

SCENARIO 3

Luxury Under Control

SCENARIO AT A GLANCE

Anna and Robert live in a large, modern smart home equipped with several energy-intensive systems, including a swimming pool, sauna, air conditioning and electric vehicles. Comfort is their priority, but they want to make sure that energy is used intelligently rather than unnecessarily.

What you need to do

- build a realistic historical hourly energy consumption profile for a minimum of 30 consecutive days,
- forecast energy demand for the next 24 hours, with the possibility of extending the forecast to 3 and 7 days,
- use real historical and forecast weather data,
- identify peak demand periods and explain changes in consumption,
- present the results in an application,
- evaluate how renewable energy and better timing of appliance use could reduce grid electricity consumption and improve overall energy efficiency.

What you need

You will work with:

- the household profile and description of the residents' behaviour,
- indicative energy consumption parameters for household appliances and systems,
- an example household location for obtaining real historical and forecast weather data,
- your own clearly documented assumptions where additional information is required.

Context

Anna and Robert live in a large, modern house equipped with smart-home technologies, a swimming pool, sauna and electric vehicles.

Comfort is very important to them, and they do not want to compromise their lifestyle. However, with several energy-intensive systems operating in the house, they want to make sure that energy is used intelligently rather than unnecessarily.

Their goal is not simply to reduce costs, but to improve efficiency, make better use of renewable energy and avoid waste while maintaining the same level of comfort.

They want a solution that will help them forecast future energy demand, understand when and why consumption is highest, and identify opportunities to improve the overall energy performance of the household without affecting their everyday comfort.

Household Profile

2 adults	large detached smart home
high standard of living	swimming pool
sauna	air conditioning
electric vehicles	extensive smart-home infrastructure
relatively high electricity consumption	comfort maintained throughout the day

Appliances and Indicative Energy Consumption Parameters

APPLIANCE / SYSTEM	INDICATIVE ENERGY CONSUMPTION
Heat pump / electric heating	1.5–4.0 kW during operation
Air conditioning	1.0–2.5 kW during operation
Refrigerator + freezer	1.5–2.2 kWh/day
Swimming pool circulation pump	0.6–1.2 kW during operation
Pool heating system	2.0–5.0 kW during operation
Sauna	6.0–9.0 kW during operation
EV charger	up to 7.4 kW per vehicle during charging
Oven	2.0–2.5 kW during operation
Induction hob	1.5–4.0 kW depending on use
Dishwasher	0.8–1.2 kWh/cycle
Washing machine	0.6–1.0 kWh/cycle
Tumble dryer	1.5–2.5 kWh/cycle
Television	0.10–0.20 kW during operation
Smart and garden lighting	0.10–0.40 kW total when active
Smart-home infrastructure	0.05–0.15 kW, continuous operation
Laptop / computer	0.05–0.25 kW during operation
Phone / tablet charging	0.005–0.02 kWh/device per charge



EXAMPLE HOUSEHOLD LOCATION

Barcelona, Spain

The values provided above are indicative and are intended to serve as input parameters for the challenge. Participants may make reasonable additional assumptions where necessary, provided that these assumptions are clearly documented in the final solution.

Participants should use real historical and forecast weather data for the indicated location.

Challenge

Your task is to create a solution that forecasts the household's energy demand and optimises that demand in terms of cost.

1 Historical Energy Consumption Profile

Based on the provided scenario, prepare a realistic historical electricity consumption profile for the household.

The historical profile should cover **a minimum of 30 consecutive days with hourly resolution**.

The profile should:

- reflect the residents' daily routine,
- include appliance and system operation,
- account for the impact of outdoor temperature,
- include realistic differences between individual days,
- reflect periods of high and low household activity,
- reflect the behavioural variability described in the scenario.

The historical profile will serve as input data for the next part of the task.

2 Energy Consumption Forecast

Prepare a model that forecasts the household's hourly energy demand.

The solution must generate a forecast for:

- the next 24 hours.

The solution should also support forecasts for:

- the next 3 days,
- the next 7 days,

depending on data availability.

The forecast should account for predicted weather conditions and the expected operation of major household systems.

3 Application

Prepare an application that presents the system's results.

