

Smart Grid Integrated Digital License Plate

Acceptance Test Demonstration Report

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This report is submitted in partial fulfillment for the final year Capstone Project in the Faculty of Engineering and Applied Science.

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Abstract

In recent years, it has become evident that traditional license plates have many flaws such as security, durability, and functionality. Current license plates have proven time and time again that it is time for an update. The world is quickly going digital as technological advancements are being made every day. License plates have not yet caught up to the times. A smart digital license plate would be a tremendous upgrade moving into this electric and digital world. Current technologies such as displays, communications, and electric vehicles have created a possibility for revolutionary smart digital license plates with features such as theft detection, renewal updates, smart grid integration, and web information access. It includes all the design aspects of the smart grid-integrated digital license plate. It contains all the test cases that will be conducted to ensure the proper function and safety of the product. Furthermore, during the concept generation, we found it feasible to program the digital license plate on a Raspberry Pi. It was also found logical to power the system using a rechargeable power bank. The system will also utilize a GPS module alongside a RFID tag and reader to support anti-theft measures. Moreover, the assembly of the product will be enclosed in a 3D-printed case designed using SolidWorks. Finally, the integration of a website will be included to manage all the smart features.

Dedication

We would like to dedicate this report to each of our group members' families who have continuously supported us throughout the university in both moral and material needs. Moreover, we would like to dedicate this report to all our professors, peers, and friends for their consistent encouragement and motivation.

Acknowledgments

We would like to express our gratitude to our supervisor Dr. Tarlochan Sidhu who made this project possible. With his guidance, we were able to get a thorough understanding of the project and how to execute our ideas. His continuous support fed our ambition to take this project above and beyond.

We would also like to acknowledge our capstone coordinator Dr. Vijay Sood. He was able to give us a strong detailed understanding of producing reports and how to have a complete presentation on our project.

Our sincere appreciation to Dr. Sheldon Williamson for offering his knowledge and guidance with this project. In our first meeting, he provided us with many ideas on smart grid technology and possible recommendations on how to implement them.

Lastly, we would like to thank our friends and family for their continued support and encouragement throughout our final year.

We will be forever grateful for this capstone project as it has not only challenged us but helped us understand the process of designing, testing, building, and implementing a product from start to finish.

Table of Contents

Abstract	2
Dedication	3
Acknowledgments	4
Table of Contents	5
List of Figures	6
List of Tables	7
List of Acronyms Used	8
1 Introduction	9
2 Acceptance Testing	10
2.1 Completion of Acceptance Tests & Results	10
2.2 Summary of Acceptance Testing.....	47
2.3 Stakeholder Requirements	49
2.4 Updated Traceability Matrix	50
3 Contribution Matrix	51
References	52

List of Figures

N/A

List of Tables

Table 2.0: Test Case #1 – User Account Creation	10
Table 2.1: Test Case #1 Results	11
Table 2.2: Test Case #2 – User Design	13
Table 2.3: Test Case #2 Results	14
Table 2.4: Test Case #3 – User Plate Renewal Payment	16
Table 2.5: Test Case #3 Results	17
Table 2.6: Test Case #4 – User Energy Payment	20
Table 2.7: Test Case #4 Results	21
Table 2.8: Test Case #5 – User Updates Personal Information	24
Table 2.9: Test Case #6 – License Plate Tracking	25
Table 2.10: Test Case #6 Results	26
Table 2.11: Test Case #7 – License Plate Removal	28
Table 2.12: Test Case #7 Results	29
Table 2.13: Test Case #8 – Application Database Refresh	32
Table 2.14: Test Case #8 Results	33
Table 2.15: Test Case #9 – Vehicle Stolen Mode	36
Table 2.16: Test Case #9 Results	37
Table 2.17: Test Case #10 – Notification for unauthorized User	40
Table 2.18: Test Case #10 Results	41
Table 2.19: Test Case #11 – User Selects Displayed Plate	42
Table 2.20: Test Case #11 Results	43
Table 2.21: Summary of Acceptance Tests	47
Table 2.22: Stakeholder Requirements Specifications	49
Table 2.23: Updated Traceability Matrix	50
Table 3.0: Report Contribution Matrix	51

List of Acronyms Used

Acronym	Meaning
12V	12-Volt
3D	Three Dimensional
CVV	Card Verification Value
FEAT	Feature
GPS	Global Positioning System
ID	Identification
LCD	Liquid Crystal Display
N/A	Not Applicable
RFID	Radio Frequency Identification
STRQ	Stakeholder Requirement
TC	Test Case
VIN	Vehicle Identification Number

1 Introduction

This capstone project aims to create a smart digital license plate that will present an innovative design for displaying all the requirements needed for a traditional license plate on a digital screen with the integration of smart grid and various other improvements. Given current technological advancements, it is highly possible to add features that allow clients to be kept updated on all current information and alerts such as theft, battery life, plate renewal, etc., all while being visually appealing. The digital license plate will be used to display the characters needed for a legal license plate, clearly for any law enforcement to read and customize in any way of the owner's choosing. A website is available for all the services a user might need, such as fulfilling the requirements to renew a vehicle owner's license plate, tracking where the license plate is and whether it has been removed/stolen.

This report will include a concept analysis to show the required key components for our prototype and some viable options we can eliminate. A system design will be provided to clearly outline the software aspect of the project, with diagrams explaining how everything will operate and coordinate for the system to run. Furthermore, visuals for a website example, using a wireframe, will show how the actual website will look and specify how a user can navigate around the services. An electrical design will give a visual representation of how the license plate circuit will operate and the connections it has with every component, along with other circuit diagrams of how the plate features will work. Multiple integration testing will be done to explain where the software aspects can be logically integrated and tested. The test will describe the scenario, and procedures being taken, alongside the expected result. A cost breakdown will also be provided with information on all parts.

Problem Statement

Many advancements have been made in technology and there is no reason for vehicles today not to be equipped with smart license plates. The current license plates endure issues such as peeling, theft, and readability. Moreover, the province of Ontario had recently updated its plates to blue ones with a new slogan. The goal was to refresh the plates and solve the peeling issue but, instead, it made matters worse as law authorities found it difficult to see the plates at night as they were not reflective. These new plates cost the province about one million dollars and shortly after were discontinued [1]. Introducing a smart digital license plate would automatically eliminate all the problems with the current license plates. Furthermore, designing, integrating, and implementing digital license plates would not only save the province issues like legibility at night, but also create cost-effective solutions for plate updates in the future.

Overview of the Report

The remainder of this report will outline all the acceptance testing that we have conducted in order to ensure the proper functionality of the prototype. It also contains the stakeholder requirements along with the updated traceability matrix.

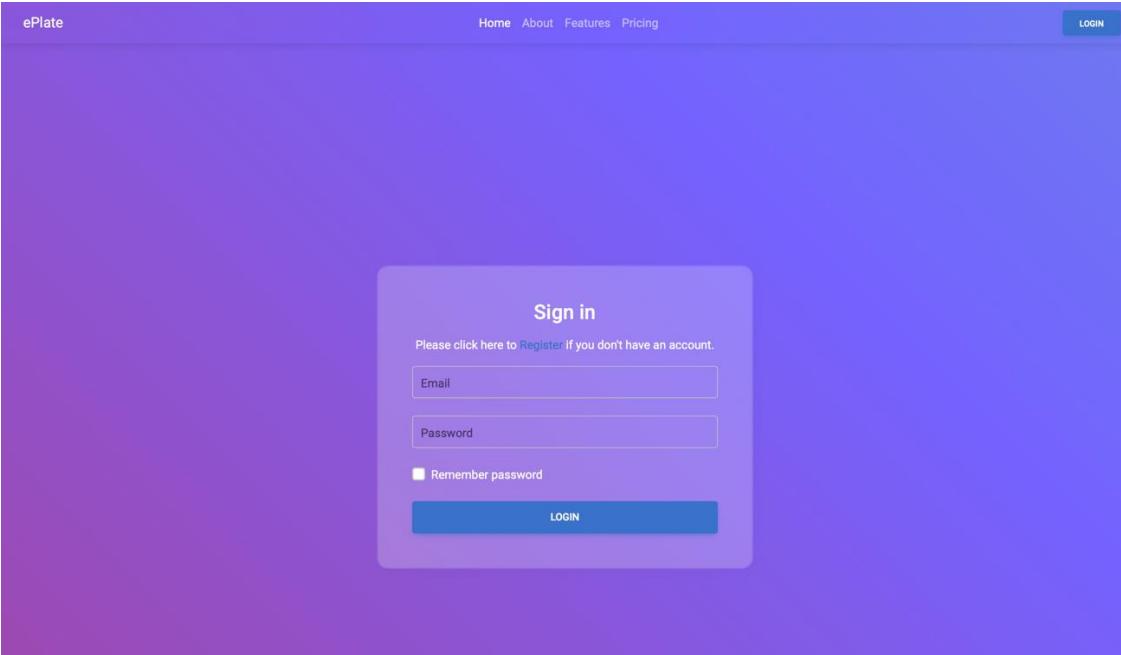
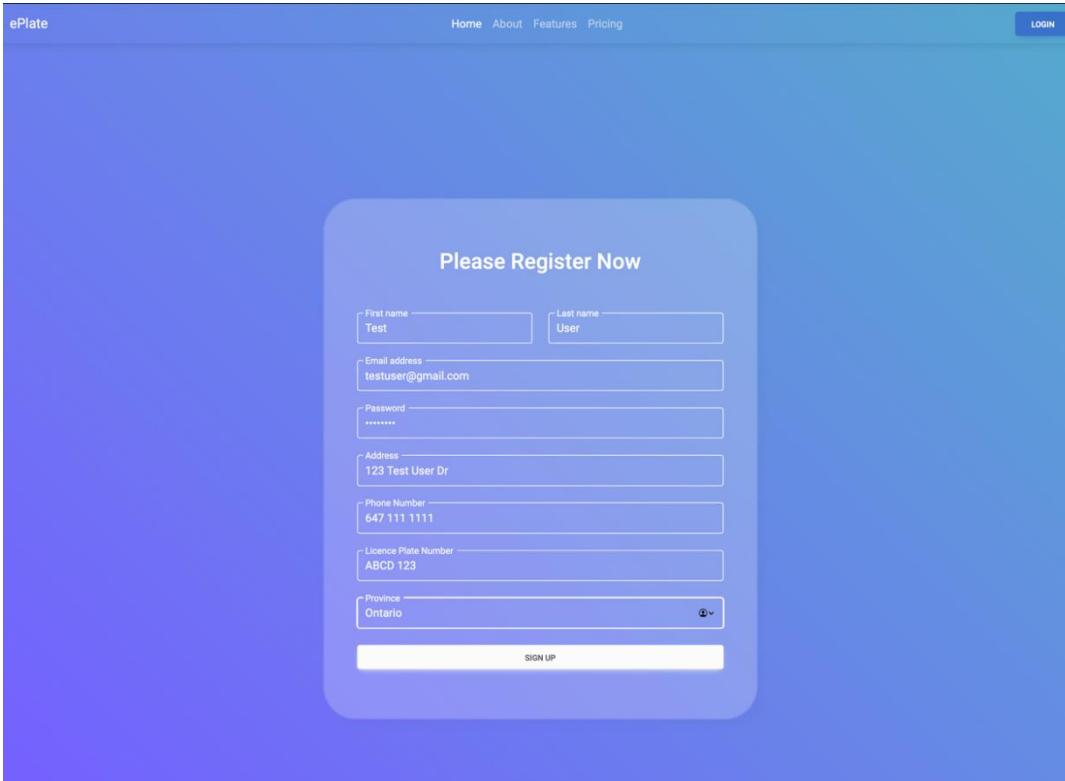
2 Acceptance Testing

