ENSE 405 Project report-out & lessons learned

EconergyCalc

Archisha Bhattacharya

Project sponsor & course facilitator

Dr. Tim Maciag (ENSE 405 professor)

Business need/opportunity

The goal of this project was to create an innovative web application that empowers individuals to make informed decisions about their energy use, ultimately contributing to reduced carbon emissions and more sustainable living. Additionally, the project aims to empower individuals to make informed choices about their energy consumption, promoting sustainable living and, as a result, contributing to the reduction of greenhouse gas emissions and environmental impact.

Reflections on project planning

Selected United Nation's (UN) Sustainable Development Goals (SDGs)

The selected UN Sustainable Development Goals (SDGs) for this project are:

- **Goal 7:** Ensure access to affordable, reliable, sustainable, and modern energy for all
- **Goal 11:** Make cities and human settlements inclusive, safe, resilient, and sustainable

This project, in alignment with UN SDG 7 (Affordable and Sustainable Energy) and SDG 11 (Sustainable Cities and Communities), addresses the vital global issue of household energy consumption. With increasing urbanization, the energy use in residential sectors emerges as a pivotal concern, both for energy sustainability and urban living standards. The objective is to develop a web application that equips individuals with the tools and knowledge to manage and optimize their energy usage. This approach is particularly critical in the context of conventional energy sources that not only deplete non-renewable resources but also exacerbate environmental degradation and climate change.

- Aligning with Goal 7, the project emphasizes the promotion of sustainable and modern energy solutions. It encourages users to identify and replace energy-inefficient appliances with eco-friendlier alternatives, thus fostering a transition towards more sustainable energy consumption patterns in households.
- In correspondence with Goal 11, the project plays a pivotal role in cultivating sustainable urban communities. By enabling users to monitor and optimize their household energy consumption, the application directly contributes to reducing the collective carbon footprint. This effort is instrumental in making cities and human settlements more environmentally responsible and sustainable.

The underlying rationale for selecting these specific goals is that individual actions, when aggregated, can significantly impact global energy consumption patterns and urban sustainability. By empowering individuals with the right tools and information, the project aims to facilitate a grassroots-level shift towards more sustainable living, ultimately contributing to the broader objectives of the UN SDGs.

Community Research and Understanding/Requirements Gathering

Community Characteristics

In the Initialization and Planning, findings from my community research showed that the community is Self-Designing with the following characteristics:

- **Existing Energy Monitoring Practices:** Many community members might already be engaged in tracking their energy consumption, possibly through utility bills, smart home applications, or basic energy consumption

calculators. This indicates a baseline level of awareness and engagement in energy monitoring within the community.

- **Specificity in Energy Consumption Data:** There is a need among members for more detailed breakdowns of energy consumption. This includes understanding the energy usage of specific devices in particular areas of the home, such as the kitchen, which can assist in making more targeted energy-saving decisions.
- **Interest in Sustainable Living:** The community shows a keen interest in adopting sustainable practices. This involves seeking advice on which household devices could be replaced with more energy-efficient alternatives, indicating a proactive stance towards environmental sustainability.

The Community can be classified under the following orientations:

- **Primary Orientation – Individual Participation in a Context Community:** The primary focus is on individual Canadian residents who are motivated to track and manage their household energy consumption and implement sustainable practices. This reflects a community-centric approach where personal actions are seen as contributing to broader community goals.
- **Secondary Orientation – Content Sharing and Collaboration:** There is a secondary but significant interest in content sharing, where members can exchange knowledge, experiences, and success stories. This can take the form of forums or posts providing tips on energy saving and efficiency, highlighting a collaborative and knowledge-sharing aspect of the community.

Figure 1 below shows the characteristics of the chosen orientations from the "Community characteristics orientation" document.

