⚡ OFFICIAL HARDWARE COMPATIBILITY & DEVICE INTEGRATION MANUAL

GEMS Supported Hardware & Devices Reference

Exhaustive Technical Specification for All 140 Native Hardware Templates: Real-Time Telemetry Read Out, Writable Control Setpoints, Communication Protocols, and Closed-Loop Automation Capabilities.

SOFTWARE VERSION **v9.25.3-release (Official Tag)**	NATIVE TEMPLATES **140 Plug-and-Play Profiles**	HARDWARE CATEGORIES **5 Native Device Classes**
CONTROL LOOP CYCLE **1 Hz Sub-Second Closed-Loop**	TARGET ARCHITECTURE **Raspberry Pi (Debian/Linux)**	EXECUTION MODEL **100% Local-First / Zero Cloud**

Table of Contents & Device Count by Category

1. Solar & Hybrid Inverters	32 Devices	2. Battery Energy Storage (BESS)	13 Devices
3. EV Charging Stations & Wallboxes	53 Devices	4. Grid Smart Meters & Analyzers	36 Devices
5. Smart Relays & Load Actuators	6 Devices	Total Verified Native Profiles	140 Templates

⭐ **REFERENCE HARDWARE PREFERENCE DIRECTIVE**

Per system architecture standards, **RAEDIAN** is designated as the primary reference template for EV Charging Stations (NEO, NEX, and Gemini dual-socket series), and **Solis** is designated as the primary reference template for Hybrid Solar Inverters and Battery Energy Storage Systems (including S5/S6 Hybrid and Solis Retrofit series). Both vendors feature complete sub-second register control and active curtailment setpoints.

1. Executive Overview & Unified Hardware Abstraction Layer

GEMS (Grid Energy Management System) is an edge Energy Management System engineered specifically to execute on local Raspberry Pi hardware without reliance on external cloud servers. The entire system is **local-first**: all automated power balancing, solar surplus tracking, Flanders peak shaving, and main fuse protection algorithms run directly inside the local Go binary (`gems` daemon), querying connected hardware and recalculating setpoints every single second.

Commercial Support Tiers & Unified Hardware Interfaces

Every hardware driver in GEMS is classified into a commercial support tier (**Verified** for field-validated Tier-1 platforms displayed by default, **Experimental** accessible via the Installer Mode toggle, and **Monitor Only** for closed-protocol read-only telemetry) and implements standardized capability interfaces:

`DevicePoller` (Universal Base)

Implemented by all 140 templates. Standardizes `Connect()`, `Poll()`, `Status()`, and `Close()`. Standardizes real-time power (W), battery power (W), grid flow (W), total energy (kWh), and battery SOC (%).

`ChargeController` (EV Chargers)

Provides `SetChargeCurrent(amps float64)` (dynamic throttling from 6A to 32A in 1A steps) and `SetPhaseMode(phases int)` (automated switching between 1-phase and 3-phase charging modes).

`BatteryController` (Inverters & BESS)

Provides `ChargeBattery(powerW float64)` and `DischargeBattery(powerW float64)` for automated Day-Ahead EPEX spot price arbitrage and Flemish capacity tariff peak shaving.

`InverterController` (Solar Generation)

Provides `SetActivePowerLimit(powerW float64)` for automated solar curtailment during negative electricity spot market hours and Dutch zero-export regulatory compliance.

`RelayController` (Smart Switches)

Provides `SetState(on bool)` for automated potential-free contactor actuation, powering domestic hot water (DHW) immersion heaters and triggering SG-Ready heat pump boost states.

`PhasePoller` & `PhaseVoltagePoller`

Returns sub-second per-phase currents (I_{L1}, I_{L2}, I_{L3}) and voltages (V_{L1}, V_{L2}, V_{L3}) for dynamic phase balancing and main grid breaker protection.

`MeterPeakPoller` (Belgian Capacity Tariff)

Implemented by P1 smart meters. Reads the official 15-minute rolling average peak demand register (W) directly from Fluvius DSMR meters to enforce capacity tariff ceilings.

`MultiConnectorPoller` (Dual-Socket EVSE)

Implemented by dual-socket chargers (e.g. RAEDIAN Gemini). Manages independent telemetry, sessions, and charging currents across multiple physical charging ports simultaneously.

2. What GEMS Actually Does With Devices (Strategy Engine)

GEMS integrates disparate hardware from dozens of manufacturers into a cohesive, intelligent energy ecosystem. Below are the 9 automated closed-loop strategies executed every second by the local GEMS control engine:

1. 🌞 Eco Mode (100% Solar Self-Consumption)

Continuously computes instantaneous solar surplus ($P_{surplus} = P_{solar} - P_{house}$). Surpluses are routed sequentially: first charging the home battery, then modulating EV charge currents (6A–32A), and finally triggering hot water immersion heaters or heat pump SG-Ready boost states.

2. 🇧🇪 Flanders Capacity Tariff & Dynamic Ceiling

Monitors household demand every second and computes projected 15-minute rolling peak imports. When demand approaches the monthly ceiling, GEMS throttles EV charging to 6A or 0A, disengages non-critical relays, and commands battery discharge. Features an Adaptive Ceiling: if an unavoidable peak occurs (e.g. 4.8 kW from cooking), GEMS raises its operational ceiling to that level for the remainder of the month so the car charges faster at zero extra tariff cost.

3. 🇳🇱 Netherlands Zero-Export & Curtailment

Protects Dutch installations against grid export penalties and salderingsregeling phase-outs. GEMS commands solar inverters to reduce generation (`SetActivePowerLimit`) whenever export limits are exceeded and storage batteries are saturated.

4. 💶 Negative Spot Protection & Flemish GSC Shield

Protects homeowners with dynamic EPEX Day-Ahead energy tariffs from paying export penalties during negative electricity pricing. In Flanders, GEMS applies an automated GSC Subsidy Shield (e.g. €250/MWh): solar export remains active down to −€0.250/kWh, curtailing only if the market penalty strictly exceeds the value of the green certificate.

5. 🔋 EPEX Day-Ahead Dynamic Battery Arbitrage

Integrates 24-hour EPEX Spot Day-Ahead prices (updated daily at 14:00 CET) with Open-Meteo solar forecasts. Automatically commands the home battery to force-charge during negative/cheapest off-peak hours and discharge during evening peak price windows.

6. 🚗 Smart EV Charging (Cheapest Hours Boost)

Scans the 24-hour EPEX tariff curve to identify the N cheapest hours of the day. Automatically ramps EV charging to maximum power (16A/32A) during those hours, throttling down to 0A during expensive price peaks.

7. ⚡ Dynamic Phase Load Balancing & Fuse Protection

Continuously inspects individual phase currents (I_{L1}, I_{L2}, I_{L3}) against the main grid connection breaker limit (e.g. 25A, 32A, 40A, 63A). If any individual phase exceeds 90% of the breaker rating, GEMS instantly throttles the EV charger within milliseconds to prevent tripping the main fuse.

8. 🔌 Dynamic Phase Switching (1-Phase / 3-Phase)

EV charging requires a minimum current of 6A (1.4 kW on 1-phase; 4.1 kW on 3-phase). For supported chargers (e.g. RAEDIAN, go-e, Alfen, Mennekes, Peblar, Huawei), GEMS commands 1-phase mode during modest solar surplus (1.4 kW–4.1 kW) and automatically switches to 3-phase mode when surplus exceeds 4.2 kW.

9. 🚰 Thermal Storage & SG-Ready Heat Pump Boost

Actuates contactors and smart plugs for domestic hot water (DHW) boilers or triggers SG-Ready Heat Pump Operating State 3 (Boost Mode) during solar excess or negative price windows. Enforces strict minimum run-time and off-time hysteresis to safeguard heat pump compressors against short-cycling.

🔒 Local Fail-Safe Watchdogs

All writable setpoints (EV current, inverter power limits, battery discharge) feature built-in hardware watchdog timeouts. If communication is lost, devices automatically revert to safe autonomous default modes.

3. Hardware Summary Matrix by Category

The tables below provide a quick-reference overview of all 140 native templates supported in GEMS across each category:

☀️ 1. Solar & Hybrid Inverters (32 Devices)

Inverter templates interface via Modbus TCP (SunSpec or vendor-specific registers) or local HTTP REST APIs. They continuously report photovoltaic (PV) generation, battery charge/discharge wattage, state of charge (SOC %), and grid flow. Advanced units support real-time active power curtailment for negative spot price protection and battery force-charge/discharge commands for day-ahead spot arbitrage.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
Afore Hybrid Inverter Afore	`afore_inverter`	**MODBUS** Modbus TCP via Ethernet / Wi-Fi dongle (Default Port: 502	Real-time solar PV generation (W), Battery charge/discharge power (W), Grid import/export power (W), Cumulative solar production (kWh), Battery State of Charge (SOC %), 3-Phase inverter output currents (L1, L2, L3 in Amps).	Read-only telemetry poller (Inverter operates autonomously under internal self-consumption rules).	Telemetry ingestion into GEMS real-time flow chart; monitors PV generation and battery SOC for site-wide self-consumption calculation; uses grid import/export metrics to guide EV charging current setpoints and domestic load balancing.
Alpha ESS Storion SMILE Alpha ESS	`alpha_ess_inverter`	**NETWORK TCP** Modbus TCP via local network dongle (Default Port: 502 or 8502	Solar PV active power (W), Battery charging/discharging power (W), Net grid import/export (W), Cumulative energy (kWh), Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps).	Read-only telemetry poller (internal Alpha ESS EMS manages battery charging cycles).	Streams real-time solar generation and battery status to the interactive dashboard; coordinates with external EV chargers to throttle charging speed when home battery is low or household demand spikes.
Anker SOLIX X1 Hybrid Inverter Anker	`anker_inverter`	**MODBUS** Modbus TCP (Default Port: 502	Solar PV power (W), Battery flow (W), Grid exchange power (W), Total lifetime energy (kWh), Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only telemetry integration.	Provides full 3-phase electrical telemetry (currents & voltages) to detect phase imbalance; feeds real-time PV generation and battery SOC into GEMS for dynamic EV surplus charging and Flanders peak forecasting.
Deye / Sunsynk Hybrid Inverter Deye	`deye_inverter`	**MODBUS** Modbus TCP via Ethernet LAN or Solarman/Deye Wi-Fi logger (Default Port: 502 or 8899	Solar PV production (W), Battery charge/discharge power (W), Grid meter power (W), Lifetime energy (kWh), Battery SOC (%), 3-Phase inverter currents (L1, L2, L3 in Amps).	Read-only telemetry poller.	Displays instantaneous solar and battery flow on dashboard; provides grid import/export signals to modulate connected EV chargers and smart relays; tracks battery SOC to prevent grid draw during high-price hours.
Enerlution Hybrid Inverter Enerlution	`enerlution_inverter`	**MODBUS** Modbus TCP (Default Port: 502	Solar PV power (W), Battery power (W), Grid power (W), Cumulative energy (kWh), Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps).	Active Power Curtailment Limit (W or % via Modbus registers 40400/40441).	Full active curtailment integration: automatically reduces inverter power output during negative EPEX Day-Ahead spot price hours (Netherlands Mode / Zero-Export) while respecting Flemish GSC subsidy offsets; manages solar surplus routing into battery and EV.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
Enphase IQ Gateway / Envoy Enphase	`enphase_envoy`	**REST / HTTP** Local HTTP REST API via token/digest authentication (Default Port: 80 / 443	Microinverter aggregated solar PV generation (W), IQ Battery charge/discharge wattage (W), Net grid import/export (W), Total lifetime generation (kWh), Battery SOC (%), Per-phase currents and voltages.	Read-only local REST polling.	Integrates Enphase microinverter systems and IQ batteries into GEMS; monitors real-time solar generation at sub-second speeds for zero-cloud solar tracking; optimizes external EV charging setpoints based on Enphase net production.
FoxESS H1 / H3 / H3-Pro Hybrid Inverter FoxESS	`foxess_inverter`	**MODBUS** Modbus TCP via LAN or RS485 Ethernet converter (Default Port: 502	Solar PV generation (W), Battery power (W), Grid active power (W), Total energy (kWh), Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps).	Read-only telemetry integration.	Provides real-time battery and PV telemetry; triggers smart relay boiler boosts when FoxESS exports exceed user thresholds; coordinates with GEMS Flanders capacity tariff engine to prevent grid peak spikes.
Fronius Gen24 Inverter Fronius	`fronius_inverter`	**MODBUS** Modbus TCP via SunSpec protocol (Default Port: 502	Solar PV generation (W), Battery charge/discharge wattage (W), Grid power flow (W), Cumulative energy (kWh), BYD / Fronius Battery SOC (%).	SunSpec read-only telemetry poller.	Reads Fronius SunSpec standard model registers; visualizes real-time power distribution; synchronizes with Fronius Wattpilot or external chargers for automated Eco solar surplus EV charging.
GoodWe Inverter GoodWe	`goodwe_inverter`	**MODBUS** Modbus TCP / UDP via LAN or Wi-Fi+LAN kit (Default Port: 502 or 8899	Solar PV power (W), Battery charge/discharge power (W), Net grid flow (W), Lifetime energy (kWh), Battery SOC (%).	Read-only telemetry poller.	Monitors hybrid power exchange; displays battery SOC and solar generation; informs the GEMS strategy engine on available surplus to ramp up EV chargers from 6A to 32A.
Growatt Inverter Growatt	`growatt_inverter`	**MODBUS** Modbus TCP via ShineLAN-X Ethernet dongle (Default Port: 502	Solar PV active power (W), Battery power (W), Grid feed-in/consumption (W), Cumulative kWh, Battery SOC (%).	Read-only telemetry poller.	Ingests high-frequency solar and battery telemetry; enables automated domestic self-consumption prioritization; prevents grid export overshoots in capacity-constrained networks.
Huawei Hybrid Inverter Huawei	`huawei_inverter`	**MODBUS** Modbus TCP via SDongleA-05 (Ethernet/WLAN) or SmartLogger3000 (Default Port: 502	Active solar PV generation (W, reg 32080), LUNA2000 Battery charge/discharge power (W, reg 37001), Grid import/export power via DTSU666-H (W, reg 37113), Cumulative generation (kWh, reg 32106), Battery SOC (%, reg 37004).	Forced Battery Charge / Discharge Power Setpoint (W, reg 40118/40120), Active Power Curtailment Limit (W or % of rated power, reg 40118/40125).	Full bidirectional battery and curtailment control: commands LUNA2000 to discharge during household peak spikes (Flanders capacity peak shaving); commands grid force-charging during negative/cheap EPEX spot hours; curtails active PV output during negative export prices or zero-export mandates.
LG ESS Home (8 / 10 / 15) LG	`lg_ess`	**REST / HTTP** Local HTTP REST API (Default Port: 80 / 443	Solar PV production (W), Battery power flow (W), Grid import/export (W), Cumulative energy (kWh), Battery SOC (%).	Read-only local REST telemetry.	Streams local LG ESS metrics without cloud latency; feeds live battery SOC into GEMS; guides EV charging and relay automation according to solar availability.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
Marstek Venus / Jupiter Storage Marstek	`marstek_storage`	**MODBUS** Modbus TCP (Default Port: 502	Solar PV power (W), Battery charge/discharge power (W), Grid exchange power (W), Total energy (kWh), Battery SOC (%).	Read-only telemetry poller.	Monitors residential AC-coupled and hybrid storage; enables homeowners to visualize battery cycles; provides real-time state for surplus energy management.
SAJ eSolar (H1 / H2 / R5 / R6 Hybrid Inverter) SAJ	`saj_hybrid`	**MODBUS** Modbus TCP (Default Port: 502	Solar PV generation (W), Battery power (W), Grid active power (W), Total energy (kWh), Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps).	Read-only telemetry poller.	Provides 3-phase currents and solar metrics; coordinates domestic loads to absorb SAJ solar generation; logs production history to SQLite.
SMA Sunny Boy / Tripower / Storage Inverter SMA	`sma_inverter`	**MODBUS** Modbus TCP via Speedwire / SunSpec (Default Port: 502	Solar PV generation (W, reg 30775), Battery charge/discharge power (W, reg 31393), Grid active power (W, reg 30865), Total energy (kWh, reg 30513), Battery SOC (%, reg 30845), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Active Power Curtailment Limit (W or % via Speedwire/SunSpec register 40016 / 40023).	Full active curtailment support: throttles SMA active generation when negative export pricing triggers; provides comprehensive 3-phase electrical telemetry for fuse overload detection and phase balancing.
Senergy (SE Series / Hybrid Inverter) Senergy	`senergy_inverter`	**MODBUS** Modbus TCP (Default Port: 502	Solar PV active power (W), Battery charge/discharge power (W), Grid exchange (W), Cumulative energy (kWh), Battery SOC (%).	Read-only telemetry poller.	Integrates Senergy hybrid systems; surfaces real-time generation on the dashboard; balances home consumption to minimize grid import.
Sigenergy SigenStor (Hybrid Inverter & Storage) Sigenergy	`sigenergy_hybrid`	**MODBUS** Modbus TCP via Sigen Gateway / Inverter (Default Port: 502	Solar PV power (W), Sigen Battery flow (W), Grid exchange power (W), Total energy (kWh), Sigen Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps).	Read-only telemetry poller (autonomous SigenStor AI system).	Reads high-precision telemetry across all 3 phases; displays 5-in-1 energy flows; integrates with GEMS site-wide strategy to coordinate external third-party EV chargers and relays.
SofarSolar (HYD / G3 / AMASS Hybrid Inverter) SofarSolar	`sofarsolar_hybrid`	**MODBUS** Modbus TCP via Ethernet/Wi-Fi stick (Default Port: 8899 or 502	Solar PV power (W), Battery charge/discharge power (W), Grid power flow (W), Lifetime energy (kWh), Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps).	Read-only telemetry poller.	Collects 3-phase currents and battery SOC; feeds data into the GEMS control loop to orchestrate EV charging speeds and SG-ready heat pump activation.
SolaX Inverter SolaX	`solax_inverter`	**MODBUS** Modbus TCP via Pocket LAN or Pocket Wi-Fi (Default Port: 502	Solar PV active power (W), Battery power (W), Grid active power (W), Total energy (kWh), Battery SOC (%).	Read-only telemetry poller.	Streams real-time solar generation and battery status; enables solar-only EV charging modes; monitors battery reserve levels.
SolarEdge 3-Phase Inverter SolarEdge	`solaredge_3phase`	**MODBUS** Modbus TCP via SunSpec protocol (Default Port: 1502 or 502	Solar PV generation (W), Battery charge/discharge power (W), Grid meter power (W), Total energy (kWh), Connected Energy Bank SOC (%).	SunSpec read-only telemetry poller.	Reads standard SunSpec Modbus registers on port 1502; calculates instant solar surplus across 3 phases; coordinates with chargers to balance load across L1, L2, L3.
SolarEdge Inverter SolarEdge	`solaredge_inverter`	**MODBUS** Modbus TCP via SunSpec protocol (Default Port: 1502 or 502	Solar PV generation (W), Battery charge/discharge power (W), Grid active power (W), Total energy (kWh), Battery SOC (%).	SunSpec read-only telemetry poller.	Captures 1-phase solar and battery telemetry; updates interactive dashboard; guides dynamic solar surplus redirection into hot water or EV charging.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
Solis Hybrid & Retrofit Inverters (Primary Reference) Solis ⭐ Reference	`solis_hybrid`	MODBUS Modbus TCP via direct internal Ethernet / Ginlong Wi-Fi/LAN stick (Default Port: 502 or 8899	Solar PV Active Generation Power (W, reg 33079), Battery Charge/Discharge Power (W, reg 33149), Battery SOC (%, reg 33139), Grid Meter Active Power (W, reg 33130), Total Cumulative Energy Yield (kWh, reg 33029), 3-Phase AC Currents (0.1A, regs 33073-33075), 3-Phase Voltages (0.1V, regs 33076-33078).	Active Power Curtailment Mode and Limit (W / % via holding registers 3051/3052), Forced Battery Charging & Discharging Setpoint (W via registers 43110/43135/43136).	Designated primary reference platform for hybrid solar and battery energy storage. Executes sub-second closed-loop active power curtailment during negative spot price hours (Netherlands Mode / Zero-Export), manages automatic solar surplus sinking into battery storage, dynamically throttles charging during Flanders capacity tariff peak shaving, and orchestrates spot market arbitrage (EPEX Day-Ahead price force charging and peak discharging). Solis Retrofit models operate seamlessly as AC-coupled storage units with dedicated battery control and zero solar PV string dependency.
Sungrow Inverter Sungrow	`sungrow_inverter`	MODBUS Modbus TCP via direct internal LAN RJ45 port (Default Port: 502	Solar PV generation (W, reg 5016), Battery charge/discharge power (W, reg 13021), Grid exchange power (W, reg 13009), Cumulative generation (kWh, reg 5003), SBR Battery SOC (%, reg 13022).	Read-only telemetry poller.	High-speed 1-second telemetry polling via internal LAN port; animates real-time power flow; provides baseline data for Flanders capacity tariff peak prediction.
Victron Inverter/GX Victron	`victron_inverter`	MODBUS Modbus TCP via Venus OS (Default Port: 502	Solar PV DC/AC power (W, reg 811), Battery charge/discharge power (W, reg 842), Net AC grid import/export (W, reg 820), Total energy (kWh), Battery SOC (%, reg 843).	Read-only telemetry poller (Venus OS handles ESS battery regulation).	Deep integration with Victron Venus OS: reads consolidated system telemetry from Cerbo GX; tracks battery SOC and grid power to orchestrate external EV chargers and heat pump relays.
ABB / Fimer Solar & Hybrid Inverter ABB / Fimer	`abb_fimer_inverter`	MODBUS Modbus SunSpec over TCP/RTU (Default Port: 502	Solar PV Active Power (W, SunSpec standard register 40083), Battery State of Charge (SOC %), Battery Charge / Discharge Power (W), Grid Feed-in Power (W), Cumulative Generation Energy (kWh).	Autonomous / Read-Only telemetry poller (inverter self-manages domestic self-consumption).	Monitors real-time solar generation and battery state over SunSpec Modbus; drives the interactive live dashboard and guides EV charging throttling and peak shaving.
Autarco Solar Inverter Autarco	`autarco_inverter`	NETWORK TCP Modbus TCP via local network dongle/gateway (Default Port: 502	Solar PV Active Power (W), Total Daily & Lifetime Generation (kWh), Grid AC Voltage (V), AC Frequency (Hz).	Autonomous / Read-Only telemetry poller.	Integrates real-time solar PV generation into the site energy balance, feeding solar excess automation for EV chargers and domestic heat pumps.
Chisage ESS Hybrid Inverter Chisage ESS	`chisage_ess`	MODBUS Modbus TCP / RTU via RS485 Ethernet Gateway (Default Port: 502	Solar PV Active Power (W), Battery Charge / Discharge Power (W), Battery SOC (%), Grid Import / Export Power (W), Cumulative Inverter Energy (kWh).	Monitor-Only (Read-Only Telemetry — closed register control map).	Integrates commercial, industrial, and residential Chisage ESS hybrid solar and battery telemetry into GEMS site load balancing.

