
New Venture Commercialization of Clean Energy Technologies

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The Clean Energy Venture Group

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CEVG Intro

- Founded in 2004
- Seven members
 - All successful mid-career professionals with backgrounds in energy, environment, finance and technology
 - Coordinated due diligence, individual decision-making
 - For more info, see www.CleanEnergyVG.com
- Six Investments to date:



Outline of Presentation

- **Motivation and definitions**
- Factors that inhibit adoption of clean energy technologies
- Overview of simulation model
- “Base case” simulation results
- Factors that determine success
- Strategies & policies that increase the odds of success

Premise

- Clean energy technologies need to be widely adopted to address climate change
 - New ventures will be the primary means of commercializing clean energy technologies
 - Clean energy ventures fail at a higher rate than comparable ventures in other industries
- Why do they fail?
- What must be done for them to succeed?

Clean Energy Technologies

- Defined: Technologies that reduces harmful emissions that result from the production and use of energy
 - e.g. Renewable and/or efficient distributed generation, energy efficiency technologies, intelligent energy management, biofuels, ancillary products and services
- Benefits
 - Reducing GHG emissions
 - Some of these technologies provide economic, energy security, increased reliability & other benefits
 - e.g. Energy Efficiency, Combined Heat & Power (CHP)
- Have not been widely adopted
 - Though some of these technologies have been available and cost effective for many years

Why New Ventures

- Clean energy technology is a disruptive innovation
 - Reduces need for predominant source of energy (fossil fuels) and for infrastructure to transport it
- Established firms have great difficulties developing and marketing disruptive innovations
 - *Innovator's Dilemma, Christensen*
- Significant new industries have primarily been created by new ventures
 - e.g. Electricity, automobiles, desktop computers and software
- But, new ventures have not been successful at commercializing clean energy technologies

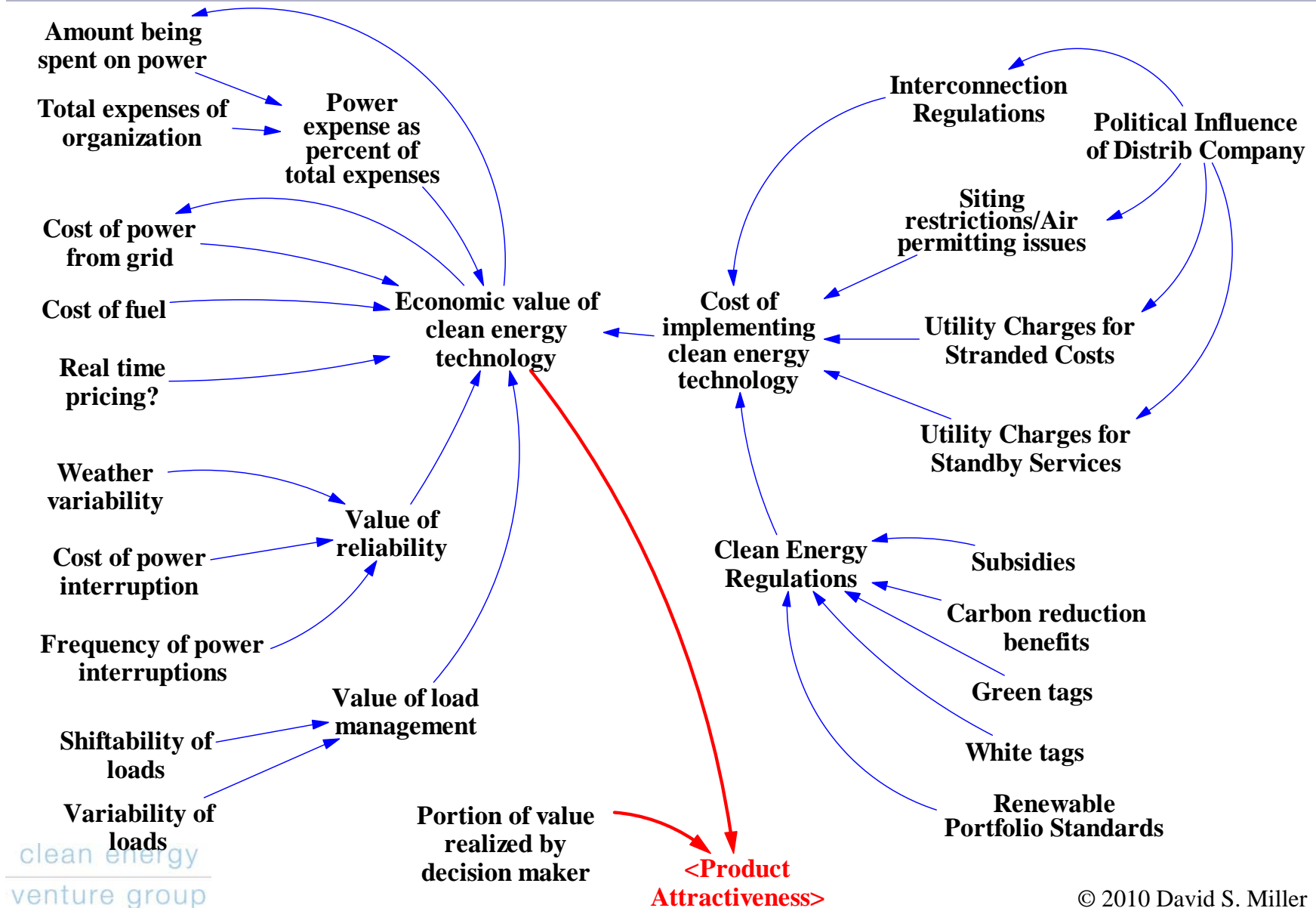
Data Collection

- Conducted 100+ interviews and meetings with clean energy entrepreneurs and stakeholders
 - Including investors, customers, energy service providers, and participants in policy-making
- In depth research of and interviews with 12+ new clean energy ventures
 - Including energy efficiency, CHP, fuel cells, solar, wind power, demand side management
 - Three of these served as case studies

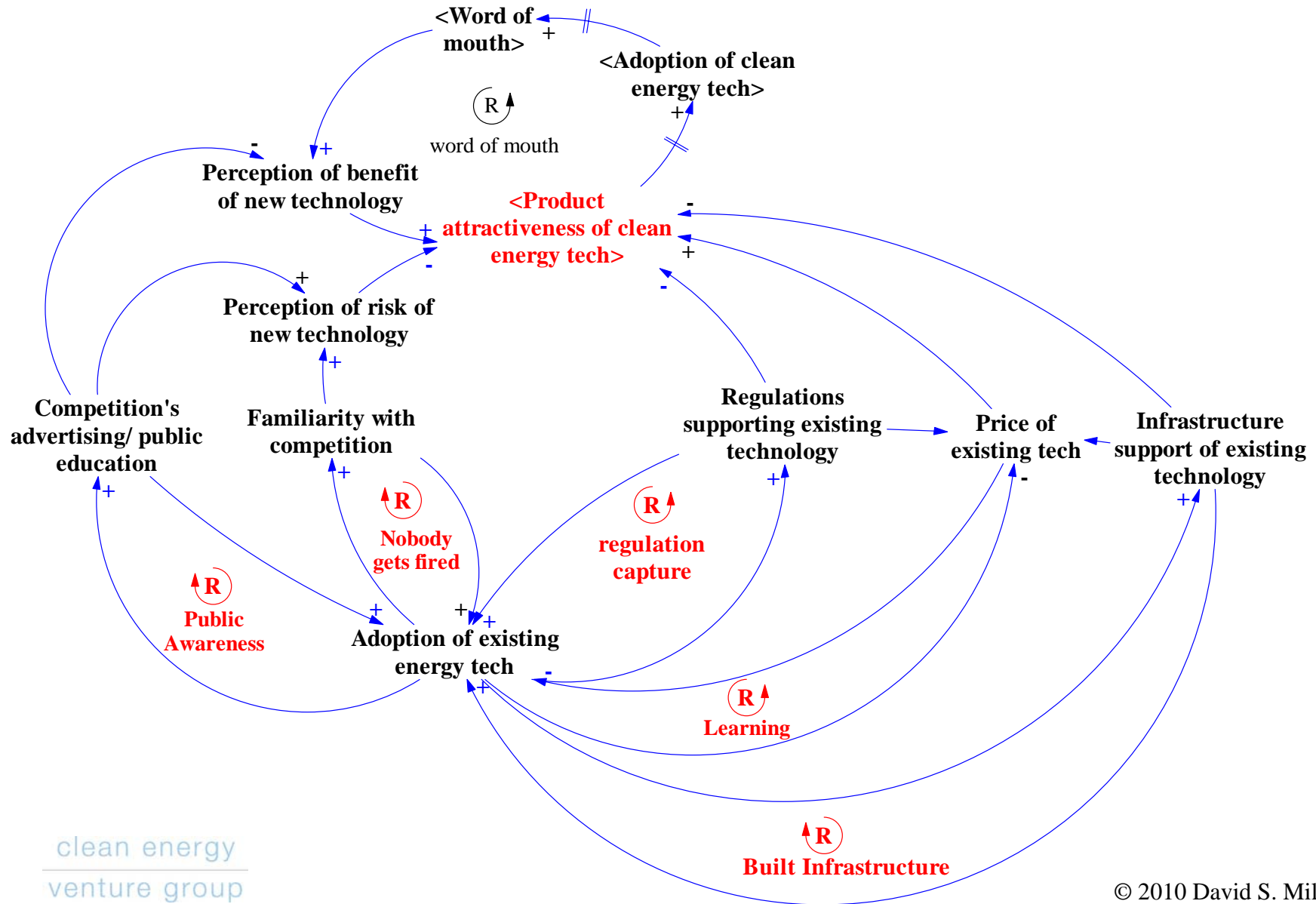
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Exogenous Economic and Regulatory Factors



Competition from Established Technologies



What's different about Clean Energy?

- Very slow adoption curve
 - Conservative customers
 - Nobody gets fired for sticking with what works!
- Entrenched competition
 - Regulatory capture
 - Infrastructure
- Dependent on commodity prices
 - No one can predict the price of oil!
- Agency problem
 - Purchaser may not benefit from features and cost savings
- Tragedy of commons
 - Few want to pay for public good of environmental benefit

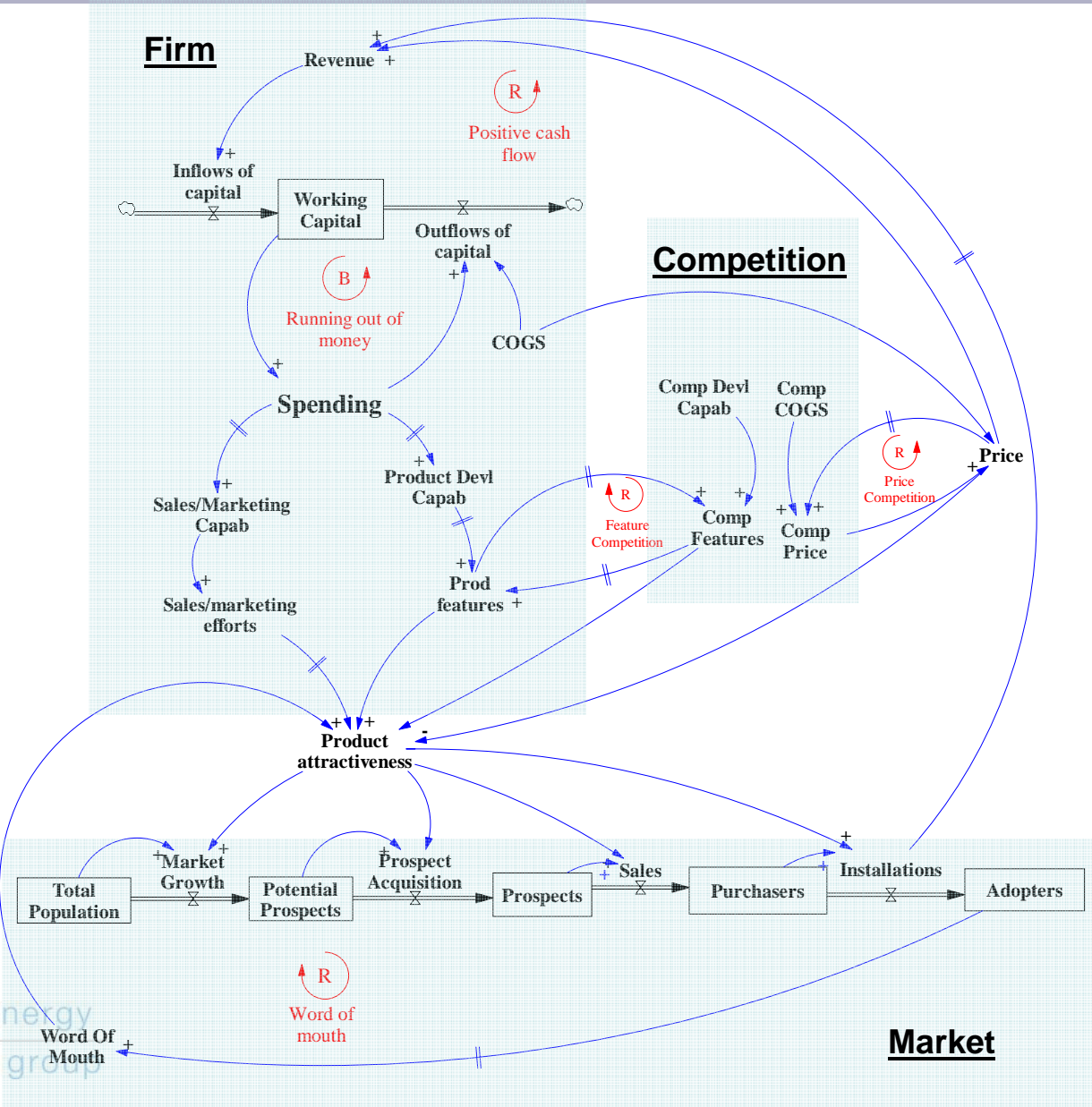
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Modeling a Clean Energy Startup

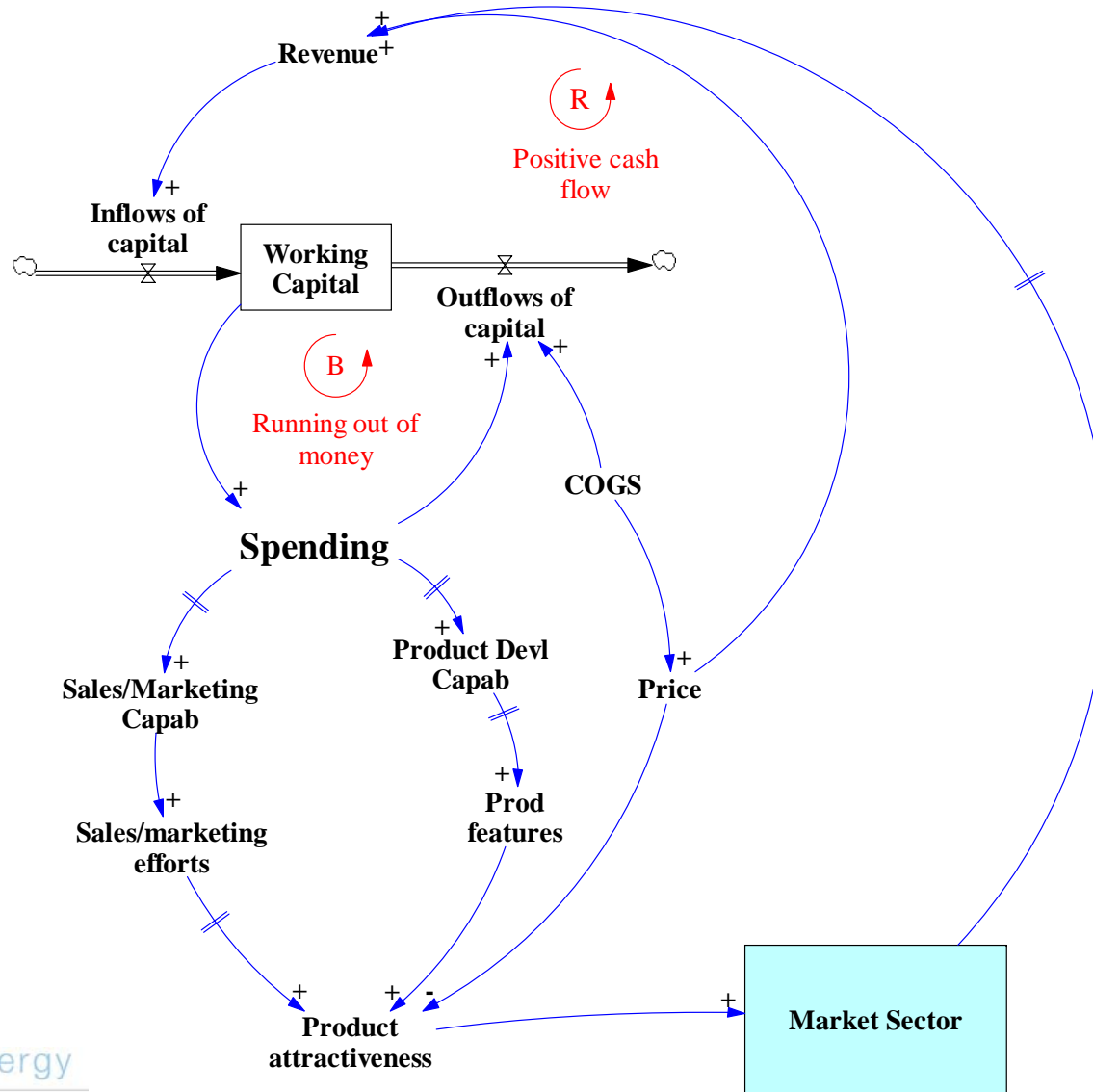
- System dynamics model based on:
 - Standard structures which model the product development, labor, and market of firms
 - Diffusion of new technologies into markets
 - Feedback loops affect all of the above
 - Interviews with many entrepreneurs and investors
 - Experience working directly with clean energy companies

