ENER-G VIEW

Team Crystal
CS 410
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ENER-G VIEW

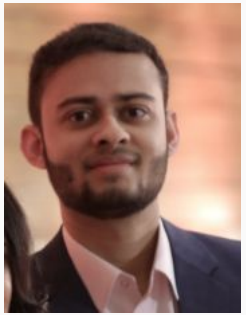
Biographies

Role TBD

Sergiy Yermak is a senior at Old Dominion University and expected to graduate in December of 2021. He is working to attain a Bachelor of Science in Computer Science. Before attending college he served in United States Navy. He enjoys a variety of things from skateboarding, diving, hiking, playing video games, and reading books.

Role TBD

Aubrie Davie is a senior at Old Dominion University pursuing a Bachelor's in Computer Science with a minor in Energy Engineering. She currently leads efforts to achieve sustainability goals set forth by the Department of Energy at Jefferson Lab in Newport News, Virginia. She lives with her husband, daughter, Labrador (Curie), and her Pithuahua (Rocker) on the James River.



Role TBD

Shyam Dhingani is a senior Undergraduate student at Old Dominion University majoring in Computer Science and minoring in Cyber Security. He is also working as a fulltime Python Developer in New York City. He loves to play video games in his free time with his friends and enjoys hiking/biking during the weekends.

Biographies

Role TBD

Kyle Chappell is a Second Degree student at Old Dominion University and is a part of the Computer Science Linked BS/MS program. He is expected to complete the Bachelor's by end of Summer 2021. He works at Fort Belvoir, VA providing data analysis, algorithm development, and other technical services. His hobbies include cooking, audio engineering, drumming, and low-voltage electronics.

Role TBD

Michael Aspinwall is a senior at Old Dominion University majoring in Computer Science. He hopes to graduate in the Winter of 2021. He loves working with computers, programming, and playing video games.

Role TBD

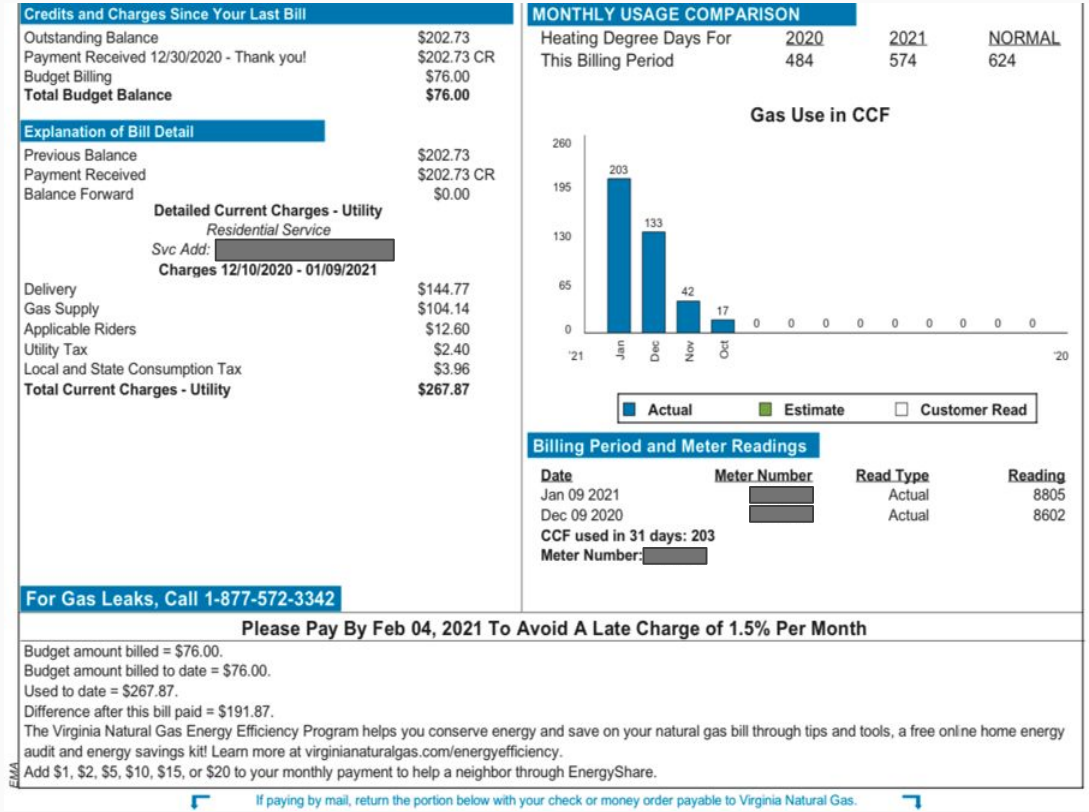
Naresh Khadka is a senior at Old Dominion University pursuing a BS in computer science. He is expected to graduate in the summer of 2021. He also graduated with his first undergraduate degree from ECPI northern Virginia. He lives in Austin, Texas, and works for Samsung Austin Semiconductor as a Senior Technician. He loves to travel and explore new places. He has two kids: one daughter and one son.