2.1 Completion of Acceptance Tests & Results

Table 2.0: Test Case #1 – User Account Creation

Test Writer:	Abdul Bhutta, Emran Soltani, Kumail Syed, Walid Ayub, Yussef Elzein			
Test Case Name:	TC #1			Test ID: Smart-TC-01
Description:	The user will register to create an account.			Type: Black Box: <input checked="" type="checkbox"/> White Box: <input type="checkbox"/>
Tester Information				
Tester Name:	Abdul Bhutta, Walid Ayub			Date: 03/04/2023
Environment:	The acceptance testing will be done on a web browser. (Google Chrome, Safari)			Time: 1:30 PM
Steps	Action	Expected Results	Pass	Fail
1	User Access Login Page and Clicks on Register	The application has redirected the user from the Login page to the Registration page	✓	
2	User inserts personal information	All characters are displayed according to the requirements	✓	
3	User will be directed to a portal page	The application will display the Dashboard	✓	
4	Verify the user has been added to the database	The user information has been added to the database	✓	
Test Result:			✓	

Table 2.1: Test Case #1 Results

<i>Step 1: User Access Login Page and Clicks on Register</i>
 <p>The screenshot shows the ePlate website's login page. At the top, there is a navigation bar with links for Home, About, Features, Pricing, and a blue 'Login' button. A central modal window titled 'Sign in' contains fields for Email and Password, a 'Remember password' checkbox, and a blue 'LOGIN' button. Below the modal, a link text 'Please click here to Register if you don't have an account.' is visible.</p>
<p><i>Step 2: User inserts personal information</i></p>  <p>The screenshot shows the ePlate website's registration page. At the top, there is a navigation bar with links for Home, About, Features, Pricing, and a blue 'Login' button. A central modal window titled 'Please Register Now' contains fields for First name (Test), Last name (User), Email address (testuser@gmail.com), Password (*****), Address (123 Test User Dr), Phone Number (647 111 1111), Licence Plate Number (ABCD 123), and Province (Ontario). A blue 'SIGN UP' button is at the bottom of the form.</p>

Step 3: User will be directed to a portal page

The screenshot shows the ePlate portal homepage. At the top right, there are links for Home, About, Features, Pricing, and a blue 'LOGOUT' button. On the left is a sidebar with a 'Dashboard' tab (which is active and highlighted in blue) and other options: My Profile, Energy Consumed, Renew Licence Plate, and Vehicle Information. The main content area is titled 'Welcome Test User'. It features several cards: 'Sticker Information' (ABCD 123), 'Renew Now' (button), 'Stolen Mode' (Not Active), 'Energy Consumption' (Due in 21 days, PAID), and 'Current Location' (Ontario Tech University).

Step 4: Verify the user has been added to the database

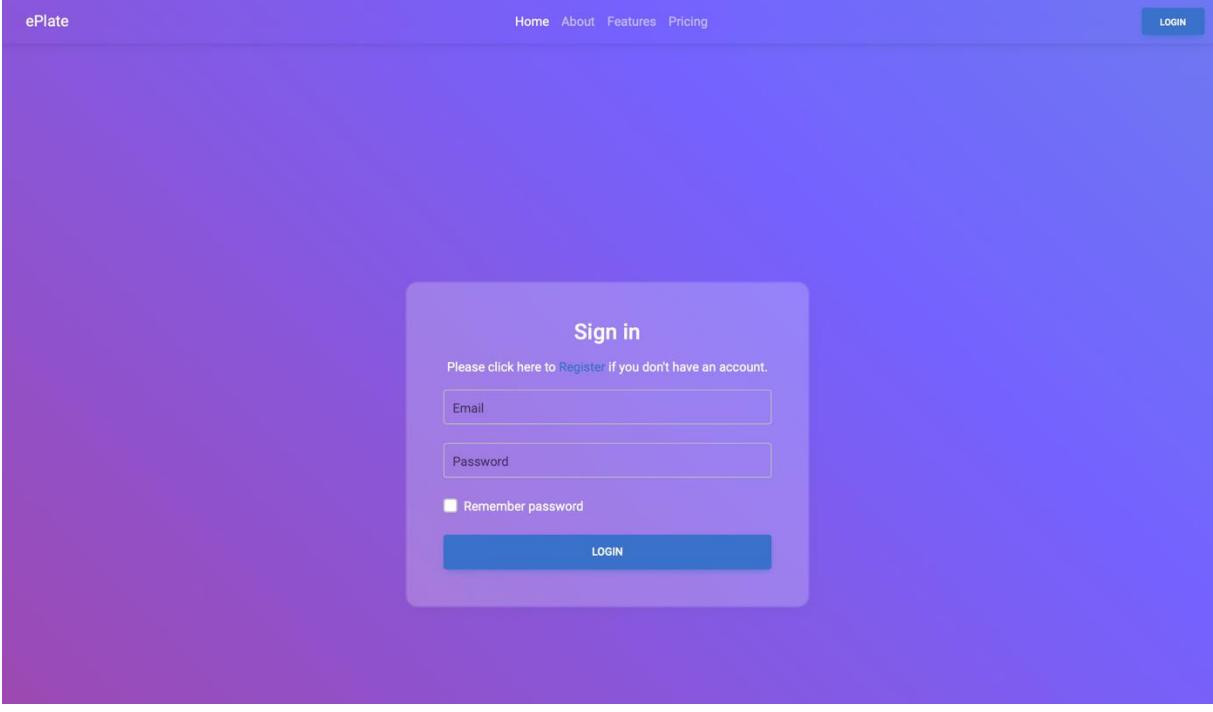
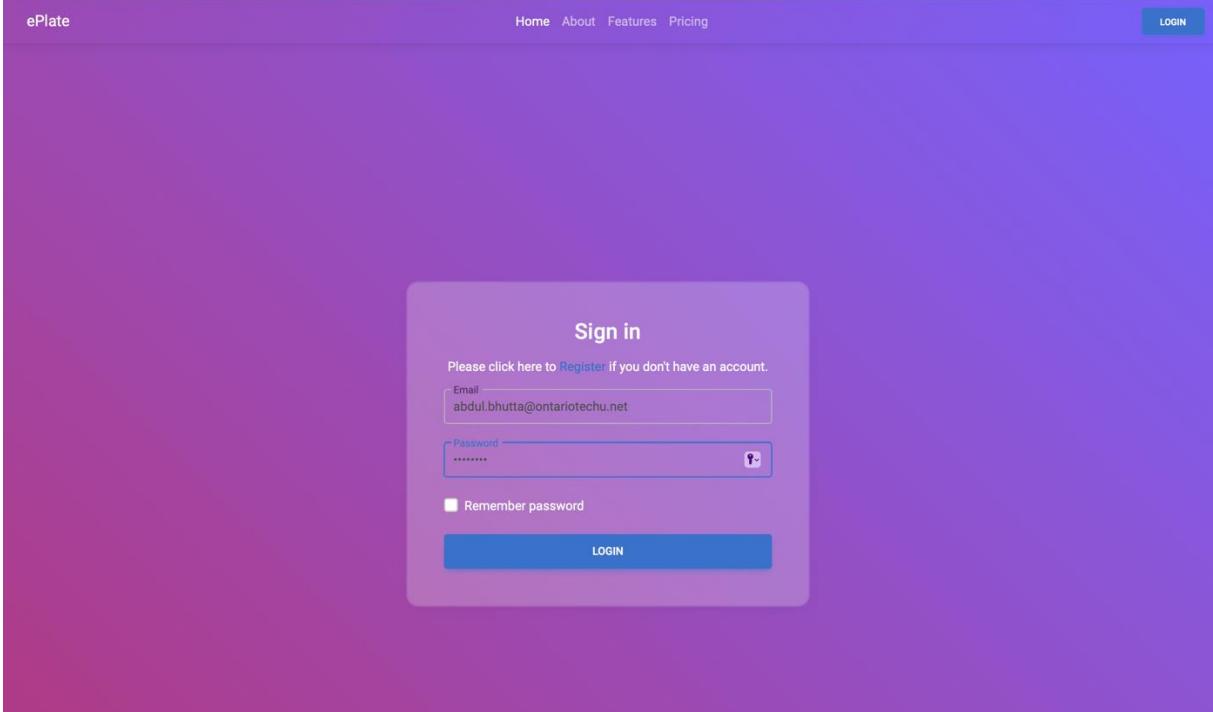
The screenshot shows the SSMS interface with the 'dbo.Users_1' table selected. The table has columns: FirstName, LastName, Password, EmailAddress, LicencePlate, Province, PhoneNumber, ReceiverSerial, Stolen, StickerDate, and VINNumber. There are three rows of data:

	FirstName	LastName	Password	EmailAddress	LicencePlate	Province	PhoneNumber	ReceiverSerial	Stolen	StickerDate	VINNumber
1	Abdul	Bhutta	password	abdul.bhutta@...	ABCD 555	ONTARIO	647-512-1111	X003EA3B41	0	DEC 2023	xxxx x:i
2	Test	User	password	testuser@gmai...	ABCD 123	Ontario	647-111-1111	xxxx xxxx	0	MAY 2023	xxxx x:i
3	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

