

**FREE
ABSTRACT**

*The first RUC diagnostics
and simulation tool for road
& transport decision makers*

ROAD USAGE CHARGING

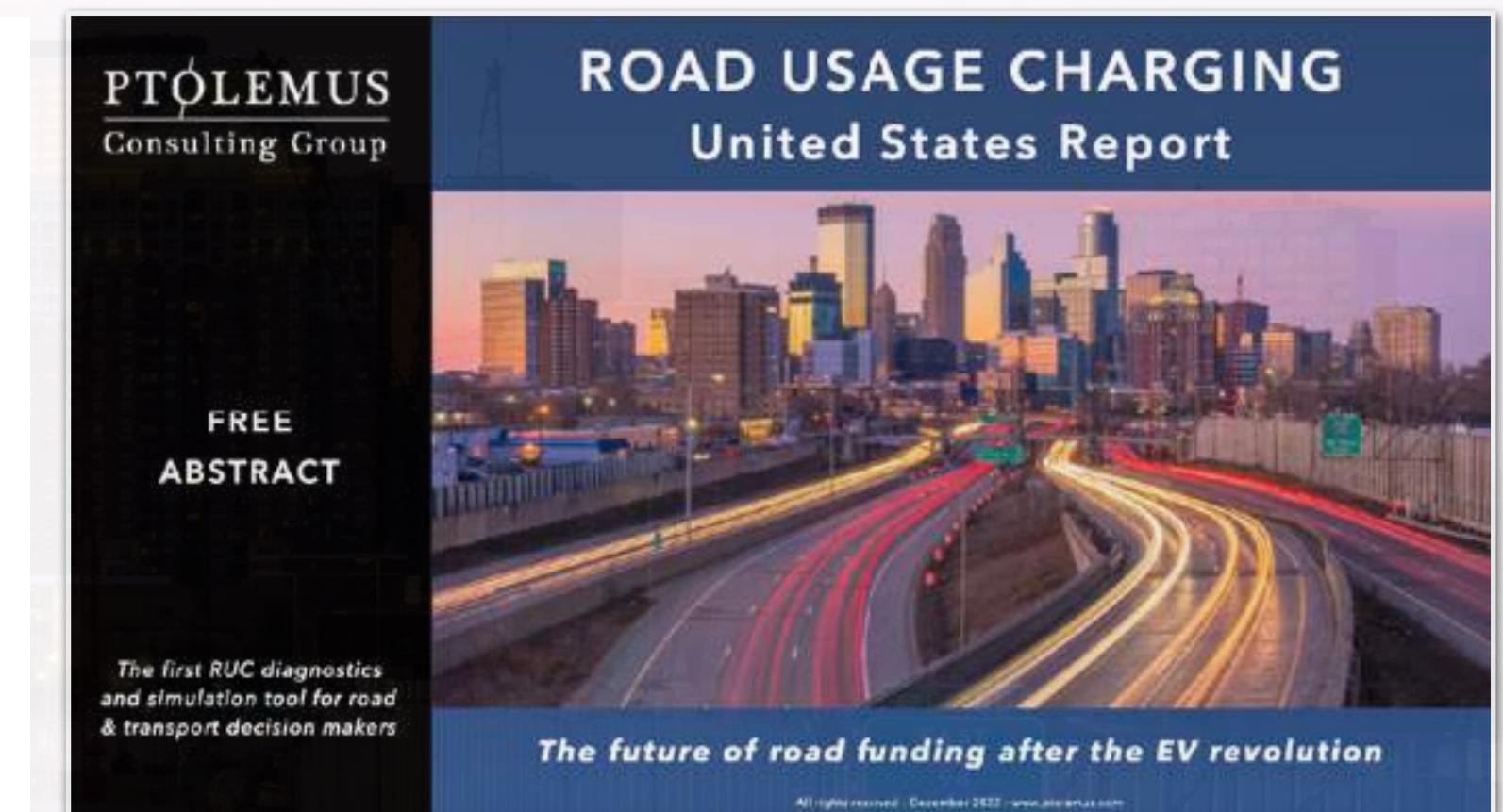
United States Report



The future of road funding after the EV revolution

This in-depth analysis and market forecast is the first decision-making tool for key stakeholders to design a successful RUC strategy

- A 300-page analysis of the current and future road financing in the US based on:
 - 10 years of constant market surveillance
 - PTOLEMUS tolling and RUC consulting experience with over 40 client assignments
 - 5 months of research and analysis including interviews with key stakeholders
 - More than 200 figures presented in the report
 - More than 90 companies mentioned
- An examination of the economic, financial, political and technological context behind RUC
- A detailed assessment of RUC vs. other major funding solutions across 9 key dimensions
- The status of road funding examined in the US including 4 in-depth profiles of US States that are at the forefront of RUC initiatives
- A comparison of RUC in the US and distance-based charging in Europe that identifies 5 key lessons and insights that the US can take away from the European experience
- The Excel output forecasts for 3 separate, connected models: i) motor fuel tax revenues ii) RUC fee rates and revenues and iii) RUC costs. **The model has been developed**
 - With inputs from over 20 reputable sources and includes PTOLEMUS own automotive and EV forecasts
 - To easily store and simulate hundreds of unique vehicle, travel, and pricing scenarios as defined by the user
 - To cover the US and all 50 states plus the District of Columbia. *The model allows the user to either select a specific state or the United States as a whole*
- Quantitative and qualitative analysis on which states would benefit the most from a RUC scheme



**More than just market research.
In-depth strategic analysis and a
complete tool to help your
organization make the right decision
to launch a new road funding model**

To generate significant RUC revenues by 2030, states will need to begin making critical decisions now

Context: The reason we developed this report

- Since 1932, the motor fuel tax has been the primary funding source for roads in the US, and until recently, it efficiently served this purpose
 - Increase in Vehicle Miles Travelled (VMT) translated (almost 1-for-1) into growth in fuel tax revenues, which were reinvested in road infrastructure to support VMT rise
- However, **trends such as the increasing vehicle fuel economy, and notably the introduction of electric vehicles (EVs)**, are changing this, as the **fuel tax is no longer viewed as a sustainable long-term road funding source**
 - Under the Biden Infrastructure plan, the US established a target for EVs to comprise 50% of all light vehicle sales by 2030
 - Both the federal government and 25 states have EV purchase incentives in place
 - The Inflation Reduction Act is only going to accelerate the transition to electric
- In anticipation of the inevitable decline in motor fuel tax revenues, states have begun looking at alternative road funding solutions with **RUC arguably as the most promising user pay solution**

Why it comes at the right time

- **38 states have already initiated RUC studies, pilots, and/or permanent programs** and 13 have also implemented some form of RUC legislation
- A growing number of key mobility stakeholders are beginning to understand the critical importance of the road funding problem
- However, the **road ahead is still to be defined**, and as such, **the winning models, technologies, and stakeholders are still to be determined**
- It will take 3-5 years at least for any new model to be effectively implemented, which makes decision-making and law-making urgent
- With the market still new and small, though growing quickly, it is a **great moment for stakeholders to enter, find their place, and even become leaders in the space**



This is the first analysis of the US RUC market as a whole, discussing the opportunity it presents for States to generate sustainable road funding and for Private Companies as a potential new market

The fate of the motor fuel tax is sealed... and decisions to guarantee 2025-30 revenues require immediate actions

A NEW ROAD FUNDING SOURCE IS NEEDED

- The fate of the gas tax is sealed... with electric vehicles, the motor fuel tax is no longer sustainable and existing infrastructure funding gaps can only widen
 - In 2022 EV sales are likely to surpass 5% of total new vehicle sales.
 - By 2030, if the US hits its target, EVs will make up more than 50% of vehicle sales
 - For each EV sold, the government (state and federal) will lose \$3,000 in motor fuel tax revenues over the vehicle's life
 - Hitting its EV 2030 sales target implies that the government will lose over \$20 billion in revenues that one year!

RUC IS ALREADY HERE

- Road Usage Charging is no longer just a theory... it is quickly becoming a viable funding source and an opportunity to:
 - Raise funds from electric and other fuel efficient vehicles for the public sector
 - Develop new competencies and reach new customers for the private sector
- In the 5 months it took to develop this report, there have been multiple major developments in the US RUC market:
 - New legislation enabling road usage fees was enacted: In June, Louisiana signed into law Act 578 enabling the state to begin collecting road usage fees from electric and hybrid vehicles

- A third RUC permanent program was launched: Virginia launched in July a voluntary RUC program that already has over 5,000 participants
- A tender was completed for RUC account managers: Oregon completed RUC tenders for a new ODOT Account Manager and for new Commercial Account Managers
- A RFP for a RUC pilot was solicited: In November, Oklahoma launched a tender for RUC project manager services
- And many more critical developments are in the pipeline
 - The state of Washington is planning to establish a permanent RUC program in early 2023
 - A national RUC pilot is under preparation



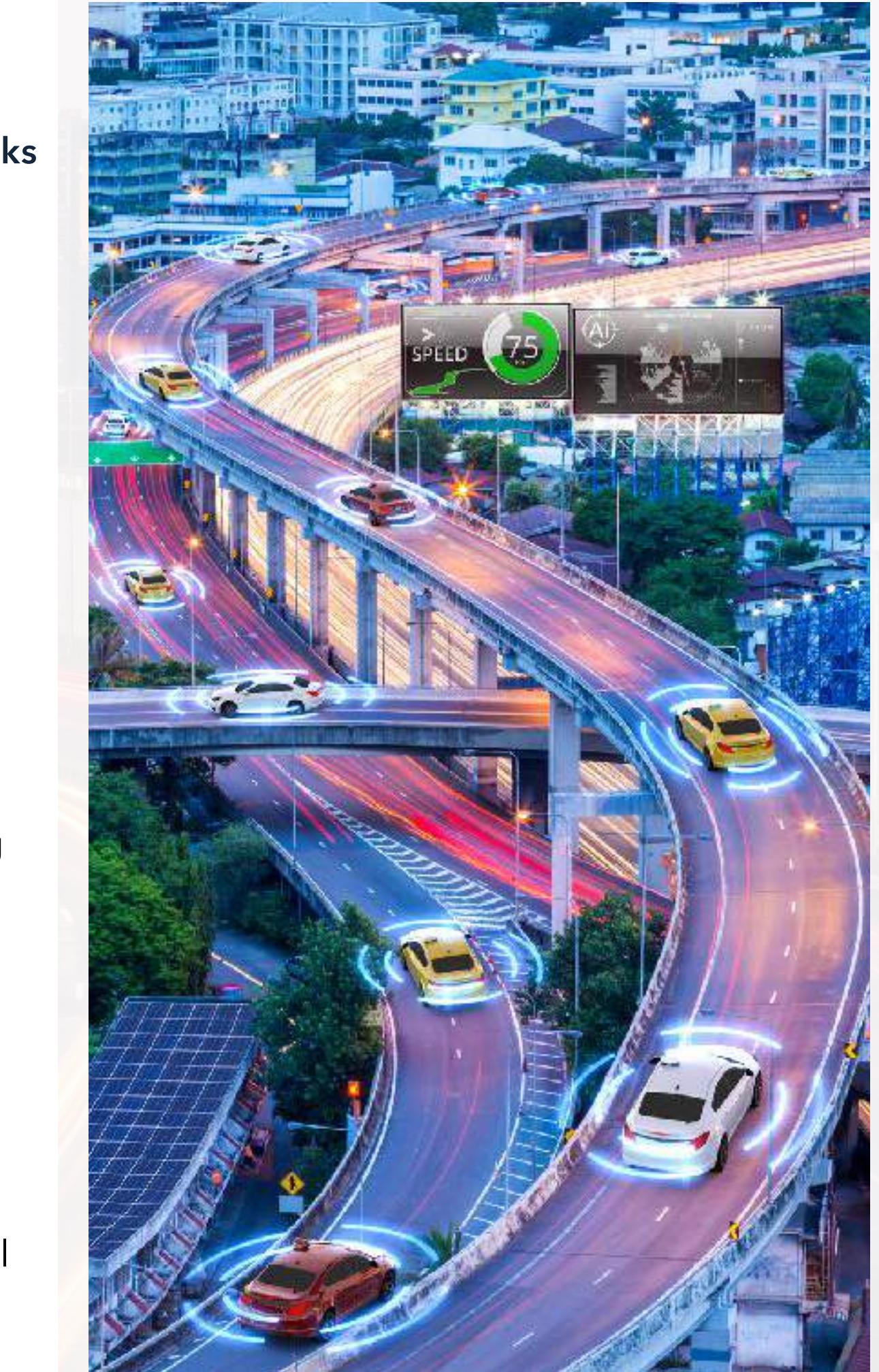
RUC can eventually become the primary road funding solution if stakeholders overcome challenges of cost and complexity

DESPITE ITS POTENTIAL, RUC STILL HAS SOME WAY TO GO

- RUC has demonstrated the potential to be an equitable and sustainable road funding solution:
 - Revenues generated and fees charged can reflect actual road usage (vehicle miles traveled)
 - Solution is agnostic to the engine propulsion technology allowing it to be equally effective for all vehicle types
 - Automated solutions can accurately charge drivers for the negative externalities of their vehicle usage (e.g. noise, pollution, congestion, health)
- However, there are 2 critical dimensions in which the motor fuel tax excelled, that presently prevent RUC from scaling:
 - **Cost:** In many operational programs, RUC costs are greater than revenues collected (i.e., a negative operational margin); *for the fuel tax, costs represent only 1-3% of revenues*
 - **Complexity:** At this stage, RUC solutions are far from seamless as users are required to interact not only with the account manager but also the mileage reporting device; *the fuel tax is collected without direct interaction with the customer*
- Challenges in these areas must be overcome for RUC to be a reliable and widely used funding solution
 - Scale will help, and multi-state coalitions could be a key to reduce unit costs
 - Giving a small tax benefit to those who report their miles could be an incentive to have the system started

WITH THE RIGHT STRATEGY & ENGAGEMENT, RUC WILL SUCCEED

- To scale, RUC needs simple, cost effective solutions, and thanks to connected vehicle technologies, these now exist:
 - **In the medium term, the key to RUC will be connected vehicles.** In-vehicle telematics using GPS and 4G/5G has the potential to provide a frictionless user experience at a cost below 5% of revenues (the “holy grail”)
 - **For non-connected vehicles, manual solutions** such as odometer photos that are checked during the safety inspection process provide a reasonable solution
 - **Aftermarket device solutions should also be explored, in combination with other applications** (e.g. Usage-Based Insurance, Car-as-a-Service, fleet management, remote diagnostics) to make their cost to RUC negligible
- For this future to happen, **RUC is also dependent on the engagement of key public and private stakeholders** including OEMs and larger technology groups; **engagement which is beginning to pick-up**
 - At least one state is preparing a RUC pilot with an OEM partner
 - Discussions with all current managers of connected vehicle services (insurers, fleet managers, etc.) should start
- It is through this **combination of scalable, cost effective technology and broader ecosystem engagement** that RUC will become a worthy successor to the motor fuel tax



The report will answer the key strategic questions about RUC in the US and help your organization navigate the evolving market

Where is RUC now?

What is Road Usage Charging (RUC) in the US context and how is it different from other road charging schemes?

What are the key factors and trends that are causing states to turn towards RUC?

What type of RUC activities have states performed and which states have been the most active?

What has been the US federal government involvement (i.e., regulatory, financial, etc.)?

Which stakeholders (public and private) have been involved and in what role?

Which technologies have been used in the and how do they compare with each other?

What other funding options exist and what are the key advantages of RUC versus other funding options?

How does RUC compare and rank versus the other funding options with regards to revenue robustness, efficiency, flexibility, equity, etc.?



Is RUC the future of road funding for the US, a complementary piece, or a short term fad?

What factors will be the most relevant in determining RUC's success?

Which states will be the most active (leading) and why?

Which stakeholders are more likely to take the lead in the market?

Which technologies are most likely to be deployed in short and longer term?

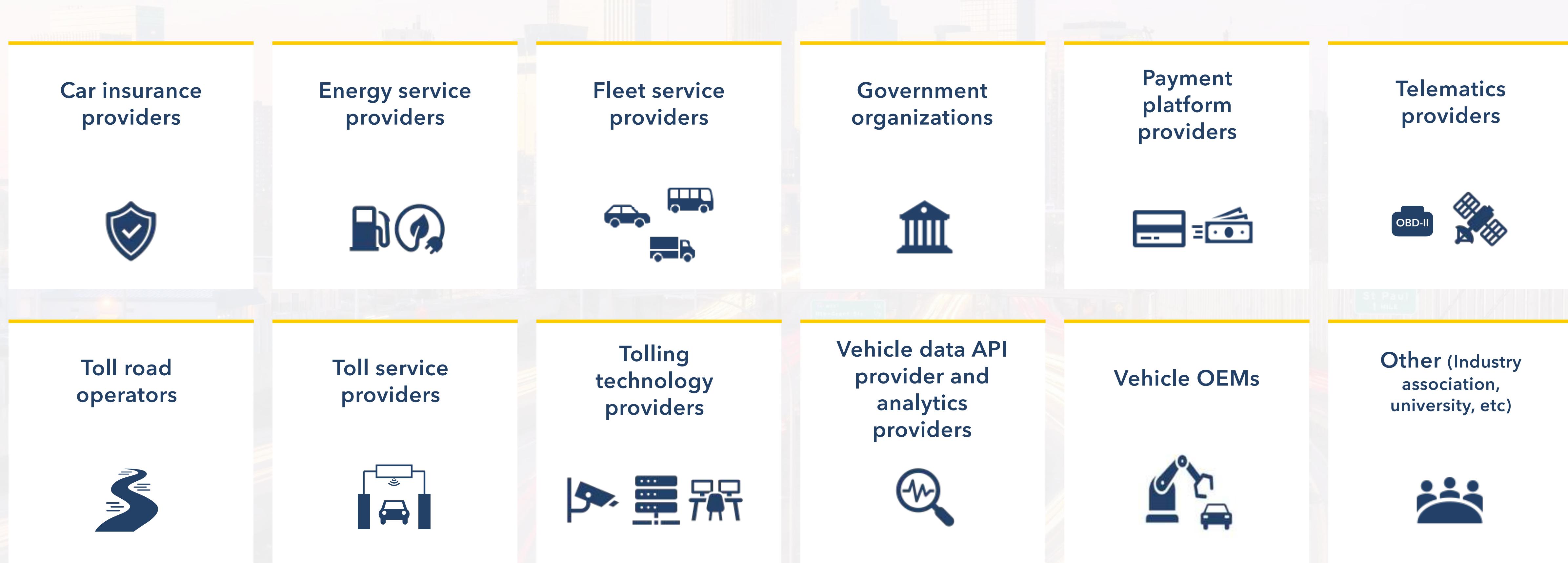
What are the key factors help lower overall costs and increase the profitability of the program?

What factors should be considered when setting RUC rates and how much revenue can a program generate in the rate setting scenario?

What will be the impact of EVs (and more fuel efficient vehicles overall) on road funding in the next 20 years, assuming the current funding status quo?

Where is RUC going?

