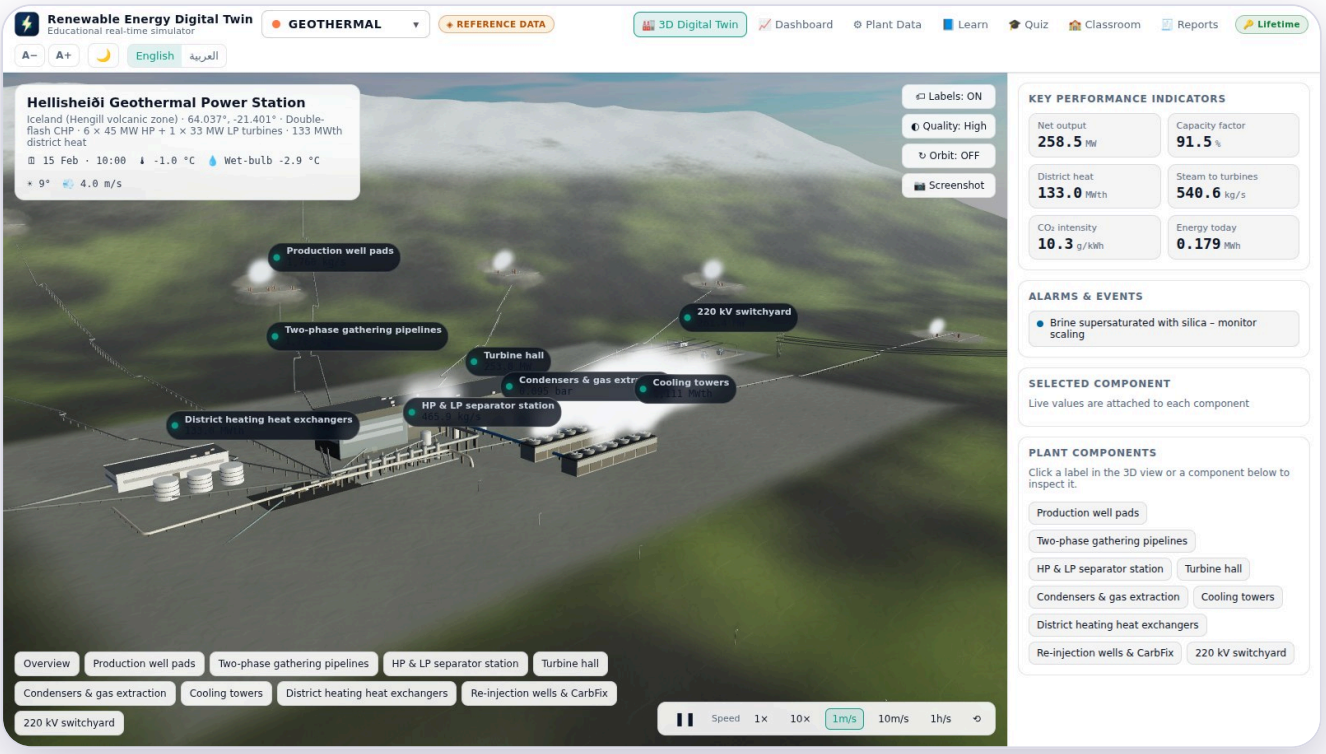
ASFAN Trading

User Manual

Renewable Energy Digital Twin

Educational real-time digital-twin simulator for geothermal, biomass, waste-to-energy, hydropower, green hydrogen, wind and solar plants – with 3D site models, live physics, quizzes and a manual plant builder.



Version 1.4.0
September 2026

Windows 10 / 11 (64-bit)
Support: 00962776140404 · info@asfanco.com

Contents

1 Welcome

Thank you for choosing **Renewable Energy Digital Twin**. This program is a real-time, three-dimensional simulator of renewable energy power plants. It was built for students, trainers, engineers and anyone who wants to understand how a modern renewable plant really works – by watching it run, changing its numbers and seeing what happens.

Every plant in the program is a **digital twin**: a 3D model of a real site whose components are driven, second by second, by a physics model of the process. The values you see on the labels, gauges and charts are computed live from weather, fuel, water, sun and wind conditions and from the operating parameters you choose.

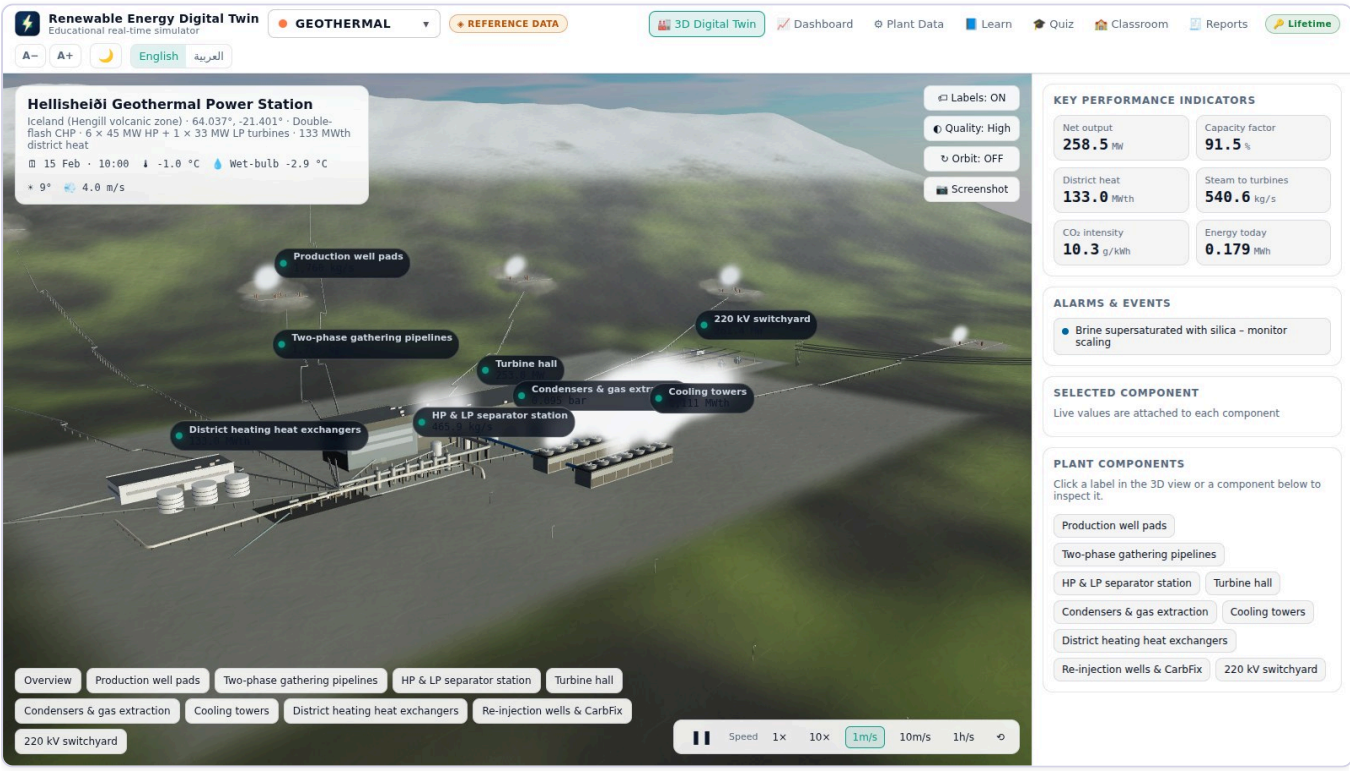


Figure 1: The 3D digital twin of the Hellisheiði geothermal power station with live values on every component.

1.1 What the program contains

- **Seven reference plants**, each a real site with its published data: geothermal (Iceland), biomass (United Kingdom), waste-to-energy (Dubai), hydropower (Aswan, Egypt), green hydrogen (NEOM, Saudi Arabia), wind (Dumat Al Jandal, Saudi Arabia) and solar (Noor Abu Dhabi, UAE).
- A **3D digital twin** of every plant with camera fly-overs, live labels, day and night, weather and satellite imagery of the real location.
- A **dashboard** with gauges, trend charts, an energy-flow diagram, all process values, environmental data and alarms.
- **Plant Data**: every operating parameter of the physics model can be changed – the twin and the dashboard react immediately. Scenarios such as drought, heatwave, storm or equipment outage are one click away.

- **Learn** pages for each technology: overview, step-by-step process, key equations, real plant data, environment and a glossary.
- A **quiz** module with auto-graded practice and exam modes, live-data questions and a printable certificate.
- A **classroom mode**: students send every finished quiz to a shared folder and the supervisor (teacher) sees each student's answers and scores – without internet or a server.
- **Reports**: a printable snapshot report, JSON and CSV export.
- A **manual plant builder**: enter the design data of your own plant and the program builds its 3D twin and runs the physics on your numbers.
- Full **English and Arabic** interface (right-to-left), adjustable text size, light and dark theme.

1.2 How to use this manual

Chapters 2 to 7 take you from the download to an activated program. Chapters 8 to 17 explain every screen in detail. Chapter 18 describes the seven reference plants, chapter 19 the automatic updates, and chapters 20 to 22 cover your data, troubleshooting and support.

Conventions

Names of buttons and screens are shown like this: **Plant Data**. Keys to press are shown like this: `Ctrl` + `S`. File names and text you type are shown like this: `RenewableEnergyDigitalTwin-Setup-1.4.0.exe` .

Tip

If you only have five minutes: install the program (chapter 5), click **Continue with the trial**, pick an energy type from the drop-down at the top left, and use the mouse to fly around the plant (chapter 10). Everything else can wait.

2 System requirements

The program runs on ordinary Windows computers and laptops. It does not need a server, a database or an internet connection for daily use.

Table 1: System requirements

Requirement	Minimum	Recommended
Operating system	Windows 10 (64-bit)	Windows 11 (64-bit)
Processor	Dual-core, 2 GHz	Quad-core, 2.5 GHz or faster
Memory (RAM)	4 GB	8 GB or more
Graphics	Any graphics chip with WebGL 2 support (Intel HD 500 series or newer, updated driver)	Dedicated graphics card (NVIDIA / AMD) for the *High* quality setting
Free disk space	600 MB	1 GB
Screen	1366 × 768	1920 × 1080 (Full HD) or larger
Internet	Not required	Recommended for automatic updates and satellite imagery under the plants
User rights	Standard user (no administrator rights needed)	

> **Note**
> The 3D view is the only demanding part of the program. On a weaker laptop set **Quality** to **Low** or **Medium** in the 3D toolbar (chapter 10) – the simulation itself is not affected.

The program is a 64-bit application. 32-bit Windows, Windows 7/8, macOS and Linux are not supported.

3 Downloading the program

The program is delivered as a single file that you download from the official ASFAN download page. You may also have received the file on a USB stick or by e-mail from your vendor – in that case skip to chapter 5.

3.1 The download page

1. Open the download page in your browser: **https://github.com/asfantrading-create/RenewableEnergyDigitalTwin-Releases/releases/latest**
2. The page shows the latest version at the top. Scroll to the **Assets** list below the release notes.
3. Click the file you want (see the table below). The browser downloads it to your *Downloads* folder. You can also use the permanent link **https://github.com/asfantrading-create/RenewableEnergyDigitalTwin-Releases/releases/latest/download/RenewableEnergyDigitalTwin-Setup.exe** – it always downloads the newest installer.
4. If the browser shows a warning about the file, follow chapter 4 – this is normal for a new program and takes two clicks.

Table 2: Files on the download page

File	What it is	When to use it
`RenewableEnergyDigitalTwin-Setup-1.4.0.exe`	Installer (Setup edition)	**Recommended.** Installs the program, creates shortcuts and updates itself automatically.
`RenewableEnergyDigitalTwin-Portable-1.4.0.exe`	Portable edition	No installation – runs directly from any folder or USB stick. Updates must be downloaded by hand.
`RenewableEnergyDigitalTwin-UserManual-EN-v1.4.0.pdf`	This manual (PDF)	English user manual.
`RenewableEnergyDigitalTwin-UserManual-AR-v1.4.0.pdf`	Arabic manual (PDF)	دليل المستخدم بالعربية.
`README.txt`	Quick instructions	Short installation and activation notes in Arabic and English.
`SHA256SUMS.txt`	Checksums	Optional: lets you verify that a download is complete and unaltered.
`latest.yml`, `*.blockmap`	Update files	Used by the automatic update – you do not need to download them.
Source code (zip / tar.gz)	Added by GitHub	Not needed – contains no program.

Note

Permanent links – they never change and always give the newest version: installer https://github.com/asfantrading-create/RenewableEnergyDigitalTwin-Releases/releases/latest/download/RenewableEnergyDigitalTwin-Setup.exe · portable https://github.com/asfantrading-create/RenewableEnergyDigitalTwin-Releases/releases/latest/download/RenewableEnergyDigitalTwin-Portable.exe · this manual https://github.com/asfantrading-create/RenewableEnergyDigitalTwin-Releases/releases/latest/download/RenewableEnergyDigitalTwin-UserManual-EN.pdf · Arabic manual https://github.com/asfantrading-create/RenewableEnergyDigitalTwin-Releases/releases/latest/download/RenewableEnergyDigitalTwin-UserManual-AR.pdf.

Tip

Always download from the official page or use the file your vendor gave you. Do not run copies of the program obtained from other websites.

3.2 Verifying the download (optional)

`SHA256SUMS.txt` lists a fingerprint (SHA-256 checksum) for every file. To compare it on Windows, open *PowerShell* in your Downloads folder and run `Get-FileHash .\RenewableEnergyDigitalTwin-Setup-1.4.0.exe -Algorithm SHA256`. The printed hash must match the line in the checksum file exactly. A mismatch means the download was interrupted – download the file again.

4 Browser and Windows security warnings

Windows and modern browsers warn about installers they have not seen many times before. Renewable Energy Digital Twin is a specialised program with a small number of users, so the warnings below can appear. They do not mean the file is dangerous – they mean the file is *new*. Each warning is dismissed once with the steps in this chapter.

4.1 Microsoft Edge: “isn’t commonly downloaded”

After the download, Edge may show the message *“RenewableEnergyDigitalTwin-Setup-1.4.0.exe isn’t commonly downloaded. Make sure you trust RenewableEnergyDigitalTwin-Setup-1.4.0.exe before you open it.”* in the Downloads panel at the top right.

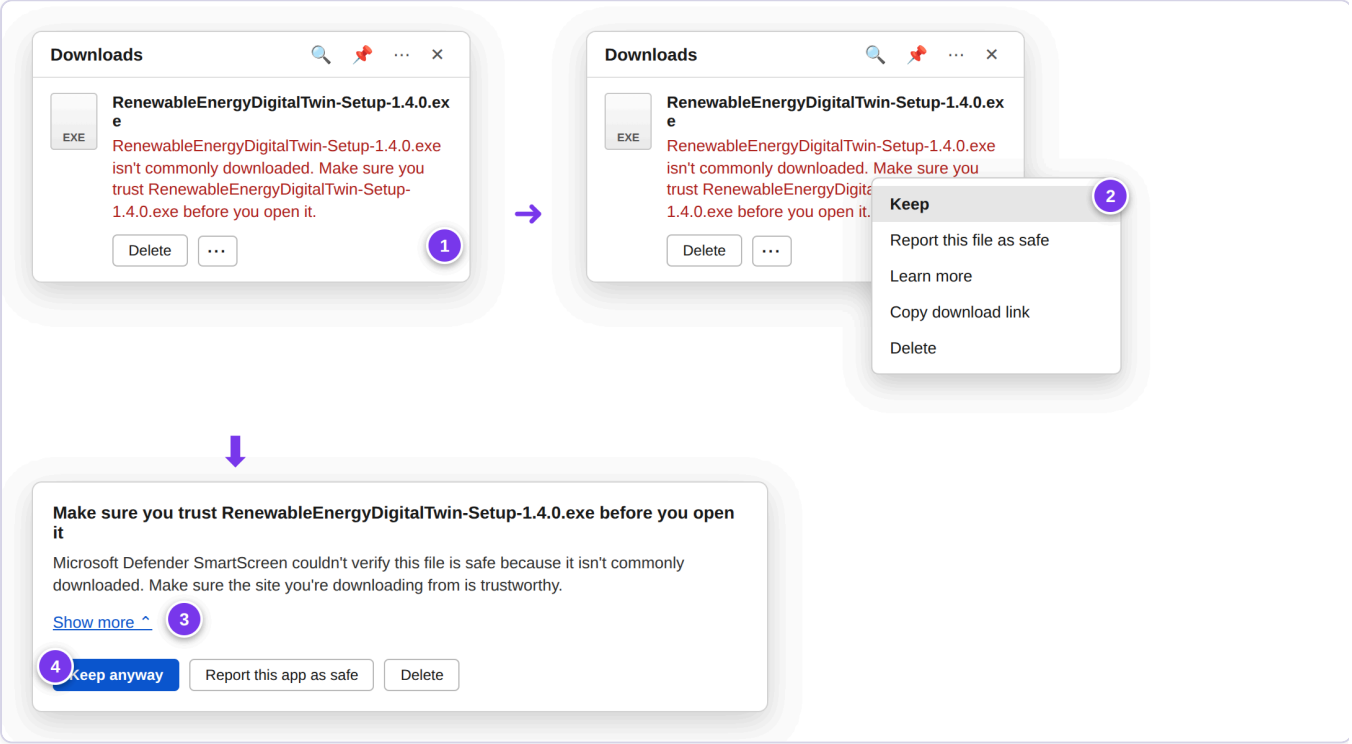


Figure 2: Keeping the download in Microsoft Edge (illustration): ⋯ → Keep → Show more → Keep anyway.

1. In the Downloads panel, click the three dots **⋯** next to the file name (**1**).
2. Click **Keep** (**2**).
3. Edge asks once more. Click **Show more** (**3**) …
4. … and then **Keep anyway** (**4**). The file is now in your Downloads folder and can be opened.

4.2 Google Chrome

Chrome shows a similar note (*“… isn’t commonly downloaded”*) in the download bubble at the top right. Click the small arrow or **⋯** next to the file and choose **Keep** (in some versions **Download suspicious file** → **Keep**). Mozilla Firefox usually shows no warning.

4.3 Windows SmartScreen: “Windows protected your PC”

When you start the installer for the first time, Windows may show a blue window titled *“Windows protected your PC”*. The installer is not yet signed with a certificate that Windows recognises; the program itself is safe.

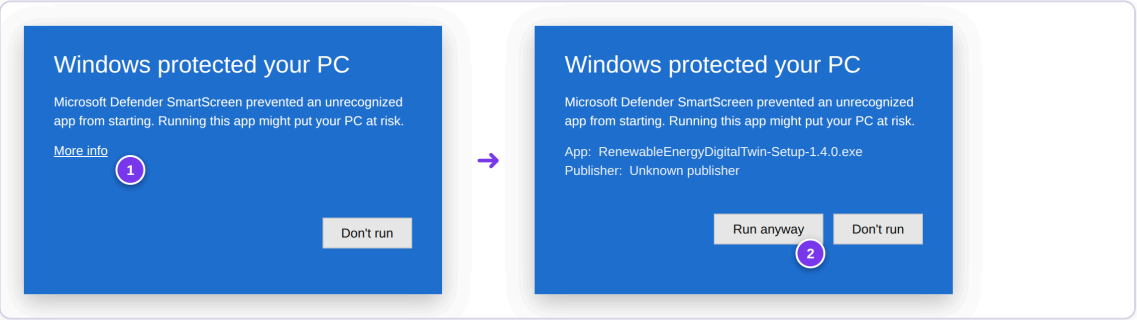


Figure 3: Windows SmartScreen (illustration): click More info, then Run anyway.

1. Click **More info** (**1**). The window now shows the file name and “Unknown publisher”.
2. Click **Run anyway** (**2**). Windows remembers this decision – the warning does not appear again for this file.

4.4 Antivirus programs

Some antivirus products flag every unknown installer. If yours blocks the file, choose *Allow* / *Restore* in the antivirus notification, or add the Setup file to its exclusions, and start the installer again. If the antivirus deleted the file, download it once more.

> **Important**
>
> If you are unsure whether a warning is one of those described here, do not click through it – send a screenshot to our support (WhatsApp **00962776140404** (+962 77 614 0404) or e-mail **info@asfanco.com**) and we will confirm within one working day.

5 Installation

5.1 Setup edition (recommended)

1. Double-click `RenewableEnergyDigitalTwin-Setup-1.4.0.exe` in your Downloads folder.
2. Pass the SmartScreen window if it appears (chapter 4).
3. A small progress window installs the program. There are no options to choose – it takes about 20 seconds.
4. The program starts automatically when the installation finishes. A shortcut **Renewable Energy Digital Twin** is placed on the Desktop and in the Start menu.

The installation is **per user**: it goes into your own profile (`%LOCALAPPDATA%\Programs\Renewable Energy Digital Twin`), needs no administrator password and does not affect other Windows users of the computer.

5.2 Portable edition

`RenewableEnergyDigitalTwin-Portable-1.4.0.exe` needs no installation. Copy it to any folder (for example a USB stick or a shared network drive) and double-click it. The first start takes a few seconds longer because the program unpacks itself to a temporary folder.

The portable edition shares its settings, license and data with the Setup edition (chapter 20), so you can use both on the same computer. It cannot update itself – see chapter 19.

5.3 Installing a newer version

Simply run the newer Setup file. It replaces the old version in place; your license, settings, entered plant data and quiz history are kept. The Setup edition normally does this by itself through the automatic update (chapter 19).

5.4 Uninstalling

Open Windows Settings → Apps → Installed apps (Windows 10: Apps & features), find **Renewable Energy Digital Twin**, click Uninstall and confirm. Your license and data folder are kept so that a later re-installation continues where you left off; to remove them as well, delete the folder `%APPDATA%\Renewable Energy Digital Twin` (chapter 20).

> **Note**
> The portable edition leaves nothing behind except the data folder mentioned above. To remove it, just delete the EXE file.

6 First start and the trial version

Double-click the **Renewable Energy Digital Twin** shortcut on the Desktop (or the portable EXE). A start screen reports the steps *Checking license*, *Starting simulation*, *Building interface* and *Rendering 3D digital twin*; after a few seconds the main window opens maximised.

On the first start the program is in **trial mode** and shows the **License & activation** window. You can enter your license key straight away (chapter 7) or click **Continue with the trial** to explore first.

