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Research

1. Hardware and software

Hardware

Hardware in the energy sector includes lots of new developing technologies e.g. IoT devices, smart meters, sensors etc.

Embedded systems are used to ensure that wind and solar energy systems are being managed and operated efficiently and they make integrating renewable energy sources into the power grid possible. This can make renewable energy sources accessible to consumers and make their maintenance easier.

Micro controllers and sensors collect data on sunlight intensity, panel temperature and system performance which can allow for real time adjustment to collect the most energy. Microprocessors can also be used in wind turbines to adjust blade pitch, yaw and generator output to maximise energy production and efficiently. Through monitoring with these technologies they can also help us gather data to be used to optimise and improve future systems to gather more energy.

Software

Software can be used to design and test renewable energy systems, this means that different conditions can be simulated to optimise the systems for different types of weather and to be efficient and reliable sources of energy. This can save companies a lot of money and can help persuade consumers to switch to renewable energy sources.

Energy management systems (EMS) can be developed to make the management of renewable systems more efficient by managing power distribution, monitor energy production etc. this ensures that renewable systems can meet consumers demands which will promote more people to use them.

Embedded systems are crucial in battery storage and efficiency. They can monitor battery performance to ensure that they are working as intended. This ensures that energy is being safely and reliably stored and distributed.

Data analytics can be used to identify trends, improve efficiency as data is collected, and help reduce redundant costs. It can also predict energy production, optimise resource allocation and forecast maintenance needs. This can be used to help owners of energy sources from solar panels on

a house to big solar and turbine farms. It drastically improves the maintainability of renewable energy sources and use algorithms and past data to tell a user how much energy they are generating and to adjust as needed with changing weather conditions.

2. Newly Emerging Technologies

Floating solar farms

With a growing population, land is becoming more and more sought after and valuable. This means that using land for solar farms comes at a cost. To combat this, floating solar farms are being developed. They are known as “floatovoltaics”. They can also be more efficient than traditional land solar farms since water’s cooling effect can help maintain optimal panel temperature.

Energy-Generating Roads

New roads are being developed to generate energy by cars being driven on them, they work by turning the stress of vehicle weight on piezoelectric materials into power. This is great to implement into high traffic areas and can be implemented on roads and on pavements.

Green Hydrogen

Hydrogen is an energy dense fuel, that only produces water as a by-product of it burning. Producing hydrogen from renewable sources (green hydrogen) could be a game changer for the renewable energy industry. Especially for things like transport and heating. It leaves no damaging residue like typical energy sources like coal. This makes it a lot safer to be burnt as well because no one is breathing in dangerous by-products.

3. Digital Solutions to Meet User Needs

Digital solutions can be developed to help map out the placement of solar panels on roofs to ensure that they are effective and efficiently generating energy. This can help find the best places to make things like solar farms and to access the reduced energy costs from having solar panels for a homeowner/ landlord.

4. Industry Specific Guidelines

Energy companies have specific guidelines which must be followed to allow compliance with local laws. Like being certified with the correct ISO certificates to ensure that the hardware being used to gather energy are safe and working correctly to ensure the safety of workers and to keep the energy produced consistent for users.

5. Sources

<https://essmag.co.uk/the-role-of-embedded-systems-in-the-energy-sector/>

<https://www.rocketmakers.com/blog/renewable-energy-software>

<https://eliteenergy.co.uk/emerging-renewable-energy-technologies/#:~:text=Energy%20storage%20technologies%20like%20grid,sources%20like%20wind%20and%20solar.>

https://joint-research-centre.ec.europa.eu/jrc-news-and-updates/5-digital-solutions-greener-europe-2022-07-05_en

<https://www.nqa.com/en-gb/certification/sectors/energy>

Proposal

1. Organisation Overview

Rolsa Technologies is a green technology company that specialises in:

- installation and maintenance of solar panels
- electric vehicle charging stations
- smart home energy management system.

They are looking for a solution to help inform customers of the different green energy systems on the market and how to reduce their carbon footprints. As a company they care about renewable energy and systems and educating consumers on such products.

They require a booking a system to allow customers to book installations and consultations, that tells staff where they need to go and when they need to be there by, this can help optimise business practices and increase sales.

2. Problem Overview

Rolsa technologies want a solution to help inform users on green energy products and their carbon footprint. This should be easily accessible to the user (no login required) to promote people to read it and interest them in Rolsa's products to then make an account to enquire about purchasing them.

