Appalachian Energy Summit

APPALACHIAN STATE UNIVERSITY

Transportation Working Group
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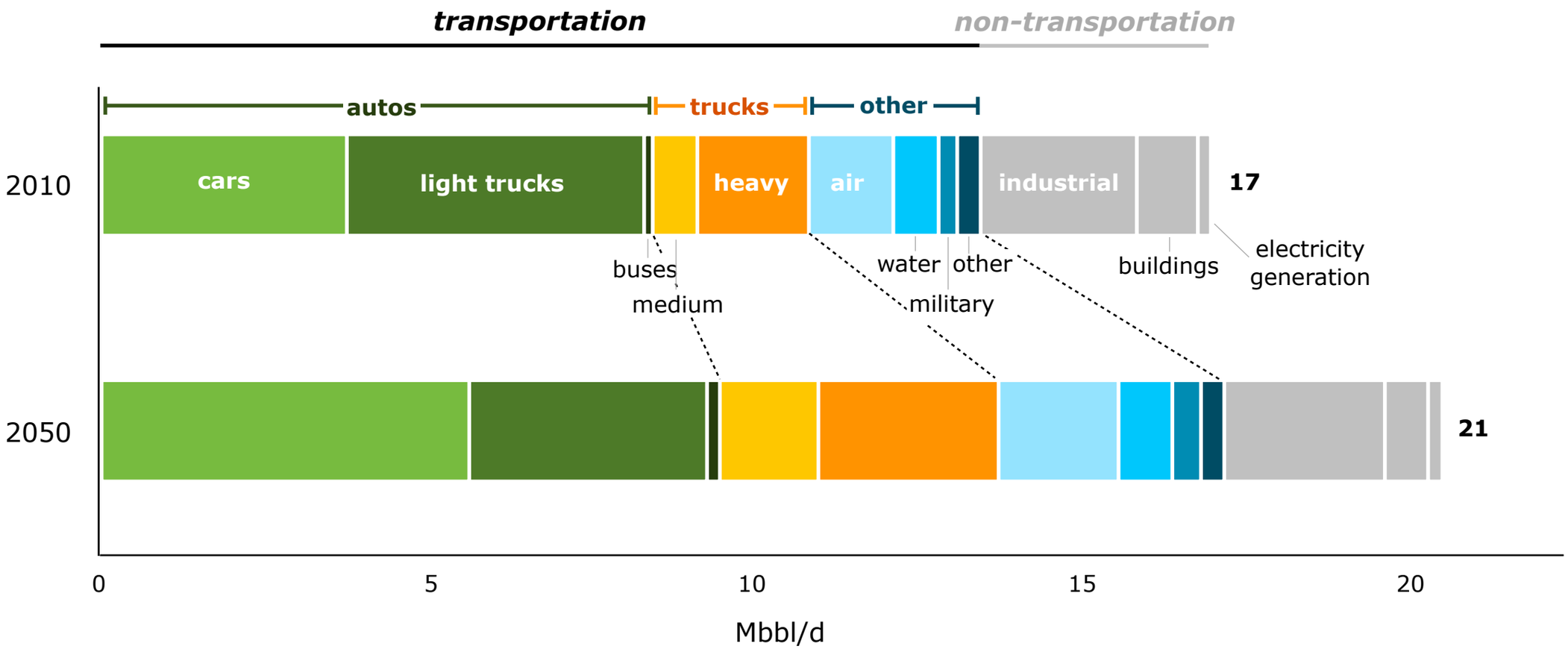
Appalachian State University

