PTOLEMUS
Consulting Group

ROAD USAGE CHARGING
United States Report

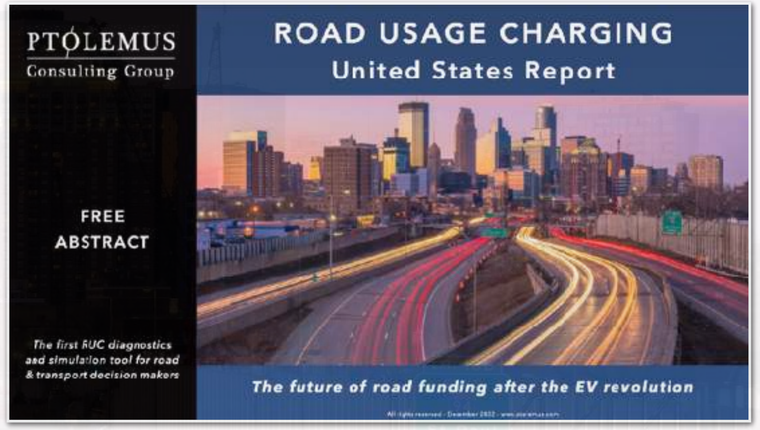
FREE
ABSTRACT

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

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**
- **Models for the US and Colorado covering**
  - Motor fuel tax revenues forecast
  - RUC fees & revenues scenario
  - RUC costs scenario
- **The 2022-2040 Excel forecast model has been developed bottom up**
  - With inputs from over 20 reputable sources and PTOLEMUS' own automotive and EV forecasts
  - To easily store and simulate hundreds of unique vehicle, travel, and pricing scenarios as defined by the user
  - Additional forecasts, scenarios, and slides on the other 49 states (+DC) can also be purchased*
- **Quantitative & qualitative analysis on which states would benefit 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

Note: * See slide 16 on pricing

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 collected 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**

Source: PTOLEMUS, Virginia DOT, Oklahoma DOT, San Diego Union Tribune, Lousiana Legislative Auditor

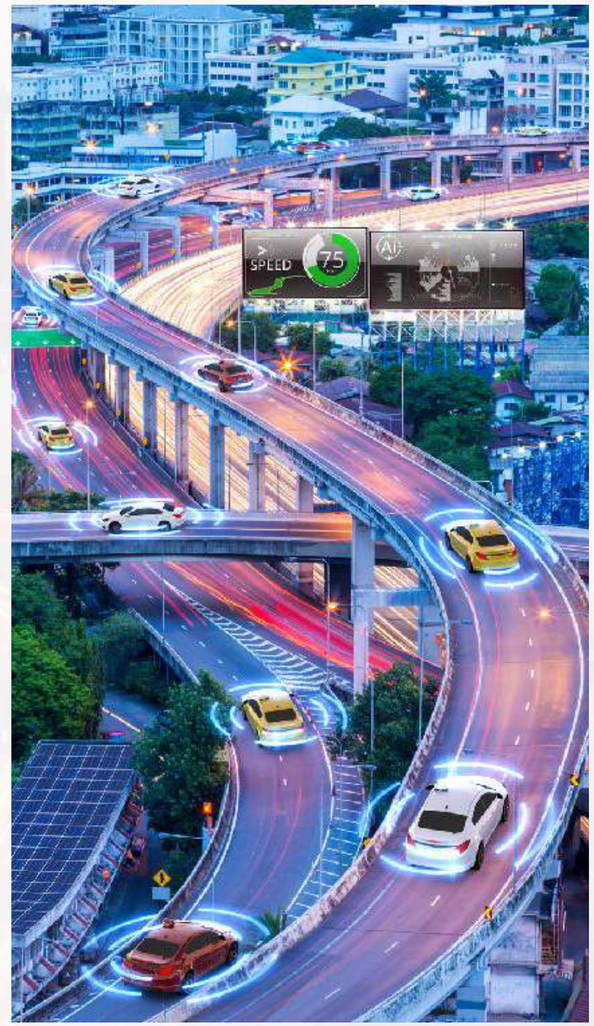
RUC can eventually become the primary road funding solution if stakeholders overcome challenges of cost and complexity

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



Source: PTOLEMUS, Virginia DOT, Oklahoma DOT, San Diego Union Tribune, Lousiana Legislative Auditor

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.?

Where is RUC going?

- 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?
- What can we learn from the European RUC (distance-based charging) experience?

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

- Car insurance providers
- Energy service providers
- Fleet service providers
- Government organizations
- Payment platform providers
- Telematics providers
- Toll road operators
- Toll service providers
- Tolling technology providers
- Vehicle data API provider and analytics providers
- Vehicle OEMs
- Other (Industry association, university, etc)

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 offers an in-depth analysis of the current state of RUC in the US and its future direction

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
  - **Leading states:** examines which states are likely to be most active in the future and why
  - **Future of RUC (conclusion):** provides PTOLEMUS' view on the medium and longer term prospects of RUC, including the key factors necessary for RUC to eventually become the main source of road funding

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

Note: *The report includes only the outputs from the US as a whole and one state (Colorado). Additional forecast, scenarios and slides on other states can be purchased separately (see pricing slide #16)

The report mentions 90+ companies and organizations

Company	Region/ Country	Type
Azuga	USA	Account managers
Emovis	USA	
Eroad	USA	
IMS	USA	
Verizon Connect	USA	
AECOM	USA	Advisors
ARUP	UK	
BERK	USA	
CDM Smith	USA	
EBP	USA	
Jacobs	USA	
WSP	USA	
Audi	Europe	Car manufacturers
BMW	Europe	
Ford	USA	
GM	USA	
Honda	Asia	
Hyundai	Asia	
Kia	Asia	
Lucid Motors	USA	
Mazda	Asia	
Mercedes	Europe	
Nissan	Asia	
Rivian	USA	
Stellantis	Europe	
Subaru	Asia	
Tesla	USA	
Toyota	Asia	
VW	Europe	

Company	Region/ Country	Type
RUC America	USA	Coalitions
TET Coalition	USA	
CalTrans	USA	DOTs
Hawaii DOT	USA	
Minnesota DOT	USA	
Oregon DOT	USA	
Utah DOT	USA	
Virginia DOT	USA	
Vermont DOT	USA	
Washington DOT	USA	
Aral	Europe	Energy companies
AS24	Europe	
BP	Europe	
PetroChina	Europe	
Shell	Europe	
Sinopec	Europe	
Total	Europe	
Fleetcor	Europe	Fleet Management Service Providers
Wex	Europe	
Eurowag	Europe	Fuel Card Issuers
UTA	Europe	
Department of Energy	USA	Governmental institutions
European Comission	Europe	
FHWA	USA	
IBTTA	USA	Industry groups
IRF	USA	
MBUFA	USA	
Fremtind	Europe	Insurance carriers
UnipolSai	Europe	

Company	Region/ Country	Type
Hourcar	USA	Other companies
SFR	Europe	
SNCF	Europe	
Steria	Europe	
Thales	Europe	
Via	USA	
VSI Labs	USA	
Zipcar	USA	
Msts	Europe	Payment and Credit
Abertis	Europe	Road Operators
Autostrade per l'Italia	Europe	
Bro Bizz	Europe	
Transurban USA	USA	
AWS	USA	Subcontractor/ supplier
Helpware	USA	
Oracle	USA	
Otonomo	Asia	
Smartcar	USA	
Wejo	Europe	
A-to-Be	Europe	Tolling service providers
Axxès	Europe	
Conduent	USA	
DKV	Europe	
easytrip	Europe	
eurotoll	Europe	
Kapch	Europe	
Neology	USA	
Telepass	Europe	
TollTickets	Europe	
TransCore	USA	

DOT: Department Of Transportation

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

15 years

15 years

Biography

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.**

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.

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.

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

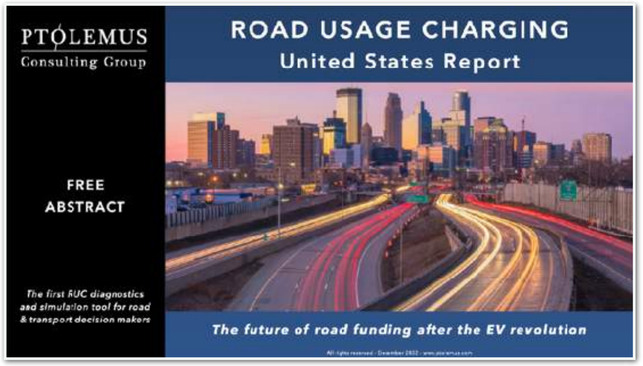
Experience	3 years	5 years	5 years	4 years
Biography	An ESCP Business School alumnus, Filippo has started developing an expertise in emergency services, in Electronic Toll Collection (ETC) and Road Usage Charging (RUC), in Usage Based Insurance (UBI), in last-mile delivery, in vehicle data hubs and vehicle data monetisation. In over 3 years at PTOLEMUS, Filippo has contributed as a core team member to 12 consulting assignments and 4 research reports. Clients he has served include Abertis Mobility Services, Advent International, Bain Capital, European Commission, FairConnect, FSI, Hitachi, Intrado, Palamon Capital, Skytoll, Telepass, wejo, Zego Insurance 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.	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. Saeeda led the financial feasibility analysis of Open Road Tolling for several road concessions in the Philippines Saeeda has also contributed to our ETC and Commercial Fleet Telematics (CFT) reports. Before PTOLEMUS, she was part of Schneider Electric's Global Automotive and eMobility team in France. Prior to that, she worked in the financial services industry. Saeeda participated in the research and writing of the report.	An HEC Paris MBA graduate, Williams joi ned 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. Prior to joining PTOLEMUS, Williams worked in Cameroon for 5 years in an engineering consulting firm focused on transport infrastructure. During his tenure at SOL SOLUTION, he led over 20 assignments for the design of a total of 1,488 km of roads budgeted at 15 to 160 million euros for clients including development finance institutions and Cameroonian ministries. Williams participated to the research and writing of the report.	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). Within PTOLEMUS, she participated in 4 consulting assignments, 2 research reports. Clients she has served include private equity firms, Abertis Mobility Services, Neology and ST Engineering. Before joining PTOLEMUS, Fatima started her career in the automotive industry. She was a software project leader for Renault for 3 years. Fatima participated to the research and writing of the report.

