A Workable Region-Based Energy Target Mechanism for Rooftop PV (and other Small-Scale Generation) Using Existing Deployed Capabilities.

A Concept Note V1.2

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Executive Summary (General Audience)

Australia's rooftop solar success has created a new challenge: **exports, not generation, are now the limiting factor**. Millions of small solar systems can already produce far more clean energy than the grid can easily absorb at certain times of day, particularly around midday. Today, the tools available to manage this are blunt ones: fixed export limits, emergency shutdowns, or indirect price signals that most households never see in real time. The result is a system where valuable clean energy is either wasted or destabilising, while grid operators are forced to react rather than plan.

Unwanted energy exports impose real costs on the system because that energy must be absorbed, curtailed, or corrected elsewhere. For households, this shows up as an ever-widening gap between what they are paid for exported energy and what they must pay to import it. In practice, solar exports are already close to worthless in many Australian states. This paper outlines a practical pathway to **restore value to daytime solar exports**, while simultaneously reducing the grid costs that ultimately drive higher retail prices.

The core idea is simple but powerful: instead of trying to control individual systems, define a **shared energy target for small-scale exports** and allow the system to self-organise around it. By publishing a clear, voluntary signal that indicates how much exported energy is useful at a given time, updated at operational timescales, millions of solar systems, batteries, and other small generators could gently adjust their exports using controls that already exist in today's inverters and controllers. Even a modest contribution, on the order of **1 kilowatt per participating system** would aggregate into gigawatts of predictable clean energy nationwide, far more reliable than today's unmanaged export swings.

As participation increases (supported through appropriate incentives such as reduced bills, free installation, or once-off opt-in payments), confidence in the aggregate response grows. Targets can then be refined by region, adjusted seasonally, and increased where local networks are upgraded. This creates a clear pathway from today's unmanaged export conditions toward a future where distributed energy is predictable, valuable, and fairly integrated into the grid. Rather than relying solely on ever-larger transmission investments to distant generators, this approach helps unlock the substantial latent capacity already present on rooftops and accelerating the energy transition while improving grid stability, market efficiency, and public confidence.

Executive Summary (Market Operator Audience)

Small-scale export-capable DER now represents a material and growing contributor to daytime system outcomes in several NEM regions. While individual systems are subject to fixed export limits and, emergency backstop mechanisms exist for network protection, aggregate export behaviour remains largely unmanaged outside of these controls. As a result, small-scale exports are predominantly weather driven, only probabilistically forecastable, and contribute to price volatility, increased ramping requirements, and a growing reliance on corrective interventions to maintain system balance.

The core challenge is not the availability of this energy, but the absence of a mechanism to shape aggregate export toward predictable, system-useful levels at operational timeframes.

This paper proposes that AEMO could explicitly define a **system-level energy target for small-scale export-capable DER**, published as a coarse, non-binding sub-regional signal and updated at dispatch or pre-dispatch intervals that can substantially influence the aggregated PV contribution. Using existing **Point-of-Common-Coupling** export controls already deployed in inverters and energy controllers, participating systems would voluntarily converge toward this target without dispatch, mandates, or unit-level control. Importantly, the mechanism does not rely on large per-unit responses to be effective. A modest indicative contribution on the order of **~1 kW per participating unit** is likely to be reliably achievable across a wide range of conditions, even at relatively low adoption levels, enabling early demonstration of predictable aggregated response.

As participation increases and confidence in fleet response grows, the scale of the export energy target can be adjusted incrementally, refined spatially with DNSP input, or varied seasonally to reflect system needs and local network conditions. In this way, the mechanism provides a clear transition pathway from today's largely unmanaged export behaviour toward a more predictable, system-integrated resource. By improving the reliability and predictability of aggregate small-scale exports, the approach supports more efficient market outcomes, reduces operational uncertainty, and provides valuable insight to inform targeted distribution network upgrades, all while remaining complementary to existing forecasting, emergency controls, and market frameworks.

Purpose

To outline a practical, voluntary mechanism by which AEMO could define a region-based **small-scale energy export target**, that would significantly influence exports using existing **Point-of-Common-Coupling (PCC)** export-limitation capability without dispatch or mandates.

While rooftop PV is the primary focus, reflecting its scale and current system impact, the mechanism is intentionally technology-agnostic and is not restricted to PV by design.

Why This Matters

Australia's rooftop PV fleet is transitioning from *capacity-constrained* to *energy-abundant*:

- Roof-filling PV designs are becoming rational and economically necessary
- Export limits at the PCC, not inverter size, are now the primary grid safeguard
- System risk is increasingly driven by **when energy is exported**, not how much PV is installed

Yet today, AEMO has no mechanism to **proactively shape aggregate small-scale generation export energy** - only blunt tools to curtail export once conditions have already deteriorated.