Overview of Model

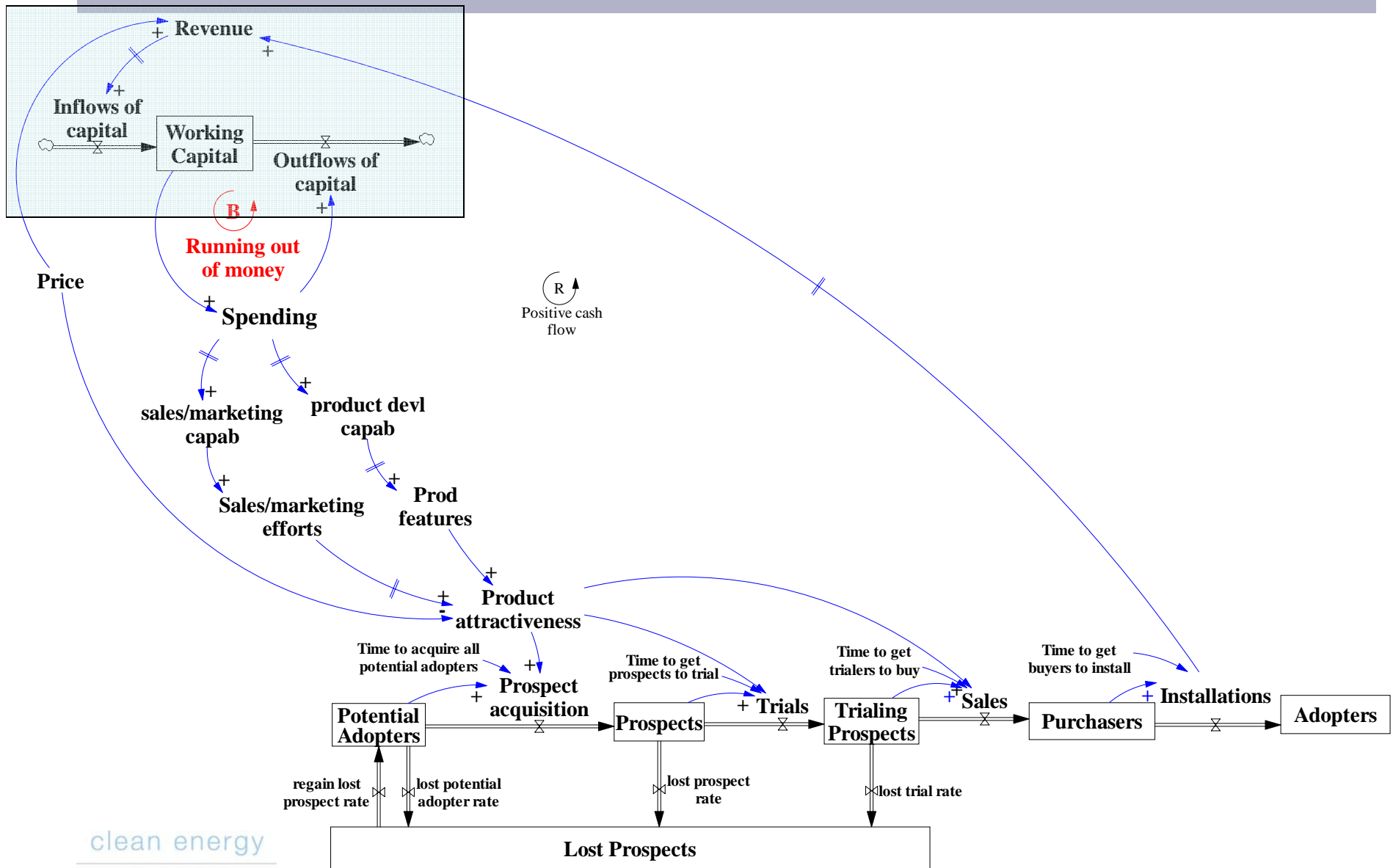


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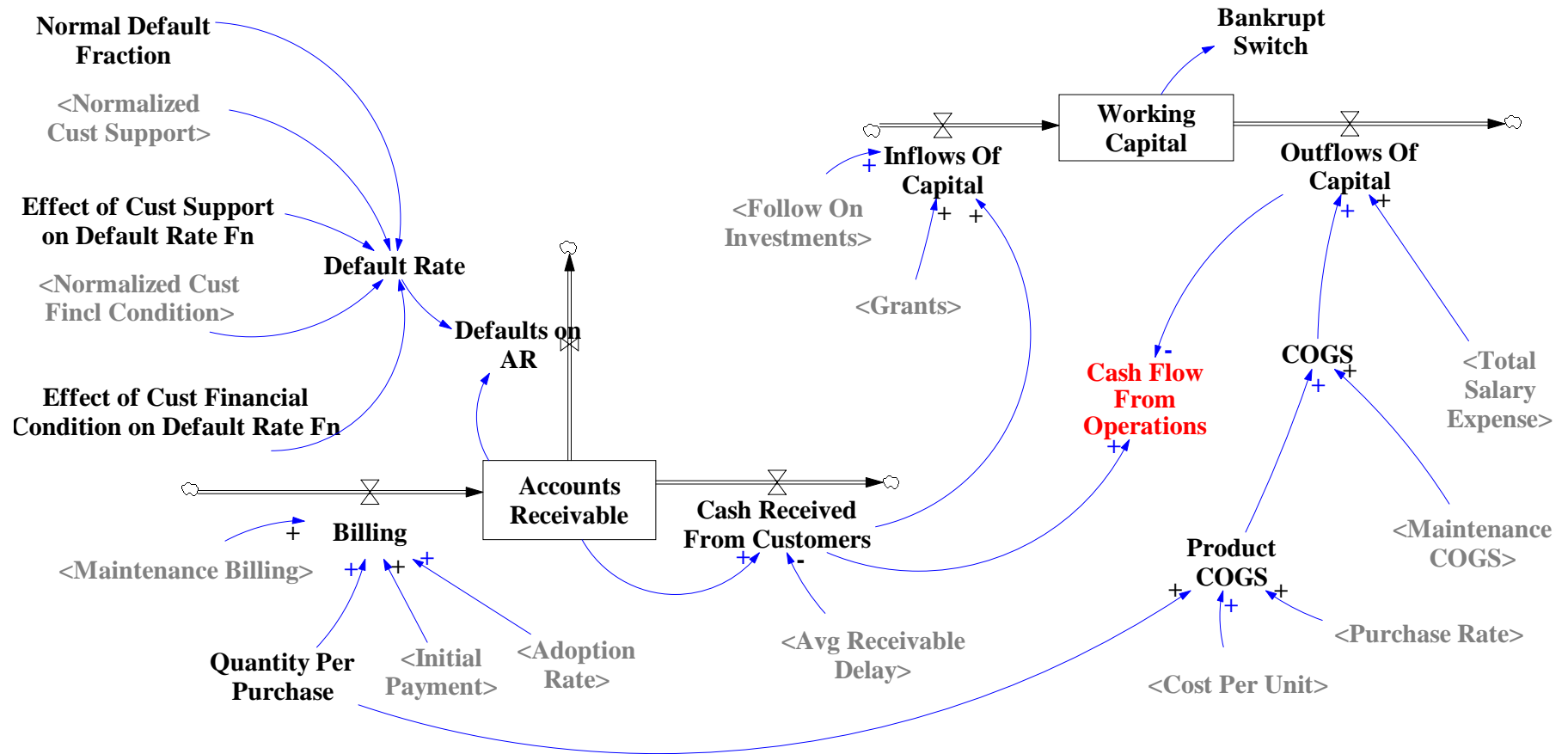
Firm



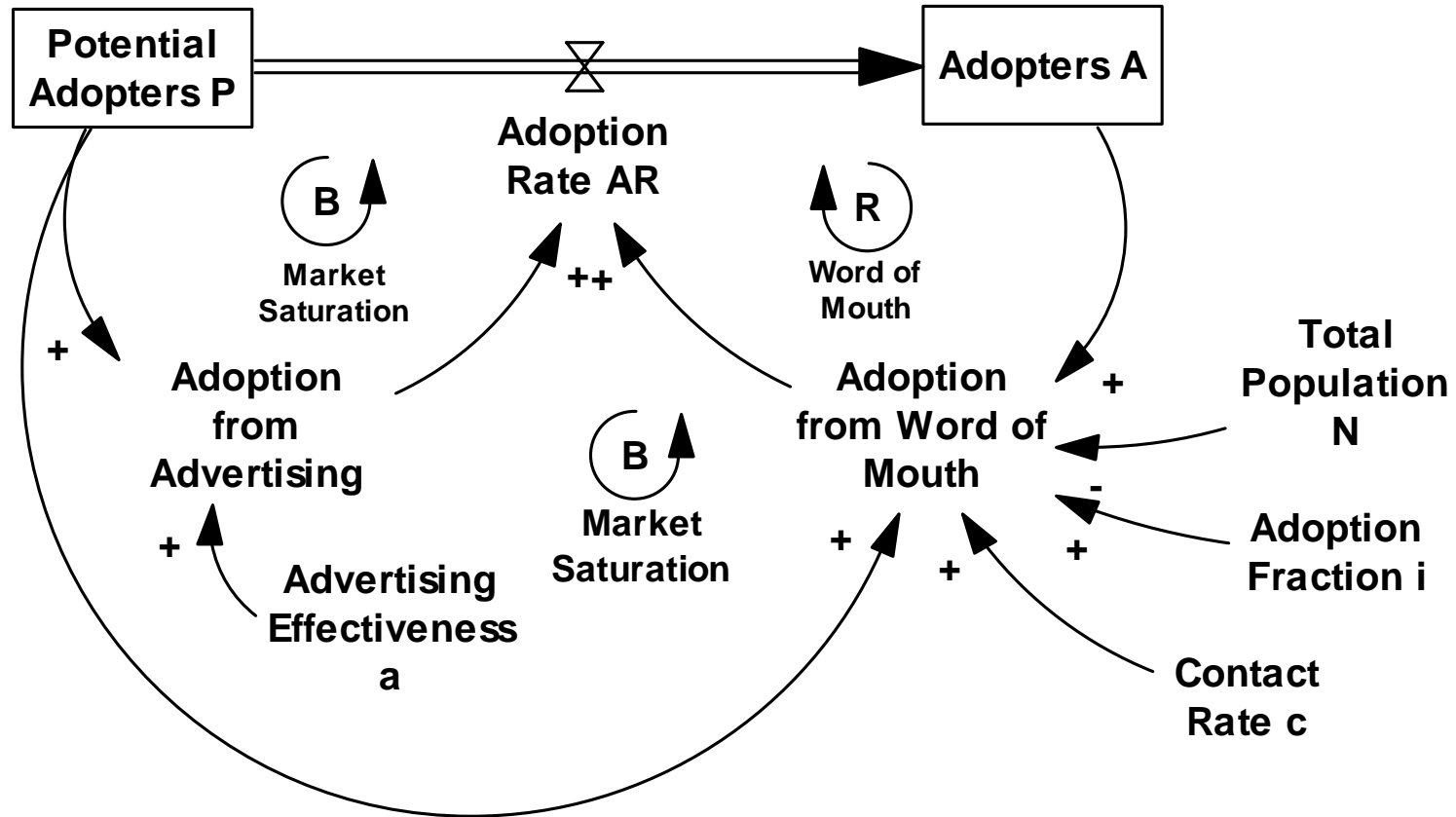
Cash Flow Model Detail



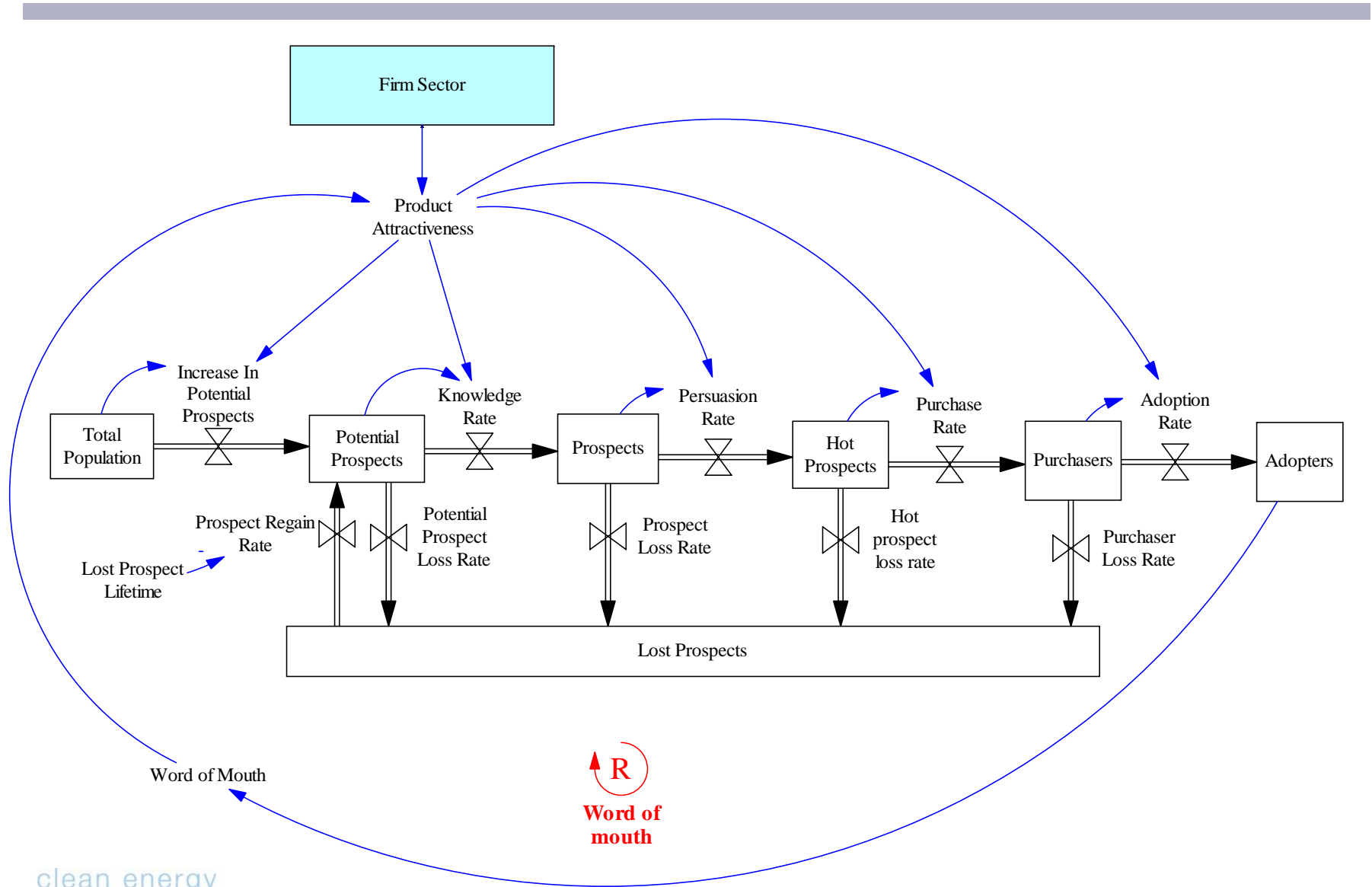
Cash Flow Model Detail



Market: Bass Diffusion Model

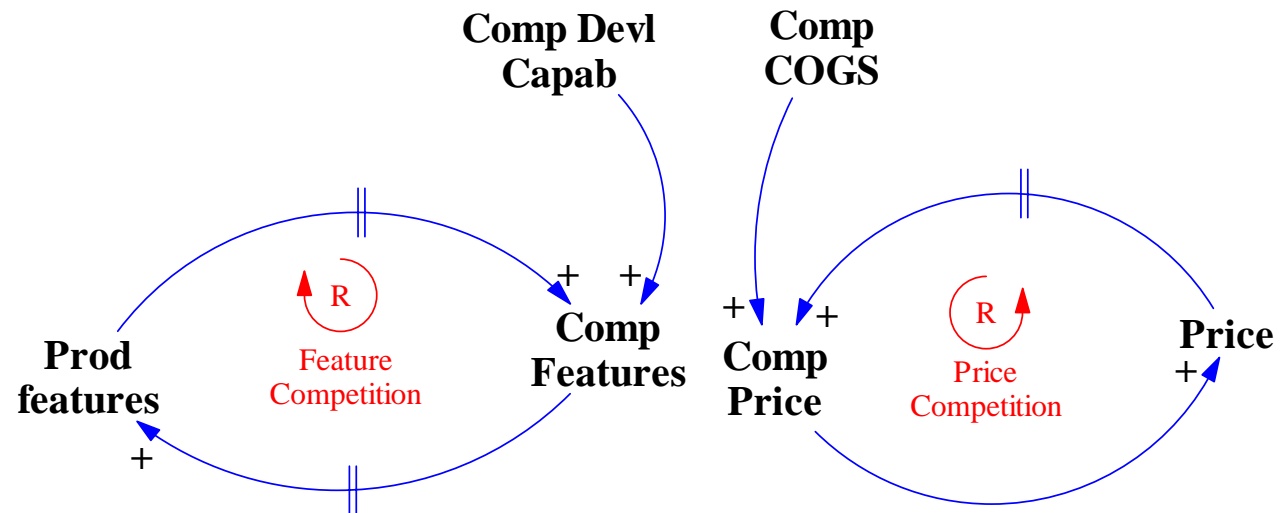


Market



Competition

- “Competitor” represents an aggregate of all competitors to the venture



Extensions to Standard Models

- Market sector for clean energy technologies
 - Data from interviews and case studies
 - “Potential adopter” stock disaggregated
- Product development sector including intellectual property issues
 - Appropriable and non appropriable feature development modeled for venture and aggregate competitor
- Runway
 - Working capital and “burn rate” constrain hiring and generate layoffs
- Effect of government policies on new clean energy ventures
 - Model takes into account effects of three classes of policies
 - Switches to turn policies on or off

Caveat

- The model is **not** meant to be predictive of the performance of any particular venture
- The particular numbers used are arbitrary
 - Though relative performance does have meaning
- The model **is** meant to provide insights into which management strategies and government policies are most effective

