Project:
Systemize Renewable Energy in Indonesia

Version	1.0.0

Deliverable Template

Date	19/12/2022
Team Name/ID	Polo Rangers

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Challenges/Risk Analysis

Risk	Date the risk is identified	Date the risk is resolved	Explanation on how the risk has been managed
Ensure scalability for a large number of users	21/11/2022	18/12/2022	The system will follow the current regulation of energy transportation in Indonesia, which is monopolized by the State Electricity Company. Therefore, the system will be used by the whole Indonesian population, but would not have grown in the level of the company. However, obviously, the roll out can not be delivered all in one. So we need to do it by batch, which means there are growth of user. Moreover, there are growth of consumer due to the growth of population as well. By using *microservice* to scale our application, we can establish our goal. As microservice runs independently, it is easy to add, remove, update or scale. Accordingly, the system components are distributed in microservices as it will be easier to manage those components.
Track energy consumption up to appliances level on consumer's end	26/11/2022	18/12/2022	Current existing system (traditional grid) only kept the data of energy sent to users, it does not keep the data of energy used by consumer. Therefore, it will be hard to plan for further energy

			efficiencies. By using a smart grid, that leverages the power of digital transformation, we can improve electricity management along with the help of Internet of Things (IoT) technologies and the use of big data.
There might be some unused energy left	30/11/2022	19/12/2022	As we try to maximize the energy production and usage, we will consume all the energy produced, and sell the rest of produced solar and wave energy. The amount of energy that we can sell is based on the differences of energy produced and consumed. The mechanism of exporting will be handled by the energy engineering department, such as undersea cables, high-voltage power lines, or convert to hydrogen gas.
The decision of the appropriate power plant usage	5/12/2022	19/12/2022	Indonesian’s Meteorological, Climatological, and Geophysical Agency have predicted waves and weather for years. However, this data have not been used yet to maximize the scheduling of the production of renewable energy. By analyzing the energy demands, supply, weather, and availability data, we shall automate the decision of which source to be used at a given instance.

State of the Art (SoTA) Analysis

SoTA systems

What I Like	To Improve
Fortum *Strømselskap | Privat | Fortum.no*. (n.d.). Fortum. https://www.fortum.no/ Fortum is an app that provides a platform to monitor your electricity and see what the electricity is used for, get the electricity price, and give energy-saving tips.	Fortum is an app that provides a platform to monitor your electricity and see what the electricity is used for, get the electricity price, and give energy-saving tips. However, this platform only provide single energy input, instead of changeable power plant.
Smart Grid Anderson, Roger & Ghafurian, Reza & Gharavi, Hamid. (2018). *Smart Grid The Future of the Electric Energy System.* Smart grid has software components that have the data for the user power consumption and power distribution, however in order to ensure the optimum power distribution, and keep track of cost and unused energy, we think of reusing it by adding several services to this component.	Calculating energy demands by analyzing the consumption and power supply data. However, there is no comparison of the amount of energy produced and consumption to maximize renewable energy production.
Solar energy prediction - Weather prediction (BMKG) *Badan Meteorologi, Klimatologi, dan Geofisika (BMKG). (n.d.).* BMKG. https://www.bmkg.go.id/ Solar Energy Prediction is the process of gathering and analyzing data in order to predict	Providing weather prediction, but not how many watts are generated. So, we do the calculation based on the weather and the solar panel capacity.

solar power generation at various times with the goal to use solar energy as much as possible, as solar is the cleanest energy among the four plants.	
Marine energy prediction - Weather prediction (BMKG) *Badan Meteorologi, Klimatologi, dan Geofisika (BMKG). (n.d.).* BMKG. https://www.bmkg.go.id/ Marine Energy Prediction is the process of gathering and analyzing data in order to predict marine power generation at various times.	Provide weather prediction and wind prediction, but no wave speed or how many watt generated. So, we will scrape the wave speed from GUI and use wave energy physic formula to calculate how many watt produced from the wave.

Requirements Refinement

Below are the Architecturally significant Requirements of the system;

1. Energy efficiency: The system would be designed and constructed in a way that maximizes energy efficiency and reduces energy consumption.
2. Renewable energy generation: The system would have the ability to generate its own renewable energy, such as through solar, geothermal, marine, and fossil fuel.
3. Unused energy data: The system would have the ability to store data of any excess energy generated, and such energy will be exported to other countries.
4. Energy management: The system would have a system in place to manage and distribute the generated energy, according to the energy production and consumption. The calculation of the energy consumption is with the assumption of zero energy loss on production and transportation.
5. Smart Grid integration: The system would be able to connect to the smart grid and we can potentially get users' appliances consumption.
6. Community involvement: The system would involve residents in residential areas, office personnel, industries managers, and distribution company admins, involved in decision-making and management of energy systems, to promote sustainability and ownership. The system also needs the users to allow the system to read the wattmeter installed in their respective houses.
7. Scalability: The system would be designed to accommodate future growth and expansion.

The following are Non-functional requirements of the system:

- Scalability
- Performance
- Reliability
- Data availability
- Capacity
- Flexibility
- Usability
- Extensibility
- Maintainability
- Environmental

User Requirements

Users would be able to do the following:

- Get appliance usage suggestions based on the weather.
- View real-time energy consumption.
- Predict energy cost and availability

The Smartgrid would perform the following:

- Collect user consumption data.
- Predict the energy demand.
- Keep track of power distribution.
- Collect the unused energy data.

Power Supply Company would perform the following:

- Collect Power Plant Generation data.
- Manage power distribution data.
- Calculates the demand
- Decide which power source to use or ignore at any time based on demand, supply, and weather data.

List of features of the System as regards the users' view;

- Allows users to view and monitor real-time energy consumption
- Users can predict the energy availability
- Users can view how much energy they consume per certain timeframe and where the energy comes from.
- User will get recommendations on energy consumption based on time

List of features as regards the Power distributor (Admins) view:

- Can predict the amount of energy produced by the power plant
- Track the energy consumed by the user overall.
- Turn on/off a particular power plant based on either the weather, supply, or demand.
- View how much energy is used by the user.

View the smart grids of individual localities to check:

- User consumption data each smart grid has received.
- Predict the energy demands per user.

- Receive the power distribution data.