The Missing Capability

AEMO cannot currently express how much rooftop PV export energy the system wants - only when export must be stopped.

This gap becomes structural as PV penetration increases and Partial DCU configurations (pending CER determination) normalise higher installed capacity behind PCC-limited connections.

The Core Idea

AEMO publishes a coarse, voluntary region specific signal describing the desirability of additional Small Scale (primarily rooftop PV) export energy at a given time.

The signal:

- expresses *direction*, not instructions
- is informational, not mandatory
- reflects system conditions AEMO already assesses
- allows DER to self-coordinate without dispatch

DER systems that already enforce export at the PCC can **voluntarily converge toward the implied energy target** using **existing control mechanisms**.

What the Signal Looks Like

A simple **Export Demand Band**, for example:

- **VERY LOW** – additional PV export is undesirable, suggest zero export
- **LOW** - exports are less desirable, reduced export suggested
- **BALANCED** *(target state)*
- **HIGH** – exports are more desirable, increase export is suggested
- **VERY HIGH** – additional PV export is highly desirable, max production is suggested

Published:

- at regional or logical sub-regional level
- with short validity (e.g. 5–10 minutes)
- derived from dispatch, pre-dispatch, constraints, and system-stress indicators
- with no unit-level or commercial information

Specific sub-regional boundaries could be defined with DNSP input to reflect known local export constraints, improving signal accuracy while providing valuable insight for targeted network upgrades.

How DER Responds (Conceptually)

DER controllers that already limit export at the PCC may voluntarily:

- reduce export when bands indicate oversupply
- restore export as conditions move back toward balance
- apply rate limits, deadbands, and randomisation to avoid synchronised behaviour

At all times:

- export never exceeds approved limits
- DNSP operating envelopes remain authoritative
- import and inverter dispatch are unaffected

Behind-the-meter optimisation (generation, storage, and load) continues uninterrupted.

Why This Works at Scale

- Feedback drives convergence toward the target at dispatch time-scales.
- Large, export-constrained systems naturally provide most response
- Smaller systems self-limit by capability
- Heterogeneity improves stability rather than undermining it
- Partial participation still delivers system benefit

This mirrors proven decentralised control paradigms used in other large-scale systems.

Broader Applicability

Although rooftop PV and home storage currently represents the vast majority of small-scale generation and is the dominant driver of midday oversupply, the underlying coordination challenge is not PV-specific.

Any small-scale generation or stored-energy discharge asset that:

- exports through a PCC-limited connection, and
- can adjust export in response to system conditions,

could participate under the same framework.

This includes, in principle, small hydro, waste-heat or low-temperature ORC systems, and thermal battery discharge, should these technologies become material at scale.

No technology-specific assumptions are embedded in the signal itself.

Security Considerations

As with any system-wide coordination signal, the integrity and authenticity of the published information is critical.

Broader cyber-security, resilience, and misuse scenarios - including the risk of a compromised "source of truth" - have **not** been explored in this concept note and would require careful consideration in any implementation.

However, the proposed signal is:

- coarse and time-limited
- informational rather than directive
- incapable of increasing export beyond approved limits

These properties inherently limit the impact of misuse compared to direct control or dispatch mechanisms.

What This Enables for AEMO

This approach provides AEMO with a **new, missing lever**:

- the ability to shape aggregate rooftop PV export energy over time, not just stop export
- proactive mitigation of midday oversupply
- smoother export profiles across regions
- reduced reliance on emergency backstops

All while preserving existing market structures, DNSP authority, and technology neutrality.

Proposed Next Step

A practical next step would be to **characterise and quantify the system-level effects of existing voluntary export-shaping mechanisms** that are already operating in the NEM, albeit at limited scale and without formal coordination.

Examples include:

- retailer-led dynamic FiT and load-shifting programs (e.g. negative or variable FiT signals),
- third-party export or load controllers operating at the PCC,
- inverter-native dynamic export or DER flexibility programs enabled through existing DNSP and manufacturer frameworks.

While these mechanisms have been deployed primarily for customer cost optimisation or local network protection, they collectively demonstrate that **export behaviour can be influenced predictably using coarse external signals**, without inverter dispatch or system-level visibility of site internals.

AEMO-led analysis of anonymised or aggregate outcomes from such programs, including changes in net export profiles, ramping behaviour, and forecast error during daylight hours would provide an evidence-based foundation for assessing whether a formalised, region-level export desirability signal could deliver material system benefits.

This analysis could be undertaken without changes to regulatory settings, market arrangements, or operational responsibilities, and would inform whether further development or standardisation is warranted.

Key Takeaway

By publishing system truth instead of instructions, AEMO can define realistic regional energy targets for rooftop PV - with a framework that naturally extends to other forms of small-scale generation.