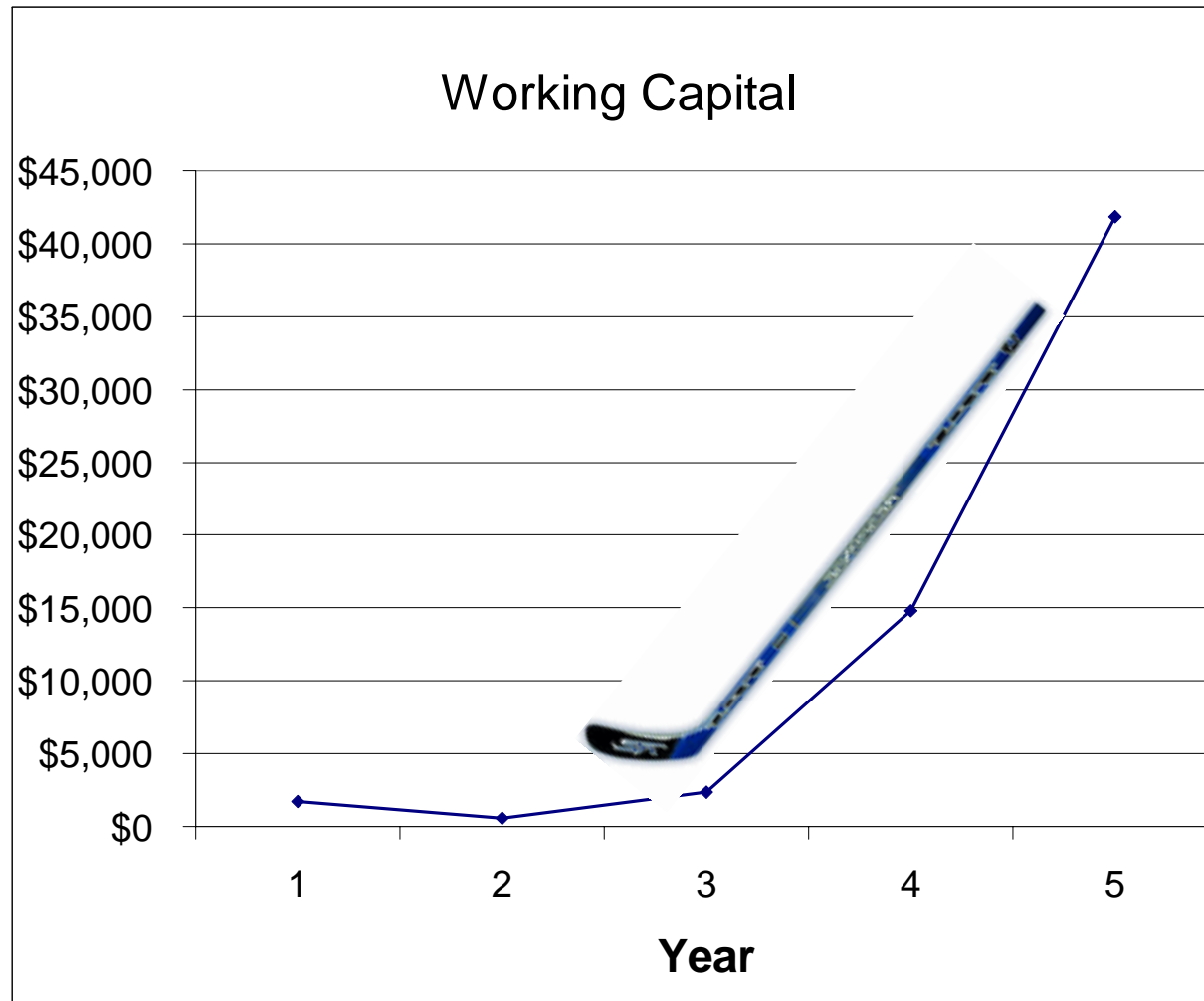
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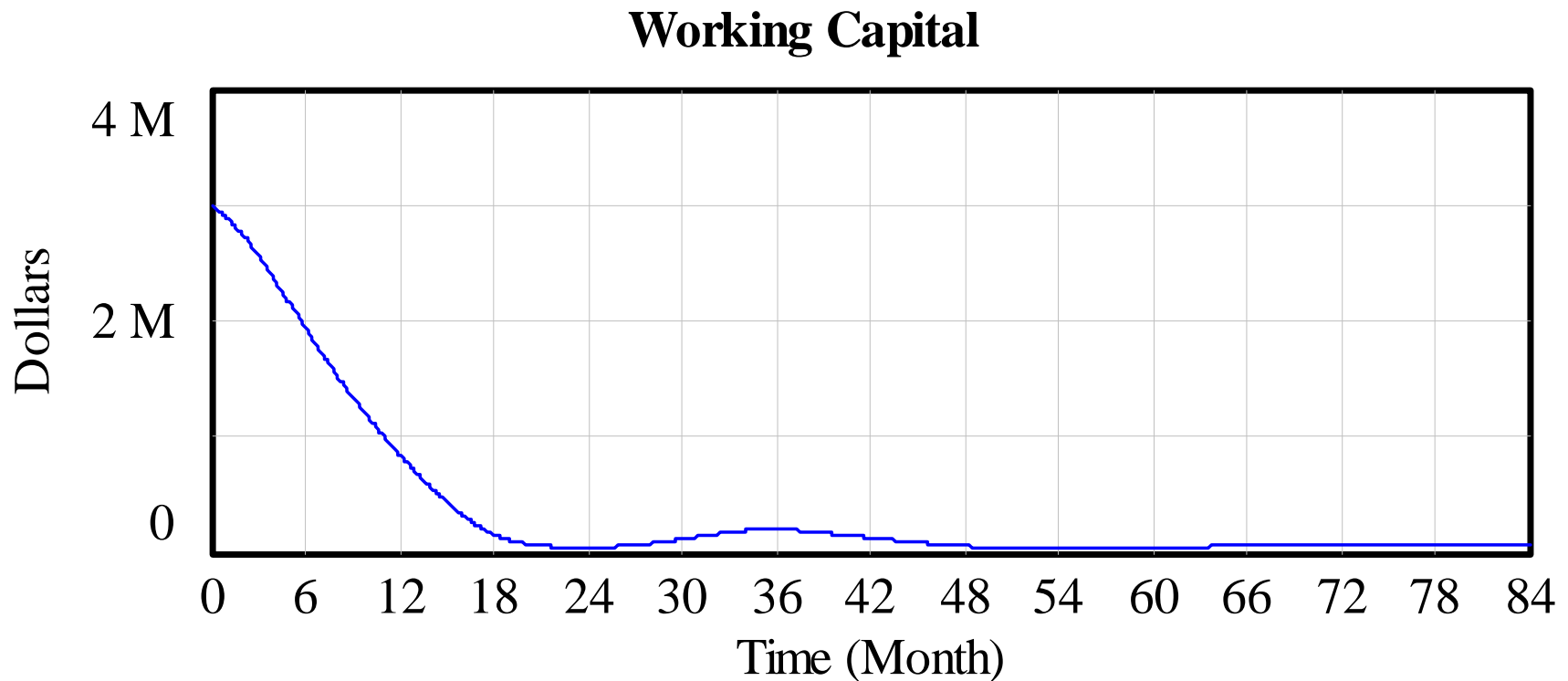
“Base Case” Simulation

- Prototypical clean energy venture poised for success
 - High value product sold to commercial customers and ready for market
 - Features advantage at lower cost
 - Engineers and sales force learn & become more productive over time
 - Management conserves capital wisely
 - Market is accessible and good prospects readily identified

Entrepreneur's Business Plan



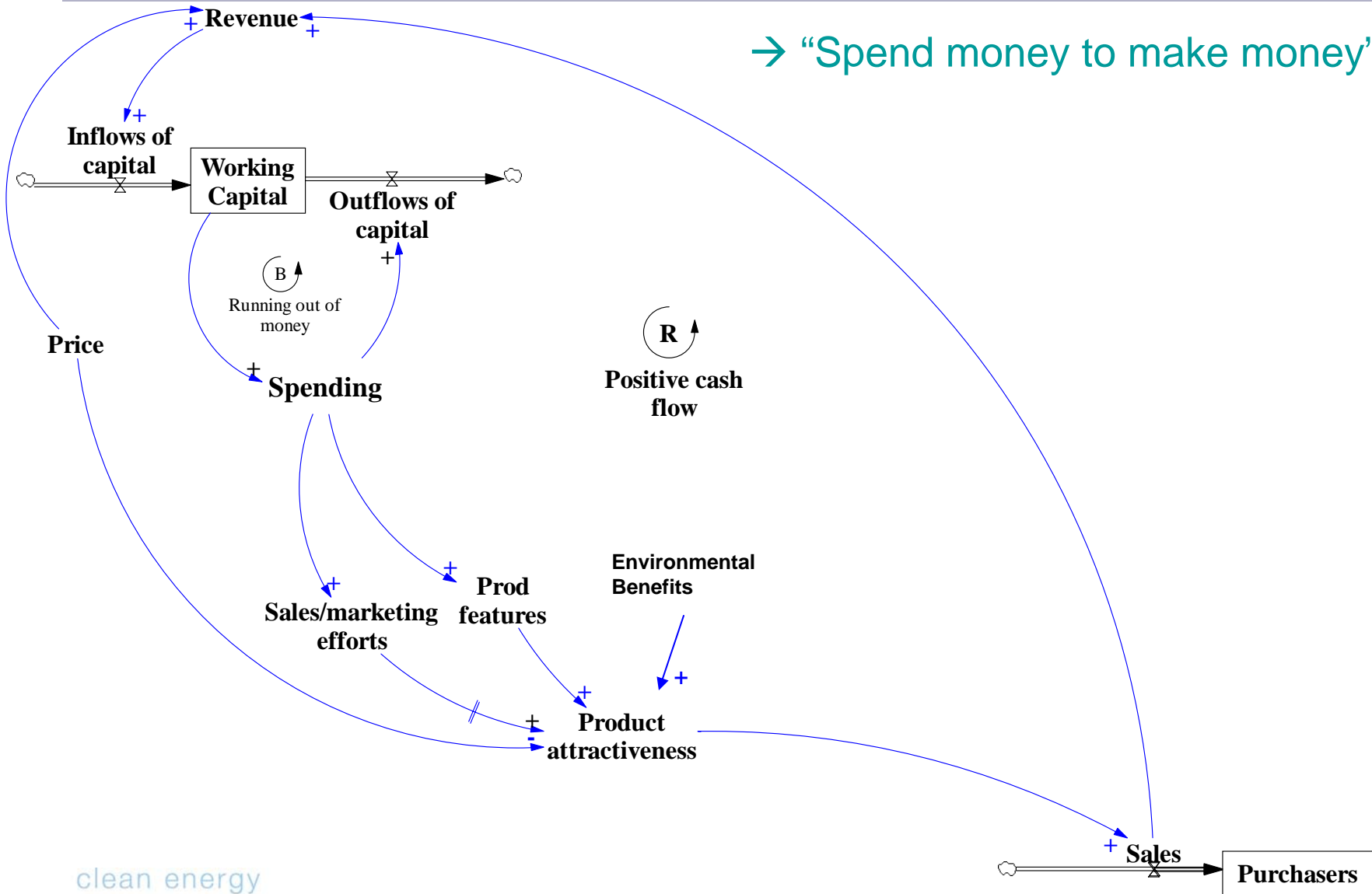
But Gets the “Valley of Death”



Working Capital : `_BaseCase(3M Invest)` 

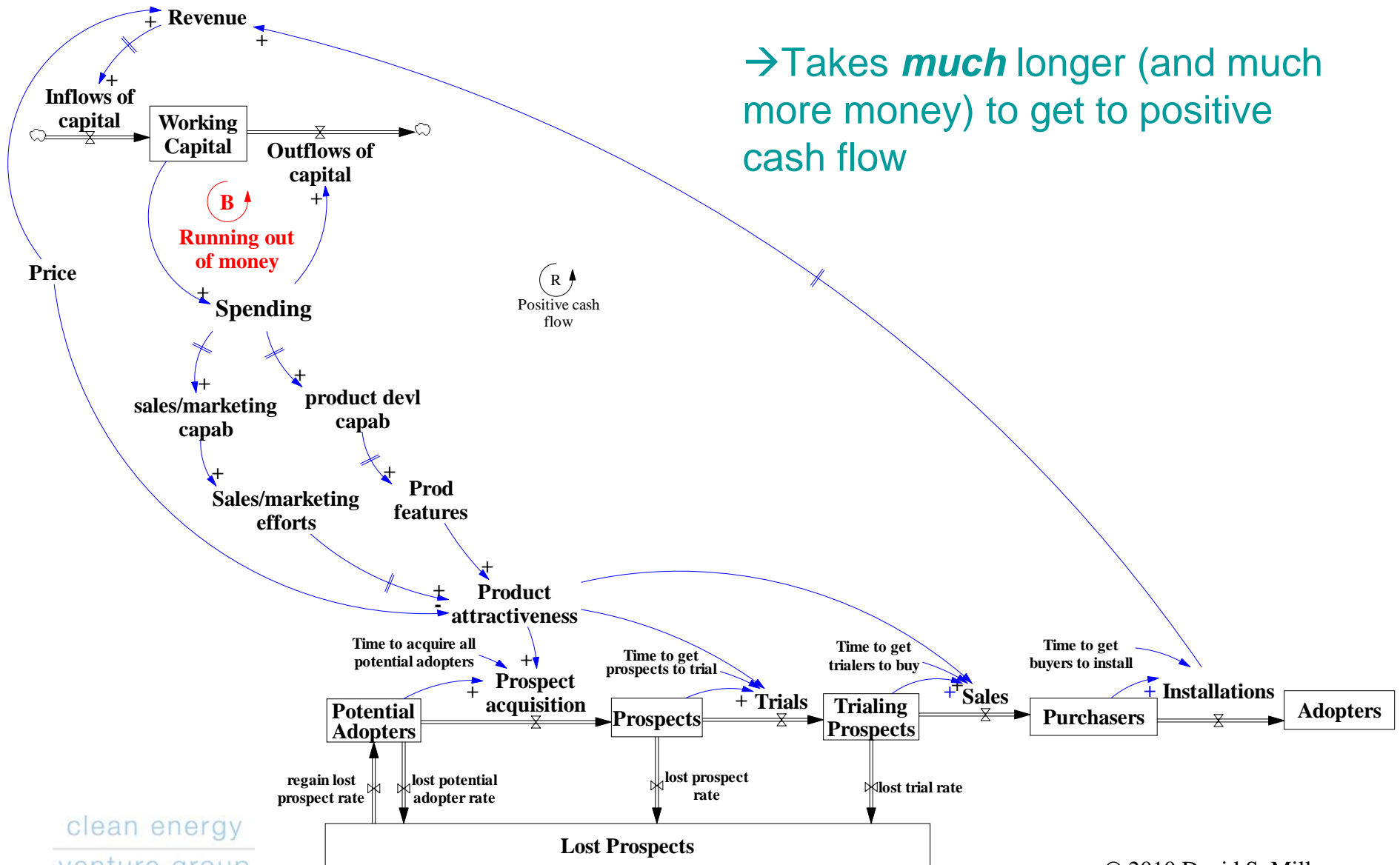
Naïve Perspective of New Venture

→ “Spend money to make money”

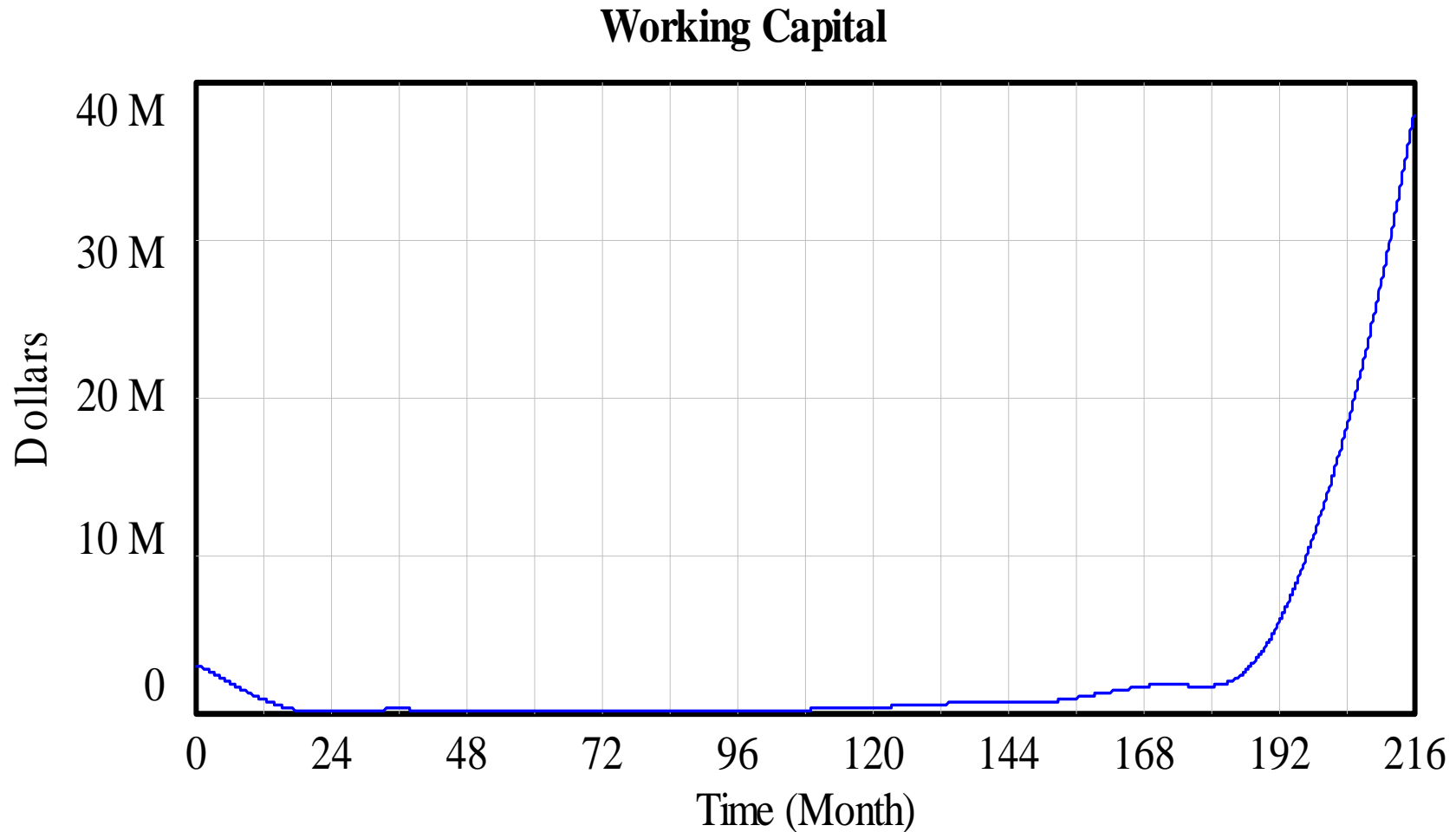


Running out of money loop

→ Takes *much* longer (and much more money) to get to positive cash flow



With Unfailing Patience and Persistence...



Working Capital : _BaseCase(3M Invest)

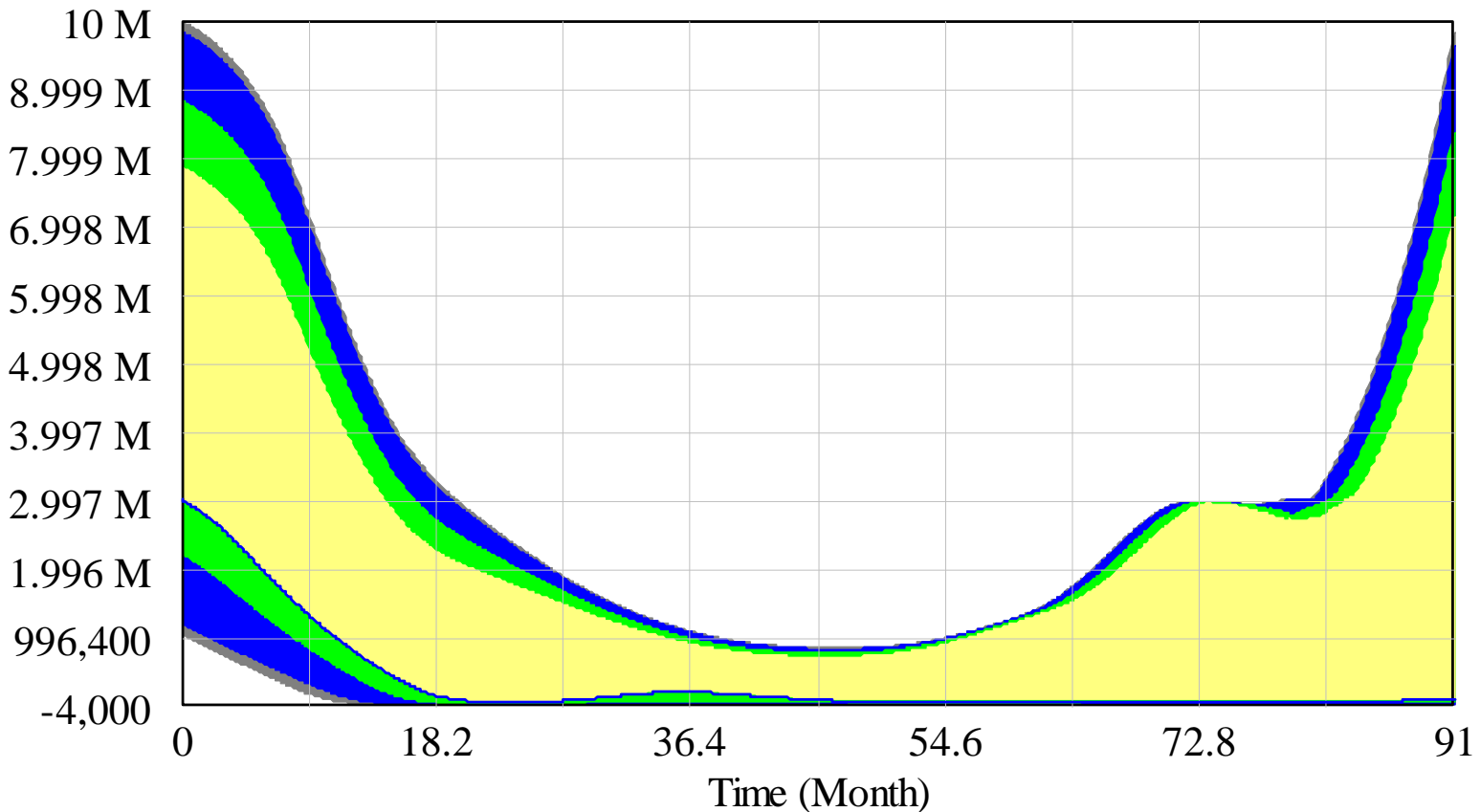
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Sensitivity to Initial Investment

