Data Type

Entity	*Attribute*	*Data Type*	*Nullable*	*Description*	*Example*
Household	Email	VARCHAR	Not Null	Max 60-character	user@x.com
	Square Footage	INTEGER	Not Null	10-digit integer	1234567
	Household Types	VARCHAR	Not Null	Max 60-character	apartment
	Public Utilities	VARCHAR	Null	Max 30-character	electric
Heating Thermostat Settings	Temperature	INTEGER	Null	Max 3-digit integer	123
Cooling Thermostat Settings	Temperature	INTEGER	Null	Max 3-digit integer	20
Address	Postal Code	INTEGER	Not Null	Max 9-digit integer	30334
	City	VARCHAR	Not Null	Max 60-character string	Atlanta
	State	VARCHAR	Not Null	Max 2-character string	GA
	Latitude	DECIMAL(8,6)	Not Null	Max 8-digit	33.702657
	Longitude	DECIMAL(9,6)	Not Null	Max 9-digit	-84.439127
Appliance	Appliance Number	INTEGER	Not Null	Max 3-digit number	003
	Model Name	VARCHAR	Null	Max 16-digit character	A134000MB
	BTU rating	INTEGER	Not Null	Max 9-digit integer	123
Manufacturer	Manufacture Name	VARCHAR	Not Null	Max 16-digit character	Samsung
Air Handler					
Air Conditioner	EER	DECIMAL(12,10)	Not Null	Max 10-digit number	55.2040402096
Heater	Energy Source	VARCHAR	Not Null	Max 16-character string	solar
Heat Pump	SEER	DECIMAL(12,10)	Not Null	Max 10-digit number	34.6780402096
	HSPF	DECIMAL(12,10)	Not Null	Max 10-digit number	78.8976402096
Water Heater	Energy Source	VARCHAR	Not Null	Max 16-character string	thermos-solar
	Temperature	INTEGER	Null	Max 3-digit number	88
	Capacity	DECIMAL(12,10)	Not Null	Max 10-digit number	23.8920404020

Power Generation	Power Generation Number	INTEGER	Not Null	Max 3-digit number	001
	Power Gen Type	VARCHAR	Not Null	Max 15-character string	solar
	Average Power	INTEGER	Not Null	Max 9-digit integer	344
	Battery Storage Capacity	INTEGER	Null	Max 9-digit integer	22

Business Logic Constraints

Household

1. A household that does not use any utilities is considered "**off-the-grid**"
2. A household that uses any utilities are considered "**on-the-grid**"
3. Squared-foot cannot be less than zero

Address

4. Postal code cannot be null and must be from United States
5. Cities must be from the United States
6. States must be from the United States

Appliances

7. Newly added households must add at least one appliance
8. Water Heater capacity cannot be less than zero
9. There must be at least one air handler type
10. There must be at least one Appliance entry

Power Generation

11. Battery storage capacity, if available, cannot be less than zero
12. Monthly power generated cannot be less than zero
13. There must be at least one power generator entry for an off-the-grid household.

Task Decomposition with Abstract Code

Main Menu

Task Decomposition

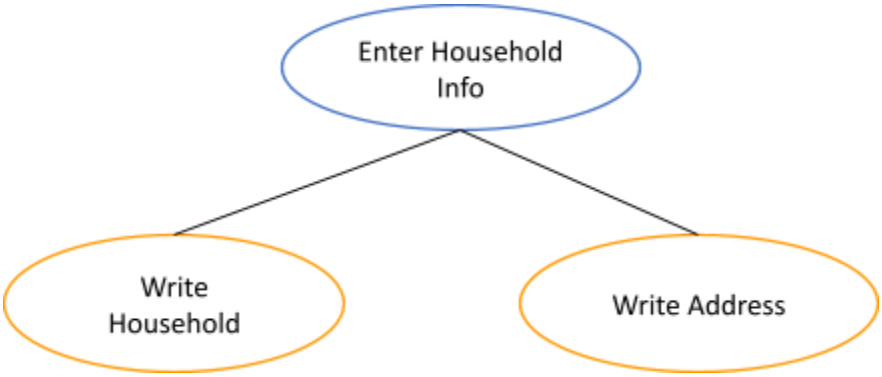
Lock Type	NA
Number of Locks	NA
Enabling Conditions	Accessing the application
Frequency	Low - 100
Consistency (ACID)	Not Critical
Subtasks	NA

