adequate insurance coverage planned
17. Risk of cost overruns addressed
18. Risk of delay considered / covered
19. Adequate return for equity investors
20. Environmental risks addressed / manageable
21. Proper certifications, permits, etc.

structure

Risk Analysis

- Pre construction
- Construction
  - Engineering
  - Construction
- Operation
- Financial
  - Exchange rate
  - Interest rate
  - Inflation
- Technical
  - Technological
  - Design
- Market
  - Supply
  - Demand
- Government
  - Government
  - Environmental
  - Regulatory
  - Political
  - Country

Risk Assessment

1. Satisfactory feasibility study and financial plan should be prepared with realistic assumptions regarding future inflation rates and interest rates
2. Cost of product or raw materials to be used by the project is assured
3. Supply of energy at reasonable cost has been assured
4. Market exists for the product, commodity, or service to be produced
5. Transportation is available at a reasonable cost to move the product to the market
6. Adequate communications are available
7. Building materials are available at the costs contemplated
8. Contractor is experienced and reliable
9. Operator is experienced and reliable
10. Management personnel are experienced and reliable
11. Untested technology is not involved (or risk coverage formally guaranteed in contractual agreements)
12. Contractual agreement among joint venture partners, if any, is satisfactory
13. Key sponsors have made an adequate equity contribution
14. Satisfactory appraisals of resources and assets have been obtained
15. Adequate insurance coverage is contemplated
16. Risk of cost overruns has been addressed
17. Risk of delay has been considered
18. Project will have an adequate return for the equity investor
19. Environmental risks are manageable
20. Licenses and permits are available
21. Currency and foreign exchange risks have been addressed

SPV Financing Structure (example*)

- Sponsorship
  - Two companies (50/50 split): 20% equity
- Construction
  - Two contractors: equipment + installation, infrastructure + logistics structure
  - Delay/cost overrun contingency funding
- Offtake
  - Pre-negotiated 10 year
  - Mixed (negotiated): fixed tariff, minimum tariff, and profit share
- Feedstock
  - Pre-negotiated rolling 2 year
  - Mixed: fixed, minimum, and profit share
  - Hedging for floating exposure
- Government
  - Green credits / gov't backed debt
  - Subsidy guarantee
- Maintenance
  - 5 year operations & maintenance agreement
- Financial Risk Management
  - Currency and interest rate risk hedging

Approach: Non-recourse SPV

- **Debt (80%)**
  - Mixtures of short, medium, long-term loans
  - Three principle banks
  - **Long-Term 60% / Short-Term 40%**
    - **30% Syndicated:** offered by a group of secondary international lenders (4 additional banks)
    - **70% Unsyndicated** (single-source): Mezzanine Facility and coverage facility for contractors
  - 80% of PPE is debt maximum (can be amplified with indirect contribution)
  - Security / Collateral:
    - Land rights (lease or mortgage)
    - Insurance policies
    - Shares in company / dividend pledges
    - Corporate sponsor guarantees
    - Project cash flows
  - US DoE loan guarantees (lowers CoC)
- Equity (20%)
  - 2 companies (Main + Offtake/Feedstock Co.)
  - SPV Export Credits: financial guarantees and/or insurance
  - **Note**: part of debt financing / purchase could be arranged via sale of share interests

**** NOTE: Based on North Sea wind energy project***

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Three Major Stakeholders

- **Transferor**
  - The entity that transfers the assets, liabilities or rights
  - The entity that creates the SPE
  - Equity could be vested in transferor and/or partners
- **Transferee**
  - The newly created SPE that receives the assets, liabilities or rights
- **Investors**
  - Typically provide all funding requirements for SPE activities through loans extended to SPE or securities other than shares (e.g., bonds) issued by SPE

Core Roles

- **Project Management**
  - Outreach
  - Due Diligence
  - Technical
  - Financial
  - SPV
  - Legal
  - Government
  - Construction
- **Financial Analysis & Structuring**
  - Risk / fin. modeling & analysis
  - Interactions with Banks & Lenders
  - Equity & debt
  - Tax
  - Operational Efficiency
  - Financial negotiations
  - Capital markets
- **Technical / Engineering**
  - Design & specifications
  - Site selection
  - Due diligence / risk profile
  - Implementation planning
- **Legal Council**
  - Legal project management
  - Contracts
  - Negotiations
- **Government Liaison**
  - Grant & loan applications
  - Subsidy analysis
  - Permits
  - Export Credit Agency
  - DOE / NREL
- **SPV Governance**
- **External Stakeholders**
  - Legal Advisors
  - Contractors
  - Technology supplier
  - Operator
  - Buyers
  - Suppliers
  - Banks
  - Insurance Companies
  - Independent engineering firms

High-Level Management Actions

- Orchestration of internal stakeholders
- Establishing core ‘Project Team’
- Setting and refining objectives
- Contract and procurement strategy
- Resourcing and high-level scheduling
- Scope definition and changes
- Risk management thresholds
- External stakeholder management

‘Structuring’ Project Finance Process

SPV ‘Demonstration Phase’ Goals

WHAT WILL BE PROVED TO EXTERNAL MARKET?

