

System Dynamics Modeling of the SmartWay Transport Partnership

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<http://ctl.mit.edu/energy>

Carbon-Efficient Supply Chains

- Challenges facing our society
 - Rising energy demand and decreasing supply
 - Impacts of climate change
- Policy approaches typically top down industry centric

“Consumer purchasing decisions are the ultimate driver of carbon emissions in an economy” and hence “All carbon emissions can be attributed to the delivery of products and services to meet the needs of the consumer”

- The Carbon Trust, UK

- Supply chain product carbon footprinting perspective



Supply Chain Potential

- Significant opportunities to reduce emissions
 - Product design and optimization
 - Supply chain reconfiguration
- Complementary to carbon pricing
 - Addresses “carbon outsourcing” issues
- Promoting sustainable consumption



341 BTU/ton-mile



3,357 BTU/ton-mile



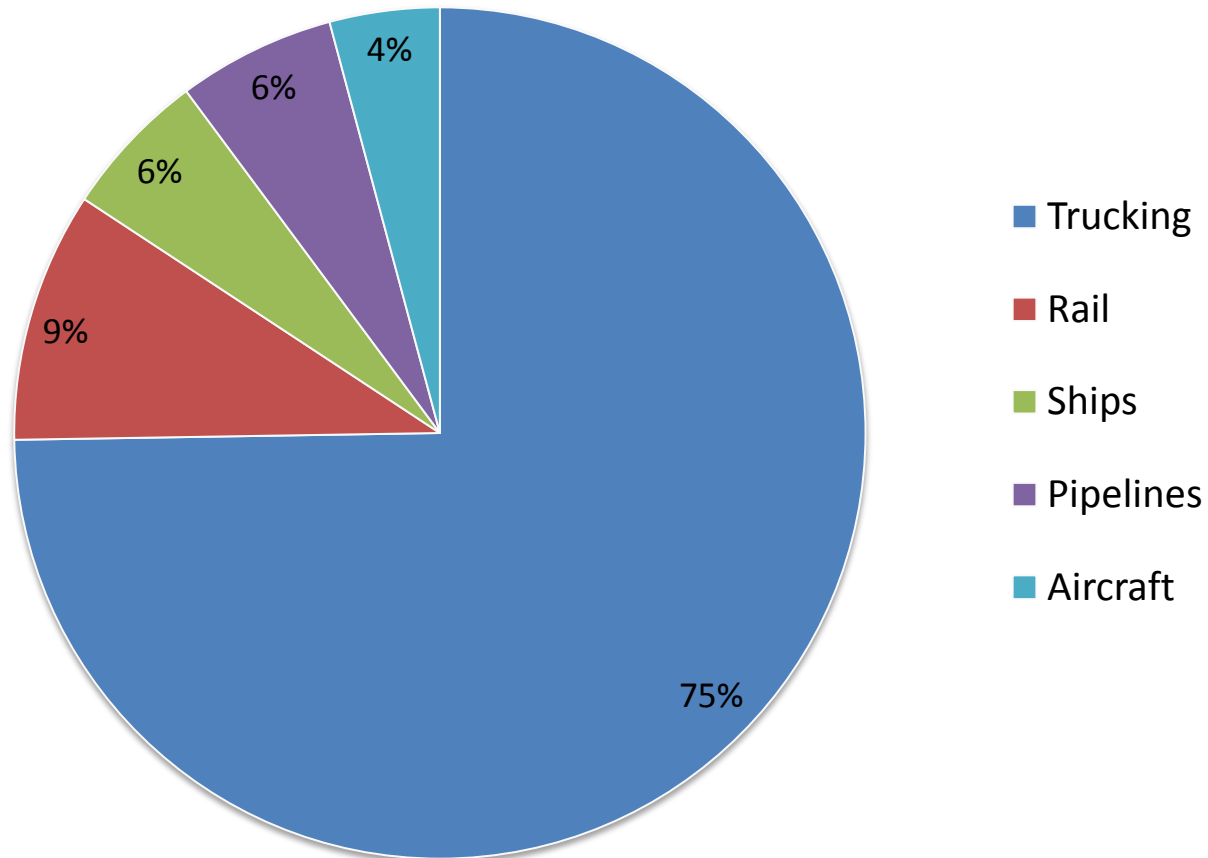
Global Carbon Label Initiatives



Voluntary Public Private Partnerships

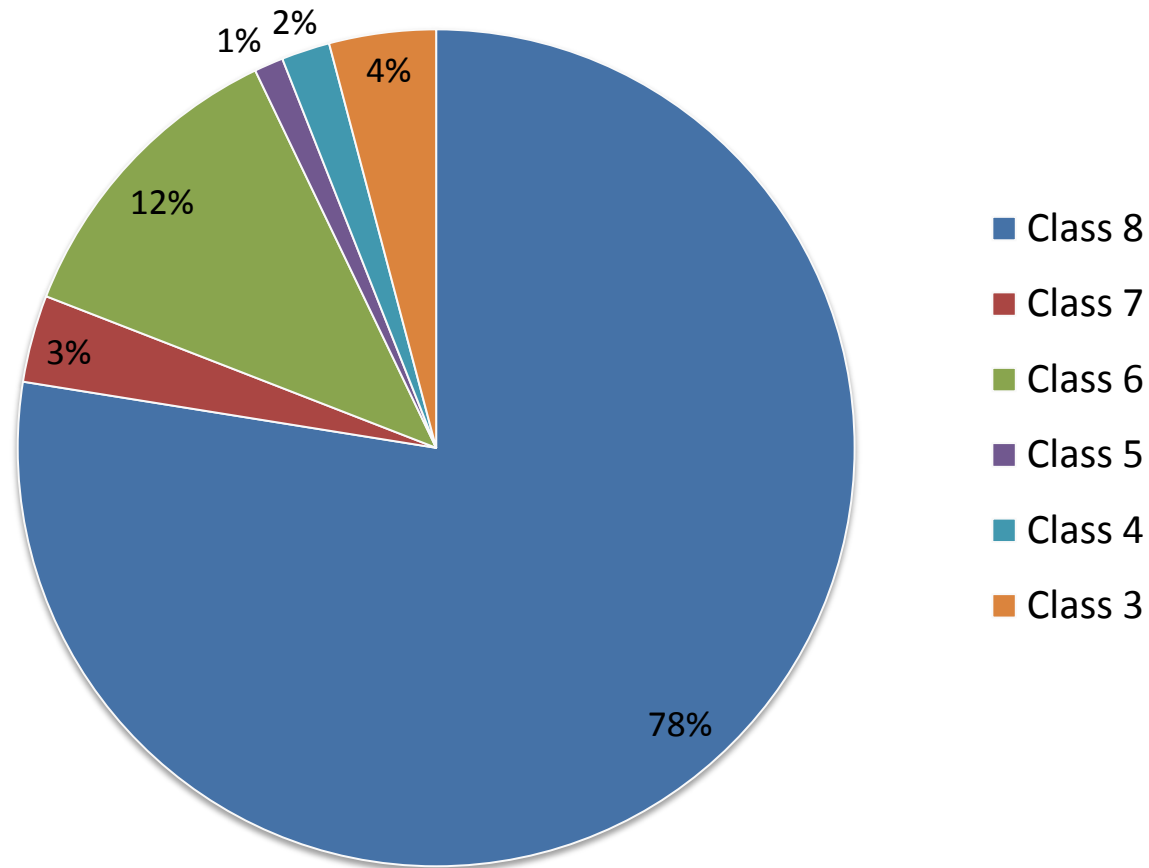
- *How would a product carbon footprint initiative be best introduced in the U.S.?*
- EPA Climate Partnership Programs
 - 36 voluntary and stewardship programs preventing 78 MMTCO₂ and saving consumers and businesses \$17 billion in 2007
- Freight Logistics – SmartWay Transport Partnership
 - In 2006, trucking and rail industry consumed 37.9 billion and 4.2 billion gallons of diesel fuel
 - Contributing 404.6 and 51.5 MMTCO₂ respectively
 - Accounting for 23.4% of transportation sector emissions and 6.4% of total U.S. GHG emissions

