1) Forward Drive project update
2) Financial modeling task report
3) RUC outreach task report
4) Spotlight briefings
5) Discussion and Q&A
1. **New mobility & RUC financial modeling**: create a framework for modeling the effects of electrification, automation, ridesharing, and teleworking on a RUC system in Washington.

2. **Equity analysis**: identify and measure potential disparate impacts of RUC to communities of color, low income households, vulnerable populations and displaced populations.

3. **Enhanced mileage reporting methods**: incorporate latest approaches to mileage reporting into a WA RUC system: in-vehicle telematics, improved smartphone apps, retail payment options, etc.

4. **Administrative cost reduction “scrum”**: workshops with other states to design RUC functions in ways that reduce the cost of collections for states.
5. Detailed pilot phase-in plan: takes into account findings from financial analysis, equity analysis, enhanced mileage reporting approaches, and cost reduction scrum

6. RUC prototype “sub-test”: conduct a small-scale test of new mileage reporting methods, equity-focused approaches, collecting RUC from fleets, and cost reduction techniques

7. RUC roadmap: detailing how Washington and other states can design a RUC policy and system to fit their circumstances (including a framework for how policy choices like resource allocation can be examined in light of more stable revenue)
Current Status of *Forward Drive* (May 2021)

Research task activities (*bold* items will be presented today):

- Financial modeling: Developed approach for **incorporating pandemic impacts into revenue forecasting and defining scenarios**

- Equity analysis: Developed *outreach and involvement plan*, began *conversations with stakeholders*, prepared for engagement activities, drafted initial financial impact analysis findings

- RUC innovation: Developed a framework for prioritizing research and testing possibilities, researched emerging technologies and business models, engaged with industry partners

- Cost reduction workshops: Identified partners for participation, crafted challenge statements for each workshop, scheduling underway

Steering Committee activities: in-depth spotlight briefings in May and June
**Forward Drive: How the 7 Tasks Work Together**

**TASK 1:** Financial analysis of mobility trends

**TASK 2:** Equity analysis and impact mitigation

**TASK 3:** RUC innovation

**TASK 4:** Cost reduction workshops

**TASK 5:** Detailed pilot phase-in plan

**TASK 6:** RUC prototype and “sub-tests”

**TASK 7:** Final report and RUC roadmap

**Schedule:** 39 months (October 2020 – December 2023)
Forward Drive Schedule

2020
Q1 TASK 1
Q2 TASK 2
Q3 TASK 3
Q4 TASK 4

2021
Q1 TASK 2
Q2 TASK 5
Q3 TASK 6
Q4 TASK 1

2022
Q1 TASK 3
Q2 TASK 6
Q3 TASK 7
Q4 TASK 5

2023
Q1 TASK 4
Q2 TASK 7
Q3
Q4
Agenda

1) Forward Drive project update
2) Financial modeling task report
3) RUC outreach task report
4) Spotlight briefings
5) Discussion and Q&A
Presentation Outline

- Financial Model Status Update
  - Methodology related to quantify potential changes in commuting patterns due to COVID-19 on vehicles miles traveled (VMT)
  - Impact of emergence of Electric vehicles on VMT
  - Impacts of autonomous vehicles and ridesharing

- Scenario Development
  - Major factors defining scenarios
  - Process of developing scenarios
  - Initial list of possible scenarios
Financial Model
Financial Model Update

- **Updated Computational Functionality**
  - VMT forecasts using Washington State Office of Financial Management (OFM) and Highway Performance Monitoring System (HPMS) as inputs
  - Potential changes in commute patterns, Work From Home (WFH)
  - Consideration of employment types for WFH impacts
  - Several features added for flexibility of analyzing multiple scenarios

- **User Enhancements Being Implemented**
  - Overall structure
  - Updatability
  - Ease of use
Selected New Features Added