RUC will impact a large number of stakeholders and this report was designed and built to guide them through the new paradigm



It also acts as a one-stop guide that will help your organization understand the evolving RUC market and position itself to succeed in it

This report and the corresponding model can help your organization:

- ✓ Understand the **dramatic impact of vehicle electrification** on road financing
- ✓ Understand **RUC's potential as a road funding alternative to the motor fuel tax along with how RUC compares against other alternatives**
- ✓ Build scenarios to **evaluate the revenue evolution of the fuel tax and potential RUC schemes**, at State or National level, thanks to our landmark Excel market forecast model
- ✓ Understand the **available technology solutions and the stakeholder landscape**
- ✓ Define if, when, and **how it can best fit into the evolving RUC market and its value chain**
- ✓ Prepare **strategic actions** to successfully enter the RUC market or expand its existing presence in it
- ✓ Establish a priority list of potential **partners, alliances, and suppliers** to help accelerate success

The report is divided into 6 sections

1 Introduction

1

- 1. Definitions
- 2. Context

2 Drivers

25

- 1. Financial and Economic
- 2. Mobility
- 3. Infrastructure
- 4. Political and Regulatory

3 Overview of the Current Market

79

- 1. Alternative Road Funding Options
- 2. Studies, Pilots, and Programs
- 3. Stakeholders and Value Chain
- 4. Technologies
- 5. Benefits and Considerations

4 In-depth Case Studies

146

- 1. Hawaii
- 2. Minnesota
- 3. Oregon
- 4. Utah

5 Lessons and Insights from Europe

191

- 1. Overview of European Road Charging
- 2. Lessons Learned and Key Insights
 - 2.1. Regional (nationwide) framework
 - 2.2. Location-based charging
 - 2.3. Interoperability
 - 2.4. Account Managers (EETS Providers)
 - 2.5. Public acceptance

6 Future of Funding and RUC

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- 1. Road Funding (Fuel Tax Decline)
- 2. Funding Potential of RUC
- 3. Cost Analysis of RUC
- 4. Evolving Account Manager Role
- 5. Leading States
- 6. RUC in the Future (Conclusion)

This report provides a comprehensive overview of the Road Usage Charging market of the United States

- The Road Usage Charging (RUC) USA Report, the first to cover the mileage-based charging market in the US, is structured into 6 sections:
- Section 1: Introduces and defines RUC in the US context
- Section 2: Identifies and analyzes the 4 key external drivers of RUC in the US:
 - Financial & economic: transportation funding, motor fuel tax, inflation
 - Mobility: vehicle miles traveled (VMT) evolution, vehicle fuel efficiency, electric vehicle adoption, connected vehicle growth
 - Infrastructure & climate: road and bridge asset condition and expansion and modernization needs
- Political & regulatory: state legislation, federal legislation and regulations, industry group involvement
- Section 3: Provides a comprehensive overview of the RUC market and how it compares to other funding options. This section has 4 subsections covering the following topics
 - Alternative road funding options: examines options to replace the motor fuel tax (e.g., vehicle registration fees, tolling, electricity tax, RUC)
 - US RUC market overview: lists and analyses the activities (studies, pilots and programs) that have been completed or are ongoing by state and coalition
 - Stakeholders and technology: explores the stakeholders (owners, advisors, account managers, subcontractors, and end users) by their position in the value chain and compares mileage-reporting options (technologies)
 - Benefits and consideration: analyzes the benefits and challenges with RUC in the context of the different road funding options and the work completed in studies to date. This analysis was completed across 8 principal dimensions
 - Revenue robustness
 - Efficiency
 - Flexibility
 - Acceptability
 - Equity
 - Interoperability
 - Data Collection & Management
 - Privacy & Security
- Section 4: Takes an in-depth look at the RUC activities of 4 states Hawaii, Minnesota, Oregon, and Utah in order to capture key lessons from these very advanced states. A similar approach is taken to covering each state as noted below
 - Key drivers: examines why the state has explored RUC and assesses how the state ranks across 11 categories (4 financial & economic, 3 mobility, and 4 infrastructure) that impact funding
 - Timeline of key events: outlines the most important events (i.e., legislative, regulatory, program related, etc.) impacting RUC activity in the state

The report also explores where the RUC market could be heading and what is required for it to achieve its potential

- **Overview of pilots and/or programs:** explores key topics, such as objectives, technology, system architecture, and participants, for each pilot or program
- **Examination of unique pilot or program features:** for example, Minnesota created a rate-setting framework and tested collecting RUC data from connected/automated vehicles (CAVs)
- **Next steps and future plans:** future RUC activities states have planned or are considering
- **Section 5: Compares RUC in the US to Europe's distance-based charging schemes and summarizes key insights and lessons that the US market can take from Europe.** There are 5 insights and lessons:
 - Importance of establishing a regional (nationwide) RUC framework
 - Benefits of location-based charging
 - The role of the roaming model to reach interoperability
 - Account Managers (EETS Providers) active role in improving the scheme
 - Implementation challenges and public acceptance
- **Section 6: Focuses on the future of road funding and RUC and the factors most relevant for RUC programs to expand and succeed.** To support this section, we developed a forecasting model, which analyzes road funding needs and RUC's funding potential in all **50 states**. Section 6 and the supporting model cover the following topics:
 - **Fuel tax funding:** forecasts the impact of fuel efficient vehicles, including electric vehicles, on motor fuel tax revenues
 - **RUC's funding potential:** analyzes RUC's revenue generation potential and the decisions required to optimize a program's funding
 - **RUC's cost structure and ability to scale:** explores RUC's base cost structure and the key factors, including technology, to lower cost and increase program profitability (*i.e., if and how RUC can reach a competitive unit cost*)
 - **Role of account managers:** looks at how the value chain and account manager roles could evolve and which companies are well positioned to enter and succeed in the market



Analysis performed in Section 6 (*subsections 1-3: motor fuel tax funding, RUC's funding potential, and RUC's cost structure and ability to scale*) incorporates outputs from PTOLEMUS' forecasting model for the United States and the state of Colorado, which was included to show the results in the case of a specific state

The report mentions 90+ companies and organizations

Company	Region/Country	Type	Company	Region/Country	Type	Company	Region/Country	Type
Azuga	USA		RUC America	USA		Hourcar	USA	
Emovis	USA		TET Coalition	USA	Coalitions	SFR	Europe	
Eroad	USA	Account managers	CalTrans	USA		SNCF	Europe	
IMS	USA		Hawaii DOT	USA		Steria	Europe	
Verizon Connect	USA		Minnesota DOT	USA		Thales	Europe	Other companies
AECOM	USA		Oregon DOT	USA	DOTs	Via	USA	
ARUP	UK		Utah DOT	USA		VSI Labs	USA	
BERK	USA		Virginia DOT	USA		Zipcar	USA	
CDM Smith	USA	Advisors	Vermont DOT	USA		Msts	Europe	Payment and Credit
EBP	USA		Washington DOT	USA		Abertis	Europe	
Jacobs	USA		Aral	Europe		Autostrade per l'Italia	Europe	
WSP	USA		AS24	Europe		Bro Bizz	Europe	Road Operators
Audi	Europe		BP	Europe		Transurban USA	USA	
BMW	Europe		PetroChina	Europe	Energy companies	AWS	USA	
Ford	USA		Shell	Europe		Helpware	USA	
GM	USA		Sinopec	Europe		Oracle	USA	
Honda	Asia		Total	Europe		Otonomo	Asia	
Hyundai	Asia		Fleetcor	Europe	Fleet Management Service Providers	Smartcar	USA	
Kia	Asia		Wex	Europe		Wejo	Europe	
Lucid Motors	USA		Eurowag	Europe	Fuel Card Issuers	A-to-Be	Europe	
Mazda	Asia	Car manufacturers	UTA	Europe		Axxès	Europe	
Mercedes	Europe		Department of Energy	USA	Governmental institutions	Conduent	USA	
Nissan	Asia		European Comission	Europe		DKV	Europe	
Rivian	USA		FHWA	USA		easytrip	Europe	
Stellantis	Europe		IBTTA	USA	Industry groups	eurotoll	Europe	
Subaru	Asia		IRF	USA		Kapch	Europe	
Tesla	USA		MBUFA	USA		Neology	USA	
Toyota	Asia		Fremtind	Europe	Insurance carriers	Telepass	Europe	
VW	Europe		UnipolSai	Europe		TollTickets	Europe	
						TransCore	USA	

The report leverages PTOLEMUS' road charging experience and the expertise of a diverse team of mobility consultants (1/2)



Frederic Bruneteau

Managing Director



Ashton Williams

Manager



Paul Maupin

Marketing Director

Experience

27 years

The founder of PTOLEMUS, Frederic has accumulated 25 years of experience of the mobility and transport domains and 15 years of strategic and financial advisory.

He has become **one of the world's foremost experts of connected mobility** and is interviewed on the subject by publications such as the Financial Times, Forbes, the Wall Street Journal and The Economist. He has also spoken at over 40 conferences on the subject.

He has **led over 180 consulting projects and helped many world leaders define their strategy and implement it.**

Biography

Clients he has served include A-to-Be, Abertis, AETIS, AGC Automotive, Allianz, Axxès, AXA, Baloise, BP, Bridgestone, BRP, CNH Industrial, Danlaw, DMP, Egis, the European Commission, Ferrovial, HERE, Hitachi, Kapsch, the Netherlands' Ministry of Transport, Mobile Devices, Neology, Octo Telematics, Michelin, OMV, MPTC, Pioneer, Q-Free, Qualcomm, Scania, Société Générale, Skytoll, ST Engineering, Telepass, Telit, TomTom, Toyota, Transurban, T-Systems, and WEX.

Frederic has led over 30 assignments related to tolling and RUC.

Frederic fully reviewed this report.

15 years

Mr. Williams has accumulated over 15 years of professional experience working for and alongside transportation and mobility companies **specialized in infrastructure operations, highway management, public private partnerships, road charging solutions and services, and mobility payments.** He has also co-founded an EV service start-up company.

Mr. Williams' responsibilities and achievements include:

Led commercial stream and development of commercial structuring for a multi-national infrastructure operator on \$3 billion express lane project in the US.

Served as Global Head of Business Development for both Abertis Mobility Services (AMS) and its toll-based mobility service provider Emovis.

Oversaw implementation of the first non-pilot US RUC project.

Led for the Abertis Group origination, diligence and execution efforts on infrastructure and mobility projects across Asia, Northern Europe, and North America.

Participated in over 40 infrastructure M&A transactions spanning 15 countries at \$78 billion (\$12 billion executed).

Ashton led the research and writing of this report.

15 years

An American citizen, Paul has 15 years of experience in digital marketing in a range of responsibilities such as web site development, copywriting, CRM, analytics, project management, product development, social media management and content strategy.

Paul has worked with a broad range of international clients and brands, large and small, to develop relevant, consistent, and results-oriented digital communication and marketing strategies across channels.

Responsibilities he endorsed over his career include:

Developed, implemented and supervised the global content marketing strategy for Radisson Hotel Group, including data-driven marketing, communication with key internal and external stakeholders;

Managed digital channels, social presence and marketing strategy for the Europe region at UPS, including implementation of paid campaigns alongside ad agencies and content creation for the pan-European central channels.

Paul reviewed the report and leads our marketing of the report.

The report leverages PTOLEMUS' road charging experience and the expertise of a diverse team of mobility consultants (2/2)



Filippo Frezet
Senior Business Analyst



Saeeda Malik
Senior Business Analyst



Williams Demanou
Business Analyst



Fatima Essakhi
Business Analyst

Experience

3 years

An ESCP Business School alumnus, Filippo has started developing an expertise in emergency services, in Electronic Toll Collection (ETC) and Road Usage Charging (RUC), in Usage Based Insurance (UBI), in last-mile delivery, in vehicle data hubs and vehicle data monetisation.

In over 3 years at PTOLEMUS, Filippo has contributed as a core team member to 12 consulting assignments and 4 research reports.

5 years

An HEC Paris MBA graduate, Saeeda has

over 5 years of experience in strategy formulation, execution, and research.

She has been working on consulting and research assignments mainly in the fields of Electronic Toll Collection (ETC), Road User Charging and Usage-based Insurance.

Clients she has served include a private equity firm, a Toll Service Provider and a major road operator in Asia.

5 years

An HEC Paris MBA graduate, Williams joined PTOLEMUS where he is developing an expertise in RUC, ETC, and UBI.

Since he joined PTOLEMUS, Williams: Took part in vendor and commercial due diligences on the UBI market.

Led a comparison of the New York City and Brussels congestion charging models.

Monitors the operational performance of 70+ telematics auto insurance programs in North America.

Biography

Before joining PTOLEMUS, he gained experience in consulting thanks to his internship as Junior Tax Consultant at KPMG Italy.

Filippo participated in the research, writing and review of the report.

4 years

An electronics and telecommunication engineer, she also holds a master degree in Smart Mobility from ENPC, Paris.

Fatima joined PTOLEMUS in 2021 and started to specialize in Electronic Toll Collection (ETC), Road Usage Charging (RUC), Intelligent Transportation Systems (ITS), Autonomous Vehicles (AV), Connected Vehicle Data (CVD).

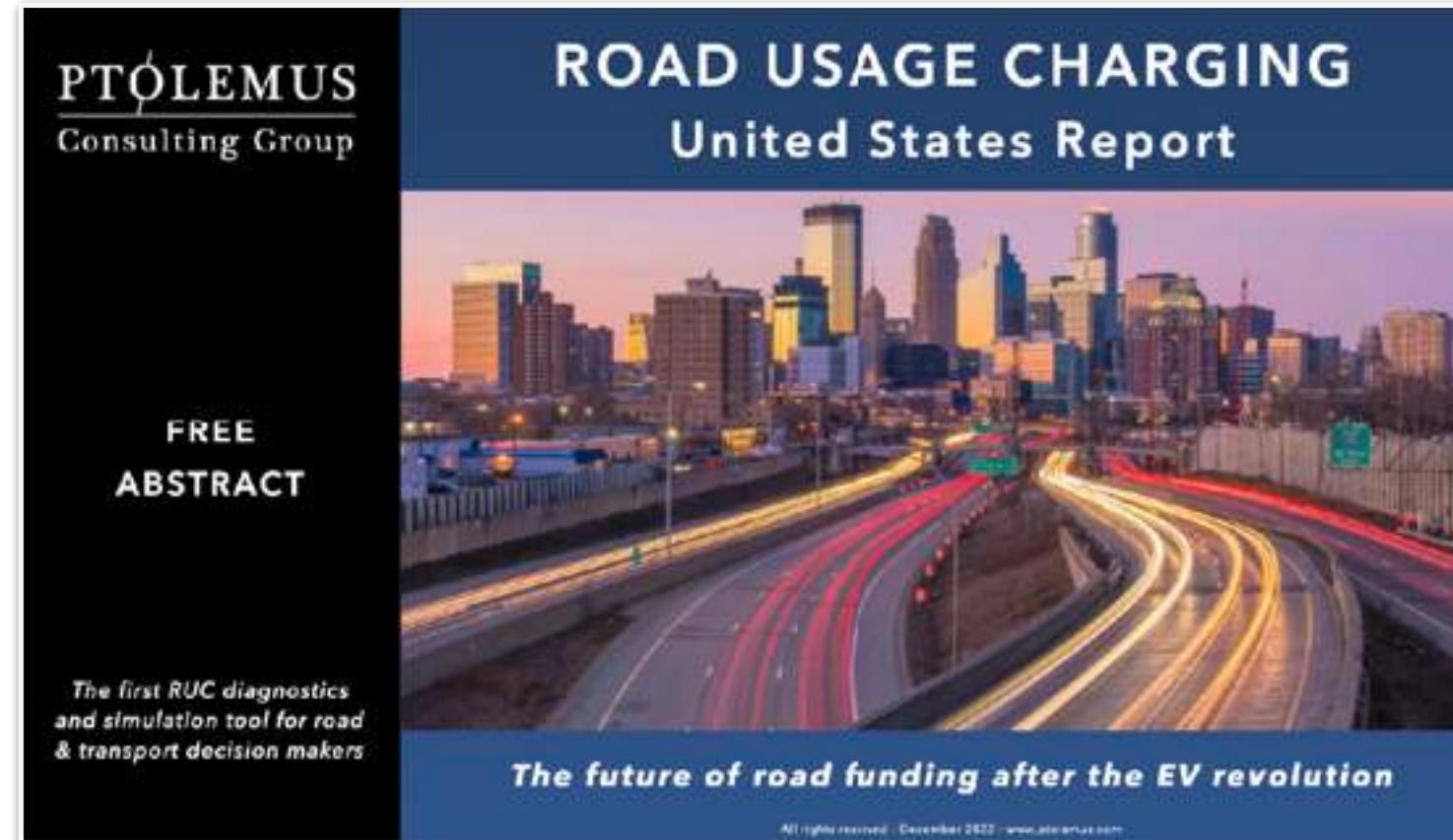
Fatima participated to the research and writing of the report.

Road Usage Charging - United States Report

Report purchase options and pricing



The report comes with a single, worldwide company licence



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You can purchase the report by requesting an invoice or buy online (Visa or MasterCard) on our website**



	Report ONLY	Market forecast model ONLY	FULL Report and market forecast model	Additional workshop
Contents	<ul style="list-style-type: none"> • A 300-page analysis of the current and future road financing in the US • An examination of the economic, financial, political and technological context behind RUC • A detailed assessment of RUC vs. other major funding solutions across 9 key dimensions • The status of road funding examined in the US including 4 in-depth profiles of US States that are at the forefront of RUC initiatives 	<ul style="list-style-type: none"> • One single excel file, 3 separate, connected models: i) motor fuel tax revenues, ii) RUC fee rates and revenues, and iii) RUC costs - Has inputs from over 20 reputable sources and includes PTOLEMUS own automotive and EV forecasts - Stores and simulates hundreds of unique vehicle, travel, and pricing scenarios as defined by the user - Covers the US and all 50 states plus the District of Columbia 	Includes both the report and market forecast content as described	<p>The full report and a market forecast demo presented to your board or strategy team</p> <p>Half-day workshop*</p>
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Avenue Louise 363
1050 Brussels
Belgium

contact@PTOLEMUS.com

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Road Usage Charging - United States Report

Extracts from the RUC USA Report



Road Usage Charging - United States Report

1. Introduction

2. Drivers

3. Overview of the Current Market

4. Case Studies

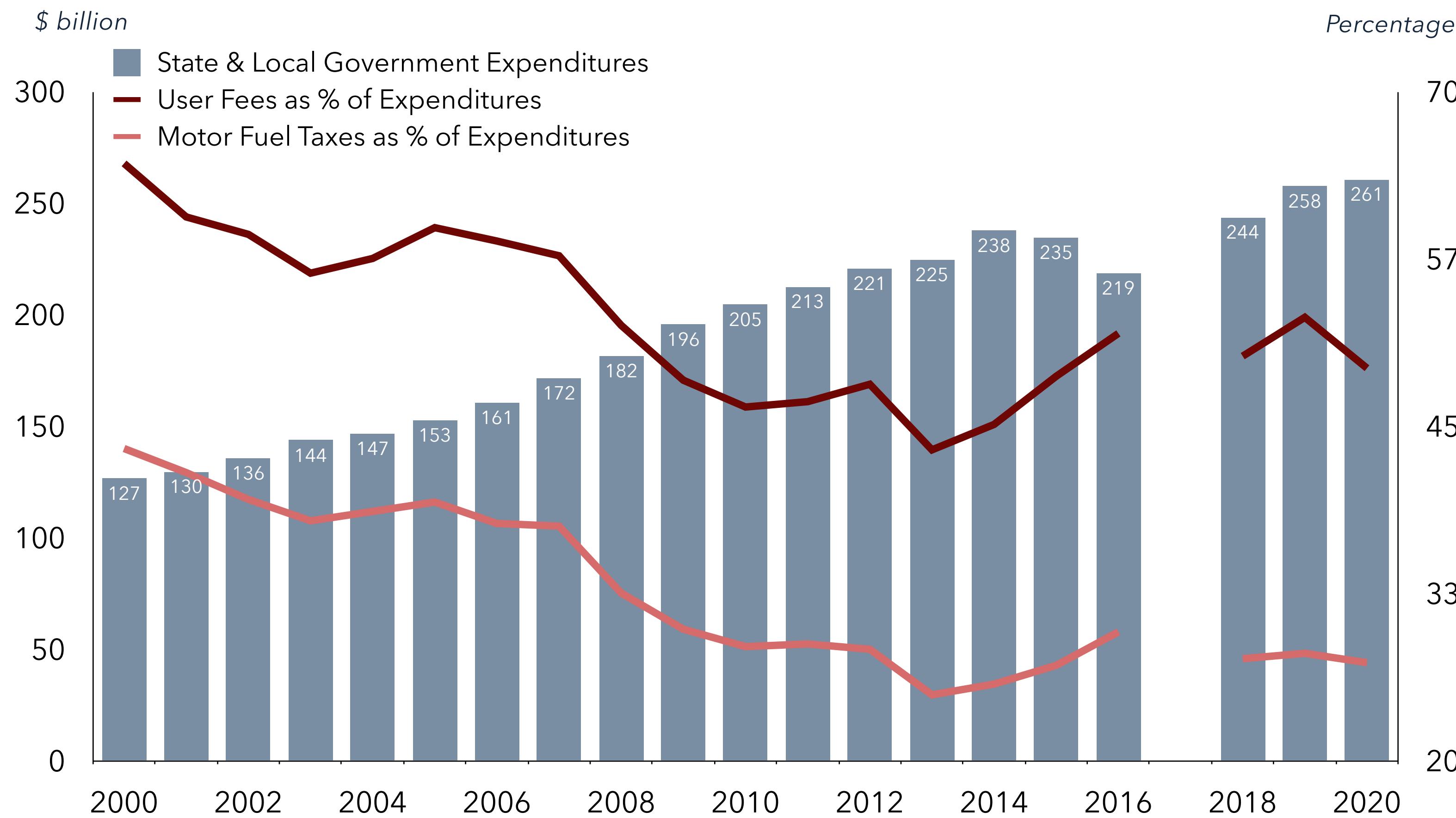
5. Lessons and Insights from Europe

6. Future of Funding and RUC



🔍 State and Local funding: Transportation user fee revenues have not kept up with the growth in expenditures

State and Local Highway Expenditures and User Fee Percentage (\$ billion / %)



- State and local government **expenditures** have shown consistent growth at a CAGR of 3.7% in the last 20 years
- Over the same period **user fee revenues**, including fuel tax revenues, **have grown at a slower rate** and thus fund a lower share of total expenditures
 - **User fee revenue** made up 64.7% of total expenditures in 2000 and by 2020 this had decreased to 49.4% (**CAGR of 2.3%**)
 - **Fuel tax revenue**, the largest portion of user fee revenue, has declined even further from 43.4% in 2000 to 27.4% in 2020 (**CAGR of 1.3%**)



DEDICATED vs. GENERAL FUNDING SOURCES

Decreasing user fee revenues have required states and local governments to find and pursue other funding sources such as general fund transfers, bonding, and property taxes.