They also want a booking system to allow users to book consultations and installations of their products. This will require user sign-up and login to ensure that people don't make fake appointments to waste time.

They also want users to be able to calculate their carbon footprint. This could be locked behind sign in to promote making an account or available to the user to further promote Rolsa's products to potential customers.

Problem Overview per User group

Staff

- Staff need a clear portal to look at their appointments so they can be in the right place at the right time.
- The system needs to be web-based to ensure portability on mobile devices as staff may need to travel out to customers properties to evaluate spaces and install products.

Customers

- Customers need to be able to see clear information to show them why they need the product and how it can help them reduce everyday costs and improve daily life.
- Customers need ease of use to make it easy to book an appointment to keep them engaged enough to make an appointments
- the carbon footprint calculator to help them keep track and control over their carbon footprint

3. Scope

Based on the time permitted for development of this system, I will be focusing on building the booking system and carbon footprint calculator. This will ensure that they are produced to the highest quality possible. I will not be focusing on different areas eg marketing, deployment, mobile-first design, payment etc.

In a proper development team these problems would be split up and set to different developers based on their skills and expertise in each area to be developed side by side to ensure max efficiency and productivity to speed up development and deliver the finished product within a reasonable time frame that the client agreed on.

4. User groups

Although everyone benefits from energy, Rolsa's main user groups are customers who care about the environment and their carbon footprint, owners of electric vehicles, homeowners/ landlords etc. These different users will need different requirements and services out of the system.

The staff are going to be the main users of the system. They will need to be able to see when their bookings are for, see user data (eg addresses to go to see if their home is equipped to do their services) there are also different type of staff who will be using the system, admin, the workers going out to houses etc who will need to be able to see different things. Especially when it comes to user data.

Customers

Customers may only be on the site a couple of times so they won't have as much time as staff to get used to it. To make their experience easier (and better) it would be better for the system to have a simple layout that people with a large range of technical knowledge can use.

Home owners

Home owners are most likely coming to Rolsa's systems because they want to add solar panels to their home or for the smart home management systems.

Home owners will be around 25-65. The website needs to be professional and precise to the point.

They will have some ability to use technology since they would need to be able to use the system to a minimum of basics like signing up, logging in, booking appointments.

They may only be able to be contacted outside of work hours for confirmations/ appointments as they will most likely being working as solar panels and owning your own home is expensive and a stable income is needed.

Environmentally Conscious People

People who are conscious for the environment can be a larger age range, people may be coming to the sit to calculate their carbon foot print and learn about green energy rather then coming to purchase something. Eg solar panels.

The age range can differ to 13 – 65. Younger people may be using the website to gather information on the topic rather then looking to install something onto a house that they most likely do not own.

They will need the information being kept up to date and easy to understand to help them learn. Even if they cannot purchase something now, they may be future customers so marketing out to them and letting them explore is also important.

Electric Vehicle owners

People who own electric cars may have different needs for a charger installation based on the type of car that they have. Eg a tesla. Age and charger type are also factors to consider. Using an adapter to charge your car in a public setting may be ok for a user, but in the comfort of their own home they are going to want something that will suit their needs better.

It's important to promote the different types of electric car chargers that Rolsa offers to reduce wasting staff and customer time and to pull customers in using their service.

Landlords/ business owners

Owners of rental properties or owners of businesses may look for a company to put electric car chargers in car parks, put solar panels on top of their properties/ stores to lower costs and promote their businesses to a larger audience.

Businesses will need a higher number of things (solar panels, car chargers etc) installed based on how many properties/ stores they may own. They will also need a different type of car charger (for car parks) that can be easily used by the public. eg. generic chargers which cars with different types of chargers will need adapters for. These will be bigger jobs that may require more staff to consult and install so they will need a different charge rate compared to regular customers.

Staff

Staff will be using the system almost daily and may need to be trained on how to use it properly whilst being complicit with laws (found in section 7) to protect peoples data. Since staff may be trained on the system and will be using it daily, the system will most likely be more complex then the user side.

Admin Staff

Admin staff will be the ones on the system for the longest amount of time and will need the most privileges on it.

To complete their work, they will need ways to view audits from staff and customers, make staff logins, handle customer and staff data etc.

They will most likely be viewing the system through a computer and not a portable device to ensure that proper data protection is taking place.