Abstraction Code

- Display Link to Enter Household Information
- Display Link to Enter Reports View
- If user clicks Enter my household info, then:
    - Jump to Household Info Form
- If user clicks View reports/query data, then:
    - Jump to Reports list

Household Information Form

Task Decomposition



Lock Type	Write-only on HouseholdInfo and Address
Number of Locks	2
Enabling Conditions	Triggered when clicking Next button
Frequency	Low - 100
Consistency (ACID)	Not Critical
Subtasks	Mother Task is required with following subtasks: - Write Household subtask - Write Address subtask

Abstraction Code

- User enters email address, five digit postal code
- User picks HomeType from the provided List
- User enters square footage for the household
- User can enter temperature for cooling and heating OR check no Heat/Cool checkbox if they choose not to.
- User checks list of public utilities from the checkbox
- When user clicks next button following check will occur:
    - If email address is inside the database, the user should use a different email address
    - Postal code will be validated against the list of postal code provided
- When the check is successful
    - Write user's input into Household table and Address Table
    - Jump to Appliance Form

Appliance Form

Task Decomposition

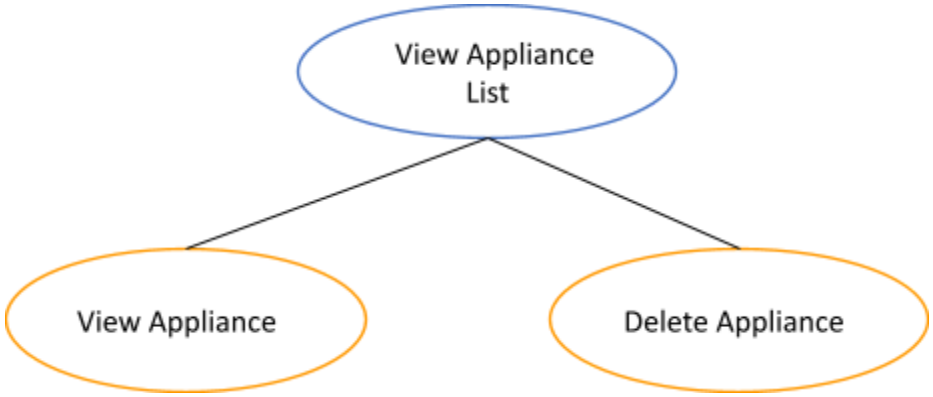
Lock Type	Write only on Appliance
Number of Locks	1
Enabling Conditions	Triggered by Add button
Frequency	High - 500
Consistency (ACID)	Not critical
Subtasks	NA

Abstraction Code

- User picks Appliance type and Manufacturer
- User enter Model name and BTU rating
- User picks Appliance Types:
    - If user picks Air handler for Appliance type, then:
        - Users must pick one or more air handler types that are: Air conditioner, Heater, or Heat pump.
        - If user picks Air conditioner for air handler type, then:
            - User enters Energy efficiency ratio (EER)
        - If user picks Heater for air handler type, then:
            - User picks the energy sources that are Electric, Gas, or Fuel oil
        - If user picks Heat pump for air handler type, then:
            - User enters Seasonal Energy Efficiency Rating (SEER) and Heating Seasonal Performance Factor (HSPF)
    - Else if user picks Water heater for Appliance type, then:
        - User picks an energy source that are Electric gas, Gas, thermosolar, or heat pump
        - User enters Capacity and current temperature
- Upon clicking Add button
    - Write user's input into Appliance
    - Jump to Appliance list