Unlike dedicated user fee revenue sources, these funding sources tend to be fungible.

As such every dollar going towards transportation is a dollar not going towards other expenditure areas (e.g. education, police, social service programs, etc.).

The motor fuel tax is levied in all 50 states but only 22 states have variable rates

- The federal fuel tax rates are 18.4 cents per gallon of gasoline and 24.3 cents per gallon of diesel fuel
 - The federal tax rate is fixed with the last increase occurring in 1993
- The state motor fuel tax rates and rate structure are set by each state legislature
 - State gasoline tax rates range from 8 cents in Alaska to 57.6 cents in Pennsylvania with an average rate of 26.3 cents
 - Only half of the states have increased their fuel tax rates since 2015
 - Most states also charge other taxes and fees associated with gasoline, which increases the average to 31.7 cents per gallon
 - Diesel rates are typically higher than the gasoline rates with an average all-in state rate of 33.4 cents

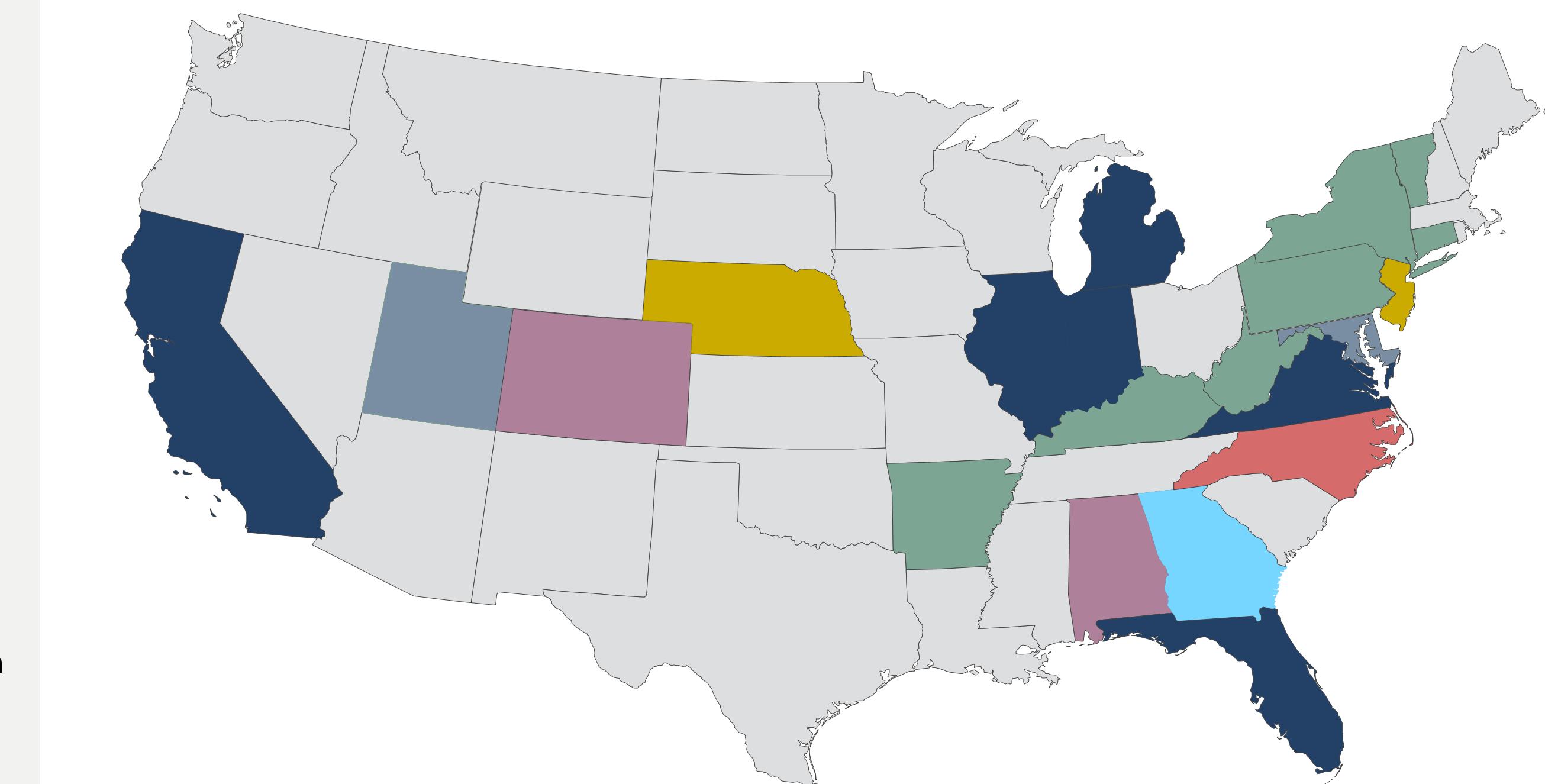
In August 2022, the average gasoline tax rate when combining federal, state, and local taxes was 50.1 cents per gallon

- Though a majority of states have fixed motor fuel tax rates, 22 states plus Washington DC have variable rates linked to different measures including inflation or CPI, gasoline prices, construction prices, population, and even vehicle fuel efficiency
 - Georgia has a tax system based on CPI and average fuel efficiency
 - States, such as Hawaii, apply a general sales tax as well as a fuel specific excise tax to gas which results in revenue fluctuating from gas sales even in situations in which the excise tax is fixed
- Some local governments also have the ability to impose taxes on motor fuel (e.g., Cook County in Illinois)

Gas Tax Schemes Across the United States

- Fixed-rate gas tax per gallon**
- Tax varies with Population & CPI
- Tax varies with CPI (or Inflation)
- Tax varies with Gasoline Prices
- Tax varies with Construction Costs
- Tax varies with vehicle fuel-efficiency and CPI

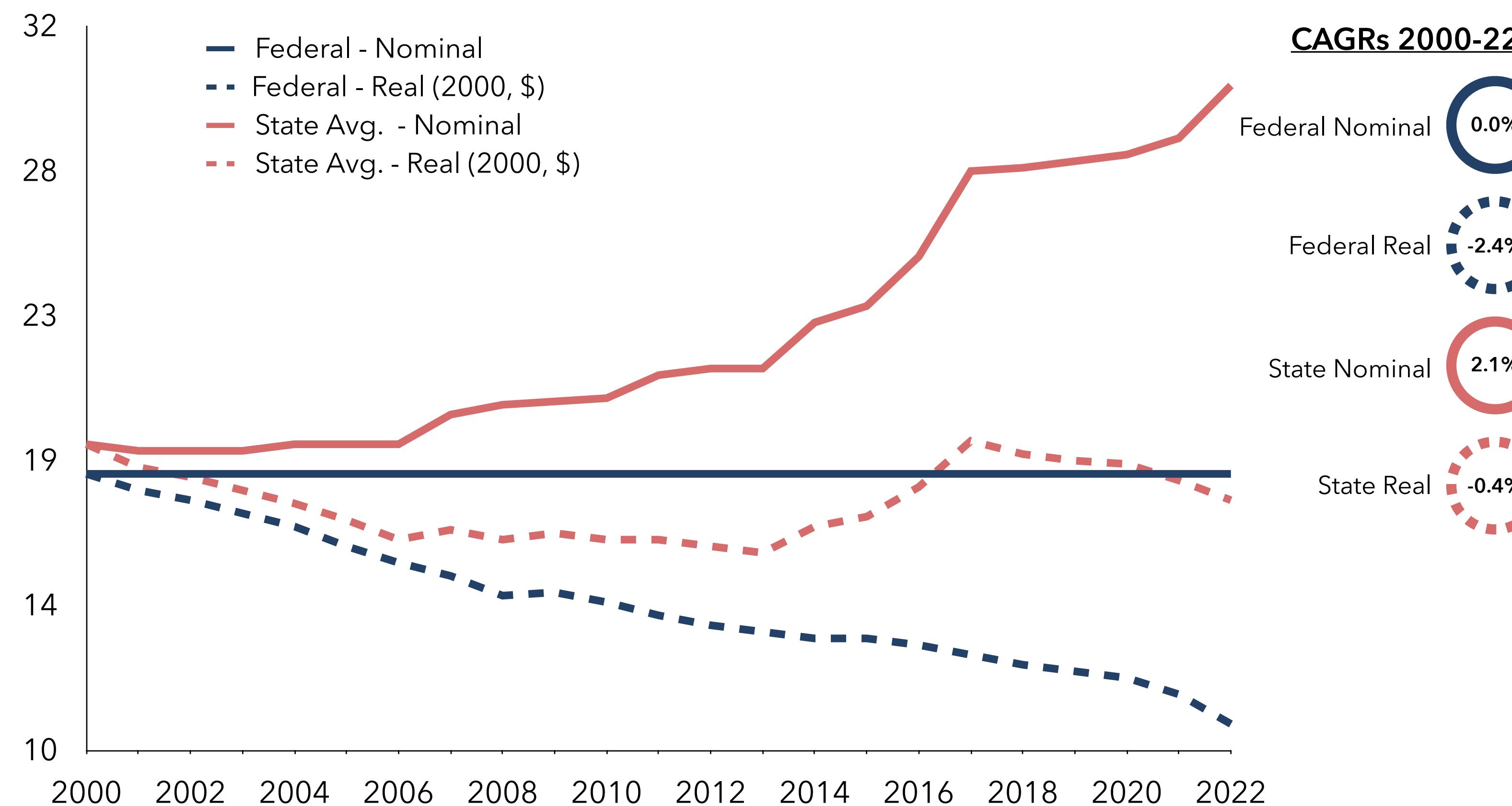
- Tax varies with Population & CPI
- Tax varies with Gasoline Prices & CPI
- Tax varies with Gasoline Prices & Other Factors



Despite recent increases by some states, fuel tax rates have declined in real terms since 2000

Federal and State^(*) Gas Tax Real and Nominal Rate Evolution (\$ cents per gallon 2000-2022)

(*) Reflects the state weighted average gas tax



- While flat in nominal terms, federal fuel tax rates have declined by 42% in real terms
- Over the same period, state fuel tax rates have increased by 56% but still remain slightly down in real terms



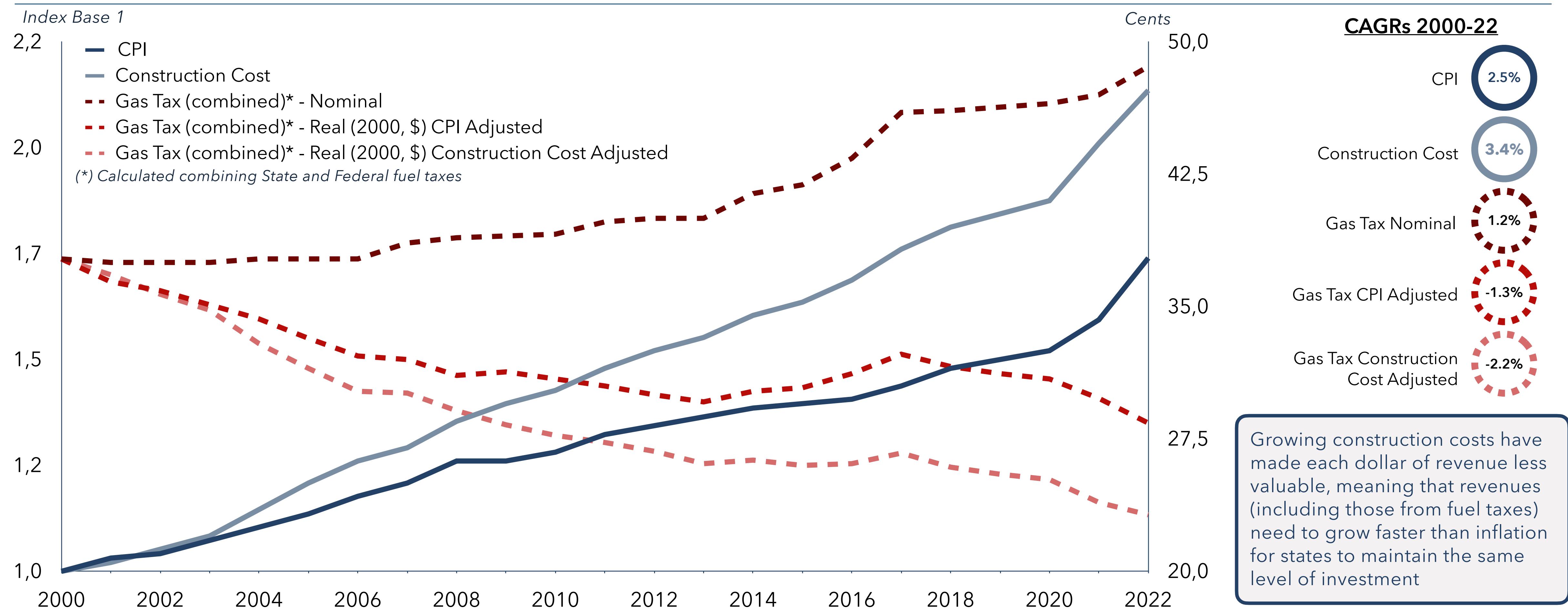
STATE FUEL TAX TRENDS

The average state fuel tax rate was flat up until 2006 and only increased slightly between 2006 and 2013. Starting in 2013, a number of states passed legislation increasing their fuel tax rates and/or linking the rates to different indexes. This resulted in a positive real CAGR (1.1%) over this period.

States have had to increase fuel tax rates as federal funds and other sources have not kept up with their expenditures, which have grown at rates above inflation as seen on the next page. This trend, searching for new funding, expands beyond the fuel tax to tolling, dedicated transportation related sales tax, and even RUC

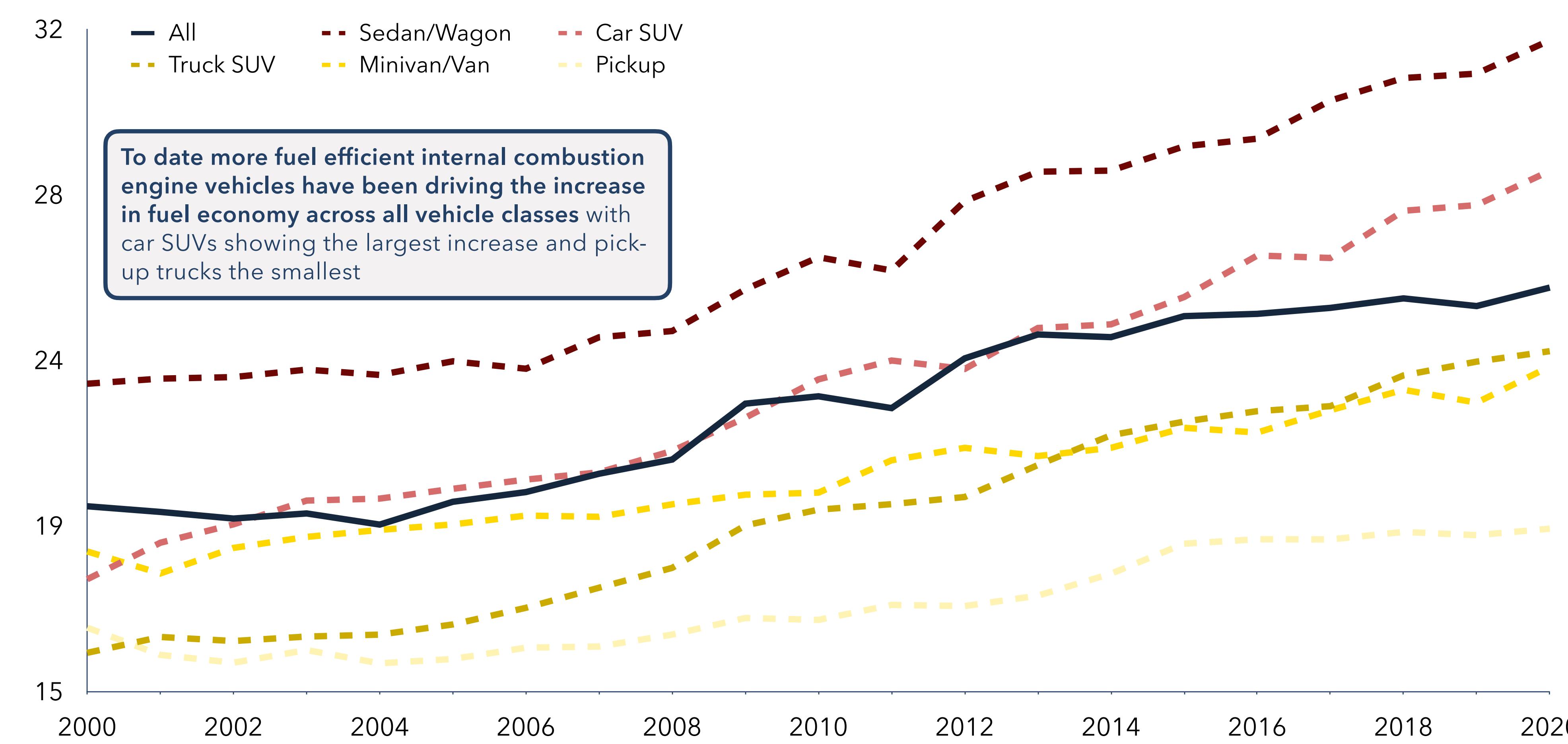
Over the period, construction costs have grown by 3.4% p.a., increasing by 50% more than inflation and putting pressure on states highway budgets