Individual participation Learning together happens in the context of a group, but it is realized in the experience of individuals. People bring different backgrounds, communication styles, and aspirations to their participation in a community. People have different levels of commitment, they take on different roles, and they use tools differently	☒ Levels of participation ☒ Personalization ☐ Individual development ☐ Multi-membership	Each user's engagement is unique, stemming from their household setup, energy consumption habits, and personal sustainability goals. By inputting an inventory of their appliances and energy use, they receive personalized insights and recommendations. Furthermore, while the community forum serves as a collective platform, individual contributions therein enrich the knowledge base, with users choosing to share experiences, ask questions, or offer advice.	**Service context** In some cases, serving a specific context becomes central to the community's identity and the ways it operates. They may live inside an organization, whose charter their practice needs to serve. They may have a mission to provide learning resources to the world or to recruit members widely. Or they may seek interactions with other communities whose domain complements their own	☒ Organization as context ☐ Cross-organizational ☐ Other related communities ☐ Public mission	The primary service context includes facilitating individual users in optimizing their energy consumption patterns and, on a broader scale, contributing to national and global sustainability goals. By empowering users with data and actionable insights, the platform champions an eco-friendly ethos, aligning with wider environmental initiatives and potentially collaborating with external bodies that share a common vision.
Content Some communities are primarily interested in creating, sharing, and providing access to documents, tools, and other content. Valuable and well-organized content is a useful resource for members	☐ Library ☐ Structured self-publish ☒ Open self-publish ☐ Content integration	While the application's primary goal revolves around individualized household energy insights, there exists a potential avenue for content sharing and consumption. By facilitating a space where users can share their knowledge, experiences, or even success stories in the form of posts, the community can benefit from diverse perspectives and real-world experiences. This user-generated content can serve as a valuable resource, enhancing the overall user experience and fostering a sense of community collaboration.			

Figure 1. Relevant Community Orientations

Technology Inventory

In the technology configuration inventory, three key platforms/tools were identified being utilized by the community: Smart Home Applications, Online Energy Calculators, and Online Forums. Smart Home Applications enable real-time

monitoring and control of appliance usage, often integrated with IoT technologies, but they can be complex to navigate and require IoT-enabled appliances, which may not be accessible for all users. Online Energy Calculators offer a convenient way to estimate the energy consumption of one or multiple appliances. However, they fall short in reflecting fluctuations in usage patterns over time and lack the functionality to maintain an inventory of appliances. Lastly, Online Forums serve as interactive platforms for users to engage in discussions and share insights. While they facilitate community engagement and knowledge sharing, these forums often lack a focused approach on niche topics like sustainability in household energy consumption, leading to generalized discussions that might not fully address the specific interests and needs of our community.

Customer

North Star Customer

The primary target customer for our project is Canadian residential household members who are keen on tracking and managing their household energy consumption while adopting sustainable practices. This group is at the core of our project's focus, as they represent proactive individuals seeking practical solutions for energy efficiency and sustainable living.

Carryover Customers

A secondary customer group includes individuals who are considering purchasing energy-efficient appliances and those interested in engaging with a community forum to find tips on energy savings and share their knowledge. This group expands the application's reach and fosters a community of like-minded users contributing to a larger dialogue on sustainability.

Customer Significance to Project's Golden Circle

Why: These customers are pivotal to our project's golden circle because they directly contribute to achieving our mission of promoting sustainable living. By empowering them to make informed choices about their energy consumption, we not only aid them in reducing their carbon footprint but also collectively contribute to the reduction of greenhouse gas emissions and broader environmental impact. Their active participation and feedback are crucial for the continuous improvement and relevance of the application.

How: The application caters to these users by allowing them to maintain a log of their appliances, and based on this information, it generates personalized recommendations for energy efficiency. This feature not only aids in tracking and managing energy use but also educates users about potential improvements and sustainable practices. The community forum aspect serves as a platform for knowledge exchange and support, enabling users to learn from and inspire each other.

What: The project offers a comprehensive web application designed to assist users in monitoring and optimizing their household energy consumption. The core functionalities include appliance logging, generating tailored recommendations for energy efficiency, and providing a community forum for users to exchange tips and experiences related to energy saving and sustainability. This solution is aimed at making energy management accessible, informative, and community-oriented, ultimately driving towards more sustainable household practices in line with the selected UN SDGs.

Drafting an Emerging Picture

Assumptions

1. **User Willingness to Adopt New Technology:** It is assumed that users are willing to transition to a new, integrated platform for monitoring and managing their energy consumption. This assumption is based on the perceived need for a more efficient and comprehensive solution than what currently exists.

