CS 410 - Spring 2021 - Team Crystal
Ener-G View

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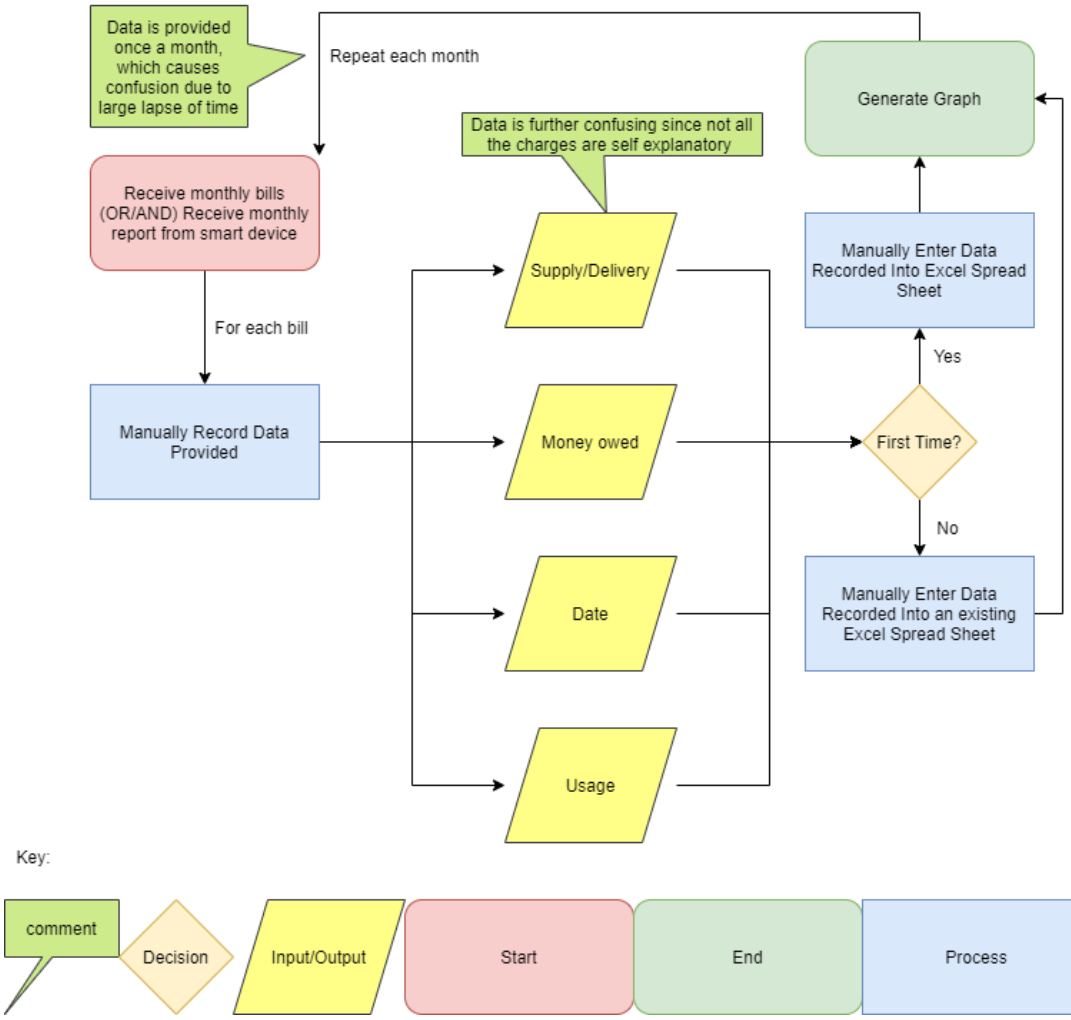
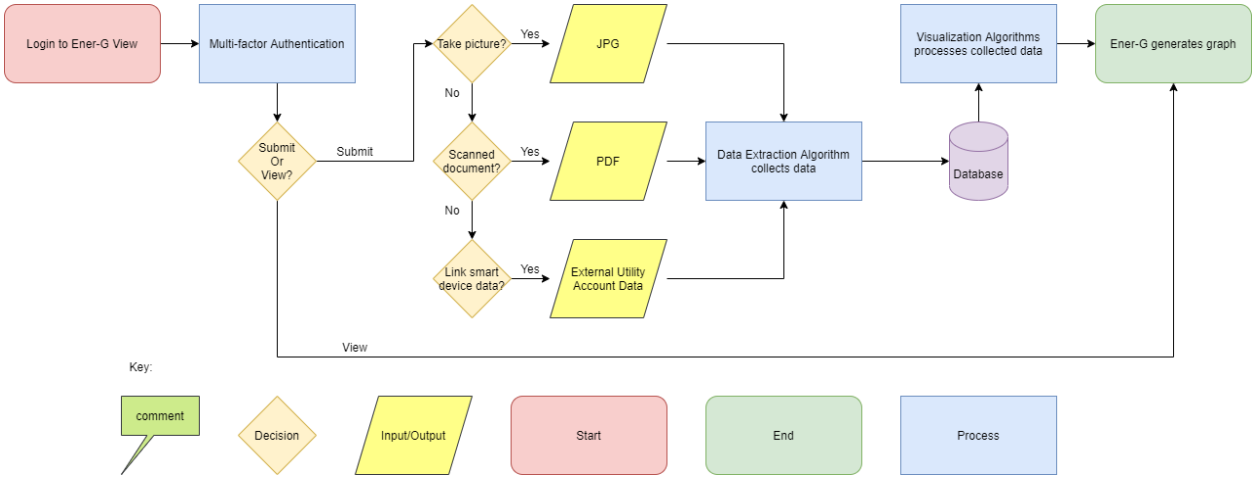
1. Introduction

