DAI – Minimise PV Clipping v2.1 – Detailed Design Specification (v1.0)

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Design Framework: DAI + RBC Framework v5.85 (Oct 2025)

Governance Reference: REFAC-ONLY compliance update (syntax + helper alignment, behaviour unchanged from v2.0)

Change Control: No-Surprises Protocol – Semantics Frozen by default.

1. Functional Overview

The DAI – Minimise PV Clipping (v2.1) automation manages solar export clipping during daytime operation. It dynamically toggles the inverter between Feed-in Priority and Self Use modes based on real-time PV surplus, forecasted headroom, and battery State of Charge (SoC). The goal is to prevent inverter clipping by utilising available battery headroom for charging when solar output exceeds site load. The automation operates autonomously between 08:00 and 14:00 (or until a user-defined cutoff) and ensures the inverter reverts to Self Use Mode afterwards. This version (v2.1) is a REFAC-ONLY compliance release that updates syntax and helper references to align with Home Assistant 2025.10 schema requirements. Behaviour remains identical to v2.0.

2. Entity and Helper Map

Role	Entity ID	Direction	Description
PV Surplus (5m avg)	sensor.dai_pv_surplus_5m_avg_w	Read	Live solar generation surplus average (W).
Forecast Margin	sensor.dai_surplus_headroom_margin_kwh	Read	Forecasted energy headroom available (kWh).
Master Battery SoC	sensor.solax_house_battery_capacity	Read	Master inverter battery state of charge.
Slave Battery	sensor.solax_garage_battery_capacity	Read	Slave inverter battery state

SoC			of charge.
PV Surplus Threshold	input_number.dai_pv_surplus_threshold_w	Read	Minimum PV surplus required to enable Feed-in Priority.
Minimum SoC Floor	input_number.dai_min_soc_hard_floor	Read	Lowest allowable battery SoC before returning to Self Use.
Feed-in Stop SoC	input_number.dai_feedin_stop_soc	Read	Upper SoC limit where Feed-in charging ceases.
Hysteresis Helper	input_number.dai_hysteresis_min	Read	Minimum dwell time between inverter mode changes (minutes).
Cutoff Time Helper	input_datetime.dai_latest_feedin_cutoff	Read	Latest permissible time for Feed-in Priority operation.
Hard Deadline	Fixed 14:00:00	Read	Absolute cutoff time enforcing Self Use mode.
Override Flag	input_boolean.dai_session_override_active	Read	Blocks writes during Octopus Free/Saving Sessions.

Agent Active Flag	input_boolean.dai_agent_active	Read	Global DAI enable toggle.
Inverter Mode Control	select.solax_house_charger_use_mode	Write	Master inverter operating mode (Feed-in / Self Use).
Logbook Entry	logbook.log	Write	Used for recording automation actions and system events.

3. Trigger Matrix and Expected Outcomes

Trigger ID	Source	Event/Time	Expected Outcome
t_live_surplus	State	Change in PV surplus average	Evaluates real-time PV headroom for mode adjustment.
t_forecast_margin	State	Change in forecasted headroom margin	Reassesses Feed-in eligibility based on forecast.
t_master_soc / t_slave_soc	State	Change in battery SoC	Checks dual-SoC thresholds for Feed-in gating.
t_schedule_tick	Time pattern	Every 5 min	Evaluates conditions and dwell timers for safe toggling.
t_morning_init	Time	09:00	Initialises cutoff validation and clamps latest cutoff to 14:00 if later.
t_hard_deadline	Time	14:00	Forces inverter to Self Use mode at hard deadline.
t_cutoff	Time	User cutoff helper	Triggers earlier Self Use if helper cutoff

		time	reached.
t_agent_toggle	State	Agent enable flag change	Activates or pauses automation.
t_override_toggle	State	Session override flag change	Suspends automation during Free/Saving sessions.

4. Logic Flow Description

• Morning Initialisation (09:00): Validates helper cutoff time; clamps any value later than 14:00. Logs warning to input_datetime.dai_latest_feedin_cutoff if clamped.
• Operating Window (08:00–14:00): Continuously monitors PV surplus, forecast headroom, SoC band, and hysteresis dwell. If all gates pass (forecast_ok, live_ok, SoC between min_floor and stop), sets inverter to Feed-in Priority. If gates fail or cutoff reached, returns inverter to Self Use Mode.
• Dual-SoC Gates: Feed-in requires both Master and Slave batteries ≥55%. Self Use is reasserted when either drops below 53%.
• Hard Stop (14:00): Forces inverter to Self Use Mode regardless of conditions; ensures safe afternoon behaviour.
• Override & Lockout: Pauses automation during Octopus Free/Saving sessions or when manual control is active.
• Hysteresis Control: Prevents frequent toggling; uses helper input_number.dai_hysteresis_min for dwell time enforcement.

5. Interaction and Control Hierarchy

Layer	Role	Behaviour / Control
PV Clipping Controller	Manages export limitation	Takes control during 08:00–14:00 daylight window; yields afterward.
Grid Charge Planner	Determines night SoC targets	Owns overnight SoC floors; independent of PV Clipping logic.
Cosy Night Cheap Charge	Controls 22:00–23:59 cheap-rate window	Operates independently; runs when PV Clipping idle.
Free Energy Session Controller	Manages Free Energy events	Pauses PV Clipping automation via override flag.

Anti-Clipping Monitor	Failsafe safety layer	Validates inverter state and battery headroom; requests Feed-in if safe.

6. Safety and Recovery Mechanisms

- Override guard prevents writes during Free or Saving Sessions.
- Dual-SoC gating ensures both batteries retain safe operating range.
- Hysteresis dwell helper avoids rapid inverter toggling.
- Hard 14:00 cutoff guarantees Self Use mode before afternoon export periods.
- All writes are idempotent and limited to Master inverter (solax_house_*).
- HA restart safety ensured by periodic schedule ticks and state re-evaluation.

7. Notifications and Logging

All key actions are logged to the Home Assistant logbook and to input_text.dai_common_log. Notifications are sent to the Pixel 9 Pro mobile device when inverter mode changes occur. Typical log entries include:

- 'Mode → Feedin Priority. Reason: All gates true.'
- 'Mode → Self Use. Reason: Post-cutoff guard.'
- '14:00 deadline → Mode changed to Self Use Mode.'
- 'Helper cutoff clamped to 14:00 for today.'

8. Acceptance Test Cases

Test Case	Action	Expected Result
A1 – Normal Operation	Allow run from 08:00 to 14:00 with adequate PV surplus.	Inverter enters Feed-in Priority when all gates pass; returns to Self Use at cutoff.
A2 – Low SoC	Reduce battery SoC below 53%.	Inverter reverts to Self Use immediately.
A3 – Hard Deadline	Wait until 14:00.	Inverter forced to Self Use; notification sent.
A4 – Override Active	Enable session override flag.	Automation suspended; no mode changes occur.
A5 – Forecast Drop	Set forecast margin sensor below zero.	Inverter reverts to Self Use; reason logged.
A6 – HA Restart	Restart Home Assistant mid-day.	Automation resumes with correct inverter state on next tick.

9. Version Lineage and Governance

v2.1 (2025-10-23): REFAC-ONLY compliance update. Converted all service calls to 'service:' syntax, aligned dwell helper to input_number.dai_hysteresis_min, and quoted string states in waits/conditions. No behavioural or logical changes. Linked to Design-Doc v5.85 §8.3.
v2.0 (2025-09-30): Introduced dual-SoC gating, cutoff helper, and dwell hysteresis logic.
v1.x (2025-08): Initial PV clipping avoidance prototype.