- Demonstrate to market ability to execute on advanced biotech innovation
- Instill sentiment of ‘growth value’ amongst current & prospective investors
- Attract partners, collaborators, providors and investors for follow-on expansion

WHAT WILL BE DEMONSTRATED TO OUR OWN BUSINESS?

- Demonstrate ability to deliver on the next generation CEtOH promise
- Forging of meaningful strategic partnerships which can be expanded
- Establish innovative & replicable product development methodology

WHAT WILL BE ADDED TO OUR CORE CAPABILITIES?

- Refinement of plant and processing performance data points at critical scale
- Develop abilility to certify ethanol output given specific system parameters
- Insulation from risk during technical proof-of-concepts via financial engineering

Basic SPV 'Flow'

1. Create comprehensive 'project brief'
   - Financial analysis
   - Comprehensive cash flow and risk analysis
   - Technical / engineering case
   - Proposed financing structure
   - Examine subsidy &/or loan guarantee feasibility (DoE debt guarantee? Export Credits? EU?)
   - Identify where legal and financing support needed
2. Identify distressed property
   - Willing owner
   - Lender / bank (ideally interested to restructure)
   - Transport-feasible agricultural provider
   - Technical match / financial & technical due diligence
3. Preliminary negotiations with range of key parties
4. Formal target plant due diligence process
5. Establish formal partnership with lender
6. Debt placement
7. Set up SPV (involves logistical pre-steps)
8. Final negotiations
9. Finalize all permits and applications
10. Equity syndication
11. Purchase & sale agreement signed
12. Closure
13. Construction starts