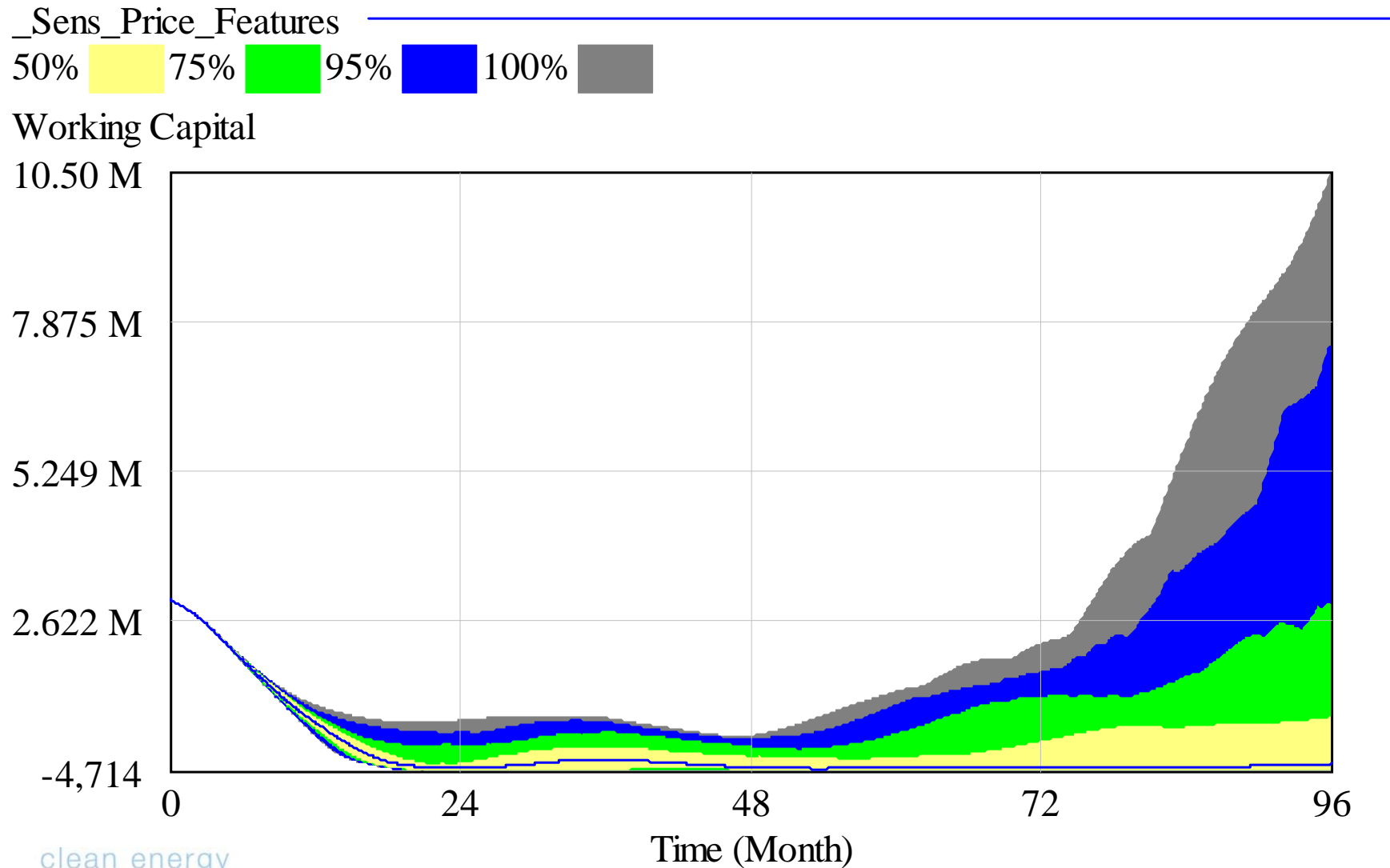
_Sens_Init_Invest



Working Capital



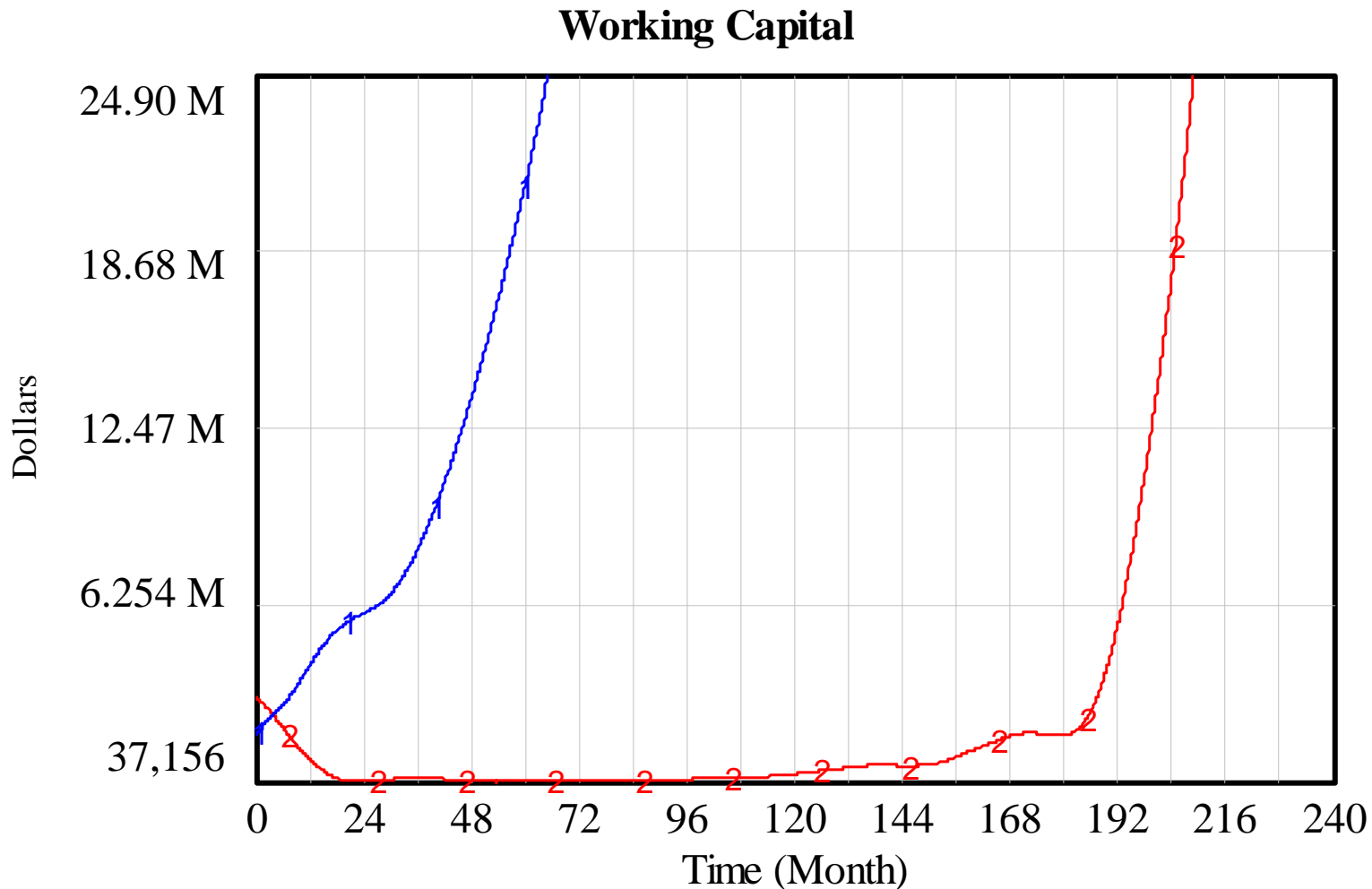
Sensitivity to Initial Price & Features



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How Does Venture Emerge from the Valley?



Working Capital: _Month180_Values_at_Month0 ——— 1 ——— 1 ——— 1 ——— 1 ——— 1 ——— 1

Working Capital: _BaseCase(3M Invest) ——— 2 ——— 2 ——— 2 ——— 2 ——— 2 ——— 2 ——— 2

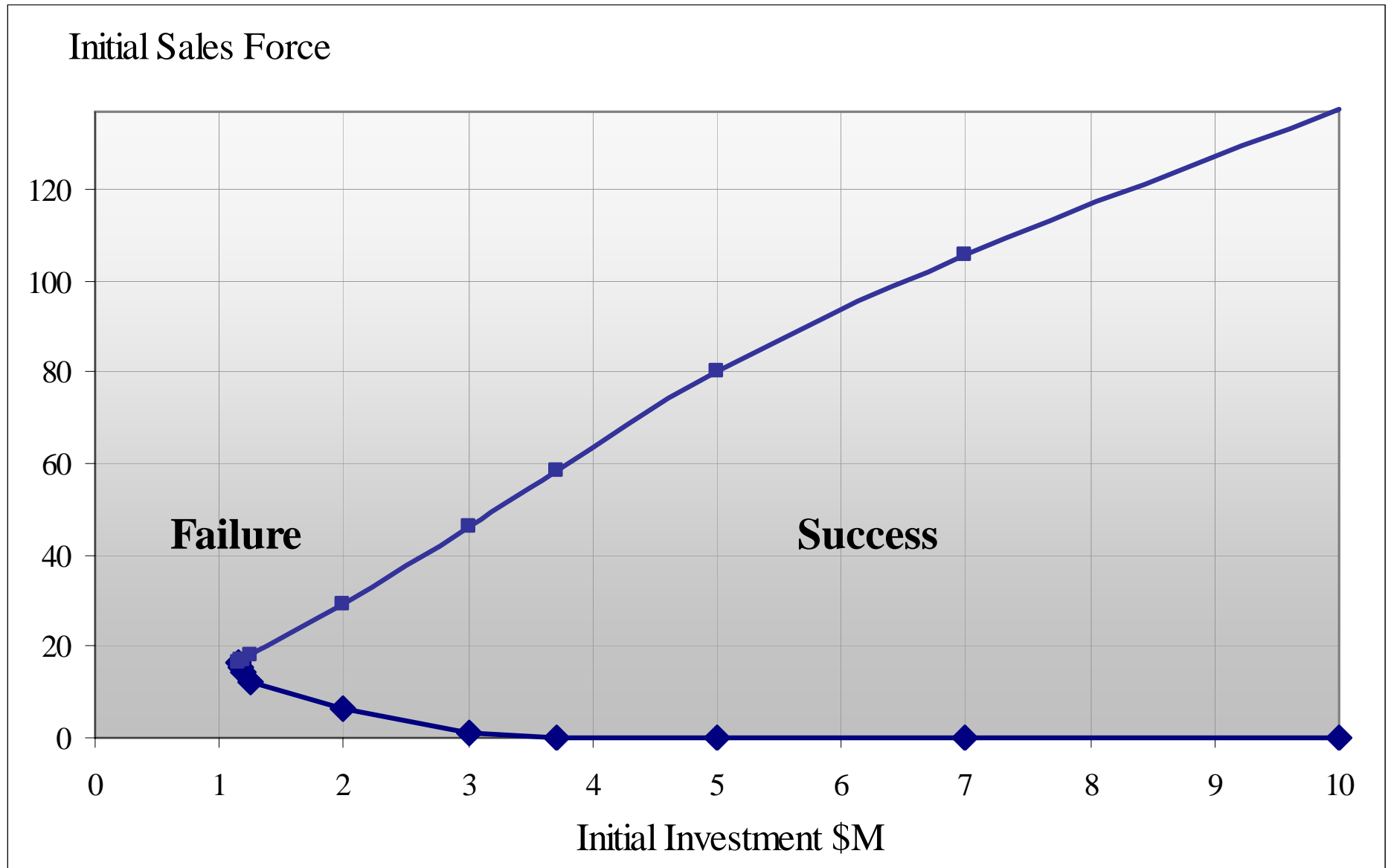
Factors for Success: Emerging from the Valley

- Enough working capital
 - To maintain and augment the work force
- Full pipeline
 - Enough potential prospects, prospects, hot prospects and purchasers
- New firms capable of adopting to feed the pipeline
 - Renewing the stock of potential prospects
- Accounts receivable being paid
 - Not too many “special arrangements”

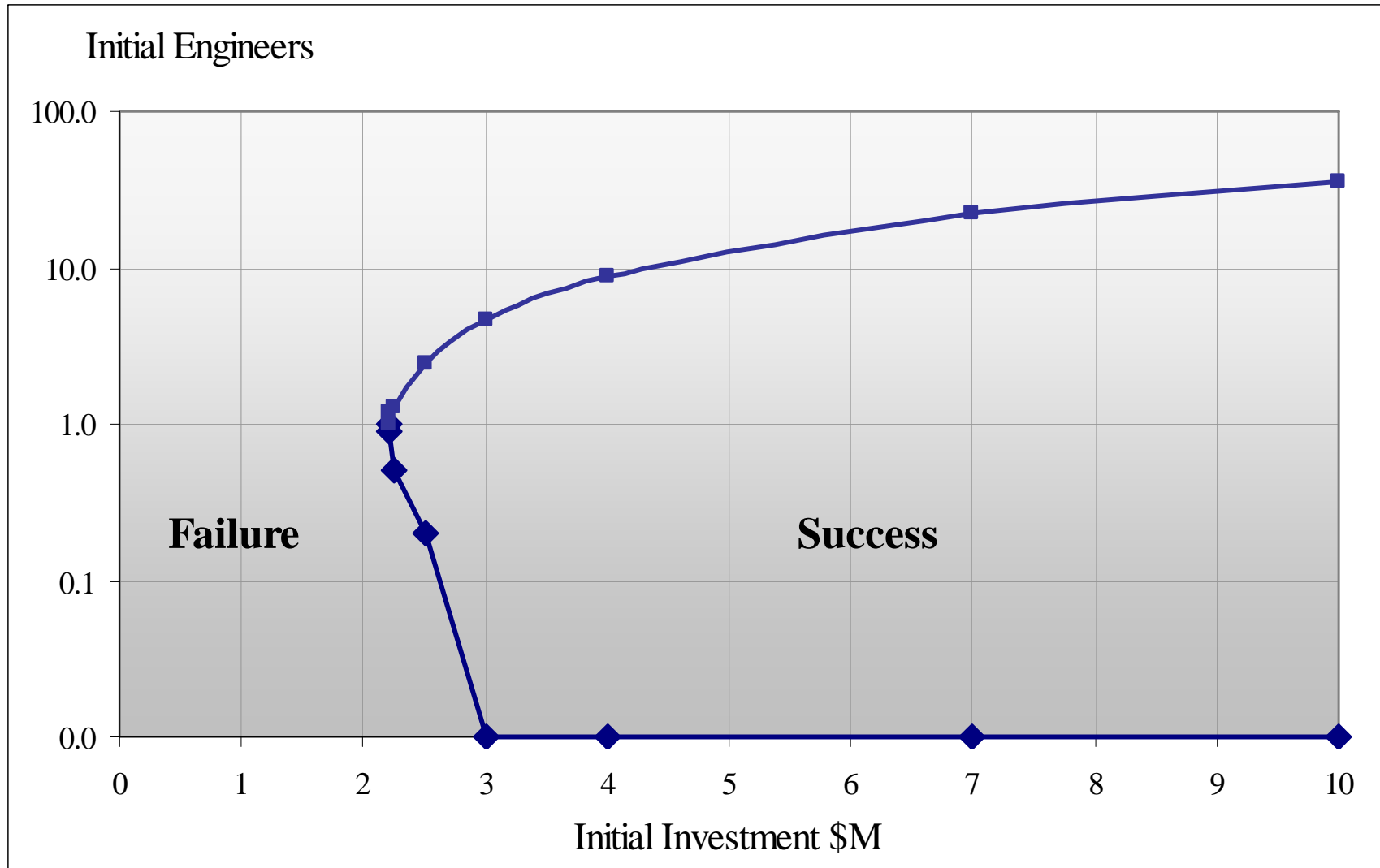
Factors for Success: Emerging from the Valley

- Enough experienced sales people
 - To have good connections with all prospects
- Enough experienced engineers
 - To provide good service and keep features ahead
- Feature advantage
 - Just enough to differentiate the product
- Price advantage
 - Maintain price high enough to augment cash
- Positive word of mouth
 - Crossing the chasm...

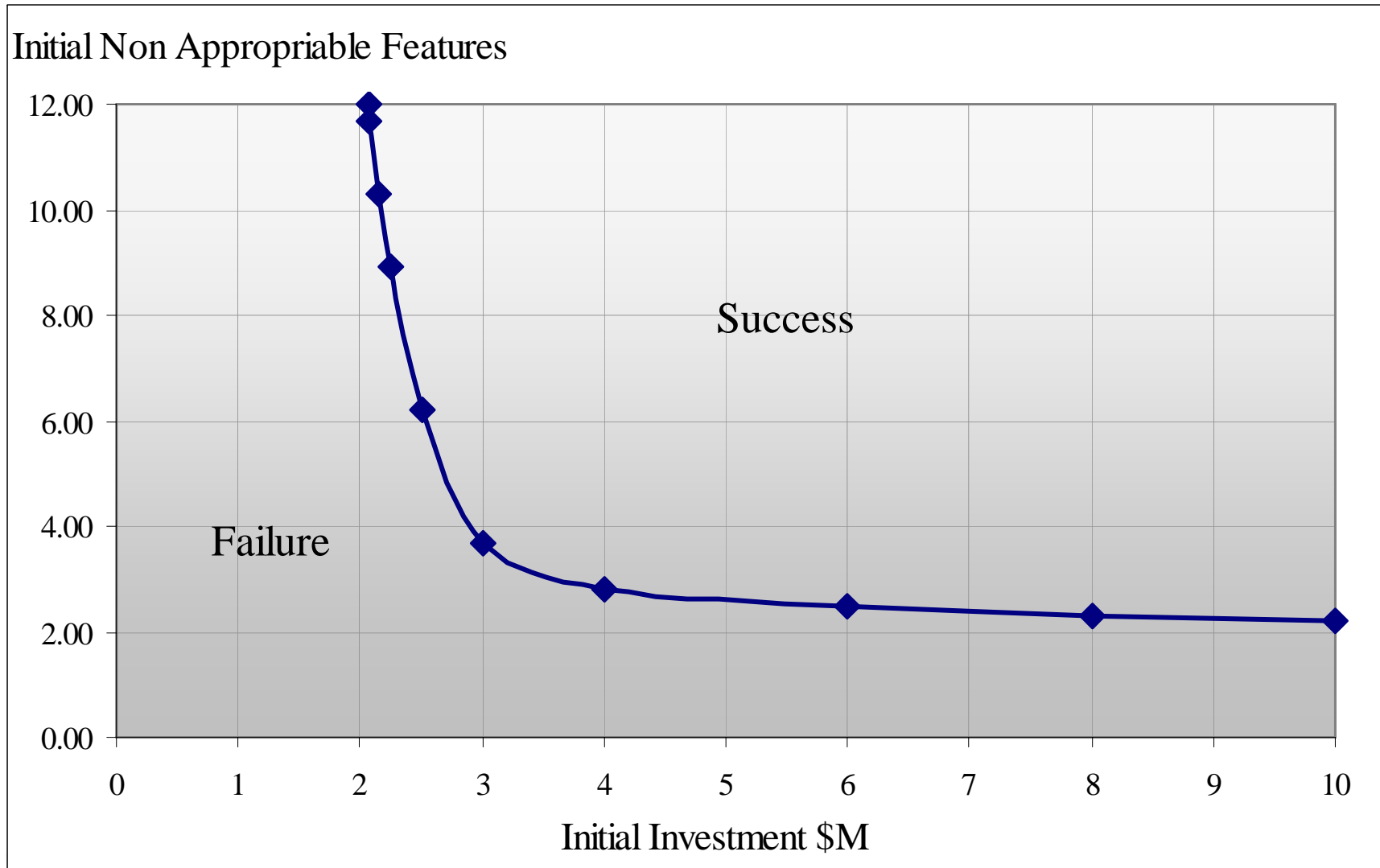
Example: Sensitivity of Success to Size of Sales Force



