Web Application for Household Energy Consumption Prediction and Tariff Recommendation

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Background

In Great Britain, electricity prices can change every 30 minutes, according to legal regulations. With so many tariffs on the market, our application aims to assist users in selecting the optimal tariff using either actual smart meter data or a predicted consumption profile based on a questionnaire.

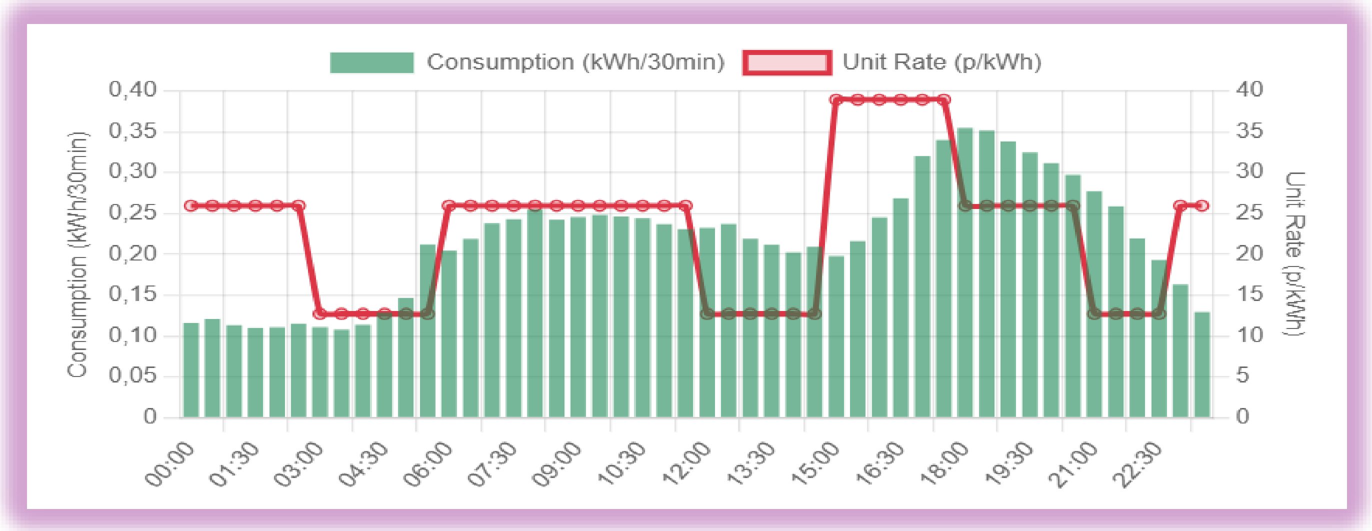


Figure 1. *An example of tariff rate and consumption change during a day. Screenshot from our application.*

Key features of the project

- Use of real tariff information of an actual energy supplier via an API.
- Forecasting of energy consumption profile from consumer usage pattern using machine learning.
- An integrated web platform for recommending tariff plans based on estimated daily energy cost.

