

Exploratory Scenario Analysis for Regional Sustainability

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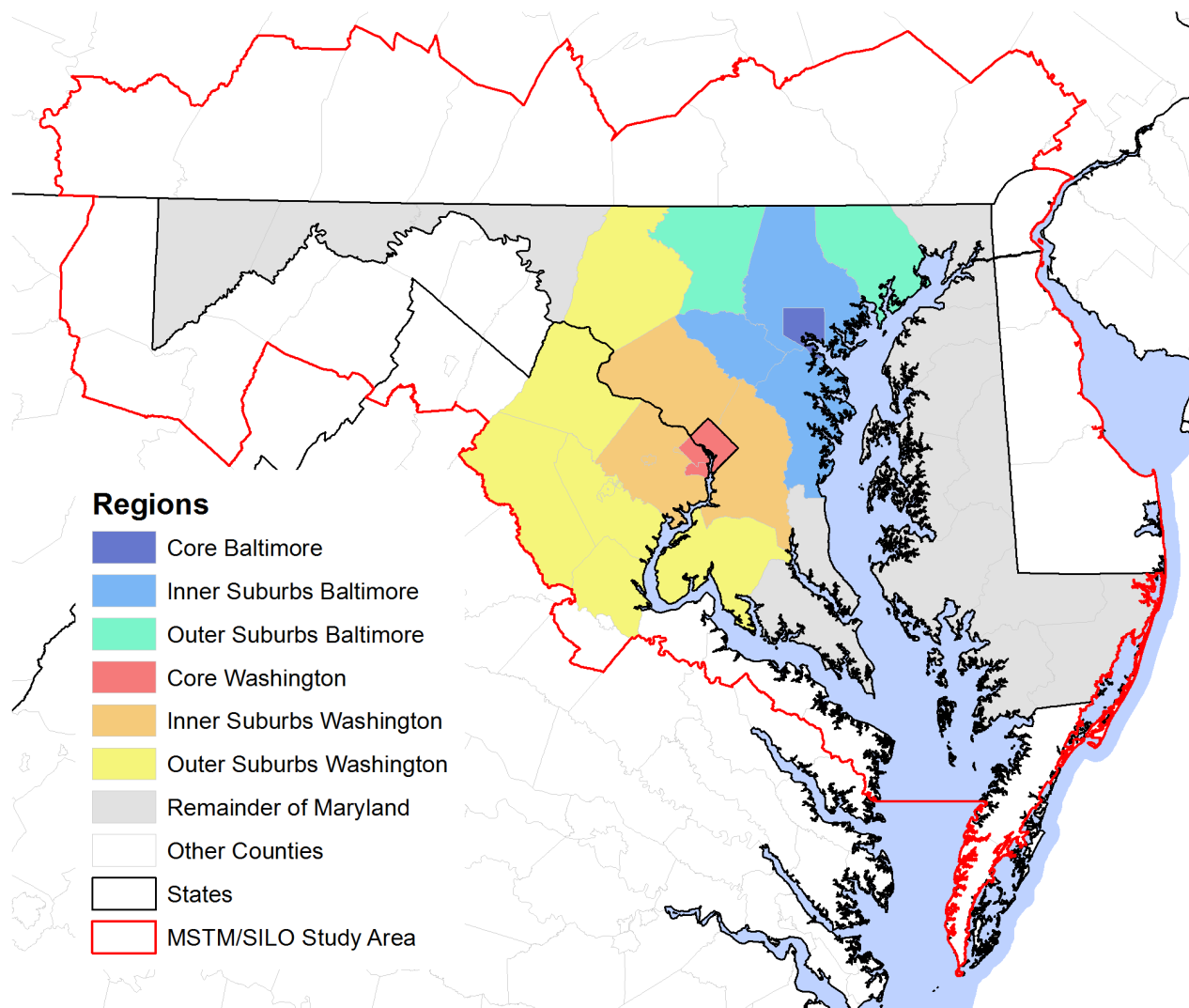


Background



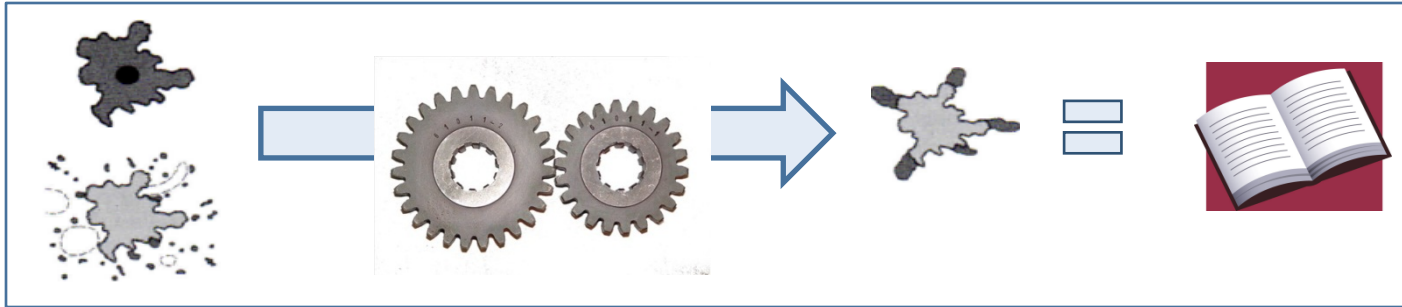
- Focus on Baltimore-Washington region
- Foundation funded; few political constraints
- Expert panel oversight, no public engagement
- Extensive exploratory scenario building effort with major differences between scenarios
- Sophisticated suite of linked models
- Economy, land use and transportation vary simultaneously; no control totals
- Used to inform climate commission
- Work in progress

The Baltimore-Washington Region: State of Maryland

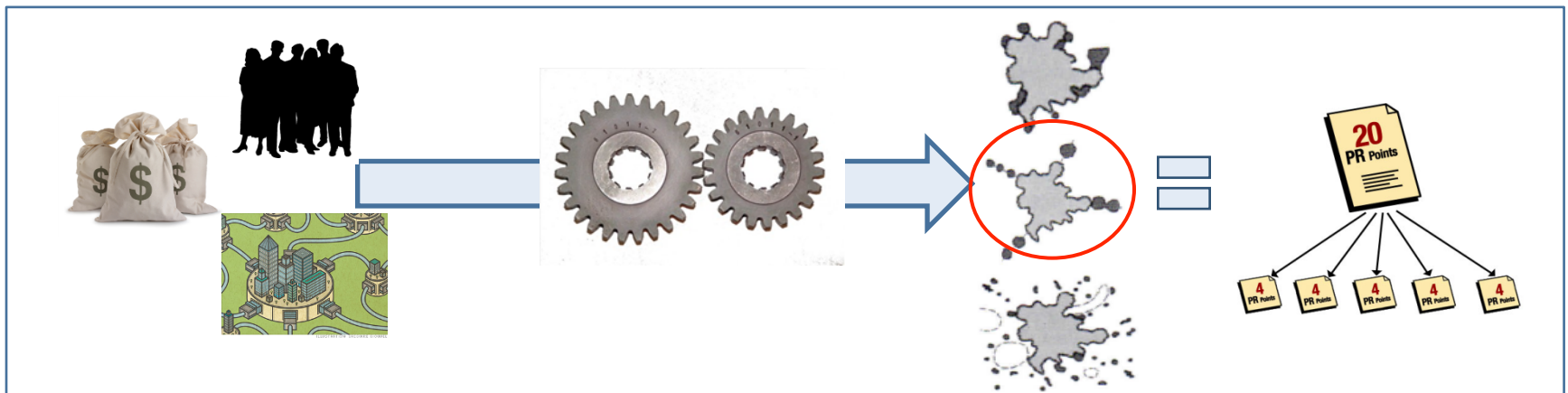


Exploratory Scenarios

1. End state planning: Testing the effects of TLU Alternatives vs. Trends on Selected Outcomes...in order to choose an optimal future TLU plan



2. Exploratory planning: Testing the effects of Multiple Trends on Many Outcomes including TLU...in order to adopt the most resilient strategies



Building Exploratory Scenarios

- ***Driving forces***
 - *Certain* in regional importance
 - *Uncertain* in strength and or direction
 - *Plausible* to occur within planning horizon
 - *Outside* the control of state, regional, and local leadership
- ***Scenarios***
 - Scenarios reflect combinations of driving forces that present plausible narratives of future events