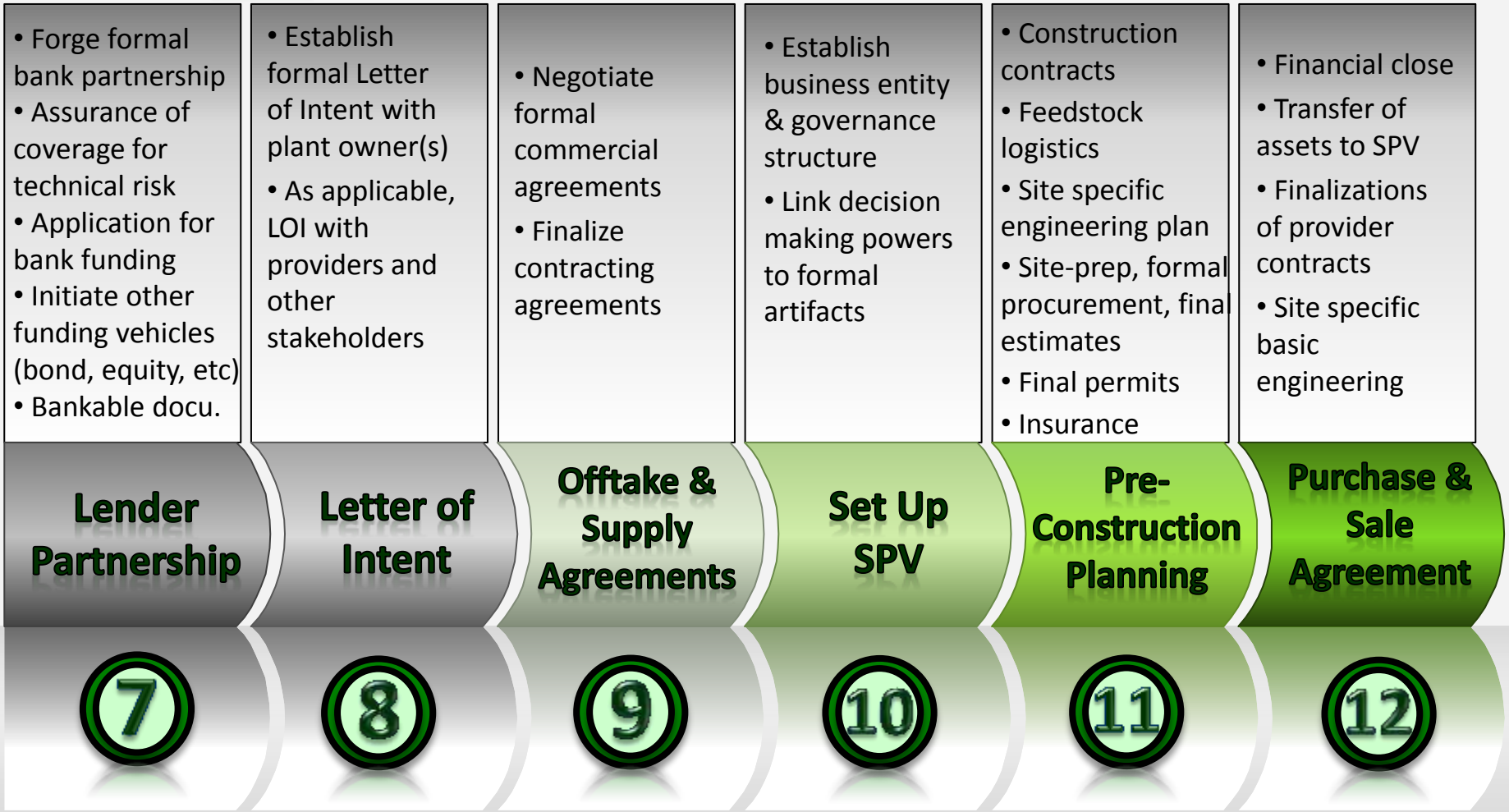
High-Level SPV Process

PLAN	PARTNER	STRUCTURE	FINANCE	ENGAGE
• Develop financing strategy proposal • Prepare technical & business pitch • Identify & contact prospective business partners • Contact financing logistics providors • Prepare gov't subsidy applications	• Agree on business model and business case with partners • Pre-negotiate ethanol offtake • Pre-negotiate feedstock supply • Engage investors • Lodge gov't application(s)	• Tighten logistical plan around partnership agreements • Tighten financial commitments and leverage to reduce capital risk premium profile • Tighten post-demo planning	• Setup SPV structure • Fund with pre-negotiated capital • Solicit additional capital on market (as needed) • Coordinate partners to timeline and technical plan	• Enable low risk test-bed for large-scale production • Opportunity to refine plant and processing at scale with yeast and enzyme agents • Launch media campaign upon implementation

1 Planning Phase

Financial and Risk Analysis	Technical Analysis	Compile Prospectus	Short-List Sites	Preliminary Negotiations & RFI/RFP	Preliminary Due Diligence
• Financial & risk anlaysis • Modeling & simulation • Econometrics & optimization • Research 3rd party finance, gov't & legal support / logistics providers	• Detailed profiling of technical factors & requirements • Specification of scaling, inputs, yields, etc. • Preliminary applications for gov't subsidies / grants	• Proposal: risk analysis, financial & tech • Prepare 'pitches' • Prepare gov't applications • Project plan, team, charter, & steering com. • Site criteria	• Short-list target sites • Approach and pitch to owners &/or financeers • Send 'feelers' in investment market • Gov't apps • Legal Project Team	• Project structuring discussions based on feedback from prospectus • Approach providers with Request for Proposal (RFP) • Approach banks	• Conduct preliminary site due dilligence • Preliminary engineering & environ.analysis • Based on outcomes, sign Commitment Letters • Concept plan
1	2	3	4	5	6