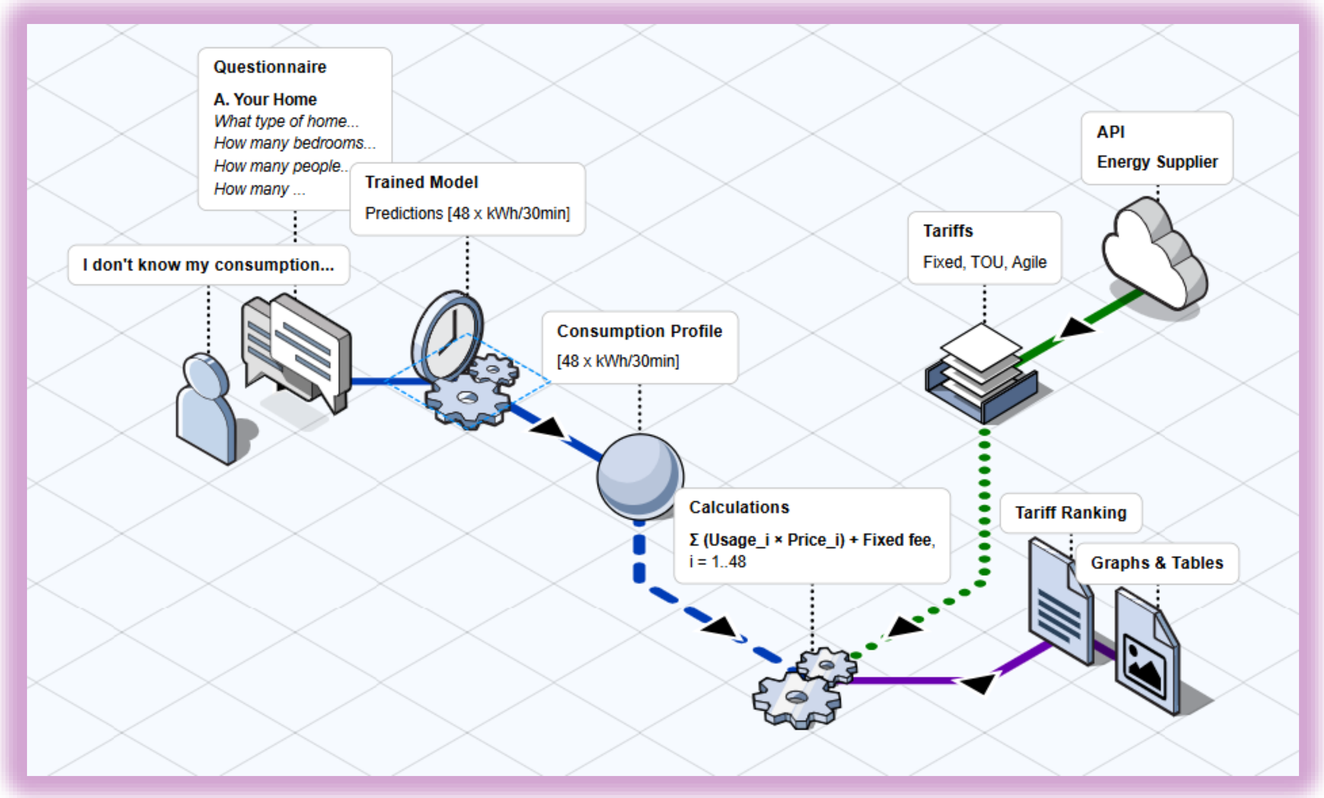


Figure 2. *Workflow of the solution: machine learning predicts the household's consumption profile, real-time tariff data is fetched via API, and the system ranks tariffs automatically..*

Methods

Tariff Integration

- Tariffs are loaded through a sequence of three API requests: retrieving the list, details, and rates.
- The data is then processed and normalized by a service that determines the tariff type (Fixed, Day-Night, Agile, Cosy).
- After that, the tariff is used for calculation according to predefined rules: **Σ (interval_price × interval_duration)+ subscription fee**