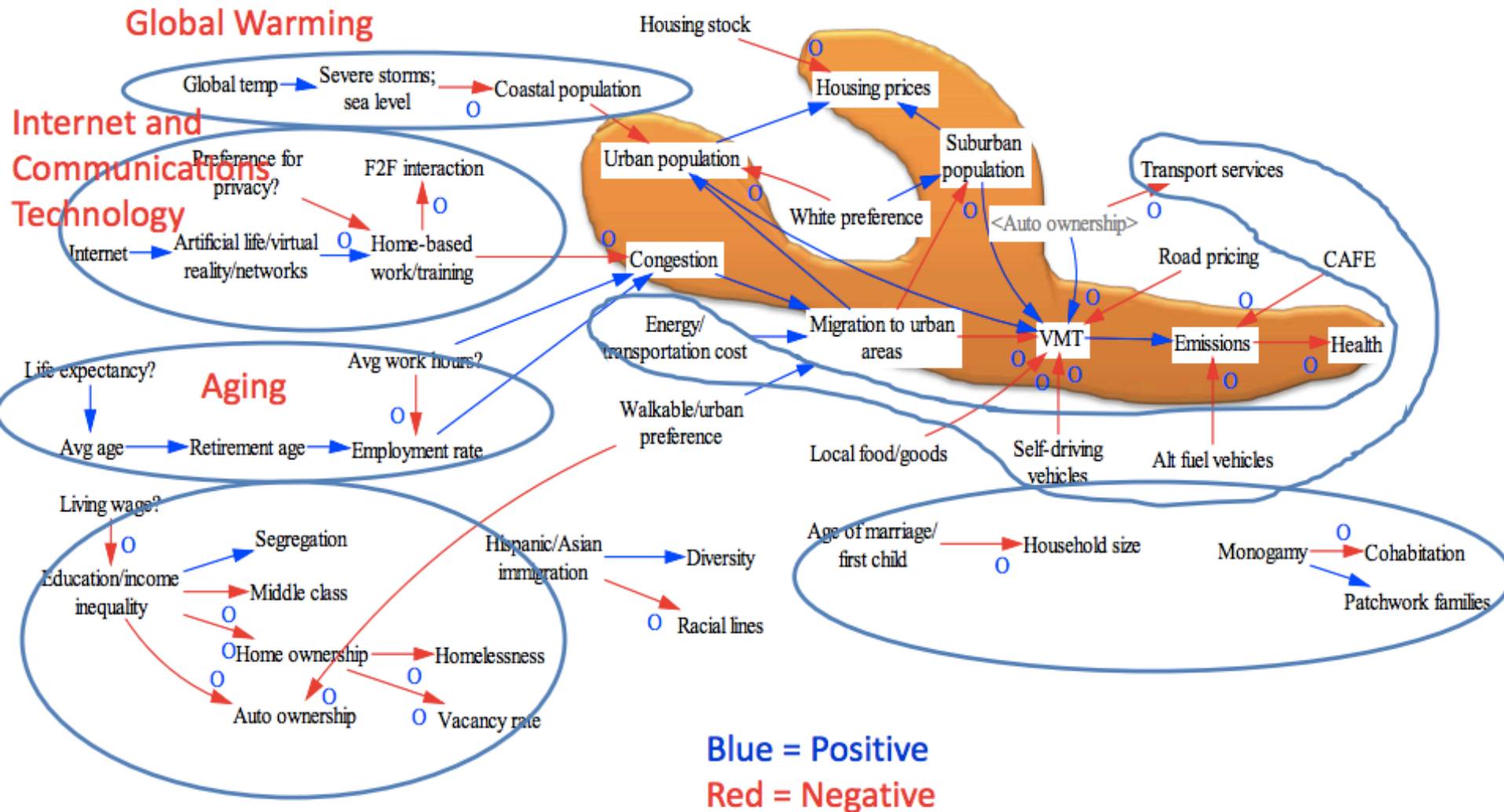
What an Exploratory Workshop Looks Like



Identify Broad Driving Forces



Social Driving Forces and Policy from Posters





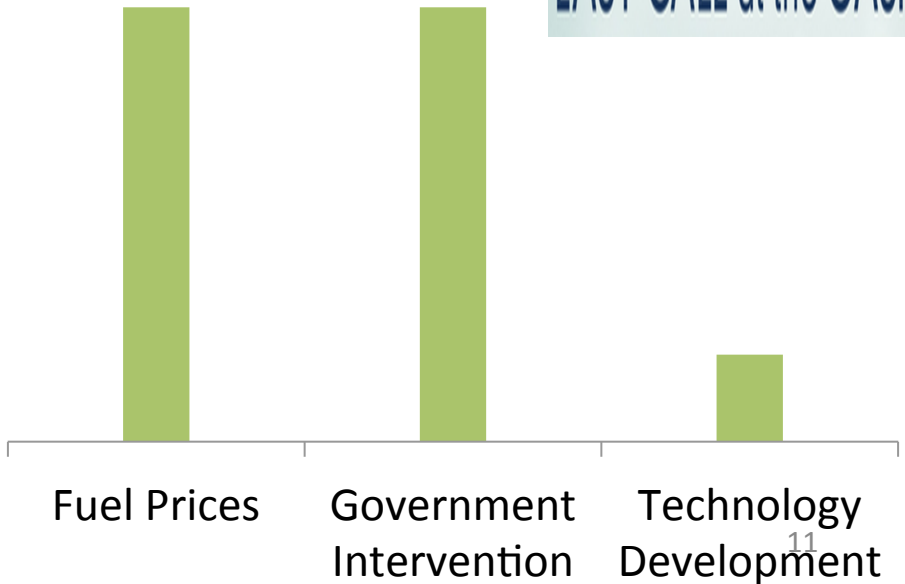
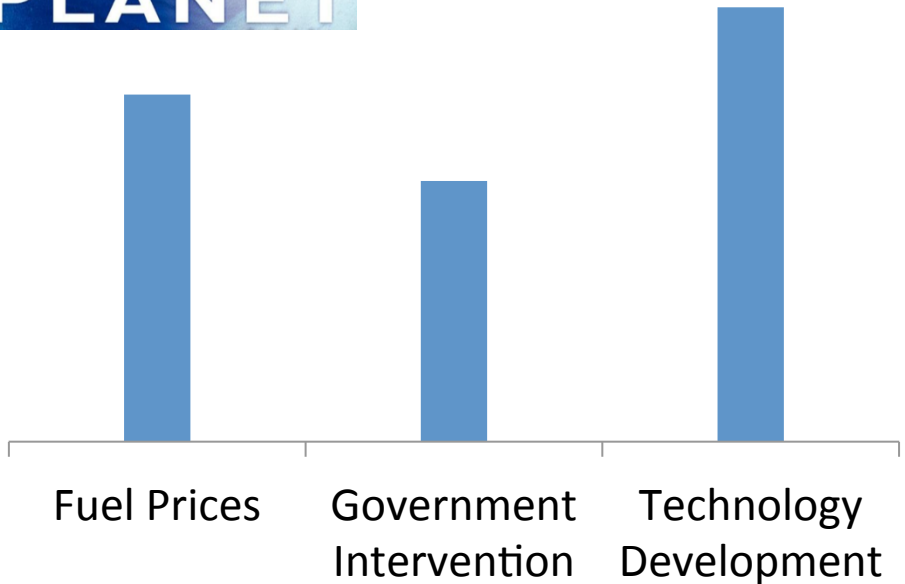
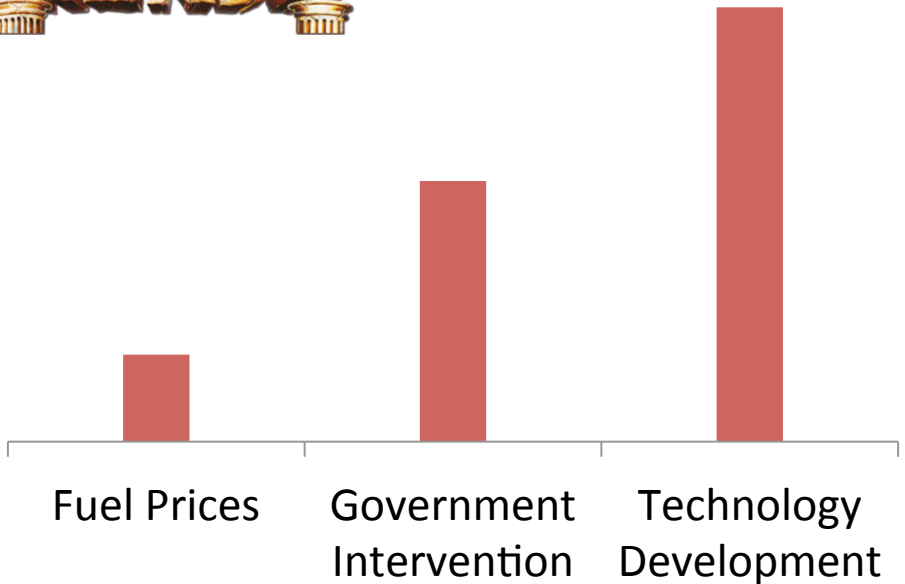
Baseline and Four Scenarios

- **Baseline:** Continuation of current policies and trends
- **Revenge of the Nerds:** Strong economic growth, autonomous vehicles, and growing inequality
- **The Blue Planet:** Strong economic growth, embrace of green technology, and major transit investments
- **Ashes and Diamonds:** Land use deregulation, highway expansion, and limited tech change
- **Last Call at the Oasis:** Resource scarcity, high fuel prices and slow economic growth

	PRESTO Scenarios			
	Blue Planet	Revenge of the Nerds	Last Call at the Oasis	Ashes and Diamonds
Technological	Green technology development driven by high carbon prices	Underestimation of technology; Embrace of technology; Profit driven tech	Green technology embraced but does not advance significantly	Technological progresses at expected rate
Economic	Strong economy drives up fossil fuel demand; Aligns with green economy	Strong economy follows technological development	Resource scarcity raises prices of fuel, water, and food -> impacts families	Inequality deepens; Economy eventually slows because of inequality
Political	Federal government surplus from strong economy	Tax receipts increase from strong economy; tech elites dominate	Acceptance of direct government intervention; Ecology > economy	Deregulation, low taxes prevails; Economic elites dominate
Social	Spirit of disruption and innovation directed to environmental and social concerns.	Spirit of disruption and innovation directed to profits; Fast technological adoption	Localism; Sense of stewardship	Libertarian social thinking prominent
Environmental	Fossil fuel resources insufficient for demand	Delayed reaction to environmental concerns	Deep scarcity; particularly water and fossil fuel	Resources abundant; environment degrading

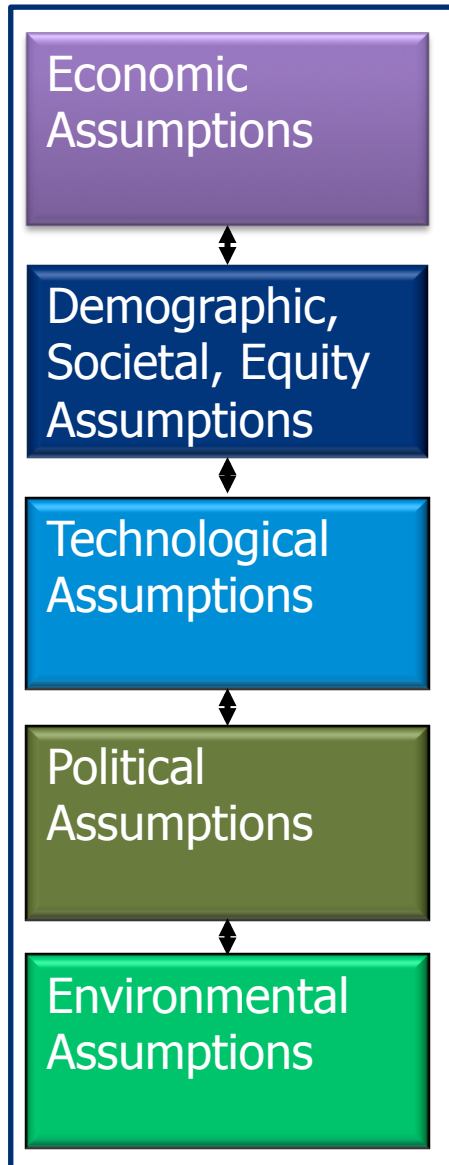
REVENGE OF THE NERDS

- This is the future in which **technological development** drives strong international and national economies; abundant fossil fuels tamp down the price of carbon based energy.
- The new **economic opportunities** in the fields of communications, 3D printing, autonomous vehicles, and energy extraction encourage reinvestment in government R & D in as well as **deregulation**.
- The growing **middle class** demands tax breaks but less government services.
- Social and environmental sustainability are encouraged through **tax breaks, pricing mechanisms, and other incentives**.
- The fast growing economy **increases inequality** but technological job displacement challenges families.