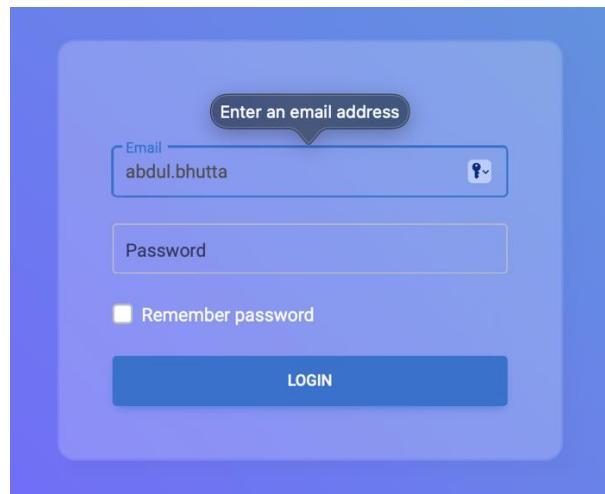
Table 2.2: Test Case #2 – User Login

Test Writer:	Abdul Bhutta, Emran Soltani, Kumail Syed, Walid Ayub, Yussef Elzein			
Test Case Name:	TC #2		Test ID:	Smart-TC-02
Description:	The User shall log in with a user ID and password.		Type:	Black Box: <input checked="" type="checkbox"/> White Box: <input type="checkbox"/>
Tester Information				
Tester Name:	Abdul Bhutta, Walid Ayub		Date:	03/04/2023
Environment:	The acceptance testing will be done on a web browser. (Google Chrome, Safari)		Time:	2:30 PM
Steps	Action	Expected Results	Pass	Fail
1	Access Login Page	The application will display the Login page	✓	
2	Enter authorized credential	All inputs have been filled with its requirements	✓	
3	Verify if user enters an email without entering an email address	The application notifies user that the email address provided does not meet the requirements	✓	
4	Verify the user cannot access dashboard with an incorrect username/password	The application notifies user that it has provided incorrect username or password	✓	
5	Verify an authorized user has access to the portal page	The application has redirected the user to the Dashboard	✓	
Test Result:			✓	

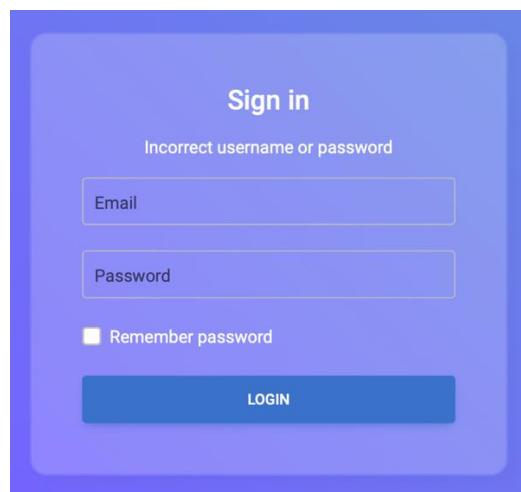
Table 2.3: Test Case #2 Results

<i>Step 1: Access Login Page</i>	
 A screenshot of the ePlate website's login page. The page has a light blue header with the "ePlate" logo on the left and navigation links "Home", "About", "Features", and "Pricing" on the right. A "LOGIN" button is located in the top right corner of the header. The main content area features a central "Sign in" form with rounded corners. It includes a registration link, two input fields for "Email" and "Password", a "Remember password" checkbox, and a large blue "LOGIN" button at the bottom.	
<i>Step 2: Enter authorized credential</i>	
 A screenshot of the ePlate website's login page, identical to the first one but with user input. The "Email" field contains the value "abdul.bhutta@ontariotechu.net". The "Password" field contains several dots, indicating a password has been entered. All other elements of the form and the surrounding page remain the same.	

Step 3: Verify if user enters an email without entering an email address



Step 4: Verify the user can not access dashboard with an incorrect username/password



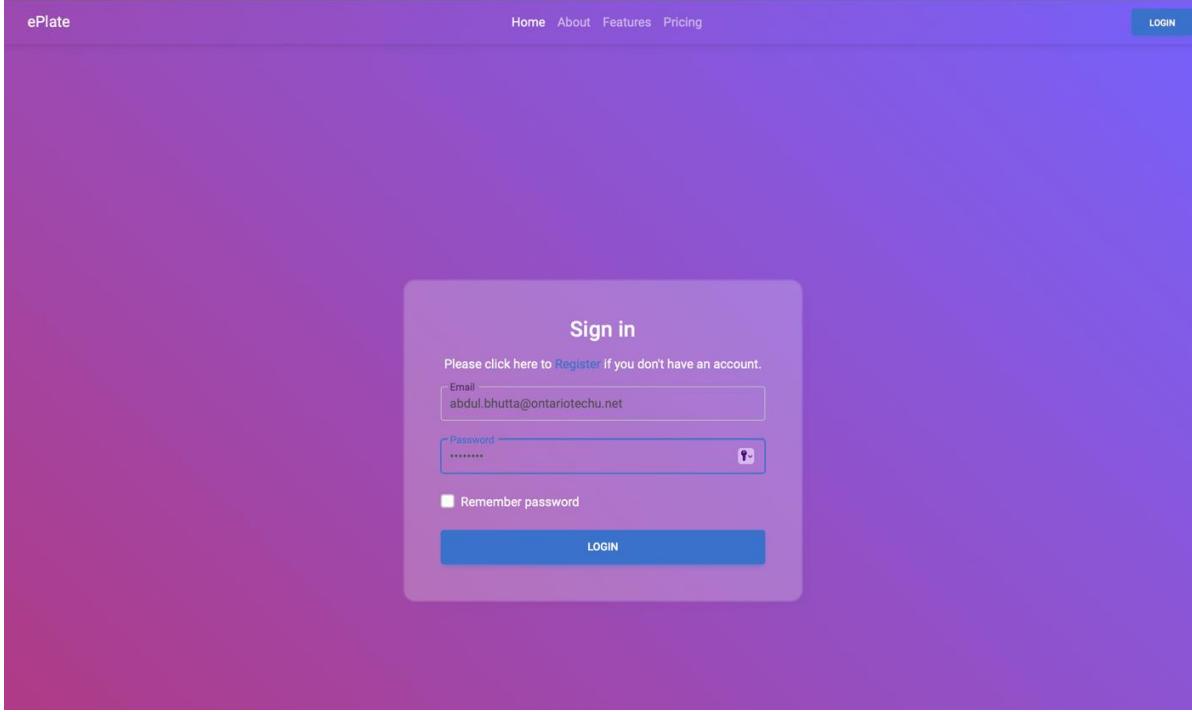
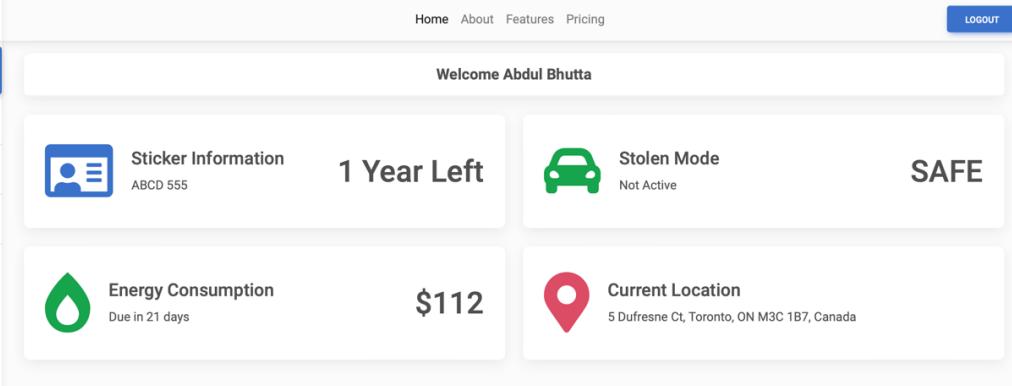
Step 5: Verify an authorized user has access to the portal page

A screenshot of a dashboard page. On the left is a sidebar with "ePlate" at the top, followed by "Dashboard" (selected), "My Profile", "Energy Consumed", "Renew Licence Plate", and "Vehicle Information". The main content area shows "Welcome Abdul Bhutta". It features several cards: "Sticker Information ABCD 555" with a "Renew Now" button, "Stolen Mode Not Active" with a green car icon and "SAFE" status, "Energy Consumption Due in 21 days" with a green leaf icon and a price of "\$112", and "Current Location 5 Dufresne Ct, Toronto, ON M3C 1B7, Canada" with a red location pin icon.

Table 2.4: Test Case #3 – User Plate Renewal Payment

Test Writer:	Abdul Bhutta, Emran Soltani, Kumail Syed, Walid Ayub, Yussef Elzein					
Test Case Name:	TC #3			Test ID:	Smart-TC-03	
Description:	The user shall be allowed to renew the license plate if no charges on the account.			Type:	Black Box: <input checked="" type="checkbox"/> White Box: <input type="checkbox"/>	
Tester Information						
Tester Name:	Abdul Bhutta, Walid Ayub			Date:	03/04/2023	
Environment:	The acceptance testing will be done on a web browser (Google Chrome, Safari)			Time:	4:45PM	
Steps	Action	Expected Results	Pass	Fail	N/A	Comments
1	User logins with authorized user	All inputs have been filled with its requirements and redirected to the dashboard page	✓			
2	Access Renew License Plate Page	The current page will be redirected to the Renewal page	✓			
3	User clicks on renew now button	Renewal pages displays all information, and the user renews his plate	✓			
4	A confirmation message will appear	A confirmation message is displayed for the user	✓			
5	Renewal update should be reflected on the page	Renewal update is displayed on the page	✓			
6	Verify sticker date on the plate	Sticker has been updated on the plate	✓			
Test Result:			✓			

Table 2.5: Test Case #3 Results

Step 1: User logs in with authorized user	
	
Step 2: Access Renew License Plate Page	
	

Step 3: User clicks on renew now button

The screenshot shows the ePlate application interface. On the left is a sidebar with navigation links: Dashboard, My Profile, Energy Consumed, Renew Licence Plate (which is highlighted in blue), and Vehicle Information. The main content area is titled "Renew Licence Plate". It contains three sections: "Plate Information" (with icons of a person and a document), "Bill Payments" (with icons of a dollar sign and a document), and "User Plates" (with an icon of a person). The "Plate Information" section displays the following details: Licence Plate: ABCD 555, VIN Number: xxxx xxxx, Expiry Date: DEC 2024, Province: ONTARIO. The "Bill Payments" section shows: Toll Charges: \$0, Fines: \$0, Fees: \$0, Total Cost: \$0. The "User Plates" section lists: Primary Plate: ABCD 555, Plate 1: ABCD 555, Plate 2: ARJS 497, Plate 3: XYZA 123. At the bottom center is a blue "RENEW NOW" button.

Step 4: A confirmation message will appear

The screenshot shows the ePlate application interface after a renewal action. The layout is identical to Step 3, with the sidebar and main content area. However, a modal dialog box is overlaid on the "Renew Licence Plate" section. The dialog contains the message: "Your license has been renewed! Please renew your license in 2024." At the bottom right of the dialog is a blue "Close" button.

