New Energy Grid

⚡ USER OPERATION & HOMEOWNER MANUAL

# GEMS User Manual

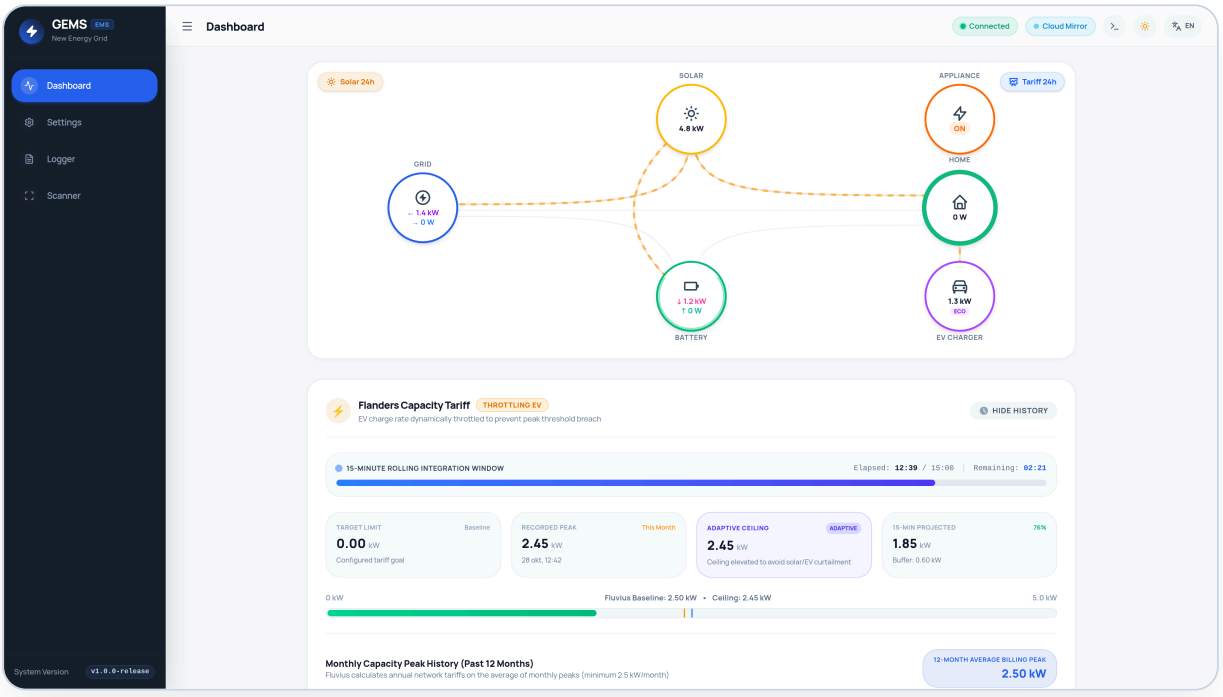
Your Complete Guide to Real-Time Energy Flow Monitoring, Smart EV Charging, Home Battery Optimization, Dynamic Tariffs, and Daily Cost Savings

**SYSTEM RELEASE**
**GEMS v9.25.3**

**TARGET AUDIENCE**
**Homeowners, Residents & Energy Managers**

**SUPPORTED HARDWARE**
**Solar Inverters, Batteries, EV Chargers, Relays**

**DOCUMENTATION EDITION**
**September 2026 • Everyday User Reference**



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# 1. Welcome to GEMS: What It Does & Why It's in Your Home

Welcome to **GEMS (Grid Energy Management System)**! Installed directly in your electrical panel on a dedicated compact computer (Raspberry Pi 5 with an ultra-reliable solid-state NVMe drive), GEMS is the intelligent central brain of your home energy setup.

In a modern home, you have several powerful electrical systems: solar panels on the roof, an electric vehicle in the driveway, a home battery storage unit, a heat pump or boiler, and everyday kitchen and laundry appliances. Without an energy manager, these systems work completely blindly:

- Your car might start charging at full speed from the expensive utility grid just as your oven turns on, causing an expensive capacity peak.
- Your solar panels might inject cheap or even negatively priced electricity into the grid while your home battery sits half empty.
- Your heat pump might run at night when electricity is pricey instead of pre-heating your water with free solar energy at noon.

**GEMS solves all of this automatically.** It measures every watt generated and consumed in your home every single second. It directs free solar power straight to where it saves you the most money, caps expensive grid import peaks, and schedules your EV charging during the cheapest hours—all 100% automatically.

> **🔒 100% Local & Private: Zero Subscriptions, Zero Cloud Dependency**
> Unlike commercial smart home products that require expensive monthly subscriptions and send your private data to remote servers, GEMS runs **entirely inside your own house**. If your internet connection goes down, GEMS continues balancing your solar, battery, and car without skipping a beat!

> ☁️ **Optional Remote Cloud Access: GRID-EMS-SERVER**
>
> While GEMS functions **100% autonomously at the edge** with zero cloud dependency, you can optionally connect your unit to **GRID-EMS-SERVER** (`https://ems.newenergygrid.com`). This optional integration allows you to check your live dashboard from your smartphone anywhere in the world, view historical fleet statistics, and receive remote technical support from your certified installer—completely subscription-free and with zero open router ports.

