Oregon Department of Transportation

LOCAL RUC PROJECT EVALUATION REPORT TO THE SECRETARY

FAST Act STSFA Grant
Fiscal Year 2017

OReGO Local RUC Program

Contents

EXECUTIVE SUMMARY

This is the final report, required under Oregon DOT RUC Program Enhancements Cooperative Agreement 16RA00013 Second Addendum signed January 11, 2018, entered into between FHWA and the Oregon DOT (ODOT). This report is for the Local Road Usage Charge Pilot Project. The purpose of this report is to provide an update on how the demonstration activities were completed with grant funds to accomplish the objectives.

Objectives

The grant objective for this project was to validate technologies and capabilities to support travel data collection at a jurisdictional (local) level. The purpose was to determine if existing RUC systems are capable of handling multiple jurisdictional needs, and to identify gaps to be addressed in the future. The pilots addressed these core objectives:

a. Device Capability: the device or technology will report data with enough frequency and accuracy for the Account Manager to have the ability to capture distances at a granular level to apply RUC rates to applicable geo-fenced boundaries.
b. System Capability: The business partner systems will capture accurate data from the Mileage Reporting Option (MRO).
c. Participant Interface: the business partners presents information to the participant in a manner that is easy to read and understand. The state and local RUC data and rates are distinguishable.
d. Data Transfer: the business partners send aggregated RUC information (for each of the pilots, alongside the existing state RUC data), to the state's internal system, RUCAS.
e. Revenue Collection: the state can interpret the data that is collected.

Summary of project

The project conducted three simultaneous pilots with up to 75 passenger vehicles in each. The intent was to test different RUC jurisdictional technical challenges:

1. Area pricing where an area, such as a city or county, is geo-fenced and a local RUC rate added to the statewide RUC rate during specific times;
2. Layered area pricing where two overlapping areas are geo-fenced, such as a city and a county, with different RUC rates during certain times of the day; and
3. Corridor pricing where a corridor is geo-fenced, and people are charged a different RUC rate for shorter trips on freeway corridors during certain times of the day to preserve capacity for through trips.

ODOT contracted two business partners to provide 3 distinct services necessary to recruit drivers, operate the pilot, and assess the outcomes:

1. Account Management (Azuga) - Provided account management services including the systems, support and services necessary to conduct the pilot demonstration. Azuga also sent anonymized data (as they do in the operational OReGO program) for RUC reporting.
2. Outreach and Recruitment (PRR) - Provided outreach services that included a recruitment marketing campaign and resulted in qualified volunteer participants for each of the three pilots.
3. Qualitative Research (PRR) – Provided analysis from the data gathered from the pilot participants about their experiences, opinions and behavior during the pilot and translating that data into a qualitative and quantitative research report.

The business partners worked together along with the OReGO Program staff to provide pilot participants with a supportive user experience.

OReGO built a RUC Administrative System to process the data transactions sent by the. The OReGO team certified Azuga's solution. The team also collaborated on the formation of the participant survey questions throughout the pilot.

Project Budget

Project Costs Thru January 2021

Project	% Complete	Baseline Budget	Amount Spent	% of Budget
Phase 1 -Pilot Development	100%	$ 2,750,000	$ 1,040,862	38%
Phase 2 - Outreach & Incentives	100%	$ 400,000	$ 602,566	151%
Phase 3 - Operational Pilot	100%	$ 200,000	$ 91,600	46%
Phase 4 - Contingency, Evaluation and Closeout	75%	$ 325,000	$ 173,747	53%
TOTAL Planned Project Budget		**$ 3,675,000**	**$ 1,908,775**	**52%**

Summary of conclusions

Completing the three pilots demonstrated that OReGO's RUC system and program has the technical capability to execute on future federal and local RUC legislative requests. The project demonstrated the Account Manager's technical capabilities and readiness to support local RUC. The research findings indicate the public is receptive to alternative options to fund transportation.

This report is intended to share with the FHWA and the RUC community of interest what is technically feasible, gaps that may need to be addressed, and to share the valuable insights and findings of this grant funded initiative.

OReGO Background

Oregon's Road Usage Charge (RUC) Program, branded OReGO, has been operational since July 2015. OReGO's mission is to provide an alternative sustainable revenue source for funding a safe and reliable multimodal transportation system. The program demonstrates that drivers are equitably taxed through miles driven as opposed to fuel purchased.

Oregon was the first state to operate a functioning mileage-based tax program—collecting money and verifying miles. The OReGO program works alongside its private sector account managers to provide choices to RUC participants, offer effective customer service, and develop reliable backend systems that are accurate, efficient, transparent, and able to operate according to public funds law. OReGO demonstrates that charging per mile can be successfully implemented at a state level; however, implementation at a local level was still unproven. Without a demonstration that RUC can be applied at a local level, RUC can never be an alternative that presents local jurisdictions with funding options. With the award of this grant, ODOT executed on the following two objectives:

1. Evolve the RUC system to match what the fuels tax system already provides—funding options for local governments, and
2. Increase RUC's interoperable platform to include local governments to decrease administrative costs.

In some states, counties and cities can levy a local-option fuels tax, which may be collected by the state. If such the case, these taxes are then remitted back to the local government for their use. Local jurisdictions may want to be able to levy a local option RUC as tax revenues are declining. Therefore, the current RUC system must be able to administer multiple tax rates from a variety of jurisdictions, from the population-heavy city to the rural county.

Local requirements for a RUC system will be varied, therefore the system must be robust and flexible to handle several jurisdictional needs. Every RUC program in the nation will need to expand its RUC system beyond its own state's needs. Indeed, the success of a RUC system hinges on its scalability and adaptability.

Because it was the first in the nation to create and successfully operate the first RUC program, Oregon believes its system and people are ready for the next big challenge of introducing RUC to local governments. The purpose of this project is to expand and test OReGO technology in order to determine if road usage charging provides a viable transportation funding option for local governments.

PROJECT DESCRIPTION & EXECUTION

How it Works

OReGO conducted three pilots: one for each identified local-option. The volunteers participating in the pilots were divided into three corresponding groups of up to 75 participants to test each technical configuration. The pilots ran concurrently and lasted six calendar months. The pilots launched in March and concluded in October 2021. The pilots occurred in the Portland metropolitan area. Each pilot was based on a per mile fee and had variable RUC rates with various times which they applied. Fees and transactions were simulated. RUC fees were displayed as they would be in an operational program, and transactions were applied to the Participants' their account (a.k.a. Wallet) as if there were payments being made.

Phase 1 – Pilot Development

The pilot development phase included all grant activities that support and implement the pilots. The activities included: creating a technical work group, conducting economic research, procuring an account manager to administer the pilots, building and testing ODOT and account manager systems, and launching an outreach program.

Technical Working Group

ODOT created a Technical Working Group (TWG) with its local partners to better inform the discussion and to ensure the pilots and resulting systems satisfied the needs and concerns of interested jurisdictions. The members of the TWG included ODOT, PBOT (Portland Bureau of Transportation), Metro (a regional governmental entity), TriMet (a transit provider), and other local leaders.