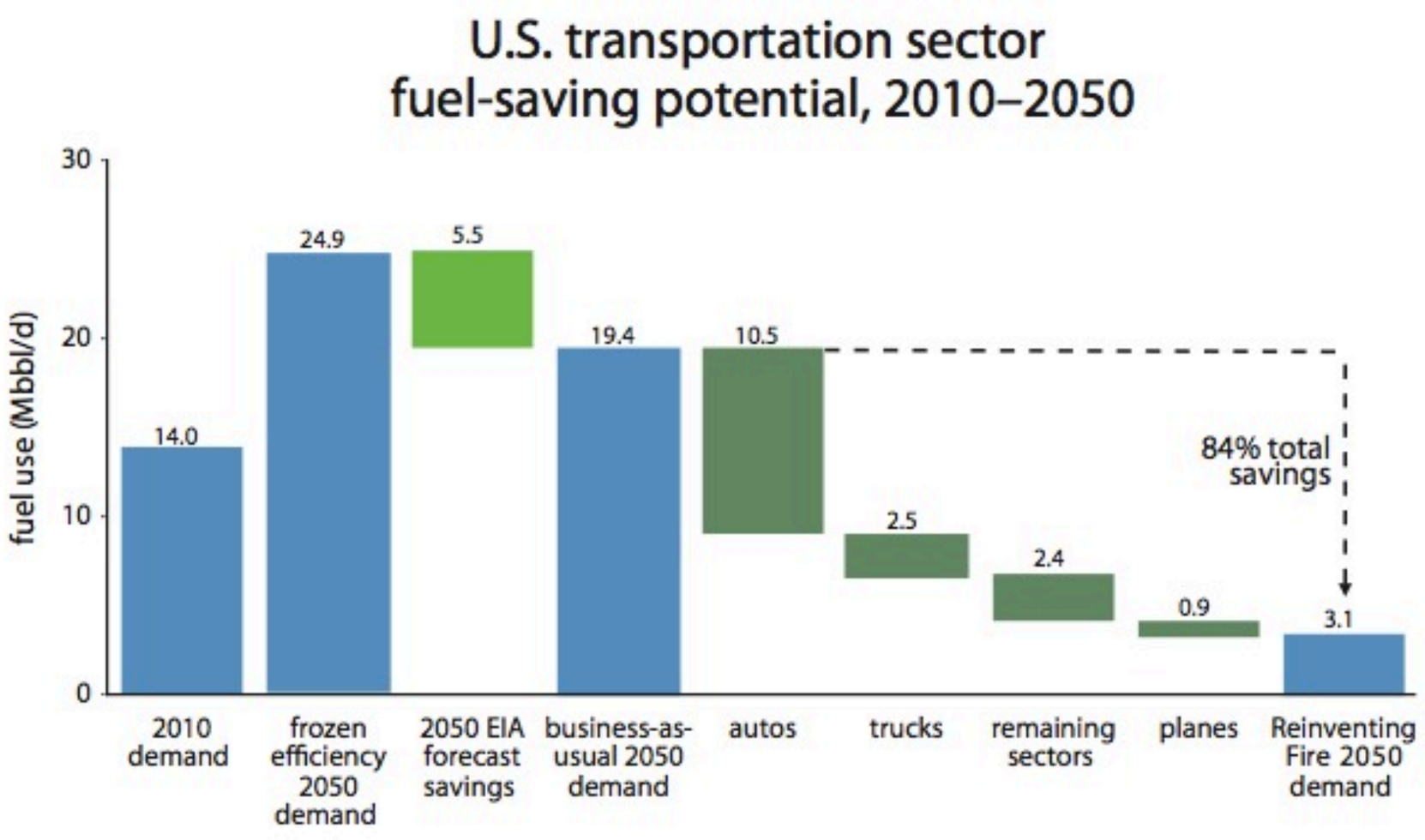
Greg Rucks

ROCKY MOUNTAIN INSTITUTE®

U.S. OIL USAGE IS DOMINATED BY PASSENGER VEHICLES

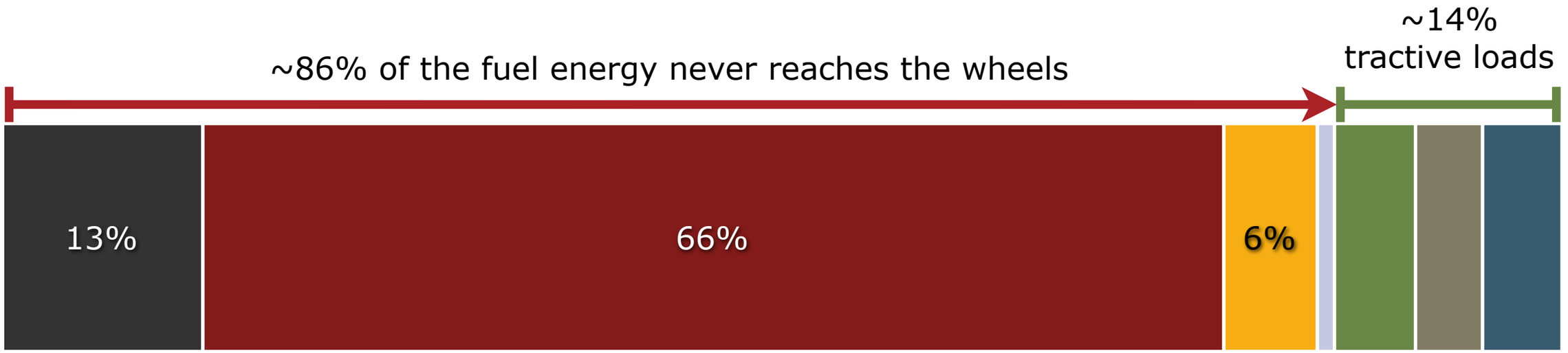


Fossil-fuel-free transportation is feasible by 2050

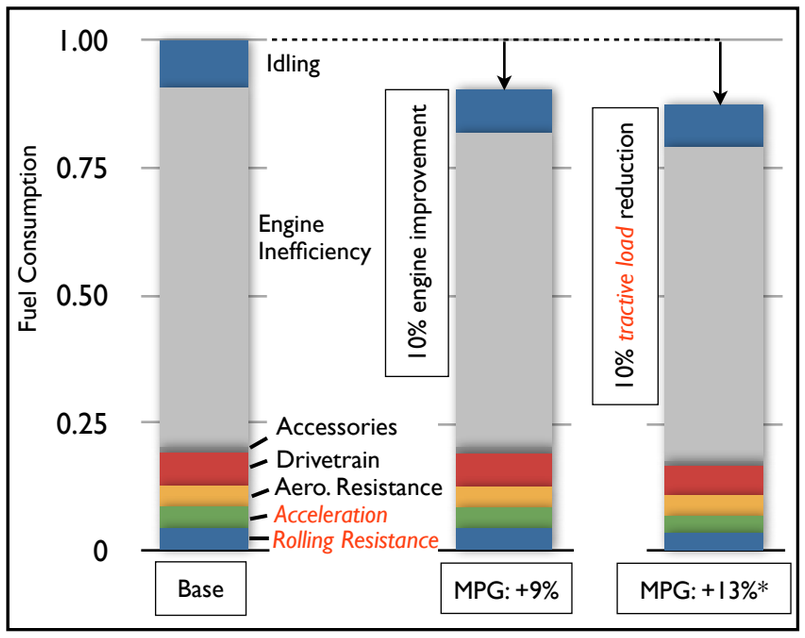


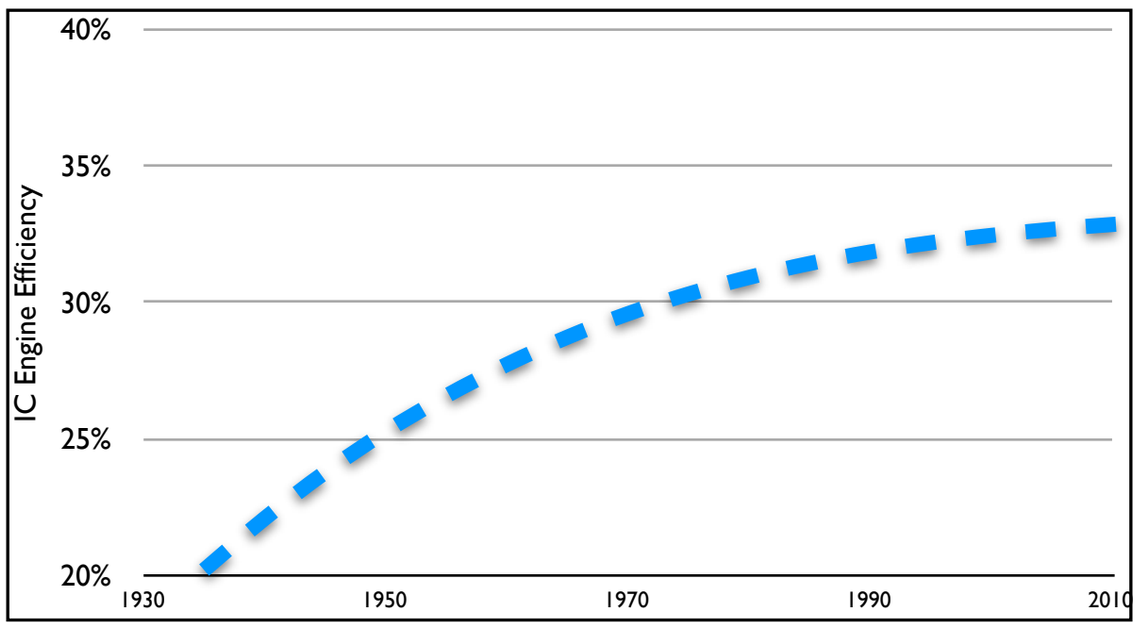
Load reduction, particularly via weight reduction, is the highest-leverage means of improving vehicle efficiency