# 2. The Interactive PowerFlow Dashboard

The central feature of GEMS is the animated **PowerFlow Hero** at the top of your dashboard. It gives you an instant, intuitive picture of where electricity is coming from and where it is going right now:

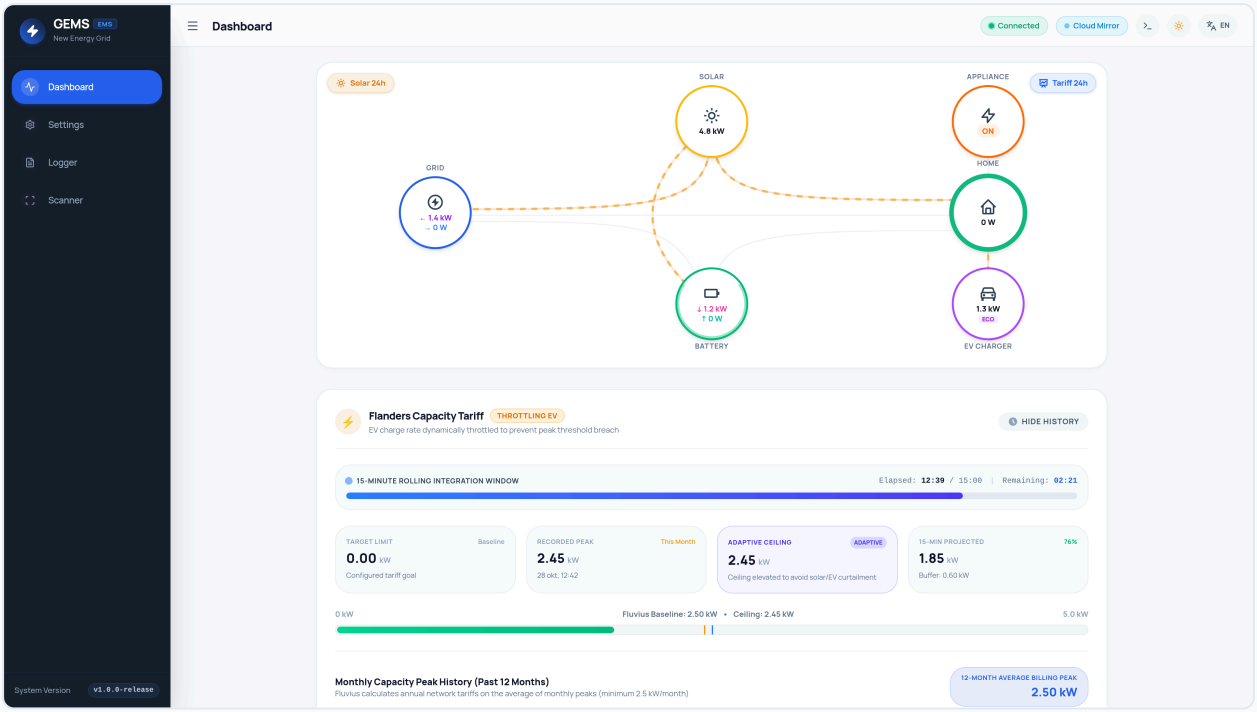



Figure 2.1: Real-time PowerFlow hero showing 4.8 kW solar output supplying the house, charging the battery, and exporting surplus.

## Understanding the PowerFlow Circles (Nodes)

| Circle Node | Color Badge | What It Tells You in Plain Language |
|---|---|---|
| **Solar** | • Gold / Amber | The total instantaneous power generated by your roof solar panels (e.g. `4.8 kW`). At night, this naturally displays `0 W`. |
| **Battery** | • Emerald Green | Shows whether your home battery is **charging** (green arrow pointing down into the battery) or **discharging** (arrow pointing up to supply the home). Also displays the live battery percentage (State of Charge, e.g. `85%`). |
| **Grid** | • Cobalt Blue | Shows your interaction with the utility company. When importing electricity, arrows point inward toward your home. When exporting surplus solar, arrows point outward toward the street. |
| **Home (Load)** | • Teal Green | The total electricity being used by your household right now (kitchen appliances, lights, TV, computer, ventilation). |
| **EV Charger** | • Purple | Shows the power flowing into your electric vehicle (e.g. `7.4 kW`) and the current charging mode (e.g. `ECO` or `FAST`). Only visible when an EV charger is connected. |
| **Relay / Heating** | • Orange | Shows whether your smart water heater or heat pump is switched **ON** or **OFF**. Only visible when smart relays are configured. |

## What the Animated Flowing Bubbles Mean

The moving colored dots between the circles show the path electricity is taking:

- **Dots moving from Solar → Home:** Your house is running on 100% free sunshine!
- **Dots moving from Solar → Battery:** Extra solar power is being stored for tonight.
- **Dots moving from Solar → EV Charger:** Your electric car is charging directly from your roof for free.
- **Dots moving from Battery → Home:** In the evening, your battery is powering your appliances without taking costly power from the grid.
- **Dots moving from Grid → Home:** Solar and battery are currently not enough to cover your appliances; the difference is pulled from the utility grid.