Listing an Appliances

Task Decomposition



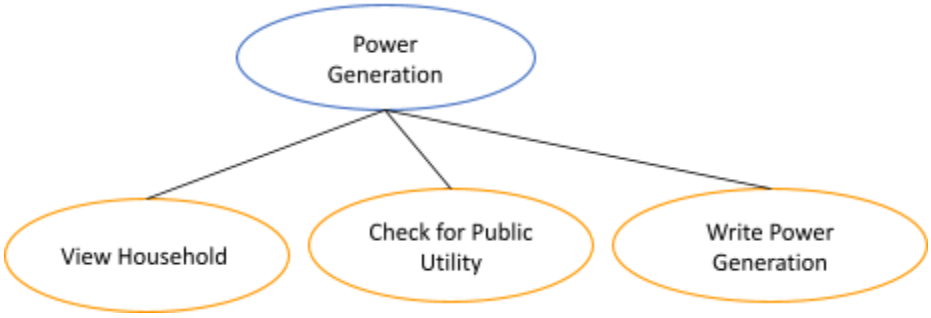
Lock Type	Write and Read on Appliance
Number of Locks	2
Enabling Conditions	Triggered by delete, “+add another appliance”, and next button
Frequency	Mid - 300
Consistency (ACID)	Not Critical; Order is critical for Appliance indexing
Subtasks	Mother task is needed under the following subtasks: ● View Appliances ● Delete Appliances

Abstraction Code

- Get the user’s Appliance Number, Type, Manufacturer, and model from the Appliance and display the corresponding information.
- Upon clicking delete button:
    - Delete corresponding information from the Appliance.
    - Get updated user’s Appliance Number, Type, Manufacturer, and model from the Appliance and display the corresponding information.
- Upon clicking “+Add another appliance” button:
    - Jump to appliance form the page (as described above) and have the user input the appliance information.
- Upon clicking Next button:
    - Check if there is at least one appliance list:
        - throw conditionals error saying there must be at least one appliance list
    - else:
        - Jump to the Power generation form page.

Add Power Generation

Task Decomposition



Lock Type	Read only Household; Write Power Generation
Number of Locks	2
Enabling Conditions	Triggered by Add button
Frequency	Mid - 200
Consistency (ACID)	Not Critical
Subtasks	Mother task is needed under the following subtasks: ● View Household ● Check public utilities ● Write PowerGeneration

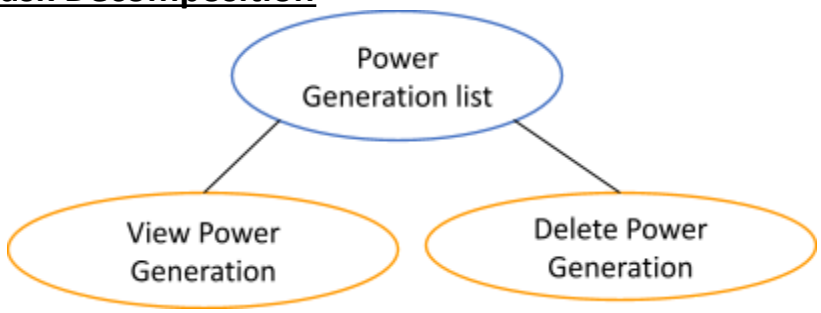
Abstraction Code

- Check if the Current User has a public utilities as “off-the-grid” via Household
- If the user has a public utility as “off-the-grid”, user has to enter the information
    - User picks Energy type
    - User enters Monthly Power Generated and Battery Storage Capacity
        - Battery Storage Capacity can be left out blank, if not applicable
    - Upon clicking Add button
        - Write user’s input into Appliance
        - Jump to Power Generation list
- If the user has a public utility as “on-the-grid”:
    - Skip button will be available, and user doesn’t have to fill out the form
    - If the “skip” button is clicked, then:
        - Jump to Power Generation list
    - User can still enter the information if needed similar to above steps
        - User picks Energy type
        - User enters Monthly Power Generated and Battery Storage Capacity
            - Battery Storage Capacity can be left out blank, if not applicable
        - Upon clicking Add button
            - Write user’s input into Appliance table