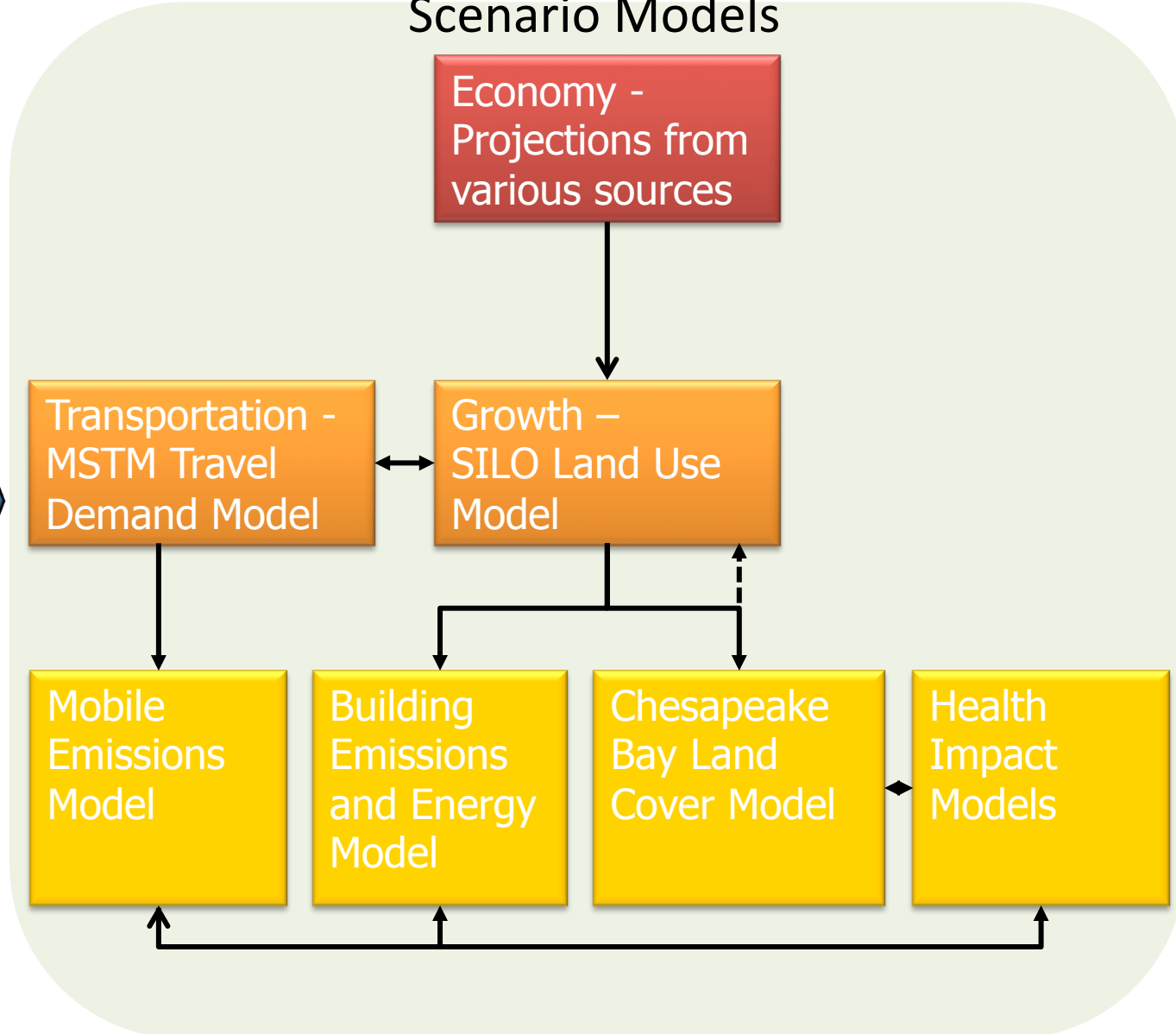


The Modeling Suite

Scenario Drivers



Scenario Models



Missing transition....

- Worth noting in a slide (or on the next one as text above the input bullets) that the fundamental challenge we have is translating rich and nuanced scenarios into limited, simple model inputs....