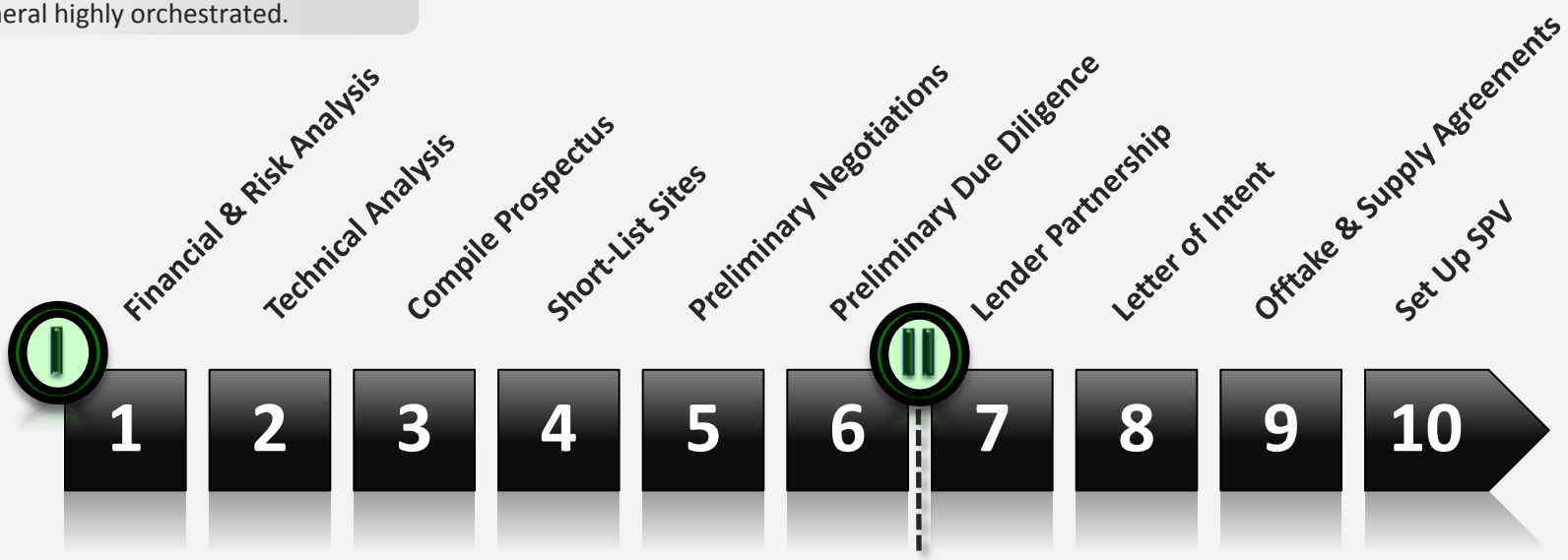
11 Implementation Phase



Storyboard Overview

SPV Storyboard

Phases are *NOT* mutually dependent: in many cases execution depends upon pre-work being performed far before effective stage. SPV implementation is in general highly orchestrated.



Modeling

Bringing together financial and technical details, model long-term financial analysis including risks / sensitivities.

Orchestrate Opportunities

Using analysis artifacts, orchestrate conversations with prospective stakeholders. Establishment depends on drawing parties together.

Draw to Agreement

Negotiation phase is most sensitive as here all interests must be carefully woven together. Lawyers and self-interest must be balanced.

End of the Beginning

The terms of the negotiations result in contracts which are the seeds for the subsequent construction and implementation.

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structure

Common Causes of Failure

- Delay in closing / concluding negotiations
- Delay in completion (increase in interest expense on construction financing & delay in revenue)
- Capital cost overrun
- Technical failure
- Financial failure of the contractor
- Uninsured casualty losses
- Technical obsolescence of the plant or equipment
- Loss of competitive position in the marketplace
- Poor management
- Increased price or shortages of raw material
- Breakdown in pledged supply, such as feedstock supply
- Government interference / political instability

Orchestrating Financing Deal

1. **Project pitch**
   - Project brief presentation
   - Supporting financials & risk analysis
   - Proposed structure
   - Tech feasibility & risk analysis
2. **Form group of sponsors**
   - Letter of intent
   - Organizing project company
   - Articles of incorporation
   - Agreements between sponsors
   - Verify recourse bankability
3. **Industrial development**
   - Project documents
   - Due diligence report
   - Legal opinions
4. **Project financing**
   - Mandate letter and financing term sheet
   - Finance documents
   - Assistance during syndication
5. **Maintenance of financing**
   - SPV management
   - Periodic contact with agent bank and sponsors

SPV Process – Finance Components

1. Strategic / commercial evaluation
2. Systematic identification and exploration of risks
3. Financial and Risk Analysis
    - Economic: core valuation (NPV of cash flows)
    - Market: econometric analysis
    - Risk Modeling: simulation / sensitivity analysis
    - Tech Risk: Integration of technical factors
4. Design of risk bearing/sharing package
5. Appropriate funding package
6. Impact of financing package on net cash flows and sensitivity analysis
7. Short list of target sites
8. Pitch to potential participants

Elements of Financing Plan

- Construction financing
- LT Financing
- Withholding tax
- Borrowing capacity
- Loan repayment parameters
- Subsidy
- Loan guarantees and covenants

SPV Financing Structure (example*)