- Jump to Power Generation list

Power Generation Listing

Task Decomposition



Lock Type	Read-only -> Power Generation Type, Average Power, Storage Capacity Read-only -> Household Public Utilities Write -> Power Generation List
Number of Locks	3
Enabling Conditions	Triggered by delete, “+add more power”, and Finish button
Frequency	Mid - 250
Consistency (ACID)	Not Critical; Order is critical for indexing
Subtasks	Mothertask is required with following Subtasks: ● View Power Generation ● Delete Power Generation Item

Abstraction Code

- Get the user’s Power Generation Number, Generation Type, Average Power, and Storage Capacity from the Power Generation and display the corresponding information.
- Upon clicking delete button:
  - Delete corresponding information from the Power Generation.
  - Get updated user’s Power Generation Number, Generation Type, Average Power, and Battery Storage Capacity from the Power Generation and display the corresponding information.
- Upon clicking “+Add another power” button:
  - Jump to power generation form page (as described above) and have the user input the power generation information.
- Upon clicking Finish button:
  - Check if there is at least one power generation list for household with “off-the-grid” public utility:
    - throw conditionals error saying there must be at least one power generation for household with “off-the-grid” public utilities:
  - Else:
    - Jump to the Power generation form page.

Reportings

Report 00 - Main Report Menu

Task Decomposition

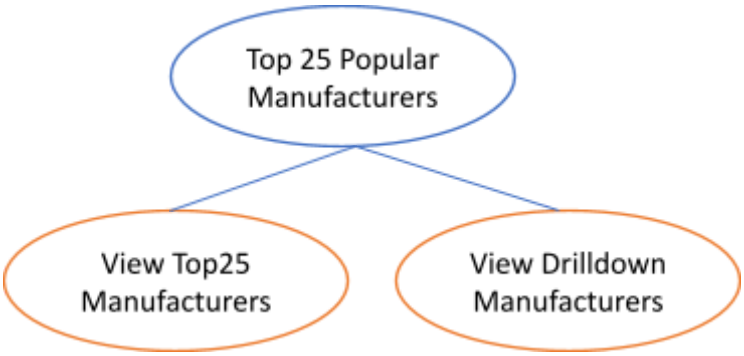
Lock Type	NA
Number of Locks	NA
Enabling Conditions	Triggers upon clicking the list of Reports
Frequency	Low - 100
Consistency (ACID)	Not Critical
Subtasks	NA

Abstraction Code

- Display Link to Top 25 Manufacturers Report
- Display Link to Manufacturer/Model Search Report
- Display Link to Heating/Cooling Methods Detail Report
- Display Link to Water Heater Statistics by State Report
- Display Link to Off the Grid Household by grid status Report
- Display Link to Household average by Radius Report
- Upon clicking a Report link,
    - Direct to the corresponding Reporting Page
- If user clicks back button,
    - Direct to the Main menu page

Report 01 - Top 25 Popular Manufacturers Report

Task Decomposition



Lock Type	Read-only -> Manufacturer Name Read-only -> Appliance Count, Type
Number of Locks	2
Enabling Conditions	Triggered on Clicking “Top 25 Manufacturers” subsection of “View Report”
Frequency	Low - 180
Consistency (ACID)	Not Critical, Order is critical
Subtasks	Mothertask is required with following Subtasks: ● View Top25 Manufacturers ● View DrillDown Manufacturers

