# Electricity Consumption Planner

**Team Composition**

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## Abstract

This project is a system to help electricity consumers optimize their appliance usage by generating a 24-hour schedule. Users input appliance power consumption and electricity rates (peak/off-peak), and the system produces a schedule to reduce costs by avoiding high rates. This document outlines the project's introduction, features, challenges, and other relevant details.

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# 1. Introduction

As a rapidly changing landscape of electricity prices and continually renewing energy tariffs are becoming more common, it fears end-users due to rising electric bills. TOU (Time of Use) pricing sets different prices depending on the time of day, with the peak hours much more expensive than off-peak hours. In such a case, consumers who are used to energy-intensive appliances may have trouble slashing all that cluttered usage leading now their bank accounts getting pinched. The **aim** of this project is to design an application that would automatically make a schedule on when to use what appliances based on the energy rates in location over time. This way, users can optimize the timing of how they use their appliances and lower the amount of money they spend on electricity by following system instructions.

# 2. Background

As TOU pricing continues to proliferate in many parts of the world, end-consumers are required to schedule and perform their energy consumption so as not to suffer during peak hours. TOU pricing is purposely shaped to lower electricity demand at peak periods and provide consumers the right incentives to reduce or shift their usage to off-peak times. Eastern Ontario can shift its demand toward otherwise underused off-peak hours — relieving pressure on power plants and thereby helping all consumers share among it — by charging more for electricity during peak periods (when supply-demand pressures are highest), and less or nothing in off-peak periods.

Think of other tools and applications that have been developed to enable consumers to manage their own energy consumption, especially in places with smart meters. **Zabit apps** like energy management systems or smart home platforms allow users to track their electricity consumption in real time and change how they consume accordingly. Still, systems currently in place can be overly complex or costly and are out of reach for a lot of people.

# 3. Problem Statement

Electricity is something we need every day, but the cost can be hard to predict because prices change throughout the day. Many people aren't aware of when electricity is most expensive, so they end up using high-energy appliances at the wrong times, leading to higher bills than expected! While energy costs are a concern for many, there aren't many tools available to help people plan their electricity use effectively. This can lead to extra financial strain and puts more demand on the power grid during peak times.As a result , this project aims to solve these problems by creating an app that helps people manage their appliance use in a more affordable way. The app will create schedules based on electricity prices and how much energy each appliance uses, helping users save money by avoiding high-cost periods.

## 4. Objective(s)/Target(s)

The main goal of this project is to create an **Electricity Consumption Planner System** that helps people plan their electricity use and save money on their bills. The system will let users enter their household appliances and generate a 24-hour schedule based on electricity rates and how much power each appliance uses. The specific targets include:

- **Lower Electricity Bills**: Give users a personalized schedule to reduce costs by avoiding expensive peak hours.
- **Better Appliance Usage**: Help users plan when to run high-energy appliances by suggesting times when electricity is cheaper.
- **Simple Interface**: Build an easy-to-use interface where users can quickly add their appliances, set preferences, and see the suggested schedule.
- **Accurate Rates**: Use real-time or pre-set electricity rate information from the local provider to create accurate schedules.
- **Save Energy**: Encourage energy-saving by reducing demand during peak hours and promoting usage during off-peak times to support grid stability.
- **Scalable and Adaptable**: Make sure the **Electricity Consumption Planner System** can handle different household sizes, types of appliances, and adjust to changes in electricity rates or future features.

## 5. List of Features

Following is list of the essential features that our **Electricity Consumption Planner System** must perform:

**1. Appliance Input**

In this software, users can input details of their household appliances (e.g., refrigerator, washing machine, air conditioner) including power consumption, and typical usage times.

**2. Electricity Rate Management**

The **Electricity Consumption Planner System** is going to display current electricity rates based on different time slots (peak, off-peak, and standard) for a 24-hour period.

**3. Consumption Planning**

Based on appliance data and electricity rates, the system generates an optimized daily usage schedule to minimize electricity costs.

**4. Daily Schedule Display**

A clear, easy-to-read schedule showing recommended times to use each appliance over a 24-hour period to maximize savings.

**5. Usage History:**

The **Electricity Consumption Planner System** is also going to display a history of previous schedules and estimated bills for reference and tracking.

**6.Historical Data Comparison:**

The **Electricity Consumption Planner System** has the functionality that enables users to compare their current energy usage and costs with historical data to assess the effectiveness of the scheduling.

**7.User Feedback and Recommendations:**

We also include a feature for users to provide feedback on their experience with the suggested schedules and allow the system to adjust based on user input.

**8. Cost Prediction:**

We are going to offer a feature that estimates the potential savings or costs associated with different appliance usage schedules, helping users visualize the impact of their choices.

## 6. Completeness Criteria

Following functionality shows our **Electricity Consumption Planner System** completeness criteria or the things that this system will at least be able to perform after deployment:

The **Electricity Consumption Planner System** should let users add their appliances, show electricity rates, and create a schedule for when to use appliances. Everything should work smoothly without errors. Moreover, the schedule created by the system should help users reduce their electricity bills by suggesting the best times to use appliances, based on the right electricity rates. In addition, this system should be simple and user-friendly. People should easily be able to add their appliances, view schedules, and navigate through the system without confusion. The system should be stable and run without crashing or freezing. All features should work as expected, even when users try different combinations of appliances. Additionally, the system should send out correct and timely reminders when it's time to use certain appliances, according to the planned schedule. Users should be able to see their past schedules and get an idea of how much they've saved by following the system's suggestions.

When all these goals are met, our **Electricity Consumption Planner System** can be considered as a product.