Problem Statement

A typical U.S. family spends $2,060 on average per year for home utility bills[1] and the cost continue 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.

Problem Characteristics

- Virginia Ranked 11 Most Expensive in 2020[4]
  - Avg. Monthly Electric: $124.54
  - Avg. Monthly Water: $70.39
  - Avg. Monthly Natural Gas: $74.32
- Natural Gas provides historical data visual on bill
  - Waterworks and Dominion do not
- Data is not centrally located
  - Must have a separate app/website page per utility for data visualization.



Credits and Charges Since Your Last Bill

Outstanding Balance	$202.73
Payment Received 12/30/2020 - Thank you!	$202.73 CR
Budget Billing	$76.00
Total Budget Balance	**$76.00**

Explanation of Bill Detail

Previous Balance	$202.73
Payment Received	$202.73 CR
Balance Forward	$0.00

Detailed Current Charges - Utility
Residential Service
Svc Add: [redacted]
Charges 12/10/2020 - 01/09/2021

Delivery	$144.77
Gas Supply	$104.14
Applicable Riders	$12.60
Utility Tax	$2.40
Local and State Consumption Tax	$3.96
Total Current Charges - Utility	**$267.87**

MONTHLY USAGE COMPARISON

Heating Degree Days For This Billing Period	2020	2021	NORMAL
	484	574	624

Gas Use in CCF

Actual Estimate Customer Read

Billing Period and Meter Readings

Date	Meter Number	Read Type	Reading
Jan 09 2021	[redacted]	Actual	8805
Dec 09 2020	[redacted]	Actual	8602

CCF used in 31 days: 203
Meter Number: [redacted]

For Gas Leaks, Call 1-877-572-3342

Please Pay By Feb 04, 2021 To Avoid A Late Charge of 1.5% Per Month

Budget amount billed = $76.00.
Budget amount billed to date = $76.00.
Used to date = $267.87.
Difference after this bill paid = $191.87.
The Virginia Natural Gas Energy Efficiency Program helps you conserve energy and save on your natural gas bill through tips and tools, a free online home energy audit and energy savings kit! Learn more at virginianaturalgas.com/energyefficiency.
Add $1, $2, $5, $10, $15, or $20 to your monthly payment to help a neighbor through EnergyShare.

If paying by mail, return the portion below with your check or money order payable to Virginia Natural Gas.

Figure 1: Virginia Natural Gas Bill

Problem Characteristics Case Study: Water

- Average family in the U.S. uses more than 300 gallons/day[6]
  - 70% indoor usage
- Household leaks waste nearly 10,000 gallons/year[7]
  - 10% of homes waste at least 90 gallons/day
- Delivery, treatment, and heating of water energy intensive
  - EPA estimates letting a faucet run for 5 minutes is equivalent to 60-watt light bulb running for 22 hours[8]
- Most energy efficient improvements require spending money upfront
  - Energy efficient appliances
    - Dishwasher
    - Washing machine

Figure 2: How Much Water Do We Use?

Problem Characteristics: High Cost of Smart Devices

- Home automation costs an average of $757[17]
  - Most users spend between $182 and $1347
- Installation for complete home automation can cost around $3000[17]
- National Average for smart thermostat: $300[18]
- Smart Faucets:
  - Moen: $430+
  - Delta: $506+
  - Kohler: $875+
- Smart lighting:
  - Bulbs: ~$10+ per bulb
  - Some bulbs require a hub
- Smart hub:
  - HomeAssist: $140
  - Google: $89.99+
  - Amazon: $99.99+
  - Phillips Hue Bridge: $60