Trucking Contributes 75% of Emissions



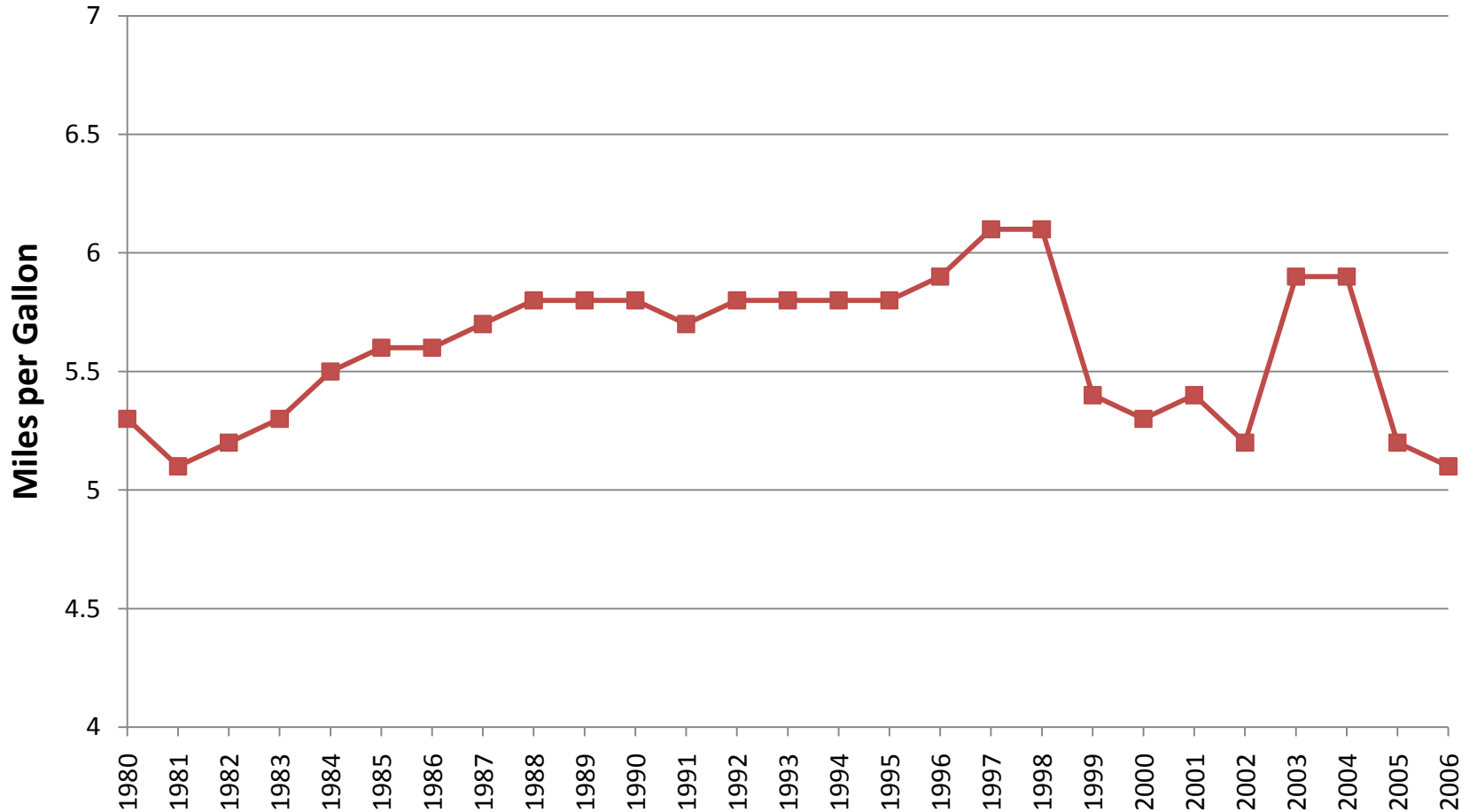
Davis, S. C., Diegel, S. W., & Boundy, R. G. (2008). *Transportation Energy Data Book - Table 5.2.*

Class 8 Trucks Consume Majority of Fuel



Davis, S. C., Diegel, S. W., & Boundy, R. G. (2008). *Transportation Energy Data Book - Table 5.2.*

Fuel Economy for Class 8 Trucks Stagnant



Davis, S. C., Diegel, S. W., & Boundy, R. G. (2008). *Transportation Energy Data Book - Table 5.2.*

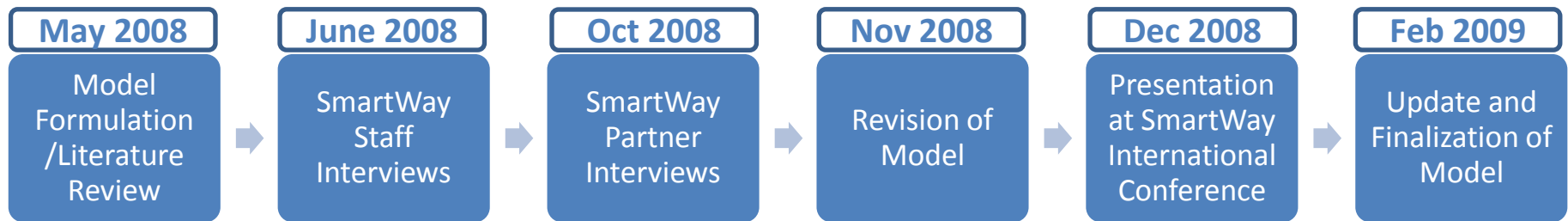
Market Inefficiencies and Barriers

- Lack of accurate and verifiable truck fuel economy info
 - Difficult for manufacturers to demonstrate and market technology enhancements
- Small truck fleets lack resources to validate strategies
- Policy solution - SmartWay Transport Partnership
 - Focused on reducing carbon emissions in freight transportation
 - Promoting the sharing of knowledge and best practices
 - Creating incentives for trucking companies to implement technology strategies - financing, branding
 - Increasing transparency across the supply chain

CTL SmartWay Study Objectives

- Understand key factors contributing to program's success
- Develop recommendations for program sustainability

Project Timeline

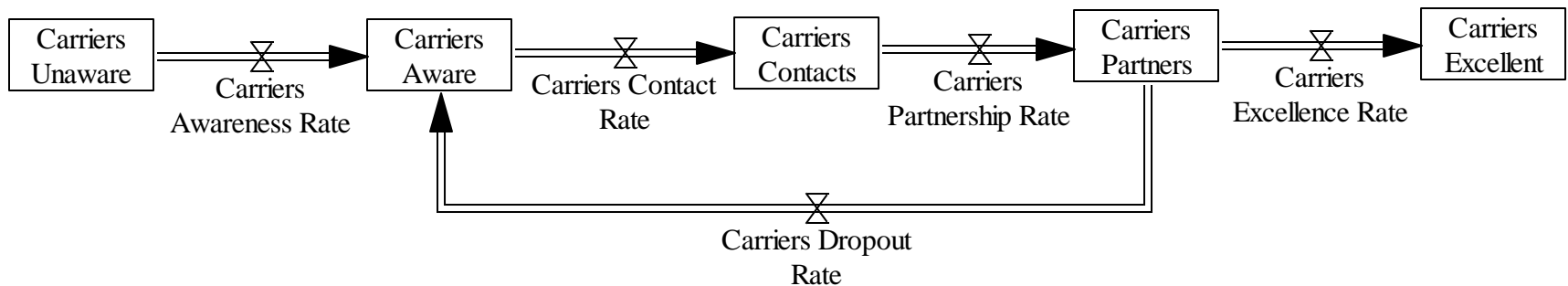


Sample Interviewees



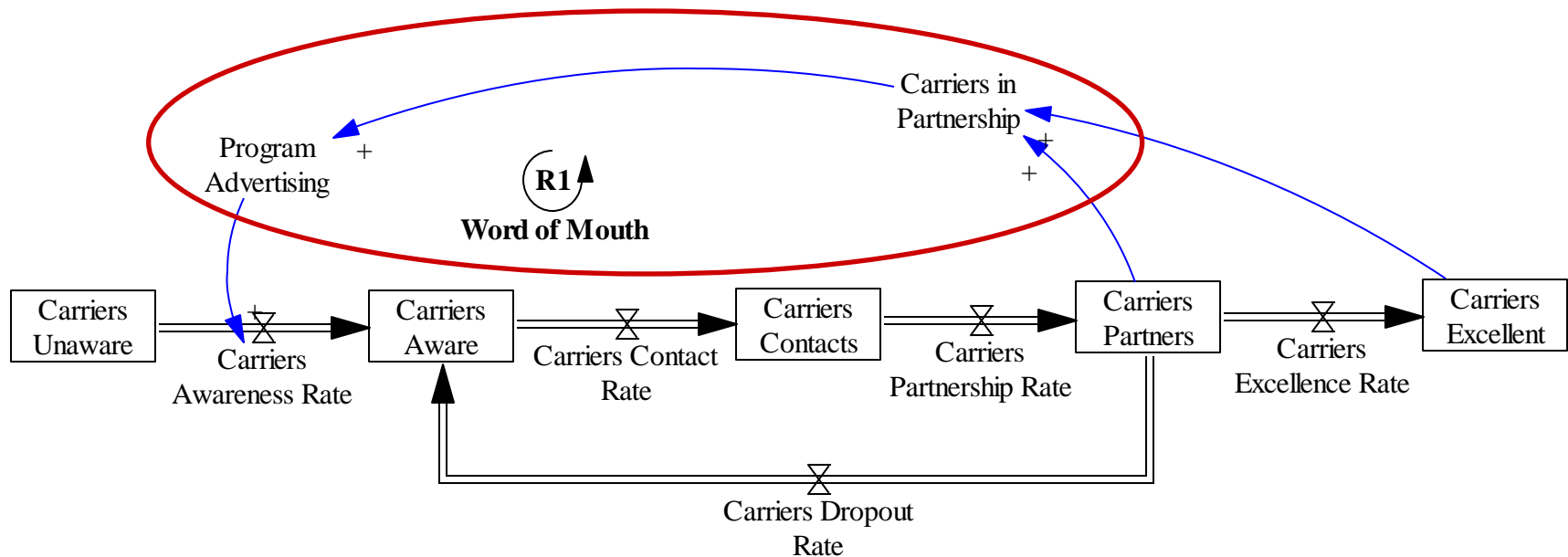
- Capturing mental models of key stakeholders through System Dynamics Modeling and performing simulations