- Sponsorship
  - Two companies (50/50 split): 20% equity
- Construction
  - Two contractors: equipment + installation, infrastructure + logistics structure
  - Delay/cost overrun contingency funding
- Offtake
  - Pre-negotiated 10 year
  - Mixed (negotiated): fixed tariff, minimum tariff, and profit share
- Feedstock
  - Pre-negotiated rolling 2 year
  - Mixed: fixed, minimum, and profit share
  - Hedging for floating exposure
- Government
  - Green credits / gov't backed debt
  - Subsidy guarantee
- Maintenance
  - 5 year operations & maintenance agreement
- Financial Risk Management
  - Currency and interest rate risk hedging

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**** NOTE: Based on North Sea wind energy project***

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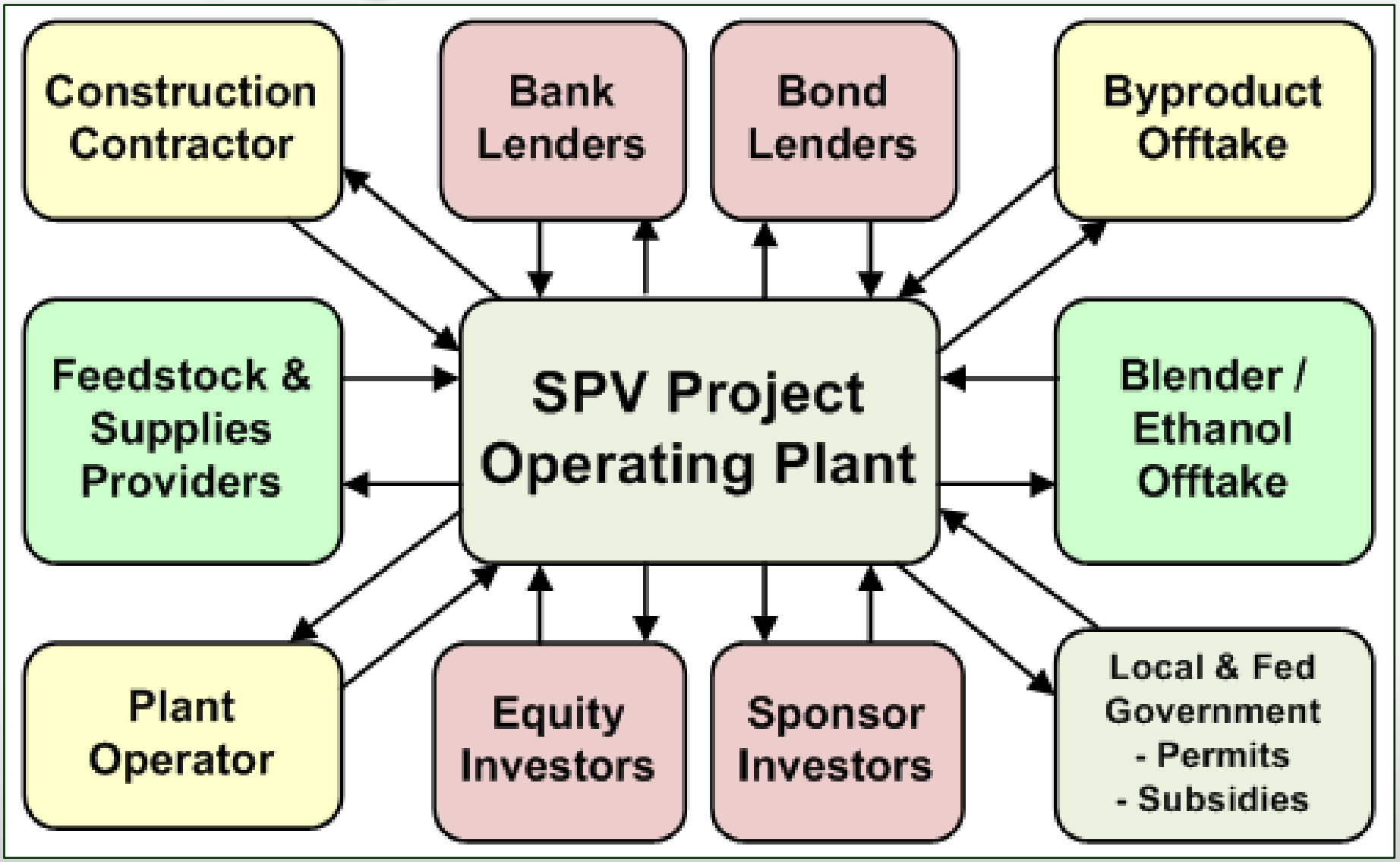
High-Level SPV Contracts