In Face Workers

In face workers will be dealing with customers face to face. This can include travelling to their house/ businesses and completing tasks that the company offers. (eg installing smart home management systems)

They will most likely be on the go and will need to have access to the addresses of customers and data on the specific customers they are dealing with. They don't need the data of customers they aren't working with or their co workers. (FINSIH THIS)

5. Empathy maps

Someone interested in having a solar panel installed

says	thinks
I'm not sure if my house gets enough sun to have solar panels installed.	There is no point on getting a consultation if my house might not be suitable for solar panels
does	feels
Can't find appropriate research or company to do a consultation with them so they don't get any installed	Unconfident in the possibility of getting solar panels and unsure what to do.

A worker trying to find customers houses

says	thinks
I can never keep track of what address I'm going too. There isn't a clear format for addresses so I have to reformat each one I don't have enough information on a client going into the consultation.	What if I miss the appointment because I can't find their house. I don't know anything about the customer and what they need going in.
does	feels
Struggles to connect and understand the clients needs in the consultation struggles to find where customers homes are.	Anxious feels like they let the customer down and didn't give them their best service

A business trying to get electric chargers installed in their car park

says	thinks
Our customers want electric chargers for their cars but I don't know what options are available. We are losing potential business because we don't have electric chargers I don't know how much they will cost to install	What if they are too expensive to install what if the car park isn't suitable for them and its a waste of money what if the investment isn't worth it
does	feels

Puts the money into a different improvement around their business, losing Rolsa technologies a big potential customer and customers lose out on being able to charge their cars.	Unsure about the costs of getting them installed feels like they don't have enough information on it to go through with it.
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6. User stories

As a/an (role)	Electric car owning customer
I want (goal)	To be able to easily purchase and get an electric car charger installed
So that (benefit)	So I can easily get to work and other places knowing I can charge my car easily at home.
Acceptance Criteria (conditions of satisfaction)	
<ul style="list-style-type: none"> - process to book the consultation and installation of the car charger easily. - be able to easily become informed on which type of charger that will be needed for their specific type of car. - be able to book a consultation and the installation easily - have to go through the consultation process before the installation. 	

As a/an (role)	customer
I want (goal)	To be able to know when my appointments are
So that (benefit)	I can see if I need to alter my bookings as plan change and so I don't forget when they are
Acceptance Criteria (conditions of satisfaction)	
<ul style="list-style-type: none"> - be able to view bookings easily and quickly after logging in to save time - be able to alter and delete bookings at the customers will to meet their needs so that they don't feel stuck in an appointment they can't cancel 	

As a/an (role)	Solar panel installer
I want (goal)	To be able to view where and when my customers appointments are
So that (benefit)	So that I can do my job efficiently and not waste customers time
Acceptance Criteria (conditions of satisfaction)	
<ul style="list-style-type: none"> - be able to view the addresses of customers. Though only the customers they are going to see as to protect user data - be able to access the system on the go via a mobile device - be able to record if the appointment was successful, unsuccessful or no show - be able to refer customers to book an installation after the consultation 	

7. Law / Guidance / Legislation

Data Protection act 2018

Since the booking system will be holding user and staff data, they need to protect it under the data protection act 2018. The data protection act means that they need to be transparent in what data is being kept and used for in their user agreement and privacy policy. (what a user will need to agree too to make an account)

Legally they have to have proper security protocols to ensure the safety of data, the ability to let a user view their data, update their data to ensure the integrity of data and the right to remove their data (the right to be forgotten). This will need to be integrated into the system, although for this instance, it is out of the scope of the project.

Equality act 2010

The equality act 2010 ensures that people are being treated equally and to criminalise discrimination against marginalised groups. This extends out to the internet, websites and systems need to be unbiased against certain groups of people and accessible to all. Everyone has a home and everyone uses energy meaning that Rolsa have a wide range of people in its clientele.

It is crucial to ensure that the website follow WCAG (Web Content Accessibility Guidelines) to ensure that people with disabilities can access their systems potentially by different means of browsing the internet. Eg with eye tracking technology. This can also bring in more customers as

they won't become frustrated using the system and go elsewhere to someone with an accessible website.