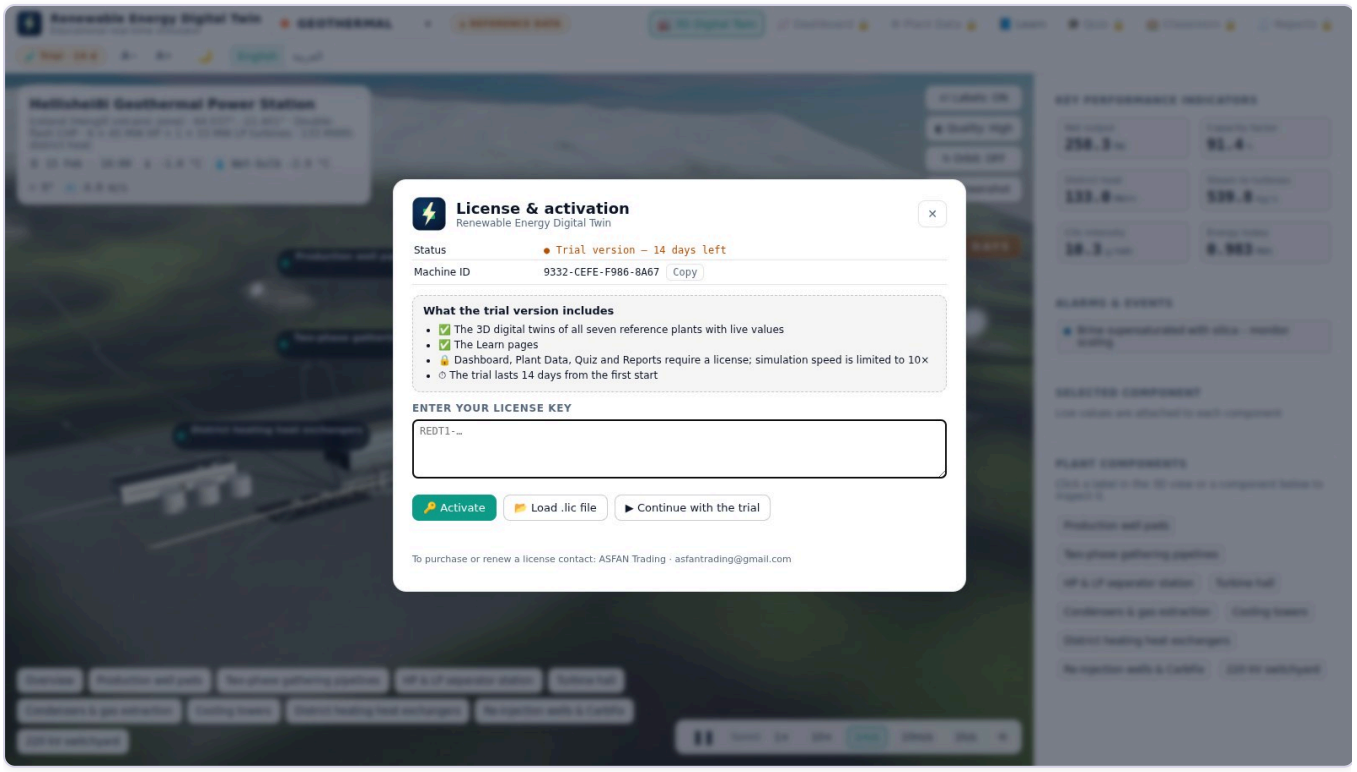


Figure 4: The first start: the license window over the 3D twin. Click Continue with the trial or enter your key.

6.1 What the trial version includes

The trial lasts **14 days** from the first start and needs no key. It is meant for evaluating the program.

Table 3: Trial version

Available in the trial	Locked until activation
The 3D digital twins of all seven reference plants with live values, camera presets, labels, day and night	Dashboard (gauges, charts, energy flow, alarms)
The Learn pages of every technology	Plant Data (entering your own values, scenarios, import/export)
Language, text size and theme settings	Quiz and certificates
Simulation speed up to 10×	Reports and data export; simulation speeds 1 m/s, 10 m/s and 1 h/s
	The manual plant builder

Available in the trial	Locked until activation
	Classroom mode (joining a class, sending quiz results)

In the trial the 3D view carries a small **TRIAL VERSION · n days** watermark and the license badge at the top of the window shows 🧪 **Trial** with the days left. Locked pages show a lock card with an Activate button instead of their content.

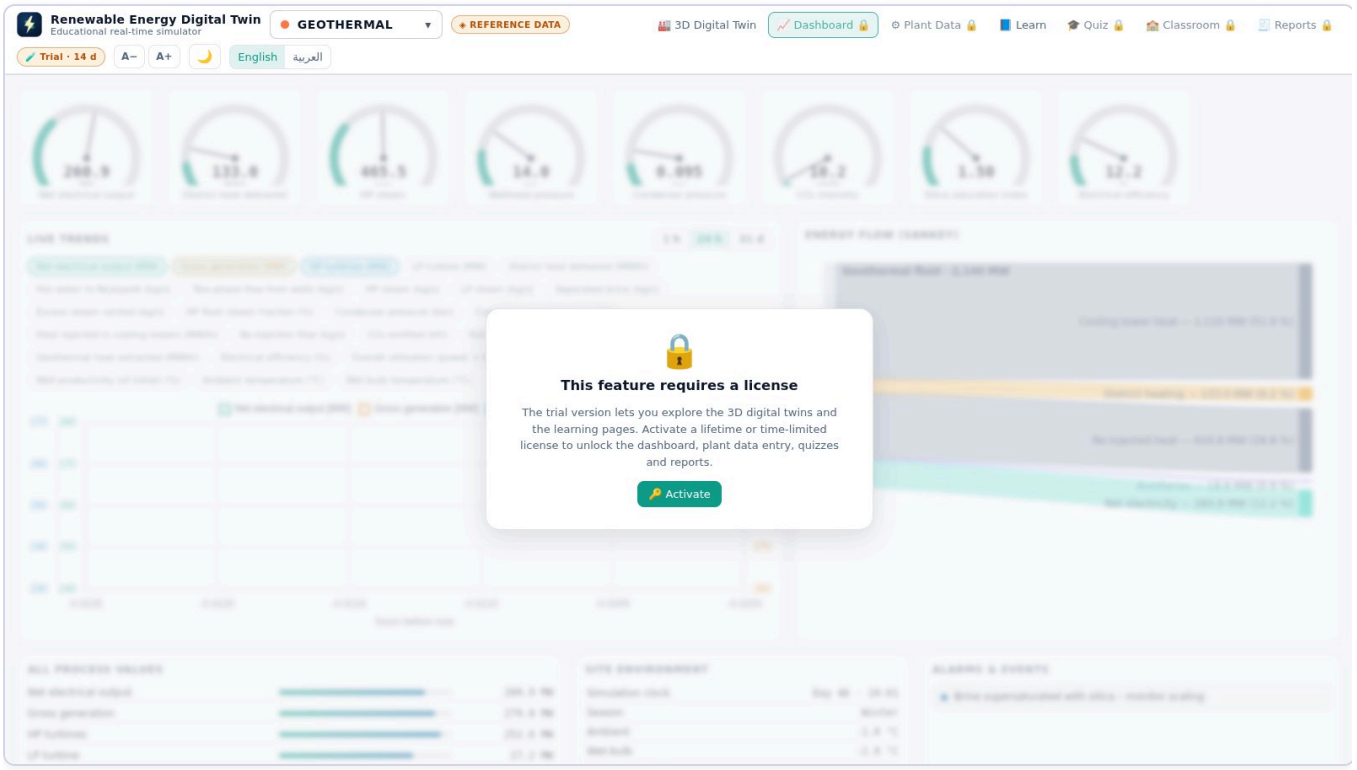


Figure 5: A locked page in the trial version. Click Activate to open the license window.

6.2 When the trial ends

After 14 days the badge changes to ⛔ **Trial ended** and the license window can no longer be closed – the program waits for a key. Enter a license key to continue – nothing you did during the trial is lost.

> **Tip**
>
> To buy a license, or to extend a trial for a class or a pilot project, contact us: WhatsApp **00962776140404** (+962 77 614 0404) or e-mail **info@asfanco.com**.

7 Activating your license

Your license is a text key that starts with `REDT1-`, delivered by e-mail or WhatsApp, either as text or as a small file with the extension `.lic`. The key is signed by ASFAN and cannot be altered; the program checks it locally, so **no internet connection is needed** for activation.

7.1 Entering the key

1. Click the license badge at the top of the window (🧪 **Trial**), or open the license window shown at start-up.
2. Paste the key into the text box under **Enter your license key**. If you received a file, click **Load .lic file** instead and choose it.
3. Click **Activate**. The message *License activated – thank you!* appears and the window closes by itself.
4. The badge now shows 🔑 **Lifetime** or 🔑 **until *date***, and every page is unlocked.

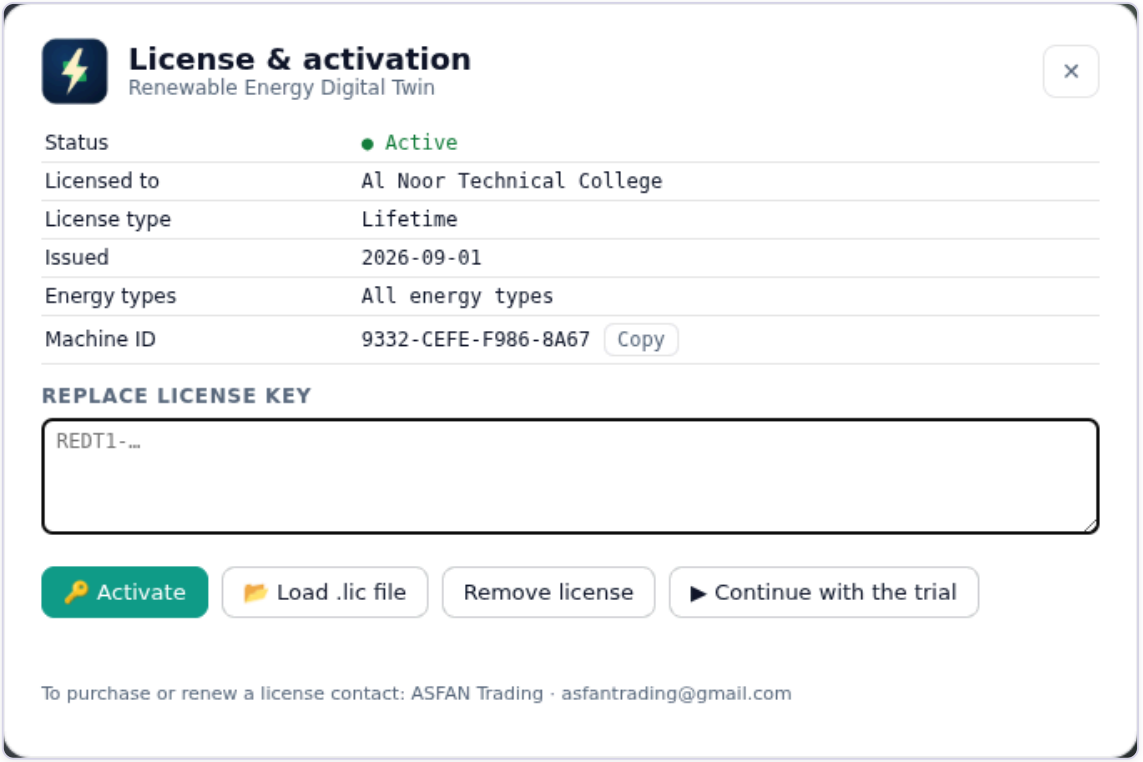


Figure 6: The license window of an activated copy: status, licensee, type, energy types covered and the Machine ID.

7.2 If activation fails

Table 4: Activation messages

Message	Meaning	What to do

Message	Meaning	What to do
the key is not valid for this product	The key was typed incompletely or belongs to another product.	Paste the complete key again (it is long – copy it from the message you received, including the part after the dot). If it still fails, send the key to support.
the license expired on *date*	A time-limited license has run out.	Contact support to renew it. You will receive a new key.
the key is bound to a different computer	This key was issued for another PC (machine-bound license).	Open the license window, click ${ui("Copy")} next to **Machine ID** and send it to support; a key for this computer will be issued.
the key format is not recognised	The pasted text is not a license key (missing ${code("REDT1-")} prefix, extra characters, an e-mail signature …).	Paste only the key. Loading the .lic file avoids copy-paste mistakes.

7.3 License types

Table 5: License types

Type	Badge	Description
Lifetime	🔑 Lifetime	Never expires for the purchased version line.
Time-limited	🔑 until 2027-06-30	Valid until the shown date. The badge turns orange during the last 14 days; after the date the badge shows ⚠ **License expired** and the program returns to the locked state until a new key is entered.
Machine-bound	(same badges)	Either type may be bound to one computer. The license window then shows **Bound to machine**.
Energy types	(same badges)	A license covers all seven energy types or a selection of them. The license window lists the covered types under **Energy types**.
Supervisor	(same badges)	Teacher / trainer license: creates classes and reads every student's answers and scores on the Classroom page (chapter 15). The license window shows **Role: Supervisor**.

7.4 Licenses limited to some energy types

If your license covers only some technologies, the others are shown with a 🔒 lock in the energy-type drop-down and cannot be opened; choosing one displays a message that names the covered types. The manual plant builder offers the covered technologies only. Ask support to extend a license – you receive a new key that you enter with Replace license key.

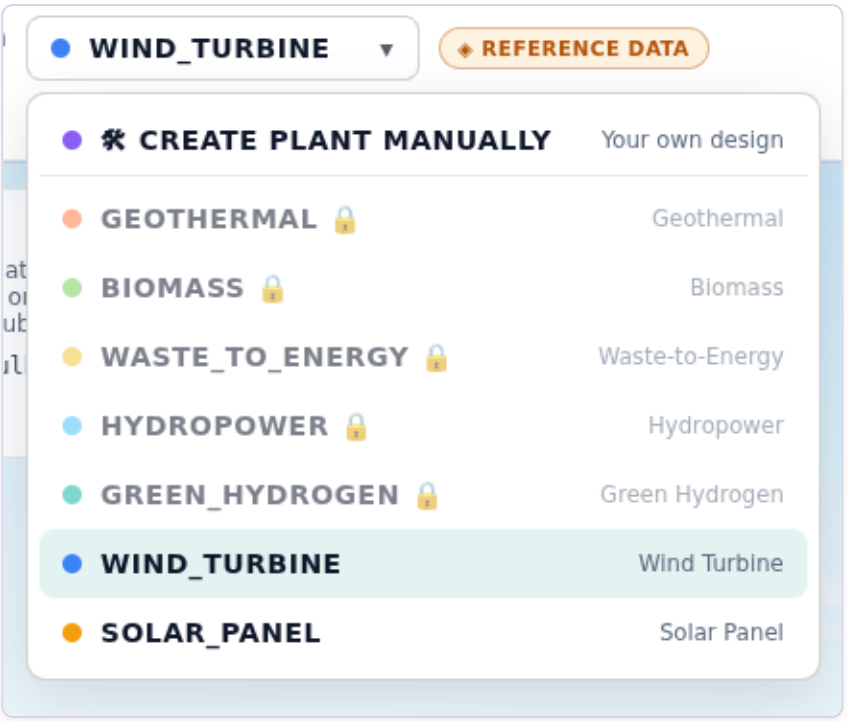


Figure 7: A license limited to wind and solar: the other energy types are locked.

7.5 Replacing or removing a key

Open the license window at any time by clicking the badge. **Replace license key** lets you enter a new key (for example after a renewal). **Remove license** deletes the key from this computer – use it before handing the computer to someone else. Your data are not affected.

> **Note**
> The key is stored on this computer only (chapter 20). Keep the e-mail or file with your key in a safe place – you need it again after re-installing Windows or when moving to another computer.

8 A tour of the interface

The main window has a **top bar** that is always visible and a **page area** below it. The 3D digital twin is the home page; the other pages – Dashboard, Plant Data, Learn, Quiz, Classroom and Reports – are opened from the navigation buttons in the top bar.

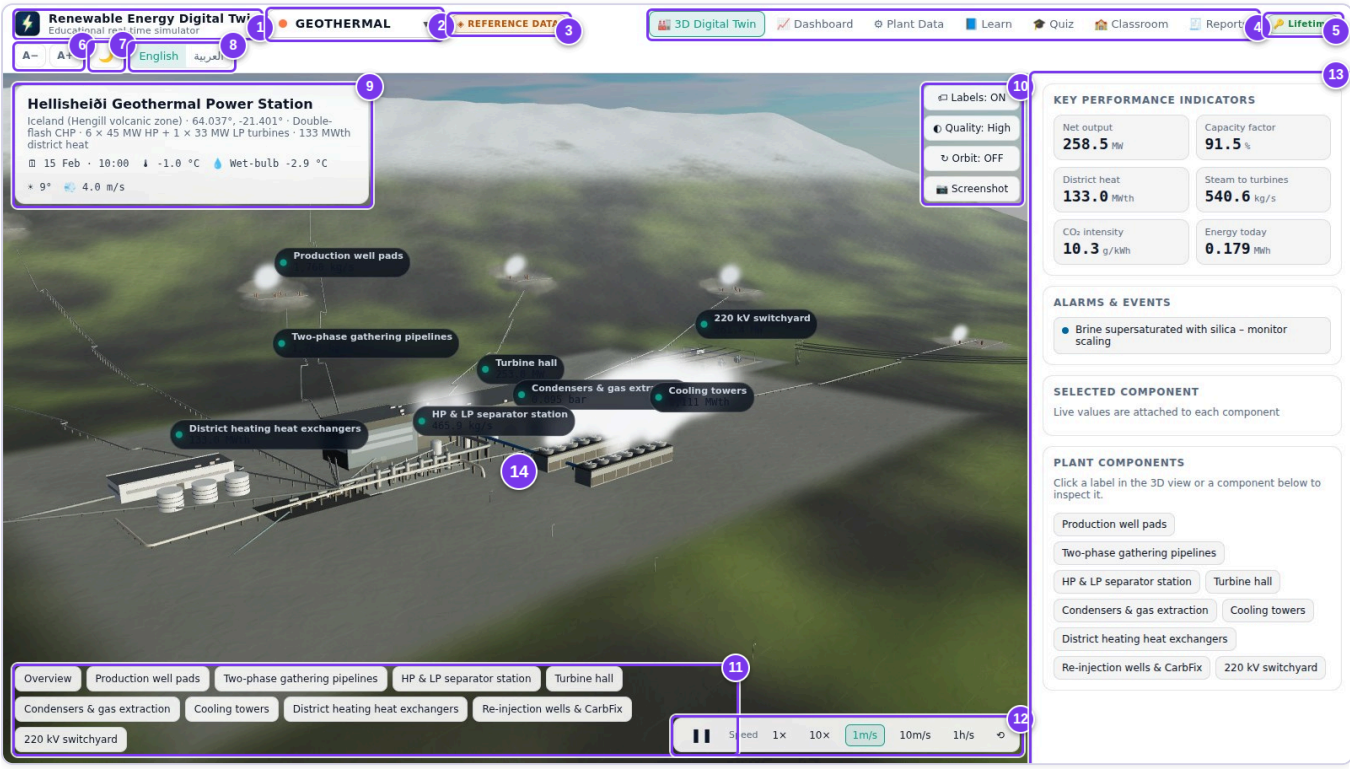


Figure 8: The main window with the elements described below.

1. **Program name**
2. **Energy-type selector** – opens the list of plants (chapter 9)
3. **Data badge** – REFERENCE DATA (built-in real-plant data) or USER DATA (your own values, chapter 12)
4. **Navigation** – 3D Digital Twin · Dashboard · Plant Data · Learn · Quiz · Classroom · Reports (chapters 10 to 16)
5. **License badge** – trial days left or license type; click to open the license window
6. **Text size** – A− / A+ make the whole interface smaller or larger
7. **Theme** – light / dark
8. **Language** – English / العربية
9. **Site card** – plant name, location, technology, simulation clock and weather
10. **3D toolbar** – labels, quality, orbit, screenshot
11. **Camera presets** – fly to each part of the plant
12. **Simulation controls** – play / pause, speed, restart
13. **Sidebar** – key performance indicators, alarms & events, selected component, list of components
14. **3D stage** – drag to orbit, scroll to zoom, right-drag to pan

8.1 The top bar

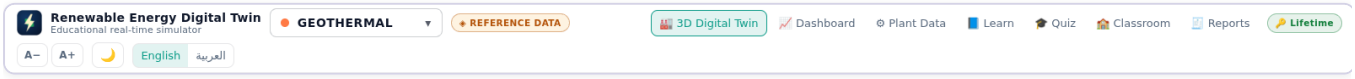


Figure 9: The top bar. On narrow windows it wraps onto two lines.

Language

Click **English** or **العربية**. The complete interface, the plant names, learn pages, quizzes and reports switch language immediately; Arabic is displayed right-to-left. The choice is remembered for the next start.

Text size

Figure 10: The text-size buttons.

A− and **A+** change the size of everything in the window in steps of 10 % between 80 % and 170 % (the default is 115 %). A small message shows the current size. Use this on high-resolution screens or when presenting on a projector.

Theme

The 🌙 / ☀ button switches between the light and the dark theme. The dark theme is easier on the eyes in a dark room and gives the 3D view more contrast.

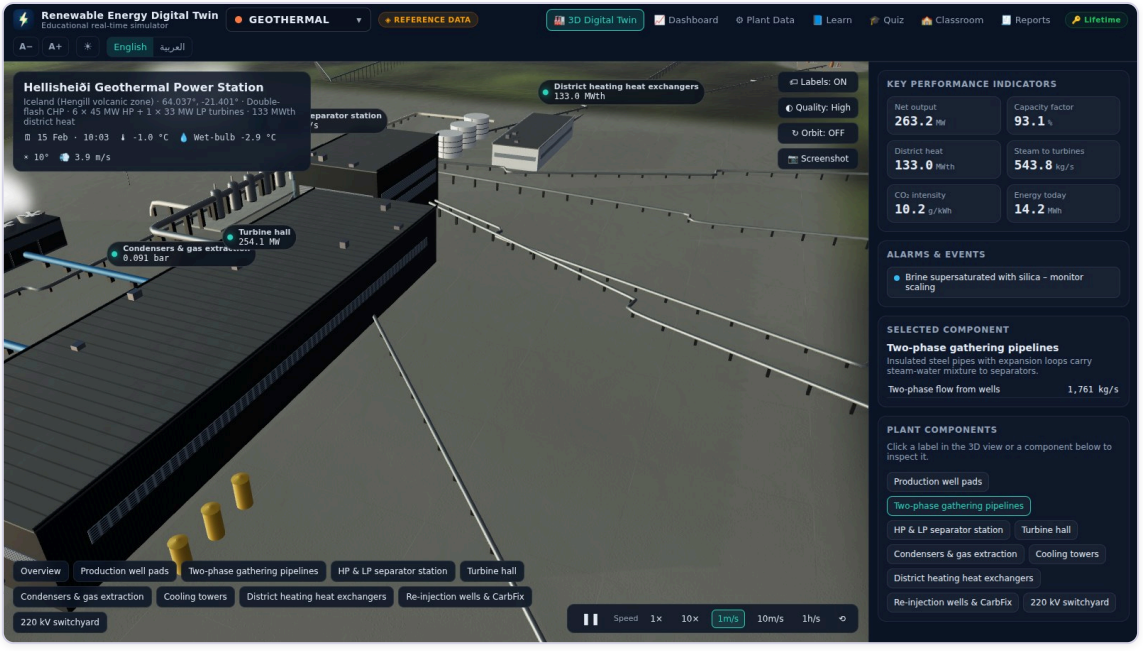


Figure 11: The dark theme.

The menu bar and keyboard shortcuts

The window also has a classic menu bar (File, View, Simulation, Help). If it is hidden, press `Alt` once to show it.

Table 6: Menu bar and shortcuts

Action	Where	Shortcut
Export report / data	File → Export Report / Data...	`Ctrl` + `S`
Import a plant configuration (JSON)	File → Import Plant Configuration...	`Ctrl` + `O`
Play / pause the simulation	Simulation → Play / Pause	`Space`
Reset the open plant to its reference data	Simulation → Reset to demo data	
Full screen on / off	View → Toggle Full Screen	`F11`
Open the Learn page	Help → User Guide	
Check for a new version	Help → Check for Updates...	
Program version	Help → About	
Exit	File → Exit	`Alt` + `F4`

> **Note**
> `Space` toggles the simulation only while the 3D view or a page without a text field has the focus – inside a text box it types a space, as usual.