Pitch of your proposal

Below is the link to our proposal video

Video Proposal

Views and Viewpoints

The following are the stakeholders and concerns of our system:

Stakeholders:
Users, the power supply companies in the village, App developer, and Architect

Concerns:
Users: Availability, Cost, Scalability, Usability, Performance.
Power Supply Companies: Energy Consumption, Network and communication, Cost, Usability, Performance, Security.
Architect: Scalability, Performance, Security, Reliability, Availability, Dependability, Network & Communication.
App Developer: Maintainability, Security, Dependability, Performance, Network & Communication, Usability.

	Energy Supply Companies	Users	Architect	Developer
Dependability		X	X	X
Energy Consumption	X	X		
Networking & Communication	X		X	X
Usability	X	X		
Performance	X		X	
Security	X	X	X	X
Cost		X		
Maintainability	X			X
Scalability	X		X	

- **User view:** This addresses the concerns of users and focuses on the functional aspects of the system from the perspective of the users of the system; that is, the performance, dependability, functionality, and usability.
- **Deployment view:** Addresses the concerns of the architect and developer, they focus on how the system is implemented from the perspective of the architect and developer (dependability, networking, and communication, security, maintainability, scalability, performance).

- **Functional view:** This addresses the concerns of the energy supply companies, and concentrates more on energy consumption, performance, security, maintainability, networking and communication

Informal Description of your system and its Software/System Architecture

To ensure loose coupling and high cohesion between different modules plus the availability of the services for example if one service goes down, others should not behave alike and are available, we are using Microservices.

Boundaries:

- Power plant service: Gives data of power being generated at a particular timestamp and the cost

- Energy supply companies:
    - Power distribution: This takes power data from power plant service and consumption data from the user consumption service, compares the supply and demand, and distributes energy fairly.
    - Power resource control: It takes the data from the power plant service, user consumption service, and prediction service to control the power resource at a given timestamp

- User consumption service (home, office, and industry consumption) and takes data from the framework of the wattmeter installed on homes, industries, and offices via the smart grid. And calculates consumption in kWh at a given timestamp individually

- User service:
    - Prediction Service: takes weather data and tells users the appliances to use and at what time to use it.
    - Cost calculation service: At any given timestamp, the service will take the unit consumption data from the user consumption service and the price of energy produced at that timestamp from the powerplant service. It multiplies the unit consumed at that time, with the price and sums it up to calculate the cost by the end of every month

System Description:

This system aims to provide the means to support an association of users with a large location scope in Indonesia. These users will share energy produced from different renewable sources like Solar power plants and Geothermal power plants and help cover their individual energy needs in their various houses or companies. This system will manage energy data received from the power supply company with the focus of letting the energy company know when to change their energy source from 4 energy sources (solar, marine, geothermal, and fossil), allowing the company to efficiently their renewable energy source. The users will also know how much they consume per energy source. This information will be informative as well, for the company, as they can use it as the basis of different charging prices per source. Additionally, the company can predict the demand of the following days, based on the previous consumption data.

Generally, the system will make use of a Smart grid to collect user consumption data, calculate the demand of users based on their consumption, keep track of power distributed and collect unused energy data which will be exported to other countries while the Power Supply Compay will primarily manage the power distribution data and rely on the weather to make a decision on which power source to use per time, and a decision can also be based on demand supply. In summary, the system will be able to maximize the user knowledge about energy costs and availability, minimize energy costs, maximize decision automation and minimize overall CO2 emissions among many others.

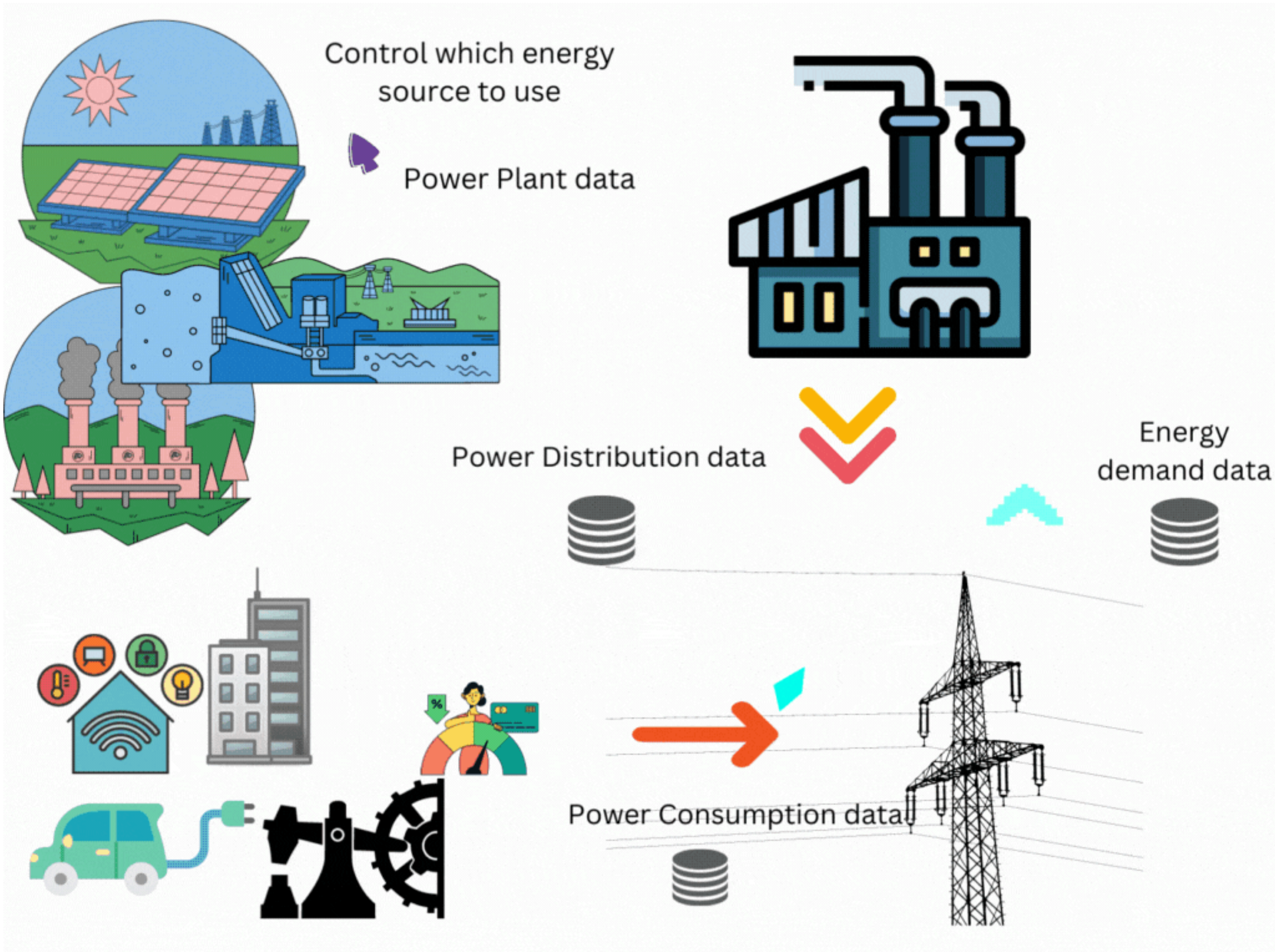

Figure 2: System Description

Prototype Description

Our application consists of two main parts which are

1. Monitor and manage
2. Predict and distribute

Monitor and manage:

It depicts all the user's end, which can be home, offices, and industries. The following are the screens for the user end.