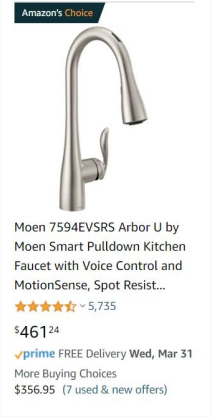


Figure 3: Moen Smart Faucet

Figure 4: Delta Smart Faucet

Figure 5: Kohler Smart Faucet

Figure 6: Honeywell Smart Thermostat

Figure 7: Google Nest Smart Thermostat

Figure 8: Ecobee Smart Thermostat

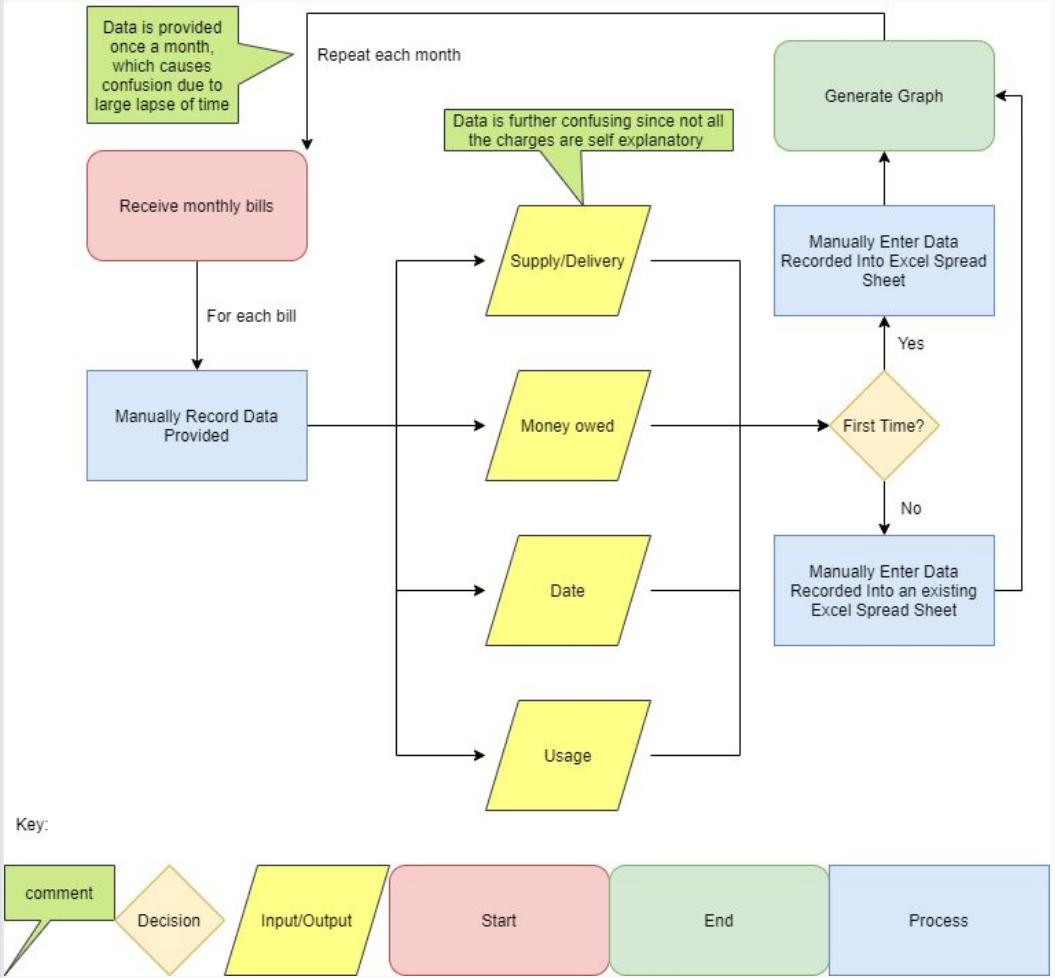
Customers & Users

- Customers:
  - Environmental Nonprofits
  - Insurance Companies
  - Property Management Companies
  - Local Governments
  - Utility Providers
- Users:
  - The average adult who pays utility bills

Current Process Flow

Characteristics:

- Time consuming
- Requires base skills, e.g., Excel Spreadsheet
- Requires manual analysis to be useful
- Data provided is vague due to several factors



Indirect Competition

- Nest Learning Thermostat
  - The Nest thermostat has its own application on which they collect the hours of cooling and heating used each month.
- Water Companies
  - Waterworks: provides numerical historical data on bill, “in-house” designed app with simple usage data (does indicate low, average, and high data), provides no reduction suggestions
- Electric Companies
  - Dominion Energy: application only for electric bill data, their “personalized energy updates” are self-reported home or appliance updates that may or may not reduce cost, bill reminder

Indirect Competition Matrix

Features	Ener-G View	Waterworks	Dominion Energy	Nest Learning Thermostat
Provides Utility Usage Data	✔	✔	✔	✔
Centralizes data for ALL utilities	✔			
Provides Historical Billing Data	✔	✔	✔	✔
Provides Cheap Tips to Reduce Utility Use	✔			-✔
Provides FREE tips to reduce utility use	✔			

