



FORECASTING AND CONTROL / ENGINEERING CASE STUDY

Home energy optimisation

Helping your solar panels, battery, car and heating work together

More and more homes now have solar panels, a home battery, an electric car or a heat pump. Each is clever in its own right, but they rarely talk to one another. The Propel Group's reference design, our blueprint for a smarter home energy system, shows how they can work together: planning ahead around the weather, your routine and the price of electricity, explaining its thinking in plain terms, and keeping your home running if the internet drops or a device stops responding.

GOING DEEPER

The design pairs physical models and machine-learning forecasts with constrained optimisation, a transparent plan and local fallback control.

THE VALUE CASE AT A GLANCE**The problem**

Solar panels, batteries, electric cars and heat pumps usually work on their own, so households miss out on savings and comfort they've already paid for.

The value

Lower running costs, more use of your own solar power, a warm home and a car that's ready on time, with the reasoning on show.

Extra value, at little or no extra cost

A clearer picture of your home's energy use helps you choose a tariff and plan upgrades. The approach also scales to commercial and industrial sites.

Why Propel

Energy engineering and digital expertise together: a glass box that explains, not a black box that decides for you.



Concept illustration created for this case study; not a photograph of a customer's home.

Why the whole home matters

Your battery, car charger and heating can each follow a perfectly sensible schedule and still get in one another's way. They are all drawing on the same supply of energy, often without knowing what the others are doing.

Meanwhile, life doesn't stand still. The weather turns, plans change, and the cost of buying electricity (or what you're paid for selling it back) shifts through the day. Optimising each device or system individually often misses the bigger picture.

Our design looks at the home as a whole. It weighs up running costs, carbon, how much you rely on your own generation, wear on your battery and, above all, your comfort. It then chooses a practical plan hour by hour, and makes the reasoning clear enough that you can see why.

GOING DEEPER

The home is treated as a single multi-objective scheduling problem across coupled assets, rather than a set of independent device schedules.



THE APPROACH

How it works: plan, act, check, adjust

Think of it rather like a satnav for your home's energy. It plans a route one to two days ahead in half-hour steps, takes the next turn, sees what actually happens, and re-plans whenever conditions change enough to matter.

THE OPERATIONAL THREAD

**Observe**

Your home and equipment

**Forecast**

Likely ranges

**Optimise**

Your goals, real limits

**Control**

The plan, with a safety net

01

Build a clear picture of the home

It brings together meter readings, solar output, what each appliance is doing, the weather forecast and your tariff. Because different manufacturers and suppliers all speak slightly different languages, it translates everything into the same units and the same clock first. Without that, no forecast or plan can be trusted.

GOING DEEPER

Provider and device adapters isolate vendor differences; normalised units and timestamps are a precondition for forecasting and optimisation.

02

Look ahead at sunshine and demand

It estimates how much your panels are likely to produce and learns how your household tends to use energy. Rather than a single guess, it gives a sensible range, so uncertainty is visible. Where your supplier has already published prices, it simply uses them rather than trying to predict them.

GOING DEEPER

Physical PV models with optional machine-learning correction, learned consumption patterns, and forecast ranges and scenarios to represent uncertainty.

03

Choose a plan that actually works

It balances the cost of buying electricity, the value of selling it back, carbon, battery wear and comfort. It does so within real-world limits: how quickly the battery can charge and discharge, how full or empty it may go, and when the car needs to be ready.

GOING DEEPER

Constrained mathematical optimisation, with energy balance, charge and discharge limits, storage bounds and readiness deadlines as constraints.

04

Act, adjust and keep things running

The plan becomes simple instructions for each device and is updated as fresh information arrives. If the plan can't be worked out, or the internet connection drops, a straightforward set of local rules takes over. Your equipment's own built-in protections stay in place throughout, so there is always a known, safe way of running.

GOING DEEPER

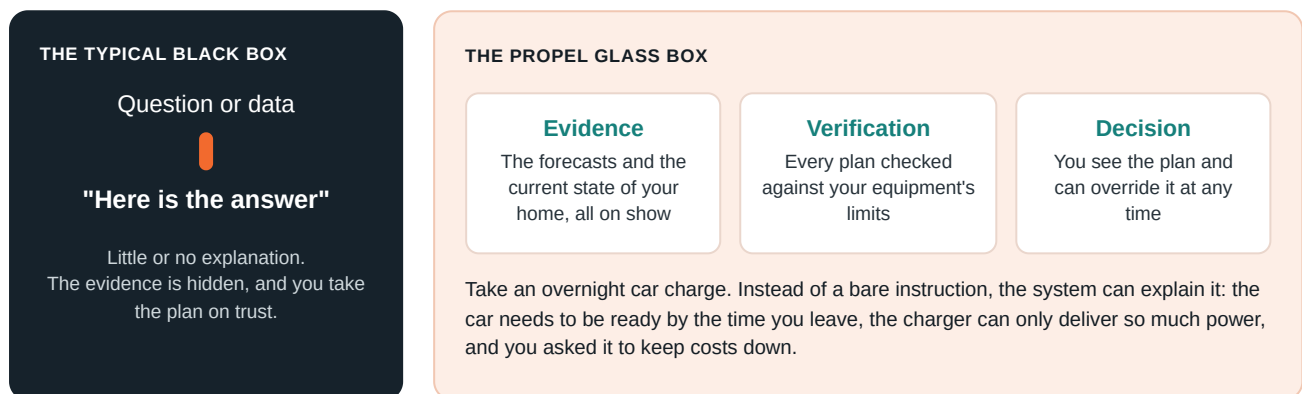
A local rule-based fallback and independent equipment protection, with defined operating modes on optimiser failure or loss of connectivity.



TECHNOLOGY AND TRUST

Black box or glass box?