9 Choosing an energy type

The drop-down at the top left of the window selects the plant you are working with. Each entry loads a complete plant: its 3D twin, physics model, reference data, learn pages and quiz questions.

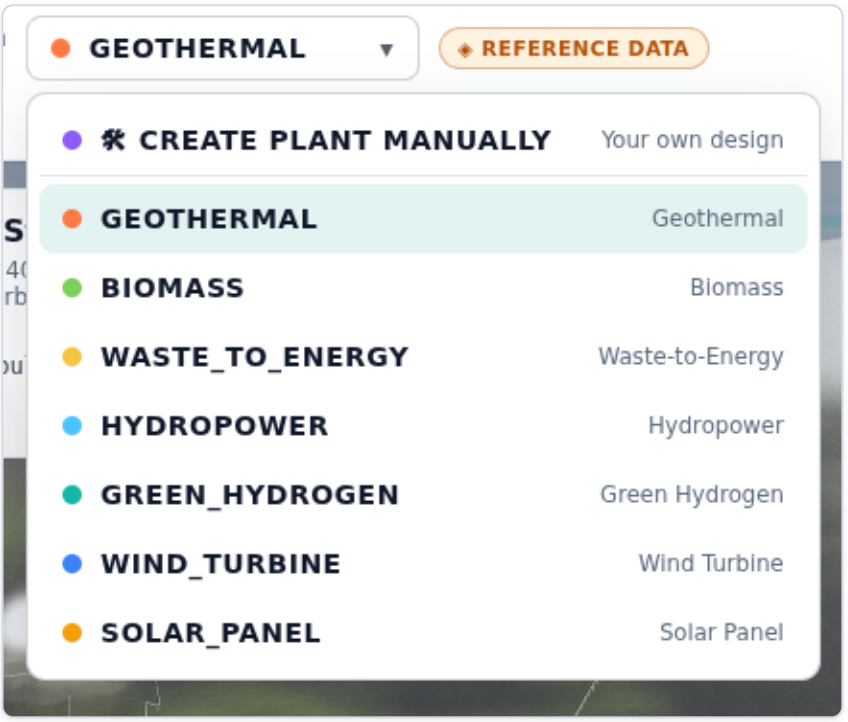


Figure 12: The energy-type drop-down. The first entry creates your own plant; the others are the reference plants.

Table 7: Entries of the energy-type drop-down

Entry	Plant	Location	Capacity
🛠 Create plant manually	Your own design (chapter 17)	—	your data
GEOTHERMAL	Hellisheiði Geothermal Power Station	Iceland	303 MW + 133 MWth heat
BIOMASS	Drax Power Station (biomass units 1–4)	United Kingdom	2,580 MW
WASTE_TO_ENERGY	Dubai Waste Management Centre – Warsan	United Arab Emirates	200 MW, 1.9 Mt waste/yr
HYDROPOWER	Aswan High Dam Hydroelectric Power Station	Egypt	2,100 MW
GREEN_HYDROGEN	NEOM Green Hydrogen Project (Oxagon)	Saudi Arabia	2.2 GW electrolysis, 600 t H_2/day
WIND_TURBINE	Dumat Al Jandal Wind Farm	Saudi Arabia	400 MW (99 turbines)
SOLAR_PANEL	Noor Abu Dhabi Solar Plant	United Arab Emirates	1,177 MWp

Switching a plant takes a few seconds while the 3D scene is built. The program remembers the last plant and page and opens them again at the next start. Each plant keeps its own entered values, scenario and quiz history; switching back and forth loses nothing.

Entries with a 🔒 lock are not covered by your license (chapter 7). When you have designed your own plant, the first entry shows its name and a ✎ pencil to edit the design (chapter 17).

10 The 3D digital twin

The 3D Digital Twin page shows the plant as a three-dimensional model on its real terrain. Every important component carries a label with its live value; steam, water, smoke, trucks, trains, rotating turbines and moving cranes follow the state of the simulation.

10.1 Moving the camera

Table 8: Camera controls

Action	Mouse / touchpad
Orbit around the plant	Hold the **left** button and drag
Zoom in / out	Scroll wheel (two-finger scroll on a touchpad)
Pan (move sideways)	Hold the **right** button and drag
Select a component	Click its label in the 3D view – the sidebar shows its description and live values
Fly to a component	Click a button in the Plant components list (sidebar) or a camera preset (bottom left)
Back to the overview	Camera preset **Overview** (bottom left)

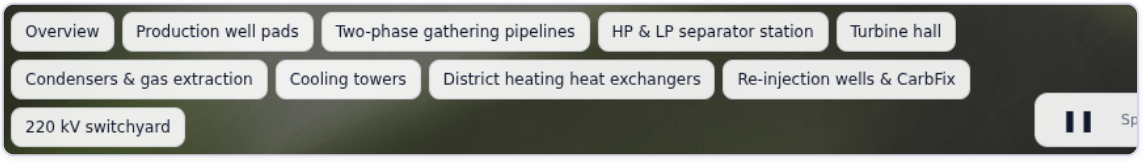


Figure 13: Camera presets (bottom left): one button per plant area.

10.2 The 3D toolbar (top right)

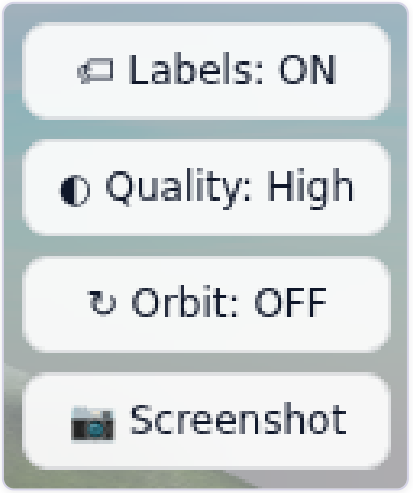


Figure 14: The 3D toolbar.

Table 9: 3D toolbar

Button	Function
🏷 Labels ON / OFF	Shows or hides the value labels on the components.

Button	Function
◖ Quality Low / Medium / High	Rendering quality. Each click cycles to the next level. Use **Low** on laptops without a dedicated graphics card or when the view is slow.
↻ Orbit ON / OFF	Rotates the camera slowly around the plant – useful for presentations.
📷 Screenshot	Saves the current 3D view as a PNG image (a file dialog opens).

10.3 Site card, clock and weather

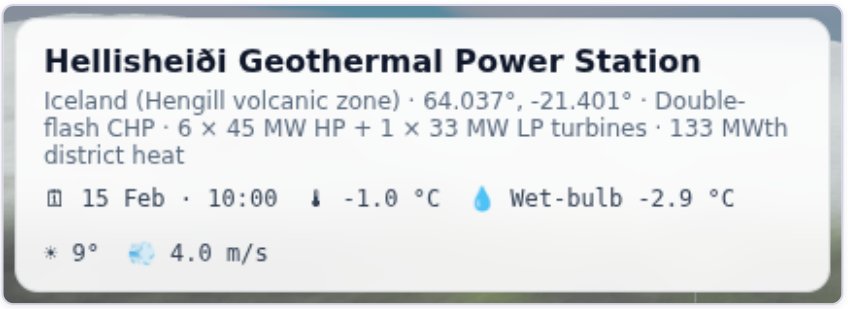


Figure 15: The site card: plant name, location, technology, date and time of the simulation, ambient and wet-bulb temperature, sun elevation and wind speed.

The card at the top left names the plant and its technology and shows the **simulation clock**: date and time of day, ambient temperature, wet-bulb temperature, sun elevation and wind speed at the site. The simulation runs faster than real time (see below); the lighting of the scene follows the clock, so you will see sunrise, sunset and night, and the weather follows the season and the climate of the site. When the simulation is paused, **PAUSED** appears on the card.

10.4 Simulation controls (bottom right)

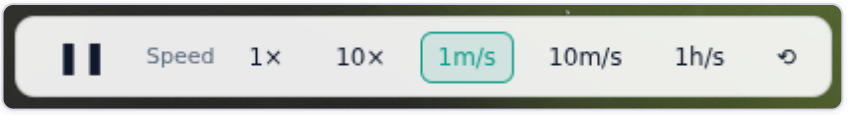


Figure 16: Play / pause, speed and restart.

Table 10: Simulation controls

Control	Function
▶ / ❚❚	Starts or pauses the simulation (also `Space`).
1×	Real time: one simulated second per second.
10×	Ten times faster. This is the highest speed available in the trial version.
1 m/s	One simulated minute per second (default).
10 m/s	Ten simulated minutes per second – a full day passes in about two and a half minutes.
1 h/s	One simulated hour per second – a month in about twelve minutes. Ideal for the 31-day charts and for reservoir or storage behaviour.
⟲	Restarts the simulation from its initial state (the clock, storage levels and history start over; your parameters are kept).

10.5 The sidebar

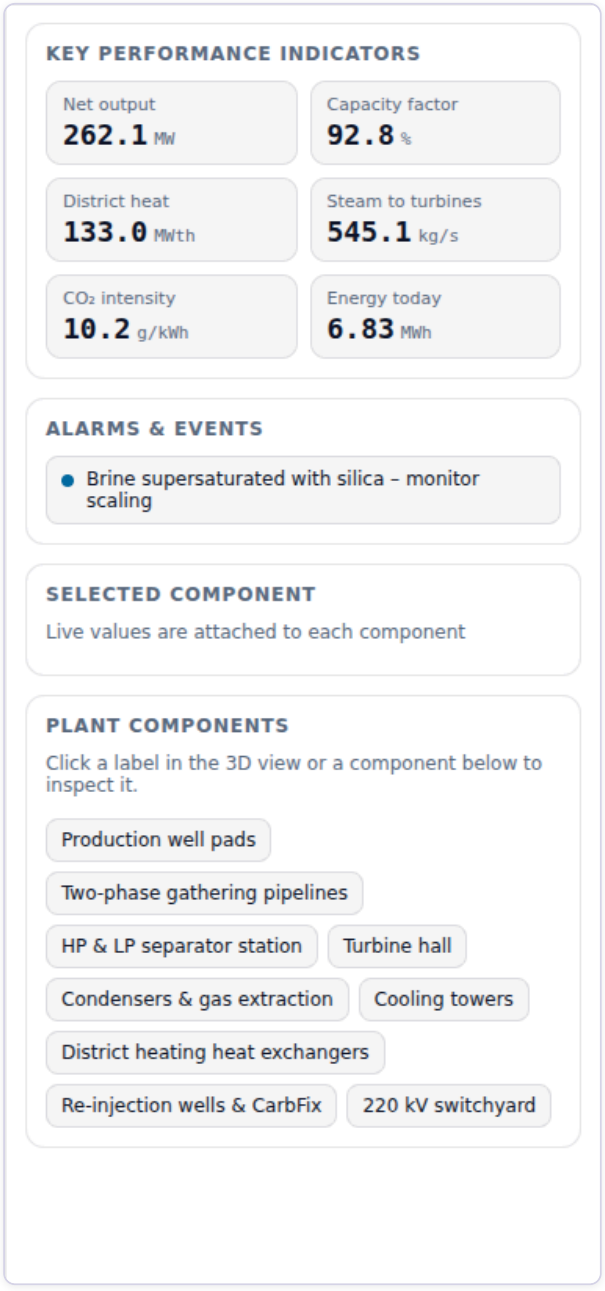


Figure 17: The sidebar next to the 3D view.

- **Key performance indicators** – the six most important numbers of the plant, updated live (for example net output, capacity factor, efficiency, CO_2 intensity, energy produced today).
- **Alarms & events** – active alarms in three levels (red = critical, orange = warning, blue = information) and the most recent events of the simulation (a unit tripping, a fuel delivery, a storm cut-out …). *All systems normal* means there is nothing to report.
- **Selected component** – after clicking a label or a component button: a short description and the live values of that component.
- **Plant components** – the list of all components; clicking one flies the camera there and selects it.

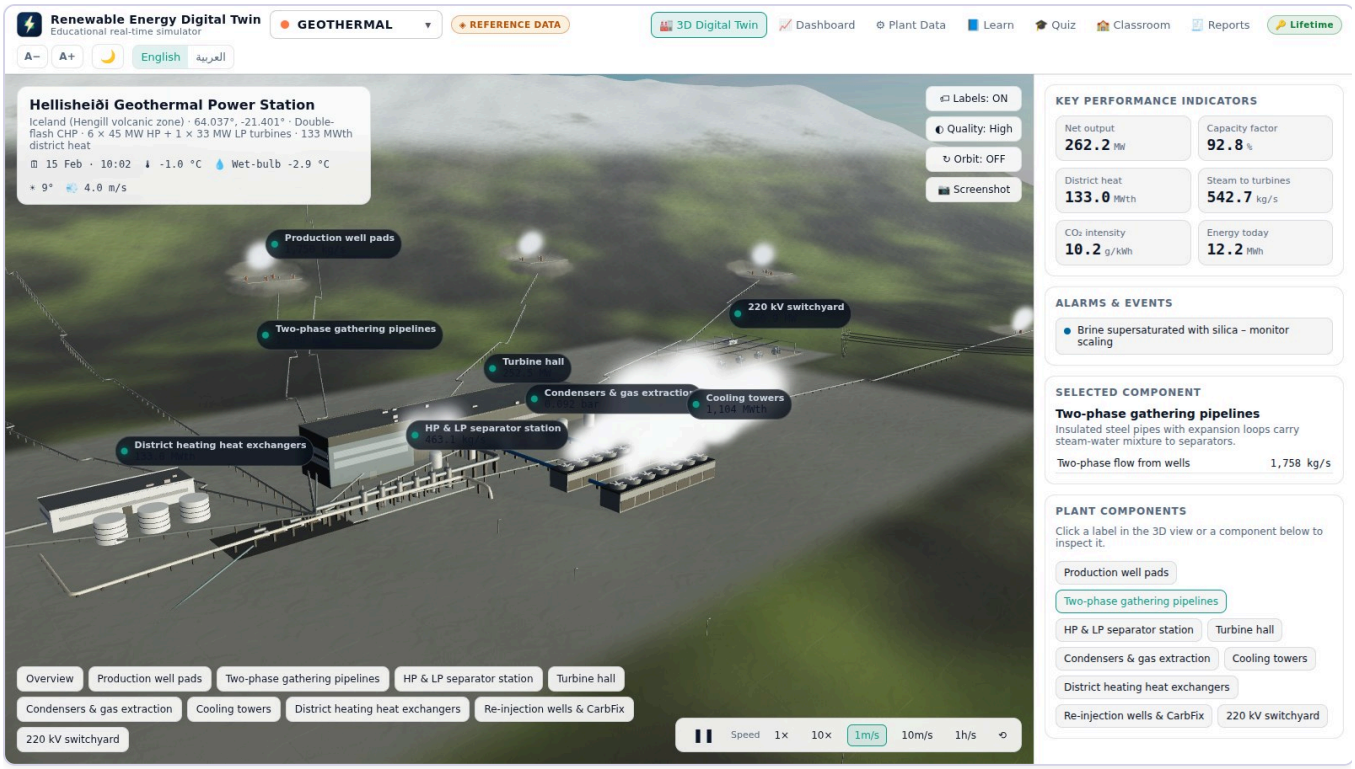


Figure 18: A selected component: the camera flies to it and the sidebar shows its description and live values.

10.6 Satellite imagery

When the computer is online, the ground around every reference plant shows real satellite imagery of the site (Esri World Imagery). Without internet a generated terrain is used instead – nothing else changes. Your own plants (chapter 17) show satellite imagery when you entered their coordinates.

> **Tip**
>
> Reading a label is often quicker than opening the dashboard. To take clean pictures of the plant, hide the labels with **Labels: OFF** and use 📷 **Screenshot**.

11 Dashboard

The Dashboard page presents the state of the running plant in the way a control room would: gauges, trend charts, an energy-flow diagram, a table of every process value, the site environment and the alarm list. It updates about once per second.

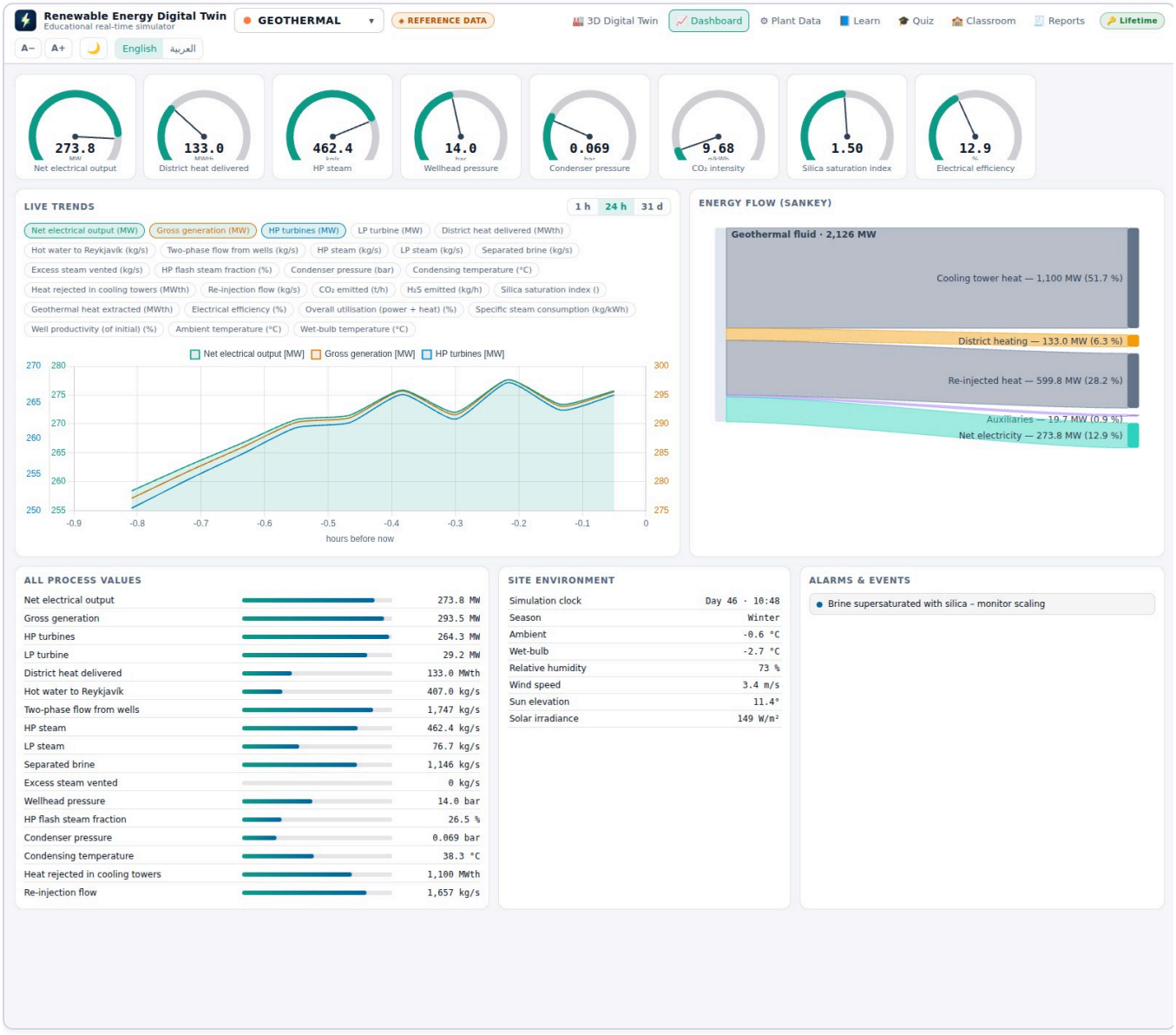


Figure 19: The dashboard of the geothermal plant.

11.1 Gauges

Figure 20: Gauges of the most important process values; a red mark shows a limit.

The top row shows up to ten gauges chosen for the technology, for example net output, fuel feed rate, boiler efficiency, condenser pressure, storage level or emission concentrations. A red mark on a gauge is a limit; the needle turns red when it is exceeded.

11.2 Live trends

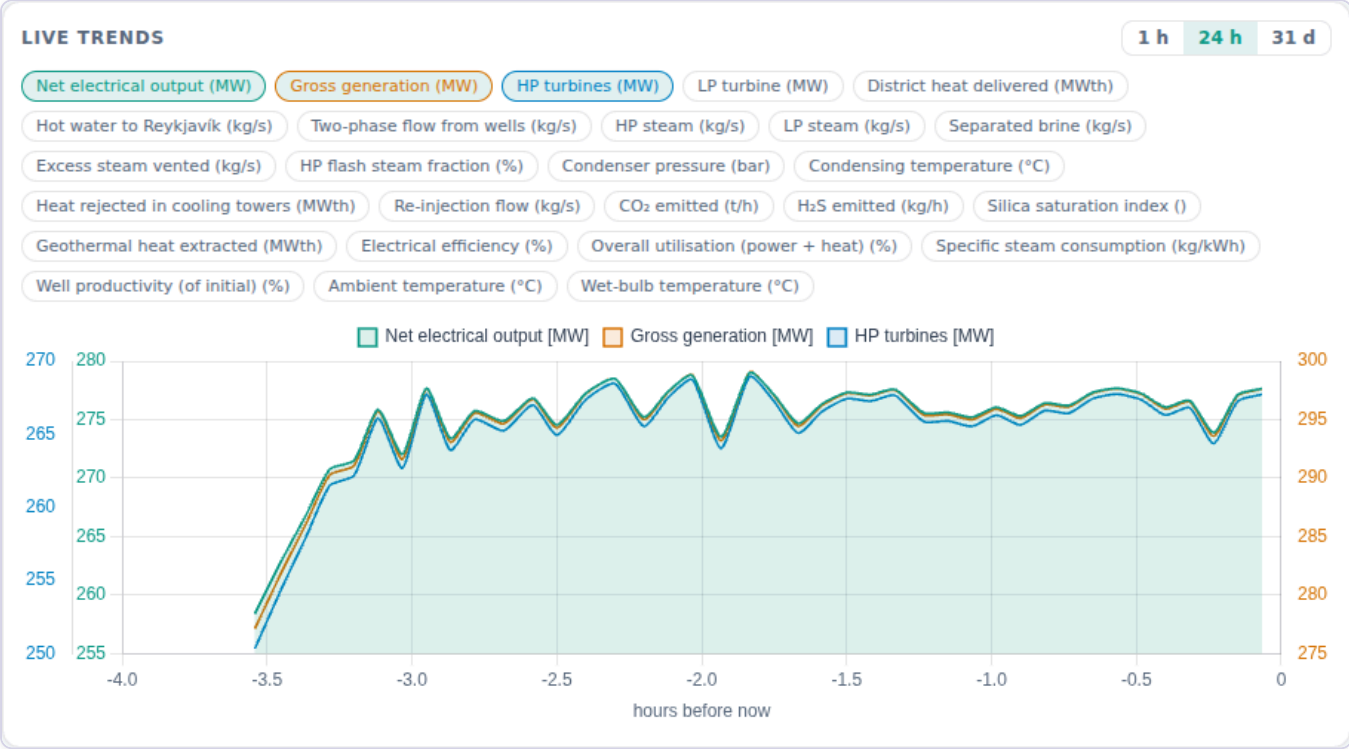


Figure 21: The trend chart: choose up to four series with the chips; the buttons select the time window.