Initial Engineers



Initial Non Appropriable Features



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- **Strategies & policies to increase the odds of success**

Key Factors for Success

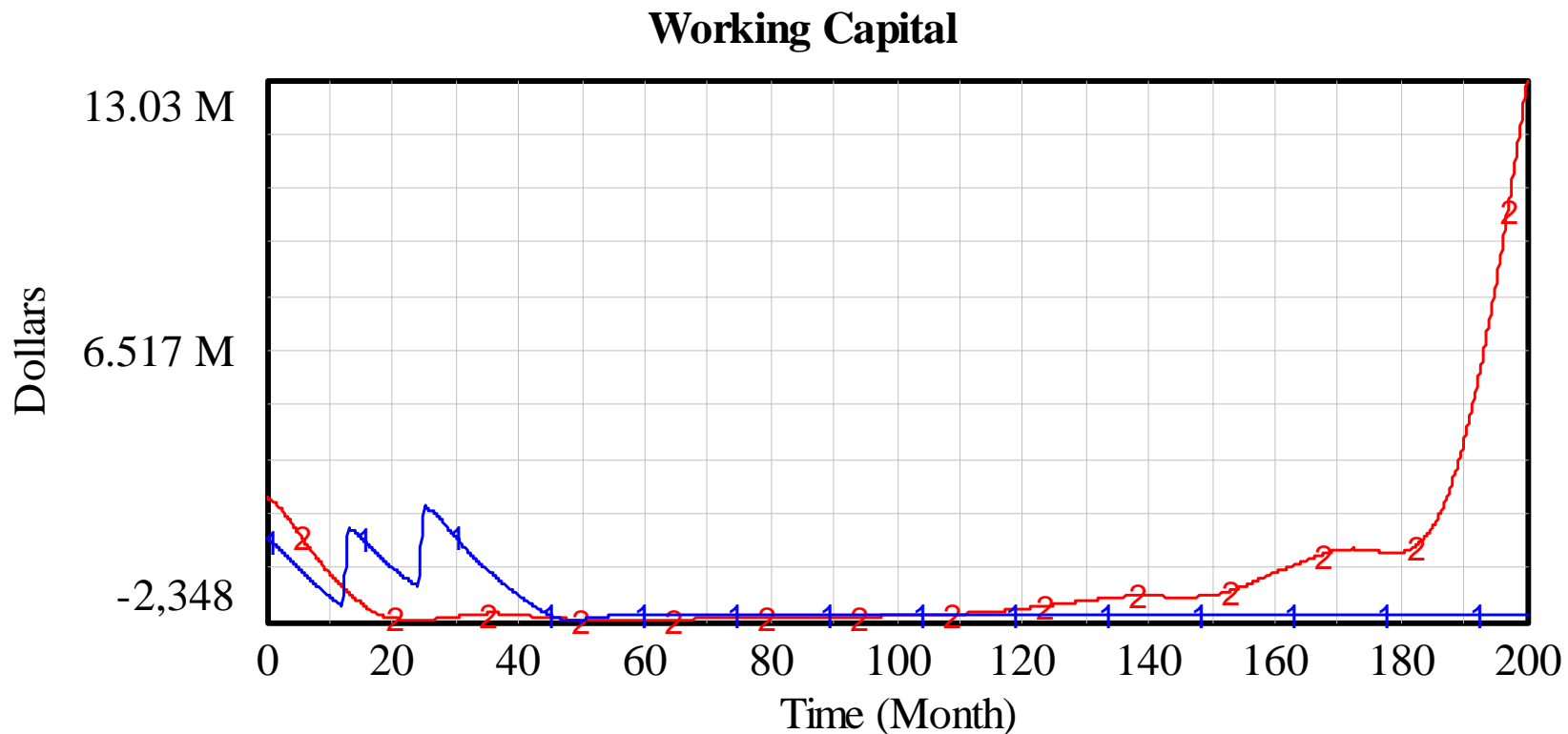
- Well known factors
 - Right Management Team
 - Greater experience leads to greater success
 - Right Market
 - Sales and marketing effectiveness
 - Sustainable Competitive Advantage
 - Non appropriable features and word of mouth
- What new insights does model provide us?

Capital Investments Question

- Better to receive \$3M once or \$2M annually for three years?
 - Even with a 20% discount rate, the staged investments have a much higher NPV
 - Better for entrepreneur to not sell too much equity initially
 - Better for investor to mitigate risk by staging investments

Strategies to Accelerate Adoption

- Higher initial investment may have much greater value than stream of future investments



Working Capital : _2M Invest_3 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1

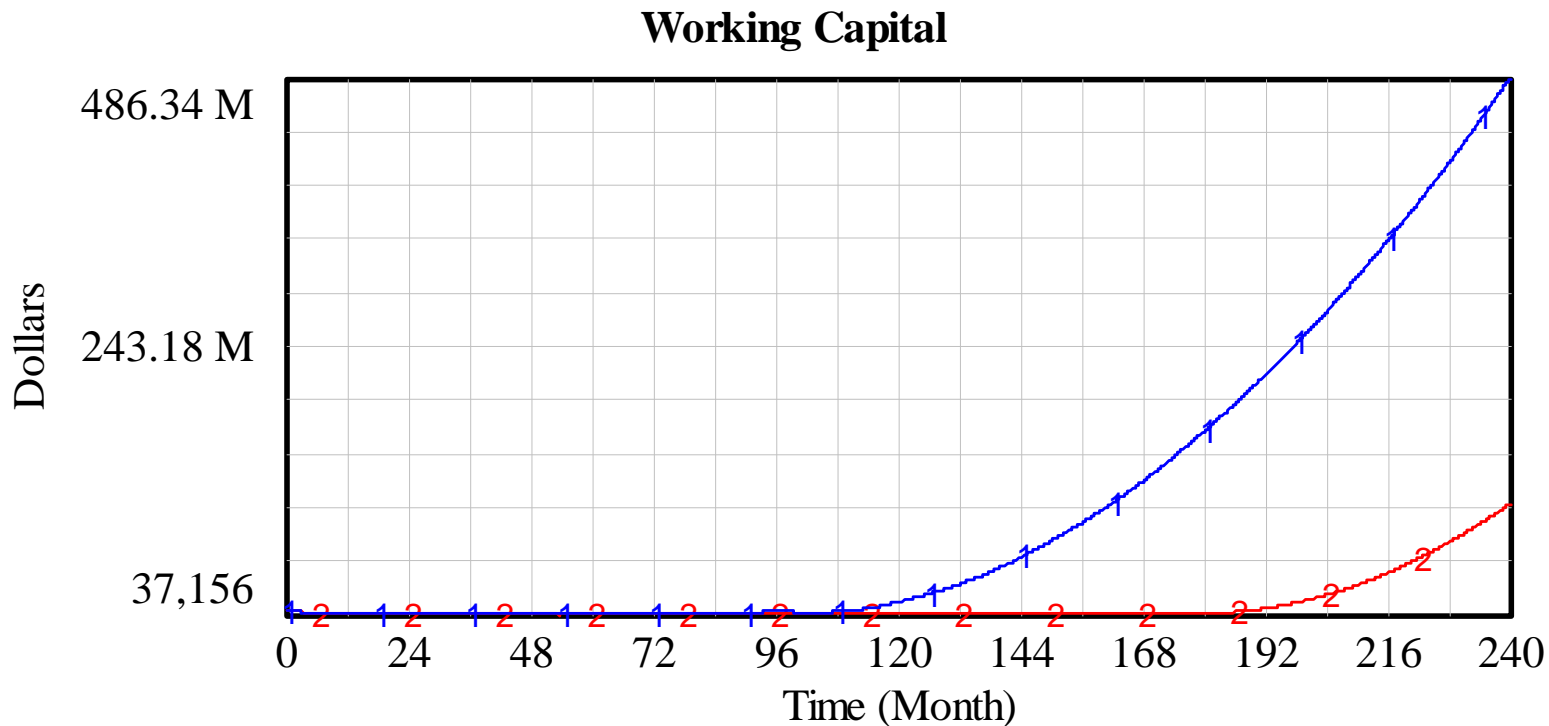
Working Capital : _BaseCase(3M Invest) — 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2

Labor Force Question

- For a new technology venture, better to have more engineering or sales oriented founders?
 - Common ratio for technology ventures is at least 2 to 1 between engineering and sales
 - Engineers usually developed the technology and needed for maintenance and support

Strategies to Accelerate Adoption

- Sales people are initially much more valuable than engineers



Working Capital : _4Sales2Engineers



Working Capital : _4Engineers2Sales



Feature Development Question

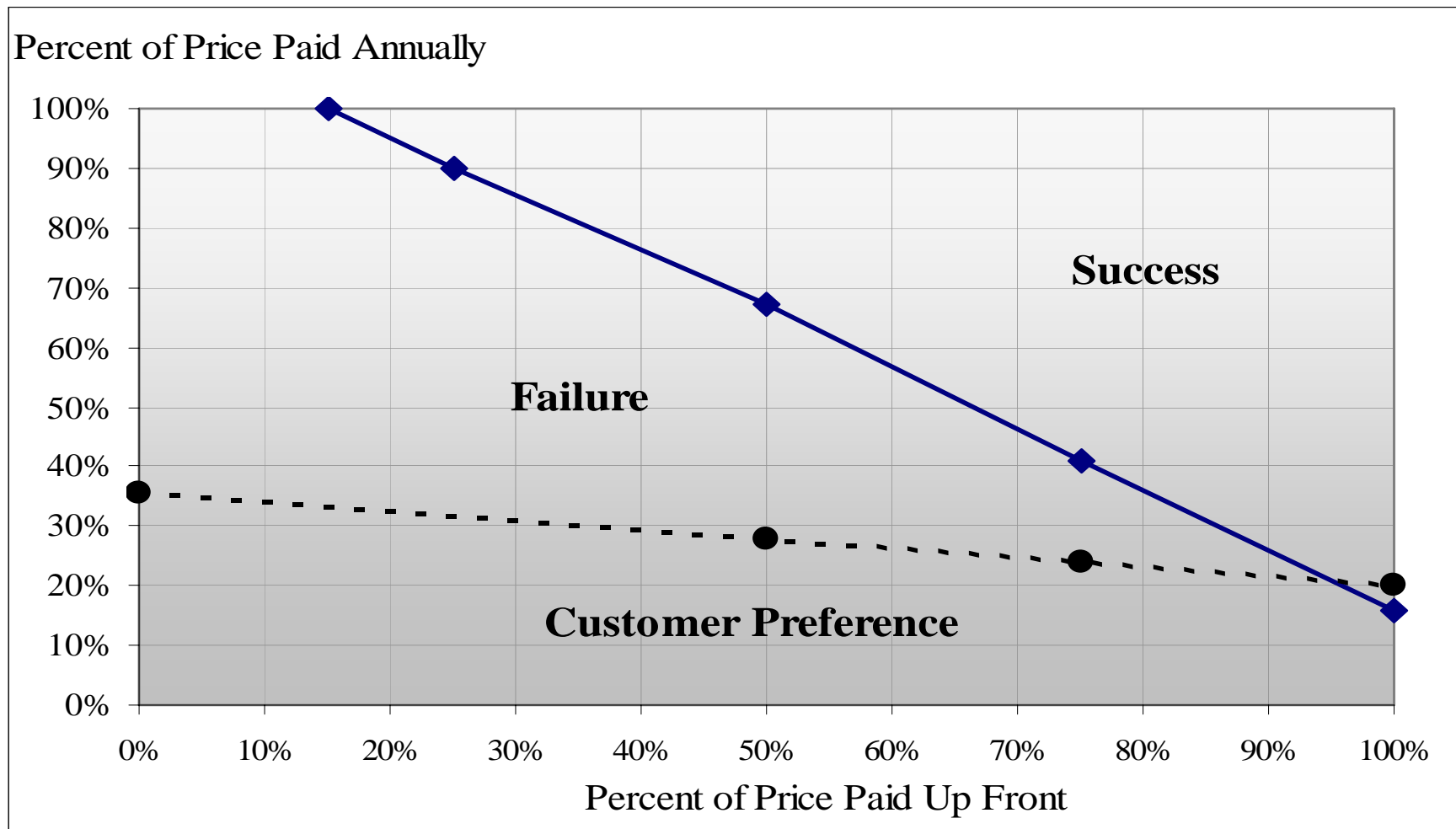
- *How much better than the competition should the venture strive for its products to be?*
 - Better features lead to more sales
 - Default goal is to be 25% more attractive
 - Would 50% be better?

Recurring Revenue Question

- *Should the venture prefer up front payments or recurring revenue?*
 - Default is for customer to pay purchase price up front plus a 20% annual maintenance charge
 - 50% annual charge would have payback of ~3 years and yield significant additional revenue

Strategies to Accelerate Adoption

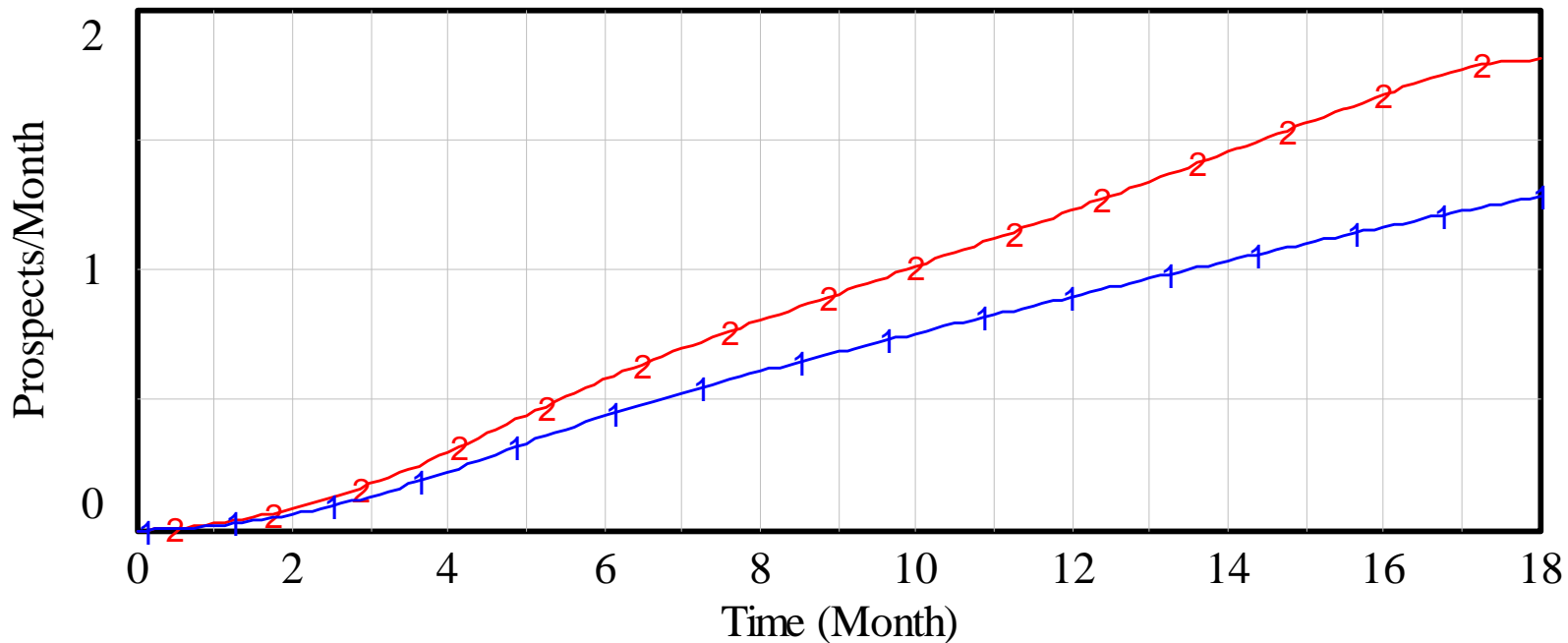
- Up front payments much more valuable



Pricing Question

- *What percent of the competition's price should the venture charge?*

Purchase Rate

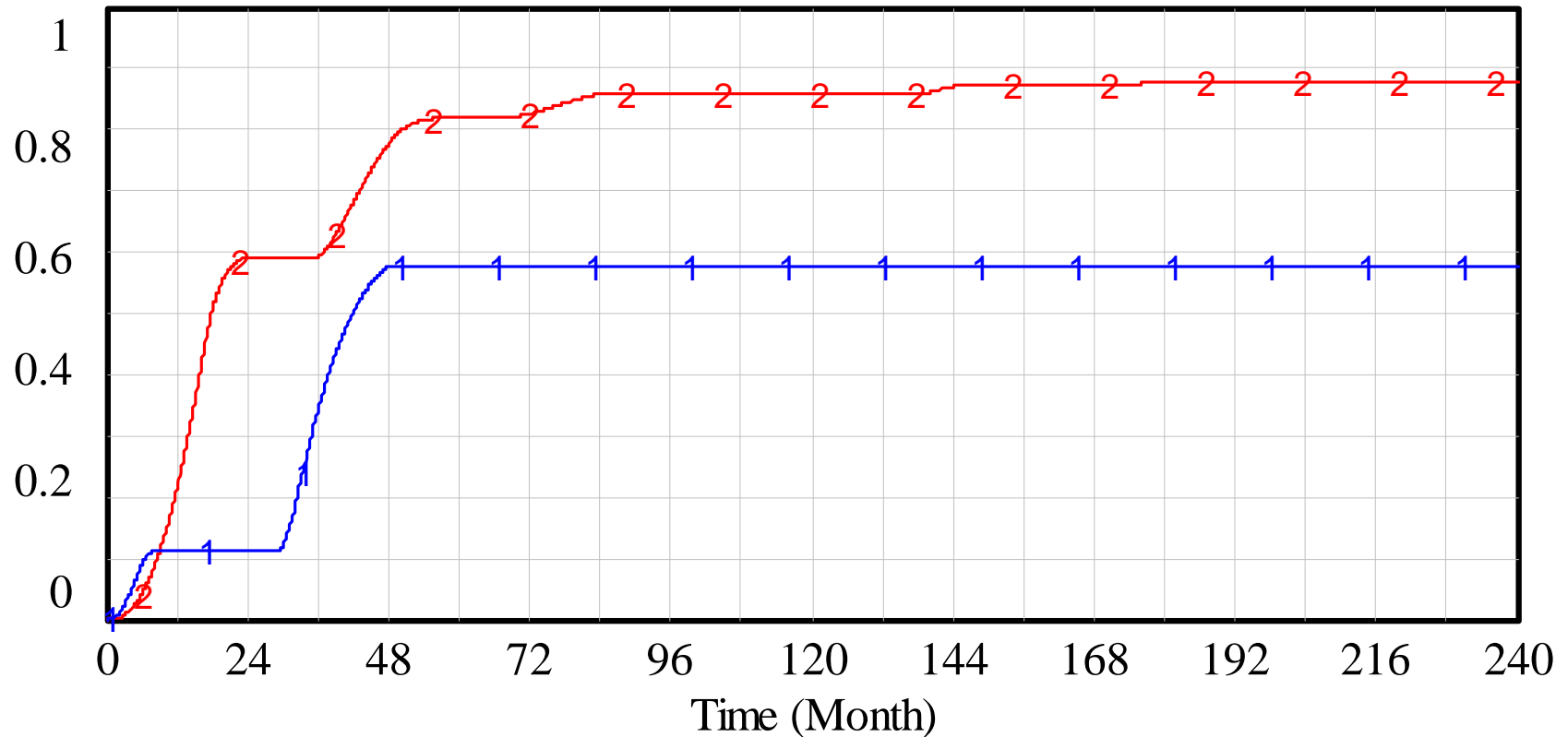


Purchase Rate : _SamePrice — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1 — 1