Energy flow through a typical internal-combustion engine drivetrain

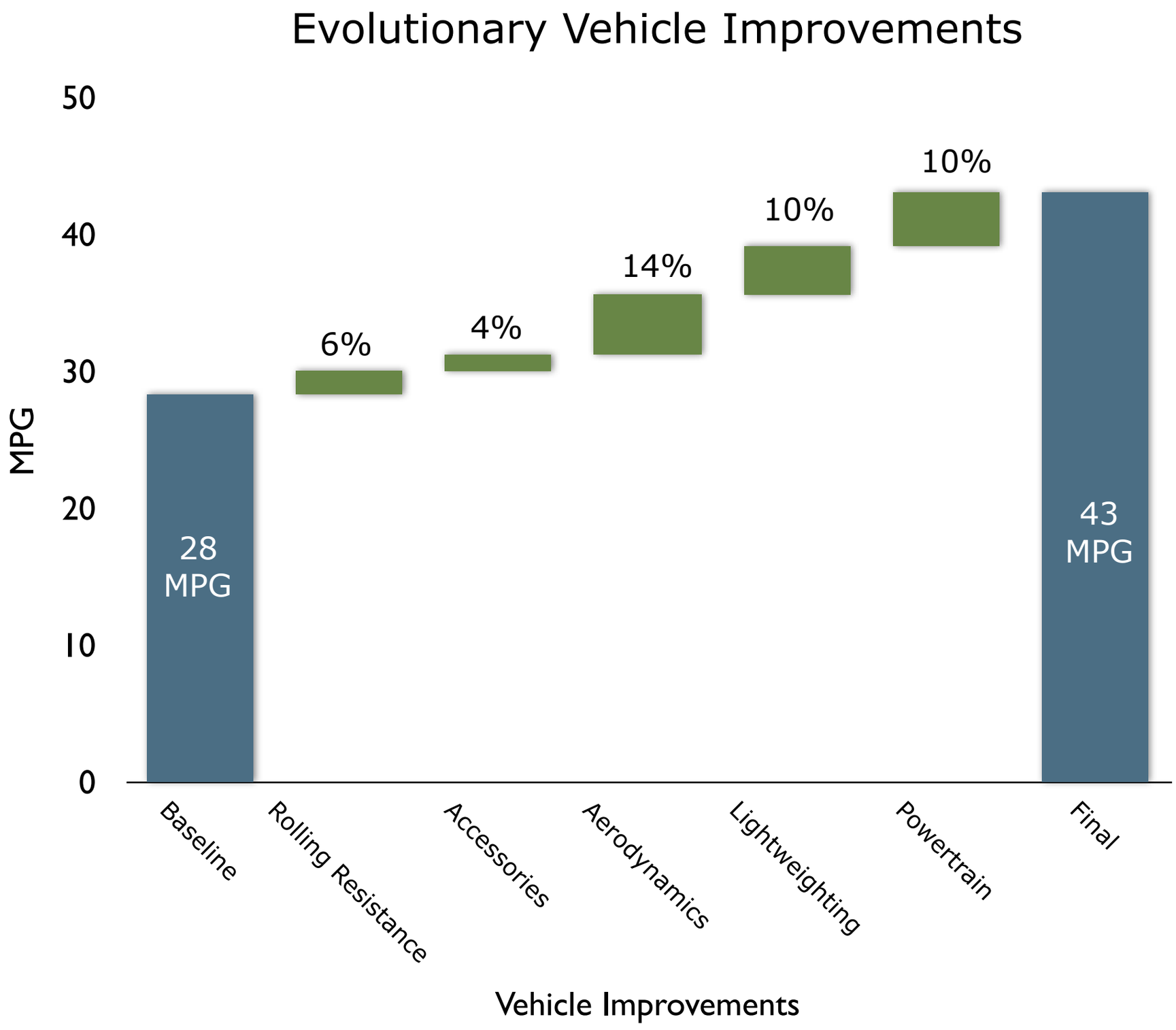


Idling
Engine Losses
Transmission Losses
Auxiliary Power
Aerodynamics
Rolling Resistance
Inertia