# 7. Challenges

Following are the major CS challenges that are faced regarding product features and previous researches or systems :

**Optimizing Energy Scheduling Algorithm**

- Developing an efficient algorithm that generates optimized appliance usage schedules based on fluctuating electricity rates can be complex. Balancing energy consumption during off-peak hours while maintaining user convenience is a key challenge.

**Handling Large Data Sets for Appliance Usage**

- Efficiently managing and storing data related to multiple appliances, their consumption patterns, and different electricity rates throughout the day may require careful data structuring and optimization to ensure smooth operation and a solid understanding of how electricity providers structure their rates.

**Algorithm Complexity and Performance**

- Ensuring that the scheduling algorithm runs efficiently without consuming excessive computational resources will be a challenge, especially if the application needs to handle multiple appliances and schedules simultaneously.

**User Input Validation**

- Developing robust mechanisms for validating user inputs such as appliance details, consumption data, and schedule adjustments will require thoughtful design to prevent incorrect or misleading results.

**User Interface Designs**

- Designing a user-friendly and intuitive interface using React JS libraries can be challenging, especially when integrating features like appliance input and schedule display.

**Testing and Debugging**

- Thorough testing to ensure the accuracy and reliability of the scheduling algorithm across different scenarios (varying consumption, rates, and user inputs) can be time-consuming and technically demanding.

**Previous Research and Solutions**

- It's important to understand the tools and systems that already exist for managing electricity use, like smart meters and energy management platforms. Looking at similar projects and research helps make sure our system uses the best methods and avoids mistakes others have made. By

studying what's already been done, we can find ways to improve our own system and make it more effective.

## 8. Knowledge Areas Required

Following are the Knowledge Areas required for this project deployment:

- React Fundamentals
- JSX (JavaScript and XML)
- JavaScript Cores
- HTML & CSS
- UI/UX Design Principles
- Optimization Algorithms
- Database Management
- Version Control (Git)
- Testing & Debugging
- Electricity Pricing Models
- Appliance Power Consumption
- API Development
- Authentication & Security
- Linear Programming
- Programming Fundamentals
- Object Oriented Programming (OOP)
- Data Structures and Algorithms (DSA)
- Software Engineering
- Software Requirements Engineering (SRE)

## 9. Learning Outcomes

Following are the learning outcomes of this project:

We will move from just knowing C++ to gaining a good understanding of ReactJS and JavaScript, allowing us to build interactive web apps. We'll learn how to create easy-to-use, attractive user interfaces using tools like ReactJS. This project will help us understand how to manage data and build web apps with reusable components, which is important in React. We will also learn how to create and improve algorithms that plan appliance usage to save electricity. Working with new technologies will make us better at finding and fixing issues in the system. We will gain in-depth knowledge about electricity pricing models, energy consumption, and how to optimize appliance usage, which will help me become more knowledgeable in this domain. I will also learn how to design systems that schedule appliance usage effectively, which will give me specialized knowledge in creating optimization algorithms for energy management.

## 10. Nature of End Product

The end product (**Electricity Consumption Planner System**) will be a **desktop application** developed in React JS that generates optimized appliance usage schedules based on electricity rates to reduce energy costs.

## 11. Initial Literature Survey

Our project builds on ideas from existing tools like smart meters and energy management systems, which help users track and manage their electricity use. Many of these tools are either too complicated, expensive, or hard for the average person to use. From reviewing these tools, we noticed that they often miss out on something important: personalized scheduling that helps users save money by avoiding high electricity rates at peak times.

Unlike these tools, our system is designed to be simple and user-friendly. It creates a 24-hour schedule for when to use appliances, based on current electricity rates. This means users can avoid peak hours and save money without having to manage everything manually. Our approach aims to make energy management easier and more affordable, so it's available to more people.

What sets our project apart is that it not only provides a practical solution but also helps us learn more about energy management. By studying electricity pricing and optimization techniques, we'll gain a better understanding of how to save on energy costs and create a system that's both educational and cost-effective.

## 12. Miscellaneous

- **Target Users:**
  - Residential electricity consumers seek to optimize energy usage and reduce costs.
  - Small and medium-sized enterprises (SMEs) with limited energy management resources.
  - Commercial buildings, offices, and shopping centers.
  - Industrial facilities, manufacturing plants, and warehouses.
  - Educational institutions, universities, and research centers.
- **Potential Partnerships:**
  - Collaborations with electricity providers, energy management companies, or smart home device manufacturers can enhance the system's functionality and reach.
- **Potential Industries:**
  - Energy and Utilities
  - Manufacturing and Production
  - Commercial and Residential Real Estate
  - Healthcare and Hospitality
  - Education and Research

- **Deployment Locations:**
  - Homes and apartments
  - Office buildings and commercial complexes
  - Industrial parks and manufacturing facilities
  - Schools and universities
  - Hospitals and healthcare facilities
- **Future Development:**
  - Potential features include integrating renewable energy sources, incorporating weather forecasts, and expanding to commercial or industrial settings.
- **Potential Integrations:**
  - Smart home systems
  - Energy management software
  - Building automation systems (BAS)
  - Industrial control systems (ICS)
  - Renewable energy systems (solar, wind, etc.)
- **Benefits for Various Stakeholders:**
  - **Consumers:** Reduced energy bills, increased energy efficiency
  - **Businesses:** Improved energy management, reduced operational costs
  - **Industries:** Enhanced energy productivity, reduced environmental impact
  - **Utilities:** Improved demand response, reduced peak demand
  - **Environment:** Reduced greenhouse gas emissions, improved sustainability.

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