Carrier Stocks and Flows



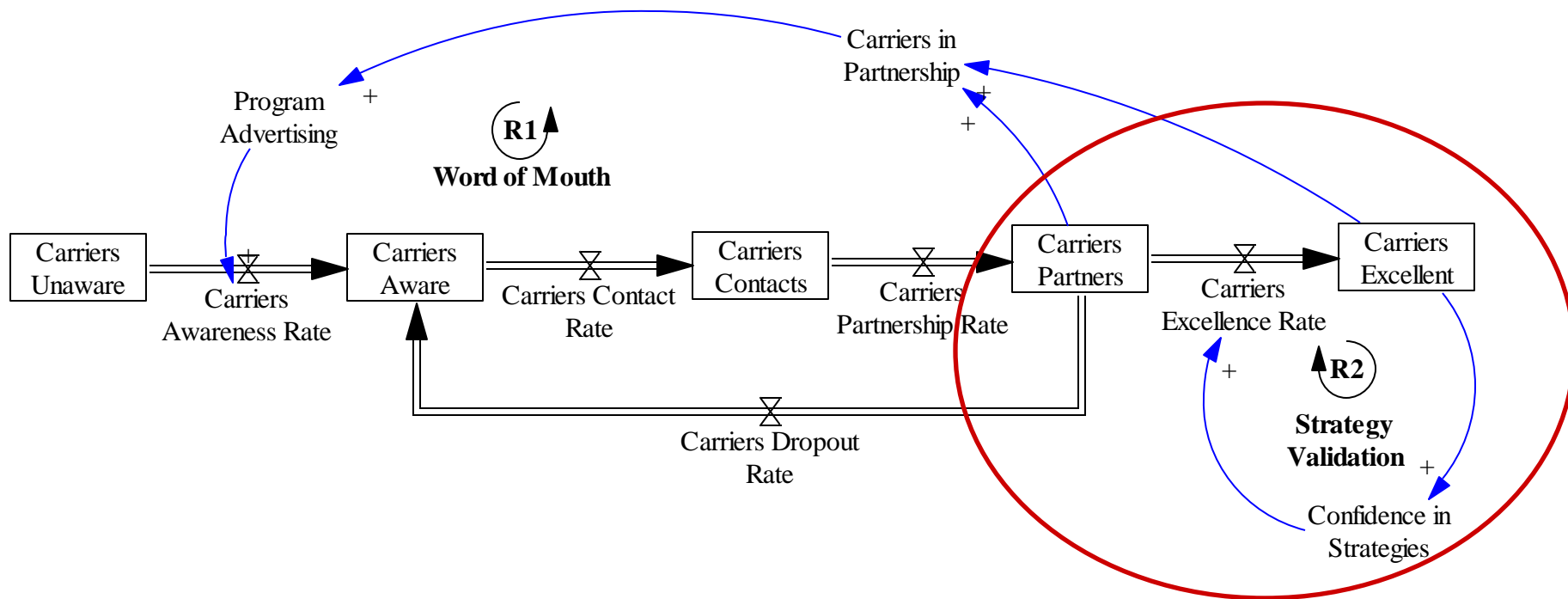
- Carriers classified in one of five stocks based on their level of awareness and participation in the program
 - Further broken down into small/large companies
- Ideally the program would want as many carriers flowing from the left to right most stock as possible
 - Excellent carriers actualize emission reductions

Reinforcing Loop 1: Word of Mouth



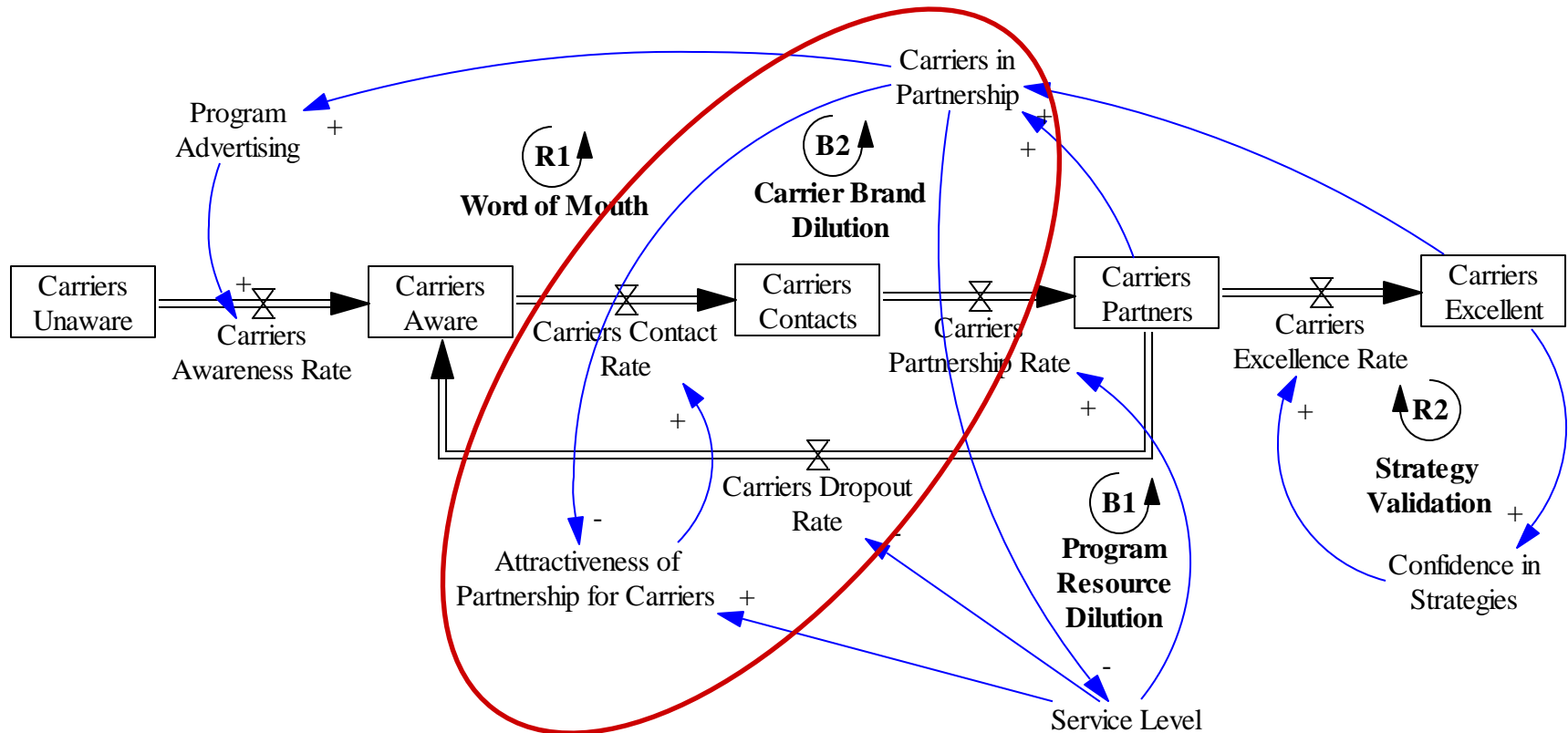
- As the number of carriers enrolled in the program increases, they generate more publicity for it
- Partners highlight their involvement during trade conferences, meetings, press releases etc.

Reinforcing Loop 2: Strategy Validation



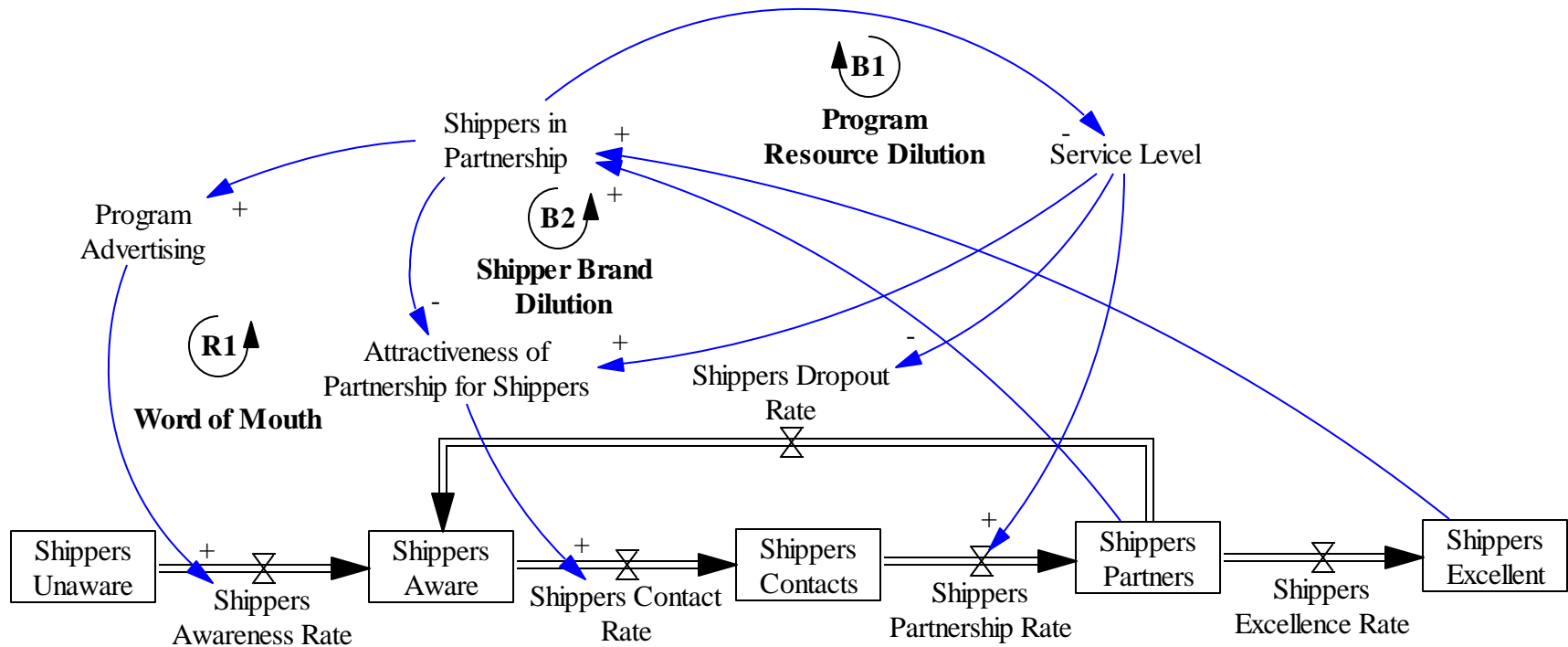
- As carriers implement and test new technologies, they are able to validate its cost effectiveness
- These results get shared through the program and help to increase industry confidence in the strategies