Account Manager Engagement

The account manager selected was an existing OReGO business partner. Through a competitive bid process, Azuga was selected to provide services. They were responsible for building the system, enrolling the volunteer participants (provided by the Outreach Business Partner), distributing devices to participants, collecting information from the vehicles and reporting information on their customer interface (website and/or phone application), providing customer service, and sending data transmissions to ODOT.

Building and Testing the Systems

Azuga updated their systems to meet the local project requirements including creating a customer interface for volunteers to review their accounts. They built a backend system that received data, applied rates, and transmitted the information to ODOT.

ODOT certified that Azuga's solution met the contractual requirements through a certification process. The project tested Azuga's solution incrementally and then conducted end-to-end systems testing.

Throughout Azuga's system build, ODOT refined its own internal RUC Administrative System, RUCAS. RUCAS was configured to process records with the layered RUC rates, run additional reports, and accurately identify and monitor how much tax was owed to each jurisdiction. ODOT conducted its own system and user testing throughout the RUCAS development process.

Phase 2 –Recruitment & Onboarding

ODOT secured a business partner, PRR, to conduct outreach recruitment and qualify volunteers appropriate for each of the three pilots. To accomplish this, approximately 3,000 recruitment mailers were sent within the Portland Metropolitan area. Social media and radio were tools along with targeted recruitment to round out the desired demographic mix. Prospective pilot candidates provided qualifying and demographic data which was used to screen candidates.

To be consistent with the operational OReGO program, qualifying criteria for pilot participation were as follows:

- Participant was verified to be the registered owner of the enrolled vehicle
- Participant vehicle was classified as a passenger vehicle
- Participant vehicle had a fuel efficiency rating of 20 mpg and greater

Additionally, participants were required to acknowledge that they agreed to drive within their selected (one of the three) pilot areas on a regular basis.

From a pool of interest, ODOT verified each candidate based on the pilot qualifier criteria. PRR filtered out unqualified candidates. Next PRR analyzed candidates based on demographic criteria. PRR then selected pilot candidates based on the demographic representation of the Portland metropolitan area. Additionally, they closely monitored the active accounts to ensure that the mix of participants in each pilot were consistent with the demographics of the pilot area. PRR considered the following criteria when selecting participants to confirmed representativeness on the basis of:

- Age
- County
- Education
- Gender
- Income
- Race and Ethnicity

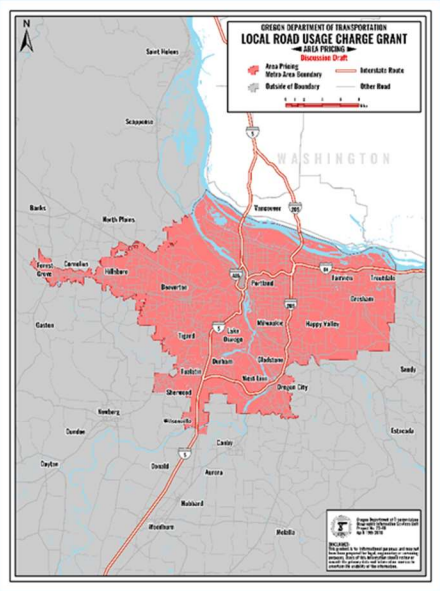
Upon selection and vetting, PRR provided the Participant Lists with all pertinent enrollment information to Azuga, so they could reach out to the Participant to complete the account set-up process.

Azuga sent vetted participants an email with instructions on how to complete their enrollment. Once the participant enrolled, they received a GPS enabled device with detailed instructions to plug the device into their OBD II port in the enrolled vehicle. This enabled Azuga's capabilities for monitoring the travel points of the enrolled vehicles. Azuga's system was configured to process travel considering these variables:

- Time of day the enrolled vehicle was driving
- Day of the week the enrolled vehicle was driving
- Whether or not the enrolled vehicle traveled inside or outside the boundary defined for the pilot

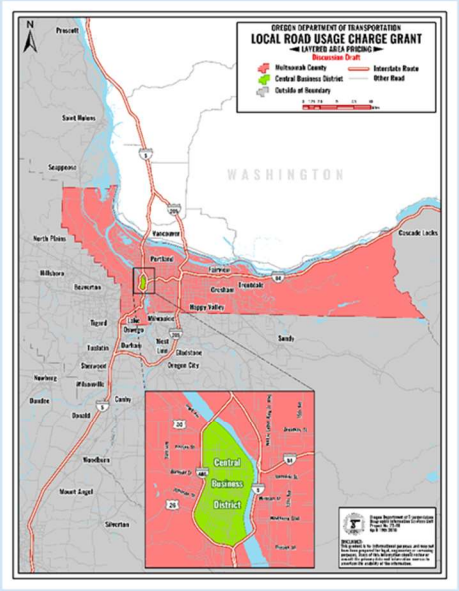
Both PRR and Azuga communicated with the selected Participants throughout the enrollment process to encourage participant interest, support, and follow-through.

Phase 3 – Operational Pilot - Collect Driving Data



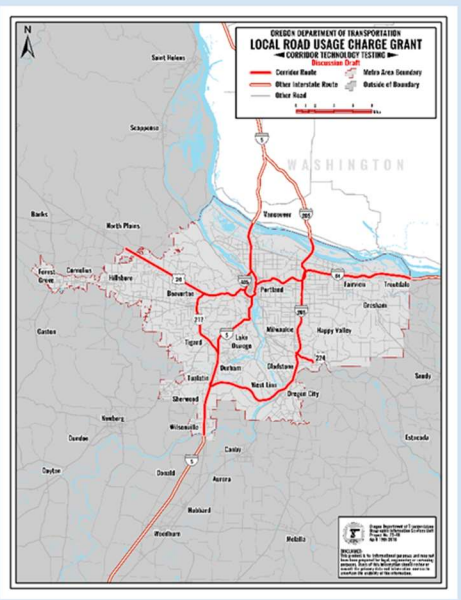
Area Boundary Pricing:
Time-of-day road charge pricing within Portland's Metro area

The intent is to verify that the state RUC can operate alongside a rather simple jurisdictional RUC.



Layer-Area Pricing:
Time-of-day road charge pricing in two overlapping areas (Portland and Multnomah County)

The intent is to prove that a local jurisdiction within another local jurisdiction can effectively assign its own RUC rules and rate independent of the larger jurisdictions that surround it.