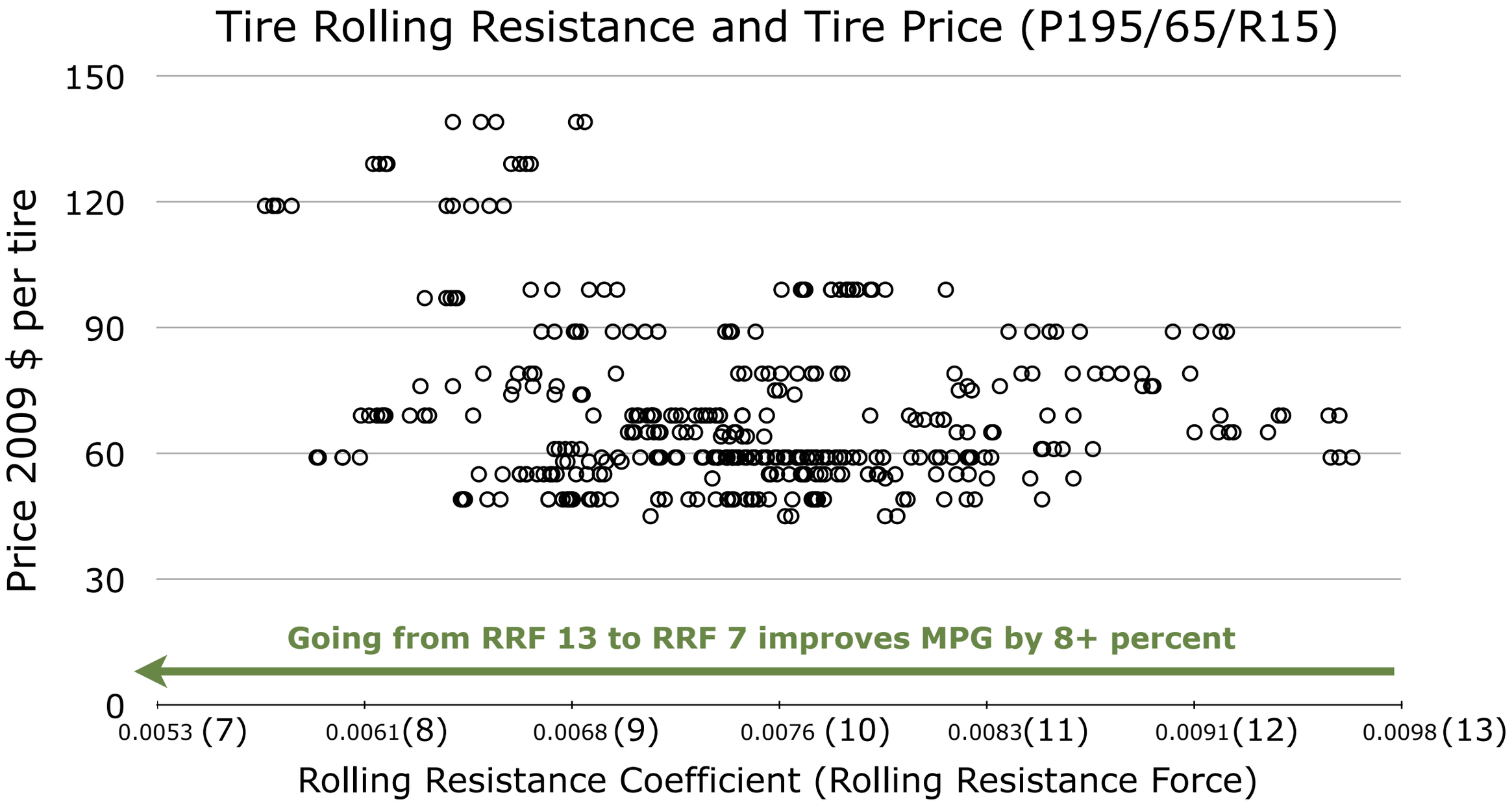




INCREMENTAL IMPROVEMENTS IMPART NEAR-TERM EFFICIENCY OPPORTUNITY



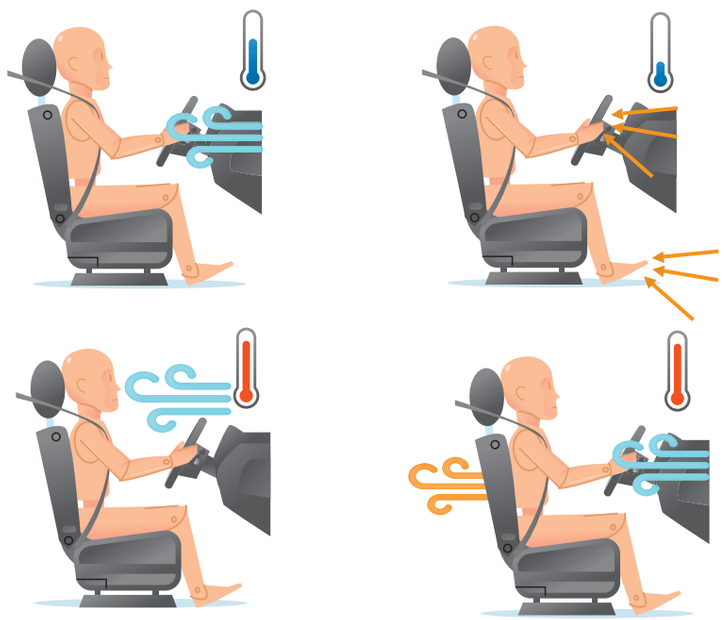
It costs little to nothing to purchase tires with dramatically improved rolling resistance—improving fuel economy 8+ percent



Efficient heating, ventilation, and air conditioning (HVAC) Can significantly improve vehicle fuel economy

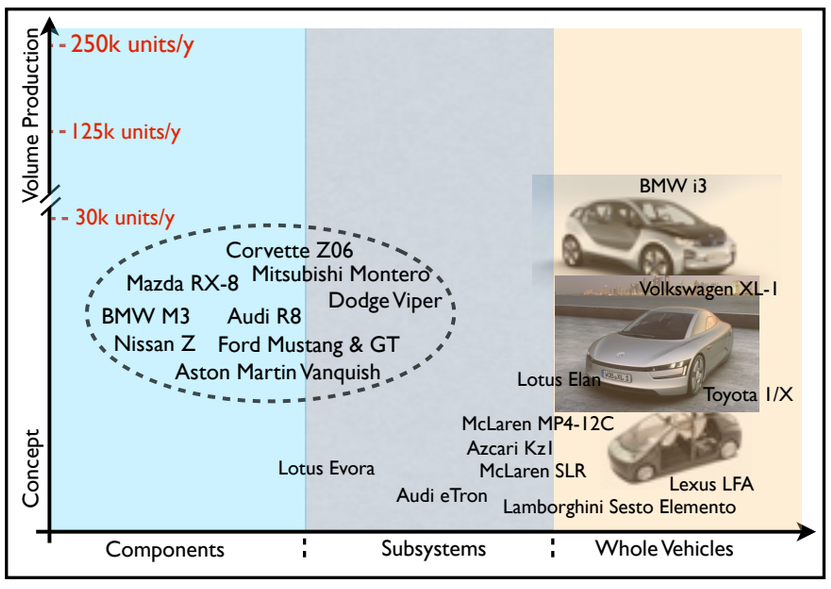
5.5% of all oil currently burned in passenger vehicles is for air conditioning