# 3. Understanding Every Number on Your Screen

Across the top and sides of the dashboard, GEMS displays key performance indicators (KPIs). Here is what each number means and why it matters to your wallet:

| Dashboard Metric | Typical Value | Plain Language Meaning |
|---|---|---|
| **Solar Today (kWh)** | `15.4 kWh` | Total energy generated by your solar panels since midnight. High in summer, lower in winter. |
| **Grid Import Today (kWh)** | `3.2 kWh` | Electricity purchased from the utility grid today. The lower this number, the more money you saved! |
| **Grid Export Today (kWh)** | `8.6 kWh` | Surplus solar energy injected back into the grid for feed-in compensation. |
| **Self-Consumption (%)** | `78%` | **The efficiency badge:** Percentage of your solar production that was used directly in your home, stored in your battery, or put into your car, instead of exported to the grid. *Higher is better!* |
| **Self-Sufficiency (%)** | `92%` | **Your independence score:** Percentage of your total household consumption that was supplied by your own solar and battery. 100% means you relied zero on the grid today! |
| **Monthly Peak (Flanders)** | `2.50 kW` | The highest 15-minute rolling average grid import recorded this calendar month. GEMS automatically holds your grid draw below this line to keep your network capacity bill at the lowest possible minimum! |
| **Current Spot Price** | `0.124 €/kWh` | If you have a dynamic contract, this shows the exact wholesale electricity price for the current hour. |
| **Belgian Renewable Share** | `72.4% Renewable` | Live national wind + solar share on the Belgian grid via Elia. When this is green, national clean energy is abundant. |

# 4. Click-to-Reveal Historical Deep Dives

Every circle on the PowerFlow diagram is interactive! If you click on any circle, a detailed analytical modal opens instantly, revealing 24-hour charts, daily records, and technical breakdowns:

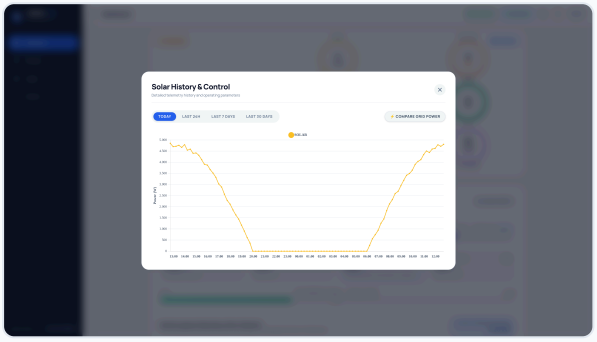



Figure 4.1: Solar Modal: Today's solar bell curve, peak production wattage, and curtailment events.

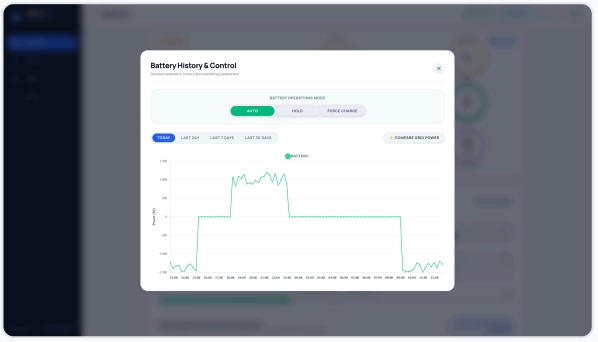



Figure 4.2: Battery Modal: 24-hour State-of-Charge (SOC %), charging speed, and energy stored.




Figure 4.3: Grid Modal: Import vs export balance and Flanders 15-minute capacity peak tracking.

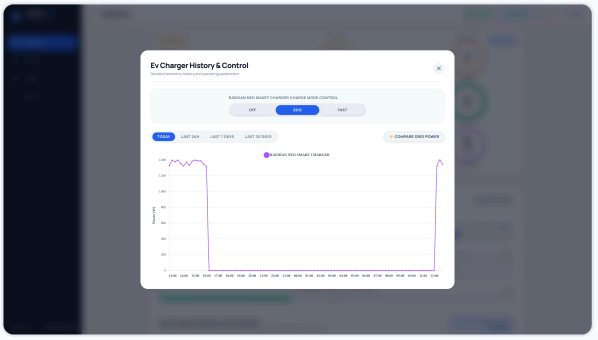



Figure 4.4: EV Charger Modal: Real-time charging setpoint, session energy added, and mode toggle.

# 5. Managing EV Charging Modes: When to Use Each

GEMS talks directly to your EV charger (using high-speed Modbus TCP or native OCPP). You can change your charging mode at any time with a single tap on the dashboard:

### 🚗 WHICH CHARGING MODE SHOULD YOU CHOOSE?

**1. ECO / Solar Only Mode**
**When to choose:** Sunny weekends, working from home, or whenever the car is parked for several hours.
**What GEMS does:** Charges strictly using excess solar production. If clouds roll in, charging throttles or pauses automatically. You get **100% free solar kilometers** without pulling costly electricity from the grid!

**2. FAST / Max Power Mode**
**When to choose:** You arrive home with an empty battery and need to leave again in 1 hour.
**What GEMS does:** Immediately supplies the maximum rated current your car and fuse box allow (e.g. 11 kW or 22 kW), drawing simultaneously from solar, battery, and grid.