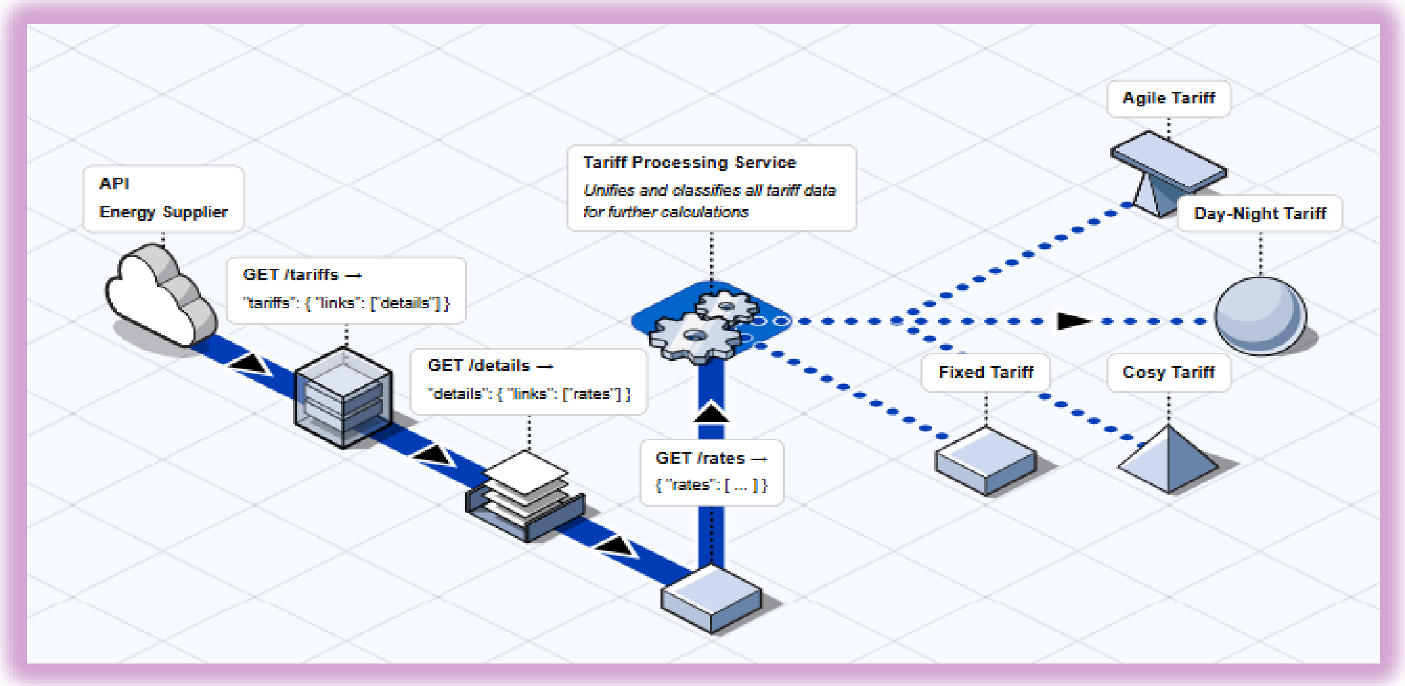


Figure 3. *From API to Tariff Types:*
API Requests → Tariff Processing → Fixed, Day-Night, Agile, Cosy

Consumption Profile Prediction from Consumer Usage Pattern Using ML

Since users without smart meters lack detailed consumption data, machine learning is used to predict their half-hourly energy profiles throughout the day. These profiles are forecasted using a Random Forest model. The key quality metric is R^2, as matching the overall shape of the consumption profile is essential for selecting the optimal tariff, rather than simply minimizing the absolute error.