Road Usage Charging - United States Report

Report purchase options and pricing

PTOLEMUS Consulting Group

The report comes with a single, worldwide company license



For more information about the report, email contact@ptolemus.com

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

	Report (1)	Forecasts & Scenarios (2)	(1) + (2)	Additional per-state RUC scenario analysis	Additional workshop
Contents	• **300-page analysis** of the current and future road financing in the US • Examination of the **economic, financial, political and technological context behind RUC** • Detailed assessment of **RUC vs. other major funding solutions** across 9 key dimensions • **4 in-depth profiles of US States** that are at the forefront of RUC initiatives	• **One Excel file with the outputs of**: 1. Fuel tax revenues forecast 2. RUC fee rates & revenues scenarios 3. RUC costs scenarios • **40+ slides summarizing and explaining these scenarios** - Covers the US and the State of Colorado	• **300-page analysis** of the current and future road financing in the US including 40+ slides summarizing and explaining the Excel file scenarios • **One Excel file with the 3 outputs** - Covers the US and the State of Colorado	Additional per-state RUC scenario analysis and slides on US states not included in the report can be purchased separately	The full report and a scenario analysis Excel tool demo presented to your board or strategy team Half-day workshop*
Company-wide license	**$2,995**	**$1,995**	**$3,995**	**Pricing on request**	**$4,995**

Note: Prices in US dollars, excluding VAT (VAT only applicable to clients located in Belgium); *Conditions apply; **Online pricing might differ due to exchange rates

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Road Usage Charging - United States Report

Extracts from the RUC USA Report

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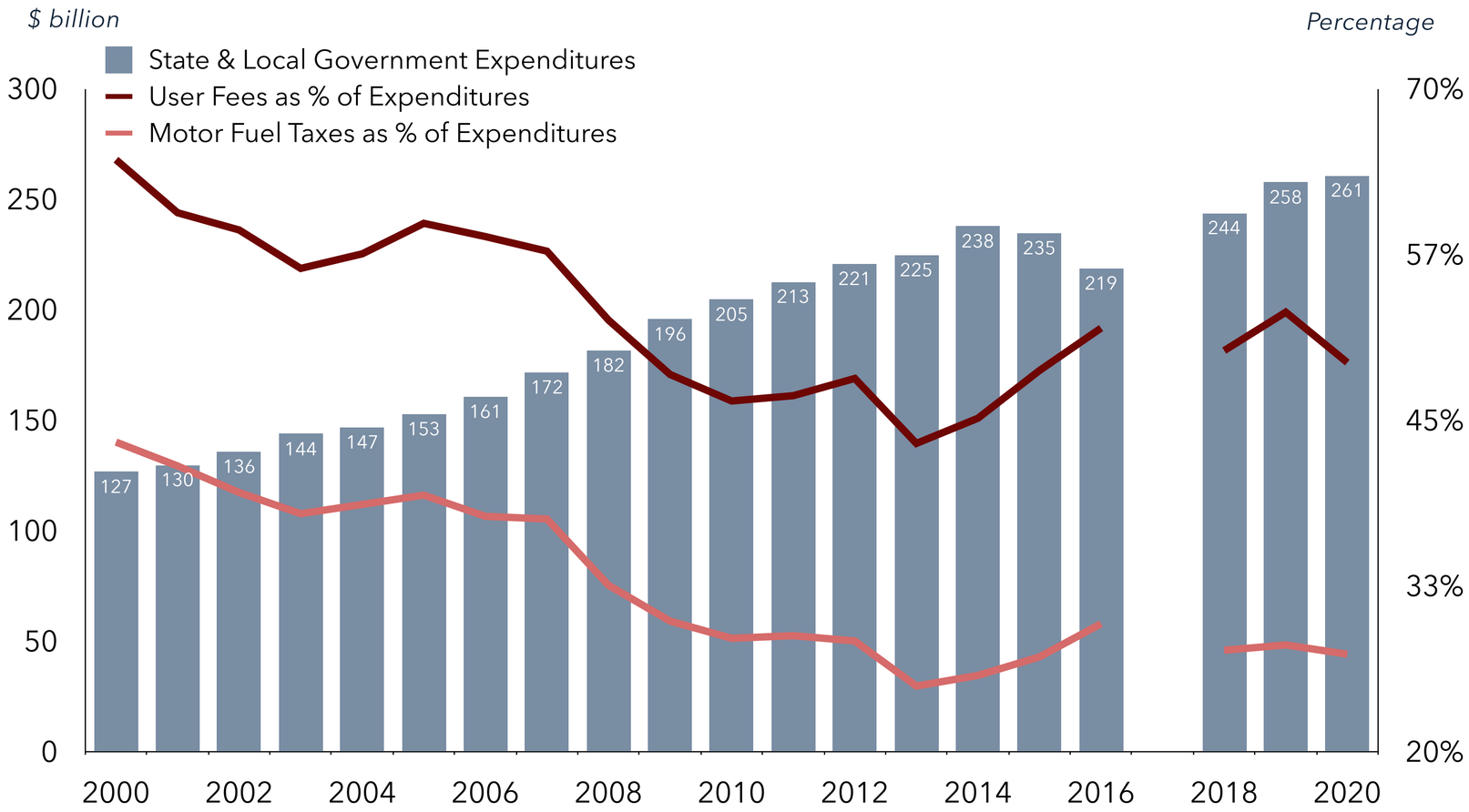
State and Local funding: Transportation user fee revenues have not kept up with the growth in expenditures

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



Source: PTOLEMUS, FHWA

- 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.).

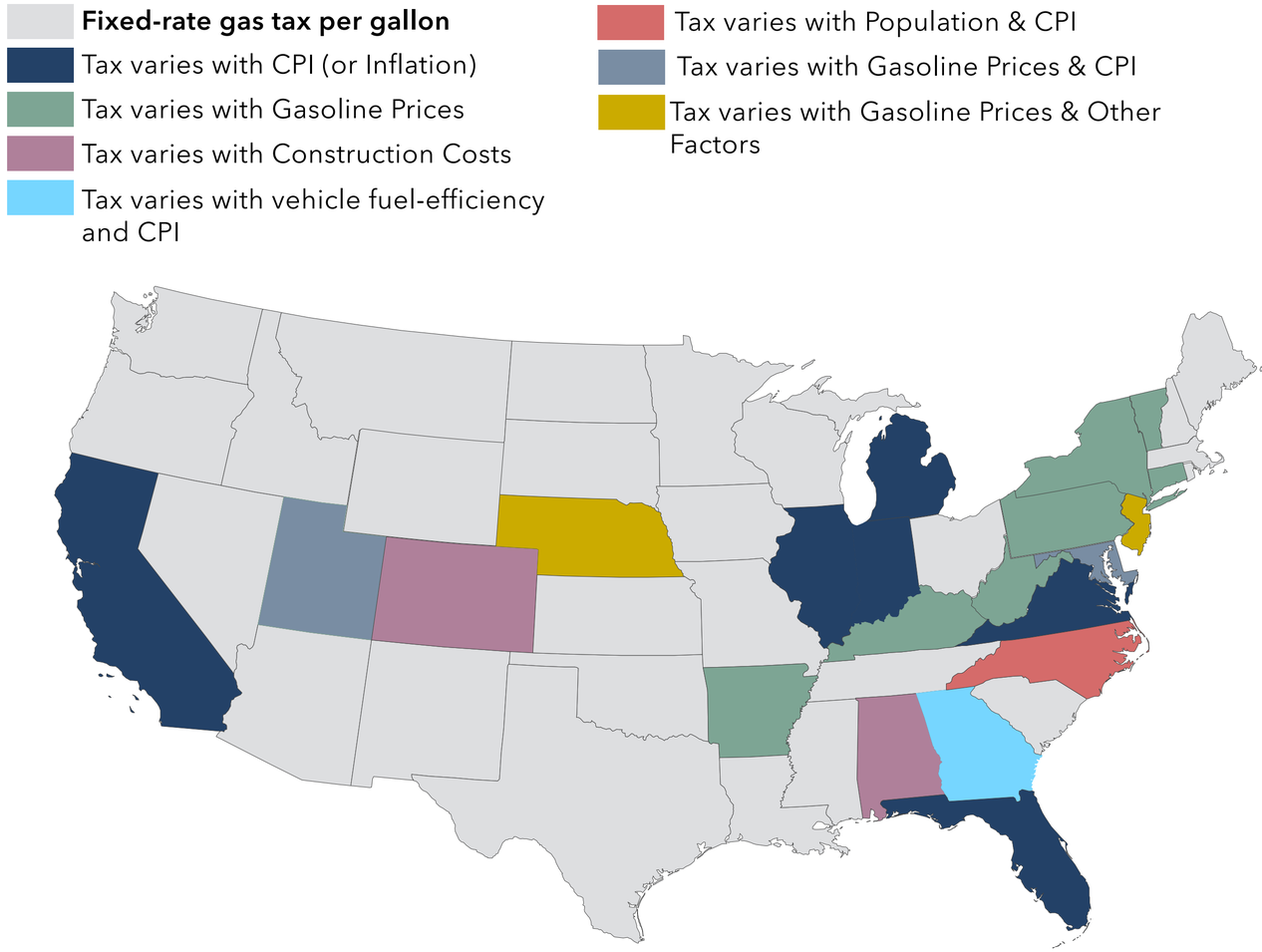
The motor fuel tax is levied in all 50 states but only 22 states have variable rates