**3. SMART Dynamic Mode**
**When to choose:** Cloudy winter days if you have a dynamic electricity contract.
**What GEMS does:** Automatically schedules charging during the 1 to 8 cheapest spot hours of the night (typically between 01:00 and 05:00) when electricity costs only a few cents.

**4. OFF / Paused Mode**
**When to choose:** The car is plugged in, but you do not want it to charge right now (e.g. reserving battery power for household dinner cooking).

### 💡 Why EV Charging Requires at Least 6 Amps

Under international automotive standards (IEC 61851), electric vehicles cannot charge at less than **6 Amps** per phase (approximately 1.4 kW on single-phase, or 4.1 kW on three-phase). In Solar-Only mode, GEMS waits until you have at least 1.4 kW of steady solar surplus before starting charging. If solar drops below this threshold for more than a few minutes, GEMS pauses charging cleanly to prevent drawing from the grid.

### 💳 Company Cars & Employer Split-Billing Compatibility

Do you drive a company car with an employer charge card or external billing subscription? GEMS connects to your charger via **Modbus TCP** on your home network. This means GEMS can optimize your charging speed and solar self-consumption **without disconnecting your employer's billing service**! Both run happily side-by-side.

# 6. Home Battery Storage & Peak Shaving

Your home battery (such as Huawei LUNA2000, BYD, or Victron) is your personal energy buffer. GEMS manages it automatically 24 hours a day based on three golden rules:

## 1. Day-to-Night Solar Buffering

During the day, your roof panels often generate more electricity than your refrigerator and lights need. Instead of dumping this power into the street for a tiny feed-in fee, GEMS pours every surplus watt into your home battery. In the evening, when the sun sets and your family turns on the oven, television, and lights, GEMS automatically discharges the battery to keep your grid meter at zero.

## 2. Peak Shaving: Protecting You from the Flanders Capacity Tariff

In Flanders, your grid network fees are determined by the **highest 15-minute average power** you draw from the grid each month (the *Capaciteitstarief*, with a minimum baseline of 2.50 kW). If you turn on the washing machine, tumble dryer, and kettle at the same time, your power demand might spike to 4.5 kW.

**How GEMS Protects You:** The millisecond your home demand rises toward your 2.50 kW ceiling, GEMS commands your home battery to discharge the difference (2.0 kW). The utility grid meter never sees the spike, keeping your monthly electricity bill at the absolute minimum baseline!

**Regional Note: The Flanders Capaciteitstarief applies strictly to Flemish grid connections. In Dutch installations, GEMS automatically hides capacity peak widgets and focuses battery strategy on Day-Ahead arbitrage and Smart Saldering.**

## 3. Smart Adaptive Ceiling: No Panic If a Peak Occurs

What happens if your battery happens to be empty on a dark winter day and an unavoidable spike reaches 4.2 kW?

In simple systems, the controller would keep strictly limiting you. But in GEMS, the **Smart Adaptive Ceiling** takes over:

- GEMS recognizes that because a 4.2 kW peak was already registered in the meter, the network operator will bill you for 4.2 kW for this calendar month anyway.
- GEMS **temporarily elevates its working ceiling to 4.2 kW for the rest of that month**!
- This allows you to charge your car faster and enjoy greater convenience without increasing your bill by a single euro!
- On midnight on the 1st of the next month, the ceiling automatically drops back down to 2.50 kW.

# 7. Dynamic Tariffs & Regional Optimization (Netherlands & Belgium)

If you have an hourly dynamic electricity contract, your price per kilowatt-hour changes every single hour according to the European EPEX Spot auction. GEMS automatically downloads tomorrow's hourly prices every afternoon at 13:00 CET.