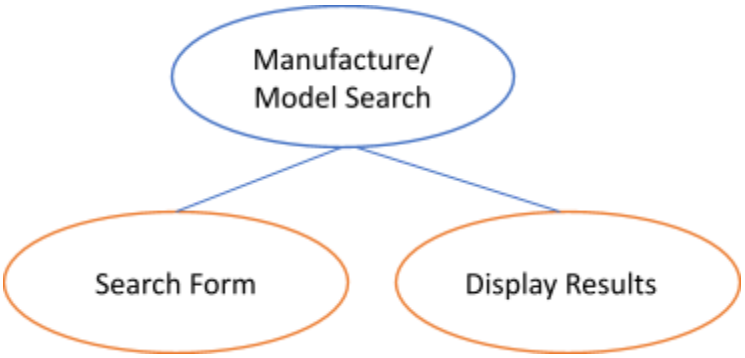
Abstraction Code

- User clicks on **Top 25 Manufactures** button subsection from **View Report** Menu
- Run **Top 25 Manufactures** task.
    - Get list of Manufacturer Name
    - For Each Manufacturer Name display affiliated Appliance Count
    - Order this list by Appliance Count Descending
    - Display only the first 25 of the result.
    - For Each Manufacturer Name display also button – **Drilldown Report**

- Run **Drilldown** sub-task:
    - If **Drilldown Report** button is clicked, then:
        - Get Manufacturer Name displayed at the top of a new report on a separate dialog box.
        - If Appliance Count is NULL, then:
            - display that no affiliated Appliances available.
        - Else:
            - Get Appliance Type and Appliance Count for this Manufacturer Name

Report 02 – Manufacturer/Model Search

Task Decomposition



Lock Type	Read-only -> Manufacturer Name Read-only -> Appliance Model_Name
Number of Locks	2
Enabling Conditions	Triggered on clicking “Manufacture/Model Search” subsection of “View Report”, when search button is clicked
Frequency	Low - 180
Consistency (ACID)	Not Critical
Subtasks	Mothertask is required with following Subtasks: ● Search subtask ● Display result subtask

Abstraction Code

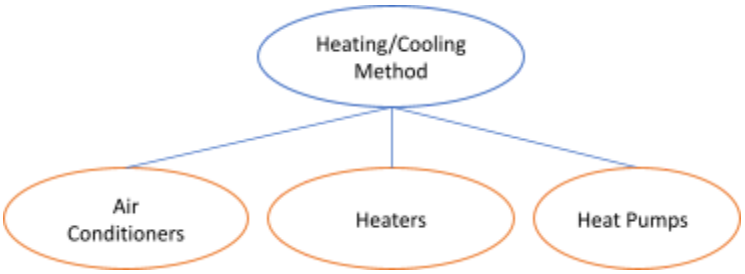
- User clicked on **Manufactures/Model Search** button subsection from **View Report** Menu
- Run **Search** subtask.
    - Show *Keyword* input fields and wait for user input.
    - Show **Cancel**, and **Search** buttons.
    - Upon:
        - Click **Search** button
            - **If** input field is empty, then:
                - Do nothing
            - **Else** validate and verify input before querying the database.
                - Search keywords, case insensitive from both Manufacturer Name and/or Appliance Model_Name
                - Run **Display Result** subtask by returning results and populate the corresponding list.
        - Click **Cancel** button

- Exits out of Manufacture/Model Search and goes back to the reports menu

- Run **Display Result** subtask
  - Show **Back** button at the end of the result table.
  - Return subset of dataset by returning results that meet all criteria populated
    - Get results from Manufacturer Name and/or Appliance Model Name displayed in two columns displayed in Ascending order for both.
      - Search *Keyword* match is case insensitive
      - Search *Keyword* string displayed is highlighted with a light green background.
  - If user clicks **Back** button, then:
    - Exits out of **Display Result** subtask and goes back to **Search** subtask