A typical U.S. family spends $2,060 on average per year for home utility bills[1] and the cost continues to rise[2]. With 31% of U.S. households struggling to pay energy bills and an expected cost increase of 2.4% by 2022[3], there is a financial strain on families. Furthermore, there is no cohesive way to track all utilities in one location. In 2020, Virginia ranked the 11th most expensive state for utility costs with the average monthly electricity bill costing $124.54, the average monthly water bill costing $70.39, and the average monthly natural gas bill costing $74.32. While some utility companies provide a visual to help customers understand these costs, others do not. Furthermore, none of the utility companies provide a centralized location for customers to monitor each of their utilities. Therefore, the current process for tracking utility usage and consumption is time consuming. Customers are left with the burden to monitor and maintain their own documentation. A customer must also possess basic skills to use spreadsheet software, such as Excel, and have basic knowledge of energy analysis to effectively monitor their own data. Even if a customer does have smart devices in their home, they often need to monitor each of them individually and still perform their own energy analysis to effectively see a reduction in their energy usage and costs. The solution to this problem is a customer focused application called Ener-G View. Ener-G View provides users with a centralized location to monitor all utilities on a monthly basis. Each month a user will be able to upload the utilities of their choice to Ener-G View, and the application will provide usage and cost visualizations and analysis. After a month of using the application, Ener-G View will take the burden of historical data tracking from users and translate that data into an easier to understand visual. The application will not only show the variance in individual utility costs and usage, but it will also show a user their monthly variance as a whole. If a user experiences any increases in utilities, Ener-G View will provide an alert to the increase along with suggestions for users to reduce their consumption and costs known as a Bright Idea. When a user encounters a situation where the cost and consumption of their utilities increases when it should have decreased, Ener-G View will alert them to contact a technician for further assistance.

1.1 Current Process Flow:



1.2 Solution Process Flow:



2. Ener-G View Product Description

Ener-G view is a centralized application that helps users view monthly usage for all utilities in one central location. The application is user-friendly and easy to use. It won't need users to install any external hardware to use it. It can benefit users with its various features like alerting increases in bills, identifying and alerting leaks, and providing tips to reduce utility bills.