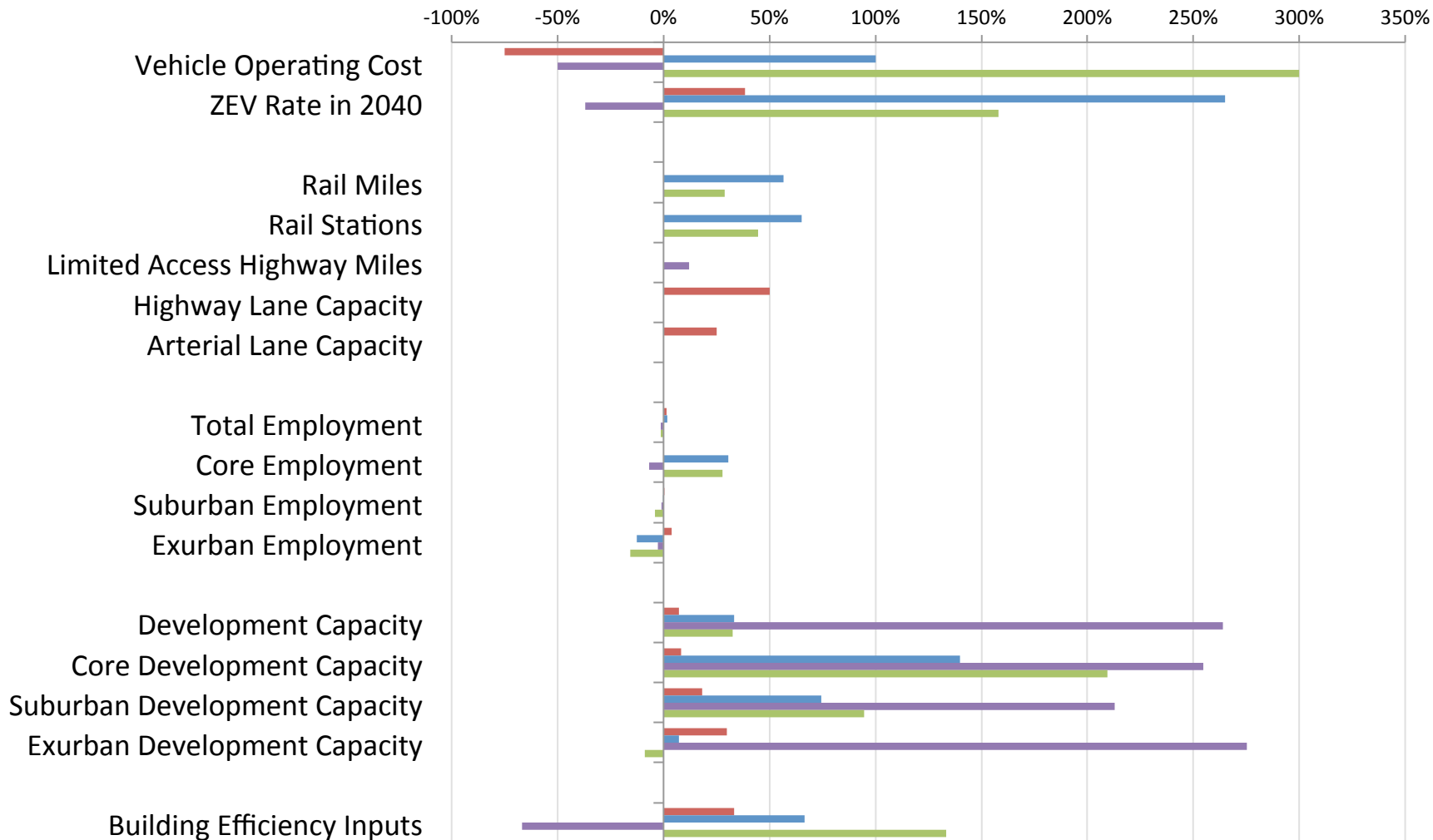


Five Critical Input Categories

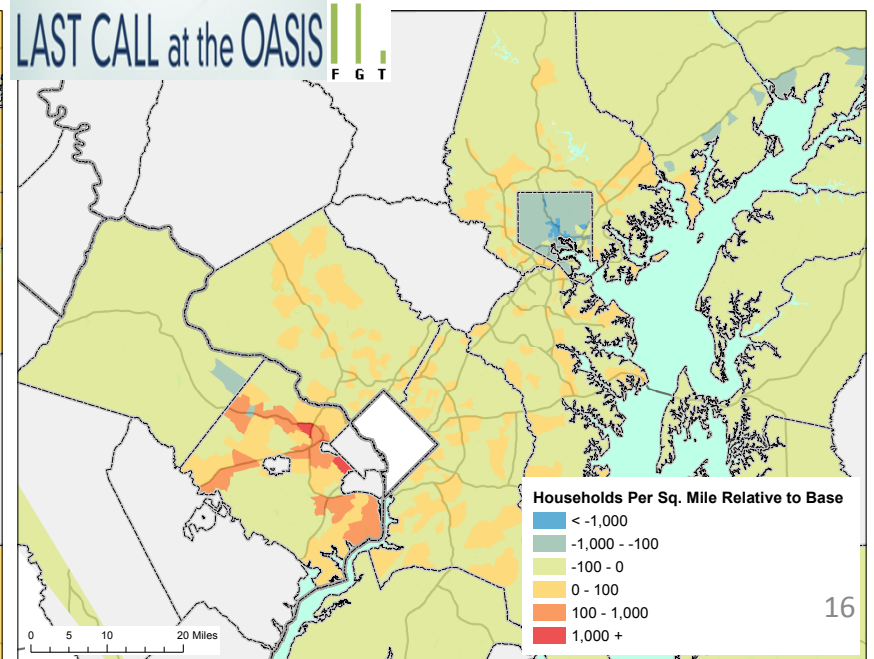
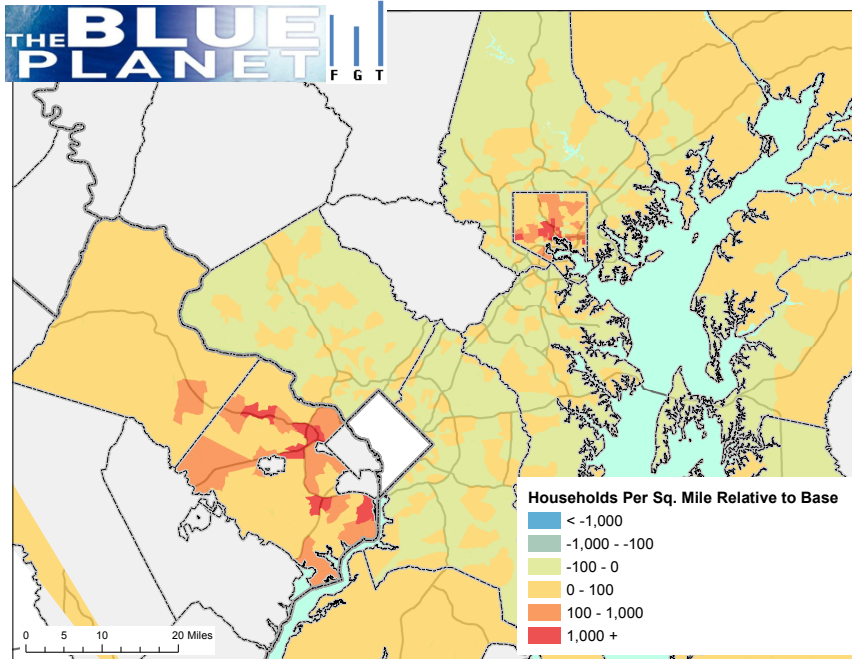
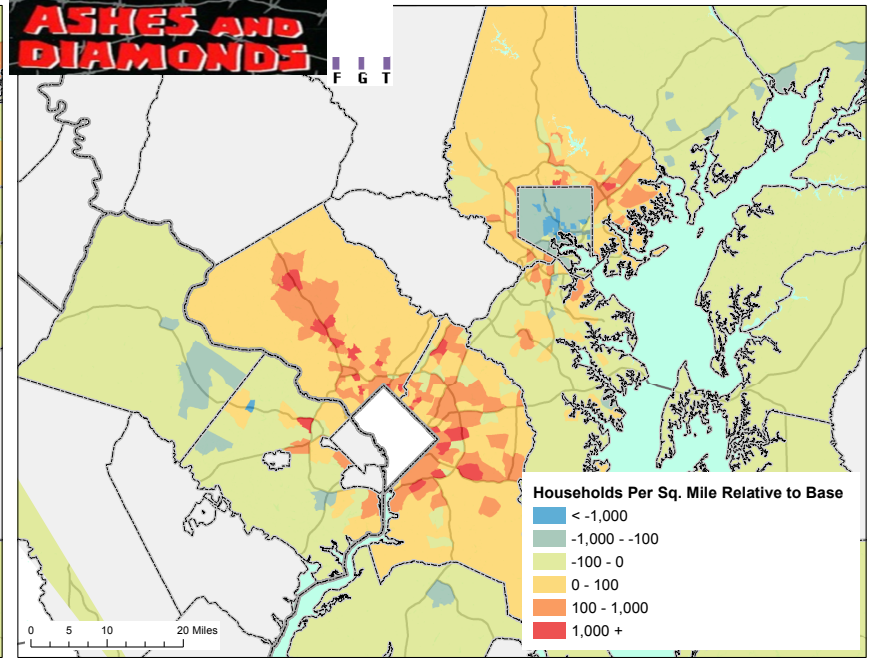
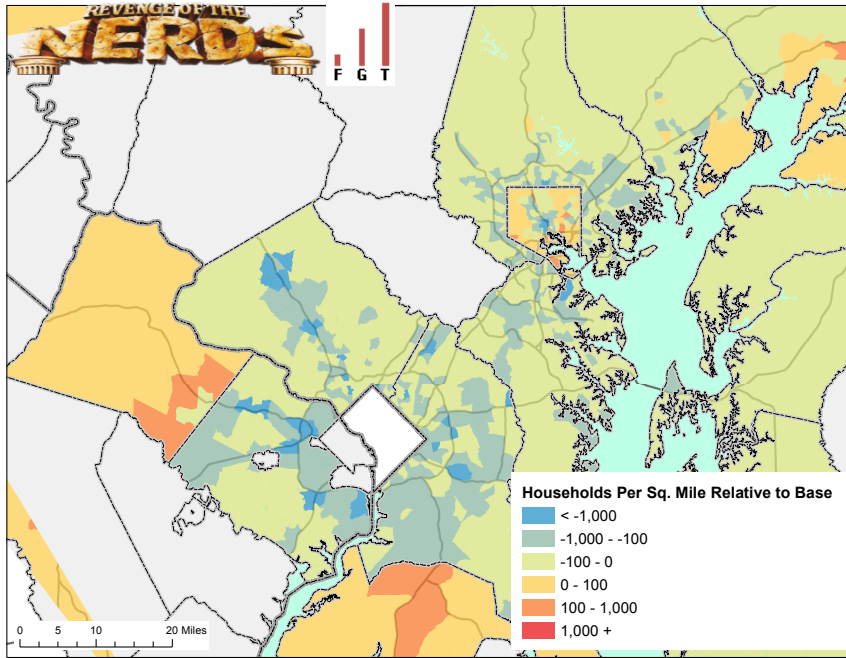
- **Employment Growth and Location**
- **Vehicles Characteristics including fuel cost**
- **Network Characteristics**
- **Land Use Controls**
- **Building Efficiency**

All Inputs

Inputs Relative to Baseline Scenario



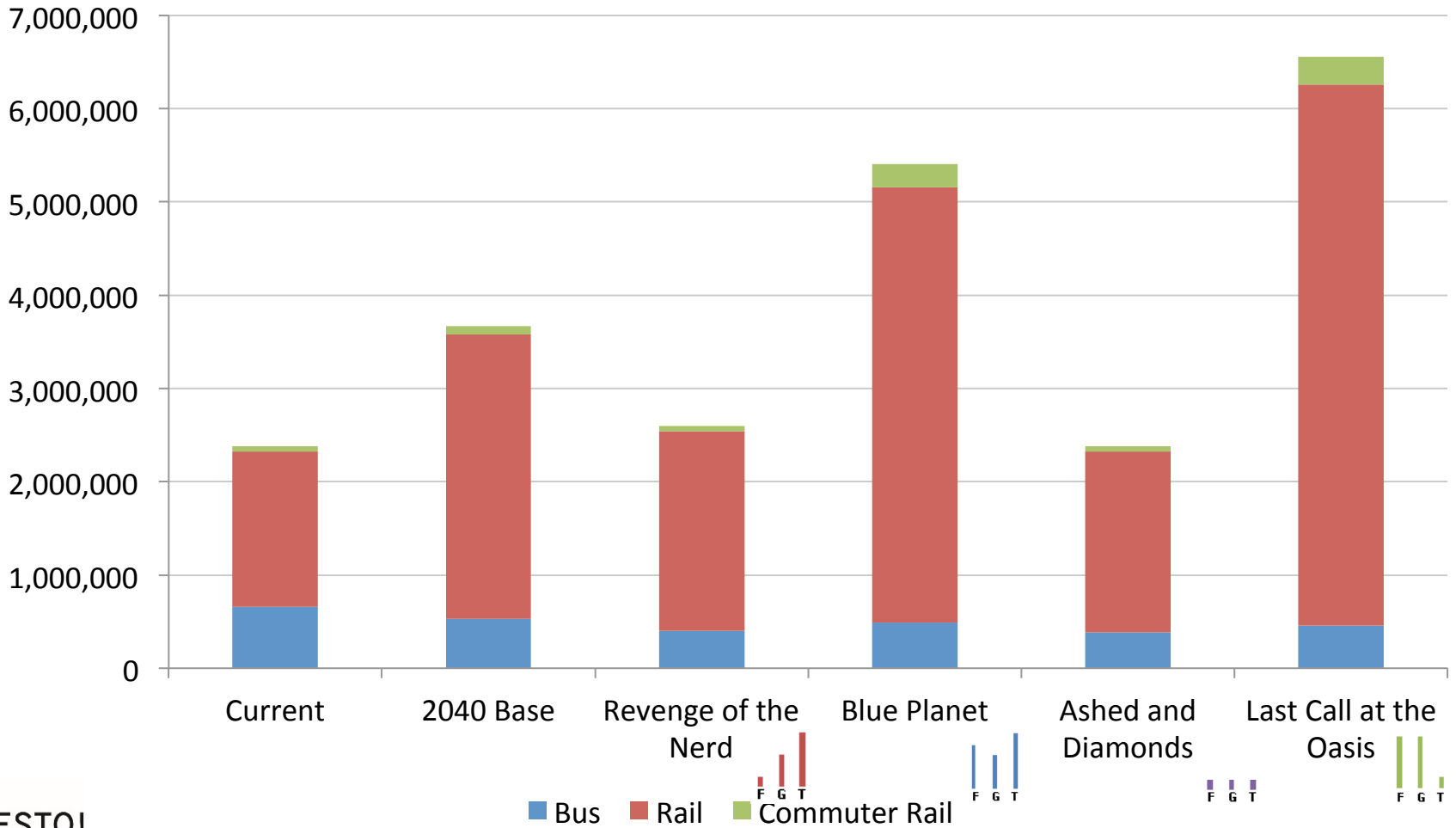
Residential Patterns Reflects Employment location, Travel Costs, and DC