- Click the **chips** above the chart to add or remove a series; up to four are drawn together, each with its own axis. The first series is shaded.
- 1 h, 24 h and 31 d select the time window. The horizontal axis shows hours (or days) before the present moment of the simulation, so the newest value is always at the right edge.
- The chart is filled as the simulation runs – at 1 h/s a complete 31-day window needs about twelve minutes.
- Hover the mouse over the chart to read exact values.

11.3 Energy flow (Sankey)

The Sankey diagram shows where the energy goes: from the fuel, water, wind or sun through the conversion steps to the electricity delivered and the losses (stack, condenser, wake, curtailment …). The width of every band is proportional to the power it carries. It is the fastest way to understand why a plant has the efficiency it has.

11.4 All process values

A complete list of everything the physics model computes – typically 25 to 50 values per plant – each with a small bar showing where the value lies in its normal range. Values above a limit are highlighted in red.

11.5 Site environment

Simulation clock and season, ambient and wet-bulb temperature, relative humidity, wind speed, sun elevation and solar irradiance. For the waste-to-energy plant this card also compares the stack emissions with the limits of the European Industrial Emissions Directive (measured / limit).

11.6 Alarms & events

The same alarms as in the 3D sidebar plus the last six events with their simulation time.

> **Tip**
> To study an effect, open the dashboard, add the relevant series to the chart, then change a parameter in **Plant Data** and come back – the chart shows the moment of the change.

12 Plant Data – entering your own values

Plant Data is where you take control of the physics model. Every operating parameter of the open plant is listed here with its reference value from the real site. Change a value and the 3D twin, the dashboard and the quiz questions react immediately.

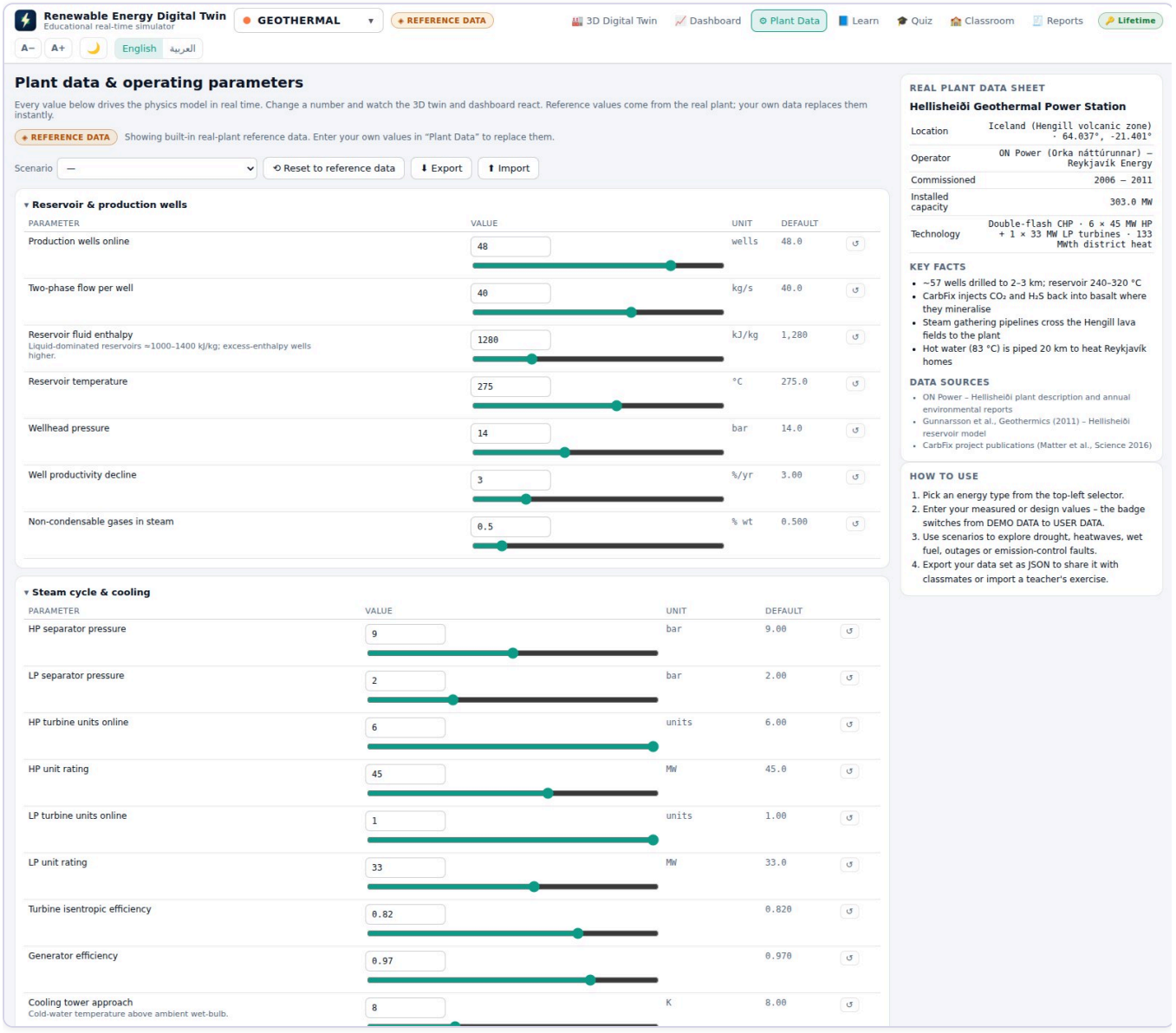


Figure 22: The Plant Data page: parameters in groups on the left, the real plant data sheet on the right.

12.1 Editing a parameter

1. Find the parameter in its group (groups can be collapsed by clicking their title). Each row shows the name, a short explanation, the value, the unit and the default.
2. Type a new value into the field or drag the slider next to it. The value is limited to the sensible range shown by the slider.
3. The field is highlighted, and the badge at the top switches from ◈ **REFERENCE DATA** to ● **USER DATA**. The simulation now runs on your data.

4 To return a single parameter to its reference value click its ↺ button; ⟲ Reset to reference data returns the whole plant.

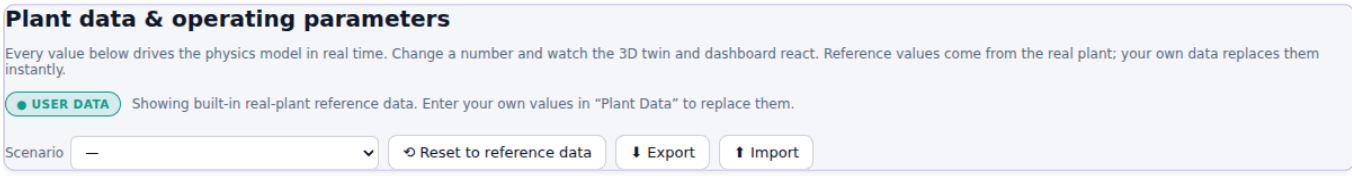


Figure 23: After a change the badge reads USER DATA. Scenario, reset, export and import are in the header.

Figure 24: A parameter group: value field, slider, unit, default and the reset button of each row.

12.2 Scenarios

The Scenario list applies a prepared set of values that tells a story: a drought or record flood at the dam, wet fuel or a port strike at the biomass plant, a summer heatwave, a dust storm, a storm with turbine cut-out, aged electrolysers, a grid curtailment order, or a failure of the flue-gas treatment. Choose a scenario, watch the twin and the dashboard, then read the alarms. Choosing the "—" entry or resetting returns to the reference data. Chapter 18 lists the scenarios of every plant.

12.3 Export and import

- ⬇ Export saves the current data set of the plant as a JSON file (all parameters, your changes and the scenario). Use it to keep several cases, to hand in an exercise or to share a set-up with colleagues.
- ⬆ Import loads such a file. If it belongs to a different energy type, the program switches to that plant first.
- Both are also in the File menu (`Ctrl` + `S` / `Ctrl` + `O`).

12.4 The real plant data sheet

The right-hand column lists the real plant: location and coordinates, operator, commissioning date, installed capacity, technology, key facts and the public data sources the reference data were taken from. Below it, How to use summarises the four steps of working with your own data.

> **Note**
> Your values are stored per plant and survive restarts. They are used everywhere – 3D labels, dashboard, live-data quiz questions and reports – until you reset them.

12.5 Typical parameter groups

Table 11: Parameter groups per plant

Plant	Groups
Geothermal	Reservoir & production wells · Steam cycle & cooling · Heat, re-injection & environment
Biomass	Operation · Fuel properties · Combustion & boiler · Steam cycle & cooling · Fuel logistics & storage · Emissions
Waste-to-energy	Operation · Waste composition · Fuel logistics & storage · Combustion & boiler · Steam cycle & cooling · Flue-gas treatment · Residues & carbon accounting
Hydropower	Reservoir & hydrology · Turbines & generators · Grid & operation
Green hydrogen	Renewable supply & storage · Electrolysis · Sea-water intake & filtration · Desalination, polishing, compression & hydrogen storage · Ammonia synthesis · Economics & environment
Wind	Site resource & weather · Turbines & generators · Wind farm, collector & grid · Economics & environment
Solar	Site resource & weather · PV modules · Array layout & structures · Inverters, transformers & grid · Soiling, cleaning & losses · Economics & environment

13 Learn

The Learn page is a compact course on the technology of the open plant, written for self-study and for use in class. It is available in the trial version.

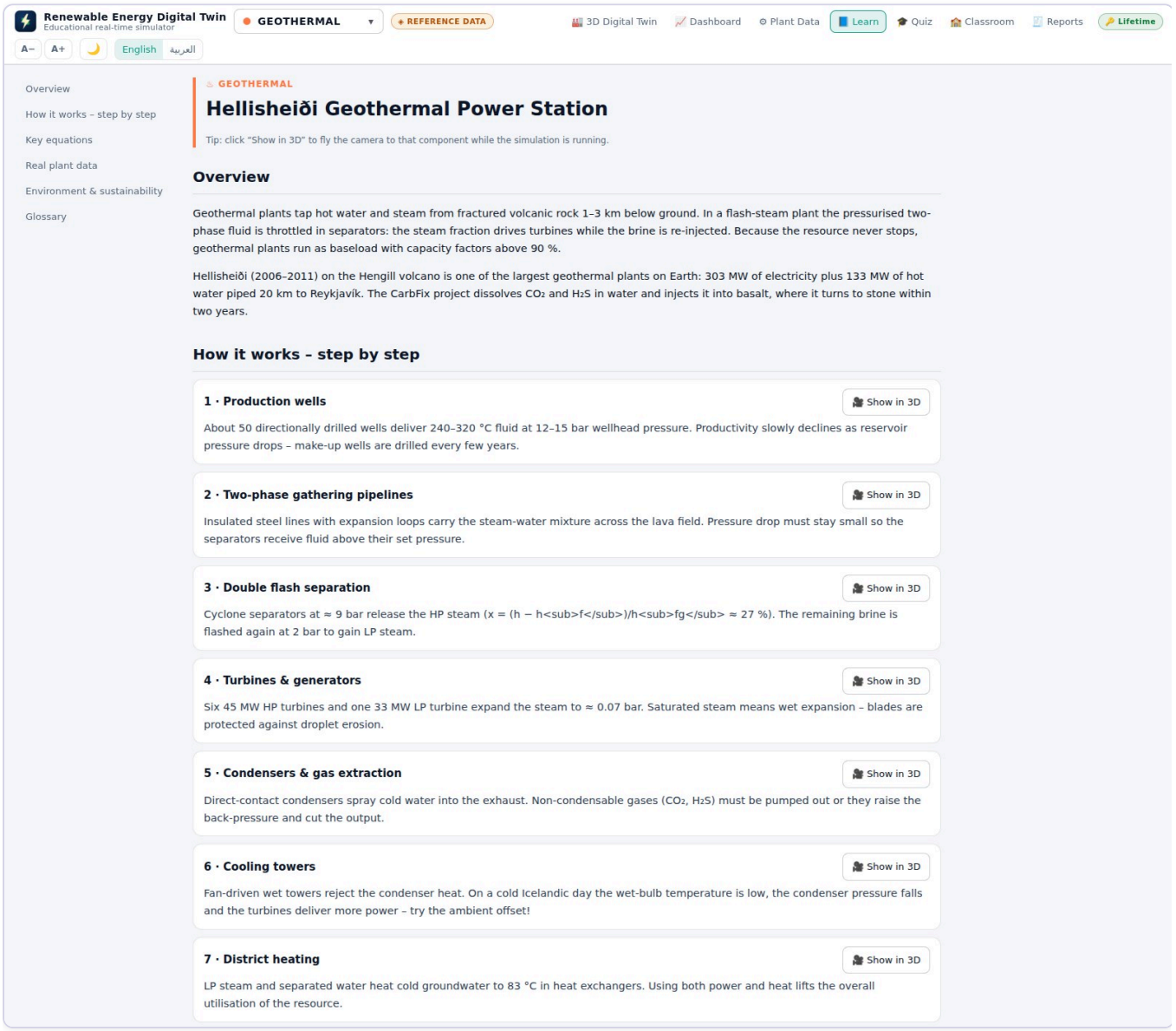


Figure 25: A Learn page. The links at the top jump to the sections.

Table 12: Sections of a Learn page

Section	Content
Overview	What the plant does, why the technology matters and how the reference site fits into its country's energy system.
How it works – step by step	The process from resource to grid, one step per component. Every step has a Show in 3D button that flies the camera to that component in the running twin.
Key equations	The formulas behind the model – energy balances, efficiencies, power curves, Betz limit, flash fractions, Faiman cell temperature, hill charts – with the meaning of every symbol.

Section	Content
Real plant data	The data sheet of the reference plant.
Environment & sustainability	Emissions, water use, land use, residues, carbon accounting and how the plant reduces its footprint.
Glossary	The technical terms used in the program, in plain language.

For a plant you designed yourself (chapter 17) the Learn page of its technology is shown with your plant's name. **Help** → **User Guide** in the menu bar also opens this page.

> **Tip**
> Read *How it works* with the 3D view open on a second monitor or in a second window: the **Show in 3D** buttons make the text and the model explain each other.

14 Quiz

The Quiz page checks what you have learned with automatically graded questions. Some questions are **live-data questions**: they ask for a value currently shown in the simulation (for example the net output or the capacity factor right now), so a quiz also trains reading the dashboard.

14.1 Starting a quiz

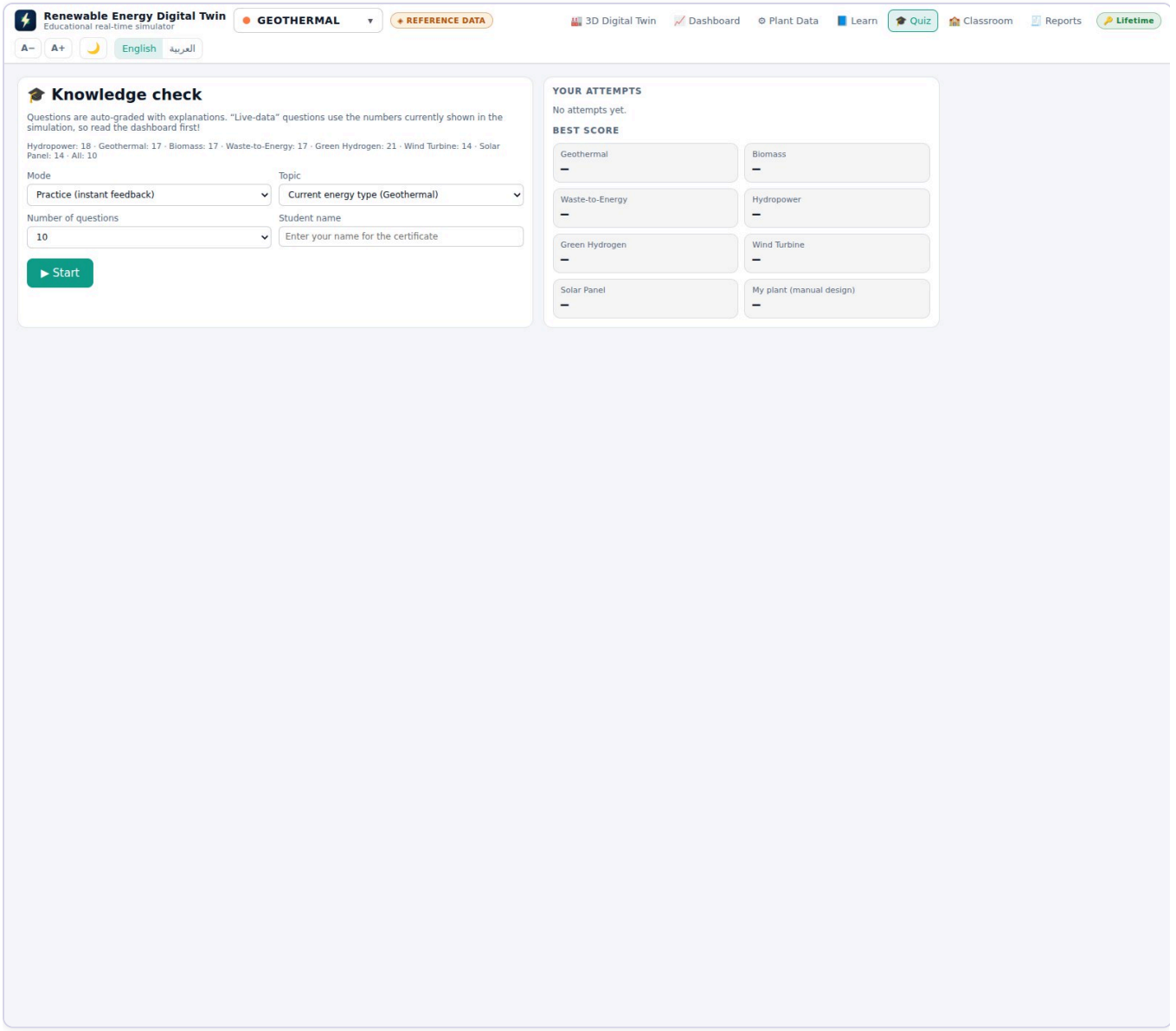


Figure 26: Quiz set-up: mode, topic, number of questions and the student name. The right-hand card lists earlier attempts and best scores.

Table 13: Quiz settings

Setting	Options
Mode	**Practice** – each answer is checked immediately with an explanation. **Exam** – timed (90 seconds per question), no feedback until the end, every question must be answered.

Setting	Options
Topic	**Current energy type** – questions about the open plant. **All energy types** – a mix from all seven plants plus general questions.
Number of questions	5, 10, 15 or 20
Student name	Printed on the certificate. The name is remembered.

Click ▶ Start. The number of available questions per topic is shown above the settings.

14.2 Answering

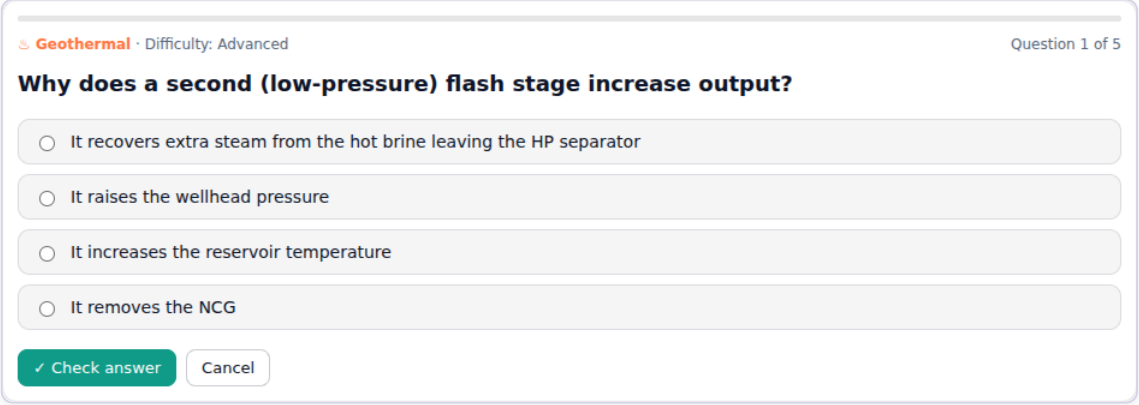


Figure 27: A question in practice mode. The header shows the topic, the difficulty and the LIVE DATA tag when the question uses current simulation values.

Table 14: Question types

Question type	How to answer
Single choice	Click one option.
True / false	Click **True** or **False**.
Multiple selection (“Select all that apply”)	Tick every correct option. Partially correct answers receive a partial score.
Numeric	Type the number (the unit is shown next to the field). Answers within the stated tolerance, usually ±5 %, are accepted.
LIVE DATA	Any of the above, but the correct answer is taken from the simulation at the moment the quiz started – read the dashboard or the 3D labels.

In practice mode click ✓ Check answer: the program shows whether you were right, the correct answer and an explanation, then Next question →. In exam mode click Next question → directly; the remaining time is shown at the top right. Cancel abandons the quiz.

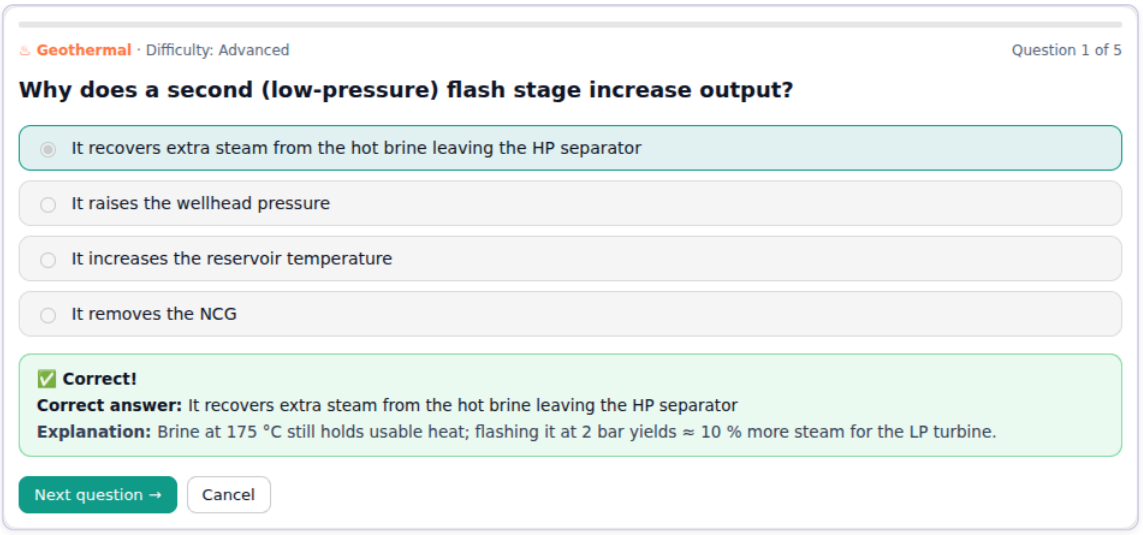


Figure 28: Feedback in practice mode: result, correct answer and explanation.