2.1. Key Product Features and Capabilities

2.1.1. Single step required by the user

2.1.2. Does not require experience with graph generation

2.2. Major Components (Hardware/Software)

2.2.1. Required Hardware

2.2.1.1. Client Device

2.2.1.1.1. Desktop Computer

2.2.1.1.2. Smartphone

2.2.1.2. Internet Access

2.2.1.2.1. Router

2.2.1.2.2. Mobile Hotspot

2.2.1.3. Raspberry Pi

2.2.1.3.1. Home Assistant

2.2.2. Required Software

2.2.2.1. Internet Browser

2.2.2.2. Ener-G View phone application

2.2.2.3. Home Assistant OS

3. Identification of Case Study

Ener-G View customers will include any company with a vested interest in utilities. Although nonprofits are concerned with reducing energy consumption and utility companies are focused on the amount of utility sold, both will be target customers of Ener-G View. While some utility providers do provide historical data and limited visualization, this is not their primary focus. They may be interested in partnering with Ener-G View to provide high-quality historical analysis and visualizations to better inform their customers of their usage habits. The target users of the application are adults who pay for utilities and wish to better track their usage habits.

4. Ener-G View Prototype Description

4.1. Prototype Architecture (Hardware/Software)

4.1.1. Hardware

4.1.1.1. Client Device

4.1.1.1.1. Desktop

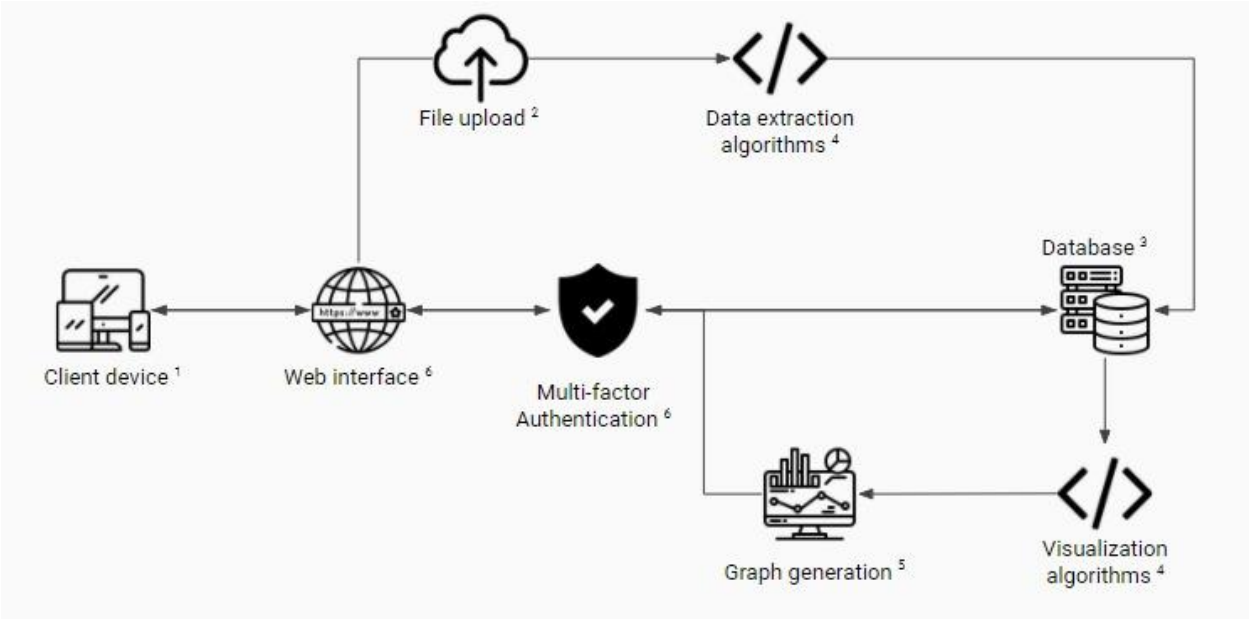
4.1.1.1.2. Smartphone

4.1.1.2. Internet Access

4.1.1.2.1. Router

4.1.1.2.2. Mobile Hotspot

4.1.1.3. Prototype Major Functional Component Diagram



4.1.2. Software

4.1.2.1. Application Technologies

4.1.2.1.1. Language(s): Python

4.1.2.1.2. Front end: HTML, CSS, Bootstrap, JavaScript

4.1.2.1.3. Back end: Python, PHP

4.1.2.1.4. API: Wink API (Nest, GE, Philips, Honeywell, and more), Domoticz API (electrical devices, electronic gadgets, water, and gas as well as weather monitoring instruments), Home Assistant