Inflation Versus Fuel Tax Growth (Inflation is in Base 1 and Fuel Tax is in \$ cents per gallon, 2000-2022)



Increasing fuel efficiency across all vehicle classes is a key reason motor fuel revenues are under threat

Fuel Economy by Vehicle Class (Miles per Gallon - MPG)



% Change 2000-20

All 28%

Cars

Sedan/Wagon 38%

Car SUV 59%

Trucks

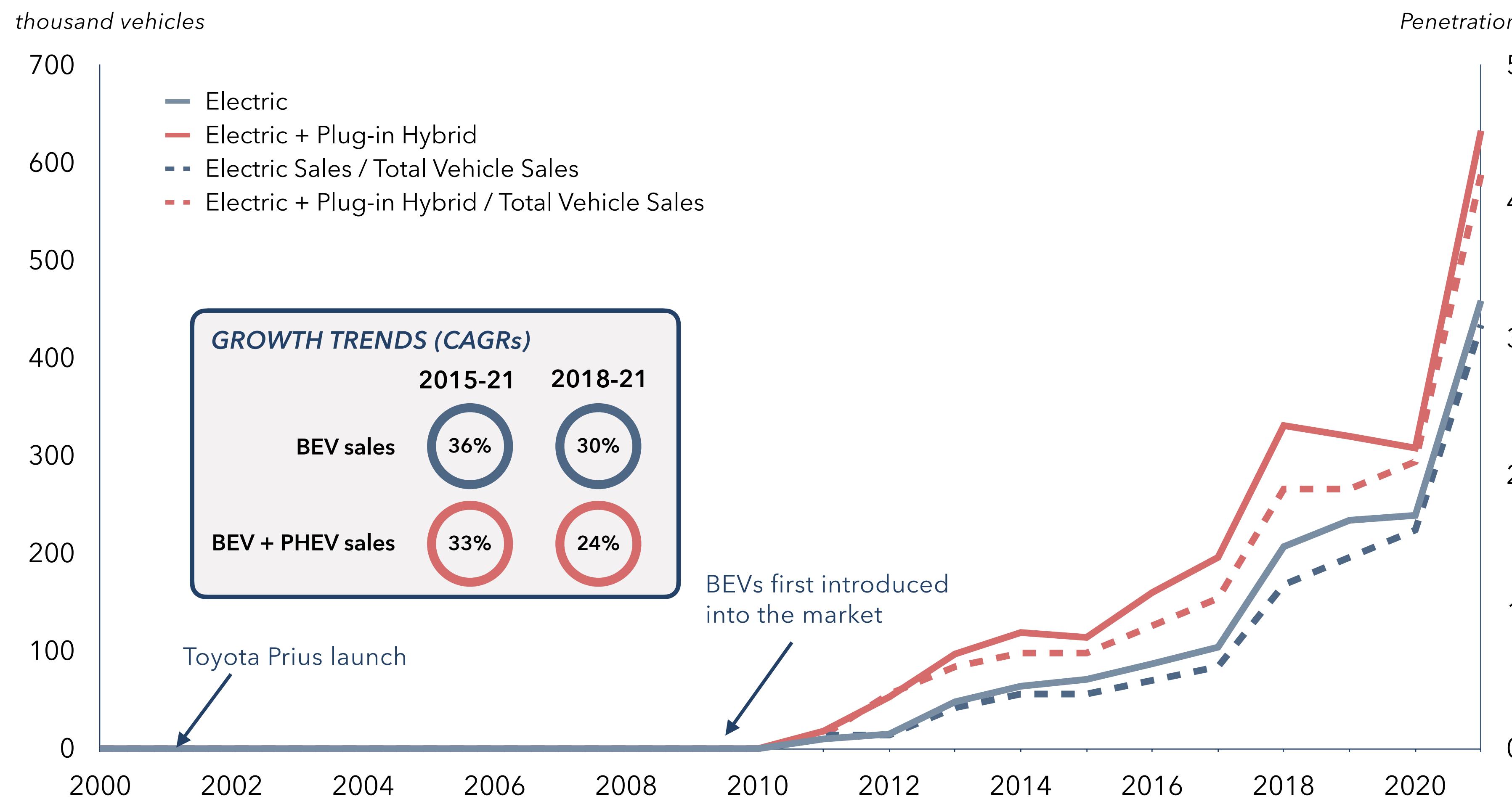
Truck SUV 48%

Minivan/Van 26%

Pick-up 15%

EVs have become mainstream, reaching 5% of all new vehicle sales, leading to a cumulative loss of \$500 million in fuel tax revenues

Electric and Plug-in Hybrid Vehicle Sales and Penetration (thousand, percentage)



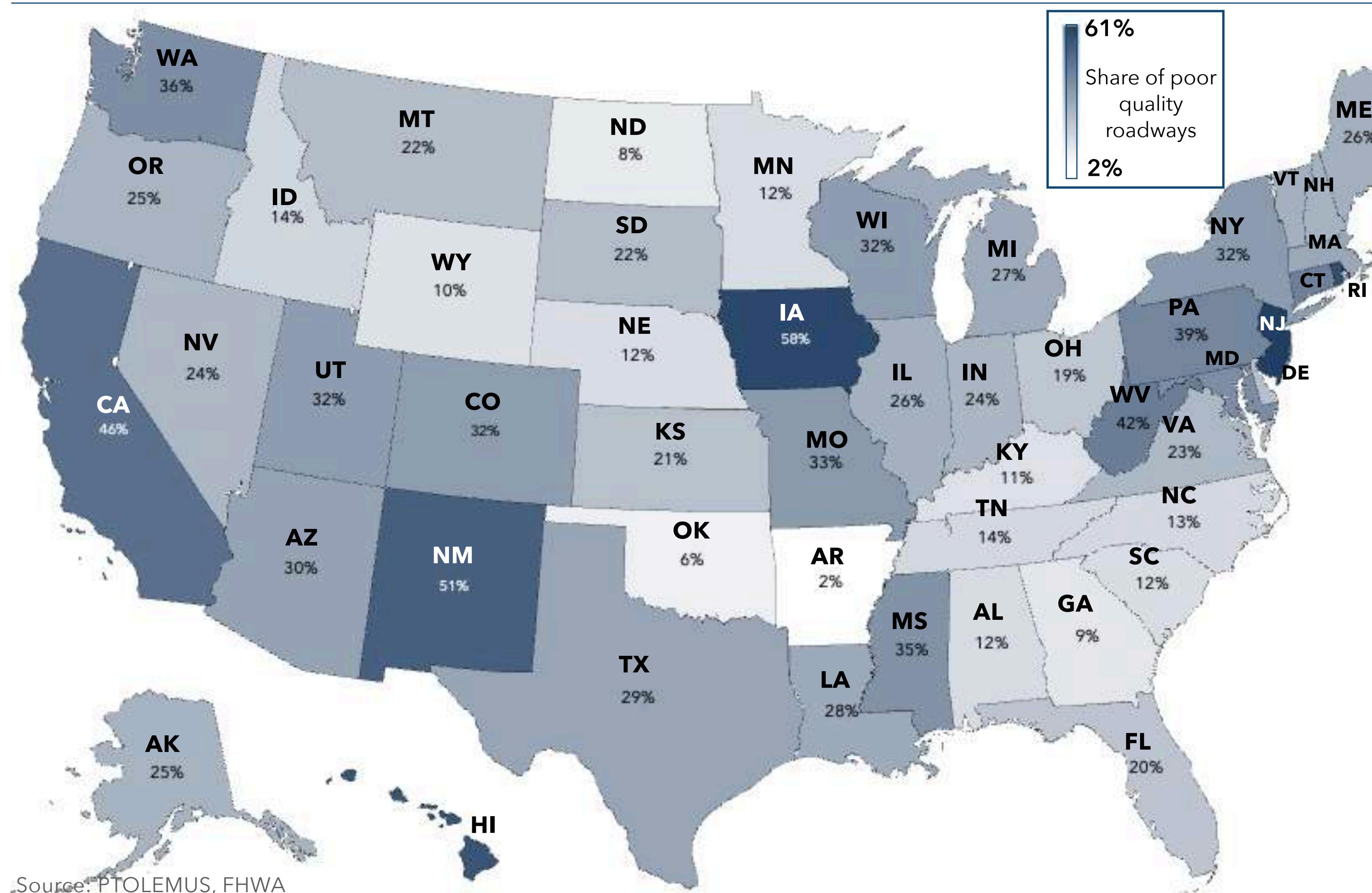
Through 2021, more than 1.5 million new battery electric vehicles (BEVs) had been sold in the US

- In 2021 alone, 450,000 BEVs were sold representing almost a third of total EV sales
- In the first half of 2022, EV sales increased more than 35% year-over-year and for the first time topped 5% of total vehicle sales

Based upon the number of EVs sold to date, federal, state, and local governments have lost in the range of \$400 million in annual fuel tax revenue. Adding plug-in hybrid vehicles takes this total above \$500 million.

With 26% of US roads in poor condition, there is urgency to act and improve infrastructure funding

Pavement Condition (percentage that is poor quality, 2020)



Source: PTOLEMUS, FHWA

Pavement Condition (Percentage)

State	Good	Fair	Poor	State	Good	Fair	Poor
AL	47%	41%	12%	MT	38%	40%	22%
AK	40%	35%	25%	NE	66%	22%	12%
AZ	20%	50%	30%	NV	28%	48%	24%
AR	9%	89%	2%	NH	34%	41%	25%
CA	25%	29%	46%	NJ	7%	32%	61%
CO	23%	45%	32%	NM	10%	38%	51%
CT	11%	49%	40%	NY	27%	41%	32%
DC				NC	32%	54%	13%
DE	38%	42%	21%	ND	60%	32%	8%
FL	36%	45%	20%	OH	49%	32%	19%
GA	47%	44%	9%	OK	46%	48%	6%
HI	7%	39%	54%	OR	18%	34%	25%
ID	59%	27%	14%	PA	19%	42%	39%
IL	34%	41%	26%	RI	6%	37%	57%
IN	36%	40%	24%	SC	41%	47%	12%
IA	2%	40%	58%	SD	29%	49%	22%
KS	44%	35%	21%	TN	61%	26%	14%
KY	33%	57%	11%	TX	22%	49%	29%
LA	31%	41%	28%	UT	26%	42%	32%
ME	30%	44%	26%	VT	32%	43%	26%
MD	23%	40%	36%	VA	21%	55%	23%
MA	14%	57%	28%	WA	13%	51%	36%
MI	34%	39%	27%	WV	15%	44%	42%
MN	50%	38%	12%	WI	34%	35%	32%
MS	16%	49%	35%	WY	59%	30%	10%
MO	17%	50%	33%	US Avg.	31%	43%	26%

Roadway condition is measured using the International Roughness Index (IRI) as presented by the FHWA. Road surfaces with an IRI below 95 are considered good, between 95 and 170 are considered fair, and above 170 are considered poor

Road Usage Charging - United States Report

1. Introduction

2. Drivers

3. Overview of the Current Market

4. Case Studies

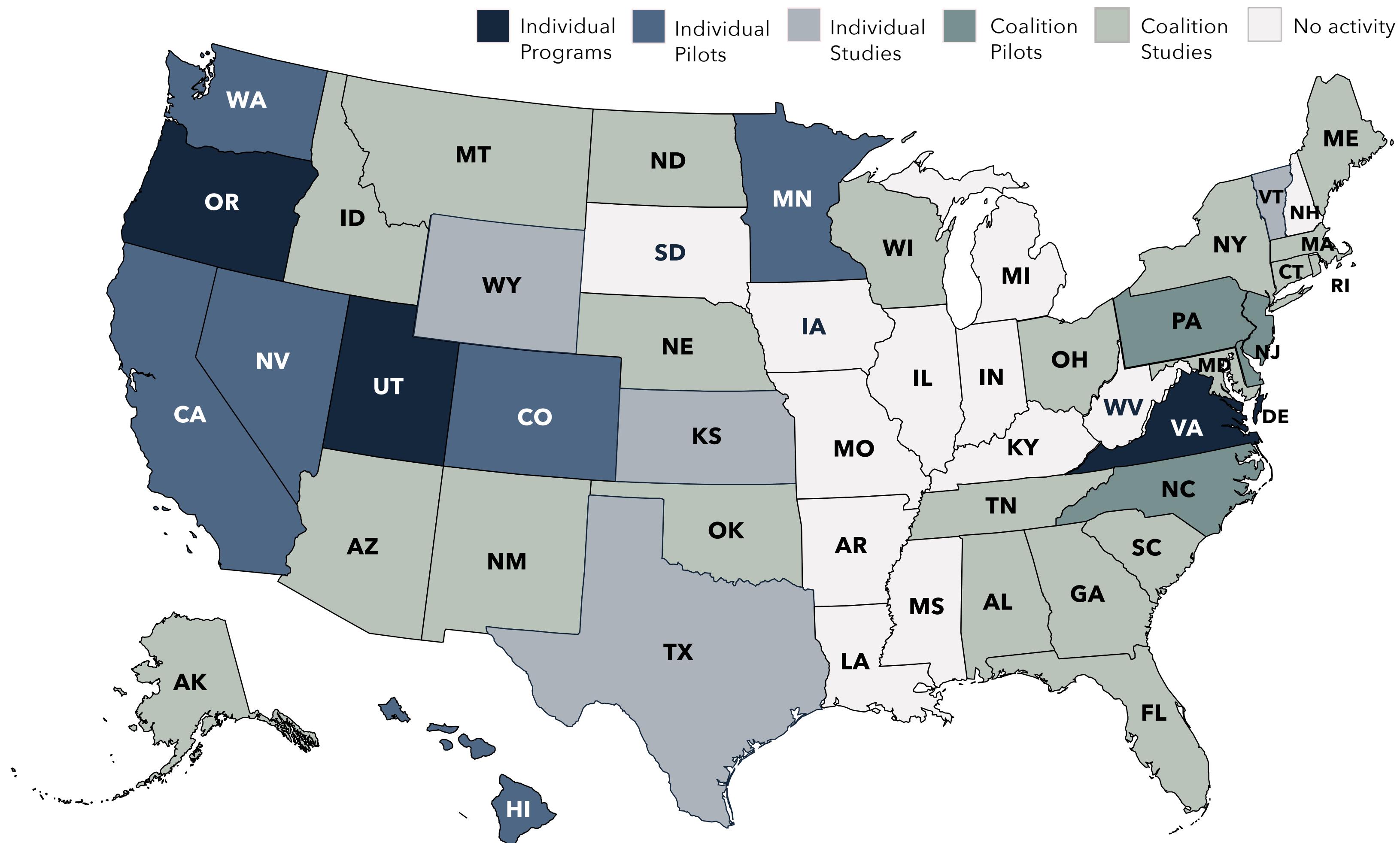
5. Lessons and Insights from Europe

6. Future of Funding and RUC



38 states have participated in and/or conducted at least one of the following RUC activities: studies, pilots, permanent programs

RUC Activity in the US

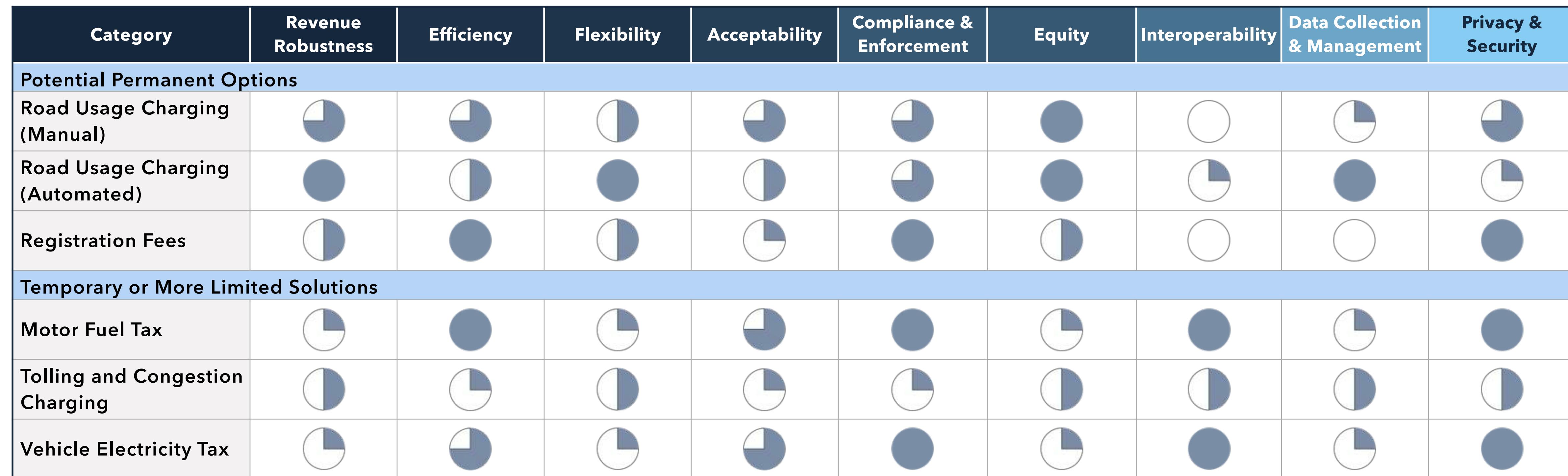


Sources: PTOLEMUS, NCSL, Caltrans, MnDOT, ODOT, UDOT, VDOT

OVERVIEW

- RUC activity has been increasing across the US with 38 states active
 - The **west coast has been the most active region** while "middle America" has been the least active
- States with pilots plus other states such as Texas, Vermont, and Wyoming have completed various studies analyzing RUC
- States including **California, Hawaii, Minnesota, and Washington** have completed or are in the process of running a state RUC pilot
 - In 2017 California ran the largest pilot with over 5,000 volunteers. This pilot had 4 different Account Managers and tested eight technologies. California completed a second pilot in 2021 and is planning to launch a third pilot in 2023
- 3 states, namely **Oregon, Utah and Virginia**, have permanent RUC programs
 - **Oregon launched its program OReGO in 2015.** It allows volunteers to pay a per-mile fee for the miles they travel and receive a credit for the fuel taxes paid
 - **Utah and Virginia launched their programs in 2020 and 2022.** Both programs are voluntary and allow participants to pay a per-mile fee instead of a fixed vehicle registration fee

RUC and registration fees have the greatest revenue potential and thus could both serve as permanent, stand-alone funding solutions



Definitions

Revenue Robustness: Potential of being a standalone and sustainable funding solution - in an electric, connected and automated mobility future
Efficiency: Cost and complexity of collecting and administering the solution
Flexibility: Capability of adjusting solution to meet new mobility challenges and policy goals
Acceptability: Ease in achieving public acceptance
Compliance & Enforcement: Cost and complexity of ensuring program

compliance and collecting revenues due
Equity: Potential fairness of the solution, particularly regarding income differences
Interoperability: Ease and capability of achieving interoperability between states
Data Collection: Amount of data collected and ability to leverage it
Privacy & Security: Level of risks associated with privacy and data security

