Alternakraft

Project Overview

The purpose of this project is to analyze, specify, design, implement, document, and demonstrate an app your team develops. The project follows the three phases outlined in the Database Application Development Methodology: Analysis & Specification, Design, and Implementation. The implementation must use a fully relational, distinct Database Management System (DBMS) that utilizes tables and supports standard SQL queries. Embedded databases (such as SQLite) may not be used. Tools that generate SQL, map programming objects to database objects, or non-tabular systems that utilize SQL as a data manipulation language are also not permitted. Additional details regarding acceptable project stacks will be communicated in the assignment directions for the project.

The due dates and deliverables that must be submitted for each phase will be provided via Canvas.

When reading through this project description, please make the following assumptions: unless otherwise specified as optional, all attributes are required; unless otherwise specified, if given a list of potential values, choices should be limited to that list; If a set of values is listed with "and/or", combinations of those values are possible, while "or" indicates only a single value is possible; that you should create normalized schemas, and minimize the use of NULL attributes whenever and wherever possible; ensure that you store non-numeric data that appear as numbers (such as street numbers, phone numbers, postal codes, etc.) as strings and not numeric data types; and avoid "catch-all" forms with unnecessary inputs that the user would leave empty or NULL. You also do not need to be concerned about handling concurrent operations that could conflict and introduce inconsistencies in your database.

This spec contains a functional description along with some screen mockups. *The user interfaces depicted in this project description are examples to guide your thinking and are not intended to capture all functionality as described.* You may implement the project UI as a traditional standalone application (e.g., Java GUIs or Python's TkInter) or as a web application (e.g., web scripting languages like PHP or JSP). Remember that your project will not be graded on its aesthetic appeal, but on its functionality.

Do not create any additional functionality that is not mentioned in this specification (such as email notifications, etc.) or attempt to enhance your final product beyond what the specification requires. Adding unwanted functionality can and will impact your grade!

Overview

Alternakraft is a nonprofit organization that wishes to accumulate data regarding households in the United States, specifically around alternative power sources and other household properties. The data collected will be "open" in the sense that anyone will be able to submit their data. Conversely, anyone can browse the selected set of reports available on the Alternakraft website.

Definitions

This section provides some basic details about the things and their properties that the system tracks. Note that some operational attributes may not be mentioned as they might not be an essential property of something. Pay close attention to the functionality section as it may imply operational attributes that may need to be included in your design.

At the core of Alternakraft are *households*. The following details will be collected for a household:

- Email
    - The email address provided will be used to identify the household.

- The square footage of the household, as a whole number
- The household type: House, apartment, townhome, condominium, or mobile home.
- The public utilities that are used by the household: electric, gas, steam, and/or fuel oil.
    - A household that does not use any utilities is considered "off-the-grid".
- The regular thermostat setting, in whole degrees Fahrenheit
    - For heating (required if the household has heating)
    - For cooling (required if the household has cooling)
- Postal code where the home is located (with matching city/state and geolocation)
    - A listing of postal codes with city, state, and their central latitude & longitude will be provided and should be used to validate user input. Entering an invalid postal code should be rejected.
    - This listing of postal codes will not change, and you do not need to worry about updating it.
    - A short sample listing of postal codes is below.

Postal Code	City	State	Latitude	Longitude
55302	Annandale	MN	45.246631	-94.11692
20227	Washington	DC	38.893311	-77.014647
14043	Depew	NY	42.904958	-78.7006
15278	Pittsburgh	PA	40.434436	-80.024817
24062	Blacksburg	VA	37.174227	-80.395698
02472	Watertown	MA	42.371296	-71.18196
07309	Jersey City	NJ	40.73276	-74.075485
00623	Cabo Rojo	PR	18.08643	-67.15222
53031	Hingham	WI	43.639395	-87.915705
60651	Chicago	IL	41.901485	-87.74055
99671	Stebbins	AK	63.511893	-162.27463
97304	Salem	OR	44.970181	-123.08033
81624	Collbran	CO	39.220166	-107.93414
82718	Gillette	WY	43.939968	-105.52445
89317	Lund	NV	38.835421	-115.02628
92232	Calexico	CA	33.026203	-115.28458
30334	Atlanta	GA	33.702657	-84.439127
36879	Waverly	AL	32.733511	-85.55322

For each household, information regarding *appliances* – air handlers and water heaters – must also be collected. Each appliance will be identified by the household it is associated with along with the order it was entered into the system (the first would be identified as "1", the second as "2", etc.). A household may have a single air handler that supports several heating/cooling methods or may have multiple air handlers. All appliances will be associated with a particular manufacturer, which will be chosen from a populated, updatable list retrieved from the database. The submitter may also optionally provide the appliance's model name.