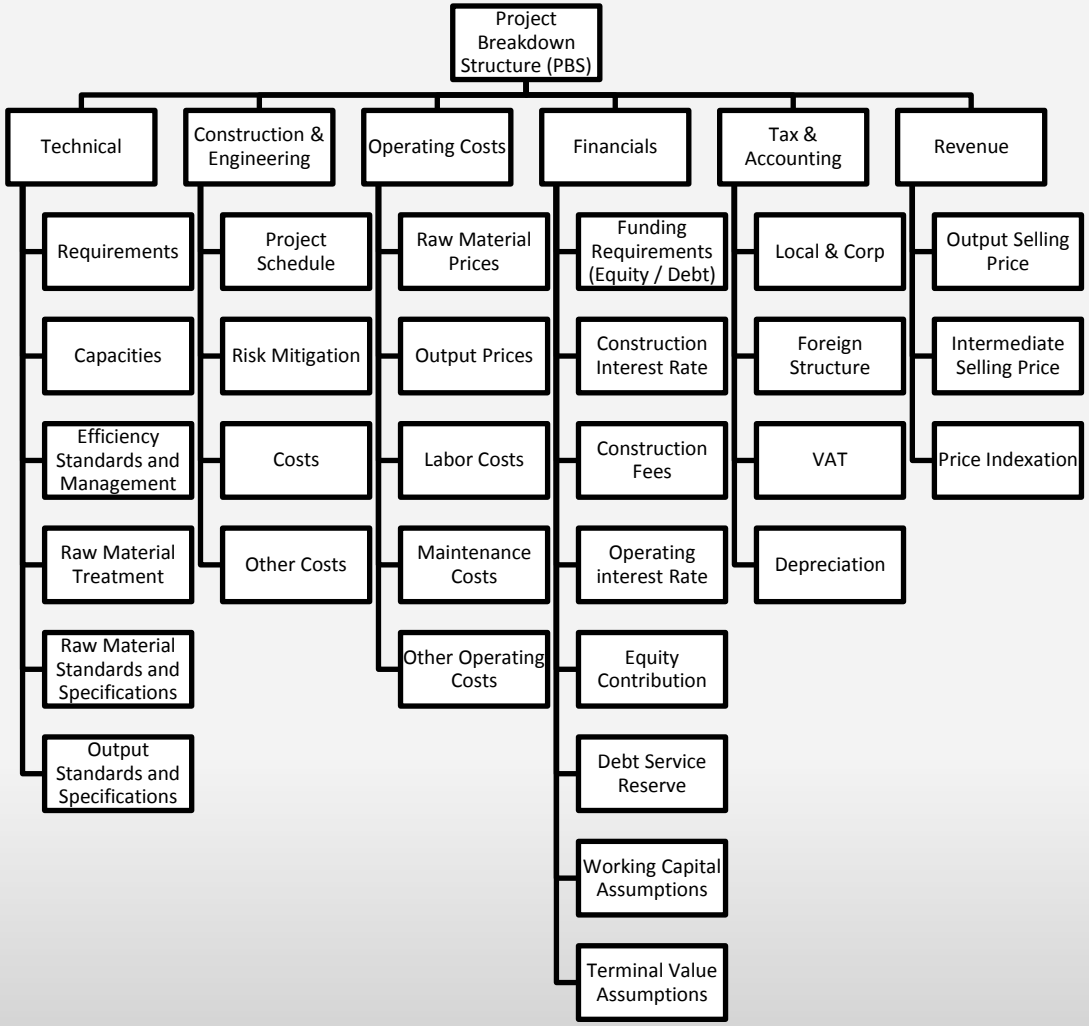
Key Documents Needed

- Bond Prospectus (if bond financing)
- Construction contracts: Engineering, Procurement and Construction (EPC) Agreement contract
- Independent Engineer Report
- Loan Agreement
- Operation & Maintenance (O&M) Agreement
- Power Purchase Agreement (PPA)
- Collateral Agency and Account Agreement
- Intercreditor Agreement
- Guarantee and Security Agreement
- Calculations and Forecasting Agreement

Documents Required (examples)