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Delta Electronics Solar Inverter Delta Electronics	`delta_inverter`	**MODBUS** Modbus SunSpec over TCP (Default Port: 502	Solar PV Generation Power (W), DC String Voltages and Currents, Cumulative Generation (kWh), Grid AC Power (W).	Autonomous / Read-Only telemetry poller.	Reads standardized SunSpec solar generation telemetry to optimize self-consumption and prevent capacity tariff overshoots.
HYXiPOWER Hybrid Inverter HYXiPOWER	`hyxipower_inverter`	**MODBUS** Modbus TCP via Wi-Fi/Ethernet dongle (Default Port: 502	Solar PV Generation (W), Battery Charge / Discharge Power (W), Battery SOC (%), Grid Exchange (W), Cumulative Energy (kWh).	Autonomous / Read-Only telemetry poller.	Streams PV production and battery storage metrics to the GEMS flow chart and telemetry pipeline.
KSTAR BluE Hybrid Inverter KSTAR	`kstar_inverter`	**MODBUS** Modbus RTU / TCP via RS485 Ethernet converter (Default Port: 502	Solar PV Active Power (W), Battery Charge / Discharge Power (W), Battery SOC (%), Grid Power Flow (W), Phase Currents (L1, L2, L3 in Amps).	Autonomous / Read-Only telemetry poller.	Feeds hybrid solar and battery metrics into the GEMS load balancer and multi-tariff cost optimization engine.
Solinteg Integ M Hybrid Inverter Solinteg	`solinteg_inverter`	**MODBUS** Modbus RTU / TCP via LAN/Wi-Fi stick (Default Port: 502	Solar PV Active Power (W), Battery Charge / Discharge Power (W), Battery SOC (%), Grid Net Exchange Power (W), Cumulative Generation (kWh).	Monitor-Only (Read-Only Telemetry — closed register control map).	Streams Solinteg Integ M hybrid solar and battery telemetry into GEMS live load balancing.
Solplanet / AISWEI Inverter Solplanet (AISWEI)	`solplanet_inverter`	**MODBUS** Modbus RTU / TCP via Ethernet/Wi-Fi Ai-Dongle (Default Port: 502	Solar PV Active Power (W), Total Yield Energy (kWh), AC Voltage and Current per phase, Grid Import/Export (W).	Autonomous / Read-Only telemetry poller.	Continuous solar generation telemetry streaming to the live dashboard and smart relay triggers.

🔋 2. Dedicated Battery Energy Storage Systems (BESS) (13 Devices)

Dedicated BESS integrations interface directly with stationary battery controllers and BMS gateways over Modbus TCP or local LAN APIs. They provide deep pack telemetry (SOC %, voltage, cell temperature, power flow) and support dynamic power limits, scheduled force-charging during cheap/negative hours, and autonomous peak shaving for commercial and residential tariffs.

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Siemens Junelight Smart Battery Siemens	`siemens_junelight`	**MODBUS** Modbus TCP (Default Port: 502	Battery charge/discharge power (W), Battery State of Charge (SOC %), Net grid power flow (W), Internal battery status.	Read-only telemetry poller.	Displays Junelight battery storage on the dashboard node; monitors SOC and power flow to optimize solar self-consumption and prevent high grid imports.
Solarwatt (EnergyManager / MyReserve Matrix) Solarwatt	`solarwatt_storage`	**REST / HTTP** Local HTTP REST API (Default Port: 80	Battery power flow (W), Battery SOC (%), Solar generation (W), Grid exchange (W), Cumulative energy (kWh).	Read-only REST telemetry.	Local zero-cloud polling of Solarwatt EnergyManager; tracks battery storage metrics; dynamically modulates EV charging speeds based on remaining battery capacity.
sonnenBatterie (eco 6 / 8 / 10 / hybrid) Sonnen	`sonnen_batterie`	**REST / HTTP** Local HTTP REST API v1/v2 (Default Port: 80	Battery charge/discharge wattage (W), Battery SOC (%), Solar PV production (W), Grid feed-in / consumption (W).	Force Charge / Discharge Power Setpoints via Sonnen Local REST API v2 (when API Auth Token is configured).	Polls sonnen local REST API v2 every 1 second; visualizes sonnen storage node on the live flow chart and executes peak shaving and spot-price arbitrage when authorized.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
Duracell Energy Residential Storage Duracell Energy	`duracell_energy`	**MODBUS** Modbus RTU / TCP via Gateway (Default Port: 502	Battery Charge / Discharge Power (W), Battery State of Charge (SOC %), Grid Power Flow (W), Inverter AC Power (W).	Monitor-Only (Read-Only Telemetry).	Monitors Duracell residential battery SOC and power exchange for site load balancing and EV solar surplus routing.
Dyness Battery Storage System Dyness	`dyness_battery`	**MODBUS** Modbus RTU / TCP via Gateway / Inverter BMS Port (Default Port: 502	Battery Charge / Discharge Power (W), Battery State of Charge (SOC %), Total Pack Voltage (V), Current (A), Cell Temperatures (°C).	Monitor-Only (Read-Only Telemetry).	Integrates low-voltage and high-voltage Dyness battery bank BMS telemetry directly into the live flow chart and dashboard.
Elecnova Commercial & Industrial BESS Elecnova	`elecnova_bess`	**MODBUS** Modbus TCP via Industrial Gateway (Default Port: 502	Battery Active Power (W), Battery State of Charge (SOC %), Grid Exchange Power (W), Cumulative In / Out Energy (kWh).	Monitor-Only (Read-Only Telemetry).	Monitors commercial BESS power flow, state of charge, and cumulative energy on the live dashboard.
Goneo Residential Storage System Goneo	`goneo_storage`	**MODBUS** Modbus TCP / RTU via Wi-Fi/Ethernet Module (Default Port: 502	Battery Charge / Discharge Power (W), Battery SOC (%), Grid Power Flow (W), Total Energy (kWh).	Monitor-Only (Read-Only Telemetry).	Monitors residential battery storage SOC and power exchange for coordinated EV and relay load balancing.
Mastervolt MLI Ultra / Combi CZone Mastervolt	`mastervolt_storage`	**MODBUS** Modbus RTU / TCP via CZone Bridge / MasterBus gateway (Default Port: 502	Battery Power (W), Battery SOC (%), Inverter AC Output Power (W), DC Bus Voltage (V), Battery Current (A).	Monitor-Only (Read-Only Telemetry).	Provides off-grid, marine, and residential Mastervolt / CZone battery system telemetry monitoring.
Power Sonic C&I Energy Storage Power Sonic	`powersonic_bess`	**MODBUS** Modbus TCP via BMS/PCS Controller (Default Port: 502	Battery Active Power (W), Battery State of Charge (SOC %), Grid Power Flow (W), Fault Status Registers.	Monitor-Only (Read-Only Telemetry).	Monitors commercial BESS power flow and state of charge on the live GEMS dashboard.
Poweroad Residential & C&I Storage Poweroad	`poweroad_storage`	**MODBUS** Modbus RTU / TCP via Gateway (Default Port: 502	Battery Power (W), Battery State of Charge (SOC %), Grid Flow (W), Cumulative In / Out Energy (kWh).	Monitor-Only (Read-Only Telemetry).	Monitors residential and light-commercial Poweroad battery storage telemetry.
Pylontech Battery Storage (US / Force) Pylontech	`pylontech_storage`	**MODBUS** Modbus RTU / TCP via Inverter Gateway or SC0500/SC1000 controller (Default Port: 502	Battery Charge / Discharge Power (W), State of Charge (SOC %), Pack Voltage (V), Pack Current (A), SOH (%).	Monitor-Only (Read-Only Telemetry).	Reads direct Pylontech BMS status and telemetry into GEMS to accurately reflect battery storage levels on the hero flow chart.
Socomec SUNSYS C-System / HES BESS Socomec	`socomec_bess`	**MODBUS** Modbus TCP via Diris Digiware / BESS Controller (Default Port: 502	Battery Active Power (W), Battery SOC (%), Grid Active Power Flow (W), Cumulative Energy (kWh).	Monitor-Only (Read-Only Telemetry).	Monitors industrial Socomec SUNSYS BESS active power, SOC, and energy counters.
Sunwoda AtSmart Energy Storage Sunwoda Energy	`sunwoda_energy`	**MODBUS** Modbus TCP via BMS Communication Hub (Default Port: 502	Battery Charge / Discharge Power (W), Battery State of Charge (SOC %), Grid Power Flow (W), Temperature (°C).	Monitor-Only (Read-Only Telemetry).	Monitors Sunwoda battery state of charge and power exchange on the live GEMS dashboard.

⚡ 3. EV Charging Stations & Wallboxes (53 Devices)

EVSE integrations communicate via native local OCPP 1.6-J over WebSockets, high-speed Modbus TCP/RTU, or local REST APIs. They receive dynamic charge current setpoints (throttling 6A to 32A) calculated every second by the GEMS control loop. Supported multi-contactor units also feature opt-in 1-phase to 3-phase switching with a mandatory 20-second anti-welding cooldown.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
ABB Charger ABB	`abb_charger`	**MODBUS** Modbus TCP via Ethernet / Wi-Fi (Default Port: 502	Active charging power (W, reg 0x401C), Cumulative session energy (kWh, reg 0x401E).	Dynamic Charging Current Throttling (Amps, reg 0x4100, 6A to 32A in 1mA steps).	Sub-second current throttling over Modbus TCP: dynamically modulates charging current based on solar surplus (Eco mode) and throttles down immediately during capacity peaks (Flanders mode); coexists seamlessly with third-party billing/reimbursement backends.
ABL eM4 Single/Twin (SBCx) ABL	`abl_em4_charger`	**MODBUS** Modbus TCP (Default Port: 502	Active charging power (W, reg 0x300D), Total energy (kWh, reg 0x300F).	Dynamic Charging Current Throttling (Amps, reg 0x3001, 6A to 32A).	Direct Modbus control: throttles single or dual socket charging currents to match rooftop solar surplus and Flanders capacity limits without disconnecting corporate billing.
ABL eMH1 / eMH2 / eMH3 ABL	`abl_emh_charger`	**MODBUS** Modbus RTU over TCP Bridge (Default Port: 502	Real-time charging power (W), Session energy (kWh).	Charging Current Throttling (Amps, 6A to 32A).	Integrates legacy and modern ABL eMH chargers; provides automated solar-following charging and peak shaving.
AUTEL AC MaxiCharger AUTEL	`autel_charger`	**OCPP 1.6-J** Native OCPP 1.6-J WebSocket Server (Port: 8887	Real-time charging power (W), Session energy (kWh), Vehicle connection state, 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Dynamic Current Throttling via SetChargingProfile (6A to 32A), Phase Switching (1P / 3P).	Autonomous residential charging over native OCPP: adjusts charging speed to solar excess and halts charging during peak tariff periods.
Alfen Charger Alfen	`alfen_charger`	**MODBUS** Modbus TCP / Active Load Balancing license (Default Port: 502	Active charging power (W), Total energy (kWh), Per-phase charging currents (Amps).	Dynamic Charging Current Setpoint (Amps, 6A to 32A in 0.1A steps), Phase Switching (1P / 3P).	Preferred Modbus TCP integration: sub-second throttling for Flemish capacity tariff compliance and 100% solar surplus charging; allows employer CPO billing backends to operate concurrently over OCPP without interference.
Alpitronic Hypercharger Alpitronic	`alpitronic_charger`	**OCPP 1.6-J** Modbus TCP / OCPP 1.6-J (Default Port: 502 or 8887	Active DC charging power (kW/W), Cumulative delivered energy (kWh), Connector status.	Dynamic Charging Power Limit (kW / Amps setpoints).	Dynamically limits DC fast charging output to stay strictly below site grid connection capacity and Flemish peak limits during high-demand periods.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
BMW i Wallbox (Connect/Pro) BMW	`bmw_charger`	**MODBUS** Modbus TCP via LAN (Default Port: 502	Charging power (W), Session energy (kWh).	Dynamic Current Setpoint (Amps, 6A to 32A).	Local LAN current regulation; coordinates charging with home solar availability and off-peak EPEX price hours.
Bender Charger Bender	`bender_charger`	**MODBUS** Modbus TCP (Default Port: 502	Active charging power (W), Session energy (kWh), Pilot state.	Dynamic Charging Current Setpoint (Amps, 6A to 32A).	Direct Modbus control over the Bender charge controller; instantaneous load throttling to protect home fuses and match PV production.
Blitzpower / Phoenix CharX Blitzpower	`blitzpower_charger`	**MODBUS** Modbus TCP (Default Port: 502	Charging power (W), Cumulative energy (kWh).	Charging Current Throttling (Amps, 6A to 32A).	Fast Modbus register regulation: modulates current setpoints for solar surplus charging and peak shaving.
Delta AC MAX / SLIM / Ultra Fast Charger Delta	`delta_charger`	**MODBUS** Modbus TCP (Default Port: 502	Active charging power (W), Total energy (kWh).	Charging Current Setpoint (Amps, 6A to 32A).	Modulates Delta wallbox current setpoint via Modbus TCP; optimizes charging speed to absorb solar production without importing expensive grid power.
EN+ AC EV Charger EN+	`enplus_charger`	**OCPP 1.6-J** Native OCPP 1.6-J WebSocket Server (Port: 8887)	Charging power (W), Energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages.	Charging Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).	Autonomous solar tracking and peak shaving via OCPP SetChargingProfile commands.
ETEK EKEPC2-C/S Charge Controller ETEK	`etek_charger`	**MODBUS** Modbus TCP via Gateway (Default Port: 502	Charging power (W), Session energy (kWh).	Dynamic Current Throttling (Amps, 6A to 32A).	Direct register writes to adjust charge rate based on real-time household power balance.
EVBox Elvi / Livo / BusinessLine EVBox	`evbox_charger`	**OCPP 1.6-J** Native OCPP 1.6-J WebSocket Server (Port: 8887	Real-time charging power (W), Total delivered energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Connector status.	Dynamic Current Throttling via SetChargingProfile (6A to 32A), Phase Switching (1P / 3P).	Full native OCPP support for EVBox: dynamically throttles charging current in 1A increments to absorb rooftop solar and prevent capacity tariff penalties.
Easee Charger Easee	`easee_charger`	**REST / HTTP** Easee Cloud REST API (Cloud credentials authentication)	Active charging power (W), Total session energy (kWh), Charger status.	Charging Current Setpoint (Amps, 6A to 32A via Cloud API).	Cloud-based setpoint dispatch for installations where local network access is not available; adjusts current to match solar production and peak limits.
Enovates SingleWallBox Enovates	`enovates_charger`	**MODBUS** Modbus TCP via LAN (Default Port: 502	Charging power (W), Total energy (kWh).	Dynamic Current Setpoint (Amps, 6A to 32A).	Direct local Modbus control; operates in harmony with external CPO billing platforms while GEMS manages local load balancing and peak shaving.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
Ensto Chago Wallbox / Pro Ensto	`ensto_charger`	MODBUS Modbus TCP (Default Port: 502	Active charging power (W), Total energy (kWh).	Charging Current Throttling (Amps, 6A to 32A).	High-reliability Scandinavian commercial/home charger; throttles charge current to respect domestic supply limits and solar surplus.
Etrel INCH / sonnenCharger Etrel	`etrel_charger`	MODBUS Modbus TCP via Ethernet (Default Port: 502	Active power (W), Session energy (kWh).	Dynamic Current Setpoint (Amps, 6A to 32A).	Local Modbus TCP regulation; optimizes charging to match sonnen or third-party battery states and rooftop solar.
Fronius Wattpilot (Home / Go) Fronius	`fronius_wattpilot`	OCPP 1.6-J Native OCPP 1.6-J WebSocket Server (Port: 8887)	Active power (W), Energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Dynamic Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).	Operates Wattpilot in zero-cloud mode directly connected to GEMS; supports dynamic 1-phase / 3-phase switching and solar surplus tracking.
GoodWe HCA Series EV Wallbox (Gen 2) GoodWe	`goodwe_charger`	MODBUS Modbus TCP (Default Port: 502	Charging power (W), Session energy (kWh).	Charging Current Setpoint (Amps, 6A to 32A).	Coordinates GoodWe wallboxes with GoodWe hybrid inverters; prioritizes battery charging before routing surplus into the EV.
Hager witty (one / plus / pro / park 2) Hager	`hager_charger`	OCPP 1.6-J Native OCPP 1.6-J WebSocket Server (Port: 8887)	Active power (W), Session energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages.	Dynamic Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).	Zero-cloud residential management of Hager witty wallboxes; solar excess following and capacity tariff peak shaving.
Huawei FusionCharge (SCharger-7KS / 22KT) Huawei	`huawei_scharger`	OCPP 1.6-J Native OCPP 1.6-J WebSocket Server (Port: 8887	Active charging power (W), Session energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Plug state.	Dynamic Current Throttling via SetChargingProfile (6A to 32A), Phase Switching (1P / 3P).	Direct local control of Huawei FusionCharge without requiring FusionSolar cloud: coordinates perfectly with Huawei SUN2000 inverters and LUNA2000 batteries to ensure the car only charges from 100% pure solar.
KEBA KeContact P30/P40 KEBA	`keba_charger`	MODBUS Modbus TCP via LAN (Default Port: 502	Active charging power (W, reg 1020), Total energy (kWh, reg 1036).	Dynamic Current Setpoint (Amps, reg 5004, 6A to 32A in 1mA steps).	Extremely robust Austrian industrial wallbox: allows GEMS to regulate current sub-second over Modbus TCP while KEBA x-series OCPP connects to corporate employer reimbursement backends.
Mennekes AMTRON (4You / 4Business / ACU / AMEDIO) Mennekes	`mennekes_ocpp`	OCPP 1.6-J Native OCPP 1.6-J WebSocket Server (Port: 8887)	Active power (W), Total energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages.	Dynamic Current Throttling via SetChargingProfile (6A to 32A), Phase Switching (1P / 3P).	Universal OCPP control for modern Mennekes product lines; enables solar-only charging and Flemish capacity peak prevention.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
Mennekes AMTRON (Xtra / Premium / HCC3 Modbus) Mennekes	`mennekes_modbus`	MODBUS Modbus TCP via LAN (Default Port: 502	Active charging power (W), Cumulative energy (kWh).	Dynamic Charging Current Throttling (Amps, 6A to 32A).	Direct local Modbus control for Mennekes premium hardware; eliminates cloud lag for instant peak shaving.
Mercedes-Benz Wallbox Mercedes-Benz	`mercedes_wallbox`	OCPP 1.6-J Native OCPP 1.6-J WebSocket Server (Port: 8887)	Active power (W), Energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages.	Charging Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).	Autonomous home charging for Mercedes-Benz Wallbox; integrates into GEMS dynamic load balancing.
NRGkick (Gen 2) NRGkick	`nrgkick_gen2`	MODBUS Modbus TCP via local Wi-Fi (Default Port: 502	Real-time charging power (W), Energy delivered (kWh).	Charging Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).	Local Modbus TCP regulation for mobile/wallbox NRGkick; automatically modulates current setpoints based on solar excess.
OCPP Charger Generic	`ocpp_charger`	OCPP 1.6-J Native OCPP 1.6-J WebSocket Server (`ws://<EMS-IP>:8887/<ChargePointID>` or `ws://<EMS-IP>:8080/api/ocpp/<ChargePointID>`)	Active power (W), Delivered energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Plug and transaction status.	Standardized OCPP 1.6-J SetChargingProfile (Current Setpoints: 0A pause and 6A to 32A).	Vendor-agnostic central system: supports hundreds of compliant commercial and residential wallboxes worldwide; coordinates dynamic charging profiles according to GEMS site strategy.
Peblar EV Charger (Home / Business / Plus) Peblar	`peblar_charger`	MODBUS Modbus TCP (Default Port: 502	Real-time charging power (W), Cumulative session energy (kWh).	Dynamic Current Setpoint (Amps, 6A to 32A in 0.1A steps), Phase Switching (1P / 3P).	Dutch engineering wallbox: allows GEMS to command sub-second current adjustments over Modbus TCP while Pebble/Peblar cloud handles business split-billing.
Phoenix Contact Charx Charger Phoenix Contact	`phoenix_charger`	MODBUS Modbus TCP (Default Port: 502	Charging power (W), Total session energy (kWh).	Charging Current Setpoint (Amps, 6A to 32A).	Industrial standard EV charge controller; modulates current setpoint to match available solar power.
Phoenix Contact EV-CC / CHARX (Modbus TCP) Phoenix Contact	`phoenix_contact_evcc`	MODBUS Modbus TCP (Default Port: 502	Active charging power (W), Total energy (kWh).	Dynamic Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).	Direct register writes to adjust charge rates for peak shaving and solar surplus.
External CPO Wallbox (OCPP 1.6-J) Generic OCPP	`generic_cpo_ocpp`	OCPP 1.6-J Native OCPP 1.6-J WebSocket Server (`ws://<EMS-IP>:8080/api/ocpp/<ChargePointID>`)	Active power (W), Delivered energy (kWh), 3-Phase currents and voltages.	Dynamic Current Throttling (Amps, 6A to 32A).	Local smart charging and straight-through OCPP proxy load arbitration with external CPO billing platforms based on solar excess and fuse limits.
Porsche Wallbox / Mobile Charger Connect Porsche	`porsche_wallbox`	OCPP 1.6-J Native OCPP 1.6-J WebSocket Server (Port: 8887)	Active charging power (W), Delivered energy (kWh), 3-Phase currents and voltages.	Dynamic Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).	Connects Porsche chargers directly to GEMS without subscription; enforces Flanders peak limits.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
RAEDIAN Gemini AC Wallbox RAEDIAN ⭐ Reference	`raedian_gemini`	MODBUS Modbus TCP via LAN (Default Port: 502	Combined active power (W), Individual Socket 1 & Socket 2 charging power (W), Per-socket energy (kWh), Individual 3-phase currents for Socket 1 (L1, L2, L3) and Socket 2 (L1, L2, L3 in Amps), Per-socket plug status.	Continuous Dynamic Current Modulation (0A to 64A total range, dynamically split across Socket 1 & Socket 2), Individual Socket Mode (Eco / Fast / Off).	Advanced dual-socket load management: balances charging speeds between two vehicles simultaneously; dynamically adjusts combined current from 0A to 64A; protects building electrical service fuses while maximizing solar self-consumption.
RAEDIAN NEO / NEX AC Wallbox RAEDIAN ⭐ Reference	`raedian_charger`	MODBUS Modbus TCP via LAN or Wi-Fi (Default Port: 502	Real-time active charging power (W), Session energy (kWh), 3-Phase charging currents (L1, L2, L3 in Amps), 3-Phase charging voltages (L1, L2, L3 in Volts), Socket status & error codes.	Continuous Dynamic Current Throttling (Amps, 6A to 32A in 0.1A increments), Automated Session Pause & Resume.	Preferred Modbus TCP flagship integration: single-read batching polls all 3-phase currents and voltages in a single request; sub-second current throttling responds instantly to solar surplus and Flanders capacity tariff peaks.
SMA EV Charger (7.4 / 22 / eCharger) SMA	`sma_evcharger`	REST / HTTP Local HTTP REST API (Default Port: 80 / 443)	Active power (W), Cumulative energy (kWh), 3-Phase currents (L1, L2, L3 in Amps).	Monitor-Only (Read-Only Telemetry — SMA EV Charger requires SEMP/SHM2 for active current control).	Monitors SMA EV Charger real-time power draw and session energy for household load accounting.
Schneider Electric EVlink (Wallbox / Pro AC) Schneider Electric	`schneider_evlink`	OCPP 1.6-J Native OCPP 1.6-J WebSocket Server (Port: 8887)	Active charging power (W), Energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages.	Dynamic Current Throttling via SetChargingProfile (6A to 32A), Phase Switching (1P / 3P).	Native OCPP setpoint regulation; provides smooth solar surplus charging and capacity peak avoidance.
Siemens VersiCharge GEN3 Wallbox Siemens	`siemens_versicharge`	OCPP 1.6-J Native OCPP 1.6-J WebSocket Server (Port: 8887	Real-time power (W), Cumulative energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages.	Dynamic Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).	Connects Siemens VersiCharge GEN3 to GEMS over OCPP; executes Flanders peak shaving and solar surplus matching.
Sigenergy SigenStor EVAC / EVDC Charger Sigenergy	`sigenergy_evac`	MODBUS Modbus TCP via Sigen Gateway (Default Port: 502	Charging power (W), Session energy (kWh), 3-Phase currents and voltages.	Dynamic Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).	Direct Modbus control over Sigen EV charging; coordinates with SigenStor battery to absorb excess solar.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
SmartEVSE v2 / v3 (HTTP / Modbus) SmartEVSE	`smartevse_charger`	**REST / HTTP** Local HTTP REST API / Modbus TCP (Default Port: 80	Active power (W), Total energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Pilot status.	Dynamic Current Throttling (Amps, 6A to 32A via /add?current=X), Phase Switching (1P / 3P).	Local REST setpoint modulation; allows open-source charging hardware to run 100% solar surplus charging without cloud accounts.
SolarEdge EV Charger SolarEdge	`solaredge_evse`	**MODBUS** Modbus TCP via SolarEdge inverter or standalone module (Default Port: 502 / 1502	Active charging power (W), Cumulative energy (kWh).	Dynamic Current Setpoint (Amps, 6A to 32A).	Synchronizes charging rate with SolarEdge inverter production; protects household main fuses.
Veton / Phoenix CharX Veton	`veton_charger`	**MODBUS** Modbus TCP via internal Phoenix Contact CHARX controller (Default Port: 502	Active charging power (W), Session energy (kWh).	Dynamic Charging Current Throttling (Amps, 6A to 32A).	Direct Modbus TCP register writes; provides seamless solar surplus charging and peak shaving for premium architectural Veton chargers.
Volkswagen / Elli / Skoda / SEAT (ID. Charger Connect / Pro) Volkswagen / Elli	`elli_charger`	**OCPP 1.6-J** Native OCPP 1.6-J WebSocket Server (Port: 8887	Active charging power (W), Total session energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Plug status.	Dynamic Current Throttling via SetChargingProfile (6A to 32A), Phase Switching (1P / 3P).	Direct native OCPP server integration: allows VW Group ID. Chargers to charge purely on excess solar power and avoid Flanders capacity tariff peaks without requiring expensive manufacturer cloud subscriptions.
Wallbox Pulsar/Commander Wallbox	`wallbox_charger`	**REST / HTTP** Cloud REST API (Wallbox Cloud Credentials Authentication)	Active charging power (W), Total energy (kWh), Charger status.	Charging Current Throttling (Amps, 6A to 32A via Cloud API).	Controls Wallbox charging current via cloud API; adjusts speed to solar excess and off-peak hours.
Webasto Next Charger Webasto	`webasto_charger`	**MODBUS** Modbus TCP via LAN or Wi-Fi (Default Port: 502	Active charging power (W, reg 5000), Delivered session energy (kWh, reg 5002).	Dynamic Charging Current Throttling (Amps, reg 5004, 6A to 32A).	Direct Modbus control: throttles Webasto wallbox within milliseconds to protect main grid fuses and prevent capacity tariff spikes while external backend handles corporate billing.
Zaptec Pro/Go Zaptec	`zaptec_charger`	**REST / HTTP** Cloud REST API (Zaptec OAuth2 authentication)	Active power (W), Cumulative energy (kWh), Session status.	Charging Current Throttling (Amps, 6A to 32A via Zaptec Cloud API).	Cloud setpoint modulation for Zaptec wallboxes; aligns charging speed with solar availability and cheap EPEX spot hours.
go-e Charger Gemini / HOMEfix / PRO go-e	`goe_charger`	**REST / HTTP** Local HTTP REST API v2 (Default Port: 80	Charging power (W), Session energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Authorization state.	Volatile RAM Charging Current Throttling (Amps, 6A to 32A via `/api/set?amx=X` + `frc` pause/resume — zero NVS flash wear), Phase Switching (1P / 3P via `/api/set?psm=X`).	High-speed local HTTP API: allows GEMS to switch dynamically between 1-phase (from 1.4 kW solar) and 3-phase (up to 22 kW) charging; throttles within milliseconds during domestic power spikes.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
Generic Local REST EVSE Gateway Generic REST	`generic_rest_evse`	**REST / HTTP** Local HTTP REST API (Default Port: 80	Real-time Charging Power (W), Cumulative Session Energy (kWh), Charging Station State.	Dynamic Charging Current Throttling (Amps, 6A to 32A).	Distributed multi-charger orchestration and dynamic load management, balancing aggregated fleet charging against local grid connection limits.
Kempower Fast Charging Infrastructure Kempower	`kempower_charger`	**MODBUS** Modbus TCP via Kempower Central Controller (Default Port: 502	Real-time Charging Power (W), Session Energy (kWh), 3-Phase Charging Currents (L1, L2, L3 in Amps).	Monitor-Only over Modbus TCP (use OCPP 1.6-J template for active charging current control).	Monitors high-power C&I commercial DC fast charging power and phase currents on the live GEMS dashboard.
MyEnergi Zappi EV Charger MyEnergi	`myenergi_zappi`	**REST / HTTP** Local HTTP REST / CGI API (Default Port: 80	Real-time Charging Power (W), Session Added Energy (kWh), Charging Status, Mode (Fast, Eco, Eco+).	Fast / Eco / Stop Mode Switching & Current Setpoint Throttling (6A to 32A).	Local zero-cloud control of Zappi chargers, dynamically commanding charge rates without dependency on external cloud servers.
SolaX Smart EV Charger SolaX	`solax_evcharger`	**MODBUS** Modbus TCP via Wi-Fi/Ethernet (Default Port: 502	Real-time Charging Power (W), Cumulative Session Energy (kWh), Phase Currents (L1, L2, L3 in Amps).	Monitor-Only over Modbus TCP (use OCPP 1.6-J template for active charging current control).	Monitors SolaX EV charger active power, energy, and phase currents over Modbus TCP.
Teltonika TeltoCharge Teltonika Energy	`teltonika_teltocharge`	**OCPP 1.6-J** Native OCPP 1.6-J WebSocket Server (Port: 8887	Real-time Charging Power (W), Cumulative Session Energy (kWh), 3-Phase Currents (L1, L2, L3 in Amps), Voltages (V).	Dynamic Charging Current Throttling (Amps, 6A to 32A via SetChargingProfile).	Native OCPP integration for European residential installations; optimizes charging against Flemish capacity peaks and EPEX spot prices.
Volt Time Source EV Charger Volt Time	`volttime_source`	**OCPP 1.6-J** Modbus TCP / OCPP 1.6-J (Default Port: 502	Real-time Charging Power (W), Cumulative Session Energy (kWh), Phase Currents (L1, L2, L3 in Amps).	Monitor-Only over Modbus TCP (use OCPP 1.6-J template for active charging current control).	Monitors Volt Time Source wallbox power, session energy, and phase currents over Modbus TCP.
Wallbox Pulsar Plus / Commander (OCPP) Wallbox	`wallbox_ocpp`	**OCPP 1.6-J** Native OCPP 1.6-J WebSocket Server (Port: 8887	Real-time Charging Power (W), Cumulative Session Energy (kWh), 3-Phase Currents (L1, L2, L3 in Amps), Voltages (V).	Dynamic Charging Current Throttling (Amps, 6A to 32A via SetChargingProfile).	Direct zero-cloud local OCPP integration for Wallbox hardware; eliminates cloud dependency and latency for responsive home energy automation.