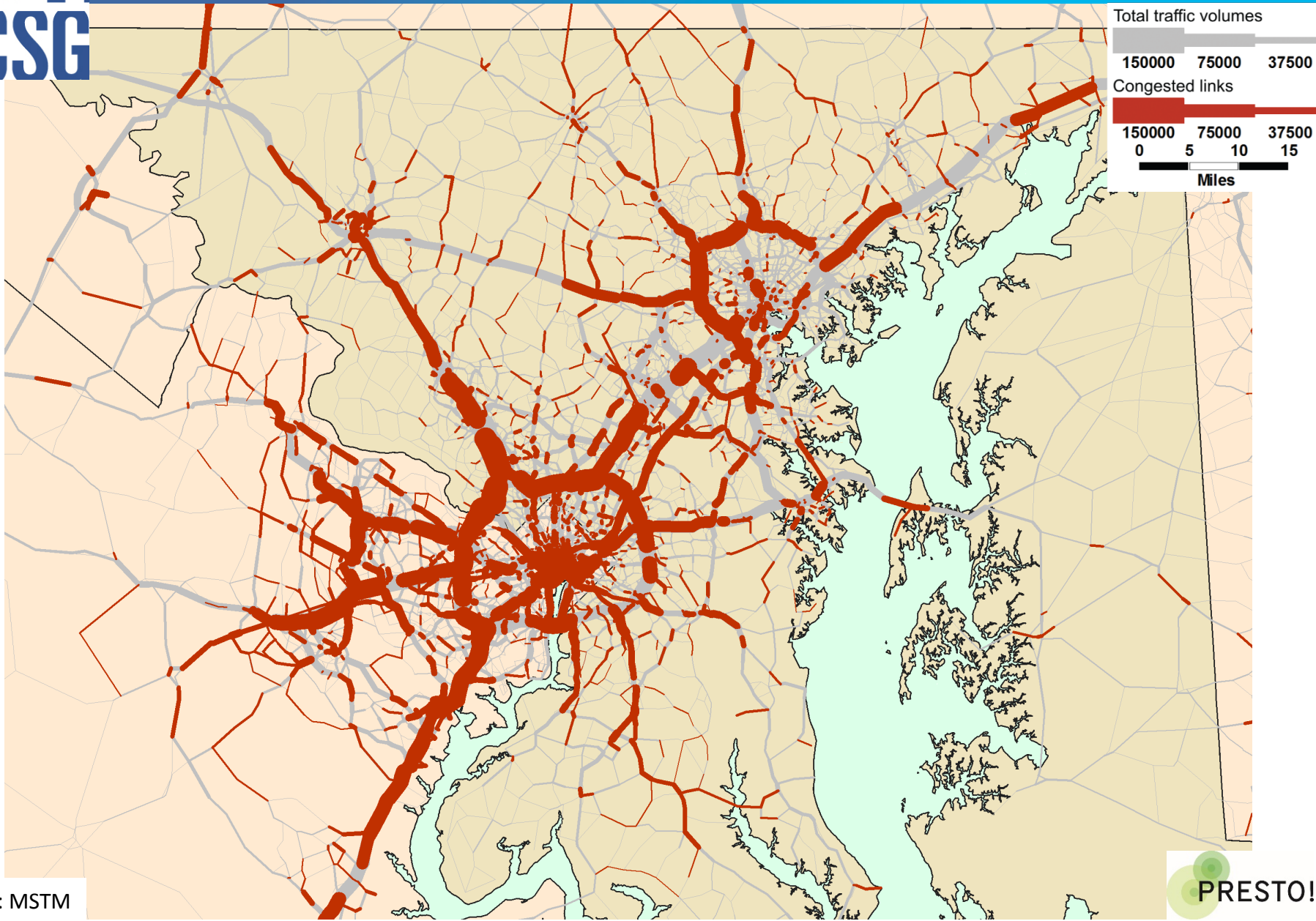
Fuel Prices Have Greatest Influence on Transit Ridership