Balancing Loop 2: Brand Dilution



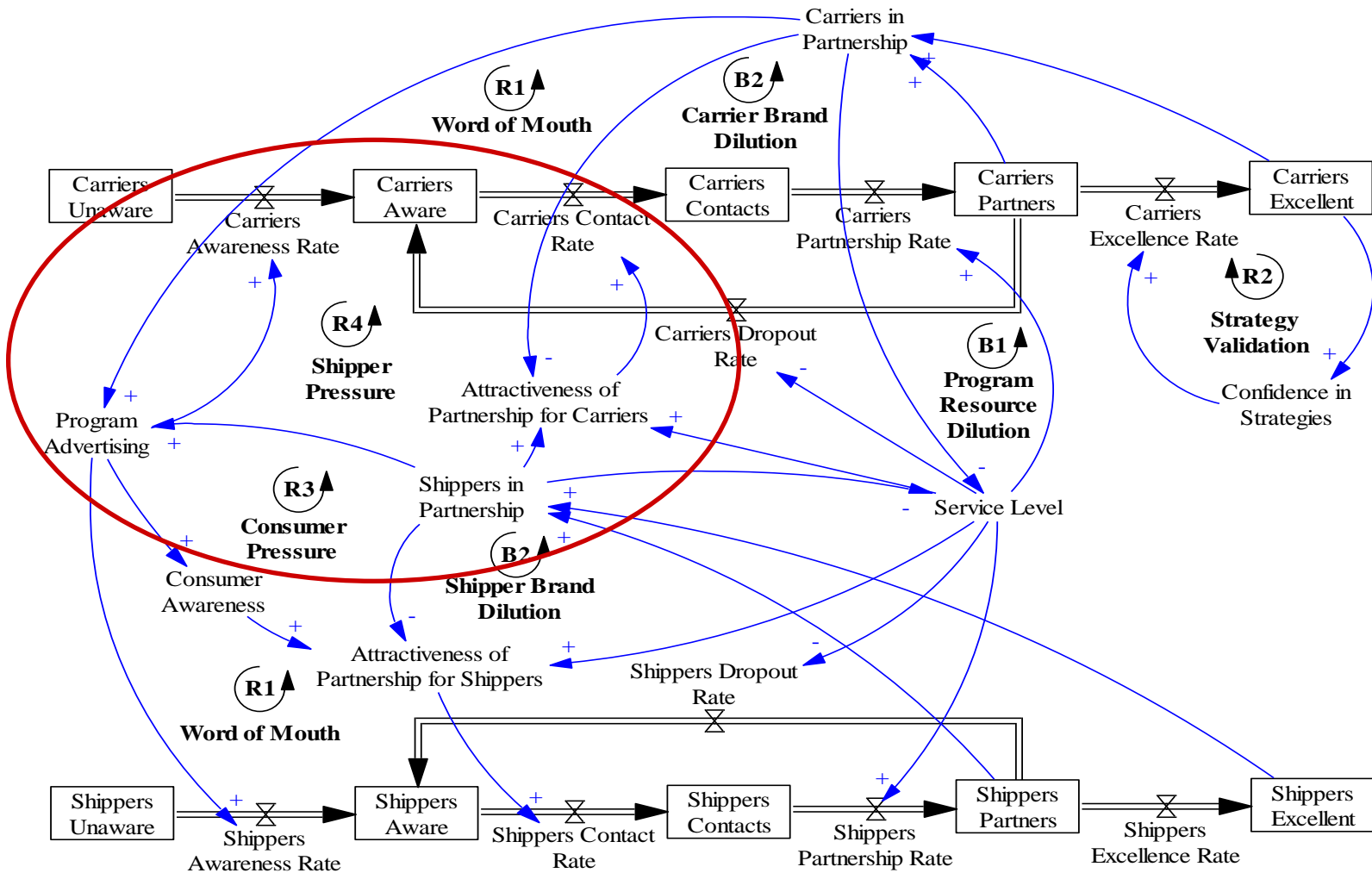
- As more companies enroll in the program, it starts to lose its initial appeal of distinction and innovativeness

Shipper Stocks and Flows



- Shipper stocks and flows are similar to carriers and they face the same reinforcing and balancing loops from word of mouth as well as brand and resource dilution

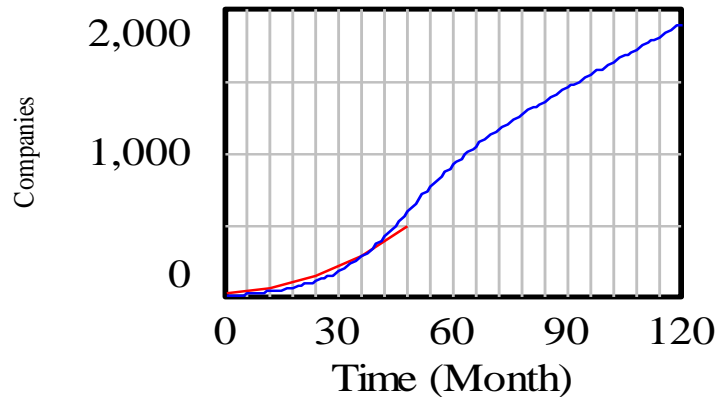
Reinforcing Loop 4: Shipper Pressure



- Shippers likewise put pressure on carriers to participate

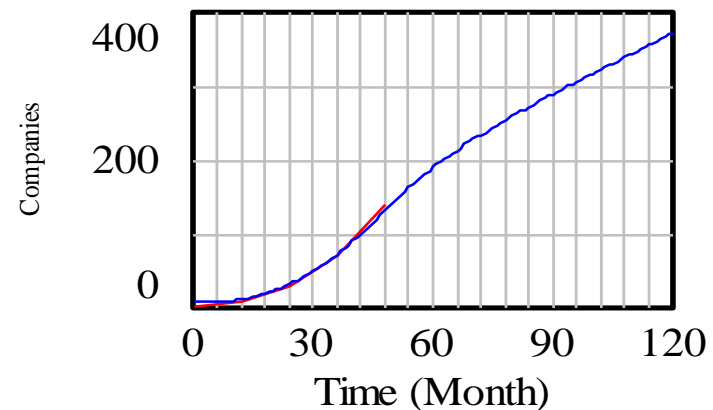
Baseline Simulation

Carrier Partners



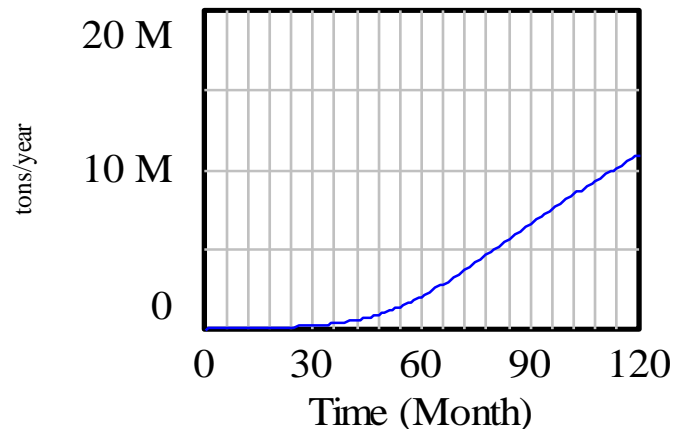
Carriers Total Partners : Simulations\Baseline ———
Carriers Historic : Simulations\Baseline ———

Shipper Partners



Shippers Total Partners : Simulations\Baseline ———
Shippers Historic : Simulations\Baseline ———