14.3 Results and certificate

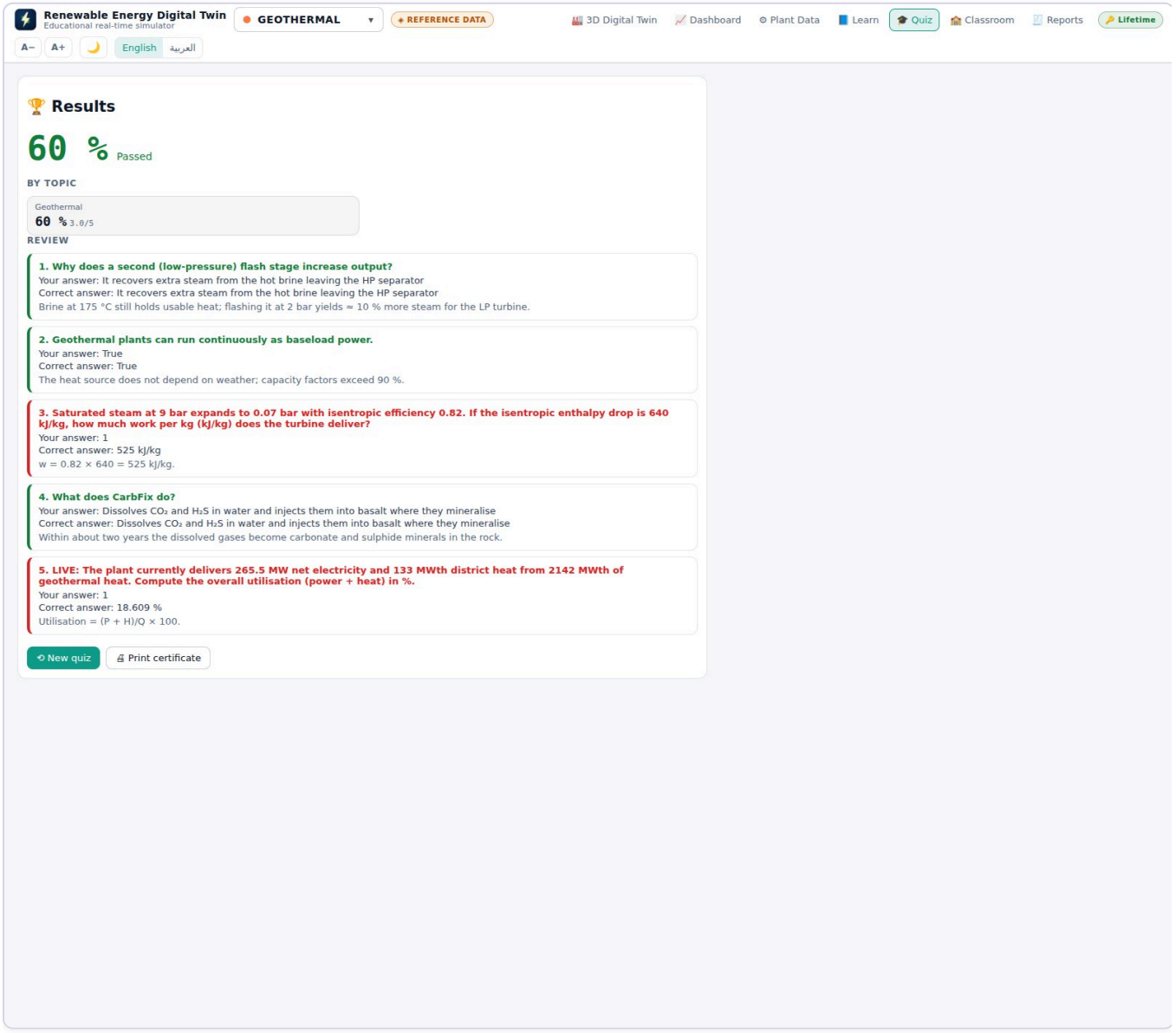


Figure 29: The results page: score, pass mark, breakdown by topic and a review of every question.

- The score is shown as a percentage; **60 % or more** is a pass.
- **By topic** breaks the score down per energy type when several were mixed.
- **Review** lists every question with your answer, the correct answer and the explanation – the most useful part for learning.
- 🖨 **Print certificate** (after a pass) opens a certificate with your name, the topic, the score and the date in a print window; choose a printer or *Microsoft Print to PDF*.
- ⟲ **New quiz** returns to the set-up page.

The set-up page keeps a history of your last attempts and the best score for every energy type. The history is stored on this computer (chapter 20) and appears in the reports.

15 Classroom mode – supervisor and students

Classroom mode lets a teacher or trainer follow the quizzes of a whole class – without a server and without internet. The teacher, called the **supervisor**, creates a class in a shared folder; the students join it, and every quiz they finish is written into that folder with all their answers. The supervisor's program reads the folder and shows a table per student.

15.1 How it works

- The **class folder** is any folder all computers can reach: a shared folder on the school or company network, a synced OneDrive / Google Drive / Dropbox folder, or a USB stick that is passed around.
- The supervisor's program writes a small file `class.json` there (class name, teacher, an identifier and a secret key).
- Each finished quiz of a joined student becomes one file in `results\`: every question, the student's answer, the correct answer, the points, the mode and the time – **signed** with the class key, so a modified file is detected.
- The supervisor opens the Classroom page and sees every student, their attempts and each answer; the tables can be exported to Excel (CSV).
- No shared folder? Students export their results as a file and send it by e-mail or WhatsApp; the supervisor imports it.

> **Note**
> The Class results table needs a **supervisor license** (issued for teachers and trainers – ask ASFAN). Students use ordinary licenses. The trial version cannot join a class because the quiz is locked in the trial.

15.2 Supervisor: creating a class

1. Create an empty folder that all students can open, for example \\SCHOOL-SERVER\Classes\Energy-101 or a folder inside your shared OneDrive.
2. Open Classroom → Class setup. Enter the class name and your name.
3. Click Choose class folder… and select the folder, then Create class. The program writes `class.json` and switches to Class results.
4. Give the students the folder path (or share the OneDrive folder with them). That is all they need.

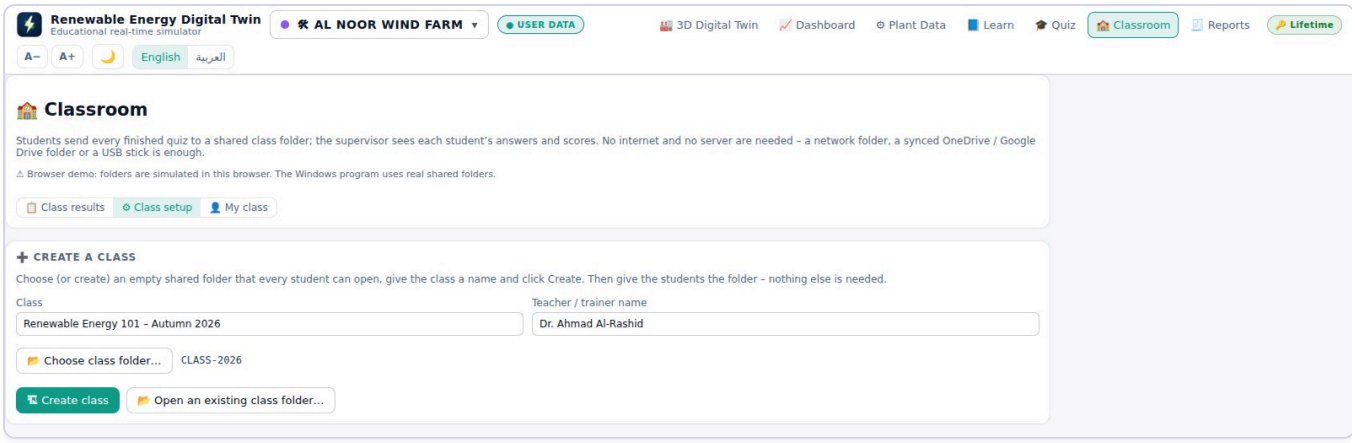


Figure 30: Class setup: class name, teacher and the shared folder.

To continue a class on another computer, or after re-installing, use **Open an existing class folder...** and select the same folder. **Leave class** disconnects this computer from the folder without deleting anything.

15.3 Students: joining the class

1. Open **Classroom**. Click **Choose class folder...** and select the folder the teacher gave you – the class name and the teacher appear.
2. Enter your name and your student ID, then click **Join class**.
3. Take quizzes as usual (chapter 14). After each quiz the results page shows *Quiz result sent to the class*, and the **Classroom** page lists your submitted results.

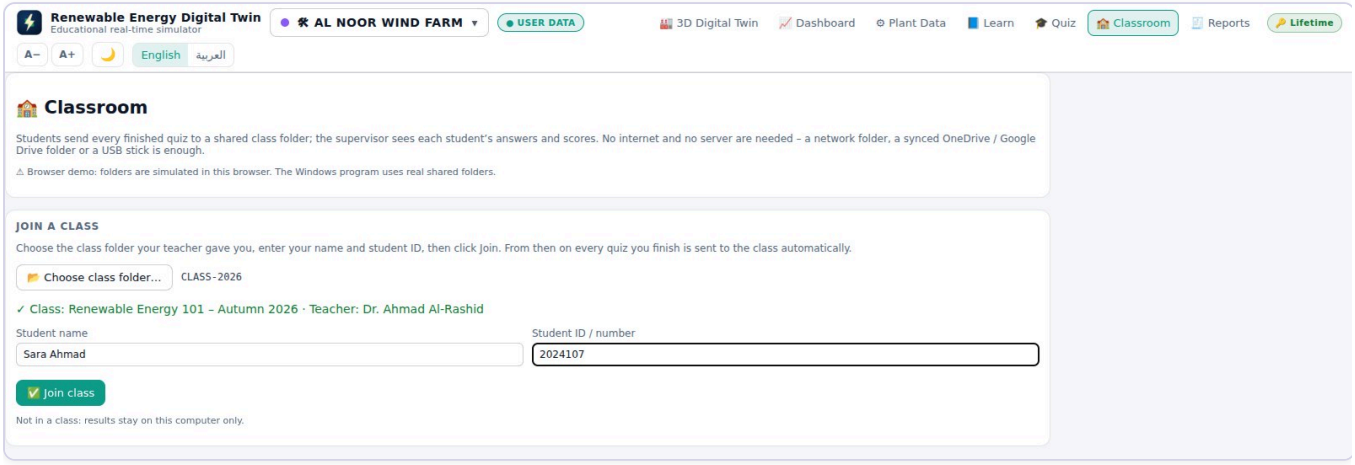


Figure 31: Joining a class: the folder is recognised, name and student ID are entered.

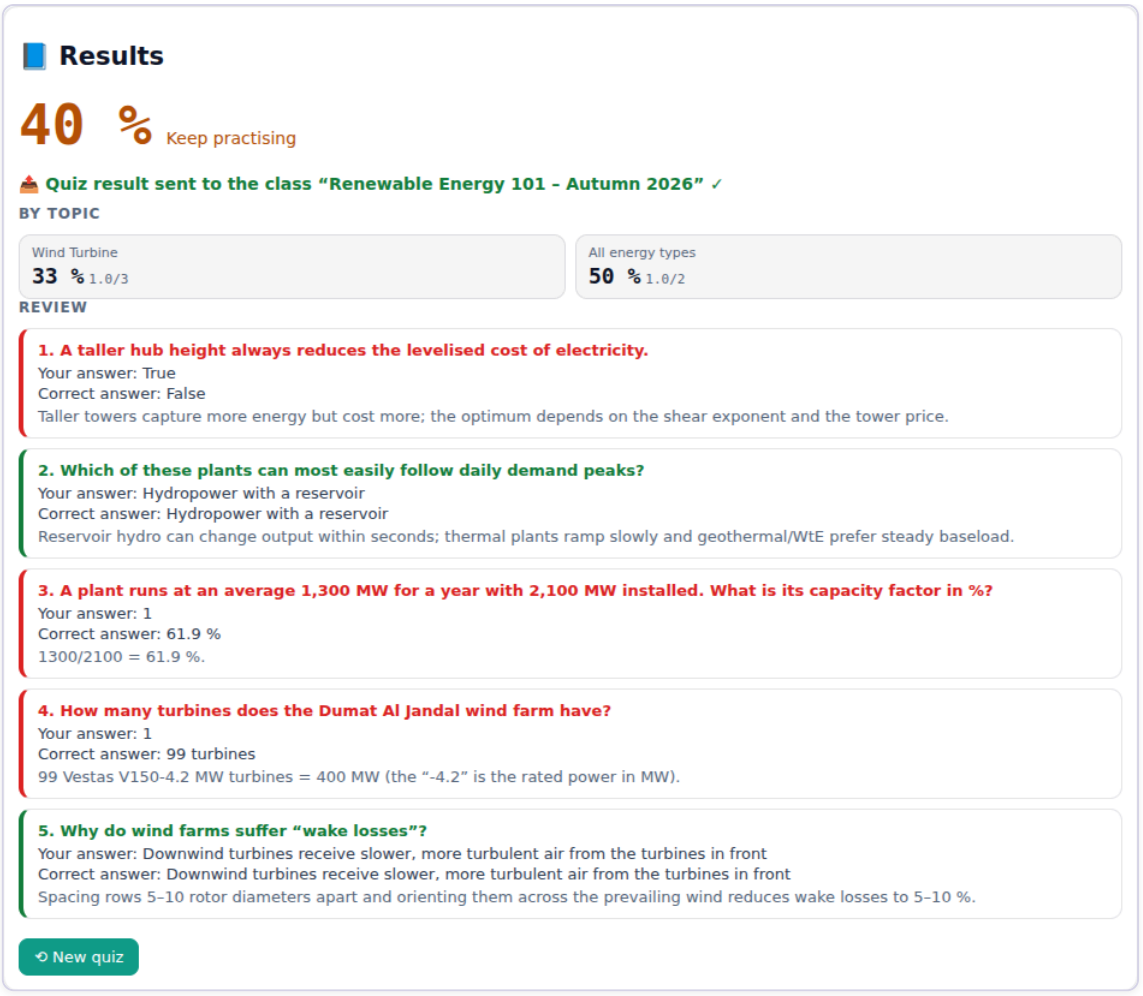


Figure 32: After a quiz: the result was sent to the class.

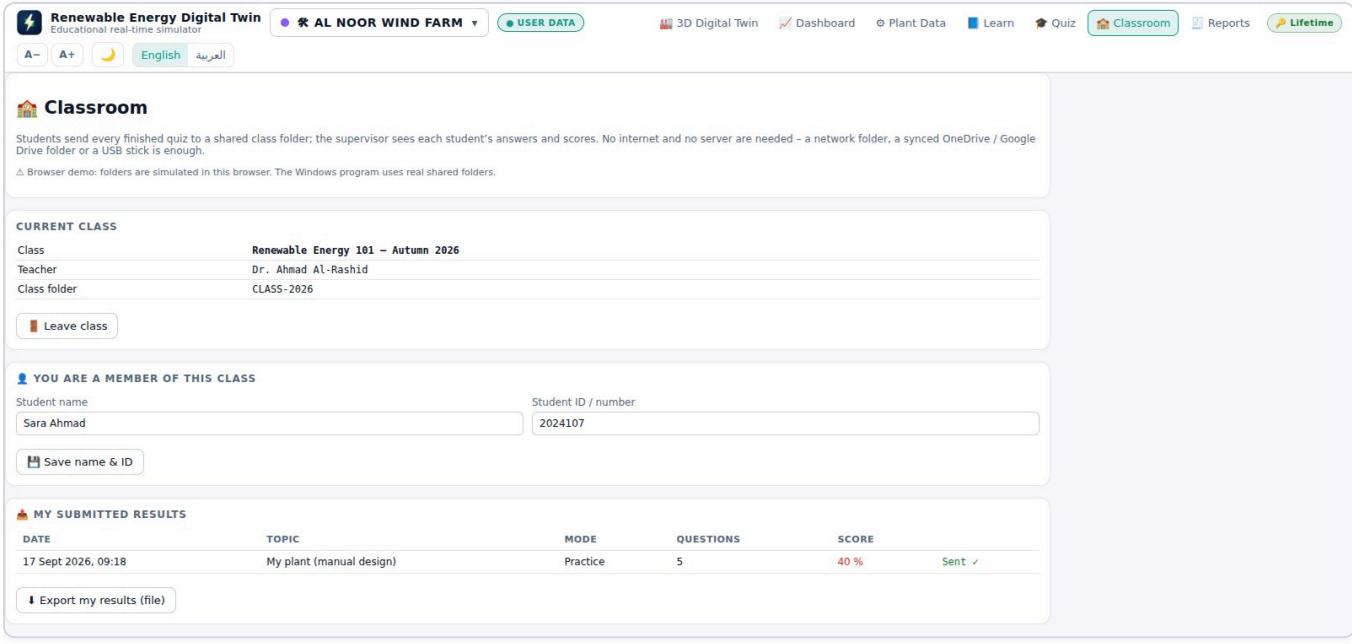


Figure 33: The student’s Classroom page: class, identity and the submitted results.

If the folder is not reachable at that moment (laptop at home, USB stick not plugged in) the result is kept on the computer and marked *Not sent yet*; **Send pending results** sends it when the folder is available again. **Export my results (file)** saves all results as one file for e-mail.

15.4 Supervisor: reading the results

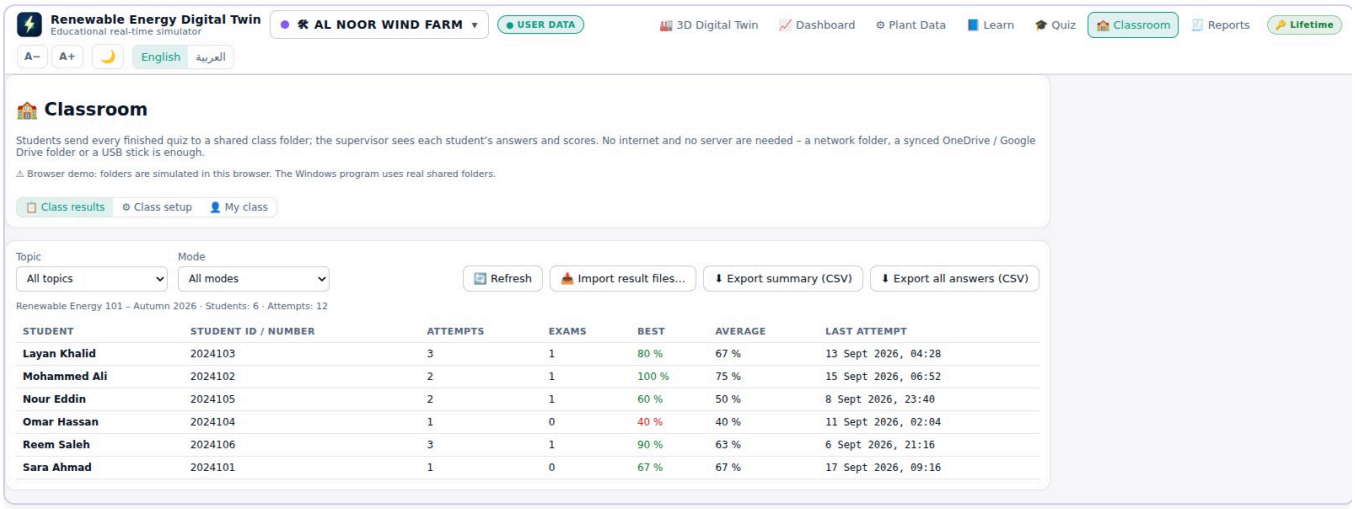


Figure 34: Class results: one row per student with attempts, exams, best and average score.

- **Refresh** reads the class folder again; **Import result files...** adds files that students sent by e-mail.
- The filters limit the table to one energy type and to practice or exam attempts.
- Click a student to list their attempts: date, topic, mode, number of questions, score, duration and the verification mark.
- Click an attempt to see every question with the student's answer, the correct answer, the points and the explanation.
- **Export summary (CSV)** and **Export all answers (CSV)** save Excel-compatible files with Arabic and English text intact.

Renewable Energy 101 – Autumn 2026 · Students: 6 · Attempts: 12

STUDENT	STUDENT ID / NUMBER	ATTEMPTS	EXAMS	BEST	AVERAGE	LAST ATTEMPT
Layan Khalid	2024103	3	1	80 %	67 %	13 Sept 2026, 04:28
Mohammed Ali	2024102	2	1	100 %	75 %	15 Sept 2026, 06:52
Nour Eddin	2024105	2	1	60 %	50 %	8 Sept 2026, 23:40
Omar Hassan	2024104	1	0	40 %	40 %	11 Sept 2026, 02:04
Reem Saleh	2024106	3	1	90 %	63 %	6 Sept 2026, 21:16
Sara Ahmad	2024101	1	0	67 %	67 %	17 Sept 2026, 09:16

📚 ATTEMPTS OF MOHAMMED ALI

DATE	TOPIC	MODE	QUESTIONS	SCORE	DURATION	RESULT
15 Sept 2026, 06:52	Solar Panel	Practice	5	100 %	4:37	✓ Verified
14 Sept 2026, 13:04	Hydropower	Exam	10	50 %	5:30	✓ Verified

📝 MOHAMMED ALI · SOLAR PANEL · PRACTICE · 15 SEPT 2026, 06:52 · 100 %

Hide answers

1. Ambient 38 °C, irradiance 900 W/m², wind 2 m/s. Using the Faiman model T = T_amb + G/(25 + 6.84·v), what is the cell temperature in °C?
Student answer: 61.3 °C
Correct answer: 61.3 °C
Result: correct (100 %)
900 / (25 + 13.68) = 23.3 K → 61.3 °C. At −0.37 %/K that costs 13 % of the STC power.

2. Why is the DC capacity of Noor Abu Dhabi (1,177 MWp) larger than its inverter AC capacity (≈ 935 MW)?
Student answer: Modules rarely reach STC output, so oversizing the array fills the inverters for more hours; the midday peak is clipped on purpose
Correct answer: Modules rarely reach STC output, so oversizing the array fills the inverters for more hours; the midday peak is clipped on purpose
Result: correct (100 %)
A DC/AC ratio of 1.2–1.3 raises annual energy per inverter dollar at the cost of a few percent of clipping.

3. Dust on the modules can cut the output of a desert PV plant by several percent within two weeks.
Student answer: True
Correct answer: True
Result: correct (100 %)
Soiling rates of 0.2–0.5 % per day are typical in the Gulf – hence robotic cleaning every 1–2 weeks.

4. Modules degrade 0.5 % per year. After 20 years what fraction of the initial power remains, in %? ((1 − 0.005)^20)
Student answer: 90.5 %
Correct answer: 90.5 %
Result: correct (100 %)
0.995^20 = 0.905 – warranties typically guarantee ≥ 85 % after 25 years.

5. A 1,177 MWp plant receives 850 W/m² on the modules. Ignoring all losses, what is the DC power in MW? (P = P_STC × POA/1000)
Student answer: 1000 MW
Correct answer: 1,000 MW
Result: correct (100 %)
1,177 × 0.85 = 1,000 MW.

Figure 35: Attempts of a student and the detail of one attempt: every question, answer and result.

> **Important**
>
> **Signature invalid – the file was modified** marks a result file that was changed after the program wrote it, or that belongs to another class. Such attempts are listed but not counted in the best and average scores.

15.5 Tips for the classroom

- Use **Exam** mode for graded tests: the timer runs, no feedback is shown before the end and every question must be answered.
- Live-data questions use what each student sees in their own simulation – ask students to keep the reference data (badge REFERENCE DATA) so that exams are comparable.
- Results are ordinary files: back up the class folder like any other course material, and delete it at the end of the term if your data-protection rules require it.