Step 5: Renewal update should be reflected on the page

The screenshot shows the ePlate web application interface. On the left is a sidebar with the following menu items:

- Dashboard
- My Profile
- Energy Consumed
- Renew Licence Plate** (highlighted)
- Vehicle Information

The main content area is titled "Renew Licence Plate". It contains three sections:

- Plate Information**: Shows Licence Plate: ABCD 555, VIN Number: xxxx xxxx, Expiry Date: DEC 2024, and Province: ONTARIO.
- Bill Payments**: Shows Toll Charges: \$0, Fines: \$0, Fees: \$0, and Total Cost: \$0.
- User Plates**: Shows Primary Plate: ABCD 555, Plate 1: ABCD 555, Plate 2: ARJS 497, and Plate 3: XYZ 123.

A "RENEW NOW" button is located at the bottom of the main content area.

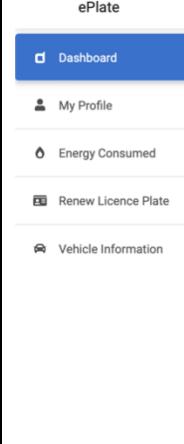
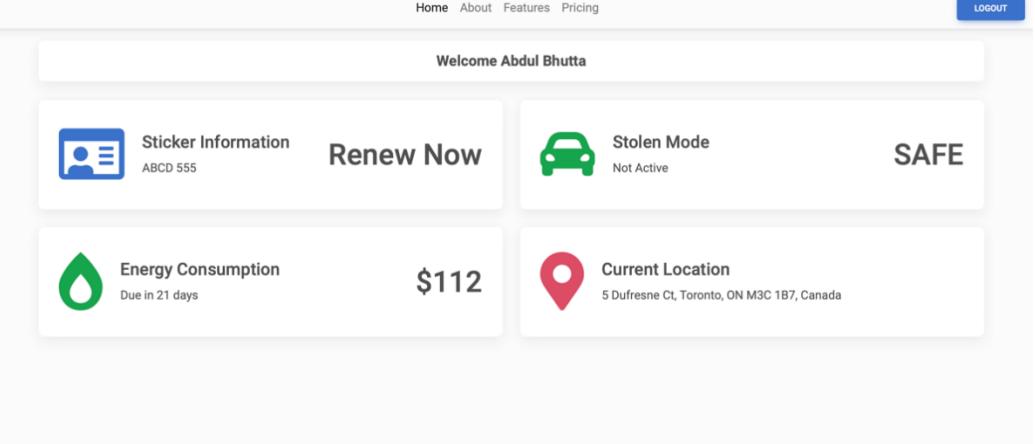
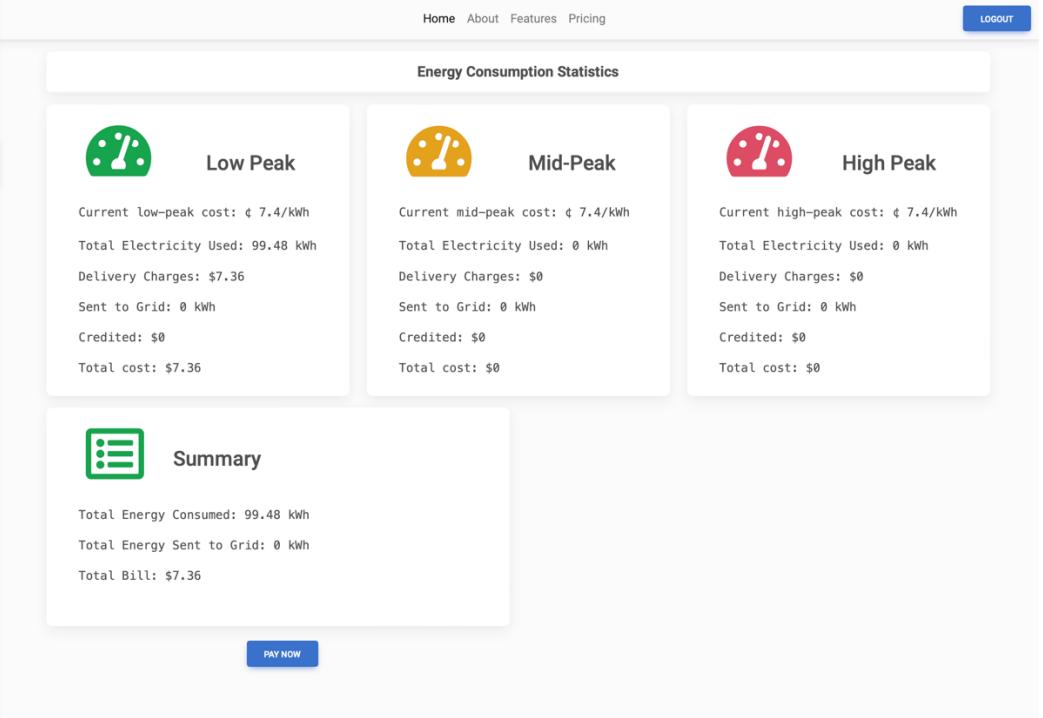
Step 6: Verify sticker date on the plate



Table 2.6: Test Case #4 – User Energy Payment

Test Writer:	Abdul Bhutta, Emran Soltani, Kumail Syed, Walid Ayub, Yussef Elzein			
Test Case Name:	TC #4		Test ID:	Smart-TC-01
Description:	The user shall have the option to pay for the energy consumed.		Type:	Black Box: <input checked="" type="checkbox"/> White Box: <input type="checkbox"/>
Tester Information				
Tester Name:	Abdul Bhutta, Walid Ayub		Date:	03/05/2023
Environment:	The acceptance testing will be done on a web browser (Google Chrome, Safari)		Time:	11:15 AM
Steps	Action	Expected Results	Pass	Fail
1	Access the Energy Consumed Page	The current page is redirected to the Energy Consumption Page	✓	
2	If user has outstanding balance, allow them to pay the amount	The user is allowed to pay due to the efficient funds on the account	✓	
3	User is shown a payment module	A payment module is displayed	✓	
4	User enters credit card information	All user required information is inputted correctly	✓	
5	Payment is processed (Simulated) and Consumption data is reset	Updates are displayed on the energy consumption page	✓	
Test Result:		✓		

Table 2.7: Test Case #4 – Results

<p style="text-align: center;"><i>Step 1: Access the Energy Consumed Page</i></p>	
	
<p style="text-align: center;"><i>Step 2: If user has outstanding balance, allow them to pay the amount</i></p>	
	

Step 3: User is shown a payment module

The screenshot shows the ePlate application interface. On the left is a sidebar with navigation links: Dashboard, My Profile, Energy Consumed (which is highlighted in blue), Renew Licence Plate, and Vehicle Information. The main content area has a header "Energy Consumption Statistics". Below it are three cards: "Low Peak" (green icon), "Mid-Peak" (orange icon), and "High Peak" (red icon). Each card displays electricity usage and cost details. To the right of these cards is a "Summary" section with a green icon, showing "Total Energy Consumed: 99.48 kWh", "Total Energy Sent to Grid: 0 kWh", and "Total Bill: \$7.36". Below the summary is a "PAY NOW" button. To the right of the summary is a "Payment Due" section with a total of "\$7.36". It contains fields for "Card Number", "Expiry Date", and "CVV", and a "PAY NOW" button.

Step 4: User enters credit card information

This screenshot is identical to the previous one, but the "Card Number" field in the "Payment Due" section is now populated with "1234 5678 1234 5678". The other fields ("Expiry Date" and "CVV") are still empty. The "PAY NOW" button is visible below the payment form.

Step 5: Payment is processed (Simulated) and Consumption data is reset

The screenshot shows the ePlate web application interface. On the left is a sidebar with navigation links: Dashboard, My Profile, Energy Consumed (which is highlighted in blue), Renew Licence Plate, and Vehicle Information. The main content area has a header with Home, About, Features, Pricing, and a Logout button. Below the header is a section titled "Energy Consumption Statistics" with three colored circles (green, orange, red) representing Low Peak, Mid-Peak, and High Peak respectively. Each circle has a corresponding section with current costs, total electricity used, delivery charges, sent to grid, credited amount, and total cost. All values are currently at \$0. Below this is a "Summary" section with a green icon, showing total energy consumed, total energy sent to grid, and total bill, all at \$0. A "PAY NOW" button is located at the bottom of the summary section.

Home About Features Pricing LOGOUT

Energy Consumption Statistics

Low Peak

Current low-peak cost: € 7.4/kWh
Total Electricity Used: 0 kWh
Delivery Charges: \$0
Sent to Grid: 0 kWh
Credited: \$0
Total cost: \$0

Mid-Peak

Current mid-peak cost: € 7.4/kWh
Total Electricity Used: 0 kWh
Delivery Charges: \$0
Sent to Grid: 0 kWh
Credited: \$0
Total cost: \$0

High Peak

Current high-peak cost: € 7.4/kWh
Total Electricity Used: 0 kWh
Delivery Charges: \$0
Sent to Grid: 0 kWh
Credited: \$0
Total cost: \$0