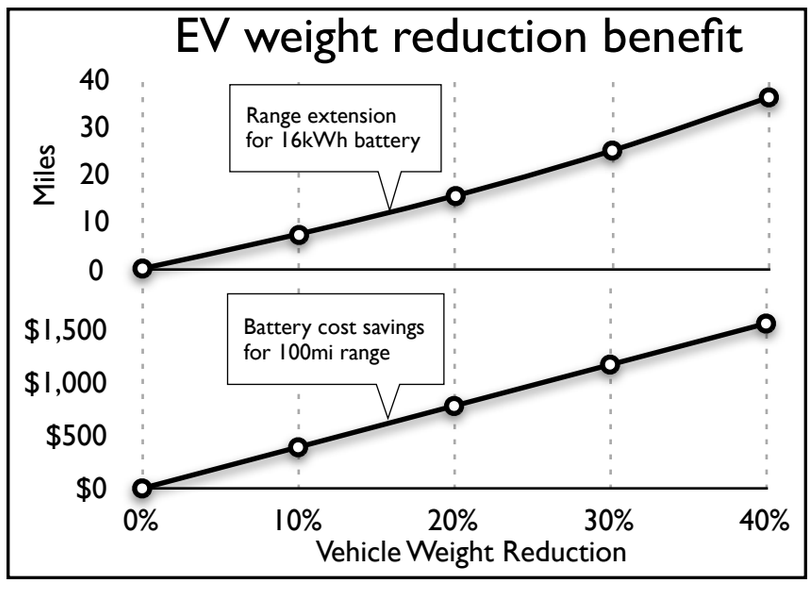
Applying the chimney effect to parked cars allows:
-Air conditioning system downsizing
-Cooler interior temperatures



high-efficiency thermal comfort Allows:
-Improved MPG
-Increased range
-Improved driving experience
-Potential for customization

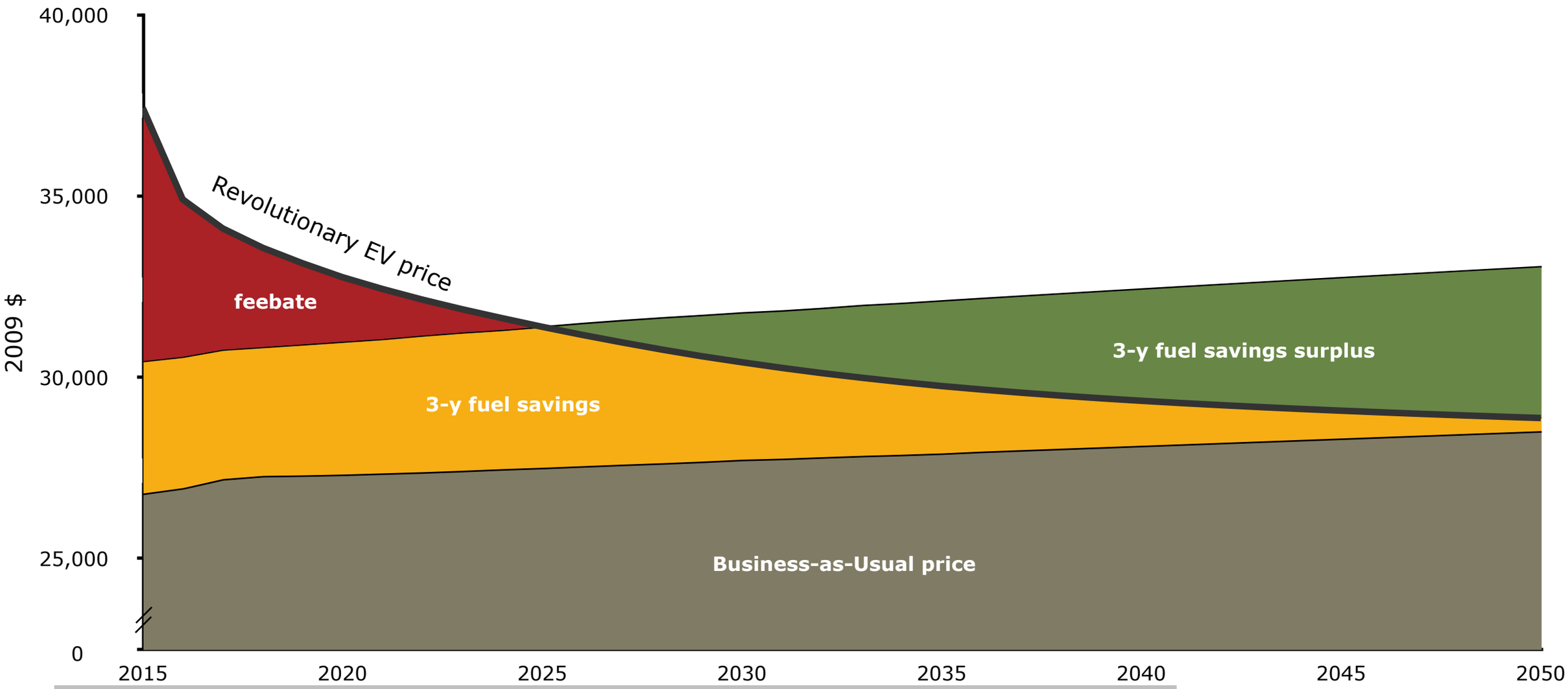
Extensive use of advanced materials, including carbon fiber composite, leads to "Revolutionary+" autos w +200 MPGe





Advanced vehicles initially cost more, but the learning curve is steep, and policy can help manufacturers descend it faster.