Appendix A - Regulatory Context: Partial DCU Configurations and System Design Incentives

Purpose of This Appendix

This appendix provides regulatory and economic context for the concept note by clarifying the current status of **Partial DCU configurations**, their economic implications, and the relevance of potential CER guidance.

It is included for background only and does not depend on a specific regulatory outcome.

Current Status of Partial DCU Configurations

Partial DCU configurations are **already lawful** and can be deployed under existing electrical and energy regulations.

In practice, Partial DCU systems:

- decouple installed generation capacity from inverter capacity,
- typically configured to constrain export at the **Point of Common Coupling (PCC)**,
- allow additional generation to serve behind-the-meter loads or storage.

There is no technical or regulatory prohibition on such designs today.

Economic Reality

Modelling and early deployments clearly demonstrate that Partial DCU-style designs deliver:

- materially higher energy yield over the year,
- improved winter and shoulder performance,
- superior alignment with electrification and energy-transition loads,
- strong return on investment compared to traditional inverter-limited designs.

As a result, Partial DCU configurations are already an **economically superior solution** in many use cases, irrespective of formal incentive treatment.

Role of CER Guidance

Partial DCU configurations can already be deployed under current rules. The role of CER guidance is therefore not to permit or prohibit these systems, but to clarify how they are recognised for incentive and scheme purposes.

If CER guidance explicitly recognises Partial DCU systems in line with the intent of small-scale energy legislation:

- such systems would be **incentivised appropriately**, rather than treated as edge cases,
- installers would be **commercially compelled** to offer them as a superior solution,
- roof-filling and export-limited designs would become the mainstream deployment model.

In this sense, CER guidance does not *enable* Partial DCU - it **accelerates adoption by aligning incentives with technical reality**.

Implications for System Coordination

As Partial DCU-style designs scale:

- installed PV capacity becomes an increasingly poor proxy for grid impact,
- PCC export limits become the dominant system safeguard,
- aggregate system risk shifts from capacity to **export energy timing**.

This transition is already underway and will intensify as:

- PV penetration increases,
- behind-the-meter loads grow,
- and storage becomes more prevalent.

Relationship to the Proposed Concept

The region-based energy target concept assumes:

- export can be constrained at the PCC,
- generation capacity is no longer the primary control variable,
- system coordination must focus on **when export occurs**, not how much capacity exists.

The concept:

- does **not** require changes to CER rules to function,
- but becomes increasingly valuable as Partial DCU adoption expands,
- provides a system-level coordination layer consistent with the economic trajectory of DER.

Key Takeaway

Partial DCU configurations are **already legal and economically compelling**.

Clear CER guidance would align incentives with this reality and accelerate adoption, making **export energy coordination - rather than capacity restriction - the central system challenge**.

The proposed region-based energy target mechanism directly addresses that challenge.

Appendix B - Practical Walkthrough: DER Response Using PCC Export Control

Purpose of This Appendix

This appendix provides a **practical, step-by-step illustration** of how a small-scale generation system or **Distributed Energy Resource (DER)** that already enforces export limits at the **Point of Common Coupling (PCC)** could respond to the proposed **regional energy target signal**.

It is illustrative only and does not prescribe a specific control algorithm, product, or implementation.

Assumptions

The walkthrough assumes a DER system that:

- enforces export limits at the PCC,
- can adjust its export limit dynamically within approved bounds,
- never exceeds DNSP-approved export limits,
- continues to optimise generation, storage, and loads behind the meter independently.

No assumptions are made about inverter brand, protocol, or internal control architecture.

Initial State

Under normal operating conditions:

- the DER system enforces its **current export limit setting** (which may be below the maximum approved limit),
- behind-the-meter optimisation (battery charging, load supply, curtailment) operates as usual,
- the system periodically retrieves the current **regional export demand band** published by AEMO.

The export limit in force at any given moment reflects prior system conditions and local optimisation, not a mandated default.

Signal Interpretation

The regional signal is interpreted as **context**, not instruction.

For example:

Export Demand Band	Interpretation
VERY LOW	Additional export is strongly discouraged
LOW	Export reduction is preferred
BALANCED	**Maintain current export setting**
HIGH	Additional export is useful
VERY HIGH	Maximum export is beneficial

The signal does **not** instruct a specific power level and does not imply any compliance obligation.

Export Adjustment Behaviour

Based on the signal, the DER system may voluntarily adjust its **internal export limit**:

- **LOW or VERY LOW**
    - the system gradually reduces its export limit **below the current setting** over a number of cycles,
    - excess generation is diverted to storage or curtailed behind the meter,
    - rate limits and deadbands prevent abrupt changes.
- **BALANCED**
    - the export limit is **held at its current value**,
    - no automatic restoration or further adjustment occurs.
- **HIGH or VERY HIGH**
    - the system may gradually increase export **toward its approved PCC limit** over a number of cycles,
    - export never exceeds the DNSP-approved maximum.