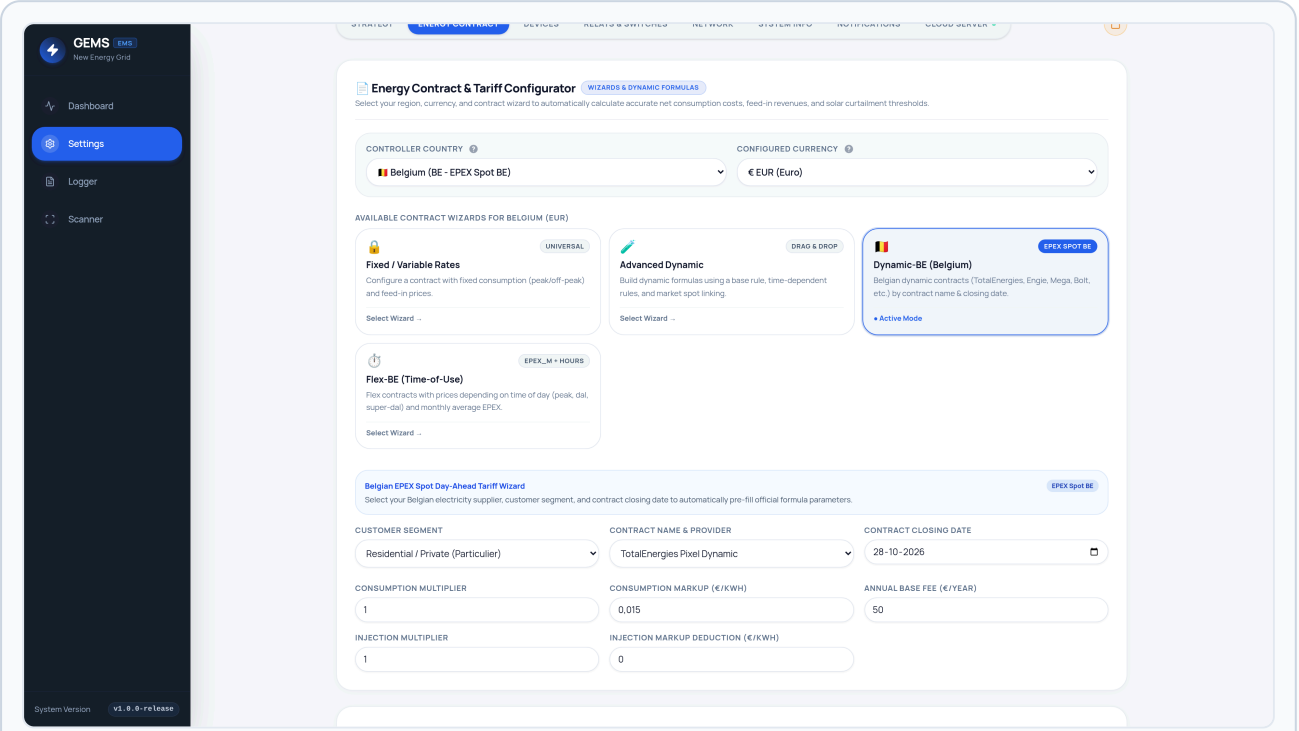



Figure 7.1: 24-Hour effective retail tariff breakdown curve showing hourly spot prices, network fees, and injection returns.

## Regional Optimization: Tailored for Your Country

GEMS features built-in regional intelligence that automatically tailors your dashboard and optimization engine to your exact country and energy contract:

### 🇳🇱 Netherlands (Dynamic-NL & Smart Saldering)

Supports Dutch dynamic contracts via the EPEX Spot NL bidding zone. Integrates Dutch Energiebelasting (€0.1316/kWh) and accounts for feed-in fees (*terugleverkosten*). Inverter curtailment protects you from feeding in during negative price hours. Belgian-specific widgets (Elia Green Energy Share and Flanders Capacity Tariff) are automatically suppressed.

### 🇧🇪 Belgium (Dynamic-BE & Capaciteitstarief)

Supports Belgian suppliers (TotalEnergies Pixel Dynamic, Mega, Bolt, Engie Dynamic, Dats 24, Eneco, Luminus) via the EPEX Spot BE bidding zone. Provides 15-minute rolling average Capaciteitstarief peak shaving, Flemish Groenestroomcertificaten (GSC) subsidy protection, and Elia Green Grid Sync Boost during peak renewable hours.

## What are Negative Electricity Prices?

On sunny, windy weekend afternoons, Europe's wind turbines and solar roofs often produce far more electricity than factories and homes are consuming. When this happens, wholesale electricity prices drop below zero: **the grid literally pays you to consume electricity!**

Conversely, if you export solar power to the grid during negative price hours, *you could be charged an injection penalty* (you pay the utility company to take your solar power!).

## The 4-Step GEMS Protection Strategy During Negative Hours

Whenever electricity prices drop below zero, GEMS automatically steps through a 4-tier financial defense:

1. **Tier 1 — Fill Your Home Battery:** GEMS directs all solar power to charge your home battery to 100%. If prices are deeply negative, GEMS even charges your battery from the grid, earning you money while charging!
2. **Tier 2 — Boost Your EV:** If your car is plugged in, GEMS switches to maximum charging speed to absorb the cheap or negative energy into your vehicle's large battery.
3. **Tier 3 — Heat Your Hot Water:** GEMS activates smart relays connected to your domestic water heater or heat pump buffer tank, storing the cheap energy as hot water for your evening shower.
4. **Tier 4 — Active Inverter Curtailment:** If your battery, car, and water tanks are all completely full and exporting would cause a financial loss, GEMS **throttles your solar inverter** down to match your exact home load, preventing a single cent of export penalties!

# 8. Flemish Groenestroomcertificaten (GSC) Subsidy Protection

Homeowners in Flanders with solar installations built before 2021 often receive guaranteed **Groenestroomcertificaten (GSC)** (green certificates) worth €90, €250, €350, or €450 for every 1,000 kWh of solar energy produced.

**💶 How GSC Value Protects You From Losing Money**

If your solar system receives **€250/certificaat (€0.250/kWh)** from Fluvius, you earn €0.250 for every kWh your panels generate, regardless of what happens on the grid.

If the wholesale market price drops to **-€0.10/kWh**, an unsmart system would panic and shut down your solar panels. But GEMS knows your GSC value! It calculates:

```
Net Return = GSC Subsidy (+€0.250) + Market Price (-€0.100) = +€0.150/kWh Net Profit!
```

Because you are still making a net profit of 15 cents per kWh, GEMS **keeps your solar panels producing at 100%**. Curtailment will only activate if the negative price drops below -€0.250/kWh (-250 €/MWh), guaranteeing you never miss a single euro of your hard-earned green subsidies!