Purchase Rate : _BaseCase(3M Invest) 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2 — 2

But still has >50% chance of failure

Cum Prob of Failure Based on Hazard Rate



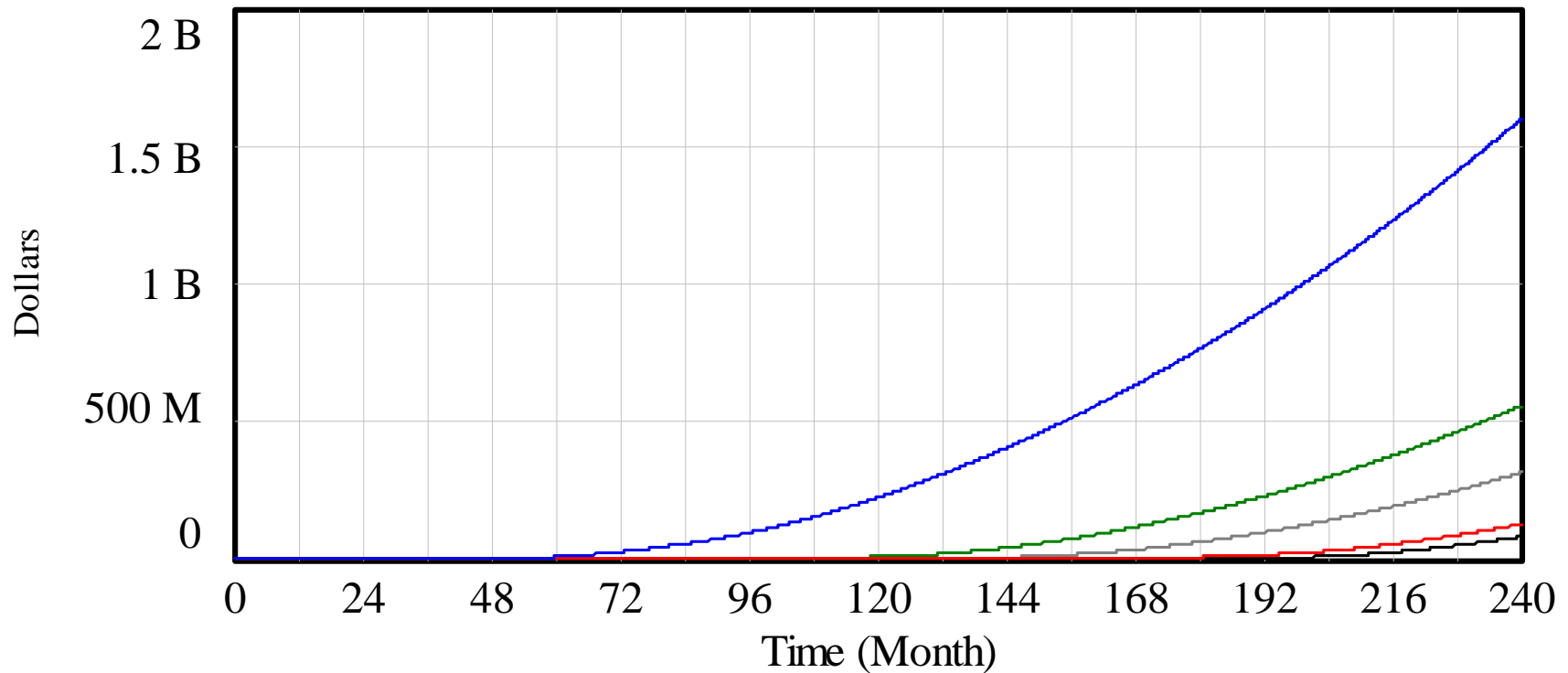
Cum Prob of Failure Based on Hazard Rate : _MgtPolicies — 1 — 1 — 1 — 1 — 1 — 1 — 1 —
Cum Prob of Failure Based on Hazard Rate : _BaseCase(3M Invest) — 2 — 2 — 2 — 2 — 2 — 2 — 2 —

Clean Energy Policies

- Carbon Policy
 - Carbon tax or cap and trade system
 - Increases cost of fossil-fuel based competition
- Subsidy Policy
 - Subsidizes clean energy R&D costs, e.g. DOE SBIR
 - Lowers cost of production
- Increasing Adoption Capability
 - Removing barriers and adding incentives for adoption
 - Increases rate of new potential prospects to feed pipeline

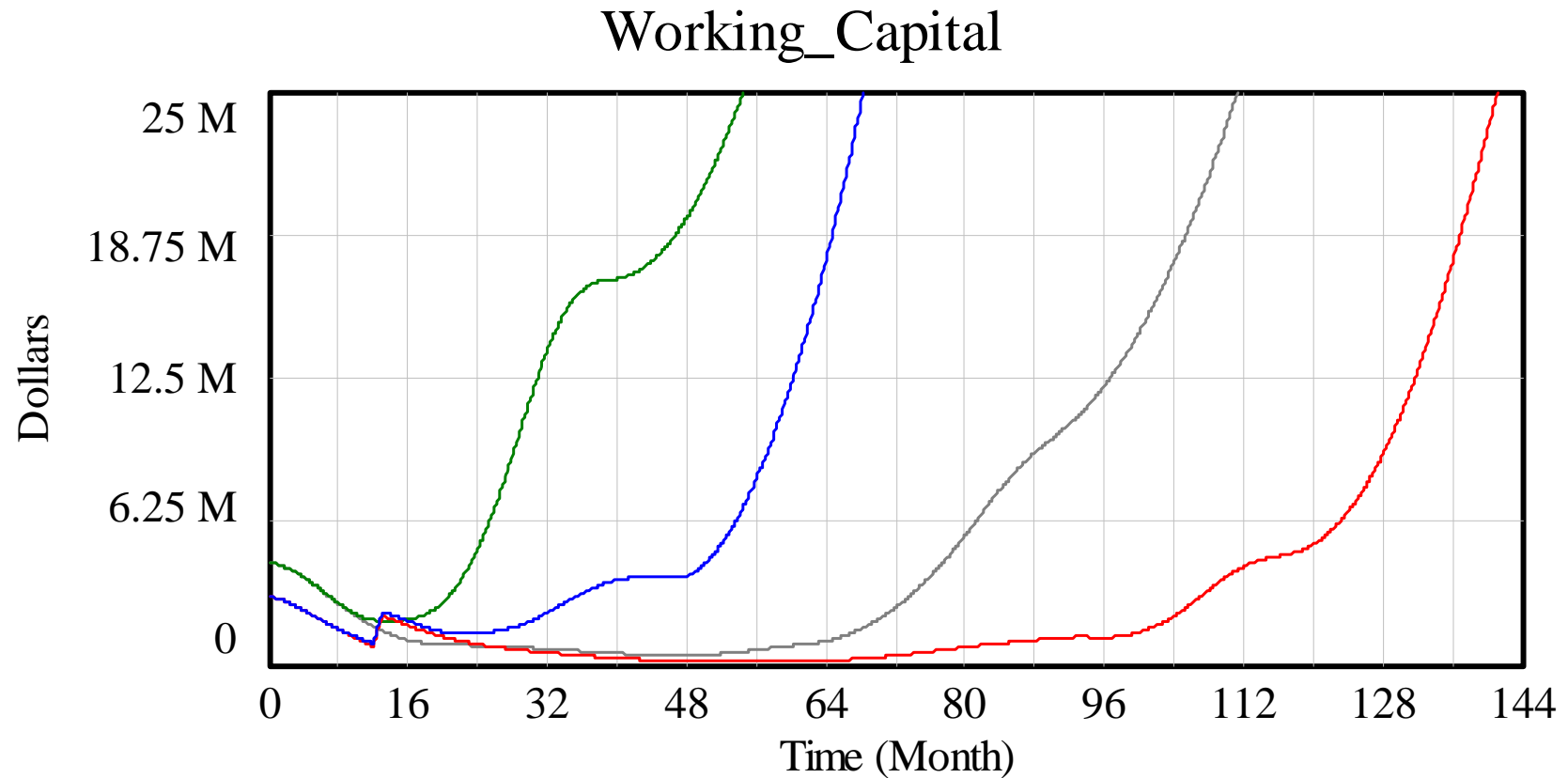
Policy Results

Working Capital



- Working Capital : AllPolicies
- Working Capital : IncreaseAdoptionCapab20
- Working Capital : CarbonCost20
- Working Capital : Subsidy-20
- Working Capital : BaseCase

Combining strategies and policies



Working Capital : AllPolicies —————

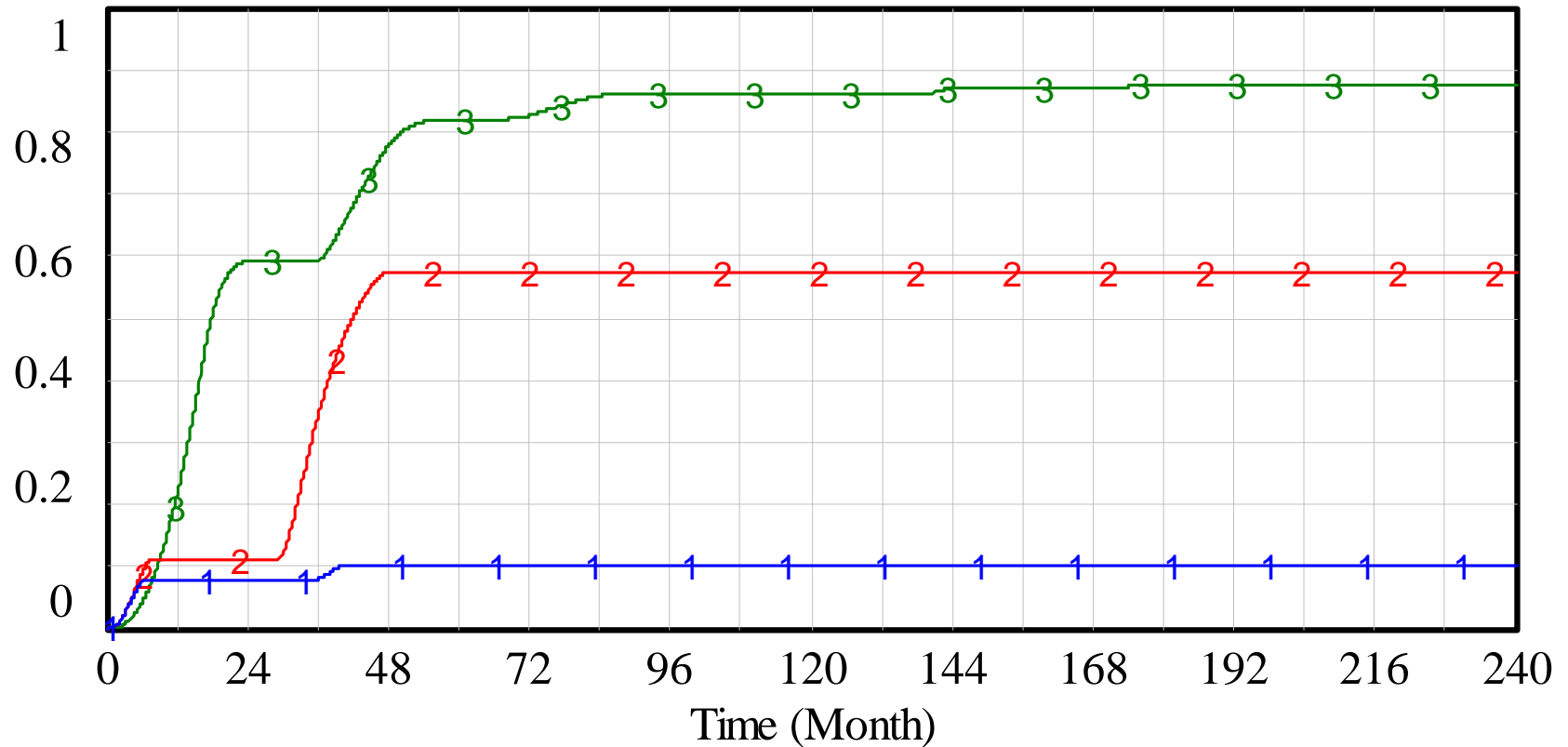
Working Capital : Base3+1_5 —————

Working Capital : Strategies&Policies —————

Working Capital : Strategies —————

Results of Implementing Strategies with Policies

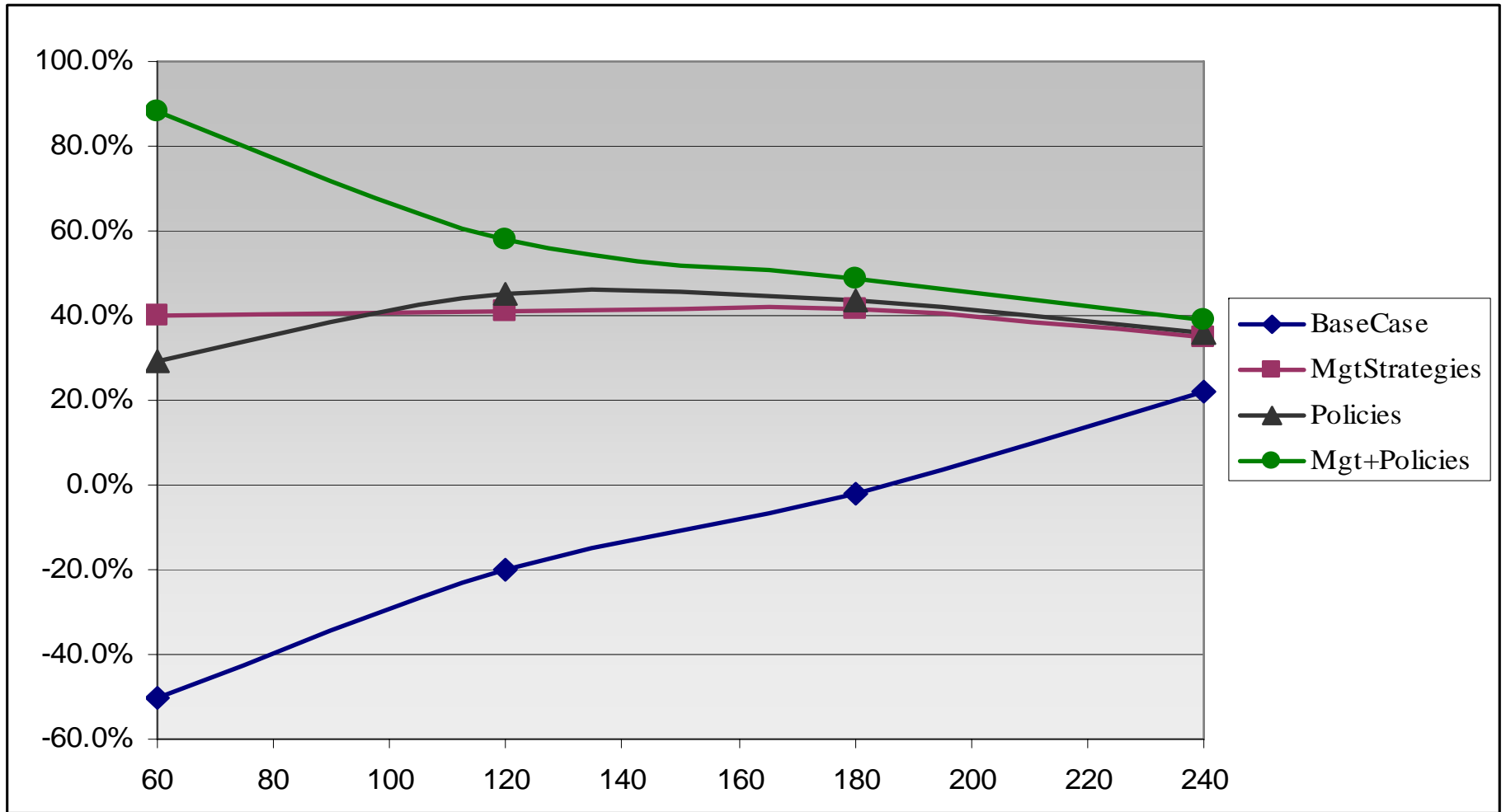
Cum Prob of Failure Based on Hazard Rate



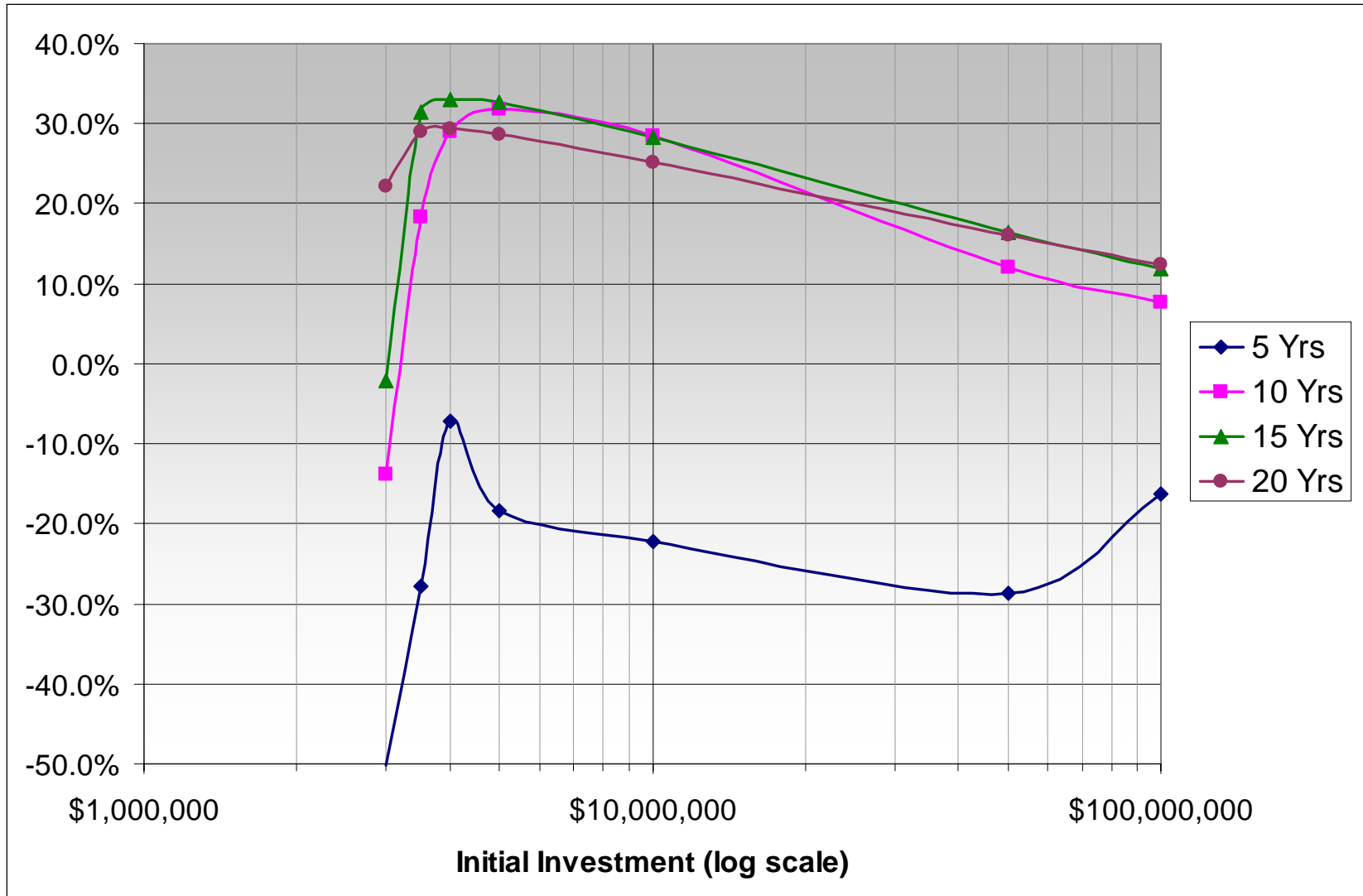
Cum Prob of Failure Based on Hazard Rate : `_MgtPolicies+GovtPolicies` — 1 — 1 — 1 — 1 —
 Cum Prob of Failure Based on Hazard Rate : `_MgtPolicies` — 2 — 2 — 2 — 2 — 2 — 2 — 2 —
 Cum Prob of Failure Based on Hazard Rate : `_BaseCase(3M Invest)` — 3 — 3 — 3 — 3 —