8. Alternative Systems

e.on next	
What does the system do well?	<ul style="list-style-type: none">- Have a welcoming theme and css to make customers comfortable from the moment the page loads- have upfront prices to reduce unease and confusion about prices- easy to see the process of getting solar panels installed
What does the system fail to do?	<ul style="list-style-type: none">- offer information about solar panels and how they help reduce your carbon footprint and energy bills- allow them to calculate their carbon footprint
What things will you take forward to your design and why?	<ul style="list-style-type: none">- a welcoming theme to entice customers into doing more research on the webpage and to help promote the products to the user.- keep the webpage clear so customers can feel at ease onb how much they are spending per service

Mer.eco	
What does the system do well?	<ul style="list-style-type: none">- provide a professional feeling website to meet their consumer demographic- provide information on electric car chargers so consumers won't be confused on what they are buying.- Have appropriate alt tags on images to accommodate when images don't load and for people using screen readers.- has a map to show customers where there

	nearest charger is located so customers don't have to go without.
What does the system fail to do?	<ul style="list-style-type: none"> - easily show customers how to purchase their chargers for their businesses so they choose them over another brand - show the pricing of a charging station and not just how much it costs to use it.
What things will you take forward to your design and why?	<ul style="list-style-type: none"> - provide clear information to help consumers become informed on green energy - have appropriate alt tags to follow wcag guidelines and be accessible to all users.

Cre8tive rooms	
What does the system do well?	<ul style="list-style-type: none"> - Clearly show information about smart home products to entice customers to buy them and so they can see how they can improve their lives - have black text on a light background so it is clear to read for people with dyslexia. - clearly display their services to the user so they know what they can offer as a company - show recent projects users can see their work so they can envision it in their space
What does the system fail to do?	<ul style="list-style-type: none"> - clearly state prices so users can see how much it will cost to the user so they can see if the product is appropriate for them - have fast loading times on certain parts of their webpage which leaves users waiting - have a clear way to purchase products which may confuse users so they won't purchase their products
What things will you take forward to your design and why?	<ul style="list-style-type: none"> - keep text easy to read by keeping dark text on light backgrounds and vice versa to make the website more inclusive to dyslexia and colour-blindness. - clearly display the services they offer so customers can be informed on what is available to purchase and have installed

9. Risks

Like any system that handles sensitive data, there is the risk of a data breach and user data being stolen. This is why ensuring that data is handled properly with proper security and due-diligence in compliance with the data protection act 2018 (as outlined in 7. law / guidance / regulations)

Malicious attacks on the system can happen extremely fast via lots of different methods eg. SQL injection, inserting code into an input bar to access a database. This is why it's important to use up-to-date security and database connections (eg using PDO over sqlite) as the digital space grows and changes.

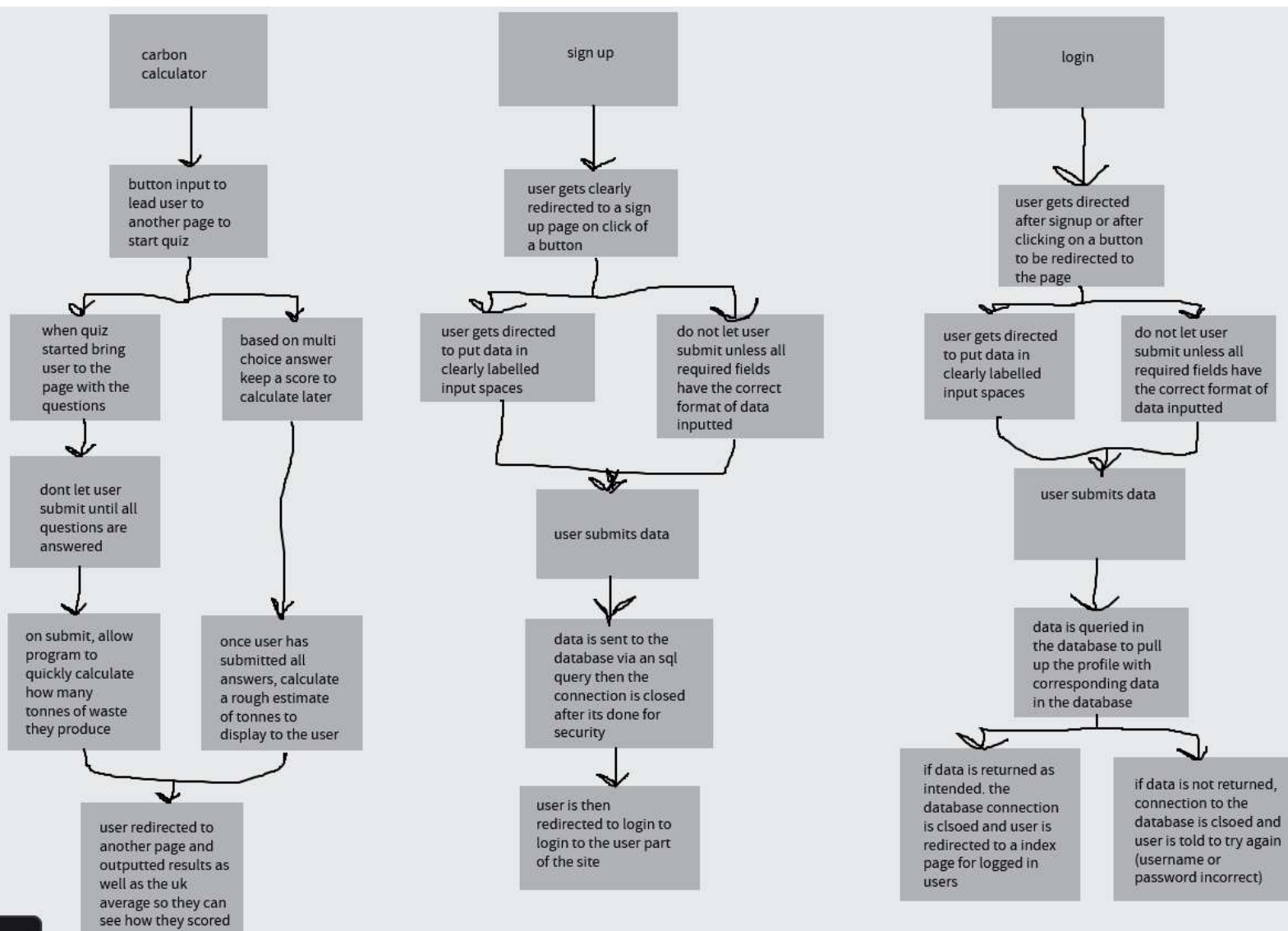
You can prevent code from being messed with in a database by limiting what a database connection can do so even if a user manages to break into a system, they can only do so much.