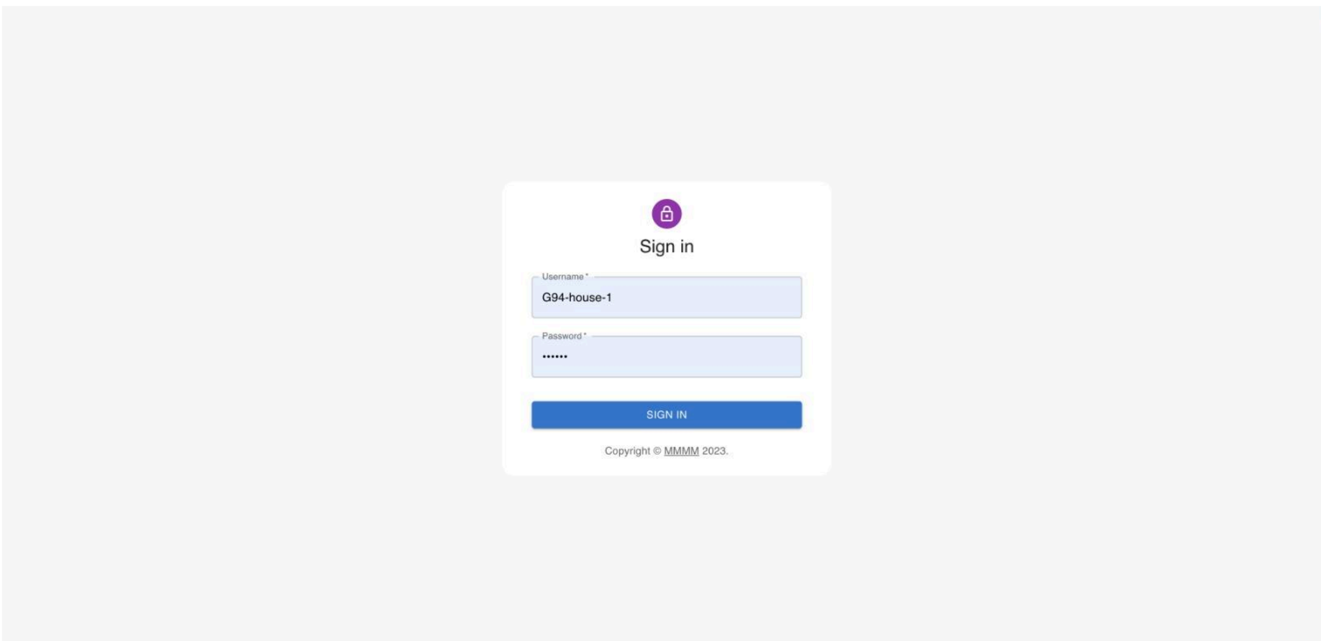

Figure 1: The Figure above shows how the interface allows the user/admin login into the various dashboard of the system

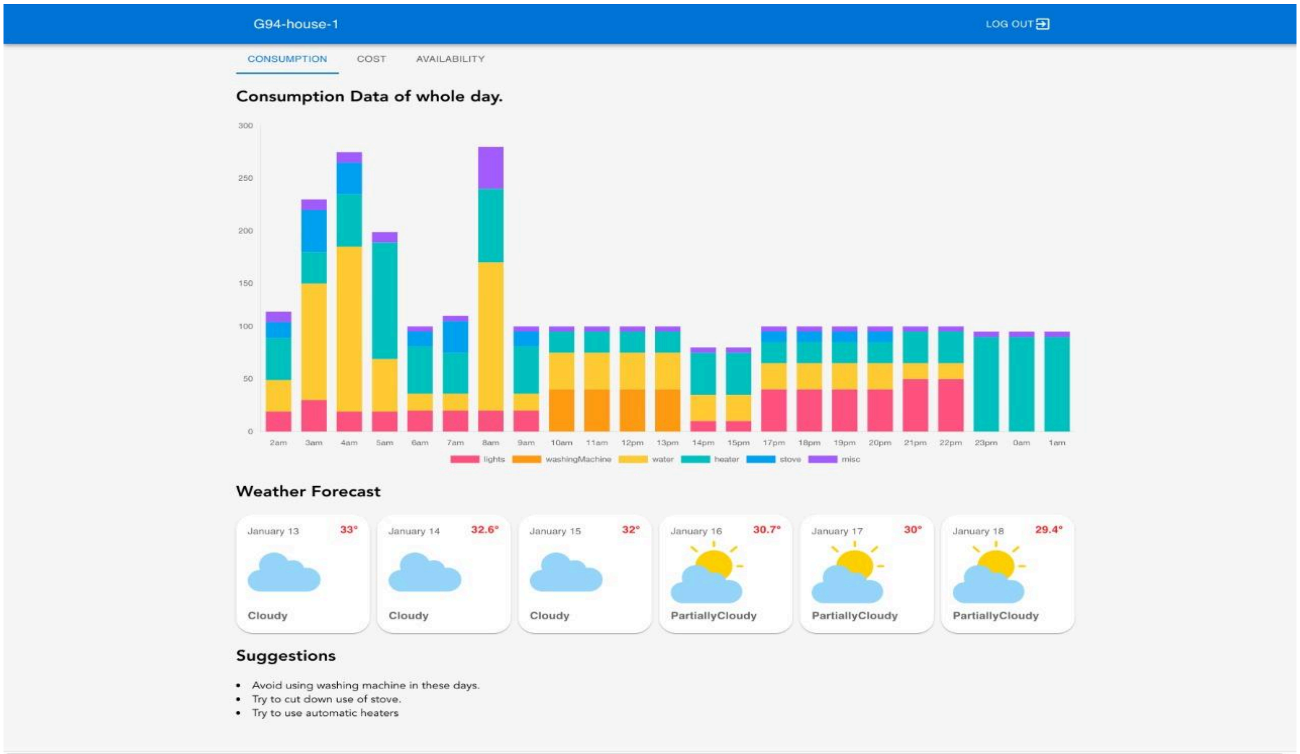

Figure 2: This shows appliance usage per hour and the suggestions based on the weather

Description: This data is taken from the smart grid and it’s been managed inside the user's consumption service. The user consumption service consists of all the appliances' consumption data per hour.