Transit Ridership in Each Scenario

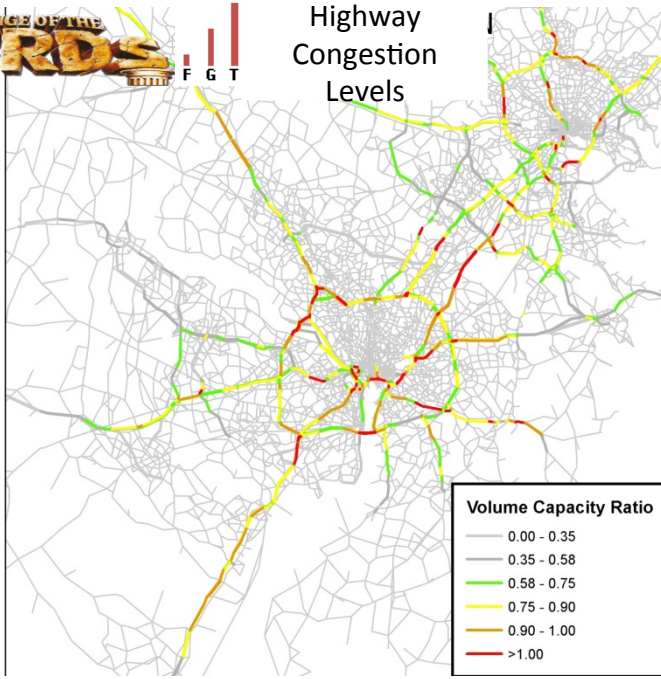


Congestion Worsens Extensively in the Baseline

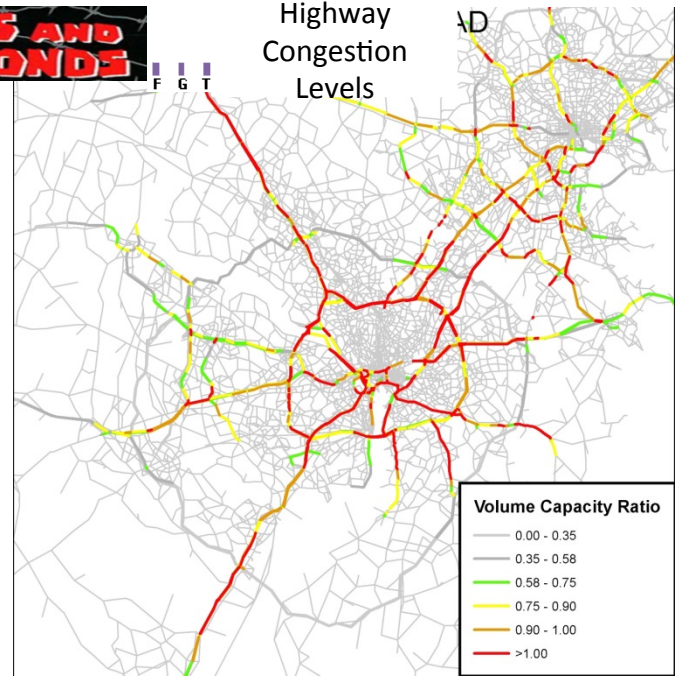




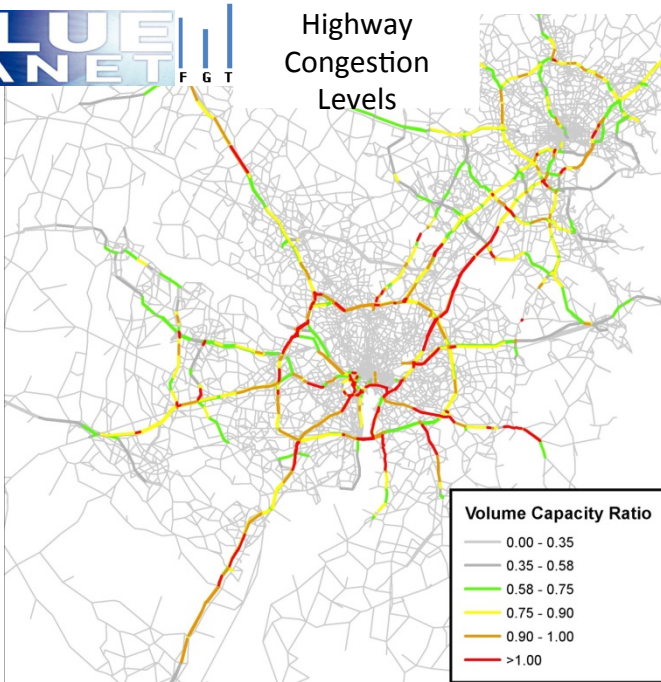
Highway Congestion Levels



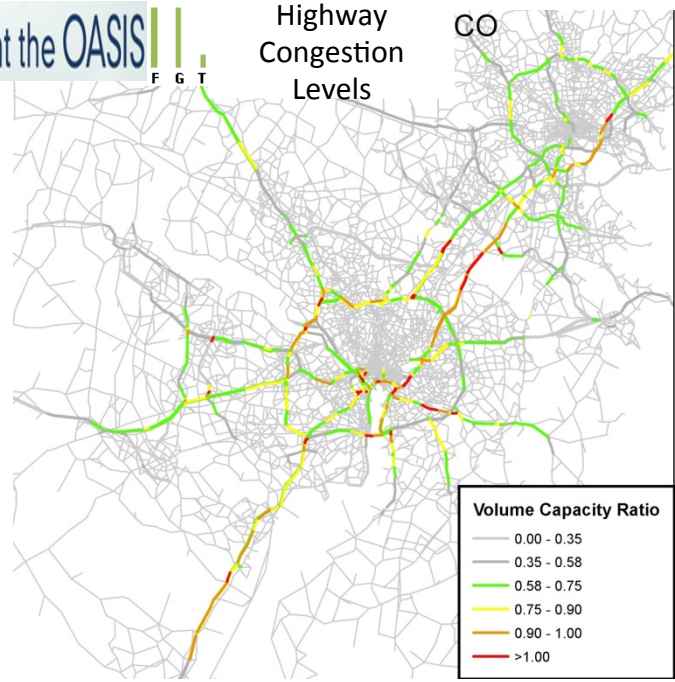
Highway Congestion Levels



Highway Congestion Levels



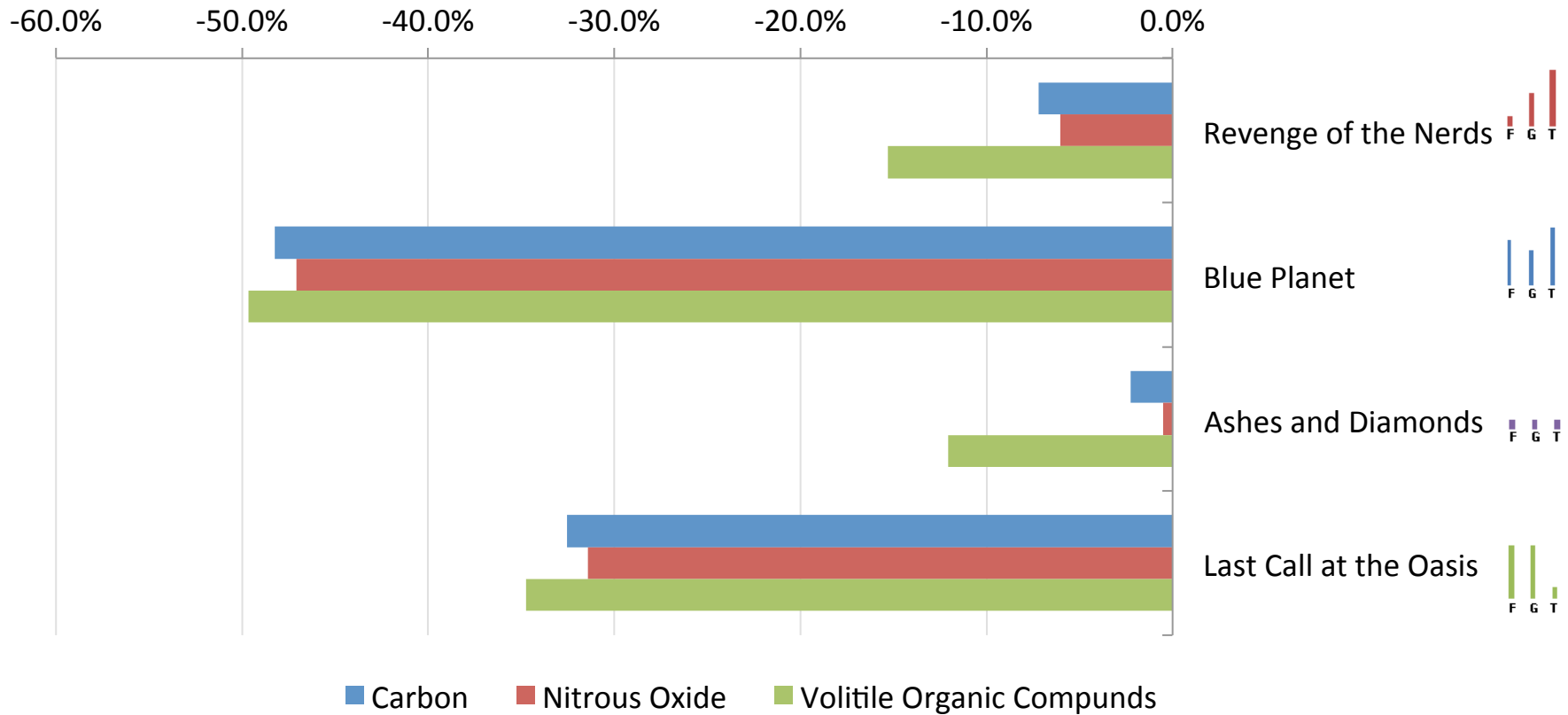
Highway Congestion Levels



Technology Drives Reductions in Carbon Emissions



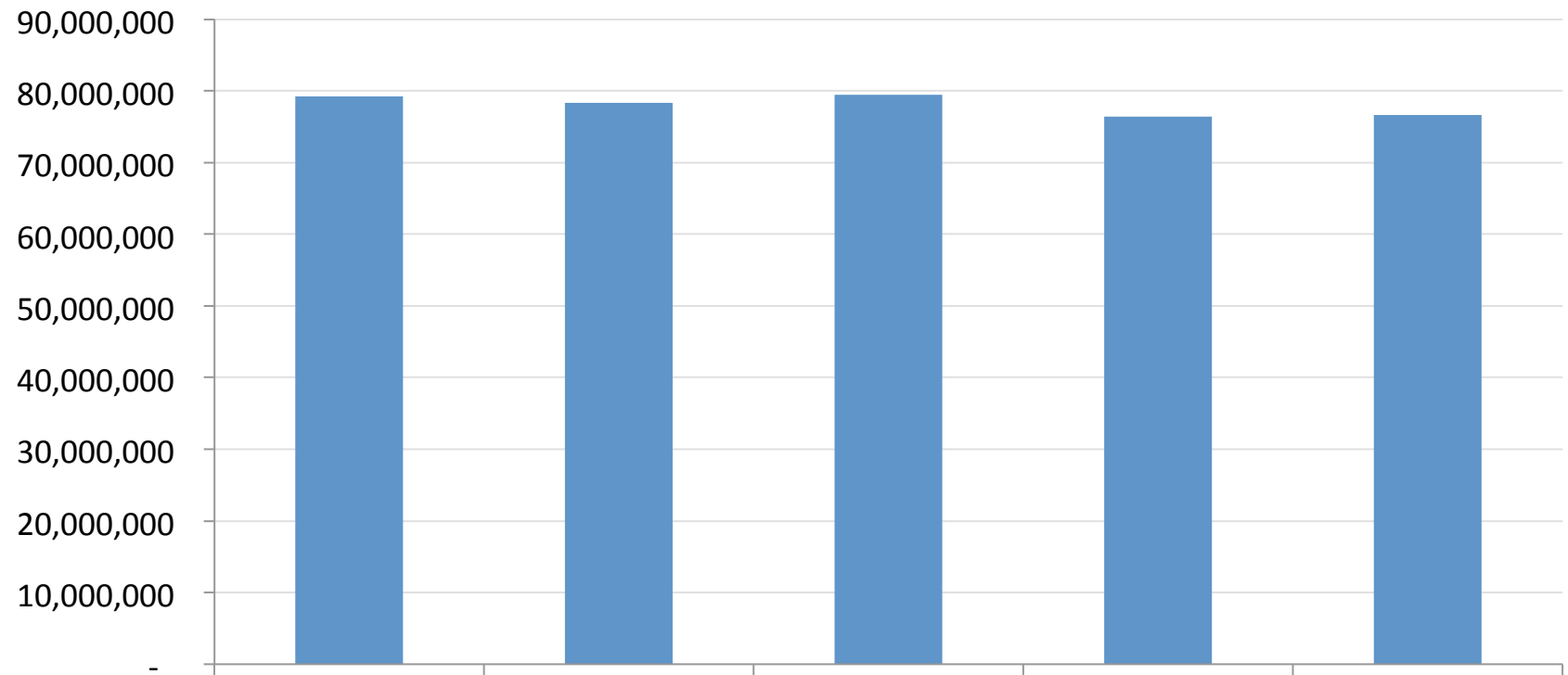
Emissions for Vehicles Relative to Base Scenario





Building Emissions Change Very Little

Total Building Emissions (Lbs)



Base

Revenge of the Nerds

Blue Planet

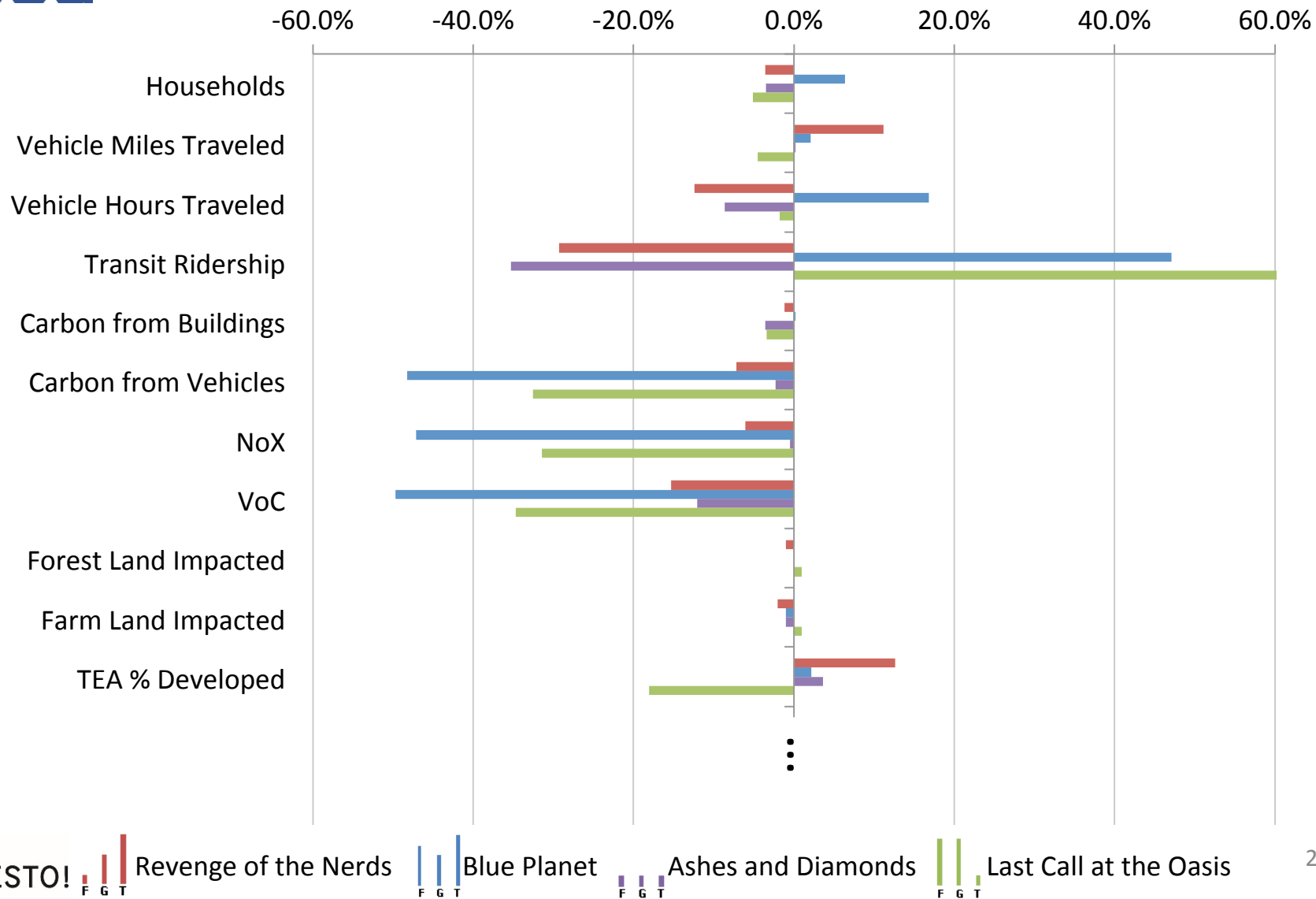
Ashes and Diamonds

Last Call at the Oasis



Compiled Results

Scenario Results Relative to Baseline



- Development capacity – **where and how much** – is key driver of land use and has impacts throughout all systems.
- Autonomous vehicles allow households to move further out and travel further, but increased highway capacity reduces congestion.
- Fuel pricing has a greater impact on mode split than investments in new infrastructure.
- The rate of electric vehicle adoption is the dominant factor in emissions from vehicles.