- 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

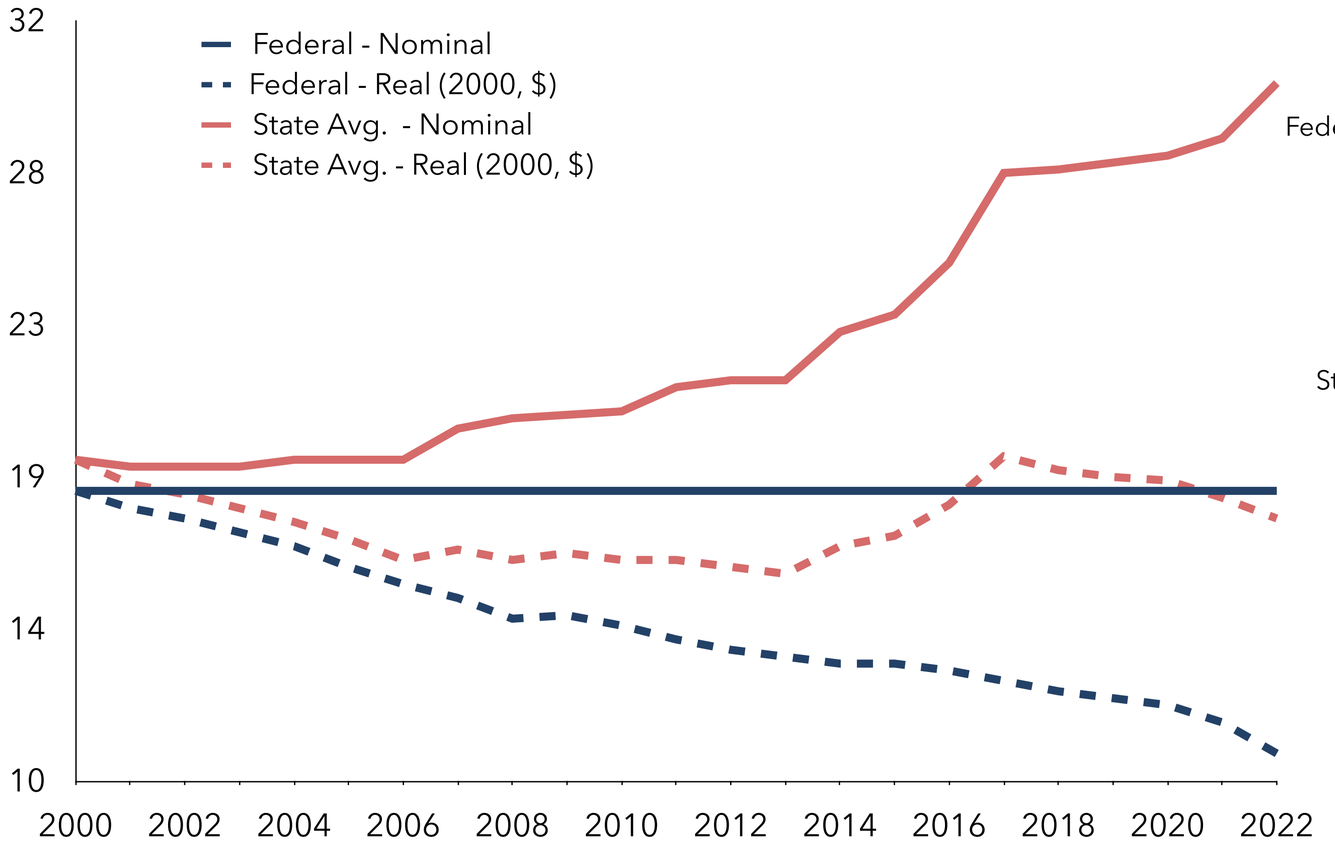


Source: PTOLEMUS, US Energy Information Administration, CPI: Consumer Price Index

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



CAGRs 2000-22

Federal Nominal	0.0%
Federal Real	-2.4%
State Nominal	2.1%
State Real	-0.4%

- **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

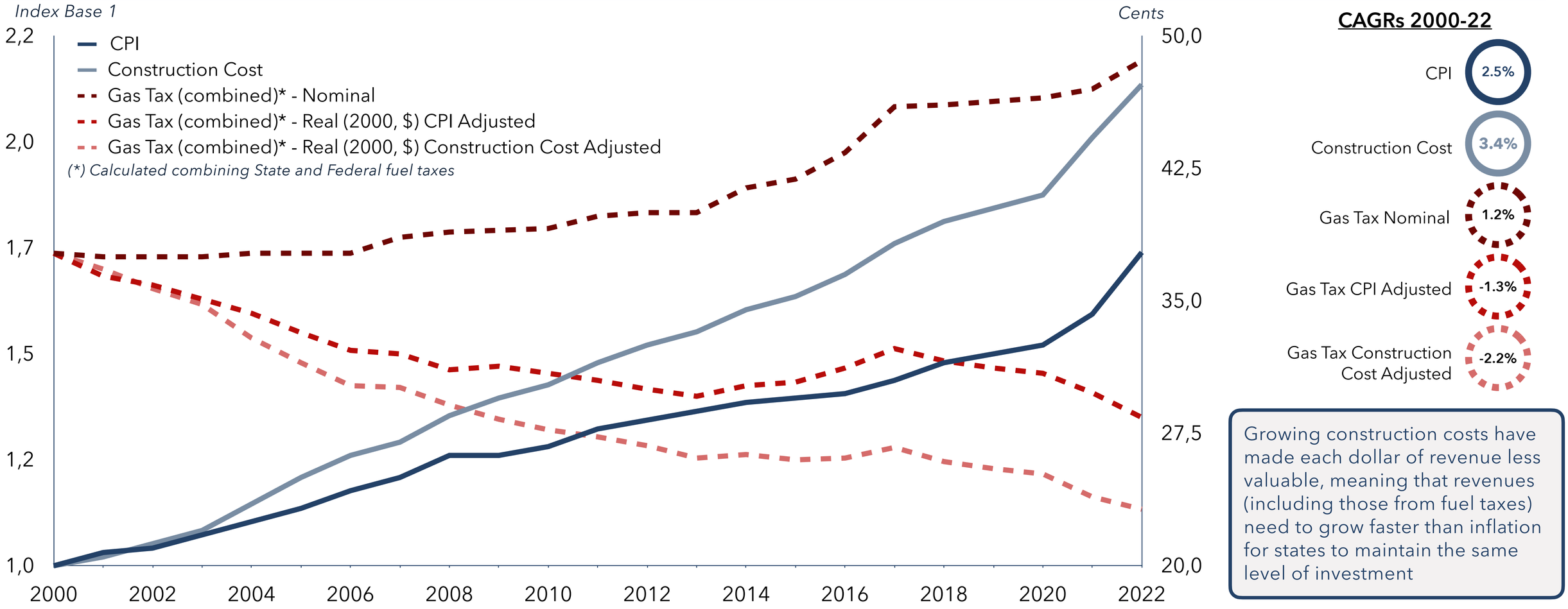
The average state fuel tax rate was flat up until 2006 and only increased slightly between 2006 and 2013. **Starting in 2013, a number of states passed legislation increasing their fuel tax rates and/or linking the rates to different indexes. This resulted in a positive real CAGR (1.1%) over this period.**

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**

Source: PTOLEMUS, FHWA, BLS

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)



CAGRs 2000-22

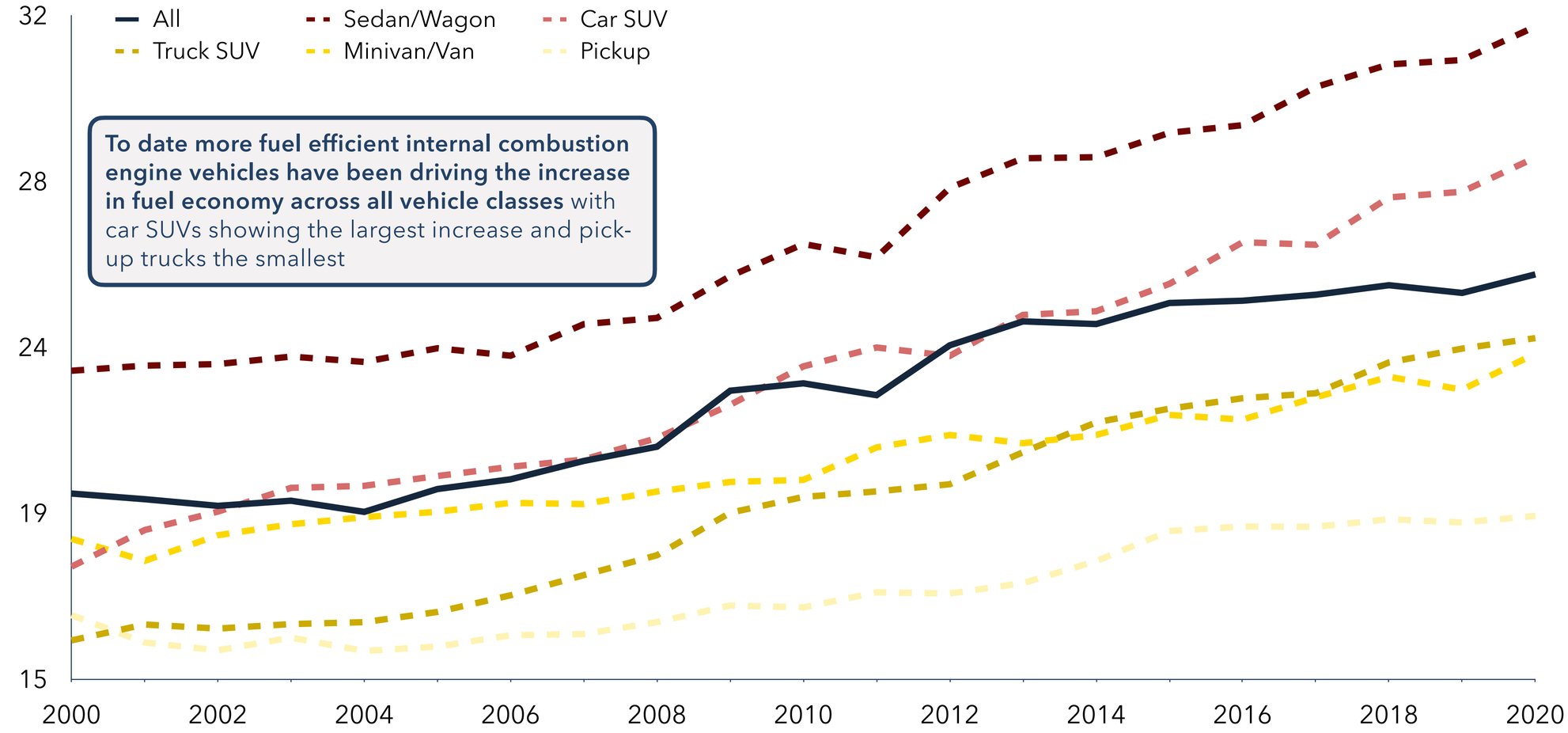
CPI	2.5%
Construction Cost	3.4%
Gas Tax Nominal	1.2%
Gas Tax CPI Adjusted	-1.3%
Gas Tax Construction Cost Adjusted	-2.2%

Growing construction costs have made each dollar of revenue less valuable, meaning that revenues (including those from fuel taxes) need to grow faster than inflation for states to maintain the same level of investment

Source: PTOLEMUS, FHWA, BLS, ENR

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)



To date more fuel efficient internal combustion engine vehicles have been driving the increase in fuel economy across all vehicle classes with car SUVs showing the largest increase and pick-up trucks the smallest