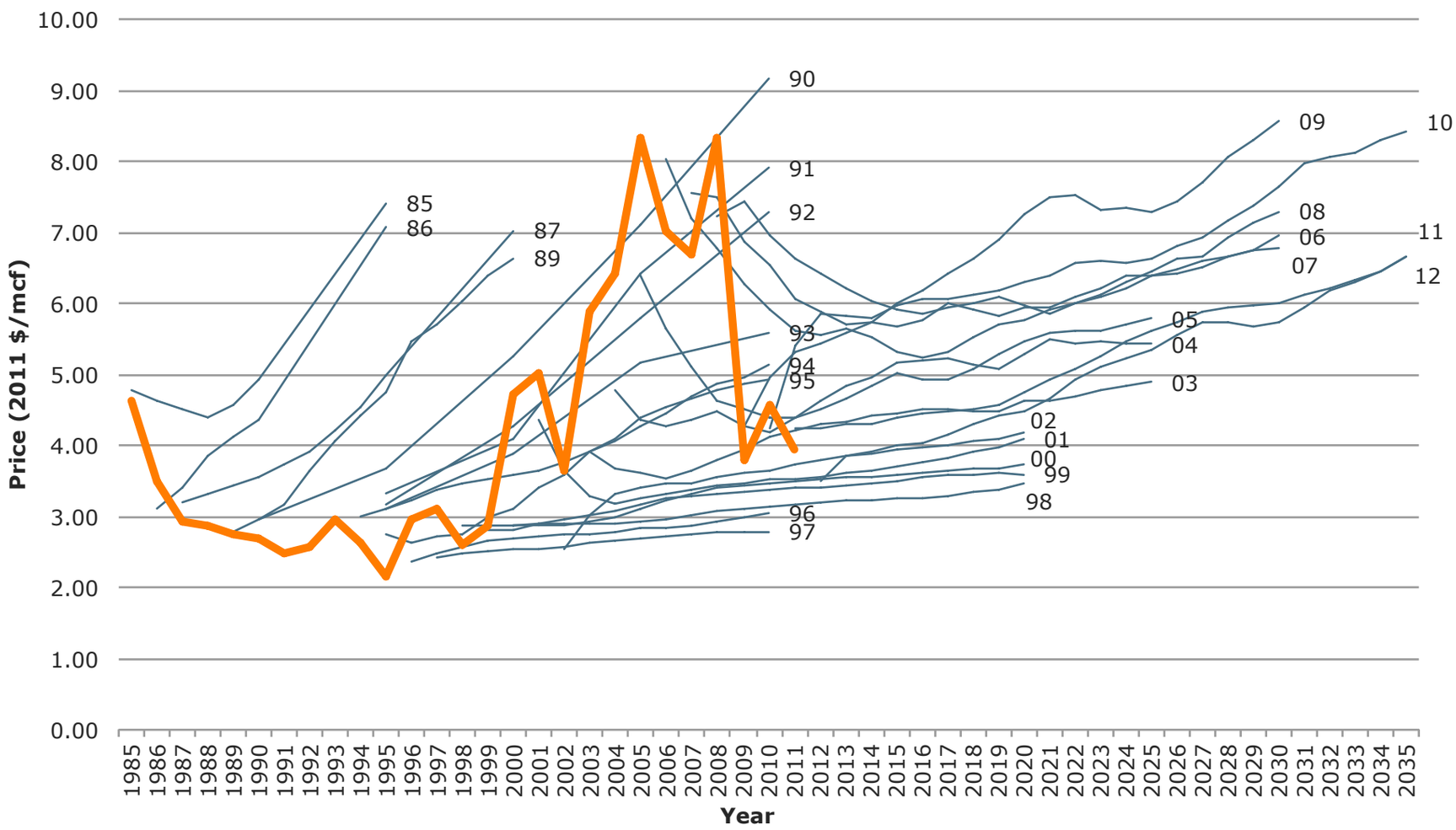
Revolutionary+ battery-electric vehicle price *vs.* Business-as-Usual vehicles, 2015–2050



Battery Cost Considerations:
-Battery cost is 25% of the price of an electric vehicle
-Lithium contribution to battery cost
-Learning curve assumes $400/kWh by 2015
  -Ford: $522-$650 current price
  -14% reduction from 2010-2011 outpaces pictured learning curve
  -Recent analysis by Roland Berger Strategy Consultants says **$250/kWh** by 2015

"Ben Franklin said there are two certainties in life: death and taxes. To that, I would add the price volatility of natural gas." (Jim Rogers, CEO, Duke Energy)

HISTORICAL NATURAL GAS PRICE PROJECTIONS



Efficient & alternative fueled vehicle cost comparison

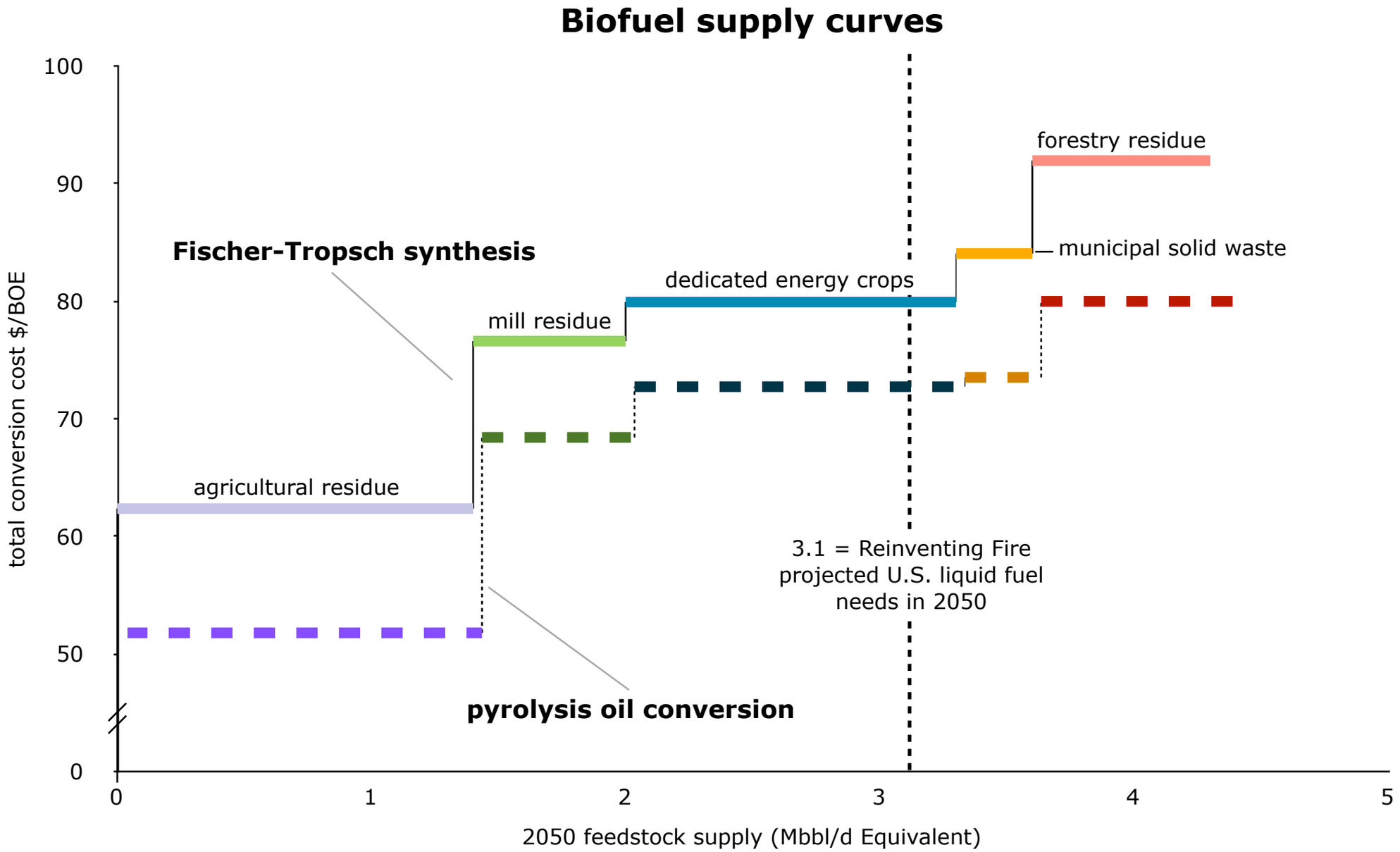
Technology	Fuel Economy (mpg)	Incremental Cost	Infrastructure Cost	Payback Period
Base ICE	25	------	-----	-----
High Efficiency ICE	36	-$4,432	$0	-----
Hybrid Electric Vehicle[1]	45	$1,400	$0	2 years
Battery Electric Vehicle[2]	100	$9,800	$.05/gge	9 years
Light Duty NGV[3]	35	$2,850	$.06/gge	6 years
Transit Bus NGV[4]	4	$21,700-53,700	$.28/gge	3-6 years
Refuse Truck NGV[5]	5	$6600-$31,600	$.22/gge	3-5 years