- Engineering, procurement, and construction (EPC)
- Operating and maintenance (O&M)
- Fuel, power supply
- Feedstock supply & transport
- Permits and government-related
- Insurance
- SPE/SPV set-up and organizational documents
- Trust and custodial agreements
- Collateral, pooling, and servicing agreements
- Loan and sale agreements
- Mortgages or deeds of trust, rights-of-way
- Liquidity and credit support agreements
- Legal opinions required by the credit rating agencies
- Offtake agreement

Project Breakdown Structure (PBS)



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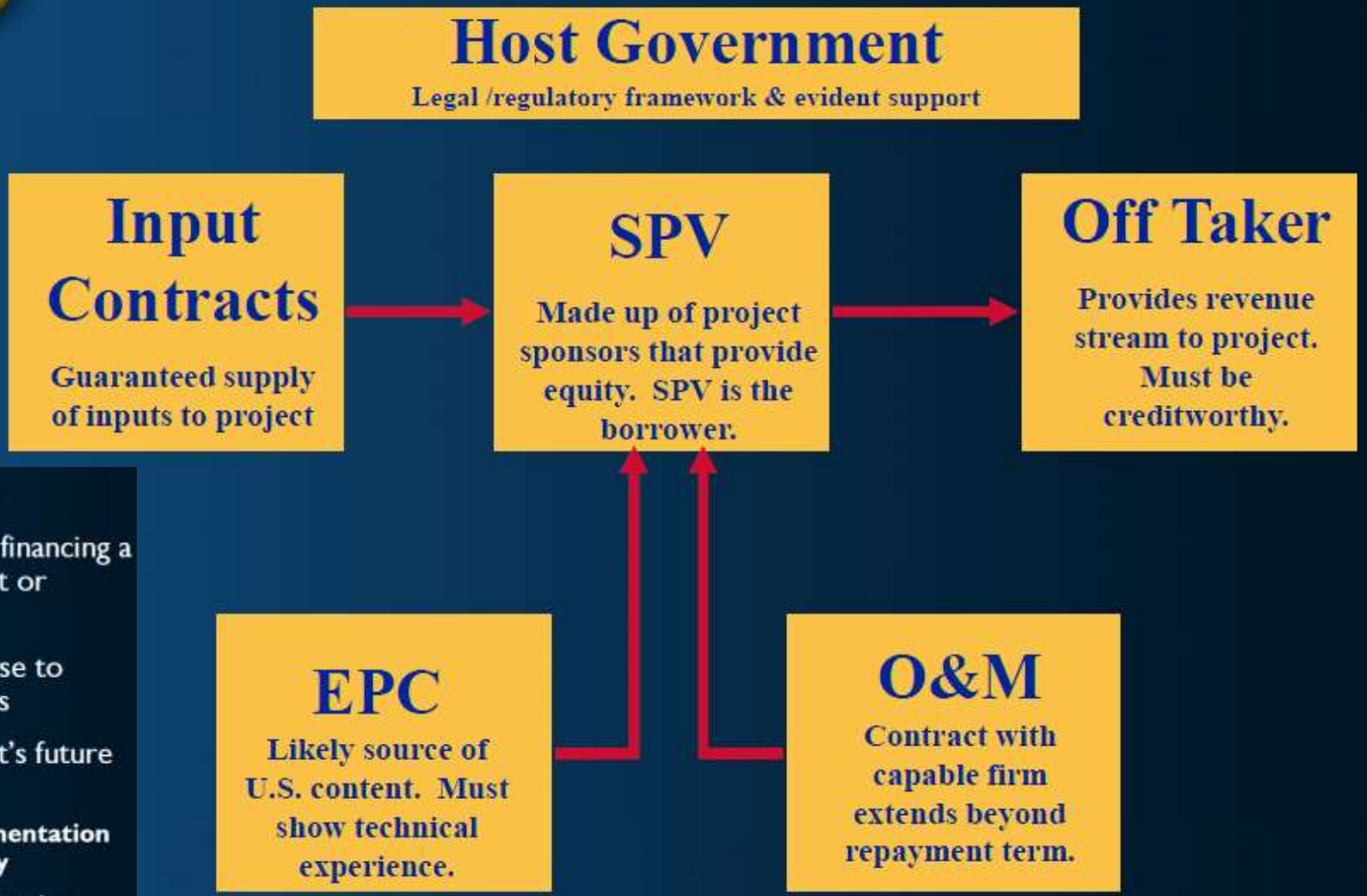
8. Final negotiations
9. Finalize all permits and applications
10. Equity syndication
11. Purchase & sale agreement signed
12. Closure
13. Construction starts