- Emissions from the building sector do not vary much across scenarios since much of the future building stock already exists.
- Land use constraints do not have large impacts on farm and forest lost, but protect valuable ecological areas.
- Generally: the cost of automobility and rate of technological change in the transportation sector have the most profound impacts.

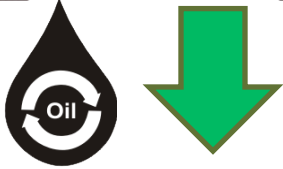


Lessons for Scenario Analysis

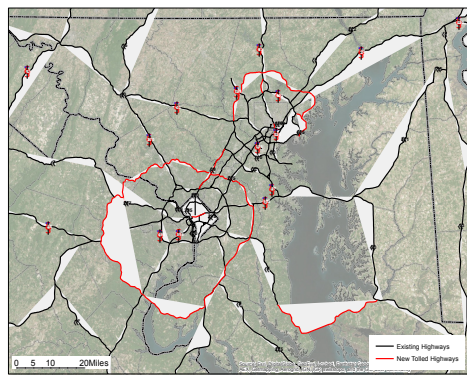
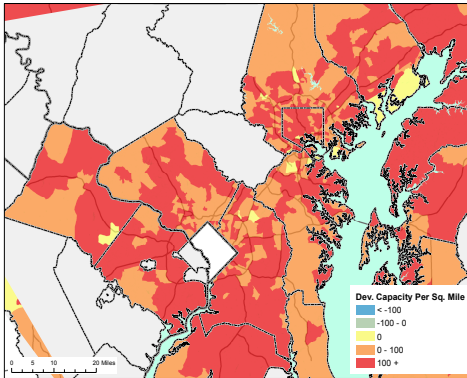
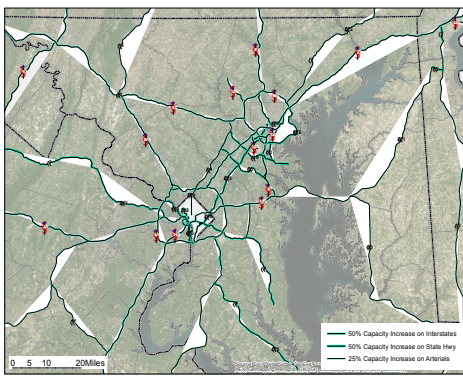
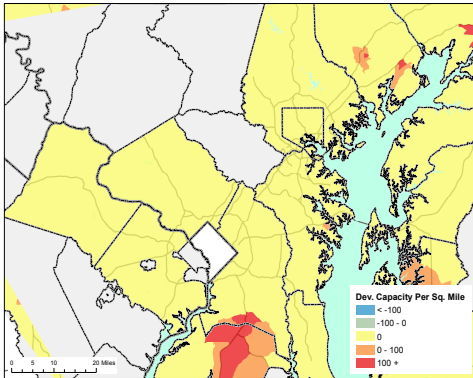
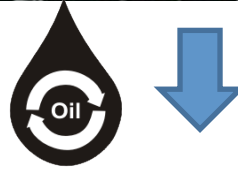
- Exploratory scenario analysis is part art, part science
- It is best suited to explore the ramifications of uncertain future trends and events.
- Loosely coupled models facilitate analysis of impacts beyond transportation-land use.
- Scenario and model complexity facilitates more robust policy analysis
- ...but hugely complicates interpretation and communication of results

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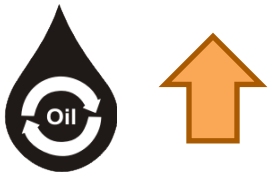
REVENGE OF THE NERDS



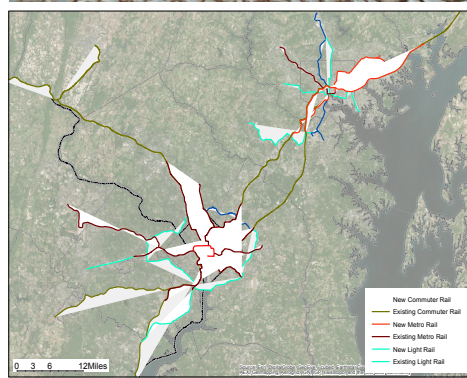
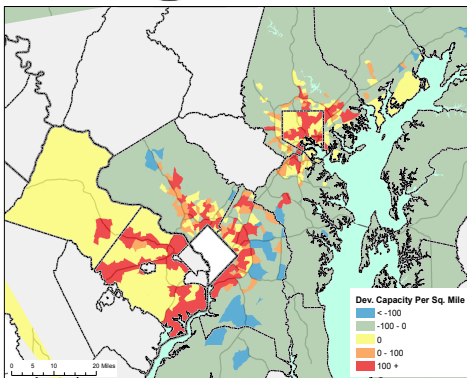
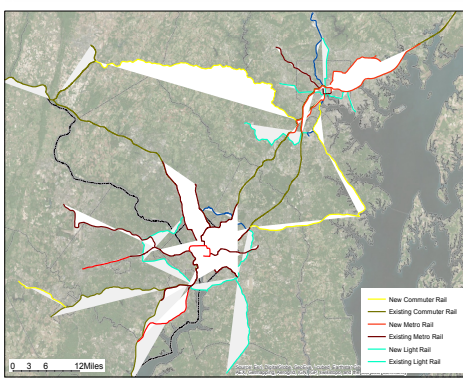
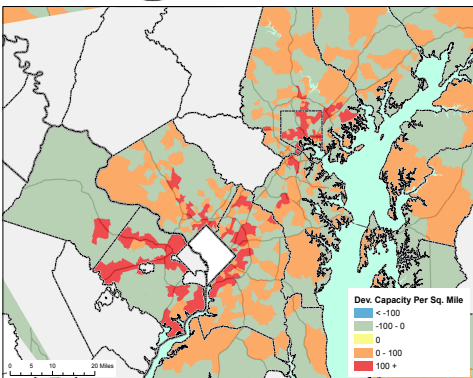
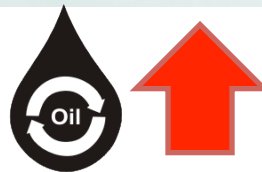
ASHES AND DIAMONDS



THE BLUE PLANET



LAST CALL at the OASIS



Inputs

Inputs Relative to Baseline Scenario

-100% -50% 0% 50% 100% 150% 200% 250% 300% 350%

CAFE standards + green vehicles

Vehicle Operating Cost
ZEV Rate in 2040

Infrastructure Investments

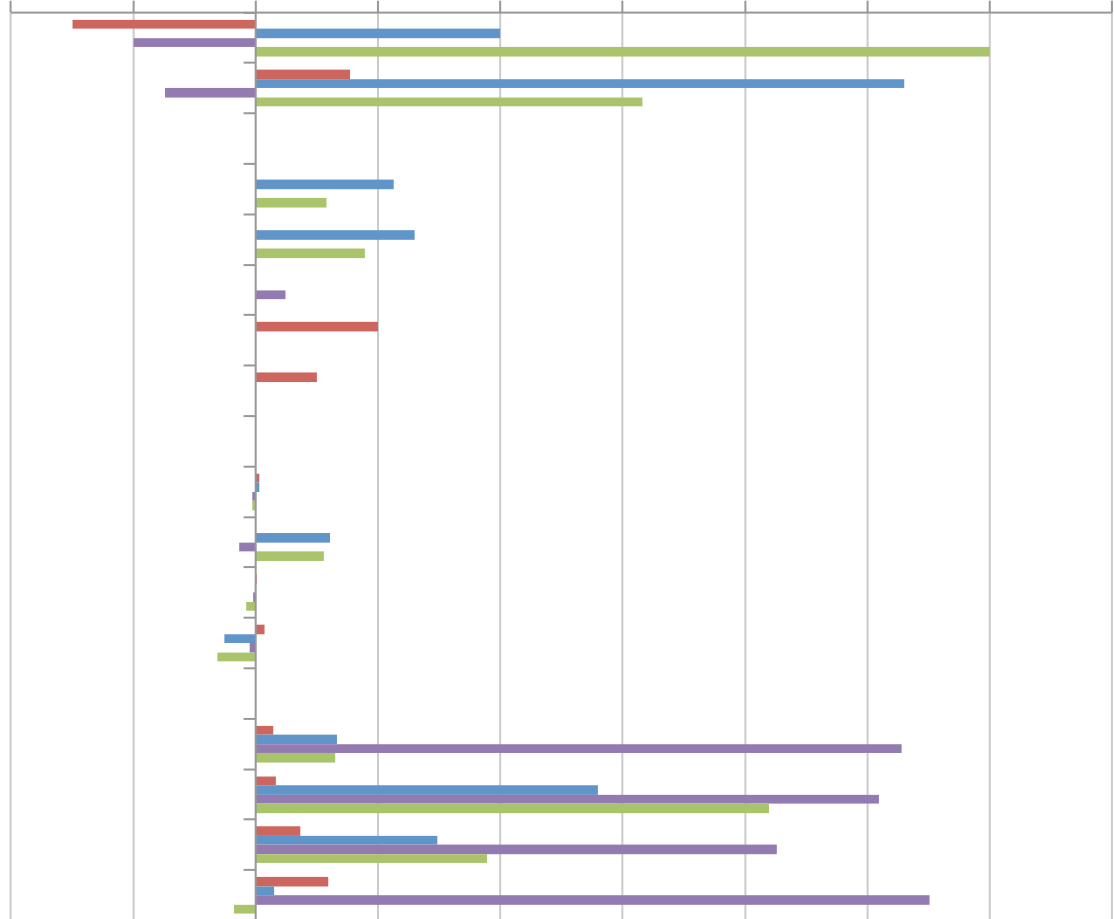
Rail Miles
Rail Stations
Limited Access Highway Miles
Hihgway Lane Capacity
Arterial Lane Capacity

Employment Impacts

Total Employment
Core Employment
Suburban Employment
Exurban Employment

Land Use Policy

Development Capacity
Core Development Capacity
Suburban Development Capacity
Exurban Development Capacity