# 9. Belgian Elia Green Grid Sync Boost

GEMS connects directly to the Belgian high-voltage transmission grid operator **Elia** via live Open Data feeds:

- GEMS tracks the real-time share of wind and solar electricity powering the Belgian national grid.
- When the national green share exceeds your configured threshold (e.g. **65% Renewable**), GEMS triggers the **Green Grid Sync Boost**.
- Your EV charger and battery will prioritize charging during these high-renewable windows, helping stabilize the national power grid while charging your car with genuinely green electricity!

# 10. Smart Relays & Heat Pump Automation

GEMS can control smart switches (like Shelly Pro or Shelly Plus contactors) to turn heavy electrical appliances on and off automatically based on your solar surplus or cheap dynamic hours:

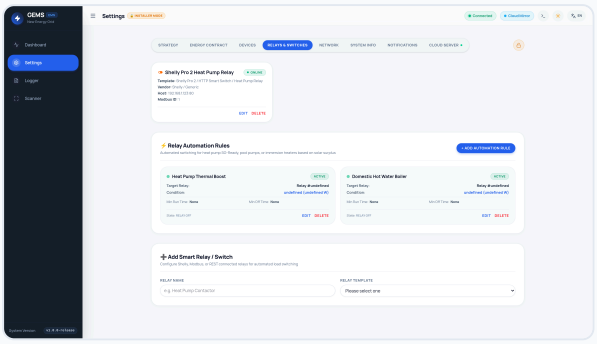


Figure 10.1: Configured relays and live ON / OFF status.

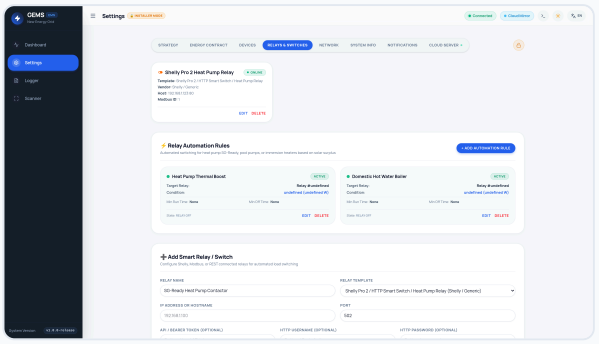


Figure 10.2: Excess solar and spot price automation rules.

## Typical Home Automation Setups

| Connected Appliance | Automatic Trigger Condition | Homeowner Benefit |
|---|---|---|
| **SG-Ready Heat Pump** | Excess solar > `1,200 Watts` for 10 minutes | Boosts the heat pump into thermal storage mode, pre-heating your living room or hot water tank for free. |
| **Electric Hot Water Boiler** | Dynamic price ≤ `0.02 €/kWh` or Solar > `1,500 W` | Stores 3,000 Watts of free or ultra-cheap heat in your hot water cylinder. |
| **Swimming Pool Filter Pump** | Daily solar surplus > `800 Watts` | Circulates your pool water only when the sun is shining, saving hundreds of euros per summer season. |

# 11. Energy Reports & Instant PDF Downloads

GEMS makes it effortless to review and share your home energy accomplishments:

## 1. One-Click Printable PDF Energy Reports (Daily, Weekly, Monthly & Yearly)

Right from your main dashboard, select your preferred reporting window (**Daily**, **Weekly**, **Monthly**, or **Yearly**) and click the **"Export PDF"** button. GEMS instantly generates a publication-quality, color-coded PDF energy summary covering:

- Total solar kilowatt-hours generated and peak wattage reached.
- Self-consumption and self-sufficiency percentages.
- Grid import vs. grid export balance.
- Total capacity peak recorded during the billing period.

## 2. Automated Sunday Evening Summary Email

If configured under **Settings** → **Notifications**, GEMS automatically emails you an executive summary every Sunday evening at 20:00, keeping you effortlessly informed about your home's energy performance.

# 12. Mobile Experience & Bottom Navigation

GEMS features an ergonomically designed responsive mobile interface that operates with native app fluidity on smartphones and wall-mounted tablets:

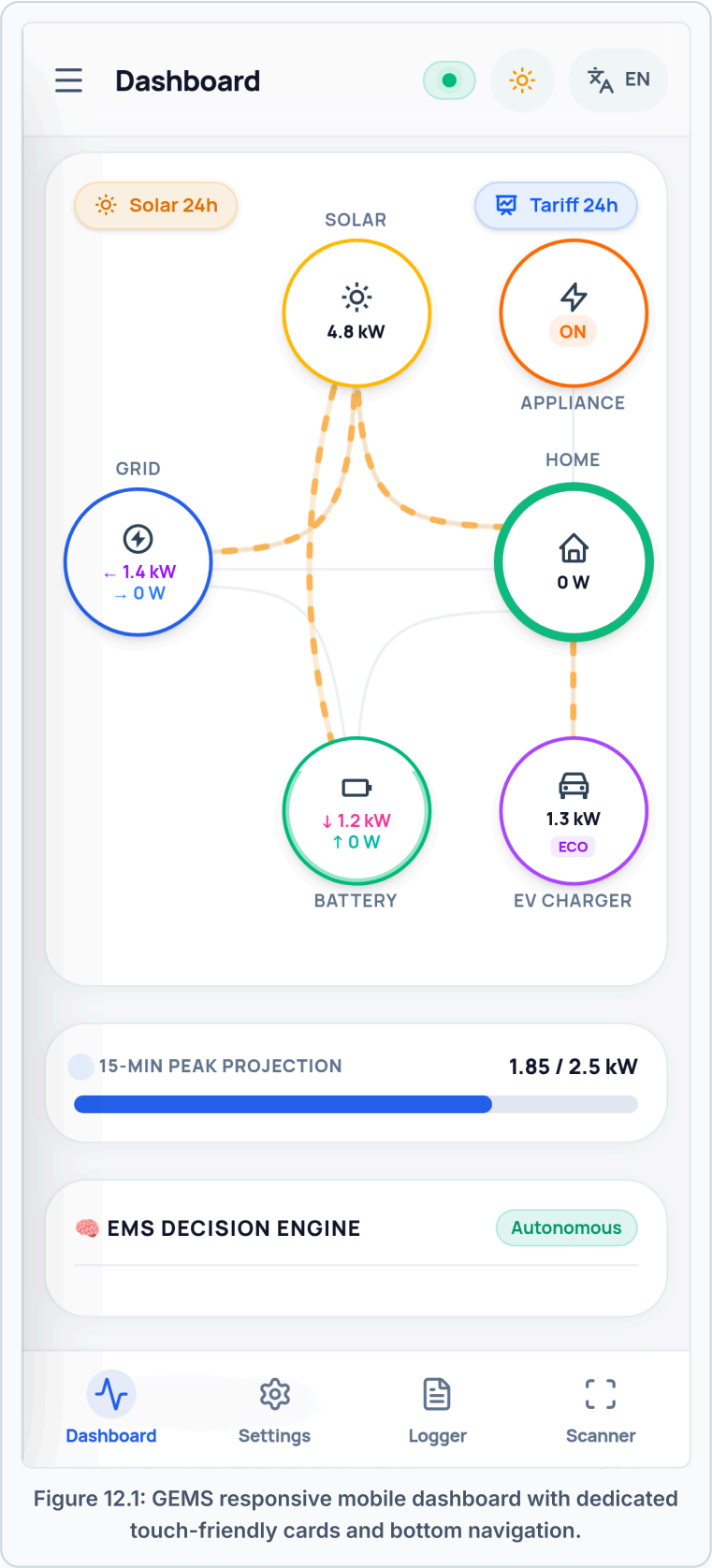



Figure 12.1: GEMS responsive mobile dashboard with dedicated touch-friendly cards and bottom navigation.

## Key Mobile Interface Features

- **Dedicated Mobile Dashboard:** A streamlined PowerFlow hero eliminating nested card borders, paired with four high-contrast summary tiles (Solar Production, Home Consumption, Net Grid, and Battery State).

- **Persistent Bottom Navigation Bar:** Easily switch between *Dashboard*, *Devices*, *Strategy*, and *Settings* with a single thumb-tap at the bottom of the screen.
- **Quick Strategy Switcher:** Instantly toggle between Eco, Flanders, or Netherlands optimization modes with one touch on the mobile dashboard.
- **Compact Responsive Topbar:** Status indicators and device connectivity adapt cleanly on narrow viewports without cluttering your screen.

> 📱 **How to Install GEMS on Your Phone Home Screen**
>
> 1. Connect your smartphone to your home Wi-Fi.
> 2. Open your web browser (Safari on iPhone, Chrome on Android) and type: `http://ems.local`
> 3. Tap the **Share button** (on iOS) or the **three dots menu** (on Android).
> 4. Select **"Add to Home Screen"**.
> 5. A GEMS icon will appear on your phone. Tapping it opens GEMS in full-screen mode without browser address bars!

# 13. Optional Cloud Remote Access (GRID-EMS-SERVER)

One of the greatest architectural strengths of GEMS is that **cloud connectivity is completely optional**:

- **100% Autonomous Edge Operation:** GEMS performs all smart solar diversion, battery balancing, EV charging, and tariff optimization entirely on your local Raspberry Pi. It never requires a cloud account or active internet connection to safeguard your home and minimize electricity costs.
- **Seamless Remote Capabilities (If Desired):** If you want to view your live energy dashboard from work, check charging status on vacation, or allow your certified installer to perform remote diagnostics, you can pair your unit to **GRID-EMS-SERVER** (`https://ems.newenergygrid.com`).