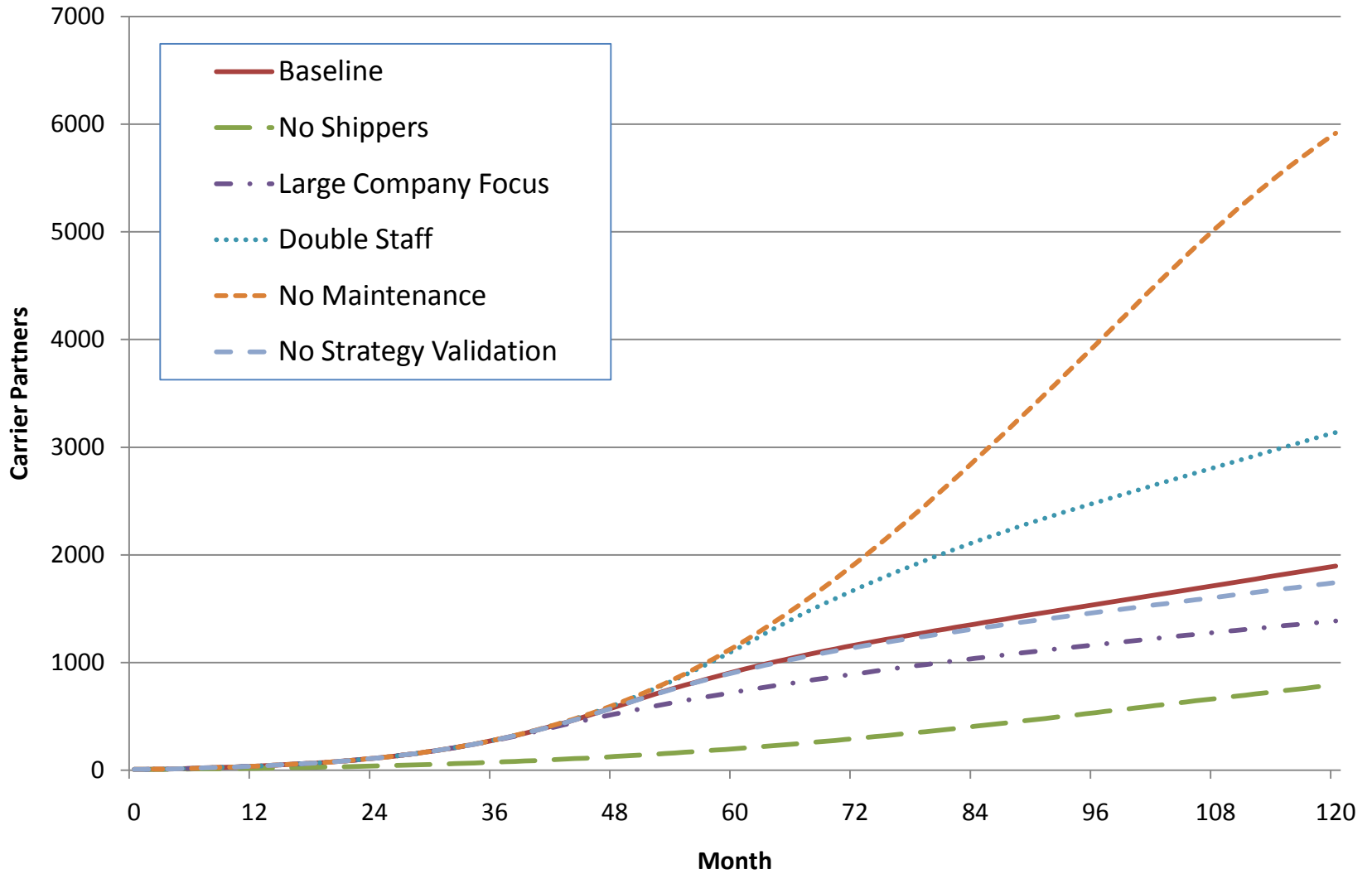
Emissions Saved



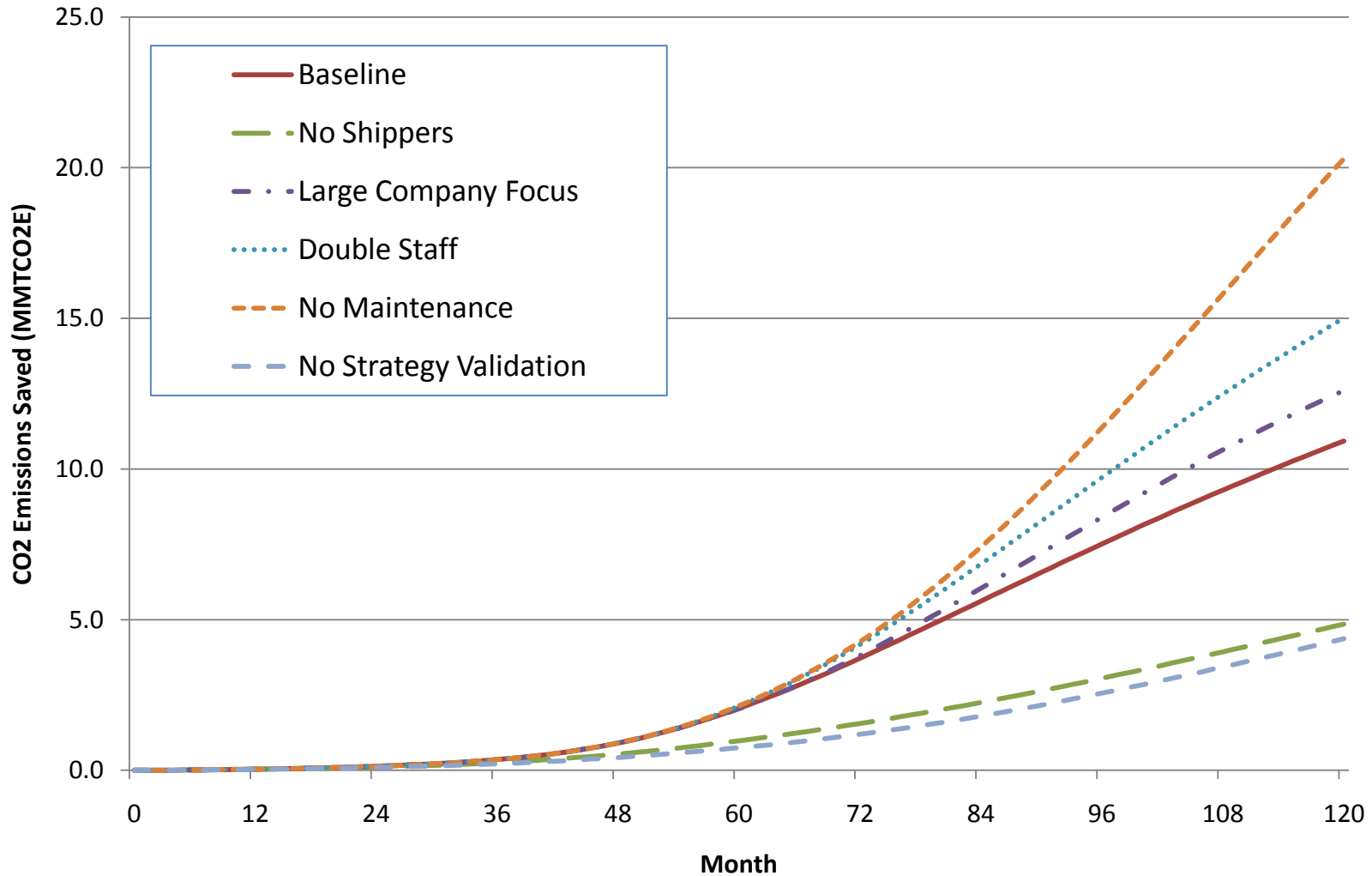
CO2 Emissions Reduced : Simulations\Baseline ———

- Rapid initial growth
 - Word of mouth
 - Advertising
 - Direct recruitment
 - Shipper pressure
- Slows down over time
 - Limited program resources