% Change 2000-20

All 28%

Cars

Sedan/Wagon 38%

Car SUV 59%

Trucks

Truck SUV 48%

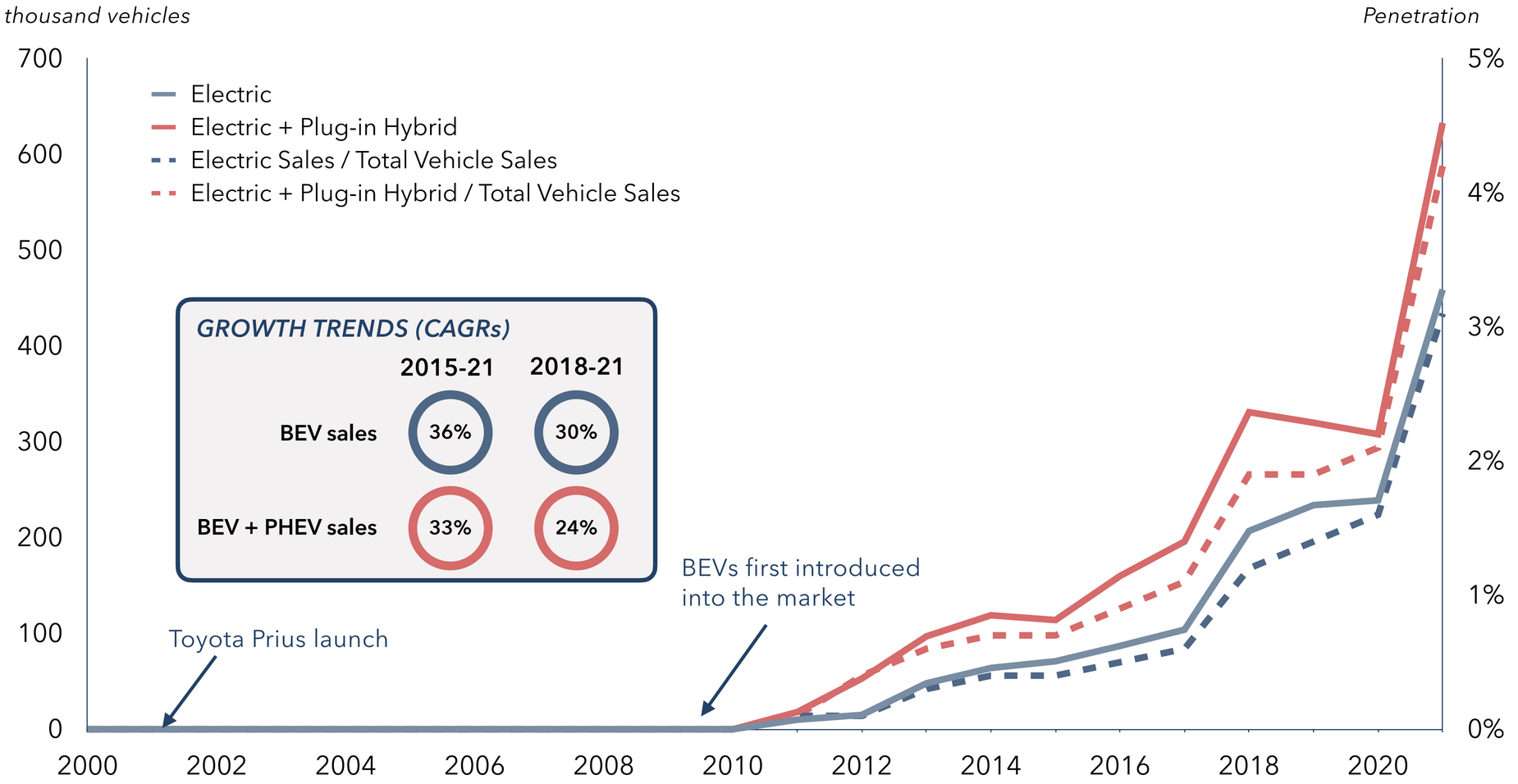
Minivan/Van 26%

Pick-up 15%

Source: PTOLEMUS, EPA

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

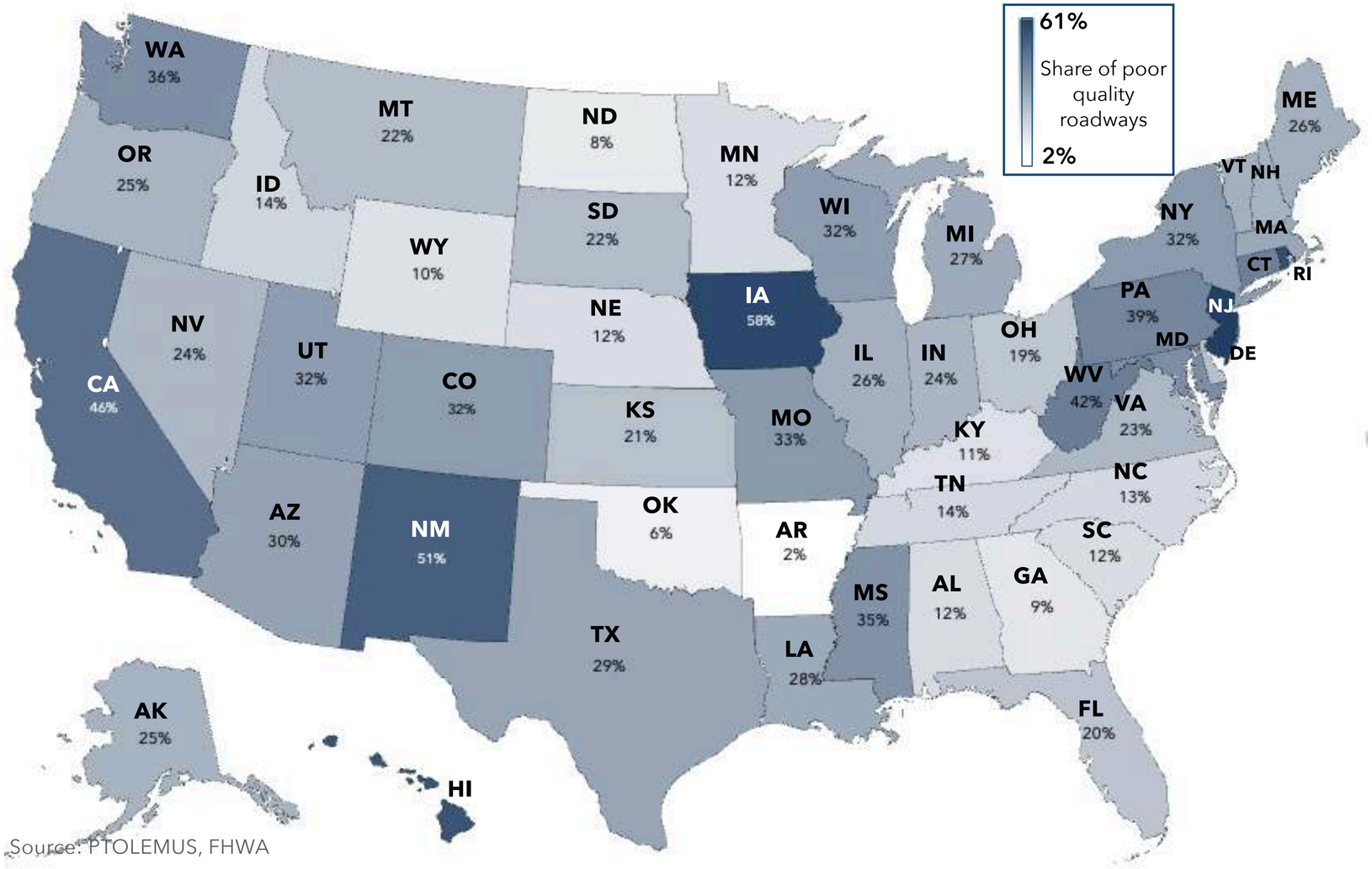
- **In 2021 alone, 450,000 BEVs were sold** representing almost a third of total EV sales
- In the first half of 2022, EV sales increased more than 35% year-over-year and for the first time topped **5% of total vehicle sales**

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.

Source: PTOLEMUS, USDOT BTS, Alliance for Automotive Innovation

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

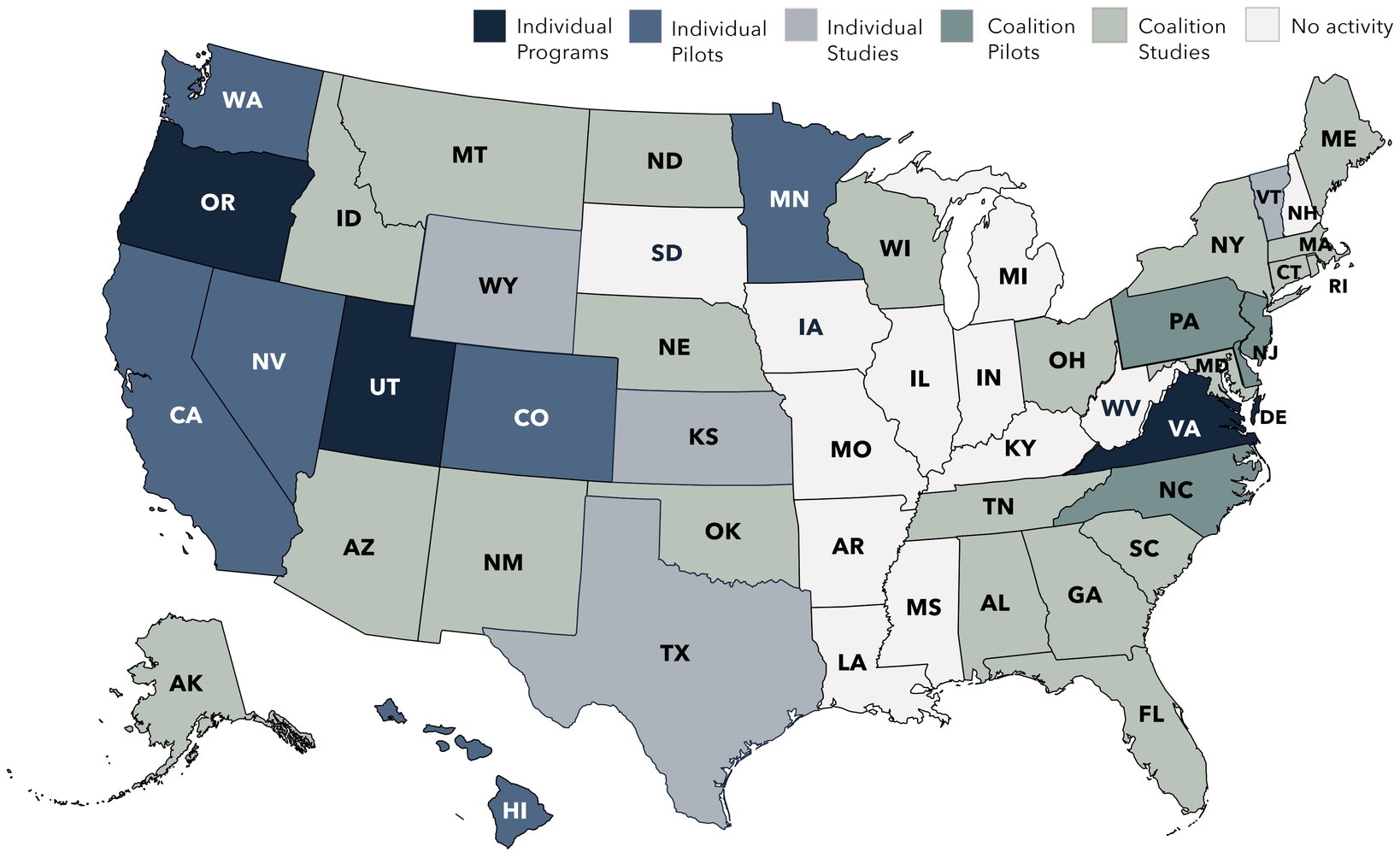
5. Lessons and Insights from Europe

6. Future of Funding and RUC

PTOLEMUS Consulting Group

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

Category	Revenue Robustness	Efficiency	Flexibility	Acceptability	Compliance & Enforcement	Equity	Interoperability	Data Collection & Management	Privacy & Security
Potential Permanent Options									
Road Usage Charging (Manual)									
Road Usage Charging (Automated)									
Registration Fees									
Temporary or More Limited Solutions									
Motor Fuel Tax									
Tolling and Congestion Charging									
Vehicle Electricity Tax									