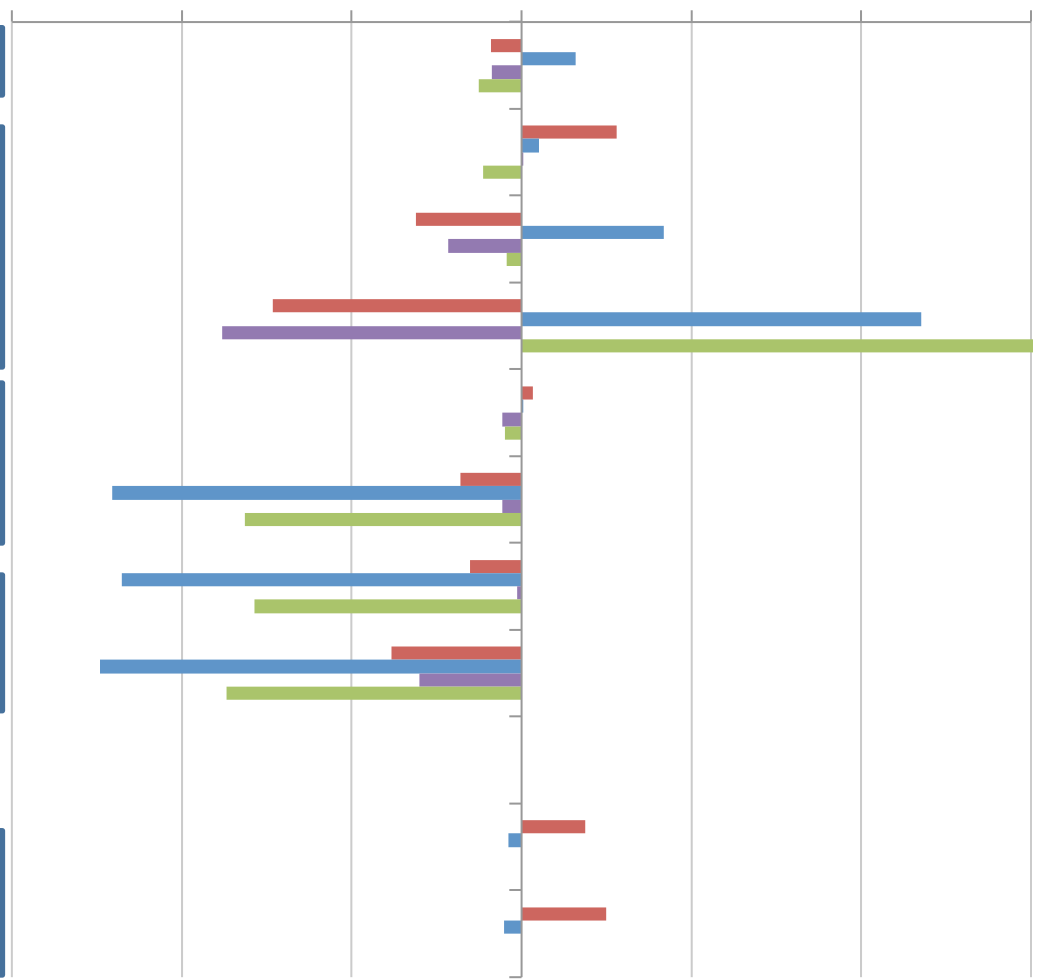
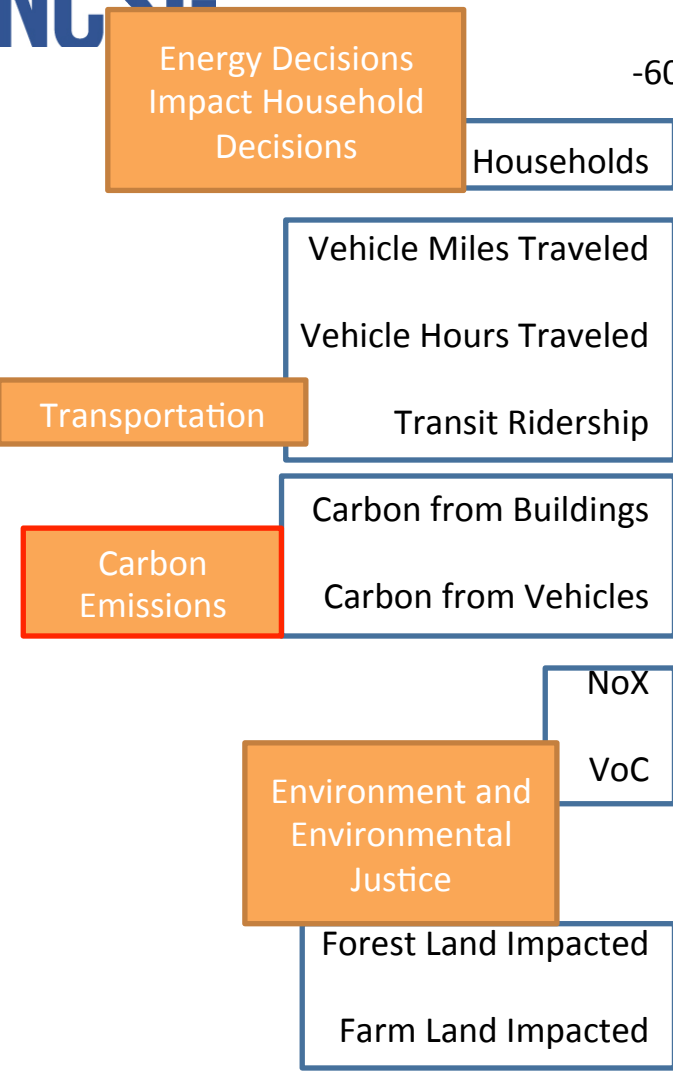


Outputs

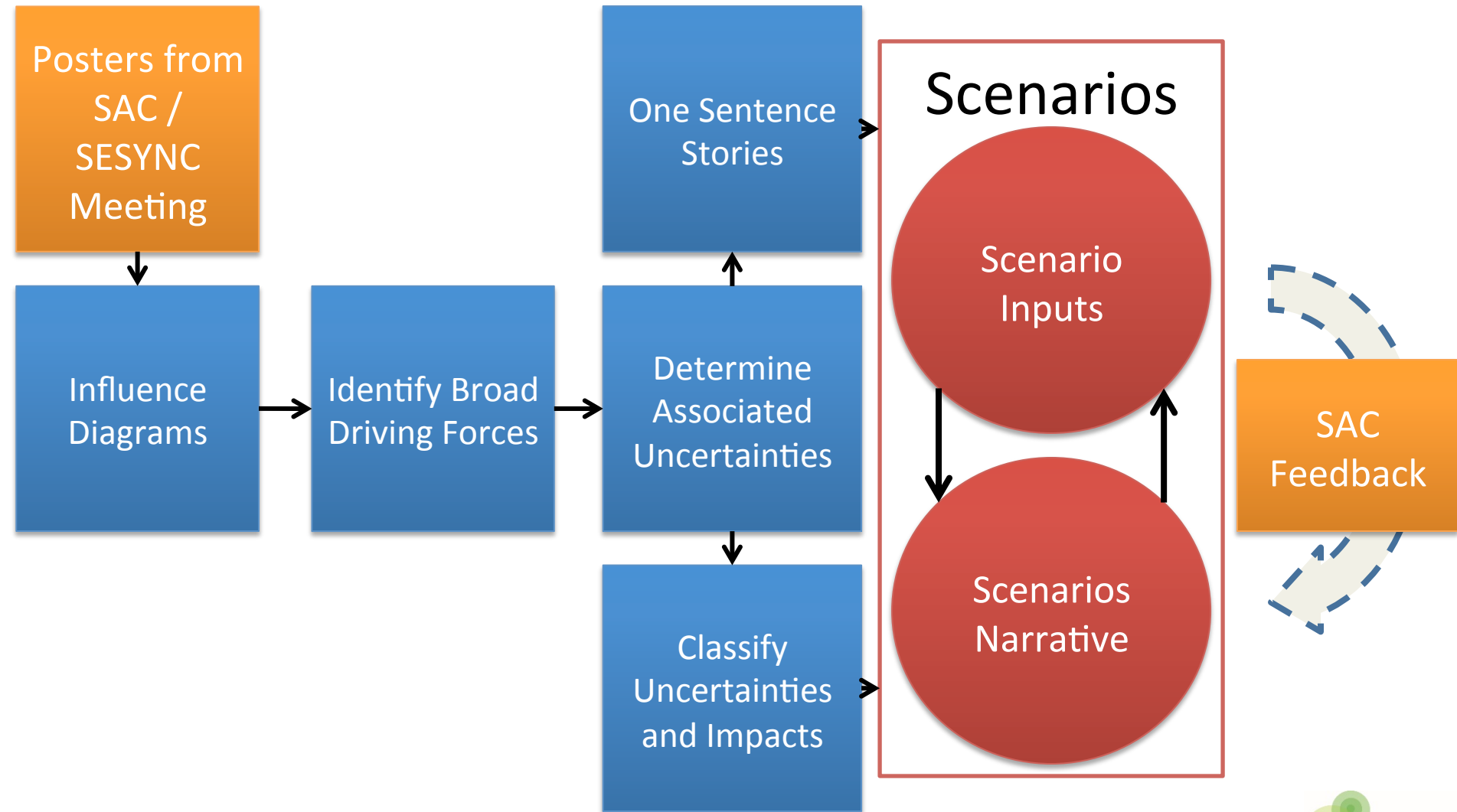


Scenario Results Relative to Baseline

-60.0% -40.0% -20.0% 0.0% 20.0% 40.0% 60.0%



SCENARIO DEVELOPMENT PROCESS



Farm and Forests Losses Similar Across Scenarios



	Base	Revenge of the Nerds	Blue Planet	Ashes and Diamonds	Last Call at the Oasis
Forest	671,535	664,914	668,935	672,740	677,523
		-0.01	0.00	0.00	0.01
Scrub-Shrub	374,434	363,533	368,596	371,541	375,642
		-0.03	-0.02	-0.01	0.00
Farm	522,269	511,727	517,336	519,467	526,040
		-0.02	-0.01	-0.01	0.01
Wetland	1,495,807	1,486,099	1,491,520	1,499,863	1,507,673
		-0.01	0.00	0.00	0.01

Impact on Critical Ecological Areas Changes with Scenarios



Acres In Targeted Ecological Area Watersheds Impacted