2. **Sufficient Technological Literacy:** The community is assumed to possess enough technological literacy to engage effectively with a web application. This includes familiarity with digital tools for tracking, data input, and participating in online forums.
3. **Stable Internet Connectivity:** Constant and reliable internet access is assumed, as the application's effectiveness is contingent on users being able to regularly access and interact with the platform.
4. **Accuracy of Self-Reported Data:** The application relies on users accurately logging their appliance usage. There is an assumption that the data entered by users will be precise and reliable for analysis and recommendation purposes.

Constraints

1. **Technological Fragmentation:** As identified, the existing technology inventory illustrates a fragmented landscape. Users are currently required to navigate multiple systems or applications to meet different needs, such as energy monitoring, community engagement, and sustainable product discovery. This fragmentation leads to inefficiencies and a disjointed user experience.
2. **Integration Challenges:** Bridging these disparate elements into a single, integrated platform presents significant technical challenges. It requires the development of a system that can seamlessly combine features like real-time monitoring, community forums, and sustainable product recommendations.
3. **Data Privacy and Security:** Ensuring user data privacy and security is a major constraint. As the application deals with personal energy usage data and potentially other sensitive information, robust security measures must be in place to protect user data.
4. **User Engagement and Retention:** Maintaining consistent user engagement and retention is a constraint. The application needs to offer sufficient value and usability to encourage continual use and active participation in the community forum.
5. **Resource Limitations:** There may be limitations in terms of resources, including funding, technical expertise, and time, which could impact the development and deployment of the application.

Project Development Plan

Technology Stack

The project commenced using the MERN stack, which encompasses MongoDB, Express.js, React, and Node.js. This full-stack solution was chosen for its scalability, flexibility in handling complex applications, and the abundant resources available for development and troubleshooting. As the project progressed, I integrated APIs from Energy Star and utilized a dataset from Natural Resources Canada. This integration allows users to look up appliances by model number and automatically fetch details, significantly streamlining the user experience by reducing manual input and potential errors.

Throughout the development, I have maintained the original tech stack due to its proven efficacy in handling the application's requirements. There has been no need for significant evolution of the technology stack; instead, we have focused on refining and optimizing the existing components to ensure robust performance and user-friendly interfaces.

Drafted Prototypes

For prototyping, I began with low-fidelity mock-ups to outline the application's basic layout and functionalities. These initial prototypes were crucial in visualizing the user journey and identifying key features, such as user registration, appliance logging and consumption trends analysis, recommendations, and forum. Figure 2 below shows the low-fidelity prototypes for the main pages planned for the application.

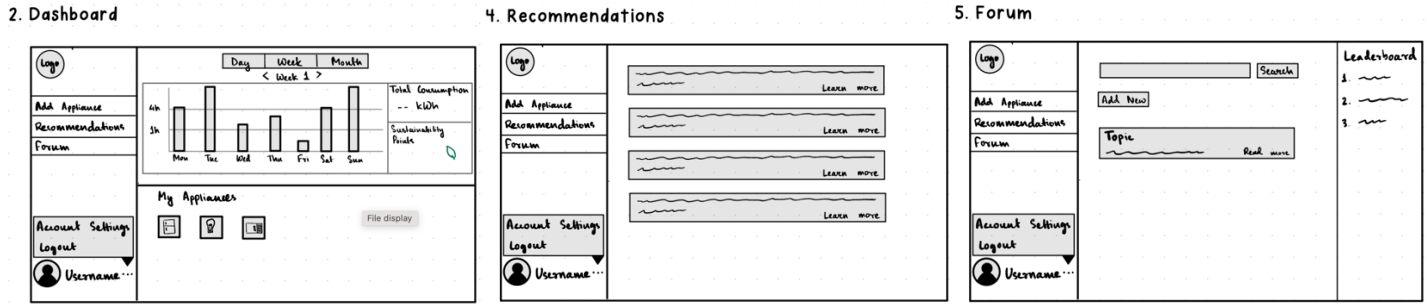


Figure 2. Low-fidelity prototype for dashboard, recommendations, and forum pages

Initial Minimum Viable Products (MVPs)