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

Source: PTOLEMUS

Legend: Most relevant category Least relevant category to assess funding sources long term viability

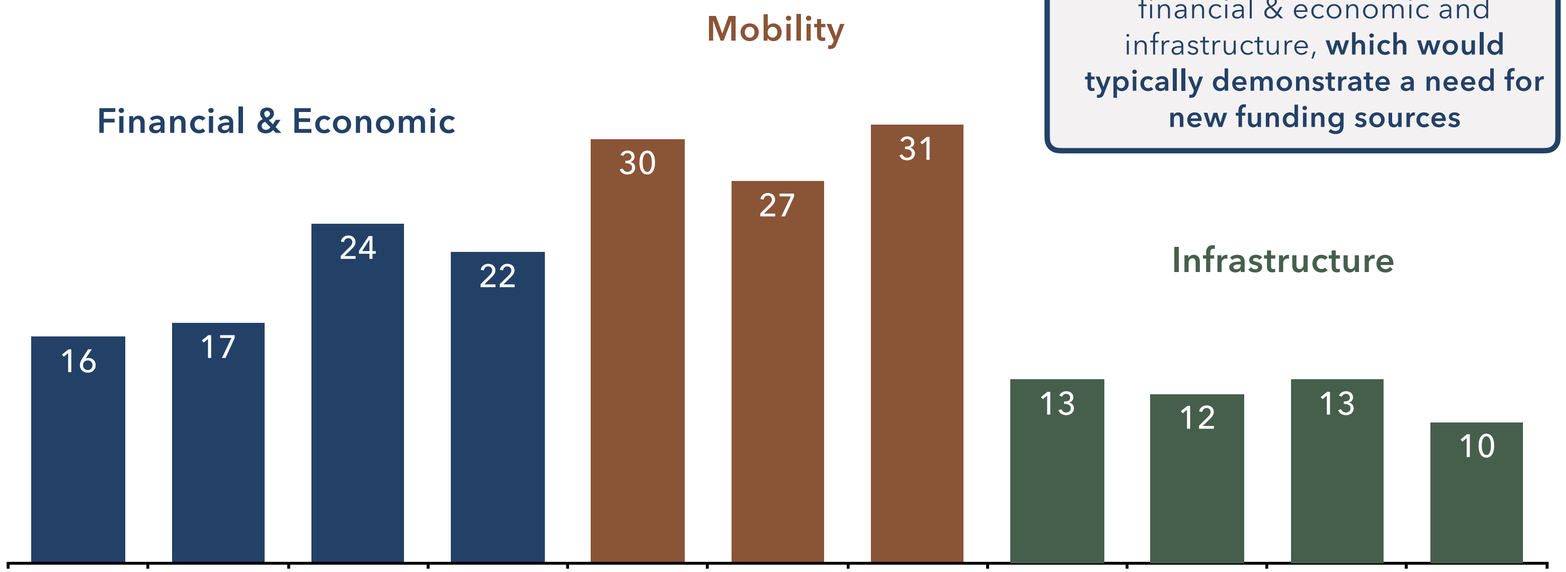
Road Usage Charging - United States Report

PTOLEMUS Consulting Group

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)

Minnesota ranks lower than other states on key drivers, particularly financial & economic and infrastructure, **which would typically demonstrate a need for new funding sources**



Motor Fuel Tax Revenue / Total State Highway Cost	User Fee Revenue / Total State Highway Cost	Gasoline Tax Rate (state)	Diesel Tax Rate (state)	Total Vehicle Miles Traveled (VMT)	VMT / Fuel Volume (vehicle fuel efficiency)	EV Sales (total) / Population	VMT / Road Length (congestion)	Percentage of Pavement in Poor Condition	Percentage of Bridges in Poor Condition	Bridges in Poor Condition / Miles of Roadway
51: Highest Dependency, 1: Lowest	51: Highest Dependency, 1: Lowest	51: Highest Rate, 1: Lowest	51: Highest Rate, 1: Lowest	51: Highest VMT, 1: Lowest	51: Highest Efficiency, 1: Lowest	51: Highest EV Penetration, 1: Lowest	51: Highest Congestion, 1: Lowest	51: Highest share poor pavement, 1: Lowest	51: Highest share poor bridge condition, 1:	51: Highest share poor bridge condition, 1:

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

RUC in Minnesota uses the terminology Distanced Based User Fee (DBF)

2003

Minnesota participated in a multi-State Pooled Fund Project on Road User Charging

2007

State legislature passed legislation to invest $5 million in a technology pilot for a fuel-neutral mileage charge

MnDOT completed research and interviews with transportation experts and the general public around a mileage-based user fee alternative to the motor fuel tax

2008

MnDOT conducted **focus groups** with the driving public to understand there perception and acceptance of distance-based fees

2009

MnDOT performed over **800 phone-mail-phone interviews** with drivers of hybrid vehicles around their understanding transportation funding

2011

MnDOT carried out **initial technical research** for a mileage-based user fee utilizing **smartphones.** Nearly 500 people participated each for a 6 month period

2013

MnDOT released the Operation Summary Report and a report evaluating the success of its mileage-based user fee pilot

2017

MnDOT was awarded a $300,000 federal grant to design a **new distance-based user fee pilot using shared mobility services**

2018

MnDOT was awarded a subsequent federal grant of $999,600, which was matched with state funds, to complete a **demonstration of the distance-based user fees through the MaaS shared mobility model**

2020

MnDOT completed a **12-month pilot on the shared mobility distance-based user fee system using embedded telematics.** 64 shared vehicles and 1 autonomous vehicle participated in the pilot

2022

MnDOT published its **final report on its distance-based user fee program**

Going forward - MnDOT has submitted an application for a new grant expanding the telematics approach

Sources: PTOLEMUS, Minnesota DOT; SM: Shared Mobility

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

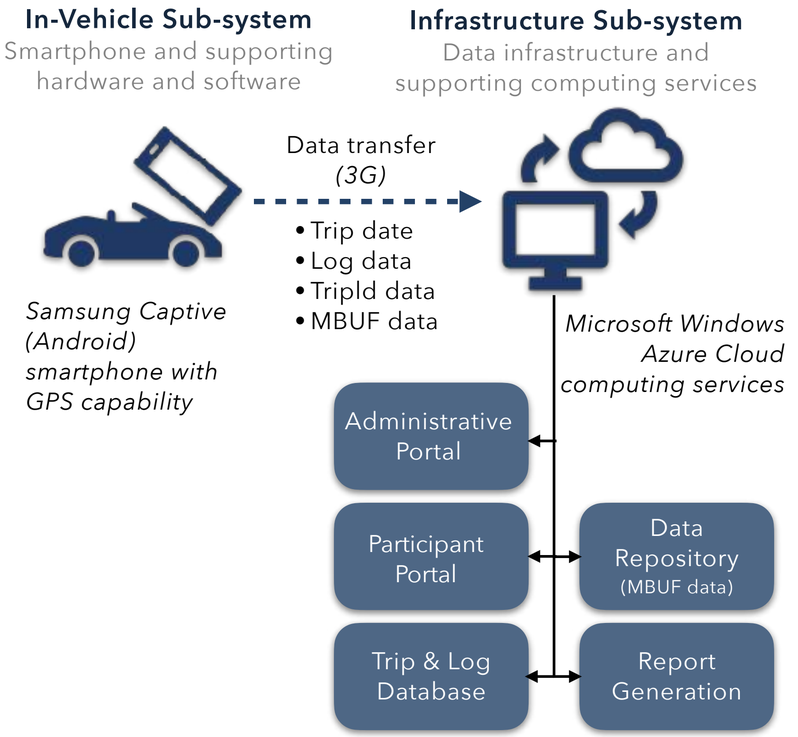
BACKGROUND

- 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 *CaptivateTM* 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 TripId 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

Sources: PTOLEMUS, Minnesota DOT - Note: *Minneapolis-Saint Paul

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**

Minnesota Road Fee Test

"*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**.*"

Sources: PTOLEMUS, Minnesota DOT

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 **fixed, per-mile rate was used to simulate the road charge**, which was **based on the average state and federal gas tax rates**
- **Information on miles traveled, location, day/time and fuel consumed was transferred directly from the SM providers and the CAV to the MnDOT back office** without requiring involvement from the actual drivers

"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

Sources: PTOLEMUS, Minnesota DOT

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

Minnesota Distance-Based Fee Phased Approach

PHASE 1: Proof of Concept

A 3-month proof of concept ensuring the accurate and secure transfer of data between the SM and CAV providers and the State. *Only one SM provider participated.*

3 Months

2018 2019 2020 2021

PROJECT COMPLETE

12 Months

PHASE 1 Results	SM Provider	CAV Provider
Participating Companies	1	1
Participating Vehicles	70	1
Unique Trips	4.633	43
Miles Traveled	103.550	1.716
Total Gross Distance-based Fees (state)	N/A	N/A
Gallons Gas Purchased	3.542	79

PHASE 2 Results	SM Provider	CAV Provider
Participating Companies	2	1
Participating Vehicles	64	1
Unique Trips	N/A	
Miles Traveled	565.839	
Total Gross Distance-based Fees (state)	15.358 US$	
Gallons Gas Purchased	18.068	

** Results were not split out between the SM and CAV Providers*

PHASE 2: Demonstration

A 12-month demonstration of the potential DBF program's feasibility and scalability. Two SM and one CAV provider participated.