📊 4. Grid Smart Meters & Energy Analyzers (36 Devices)

Smart meter templates interface directly via P1 port serial (RJ12 cable at 115200 baud), network P1 bridges, or RS485/Modbus TCP meters. They supply net grid import/export power (W), lifetime energy totals (kWh), per-phase currents (L1, L2, L3), per-phase voltages, and the official 15-minute rolling average peak demand register required for Flemish capacity tariff calculations.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
ABB A43 / A44 / B23 / B24 Meter ABB	`abb_meter`	**MODBUS** Modbus RTU via RS485-to-Ethernet Gateway or Modbus TCP (Default Port: 502	Active grid import/export power (W), Total active import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Frequency (Hz).	Read-only grid telemetry.	High-precision grid boundary metering; feeds continuous 3-phase currents into GEMS phase-load balancing engine to prevent tripping main service fuses; drives Flanders 15-minute capacity peak calculations.
Acrel ADW300 Meter Acrel	`acrel_adw300`	**MODBUS** Modbus TCP (Default Port: 502	Total active power (W), Import/export energy (kWh), Per-phase active power (W), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	Monitors main grid connection or sub-distribution panels; informs GEMS about exact phase loads to modulate EV charger speeds and safeguard service fuses.
B+GE-TECH WS100 / DS100 Meter B+GE-TECH	`bgetech_ws100`	**MODBUS** Modbus TCP / RTU Gateway (Default Port: 502	Real-time import/export power (W), Total active energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	Direct grid boundary metering; provides real-time wattage for closed-loop EV charging solar surplus tracking and Flanders peak shaving.
Carlo Gavazzi EM112 / EM340 / EM540 Carlo Gavazzi	`carlogavazzi_em340`	**MODBUS** Modbus RTU via RS485 USB/Ethernet Gateway (Default Port: 502	Net active power (W), Total import/export kWh, 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	Fast sub-second boundary meter (especially EM540); crucial for instant reactive throttling of EV chargers during household spikes to protect main fuses.
Carlo Gavazzi EM24 (RS485/Ethernet) Carlo Gavazzi	`carlogavazzi_em24`	**MODBUS** Modbus TCP / Modbus RTU Gateway (Default Port: 502	Total active power (W, signed: + import, - export), Cumulative energy registers (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	Industry-standard utility meter used in premium solar and EVSE installations; provides deterministic 1-second telemetry for GEMS peak shaving and dynamic load balancing.
ESPHome DSMR / DLMS Smart Meter ESPHome	`esphome_meter`	**REST / HTTP** Local HTTP REST JSON API (Default Port: 80	Real-time grid power (W), Total import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Gas consumption (m^3).	Read-only REST telemetry.	Integrates DIY open-hardware P1 readers into GEMS; delivers full digital telegram data over Wi-Fi with zero cloud dependencies.
Eastron SDM120 / SDM220 / SDM230 (1-Phase Meter) Eastron	`eastron_sdm120_230`	**MODBUS** Modbus RTU via RS485-to-Ethernet Bridge or USB dongle (Default Port: 502	Active power (W), Total import/export energy (kWh), Phase current (Amps), Line voltage (Volts), Power factor.	Read-only telemetry poller.	Monitors single-phase grid connections, dedicated heat pump sub-circuits, or single-phase PV inverters; integrates into GEMS load analysis.
Eastron SDM630 3-Phase Meter Eastron	`eastron_sdm630`	**MODBUS** Modbus RTU via RS485 Gateway or Modbus TCP (Default Port: 502	Net total active power (W, reg 0x0034), Total import/export energy (kWh), Individual phase currents (L1, L2, L3 in Amps, reg 0x0006), Individual phase voltages (L1, L2, L3 in Volts, reg 0x0000).	Read-only grid telemetry.	Widely deployed 3-phase meter; provides foundational telemetry for GEMS Flanders capacity tariff management, phase imbalance tracking, and solar surplus routing.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
Eastron SDM72D / SMART X96 3-Phase Meter Eastron	`eastron_sdm72_x96`	**MODBUS** Modbus RTU via RS485-to-Ethernet Bridge (Default Port: 502	Total active power (W), Active import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	High-density DIN-rail energy monitoring; feeds live grid metrics into GEMS strategy loop to throttle chargers and log energy reports.
Eltako DSZ15DZMOD / DSZ16 Meter Eltako	`eltako_meter`	**MODBUS** Modbus RTU via RS485 Gateway (Default Port: 502	Active power (W), Import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	German precision submetering; provides real-time phase currents and grid import/export for GEMS household overload protection.
Finder 7M.24 / 7M.38 Meter Finder	`finder_7m`	**MODBUS** Modbus RTU via RS485 Bridge (Default Port: 502	Active power (W), Import/export active energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	Reliable MID-certified grid metering; feeds live electrical data into GEMS for closed-loop dynamic current regulation.
HomeWizard Meter HomeWizard	`homewizard_meter`	**REST / HTTP** Local HTTP REST API v1 (Default Port: 80	Active grid power (W), Total import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Coupled gas meter consumption (m^3).	Read-only local REST API.	Plug-and-play Wi-Fi P1 reader: enables GEMS to poll digital meter telegrams every 1-2 seconds with zero cabling; supports full Flemish & Dutch capacity tariff tracking.
Homey Energy Dongle (P1) Homey	`homey_p1`	**REST / HTTP** Local Network UDP Broadcast / HTTP (Default Port: 80)	Active grid power (W), Total import/export energy (kWh), 3-Phase currents and voltages.	Read-only telemetry poller.	Captures local network telemetry broadcasts from Homey P1 dongles; streams live household grid flow into GEMS dashboard.
Inepro PRO380-MOD / PRO1-MOD Meter Inepro	`inepro_pro380`	**MODBUS** Modbus RTU via RS485 Gateway (Default Port: 502	Total active power (W), Import/export kWh registers, 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	High-accuracy Dutch utility metering; supplies 3-phase currents for GEMS dynamic load balancing and fuse protection.
Lovato DMG610 3-Phase Meter Lovato	`lovato_dmg610`	**MODBUS** Modbus TCP / RTU (Default Port: 502	Total active power (W), Import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	Industrial-grade grid analyzer; provides rapid electrical metrics to protect main supply lines from transformer or fuse overload.
Loxone Miniserver Loxone	`loxone_miniserver`	**REST / HTTP** Local HTTP JSON API (Default Port: 80 / 443	Aggregated household power (W), Submeter power values (W), Total energy counters (kWh).	Read-only REST telemetry poller.	Bridges smart home installations running Loxone Miniserver into GEMS; allows GEMS to utilize Loxone smart meter data as the primary grid reference.
Niko Home Control (NHC II) Niko	`niko_nhc`	**REST / HTTP** Local Hobby API / REST (Default Port: 8884 or 80	Real-time grid import/export power (W), Sub-circuit power consumption (W), Cumulative energy (kWh).	Read-only local API.	Seamless integration with popular Belgian Niko Home Control installations; reads electricity clamp measurements to drive GEMS peak shaving.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
P1 Smart Meter (Network/TCP) Generic	`p1_network`	**P1 / SERIAL** Raw TCP Socket stream (Default Port: 23	Real-time active power (+ import / - export in Watts, OBIS 1.7.0 & 2.7.0), Cumulative tariff 1 & 2 energy (kWh, OBIS 1.8.1/2 & 2.8.1/2), 3-Phase currents (L1, L2, L3 in Amps, OBIS 31.7.0, 51.7.0, 71.7.0), 3-Phase voltages (L1, L2, L3 in Volts, OBIS 32.7.0, 52.7.0, 72.7.0), Flemish 15-minute peak demand register (W, OBIS 1.6.0), Gas consumption (m^3, OBIS 0-1:24.2.1).	Read-only digital telegram stream.	Primary grid interface for remote P1 meters over LAN: decodes official Fluvius (Belgium) and DSMR 4.x/5.x (Netherlands) telegrams; powers GEMS predictive Flanders capacity tariff engine and adaptive peak ceiling.
P1 Smart Meter (USB/Serial) Generic	`p1_serial`	**P1 / SERIAL** Direct Serial TTY (/dev/ttyUSB0 or /dev/ttyAMA0	Real-time active power (W, OBIS 1.7.0/2.7.0), Tariff 1/2 import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Belgian quarterly maximum peak demand (W, OBIS 1.6.0), Gas meter volume (m^3).	Read-only digital telegram stream.	Direct zero-latency hardware connection to Belgian/Dutch smart meters; provides 1-second CRC-validated telegrams; core foundation for sub-second EV load balancing and Flanders capacity peak avoidance.
SMA Energy Meter 2.0 / Data Manager M (Modbus TCP) SMA	`sma_energymeter`	**MODBUS** Modbus TCP (Default Port: 502	Active grid import/export power (W), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Active Power Curtailment Dispatch (commands SMA inverters via Data Manager).	Measures grid boundary power and acts as a gateway; informs GEMS about net exchange; executes active solar feed-in curtailment via SMA communications.
Schneider Electric Acti9 iEM3000 / PM3200 Series Schneider Electric	`schneider_iem3000`	**MODBUS** Modbus RTU via RS485 Gateway or Modbus TCP (Default Port: 502	Total active power (W), Active energy import/export (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	Commercial and residential grade submetering; provides deterministic phase current telemetry to safeguard distribution boards from overloading.
Shelly 3EM (Gen 1 3-Phase Meter) Shelly	`shelly_3em`	**REST / HTTP** Local HTTP REST API (Default Port: 80	Total active power (W), Per-phase power (W), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Cumulative returned/consumed energy (kWh).	Built-in 10A Contactor Output (Turn ON / Turn OFF via /relay/0?turn=on).	Reads high-speed 3-phase clamp measurements over Wi-Fi; built-in contactor can be automated to trigger external thermal loads or disconnect non-essential appliances during capacity peaks.
Shelly Pro 3EM / Gen3 3EM-63T (3-Phase Meter) Shelly	`shelly_pro_3em`	**REST / HTTP** Local Gen 2/3 HTTP RPC (Default Port: 80	Net active power across phases (W), Per-phase active power (W), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), 4-Quadrant energy counters (kWh).	Built-in Auxiliary Relay Output (Turn ON / Turn OFF via /rpc/Switch.Set).	High-reliability Ethernet-connected DIN meter: feeds instant phase telemetry into GEMS for sub-second EV current throttling; auxiliary relay output automates heat pump boost or domestic hot water.
Siemens SENTRON (PAC2200 / 7KT1665 Meter) Siemens	`siemens_pac2200`	**MODBUS** Modbus TCP (Default Port: 502	Total active power (W), Cumulative import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	Premium industrial grade metering; monitors connection capacity and streams telemetry to GEMS for active load shedding and ROI calculations.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
Socomec COUNTIS E24/E34/E44 / DIRIS A-40 Socomec	`socomec_meter`	**MODBUS** Modbus RTU via RS485 Gateway (Default Port: 502	Total active power (W), Active energy import/export (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	Accurate 3-phase commercial and domestic metering; informs GEMS about phase load distribution to balance EV charging and avoid tripping supply fuses.
WAGO 879 Series (879-3000 / 879-3020 / 879-3040) WAGO	`wago_879`	**MODBUS** Modbus TCP (Default Port: 502	Active power (W), Total active energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Read-only grid telemetry.	Precision DIN-rail meter; streams 3-phase currents and voltages into GEMS for real-time fuse protection, solar surplus calculations, and energy flow visualization.
Accuenergy AcuRev / Acuvim Series Meter Accuenergy	`accuenergy_meter`	**MODBUS** Modbus TCP / RTU via RS485 Gateway (Default Port: 502	Real-Time Net Grid Active Power (W), Total Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).	Autonomous / Read-Only grid telemetry.	High-precision 3-phase grid boundary monitoring and phase load balancing for commercial and residential installations.
Algodue UPM209 / UPM309 Series Meter Algodue	`algodue_meter`	**MODBUS** Modbus RTU / TCP via RS485 Gateway (Default Port: 502	Real-Time Net Grid Active Power (W), Total Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).	Autonomous / Read-Only grid telemetry.	Continuous grid exchange measurement, power factor monitoring, and breaker overload protection.
Chint DTSU666 / DTSU666-H 3-Phase Meter Chint	`chint_dtsu666`	**MODBUS** Modbus RTU via RS485 / Modbus TCP Gateway (Default Port: 502	Real-Time Net Grid Active Power (W), Total Import & Export Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).	Autonomous / Read-Only grid telemetry.	Standard 3-phase bidirectional grid meter integration; drives solar surplus calculations and EV charger current modulation.
Hager ECM / ECR / ECP Energy Meter Hager	`hager_meter`	**MODBUS** Modbus RTU / TCP via Agardio / IP Gateway (Default Port: 502	Real-Time Net Grid Power (W), Total Import Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).	Autonomous / Read-Only grid telemetry.	DIN-rail residential distribution board monitoring, feeding sub-second phase telemetry into GEMS overload protection.
Janitza UMG Series Power Analyzer Janitza	`janitza_umg`	**MODBUS** Modbus TCP (Default Port: 502	Real-Time Net Grid Power (W), Total Import Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Line Voltages (V), Frequency (Hz).	Autonomous / Read-Only grid telemetry.	High-precision industrial power analyzer integration, capturing high-frequency grid flow and phase imbalance metrics.
Kamstrup Energy Meter (Modbus Gateway) Kamstrup	`kamstrup_meter`	**MODBUS** Modbus RTU / TCP via M-Bus / Modbus Gateway (Default Port: 502	Real-Time Net Grid Power (W), Total Import Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).	Autonomous / Read-Only grid telemetry.	Integrates utility electricity and district heating/cooling submeters into the GEMS overall energy overview.
Landis+Gyr Industrial Utility Meter Landis+Gyr	`landisgyr_meter`	**MODBUS** Modbus RTU / TCP via Communication Unit (Default Port: 502	Real-Time Net Grid Power (W), Total Import & Export Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).	Autonomous / Read-Only grid telemetry.	Monitors large commercial and industrial connection points to ensure dynamic peak shaving compliance.
Phoenix Contact EMpro Energy Meter Phoenix Contact	`phoenix_empro`	**MODBUS** Modbus TCP (Default Port: 502	Real-Time Net Grid Power (W), Total Import Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).	Autonomous / Read-Only grid telemetry.	Streams real-time 3-phase grid boundary measurements into GEMS for instantaneous solar tracking.
Weidmüller Energy Meter (500 / 600 / 700) Weidmüller	`weidmuller_meter`	**MODBUS** Modbus TCP (Default Port: 502	Real-Time Net Grid Power (W), Total Import Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).	Autonomous / Read-Only grid telemetry.	Industrial grade power monitoring for multi-tenant and facility sub-distribution boards.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
YouLess LS120 Pulse & P1 Meter YouLess	`youless_ls120`	REST / HTTP Local HTTP REST API (Default Port: 80	Real-Time Net Grid Power (W), Total Import Energy (kWh).	Autonomous / Read-Only grid telemetry.	Connects to digital smart meter P1 ports or legacy optical rotating disc meters over local LAN without cloud subscriptions.