Our MVPs evolved in stages to incrementally introduce core features to our users:

- **MVP 1:** Focused on the essential functionalities required for a user to register, log in, and begin tracking their energy consumption. This included adding and viewing appliance details, as well as a rudimentary dashboard for visualizing total energy consumption.
- **MVP 2:** Expanded upon the first iteration by incorporating more detailed analytics with weekly, and monthly consumption trends. This provided users with more granular insights into their energy usage patterns.
- **MVP 3:** Introduced community-driven features, allowing users to contribute to the forum, share energy-saving tips, and engage with other community members through post upvotes, downvotes, and replies. A leaderboard was also implemented to recognize the most active contributors.
- **Additional Features:** The final stage includes advanced functionalities like total cost calculations and the quick appliance add feature using camera/model number recognition. This further simplifies the process of tracking energy use and costs, providing a comprehensive tool for users to manage their energy consumption effectively.

Reflections on project results

Software Design Activities and Findings

Reflection on “Planning and initialization” Video

Initially, the envisioned application included key deliverables such as user authentication, a dashboard for energy tracking, the addition and management of appliances, energy consumption calculations, and a community forum. Throughout the development process, we also integrated additional features like appliance lookup via model number and a stopwatch feature for easier logging. Figure 3 below shows the “Add new appliance” form on the application.

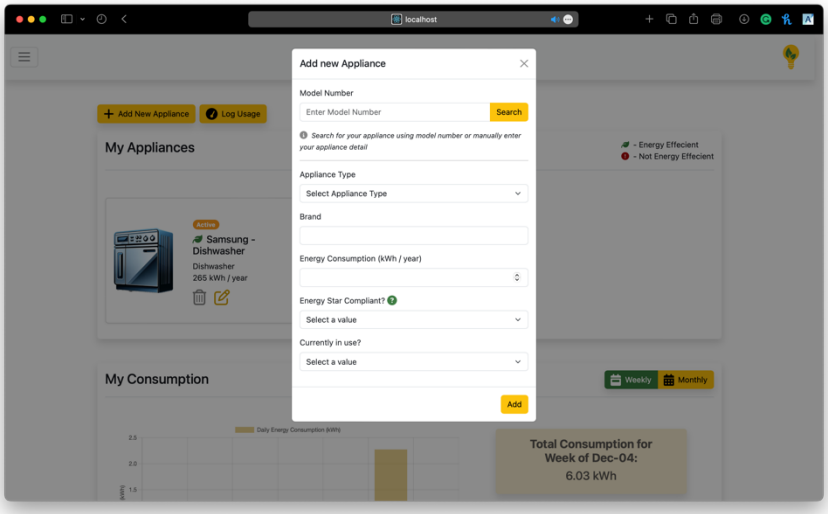


Figure 3. “Add new appliance” form

Upon reviewing the "Planning and initialization" video, the final product closely matches the solution we initially envisioned. The core functionalities were implemented as planned, with iterative enhancements based on monthly scrums and feedback from Dr. Maciag. Some features, like the stopwatch, were added to improve user experience based on insights gained during development.

Design Activities and Class Linkages

The software design activities were iterative, involving prototyping, class and peer feedback, and refinement. This aligns with agile development methodologies discussed in class, emphasizing adaptability and user-centered design.

I linked these activities back to class discussions by incorporating gamification strategies and knowledge management principles, emphasizing user engagement and efficient data handling. For instance, I integrated gamification elements like a leaderboard and a points system to encourage community interaction, a concept borrowed from lectures on enhancing user engagement. Figure 4 below show the leaderboard implemented in the forum section.