Results of implementing strategies and policies

Investment Returns



Investment Returns by Month



Conclusions

- Valley of Death cannot be eliminated, but can be drastically reduced
 - From fifteen years to five years to one year
 - Policies leads to faster rapid adoption
- A combination of effective policies and the proposed management strategies is best
 - Reduce probability of failure from ~90% to ~10%
- We do not need to come up with new policies or technologies to increase adoption
 - Just effectively use what we have

MIT Cleantech Management Flight Simulator

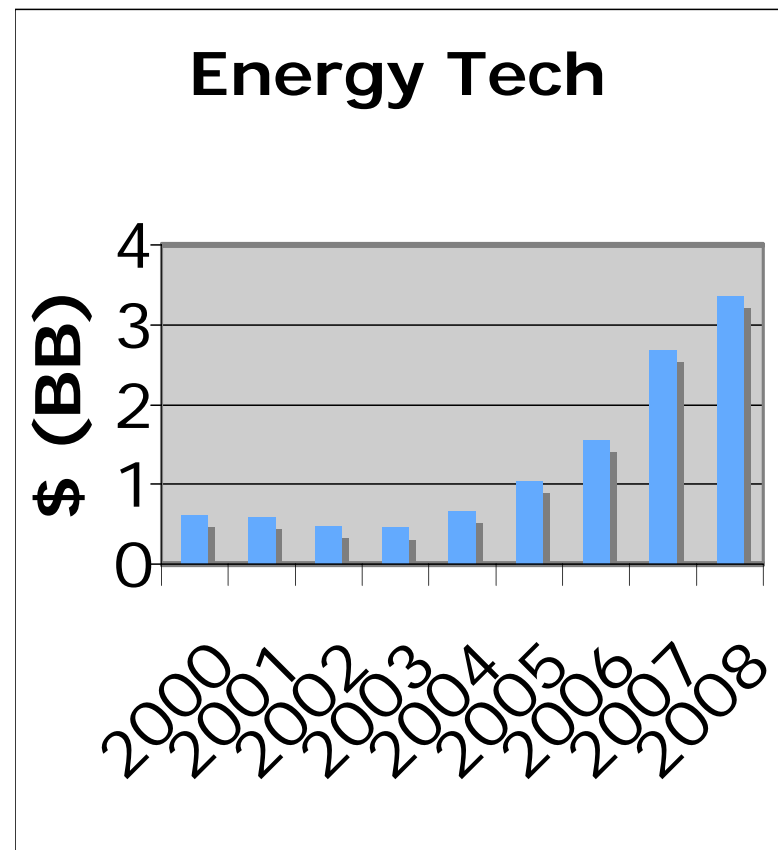
- Run model in accelerated time
- Make key management and investment decisions
- Get to try again until you get it right...
- joehsueh@mit.edu

CEVG investment criteria

- Clean energy – the company's product reduces pollution (e.g. carbon) resulting from the production or use of energy.
- Sustainable Competitive Advantage – the offering differs significantly from alternatives, has the potential to dominate a specific market and has meaningful barriers to entry.
- Market size – the target market is large, and it is reasonable to expect significant revenue.
- Management team – the team currently, or with help, possesses the experience and capabilities to successfully execute the business plan.
- Exit – there are realistic exit options to achieve our investment return.
- CEVG value – the company will benefit significantly from the value of CEVG's expertise, network and advice.

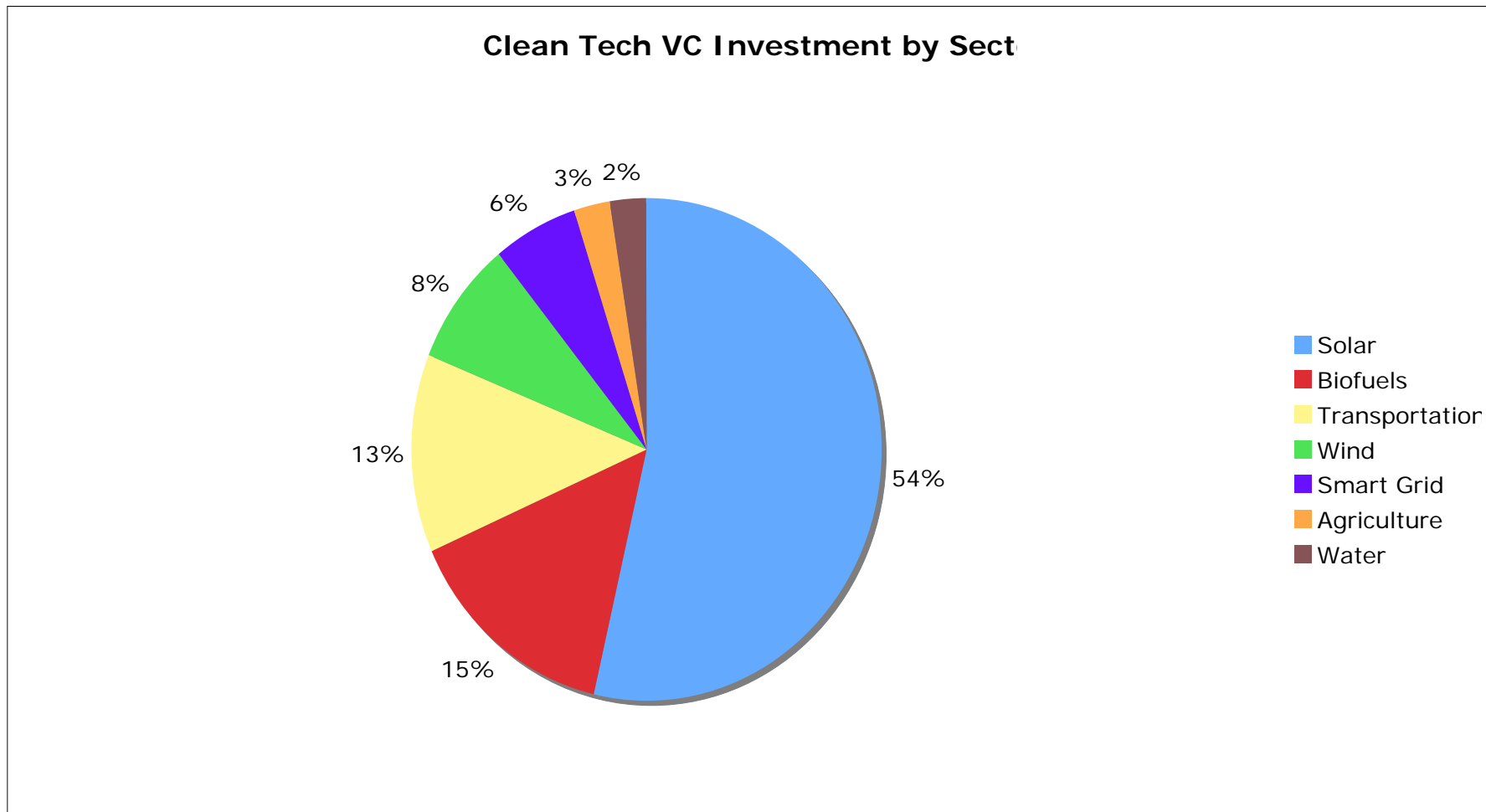
Clean tech has been garnering it's fair share of risk capital

- Clean Tech totaled over \$3 BB in 2008
- Grew 22% between '07 and '08
- Largest deals are in solar and biofuels
- Total investment was over \$150 BB in 2008



Source: CleanEdge

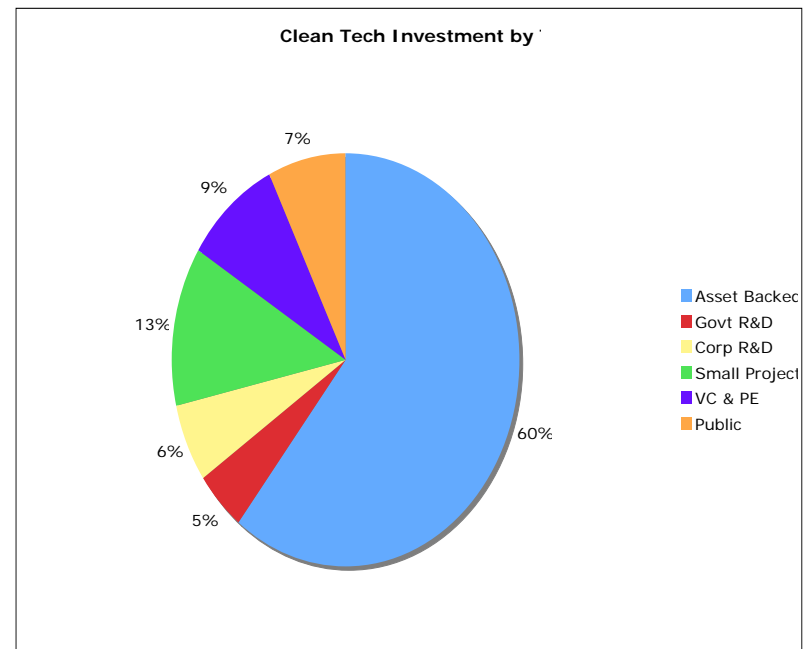
Solar and biofuels dominate the investment landscape



Source: Cleantech Group
[clean energy](#)
[venture group](#)

Moreover, risk capital only represents a fraction of Clean Tech investment.

- CT is central to govt. stimulus packages
- 5% growth from '07 to '08
- Public markets fell by 50%
- Sector as a whole was somewhat buffered from financial ice storm



Source: CleanEdge

A few thoughts on trends

- **It is early in the cleantech game, and the field will broaden.**
 - 45% of public market cap is wind
 - 40% is solar
 - Majority is small cap
- **Capital is adjusting to new time frames.**
 - 2-3 year liquidity is unlikely in the vast majority of clean tech deals
 - 7-10 year deals -- and associated capital needs are far more likely
 - Size of the prize is enormous
- **The role of disruptive technologies will evolve.**
 - Energy infrastructure changes gradually
 - Breakthroughs in generation and storage technologies will depend on infrastructure to succeed

A few thoughts on trends (cont'd)

- **Cleantech will grow, but profits will be challenging.**
 - Long time frames to adoption
 - Capital issues
 - Need for policy clarity
- **Business models will be important.**
 - Many competing technologies in each area of clean tech
 - Strategy and execution will determine winners as much -- or more -- than technical elegance
 - Capital efficiency is key to retaining investment interest
- **Government policy is a necessary evil.**
 - Subsidies
 - Clear and level playing field
 - Permitting and regulation
 - All energy is a regulated market!
 - Beware 2d and 3rd order effects

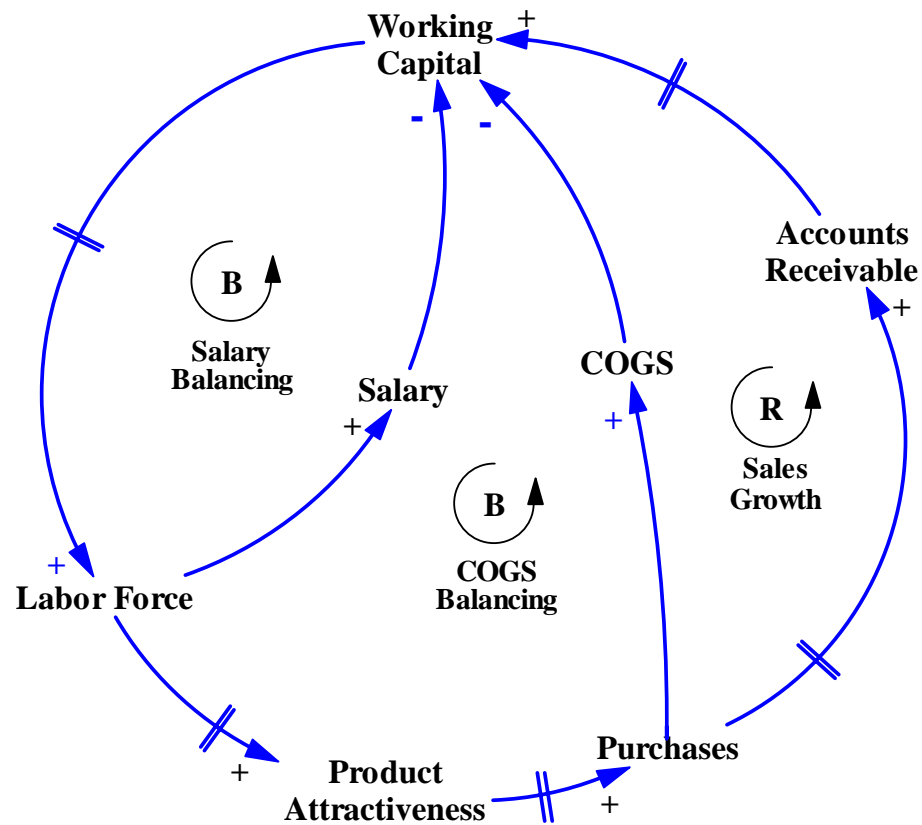
Looking ahead - Opportunities

- Energy efficiency
 - Commercial buildings
 - Residential
 - Application of intelligence to the efficiency problem
- Storage
 - Virtually all renewables are periodic
 - Storage is expensive and inefficient
 - Opportunity for disruptive technology
- The “Smart Grid”
- Financing the Capital Gap

Looking ahead - Opportunities (cont'd)

- Earlier stage renewables
 - Current, tidal and wave energy
 - Geothermal
- Water
- System integration
 - Small scale solar

Oscillatory Growth Loops



Limits to Exponential Growth

- More customers than the firm is able to service
 - Leading to loss of customers and a poor reputation
- Hiring and training enough well qualified employees
 - Lowering the productivity of the firm;
- Inspiring competition to poach experienced employees
 - Increasing the cost of labor (to reduce poaching) and enabling competitors to catch up more quickly;
- Inspiring new competitors to enter the market
 - Leading to pressure to reduce prices
- Saturating one or more segments of the market
 - For example, early adopters

Motivation

- Clean energy technologies are not as widely adopted:
 - as would optimally benefit users and society
 - as would be suggested by economic analysis
- Companies founded to commercialize these technologies have had significant difficulties bringing them to market
- Diffusion of new clean energy technology into energy engineering systems
 - New ventures have achieved wide adoption of discontinuous technologies in many fields
 - *Primarily* new ventures
 - But new clean energy technology ventures fail to do so
 - Why?
 - What can we do about it?

Why this is an important problem

- Clean energy technology ventures spend much more time in the valley
 - Very slow adoption curve, conservative customers, entrenched competition, uncertainty about fossil fuel prices, agency problem, etc.
- When ventures commercializing important technology die in the valley, society suffers
 - Lose out on options to address climate change

Research Objectives

- Why are clean energy technologies not adopted as often as would be expected?
- What are the institutional, regulatory, economic & technical factors?
- What factors determine whether companies commercializing clean energy technologies will succeed or fail in bringing them to market?
- What strategies and policies will increase the odds of success of these companies and the widespread adoption of clean energy technology?

Contributions

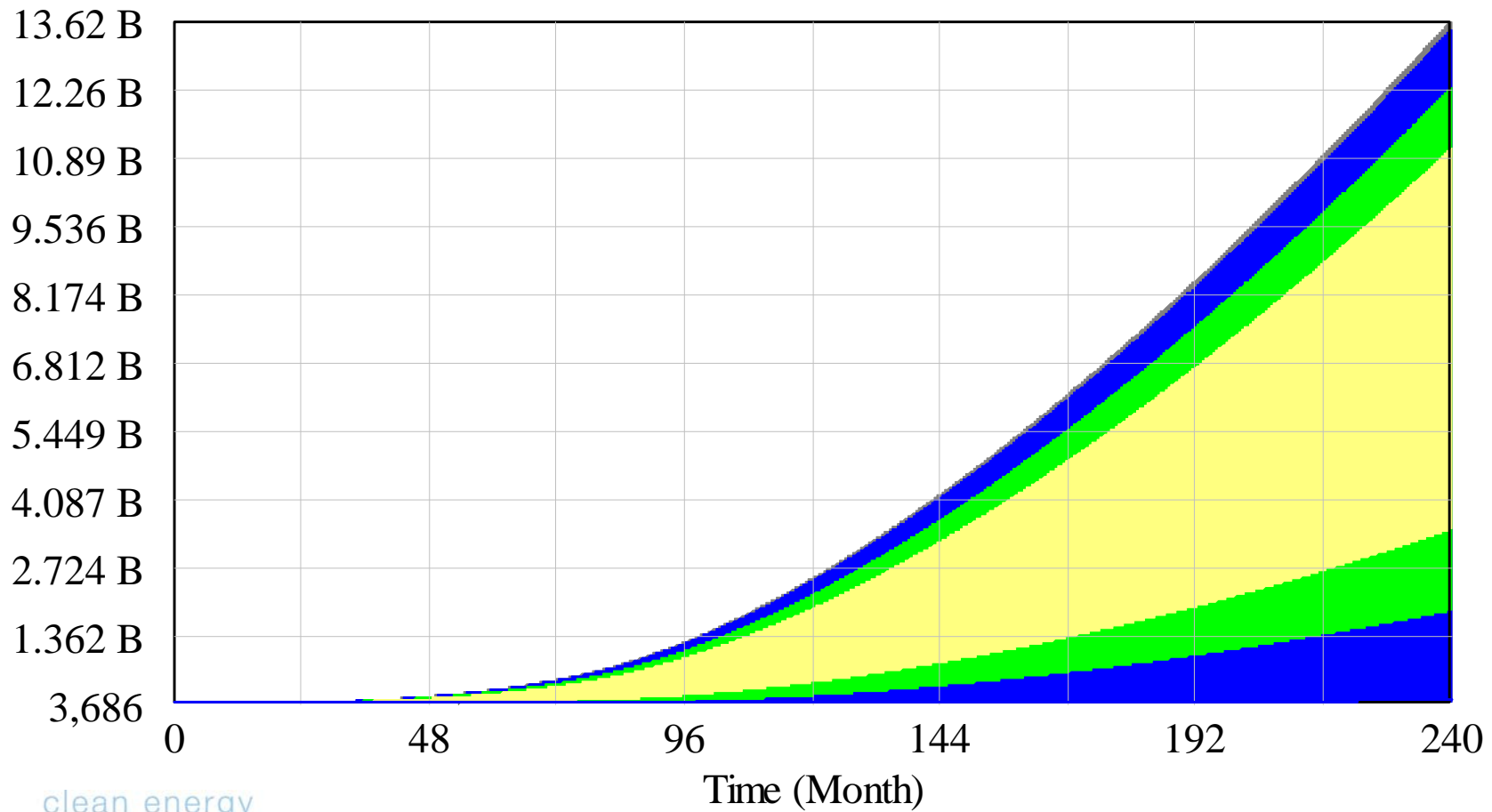
- Simulation Model
 - Market sector for clean energy technologies
 - Product development sector including intellectual property issues
 - Runway
 - Effect of government policies on new clean energy ventures
- Factors that contribute to success or failure
- Management strategies that increase odds of success
- Importance of government policies to success