Figure 3: This is the user's dashboard which demonstrates the cost of units consumed by the user per hour. It also shows the cost of all the energy produced per hour, followed by the cost of each energy resource production.

Description: The cost of all the energy resources is coming from the power plant service and the cost graph represented above is the product of the units consumed by the users, coming from the user consumption service and the cost coming from the power plant service having the cost of each energy resource in that particular time.

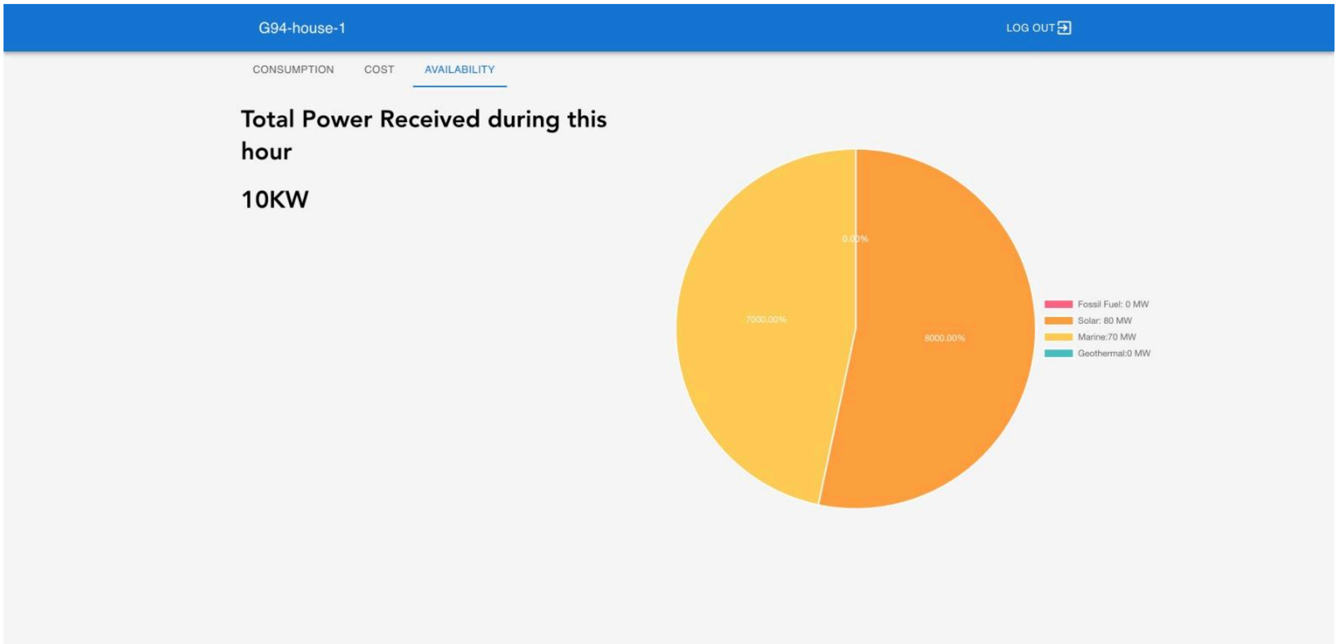

Figure 4: This shows the user the total energy being received in the current hour and the composition of the energy from different energy resources

Description: This data is coming from the power plant service and user consumption service

Predict and distribute

This part we will make use of weather forecast to predict when to use which energy. We will create it as an API which will be one of the micro-services which we will create.

a. Solar energy: we will know how much energy we would get from solar energy by using a dataset to count how many watts are generated. Normally, the power generated will vary based on the weather.
Ex: when there is rain or cloudy, the power generated would be different than on a sunny day.

b. Wave energy: we will use the information about wind speed as it affects the wave speed & high.

c. Geothermal: This is the backup energy so our system will switch to use it only when solar & wave are in a suitable situation to be produced.

d. Fossil: In rare situations, where there is a small change that all of the other renewable energies might not work, so we have traditional energy as the last backup plan.

Badan Meteorologi, Klimatologi, dan Geofisika (BMKG). (n.d.). Digital Forecast for Indonesia.Data.bmkg.go.id.
https://data.bmkg.go.id/DataMKG/MEWS/DigitalForecast/DigitalForecast-Indonesia.xml

Badan Meteorologi, Klimatologi, dan Geofisika (BMKG). (n.d.). Maritime Forecast for the next week. Maritim.bmkg.go.id.
https://maritim.bmkg.go.id/prakiraan/satu_minggu_kedepan/?hari=