Report 03 – Heating/Cooling Method Details

Task Decomposition



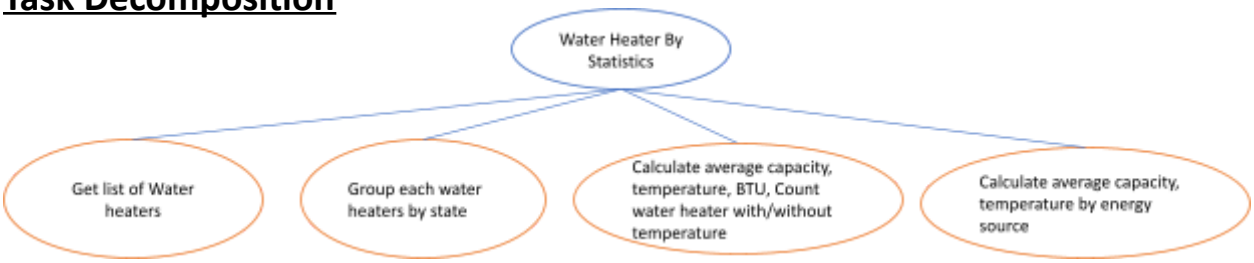
Lock Type	Read-only -> Household Types, Read only -> Air Conditioner Count, Average BTU, Average EER Read only -> Heaters Count, Average BTU, Average SEER Read only -> Heat Pumps Average BTU, Average HSPF
Number of Locks	4
Enabling Conditions	Triggered on clicking “Heating/Cooling Method Details” subsection of “View Report”
Frequency	Low - 180
Consistency (ACID)	Not Critical
Subtasks	Mothertask is required with following Subtasks: ● Grouped by Household types ● Air Conditioner ● Heaters ● Heat Pump

Abstraction Code

- User clicked on **Heating/Cooling Method Details** button subsection from **View Report** Menu
- Show **Cancel** button
- Run subtask - **Grouped by Household Types**
    - Display list of Household Types
    - For each Household Types
        - Get list of available Air Handler and its **Heating/Cooling Method**
    - According to the **Heating/Cooling Method**, display information
        - If **Heating/Cooling Method** is Air Conditioner, then:
            - Display from Air Conditioner -> Count, Average BTU, Average EER
        - Else if **Heating/Cooling Method** is Heaters Count:
            - Display from Heaters -> Count, Average BTU, Average SEER
        - Else **Heating/Cooling Method** is Heat Pumps:
            - Display from Heat Pumps -> Average BTU, Average HSPF
- If user clicks **Cancel** button, then:
    - Exits out of current page and goes back to the main **Report Menu**

Report 04 – Water heater statistics by state

Task Decomposition



Lock Type	Read-only -> Household Read-only -> Address state Read-only -> Water Heater
Number of Locks	3
Enabling Conditions	Triggered by clicking on “Water Heater statistics by State” subsection of “View Report”, and when button for drilldown report is clicked
Frequency	Low - 180
Consistency (ACID)	Not Critical
Subtasks	Mothertask is required with following Subtasks: ● Get a list of Water heaters ● Group Water heaters by State ● Calculate average capacity, temperature, BTU, and count Water heater with Null ● Calculate average capacity, temperature, by each energy source in a state