- Ability to model WFH assumptions in terms of increase in WFH (0%, 25%, 50%, 100%) as a result of Covid-19
- Inclusion of decrease in non-work/discretionary trips (0%, 25%, 50%)
- EIA Fleet Fuel Economy Assumptions (Reference, Clean Fuel, $15-35 Carbon fee)
- Selection of COVID-19 scenario (Baseline, Resurgence)
- Consideration of Electric/Autonomous vehicles and Shared Rides
2020 VMT Forecast

Source: Transportation Revenue Forecast Council: September 2020 Transportation Economic and Revenue Forecasts
Observations on 2020 Forecast

- Based on:
  - Employment
  - Vehicle Registrations
  - Gas Prices

- Does not include work-from-home/telecommuting impacts on VMT
- Implies return of VMT to pre-COVID levels in the long-term future
Expected Work From Home Trends

By design or default, most US companies are heading toward a hybrid office workweek

- It's been great! We're better off giving up on office space entirely: 13%
- No turning back: Many of our office employees will work remotely a significant amount of their time: 11%
- Going with the flow. Business performance is not suffering. We'll likely increase the level of remote work: 32%
- Prefer limited remote schedules but people like it, including future talent: 26%
- Back to the office as soon as feasible. We're at our best on-site and in person: 17%

Q: Which of the following statements best describes how you feel about remote work at your company?
Source: PwC US Remote Work Survey
January 12, 2021, Base: 133 US executives

Over half of employees want to work remotely three days a week or more

- I would not want to work remotely: 8%
- 1-3 days per month: 10%
- One day per week: 10%
- Two days per week: 19%
- Three days per week: 16%
- Four days per week: 10%
- Five days per week: 29%

Q: How often would you want to work remotely after COVID-19 is no longer a concern if your employer allowed you to work remotely as you want to?
Totals do not add up to 100% due to rounding.
Source: PwC US Remote Work Survey
January 12, 2021, Base: 1,200 US office workers

Work From Home Considerations in VMT Forecasts

- Important to specifically include the WFH impacts on VMT
- Develop a methodology that:
  - Is based on reliable data
  - Captures pre-Covid WFH occupations
  - Be specific to the State of Washington
- Challenge: Data?
IPUMS (Integrated Public Use Microdata Series)

IPUMS USA (originally, the "Integrated Public Use Microdata Series") is a website and database providing access to over sixty integrated, high-precision samples of the American population drawn from sixteen federal censuses, from the American Community Surveys of 2000-present.

- Data based on American Community Survey (ACS) from 2000-present
- Includes commute modes by occupation types
- Includes over 300 occupation categories and corresponding commuting information by geography
These maps are intended to show the level of detail in terms of geography at which the IPUMS data is organized.

The numbers in the map correspond to the location names in the list on the left.
2018-ONWARD OCCUPATION CODES

This page presents the 2018-onward census occupational classification system recorded in the IPUMS variable OCC.

<table>
<thead>
<tr>
<th>Occupation Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>MANAGEMENT, BUSINESS, SCIENCE, AND ARTS OCCUPATIONS</td>
</tr>
<tr>
<td>SERVICE OCCUPATIONS</td>
</tr>
<tr>
<td>SALES AND OFFICE OCCUPATIONS</td>
</tr>
<tr>
<td>NATURAL RESOURCES, CONSTRUCTION, AND MAINTENANCE OCCUPATIONS</td>
</tr>
<tr>
<td>PRODUCTION, TRANSPORTATION, AND MATERIAL MOVING OCCUPATIONS</td>
</tr>
</tbody>
</table>

### OCC | Occupation
--- | ---
Not Applicable
000 | N/A (not applicable)

**Management, Business, Science, and Arts Occupations:**

**Management, Business, and Financial Occupations:**

- 0010 Chief executives and legislators
- 0020 General and operations managers
- 0040 Advertising and promotions managers
- 0051 Marketing managers
- 0052 Sales managers

This is a screenshot of the IPUMS data categories web page.
The link can be used to access this page to review the entire list of over 300 occupation categories.
This is a screenshot of IPUMS data used for this study.