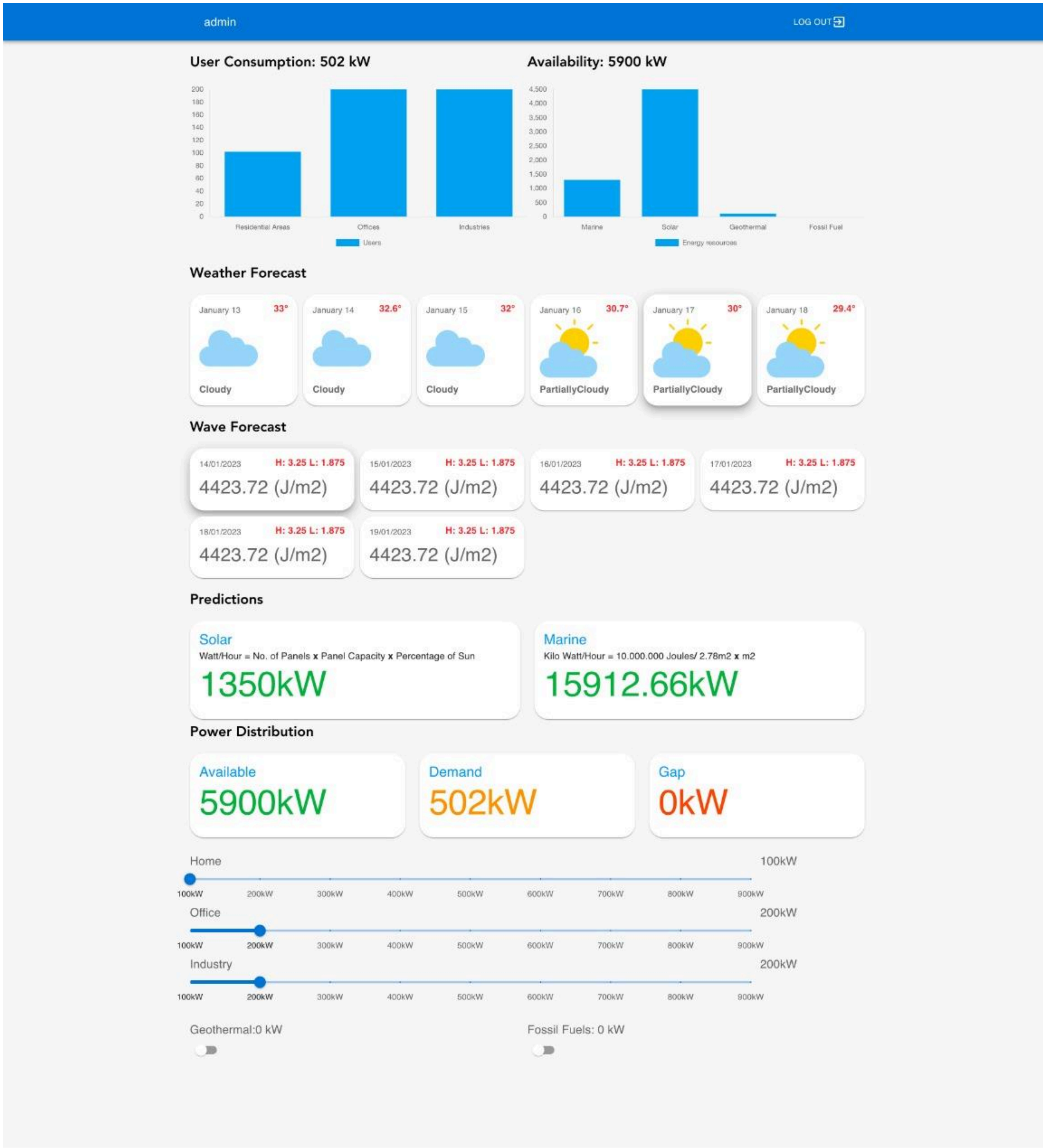

Figure 5: This shows the admin dashboard of the total consumption of the users and the overall energy produced by each energy resource in the current hour. The Weather forecast and wave prediction for the next 5 days and the forecast of solar and marine energy by the selection of any wave and weather prediction. There are adjustment scales for each consumer power distribution, and the

toggles switches depict the state of the geothermal power plant and fossil fuel plant

Description:

The consumption data is the overall summation of the energy consumption in the current hour. This data comes from the user consumption service.

The availability data of each energy resource comes from the power plant service at the current hour.

The weather predictions are coming from the weather API for the next five days. This weather prediction API returns the percentage of the sun, which will be kept to be used in the formula for calculating solar energy.

The system scrapes vertical wave height per day from BMKG (the Indonesian Government Website which publishes the geological prediction). It uses the data to calculate marine energy production prediction for each day.

After the system get the total generated power from the sun and wave, the system will compare the sum of the consumption and the power produced in the current hour. Excess energy will be stored in the database, and the extra energy produced is calculated for selling purposes.

If the demand exceeds the overall production, then two options are given in the form of toggle switches that depict the status of geothermal power plants and fossil fuel power plants.

The power supply company admin can turn on or off the geothermal and fossil fuel plants to meet the high demand shortfall. The draggable scales make it easy for the distributor personnel to manage this power distribution among the users.

Design Decisions

Design Decision 1

Concern (Identifier: Description)		*Con#1: What is important for the quality of the system?*
Ranking criteria (Identifier: Name)		*Cr#1: scalability of the system* *Cr#2: reusability for the developer*
Options	***Identifier: Name***	*Con#1-Opt#1: microservices architecture*
	Description	*Microservices architecture consists of multiple backends having their own databases and own APIs. They can be connected with different multiple frontends or to even one frontend*
	Status	*This option is decided.*
	Relationship(s)	*This decision **is related to** decision Con#2-Opt#1: "Public-Subscribe Pattern"*
	Evaluation	*Cr#1: A Microservices Architecture to ensure scalability is more important because it will be able to handle a large number of users ensuring them the availability of data. The village is prone to expand therefore the application is supposed to cater to more and more users.* *Cr#2: Microservices architecture is a bit complex and hence makes the code limited to reuse.*
	Rationale of decision	*This option is decided because achieving scalability is more important than achieving reusability of code.*
	Identifier: Name	*Con#1-Opt#2: Model View Controller Architecture*
	Description	*MVC architecture is made up of a Model, View, and Controller. The mode consists of a database model, View is a frontend and Controller has the main business logic*
	Status	*This option is rejected.*
	Relationship(s)	-
	Evaluation	*Cr#1: This architecture can't handle multiple users at the same time as compared to Microservices. there is a huge gap between the microservices' performance and MVC's performance* *Cr#2: This option facilitates code reusability to a great extent.*
	Rationale of decision	*This option is rejected because scalability (Cr#1) is not supported by this option sufficiently.*

Design Decision 2

Concern (Identifier: Description)		*Con#2: What design is more important for a Data-intensive system?*
Ranking criteria (Identifier: Name)		*Cr#1: Data Availability* *Cr#2: Security*
Options	***Identifier: Name***	*Con#2-Opt#1: Publish Subscribe Pattern*
	Description	*Publish subscribe pattern works by having an observer subscribed to the data stream, it shall keep listening to it and shall publish data whenever available*
	Status	*This option is decided.*
	Relationship(s)	*This decision **is related to** decision Con#1-Opt#1: "Microservices"*
	Evaluation	*Cr#1: Publish Subscribe pattern will ensure data availability by publishing data to the subscriber. It shows real-time changes in the data to the user whenever something changes from the backend.* *Cr#2: Publish subscribe pattern although keeps listening and publishing streams of data but don't ensure the security.*
	Rationale of decision	*This option is decided because a heavily data relying system is depending on how fast the data is available, therefore security doesn't remain a big concern here.*
	Identifier: Name	*Con#2-Opt#2: Request-Response Pattern*
	Description	*Request-Response pattern works by having a software module send a request to a second software module and wait for a response.*
	Status	*This option is rejected.*
	Relationship(s)	-
	Evaluation	*Cr#1: The request-response pattern only works when the request is generated, compared to the Publish-Subscribe Model.* *Cr#2: Security is more certain with this model because there is a limited number of communications.*
	Rationale of decision	*This option is rejected because data availability(Cr#1) is not supported by this option efficiently. It requires users to request every time to view the changes in the system*