At all times:

- export ≤ approved PCC limit,
- import behaviour is unaffected,
- inverter dispatch is not necessarily required (export limit adjustment should be sufficient)

Stability and Anti-Synchronisation Measures

To avoid oscillation or synchronised behaviour across many units, DER controllers may apply:

- minimum hold times,
- hysteresis around band transitions,
- randomised response delays,
- capped rates of change.

Such measures are standard in distributed control systems and require no coordination between units.

Loss of Signal or Ambiguity

If the regional signal becomes unavailable, stale, or ambiguous:

- the DER system ***gradually*** reverts to its **locally configured behaviour**,
- export remains constrained by the approved PCC limit,
- no degraded or unsafe operation occurs.

The signal is therefore would typically be **non-critical** to safe system operation – but in the event of high reliance on the mechanism and loss of control signal, a ***gradual shift to normal process*** ensures there is time for mitigation to be put in place (mitigation process already in place may be sufficient).

System Shutdown or Low Generation

When generation falls below meaningful export levels (e.g. evening or adverse conditions, Battery low state of charge):

- the DER system restores export settings to normal operating behaviour,
- regional signals are ignored until meaningful export resumes.

This prevents unnecessary control activity during non-export periods.

Aggregate System Outcome

At scale, this behaviour results in:

- ***Aggregate export from PV and other small scale DER sources converges toward a specific energy target,***
- large export-capable systems contributing proportionally more response,
- smaller systems responding naturally within their limits,
- reduced midday oversupply without abrupt curtailment.

Partial participation still delivers material system benefit. How well the DER sources converge on the target provide forecasting for the dispatch solution and could potentially (eventually) result in the metric being based on a "virtual dispatchable block" included in the dispatch solution.

Key Takeaway

The regional energy signal provides **directional guidance** toward the grid balancing regional/subregional DER Energy target.

DER responds by:

- reducing export when supply exceeds demand,
- increasing export only when additional energy is genuinely useful,
- holding steady when conditions are balanced.

This enables decentralised, increasingly stable export shaping **without dispatch, mandates, or specific central control**. This is an opt-in solution that can be incentivised through reduced billing or programs similar to that of SRES. It also eliminates system owner's fear that control of their systems may be taken away.

Appendix C — Proof of Principle: Site-Level Response Using a Retail FiT Signal

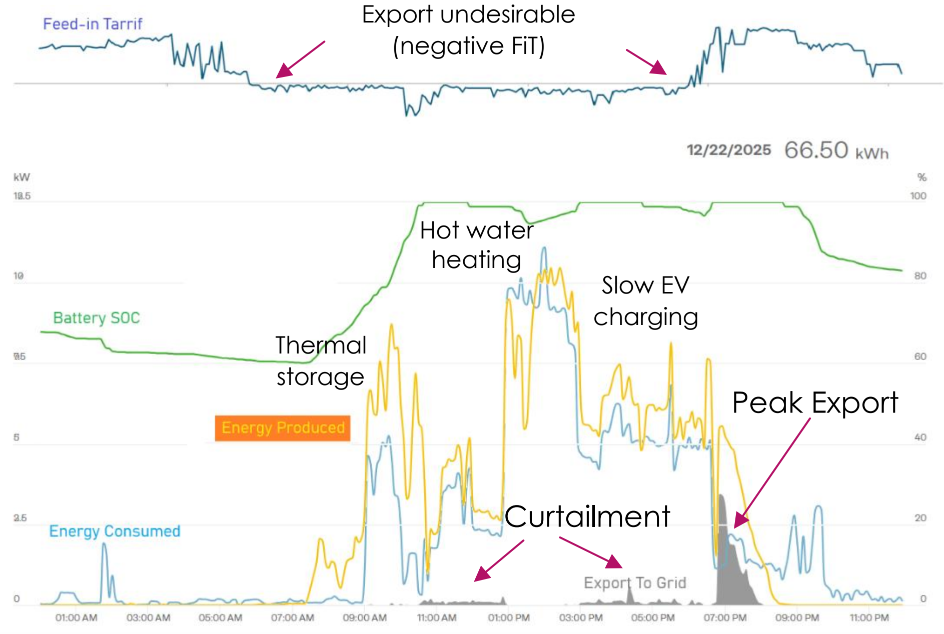
Purpose

This appendix demonstrates a real-world site DER site already using an external signal to manage exports. It shows that export behaviour can be shaped **voluntarily and predictably** using an external economic signal, without inverter dispatch, mandated control, or system-level visibility of site internals.

The example uses a retail **feed-in tariff (FiT)** price signal as a **proxy** for the type of coarse, region-level export desirability signal proposed in this concept note. The purpose is not to optimise revenue, but to demonstrate that export limits applied at the **Point of Common Coupling (PCC)** naturally translate a system-level signal into an appropriate and stable local response — including reducing production where required.