1 15k miles driven per year, Prius C Hybrid ($23,537) vs. Camry ($22,097)
2 Nissan Versa ($18,640) vs. Leaf ($28,421after $7500 tax credit)
3 Honda Civic ($19,455) vs Honda Civic CNG ($22,305 after $4000 tax credit)
4 35k miles driven per year, range is with/without fed tax credits
5 25k miles driven per year, range is with/without fed tax credits

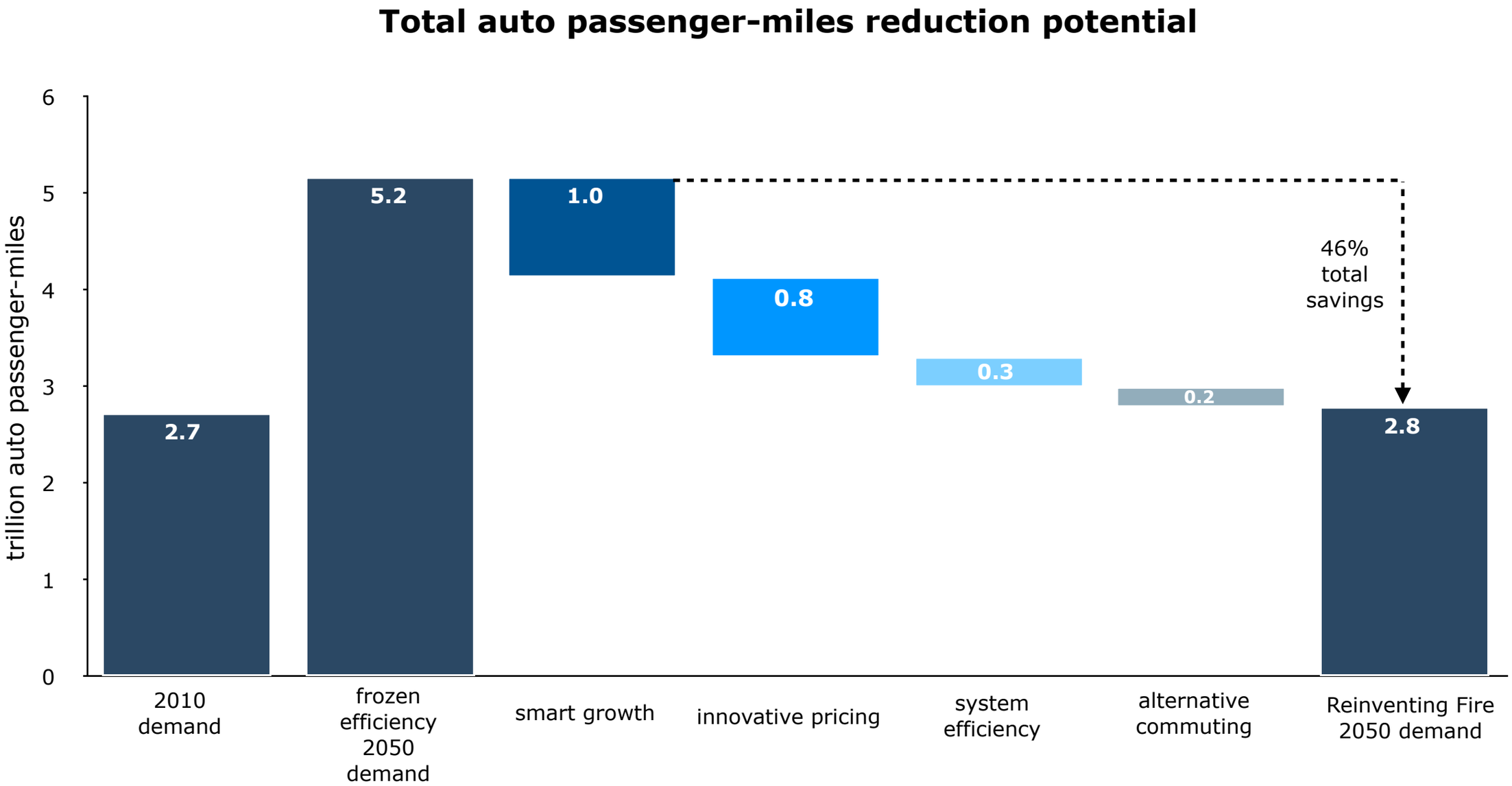
Other Considerations:
-Battery learning curve steeper than natural gas learning curve
-Long term applicability of natural gas infrastructure - EVs can add storage capacity to a distributed renewable grid
-GHG intensity: NG emits 6-11% fewer greenhouse gasses (EPA) than gasoline but controversial study (Princeton) showed well to wheels emissions canceled GHG benefit of natural gas vs. coal
-EV efficiency 80%, internal combustion engines 25-30%, NG to electricity via gas turbine (CCGT) 50-60%
-Natural gas very compelling for medium-sized truck fleets (the larger the fleet, the better) and transit buses (assuming high VMT)