16 Reports and data export

The Reports page produces a document of the running simulation for a lab notebook, a homework hand-in or a presentation, and exports the raw numbers for Excel or other tools.

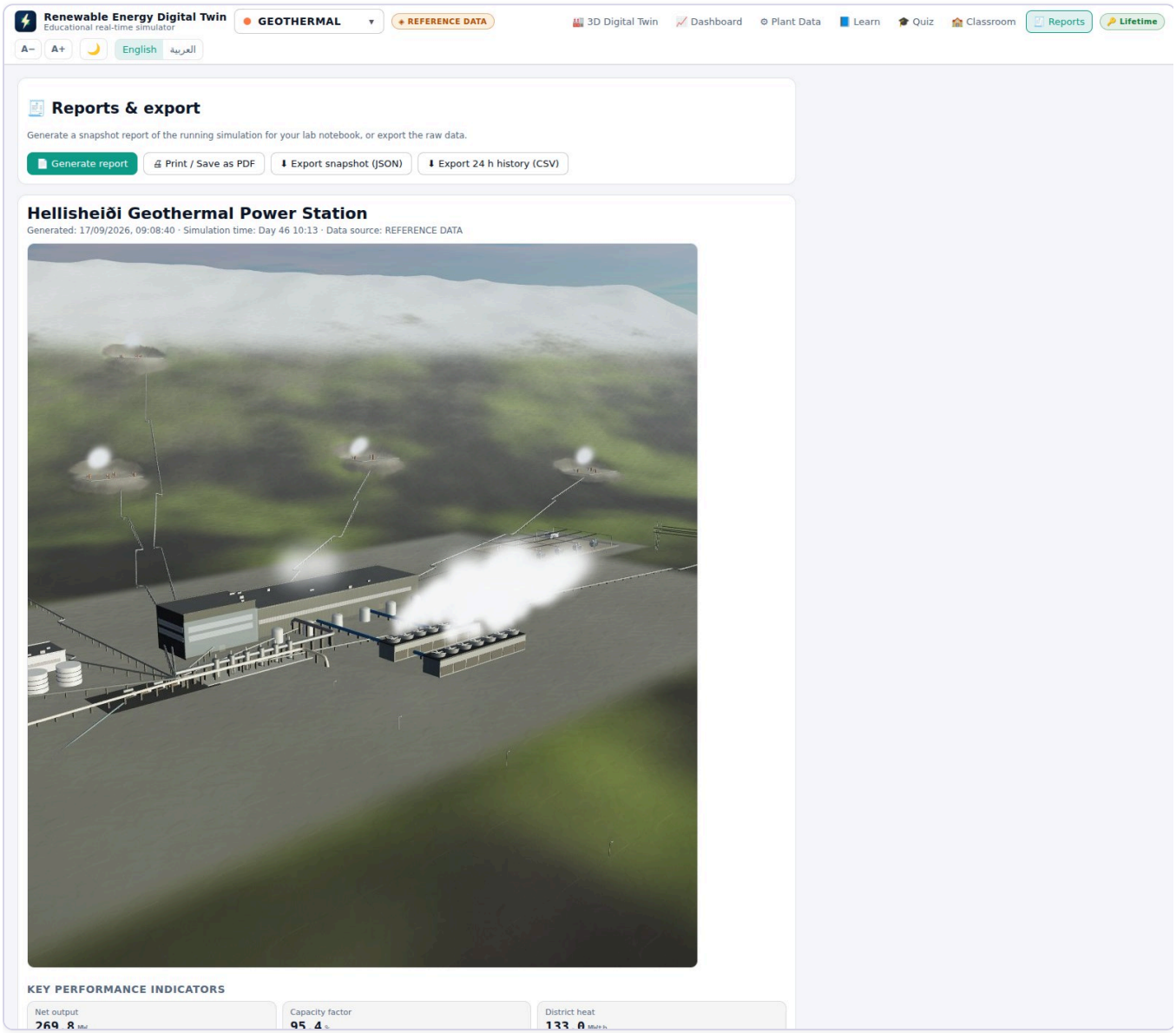


Figure 36: A generated report.

Table 15: Reports page

Button	Result
📄 Generate report	Builds the report on the page: plant name, generation time, simulation time, data source (reference or user data and scenario), a picture of the 3D twin, the key performance indicators, active alarms, all process values, all parameters used (changed ones are marked) and your quiz performance.
🖨 Print / Save as PDF	Opens the Windows print dialog for the report (`Ctrl` + `P` does the same). Choose *Microsoft Print to PDF* to save a PDF file.

Button	Result
⬇ Export snapshot (JSON)	Saves the current state – parameters, process values, KPIs, alarms, environment and simulation time – as a JSON file.
⬇ Export 24 h history (CSV)	Saves the last 24 simulated hours of every process value as a CSV table (one row every few minutes). Opens directly in Excel; the first column is the simulation time in seconds.

Files are saved through the normal Windows save dialog; the suggested location is your *Documents* folder and the file name contains the energy type.

> **Tip**
> Generate the report right after an experiment (scenario or parameter change): the picture of the twin and the alarm list document exactly what you saw.

17 Build your own plant (manual plant builder)

Besides the seven reference plants, the program can build a plant from **your** design data: a wind farm you are planning, the solar plant of your city, a hydropower project from a case study or a hypothetical hydrogen plant. You choose the technology and enter the few design values that define the plant; the program derives every other parameter, builds a 3D twin that matches your numbers and runs the physics on it. Learn pages, quizzes and reports then follow your plant.

17.1 Creating a plant

1. Open the energy-type drop-down and click 🛠 **Create plant manually** (the first entry).
2. **Technology** – choose one of the seven technology cards.
3. **Site & design data** – enter a plant name (required), the country or location, a climate preset, optional coordinates (latitude / longitude), the operator and the planned commissioning year; then the required design values of the technology (see the tables below). The allowed range is shown under each field.
4. Click **Next ›**. **Review & create** summarises the installed capacity, the technology line and all inputs.
5. Click 🏗 **Create plant & open the 3D twin**. After a few seconds the twin of your plant appears and the drop-down shows your plant as its first entry.

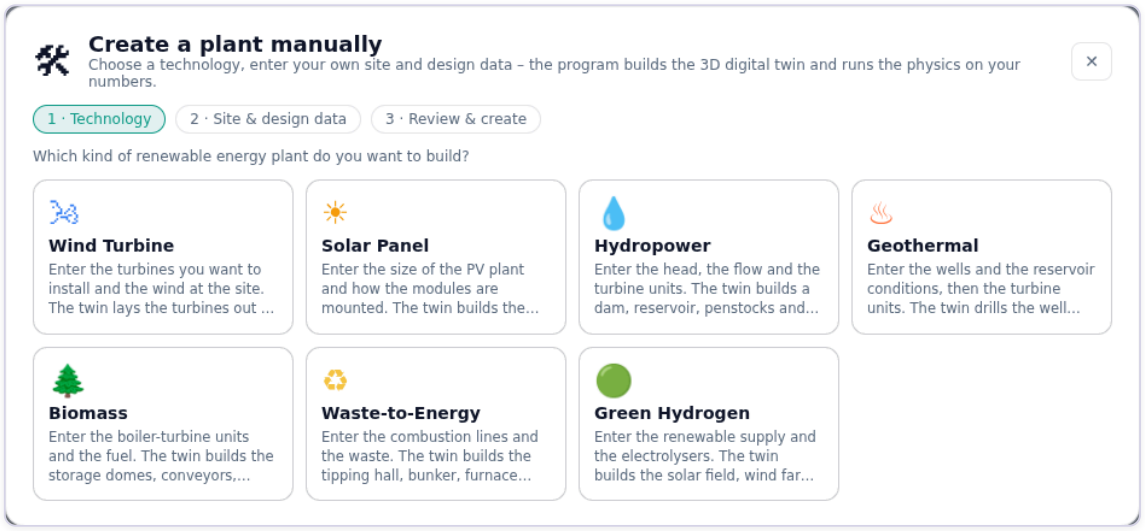


Figure 37: Step 1 – choose the technology.

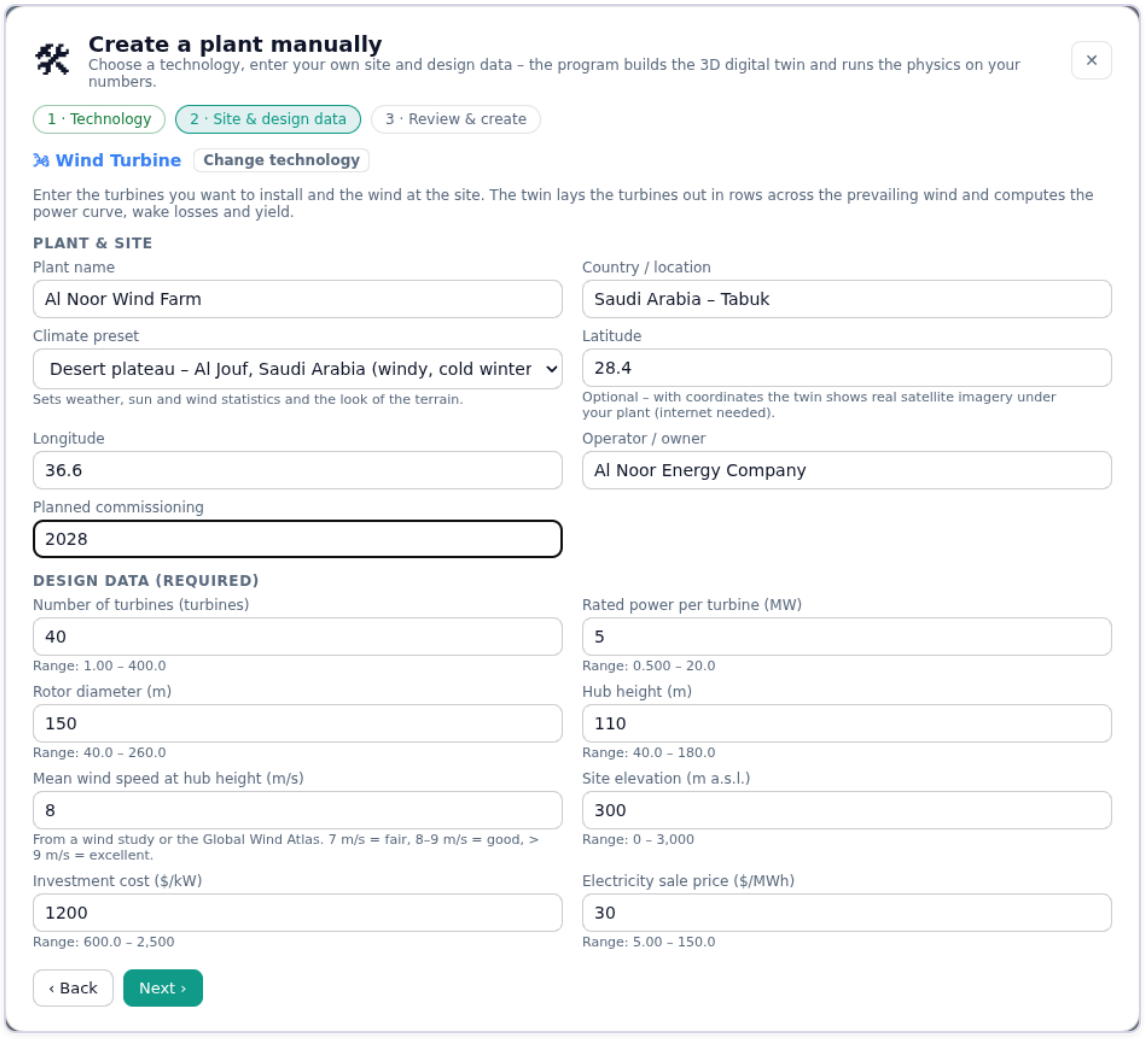


Figure 38: Step 2 – plant, site and the required design data of a wind farm.

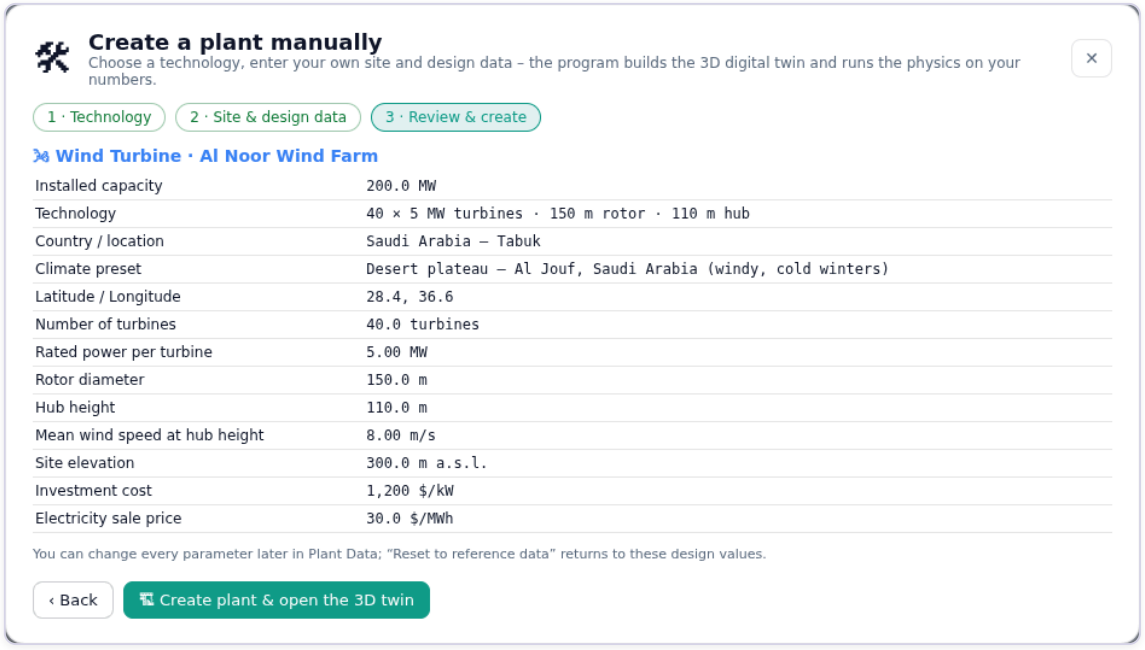


Figure 39: Step 3 – review and create.

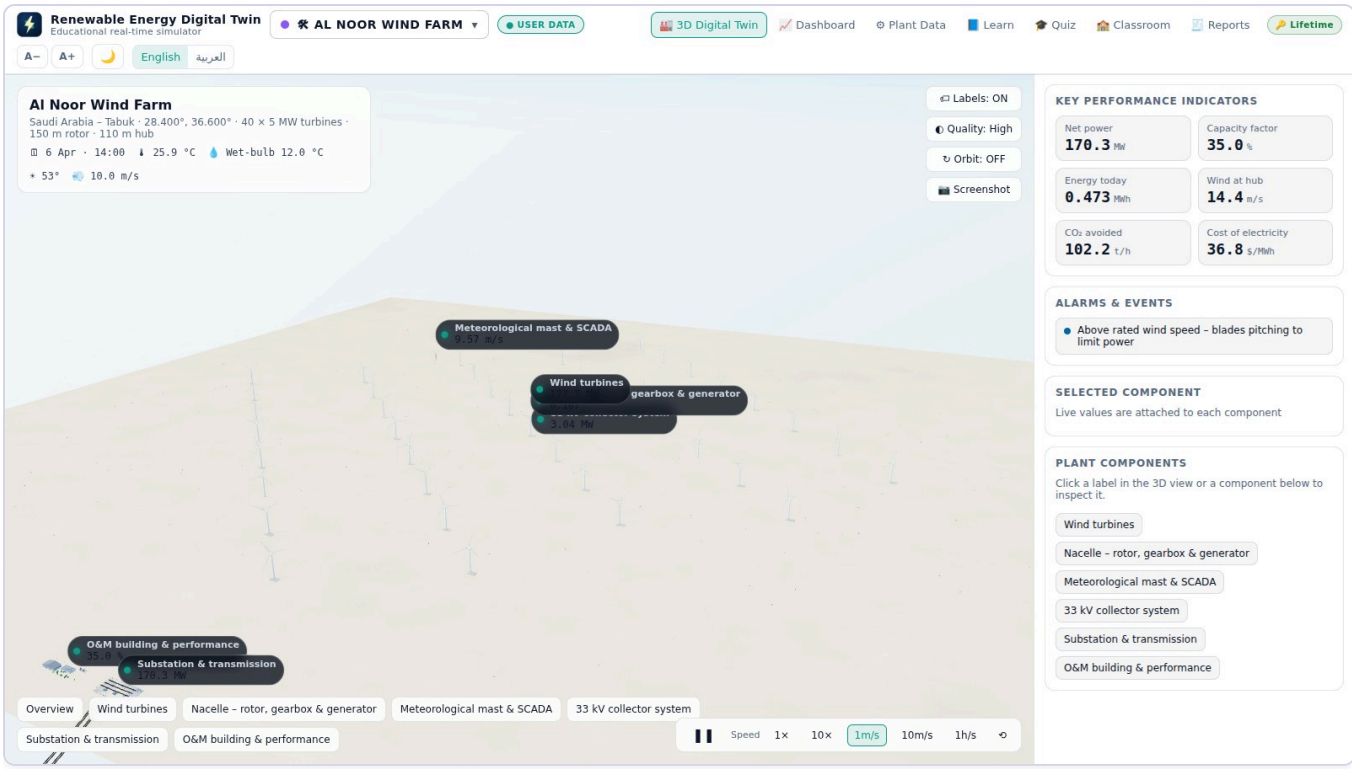


Figure 40: The generated 3D twin of a 40-turbine wind farm designed in the wizard.

17.2 Climate presets

The climate preset sets the weather, sun and wind statistics of the site and the look of the terrain. Choose the one closest to your location.

Table 16: Climate presets

Preset	Character
Desert plateau – Al Jouf, Saudi Arabia	Windy, cold winters
Red Sea coast – NEOM, Saudi Arabia	Sun and wind
Gulf desert – Abu Dhabi, UAE	Very hot, hazy
Gulf coast – Dubai, UAE	Hot, humid
Nile valley – Aswan, Egypt	Hot, dry
Temperate lowland – Yorkshire, UK	Mild, rainy
Sub-arctic volcanic – Hengill, Iceland	Cold, windy

17.3 Required design data per technology

Table 17: Wind turbine – design data

Wind turbine	Unit	Range
Number of turbines	turbines	1 – 400
Rated power per turbine	MW	0.5 – 20
Rotor diameter	m	40 – 260
Hub height	m	40 – 180

Wind turbine	Unit	Range
Mean wind speed at hub height (7 m/s = fair, 8–9 m/s = good, > 9 m/s = excellent)	m/s	3 – 14
Site elevation	m a.s.l.	0 – 3,000
Investment cost	$/kW	600 – 2,500
Electricity sale price	$/MWh	5 – 150

Table 18: Solar panel – design data

Solar panel	Unit	Range
DC capacity	MWp	1 – 5,000
Inverter AC capacity (0 = DC ÷ 1.25)	MW	0 – 5,000
Module efficiency	%	12 – 26
Module tilt (fixed structures)	°	0 – 45
Single-axis trackers (0 = no, 1 = yes)		0 – 1
Bifacial modules (0 = no, 1 = yes)		0 – 1
Investment cost	$/Wp	0.3 – 2.5
Electricity sale price	$/MWh	5 – 200

Table 19: Hydropower – design data

Hydropower	Unit	Range
Number of turbine units	units	1 – 40
Rated power per unit	MW	1 – 1,000
Rated net head	m	5 – 800
Rated flow per unit	m^3/s	1 – 800
Mean river inflow	m^3/s	5 – 20,000
Reservoir evaporation	mm/day	0 – 15

Table 20: Geothermal – design data

Geothermal	Unit	Range
Production wells	wells	1 – 200
Two-phase flow per well	kg/s	5 – 60
Reservoir temperature	°C	200 – 330
Turbine units	units	1 – 20
Rated power per unit	MW	5 – 120
District heating demand (0 = electricity only)	MWth	0 – 800

Table 21: Biomass – design data

Biomass	Unit	Range
Boiler-turbine units	units	1 – 8
Rated power per unit	MW	5 – 700
Fuel moisture (as received)	%	3 – 40
Higher heating value (dry)	MJ/kg	15 – 22
Main steam pressure	bar	60 – 250

Biomass	Unit	Range
Main steam temperature	°C	400 – 600

Table 22: Waste-to-energy – design data

Waste-to-energy	Unit	Range
Combustion lines	lines	1 – 12
Waste capacity per line	t/h	5 – 60
Waste moisture	%	10 – 60
Plastics share	% wet	0 – 50
Food & garden organics share	% wet	0 – 80
Steam pressure	bar	30 – 90

Table 23: Green hydrogen – design data

Green hydrogen	Unit	Range
Solar PV capacity	MW	0 – 4,000
Wind farm capacity	MW	0 – 3,000
Electrolyser modules	modules	1 – 400
Power per module	MW	5 – 50
Battery storage	MWh	0 – 2,000
Water consumption	L/kg H_2	9 – 40
Renewable electricity cost	$/MWh	5 – 100

17.4 What the program does with your data

- Your design values become the plant's own **reference data**: Plant Data shows them as defaults with widened ranges, and Reset to reference data returns to your design.
- All other operating parameters (efficiencies, losses, temperatures, logistics, costs …) are derived from typical values of the technology and can be changed like any other.
- The gauges of the dashboard are scaled to the size of your plant; the components carry generic names (turbines, substation, boiler house …).
- The 3D twin is generated from the numbers: turbine rows sized by rotor diameter and hub height, PV blocks and inverter stations by capacity, a dam and powerhouse by head and units, well pads, storage domes or furnace lines by their counts.
- A "design" scenario plus the relevant scenarios of the technology (storm, heatwave, drought …) are available.
- The Learn page, quiz (including live-data questions) and reports use the chosen technology and your plant name.

17.5 Editing or deleting your plant

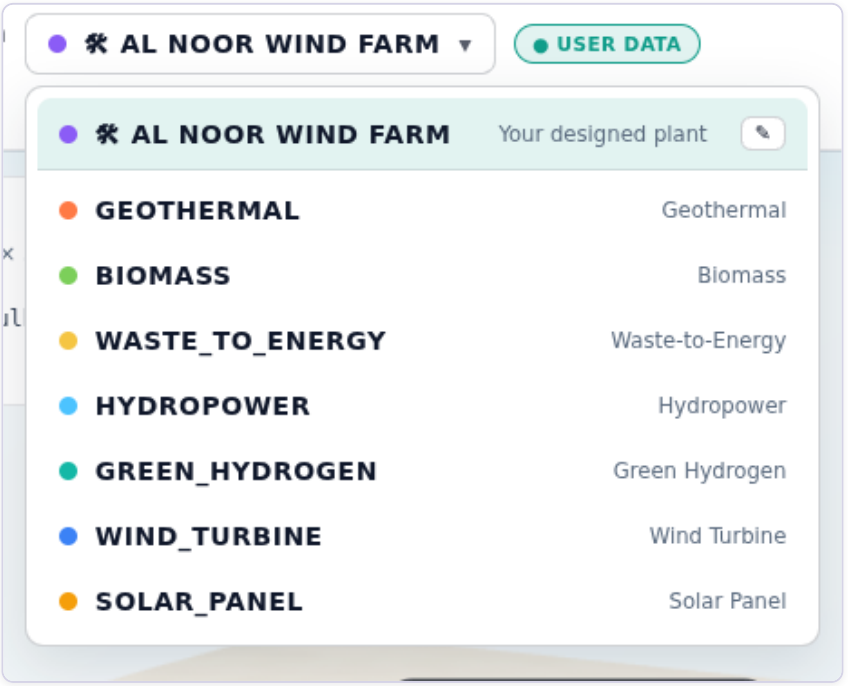


Figure 41: Your plant in the drop-down, with the ✎ pencil that opens the design for editing.