🔌 5. Smart Relays & Load Actuators (6 Devices)

Actuator templates integrate potential-free contactors, smart DIN plugs, and SG-Ready heat pump inputs over local LAN REST/RPC or Modbus coils. GEMS automatically triggers domestic hot water (DHW) immersion heaters, heat pump boost states, or pool pumps when solar surplus or negative pricing thresholds are reached, with built-in minimum run-time hysteresis.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
Generic HTTP Relay Generic	`generic_relay`	REST / HTTP Local HTTP REST (Default Port: 80 / 8080	Active power consumption of connected appliance (W, optional if meter reported).	Relay Contactor Output State (Turn ON / Turn OFF).	Automated contactor control: engages domestic hot water immersion heaters, pool circulation pumps, or resistive heating when solar export exceeds configurable thresholds (e.g., > 1500W for 2 minutes); enforces minimum run-time and off-time hysteresis.
Shelly Plus 1PM / Pro 1PM / Plug S (Relay & Power) Shelly	`shelly_plus_1pm`	REST / HTTP Local Gen 2/3 HTTP RPC (Default Port: 80	Connected appliance active power (W), Cumulative energy consumption (kWh), Internal device temperature (°C), Supply voltage (V).	Relay Contactor Output State (Turn ON / Turn OFF via /rpc/Switch.Set).	SG-Ready Heat Pump Boost & Appliance Automation: drives Heat Pump SG-Ready Operating State 3 (thermal boost mode) or hot water boilers during solar surplus or negative spot price hours; tracks real-time load wattage in GEMS logger.
Modbus Digital I/O Relay Module Modbus Relais / I/O	`modbus_relay`	MODBUS Modbus TCP / RTU via RS485 (Default Port: 502	Digital Input / Output Coil States (Open / Closed).	Relay Coil Actuation (Coil 1–8 Turn ON / OFF).	Industrial-grade contactor switching for high-current loads, three-phase thermal heaters, and heavy machinery peak shedding.
SG-Ready Heat Pump (Daikin/Nibe/Bosch/Vaillant/Panasonic) SG-Ready (Daikin, Nibe, Bosch/Nefit, Vaillant, Panasonic, Mitsubishi, Stiebel Eltron, Wolf)	`sgready_heatpump`	REST / HTTP Local HTTP REST / Relay Controller (Default Port: 80	Operating State (Operating State 1: Lock / State 2: Normal / State 3: Boost / State 4: Fast Heat), Power Consumption (W).	SG-Ready Operating Mode (State 2 Normal vs. State 3 Thermal Boost).	Automated heat pump thermal storage: commands State 3 (increased thermal setpoint) during solar surplus or negative dynamic price hours to preheat domestic water and buffers; returns to State 2 during grid peaks.
Shelly Plus 1 / Pro 1 (Dry Contact Relay) Shelly	`shelly_plus_1`	REST / HTTP Local HTTP RPC (Default Port: 80	Switch State (On / Off), Device Temperature (°C), Input State.	Dry Contact Relay Output State (Turn ON / Turn OFF).	Potential-free contact closure to trigger SG-Ready heat pump inputs, EV charger external inhibit terminals, or domestic circulation pumps.

DEVICE & VENDOR	TEMPLATE ID	PROTOCOL & PORT	🔍 READ OUT	🎛️ CONTROLLED	⚡ AUTOMATION ROLE
Shelly Plus 2PM / Pro 2PM (Dual Relay & Meter) Shelly	`shelly_plus_2pm`	**REST / HTTP** Local HTTP RPC (Default Port: 80	Channel 1 & Channel 2 Active Power (W), Cumulative Energy per channel (kWh), Supply Voltage (V).	Dual Relay Output States (Channel 0 & Channel 1 Independent On / Off).	Independent dual-circuit automation: controls and measures multiple resistive heating stages or controls dual-coil SG-Ready heat pump configurations (State 1 through State 4).

4. Detailed Hardware Specification by Category (All 140 Devices)

This section provides the complete technical breakdown for every single native hardware template supported by GEMS, detailing hardware models, connection interfaces, readable telemetry, controllable setpoints, and practical automation roles.

☀️ Category 1: Solar & Hybrid Inverters (32 Native Templates)

Inverter templates interface via Modbus TCP (SunSpec or vendor-specific registers) or local HTTP REST APIs. They continuously report photovoltaic (PV) generation, battery charge/discharge wattage, state of charge (SOC %), and grid flow. Advanced units support real-time active power curtailment for negative spot price protection and battery force-charge/discharge commands for day-ahead spot arbitrage.

1.1 Afore Hybrid Inverter `afore_inverter`

MODBUS

Manufacturer / Vendor: Afore

Communication Interface: Modbus TCP via Ethernet / Wi-Fi dongle (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Afore AF-T (3-Phase) & AF-S (1-Phase) Series Hybrid Inverters (1kW – 30kW)

🔍 **TELEMETRY READ OUT**
Real-time solar PV generation (W), Battery charge/discharge power (W), Grid import/export power (W), Cumulative solar production (kWh), Battery State of Charge (SOC %), 3-Phase inverter output currents (L1, L2, L3 in Amps).

🎛️ **CONTROLLED SETPOINTS**
Read-only telemetry poller (Inverter operates autonomously under internal self-consumption rules).

⚡ **HANDLED & AUTOMATION ROLE**
Telemetry ingestion into GEMS real-time flow chart; monitors PV generation and battery SOC for site-wide self-consumption calculation; uses grid import/export metrics to guide EV charging current setpoints and domestic load balancing.

1.2 Alpha ESS Storion SMILE `alpha_ess_inverter`

NETWORK TCP

Manufacturer / Vendor: Alpha ESS

Communication Interface: Modbus TCP via local network dongle (Default Port: 502 or 8502, Slave ID: 85)

Supported Hardware Models: Alpha ESS Storion SMILE5, SMILE-T10, SMILE-G3 Hybrid Inverter & Storage Systems

🔍 **TELEMETRY READ OUT**
Solar PV active power (W), Battery charging/discharging power (W), Net grid import/export (W), Cumulative energy (kWh), Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps).

🎛️ **CONTROLLED SETPOINTS**
Read-only telemetry poller (internal Alpha ESS EMS manages battery charging cycles).

⚡ **HANDLED & AUTOMATION ROLE**
Streams real-time solar generation and battery status to the interactive dashboard; coordinates with external EV chargers to throttle charging speed when home battery is low or household demand spikes.

1.3 Anker SOLIX X1 Hybrid Inverter `anker_inverter`

MODBUS

Manufacturer / Vendor: Anker

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Anker SOLIX X1 Hybrid Energy Storage System (Single-Phase & Three-Phase)

🔍 **TELEMETRY READ OUT**
Solar PV power (W), Battery flow (W), Grid exchange power (W), Total lifetime energy (kWh), Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ **CONTROLLED SETPOINTS**
Read-only telemetry integration.

⚡ **HANDLED & AUTOMATION ROLE**
Provides full 3-phase electrical telemetry (currents & voltages) to detect phase imbalance; feeds real-time PV generation and battery SOC into GEMS for dynamic EV surplus charging and Flanders peak forecasting.

1.4 Deye / Sunsynk Hybrid Inverter `deye_inverter`

MODBUS

Manufacturer / Vendor: Deye

Communication Interface: Modbus TCP via Ethernet LAN or Solarman/Deye Wi-Fi logger (Default Port: 502 or 8899, Slave ID: 1)

Supported Hardware Models: Deye SUN-(3-12)K-SG04LP3 / SUN-(5-16)K-SG01LP1, Sunsynk Hybrid Inverters

🔍 **TELEMETRY READ OUT**
Solar PV production (W), Battery charge/discharge power (W), Grid meter power (W), Lifetime energy (kWh), Battery SOC (%), 3-Phase inverter currents (L1, L2, L3 in Amps).

🎛️ **CONTROLLED SETPOINTS**
Read-only telemetry poller.

⚡ **HANDLED & AUTOMATION ROLE**
Displays instantaneous solar and battery flow on dashboard; provides grid import/export signals to modulate connected EV chargers and smart relays; tracks battery SOC to prevent grid draw during high-price hours.

1.5 Enerlution Hybrid Inverter `enerlution_inverter`

MODBUS

Manufacturer / Vendor: Enerlution

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Enerlution Hybrid Energy Storage Inverters (L3-L12 Series)

🔍 TELEMETRY READ OUT
Solar PV power (W), Battery power (W), Grid power (W), Cumulative energy (kWh), Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps).

🎛️ CONTROLLED SETPOINTS
Active Power Curtailment Limit (W or % via Modbus registers 40400/40441).

⚡ HANDLED & AUTOMATION ROLE
Full active curtailment integration: automatically reduces inverter power output during negative EPEX Day-Ahead spot price hours (Netherlands Mode / Zero-Export) while respecting Flemish GSC subsidy offsets; manages solar surplus routing into battery and EV.

1.6 Enphase IQ Gateway / Envoy `enphase_envoy`

REST / HTTP

Manufacturer / Vendor: Enphase

Communication Interface: Local HTTP REST API via token/digest authentication (Default Port: 80 / 443, Endpoints: /api/v1/production, /ivp/livedata/status)

Supported Hardware Models: Enphase IQ Gateway, Envoy-S Standard / Metered, IQ System Controller (IQ Battery 3T/10T)

🔍 TELEMETRY READ OUT
Microinverter aggregated solar PV generation (W), IQ Battery charge/discharge wattage (W), Net grid import/export (W), Total lifetime generation (kWh), Battery SOC (%), Per-phase currents and voltages.

🎛️ CONTROLLED SETPOINTS
Read-only local REST polling.

⚡ HANDLED & AUTOMATION ROLE
Integrates Enphase microinverter systems and IQ batteries into GEMS; monitors real-time solar generation at sub-second speeds for zero-cloud solar tracking; optimizes external EV charging setpoints based on Enphase net production.

1.7 FoxESS H1 / H3 / H3-Pro Hybrid Inverter `foxess_inverter`

MODBUS

Manufacturer / Vendor: FoxESS

Communication Interface: Modbus TCP via LAN or RS485 Ethernet converter (Default Port: 502, Slave ID: 1 or 247)

Supported Hardware Models: FoxESS H1, AC1, H3, H3-Pro, AIO Series Hybrid Storage Inverters

🔍 TELEMETRY READ OUT
Solar PV generation (W), Battery power (W), Grid active power (W), Total energy (kWh), Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps).

🎛️ CONTROLLED SETPOINTS
Read-only telemetry integration.

⚡ HANDLED & AUTOMATION ROLE
Provides real-time battery and PV telemetry; triggers smart relay boiler boosts when FoxESS exports exceed user thresholds; coordinates with GEMS Flanders capacity tariff engine to prevent grid peak spikes.

1.8 Fronius Gen24 Inverter `fronius_inverter`

MODBUS

Manufacturer / Vendor: Fronius

Communication Interface: Modbus TCP via SunSpec protocol (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Fronius Primo Gen24, Symo Gen24 Plus, Symo Hybrid, Tauro (SunSpec Modbus)

🔍 TELEMETRY READ OUT
Solar PV generation (W), Battery charge/discharge wattage (W), Grid power flow (W), Cumulative energy (kWh), BYD / Fronius Battery SOC (%).

🎛️ CONTROLLED SETPOINTS
SunSpec read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Reads Fronius SunSpec standard model registers; visualizes real-time power distribution; synchronizes with Fronius Wattpilot or external chargers for automated Eco solar surplus EV charging.

1.9 GoodWe Inverter `goodwe_inverter`

MODBUS

Manufacturer / Vendor: GoodWe

Communication Interface: Modbus TCP / UDP via LAN or Wi-Fi+LAN kit (Default Port: 502 or 8899, Slave ID: 247)

Supported Hardware Models: GoodWe ET, EH, ES, EM, Lynx Home F Series Hybrid Inverters (ARM/DSP)

🔍 TELEMETRY READ OUT
Solar PV power (W), Battery charge/discharge power (W), Net grid flow (W), Lifetime energy (kWh), Battery SOC (%).

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Monitors hybrid power exchange; displays battery SOC and solar generation; informs the GEMS strategy engine on available surplus to ramp up EV chargers from 6A to 32A.

1.10 Growatt Inverter `growatt_inverter`

MODBUS

Manufacturer / Vendor: Growatt

Communication Interface: Modbus TCP via ShineLAN-X Ethernet dongle (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Growatt SPH, MIN, MOD, MID Series Hybrid and Grid-Tied Inverters (ShineLAN-X)

🔍 TELEMETRY READ OUT
Solar PV active power (W), Battery power (W), Grid feed-in/consumption (W), Cumulative kWh, Battery SOC (%).

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Ingests high-frequency solar and battery telemetry; enables automated domestic self-consumption prioritization; prevents grid export overshoots in capacity-constrained networks.

1.11 Huawei Hybrid Inverter `huawei_inverter`

MODBUS

Manufacturer / Vendor: Huawei

Communication Interface: Modbus TCP via SDongleA-05 (Ethernet/WLAN) or SmartLogger3000 (Default Port: 502, Slave ID: 1 or 2)

Supported Hardware Models: Huawei SUN2000 Series (2KTL-6KTL-L1, 3KTL-10KTL-M1, 12KTL-25KTL-M2/M5, 30KTL-100KTL-M3, MAP0, MB0) with LUNA2000 Battery (5kWh-30kWh)

🔍 TELEMETRY READ OUT
Active solar PV generation (W, reg 32080), LUNA2000 Battery charge/discharge power (W, reg 37001), Grid import/export power via DTSU666-H (W, reg 37113), Cumulative generation (kWh, reg 32106), Battery SOC (%, reg 37004).

🎛️ CONTROLLED SETPOINTS
Forced Battery Charge / Discharge Power Setpoint (W, reg 40118/40120), Active Power Curtailment Limit (W or % of rated power, reg 40118/40125).

⚡ HANDLED & AUTOMATION ROLE
Full bidirectional battery and curtailment control: commands LUNA2000 to discharge during household peak spikes (Flanders capacity peak shaving); commands grid force-charging during negative/cheap EPEX spot hours; curtails active PV output during negative export prices or zero-export mandates.

1.12 LG ESS Home (8 / 10 / 15) `lg_ess`

REST / HTTP

Manufacturer / Vendor: LG

Communication Interface: Local HTTP REST API (Default Port: 80 / 443, JSON endpoints: /v1/user/setting/network)

Supported Hardware Models: LG ESS Home 8, Home 10, Home 15 Hybrid Energy Storage Systems

🔍 TELEMETRY READ OUT
Solar PV production (W), Battery power flow (W), Grid import/export (W), Cumulative energy (kWh), Battery SOC (%).

🎛️ CONTROLLED SETPOINTS
Read-only local REST telemetry.

⚡ HANDLED & AUTOMATION ROLE
Streams local LG ESS metrics without cloud latency; feeds live battery SOC into GEMS; guides EV charging and relay automation according to solar availability.

1.13 Marstek Venus / Jupiter Storage `marstek_storage`

MODBUS

Manufacturer / Vendor: Marstek

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Marstek Venus Series, Jupiter Hybrid All-In-One Battery Energy Storage

🔍 TELEMETRY READ OUT
Solar PV power (W), Battery charge/discharge power (W), Grid exchange power (W), Total energy (kWh), Battery SOC (%).

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Monitors residential AC-coupled and hybrid storage; enables homeowners to visualize battery cycles; provides real-time state for surplus energy management.

1.14 SAJ eSolar (H1 / H2 / R5 / R6 Hybrid Inverter) `saj_hybrid`

MODBUS

Manufacturer / Vendor: SAJ

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: SAJ eSolar H1, H2, R5, R6 Series Hybrid & Storage Inverters (B1/B2 Batteries)

🔍 TELEMETRY READ OUT
Solar PV generation (W), Battery power (W), Grid active power (W), Total energy (kWh), Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps).

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Provides 3-phase currents and solar metrics; coordinates domestic loads to absorb SAJ solar generation; logs production history to SQLite.

1.15 SMA Sunny Boy / Tripower / Storage Inverter `sma_inverter` MODBUS

Manufacturer / Vendor: SMA

Communication Interface: Modbus TCP via Speedwire / SunSpec (Default Port: 502, Slave ID: 126 or 3)

Supported Hardware Models: SMA Sunny Boy (1.5-6.0), Sunny Tripower (3.0-10.0, X, Smart Energy), Sunny Island, Sunny Boy Storage

🔍 TELEMETRY READ OUT
Solar PV generation (W, reg 30775), Battery charge/discharge power (W, reg 31393), Grid active power (W, reg 30865), Total energy (kWh, reg 30513), Battery SOC (%, reg 30845), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Active Power Curtailment Limit (W or % via Speedwire/SunSpec register 40016 / 40023).

⚡ HANDLED & AUTOMATION ROLE
Full active curtailment support: throttles SMA active generation when negative export pricing triggers; provides comprehensive 3-phase electrical telemetry for fuse overload detection and phase balancing.

1.16 Senergy (SE Series / Hybrid Inverter) `senergy_inverter` MODBUS

Manufacturer / Vendor: Senergy

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Senergy SE Series Hybrid & Storage Inverters (3kW – 15kW)

🔍 TELEMETRY READ OUT
Solar PV active power (W), Battery charge/discharge power (W), Grid exchange (W), Cumulative energy (kWh), Battery SOC (%).

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Integrates Senergy hybrid systems; surfaces real-time generation on the dashboard; balances home consumption to minimize grid import.

1.17 Sigenergy SigenStor (Hybrid Inverter & Storage) `sigenergy_hybrid` MODBUS

Manufacturer / Vendor: Sigenergy

Communication Interface: Modbus TCP via Sigen Gateway / Inverter (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Sigenergy SigenStor 5-in-1 Energy Storage System (Inverter, Battery, EVDC/EVAC)

🔍 TELEMETRY READ OUT
Solar PV power (W), Sigen Battery flow (W), Grid exchange power (W), Total energy (kWh), Sigen Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps).

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller (autonomous SigenStor AI system).

⚡ HANDLED & AUTOMATION ROLE
Reads high-precision telemetry across all 3 phases; displays 5-in-1 energy flows; integrates with GEMS site-wide strategy to coordinate external third-party EV chargers and relays.

1.18 SofarSolar (HYD / G3 / AMASS Hybrid Inverter) `sofarsolar_hybrid` MODBUS

Manufacturer / Vendor: SofarSolar

Communication Interface: Modbus TCP via Ethernet/Wi-Fi stick (Default Port: 8899 or 502, Slave ID: 1)

Supported Hardware Models: SofarSolar HYD 3000-6000-ES, HYD 5K-20KTL-3PH, G3 Series, AMASS StoreEdge Batteries

🔍 TELEMETRY READ OUT
Solar PV power (W), Battery charge/discharge power (W), Grid power flow (W), Lifetime energy (kWh), Battery SOC (%), 3-Phase currents (L1, L2, L3 in Amps).

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Collects 3-phase currents and battery SOC; feeds data into the GEMS control loop to orchestrate EV charging speeds and SG-ready heat pump activation.

1.19 SolaX Inverter `solax_inverter` MODBUS

Manufacturer / Vendor: SolaX

Communication Interface: Modbus TCP via Pocket LAN or Pocket Wi-Fi (Default Port: 502, Slave ID: 1)

Supported Hardware Models: SolaX Power X1-Hybrid, X3-Hybrid Gen 2/3/4, X1/X3-Fit, Triple Power Batteries

🔍 TELEMETRY READ OUT
Solar PV active power (W), Battery power (W), Grid active power (W), Total energy (kWh), Battery SOC (%).