Besides testing the technology and the data collection, transaction processing, and revenue reporting processes, the demonstration period looked to:

- Assess the broader public opinion and educate the public about the DBF alternative
- Identify any program gaps as well as key lessons for addressing future DBF projects in Minnesota

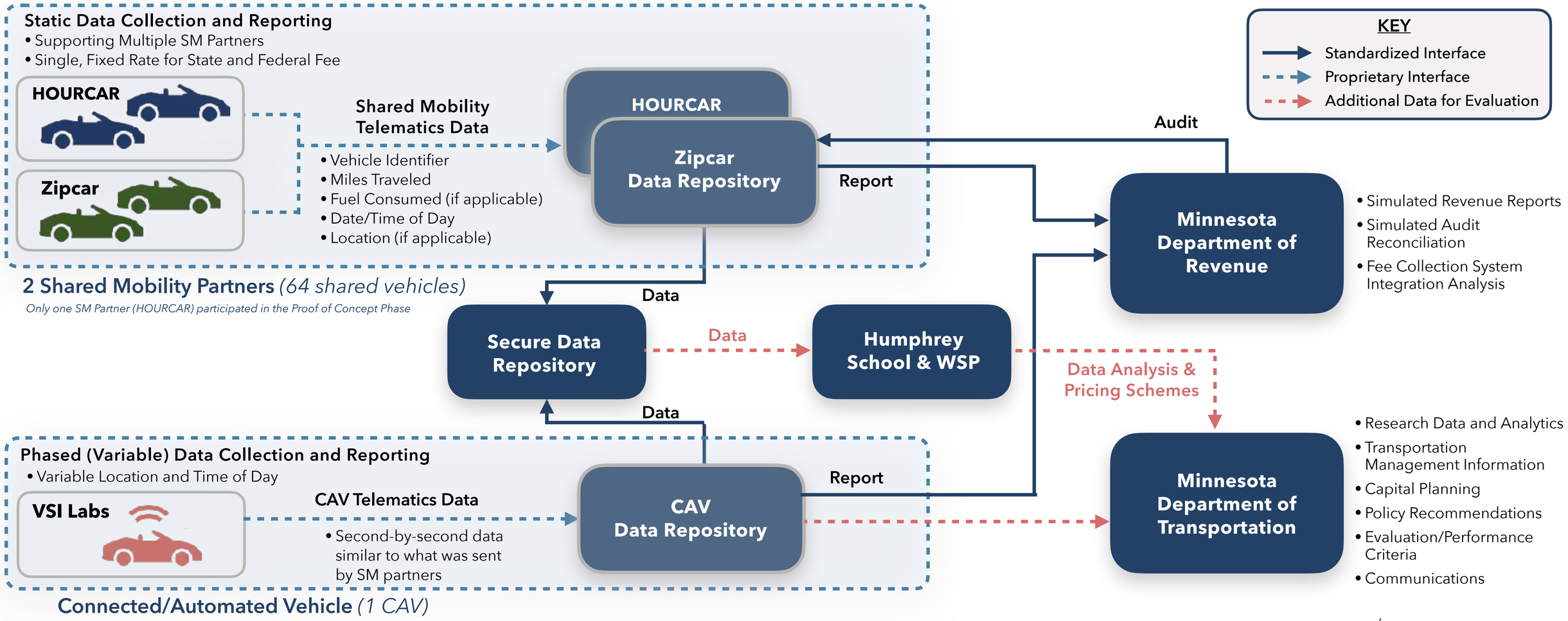
Sources: PTOLEMUS, Minnesota DOT

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



Sources: PTOLEMUS, Minnesota DOT

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**

DBF = State Rate (SR) + Federal Rate (FR)

State Rate = State Fuel Tax Revenue / Total State VMT
Federal Rate = Federal Fuel Tax Revenue / Total Federal VMT

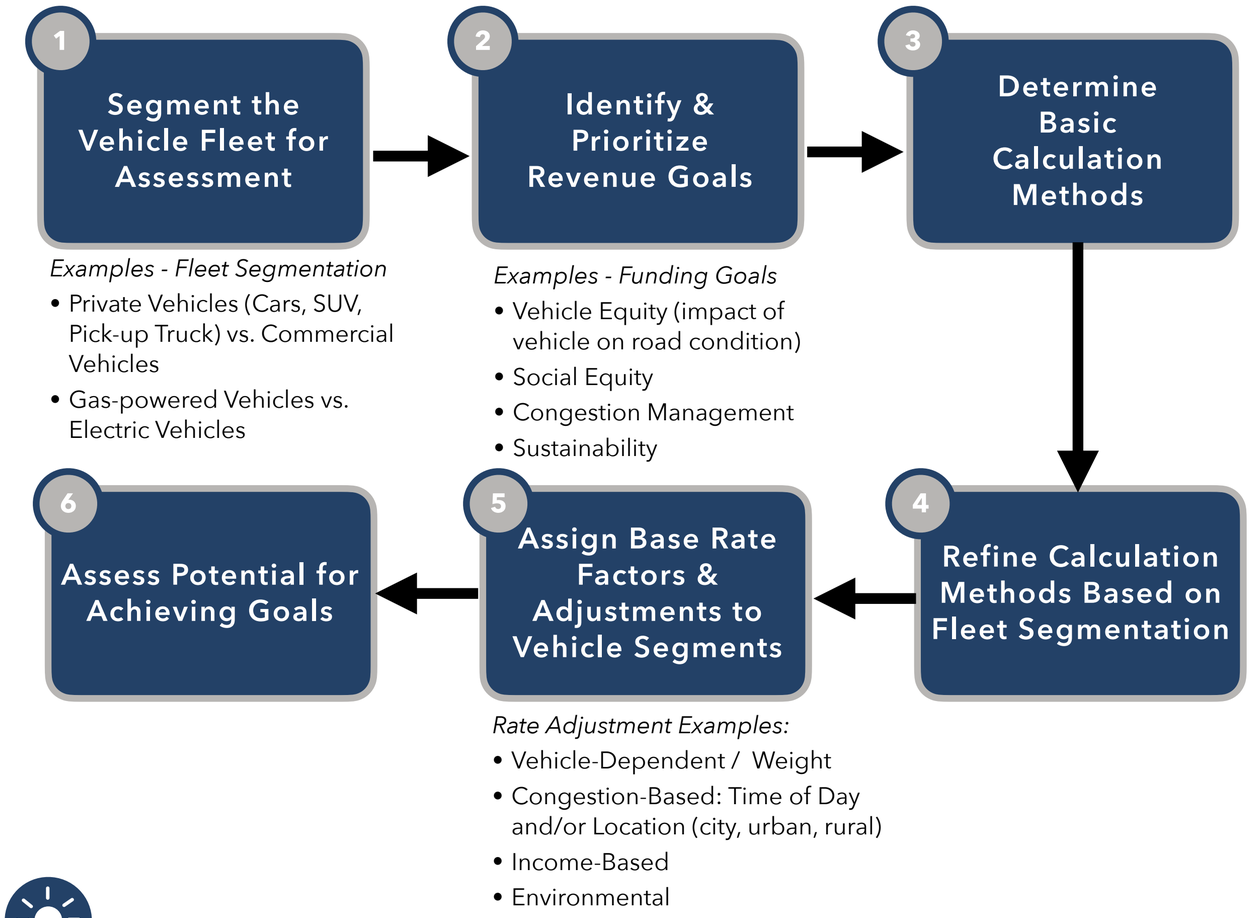
2. **Established a DBF rate formula, assessing a single DBF rate, netting state and federal motor fuel tax revenues against the DBF fees collected. Rates were 28.5 cents per gallon for the state tax and 18.4 cents for federal**

Net DBF = [(# miles traveled * Per-Mile Rate)
- (# gallons of gasoline consumed * motor fuel tax rate)]

3. **Applied the above frameworks to determine the Demonstration Fee rates**

Source: PTOLEMUS, MnDOT

Minnesota's Rate Setting Framework



Examples - Fleet Segmentation
- Private Vehicles (Cars, SUV, Pick-up Truck) vs. Commercial Vehicles
- Gas-powered Vehicles vs. Electric Vehicles

Examples - Funding Goals
- Vehicle Equity (impact of vehicle on road condition)
- Social Equity
- Congestion Management
- Sustainability

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.

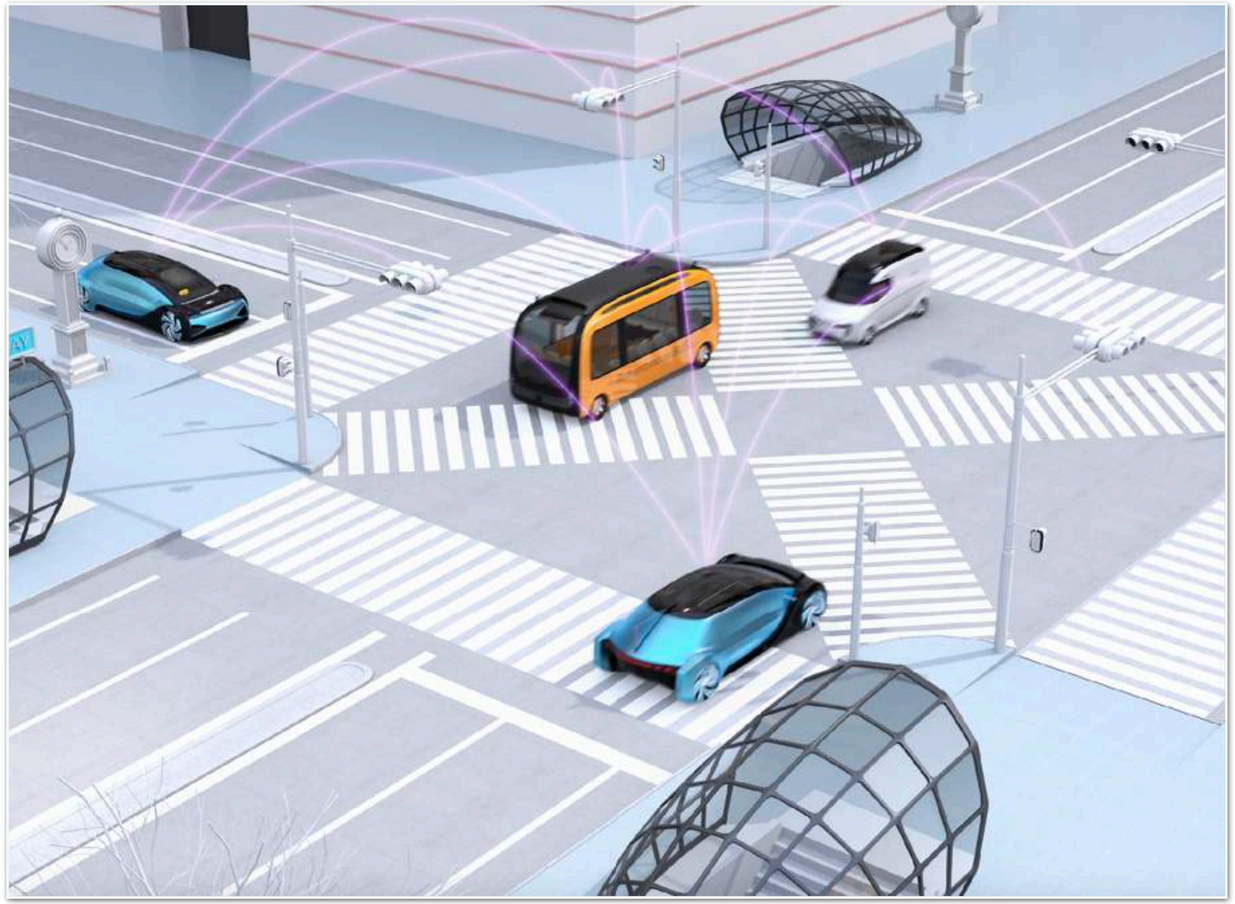
CAV: The pilot was also the first to collect RUC data from a Connected & Automated Vehicle

- **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

Source: PTOLEMUS



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.