4.1.2.1.5. Database: MySQL

4.1.2.1.6. Deployment: Docker

4.1.2.1.7. Multi-Factor Authentication: Duo

4.1.2.2. Development Tools

4.1.2.2.1. Code Repository: cs.odu GitLab

4.1.2.2.2. IDE: PyCharm / VS Code

4.1.2.2.3. Prototyping: PSD Repo

4.1.2.2.4. Testing Framework: PyTest/PyHamcrest

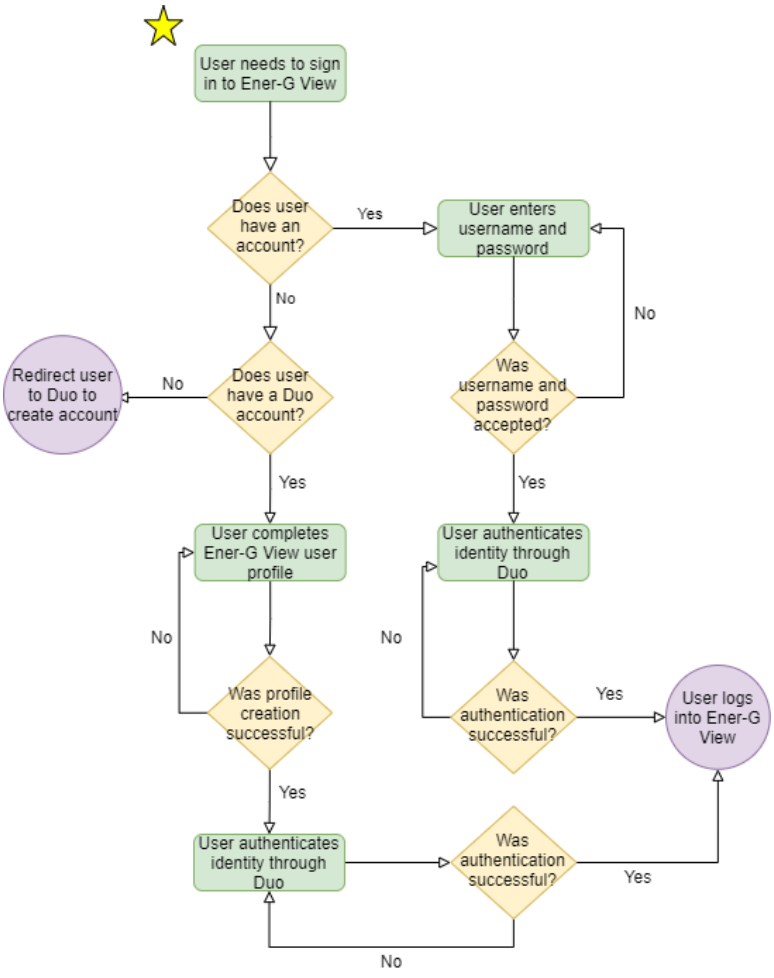
4.1.2.2.5. API Testing: PyTest/PyHamcrest