Direct Competition

- Flow Assessment System (F.A.S) and Sense:
  - Separate devices used to track electricity and water consumption; F.A.S monitors water usage through a wireless sensor; Sense is connected to a home's main panel box to monitor electricity usage and requires a professional electrician to install the device.
- Honeywell Home:
  - Aggregates Honeywell smart devices into a centralized location to monitor electricity used for heating and cooling as well as security monitors, doorbells, humidifiers, and air purifiers; Provides an alert when a device is in use; Exclusively for the Honeywell brand ecosystem.
- Home Assistant:
  - Aggregates smart devices into one user interface regardless of device brand; Provides a home automation hub to integrate smart devices and allow for centralized device control; Requires a considerable amount of set up and understanding of programming to format the hub to user's unique ecosystem.

Direct Competition Matrix

Features	Ener-G View	Flow Assessment System + Sense	Honeywell Home	Home Assistant
Does not require expensive external hardware	✔			
Provides FREE tips to reduce utility use	✔			
Centralizes data for ALL utilities	✔		✔	✔
Will NOT cause damage due to installation	✔			
Alert user to sharp usage increases	✔	✔		

Solution Characteristics

What we'll do:

- Monthly usage visual for all utilities
- After 1-month, historical usage
  - Historical data per utility
  - Monthly variance as a whole
  - Alert to sharp increases
  - Possible leaks and what to do
- Centralized data
  - All utility data (e.g. usage and consumption)
  - Visualization provided for all utilities
- Include incidental data
  - Outside temperature causes different utility usage
    - Include these factors in analysis by recording local temperature on that day

What we won't do:

- Ener-G View is not designed for paying bills
- Ener-G View will not provide an actual discount
- Ener-G View will not provide real-time usage monitoring
- Ener-G View will not be able to diagnose any type of leak or equipment malfunction

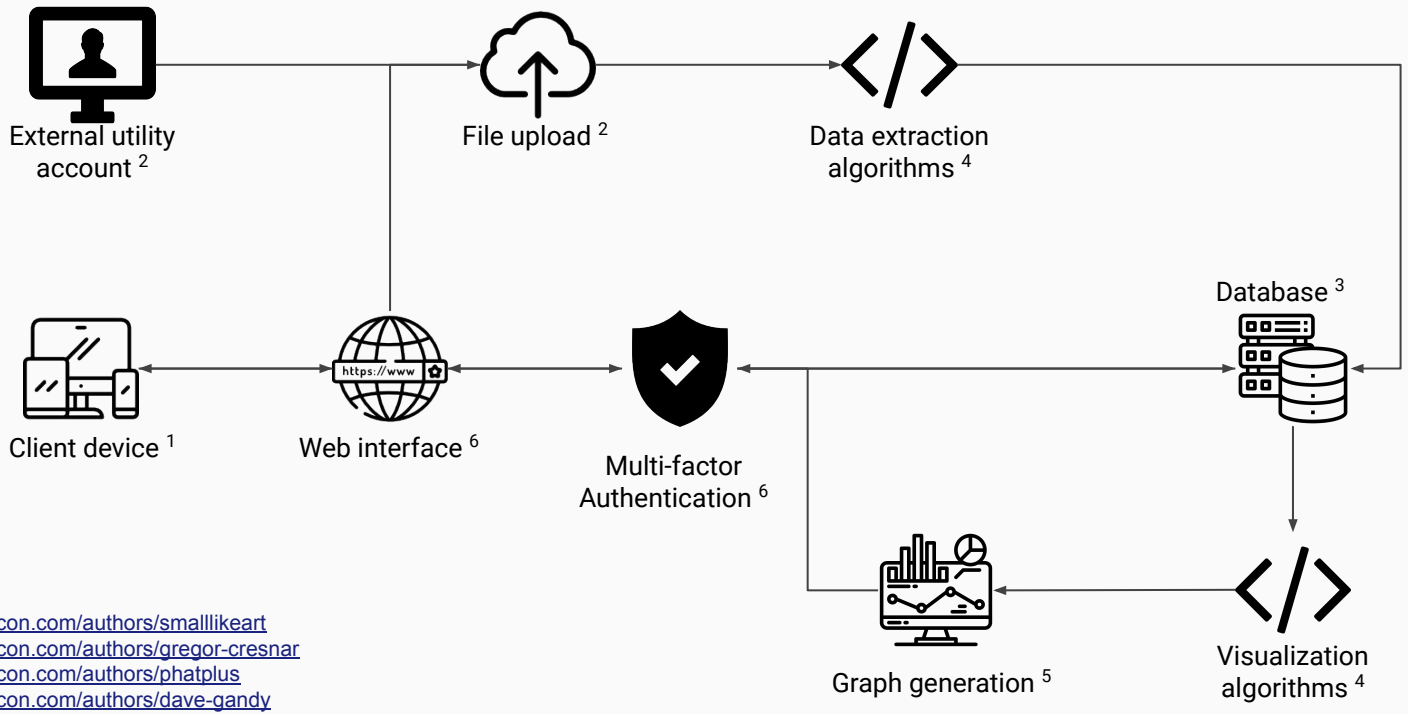
Required Hardware

- Client device:
  - Desktop Computer
  - Smartphone
- Internet Access:
  - Router
  - Mobile hotspot