Summary

Total Energy Consumed: 0 kWh
Total Energy Sent to Grid: 0 kWh
Total Bill: \$0

PAY NOW

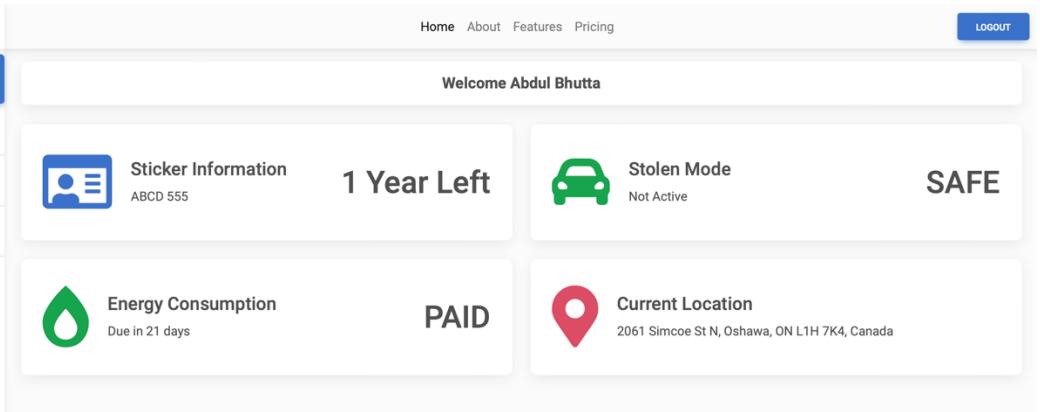
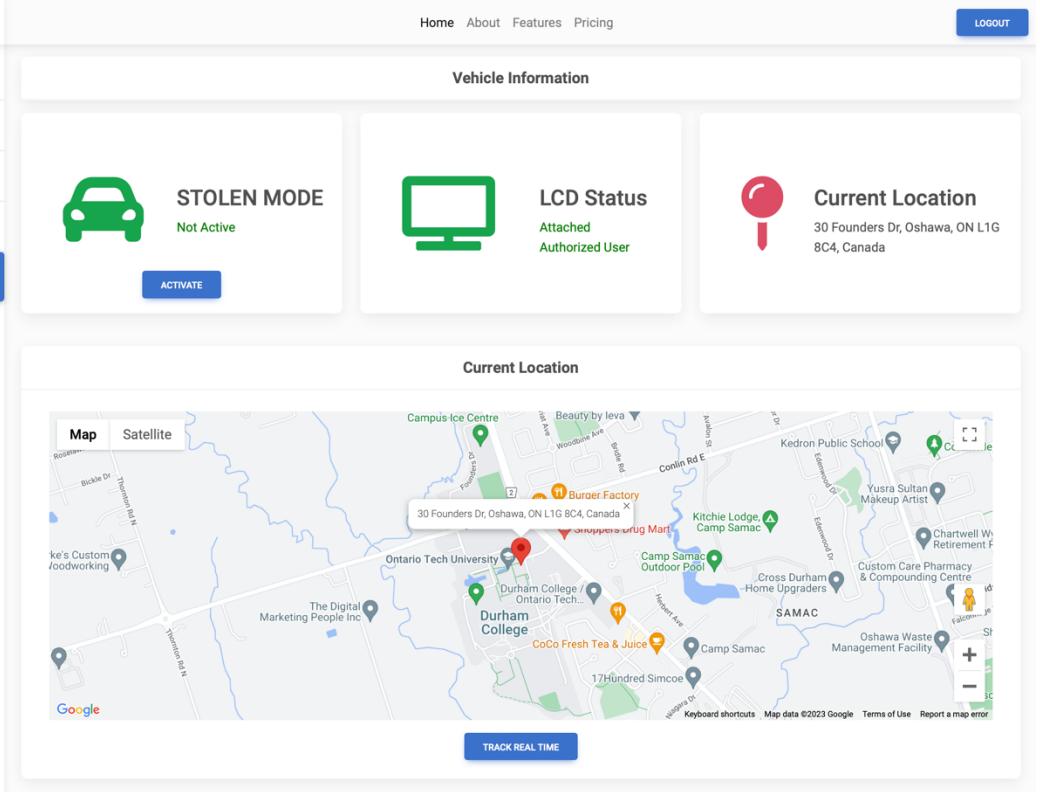
Table 2.8: Test Case #5 – User Updates Personal Information

Test Writer:	Abdul Bhutta, Emran Soltani, Kumail Syed, Walid Ayub, Yussef Elzein					
Test Case Name:	TC #5			Test ID:	Smart-TC-0	
Description:	The user shall be able to update personal information.			Type:	Black Box: <input checked="" type="checkbox"/> White Box: <input type="checkbox"/>	
Tester Information						
Tester Name:	Abdul Bhutta, Walid Ayub			Date:	03/06/2023	
Environment:	The acceptance testing will be done on a web browser. (Google Chrome, Safari)			Time:	12:30 PM	
Steps	Action	Expected Results	Pass	Fail	N/A	Comments
1	Incorrect or missing information	Error message will be displayed			✓	
2	The user will input correct information in the displayed textbox	The application will display a confirmation page.			✓	
3	Results of update should be correct	Account updated in the database must match information			✓	
Test Result:					✓	Test Case Not Completed. See Table 2.21 in Section 2.2 for details.

Table 2.9: Test Case #6 – License Plate Tracking

Test Writer:	Abdul Bhutta, Emran Soltani, Kumail Syed, Walid Ayub, Yussef Elzein					
Test Case Name:	TC #6			Test ID:	Smart-TC-06	
Description:	The user shall be able to view the location of the license plate.			Type:	Black Box: <input checked="" type="checkbox"/> White Box: <input type="checkbox"/>	
Tester Information						
Tester Name:	Abdul Bhutta, Walid Ayub			Date:	03/06/2023	
Environment:	The acceptance testing will be done on a web browser. (Google Chrome, Safari)			Time:	1:14 PM	
Steps	Action	Expected Results	Pass	Fail	N/A	Comments
1	User is logged in and accesses vehicle information page	The user is logged in and is redirected to the vehicle information page	✓			
2	User is shown the current location of the License Plate with an address	A map is displayed with the current location of the plate along with the full address	✓			
3	User has option to view real time tracking of the plate	User is shown a full map of the real time tracking	✓			
4	Verify the plate is being tracked	An icon of a car showing the exact location can be viewed on the map	✓			
Test Result:			✓			

Table 2.10: Test Case #6 Results

<p><i>Step 1: User is logged in and accesses vehicle information page</i></p>	
 <p>The screenshot shows the ePlate vehicle information page. On the left is a sidebar with a blue header 'ePlate' and a 'Dashboard' button. Below it are 'My Profile', 'Energy Consumed', 'Renew Licence Plate', and 'Vehicle Information'. The main area has a 'Welcome Abdul Bhutta' message. It displays 'Sticker Information' for 'ABCD 555' with a '1 Year Left' validity period. A green car icon indicates 'Stolen Mode Not Active' and 'SAFE'. Under 'Energy Consumption', it says 'PAID' and shows a green water drop icon with 'Due in 21 days'. The 'Current Location' is listed as '2061 Simcoe St N, Oshawa, ON L1H 7K4, Canada' with a red location pin.</p>	
<p><i>Step 2: User is shown the current location of the License Plate with an address</i></p>	
 <p>The screenshot shows the 'Vehicle Information' page. The sidebar has a blue header 'ePlate' and a 'Vehicle Information' button. The main area shows 'STOLEN MODE' (Not Active) with an 'ACTIVATE' button, 'LCD Status' (Attached, Authorized User), and the 'Current Location' (30 Founders Dr, Oshawa, ON L1G 8C4, Canada) with a red location pin. Below this is a map of the area around Durham College/Ontario Tech University, with a callout showing the exact location at 30 Founders Dr. A 'TRACK REAL TIME' button is at the bottom of the map.</p>	

Step 3: User has option to view real time tracking of the plate

ePlate

Home About Features Pricing [LOGOUT](#)

Dashboard My Profile Energy Consumed Renew Licence Plate **Vehicle Information**

Real Time Asset Tracking

A map of Oshawa, Ontario, showing the location of vehicle 30 Founders Dr, Oshawa, ON L1G 8C4, Canada. The vehicle is tracked in real-time, indicated by a purple car icon with a red dot. Other locations marked on the map include Mr Sub, Rafi Caterers, Campus Ice Centre, Permanent Beauty by Ieva, Kedron Park, KEDRON, Kitchie Lodge, Camp Samac, Camp Samac Outdoor Pool, Shoppers Drug Mart, Durham College, Ontario Tech University, CoCo Fresh Tea & Juice, 17Hundred Simcoe, Camp Samac, Kinark Child and Family Services, Cedar Valley Conservation Area, and various local businesses and landmarks. A blue button labeled "RETURN" is located at the bottom of the map.

Step 4: Verify the plate is being tracked

ePlate

Home About Features Pricing [LOGOUT](#)

Dashboard My Profile Energy Consumed Renew Licence Plate **Vehicle Information**

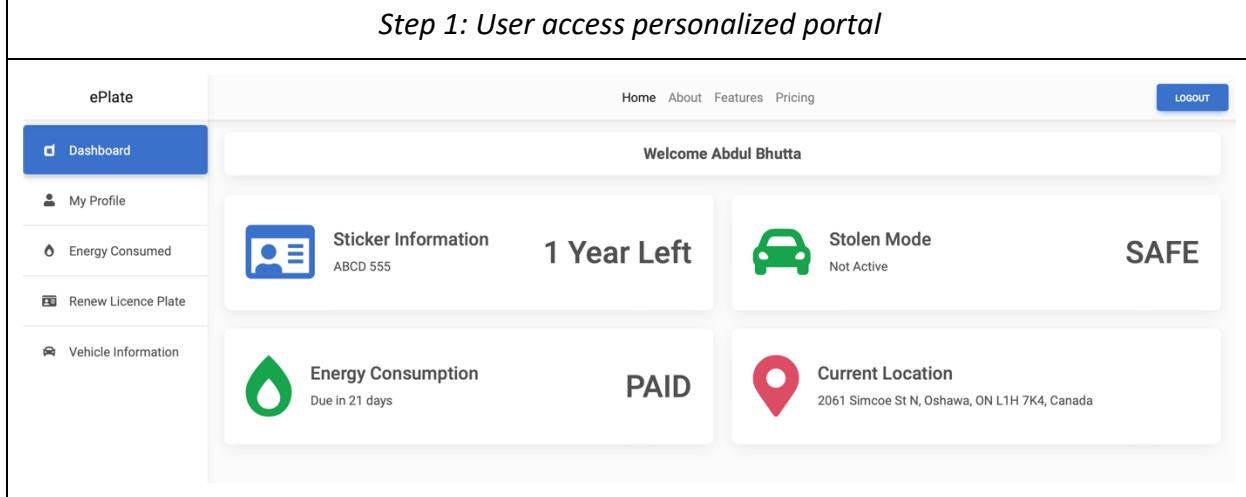
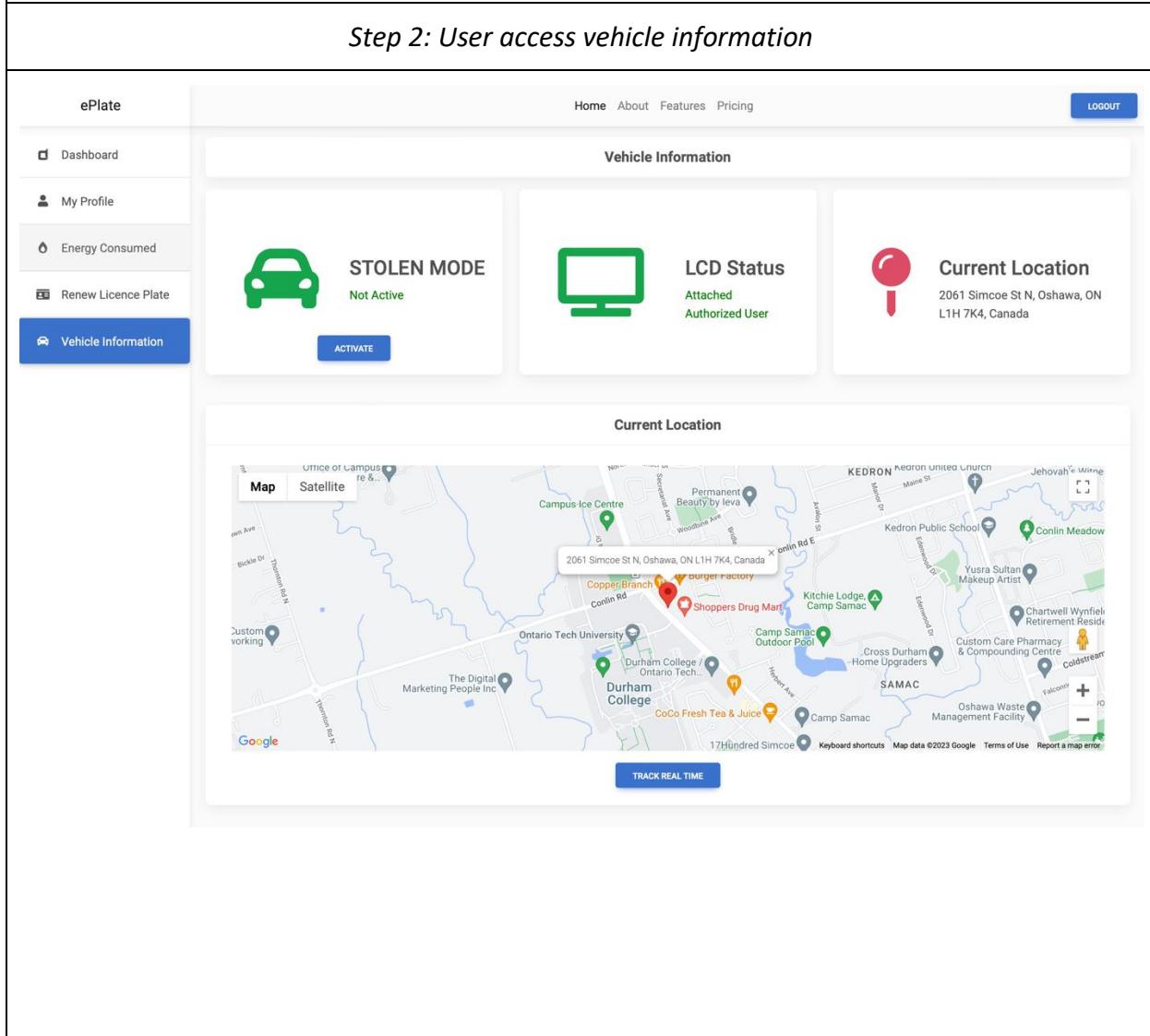
Real Time Asset Tracking