Click the ✎ pencil next to your plant in the drop-down, or **✎ Edit design** in the header of **Plant Data**, to reopen the wizard with your values. **Save changes** rebuilds the twin. In the review step, **🗑 Delete this plant** removes it (the reference plants are never affected). One designed plant is kept at a time – export its **Plant Data** as JSON if you want to keep several designs.

> **Note**
> The technology of your plant must be covered by your license; locked technologies show a 🔒 in the wizard.

18 The seven reference plants

This chapter introduces each reference plant, what its model computes, the scenarios you can apply and the components you can inspect in the twin. All reference values come from public sources listed on the plant's data sheet in Plant Data.

18.1 Geothermal – Hellisheiði Geothermal Power Station, Iceland

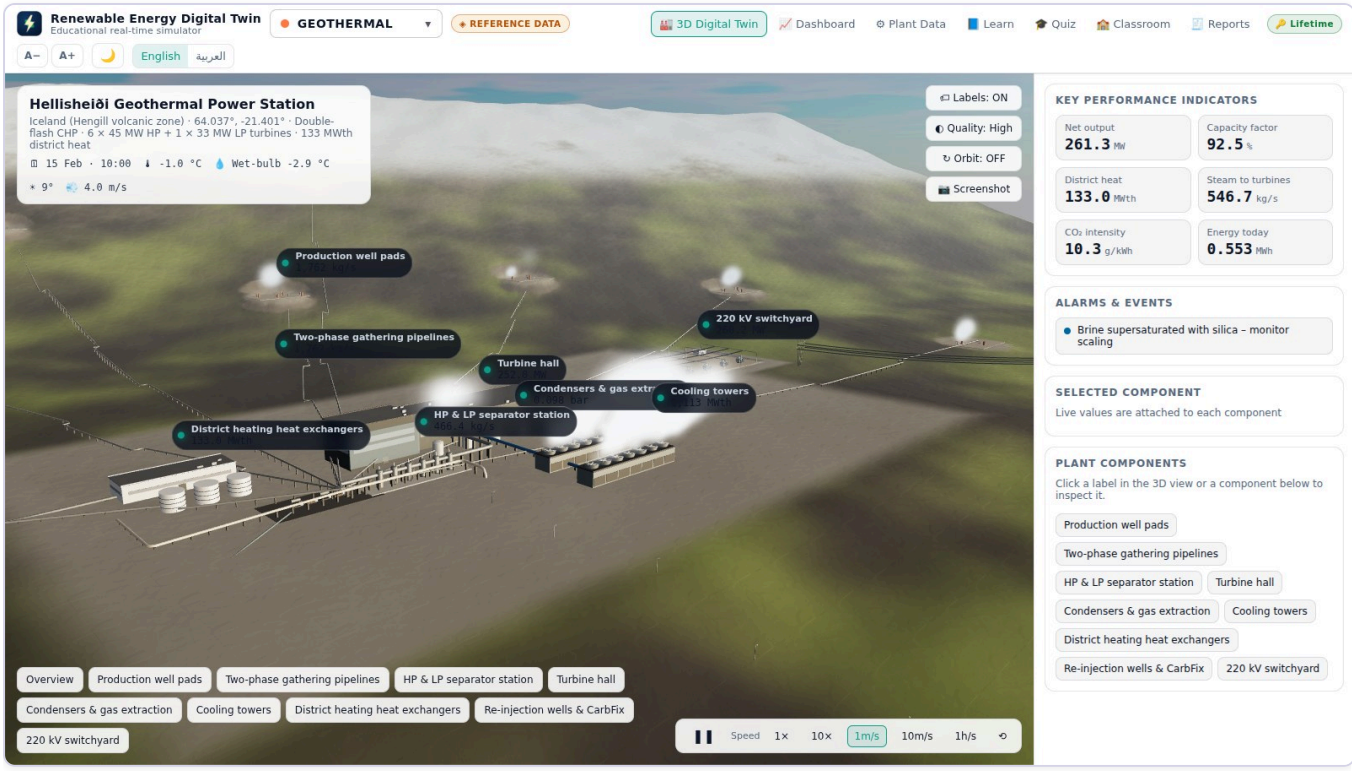


Figure 42: Hellisheiði: well pads on the Hengill lava fields, gathering pipelines, separators, turbine hall and cooling towers.

Operator	ON Power (Orka náttúrunnar) – Reykjavík Energy
Commissioned	2006 – 2011
Capacity	303 MW electricity + 133 MWth district heat
Technology	Double-flash combined heat and power: 6 × 45 MW high-pressure and 1 × 33 MW low-pressure turbines

About 57 wells drilled to 2–3 km tap a 240–320 °C reservoir. The two-phase flow is separated into high- and low-pressure steam that drives the turbines; the separated brine and the condensate are re-injected, and the CarbFix process injects CO_2 and H_2S into basalt where they mineralise. Hot water at 83 °C is piped 20 km to heat Reykjavík.

- **Gauges:** net electrical output, district heat delivered, HP steam, wellhead pressure, condenser pressure, CO_2 intensity, silica saturation index, electrical efficiency.
- **Scenarios:** design operation · winter – maximum heat demand · aging reservoir (25 wells, high decline) · high-enthalpy wells (2000 kJ/kg) · CarbFix offline.

- **Components:** production well pads · two-phase gathering pipelines · HP & LP separator station · turbine hall · condensers & gas extraction · cooling towers · district heating heat exchangers · re-injection wells & CarbFix · 220 kV switchyard.

18.2 Biomass – Drax Power Station, United Kingdom

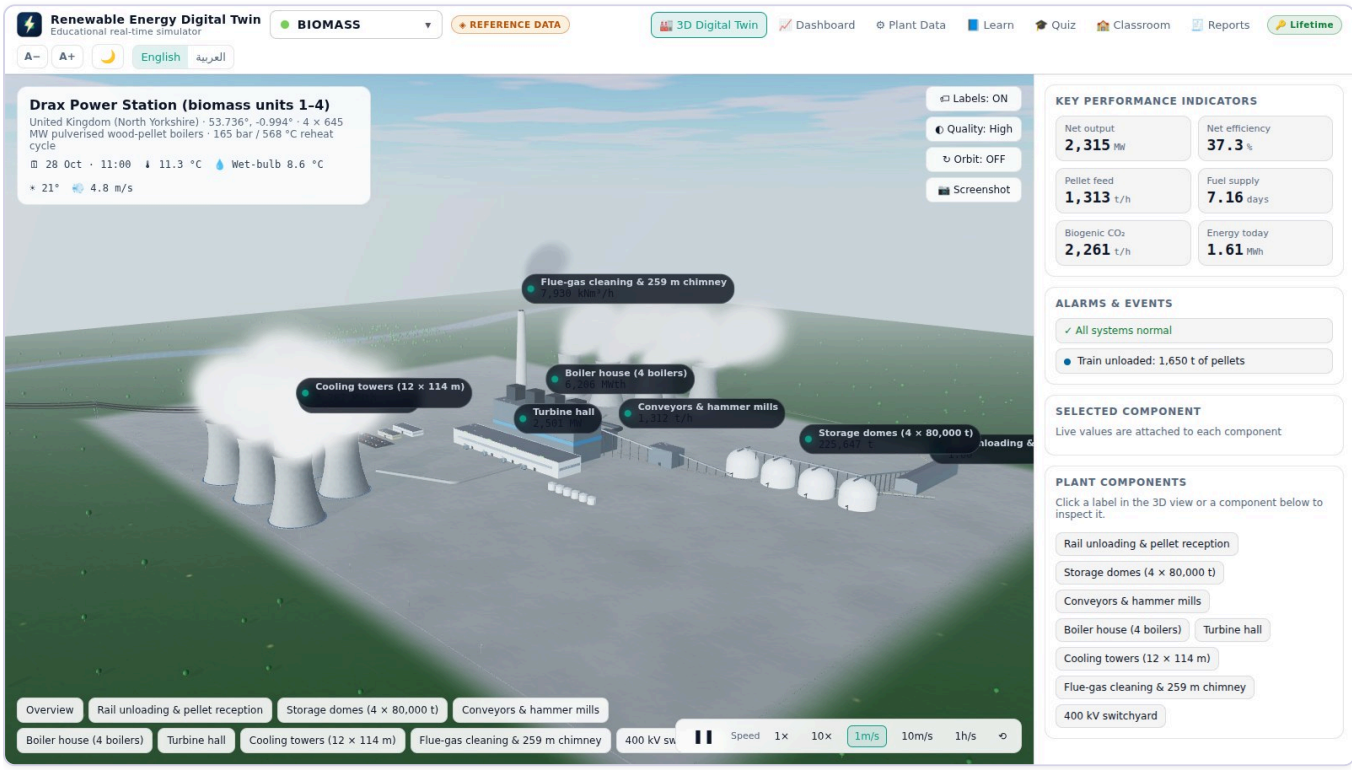


Figure 43: Drax: rail unloading, the four storage domes, boiler house, turbine hall, twelve cooling towers and the 259 m chimney.

Operator	Drax Group plc
Commissioned	1974 (coal) · converted to biomass 2013 – 2018
Capacity	2,580 MW (4 × 645 MW)
Technology	Pulverised wood-pellet boilers, 165 bar / 568 °C reheat steam cycle

Drax burns about 7 million tonnes of wood pellets a year, delivered by 14 trains a day into four 50 m domes holding 80,000 t each. The model follows the fuel from moisture and heating value through the boiler and the Rankine cycle to the 400 kV grid, including the supply chain and the biogenic carbon accounting behind the BECCS pilot.

- **Gauges:** net power to grid, pellet feed rate, fuel LHV, boiler efficiency, net plant efficiency, flue-gas O_2, condenser pressure, storage level, days of fuel supply.
- **Scenarios:** baseload operation · wet fuel (30 % moisture chips) · port strike (4 trains/day) · two units in outage · summer heatwave (+12 K).
- **Components:** rail unloading & pellet reception · storage domes · conveyors & hammer mills · boiler house · turbine hall · cooling towers · flue-gas cleaning & chimney · 400 kV switchyard.

18.3 Waste-to-energy – Dubai Waste Management Centre, Warsan

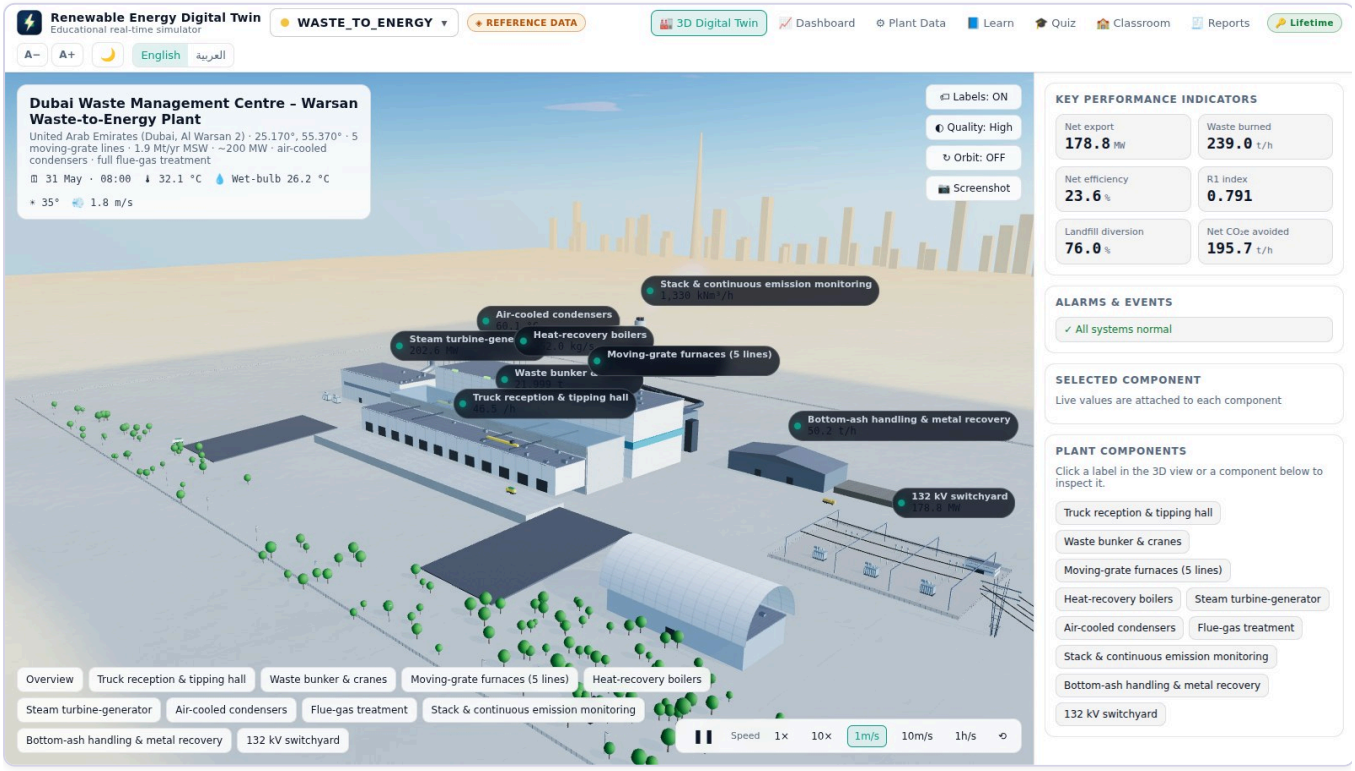


Figure 44: Warsan: tipping hall, waste bunker, five furnace lines, flue-gas treatment, air-cooled condensers and stack.

Operator	Dubai Waste Management Company for Dubai Municipality
Commissioned	2023 – 2024 (5 lines)
Capacity	≈ 200 MW from 1.9 Mt of waste per year
Technology	Five moving-grate lines, air-cooled condensers, full flue-gas treatment

The world's largest single-site waste-to-energy plant treats 5,666 t of household waste a day, powers about 135,000 homes and diverts about 45 % of Dubai's waste from landfill. The model computes the heating value from the waste composition, the furnace and boiler, the emission control to EU limits, residues, metal recovery and the net CO_2 balance versus landfill.

- **Gauges:** net power exported, waste incinerated, waste LHV, boiler and net electrical efficiency, furnace temperature, condenser pressure, NOx and dust at stack, bunker level, days of waste in bunker, R1 index, waste diverted from landfill.
- **Scenarios:** design operation · August heat (47 °C afternoons) · wet, organic-rich waste · plastic-rich commercial waste · flue-gas treatment degraded · two lines in maintenance.
- **Components:** truck reception & tipping hall · waste bunker & cranes · moving-grate furnaces · heat-recovery boilers · steam turbine-generator · air-cooled condensers · flue-gas treatment · stack & emission monitoring · bottom-ash handling & metal recovery · 132 kV switchyard.

18.4 Hydropower – Aswan High Dam, Egypt

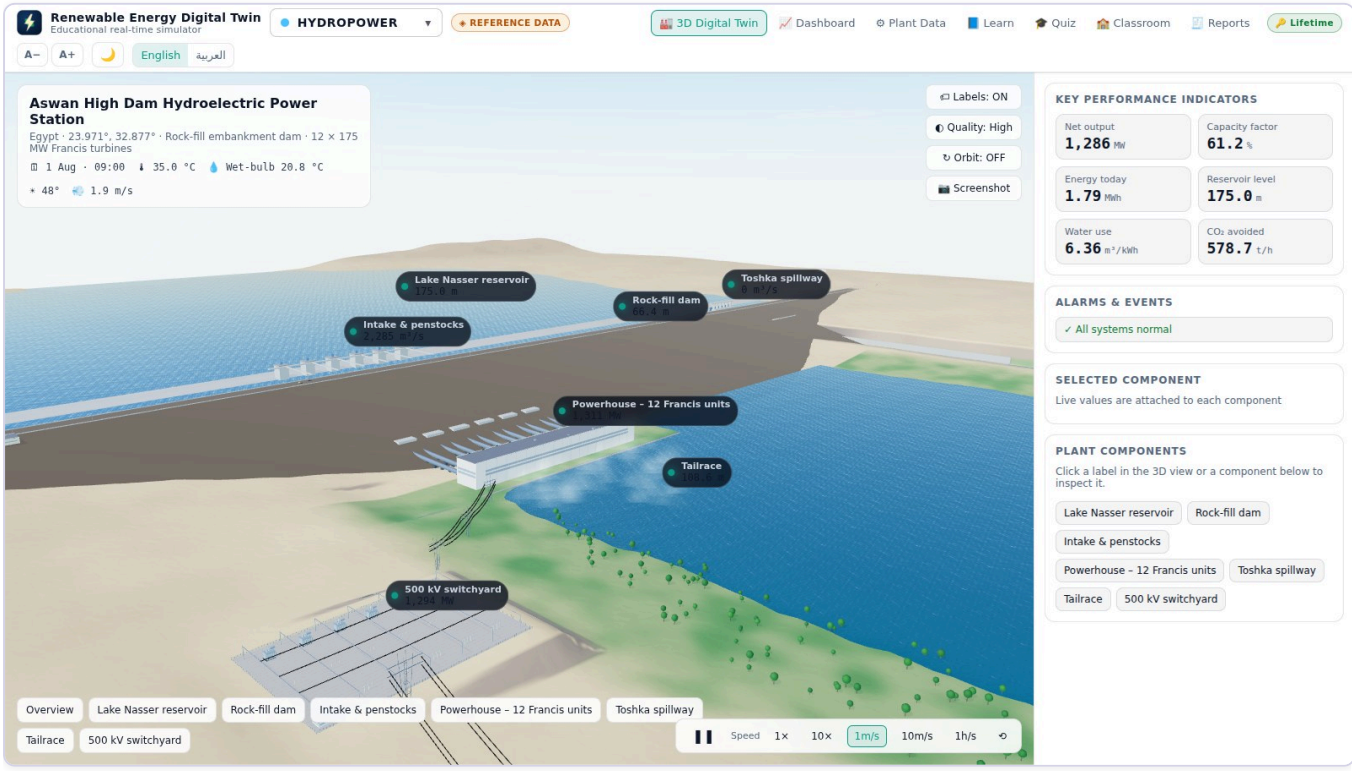


Figure 45: Aswan: Lake Nasser, the rock-fill dam, intakes and penstocks, the powerhouse with twelve Francis units and the Toshka spillway.

Operator	Hydro Power Plants Executive Authority / EEHC
Commissioned	1967 – 1971
Capacity	2,100 MW (12 × 175 MW Francis turbines)
Technology	Rock-fill embankment dam, 111 m high, 3,830 m long

Lake Nasser holds about 132 km³ of live storage. The model runs the reservoir balance (inflow, evaporation, turbine and spillway discharge), the turbine hill chart, grid frequency and generator temperatures, and shows what a drought, a record flood or a major overhaul does to the output.

- **Gauges:** net power to grid, reservoir level, storage, net head, turbine discharge, units online, turbine efficiency, grid frequency, generator winding temperature.
- **Scenarios:** average year · drought (low reservoir) · record flood year · major overhaul (4 units out).
- **Components:** Lake Nasser reservoir · rock-fill dam · intake & penstocks · powerhouse · Toshka spillway · tailrace · 500 kV switchyard.

18.5 Green hydrogen – NEOM Green Hydrogen Project, Saudi Arabia

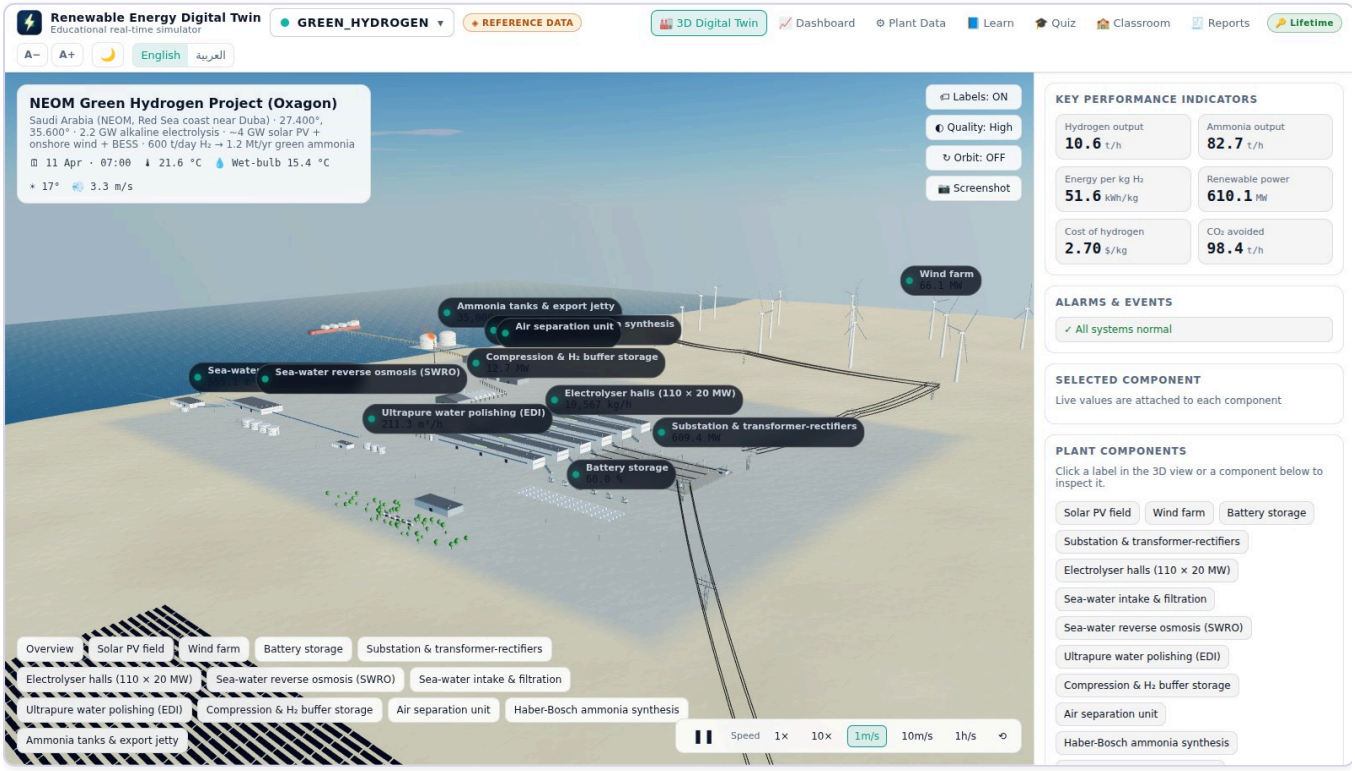


Figure 46: NEOM: solar field, wind farm, battery storage, electrolyser halls, water treatment, hydrogen storage and the ammonia plant at the Oxagon port.