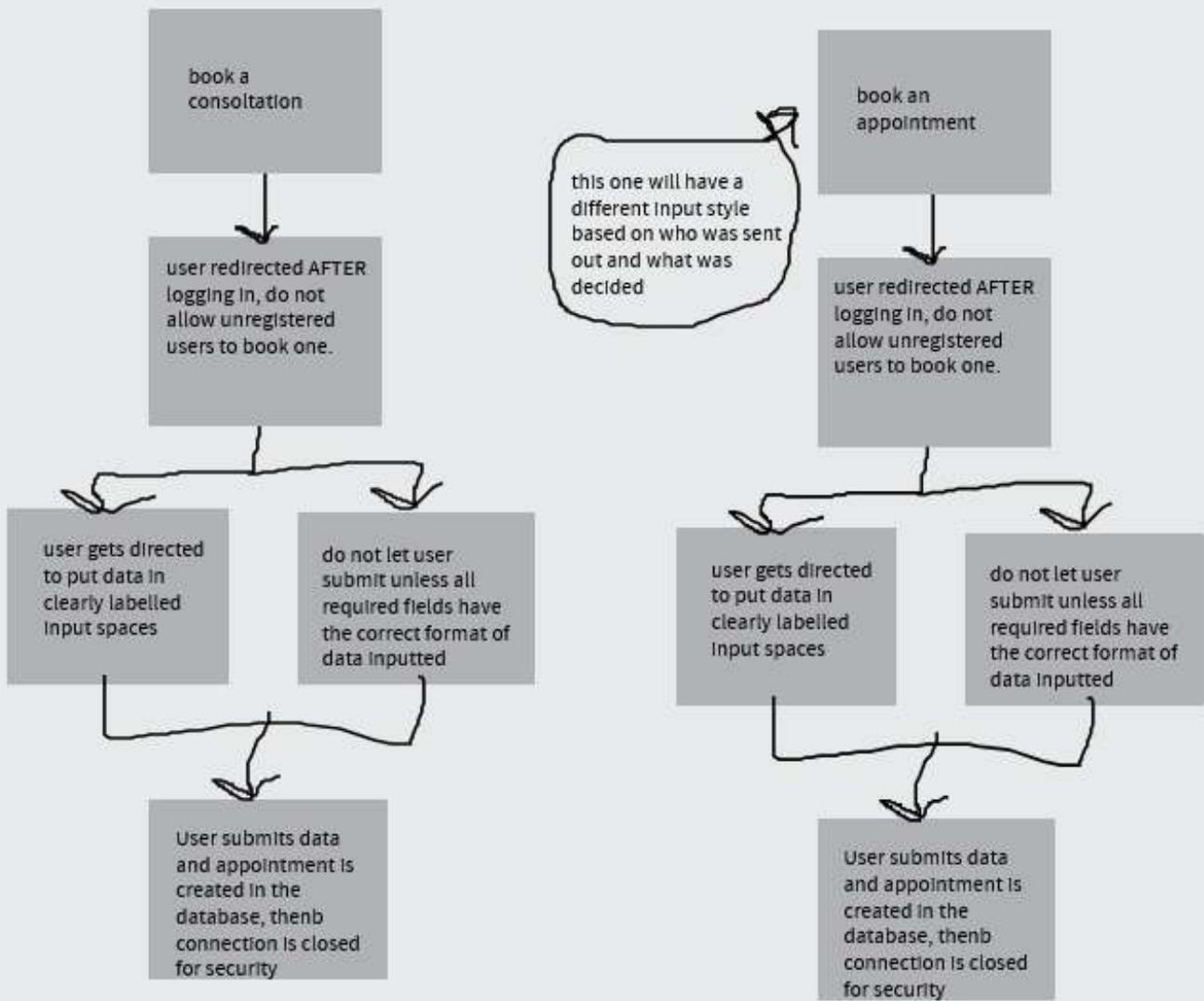
A change in legislation can also be a risk because systems may need to be completely overhauled/ altered to meet compliance with the new law.