Real World Demonstration

This DER is fitted with "Filled Roof North+West DCU optimised" PV System with thermal and electrical battery storage and EV charging. The plot is for a cloudy Melbourne December day where the FiT is below zero for most of the daylight hours. System maximum production is 10kW and exports are limited to 5kW. A Village Energy Voltello device is used for ***Negative Fit Export Curtailment*** configured to export at most 100W during negative Fit events.



In response to the negative FiT, the site prioritises local absorption of surplus generation through household consumption, battery charging, hot water heating, thermal and battery storage, and electric vehicle charging.

When no local storage or controllable loads are available to absorb the export, **export is constrained to 100W**. Where necessary, this requires the inverter to **reduce (curtail) production** to approximately match on-site consumption, ensuring that no export occurs while the external signal indicates that **exports are undesirable**. This resulted in an approximate **curtailment of 25kWh** for the day lowering the production total from around 90kWh to 65kWh rather than exporting that surplus to the grid when it was not required.

When the spot price of the rises above 0 cents/kWh, exports are again permitted up to the configured PCC export limit. The plot demonstrates that during the evening peak, FiT price returned to the positive indicating **exports were desirable** and DER was able contribute some spare solar production capacity to help reduce the peak. On this particular occasion, the site chose not to export from the battery storage – which of course it entirely up to the site owner how may have had plans for that energy.

While this day was a moderately poor production day for this site due to high curtailment, the resulting behaviour demonstrates that:

- High solar capacity does not imply uncontrolled export.
- Export can be reduced smoothly to zero during periods of low system value.
- Production reduction occurs only after local absorption options are exhausted (energy is not wasted)
- Export resumes automatically when system conditions improve, without manual intervention.

Implications for Regional Aggregation

While this appendix focuses on a single site, the behaviour demonstrated here scales linearly:

- Each site independently responds to the same coarse external signal.
- No coordination or communication between sites is required.
- Export shaping occurs through existing PCC limit and inverter control mechanisms.

At scale, **aggregate export converges** toward system-useful levels over time. From the market operator's perspective, this appears as **predictable, voluntary shaping of small-scale export energy**, achieved without emergency curtailment or intrusive control mechanisms.

Limitations and Further Considerations

This appendix does not explore:

- Security, trust, or resilience of the signal source
- Adversarial, erroneous, or failure scenarios

- Optimal signal construction, governance, or incentive design

These considerations are acknowledged as important and non-trivial, but are **orthogonal to the core proof of principle** demonstrated here: ***that a coarse external signal, applied through existing PCC export limits and inverter controls, is sufficient to produce predictable and system-relevant export behaviour across the grid.***

Appendix D - Incentive and Compliance Framework

Purpose

This appendix outlines a **voluntary incentive and compliance framework** that could support adoption of the proposed region-based energy target mechanism, while avoiding mandatory participation, heavy enforcement, or intrusive control.

The intent is to:

- reward behaviour that aligns with system needs,
- discourage behaviour that undermines agreed outcomes,
- preserve customer autonomy and technology neutrality.

Voluntary Participation Model

Participation in the framework would be **opt-in**, with no obligation on DER owners to participate.

Participants would explicitly agree to:

- receive the regional energy target signal,
- apply a reasonable local response within approved PCC export limits,
- accept basic compliance conditions associated with any incentive received.

Non-participants would continue to operate under existing arrangements with no penalty.

Incentive Design Principles

Any incentive mechanism should adhere to the following principles:

1. **Outcome-based, not prescriptive**
   Incentives reward *results* (export behaviour aligning with system needs), not specific control methods.
2. **Proportionate to contribution**
   Larger export-capable systems naturally receive greater incentive due to their ability to provide more response.
3. **Technology-agnostic**
   PV, storage, thermal discharge, and other small-scale generation are treated equivalently at the PCC.
4. **Time-limited and reviewable**
   Incentives may evolve as system conditions and DER penetration change.

Example Incentive Mechanisms

Several non-exclusive mechanisms could be employed:

1. Retailer-Delivered Incentives

Retailers may:

- offer enhanced FiT structures,
- provide bill credits,
- integrate participation into existing "smart shift" or dynamic pricing programs.

In this model:

- the regional signal defines *system need*,
- the retailer defines *customer reward*.

2. Direct Participation Credits

Participants could receive:

- a fixed availability payment,
- periodic participation credits,
- or credits linked to measured response during oversupply periods.

This approach mirrors existing demand-response incentive structures without requiring dispatch authority.

3. DNSP or Program-Level Incentives

DNSPs or program administrators may:

- fund participation in constrained areas,
- target regions with known export congestion,
- align incentives with network investment deferral objectives.