The application must display:

- forecast hourly energy consumption,
- forecast total energy consumption for the selected period,
- outdoor temperature forecast,
- hours with the highest expected demand,
- a brief explanation of the expected increase or decrease in consumption.

The user should be able to view a forecast for at least the next 24 hours.

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Renewable Energy Simulator

The solution should include a module for assessing the impact of an investment in renewable energy sources on Anna and Robert's household.

The module should allow the user to select the installation capacity in kWp.

For the purpose of the challenge, it may be assumed that the house has suitable conditions for a rooftop photovoltaic installation.

For the selected option, the application should present:

01

estimated annual energy production,

02

**the share of self-generated energy
in covering household demand,**

03

**estimated reduction in electricity
purchased from the grid,**

04

estimated savings,

05

indicative payback period for:

A

a renewable energy installation
without changing current habits,

B

a renewable energy installation
combined with shifting selected
energy-consuming activities
to more favourable periods.

The module should enable comparison of at least several installation capacity options.

We provide common assumptions for electricity tariffs and PV costs for all teams in the shared attachment. For any other assumptions, such as renewable energy production, you are free to choose your own values. Just state them clearly in your solution.

Description of Residents' Behaviour

6:30–9:00

Anna and Robert usually start their day between 6:30 and 7:00.

During this time:

- lighting is used,
- breakfast and coffee are prepared,
- heating or air conditioning maintains comfortable indoor conditions,
- electronic devices are used and charged,
- the swimming pool circulation system may already be operating,
- electric vehicles may still be charging after the night.

9:00–16:00

The residents may be at work or outside the house.

Even when nobody is at home, several systems continue to operate, including:

- swimming pool equipment,
- heating or air conditioning,
- refrigerator and freezer,
- ventilation,
- smart-home infrastructure,
- standby devices.

The household therefore maintains a relatively high base load throughout the day.

16:00–19:00

Household activity gradually increases.

Anna and Robert may:

- prepare meals,
- use computers or televisions,
- use the washing machine or tumble dryer,
- run the dishwasher,
- connect one or both electric vehicles for charging.

19:00–23:00

Evening energy demand may be particularly high.

During this period, the residents may:

- use the sauna,
- use garden and indoor lighting,
- prepare dinner,
- entertain guests,
- use television and entertainment systems,
- charge electric vehicles,
- maintain heating or air conditioning.

Several high-power systems may operate simultaneously.

23:00–6:30

Active household use decreases, but the house continues to consume energy.

The following may remain active:

- swimming pool systems,
- refrigerator and freezer,
- smart-home infrastructure,
- heating or cooling,
- standby devices,
- electric vehicle charging.

Behavioural Variability

The household profile is not identical every day.

The following should be taken into account:

- the sauna is used only on selected days,
- pool heating and circulation may operate for different periods,
- electric vehicles are not charged every day,
- vehicle charging duration depends on previous use,
- guests may significantly increase evening energy consumption,
- weather conditions affect heating and air-conditioning demand,
- weekends may involve higher daytime occupancy,
- washing, drying and dishwasher use vary between days,
- Anna and Robert may occasionally be away from home,
- several high-power systems may operate simultaneously, creating significant peak demand.

Required Outcome

At the end of the challenge, the solution should include:

- | | |
|---|--|
| ☐ 1 a historical hourly energy consumption profile covering a minimum of 30 consecutive days, | ☐ 2 an energy consumption forecasting model, |
| ☐ 3 an hourly forecast for the next 24 hours, | ☐ 4 the ability to present forecasts for the next 3 and 7 days, |
| ☐ 5 an application presenting the results, | ☐ 6 identification of the hours with the highest expected demand, |
| ☐ 7 a brief explanation of changes in forecast energy consumption, | ☐ 8 a simulator showing the impact of a renewable energy investment on the household's energy balance and costs. |

Final Objective

The solution should make it possible to answer the following questions:

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- Q1** What energy demand can be expected in this household over the next 24 hours, 3 days, and 7 days?
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- Q2** During which hours will energy demand be highest?
-
- Q3** What changes in household habits could be proposed to optimise the use of renewable energy and electricity from the grid?
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- Q4** How could the selected renewable energy investment affect the amount of electricity purchased from the grid, household costs, and the investment payback period?
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