Data columns include geography, occupation type and total number of workers as well as those working from home.
IPUMS Total Employed Population (2019)
IPUMS WFH Employment and WFH Percentage (2019)
Legend

**Total Employed**
- 10000 or Less
- 10001 - 20000
- 20001 - 30000
- 30001 - 40000
- 40001 or More

**Work From Home Percentage**
- 1.5 or Less
- 1.5 - 2.5
- 2.5 - 5.0
- 5.0 - 7.5
- 7.5 or More
## 2017 National Household Travel Survey Trip Purpose Distribution

<table>
<thead>
<tr>
<th>Trip Types/Purposes</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular home activities (chores, sleep)</td>
<td>4%</td>
</tr>
<tr>
<td>Work from home (paid)</td>
<td>0%</td>
</tr>
<tr>
<td>Work</td>
<td>18%</td>
</tr>
<tr>
<td>Work-related meeting / trip</td>
<td>3%</td>
</tr>
<tr>
<td>Volunteer activities (not paid)</td>
<td>1%</td>
</tr>
<tr>
<td>Drop off /pick up someone</td>
<td>15%</td>
</tr>
<tr>
<td>Change type of transportation</td>
<td>1%</td>
</tr>
<tr>
<td>Attend school as a student</td>
<td>1%</td>
</tr>
<tr>
<td>Attend child care</td>
<td>0%</td>
</tr>
<tr>
<td>Attend adult care</td>
<td>0%</td>
</tr>
<tr>
<td>Buy goods (groceries, clothes, appliances, gas)</td>
<td>14%</td>
</tr>
<tr>
<td>Buy services (dry cleaners, banking, service a car, pet care)</td>
<td>2%</td>
</tr>
<tr>
<td>Buy meals (go out for a meal, snack, carry-out)</td>
<td>10%</td>
</tr>
<tr>
<td>Other general errands (post office, library)</td>
<td>3%</td>
</tr>
<tr>
<td>Recreational activities (visit parks, movies, bars, museums)</td>
<td>9%</td>
</tr>
<tr>
<td>Exercise (go for a jog, walk, walk the dog, go to the gym)</td>
<td>8%</td>
</tr>
<tr>
<td>Visit friends or relatives</td>
<td>7%</td>
</tr>
<tr>
<td>Health care visit (medical, dental, therapy)</td>
<td>2%</td>
</tr>
<tr>
<td>Religious or other community activities</td>
<td>2%</td>
</tr>
<tr>
<td>Something else</td>
<td>1%</td>
</tr>
</tbody>
</table>
Identifying Workers/Occupations Expected to Continue Working From Home

Washington’s 3,000,000 workers

Per 2019 Census data (IPUMS/ACS)

Approximately 27% working in professions with high work from home potential

800,000 high work from home potential

When they must commute to work, approximately 66% drive

Drive to work (when they commute)

Baseline # workers expected to WFH

Scenario-specific factors to be applied to this baseline
Work From Home Vehicle Miles Traveled Forecasting Approach

1. Identify occupations expected to WFH (WFH > 5%)
2. Apply average work trip length of 10 miles
   \textit{Computed from NHTS data}
3. Calculate scenario-specific VMT decrease
4. Subtract the WFH VMT from the Baseline VMT
VMT Forecast Comparison

- **Reference** represents CDM Smith’s base case developed by removing heavy vehicles from the September 2020 OFM forecasts extending through 2050.
- **Low WFH Scenario** represents an assumed 25% increase in workers’ WFH and 10% decrease in discretionary trips resulting in an aggregate 3.3% decrease in overall VMT.
- **Medium WFH Scenario** represents an assumed 50% increase in workers’ WFH and 15% decrease in discretionary trips resulting in an aggregate 5% decrease in overall VMT. Higher WFH assumptions result in a greater decrease in VMT.
- **High WFH Scenario** represents an assumed 100% increase in workers’ WFH and 25% decrease in discretionary trips resulting in an aggregate 8.3% decrease in overall VMT.
Current Work