Development plans need to have flexibility to not only meet changing client needs but to keep up to date with current and future legislation changes to make the system realistically feasible.

If the system isn't flexible then the system may need to be completely redone during development if legislation changes or in future which can extend development time and cost a lot of money.

10. Decomposition





11. User Acceptance Criteria

Users need to feel comfortable using systems, especially when it comes to inserting their personal data. They need to gain interest in the product and feel safe inputting their details into the system.

They will need things like:

- a clear and obvious navigation bar
- ease of use when trying to research and buy products
- clear instructions on each booking page to reduce customers getting confused and frustrated.
- Fast loading times so they don't become impatient and go somewhere else.
- Be able to view and alter bookings so they feel in control over it and so they can manage their time accordingly.

12. Functional and Non-Functional Requirements

Functional Requirements (business needs)	Non-Functional Requirements (how the system should do things)
<ul style="list-style-type: none">- user should be able to easily browse information about green energy products to help them gain interest in a product- users should be able to alter and cancel their appointments so that they don't waste anyone's time when they are unavailable.- users should be able to view their appointments so that they can be informed on when it is.-users should be able to easily navigate the website no matter what limitations they may have (e.g colour blindness, parkinsons) by keeping the interface easy to understand.	<ul style="list-style-type: none">- hash passwords using sha256 so that their passwords are kept as secure as possible- proper encryption when moving data to ensure that if it is packet sniffed there's nothing worth stealing- pages load in 2-5 seconds at most to keep a users attention so they don't choose to use another service- system should be easy to use so users will choose it over other providers- system should be adaptive to change to ensure that it can handle updates and changes that need to be made as time goes on- system should be able to run on portable devices and on desktops to ensure that everyone can access it from the device they have.

13. Key Performance Indicators (KPI)

There are different ways of monitoring the performance of a new system, this can be from:

- a rise in sales
- increased user account creation
- increased bookings
- increased referrals to new customers
- improved reviews on review platforms eg. trust pilot
- increased number of repeat visitors

These all help boost businesses, the system the customers have to use can make or break the success of a business. After building the new system Rolsa Technologies should see what is listed above.

People like to not think so if systems are easy to use and effective to meet a user's needs then they will recommend it to others who have the same needs.

14. Description of proposed Solution

For the proposed solution, Rolsa Technologies will need a solution that is professional to reach a target demographic of adults who own land (home, business etc) that shares information about green energy to allow users to learn about alternative energy sources to allow them to make informed decisions on what they are purchasing.

With features to login, book consultations and installations of products and to be able to track their own carbon footprint with a carbon footprint calculator.

I will build a booking system within the scope of a booking system that allows user to create accounts (sign up), log into the accounts to book consultations and installations for solar panels, electric car chargers and smart home devices. This will entail building a database to store data securely, a good and easy to use user interface compliment with WCAG regulations to keep it accessible for all users.

I will also develop a carbon footprint calculator to allow users to find out their carbon footprint and provide information for users looking to find out more about green energy.