Design Decision 3

Concern (Identifier: Description)		*Con#3: Which renewable energy source should be used?*
Ranking criteria (Identifier: Name)		*Cr#1: Reliability/Predictable, Sustainability* *Cr#2: Availability*
Options	***Identifier: Name***	*Con#3-Opt#1: Solar, Geothermal, Marine, Fossil Fuel*
	Description	*Solar: In average, 2975 hours of sunlight per year, Indonesia still the lowest user of solar energy among G-20 nations* *Geothermal: Indonesia has a huge of geothermal potential in the world since the location of the country is in the ring of fire in volcano line.* *Marine: As an archipelago country with more than 17000 islands, ocean covers seventy percent of the Indonesia archipelago.* *Fossil Fuel: The primary energy supply in Indonesia is mainly based on fossil fuels like oil, gas, and carbon.*
	Status	*This option is decided*
	Relationship(s)	-
	Evaluation	*Cr#1: While Geothermal and Fossil Fuel might not be sustainable, but indeed can be predicted and reliable as well as Solar, and Marine, which are in turn, very sustainable and will be used more.* *Cr#2: Nevertheless, not all of these energy availabilities can be guaranteed at all times.*
	Rationale of decision	*This option is rejected because scalability (Cr#1) is not supported by this option sufficiently.*
	Identifier: Name	*Con#3-Opt#2: Nuclear, Wind*
	Description	*Nuclear is a form of energy that is produced by the controlled splitting of atoms, known as nuclear fission.* *Wind energy is a form of renewable energy that harnesses the power of the wind to generate electricity.*
	Status	*This option is rejected.*
	Relationship(s)	-
	Evaluation	*Cr#1: Though Nuclear energy is sustainable. Nevertheless, it has a lot of controversies and lacks user trust while wind energy is not easily predictable, hence, not reliable.* *Cr#2: However, Nuclear and wind energy have a lot of availability.*
	Rationale of decision	*This option is decided because achieving a reliable and predictable energy source is more important.*

Design Decision 4

Concern (Identifier: Description)		*Con#4: How can this system achieve optimum power distribution?*
Ranking criteria (Identifier: Name)		*Cr#1: Sustainability* *Cr#2: Energy Consumption*
Options	***Identifier: Name***	*Con#4-Opt#1: Smart Grid*
	Description	*A Smart Grid has software and hardware components. It takes care of individuals' energy needs and supplies power very smartly without wasting energy and carbonization.*
	Status	*This option is decided.*
	Relationship(s)	*-*
	Evaluation	*Cr#1: The Smart Grid will ensure individuals' energy needs are distributed equally by accurately calculating energy demands.* *Cr#2: The Smart Grid, will however not fully consider the energy consumption of each user.*
	Rationale of decision	*This option is chosen because achieving sustainability is very important and avoids energy wastage.*
	Identifier: Name	*Con#4-Opt#2: Electric grid*
	Description	*An electric grid is a network of synchronized power providers and consumers connected by transmission and distribution lines and operated by one or more control centers.*
	Status	*This option is rejected.*
	Relationship(s)	*-*
	Evaluation	*Cr#1: Making use of the Electric grid will not help maximize the sustainability goals.* *Cr#2: This option indeed takes into consideration the fairness and consumption of users and energy are being distributed based on usage.*
	Rationale of decision	*This option is rejected because Sustainability (Cr#1) is not supported by this option sufficiently.*

Design Decision 5

<table>
<tr><td colspan="2">Concern (Identifier: Description)</td><td>Con#5: How should the power plant data be managed?</td></tr>
<tr><td colspan="2">Ranking criteria (Identifier: Name)</td><td>Cr#1: Scalability
Cr#2: Consistency</td></tr>
<tr><td rowspan="12">Options</td><td>Identifier: Name</td><td>Con#5-Opt#1: SQL database</td></tr>
<tr><td>Description</td><td>SQL databases are structured databases with relations among entities.</td></tr>
<tr><td>Status</td><td>This option is rejected.</td></tr>
<tr><td>Relationship(s)</td><td>-</td></tr>
<tr><td>Evaluation</td><td>Cr#1: SQL databases don't provide scalability.
Cr#2: However its structured approach ensures consistency.</td></tr>
<tr><td>Rationale of decision</td><td>This option is rejected because scalability (Cr#1) is not supported by this option sufficiently.</td></tr>
<tr><td>Identifier: Name</td><td>Con#5-Opt#2: No-Sql Database</td></tr>
<tr><td>Description</td><td>NoSQL databases are non-tabular databases and store data in the form of documents and in non-relational, unstructured form.</td></tr>
<tr><td>Status</td><td>This option is decided.</td></tr>
<tr><td>Relationship(s)</td><td>-</td></tr>
<tr><td>Evaluation</td><td>Cr#1: NoSQL Database can handle large amounts of data, is flexible in storing data, and ensures scalability
Cr#2: However due to the non-structured approach of managing data, it doesn’t ensure consistency</td></tr>
<tr><td>Rationale of decision</td><td>This option is decided because achieving database scalability is more important than achieving consistency.</td></tr>
</table>