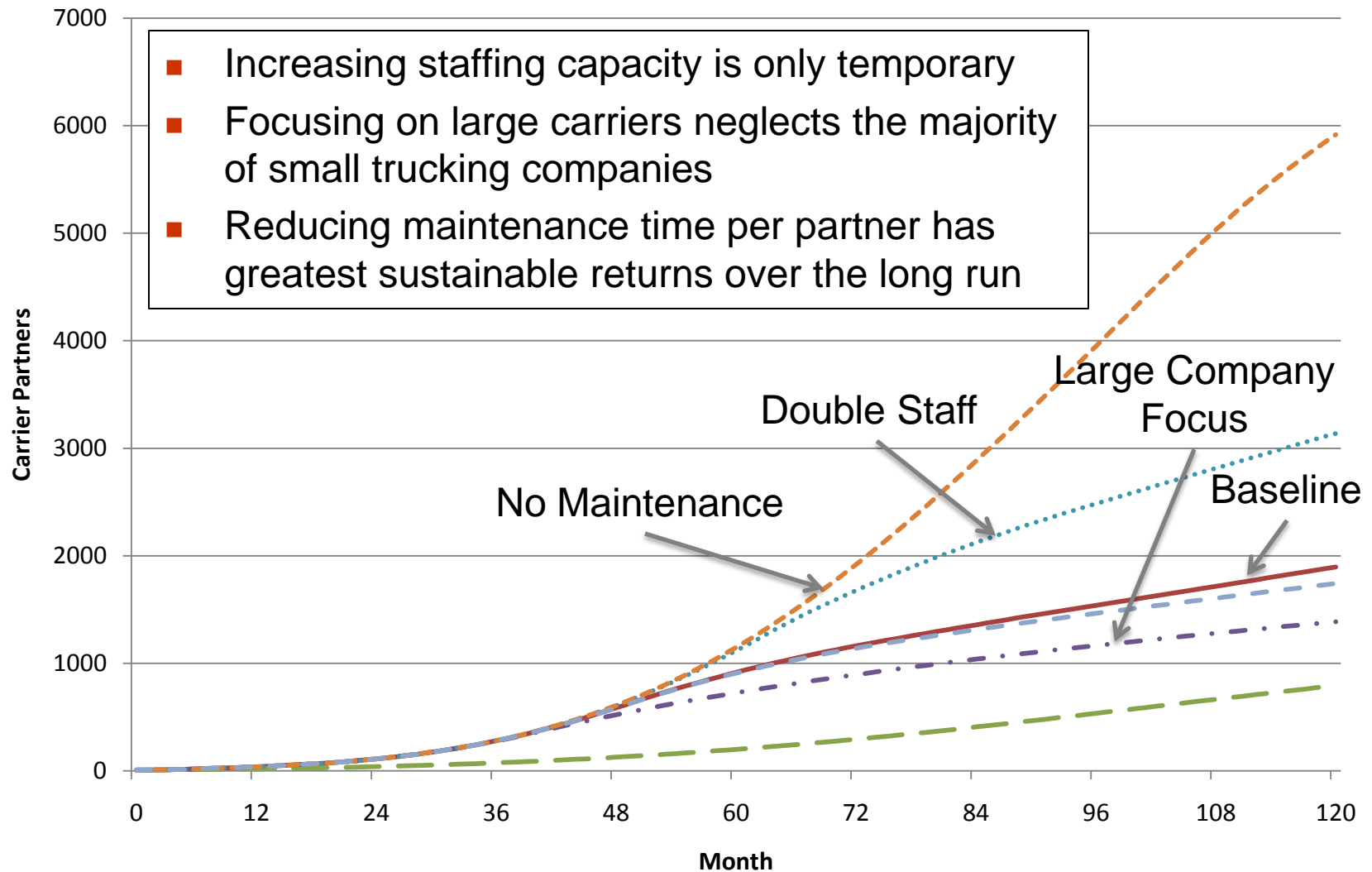
Scenarios - Carrier Partners



Scenarios - CO₂ Emissions Saved

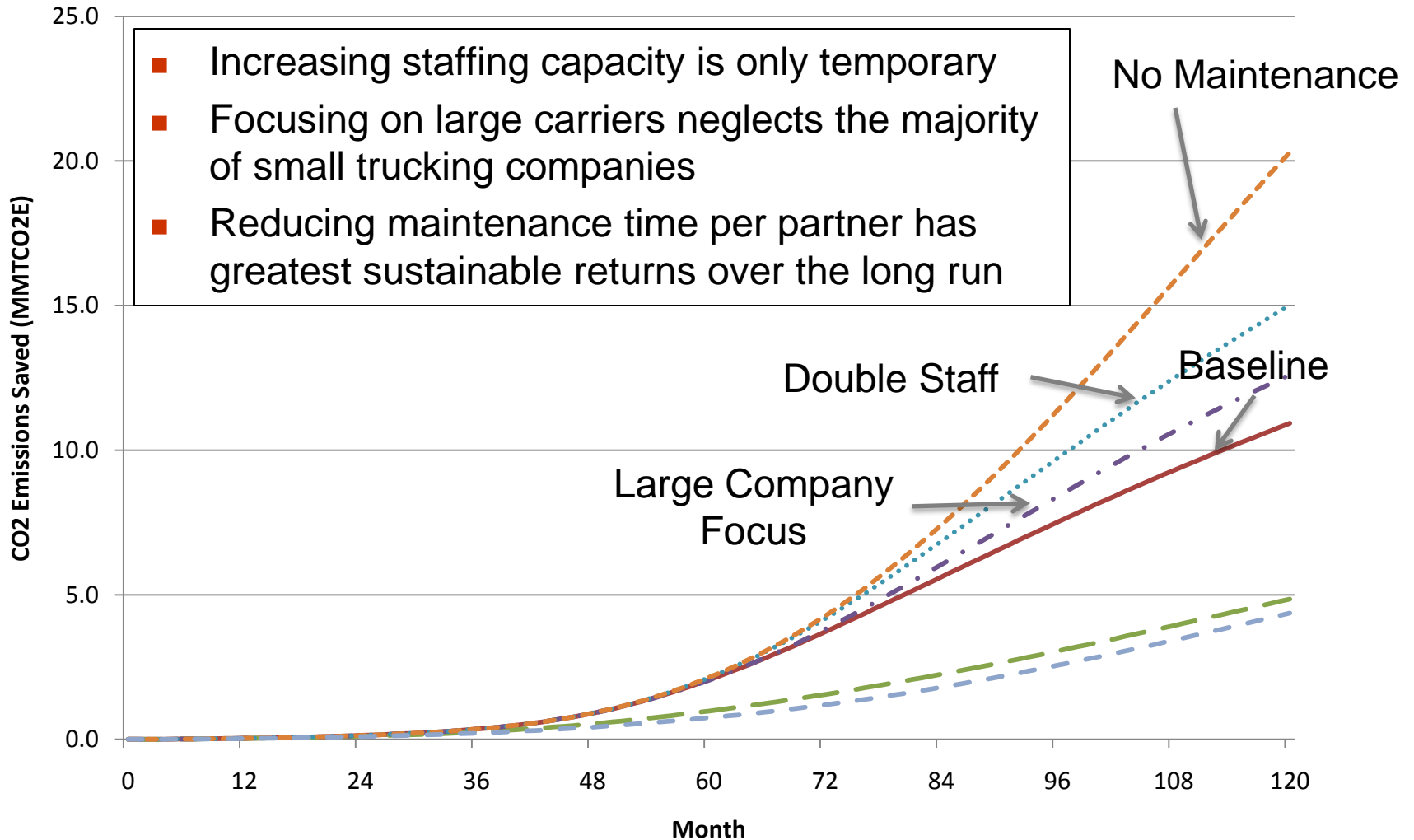


Service Level Scenarios - Carriers

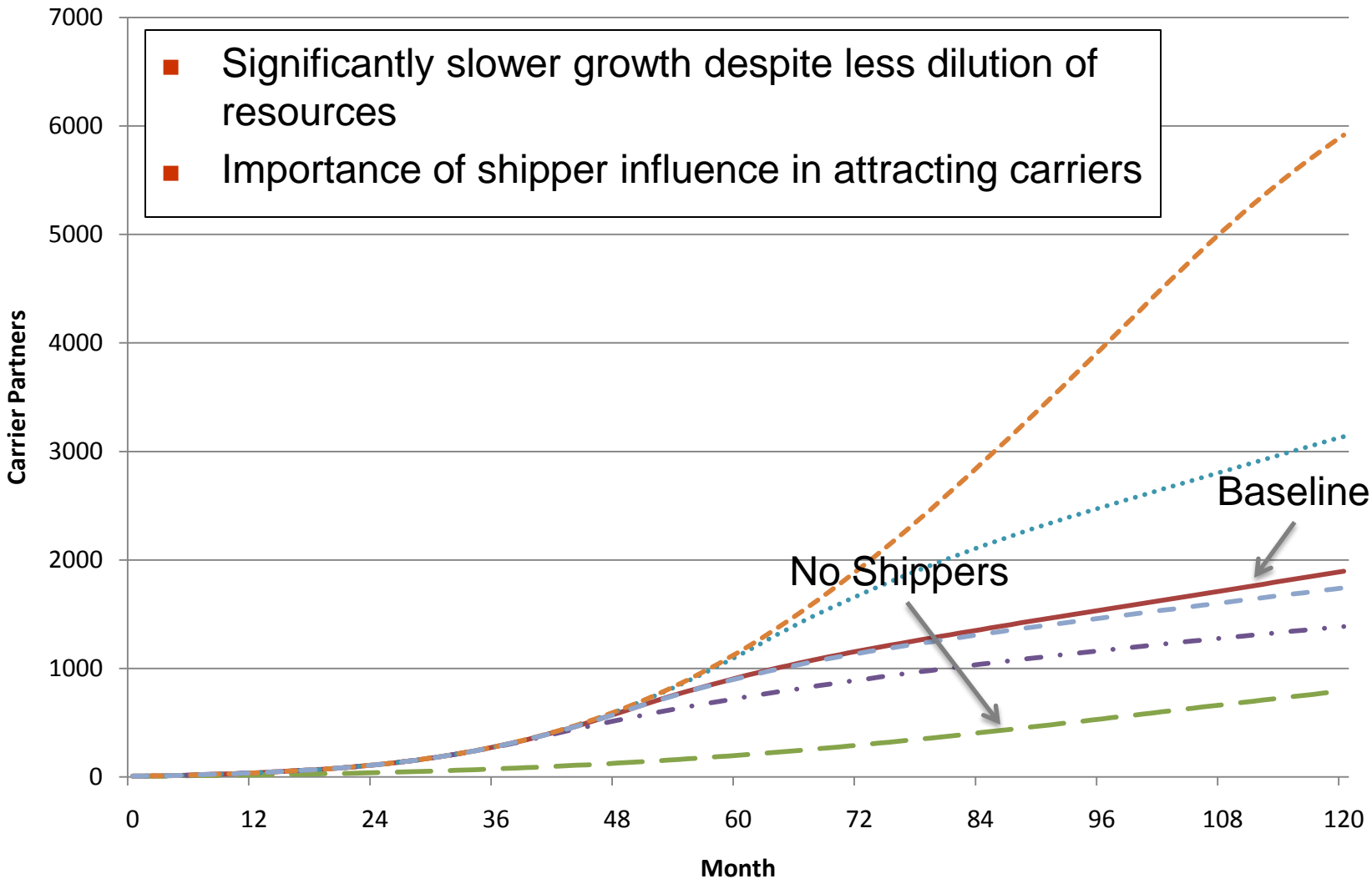


- Increasing staffing capacity is only temporary
- Focusing on large carriers neglects the majority of small trucking companies
- Reducing maintenance time per partner has greatest sustainable returns over the long run