4.1.2.2.6. Documentation: PyDoc/Doxygen

4.1.2.2.7. Issue Tracker: GitLab

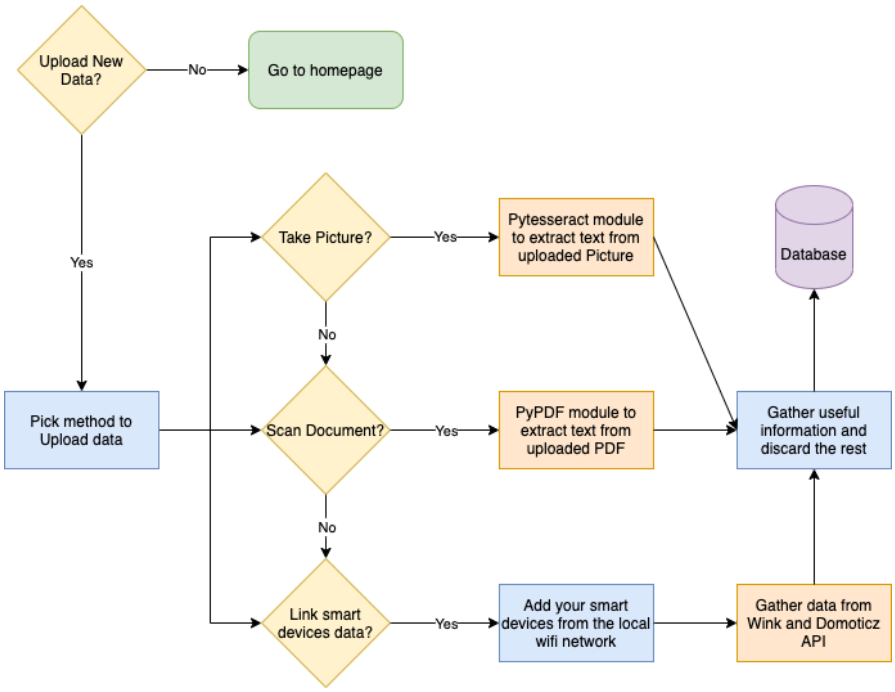
4.2. Prototype Features and Capabilities

4.2.1. Users will be able to create an account and login using Multi-Factor Authentication.

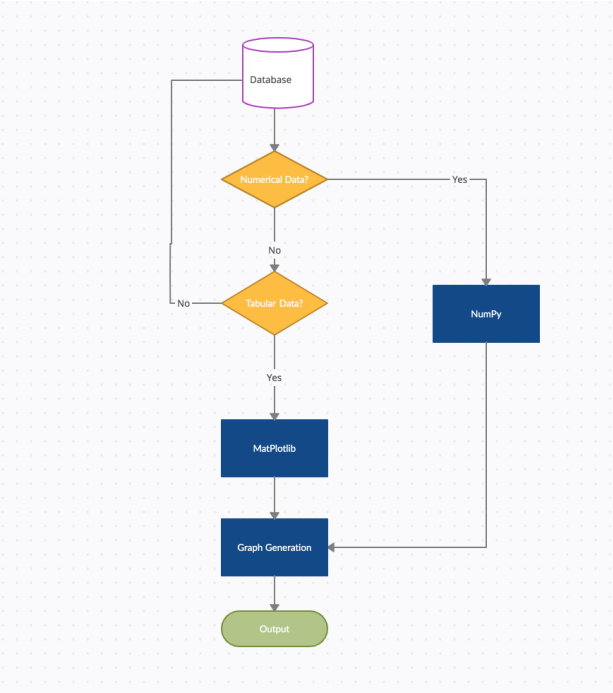


4.2.2. Users will be able to specify what utilities they want to track with Ener-G View.

4.2.3. Simulate extracting data from smart device



4.2.4. Graphs will be created from user data with room for expansion in the future



4.2.5. Bright Ideas will be available, but not fully tied to user data

4.2.6. Database will be implemented in MySQL for prototype and NoSQL or MongoDB for RWP.

4.2.7. The user will be able to view data and receive notifications from a web interface. Notifications will not be sent via text or email in the prototype.

4.2.8. Bright Ideas suggesting one-time improvements can be added to and checked off from a to-do list.

4.2.9. Users will be able to add user appliance profiles, (i.e., type of washer, water heater) to their profile, but will not influence the Bright Ideas presented to the user.

4.2.10. All data will be centralized around a user account.

4.2.11. The ability to connect to an external utility account and automatically download bills will not be provided in the prototype.