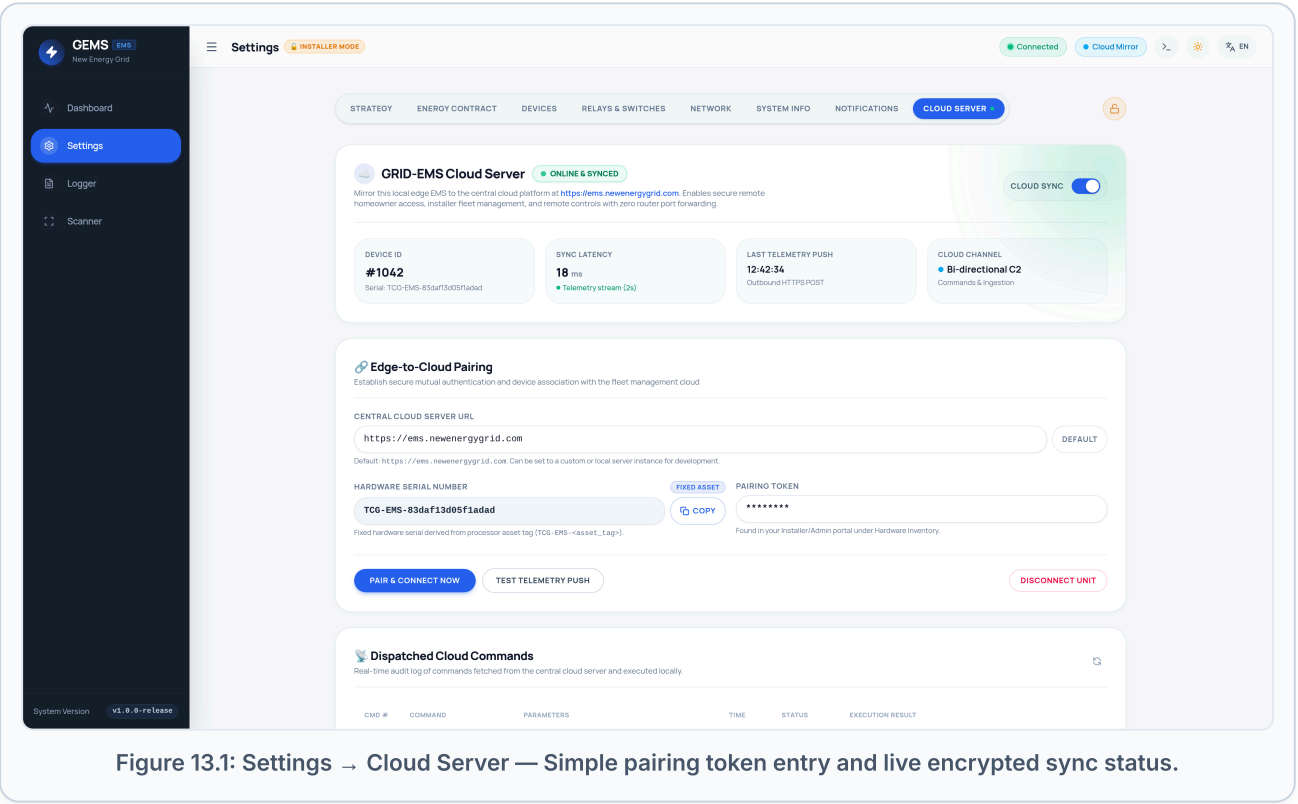



Figure 13.1: Settings → Cloud Server — Simple pairing token entry and live encrypted sync status.

## How to Connect (Pairing in 60 Seconds)

1. Log in to your GEMS local dashboard and navigate to **Settings → Cloud Server**.
2. Obtain your 16-character pairing token from your installer or your user account on `https://ems.newenergygrid.com`.
3. Paste the token into the **Pairing Token** field and click **Pair & Connect Now**.
4. Within seconds, the indicator turns to **● ONLINE & SYNCED**.

**🔒 Outbound-Only Security: Zero Port Forwarding**

Unlike traditional security cameras or home servers, GEMS connects outbound to GRID-EMS-SERVER over TLS 1.3 encryption. **You never need to open any ports or modify firewall rules on your home router.** Your home network remains 100% shielded from internet scanners.

# 14. Homeowner Frequently Asked Questions & Everyday Tips

## Q: What happens if our home internet goes down?

**Nothing stops working!** Because GEMS runs 100% locally on your Raspberry Pi microcomputer inside your electrical cabinet, solar self-consumption, battery peak shaving, and EV charging controls continue running normally. When internet is restored, GEMS simply fetches the newest Day-Ahead price forecast.

## Q: When does my Flanders capacity peak reset?

In Flanders, the *Capaciteitstarief* billing cycle is measured per calendar month. At midnight on the 1st of every month (00:00), GEMS automatically resets its peak counter and begins tracking the new month's baseline.

## Q: How can I access GEMS when I am away from home?

The simplest and official method is to link your unit to **GRID-EMS-SERVER** (see Section 13). Once paired, you can securely open `https://ems.newenergygrid.com` from any smartphone, tablet, or laptop worldwide. Alternatively, for local-only setups, you can access your unit via **Raspberry Pi Connect** or a private home VPN (such as WireGuard or Tailscale).

## Q: Why did my EV stop charging when the sun was still shining?

If your charger is set to **ECO / Solar Only** mode, your car requires at least 1.4 kW (single-phase) or 4.1 kW (three-phase) of continuous surplus. If heavy domestic appliances (such as an oven or washing machine) turned on, or if heavy clouds rolled in, GEMS temporarily paused your EV to prevent drawing costly power from the utility grid. Charging resumes as soon as solar surplus stabilizes!

## Q: Can I adjust settings myself without calling the installer?

Yes! Everyday settings—such as switching the interface language between **Nederlands (NL)**, **Français (FR)**, and **English (EN)**, changing your EV charging mode (Eco vs Fast), reviewing energy graphs, downloading PDF reports, or toggling smart relays—can be performed directly from the main dashboard at any time. Critical electrical parameters (such as main breaker ratings and hardware drivers) are safely protected behind **Installer Mode** so you can never accidentally misconfigure your electrical protection limits, while live safety banners immediately notify you on screen if a meter cable is unplugged or main fuse protection engages.