Sources: NESCAUM VISION NE Transportation Fleet Model; EIA Energy Outlook 2011; New York Times, NESCAUM Economic Analysis of a Program to Propote Clean Transportation Fuels in the NE/Mid-Atlantic Region; NREL 2010, "Business Case for Compressed Natural Gas in Municipal Fleets;", MJ Bradley & Assoc 2012, "Perspectives on Electric Vehicles and Charging Infrastructure

THREE BIOFUEL CONVERSION PATHWAYS WITH NON-CROPLAND BIOFEEDSTOCKS LEAD TO COST-COMPETITIVE BIOFUELS



USING VEHICLES MORE EFFICIENTLY LEADS TO A REDUCTION IN VEHICLE MILES TRAVELED (VMT) OF NEARLY 50%



VMT Reduction approach summary

VMT Strategy	VMT Tactic	Timeframe	Example(s)
Innovative Pricing	Vehicle Miles Traveled fee of 1-2¢/mi	near	California: 3.9-4.3% projected VMT reduction
	Pay as you drive insurance	near	Massachusetts: 3-7% VMT reduction based on insurance claims
	Congestion Pricing	near to mid	London: 22% measured reduction in congestion, 37% increase in public transit ridership
	Parking fees / demand-responsive parking	near to mid	SFPark, ParkMe, StreetLine
Alternative Commuting	Work from home, work hubs, condensed work weeks, carpooling	near	eWorkplace (productivity gains) Stamford, CT: 0.7-1.8% VMT reduction by 2030
	Rideshare / Carshare	near	ZipCar, ZimRide
	Bikeshare	near	DC Capitol Bikeshare
	HOV lanes	near to mid	DC
	New public transit	far	Sacramento: Projected 6-10% VMT reduction by 2035
	Bike lanes, sidewalks	near to mid	Stamford, CT: 0.4% VMT reduction by 2030
Smart Growth	Transit-oriented development, Work/ live/shop neighborhoods	far	Portland: 8-10% due to urban growth boundary and commuting improvements Atlantic Station, GA: 59% residential and 36% employee VMT reduction from "live-work-play" community
System Efficiency	Data integration and system interoperability	near to mid	Embark, BART
	Intelligent Transportation Systems (ITS)	mid to far	ITS America, Multi state coalition
	Enhanced Mobility on Demand	mid to far	

VMT Reduction approaches & the potential of software to make an immediate impact: Bikesharing

capital bikeshare

Spotcycle App

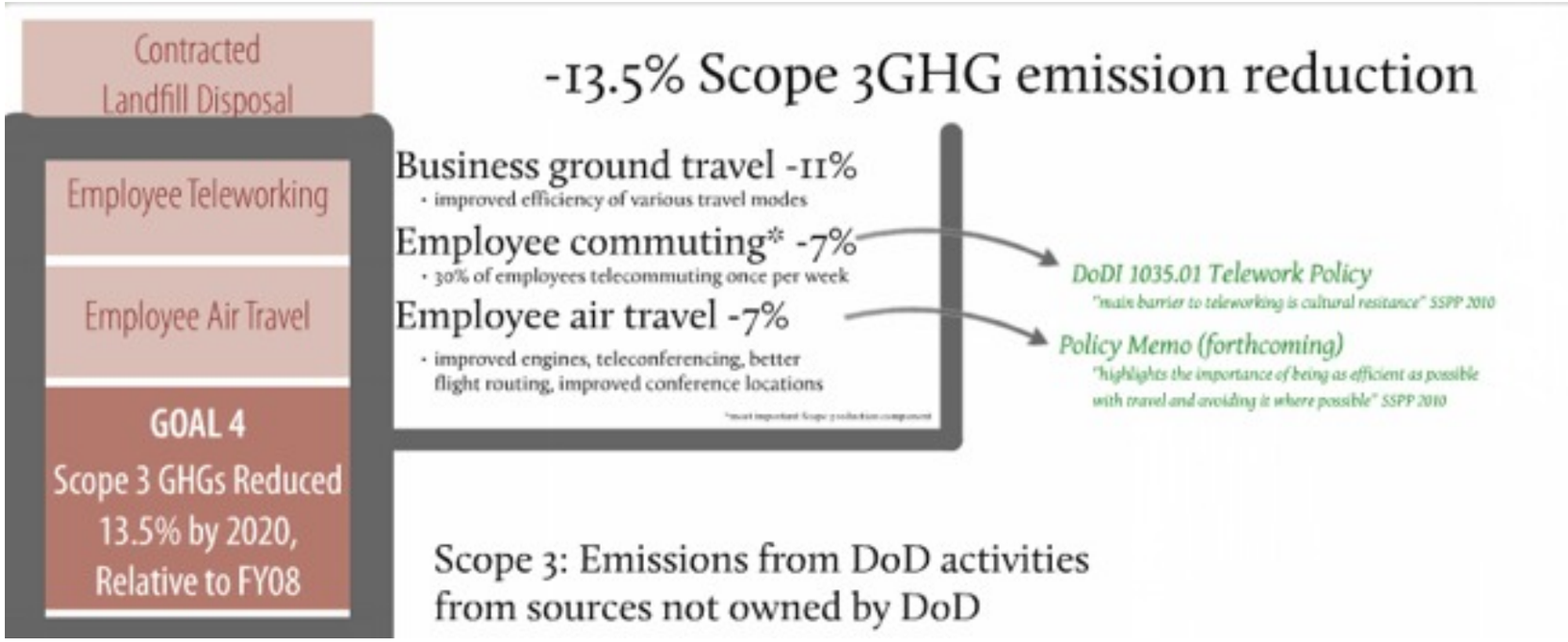
weBike
collegiate bike sharing

VMT Reduction approaches: Telecommuting

Software/Metrics:

eWorkPlace

Policy:



VMT Reduction approaches & the potential of software to make an immediate impact: Parking