- Quality check of the updated financial model
- Incorporate the ability to analyze technology penetration impact on the VMT and revenue estimates
- Development of scenarios to be analyzed
Scenario Development
Factors Defining Future Revenue Scenarios

- Economic growth
- Covid outlook
- Telecommuting
- E-Commerce
- Technology adoption/Electric and Autonomous vehicles
- Temporal interactions of the above
Factors Defining Future Revenue Scenarios

- Economic growth
  - Flat
  - Slow growth
  - Fast economic growth

- Covid outlook
  - Return to normal
  - Resurgence

- Telecommuting
  - Pre-Covid levels
  - 25% additional WFH
  - 50% additional WFH

- E-Commerce
  - Pre-Covid levels
  - Reduction in discretionary trips

- Technology adoption/Electric and Autonomous vehicles
  - EV/AV/TNC, Low, Medium or High

- Temporal interactions of the above
  - VMT forecasts for each of the above
Approach to Scenario Development

- Scenarios cannot be defined in “isolation” using just a single factor, e.g., “Low Economic Growth”
- Analyzing ALL possible combinations of the factors is not practical
- Define a “Baseline Scenario” using appropriate factors’ ranges
- Identify 5 “plausible” combinations to develop a reasonable number of preliminary scenarios to analyze
- Select 3 scenarios to be analyzed in detail
Sources of Information

- **Economic Growth**: US Energy Information Administration (EIA), Low, Medium, High
- **Covid Outlook**: Various scenarios assumed by project team
- **Telecommuting**: IPUMS USA as per methodology described
- **E-Commerce**: Assumed scenario ranges by project team
- **Technology/electrification of vehicles**: EIA and Bloomberg New Energy Finance (BNEF)
Deeper Dive into Autonomous Vehicles and Ride-sharing
Acronyms

- Electric Vehicles (EV)
- Autonomous Vehicles (AV)
- Privately Owned Autonomous Vehicles (PoAV)
- Privately Owned Low Autonomy Vehicle (PoLAV)
- Transport Network Companies (TNCs)
Bloomberg Energy now estimates new sales of fully electric vehicles will exceed cars with internal combustion engines by 2038.
Trends and Impacts of AV, EV and TNCs on Travel

- Rapid shift to electric vehicles (EV)
  - Battery cost decline – increasing battery capacity
  - Cost of ownership of fully EV will soon match traditional ICE vehicles

- Vehicle automation – moving toward a “driverless” technology (AV)
  - Question is not “if” but “when”... and maybe exactly “how”

- Emergence and growth in Mobility as a Service (MaaS) – Shared Mobility (TNCs)
  - Services such as Uber and Lyft – still a small share of total travel but growing
Defining the Spectrum of Vehicle Automation

**SAE Levels of Vehicle Automation**

- **Level 1: Driver Assistance**
  - Mode specific driver assistance systems such as steering or accel/decel; driver does all else

- **Level 2: Partial Automation**
  - Driver assistance systems for both steering and accel/decel, but driver still in overall control

- **Level 3: Conditional Automation**
  - Automated / dynamic driving in most cases assuming driver takes control when needed

- **Level 4: High Automation**
  - Full automated driverless operation under certain conditions such as pre-defined, geofenced area

- **Level 5: Full Automation**
  - Automated driverless system covering all roadways and all conditions without limits
Some Key Impacts and Questions

All Vehicles
- Fossil Fuel
- Non-Fossil
  - Electric
  - Hybrid

- Personal Electric Vehicle (PEV)
- Autonomous Vehicles (AV)
- Shared Mobility (TNC)
Electrification Scenarios

Percent of VMT Traveled by Electric Vehicles

- High Economic Growth
- EIA High oil price
- EIA Reference case
- Bloomberg ENEP
- Medium
EIA Reference Case Potential Missing Factors

- Reference case assumes no CAFE standards in future
- CAFE likely to return along with significant funding for electrification
- Using the current EIA Reference Case could be misleading
In the Long Term* – Three Choices for Auto Drivers