Feature	RWP	Prototype
Extract data from a JPG	Yes	Yes
Extract data from PDF	Yes	Yes
Extract data from smart device	Yes	Simulated
Create account	Yes	Yes
Multi-factor Authentication	Yes	Yes
Graph Visualization	Yes	Yes, partial
Bright Ideas	Yes	Yes, partial
Database	Yes, DOM	Yes, ERM
Web interface	Yes	Yes
Notifications	Yes	Yes, partial
Bright Idea To-Do List	Yes	Yes
User appliance profile	Yes	Yes, partial
Centralize utility data	Yes	Yes
Connect to external utility account	Yes	No

4.3. Prototype Development Challenges

4.3.1. Time constraints due to the length of the course.

4.3.2. Size of the team due to various semester enrollment amongst team members.

4.3.3. Learning new languages and APIs required for implementation.

4.3.4. Learning and implementing the database schema most efficient for application functionality.

4.3.5. Simulation of Home Assistant functioning with Ener-G View.

4.4. Real World Product Risks

Legal Risks

L1: Compromise of personally identifiable information.

Mitigation:

- Reduce probability: Utilize database security best practices
- Reduce impact: Do not collect personal information such as: names, account number, DoB.

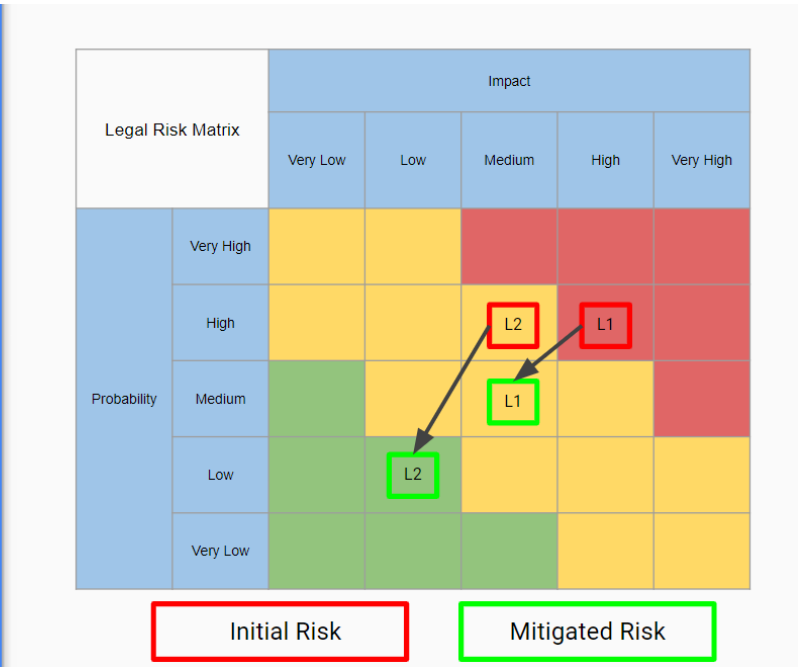
Initial Risk: **HIGH** -> Mitigated Risk: **MEDIUM**

L2: Buy-in from utilities required for syncing accounts to Ener-G View.

Mitigation:

- Reduce probability: Manually input data from utility bill
- Reduce impact: Offer incentive for utility companies to partner with Ener-G View.

Initial Risk: **HIGH** -> Mitigated Risk: **LOW**



Customer Risks

C1: User will discontinue use of service if data extraction isn't accurate.

Mitigation:

- Reduce probability: Optimize the recognition algorithm.
- Reduce impact: Allow user to identify the data they would like to be extracted.

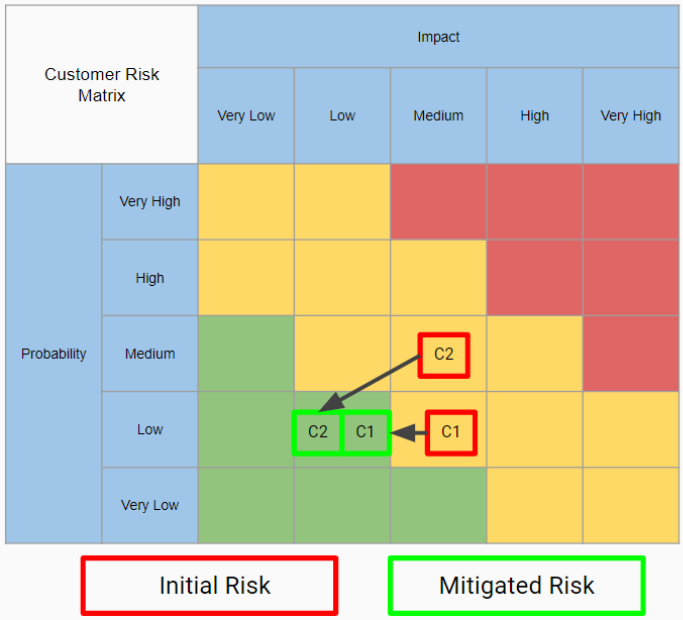
Initial Risk: **MEDIUM** -> Mitigated Risk: **LOW**

C2: Product is not useful to utility customers.