Sensitivity to Capability to Adopt

_Sens_Cap_Adopt

50% 75% 95% 100%

Working Capital

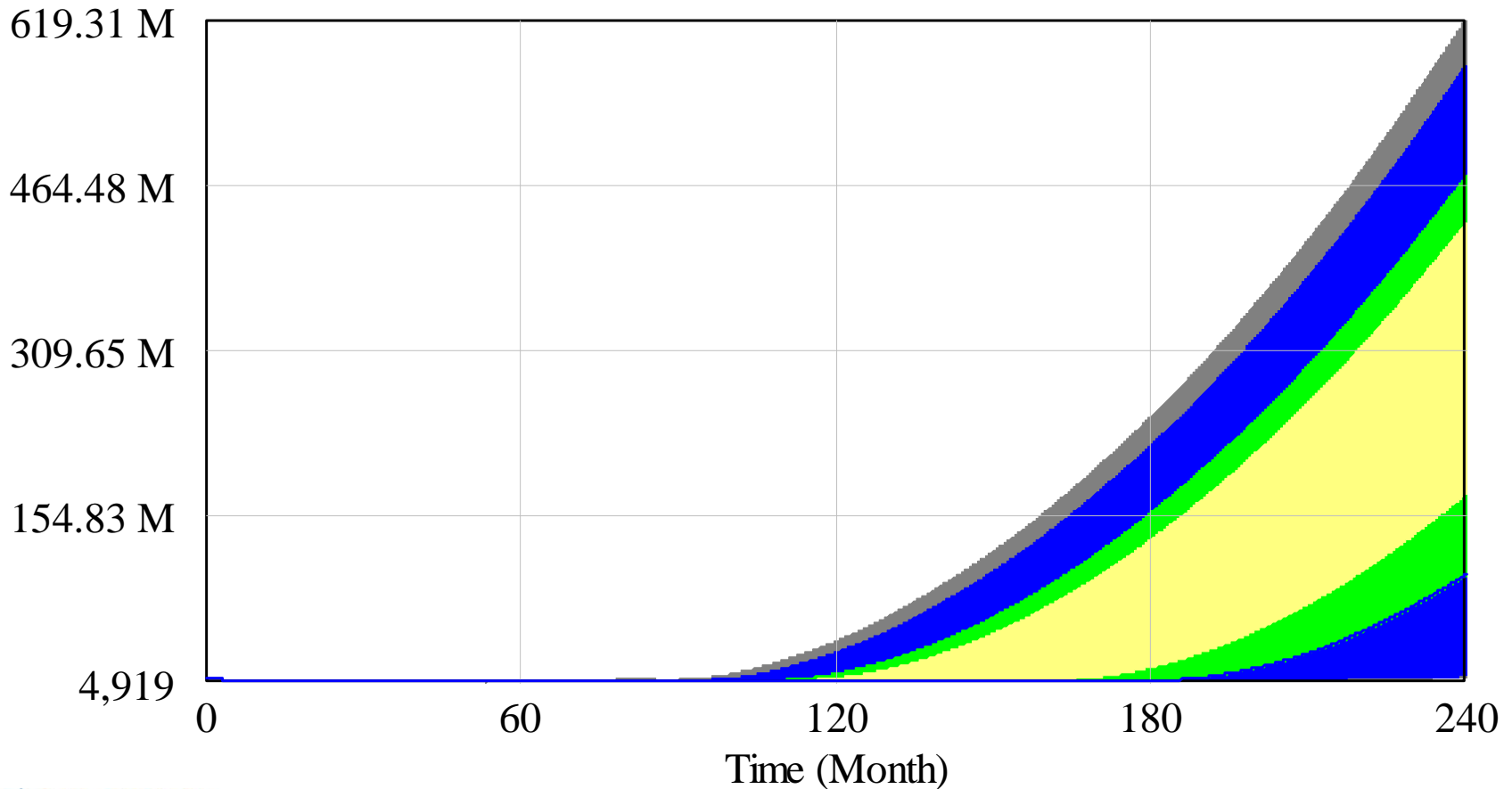


Sensitivity to Word Of Mouth

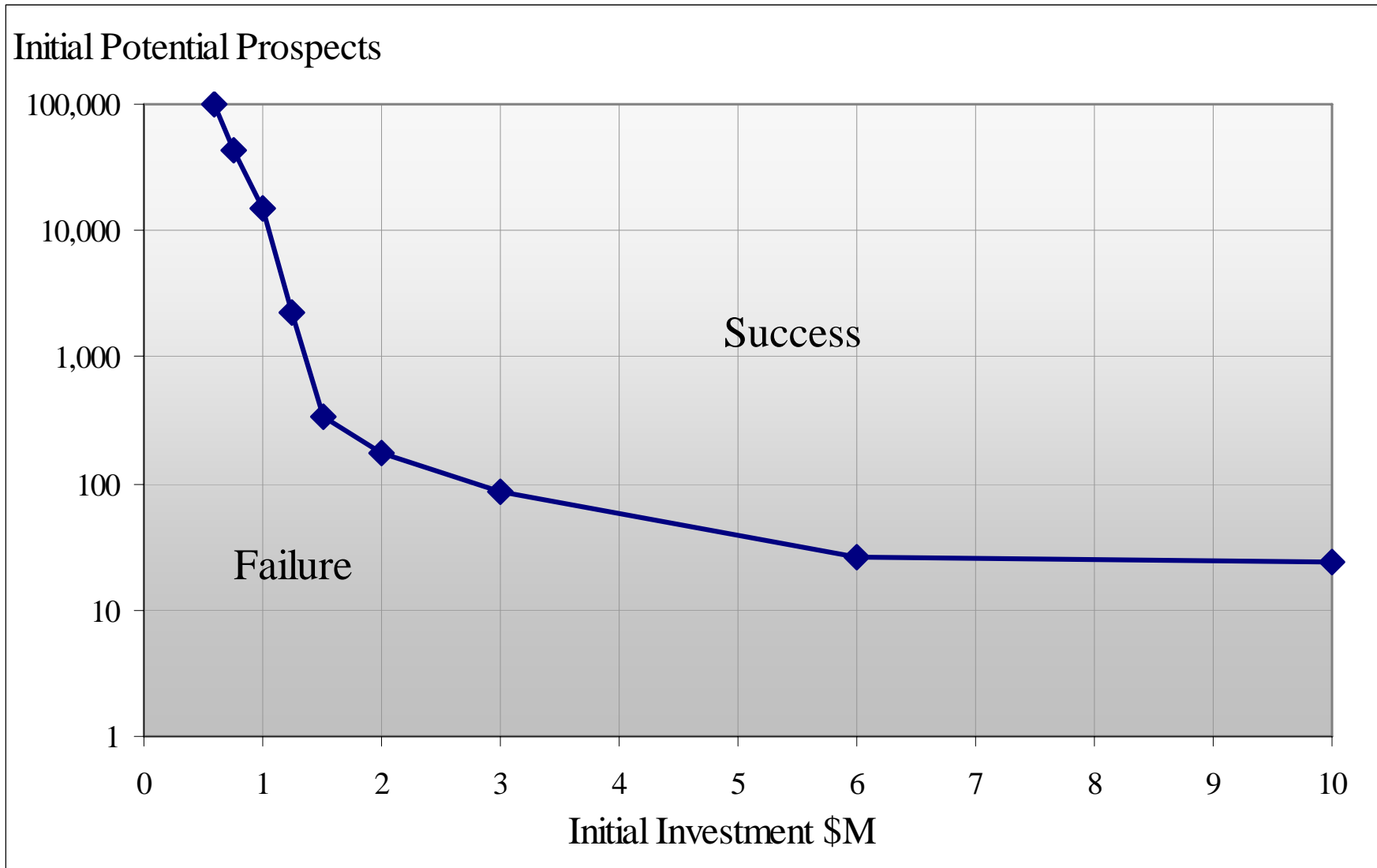
_Sens_WOM

50% 75% 95% 100%

Working Capital



Initial Potential Prospects

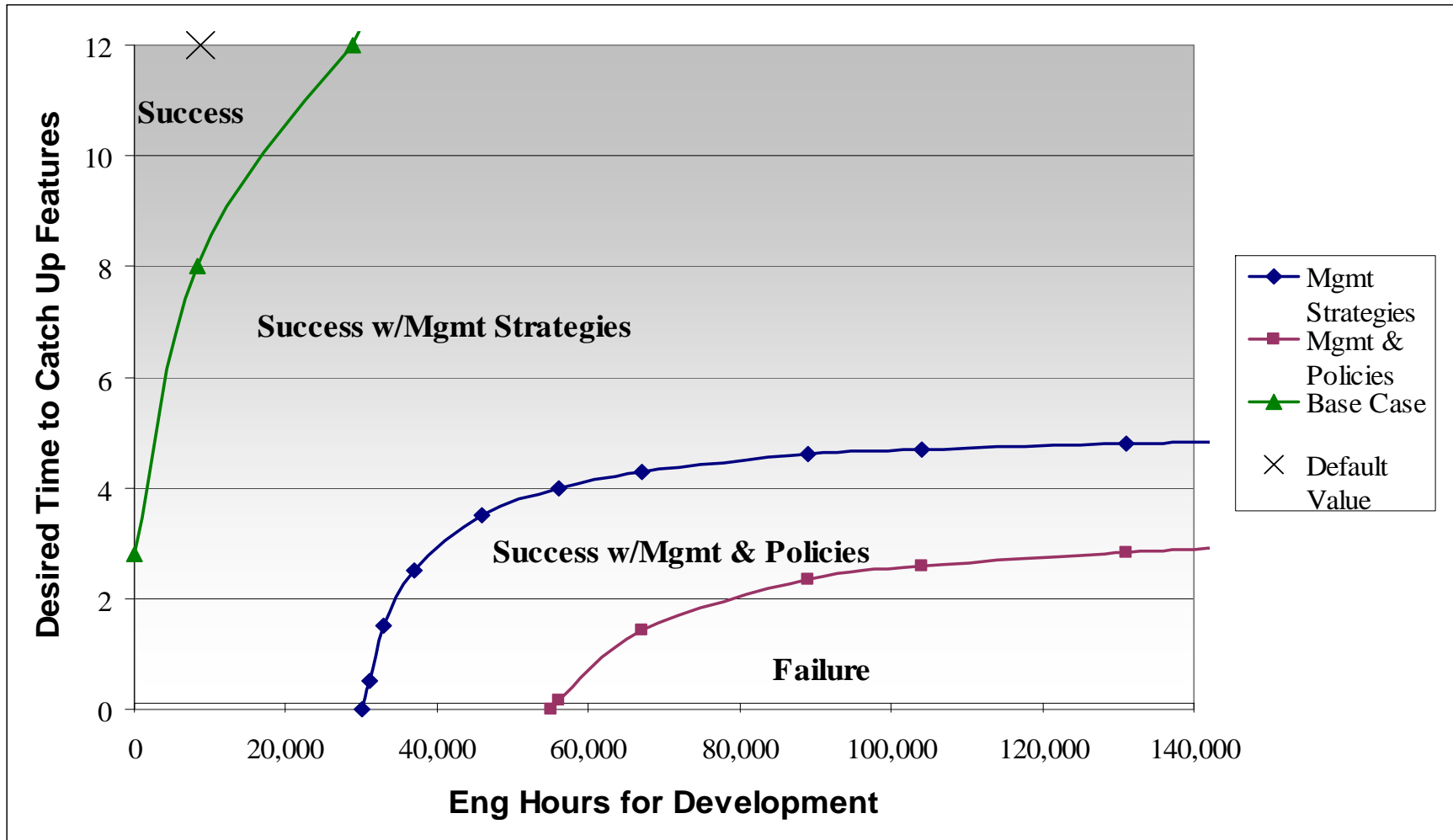


Aggressive Competitor Attributes

Parameter	Default Value for Venture	Default Value for Competition	Bankrupt in Base Case	Bankrupt w/ Mgmt Strategies	Bankrupt w/ Strategies & Policies
Initial Features(NA)	4	2	2.62	4.6	6
Initial Features(A)	110	100	122.5	450	630
Avg Feature Devl Time(NA)	12	24	14.5	-	-
Avg Feature Devl Time(A)	2	4	0.1	-	-
Desired Feature Ratio (NA)	1.25, 1.1	1.1	1.3	-	-
Desired Feature Ratio (A)	1.25, 1.1	1.1	1.8	-	-
Desired Time to Catch up Features (NA)	4	12	8.3	-	-
Desired Time to Catch up Features (A)	2	6	0.1	-	-
Eng Effort for Development(NA)	Variable	8,750	16,500	-	-
Eng Effort for Development(A)	Variable	8,750	-	-	-

NA = Non Appropriate, A= Appropriate

Robustness in face of aggressive competitor



Factors for Profitability

Time (Month)	12	36	60
Accounts Receivable	37%	29%	12%
Engineers	9%	67%	33%
Avg Engineer Experience	65%	83%	45%
Avg Sales Experience	6%	2%	1%
Cumulative Purchases	12%	13%	7%
Potential Prospects	38%	64%	34%
Hot Prospects	44%	40%	21%
Purchasers	21%	14%	7%
Adopters	58%	87%	68%
Features [self,appropriable]	65%	19%	-14%
Features [self,nonappropriable]	68%	44%	76%
Features [competitor,nonappropriable]	-18%	55%	56%
FUD [self,appropriable]	49%	20%	8%
FUD [self,nonappropriable]	66%	54%	42%
FUD [competitor,nonappropriable]	-11%	32%	21%

Summary of Sensitivity Analysis

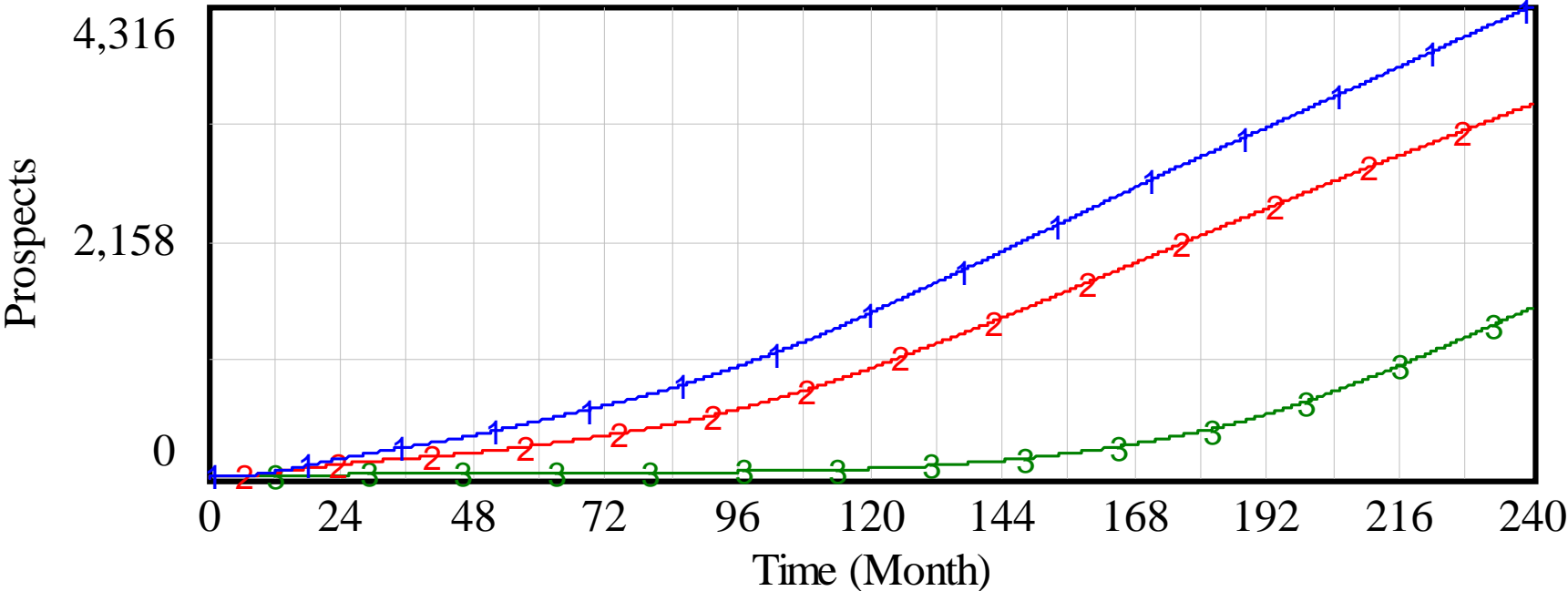
	Min Working Capital	Low end of 50% band	High end of 50% band	Max Working Capital	Min Cum Prob Failure	Low end of 50% band	High end of 50% band	Max Cum Prob Failure
Baseline	\$100	\$100	\$100	\$100	88%	88%	88%	88%
Initial Investment	\$0	\$106	\$689	\$717	56%	60%	87%	100%
Sales Cycle	\$0	\$0	\$2	\$537	35%	88%	100%	100%
Init Capab to Adopt	\$0	\$3,500	\$11,000	\$1,362	30%	32%	56%	100%
Receivables	\$0	\$0	\$1.40	\$347	87%	95%	100%	100%
SalesForce	\$0	\$0	\$708	\$787	30%	45%	100%	100%
Engineers	\$0	\$0	\$0.065	\$1,000	32%	100%	100%	100%
Features	\$0	\$0	\$0.002	\$1,698	48%	100%	100%	100%
Price	\$0	\$0	\$0	\$14,000	2%	100%	100%	100%
Word of Mouth	\$3	\$170	\$425	\$619	53%	77%	87%	95%

Policy Sensitivity Analysis

	Min Working Capital	Low end of 50% band	High end of 50% band	Max Working Capital	Min Cum Prob Failure	Low end of 50% band	High end of 50% band	Max Cum Prob Failure
Policy to Incr Capab to Adopt	\$112	\$377	\$1,315	\$4,543	50%	80%	86%	100%
Policy to Incr Carbon Cost	\$105	\$1,100	\$4,266	\$1,260	9%	72%	86%	87%
Policy to provide Subsidy	\$101	\$120	\$180	\$795	40%	84%	87%	90%
All Policies	\$256	\$3,400	\$12,000	\$48,000	5.00%	67%	83%	100%

Adopters

Adopters



Adopters : _MgmtStrat+GovtPolicies 1 1 1 1 1 1 1 1 1 1
 Adopters : _MgtPolicies 2 2 2 2 2 2 2 2 2 2
 Adopters : _BaseCase(3M Invest) 3 3 3 3 3 3 3 3 3 3

Potential Future Work

- Quantitative data on clean energy technology ventures
- Further development of model
- Applicability of model and strategy suggestions to ventures in other industries
- Behavioral analysis of new ventures
- Further testing of proposed strategies