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Streams real-time solar generation and battery status; enables solar-only EV charging modes; monitors battery reserve levels.

1.20 SolarEdge 3-Phase Inverter `solaredge_3phase`

MODBUS

Manufacturer / Vendor: SolarEdge

Communication Interface: Modbus TCP via SunSpec protocol (Default Port: 1502 or 502, Slave ID: 1)

Supported Hardware Models: SolarEdge 3-Phase Inverters (SE3K – SE33.3K, StorEdge 3-Phase with SetApp)

🔍 TELEMETRY READ OUT
Solar PV generation (W), Battery charge/discharge power (W), Grid meter power (W), Total energy (kWh), Connected Energy Bank SOC (%).

🎛️ CONTROLLED SETPOINTS
SunSpec read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Reads standard SunSpec Modbus registers on port 1502; calculates instant solar surplus across 3 phases; coordinates with chargers to balance load across L1, L2, L3.

1.21 SolarEdge Inverter `solaredge_inverter`

MODBUS

Manufacturer / Vendor: SolarEdge

Communication Interface: Modbus TCP via SunSpec protocol (Default Port: 1502 or 502, Slave ID: 1)

Supported Hardware Models: SolarEdge 1-Phase HD-Wave Inverters (SE2200H – SE6000H, StorEdge 1-Phase)

🔍 TELEMETRY READ OUT
Solar PV generation (W), Battery charge/discharge power (W), Grid active power (W), Total energy (kWh), Battery SOC (%).

🎛️ CONTROLLED SETPOINTS
SunSpec read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Captures 1-phase solar and battery telemetry; updates interactive dashboard; guides dynamic solar surplus redirection into hot water or EV charging.

1.22 Solis Hybrid & Retrofit Inverters (Primary Reference) `solis_hybrid`

⭐ Reference Flagship

MODBUS

Manufacturer / Vendor: Solis

Communication Interface: Modbus TCP via direct internal Ethernet / Ginlong Wi-Fi/LAN stick (Default Port: 502 or 8899, Slave ID: 1)

Supported Hardware Models: Solis S5-EH1P, S6-EH1P Series (Single-Phase Hybrid), S6-EH3P Series (Three-Phase Hybrid 5kW-20kW), Solis RAI-3K-48V-5G, S6-EA1P3.6K-L, S6-EA1P5K-L Series (AC-Coupled Storage Retrofit)

🔍 TELEMETRY READ OUT
Solar PV Active Generation Power (W, reg 33079), Battery Charge/Discharge Power (W, reg 33149), Battery SOC (%, reg 33139), Grid Meter Active Power (W, reg 33130), Total Cumulative Energy Yield (kWh, reg 33029), 3-Phase AC Currents (0.1A, regs 33073-33075), 3-Phase Voltages (0.1V, regs 33076-33078).

🎛️ CONTROLLED SETPOINTS
Active Power Curtailment Mode and Limit (W / % via holding registers 3051/3052), Forced Battery Charging & Discharging Setpoint (W via registers 43110/43135/43136).

⚡ HANDLED & AUTOMATION ROLE
Designated primary reference platform for hybrid solar and battery energy storage. Executes sub-second closed-loop active power curtailment during negative spot price hours (Netherlands Mode / Zero-Export), manages automatic solar surplus sinking into battery storage, dynamically throttles charging during Flanders capacity tariff peak shaving, and orchestrates spot market arbitrage (EPEX Day-Ahead price force charging and peak discharging). Solis Retrofit models operate seamlessly as AC-coupled storage units with dedicated battery control and zero solar PV string dependency.

1.23 Sungrow Inverter `sungrow_inverter`

MODBUS

Manufacturer / Vendor: Sungrow

Communication Interface: Modbus TCP via direct internal LAN RJ45 port (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Sungrow SH5.0RT, SH6.0RT, SH8.0RT, SH10RT, SH15T, SH20T Hybrid Inverters (SBR096-SBR256)

🔍 TELEMETRY READ OUT
Solar PV generation (W, reg 5016), Battery charge/discharge power (W, reg 13021), Grid exchange power (W, reg 13009), Cumulative generation (kWh, reg 5003), SBR Battery SOC (%, reg 13022).

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
High-speed 1-second telemetry polling via internal LAN port; animates real-time power flow; provides baseline data for Flanders capacity tariff peak prediction.

1.24 Victron Inverter/GX `victron_inverter`

MODBUS

Manufacturer / Vendor: Victron

Communication Interface: Modbus TCP via Venus OS (Default Port: 502, Unit ID: 100 for System Calc / 228 for Inverter)

Supported Hardware Models: Victron Energy MultiPlus-II, Quattro, Cerbo GX, Ekrano GX, Color Control GX (Venus OS)

🔍 TELEMETRY READ OUT
Solar PV DC/AC power (W, reg 811), Battery charge/discharge power (W, reg 842), Net AC grid import/export (W, reg 820), Total energy (kWh), Battery SOC (%, reg 843).

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller (Venus OS handles ESS battery regulation).

⚡ HANDLED & AUTOMATION ROLE
Deep integration with Victron Venus OS: reads consolidated system telemetry from Cerbo GX; tracks battery SOC and grid power to orchestrate external EV chargers and heat pump relays.

1.25 ABB / Fimer Solar & Hybrid Inverter `abb_fimer_inverter`

MODBUS

Manufacturer / Vendor: ABB / Fimer

Communication Interface: Modbus SunSpec over TCP/RTU (Default Port: 502, Slave ID: 1)

Supported Hardware Models: ABB UNO-DM-PLUS, REACT 2, TRIO, PVI, and Fimer string/hybrid inverters

🔍 TELEMETRY READ OUT
Solar PV Active Power (W, SunSpec standard register 40083), Battery State of Charge (SOC %), Battery Charge / Discharge Power (W), Grid Feed-in Power (W), Cumulative Generation Energy (kWh).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only telemetry poller (inverter self-manages domestic self-consumption).

⚡ HANDLED & AUTOMATION ROLE
Monitors real-time solar generation and battery state over SunSpec Modbus; drives the interactive live dashboard and guides EV charging throttling and peak shaving.

1.26 Autarco Solar Inverter `autarco_inverter`

NETWORK TCP

Manufacturer / Vendor: Autarco

Communication Interface: Modbus TCP via local network dongle/gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Autarco SX, MX, and LX series single-phase and three-phase solar inverters

🔍 TELEMETRY READ OUT
Solar PV Active Power (W), Total Daily & Lifetime Generation (kWh), Grid AC Voltage (V), AC Frequency (Hz).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Integrates real-time solar PV generation into the site energy balance, feeding solar excess automation for EV chargers and domestic heat pumps.

1.27 Chisage ESS Hybrid Inverter `chisage_ess`

MODBUS

Manufacturer / Vendor: Chisage ESS

Communication Interface: Modbus TCP / RTU via RS485 Ethernet Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Chisage ESS Commercial, Industrial & Residential Hybrid Inverters (3kW – 50kW)

🔍 TELEMETRY READ OUT
Solar PV Active Power (W), Battery Charge / Discharge Power (W), Battery SOC (%), Grid Import / Export Power (W), Cumulative Inverter Energy (kWh).

🎛️ CONTROLLED SETPOINTS
Monitor-Only (Read-Only Telemetry — closed register control map).

⚡ HANDLED & AUTOMATION ROLE
Integrates commercial, industrial, and residential Chisage ESS hybrid solar and battery telemetry into GEMS site load balancing.

1.28 Delta Electronics Solar Inverter `delta_inverter`

MODBUS

Manufacturer / Vendor: Delta Electronics

Communication Interface: Modbus SunSpec over TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Delta M6A, M8A, M10A, M15A, M50A, and RPI commercial/residential series

🔍 TELEMETRY READ OUT
Solar PV Generation Power (W), DC String Voltages and Currents, Cumulative Generation (kWh), Grid AC Power (W).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Reads standardized SunSpec solar generation telemetry to optimize self-consumption and prevent capacity tariff overshoots.

1.29 HYXiPOWER Hybrid Inverter `hyxipower_inverter`

MODBUS

Manufacturer / Vendor: HYXiPOWER

Communication Interface: Modbus TCP via Wi-Fi/Ethernet dongle (Default Port: 502, Slave ID: 1)

Supported Hardware Models: HYXiPOWER 1-Phase & 3-Phase Residential & Commercial Hybrid Inverters

🔍 TELEMETRY READ OUT
Solar PV Generation (W), Battery Charge / Discharge Power (W), Battery SOC (%), Grid Exchange (W), Cumulative Energy (kWh).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Streams PV production and battery storage metrics to the GEMS flow chart and telemetry pipeline.

1.30 KSTAR BluE Hybrid Inverter `kstar_inverter`

MODBUS

Manufacturer / Vendor: KSTAR

Communication Interface: Modbus RTU / TCP via RS485 Ethernet converter (Default Port: 502, Slave ID: 1)

Supported Hardware Models: KSTAR BluE-S, BluE-H3, and BluE-G residential and C&I hybrid systems

🔍 **TELEMETRY READ OUT**
Solar PV Active Power (W), Battery Charge / Discharge Power (W), Battery SOC (%), Grid Power Flow (W), Phase Currents (L1, L2, L3 in Amps).

🎛️ **CONTROLLED SETPOINTS**
Autonomous / Read-Only telemetry poller.

⚡ **HANDLED & AUTOMATION ROLE**
Feeds hybrid solar and battery metrics into the GEMS load balancer and multi-tariff cost optimization engine.

1.31 Solinteg Integ M Hybrid Inverter `solinteg_inverter`

MODBUS

Manufacturer / Vendor: Solinteg

Communication Interface: Modbus RTU / TCP via LAN/Wi-Fi stick (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Solinteg Integ M OHT/OMT Series (3kW – 50kW) 3-Phase Hybrid Inverters

🔍 **TELEMETRY READ OUT**
Solar PV Active Power (W), Battery Charge / Discharge Power (W), Battery SOC (%), Grid Net Exchange Power (W), Cumulative Generation (kWh).

🎛️ **CONTROLLED SETPOINTS**
Monitor-Only (Read-Only Telemetry — closed register control map).

⚡ **HANDLED & AUTOMATION ROLE**
Streams Solinteg Integ M hybrid solar and battery telemetry into GEMS live load balancing.

1.32 Solplanet / AISWEI Inverter `solplanet_inverter`

MODBUS

Manufacturer / Vendor: Solplanet (AISWEI)

Communication Interface: Modbus RTU / TCP via Ethernet/Wi-Fi Ai-Dongle (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Solplanet ASW H-S2, ASW H-T2, ASW-LT-G2/G3 Single and 3-Phase Inverters

🔍 **TELEMETRY READ OUT**
Solar PV Active Power (W), Total Yield Energy (kWh), AC Voltage and Current per phase, Grid Import/Export (W).

🎛️ **CONTROLLED SETPOINTS**
Autonomous / Read-Only telemetry poller.

⚡ **HANDLED & AUTOMATION ROLE**
Continuous solar generation telemetry streaming to the live dashboard and smart relay triggers.

🔋 Category 2: Dedicated Battery Energy Storage Systems (BESS) (13 Native Templates)

Dedicated BESS integrations interface directly with stationary battery controllers and BMS gateways over Modbus TCP or local LAN APIs. They provide deep pack telemetry (SOC %, voltage, cell temperature, power flow) and support dynamic power limits, scheduled force-charging during cheap/negative hours, and autonomous peak shaving for commercial and residential tariffs.

2.1 Siemens Junelight Smart Battery `siemens_junelight`

MODBUS

Manufacturer / Vendor: Siemens

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Siemens Junelight Smart Battery Energy Storage System (3.3kWh – 19.8kWh)

🔍 TELEMETRY READ OUT
Battery charge/discharge power (W), Battery State of Charge (SOC %), Net grid power flow (W), Internal battery status.

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Displays Junelight battery storage on the dashboard node; monitors SOC and power flow to optimize solar self-consumption and prevent high grid imports.

2.2 Solarwatt (EnergyManager / MyReserve Matrix) `solarwatt_storage`

REST / HTTP

Manufacturer / Vendor: Solarwatt

Communication Interface: Local HTTP REST API (Default Port: 80, JSON endpoint: /rest/kiwigrid/private/items)

Supported Hardware Models: Solarwatt EnergyManager Pro, MyReserve Matrix Battery Storage System

🔍 TELEMETRY READ OUT
Battery power flow (W), Battery SOC (%), Solar generation (W), Grid exchange (W), Cumulative energy (kWh).

🎛️ CONTROLLED SETPOINTS
Read-only REST telemetry.

⚡ HANDLED & AUTOMATION ROLE
Local zero-cloud polling of Solarwatt EnergyManager; tracks battery storage metrics; dynamically modulates EV charging speeds based on remaining battery capacity.

2.3 sonnenBatterie (eco 6 / 8 / 10 / hybrid) `sonnen_batterie`

REST / HTTP

Manufacturer / Vendor: Sonnen

Communication Interface: Local HTTP REST API v1/v2 (Default Port: 80, JSON endpoint: /api/v2/status)

Supported Hardware Models: sonnenBatterie eco 6, eco 8, eco 8.2, eco 10, sonnenBatterie hybrid 9.53

🔍 TELEMETRY READ OUT
Battery charge/discharge wattage (W), Battery SOC (%), Solar PV production (W), Grid feed-in / consumption (W).

🎛️ CONTROLLED SETPOINTS
Force Charge / Discharge Power Setpoints via Sonnen Local REST API v2 (when API Auth Token is configured).

⚡ HANDLED & AUTOMATION ROLE
Polls sonnen local REST API v2 every 1 second; visualizes sonnen storage node on the live flow chart and executes peak shaving and spot-price arbitrage when authorized.

2.4 Duracell Energy Residential Storage `duracell_energy`

MODBUS

Manufacturer / Vendor: Duracell Energy

Communication Interface: Modbus RTU / TCP via Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Duracell Energy Dura5, DuraCharge, and Durai storage systems

🔍 TELEMETRY READ OUT
Battery Charge / Discharge Power (W), Battery State of Charge (SOC %), Grid Power Flow (W), Inverter AC Power (W).

🎛️ CONTROLLED SETPOINTS
Monitor-Only (Read-Only Telemetry).

⚡ HANDLED & AUTOMATION ROLE
Monitors Duracell residential battery SOC and power exchange for site load balancing and EV solar surplus routing.

2.5 Dyness Battery Storage System `dyness_battery`

MODBUS

Manufacturer / Vendor: Dyness

Communication Interface: Modbus RTU / TCP via Gateway / Inverter BMS Port (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Dyness Tower, Powerbox F, DL5.0C, and A48100 residential lithium batteries

🔍 TELEMETRY READ OUT
Battery Charge / Discharge Power (W), Battery State of Charge (SOC %), Total Pack Voltage (V), Current (A), Cell Temperatures (°C).

🎛️ CONTROLLED SETPOINTS
Monitor-Only (Read-Only Telemetry).

⚡ HANDLED & AUTOMATION ROLE
Integrates low-voltage and high-voltage Dyness battery bank BMS telemetry directly into the live flow chart and dashboard.

2.6 Elecnova Commercial & Industrial BESS `elecnova_bess`

MODBUS

Manufacturer / Vendor: Elecnova

Communication Interface: Modbus TCP via Industrial Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Elecnova ECO Series Commercial & Industrial Outdoor Cabinet BESS (50kW – 500kW)

🔍 TELEMETRY READ OUT
Battery Active Power (W), Battery State of Charge (SOC %), Grid Exchange Power (W), Cumulative In / Out Energy (kWh).

🎛️ CONTROLLED SETPOINTS
Monitor-Only (Read-Only Telemetry).

⚡ HANDLED & AUTOMATION ROLE
Monitors commercial BESS power flow, state of charge, and cumulative energy on the live dashboard.

2.7 Goneo Residential Storage System `goneo_storage`

MODBUS

Manufacturer / Vendor: Goneo

Communication Interface: Modbus TCP / RTU via Wi-Fi/Ethernet Module (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Goneo Residential All-in-One Energy Storage Systems

🔍 TELEMETRY READ OUT
Battery Charge / Discharge Power (W), Battery SOC (%), Grid Power Flow (W), Total Energy (kWh).

🎛️ CONTROLLED SETPOINTS
Monitor-Only (Read-Only Telemetry).

⚡ HANDLED & AUTOMATION ROLE
Monitors residential battery storage SOC and power exchange for coordinated EV and relay load balancing.

2.8 Mastervolt MLI Ultra / Combi CZone `mastervolt_storage`

MODBUS

Manufacturer / Vendor: Mastervolt

Communication Interface: Modbus RTU / TCP via CZone Bridge / MasterBus gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Mastervolt MLI Ultra Lithium-ion series, Mass Combi Ultra, CZone Modbus Bridge

🔍 TELEMETRY READ OUT
Battery Power (W), Battery SOC (%), Inverter AC Output Power (W), DC Bus Voltage (V), Battery Current (A).

🎛️ CONTROLLED SETPOINTS
Monitor-Only (Read-Only Telemetry).

⚡ HANDLED & AUTOMATION ROLE
Provides off-grid, marine, and residential Mastervolt / CZone battery system telemetry monitoring.

2.9 Power Sonic C&I Energy Storage `powersonic_bess`

MODBUS

Manufacturer / Vendor: Power Sonic

Communication Interface: Modbus TCP via BMS/PCS Controller (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Power Sonic PS-C&I and PowerBlock Commercial & Industrial BESS

🔍 TELEMETRY READ OUT
Battery Active Power (W), Battery State of Charge (SOC %), Grid Power Flow (W), Fault Status Registers.

🎛️ CONTROLLED SETPOINTS
Monitor-Only (Read-Only Telemetry).

⚡ HANDLED & AUTOMATION ROLE
Monitors commercial BESS power flow and state of charge on the live GEMS dashboard.

2.10 Poweroad Residential & C&I Storage `poweroad_storage`

MODBUS

Manufacturer / Vendor: Poweroad

Communication Interface: Modbus RTU / TCP via Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Poweroad ERA, Centauri, and H-ES residential & commercial energy storage systems

🔍 TELEMETRY READ OUT
Battery Power (W), Battery State of Charge (SOC %), Grid Flow (W), Cumulative In / Out Energy (kWh).

🎛️ CONTROLLED SETPOINTS
Monitor-Only (Read-Only Telemetry).

⚡ HANDLED & AUTOMATION ROLE
Monitors residential and light-commercial Poweroad battery storage telemetry.

2.11 Pylontech Battery Storage (US / Force) `pylontech_storage`

MODBUS

Manufacturer / Vendor: Pylontech

Communication Interface: Modbus RTU / TCP via Inverter Gateway or SC0500/SC1000 controller (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Pylontech US2000, US3000, US5000, Force-H1, Force-H2, and Pelio series

🔍 TELEMETRY READ OUT
Battery Charge / Discharge Power (W), State of Charge (SOC %), Pack Voltage (V), Pack Current (A), SOH (%).

🎛️ CONTROLLED SETPOINTS
Monitor-Only (Read-Only Telemetry).

⚡ HANDLED & AUTOMATION ROLE
Reads direct Pylontech BMS status and telemetry into GEMS to accurately reflect battery storage levels on the hero flow chart.

2.12 Socomec SUNSYS C-System / HES BESS `socomec_bess` MODBUS

Manufacturer / Vendor: Socomec

Communication Interface: Modbus TCP via Diris Digiware / BESS Controller (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Socomec SUNSYS C-System and SUNSYS HES L / XL Industrial Energy Storage Systems

🔍 TELEMETRY READ OUT
Battery Active Power (W), Battery SOC (%), Grid Active Power Flow (W), Cumulative Energy (kWh).

🎛️ CONTROLLED SETPOINTS
Monitor-Only (Read-Only Telemetry).

⚡ HANDLED & AUTOMATION ROLE
Monitors industrial Socomec SUNSYS BESS active power, SOC, and energy counters.

2.13 Sunwoda AtSmart Energy Storage `sunwoda_energy` MODBUS

Manufacturer / Vendor: Sunwoda Energy

Communication Interface: Modbus TCP via BMS Communication Hub (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Sunwoda AtSmart Residential Battery System and Noah C&I BESS

🔍 TELEMETRY READ OUT
Battery Charge / Discharge Power (W), Battery State of Charge (SOC %), Grid Power Flow (W), Temperature (°C).

🎛️ CONTROLLED SETPOINTS
Monitor-Only (Read-Only Telemetry).

⚡ HANDLED & AUTOMATION ROLE
Monitors Sunwoda battery state of charge and power exchange on the live GEMS dashboard.

⚡ Category 3: EV Charging Stations & Wallboxes (53 Native Templates)

EVSE integrations communicate via native local OCPP 1.6-J over WebSockets, high-speed Modbus TCP/RTU, or local REST APIs. They receive dynamic charge current setpoints (throttling 6A to 32A) calculated every second by the GEMS control loop. Supported multi-contactor units also feature opt-in 1-phase to 3-phase switching with a mandatory 20-second anti-welding cooldown.

3.1 ABB Charger `abb_charger`

MODBUS

Manufacturer / Vendor: ABB

Communication Interface: Modbus TCP via Ethernet / Wi-Fi (Default Port: 502, Slave ID: 1)

Supported Hardware Models: ABB Terra AC Wallbox (TAC-W7, TAC-W11, TAC-W22 Series)

🔍 TELEMETRY READ OUT	🎛️ CONTROLLED SETPOINTS	⚡ HANDLED & AUTOMATION ROLE
Active charging power (W, reg 0x401C), Cumulative session energy (kWh, reg 0x401E).	Dynamic Charging Current Throttling (Amps, reg 0x4100, 6A to 32A in 1mA steps).	Sub-second current throttling over Modbus TCP: dynamically modulates charging current based on solar surplus (Eco mode) and throttles down immediately during capacity peaks (Flanders mode); coexists seamlessly with third-party billing/reimbursement backends.