Road Usage Charging - United States Report

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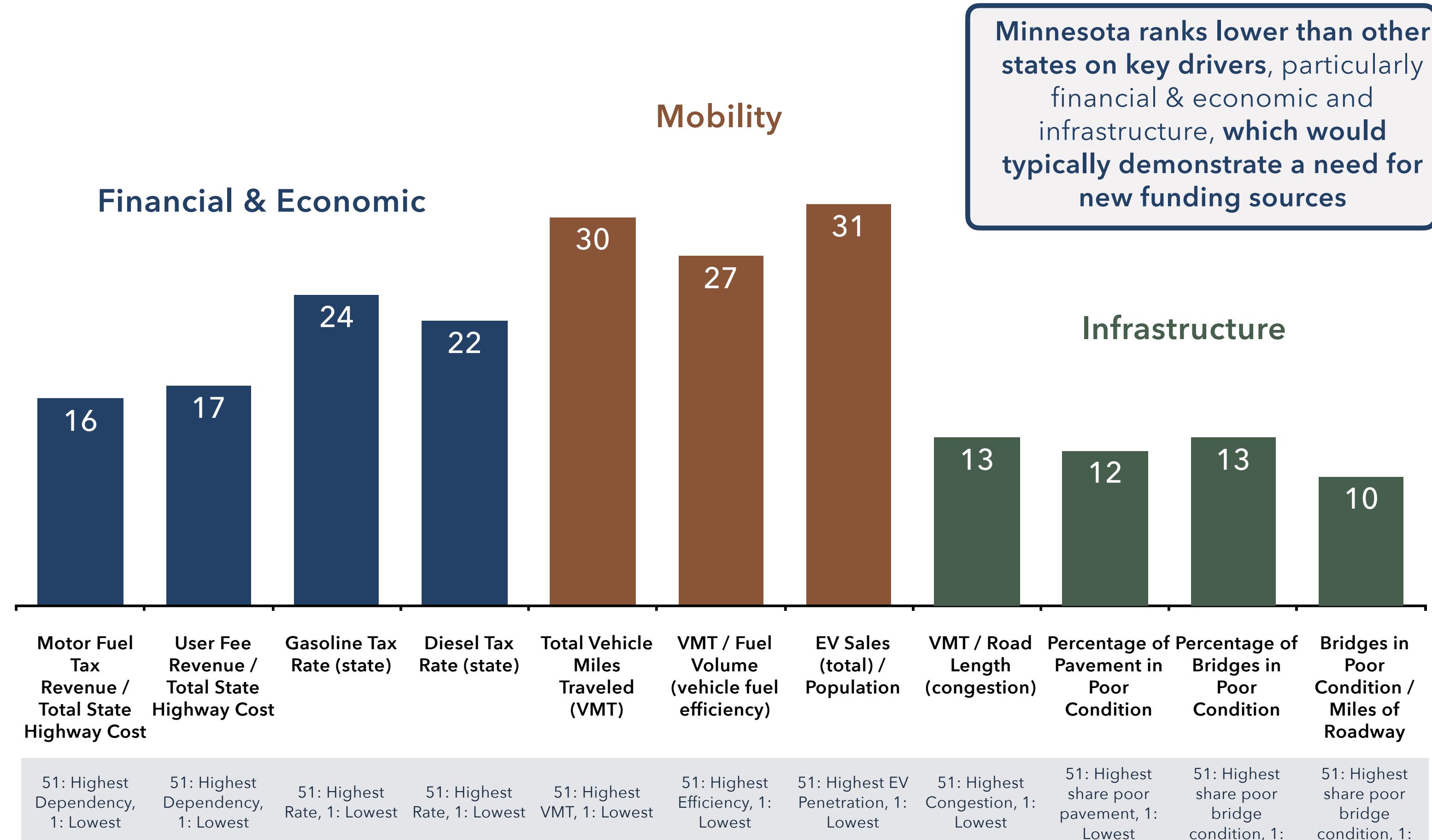
4. Case Studies

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Trends in new mobility and their impact on road funding are key drivers behind Minnesota's RUC program

Ranking of Minnesota Across Key RUC Drivers (ranks Minnesota against other 49 states and DC)



Sources: PTOLEMUS, Minnesota DOT, FHWA

FUEL EFFICIENCY AND ELECTRIC VEHICLES

- In its 2013 and 2022 RUC program reports, improving vehicle fuel economy is listed as a key reason for needing distance-based user fees as the fuel tax is the state's top funding source (37%)
- While referenced in the 2013 report, EVs are noted as a particularly impactful trend in the more recent report with Minnesota having established a state objective of 20% EV adoption by 2030
 - Minnesota presently has a \$75 annual fee for EVs in lieu of fuel taxes

SHARED MOBILITY TRENDS

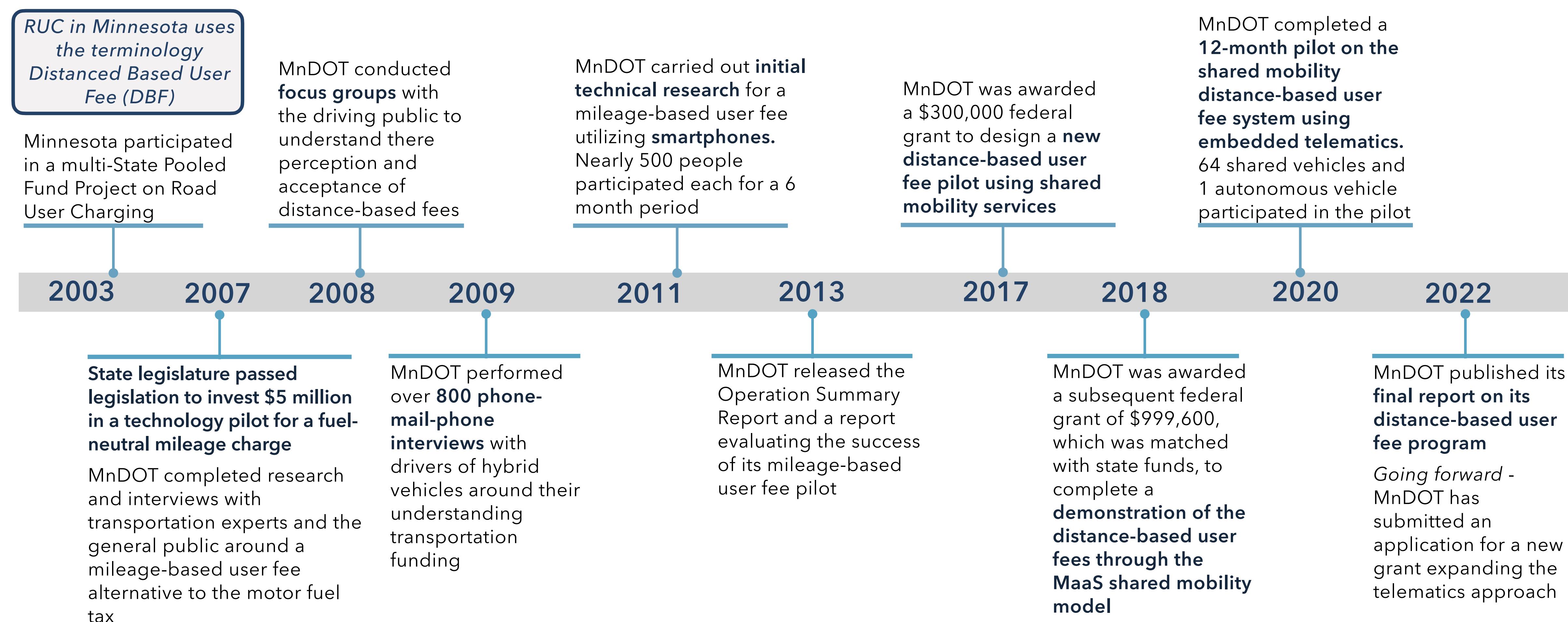
- The 2022 report notes that shared mobility trends, particularly if combined with autonomous EVs, create a high risk for road funding, as they could result in the total number of vehicles decreasing while the total miles traveled increase



In Minnesota, vehicle registration rates are higher than in neighboring states. Minnesota residents thus frequently register their vehicles in neighboring states. This leakage issue has been a trigger for distance-based charging. To capture this tax leakage, the state legislature suggested exploring a road usage charge in lieu of registration fees

Since 2003, Minnesota has completed 2 pilot projects, one using smartphones and the second using embedded telematics

Minnesota Department of Transportation (MnDOT) Distance-Based Fee Timeline



Minnesota's 2011 pilot utilized smartphones to assess the feasibility of distance-based fees

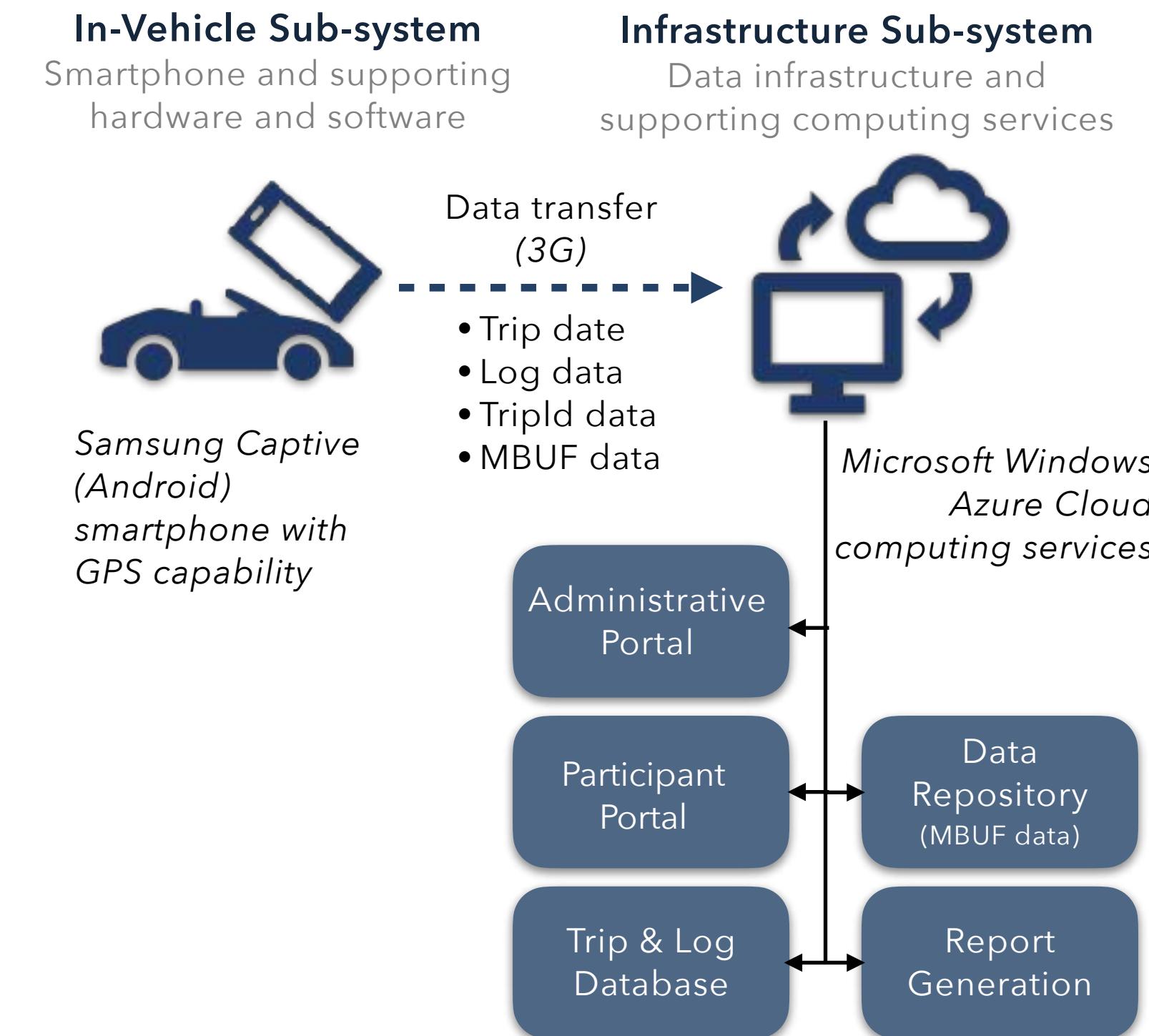
BACKGROUND

- The initial pilot was funded through a \$5 million state government appropriation to demonstrate technologies that would allow a road usage charge to replace the motor fuel tax
- The study was organized by MnDOT alongside 3 prime contractors (the project team)
 - Mixon Hill, program management oversight (PMT) contractor
 - Battelle, led the field deployment team
 - SAIC, led research and development components
- The main objective of the study was to inform future policy decisions regarding both mileage-based user fees and connected vehicle applications

PILOT SET-UP & TECHNOLOGY

- The pilot was conducted in the Twin Cities Metro Area* using smartphones between September 2011 and October 2012
 - A total of **478 volunteers participated**, split between 3 groups that tested at different times, each for 6 months
 - Each of them was given a **Samsung Captivate™ Android smartphone** with CoPilot(R) navigation software, Google Navigation, and custom in-vehicle signage and MBUF functionality
 - A **fixed fee of \$0.03 per mile** was charged unless the customer opted in for sharing personal data and then a **variable fee was charged**
- The variable charge had lower rates for off peak periods and zones outside of the Twin Cities
- The **data that the smartphone transferred** through a 3G data connection to its infrastructure sub-systems included:
 - Second-by-second trip data** (generated by Probe Data Collection system element) such as time, location, heading, and vehicle speed
 - Event-based log data** which was recorded and time-stamped whenever system events occurred;
 - Unique trip identification numbers** or Tripld data
 - Number of miles driven by fee category**, or MBUF data
- Overall the pilot collected more than **660 million trip data points** and simulated \$32,000 in fees

High Level Overview of System Design



System was designed to support 3 key requirements:

- Assess mileage-based user fees
- Convey safety alerts to drivers
- Collect vehicle-related data to support travel time estimates

Key findings from this pilot, such as “drivers value simplicity” have been instrumental in shaping the technology choices and operational strategy of RUC in Minnesota

Key Findings Related to RUC (listed based upon view of how impactful the finding was on design of subsequent pilots)

#	Key Findings	Details/Comments*
1	Drivers value simplicity	Dealing with smartphones required significantly more involvement on the part of the driver than the existing funding process (fuel tax) and many participants noted this as a weakness of the program
2	Many user requirements are needed for a RUC program, which drive up cost and friction	There were a number of activities that required significant customer engagement unlike with the motor fuel tax. Examples include reporting of odometer mileage, invoicing processes, and installing and managing devices
3	Numerous different organizations are needed for a RUC program increasing its complexity	Supporting many customer interactions requires significant resources both operationally, including many specialized firms, and financially
4	An “opt-in” discount system approach to sharing data can work but requires native technology	The pilot allowed participants to share data by opting in. Those opt-in participants received discounts on trips. Noting the above, there were software and hardware challenges resulting in many miles not being captured and some drivers being overcharged
5	Privacy was not of paramount concern to participants	The main privacy concern was around the storage of data by the state and preventing hackers from accessing and misusing this data
6	Participants are willing to accept modest monthly invoices	Average fees were \$20 a month. Only 17% of participants viewed this as more than anticipated
7	Communications on how funds are used is key for a program’s acceptance	Communications proved important for the program’s acceptance. Participants joined the pilot without knowing how transportation funds were used but left with a better understanding and viewed the sources and uses as relatively reasonable



“

Many of the participants in the MRFT who preferred the fuel tax over an MBUF program noted that one of the significant reasons they preferred the fuel tax was its simplicity....

This desire for simplicity was echoed in participants’ perceptions regarding device usability and overall opinions of this particular MBUF technology solution. Again and again, participants in the MRFT expressed a desire for the technology to be integrated into the vehicle so that it would require little (if any) interaction on their part.



Minnesota's second pilot, launched in 2019, was designed to capture the lessons learned from the first one

BACKGROUND

- This new pilot was funded through 2 STSFA grants plus state funding (grants required a 50% local match)
- The first STSFA grant of \$300,000 (awarded in 2017) for exploring ways to design a distance-based user fee pilot with shared mobility (SM) providers
- The second of \$1 million (awarded in 2018) was for running the demonstration program
- The program was designed to leverage the lessons learned from the first pilot around complexity, cost, privacy and security, while also leveraging emerging technology and business models

PILOT SET-UP & TECHNOLOGY

- The pilot was split into 2 phases, carried out over an almost 2-year period:
 - First, a proof of concept
 - Second, a demonstration of 3 main processes: data collection, transaction processing, revenue reporting
 - Participating were 2 shared mobility (SM) providers and a connected/automated vehicle (CAV) research partner
 - HOURCAR, a non-profit car sharing group out of Minnesota
 - Zipcar, a leading national car share group, part of the Avis Budget Group
 - VSI Labs a leading CAV research group
 - This contrasts with the first pilot that had almost 500 individual participants
- MnDOT initially approached a leading OEM to participate, as the technology partner and utilize their in-vehicle telematics system. After the OEM decided not to participate, MnDOT brought onboard the shared mobility providers



“ A car sharing-based DBF will not in and of itself be a viable long-term funding solution for the State.

Rather, car sharing services were selected because they are fleet-based and reliant on embedded telematics; 2 fundamental aspects of MnDOT's long-term vision for DBF development and implementation.