A map of Oshawa, Ontario, showing the location of vehicle 32 Founders Dr, Oshawa, ON L1H 7K4, Canada. The vehicle is tracked in real-time, indicated by a purple car icon with a red dot. Other locations marked on the map include Mr Sub, Rafi Caterers, Campus Ice Centre, Permanent Beauty by Ieva, Kedron Park, KEDRON, Kitchie Lodge, Camp Samac, Camp Samac Outdoor Pool, Shoppers Drug Mart, Durham College, Ontario Tech University, CoCo Fresh Tea & Juice, 17Hundred Simcoe, Camp Samac, Kinark Child and Family Services, Cedar Valley Conservation Area, and various local businesses and landmarks. A blue button labeled "RETURN" is located at the bottom of the map.

Table 2.11: Test Case #7 – License Plate Removal

Test Writer:	Abdul Bhutta, Emran Soltani, Kumail Syed, Walid Ayub, Yussef Elzein					
Test Case Name:	TC #7			Test ID:	Smart-TC-07	
Description:	The user shall be notified if the license plate is removed.			Type:	Black Box: <input checked="" type="checkbox"/> White Box: <input type="checkbox"/>	
Tester Information						
Tester Name:	Abdul Bhutta, Walid Ayub			Date:	03/06/2023	
Environment:	The acceptance testing will be done on a web browser. (Google Chrome, Safari)			Time:	2:15 PM	
Steps	Action	Expected Results	Pass	Fail	N/A	Comments
1	User access personalized portal	The application displays the dashboard page	✓			
2	User access vehicle information	The dashboard page is redirected to the vehicle information page	✓			
3	User removes LCD screen	The LCD displays a message notifying user that "LCD NOT COMPATIBLE"	✓			
4	User will be notified on the application	The application displays warning alerts that the LCD has been removed	✓			
5	User will be attached when the LCD is attached again.	The LCD displays the users license plate	✓			
6	Verify its updated on the application	The application displays alerts that the LCD has been successfully reconnected	✓			
Test Result:			✓			

Table 2.12: Test Case #7 Results

Step 1: User access personalized portal	
	
Step 2: User access vehicle information	
	

Step 3: User removes LCD screen



Step 4: User will be notified on the application

The screenshot shows a user interface for a vehicle tracking and management system. The top navigation bar includes links for Home, About, Features, Pricing, and a Logout button. A red alert banner in the top right corner indicates that the LCD has been removed. The main content area is divided into several sections: a 'Vehicle Information' summary, a 'STOLEN MODE' status card (green icon, Not Active, ACTIVATE button), an 'LCD Status' card (monitor icon, Not Attached, Authorized User), and a 'Current Location' card (key icon, 2061 Simcoe St N, Oshawa, ON L1H 7K4, Canada). Below these is a detailed map of the area around 2061 Simcoe St N, Oshawa, with various locations like Ontario Tech University, Durham College, and Camp Samac marked. A 'TRACK REAL TIME' button is located at the bottom of the map section.

Step 5: User will be attached when the LCD is attached again.



Step 6: Verify its updated on the application

The screenshot shows the 'Vehicle Information' section of the ePlate application. On the left, there's a sidebar with links: Dashboard, My Profile, Energy Consumed, Renew Licence Plate, and Vehicle Information (highlighted in blue). The main area has a header 'Vehicle Information' with a green alert bar that says 'Alert' and 'LCD Reconnected'. There are three cards: 'STOLEN MODE' (Not Active), 'LCD Status' (Attached, Authorized User), and 'Current Location' (2061 Simcoe St N, Oshawa, ON L1H 7K4, Canada). Below these is a map titled 'Current Location' showing the surroundings of the address. A 'TRACK REAL TIME' button is at the bottom of the map section.

Table 2.13: Test Case #8 – Application Database Refresh

Test Writer:	Abdul Bhutta, Emran Soltani, Kumail Syed, Walid Ayub, Yussef Elzein					
Test Case Name:	TC # 8			Test ID:	Smart-TC-08	
Description:	The application will update the required database with the user payments/renewed date.			Type:	Black Box: <input checked="" type="checkbox"/> White Box: <input type="checkbox"/>	
Tester Information						
Tester Name:	Abdul Bhutta, Walid Ayub			Date:	03/06/2023	
Environment:	The acceptance testing will be done on a web browser. (Google Chrome, Safari)			Time:	5:45 PM	
Steps	Action	Expected Results	Pass	Fail	N/A	Comments
1	Access personalized portal	The application displays the Dashboard page	✓			
2	Access Renew License Plate page	The Dashboard is redirected to the Renew License Plate page	✓			
3	User should not be allowed to renew if there is any outstanding balance.	The user is allowed to pay due to the efficient funds on the account	✓			
4	User will be requested to enter credit card information	All required inputs have been filled correctly	✓			
5	User will submit, and a confirmation will be displayed	User has submitted and the application has displayed messages notifying it was successful along with the expiry date	✓			
6	Verify the changes	Updates are displayed on the Renew License Plate page	✓			
7	Verify sticker has been updated on the licence plate	Sticker update is displayed on user's license plate	✓			
Test Result:			✓			

Table 2.14: Test Case #8 Results

Step 1: Access personalized portal	
Step 2: Access Renew License Plate page	
Step 3: User should not be allowed to renew if there is any outstanding balance.	

Step 4: User will be requested to enter credit card information

ePlate

Home About Features Pricing LOGOUT

Dashboard My Profile Energy Consumed Renew Licence Plate Vehicle Information

Renew Licence Plate

Plate Information

Licence Plate: ABCD 555
VIN Number: xxxx xxxx
Expiry Date: DEC 2024
Province: ONTARIO

Bill Payments

Toll Charges: \$0
Fines: \$15
Fees: \$50
Total Cost: \$65

User Plates

Primary Plate: ABCD 555
Plate 1: ABCD 555
Plate 2: ARJS 497
Plate 3: XYZA 123

RENEW NOW

Payment Due \$65

Please enter your payment details

Card Number: 1234 5678 1234 5678
Expiry Date: 09/2023 CVV: ...

PAY NOW

Step 5: User will submit, and a confirmation will be displayed

ePlate

Home About Features Pricing LOGOUT

Dashboard My Profile Energy Consumed Renew Licence Plate Vehicle Information

Renew Licence Plate

Plate Information

Licence Plate: ABCD 555
VIN Number: xxxx xxxx
Expiry Date: DEC 2024
Province: ONTARIO

Bill Payments

Toll Charges: \$0
Fines: \$15
Fees: \$50
Total Cost: \$65

User Plates

Primary Plate: ABCD 555
Plate 1: ABCD 555
Plate 2: ARJS 497
Plate 3: XYZA 123

Your payment has been processed!

Close

Payment Due \$65

Please enter your payment details

Card Number: 1234 5678 1234 5678
Expiry Date: 09/2023 CVV: ...

PAY NOW

Home About Features Pricing LOGOUT

Renew Licence Plate

Plate Information

Licence Plate: ABCD 555
VIN Number: xxxx xxxx
Expiry Date: DEC 2024
Province: ONTARIO

Bill Payments

Toll Charges: \$0
Fines: \$0
Fees: \$50
Total Cost: \$65

User Plates

Primary Plate: ABCD 555
Plate 1: ABCD 555
Plate 2: ARJS 497
Plate 3: XYZA 123

Your license has been renewed! Please renew your license in 2025.