Source: PTOLEMUS, MnDOT - Note: PII: Personal Identifiable Information

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

PTOLEMUS Consulting Group

The most comparable systems to RUC that are deployed at scale are the European distance-based nationwide schemes using GPS

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

Source: PTOLEMUS

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**

PTOLEMUS Consulting Group

To support our forecast, PTOLEMUS created a model that examines road funding needs and RUC's 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

1. Sales (Vehicle Sales - Forecast)
- Light Vehicles (all & electric)
- Heavy Vehicles (all & electric)

2. Registered (Registered Vehicles - Actual)
- Light Vehicles (all & electric)
- Heavy Vehicles (all & electric)

3. Scrap Rate (Rate of Replacement of Old Vehicles - Forecast)
- Light Vehicles (all & electric)
- Heavy Vehicles (all & electric)

4. LV Split (Rate of Light Vehicles between cars and trucks- Forecast)

5. MPG Forecast (Fuel Efficiency of New Vehicles - Forecast)
- Light Vehicles (gasoline & electric)
- Heavy Vehicles (gasoline & electric)

6. MPG Average (Fuel Efficiency of Registered Vehicles - Actual)
- Light Vehicles (all & electric)
- Heavy Vehicles (all & electric)

B. VMT Data

7. VMT Total (VMT Growth - Forecast)
- Light Vehicles (all)
- Heavy Vehicles (all)

8. VMT Urban Split (VMT Split between Urban & Rural - Forecast)
- Light Vehicles (all)
- Heavy Vehicles (all)

C. Fuel Tax Data

9. Fuel Tax Rates (Motor Fuel Tax Rate - Forecast)
- State (gasoline & diesel)
- Federal (gasoline & diesel)

D. Connected Vehicle Data

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
- Motor Fuel Tax Revenues (State only)
- Motor Fuel Tax Revenues State plus Federal

Model_RUC Revenue
- RUC Revenue (vehicle class)
- RUC Revenue (vehicle fuel efficiency)
- RUC Revenue (urban vs rural drivers)

Model_RUC Cost
- Operating cost (implementation and operations)
- Operating margin

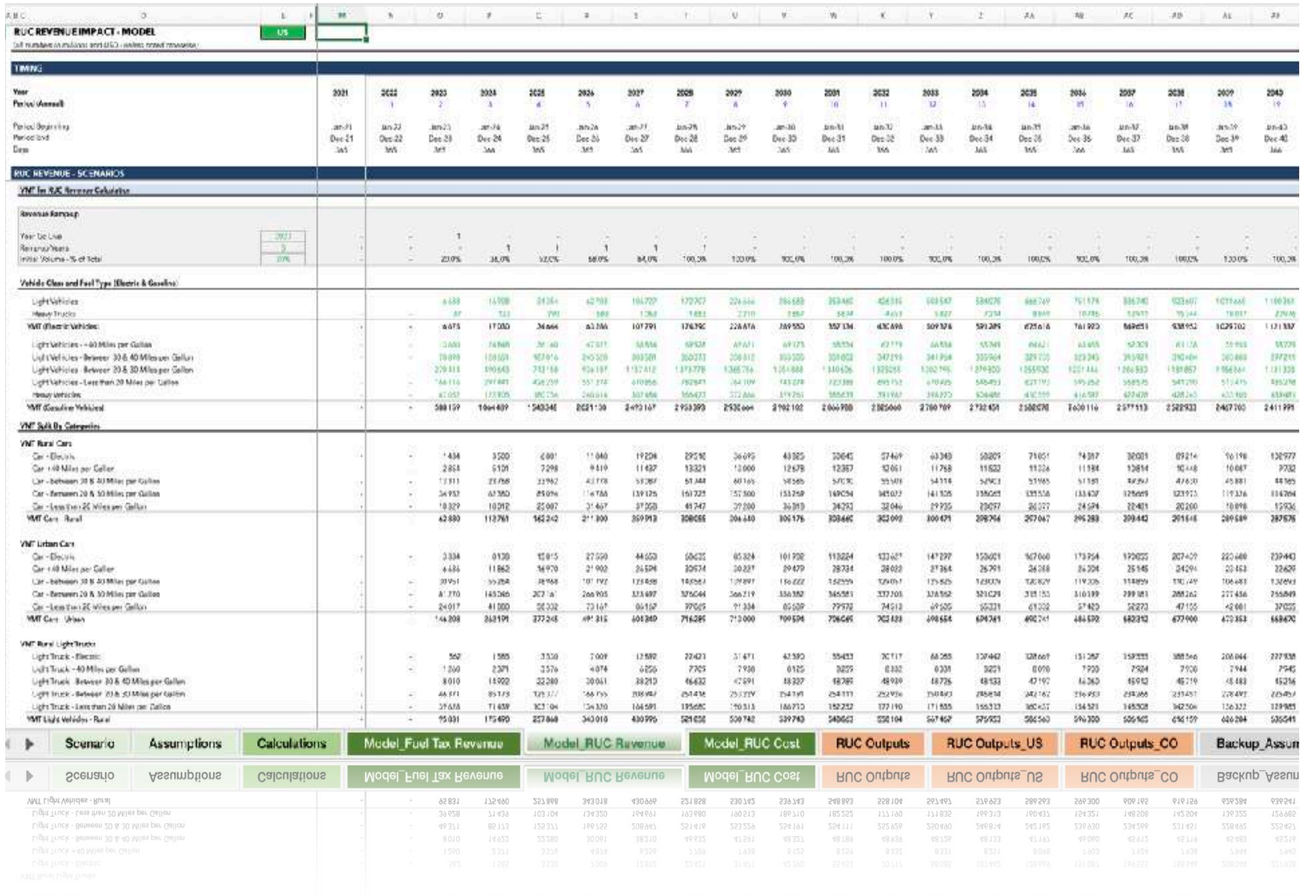
PTOLEMUS has leveraged its Automotive, BEVs and Connected Vehicle market forecasts for this analysis.

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

Source: PTOLEMUS

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 integrates 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 Colombia
    - The user is able to select each state individually or the United States as a whole
  - **Multiple vehicle classes:**
    - Light ICE, light electric, heavy ICE and heavy electric vehicles.
  - **Model also provides options to**
    - Split light vehicles between cars and light trucks
    - Analyze light vehicles by fuel efficiency (5 categories)
  - **Key mileage reporting technologies**: Manual and automated solutions including Odometer photo, OBD-II dongles (with and without GPS) and in-vehicle telematics



The motor fuel tax revenue forecast covers the period 2022 to 2040 for the US as a whole, and the state of Colorado

Motor Fuel Tax Revenues - Report Section Overview

- The **purpose of this section is to help stakeholders understand the potential impact of vehicle electrification** (and other relevant factors) **on state and federal motor fuel tax revenues** and thus transportation funding
  - In a more aggressive electrification case, fuel tax revenues will be less than what is forecasted while a more conservative case would increase revenues
  - Other key factors that impact fuel tax revenues, and are covered in the forecast, include the fuel tax rates set by states and the federal government, the evolution of the average fuel economy of gas-powered vehicles, and the light vs. heavy vehicle split
- The **motor fuel tax revenue forecast presented in this section covers the period 2022 to 2040 for the US, as a whole, and the state of Colorado**
- **Colorado was selected as a case study for this report as it provides an interesting contrast to the US market** as a whole, having the following characteristics:
  - Fast growing state with regards to VMT
  - Above (US) average EV penetration and ambitious statewide electrification plans
  - Aggressive plan for motor fuel tax increases

The forecasts provided in the section slides are meant to represent a reasonable case. However, we would recommend any stakeholder that is serious about understanding these impacts, to use those to develop their own forecast and run serious sensitivity analysis around them.

PTOLEMUS is able and willing to assist in this work.

Topic covered in Section	Details (split)	US	CO
New Vehicle Sales	Light Vehicle vs. Heavy Vehicle	✓	✓
Total Registered Vehicles	Light Vehicle vs. Heavy Vehicle	✓	✓
Electric Vehicles Sales and Registered	Light Vehicle vs. Heavy Vehicle	✓	✓
VMT	Light Vehicle vs. Heavy Vehicle / Urban vs. Rural	✓	✓
MPG	Light Vehicle vs. Heavy Vehicle	✓	✓
Motor Fuel Tax Rate	State vs. State plus Federal	✓	✓
Motor Fuel Tax Revenues - Base Scenario	LV (State) LV (State plus Federal) HV (State) HV (State plus	✓	✓
Motor Fuel Tax Revenues - Sensitivity	LV (State) LV (State plus Federal) HV (State) HV (State plus		✓

Source: PTOLEMUS

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
Partnership strategy	Partnership strategy	Market forecasting

