Accelerating Market Integration of Renewables in Armenia: The Flexibility and Active Consumer Imperative

Status Quo, Regulatory Gaps, and Policy Roadmap for the Clean Energy Transition in Armenia

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Armenia's Energy Security and RES Ambition

The Dual Imperative: Security and Decarbonization

- **High Energy Security Risk:** Approximately 70% of electricity production relies on fuel imported from a single external source (gas for thermal, and nuclear fuel). This creates significant supply vulnerability.

- **Strategic Pivot to Indigenous RES:** The government's Energy Strategy mandates maximizing the use of domestic resources.

- **RES Targets:** One of core goals is the integration of up to **1 GW of solar capacity by 2030**.

System Size Context: Armenia's typical peak load is approximately 1,300 MW. The planned 1 GW of solar capacity represents a monumental shift in generation profile.

Market Liberalization

Legal Scheme: New Market Structure and Flexibility Segments Absence of large-scale storage and flexible generation

- **Challenge:** Transitioning from a monopolized, regulated single-buyer model to market-based model.
- **Solution:** New wholesale market structure began operating in 2022, including three critical segments for flexibility:

1. **Day-Ahead Market (DAM):** For short-term price signals and physical scheduling.

2. **Balancing:** For real-time system balance, managing RES deviation, and deviation compensation.

3. **Ancillary Services (AS):** For technical stability, frequency control, and fast reserve.

System Flexibility and Regulation

- **Enhancing Operational Flexibility** – optimizing hydropower scheduling, expanding storage options, and increasing system responsiveness to variable generation.

- **Regulatory Framework Updates** – introducing new provisions for energy storage, aggregator participation, and active consumer engagement in the electricity market.

- **Balancing and Ancillary Services Development** – strengthening mechanisms for reserve management and frequency control to ensure stable operation under higher renewable penetration, and introducing balancing market.

- **Integration with Market Platforms** – preparing rules for day-ahead, intraday, and balancing services in coordination with regional partners.

Addressing Legal Gaps for Decentralized Flexibility

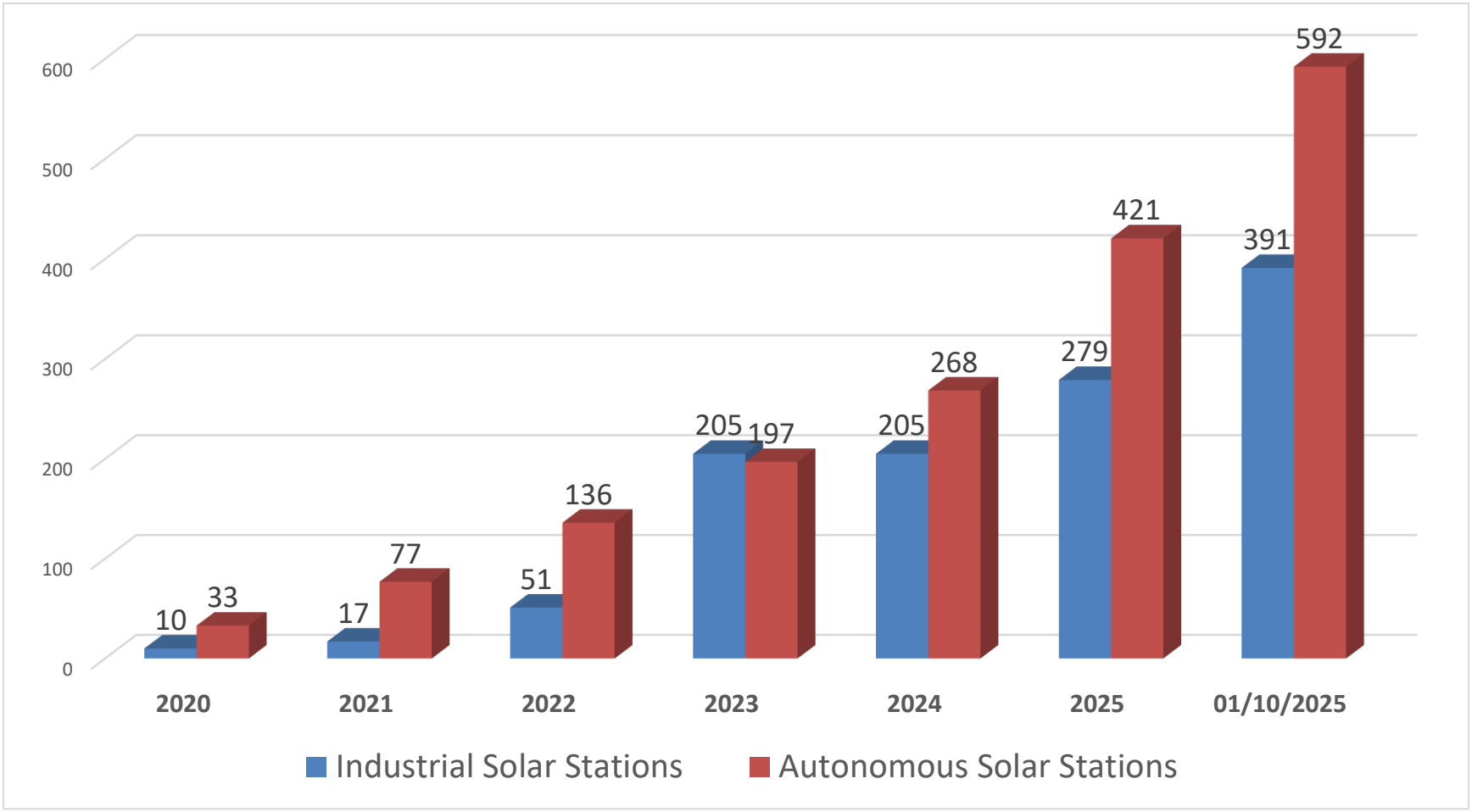
The Active Consumer Gap: Empowering Energy Communities and Demand Response

- **Existing Framework - "Autonomous Power Producer" (Prosumer):** Currently defined under the Law on Electricity as a consumer producing electricity for their own needs using RES, operating under a net metering contract. This is a passive role.