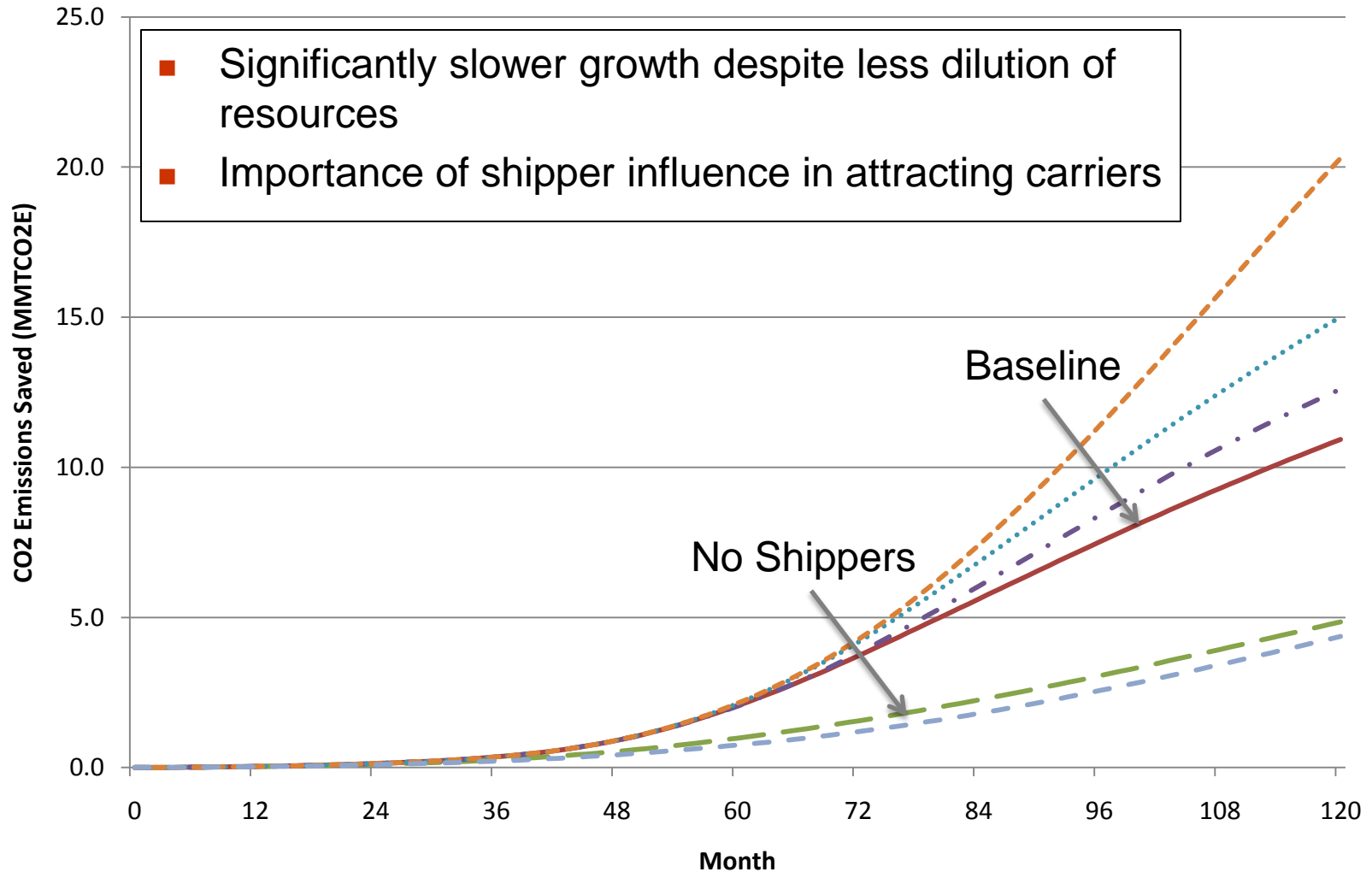
No Shippers Scenario - Emissions



No Shippers Scenario - Carriers



No Shippers Scenario - Emissions



Conclusions

- Importance of shipper participation in program
- Need to streamline partner services
- Strengths of a well designed program
- Benefits from knowledge sharing
- Motivated partners in voluntary partnerships

Questions?

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Climate Change

“Few challenges facing America, and the world, are more urgent than combating climate change. The science is beyond dispute and the facts are clear”

- President Barack Obama

- Nations meeting at the end of the year in Copenhagen to negotiate successor agreement to the Kyoto Protocol
- EU Emissions Trading Scheme currently world's largest carbon cap and trade system in its 2nd phase
- Obama administration's stated intention to reduce U.S. GHG emissions by 80% by 2050
- U.S. EPA recently proposed first comprehensive system for reporting GHG emissions
- U.S. Congress involved in drafting of climate change legislation – American Clean Energy and Security Act

Policy Solutions

- Typically top down industry sector centric economic approaches – Cap and Trade Systems
- Traditional corporate carbon footprinting focused on internal operations – GHG Protocol Scope I & II

“Consumer purchasing decisions are the ultimate driver of carbon emissions in an economy” and hence “All carbon emissions can be attributed to the delivery of products and services to meet the needs of the consumer”

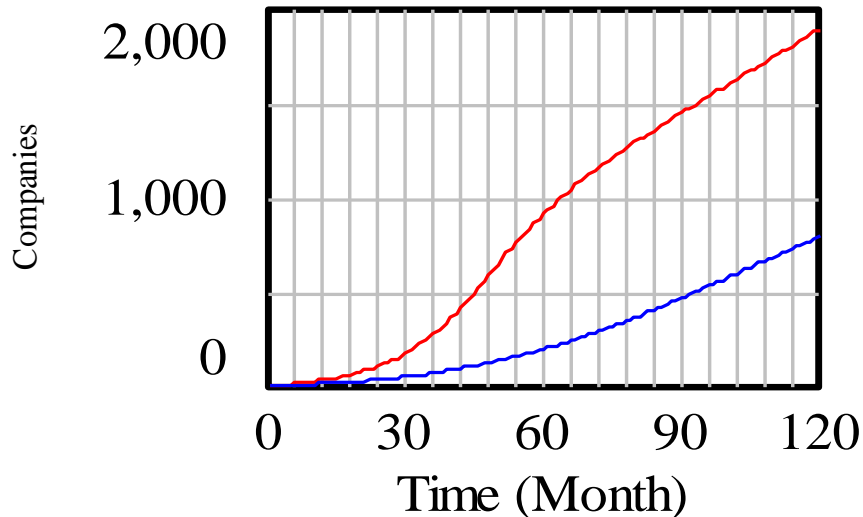
- The Carbon Trust, UK

- Supply chain product carbon footprinting perspective
 - Life Cycle Assessment / Industrial Ecology

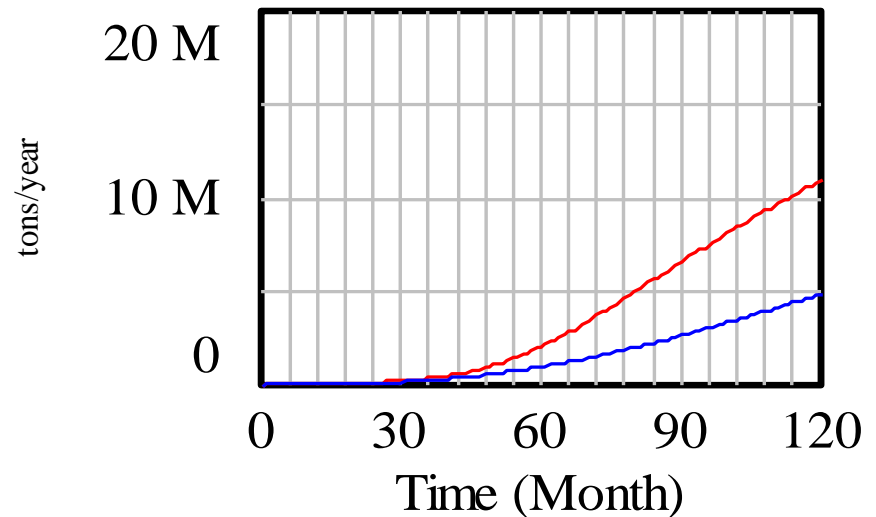


No Shippers Scenario

Carrier Partners



Emissions Saved



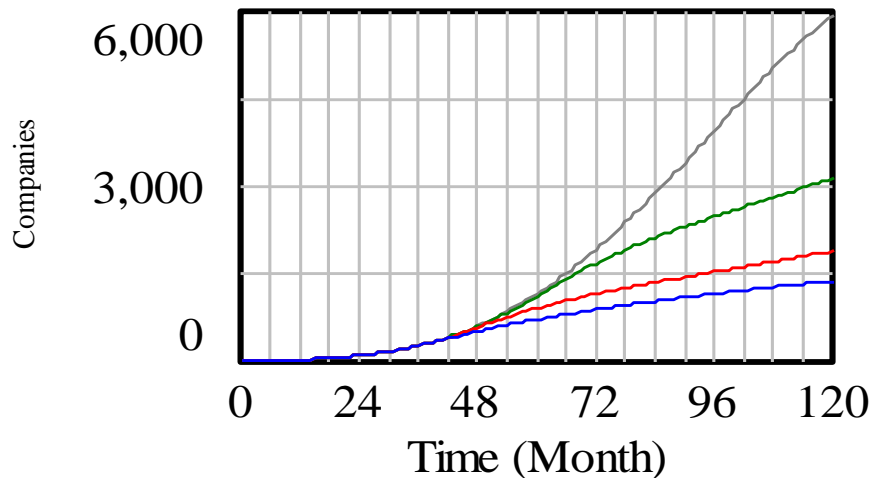
Carriers Total Partners : Simulations\No Shippers — blue line
Carriers Total Partners : Simulations\Baseline — red line

CO2 Emissions Reduced : Simulations\No Shippers — blue line
CO2 Emissions Reduced : Simulations\Baseline — red line