3.2 ABL eM4 Single/Twin (SBCx) `abl_em4_charger`

MODBUS

Manufacturer / Vendor: ABL

Communication Interface: Modbus TCP (Default Port: 502, Unit ID: 255 or 1)

Supported Hardware Models: ABL Wallbox eM4 Single & eM4 Twin (with internal SBCx Controller)

🔍 TELEMETRY READ OUT	🎛️ CONTROLLED SETPOINTS	⚡ HANDLED & AUTOMATION ROLE
Active charging power (W, reg 0x300D), Total energy (kWh, reg 0x300F).	Dynamic Charging Current Throttling (Amps, reg 0x3001, 6A to 32A).	Direct Modbus control: throttles single or dual socket charging currents to match rooftop solar surplus and Flanders capacity limits without disconnecting corporate billing.

3.3 ABL eMH1 / eMH2 / eMH3 `abl_emh_charger`

MODBUS

Manufacturer / Vendor: ABL

Communication Interface: Modbus RTU over TCP Bridge (Default Port: 502, Slave ID: 1)

Supported Hardware Models: ABL Wallbox eMH1, eMH2, eMH3 Series (with RS485-to-Ethernet Bridge)

🔍 TELEMETRY READ OUT	🎛️ CONTROLLED SETPOINTS	⚡ HANDLED & AUTOMATION ROLE
Real-time charging power (W), Session energy (kWh).	Charging Current Throttling (Amps, 6A to 32A).	Integrates legacy and modern ABL eMH chargers; provides automated solar-following charging and peak shaving.

3.4 AUTEL AC MaxiCharger `autel_charger`

OCPP 1.6-J

Manufacturer / Vendor: AUTEL

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887, ws://<EMS-IP>:8887/<ChargePointID>)

Supported Hardware Models: Autel MaxiCharger AC Compact / MaxiCharger AC Wallbox (7.4kW, 11kW, 22kW)

🔍 TELEMETRY READ OUT	🎛️ CONTROLLED SETPOINTS	⚡ HANDLED & AUTOMATION ROLE
Real-time charging power (W), Session energy (kWh), Vehicle connection state, 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).	Dynamic Current Throttling via SetChargingProfile (6A to 32A), Phase Switching (1P / 3P).	Autonomous residential charging over native OCPP: adjusts charging speed to solar excess and halts charging during peak tariff periods.

3.5 Alfen Charger `alfen_charger` MODBUS

Manufacturer / Vendor: Alfen

Communication Interface: Modbus TCP / Active Load Balancing license (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Alfen Eve Single Pro-line, Eve Single S-line, Eve Double Pro-line (Direct Modbus TCP)

🔍 TELEMETRY READ OUT
Active charging power (W), Total energy (kWh), Per-phase charging currents (Amps).

🎛️ CONTROLLED SETPOINTS
Dynamic Charging Current Setpoint (Amps, 6A to 32A in 0.1A steps), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Preferred Modbus TCP integration: sub-second throttling for Flemish capacity tariff compliance and 100% solar surplus charging; allows employer CPO billing backends to operate concurrently over OCPP without interference.

3.6 Alpitronic Hypercharger `alpitronic_charger` OCPP 1.6-J

Manufacturer / Vendor: Alpitronic

Communication Interface: Modbus TCP / OCPP 1.6-J (Default Port: 502 or 8887, Unit ID: 1)

Supported Hardware Models: Alpitronic Hypercharger HYC50, HYC150, HYC300, HYC400 DC Fast Chargers

🔍 TELEMETRY READ OUT
Active DC charging power (kW/W), Cumulative delivered energy (kWh), Connector status.

🎛️ CONTROLLED SETPOINTS
Dynamic Charging Power Limit (kW / Amps setpoints).

⚡ HANDLED & AUTOMATION ROLE
Dynamically limits DC fast charging output to stay strictly below site grid connection capacity and Flemish peak limits during high-demand periods.

3.7 BMW i Wallbox (Connect/Pro) `bmw_charger` MODBUS

Manufacturer / Vendor: BMW

Communication Interface: Modbus TCP via LAN (Default Port: 502, Slave ID: 1)

Supported Hardware Models: BMW i Wallbox Connect, BMW i Wallbox Pro (Modbus TCP / UDP)

🔍 TELEMETRY READ OUT
Charging power (W), Session energy (kWh).

🎛️ CONTROLLED SETPOINTS
Dynamic Current Setpoint (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Local LAN current regulation; coordinates charging with home solar availability and off-peak EPEX price hours.

3.8 Bender Charger `bender_charger` MODBUS

Manufacturer / Vendor: Bender

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Bender CC612, CC613 Charge Controllers (embedded in various OEM wallboxes)

🔍 TELEMETRY READ OUT
Active charging power (W), Session energy (kWh), Pilot state.

🎛️ CONTROLLED SETPOINTS
Dynamic Charging Current Setpoint (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Direct Modbus control over the Bender charge controller; instantaneous load throttling to protect home fuses and match PV production.

3.9 Blitzpower / Phoenix CharX `blitzpower_charger` MODBUS

Manufacturer / Vendor: Blitzpower

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Blitzpower AC Wallbox Series (Phoenix Contact CHARX architecture)

🔍 TELEMETRY READ OUT
Charging power (W), Cumulative energy (kWh).

🎛️ CONTROLLED SETPOINTS
Charging Current Throttling (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Fast Modbus register regulation: modulates current setpoints for solar surplus charging and peak shaving.

3.10 Delta AC MAX / SLIM / Ultra Fast Charger `delta_charger` MODBUS

Manufacturer / Vendor: Delta

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Delta AC MAX Basic/Smart (7.4kW/11kW/22kW), Delta SLIM, Ultra Fast EV Chargers

🔍 TELEMETRY READ OUT
Active charging power (W), Total energy (kWh).

🎛️ CONTROLLED SETPOINTS
Charging Current Setpoint (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Modulates Delta wallbox current setpoint via Modbus TCP; optimizes charging speed to absorb solar production without importing expensive grid power.

3.11 EN+ AC EV Charger `enplus_charger`

OCPP 1.6-J

Manufacturer / Vendor: EN+

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887)

Supported Hardware Models: EN+ AC EV Charger Series (Home / Commercial Series)

🔍 TELEMETRY READ OUT
Charging power (W), Energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages.

🎛️ CONTROLLED SETPOINTS
Charging Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Autonomous solar tracking and peak shaving via OCPP SetChargingProfile commands.

3.12 ETEK EKEPC2-C/S Charge Controller `etek_charger`

MODBUS

Manufacturer / Vendor: ETEK

Communication Interface: Modbus TCP via Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: ETEK EKEPC2-C / EKEPC2-S Intelligent Charge Controller (Modbus RTU/TCP)

🔍 TELEMETRY READ OUT
Charging power (W), Session energy (kWh).

🎛️ CONTROLLED SETPOINTS
Dynamic Current Throttling (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Direct register writes to adjust charge rate based on real-time household power balance.

3.13 EVBox Elvi / Livo / BusinessLine `evbox_charger`

OCPP 1.6-J

Manufacturer / Vendor: EVBox

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887, ws://<EMS-IP>:8887/<ChargePointID>)

Supported Hardware Models: EVBox Elvi, EVBox Livo, EVBox BusinessLine (OCPP 1.6-J)

🔍 TELEMETRY READ OUT
Real-time charging power (W), Total delivered energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Connector status.

🎛️ CONTROLLED SETPOINTS
Dynamic Current Throttling via SetChargingProfile (6A to 32A), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Full native OCPP support for EVBox: dynamically throttles charging current in 1A increments to absorb rooftop solar and prevent capacity tariff penalties.

3.14 Easee Charger `easee_charger`

REST / HTTP

Manufacturer / Vendor: Easee

Communication Interface: Easee Cloud REST API (Cloud credentials authentication)

Supported Hardware Models: Easee Home, Easee Charge (Cloud REST API)

🔍 TELEMETRY READ OUT
Active charging power (W), Total session energy (kWh), Charger status.

🎛️ CONTROLLED SETPOINTS
Charging Current Setpoint (Amps, 6A to 32A via Cloud API).

⚡ HANDLED & AUTOMATION ROLE
Cloud-based setpoint dispatch for installations where local network access is not available; adjusts current to match solar production and peak limits.

3.15 Enovates SingleWallBox `enovates_charger`

MODBUS

Manufacturer / Vendor: Enovates

Communication Interface: Modbus TCP via LAN (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Enovates SingleWallBox (Modbus TCP)

🔍 TELEMETRY READ OUT
Charging power (W), Total energy (kWh).

🎛️ CONTROLLED SETPOINTS
Dynamic Current Setpoint (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Direct local Modbus control; operates in harmony with external CPO billing platforms while GEMS manages local load balancing and peak shaving.

3.16 Ensto Chago Wallbox / Pro `ensto_charger`

MODBUS

Manufacturer / Vendor: Ensto

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Ensto Chago Wallbox, Ensto One, Ensto Pro Series (Modbus TCP)

🔍 TELEMETRY READ OUT
Active charging power (W), Total energy (kWh).

🎛️ CONTROLLED SETPOINTS
Charging Current Throttling (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
High-reliability Scandinavian commercial/home charger; throttles charge current to respect domestic supply limits and solar surplus.

3.17 Etrel INCH / sonnenCharger `etrel_charger` MODBUS

Manufacturer / Vendor: Etrel

Communication Interface: Modbus TCP via Ethernet (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Etrel INCH Pro, Etrel INCH Lite, sonnenCharger (Modbus TCP)

🔍 TELEMETRY READ OUT
Active power (W), Session energy (kWh).

🎛️ CONTROLLED SETPOINTS
Dynamic Current Setpoint (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Local Modbus TCP regulation; optimizes charging to match sonnen or third-party battery states and rooftop solar.

3.18 Fronius Wattpilot (Home / Go) `fronius_wattpilot` OCPP 1.6-J

Manufacturer / Vendor: Fronius

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887)

Supported Hardware Models: Fronius Wattpilot Home (11J/22J), Fronius Wattpilot Go (11J/22J)

🔍 TELEMETRY READ OUT
Active power (W), Energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Dynamic Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Operates Wattpilot in zero-cloud mode directly connected to GEMS; supports dynamic 1-phase / 3-phase switching and solar surplus tracking.

3.19 GoodWe HCA Series EV Wallbox (Gen 2) `goodwe_charger` MODBUS

Manufacturer / Vendor: GoodWe

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: GoodWe HCA Series EV Wallbox (Gen 2 Modbus TCP)

🔍 TELEMETRY READ OUT
Charging power (W), Session energy (kWh).

🎛️ CONTROLLED SETPOINTS
Charging Current Setpoint (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Coordinates GoodWe wallboxes with GoodWe hybrid inverters; prioritizes battery charging before routing surplus into the EV.

3.20 Hager witty (one / plus / pro / park 2) `hager_charger` OCPP 1.6-J

Manufacturer / Vendor: Hager

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887)

Supported Hardware Models: Hager witty, witty one, witty plus, witty pro, witty park 2 (OCPP 1.6-J)

🔍 TELEMETRY READ OUT
Active power (W), Session energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages.

🎛️ CONTROLLED SETPOINTS
Dynamic Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Zero-cloud residential management of Hager witty wallboxes; solar excess following and capacity tariff peak shaving.

3.21 Huawei FusionCharge (SCharger-7KS / 22KT) `huawei_scharger` OCPP 1.6-J

Manufacturer / Vendor: Huawei

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887, ws://<EMS-IP>:8887/<ChargePointID>)

Supported Hardware Models: Huawei FusionCharge AC Wallbox (SCharger-7KS Single-Phase, SCharger-22KT Three-Phase)

🔍 TELEMETRY READ OUT
Active charging power (W), Session energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Plug state.

🎛️ CONTROLLED SETPOINTS
Dynamic Current Throttling via SetChargingProfile (6A to 32A), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Direct local control of Huawei FusionCharge without requiring FusionSolar cloud: coordinates perfectly with Huawei SUN2000 inverters and LUNA2000 batteries to ensure the car only charges from 100% pure solar.

3.22 KEBA KeContact P30/P40 `keba_charger`

MODBUS

Manufacturer / Vendor: KEBA

Communication Interface: Modbus TCP via LAN (Default Port: 502, Unit ID: 255)

Supported Hardware Models: KEBA KeContact P30 (c-series, x-series), KeContact P40 Series (Modbus TCP / UDP)

🔍 TELEMETRY READ OUT
Active charging power (W, reg 1020), Total energy (kWh, reg 1036).

🎛️ CONTROLLED SETPOINTS
Dynamic Current Setpoint (Amps, reg 5004, 6A to 32A in 1mA steps).

⚡ HANDLED & AUTOMATION ROLE
Extremely robust Austrian industrial wallbox: allows GEMS to regulate current sub-second over Modbus TCP while KEBA x-series OCPP connects to corporate employer reimbursement backends.

3.23 Mennekes AMTRON (4You / 4Business / ACU / AMEDIO) `mennekes_ocpp`

OCPP 1.6-J

Manufacturer / Vendor: Mennekes

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887)

Supported Hardware Models: Mennekes AMTRON 4You, AMTRON 4Business, AMTRON Professional, AMEDIO (OCPP 1.6-J)

🔍 TELEMETRY READ OUT
Active power (W), Total energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages.

🎛️ CONTROLLED SETPOINTS
Dynamic Current Throttling via SetChargingProfile (6A to 32A), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Universal OCPP control for modern Mennekes product lines; enables solar-only charging and Flemish capacity peak prevention.

3.24 Mennekes AMTRON (Xtra / Premium / HCC3 Modbus) `mennekes_modbus`

MODBUS

Manufacturer / Vendor: Mennekes

Communication Interface: Modbus TCP via LAN (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Mennekes AMTRON Xtra, AMTRON Premium, HCC3 Controller Series (Modbus TCP)

🔍 TELEMETRY READ OUT
Active charging power (W), Cumulative energy (kWh).

🎛️ CONTROLLED SETPOINTS
Dynamic Charging Current Throttling (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Direct local Modbus control for Mennekes premium hardware; eliminates cloud lag for instant peak shaving.

3.25 Mercedes-Benz Wallbox `mercedes_wallbox`

OCPP 1.6-J

Manufacturer / Vendor: Mercedes-Benz

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887)

Supported Hardware Models: Mercedes-Benz Wallbox (Home AC Charger, up to 22kW)

🔍 TELEMETRY READ OUT
Active power (W), Energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages.

🎛️ CONTROLLED SETPOINTS
Charging Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Autonomous home charging for Mercedes-Benz Wallbox; integrates into GEMS dynamic load balancing.

3.26 NRGkick (Gen 2) `nrgkick_gen2`

MODBUS

Manufacturer / Vendor: NRGkick

Communication Interface: Modbus TCP via local Wi-Fi (Default Port: 502, Slave ID: 1)

Supported Hardware Models: NRGkick Gen 2 Mobile & Wall-Mounted Smart EV Charger (Local Modbus TCP / Wi-Fi)

🔍 TELEMETRY READ OUT
Real-time charging power (W), Energy delivered (kWh).

🎛️ CONTROLLED SETPOINTS
Charging Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Local Modbus TCP regulation for mobile/wallbox NRGkick; automatically modulates current setpoints based on solar excess.

3.27 OCPP Charger `ocpp_charger`

OCPP 1.6-J

Manufacturer / Vendor: Generic

Communication Interface: Native OCPP 1.6-J WebSocket Server (`ws://<EMS-IP>:8887/<ChargePointID>` or `ws://<EMS-IP>:8080/api/ocpp/<ChargePointID>`)

Supported Hardware Models: Universal Generic OCPP 1.6-J Smart EV Charger (Any OCPP 1.6-J compliant hardware)

🔍 **TELEMETRY READ OUT**
Active power (W), Delivered energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Plug and transaction status.

🎛️ **CONTROLLED SETPOINTS**
Standardized OCPP 1.6-J SetChargingProfile (Current Setpoints: 0A pause and 6A to 32A).

⚡ **HANDLED & AUTOMATION ROLE**
Vendor-agnostic central system: supports hundreds of compliant commercial and residential wallboxes worldwide; coordinates dynamic charging profiles according to GEMS site strategy.

3.28 Peblar EV Charger (Home / Business / Plus) `peblar_charger`

MODBUS

Manufacturer / Vendor: Peblar

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Peblar Home, Peblar Business, Peblar Plus (Modbus TCP Direct)

🔍 **TELEMETRY READ OUT**
Real-time charging power (W), Cumulative session energy (kWh).

🎛️ **CONTROLLED SETPOINTS**
Dynamic Current Setpoint (Amps, 6A to 32A in 0.1A steps), Phase Switching (1P / 3P).

⚡ **HANDLED & AUTOMATION ROLE**
Dutch engineering wallbox: allows GEMS to command sub-second current adjustments over Modbus TCP while Pebble/Peblar cloud handles business split-billing.

3.29 Phoenix Contact Charx Charger `phoenix_charger`

MODBUS

Manufacturer / Vendor: Phoenix Contact

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Phoenix Contact CHARX SEC / EV-CC-AC1-M3 Series (Modbus TCP)

🔍 **TELEMETRY READ OUT**
Charging power (W), Total session energy (kWh).

🎛️ **CONTROLLED SETPOINTS**
Charging Current Setpoint (Amps, 6A to 32A).

⚡ **HANDLED & AUTOMATION ROLE**
Industrial standard EV charge controller; modulates current setpoint to match available solar power.

3.30 Phoenix Contact EV-CC / CHARX (Modbus TCP) `phoenix_contact_evcc`

MODBUS

Manufacturer / Vendor: Phoenix Contact

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Phoenix Contact EV-CC-AC1-M3 / CHARX Control Modular (Modbus TCP)

🔍 **TELEMETRY READ OUT**
Active charging power (W), Total energy (kWh).

🎛️ **CONTROLLED SETPOINTS**
Dynamic Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).

⚡ **HANDLED & AUTOMATION ROLE**
Direct register writes to adjust charge rates for peak shaving and solar surplus.

3.31 External CPO Wallbox (OCPP 1.6-J) `generic_cpo_ocpp`

OCPP 1.6-J

Manufacturer / Vendor: Generic OCPP

Communication Interface: Native OCPP 1.6-J WebSocket Server (`ws://<EMS-IP>:8080/api/ocpp/<ChargePointID>`)

Supported Hardware Models: AC Wallbox Series compatible with OCPP 1.6-J and External CPO Reimbursement

🔍 **TELEMETRY READ OUT**
Active power (W), Delivered energy (kWh), 3-Phase currents and voltages.

🎛️ **CONTROLLED SETPOINTS**
Dynamic Current Throttling (Amps, 6A to 32A).

⚡ **HANDLED & AUTOMATION ROLE**
Local smart charging and straight-through OCPP proxy load arbitration with external CPO billing platforms based on solar excess and fuse limits.

3.32 Porsche Wallbox / Mobile Charger Connect `porsche_wallbox`

OCPP 1.6-J

Manufacturer / Vendor: Porsche

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887)

Supported Hardware Models: Porsche Mobile Charger Connect, Porsche Wallbox (OCPP 1.6-J)

🔍 **TELEMETRY READ OUT**
Active charging power (W), Delivered energy (kWh), 3-Phase currents and voltages.

🎛️ **CONTROLLED SETPOINTS**
Dynamic Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).

⚡ **HANDLED & AUTOMATION ROLE**
Connects Porsche chargers directly to GEMS without subscription; enforces Flanders peak limits.

3.33 RAEDIAN Gemini AC Wallbox `raedian_gemini`

⭐ Reference Flagship | MODBUS

Manufacturer / Vendor: RAEDIAN

Communication Interface: Modbus TCP via LAN (Default Port: 502, Slave ID: 1)

Supported Hardware Models: RAEDIAN Gemini Dual-Socket AC Commercial & Fleet Wallbox (Up to 2× 22kW, 44kW total)

🔍 TELEMETRY READ OUT
Combined active power (W), Individual Socket 1 & Socket 2 charging power (W), Per-socket energy (kWh), Individual 3-phase currents for Socket 1 (L1, L2, L3) and Socket 2 (L1, L2, L3 in Amps), Per-socket plug status.

🎛️ CONTROLLED SETPOINTS
Continuous Dynamic Current Modulation (0A to 64A total range, dynamically split across Socket 1 & Socket 2), Individual Socket Mode (Eco / Fast / Off).

⚡ HANDLED & AUTOMATION ROLE
Advanced dual-socket load management: balances charging speeds between two vehicles simultaneously; dynamically adjusts combined current from 0A to 64A; protects building electrical service fuses while maximizing solar self-consumption.

3.34 RAEDIAN NEO / NEX AC Wallbox `raedian_charger`

⭐ Reference Flagship | MODBUS

Manufacturer / Vendor: RAEDIAN

Communication Interface: Modbus TCP via LAN or Wi-Fi (Default Port: 502, Slave ID: 1 or 2)

Supported Hardware Models: RAEDIAN NEO Series, RAEDIAN NEX Series AC Smart Wallbox (7.4kW, 11kW, 22kW)

🔍 TELEMETRY READ OUT
Real-time active charging power (W), Session energy (kWh), 3-Phase charging currents (L1, L2, L3 in Amps), 3-Phase charging voltages (L1, L2, L3 in Volts), Socket status & error codes.

🎛️ CONTROLLED SETPOINTS
Continuous Dynamic Current Throttling (Amps, 6A to 32A in 0.1A increments), Automated Session Pause & Resume.

⚡ HANDLED & AUTOMATION ROLE
Preferred Modbus TCP flagship integration: single-read batching polls all 3-phase currents and voltages in a single request; sub-second current throttling responds instantly to solar surplus and Flanders capacity tariff peaks.

3.35 SMA EV Charger (7.4 / 22 / eCharger) `sma_evcharger`

REST / HTTP

Manufacturer / Vendor: SMA

Communication Interface: Local HTTP REST API (Default Port: 80 / 443)

Supported Hardware Models: SMA EV Charger 7.4, SMA EV Charger 22

🔍 TELEMETRY READ OUT
Active power (W), Cumulative energy (kWh), 3-Phase currents (L1, L2, L3 in Amps).

🎛️ CONTROLLED SETPOINTS
Monitor-Only (Read-Only Telemetry — SMA EV Charger requires SEMP/SHM2 for active current control).

⚡ HANDLED & AUTOMATION ROLE
Monitors SMA EV Charger real-time power draw and session energy for household load accounting.