Mitigation:

- Reduce probability: Provide useful energy saving solutions.
- Reduce impact: Regularly perform surveys to ensure end-user satisfaction.

Initial Risk: **MEDIUM** -> Mitigated Risk: **LOW**



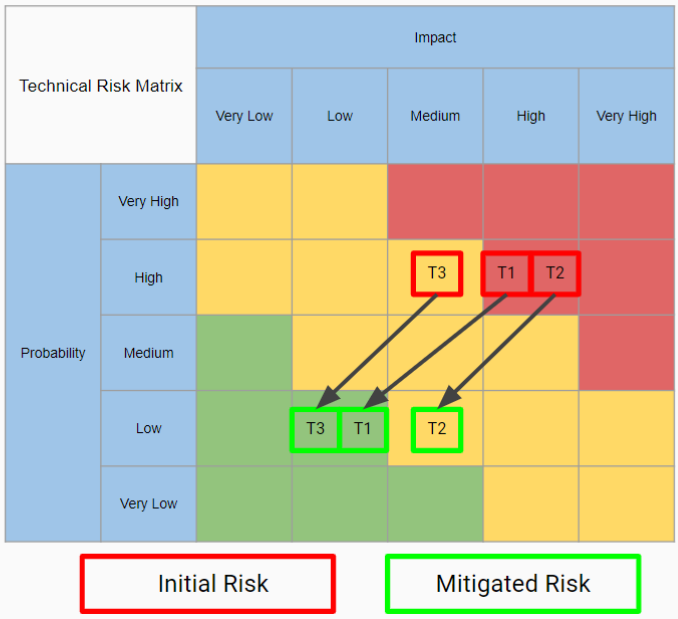
Technical Risks

T1: Security threats against user data (confidentiality, integrity, and availability).

Mitigation:

- Reduce probability: Implement best practice security features to protect against passive and active attacks
  - Encryption in transit (HTTPS)
  - At-rest encryption
  - Multi-Factor Authentication (MFA)
- Reduce impact: Implement secure data backup and restoration using AWS

Initial Risk: **HIGH** -> Mitigated Risk: **LOW**



Technical Risks

T2: Reliance on third-party APIs/Utilities (AWS).

Mitigation:

- Reduce Probability: Perform troubleshooting, proof of concept, and prototyping to ensure functionality
- Reduce impact: Third-party resources may need to change if desired functionality is not initially achieved.

Initial Impact: **HIGH** -> Mitigated Impact: **MEDIUM**

T3: Differing structures of bills may cause problems for automatically extracting billing information.

Mitigation:

- Reduce probability: Identifying key phrases for system to recognize and extract
- Reduce impact: Users may also define what information they would like the system to extract.

Initial Risk: **MEDIUM** -> Mitigated Risk: **LOW**

5. Glossary

5.1. Applicable Riders: temporary rate changes (fluctuate based on weather or demand on the supply system)
5.2. Delivery: cost of materials to transmit natural gas to residence
5.3. Distribution Service: cost of equipment to deliver electricity
5.4. Electricity Supply Svc (ESS): cost of generation, transmission, and fuel to deliver electricity
5.5. Hcf: hundred cubic feet (1 hcf=748 gallons) (measurement for water and natural gas; also known as ccf)
5.6. kWh: kilowatts per hour (measurement for electricity)
5.7. Sales and Use Surcharge: fee charged to recover Energy company's purchase and leases, based on personal consumption
5.8. Supply: cost of the amount of utility delivered ($/unit of measurement)

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