Aspects of Solution

- User can submit a pdf file or picture
- Optional smart device compatibility
- Notification when bill due date approaching
  - In-app notifications
  - Website alert
- Type of Software:
  - Web Application
- Required Tools:
  - Server and Database: AWS
  - Third-party Python libraries: PyTesseract for optical character recognition on images, PyPDF for PDF parsing, and NumPy for analytics

Major Functional Component Diagram



Icons:

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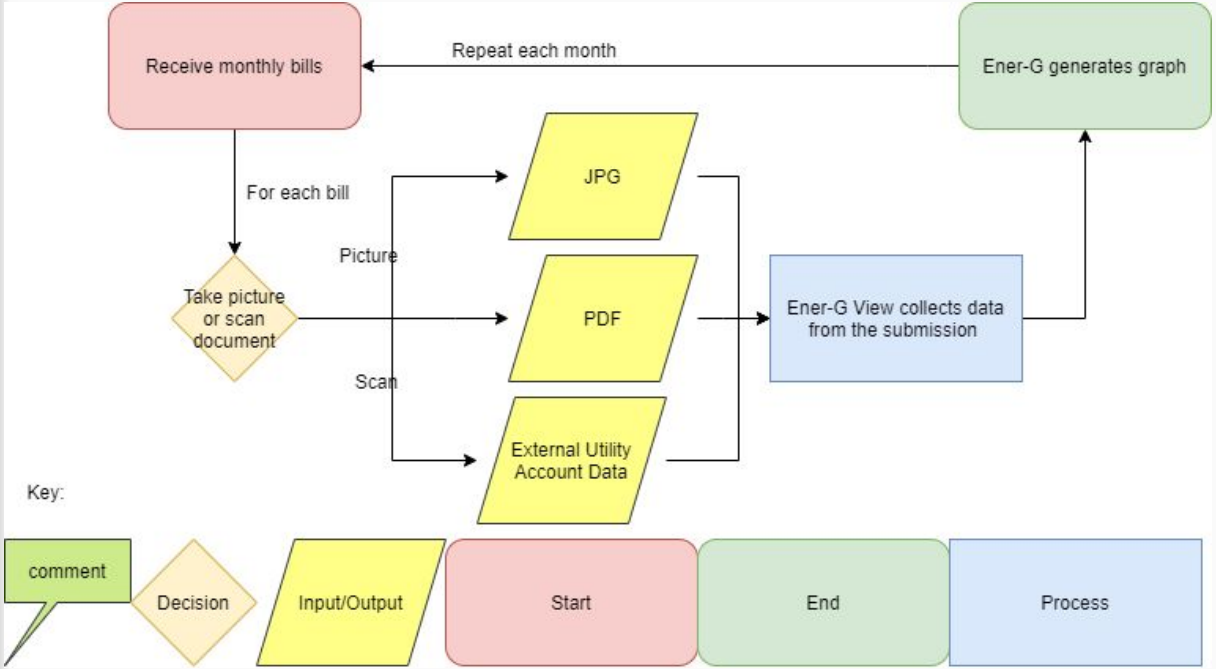
4. https://www.flaticon.com/authors/dave-gandy
5. https://www.flaticon.com/authors/xnimrodx
6. https://www.freepik.com

Solution Characteristics: Bright Ideas

- Avoid using electricity in the early morning and late at night in the winter[12]
- Avoid using hot water in the early morning and late at night in the winter[12]
- Only wash a full load of dishes in dishwasher[13]
- Use cold water as much as possible when doing laundry[16]
- Only wash a full load of clothes[13]
- Consider hand washing small amounts of clothing[13]
- Hang clothes to dry[16]
- Take colder showers in the summer[8]
- Take advantage of windows for natural lighting[14]
- In the spring and fall, use windows to regulate house temperature[14]
- Fill sink to do dishes to reduce water usage[8]
- Reduce shower by 3 minutes[8]
- Reduce peak usage[15]
- Unplug small appliances and devices when not in use[10]
- Turn off lights when exiting a room[11]
- Use lamps instead of overhead lighting[13]
- Avoid using electricity from 1-7pm in the summer[12]
- Avoid using hot water from 1-7pm in the summer[12]
- Use LED light bulbs instead of incandescent or CFL bulbs[11]
- Replace HVAC filters regularly (Every three months)[13]

Solution Process Flow

- Characteristics
  - Single step required by the user
  - Does not require experience with graph generation



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.