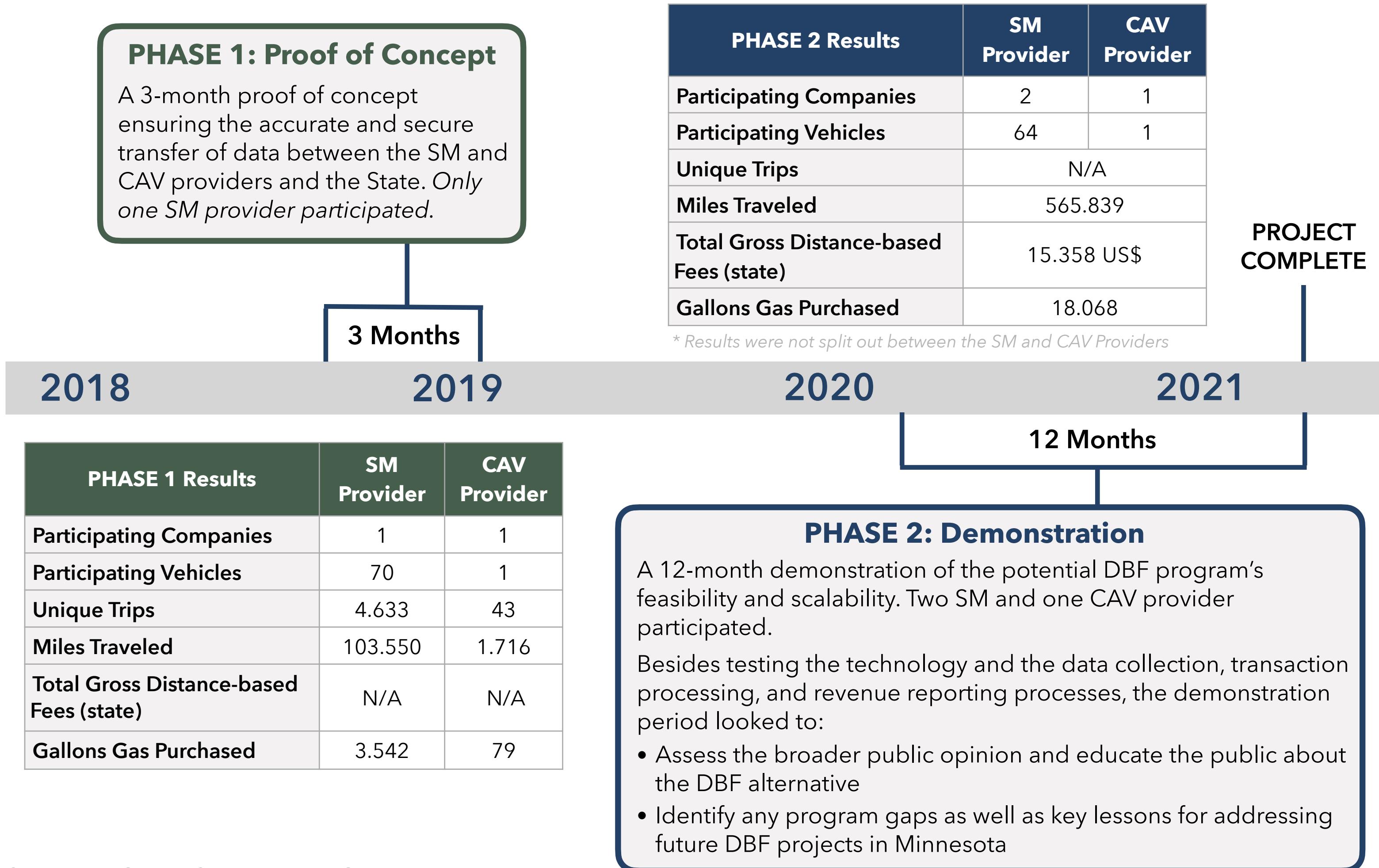


Reasons for Selecting Car Sharing Partners

1. Ease of Using Embedded Technologies
2. Cost Efficiencies Achieved through Use of Existing Technologies
3. Increased Privacy Protection
4. Decreased Risk of RUC Evasion
5. Leveraging Existing Fee Processes
6. Potential Expansion to Additional Fleets

The pilot first tested the technology and then its feasibility and scalability

Minnesota Distance-Based Fee Phased Approach



Sources: PTOLEMUS, Minnesota DOT

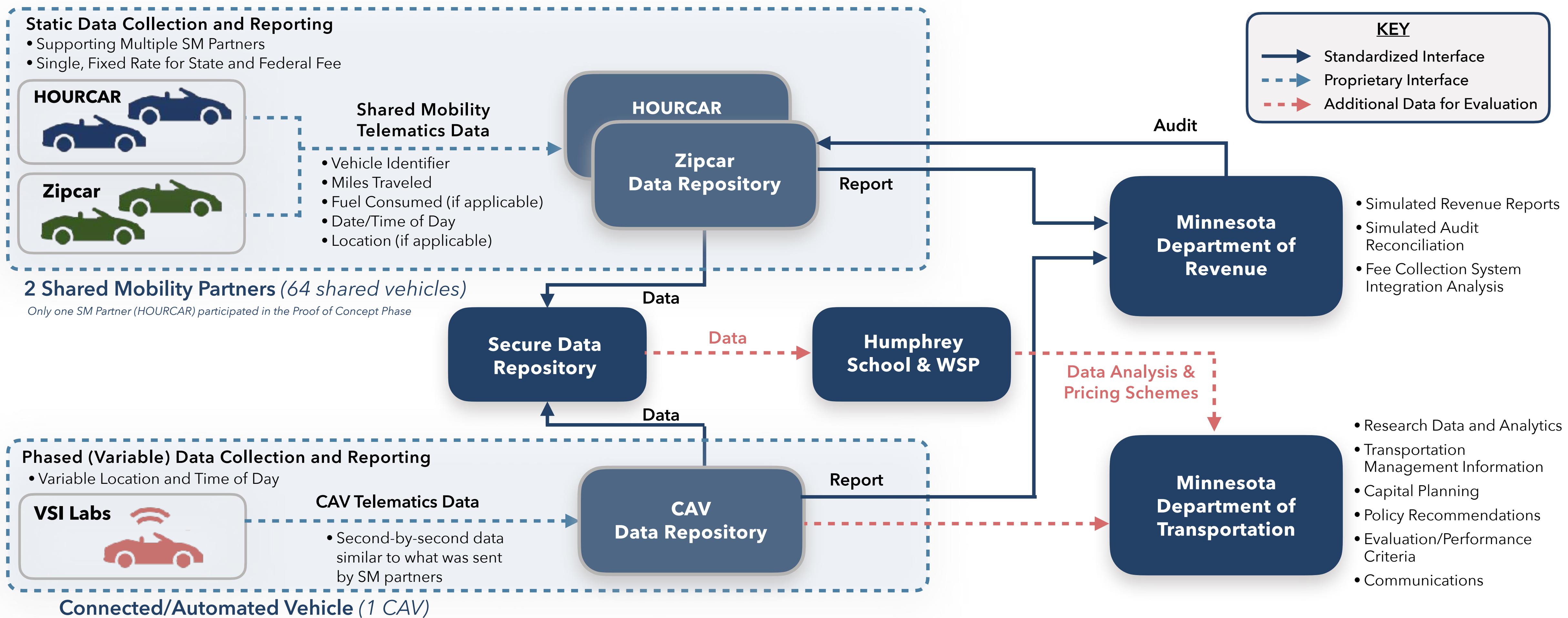
PROJECT OBJECTIVES

- **Technical Feasibility**
 - Confirm the reliability of utilizing embedded telematics systems to capture and securely transmit critical DBF data
 - Confirm the ability of the Minnesota Department of Revenue's fee collection systems to ingest data from shared vehicles and calculate the correct fees
 - Confirm the audibility of the system
 - Confirm the system is designed in a way that provides strong protection for data privacy
- **Administrative Efficiency:** Develop a highly efficient collection structure that has customer touch points limited to the SM providers
- **Pricing Framework:** Develop a flexible pricing framework that takes into account factors such as vehicle class, time of day, etc.
- **Future Implementation:** Develop a project that puts the state on path for a larger future DBF deployment as well as positions the state for partnerships both local and nationally



🔍 Functional Architecture: The pilot was designed to limit data collection and reporting touch points by utilizing embedded telematics and working with existing businesses instead of the end fee payer

Minnesota DBF Functional Architecture from Demonstration Phase



Rate Setting: The pilot was the first to simulate collecting both state and federal user fees and to develop a rate-setting framework

- Minnesota's pilot established a **per mile fixed fee**, the Distance-Based Fee (DBF) rate for participating shared vehicles
 - The rate used simulated the motor fuel tax rates for both the state and federal motor fuel tax regimes
- To establish the DBF rate, the project team applied a 3-step process, as outlined below
- The outcome was a **Demonstration Fee rate of 2.7 cents per mile (1.6 cent covering state costs and 1.1 cent for federal)**

Demonstration Fee Rate Setting Process (State and Federal Rates)

- 1 Developed a framework for a potential DBF pricing scheme using an initial flat fee based upon state and federal revenue and VMT averages

$$\text{DBF} = \text{State Rate (SR)} + \text{Federal Rate (FR)}$$

$$\text{State Rate} = \text{State Fuel Tax Revenue} / \text{Total State VMT}$$

$$\text{Federal Rate} = \text{Federal Fuel Tax Revenue} / \text{Total Federal VMT}$$

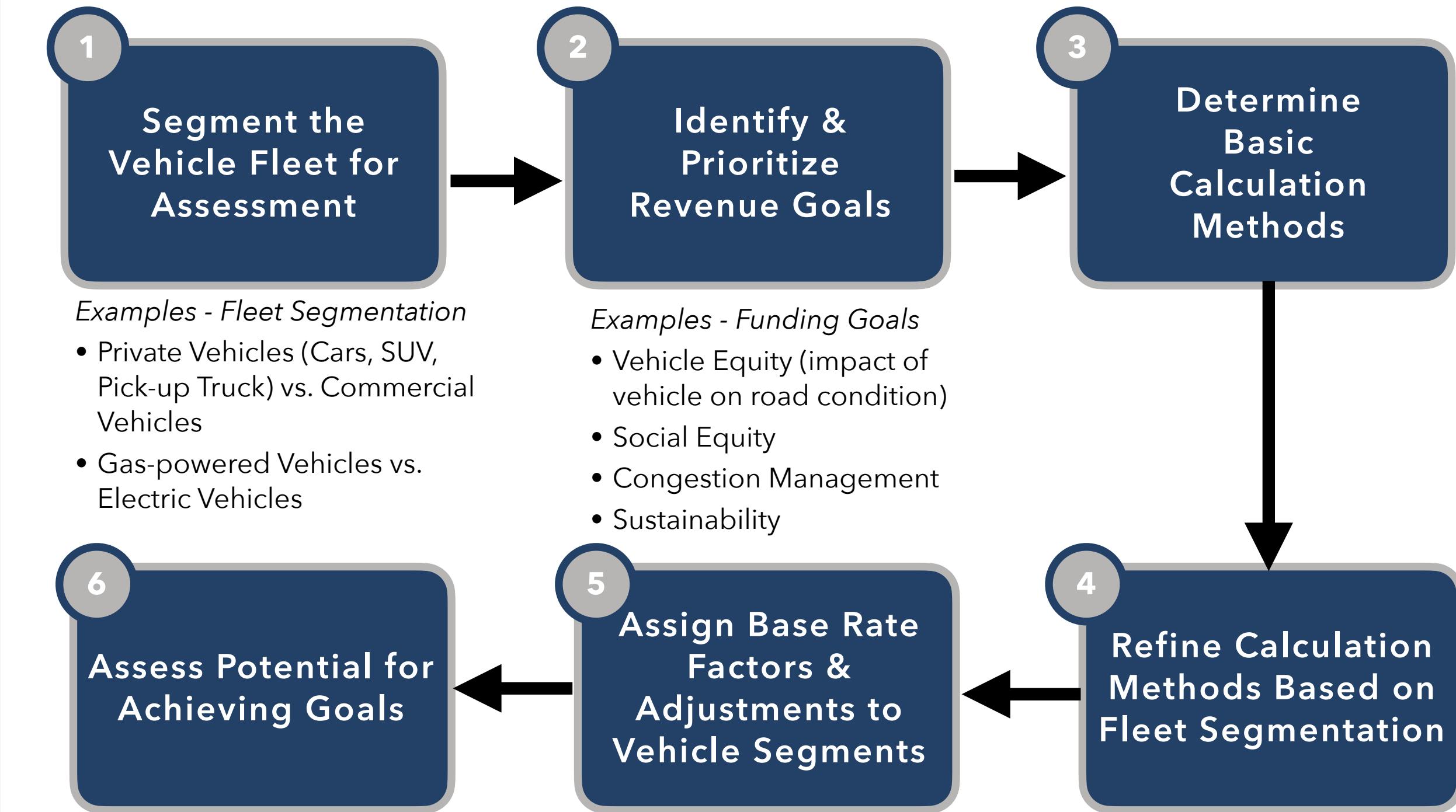
- 2 Established a DBF rate formula, assessing a single DBF rate, netting state and federal motor fuel tax revenues against the DBF fees collected. Rates were 28.5 cents per gallon for the state tax and 18.4 cents for federal

$$\text{Net DBF} = [(\# \text{ miles traveled} * \text{Per-Mile Rate})$$

$$- (\# \text{ gallons of gasoline consumed} * \text{motor fuel tax rate})]$$

- 3 Applied the above frameworks to determine the Demonstration Fee rates

Minnesota's Rate Setting Framework



Rate Adjustment Examples:

- Vehicle-Dependent / Weight
- Congestion-Based: Time of Day and/or Location (city, urban, rural)
- Income-Based
- Environmental



As part of the pilot, MnDOT along with its partners developed a rate-setting framework and explored different variable fee options. Though the demonstration fee utilized a fixed per-mile DBF rate, MnDOT's report made it clear that a fixed fee model was not fully aligned with other state objectives and policies.

For example, larger, heavier vehicles paid the same as smaller, light vehicles. Going forward, this rate-setting framework is likely to play an important part in shaping Minnesota's RUC program and policies.

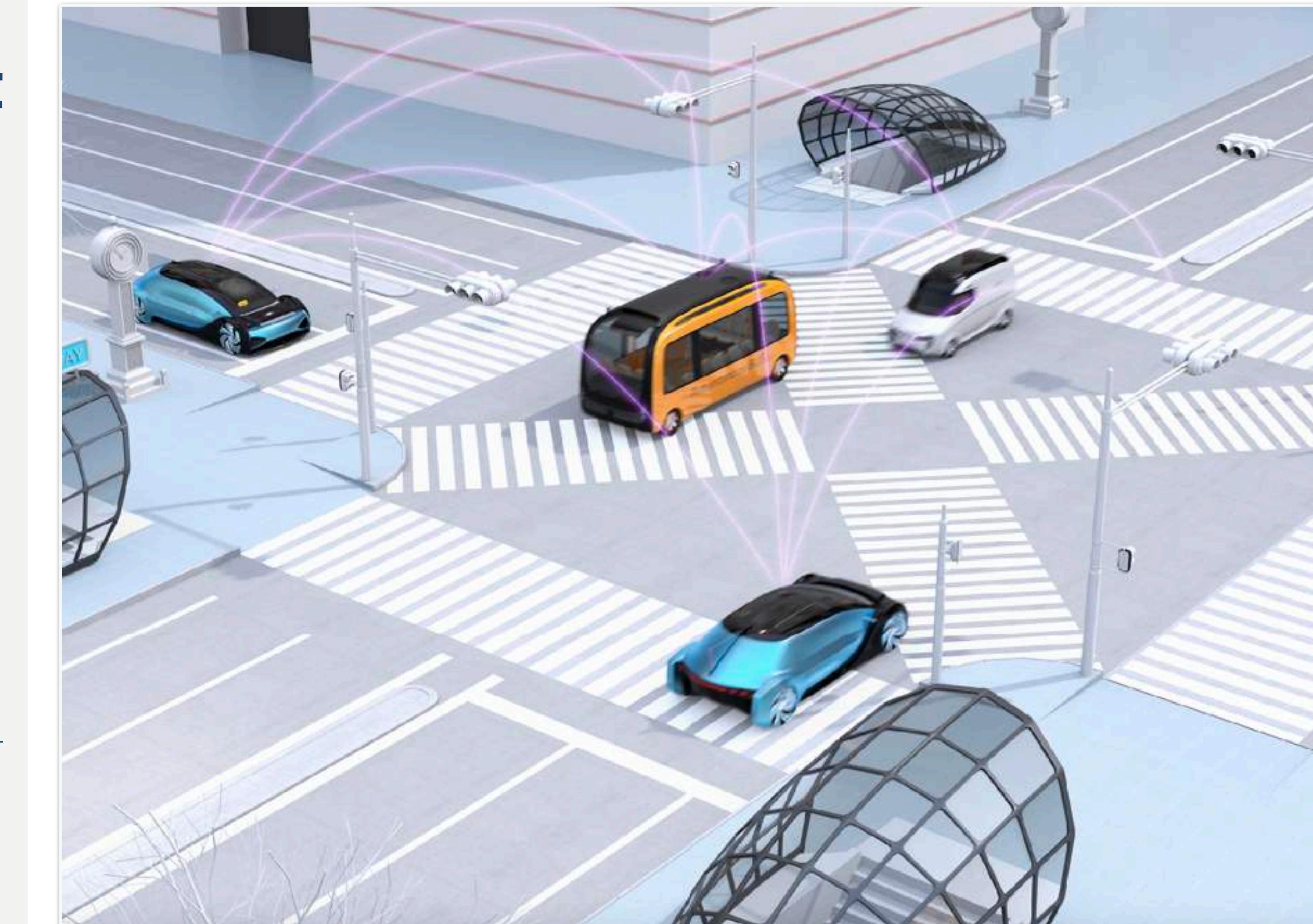
🔍 CAV: The pilot was also the first to collect RUC data from a Connected & Automated Vehicle

- MnDOT worked with a CAV partner to ensure that the distance-based fees could be future proof and scalable to a world with CAVs
- This trial proved successful, as the **MnDOT was able to securely transfer second-by-second vehicle and location data from the CAV to a secure data repository**
- The **CAV also demonstrated other use cases** that could be beneficial to the state as it continues to explore distance-based fees
- These use cases included:
 - **State Border Crossing** - the CAV managed a 188 mile round trip during which it crossed into Wisconsin. The CAV systems were able to accurately detect the border crossing and differentiate between the miles driven in Minnesota and Wisconsin

- **Lane Detection** - the CAV made several trips on I-394 switching between the general purpose and high-occupancy toll (HOT) lanes. The CAV's system was able to accurately detect the lane in which the vehicle was traveling and for how many miles it travelled in that lane

The CAV proved effective at determining the lane in which the vehicle was traveling, demonstrating the potential for variable rate charging schemes similar to express lanes

- **Lane Detection with Occupants** - The HOT lane test was performed with single and multiple vehicle occupants. The sensors in the CAV were able to determine the number of occupants and report back this data



Significant investment is currently going towards CAVs, which have the potential to disrupt the traditional car ownership model by increasing vehicle utilization and improving safety (for example with shared robo-taxis).

This disruption will likely also impact the road funding model, decreasing revenues and increasing costs.

If CAVs are electric as most anticipate, fuel tax revenues will be negatively impacted.

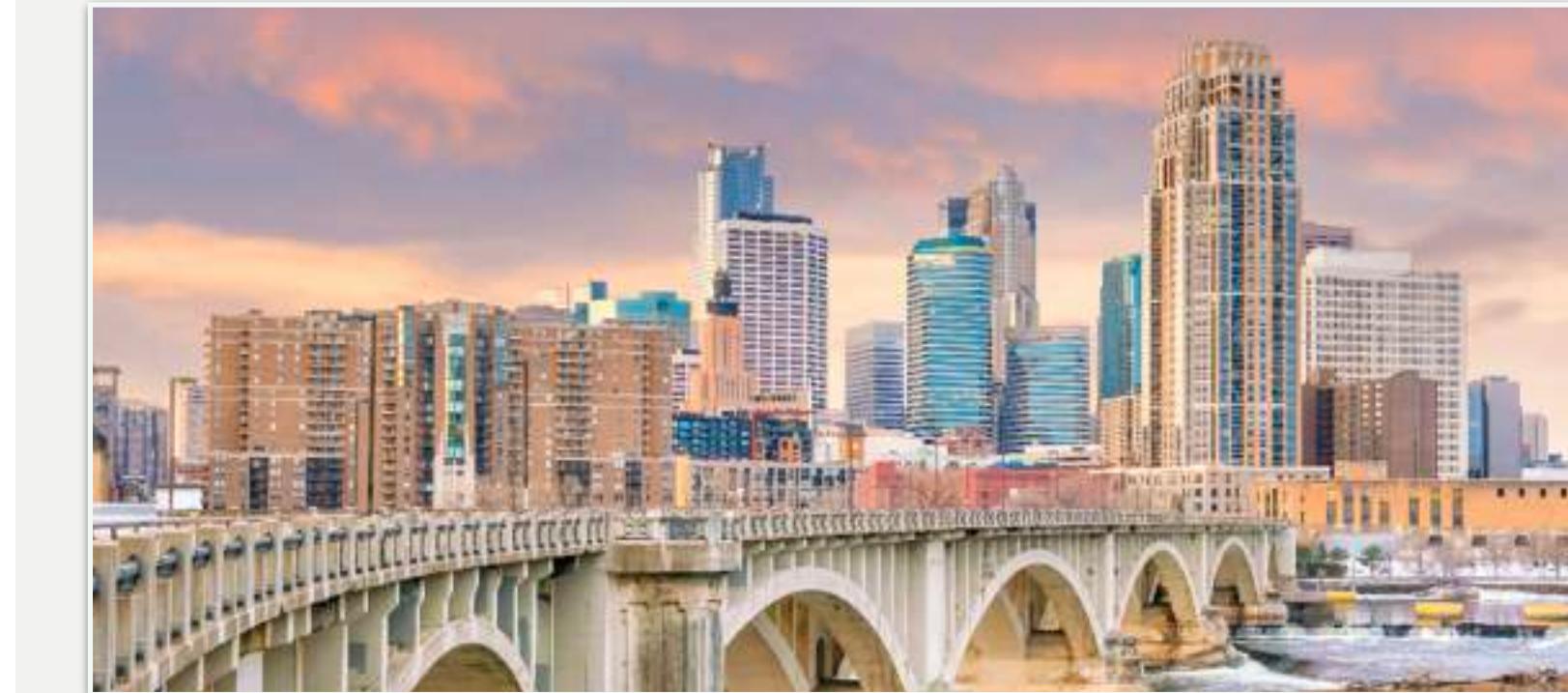
At the same time, higher vehicle utilization has 2 impacts: i) less revenue from registration taxes, the second largest user fee and ii) higher road maintenance costs due to the additional vehicle miles travelled.