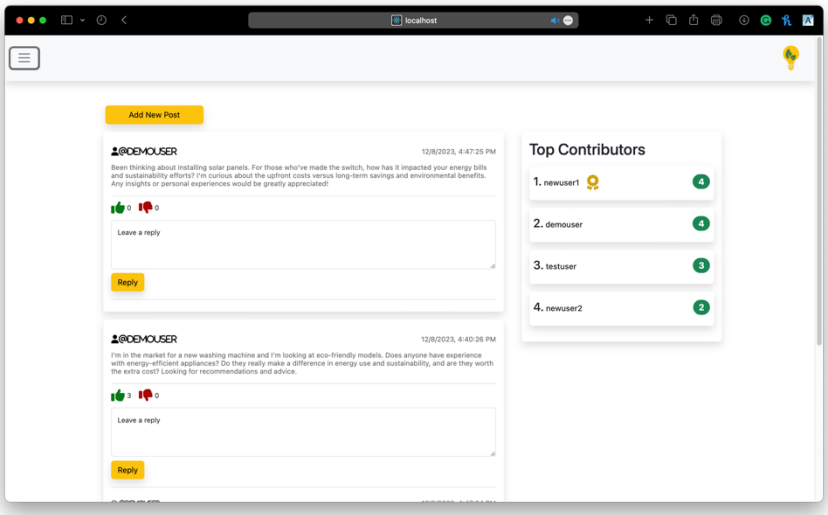
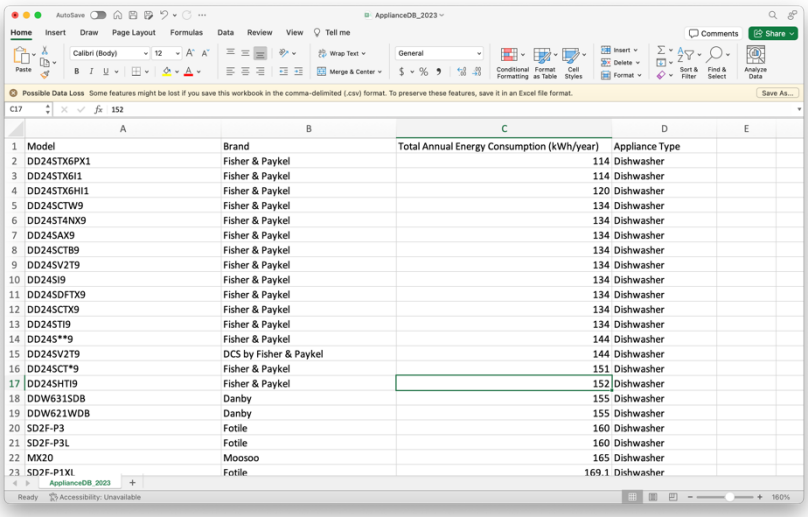


Figure 4. Leaderboard implemented in the forum showcasing top contributors

In knowledge management, we discussed how information is structured and retrieved, inspiring us to implement an API for appliance data which streamlined the user experience by simplifying the appliance-adding process. Figure 5 below show the dataset obtained from the Natural Resources Canada website.



	A	B	C	D	E
1	Model	Brand	Total Annual Energy Consumption (kWh/year)	Appliance Type	
2	DD24STX6PX1	Fisher & Paykel	114	Dishwasher	
3	DD24STX6I1	Fisher & Paykel	114	Dishwasher	
4	DD24STX6HI1	Fisher & Paykel	120	Dishwasher	
5	DD24SCTW9	Fisher & Paykel	134	Dishwasher	
6	DD24ST4NX9	Fisher & Paykel	134	Dishwasher	
7	DD24SAX9	Fisher & Paykel	134	Dishwasher	
8	DD24SCTB9	Fisher & Paykel	134	Dishwasher	
9	DD24SV2T9	Fisher & Paykel	134	Dishwasher	
10	DD24SI9	Fisher & Paykel	134	Dishwasher	
11	DD24SDFTX9	Fisher & Paykel	134	Dishwasher	
12	DD24SCTX9	Fisher & Paykel	134	Dishwasher	
13	DD24STI9	Fisher & Paykel	134	Dishwasher	
14	DD24S**9	Fisher & Paykel	144	Dishwasher	
15	DD24SV2T9	DCS by Fisher & Paykel	144	Dishwasher	
16	DD24SCT*9	Fisher & Paykel	151	Dishwasher	
17	DD24SHTI9	Fisher & Paykel	152	Dishwasher	
18	DDW631SDB	Danby	155	Dishwasher	
19	DDW621WDB	Danby	155	Dishwasher	
20	SD2F-P3	Fotile	160	Dishwasher	
21	SD2F-P3L	Fotile	160	Dishwasher	
22	MX20	Moosoo	165	Dishwasher	
23	SD2F-P1XL	Fotile	169.1	Dishwasher	

Figure 5. Dataset of available appliances in Canada (source: https://natural-resources.canada.ca/energy-efficiency/10832)

Rhizomatic learning from our pedagogy discussions influenced the forum's design, fostering an environment where users learn from each other organically, mirroring a natural, interconnected learning process. Figure 6 below shows users sharing knowledge with each other and engaging in rhizomatic learning.