Close

Step 6: Verify the changes

Home About Features Pricing LOGOUT

Renew Licence Plate

Plate Information

Licence Plate: ABCD 555
VIN Number: xxxx xxxx
Expiry Date: DEC 2025
Province: ONTARIO

Bill Payments

Toll Charges: \$0
Fines: \$0
Fees: \$0
Total Cost: \$0

User Plates

Primary Plate: ABCD 555
Plate 1: ABCD 555
Plate 2: ARJS 497
Plate 3: XYZA 123

MAX RENEWAL REACHED

Step 7: Verify sticker has been updated on the licence plate



Table 2.15: Test Case #9 – Vehicle Stolen Mode

Test Writer:	Abdul Bhutta, Emran Soltani, Kumail Syed, Walid Ayub, Yussef Elzein					
Test Case Name:	TC #9			Test ID:	Smart-TC-09	
Description:	The user can initiate stolen mode and disable vehicle, if applicable.			Type:	Black Box: <input checked="" type="checkbox"/> White Box: <input type="checkbox"/>	
Tester Information						
Tester Name:	Abdul Bhutta, Walid Ayub			Date:	03/06/2023	
Environment:	The acceptance testing will be done on a web browser. (Google Chrome, Safari)			Time:	8: 10 PM	
Steps	Action	Expected Results	Pass	Fail	N/A	Comments
1	User access personalized portal	The Dashboard is displayed	✓			
2	User access vehicle information	The Dashboard is redirected to the Vehicle Information page	✓			
3	User activates stolen mode	Stolen mode is activated after user confirms when application asks whether they would like to continue	✓			
4	User shall receive an alert	A warning alert is displayed on all pages that vehicle is stolen	✓			
5	Verify output on plate	The license plate displays a message that it is stolen and to call authorities	✓			
Test Result:			✓			

Table 2.16: Test Case #9 Results

<i>Step 1: User access personalized portal</i>
<i>Step 2: User access vehicle information</i>

Step 3: User activates stolen mode

The screenshot shows the 'Vehicle Information' section of the ePlate app. On the left, there's a sidebar with options like Dashboard, My Profile, Energy Consumed, Renew Licence Plate, and Vehicle Information (which is selected). In the center, there are three cards: 'STOLEN MODE' (Not Active), 'LCD Status' (Attached, Authorized User), and 'Current Location' (2061 Simcoe St N, Oshawa, ON L1H 7K4, Canada). A modal window is open over the map, asking 'Are you sure you want to activate stolen mode? This will DISABLE the vehicle as well if possible!' with 'Cancel' and 'OK' buttons. The map shows the vehicle's current location in Oshawa, with various landmarks and roads labeled.

Step 4: User shall receive an alert

The screenshot shows the 'Vehicle Information' section after Stolen Mode has been activated. The 'Stolen Mode' card now displays 'Active' and 'VEHICLE IS STOLEN'. The 'LCD Status' card remains the same. The 'Current Location' card still shows the same address. The map below is identical to the previous screenshot, showing the vehicle's location in Oshawa. A red banner at the top of the page says 'Stolen Mode Activated'.

Step 5: Verify output on plate



Table 2.17: Test Case #10 – Notification for Unauthorized User

Test Writer:	Abdul Bhutta, Emran Soltani, Kumail Syed, Walid Ayub, Yussef Elzein			
Test Case Name:	TC #10		Test ID:	Smart-TC-10
Description:	The user shall be notified if an unauthorized LCD is attached.		Type:	Black Box: <input checked="" type="checkbox"/> White Box: <input type="checkbox"/>
Tester Information				
Tester Name:	Abdul Bhutta, Walid Ayub		Date:	03/07/2023
Environment:	The acceptance testing will be done on a web browser. (Google Chrome, Safari)		Time:	1:45 PM
Steps	Action	Expected Results	Pass	Fail
1	User access authorized dashboard	The Dashboard is displayed	✓	
2	LCD is removed from microcontroller and an unauthorized LCD is attached	The LCD displays message that “LCD NOT COMPATIBLE”	✓	
3	The user shall be notified	A caution alert is displayed on all pages that an unauthorized LCD is attached	✓	
Test Result:		✓		

Table 2.18: Test Case #10 Results

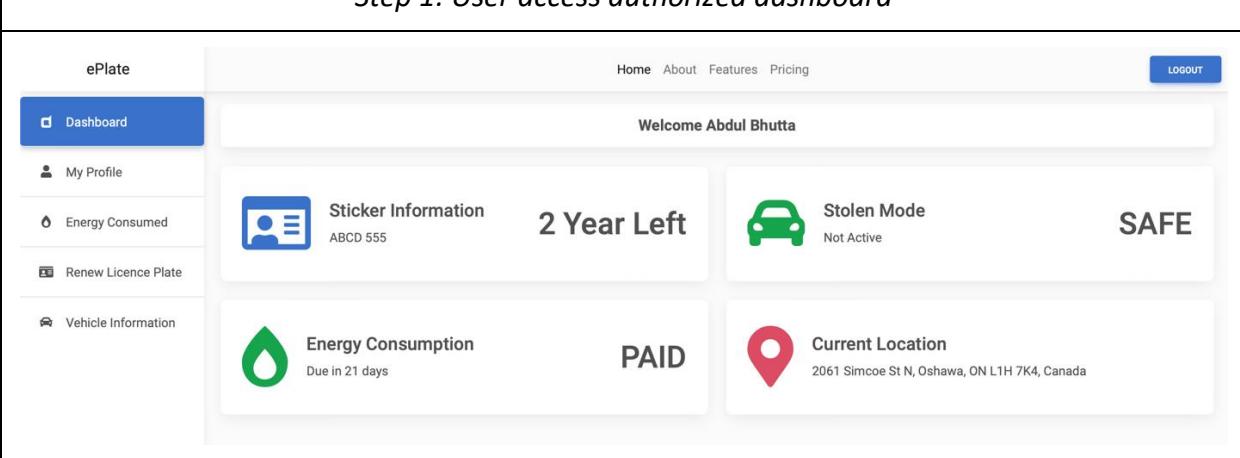
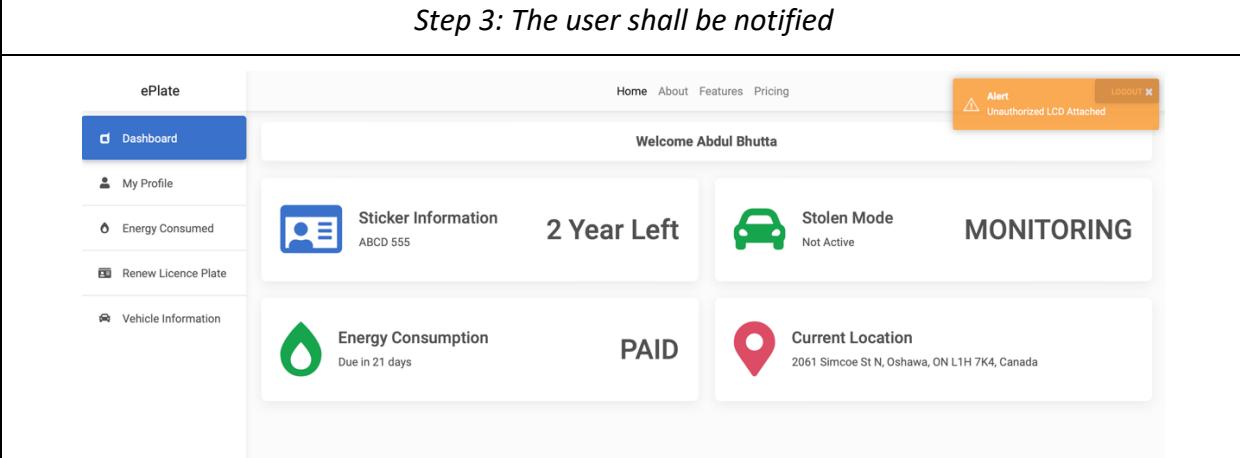
<i>Step 1: User access authorized dashboard</i>	
	<p>ePlate</p> <p>Home About Features Pricing LOGOUT</p> <p>Welcome Abdul Bhutta</p> <p>Sticker Information ABCD 555 2 Year Left Stolen Mode Not Active SAFE</p> <p>Energy Consumption Due in 21 days PAID Current Location 2061 Simcoe St N, Oshawa, ON L1H 7K4, Canada</p>
<i>Step 2: LCD is removed from microcontroller and an unauthorized LCD is attached</i>	
	<p>192.168.2.53 (raspberrypi) - VNC Viewer</p> <p>LCD NOT COMPATIBLE</p>
<i>Step 3: The user shall be notified</i>	
	<p>ePlate</p> <p>Home About Features Pricing LOGOUT</p> <p>Welcome Abdul Bhutta</p> <p>Sticker Information ABCD 555 2 Year Left Stolen Mode Not Active MONITORING</p> <p>Energy Consumption Due in 21 days PAID Current Location 2061 Simcoe St N, Oshawa, ON L1H 7K4, Canada</p>

Table 2.19: Test Case #11 – User Selects Displayed Plate

Test Writer:	Abdul Bhutta, Emran Soltani, Kumail Syed, Walid Ayub, Yussef Elzein					
Test Case Name:	TC # 11				Test ID:	Smart-TC-11
Description:	The user shall be allowed to interchange between license plates. (Multiple Cars)				Type:	Black Box: <input checked="" type="checkbox"/> White Box: <input type="checkbox"/>
Tester Information						
Tester Name:	Abdul Bhutta, Walid Ayub				Date:	03/07/2023
Environment:	The acceptance testing will be done on a web browser (Google Chrome, Safari)				Time:	4:15 PM
Steps	Action	Expected Results	Pass	Fail	N/A	Comments
1	User access authorized dashboard	The Dashboard is displayed	✓			
2	User access my profile portal	The Dashboard is redirected to the profile page	✓			
3	User selects primary plate to display	The primary plate is selected through the many options	✓			
4	User will need to confirm selection	User confirms the selection when asked by application	✓			
5	User will see a confirmation message	A confirmation message is displayed letting user know it has been updated successfully	✓			
6	User will see the changes made to profile account	Updates will be displayed in each field of the profile page	✓			
7	Verify on licence plate has been updated	LCD screen shows license plate with correct updates	✓			
Test Result:			✓			