Distance based user fees can help fill this gap, and CAVs, as demonstrated in the pilot, are equipped with the systems required to effectively and securely deploy RUC across the state's road network.

MnDOT has applied for a grant to fund a 3rd pilot based on a partnership with an OEM leveraging vehicles' embedded telematics

Key Pilot Findings To Inform Future Programs in Minnesota

#	Findings	Details/Comments*
1	Fleet-based approaches to DBF assessment are accurate and reliable	DBF can be collected from fleet-based telematics and audited. The aggregation of fleet data provides greater privacy to the individual users of fleet services by eliminating the need to collect PII and maintain individual user accounts
2	Leveraging fleet-based telematics reduces complexity and improves flexibility	Utilizing in-vehicle telematics eliminated the need for aftermarket devices, which had caused some practical issues to users in the previous pilot
3	Fleet-based approaches may reduce administrative costs	Fleet-based DBF reduced the overall project's administrative burden by reducing the number of touch points (i.e., 64 vehicles and 1,400 SM customers participated but MnDOT only had 2 SM providers to interact with) and simplifying the audit process
4	Fleet-based approaches can improve compliance and reduce enforcement costs	Shifting the burden of compliance and enforcement to the private sector (SM) greatly reduced the incentive to evade the fee
5	CAV systems are a viable data collection technology	The DBF was successfully collected from CAV systems, which proved capable of providing other data useful for transportation network development and efficiency
6	Embedded telematics – already installed by OEMs in almost all new vehicles – could be used to more efficiently and effectively deploy DBF	The majority of new vehicles have telematics systems already in-place that manufacturers have installed. These systems and this data could be utilized to generate a secure DBF at scale
7	A statewide DF could support other revenue and pricing systems	The majority of new vehicles have telematics systems already in-place that manufacturers have installed. These systems and this data could be utilized to generate a secure DBF at scale
8	Unique challenges remain with fleet based DBF development implementation	Many challenges remain including better understanding administrative cost efficiencies, the benefits of working directly with OEMs, and how multi-state interoperability would work, etc.



FOR MINNESOTA, WHAT MIGHT RUC LOOK LIKE IN THE FUTURE?

1. Distance-based fees deployed for specific vehicles (connected/electric), alongside the gas tax for the rest. Thus RUC would initially act as a parallel revenue stream
2. Commercial account managers would be companies already operating in the Minnesota business ecosystem with OEMs being the main partners
3. Embedded telematics would be used to administer and collect fees
4. Variable fees would be charged that account for vehicle weight (high damage) among other factors

Road Usage Charging - United States Report

1. Introduction
2. Drivers
3. Overview of the Current Market
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6. Future of Funding and RUC



The most comparable systems to RUC that are deployed at scale are the European distance-based nationwide schemes that leverage GNSS technology

Comparison of Road Charging Models in the US and Europe

	 United States	 Europe
 Objective / Motivation	★ Replacement source for lost motor fuel tax revenue due to increased penetration of fuel efficient vehicle	★ Initially focused on road funding and more recently negative externalities associated with roads (climate related issues)
 Vehicle Types	★ Light Vehicles (passenger cars and light trucks)	★ Heavy Goods Vehicles (Class 4 Trucks and higher)
 Regulation	★ Bottom up approach: state's are developing their own regulations with the federal government mainly providing support through funding (i.e., grants)	★ Top down approach: the framework for road pricing including distance based pricing is established at the EU level
 Technology	★ Multiple technology options are preferred as the approach is focused on fostering privacy and lowering costs	★ Flexible approach to technology to ensure interoperability across countries and add-on services to improve the customer experience
 Interoperability	★ The clearinghouse model has been the favored option with regards to testing interoperability	★ The roaming model is used to reach interoperability
 Account Management	★ Most pilots and programs have had a single or a limited number of account managers coming from the fleet management or tolling industries	★ Competitive market with account managers (EETS providers) from the fleet, energy/fuel, and tolling ecosystems

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To support our forecast, PTOLEMUS created a model that examines road funding needs and RUCs potential in all 50 states

PTOLEMUS Model and Forecasting Structure

Inputs (Historic Data)

FED Data New Vehicles Sales (by vehicle class, 1976-21)
GoodCar Data New Vehicles Sales (by make / model, 2020-21)
AFIA Data Electric Vehicle Sales (by state, 2011-21)
FHWA Data (Vehicles) Registered Vehicles (by state and vehicle class 2010-20)
FHWA Data (VMT) Vehicle Miles Travelled (by state and urban/rural 2010-20)
FHWA Data (Fuel) Motor Fuel Usage (by state and gasoline/diesel 2010-20)
EPA Data Production MPG Averages (by vehicle class 1975-21)
EIA Data Motor Fuel Tax Rates (by states and gasoline/diesel 2010-20)

Inputs (Forecasts)

A. Vehicle Data	B. VMT Data
1. Sales (Vehicle Sales - Forecast) - Light Vehicles (all & electric) - Heavy Vehicles (all & electric)	7. VMT Total (VMT Growth - Forecast) - Light Vehicles (all) - Heavy Vehicles (all)
2. Registered (Registered Vehicles - Actual) - Light Vehicles (all & electric) - Heavy Vehicles (all & electric)	8. VMT Urban Split (VMT Split between Urban & Rural - Forecast) - Light Vehicles (all) - Heavy Vehicles (all)
3. Scrap Rate (Rate of Replacement of Old Vehicles - Forecast) - Light Vehicles (all & electric) - Heavy Vehicles (all & electric)	C. Fuel Tax Data
4. LV Split (Rate of Light Vehicles between cars and trucks- Forecast)	9. Fuel Tax Rates (Motor Fuel Tax Rate - Forecast) - State (gasoline & diesel) - Federal (gasoline & diesel)
5. MPG Forecast (Fuel Efficiency of New Vehicles - Forecast) - Light Vehicles (gasoline & electric) - Heavy Vehicles (gasoline & electric)	D. Connected Vehicle Data
6. MPG Average (Fuel Efficiency of Registered Vehicles - Actual) - Light Vehicles (all & electric) - Heavy Vehicles (all & electric)	10. Connected Vehicles (Active Connected Vehicles % - Forecast) - Light Vehicles (all & electric) - Heavy Vehicles (all & electric)
E. Funding Data	11. Funding Data (State + Federal) - Motor Fuel Tax Revenues - All User Fee Revenues - All Highway Revenues

Calculations

Scenario (Selection of State, Cases (Vehicle, Revenue, Operating), and Sensitivities)
- State Selection: US plus 50 states and DC
- Case Selection: 5 cases for each variable
- Other operating (revenue and cost) variables
- Sensitivities: Increase/Decrease in growth rates versus Case Selection

Assumptions (Takes inputs and runs cases defined in Scenario Tab)
--

MPG Calculation (MPG Calculation of Scrapped Vehicles)	Calculations (Calculates key variables for determining motor fuel revenue)
	- Total Vehicles - Vehicle Miles Travelled - Vehicle Fuel Economy - Motor Fuel Tax Rate - RUC Per Mile Rates

Outputs (Results)

Model_Fuel Tax Revenue	Model_RUC Revenue	Model_RUC Cost
- Motor Fuel Tax Revenues (State only) - Motor Fuel Tax Revenues State plus Federal	- RUC Revenue (vehicle class) - RUC Revenue (vehicle fuel efficiency) - RUC Revenue (urban vs rural drivers)	- Operating cost (implementation and operations) - Operating margin

PTOLEMUS has used its existing Automotive, BEVs and Connected Vehicle market forecasts for this analysis.

The model also provides flexibility to easily run sensitive on the PTOLEMUS cases or incorporate third party forecasts



Our model forecasts fuel tax revenues, RUC's revenues and costs with various scenarios and detailed assumptions

- PTOLEMUS has developed a proprietary **forecasting model**, which allows users to run and evaluate different scenarios for:
 - **Motor fuel tax (MTF) revenues**
 - **RUC rates setting schemes and revenues**
 - **RUC costs**
 - The **model is built using historic data and incorporates both dynamic and static variables** ("Inputs")
 - Utilizes 22 key dynamic inputs to create effectively an unlimited number of new cases
 - For each input the user can run up to 5 unique scenarios. PTOLEMUS has produced forecasts for a base, low, and high case
 - Users can input additional cases
 - For each case the user can run unlimited sensitivities, adjusting the forecast up or down by a defined percentage
 - The model covers:
 - **All states:** 50 states plus the District of Columbia
 - The user is able to select each individually or the United States a whole
 - **Multiple vehicle classes:** Key forecasted inputs are provided light ICE, light electric, heavy IC and heavy electric vehicles. Model also provides options to
 - Split light vehicles between cars and trucks
 - Analyze light vehicles by fuel efficiency (5 categories)
 - **Key mileage reporting technologies:** Manual and automated solutions including Odometer photo, OBD-II (with and without GPS) and in-vehicle telematics

RUC Revenue Impact Model																										
US																										
TIME																										
Year	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	
Period (Annual)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
PeriodBeginning	Jan 21	Jan 22	Jan 23	Jan 24	Jan 25	Jan 26	Jan 27	Jan 28	Jan 29	Jan 30	Jan 31	Jan 32	Jan 33	Jan 34	Jan 35	Jan 36	Jan 37	Jan 38	Jan 39	Jan 40	Jan 41	Jan 42	Jan 43	Jan 44		
PeriodEnd	Dec 21	Dec 22	Dec 23	Dec 24	Dec 25	Dec 26	Dec 27	Dec 28	Dec 29	Dec 30	Dec 31	Dec 32	Dec 33	Dec 34	Dec 35	Dec 36	Dec 37	Dec 38	Dec 39	Dec 40	Dec 41	Dec 42	Dec 43	Dec 44		
Date	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	365	
RUC REVENUE - SCENARIOS																										
WMT for RUC Revenue Calculation																										
Revenue Revenue																										
Year On Year	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	
Revenue YTD	100	110	121	133	144	155	166	177	188	199	210	221	232	243	254	265	276	287	298	309	320	331	342	353	364	
Vehicle Class and Fuel Type (Electric & Gasoline)																										
Light Vehicle	1518	1618	1718	1818	1918	2018	2118	2218	2318	2418	2518	2618	2718	2818	2918	3018	3118	3218	3318	3418	3518	3618	3718	3818		
Heavy Trucks	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
VMT (Electric Vehicles)	+ 1615	+ 1716	+ 1817	+ 1918	+ 2019	+ 2120	+ 2221	+ 2322	+ 2423	+ 2524	+ 2625	+ 2726	+ 2827	+ 2928	+ 3029	+ 3130	+ 3231	+ 3332	+ 3433	+ 3534	+ 3635	+ 3736	+ 3837	+ 3938	+ 4039	
Light Vehicles - HDG Miles per Gallon	11.62	12.63	13.64	14.65	15.66	16.67	17.68	18.69	19.70	20.71	21.72	22.73	23.74	24.75	25.76	26.77	27.78	28.79	29.80	30.81	31.82	32.83	33.84	34.85	35.86	
Light Vehicles - Between 10 & 40 Miles per Gallon	12.48	13.50	14.51	15.52	16.53	17.54	18.55	19.56	20.57	21.58	22.59	23.60	24.61	25.62	26.63	27.64	28.65	29.66	30.67	31.68	32.69	33.70	34.71	35.72	36.73	
Light Vehicles - Between 20 & 40 Miles per Gallon	12.11	12.12	12.13	12.14	12.15	12.16	12.17	12.18	12.19	12.20	12.21	12.22	12.23	12.24	12.25	12.26	12.27	12.28	12.29	12.30	12.31	12.32	12.33	12.34		
Light Vehicles - Less than 20 Miles per Gallon	10.11	10.48	10.75	11.02	11.29	11.56	11.83	12.10	12.37	12.64	12.91	13.18	13.45	13.72	14.00	14.27	14.54	14.81	15.08	15.35	15.62	15.89	16.16	16.43	16.70	
Heavy Vehicles	60.03	113.45	167.76	222.07	276.38	330.69	385.00	439.31	493.62	547.93	592.24	646.55	699.86	753.17	807.48	860.79	914.10	967.41	1020.72	1074.03	1127.34	1180.65	1233.96	1287.27	1340.58	
VMT (Gasoline Vehicles)	888115	1045180	1202155	1360130	1518105	1675080	1832055	1989030	2146015	2303000	2460985	2617970	2774955	2931940	3088925	3245910	3402895	3559880	3716865	3873850	4030835	4187820	4344805	4499790	4656775	4813760
VMT Split By Categories																										
WMT Rural Cars	+ 1434	+ 1502	+ 1569	+ 1636	+ 1704	+ 1771	+ 1838	+ 1905	+ 1972	+ 2039	+ 2106	+ 2173	+ 2240	+ 2307	+ 2374	+ 2441	+ 2508	+ 2575	+ 2642	+ 2709	+ 2776	+ 2843	+ 2910	+ 2977	+ 3044	
Car - Electric	+ 1634	+ 1710	+ 1786	+ 1862	+ 1938	+ 2014	+ 2090	+ 2166	+ 2242	+ 2318	+ 2394	+ 2470	+ 2546	+ 2622	+ 2698	+ 2774	+ 2850	+ 2926	+ 3002	+ 3078	+ 3154	+ 3230	+ 3306	+ 3382	+ 3458	
Car - 40 Miles per Gallon	+ 1634	+ 1710	+ 1786	+ 1862	+ 1938	+ 2014	+ 2090	+ 2166	+ 2242	+ 2318	+ 2394	+ 2470	+ 2546	+ 2622	+ 2698	+ 2774	+ 2850	+ 2926	+ 3002	+ 3078	+ 3154	+ 3230	+ 3306	+ 3382	+ 3458	
Car - Between 20 & 40 Miles per Gallon	+ 12.91	+ 22.58	+ 32.25	+ 41.92	+ 51.59	+ 61.26	+ 70.93	+ 80.60	+ 89.27	+ 98.94	+ 108.61	+ 118.28	+ 127.95	+ 137.62	+ 147.29	+ 156.96	+ 166.63	+ 176.30	+ 185.97	+ 195.64	+ 205.31	+ 215.98	+ 225.65	+ 235.32	+ 245.00	
Car - Between 20 & 30 Miles per Gallon	+ 12.91	+ 22.58	+ 32.25	+ 41.92	+ 51.59	+ 61.26	+ 70.93	+ 80.60	+ 89.27	+ 98.94	+ 108.61	+ 118.28	+ 127.95	+ 137.62	+ 147.29	+ 156.96	+ 166.63	+ 176.30	+ 185.97	+ 195.64	+ 205.31	+ 215.98	+ 225.65	+ 235.32	+ 245.00	
Car - Less than 20 Miles per Gallon	+ 12.91	+ 22.58	+ 32.25	+ 41.92	+ 51.59	+ 61.26	+ 70.93	+ 80.60	+ 89.27	+ 98.94	+ 108.61	+ 118.28	+ 127.95	+ 137.62	+ 147.29	+ 156.96	+ 166.63	+ 176.30	+ 185.97	+ 195.64	+ 205.31	+ 215.98	+ 225.65	+ 235.32	+ 245.00	
VMT Cars Rural	+ 84.86	+ 112.70	+ 140.54	+ 168.38	+ 196.22	+ 224.06	+ 251.90	+ 279.74	+ 307.58	+ 335.42	+ 363.26	+ 391.10	+ 418.94	+ 446.78	+ 474.62	+ 502.46	+ 530.30	+ 558.14	+ 585.98	+ 613.82	+ 641.66	+ 669.50	+ 697.34	+ 725.18	+ 752.92	+ 780.76
WMT Urban Cars																										
Car - Electric	+ 13.84	+ 15.18	+ 16.51	+ 17.85	+ 19.19	+ 20.53	+ 21.87	+ 23.21	+ 24.55	+ 25.89	+ 27.23	+ 28.57	+ 30.01	+ 31.45	+ 32.79	+ 34.23	+ 35.57	+ 37.01	+ 38.35	+ 39.69	+ 41.03	+ 42.37	+ 43.71	+ 45.05	+ 46.39	
Car - 40 Miles per Gallon	+ 16.92	+ 17.67	+ 18.42	+ 19.17	+ 19.92	+ 20.67	+ 21.42	+ 22.17	+ 22.92	+ 23.67	+ 24.42	+ 25.17	+ 25.92	+ 26.67	+ 27.42	+ 28.17	+ 28.92	+ 29.67	+ 30.42	+ 31.17	+ 31.92	+ 32.67	+ 33.42	+ 34.17	+ 34.92	
Car - Between 20 & 40 Miles per Gallon	+ 16.92	+ 17.67	+ 18.42	+ 19.17	+ 19.92	+ 20.67	+ 21.42	+ 22.17	+ 22.92	+ 23.67	+ 24.42	+ 25.17	+ 25.92	+ 26.67	+ 27.42	+ 28.17	+ 28.92	+ 29.67	+ 30.42	+ 31.17	+ 31.92	+ 32.67	+ 33.42	+ 34.17	+ 34.92	
Car - Between 20 & 30 Miles per Gallon	+ 16.92	+ 17.67	+ 18.42	+ 19.17	+ 19.92	+ 20.67	+ 21.42	+ 22.17	+ 22.92	+ 23.67	+ 24.42	+ 25.17	+ 25.92	+ 26.67	+ 27.42	+ 28.17	+ 28.92	+ 29.67	+ 30.42	+ 31.17	+ 31.92	+ 32.67	+ 33.42	+ 34.17	+ 34.92	
Car - Less than 20 Miles per Gallon	+ 16.92	+ 17.67	+ 18.42	+ 19.17	+ 19.92	+ 20.67	+ 21.42	+ 22.17	+ 22.92	+ 23.67	+ 24.															