Corridor Pricing Sub-Pilot:
Time-of-day road charge pricing on specific highway corridors (Portland Metro area)

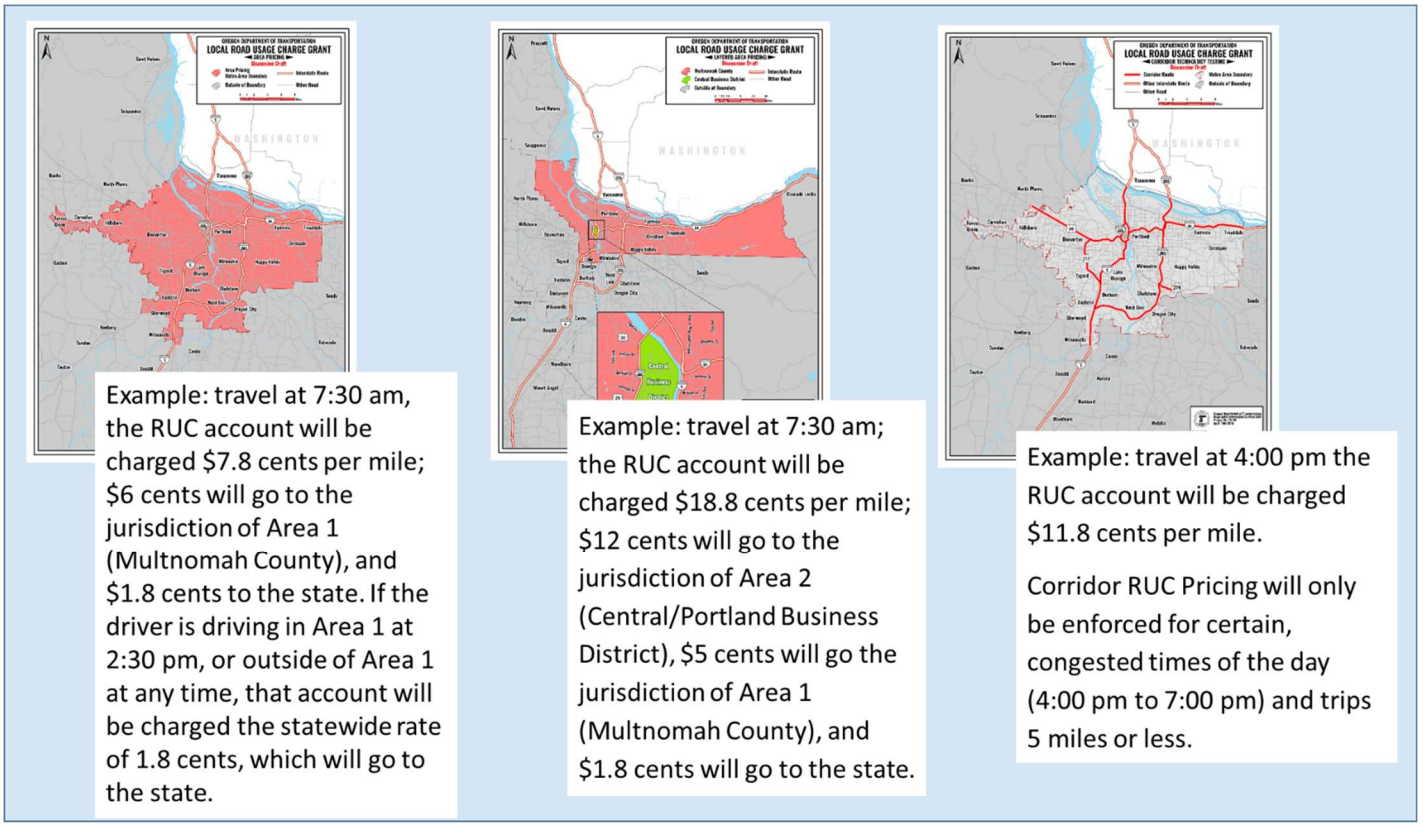
The intent is to discourage drivers from using the highway for short distance. This will decrease congestion for thru-traffic on Oregon's highways.

Note that the rates and times were slightly modified from those indicated in the original grant proposal to reflect current RUC rates and to improve the pilot outcomes.

Pilot Rates and Hours

The rates included in the table below represent how much is charged per mile of travel in the geographic areas and timeframes indicated.

Pilot 1	$0.018 Oregon state rate all the time for all days of the week $0.050 Portland Metro rate only during 7am–10am weekdays
Pilot 2	$0.018 Oregon state rate all the time for all days of the week $0.060 Multnomah County rate only during 7am–10am weekdays $0.120 Portland Central Business District only during 8am-11am weekdays
Pilot 3	$0.018 Oregon state rate all the time for all days of the week $0.010 Portland Corridor rate only during 4pm-7pm weekdays The Portland Corridor rate was waived if the vehicle was on the corridor for more than five miles



Collect Participant Input

PRR handled the recruitment of a minimum of 75 participants throughout for each pilot. Once on-boarded, PRR engaged participants in an online qualitative research study to learn about their

experiences, opinions, and changes in their behavior during the study. PRR also provided ongoing customer support through and beyond the duration of the study.

Qualitative research objectives:

- Recruit and retain a minimum of 75 participants in each sub-pilot.
- Collect user-experience feedback from participants throughout the pilot.
- Distill research information into key recommendations and considerations for future policies.

Goal: Pilot participants develop a new or stronger relationship to OReGO

- Objective: Support relationship building through research touchpoints with participants.

Phase 4 – Evaluation and Closeout

Pilot Findings and Evaluation

This report is intended to accomplish this phase and close the project. OReGO has analyzed the RUC data received and the simulation of jurisdictional transactions. The remainder of this document is focused on the findings and overall evaluation of the pilot. This report provides a quantitative and qualitative analysis of what was done, challenges to be overcome, potential to deploy on a broader scale, and recommendations.

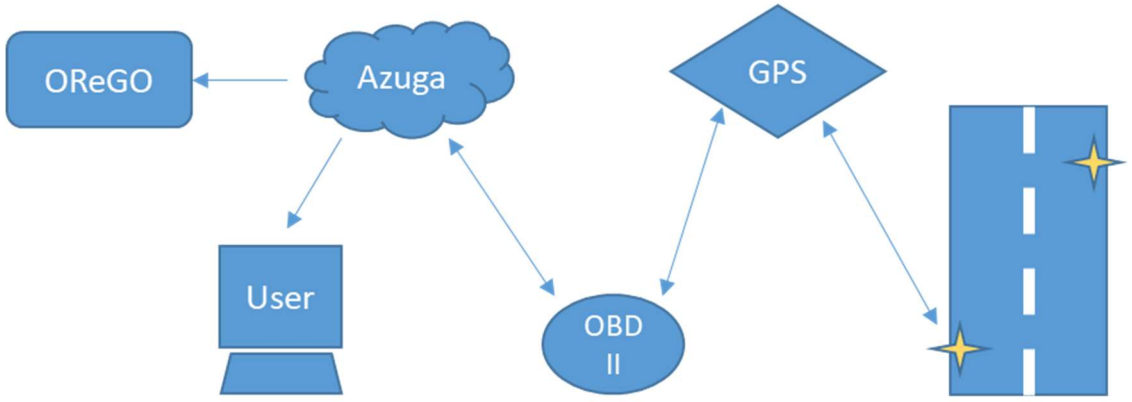
This report includes input from the business partners, Azuga and PRR, who each delivered evaluations of the pilot, as well as OReGO's assessments. The account manager's evaluation report is focused on technical observations and lessons. The outreach partner's report is based on the participant feedback throughout pilot to garner insight about their experiences and attitudes. Their evaluation report is oriented towards behavioral observations and statistics. The report will outline OReGO's overarching findings, recommendations and conclusions.

