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Problem Statement

A typical U.S. family spends $2,060 on average per year for home utility bills\textsuperscript{[1]} and the cost continue to rise\textsuperscript{[2]}. With 31\% of U.S. households struggling to pay energy bills and an expected cost increase of 2.4\% by 2022\textsuperscript{[3]}, there is a financial strain on families, which has only increased due to the COVID-19 pandemic.
Problem Characteristics

  - 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.

Figure 1: Virginia Natural Gas Bill [^9]
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

[^6]: Reference [6]
[^7]: Reference [7]
[^8]: Reference [8]

Figure 2: How Much Water Do We Use? [5]
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
Major Functional Component Diagram

Icons:
1. https://www.flaticon.com/authors/smalllikeart
2. https://www.flaticon.com/authors/gregorcresnar
3. https://www.flaticon.com/authors/phatplus
4. https://www.flaticon.com/authors/dave-gandy
5. https://www.flaticon.com/authors/xdnimrod
Competition

- **Natural Gas Companies**
  - VA Natural Gas: provides historical information on bill, has energy audit function (not useful for renters, those in apartments, or owners with minimal knowledge of their home)

- **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
## Competition Matrix

<table>
<thead>
<tr>
<th>Features</th>
<th>Ener-G View</th>
<th>VA Natural Gas</th>
<th>Waterworks</th>
<th>Dominion Energy</th>
</tr>
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<tbody>
<tr>
<td>Provides Utility Usage Data</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Provides App for Individual Utility</td>
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<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Centralizes Data for all Utilities</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provides Historical Billing Data</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Provides Costly Tips to Reduce Utility Use</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Provides FREE Tips to Reduce Utility Use</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 (i.e. usage and consumption) stored in one location
  ○ Visualization provided for all utilities in one location

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
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)\(^{[13]}\)
Aspects of Solution

- User can submit a pdf file or picture
- 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
Solution Process Flow

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

- **Client device:**
  - Desktop Computer
  - Smartphone

- **Internet Access:**
  - Router
  - Mobile hotspot
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**

<table>
<thead>
<tr>
<th>Probability</th>
<th>Impact</th>
<th>Very Low</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very High</th>
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<tr>
<td>Very Low</td>
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</tbody>
</table>

**Legal Risk Matrix**
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

<table>
<thead>
<tr>
<th>Customer Risk Matrix</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very Low</td>
</tr>
</tbody>
</table>

![Risk Matrix Diagram]

Initial Risk | Mitigated Risk
--- | ---
C1 | C1
C2 | C2

Feasibility Presentation
**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 Risk Matrix**

<table>
<thead>
<tr>
<th>Impact</th>
<th>Very Low</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very High</th>
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<tr>
<td>Very Low</td>
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</tbody>
</table>
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
References

References for “Bright Ideas”


   https://www.smithsonianmag.com/smart-news/case-washing-clothes-cold-water-180955459/#~:text=Roughly%2075%20percent%20of%20the%20water%20you%20use%20in%20your%20laundry%20can%20be%20saved%20by%20washing%20in%20cold%20water&text=Many%20people%20believe%20that%20washing%20clothes%20in%20hot%20water%20is%20more%20effective%20at%20cleaning%20than%20washing%20them%20in%20cold%20water%20but%20in%20reality%20hot%20water%20does%20not%20kill%20more%20germs%20than%20cold%20water%20does%20and%20it%20is%20also%20wasteful%20of%20energy.

24
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)