SPV Governance

- **Financial Structure (case of distressed EtOH plant)**
  - Tied to particular risk profile and existing financing of particular project
  - Involves negotiating with current debt and equity holders to restructure ownership
  - Carefully hedge equity and debt risk exposures to reduce cost of capital
  - Note: by lowering risk, expected return on investment is lowered (though regularized)
- **Ownership**
  - One or more **sponsors** orchestrate creation (establish legal SPV entity)
  - Sponsors typically minority capital providers (not considered 'owners')
  - Particular mix of debt and equity investment tailored to sponsor(s) & project goals
  - Majority risks borne by SPV investors (share , bond, and loan investors)
  - SPV established as independent institutional unit / entity
    - Decision making autonomy from sponsors (in respect of its principal business function)
    - Financial risks borne by principle investors (typically *not* sponsor)
    - Can be managed by an independent 3rd party board (for fee)
    - Define if project perpetual or terminal (and value accordingly)
    - Contracted parties must be *creditworthy* & *contractually bound* by SPV to fulfill duties (i.e.: construction, maintenance, feedstock provision, EtOH offtake, etc.)
  - SBV must satisfy ***one*** of following criteria (US FASB):
    1. Insufficient sponsor at-risk equity (10% or lower stake)
    2. Shareholders lack decision making rights
    3. Shareholders do not absorb losses
    4. Shareholders do not receive expected residual returns

US Export Bank SPV Context

PF Project Structure

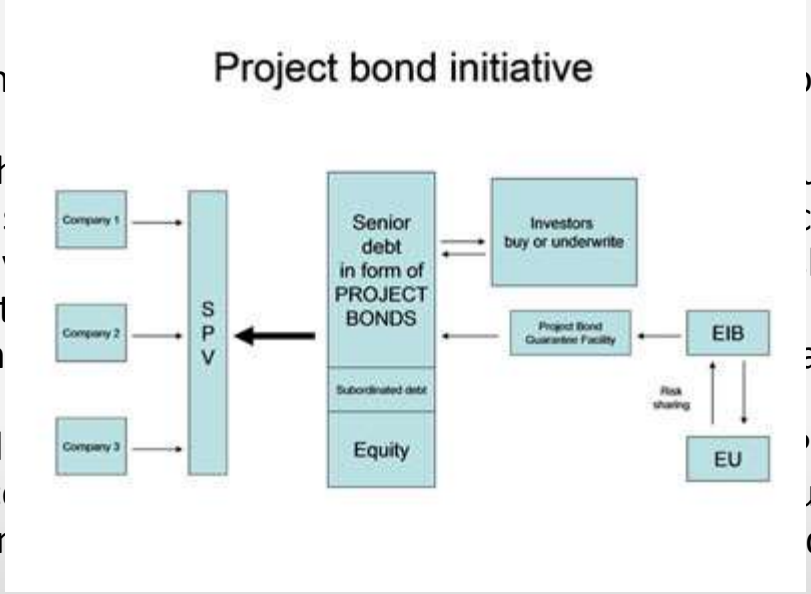


Project Finance

- SPV borrower financing a greenfield project or expansion
- Limited recourse to parent companies
- Analyze project's future cash flows
- **Complex documentation to perfect security**
- **More than 15% equity required, so total debt provided less than 85%**

EIB and EC authorise the concept “Bond Initiative” for infrastructure financing

- http://www.railwayinsider.eu/wp/archives/42954
- EIB Board authorised the EC cooperation agreement on the Pilot Phase for Bond Initiative to finance infrastructure projects by 2020.
  The objective of this initiative is to stimulate capital market financing for large-scale infrastructure projects in the areas of Trans-European networks, as well as broadband telecommunications. The initiative is designed to enable promoters of infrastructure projects to attract additional private finance from institutional investors such as insurance companies and other funds.
  The bonds will be issued by th…r the Member States.
  The EIB will provide credit enh…ument (either a loan or contingent facility) to …company. The project company will generall…hed to build, finance and operate an infrast…
  According to EIB, this financin…ase the availability of private sector fi…
  In a speech in 2010, EC Presid…Project Bond Initiative” to mobilise the nec…ucture: EU objectives for 2020 on tran…quire investments of EUR 2 Trillion.
  Source: www.eib.org Graphic: EIB



SPV: Managing for Success

Strategy Guidance

Maintain focus

Stakeholder Management

Align and balance interests

Artifact Management

Legal documents, contracts, financial and technical briefs

Project Management

Highly orchestrated

Risk Management

Constant risk analysis and mitigation