All reports are imbedded in this report and will be shared with FHWA and the RUC community of interest.

TECHNOLOGIES

The diagram below illustrates, in very simple terms, the key technical elements.

- Driving data is collected by the OBDII device in the driver's vehicle.
- GPS pings (between the GPS satellite and the OBDII device) provide the data-points to determine the geofence coordinates of the vehicle.
- Azuga's system processes the data at recurring intervals (1 or 15 seconds) and applies the proper rate based on the vehicle's pilot group and the vehicle's location.
- Azuga's customer portal presents the driving data and RUC charges
- Azuga transmits RUC data to OReGO



Azuga's Pilot Results Report in Appendix B Section 3.1 provides a much broader and detailed outline of the technologies used for this pilot. Below is a brief summary with excerpts from Azuga's Report:

1. OBDII device - OBD II plugin devices with GPS technology were utilized. For the pilot, Azuga increased the frequency of positioning data sent from the devices to accommodate the need for higher precision. This was necessary to determine the precise location and time that area or corridor boundaries are crossed to ensure complete and accurate accounting of driving activity within areas subject to local pricing.
2. The pilot required GPS technology to differentiate between positions within the boundaries at variable times of day and days of week. The GPS provided the data-points necessary for Azuga to discern positions in and outside of the geofenced boundaries.
3. Geofence System Logic – Azuga's system was configured to translate and process latitude and longitude points to determine a vehicle's position and within geofenced boundaries and to apply the applicable RUC rate.

To accommodate the geofence boundaries defined in the pilot requirements, a higher GPS location sampling frequency was necessary. This sampling rate enabled greater accuracy determining of the precise location and time at which area or corridor boundaries are crossed within pilot boundaries. This chart illustrates the sampling frequency when compared to OReGO's operational system.

	Sampling Frequency
Operational OReGO program	**30 seconds**
Area and Layered Area sub-pilots	15 seconds
Corridor sub-pilot	1 second

One second sampling was necessary for the corridor sub-pilot because of the relatively small footprint of corridor entry and exit points. At high speeds, it would be possible to miss an entry or exit if the sampling rate was any less frequent. The geofence sizes necessary to accommodate the detection of corridor entries and exits on highway entry and exit ramps are often limited to 200 feet in length. Vehicles traveling at higher speeds can pass completely through a geofence of this size if the sampling rate is at too low of a frequency.

While increasing the location sampling rates made it possible to achieve pilot objectives, there are some negative consequences. The amount of data that has to be transmitted, processed, and stored increases linearly with the sampling rate. This increases processing and storage cost as well as cellular transmission cost. Cellular transmission cost is the greater of these at this time.

PILOT OPERATIONS

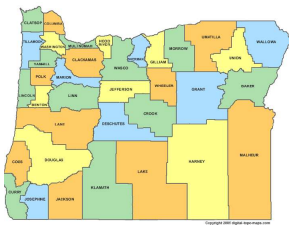
System Logic

Foundational to the system logic is the parsing of travel data and applying the appropriate RUC rate. When the program was developed, the concepts of Rule ID, Sub-Rule ID and Zone ID requirements were defined. These pilots were an opportunity to test and implement them.

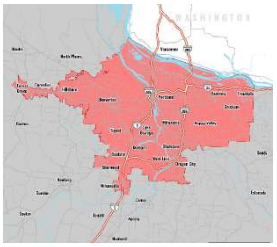
- Rule ID – identifier for each state or province in North America with geo-fenced boundaries where the RUC rate applies to that entire area
- Sub Rule ID – an identifier for a geographic area within a Rule ID, such as a political subdivision (county or city), which has a separate rate that is added to the Rule ID rate
- Zone ID – an identifier for a geographic area that may have different rates applied according to day/time/location, and which may be added to either of the other rates

Rule ID

Sub Rule ID



Zone Rule ID



This Rule Table essentially contains the business rules that correspond to each geo-fenced area. The table indicates the values for each ID, the corresponding rates, along with geographic areas and timeframes. Using GPS coordinates, at the pilot sampling rate (of 15 or 1 second), Azuga applied the appropriate rate as defined below:

Key	STATE / LOCATION	Admin ID	Rule ID	Sub Rule ID	Zone Rule ID	Priority	Description	RUC Rate	Credit Rate	Start Time	End Time
112	Oregon	OR	41	1	1	2	General miles within Oregon	0.017	0.34	0:00:00	23:59:59
113	Oregon	OR	41	2	1	1	Miles traveled off public roads within Oregon	0.000	0.34	0:00:00	23:59:59
114	No State / Undifferentiated	OR	00	1	1	2	Vehicle location cannot be determined	0.018	0.36	0:00:00	23:59:59
115	Oregon	OR	41	1	1	2	General miles within Oregon	0.018	0.36	0:00:00	23:59:59
116	Oregon	OR	41	2	1	1	Miles traveled off public roads within Oregon	0.000	0.00	0:00:00	23:59:59
117	Oregon	OR	41	3	1	1	Portland Metro Area: Peak Time Weekdays	0.050	0.00	7:00:00	9:59:59
118	Oregon	OR	41	3	2	1	Portland Metro Area: Peak Time Weekdays	0.018	0.36	7:00:00	9:59:59
119	Oregon	OR	41	4	1	2	Multnomah County: Peak Time Weekdays	0.060	0.00	7:00:00	9:59:59
120	Oregon	OR	41	4	2	2	Multnomah County: Peak Time Weekdays	0.018	0.36	7:00:00	9:59:59
121	Oregon	OR	41	5	1	1	Portland Central Business District: Peak Time Weekdays	0.120	0.00	8:00:00	10:59:59
122	Oregon	OR	41	5	2	1	Portland Central Business District: Peak Time Weekdays	0.060	0.00	8:00:00	9:59:59
123	Oregon	OR	41	5	3	1	Portland Central Business District: Peak Time Weekdays	0.018	0.36	8:00:00	10:59:59
124	Oregon	OR	41	6	1	1	Portland Corridor Routes: Peak Time Weekdays	0.100	0.00	16:00:00	18:59:59
125	Oregon	OR	41	6	2	1	Portland Corridor Routes: Peak Time Weekdays	0.018	0.36	16:00:00	18:59:59

Aggregated Monthly Local RUC is also presented on the Monthly Statement by zone:

Zone	Taxable Miles	Road Usage Charge
Multnomah	9.4	**$0.56**
Zone	Taxable Miles	Road Usage Charge
Multnomah(CBD)	2.5	**$0.15**
Zone	Taxable Miles	Road Usage Charge
Central business District	2.5	**$0.30**

Daily Local RUC trips are reported in the participant's Monthly RUC Statement:

Daily Activity Log Summary - Local RUC

Date	Zone	Taxable Mile	Daily RUC
12-29-2020	Multnomah	9.4	$0.56
12-29-2020	Multnomah(CBD)	2.5	$0.15
12-29-2020	Central business District	2.5	$0.30

The total Monthly RUC is deducted from the participant's account:

Statewide RUC

2012 Chevrolet Volt	$1.40

Local RUC

2012 Chevrolet Volt	$1.01
	$2.41

Wallet Balance

Beginning Balance	Activity	Amount	Final Balance
-$3.96	December RUC	-$2.41	-$6.37
			-$6.37

RUC Revenues

The aggregated RUC data is sent to OReGO's Administrative System. The simulated RUC revenues were broken out accordingly:

Jurisdiction	Name	March	April	May	June	July	August	Totals
State	**Statewide RUC**	**$ 352.35**	**$ 815.95**	**$1,068.34**	**$1,005.25**	**$1,049.53**	**$ 995.92**	**$5,287.34**
Area	Portand Metro (Area)	$ 118.54	$ 210.72	$ 194.38	$ 224.45	$ 219.51	$ 230.87	$1,198.47
Layered	Multnomah County	$ 76.92	$ 201.87	$ 185.48	$ 219.51	$ 196.25	$ 231.15	$1,111.18
Layered	Multnomah Co. + Central Business Dist.	$ 4.52	$ 16.15	$ 13.28	$ 20.35	$ 16.84	$ 17.30	$ 88.44
Layered	Central Business District	$ 1.53	$ 5.11	$ 4.49	$ 7.16	$ 5.04	$ 6.02	$ 29.35
Corridor	Corridor (Corridor)	$ 10.64	$ 32.02	$ 63.24	$ 54.04	$ 57.41	$ 50.10	$ 267.45
	Total Local RUC	**$ 212.15**	**$ 465.87**	**$ 460.87**	**$ 525.51**	**$ 495.05**	**$ 535.44**	**$2,694.89**

In the future, the data could be sent to a clearinghouse to be processed and distributed to jurisdictions rather than sending the data to OReGO and jurisdictions individually.

TECHNICAL OUTCOMES & OBSERVATIONS

Net Statewide and Local Charged by Month – excerpt from Azuga's Report

A total of $7,982.62 of net RUC (mileage charge minus fuel tax credit) was charged to the entire participant group across all three sub-pilots.

This breaks down into $5,287.34 charged for statewide mileage and $1,198.47, $1,229.36, and $267.45 for the Area, Layered Area and Corridor sub-pilots respectively. Layered Area charges comprise Multnomah County, Central Business District (CBD), and Multnomah County plus CBD combined. The highest total net RUC was charged in July ($1,544.58) due to higher statewide charges that month while the highest month for local RUC charges was August ($535.44) as a result of more travel in the Portland Metro Area and Multnomah County during peak hours. The Layered Area and Area sub-pilots outpaced the Corridor sub-pilot because Corridor trips were only charged for distances less than five miles on corridor roadways. This was designed to encourage throughput on those roadways.

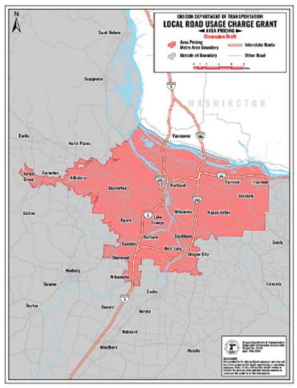
Name	Rule ID	Subrule ID	ZoneRule ID	March	April	May	June	July	August	Totals
Undifferentiated Net RUC	0	1	1	0.41	0.38	1.05	0.64	0.34	0.35	3.17
General OR Net RUC	41	1	1	330.89	772.46	1026.87	956.82	1004.65	941.48	5033.17
State Portland Metro Net RUC	41	3	2	13.17	24.62	20.88	26.11	24.66	28.91	138.35
State Mult. County Net RUC	41	4	2	6.97	16.33	15.10	18.45	15.91	22.00	94.76
State CBD Net RUC	41	5	3	0.30	0.62	0.54	0.76	0.57	0.74	3.53
State Corridor Net RUC	41	6	2	0.61	1.54	3.90	2.47	3.40	2.44	14.36
Statewide RUC (incl. Undifferentiated)				352.35	815.95	1068.34	1005.25	1049.53	995.92	**5287.34**
Portland Metro Net RUC	41	3	1	118.54	210.72	194.38	224.45	219.51	230.87	1198.47
Multnomah County Net RUC	41	4	1	76.92	201.87	185.48	219.90	196.25	231.15	1111.57
Mult. County + CBD Net RUC	41	5	1	4.52	16.15	13.28	20.35	16.84	17.3	88.44
CBD Net RUC	41	5	2	1.53	5.11	4.49	7.16	5.04	6.02	29.35
Corridor Net RUC	41	6	1	10.64	32.02	63.24	54.04	57.41	50.10	267.45
Local RUC				212.15	465.87	460.87	525.90	495.05	535.44	**2695.28**
Total Net RUC Charged				564.50	1281.82	1529.21	1531.15	1544.58	1531.36	**7982.62**

Sub-Pilot Technical Assessment

Introduction

At the completion of the Local Project, all parties involved concluded that RUC technology could support a Local RUC implementation. The current device model captured all travel, messages were accurately sent, and simulated tax monies were correctly allocated to appropriate mock jurisdictions in all three pilots. During the course of the project, however, several lessons were learned about each pilot.

Area Pilot
$1,198.47 RUC

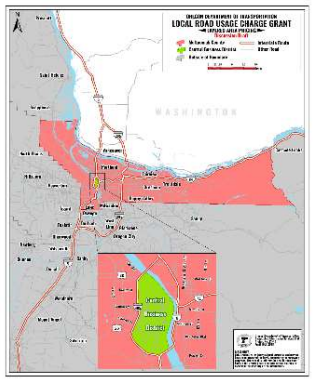


The Area pilot implemented the assessment of two tax levels in a specific area, proving that RUC is possible when geo-fencing a specific zone and applying new or different rules to only that zone. This RUC complexity could be useful in the future to assess a tax for travel in different counties, for instance, or for specific zones such as congestion, pollution, or construction zones. The area defined for the pilot, the Portland Metro area, was able to generate $1,198.47 of tax revenue during the course of the six month project from approximately 75 vehicles that could be filtered back into maintenance costs for that specific area if implemented in the live program.

While the geo-fencing of an area was successfully implemented, the integration of time of day was a bit more difficult to implement. Like the area boundary lines, time of day was precisely defined for the pilot for ease of implementation.

However, as the pilot operated it was discovered there were nuanced situations that were not accounted for. This suggests that defining business rules with more specificity is needed. For example, if a vehicle entered the boundary before the time of day, but continued to travel a significant amount within the boundary during the time of day hours, the pricing for hours in the zone were not included. Before the pilot implementation is considered for production complex business rules would need to be put in place to support the technology for accuracy and intent.