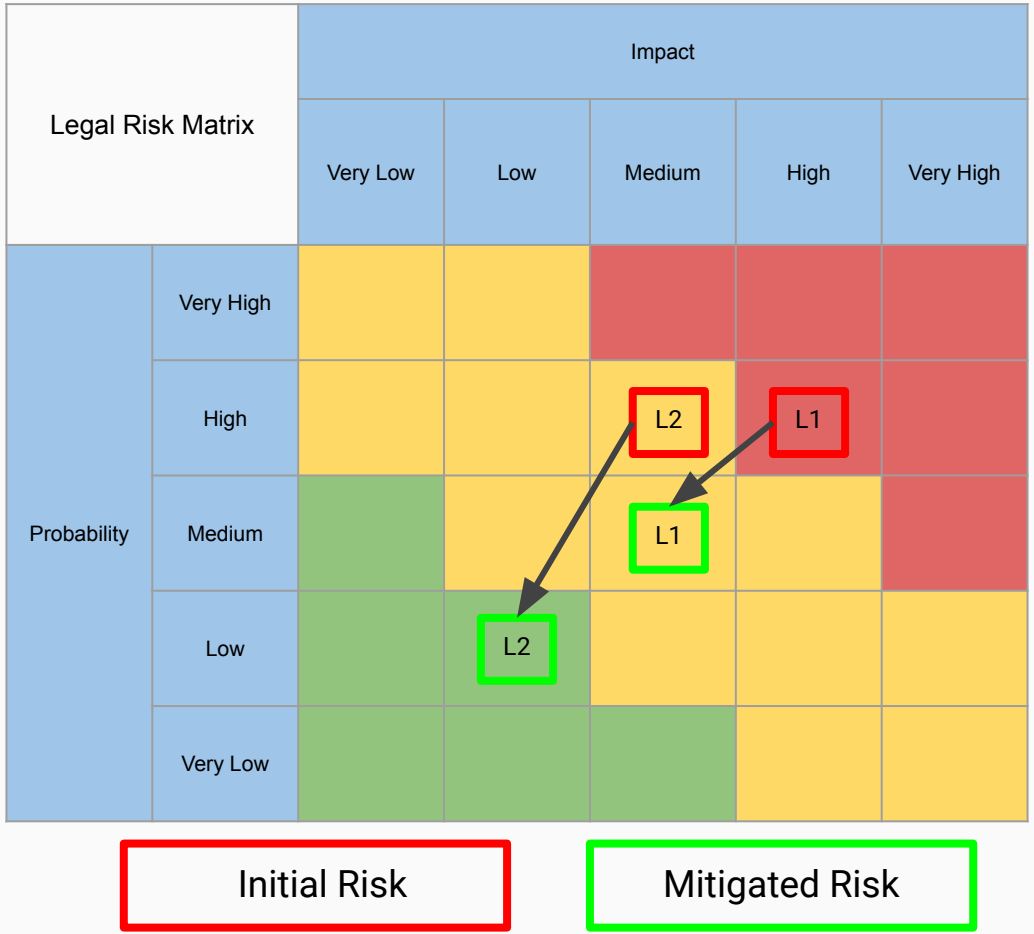
Initial Risk: **HIGH** -> Mitigated Risk: **MEDIUM**

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.