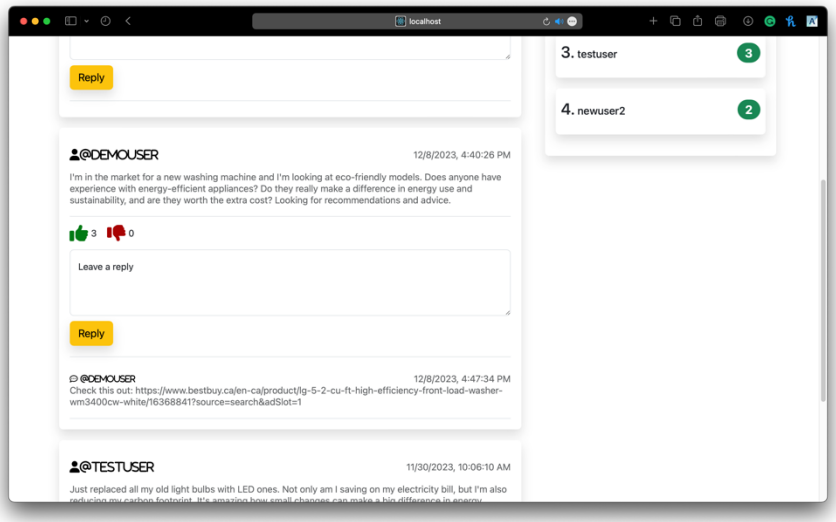


Figure 6. Forum section showing users interacting with each other and sharing their knowledge through replies

Personal Reflections

Reflecting on this project, I consider it a significant professional achievement. The successful realization of the MVPs and the practical application of a new technology stack, React, are milestones that underscore the project's success. The initial foray into extensive documentation, though initially daunting, ultimately became an essential tool for aligning the application's functionality with the UN SDGs and refining feature selection.

The project's high points included the successful implementation of React, which will be an invaluable asset in future projects, such as my upcoming capstone. On the other hand, managing the breadth of documentation presented an initial challenge but was overcome through diligent effort and became integral to the project's strategic direction.

For future projects, I would maintain the integration of continuous learning within the development process, leveraging new skills and technologies. Differently, I would approach documentation more strategically, allocating time to digest and incorporate it into the project's framework from the outset. Additionally, I would explore integrating mechanisms to contain disinformation, apply structured change management, and utilize metadata tags for enhanced content discoverability and user engagement. These are identified as pivotal elements that could further enhance the quality and user experience of the application.

General reflections on the class & project experience

Prior Knowledge/Expose to UN SDG(s)

No, I was not aware of the United Nations Sustainable Development Goals (SDGs). This course has been instrumental in introducing me to these important global objectives and has significantly broadened my understanding of the role that engineering and technology play in addressing critical global challenges such as poverty, inequality, climate action, and sustainable cities and communities.

Before taking this class, I was not consciously focused on the areas encompassing the UN Sustainable Development Goals (SDGs) while engineering software solutions, primarily because I wasn't aware of these goals. However, looking back, some of the projects I worked on inadvertently aligned with certain SDGs. For instance:

1. **Greenhouse Monitoring System**: This project, aimed at optimizing the growth conditions in greenhouses using a temperature/humidity sensor and soil moisture sensor powered by the STM32F103RB microcontroller, indirectly contributes to SDG 15: Life on Land. By enhancing agricultural practices and promoting sustainable land use, this system can aid in maintaining ecosystems and supporting biodiversity.
2. **Handwriting Recognition System**: This system, designed to convert handwritten text into digital format using an Artificial Intelligence (AI) model trained on labelled images and a Convolutional Neural Network (CNN) architecture, aligns with SDG 4: Quality Education. It has potential applications in educational settings, such as aiding students with disabilities or streamlining educational content digitization, thereby enhancing accessibility and quality of education.