Additional properties for appliances include:

- BTU rating, whole number
- Appliance type
    - Air handler
        - Heating/cooling method

- Air conditioner
  - Energy efficiency ratio (EER), decimal number (to the tenth decimal point)
- Heater
  - Energy source: Electric, gas, or fuel oil
- Heat pump
  - Seasonal energy efficiency rating (SEER), decimal number (to the tenth decimal point)
  - Heating seasonal performance factor (HSPF), decimal number (to the tenth decimal point)

- Water heater
  - Capacity in gallons, decimal value (to the tenth decimal point)
  - Current temperature setting, optional, whole number
  - Energy source: Electric, gas, thermosolar, or heat pump

Finally, *household power generation* information may be collected, which is optional unless a household is "off-the-grid". A household may have none, one or more than one power generator. Many homes also have battery storage, usually exclusive to a single generator, whose capacity must also be recorded. Each power generator will be identified by the household it is associated with along with the order it was entered into the system (the first would be identified as "1", the second as "2", etc.). For each generator, the following information must be collected:

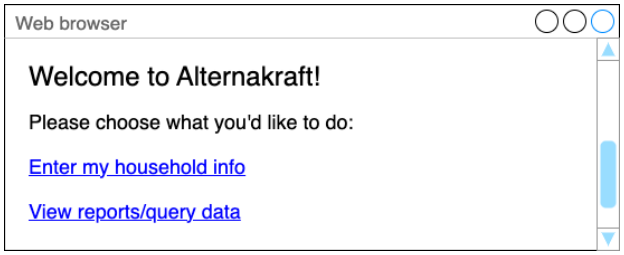
- Generation type: solar-electric or wind
- Average monthly kilowatt hours generated, whole number
- Battery storage capacity in kilowatt hours, optional, whole number

Functionality

The user interface for the application should be consistent, with all inputs appropriately labeled, and with appropriate input controls used (such as a textbox for text, drop-down for a single choice list, spinner for whole numbers, etc.). Any instances where a NULL value might be returned should be replaced with an empty string.

Main menu

When initially accessing the application, a menu with two choices should be displayed: either enter household information, or view reports.



Household Information

When the "Enter my household info" option is chosen, the user will be provided with the following interface to enter their household information into the system. Note that it is not necessary to provide the user with an option to go back and/or be able to change data they have previously entered.

Household info

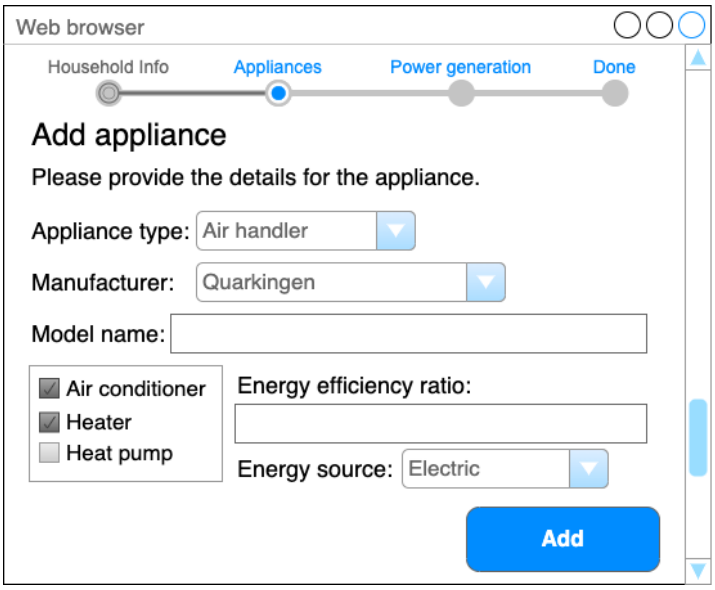
On this page the various properties of the household are captured. Remember to validate user input, such as the postal code entered not matching one listed in the database, an email address that already exists in the database, or requiring a heating/cooling thermostat entry unless the user has indicated they do not have heating or cooling. If these validations fail, an appropriate error message should be displayed. Once the user clicks "next", the information is saved to the database, and the user is taken to the next page.