Compliance Expectations (Light-Touch)

Because participation is voluntary, compliance requirements should be **minimal and proportionate**.

Typical expectations might include:

- maintaining functional PCC export limiting,
- not deliberately defeating the agreed response mechanism,

- avoiding systematic export during clearly signalled oversupply periods.

Importantly:

- **perfect compliance is not required**,
- occasional deviations are acceptable,
- aggregate behaviour matters more than individual events.

Handling Non-Compliance

Where incentives are paid, a **limited penalty framework** may apply to participants who repeatedly act contrary to agreed conditions.

Possible responses include:

- suspension of incentive payments,
- clawback of recent credits,
- removal from the program.

No penalties would apply to:

- non-participants,
- sites experiencing technical faults,
- situations outside participant control.

This ensures the framework remains fair and credible without becoming punitive.

Avoiding Perverse Incentives

The framework explicitly avoids:

- rewarding export during oversupply,
- encouraging deliberate system manipulation,
- incentivising curtailment when local energy use remains beneficial.

Participants are free to:

- prioritise local loads,
- charge storage,
- optimise behind-the-meter behaviour before any export shaping occurs.

Key Takeaway

A voluntary, incentive-led framework can:

- encourage broad participation,
- align DER behaviour with system needs,
- avoid heavy regulation or enforcement,
- scale naturally as DER penetration increases.

By rewarding cooperation rather than mandating control, the proposed mechanism remains flexible, fair, and politically durable.

Appendix E - Implementation Pathways and Adoption Timeline

Purpose

This appendix outlines **practical implementation pathways** for the proposed region-based energy target mechanism and assesses how quickly it could be adopted using **existing DER capabilities**, without requiring new standards, hardware mandates, or centralised control systems.

The intent is to demonstrate that the proposal is not speculative - it is **deployable using today's technology**.

Core Implementation Requirement

At its simplest, participation requires only that a DER system can (as most modern units can):

- enforce an export limit at the Point of Common Coupling (PCC), and
- adjust that limit (or equivalent export behaviour) in response to an external signal.

These capabilities already exist across much of the Australian DER ecosystem.

The System operator does not require any visibility into:

- inverter internals,
- battery state of charge,
- customer load profiles

Implementation Pathways

Multiple, non-exclusive pathways exist for delivering the mechanism.

1. Inverter-Native Integration

Many modern inverters already support:

- PCC export limiting,
- Australian DER / emergency backstop frameworks,
- cloud-connected configuration interfaces.

For these systems, implementation could involve:

- consuming the regional signal via existing cloud infrastructure,
- mapping the signal to an internal export-limit adjustment,
- preserving all existing DNSP and compliance constraints.

This pathway requires only **minimal firmware change** and no additional hardware.

2. Retailer or Aggregator Integration

Retailers and service providers already delivering:

- dynamic FiT structures,
- load-shifting programs,
- customer-facing optimisation services,

could integrate the regional signal as an **input layer**, allowing them to:

- align customer optimisation with system needs,
- harmonise economic and system signals,
- reduce conflicts between retailer incentives and grid outcomes.

In this model:

- the system operator defines *what is needed*,
- the retailer defines *how customers are rewarded*.

3. Third-Party or Standalone Devices

The required functionality is modest:

- basic connectivity,
- simple signal interpretation,
- secure interaction with an inverter or export-limiting interface.

Such functionality could be delivered by:

- low-cost standalone devices,
- retrofit modules,
- or embedded controllers,

at very low cost and with minimal installation complexity.

This pathway enables:

- rapid retrofitting of existing systems lacking retailer or manufacturer control mechanisms,
- participation without inverter replacement,
- technology-neutral access.

From a hardware perspective, the implementation of a third-party export-control or energy-target compliance device presents a very minimal material cost or technical barrier.

Comparable Wi-Fi–enabled controller hardware (based on pre-approved, extra-low-voltage ESP32 platforms) has been demonstrated at very low production volumes with assembled board costs in the order of AUD **$15 per unit**. At moderate production scale, these costs reduce substantially, making a **fully packaged standalone device in the order of ~AUD $20 per unit** both realistic and defensible.

Additional costs associated with enclosure, power supply, and basic functional testing are modest, particularly where the device operates entirely within extra-low-voltage limits and leverages existing certified radio and power modules. As such, hardware cost and deployment complexity are not limiting factors for the rapid adoption of third-party devices capable of supporting export management or energy-target signalling frameworks. Brand and model compatibility stands as the greatest impediment.

Incentives programs for end user uptake (similar to the LED conversion programs of the past) and incentives for manufacturers to integrate legacy models with these units would be easily justifiable under many renewable incentive programs.

4. Hybrid Approaches

In practice, deployment is likely to involve a **mix** of the above:

- inverter-native where available,
- retailer-led where commercial incentives exist,
- third-party devices for legacy systems.