Importance of UN SDG(s) in Our Role and Responsibility as an Engineer

Understanding the United Nations Sustainable Development Goals (SDGs) can significantly enhance an engineer's perspective on their societal role and responsibilities. The SDGs provide a comprehensive framework addressing global challenges like climate change, poverty, and inequality. For engineers, this knowledge fosters a greater awareness of the environmental and social impacts of their work, encouraging sustainable, ethical, and innovative solutions. It also promotes interdisciplinary collaboration and long-term planning, aligning engineering projects with global efforts for a sustainable future. Thus, familiarity with the SDGs can guide engineers in contributing positively and responsibly to society, both locally and globally.

Our experience(s) in Addressing the Selected UN SDG(s)

Developing an application like EconergyCalc that focuses on United Nations Sustainable Development Goals (SDGs) 7 (Affordable and Clean Energy) and 11 (Sustainable Cities and Communities) involves a range of experiences, lessons, challenges, and considerations:

1. **Energy Efficiency Recommendations:** The app should offer practical, personalized, and actionable energy-saving recommendations. This involves understanding different appliances' energy consumption patterns and providing tips that are feasible and effective for users.
2. **Community Engagement:** Facilitating a community forum requires moderation and content management to ensure constructive and respectful discussions. Encouraging peer-to-peer learning and sharing best practices can foster a supportive community focused on sustainability.
3. **Sustainability Reporting and Impact Measurement:** Tracking and reporting the app's impact on energy savings and sustainability practices is crucial. This could involve developing metrics and analytics to measure and demonstrate how the app contributes to achieving SDGs 7 and 11.
4. **Education and Awareness:** The app can be a tool for educating users about sustainable energy use and urban living. Incorporating educational content about the SDGs and the importance of energy conservation can enhance user engagement and impact.
5. **Adapting to Technological and Environmental Changes:** The field of energy efficiency is constantly evolving. The app should be adaptable to new technologies, changing energy sources, and evolving user needs.
6. **Economic and Social Considerations:** The app should be economically viable and consider social factors like varying energy costs, access to technology, and different lifestyles. It should cater to users from diverse socio-economic backgrounds.
7. **Feedback and Continuous Improvement:** Incorporating user feedback for continuous improvement of the app is essential. Regular updates based on user experiences and technological advancements will keep the app relevant and effective.

By addressing these considerations, the engineering of this software solution can effectively contribute to achieving the targeted UN SDGs, making a meaningful impact on individual and community energy practices.

Importance of UN SDG(s) in Software Engineering

As a future engineer, I think the UN SDG(s) as a whole are important in guiding global efforts towards a sustainable future. These goals offer a comprehensive framework to address major challenges such as poverty, inequality, climate change, and environmental degradation, which are increasingly relevant in all fields, including software engineering. The SDGs can significantly help software engineers in several ways:

1. **Guiding Framework for Impactful Work:** They provide a clear set of objectives to align your projects with, ensuring that your work contributes to global sustainability and societal well-being.
2. **Innovation and Creativity:** The challenges posed by the SDGs can inspire innovative solutions and creative problem-solving in software development, pushing the boundaries of what technology can achieve in terms of social and environmental impact.
3. **Market Opportunities:** As more organizations and governments commit to these goals, there is a growing market for technologies and software solutions that support these objectives, creating new opportunities for software engineers.
4. **Ethical Responsibility and Reputation:** Working on projects aligned with the SDGs enhances your ethical standing and reputation. It demonstrates a commitment to responsible and sustainable engineering practices.
5. **Interdisciplinary Collaboration:** The SDGs encourage collaboration across different fields. As a software engineer, you'll have the opportunity to work with professionals from diverse backgrounds to create holistic solutions.

However, there are considerations that could be seen as hindrances:

1. **Complexity in Implementation:** Integrating the broad and sometimes complex objectives of the SDGs into software projects can be challenging, requiring a deep understanding of the goals and the specific contexts they address.
2. **Resource Allocation:** Focusing on SDG-aligned projects might require more resources, in terms of time and investment, to ensure both sustainability and effectiveness.