- **Option A:** Continue driving a privately owned low autonomy vehicle *(PoLAV)*
  - This will be the choice of folks who like to drive, or those who fear loss of control
  - May be preferred option in rural areas for decades

- **Option B:** Privately owned driverless autonomous vehicle (L5) *(PoAV)*
  - Will likely reduce the number of vehicles per household
  - AV can be programmed to return home to take someone else to a different destination
  - Could be a significant choice in urban markets

- **Option C:** Rely fully on 3rd party *Shared Mobility* services using driverless L5 vehicles for all travel *(TNCs)*
  - Decline to replace household vehicles as they age out
  - Essentially the new “no car” households, where all trips are made using phone apps (like Uber)
  - This will be quite likely in larger urban areas – majority of future urban travel

(* Long Term refers to a point in time when Level 5 Autonomous vehicles are commonly available, 20+ years)
The Most Likely Choice in the Long Term: Option C

- This will result in a lot less vehicles but an increase in VMT
- Changing economics of travel
  - Electric vehicles will reduce operating cost of vehicles and increase vehicle life to 500,000-700,000 miles
  - Shared mobility will reduce idle time of vehicles from 90-95% today to 50% or less tomorrow
  - Level 5 autonomous vehicles will enable elimination of the driver from 3rd party services
- Combined effect of these changes will dramatically reduce the typical “cost per mile” of shared mobility
  - From $2.00-$2.50 per mile today
  - To $0.15-$0.25 per mile tomorrow
- If owning your own vehicle cost over $0.50 per mile (including insurance, financing, repairs and fuel); will people still own their own cars, or simply used shared mobility
  - Most analysts (including the auto industry itself) believe they will move away from private car ownership
Option A: Continue with Typical 3 Car Household

Three Car Household (Today)
- Car 1 - to/from Job 1
- Car 2 - to/from Job 2
- Car 3 - to/from Mall

Total VMT = 50 miles
Option B: Privately Own a Single L5 Autonomous Vehicle

Job 1

7 mi.

10 mi.

7 mi.

Home

Job 2

8 mi.

7 mi.

Mall

Morning Trip to Job 1

Morning Trip to Job 2

Midday Trip to Mall

PM Trip Job 1 & Job 2 to Home

Total VMT = 75 miles (50% VMT Increase)

Single Privately Owned AV

Occupied Trip

Empty Vehicle

Total VMT = 75 miles (50% VMT Increase)
Option C: Shared Mobility

Total VMT = 85 miles
(70% VMT Increase)
Relevant Questions and Comments

- As Electric vehicles share increases, better computation of VMT impact becomes more important
- There is no single “forecast” of the distribution of electric vehicles between EV, PoAV or TNCs, so a “Scenario Analysis” type approach needs to be taken
  - More EVs
  - More PoAves
  - More TNCs
  - Other combinations
## Shortlisted Scenarios

<table>
<thead>
<tr>
<th>Factors</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
<th>Scenario 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Growth</td>
<td>Flat</td>
<td>Moderate</td>
<td>High</td>
<td>High</td>
<td>Flat</td>
</tr>
<tr>
<td>Covid Outlook</td>
<td>Return to Normal</td>
<td>Resurgence</td>
<td>Return to Normal</td>
<td>Return to Normal</td>
<td>Return to Normal</td>
</tr>
<tr>
<td>Telecommuting Patterns</td>
<td>50% More</td>
<td>100% More</td>
<td>25% More</td>
<td>50% More</td>
<td>25% More</td>
</tr>
<tr>
<td>E-Commerce</td>
<td>Pre-Covid</td>
<td>25% More</td>
<td>50% More</td>
<td>50% More</td>
<td>25% More</td>
</tr>
<tr>
<td>Electrification of Automobiles</td>
<td>High Oil Price (EIA)</td>
<td>High EV (Bloomberg)</td>
<td>Medium</td>
<td>High Oil Price (EIA)</td>
<td>High Economic Growth (EIA)</td>
</tr>
<tr>
<td>Vehicle Technology</td>
<td>More PoAV</td>
<td>More TNC</td>
<td>More Ev</td>
<td>More TNC</td>
<td>More PoLAV</td>
</tr>
</tbody>
</table>