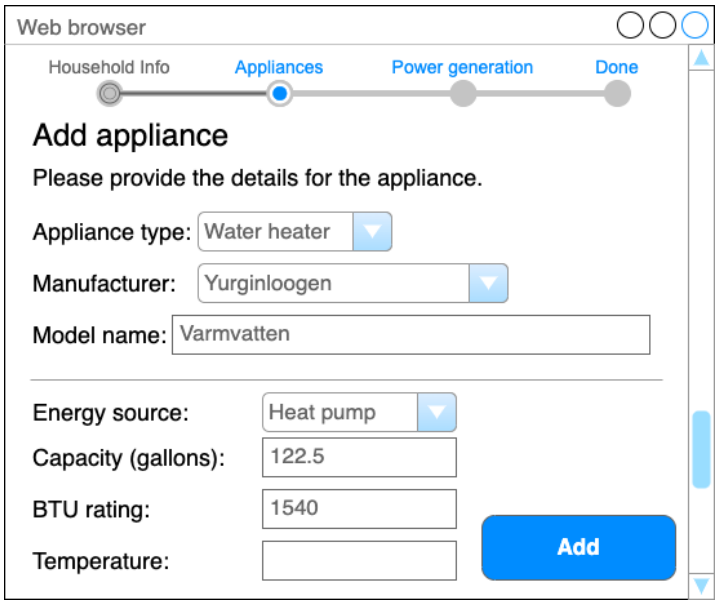
Appliances

Since a newly added household will not have any appliances, the user should first be shown the "add appliance" form.

Add appliance

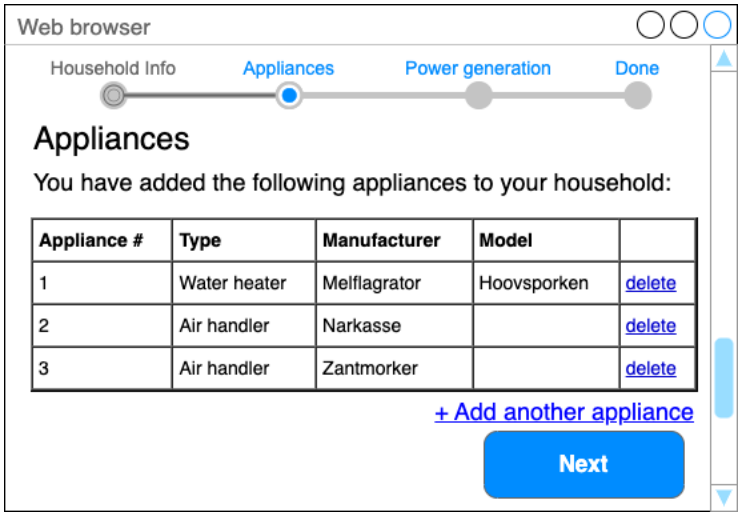
This form is used to add details for the appliance they would like to add. To optimize data entry, the appliance type should be chosen first, after which prompts for manufacturer, model name, and the information specific for that type should be provided. For an air handler, as the user chooses heating/cooling method(s), fields to collect the attributes for that method should be displayed. Data should be persisted to the database when saving from this screen.





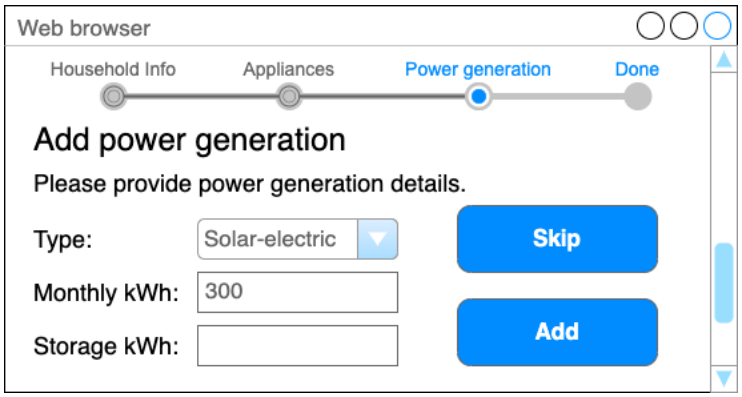
Appliance listing

After adding an appliance, the appliance listing is shown, which will list each appliance's number, type, manufacturer, and model name. Three options should be given on this screen: either to add another appliance (returning the user to the add appliance form), to delete an appliance (if details were entered incorrectly), or to finish adding appliances and move on to the next screen. (While it is unlikely that an appliance will be deleted, if it is, the appliance number should not be re-used. If all appliances are deleted, the user cannot leave this screen until at least one appliance has been added.)