Layered Area Pilot
$1,229.36 RUC



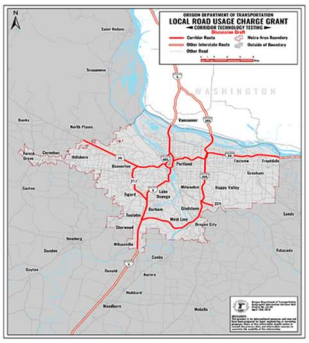
For the Layered Area pilot an additional layer of complexity was added, with three separate geo-fenced boundaries defined with three separate rates, and three separate on and off times of day. These layers imitated Oregon state, Multnomah County, and Portland Central Business District boundaries, proving that different jurisdictions can implement individualized rates and rules to fit their local needs within the current RUC system. Moreover, this pilot proves the overall scalability of the RUC system in general. An innumerable amount of municipalities could participate and their rates and rules could be accurately handled without system modifications. The areas defined for the pilot, were able to generate $1,229.36 of tax revenue during the course of the six month project from approximately 75 vehicles. A few mapping difficulties did emerge upon pilot execution, however.

To accurately define all three layers of boundaries, thousands of GPS points were defined and mapped, which proved to be unexpectedly labor intensive. Additionally, the mapping technology that was used during the project did not factor in elevation as a data point. While this typically is not an issue, a fact that was not considered was the number of many elevated intersections in Multnomah County and the Portland Central Business District. Though these inefficiencies did not have an impact on the overall RUC amount for this pilot, the viewable mapping faults could bring in to question the accuracy of the overall system from a participant's perspective. The business would need to take into account how this looks to a RUC payer and consider other available mapping technologies prior to implementing similar layered boundaries in production.

In addition, RUC programs would need to consider the participants' voiced concerns regarding equity in RUC implementation. When asked during the pilot, a few did remark that, for people who work in the Portland Central Business District, the current fees and time of day schedule seemed unfair. Several of these individuals also brought up that citizens who drive for a living, such as meal delivery drivers, could be charged a larger, disproportionate amount compared to others. This subset of people also tends to be paid a lower wage, exacerbating the potential inequity. A RUC Program would need to mitigate this perception in some manner to address equity concerns.

Corridor Pilot

$267.45 RUC



As the most complex pilot of the project, the Corridor pilot implemented mock charges for entering and exiting main thoroughfares identified within the area for short distances. The identified corridors for implementation were highways within the Portland Metro area. The maximum distance chosen to be priced was five miles, meaning that any vehicle traveling a distance over five miles on the corridor did not accrue the charge. The intent was to focus on the heaviest traveled roadways during the densest traveled hours and see if RUC charges would have an impact on driving behavior for those who are local and not commuting. It was also seen as a way to encourage through traffic on those corridors and to discourage on/off trips. Once again, the technology was able to handle identifying entry and exit points and length of travel all within the pilot definitions.

The simulated tax revenue during the pilot was $267.45 over the course of the six month pilot from approximately 75 drivers. While this amount is significantly less than the other pilots because of the limiting rule definitions, the participants involved in the project showed overwhelming support for the possibility that those funds could go directly to maintain that specific corridor. This suggests that tolling could reside on the same technology platform as a RUC program.

Due to the extreme complexity of this pilot, many problems were solved and lessons were learned during implementation. Similar to the Layered Area pilot, mapping accuracy was the greatest hurdle. The implementation approach was to define every on and off ramp of the identified corridors to then trigger a calculation for distance traveled. This again required thousands and thousands of GPS points to be manually defined. Furthermore, the same mapping technology was used as in Layered Area, leaving out the element of elevation. Because nearly all entry and exit points to the identified interstates in Oregon are part of an overpass or underpass, and because these points did impact the RUC calculations, this posed the largest challenge to the project. The suggested mitigation was to implement "Course Over Ground," a proprietary algorithm developed by a business partner that takes the direction of travel provided by the vehicle's device and compares that with the defined geo-fences and angle of possible travel within the geo-fence to determine the specific roadway being traveled. Upon reflection, the project team acknowledges that the chosen implementation method could be reimagined to design a more manageable and efficient utilization. The technology, however, operated flawlessly with the given definitions.

Another hurdle that was discovered during the pilot was the acquisition of traveled GPS points. For the current RUC program, traveled GPS points are obtained only every 30 seconds, which has proven to be highly accurate for current needs. However, with more finite boundary definitions in this pilot it was determined that travel GPS points needed to be acquired more frequently – like every 15 seconds. Once the pilot was executed with this change, analysis still began to identify missed entry points for the

Corridor pilot. Upon deeper analysis it was discovered this was due to the high rate of acceleration typical at an onramp to the identified roadways. To combat this, travel GPS acquisition was increased to every second. This eliminated all missed entry points and was a viable solution for the Corridor pilot. However, due to the increase in frequency, the amount of data obtained and stored by the business partner skyrocketed, along with costs. Before any implementation into the program is considered, different solutions should be contemplated to limit the increased data storage costs.

Technology Lessons - Azuga's Pilot Results Report

Precise geofence definitions

In some cases, it is necessary to include thousands of points to accurately define a single area of interest. The Area sub-pilot encompassing the Portland metro area was one such case. It was also critical to be able to position geofences at the exact locations used to enter and exit roadways for the Corridor sub-pilot without encroaching on other roadways. Otherwise, false corridor entry and exit events could occur.

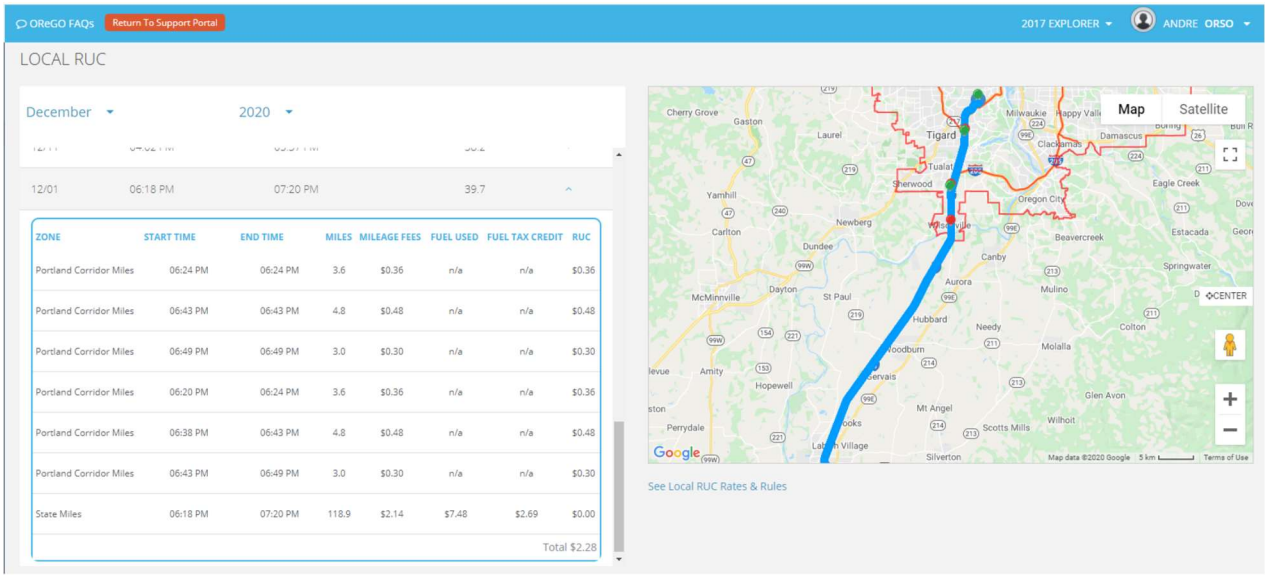
Course over ground

The Corridor sub-pilot presented a few notable challenges with regard to detecting corridor entry and exit events accurately and consistently on certain roadways. One challenge was that some roadway entry and exit points were extremely close to roadways going in the opposite direction, often directly adjacent. The proximity was sometimes so close that a phenomenon called GPS drift could result in the appearance that the vehicle was on the adjacent roadway triggering a false entry or exit event.
A related problem was that other roadways not part of a designated corridor road sometimes pass under or over the corridor entry or exit locations. Examples include overpasses and underpasses or stacked highways. Geo-fences are two dimensional and cannot account for altitude differences, so traffic traveling on roadways that pass under or over a designated corridor road can trigger false geofence entry or exits.