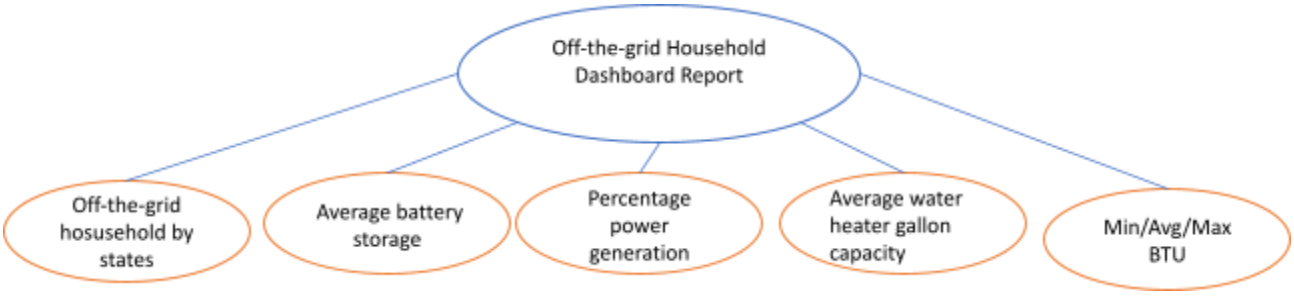
Abstraction Code

- User clicked on **Water heater statics by state** button subsection from **View Report** Menu
- Show **Cancel** buttons
- Run subtask - **Get a list of Water heaters:**
    - Get a list of all Water heater Appliances
- Run subtask - **Group Water heaters by State:**
    - Group all the Water heater Appliances by Address state by using Appliance appliance number, Household email, and Address postal code
- Run subtask - **Calculate average capacity, temperature, BTU, and count Water heater with NULL:**
    - For each state that has Water heater:
        - Calculate average the Water heater capacity and round them up by whole number.
        - Calculate average the Water heater BTU rating and round them up by whole number.
        - Calculate average the Water heater temperature and round them up by tenths.

        - Count all Water heater where Water heater temperature is Null
        - Count all Water heater where Water heater temperature is not Null
    - For the state that doesn't have any Water heater associated:
        - All values will be 0.
    - Consolidate information for each state and sort it by state Abbreviation in an ascending order.
    - If user clicks **Cancel** button, then:
        - Exits out of current page and goes back to the main **Report Menu**
- When the user clicks on the link for each state provided in a row, drill-down report will be displayed for the selected State.
- Run subtask - **Calculate average capacity, temperature, by each energy source in a state:**
    - Show **Back** button at the end of the drilldown report.
    - For each drill down report:
        - Get a list of all Water heater Appliances for the selected State
        - Group the Water heater appliances by each Water heater energy_source
        - For each energy source:
            - Get MIN Water heater capacity and round them up by whole number.
            - Calculate average the Water heater capacity and round them up by whole number.
            - Get MAX Water heater capacity and round them up by whole number.
            - Get MIN Water heater Temperature and round them up by whole tenths.
            - Calculate average the Water heater Temperature and round them up by whole tenths.
            - Get MAX Water heater Temperature and round them up by whole tenths.
        - Consolidate information for each state and sort it by energy source in an ascending order.
    - If user clicks **Back** button, then:
        - Exits out of the current page and goes back to **Water heater statistics by state** page.

Report 05 – Off-the-grid household dashboard

Task Decomposition



Lock Type	Read only - > Household, Read only - > Address, Read only - > Appliance, Read only - > Power Generation
Number of Locks	4
Enabling Conditions	Triggered by clicking view Off-the-grid Household Dashboard Report
Frequency	Low - 180
Consistency (ACID)	Not Critical
Subtasks	Mothertask is required with following Subtasks: ● Group by household types ● Off-the-grid household by states subtask ● Average battery storage subtask ● Percentage power generation subtask ● Average water heater gallon capacity subtask ● Min/Avg/Max BTU subtask

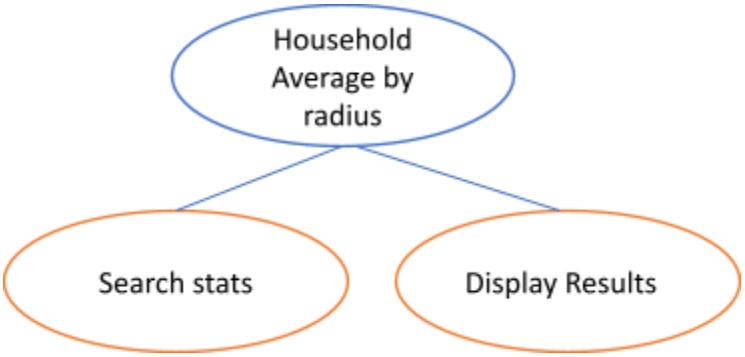
Abstraction Code

- User clicked on **Off-the-grid Household Dashboard** button subsection from **View Report** Menu
- Display **Cancel** button
- Group by household types (off/on-the grid)
- Run the following records:
    - Run subtask - **Off-the-grid household by states**
        - Get zero public utilities count from the Household and group them by state.
        - Get the maximum household counts.
        - Display the values with the columns of state and its off-the-grid counts in the report.
    - Run subtask - **Average battery storage subtask**