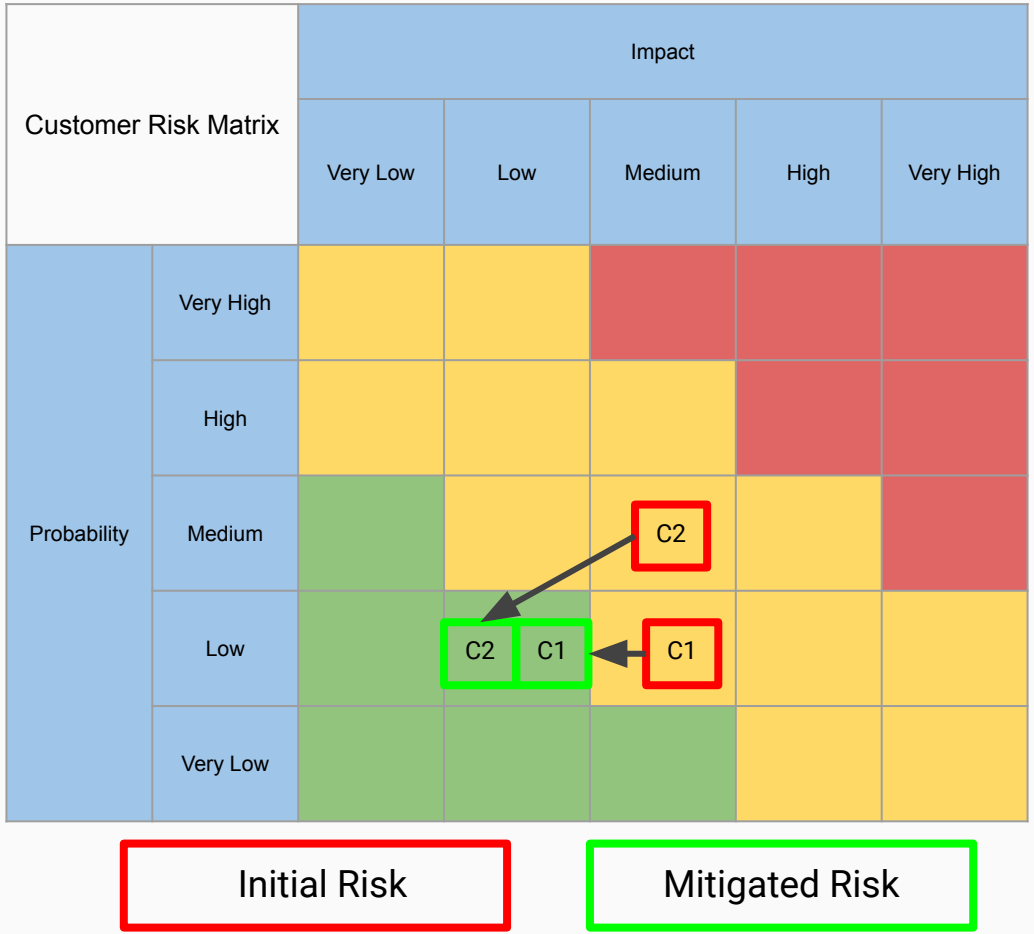
Initial Risk: **MEDIUM** -> Mitigated Risk: **LOW**