UML Static and Dynamic Architecture View

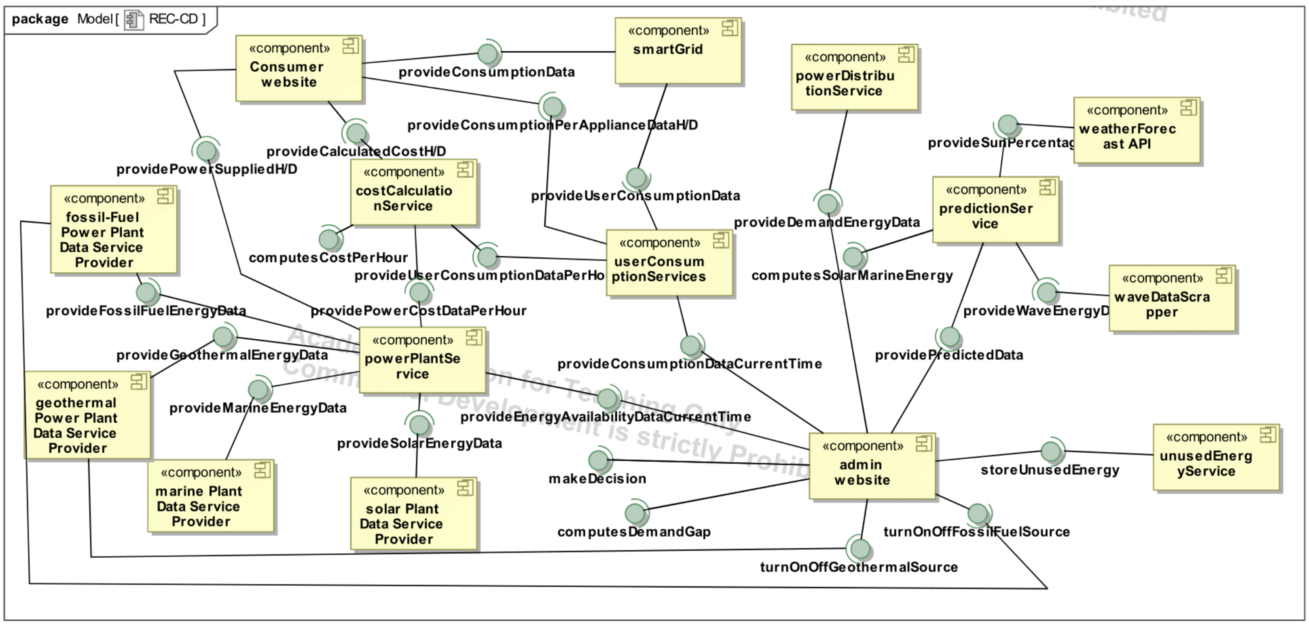

Figure 6, shows the component diagram of the system.

Below are descriptions of the components:

1. Geothermal Power Plant Data Service Provider: This component generates geothermal energy, with data shared with the power plant service.
2. Fossil-Fuel Power Plant Data Service Provider: This component generates fossil fuel energy, with data shared with the power plant service.
3. Marine Plant Data Service Provider: This component generates marine energy, with data shared with the power plant service.
4. Solar Plant Data Service Provider: This component generates solar energy, with data shared with the power plant service.
5. Power Plant service: This component receives power data from different power plants per hour, it holds the data of different power resources, the cost, and the power they produced with the timestamp. It shares data with the distribution company as well as the consumer. Its data is useful for cost calculation.
6. Consumer website: The consumer is the end user of the app, who can keep track of the power consumption cost and availability website. The

consumption data recorded by the user's watt meter goes to the Smart Grid.

7. Smart grid: This keeps track of user consumption on the appliance level and supplies this data to the user consumption service in real-time.
8. User consumption service: The user's consumption service shares data with the admin and the consumer, to keep track of his consumption. Its data is also useful for cost calculation
9. Cost Calculation service: This service utilizes data from the power plant service and user consumption service to compute the cost for units consumed per hour.
10. Admin website: The admin will receive data from the user consumption service to compute the overall energy usage as per the consumer types. This component also receives power plant service to keep track of the energy production per plant. It also uses prediction service and user consumption, based on that the admin gets to decide the demand gap and checks whether the available energy is sufficient to meet the gap, if not, the admin turn on the geothermal or fossil fuel generators. In this component, the admin can also control the power distribution per consumer type.
11. Unused energy service: After calculating the power supplied and the consumption, the gap is determined and the data is stored in the database, while the energy is exported to other countries.
12. Prediction service: This service takes the weather forecast data to compute the sun percentage and the wave data scrapper to compute the marine energy. The sun percentage is used to calculate solar energy. This data is then sent to the admin and consumers.
13. Power distribution service: This service takes data from the admin to store the energy supplied per consumer type. Whenever the admin controls the power distribution from the portal, the change data is supplied to this service.
14. Wave Data Scrapper: The Wave data scrapper provides wave energy data by comparing the high and low waves per beach, this wave data is supplied to the prediction service.

15. Weather Forecast API: This component gives the percentage of sun, date, and temperature. This data is supplied to the prediction service.

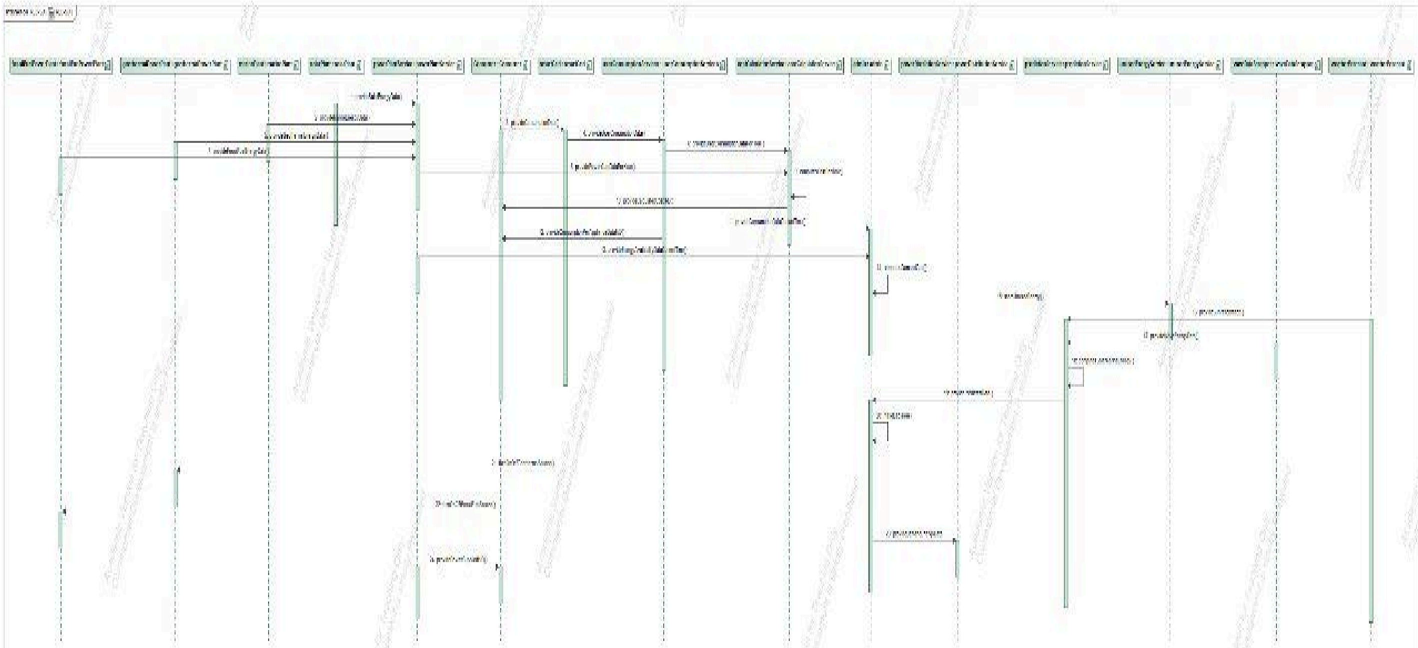

Figure 7: This shows the sequence diagram of the system.