        - Get the average battery storage value with zero public utilities count from the Household and Power Generation
        - Round the average battery storage value in the whole number
        - Display the average battery storage values with the columns of the off-the-grid household in the report.
    - Run subtask - **Percentage power generation subtask**
        - Get solar-electric, wind, and mixed counts from the power generation
        - Get the percentage values for solar-electric, wind and mixed in decimals rounded by tenths.
        - Display the percentage of power generation values with the columns of solar electric, wind and mixed in the report.
    - Run subtask - **Average water heater gallon capacity subtask**
        - Get the average water heater gallon capacity with zero public utilities count from the Household and Appliance. (for off-the-grid)
        - Get the average water heater gallon capacity with the ones with at least one public utility count from the Household and Appliance. (for “on-the-grid”)
        - Get the average water heater gallon capacity for both off-the-grid and “on-the-grid” and round them up by tenths.
        - Display the average water heater gallon capacity with the columns of on/off-the-grid in the report.
    - Run subtask - **Min/Avg/Max BTU subtask**
        - Get the BTU values with zero public utilities count from the Household and Appliance and group them by appliance type.
        - Get the minimum, average, and maximum BTU values and round them up to the whole number.
        - Display the minimum, average, and maximum BTU values for each appliance type in the report.
    - If user clicks **Cancel** button, then:
        - Exits out of current page and goes back to the main **Report Menu**

Report 06 – Household averages by Radius

Task Decomposition



Lock Type	Read-only -> Household Count, Type, Average Square Footage, Average Heating Temp, Average Cooling Temp, Public Utilities, Grid-Status, Read-only -> Address Postal Code, Latitude, Longitude Read-only -> Power Generation Count, Types, Average Monthly Read-only -> Battery Storage
Number of Locks	4
Enabling Conditions	Triggered by clicking on "Household averages by radius" subsection of "View Report"
Frequency	Low - 180
Consistency (ACID)	Not Critical
Subtasks	Mothertask is required with following Subtasks: ● Search stats ● Display Results

Abstraction Code

- User clicked on **Household averages by Radius** link/button subsection from **View Report** Menu
- Display **Postal Code search bar, Radius dropdown**, **Cancel** and **Back** button
- Run Subtask - Search stats
    - When user enters postal code and chooses a radius from dropdown and clicks search button,
        - If the Postal Code exists in the records, then:
            - Show Display Results subtask
        - Else:
            - Display Error Message
    - Click **Back** button
        - Exists out of **Household Average by Radius** report and goes back to search page

- Run Subtask - Display Results
    - Display search parameters: Postal Code and *Search Radius*
    - Return subset of the dataset by returning results that meet all the criteria populated:
        - Distance = Less than or equal to distance between two Postal Code
            - Convert the Latitude and Longitude to radians value
            - Haversine formula used to calculate distance between two points defined by latitude and longitude coordinates as follows:

$$\Delta\, lat = lat2 - lat1$$
$$\Delta\, lon = lon2 - lon1$$
$$a = \sin2\,(\Delta\, lat / 2) + \cos(lat1) * \cos(lat2) * \sin2\,(\Delta\, lon / 2)$$
$$c = 2 * \text{atan2}\,(\sqrt{a}, \sqrt{(1 - a)})$$
$$d = R * c$$

            - Within this radius
                - Display all from Household Count according to Household Type including count = 0.
                - Display from Household -> Average Square Footage, Average Heating Temp, Average Cooling Temp, Public Utilities
                    - Also Display - Grid Status of a Household,
                - Display from Power Generation -> Count, Average Monthly Power Generation
                    - Also Display - Homes with power generation, Most common generation method,
                - if available, Display from Battery -> Battery Storage
            - If the search Radius is 0, show the statistics for the households that are within that postal code.
        - Click **Back** link/button goes to previous screen of subtask - Search
    - If user clicks **Cancel** button, then:
        - Exits out of current page and goes back to the main **Report Menu**