3. **Balancing Commercial and Sustainable Goals:** In a commercial setting, aligning with the SDGs may sometimes conflict with profit-driven objectives, requiring a careful balance to ensure business viability.

Embracing the UN SDGs can be more beneficial than hindering. They provide a valuable framework for creating meaningful, impactful work while fostering innovation and ethical practices in the tech industry. While there are challenges in aligning with these goals, the potential benefits in terms of personal fulfillment, professional growth, and global impact are significant.

UN SDG(s) versus Customer Requests

The decision to use the United Nations Sustainable Development Goals (SDGs) to guide our work as a software engineer involves balancing the ideals represented by the SDGs with the practicalities of customer requests and market demands. Both aspects are important and can often be integrated thoughtfully.
Ideally, integrating the principles and objectives of the SDGs into your work can lead to more sustainable, socially responsible, and impactful software solutions. Focusing on projects that contribute to these global goals can enhance the societal value of your work and foster long-term, positive change. It also aligns with a growing global trend towards sustainability and ethical business practices.

However, in a commercial setting, customer needs and requests are paramount. The primary objective is often to deliver solutions that meet the specific requirements and expectations of your clients. This doesn't mean disregarding the SDGs entirely, but rather finding a balance where customer needs are met while also considering the potential impact on sustainability and social responsibility.

The key is to find a balanced approach to software development, which involves:

- **Educating Clients:** Sometimes, clients may not be fully aware of how aligning their projects with the SDGs could benefit them. As an engineer, you can educate them on the value addition in terms of brand reputation, customer loyalty, and long-term sustainability.
- **Innovative Solutions:** Look for innovative ways to incorporate aspects of the SDGs into your software solutions without compromising on meeting customer needs. This could involve suggesting features or functionalities that align with these goals.
- **Ethical Decision-Making:** In cases where client demands directly conflict with the principles of the SDGs, it becomes a matter of ethical decision-making. As an engineer, you have the discretion to choose projects that align with your values.

Also, with the increasing global emphasis on sustainability and ethical practices, aligning our work with the SDGs can help us position yourself at the forefront of emerging industry trends, ensuring that your work remains relevant, innovative, and competitive in a rapidly evolving market.

Application of UN SDG(s) in Future Work

Yes, I will be using my understanding of the United Nations Sustainable Development Goals (SDGs) in engineering solutions in the future as the SDGs provide a globally recognized framework for addressing key challenges such as climate change, poverty, and inequality. By aligning our engineering projects with these goals, I can contribute to sustainable development, which is increasingly important in a world facing environmental and social challenges. Future engineers have a responsibility to consider the broader impact of your work on society and the environment. Aligning my projects with the SDGs helps ensure that my contributions are beneficial and ethically sound. Also, there is a growing demand for sustainable and socially responsible products and services. Integrating the SDGs into your engineering solutions can make them more attractive to a market that values sustainability, opening up new opportunities and customer segments.

Yes, I believe learning about the United Nations Sustainable Development Goals (SDGs) can significantly inform my career path decisions in the future. This knowledge provides a broader understanding of global challenges and the role that technology and engineering can play in addressing them. By being aware of these goals, I am more inclined to seek out or initiate projects that contribute to sustainable development, ethical practices, and social responsibility. This could lead to career opportunities in sectors focused on renewable energy, sustainable urban development, or technology for social good.

Final Comments

The development of a household energy calculator app, designed in line with UN SDGs 7 and 11, integrates user education on sustainable practices and leverages behavioral science to encourage energy-efficient habits. It's vital to consider local energy patterns, collaborate with stakeholders for broader reach and insights, and measure the app's impact rigorously. Emphasizing scalability, the app should comply with data protection laws and prioritize eco-friendly practices. A feedback loop, strategic marketing, and continuous updates will ensure the app remains effective and grows its user base, thereby contributing meaningfully to the SDGs. By considering these aspects, the project can be more effectively tailored to meet its objectives, ensuring it not only serves its immediate functional purpose but also contributes meaningfully to the targeted SDGs.