PDF version of diagram: http://tiny.cc/PolloRangersDiagram

- Geothermal, Fossil-Fuel, Marine, and solar Data Service Providers: They all provide cost and power plant data to the service per timestamp.
- Power plant service: This provides the power data of all the energy resources along with the cost in a given timestamp, this data is shared with consumers, admin, and cost calculation service.
- Consumer service: This provides the energy consumption data from the framework of the wattmeter installed by each home, this data can be accessed by the smart grid.
- Smart grid service: This provides the user consumption data per appliance to the user consumption service.
- User consumption service: This gets data from the smart grid about the user consumption per appliance in a given timestamp. This data is useful for cost calculation, admin, and for the user itself to keep track of usage.
- Cost Calculation service: This takes data from the power plant service and user consumption data to compute the cost per hour.

- Admin service: This uses the data from the user consumption service and power plant to compute the demand gap. It also makes decisions on whether to turn on or off the geothermal/fossil fuel plant.
- Unused energy service: This takes data from the Admin to store the unused energy data.
- Prediction Service: This takes data from the weather forecast and Wave data scrapper and computes the solar and marine energy and provides the predicted data to the admin and user.
- Wave Data Scrapper & Weather Forecast API: These provide data to the prediction service.

Implementation Architecture

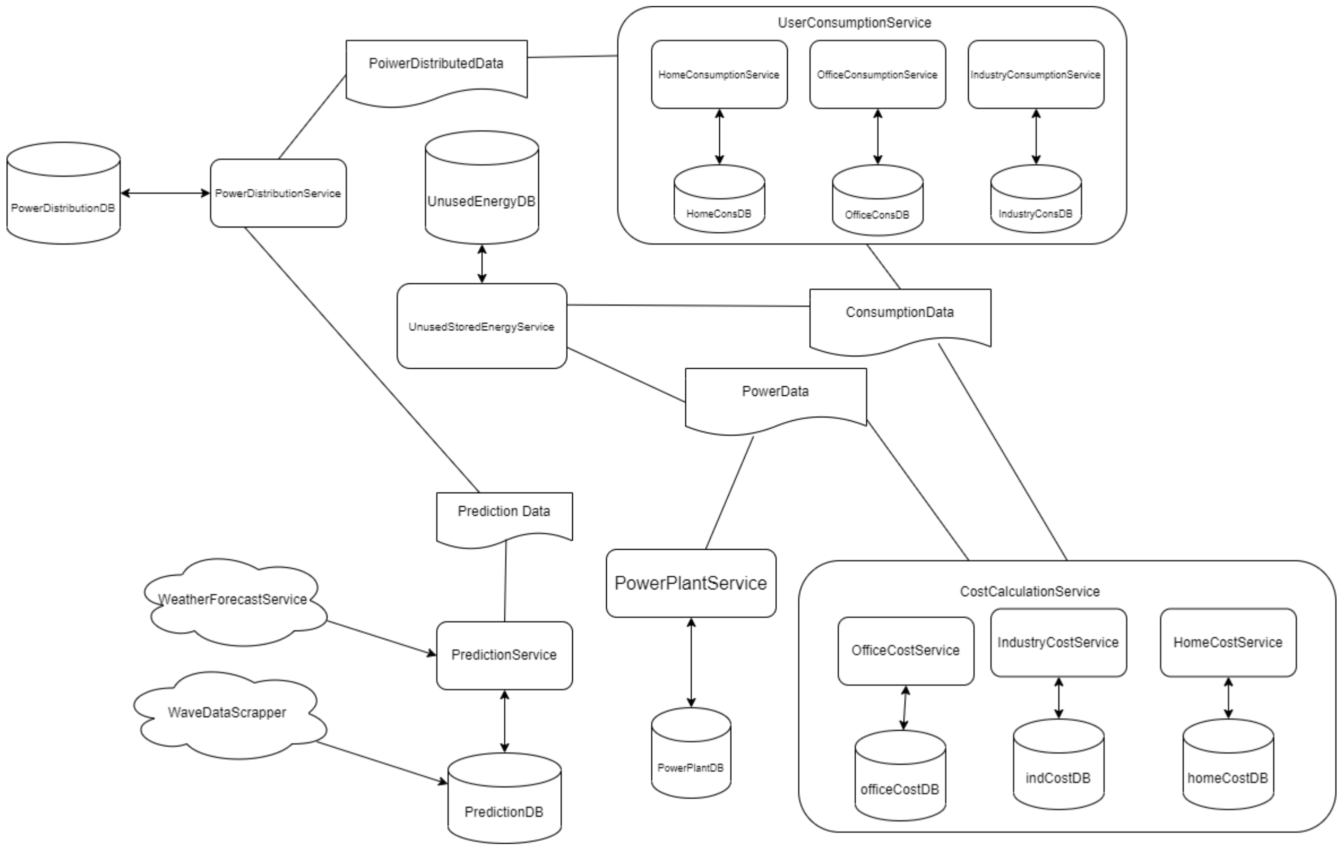

Figure 8: This shows the architecture of the system.

Summary

In summary, the main focus of this project is to create a data management system for a renewable energy community concentrating on Indonesia as the location to maximize the production and usage of renewable energy as much as possible.

The system allows the consumers to see the energy availability. Moreover, It allows users to see their energy consumption per hour and cost. The system also provides suggestions for appliance usage based on the weather.

For the power distributor side, the system allows them to make decisions on whether to turn on or off the geothermal/fossil-fuel plant based on the demand gap. On the other hand, the system also keeps the data of excess production which can be used for selling purposes.

Overall, the system will be able to maximize the user knowledge about energy costs and the availability of renewable energy which minimizes overall CO_2 emissions, among many others, as demonstrated via the components illustrated in this project.