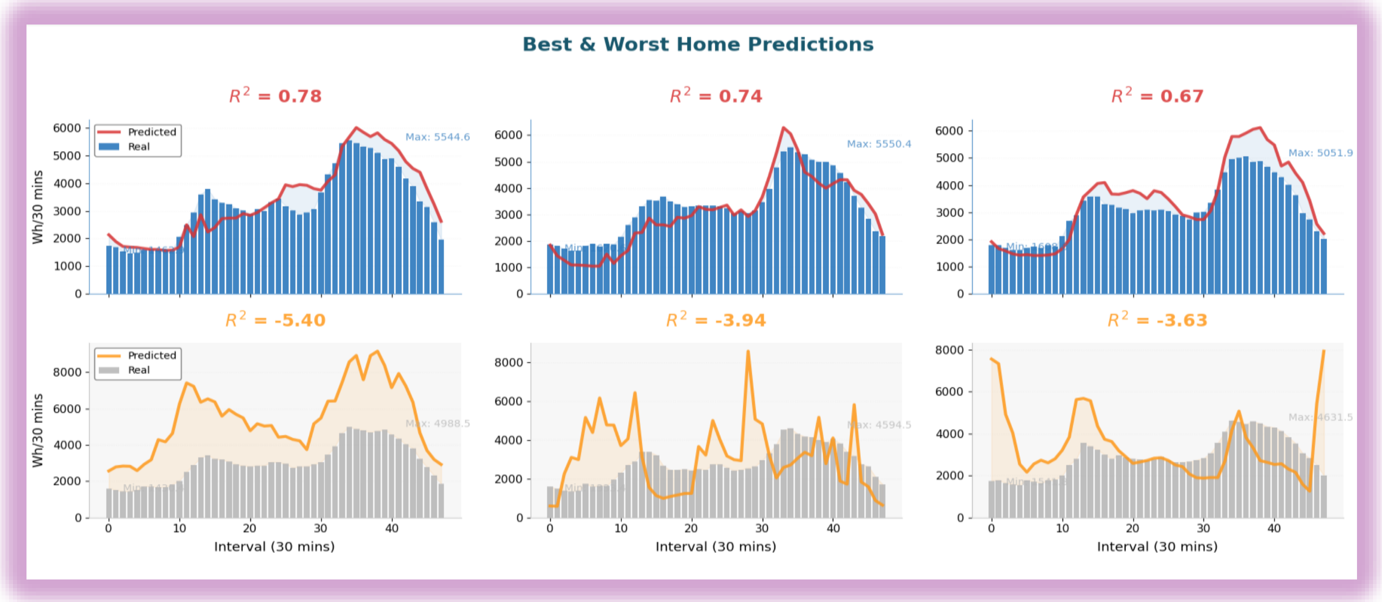
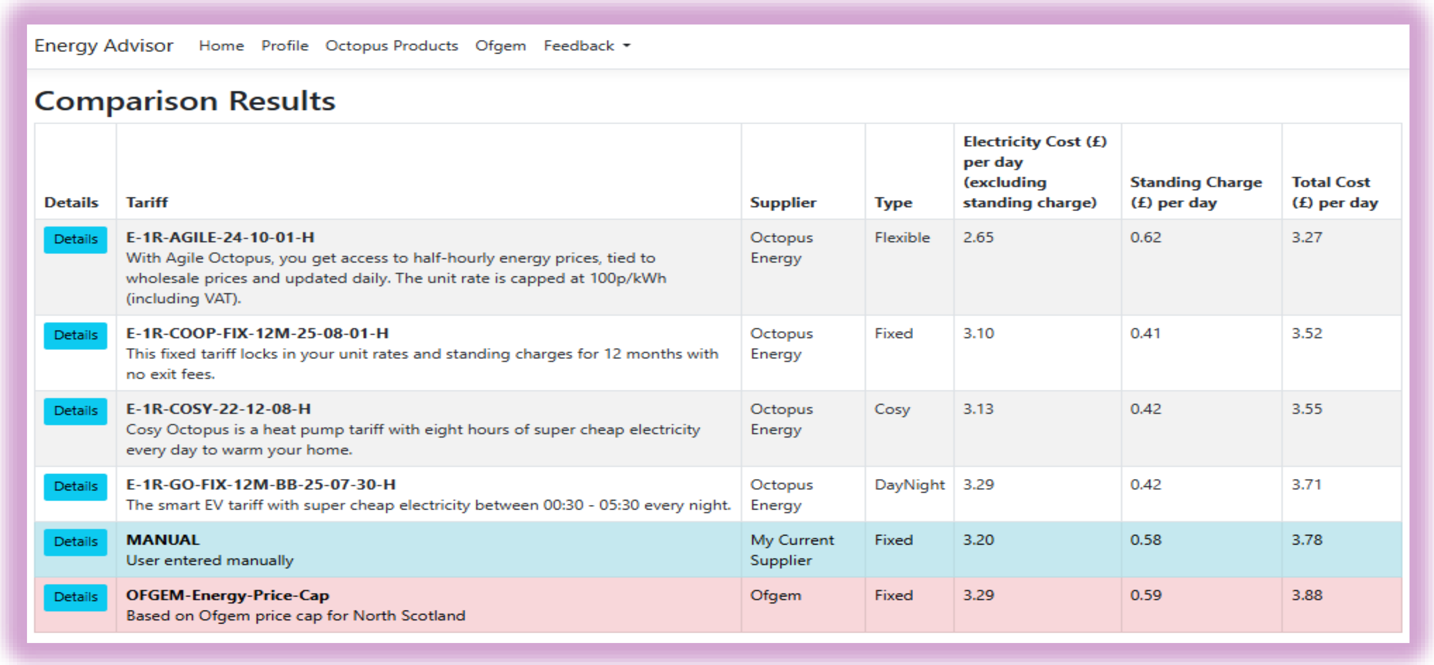


Figure 4. *Best and worst home predictions: Random Forest model.*

Results

A fully integrated working prototype has been developed, combining ML-based consumption prediction with tariff analysis to deliver a practical tool for household energy management.
A working prototype integrates ML-based consumption prediction and tariff analysis, providing actionable recommendations for household energy management.