3.36 Schneider Electric EVlink (Wallbox / Pro AC) `schneider_evlink`

OCPP 1.6-J

Manufacturer / Vendor: Schneider Electric

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887)

Supported Hardware Models: Schneider Electric EVlink Wallbox, EVlink Pro AC, EVlink Smart Wallbox (OCPP 1.6-J)

🔍 TELEMETRY READ OUT
Active charging power (W), Energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages.

🎛️ CONTROLLED SETPOINTS
Dynamic Current Throttling via SetChargingProfile (6A to 32A), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Native OCPP setpoint regulation; provides smooth solar surplus charging and capacity peak avoidance.

3.37 Siemens VersiCharge GEN3 Wallbox `siemens_versicharge`

OCPP 1.6-J

Manufacturer / Vendor: Siemens

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887, ws://<EMS-IP>:8887/<ChargePointID>)

Supported Hardware Models: Siemens VersiCharge GEN3 AC Smart Wallbox (Commercial & Residential 7.4kW - 22kW)

🔍 TELEMETRY READ OUT
Real-time power (W), Cumulative energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages.

🎛️ CONTROLLED SETPOINTS
Dynamic Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Connects Siemens VersiCharge GEN3 to GEMS over OCPP; executes Flanders peak shaving and solar surplus matching.

3.38 Sigenergy SigenStor EVAC / EVDC Charger `sigenergy_evac` MODBUS

Manufacturer / Vendor: Sigenergy

Communication Interface: Modbus TCP via Sigen Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Sigenergy Sigen EVAC AC Wallbox, Sigen EVDC Bidirectional Fast Charger

🔍 TELEMETRY READ OUT
Charging power (W), Session energy (kWh), 3-Phase currents and voltages.

🎛️ CONTROLLED SETPOINTS
Dynamic Current Throttling (Amps, 6A to 32A), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Direct Modbus control over Sigen EV charging; coordinates with SigenStor battery to absorb excess solar.

3.39 SmartEVSE v2 / v3 (HTTP / Modbus) `smartevse_charger` REST / HTTP

Manufacturer / Vendor: SmartEVSE

Communication Interface: Local HTTP REST API / Modbus TCP (Default Port: 80, REST endpoint: /add)

Supported Hardware Models: SmartEVSE v2, SmartEVSE v3 Open-Source EV Charging Controller

🔍 TELEMETRY READ OUT
Active power (W), Total energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Pilot status.

🎛️ CONTROLLED SETPOINTS
Dynamic Current Throttling (Amps, 6A to 32A via /add?current=X), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Local REST setpoint modulation; allows open-source charging hardware to run 100% solar surplus charging without cloud accounts.

3.40 SolarEdge EV Charger `solaredge_evse` MODBUS

Manufacturer / Vendor: SolarEdge

Communication Interface: Modbus TCP via SolarEdge inverter or standalone module (Default Port: 502 / 1502, Slave ID: 1)

Supported Hardware Models: SolarEdge Home EV Charger (Integrated Inverter-Charger & Standalone AC Wallbox)

🔍 TELEMETRY READ OUT
Active charging power (W), Cumulative energy (kWh).

🎛️ CONTROLLED SETPOINTS
Dynamic Current Setpoint (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Synchronizes charging rate with SolarEdge inverter production; protects household main fuses.

3.41 Veton / Phoenix CharX `veton_charger` MODBUS

Manufacturer / Vendor: Veton

Communication Interface: Modbus TCP via internal Phoenix Contact CHARX controller (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Veton One, Veton Two, Veton Wallbox Series (Design Luxury Chargers)

🔍 TELEMETRY READ OUT
Active charging power (W), Session energy (kWh).

🎛️ CONTROLLED SETPOINTS
Dynamic Charging Current Throttling (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Direct Modbus TCP register writes; provides seamless solar surplus charging and peak shaving for premium architectural Veton chargers.

3.42 Volkswagen / Elli / Skoda / SEAT (ID. Charger Connect / Pro) `elli_charger` OCPP 1.6-J

Manufacturer / Vendor: Volkswagen / Elli

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887, ws://<EMS-IP>:8887/<ChargePointID>)

Supported Hardware Models: Volkswagen ID. Charger Connect / Pro, Elli Charger, Skoda iV Charger, SEAT Charger

🔍 TELEMETRY READ OUT
Active charging power (W), Total session energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Plug status.

🎛️ CONTROLLED SETPOINTS
Dynamic Current Throttling via SetChargingProfile (6A to 32A), Phase Switching (1P / 3P).

⚡ HANDLED & AUTOMATION ROLE
Direct native OCPP server integration: allows VW Group ID. Chargers to charge purely on excess solar power and avoid Flanders capacity tariff peaks without requiring expensive manufacturer cloud subscriptions.

3.43 Wallbox Pulsar/Commander `wallbox_charger` REST / HTTP

Manufacturer / Vendor: Wallbox

Communication Interface: Cloud REST API (Wallbox Cloud Credentials Authentication)

Supported Hardware Models: Wallbox Pulsar Plus, Pulsar Max, Commander 2, Copper SB (Wallbox Cloud REST API)

🔍 TELEMETRY READ OUT
Active charging power (W), Total energy (kWh), Charger status.

🎛️ CONTROLLED SETPOINTS
Charging Current Throttling (Amps, 6A to 32A via Cloud API).

⚡ HANDLED & AUTOMATION ROLE
Controls Wallbox charging current via cloud API; adjusts speed to solar excess and off-peak hours.

3.44 Webasto Next Charger `webasto_charger` MODBUS

Manufacturer / Vendor: Webasto

Communication Interface: Modbus TCP via LAN or Wi-Fi (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Webasto Next, Webasto Live, Webasto Unite (Modbus TCP Direct)

🔍 TELEMETRY READ OUT
Active charging power (W, reg 5000), Delivered session energy (kWh, reg 5002).

🎛️ CONTROLLED SETPOINTS
Dynamic Charging Current Throttling (Amps, reg 5004, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Direct Modbus control: throttles Webasto wallbox within milliseconds to protect main grid fuses and prevent capacity tariff spikes while external backend handles corporate billing.

3.45 Zaptec Pro/Go `zaptec_charger` REST / HTTP

Manufacturer / Vendor: Zaptec

Communication Interface: Cloud REST API (Zaptec OAuth2 authentication)

Supported Hardware Models: Zaptec Go, Zaptec Pro (Zaptec Cloud REST API)

🔍 TELEMETRY READ OUT
Active power (W), Cumulative energy (kWh), Session status.

🎛️ CONTROLLED SETPOINTS
Charging Current Throttling (Amps, 6A to 32A via Zaptec Cloud API).

⚡ HANDLED & AUTOMATION ROLE
Cloud setpoint modulation for Zaptec wallboxes; aligns charging speed with solar availability and cheap EPEX spot hours.

3.46 go-e Charger Gemini / HOMEfix / PRO `goe_charger` REST / HTTP

Manufacturer / Vendor: go-e

Communication Interface: Local HTTP REST API v2 (Default Port: 80, JSON endpoints: /api/status, /api/set)

Supported Hardware Models: go-e Charger Gemini, Gemini flex, HOMEfix, HOME+ (Local HTTP API v2)

🔍 TELEMETRY READ OUT
Charging power (W), Session energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Authorization state.

🎛️ CONTROLLED SETPOINTS
Volatile RAM Charging Current Throttling (Amps, 6A to 32A via `/api/set?amx=X` + `frc` pause/resume — zero NVS flash wear), Phase Switching (1P / 3P via `/api/set?psm=X`).

⚡ HANDLED & AUTOMATION ROLE
High-speed local HTTP API: allows GEMS to switch dynamically between 1-phase (from 1.4 kW solar) and 3-phase (up to 22 kW) charging; throttles within milliseconds during domestic power spikes.

3.47 Generic Local REST EVSE Gateway `generic_rest_evse` REST / HTTP

Manufacturer / Vendor: Generic REST

Communication Interface: Local HTTP REST API (Default Port: 80, REST endpoint: /api/v1)

Supported Hardware Models: Open Local REST EVSE Controllers and Load Gateways

🔍 TELEMETRY READ OUT
Real-time Charging Power (W), Cumulative Session Energy (kWh), Charging Station State.

🎛️ CONTROLLED SETPOINTS
Dynamic Charging Current Throttling (Amps, 6A to 32A).

⚡ HANDLED & AUTOMATION ROLE
Distributed multi-charger orchestration and dynamic load management, balancing aggregated fleet charging against local grid connection limits.

3.48 Kempower Fast Charging Infrastructure `kempower_charger` MODBUS

Manufacturer / Vendor: Kempower

Communication Interface: Modbus TCP via Kempower Central Controller (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Kempower C-Series and S-Series Fast Charging Satellites & Power Units

🔍 TELEMETRY READ OUT
Real-time Charging Power (W), Session Energy (kWh), 3-Phase Charging Currents (L1, L2, L3 in Amps).

🎛️ CONTROLLED SETPOINTS
Monitor-Only over Modbus TCP (use OCPP 1.6-J template for active charging current control).

⚡ HANDLED & AUTOMATION ROLE
Monitors high-power C&I commercial DC fast charging power and phase currents on the live GEMS dashboard.

3.49 MyEnergi Zappi EV Charger `myenergi_zappi`

REST / HTTP

Manufacturer / Vendor: MyEnergi

Communication Interface: Local HTTP REST / CGI API (Default Port: 80, Endpoint: /cgi-jstatus)

Supported Hardware Models: MyEnergi Zappi v2 and v2.1 with Hub / built-in Wi-Fi

🔍 **TELEMETRY READ OUT**
Real-time Charging Power (W), Session Added Energy (kWh), Charging Status, Mode (Fast, Eco, Eco+).

🎛️ **CONTROLLED SETPOINTS**
Fast / Eco / Stop Mode Switching & Current Setpoint Throttling (6A to 32A).

⚡ **HANDLED & AUTOMATION ROLE**
Local zero-cloud control of Zappi chargers, dynamically commanding charge rates without dependency on external cloud servers.

3.50 SolaX Smart EV Charger `solax_evcharger`

MODBUS

Manufacturer / Vendor: SolaX

Communication Interface: Modbus TCP via Wi-Fi/Ethernet (Default Port: 502, Slave ID: 1)

Supported Hardware Models: SolaX Smart EV Charger X1-EVC / X3-EVC (7.2kW – 22kW)

🔍 **TELEMETRY READ OUT**
Real-time Charging Power (W), Cumulative Session Energy (kWh), Phase Currents (L1, L2, L3 in Amps).

🎛️ **CONTROLLED SETPOINTS**
Monitor-Only over Modbus TCP (use OCPP 1.6-J template for active charging current control).

⚡ **HANDLED & AUTOMATION ROLE**
Monitors SolaX EV charger active power, energy, and phase currents over Modbus TCP.

3.51 Teltonika TeltoCharge `teltonika_teltocharge`

OCPP 1.6-J

Manufacturer / Vendor: Teltonika Energy

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887, ws://<EMS-IP>:8887/<ChargePointID>)

Supported Hardware Models: Teltonika TeltoCharge EVC1 Series (7.4kW – 22kW)

🔍 **TELEMETRY READ OUT**
Real-time Charging Power (W), Cumulative Session Energy (kWh), 3-Phase Currents (L1, L2, L3 in Amps), Voltages (V).

🎛️ **CONTROLLED SETPOINTS**
Dynamic Charging Current Throttling (Amps, 6A to 32A via SetChargingProfile).

⚡ **HANDLED & AUTOMATION ROLE**
Native OCPP integration for European residential installations; optimizes charging against Flemish capacity peaks and EPEX spot prices.

3.52 Volt Time Source EV Charger `volttime_source`

OCPP 1.6-J

Manufacturer / Vendor: Volt Time

Communication Interface: Modbus TCP / OCPP 1.6-J (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Volt Time Source and Source Pro Smart Charging Stations

🔍 **TELEMETRY READ OUT**
Real-time Charging Power (W), Cumulative Session Energy (kWh), Phase Currents (L1, L2, L3 in Amps).

🎛️ **CONTROLLED SETPOINTS**
Monitor-Only over Modbus TCP (use OCPP 1.6-J template for active charging current control).

⚡ **HANDLED & AUTOMATION ROLE**
Monitors Volt Time Source wallbox power, session energy, and phase currents over Modbus TCP.

3.53 Wallbox Pulsar Plus / Commander (OCPP) `wallbox_ocpp`

OCPP 1.6-J

Manufacturer / Vendor: Wallbox

Communication Interface: Native OCPP 1.6-J WebSocket Server (Port: 8887, ws://<EMS-IP>:8887/<ChargePointID>)

Supported Hardware Models: Wallbox Pulsar Plus, Pulsar Max, Commander 2 / 2s

🔍 **TELEMETRY READ OUT**
Real-time Charging Power (W), Cumulative Session Energy (kWh), 3-Phase Currents (L1, L2, L3 in Amps), Voltages (V).

🎛️ **CONTROLLED SETPOINTS**
Dynamic Charging Current Throttling (Amps, 6A to 32A via SetChargingProfile).

⚡ **HANDLED & AUTOMATION ROLE**
Direct zero-cloud local OCPP integration for Wallbox hardware; eliminates cloud dependency and latency for responsive home energy automation.

📊 Category 4: Grid Smart Meters & Energy Analyzers (36 Native Templates)

Smart meter templates interface directly via P1 port serial (RJ12 cable at 115200 baud), network P1 bridges, or RS485/Modbus TCP meters. They supply net grid import/export power (W), lifetime energy totals (kWh), per-phase currents (L1, L2, L3), per-phase voltages, and the official 15-minute rolling average peak demand register required for Flemish capacity tariff calculations.

4.1 ABB A43 / A44 / B23 / B24 Meter `abb_meter`

MODBUS

Manufacturer / Vendor: ABB

Communication Interface: Modbus RTU via RS485-to-Ethernet Gateway or Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: ABB A43, A44 (3-Phase Direct/CT), B23, B24 (3-Phase Compact) Modbus Meters

🔍 TELEMETRY READ OUT
Active grid import/export power (W), Total active import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Frequency (Hz).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
High-precision grid boundary metering; feeds continuous 3-phase currents into GEMS phase-load balancing engine to prevent tripping main service fuses; drives Flanders 15-minute capacity peak calculations.

4.2 Acrel ADW300 Meter `acrel_adw300`

MODBUS

Manufacturer / Vendor: Acrel

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Acrel ADW300 Series Wireless / Ethernet 3-Phase Multi-Function Energy Meter

🔍 TELEMETRY READ OUT
Total active power (W), Import/export energy (kWh), Per-phase active power (W), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Monitors main grid connection or sub-distribution panels; informs GEMS about exact phase loads to modulate EV charger speeds and safeguard service fuses.

4.3 B+GE-TECH WS100 / DS100 Meter `bgetech_ws100`

MODBUS

Manufacturer / Vendor: B+GE-TECH

Communication Interface: Modbus TCP / RTU Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: B+GE-TECH WS100, DS100 Series 3-Phase DIN-Rail Modbus Smart Meters

🔍 TELEMETRY READ OUT
Real-time import/export power (W), Total active energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Direct grid boundary metering; provides real-time wattage for closed-loop EV charging solar surplus tracking and Flanders peak shaving.

4.4 Carlo Gavazzi EM112 / EM340 / EM540 `carlogavazzi_em340`

MODBUS

Manufacturer / Vendor: Carlo Gavazzi

Communication Interface: Modbus RTU via RS485 USB/Ethernet Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Carlo Gavazzi EM112 (1-Phase), EM340 (3-Phase Direct), EM540 (Ultra-Fast 3-Phase) Meters

🔍 TELEMETRY READ OUT
Net active power (W), Total import/export kWh, 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Fast sub-second boundary meter (especially EM540); crucial for instant reactive throttling of EV chargers during household spikes to protect main fuses.

4.5 Carlo Gavazzi EM24 (RS485/Ethernet) `carlogavazzi_em24`

MODBUS

Manufacturer / Vendor: Carlo Gavazzi

Communication Interface: Modbus TCP / Modbus RTU Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Carlo Gavazzi EM24 Series 3-Phase Energy Meter (RS485 & Ethernet LAN versions)

🔍 TELEMETRY READ OUT
Total active power (W, signed: + import, - export), Cumulative energy registers (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Industry-standard utility meter used in premium solar and EVSE installations; provides deterministic 1-second telemetry for GEMS peak shaving and dynamic load balancing.

4.6 ESPHome DSMR / DLMS Smart Meter `esphome_meter`

REST / HTTP

Manufacturer / Vendor: ESPHome

Communication Interface: Local HTTP REST JSON API (Default Port: 80, Endpoint: /sensor/grid_power or /text_sensor/dsmr)

Supported Hardware Models: ESPHome Smart Meter Gateway (P1 DSMR Reader / DLMS / SML IR Optical Heads on ESP8266/ESP32)

🔍 TELEMETRY READ OUT
Real-time grid power (W), Total import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Gas consumption (m³).

🎛️ CONTROLLED SETPOINTS
Read-only REST telemetry.

⚡ HANDLED & AUTOMATION ROLE
Integrates DIY open-hardware P1 readers into GEMS; delivers full digital telegram data over Wi-Fi with zero cloud dependencies.

4.7 Eastron SDM120 / SDM220 / SDM230 (1-Phase Meter) `eastron_sdm120_230`

MODBUS

Manufacturer / Vendor: Eastron

Communication Interface: Modbus RTU via RS485-to-Ethernet Bridge or USB dongle (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Eastron SDM120, SDM220, SDM230 Series 1-Phase DIN-Rail Modbus Smart Meters

🔍 TELEMETRY READ OUT
Active power (W), Total import/export energy (kWh), Phase current (Amps), Line voltage (Volts), Power factor.

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Monitors single-phase grid connections, dedicated heat pump sub-circuits, or single-phase PV inverters; integrates into GEMS load analysis.

4.8 Eastron SDM630 3-Phase Meter `eastron_sdm630`

MODBUS

Manufacturer / Vendor: Eastron

Communication Interface: Modbus RTU via RS485 Gateway or Modbus TCP (Default Port: 502, Slave ID: 1, Baud: 9600)

Supported Hardware Models: Eastron SDM630 Modbus V2 / V3 / MCT 3-Phase Multifunction Energy Meter

🔍 TELEMETRY READ OUT
Net total active power (W, reg 0x0034), Total import/export energy (kWh), Individual phase currents (L1, L2, L3 in Amps, reg 0x0006), Individual phase voltages (L1, L2, L3 in Volts, reg 0x0000).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Widely deployed 3-phase meter; provides foundational telemetry for GEMS Flanders capacity tariff management, phase imbalance tracking, and solar surplus routing.

4.9 Eastron SDM72D / SMART X96 3-Phase Meter `eastron_sdm72_x96`

MODBUS

Manufacturer / Vendor: Eastron

Communication Interface: Modbus RTU via RS485-to-Ethernet Bridge (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Eastron SDM72D-Modbus, SDM72DR, SMART X96-1 / X96-5 Multifunction Meters

🔍 TELEMETRY READ OUT
Total active power (W), Active import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
High-density DIN-rail energy monitoring; feeds live grid metrics into GEMS strategy loop to throttle chargers and log energy reports.

4.10 Eltako DSZ15DZMOD / DSZ16 Meter `eltako_meter`

MODBUS

Manufacturer / Vendor: Eltako

Communication Interface: Modbus RTU via RS485 Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Eltako DSZ15DZMOD-3×80A, DSZ16 Series 3-Phase Modbus Energy Meters

🔍 TELEMETRY READ OUT
Active power (W), Import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
German precision submetering; provides real-time phase currents and grid import/export for GEMS household overload protection.

4.11 Finder 7M.24 / 7M.38 Meter `finder_7m` MODBUS

Manufacturer / Vendor: Finder

Communication Interface: Modbus RTU via RS485 Bridge (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Finder 7M Series (7M.24 1-Phase, 7M.38 3-Phase Bi-directional Modbus Meters)

🔍 TELEMETRY READ OUT
Active power (W), Import/export active energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Reliable MID-certified grid metering; feeds live electrical data into GEMS for closed-loop dynamic current regulation.

4.12 HomeWizard Meter `homewizard_meter` REST / HTTP

Manufacturer / Vendor: HomeWizard

Communication Interface: Local HTTP REST API v1 (Default Port: 80, JSON Endpoint: /api/v1/data)

Supported Hardware Models: HomeWizard Wi-Fi P1 Meter (HWE-P1), HomeWizard Wi-Fi kWh Meter (1-Phase & 3-Phase)

🔍 TELEMETRY READ OUT
Active grid power (W), Total import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Coupled gas meter consumption (m^3).

🎛️ CONTROLLED SETPOINTS
Read-only local REST API.

⚡ HANDLED & AUTOMATION ROLE
Plug-and-play Wi-Fi P1 reader: enables GEMS to poll digital meter telegrams every 1-2 seconds with zero cabling; supports full Flemish & Dutch capacity tariff tracking.

4.13 Homey Energy Dongle (P1) `homey_p1` REST / HTTP

Manufacturer / Vendor: Homey

Communication Interface: Local Network UDP Broadcast / HTTP (Default Port: 80)

Supported Hardware Models: Homey Energy Dongle (P1 Wi-Fi Gateway)

🔍 TELEMETRY READ OUT
Active grid power (W), Total import/export energy (kWh), 3-Phase currents and voltages.

🎛️ CONTROLLED SETPOINTS
Read-only telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Captures local network telemetry broadcasts from Homey P1 dongles; streams live household grid flow into GEMS dashboard.

4.14 Inepro PRO380-MOD / PRO1-MOD Meter `inepro_pro380` MODBUS

Manufacturer / Vendor: Inepro

Communication Interface: Modbus RTU via RS485 Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Inepro PRO380-MOD, PRO1-MOD Series 3-Phase & 1-Phase DIN-Rail Modbus Meters

🔍 TELEMETRY READ OUT
Total active power (W), Import/export kWh registers, 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
High-accuracy Dutch utility metering; supplies 3-phase currents for GEMS dynamic load balancing and fuse protection.

4.15 Lovato DMG610 3-Phase Meter `lovato_dmg610` MODBUS

Manufacturer / Vendor: Lovato

Communication Interface: Modbus TCP / RTU (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Lovato Electric DMG610, DMG800 Series Digital Multimeters

🔍 TELEMETRY READ OUT
Total active power (W), Import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Industrial-grade grid analyzer; provides rapid electrical metrics to protect main supply lines from transformer or fuse overload.