- **Regulatory Gap - Active Consumers, Aggregators & Energy Communities:** Armenia lacks explicit legal definitions and frameworks for these entities. Without legal standing, small-scale distributed flexibility cannot be aggregated or participate commercially in the new markets.

- **Steps Taken – The new Law on Electricity:** Legally defines and empowers **Active Consumers»** and **«Aggregators»** to enable collective investment and commercial participation in flexibility markets, though it does not establish frameworks for **«Energy Communities».**

INSTALLED CAPACITY OF SOLAR PV STATIONS BY MW



Technical Scheme 1: Digitalization and Demand Response

Unlocking Latent Flexibility: Smart Meters and Dynamic Compensation

- **Smart Meter Penetration:** Approximately 70% of the nearly one million customers of the distribution company (ENA) already have smart meters. However, only 65% of them have the required software fully activated.

- **Underutilization Challenge - Untapped Potential:** Little systemic use has been made of the smart meter data to develop dynamic tariffs (e.g., Time-of-Use pricing) or incentivize Demand Response (DR). This means a key flexibility tool is currently inactive.

- **Possible Policy Steps:** After full activation of all smart meters the decision must be issued to mandate the use of smart meter data for DR and establish time-varying tariffs during daytime.

Storage, Aggregation and Flexibility Planning

- **Energy Storage Development** – planning development of battery storage solutions to improve balancing capabilities and optimize renewable integration.
  - **Pilot Project – Armenia: Energy Storage & Grid Flexibility -** Armenia is preparing to launch its first **pilot battery storage projects:** 30 MW / 120 MWh configuration has been identified as viable for the near-term.

- **Reactive Power Support Equipment** – considering capacitor banks, synchronous condensers, and other voltage-support technologies to strengthen grid stability and power quality.
  - The national distribution company (ENA) is implementing a **reactive power compensation programme**, including the deployment of capacitor banks across major substations.

Technical Scheme 2: Energy Storage Systems (ESS)

The Role of Batteries: Regulatory Clarity and Ownership Models

- **Regulatory Status – Developing Definitions:** The new draft Law on Electricity has the definition of energy storage. According to the draft, the ESS can buy and sell electricity on the market, provide storage and other services to market participants. According to the draft law, ESS have equal, non-discriminatory access to the market as wholesale trade participants and ancillary service providers (e.g., frequency response).

- **Ownership – TSO/DSO vs. Market Participation:** A key hurdle on whether the TSO/DSO should own and operate market-facing storage assets is solved in the new draft Law. It mandates strict legal and functional **unbundling** for any TSO/DSO-owned ESS. This will preserve market competition and prevent the TSO/DSO from undermining private investment in flexibility assets.

The Regional Flexibility Buffer

System Resilience: Interconnectivity and Regional Trade

- **Strategic Goal -** The ongoing construction of 400 kV transmission line to **Iran** will significantly expand the country's export capabilities, enabling large-capacity electricity flows to its southern neighbour. Another project is underway to build a new power line which will significantly increase cross-border energy capacity and facilitate energy trade and market coupling with **Georgia**.

- **Function as Flexibility - Regional Trade as a Buffer:** Increased trade capacity provides the highest level of systemic flexibility for Armenia's small grid.
  1. **Import Capacity:** Can provide rapid balancing power during domestic RES shortfalls.
  2. **Export Capacity:** Allows for the efficient export of surplus solar power.

- **Policy Steps –** The new law will adopt key rules necessary to maximize opportunities for electricity trading with neighboring systems. Commercial and operational rules will be further developed.

Summary of Priority Policy Actions

Roadmap for Flexibility Activation

- **Legal and Regulatory Activation –** Adoption of the new **Law on Electicity** and development of **Secondary Legislation**. The regulation must be designed to accommodate the aggregation of small-scale distributed resources, ensuring that active consumers, batteries, DR, and energy communities can participate efficiently.

- **Digital Activation -** Develop **Dynamic Tariffs & Fees** and **Demand Response** utilizing smart meter data.

- **Grid Modernization and Flexibility Investments** – Expansion of transmission capacity to neighboring countries, digital monitoring, and deployment of storage and reactive power support systems.

- **Market Integration and Cross-Border Cooperation** – Alignment of market rules with regional partners, participation in coordinated power exchanges, and the **introduction of a Green Certificate (Guarantee of Origin) scheme** to verify renewable origin and facilitate compliance and regional trading.

- **Energy Storage (ESS) –** Development of battery storage solutions, in addition to the pilot project. The rules should prioritize independent market access for investor-owned ESS (as wholesale traders and balancing providers) and mandate strict legal and functional unbundling for any TSO-owned assets to preserve market competition.

Thank you for your attention

We look forward to working with our partners to implement our critical reforms in electricity sector.