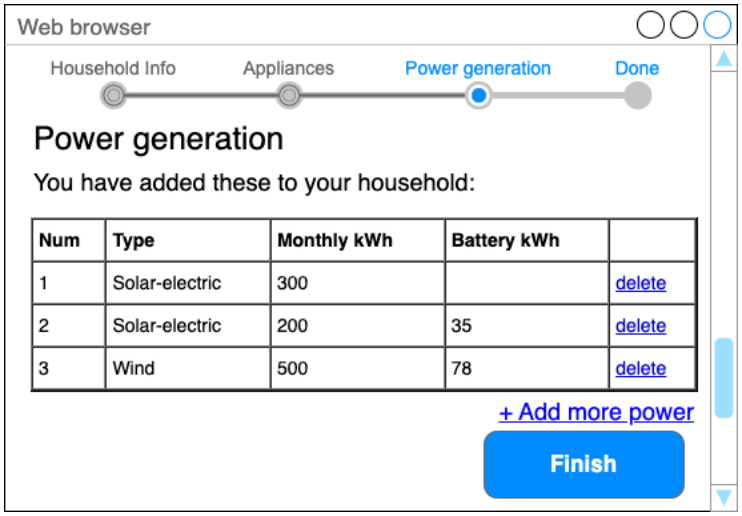
Add power generation

Like appliances, a newly added household will not have any power generation information, so the user should be shown the "Add power generation" form. However, if a household is NOT "off-the-grid", the user has the option to skip this screen and finish submitting their data. If a house is "off-the-grid", no option for skipping should be presented. If the user enters data on this form, hitting "next" will save the entered data and take them to the power generation listing.



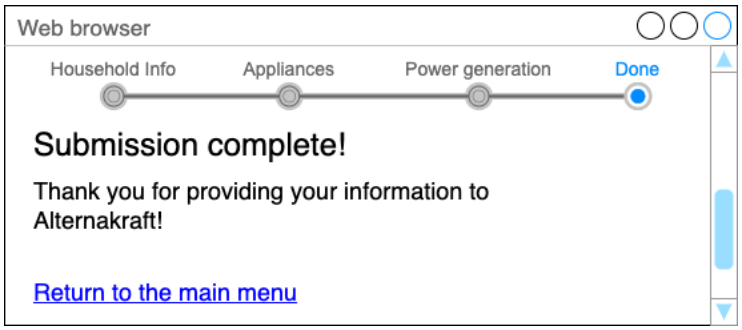
Power generation listing

This form will be displayed after adding a power generation method. For each method that has been entered, the generator type, monthly kilowatt hours, and battery storage capacity (if applicable) are displayed. Three options should be given on this screen: to add another power generation method (returning the user to the add power generation form), to delete a power generation method (if details were entered incorrectly), or to finish and move on to the next screen. (While it is unlikely that a generator will be deleted, if it is, its number should not be re-used. If all generators are deleted and the household is "off-the-grid", the user cannot leave this screen until at least one generator has been added.)



Wrapping up

After the user has finished adding or has skipped power generation information, a thank you message should be displayed to them, with a link to the main menu provided.



Reports

When the user chooses the "View reports" menu option, a list with links to generate each report listed in this section will be displayed. If a report does not require any parameters, it should be displayed immediately. Otherwise, appropriate inputs for the parameters should be displayed along with a "submit" button to execute the report with the parameters. Missing or incorrect parameters should prevent a report from executing, with an appropriate error message shown. Tables, when displayed, must have an appropriate header row.

Some report pages, as defined, can provide information utilizing a single database query and are expected to be written with a single query. In some cases, a report page will require information from multiple queries, in which case the use of multiple queries is acceptable. Whether a report page requires a single query or multiple will not be indicated here and must be determined from the description provided.

In the event a report does not return any results, an appropriate message should be displayed instead of a blank page or an empty table. Any instances where a NULL value might be returned should be replaced with an empty string, unless otherwise specified in the report definition. If a sort order is not specified as ascending or descending, then ascending order is implied. If a number is rounded, unless otherwise specified, it should follow the "half rounds up" method that most DBMSes implement.

No UI mockups are provided for this section.

Top 25 popular manufacturers

This report will list the top twenty-five manufacturers with the most appliances in the database. A column for each manufacturer will be displayed, and a column for the raw count of appliances for that manufacturer (as an integer), ordered by count descending.

In addition, a drilldown report by manufacturer must be provided, which can be accessed with an appropriate mechanism, such as a button or link. The drilldown report for the manufacturer will list the manufacturer name at the top, and then a table with the following details: a column for each appliance type, and a column with the raw count of appliances of that type for that manufacturer (as an integer).