The solution Azuga developed was to utilize direction of travel information (course over ground) provided by the plug in devices coupled with advanced geo-fences that include parameters defining the range of angles a vehicle can travel within the geofence.

Mapping capabilities

A key requirement for the pilot was to render the exact paths traveled by individual vehicles on graphical road maps within the online customer portal provided to participants to access account and road usage information. The higher GPS sampling rates enabled Azuga to switch to point by point mapping thus rendering higher accuracy than can be achieved by mapping services like the Google Maps API. These services use heuristic rules to deduce the path of travel on roadways and can occasionally pick the wrong path between two known points if there are multiple possibilities. The blue line on the map in the image below is a rendering of all points collected for a particular Corridor sub-pilot trip. GPS points were provided every second in this case.



Technical Conclusions

From a technical feasibility standpoint, the pilot concluded that the core technology can support mileage collection at a jurisdictional level. Complex business rules would need to be developed, including any related to equity. Another topic to be addressed is that of scalability.

The Corridor pilot proved to be the most challenging of the 3. In general, more work would be needed capture distances at a granular level to apply RUC rates to finite geo-fenced boundaries. Technical challenges to be addressed are the sampling rates due to the amount of data that must be transmitted, processed, and stored. They will increase linearly with the sampling rate. This increases processing and storage costs as well as cellular transmission cost.

As with most burgeoning technologies, there will be some gaps and spottiness when power levels drop low enough. At that time the device may behave as if the device has been disconnected. In addition, cellular communications capabilities can drop to zero in underground parking garages, especially multiple levels below ground.

More technological details are contained in Azuga's Local RUC Pilot Results Report.

OReGO Local Road Usage Charge Pilot

RESEARCH OUTCOMES AND OBSERVATIONS

OReGO determined that 75 active participants in each sub pilot would provide an appropriate pool and sample size for the demonstration. OReGO partnered with PRR to recruit the 225 participants and maintain the minimum required pool. To account for attrition throughout the pilot PRR over-recruited (achieving 251 participants).

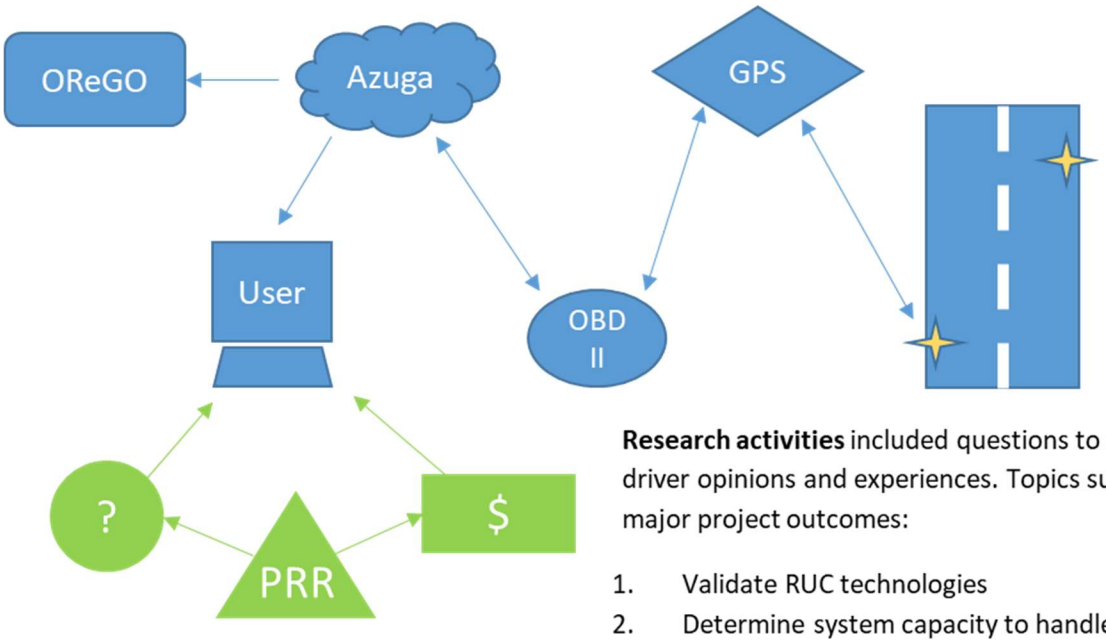
PRR used multiple methods to reach and recruit potentially interested and eligible participants in the study area:

- Geo-targeted digital/social media advertising
- Postcard mailing to 40,000 randomized households within the Portland Metro Area
- Outreach to a vetted list of 20 community-based organizations (CBOs) and compensation at $200 per CBO for help with recruitment

Of the 2,649 people who completed the screener survey, 1,468 of them met basic qualifications such as owning a vehicle that was compatible with the device and driving in a least one of the designated sub-pilot areas.

Financial incentives were a key component to encouraging people to participate and stay in the pilot study. Every participant could earn up to $450 for full participation. They earned $50 for plugging in the device, $25 for each of the 14 activities they completed, and another $50 for returning the device at the end of the study.

All 14 activities included a mix of open-ended and closed-ended questions, including questions where participants could upload images and videos to share more about their experiences. All research participants saw and responded to identical activities and questions.