Market research services

Off-the-shelf reports	Subscription services	Custom market research

Fields of expertise

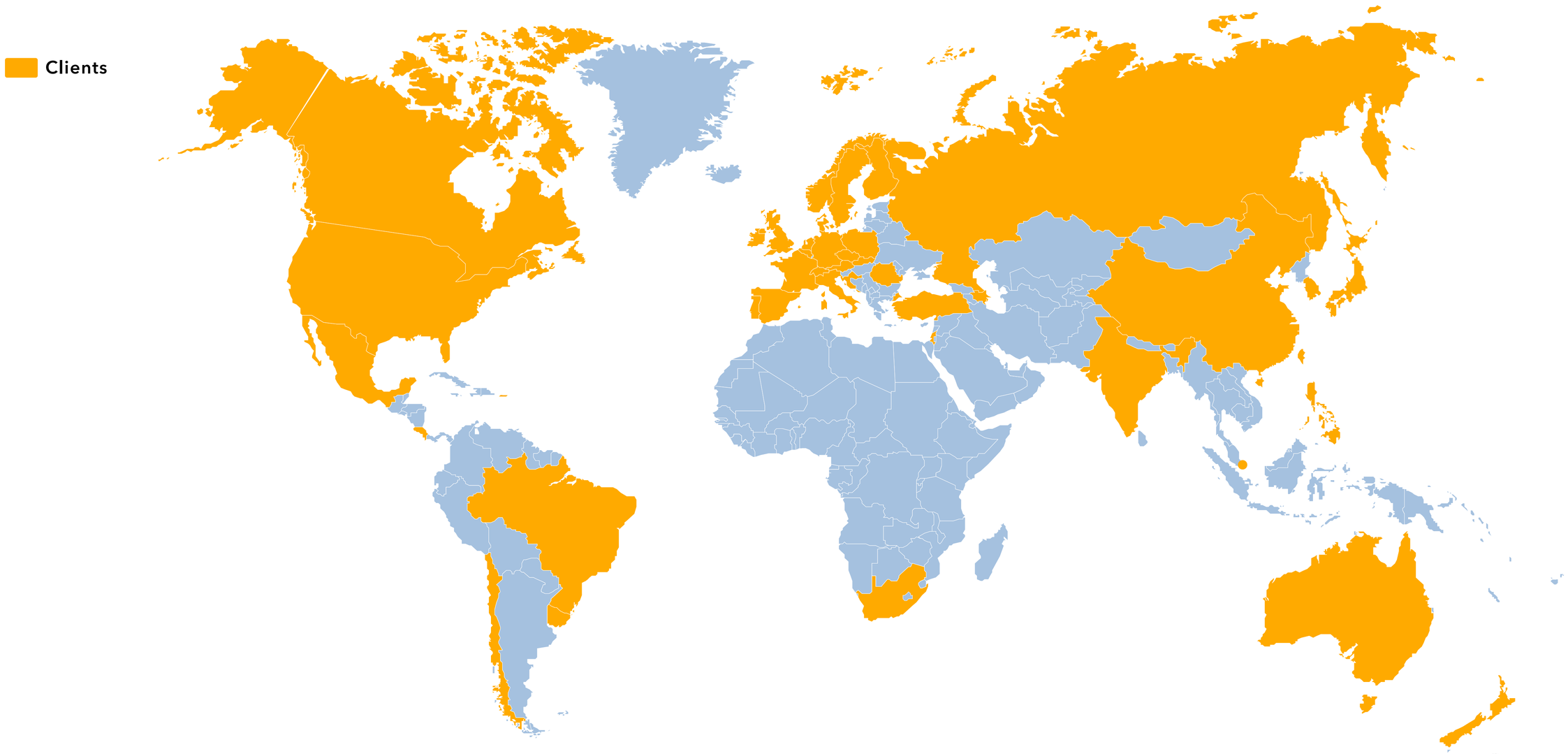
RUC and tolling	Digital & connected insurance	Vehicle data and analytics
IoT & connectivity	Emergency services	Vehicle services
Mobility services	Vehicle automation	Electrification

We serve over 350 clients across 6 major mobility verticals

Some of our references

Source: PTOLEMUS

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

ST Engineering TRANSCORE

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

Major toll solution provider

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

Major toll solution provider

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

Major toll solution and ITS provider

Defined & implemented its partnership strategy in the connected vehicle ecosystem

Future EETS provider

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

Wallonie SOFICO

Identified market opportunities & defined strategic plan in connected mobility services

Road & infrastructure operator

Assisted the board of its technology unit in its strategy definition

Global motorway operator

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

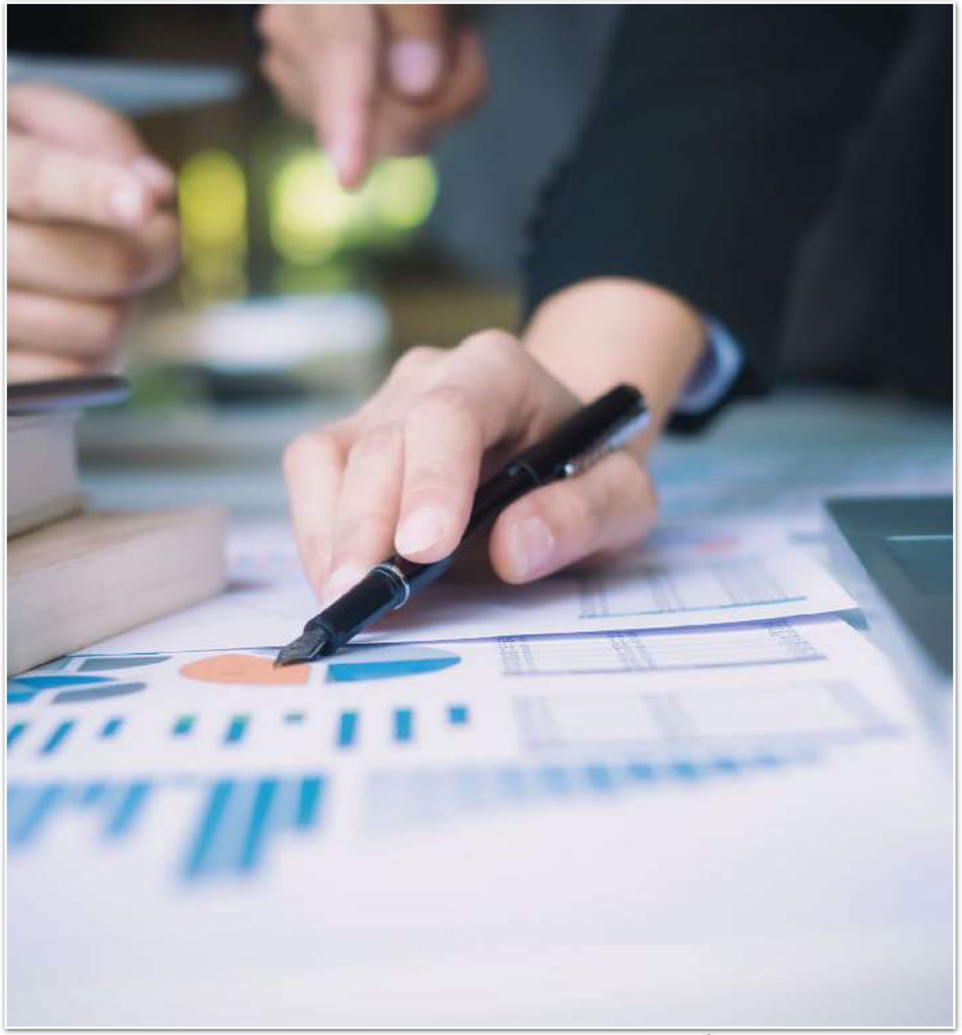
Télit

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

EETS provider

PTOLEMUS can help your organisation define and achieve its strategy in the domain of RUC, electronic tolling and mobility

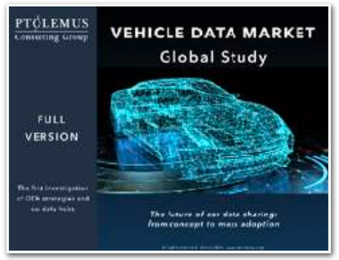
- **Strategy definition**
  - Road policy strategy assistance
  - Scenario planning, simulation & analysis
  - Mobile tolling strategy development
  - Multimodal mobility design and planning
  - Connected vehicle payment integration
  - Strategy orientation workshops
- **Innovation strategy**
  - Vertical market assessments
  - Product definition
  - Consent management
  - Data collection & analytics strategy
  - Device strategy
  - Stakeholder consultation / engagement
- **Innovation delivery**
  - Proof of concept design & launch
  - Architecture definition
  - Project management
- **Investment assistance**
  - M&A strategy
  - Commercial due diligence
  - Technology due diligence
  - Feasibility studies
  - Vehicle data market sizing
  - Business case development
  - Cost benefit analyses
  - Post-merger integration
- **Procurement**
  - Definition of road charging schemes
  - Assistance to tenders
  - Selection and sourcing of RUC technology
- **Partnership strategy**
  - Partnership strategy definition
  - Assistance to tender response
- **Project management**
  - Assistance in management of road pricing projects
  - Congestion charge project management



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

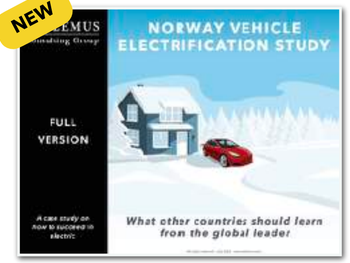
AUTONOMOUS DRIVING

CONNECTED VEHICLE



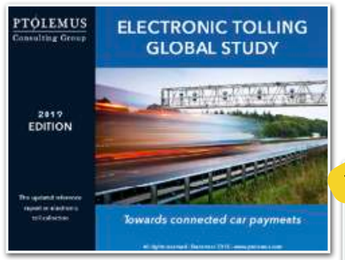
ELECTRIFICATION

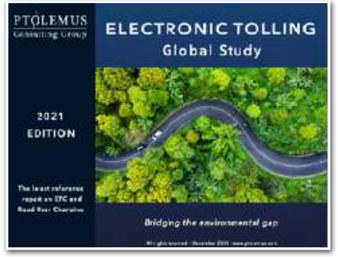
NEW



SOON

TOLLING & ROAD USAGE CHARGING





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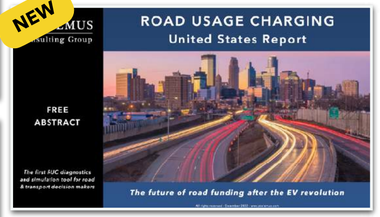
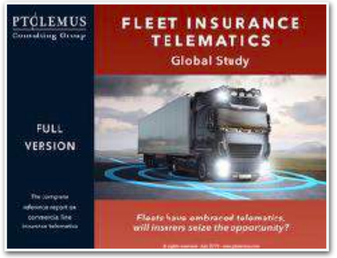


FLEET MANAGEMENT



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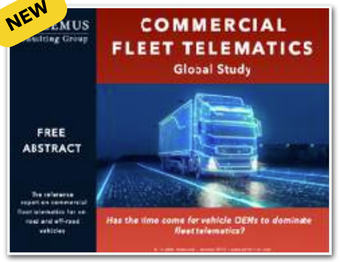
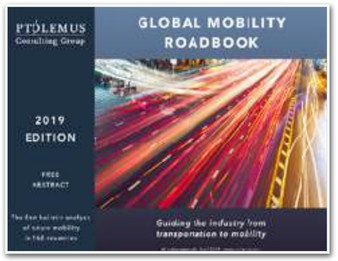


INSURANCE

NEW

MOBILITY



SOON

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:

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