Manufacturer/model search

This report will allow the user to enter any string and return a list of distinct results where the entered string matches (with case insensitivity) any part of a manufacturer name or model name. For example, a search for "air" would match on the manufacturer names "Airsense", "Springaire", "Max Aire" and all models from those manufacturers, or the model name "Fairstone" and its manufacturer. Columns for the manufacturer name and model name must be displayed, ordered by manufacturer name ascending and model name ascending. In addition, the cell with the manufacturer name, model name (or both) that matched the search string must be highlighted with a light green background to indicate to the user which field matched their search term.

Heating/cooling method details

Grouped by household type the following statistics will be displayed, with a column for each:

- The count of air conditioners, average air conditioner BTUs (as a whole number, rounded), and the average EER (as a decimal number, rounded to tenths)
- The count of heaters, average heater BTUs (as a whole number, rounded), and the most common energy source
- The count of heat pumps, average heat pump BTUs (as a whole number, rounded), and the average SEER (as a decimal number, rounded to tenths) and the average HSPF (as a decimal number, rounded to tenths)

Water heater statistics by state

This report will have two parts. In the first, a table with water heater statistics for each state will be displayed: the state's abbreviation, the average water heater capacity (a whole number, rounded),the average water heater BTUs (a whole number, rounded), and the average water heater temperature setting (a decimal number, rounded to tenths), the count of water heaters where a temperature setting has been provided, and the count of water heaters where no temperature setting has been provided, sorted by state abbreviation ascending. If there are no water heaters and/or households for a state, it should be displayed on this report with zeroes for all statistical columns.

In addition, a drilldown report by state must be provided, which can be accessed with an appropriate mechanism, such as a button or link from the state's row in the parent report's table. The drilldown page will show the selected state as a header or report title, and will have a table that contains a column for each energy source, and, grouped by energy source, the minimum water heater capacity (a whole number, rounded), the average water heater capacity (a whole number, rounded), the maximum water heater capacity (a whole number, rounded), the minimum temperature setting , the average temperature setting , and the maximum temperature setting (decimal numbers, rounded to tenths). The rows should be ordered by energy source in ascending order.

Off-the-grid household dashboard

This report will provide different pieces of information on the report page: First, the state with the most off-the-grid households will be listed, along with the count of its households. (This will be the only state-specific statistic, all other statistics will be for all states.) Next, for all off-the-grid households, the average battery storage capacity (as a whole number, rounded) should be displayed. A table will breakdown, for all off-the-grid households, the percentages (as decimal numbers, rounded to tenths) for each power generation type (solar-electric, wind, or mixed). Another table will show the average water heater gallon capacity (as a decimal number, rounded to tenths) for all off-the-grid households, alongside the average water heater gallon capacity (as a decimal number, rounded to tenths) for all "on-the-grid" households. In another table, the minimum, average and maximum (as whole numbers, rounded) BTUs for all off-the-grid households' appliances will be displayed, grouped by appliance type.

Household averages by radius

It is believed that users will be interested to know the household statistics within a certain distance of a postal code. This report will require two user inputs: the postal code to center the search on, and the search radius (a whole number, with the following choices available: 0, 5, 10, 25, 50, 100, and 250). The postal code input should be validated, and if invalid, an appropriate error message displayed. The search radius would include any postal codes whose distance is less than or equal to the distance input. For example, if the user chooses 5, then anything within <=5.0 miles would be returned. A search radius of zero (0) is acceptable if the user wishes to search only within a postal code. The search result should include the postal code, the search radius, and, for the households within that search radius, the count of households, the count of households for each household type (displaying 0 if there are none for that type), average square footage (as a whole number, rounded), the average heating temperature (as a decimal number rounded to tenths), the average cooling temperature (as a decimal number rounded to tenths), which public utilities are used (displayed in a single cell, separated by commas), the count of "off-the-grid" homes, the count of homes with power

generation, the most common generation method, the average monthly power generation (as a whole number, rounded) and the count of households with battery storage.

To determine the distances between postal codes, the *haversine* formula should be used to calculate the straight-line distance between two points. The formula is provided below (additional details can be found at http://www.movable-type.co.uk/scripts/latlong.html, along with examples for utilizing it in database queries). Note that latitude and longitude are expressed in degrees, which must be converted to radians for these calculations, the Earth's radius (approx. 3958.75 mi) should be used for *R*.

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

To better understand using complex functions such as this one within database queries, you should perform this calculation individually every time it is needed instead of using a built-in or custom function. The calculation should not be performed outside of the database.