Many smart systems simply announce "charging now" and leave you to wonder why. We provide you with the insights to make informed decisions about what's right for you and your home. Our design works as a glass box: you can see what it expects to happen, which information it used, what it is aiming for and which limits are shaping each decision.



This openness is at the heart of how The Propel Group works. A system you can understand is a system you can trust, and one you can hold to account.

THE TECHNOLOGY, IN PLAIN TERMS

WHAT IT DOES FOR YOU

Forecasting

Physical models and machine learning

Engineering models of solar generation give a solid foundation. Learning from your household's habits, and fine-tuning forecasts for local conditions, fills in the rest. Ranges and scenarios show how confident each forecast is.

Planning

Constrained mathematical optimisation

The planner balances the goals you have chosen within the real limits of energy, power, storage and your own requirements. Forecasts are estimates, but your equipment's limits and the things you've said must happen are fixed.

Re-planning as it goes

Model predictive control

The rolling plan looks ahead, acts on the next step, then re-plans from fresh readings. So when a forecast is off, or a device becomes unavailable, the schedule adapts.

Record-keeping and compatibility

Modular control and replay

Each make of device and each data supplier connects through its own adapter, so the planner doesn't need rewriting when your equipment changes. A log of every decision, a record of each settings change and a simple back-up mode make it possible to see what went wrong, replay past decisions and respond predictably if the internet drops or a device stops responding.

A note on artificial intelligence: no chatbot is needed to work out the plan. It is calculated with well-established engineering mathematics. AI can help explain the plan; it doesn't decide it. Checking the system means checking the data, what is physically possible and how the controls behave, with every input traceable to its source, much as a good report cites its references.



THE USER EXPERIENCE

A plan you can see and shape

At the heart of the experience is a single, clear view of the day. It shows the expected solar generation and household demand alongside what each device is planning to do, and how things actually turned out. At a glance, you can see why something is happening, what is driving it, and what would change if you altered a preference or the forecast moved.

One plan across the whole home

AN ILLUSTRATIVE DAY / NO MEASURED DATA

	Overnight	Morning	Daytime	Evening
Solar outlook	Low	Variable		Low
Battery plan	Hold a reserve	Adjust as the forecast firms up		Cover the evening's demand
Flexible appliances Car, hot water and so on	Get ready for when you need them		Meet your deadline	

Each new reading refines the forecast, which updates the plan, which decides the next action.

An illustrative day. Periods are conceptual; no measured generation, prices, savings or device performance are shown.

What the household sees

Forecast and reality

Expected conditions sit alongside what actually happened. Uncertainty is shown openly, rather than presenting a single forecast as an outcome, and any gap becomes a prompt to review or re-plan.

The plan, explained

Car charging, flexible appliances and battery reserves are laid out on a simple timeline, together with the goal and limits in play, so even an apparently surprising decision can be understood.

Your preferences, your call

You can set when things need to be ready, how warm you like the house, and whether cost or carbon matters more. Any changes you make, and the mode the system is running in, are always clear, including when it has switched to its simple back-up settings.

Explaining unexpected outcomes

Like a flight recorder, the design keeps a log of each decision: the forecasts, prices and device states, plus the settings in use at the time. Replaying a decision shows whether the forecast was wrong, a setting needed changing or a device didn't respond. Any breach of a limit is flagged for your review, not hidden away.

VALUE FOR YOUR HOME, AND BEYOND

What it's designed to deliver

The design brings everything together in one system: what it knows about your equipment, live readings, forecasts, the planner and your own controls. Its value comes from coordinating the whole home while keeping comfort, being ready on time and equipment limits firmly in view.

Keep energy costs in check

Your battery, and anything that can run at a flexible time, is scheduled around expected sunshine and prices, so devices don't each make a sensible choice that adds up to an expensive one.

Make the most of your own generation

Anything that can run at a flexible time is lined up with likely sunshine and demand, and the visible plan shows the trade-off between using, storing and selling your energy.

Choose your tariff with confidence

Over time, the system builds a clear picture of how and when your household really uses energy. It is designed to help you choose your tariff with confidence, comparing time-of-use, flat-rate and export options against the way you actually live, rather than relying on guesswork or a supplier's averages.

Look after your home and equipment

Being ready on time, comfort, power limits and battery wear are all part of the decision. A good schedule meets the household's needs, not just an energy target.

Adapt when things change

The plan updates as readings and forecasts change. You can always override the plan, every decision is recorded, and a dependable back-up mode means you always know how the system is running.

How we propose to measure it

We believe claims about savings should be tested, not assumed. These are the measures we propose:

MEASURE	HOW IT WOULD BE ASSESSED
Savings over a simpler approach	Replay the same demand, weather, tariffs and equipment against a sensible set of simple, fixed rules, including the cost of battery wear.
Forecast quality	Compare forecast and actual generation and demand, and check how often reality falls within the predicted ranges.
Comfort and reliability	Track any times the car or hot water wasn't ready, the home wasn't comfortable, or an equipment limit was breached.
Energy and carbon	Measure how much of your own energy you use, how much you buy from the grid, and the estimated emissions, all calculated the same way.

From homes to industry

The same approach can be applied to energy scheduling on commercial and industrial sites: predict demand, model the flexibility available, enforce limits and show the plan. Industrial use needs process-specific models, constraints and validation, and a clear line between advice and automatic control.

Getting started. For installers, energy suppliers and equipment makers, Propel's Northstar Framework® agrees the value first, then builds with the people who will use the system: typically a first working system in one to two weeks, and measurable value in four to eight.

Engineering case study, September 2026. Based on the Propel UK Home Energy Optimiser reference design. The benefits described are intended outcomes and the evaluation measures are proposed; no measured results are reported here. thepropelgroup.com