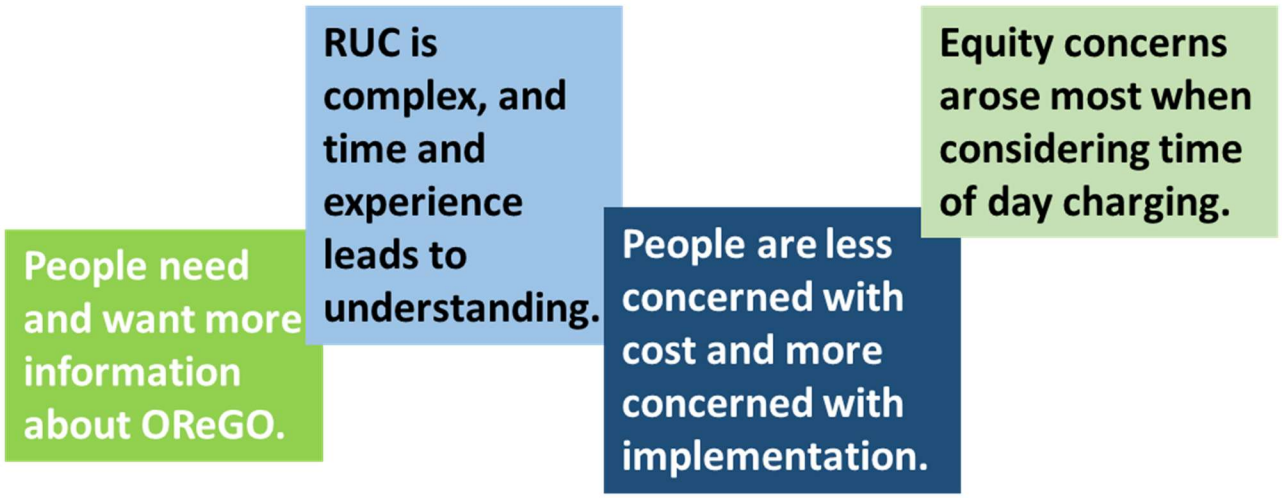


Research activities included questions to understand driver opinions and experiences. Topics support three major project outcomes:

1. Validate RUC technologies
2. Determine system capacity to handle multiple jurisdictions
3. Identify gaps to be addressed in the future.

Research Assessments

Some questions were asked more than once to gauge changes in opinions as Participants became more informed and familiar with RUC. Responses were analyzed by researchers and organized into the following Key Findings:



Questions were categorized (left column). The PRR research team distilled Key Findings derived from the responses and presented observations and recommendations by topics (right column), summarized as follows:

Attitudes: • Would this local pricing option change people's driving behavior? Why or why not?	Behavior change due to Local RUC • Travel frequency did not change • Many found potential RUC affordable to their driving

• Did the local pricing option change their perception of RUC?	• Most expect RUC unlikely to affect their trips or travel behavior but 25% would change their travel behavior Support for RUC and tolling • Education changes options – Many said their thinking changed through learning about transportation funding • Support for variable tolling is mixed • Most were favorable to RUC pricing (express it was less than what they expected • Equity in implementation for low income individuals – how would the pay
Audiences: • Who chooses to participate, and why? • Who doesn't choose to participate (drops out), and why?	• Participants were demographically representative of the people in the Portland metro area • Participants expressed they found the study to be fulfilling way to contribute to the future of Oregon • Most were motivated by money • Most were comfortable sharing data
Barriers: • What obstacles do drivers encounter? • How do drivers overcome barriers?	• Device installation was an issue for some – 75% were satisfied • Participants don't want 2 devices (RUC and tolling) • Many had confusion and uncertainty about RUC Account summary of charges • Zone pricing was too confusing • Of the 3 pilots more in the Area pilot expressed support
Experience: • How do drivers experience local road charging? • What did they learn about OReGO and transportation funding?	• Participants learned about transportation funding and complexities and many agreed there aren't enough funds to meet the need • While travel frequency didn't change, participants thought more about their driving behaviors • Many found the RUC Statements and RUC reporting on the User portal to be confusing
Information Needs: • What do drivers want/need to know at each key operational step for understandability?	• Over half found it easy to understand the concept of charging based on zones • Participants wanted more support and customer service options • Over time and with resources Participants understanding about RUC improved • People expressed concerns about data usage and protection

Opportunities:

- What do they like about OReGO and local RUC?
- What aspects are useful, understood, and supported? How can ODOT meet these needs in future applications of Local RUC?

- Improve how we explain the breakdown of the RUC process/fees and be consistent with terminology across partners
- Emphasize the concepts that participants liked about RUC (fairness, affordable and lead to more informed driving)
- Revisit messaging and material about data and privacy (emphasizing stored/used safely)
- Equity concerns were most commonly related to drivers with low incomes and people who drive to work

Research Lessons

The primary outcomes and opportunity for improvement themes are summarized:

- Simplify the RUC on-boarding process and seek a one device solution (when necessary)
- Improve explanations and user support to strengthen their understanding of RUC fees and how they are calculated
- Strive for more consistent RUC terminology across partner platforms
- Strengthen messaging about fuels tax versus RUC and the fairness of RUC
- Improve messaging about how data is secured, used and by whom
- Address equity concerns openly and with creative solutions
- Provide tools that intuitively inform people where their money goes and their investment in maintaining state and local roads

Research Conclusions

RUC Users can see the value and equity in RUC as an alternative to fuels tax as electric vehicles become ubiquitous. Participants were able to grasp the concept of RUC combined with tolling and the benefits of both coexisting on the same platform. RUC Users understood the basic concepts of zone pricing and need. People are interested in transportation and want to help contribute to solving funding issues and road sustainability.

PRR Executive Summary

OReGO Local RUC_Executive Sumr

More details can be found in PRR's report

OReGO Local RUC Pilot Research Repo

FINAL CONCLUSIONS

This pilot demonstrated that zone pricing can technically be supported. Given time and experience, participants gain familiarity. As that occurs, participants gain an understanding of how roads are funded and then in turn often support funding roads. They also support the jurisdictions that maintain them.

OReGO recommends any near term pursuit of zone pricing start with a more simplistic technical option such as the Area or Layered Price models. This would better accommodate shoring up the funding gap from a technical perspective while allowing more time for technical maturity.

Furthermore, OReGO recommends that a zone price implementation is preceded with careful planning and consideration given to addressing the current technical limitations and opportunities uncovered through this project's research findings and lessons learned. Complex business rules will need to be developed and scalability addressed. Equity is a consistent concern that will need to be addressed through research. An Equity Study is underway that may provide valuable insights and illuminate next steps.

Appendix A – Terms and Acronyms

Term / Acronym	Definition
AM	Account Manager
BP	Business Partner
FAST Act	Fixing America's Surface Transportation Act: Grant that enabled OReGO Program to conduct this project
FHWA	Federal Highway Administration: Entity administering the FAST Act grant
GPS	Global Positioning System
Geofence	The use of GPS or RFID technology to create a virtual geographic boundary, enabling software to trigger a response when a mobile device enters or leaves a particular area.
ODOT	Oregon Department of Transportation: A department of the state of Oregon responsible for providing a safe, efficient transportation system that supports economic opportunity and livable communities for Oregonians.
OReGO	Oregon's RUC Program
RUC	Road Usage Charge: A mechanism to tax on miles driven by a vehicle on public road, and used to fund the transportation infrastructure.
RUC West	(Formerly Western Road Usage Charge Consortium) RUC West brings together leaders from state transportation organizations to share best practices and research Road Usage Charge.
RUCAS	Road Usage Charge Administration System: The system used by the OReGO Program team to administer and manage the Road Usage Charge program.
STIP	Statewide Transportation Improvement Plan
STSFA	Surface Transportation System Funding Alternatives: Program under FHWA that provides grant funding
TWG	Technical Working Group

Exhibit A

Local
RUC_M060S-Project_

Exhibit B

OReGO Local Road
Usage Charge Pilot