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**



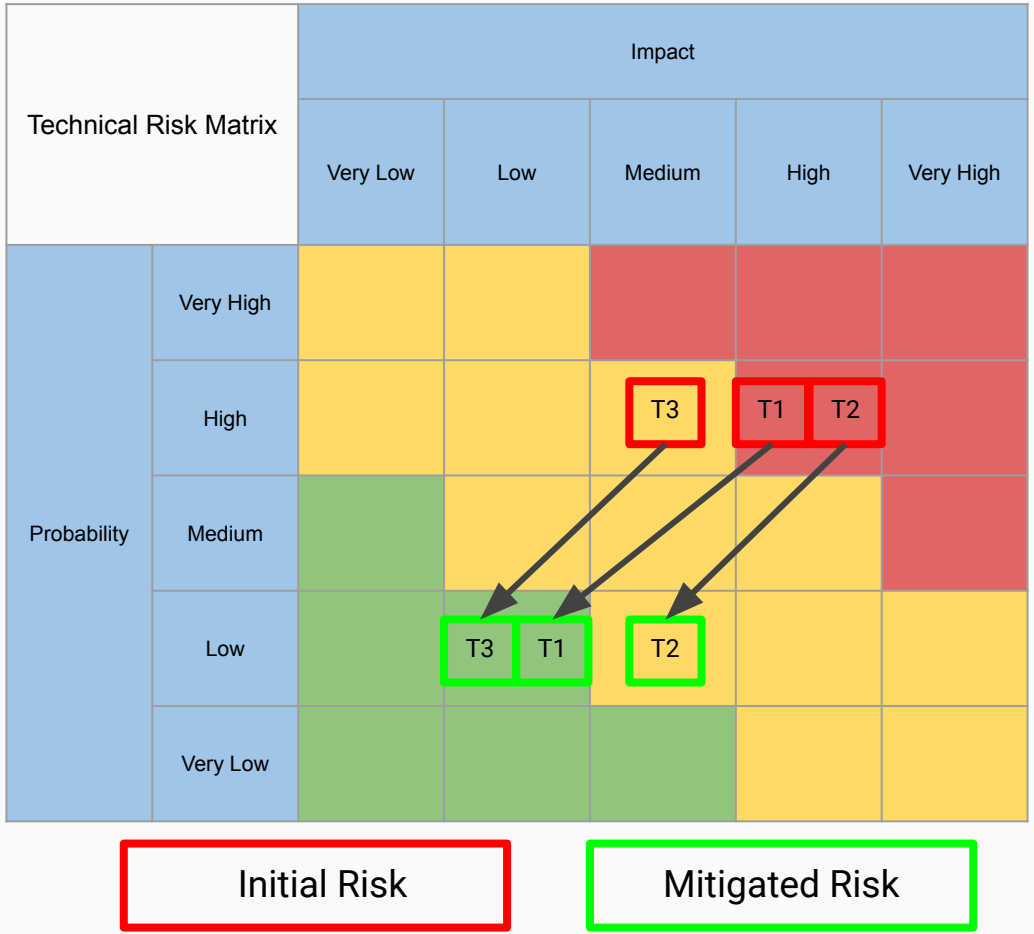
Technical Risks

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.

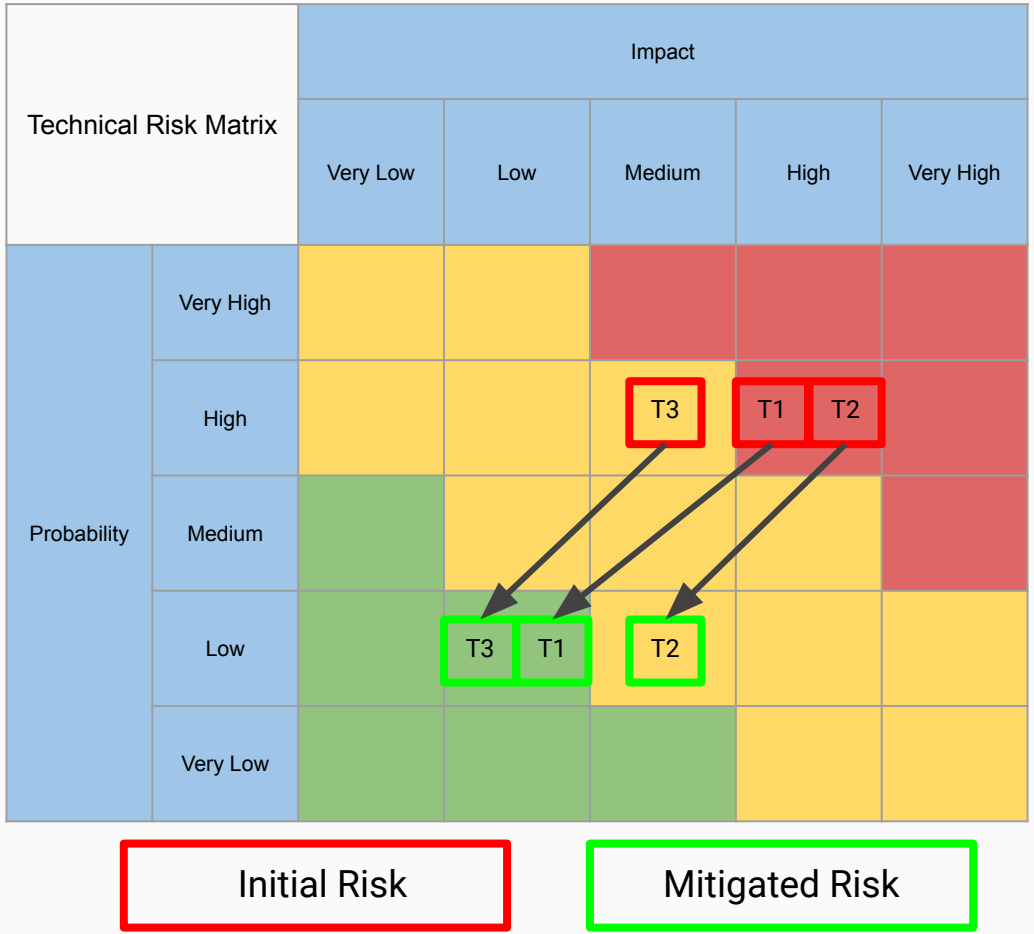
Initial Impact: **HIGH** -> Mitigated Impact: **MEDIUM**

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**



Conclusion

- Current solutions:
  - Require multiple accounts
  - Place the burden on the customer to monitor and reduce usage
  - Place a financial burden on the customer to invest in energy efficient technology to lower their monthly costs
- Ener-G View:
  - Aggregates data from monthly energy utilities in one location
  - Allows users to visualize their usage
  - Provides low-cost tips for reduction leads to a decrease in consumption and cost

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Glossary

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