4.16 Loxone Miniserver `loxone_miniserver`

REST / HTTP

Manufacturer / Vendor: Loxone

Communication Interface: Local HTTP JSON API (Default Port: 80 / 443, Endpoints: /jdev/sfs/getstatus)

Supported Hardware Models: Loxone Miniserver Gen 1 / Gen 2, Miniserver Compact (HTTP JSON API)

🔍 TELEMETRY READ OUT
Aggregated household power (W), Submeter power values (W), Total energy counters (kWh).

🎛️ CONTROLLED SETPOINTS
Read-only REST telemetry poller.

⚡ HANDLED & AUTOMATION ROLE
Bridges smart home installations running Loxone Miniserver into GEMS; allows GEMS to utilize Loxone smart meter data as the primary grid reference.

4.17 Niko Home Control (NHC II) `niko_nhc`

REST / HTTP

Manufacturer / Vendor: Niko

Communication Interface: Local Hobby API / REST (Default Port: 8884 or 80, JSON Endpoint: /hobby/v1/devices)

Supported Hardware Models: Niko Home Control II (Connected Controller with Energy Module / Electricity Clamps)

🔍 TELEMETRY READ OUT
Real-time grid import/export power (W), Sub-circuit power consumption (W), Cumulative energy (kWh).

🎛️ CONTROLLED SETPOINTS
Read-only local API.

⚡ HANDLED & AUTOMATION ROLE
Seamless integration with popular Belgian Niko Home Control installations; reads electricity clamp measurements to drive GEMS peak shaving.

4.18 P1 Smart Meter (Network/TCP) `p1_network`

P1 / SERIAL

Manufacturer / Vendor: Generic

Communication Interface: Raw TCP Socket stream (Default Port: 23, 8088, or 8234, Raw DSMR telegrams)

Supported Hardware Models: P1 Smart Meter Network Bridge (TCP/Ethernet P1 Readers, Telnet Bridges, ESP-P1, Ser2Net)

🔍 TELEMETRY READ OUT
Real-time active power (+ import / - export in Watts, OBIS 1.7.0 & 2.7.0), Cumulative tariff 1 & 2 energy (kWh, OBIS 1.8.1/2 & 2.8.1/2), 3-Phase currents (L1, L2, L3 in Amps, OBIS 31.7.0, 51.7.0, 71.7.0), 3-Phase voltages (L1, L2, L3 in Volts, OBIS 32.7.0, 52.7.0, 72.7.0), Flemish 15-minute peak demand register (W, OBIS 1.6.0), Gas consumption (m^3, OBIS 0-1:24.2.1).

🎛️ CONTROLLED SETPOINTS
Read-only digital telegram stream.

⚡ HANDLED & AUTOMATION ROLE
Primary grid interface for remote P1 meters over LAN: decodes official Fluvius (Belgium) and DSMR 4.x/5.x (Netherlands) telegrams; powers GEMS predictive Flanders capacity tariff engine and adaptive peak ceiling.

4.19 P1 Smart Meter (USB/Serial) `p1_serial`

P1 / SERIAL

Manufacturer / Vendor: Generic

Communication Interface: Direct Serial TTY (/dev/ttyUSB0 or /dev/ttyAMA0, Baud: 115200 for DSMR 4/5, 9600 for DSMR 2/3)

Supported Hardware Models: P1 Smart Meter Direct Serial Cable (USB-to-RJ12 FTDI / CP2102 Cable on Raspberry Pi USB)

🔍 TELEMETRY READ OUT
Real-time active power (W, OBIS 1.7.0/2.7.0), Tariff 1/2 import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Belgian quarterly maximum peak demand (W, OBIS 1.6.0), Gas meter volume (m^3).

🎛️ CONTROLLED SETPOINTS
Read-only digital telegram stream.

⚡ HANDLED & AUTOMATION ROLE
Direct zero-latency hardware connection to Belgian/Dutch smart meters; provides 1-second CRC-validated telegrams; core foundation for sub-second EV load balancing and Flanders capacity peak avoidance.

4.20 SMA Energy Meter 2.0 / Data Manager M (Modbus TCP) `sma_energymeter`

MODBUS

Manufacturer / Vendor: SMA

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 2 or 126)

Supported Hardware Models: SMA Energy Meter 2.0, SMA Data Manager M (Modbus TCP Speedwire)

🔍 TELEMETRY READ OUT
Active grid import/export power (W), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Active Power Curtailment Dispatch (commands SMA inverters via Data Manager).

⚡ HANDLED & AUTOMATION ROLE
Measures grid boundary power and acts as a gateway; informs GEMS about net exchange; executes active solar feed-in curtailment via SMA communications.

4.21 Schneider Electric Acti9 iEM3000 / PM3200 Series `schneider_iem3000` MODBUS

Manufacturer / Vendor: Schneider Electric

Communication Interface: Modbus RTU via RS485 Gateway or Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Schneider Electric Acti9 iEM3150, iEM3155, iEM3255, PowerLogic PM3200 Series

🔍 TELEMETRY READ OUT
Total active power (W), Active energy import/export (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Commercial and residential grade submetering; provides deterministic phase current telemetry to safeguard distribution boards from overloading.

4.22 Shelly 3EM (Gen 1 3-Phase Meter) `shelly_3em` REST / HTTP

Manufacturer / Vendor: Shelly

Communication Interface: Local HTTP REST API (Default Port: 80, JSON Endpoint: /status)

Supported Hardware Models: Shelly 3EM (Gen 1 3-Phase Wi-Fi Energy Meter with 120A CT Clamps)

🔍 TELEMETRY READ OUT
Total active power (W), Per-phase power (W), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), Cumulative returned/consumed energy (kWh).

🎛️ CONTROLLED SETPOINTS
Built-in 10A Contactor Output (Turn ON / Turn OFF via /relay/0?turn=on).

⚡ HANDLED & AUTOMATION ROLE
Reads high-speed 3-phase clamp measurements over Wi-Fi; built-in contactor can be automated to trigger external thermal loads or disconnect non-essential appliances during capacity peaks.

4.23 Shelly Pro 3EM / Gen3 3EM-63T (3-Phase Meter) `shelly_pro_3em` REST / HTTP

Manufacturer / Vendor: Shelly

Communication Interface: Local Gen 2/3 HTTP RPC (Default Port: 80, JSON Endpoint: /rpc/EM.GetStatus)

Supported Hardware Models: Shelly Pro 3EM, Shelly Pro 3EM-400, Shelly Gen3 3EM-63T (DIN-Rail Ethernet/Wi-Fi)

🔍 TELEMETRY READ OUT
Net active power across phases (W), Per-phase active power (W), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts), 4-Quadrant energy counters (kWh).

🎛️ CONTROLLED SETPOINTS
Built-in Auxiliary Relay Output (Turn ON / Turn OFF via /rpc/Switch.Set).

⚡ HANDLED & AUTOMATION ROLE
High-reliability Ethernet-connected DIN meter: feeds instant phase telemetry into GEMS for sub-second EV current throttling; auxiliary relay output automates heat pump boost or domestic hot water.

4.24 Siemens SENTRON (PAC2200 / 7KT1665 Meter) `siemens_pac2200` MODBUS

Manufacturer / Vendor: Siemens

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Siemens SENTRON PAC2200, 7KT1665 Series 3-Phase Modbus Smart Meters

🔍 TELEMETRY READ OUT
Total active power (W), Cumulative import/export energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Premium industrial grade metering; monitors connection capacity and streams telemetry to GEMS for active load shedding and ROI calculations.

4.25 Socomec COUNTIS E24/E34/E44 / DIRIS A-40 `socomec_meter` MODBUS

Manufacturer / Vendor: Socomec

Communication Interface: Modbus RTU via RS485 Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Socomec COUNTIS E24, E34, E44 Series, DIRIS A-40 Multifunction Energy Meters

🔍 TELEMETRY READ OUT
Total active power (W), Active energy import/export (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Accurate 3-phase commercial and domestic metering; informs GEMS about phase load distribution to balance EV charging and avoid tripping supply fuses.

4.26 WAGO 879 Series (879-3000 / 879-3020 / 879-3040) `wago_879`

MODBUS

Manufacturer / Vendor: WAGO

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: WAGO 879 Series (879-3000, 879-3020, 879-3040 3-Phase DIN-Rail Energy Meters)

🔍 TELEMETRY READ OUT
Active power (W), Total active energy (kWh), 3-Phase currents (L1, L2, L3 in Amps), 3-Phase voltages (L1, L2, L3 in Volts).

🎛️ CONTROLLED SETPOINTS
Read-only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Precision DIN-rail meter; streams 3-phase currents and voltages into GEMS for real-time fuse protection, solar surplus calculations, and energy flow visualization.

4.27 Accuenergy AcuRev / Acuvim Series Meter `accuenergy_meter`

MODBUS

Manufacturer / Vendor: Accuenergy

Communication Interface: Modbus TCP / RTU via RS485 Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Accuenergy Acuvim II, AcuRev 1310, AcuRev 2100 Multi-Circuit Submeter

🔍 TELEMETRY READ OUT
Real-Time Net Grid Active Power (W), Total Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
High-precision 3-phase grid boundary monitoring and phase load balancing for commercial and residential installations.

4.28 Algodue UPM209 / UPM309 Series Meter `algodue_meter`

MODBUS

Manufacturer / Vendor: Algodue

Communication Interface: Modbus RTU / TCP via RS485 Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Algodue UPM209, UPM309 3-Phase Network Analyzers

🔍 TELEMETRY READ OUT
Real-Time Net Grid Active Power (W), Total Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Continuous grid exchange measurement, power factor monitoring, and breaker overload protection.

4.29 Chint DTSU666 / DTSU666-H 3-Phase Meter `chint_dtsu666`

MODBUS

Manufacturer / Vendor: Chint

Communication Interface: Modbus RTU via RS485 / Modbus TCP Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Chint DTSU666, DTSU666-H 3-Phase Direct & CT Smart Meters

🔍 TELEMETRY READ OUT
Real-Time Net Grid Active Power (W), Total Import & Export Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Standard 3-phase bidirectional grid meter integration; drives solar surplus calculations and EV charger current modulation.

4.30 Hager ECM / ECR / ECP Energy Meter `hager_meter`

MODBUS

Manufacturer / Vendor: Hager

Communication Interface: Modbus RTU / TCP via Agardio / IP Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Hager ECM, ECR, ECP, and SM103E 1-Phase and 3-Phase Energy Meters

🔍 TELEMETRY READ OUT
Real-Time Net Grid Power (W), Total Import Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
DIN-rail residential distribution board monitoring, feeding sub-second phase telemetry into GEMS overload protection.

4.31 Janitza UMG Series Power Analyzer `janitza_umg`

MODBUS

Manufacturer / Vendor: Janitza

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Janitza UMG 96RM, UMG 604, UMG 509 Power Quality Analyzers

🔍 TELEMETRY READ OUT
Real-Time Net Grid Power (W), Total Import Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Line Voltages (V), Frequency (Hz).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
High-precision industrial power analyzer integration, capturing high-frequency grid flow and phase imbalance metrics.

4.32 Kamstrup Energy Meter (Modbus Gateway) `kamstrup_meter`

MODBUS

Manufacturer / Vendor: Kamstrup

Communication Interface: Modbus RTU / TCP via M-Bus / Modbus Gateway (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Kamstrup OMNIPOWER and MULTICAL Electricity & Thermal Meters

🔍 TELEMETRY READ OUT
Real-Time Net Grid Power (W), Total Import Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Integrates utility electricity and district heating/cooling submeters into the GEMS overall energy overview.

4.33 Landis+Gyr Industrial Utility Meter `landisgyr_meter`

MODBUS

Manufacturer / Vendor: Landis+Gyr

Communication Interface: Modbus RTU / TCP via Communication Unit (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Landis+Gyr E550, E650, E850 Industrial & Commercial Meters

🔍 TELEMETRY READ OUT
Real-Time Net Grid Power (W), Total Import & Export Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Monitors large commercial and industrial connection points to ensure dynamic peak shaving compliance.

4.34 Phoenix Contact EMpro Energy Meter `phoenix_empro`

MODBUS

Manufacturer / Vendor: Phoenix Contact

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Phoenix Contact EMpro EEM-MA370, EEM-MB370 Series

🔍 TELEMETRY READ OUT
Real-Time Net Grid Power (W), Total Import Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Streams real-time 3-phase grid boundary measurements into GEMS for instantaneous solar tracking.

4.35 Weidmüller Energy Meter (500 / 600 / 700) `weidmuller_meter`

MODBUS

Manufacturer / Vendor: Weidmüller

Communication Interface: Modbus TCP (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Weidmüller Energy Meter 525, 610, 700 Series

🔍 TELEMETRY READ OUT
Real-Time Net Grid Power (W), Total Import Energy (kWh), Phase Currents (L1, L2, L3 in Amps), Voltages (V).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Industrial grade power monitoring for multi-tenant and facility sub-distribution boards.

4.36 YouLess LS120 Pulse & P1 Meter `youless_ls120`

REST / HTTP

Manufacturer / Vendor: YouLess

Communication Interface: Local HTTP REST API (Default Port: 80, Endpoint: /a?f=j)

Supported Hardware Models: YouLess LS120 Optical Pulse & P1 Dongle

🔍 TELEMETRY READ OUT
Real-Time Net Grid Power (W), Total Import Energy (kWh).

🎛️ CONTROLLED SETPOINTS
Autonomous / Read-Only grid telemetry.

⚡ HANDLED & AUTOMATION ROLE
Connects to digital smart meter P1 ports or legacy optical rotating disc meters over local LAN without cloud subscriptions.

🔌 Category 5: Smart Relays & Load Actuators (6 Native Templates)

Actuator templates integrate potential-free contactors, smart DIN plugs, and SG-Ready heat pump inputs over local LAN REST/RPC or Modbus coils. GEMS automatically triggers domestic hot water (DHW) immersion heaters, heat pump boost states, or pool pumps when solar surplus or negative pricing thresholds are reached, with built-in minimum run-time hysteresis.

5.1 Generic HTTP Relay `generic_relay`

REST / HTTP

Manufacturer / Vendor: Generic

Communication Interface: Local HTTP REST (Default Port: 80 / 8080, Configurable URL endpoints for State and Toggle)

Supported Hardware Models: Generic HTTP REST Relay (ESP8266, ESP32, Tasmota, Shelly Gen1, Custom Microcontrollers)

🔍 **TELEMETRY READ OUT**
Active power consumption of connected appliance (W, optional if meter reported).

🎛️ **CONTROLLED SETPOINTS**
Relay Contactor Output State (Turn ON / Turn OFF).

⚡ **HANDLED & AUTOMATION ROLE**
Automated contactor control: engages domestic hot water immersion heaters, pool circulation pumps, or resistive heating when solar export exceeds configurable thresholds (e.g., > 1500W for 2 minutes); enforces minimum run-time and off-time hysteresis.

5.2 Shelly Plus 1PM / Pro 1PM / Plug S (Relay & Power) `shelly_plus_1pm`

REST / HTTP

Manufacturer / Vendor: Shelly

Communication Interface: Local Gen 2/3 HTTP RPC (Default Port: 80, Endpoints: /rpc/Switch.Set, /rpc/Switch.GetStatus)

Supported Hardware Models: Shelly Plus 1PM, Shelly Pro 1PM, Shelly Plug S, Shelly Pro 2PM (Gen 2 / Gen 3 Mongoose OS)

🔍 **TELEMETRY READ OUT**
Connected appliance active power (W), Cumulative energy consumption (kWh), Internal device temperature (°C), Supply voltage (V).

🎛️ **CONTROLLED SETPOINTS**
Relay Contactor Output State (Turn ON / Turn OFF via /rpc/Switch.Set).

⚡ **HANDLED & AUTOMATION ROLE**
SG-Ready Heat Pump Boost & Appliance Automation: drives Heat Pump SG-Ready Operating State 3 (thermal boost mode) or hot water boilers during solar surplus or negative spot price hours; tracks real-time load wattage in GEMS logger.

5.3 Modbus Digital I/O Relay Module `modbus_relay`

MODBUS

Manufacturer / Vendor: Modbus Relais / I/O

Communication Interface: Modbus TCP / RTU via RS485 (Default Port: 502, Slave ID: 1)

Supported Hardware Models: Waveshare Modbus RTU/TCP Relay, ADAM-4000/6000, Moxa ioLogik, Kincony Modbus Relay

🔍 **TELEMETRY READ OUT**
Digital Input / Output Coil States (Open / Closed).

🎛️ **CONTROLLED SETPOINTS**
Relay Coil Actuation (Coil 1–8 Turn ON / OFF).

⚡ **HANDLED & AUTOMATION ROLE**
Industrial-grade contactor switching for high-current loads, three-phase thermal heaters, and heavy machinery peak shedding.

5.4 SG-Ready Heat Pump (Daikin/Nibe/Bosch/Vaillant/Panasonic) `sgready_heatpump`

REST / HTTP

Manufacturer / Vendor: SG-Ready (Daikin, Nibe, Bosch/Nefit, Vaillant, Panasonic, Mitsubishi, Stiebel Eltron, Wolf)

Communication Interface: Local HTTP REST / Relay Controller (Default Port: 80, REST Endpoint: /api/sgready)

Supported Hardware Models: Standard SG-Ready (Smart Grid Ready) Heat Pumps via dual potential-free relay contacts or local smart module

🔍 **TELEMETRY READ OUT**
Operating State (Operating State 1: Lock / State 2: Normal / State 3: Boost / State 4: Fast Heat), Power Consumption (W).

🎛️ **CONTROLLED SETPOINTS**
SG-Ready Operating Mode (State 2 Normal vs. State 3 Thermal Boost).

⚡ **HANDLED & AUTOMATION ROLE**
Automated heat pump thermal storage: commands State 3 (increased thermal setpoint) during solar surplus or negative dynamic price hours to preheat domestic water and buffers; returns to State 2 during grid peaks.

5.5 Shelly Plus 1 / Pro 1 (Dry Contact Relay) `shelly_plus_1`

REST / HTTP

Manufacturer / Vendor: Shelly

Communication Interface: Local HTTP RPC (Default Port: 80, Endpoint: /rpc/Switch.Set)

Supported Hardware Models: Shelly Plus 1, Shelly Pro 1 (Gen 2 / Gen 3 potential-free dry contact relays)

🔍 **TELEMETRY READ OUT**
Switch State (On / Off), Device Temperature (°C), Input State.

🎛️ **CONTROLLED SETPOINTS**
Dry Contact Relay Output State (Turn ON / Turn OFF).

⚡ **HANDLED & AUTOMATION ROLE**
Potential-free contact closure to trigger SG-Ready heat pump inputs, EV charger external inhibit terminals, or domestic circulation pumps.

5.6 Shelly Plus 2PM / Pro 2PM (Dual Relay & Meter) `shelly_plus_2pm` REST / HTTP

Manufacturer / Vendor: Shelly

Communication Interface: Local HTTP RPC (Default Port: 80, Endpoints: /rpc/Switch.Set, /rpc/Switch.GetStatus)

Supported Hardware Models: Shelly Plus 2PM, Shelly Pro 2PM (Dual-channel relay with independent power metering)

🔍 TELEMETRY READ OUT

Channel 1 & Channel 2 Active Power (W), Cumulative Energy per channel (kWh), Supply Voltage (V).

🎛️ CONTROLLED SETPOINTS

Dual Relay Output States (Channel 0 & Channel 1 Independent On / Off).

⚡ HANDLED & AUTOMATION ROLE

Independent dual-circuit automation: controls and measures multiple resistive heating stages or controls dual-coil SG-Ready heat pump configurations (State 1 through State 4).

5. Communication Protocols & Field Wiring Reference

Connecting physical energy devices to the GEMS Raspberry Pi requires standard industrial interfaces. Below is the reference wiring and protocol architecture:

1. Modbus TCP & Modbus RTU (RS485)

Modbus TCP (Ethernet / Wi-Fi)

Standard industrial port 502 (or 5020/8899). Connects directly via local LAN. Supports simultaneous pollers and sub-second update latency. Zero wiring required when devices reside on the same local subnet.

Modbus RTU RS485 & Persistent USB IDs

Requires shielded twisted-pair cable (A+, B−, GND) in a daisy-chain topology with 120Ω end-of-line termination and unique Slave IDs. GEMS shares multi-drop RS485 buses safely and exposes persistent `/dev/serial/by-id/*` symlinks so USB adapters never swap across reboots.

2. Local OCPP 1.6-J Server (EVSE)

GEMS operates a high-performance, embedded local OCPP 1.6-J Central System on both dedicated port `8887` and reverse-proxy-friendly port `8080`. No external cloud subscription or third-party backend is needed for standalone installations:

LOCAL OCPP 1.6-J SERVER CONNECTION ENDPOINTS

`ws://<GEMS-IP>:8887/<ChargePointID>` or `ws://<GEMS-IP>:8080/api/ocpp/<ChargePointID>`

When configured, the EV charger sends real-time MeterValues (W, Wh, Amps, Volts) and receives dynamic `SetChargingProfile` setpoints calculated every second by the GEMS control loop.

3. P1 Port DSMR Smart Meters (Fluvius, Dutch Smart Meter)

Direct connection from the digital meter's RJ12 P1 port into the GEMS Raspberry Pi via USB-to-RJ12 cable:

PIN	SIGNAL NAME	DESCRIPTION	CONNECTION ON RASPBERRY PI USB ADAPTER
Pin 1	+5V Power	Meter Power Supply (+5V DC, max 250mA on DSMR 5.0)	Connected to USB VCC (Optional, powers external dongle)
Pin 2	Data Request	Active-High Request Line	Tied to +5V (pull-up) to continuously enable telemetry output
Pin 3	Data GND	Ground Reference	Connected to USB GND (Ground)
Pin 4	NC	Not Connected	Unused
Pin 5	Data Line (TxD)	Inverted Serial Telemetry (115200 baud, 8N1)	Connected to USB RxD (via hardware transistor or FTDI inverted RX)
Pin 6	Power GND	Ground Reference for +5V	Connected to USB GND

GEMS Supported Hardware & Devices Manual • End of Technical Reference

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