Energy Advisor Home Profile Octopus Products Ofgem Feedback

Comparison Results

Details	Tariff	Supplier	Type	Electricity Cost (£) per day (excluding standing charge)	Standing Charge (£) per day	Total Cost (£) per day
Details	**E-1R-AGILE-24-10-01-H** With Agile Octopus, you get access to half-hourly energy prices, tied to wholesale prices and updated daily. The unit rate is capped at 100p/kWh (including VAT).	Octopus Energy	Flexible	2.65	0.62	3.27
Details	**E-1R-COOP-FIX-12M-25-08-01-H** This fixed tariff locks in your unit rates and standing charges for 12 months with no exit fees.	Octopus Energy	Fixed	3.10	0.41	3.52
Details	**E-1R-COSY-22-12-08-H** Cosy Octopus is a heat pump tariff with eight hours of super cheap electricity every day to warm your home.	Octopus Energy	Cosy	3.13	0.42	3.55
Details	**E-1R-GO-FIX-12M-BB-25-07-30-H** The smart EV tariff with super cheap electricity between 00:30 - 05:30 every night.	Octopus Energy	DayNight	3.29	0.42	3.71
Details	**MANUAL** User entered manually	My Current Supplier	Fixed	3.20	0.58	3.78
Details	**OFGEM-Energy-Price-Cap** Based on Ofgem price cap for North Scotland	Ofgem	Fixed	3.29	0.59	3.88

Figure 6. *Application view showing tariff recommendation for a sample household.*

Conclusions & Future Work

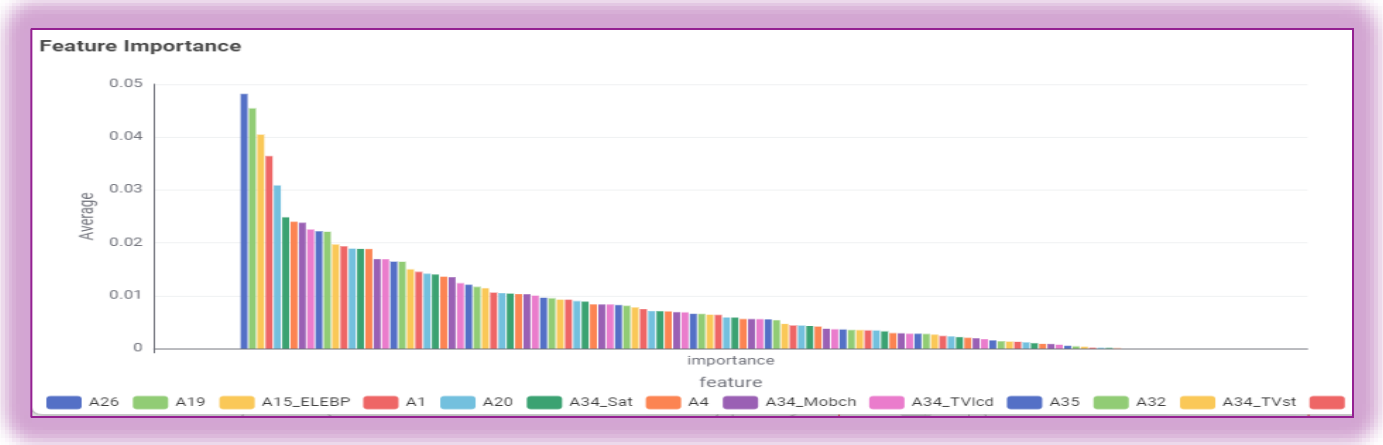


Figure 5. *Feature importance results highlight which questions can be prioritized or revised.*
Top features:
A26 – How many loads of washing do you do a week?
A19 - How many lightbulbs does your house have?

Despite the demonstrated viability of the project, further improvements are needed. Integrating tariffs from all providers, refining the ML model, and optimizing the questionnaire will enhance the accuracy and applicability of the solution. Expanding the dataset and testing the system on a broader range of households will further validate its effectiveness and support real-world deployment.

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