Table 2.20: Test Case #11 Results

<i>Step 1: User access authorized dashboard</i>																
<p>The screenshot shows the ePlate authorized dashboard. On the left is a sidebar with 'ePlate' at the top, followed by 'Dashboard' (which is highlighted in blue), 'My Profile', 'Energy Consumed', 'Renew Licence Plate', and 'Vehicle Information'. The main content area has a header 'Welcome Abdul Bhutta'. Below it are several cards: 'Sticker Information' (ABCD 555) with a 2-year validity period; 'Energy Consumption' (PAID, due in 21 days); 'Stolen Mode' (Not Active, SAFE); and 'Current Location' (2061 Simcoe St N, Oshawa, ON L1H 7K4, Canada). A 'Logout' button is in the top right corner.</p>																
<i>Step 2: User access my profile portal</i>																
<p>The screenshot shows the ePlate user profile portal. The sidebar is identical to the dashboard. The main content area is titled 'User Profile' and displays a profile picture of Abdul Bhutta, his license plate ABCD 555, and a note that Stolen Mode is Not Active. To the right is a table of personal details:</p> <table border="1"> <tbody> <tr> <td>Full Name</td> <td>Abdul Bhutta</td> </tr> <tr> <td>Email</td> <td>abdul.bhutta@ontariotechu.net</td> </tr> <tr> <td>Phone Number</td> <td>647-512-1111</td> </tr> <tr> <td>Address</td> <td>25 Carleton St</td> </tr> <tr> <td>Sticker Date</td> <td>DEC 2025</td> </tr> <tr> <td>Serial Number</td> <td>X003EA3B41</td> </tr> <tr> <td>Plate Number</td> <td>ABCD 555</td> </tr> <tr> <td>VIN Number</td> <td>XXXX XXXX</td> </tr> </tbody> </table> <p>Below this is a section titled 'Select Primary Plate' with a dropdown menu labeled 'Select Plate' and a 'UPDATE PLATE' button.</p>	Full Name	Abdul Bhutta	Email	abdul.bhutta@ontariotechu.net	Phone Number	647-512-1111	Address	25 Carleton St	Sticker Date	DEC 2025	Serial Number	X003EA3B41	Plate Number	ABCD 555	VIN Number	XXXX XXXX
Full Name	Abdul Bhutta															
Email	abdul.bhutta@ontariotechu.net															
Phone Number	647-512-1111															
Address	25 Carleton St															
Sticker Date	DEC 2025															
Serial Number	X003EA3B41															
Plate Number	ABCD 555															
VIN Number	XXXX XXXX															

Step 3: User selects primary plate to display

The screenshot shows the ePlate application's user profile page. On the left, there is a sidebar with navigation links: Dashboard, My Profile (which is highlighted in blue), Energy Consumed, Renew Licence Plate, and Vehicle Information. The main content area displays a user profile for "Abdul Bhutta" with a placeholder profile picture. Below the name are the license plate number "ABCD 555" and the status "Stolen Mode: Not Active". To the right of the profile is a table of user information:

Full Name	Abdul Bhutta
Email	abdul.bhutta@ontariotechu.net
Phone Number	647-512-1111
Address	25 Carleton St
Sticker Date	DEC 2025
Serial Number	X003EA3B41
Plate Number	ABCD 555
VIN Number	XXXX XXXX

Below the user info is a modal window titled "Select Primary Plate" containing a dropdown menu with three options: "ABCD 555", "ARJS 497", and "XYZA 123". The "ABCD 555" option is selected.

Step 4: User will need to confirm selection

The screenshot shows the same user profile page as the previous step, but with a confirmation dialog box overlaid. The dialog asks "Are you sure you want to update your primary plate?" with "Cancel" and "OK" buttons. The "Select Primary Plate" dropdown menu is still visible below the dialog, showing "XYZA 123" as the selected option. The rest of the page content is dimmed by a gray overlay.

Step 5: User will see a confirmation message

The screenshot shows the 'User Profile' page of the ePlate application. On the left sidebar, 'My Profile' is selected. The main area displays a user profile for 'Abdul Bhutta' with a placeholder image. Below the profile, it says 'ABCD 555' and 'Stolen Mode: Not Active'. To the right is a table with profile details: Full Name (Abdul Bhutta), Email (abdul.bhutta@ontariotechu.net), Phone Number (647-512-1111), Address (25 Carleton St), Sticker Date (DEC 2025), Serial Number (X003EA3B41), and Plate Number (ABCD 555). A modal window at the bottom center displays the message 'Plate updated successfully!' with a 'Close' button.

Step 6: User will see the changes made to profile account

The screenshot shows the 'User Profile' page of the ePlate application. The sidebar shows 'My Profile' is selected. The profile area now shows 'XYZA 123' instead of 'ABCD 555'. The rest of the profile details remain the same: Full Name (Abdul Bhutta), Email (abdul.bhutta@ontariotechu.net), Phone Number (647-512-1111), Address (25 Carleton St), Sticker Date (DEC 2025), Serial Number (X003EA3B41), Plate Number (XYZA 123), and VIN Number (XXXX XXXX). A modal window at the bottom center displays a dropdown menu labeled 'Select Primary Plate' with 'Select Plate' as the current selection, and a 'UPDATE PLATE' button below it.

Step 7: Verify on licence plate has been updated



2.2 Summary of Acceptance Testing

Table 2.21: Summary of Acceptance Tests

TC ID	Description	Preconditions	Inputs	Outputs	Pass/Fail	Comments
TC #1	The user will register to create an account.		User Information	User will be redirected to personalized dashboard.	PASS	
TC #2	The User shall log in with a user ID and password.		Authorized Credentials	Users will be redirected to a personalized dashboard.	PASS	
TC #3	The user shall be allowed to renew the license plate if no charges on account	User must be logged in	Button	Users should see updated changes on bill payments and the license plate.	PASS	
TC #4	The user shall have the option to pay for the energy consumed.	User must be logged in	Button, Payment Module	The user shall see the payment module if they have an outstanding balance. Once payment is approved, the total cost should be updated	PASS	
TC #5	The user shall be able to update personal information	User must be logged in	Button	The new update should be reflected on the profile page	NOT TESTED	We did not add the module to edit the user's information as we are not sure if user should be allowed to edit any plate information. An edit button maybe added to update the current phone number and email in the next update.
TC #6	The user shall be able to view the location of the license plate	User must be logged in	Button	The user shall view the location of the license plate.	PASS	Users can click on the button below the map if

						they want to track the plate in real-time.
TC #7	The user shall be notified if the license plate is removed	User must be logged in	None	The user shall see an alert stating the license plate has been removed.	PASS	
TC #8	The application will update the required database with the user payments/renewed date	User must be logged in	Button, Payment Module	If the user has an outstanding balance, the user shall see a payment module. If the payment is approved, the sticker expiry date will be updated.	PASS	The payment module is simulated, and no actual check is performed.
TC #9	The user can initiate stolen mode and disable vehicle, if applicable.	User must be logged in	Button	The user will see an alert on all pages on the application and the license plate will be updated	PASS	
TC #10	The user shall be notified if an unauthorized LCD is attached.	User must be logged in	None	The user shall see an alert on all pages in the application and the license plate will be updated	PASS	
TC #11	The user shall be allowed to interchange between license plates. (Multiple Cars)	User must be logged in	Button	The user shall see the changes on all pages in the application and license plate	PASS	This mode is for users with multiple cars but want to use only one license plate for all cars.

2.3 Stakeholder Requirements

Table 2.22: Stakeholder Requirements Specifications

Stakeholder Requirement	Description
STRQ-1	<p>THE USER WILL REGISTER TO CREATE AN ACCOUNT</p> <p><i>FEAT1: The user will register and input the following information: First Name, Last Name, Email, Password, and License Plate Number.</i></p> <p><i>FEAT2: It shall indicate all the mandatory fields.</i></p>
STRQ-2	<p>THE USER SHALL LOGIN WITH USERNAME AND PASSWORD</p> <p><i>FEAT2: The user shall login with the registered username and password.</i></p>
STRQ-3	<p>THE USER SHALL CHOOSE TO PAY FOR RENEWAL TICKET</p> <p><i>FEAT3: The user shall be able to pay the renewal fee which will be reflected in the MTO database.</i></p>
STRQ-4	<p>THE USER SHALL CHOOSE TO PAY FOR THE ENERGY CONSUMED</p> <p><i>FEAT4: The user shall be able to pay the energy consumed which will be reflected in the power grid database.</i></p>
STRQ-5	<p>THE USER SHALL BE ABLE TO UPDATE PERSONAL INFORMATION</p> <p><i>FEAT5: The user shall be able to add or remove the license plate.</i></p>
STRQ-6	<p>THE USER SHALL BE ABLE TO VIEW THE LOCATION OF THE LICENSE PLATE</p> <p><i>FEAT6: The user shall be able to keep track of the movement of the license plate.</i></p>
STRQ-7	<p>THE USER SHALL BE NOTIFIED IF THE LICENCE PLATE IS REMOVED</p> <p><i>FEAT7: The user shall be notified if the license plate is removed from the chassis.</i></p> <p><i>FEAT8: The user shall be allowed to report the plate stolen.</i></p>
STRQ-8	<p>THE APPLICATION WILL UPDATE THE REQUIRED DATABASE WITH THE USER PAYMENTS/RENEWED DATE</p> <p><i>FEAT9: The user will not be able to see the changes made but the updated renewal date and payments will be kept.</i></p>
STRQ-9	<p>THE USER SHALL BE ABLE TO DISABLE VEHICLES WHEN STOLEN</p> <p><i>FEAT10: The user shall have access to disable the electrical vehicle IF STOLEN ONLY!</i></p>

2.4 Updated Traceability Matrix

Table 2.23: Updated Traceability Matrix

		Requirements								
		STRQ-1	STRQ-2	STRQ-3	STRQ-4	STRQ-5	STRQ-6	STRQ-7	STRQ-8	STRQ-9
Test Cases	TC-1	✓	✓						✓	
	TC-2		✓							
	TC-3		✓	✓		✓			✓	
	TC-4		✓		✓				✓	
	TC-5		✓			✓			✓	
	TC-6		✓				✓			
	TC-7		✓					✓		
	TC-8		✓		✓				✓	
	TC-9		✓					✓		✓
	TC-10		✓					✓		
	TC-11		✓							

3 Contribution Matrix

The contribution matrix in the table below displays how the work for report #2 was divided.

Table 3.0: Report Contribution Matrix

Report #2 Sections	Group Members				
	Abdul Bhutta	Yussef Elzein	Emran Soltani	Kumail Syed	Walid Ayub
Section 1: Introduction					
		✓	✓	✓	
Section 2: Acceptance Testing					
Acceptance Test Definition	✓				✓
Acceptance Test Completion	✓				✓
Acceptance Test Results	✓				
Summary of Acceptance Testing	✓				✓
Stakeholder Requirements	✓	✓	✓	✓	✓
Updated Traceability Matrix		✓			✓
Section 3: Contribution Matrix					
Contribution Matrix		✓	✓	✓	
Other:					
Report Formatting		✓	✓	✓	
Report Corrections		✓	✓	✓	

References

1. J. Wood, "Despite Ford promises, failed Ontario licence plates increased costs by 26 per cent," Newsroom, 16-Jun-2021. [Online]. Available: <https://www.taxpayer.com/newsroom/despite-ford-promises,-failed-ontario-licence-plates-increased-costs-by-26-per-cent#:~:text=Throughout%20the,have%20added%20up%20to%20%24913%2C867>. [Accessed: 10-Oct-2022].