The above scenarios will be analyzed further to select 3 scenarios for final detailed analysis.
Summary of Progress to Date

- Financial model has been updated/enhanced to capture scenarios related to COVID-19 impacts
- All other inputs to the financial model have been updated
- Additional analysis capabilities have been incorporated
- Impacts of Electric/Autonomous/Shared vehicles being incorporated using additional analytical model
- The environment is being improved to make the computation process more user-friendly
Next Steps

- QA/QC of the updated Financial Model
- Finalize three scenarios to be analyzed
- Develop revenue outlook for each scenario
Thank you!!
ghafoorzf@cdmsmith.com
Agenda

1) Forward Drive project update
2) Financial modeling task report
3) RUC outreach task report
4) Spotlight briefings
5) Discussion and Q&A
RUC Equity Analysis

Mandate: “Identify and measure potential disparate impacts of RUC to communities of color, low-income households, displaced communities and vulnerable populations through targeted outreach and engagement.”

Method: Series of focus groups, surveys and one-on-one interviews using a pre-determined set of questions.
Progress to Date

- Identified more than 200 organizations representing “target” population
- Sent email (from WTSC) to each group inviting them to participate in equity analysis
- Telephone calls and personal emails to gauge interest
- Refined listing as a result of phone calls and personal emails
- 2nd mailing sent week of May 10
- Created questions for focus group/survey
- Created incentive compensation plan for focus group/survey effort
- Drafted document providing additional detail on RUC effort for target population organizations
Interested Groups (as of May 12)

- El Centro De La Raza
- Kent Black Action Commission
- Refugee Women’s Alliance
- One America
- Disability Rights WA
- CIRCC (Coalition of Immigrants & Refugees & Communities of Color)
- The Filipino Chamber of the Northwest
Reactions to Date

• “What do I currently pay for the roads?”
• “How and when will the road usage charge change?”
• “Why ask our opinion now when here is no known timeline to change how roads are funded?”
• “How will you make it fair for those who can’t work from home?”
• “We travel further for everything in Eastern Washington.”
• “Will my opinion matter?”
• “The usage road charge might hurt small, minority businesses.”

Some people expressed confusion and surprise that they are being asked their opinion and inputs
Criteria for Engagement Sessions

- Ethnic balance
- Geographic balance (statewide, including urban and rural areas)
- Include persons with disabilities
- Include refugee and immigrant populations
- Include professional driver communities
- Focus groups from 8 to 12 individuals
Next Steps

• Identify focus group participants (week of May 17)
• Schedule focus groups (May and June)
• Develop Survey (Week of May 24)
• Identify individuals for one-on-one interviews (Week of May 31)
• Conduct Focus Groups, surveys and one-on-one interviews (May, June, July and August)
• Compile report on analysis of findings (September)
• Brief the Commission: Ongoing
Agenda

1) Forward Drive project update
2) Financial modeling task report
3) RUC outreach task report
4) Spotlight briefings
5) Discussion and Q&A
May 27 at 2 pm
Equity Spotlight Briefing

AGENDA

• Welcome & Introductions
• Definitions: What is equity? Who qualifies as low-income? How does income correspond with race and ethnicity, and geography?
• Equity Analysis – Findings
• Outreach Approach
• Look ahead – incorporating findings and feedback
June 1 at 10 am
RUC Innovation Spotlight Briefing

AGENDA

• Welcome & Introductions
• Policy drivers and system improvement needs
• Framework for analyzing emerging technologies
• Findings and opportunities
June 4 at 1:30 pm
Cost Reduction Spotlight Briefing

AGENDA

• Welcome & Introductions
• Cost analysis framework
• Workshop structure
• Challenge statements
2021 Steering Committee Meeting Dates

- July 28, 9:30am-Noon
- December 13, 10am-2:30pm
Questions & Discussion