The framework is intentionally agnostic to delivery method.

Adoption Speed and Market Dynamics

Adoption could occur **rapidly** due to several reinforcing factors:

1. Low Technical Barrier

- No new grid connection processes required
- No changes to DNSP limits
- No complex control logic
- No high-cost hardware

This makes trials and pilots straightforward.

2. Strong Economic Alignment

Participants benefit from:

- avoiding negative-value exports or benefit from participation incentives,
- improving utilisation of local generation,
- aligning export with periods of genuine system value.

Retailers benefit from:

- reduced exposure to negative wholesale pricing,
- better-aligned customer behaviour.

3. Competitive Pressure

The DER market is highly competitive.

Once one pathway demonstrates:

- improved customer outcomes, or
- preferential treatment or incentives,

other vendors, retailers, and integrators are strongly incentivised to follow.

This dynamic has historically driven **fast feature parity** in inverter and DER markets.

Evidence of Existing Capability (Non-Exhaustive)

Several DER platforms operating in the Australian market already implement **substantially similar functionality** to that required by the proposed mechanism, demonstrating that the technical foundation is mature and widely deployed.

Examples include:

- **DNSP Flexible Export / Dynamic Export / Emergency Backstop programs**, where approved inverters act as the *sole export controller* at the Point of Common Coupling and respond to external instructions issued under Australian DER frameworks (e.g. IEEE 2030.5 / CSIP-AUS) (eg Energy QLD Ergon/Energex Dynamic Export).
- **Inverter-native cloud control platforms**, which allow authenticated, installer- or utility-authorised adjustment of export behaviour, including temporary reduction or suppression of export, without altering site generation capability or customer load operation (eg Fronius Cloud control).
- **Retailer-led optimisation programs**, where export behaviour (including battery discharge to grid) is shaped dynamically in response to wholesale pricing, network conditions, or program incentives (Eg Amber SmartShift). These programs already reconcile:
  - customer economic outcomes,
  - storage operation,
  - and export control.
- **Third-party controller devices**, which operate independently of inverter manufacturers and provide export shaping by interfacing with PCC controls, often with deeper optimisation than is required for the proposed mechanism (eg Village Energy, Catch Control, Zeco Marshall).

These examples demonstrate that:

- export control at the PCC is already a solved problem,
- secure remote authorisation models already exist,
- and customer-facing deployment has proven acceptable at scale.

The proposed regional energy target signal does **not** require any of these systems to change their fundamental operation - it simply provides a **clearer, system-level input** for decisions they already make.

Incremental Participation Is Valuable

The mechanism delivers benefit even with:

- partial participation,
- uneven geographic uptake,
- mixed technology support.

This allows adoption to begin immediately and improve over time without a "big bang" rollout.

Indicative Adoption Timeline (Illustrative)

Phase	Timeframe	Description
Concept validation	0–12 months	Signal definition, limited trial, observation only
Early adoption	3–12 months	Inverter / retailer / third-party integration begins (probably concurrently with conceptual validation)
Broad availability	1–3 years	Feature becomes standard in new DER systems, formalised in existing systems with firmware updates
Normalised operation	3+ years	Export shaping considered routine behaviour

This timeline is **significantly shorter** than alternatives involving new standards, mandates, or dispatch mechanisms.

Key Takeaway

The proposed mechanism can be:

- implemented using existing DER capabilities,
- delivered through multiple competitive pathways,
- adopted incrementally without system risk.

Its simplicity and alignment with existing incentives make **rapid uptake not only possible, but likely**, particularly as export-constrained, high-generation sites become the norm.

Appendix F - Market Interaction and the Aggregate DER (“Virtual DUID”) Effect

Purpose

This appendix addresses a key market-design nuance associated with the proposed region-based energy target mechanism:

> whether publishing such a target could, in effect, behave like the dispatch of a very large aggregate supply unit, and whether this raises concerns regarding market neutrality or participant impacts.

This issue is subtle, material, and warrants explicit consideration.

The Aggregate DER Reality in the NEM and WEM

In several NEM regions - particularly Queensland, South Australia, and Victoria - small-scale solar generation already represents a **dominant source of daytime energy**.

In operational terms, this means:

- rooftop PV and similar small-scale generation already behave as a **large, non-dispatchable aggregate supply block**, and
- dispatchable generators already compete for the **residual demand** remaining after its contribution.

This aggregate supply block exists today regardless of any coordination mechanism.

The Existing “Virtual DUID” Effect

From a market perspective, aggregate small-scale generation already functions as a *de facto* “virtual DUID”:

- it is non-biddable,
- price-insensitive at the individual unit level,
- weather-driven,
- and only probabilistically forecastable.