Operator	NEOM Green Hydrogen Company – ACWA Power · Air Products · NEOM
Commissioned	2026 – 2027 (design data)
Capacity	2.2 GW alkaline electrolysis · 600 t H_2/day · 1.2 Mt green ammonia/year
Technology	≈ 4 GW solar PV and onshore wind with battery storage in an isolated micro-grid

The plant is not connected to the grid: solar, wind and batteries feed the electrolysers directly, so hydrogen production follows the weather. The model covers the renewable supply, the electrolyser stacks (cell voltage, efficiency, degradation), the complete **water train** – sea-water intake, filtration, reverse-osmosis desalination with brine return and ultrapure polishing – hydrogen compression and buffer storage, the air separation unit and Haber-Bosch ammonia synthesis, and the levelised cost of hydrogen.

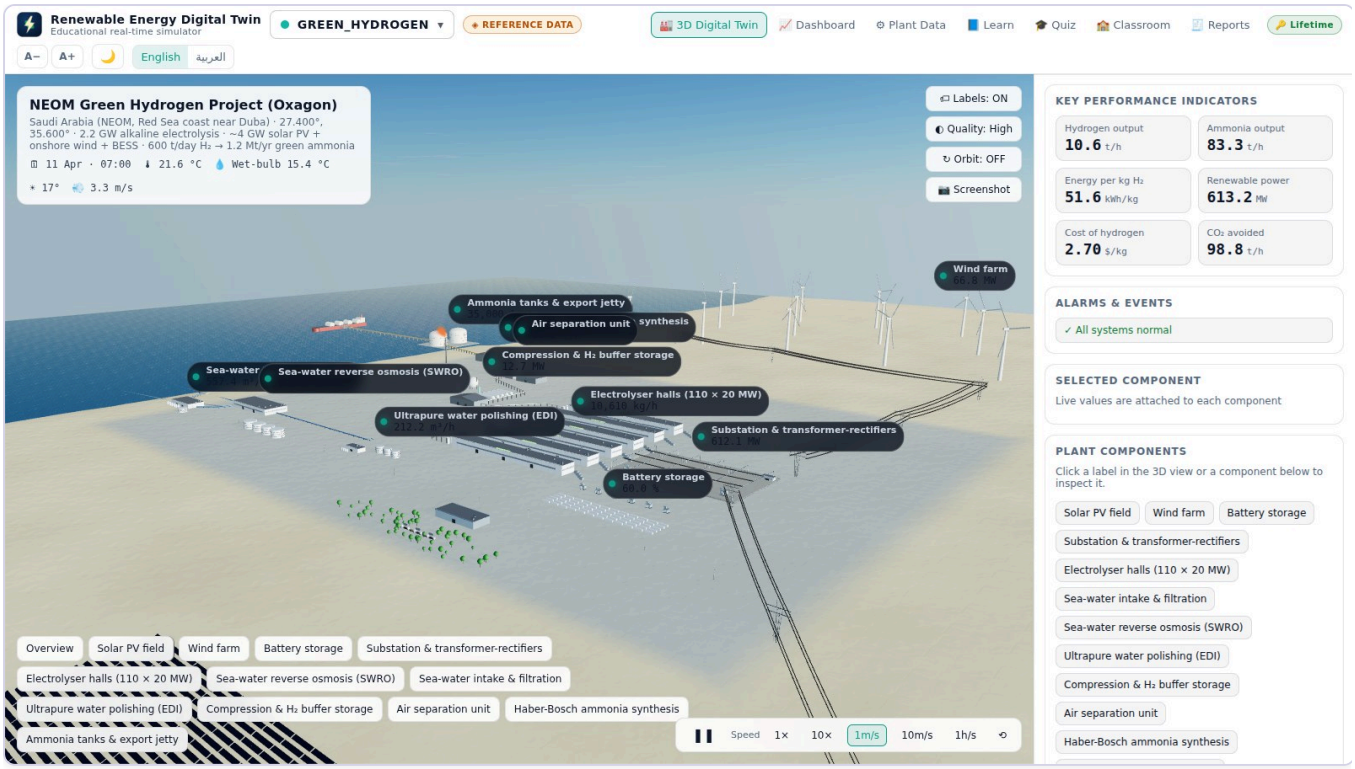


Figure 47: The water treatment train of the hydrogen plant: intake and filtration, sea-water reverse osmosis and ultrapure polishing.

- **Gauges:** hydrogen production, renewable power available, electrolysis power, modules online, cell voltage, stack efficiency, specific energy consumption, ultrapure water demand, brine salinity, buffer storage level, ammonia production, battery state of charge, levelised cost of hydrogen.
- **Scenarios:** design operation · dust storm (40 % solar, weak wind) · aged stacks (60,000 h, 2.0 V) · large H_2 buffer + 1 GWh battery · grid-connected (500 MW import) · 2030 costs.
- **Components:** solar PV field · wind farm · battery storage · substation & transformer-rectifiers · electrolyser halls · sea-water intake & filtration · sea-water reverse osmosis · ultrapure water polishing (EDI) · compression & H_2 buffer storage · air separation unit · Haber-Bosch ammonia synthesis · ammonia tanks & export jetty.

18.6 Wind – Dumat Al Jandal Wind Farm, Saudi Arabia

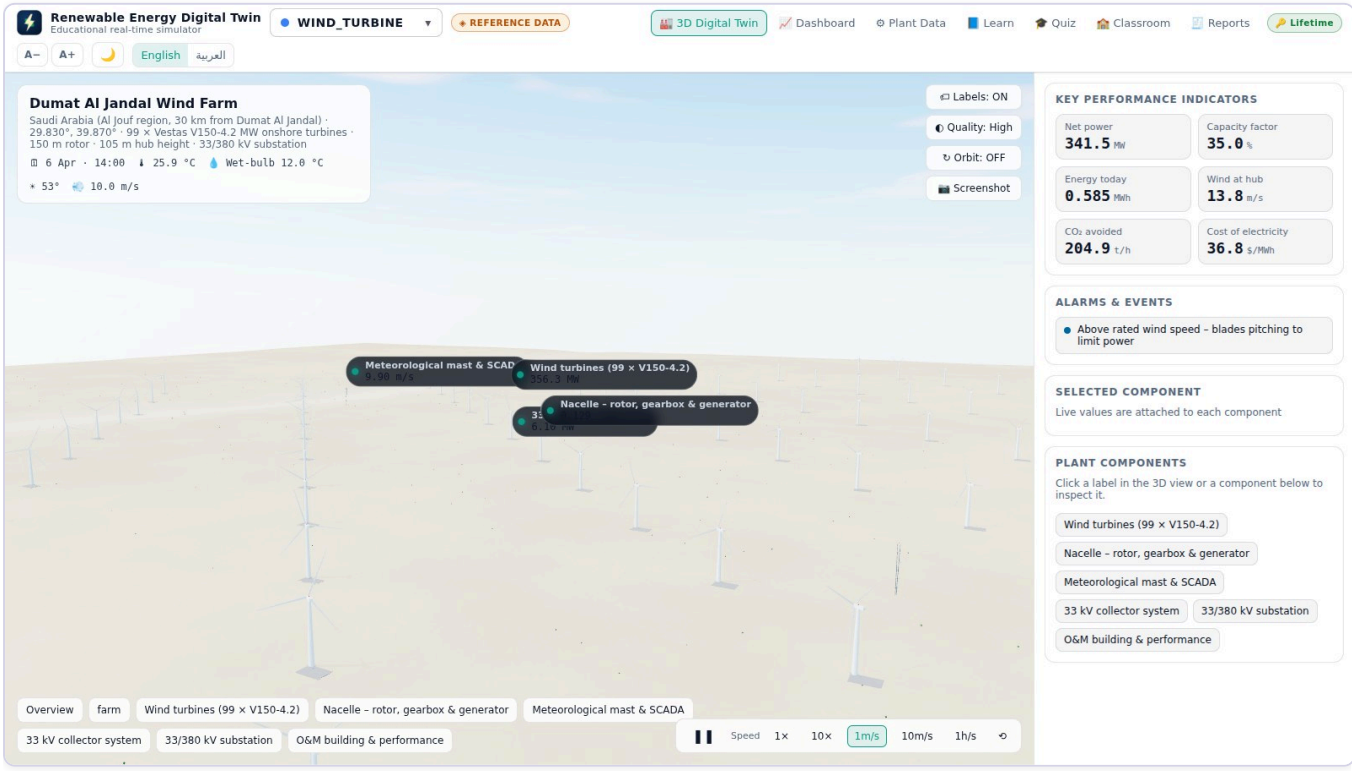


Figure 48: Dumat Al Jandal: 99 turbines in rows across the prevailing wind, the meteorological mast, collector system and substation.

Operator	EDF Renewables · Masdar (Dumat Al Jandal Wind Company)
Commissioned	2021 – 2022 – the first utility-scale wind farm in Saudi Arabia
Capacity	400 MW (99 × Vestas V150-4.2 MW)
Technology	150 m rotor, 105 m hub height, 33/380 kV substation

The largest wind farm in the Middle East at commissioning produces about 1.4 TWh a year under a record-low tariff of 2.13 US¢/kWh. The model computes the wind at hub height from the site statistics (wind shear, air density), the turbine power curve with cut-in, rated and cut-out speeds, wake losses depending on wind direction, hot-weather derating, curtailment, capacity factor, levelised cost of electricity and avoided CO_2.

- **Gauges:** net power to grid, wind speed at hub height, turbines generating, rotor power coefficient Cp, 7-day capacity factor, levelised cost of electricity, CO_2 avoided.
- **Scenarios:** typical spring day · storm (turbines cut out above 25 m/s) · calm high-pressure day · sandstorm (blade erosion & dust) · summer heatwave · grid curtailment order 50 % · repowering (60 × 6.6 MW, 170 m rotors).
- **Components:** wind turbines · nacelle (rotor, gearbox & generator) · meteorological mast & SCADA · 33 kV collector system · 33/380 kV substation · O&M building & performance.

18.7 Solar – Noor Abu Dhabi Solar Plant, United Arab Emirates

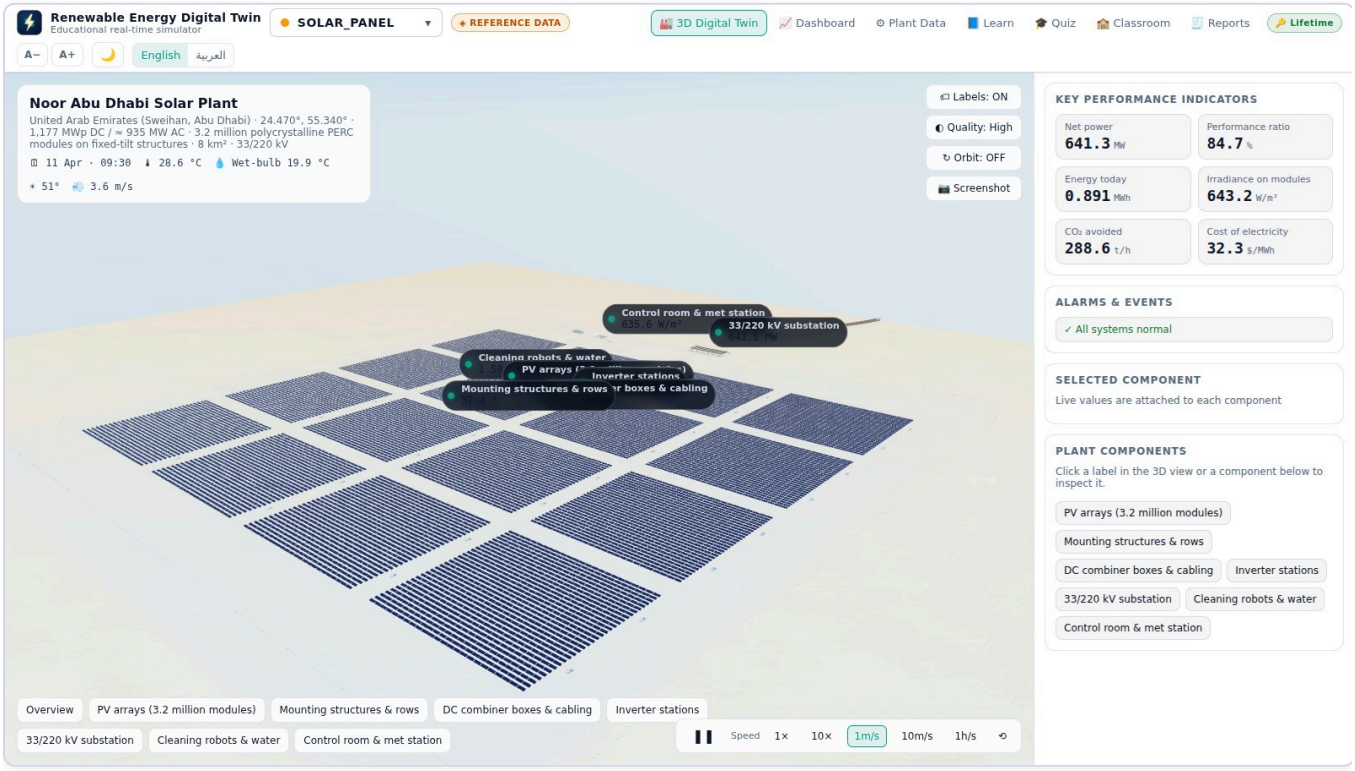


Figure 49: Noor Abu Dhabi: PV arrays on fixed-tilt structures, inverter stations, substation, cleaning robots and the met station.

Operator	Sweihan PV Power Company – EWEC · Marubeni · JinkoSolar
Commissioned	2019 – the world's largest single-site PV plant at the time
Capacity	1,177 MWp DC / ≈ 935 MW AC
Technology	3.2 million polycrystalline PERC modules on fixed-tilt structures over 8 km², 33/220 kV

The model follows the sun: global, direct and diffuse irradiance, the plane-of-array irradiance for fixed or tracking structures with row shading, cell temperature and its effect on efficiency, soiling in the desert and the night-time cleaning robots, inverter loading and clipping, performance ratio, specific yield, levelised cost of electricity and avoided CO_2.

- **Gauges:** net power to grid, plane-of-array irradiance, cell temperature, soiling loss, performance ratio, 7-day capacity factor, levelised cost of electricity, CO_2 avoided.
- **Scenarios:** clear spring day · summer heatwave · dust storm (30 % sun, heavy deposit) · cleaning robots down for 45 days · retrofit single-axis trackers · 2030 modules (23 % bifacial TOPCon) · grid curtailment order 40 %.
- **Components:** PV arrays · mounting structures & rows · DC combiner boxes & cabling · inverter stations · 33/220 kV substation · cleaning robots & water · control room & met station.

Note

The program is an educational simulator. Its values are estimates of a physics model built on published design data – they are not measurements from the real plants and must not be used for operational or commercial decisions.

19 Updates

ASFAN publishes improvements and new features as new versions on the download page. The **Setup edition** installs them by itself; the **portable edition** tells you when a new file is available.

19.1 Automatic updates (Setup edition)

1. About ten seconds after each start – and every four hours while it runs – the program checks the download page for a newer version. This needs an internet connection; without one nothing happens.
2. When a new version exists it is downloaded in the background while you keep working. A small card at the bottom right shows the progress.
3. When the download is complete the card reads **Update x.y.z is ready**. Click Restart now to install it immediately, or Later – the update is installed automatically the next time you close the program.
4. After the restart the new version is running. License, settings and data are kept.

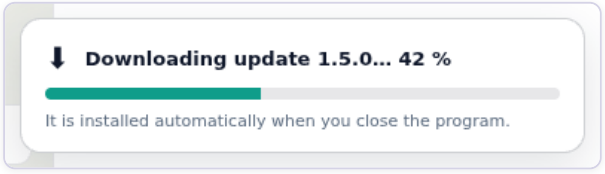


Figure 50: An update is being downloaded in the background.

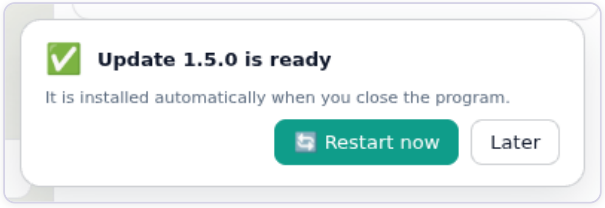


Figure 51: The update is ready: restart now or later.

19.2 Checking by hand

Help → Check for Updates… runs a check immediately and reports *You have the latest version* or starts the download. *Could not check for updates* means the computer is offline or the download page is unreachable – try again later.

19.3 Portable edition

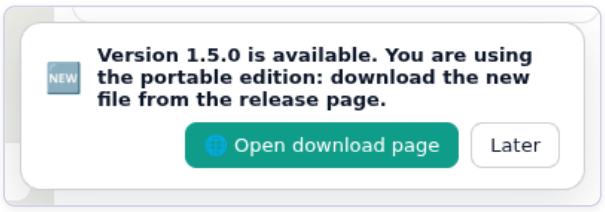


Figure 52: The portable edition shows a notice with a link to the download page.

The portable edition cannot replace its own file. When a new version exists it shows a notice with **Open download page**: download the new `RenewableEnergyDigitalTwin-Portable-.exe`, then delete the old file. Your data are kept because they are stored outside the EXE (chapter 20).

19.4 Which version do I have?

Help → **About** shows the version number; it is also printed at the bottom of the license window. The current version of this manual is **1.4.0**.

> **Note**
> Updates are downloaded only from the official ASFAN download page and are checked for integrity before they are installed. The program never sends any of your data anywhere.

20 Your data, backups and moving to another computer

20.1 Where the program keeps its data

Everything the program stores about you is in one folder of your Windows profile:

`%APPDATA%\Renewable Energy Digital Twin` (paste this into the address bar of File Explorer to open it – usually C:\Users*your name*\AppData\Roaming\Renewable Energy Digital Twin)

Table 24: Data locations

Item	Where	Notes
License key	`license.json`	Delete it to remove the license (same as Remove license).
Trial period	`trial.json`	Records the first start of the trial.
Settings, entered plant data, your designed plant, quiz history	`Local Storage\` sub-folder	Stored in the program's local database; do not edit by hand.
Exports (JSON, CSV), reports, screenshots	Wherever you saved them (Documents by default)	Ordinary files – copy, e-mail or archive them freely.

Nothing is stored in the cloud and no usage data are sent to ASFAN. The only network connections the program makes are the update check (chapter 19) and, when online, the satellite imagery for the 3D terrain.

20.2 Backup

Copy the folder above to a USB stick or to your backup drive. Restoring it into the same location on a fresh installation brings back the license, settings, data and quiz history.

20.3 Moving to another computer

1. Install the program on the new computer (chapter 5) and activate it with your key (chapter 7). A key that is not bound to a machine works on your new computer without any change.
2. If your license is **bound to a machine**, send the new computer's Machine ID (license window → Copy) to support; you receive a key for the new computer.
3. Optionally copy the data folder from the old computer to the new one to keep your settings and entered data. The portable edition uses the same folder.

20.4 Resetting the program

To return to a fresh state (all settings, entered data and quiz history removed), close the program, delete the folder above except `license.json`, and start again. To also remove the license, delete the whole folder.

Important

Remove license or deleting `license.json` does not cancel the license – the key remains valid and can be entered again. Keep the message with your key.

21 Troubleshooting and FAQ

Table 25: Frequently asked questions

Problem	Cause and solution
Edge or Chrome refuses to keep the download	The file is new to the browser's reputation service. Follow chapter 4 (⋯ → Keep → Show more → Keep anyway).
"Windows protected your PC" when starting the installer	SmartScreen does not know the unsigned installer yet. Click **More info** → **Run anyway** (chapter 4).
The antivirus deleted or blocked the Setup file	Restore / allow it in the antivirus and add it to the exclusions, or download it again. Contact support if the problem persists.
The program does not start, or the window stays white	Wait 20 seconds – the first start is slower. If nothing happens, restart Windows and start the program again. If still nothing, run the Setup file again (it repairs the installation) or contact support with your Windows version.
"3D view unavailable" message	The graphics driver does not provide WebGL 2. Update the graphics driver from the manufacturer (Intel, NVIDIA, AMD) or Windows Update. The dashboard, plant data, quiz and reports keep working.
The 3D view is black, jerky or slow	Set **Quality** to **Low** in the 3D toolbar, close other 3D programs and browsers, and on a laptop plug in the charger (Windows lowers graphics performance on battery). Make sure the laptop uses its dedicated graphics card for the program (Windows Settings → Display → Graphics).
High CPU or fan noise	Normal for a 3D program. Lower the quality, pause the simulation when you do not need it, or work on the other pages – the 3D view is not rendered while another page is open.
Text is too small or too large	Use **A−** / **A+** in the top bar (chapter 8). The size is remembered.
The top bar shows two lines or elements are cut off	The window is narrow. Maximise the window, reduce the text size with **A−** or use full screen (`F11`).
The interface is in the wrong language	Click **English** or **العربية** in the top bar.
"Activation failed …"	See the table in chapter 7. In most cases the key was pasted incompletely – use **Load .lic file**.
The badge shows "License expired" or "Trial ended"	The time-limited license or the trial has run out. Contact support for a new key; enter it with **Replace license key**.
An energy type shows a 🔒 lock	Your license does not include it. Ask support to extend the license (chapter 7).
Simulation speeds above 10× are refused	The trial version is limited to 10×. Activate a license.

Problem	Cause and solution
Values look wrong after playing with parameters	Click ⟲ **Reset to reference data** in Plant Data, or choose the "—" scenario. Each plant is reset separately.
The trend chart is empty	The chart fills as the simulation runs. Increase the speed (1 h/s) to fill the 24 h and 31 d windows quickly.
My designed plant disappeared	A license change or a deleted plant returns the program to a reference plant. Check the first entry of the energy-type drop-down; if the plant was deleted, re-enter it or import its exported JSON.
No satellite imagery under the plant	The computer is offline or a firewall blocks the map service. The program works normally without it.
The update never appears	The computer is offline, or you use the portable edition (chapter 19). **Help** → **Check for Updates…** reports the result.
Certificate or report does not print	Choose a printer in the Windows print dialog; *Microsoft Print to PDF* creates a PDF file if no printer is available.
I forgot where my exports are	The save dialog proposes your *Documents* folder; the file names start with the energy type (for example `wind_turbine-plant-data.json`).

22 Support and contact

We are glad to help with installation, licenses, questions about the models and with suggestions for new features.

ASFAN Trading – Customer support

📱 **WhatsApp** **00962776140404 (+962 77 614 0404)**

✉️ **E-mail** **info@asfanco.com**

Support hours: Sunday to Thursday, 9:00 – 17:00 (Amman time, UTC+3). Messages received outside these hours are answered on the next working day.

22.1 What to include in a support request

- The **program version** (Help → About) and your Windows version.
- A **screenshot** of the problem or of the message (`Win` + `Shift` + `S` copies part of the screen; paste it into the message).
- For license questions: the **name on your license** and, for machine-bound keys, the **Machine ID** from the license window (Copy button).
- What you did before the problem appeared, and whether it happens every time.

22.2 Purchasing and licensing

Licenses are available for a lifetime or for a fixed period, for one computer or several, and for all energy types or a selection. Educational institutions receive class licenses. Write to info@asfanco.com or on WhatsApp for a quotation.

22.3 About the program

Product	Renewable Energy Digital Twin
Version	1.4.0
Publisher	ASFAN Trading
Download page	https://github.com/asfantrading-create/RenewableEnergyDigitalTwin-Releases/releases/latest
Supported systems	Windows 10 / 11, 64-bit