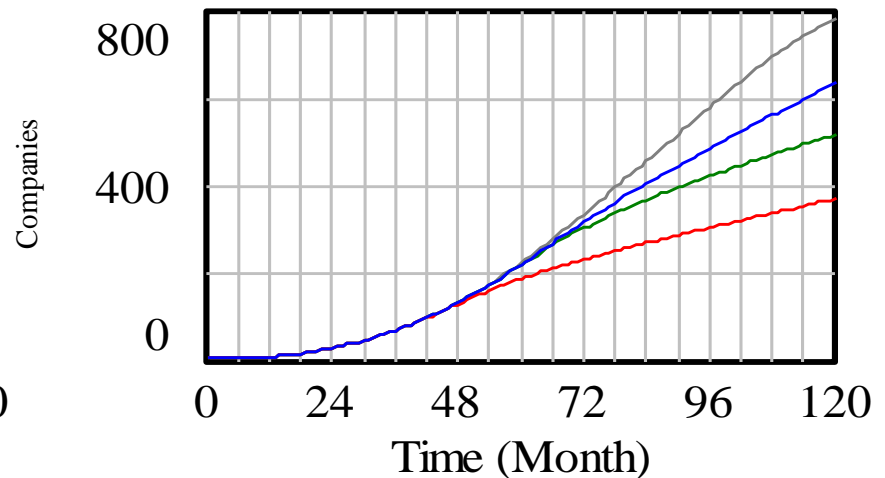
- Significantly slower growth despite less dilution of resources
 - Importance of shipper influence in attracting carriers
 - Leverage carrier participation through providing additional incentives or setting program membership as a requirement for contracts
- Lower CO₂ emissions savings without inclusion of shippers

Service Level Based Scenarios

Carrier Partners



Shipper Partners



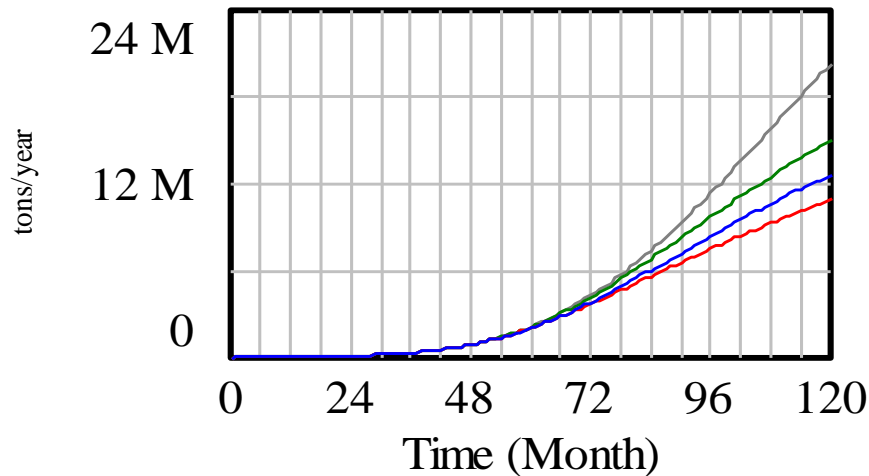
Carriers Total Partners : Simulations\Large Cpy Focus ————
 Carriers Total Partners : Simulations\Baseline ————
 Carriers Total Partners : Simulations\Double Staff ————
 Carriers Total Partners : Simulations\No Maintenance ————

Shippers Total Partners : Simulations\Large Cpy Focus ————
 Shippers Total Partners : Simulations\Baseline ————
 Shippers Total Partners : Simulations\Double Staff ————
 Shippers Total Partners : Simulations\No Maintenance ————

1. Doubling the staffing capacity
2. Focusing staff attention on large companies
3. Reducing the maintenance time required from the program

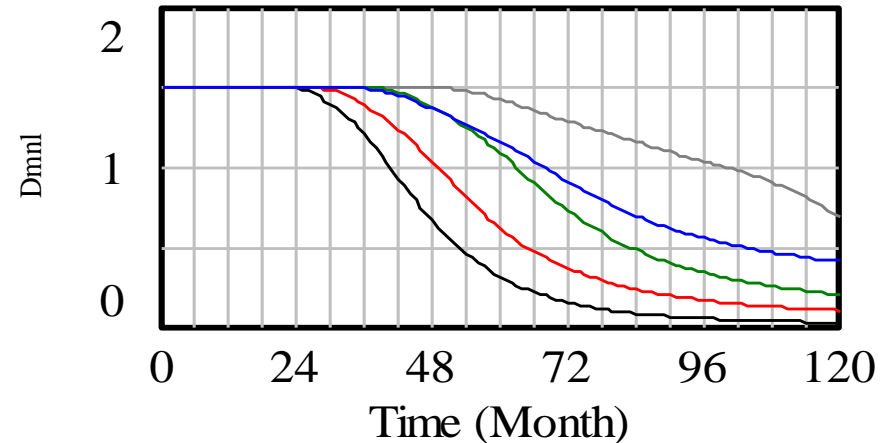
Service Level Based Scenarios

Emissions Saved



CO2 Emissions Reduced : Simulations\Large Cpy Focus — (blue line)
 CO2 Emissions Reduced : Simulations\Baseline — (red line)
 CO2 Emissions Reduced : Simulations\Double Staff — (green line)
 CO2 Emissions Reduced : Simulations\No Maintenance — (grey line)

Service Level

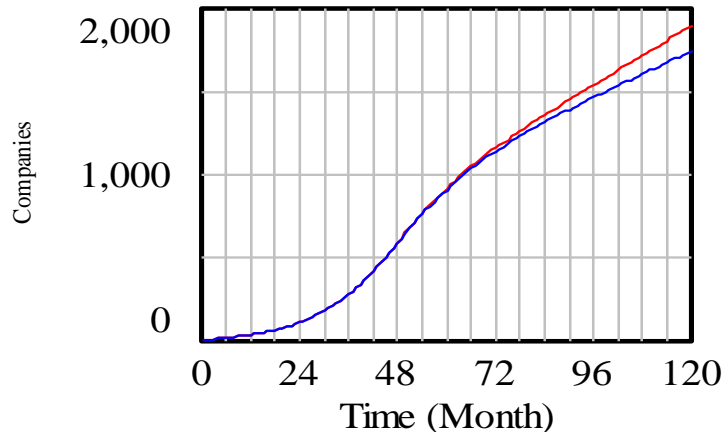


Service Level Large Companies : Simulations\Large Cpy Focus — (blue line)
 Service Level : Simulations\Baseline — (red line)
 Service Level : Simulations\Double Staff — (green line)
 Service Level : Simulations\No Maintenance — (grey line)
 Service Level Small Carriers : Simulations\Large Cpy Focus — (black line)

- Increasing staffing capacity is only a temporary solution
- Focusing on large carriers neglects the majority of small trucking companies which benefit from program services the most
- Reducing maintenance time per partner has greatest sustainable returns over the long run

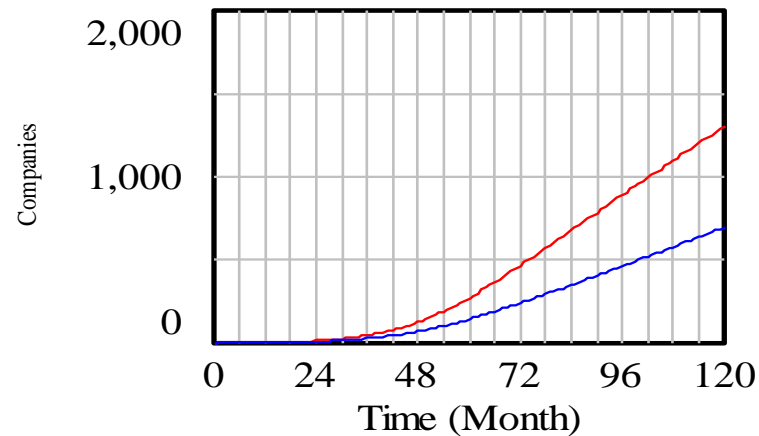
No Strategy Validation Scenario

Carrier Partners



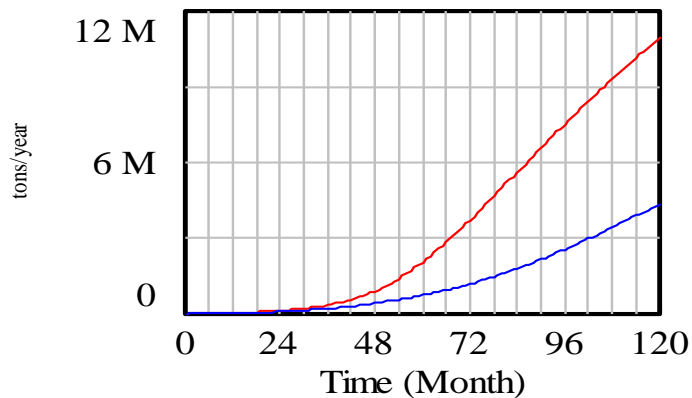
Carriers Total Partners : Simulations\No Strategy Validation —
 Carriers Total Partners : Simulations\Baseline —

Carriers Excellent



Total Carriers Excellent : Simulations\No Strategy Validation —
 Total Carriers Excellent : Simulations\Baseline —

Emissions Saved



CO2 Emissions Reduced : Simulations\No Strategy Validation —
 CO2 Emissions Reduced : Simulations\Baseline —

- Importance of strategy validation
- SmartWay's value proposition
 - Platform for sharing best practices
 - Eliminates unnecessary repeated costs of companies having to independently verify technologies
 - Benefits small companies with limited technical resources

SmartWay Program Evaluation

- High membership
- Motivated partners
 - Embedded in contracts
 - Global template
- Lack of accurate data of exact CO₂ savings
- Cost-effectiveness ...
 - \$2 per ton – CCX
 - \$3 per ton – RGGI
 - \$0.5 per ton – EPA SmartWay

SmartWay Model Takeaways

- Importance of shipper participation in program
- Value of knowledge sharing in partnership for technology diffusion
- Availability of quality tools and services
- Dilution of brand not as significant
- Advantages of voluntary private public partnerships