Dispatchable market participants already experience its effects through:

- compressed or negative daytime prices,
- steep ramping requirements,
- sudden changes in residual demand,
- and increasing reliance on emergency or corrective interventions.

The absence of an explicit coordination mechanism does not prevent these impacts - it simply makes them **less predictable**.

What the Proposed Mechanism Changes

The proposed regional energy target does **not** introduce a new supply block into the market.

Instead, it:

- provides a **clearer description** of the intended envelope of an aggregate supply block that already exists,
- reduces uncertainty around its contribution,
- and enables voluntary convergence of export behaviour toward that envelope.

Critically:

- no dispatch instructions are issued,
- no participant is compelled to respond,
- no bids, offers, or prices are set,
- and no individual generator is targeted or constrained.

The signal is **informational**, not operational.

Dispatch Versus Description

While the proposed signal may have dispatch-like *consequences* at an aggregate level, it is not dispatch in a legal, operational, or market-design sense.

The distinction is important:

- **Dispatch** determines who must generate and in what quantity.
- **Description** clarifies the expected contribution of non-dispatchable resources.

AEMO already publishes information - including forecasts, pre-dispatch schedules, and system need indicators - that materially influence market behaviour.
This proposal extends that informational role to a component of the system that has historically been treated as opaque.

Market Neutrality and Participant Impact

By reducing uncertainty rather than imposing control, the mechanism improves market neutrality:

- residual demand profiles become clearer,
- ramping risk is reduced,
- risk premiums embedded in bids may fall,
- emergency interventions become less frequent.

Rather than favouring any participant class, the mechanism improves **predictability**, which benefits efficient operators across technologies.

Transition Considerations

A more predictable small-scale contribution supports an orderly energy transition by:

- reducing forced cycling and uneconomic operation of legacy units,
- allowing more efficient utilisation during remaining operating life,
- improving planning conditions for firming, storage, and future low-carbon capacity.

This does not delay transition; it enables it to occur with **lower system risk and lower cost**.

Key Takeaway

The proposed regional energy target does not compete with dispatched generation.

It defines the envelope within which non-dispatchable generation already operates.

By replacing assumption and guesswork with coordination, the mechanism improves efficiency, stability, and transparency without expanding AEMO's role beyond its existing information and coordination mandate.

Appendix G – Sub-Regional Definition and DNSP Involvement

Purpose

This appendix clarifies how **sub-regional boundaries for the proposed export-energy signal could be defined**, and why **DNSP participation is both natural and beneficial** to the long-term efficiency of the distribution network.

Role of DNSPs in Sub-Regional Definition

While AEMO is well placed to assess system-level and regional conditions, **DNSPs are uniquely positioned to identify localised export constraints** that are not visible at broader regional granularity.

In practice:

Local oversupply issues often arise **within small sections of an otherwise healthy sub-region**.

- Voltage rise, thermal limits, or feeder-level congestion may occur even when aggregate regional demand remains strong.
- These constraints are already known to DNSPs through operational experience, monitoring, and connection studies.

Under the proposed framework, **DNSPs could assist in defining logical sub-regions** that reflect:

- feeder groupings,
- constrained zones,
- known weak sections of the network,
- or areas targeted for future augmentation.

This allows the published export-energy signal to more accurately reflect **where export is genuinely useful**, and where restraint is preferable.

System and Network Benefits

Incorporating DNSP-informed sub-regional signals offers several long-term benefits:

Targeted export shaping

Export reduction is focused where it is actually needed, rather than applied broadly across an entire region.

Improved network planning visibility

Persistent reliance on export suppression in a given sub-region becomes a **clear indicator of latent network capacity constraints**, helping DNSPs prioritise upgrades.

Efficient capital allocation

Network investment can be directed toward areas where increased export would unlock meaningful additional energy value, rather than defaulting to large-scale upstream transmission expansion.

Better utilisation of existing infrastructure

Controlled export shaping reveals how much additional energy the existing network *could* accommodate if local constraints were addressed.

Relationship to Partial DCU and Latent Capacity

Observed behaviour at test sites highlights this opportunity clearly.
Monitoring the curtailed production and export capacity of the test sites suggests strongly that **substantial latent capacity exists in parts of the local network** - albeit unmanaged and unsuitable for routine operation today.

With:

- PCC-based export control,
- sub-regional awareness,
- and Partial DCU-style designs becoming more common,

this latent capacity could be **safely and progressively unlocked** through targeted DNSP upgrades, rather than relying exclusively on distant large-scale generation and high-capacity transmission infrastructure.

Key Takeaway

DNSP involvement in defining sub-regional export-energy signals:

- improves accuracy,
- reduces unnecessary restriction,
- supports smarter network investment,
- and enables a more distributed, resilient energy transition.

The proposed mechanism therefore acts not only as a coordination tool, but also as a **long-term planning signal** for both system operators and network businesses.