Road Usage Charging - United States Report

About PTOLEMUS



PTOLEMUS Consulting Group

PTOLEMUS is the first strategy consulting and research firm entirely focused on geo-connected mobility and automation



Strategy consulting services

Strategy definition	M&A advisory	Procurement strategy	RUC and tolling	Motor insurance	Vehicle data and analytics
Partnership strategy	Business development	Market forecasting	IoT & connectivity	Emergency services	Vehicle services



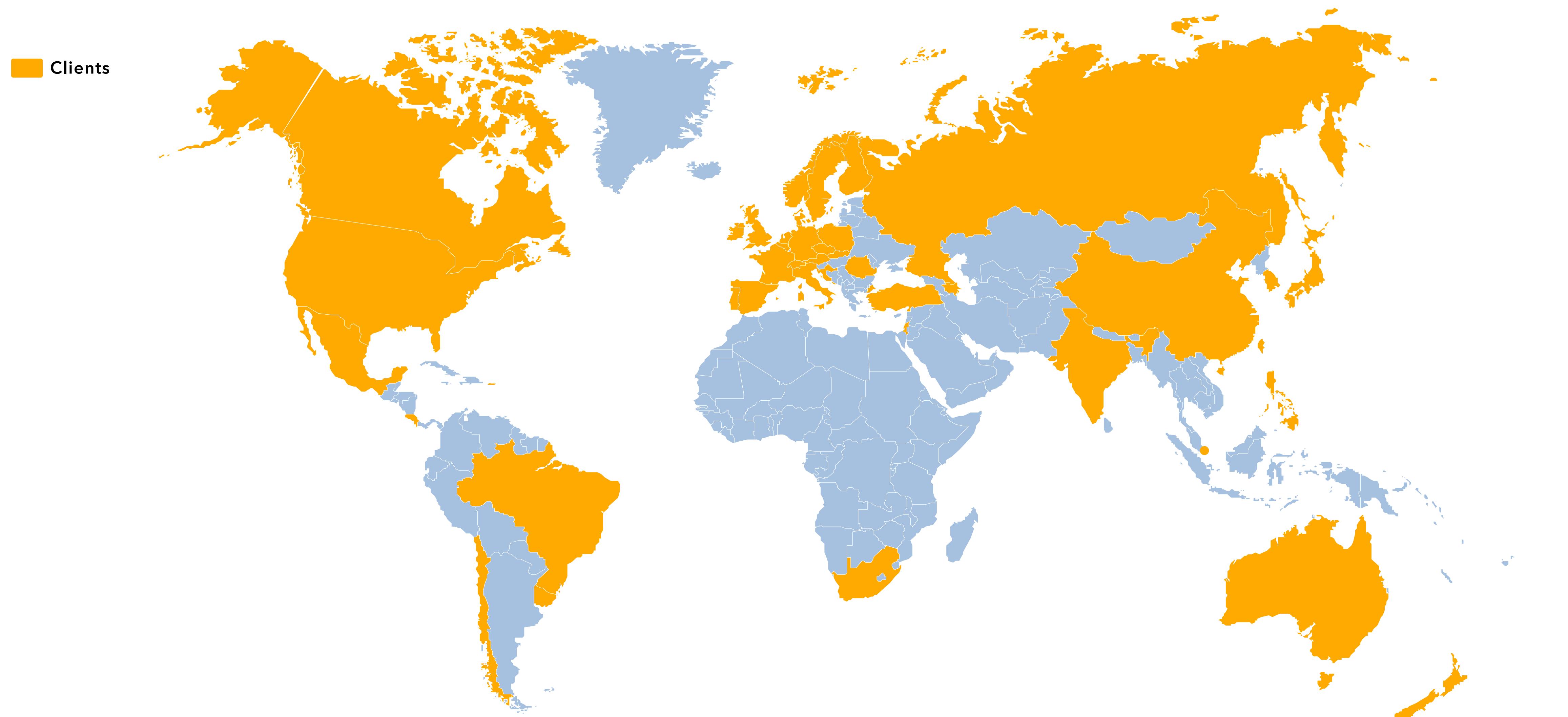
Market research services

Off-the-shelf reports	Subscription services	Custom market research	Mobility services	Vehicle automation	Electrification
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We serve over 350 clients across the mobility ecosystem

Business area	Clients	Business area	Clients
Analytics, maps & apps providers		Insurers, aggregators & assistance providers	
Automotive OEMs & suppliers		Tolling & ITS	
Banks & private equity investors		Telematics solution providers	
Device & location suppliers			
Mobile telecom players			

Our team of consultants, experts and analysts with 13 nationalities, serve our clients in 40 countries



A member of the IRF and IBTTA, PTOLEMUS has performed nearly 200 consulting assignments including 46 in tolling, RUC and ITS



Advised ST Engineering in the commercial due diligence for the acquisition of TransCore, the leading US-based toll solution provider



Helped a US-based toll solution provider to identify project opportunities and build its sales pipeline in the US and other 22 markets



Conducted an in-depth examination of the demand for tolling solutions in North America and helped identifying M&A target and partners



Defined the value proposition for RUC and selected optimal partners and M&A targets to enter the US market



Defined & implemented its partnership strategy in the connected vehicle ecosystem

Major toll solution provider

Major toll solution provider

Major toll solution and ITS provider

Future EETS provider



For the Wallonian road operator, evaluated the feasibility of a shadow tolling scheme



Identified market opportunities & defined strategic plan in connected mobility services



Assisted the board of its technology unit in its strategy definition



Evaluated the technologies & business potential of the EU electronic tolling market



Helped a major EETS provider redefine its strategy and go-to-market plan



Road & infrastructure operator

Global motorway operator



EETS provider

PTOLEMUS can help your organisation define and achieve its strategy in fast moving times

• Strategy definition

- Road policy strategy assistance
- Market entry assistance
- Data strategy and analysis
- Mobile tolling strategy development
- Multimodal mobility design and planning
- Future vision of vehicle payments
- Strategy orientation workshops

• Procurement

- M&A strategy
- Commercial due diligence
- Technology due diligence
- Feasibility studies
- Vehicle data market sizing
- Business case development
- Cost benefit analyses
- Post-merger integration

• Innovation strategy

- Vertical market assessments
- Product definition
- Consent management
- Data analytics strategy

• Business development

- Partnership strategy definition
- Assistance to tender response

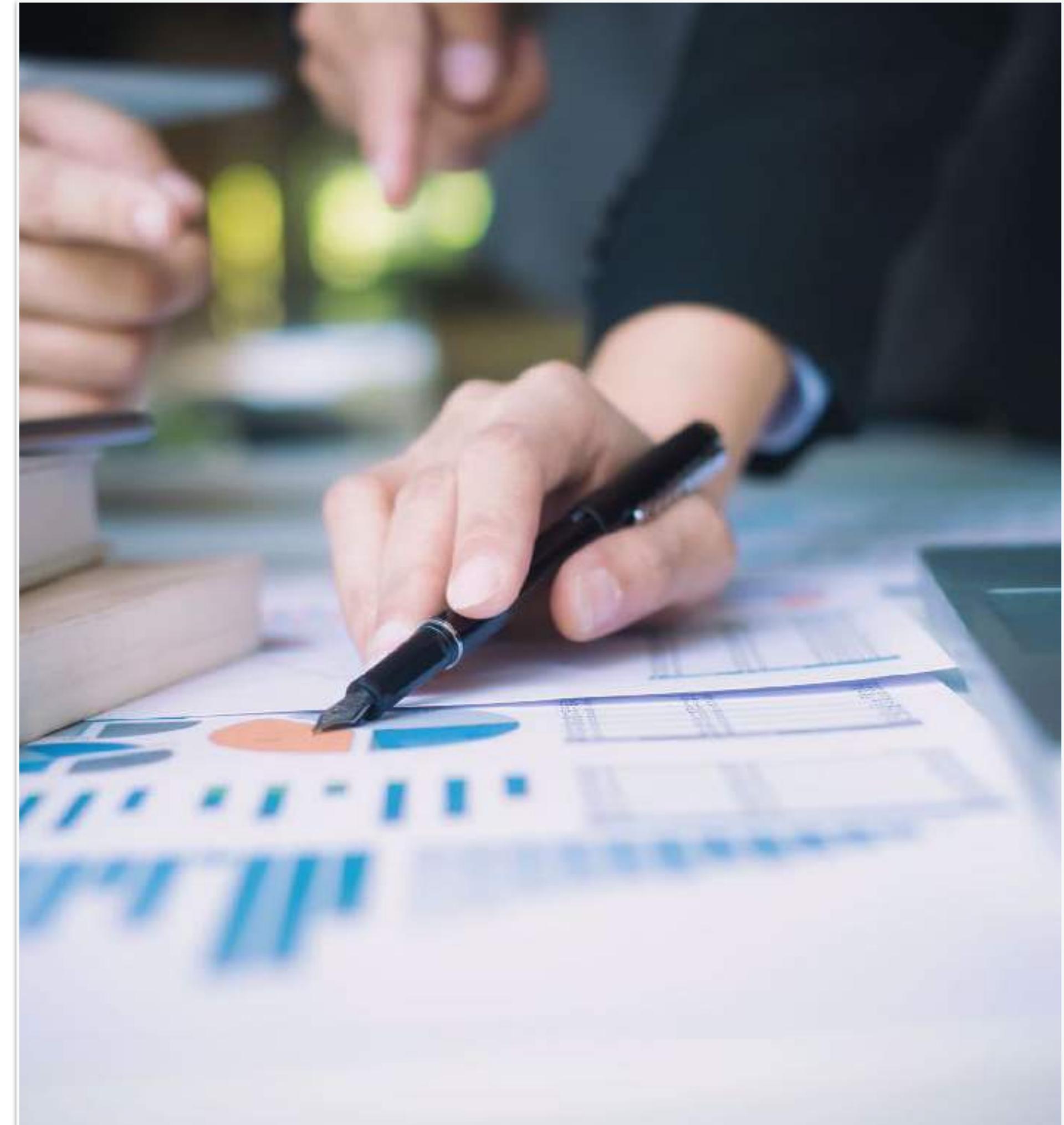
• Project management

- Assistance in management of road pricing projects
- Congestion charge project management

• Innovation delivery

- Proof of concept design & launch
- Architecture definition
- Project management

• Investment assistance

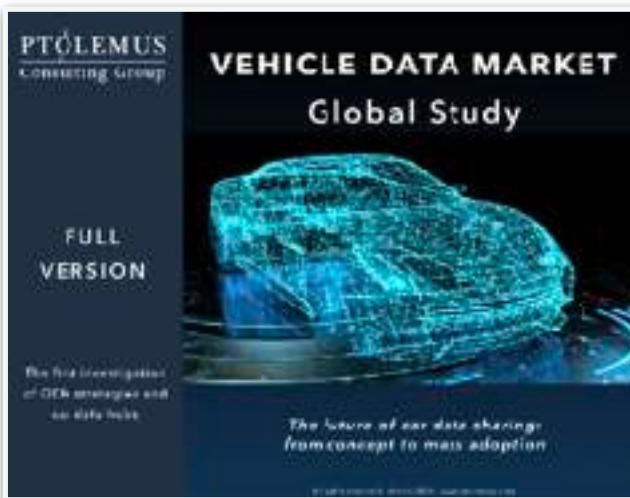


Thanks to its unique positioning and consulting activities, PTOLEMUS publishes landmark reports and market forecasts

AUTONOMOUS DRIVING



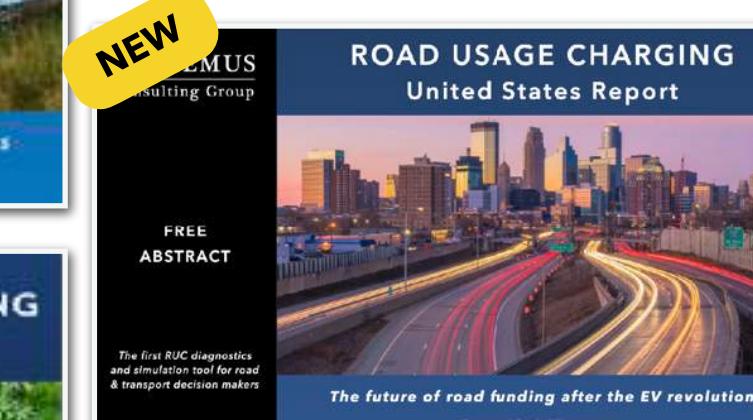
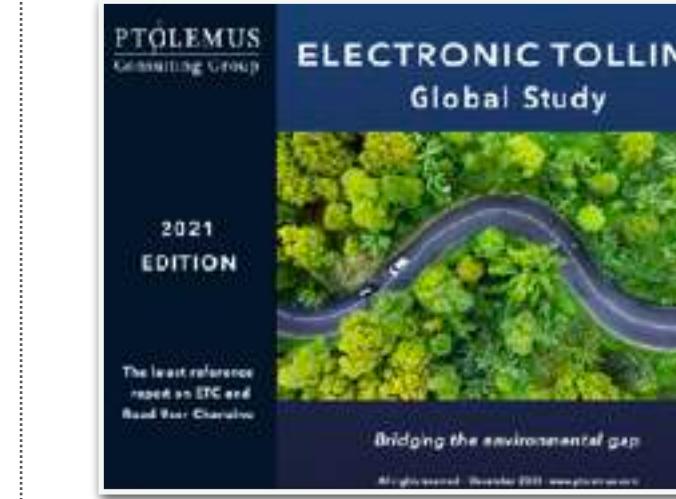
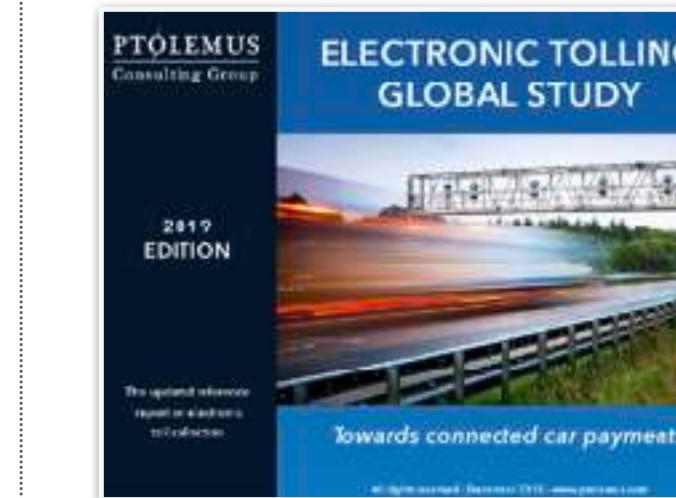
CONNECTED VEHICLE



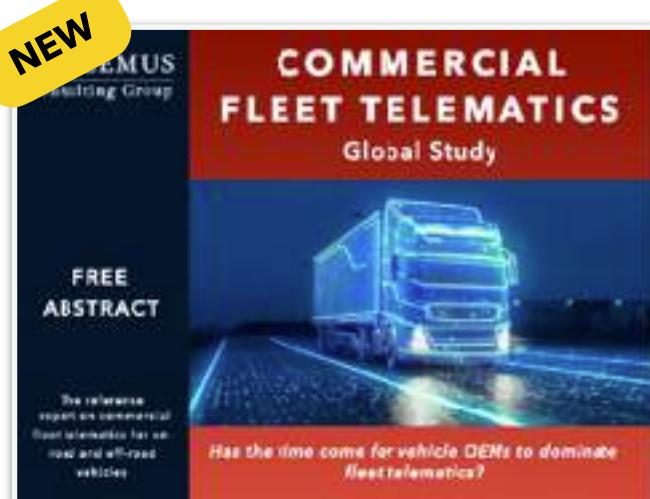
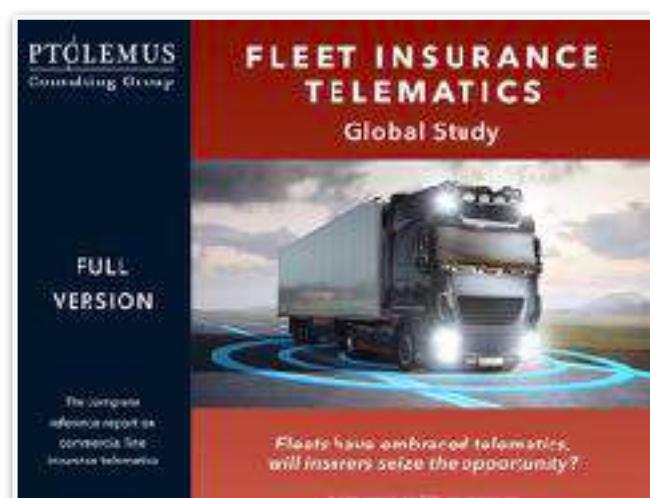
ELECTRIFICATION



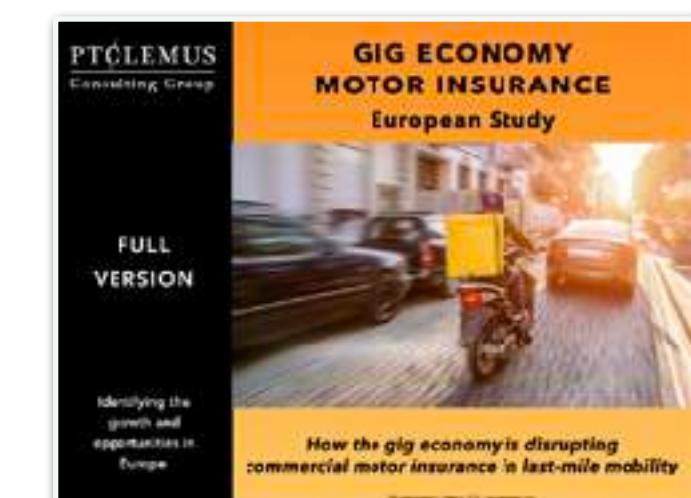
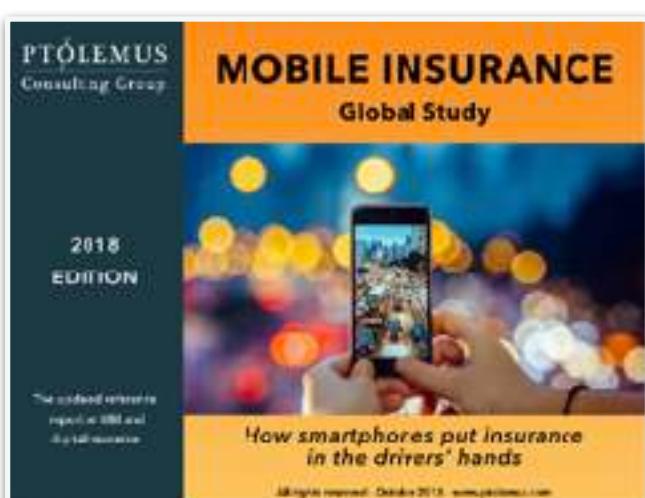
ELECTRONIC TOLLING and ROAD USAGE CHARGING



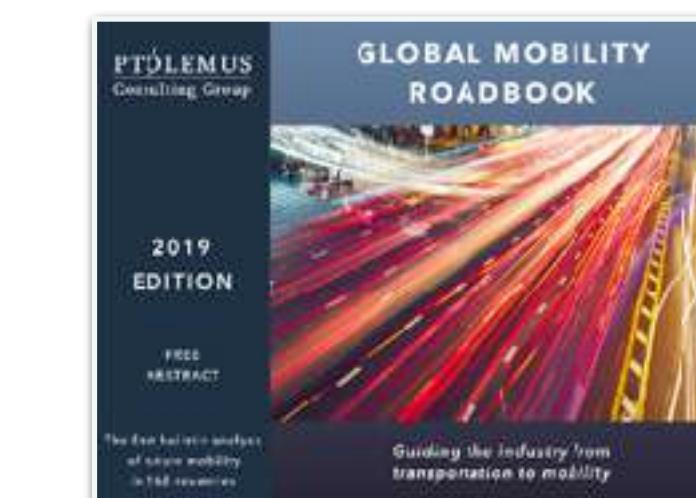
FLEET MANAGEMENT



INSURANCE



MOBILITY



Notes: 1. Most of our reports come with bottom-up market forecasts for 18 regions for 10-year timeframe,
2. To receive all our reports & other research, a subscription model exists

PTOLEMUS Consulting Group

Strategies for Mobile Companies

For any assistance in your RUC and mobility strategy, please contact:

Frederic Bruneteau

Managing Director

fbruneteau@PTOLEMUS.com

Ashton Williams

Manager

awilliams@PTOLEMUS.com

contact@PTOLEMUS.com

www.PTOLEMUS.com

@PTOLEMUS

